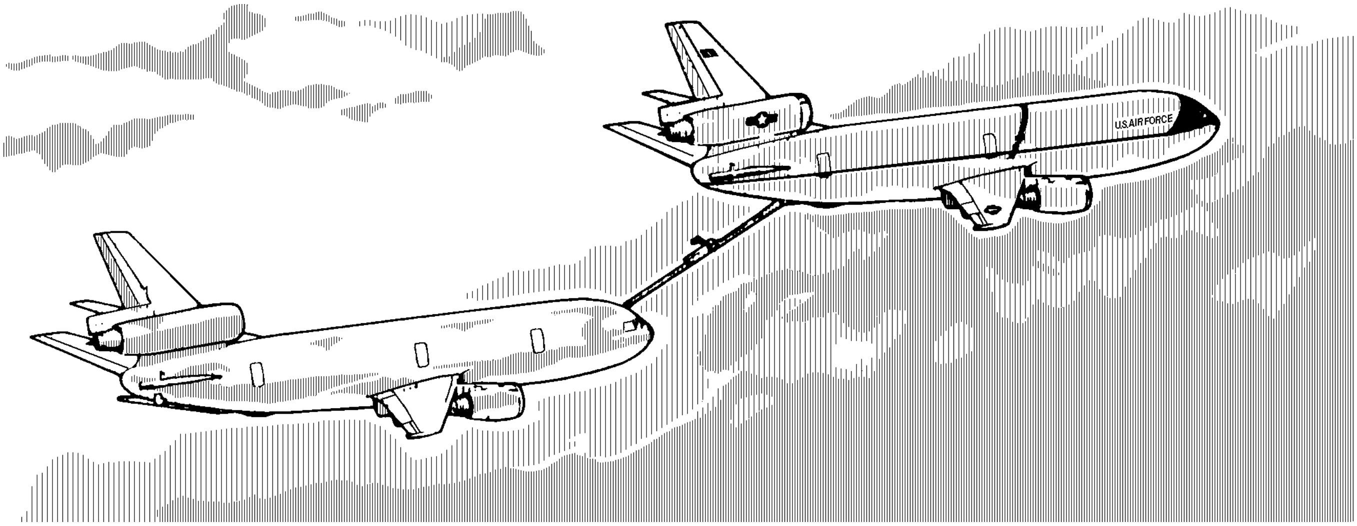
TO 1C-10(K)A-1
VOLUME 1

FLIGHT MANUAL

USAF SERIES
KC-10A
AIRCRAFT



Prepared by HEBCO, INC.
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Refer to Technical Order Index TO 0-1-1-3 or https://toindex-s.robins.af.mil/toindex for current status of flight manuals, safety and operational supplements, and applicable checklists.

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C 6 APRIL 2001
CHANGE 8 15 JANUARY 2008

LIST OF EFFECTIVE PAGES

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NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands.

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KC-10A
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▮ Indicates that the Government has UNLIMITED RIGHTS to 100 percent of that line-item.

ATA Chapter	Description of Systems to which the Government has UNLIMITED RIGHTS
◩ 21-00	Modifications to the Environmental Control System including:
◩ 21-24	Galley, lavatory, aerial refueling operators (ARO) ventilation, and ARO avionics rack
◩ 23-00	Modifications to the communications system, including the addition of:
▮ 23-25	UHF communications system
▮ 23-25-3	UHF COMM/NAV-50
▮ 23-26	UHF satellite communications and AFSATCOM
▮ 23-51	Flight interphone
▮ 23-53	Secure voice
▮ 23-55	Iridium phone
◩ 25-00	Modifications to the interior, including:
▮ 25-19	Environmental curtain and crew rest bunks
▮ 25-21	Seat pallets
◩ 25-52	Cargo handling system
▮ 25-58	ARO Compartment Equipment Racks
▮ 25-90	ARO station in lower aft fuselage
▮ 25-91	ARO seats
◩ 28-00	Modifications to the Fuel System, including:
▮ 28-21	Tank refueling and defueling system, forward and aft fuselage tanks, isolation valve, and transfer valve
▮ 28-22-5	Addition of forward and aft fuselage fuel supply tanks
▮ 28-22-6	Addition of wing tip fuel pumps for tip tank transfer
▮ 28-25	Fuel shroud drain
▮ 28-51	Hydraulic alternate supply - auxiliary system for aerial refueling
▮ 28-52	ARO viewing door actuation
▮ 28-60	Aerial refueling system
▮ 28-61	Fuel supply for aerial refueling
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▮ 28-63	Aerial refueling pump low-pressure control
▮ 28-64	Aerial refueling offload fuel flow indicator
▮ 28-65	Refueling scavenging system
▮ 28-70	Aerial refueling boom installation, boom control system, and boom control unit
▮ 28-71	Boom mechanical system
▮ 28-72	Boom flight control and actuation systems
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▮ 28-77	AR Pilot's director display and boom marker lighting
▮ 28-78	Boom stowage and hoist system
▮ 28-79	Nozzle pneumatic disconnect and indicator system
▮ 28-81	Aerial refueling hose and drogue installation
▮ 28-85	Aerial refueling hose and drogue lighting
▮ 28-86	Boom post FOT&E
▮ 28-91	Universal aerial refueling receptacle slipway installation (UARRSI)
▮ 28-95	Aerial refueling receiver lighting and UARRSI lighting

- ◪ 31-00 Modifications to instruments:
  - ▮ 31-15 ARO compartment panels including boom operators instrument panel and overhead ARO instrument panel

- ◪ 33-00 Modifications to lighting systems, including:
  - ▮ 33-15 ARO refueling display and instrument panels lighting
  - ▮ 33-45 Anticollision and rendezvous lights
  - ▮ 33-49 Wing lights and fuselage lights
  - ▮ 33-49-1 Formation lights
  - ▮ 33-49-2 Aerial refueling underbody lights
  - ▮ 33-61 ARO instrument and panel lights
  - ▮ 33-62 ARO compartment lights

- ◪ 34-00 Modifications to navigation systems, including:
  - ▮ 34-21-4 TACAN radio magnetic indicators
  - ▮ 34-54 IFF transponder
  - ▮ 34-56 TACAN
  - ▮ 34-58 UHF ADF
  - ▮ 34-59-1 I-Band beacon
  - ▮ 34-59-2 J-Band beacon

- ◪ 35-00 Modifications to oxygen systems, including:
  - ▮ 35-10 Crew oxygen supply system
  - ◪ 35-20 Passenger oxygen system excluding chemical oxygen generator

- ◪ 36-00 Modifications to the pneumatics systems, including:
  - ▮ 36-23 Manifold failure detection system

- ◪ 51-00 Structural modifications to the DC-10 to accommodate the above systems and stations, including:
  - ▮ ARO Compartment
  - ▮ Forward/aft fuselage tanks
  - ▮ UARRSI
  - ▮ Attachments for barrier nets
  - ▮ Boom installation
  - ▮ Drogue installation
  - ▮ Aerial refueling system
  - ▮ Revised aft cg position

- ◪ 52-00 Doors
  - ▮ 52-49 ARO sighting door
  - ▮ 52-57 ARO compartment door
  - ▮ 52-60 Crew exit/entry ladder and crew walkways

- ◪ 53-00 Fuselage
  - ▮ 53-54 ARO and boom fairings

- ◪ 56-00 Windows
  - ▮ 56-44 ARO scanning windows and mirrors

LEGEND:

▯ Indicates that the line-item is not applicable.

◪ Indicates that the Government has UNLIMITED RIGHTS to a portion of that line-item.

▮ Indicates that the Government has UNLIMITED RIGHTS to 100 percent of that line-item.

STATUS PAGE

This page contains a listing of the related Operational and/or Safety Supplements that currently affect the Flight Manual on the date of this publication.

CURRENT SAFETY AND OPERATIONAL SUPPLEMENTS	DATE	SHORT TITLE

SAFETY AND OPERATIONAL SUPPLEMENTS INCORPORATED IN THIS CHANGE	DATE	SHORT TITLE
TO 1C-10(K)A-1S-162	1 Feb 06	Russian TS-1 Fuel

RESCINDED SAFETY AND OPERATIONAL SUPPLEMENTS	DATE	SHORT TITLE

SCOPE. This manual contains the necessary information for safe and efficient operation of your aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal, abnormal and emergency operating procedures.

Your experience is recognized; therefore, basic flight principles are avoided. Instructions in this manual are prepared to be understandable by the least experienced crew that can be expected to operate the aircraft unsupervised. This manual provides the best possible operating instructions under most circumstances, but it is not a substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc. may require a modification of the procedure.

PERMISSIBLE OPERATIONS. The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance from the using command must be obtained before any questionable operation, which is not specifically permitted in this manual, is attempted.

HOW TO BE ASSURED OF HAVING LATEST DATA. Refer to TO 01-1-3 or https://toindex-s.robins.af.mil/toindex for a listing of all current flight manuals, safety supplements, operational supplements, and checklists. Also check the Flight Manual cover page, the title block of each safety and operational supplement, and all status pages attached to formal safety and operational supplements. Clear up all discrepancies before flight.

ARRANGEMENT. This manual is divided into fairly independent sections to simplify reading it straight through or using it as a reference manual. All sections must be read thoroughly and fully understood for safe and efficient aircraft operation.

SAFETY SUPPLEMENTS. Information involving safety will be promptly forwarded to you in a safety supplement. Urgent information is published in interim safety supplements and transmitted by teletype. Formal supplements are mailed. The supplement title block and status page (published with formal supplement only) should be checked to determine the supplement’s effect on the manual and other outstanding supplements.

OPERATIONAL SUPPLEMENTS. Information involving changes to operating procedures will be forwarded to you by operational supplements. The procedure for handling operational supplements is the same as for safety supplements.

CHECKLISTS. This manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplification. Primary line items in the flight manual and checklist are identical. If a formal safety or operational supplement affects your checklist, the affected checklist page will be attached to the supplement. Retain until superseded.

HOW TO GET PERSONAL COPIES. Each flight crew member is entitled to personal copies of the Flight Manual, Safety Supplements, Operational Supplements and Checklists. The required quantities should be ordered before you need them to assure their prompt receipt. Check with your publication distribution officer - it is his job to fulfill your TO requests. Basically, you must order the required quantities from the Numerical Index and Requirement Table (NIRT). TO 00-5-1 gives detailed information for ordering these publications. Make sure a system is established at your base to deliver these publications to the flight crews immediately.

MANUAL BINDERS. Loose-leaf binders are available for use with your manual. They are obtained through local purchase procedures and are listed in the Federal Supply Schedule (FSC Group 75, Office Supplies, Part 1). Check with your local supply personnel for assistance in procuring these items.

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

WARNING

Operating procedures, techniques, etc., which could result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, techniques, etc., which could result in damage to equipment if not carefully followed.

NOTE

An operating procedure, technique, etc., which is considered essential to emphasize.

SHALL, WILL, SHOULD, AND MAY. The following definitions apply to the words shall, will, should, and may.

SHALL or WILL	-	The instructions or procedure prefaced by shall or will are mandatory.
SHOULD	-	Normally used to indicate a preferred but nonmandatory method of accomplishment.
MAY	-	An acceptable or suggested means of accomplishment.

YOUR RESPONSIBILITY - TO LET US KNOW. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual Program are welcome. These should be forwarded on AF Form 847 as directed by AFI 11-215 through your Command Headquarters to 544 ACSS, Tinker AFB, 73145-3018.

TABLE OF CONTENTS

INTRODUCTION

GENERAL

■ The KC-10 Flight Manual contains eight sections.

The content of each section is described in detail as follows:

Section I - Systems Description

The Systems Description is presented within section I starting with Aircraft General followed by major subject.

Each subject is subdivided in relation to the type of material being presented. This information is flight crew oriented with the description designed to support the procedures. Primary emphasis is on the end result of the operation of a control or unit or required operation by the crew, rather than a description of how the system operates.

Descriptive text is used to support the functional diagrams, but only when necessary for complete understanding. Functional diagrams are used to show what happens when a control is actuated rather than to illustrate how the system works. When used, the diagram illustrates a normal operational condition that will be meaningful to the flight crew. Where primary diagrams are used in conjunction with diagrams of subsystems, the relationship between the main system and the subsystem is identified by the consistency of layout and use of common symbols and colors.

Emergency Checklist Procedures

A crewmember detecting an existing or impending emergency condition will immediately inform the pilot.

The pilot will take necessary action to establish and/or maintain control of the aircraft and call for the appropriate checklist. On this command, the crewmember(s) designated on the checklist will accomplish their memory (bold type) items.

The engineer will then read aloud in sequence each checklist item including the response, starting with the memory items.

Following the reading of a memory checklist item the designated crewmember will confirm that the item was accomplished and call out the response. Example: (FE) "Fuel Lever..."OFF". The pilot checks that fuel lever is in OFF and responds: "OFF".

As each non-memory item requiring a response is read aloud, the designated crewmember will perform the required action and call out the response when the action is completed. Example: (FE) "AP Levers OFF". The pilot disengages the autopilot and responds: "OFF".

Applicable items of amplification on the abbreviated checklist should also be read aloud. The appropriate crewmember will acknowledge the item with a suitable response. Example: (FE) "Crosswind limitation 15 knots". The pilot will acknowledge with a phrase such as, "Understand 15 knots" or "Roger 15 knots."

Upon completion of a checklist, the engineer reading will announce "_____ CHECKLIST COMPLETED".

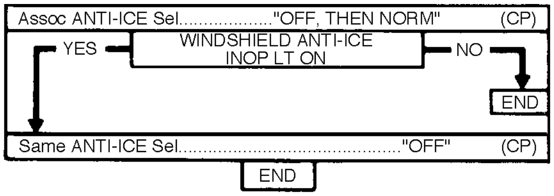
Section II - Emergency Procedures

All Emergency Procedures regardless of system, are presented in this section.

Format is identical to that described for Abnormal Procedures. Memory items are in bold type and boxed.

Section IIA - Abnormal Procedures

Throughout the abnormal procedures, the following YES/NO logic will be used (when necessary) to indicate a procedure decision path:



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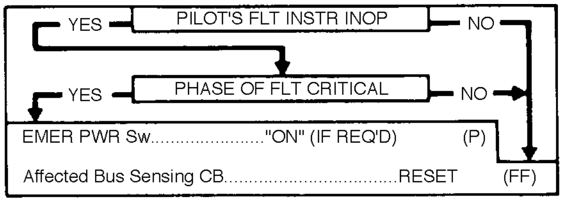
The operator must observe an indication or condition and select the appropriate answer (YES or NO). The operator will then follow the appropriate arrow to the next step in the procedure. In some cases the procedure may continue to branch out or connect with another arrow as follows:



SA1-543

All procedures continuing to another page will be identified by CONTINUED block(s).

Abnormal Procedures are written with the assumption that, in addition to the steps listed, the circuit breakers (if applicable) have been checked and are not a factor. Also, these procedures consider single problems only, and if more than one problem exists, the crew is responsible for establishing the priority of action.

Section III - Limitations

This section contains certification and warranty limitations governing operation of the aircraft. Only those limitations of interest to the flight crew will be given. Performance limitations which are contained in other parts of the manual shall only be referenced.

Section IV - Normal Procedures

This section contains detailed procedures for conducting a normal flight with all aircraft systems operational. Procedures are listed by phase-of-flight, starting with flight preparation and exterior safety inspection, and extending through post-flight duties at destination.

Line items which define the steps to be accomplished during each phase of flight are amplified to define the action required to perform the step.

Section V - Mission Preparation

This section is divided into two subsections, 1; Crew Duties, and 2; Operating Techniques. Crew Duties contains rules and procedures required for operation of the KC-10A. Instructions contained here do not include information covered elsewhere. Operating Techniques shall contain the procedures and techniques for operating at varying conditions of takeoff, enroute climb, descent, approach, landing and automatic flight.

Section VI - Flight Characteristics

This section contains information concerning stall and stability characteristics.

Section VII - Adverse Weather Conditions

This section contains information concerning hot and cold weather operation and other unusual weather conditions.

Section VIII - Receiver/Tanker Refueling

This section contains specific information concerning KC-10 air refueling operations. The section addresses refueling operations from both the KC-10 tanker and KC-10 receiver perspective. Section VIII is divided into four subsections, 1. General Operations, 2. Rendezvous Procedures, 3. Receiver Air Refueling Procedure, and 4. Tanker Air Refueling Procedures.

SECTION I

SYSTEMS DESCRIPTION

TABLE OF CONTENTS

PART 1

AIRCRAFT GENERAL

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

AIRCRAFT GENERAL

AIRCRAFT GENERAL DESCRIPTION

The USAF Series KC-10A Extender aircraft manufactured by McDonnell Douglas Corp., is a swept-wing tri-jet monoplane designed for refueling military aircraft and airlifting cargo and support personnel. The aircraft has fully retractable tricycle landing gear with a load bearing center gear and is powered by three interchangeable General Electric CF6-50C2 high bypass ratio turbofan engines. Each engine is flat rated at 52,500 pounds static takeoff thrust at sea level up to 86° F (30° C). The KC-10A is capable of operating at altitudes up to 42,000 feet. A fan thrust reverser system is installed for each engine. In addition to being equipped for air refueling military aircraft requiring either a boom or hose/drogue, the KC-10A may be air refueled from another KC-10A or a suitably equipped tanker aircraft.

The KC-10A has been equipped with a Rockwell Collins flight management system (FMS-800) incorporating global positioning system (GPS) navigation receivers. The FMS also provides functional control of the aircraft's three inertial navigation units (INUS), the TACAN and ADF navigation radios, and the IFF. Additionally, the electromechanical HSI is replaced by a Rockwell Collins FDS-255 electronic horizontal situation indicator (EHSI) to improve situational awareness.

AIRCRAFT DIMENSIONS

Exterior dimensions and ground clearances are shown in figure 1.1-1. A diagram of aircraft compartments is shown in figure 1.1-2 and a typical mixed passenger/cargo configuration is shown in figure 1.1-3. Turning radius is shown in figure 1.1-4, servicing diagram is shown in figure 1.1-5, and engine danger areas are shown in figure 1.1-6.

AIRCRAFT GROSS WEIGHT

The design maximum takeoff gross weight of the KC-10A aircraft is 590,000 pounds and the normal maximum landing gross weight is 436,000 pounds. Maximum gross ramp/taxi weight is 593,000 pounds. The maximum zero fuel weight is 414,000 pounds. For additional weight information refer to current KC-10A weight and balance manuals.

INTERIOR ARRANGEMENT

The aircraft interior is designed to accommodate a Pilot, Copilot, Flight Engineer, and Boom Operator in the flight compartment. An additional seat on the aft bulkhead of the flight compartment is provided for an extra crewmember/observer. Twenty removable seats are located immediately aft of the flight compartment. Six of these are provided for extra crewmembers and fourteen for support personnel.

In addition to these seats, complete provisions may be installed to accommodate 55 additional passengers/support personnel. The air refueling operator's (ARO) compartment will accommodate a boom operator, an instructor boom operator, and an observer/trainee during refueling operations. The ARO compartment will not be occupied during takeoff and landing.

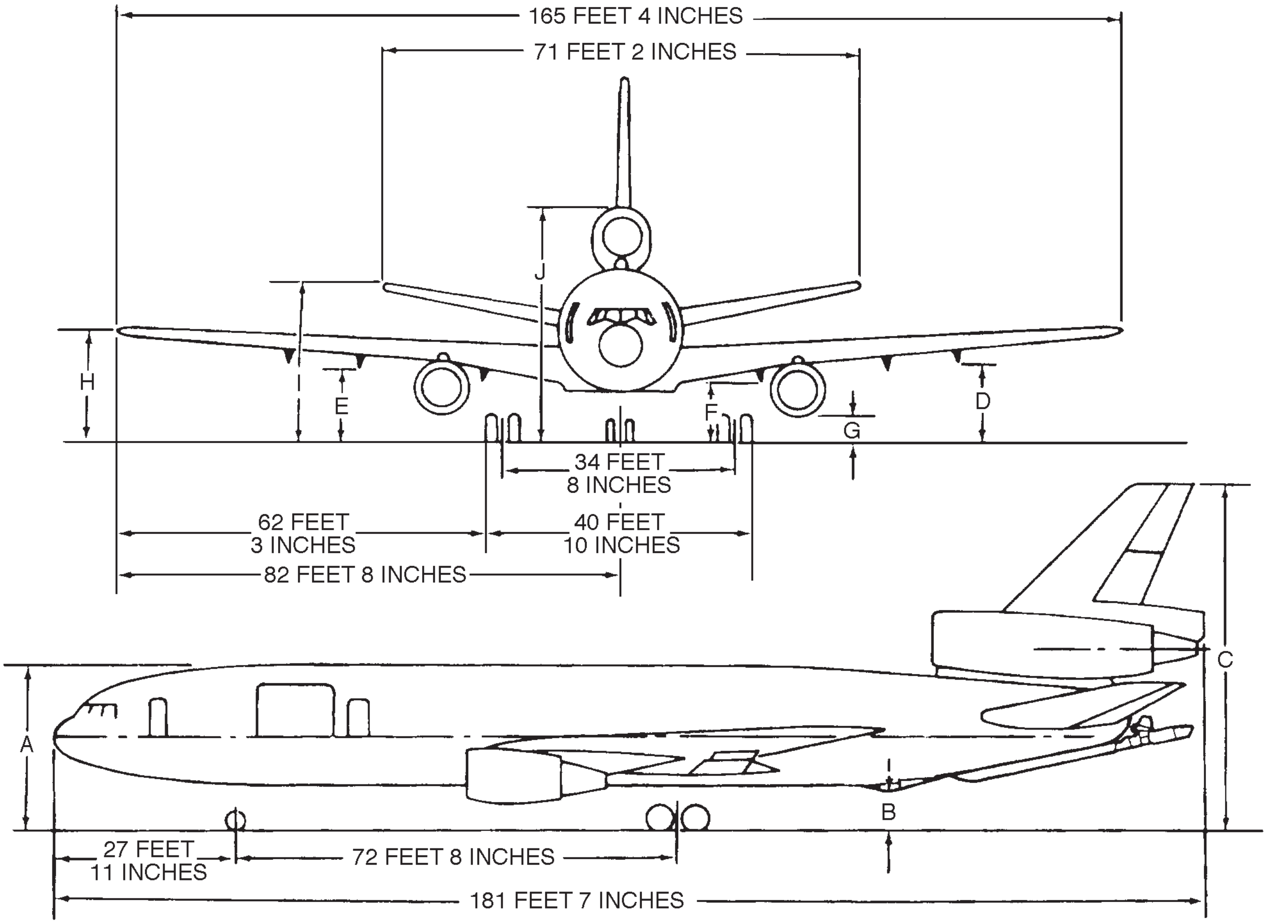
Code	Number of seats installed in forward cabin	Cargo Pallets HCU-6/E
A	14	23
B	16	23
C	20	23
D	75	17
E	0	25 or 27
F	6	25
G	20	17
H	63	17
I	51	17
J	16	0

NOTE

Placards for switch positions, circuit breakers, etc., reading CAPTAIN or CAPT will be construed to mean pilot, and placards reading FIRST OFFICER or F/O will be construed to mean copilot. The Flight Engineer's position is placarded FLIGHT ENGINEER or FE. Controls, switches, indicators, etc., in the ARO compartment are placarded appropriately.

FLIGHT CREW

Cockpit Flight Crew accommodations are arranged in a conventional manner, the Pilot's station on the



VERTICAL CLEARANCE						
	NOMINAL CLEARANCE MAXIMUM RAMP WEIGHT NOMINAL CENTER GRAVITY		MINIMUM CLEARANCE CRITICAL WEIGHT AND CENTER GRAVITY		MAXIMUM CLEARANCE CRITICAL WEIGHT AND CENTER GRAVITY	
	FT - IN.	METERS	FT - IN.	METERS	FT - IN.	METERS
A	27-2	8.28	27-1	8.25	28-1	8.56
B	6-1	1.85	5-10	1.78	6-10	2.08
C	57-7	17.55	57-2	17.42	58-7	17.86
D	10-9	3.28	10-8	3.25	11-10	3.61
E	9-8	2.95	9-7	2.92	10-6	3.20
F	7-9	2.36	7-9	2.36	8-5	2.57
G	2-11	0.89	2-10	0.86	3-7	1.09
H	14-6	4.42	14-4	4.37	16-3	4.95
I	23-10	7.26	23-5	7.14	24-10	7.57
J	36-10	11-23	36-7	11.15	37-8	11.48

SA1-18B

Figure 1.1-1. Aircraft Dimensions and Vertical Clearance Table

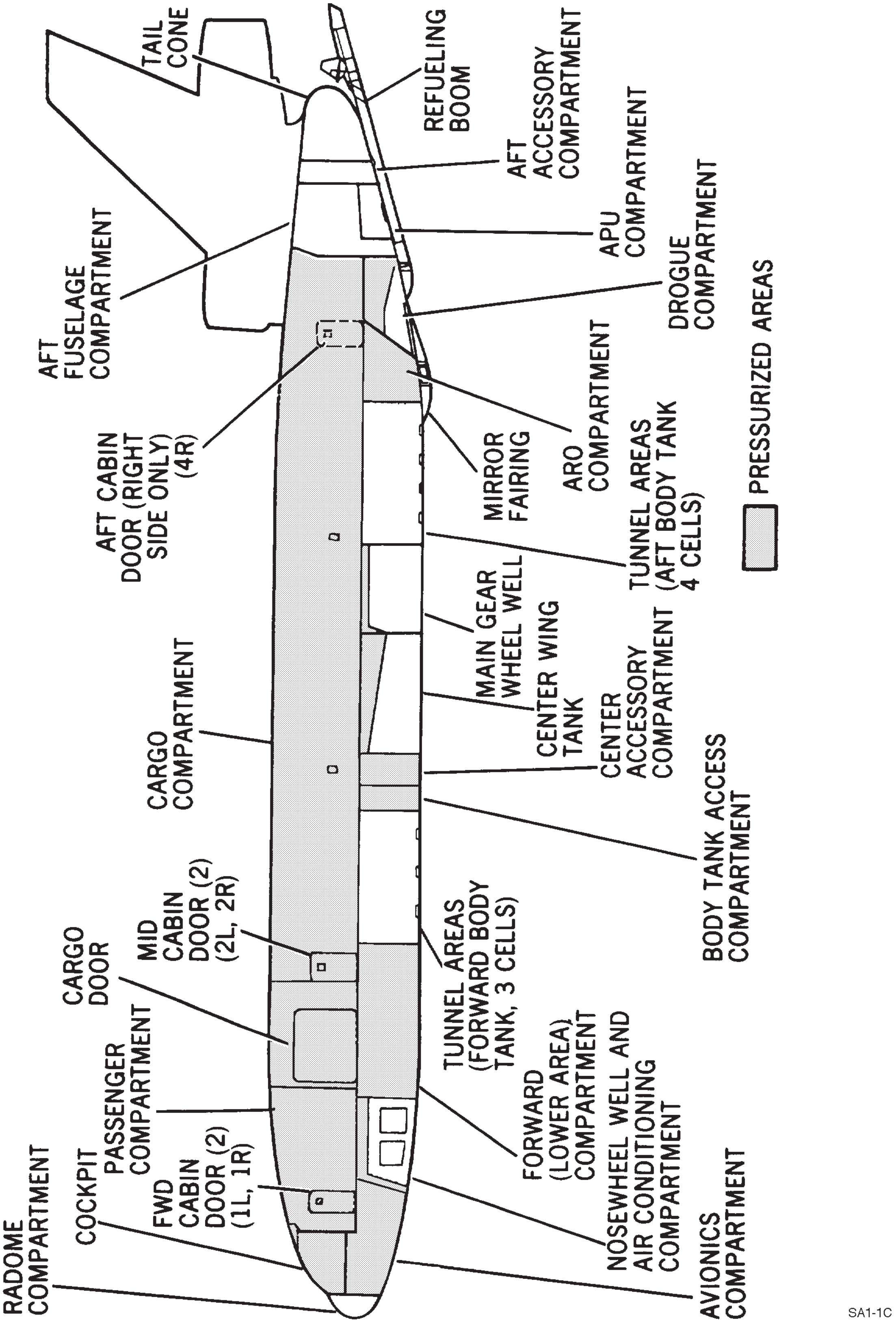


Figure 1.1-2. Compartment Diagram

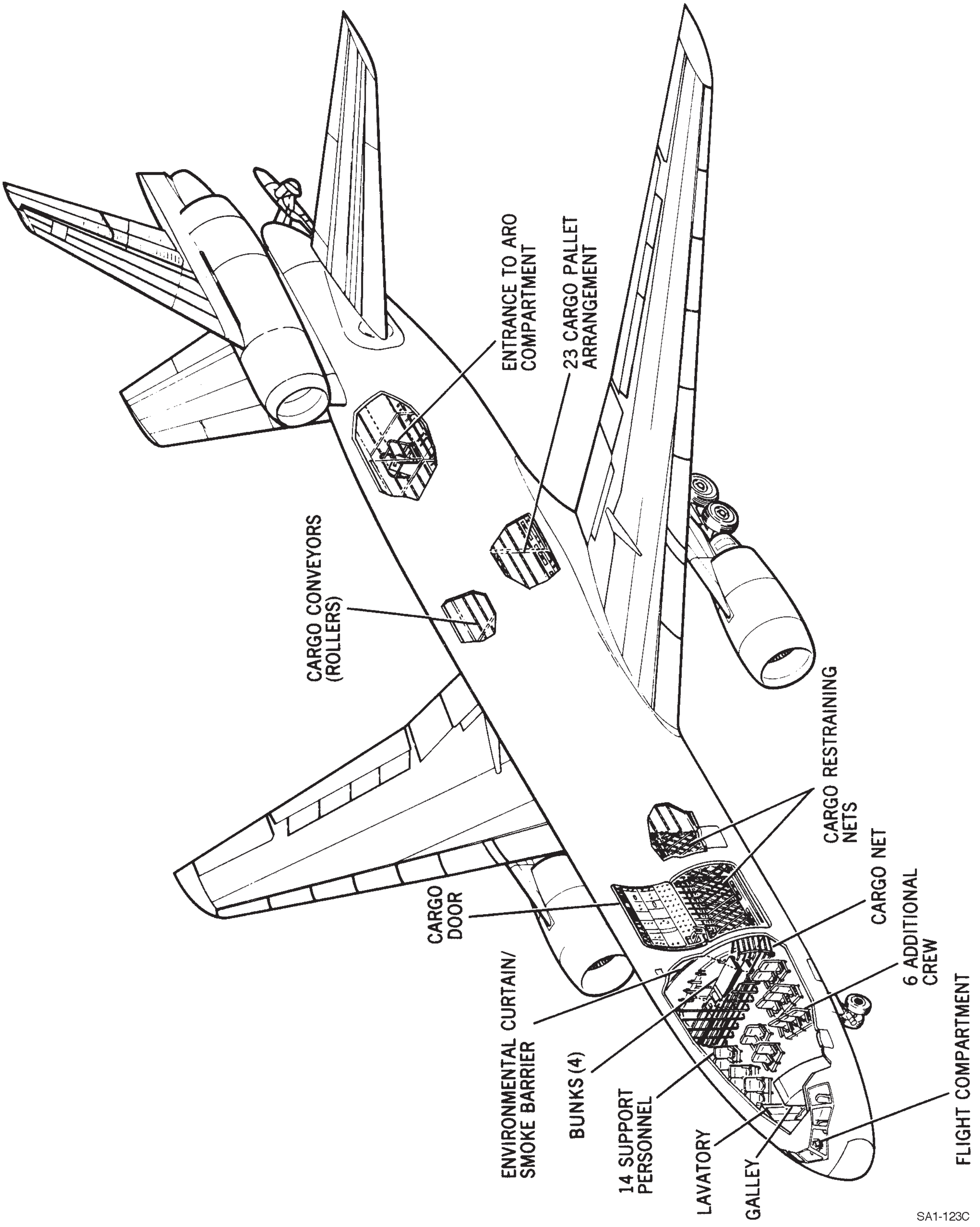
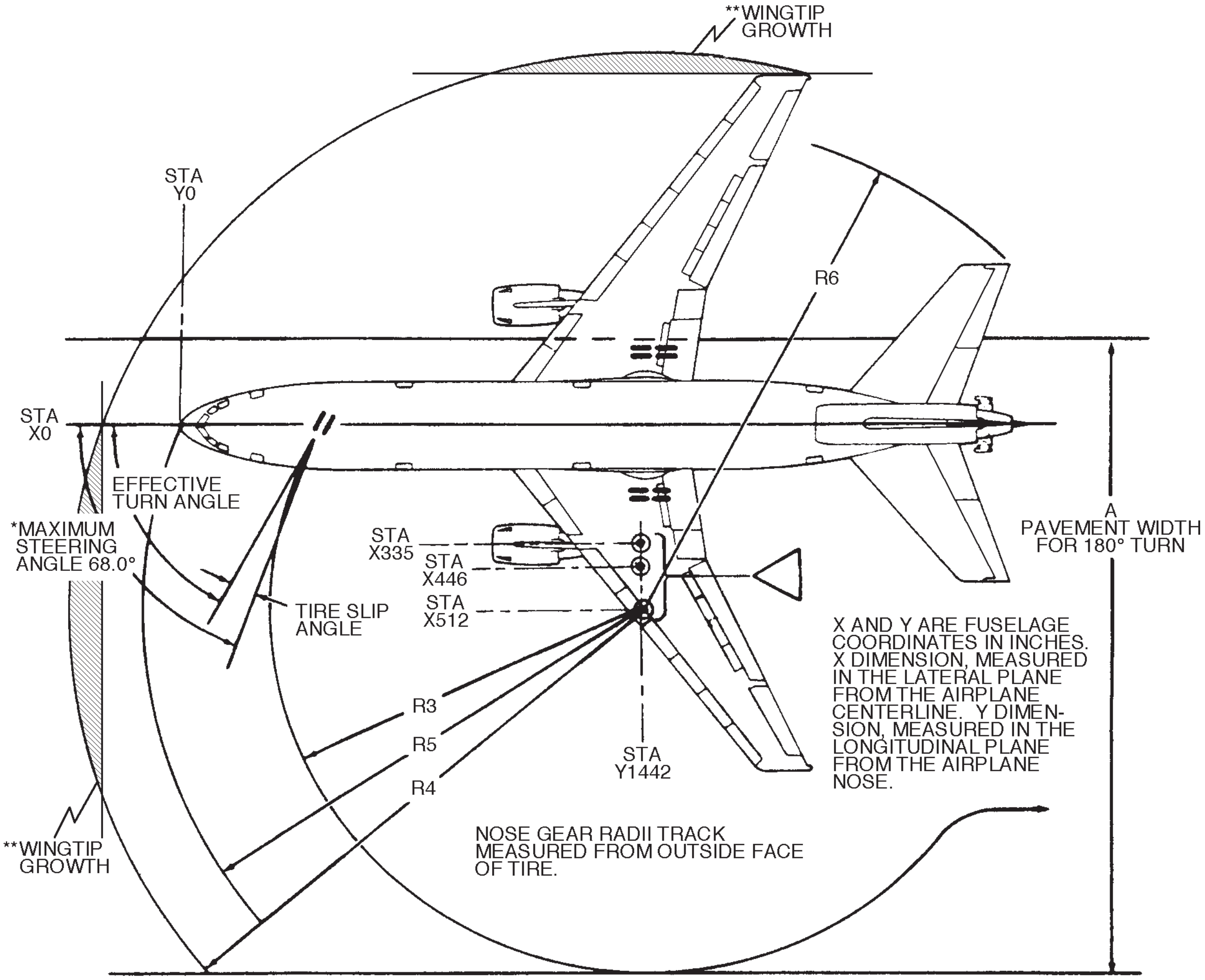


Figure 1.1-3. Support Personnel Cargo Configuration - Typical



1 MINIMUM RADIUS TURN RECOMMENDED FOR NORMAL, ROUTINE OPERATIONS. LIMITED TO AVOID EXCESSIVE TIRE WEAR AND REDUCTION OF LANDING GEAR FATIGUE LIFE.

2 MAXIMUM STEERING-SYMMETRICAL THRUST:
NO DIFFERENTIAL BRAKING
SLOW CONTINUOUS TURN
AFT CENTER OF GRAVITY
MAX GROSS WEIGHT

3 MAXIMUM STEERING-ASYMMETRICAL THRUST:
LIGHT DIFFERENTIAL BRAKING
SLOW CONTINUOUS TURN
AFT CENTER OF GRAVITY
MAX GROSS WEIGHT

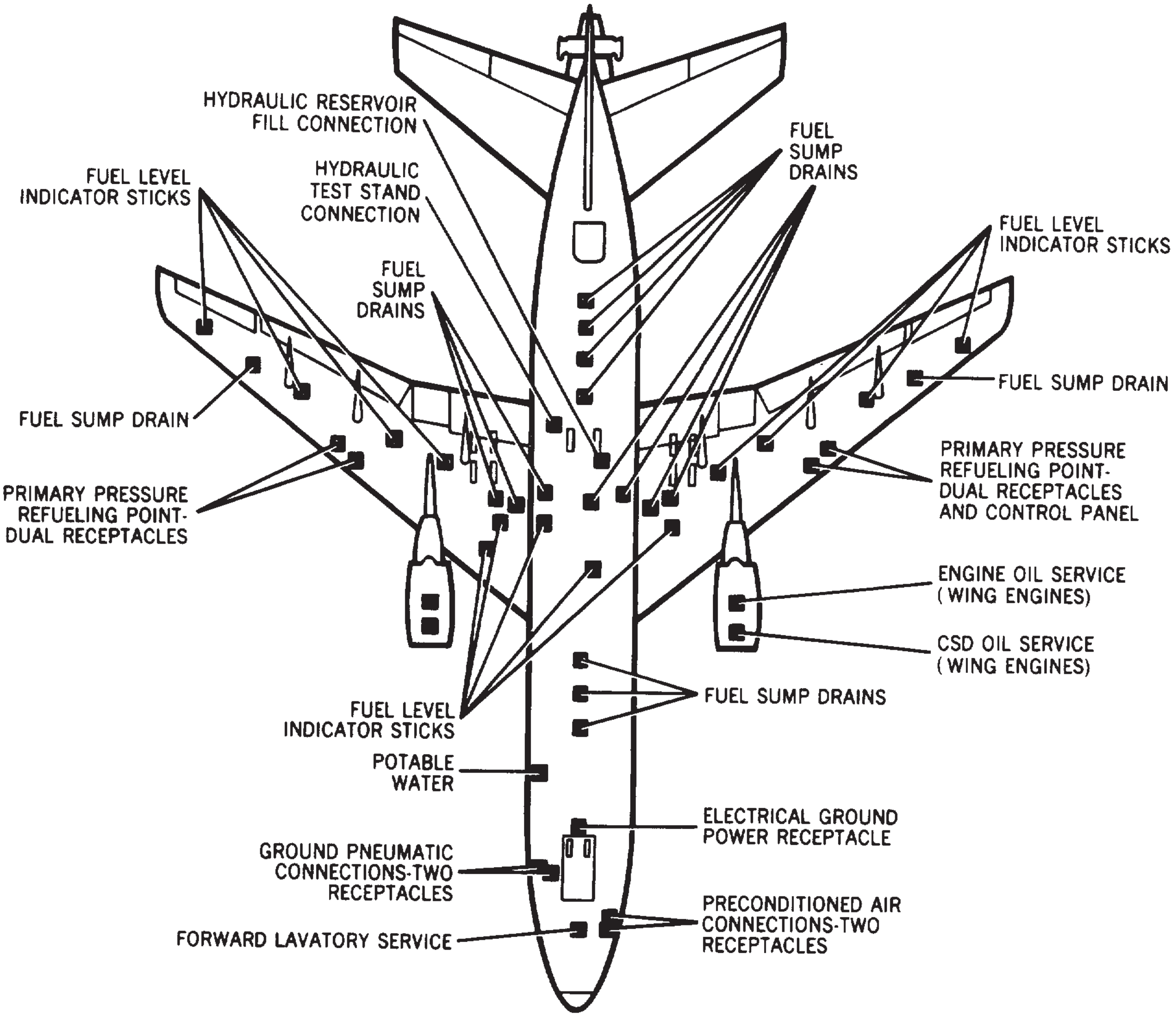
TYPE OF TURN	EFFECTIVE TURN ANGLE	TIRE SLIP ANGLE	X	Y	A	R3	R4	R5	R6
1	—	—	512	1442	149.5 FT.	85.2 FT.	130.5 FT.	109.6 FT.	109.8 FT.
2	62.9°	5.1°	446	1442	141.4 FT.	83.5 FT.	125.3 FT.	107.5 FT.	105.9 FT.
3	66.9°	1.1°	335	1442	128.5 FT.	79.8 FT.	116.1 FT.	104.7 FT.	99.5 FT.

* NOTE: ANGLE MEASURED RELATIVE TO GROUND.

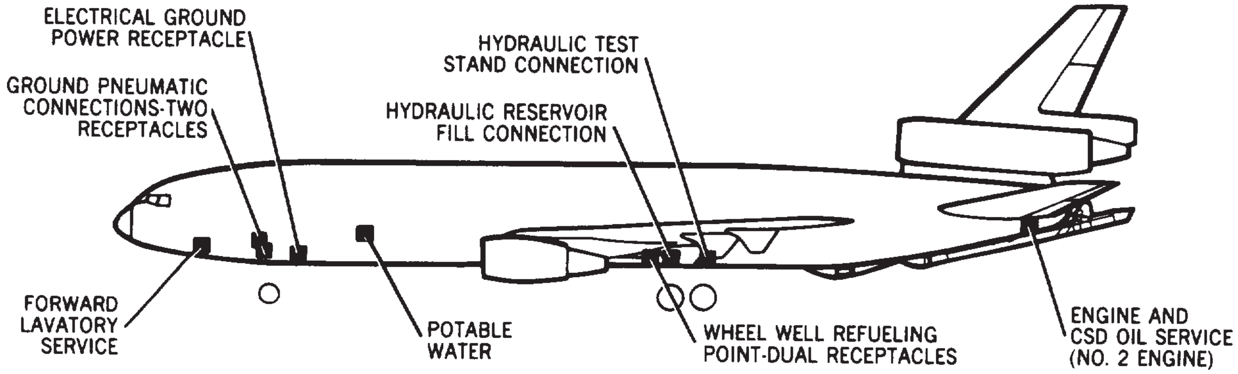
** NOTE: A WORST CASE TURN RESULTS IN WINGTIP GROWTH OF 5 FEET 2 INCHES TO THE SIDE AND 7 FEET 2 INCHES TO THE FRONT.

SA1-21C

Figure 1.1-4. Minimum Taxiing Radii



VIEW LOOKING UP



SA1-259A

Figure 1.1-5. Servicing Diagram

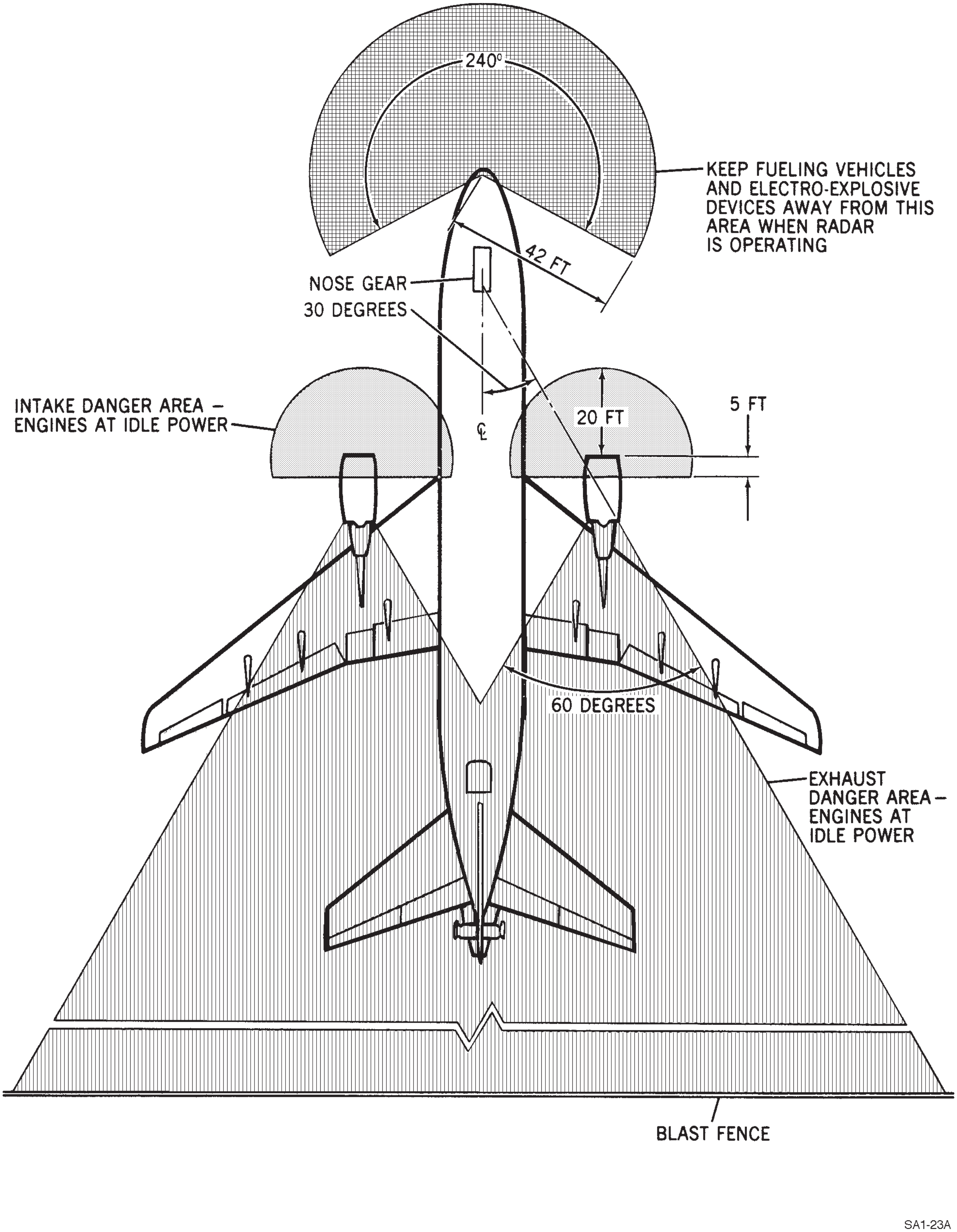
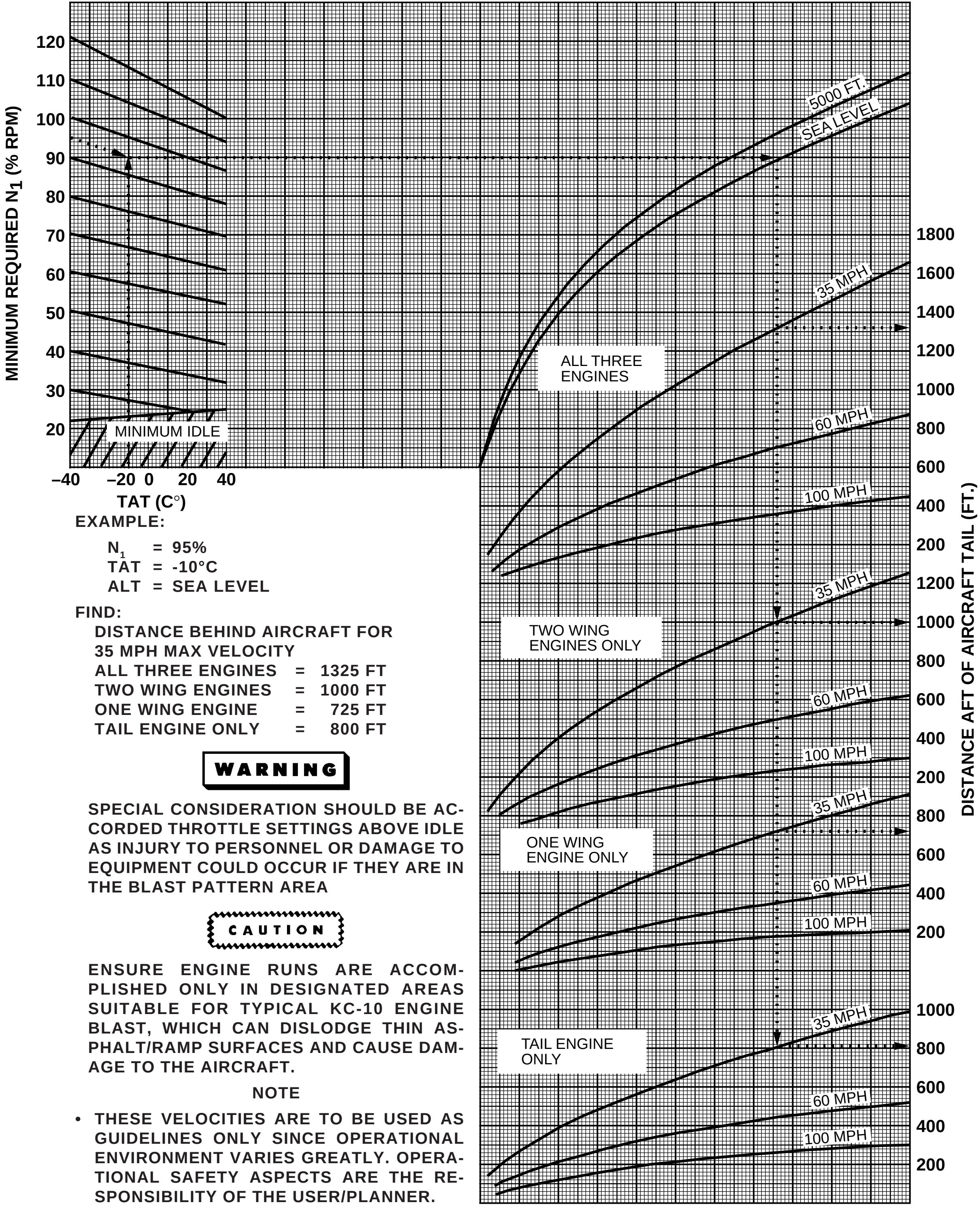


Figure 1.1-6. Danger Areas (Sheet 1)

EXHAUST WAKE VELOCITIES (ESTIMATED)

KC-10A, CF6-50 SERIES ENGINES



EXAMPLE:

N_1 = 95%
TAT = -10°C
ALT = SEA LEVEL

FIND:

DISTANCE BEHIND AIRCRAFT FOR 35 MPH MAX VELOCITY

ALL THREE ENGINES	=	1325 FT
TWO WING ENGINES	=	1000 FT
ONE WING ENGINE	=	725 FT
TAIL ENGINE ONLY	=	800 FT

WARNING

SPECIAL CONSIDERATION SHOULD BE ACCORDED THROTTLE SETTINGS ABOVE IDLE AS INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT COULD OCCUR IF THEY ARE IN THE BLAST PATTERN AREA

CAUTION

ENSURE ENGINE RUNS ARE ACCOMPLISHED ONLY IN DESIGNATED AREAS SUITABLE FOR TYPICAL KC-10 ENGINE BLAST, WHICH CAN DISLODGE THIN ASPHALT/RAMP SURFACES AND CAUSE DAMAGE TO THE AIRCRAFT.

NOTE

- THESE VELOCITIES ARE TO BE USED AS GUIDELINES ONLY SINCE OPERATIONAL ENVIRONMENT VARIES GREATLY. OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER/PLANNER.
- CROSS WINDS WILL HAVE CONSIDERABLE EFFECT ON VELOCITIES.

Figure 1.1-6. Danger Areas (Sheet 2)

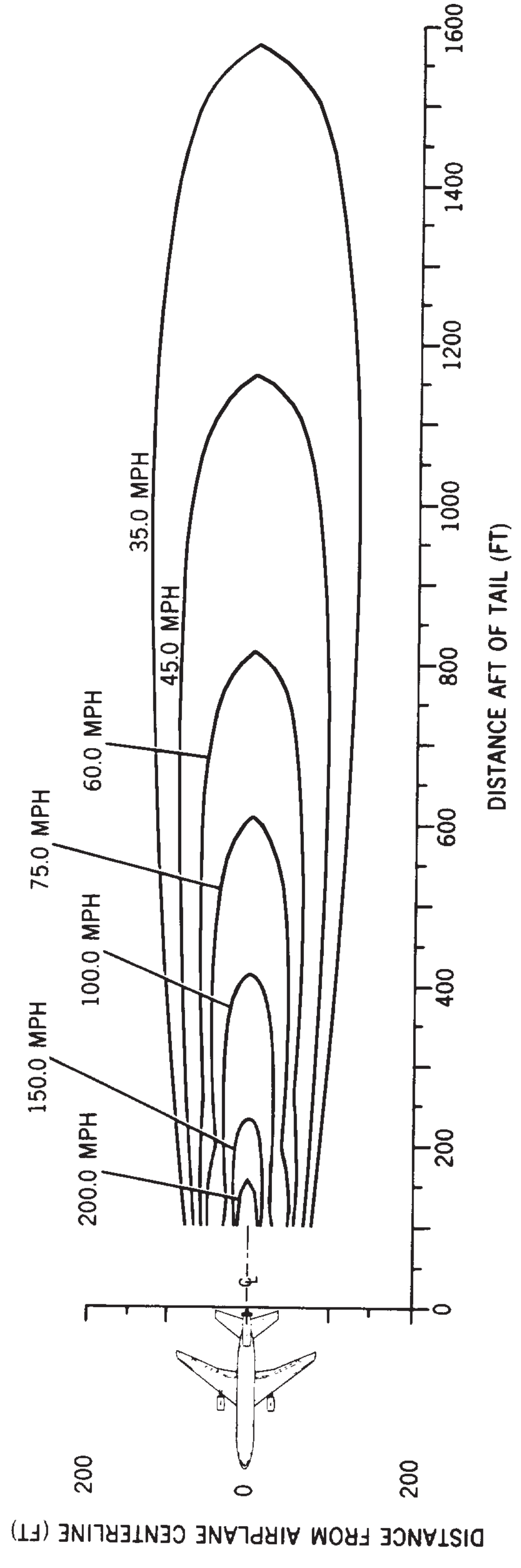
KC-10A

EXHAUST WAKE VELOCITY PROFILES
ENGINES ONE, TWO, AND THREE OPERATING
CF6-50C2 TAKEOFF THRUST

PLAN VIEW

NOTES

1. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE OPERATIONAL ENVIRONMENT VARIES GREATLY – OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER/PLANNER.
2. ALL VELOCITY VALUES ARE STATUTE MILES/HOUR.
3. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS.
4. SEA LEVEL STATIC – STANDARD DAY.



SA1-439

Figure 1.1-6. Danger Areas (Sheet 3)

left, the Copilot's station on the right, and the Flight Engineer's facing outboard behind the Copilot's seat. Seating, communications facilities, and oxygen outlets are provided for the boom operator and crewmember/observer seats behind the Pilot's station. Storage facilities for loose equipment are provided at each station in addition to the storage areas in the Flight Crew coatroom adjacent to the crewmember/observer's position. There is also a Flight Crew luggage stowage compartment aft of the cockpit area on the left side of the aircraft. All controls and indicators in the cockpit are illustrated in this section. For cockpit arrangement and the Pilot's, Copilot's, Flight Engineer's and Boom Operator's forward station see figures 1.1-10, 1.1-11 and 1.1-13. Controls for operation of cockpit clearview windows and sun visors are presented in figure 1.1-12. The Pilot's and Copilot's instrument panels and consoles are shown in figure 1.1-14 through figure 1.1-21. The Flight Engineer's instrument panels and consoles are shown in figure 1.1-22 through figure 1.1-28. The ARO station arrangement is shown in figure 1.1-29.

FUSELAGE

The wide-bodied fuselage is of semi-monocoque metal construction. All areas are pressurized except the nose radome, wheelwells, center wing fuel section, lower fuselage fuel and the fuselage aft of the ARO compartment. The fuselage is divided lengthwise into an upper-floor level and a lower-floor level area. The passenger/cargo compartment with lavatories and galley facilities are above the floor level in a pressurized area. The body tanks (compartmented bladder type) are located in unpressurized structural cavities in the lower section of the fuselage. The body tank access compartment and the center accessory compartment are pressurized. The aft accessory compartment is located in the unpressurized portion of the fuselage behind the pressure bulkhead. The ARO compartment is located below the floor level of the passenger/cargo compartment. The ARO compartment is pressurized and access is gained through a hatch located at the rear of the upper-floor level. Five entrance/exit doors are usable. Both over-wing doors and the left rear door have been deactivated. The cargo door is located on the left side of the fuselage forward of the wing.

WING

The cantilevered wing consists of a primary box structure with leading and trailing edge secondary structures. The box contains integral fuel tanks. The primary wing box also carries the main landing gear supporting structure, center-line gear, engine pylons, full span leading edge slats, spoilers, and trailing edge ailerons and flaps. Rupture-resistant fuel tanks and lines are provided in case of landing gear or flap breakaway.

TAIL

The tail includes an adjustable horizontal stabilizer, right and left two-section elevators, a tail-engine pylon, a fixed vertical stabilizer, and a two-section (four-segment) rudder. The adjustable horizontal stabilizer is pivoted at the trailing edge and employs hydraulic powered motors to change the angle-of-incidence.

ENGINE DANGER AREAS

GROUND PERSONNEL

All personnel working in the vicinity of a wing engine inlet should be aware of the invisible forces surrounding the engine inlets while the engine is running (figure 1.1-7).

PULLING FORCE

Pulling force produced by the suction surrounding an engine inlet are overpowering and the manner in which loose articles as well as ground personnel can be ingested into the engine should be emphasized (figure 1.1-8). The pulling force felt over the body is the same force felt in a strong wind, except that a wind of 25 mph exerts a force of only 20 pounds on an average sized person. By comparison, a force of 1,000 pounds is exerted on a person standing within a step in front of an engine operating at takeoff thrust.

IDLE THRUST

With the engine thrust reduced to idle, the pulling force is greater than 300 pounds. Unless there is something to hold on to for support, a person can offer only about 95 pounds of resistance by skidding on the bottom of his shoes. This means that the pulling force generated by an engine operating at idle power is enough to pull anyone into the spinning compressor. Certainly it is enough to pull articles of clothing such as caps and gloves, loose articles in shirt pockets and small tools.

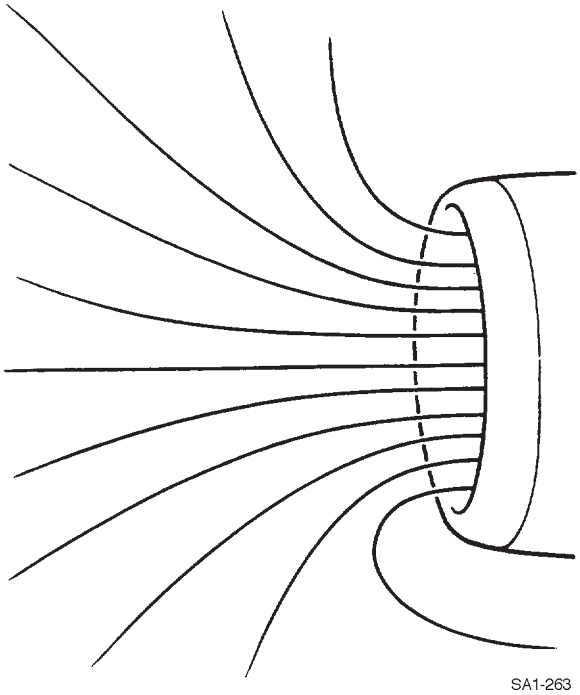


Figure 1.1-7. Engine Inlet Airflow Pattern

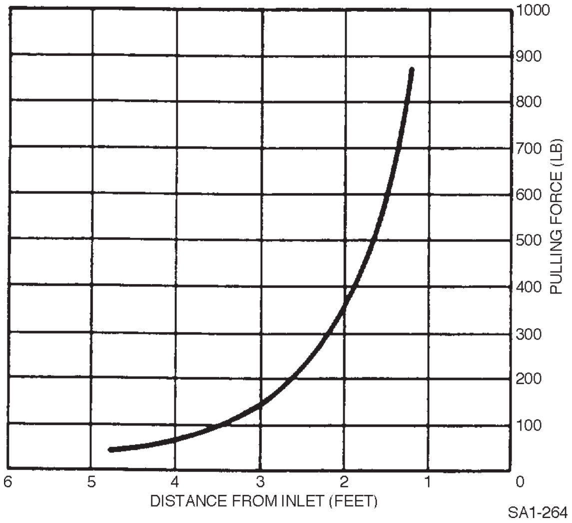


Figure 1.1-8. Pulling Force (Suction) At The Inlet of KC-10A Engine Operating at Takeoff Power

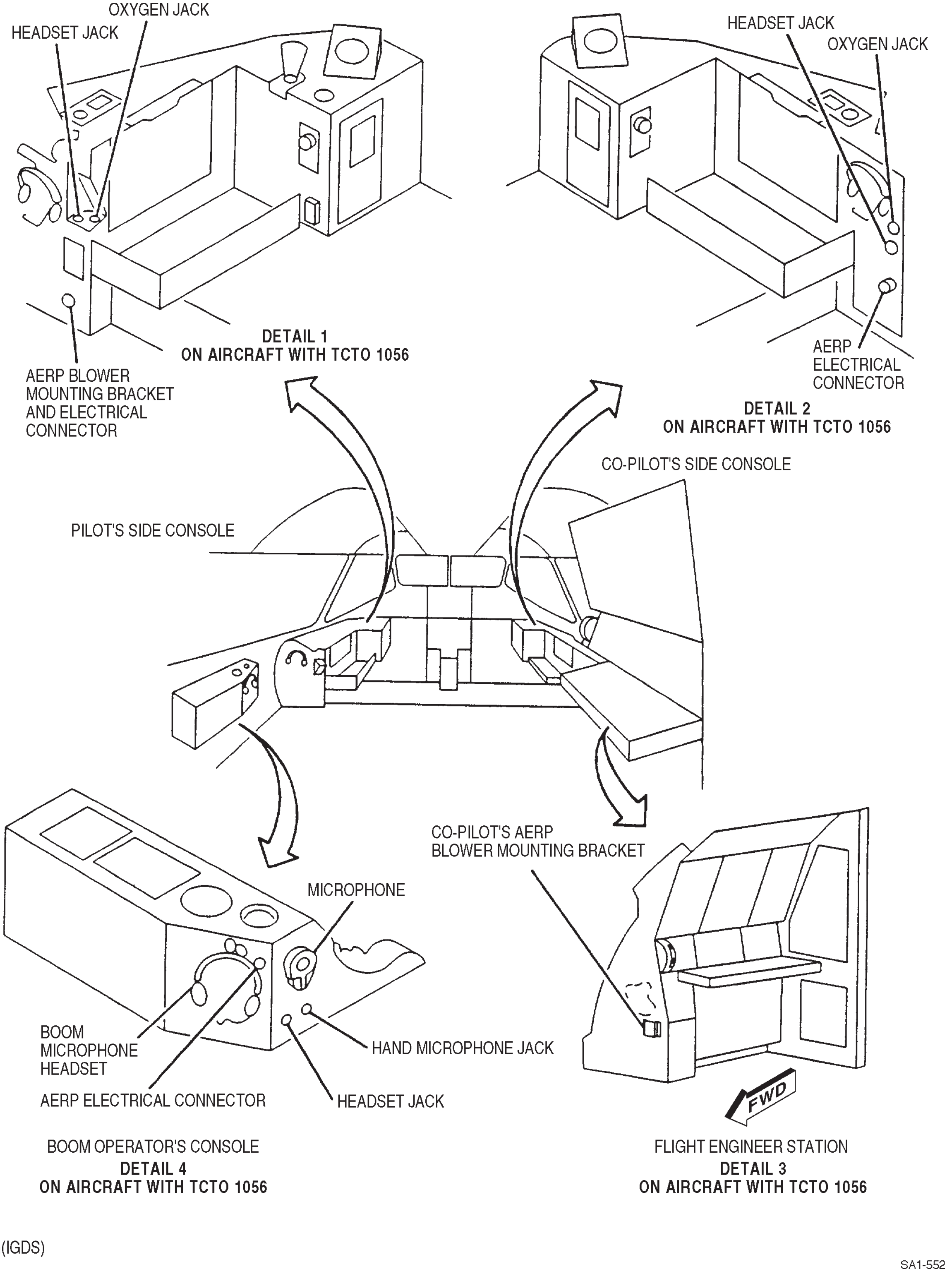


Figure 1.1-9. Aircrew Eye/Respiratory Protection (AERP) System - Flight Compartment

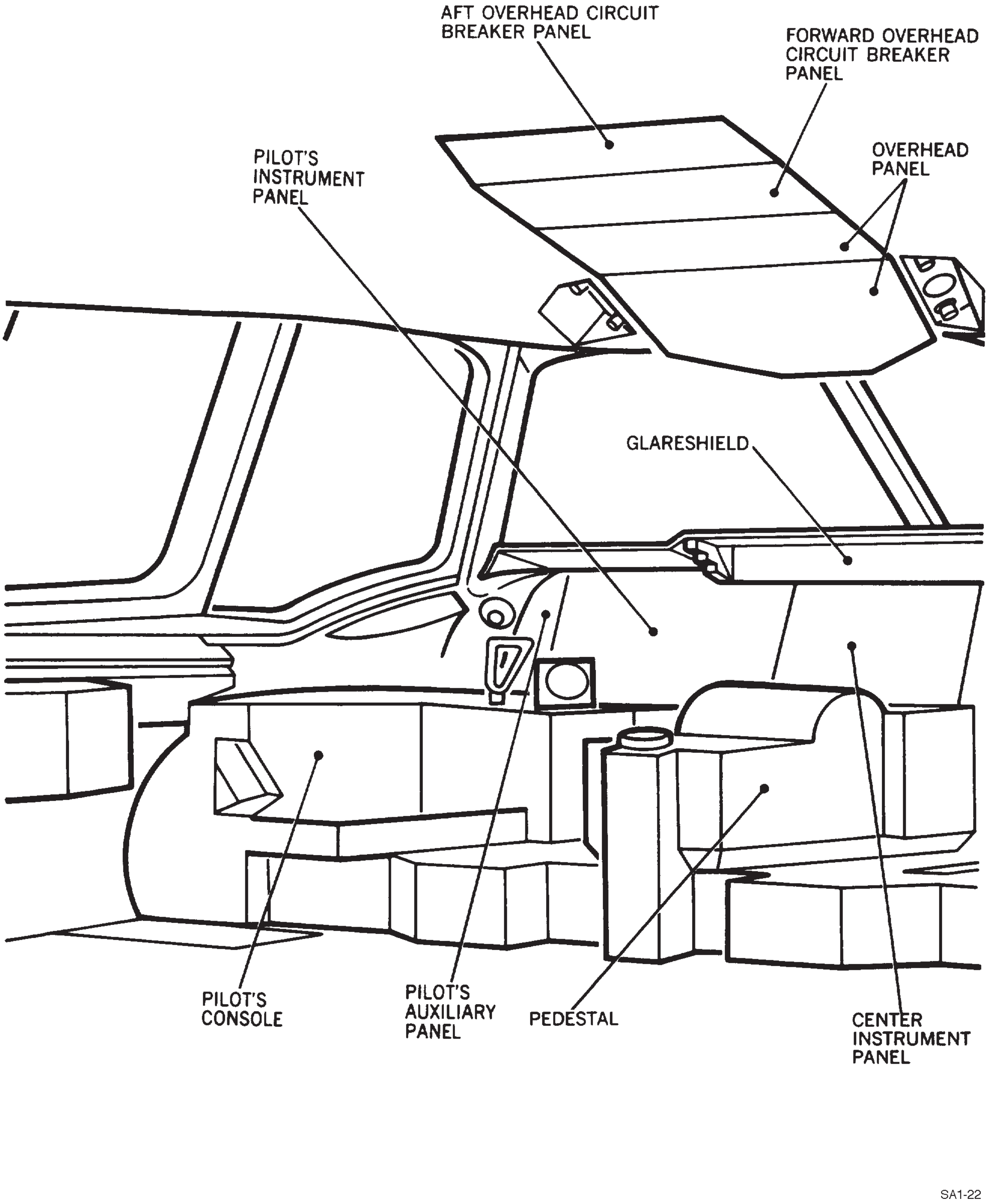


Figure 1.1-10. Pilot's Station

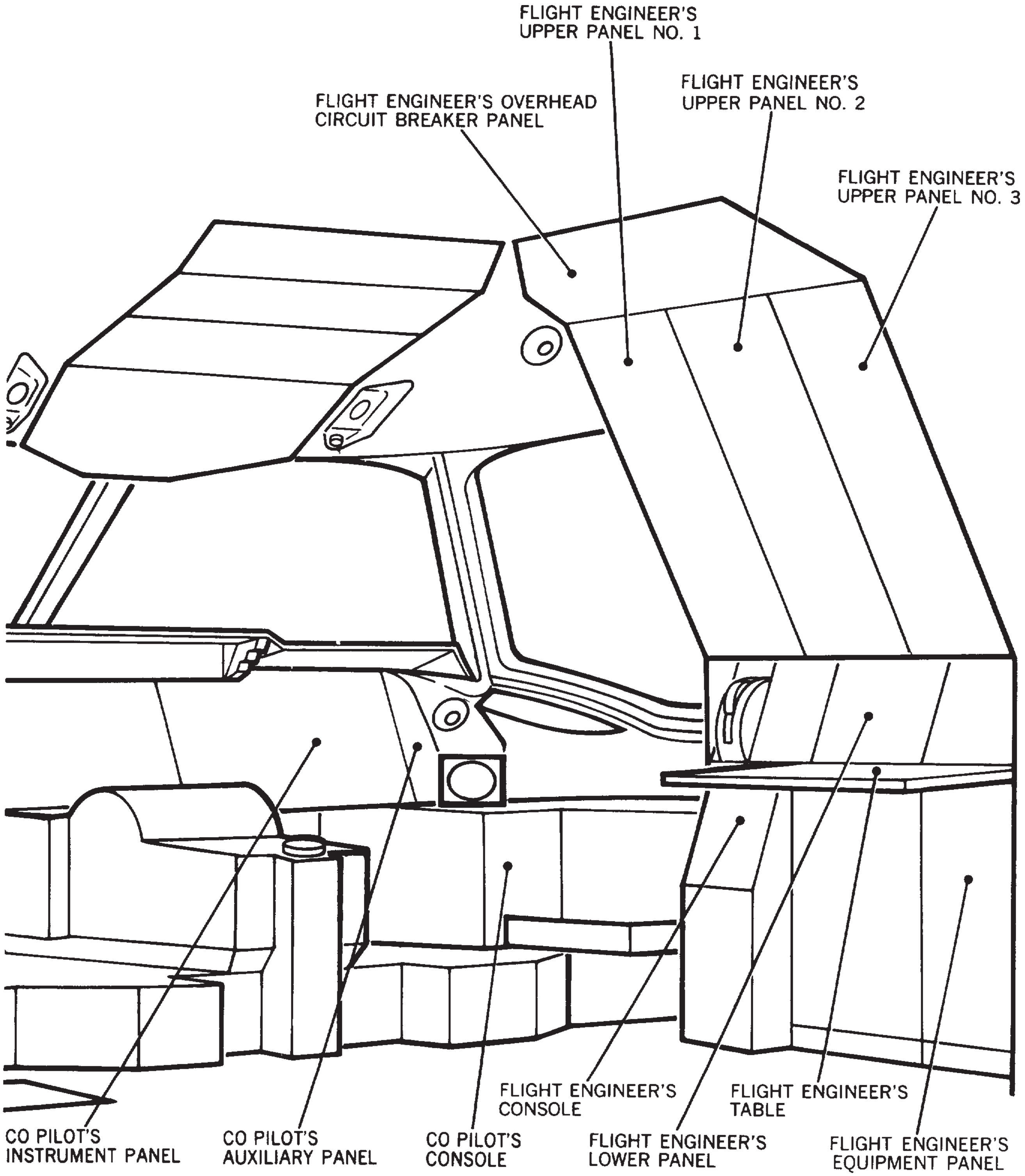
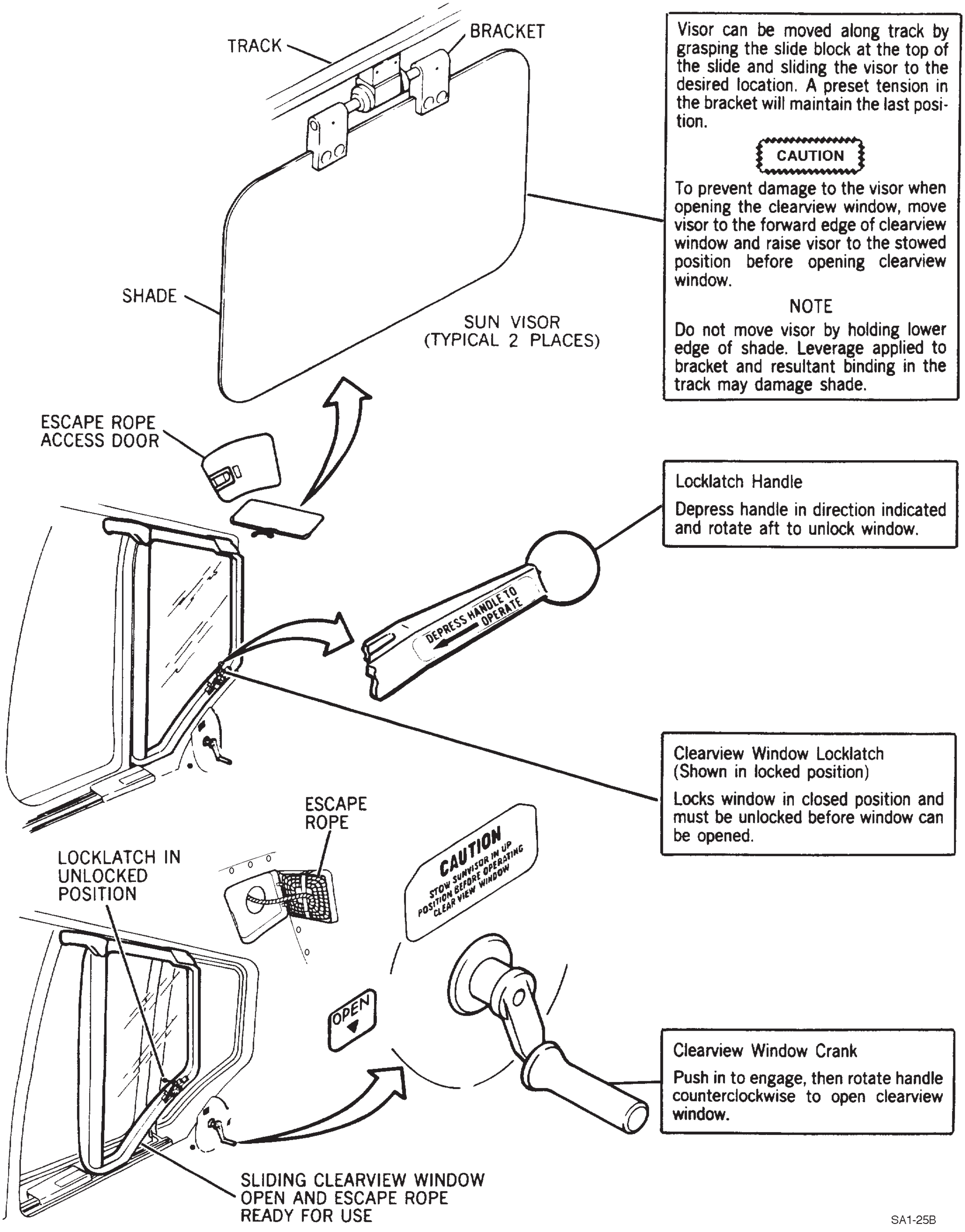


Figure 1.1-11. Copilot's and Flight Engineer's Station



Visor can be moved along track by grasping the slide block at the top of the slide and sliding the visor to the desired location. A preset tension in the bracket will maintain the last position.

CAUTION

To prevent damage to the visor when opening the clearview window, move visor to the forward edge of clearview window and raise visor to the stowed position before opening clearview window.

NOTE

Do not move visor by holding lower edge of shade. Leverage applied to bracket and resultant binding in the track may damage shade.

Locklatch Handle

Depress handle in direction indicated and rotate aft to unlock window.

Clearview Window Locklatch
(Shown in locked position)

Locks window in closed position and must be unlocked before window can be opened.

Clearview Window Crank

Push in to engage, then rotate handle counterclockwise to open clearview window.

Figure 1.1-12. Sun Visors and Clearview Windows

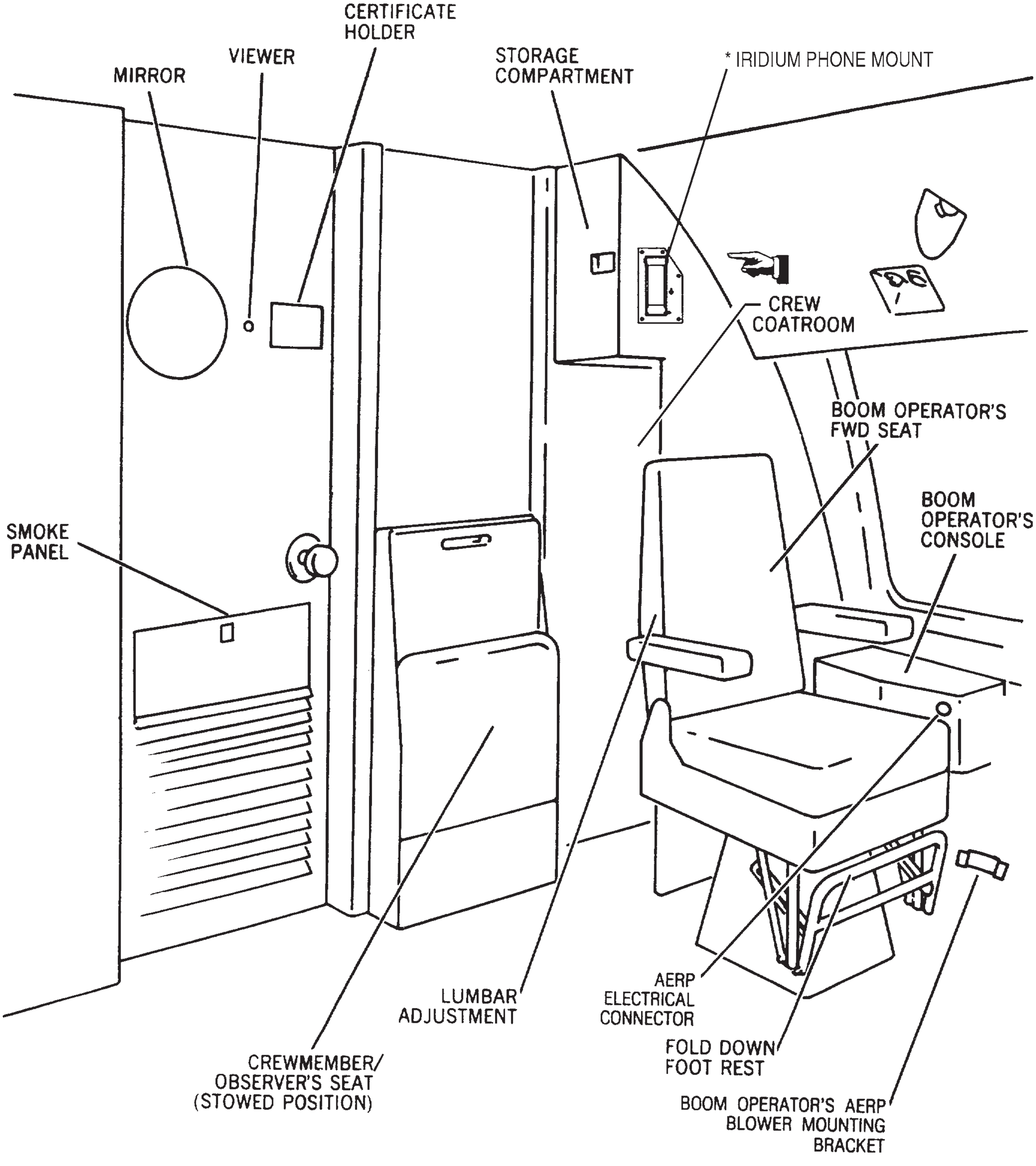


Figure 1.1-13. Boom Operator's Forward Station and Crewmember/Observer's Station

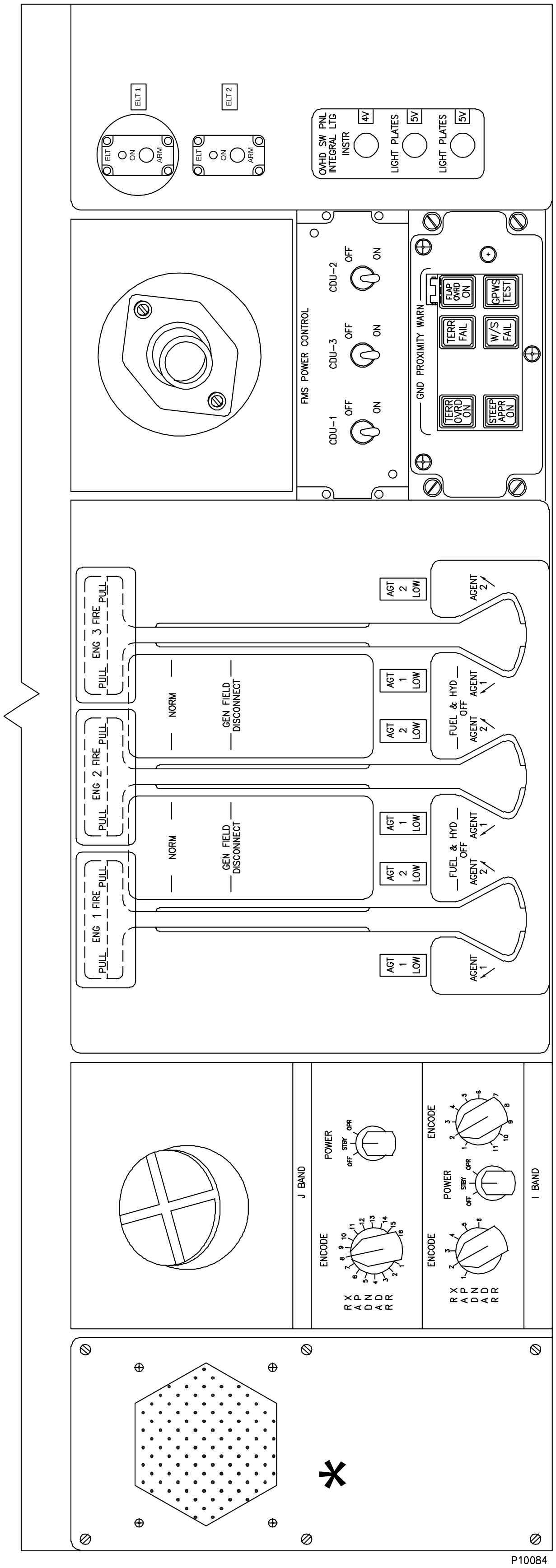


Figure 1.1-14. Aft Overhead Panel

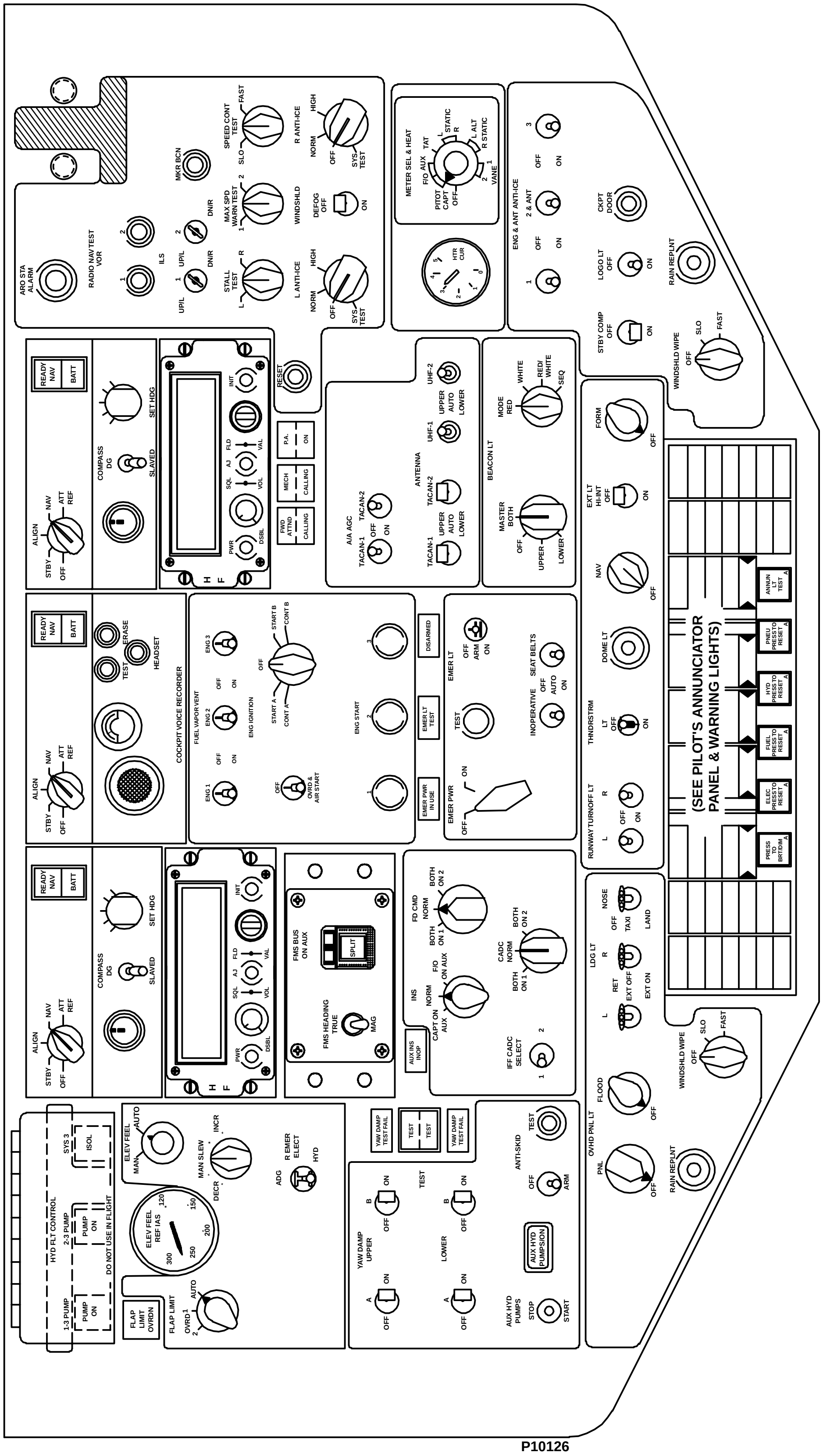


Figure 1.1-15. Forward Overhead Panel

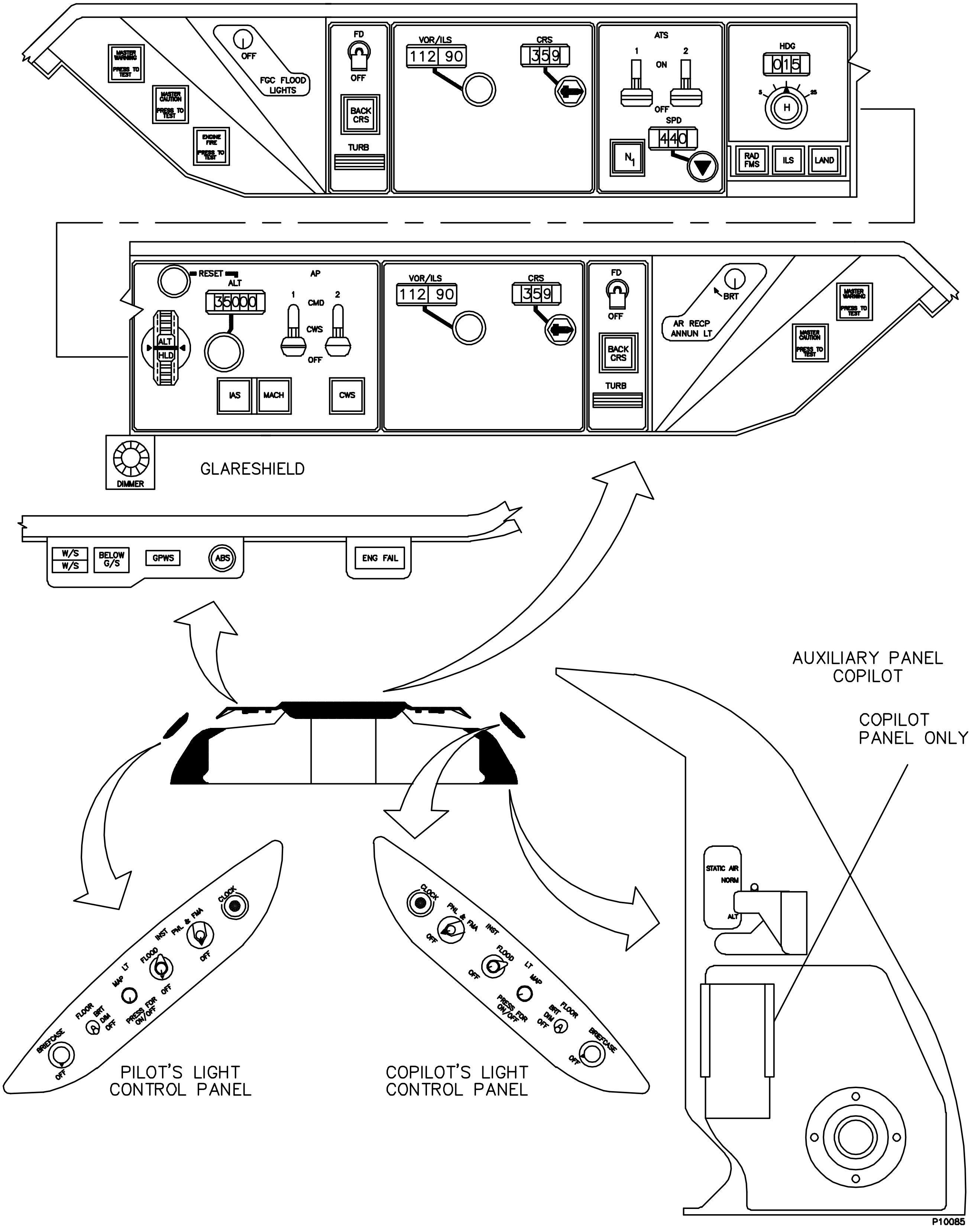


Figure 1.1-16. Center Instrument Panel

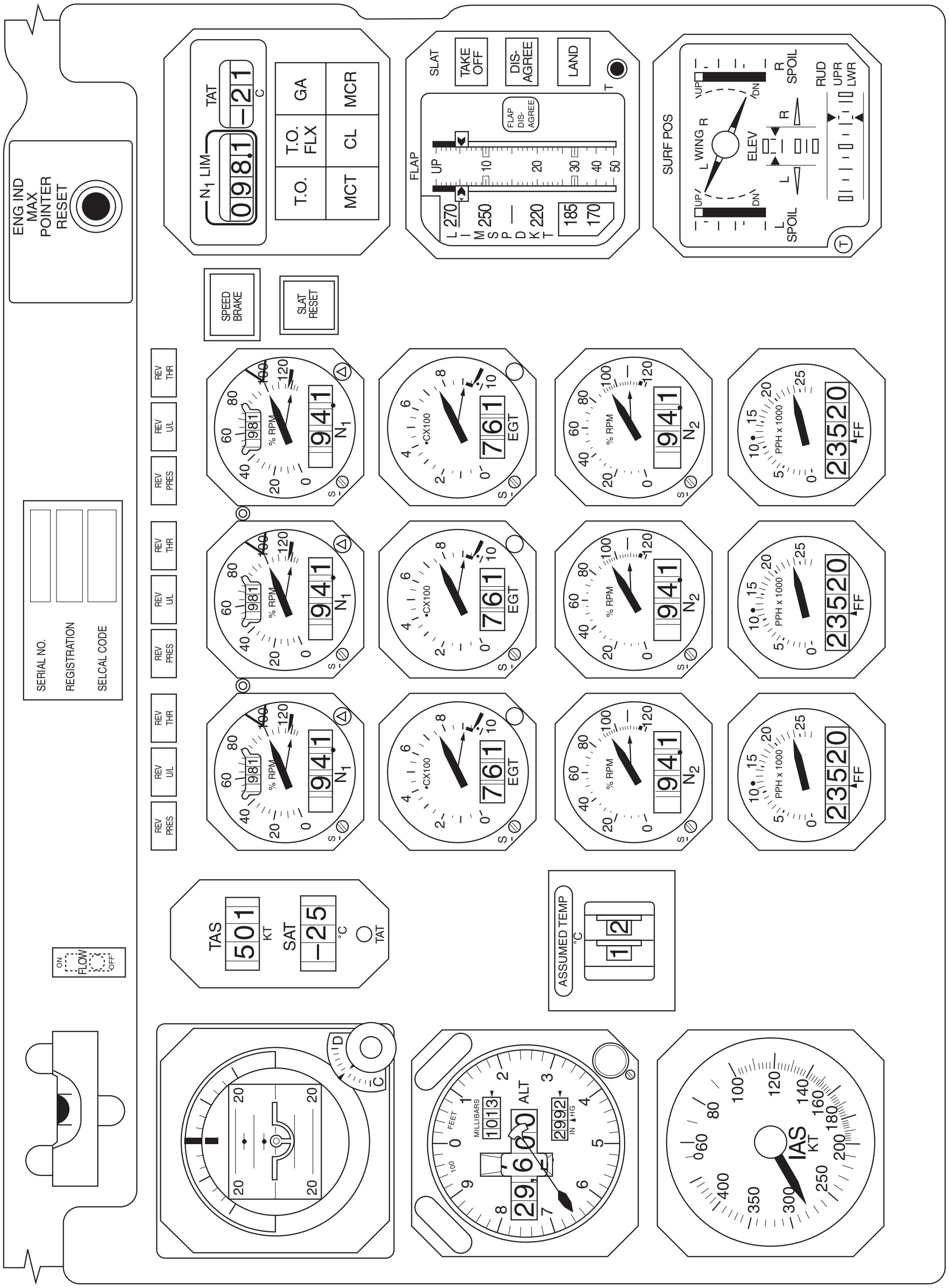


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Figure 1.1-17. Center Instrument Panel

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* **AFTER TCTO 956**

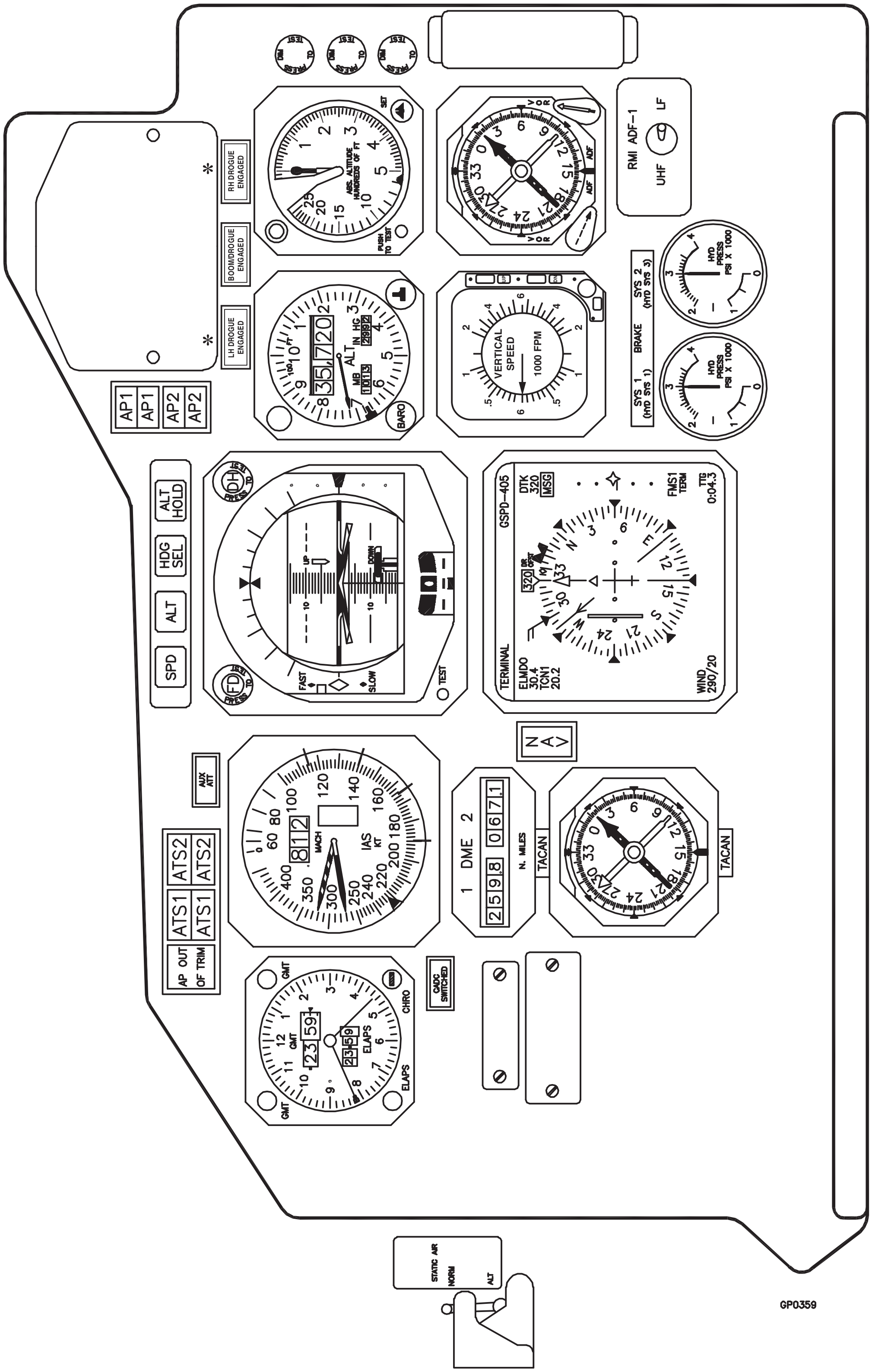

Figure 1.1-18. Pilot's Instrument Panel

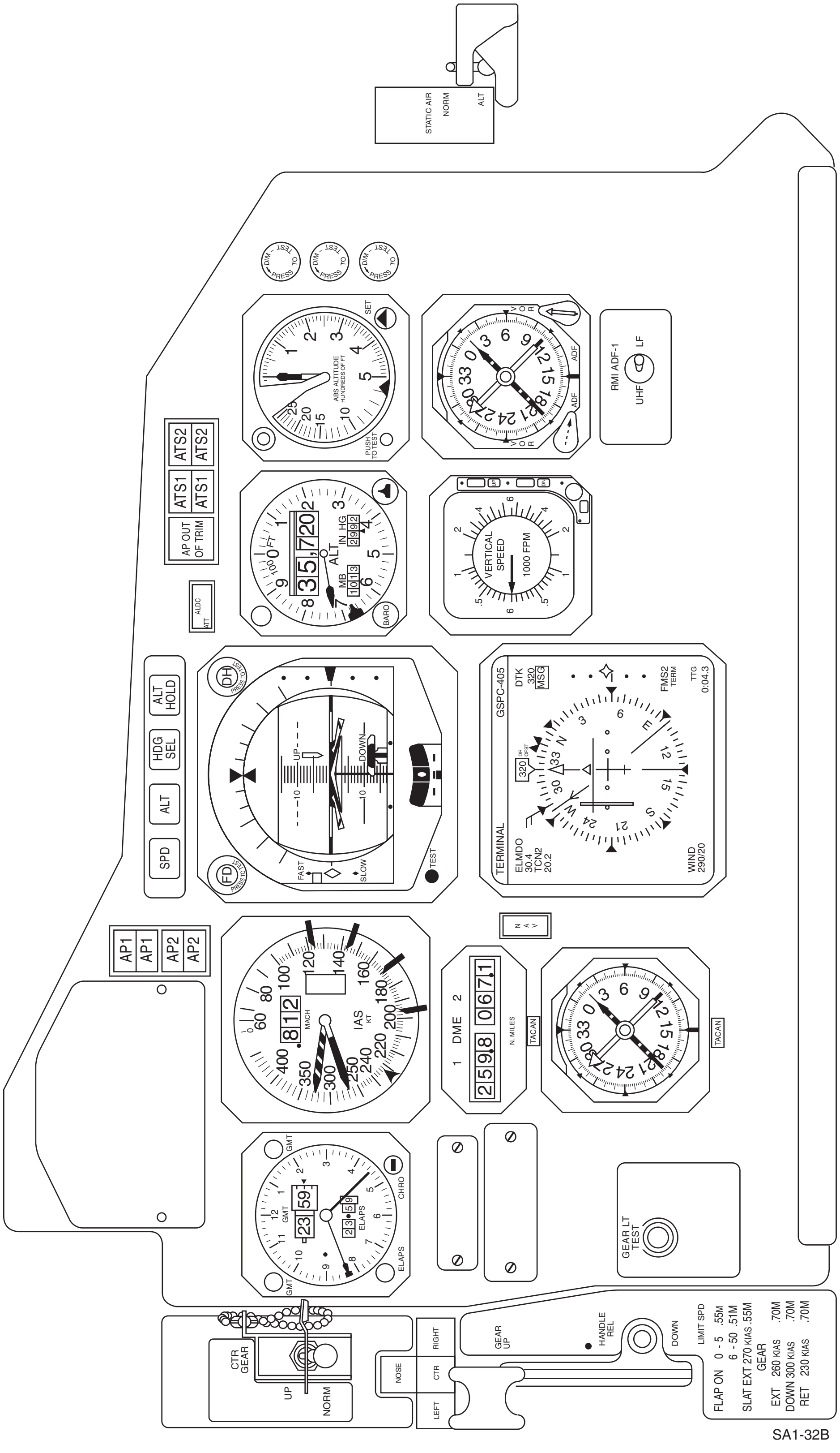

Figure 1.1-19. Copilot's Instrument Panel

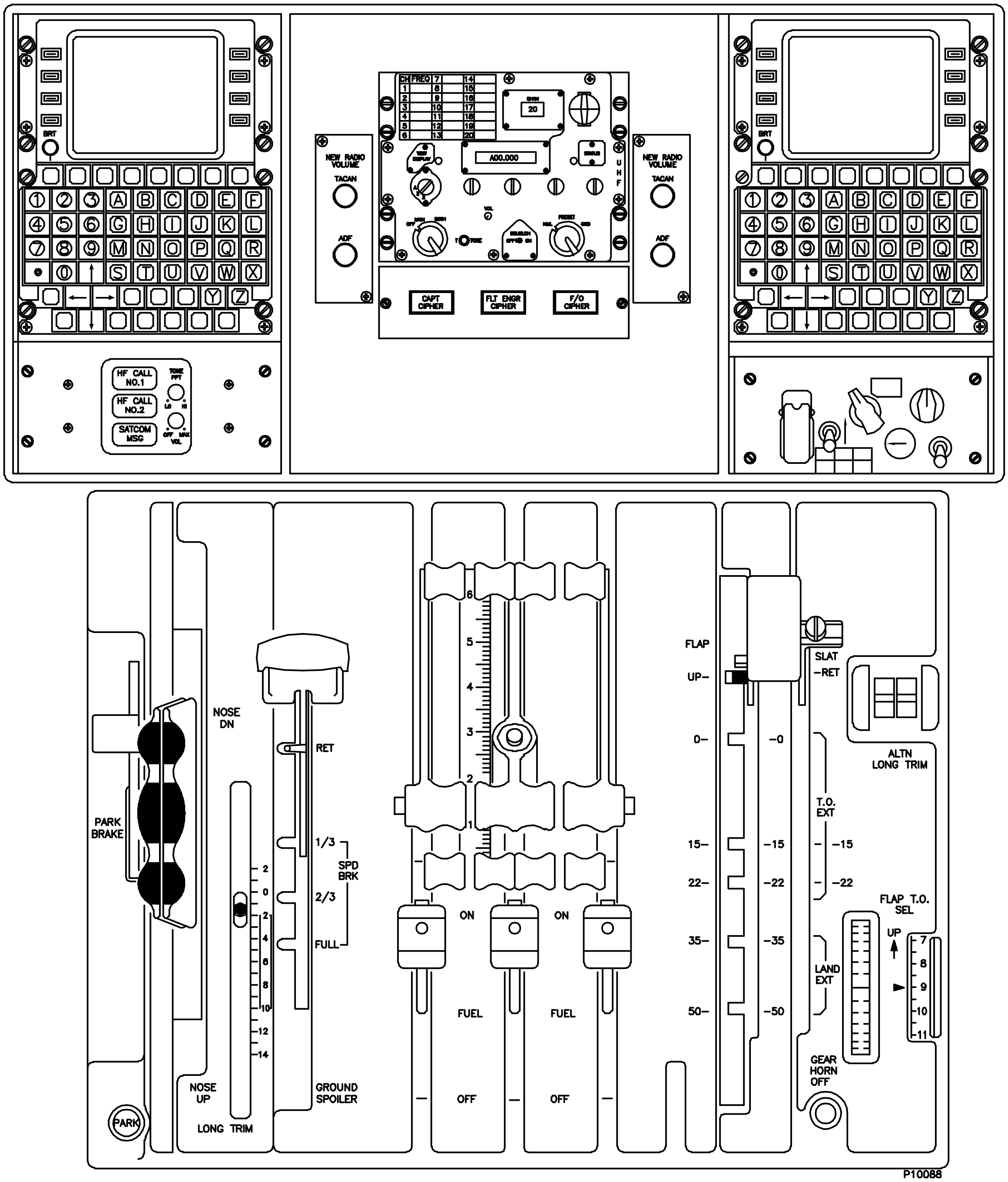

Figure 1.1-20. Forward Pedestal

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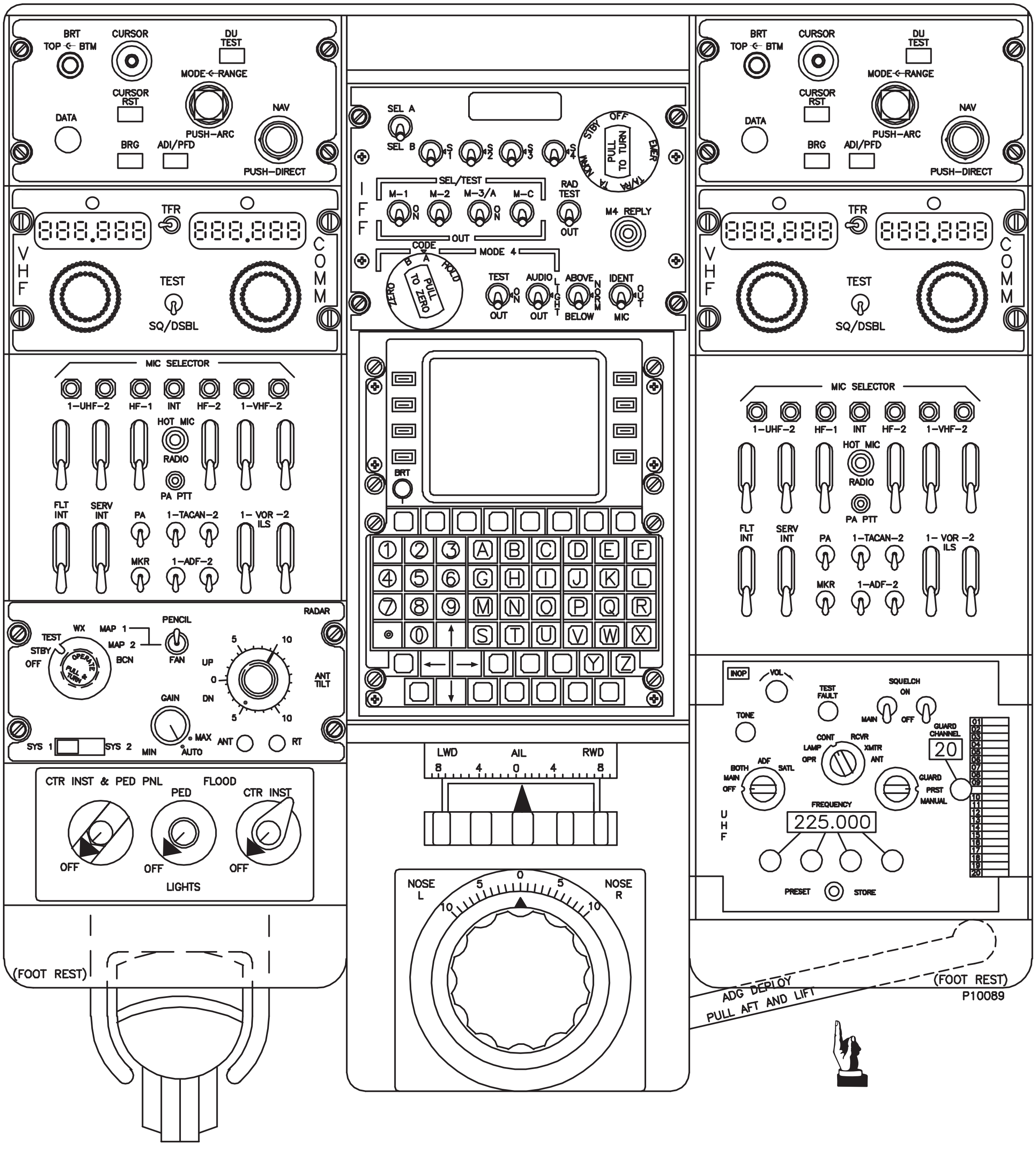


Figure 1.1-21. Aft Pedestal

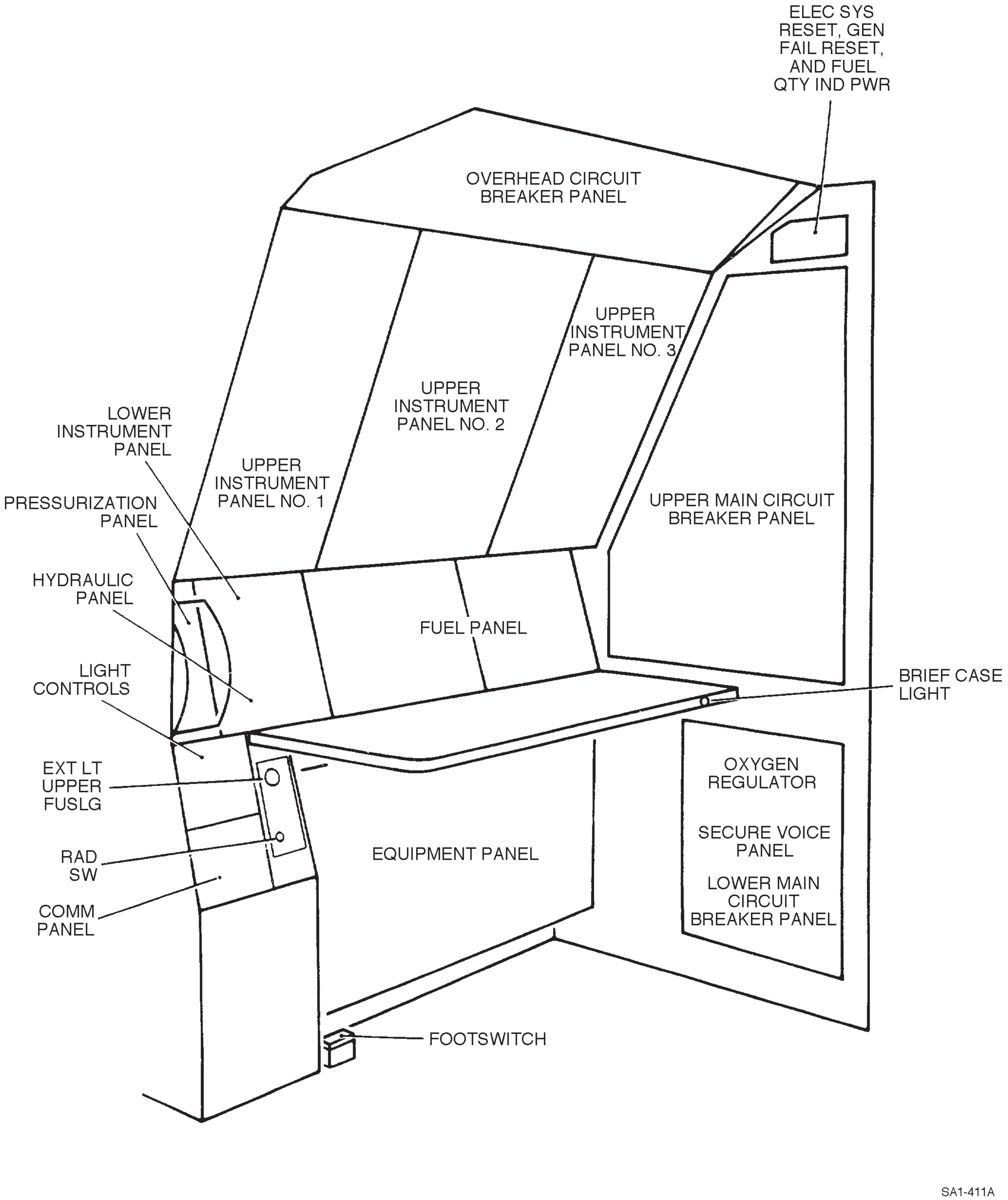
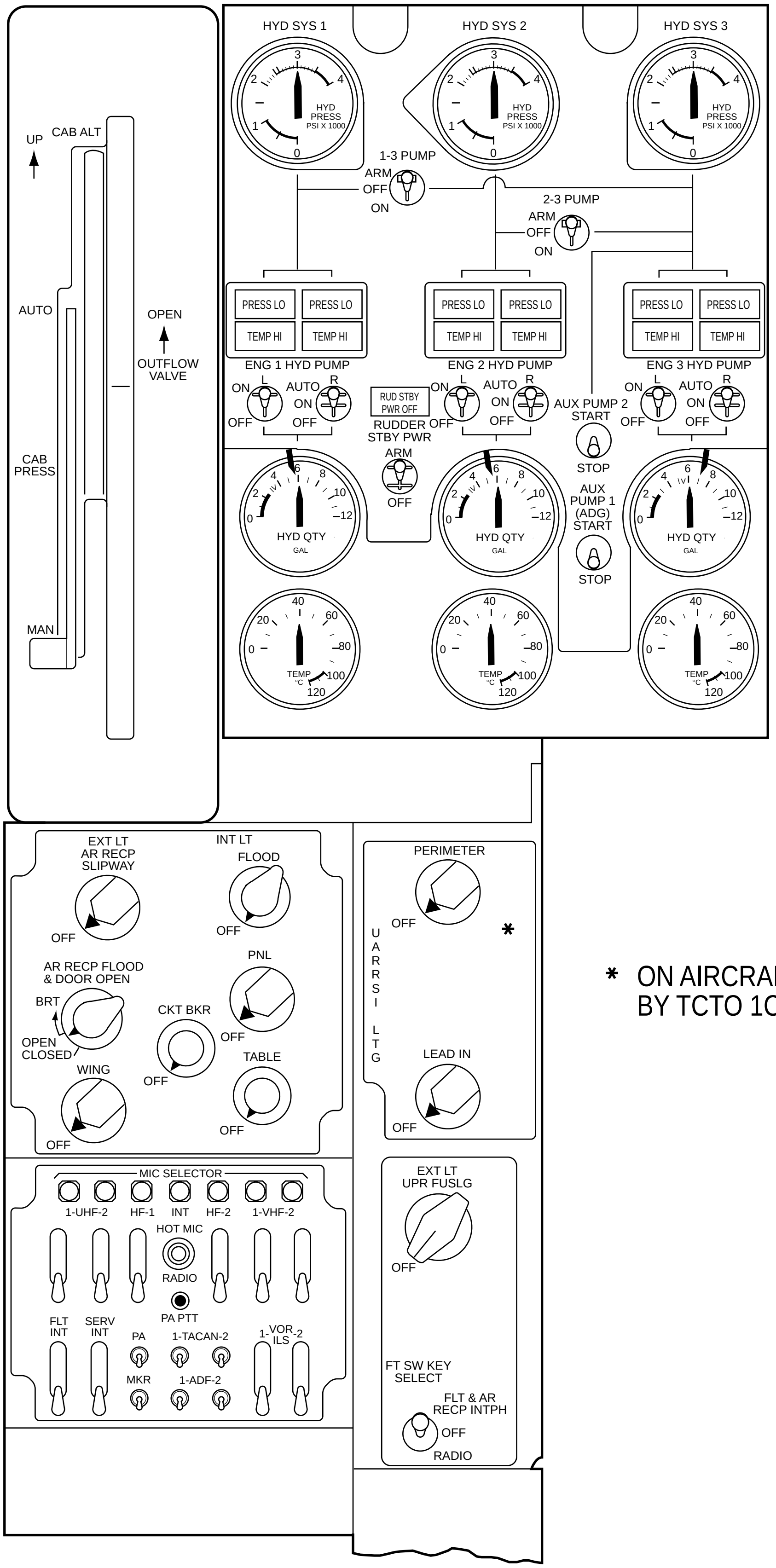


Figure 1.1-22. Flight Engineer's Compartment



* ON AIRCRAFT MODIFIED
BY TCTO 1C-10(K)A-957

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Figure 1.1-23. Flight Engineer's Lower Instrument Panel, Hydraulic Panel And Console

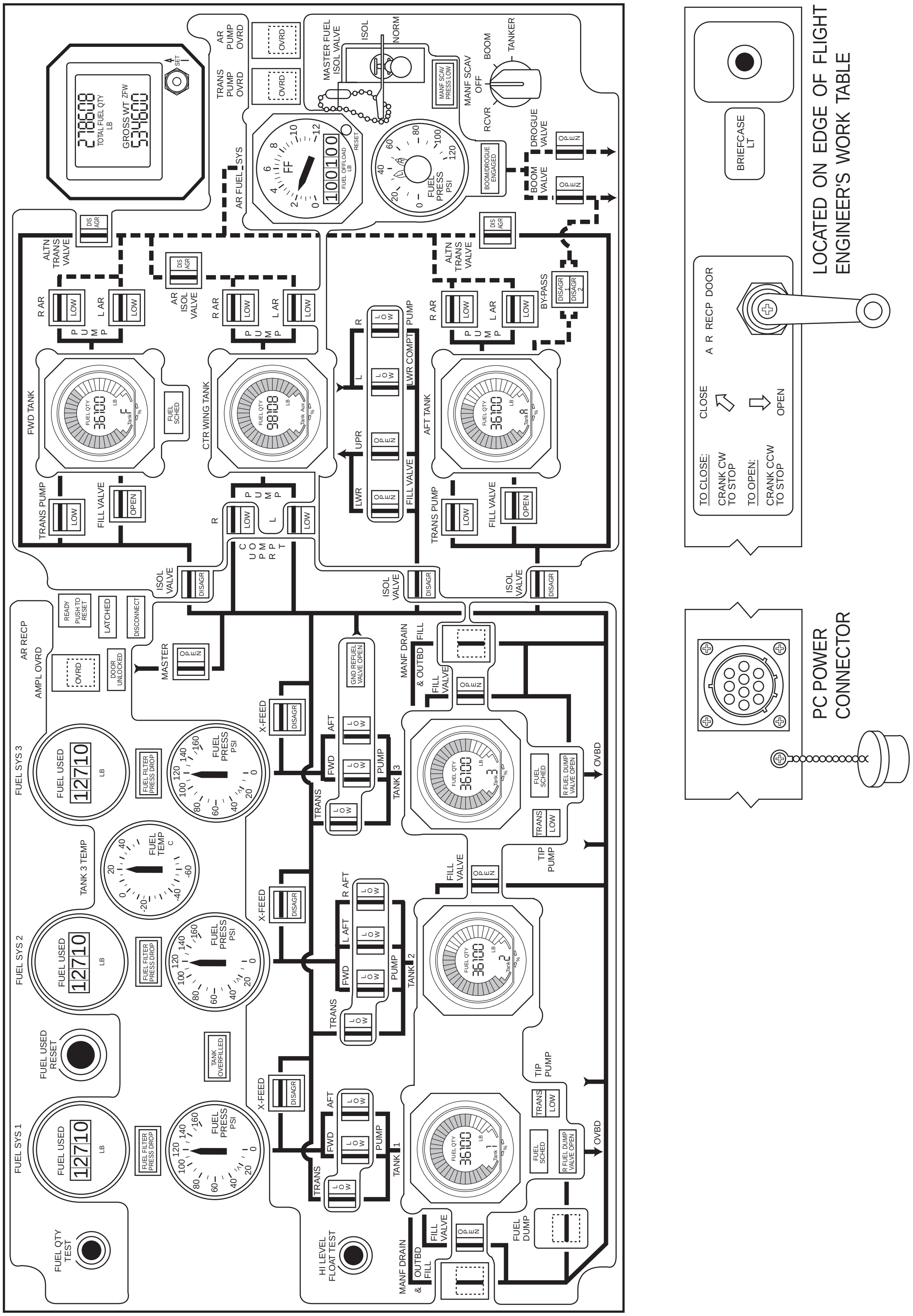

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Figure 1.1-24. Flight Engineer's Lower Instrument Panel, Fuel and Miscellaneous

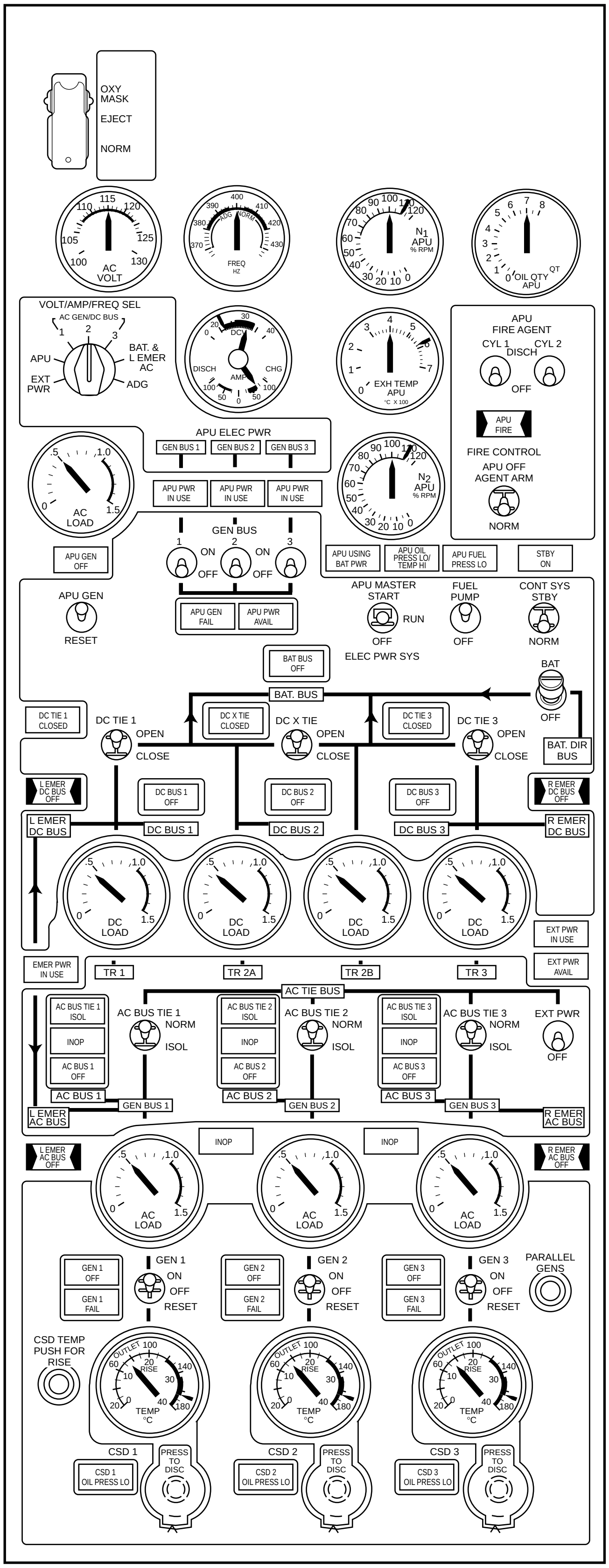

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Figure 1.1-25. Flight Engineer's Upper Instrument Panel No. 1

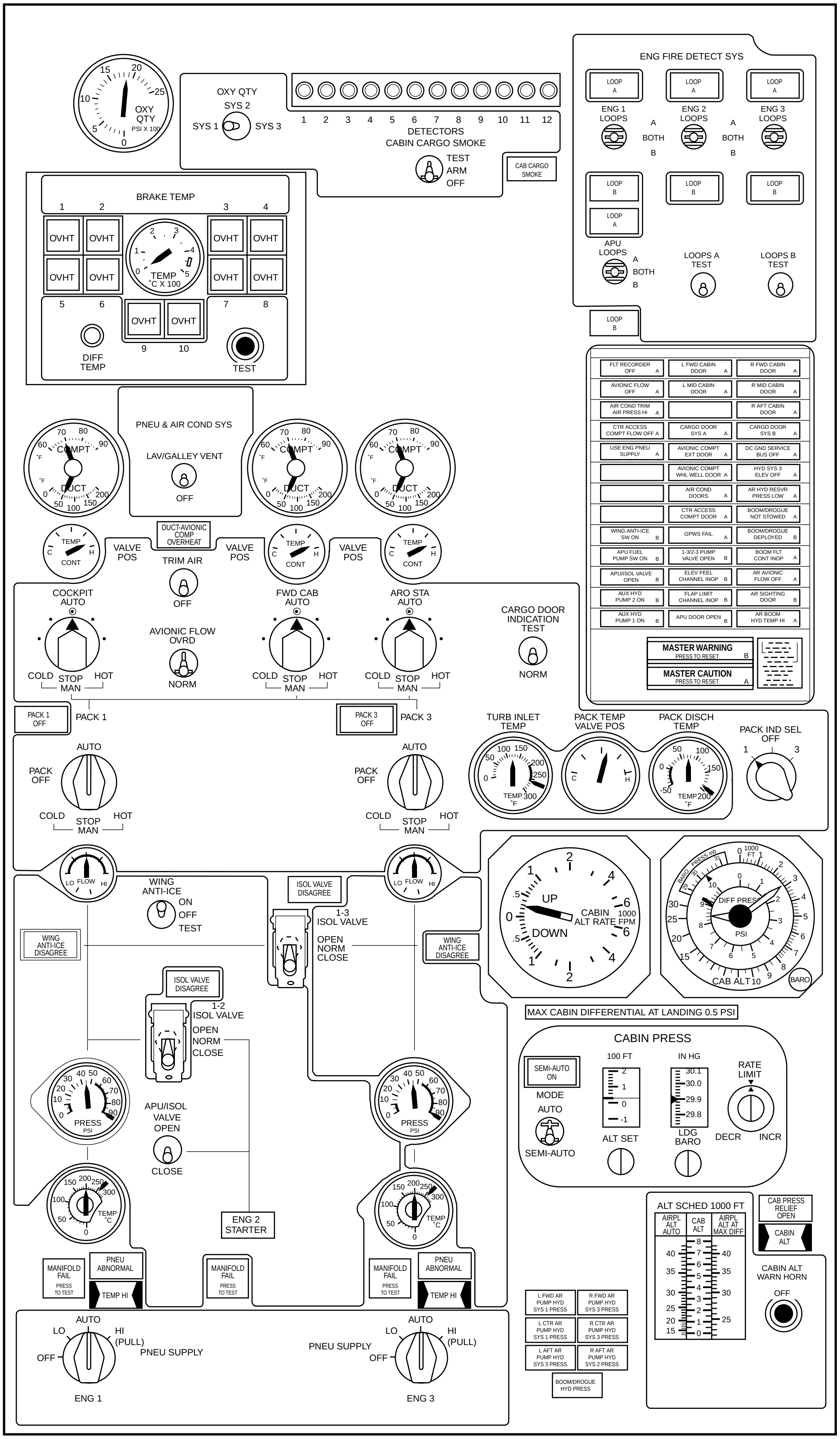

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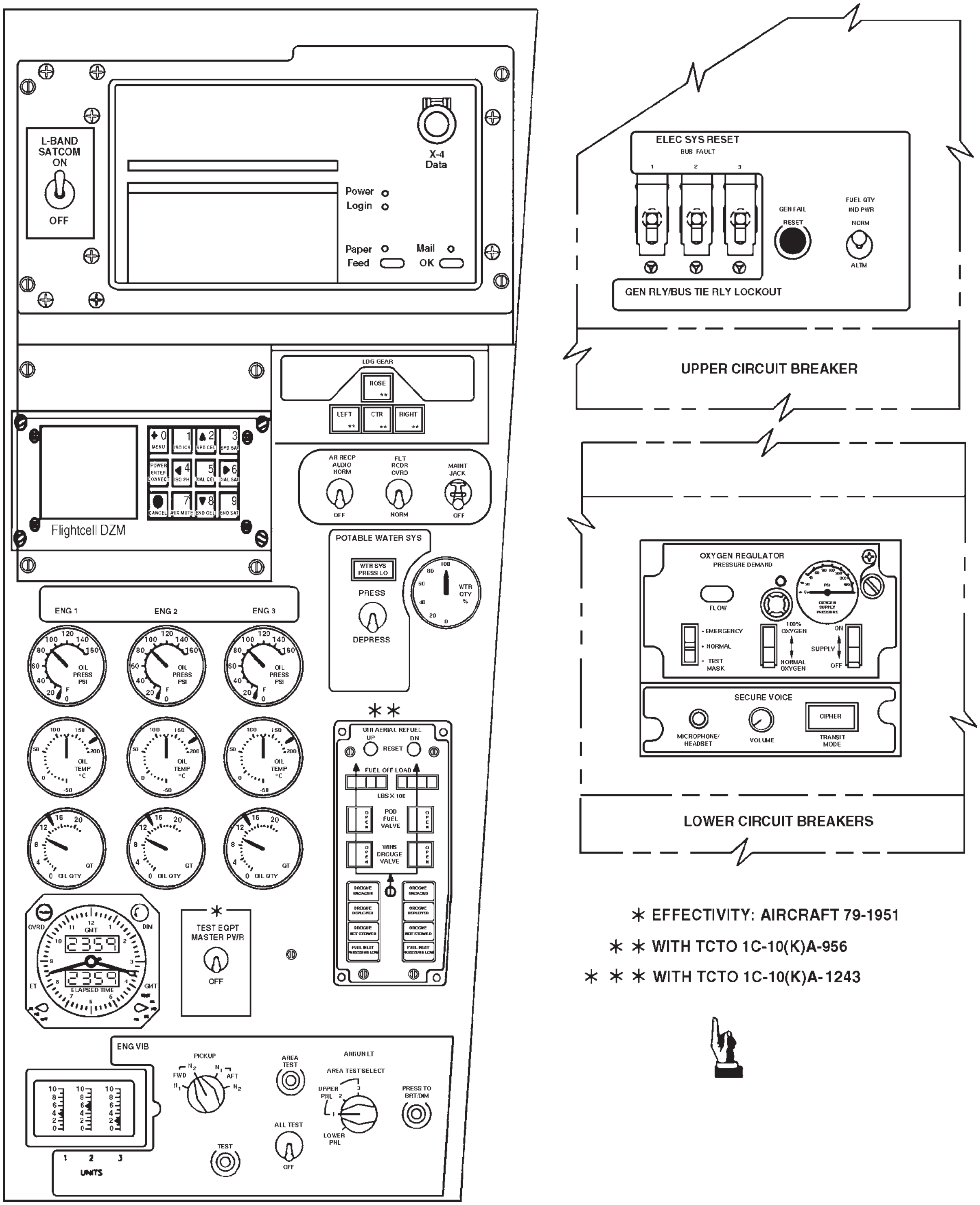
Figure 1.1-26. Flight Engineer's Upper Instrument Panel No. 2



∗ EFFECTIVITY: AIRCRAFT 79-1951

∗ ∗ WITH TCTO 1C-10(K)A-956

∗ ∗ ∗ WITH TCTO 1C-10(K)A-1243

Figure 1.1-27. Flight Engineer's Upper Instrument Panel No. 3

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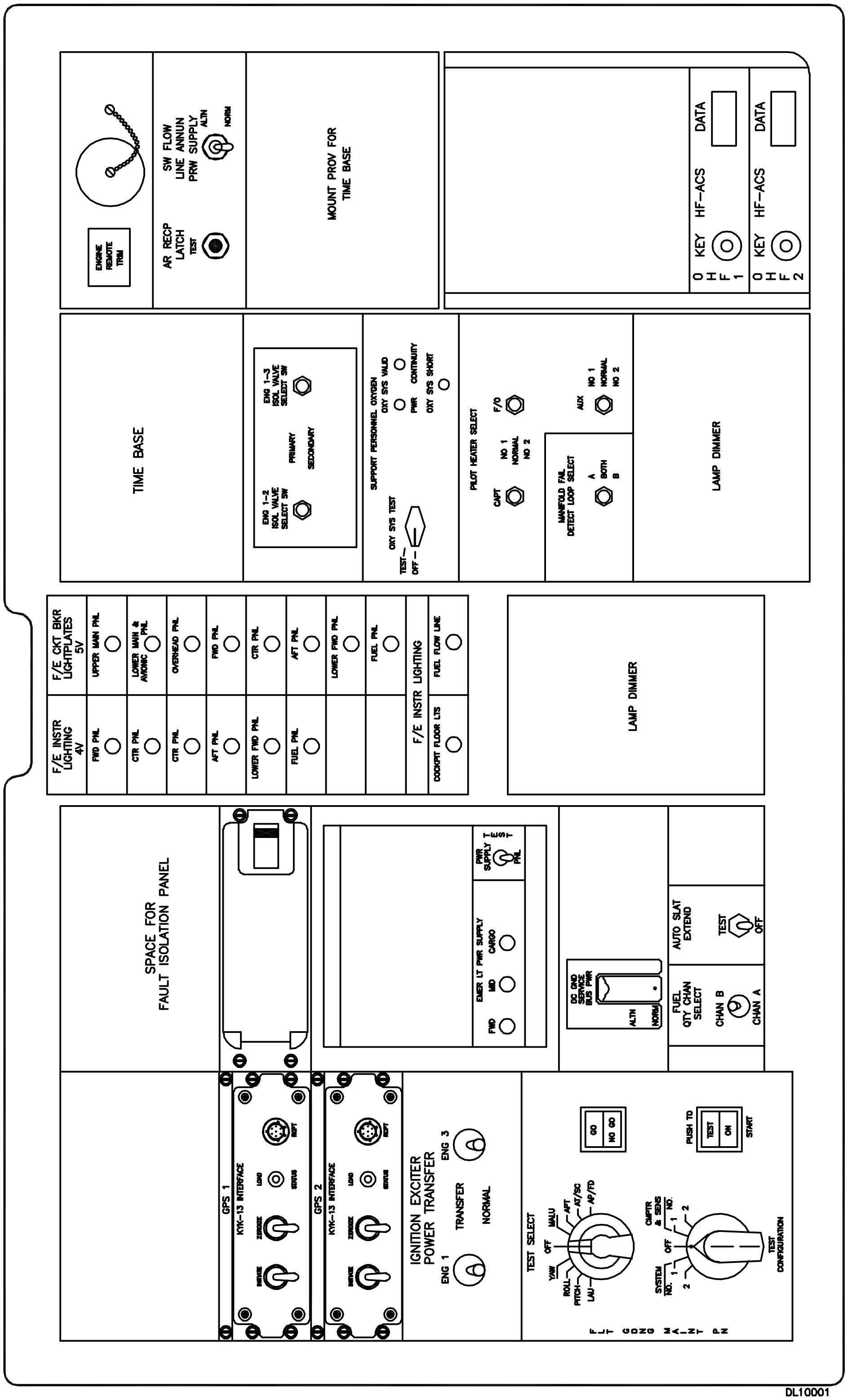
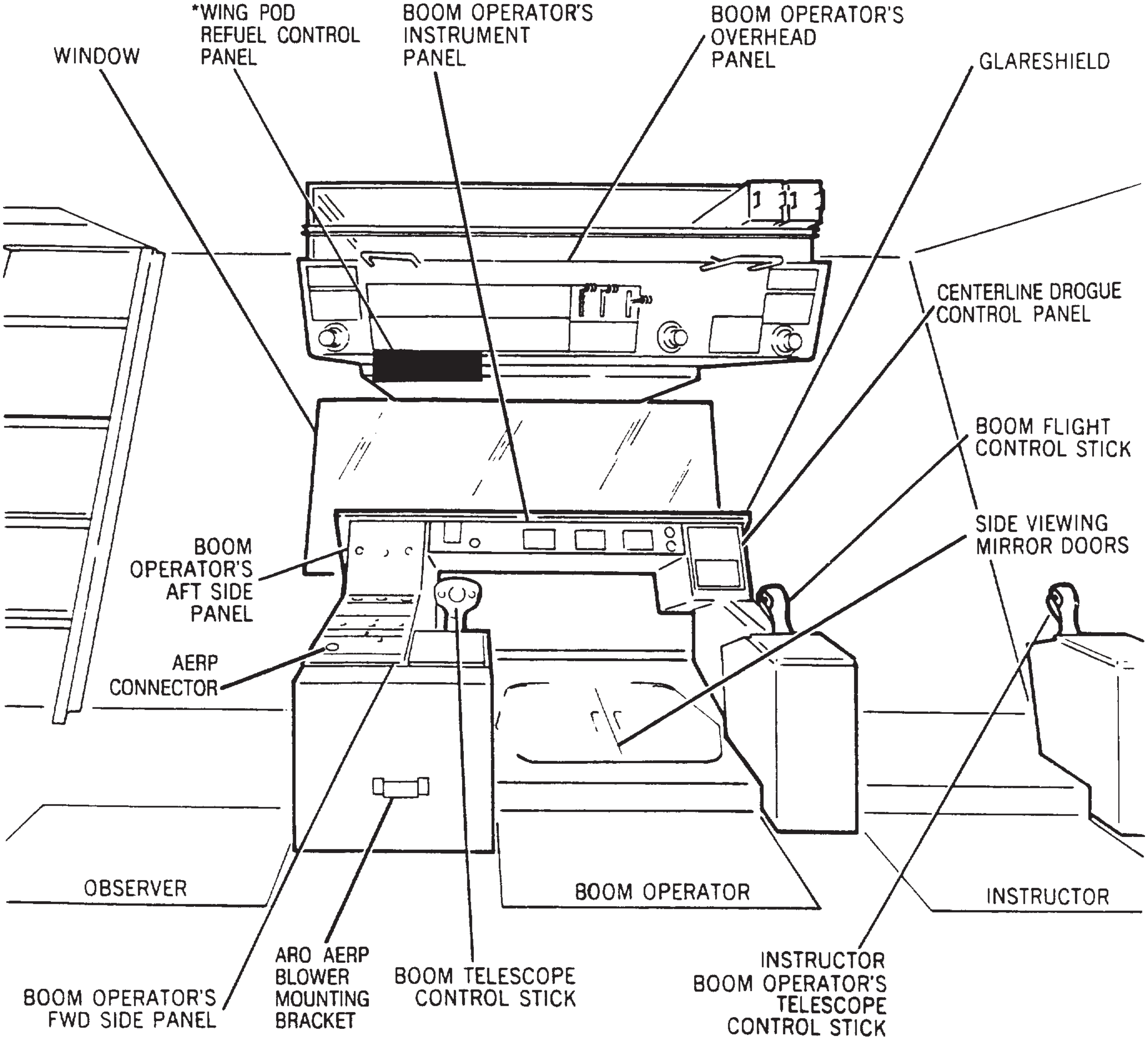


Figure 1.1-28. Flight Engineer's Equipment Panel



* WITH TCTO 1C-10(K)A-956

For complete breakdown and description of ARO compartment see part 15. (Air Refueling Boom/Hose).

SA1-555B

Figure 1.1-29. ARO Compartment

LOOSE ARTICLES

This presents a common but extremely hazardous dilemma - attempting to recover the article to avoid engine damage may result in stepping too close to the engine inlet. The pulling force increases rapidly as the distance decreases between the object and the inlet. The suction more than doubles with each half step closer. Also merely turning the body 90 from profile could double the force, and standing up from a crouched position could triple the effect.

DANGEROUS PROXIMITY

Not only do the pulling forces increase rapidly as the object moves toward the inlet, but the airflow changes rapidly around the inlet. A body passing through the different airflows is subject to a twisting effect which could cause tumbling and a loss of body control. The effect is especially strong near the lower lip of the engine inlet. Additional margins of safety must be observed to preclude the possibility of tripping or stumbling toward the inlet, or momentary inattention while working.

ENGINE RUN-UP

There is no maintenance or operational procedure requiring personnel to be in the vicinity of an engine during power run-up. Note that the restricted area for the inlet extends aft of the inlet opening as well as in front. Operating the engine(s) at high power settings around the flight ramp is not typical, however the throttle could be advanced without any warning to ground personnel.

PORTABLE SCREENS

Portable screens are not usually found on ramp areas, and danger areas around restricted areas are not usually marked. These two preventive measures should be used for ramp safety as they provide an extra margin of safety for ground personnel working in the vicinity of the engine.

GALLEY DESCRIPTION

The galley is located inboard and forward of the left forward passenger door 1L (figure 1.1-30).

The galley provides facilities for receiving, storing, and preparing inflight meals for the crew and/or passengers. The galley also provides stowage space for standard items of inflight equipment. The galley contains two ovens, a coffeemaker, beverage container, hot cup and receptacle, work light, work counter, electrical control panel, two-compartment thermostatically controlled refrigerator, sink, paper cup dispenser, bottle opener, waste chute and waste container, food tray stowage compartment, first aid kit stowage compartment, miscellaneous stowage drawer and compartment, stowage and fire extinguisher compartment, stowage and life raft compartment, and an exposure suit compartment.

LAVATORIES DESCRIPTION

The forward lavatory is located inboard and forward of the right forward door 1R (figure 1.1-31). The Z lavatory, on aircraft in the expanded Code D and Code J configuration, is installed on the left side of the cabin just forward of the cargo door (figure 1-32). The toilet in each lavatory is a self-contained unit. The forward lavatory has a drinking fountain recess accessible from the passenger compartment aisle.

Each lavatory contains a flushing-type toilet, pullman-type cabinet including washbasin with hot and cold running water, dispenser cabinet, mirror group, convenience panel, and a ceiling group with oxygen supply and speaker unit. A pullman-type cabinet in each lavatory contains a pullman deck, which includes a washbasin with hot and cold water controls, ashtray and soap dispenser; adjustable air outlet; toilet flushing handle and a utility cabinet with holders for toilet tissue; sanitary napkins; sickness bags; a bin for sickness container disposal, and a wastepaper disposal container. A mirror in each lavatory covers almost all of the lavatory wall above the pullman deck. A light is installed along the vertical edge of the mirror and provides illumination for the lavatory enclosure. A dispenser cabinet in each lavatory is mounted to the side wall above the pullman deck and contains dispensers for paper cups, facial tissues, and paper towels. A convenience

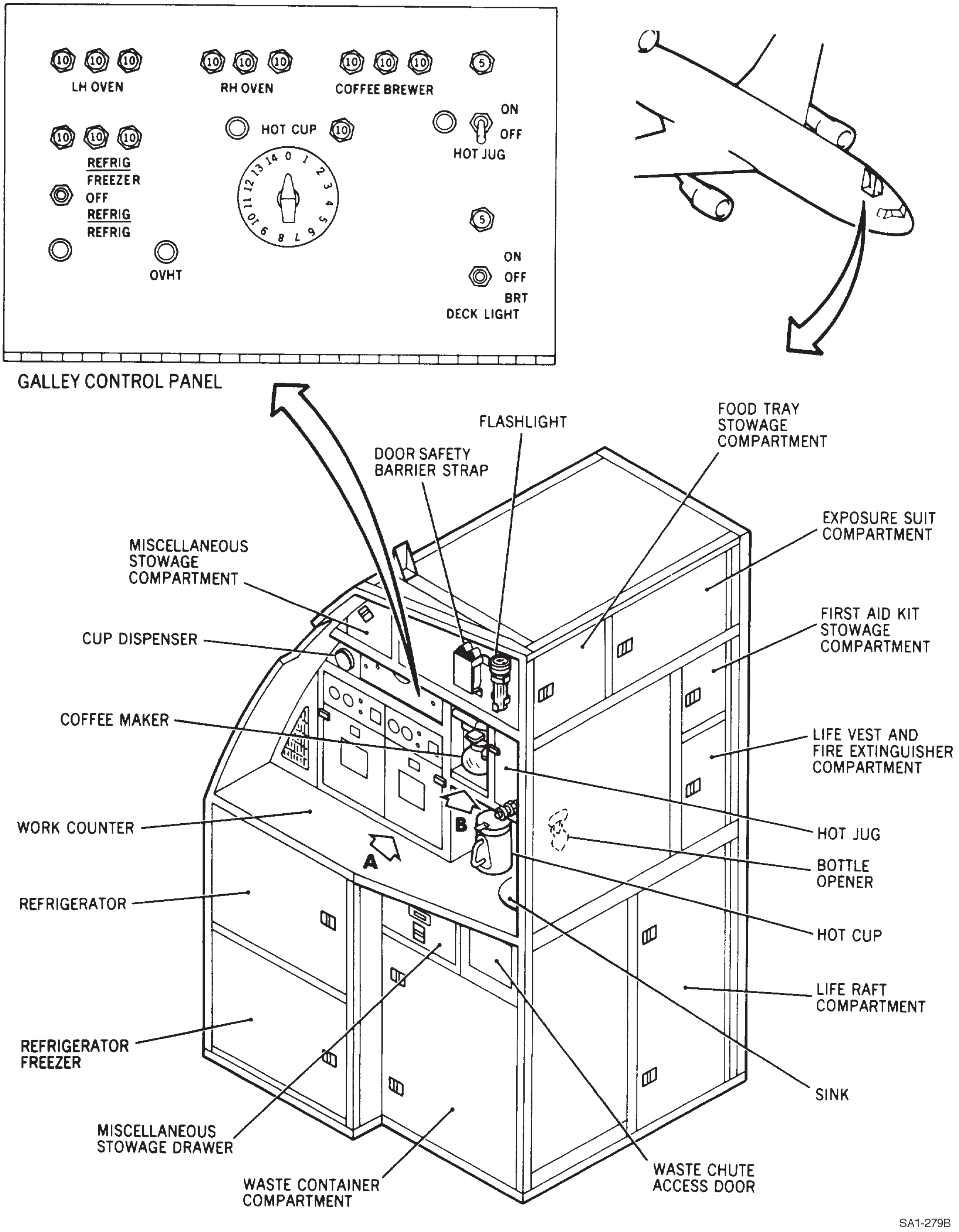
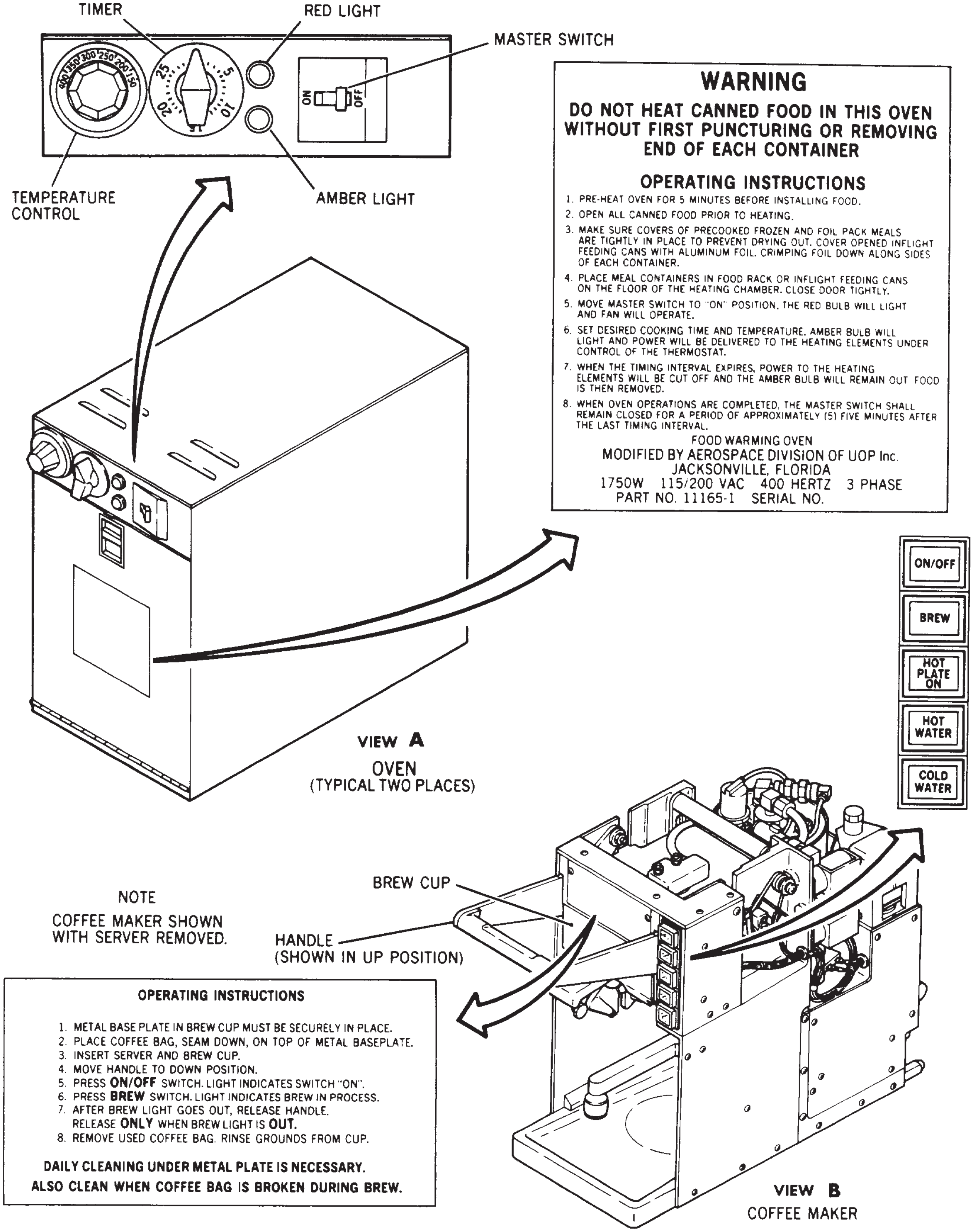


Figure 1.1-30. Galley Unit (Sheet 1)



WARNING

DO NOT HEAT CANNED FOOD IN THIS OVEN WITHOUT FIRST PUNCTURING OR REMOVING END OF EACH CONTAINER

OPERATING INSTRUCTIONS

1. PRE-HEAT OVEN FOR 5 MINUTES BEFORE INSTALLING FOOD.
2. OPEN ALL CANNED FOOD PRIOR TO HEATING.
3. MAKE SURE COVERS OF PRECOOKED FROZEN AND FOIL PACK MEALS ARE TIGHTLY IN PLACE TO PREVENT DRYING OUT. COVER OPENED INFLIGHT FEEDING CANS WITH ALUMINUM FOIL, CRIMPING FOIL DOWN ALONG SIDES OF EACH CONTAINER.
4. PLACE MEAL CONTAINERS IN FOOD RACK OR INFLIGHT FEEDING CANS ON THE FLOOR OF THE HEATING CHAMBER. CLOSE DOOR TIGHTLY.
5. MOVE MASTER SWITCH TO "ON" POSITION. THE RED BULB WILL LIGHT AND FAN WILL OPERATE.
6. SET DESIRED COOKING TIME AND TEMPERATURE. AMBER BULB WILL LIGHT AND POWER WILL BE DELIVERED TO THE HEATING ELEMENTS UNDER CONTROL OF THE THERMOSTAT.
7. WHEN THE TIMING INTERVAL EXPIRES, POWER TO THE HEATING ELEMENTS WILL BE CUT OFF AND THE AMBER BULB WILL REMAIN OUT. FOOD IS THEN REMOVED.
8. WHEN OVEN OPERATIONS ARE COMPLETED, THE MASTER SWITCH SHALL REMAIN CLOSED FOR A PERIOD OF APPROXIMATELY (5) FIVE MINUTES AFTER THE LAST TIMING INTERVAL.

FOOD WARMING OVEN
MODIFIED BY AEROSPACE DIVISION OF UOP Inc.
JACKSONVILLE, FLORIDA
1750W 115/200 VAC 400 HERTZ 3 PHASE
PART NO. 11165-1 SERIAL NO.

OPERATING INSTRUCTIONS

1. METAL BASE PLATE IN BREW CUP MUST BE SECURELY IN PLACE.
2. PLACE COFFEE BAG, SEAM DOWN, ON TOP OF METAL BASEPLATE.
3. INSERT SERVER AND BREW CUP.
4. MOVE HANDLE TO DOWN POSITION.
5. PRESS **ON/OFF** SWITCH. LIGHT INDICATES SWITCH "ON".
6. PRESS **BREW** SWITCH. LIGHT INDICATES BREW IN PROCESS.
7. AFTER BREW LIGHT GOES OUT, RELEASE HANDLE. RELEASE **ONLY** WHEN BREW LIGHT IS **OUT.**
8. REMOVE USED COFFEE BAG. RINSE GROUNDS FROM CUP.

DAILY CLEANING UNDER METAL PLATE IS NECESSARY.
ALSO CLEAN WHEN COFFEE BAG IS BROKEN DURING BREW.

Figure 1.1-30. Galley Unit (Sheet 2)

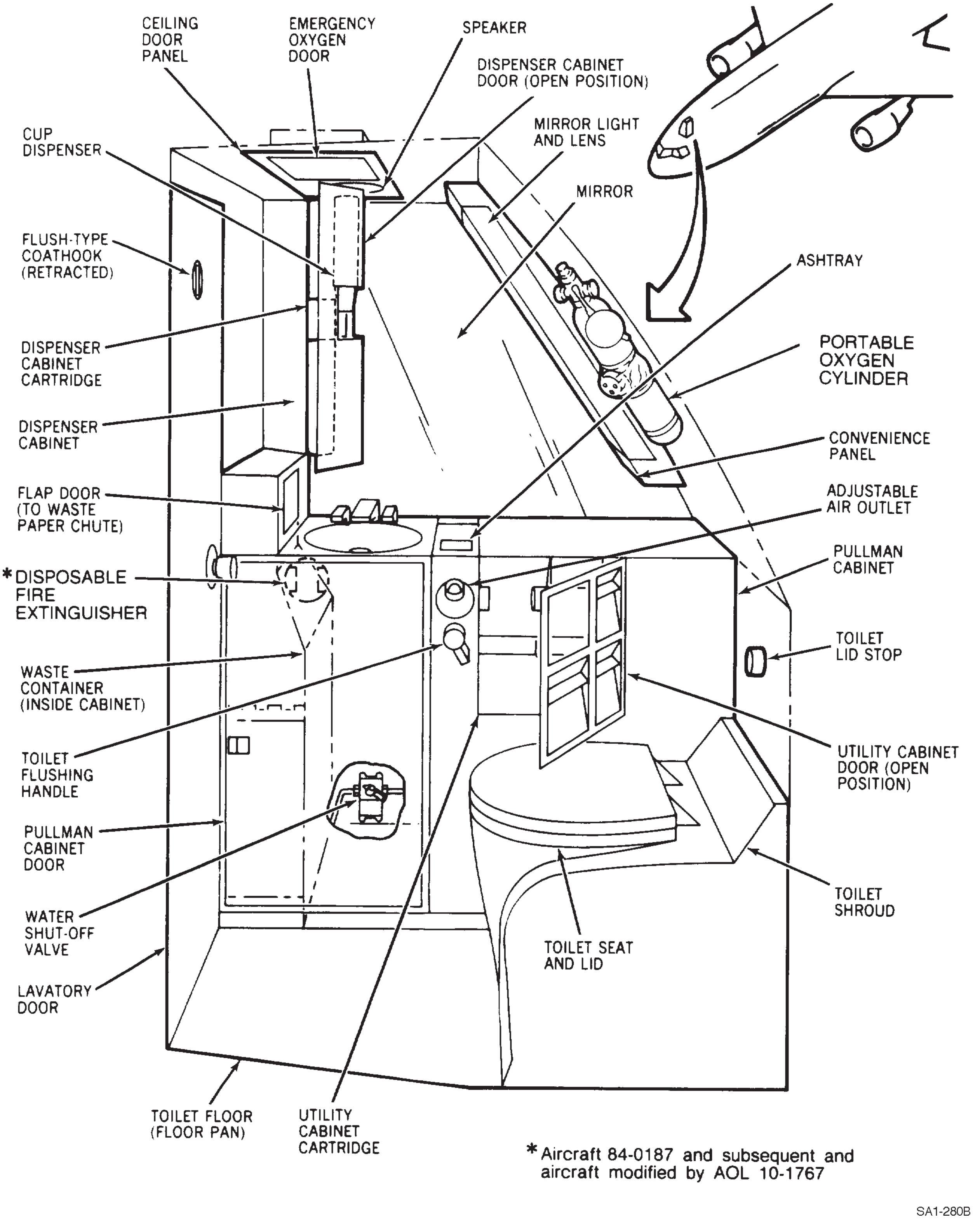


Figure 1.1-31. Forward Lavatory Arrangement

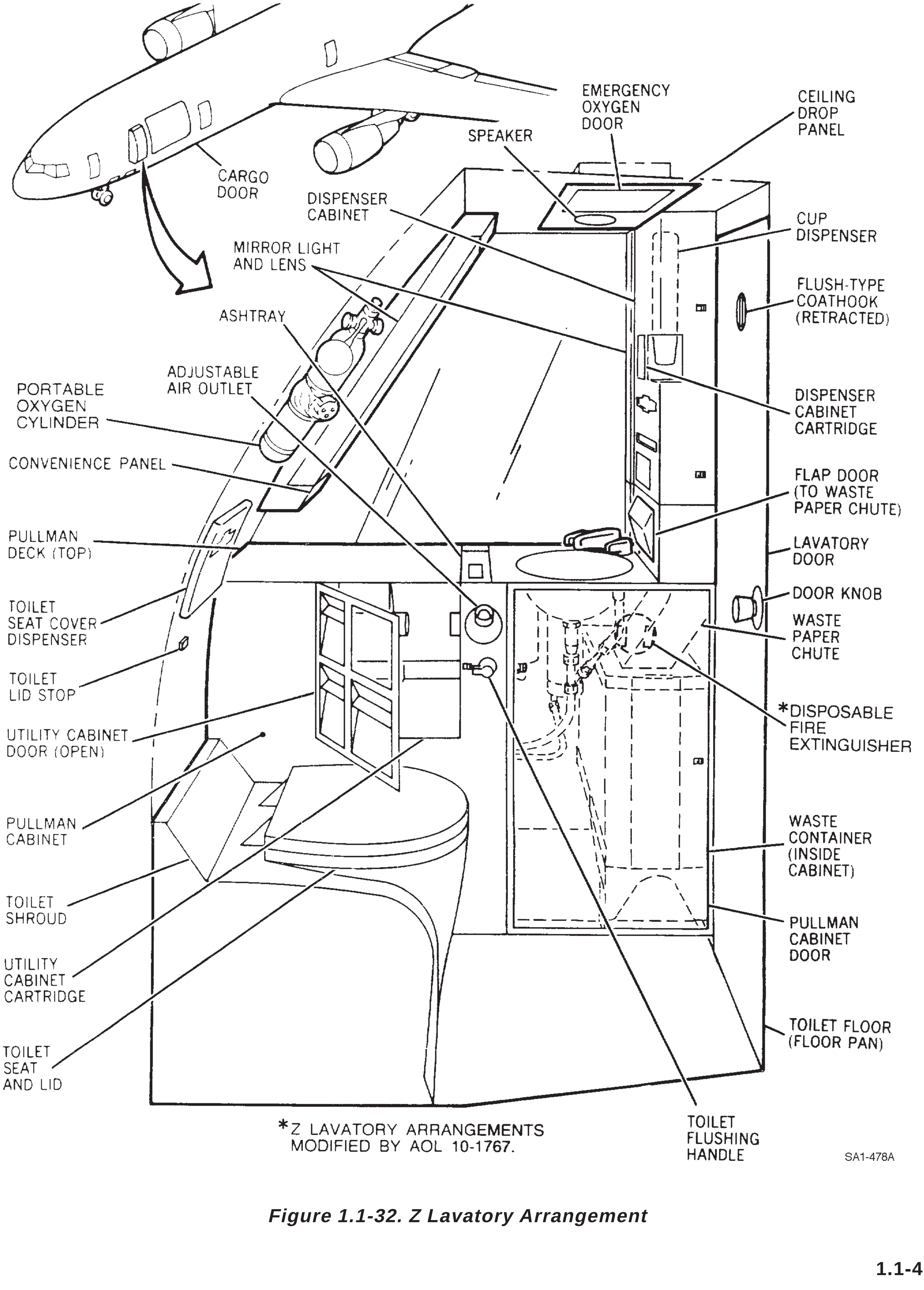


Figure 1.1-32. Z Lavatory Arrangement

panel in each lavatory incorporates an electrical razor outlet and razor blade disposal slot. A sign that illuminates, to order a lavatory occupant to return to his/her seat, is located on the light panel opposite the convenience panel. A water shut-off valve, located below the washbasin, shuts off water to the lavatory and drinking fountain when moved to the closed position. Circuit protection for both lavatories is located on the overhead panel circuit breaker panel (figures 1.4-9 and 1.4-10).

WASTE SYSTEM, FORWARD AND MID LAVATORIES

The forward and Z lavatory waste systems provide a recirculation type flushing toilet with integral tank and associate plumbing for priming, draining, and rinsing the tank. The forward lavatory waste system is serviced at the service panel located on the lower fuselage at station 405 and is primed with water and chemical mixture. A heated drain port at the forward service panel will prevent freezing of any fluid accumulation. The Z lavatory waste system is serviced through the upper cargo door opening. The service panel, snorkel assembly, and rinse nipple assembly are located behind the outboard door of the aft cabinet on the lavatory at station 625.

Draining the waste tanks is accomplished by opening the drain valve of each toilet using the respective drain valve control on the service panels.

Waste water from the galley, washstand, and drinking fountain is collected in drain manifolds and routed overboard through a heated drain mast.

GROUND SERVICE POWER FUNCTION

The ground service power supply operates the electrical components for draining and priming the waste system.

POTABLE WATER SYSTEM

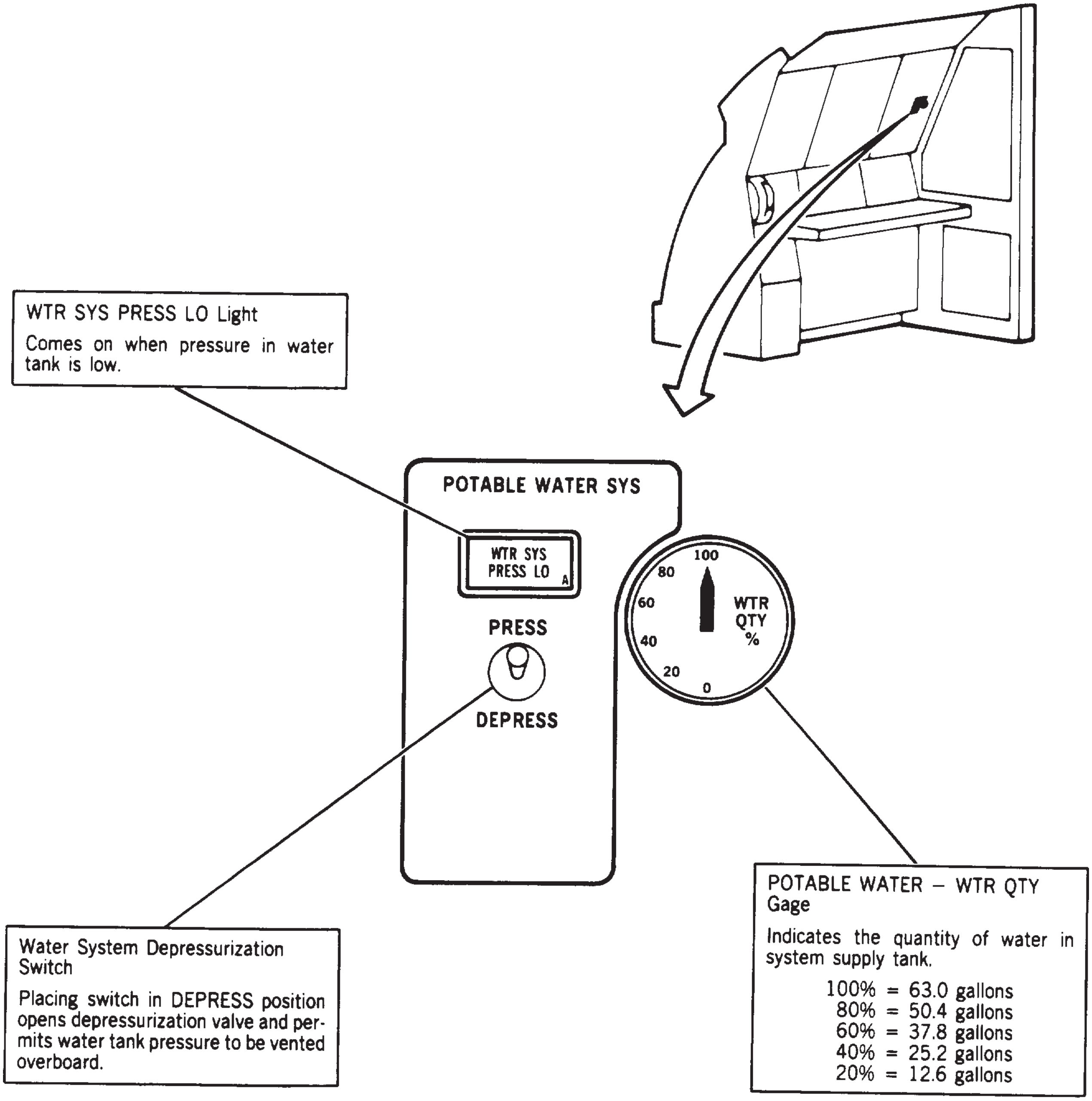
A single 63-gallon, potable water system provides pressurized and filtered fresh water to the galley, coffee maker, drinking fountain and lavatory washstand. When the engines or APU are operating, bleed-air pressure automatically pressurizes the water system from 38 to 43.5 psi. If engine or APU air pressure falls below 26 ±1 psi, a compressor motor is automatically energized to maintain normal system pressure, providing electrical power is available. When electrical power or pneumatic systems are not available, the system can be pressurized at the exterior service panel. A water system low pressure indicating light, and a water quantity indicator graduated in percent of capacity for the tank, are located on the FE Upper Panel No. 3 (figure 1.1-33).

PALLETIZED INSTRUMENTATION SYSTEM

Internal modifications have been made to aircraft 79-1951 for installation of a palletized flight test data acquisition system. Electrical power for the data system is controlled through the TEST EQUIP MASTER PWR switch located on the Flight Engineer's Upper Instrument Panel No. 3 (figure 1.1-27). Placing the switch in the OFF position will isolate the data system from the aircraft's electrical system. Circuit protection is provided through the TEST EQUIP CONT PWR circuit breaker and TEST EQUIP PWR circuit breaker. The electrical shorting plug connection for the data system is shown on the TEST EQUIPMENT DISTRIBUTION PANEL. Specific descriptions of the palletized data system and its components are contained in the user's handbook. Further aircraft specific information is contained in the Partial Flight Manual for aircraft 79-1951.

LIGHTING DESCRIPTION

Normal aircraft lighting systems comprise the cockpit, passenger cabin, galley, ARO compartment, and exterior systems. The latter category includes only those exterior lights which are controlled from the cockpit. Within each major subsystem, the general illumination, supplementary, and standby lighting systems are discussed if applicable.



WTR SYS PRESS LO Light

Comes on when pressure in water tank is low.

Water System Depressurization Switch

Placing switch in DEPRESS position opens depressurization valve and permits water tank pressure to be vented overboard.

POTABLE WATER – WTR QTY Gage

Indicates the quantity of water in system supply tank.

100% = 63.0 gallons
80% = 50.4 gallons
60% = 37.8 gallons
40% = 25.2 gallons
20% = 12.6 gallons

FLIGHT ENGINEER'S UPPER PANEL NO. 3

SA1-427

Figure 1.1-33. Potable Water Controls And Indicators

COCKPIT LIGHTING

Cockpit illumination is provided by primary, secondary, thunderstorm, and standby lighting systems. The primary system consists of integrally lighted instruments and lightplates with individual control circuits to provide a continuous control of the illumination from maximum intensity to off. Fluorescent lamps are used in a dome light for general illumination of the cockpit. For the secondary system, fluorescent and incandescent-lamp floodlights are used for the main instrument panels and the Flight Engineer's work table. Incandescent floodlights are used for the Overhead Panel, the Pedestal, and the Flight Engineer's Instrument Panels. Individual controls are used for the floodlights to vary the illumination level, from maximum light intensity to off. A thunderstorm switching circuit is installed to override all instrument floodlight and dome light controls, and provide high-intensity illumination. Supplementary map, briefcase, chart holder, worktable, and floorlights are provided for crew utilization, as required. A standby lighting system is provided, which automatically turns on the selected white floodlights of the secondary lighting system, if normal electrical power fails to supply dc bus one. The standby system will provide the following operation:

1. The Center Instrument Panel incandescent floods will be energized only, and will illuminate the standby horizon, altimeter, and airspeed indicators. With the incandescent floodlight control in the full OFF position, the Center Instrument Panel will be illuminated with a preset light intensity. With a clockwise rotation of this control, the preset illumination level can be increased to maximum light intensity.

2. The left incandescent floodlight for the Overhead Panel and the Flight Engineer's Overhead Panel will be operated at preset light intensity. In the event of total loss of electrical power, the battery switch must be at BAT for the standby lights to operate. With the EMER PWR switch in the ON position, the incandescent floodlights for the Pilot's and Copilot's Instrument Panels will be energized with their respective incandescent floodlight knobs in the full OFF position, and will provide illumination at a preset light intensity. A clockwise rotation of the respective control will allow illumination level to be increased to maximum light intensity.

CABIN LIGHTING

Illumination in the cabin is provided by direct overhead lighting. Two trough lights at the forward end of the cabin, and ceiling lights provide illumination for the passenger portion of the cabin. In the cargo portion of the cabin, ceiling lights provide illumination throughout the cargo section back to the pressure bulkhead. There are threshold boarding lights in each entry way. In the event of cabin depressurization, the overhead lighting in all cabin sections is automatically actuated.

ARO COMPARTMENT LIGHTING

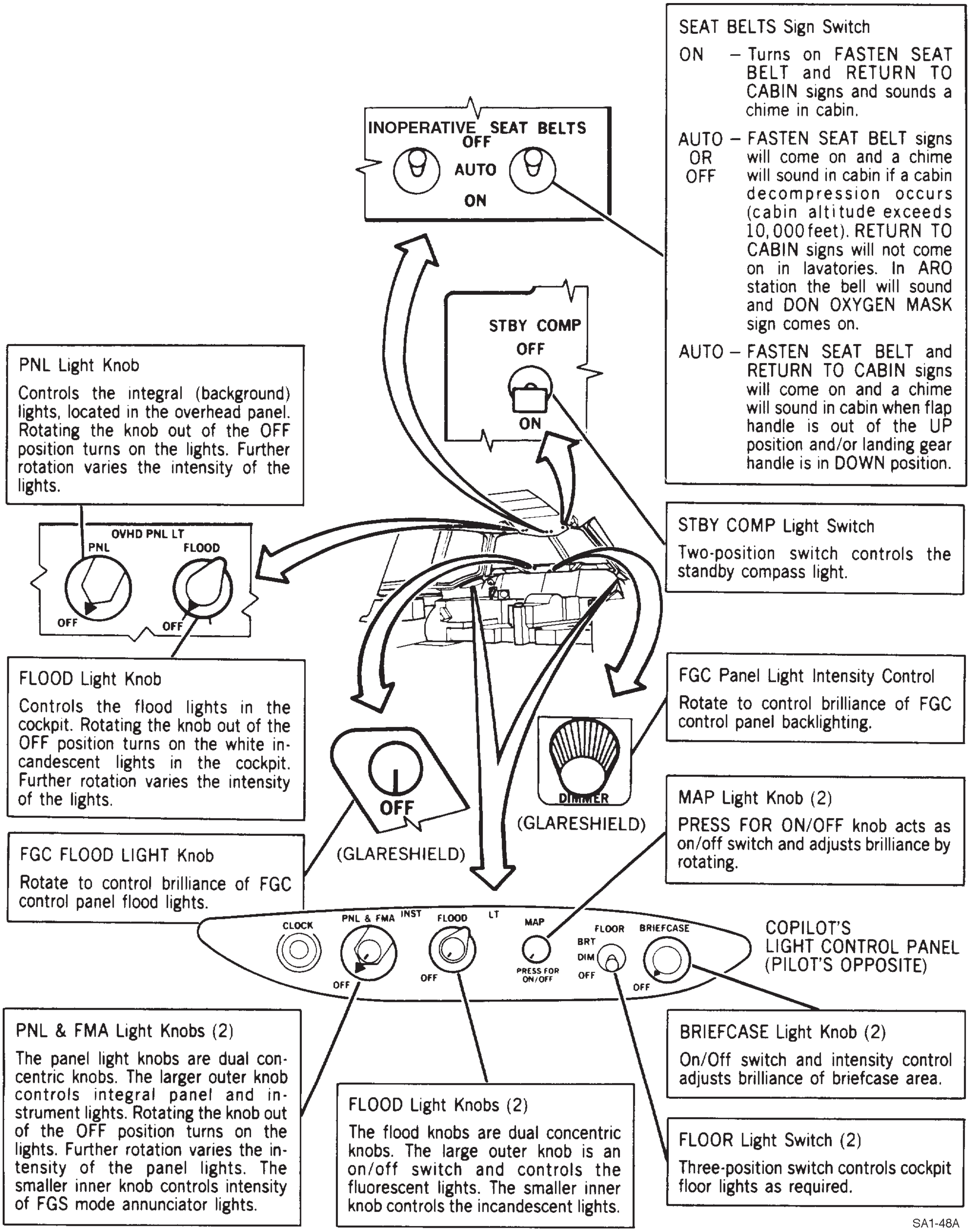
Two incandescent lights in the ceiling are turned on or off by moving the INCAND switch to the proper position. These lights also can be turned on or off by a switch located at the top of the entry ladder, just below the cargo compartment floor level. Three fluorescent lights located in the ceiling are controlled by the rheostat located on the Boom Operator's Lower Side Panel. One light located at the bottom of the entry ladder and one located in the floor forward of the observer's seat are controlled by a switch located on the Boom Operator's Lower Side Panel. Boom position, instrument, gage and panel lights are controlled by rheostats located on the Boom Operator's Side Panel. Two lights located in the forward wall of the ARO compartment and one in the ceiling are used to illuminate the Overhead Panel and the Boom Operator's Lower Side Panel. They are controlled by rheostats located on the Boom Operator's Lower Side Panel. An IBO light is provided on the left overhead panel. Controls are on the light itself.

EXTERIOR LIGHTING

The exterior lighting consists of landing, ground operating, wing scan, high intensity strobe, formation and position lights, and pilot director lights (figures 1.1-36, 1.1-37 and 1.1-38). The controllable-sequence anti-collision/rendezvous lights serve a dual purpose as anti-collision beacons (white) and coded identification lights (white or red or white and red) for use during formation refueling operations. One is located on top center and one on bottom center of the fuselage. There are four landing lights, one located on each side of the forward fuselage and two on the nose gear. Two ground flood/runway turnoff lights located on each side of the fuselage near the wing root, may be used to supplement the nose gear landing lights during taxi operations and for general illumination. Scan lights for the wing, engine one nacelle and engine three nacelle illumination are located on each side of the fuselage forward of the wing. Position lighting consists of a non-standard arrangement of lights on each wing tip. Dual red and green lights are mounted on each wing tip in the standard manner, but the white position lights are mounted two on the trailing edge of each wing tip, rather than on the tail. This wing tip arrangement still provides standard left/right and fore/aft orientation to an external observer. In addition, each wing tip has three sequentially flashing high intensity lights which flash alternately with the anti-collision/rendezvous lights and are controlled from the cockpit. Formation lights are located fore and aft on both sides of the fuselage, both sides of the vertical stabilizer and on each wing tip to aid in orientation during night formation flights. Logo lights are mounted on the horizontal stabilizer and positioned to illuminate the logo on the vertical stabilizer. Fuselage lights, located on each inboard flap hinge, illuminate the forward underbody fuselage. Lights located in the vertical stabilizer illuminate the upper fuselage. The aft fuselage is illuminated by a light located in the inboard side of each outboard flap hinge. Floodlights, located in the tailcone, illuminate the receiver aircraft during refueling. The control is located on the ARO Forward Side Panel. Underwing lights are located in the ARO external mirror fairing and illuminate the underside of the wing. The horizontal stabilizer lights are located in the fuselage below the stabilizer and illuminate the underside of the horizontal stabilizer. The controls are located on the Boom Operator's Overhead Panel.

CONTROLS AND INDICATORS

Controls and indicators (figures 1.1-34 and 1.1-35) are on the Overhead Panel, the Pilot's and Copilot's Light Control Panels, and the Flight Engineer's Lower Panel. Locations of the panels and individual controls and indicators are illustrated and described in this section. For additional information regarding a specific system, refer to the pertinent part of this manual for an expanded description of system operation.



SEAT BELTS Sign Switch

ON – Turns on FASTEN SEAT BELT and RETURN TO CABIN signs and sounds a chime in cabin.

AUTO OR OFF – FASTEN SEAT BELT signs will come on and a chime will sound in cabin if a cabin decompression occurs (cabin altitude exceeds 10,000 feet). RETURN TO CABIN signs will not come on in lavatories. In ARO station the bell will sound and DON OXYGEN MASK sign comes on.

AUTO – FASTEN SEAT BELT and RETURN TO CABIN signs will come on and a chime will sound in cabin when flap handle is out of the UP position and/or landing gear handle is in DOWN position.

PNL Light Knob

Controls the integral (background) lights, located in the overhead panel. Rotating the knob out of the OFF position turns on the lights. Further rotation varies the intensity of the lights.

STBY COMP Light Switch

Two-position switch controls the standby compass light.

FLOOD Light Knob

Controls the flood lights in the cockpit. Rotating the knob out of the OFF position turns on the white incandescent lights in the cockpit. Further rotation varies the intensity of the lights.

FGC Panel Light Intensity Control

Rotate to control brilliance of FGC control panel backlighting.

MAP Light Knob (2)

PRESS FOR ON/OFF knob acts as on/off switch and adjusts brilliance by rotating.

FGC FLOOD LIGHT Knob

Rotate to control brilliance of FGC control panel flood lights.

PNL & FMA Light Knobs (2)

The panel light knobs are dual concentric knobs. The larger outer knob controls integral panel and instrument lights. Rotating the knob out of the OFF position turns on the lights. Further rotation varies the intensity of the panel lights. The smaller inner knob controls intensity of FGS mode annunciator lights.

FLOOD Light Knobs (2)

The flood knobs are dual concentric knobs. The large outer knob is an on/off switch and controls the fluorescent lights. The smaller inner knob controls the incandescent lights.

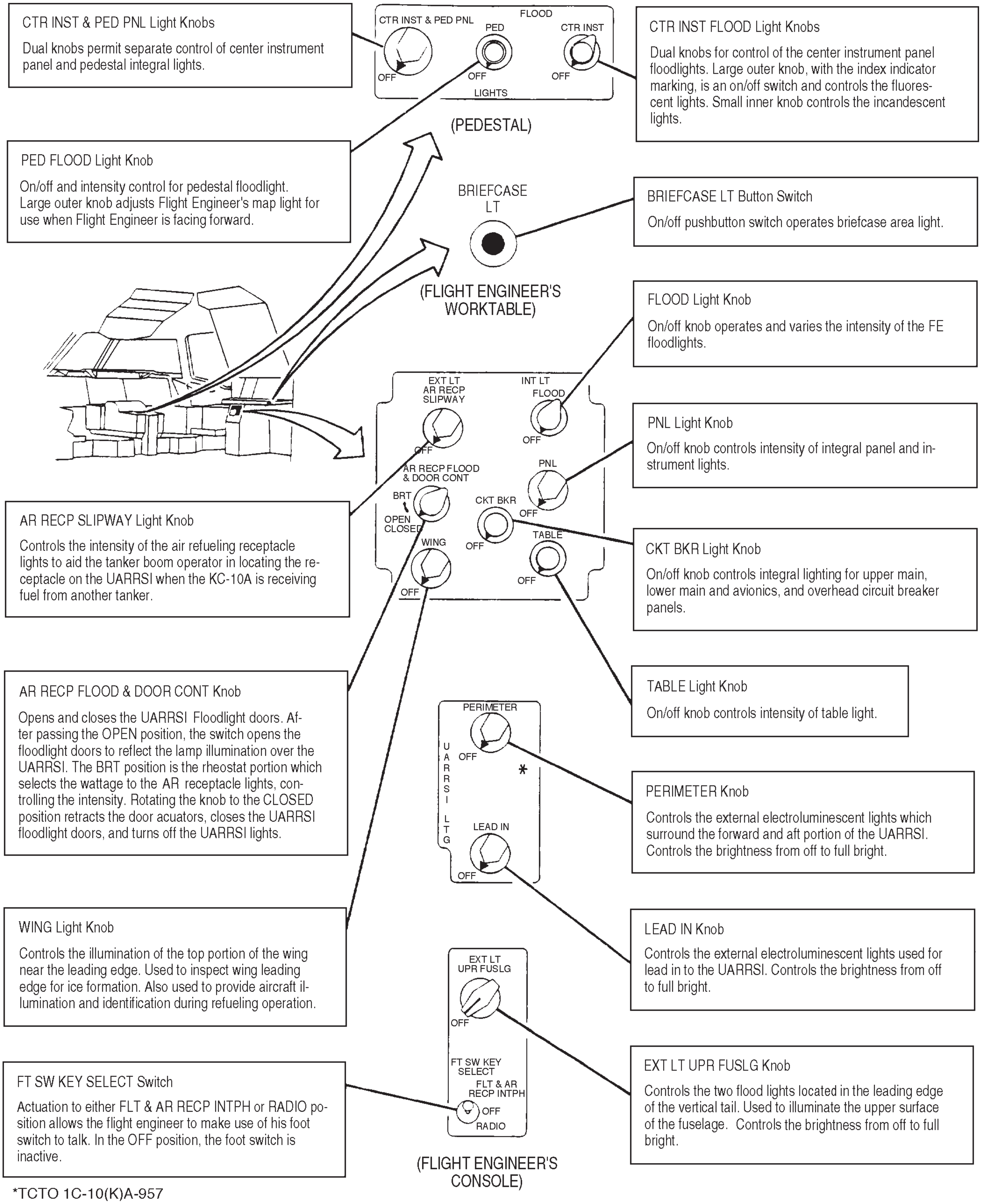
BRIEFCASE Light Knob (2)

On/Off switch and intensity control adjusts brilliance of briefcase area.

FLOOR Light Switch (2)

Three-position switch controls cockpit floor lights as required.

Figure 1.1-34. Cockpit Lighting Controls and Indicators (Sheet 1)



CTR INST & PED PNL Light Knobs

Dual knobs permit separate control of center instrument panel and pedestal integral lights.

PED FLOOD Light Knob

On/off and intensity control for pedestal floodlight. Large outer knob adjusts Flight Engineer's map light for use when Flight Engineer is facing forward.

AR RECP SLIPWAY Light Knob

Controls the intensity of the air refueling receptacle lights to aid the tanker boom operator in locating the receptacle on the UARRSI when the KC-10A is receiving fuel from another tanker.

AR RECP FLOOD & DOOR CONT Knob

Opens and closes the UARRSI Floodlight doors. After passing the OPEN position, the switch opens the floodlight doors to reflect the lamp illumination over the UARRSI. The BRT position is the rheostat portion which selects the wattage to the AR receptacle lights, controlling the intensity. Rotating the knob to the CLOSED position retracts the door acuators, closes the UARRSI floodlight doors, and turns off the UARRSI lights.

WING Light Knob

Controls the illumination of the top portion of the wing near the leading edge. Used to inspect wing leading edge for ice formation. Also used to provide aircraft illumination and identification during refueling operation.

FT SW KEY SELECT Switch

Actuation to either FLT & AR RECP INTPH or RADIO position allows the flight engineer to make use of his foot switch to talk. In the OFF position, the foot switch is inactive.

CTR INST FLOOD Light Knobs

Dual knobs for control of the center instrument panel floodlights. Large outer knob, with the index indicator marking, is an on/off switch and controls the fluorescent lights. Small inner knob controls the incandescent lights.

BRIEFCASE LT Button Switch

On/off pushbutton switch operates briefcase area light.

FLOOD Light Knob

On/off knob operates and varies the intensity of the FE floodlights.

PNL Light Knob

On/off knob controls intensity of integral panel and instrument lights.

CKT BKR Light Knob

On/off knob controls integral lighting for upper main, lower main and avionics, and overhead circuit breaker panels.

TABLE Light Knob

On/off knob controls intensity of table light.

PERIMETER Knob

Controls the external electroluminescent lights which surround the forward and aft portion of the UARRSI. Controls the brightness from off to full bright.

LEAD IN Knob

Controls the external electroluminescent lights used for lead in to the UARRSI. Controls the brightness from off to full bright.

EXT LT UPR FUSLG Knob

Controls the two flood lights located in the leading edge of the vertical tail. Used to illuminate the upper surface of the fuselage. Controls the brightness from off to full bright.

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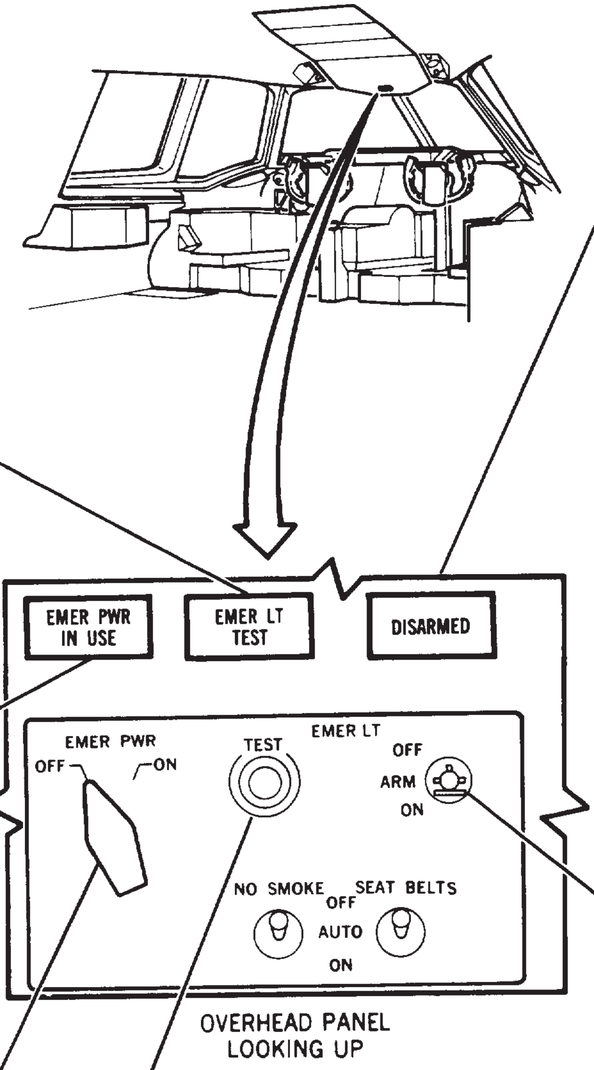
Figure 1.1-34. Cockpit Lighting Controls and Indicators (Sheet 2)



EMER LT TEST Light

Comes on after the emergency lights TEST button is pushed and held for 3 to 5 seconds if all battery pack voltages are normal during emergency lighting test.

EMER PWR IN USE Light

Comes on when the emergency power switch is placed in the ON position. Indicates that essential equipment is connected to the emergency power source.

EMER PWR Switch

OFF – Permits the left emergency ac and dc buses to receive power from the main distribution system and the battery to be charged when the battery switch is in the BAT position.

ON – Transfers left emergency ac and dc buses to the inverter and battery respectively. Turns on EMER PWR IN USE Light and disconnects battery charger from battery.

TEST Button

Push to test battery packs. All emergency lights will come on for testing condition of batteries under load. EMER LT TEST light will come on if all voltages are normal.

DISARMED Light

Comes on after the EMER LT switch is placed in the ON position. Remains on as long as sequential power is available.

EMER LT Switch

OFF – Prevents lights from coming on. DISARMED Light will come on. Connects battery packs to the continuous charging system when power is available to the airplane. The cockpit switch OFF position may be overriden by placing the emergency lights switch located on the crew/personnel compartment control panel in the ON position.

ARM – Provides automatic sequential-power selection for emergency lighting. Also connects battery packs to the continuous charging system when power is available to the airplane. Allows emergency lighting system to turn on automatically whenever normal airplane power is interrupted.

ON – Causes the emergency lights and the DISARMED light to come on. These lights will remain on as long as sequential power is available.

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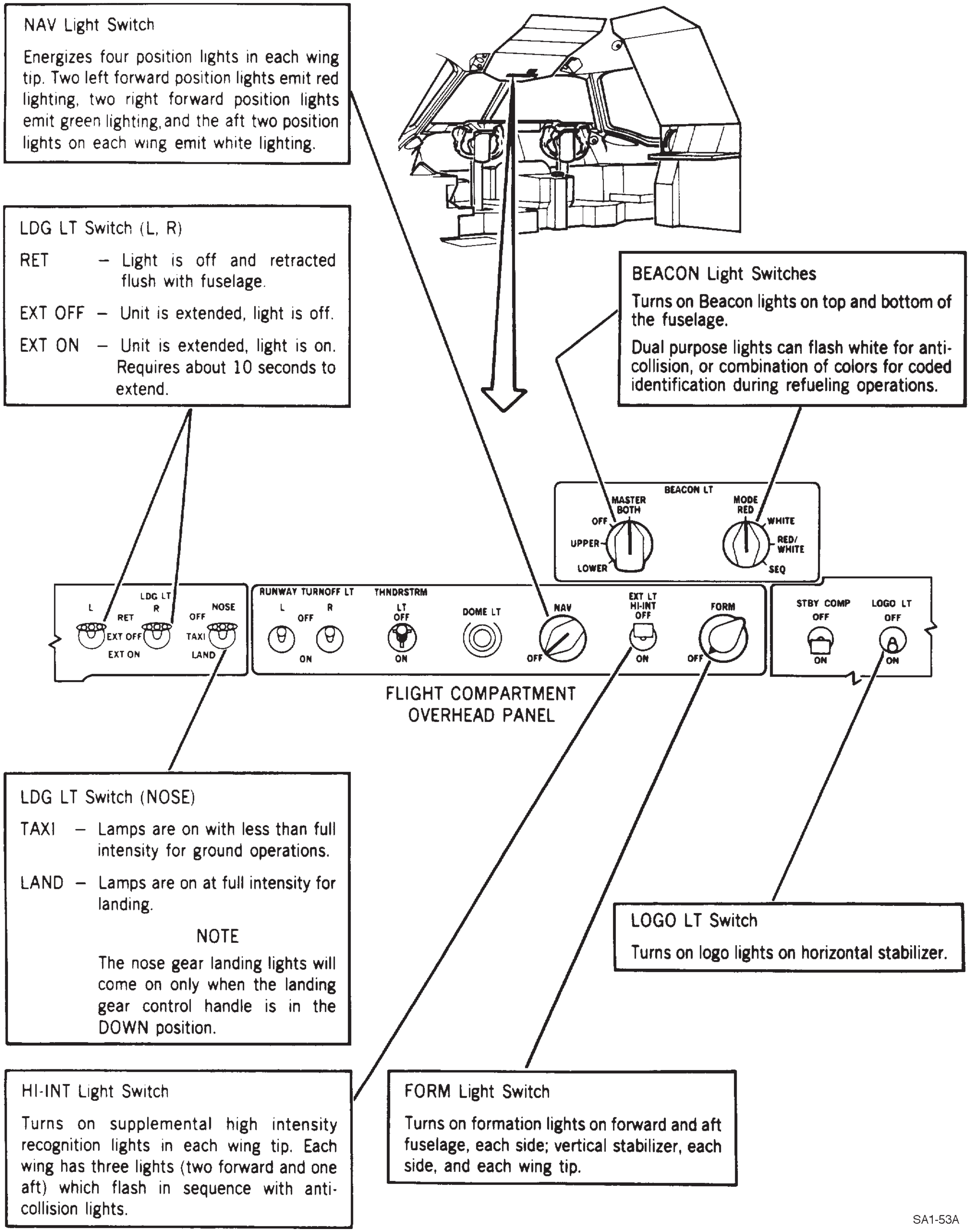
Figure 1.1-34. Cockpit Lighting Controls and Indicators (Sheet 3)



NAV Light Switch

Energizes four position lights in each wing tip. Two left forward position lights emit red lighting, two right forward position lights emit green lighting, and the aft two position lights on each wing emit white lighting.

LDG LT Switch (L, R)

RET – Light is off and retracted flush with fuselage.

EXT OFF – Unit is extended, light is off.

EXT ON – Unit is extended, light is on. Requires about 10 seconds to extend.

BEACON Light Switches

Turns on Beacon lights on top and bottom of the fuselage.

Dual purpose lights can flash white for anti-collision, or combination of colors for coded identification during refueling operations.

LDG LT Switch (NOSE)

TAXI – Lamps are on with less than full intensity for ground operations.

LAND – Lamps are on at full intensity for landing.

NOTE

The nose gear landing lights will come on only when the landing gear control handle is in the DOWN position.

LOGO LT Switch

Turns on logo lights on horizontal stabilizer.

HI-INT Light Switch

Turns on supplemental high intensity recognition lights in each wing tip. Each wing has three lights (two forward and one aft) which flash in sequence with anti-collision lights.

FORM Light Switch

Turns on formation lights on forward and aft fuselage, each side; vertical stabilizer, each side, and each wing tip.

Figure 1.1-35. Exterior Lighting Controls

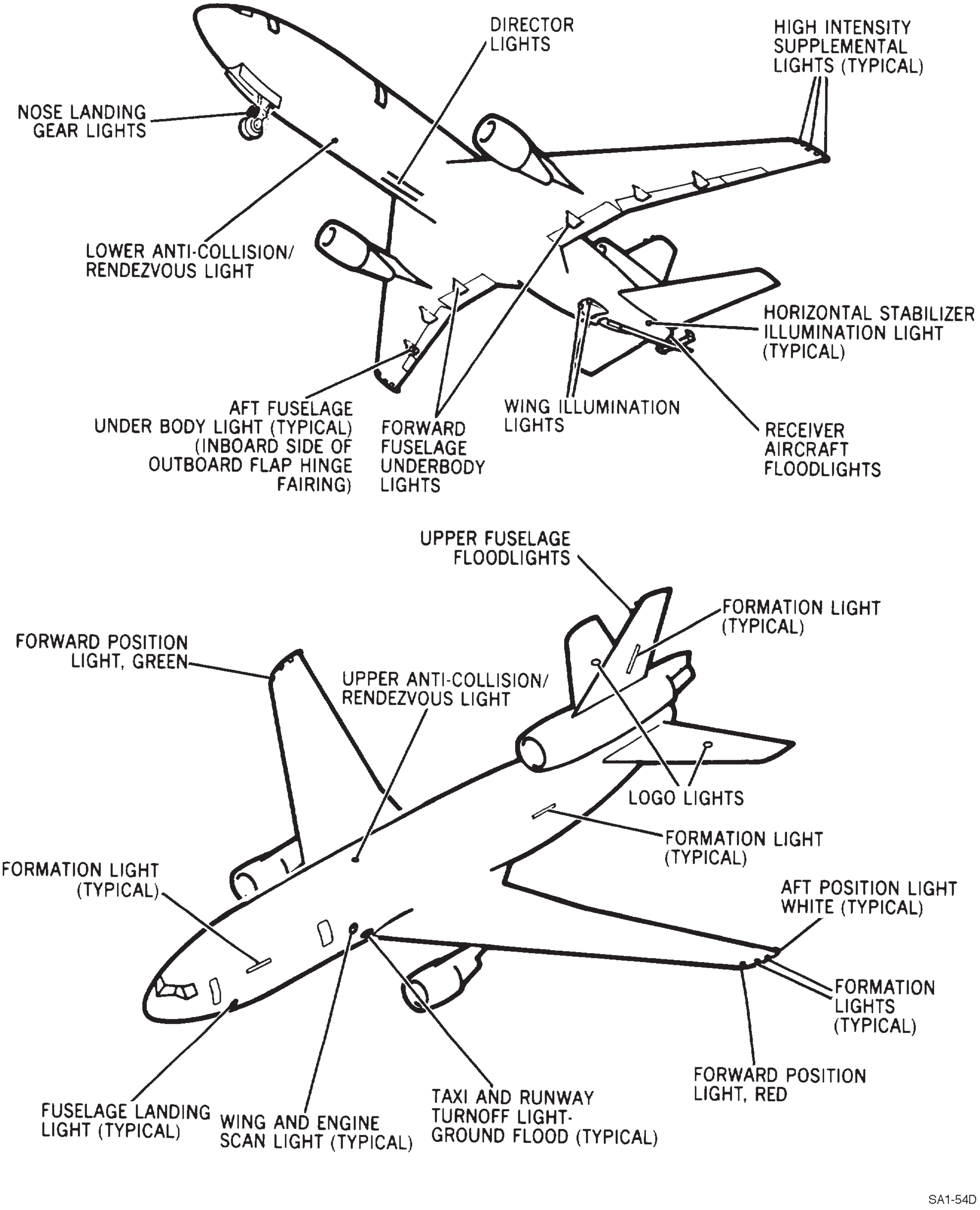


Figure 1.1-36. Exterior Lighting

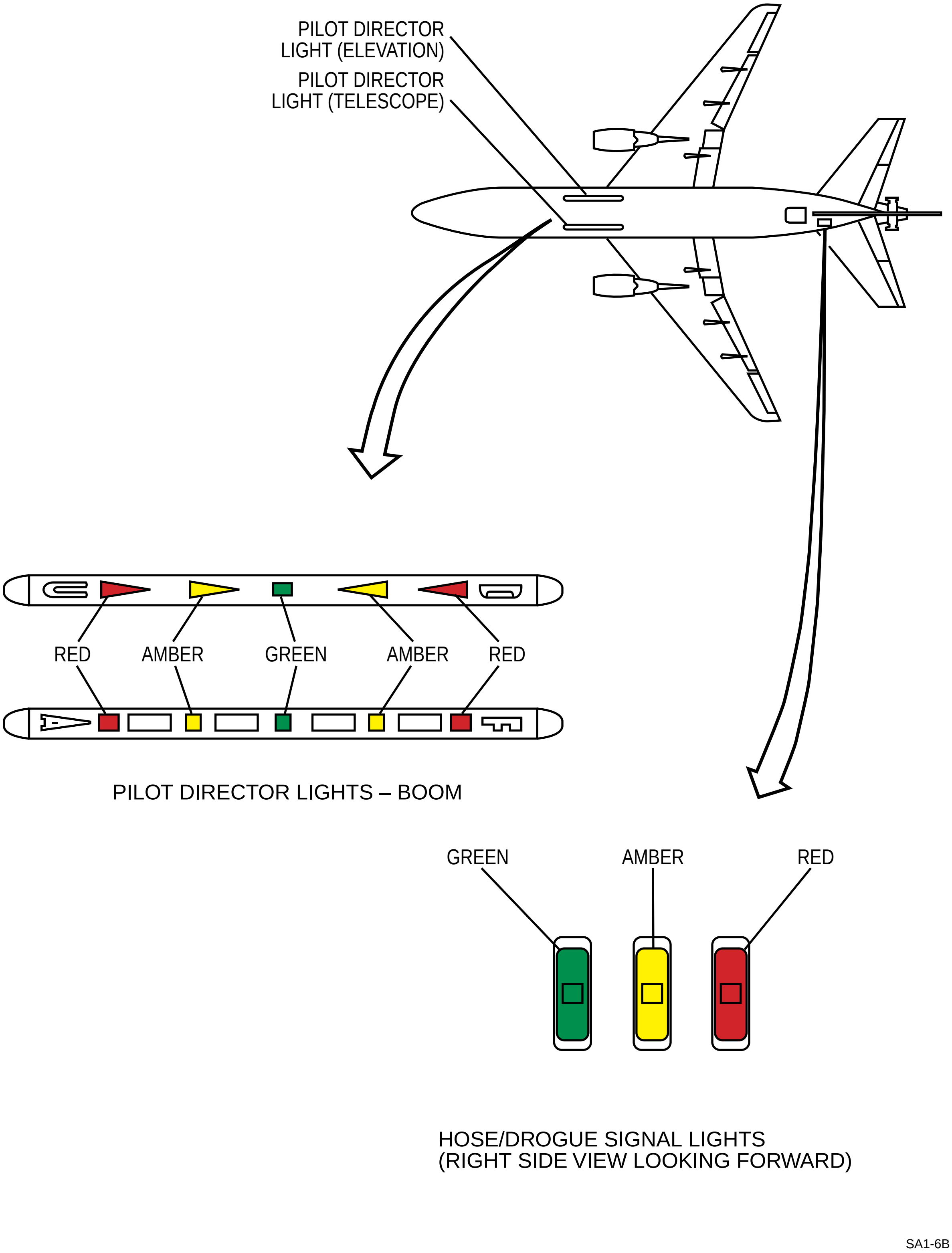


Figure 1.1-37. Pilot Director/Signal Lights - Boom/Drogue

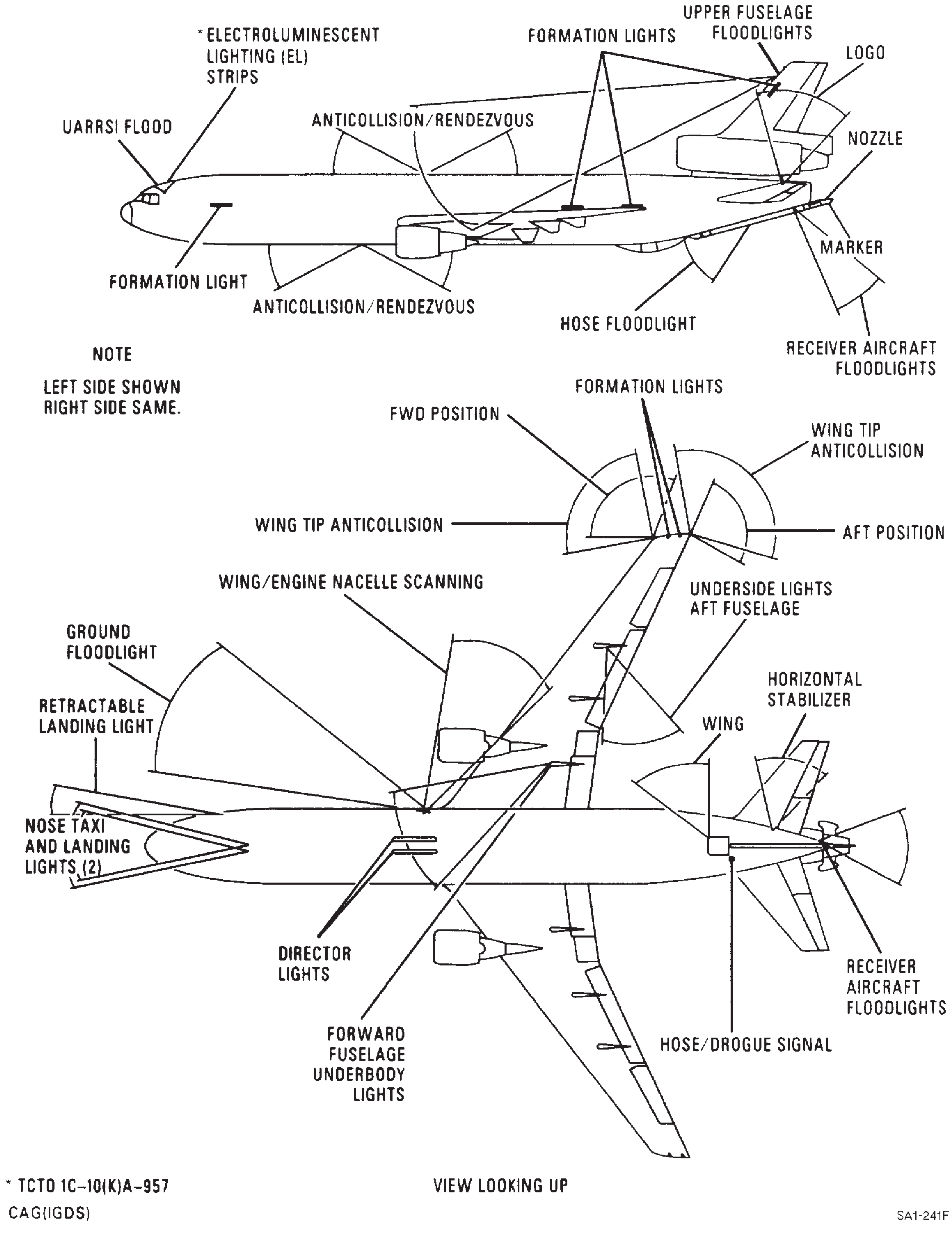


Figure 1.1-38. Exterior Lighting Patterns

SEATS DESCRIPTION

The cockpit contains seats for a Pilot, Copilot, Flight Engineer, and Boom Operator (figures 1.1-39, 1.1-40 and 1.1-41). An additional seat on the aft bulkhead of the flight compartment is provided for an extra crewmember/observer. The Flight Engineer's seat is located behind the Copilot's station. The Boom Operator's and crewmember/observer's seats are located behind the Pilot's station. All seats, except the extra crewmember/observer's seat, have electrical and/or manual adjustments. If the electrical control or power supply of a seat fails, full movement of the seat is possible through manual operation. A CAUTION placard is installed on the inboard side of the Pilot's, Copilot's, Flight Engineer's and Boom Operator's seats, cautioning the user not to manually position the seat vertically unless the seat is occupied.

All seats are equipped with seat belts and dual shoulder harnesses with inertial reels. All seats except the extra crewmember/ observer's seat are equipped with a crotch belt.

Seats for the Pilot and Copilot are power operated by two electric motors to provide vertical and horizontal adjustments. The recline, lumbar support, armrest, and thigh support controls are manually operated. The Copilot's seat has a recline limit switch which inhibits outboard movement of the seat whenever the backrest is reclined more than one notch from the upright position.

The seat indicator incorporates two numerical index scales; one scale representing the vertical position of the seat and the other the horizontal. By means of individual exit control switches, the Pilot's and Copilot's seat may be moved to the full aft and outboard positions to facilitate exit.

The Pilot's Design Eye Fore and Aft Locator consists of optical painted white lines on the glareshield. An illustration and the operation of the white line optical locator is shown in figure 1.1-43.

NOTE

> Use of nonstandard seat cushions in the pilot/copilot seats may interfere with control column movement.

The Flight Engineer's seat is also power operated to provide vertical and horizontal adjustments. The recline, lumbar support, armrest, and swivel controls are manually operated. The swivel control permits adjustment between forward and outboard facing positions. When facing forward, the seat can be raised higher vertically than when facing the FE's panel.

On power-operated seats, placing the power ON/OFF switch to OFF after adjusting the seat for takeoff or landing prevents seat movement (runaway seat) in the event of an electrical short in the seat wiring.

The Boom Operator's (forward position) seat has manual adjustments only. These adjustments provide vertical, forward, aft, lumbar support, and swivel movement. The backrest is fixed and cannot be adjusted.

The extra crewmember/observer's seat is a folding, nonadjustable type bolted directly to the floor structure and aft cockpit wall.

ARO STATION SEATS

WARNING

> ARO compartment will not be occupied during takeoff and landing.

The Boom Operator's and Instructor's seats have manual adjustment in both the vertical and horizontal positions. The horizontal seat lock can be operated by either a release control located on the forward edge of the seat, under the operator's left leg, or by a button type of control, located on the top center of the seat back. After the seat is unlocked, it can be moved manually forward and aft to the desired position. The vertical locking mechanism is operated by pulling up on the release lever, located under the operator's right leg, on the forward edge of the seat. Spring tension will raise the seat after the lock is released and the operator's weight is reduced, the weight of the operator will cause the seat to lower. The observer's seat is non-adjustable. The ARO station contains seats for an Observer, Boom Operator, and Instructor. Each seat is equipped with a quick release retractable seat belt.

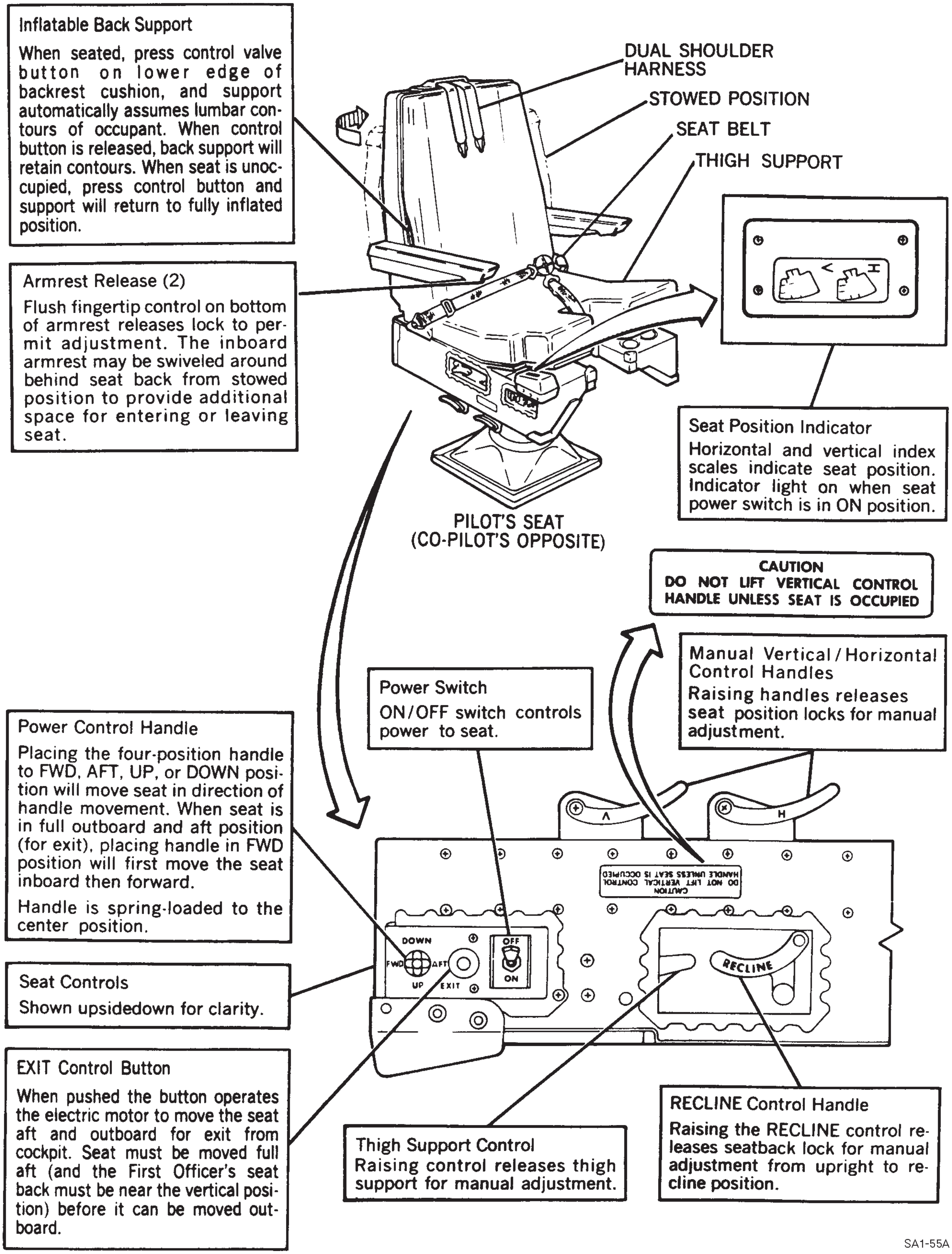
The Boom Operator's designed eye position is attained by adjusting the seat vertically until the aft periscope mirror track appears to be a tunnel. After vertical position is attained, move the seat forward or aft until the line of sight is parallel with the upper surface of the Instrument Panel Glareshield. The upper forward edge of the glareshield should be even with the rivet tops along the lower edge of the glareshield (figure 1.1-42). The designed seat position is not a point that must be strictly maintained. Seat position can be varied to accommodate individual physical characteristics. The seat should be positioned so the operator can see the boom position instruments, AR SIG SYS status lights, and the complete disconnect envelope, with minimum head movement, and control the boom smoothly throughout the entire refueling envelope without causing fatigue. Adjustable armrests are provided for the Boom Operator and Instructor. Lock release levers are located on the aft inboard side of each armrest. Spring tension will raise the armrest to the full up position when the locking lever is pulled forward and no weight is placed on the armrest. A slight amount of pressure is required to lower the armrest after the lock is released. After seat adjustment is completed, raise or lower the armrest as required to attain proper arm support.

NOTE

> Boom elevation control may be affected if the armrest is set too high.

PASSENGER SEATS

Passenger seat units are identified as tourist-type economy seats, with variations incorporated with respect to location within the aircraft. Seats are attached to floor-mounted and pallet-mounted seat tracks, and can be positioned in the fore-and-aft direction only. Each seat is equipped with the following: an adjustable backrest, seatbelt, armrest and recline lock control button, life vest and EPOS storage provisions, and a utility table. Provisions are incorporated in front row seats for installation of plug-in type utility tables.



Inflatable Back Support

When seated, press control valve button on lower edge of backrest cushion, and support automatically assumes lumbar contours of occupant. When control button is released, back support will retain contours. When seat is unoccupied, press control button and support will return to fully inflated position.

Armrest Release (2)

Flush fingertip control on bottom of armrest releases lock to permit adjustment. The inboard armrest may be swiveled around behind seat back from stowed position to provide additional space for entering or leaving seat.

Seat Position Indicator

Horizontal and vertical index scales indicate seat position. Indicator light on when seat power switch is in ON position.

CAUTION

DO NOT LIFT VERTICAL CONTROL HANDLE UNLESS SEAT IS OCCUPIED

Manual Vertical/Horizontal Control Handles

Raising handles releases seat position locks for manual adjustment.

Power Switch

ON/OFF switch controls power to seat.

Power Control Handle

Placing the four-position handle to FWD, AFT, UP, or DOWN position will move seat in direction of handle movement. When seat is in full outboard and aft position (for exit), placing handle in FWD position will first move the seat inboard then forward.

Handle is spring-loaded to the center position.

Seat Controls

Shown upsidedown for clarity.

EXIT Control Button

When pushed the button operates the electric motor to move the seat aft and outboard for exit from cockpit. Seat must be moved full aft (and the First Officer's seat back must be near the vertical position) before it can be moved outboard.

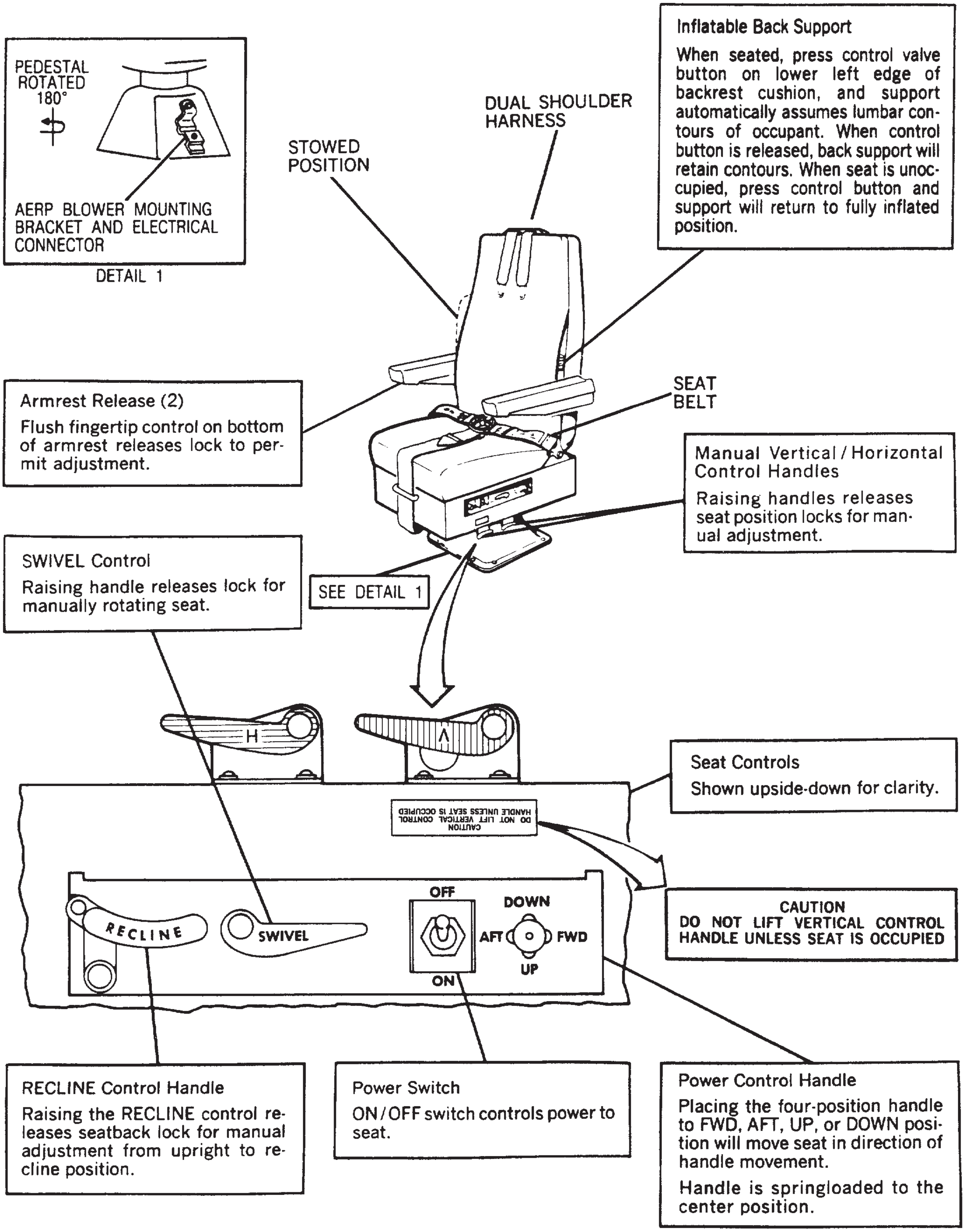
Thigh Support Control

Raising control releases thigh support for manual adjustment.

RECLINE Control Handle

Raising the RECLINE control releases seatback lock for manual adjustment from upright to recline position.

Figure 1.1-39. Pilot's and Copilot's Seats



Inflatable Back Support

When seated, press control valve button on lower left edge of backrest cushion, and support automatically assumes lumbar contours of occupant. When control button is released, back support will retain contours. When seat is unoccupied, press control button and support will return to fully inflated position.

Armrest Release (2)

Flush fingertip control on bottom of armrest releases lock to permit adjustment.

Manual Vertical / Horizontal Control Handles

Raising handles releases seat position locks for manual adjustment.

SWIVEL Control

Raising handle releases lock for manually rotating seat.

Seat Controls

Shown upside-down for clarity.

CAUTION
DO NOT LIFT VERTICAL CONTROL HANDLE UNLESS SEAT IS OCCUPIED

RECLINE Control Handle

Raising the RECLINE control releases seatback lock for manual adjustment from upright to recline position.

Power Switch

ON / OFF switch controls power to seat.

Power Control Handle

Placing the four-position handle to FWD, AFT, UP, or DOWN position will move seat in direction of handle movement.

Handle is springloaded to the center position.

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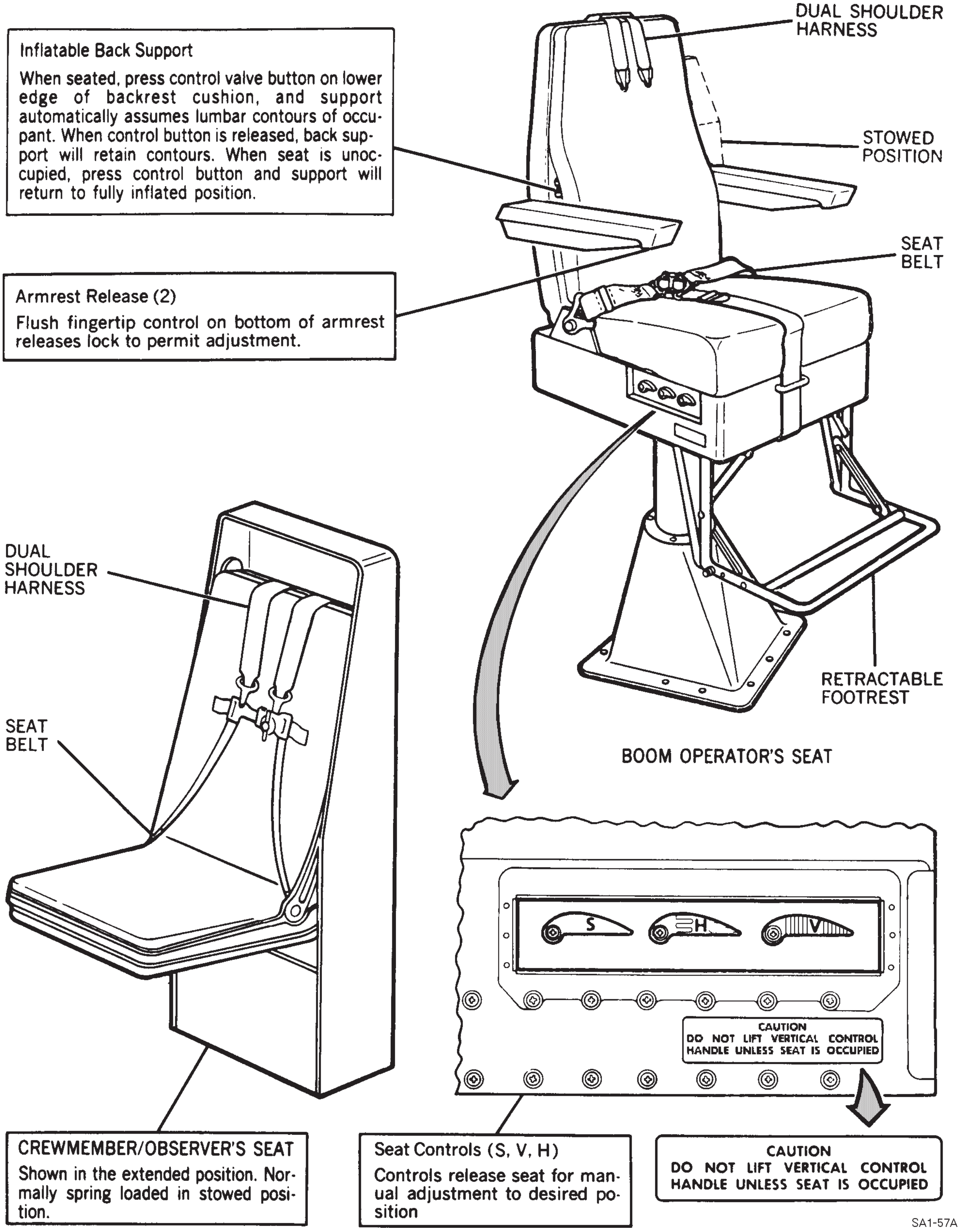
Figure 1.1-40. Flight Engineer's Seat



Inflatable Back Support

When seated, press control valve button on lower edge of backrest cushion, and support automatically assumes lumbar contours of occupant. When control button is released, back support will retain contours. When seat is unoccupied, press control button and support will return to fully inflated position.

Armrest Release (2)

Flush fingertip control on bottom of armrest releases lock to permit adjustment.

CREWMEMBER/OBSERVER'S SEAT

Shown in the extended position. Normally spring loaded in stowed position.

Seat Controls (S, V, H)

Controls release seat for manual adjustment to desired position

CAUTION
DO NOT LIFT VERTICAL CONTROL HANDLE UNLESS SEAT IS OCCUPIED

Figure 1.1-41. Boom Operator's and Crewmember/Observer's Seats

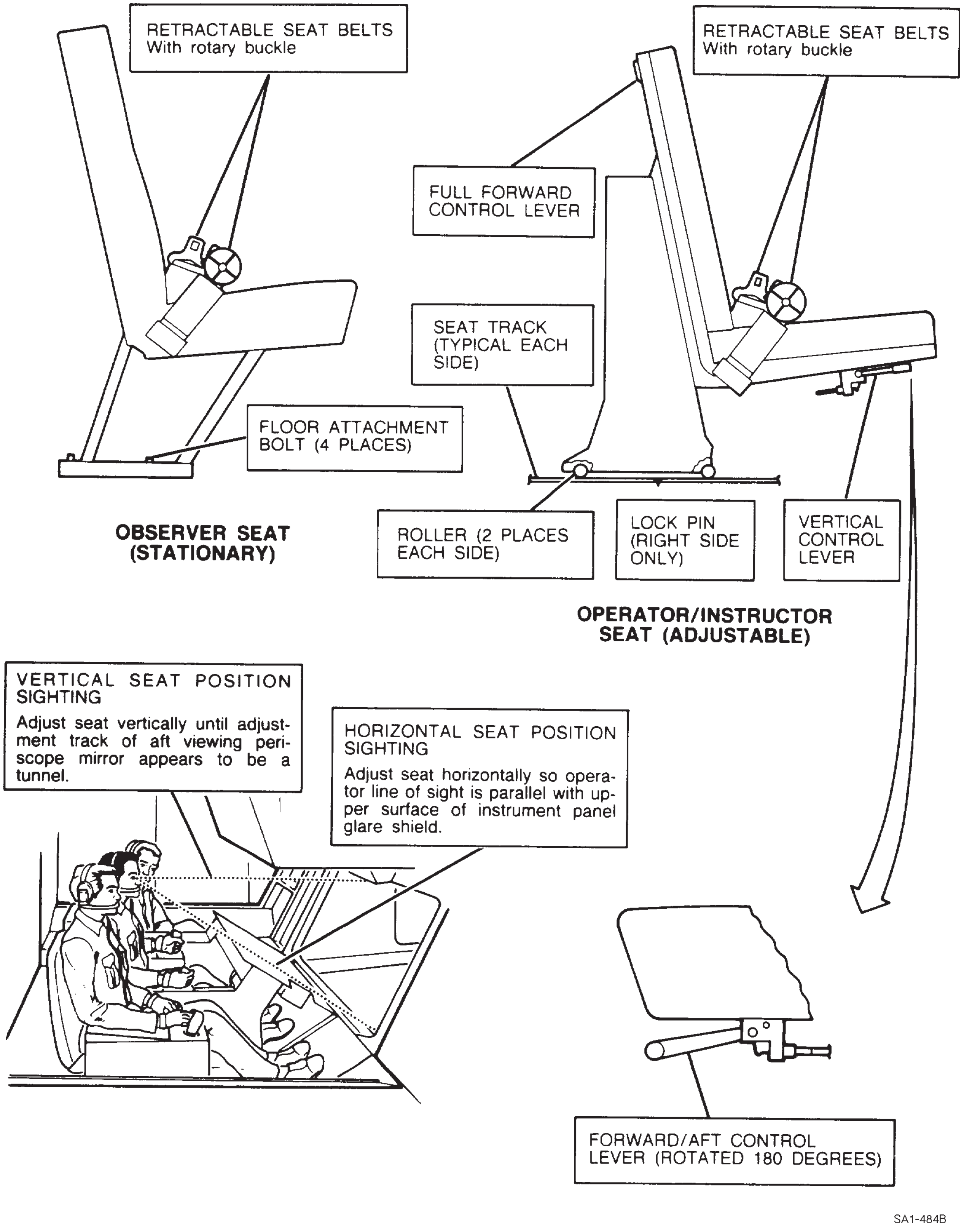


Figure 1.1-42. ARO Seats and Seat Positioning

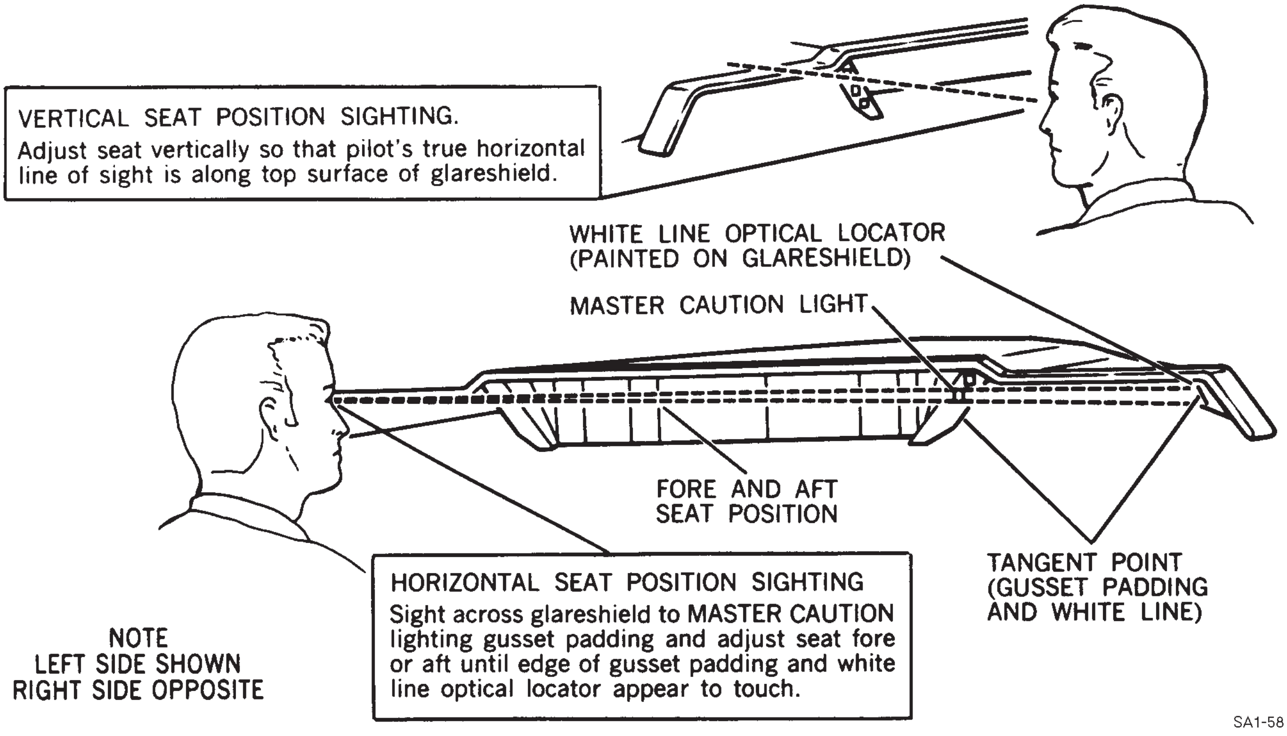


Figure 1.1-43. Pilot Eye Locator - Optical White Line

WARNING AND CAUTION SYSTEMS DESCRIPTION

The warning and caution systems provide aural, visual, and tactile indications to warn of unsafe operating conditions or aircraft configurations, and systems malfunctions. Warnings of fire or overheating, unsafe landing gear conditions, altitude advisory indications, slats extended above placarded limit speeds, ground proximity, autopilot disengaged, loss of cooling airflow through inertial navigation unit, and excessive cabin altitude are both visual and aural. Stabilizer motion, overspeed, and takeoff configuration warnings are aural only. Stall warning is provided by stick shaker only, with no accompanying visual or aural indications.

CENTRAL AURAL WARNING SYSTEM

Aural warnings (except APU fire) are generated in a central control unit which provides warning discrimination by means of varying the pitch, duration, and repetitive frequency of the aural signal (figure 1.1-44). The aural warnings can be tested for all conditions except cabin altitude. Once sounded, the aural warnings can be silenced by operating the appropriate silencing switch or returning the aircraft to the correct configuration for the condition indicated. Detailed information regarding the operation and testing of each of the central aural warning system functions is covered in the description, and controls and indicators sections, of each of those chapters dealing with the applicable systems.

APU EXTERNAL WARNING HORN

Aural warning for APU fire is provided by an exterior horn located just aft of the left wheelwell. Provisions are made for silencing the horn for subsequent warnings.

VISUAL WARNING AND CAUTION SYSTEM

Visual warning and caution indications are provided in the engine fire and fuel control handles and by annunciator lights. Where practical, individual lights are located adjacent to or in the controls or indicators for the respective system. Lights pertaining to

WARNING INDICATED	AURAL WARNING CHARACTERISTIC	VISUAL INDICATION	CONDITION INDICATED	TEST	DEACTIVATE
APU FIRE	Extremely loud exterior horn.	APU FIRE Light (F/E), APU FIRE Light (summary), MASTER WARN Lights.	Fire or overheat in APU compartment.	LOOPS TEST Switch (no aural warning in test).	HORN Switch on APU GND CONT Panel, or APU FIRE CONTROL Switch.
CABIN ALTITUDE	Intermittent car horn sound (identical to takeoff warning).	CABIN ALT Lights.	Cabin altitude has exceeded allowable limit.	None	Press CABIN ALT WARN HORN Button.
ENGINE FIRE	Intermittent, bell-like ringing sound.	ENG FIRE Handle. Fuel Lever, ENGINE FIRE Light, and respective LOOPS A and B Lights.	Fire or overheat in engine nacelle.	LOOPS TEST Switches.	Press ENGINE Light or pull ENG FIRE Handle.
LANDING GEAR (Throttles)	Continuous car horn sound.	Red lights for any gear not down and locked.	Any gear not down and locked and any throttle retarded to IDLE and air speed is less than 215 knots.	(1) GEAR TEST Button (no aural warning). (2) GEAR Handle when pulled out (visual and aural warning).	Gear horn off button, provided flaps are in approach config. (less than 28.5°).
LANDING GEAR (Flaps)	Continuous car horn sound.	None unless unsafe gear condition exists.	Any gear not down and locked and flaps extended 28.5° or more.	None	Extend gear.
OVERSPEED	Chicken-like clucking sound.	None	Airspeed above V_{MO}/M_{MO}.	MAX SPD WARN Test switch.	Correct overspeed condition.
STABILIZER IN MOTION	Continuous deep pitched air horn sound.	(Stabilizer LONG TRIM indicator may be crosschecked).	Horizontal stabilizer in motion (no warning until continuous movement exceeds one degree).	Operate longitudinal trim controls.	Warning silenced when stabilizer is stopped.
STALL WARNING	None	None	Airspeed approaching stall condition for flap/slat configuration.	STALL TEST Switch.	Correct stall condition.
	Tactile warning by stick shaker. Both columns will vibrate simultaneously.				
TAKEOFF WARNING	Intermittent car horn sound (identical to cabin altitude warning).	None	Slats not in T.O. EXT range. Flaps in landing range. Spoiler handle not fully forward. Stabilizer setting not in green band.	Configure to any of noted conditions and advance throttle number one or two.	Correct control SETTING(s).
		PARK BRAKE ON light.	Parking brake is not released; ground shift mechanism is in ground mode and either throttle 1 or 2 is advanced for takeoff.	None	Release parking brake.
SLATS EXTENDED WARNING (1)	Chicken-like clucking sound (identical to overspeed warning). (1) AND (2)	Slat TAKEOFF light (1)	Slats extended above placarded slat extend limit speed. (1)	None (1)	Slow to below placarded slat extend limit speed and retract slats. (1)
SLATS EXTENDED WARNING (2)		None (2)	Flap/slat handle moved from UP/RET at speeds above placarded slat extend limit speed (2)	None (2)	Slow to below placarded slat extend limit speed and extend slats. (2)
GROUND PROXIMITY WARNING	Various vocal alerts/commands (see ENHANCED GROUND PROXIMITY WARNING SYSTEM, Section I, Part 6).	Red GPWS light on glareshield.	EGPWS has six warning modes with various submodes and one advisory mode. MODE 1 - Excessive rate of descent with respect to AGL altitude. MODE 2 - Flight into rising terrain or gradual descent into terrain. MODE 3 - Excessive altitude loss after takeoff or during go-around. MODE 4 - Insufficient terrain clearance with respect to phase of flight, speed, and configuration.	GPWS TEST switch.	(1) Increase climb rate. (2) Extend gear/ flaps. (3) Reduce rate of descent. (4) Pull up.

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Figure 1.1-44. Aural Warning and Caution System Particulars (Sheet 1)

WARNING INDICATED	AURAL WARNING CHARACTERISTIC	VISUAL INDICATION	CONDITION INDICATED	TEST	DEACTIVATE
		Amber BELOW G/S light on glareshield. None Red/Amber windshear annunciator on.	MODE 5 - Excessive deviation below the glideslope when below 1000 feet radio altitude. MODE 6 - Descent through preprogrammed/set altitudes below 2500 feet radio altitude, Excessive bank angle for flight conditions. MODE 7 - Severe windshear condition.		(5) Correct deviation. (6) None (7) Exit windshear condition.
TRAFFIC ALERT	Various vocal traffic advisories/resolution advisories (see ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM, Section I, Part 14).	Traffic symbols and red/green arcs on TVSI (see ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM, Section I, Part 14).	Potential traffic conflict.	Self-test initiated with Mode 3/A IFF test.	Comply with resolution advisory; select TA only or NORM with IFF/ETCAS master switch.
AUTOPILOT DISENGAGE		Flashing red AP Light for associated system.		None	Press AP Light or Autopilot release button.
INS WARNING (on ground)	Loud intermittent exterior horn.	Applicable system INS FLOW OFF light on. (Pilot Overhead Annunciator Panel.)	(1) Loss of cooling airflow thru INS unit. (2) INS operating on battery power with AC power removed.	None	Turn off applicable INS systems.
ALTITUDE ADVISORY	Dual airhorn sound of 2-second total duration.	Steady altitude advisory light on altimeters. Stays on until within 250 feet of selected altitude.	Aircraft at 750 feet capture threshold relative to selected altitude.	Selection of altitude above field elevation and rotation of Bar Set Knob to 750 feet and 250 feet of selected altitude.	Steady Light - Select new altitude. Flashing Light - Push altitude RESET button.
	None	Flashing Altitude Advisory light on altimeters.	Deviation occurs from captive threshold prior reaching 250 feet of selected altitude.		
	None	None	Maintain selected altitude within +250 feet.		
	None	Flashing Altitude Advisory light on altimeters.	Deviation of more than +250 feet after selected altitude capture.		

INSTRUMENT MARKINGS

Four colors are used in the instrument markings. These reflect the latest operating limitations and take the form of arcs and radials. The colors used and their meanings are as follows:

RED	Warning, danger, maximum limit, minimum limit
YELLOW	Caution; abnormal
WHITE OR GREEN	Continuous, normal range

Careful attention should be given to the instrument markings, because of the precautions and limitations they represent.

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Figure 1.1-44. Aural Warning and Caution System Particulars (Sheet 2) systems with controls or indicators in more than one area are located on annunciator panels on the Forward Overhead Panel and Flight Engineer's Upper Instrument Panel No. 2 (figures 1.1-45 and 1.1-46). The red MASTER WARNING lights come on to indicate a condition that requires immediate attention. The amber MASTER CAUTION lights come on to indicate a condition that requires less than immediate attention. Master warning and master caution lights come on concurrently with their respective individual warning and caution lights at the respective crew stations. Additionally, the Pilot's and Copilot's MASTER WARNING or MASTER CAUTION lights will come on whenever certain selected warning or caution lights come on at the Flight Engineer's station. Pushing either of the Pilots' MASTER WARNING or MASTER CAUTION lights will turn the respective lights off at both pilot stations and reset the system for subsequent indications. The Flight Engineer's MASTER WARNING or MASTER CAUTION lights can be reset only from the Flight Engineer's station and do not reset the Pilots' lights. The individual warning or caution lights will remain on until the condition has been corrected. Certain individual caution lights are considered advisory and do not cause the MASTER CAUTION lights to come on. Summary lights and cue lights on the Pilot's annunciator panel provide indications of warnings or cautions associated with the various aircraft systems. The summary lights are not resettable and will remain on until the condition is corrected. The cue lights may be reset and, when pushed, will also turn off both Pilots' MASTER CAUTION lights. Annunciator light brilliance is controlled by PRESS TO BRT/DIM buttons on the Overhead Panel and on the Flight Engineer's panel. The buttons affect all annunciator lights at the respective crew station except the MASTER WARNING and the MASTER CAUTION lights and the DOOR lights on the Flight Engineer's Panel.

TACTILE WARNING SYSTEM

The dual stall warning system actuates a stick shaker to warn of an impending stall. No visual stall warning is provided.

GROUND PROXIMITY WARNING SYSTEM

For detailed description of ground proximity warning system, refer to Altitude Advisory System, Part 6.

CONTROLS AND INDICATORS

Controls and indicators are located on the Flight Engineer's Upper Panel No. 1, Upper Panel No. 2, Upper Panel No. 3, Pilot's Instrument Panels, Overhead Panel, Pedestal, and glareshield. Illustrations of the panels are in this section. Individual controls and indicators also are illustrated and described in this section.

CARGO EQUIPMENT

CARGO COMPARTMENT

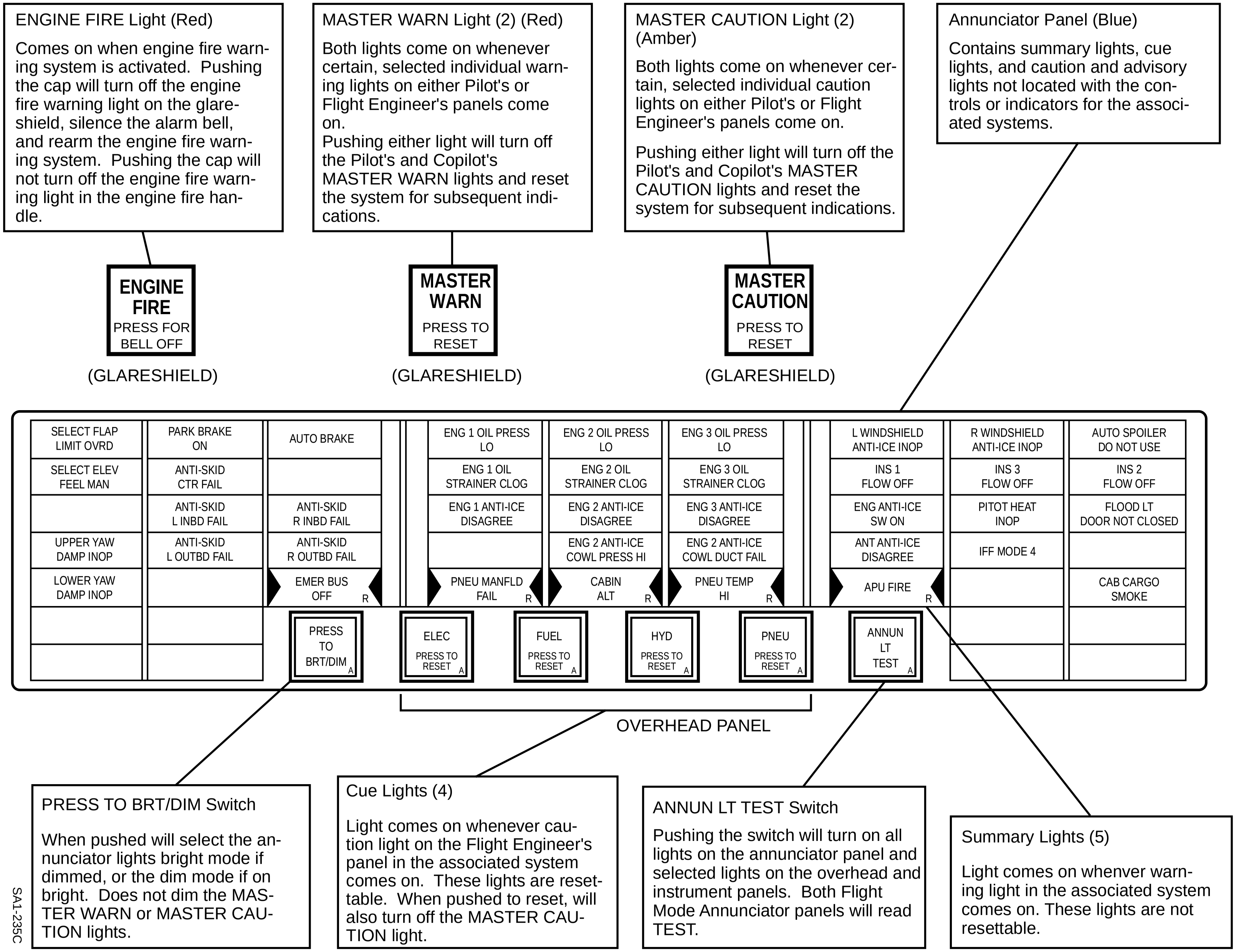
While the primary mission of the KC-10A is aerial refueling of fighter, bomber and transport aircraft, the KC-10A can also carry cargo and personnel. The cargo handling system is basically a manual loading system with a laterally powered assist to accommodate the standard 88 x 108 inch HCU-6/E cargo pallets in all-cargo or mixed cargo/personnel configuration, with a varied number of pallets for each configuration.

CARGO SYSTEM

The cargo system is composed of outboard side and center guide and restraint rails, fore and aft restraint devices, and conveyors. A cargo barrier net (figure 1.1-47), capable of furnishing 9g restraint for 175,000 pounds of cargo, can be installed in any one of three locations, depending on the selected cargo/personnel configuration. The net straps along the top and sides are attached by pins to eyebolts which are permanently attached to the fuselage shell structure. On the floor, the net straps are attached by pins to the net attach brackets mounted in the seat tracks.

ENVIRONMENTAL CURTAIN

An environmental curtain (figure 1.1-48) is fastened to permanently installed overhead and removable side panels by means of velcro. Four tiedown fittings, which are secured to the bottom of the curtain, are fastened to the cargo floor seat tracks to complete the installation. A passageway, between the passenger area and cargo compartment, is provided by unzipping the curtain from the right hand



ENGINE FIRE Light (Red)

Comes on when engine fire warning system is activated. Pushing the cap will turn off the engine fire warning light on the glareshield, silence the alarm bell, and rearm the engine fire warning system. Pushing the cap will not turn off the engine fire warning light in the engine fire handle.

MASTER WARN Light (2) (Red)

Both lights come on whenever certain, selected individual warning lights on either Pilot's or Flight Engineer's panels come on.

Pushing either light will turn off the Pilot's and Copilot's MASTER WARN lights and reset the system for subsequent indications.

MASTER CAUTION Light (2) (Amber)

Both lights come on whenever certain, selected individual caution lights on either Pilot's or Flight Engineer's panels come on.

Pushing either light will turn off the Pilot's and Copilot's MASTER CAUTION lights and reset the system for subsequent indications.

Annunciator Panel (Blue)

Contains summary lights, cue lights, and caution and advisory lights not located with the controls or indicators for the associated systems.

PRESS TO BRT/DIM Switch

When pushed will select the annunciator lights bright mode if dimmed, or the dim mode if on bright. Does not dim the MASTER WARN or MASTER CAUTION lights.

Cue Lights (4)

Light comes on whenever caution light on the Flight Engineer's panel in the associated system comes on. These lights are resettable. When pushed to reset, will also turn off the MASTER CAUTION light.

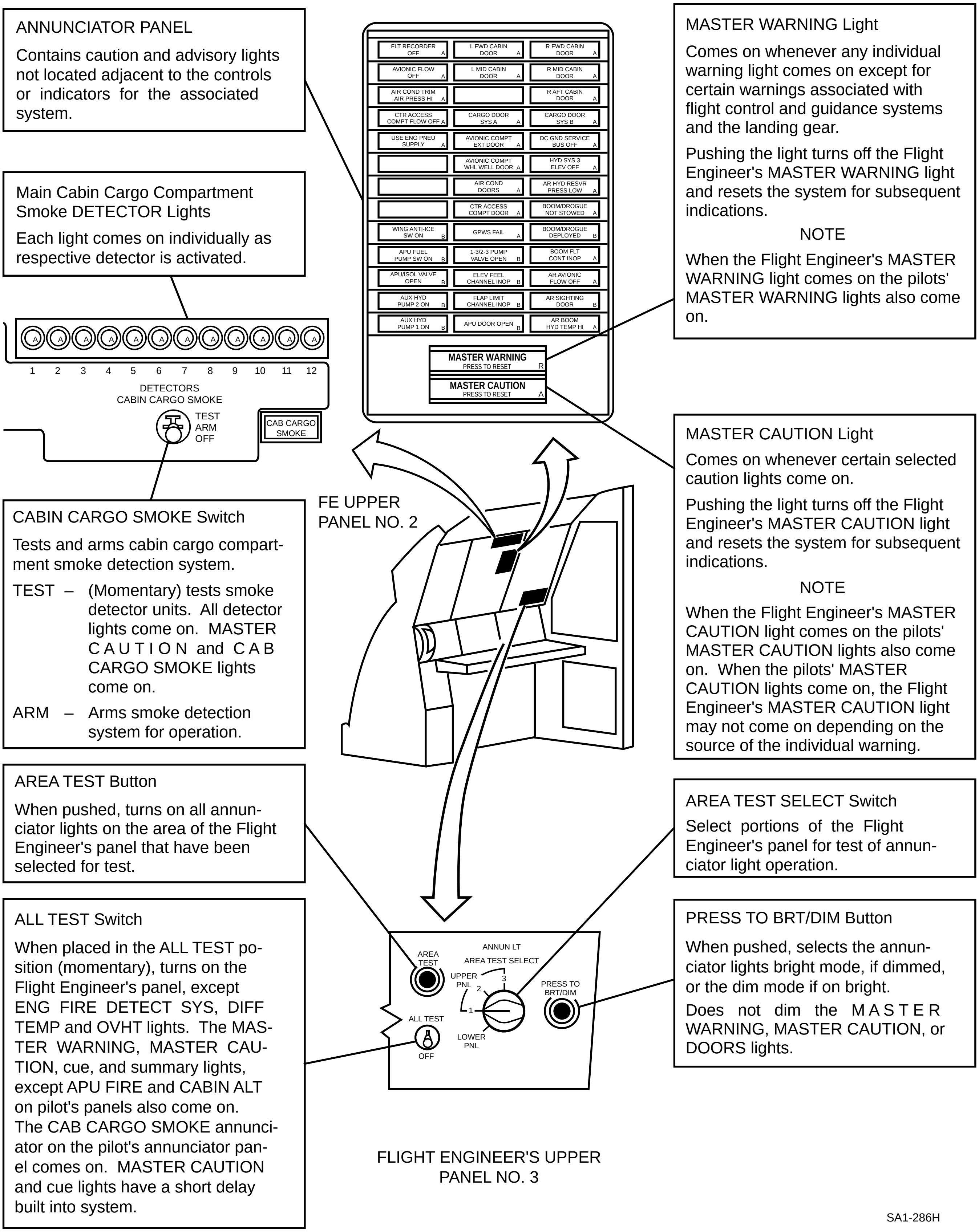
ANNUN LT TEST Switch

Pushing the switch will turn on all lights on the annunciator panel and selected lights on the overhead and instrument panels. Both Flight Mode Annunciator panels will read TEST.

Summary Lights (5)

Light comes on whenver warning light in the associated system comes on. These lights are not resettable.

Figure 1.1-45. Pilot's Annunciator Panel and Warning Lights



ANNUNCIATOR PANEL

Contains caution and advisory lights not located adjacent to the controls or indicators for the associated system.

Main Cabin Cargo Compartment Smoke DETECTOR Lights

Each light comes on individually as respective detector is activated.

CABIN CARGO SMOKE Switch

Tests and arms cabin cargo compartment smoke detection system.

TEST – (Momentary) tests smoke detector units. All detector lights come on. MASTER CAUTION and CAB CARGO SMOKE lights come on.

ARM – Arms smoke detection system for operation.

AREA TEST Button

When pushed, turns on all annunciator lights on the area of the Flight Engineer's panel that have been selected for test.

ALL TEST Switch

When placed in the ALL TEST position (momentary), turns on the Flight Engineer's panel, except ENG FIRE DETECT SYS, DIFF TEMP and OVHT lights. The MASTER WARNING, MASTER CAUTION, cue, and summary lights, except APU FIRE and CABIN ALT on pilot's panels also come on.
The CAB CARGO SMOKE annunciator on the pilot's annunciator panel comes on. MASTER CAUTION and cue lights have a short delay built into system.

MASTER WARNING Light

Comes on whenever any individual warning light comes on except for certain warnings associated with flight control and guidance systems and the landing gear.

Pushing the light turns off the Flight Engineer's MASTER WARNING light and resets the system for subsequent indications.

NOTE

When the Flight Engineer's MASTER WARNING light comes on the pilots' MASTER WARNING lights also come on.

MASTER CAUTION Light

Comes on whenever certain selected caution lights come on.

Pushing the light turns off the Flight Engineer's MASTER CAUTION light and resets the system for subsequent indications.

NOTE

When the Flight Engineer's MASTER CAUTION light comes on the pilots' MASTER CAUTION lights also come on. When the pilots' MASTER CAUTION lights come on, the Flight Engineer's MASTER CAUTION light may not come on depending on the source of the individual warning.

AREA TEST SELECT Switch

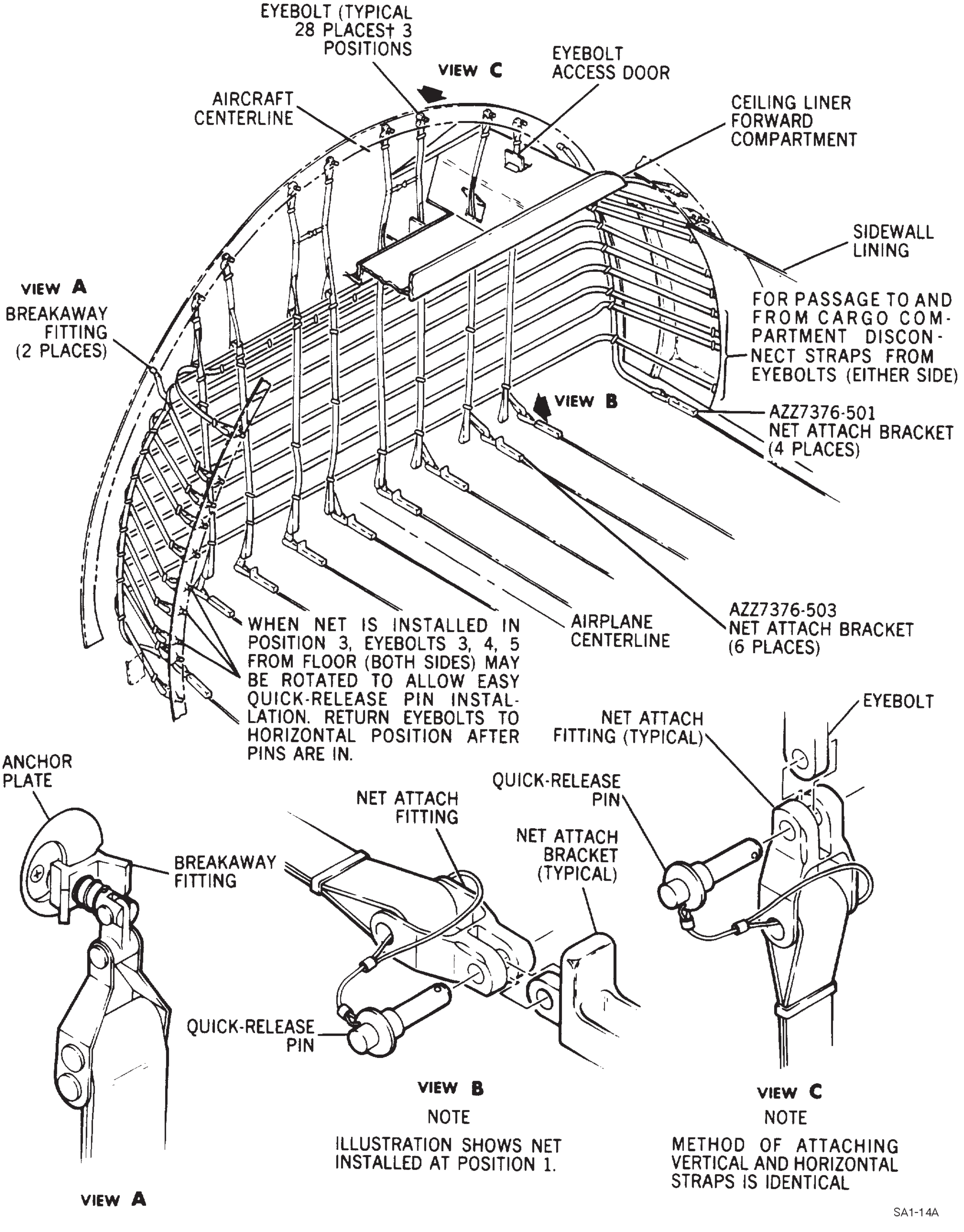
Select portions of the Flight Engineer's panel for test of annunciator light operation.

PRESS TO BRT/DIM Button

When pushed, selects the annunciator lights bright mode, if dimmed, or the dim mode if on bright.

Does not dim the MASTER WARNING, MASTER CAUTION, or DOORS lights.

Figure 1.1-46. Cabin Cargo Smoke Detector System/ Flight Engineer's Annunciator Panel



FOR PASSAGE TO AND FROM CARGO COMPARTMENT DISCONNECT STRAPS FROM EYEBOLTS (EITHER SIDE)

WHEN NET IS INSTALLED IN POSITION 3, EYEBOLTS 3, 4, 5 FROM FLOOR (BOTH SIDES) MAY BE ROTATED TO ALLOW EASY QUICK-RELEASE PIN INSTALLATION. RETURN EYEBOLTS TO HORIZONTAL POSITION AFTER PINS ARE IN.

NOTE

ILLUSTRATION SHOWS NET INSTALLED AT POSITION 1.

NOTE

METHOD OF ATTACHING VERTICAL AND HORIZONTAL STRAPS IS IDENTICAL

Figure 1.1-47. Cargo Barrier Net

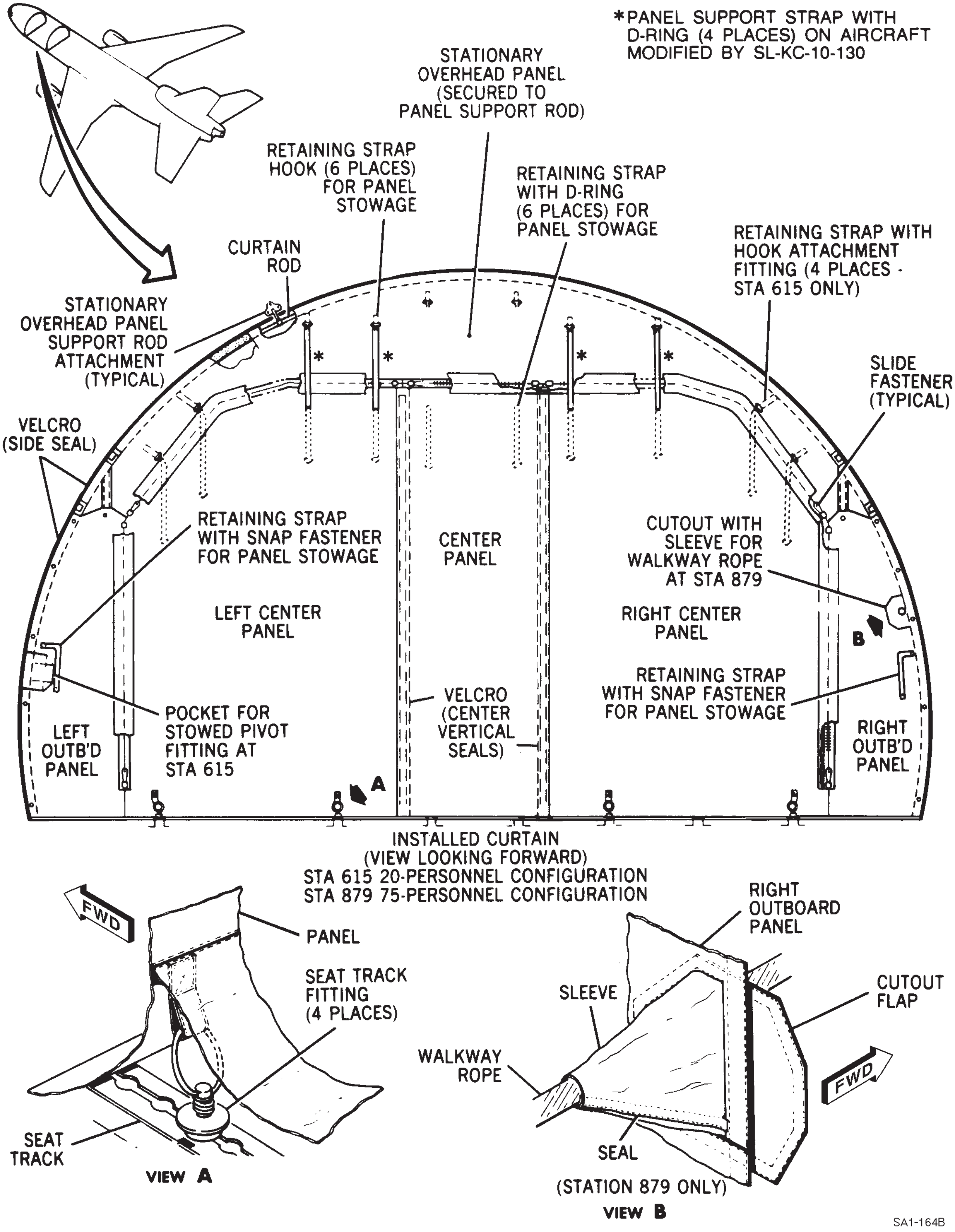


Figure 1.1-48. Environmental Curtain/Smoke Barrier

panel located over the walkway. The curtain is installed at station 615 for the 6 to 20 personnel configurations and station 879 for the 75 personnel configuration.

CAUTION

> When cargo or passengers are carried, the environmental curtain shall be fully installed. This will ensure that the occupants have adequate protection from smoke, fumes and noise. If mission requirements dictate, the curtain need not be fully installed, if only crewmembers/maintenance personnel are carried.

CARGO COMPARTMENT DECALS AND MARKINGS

Decals on the cargo compartment floor, and compartment location identifiers along the sidewalls, provide the means to position cargo handling system components, and load cargo, in specific areas as planned.

As an aid for installing and positioning the cargo system, decals of two differing colors are installed on the aircraft floor. Yellow decals are for 88 x 108 inch pallets loaded longitudinally in the aircraft. White decals are used on the left side of the cargo compartment when the 88 x 108 inch pallets are to be loaded laterally. In addition, other decals identify pallet positions (1L, 1R, 2L, 2R, etc.). These decals are also color-coded yellow and white with respect to longitudinal and lateral loading of pallets.

Cargo compartment identification notations are stenciled along both sidewalls. The stenciled notations consist of compartment identification by letters (for each cargo floor pallet position), fore and aft compartment area boundary markers with the applicable fuselage section number, and the load-weight capacity within each compartment boundary. On the righthand wall, single letters (A through N) identify compartments for longitudinal pallet loading on both sides of the cargo floor. On the lefthand wall, double letters (AA through RR) identify compartments for lateral pallet loading on the left side of the cargo floor only.

CARGO COMPARTMENT FLOOR HEIGHT

Cargo compartment floor height above ground level varies with aircraft gross weight and loading/unloading operations. The height ranges from a minimum of 15 feet, 8 inches to a maximum of 16 feet, 8 inches. Cargo loading equipment must be able to adjust to these floor heights.

CONFIGURATIONS

ALL CARGO CONFIGURATION

Twenty-Five Pallets All Cargo

In the all-cargo configuration (figure 1.1-49), twenty-five HCU-6/E pallets may be loaded with their 108 inch dimension longitudinal in the aircraft. This arrangement allows an aisle along both sides of the cargo pallets. This arrangement is capable of accommodating coupled pallets mixed with single pallets. The coupled pallets can be oriented laterally as well as longitudinally when using the one-inch pallet coupler.

Twenty-Seven Pallets All Cargo

In the twenty-seven pallet all-cargo configuration, eleven pallets on the left side are loaded with their 108 inch dimension lateral in the aircraft. An aisle is provided along the right side for access to the ARO compartment and for inspection of the cargo load. Coupled pallets can be accommodated, but require rotation before movement into position. The 9g cargo barrier net is installed at fuselage station 495.

MIXED PERSONNEL/CARGO CONFIGURATION

For cargo missions requiring additional crewmembers or support personnel, space for cargo and space for seats represents a tradeoff. Three configurations are possible, depending upon the number of personnel to be carried (figures 1.1-50, and 1.1-51). The mixed cargo/personnel configurations provide space for as many as 20 seats installed in seat tracks forward of the main cargo door.

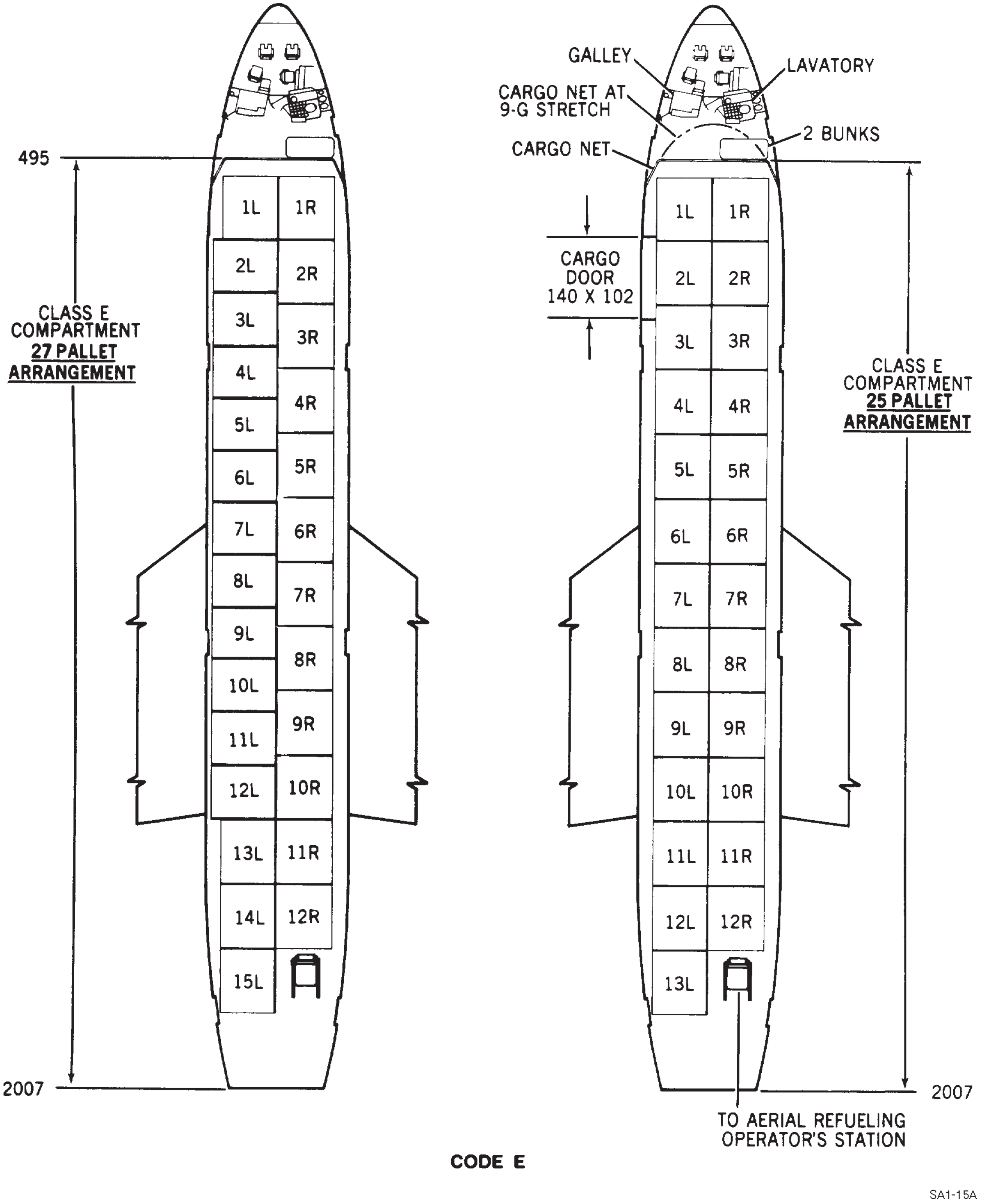


Figure 1.1-49. All-Cargo Configurations (CODE E)

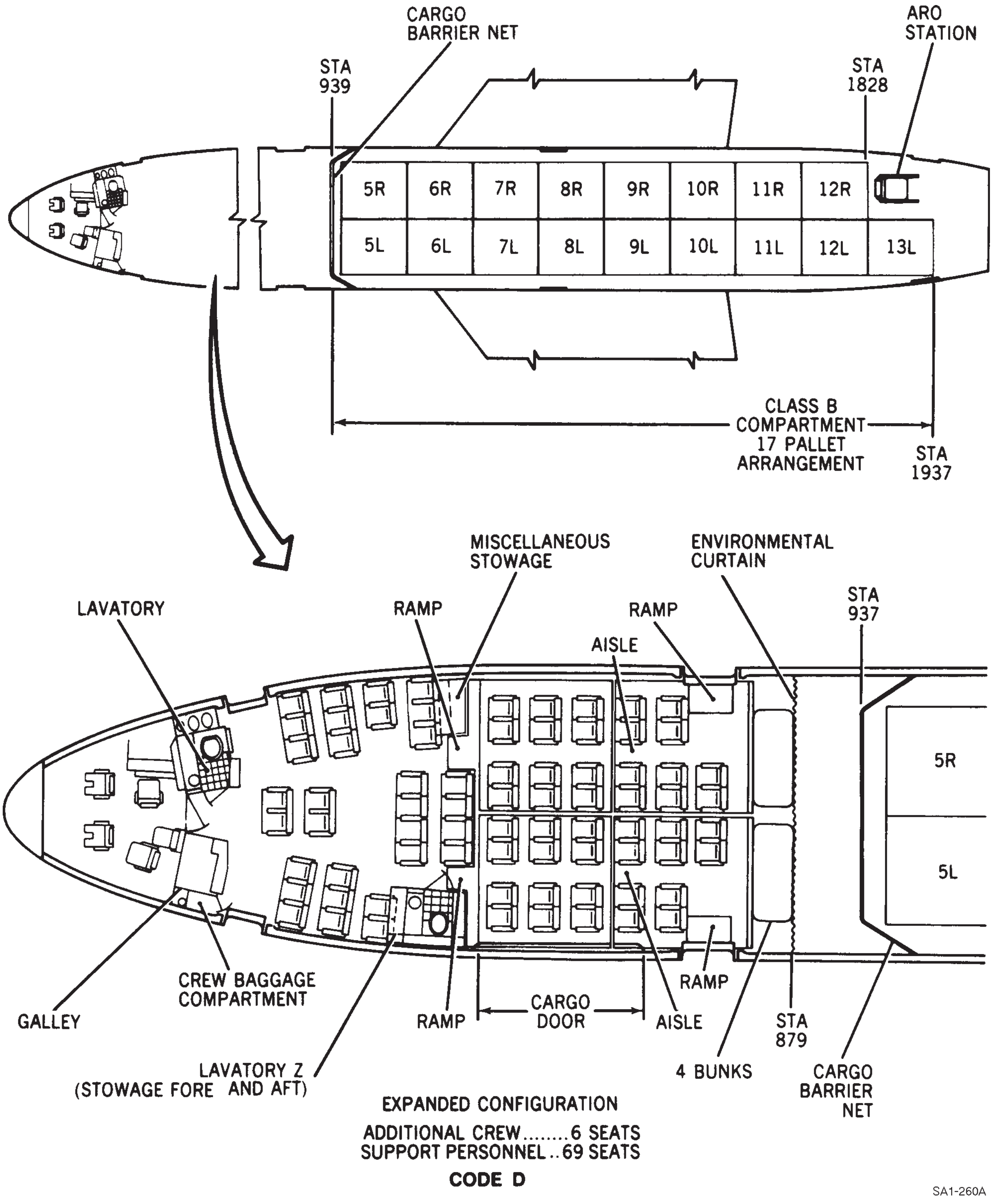


Figure 1.1-50. Mixed Cargo/Personnel Configuration (Sheet 1)

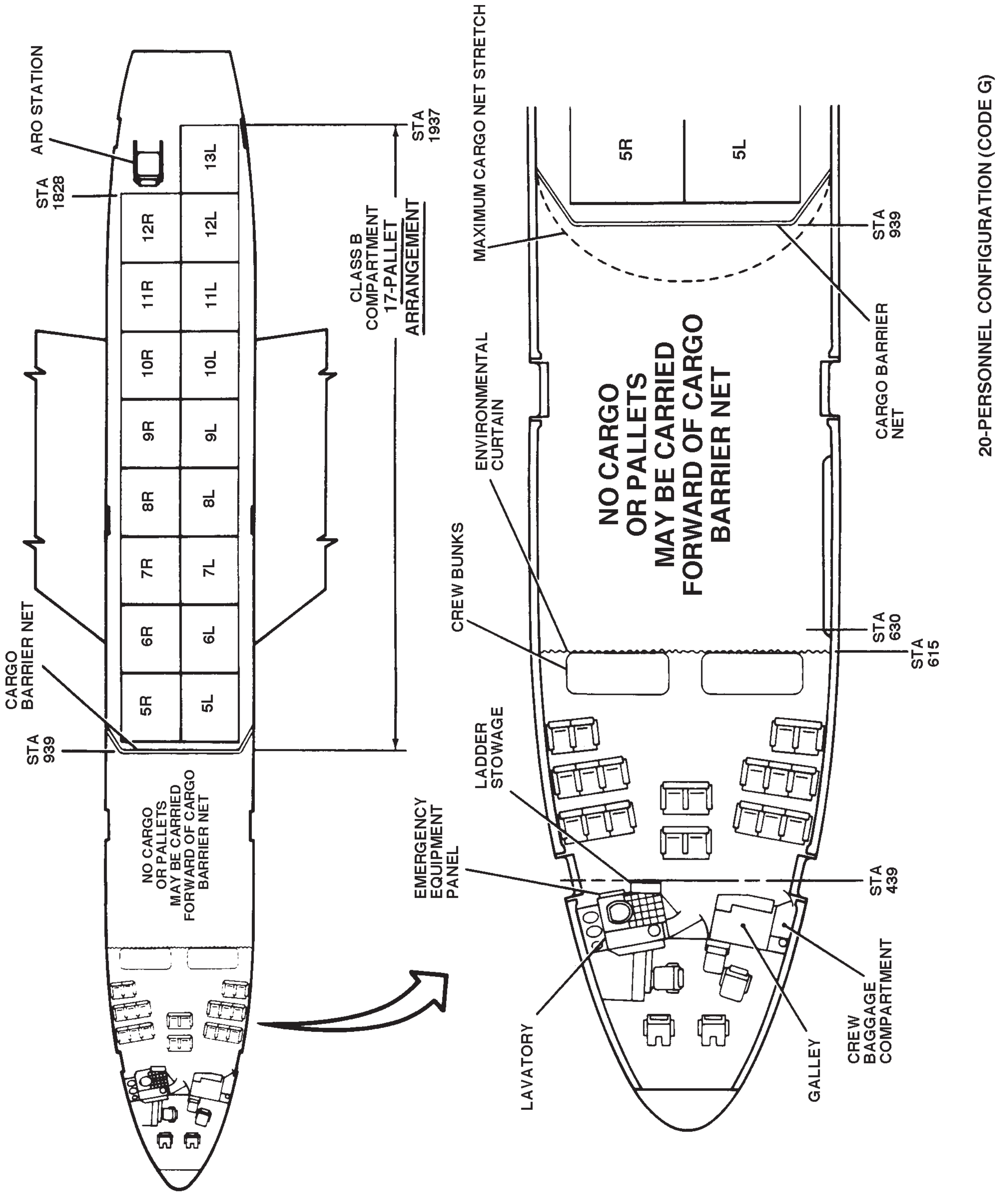
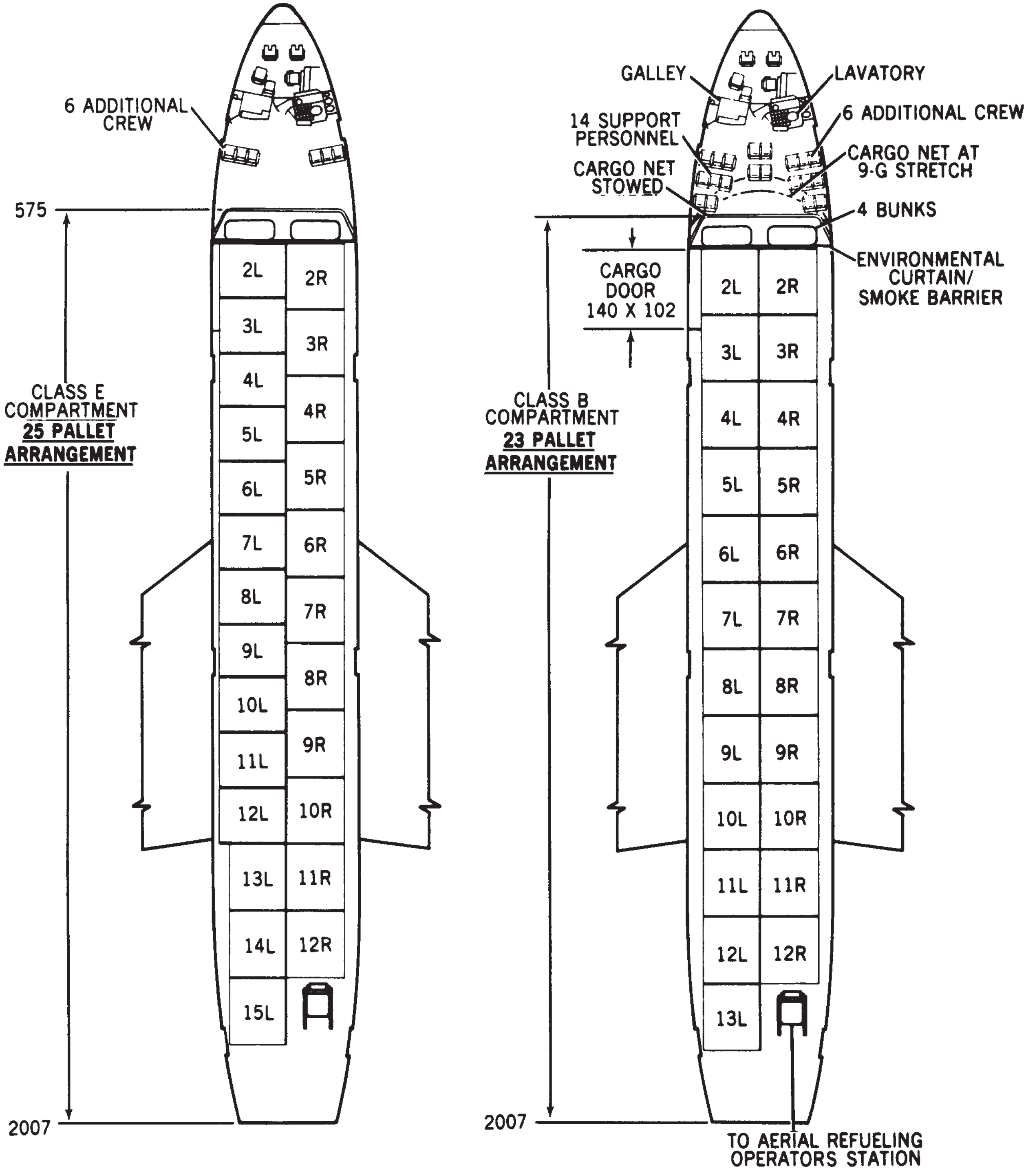


Figure 1.1-50. Mixed Cargo/Personnel Configuration (Sheet 2)



CODE F **CODE C**

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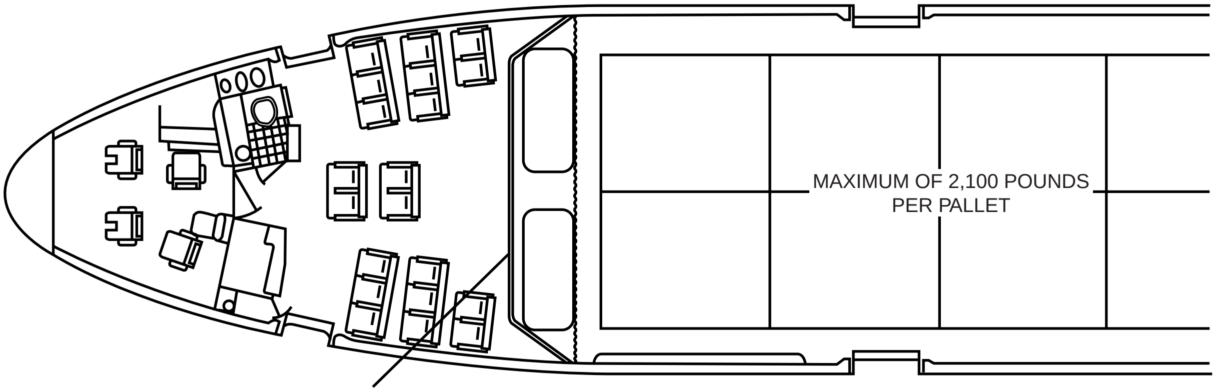
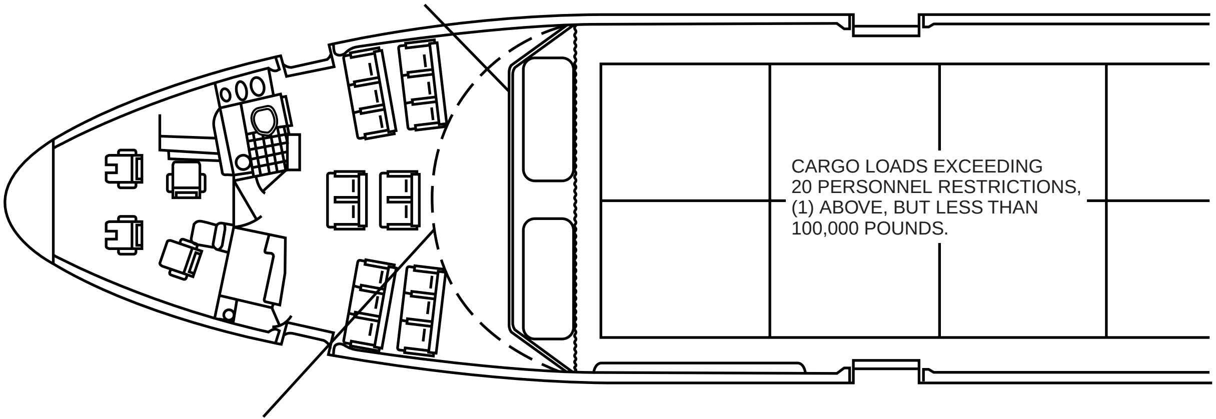
Figure 1.1-51. Mixed Personnel/Cargo Configurations (Sheet 1)



CARGO BARRIER NET IN
RIGGED POSITION

(1) 20-PERSONNEL CONFIGURATION (CODE C)

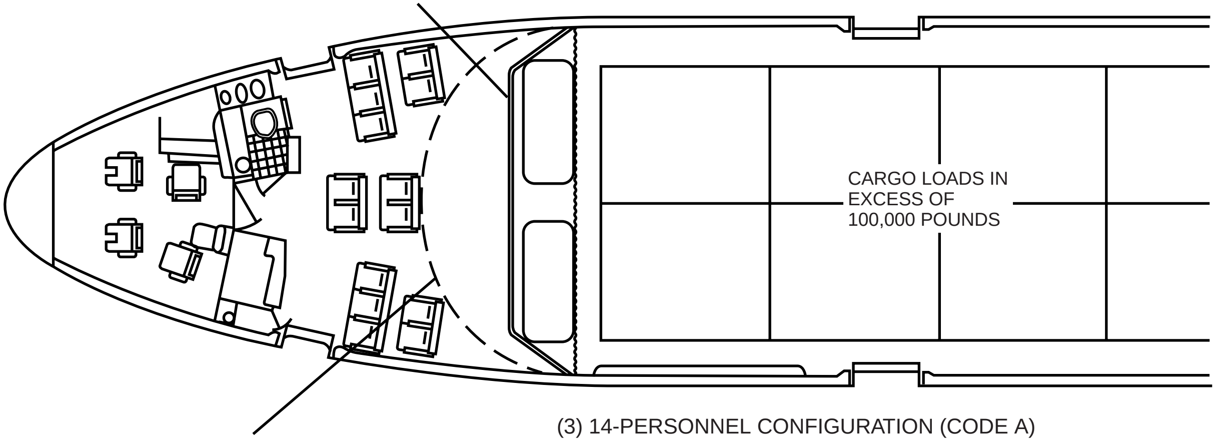
CARGO BARRIER NET IN
RIGGED POSITION



MAXIMUM CARGO BARRIER NET STRETCH AT 9g's
CARGO LOAD AT 100,000 LBS.

(2) 16-PERSONNEL CONFIGURATION (CODE B)

CARGO BARRIER NET IN
RIGGED POSITION



(3) 14-PERSONNEL CONFIGURATION (CODE A)

MAXIMUM CARGO BARRIER NET STRETCH AT 9g's
CARGO LOAD AT 175,000 LBS.

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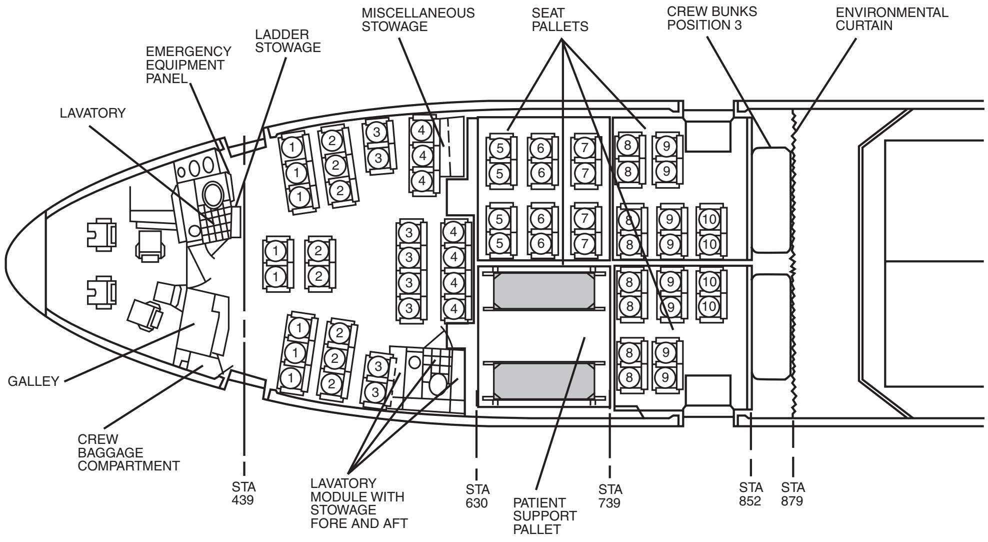
Figure 1.1-51. Mixed Personnel/Cargo Configurations (Sheet 2)

Patient Support Pallet Configuration 1 (Code H)



Patient Support Pallet Configuration 2 (Code I)

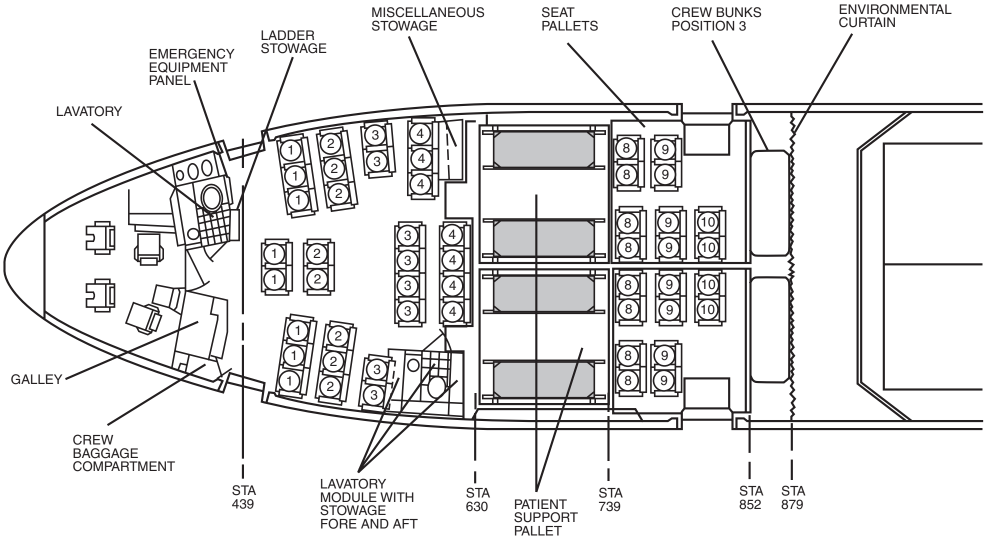


Figure 1.1-51. Mixed Personnel/Cargo Configurations (Sheet 3)

Cargo handling system components in this area are removed and stowed. The 9g cargo barrier net is located behind the seats at fuselage station 575 or forward of cargo at fuselage station 939. The environmental curtain is installed at station 615.

Twenty-Five Pallets Mixed Personnel/Cargo

The 25 pallet arrangement is identical to the 27 pallet arrangement of the all-cargo configuration with the exception of the two most forward pallets. Because the arrangement provides an aisle down one side only of the pallets, the compartment is classified as a Class E compartment. Then only six additional crew member seats may be installed forward of the main cargo compartment because of the limited provisions for long term oxygen supply.

Twenty-Three Pallets Mixed Personnel/Cargo

The 23 pallet arrangement is identical to the 25 pallet arrangement of the all cargo configuration except that the pallet positions 1L and 1R are replaced by seats. This arrangement has 20 seats installed, 6 additional crew and 14 support personnel. An aisle is provided on each side of the cargo pallets for fire fighting access. This arrangement is classified as a Class B compartment.

MIXED 75 PERSONNEL/CARGO CONFIGURATION

This configuration provides for 75 seats to be located in the forward area of the cargo compartment. With five seats in the flight compartment, the total number of personnel carried is 80. The requirement of the cargo handling system is identical to the first mixed personnel/cargo configuration except that the 9g cargo barrier net is relocated behind the seats at fuselage station 939. The seats forward of the main cargo door are installed in the floor-mounted seat tracks. The seats aft of the forward edge of the cargo door are mounted on four specially designed pallets. This configuration provides for seventeen HCU-6/E cargo pallets to be loaded aft of the barrier net. The pallets are oriented longitudinally to provide walkways on both sides of the cargo compartment. This permits the compartment to be classified as a Class B compartment.

NOTE

> The environmental curtain is installed at station 879.

CARGO HANDLING SYSTEM DESCRIPTION

The cargo handling system provides powered rollers for moving pallet-type containers laterally (inboard-outboard) in the cargo compartment and longitudinal rollers for moving the containers longitudinally (fore-and-aft) in the cargo compartment. The system can handle 88 x 108 cargo pallets. The cargo handling system consists of outboard side and center rails, end restraint rails, fore and aft restraints, laterally powered rollers, and longitudinal roller channels. The side and center guide rails also serve as lateral restraints. All rails and the fore and aft restraints components provide vertical restraint. The cargo handling system is secured to seat tracks in the cargo compartment. Omnidirectional rollers, powered rollers, and restraints are provided across the width of the cargo compartment in the doorway area. The remaining areas in the cargo compartment are provided with longitudinal roller channels, and fore-and-aft restraints; side, center, and end restraint rails.

OMNIDIRECTIONAL ROLLERS

The cargo pallets are supported in the doorway by omnidirectional rollers. These rollers swivel and permit loaded pallets to be moved in any direction.

POWERED ROLLERS

The doorway area is equipped with retractable, powered friction rollers, which move the pallets through the doorway during loading and unloading cycles and position them to move forward or aft. Once a pallet is ready to move in the fore-and-aft direction, the lateral powered rollers are retracted and the pallets are manually moved into position for weight and balance requirements prior to flight.

Eight powered rollers are installed to move pallets inboard during loading and outboard during unloading. The rollers elevate and rotate to move cargo when electrically energized. When deenergized, the rollers automatically retract to clear the cargo pallet to be moved longitudinally by winch or manual operation.

PIVOT CAPABILITY

The powered rollers in one row have the capability of being driven in the opposite direction to rollers in another row. This capability, used in conjunction with a removable pivot fitting mounted in the omnidirectional area, makes it possible to rotate palletized cargo in a controlled manner.

DOOR SILL CONVEYOR

The cargo door sill conveyor is provided as protection for the sill. The three-piece conveyor is attached to door spools in the cargo doorway area, to become a balance point for moving pallets in or out of the cargo compartment. The door sill bumper on the conveyor prevents damage to the aircraft from loading equipment. Two pallet stops in the center of the conveyor prevent accidental rollout of pallets during loading operations. Vertically mounted rollers are attached at the forward and aft ends of the convevor to prevent damage to the cargo door jamb when pallets are moved in or out of the cargo compartment.

CONTROLS

Controls for the powered roller system (figure 1.1-52) are located in a panel adjacent to the forward edge of the cargo door. A pendant attached to the panel enables one man to operate the controls which regulate power to the rollers, the number of rollers to be energized, and observe the loading/unloading operation. The panel includes two switches, an indicator light, and a pendant control receptacle for operation of the lateral loading/unloading system. The two-position POWER switch illuminates the panel indicator and provides power for system operation when placed in the ON position. The adjacent two-position toggle switch is used to select the roller channels to be energized in the cargo doorway area. The pendant control receptacle permits an attached cable and control unit directional movement of selected rollers. The pendant is stowed on a bracket just below the control panel.

CARGO WINCH

A lightweight portable cargo winch is provided to assist manual fore-and-aft loading/unloading operations for the cargo compartment. The winch is attached to seat tracks by means of an adapter. It can be moved to various locations in the cargo compartment as necessary to move cargo pallets. Electrical power for the winch is available at four outlets along the right side wall of the compartment. The winch is rated at 900 pounds, is powered by a 400 Hz, 3 phase, 115/200 VAC motor, and includes a 75-foot usable stainless steel cable and a pendant for operating the unit.

CARGO RESTRAINTS

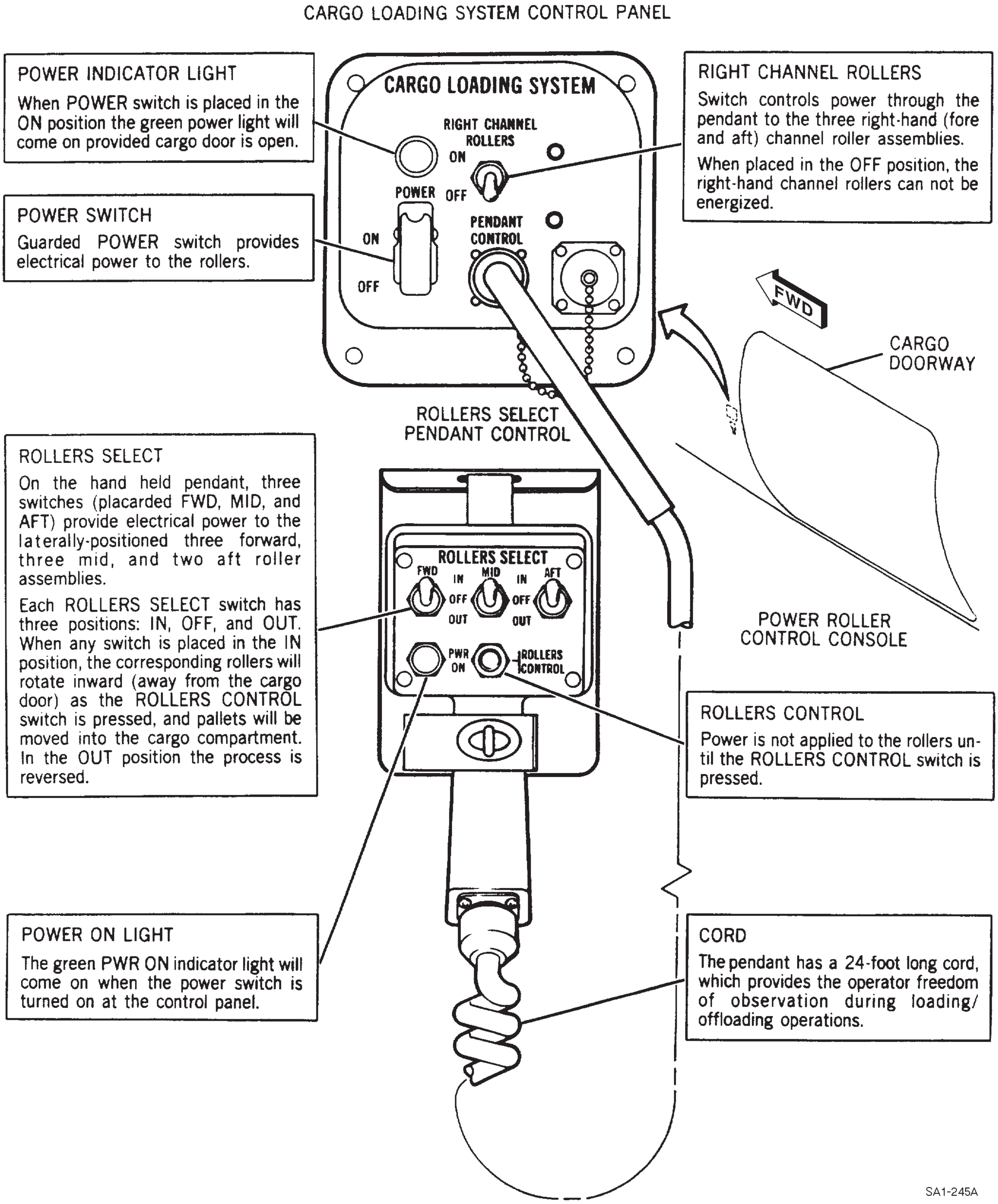
Loaded pallets are secured to the cargo handling system conveyor by fore-and-aft as well as lateral restraints, and by side guide, center guide, and end restraint rails.

FORE AND AFT RESTRAINTS

Fore and aft restraints for the pallet are provided by latches with retractable pawls, and by end restraint rails. When raised, the latch pawls lock in the upright position to form a hook which fits over the pallet edge. When released, the pawls lower into the latch base or frame. Four restraint latches are used at the forward and aft ends of each pallet, except for the last pallet in the line, which is secured in place by the end restraint rails. There are three types of fore-and-aft restraint latch attachments; one for the seat tracts, one for the roller channels, and one for the conveyor panels.

LATERAL RESTRAINTS

In the door area, lateral restraints for the pallet are provided by latches with a retractable pawl, and by the side and center guide rails. The latches are located in the omnidirectional conveyor panels. Latches are also provided at the cargo door sill for an alternate loading configuration of pallets.



CARGO LOADING SYSTEM CONTROL PANEL

ROLLERS SELECT PENDANT CONTROL

POWER INDICATOR LIGHT

When POWER switch is placed in the ON position the green power light will come on provided cargo door is open.

POWER SWITCH

Guarded POWER switch provides electrical power to the rollers.

RIGHT CHANNEL ROLLERS

Switch controls power through the pendant to the three right-hand (fore and aft) channel roller assemblies.

When placed in the OFF position, the right-hand channel rollers can not be energized.

ROLLERS SELECT

On the hand held pendant, three switches (placarded FWD, MID, and AFT) provide electrical power to the laterally-positioned three forward, three mid, and two aft roller assemblies.

Each ROLLERS SELECT switch has three positions: IN, OFF, and OUT. When any switch is placed in the IN position, the corresponding rollers will rotate inward (away from the cargo door) as the ROLLERS CONTROL switch is pressed, and pallets will be moved into the cargo compartment. In the OUT position the process is reversed.

ROLLERS CONTROL

Power is not applied to the rollers until the ROLLERS CONTROL switch is pressed.

POWER ON LIGHT

The green PWR ON indicator light will come on when the power switch is turned on at the control panel.

CORD

The pendant has a 24-foot long cord, which provides the operator freedom of observation during loading/offloading operations.

Figure 1.1-52. Powered Rollers Control

PART 2

POWER PLANT/APU - FIRE PROTECTION

TABLE OF CONTENTS

POWER PLANT/APU - FIRE PROTECTION

POWER PLANT DESCRIPTION

The General Electric CF6-50C2 engine is a dual rotor, front fan, high bypass ratio engine designed for subsonic tanker/ transport aircraft.

The core engine consists of a variable stator, 14-stage high pressure ratio compressor, an annular combustor, a two-stage air-cooled turbine, gearbox, controls and accessories. To provide stall-free engine performance, the pitch angle of the inlet guide vanes plus the first five stages of stator vanes of the compressor is variable. In addition, variable bypass valves are installed in the core flowpath to the inlet to the engine high pressure compressor. Movement of the stator vanes and bypass valves is scheduled as a function of core engine speed and compressor inlet temperature. The integrated front fan and low pressure compressor are driven by a four stage, low pressure turbine by a connecting shaft. There is no mechanical connection between the core engine and the fan. However, the core engine cowling forms the inner cone for the fan nozzle and the core engine discharges through fixed area type nozzles.

The turbine-driven front fan increases mass airflow and decreases jet velocity, giving the CF6-50C2 quieter operation, greatly improved thrust and Specific Fuel Consumption (SFC). The bypass ratio is 4.31 to 1. At full rated power the fan produces 73% of total power and the core engine produces 27% of the total power. The engine is flat rated at 30°C at sea level and produces approximately 52,500 pounds of thrust. Thrust decreases with increases in temperature and altitude.

The CF6-50C2 engine is serviced with Mobil Jet Oil II as specified by General Electric CF6 Service Bulletin 79-1.

ENGINE LIFE

Engine Cycles

CF6-50C2 engine compressor and turbine disks are subject to low cycle fatigue and must be replaced when cycle limits are exceeded. An accurate record of cycles must be maintained in order to control these life-limited components. Basically an engine cycle involves a major change from one thrust setting to another and the resulting change in stress that affects the low cycle fatigue life of rotating parts. For recording engine cycles on the AFTO Form 781H, one cycle is defined as any flight, consisting of one takeoff and one landing, and each touch-and-go landing. Missed approaches and breakaways will not be recorded as engine cycles on AFTO Form 781H.

ENGINE INSTRUMENTS

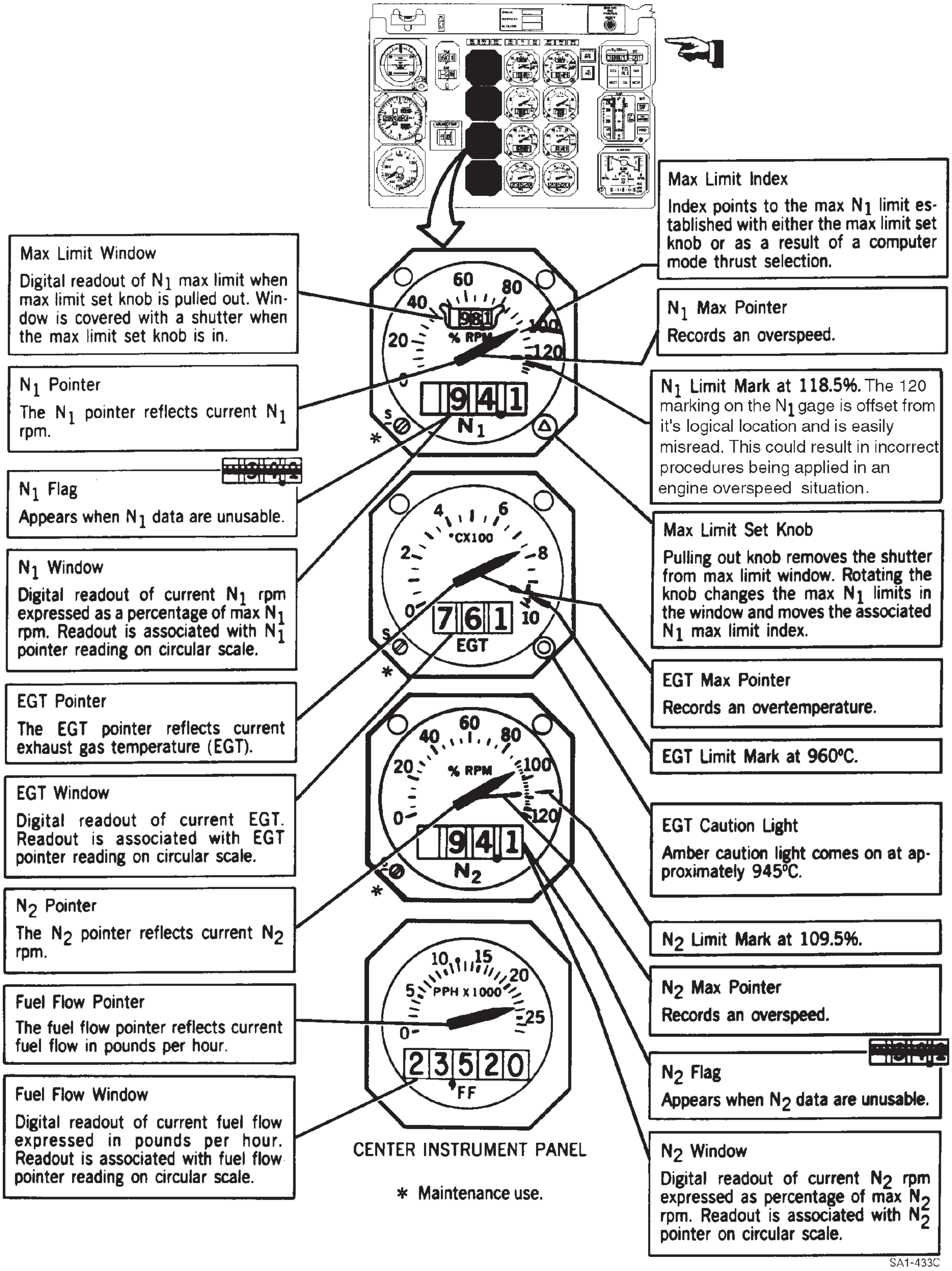
The N_1 tachometers, Exhaust Gas Temperature gages, N_2 tachometers, and Fuel Flow Rate gages (figure 1.2-1) are located on the center instrument panel. The engine oil gages are located on the Flight Engineer’s Upper Instrument Panel (figure 1.1-28). Instrument markings are shown in figure 3-1.

IGNITION SYSTEMS

A dual ignition system is provided for each engine (figure 1.2-2). Each system is controlled by an engine ignition selector switch and an override and airstart switch. Ignition system A is powered by the left ac emergency bus and system B is powered by the right ac emergency bus. Each system has an individual starting ignition system and a continuous ignition system control mode. To energize the igniter plugs in a selected engine when using the START A or B positions, the applicable starter button must be pushed and the applicable engine fuel lever must be moved out of the OFF position. Moving the lever toward ON will energize the ignition system prior to initiating fuel flow. The lever is moved to ON at approximately 15% N_2 rotor speed. As the N_2 rotor accelerates to approximately 45% N_2 rpm the start switch holding circuit is deenergized and the engine starter switch pops out, discontinuing starting and ignition. The CONT A or B positions require only that the engine fuel lever be ON. A single override and airstart switch is provided for all three engines. The override and airstart switch bypasses the fuel lever switch, start switch, and the engine ignition selector switch to provide dual ignition to all engines simultaneously. It also provides power to the start switch, should starter assist be required for a restart.

The start and continuous positions of the ignition selector both provide 15-joule high energy ignition.

The ignition exciter power transfer switches on the Flight Engineer’s equipment panel increase aircraft dispatch and reliability by allowing the power source for the B igniters on engines 1 and 3 to be transferred from the right ac emergency bus to the left ac emergency bus. The switches are intended for use on the ground prior to engine start if system A ignition is inoperative.



Max Limit Window

Digital readout of N_1 max limit when max limit set knob is pulled out. Window is covered with a shutter when the max limit set knob is in.

N_1 Pointer

The N_1 pointer reflects current N_1 rpm.

N_1 Flag

Appears when N_1 data are unusable.

N_1 Window

Digital readout of current N_1 rpm expressed as a percentage of max N_1 rpm. Readout is associated with N_1 pointer reading on circular scale.

EGT Pointer

The EGT pointer reflects current exhaust gas temperature (EGT).

EGT Window

Digital readout of current EGT. Readout is associated with EGT pointer reading on circular scale.

N_2 Pointer

The N_2 pointer reflects current N_2 rpm.

Fuel Flow Pointer

The fuel flow pointer reflects current fuel flow in pounds per hour.

Fuel Flow Window

Digital readout of current fuel flow expressed in pounds per hour. Readout is associated with fuel flow pointer reading on circular scale.

Max Limit Index

Index points to the max N_1 limit established with either the max limit set knob or as a result of a computer mode thrust selection.

N_1 Max Pointer

Records an overspeed.

N_1 Limit Mark at 118.5%. The 120 marking on the N_1 gage is offset from it's logical location and is easily misread. This could result in incorrect procedures being applied in an engine overspeed situation.

Max Limit Set Knob

Pulling out knob removes the shutter from max limit window. Rotating the knob changes the max N_1 limits in the window and moves the associated N_1 max limit index.

EGT Max Pointer

Records an overtemperature.

EGT Limit Mark at 960°C.

EGT Caution Light

Amber caution light comes on at approximately 945°C.

N_2 Limit Mark at 109.5%.

N_2 Max Pointer

Records an overspeed.

N_2 Flag

Appears when N_2 data are unusable.

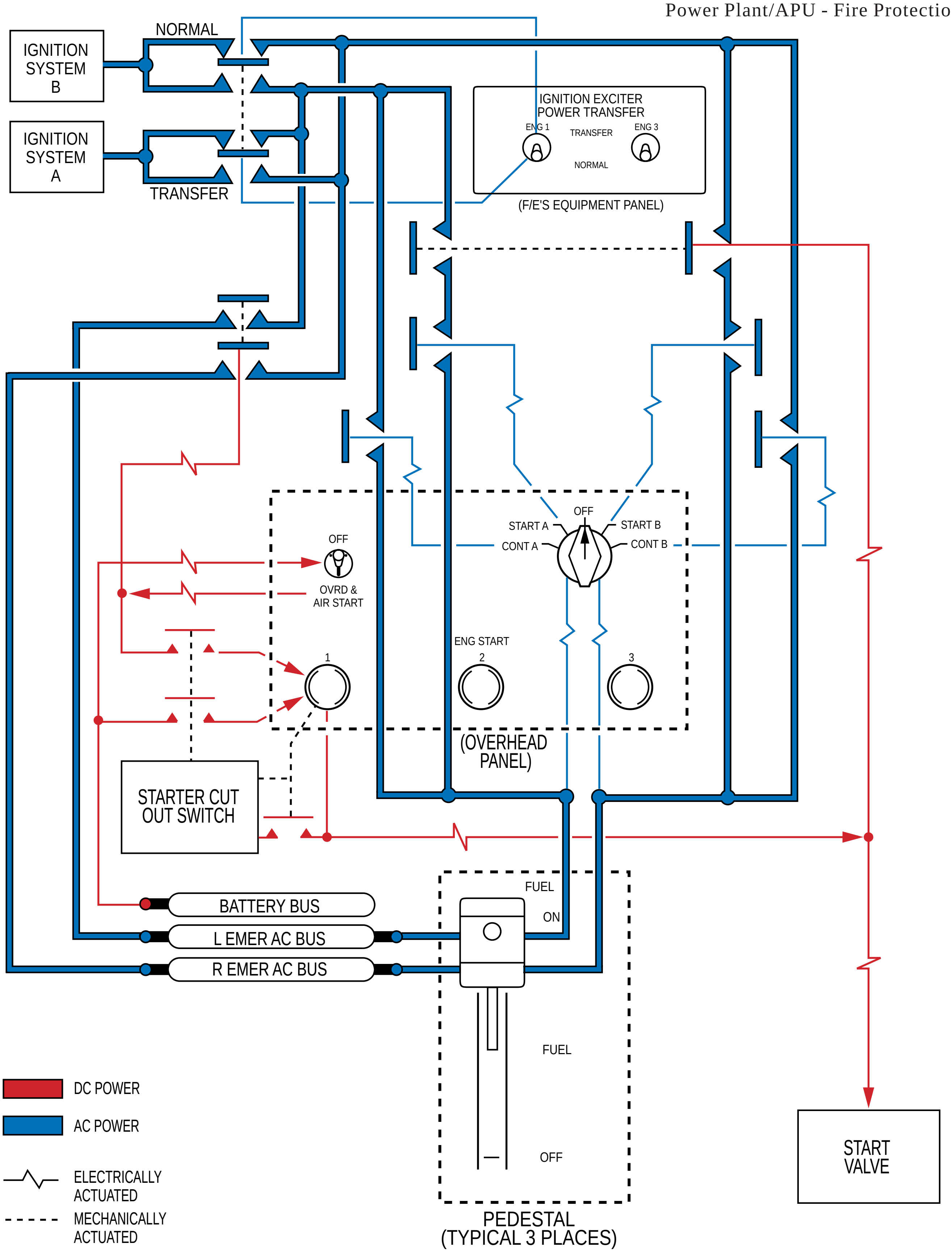
N_2 Window

Digital readout of current N_2 rpm expressed as percentage of max N_2 rpm. Readout is associated with N_2 pointer on circular scale.

CENTER INSTRUMENT PANEL

* Maintenance use.

Figure 1.2-1. Engine Instruments



SA1-217A

Figure 1.2-2. Ignition System/Engine

STARTING SYSTEMS

The engines can be started by pneumatic power from an external source, the onboard APU, or from engine 1 or 3. During engine start using the APU, the APU will operate automatically at N_1 speeds up to 100% in normal control to provide higher starting pressure when start A or B is selected and the APU/ISOL VALVE is open. Starting pressure from any source is indicated by an applicable pneumatic system pressure gage, depending upon source and the positions of the isolation valves. Each individual start switch, when pushed, is magnetically held if the engine ignition selector is in one of the two starting positions provided, or if the override and airstart switch is at OVRD & AIR START position. When pushed and held, a light in the switch will come on to indicate the associated engine valve is open. As engine N_2 rotor cranking speed reaches approximately 45% rpm, the starter switch should pop out automatically and the light will go off, indicating the start valve is closed. The start sequence may be terminated at any time by manually disengaging the start switch. For airstart requirements, the starters can be engaged at any engine speed up to 20% N_2 rpm.

FUEL CONTROL SYSTEM

Fuel from the applicable wing tank enters the two-stage engine-driven pump, then passes through the fuel/oil heat exchanger, the fuel filter, the fuel control unit, the pressurizing and drain valve, the fuel flow transmitter, and the fuel manifold (figure 1.2-3). The fuel control unit contains a shutoff valve controlled by a fuel lever on the pedestal. Fuel moving through the fuel/oil heat exchanger is heated to prevent fuel system icing. A pressure differential switch is provided across the main fuel filter which will activate a FUEL FILTER PRESS DROP light indicating impending clogging of the filter. If filter clogs to a predetermined degree, fuel will bypass the filter to maintain flow to the engine. A dual idle speed feature is incorporated in the fuel control. Ground idle is the minimum operating speed of the engine and is intended to minimize thrust, fuel use, noise, and jet blast. Flight idle provides an increased idle rpm which permits rapid response to throttle advancement. The ground and flight idle modes are controlled by the ground control relays. The ground shift selects flight idle during takeoff rotation, and returns to ground idle upon landing. The flight idle mode is retained for a short period of time to provide rapid acceleration in the reverse thrust mode after landing.

OIL SYSTEM

Each engine oil system is completely self-contained (figure 1.2-4). Oil for engine lubrication is supplied by an oil tank mounted on the engine accessory section. Oil is pumped under pressure to the engine and returns to the oil tank through an engine oil scavenge filter and through the fuel-oil heat exchanger. A pressure differential switch is provided across the oil scavenge filter which will activate an ENGINE OIL STRAINER CLOGGING light to indicate impending scavenge filter clogging. If the filter clogs to a predetermined degree, the oil will bypass the filter to maintain adequate flow to the engine.

Oil Quantity

The cockpit OIL QUANTITY gage indicates the normal usable fluid level in the oil tank. The gage is marked from 0 to 22 quarts and has an accuracy of ±1 quart. A full quantity reading on the dipstick is approximately 18 quarts on the gage. A tank quantity of 6 quarts (4 quarts usable) approximates zero on the gage. When the engine is running, the tank oil quantity and gage indications will decrease due to additional distribution of oil within the oil system such as sumps, gearboxes, and supply and scavenge lines. The magnitude of the quantity decrease, commonly referred to as gulping, varies with rotor speed. High gulping is associated with high N_2. Aircraft acceleration on the runway and aircraft rotation will transiently increase gulping. Oil temperature (thermal expansion), aeration, and aircraft pitch attitude will also influence gulping.

VIBRATION INDICATING SYSTEM

Engine vibration is sensed by two vibration pickups mounted on each engine. An engine vibration indicator, selector switch, and test button are located on the Flight Engineer's Panel. Fan and turbine unbalance are monitored.

ENGINE FAILURE DETECTOR SYSTEM

A N_1 difference detector alerts the flight crew of engine N_1 rpm loss on any of the three engines during takeoff ground roll by turning on the ENG FAIL light on each side of the glareshield. The system is armed when the N_1 is advanced past 85% and is activated when and 11% difference or greater is detected.

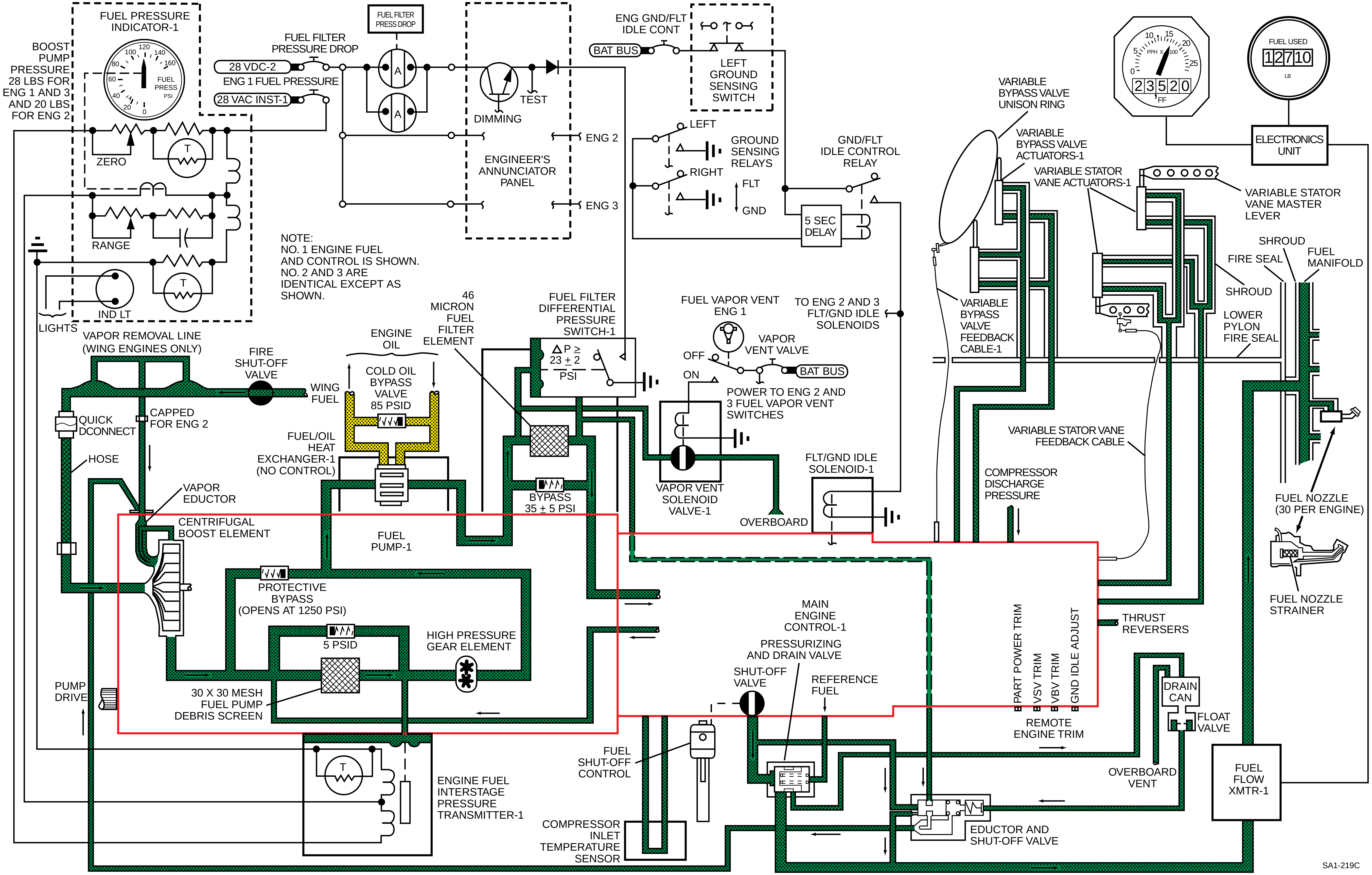
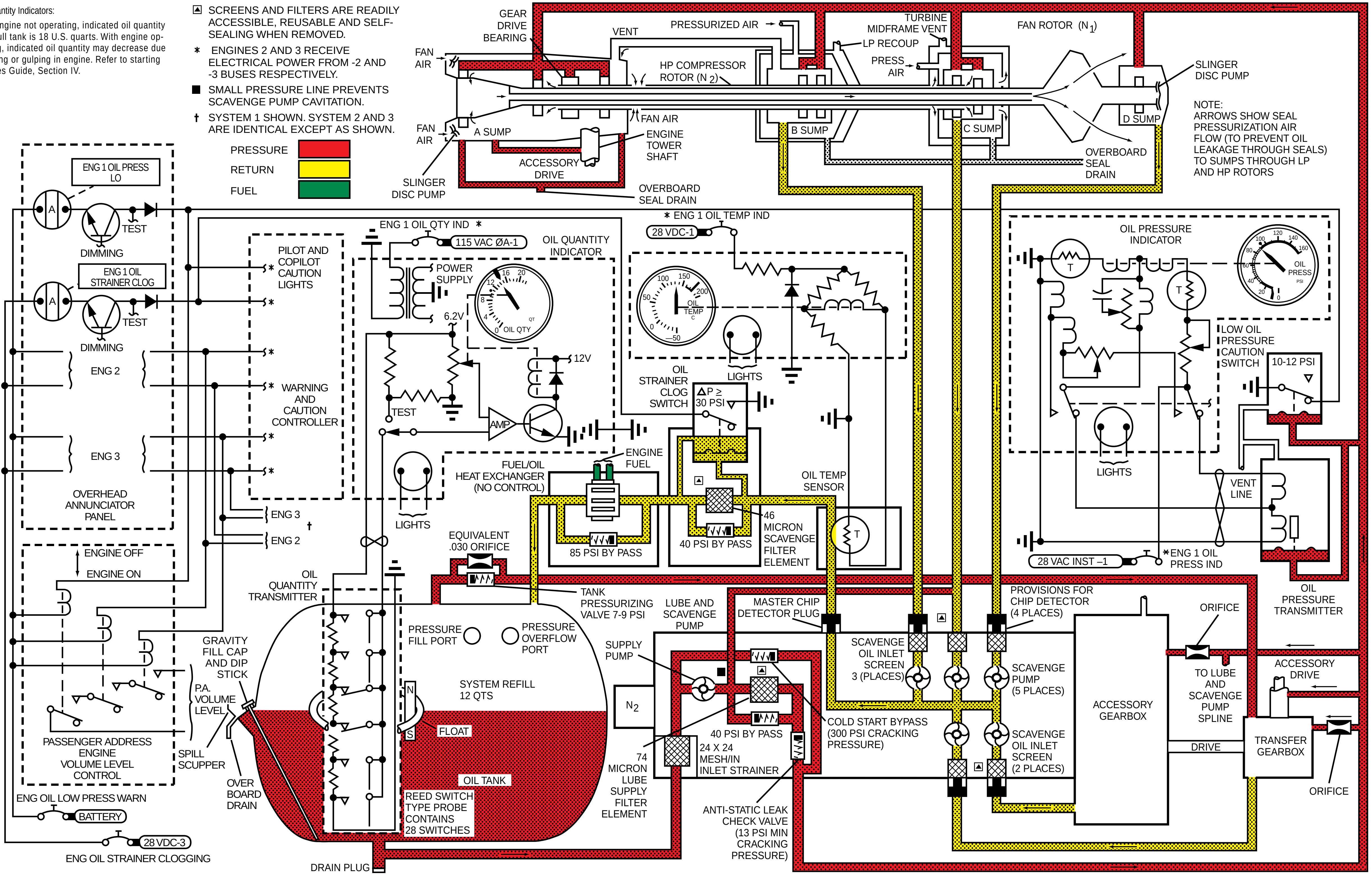


Figure 1.2-3. Engine Fuel Control System Schematic

Oil Quantity Indicators:

With engine not operating, indicated oil quantity for a full tank is 18 U.S. quarts. With engine operating, indicated oil quantity may decrease due to hiding or gulping in engine. Refer to starting Engines Guide, Section IV.



NOTES:

- ▣ SCREENS AND FILTERS ARE READILY ACCESSIBLE, REUSABLE AND SELF-SEALING WHEN REMOVED.
- ∗ ENGINES 2 AND 3 RECEIVE ELECTRICAL POWER FROM -2 AND -3 BUSES RESPECTIVELY.
- ■ SMALL PRESSURE LINE PREVENTS SCAVENGE PUMP CAVITATION.
- † SYSTEM 1 SHOWN. SYSTEM 2 AND 3 ARE IDENTICAL EXCEPT AS SHOWN.

PRESSURE 🟥
RETURN 🟨
FUEL 🟩

Figure 1.2-4. Engine Oil System Schematic

THRUST REVERSING SYSTEM

The thrust reversing system, for each engine, is powered by regulated pneumatic pressure from the engine. The reversers can be activated with the engine pneumatic selectors on or off. Operation is in response to thrust reverser lever movement. The thrust reverser levers cannot be raised to the reverse thrust position unless the applicable throttle is in the idle position. An in-flight reverse thrust interlock prevents deployment of the thrust reversers unless the landing gear is down. After landing gear is down, initial reverser lever movement unlocks the respective system, starts reverser deployment, and is indicated by the REV U/L and REV PRES lights coming on. The reverser lever cannot be raised past the detent position to the reverse thrust power range unless the fan reverser system on the respective engine is fully deployed. The fan reverser system, when fully deployed, will turn on the REV THR light, turn off the REV U/L and REV PRES and respectively release the interlock for engine number 1 and 3 reverse levers. For engine number 2 interlock release, full fan reverser deployment and nose gear ground shift actuation is required.

Reverse thrust can be applied up to the reverse stop but not to exceed 95% N_1 rpm if required. There are no interlocks or requirements for stopping at any intermediate position when coming out of reverse thrust.

Mechanically, fan reverse thrust is accomplished by aft movement of a section of the engine cowl to expose fixed cascades and operate blocker doors that rotate across the fan exhaust stream. This action blocks the normal exhaust flow and forces the exhaust through the cascades at a forward angle to provide reverse thrust. In case of a failure, the reverser will stay in the last selected position. Operation of the REV U/L, REV PRES, and REV THR lights are covered in this part.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Pilot’s Pedestal, Center Instrument Panel, Overhead Panel, and Flight Engineer’s Lower Panel. Illustrations of the panels are in Part 1, Aircraft General.

FIRE PROTECTION

The fire protection system provides the means to detect and extinguish a fire in the nacelles and the auxiliary power unit (APU) compartment (figure 1.2-5).

The fire protection system consists of fire and smoke detection, fire/smoke warnings, and fire extinguishing subsystems (figure 1.2-6).

A smoke detection system is provided for the cabin cargo compartment.

FIRE DETECTION SYSTEMS

Engines and APU

Each detection system consists of two redundant sensing elements (fire detector loops) mounted parallel to each other. The sensing elements for each fire area are monitored by a control unit. False fire warnings are minimized because normal operation requires that both loops must be subjected simultaneously to fire or overheat conditions before they electrically trigger the control units and energize the alarm system. If one sensing loop is defective, the aircraft can still be dispatched, or continue in flight, using the single operational detector by moving the applicable loops selector switch to the operating loop position. In normal operation, with the loops selector switch at BOTH, if a single system is falsely energized, only the applicable loop light comes on and the fire warning lights and bell or horn do not activate.

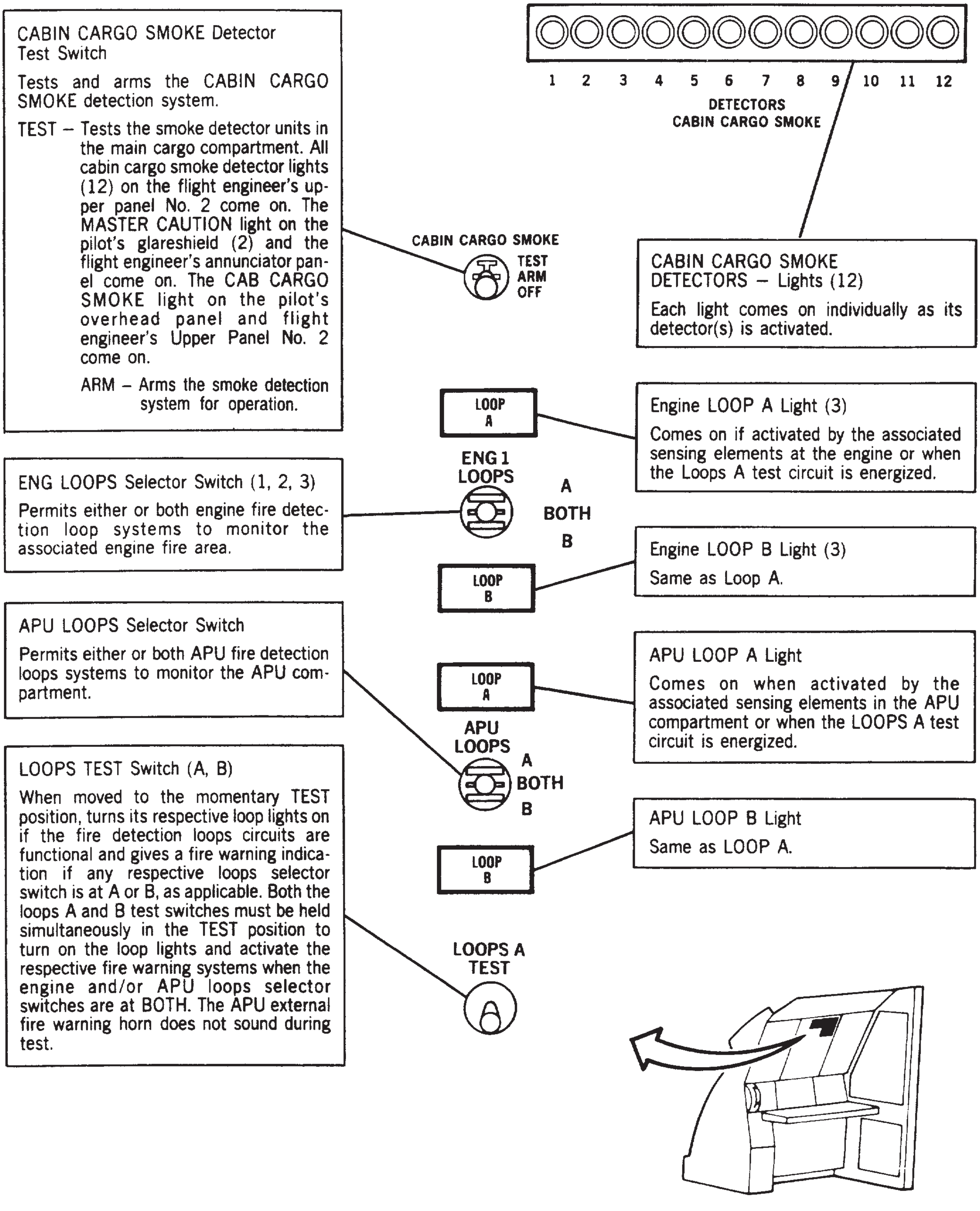
Cabin Cargo Compartment

The cabin cargo compartment detection system consists of sixteen smoke detectors in the compartment ceiling. Any individual detector activates the cabin cargo smoke caution system, when smoke is detected (figure 1.2-5).

FIRE WARNING SYSTEMS

Engines and APU

The fire warning for the engines consists of engine fire lights in the engine fire handles on the overhead panel, and engine fire light on the glareshield, fuel



CABIN CARGO SMOKE Detector Test Switch

Tests and arms the CABIN CARGO SMOKE detection system.

TEST – Tests the smoke detector units in the main cargo compartment. All cabin cargo smoke detector lights (12) on the flight engineer's upper panel No. 2 come on. The MASTER CAUTION light on the pilot's glareshield (2) and the flight engineer's annunciator panel come on. The CAB CARGO SMOKE light on the pilot's overhead panel and flight engineer's Upper Panel No. 2 come on.

ARM – Arms the smoke detection system for operation.

CABIN CARGO SMOKE DETECTORS – Lights (12)

Each light comes on individually as its detector(s) is activated.

Engine LOOP A Light (3)

Comes on if activated by the associated sensing elements at the engine or when the Loops A test circuit is energized.

ENG LOOPS Selector Switch (1, 2, 3)

Permits either or both engine fire detection loop systems to monitor the associated engine fire area.

Engine LOOP B Light (3)

Same as Loop A.

APU LOOPS Selector Switch

Permits either or both APU fire detection loops systems to monitor the APU compartment.

APU LOOP A Light

Comes on when activated by the associated sensing elements in the APU compartment or when the LOOPS A test circuit is energized.

APU LOOP B Light

Same as LOOP A.

LOOPS TEST Switch (A, B)

When moved to the momentary TEST position, turns its respective loop lights on if the fire detection loops circuits are functional and gives a fire warning indication if any respective loops selector switch is at A or B, as applicable. Both the loops A and B test switches must be held simultaneously in the TEST position to turn on the loop lights and activate the respective fire warning systems when the engine and/or APU loops selector switches are at BOTH. The APU external fire warning horn does not sound during test.

FLIGHT ENGINEER'S UPPER PANEL NO. 2

SA1-79B

Figure 1.2-5. Fire Protection - Controls and Indicators (Sheet 1)

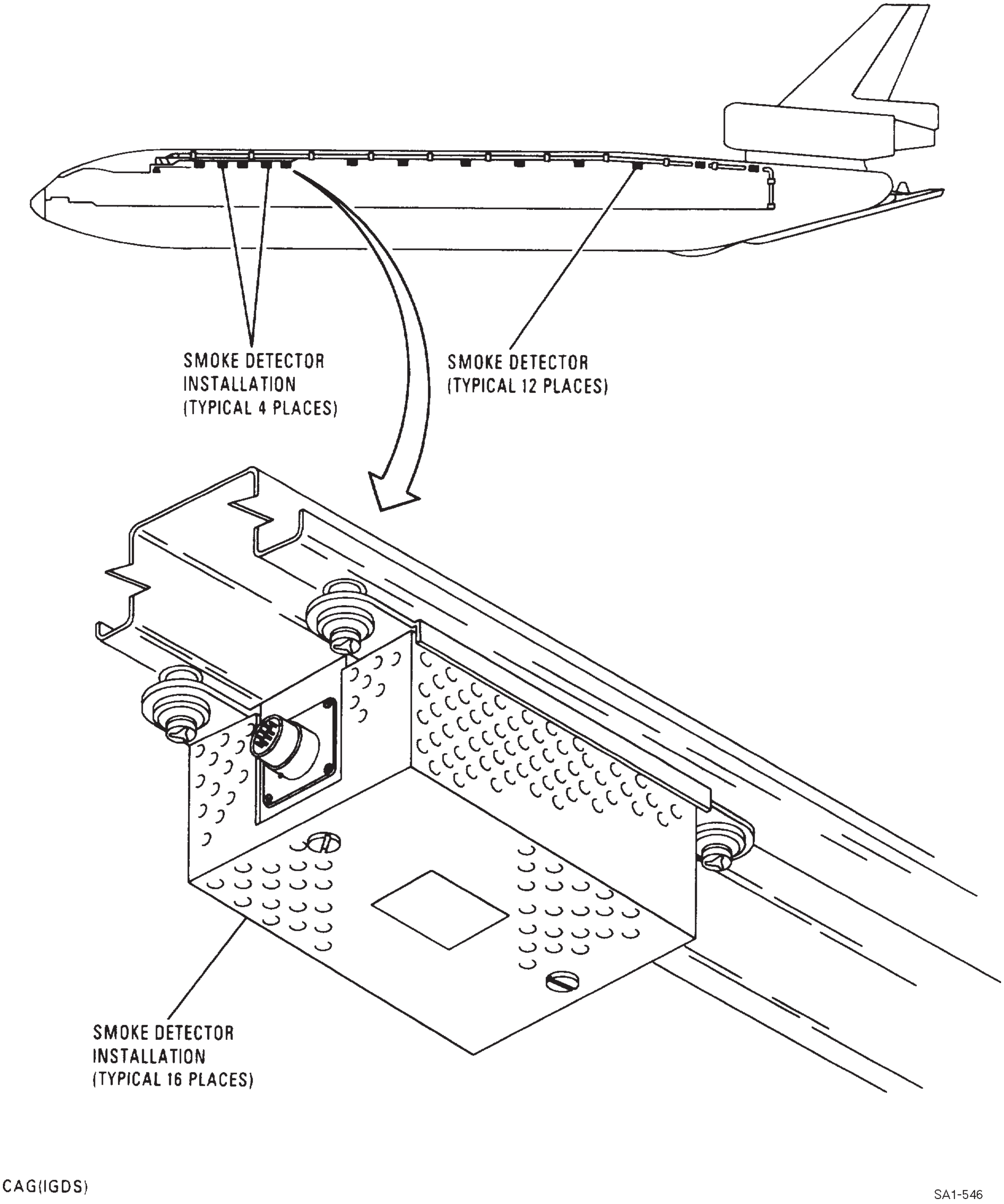
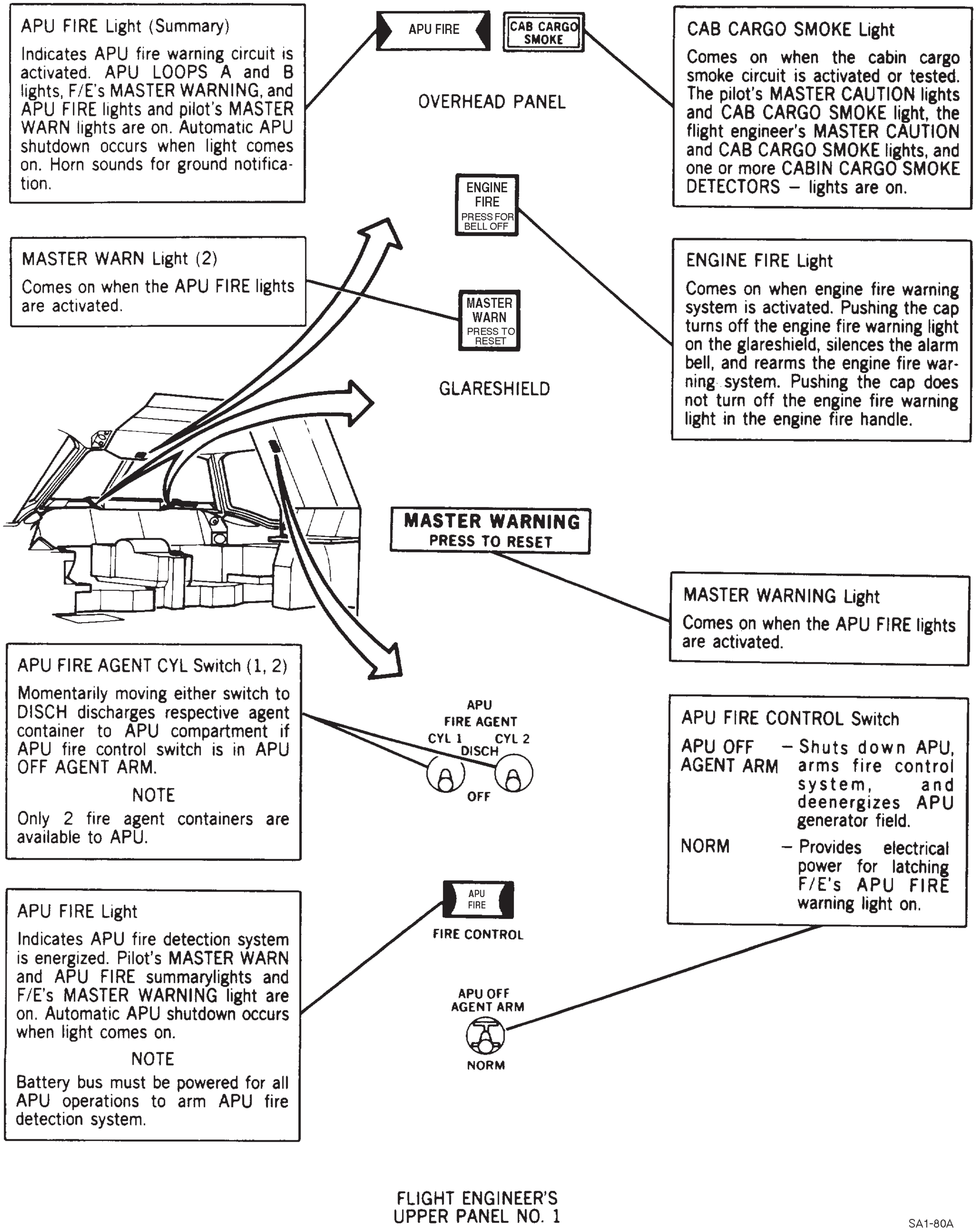


Figure 1.2-5. Fire Protection - Controls and Indicators (Sheet 2)



APU FIRE Light (Summary)

Indicates APU fire warning circuit is activated. APU LOOPS A and B lights, F/E's MASTER WARNING, and APU FIRE lights and pilot's MASTER WARN lights are on. Automatic APU shutdown occurs when light comes on. Horn sounds for ground notification.

MASTER WARN Light (2)

Comes on when the APU FIRE lights are activated.

APU FIRE AGENT CYL Switch (1, 2)

Momentarily moving either switch to DISCH discharges respective agent container to APU compartment if APU fire control switch is in APU OFF AGENT ARM.

NOTE

Only 2 fire agent containers are available to APU.

APU FIRE Light

Indicates APU fire detection system is energized. Pilot's MASTER WARN and APU FIRE summarylights and F/E's MASTER WARNING light are on. Automatic APU shutdown occurs when light comes on.

NOTE

Battery bus must be powered for all APU operations to arm APU fire detection system.

CAB CARGO SMOKE Light

Comes on when the cabin cargo smoke circuit is activated or tested. The pilot's MASTER CAUTION lights and CAB CARGO SMOKE light, the flight engineer's MASTER CAUTION and CAB CARGO SMOKE lights, and one or more CABIN CARGO SMOKE DETECTORS – lights are on.

ENGINE FIRE Light

Comes on when engine fire warning system is activated. Pushing the cap turns off the engine fire warning light on the glareshield, silences the alarm bell, and rearms the engine fire warning system. Pushing the cap does not turn off the engine fire warning light in the engine fire handle.

MASTER WARNING Light

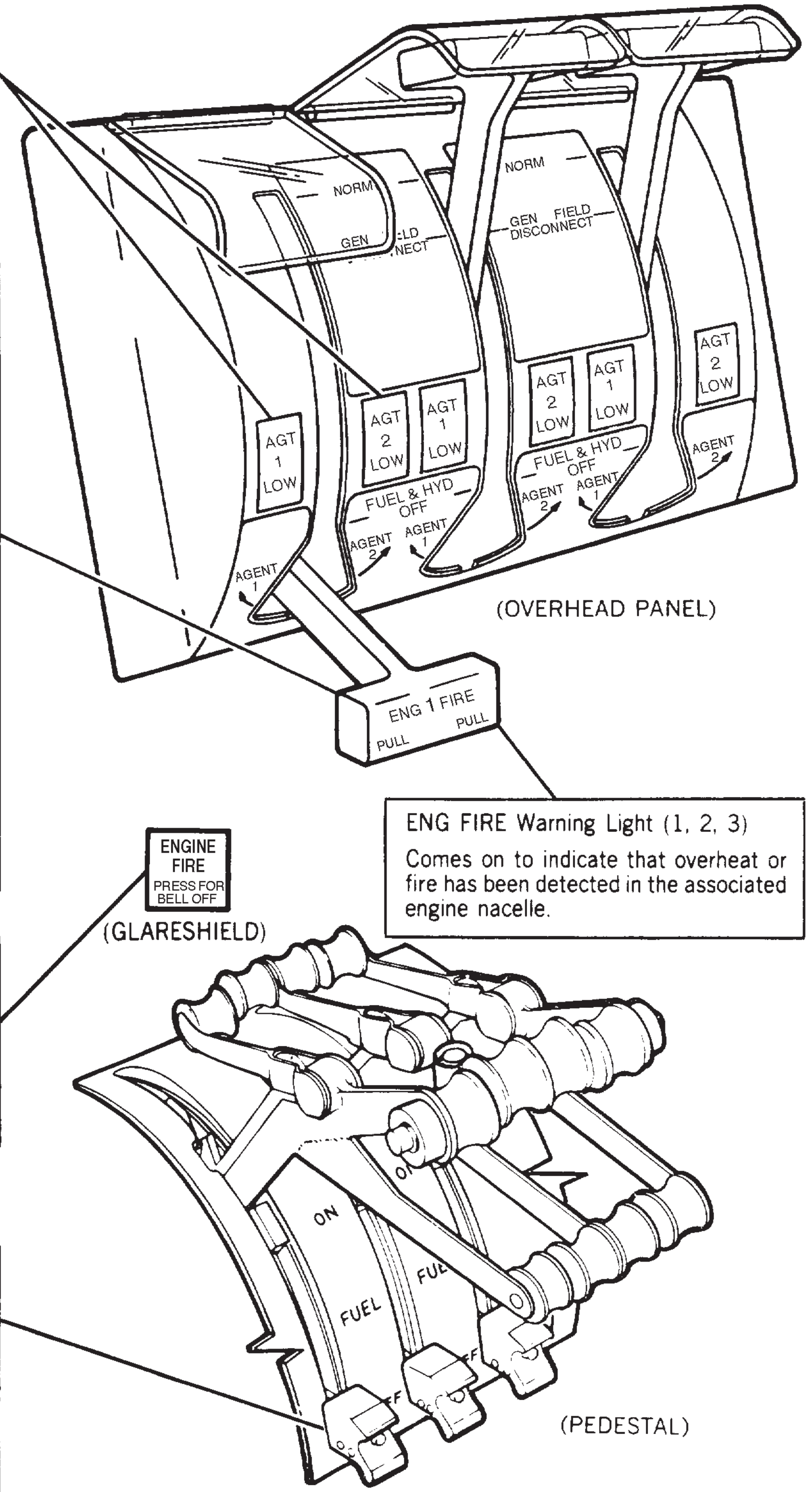
Comes on when the APU FIRE lights are activated.

APU FIRE CONTROL Switch

APU OFF AGENT ARM – Shuts down APU, arms fire control system, and deenergizes APU generator field.

NORM – Provides electrical power for latching F/E's APU FIRE warning light on.

Figure 1.2-5. Fire Protection - Controls and Indicators (Sheet 3)



AGT LOW Light (1, 2)

Indicates that fire extinguishing agent in respective cylinder has been discharged. Engine 2 (and APU) AGENT LOW Light 1 and 2 are powered by battery bus.

ENG FIRE Handle (1, 2, 3)

Shuts off electrical power, alarm bell, fuel and hydraulic supply and, when pulled full forward and rotated, discharges agent into selected engine nacelle.

GEN FIELD DISCONNECT — Deenergizes respective generator field and silences alarm bell if not already silenced by respective ENGINE FIRE light.

FUEL & HYD OFF — Shuts off respective fuel and hydraulic supply, and positions engine fire handle to permit rotation for agent discharge into selected nacelle.

NOTE

Twisting engine fire handle while pulling handle may result in premature firing of extinguishing agent.

ENGINE FIRE Light

Comes on when engine fire warning system is activated. Pushing light turns off light, silences alarm bell, and rearms engine fire warning system. Pushing light does not turn off ENG FIRE warning light in engine fire handle.

Fuel Lever Light (3)

The light in fuel lever comes on when respective engine fire warning light (in engine fire handle) is activated. Indicates which fuel lever to shut off.With engine fire handle pulled and fuel lever ON or OFF, the light remains on if fire warning still exists. With engine fire handle pulled and fire warning terminated, light remains on until fuel lever is moved to OFF position.

ENG FIRE Warning Light (1, 2, 3)

Comes on to indicate that overheat or fire has been detected in the associated engine nacelle.

Figure 1.2-5. Fire Protection - Controls and Indicators (Sheet 4)

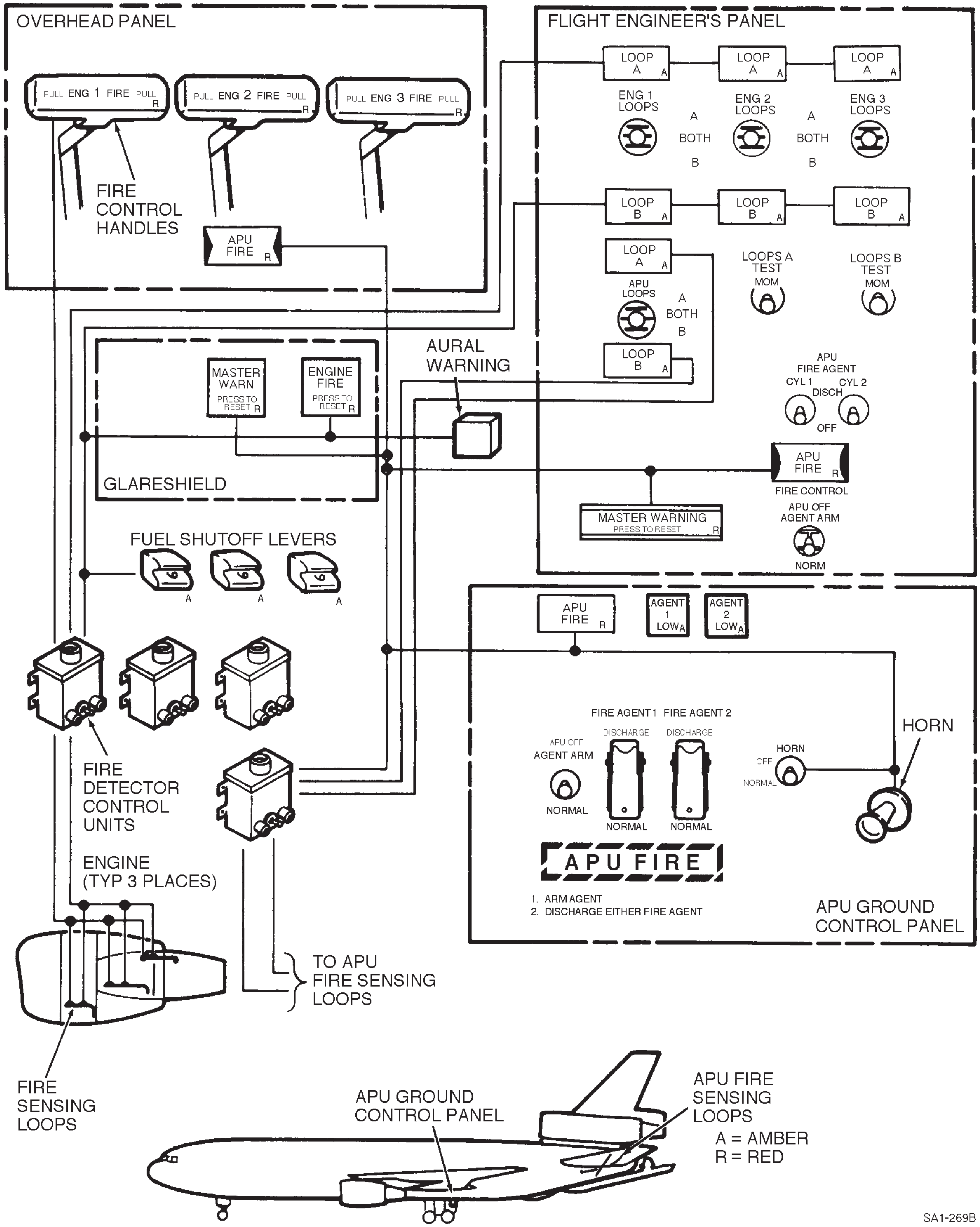


Figure 1.2-6. Fire Protection Controls Schematic

lever lights, loops A and B lights on the Flight Engineer's Panel, and a bell sound from the aural warning system. The fire handle light and fuel lever light identify which engine has a fire warning when the bell rings and, simultaneously, the engine fire light comes on. A bell cutoff switch, generator field cutoff switch, and fuel and hydraulic shutoff features are actuated when the engine fire handle is pulled. Rotating the fire handle permits release of extinguishing agent into proper nacelle. The light in the engine fire handle remains on until the fire is extinguished. The light in the fuel shutoff lever remains on until the fire is extinguished and the lever is moved to OFF.

The fire warning for the APU consists of three master warning lights (two on the glareshield and one on the Flight Engineer's Panel), an APU fire light and the APU loops A and B lights on the Flight Engineer's Panel, an APU fire summary light on the overhead panel and warning horn and APU fire light on the external APU fire warning panel. The APU automatically shuts down when a fire is detected.

Cabin Cargo Compartment

The cabin cargo compartment smoke detector caution system consists of two cabin cargo smoke annunciator lights, one on the Pilot's Overhead Panel and one on the Flight Engineer's Panel; and twelve smoke detector lights on the Flight Engineer's Panel. Master caution lights, two on the glareshield and one on the Flight Engineer's Panel, come on when the smoke annunciator lights come on.

FIRE EXTINGUISHING SYSTEMS

Engines and APU

The engine and APU fire extinguishing system consists of three, dual-container fixed systems. Each system contains two fire agent containers, distribution lines, control circuits, and fire agent low lights. The agent can be selected and dispensed by using the engine fire handles or APU fire agent discharge switches. The two fire agent containers in system 2 are shared by the APU and engine 2.

CONTROLS AND INDICATORS

Controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel No. 1, Upper Panel No. 2, the Pilot's Overhead Panel, the Pedestal, and the Glareshield. Illustrations of the major panels are in Part 1, Section I. Individual controls and indicators are illustrated and described in this part.

AUXILIARY POWER UNIT

The Auxiliary Power Unit (APU) is an onboard gas turbine source of pneumatic and electrical power for engine starting, operation of the air conditioning system on the ground, and electrical systems in flight (figure 1.2-7). The APU compartment is located in an unpressurized area of the lower aft fuselage section. The APU can be started in flight for auxiliary electrical and/or pneumatic power. Electrical power demand has automatic priority over pneumatic power whenever the combined demand exceeds the total APU capability. Where takeoff performance is a critical factor, the APU may be used to power the air conditioning system, in lieu of using engine bleed air during the takeoff segment.

Onboard aircraft battery power is provided for starting the APU. A battery powered pump provides starting fuel flow to the APU from main tank 2. This pump is normally used for an APU start when ac power is not available. As soon as ac power is available, APU fuel can be supplied by any tank pump in main tank 2. Fuel pressure from at least one tank pump must be available if the APU is to be operated. When using one of the tank 2 pumps, the right, aft pump is preferred.

The APU generator is identical to the three engine-driven generators. However, in place of a Constant Speed Drive (CSD), a fuel governor maintains a constant-speed control of the APU high pressure rotor from which the generator is driven.

The APU is capable of operating both air conditioning packs prior to or after engine start. Also, under most conditions, the APU has sufficient capability to fulfill normal air conditioning requirements while satisfying full electrical power demands on the ground. The APU has demonstrated two pack pneumatic capability at FL 250. The APU control system has automatic shutdown protection for the following conditions: fire warning; overspeed; high Exhaust Gas Temperature (EGT); low oil pressure; high oil temperature; starter motor energized over 1 minute; loss of EGT, N_1 or N_2 signals. The APU is serviced with Mobil Jet Oil II as specified by General Electric Service Bulletin 79-1.

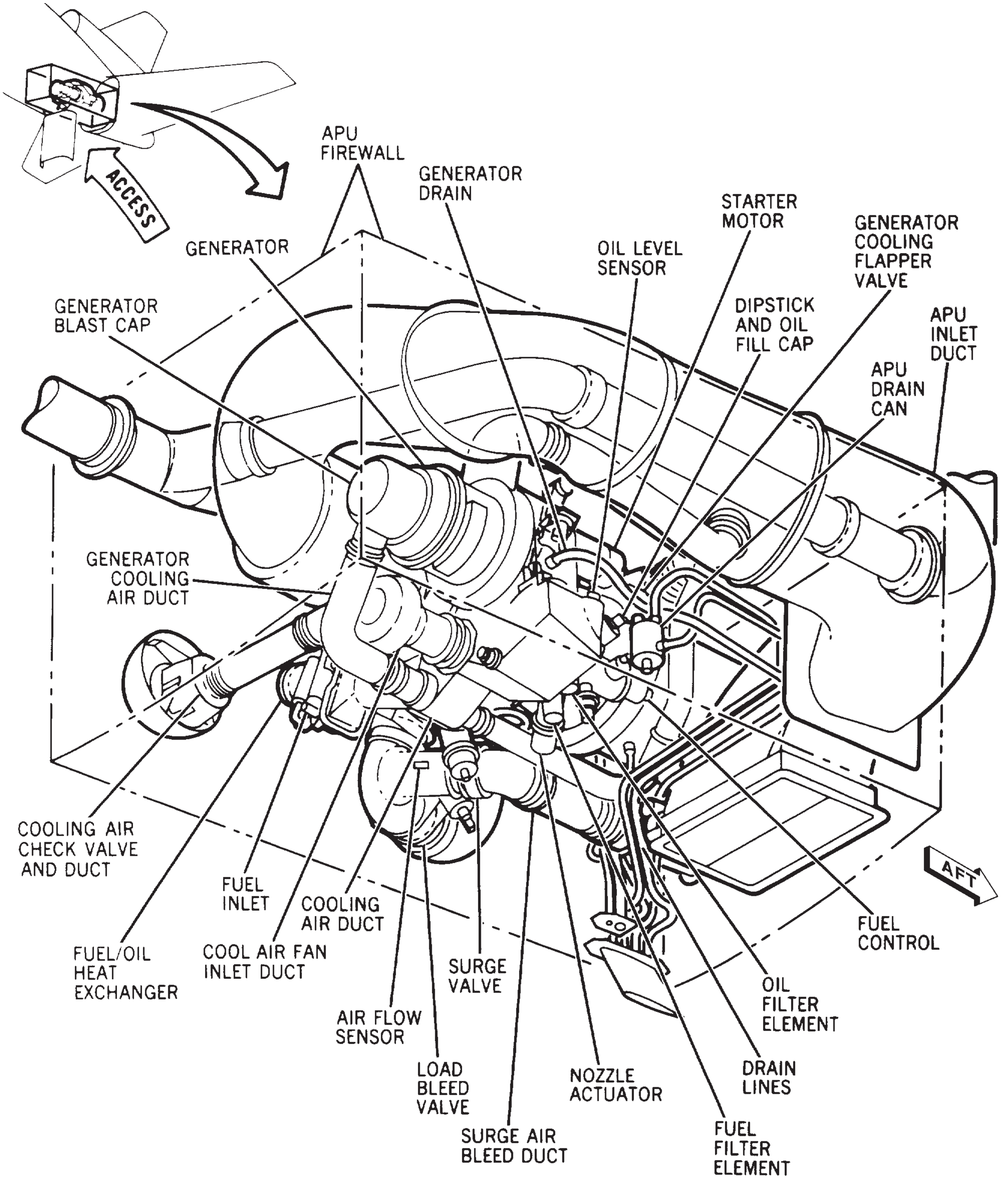


Figure 1.2-7. APU Major Component Locations (Sheet 1)

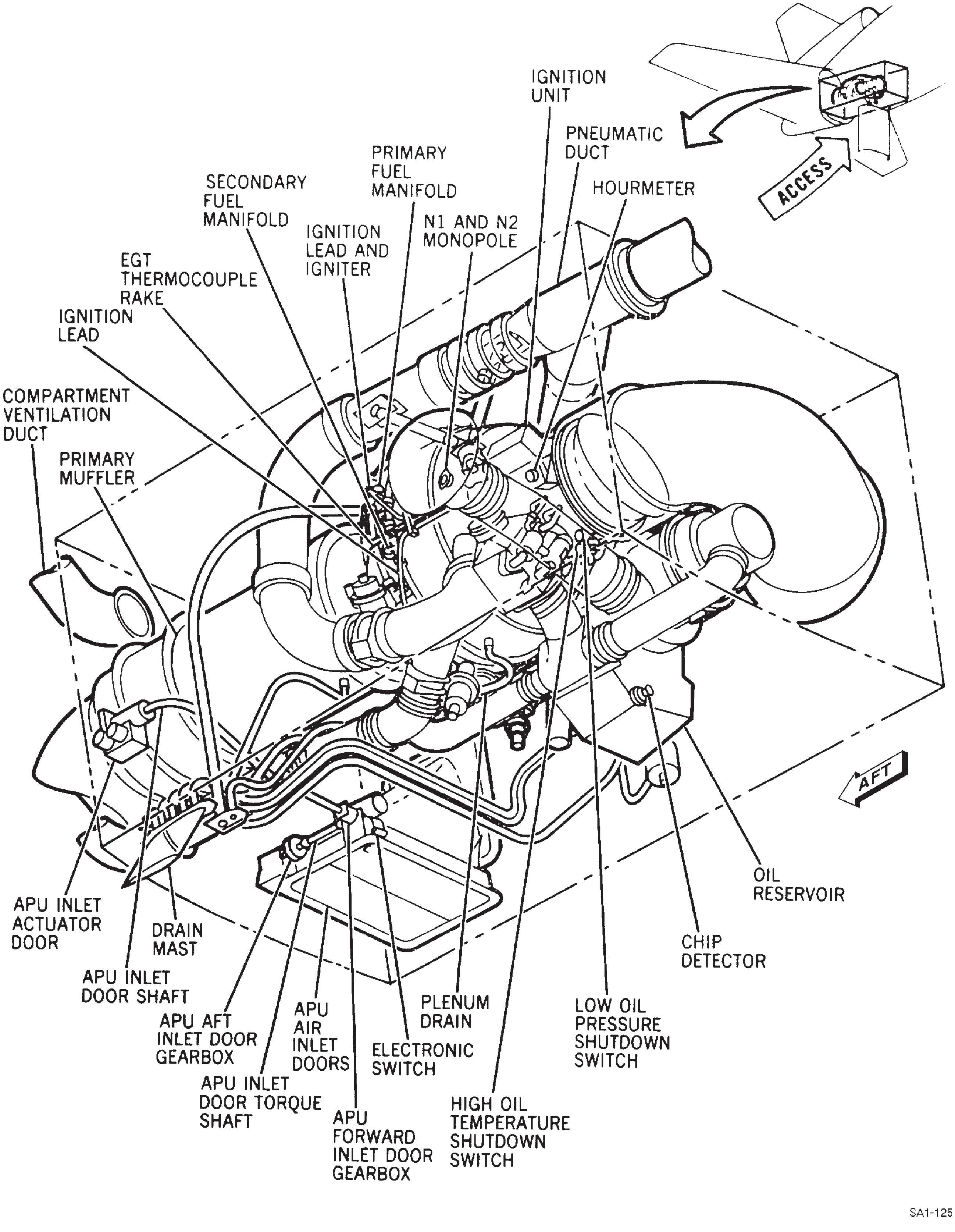


Figure 1.2-7. APU Major Component Locations (Sheet 2)

OPERATIONAL INFORMATION

APU Compartment

The APU is installed in an acoustically treated, fire-sealed, unpressurized compartment. This includes the sealed-when-closed access door. The door must remain closed when the APU is operating to ensure containment of the fire and fire agent if a fire should occur.

Access Door

The APU access door also has a pressure relief function. In case of a manifold duct rupture or any other failure which causes a high pressure within the APU compartment, the door blows open without damage to its latches.

CAUTION

> The APU should not be operated when the battery is removed or disconnected. When the battery is removed, the fire agent cannot be discharged.

Oil Lubrication System

The APU is equipped with a self-contained oil lubricating system (figure 1.2-8). The wet-sump oil reservoir has a maximum capacity of 10 quarts. Approximately 8 quarts are usable. An oil fill cap with an integral dipstick is provided on the right forward side of the oil reservoir. The full mark on the dipstick is equivalent to 8 quarts on the APU oil quantity gage located in the cockpit (figure 1.2-9). A gage/dipstick indication difference of 1 quart is considered acceptable.

Approximately 2.5 to 3.0 quarts of oil are absorbed (gulped) into various passages and bearing cavities during the APU starting process. For APU operation, the before-start oil level should not be below 6 quarts.

During APU N_1 acceleration, as N_1 rpm increases above 64 percent, less oil is maintained in the passages and bearing cavities, and the reservoir oil quantity is increased approximately 1 quart.

Chip Detector

The chip detector (located at a low point in the oil reservoir) can be removed without draining the oil. The oil is restrained by a flow-check valve in the detector screen.

Bypass Valve

A bypass valve is provided for bypassing oil around the oil filter if the element should become clogged. Oil pressure is regulated at 90 ± 10 psig by the spring-loaded ball-seat relief valve.

Drain Can

An APU drain can (located on the left firewall) is provided to collect fluid from the fuel control and fuel pressure switch (figure 1.2-10). A manual drain valve is provided for draining the can while the aircraft in on the ground. During flight, the can is automatically drained through the APU drain mast by ram air which is routed to the can after entering an inlet port in the leading edge of the mast (figure 1.2-11).

Start Preparation

When preparing to start the APU, if crossfeed 2 control switch is found to have been left in OPEN and 28-VDC bus 2 power is not available, the crossfeed valve can be manually closed and the crossfeed control knob placed in the closed position before initiating the starting sequence. However, an alternate and faster method of closing the valve is to utilize battery direct power. To accomplish this, place the crossfeed 2 control switch (in the cockpit) in the closed position, and place the power switch (on the ground refueling control panel) momentarily in the ARM position. The crossfeed valve automatically closes, the power switch can then be placed momentarily in the DISARM position, and a normal APU start can be initiated.

Inlet Door

The APU inlet door actuator operates the APU exhaust door together with the APU inlet door. The door operation time from closed to full open and from full open to full closed is approximately 20 seconds in each direction.

Proximity Switch

The APU door proximity switch operates the proximity switch relay when the inlet door is in the full open position (approximately 20 seconds). Operation of the relay causes the APU DOOR OPEN light to come on.

Automatic Starting Sequence

When the APU door open light is on, with the APU in the normal control mode (APU control switch in

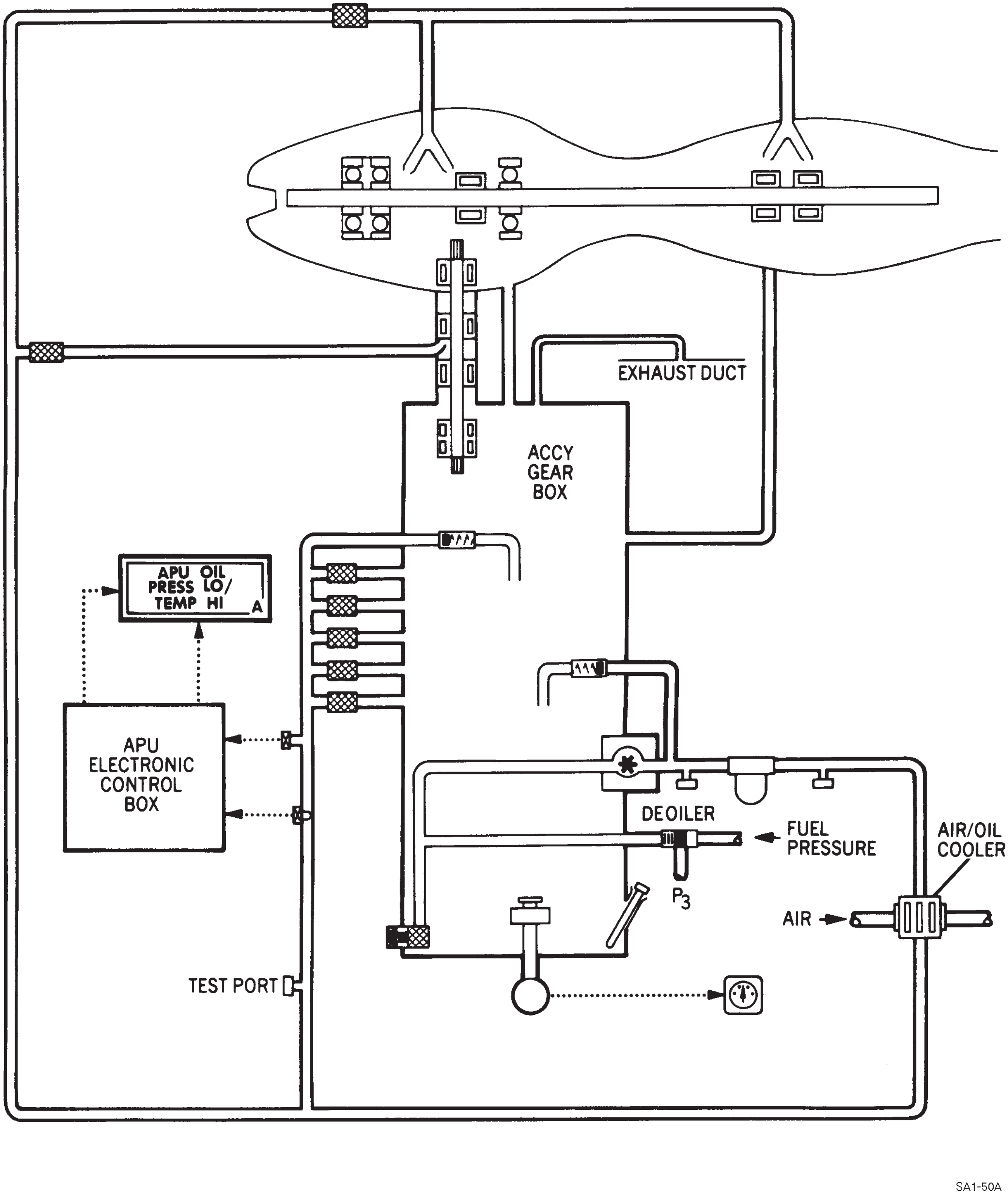
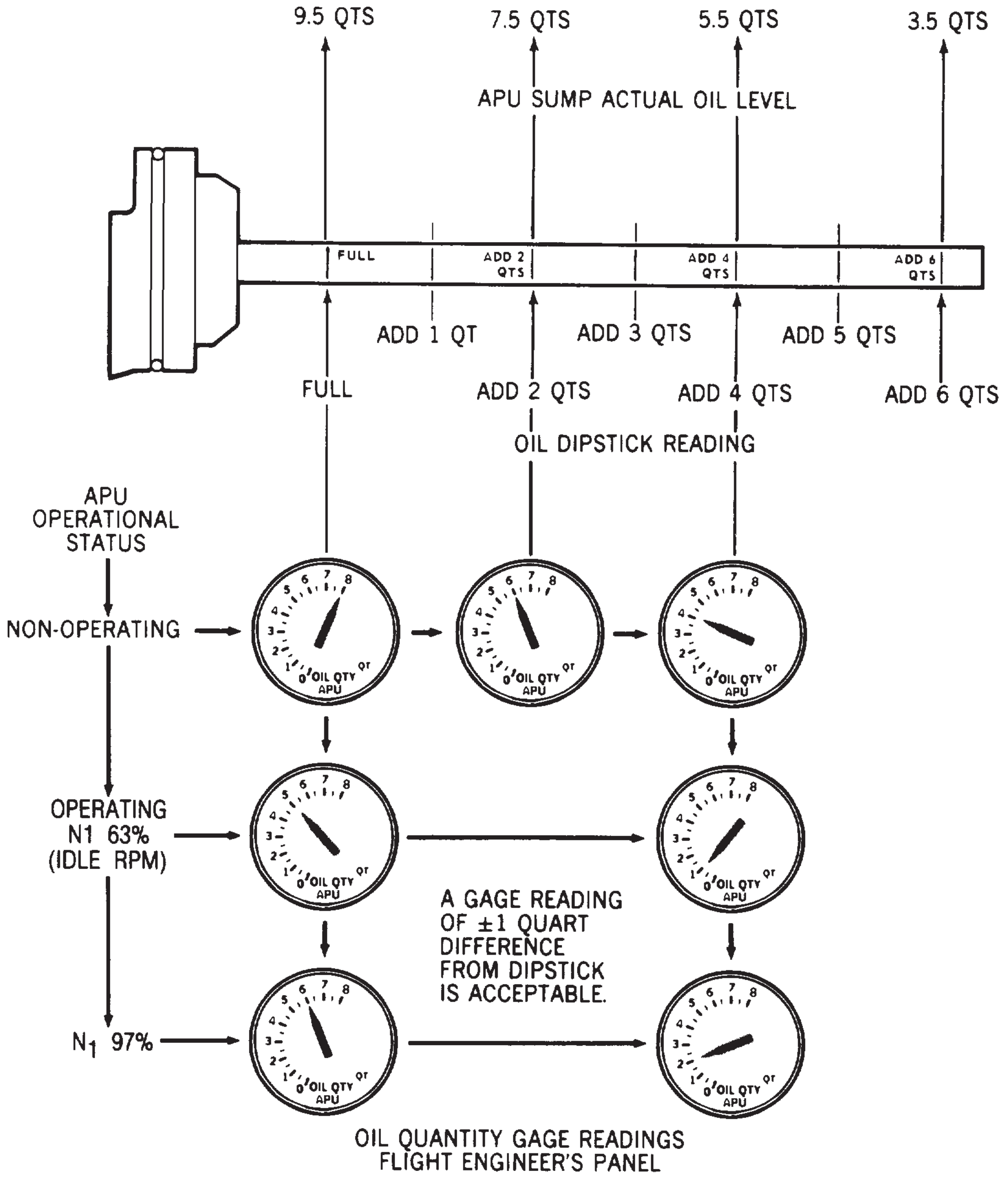


Figure 1.2-8. APU Oil System Functional Diagram



NOTE:

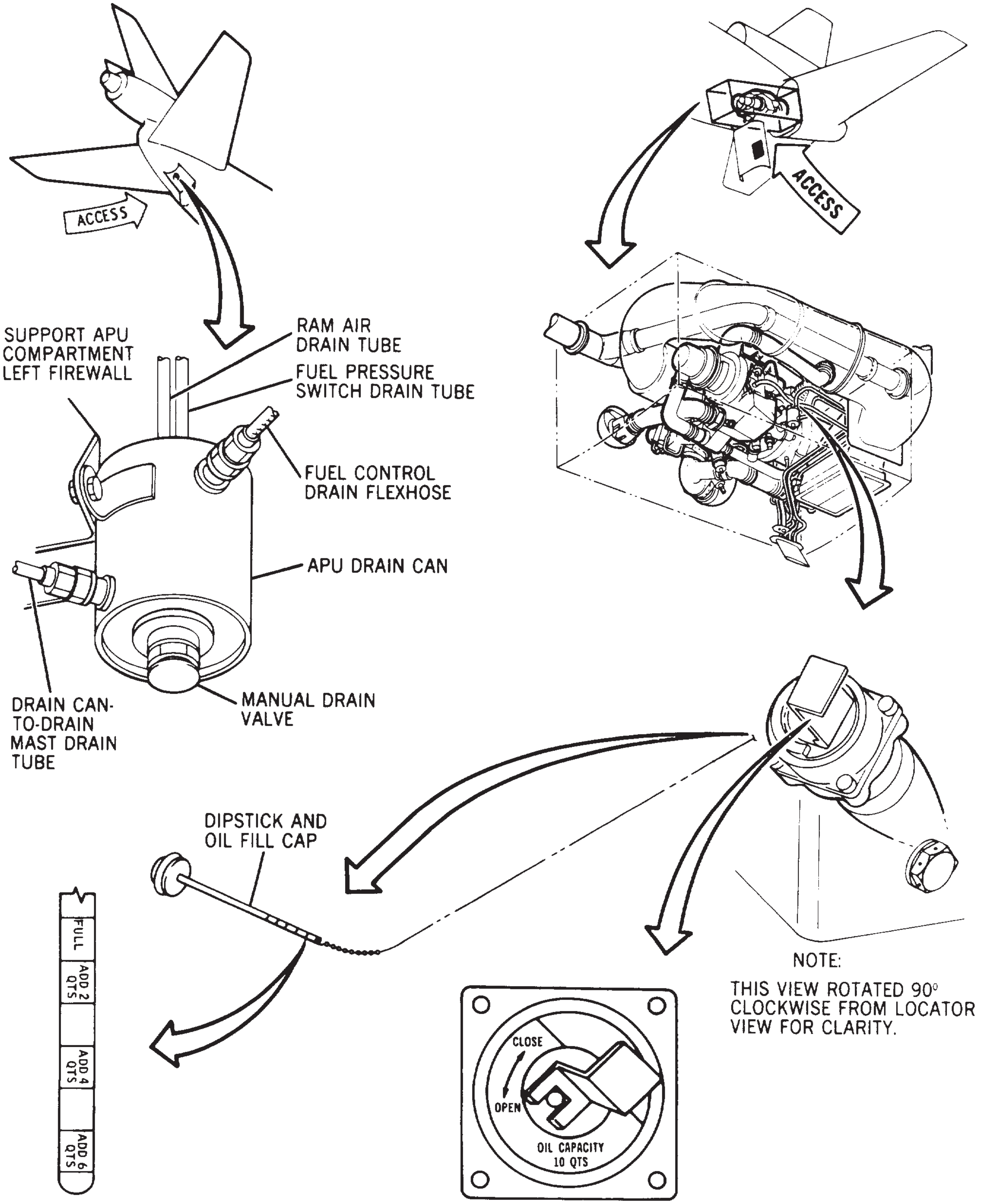
MAXIMUM OF 8 QUARTS OF OIL ARE USABLE FROM THE APU OIL SUMP.

DO NOT START APU IF INDICATED OIL QUANTITY NON-OPERATING IS BELOW 6 QUARTS.

DO NOT CONTINUE OPERATION IF INDICATED OIL QUANTITY REACHES ZERO WHEN N1 IS AT IDLE RPM.

SA1-129A

Figure 1.2-9. APU Oil Quantity System Relationships



NOTE:
THIS VIEW ROTATED 90° CLOCKWISE FROM LOCATOR VIEW FOR CLARITY.

SA1-126

Figure 1.2-10. APU Drain Can And Oil Fill Cap/Dipstick

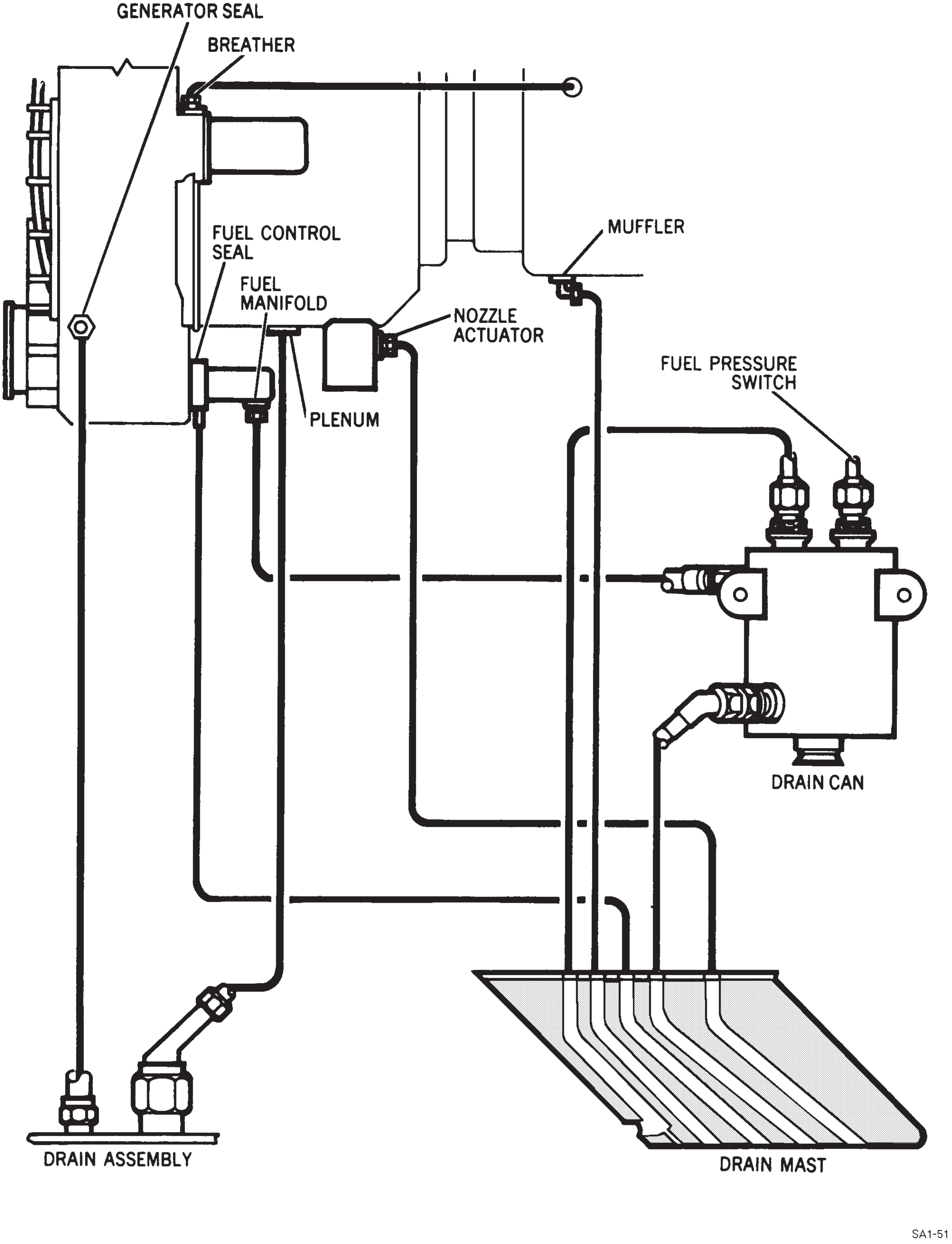


Figure 1.2-11. APU Drain System

NORM) and the APU master switch is placed momentarily in START then released to RUN, the following automatic starting sequence is initiated:

1. The APU inlet and exhaust doors fully open.
2. Cranking begins.
3. At 6.5% N_2 rpm, the fuel shutoff valve opens permitting fuel flow through the primary fuel manifold. Dual ignition is initiated, both igniters fire, and combustion is established.
4. At approximately 35% N_2 rpm (after combustion has been attained) additional fuel is supplied through the secondary fuel manifold. Through the intermediate speed ranges, the fuel is metered by the scheduling valve.
5. Before reaching 50% N_2 rpm, the APU oil pressure low light goes off.
6. At 50% N_2 rpm, the starter disengages.
7. As N_2 speed approaches 95% N_2 rpm, the fuel control governor begins to function and terminates acceleration at approximately 100% rpm.
8. At 95% N_2 rpm, ignition is cut off, and electrical power supply is switched from the battery to the permanent magnetic generator (PMG). The PMG supplies electrical power to the APU electronic control and the hourmeter. If the amber APU using battery power light remains on, this indicates a problem in the PMG, and a maintenance log entry should be made.
9. At 100% N_2 rpm, the fuel control governor stops acceleration and maintains N_2 speed at 100 ± 1% rpm.
10. If in flight, terminate start if idle N_2 rpm is not attained within 3.5 minutes or if N_2 rpm exceeded 10% but start cannot be completed. Comply with APU starter duty cycle limitations before attempting a second start.

APU Doors

Total APU start time from doors full open to 100% N_2 rpm should be from 12 to 23 seconds.

CAUTION

> The maximum starter duty cycle should not exceed 1 minute on and 5 minutes off for a maximum of four start attempts within a 20-minute period. This maximum duty cycle should be followed by a cooling period of not less than 1 hour.

As N_2 rpm is being maintained constant in the normal control mode (APU control switch in NORM), N_1 rotor speed is adjusted in response to bleed air load demands. The following pneumatic load demand/approximate N_1 rpm values can be used for functionally testing the N_1 speed control:

Pneumatic Load Demand	Approx. N_1 rpm (Percent)
No pneumatic load; pneumatic isolation valves and APU/isolation valve closed	
Below 7000 ±1500 feet MSL	**63 ±2**
Above 7000 ±1500 feet MSL	**89 ±3**
Engine ignition selector in position START A or START B	**97 ±2**

Fuel Consumption

APU fuel consumption will vary according to the electrical and pneumatic loading. Typical consumption for ground operation averages between 350-500 pounds per hour.

Standby Mode Starting

When the APU is started and operated in the standby control mode (APU control switch in STBY), the starting sequence is identical to that of the normal control mode except that the N_1 variable geometry turbine nozzles and the electronic fine speed control of N_2 rpm are inoperative. N_1 stabilizes between 75 and 100% rpm, depending upon electrical load and ambient temperature. Bleed air demands have almost no effect on N_1 rpm in the standby control mode. Under certain temperature and load combinations, changes in bleed air demand may result in unpredictable insignificant changes in N_1 rpm.

NOTE

- To be performed when APU will not start in normal mode after several attempts, has automatically shut down, or operation is erratic.
- Standby control is a conditional mode used only when normal mode malfunctions.
- Starting in standby mode is acceptable, up to 10,000 feet.

Standby Mode Operation

When operating in the standby control mode, the potential for N_1 overspeed increases as the ambient temperature decreases. At temperatures around 7°C or lower and operating with full electrical load, N_1 may overspeed and automatically shutdown. At sub-zero temperatures N_1 may overspeed with a minimum electrical load. When overspeed and automatic shutdown is encountered, while operating in the standby mode at low ambient temperatures, the electrical load should be reduced to a minimum or completely removed. A restart should be attempted.

Fuel Flow

In the standby control mode (N_2 speed electronic fine control inoperative), the flyweight governor controls fuel flow to maintain 100 ±4% N_2 rpm.

Automatic Shutdown

Automatic shutdown of the APU is accomplished in the event of any of the following, regardless of the control mode selected:

1. Start relay shorted.
2. Fuel solenoid shorted - below 6.5% N_2 rpm.
3. Fuel augmentation solenoid shorted - below 6.5% N_2 rpm.
4. Ignition unit shorted - below 6.5% N_2 rpm.
5. Starter motor energized for more than 60 seconds - below 50% N_2 rpm.
6. Loss of N_1 or N_2 signal.
7. Loss of EGT signal.
8. Loss of battery bus power.
9. EGT temperature high - above 585°C.
10. APU fire warning.
11. Load control valve solenoid shorted.
12. APU intake doors starting to close.
13. Oil temperature high.
14. Oil pressure low for more than 20 ±3 seconds - above 95% N_2 rpm - 65 ±5 psig.
15. Nozzle actuator solenoid shorted - above 95% N_2 rpm.
16. Reverse bleed air flow - above 95% N_2 rpm.
17. N_1 or N_2 overspeed - at 110% rpm.

Failure/Damage

If the APU sustains compressor damage to the extent of physical separation of parts of the compressor, debris can enter the pneumatic ducts, damage the ducts, proceed on to an engine(s) or air conditioning pack(s), and cause damage to the turbine in the pack or engine starter. Depending on the operational status of the engine or starter, the damage may be immediate or delayed. When the APU is providing the only pneumatic supply, a damaged APU compressor may be indicated by an otherwise unexplained decrease in pneumatic pressure for a given N_1 rpm.

DURING FLIGHT

APU inflight windmill starts are not possible. Normal control mode N_1 speed control can be functionally tested by using the same pneumatic load demand/approximate N_1 rpm values previously listed.

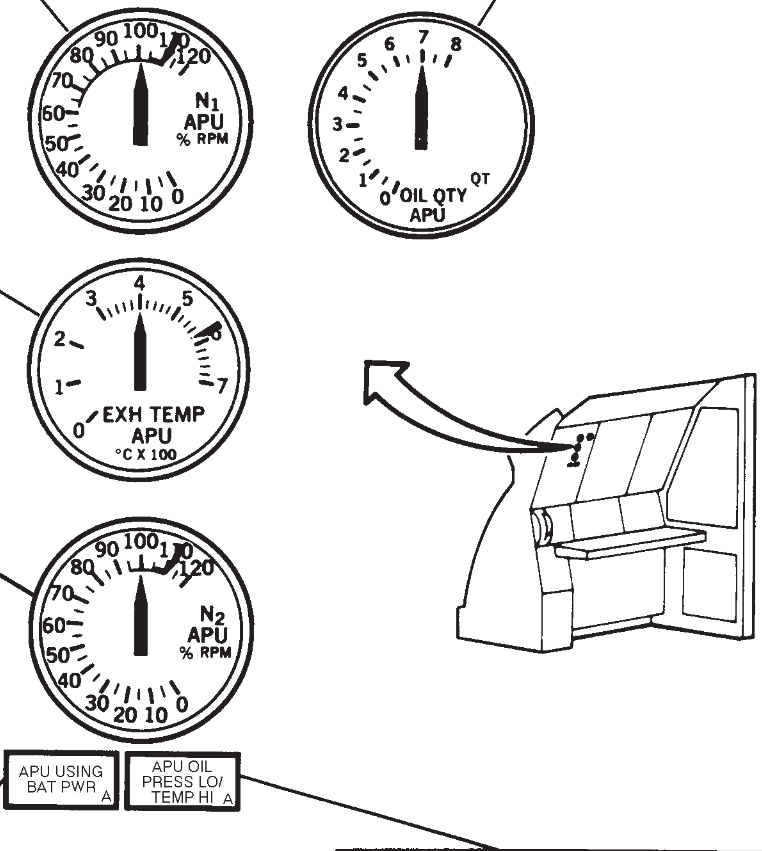
In the standby control mode during flight, N_1 and N_2 control technique and speed ranges are identical to those when operating on the ground with the same ambient temperatures and electrical load demands.

AFTER LANDING

The APU oil quantity gage has a self-test circuit incorporated within the instrument. It can be activated by turning the test screen located on the back of the instrument (with the wiring connected). The test should drive the pointer to a blue dot on the instrument dial.

CONTROLS AND INDICATORS

Controls, indicators, and annunciators lights are on the Flight Engineer’s Upper Panel No. 1, Upper Panel No. 2, the Overhead Panel, and the glareshield. Illustrations of the major panels are in Part 1, Section I. The individual controls and indicators are illustrated and described in this part (figures 1.2-12 through 1.2-15).



APU % RPM N_1 Gage

Indicates percent of rated rotor speed, normal operating range, caution range, and limit. Automatic shutdown will occur at 110% of rated speed. Indicator is powered from the battery bus during the start sequence and is self-powered after the APU is up to speed.

APU OIL QTY Gage

Indicates usable oil quantity remaining (in quarts). Indicator is powered from ac bus 2 and, accordingly, may not indicate during a ground start using battery power.

APU EGT Gage

Indicates exhaust gas temperature and limit. Indicator is powered from the battery bus during the start sequence and is self-powered after the APU is up to speed.

APU % RPM N_2 Gage

Indicates percent of rated rotor speed, normal operating range, caution range, and limit. Indicator is powered from the battery bus during the start sequence and is self-powered after the APU is up to speed.

APU USING BAT PWR Light

When on, indicates the APU is not supplying its own electrical power required for operation of the APU, and that electrical power is being supplied to the APU from the aircraft electrical system. If the battery is supplying electrical power (with this light on) and the battery switch is moved to OFF, the APU will shut down automatically. The light is normally on until the APU reaches the operating range.

NOTE

Continued operation of the APU with the APU USING BAT PWR light on, when the APU generator is inoperative and no other source of AC power is supplied to the aircraft, will deplete the aircraft battery.

APU OIL PRESS LO/TEMP HI Light

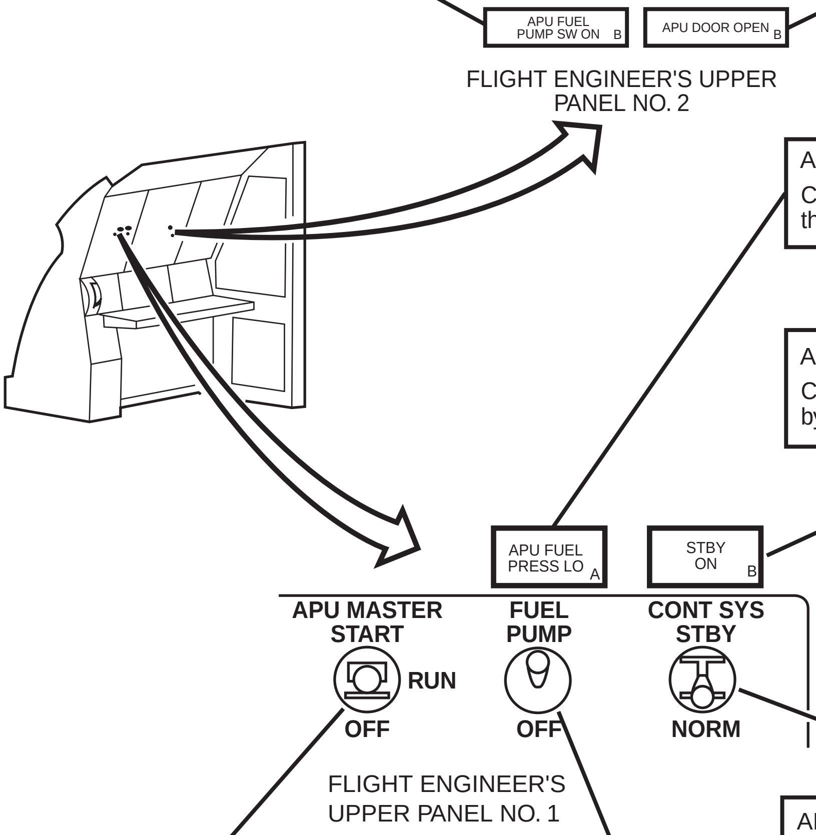
Comes on when either the oil pressure decreases below allowable limit or oil temperature exceeds allowable limit. Automatic shutdown will occur when light comes on except during start. The light is normally on during start and goes out at or below 50% N_2 rpm.

NOTE

Failure of the low oil pressure circuitry will inhibit the starting system. The APU OIL PRESS LO/TEMP HI light will come on flashing if N_2 is less than 6.5%.

SA1-93B

Figure 1.2-12. APU Controls and Indictors (Sheet 1)



APU FUEL PUMP SW ON Light

Comes on to indicate APU fuel pump switch is ON.

APU DOOR OPEN Light

Indicates that APU inlet door is open. Door opens automatically during starting sequence and closes when APU is shut down.

APU FUEL PRESS LO Light

Comes on when fuel pressure falls below the starting or operating limit.

APU STANDBY ON Light

Comes on when APU is operating in standby control mode.

APU CONT SYS Switch

The STBY position provides an alternate electronic control mode to permit continued APU operation when the normal mode fails. The automatic overtemperature protection capability is maintained but N_1 speed is no longer regulated. N_1 RPM will not respond to increased bleed air demand but will increase with increased electrical loads. If N_1/N_2 speeds or EGT approach their upper limits, the APU load should be reduced to prevent an automatic shutdown.

APU MASTER Switch

START – Momentary position used to initiate APU start. Switch should be moved to START after APU DOOR OPEN light comes on.

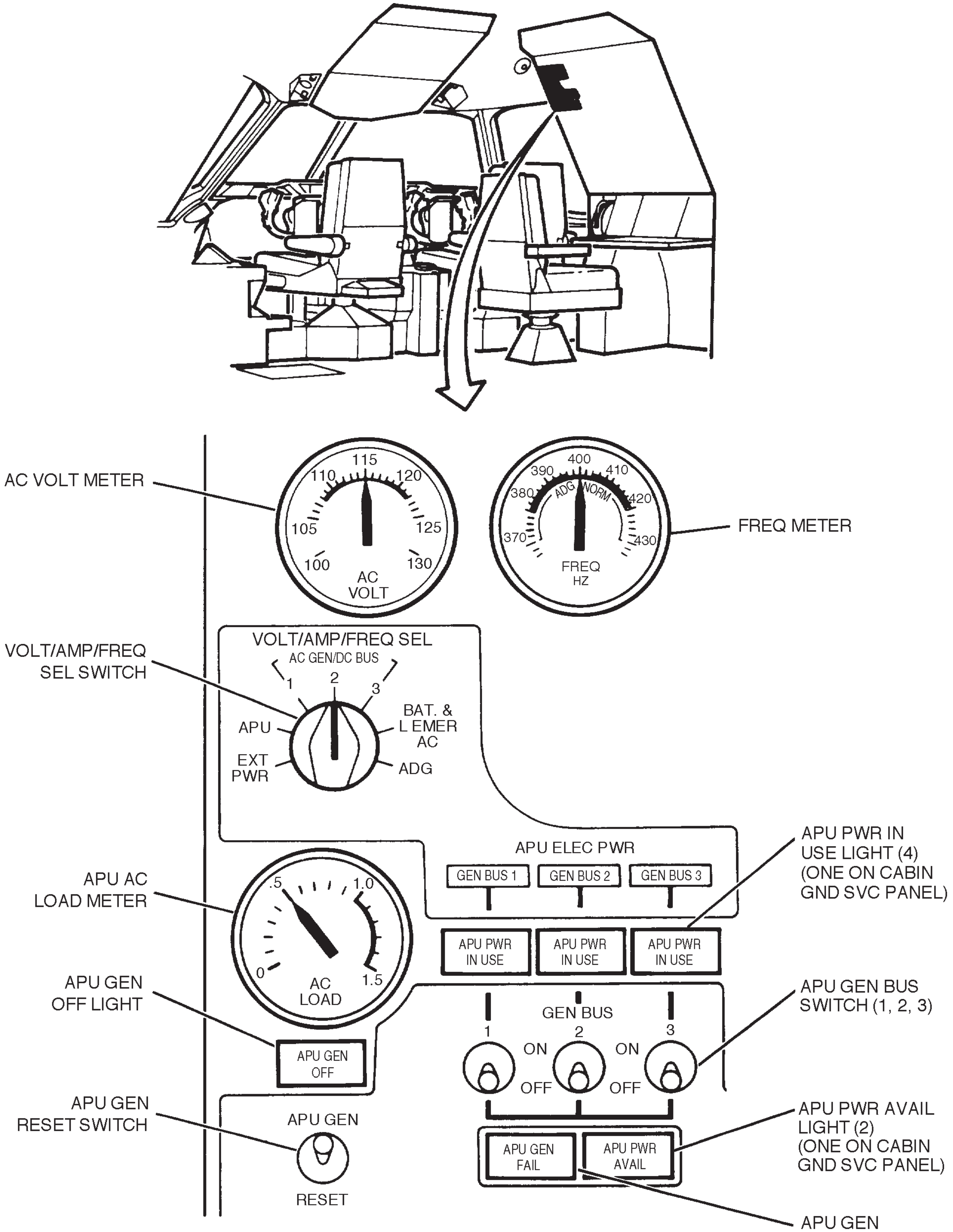
RUN – A fixed position used to open APU inlet doors and for operation in normal and standby modes.

OFF – A fixed position used to shut down the APU and close the APU inlet doors. An automatic 90 second time delay is provided after the APU/ISOL valve is moved to CLOSED, to insure adequate cooling at shutdown. Shutdown is accomplished through the overspeed protection circuit. This tests the overspeed protection system during each shutdown.

FUEL PUMP Switch

Controls operation of the tank-mounted, battery-powered APU fuel booster pump. Will operate only if the APU master switch is at START or RUN.

Figure 1.2-12. APU Controls and Indicators (Sheet 2)



FLIGHT ENGINEER'S UPPER PANEL NO. 1
(For description of above controls and
Indicators refer to Electrical System)

SA1-96A

Figure 1.2-12. APU Controls and Indicators (Sheet 3)

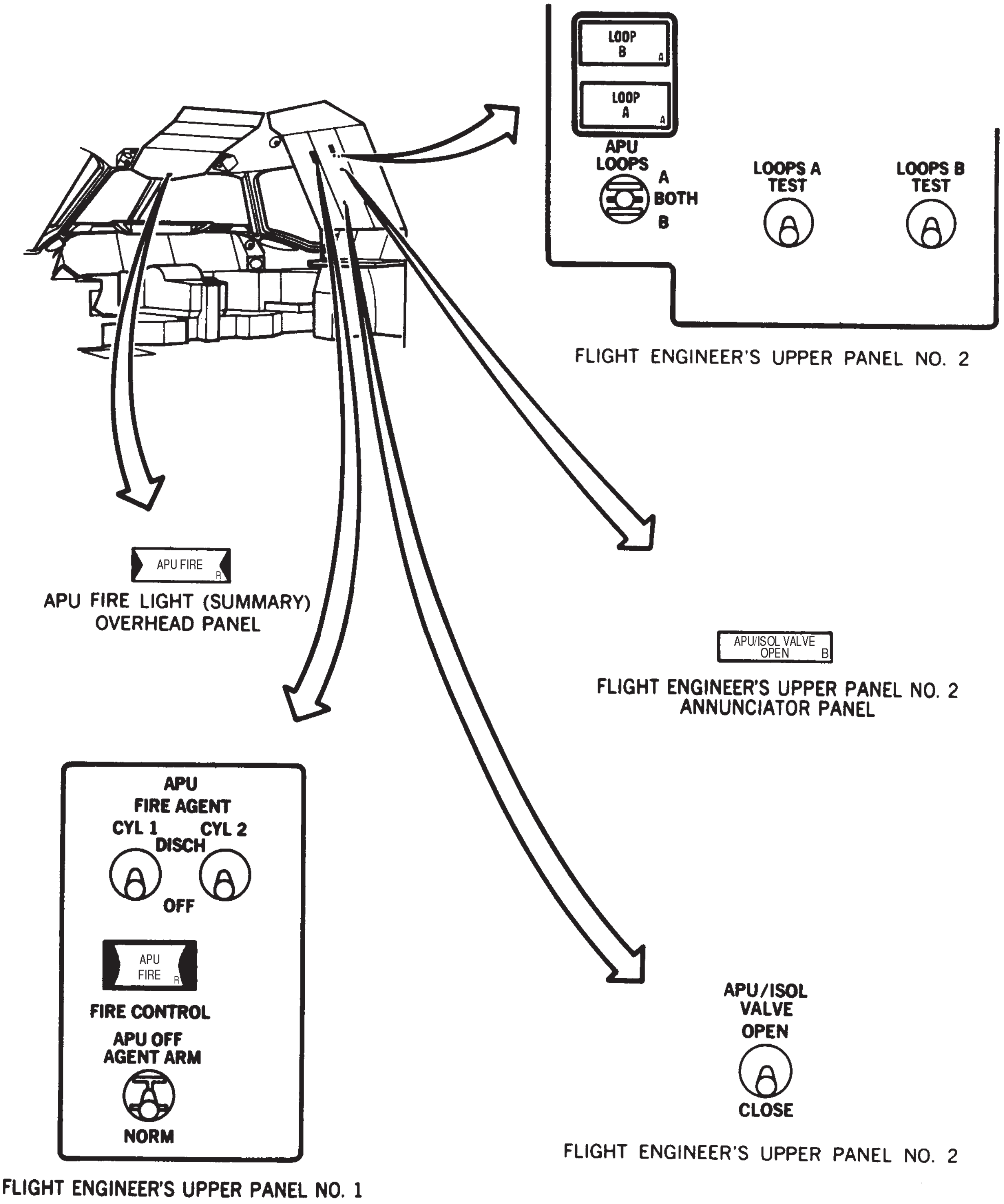


Figure 1.2-12. APU Controls and Indicators (Sheet 4)

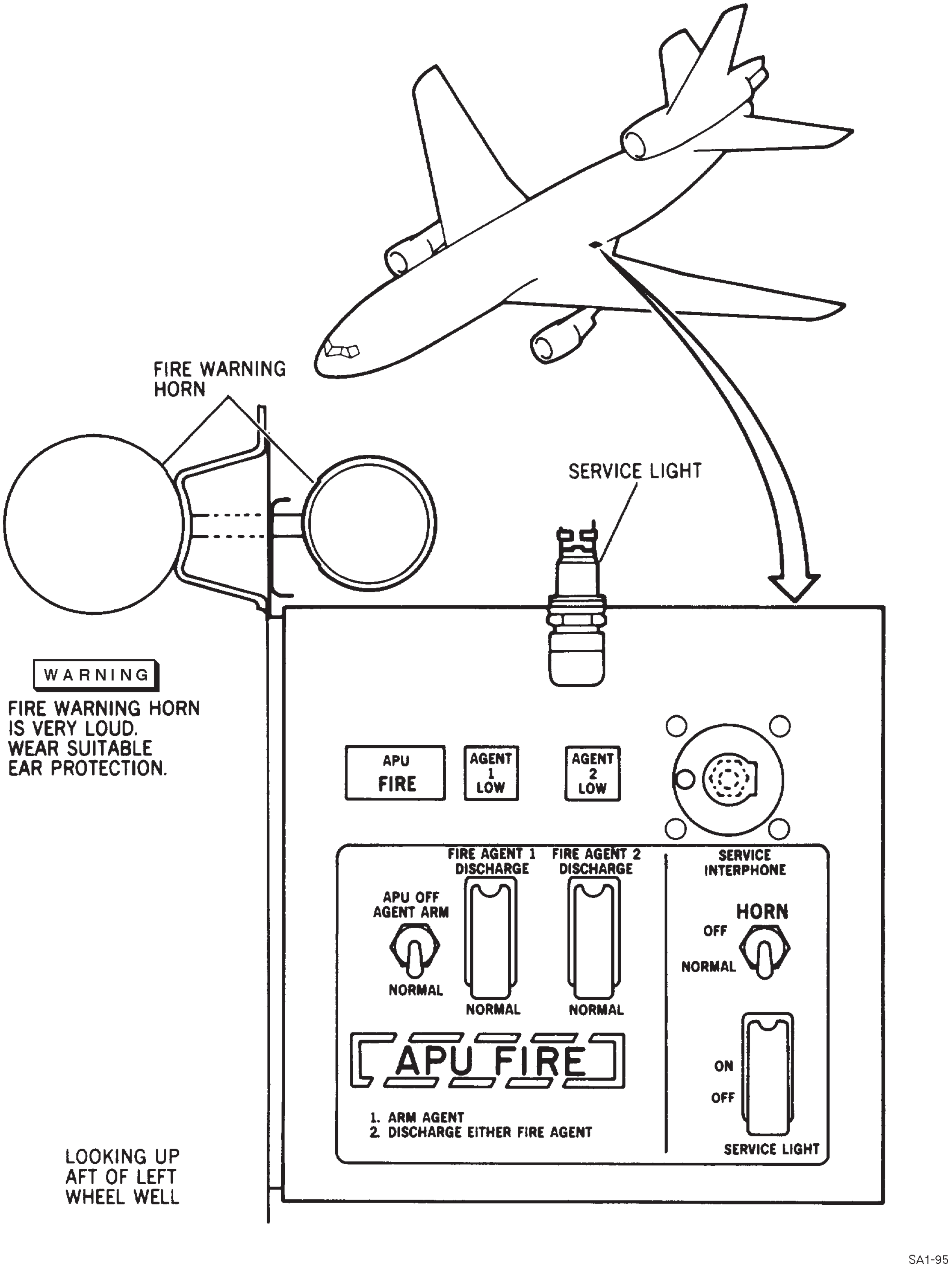
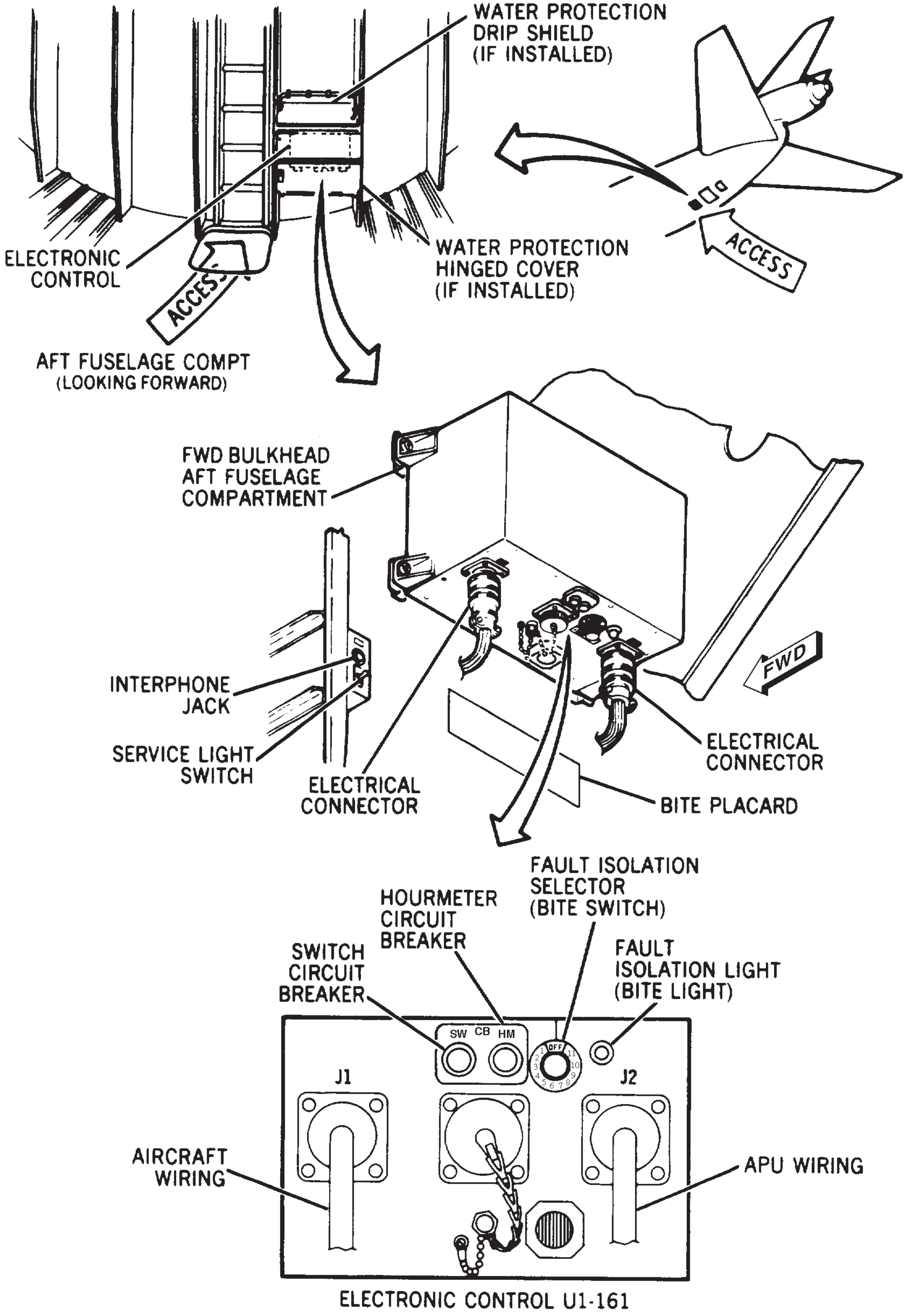


Figure 1.2-13. APU External Fire Warning Components



SA1-127

Figure 1.2-14. APU Electronic Control Unit

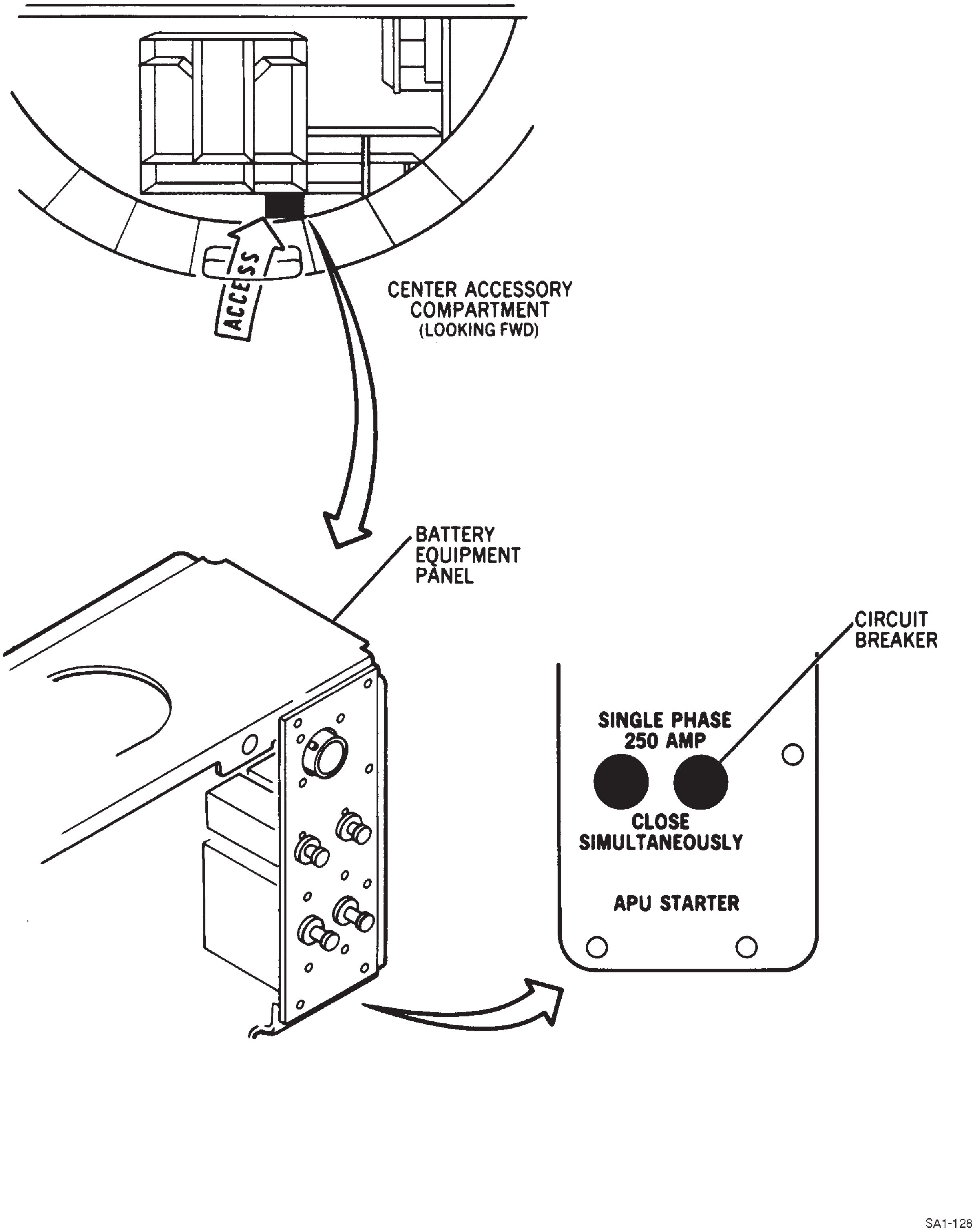


Figure 1.2-15. APU Starter Circuit Breaker

PART 3

FUEL AND UARRSI

TABLE OF CONTENTS

FUEL AND UARRSI

FUEL SYSTEM DESCRIPTION

MAIN TANKS

The aircraft has three integral wing tanks (referred to as main tanks) outboard of the fuselage (figures 1.3-1, 1.3-2, and 1.3-3). Tank 1 in the left wing and tank 3 in the right wing are each comprised of an inboard and outboard compartment. Fuel is reserved in the outboard compartment until inboard compartment fuel quantity decreases to a predetermined level, then outboard fuel passes into the inboard compartment automatically. Tank 2 is divided into two compartments, one either side of the fuselage interconnected by fuel and vent lines. The main tank fuel capacity is 40,700 pounds for tank 1, 65,400 pounds for tank 2, and 40,700 pounds for tank 3, at a fuel density of 6.7 lb/gal.

BODY TANKS

The body tanks, comprised of the FWD TANK, CTR WING TANK, and AFT TANK, are located within the fuselage of the aircraft. FWD and AFT TANKS are each comprised of longitudinally interconnected bladder sections. The CTR WING TANK is comprised of two compartments. The upper compartment is above the wing torque box and the lower compartment is in the underwing barrel section of the fuselage. The two compartments are not interconnected and crew action is required to transfer fuel from lower to upper compartment. The body tank fuel capacity is 55,300 pounds for the forward tank, 98,108 pounds for the center wing tank, and 64,200 pounds for the aft tank, at a fuel density of 6.7 lb/gal.

ENGINE FUEL SYSTEM

Each engine has its own fuel system (figures 1.3-2 and 1.3-3). A tank pump discharge manifold for each main tank feeds fuel directly to each engine. Each integral main tank contains its own pump inlets. Any engine can be fed from any tank using the Engine Crossfeed and Transfer Pump systems. The forward and aft fuselage tanks require opening an isolation valve prior to supplying fuel to the crossfeed manifold.

APU FUEL SYSTEM

A dc electric pump powered by the battery delivers fuel from tank 2 for starting the APU. Fuel from tank 2 is supplied to the APU for normal operation.

FUEL CROSSFEED OPERATION

The fuel crossfeed system consists of three electrically operated gate valves and associated plumbing. Operation of these gate valves enables any engine to be supplied with fuel from any tank. The crossfeed system also provides the capability to transfer fuel from one tank to any other and to dump fuel.

WARNING

> If crossfeed valves are open and main tanks are below automatic dump shutoff level (approximately 11,500 pounds for main tanks), actuation of either the TRANS PUMP OVRD switch, dump switch, boom switch or drogue switch will close all crossfeed valves.

FUEL TRANSFER SYSTEM

Fuel may be transferred from any tank to any other tank without affecting the engine feed system. Each of the six tanks has at least one fuel transfer pump plumbed directly into the fill/transfer manifold. Fuel transfer is accomplished by activating the pump in the appropriate tanks and filling the desired tank through the same fill valve used for ground and aerial refueling. Transfer to the three aerial refueling tanks - forward fuselage, center wing, and aft fuselage tank - is attainable using the main tank transfer pumps. Higher flows are available by opening the crossfeed valves of the three main tanks and operating all engine feed pumps.

ALTERNATE FUEL TRANSFER SYSTEM

In the event of a transfer pump failure, transfer operation from the affected tank can be continued by either opening the crossfeed valve in the main tank and transferring with the feed pump, or opening the alternate transfer and isolation valves in either forward or aft fuselage tank and transferring with an AR pump. To prevent inadvertent depletion of main tank reserve fuel, fuel transfer out of the main tanks is automatically stopped by shutdown of the transfer pumps and closure of the crossfeed valves (if open), at the dump cutoff level which is 11,000 pounds for No. 1 and 3 mains and 12,000 pounds for No. 2 main. The outboard compartments of the No. 1 and 3 main tanks are maintained full for optimum wing loading performance while the inboard compartment fuel is either above

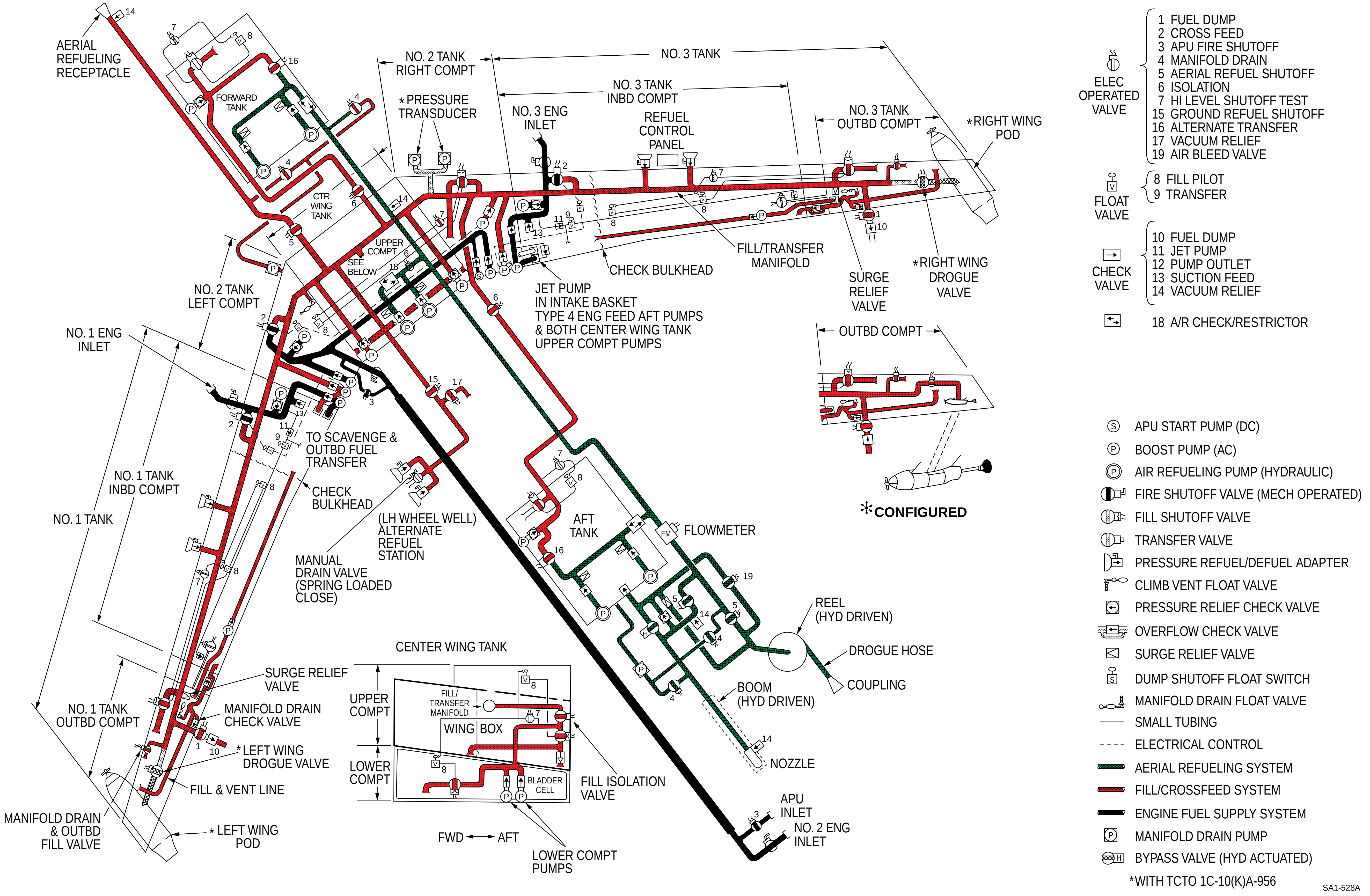


Figure 1.3-1. Fuel System

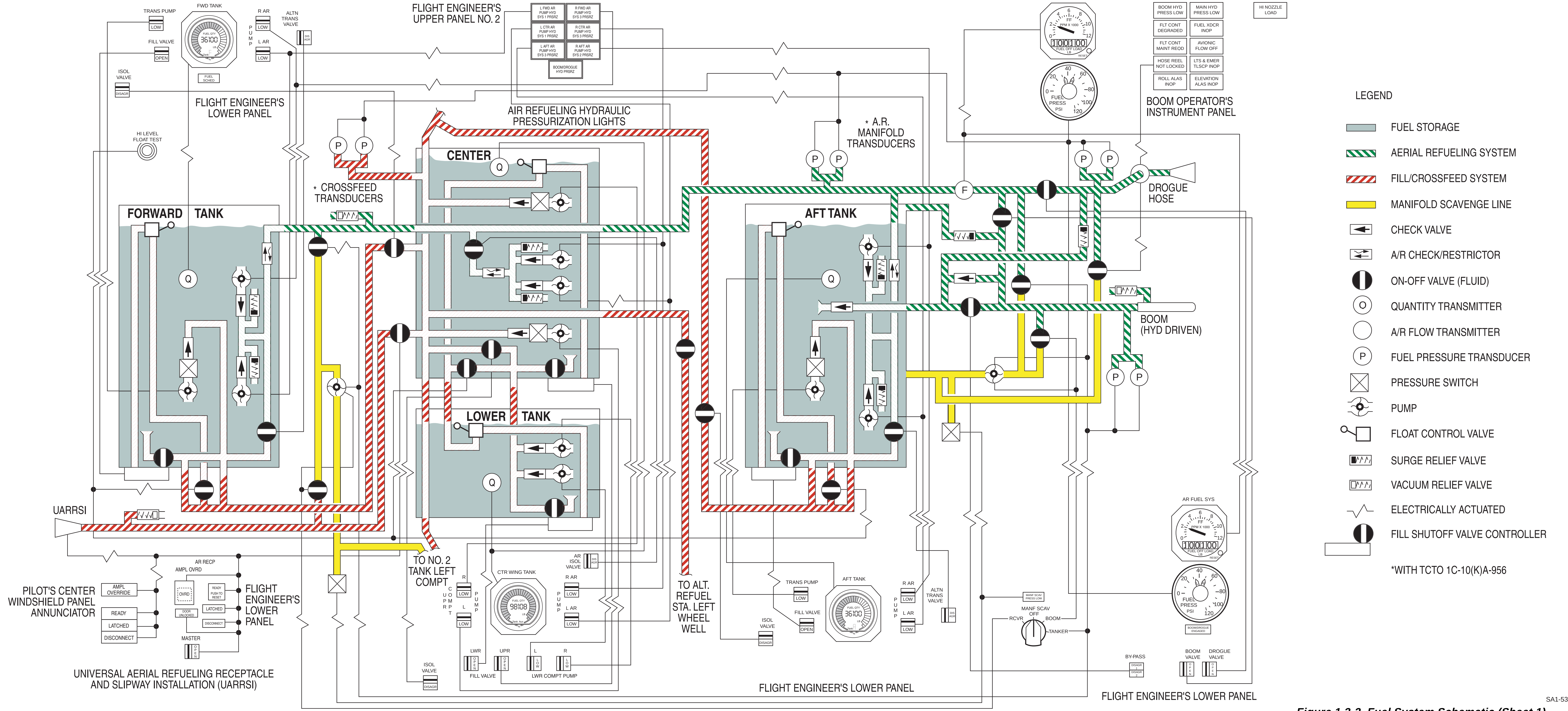


Figure 1.3-2. Fuel System Schematic (Sheet 1)

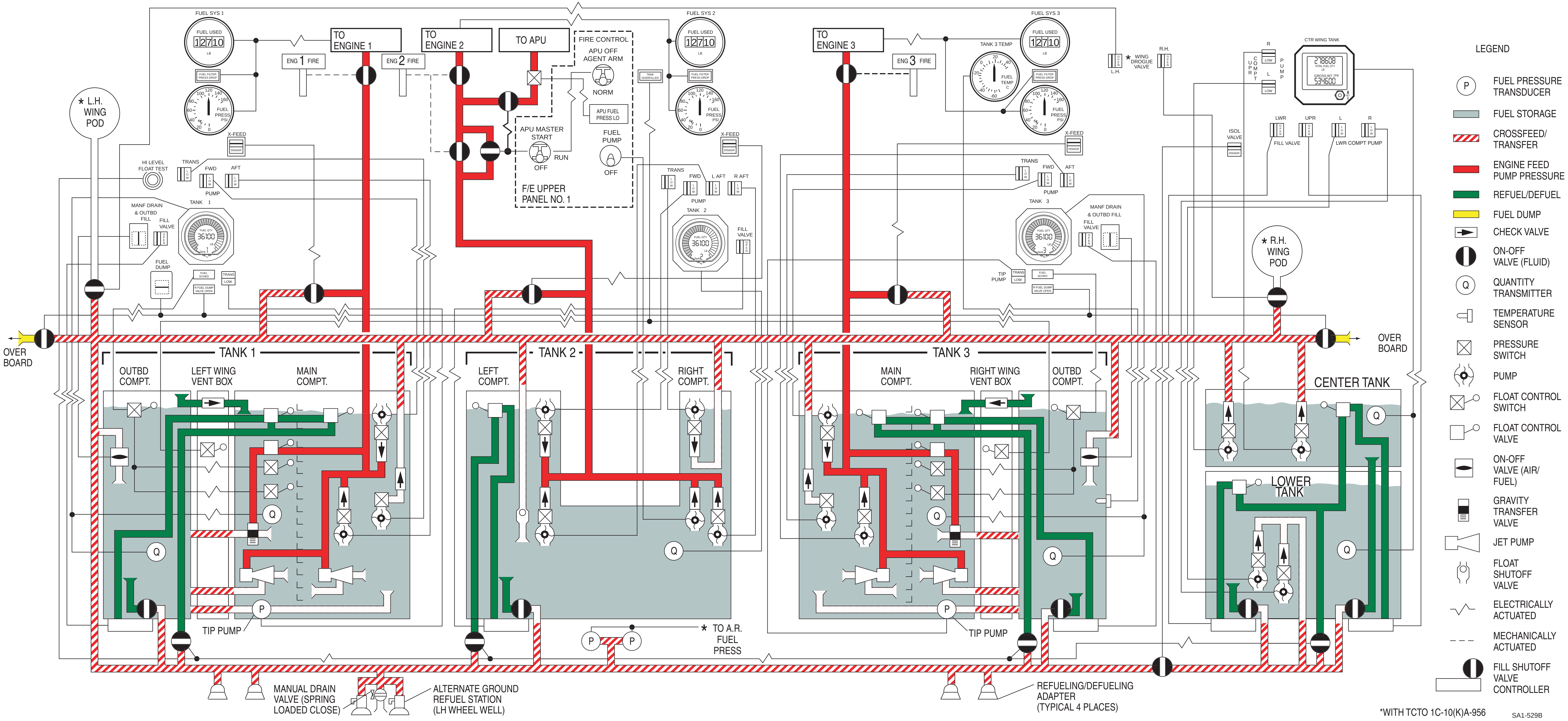
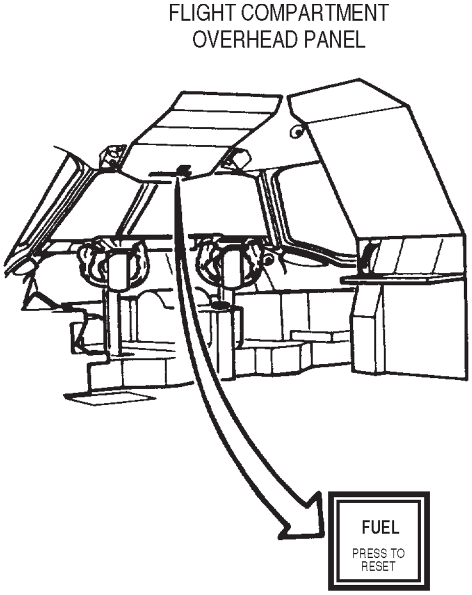
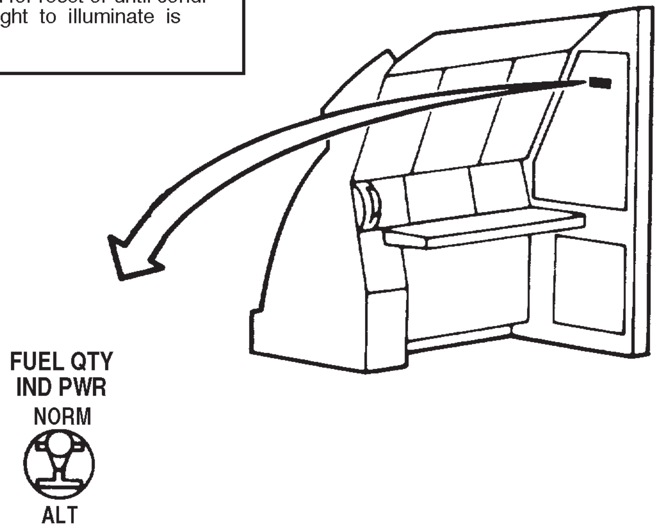


Figure 1.3-2. Fuel System Schematic (Sheet 2)



FUEL Cue Light

Comes on when any main tank pump pressure low light or FWD Body fuel schedule light comes on or during premature tip pump operation, and remains on until pushed for reset or until condition causing light to illuminate is corrected.



FUEL QTY IND PWR Switch

NORM – Provides ac bus No. 1 power for the indicating system and allows ground refueling from battery power.

ALT – Provides an alternate power (ac bus No. 2) source.

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Figure 1.3-3. Fuel System - Controls and Indicators the undumpable level during fuel transfer operation or above the 5,000 pound level during engine feed only operation.

OUTBOARD FUEL COMPARTMENT

The outboard compartment fuel is transferred inboard during engine feed operation as the inboard compartment fuel level drops below 5,000 pounds. A float valve allows a gravity transfer valve to open. Another float valve activates the alternate jet transfer system allowing fuel transfer and complete drainage of all outboard compartment fuel. Either transfer system is capable of transferring at a rate exceeding the maximum cruise engine fuel requirement.

TRANSFER PUMP OVERRIDE SWITCH

The outboard compartment fuel can also be transferred inboard, through the tip transfer pumps, any time the transfer pump override switch is used and the fuel quantity is below the 11,000 pound cutoff level. The intended function of the transfer pump override switch is to allow transfer of additional fuel out of the main tanks below the dump cutoff level.

WARNING

> With the loss of DC BUS 2, the Fuel Dump Valve indicators and Fuel Low Level Shutoff function will be inoperative and the Fuel Transfer Pumps will go to the override mode. When dumping fuel without DC BUS 2 power, the Fuel Quantity Gages must be monitored to prevent fuel from being dumped below the minimum allowable level.

NOTE

> Wing tip transfer pumps will not operate until wing fuel level is below 11,000 pounds in tanks 1 or 3.

Use of the transfer pump override switch will result in the following:

1. Reactivate any of the three main tank transfer pumps.
2. Activate the No. 1 and 3 main tank tip pumps and transfer all fuel inboard.
3. Arm the forward fuselage transfer pump if the fuel quantity is below 15,000 pounds. The pump will not operate until the pump switch is operated.

FORWARD FUSELAGE TANK FUEL MANAGEMENT

For aircraft balance control, in the tanker configuration, fuel transfer out of the forward fuselage tank is automatically stopped at a 15,000-pound level and normally maintained by the operator until the No. 1 and 3 main tanks are at a 5,000 pound level. The flight engineer may then transfer fuel out of the forward fuselage tank, into the main tanks, by actuation of the transfer override switch, and the main tank fill valve switches (figures 1.3-4 and 1.3-5).

The transfer pump override switch will arm the forward fuselage tank transfer pump and also turn on the No. 1 and 3 main tip pumps. If any usable fuel is in the forward fuselage tank when the No. 1 and 3 main tank fuel is below the 4,000 pound level, the forward fuselage tank schedule light will turn on, indicating abnormal fuel scheduling. Fuel from any and all tanks may be transferred to any and all body tanks while simultaneously offloading fuel to a receiver aircraft.

NOTE

> This 15,000, 5000, and 4000 pound values may vary significantly with fuel density and aircraft attitude.

GROUND REFUELING SYSTEM

WARNING

> Aircraft grounding cables shall be connected properly to minimize fire hazard from static electrical discharge during any refueling or defueling operations.

CAUTION

- Disconnect ground cable last.
- Do not operate radio, radar, or other electrical/electronics equipment on aircraft during ground refueling or defueling operations.

NOTE

> During ground operations, bar lines on the fuel system switches, located on the Flight Engineer's Fuel Panel, will be illuminated by battery power.

The following six pages show the Flight Engineer's fuel panels, separated for clarity and convenience in describing the system's operation.

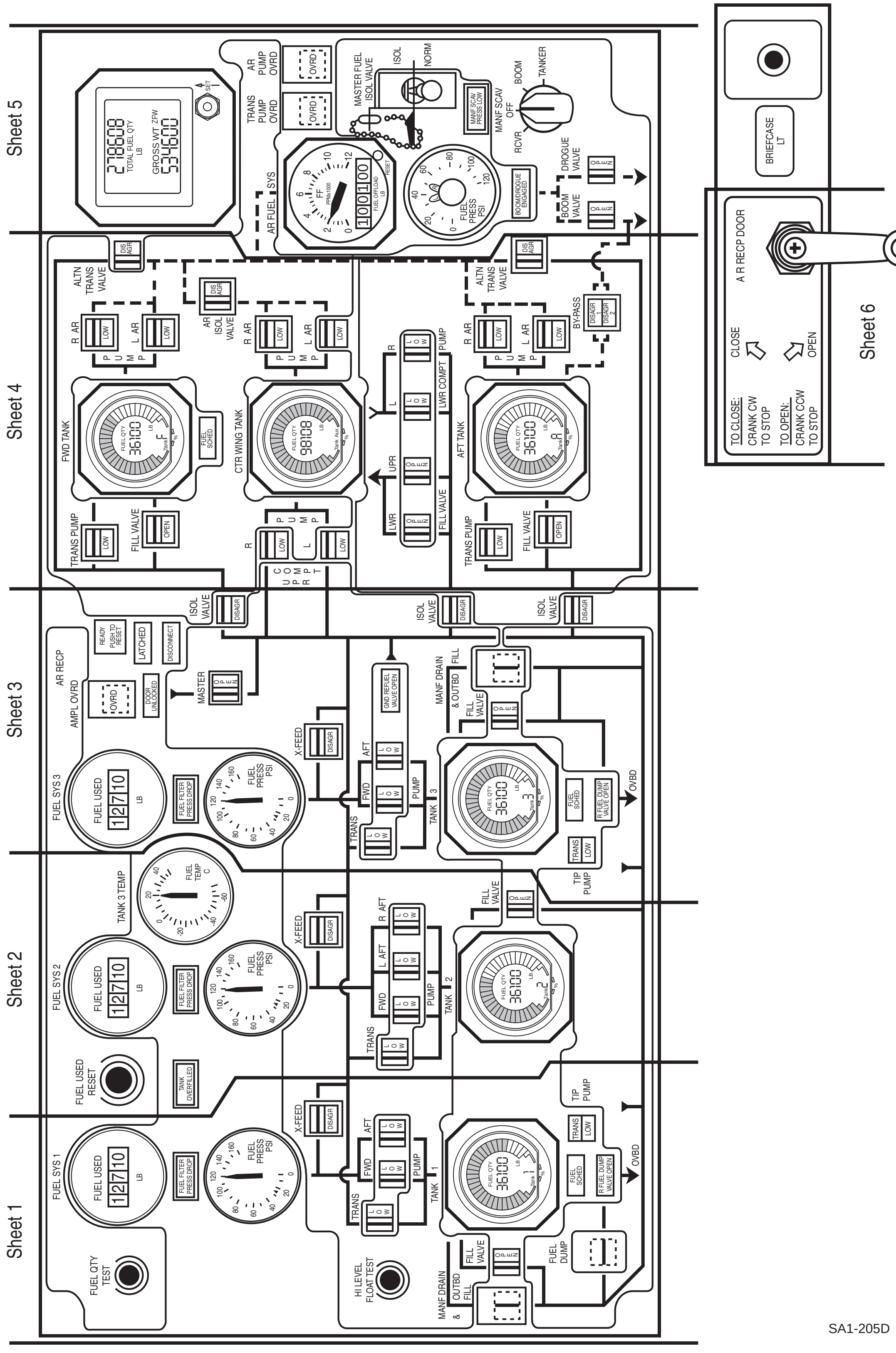


Figure 1.3-4. Flight Engineer's Fuel Panel, System Operation

HI LEVEL FLOAT TEST Button

During fueling, with the fill valve switch(es) at open position and fill valve open light(s) on, pushing in and holding the HI LEVEL FLOAT TEST button in the test position causes the fill valve open light(s) to go out. This ensures proper operation of fuel tank HI LEVEL floats prior to refueling to maximum fuel in each tank. When the HI LEVEL FLOAT TEST button is released the FILL VALVE OPEN lights come on again.

MANIFOLD DRAIN & OUTBOARD FILL Switches (Tank 1, 3)

DRAIN/FILL - Opens the respective tank 1 or tank 3 drain/fill valve to provide refill of the respective outboard compartment to maintain lateral balance when the respective 1 or 3 fill valve is failed closed. Under such circumstances, fuel flows at a reduced rate. Open the drain/fill valve to permit entry of air from the outboard main compartment to allow usable fuel in the manifold to drain into tank 2 through a float valve, when tank 2 fuel level decreases to approximately 2000 pounds.

NORM – Is off (close) position.

CAUTION

If manifold scavenge valve circuit breaker trips, do not reset until maintenance personnel can ensure solenoid housing is intact and that the solenoid coil is not shorted to the solenoid case.

FUEL DUMP Switch

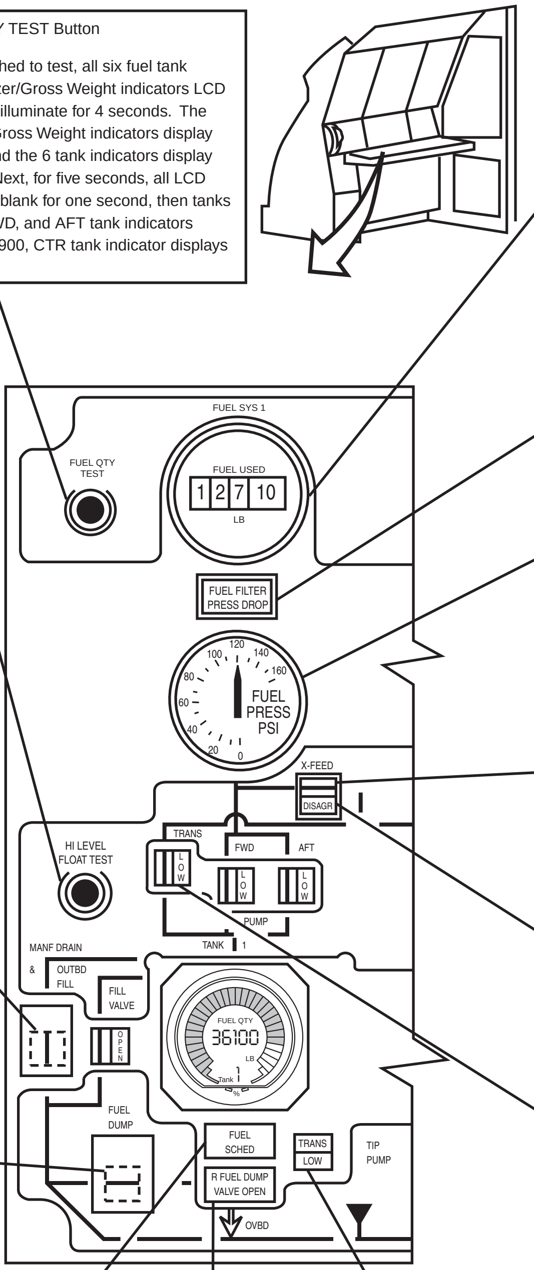
OPEN - Actuation of the switch opens both dump valves and arms the dump level valves and arms the dump level float switches. The two dump valves are on the trailing edge of the wing between the outboard aileron and the flap. All fill valves, except the center wing tank upper compartment, close while the dump valves are open. All crossfeed valves close automatically when the fuel level in any tank reaches the fuel dump level float switches (approximately 11,000 pounds in tanks 1 and 3, or 12,000 pounds in tank 2). The associated X-FEED DISAGR light comes on and remains on until the associated X-FEED switch is turned off or the fuel dump switch is closed. The individual transfer pumps are shut off by actuation of the respective dump level float switch when the dump switch is in the open position.

FUEL SCHED Lights

Outboard compartment fuel is transferred inboard during engine feed operation as inboard fuel level drops below 5000 pounds. A float valve allows a gravity transfer valve to open. The FUEL SCHED light in fuel system 1 & 3 comes on to indicate a premature fuel transfer or a failure to transfer fuel on schedule.

FUEL QTY TEST Button

When pushed to test, all six fuel tank and Totalizer/Gross Weight indicators LCD segments illuminate for 4 seconds. The Totalizer/Gross Weight indicators display 888880 and the 6 tank indicators display 188880. Next, for five seconds, all LCD segments blank for one second, then tanks 1, 2, 3, FWD, and AFT tank indicators display 99900, CTR tank indicator displays 199900.



FUEL USED Indicator (3)

Indicates total fuel consumed by the associated engine since the last time it was reset to zero. No. 2 fuel used indicator does not indicate APU fuel used.

FUEL FILTER PRESS DROP Light (3)

Senses fuel pressure differential and indicates an impending fuel filter clogging. Continued operation with this light on may allow a bypass valve to open which then permits any contaminants to pass further into the fuel control system. No indication of this bypassing is provided.

FUEL PRESS Gage (3)

With engines operating, indicates the sum of fuel tank pumps and engine first stage pump pressure.

NOTE

Indicates tank pump no flow pressure, when the associated engine is not running.

X-FEED Control Switch (3)

By pushing the appropriate crossfeed valve(s) switch to the OPEN position, fuel feed can be from any tank to any or all engines and/or transferred from any main tank to any main tank by utilizing the appropriate fill valve(s) and pumps.

X-FEED DISAGREE Light (3)

Comes on when the crossfeed valve position disagrees with the crossfeed position.

TANK PUMP Switch (TRANS, FWD, AFT)

The pumps are powered by separate systems. Each pump is capable of supplying fuel for two engines at takeoff thrust. The activated aft pumps provide continuous scavenging of the tanks. The transfer pump provides a method of transferring fuel from tank 1 to any other tank or engine.

TIP PUMP(S) TRANS Light

Is illuminated when fuel is transferred from the outboard (TIP) compartment to the inboard compartment by using the tip transfer pumps. These operate any time the transfer override switch is in OVRD and the wing fuel is below 11,000 pounds.

FUEL DUMP VALVE OPEN Light

Is illuminated when the associated dump valve is open.

CAG(IGDS)

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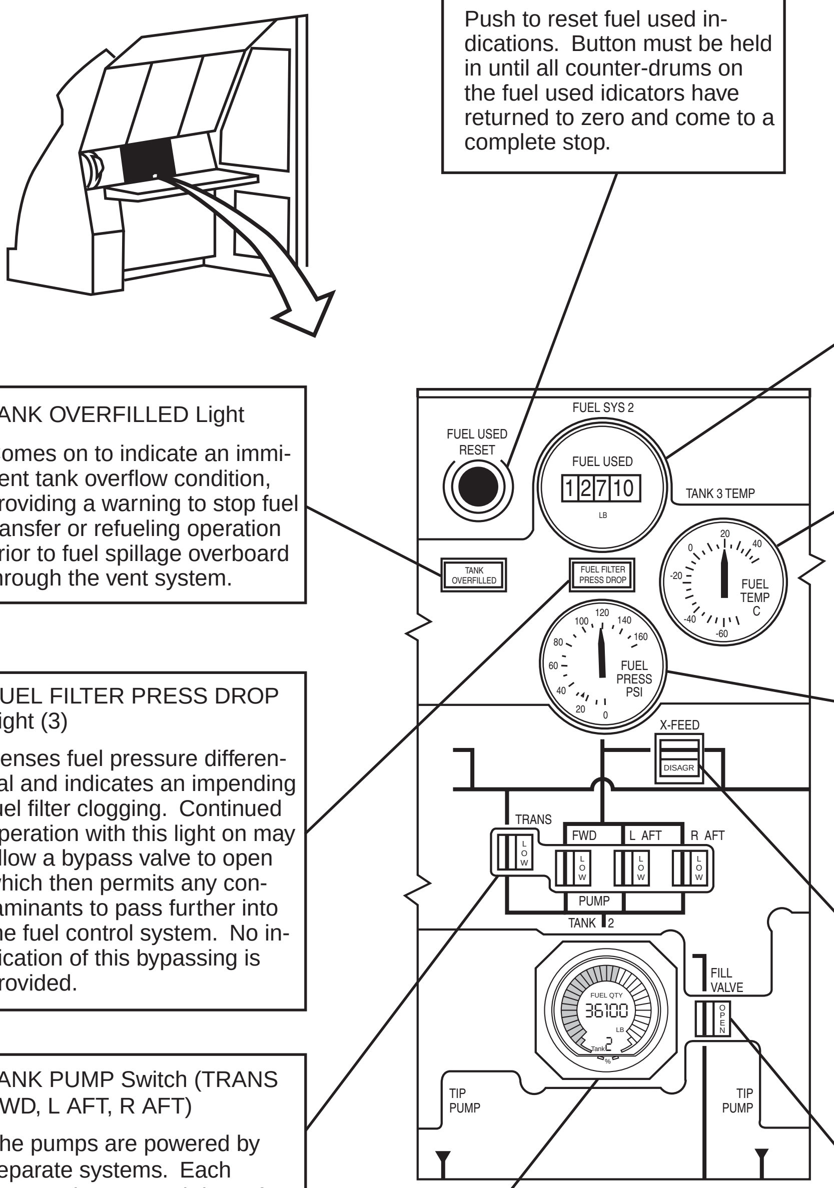
Figure 1.3-5. Flight Engineer's Fuel Panel (Sheet 1)



FUEL USED RESET Button

Push to reset fuel used indications. Button must be held in until all counter-drums on the fuel used idicators have returned to zero and come to a complete stop.

FUEL USED Indicator (3)

Indicates total fuel consumed by the associated engine since the last time it was reset to zero. No. 2 fuel used indicator does not indicate APU fuel used.

TANK OVERFILLED Light

Comes on to indicate an imminent tank overflow condition, providing a warning to stop fuel transfer or refueling operation prior to fuel spillage overboard through the vent system.

FUEL TEMP Gage

Indicates temperature in the outboard compartment of No. 3 tank in degrees centigrade.

FUEL FILTER PRESS DROP Light (3)

Senses fuel pressure differential and indicates an impending fuel filter clogging. Continued operation with this light on may allow a bypass valve to open which then permits any contaminants to pass further into the fuel control system. No indication of this bypassing is provided.

FUEL PRESS Gage (3)

With engines operating, indicates the sum of fuel tank pumps and engine first stage pump pressure.

NOTE

Indicates tank pump no flow pressure, when the associated engine is not running.

X-FEED DISAGREE Light (3)

Comes on when the crossfeed valve position disagrees with the crossfeed control switch position.

TANK PUMP Switch (TRANS FWD, L AFT, R AFT)

The pumps are powered by separate systems. Each pump is capable of supplying fuel for two engines at takeoff thrust. The activated aft pumps provide continuous scavenging of the tank. The transfer pump provides a method of transferring fuel from tank 2 to any other tank or engine. Tank 2 left aft pump is powered by the right emergency ac bus. This bus can be powered by the ADG.

FUEL QTY Indicator

Provides a continuous reading of fuel quantity in the associated tank to the nearest 100 pounds.

FILL VALVE OPEN Light (7)

Comes on during fuel transfer or refueling indicating fill valve is OPEN. All tank fill valves, except the center wing tank upper compartment fill valve, automatically return to close if fuel dump switch is OPEN.

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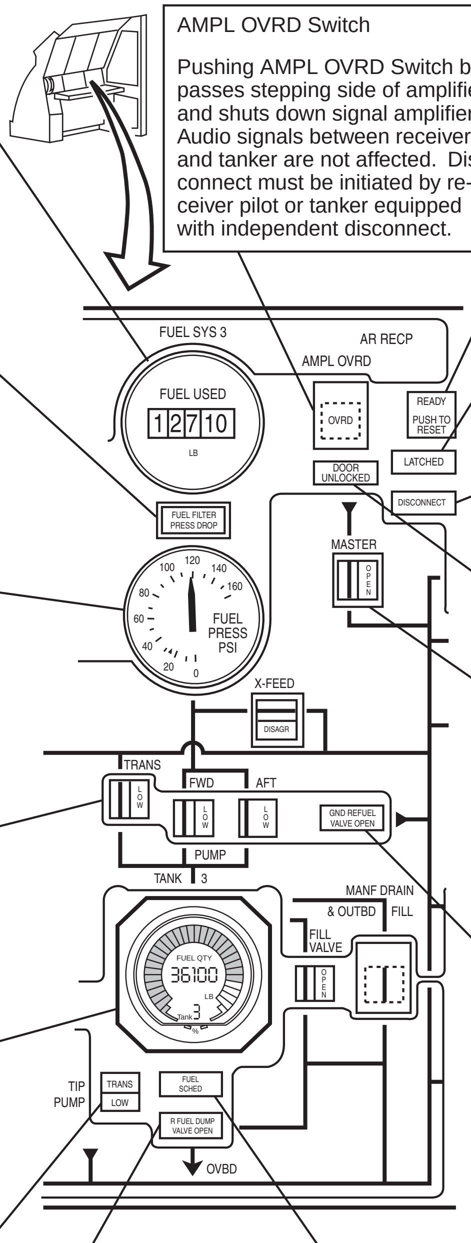
Figure 1.3-5. Flight Engineer's Fuel Panel (Sheet 2)



FUEL USED Indicator (3)

Indicates total fuel consumed by the associated engine since the last time it was reset to zero.

FUEL FILTER PRESS DROP Light (3)

Senses fuel pressure differential and indicates an impending fuel filter clogging. Continued operation with this light on may allow a bypass valve to open which then permits any contaminants to pass further into the fuel control system. No indication of this bypassing is provided.

FUEL PRESS Gage (3)

With engines operating, indicates the sum of fuel tank pumps and engine first stage pump pressure.

NOTE

Indicates tank pump no flow pressure, when the associated engine is not running.

TANK PUMP Switch (TRANS, FWD, AFT)

The pumps are powered by separate systems. Each pump is capable of supplying fuel for two engines at takeoff thrust. The activated aft pumps provide continuous scavenging of the tank. The transfer pump provides a method of transferring fuel from tank 3 to any other tank or engine.

FUEL QTY Indicator

Provides a continuous reading of fuel quantity in the associated tank to the nearest 100 pounds.

TIP PUMP(S) LOW PRESS Light

Is illuminated anytime the transfer pump override switch is in OVRD, and the wing fuel level is above 11,000 pounds or the outboard wing compartment fuel level is zero or approaching zero.

R FUEL DUMP VALVE OPEN Light

Indicates Right Fuel Dump Valve is open. Automatic interlock closes all fill valves while dump valve is open.

AMPL OVRD Switch

Pushing AMPL OVRD Switch bypasses stepping side of amplifier and shuts down signal amplifier. Audio signals between receiver and tanker are not affected. Disconnect must be initiated by receiver pilot or tanker equipped with independent disconnect.

FUEL SCHED Lights

Outboard compartment fuel is transferred inboard during engine feed operation as inboard fuel level drops below 5000 pounds. A float valve allows a gravity transfer valve to open. The FUEL SCHED light in fuel system 1 & 3 comes on to indicate a premature fuel transfer or a failure to transfer fuel on schedule.

READY PUSH TO RESET Light

Indicates UARRSI door open and system ready to receive fuel. After disconnect, UARRSI does not latch fuel nozzle again unless reset.

LATCHED Light

Indicates nozzle is inserted in the UARRSI and locked in place.

DISCONNECT Light

Indicates electrical power is terminated to latch control solenoid. Ports pressure to unlatch side of cylinder and allows boom nozzle to be withdrawn. Movement of latch triggers DISCONNECT Light on and LATCHED Light out.

DOOR UNLOCKED Light

Comes on as uplock arm actuates switch when door lock handle is pulled out.

MASTER Switch

Opens AR Receiver Valve to initiate refueling from another tanker. Intake manifold is same one used by ground refueling system and allows fuel distribution to selected tanks. Supplies power to AR amplifier circuit. Master Switch and valve OPEN light comes on to indicate valve is open.

GND REFUEL VALVE OPEN Light

Indicates Ground Refuel Valve is open for refuel/defuel operation. If light is on, verify fueling status with ground crew. If not required for servicing, request ground crew manually close check valve in left main wheel well area.

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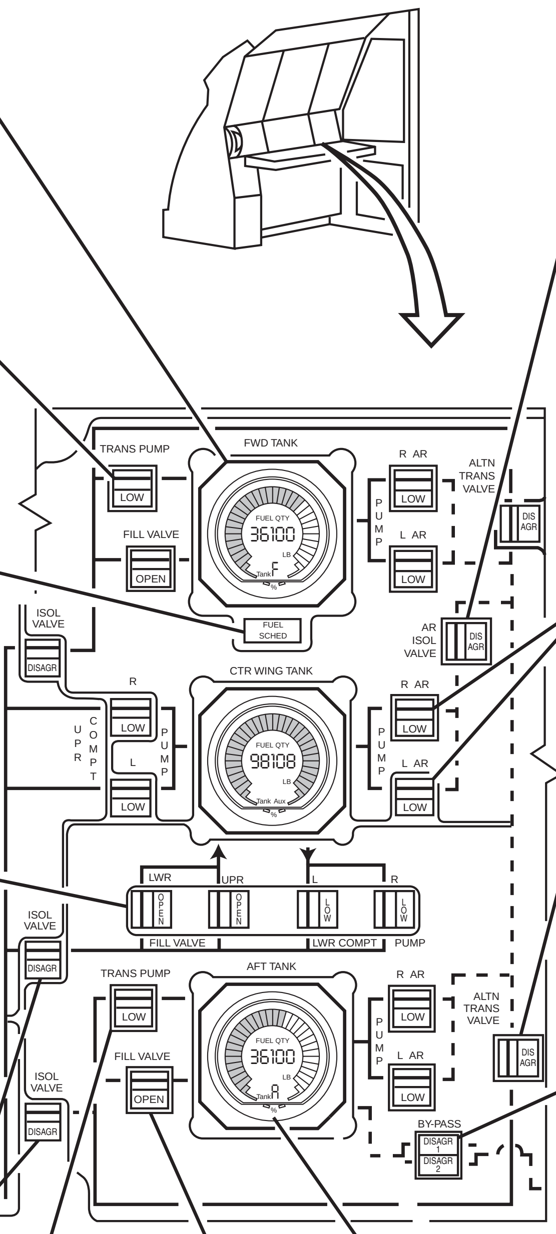
Figure 1.3-5. Flight Engineer's Fuel Panel (Sheet 3)



FWD TANK

Fuel transfer out of the forward tank is automatically stopped at approximately 15,000 pound level.

TRANS PUMP

Fuel transfer is accomplished by pushing switch to activate fuel pump at FWD tank. Fuel can be directed to receiver tank by opening forward isolation valve and selected fill valve.

FUEL SCHED Light

If any fuel is in the forward fuselage tank when No. 1 or No. 3 main tank fuel is below the 4,000 pound level with fuel remaining in the FWD TANK, the forward tank schedule light comes on, indicating abnormal fuel scheduling.

FILL VALVE OPEN Light

Comes on during fuel transfer or when refueling indicating fill valve is OPEN. Fill valves automatically return to close if dump switch is activated. The upper compartment fill valve of the auxiliary tank does not automatically close when the FUEL DUMP switch is at OPEN.

ISOL VALVE

Prevents inadvertent mixing of fuel in forward and aft body tanks and center wing tank with fuel in main tanks when different type of fuel is carried for air refueling.

TRANS PUMP

Fuel transfer is accomplished by pushing switch to pump fuel from AFT TANK. Open the aft isolation valve and the fill valve on receiver tank.

AR ISOL VALVE

Prevents inadvertent offload of center wing fuel if the fuel is different than that carried in the forward tank and aft tank. If ISOL VALVE is closed the center wing AR Pumps will not operate.

R AR/L AR PUMPS

Air Refueling Pumps are driven by different hydraulic systems for reliability. Pump speed is varied by means of variable displacement drive motors controlled by a pressure transducer near nozzle of ARB.

Prior to hook-up the pump switches may be armed, but pumps do not start until Tanker/Receiver contact is made. Pumps turn off automatically on disconnect.

ALT TRANS VALVE

Provides an alternate method of fuel transfer from the Forward/Aft tanks to another fuel tank using aerial refuel pumps in the event of Transfer Pump failure. Fuel may be off loaded via this method at a reduced rate using transfer pumps.

BY-PASS DISAGREE Lights

Come on when the by-pass valve position disagrees with the position selected at the boom control unit.

FILL VALVE

The fill valve controls the flow from the manifolds into each tank. The fill valve is closed by pushing the switch a second time, or automatically by the full-level shutoff system, or by a hydromechanical control circuit if tank pressure should exceed 9 psig due to a fill shutoff valve failure.

FUEL QTY Indicator

Provides a continuous reading of fuel quantity in the associated tank to the nearest 100 pounds.

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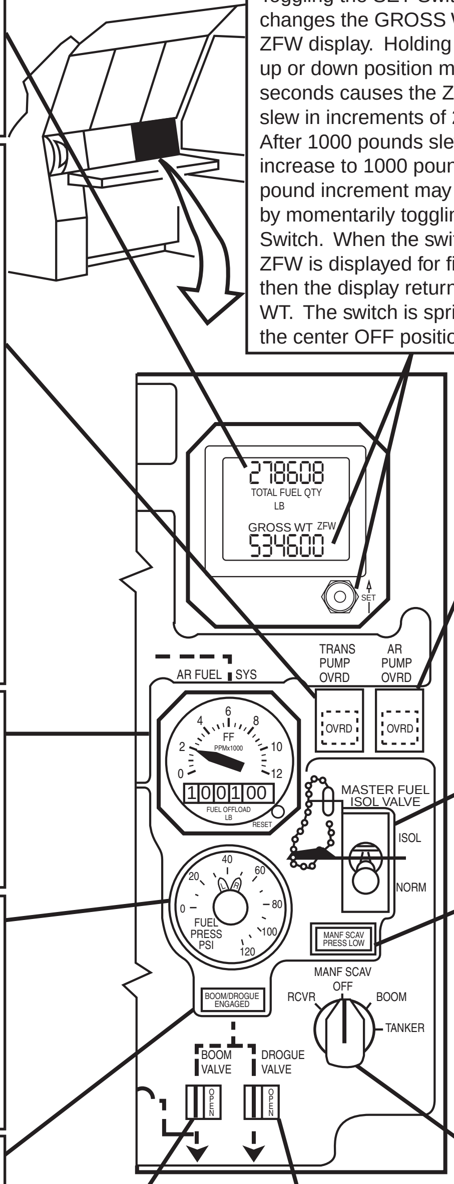
Figure 1.3-5. Flight Engineer's Fuel Panel (Sheet 4)



TOTAL FUEL QTY/GROSS WT Indicator

Provides continuous total fuel quantity readout to the nearest 200 pounds and provides continuous gross weight readout to the nearest 250 pounds.

TRANS PUMP OVRD Switch

Allows start up of main tank transfer pumps after shutdown (11,000; 12,000; 11,000 levels) during fuel dump or transfer to fuselage tanks while offloading through boom or drogue.

WARNING

If crossfeed valves are open and main fuel tanks are below automatic dump shutoff level (approximately 11,500 lbs for main tanks), actuation of TRANS PUMP OVRD switch will automatically close all crossfeed valves.

Fuel Flow/OFFLOAD Gage

Provides the offload rate of fuel flow and total fuel quantity transferred to receiver aircraft.

Offload may be reset to zero by rotation of reset knob.

FUEL PRESSURE Gage

Provides air refueling pressure at the Boom/Drogue/Refuel manifold. Pressure indications from two transducers at the same location normally coincide.

BOOM/DROGUE ENGAGED Light

Indicates satisfactory hook-up with receiver aircraft.

BOOM VALVE Switch

The Boom Valve can be opened by pushing the Boom Valve Switch if the BOOM CONTROL AR MASTER POWER Switch in the Boom Operator's compartment is armed. The BOOM VALVE closes and does not open if the BY-PASS valve is open.

3 Position toggle SET Switch

Toggling the SET Switch up or down changes the GROSS WT display to ZFW display. Holding the switch in its up or down position more than three seconds causes the ZFW display to slew in increments of 200 pounds. After 1000 pounds slew increments increase to 1000 pounds. The 200 pound increment may be reselected by momentarily toggling the SET Switch. When the switch is released ZFW is displayed for five seconds then the display returns to GROSS WT. The switch is spring loaded to the center OFF position.

DROGUE VALVE Switch

The Drogue Valve can be opened by pushing the Drogue Valve switch if the drogue control master power switch is armed. The line across the switch illuminates, indicating switch actuation. The OPEN portion of the switch illuminates, indicating the valve is open.

AR PUMP OVRD Switch

Replaces refueler contact signal to Fuel Pressure Control Unit, which enables fuel transfer between internal tanks. Restarts AR Pump after shutdown at 15,000 pound level in FWD TANK. Allows start of AR Pumps for internal fuel transfer.

MASTER FUEL ISOL VALVE SWITCH

ISOL Position	Locks FWD, CTR, and AFT ISOL VALVE in closed position. Deactivates CTR WING LWR COMPT TRANS PUMPS.
NORM Position	Allows offloading of fuel from any body tank and internal transfer of fuel from any tank to any other tank using TRANS and/or AR PUMPS.

MANF SCAV PRESS LOW Light

Manifold Scavenge Pressure Low light comes on to indicate manifold drainage is complete.

MANF SCAV Selector

Manifold Scavenge Selector Valve provides means of draining all air refueling manifolds and boom after air refueling is complete. Drainage reduces the unavailable fuel and reduces the hazard of fuel spillage during crash landing.

CAUTION

If manifold scavenge valve circuit breaker trips, do not reset until maintenance personnel can ensure solenoid housing is intact and that the solenoid coil is not shorted to the solenoid case.

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Figure 1.3-5. Flight Engineer's Fuel Panel (Sheet 5)

The KC-10A is normally fueled through two adjacent pressure receptacles in the right wing. Two additional receptacles are installed in the left wing to permit refueling simultaneously where such ground capability exists. A fueling panel (figure 1.3-6) located near the two receptacles in the right wing provides complete control of filling. The system automatically switches to the battery when no other source of power is available. Two fuselage fill receptacles are mounted just forward of the left main wheel well and are accessible from the ground. Fill control may be accomplished from the cockpit or the wing fill station. The fuselage fill receptacles are connected to the fill/transfer manifold which distributes fuel to the forward and aft fuselage tanks as well as the wing tanks. The line between the fuselage fill receptacles and the ground refuel shutoff valve is manually drained after refueling through the fuselage fill receptacles. Each wing fill receptacle connects to the fill/transfer manifold located inside the tanks. This manifold distributes fuel to the wing tanks and to the fuselage tanks throughout the fuselage manifold. Flexible couplings outside the fuel tanks are shrouded. Leakage of the primary seal is checked with push to drain valves. The forward tank fill line, running within the pressurized fuselage, is also shrouded.

The aft tank fill line is located in the main wheel well and wing fillet, which is an unpressurized area. The section located in the main wheel well is stainless steel tubing with shrouded couplings.

A fill shutoff valve controls the flow of fuel from the manifolds into each tank. The valve design controls the rate of closure so that excessive pressure surges are avoided. The fuel is discharged into all tanks through expanded inlet piping located low in the tank. In the main tanks, this level is below the normal low fuel level in order to reduce the velocity and fluid agitation which could otherwise contribute to buildup of electrostatic charges.

FUEL SHUTOFF VALVES

Each fuel fill shutoff valve is closed by a manually operated shutoff switch at the fueling panel, by a signal from the preselected partial fill level control, automatically by the full-level shutoff system, or by a hydromechanical control circuit if fuel pressure in the tank should exceed 9 psig due to a fill shutoff valve failure. The automatic full-level shutoff system is designed to maintain the required expansion space above the fuel with the aircraft in any position on any normal ramp. The operation of the automatic full-level shutoff system can be prechecked any time during fueling from the control station.

DEFUELING SYSTEM

CAUTION

- Qualified personnel shall be stationed at Flight Engineer's Fuel Control Panel for AC pumping unit defueling and at ground defueling units for all defueling operations.
- All personnel shall be in communication through the aircraft interphone system when more than one station is involved in defueling operations.

Selective tank defueling from the wing refueling adapters requires opening the refueling adapter's check valve manually and turning ON the associated tank transfer pump, or opening the fuel system crossfeed valve and turning ON the associated engine tank pumps. Defueling operation from the ground station is identical to the wing station operation except a defueling tank on the adapter face must be raised rather than opening a check valve. Suction defueling the aircraft from any refueling adapter also requires manually opening that refueling adapter's check valve or raising the tank at the ground station adapters.

Applying suction to this refueling adapter opens the suction defuel check valves and draws fuel through the transfer pumps into the fill-crossfeed manifold. Each tank cannot be selectively defueled using this method, nor can it be completely defueled.

VENT SYSTEM

Each fuel tank is vented through a piping system to one of the two vent boxes in the outboard wing sections. The vent outlets are located in the bottom wing surface and are designed to be non-icing and drip-free. They are remote from the wing tip and wing edges to avoid those areas most subject to lightning strike impingement or streamering. Flame arrestors with bypass valves are installed as standard equipment in the vent system. A unique feature is the venting of the outboard wing tanks to the opposite vent box, which essentially eliminates fuel spillage or siphoning during adverse attitudes

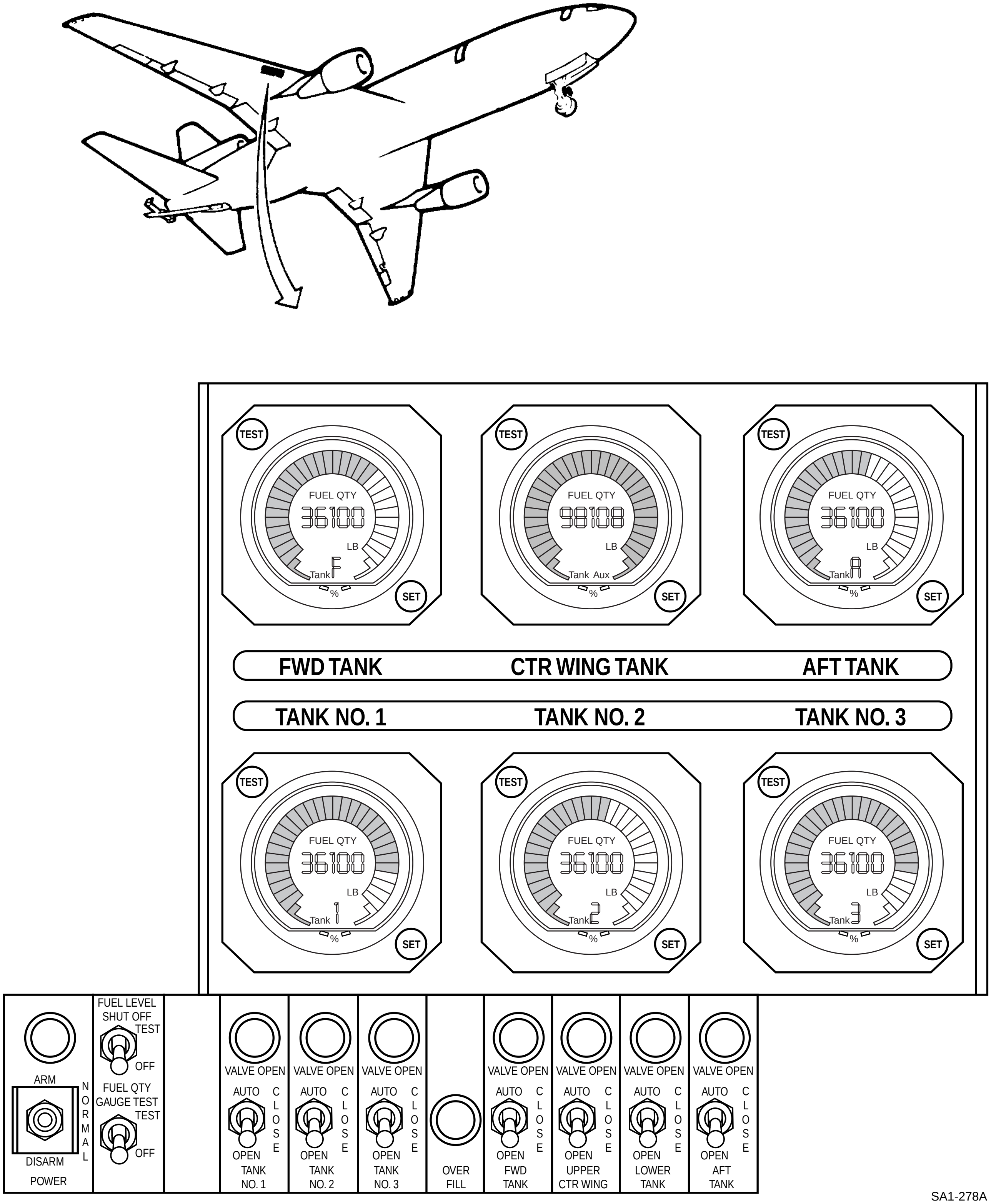


Figure 1.3-6. Refueling Panel, Right Wing

or severe and prolonged taxi maneuvers. Each tank has an open bellmouth main vent port with no valves which could fail and block overflow in the event of a fill valve shutoff failure. Alternate vent ports for aircraft maneuvering are fitted with float valves to prevent overflow when they are submerged. Float drain valves permit the fuel that may have entered the vent system to return to the tank when the fluid level in the line is above the fluid level in the tank. The cavity between the tank inner wall and the bladder cell in the fuselage and lower center wing tanks is vented overboard. Flame arrestors are installed in the overboard vent line. The cavity is also vented through a low pressure loaded check valve to its respective tank main line. Relief valves are installed between the two cross wing vent lines. In the event of an abnormal tank pressure, a relief valve will open and allow vent flow out of both cross wing vent lines.

FUEL DUMPING SYSTEM

Fuel dumping may use transfer, tank pump, and/or AR pumps to pump the fuel overboard through exits on each wing located at the trailing edge between the low speed aileron and the flap. The dump flow is controlled by two electrically operated shutoff valves, one on each side and the low level shutoff controls in the three main tanks.

The dump valves are dc motor operated valves energized by a single dump switch. There is an indicating light located at the Flight Engineer's station for each dump valve that indicates when the valve is not closed. Any time during the fuel dumping operation the Flight Engineer can stop the flow of fuel overboard by closing the dump switch and turning off the transfer pumps. The dump valves are on separate electrical buses. With the dump switch on, when the fuel level in any main tank reaches the undumpable limit or forward fuselage tank reaches 15,000 pounds, its transfer pump will shut off and all crossfeed disagree lights will come on if crossfeeds are open, indicating the valves are closed. The lights will remain on until the crossfeed control switch is moved to the closed position. Remaining transfer pumps will continue to operate and will shut off as each main tank reaches its undumpable level.

WARNING

> With the loss of DC BUS 2, the Fuel Dump Valve indicators and Fuel Low Level Shutoff function will be inoperative and the Fuel Transfer Pumps will go to the override mode. When dumping fuel without DC BUS 2 power, the Fuel Quantity Gages must be monitored to prevent fuel from being dumped below the minimum allowable level.

CONTINUOUS SCAVENGE SYSTEM

A continuous scavenge system is provided to prevent water accumulations within the tanks by pumping fuel from the low points to the fuel pump inlets. The system consists of jet pumps, pressure actuated shutoff valves, check valves and scavenge rakes. Jet pumps are used to scavenge the fuel tank low points where the tank bottom is too flat for gravity draining. The primary flow of these pumps is obtained from the pump manifolds in each tank. The outlets of the jet pumps are located so that the discharge is directed toward an aft pump inlet. The jet pumps are in operation whenever the pumps are working. For tanks No. 1 and 3 there are two jet pumps, one pumping the low points of the outboard compartment and the other pumping the low points of the main compartment. Since the outboard compartment must be maintained full during most of the flight, a small bleed flow tapped off of the engine fuel supply is directed to this compartment through the pilot float valve line. The bleed flow to the compartment is greater than the scavenge flow from the compartment to ensure that the outboard compartment remains full. Check valves in the primary flow line of the jet pumps prevent air entry in the engine supply line during suction feed operation (boost pumps off). A pressure-operated valve in the outboard compartment secondary flow (scavenge flow) line is opened by boost pressure and is used to prevent drainage from the outboard compartment to the main compartment when the boost pumps are not operating. Two jet pumps are used in the No. 2 main tank. One is located in the left compartment and one is located in the right compartment. They are located low in the tank and pump fuel to the two pumps mounted on the rear spar.

The upper center wing tank contains two identical scavenge systems, one for the left side and one for the right side. Each system has two jet pumps deriving motive flow from its respective fuel transfer pump and returning the scavenge flow to the inlet of the same pump. The lower center wing contains a bladder cell and does not have a scavenge system. The forward and aft body tank jet pumps, one in the forward tank and three in the aft tank, scavenge fuel from the forward compartments and discharge into the aft compartments where the pumps are located. The jet pump primary flow is obtained from either the transfer pump or off-load pump manifolds.

Scavenge pumps transfer residual fuel below the flapper check valves from the forward cells into the aft cells. Electric pumps can be used to transfer fuel from the aft cells for engine feed.

FLIGHT ENGINEER'S FUEL PANEL ANNUNCIATOR LIGHTS

CAUTION

> Fuel System annunciator lights are not push-to-test circuits. Pushing in on the FUEL SCHED or FUEL DUMP VALVE OPEN light disengages the circuit and renders the light inoperative; malfunction would not be annunciated.

NOTE

> Annunciator lights can be tested by either the ALL TEST switch or the ANNUN LT AREA TEST SELECT switch and pushing the AREA TEST pushbutton.

DIGITAL FUEL QUANTITY INDICATING SYSTEM

The Digital Fuel Quantity Indicating System (DFQIS) consists of the following new components: LCD quantity indicators (all positions), LCD totalizer/gross weight indicator, LED wing refueling panel indicators, and power supply.

The DFQIS is compatible with the existing fuel tank components and external wiring. It does not require any mechanical or electrical modifications to the aircraft. All cockpit DFQlS fuel quantity indicators are interchangeable, however, DFQIS components cannot be intermixed with the existing fuel system components. The fuel quantity indicating system must be all DFQIS components or all existing components.

The power sources and circuit breakers have not changed from the existing fuel quantity indicating system.

MAIN AND BODY TANK QUANTITY INDICATORS

The fuel quantity indicators consist of a lighted liquid crystal display (LCD). Fuel quantity is displayed digitally with 100 pounds resolution. Quantity is also displayed by a LCD segmented arc on the indicator rim beginning at the 7 o'clock position (empty) and extending clockwise to the 5 o'clock position (full). Compensator/system tests are accomplished internally whenever the FUEL QTY TEST button is pushed. The FUEL QTY CHAN SELECT (A/B) switch is deactivated .

LCD SEGMENT ARC SCALING

CAUTION

> The segmented arc is for reference only. The digital display must be used for all fuel tank quantity determinations.

The LCD segmented arc scale will indicate maximum fuel tank quantities based on a wide range of fuel density values.

TOTALIZER/GROSS WEIGHT INDICATOR

The totalizer/gross weight indicator consists of a lighted liquid crystal display. It displays total fuel quantity, zero fuel weight (ZFW), and gross weight digitally with 200 LBS resolution. The gross weight indicator uses a 3 position, momentary-toggle SET switch, spring loaded to the center off position. Toggling the SET switch up or down immediately changes the GROSS WT display to ZFW display. Holding the SET switch in the up or down position for more than 3 seconds causes the display to slew up or down in increments of 200 LBS. Once the ZFW display has incremented 1000 LBS, the slew increment increases to 1000 LBS. The lower increment may be reselected by momentarily toggling the SET switch. When the SET switch is released, the ZFW is displayed for 5 seconds after which the display returns to the GROSS WT display.

BUILT-IN-TEST SYSTEM

All tank quantity indicators are equipped with power-up, automatic background and initiated built-in-test features. These features are:

- Power-up BIT occurs when power is initially supplied to the DFQIS and test all replaceable components.
- Automatic background BIT occurs whenever the system is powered and constantly monitors: indicator performance, aircraft wiring, tank located components, and fuel contamination.
- Initiated BIT occurs whenever the FUEL QTY TEST button is pressed.

Regardless of the BIT mode, any detected faults are stored in a non-volatile memory for later reference by maintenance personnel.

When the BIT modes detect a fault that may cause the display of erroneous information, the affected LCD quantity display blanks. The indicator will remain blank until maintenance action is performed. When any quantity indicator blanks, the totalizer/gross weight indicator will continue to sum the fuel quantities from all remaining operative tank indicators causing the quantity displayed to be unreliable.

ABNORMAL INDICATIONS

Abnormal indications of any quantity indicator are easy to recognize: the quantity display blanks. This occurs when any of the BIT modes detects a fault that may cause the display of erroneous information. Reillumination of the display is not possible until maintenance action is performed.

When any quantity indicator blanks, the totalizer/gross weight indicator will continue to sum the fuel quantities from all remaining operative tank indicators causing the quantity displayed to be unreliable.

UNIVERSAL AIR REFUELING RECEPTACLE AND SLIPWAY INSTALLATION (UARRSI)

The KC-10A is equipped to receive fuel from another tanker by means of the Universal Air Refueling Receptacle and Slipway Installation (UARRSI) (figure 1.3-7). The UARRSI provides a means of refueling any or all tanks from a boom-type tanker aircraft. Fuel is transferred from the tanker boom through a receptacle located on the top of the aircraft above the Flight Engineer's station. Fuel from the receptacle flows through a manifold to an air refuel isolation valve and from there to the crossfeed fuel manifolds. Fuel from the manifold flows into the aircraft tanks through the tank refuel valves.

The receptacle is normally covered by a hydraulically actuated door, hinged along the forward edge.

When retracted, the aft end of the door moves down to expose the receptacle. In this position, the door serves as a boom slipway. The receptacle is equipped with an induction coil which mates with a similar coil in the tanker boom. The purpose of the coil is to transfer refueling system sequence signals from one aircraft to another.

A maximum of 1200 GPM, approximately 7,800 lb/min, onload is expected with all valves open.

The receiver manifold has scavenge capability consisting of a drain line, drain valve, and pump. The fuel removed from the manifold is discharged into the No. 2 main tank.

The UARRSI slipway door and toggles are hydraulically operated from hydraulic system one. The UARRSI hydraulic system is normally unpressurized except during actual use to prevent the possibility of hydraulic leaks in the cockpit overhead.

The UARRSI hydraulic system manual shutoff valve is located under the cabin floor, just forward of the left cabin door. The shutoff valve is used to isolate the UARRSI from the hydraulic system.

A crank handle (figure 1.3-8) on the Flight Engineer's table controls the door actuation system which opens and closes the UARRSI slipway door. The slipway door is spring loaded open and hydraulically closed. The receptacle indicating system shows the status of the UARRSI before, during, and after receiving fuel from another tanker aircraft. Annunciator lights on the Flight Engineer's Panel and Windshield Panel (figure 1.3-9) will show READY, LATCHED, DISCONNECT, and AMPL OVERRIDE. The DOOR UNLOCK light is located on the Flight Engineer's Panel. When the nozzle of the refueling aircraft makes contact with the UARRSI receptacle, the READY annunciator light will go out and the latching system is activated which holds the refueling nozzle in the receptacle. The LATCHED annunciator light on the Flight Engineer's Panel and the Windshield Panel will come on to indicate latching is complete and the KC-10A is ready to receive fuel from another aircraft. When refueling is complete, the refueling nozzle can be disconnected by the tanker boom operator or the receiver pilot.

A test switch placarded AR RECP LATCH, located on the Flight Engineer's Equipment Panel (figure 1.3-10),

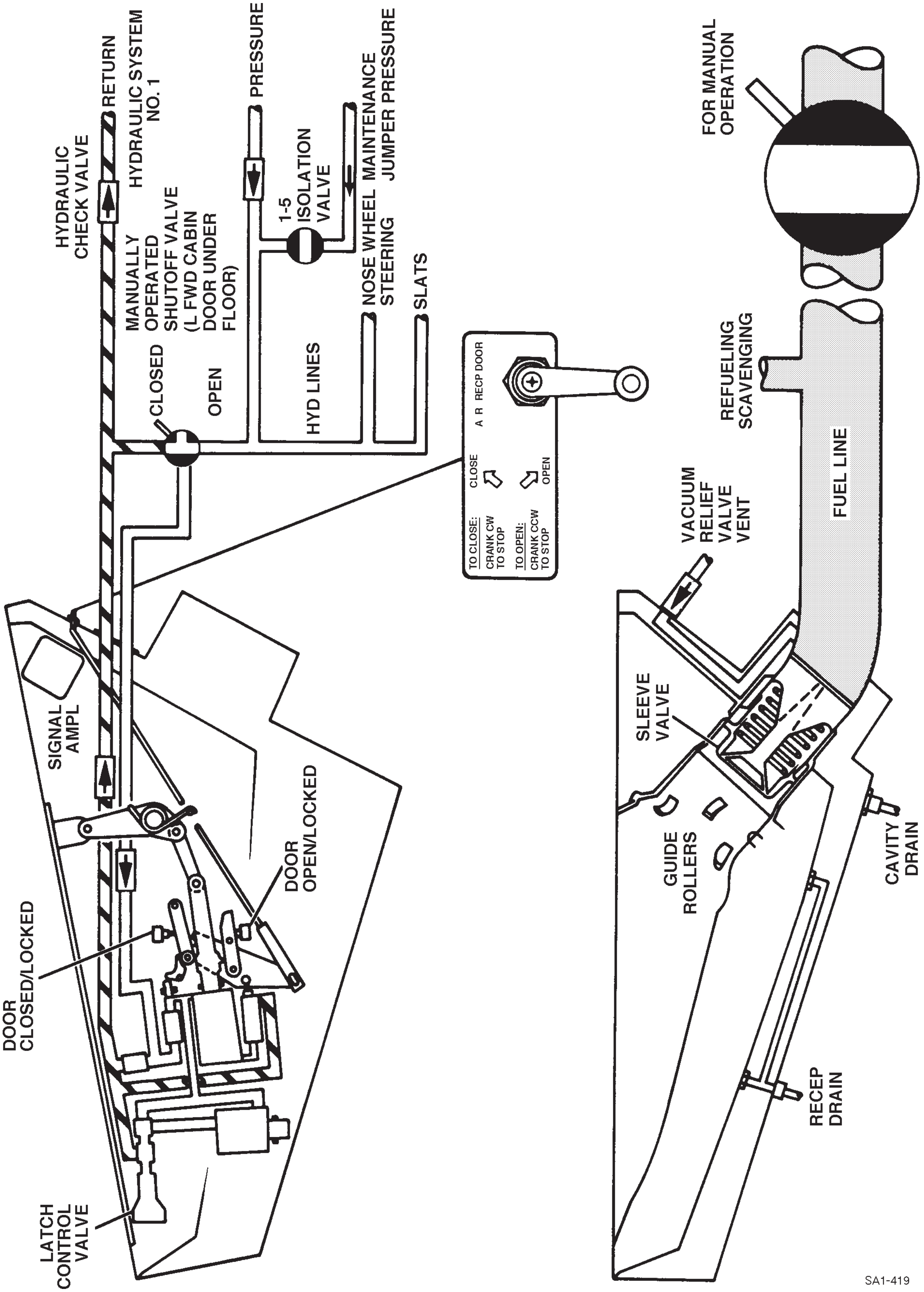
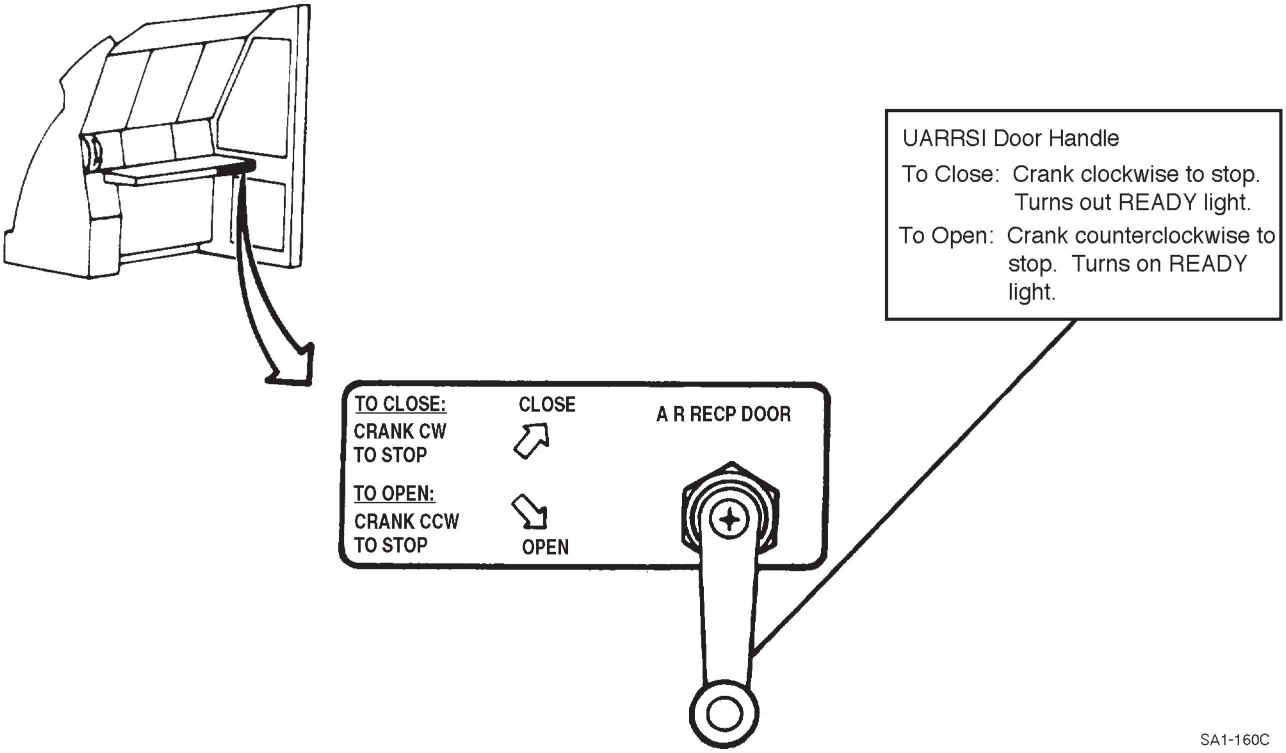


Figure 1.3-7. Universal Air Refueling Receptacle and Slipway Installation Schematic

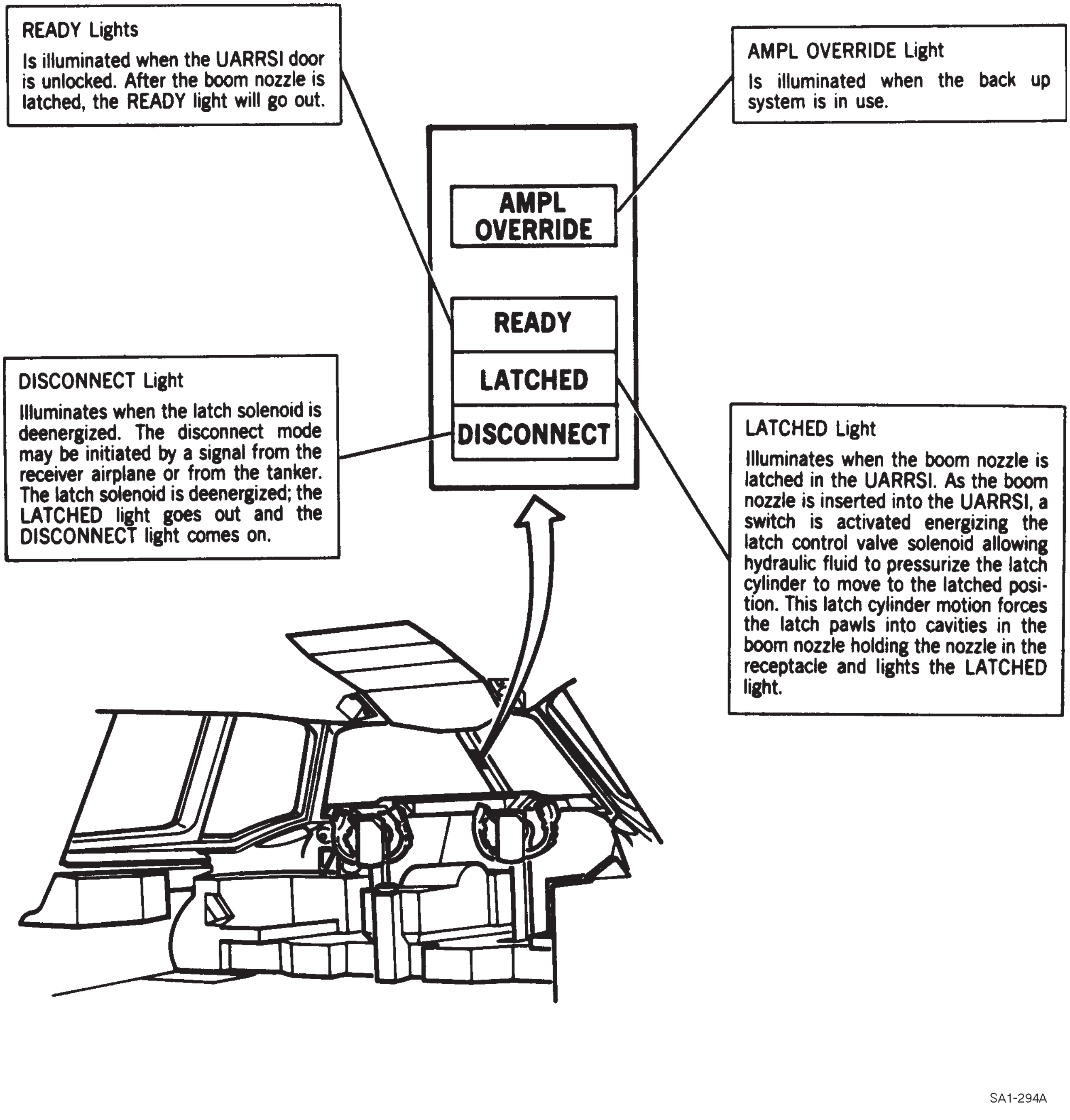


UARRSI Door Handle

To Close: Crank clockwise to stop. Turns out READY light.

To Open: Crank counterclockwise to stop. Turns on READY light.

Figure 1.3-8. UARRSI Door Handle, Flight Engineer's Table



READY Lights

Is illuminated when the UARRSI door is unlocked. After the boom nozzle is latched, the READY light will go out.

AMPL OVERRIDE Light

Is illuminated when the back up system is in use.

DISCONNECT Light

Illuminates when the latch solenoid is deenergized. The disconnect mode may be initiated by a signal from the receiver airplane or from the tanker. The latch solenoid is deenergized; the LATCHED light goes out and the DISCONNECT light comes on.

LATCHED Light

Illuminates when the boom nozzle is latched in the UARRSI. As the boom nozzle is inserted into the UARRSI, a switch is activated energizing the latch control valve solenoid allowing hydraulic fluid to pressurize the latch cylinder to move to the latched position. This latch cylinder motion forces the latch pawls into cavities in the boom nozzle holding the nozzle in the receptacle and lights the LATCHED light.

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Figure 1.3-9. UARRSI Status Annunciator Lights - Windshield Panel can be used to verify that the UARRSI latch actuation system is operating and that the annunciator lights operate in their normal sequence. The test switch is used without a nozzle or tester.

The receptacle poppet valve is spring loaded to the close position and will close automatically when the nozzle is retracted from the receptacle.

The UARRSI provides communication between the flight crew of the KC-10A as a receiver aircraft and the crew of another tanker during in-flight refueling provided the tanker is so equipped. The UARRSI audio system is connected to the flight interphone system. Audio input signals from another tanker pass through the UARRSI coil, are amplified by the UARRSI signal amplifier, then by the flight interphone amplifier to a headset speaker at each crew station monitoring flight interphone. The UARRSI audio system can be operated by each flight crew member by actuating their remote PTT switch to interphone position. The audio panel PTT switch will not transfer the UARRSI amplifier to the transmit mode. A two-position switch labeled OFF-ON is available to the flight engineer. This switch allows the flight crew control of the UARRSI signal amplifier as follows:

OFF - UARRSI signal amplifier restricted to receive mode allowing the flight crew to communicate with each other and not be monitored in the other tanker.

ON - PTT control of UARRSI amplifier from Pilot, Copilot, Flight Engineer and Boom Operator's Forward Station.

AR MASTER SWITCH

The signal amplifier is turned on when the AR MASTER switch is pressed ON. The receiver aircraft signal system works in conjunction with the tanker aircraft to set up the automatic signal system monitoring features of the refueling system for READY, LATCHED, and DISCONNECT connections. With the AR Master switch ON and the slipway door open, the signal system will be in the READY condition. When the boom is placed in the receptacle, the signal system is triggered to LATCHED, the toggles engage the boom and contact made signal is sent to the tanker. A disconnect signal from either receiver or tanker will retract the toggle latches and release the boom. The system is returned to ready by momentarily pressing the AR RESET switch.

OVERRIDE POSITION (MANUAL BOOM LATCHING)

If the LATCHED light fails to illuminate, it indicates a system malfunction. The Amplifier Override switch may be placed in the OVRD position. This action bypasses the signal amplifier, changes the power source to the signal system, and allows the interphone to function properly between tanker and receiver. The refueling status lights will indicate AMPL OVERRIDE as well as READY, LATCHED, and DISCONNECT.

CAUTION

> When operating in manual boom latching mode, the receiver must initiate all disconnects.

DOOR UNLOCKED ANNUNCIATOR LIGHT

The DOOR UNLOCKED annunciator light will remain on until the UARRSI doors are closed by operation of the control handle on the Flight Engineer's table.

UARRSI LIGHTING SYSTEM

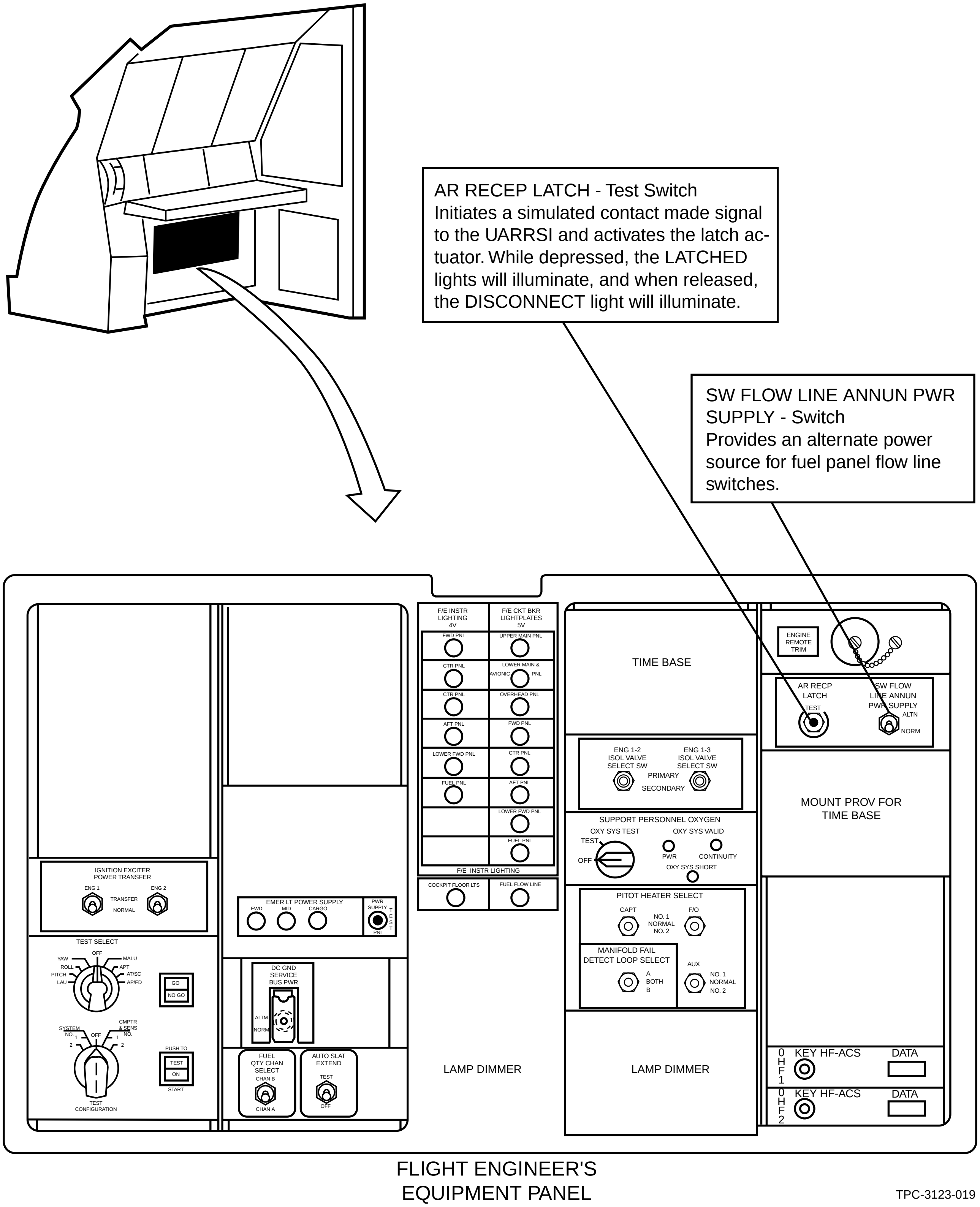
In-flight refueling at night requires lighting the UARRSI to aid the tanker boom operator in locating the receptacle on the receiving aircraft. Two types of lighting systems installed on the KC-10A consist of slipway lights which are a part of the UARRSI unit, and floodlights designed into the aircraft structure. Modified aircraft also have electroluminescent (EL) light strips that replace red lead-in strips.

Slipway Lights

The slipway lights are in four replaceable modules containing three lamps each. The lamps are exposed when the slipway door is open and the brightness is controlled by a rotary switch on the Flight Engineer's Panel.

Floodlights

Two floodlights are located on each side of the UARRSI. Their illumination is reflected by a mirrored inner surface of extendable door. The intensity of light is controlled by a rheostat on the Flight Engineer's Panel.



AR RECEP LATCH - Test Switch
Initiates a simulated contact made signal to the UARRSI and activates the latch actuator. While depressed, the LATCHED lights will illuminate, and when released, the DISCONNECT light will illuminate.

SW FLOW LINE ANNUN PWR SUPPLY - Switch
Provides an alternate power source for fuel panel flow line switches.

Figure 1.3-10. AR Receptacle Test Switch

The light-reflecting doors open to a wide angle enabling the flood lights to reflect light high on the fuselage.

An annunciator on the Forward Overhead Panel labeled FLOOD LIGHT DOOR NOT CLOSED will illuminate if the AR receptacle flood light and door control on the Flight Engineer's Lighting Panel is in the closed position and the flood light doors are open.

* EL Light Strips

Aircraft modified with Electroluminescent (EL) Light strips will have the current air refueling red striped decal removed. They will be replaced with EL strips. Each strip is 3 inches wide and is positioned to form a forward perimeter, lead-in stripes, aft left and right perimeter strips. The clear aviation green EL portion is energized and rheostatically controlled from the flight engineer position.

SYSTEM OPERATION

The AR receptacle flood light and door control on the Flight Engineer's Lighting Panel is a combination switch/rheostat assembly. The switch portion is marked OPEN and CLOSED. The flood light doors are opened and closed by this switch. After passing the OPEN position, the switch opens the flood light doors to reflect the lamp illumination over the UARRSI.

The rheostat portion selects the wattage to the AR receptacle flood lights, controlling the intensity of the light. Rotating the switch to the closed position will turn off the flood lights and close the doors.

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PART 4

ELECTRICAL

TABLE OF CONTENTS

ELECTRICAL

ELECTRICAL DESCRIPTION

The AC and DC electrical systems (figure 1.4-1) are normally powered by three 90-KVA engine-driven generators. They may also be powered by an auxiliary power unit (APU)-driven generator or through an external power receptacle. Portions of the system may be powered by a battery and other portions by an air-driven generator (ADG). Distribution and control is effected through panels, annunciators, indicators, switches, buses, and circuit breakers (figures 1.4-2 through 1.4-11).

CAUTION

- If manifold scavenge valve circuit breaker trips, do not reset until maintenance personnel can ensure solenoid housing is intact and that the solenoid coil is not shorted to the solenoid case.
- If numerous circuit breakers trip for one or more sub-systems, the circuit breakers should not be reset unless an emergency condition exists, until maintenance actions are complete.
- Circuit breakers may not open in the event a Kapton wire flashover occurs.

Operational simplicity and reliability are provided by protective circuitry with automatic corrective action included. The electrical generating system is AC, with necessary DC power provided by transformer/rectifier units or the battery.

NOTE

- If a circuit breaker trips, a cooling period of 90 seconds should be allowed before resetting. A tripped circuit breaker should never be reset more than once.
- Approximately 85% of wire used in the KC-10A is a polymide wire known as Kapton. A characteristic of this wire is a phenomenon known as "Flashover". Should a circuit short out and the circuit breaker fail to open, the insulation of the wire will begin to carbonize. This effectively makes that portion of the wire a conductor. This will in turn cause the adjacent wire to fail and carbonize. After the adjacent wire carbonizes, the original wire may burn in a flash type fire. This pattern may continue and burn through an entire wire bundle. The insulation will not continue to burn after electrical power is removed from the circuit. A failure in this pattern may lead to a flashover, which may occur so quickly, circuit breakers may not open before the wire bundle burns through.
- An indication of a Kapton wire bundle failure may be numerous circuit breakers opening for one or more sub-systems, i.e., hydraulic system indicators or fuel quantity indicators, etc. In this condition, it is recommended that the circuit breakers not be reset, unless an emergency condition exists, or until maintenance actions are complete.

AC ELECTRICAL SYSTEM

AC Generating System

During ground operations, 3-phase 115/200-VAC, 400-Hz power is supplied by an external power source, the APU-driven generator, or by one or more of the three engine-driven generators. In flight, normal power is furnished by the three engine-driven generators. The generators will function either parallel, unparalleled, or isolated. Frequency control of each engine-driven generator is provided by an associated engine-driven constant speed drive (CSD) unit. CSD disconnect can be accomplished at any time, but reengagement is possible only on the ground after the engine has come to a complete stop. Each generator is capable of supplying sufficient power for operation of all essential electrical systems.

NOTE

The constant speed drive (CSD) transmission is serviced with Mobil Jet Oil II as specified by Sundstrand Specification: MS 02.40 (as revised).

The APU-driven generator serves as a supplemental power source when required inflight with the APU in normal mode. The APU-driven generator is identical to the three engine-driven generators. The APU generator does not have a CSD. The APU is governed to drive the generator at the correct speed. The APU generator cannot be paralleled with any engine generator or the external power source.

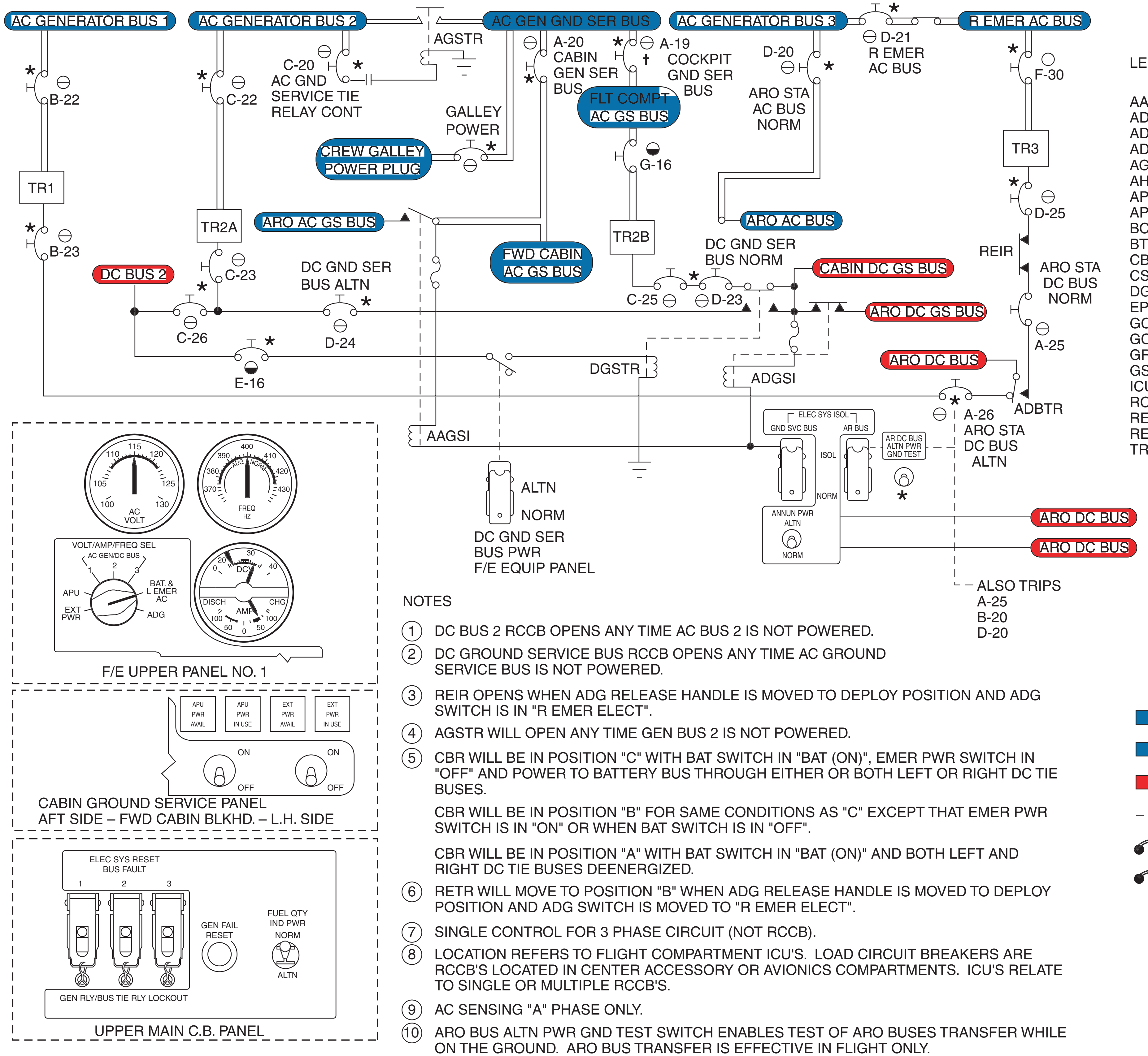
A battery/static inverter combination can provide approximately 30 minutes of left emergency AC and DC bus power for the Pilot's flight instruments and essential communication and navigation equipment when normal sources are inoperative. Emergency AC power for an auxiliary hydraulic pump or the Copilot's instruments on the right emergency AC and DC buses can be supplied by deploying the ADG and selecting the desired mode of the ADG control switch.

AC Distribution System

Three independent AC channels provide power to associated generator buses and remaining AC buses. Paralleling of the channels is accomplished through the AC tie bus. This design permits assumption of electrical loads by any functioning generator(s).

A fourth, independent AC channel permits distribution of APU generator power to the generator buses for ground or inflight operations. The two emergency AC buses can be energized by powering generator buses 1 and 3 from any of the engine-driven generators, the APU-driven generator or the external power source. An emergency AC source is available to the left emergency AC bus through the battery/inverter combination. The ADG may be used to power the right emergency AC bus.

The generator buses and the AC ground service bus supply most of the centrally located and/or high-current loads (hydraulic pumps, most fuel pumps, AC buses and galley power).



NOTES

① DC BUS 2 RCCB OPENS ANY TIME AC BUS 2 IS NOT POWERED.

② DC GROUND SERVICE BUS RCCB OPENS ANY TIME AC GROUND SERVICE BUS IS NOT POWERED.

③ REIR OPENS WHEN ADG RELEASE HANDLE IS MOVED TO DEPLOY POSITION AND ADG SWITCH IS IN "R EMER ELECT".

④ AGSTR WILL OPEN ANY TIME GEN BUS 2 IS NOT POWERED.

⑤ CBR WILL BE IN POSITION "C" WITH BAT SWITCH IN "BAT (ON)", EMER PWR SWITCH IN "OFF" AND POWER TO BATTERY BUS THROUGH EITHER OR BOTH LEFT OR RIGHT DC TIE BUSES.

CBR WILL BE IN POSITION "B" FOR SAME CONDITIONS AS "C" EXCEPT THAT EMER PWR SWITCH IS IN "ON" OR WHEN BAT SWITCH IS IN "OFF".

CBR WILL BE IN POSITION "A" WITH BAT SWITCH IN "BAT (ON)" AND BOTH LEFT AND RIGHT DC TIE BUSES DEENERGIZED.

⑥ RETR WILL MOVE TO POSITION "B" WHEN ADG RELEASE HANDLE IS MOVED TO DEPLOY POSITION AND ADG SWITCH IS MOVED TO "R EMER ELECT".

⑦ SINGLE CONTROL FOR 3 PHASE CIRCUIT (NOT RCCB).

⑧ LOCATION REFERS TO FLIGHT COMPARTMENT ICU'S. LOAD CIRCUIT BREAKERS ARE RCCB'S LOCATED IN CENTER ACCESSORY OR AVIONICS COMPARTMENTS. ICU'S RELATE TO SINGLE OR MULTIPLE RCCB'S.

⑨ AC SENSING "A" PHASE ONLY.

⑩ ARO BUS ALTN PWR GND TEST SWITCH ENABLES TEST OF ARO BUSES TRANSFER WHILE ON THE GROUND. ARO BUS TRANSFER IS EFFECTIVE IN FLIGHT ONLY.

LEGEND

AAGSI	ARO COMPT AC GROUND SERVICE BUS ISOLATE
ADG	AIR DRIVEN GENERATOR
ADBTR	ARO DC BUS TRANSFER RELAY
ADGSI	DC GROUND SERVICE ISOLATE
AGSTR	AC GROUND SERVICE TIE RELAY
AHP1PTR	AUXILIARY HYDRAULIC PUMP 1 POWER TRANSFER RELAY
APR	AUXILIARY POWER RELAY
APU	AUXILIARY POWER UNIT
BCU	BUS CONTROL UNIT
BTR	BUS TIE RELAY
CBR	CHARGER BATTERY RELAY
CSD	CONSTANT SPEED DRIVE
DGSTR	DC GROUND SERVICE TRANSFER RELAY
EPR	EXTERNAL POWER RELAY
GCR	GENERATOR CONTROL RELAY
GCU	GENERATOR CONTROL UNIT
GR	GENERATOR RELAY
GSR	GROUND SERVICE RELAY
ICU	INDICATOR CONTROL UNIT
RCCB	REMOTE CONTROL CIRCUIT BREAKER
REIR	RT EMER ISOLATION RELAY
RETR	RT EMER TRANSFER RELAY
TR	TRANSFORMER/RECTIFIER

○	FWD AND AFT OVERHEAD CIRCUIT BREAKER PANEL.
⊕	F/E OVERHEAD CIRCUIT BREAKER PANEL.
⊖	UPPER MAIN CIRCUIT BREAKER PANEL
◒	LOWER MAIN CIRCUIT BREAKER PANEL
⊛	POWER FROM BATTERY BUS.
●	POWER FROM BATTERY DIRECT BUS.
†	POWER COMES FROM BATTERY BUS THROUGH BUS/APU CONTROL UNIT OR FROM GENERATOR'S PMG ONCE A GENERATOR IS UP TO SPEED.
*	RCCB
🟦	AC SYSTEM
🟦	INVERTER OUTPUT AND ADG AC POWER
🟥	DC SYSTEM
– – –	MECHANICALLY ACTUATED
	RCCB NORMALLY CLOSED
	RCCB NORMALLY OPEN

SA1-225E

Figure 1.4-1. Electrical System Schematic (Sheet 1)

NOTE:
UNLESS OTHERWISE NOTED,
CONTROLS AND INDICATORS
ARE LOCATED ON F/E
UPPER PANEL NO. 1.

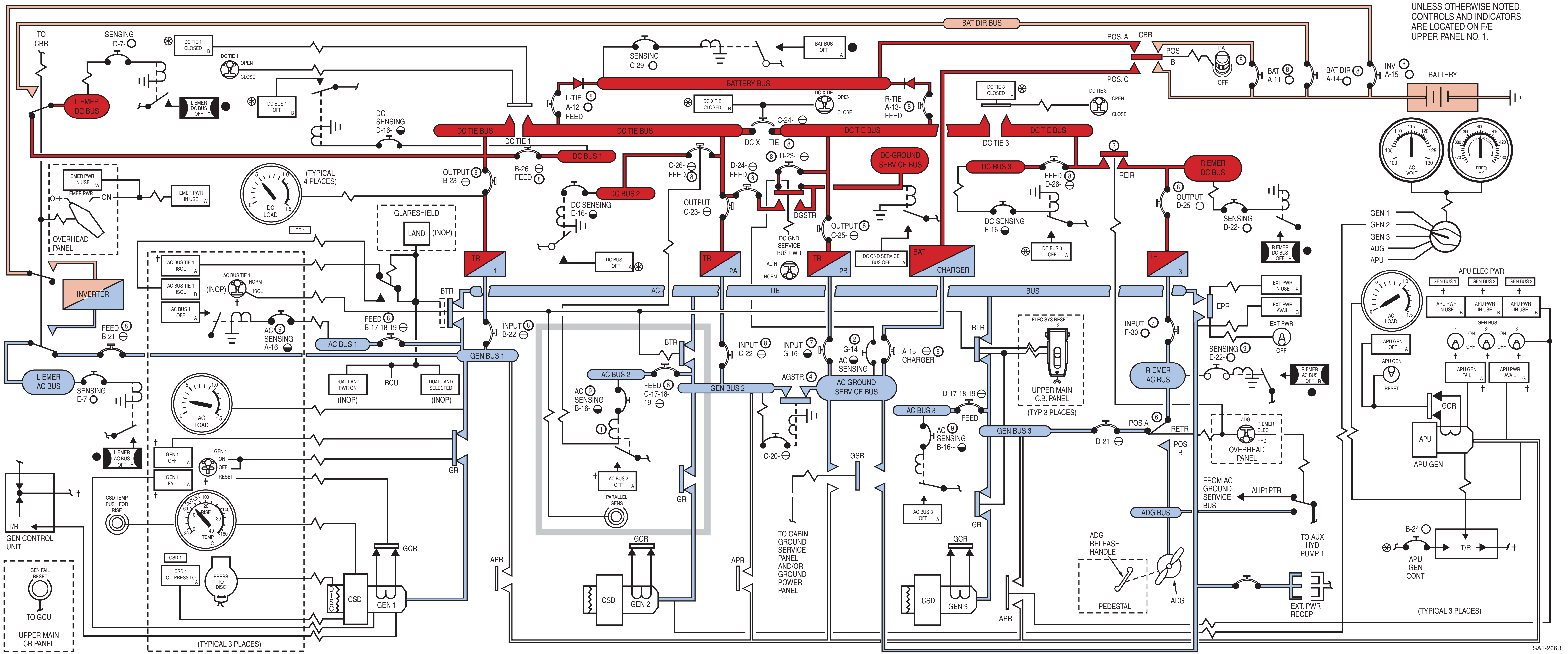


Figure 1.4-1. Electrical System Schematic (Sheet 2)

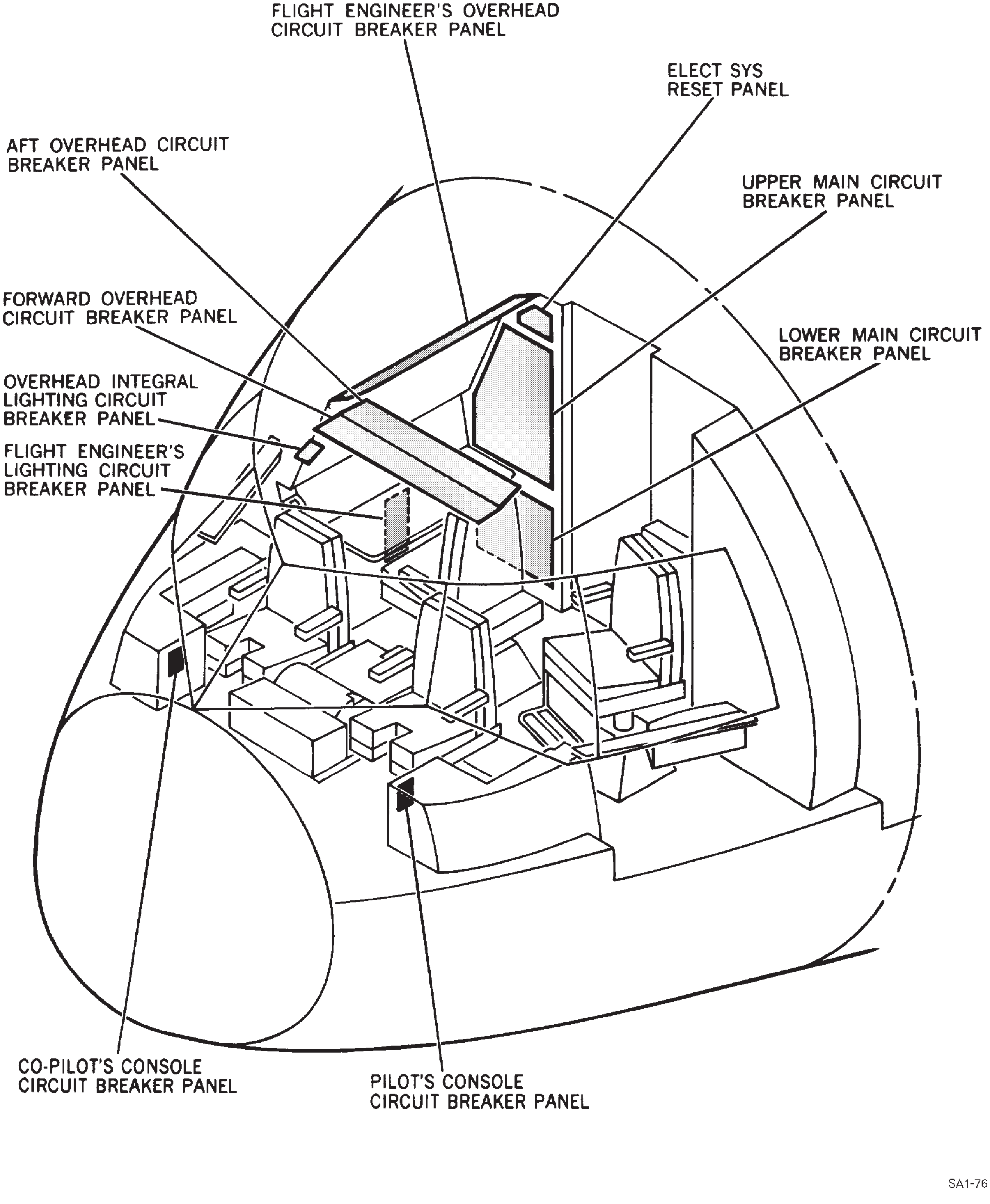


Figure 1.4-2. Circuit Breaker Panel Locations - Flight Compartment

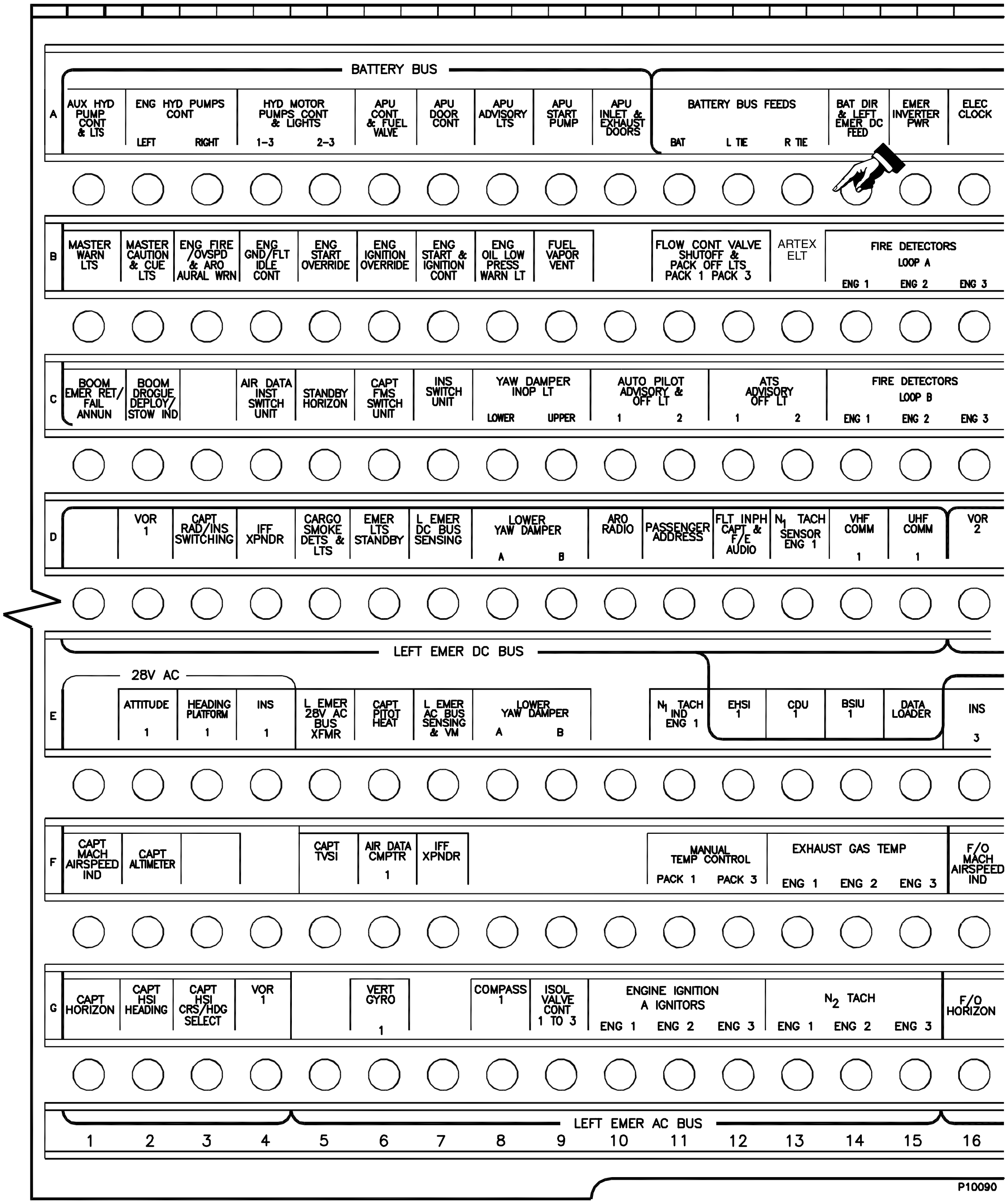


Figure 1.4-3. Forward and Aft Overhead Circuit Breaker Panels (Sheet 1)

Pages 1.4-11 and 1.4-12 are deleted.

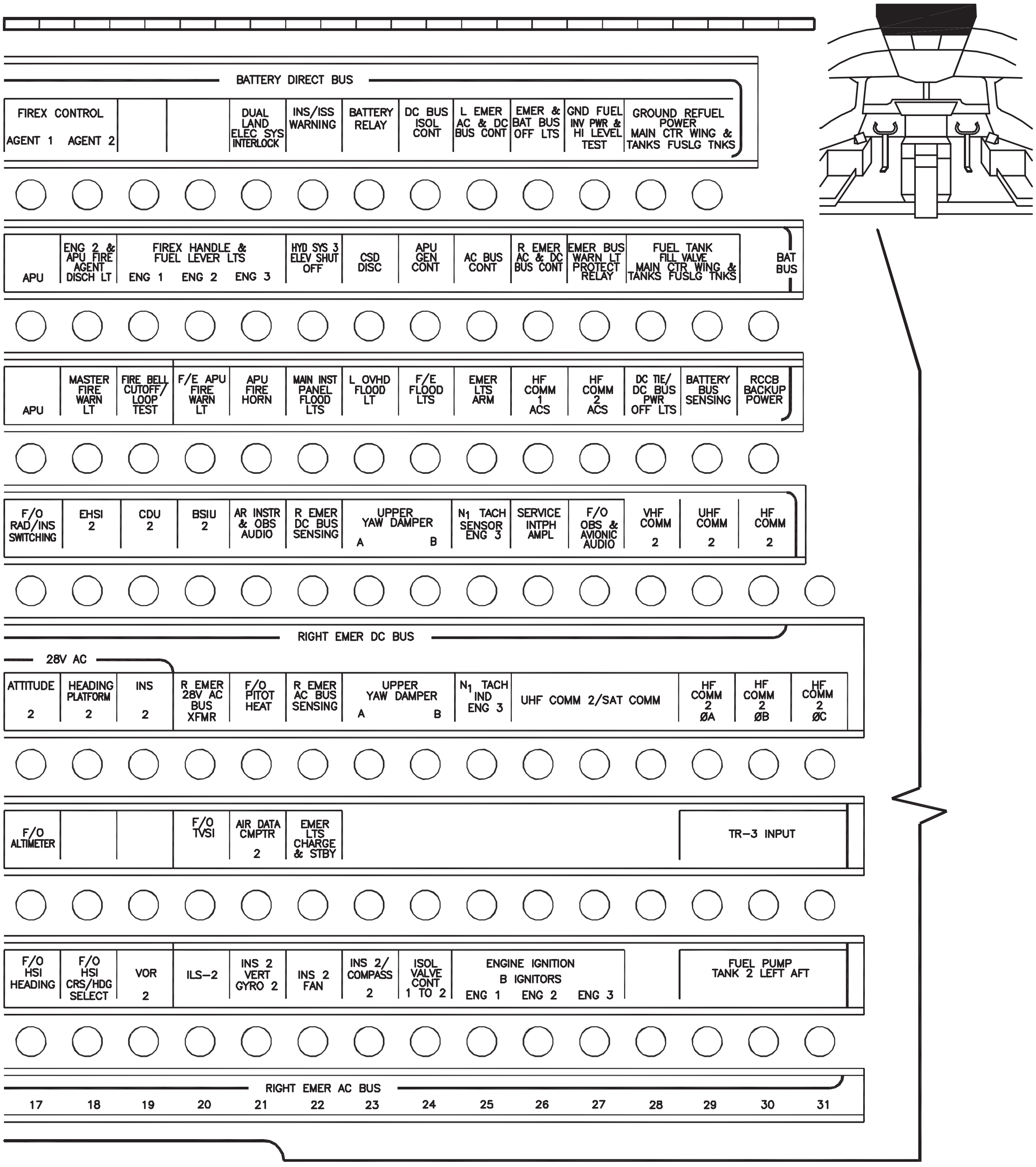


Figure 1.4-3. Forward and Aft Overhead Circuit Breaker Panels (Sheet 2)

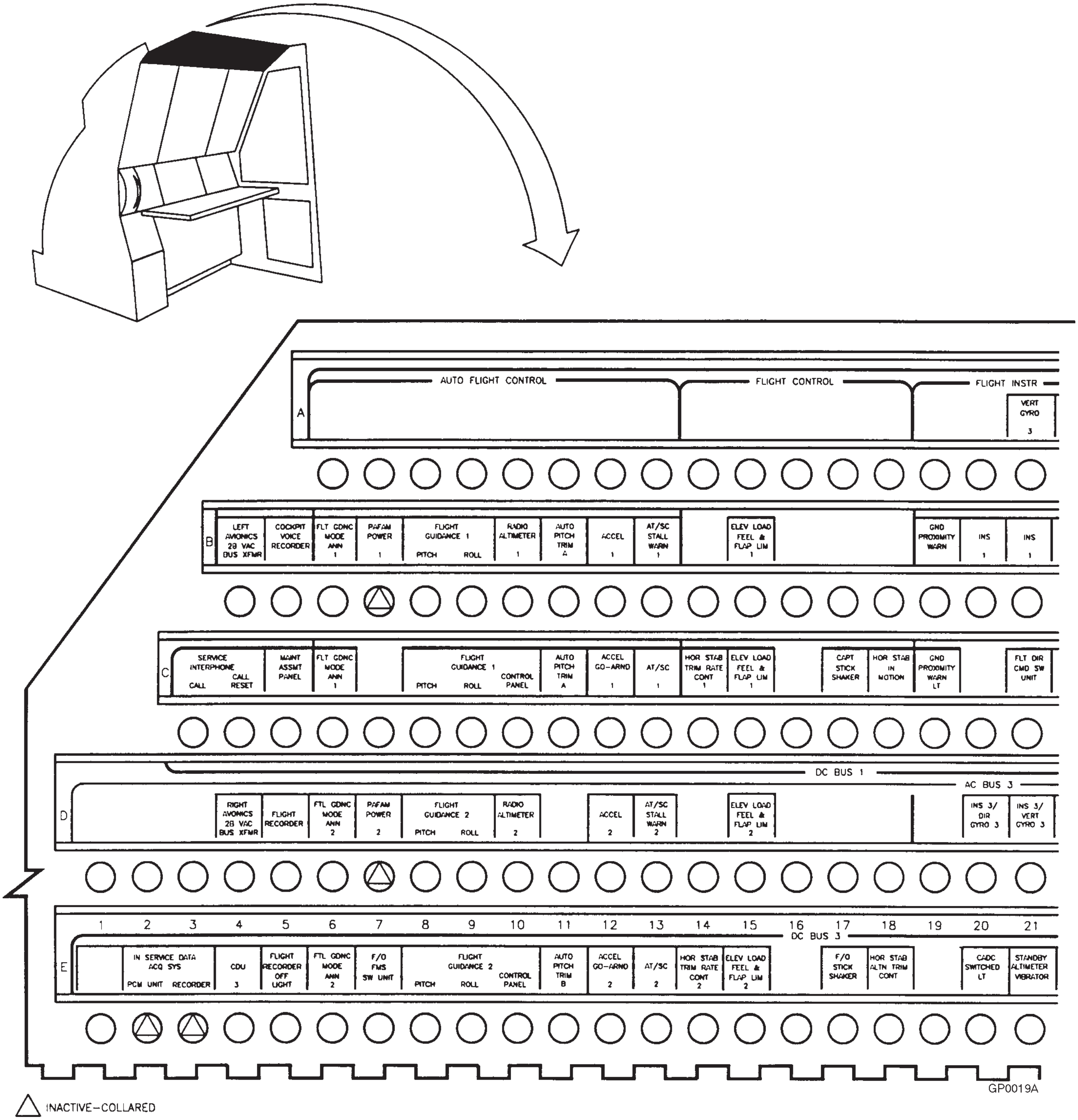
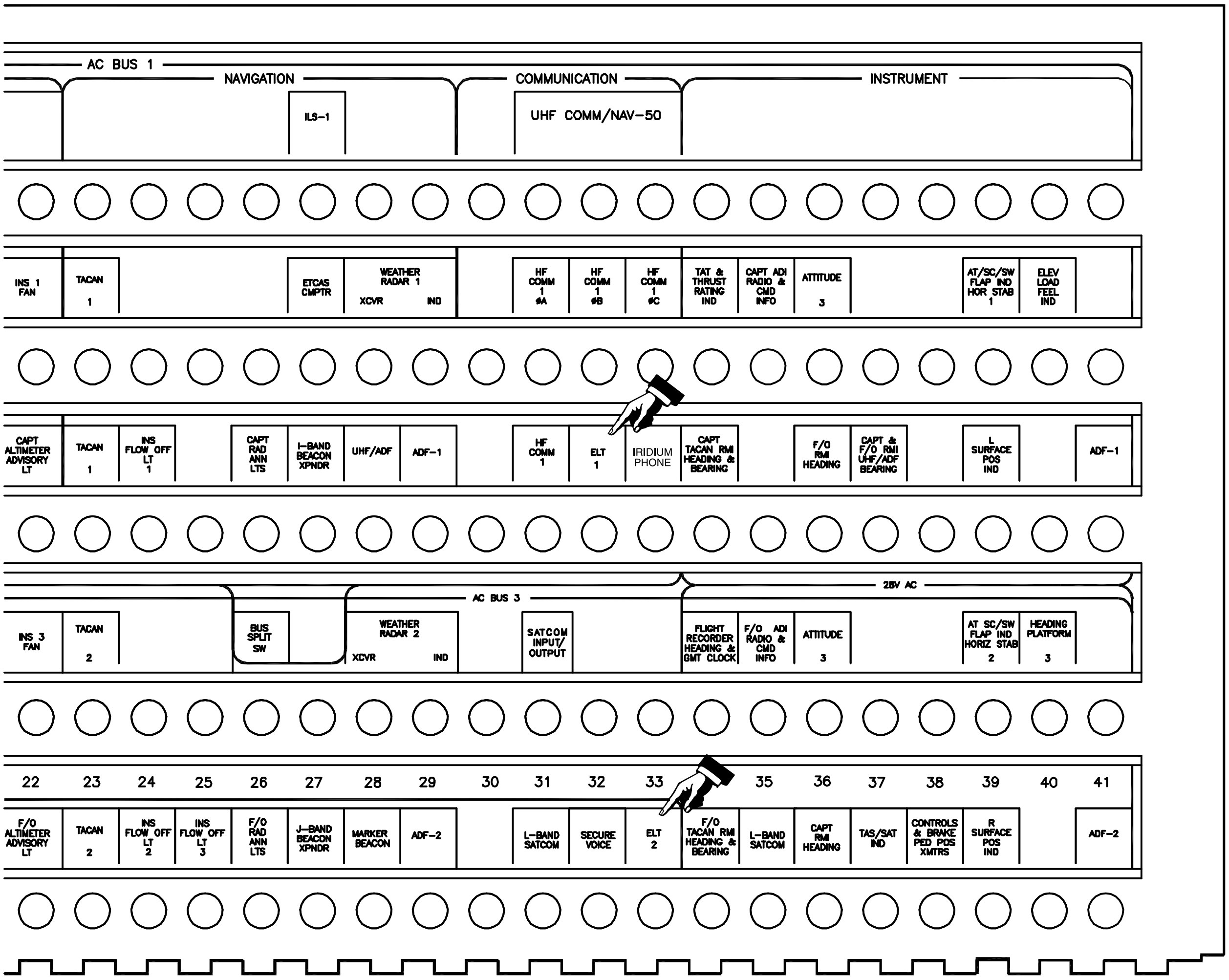


Figure 1.4-4. Flight Engineer’s Overhead Circuit Breaker Panels (Sheet 1)

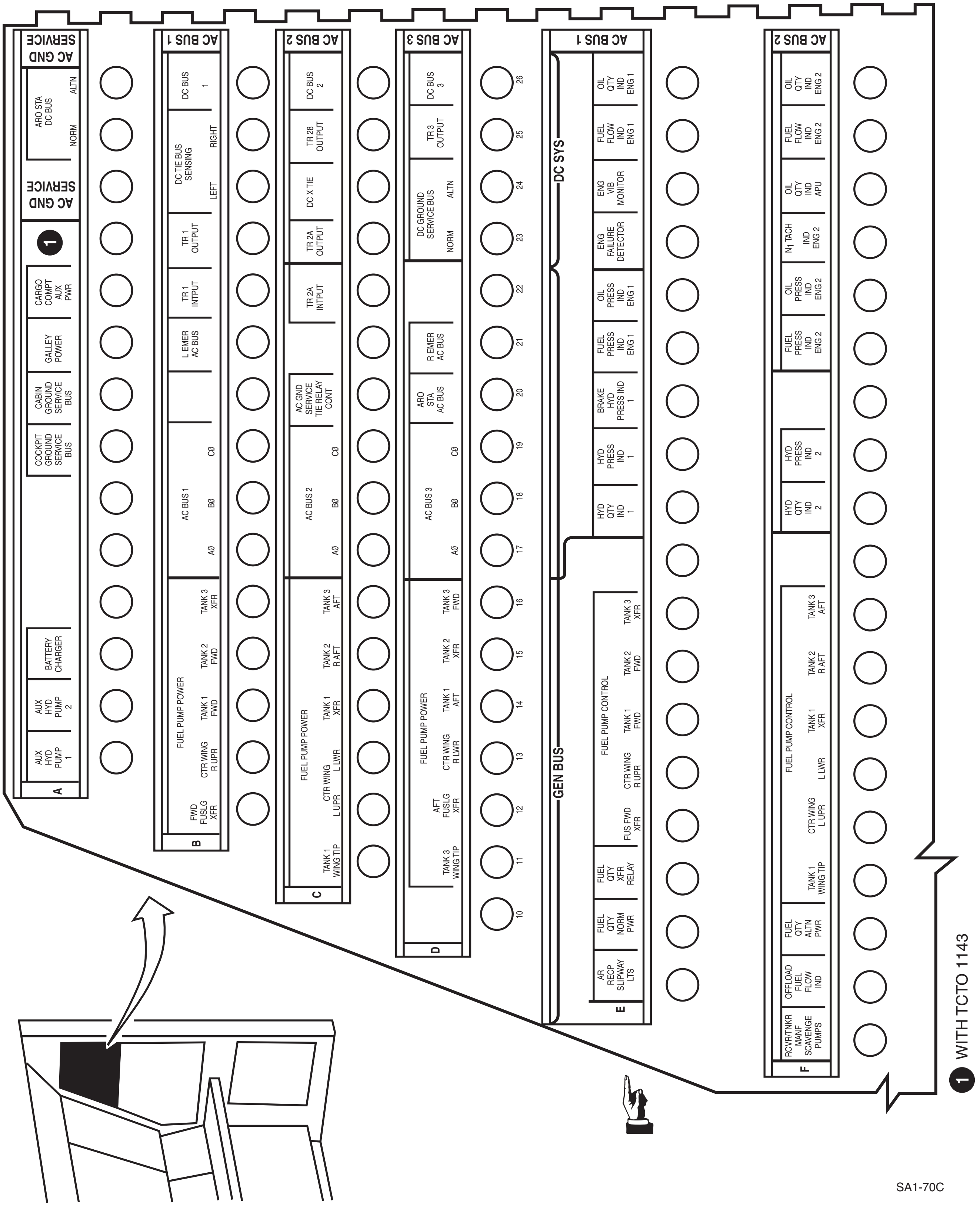


*** WITH TCTO 1C-10(K)A-1243**

P10092

Figure 1.4-4. Flight Engineer's Overhead Circuit Breaker Panels (Sheet 2)

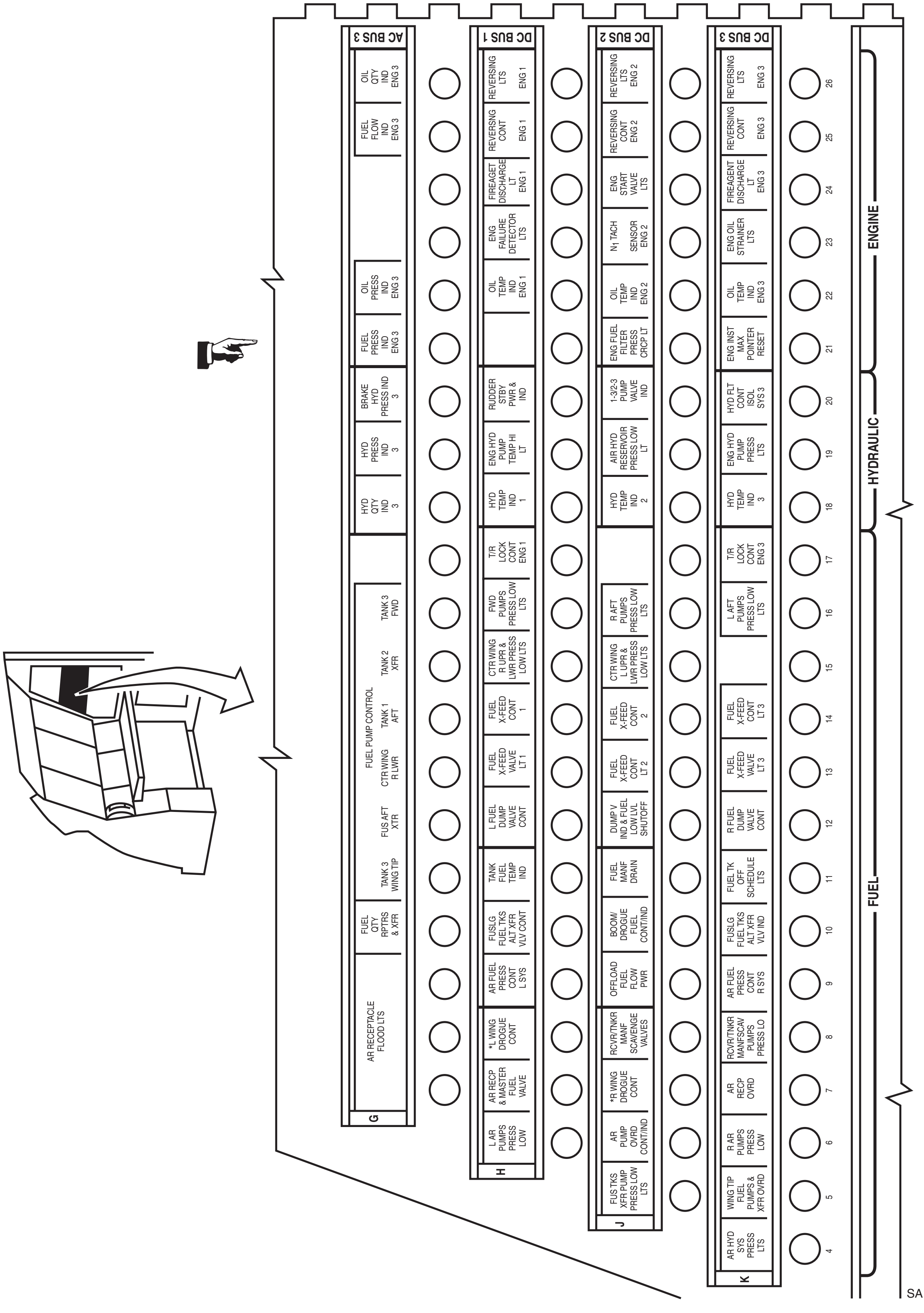
Page 1.4-16 is deleted.



① WITH TCTO 1143

SA1-70C

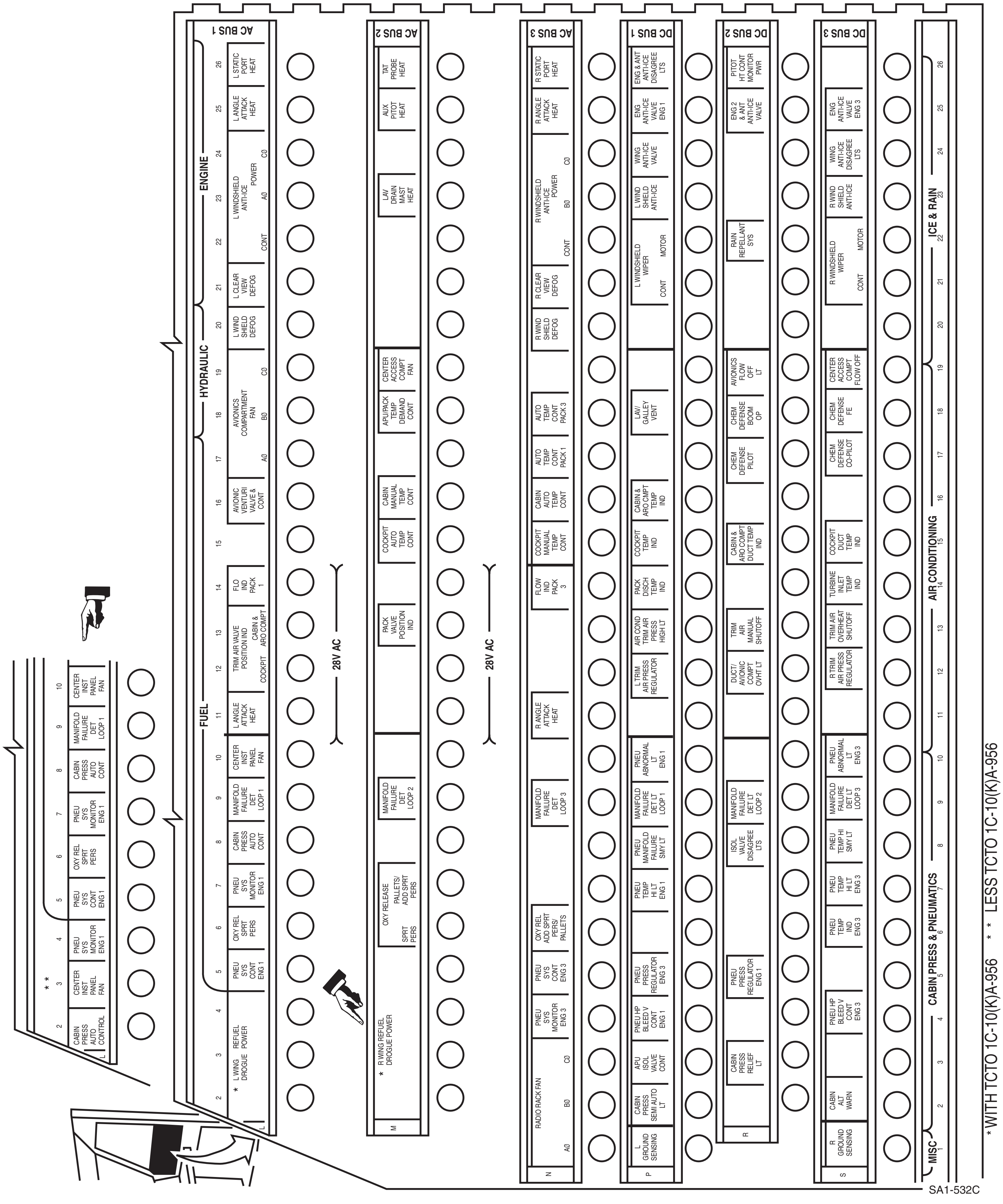
Figure 1.4-5. Flight Engineer's Upper Main Circuit Breaker Panel (Sheet 1)



*WITH TCTO 1C-10(K)A-956

SA1-533A

Figure 1.4-5. Flight Engineer's Upper Main Circuit Breaker Panel (Sheet 2)



* WITH TCTO 1C-10(K)A-956 * * LESS TCTO 1C-10(K)A-956

Figure 1.4-5. Flight Engineer's Upper Main Circuit Breaker Panel (Sheet 3)

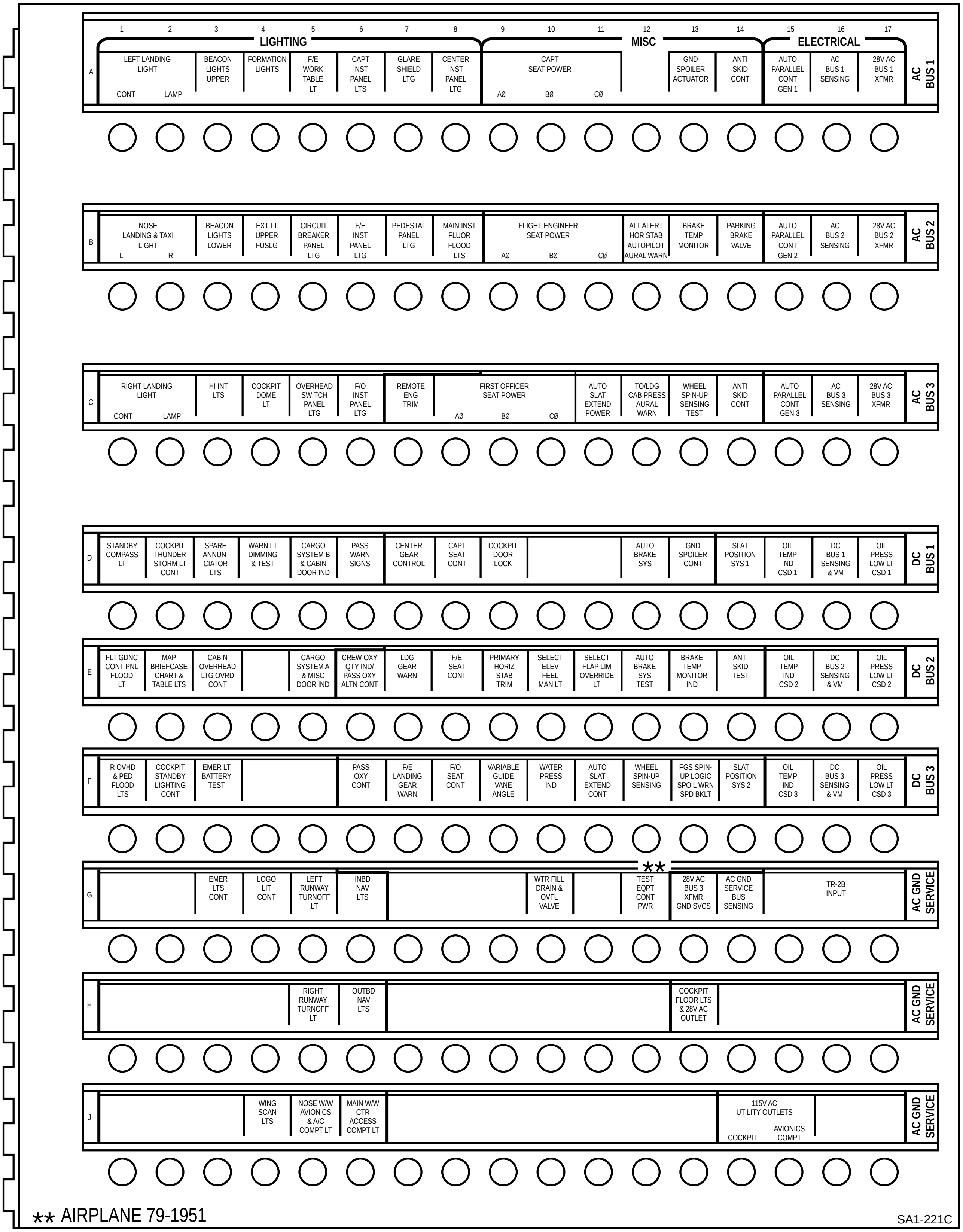


Figure 1.4-6. Flight Engineer’s Lower Main Circuit Breaker Panel

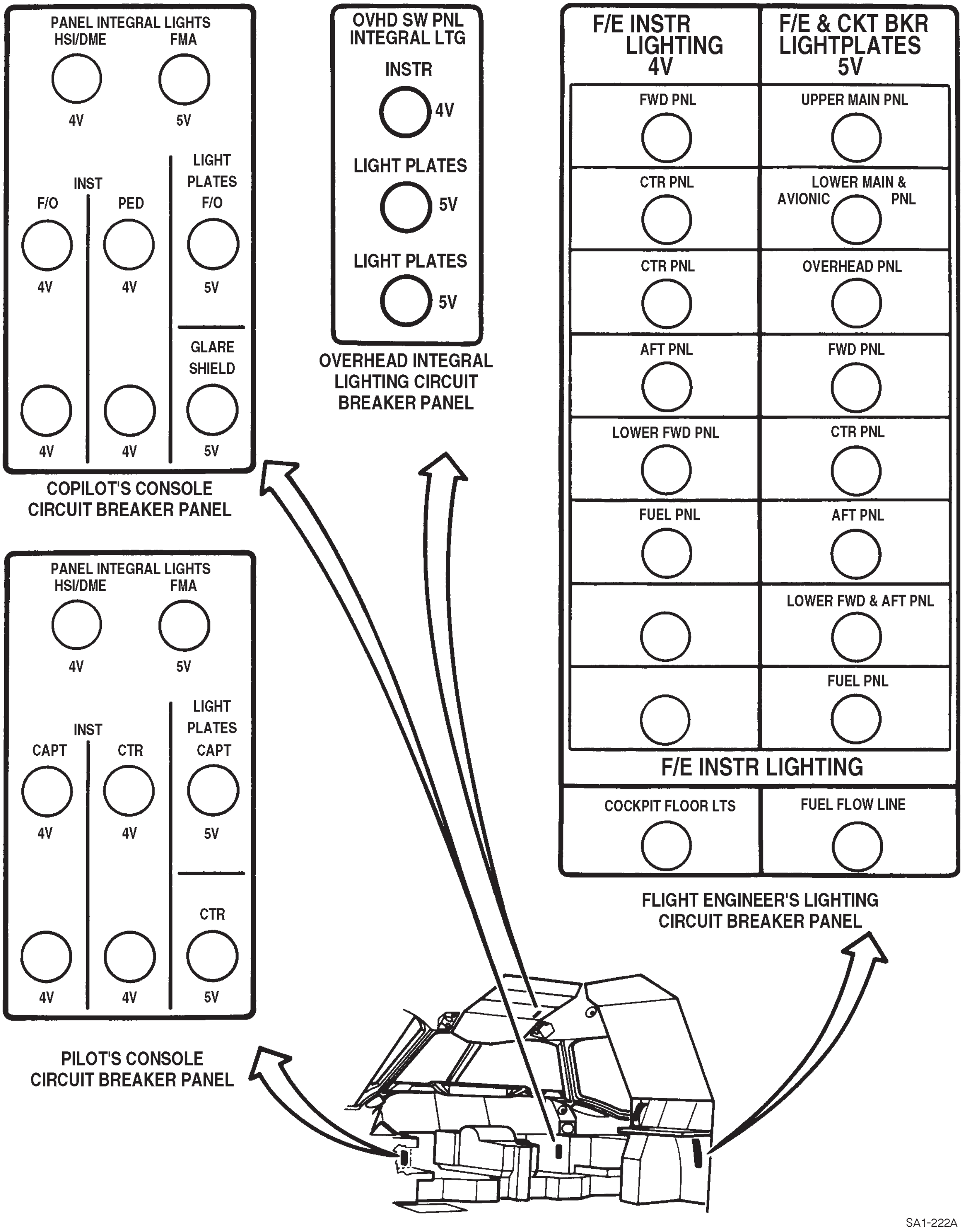
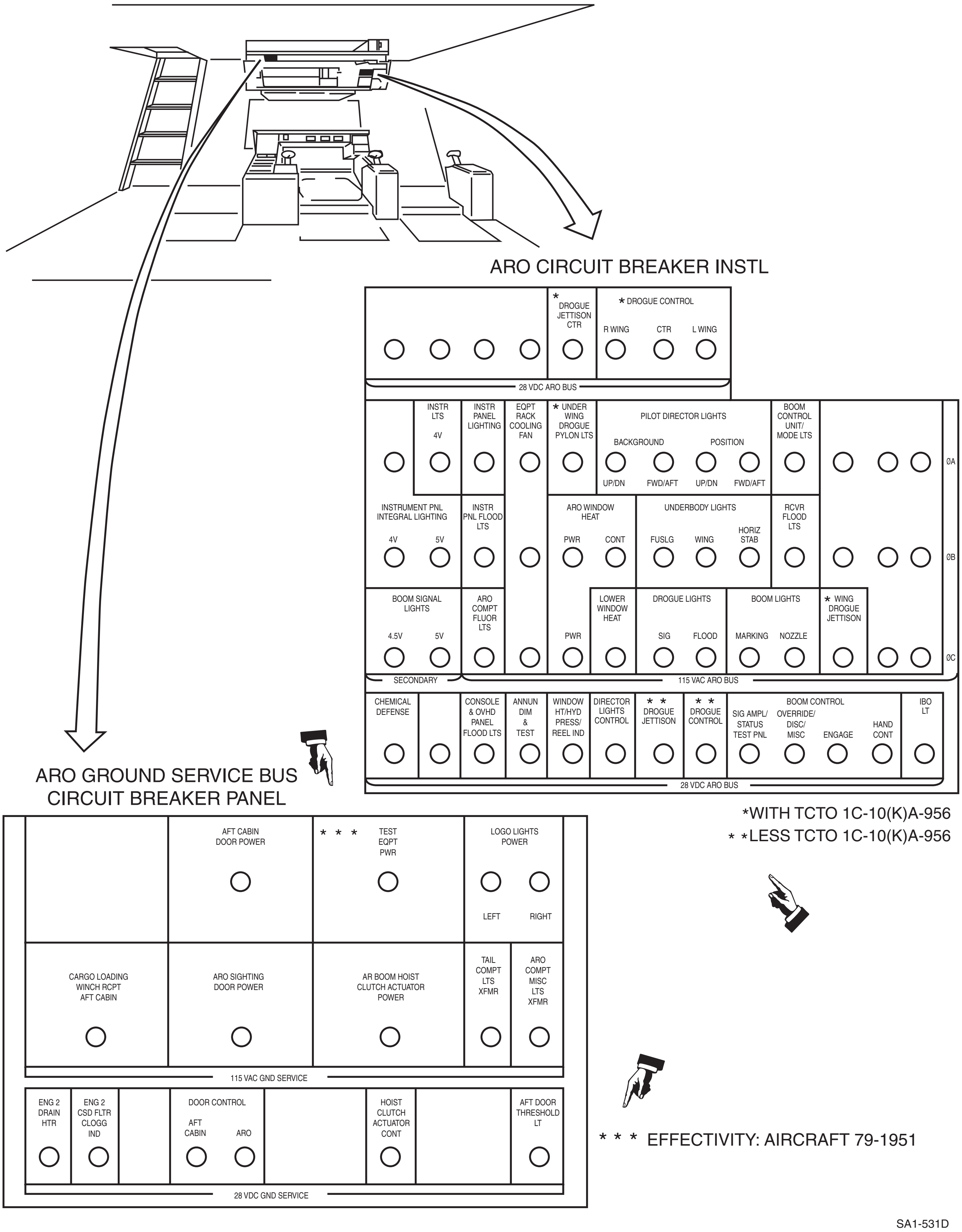


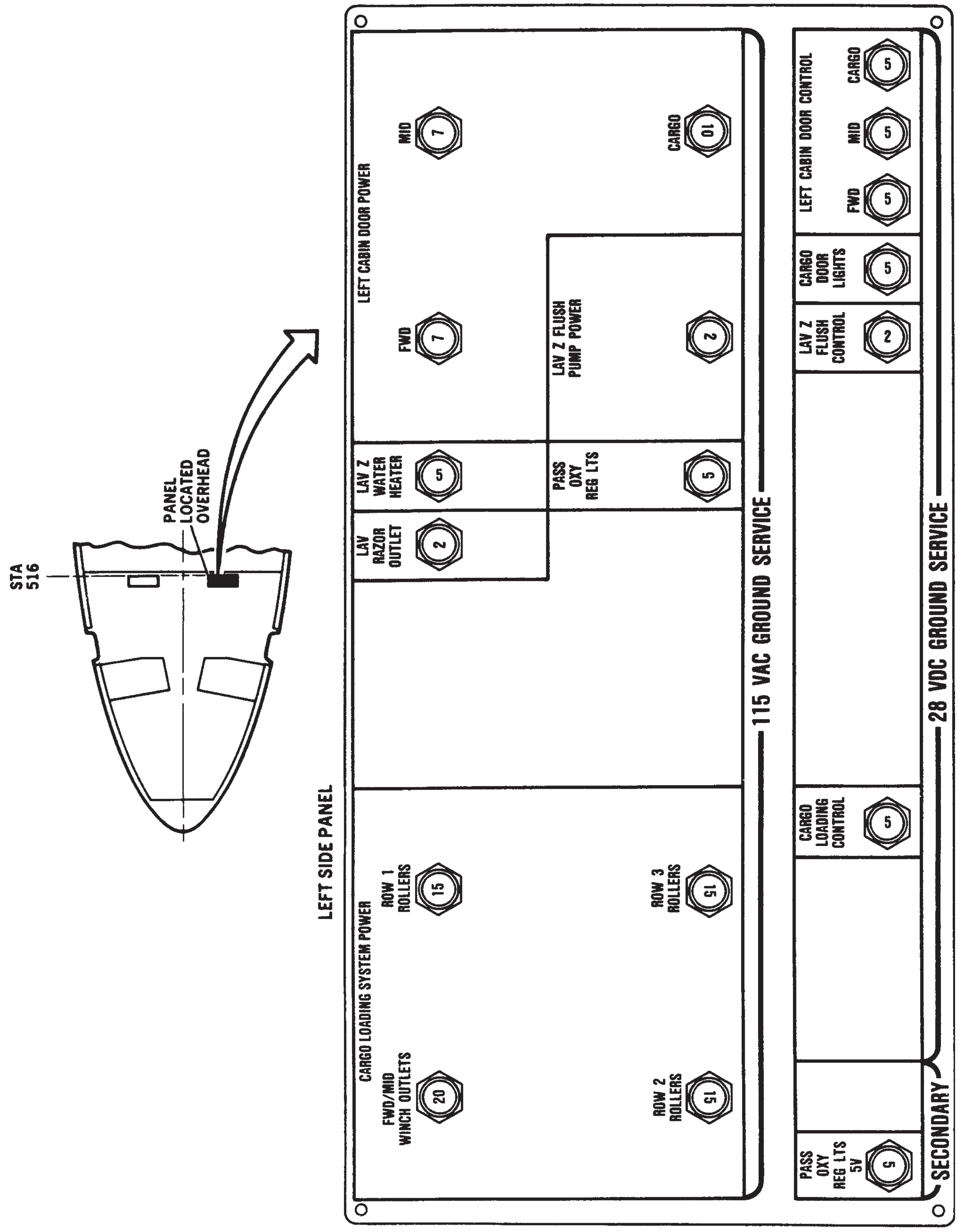
Figure 1.4-7. Miscellaneous Circuit Breaker Panels



*WITH TCTO 1C-10(K)A-956
* *LESS TCTO 1C-10(K)A-956

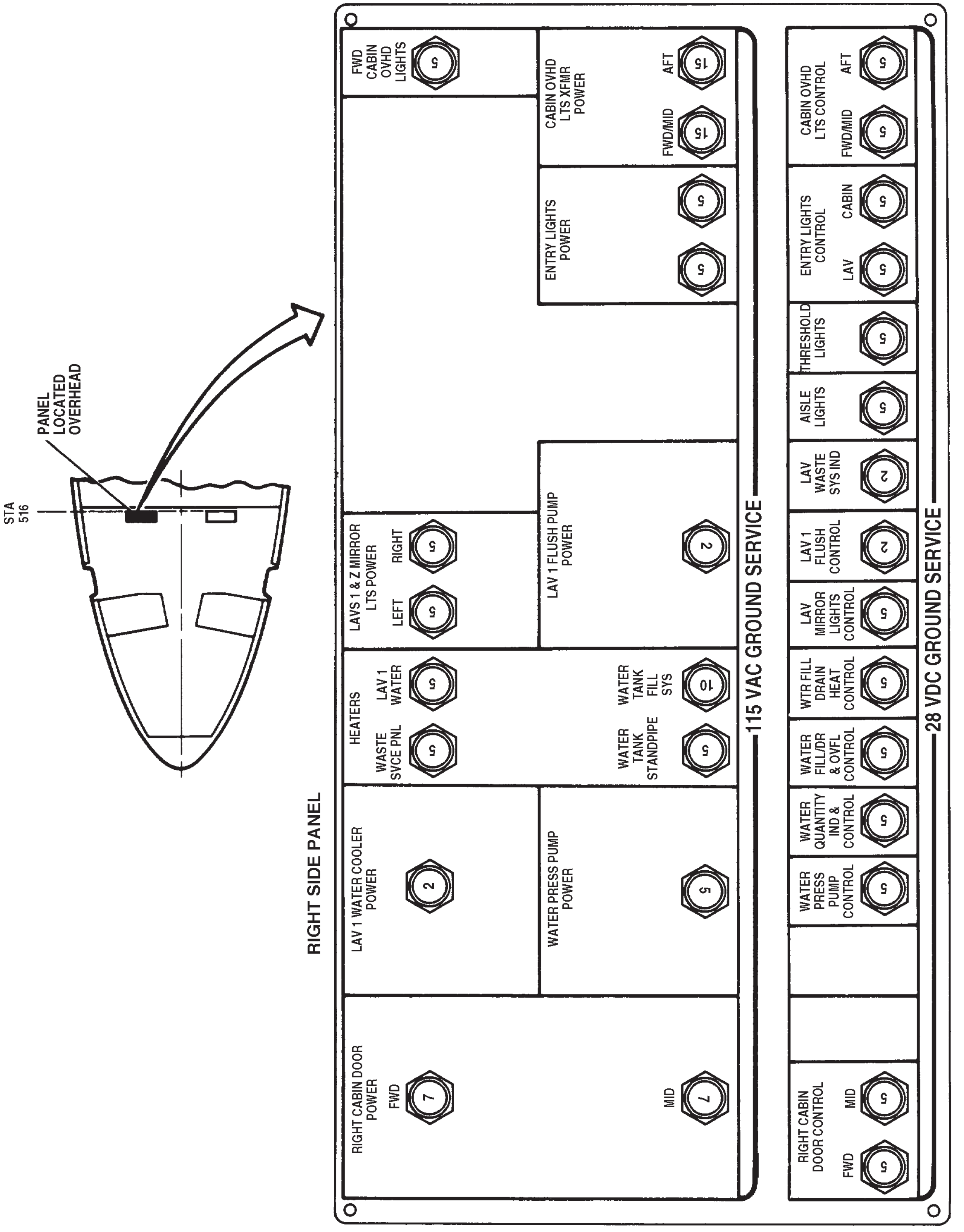
* * * EFFECTIVITY: AIRCRAFT 79-1951

Figure 1.4-8. ARO Circuit Breaker Panels



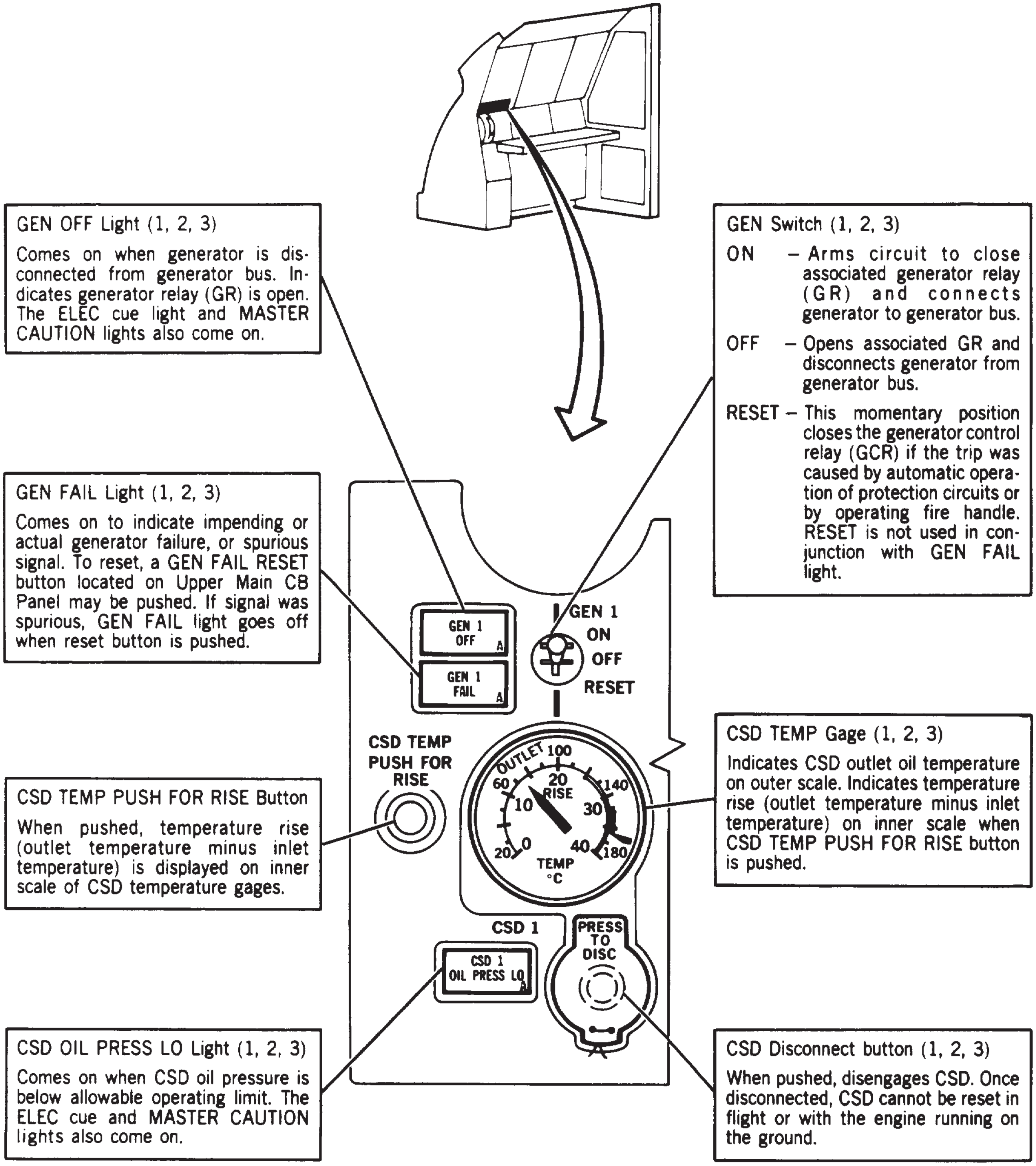
SA1-176

Figure 1.4-9. Overhead Circuit Breaker Panel, Left Side



SA1-177

Figure 1.4-10. Overhead Circuit Breaker Panel, Right Side



GEN OFF Light (1, 2, 3)

Comes on when generator is disconnected from generator bus. Indicates generator relay (GR) is open. The ELEC cue light and MASTER CAUTION lights also come on.

GEN FAIL Light (1, 2, 3)

Comes on to indicate impending or actual generator failure, or spurious signal. To reset, a GEN FAIL RESET button located on Upper Main CB Panel may be pushed. If signal was spurious, GEN FAIL light goes off when reset button is pushed.

CSD TEMP PUSH FOR RISE Button

When pushed, temperature rise (outlet temperature minus inlet temperature) is displayed on inner scale of CSD temperature gages.

CSD OIL PRESS LO Light (1, 2, 3)

Comes on when CSD oil pressure is below allowable operating limit. The ELEC cue and MASTER CAUTION lights also come on.

GEN Switch (1, 2, 3)

ON – Arms circuit to close associated generator relay (GR) and connects generator to generator bus.

OFF – Opens associated GR and disconnects generator from generator bus.

RESET – This momentary position closes the generator control relay (GCR) if the trip was caused by automatic operation of protection circuits or by operating fire handle. RESET is not used in conjunction with GEN FAIL light.

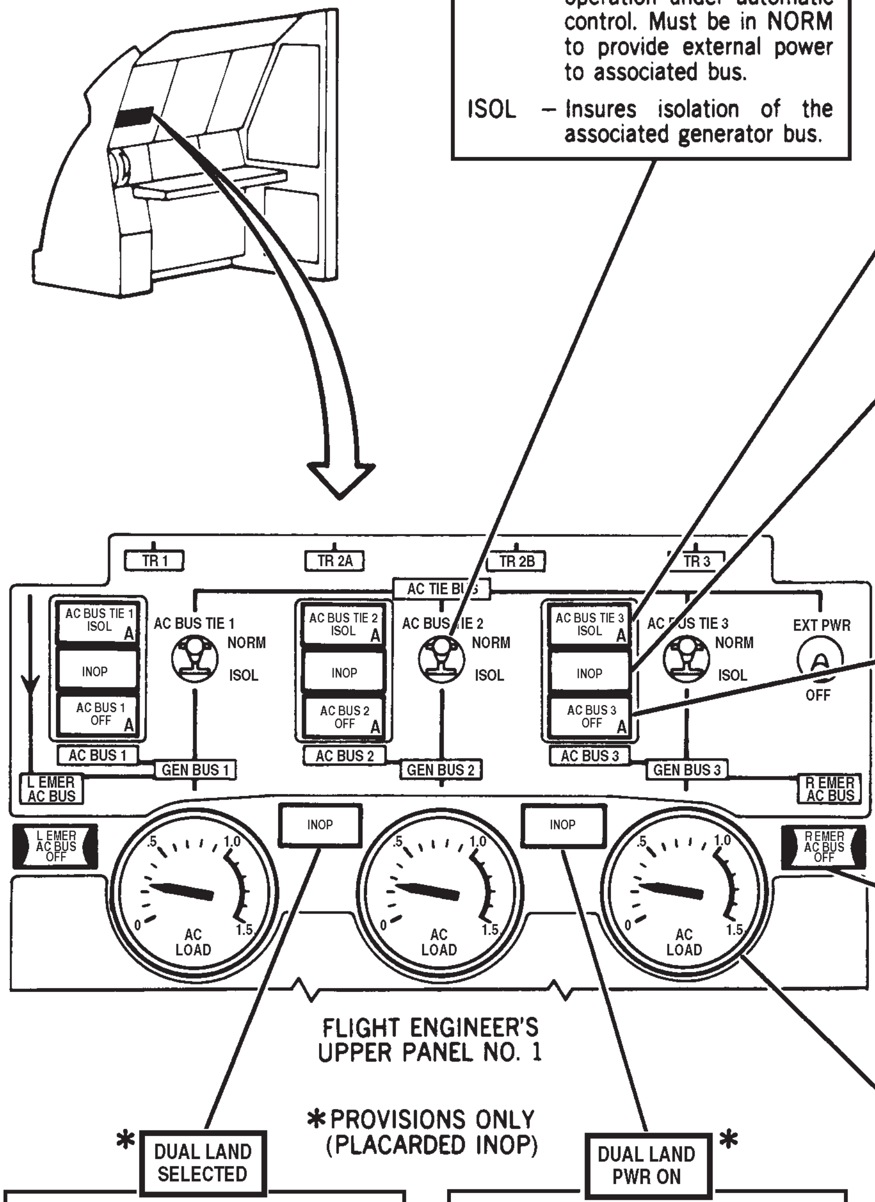
CSD TEMP Gage (1, 2, 3)

Indicates CSD outlet oil temperature on outer scale. Indicates temperature rise (outlet temperature minus inlet temperature) on inner scale when CSD TEMP PUSH FOR RISE button is pushed.

CSD Disconnect button (1, 2, 3)

When pushed, disengages CSD. Once disconnected, CSD cannot be reset in flight or with the engine running on the ground.

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 1)



AC BUS TIE Switch (1, 2, 3)

NORM – Permits paralleled, unparalleled, or isolated operation under automatic control. Must be in NORM to provide external power to associated bus.

ISOL – Insures isolation of the associated generator bus.

AC BUS TIE ISOL Light (1, 2, 3)

Comes on when associated bus tie relay is open.

AC BUS TIE ISOL Light (1, 2, 3)

Comes on when DUAL LAND mode is operative and the associated bus tie relay is open.

AC BUS TIE 3
ISOL

PLACARDED INOP

AC BUS OFF Light (1, 2, 3)

Comes on when associated AC bus is deenergized. The ELEC cue and MASTER CAUTION lights also come on.

EMER AC BUS OFF Light (L and R)

Comes on when the associated emergency ac bus is deenergized. The EMER BUS OFF summary light (on pilot's overhead panel) and the MASTER WARNING lights also come on.

AC LOAD Meter (3)

Indicates the load on the generator as compared to its rated load. Scale of .5 means generator is operating at 50% of rated load capacity.

DUAL LAND SELECTED Light

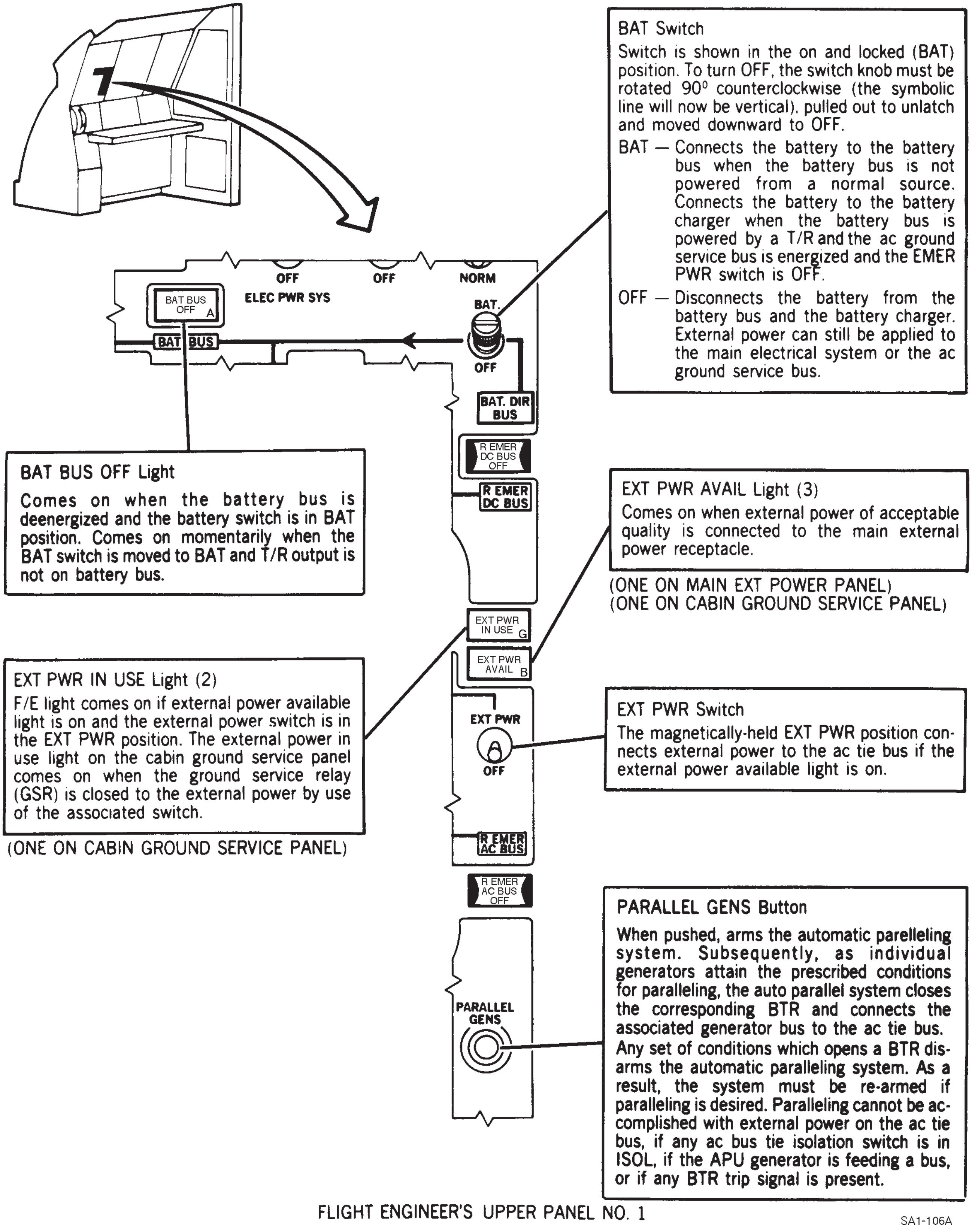
Comes on when DUAL LAND FGCS mode has been selected. Indicates the main electrical distribution system has been commanded to operate in a manner appropriate to this type of automatic landing.

DUAL LAND PWR ON Light

Comes on when DUAL LAND mode has been selected and the electrical system configuration meets the requirements for this type of automatic landing.

SA1-105A

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 2)



BAT Switch

Switch is shown in the on and locked (BAT) position. To turn OFF, the switch knob must be rotated 90° counterclockwise (the symbolic line will now be vertical), pulled out to unlatch and moved downward to OFF.

BAT — Connects the battery to the battery bus when the battery bus is not powered from a normal source. Connects the battery to the battery charger when the battery bus is powered by a T/R and the ac ground service bus is energized and the EMER PWR switch is OFF.

OFF — Disconnects the battery from the battery bus and the battery charger. External power can still be applied to the main electrical system or the ac ground service bus.

BAT BUS OFF Light

Comes on when the battery bus is deenergized and the battery switch is in BAT position. Comes on momentarily when the BAT switch is moved to BAT and T/R output is not on battery bus.

EXT PWR AVAIL Light (3)

Comes on when external power of acceptable quality is connected to the main external power receptacle.

(ONE ON MAIN EXT POWER PANEL)
(ONE ON CABIN GROUND SERVICE PANEL)

EXT PWR IN USE Light (2)

F/E light comes on if external power available light is on and the external power switch is in the EXT PWR position. The external power in use light on the cabin ground service panel comes on when the ground service relay (GSR) is closed to the external power by use of the associated switch.

(ONE ON CABIN GROUND SERVICE PANEL)

EXT PWR Switch

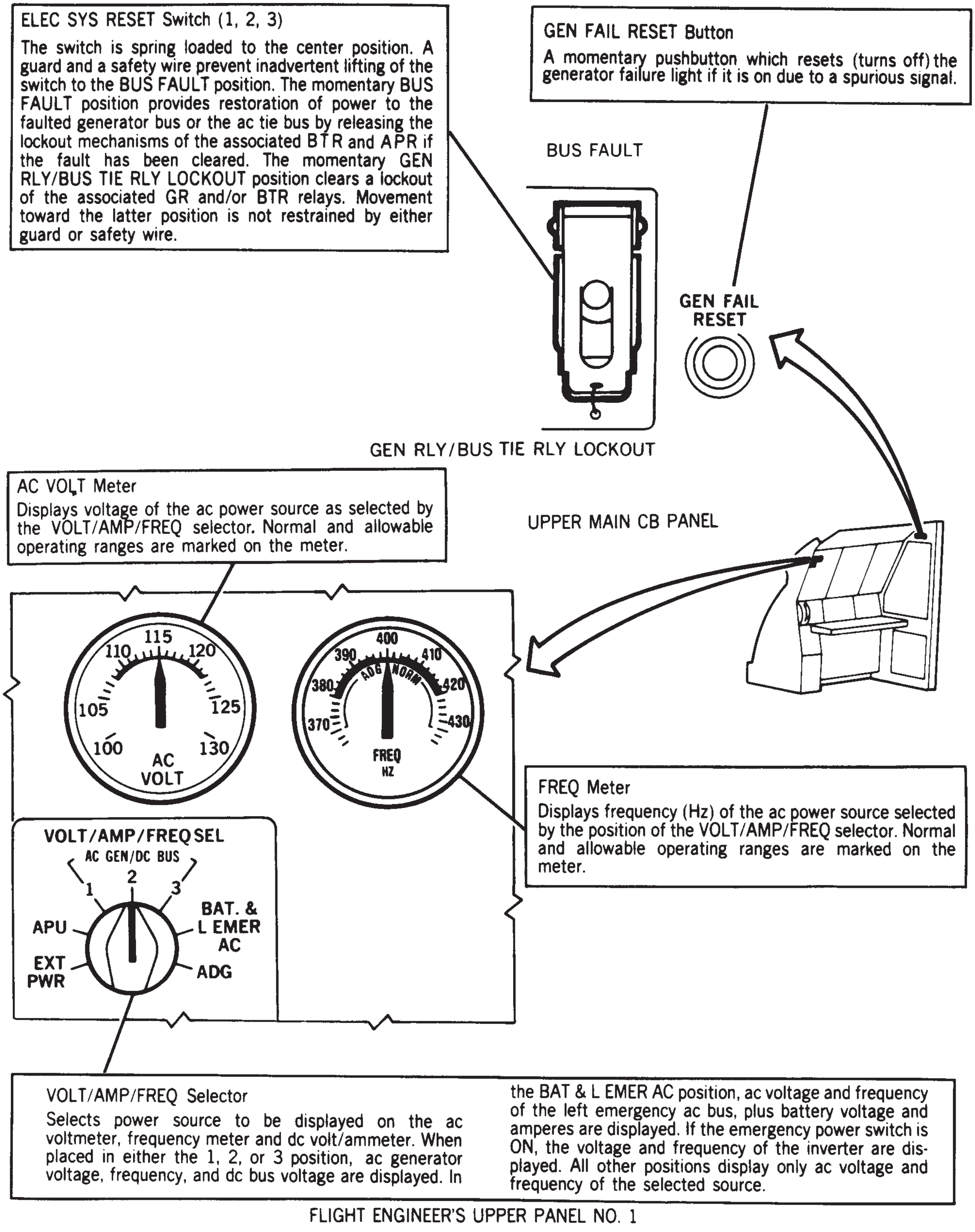
The magnetically-held EXT PWR position connects external power to the ac tie bus if the external power available light is on.

PARALLEL GENS Button

When pushed, arms the automatic parelleling system. Subsequently, as individual generators attain the prescribed conditions for paralleling, the auto parallel system closes the corresponding BTR and connects the associated generator bus to the ac tie bus. Any set of conditions which opens a BTR disarms the automatic paralleling system. As a result, the system must be re-armed if paralleling is desired. Paralleling cannot be accomplished with external power on the ac tie bus, if any ac bus tie isolation switch is in ISOL, if the APU generator is feeding a bus, or if any BTR trip signal is present.

FLIGHT ENGINEER'S UPPER PANEL NO. 1

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 3)



ELEC SYS RESET Switch (1, 2, 3)

The switch is spring loaded to the center position. A guard and a safety wire prevent inadvertent lifting of the switch to the BUS FAULT position. The momentary BUS FAULT position provides restoration of power to the faulted generator bus or the ac tie bus by releasing the lockout mechanisms of the associated BTR and APR if the fault has been cleared. The momentary GEN RLY/BUS TIE RLY LOCKOUT position clears a lockout of the associated GR and/or BTR relays. Movement toward the latter position is not restrained by either guard or safety wire.

GEN FAIL RESET Button

A momentary pushbutton which resets (turns off) the generator failure light if it is on due to a spurious signal.

AC VOLT Meter

Displays voltage of the ac power source as selected by the VOLT/AMP/FREQ selector. Normal and allowable operating ranges are marked on the meter.

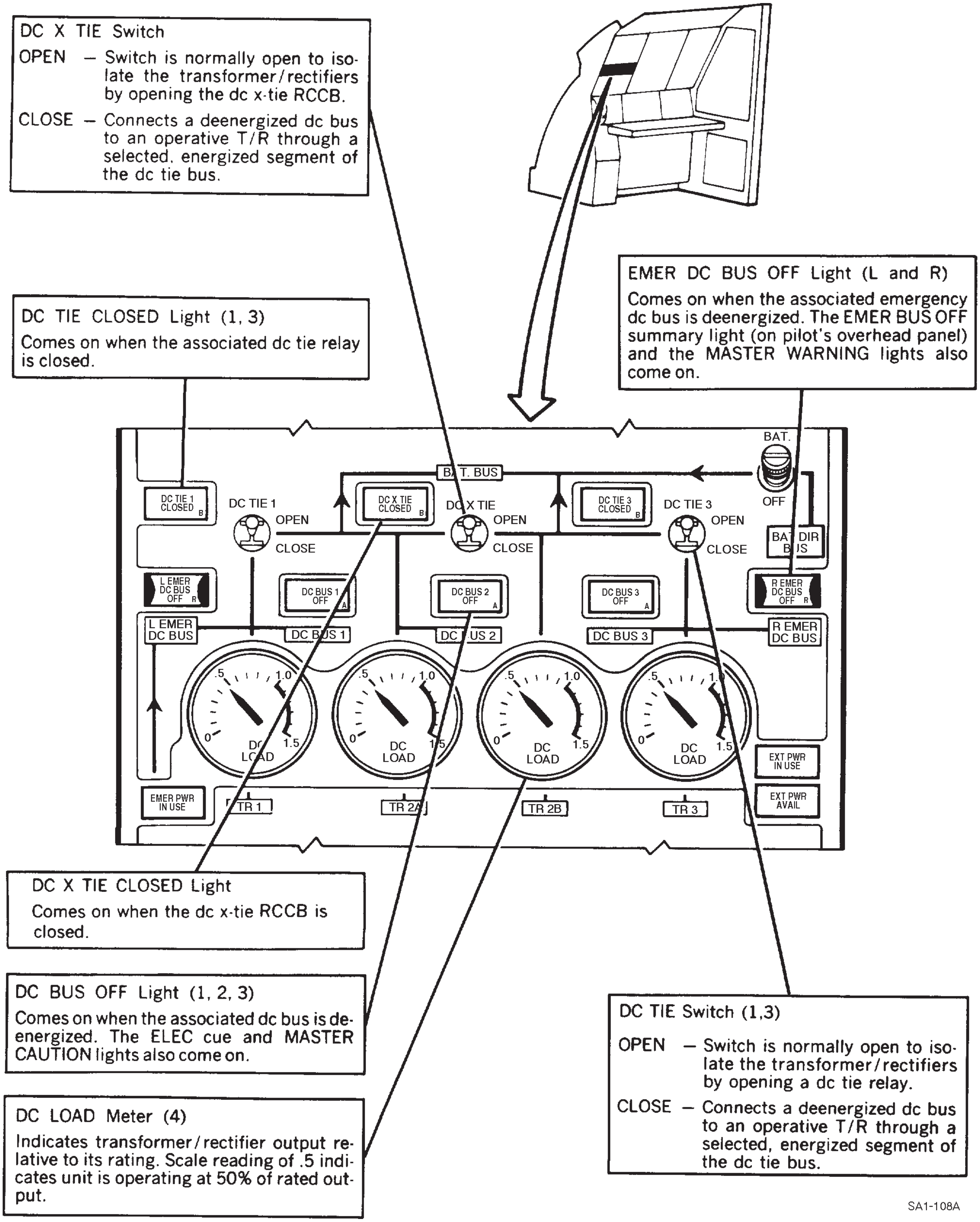
FREQ Meter

Displays frequency (Hz) of the ac power source selected by the position of the VOLT/AMP/FREQ selector. Normal and allowable operating ranges are marked on the meter.

VOLT/AMP/FREQ Selector

Selects power source to be displayed on the ac voltmeter, frequency meter and dc volt/ammeter. When placed in either the 1, 2, or 3 position, ac generator voltage, frequency, and dc bus voltage are displayed. In the BAT & L EMER AC position, ac voltage and frequency of the left emergency ac bus, plus battery voltage and amperes are displayed. If the emergency power switch is ON, the voltage and frequency of the inverter are displayed. All other positions display only ac voltage and frequency of the selected source.

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 4)



DC X TIE Switch

OPEN — Switch is normally open to isolate the transformer/rectifiers by opening the dc x-tie RCCB.

CLOSE — Connects a deenergized dc bus to an operative T/R through a selected, energized segment of the dc tie bus.

DC TIE CLOSED Light (1, 3)

Comes on when the associated dc tie relay is closed.

EMER DC BUS OFF Light (L and R)

Comes on when the associated emergency dc bus is deenergized. The EMER BUS OFF summary light (on pilot's overhead panel) and the MASTER WARNING lights also come on.

DC X TIE CLOSED Light

Comes on when the dc x-tie RCCB is closed.

DC BUS OFF Light (1, 2, 3)

Comes on when the associated dc bus is deenergized. The ELEC cue and MASTER CAUTION lights also come on.

DC LOAD Meter (4)

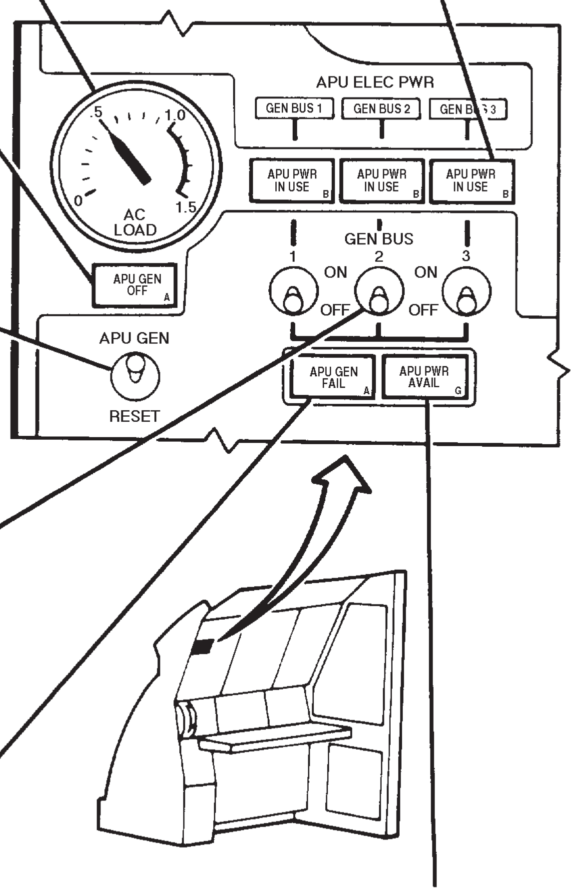
Indicates transformer/rectifier output relative to its rating. Scale reading of .5 indicates unit is operating at 50% of rated output.

DC TIE Switch (1,3)

OPEN — Switch is normally open to isolate the transformer/rectifiers by opening a dc tie relay.

CLOSE — Connects a deenergized dc bus to an operative T/R through a selected, energized segment of the dc tie bus.

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 5)



APU AC LOAD Meter

Indicates the load on the generator as compared to its rated load. Reading of .5 means that APU generator is operating at 50% of rated load.

APU GEN OFF Light

Comes on during APU start (before generator is up to speed) or whenever APU generator output does not meet specified electrical requirements and the APU is up to speed. The ELEC cue and MASTER CAUTION lights also come on, except during start sequence. Whenever the APU PWR AVAIL light is on, the APU GEN OFF light is off.

APU GEN RESET Switch

In APU GEN position, the APU generator control (field) relay (GCR) is normally closed. If the GCR is tripped by a protective circuit or by manual operation of the APU fire control switch, the GCR can be closed by utilizing the momentary RESET position (provided the fault has been cleared and the APU fire control switch is at NORM).

APU GEN BUS Switch (1, 2, 3)

ON — Closes the associated auxiliary power relay (APR) and puts the APU on the bus if the bus is not already powered by the associated engine-driven generator. The APU has priority over external power.

OFF — Disconnects APU from the generator bus.

APU GEN FAIL Light

Comes on to indicate actual or impending APU generator failure or spurious signal. To reset, a generator failure reset button, located on the Upper Main CB Panel, may be pushed. If signal was spurious, generator failure light goes off.

APU PWR IN USE Light (4)

Comes on when APU PWR AVAIL light is on , the APU GEN BUS switch is ON, and the electrical system mode has specified an APU priority (APR is closed). The APU PWR IN USE light on the cabin ground service panel comes on when the APU generator supplies the ground service bus thru the ground service relay (GSR).

(ONE ON CABIN GROUND SERVICE PANEL)

APU PWR AVAIL Light (2)

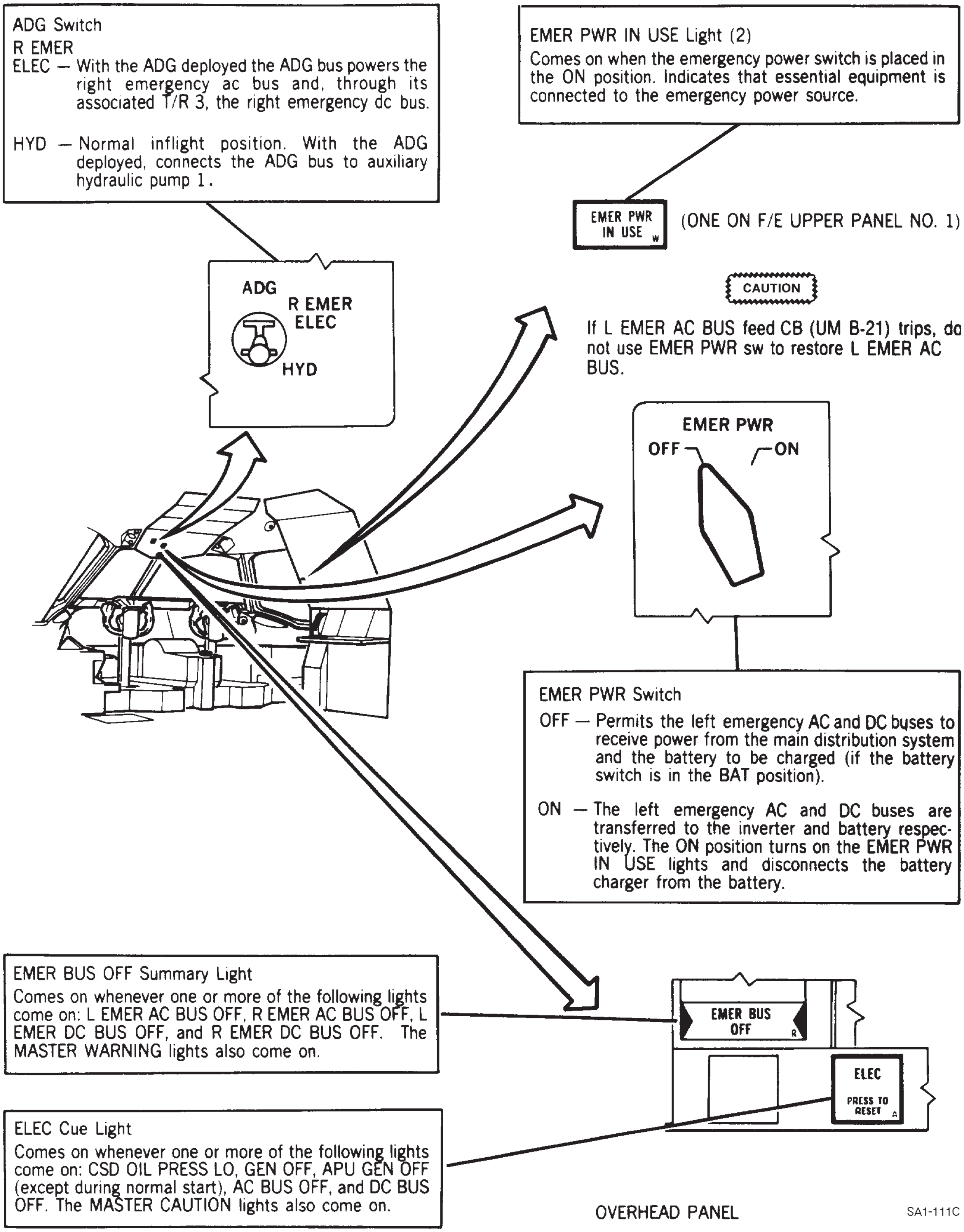
Comes on whenever APU generator is providing power of correct phase rotation, voltage, and frequency.

(ONE ON CABIN GROUND SERVICE PANEL)

FLIGHT ENGINEER'S UPPER PANEL NO. 1

SA1-110A

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 6)



ADG Switch

R EMER
ELEC — With the ADG deployed the ADG bus powers the right emergency ac bus and, through its associated T/R 3, the right emergency dc bus.

HYD — Normal inflight position. With the ADG deployed, connects the ADG bus to auxiliary hydraulic pump 1.

EMER PWR IN USE Light (2)

Comes on when the emergency power switch is placed in the ON position. Indicates that essential equipment is connected to the emergency power source.

(ONE ON F/E UPPER PANEL NO. 1)

CAUTION

If L EMER AC BUS feed CB (UM B-21) trips, do not use EMER PWR sw to restore L EMER AC BUS.

EMER PWR Switch

OFF — Permits the left emergency AC and DC buses to receive power from the main distribution system and the battery to be charged (if the battery switch is in the BAT position).

ON — The left emergency AC and DC buses are transferred to the inverter and battery respectively. The ON position turns on the EMER PWR IN USE lights and disconnects the battery charger from the battery.

EMER BUS OFF Summary Light

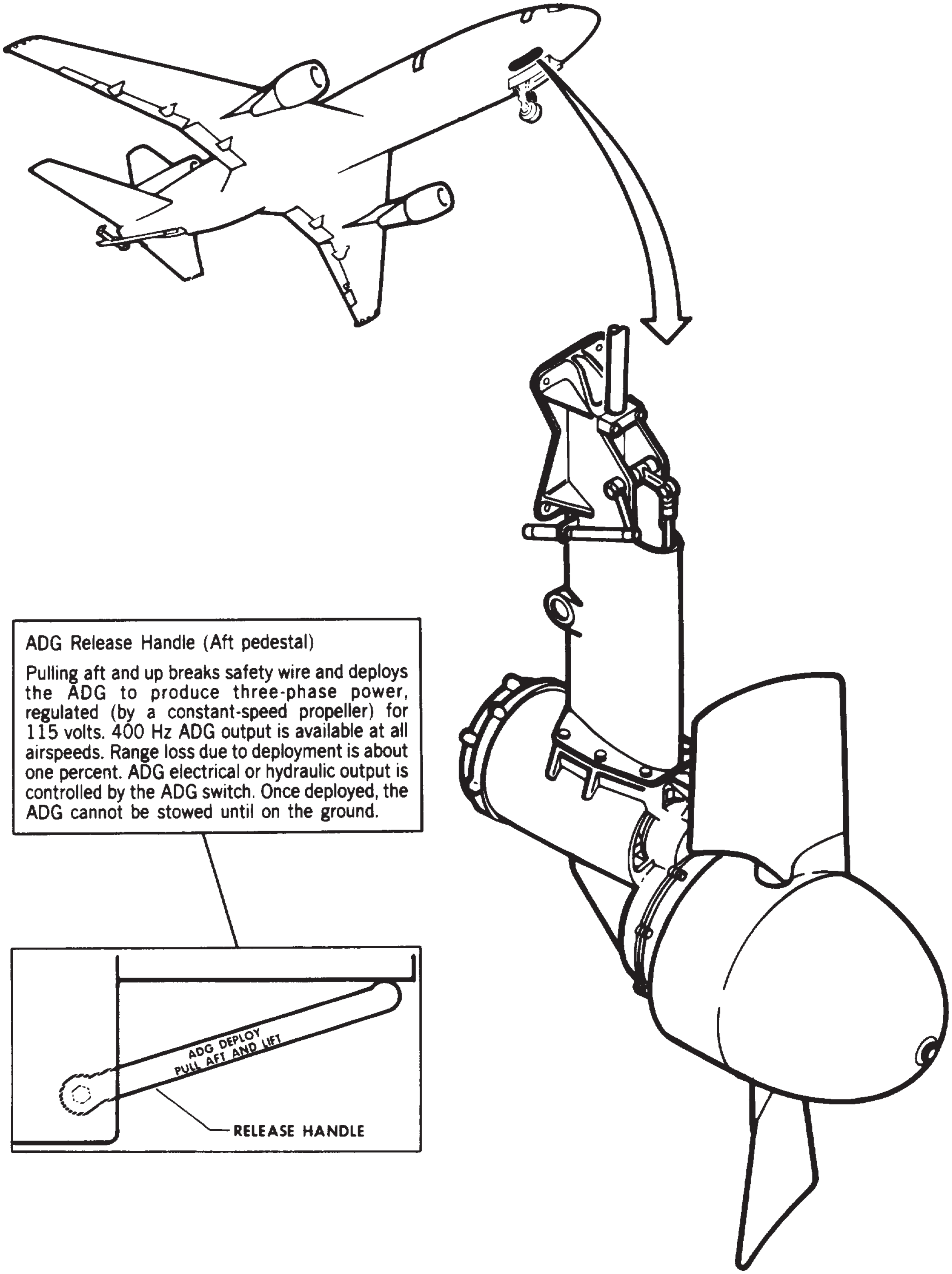
Comes on whenever one or more of the following lights come on: L EMER AC BUS OFF, R EMER AC BUS OFF, L EMER DC BUS OFF, and R EMER DC BUS OFF. The MASTER WARNING lights also come on.

ELEC Cue Light

Comes on whenever one or more of the following lights come on: CSD OIL PRESS LO, GEN OFF, APU GEN OFF (except during normal start), AC BUS OFF, and DC BUS OFF. The MASTER CAUTION lights also come on.

OVERHEAD PANEL

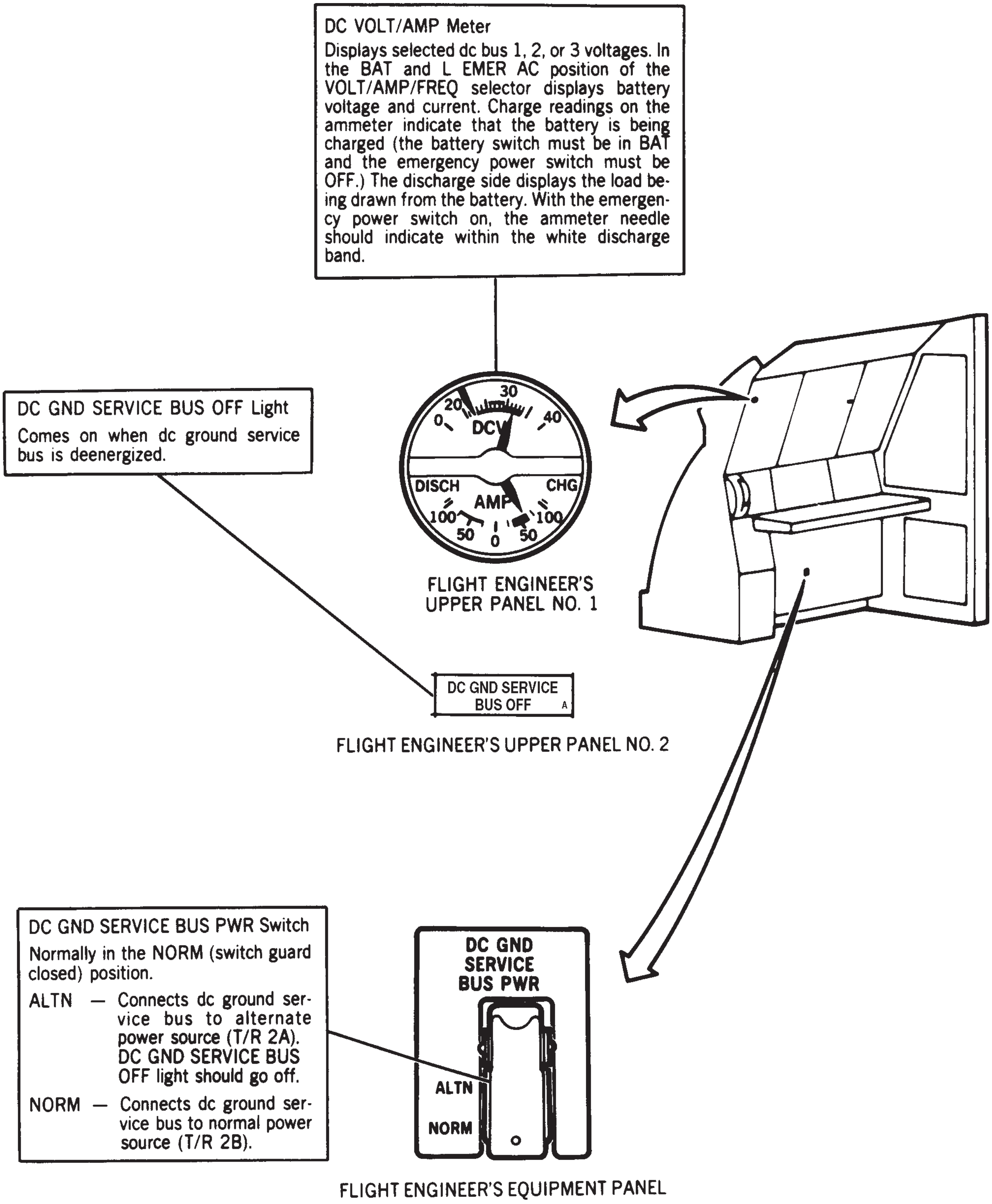
Figure 1.4-11. Electrical System Controls and Indicators (Sheet 7)



ADG Release Handle (Aft pedestal)

Pulling aft and up breaks safety wire and deploys the ADG to produce three-phase power, regulated (by a constant-speed propeller) for 115 volts. 400 Hz ADG output is available at all airspeeds. Range loss due to deployment is about one percent. ADG electrical or hydraulic output is controlled by the ADG switch. Once deployed, the ADG cannot be stowed until on the ground.

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 8)



DC VOLT/AMP Meter

Displays selected dc bus 1, 2, or 3 voltages. In the BAT and L EMER AC position of the VOLT/AMP/FREQ selector displays battery voltage and current. Charge readings on the ammeter indicate that the battery is being charged (the battery switch must be in BAT and the emergency power switch must be OFF.) The discharge side displays the load being drawn from the battery. With the emergency power switch on, the ammeter needle should indicate within the white discharge band.

DC GND SERVICE BUS OFF Light

Comes on when dc ground service bus is deenergized.

DC GND SERVICE BUS PWR Switch

Normally in the NORM (switch guard closed) position.

ALTN — Connects dc ground service bus to alternate power source (T/R 2A). DC GND SERVICE BUS OFF light should go off.

NORM — Connects dc ground service bus to normal power source (T/R 2B).

Figure 1.4-11. Electrical System Controls and Indicators (Sheet 9)

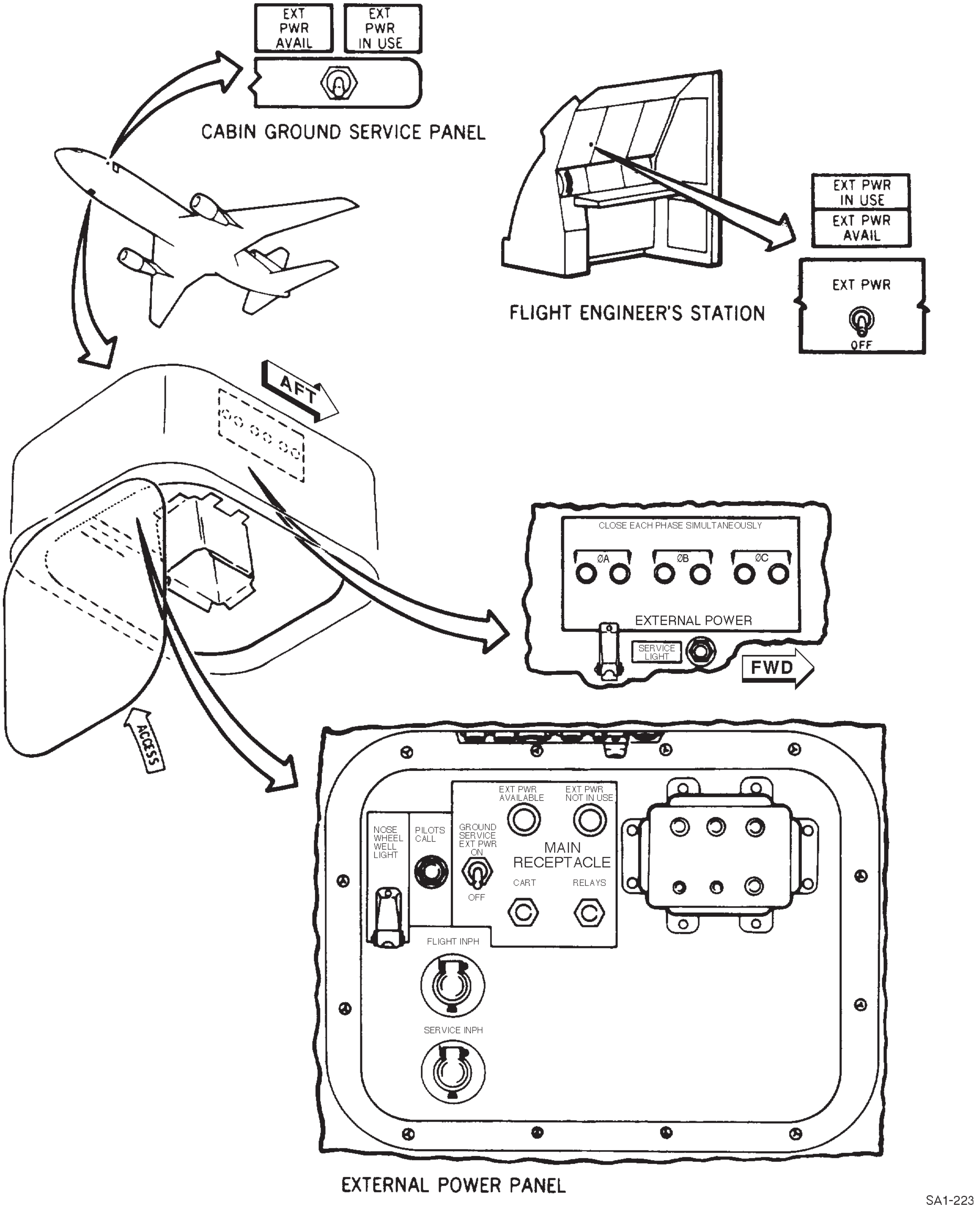


Figure 1.4-11. Electrical System Controls and Indicators (Sheet 10)

Power for lower current, non-centrally located loads and essential loads is supplied through the three main AC buses, ARO AC buses, remote ground service buses, and the two AC emergency buses. Radio and instrument buses supply their respective component loads. The AC ground service bus also provides power to those components essential to ground servicing operations. Energizing the total normal distribution system, when the total system is not required, is thus avoided.

Protective circuitry is provided to automatically isolate faults. Additionally, when no other source is available and just one engine-driven generator is operating, all buses are automatically connected to that source.

DC ELECTRICAL SYSTEM

DC Generating System

Four transformer/rectifiers (TR's) are the primary source of DC power. The battery and/or the ADG (through TR 3) may be used as emergency DC power sources.

A battery charger keeps the battery fully charged when the AC ground service bus is powered, the battery bus is powered by a TR, and the battery switch is in BAT. Sensors in the battery provide protection and control for the charger.

DC Distribution System

Similar to the AC system, three counterpart DC channels, originating in TR's 1, 2A, and 3 (powered by the APU generator, the external power source, or an engine generator via generator buses 1, 2 and the right emergency AC bus), energize their associated DC buses. A fourth DC channel, normally originating in TR 2B (powered from the AC ground service bus by either the APU, the external power source, or AC generator bus 2), energizes the DC ground service bus. TR 2A can be manually selected as an alternate power source for the DC ground service bus. Normally the battery bus is powered from TR's 2A and 2B. Emergency DC power is available to the right emergency DC bus from the ADG through TR 3. Emergency DC power is available to the left emergency DC bus and the battery bus from the battery. Unlike the AC system, the DC buses are electrically isolated. Two or more DC buses can be operated in parallel, if required, via the DC tie bus by closing the appropriate DC tie switches. The battery direct bus is powered at all times, regardless of battery switch position.

CONTROLS AND INDICATORS

Controls and indicators (figure 1.4-11) required to operate and monitor the electrical systems are on the Flight Engineer's Upper Panel No. 1 and on the Pilot's Overhead Panel and Glareshield. Illustrations of the major panels are in Section I, Part 1. Individual controls, circuit breakers, and indicators are illustrated and described in this part.

ARO COMPARTMENT

Generator bus 3 is the normal power source for the ARO AC bus. TR-3 is the normal power source for the ARO DC bus.

TR-1 provides backup power automatically in flight. Refer to Section I, Part 15, for the Boom Operator's controls, indicators, and circuit breakers.

KC-10A POWER SOURCES

BATTERY DIRECT BUS

ELECTRICAL
- BATTERY BUS FEEDS (BAT,L TIE, R TIE)
- BATTERY DIR & L EMER DC FEED
- BATTERY RELAY
- DC BUS ISOL CONT
- EMER & BAT BUS OFF LTS
- EMER INVERTER POWER
- L EMER AC & DC BUS CONT

FIRE CONTROL
- FIREX CONTROL (AGENT 1,2)

FLT GUIDANCE/AUTOTHROTTLES
- DUAL LAND ELEC SYS INTERLOCK

FUEL
- GRD FUEL INV PWR & HI LEVEL TEST
- GRD REFUEL POWER
  (MAIN, CTR WING, FUSLG TANKS)

IFF

INSTRUMENTS
- ELEC CLOCK
- INS/ISS WARNING

BATTERY BUS

APU
- APU ADVISORY LIGHTS
- APU CONT & FUEL VALVE
- APU DOOR CONT
- APU GEN CONT
- APU INLET & EXHAUST DOORS
- APU START PUMP

BOOM/DROGUE
- BOOM DROGUE DEPLOY/STOW IND
- BOOM EMER RET/FAIL ANNUN

ELECTRICAL
- AC BUS CONT
- BATTERY BUS SENSING
- CSD DISC
- DC TIE/DC BUS PWR OFF LTS
- EMER BUS WARN LT PROTECT RELAY
- RCCB BACKUP POWER
- R EMER AC&DC BUS CONT

ENGINES
- ENG GND/FLT IDLE CONT
- ENG IGNITION OVERRIDE
- ENG OIL LOW PRESS WARN LT
- ENG START & IGNITION CONT
- ENG START OVERRIDE
- FUEL VAPOR VENT

FIRE CONTROL
- APU FIRE HORN
- ENG FIRE/OVSPD & ARO AURAL WARN
- ENG 2 & APU FIRE AGENT DISC LT
- F/E APU FIRE WARN
- FIRE BELL CUTOFF/LOOP TEST
- FIRE DETECTORS LOOP A (ENG 1, 2, 3, APU)
- FIRE DETECTORS LOOP B (ENG 1, 2, 3, APU)
- FIREX HANDLE & FUEL LEVER LTS (ENG 1,2,3)
- MASTER FIRE WARN LT

FLIGHT CONTROL
- YAW DAMPER INOP LT (LOWER, UPPER)

FLT GUIDANCE/AUTOTHROTTLES
- AIR DATA INST SWITCH UNIT
- ATS ADVISORY OFF LT (1,2)

FUEL
- FUEL TANK FILL VALVE MAIN, CTR WING,
  (MAIN, CTR, & FUSLG TANKS)

HYDRAULICS
- AUX HYD PUMP CONT & LTS
- ENG HYD PUMPS CONT (LEFT, RIGHT)
- HYD MOTOR-PUMPS CONT & LTS (1-3, 2-3)
- HYD SYS 3 ELEV SHUTOFF

INSTRUMENTS
- CAPT FMS SWITCHING UNIT
- INS SWITCH UNIT
- STANDBY HORIZON
- CAPT RAD/INS SWITCHING

LIGHTING
- EMER LTS ARM
- F/E FLOOD LTS
- L OVHD FLOOD LT
- MAIN INST PANEL FLOOD LTS
- MASTER CAUTION & CUE LTS
- MASTER WARN LTS

PNUE/AIR COND/PRESS
- FLOW CONT VALVE SHUTOFF & PACK OFF
  LTS (PACK 1, PACK 3)

RADIO/PA/INTERPHONE
- **WITH TCTO 1248** ARTEX ELT ◀

28VDC ARO BUS

BOOM/DROGUE
- BOOM CONTROL: ENGAGE
  - HAND CONT
  - OVERRIDE/ DISC/ MISC
  - SIG AMPL/STATUS TEST PNL
- LESS TCTO 1C-10(K)A-956
- DROGUE CONTROL
- DROGUE JETTISON ◀
- WITH TCTO 1C-10(K)A-956
- DROGUE CONTROL: CTR
- DROGUE JETTISON CONT ◀

INSTRUMENTS
- WINDOW HT/HYD PRESS/REEL IND

LIGHTING
- ARO ANNUN DIM & TEST
- ARO CONSOLE & OVHD PANEL FLOOD LTS
- ARO DIRECTOR LIGHTS CONTROL
- ARO IBO LT

28VDC GND SVC BUS

BOOM/DROGUE
- HOIST CLUTCH ACTUATOR CONT

CARGO LOADING
- CARGO LOADING CONTROL

DOORS
- AFT CABIN DOOR CONT
- ARO DOOR CONTROL
- L CABIN DOOR CONTROL (FWD, MID, CARGO)
- R CABIN DOOR CONTROL (FWD, MID)

ENGINES
- ENG 2 CSD FLTR CLOG IND

ICE CONTROL & RAIN
- ENG 2 DRAIN HTR

LIGHTING
- AISLE LIGHTS
- AFT DOOR THRESHOLD LT
- CABIN OVHD LTS CONTROL (AFT, FWD/MID)
- CABIN OVHD LTS XFMR POWER (AFT, FWD/MID)
- CARGO DOOR LTS
- ENTRY LIGHTS CONTROL (CABIN, LAV)
- LAV MIRROR LIGHTS CONTROL
- PASS OXY REG LTS (2)
- THRESHOLD LIGHTS

WATER/WASTE
- LAV 1 FLUSH CONTROL
- LAV WASTE SYS IND
- LAV Z FLUSH CONTR
- WATER FILL/DR & OVFL CONT
- WATER PRESS PUMP CONTROL
- WATER QUANTITY INDIC & CONTROL
- WTR FILL DRAIN HEAT CONT

L EMER DC BUS

ELECTRICAL
- L EMER DC BUS SENSING

ENGINES
- N_1 TACH SENSOR ENG 1

FIRE CONTROL
- CARGO SMOKE DETS & LTS

FLIGHT CONTROLS
- LOWER YAW DAMPER (A, B)

IFF
- IFF XFDR
- IFF XPNDR

INSTRUMENTS
- CAPT RAD/INS SWITCHING
- EGPWS/ETCAS SPEAKER
- EHSI 1
- FMS CDU1
- FMS BSIU 1
- FMS DATA LOADER
- VOR 1

LIGHTING
- EMER LTS STANDBY

RADIO/PA/INTERPHONE
- FLT INPH CAPT & F/E AUDIO
- PASSENGER ADDRESS
- VHF COMM 1

R EMER DC BUS

ELECTRICAL
- R EMER DC BUS SENSING

ENGINES
- N_1 TACH SENSOR ENG 3

FLIGHT CONTROLS
- UPPER YAW DAMPER (A, B)

INSTRUMENTS
- EHSI 2
- FMS CDU 2
- FMS BSIU 2
- F/O RAD/INS SWITCHING
- VOR 2

RADIO/PA/INTERPHONE
- AR INSTR & OBS AUDIO
- F/O OBS & AVIONIC AUDIO
- HF COMM 2
- SERVICE INTPH AMPL
- VHF COMM 2
- UHF COMM 2

DC BUS 1

DOORS
CARGO SYS B & CABIN DOOR IND

DROGUE
WITH TCTO 1C-10(K)A-956
DROGUE CONTROL: R WING
DROGUE CONTROL: L WING ◀

ELECTRICAL
DC BUS 1 SENSING & VM
OIL PRESS LOW LT CSD 1
OIL TEMP IND CSD 1

ENGINES
ENG FAILURE DETECTOR LTS
OIL TEMP IND ENG 1
REVERSING CONT ENG 1
REVERSING LTS ENG 1
T/R LOCK CONT ENG 1

FIRE CONTROL
FIRE AGENT DISCHARGE LT ENG 1

FLIGHT CONTROLS
AUTO PITCH TRIM A
CAPT STICK SHAKER
ELEV LOAD FEEL & FLAP LIMIT 1
GND SPOILER CONT
HORIZ STAB IN MOTION
HORIZ STAB TRIM RATE CONT 1
RUDDER STBY PWR & IND
SLAT POSITION SYS 1

FLT GUIDANCE/AUTO THROTTLES
ACCEL GO AROUND 1
AT/SC 1
FLT DIR CMD SW UNIT
FLT GDNC MODE ANN 1
FLT GDNC 1 CONTROL PANEL
FLT GDNC 1 PITCH
FLT GDNC 1 ROLL
MAINT ASSMT PANEL
AR FUEL PRESS CONT L SYS
AR RECP & MASTER FUEL VALVE
CTR WING R UPR & LWR PRESS LOW LTS
FUEL X-FEED CONT 1
FUEL X-FEED VALVE LT 1
FUEL X-FEED VALVE LT 3
FUSLG FUEL TKS ALT XFR VLV CONT
FWD PUMPS PRESS LOW LTS
L AR PUMPS PRESS LOW
L FUEL DUMP VALVE CONT
TANK FUEL TEMP IND

HYDRAULICS
ENG HYD PUMP TEMP HI LT
HYD TEMP IND 1

ICE CONTROL & RAIN
ENG & ANT ANTI-ICE DISAGREE LTS
ENG ANTI-ICE VALVE ENG 1
L WINDSHIELD ANTI-ICE (CONT/PWR)
L WINDSHIELD WIPER (CONT/PWR)
WING ANTI-ICE VALVE

IFF/L-BAND SATCOM
IFF CAUTION LT
L-BAND SATCOM

INSTRUMENTS
BUS SPLIT SWITCH
CAPT ALTIMETER ADVISORY L
CAPT RAD ANN LTS
GROUND PROX WARN LT
I-BAND BEACON XPNDR
INS FLOW OFF LT 1
UHF/ADF
TACAN 1

LANDING GEAR
AUTO BRAKE SYS
CENTER GEAR CONTROL
L GROUND SENSING

LIGHTING
COCKPIT THUNDERSTORM LT CONT
PASS WARN SIGNS
SPARE ANNUNCIATOR LTS
STANDBY COMPASS LT
WARN LT DIMMING & TEST

MISCELLANEOUS & MAINTENANCE
CAPT SEAT CONT
COCKPIT DOOR LOCK
MAINT ASSMT PANEL

PNEU/AIR COND/PRESS
AIR COND TRIM AIR PRESS HIGH LT
APU ISOL VALVE CONT
CABIN & ARO COMPT TEMP IND
CABIN PRESS SEMI-AUTO LT
COCKPIT TEMP IND
LAV/GALLEY VENT
L TRIM AIR PRESS REGULATOR
MANIFOLD FAILURE DET LT LOOP 1
PACK DISCH TEMP IND
PNEU ABNORMAL LT ENG 1
PNEU HP BLEED V CONT ENG 1
PNEU MANIFOLD FAILURE SMY LT
PNEU PRESS REGULATOR: ENG 3
PNEU TEMP HI LT: ENG 1

RADIO/PA/INTERPHONE
ADF 1
WITH TCTO 1248 ELT ◀
HF COMM 1
SERVICE INTERPHONE (CALL, CALL RESET)
WITH TCTO 1C-10(K)A-1243 IRIDIUM PHONE ◀

DC BUS 2

DOORS
CARGO SYS A & MISC DOOR IND

ELECTRICAL
DC BUS 2 SENSING & VM
OIL PRESS LOW LT CSD 2
OIL TEMP IND CSD 2

ENGINES
ENGINE START VALVE LTS
N1 TACH SENSOR ENG 2
OIL TEMP IND ENG 2
REVERSING CONT ENG 2
REVERSING LTS ENG 2

FLIGHT CONTROLS
PRIMARY HORIZ STAB TRIM
SELECT ELEV FEEL MAN LT
SELECT FLAP LIM OVERRIDE LT

FUEL
AR PUMP OVRD CONT/IND
BOOM/DROGUE FUEL CONT/IND
CTR WING L UPR & LWR PRESS LOW LTS
DUMP V IND & FUEL LOW LVL SHUTOFF
ENG FUEL FILTER PRESS DROP LTS
FUEL MANF DRAIN
FUEL X-FEED CONT 2
FUEL X-FEED CONT LT 2
FUSLG AUX TANK XFR PUMPS
OFFLOAD FUEL FLOW PWR
R AFT PUMPS PRESS LOW LIGHTS
RCVR/TNKR MANF SCAVENGE VALVES

HYDRAULICS
AR HYD RESERVOIR PRESS LOW LT
HYD TEMP IND 2
1-3/2-3 PUMP VALVE IND

ICE CONTROL & RAIN
ENG 2 & ANTI-ICE VALVE
PITOT HEAT CONT MONITOR PWR
RAIN REPELLANT SYS

LANDING GEAR
ANTI SKID TEST
AUTO BRAKE SYS TEST
BRAKE TEMP MONITOR IND
LDG GEAR WARN

LIGHTING
CABIN OVERHEAD LTG OVRD CONT
FLT GNDC CONT PNL FLOOD LT
MAP BRIEFCASE CHART & TABLE LTS

MISCELLANEOUS & MAINTENANCE
CHEM DEFENSE BOOM OP
CHEM DEFENSE PILOT
F/E SEAT CONTROL

OXYGEN
CREW OXY QTY IND/PASS OXY ALTN CONT

PNEU/AIR COND/PRESS
AVIONICS FLOW OFF LT
CABIN & ARO COMPT DUCT TEMP IND
CABIN PRESS RELIEF LT
DUCT/AVIONIC COMPT OVHT LT
ISOL VALVE DISAGREE LTS
MANIFOLD FAILURE DET LT LOOP 2
PNEU PRESS REGULATOR: ENG 1
TRIM AIR MANUAL SHUTOFF

DC BUS 3

ELECTRICAL
DC BUS 3 SENSING & VM
OIL PRESS LOW LT CSD 3
OIL TEMP IND CSD 3

ENGINES
ENG INST MAX POINTER RESET
ENG OIL STRAINER LTS
OIL TEMP IND ENG 3
REVERSING CONT ENG 3
REVERSING LTS ENG 3
VARIABLE GUIDE VANE ANGLE
T/R LOCK CONT ENG 3

FIRE CONTROL
FIRE AGENT DISCHARGE LT ENG 3

FLIGHT CONTROLS
AUTO PITCH TRIM B
AUTO SLAT EXTEND CONTROL
ELEV LOAD FEEL & FLAP LIMIT 2
FGS SPINUP LOGIC SPOIL WRN SPD BK LT
F/O STICK SHAKER
HOR STAB ALTN TRIM CONT
HORIZ STAB TRIM RATE CONT 2
SLAT POSITION SYS 2

FLT GUIDANCE/AUTO THROTTLES
ACCEL GO AROUND 2
AT/SC 2
FLT GDNC MODE ANN 2
FLT GDNC 2 CONTROL PANEL
FLT GDNC 2 PITCH
FLT GDNC 2 ROLL

DC BUS 3 (CONT)

FUEL
AR FUEL PRESS CONT R SYS
AR RECP OVRD
FUEL TK OFF SCHEDULE LTS
FUEL X-FEED CONT LT 3
FUSLG FUEL TKS ALT XFR VLV IND
L AFT PUMPS PRESS LOW LIGHTS
R AR PUMPS PRESS LOW
R FUEL DUMP VALVE CONT
RCVR/TNKR MANF SCAV PUMPS PRESS LOW
WING TIP FUEL PUMP & XFR OVRD

HYDRAULICS
AR HYD SYS PRESS LTS
ENG HYD PUMP PRESS LTS
HYD FLT CONT ISOL SYS 3
HYD TEMP IND 3

ICE CONTROL & RAIN
ENG ANTI-ICE VALVE ENG 3
R ANGLE ATTACK HEAT
R WINDSHIELD ANTI-ICE (CONT/PWR)
R WINDSHIELD WIPER (CONT/PWR)
WING ANTI-ICE DISAGREE LTS

IFF

INSTRUMENTS
CADC SWITCHED LT
FMS CDU 3
F/O ALTIMETER ADVISORY LT
F/O FMS SWITCHING UNIT
F/O RAD ANN LTS
INS FLOW OFF LT 2
INS FLOW OFF LT 3
J-BAND BEACON XPNDR
MARKER BEACON
STANDBY ALTIMETER VIBRATOR
TACAN 2

LANDING GEAR
F/E LANDING GEAR WARNING
R GROUND SENSING
WHEEL SPINUP SENSING

LIGHTING
COCKPIT STANDBY LIGHTING CONT
EMER LT BATTERY TEST
R OVHD & PED FLOOD LTS

MISCELLANEOUS & MAINTENANCE
CHEM DEFENSE COPILOT
CHEM DEFENSE FE
F/O SEAT CONTROL

OXYGEN
PASS OXY CONT

PNEUMATICS/AIR CONDITIONING/PRESSURIZATION
CABIN ALT WARN
CENTER ACCESS COMPT FLOW OFF
COCKPIT DUCT TEMP CONT
MANIFOLD FAILURE DET LT LOOP 3
PNEU ABNORMAL LT ENG 3
PNEU HP BLEED V CONT ENG 3
PNEU TEMP HI LT: ENG 3
PNEU TEMP IND ENG 3
PNEU TEMP HI SMY LT
RT TRIM AIR PRESS REGULATOR
TRIM AIR OVERHEAT SHUTOFF
TURBINE INLET TEMP IND

RADIO/PA/INTERPHONE
ADF 2
FLT RECORDER OFF LIGHT
IN SERVICE DATA ACQ SYSY (REMOTE UNIT, RECORDER)
KEY GENERATOR
SECURE VOICE
WITH TCTO 1248 ELT 2 ◀

WATER/WASTE
WATER PRESS IND

115VAC ARO BUS

DROGUE

WITH TCTO 1C-10(K)A-956
WING DROGUE JETTISON ◀

ICE CONTROL & RAIN
ARO LOWER WINDOW HEAT
ARO WINDOW HEAT-POWER (2), CONTROL

LIGHTING
ARO COMPT FLUOR LTS
ARO INSTR PNL FLOODLITES
ARO INSTR PNL LIGHTING
BOOM CONTROL UNIT/MODE LTS
BOOM LIGHTS (MARKING, NOZZLE)
DROGUE LIGHTS (SIG, FLOOD)
PILOT DIRECTOR LTS
RCVR FLOOD LTS
UNDERBODY LTS

MISCELLANEOUS & MAINTENANCE
CHEM DEFENSE: ARO

PNEUMATICS/AIR CONDITIONING/PRESSURIZATION
ARO EQPT RACK COOLING FAN (3).

AC SECONDARY ARO BUS

LIGHTING
ARO INSTR LTS
ARO INSTR PNL INTEGRAL LIGHTING (2)
BOOM SIGNAL LTS (2)

115VAC GND SVC BUS

BOOM/DROGUE
AR BOOM HOIST CLUTCH ACTUATOR POWER

CARGO LOADING
CARGO LOADING WINCH RCPT AFT CABIN
FWD/MID WINCH OUTLETS
ROW 1 ROLLERS
ROW 2 ROLLERS
ROW 3 ROLLERS

DOORS
AFT CABIN DOOR POWER
ARO SIGHTING DOOR POWER
L CABIN DOOR POWER (FWD, MID, CARGO)
R CABIN DOOR POWER (FWD, MID)

ELECTRICAL
AC GND SERVICE BUS
AC GND SERVICE BUS SENSING
ARO STA DC BUS (NORM, ALT)
BATTERY CHARGER
CABIN GROUND SERVICE BUS
COCKPIT GROUND SERVICE BUS
EXTERNAL PWR
GALLEY PWR
TR 2B INPUT
28V AC BUS 3 XFMR GND SVCS
115V AC UTILITY OUTLETS
(COCKPIT, AVIONICS COMPT)

HYDRAULICS
AUX HYD PUMP 1
AUX HYD PUMP 2

LIGHTING
ARO COMP MISC LTS XFMR
COCKPIT FLOOR LTS & 28V AC OUTLET
EMER LTS CONT
ENTRY LIGHTS POWER (2)
FWD CABIN OVHD LTS
MAIN W/W CTR ACCESS COMPT LT
INBD NAV LTS
LAV 1 & Z MIRROR LTS POWER (LT, RT)
LEFT RUNWAY TURNOFF LT
LOGO LITE CONT

LIGHTING (CONT)
LOGO LTS POWER (LEFT, RIGHT)
NOSE W/W AVIONICS & A/C COMP LT
OUTBD NAV LTS
PASS OXY REG LTS (2)
TAIL COMP LTS XFMR
RIGHT RUNWAY TURNOFF LT
WING SCAN LTS

MISCELLANEOUS & MAINTENANCE
TEST EQUIP CONT PWR
TEST EQUIP PWR

WATER/WASTE
LAV RAZOR OUTLET
LAV 1 FLUSH PUMP POWER
LAV 1 WATER COOLER POWER
LAV 1 WATER HEATER
LAV Z FLUSH PUMP POWER
LAV Z WATER HEATER
WASTE SVCE PNL HEATER
WATER TANK STANDPIPE HTR
WATER TANK FILL SYS
WATER PRESS PUMP POWER
WTR DRAIN & OVFL VALVE

28VAC L EMER BUS

FLT GUIDANCE/AUTO THROTTLES
CAPT HSI CRS/HDG SELECT
HEADING PLATFORM 1

INSTRUMENTS
ATTITUDE 1
CAPT ALTIMETER
CAPT HORIZON
CAPT HSI HEADING
CAPT MACH AIRSPEED IND
CAPT VERT SPEED IND
INS 1
VOR 1

28VAC R EMER BUS

FLT GUIDANCE/AUTO THROTTLES
F/O HSI CRS/HDG SELECT
HEADING PLATFORM 2

INSTRUMENTS
ATTITUDE 2
F/O ALTIMETER
F/O HORIZON
F/O HSI HEADING

28VAC R EMER BUS (CONT)

INSTRUMENTS (CONT)
F/O MACH AIRSPEED IND
F/O VERT SPEED IND
INS 2
INS 3
VOR 2

28VAC BUS 1

FLIGHT CONTROLS
ELEV LOAD FEEL INDICATOR
L SURFACE POS IND

FLT GUIDANCE/AUTO THROTTLES
AT/SC/SW FLAP IND HOR STAB 1

ICE CONTROL & RAIN
L ANGLE ATTACK HEAT
R ANGLE ATTACK HEAT

INSTRUMENTS
ATTITUDE 3
CAPT & F/O RMI UHF/ADF BEARING
CAPT ADI RADIO & CMD INFO
CAPT TACAN RMI HEADING & BEARING
FLT RECORDER HEADING & GMT CLOCK
F/O RMI HEADING
TAT & THRUST RATING IND

RADIO/PA/INTERPHONE
ADF 1

28VAC BUS 3

FLIGHT CONTROLS
R SURFACE POS IND

FLT GUIDANCE/AUTO THROTTLES
AT/SC/SW FLAP IND HOR STAB 2

INSTRUMENTS
ATTITUDE 3
CAPT RMI HEADING
CONTROLS & BRAKE PED POS XMTRS
F/O ADI RADIO & CMD INFO
T/O TACAN RMI HEADING & BEARING
HEADING PLATFORM 3
TAS/SAT IND

RADIO/PA/INTERPHONE
ADF 2

L EMER AC BUS

ELECTRICAL
L EMER AC BUS SENSING & VM
L EMER 28V AC BUS XFMR

ENGINES
ENG IGNITION A IGNITORS (ENG 1, 2, 3)
EXHAUST GAS TEMP (ENG 1, 2, 3)
N1 TACH IND ENG 1
N2 TACH (ENG 1, 2, 3)

FLIGHT CONTROLS
LOWER YAW DAMPER (A, B)

ICE CONTROL & RAIN
CAPT PITOT HEAT

INSTRUMENTS
AIR DATA CMPTR 1
COMPASS 1
CAPT TVSI
IFF XPNDR
VERT GYRO 1

PNEU/AIR COND/PRESS
ISOL VALVE CONTROL 1 TO 3
MANUAL TEMP CONTROL (PACK 1, 3)

RADIO/PA/INTERPHONE
UHF COMM 1

R EMER AC BUS

ELECTRICAL
R EMER AC BUS SENSING
R EMER 28V AC BUS XFMR
TR 3 INPUT

ENGINES
ENG IGNITION B IGNITORS (ENG 1, 2, 3)
N1 TACH IND ENG 3

FUEL
FUEL PUMP POWER
TANK 2: L AFT

ICE CONTROL & RAIN
F/O PITOT HEAT

IFF
UHF COMM 2

R EMER AC BUS (CONT)

INSTRUMENTS
AIR DATA CMPTR 2
ILS 2
INS 2/COMPASS
INS 2 FAN
INS 2 VERT GYRO 2
F/O TVSI

LIGHTING
EMER LTS CHARGE & STBY

PNEU/AIR CONT/PRESS
ISOL VALVE CONTROL 1 TO 2

RADIO/PA/INTERPHONE
HF COMM 2
UHF COMM 2/SAT COMM

AC BUS 1

DROGUE
WITH TCTO 1C-10(K)A-956
L WING REFUEL DROGUE POWER
R WING REFUEL DROGUE POWER ◀

ELECTRICAL
AC BUS 1 SENSING
AUTO PARALLEL CONT GEN 1
DC BUS 1
DC TIE BUS SENSING (LEFT, RIGHT)
L EMER AC BUS
TR 1 INPUT
TR 1 OUTPUT
28V AC BUS 1 XFMR

ENGINES
ENG FAILURE DETECTOR
ENG VIB MONITOR
OIL PRESS IND ENG 1
OIL QTY IND ENG 1

FLIGHT CONTROLS
AUTO PITCH TRIM
ELEV LOAD FEEL & FLAP LIMIT 1
GND SPOILER ACTUATOR

FLT GUIDANCE/AUTO THROTTLES
ACCEL 1
AT/SC STALL WARN 1
FLT GDNC MODE ANN 1
FLT GDNC 1 PITCH
FLT GDNC 1 ROLL
LEFT AVIONICS 28V AC BUS XFMR
PAFM POWER 1

FUEL
FUEL FLOW IND ENG 1
FUEL PUMP CONTROL
TANK 1: FWD
TANK 2: FWD
TANK 3: XFR
CTR WING R UPR & LWR
FUEL PUMP POWER
TANK 1: FWD
TANK 2: FWD
TANK 3: XFR
CTR WING R UPR
FWD FUSLG XFR
FUEL QTY NORM POWER
FUEL QTY XFR RELAY

HYDRAULICS
HYD PRESS IND 1
HYD CITY IND 1

ICE CONTROL & RAIN
L ANGLE ATTACK HEAT
L CLEARVIEW DEFOG
L STATIC PORT HEAT
L WINDSHIELD ANTI-ICE (CONT/PWR)
L WINDSHIELD DEFOG

INSTRUMENTS
ETCAS CMPTR
GROUND PROX WARN
ILS 1
INS 1
INS 1 FAN
RADIO ALTIMETER 1
VERT GYRO 3

LANDING GEAR
ANTI SKID CONTROL
BRAKE HYD PRESS IND 1

LIGHTING
AR RECP SLIPWAY LTS
BEACON LIGHTS UPPER
CAPT INST PANEL LTG
CENTER INST PANEL LTG
F/E WORK TABLE LT
FORMATION LTS
GLARE SHIELD LTG
LEFT LANDING LIGHT (CONT, LAMP)

AC BUS 1 (CONT)

MISCELLANEOUS & MAINTENANCE
- CAPT SEAT POWER

OXYGEN
- PASS OXY RELEASE PALLETS
  ADD SPT PERS

PNEU/AIR COND/PRESS
- AVIONICS COMP FAN
- AVIONIC VENTURI VALVE & CONT
- CABIN PRESS AUTO CONT
- CENTER INST PANEL FAN
- FLOW IND: PACK 1
- MANIFOLD FAILURE DET LOOP 1
- PNEU SYS CONTROL: ENG 1
- PNEU SYS MONITOR: ENG 1
- TRIM AIR VALVE POSITION IND
  (COCKPIT, CABIN & ARO COMPT)

RADIO/PA/INTERPHONE
- COCKPIT VOICE RECORDER
- HF COMM 1
- UHF COMM/NAV 50

RADAR
- IND 1
- XCVR 1

AC BUS 2

APU
- OIL QTY IND APU

ELECTRICAL
- AC BUS 2 SENSING
- AC GNS SERVICE TIE RELAY CONT
- AUTO PARALLEL CONT GEN 2
- DC BUS 2
- DC X TIE
- TR 2A INPUT
- TR 2A OUTPUT
- TR 2B OUTPUT
- 28V AC BUS 2 XFMR

ENGINES
- N1 TACH IND ENG 2
- OIL PRESS IND ENG 2
- OIL QTY IND ENG 2

FLT GUIDANCE/AUTO THROTTLES
- ALT ALERT HOR STAB AUTOPILOT AURAL WARN

FUEL
- FUEL FLOW IND ENG 2
- FUEL PRESS IND ENG 1
- FUEL PRESS IND ENG 2
- FUEL PUMP CONTROL
  - TANK 1:
  - TANK 2: XFR
  - TANK 3: R AFT
  - CTR WING L LV AFT
  - CTR WING L UPR & LWR
  - TANK 1 WING TIP
- FUEL PUMP POWER
  - TANK 1: XFR
  - TANK 2: R AFT
  - TANK 3: AFT
  - CTR WING L LWR
  - CTR WING L UPR
  - TANK 1 WING TIP
- FUEL QTY ALTN POWER
- OFFLOAD FUEL FLOW IND
- RCVR/TNKR MANF SCAVENGE PUMPS

HYDRAULICS
- HYD PRESS IND 2
- HYD QTY IND 2

ICE CONTROL & RAIN
- AUX PITOT HEAT
- LAV DRAIN MAST HEAT
- TAT PROBE HEAT

LANDING GEAR
- BRAKE TEMP MONITOR
- PARKING BRAKE VALVE

LIGHTING
- BEACON LIGHTS LOWER
- CIRCUIT BREAKER PANEL LTG
- EXT LT UPPER FUSLG
- F/E INST PANEL LTG
- MAIN INST FLUOR FLOOD LTS
- NOSE LANDING & TAXI LT (L,R)
- PEDESTAL PANEL LTG

MISCELLANEOUS & MAINTENANCE
- F/E SEAT POWER

OXYGEN
- PASS OXY RELEASE

AC BUS 2 (CONT)

PNEU/AIR COND/PRESS
- APU/PACK TEMP DEMAND CONT
- CABIN MANUAL TEMP CONT
- CENTER ACCESS COMPT FAN
- COCKPIT AUTO TEMP CONT
- MANIFOLD FAILURE DET LOOP 2
- PACK VALVE POSITION IND

AC BUS 3

ELECTRICAL
- AC BUS 3 SENSING
- ARO STA AC BUS
- AUTO PARALLEL CONT GEN 3
- DC BUS 3
- DC GROUND SERVICE BUS (NORM, ALT)
- R EMER AC BUS
- TR 3 OUTPUT
- 28V AC BUS 3 XFMR

ENGINES
- OIL PRESS IND ENG 3
- OIL QTY IND ENG 3
- REMOTE ENG TRIM

FLIGHT CONTROLS
- AUTO SLAT EXTEND POWER
- ELEV LOAD FEEL & FLAP LIMIT 2

FLT GUIDANCE/AUTO THROTTLES
- ACCEL 2
- AT/SC STALL WARN 2
- FLT GDNC MODE ANN 2
- FLT GDNC 2 PITCH
- FLT GDNC 2 ROLL
- PAFM POWER 2
- RIGHT AVIONICS 28V AC BUS XFMR

FUEL
- FUEL FLOW IND ENG 3
- FUEL PRESS IND ENG 3
- FUEL PUMP CONTROL
  - TANK 1: AFT
  - TANK 2: XFR
  - TANK 3: FWD
  - CTR WING R LWR
  - FUS AFT XFR
  - FUS FWD XFR
  - TANK 3 WING TIP

FUEL (CONT)
- FUEL PUMP POWER
  - TANK 1: AFT
  - TANK 2: XFR
  - TANK 3: FWD
  - AFT FUSLG XFR
  - CTR WING R LWR
  - TANK 3 WING TIP
- FUEL QTY RPT PTS & XFR

HYDRAULICS
- HYD PRESS IND 3
- HYD QTY IND 3

ICE CONTROL & RAIN
- R CLEARVIEW DEFOG
- R STATIC PORT HEAT
- R WINDSHIELD ANTI-ICE (CONT/PWR)
- R WINDSHIELD DEFOG

IFF

INSTRUMENTS
- INS 3 DIR GYRO 3
- INS 3 FAN
- INS 3 VERT GYRO 3
- RADIO ALTIMETER 2
- TACAN 1
- TACAN 2

LANDING GEAR
- ANTI SKID CONTROL
- BRAKE HYD PRESS IND 3
- WHEEL SPINUP SENSING TEST

LIGHTING
- AR RECP FLOOD LTS
- COCKPIT DOME LT
- COPILOT CONSOLE: FMA
  - GLARE SHIELD
  - HSI/DME
  - INST F/O (2)
  - INST PED (2)
  - LIGHTPLATES F/O
- F/E LIGHTING PANEL
  - F/E INST LTS: AFT PNL
    - CTR PNL (2)
    - FWD PNL
    - LOWER FWD PNL
    - FUEL PNL
  - F/E INSTR COCKPIT FLOOR LTS
  - LIGHTING: FUEL FLOW LINE
  - F/E & C/B FWD PNL
  - LIGHTPLATES: AFT PNL

AC BUS 3 (CONT)

LIGHTING (CONT)

- F/E LIGHTING PANEL (CONT)
  - FUEL PNL
    - LOWER MAIN & AVIONIC PNL
    - LWR FWD & AFT PNL
    - OVERHEAD PNL
    - UPPER MAIN PNL
- F/O INST PANEL LTG
- HI-INT LTS
- OVERHEAD SW PANEL LTG
- OVERHEAD SW PANEL: INST
- PILOTS CONSOLE: CAPT INST (2)
  - CTR
  - CTR INST (2)
  - FMA
  - HSI/DME
- RIGHT LANDING LT (CONT, LAMP)

MISCELLANEOUS & MAINTENANCE

- F/O SEAT POWER
- T.O. LDG & CABIN PRESS AURAL WARNING

OXYGEN

- PAA OXY RELEASE

PNEU/AIR COND/PRESS

- AUTO TEMP CONT PACK 1
- AUTO TEMP CONT PACK 3
- CABIN AUTO TEMP CONT
- COCKPIT MANUAL TEMP CONT
- FLOW IND: PACK 3
- MANIFOLD FAILURE DETECTOR LOOP PACK 3
- PNEU SYS CONTROL: ENG 1
  - PNEU SYS MONITOR: ENG 1
  - RADIO RACK FAN

RADIO/PA/INTERPHONE

- FLT RECORDER

RADAR

- IND 2
- XCVR2

CIRCUIT BREAKER LISTING

PANEL LEGEND

NOTE

ASTERISKED CIRCUIT BREAKERS WILL BE PULLED AND COLLARED WHEN EQUIPMENT IS NOT INSTALLED.

AGS	ARO GROUND SERVICE BUS	OI	OVERHEAD INTEGRAL
ARO	ARO	OL	OVERHEAD LEFT
CC	COPILOTS CONSOLE	OR	OVERHEAD RIGHT
EPP	EXTERNAL POWER PANEL	PC	PILOTS CONSOLE
FEL	FLIGHT ENGINEERS LIGHTING	PO	PILOTS OVERHEAD
LM	FLIGHT ENGINEERS LOWER MAIN	UM	FLIGHT ENGINEERS UPPER MAIN
OH	FLIGHT ENGINEERS OVERHEAD		

APU

APU ADVISORY LIGHTS	PO A-8	BATTERY BUS
APU CONT & FUEL VALVE	PO A-6	BATTERY BUS
APU DOOR CONT	PO A-7	BATTERY BUS
APU GEN CONT	PO B-24	BATTERY BUS
APU INLET & EXHAUST DOORS	PO A-10	BATTERY BUS
APU START PUMP	PO A-9	BATTERY BUS
OIL CITY IND APU	UM F-24	AC BUS 2

BOOM/DROGUE

AR BOOM HOIST CLUTCH ACTUATOR POWER	AGS	115VAC GND SVC BUS
BOOM DROGUE DEPLOY/STOW IND	PO C-2	BATTERY BUS
BOOM CONTROL: ENGAGE	ARO	28VDC ARO BUS
HAND CONT	ARO	28VDC ARO BUS
OVERRIDE/DISC/MISC	ARO	28VDC ARO BUS
SIG AMPL/STATUS TEST PNL	ARO	28VDC ARO BUS
BOOM EMER RET/FAIL ANNUN	PO C-1	BATTERY BUS
LESS TCTO 1C-10(K)A-956		
DROGUE CONTROL	ARO	28VDC ARO BUS
DROGUE JETTISON ◀	ARO	28VDC ARO BUS
WITH TCTO 1C-10(K)A-956		
DROGUE CONTROL:		
*R WING	ARO	28VDC BUS1
CTR	ARO	28VDC ARO BUS
*L WING	ARO	28VDC BUS 1
*L WING REFUEL DROGUE POWER	UM L-3	AC BUS 1
*R WING REFUEL DROGUE POWER	UM M-3	AC BUS 1
*WING DROGUE JETTISON	ARO	115VAC ARO øC
DROGUE JETTISON CONT	ARO	28VDC ARO BUS ◀
HOIST CLUTCH ACTUATOR CONT	AGS	28VDC GND SVC BUS

CARGO LOADING

*CARGO COMPT AUX PWR	UM A-22	115VAC GND SVC BUS
CARGO LOADING CONTROL	OL	28VDC GND SVC BUS
CARGO LOADING WINCH RCPT AFT CABIN	AGS	115VAC GND SVC BUS
FWD/MID WINCH OUTLETS	OL	115VAC GND SVC BUS
ROW 1 ROLLERS	OL	115VAC GND SVC BUS
ROW 2 ROLLERS	OL	115VAC GND SVC BUS
ROW 3 ROLLERS	OL	115VAC GND SVC BUS

CIRCUIT BREAKER LISTING (CONT)

DOORS

AFT CABIN DOOR CONT	AGS	28VDC GND SVC BUS
AFT CABIN DOOR POWER	AGS	115VAC GND SVC BUS
ARO DOOR CONTROL	AGS	28VDC GND SVC BUS
ARO SIGHTING DOOR POWER	AGS	115 VAC GND SVC BUS
CARGO SYS A & MISC DOOR IND	LM E-5	DC BUS 2
CARGO SYS B & CABIN DOOR IND	LM D-5	DC BUS 1
L CABIN DOOR CONTROL (FWD, MID, CARGO)	OL	28VDC GND SVC BUS
L CABIN DOOR POWER (FWD, MID, CARGO)	OL	115VAC GND SVC BUS
R CABIN DOOR CONTROL (FWD, MID)	OR	28VDC GND SVC BUS
R CABIN DOOR POWER (FWD, MID)	OR	115VAC GND SVC BUS

ELECTRICAL

AC BUS CONT	PO B-25	BATTERY BUS
AC BUS 1	UM B-17, 18, 19	AC BUS 1
AC BUS 1 SENSING	LM A-16	AC BUS 1
AC BUS 2	UM C-17, 18, 19	AC BUS 2
AC BUS 2 SENSING	LM B-16	AC BUS 2
AC BUS 3	UM D-17, 18, 19	AC BUS 3
AC BUS 3 SENSING	LM C-16	AC BUS 3
AC GND SERVICE BUS	UM A-24	AC GND SVC BUS
AC GND SERVICE BUS SENSING	LM G-14	AC GND SVC BUS
AC GND SERVICE TIE RELAY CONT	UM C-20	AC BUS 2
ARO STA AC BUS	UM D-20	AC BUS 3
ARO STA DC BUS (NORM, ALT)	UM A-25, 26	AC GND SVC BUS
AUTO PARALLEL CONT GEN 1	LM A-15	AC BUS 1
AUTO PARALLEL CONT GEN 2	LM B-15	AC BUS 2
AUTO PARALLEL CONT GEN 3	LM C-15	AC BUS 3
BATTERY BUS FEEDS (BAT, L TIE, R TIE)	PO A-11, 12, 13	BATTERY DIRECT BUS
BATTERY BUS SENSING	PO C-29	BATTERY BUS
BATTERY CHARGER	UM A-15	AC GND SVC BUS
BATTERY DIR & L EMER DC FEED	PO A-14	BATTERY DIRECT BUS
BATTERY RELAY	PO A-23	BATTERY DIRECT BUS
CABIN GROUND SERVICE BUS	UM A-20	AC GND SVC BUS
COCKPIT GROUND SERVICE BUS	UM A-19	AC GND SVC BUS
CSD DISC	PO B-23	BATTERY BUS
DC BUS ISOL CONT	PO A-24	BATTERY DIRECT BUS
DC BUS 1	UM B-26	AC BUS 1
DC BUS 2	UM C-26	AC BUS 2
DC BUS 3	UM D-26	AC BUS 3
DC BUS 1 SENSING & VM	LM D-16	DC BUS 1
DC BUS 2 SENSING & VM	LM E-16	DC BUS 2
DC BUS 3 SENSING & VM	LM F-16	DC BUS 3
DC GROUND SERVICE BUS (NORM, ALT)	UM D-23, 24	AC BUS 3
DC TIE BUS SENSING (LEFF, RIGHT)	UM B-24, 25	AC BUS 1
DC TIE/DC BUS PWR OFF LTS	PO C-28	BATTERY BUS

CIRCUIT BREAKER LISTING (CONT)

ELECTRICAL (CONT)

DC X TIE	UM C-24	AC BUS 2
EMER & BAT BUS OFF LTS	PO A-26	BATTERY DIRECT BUS
EMER BUS WARN LT PROTECT RELAY	PO B-27	BATTERY BUS
EMER INVERTER PWR	PO A-15	BATTERY DIRECT BUS
EXTERNAL PWR	EPP	AC GND SVC BUS
GALLEY PWR	UM A-21	AC GND SVC BUS
L EMER AC & DC BUS CONT	PO A-25	BATTERY DIRECT BUS
L EMER AC BUS	UM B-21	AC BUS 1
L EMER AC BUS SENSING & VM	PO E-7	L EMER AC BUS
L EMER DC BUS SENSING	PO D-7	L EMER DC BUS
L EMER 28V AC BUS XFMR	PO E-5	L EMER AC BUS
OIL PRESS LOW LT CSD 1	LM D-17	DC BUS 1
OIL PRESS LOW LT CSD 2	LM E-17	DC BUS 2
OIL PRESS LOW LT CSD 3	LM F-17	DC BUS 3
OIL TEMP IND CSD 1	LM D-15	DC BUS 1
OIL TEMP IND CSD 2	LM E-15	DC BUS 2
OIL TEMP IND CSD 3	LM F-15	DC BUS 3
RCCB BACKUP POWER	PO C-30	BATTERY BUS
R EMER AC & DC BUS CONT	PO B-26	BATTERY BUS
R EMER AC BUS	UM D-21	AC BUS 3
R EMER AC BUS SENSING	PO E-22	R EMER AC BUS
R EMER DC BUS SENSING	PO D-22	R EMER DC BUS
R EMER 28V AC BUS XFMR	PO E-20	R EMER AC BUS
TR 1 INPUT	UM B-22	AC BUS 1
TR 1 OUTPUT	UM B-23	AC BUS 1
TR 2A INPUT	UM C-22	AC BUS 2
TR 2A OUTPUT	UM C-23	AC BUS 2
TR 2B INPUT	LM G-15, 16, 17	AC GND SVC BUS
TR 2B OUTPUT	UM C-25	AC BUS 2
TR 3 INPUT	PO F-29, 30, 31	R EMER AC BUS
TR 3 OUTPUT	UM D-25	AC BUS 3
28V AC BUS 1 XFMR	LM A-17	AC BUS 1
28V AC BUS 2 XFMR	LM B-17	AC BUS 2
28V AC BUS 3 XFMR	LM C-17	AC BUS 3
28V AC BUS 3 XFMR GND SVCS	LM G-13	AC GND SVC BUS
115V AC UTILITY OUTLETS (COCKPIT, AVIONICS COMPT)	LM J-14, 15	AC GND SVC BUS

CIRCUIT BREAKER LISTING (CONT)

ENGINES

ENG 2 CSD FLTR CLOG IND	AGS	28VDC GND SVC BUS
ENG FAILURE DETECTOR	UM E-23	AC BUS 1
ENG FAILURE DETECTOR LTS	UM H-23	DC BUS 1
ENG GND/FLT IDLE CONT	PO B-4	BATTERY BUS
ENG IGNITION A IGNITORS (ENG 1, 2, 3)	PO G-10, 11, 12	L EMER AC BUS
ENG IGNITION B IGNITORS (ENG 1, 2, 3)	PO G-25, 26, 27	R EMER AC BUS
ENG IGNITION OVERRIDE	PO B-6	BATTERY BUS
ENG INST MAX POINTER RESET	UM K-21	DC BUS 3
ENG OIL LOW PRESS WARN LT	PO B-8	BATTERY BUS
ENG OIL STRAINER LTS	UM K-23	DC BUS 3
ENG START & IGNITION CONT	PO B-7	BATTERY BUS
ENG START OVERRIDE	PO B-5	BATTERY BUS
ENGINE START VALVE LTS	UM J-24	DC BUS 2
*ENG VIB MONITOR	UM E-24	AC BUS 1
EXHAUST GAS TEMP (ENG 1, 2, 3)	PO F-13, 14, 15	L EMER AC BUS
FUEL VAPOR VENT	PO B-9	BATTERY BUS
N1 TACH IND ENG 1	PO E-11	L EMER AC BUS
N1 TACH IND ENG 2	UM F-23	AC BUS 2
N1 TACH IND ENG 3	PO E-25	R EMER AC BUS
N1 TACH SENSOR ENG 1	PO D-13	L EMER DC BUS
N1 TACH SENSOR ENG 2	UM J-23	DC BUS 2
N1 TACH SENSOR ENG 3	PO D-25	R EMER DC BUS
N2 TACH (ENG 1, 2, 3)	PO G-13, 14, 15	L EMER AC BUS
OIL PRESS IND ENG 1	UM E-22	AC BUS 1
OIL PRESS IND ENG 2	UM F-22	AC BUS 2
OIL PRESS IND ENG 3	UM G-22	AC BUS 3
OIL QTY IND ENG 1	UM E-26	AC BUS 1
OIL QTY IND ENG 2	UM F-26	AC BUS 2
OIL QTY IND ENG 3	UM G-26	AC BUS 3
OIL TEMP IND ENG 1	UM H-22	DC BUS 1
OIL TEMP IND ENG 2	UM J-22	DC BUS 2
OIL TEMP IND ENG 3	UM K-22	DC BUS 3
REMOTE ENG TRIM	LM C-7	AC BUS 3
REVERSING CONT ENG 1	UM H-25	DC BUS 1
REVERSING CONT ENG 2	UM J-25	DC BUS 2
REVERSING CONT ENG 3	UM K-25	DC BUS 3
REVERSING LTS ENG 1	UM H-26	DC BUS 1
REVERSING LTS ENG 2	UM J-26	DC BUS 2
REVERSING LTS ENG 3	UM K-26	DC BUS 3
T/R LOCK CONT ENG 1	UM H-17	DC BUS 1
T/R LOCK CONT ENG 3	UM K-17	DC BUS 3
TAT & THRUST RATING IND	OH B-34	28VAC BUS
VARIABLE GUIDE VANE ANGLE	LM F-9	DC BUS 3

CIRCUIT BREAKER LISTING (CONT)

FIRE CONTROL

APU FIRE HORN	PO C-21	BATTERY BUS
CARGO SMOKE DETS & LTS	PO D-5	L EMER DC BUS
ENG FIRE/OVSPD & ARO AURAL WARN	PO B-3	BATTERY BUS
ENG 2 & APU FIRE AGENT DISCH LT	PO B-18	BATTERY BUS
F/E APU FIRE WARN LT	PO C-20	BATTERY BUS
FIRE AGENT DISCHARGE LT ENG 1	UM H-24	DC BUS 1
FIRE AGENT DISCHARGE LT ENG 3	UM K-24	DC BUS 3
FIRE BELL CUTOFF/LOOP TEST	PO C-19	BATTERY BUS
FIRE DETECTORS LOOP A (ENG 1, 2, 3, APU)	PO B-14, 15, 16, 17	BATTERY BUS
FIRE DETECTORS LOOP B (ENG 1, 2, 3, APU)	PO C-14, 15, 16, 17	BATTERY BUS
FIREX CONTROL (AGENT 1, 2)	PO A-17, 18	BATTERY DIRECT BUS
FIREX HANDLE & FUEL LEVER LTS (ENG 1, 2, 3)	PO B-19, 20, 21	BATTERY BUS
MASTER FIRE WARN LT	PO C-18	BATTERY BUS

FLIGHT CONTROLS

AUTO PITCH TRIM	OH B-11	AC BUS 1
AUTO PITCH TRIM A	OH C-11	DC BUS 1
AUTO PITCH TRIM B	OH E-11	DC BUS 3
AUTO SLAT EXTEND CONTROL	LM F-11	DC BUS 3
AUTO SLAT EXTEND POWER	LM C-11	AC BUS 3
CAPT STICK SHAKER	OH C-17	DC BUS 1
ELEV LOAD FEEL & FLAP LIMIT 1	OH B-15, C-15	AC BUS 1, DC BUS 1
ELEV LOAD FEEL & FLAP LIMIT 2	OH D-15, E-15	AC BUS 3, DC BUS 3
ELEV LOAD FEEL INDICATOR	OH B-40	28VAC BUS 1
FGS SPINUP LOGIC SPOIL WARN SPD BKLT	LM F-13	DC BUS 3
F/O STICK SHAKER	OH E-17	DC BUS 3
GND SPOILER ACTUATOR	LM A-13	AC BUS 1
GND SPOILER CONT	LM D-13	DC BUS 1
HOR STAB ALTN TRIM CONT	OH E-18	DC BUS 3
HORIZ STAB IN MOTION	OH C-18	DC BUS 1
HORIZ STAB TRIM RATE CONT 1	OH C-14	DC BUS 1
HORIZ STAB TRIM RATE CONT 2	OH E-14	DC BUS 3
L SURFACE POS IND	OH C-39	28VAC BUS 1
LOWER YAW DAMPER (A, B)	PO D-8, 9	L EMER DC BUS
	PO E-8, 9	L EMER AC BUS
PRIMARY HORIZ STAB TRIM	LM E-9	DC BUS 2
R SURFACE POS IND	OH E-39	28VAC BUS 3
RUDDER STBY PWR & IND	UM H-20	DC BUS 1
SELECT ELEV FEEL MAN LT	LM E-10	DC BUS 2
SELECT FLAP LIM OVERRIDE LT	LM E-11	DC BUS 2
SLAT POSITION SYS 1	LM D-14	DC BUS 1
SLAT POSITION SYS 2	LM F-14	DC BUS 3
UPPER YAW DAMPER (A, B)	PO D-23, 24	R EMER DC BUS
	PO E-23, 24	R EMER AC BUS
YAW DAMPER INOP LT (LOWER, UPPER)	PO C-8, 9	BATTERY BUS

CIRCUIT BREAKER LISTING (CONT)

FLT GUIDANCE/AUTO THROTTLES

ACCEL 1	OH B-12	AC BUS 1
ACCEL 2	OH D-12	AC BUS 3
ACCEL GO AROUND 1	OH C-12	DC BUS 1
ACCEL GO AROUND 2	OH E-12	DC BUS 3
AIR DATA INST SWITCH UNIT	PO C-4	BATTERY BUS
ALT ALERT HOR STAB AUTOPILOT AURAL WARN	LM B-12	AC BUS 2
ATS ADVISORY OFF LT (1, 2)	PO C-12, 13	BATTERY BUS
AT/SC STALL WARN 1	OH B-13	AC BUS 1
AT/SC STALL WARN 2	OH D-13	AC BUS 3
AT/SC/SW FLAP IND HOR STAB 1	OH B-39	28VAC BUS 1
AT/SC/SW FLAP IND HOR STAB 2	OH D-39	28VAC BUS 3
AT/SC 1	OH C-13	DC BUS 1
AT/SC 2	OH E-13	DC BUS 3
AUTOPILOT ADVISORY & OFF LT (1, 2)	PO C-10, 11	BATTERY BUS
CAPT HSI CRS/HDG SELECT	PO G-3	28VAC L EMER BUS
*DUAL LAND ELEC SYS INTERLOCK	PO A-21	BATTERY DIRECT BUS
FLT DIR CMD SW UNIT	OH C-21	DC BUS 1
FLT GDNC MODE ANN 1	OH B-6	AC BUS 1
	OH C-6	DC BUS 1
FLT GDNC MODE ANN 2	OH D-6	AC BUS 3
	OH E-6	DC BUS 3
FLT GDNC 1 CONTROL PANEL	OH C-10	DC BUS 1
FLT GDNC 1 PITCH	OH B-8	AC BUS 1
	OH C-8	DC BUS 1
FLT GDNC 1 ROLL	OH B-9	AC BUS 1
	OH C-9	DC BUS 1
FLT GDNC 2 CONTROL PANEL	OH E-10	DC BUS 3
FLT GDNC 2 PITCH	OH D-8	AC BUS 3
	OH E-8	DC BUS 3
FLT GDNC 2 ROLL	OH D-9	AC BUS 3
	OH E-9	DC BUS 3
F/O HSI CRS/HDG SELECT	PO G-18	28V AC R EMER BUS
HEADING PLATFORM 1	PO E-3	28VAC L EMER BUS
HEADING PLATFORM 2	PO E-18	28VAC R EMER BUS
LEFT AVIONICS 28V AC BUS XFMR	OH B-4	AC BUS 1
MAINT ASSMT PANEL	OH C-5	DC BUS 1
*PAFM POWER 1	OH B-7	AC BUS 1
*PAFM POWER 2	OH D-7	AC BUS 3
RIGHT AVIONICS 28V AC BUS XFMR	OH D-4	AC BUS 3

CIRCUIT BREAKER LISTING (CONT)

FUEL

AR FUEL PRESS CONT L SYS	UM H-9	DC BUS 1
AR FUEL PRESS CONT R SYS	UM K-9	DC BUS 3
AR PUMP OVRD	UM K-7	DC BUS 3
AR RECP & MASTER FUEL VALVE	UM H-7	DC BUS 1
AR PUMP OVRD CONT/IND	UM J-6	DC BUS 2
BOMD/DROGUE FUEL CONT/IND	UM J-10	DC BUS 2
CTR WING L UPR & LWR PRESS LOW LTS	UM J-15	DC BUS 2
CTR WING R UPR & LWR PRESS LOW LTS	UM H-15	DC BUS 1
DUMP V IND & FUEL LOW LVL SHUTOFF	UM J-12	DC BUS 2
ENG FUEL FILTER PRESS DROP LTS	UM J-21	DC BUS 2
FUEL FLOW IND ENG 1	UM E-25	AC BUS 1
FUEL FLOW IND ENG 2	UM F-25	AC BUS 2
FUEL FLOW IND ENG 3	UM G-25	AC BUS 3
FUEL MANF DRAIN	UM J-11	DC BUS 2
FUEL PRESS IND ENG 1	UM E-21	AC BUS 1
FUEL PRESS IND ENG 2	UM F-21	AC BUS 2
FUEL PRESS IND ENG 3	UM G-21	AC BUS 3
FUEL PUMP CONTROL		
TANK 1: AFT	UM G-14	AC BUS 3
FWD	UM E-14	AC BUS 1
XFR	UM F-14	AC BUS 2
TANK 2: FWD	UM E-15	AC BUS 1
R AFT	UM F-15	AC BUS 2
XFR	UM G-15	AC BUS 3
TANK 3: FWD	UM G-16	AC BUS 3
AFT	UM F-16	AC BUS 2
XFR	UM E-16	AC BUS 1
CTR WING L LWR	UM F-13	AC BUS 2
CTR WING L UPR	UM F-12	AC BUS 2
CTR WING R LWR	UM G-13	AC BUS 3
CTR WING R UPR	UM E-13	AC BUS 1
FUS AFT XFR	UM G-12	AC BUS 3
FUS FWD XFR	UM E-12	AC BUS 3
TANK 1 WING TIP	UM F-11	AC BUS 2
TANK 3 WING TIP	UM G-11	AC BUS 3
FUEL PUMP POWER		
TANK 1: AFT	UM D-14	AC BUS 3
FWD	UM B-14	AC BUS 1
XFR	UM C-14	AC BUS 2
TANK 2: FWD	UM B-15	AC BUS 1
L AFT	PO G-29, 30, 31	R EMER AC BUS
R AFT	UM C-15	AC BUS 2
XFR	UM D-15	AC BUS 3
TANK 3: AFT	UM C-16	AC BUS 2
FWD	UM D-16	AC BUS 3
XFR	UM B-16	AC BUS 1
AFT FUSLG XFR	UM D-12	AC BUS 3
CTR WING L LWR	UM C-13	AC BUS 2
CTR WING L UPR	UM C-12	AC BUS 2

CIRCUIT BREAKER LISTING (CONT)

FUEL (CONT)

FUEL PUMP POWER (CONT)		
CTR WING R LWR	UM D-13	AC BUS 3
CTR WING R UPR	UM B-13	AC BUS 1
FWD FUSLG XFR	UM B-12	AC BUS 1
TANK 1 WING TIP	UM C-11	AC BUS 2
TANK 3 WING TIP	UM D-11	AC BUS 3
FUEL QTY ALTN POWER	UM F-10	AC BUS 2
FUEL QTY NORM POWER	UM E-10	AC BUS 1
FUEL QTY RPTRS & XFR	UM G-10	AC BUS 3
FUEL QTY XFR RELAY	UM E-11	AC BUS 1
FUEL TANK FILL VALVE (ALL TANKS)	PO B-28, 29	BATTERY BUS*
FUEL TK OFF SCHEDULE LTS	UM K-11	DC BUS 3
FUEL X-FEED CONT 1	UM H-14	DC BUS 1
FUEL X-FEED CONT 2	UM J-14	DC BUS 2
FUEL X-FEED CONT 3	UM K-14	DC BUS 3
FUEL X-FEED CONT LT 1	UM H-13	DC BUS 1
FUEL X-FEED CONT LT 2	UM J-13	DC BUS 2
FUEL X-FEED CONT LT 3	UM K-14	DC BUS 3
FUEL X-FEED VALVE LT 1	UM H-13	DC BUS 1
FUEL X-FEED VALVE LT 2	UM J-13	DC BUS 2
FUEL X-FEED VALVE LT 3	UM K-13	DC BUS 1
FUSLG AUX TANK XFR PUMPS	UM J-5	DC BUS 2
FUSLG FUEL TKS ALT XFR VLV CONT	UM H-10	DC BUS 1
FUSLG FUEL TKS ALT XFR VLV IND	UM K-10	DC BUS 3
FWD PUMPS PRESS LOW LTS	UM H-16	DC BUS 1
GND FUEL INV PWR & HI LEVEL TEST	PO A-27	BATTERY DIRECT BUS
GROUND REFUEL POWER (ALL TANKS)	PO A-28, 29	BATTERY DIRECT BUS
L AR PUMPS PRESS LOW LIGHTS	UM K-16	DC BUS 3
L AR PUMPS PRESS LOW	UM H-6	DC BUS 1
L FUEL DUMP VALVE CONT	UM H-12	DC BUS 1
OFFLOAD FUEL FLOW IND	UM F-9	AC BUS 2
OFFLOAD FUEL FLOW PWR	UM J-9	DC BUS 2
R AFT PUMPS PRESS LOW LIGHTS	UM J-16	DC BUS 2
R AR PUMPS PRESS LOW	UM K-6	DC BUS 3
R FUEL DUMP VALVE CONT	UM K-12	DC BUS 3
RCVR/TNKR MANF SCAVENGE PUMPS	UM F-8	AC BUS 2
RCVR/TNKR MANF SCAV PUMPS PRESS LOW	UM K-8	DC BUS 3
RCVR/TNKR MANF SCAVENGE VALVES	UM J-8	DC BUS 2
TANK FUEL TEMP IND	UM H-11	DC BUS 1
WING TIP FUEL PUMP & XFR OVRD	UM K-5	DC BUS 3

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* Fuel Isolation Valves receive power through the FUEL TANK FILL VALVE CTR WING & FUSLG TKS (PO B-29) circuit breaker.

CIRCUIT BREAKER LISTING (CONT)

HYDRAULICS

AR HYD RESERVOIR PRESS LOW LT	UM J-19	DC BUS 2
AR HYD SYS PRESS LTS	UM K-4	DC BUS 3
AUX HYD PUMP CONT & LTS	PO A-1	BATTERY BUS
AUX HYD PUMP 1	UM A-13	AC GND SVC BUS
AUX HYD PUMP 2	UM A-14	AC GND SVC BUS
ENG HYD PUMPS CONT (LEFT, RIGHT)	PO A-2, 3	BATTERY BUS
ENG HYD PUMP PRESS LTS	UM K-19	DC BUS 3
ENG HYD PUMP TEMP HI LT	UM H-19	DC BUS 1
HYD FLT CONT ISOL SYS 3	UM K-20	DC BUS 3
HYD MOTOR-PUMPS CONT & LTS (1-3, 2-3)	PO A-4, 5	BATTERY BUS
HYD PRESS IND 1	UM E-19	AC BUS 1
HYD PRESS IND 2	UM F-19	AC BUS 2
HYD PRESS IND 3	UM G-19	AC BUS 3
HYD QTY IND 1	UM E-18	AC BUS 1
HYD QTY IND 2	UM F-18	AC BUS 2
HYD QTY IND 3	UM G-18	AC BUS 3
HYD SYS 3 ELEV SHUTOFF	PO B-22	BATTERY BUS
HYD TEMP IND 1	UM H-18	DC BUS 1
HYD TEMP IND 2	UM J-18	DC BUS 2
HYD TEMP IND 3	UM K-18	DC BUS 3
1-3/2-3 PUMP VALVE IND	UM J-20	DC BUS 2

ICE CONTROL & RAIN

ARO LOWER WINDOW HEAT	ARO	115VAC ARO BUS
ARO WINDOW HEAT-POWER (2), CONTROL	ARO	115VAC ARO BUS
AUX PITOT HEAT	UM M-25	AC BUS 2
CAPT PITOT HEAT	PO E-6	L EMER AC BUS
ENG & ANT ANTI-ICE DISAGREE LTS	UM P-26	DC BUS 1
ENG ANTI-ICE VALVE ENG 1	UM P-25	DC BUS 1
ENG ANTI-ICE VALVE ENG 3	UM S-25	DC BUS 3
ENG 2 & ANTI-ICE VALVE	UM R-25	DC BUS 2
ENG 2 DRAIN HTR	AGS	28VDC GND SVC BUS
F/O PITOT HEAT	PO E-21	R EMER AC BUS
L ANGLE ATTACK HEAT	UM L-11	28VAC BUS 1
	UM L-25	AC BUS 1
L CLEARVIEW DEFOG	UM L-21	AC BUS 1
L STATIC PORT HEAT	UM L-26	AC BUS 1
L WINDSHIELD ANTI-ICE (CONT)	UM L-22	AC BUS 1
(PWR)	UM L-23, 24	AC BUS 1
	UM P-23	DC BUS 1
L WINDSHIELD DEFOG	UM L-20	AC BUS 1
L WINDSHIELD WIPER (CONT)	UM P-21	DC BUS 1
(MOTOR)	UM P-22	DC BUS 1
LAV DRAIN MAST HEAT	UM M-23	AC BUS 2
PITOT HEAT CONT MONITOR PWR	UM R-26	DC BUS 2

CIRCUIT BREAKER LISTING (CONT)

ICE CONTROL & RAIN (CONT)

R ANGLE ATTACK HEAT	UM N-11	28VAC BUS 1
	UM N-25	DC BUS 3
R CLEARVIEW DEFOG	UM N-21	AC BUS 3
R STATIC PORT HEAT	UM N-26	AC BUS 3
R WINDSHIELD ANTI-ICE (CONT)	UM N-22	AC BUS 3
(PWR)	UM N-23, 24	AC BUS 3
	UM S-23	DC BUS 3
R WINDSHIELD DEFOG	UM N-20	AC BUS 3
R WINDSHIELD WIPER (CONT)	UM S-21	DC BUS 3
(PWR)	UM S-22	DC BUS 3
RAIN REPELLANT SYS	UM R-22	DC BUS 2
TAT PROBE HEAT	UM M-26	AC BUS 2
WING ANTI-ICE VALVE	UM P-24	DC BUS 1
WING ANTI-ICE DISAGREE LTS	UM S-24	DC BUS 3

INSTRUMENTS

AIR DATA CMPTR 1	PO F-6	L EMER AC BUS
AIR DATA CMPTR 2	PO F-21	R EMER AC BUS
ATTITUDE 1	PO E-2	28VAC L EMER BUS
ATTITUDE 2	PO E-17	28VAC R EMER BUS
ATTITUDE 3	OH B-36	28VAC BUS 1
	OH D-36	28VAC BUS 3
BSIU 1	PO E-14	L EMER DC BUS
BSIU 2	PO D-20	R EMER DC BUS
BUS SPLIT SW	OH D-26	DC BUS 1
CADC SWITCHED LT	OH E-20	DC BUS 3
CAPT & F/O RMI UHF/ADF BEARING	OH C-37	28VAC BUS 1
CAPT ADI RADIO & CMD INFO	OH B-35	28VAC BUS 1
CAPT ALTIMETER	PO F-2	28VAC L EMER BUS
CAPT ALTIMETER ADVISORY LT	OH C-22	DC BUS 1
CAPT FMS SW UNIT	PO C-6	BATTERY BUS
CAPT HORIZON	PO G-1	28VAC L EMER BUS
CAPT HSI HEADING	PO G-2	28VAC L EMER BUS
CAPT MACH AIRSPEED IND	PO F-1	28VAC L EMER BUS
CAPT RAD/INS SWITCHING	PO D-3	L EMER DC BUS
CAPT RMI HEADING	OH E-36	28VAC BUS 3

CIRCUIT BREAKER LISTING (CONT)

INSTRUMENTS (CONT)

CAPT RAD ANN LTS	OH C-26	DC BUS 1
CAPT RADIO SWITCHING	PO C-3	BATTERY BUS
CAPT TACAN RMI HEADING & BEARING	OH C-34	28VAC BUS 1
CAPT TVSI	PO F-5	L EMER AC BUS
CAPT VERT SPEED IND	PO F-3	28VAC L EMER BUS
CDU 1	PO E-13	L EMER DC BUS
CDU 2	PO D-19	R EMER DC BUS
CDU 3	OH E-4	DC BUS 3
COMPASS 1	PO G-8	L EMER AC BUS
CONTROLS & BRAKE PED POS XMTRS	OH E-38	28VAC BUS 3
DATA LOADER	PO E-15	L EMER DC BUS
EHSI 1	PO E-12	L EMER DC BUS
EHSI 2	PO D-18	R EMER DC BUS
ELEC CLOCK	PO A-16	BATTERY DIR BUS
ETCAS CMPTR	OH B-27	AC BUS 1
F/O ADI RADIO & CMD INFO	OH D-35	28VAC BUS 3
F/O ALTIMETER	PO F-17	28VAC R EMER BUS
F/O ALTIMETER ADVISORY LT	OH E-22	DC BUS 3
F/O FMS SW UNIT	OH E-7	DC BUS 3
F/O HORIZON	PO G-16	28VAC R EMER BUS
F/O HSI HEADING	PO G-17	28VAC R EMER BUS
F/O MACH AIRSPEED IND	PO F-16	28VAC R EMER BUS
F/O RAD ANN LTS	OH E-26	DC BUS 3
F/O RAD/INS SWITCHING	PO D-17	R EMER DC BUS
F/O RADIO SWITCHING	PO D-18	R EMER DC BUS
F/O RMI HEADING	OH C-36	28VAC BUS 1
F/O TACAN RMI HEADING & BEARING	OH E-34	28VAC BUS 3
F/O TVSI	PO F-20	R EMER AC BUS
F/O VERT SPEED IND	PO F-18	28VAC R EMER BUS
GROUND PROX WARN	OH B-19	AC BUS 1
GROUND PROX WARN LT	OH C-19	DC BUS 1
HEADING PLATFORM 3	OH D-40	28VAC BUS 3
I-BAND BEACON XPNDR	OH C-27	DC BUS 1
ILS 1	OH A-27	AC BUS 1
ILS 2	PO G-20	R EMER AC BUS
INS FLOW OFF LT 1	OH C-24	DC BUS 1
INS FLOW OFF LT 2	OH E-24	DC BUS 3
INS FLOW OFF LT 3	OH E-25	DC BUS 3
INS SWITCH UNIT	PO C-7	BATTERY BUS
INS/ISS WARNING	PO A-22	BATTERY DIRECT BUS
INS 1	PO E-4	28VAC L EMER BUS
	OH B-20, 21	AC BUS 1
INS 1 FAN	OH B-22	AC BUS 1
INS 2	PO E-19	28VAC R EMER BUS
INS 2/COMPASS	PO G-23	R EMER AC BUS
INS 2 FAN	PO G-22	R EMER AC BUS
INS 2 VERT GYRO 2	PO G-21	R EMER AC BUS
INS 3	PO E-16	28VAC R EMER BUS
INS 3 DIR GYRO 3	OH D-20	AC BUS 3
INS 3 FAN	OH D-22	AC BUS 3
INS 3 VERT GYRO 3	OH D-21	AC BUS 3
J-BAND BEACON XPNDR	OH E-27	DC BUS 3
MARKER BEACON	OH E-28	DC BUS 3
RADIO ALTIMETER 1	OH B-10	AC BUS 1
RADIO ALTIMETER 2	OH D-10	AC BUS 3
STANDBY ALTIMETER VIBRATOR	OH E-21	DC BUS 3
STANDBY HORIZON	PO C-5	BATTERY BUS

CIRCUIT BREAKER LISTING (CONT)

INSTRUMENTS (CONT)

TACAN 1	OH B-23	AC BUS 3
	OH C-23	DC BUS 3
TACAN 2	OH D-23	AC BUS 3
	OH E-23	DC BUS 3
TAS/SAT IND	OH E-37	28VAC BUS 3
UHF/ADF	OH C-28	DC BUS 1
VERT GYRO 1	PO G-6	L EMER AC BUS
VERT GYRO 3	OH A-21	AC BUS 1
VOR 1	PO G-4	28VAC L EMER BUS
	PO D-2	L EMER DC BUS
VOR 2	PO G-19	28VAC R EMER BUS
	PO D-16	R EMER DC BUS
WINDOW HT/HYD PRESS/REEL IND	ARO	28VDC ARO BUS

LANDING GEAR

ANTI SKID CONTROL	LM A-14	AC BUS 1
	LM C-14	AC BUS 3
ANTI SKID TEST	LM E-14	DC BUS 2
ANTI BRAKE SYS	LM D-12	DC BUS 1
ANTI BRAKE SYS TEST	LM E-12	DC BUS 2
BRAKE HYD PRESS IND 1	UM E-20	AC BUS 1
BRAKE HYD PRESS IND 3	UM G-20	AC BUS 3
BRAKE TEMP MONITOR	LM B-13	AC BUS 2
BRAKE TEMP MONITOR IND	LM E-13	DC BUS 2
CENTER GEAR CONTROL	LM D-7	DC BUS 1
F/E LANDING GEAR WARNING	LM F-7	DC BUS 3
LDG GEAR WARN	LM E-7	DC BUS 2
L GROUND SENSING	UM P-1	DC BUS 1
PARKING BRAKE VALVE	LM B-14	AC BUS 2
R GROUND SENSING	UM S-1	DC BUS 3
WHEEL SPINUP SENSING	LM F-12	DC BUS 3
WHEEL SPINUP SENSING TEST	LM C-13	AC BUS 3

LIGHTING

AISLE LIGHTS	OR	28VDC GND SVC BUS
AFT DOOR THRESHOLD LT	AGS	28VDC GND SVC BUS
AR RECP FLOOD LTS	UM G-7, 8, 9	AC BUS 3
AR RECP SLIPWAY LTS	UM E-9	AC BUS 1
ARO ANNUN DIM & TEST	ARO	28VDC ARO BUS
ARO COMPT FLUOR LTS	ARO	115VAC ARO BUS
ARO COMP MISC LTS XFMR	AGS	115VAC GND SVC BUS
ARO CONSOLE & OVHD PANEL FLOOD LTS	ARO	28VDC ARO BUS

CIRCUIT BREAKER LISTING (CONT)

LIGHTING (CONT)

ARO DIRECTOR LIGHTS CONTROL	ARO	28VDC ARO BUS
ARO IBO LT	ARO	28VDC ARO BUS
ARO INSTR LTS	ARO	AC SECONDARY ARO BUS
ARO INSTR PNL FLOODLITES	ARO	115VAC ARO BUS
ARO INSTR PNL INTEGRAL LIGHTING (2)	ARO	AC SECONDARY ARO BUS
ARO INSTR PNL LIGHTING	ARO	115VAC ARO BUS
BEACON LIGHTS LOWER	LM B-3	AC BUS 2
BEACON LIGHTS UPPER	LM A-3	AC BUS 1
BOOM CONTROL UNIT/MODE LTS	ARO	115VAC ARO BUS
BOOM LIGHTS (MARKING, NOZZLE)	ARO	115VAC ARO BUS
BOOM SIGNAL LTS (2)	ARO	AC SECONDARY ARO BUS
CABIN OVHD LTS CONTROL (AFT, FWD/MID)	OR	28VDC GND SVC BUS
CABIN OVHD LTS XFMR POWER (AFT, FWD/MID)	OR	28VDC GND SVC BUS
CABIN OVERHEAD LTG OVRD CONT	LM E-3	DC BUS 2
CAPT INST PANEL LTG	LM A-6	AC BUS 1
CARGO DOOR LTS	OL	28VDC GND SVC BUS
CENTER INST PANEL LTG	LM A-8	AC BUS 1
CIRCUIT BREAKER PANEL LTG	LM B-5	AC BUS 2
COCKPIT DOME LT	LM C-4	AC BUS 3
COCKPIT FLOOR LTS & 28V AC OUTLET	LM H-13	AC GND SVC
COCKPIT STANDBY LIGHTING CONT	LM F-2	DC BUS 3
COCKPIT THUNDERSTORM LT CONT	LM D-2	DC BUS 1
COPILOT CONSOLE: FMA	CC	115VAC BUS 3
GLARE SHIELD	CC	115VAC BUS 3
HSI/DME	CC	115VAC BUS 3
INST F/O (2)	CC	115VAC BUS 3
INST PED (2)	CC	115VAC BUS 3
LIGHTPLATES F/O	CC	115VAC BUS 3
DROGUE LIGHTS (SIG, FLOOD)	ARO	115VAC ARO BUS
EMER LTS ARM	PO C-25	BATTERY BUS
EMER LT BATTERY TEST	LM F-3	DC BUS 3
EMER LTS CHARGE & STBY	PO F-22	R EMER AC BUS
EMER LTS CONT	LM G-3	AC GND SVC BUS
EMER LTS STANDBY	PO D-6	L EMER DC BUS
ENTRY LIGHTS POWER (2)	OR	115VAC GND SVC BUS
ENTRY LIGHTS CONTROL (CABIN, LAV)	OR	28VDC GND SVC BUS
EXT LT UPPER FUSLG	LM B-4	AC BUS 2
FLT GNDC CONT PNL FLOOD LT	LM E-1	DC BUS 2
F/E FLOOD LTS	PO C-24	BATTERY BUS
F/E INST PANEL LTG	LM B-6	AC BUS 2
F/E LIGHTING PANEL		
F/E INST LTS: AFT PNL	FEL	115VAC BUS 3
CTR PNL (2)	FEL	115VAC BUS 3
FWD PNL	FEL	115VAC BUS 3
LOWER FWD PNL	FEL	115VAC BUS 3
FUEL PNL	FEL	115VAC BUS 3
F/E INSTR: COCKPIT FLOOR LTS	FEL	115VAC BUS 3
LIGHTING: FUEL FLOW LINE	FEL	115VAC BUS 3
F/E & C/B: FWD PNL	FEL	115VAC BUS 3

CIRCUIT BREAKER LISTING (CONT)

LIGHTING (CONT)

F/E LIGHTING PANEL (CONT)			
LIGHTPLATES:	AFT PNL	FEL	115VAC BUS 3
	CTR PNL	FEL	115VAC BUS 3
	FUEL PNL	FEL	115VAC BUS 3
	LOWER MAIN & AVIONIC P	FEL	115VAC BUS 3
	LWR FWD & AFT PNL	FEL	115VAC BUS 3
	OVERHEAD PNL	FEL	115VAC BUS 3
	UPPER MAIN PNL	FEL	115VAC BUS 3
F/E WORK TABLE LT	LM A-5	AC BUS 1	
F/O INST PANEL LTG		LM C-6	AC BUS 3
FORMATION LTS		LM A-4	AC BUS 1
FWD CABIN OVHD LTS		OR	115VAC GND SVC BUS
GLARE SHIELD LTG		LM A-7	AC BUS 1
HI-INT LTS		LM C-3	AC BUS 3
INBD NAV LTS		LM G-6	AC GND SVC BUS
LAV MIRROR LIGHTS CONTROL		OR	28VDC GND SVC BUS
LAV 1 & Z MIRROR LTS POWER (LT, RT)		OR	115VAC GND SVC BUS
L OVHD FLOOD LT		PO C-23	BATTERY BUS
LEFT LANDING LIGHT (CONT, LAMP)		LM A-1, 2	AC BUS 1
LEFT RUNWAY TURNOFF LT		LM G-5	AC GND SVC BUS
LOGO LITE CONT		LM G-4	AC GND SVC BUS
LOGO LTS POWER (LEFT, RIGHT)		AGS	115VAC GND SVC BUS
MAIN INST FLUOR FLOOD LTS		LM B-8	AC BUS 2
MAIN INST PANEL FLOOD LTS		PO C-22	BATTERY BUS
MAIN W/W CTR ACCESS COMPT LT		LM J-6	AC GND SVC BUS
MAP BRIEFCASE CHART & TABLE LTS		LM E-2	DC BUS 2
MASTER CAUTION & CUE LTS		PO B-2	BATTERY BUS
MASTER WARN LTS		PO B-1	BATTERY BUS
NOSE LANDING & TAXI LT (L, R)		LM B-1, 2	AC BUS 2
NOSE W/W AVIONICS & A/C COMP LT		LM J-5	AC GND SVC BUS
OUTBD NAV LTS		LM H-6	AC GND SVC BUS
OVERHEAD SW PANEL LTG		LM C-5	AC BUS 3
OVERHEAD SW PANEL:	INST	OI	115VAC BUS 3
	LIGHTPLATES (2)	OI	115VAC BUS 3
PASS OXY REG LTS (2)		OL	28VAC GND SVC 115VAC GND SVC
PASS WARN SIGNS		LM D-6	DC BUS 1
TAIL COMP LTS XFMR		AGS	115VAC GND SVC BUS
THRESHOLD LIGHTS		OR	28VDC GND SVC BUS
PILOT DIRECTOR LTS:			
(BACKGROUND	UP/DN, FWD/AFT)	ARO	115VAC ARO BUS
(POSITION	UP/DN, FWD/AFT)	ARO	115VAC ARO BUS
PILOTS CONSOLE:	CAPT INST (2)	PC	115VAC BUS 3
	CTR	PC	115VAC BUS 3
	CTR INST (2)	PC	115VAC BUS 3
	FMA	PC	115VAC BUS 3
	HSI/DME	PC	115VAC BUS 3
	LIGHTPLATES CAPT	PC	115VAC-BUS 3

CIRCUIT BREAKER LISTING (CONT)

LIGHTING (CONT)

PEDESTAL PANEL LTG	LM B-7	AC BUS 2
R OVHD & PED FLOOD LTS	LM F-1	DC BUS 3
RIGHT LANDING LT (CONT, LAMP)	LM C-1, 2	AC BUS 3
RIGHT RUNWAY TURNOFF LT	LM H-5	AC GND SVC BUS
RCVR FLOOD LTS	ARO	115VAC ARO BUS
SPARE ANNUNCIATOR LTS	LM D-3	DC BUS 1
STANDBY COMPASS LT	LM D-1	DC BUS 1
UNDERBODY LTS (FUSLG, WING, HORIZ STAB)	ARO	115VAC ARO BUS
WARN LT DIMMING & TEST	LM D-4	DC BUS 1
WING SCAN LTS	LM J-4	AC GND SVC BUS

MISCELLANEOUS & MAINTENANCE

CAPT SEAT CONT	LM D-8	DC BUS 1
CAPT SEAT POWER	LM A-9, 10, 11	AC BUS 1
CHEM DEFENSE: ARO	ARO	115VAC ARO BUS
CHEM DEFENSE BOOM OP	UM R-18	DC BUS 2
CHEM DEFENSE COPILOT	UM S-17	DC BUS 3
CHEM DEFENSE FE	UM S-18	DC BUS 3
CHEM DEFENSE PILOT	UM R-17	DC BUS 2
COCKPIT DOOR LOCK	LM D-9	DC BUS 1
F/E SEAT CONTROL	LM E-8	DC BUS 2
F/E SEAT POWER	LM B-9, 10, 11	AC BUS 2
F/O SEAT CONTROL	LM F-8	DC BUS 3
F/O SEAT POWER	LM C-8, 9, 10	AC BUS 3
MAINT ASSMT PANEL	OH C-5	DC BUS 1
TEST EQUIP CONT PWR	LM G-12	AC GND SVC BUS
TEST EQUIP PWR	AGS	115VAC GND SVC BUS
T.O. LDG & CABIN PRESS AURAL WARNING	LM C-12	AC BUS 3

OXYGEN

CREW OXY QTY IND/PASS OXY ALTN CONT		LM E-6	DC BUS 2
PASS OXY CONT		LM F-6	DC BUS 3
PASS OXY RELEASE:	PALLETS/ADD SPRT PERS	UM N-6	AC BUS 3
		UM M-7	AC BUS 2
		UM L-6	AC BUS 1
	SPRT PERS	UM M-6	AC BUS 2

CIRCUIT BREAKER LISTING (CONT)

PNEUMATICS/AIR CONDITIONING/PRESSURIZATION

AIR COND TRIM AIR PRESS HIGH LT	UM P-13	DC BUS 1
APU ISOL VALVE CONT	UM P-3	DC BUS 1
APU/PACK TEMP DEMAND CONT	UM M-18	AC BUS 2
ARO EQPT RACK COOLING FAN (3)	ARO	115VAC ARO BUS
AUTO TEMP CONT PACK 1	UM N-17	AC BUS 3
AUTO TEMP CONT PACK 3	UM N-18	AC BUS 3
AVIONICS COMP FAN	UM L-17, 18, 19	AC BUS 1
AVIONICS VENTURI VALVE & CONT	UM L-16	AC BUS 1
AVIONICS FLOW OFF LT	UM R-19	DC BUS 2
CABIN ALT WARN	UM S-2	DC BUS 3
CABIN AUTO TEMP CONT	UM N-16	AC BUS 3
CABIN & ARO COMPT DUCT TEMP IND	UM R-15	DC BUS 2
CABIN & ARO COMPT TEMP IND	UM P-16	DC BUS 1
CABIN MANUAL TEMP CONT	UM M-16	AC BUS 2
CABIN PRESS AUTO CONT LESS TCTO 1C-10(K)A-956	UM L-2 ◄	AC BUS 1
WITH TCTO 1C-10(K)A-956	UM L-8 ◄	
CABIN PRESS RELIEF LT	UM R-3	DC BUS 2
CABIN PRESS SEMI-AUTO LT	UM P-2	DC BUS 1
CENTER ACCESS COMPT FAN	UM M-19	AC BUS 2
CENTER ACCESS COMPT FLOW OFF	UM S-19	DC BUS 3
CENTER INST PANEL FAN LESS TCTO 1C-10(K)A-956	UM L-3 ◄	AC BUS 1
WITH TCTO 1C-10(K)A-956	UM L-8 ◄	
COCKPIT AUTO TEMP CONT	UM M-15	AC BUS 2
COCKPIT DUCT TEMP CONT	UM S-15	DC BUS 3
COCKPIT MANUAL TEMP CONT	UM N-15	AC BUS 3
COCKPIT TEMP IND	UM P-15	DC BUS 1
DUCT/AVIONICS COMPT OVHT LT	UM R-12	DC BUS 2
FLOW CONT VALVE SHUTOFF & PACK OFF LTS (PACK 1, PACK 3)	PO B-11, 12	BATTERY BUS
FLOW IND: PACK 1	UM L-14	AC BUS 1
PACK 3	UM N-14	AC BUS 3
ISOL VALVE CONTROL 1 TO 2	PO G-24	R EMER AC BUS
ISOL VALVE CONTROL 1 TO 3	PO G-9	L EMER AC BUS
ISOL VALVE DISAGREE LTS	UM R-8	DC BUS 2
LAV/GALLEY VENT	UM P-18	DC BUS 1
L TRIM AIR PRESS REGULATOR	UM P-12	DC BUS 1
MANIFOLD FAILURE DET LOOP 1	UM L-9	AC BUS 1
MANIFOLD FAILURE DET LOOP 2	UM M-9	AC BUS 2
MANIFOLD FAILURE DET LOOP 3	UM N-9	AC BUS 3
MANIFOLD FAILURE DET LT LOOP 1	UM P-9	DC BUS 1
MANIFOLD FAILURE DET LT LOOP 2	UM R-9	DC BUS 2
MANIFOLD FAILURE DET LT LOOP 3	UM S-9	DC BUS 3
MANUAL TEMP CONTROL (PACK 1, 3)	PO F-11, 12	L EMER AC BUS
PACK DISCH TEMP IND	UM P-14	DC BUS 1
PACK VALVE POSITION IND	UM M-13	AC BUS 2
PNEU ABNORMAL LT ENG 1	UM P-10	DC BUS 1
PNEU ABNORMAL LT ENG 3	UM S-10	DC BUS 3
PNEU HP BLEED V CONT ENG 1	UM P-4	DC BUS 1
PNEU HP BLEED V CONT ENG 3	UM S-4	DC BUS 3
PNEU MANIFOLD FAILURE SMY LT	UM P-8	DC BUS 1

CIRCUIT BREAKER LISTING (CONT)

PNEUMATICS/AIR CONDITIONING/PRESSURIZATION (CONT)

PNEU PRESS REGULATOR: ENG 1	UM R-5	DC BUS 2
ENG 3	UM P-5	DC BUS 1
PNEU SYS CONTROL: ENG 1	UM L-5	AC BUS 1
ENG 3	UM N-5	AC BUS 3
PNEU SYS MONITOR: ENG 1 LESS TCTO 1C-10(K)A-956	UM L-4 ◀	AC BUS 1
WITH TCTO 1C-10(K)A-956	UM L-7 ◀	
ENG 3	UM N-4	AC BUS 3
PNEU TEMP HI LT: ENG 1	UM P-7	DC BUS 1
ENG 3	UM S-7	DC BUS 3
PNEU TEMP IND ENG 3	UM S-6	DC BUS 3
PNEU TEMP HI SMY LT	UM S-8	DC BUS 3
RADIO RACK FAN	UM N-1, 2, 3	AC BUS 3
RT TRIM AIR PRESS REGULATOR	UM S-12	DC BUS 3
TRIM AIR MANUAL SHUTOFF	UM R-13	DC BUS 2
TRIM AIR OVERHEAT SHUTOFF	UM S-13	DC BUS 3
TRIM AIR VALVE POSITION IND (COCKPIT, CABIN & ARO COMPT)	UM L-12, 13	AC BUS 1
TURBINE INLET TEMP IND	UM S-14	DC BUS 3

IFF/RADIO/PA/INTERPHONE

ADF 1	OH C-41	28VAC BUS 1
	OH C-29	DC BUS 1
ADF 2	OH E-41	28VAC BUS 3
	OH E-29	DC BUS 3
AR INSTR & OBS AUDIO	PO D-21	R EMER DC BUS
COCKPIT VOICE RECORDER	OH B-5	AC BUS 1
WITH TCTO 1248 ELT 1	OH C-32	DC BUS 1
ELT 2	OH E-33	DC BUS 3
ARTEX ELT	PO B-13	BATT DIRECT BUS ◀
ELT RESET	OH C-32	DC BUS 1
FLT INPH CAPT & F/E AUDIO	PO D-12	L EMER DC BUS
FLT RECORDER	OH D-5	AC BUS 3
FLT RECORDER HEADING & GMT CLOCK	OH D-34	28VAC BUS
FLT RECORDER OFF LIGHT	OH E-5	DC BUS 3
F/O OBS & AVIONIC AUDIO	PO D-27	R EMER DC BUS
HF COMM 1	OH B-31, 32, 33	AC BUS 1
	OH C-31	DC BUS 1
HF COMM 2	PO E-29, 30, 31	R EMER AC BUS
	PO D-30	R EMER DC BUS
IFF XPNDR	PO F-7	L EMER DC BUS
*IN SERVICE DATA ACQ SYS (REMOTE UNIT, RECORDER)	OH E-2, 3	DC BUS 3
KEY GENERATOR	OH E-33	DC BUS 3
PASSENGER ADDRESS	PO D-11	L EMER DC BUS
SECURE VOICE	OH E-32	DC BUS 3
SERVICE INTERPHONE (CALL, CALL RESET)	OH C-3, 4	DC BUS 1
SERVICE INTPH AMPL	PO D-26	R EMER DC BUS

CIRCUIT BREAKER LISTING (CONT)

RADIO/ PA/ INTERPHONE (CONT)

VHF COMM 1	PO D-10	L EMER DC BUS
VHF COMM 2	PO D-28	R EMER DC BUS
UHF COMM 1	PO D-15	L EMER AC BUS
UHF COMM 2/SAT COMM	PO E-27	R EMER AC BUS
UHF COMM 2	PO D-29	R EMER DC BUS
* UHF COMM/NAV 50	OH A-31	AC BUS 1

WATER/WASTE

LAV RAZOR OUTLET	OL	115VAC GND SVC BUS
LAV 1 FLUSH CONTROL	OR	28VDC GND SVC BUS
LAV 1 FLUSH PUMP POWER	OR	115VAC GND SVC BUS
LAV 1 WATER COOLER POWER	OR	115VAC GND SVC BUS
LAV 1 WATER HEATER	OR	115VAC GND SVC BUS
LAV WASTE SYS IND	OR	28VDC GND SVC BUS
LAV Z FLUSH CONTR	OL	28VDC GND SVC BUS
LAV Z FLUSH PUMP POWER	OL	115VAC GND SVC BUS
LAV Z WATER HEATER	OL	115VAC GND SVC BUS
WASTE SVCE PNL HEATER	OR	115VAC GND SVC BUS
WATER FILL/DR & OVFL CONT	OR	28VDC GND SVC BUS
WATER TANK STANDPIPE HTR	OR	115VAC GND SVC BUS
WATER TANK FILL SYS	OR	115VAC GND SVC BUS
WATER PRESS IND	LM F-10	DC BUS 3
WATER PRESS PUMP CONTROL	OR	28VDC GND SVC BUS
WATER PRESS PUMP POWER	OR	115VAC GND SVC BUS
WATER QUANTITY INDIC & CONTROL	OR	28VDC GND SVC BUS
WTR DRAIN & OVFL VALVE	LM G-10	AC GND SVC BUS
WTR FILL DRAIN HEAT CONT	OR	28VDC GND SVC BUS

RADAR

IND 1	OH B-29	AC BUS 1
IND 2	OH D-29	AC BUS 3
XCVR1	OH B-28	AC BUS 1
XCVR2	OH D-28	AC BUS 3

PART 5

HYDRAULICS

TABLE OF CONTENTS

HYDRAULICS

HYDRAULICS DESCRIPTION

Three separate, parallel, continuously operating, 3000-psi hydraulic systems (figures 1.5-1 through 1.5-3) operate the hydraulic components of the aircraft.

Each system is powered by two engine-driven hydraulic pumps, mounted on the engine accessory case. Hydraulic system 3 can also be pressurized in an emergency and for ground maintenance checks, by two ac electric motor-driven, variable-displacement pumps. Emergency hydraulic power is supplied by an air-driven generator which provides electrical power to drive one of the ac electric motor-driven pumps in hydraulic system 3. Each of the three systems is independent of each other and there is no fluid transfer between systems. Two reversible motor pumps can transfer power from an operating hydraulic system to an unpressurized system in the event of engine failure. Two non-reversible motor pumps will provide transfer of power to certain components of the flight control system.

Each of the three hydraulic systems has a separate reservoir, manifold, accumulator, and connections for an external hydraulic power source.

The hydraulic system is serviced with Skydrol 500B-4, Skydrol LD-4, or Hyjet IV as specified in Douglas Material Specification (DMS) 2014 for the KC-10.

ENGINE-DRIVEN PUMPS

Each of the three engines has a left and right engine-driven hydraulic pump to pressurize the three, normally independent, hydraulic systems. These systems power the flight controls, horizontal stabilizer, landing gear, brakes, nosewheel steering, UARRSI, boom telescoping and flight controls, fuel pump hydraulic motors, and boom hoist and tension. The pumps are normally controlled by individual switches on the Flight Engineer's Panel. With the pump switch off, the pump continues to rotate in a no flow condition. If the electrical control power for any pump is interrupted, the pump will remain operational, or will start automatically if previously turned off. A fire shutoff valve in each system controls the fluid supply to both pumps of the associated engine.

AUXILIARY PUMPS

Two electrical auxiliary hydraulic pumps are installed in hydraulic system 3 primarily for ground use with the engines shut down. The auxiliary pumps can be individually controlled from the Flight Engineer's Station or simultaneously controlled by a single switch on the Pilot's Overhead Panel. Additionally, auxiliary hydraulic pump 1 can be used as an emergency pressure source for the flight controls. Emergency hydraulic power can be supplied in the event of a multiple pump and/or engine failure by the Air-Driven Generator (ADG). The ADG can be deployed to provide electrical power to drive AUX PUMP 1 in hydraulic system 3.

By using the auxiliary hydraulic pumps, or the ground hydraulic power connections into system 3, pressure can be delivered via the reversible motor pumps to either of the other two systems.

1-3/2-3 REVERSIBLE MOTOR PUMPS

The reversible motor pumps (1-3 and 2-3) are installed to transfer pressure from an operating hydraulic system to an unpressurized hydraulic system. Pressure can be transferred in either direction. No fluid transfer takes place, the transfer of energy is mechanical.

Control switches for these pumps are on the Flight Engineer's Panel. If the fluid in the reservoir of either of the operating systems or the system being pressurized falls below a preset minimum, that motor-pump combination will automatically stop operating.

The reversible motor pump switches on the Flight Engineer's Panel are labeled ARM, OFF, and ON. The ARM position is used for the Flight Engineer's preflight check-out to pressurize the reservoir using the auxiliary pumps before engine start-up. After engine start and before take-off, the switch is placed in the ARM position.

With the Flight Engineer's switch in the ARM position, a decrease in any engine N_2 RPM below 45% or an auto-slat extend signal, will cause the reversible motor pump shutoff valves to actuate automatically, turning on the reversible motor pump, if a differential pressure exists. In addition, the reversible motor pump shutoff valves are actuated automatically

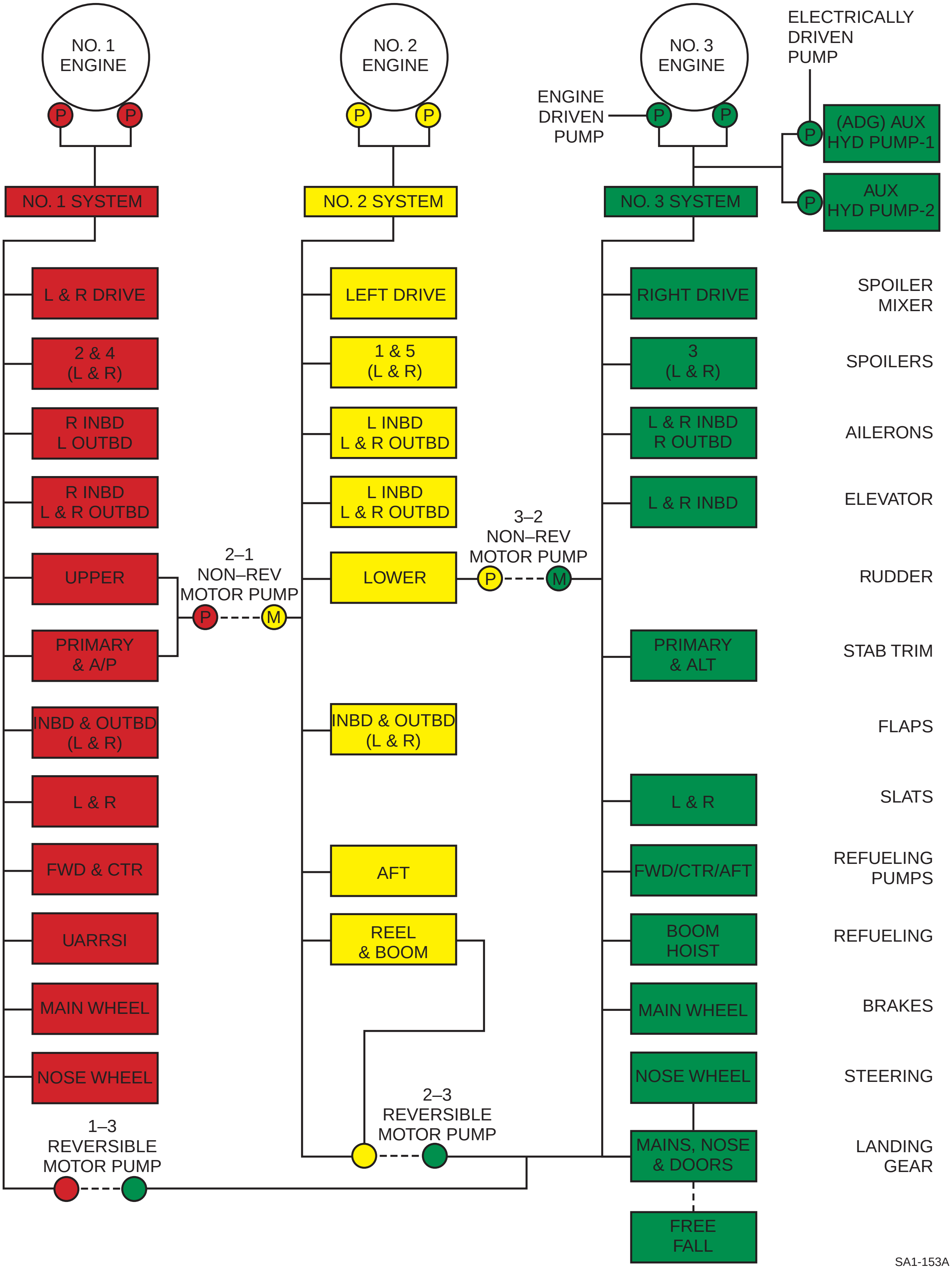


Figure 1.5-1. Hydraulic Systems Block Diagram

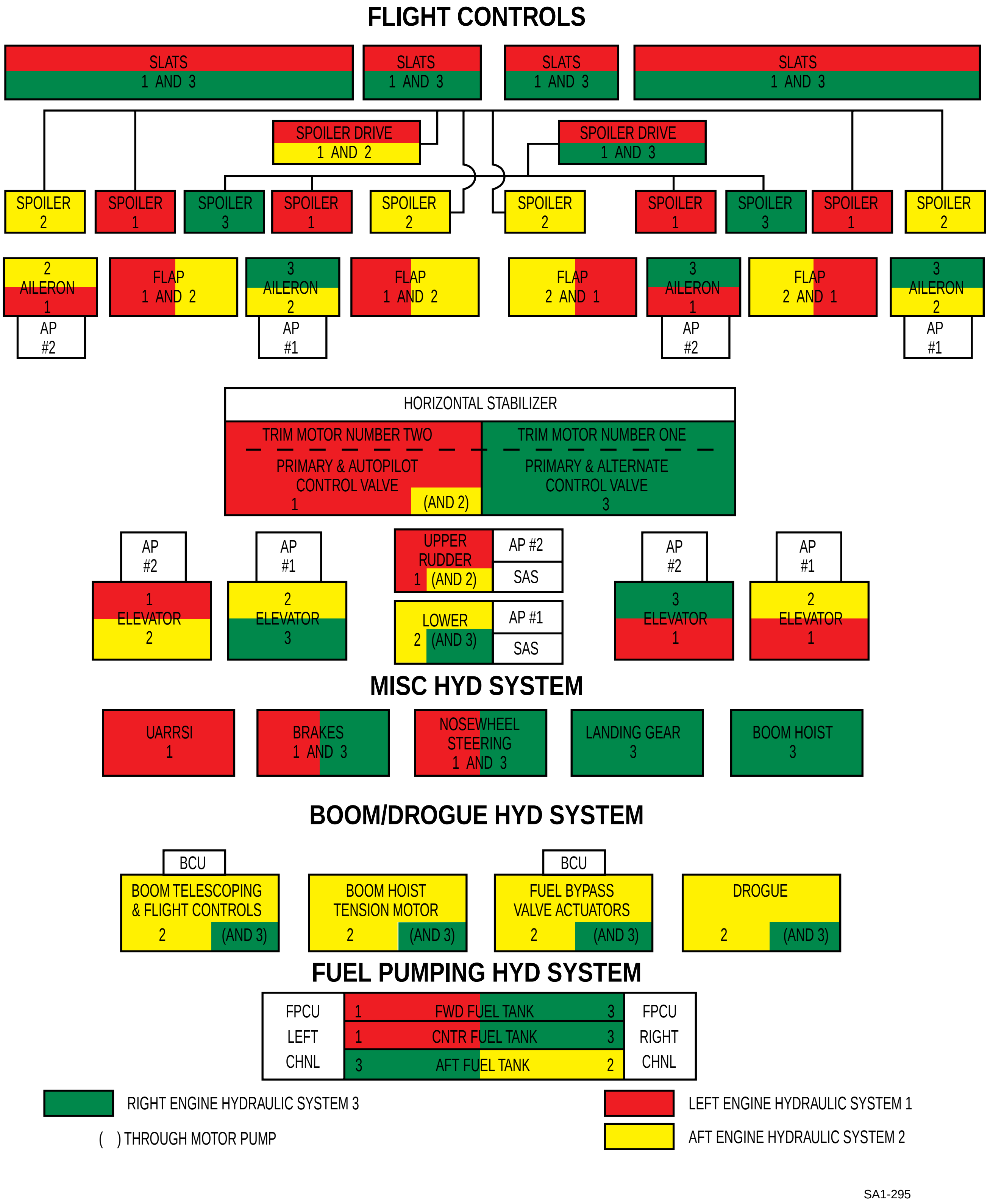


Figure 1.5-2. Hydraulic Systems Arrangement - Flight Controls

by auto-slat extend signals and switches off the signals from the auto-slat reset switch. This provides positive slat deployment under any stall regime the aircraft may encounter.

NOTE

> Regardless of switch position, motor pumps are turned on when auto-slat system is activated.

NON-REVERSIBLE MOTOR PUMPS

Two non-reversible motor pumps provide transfer of hydraulic pressure from one system to another to power the lower rudder, upper rudder, and horizontal stabilizer. The non-reversible motor pumps may be deactivated by moving the RUDDER STBY PWR switch to OFF.

2-1 Non-Reversible Motor Pump

The 2-1 non-reversible motor pump transfers power, not fluid, from hydraulic system 2 to hydraulic system 1 for the upper rudder and horizontal stabilizer trim.

3-2 Non-Reversible Motor Pump

The 3-2 non-reversible motor pump transfers power, not fluid, from hydraulic system 3 to hydraulic system 2 for the lower rudder.

HYDRAULIC SYSTEM 3 ELEVATOR SHUTOFF FEATURE

The Hydraulic System 3 elevator shutoff feature will preserve a significant portion of longitudinal and lateral control even with catastrophic in-flight damage to all three hydraulic systems in the tail of the aircraft.

This feature consists of four separate installations including:

1. An electrically operated shutoff valve and a corresponding return line check valve to the No. 3 system feeding the elevator (figure 1.5-3) and the 3-2 nonreversible motor pump (figure 1.6-2).
2. A No. 3 hydraulic reservoir quantity sensor to detect fast or slow leakage.
3. A light in the cockpit to indicate that the electrically operated shutoff valve has been activated (figure 1.5-4).
4. Modification of the No. 3 hydraulic system quantity gage chevron marking to indicate a minimum dispatch level of 5 1/4 gallons in lieu of 3 3/4 gallons (figure 1.5-3).

In the event that the reservoir quantity reaches a predetermined minimum level, the No. 3 hydraulic valve will shut off and the hydraulic pressure in system No. 3 will be preserved forward of the valve. This provides the crew with a minimum of longitudinal control by stabilizer trim input at half the normal rate, lateral control through right inboard, right outboard and left inboard aileron input coupled with partial spoiler deflection, slats but no flaps, and finally nose wheel steering after landing. If systems No. 1 and No. 2 are not lost, additional control in all axes will be available.

In the event that the No. 3 hydraulic shutoff valve is actuated, pressure to the KC-10 Aerial Refueling Boom (ARB) stowage winch will be maintained. Hydraulic power to the ARB control surfaces is provided by the No. 2 system and will be maintained if the No. 2 system is not lost.

Illumination of the HYD SYS 3 ELEV OFF light on the Flight Engineer's annunciator panel will activate the Pilot's Master Caution Lights.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel Number 2, the Flight Engineer's Lower Panel, the Overhead Panel, and the Glareshield (figure 1.5-4).

Illustrations of these major panels are in Part 1, Aircraft General. Individual controls and indicators are illustrated and described in this part.

AIR REFUELING HYDRAULIC SYSTEM

HYDRAULIC FUEL PUMPS

Six hydraulically-driven fuel pumps are essential components of the Air Refueling delivery system. Two pumps are located in each of the forward and aft tanks and in the center wing tank. Each of two pumps in any single tank are driven by different hydraulic systems to increase reliability.

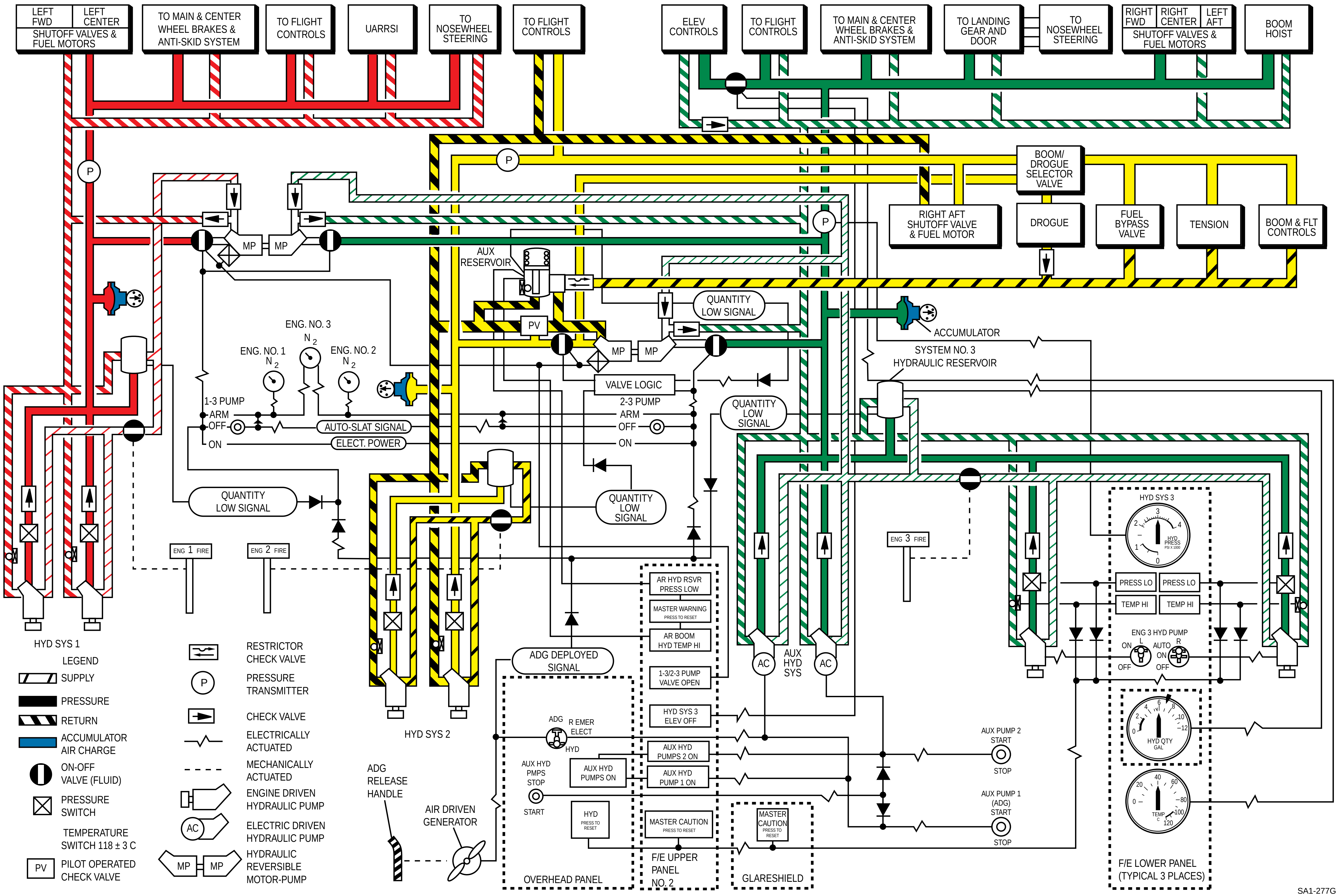
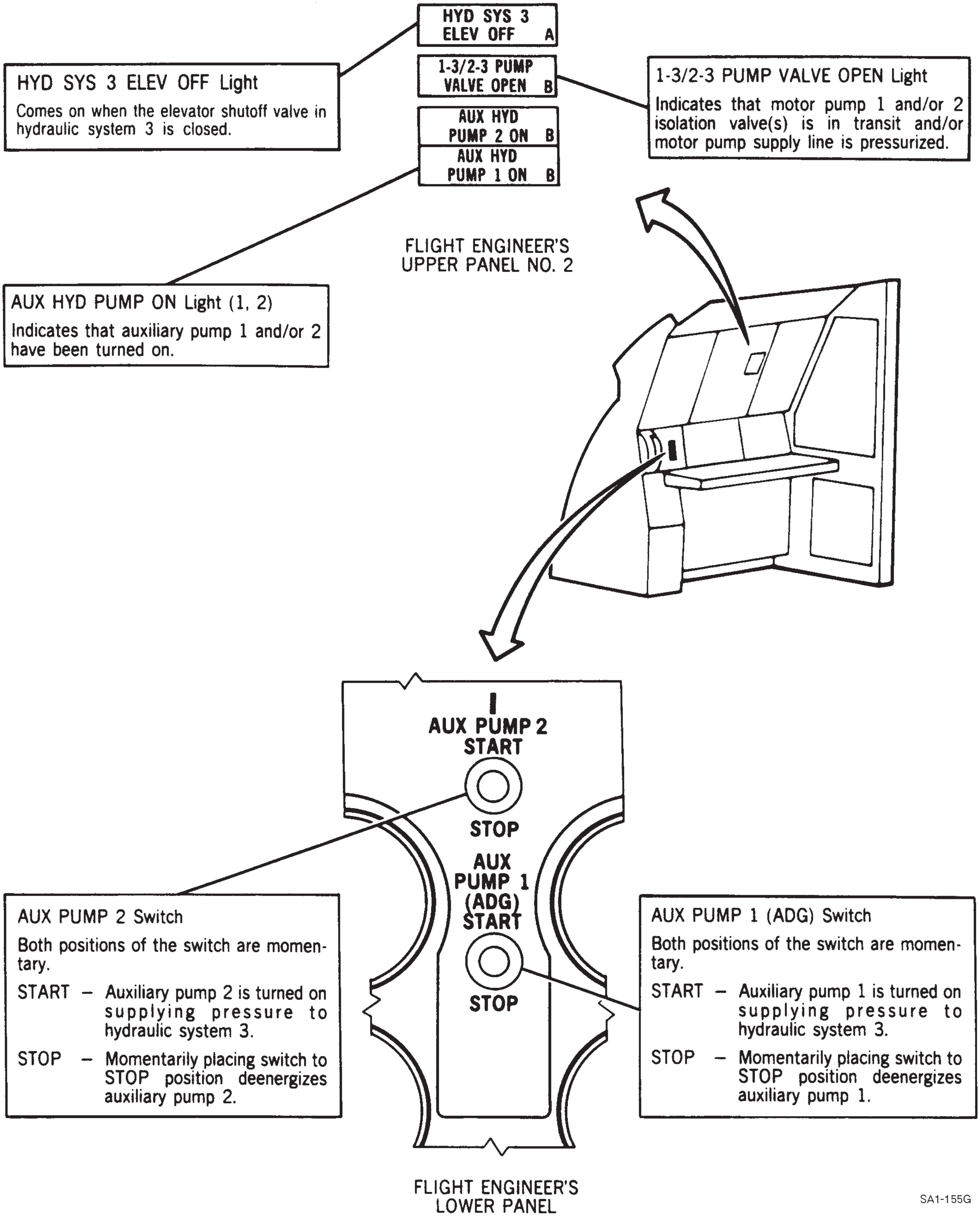


Figure 1.5-3. Hydraulic System Schematic



HYD SYS 3 ELEV OFF Light

Comes on when the elevator shutoff valve in hydraulic system 3 is closed.

1-3/2-3 PUMP VALVE OPEN Light

Indicates that motor pump 1 and/or 2 isolation valve(s) is in transit and/or motor pump supply line is pressurized.

AUX HYD PUMP ON Light (1, 2)

Indicates that auxiliary pump 1 and/or 2 have been turned on.

AUX PUMP 2 Switch

Both positions of the switch are momentary.

START – Auxiliary pump 2 is turned on supplying pressure to hydraulic system 3.

STOP – Momentarily placing switch to STOP position deenergizes auxiliary pump 2.

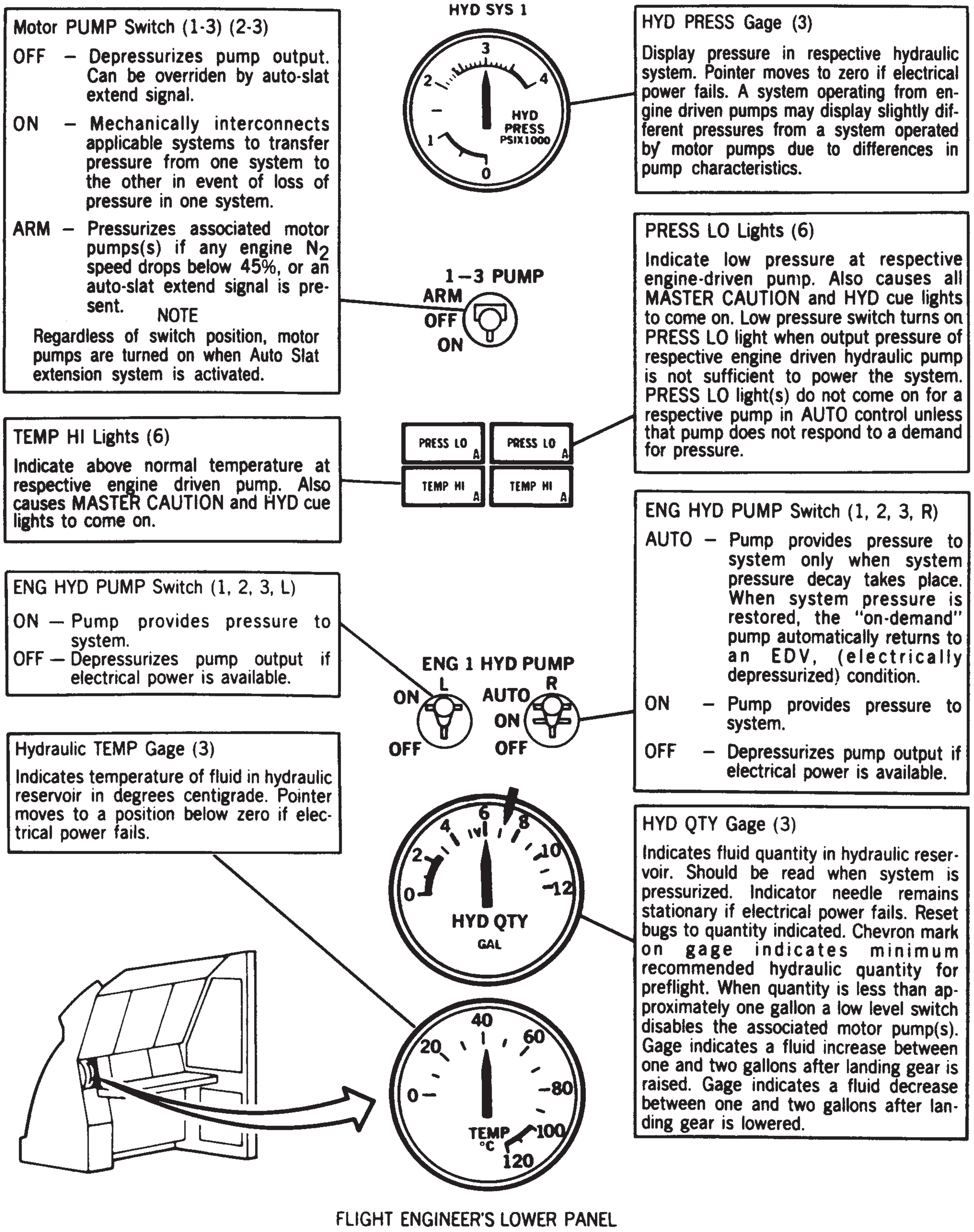
AUX PUMP 1 (ADG) Switch

Both positions of the switch are momentary.

START – Auxiliary pump 1 is turned on supplying pressure to hydraulic system 3.

STOP – Momentarily placing switch to STOP position deenergizes auxiliary pump 1.

Figure 1.5-4. Hydraulic System Controls and Indicators (Sheet 1)



Motor PUMP Switch (1-3) (2-3)

OFF – Depressurizes pump output. Can be overriden by auto-slat extend signal.

ON – Mechanically interconnects applicable systems to transfer pressure from one system to the other in event of loss of pressure in one system.

ARM – Pressurizes associated motor pumps(s) if any engine N_2 speed drops below 45%, or an auto-slat extend signal is present.

NOTE

Regardless of switch position, motor pumps are turned on when Auto Slat extension system is activated.

HYD PRESS Gage (3)

Display pressure in respective hydraulic system. Pointer moves to zero if electrical power fails. A system operating from engine driven pumps may display slightly different pressures from a system operated by motor pumps due to differences in pump characteristics.

PRESS LO Lights (6)

Indicate low pressure at respective engine-driven pump. Also causes all MASTER CAUTION and HYD cue lights to come on. Low pressure switch turns on PRESS LO light when output pressure of respective engine driven hydraulic pump is not sufficient to power the system. PRESS LO light(s) do not come on for a respective pump in AUTO control unless that pump does not respond to a demand for pressure.

TEMP HI Lights (6)

Indicate above normal temperature at respective engine driven pump. Also causes MASTER CAUTION and HYD cue lights to come on.

ENG HYD PUMP Switch (1, 2, 3, L)

ON – Pump provides pressure to system.

OFF – Depressurizes pump output if electrical power is available.

ENG HYD PUMP Switch (1, 2, 3, R)

AUTO – Pump provides pressure to system only when system pressure decay takes place. When system pressure is restored, the "on-demand" pump automatically returns to an EDV, (electrically depressurized) condition.

ON – Pump provides pressure to system.

OFF – Depressurizes pump output if electrical power is available.

Hydraulic TEMP Gage (3)

Indicates temperature of fluid in hydraulic reservoir in degrees centigrade. Pointer moves to a position below zero if electrical power fails.

HYD QTY Gage (3)

Indicates fluid quantity in hydraulic reservoir. Should be read when system is pressurized. Indicator needle remains stationary if electrical power fails. Reset bugs to quantity indicated. Chevron mark on gage indicates minimum recommended hydraulic quantity for preflight. When quantity is less than approximately one gallon a low level switch disables the associated motor pump(s). Gage indicates a fluid increase between one and two gallons after landing gear is raised. Gage indicates a fluid decrease between one and two gallons after landing gear is lowered.

FLIGHT ENGINEER'S LOWER PANEL

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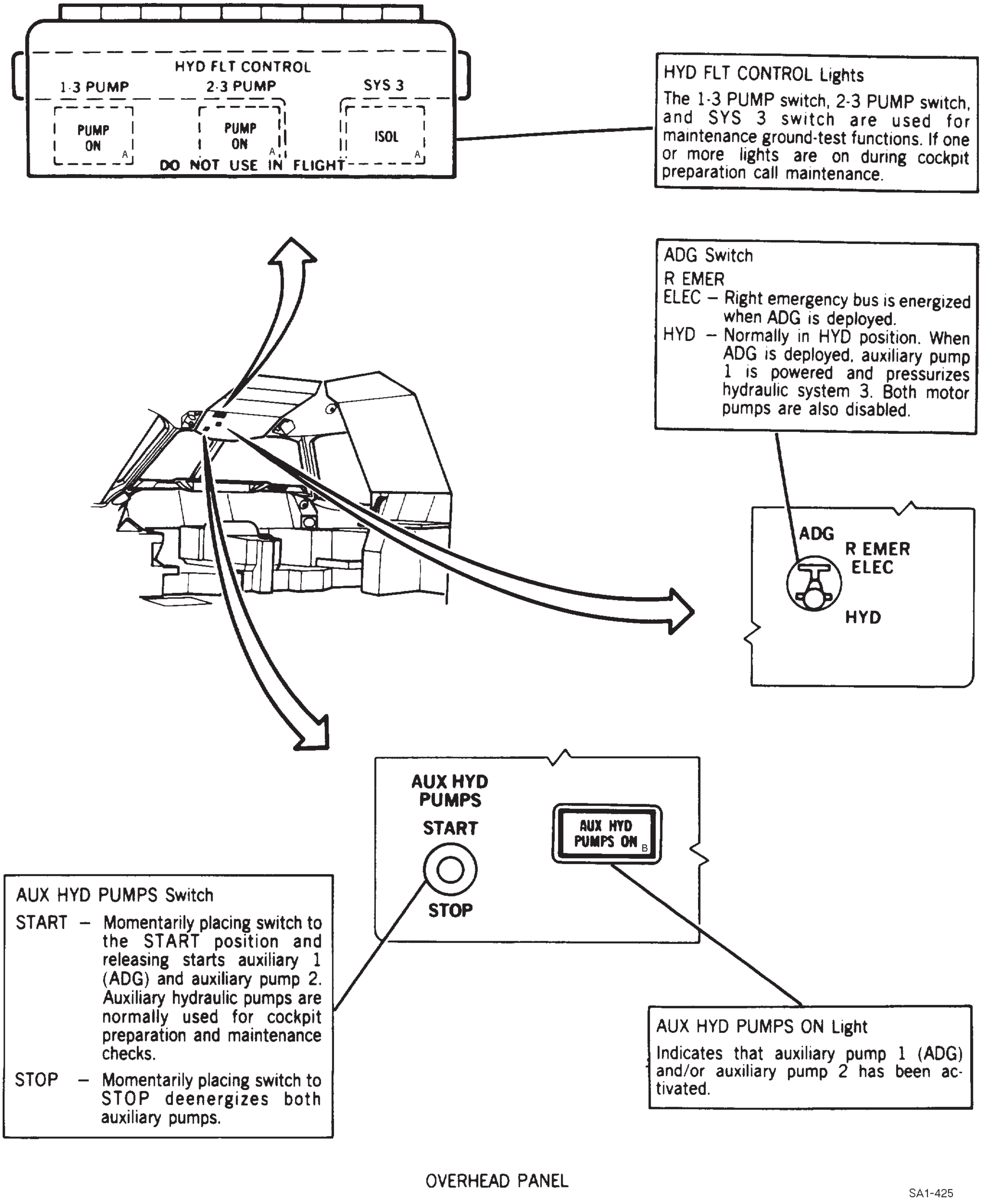
Figure 1.5-4. Hydraulic System Controls and Indicators (Sheet 2)



HYD FLT CONTROL Lights

The 1-3 PUMP switch, 2-3 PUMP switch, and SYS 3 switch are used for maintenance ground-test functions. If one or more lights are on during cockpit preparation call maintenance.

ADG Switch

R EMER ELEC – Right emergency bus is energized when ADG is deployed.

HYD – Normally in HYD position. When ADG is deployed, auxiliary pump 1 is powered and pressurizes hydraulic system 3. Both motor pumps are also disabled.

AUX HYD PUMPS Switch

START – Momentarily placing switch to the START position and releasing starts auxiliary 1 (ADG) and auxiliary pump 2. Auxiliary hydraulic pumps are normally used for cockpit preparation and maintenance checks.

STOP – Momentarily placing switch to STOP deenergizes both auxiliary pumps.

AUX HYD PUMPS ON Light

Indicates that auxiliary pump 1 (ADG) and/or auxiliary pump 2 has been activated.

Figure 1.5-4. Hydraulic System Controls and Indicators (Sheet 3)

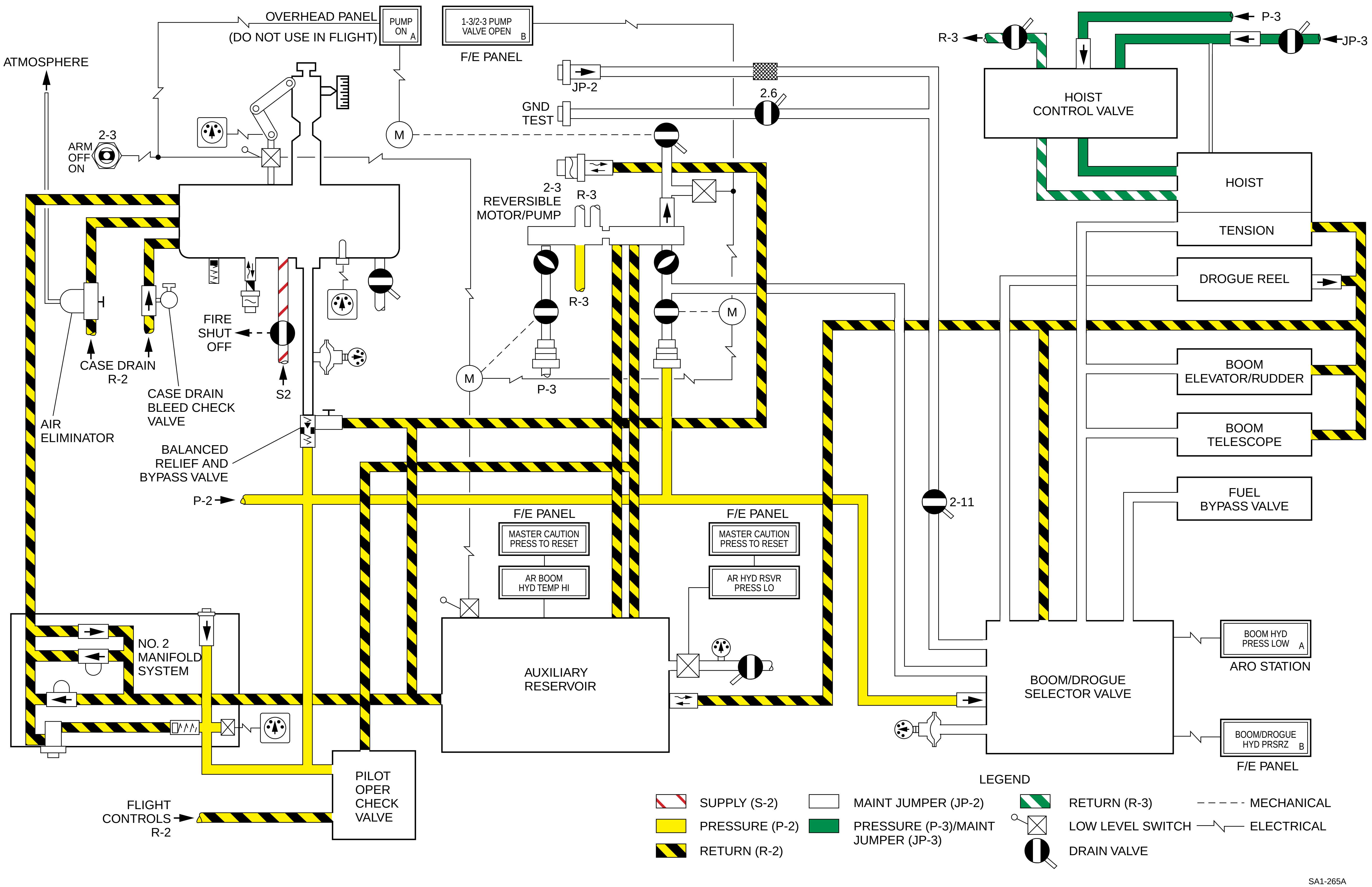


Figure 1.5-5. Boom/Drogue Hydraulic Subsystems

UARRSI HYDRAULIC SYSTEM

The UARRSI hydraulic system operates the Slipway Door and Receptacle, as well as the intake check valve for the refueling manifold. The hydraulic system is normally unpressurized except during actual use, to prevent the possibility of hydraulic leaks.

Prior to operating the UARRSI hydraulic system, the air refueling receptacle shutoff valve located under the cabin floor, just forward of the left cabin door must be manually opened. After the refueling operation is complete and slipway doors are closed, the valve must be manually closed to depressurize the system.

HYDRAULIC ALTERNATE SUPPLY SYSTEM

The hydraulic alternate supply system provides hydraulic power to the boom/drogue selector valve in the event of a failure of hydraulic system 2. An auxiliary reservoir provides a source of hydraulic fluid. A motor actuated shutoff valve prevents fluid loss in the event of a break in a hydraulic line. Hydraulic system 3 will supply pressure through the 2-3 motor-pump. The system is enabled by placing the 2-3 pump switch to the ON position.

Actuation is accomplished when the Boom Operator places the Hydraulic Selector to either the BOOM or Drogue position. The system is deactivated when the Hydraulic Selector is placed to OFF.

BOOM/DROGUE SELECTOR VALVE

The boom/drogue selector valve provides hydraulic power to either the boom or drogue as selected by the ARO for refueling requirements (figure 1.5-5). The boom/drogue selector valve will also shut off both systems.

ACCUMULATOR

The accumulator stores a reserve supply of hydraulic fluid under pressure for the boom/drogue selector valve and also absorbs system pressure surges. The accumulator permits a rise in system pressure, thereby absorbing the shock of pump surges, and relieving the pressure lines of high-impact loads. When the hydraulic pumps are not operating, the accumulator provides system pressure at a diminishing rate until a quantity equal to the stored volume of fluid in the accumulator has been used. A dial-type pressure gage is provided to indicate the gas pressure in the accumulator and is visible to the ARO through the sighting window.

AIR REFUELING BOOM (ARB) HOIST AND LATCH SYSTEM

The Air Refueling Boom (ARB) Hoist and Latch System deploys the boom for inflight refueling or ground maintenance and retracts it in a storage position. The hydraulically-driven boom hoist motor is controlled by a manually operated cable and mechanical lever linkage extending from the ARO station aft to the hydraulic valve.

DUAL BYPASS VALVE

The hydraulically operated bypass valve is a dual passage valve with a single inlet and outlet, normally spring-loaded to the closed position. The dual bypass valve is actuated to the open position by hydraulic pressure. A manual override provides for closing and locking either section of the bypass valve.

ARB HYDRAULIC SYSTEM PRESSURE INDICATOR

A pressure switch is installed to indicate adequate pressure available in the ARO hydraulic reservoir.

Low hydraulic pressure in the ARO hydraulic system will cause both Pilot's master caution lights on the Glareshield to come on, as well as the hydraulic cue light on the Pilot's Overhead Panel, and the Flight Engineer's master caution light will come on, also BOOM HYD PRESS LOW annunciator light will come on.

Two annunciator lights on the Flight Engineer's Annunciator Panel will monitor the status of the ARB hydraulic system. One annunciator light will indicate HYD TEMP HIGH, while the other will indicate HYD PRESS LOW.

A pressure gage installed in the left wheel well compartment is for maintenance use.

PART 6

TABLE OF CONTENTS

FLIGHT CONTROLS

FLIGHT CONTROLS DESCRIPTION

All primary and secondary flight controls (figures 1.6-1 and 1.6-2) are fully hydraulic powered systems. There is no feedback of control surface forces to the Pilots; therefore, all control system feel is artificially induced. The primary flight controls consist of inboard and outboard ailerons, upper and lower two segment rudders, and inboard and outboard pairs of elevators. The secondary flight controls consist of inboard and outboard leading edge slats, inboard and outboard trailing edge flaps, wing spoilers, and an adjustable horizontal stabilizer.

Flight controls are held in place by hydraulic power, which acts as an internal gust lock and protects the control surfaces against structural damage from wind gusts.

PRIMARY FLIGHT CONTROLS

Lateral Control System

The lateral control system has inboard and outboard ailerons, with each surface powered by two of the three hydraulic systems. Aileron lateral control is augmented on the down-going wing by wing spoilers operating in proportion to control wheel displacement and/or speed brake input. With both flaps and slats retracted and the alternate gear extension lever stowed, a lockout mechanism fairs and locks the outboard ailerons in the neutral position. In this configuration, lateral control is provided by the inboard ailerons and the lateral control function of the wing spoilers. When the flaps or the slats are extended, or the alternate gear extension lever is raised, the outboard ailerons become operable to assist in low speed lateral control. A lateral trim system is provided.

Longitudinal Control System

The longitudinal control system has inboard and outboard pairs of elevators. Each surface is powered by two of the three hydraulic systems. The elevators incorporate an automatic load feel system which varies elevator feel as a function of airspeed and horizontal stabilizer position (figure 1.6-3). The load feel system has backup manual control in the event of malfunction of the automatic system. The longitudinal control system is provided with an adjustable horizontal stabilizer for maintaining longitudinal trim (figure 1.6-4).

Directional Control System

The directional control system has an upper and lower rudder, each having two segments. Each forward segment of the rudders is powered by one of the three hydraulic systems. The aft segment of each rudder is hinged to the forward segment and is mechanically bused in such a manner that it deflects in the same direction as the forward segment to provide a more effective airfoil. Non-reversible motor-pumps are provided in the hydraulic system to automatically provide a standby source of hydraulic pressure to the upper or lower rudder or stabilizer trim should the normal pressure source become inoperative. A compensator with a low fluid level switch automatically shuts off hydraulic flow to the non-reversible motor-pump in a hydraulic system with low fluid. A RUDDER STBY PWR switch (figure 1.6-5) provides manual override control to shut off hydraulic flow to both non-reversible motor-pumps, and a RUD STBY PWR OFF light to indicate when either or both non-reversible motorpumps are inoperative. When both non-reversible motor-pumps are inoperative rudder standby power is not available. A rudder trim system is provided.

Dual yaw damper systems for each rudder provide directional stability augmentation and turn coordination. The system operates the rudder hydraulic control valves directly and there is no feedback to the Pilots' rudder pedals during normal manual or autopilot operation.

SECONDARY FLIGHT CONTROLS

Spoiler System

The wing spoilers provide five major operational modes:

1. Lateral control augmentation in all modes of operation.
2. Automatic extension of 2/3 spoilers upon main wheel spinup. Full ground spoiler extension when nose gear strut is compressed (Flaps ≥ 30°).

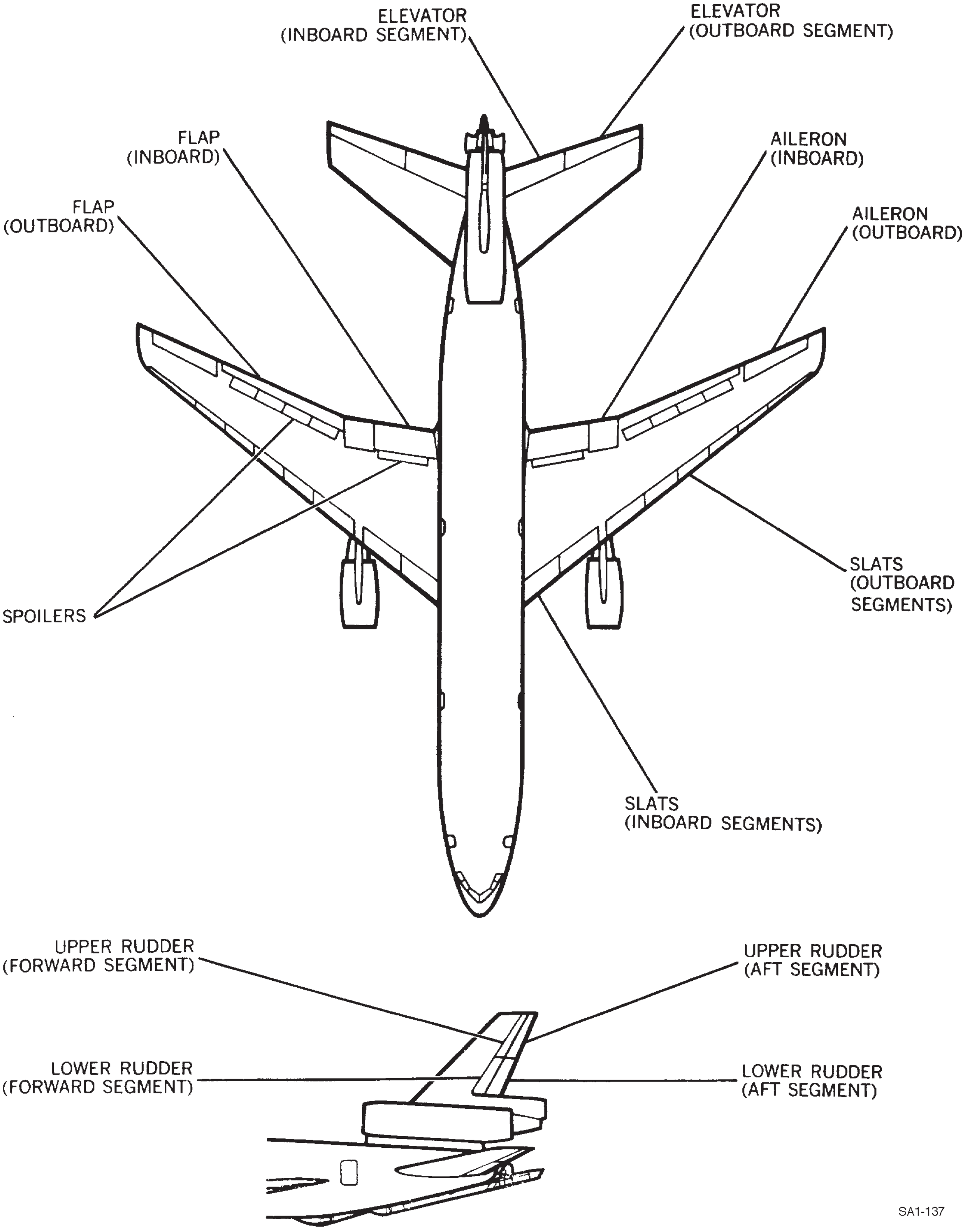


Figure 1.6-1. Flight Controls - Major Components

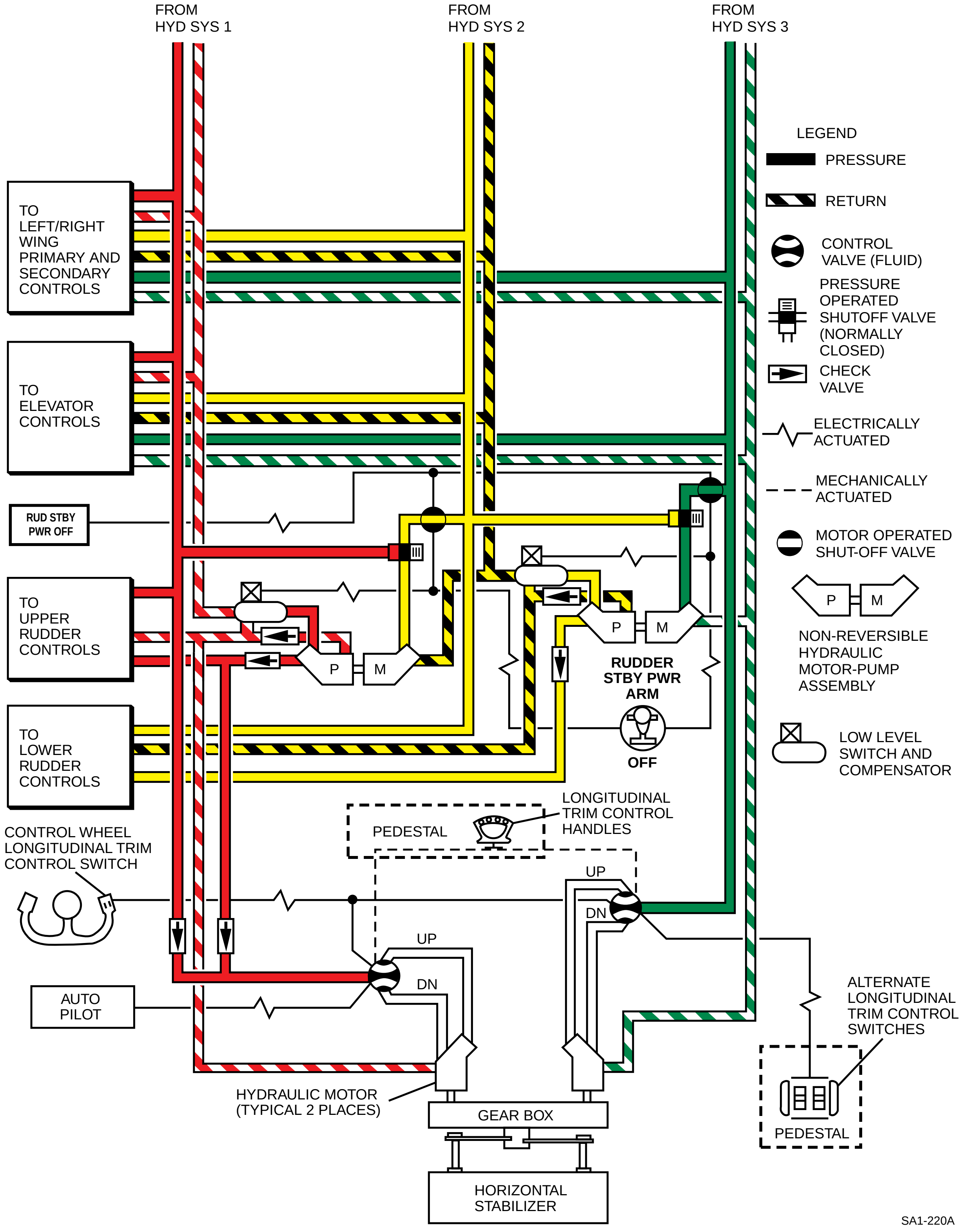
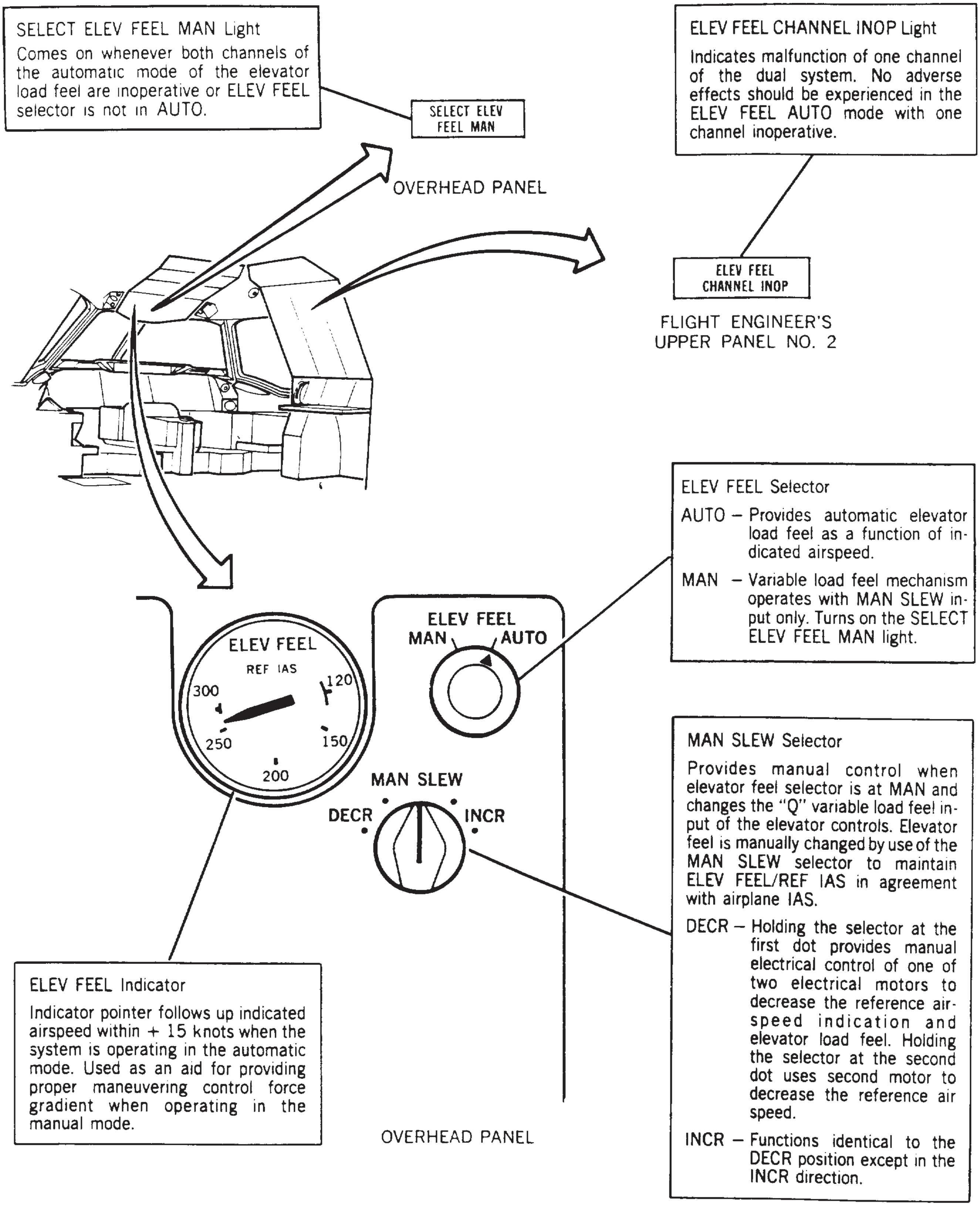


Figure 1.6-2. Flight Control System



SELECT ELEV FEEL MAN Light

Comes on whenever both channels of the automatic mode of the elevator load feel are inoperative or ELEV FEEL selector is not in AUTO.

ELEV FEEL CHANNEL INOP Light

Indicates malfunction of one channel of the dual system. No adverse effects should be experienced in the ELEV FEEL AUTO mode with one channel inoperative.

ELEV FEEL Selector

AUTO – Provides automatic elevator load feel as a function of indicated airspeed.

MAN – Variable load feel mechanism operates with MAN SLEW input only. Turns on the SELECT ELEV FEEL MAN light.

MAN SLEW Selector

Provides manual control when elevator feel selector is at MAN and changes the "Q" variable load feel input of the elevator controls. Elevator feel is manually changed by use of the MAN SLEW selector to maintain ELEV FEEL/REF IAS in agreement with airplane IAS.

DECR – Holding the selector at the first dot provides manual electrical control of one of two electrical motors to decrease the reference airspeed indication and elevator load feel. Holding the selector at the second dot uses second motor to decrease the reference air speed.

INCR – Functions identical to the DECR position except in the INCR direction.

ELEV FEEL Indicator

Indicator pointer follows up indicated airspeed within + 15 knots when the system is operating in the automatic mode. Used as an aid for providing proper maneuvering control force gradient when operating in the manual mode.

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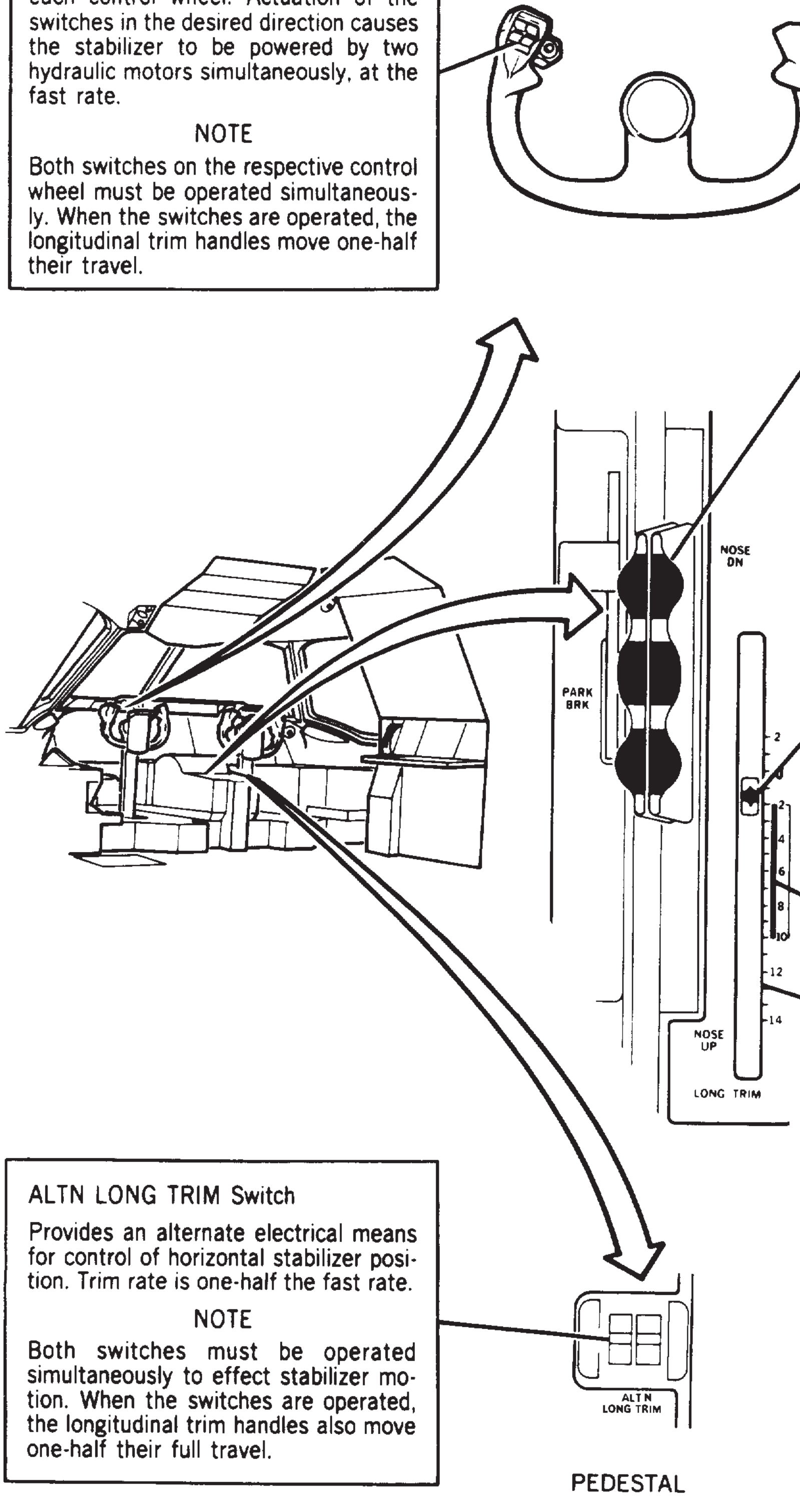
Figure 1.6-3. Elevator Feel



Control Wheel Trim Switch (2)
(Pilot & Copilot)

Stabilizer motion is electrically controlled by dual trim switches located on each control wheel. Actuation of the switches in the desired direction causes the stabilizer to be powered by two hydraulic motors simultaneously, at the fast rate.

NOTE

Both switches on the respective control wheel must be operated simultaneously. When the switches are operated, the longitudinal trim handles move one-half their travel.

LONG TRIM Handles

The handles provide direct mechanical control of the horizontal stabilizer control valves. The trim handles have the same function as the electric control wheel trim switches, and alternate trim switches except that they provide override authority over both. Moving the handles to full travel moves the stabilizer at the fast rate. Moving the handles to half their full travel moves the stabilizer at one-half the fast rate.

NOTE

Both longitudinal trim handles must be operated together to move the horizontal stabilizer.

LONG TRIM Indicator

The longitudinal trim indicator is mechanically connected to the horizontal stabilizer and indicates position and movement of the horizontal stabilizer.

LONG TRIM Green Band

Indicates allowable trim range for takeoff.

LONG TRIM Position Indicator Scale

Shows the position of the stabilizer in degrees of airplane nose up or down when read opposite the longitudinal trim indicator.

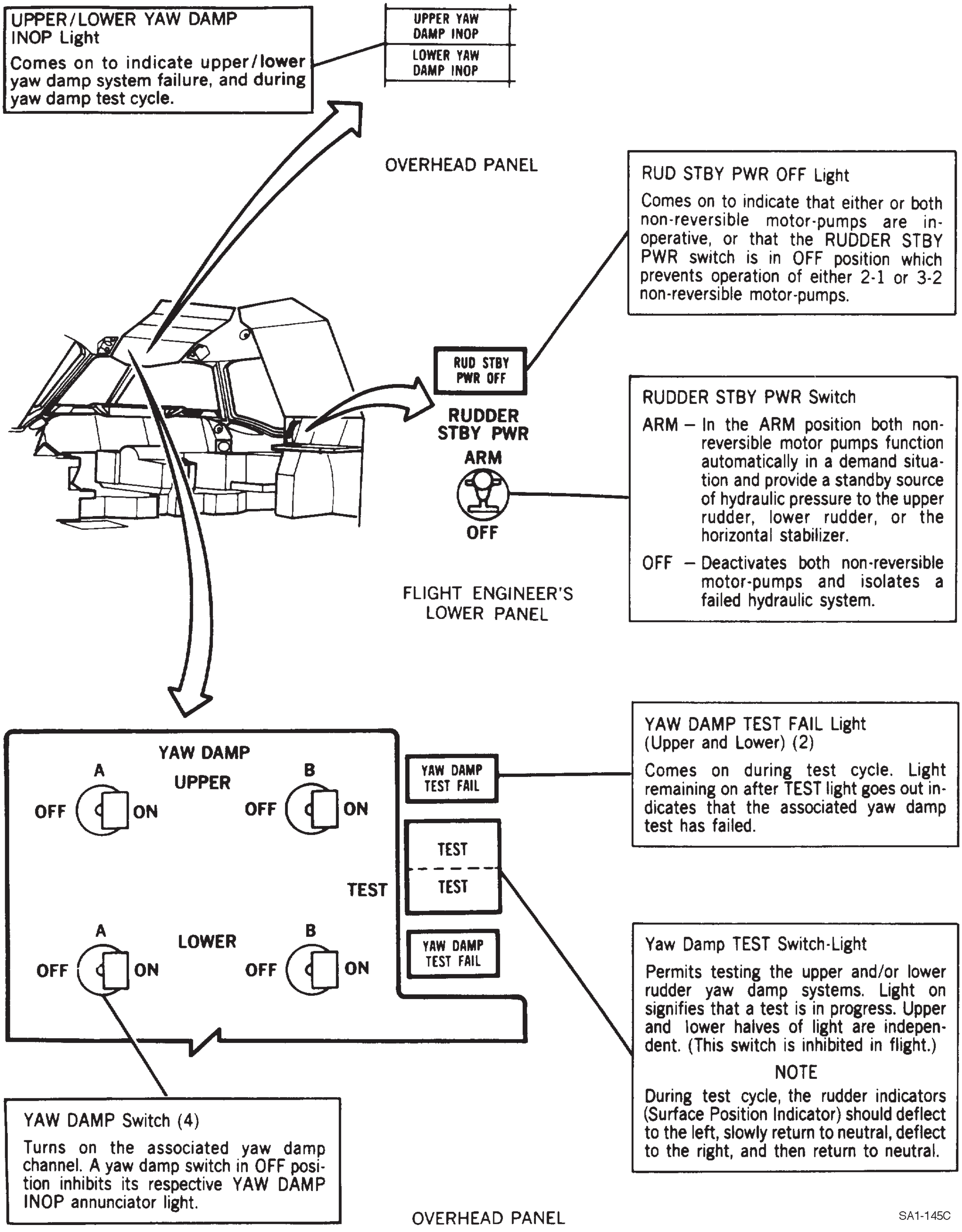
ALTN LONG TRIM Switch

Provides an alternate electrical means for control of horizontal stabilizer position. Trim rate is one-half the fast rate.

NOTE

Both switches must be operated simultaneously to effect stabilizer motion. When the switches are operated, the longitudinal trim handles also move one-half their full travel.

Figure 1.6-4. Longitudinal Trim



UPPER/LOWER YAW DAMP INOP Light

Comes on to indicate upper/lower yaw damp system failure, and during yaw damp test cycle.

RUD STBY PWR OFF Light

Comes on to indicate that either or both non-reversible motor-pumps are inoperative, or that the RUDDER STBY PWR switch is in OFF position which prevents operation of either 2-1 or 3-2 non-reversible motor-pumps.

RUDDER STBY PWR Switch

ARM – In the ARM position both non-reversible motor pumps function automatically in a demand situation and provide a standby source of hydraulic pressure to the upper rudder, lower rudder, or the horizontal stabilizer.

OFF – Deactivates both non-reversible motor-pumps and isolates a failed hydraulic system.

YAW DAMP TEST FAIL Light (Upper and Lower) (2)

Comes on during test cycle. Light remaining on after TEST light goes out indicates that the associated yaw damp test has failed.

Yaw Damp TEST Switch-Light

Permits testing the upper and/or lower rudder yaw damp systems. Light on signifies that a test is in progress. Upper and lower halves of light are independent. (This switch is inhibited in flight.)

NOTE

During test cycle, the rudder indicators (Surface Position Indicator) should deflect to the left, slowly return to neutral, deflect to the right, and then return to neutral.

YAW DAMP Switch (4)

Turns on the associated yaw damp channel. A yaw damp switch in OFF position inhibits its respective YAW DAMP INOP annunciator light.

Figure 1.6-5. Yaw Damp and Rudder Standby Power

NOTE

Ground spoilers cannot be activated during flight.

3. Automatic ground spoiler extension upon application of reverser lever during rejected takeoff to increase braking efficiency (Flaps <30°).
4. Manual extension of the ground spoilers during landing or rejected takeoff.
5. Selectable extension of all spoilers inflight to serve as speedbrakes.

The lateral control function of the wing spoilers is active in all modes of operation. The spoilers augment lateral control by extending on the down-going wing in proportion to control wheel displacement. If the spoilers are extended on both wings in the speedbrakes mode, lateral control inputs extend the spoiler panels on the down-going wing until fully extended, and the spoilers on the up-going wing retract as required. If all spoiler panels are fully extended in the ground spoiler mode, lateral control inputs retract the spoilers on the wing opposite to the desired direction of roll to permit better control during crosswind operation. With the flaps in any position other than full up, the spoilers will deflect approximately one inch to prevent rubbing on the flap vane and may be noted on the surface position indicator.

In the event a go-around is necessary after ground spoiler extension, advancing throttle 2 automatically unlatches the spoiler handle, (figure 1.6-6) allowing it to go full forward to the retract detent, disarm, and retract the spoilers. In the event of a rejected takeoff, the ground spoilers extend fully when: the nose gear strut is compressed, throttle 1 and 3, or throttle 2 thrust reverser lever is placed to the reverse thrust position and spoiler handle is in armed (up) position.

Flap System

The trailing edge flap (figures 1.6-7 and 1.6-8) system consists of inboard and outboard flap segments on each wing. Each segment is powered by hydraulic systems 1 and 2. The inboard flap control valve is connected to the cockpit flap handle. The inboard flaps are interconnected by a cable bus system to ensure symmetrical motion. The outboard flap control valves are cable controlled by inboard flap position feedback, thus slaving outboard flap position. In addition to the normal flap control fixed flap position detents, the system incorporates a flap takeoff selector wheel which provides a preselectable detent in unlimited increments from 1 to 25°. Also incorporated is a dual automatic flap limit system (figure 1.6-9). When the flaps are extended between 20 and 50°, the system provides automatic retraction (or prevents extension), to protect structural integrity in the event that selected flap position airspeed limitations are exceeded. As airspeed is reduced, the flaps automatically assume the selected position. The system has a manual override capability in the event both systems malfunction.

Slat System

The leading edge slat (figures 1.6-7 and 1.6-8) system provides lift augmentation. The slats are divided into eight segments on each wing and are hydraulically powered by hydraulic systems one and three, each capable of operating the slats full travel. The outboard slats have four positions: retract, auto extend, takeoff, and land. The inboard slats have three positions: retract, takeoff, and land. The inboard slat control valve is connected to the cockpit slat handle. The outboard slat control valves are controlled by inboard slat position feedback, thus slaving outboard slat position to inboard slat position. The auto slat extend system is controlled by the stall warning system. When the flaps and slats are retracted, the auto slats are retracted, the auto slat extend system partially extends the outboard slats at the onset of stall warning. The five outermost outboard slat segments are anti-iced. Inboard slats do not have anti-ice capability. Slat position indicating lights are provided on the instrument panel.

Trim System

Lateral trim control is provided by the aileron trim knob (figure 1.6-10) which repositions the neutral point of the ailerons. If more than 5° of trim is required, the lateral control spoilers begin to deflect. Aileron trim is indicated on the aileron trim indicator, the surface position indicator (figure 1.6-11) and by physical displacement of the control wheel.

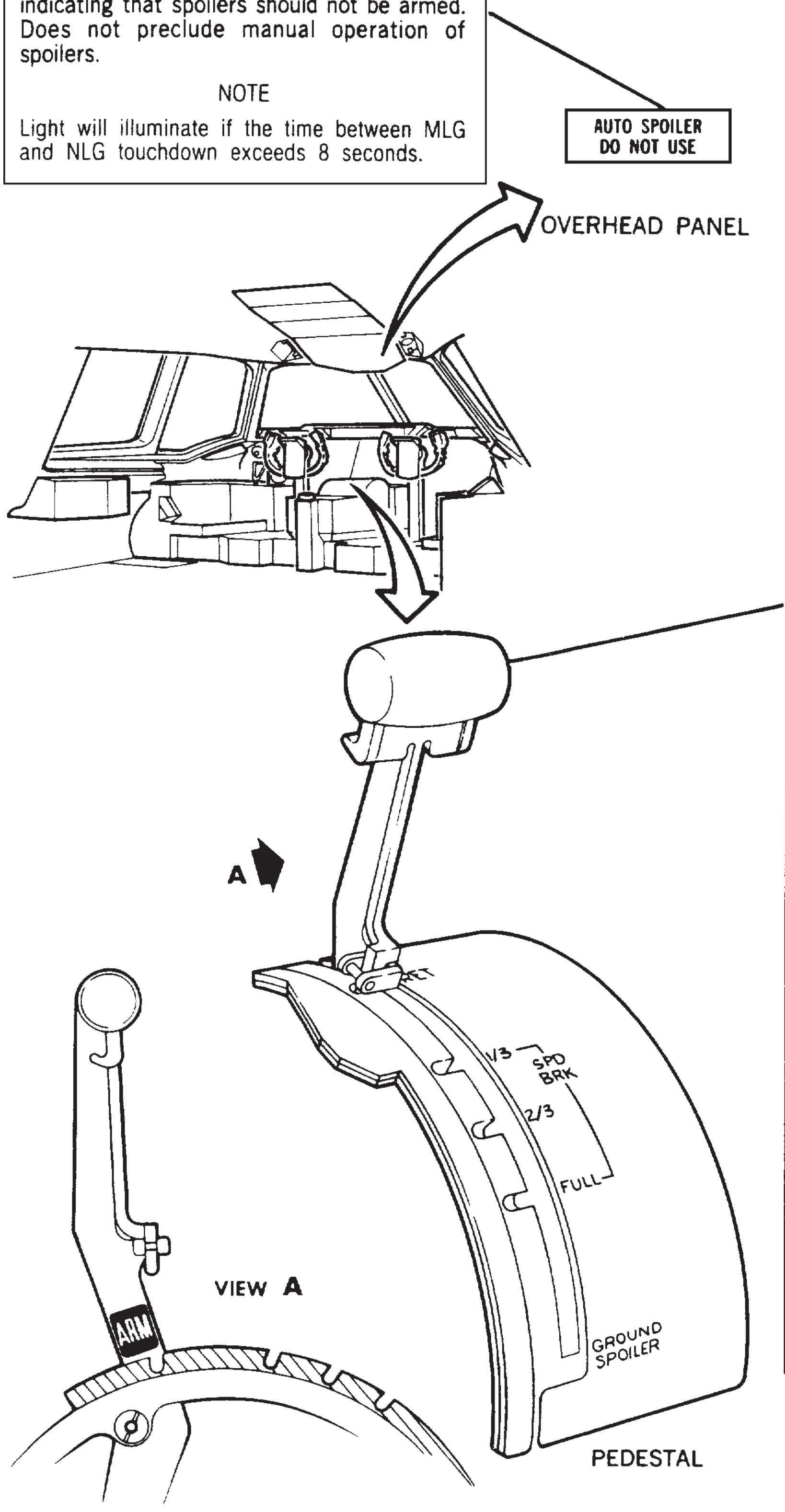
Directional control is provided by the rudder trim knob (figure 1.6-10) which repositions the neutral point of the rudders. Rudder trim is indicated on the rudder trim indicator, the surface position indicator (figure 1.6-11), and by physical displacement of the rudder pedals.

AUTO SPOILER DO NOT USE Light

Comes on when some portion of the automatic spoiler system has malfunctioned indicating that spoilers should not be armed. Does not preclude manual operation of spoilers.

NOTE

Light will illuminate if the time between MLG and NLG touchdown exceeds 8 seconds.



SPOILER Handle

Used to select the automatic operating modes or control the manual modes of the spoiler system.

Automatic – When armed for takeoff (flaps less than 30°), the spoiler handle moves to GROUND SPOILER position and ground spoilers automatically extend fully when the number one and three reverser levers, or the number two reverser lever is used for a rejected takeoff when in the ground mode.

When armed prior to landing (flaps 30° or more), the spoiler handle moves to approximately 2/3 position with proportional ground spoilers extension upon main wheels spinup at touchdown, and when the nose gear strut is compressed, the spoiler handle moves to GROUND SPOILER position and ground spoilers extend fully.

NOTE

- The handle is spring loaded to the RET position, and must be at RET before it can be pulled up and remain in the armed position. When armed (up), a red placard labeled ARM in white letters can be seen on both sides of the spoiler handle.
- Speedbrakes are mechanically locked out with more than 5° flaps set.

Manual – In flight, with flaps at less than 5°, the handle is used to control the speedbrake mode by squeezing the "T" handle release, then pulling handle aft to the 1/3, 2/3, or FULL positions. The handle stops at the FULL position.

NOTE

Ground spoilers are mechanically locked out until nose gear is compressed.

When in the ground mode, the handle can be used to control the ground spoiler mode by pulling the handle up and aft to the GROUND SPOILER position. In the aft position, pulling the handle up locks the handle aft.

SA1-139D

Figure 1.6-6. Spoilers

Flap Retract Gate

Prevents inadvertent retraction of the slats when retracting the flaps.

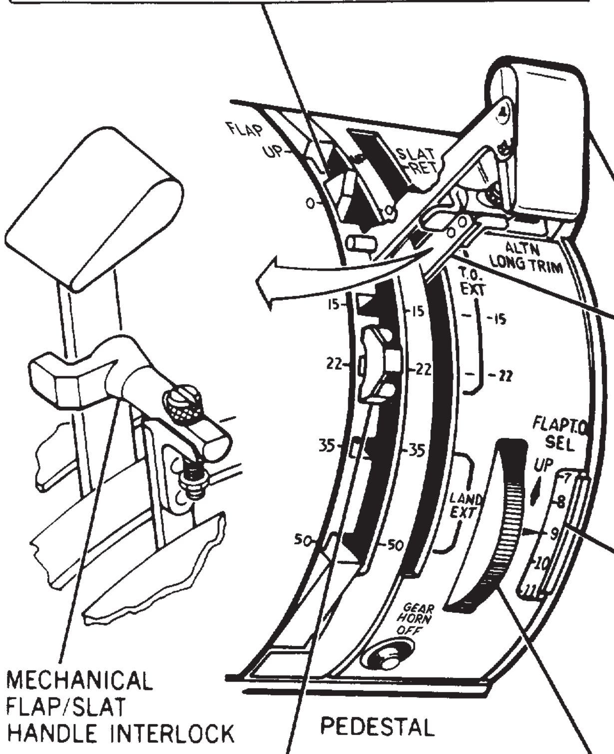
The flap handle must be pushed down with the slat handle raised to pass through the gate into the UP/RET position.

FLAP/SLAT Handles

The flap and slat handles are mechanically coupled to each other. When the flap handle is positioned to a setting from 0 through 25 degrees, the slat handle moves into the T.O. EXT range. When the flap handle is at 35, or 50 degrees the slat handle moves into the LAND EXT range. The flap handle cannot be moved independently of the slat handle unless the mechanical interlock is intentionally uncoupled. The flap handle can be split from the slat handle only in the UP/RET position. Both the flap and slat handles must be raised together at UP/RET position before they can be physically split. The slat handle can never be moved independent of the flap handle.

NOTE

A detent bypass prevents the slat handle from engaging the preselectable FLAP T.O. SELector detent during flap retraction. However, if the flap setting is less than 20° beyond the preselectable FLAP T.O. SELector detent setting the bypass does not arm, and the slat handle engages in the detent, preventing further handle movement. Slat handle must be lifted to disengage it from the detent to continue flap retraction.



FLAP T.O. Window

Indicates the degrees selected for the preselectable flap detent.

NOTE

When not used, insure that FLAP T.O. SELector is rotated to full UP (0°) position.

FLAP T.O. SELector

Provides a preselectable movable detent for any flap setting between 1 and 25 degrees.

NOTE

If a flap setting of 0°, 15°, 22° is selected, the flap handle drops into the fixed detent. Any other flap selection results in only the slat handle dropping into the preselected FLAP T.O. SELector detent. Both handles must be lifted to manually reposition the flaps. Attempting to reposition the flaps with the FLAP T.O. SELector can cause the handles to bind in the detents and prevent lifting the handles from the detents until pressure resulting from wheel movement is relieved.

Maneuvering Flaps

Prevents extension of the flaps beyond or retraction of the flaps to less than 22° until lifting pressure is released to allow the handle to drop into the 22° detent, and then re-applied to cause the handle to pass through the gate.

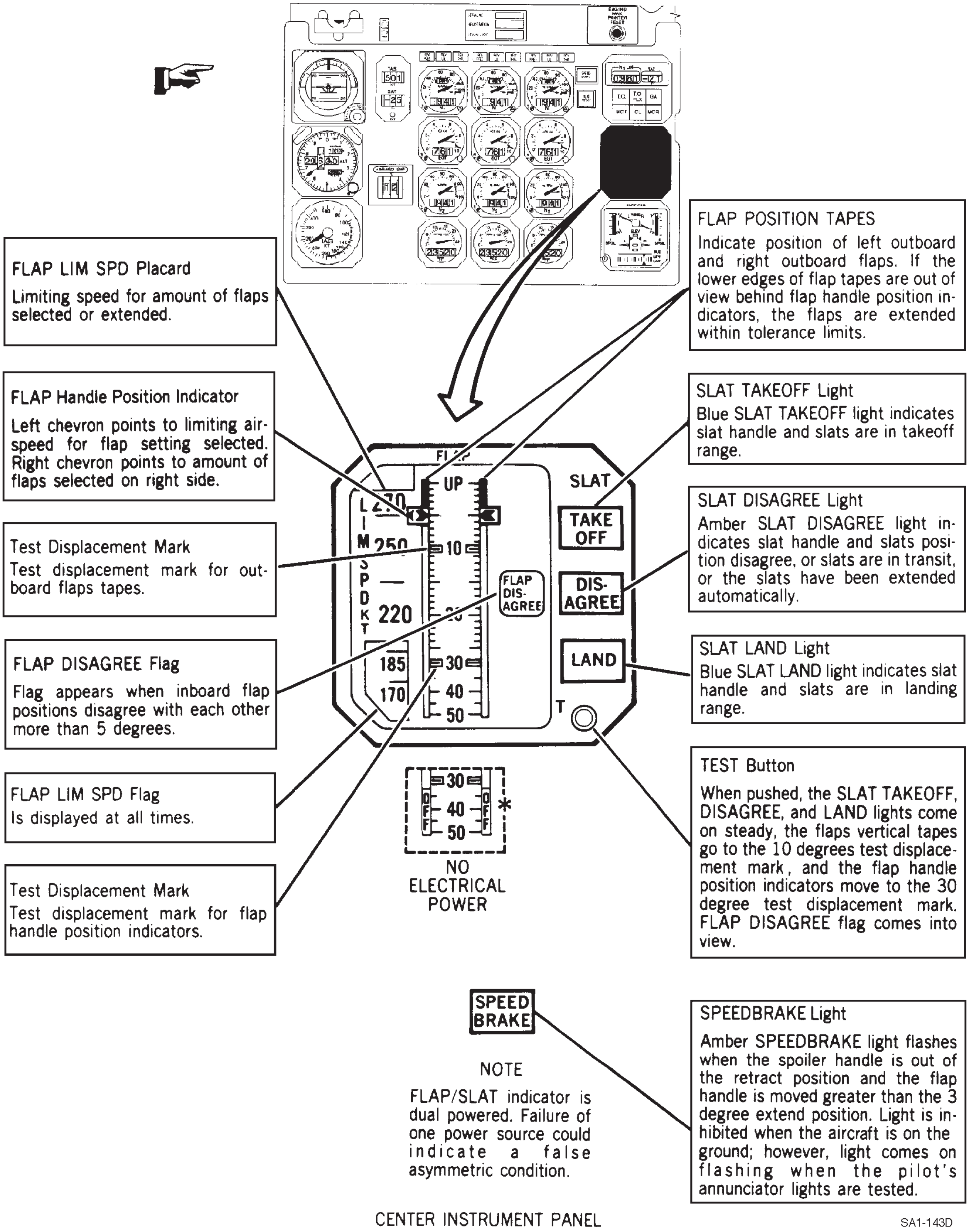
SLAT RESET Switch-Light

Comes on to indicate the outboard slats have been extended by the stall warning system to the auto slat extend position. Automatic slat extension occurs in flight simultaneously with stick shaker actuation (clean configuration at speeds less than 270 KIAS/0.55 MACH). In flight pushing the switch-light retracts the slats, turns off the light, and rearms the automatic slat extend system.

(CENTER INSTRUMENT PANEL)

SA1-140C

Figure 1.6-7. Flap/Slat System



FLAP LIM SPD Placard
Limiting speed for amount of flaps selected or extended.

FLAP Handle Position Indicator
Left chevron points to limiting airspeed for flap setting selected. Right chevron points to amount of flaps selected on right side.

Test Displacement Mark
Test displacement mark for outboard flaps tapes.

FLAP DISAGREE Flag
Flag appears when inboard flap positions disagree with each other more than 5 degrees.

FLAP LIM SPD Flag
Is displayed at all times.

Test Displacement Mark
Test displacement mark for flap handle position indicators.

FLAP POSITION TAPES
Indicate position of left outboard and right outboard flaps. If the lower edges of flap tapes are out of view behind flap handle position indicators, the flaps are extended within tolerance limits.

SLAT TAKEOFF Light
Blue SLAT TAKEOFF light indicates slat handle and slats are in takeoff range.

SLAT DISAGREE Light
Amber SLAT DISAGREE light indicates slat handle and slats position disagree, or slats are in transit, or the slats have been extended automatically.

SLAT LAND Light
Blue SLAT LAND light indicates slat handle and slats are in landing range.

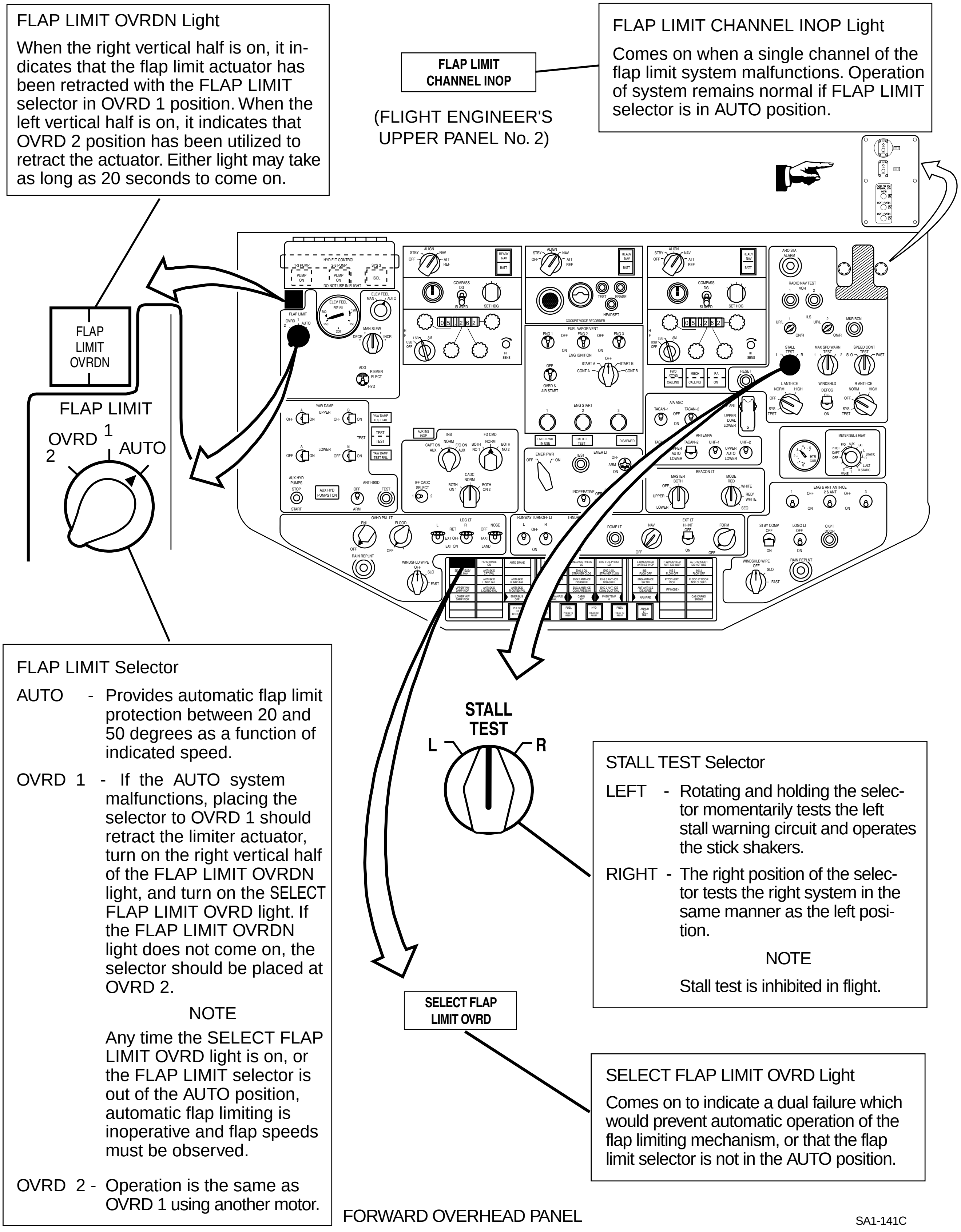
TEST Button
When pushed, the SLAT TAKEOFF, DISAGREE, and LAND lights come on steady, the flaps vertical tapes go to the 10 degrees test displacement mark, and the flap handle position indicators move to the 30 degree test displacement mark. FLAP DISAGREE flag comes into view.

SPEEDBRAKE Light
Amber SPEEDBRAKE light flashes when the spoiler handle is out of the retract position and the flap handle is moved greater than the 3 degree extend position. Light is inhibited when the aircraft is on the ground; however, light comes on flashing when the pilot's annunciator lights are tested.

NOTE

FLAP/SLAT indicator is dual powered. Failure of one power source could indicate a false asymmetric condition.

Figure 1.6-8. Flap/Slat Indicator



FLAP LIMIT OVRDN Light

When the right vertical half is on, it indicates that the flap limit actuator has been retracted with the FLAP LIMIT selector in OVRD 1 position. When the left vertical half is on, it indicates that OVRD 2 position has been utilized to retract the actuator. Either light may take as long as 20 seconds to come on.

FLAP LIMIT CHANNEL INOP Light

Comes on when a single channel of the flap limit system malfunctions. Operation of system remains normal if FLAP LIMIT selector is in AUTO position.

FLAP LIMIT Selector

AUTO - Provides automatic flap limit protection between 20 and 50 degrees as a function of indicated speed.

OVRD 1 - If the AUTO system malfunctions, placing the selector to OVRD 1 should retract the limiter actuator, turn on the right vertical half of the FLAP LIMIT OVRDN light, and turn on the SELECT FLAP LIMIT OVRD light. If the FLAP LIMIT OVRDN light does not come on, the selector should be placed at OVRD 2.

NOTE

Any time the SELECT FLAP LIMIT OVRD light is on, or the FLAP LIMIT selector is out of the AUTO position, automatic flap limiting is inoperative and flap speeds must be observed.

OVRD 2 - Operation is the same as OVRD 1 using another motor.

STALL TEST Selector

LEFT - Rotating and holding the selector momentarily tests the left stall warning circuit and operates the stick shakers.

RIGHT - The right position of the selector tests the right system in the same manner as the left position.

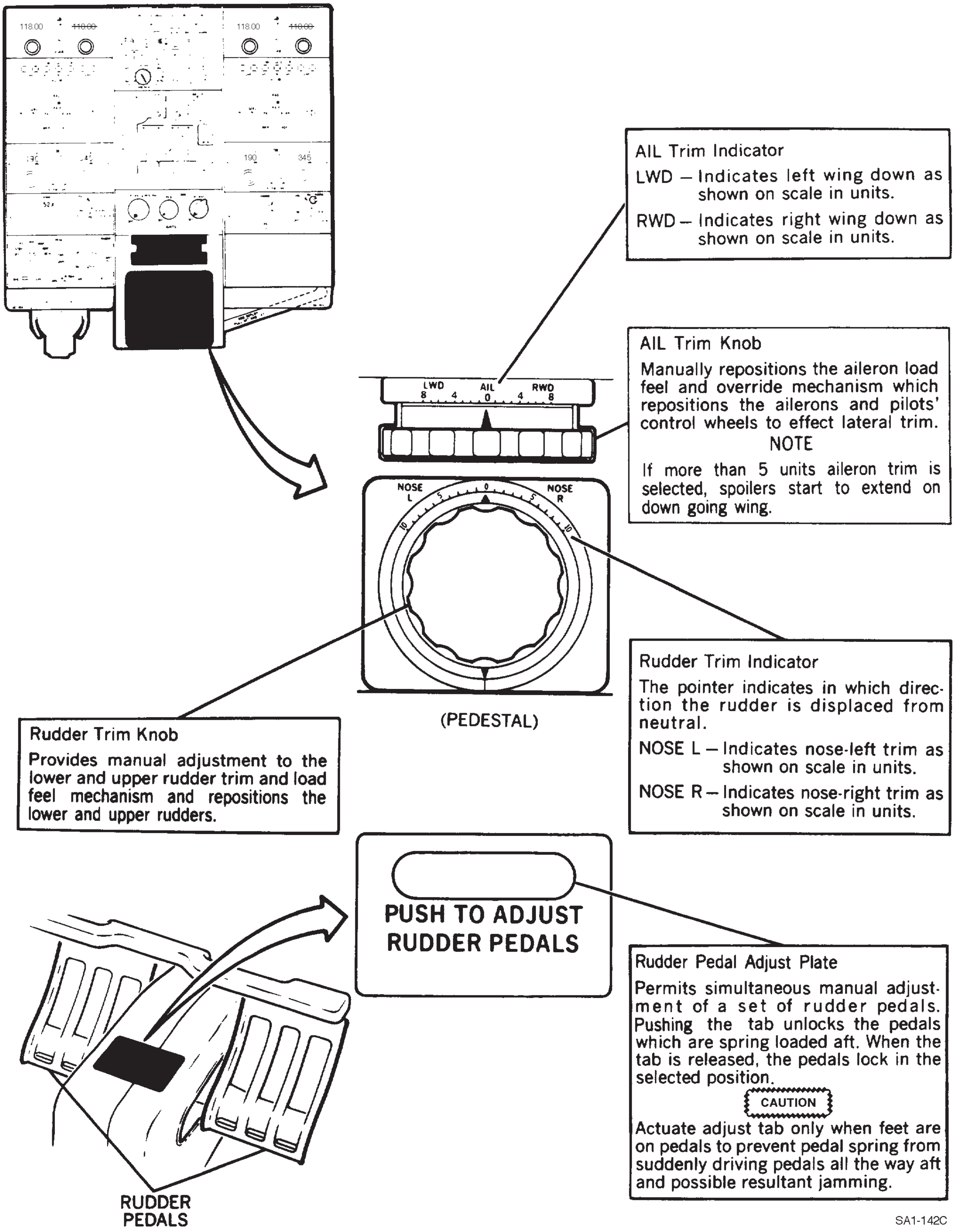
NOTE

Stall test is inhibited in flight.

SELECT FLAP LIMIT OVRD Light

Comes on to indicate a dual failure which would prevent automatic operation of the flap limiting mechanism, or that the flap limit selector is not in the AUTO position.

Figure 1.6-9. Flap Limit and Stall Test



AIL Trim Indicator

LWD – Indicates left wing down as shown on scale in units.

RWD – Indicates right wing down as shown on scale in units.

AIL Trim Knob

Manually repositions the aileron load feel and override mechanism which repositions the ailerons and pilots' control wheels to effect lateral trim.

NOTE

If more than 5 units aileron trim is selected, spoilers start to extend on down going wing.

Rudder Trim Indicator

The pointer indicates in which direction the rudder is displaced from neutral.

NOSE L – Indicates nose-left trim as shown on scale in units.

NOSE R – Indicates nose-right trim as shown on scale in units.

Rudder Trim Knob

Provides manual adjustment to the lower and upper rudder trim and load feel mechanism and repositions the lower and upper rudders.

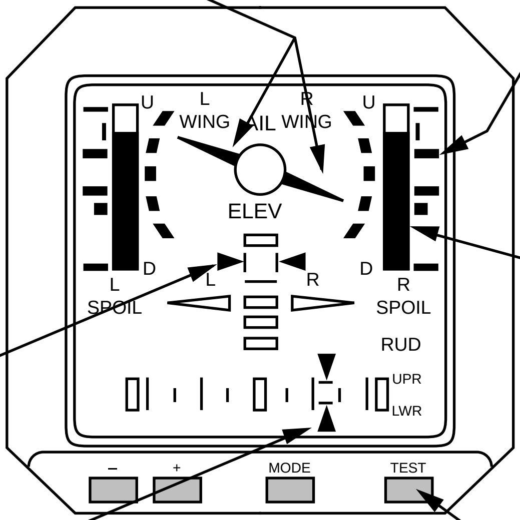
Rudder Pedal Adjust Plate

Permits simultaneous manual adjustment of a set of rudder pedals. Pushing the tab unlocks the pedals which are spring loaded aft. When the tab is released, the pedals lock in the selected position.

CAUTION

Actuate adjust tab only when feet are on pedals to prevent pedal spring from suddenly driving pedals all the way aft and possible resultant jamming.

Figure 1.6-10. Trim Systems and Rudder Pedal Adjustment



WING Deflection Pointer (L,R)

Indicates wing deflection direction and is driven by the summed displacement of the inboard and outboard ailerons. When the flaps and slats are retracted and alternate gear extension lever is stowed, the SURF POS indicator will show 1/2 deflection for ailerons, indicating outboard aileron lockout.

ELEV Indicator (L, R)

Displays the summed displacement of the inboard and outboard elevator segments.

RUD Indicator (Upper/Lower)

Visually displays the upper and lower rudder deflection.

Spoiler Tape Reference Marks

▬ — Spoilers fully extended
▮ ▬ — Speedbrake upper limit
▬ — Two-thirds speed brake
■ — One-third speed brake
▬ — Spoilers retracted

NOTE

Spoiler tapes will move from reference marks with pilot's control wheel inputs

SPOIL Indicator (L, R)

Two vertically moving tapes proportionately display the amount of spoiler movement for speedbrake, lateral control, and ground spoiler modes of operation. Pilot's control wheel must be neutral for both tapes to indicate DN or UP.

TEST Button

Drives all surface position indicating pointers to a pre-programmed test position (indicated by magenta reference marks) to verify indicator operation. Indicator is shown in the test position

NOTE

- The surface positiion indicator is dual powered. Failure of one power source could indicate a false asymmetric condition.
- The -, +, and MODE pushbutton switches located on the front bezel are for ground maintenance operation. The normal display (indicators) will reappear after 5 mintes should a maintenance menu page be displayed.

Indicator Self-Test

1. Ensure spoilers are in retracted position.
2. Ensure ailerons, rudders, and elevators are in neutral positions.
3. Push and hold indicator self-test button. Check that indicator pointers for all surfaces are aligned with magenta test marks located at approximately 3.4 deflection on corresponding scale.
4. Release self-test button. All displays should return to original positions.

Figure 1.6-11. Surface Position Indicator

Longitudinal trim is provided by a two-speed, hydraulically powered, adjustable horizontal stabilizer. The stabilizer is powered by two hydraulic motors independently powered by hydraulic systems 1 and 3.

Additionally, if pressure in hydraulic system 1 fails, pressure is supplied by hydraulic system 2 through the 2-1 non-reversible motor-pump, provided the RUDDER STBY PWR switch is in ARM position.

The compensator in the system senses any loss of pressure and isolates a small loop to the rudder from the non-reversible motor pump. This restores pressure to the upper rudder and the horizontal stabilizer in the case of hydraulic system 1 or the lower rudder in the case of hydraulic system 2, which is supplied pressure through the 3-2 non-reversible motor pump. A RUDDER STBY PWR switch provides manual override control to shut off hydraulic flow to both non-reversible motor-pumps. The stabilizer automatically operates at two different trim rates as a function of airspeed to provide optimum performance. Rate is also dependent upon which stabilizer control input is in use. The longitudinal trim system uses four inputs to command horizontal stabilizer adjustment:

1. Control wheel longitudinal trim control switches (figure 1.6-4). These are the primary electrical fast rate stabilizer controls.

2. Alternate longitudinal trim switches. These provide an alternate means of electrical half primary rate stabilizer control.

3. Longitudinal trim control handles. These are mechanically connected to the stabilizer control valves and have override authority over all other stabilizer controls. The trim handles provide both slow and fast trim rates, depending on selection of half or full travel, respectively. The handles follow-up the motion of the stabilizer control valves. When the control wheel trim switches or the alternate trim switches are used, the handles move one half their full travel in the direction of trimming.

4. The autopilot, when engaged in command or CWS, operates the stabilizer through an auto pitch trim system, and does not cause the longitudinal trim handles to move. When the autopilot is engaged in the command mode, operating the control wheel trim switches, alternate trim switches, or longitudinal trim handles causes the autopilot to disengage. When the autopilot is engaged in the CWS mode, the autopilot does not disengage when trimming the stabilizer, except during the turbulence (TURB) mode. An autopilot out of trim light is provided on each Pilot's Control Panel. When illuminated, it warns of large auto pitch trim changes. If on continuously it indicates auto pitch trim failure.

A stabilizer position indicator and scale are provided. A green band is superimposed on the position indicating scale to indicate the normal range for takeoff.

WARNING SYSTEMS

Takeoff Warning System

The takeoff warning aural signal (intermittent car horn sound, identical to cabin altitude warning) warns the Flight Crew of an unsafe flight control configuration for takeoff. The warning sounds when either throttle 1 or 2 is advanced for takeoff with the ground shift mechanism in the ground mode and any one of the following conditions exist:

1. Slats not in takeoff-extend range.

2. Flaps in landing range, 35° or greater.

3. Spoiler handle not fully forward.

4. Stabilizer setting not in green band.

5. Parking brake not released.

Slats Extended Warning System

An aural signal (same as overspeed warning) alerts the Flight Crew to reduce airspeed and retract the slats when the slats are in the takeoff position and the airspeed exceeds the placarded slat extend limit speed.

Slat Handle Extend Warning

If the flap/slat handle has been moved from the UP/RET position, an aural signal (same as overspeed and slat extended warnings) alerts the flight crew to move the flap/slat handle to UP/RET until airspeed is reduced below placarded slat extend speed.

Stall Warning System

A tactile stall warning informs the Flight Crew of an approaching stall condition for the existing flap/slat configuration. Either channel of a dual system actuates a stick shaker which vibrates both control columns. When the flaps and slats are retracted, the outboard slats partially extend and the SLAT RESET switchlight (figure 1.6-7) comes on at the onset of stall warning. Auto slat extend/stall warning is inhibited above 270 KIAS/0.55 Mach.

Stabilizer In-Motion Warning System

An aural signal (continuous deep pitched air horn sound) informs the Flight Crew that the horizontal stabilizer is in motion. The aural signal sounds after continuous movement of more than 1° stabilizer travel at a rate greater than 0.08° per second for manual trim and after continuous movement of more than 1° stabilizer travel when in the automatic pitch trim mode of operation.

CONTROLS AND INDICATORS

Controls, indicators, and annunciator lights are on the Pedestal, Center Instrument Panel, Flight Engineer's Upper Panel No. 2, and Flight Engineer's Lower Panel. Illustrations of the major panels are in Part 1, Section I. Individual controls and indicators are illustrated and described in this part.

FLIGHT INSTRUMENTS

FLIGHT INSTRUMENTS DESCRIPTION

The flight instruments section includes the pitot static system, the air data system (figure 1.6-13), and those basic flight instruments, standby instruments, and related components which provide altitude, airspeed, heading, Mach, vertical speed, true airspeed, overspeed warning, attitude, and air temperature data to the flight crew. Sensors provide inputs to two central air data computers where temperature and instrument position corrective factors are applied as appropriate.

PITOT/STATIC SYSTEM

During normal operation, the pitot/static system inputs pressure values to the central air data computers which provide computed outputs for readout of airspeed, vertical speed, and altitude.

Two parallel static systems (the Pilot's and Copilot's) provide inputs to the central air data computers, while a third system (the alternate static) provides raw inputs (uncorrected barometric) to the standby altimeter (figure 1.6-14), the standby airspeed indicator, the cabin pressure controller, and the cabin/flight differential pressure indicator. An alternate static source selector provides the capability to shut off the normal static source of the Pilot's and/or Copilot's static system, if required, and utilize the alternate static source.

PRIMARY FLIGHT INSTRUMENTS

The primary Mach/AS indicators (figure 1.6-15), true airspeed and vertical speed indicators (figure 1.6-16), altimeters (figure 1.6-15), and the overspeed warning system derive their inputs from the central air data computers which receive and process (correct for temperature and position error) raw data from the pitot static system. The overspeed warning sensor activates an aural warning device when limiting airspeeds are reached.

DIRECTIONAL INDICATING SYSTEMS

Magnetic heading reference is provided by two independent compass systems. Each compass system is stabilized by the associated inertial platform and receives magnetic inputs from its individual flux valve. Each compass system is controlled by its individual compass controller (figure 1.6-17) located on the Overhead Panel. A COMPASS switch on the compass controller selects the SLAVED (normal) mode or DG (unslaved) mode of operation. A synchronization indicator provides a visual indication of synchronization accuracy while in the slaved mode. A SET HDG knob provides two rates, fast and slow, for slewing the compass cards in either the clockwise or counterclockwise direction, and is spring-loaded to the center position. The compass heading is displayed on the radio magnetic indicator (RMI) compass cards at all times and on the electronic horizontal situation indicator (EHSI) compass cards when the FMS HDG switch is set to MAG (figure 1.6-17). The number one compass system drives the Pilot's EHSI and TACAN RMI and the Copilot's VOR/ADF RMI. The number two compass system drives the Copilot's EHSI and TACAN RMI and the Pilot's VOR/ADF RMI.

True heading reference is provided by the INS for display on the EHSIs. INS1 provides the heading reference for the pilot's EHSI; INS2 provides the heading reference for the copilot's EHSI. True reference is selected by positioning the FMS heading switch to TRUE. A white “TRU” symbol to the left of the lubber line on the EHSI indicates true heading.

NOTE

> TACAN, VOR, and ADF courses and/or bearings are computed and displayed in true on the EHSI when the FMS HDG switch is set to TRUE.

ATTITUDE DIRECTOR INDICATOR

For the purpose of this part, the Attitude Director Indicator (ADI) is considered as a basic attitude display and not for the broader role it performs as the command focal point in the flight director and flight guidance subsystems. These diverse aspects are described in the navigation and flight guidance parts of Section I.

Two remote inertial platforms (Pilot's and Copilot's) provide basic attitude information to their respective ADI's. A third inertial platform is installed to provide input to the indicators in the event of a failure of either inertial platform 1 or 2. The INS switch (figure 1.6-24) permits selection of the third inertial platform for input to either the Pilot's or Copilot's indicators. A GYRO warning flag on the ADI indicates attitude data are unusable. The ADI has a test button which, when pushed, tests the attitude, flight director, and rising runway functions.

STANDBY ATTITUDE INDICATOR

The Standby Attitude Indicator provides a continuous indication of aircraft attitude in pitch and roll. It consists of a standby attitude indicator, located on the center instrument panel, powered by 115 VAC, three phase current supplied by a static inverter connected to the 28 VDC battery bus. The standby attitude indicator operates independently from all other navigation systems. The indicator is basically a gyro wheel rotating in such a manner that its spin axis is relatively vertical to the surface of the earth.

FLIGHT RECORDER

The digital flight data recorder (DFDR) records data from aircraft subsystems and sensors (figure 1.6-25). The recorder is on when the parking brake is released and engine(s) are running, or when the aircraft systems are in flight mode. The recorder is on when the switch, located on the Flight Engineer's Panel, is set to override.

CONTROLS AND INDICATORS

Controls, indicators and annunciator are on the Pilot's and Copilot's Instrument Panels, Center Instrument Panel, Overhead Panel, Pilot's Auxiliary Panel, Aft Pedestal, and Flight Engineer's Upper No. 2 and 3 Panels. Illustrations of the panels are in Part 1 of this section. Individual controls and indicators are illustrated and described in this part.

NOTE

Refer to Electrical, Part 4, for loss of power to flight instruments.

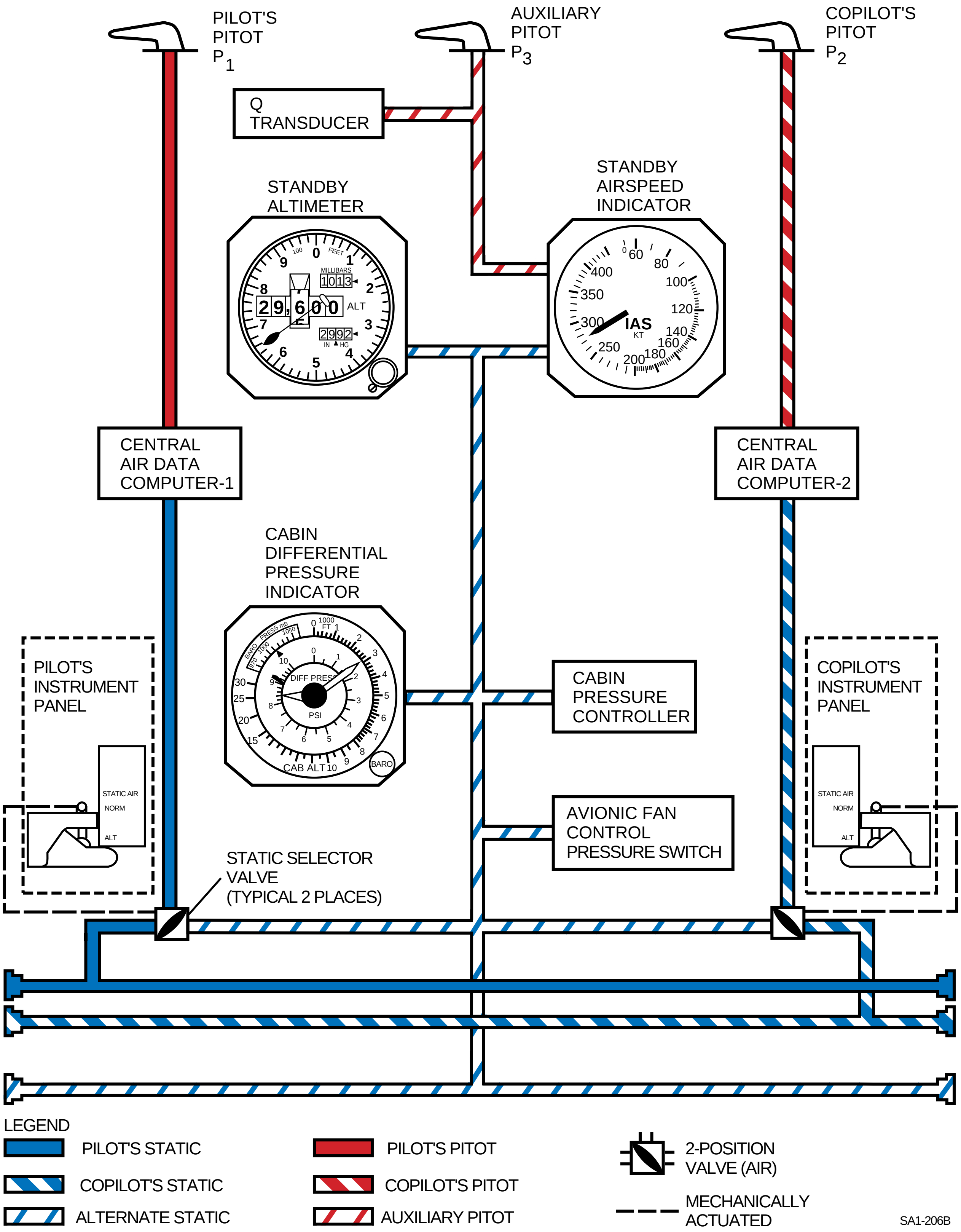


Figure 1.6-12. Pitot/Static System

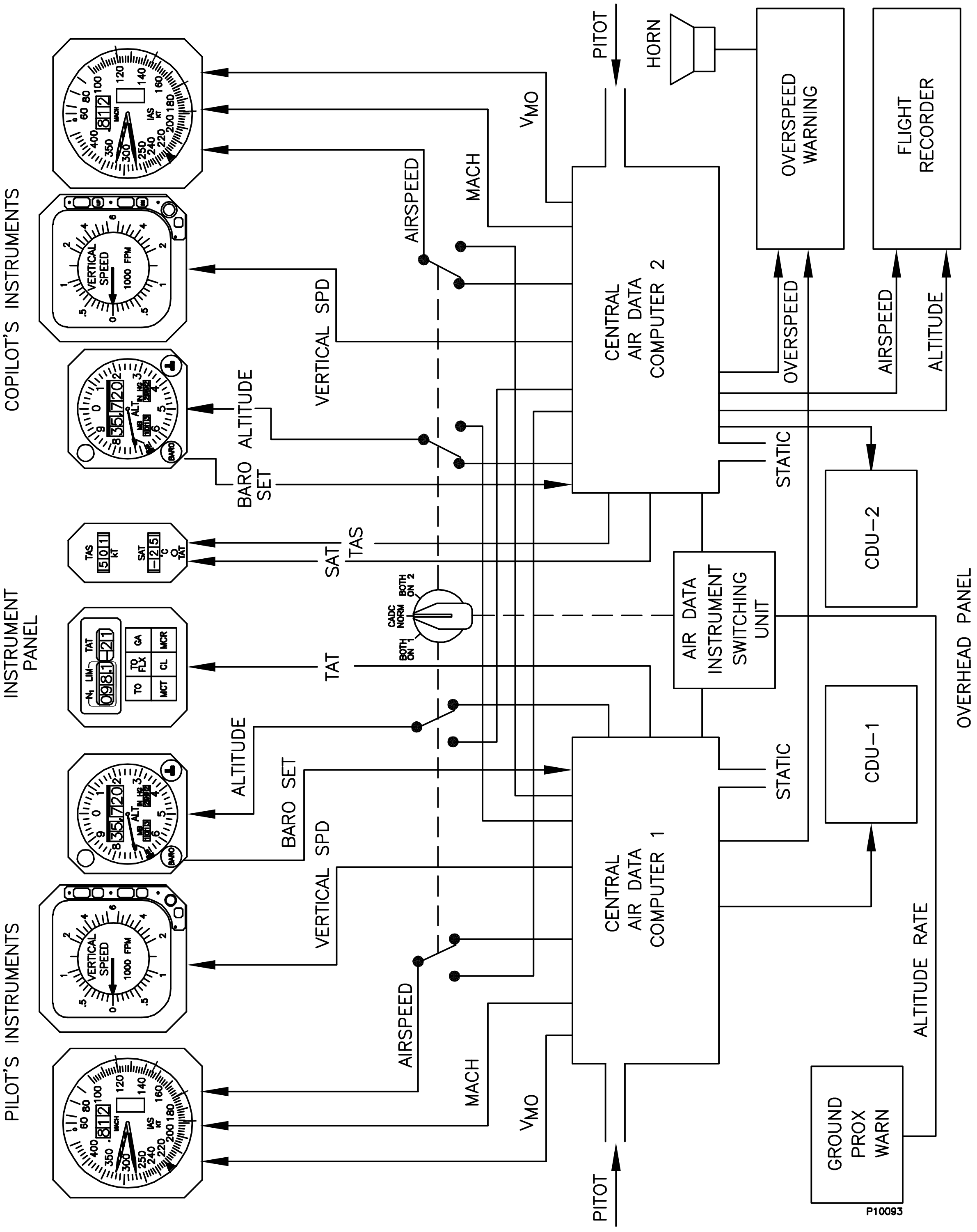


Figure 1.6-13. Central Air Data Computer Pitot Static Interface

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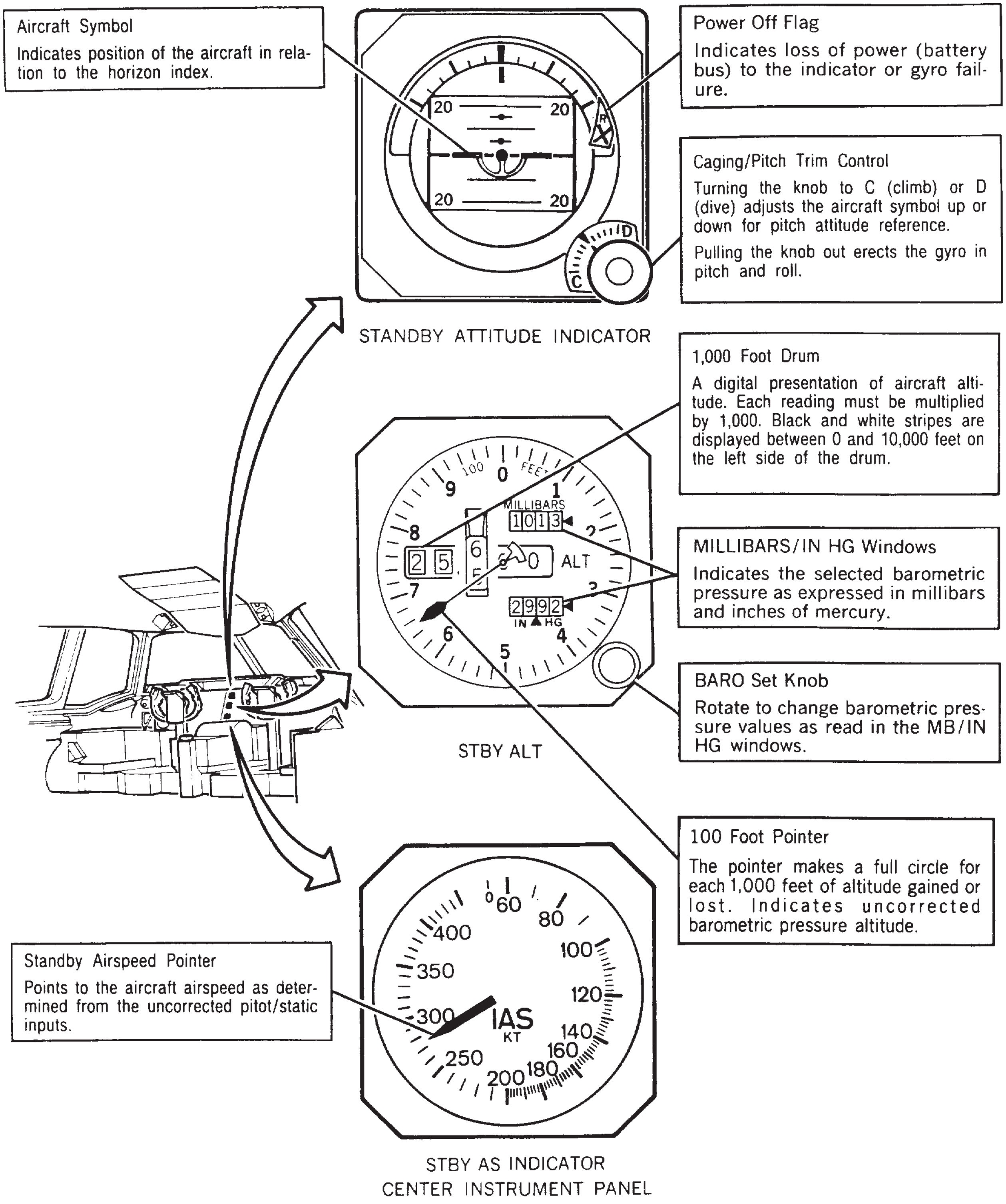


Aircraft Symbol

Indicates position of the aircraft in relation to the horizon index.

Power Off Flag

Indicates loss of power (battery bus) to the indicator or gyro failure.

Caging/Pitch Trim Control

Turning the knob to C (climb) or D (dive) adjusts the aircraft symbol up or down for pitch attitude reference.

Pulling the knob out erects the gyro in pitch and roll.

1,000 Foot Drum

A digital presentation of aircraft altitude. Each reading must be multiplied by 1,000. Black and white stripes are displayed between 0 and 10,000 feet on the left side of the drum.

MILLIBARS/IN HG Windows

Indicates the selected barometric pressure as expressed in millibars and inches of mercury.

BARO Set Knob

Rotate to change barometric pressure values as read in the MB/IN HG windows.

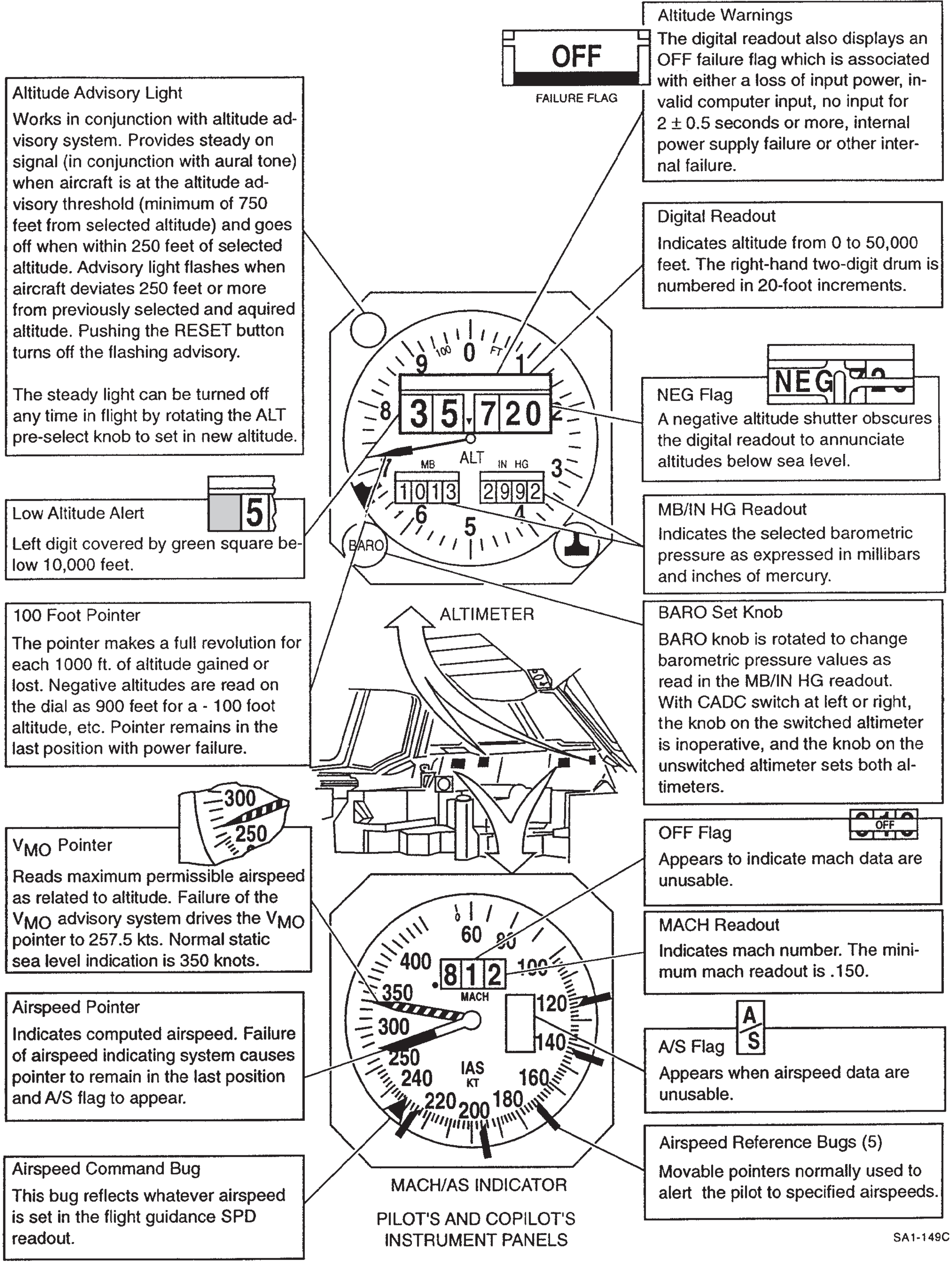
100 Foot Pointer

The pointer makes a full circle for each 1,000 feet of altitude gained or lost. Indicates uncorrected barometric pressure altitude.

Standby Airspeed Pointer

Points to the aircraft airspeed as determined from the uncorrected pitot/static inputs.

Figure 1.6-14. Standby Flight Instruments



Altitude Advisory Light

Works in conjunction with altitude advisory system. Provides steady on signal (in conjunction with aural tone) when aircraft is at the altitude advisory threshold (minimum of 750 feet from selected altitude) and goes off when within 250 feet of selected altitude. Advisory light flashes when aircraft deviates 250 feet or more from previously selected and aquired altitude. Pushing the RESET button turns off the flashing advisory.

The steady light can be turned off any time in flight by rotating the ALT pre-select knob to set in new altitude.

Low Altitude Alert

Left digit covered by green square below 10,000 feet.

100 Foot Pointer

The pointer makes a full revolution for each 1000 ft. of altitude gained or lost. Negative altitudes are read on the dial as 900 feet for a - 100 foot altitude, etc. Pointer remains in the last position with power failure.

V_{MO} Pointer

Reads maximum permissible airspeed as related to altitude. Failure of the V_{MO} advisory system drives the V_{MO} pointer to 257.5 kts. Normal static sea level indication is 350 knots.

Airspeed Pointer

Indicates computed airspeed. Failure of airspeed indicating system causes pointer to remain in the last position and A/S flag to appear.

Airspeed Command Bug

This bug reflects whatever airspeed is set in the flight guidance SPD readout.

Altitude Warnings

The digital readout also displays an OFF failure flag which is associated with either a loss of input power, invalid computer input, no input for 2 ± 0.5 seconds or more, internal power supply failure or other internal failure.

Digital Readout

Indicates altitude from 0 to 50,000 feet. The right-hand two-digit drum is numbered in 20-foot increments.

NEG Flag

A negative altitude shutter obscures the digital readout to annunciate altitudes below sea level.

MB/IN HG Readout

Indicates the selected barometric pressure as expressed in millibars and inches of mercury.

BARO Set Knob

BARO knob is rotated to change barometric pressure values as read in the MB/IN HG readout. With CADC switch at left or right, the knob on the switched altimeter is inoperative, and the knob on the unswitched altimeter sets both altimeters.

OFF Flag

Appears to indicate mach data are unusable.

MACH Readout

Indicates mach number. The minimum mach readout is .150.

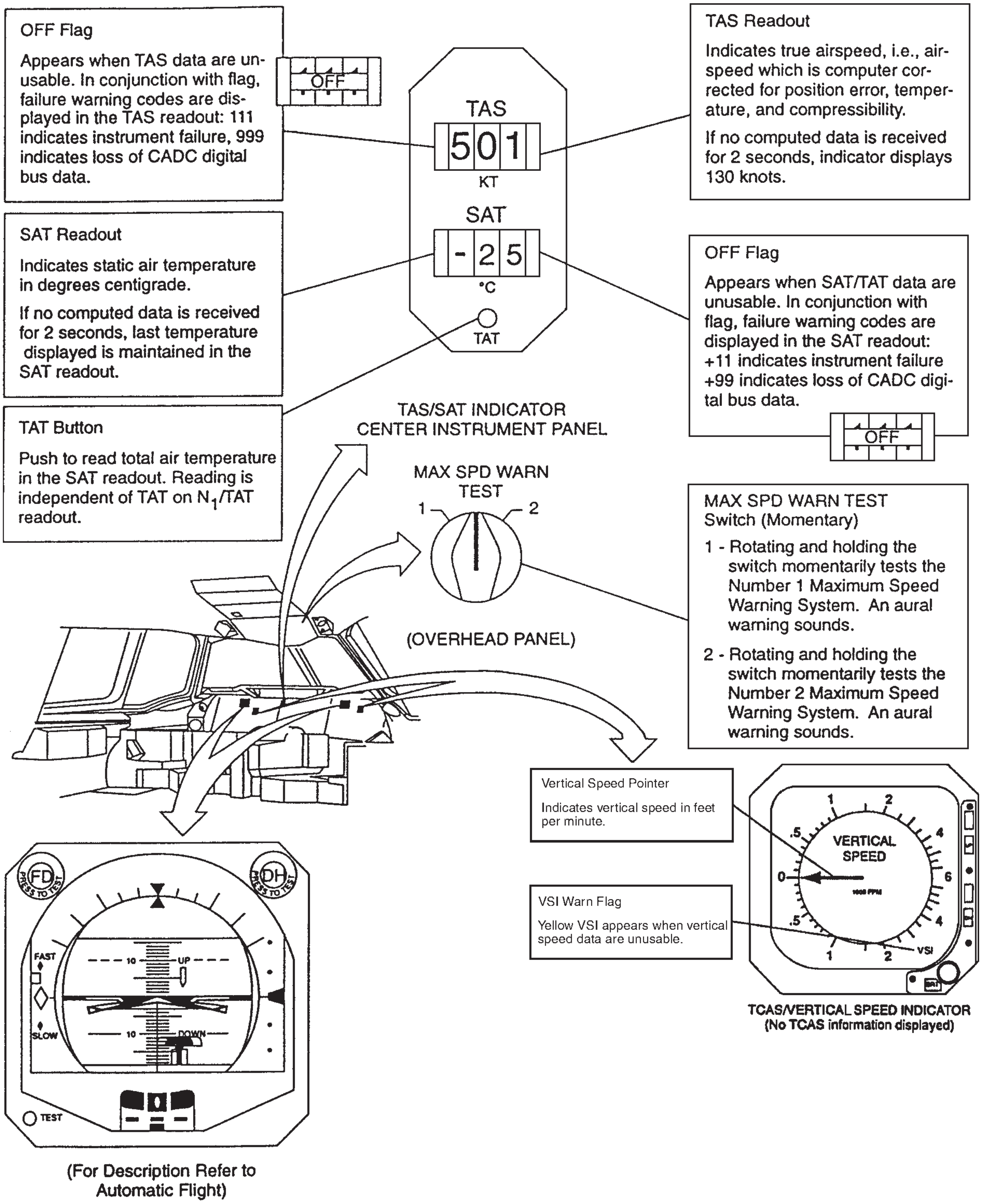
A/S Flag

Appears when airspeed data are unusable.

Airspeed Reference Bugs (5)

Movable pointers normally used to alert the pilot to specified airspeeds.

Figure 1.6-15. Altimeter and Mach/Airspeed Indicator



OFF Flag

Appears when TAS data are unusable. In conjunction with flag, failure warning codes are displayed in the TAS readout: 111 indicates instrument failure, 999 indicates loss of CADC digital bus data.

SAT Readout

Indicates static air temperature in degrees centigrade.

If no computed data is received for 2 seconds, last temperature displayed is maintained in the SAT readout.

TAT Button

Push to read total air temperature in the SAT readout. Reading is independent of TAT on N_1/TAT readout.

TAS Readout

Indicates true airspeed, i.e., airspeed which is computer corrected for position error, temperature, and compressibility.

If no computed data is received for 2 seconds, indicator displays 130 knots.

OFF Flag

Appears when SAT/TAT data are unusable. In conjunction with flag, failure warning codes are displayed in the SAT readout:
+11 indicates instrument failure
+99 indicates loss of CADC digital bus data.

MAX SPD WARN TEST
Switch (Momentary)

1 - Rotating and holding the switch momentarily tests the Number 1 Maximum Speed Warning System. An aural warning sounds.

2 - Rotating and holding the switch momentarily tests the Number 2 Maximum Speed Warning System. An aural warning sounds.

Vertical Speed Pointer

Indicates vertical speed in feet per minute.

VSI Warn Flag

Yellow VSI appears when vertical speed data are unusable.

PILOT'S AND COPILOT'S INSTRUMENT PANELS

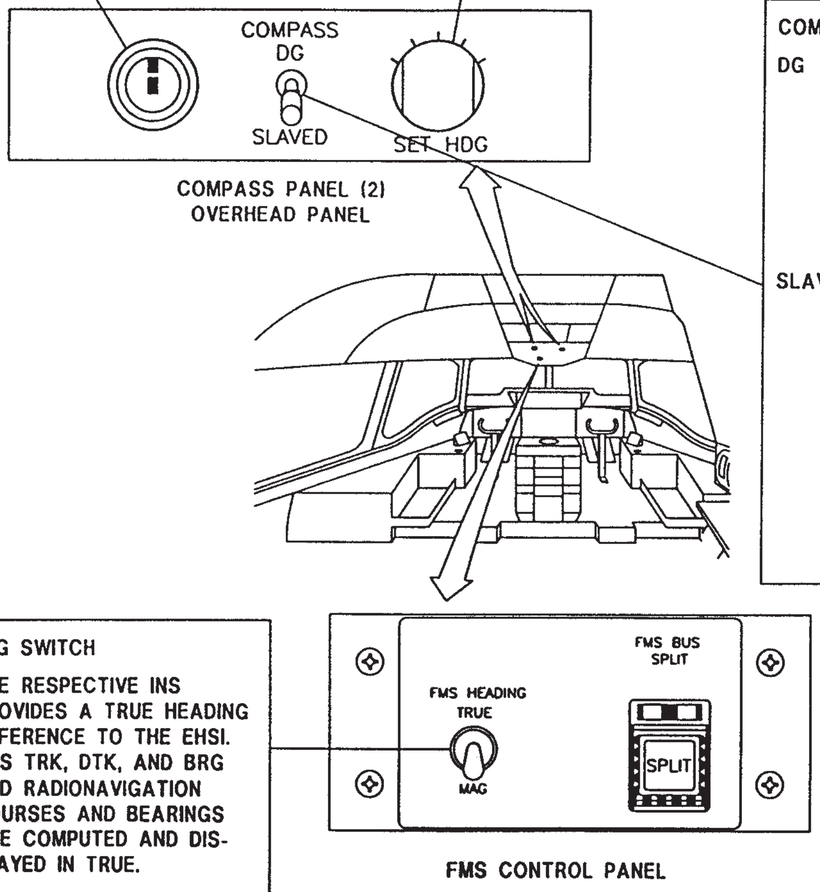
Figure 1.6-16. Max Speed Warning Test Switch, TAS/SAT ADI and TCAS/Vertical Speed Indicator

COMPASS SET HDG KNOB

PERMITS MANUAL RE-SYNCHRONIZATION OF THE COMPASS COUPLER OUTPUTS WITH THE FLUX VALVE WHEN IN THE **SLAVED** MODE, OR SELECTION OF COMPASS HEADING WHEN IN THE **DG** MODE. FIRST MARK ON EITHER SIDE PROVIDES SLOW HEADING CORRECTION, SECOND MARK PROVIDES ACCELERATED HEADING CORRECTION. KNOB IS SPRING LOADED TO NEUTRAL POSITION.

SYNCHRONIZATION INDICATOR

DEVIATION FROM CENTER LINE INDICATES THE COMPASS IS NOT SYNCHRONIZED WITH THE FLUX VALVE.



COMPASS SWITCH

DG —PERMITS RESPECTIVE COMPASS SYSTEM TO BE OPERATED AS AN AZIMUTH STABILIZED REFERENCE, WITH HEADING REFERENCE SELECTABLE BY THE PILOT AND INDEPENDENT OF THE FLUX VALVE.

SLAVED—NORMAL POSITION IN WHICH THE COMPASS CARD IS SLAVED TO THE FLUX VALVE AND COMPASS COUPLER. AUTOMATIC SLAVING OCCURS WITHIN A FEW MOMENTS AFTER ELECTRICAL POWER IS APPLIED. CYCLING THE SWITCH ONCE AND RETURNING TO **SLAVED** ENERGIZES A FAST SYNC RATE.

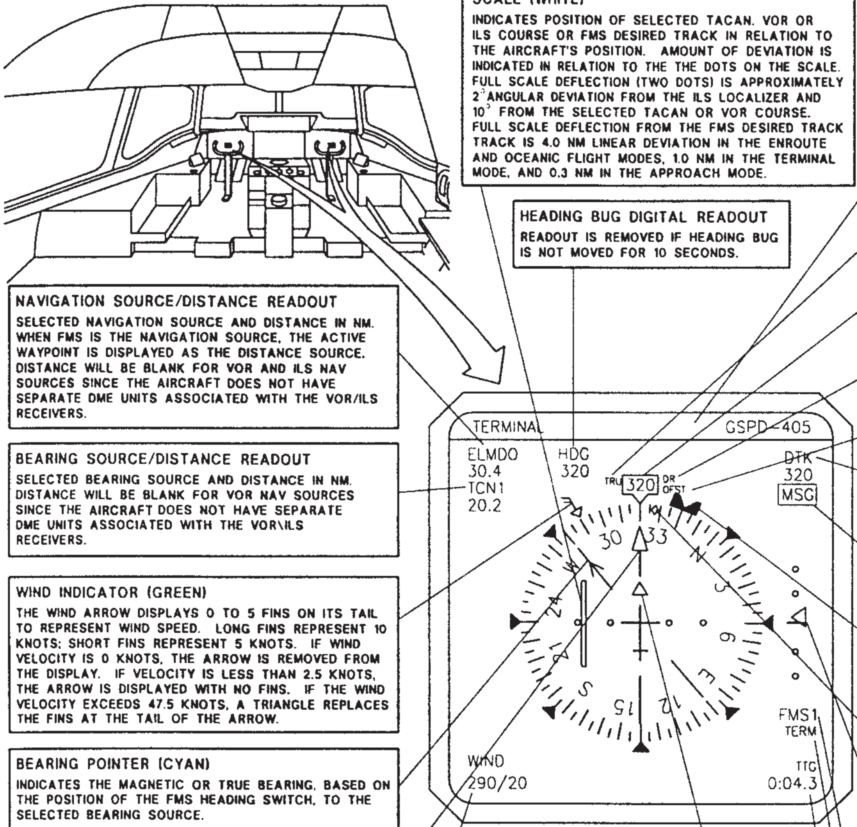
CP0238

FMS HEADING SWITCH

TRUE —THE RESPECTIVE INS PROVIDES A TRUE HEADING REFERENCE TO THE EHSI. FMS TRK, DTK, AND BRG AND RADIONAVIGATION COURSES AND BEARINGS ARE COMPUTED AND DISPLAYED IN TRUE.

MAG —NORMAL POSITION. THE RESPECTIVE COMPASS SYSTEM PROVIDES A MAGNETIC HEADING REFERENCE TO THE EHSI. FMS TRK, DTK, AND BRG AND RADIONAVIGATION COURSES AND BEARINGS ARE COMPUTED AND DISPLAYED IN MAGNETIC.

Figure 1.6-17. Compass Controller and FMS Heading Switch



COURSE DEVIATION INDICATOR (MAGENTA) AND SCALE (WHITE)

INDICATES POSITION OF SELECTED TACAN, VOR OR ILS COURSE OR FMS DESIRED TRACK IN RELATION TO THE AIRCRAFT'S POSITION. AMOUNT OF DEVIATION IS INDICATED IN RELATION TO THE THE DOTS ON THE SCALE. FULL SCALE DEFLECTION (TWO DOTS) IS APPROXIMATELY 2° ANGULAR DEVIATION FROM THE ILS LOCALIZER AND 10° FROM THE SELECTED TACAN OR VOR COURSE. FULL SCALE DEFLECTION FROM THE FMS DESIRED TRACK TRACK IS 4.0 NM LINEAR DEVIATION IN THE ENROUTE AND OCEANIC FLIGHT MODES, 1.0 NM IN THE TERMINAL MODE, AND 0.3 NM IN THE APPROACH MODE.

HEADING BUG DIGITAL READOUT

READOUT IS REMOVED IF HEADING BUG IS NOT MOVED FOR 10 SECONDS.

NAVIGATION SOURCE/DISTANCE READOUT

SELECTED NAVIGATION SOURCE AND DISTANCE IN NM. WHEN FMS IS THE NAVIGATION SOURCE, THE ACTIVE WAYPOINT IS DISPLAYED AS THE DISTANCE SOURCE. DISTANCE WILL BE BLANK FOR VOR AND ILS NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

BEARING SOURCE/DISTANCE READOUT

SELECTED BEARING SOURCE AND DISTANCE IN NM. DISTANCE WILL BE BLANK FOR VOR NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR\ILS RECEIVERS.

WIND INDICATOR (GREEN)

THE WIND ARROW DISPLAYS 0 TO 5 FINS ON ITS TAIL TO REPRESENT WIND SPEED. LONG FINS REPRESENT 10 KNOTS; SHORT FINS REPRESENT 5 KNOTS. IF WIND VELOCITY IS 0 KNOTS, THE ARROW IS REMOVED FROM THE DISPLAY. IF VELOCITY IS LESS THAN 2.5 KNOTS, THE ARROW IS DISPLAYED WITH NO FINS. IF THE WIND VELOCITY EXCEEDS 47.5 KNOTS, A TRIANGLE REPLACES THE FINS AT THE TAIL OF THE ARROW.

BEARING POINTER (CYAN)

INDICATES THE MAGNETIC OR TRUE BEARING, BASED ON THE POSITION OF THE FMS HEADING SWITCH, TO THE SELECTED BEARING SOURCE.

COURSE POINTER (WHITE)

INDICATES SELECTED COURSE FOR TACAN, VOR, OR ILS NAV SOURCES. INDICATES DESIRED TRACK TO THE ACTIVE WAYPOINT FOR THE FMS NAV SOURCE. IN FMS, THE COURSE ARROW IS POSITIONED AUTOMATICALLY THROUGH THE FMS (FGS NAV COURSE SELECTOR KNOB IS INACTIVE); MANUAL COURSE CHANGES MAY BE MADE THROUGH THE CDU.

WIND READOUT

INDICATES WIND DIRECTION AND VELOCITY.

FREE FORMAT LINE

LEFT SIDE DISPLAYS THE FMS SCALING MODE WHEN FMS IS THE SELECTED NAV SOURCE. RIGHT SIDE DISPLAYS GROUNDSPEED.

HEADING SOURCE

MAGNETIC (BLANK) OR TRUE (TRU).

DIGITAL HEADING READOUT AND LUBBER LINE POINTER

INDICATES AIRCRAFT HEADING.

DR OR RAIM ALERT

DEAD RECKONING OR GPS RAIM ALERT.

OFST ANNUNCIATOR

INDICATES AN FMS PARALLEL OFFSET IS ACTIVE.

COURSE READOUT/LABEL

SELECTED COURSE (CRS) OR DESIRED TRACK (DTK).

MSG (AMBER)

FMS MESSAGE ALERT. INDICATES ANNUNCIATION OF CERTAIN FMS MESSAGES ON THE CDU (SEE FIGURE 1.14-15 FOR WHICH FMS MESSAGES ILLUMINATE THE MSG ANNUNCIATOR).

HEADING BUG (MAGENTA)

A MOVABLE INDEX CONTROLLED BY THE HEADING SELECTOR KNOB ON THE FGS PANEL WHICH INDICATES SELECTED HEADING.

FMS TRACK ANGLE INDICATOR (CYAN)

DIAMOND SYMBOL INDICATES THE ACTUAL AIRCRAFT GROUND TRACK WHEN FMS IS THE SELECTED NAVIGATION SOURCE.

GLIDESLOPE DEVIATION INDICATOR (MAGENTA TRIANGLE OUTLINED IN WHITE)

INDICATES GLIDESLOPE CENTER RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS 1/2° ABOVE/BELOW GLIDESLOPE (1/4° PER DOT). ONLY VISIBLE WITH LOC SELECTED AND GLIDESLOPE VALID.

VNAV DEVIATION INDICATOR (MAGENTA CROSS OUTLINED IN WHITE)

INDICATES FMS VERTICAL PATH RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS ± 1000 FEET IN OCEANIC, ENROUTE, AND TERMINAL MODES, AND ± 300 FEET IN APPROACH MODE. ONLY VISIBLE WHEN FMS IS SELECTED.

NAVIGATION SOURCE

FMS, LOC, BC, VOR, OR TCN. NO. 1 SYSTEMS MAY BE SELECTED ON THE PILOT'S EHSI; NO. 2 SYSTEMS MAY BE SELECTED ON THE COPILOT'S EHSI (NO CROSS-SIDE SELECTIONS AVAILABLE).

FMS SCALING MODE

WHEN FMS IS THE SELECTED NAV SOURCE, DISPLAYS APPROACH (APPR), TERMINAL (TERM), ENROUTE (ENRT) OR OCEANIC (OCNC). ENRT WILL BLANK AFTER 10 SECONDS. ALSO DISPLAYED SPELLED OUT ON LEFT SIDE OF FREE FORMAT LINE.

NAVIGATION DATA READOUT

DISPLAYS TIME-TO-GO (TTG), GROUNDSPEED (GSPD), TRUE AIRSPEED (TAS), ELAPSED TIME (ET) OR BLANK, AS SELECTED ON THE EHSI CONTROL PANEL. GROUNDSPEED IS ALSO DISPLAYED ON THE RIGHT SIDE OF THE FREE FORMAT LINE.

TO/FROM INDICATOR (WHITE)

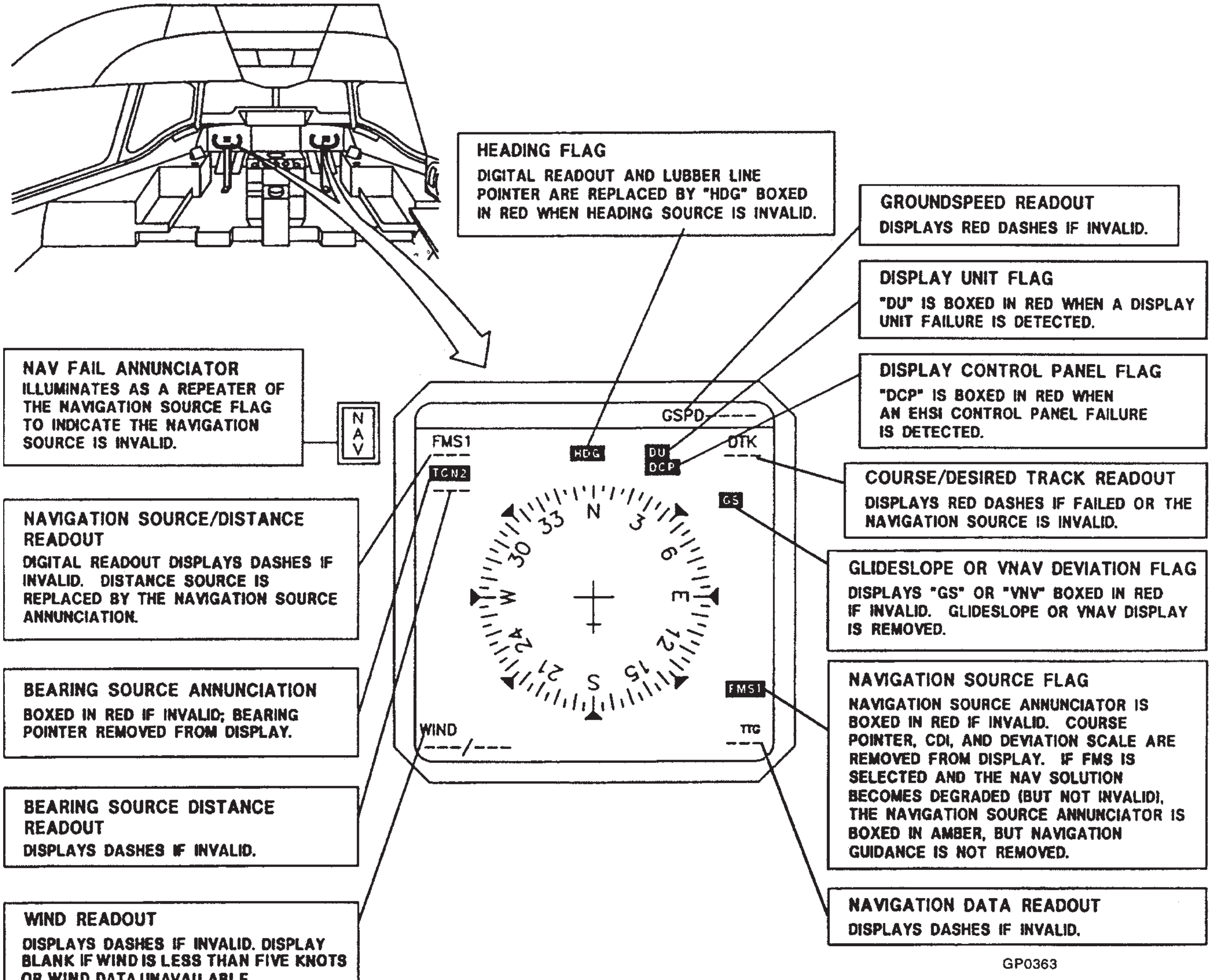
INDICATES WHETHER THE SELECTED COURSE, IF FLOWN, TAKES THE AIRCRAFT TOWARD OR AWAY FROM THE STATION/WAYPOINT. WHEN THE NAV SOURCE IS NOT FMS, THE INDICATOR IS SET TO "TO" WHEN THE ANGULAR DIFFERENCE BETWEEN THE RELATIVE BEARING TO THE STATION AND THE SELECTED COURSE IS LESS THAN 89°. WHEN THE ANGLE IS GREATER THAN 91°, "FROM" IS DISPLAYED. THE INDICATOR BLANKS BETWEEN 89° AND 91° OR WHEN LOC OR BC IS SELECTED. WHEN FMS IS THE NAV SOURCE, TO/FROM INDICATION IS DETERMINED BY THE FMS.

ALSO DOUBLES AS FMS WAYPOINT ANNUNCIATOR. BEGINS FLASHING A USER SELECTABLE 10-120 SECONDS (10 SECONDS IN TERMINAL AND APPROACH MODES) BEFORE THE SWITCH POINT FOR WAYPOINT CHANGE AND THEN RETURNS TO STEADY WHEN THE WAYPOINT CHANGE IS AUTOMATICALLY MADE. CONTINUES FLASHING IN MANUAL WAYPOINT SEQUENCING MODE (ENROUTE AND OCEANIC FLIGHT MODES) TO INDICATE A MANUAL WAYPOINT CHANGE IS REQUIRED.

NOTE: IN THE CASE OF WAYPOINT PASSED WHEN IN THE ENROUTE/OCEANIC FLIGHT MODES AND MANUAL WAYPOINT SEQUENCING, THE CDU "« WPT PASSED »" ANNUNCIATION IS DISPLAYED AND THE FMS MSG ANNUNCIATOR IS DISPLAYED.

GP0365

Figure 1.6-18. Electronic Horizontal Situation Indicator (EHSI) (360° HSI Display Mode Shown)



HEADING FLAG
DIGITAL READOUT AND LUBBER LINE POINTER ARE REPLACED BY "HDG" BOXED IN RED WHEN HEADING SOURCE IS INVALID.

GROUNDSPEED READOUT
DISPLAYS RED DASHES IF INVALID.

DISPLAY UNIT FLAG
"DU" IS BOXED IN RED WHEN A DISPLAY UNIT FAILURE IS DETECTED.

DISPLAY CONTROL PANEL FLAG
"DCP" IS BOXED IN RED WHEN AN EHSI CONTROL PANEL FAILURE IS DETECTED.

NAV FAIL ANNUNCIATOR
ILLUMINATES AS A REPEATER OF THE NAVIGATION SOURCE FLAG TO INDICATE THE NAVIGATION SOURCE IS INVALID.

COURSE/DESIRED TRACK READOUT
DISPLAYS RED DASHES IF FAILED OR THE NAVIGATION SOURCE IS INVALID.

NAVIGATION SOURCE/DISTANCE READOUT
DIGITAL READOUT DISPLAYS DASHES IF INVALID. DISTANCE SOURCE IS REPLACED BY THE NAVIGATION SOURCE ANNUNCIATION.

GLIDESLOPE OR VNAV DEVIATION FLAG
DISPLAYS "GS" OR "VNV" BOXED IN RED IF INVALID. GLIDESLOPE OR VNAV DISPLAY IS REMOVED.

BEARING SOURCE ANNUNCIATION
BOXED IN RED IF INVALID; BEARING POINTER REMOVED FROM DISPLAY.

NAVIGATION SOURCE FLAG
NAVIGATION SOURCE ANNUNCIATOR IS BOXED IN RED IF INVALID. COURSE POINTER, CDI, AND DEVIATION SCALE ARE REMOVED FROM DISPLAY. IF FMS IS SELECTED AND THE NAV SOLUTION BECOMES DEGRADED (BUT NOT INVALID), THE NAVIGATION SOURCE ANNUNCIATOR IS BOXED IN AMBER, BUT NAVIGATION GUIDANCE IS NOT REMOVED.

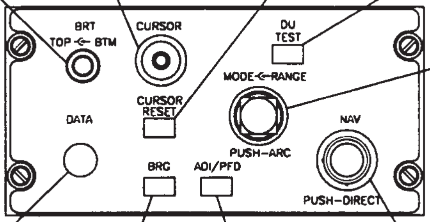
BEARING SOURCE DISTANCE READOUT
DISPLAYS DASHES IF INVALID.

WIND READOUT
DISPLAYS DASHES IF INVALID. DISPLAY BLANK IF WIND IS LESS THAN FIVE KNOTS OR WIND DATA UNAVAILABLE.

NAVIGATION DATA READOUT
DISPLAYS DASHES IF INVALID.

GP0363

Figure 1.6-19. EHSI Failure Modes



CURSOR CONTROL

THE CURSOR CONTROL MOVES A CROSSHAIR SYMBOL IN X-Y MOTION ON THE MAP AND MAP ARC DISPLAYS. THE BEARING/DISTANCE TO THE CURSOR IS DISPLAYED AT THE BOTTOM OF THE EHSI. A DASHED LINE CONNECTS THE AIRCRAFT SYMBOL AND CURSOR. THE CURSOR IS ACTIVE (IN VIEW) WHEN THE CURSOR CONTROL IS MOVED. AFTER 30 SECONDS OF NO MOVEMENT, THE CURSOR FUNCTION IS REMOVED FROM THE DISPLAY AND THE BEARING/DISTANCE IS RESET TO ZERO.

DU TEST BUTTON

A MOMENTARY PRESS OF THE DU TEST BUTTON ACCESSES THE DU STATUS PAGE (WEIGHT-ON-WHEELS ONLY). PRESSING AND HOLDING THE TEST BUTTON FOR TWO SECONDS DISPLAYS THE "PRESS TEST TO CONTINUE IBIT" MESSAGE. PRESSING AND HOLDING THE TEST BUTTON FOR TWO SECONDS INITIATES BIT. IF THE SECOND PRESS IS NOT MADE WITHIN FIVE SECONDS, THE COMMAND IS CANCELED AND THE CONFIRM MESSAGE IS REMOVED FROM THE DISPLAY. IBIT REQUIRES APPROXIMATELY ONE SECOND AND THE DISPLAY RETURNS TO THE DU STATUS PAGE UPON COMPLETION. PRESS THE PUSH-DIRECT BUTTON TO RETURN TO THE NORMAL DISPLAY.

BRIGHTNESS CONTROL

OUTER KNOB – INACTIVE (RESERVED FOR FUTURE SYSTEM GROWTH).

INNER KNOB – CONTROLS BRIGHTNESS OF THE EHSI DISPLAY UNIT.

CURSOR RESET BUTTON

RESETS THE CURSOR LOCATION BACK TO THE AIRCRAFT SYMBOL AND ZEROES THE BEARING/DISTANCE.

MODE CONTROLS

THE MODE SELECT KNOB IS A DUAL CONCENTRIC KNOB (MODE SELECT AND RANGE) WITH A CENTER PUSHBUTTON (ARC SELECTION).

MODE SELECTOR – THE OUTER KNOB IS A BLIND ROTARY SWITCH WHICH MAY BE TURNED IN EITHER DIRECTION AND SELECTS EITHER HSI OR MAP DISPLAY MODES.

RANGE SELECTOR – THE INNER KNOB SELECTS THE RANGE FOR DISPLAYS WHERE RANGE IS APPLICABLE. AVAILABLE FULL-SCALE RANGES ARE 2.5, 5, 10, 20, 40, 80, 160, 320, AND 640 NM. RANGE DEFAULTS TO LAST SELECTED VALUE ON POWER-UP.

ARC PUSHBUTTON – THE CENTER PUSHBUTTON SELECTS THE ARC MODE ON EITHER THE HSI OR MAP DISPLAYS.

DATA SELECTOR

BLIND SELECTOR SWITCH THAT MAY BE TURNED IN EITHER DIRECTION TO SELECT ON-SIDE FMS NAVIGATION DATA. POSSIBLE SELECTIONS INCLUDE OFF (NO NAVIGATION DATA DISPLAYED), GSPD (GROUNDSPEED), TAS (TRUE AIRSPEED), TTG (TIME-TO-GO TO NEXT WAYPOINT WHEN FMS IS THE SELECTED NAV SOURCE), ET (ELAPSED TIME FROM WEIGHT-OFF-WHEELS).

ADI/PFD BUTTON

INACTIVE (RESERVED FOR FUTURE SYSTEM GROWTH).

NAVIGATION SOURCE CONTROLS

NAV SOURCE SELECTOR – BLIND SELECTOR SWITCH THAT MAY BE TURNED IN EITHER DIRECTION TO SELECT THE PRIMARY NAVIGATION (COURSE) SOURCE. POSSIBLE SELECTIONS ARE FMS, VOR, AND TCN. THE VOR SELECTION WILL DISPLAY LOC IF THE VHF NAV RECEIVER IS TUNED TO A VALID LOCALIZER FREQUENCY. BC WILL BE DISPLAYED IF TUNED TO A VALID LOCALIZER FREQUENCY AND BACK CRS IS SELECTED ON THE FGS CONTROL PANEL. THE NUMBER SUFFIX AFTER THE NAV SOURCE REFERS TO THE PILOT'S (#1) OR COPILOT'S (#2) NAVIGATION SYSTEM. THE PILOT'S CONTROL SEQUENCES THROUGH THE #1 NAV SYSTEM SELECTIONS (FMS1, VOR1, TCN1) AND THE COPILOT'S CONTROL PANEL SEQUENCES THROUGH THE #2 NAV SYSTEM SELECTIONS (FMS2, VOR2, TCN2).

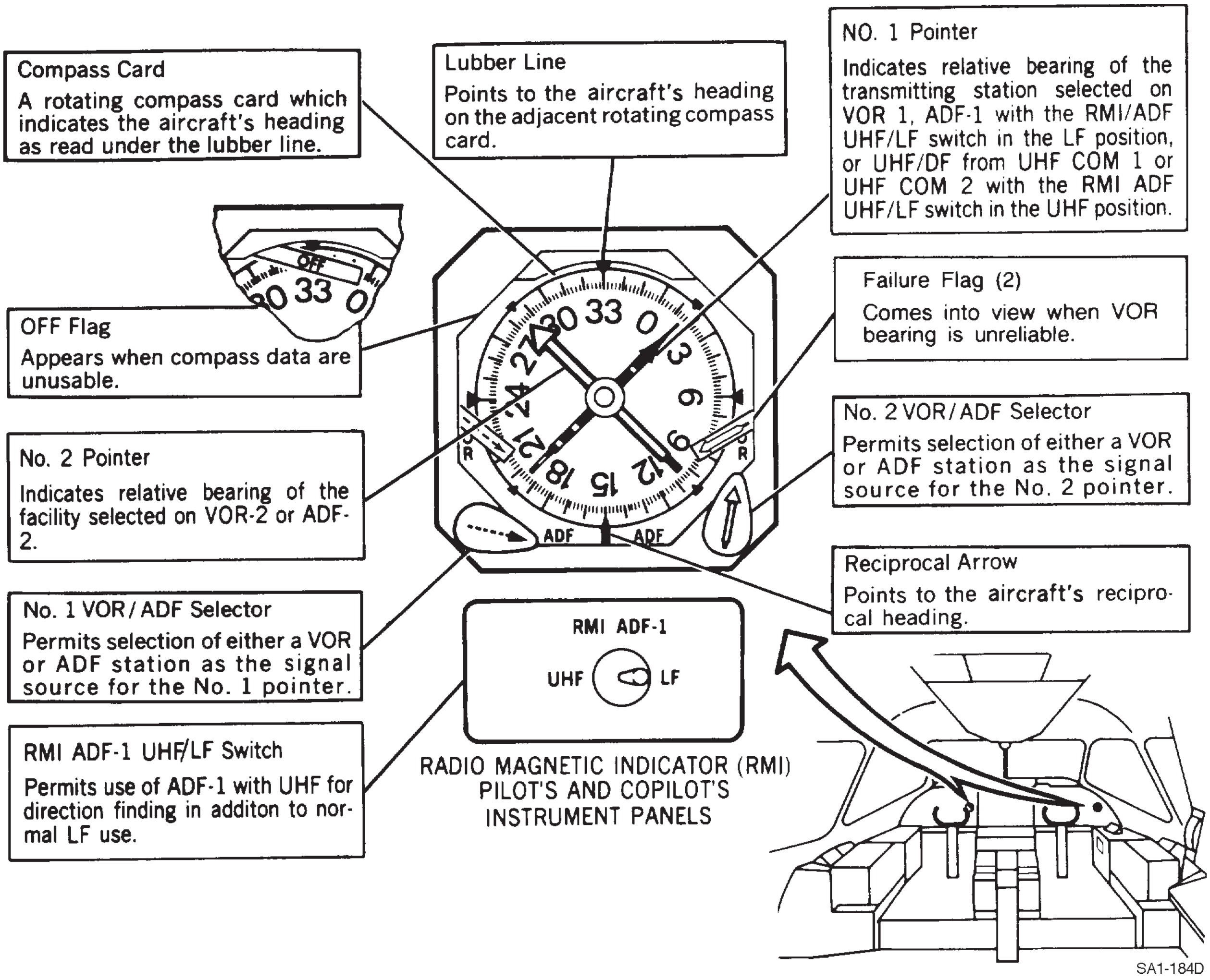
COURSE SYNC (DIRECT-TO) – THE CENTER PUSHBUTTON PROVIDES A COURSE SYNC FUNCTION. PRESSING THE BUTTON WHILE FMS IS THE NAVIGATION SOURCE PLACES THE FMS INTO A DIRECT-TO NAVIGATION MODE TO THE ACTIVE WAYPOINT.

BEARING SELECT BUTTON

SELECTS THE NAVIGATION SOURCE TO BE DISPLAYED ON THE EHSI BEARING POINTER. POSSIBLE BEARING SOURCE SELECTIONS ARE OFF, FMS1, FMS2, VOR1, VOR2, TCN1, TCN2, ADF1, AND ADF2.

GP0279

Figure 1.6-20. Electronic Horizontal Situation Indicator Control Panel



Compass Card

A rotating compass card which indicates the aircraft's heading as read under the lubber line.

Lubber Line

Points to the aircraft's heading on the adjacent rotating compass card.

NO. 1 Pointer

Indicates relative bearing of the transmitting station selected on VOR 1, ADF-1 with the RMI/ADF UHF/LF switch in the LF position, or UHF/DF from UHF COM 1 or UHF COM 2 with the RMI ADF UHF/LF switch in the UHF position.

OFF Flag

Appears when compass data are unusable.

Failure Flag (2)

Comes into view when VOR bearing is unreliable.

No. 2 Pointer

Indicates relative bearing of the facility selected on VOR-2 or ADF-2.

No. 2 VOR/ADF Selector

Permits selection of either a VOR or ADF station as the signal source for the No. 2 pointer.

No. 1 VOR/ADF Selector

Permits selection of either a VOR or ADF station as the signal source for the No. 1 pointer.

Reciprocal Arrow

Points to the aircraft's reciprocal heading.

RMI ADF-1 UHF/LF Switch

Permits use of ADF-1 with UHF for direction finding in additon to normal LF use.

Figure 1.6-21. RMI and ADF Systems

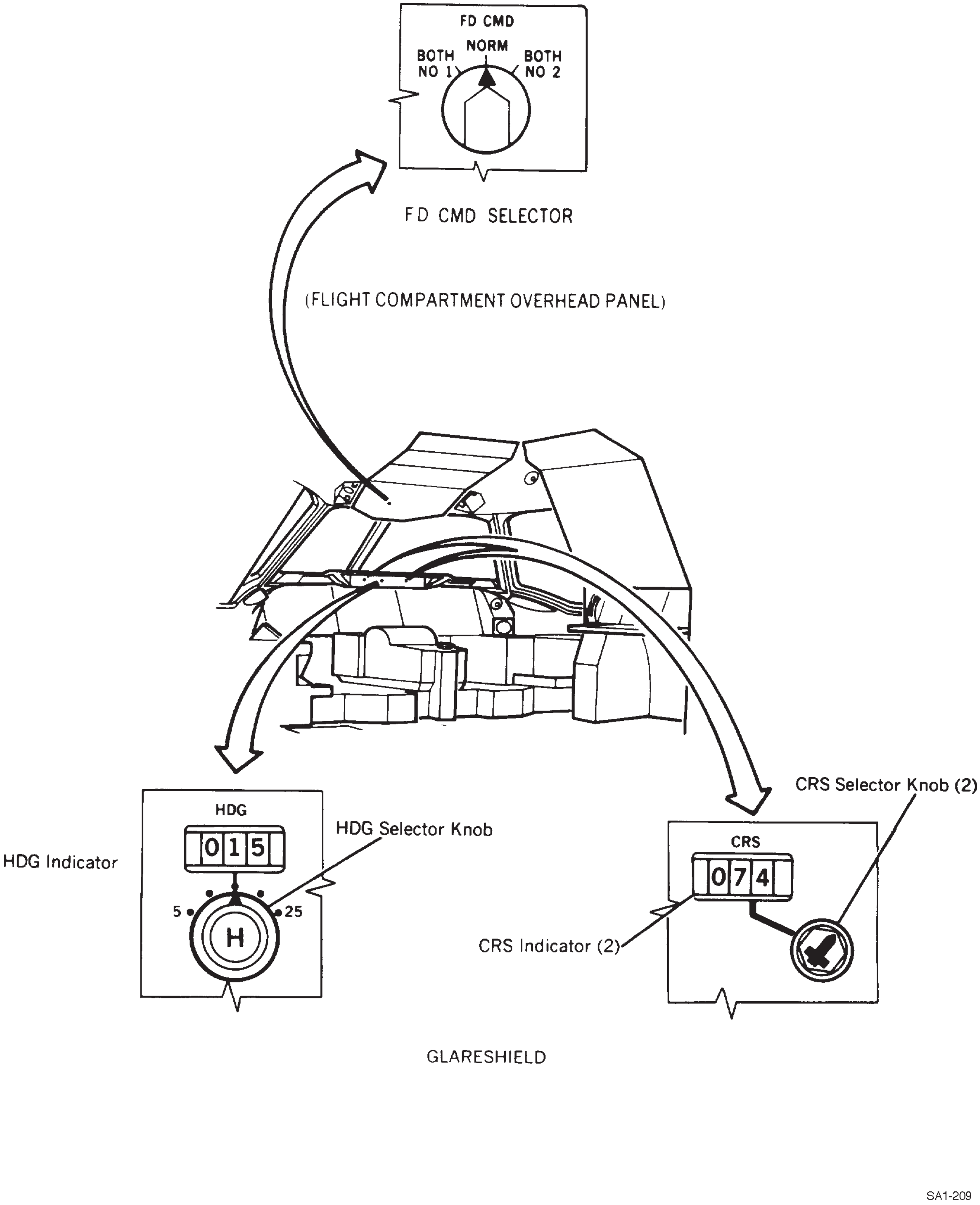


Figure 1.6-22. FD CMD Selector, CRS and HDG Indicators

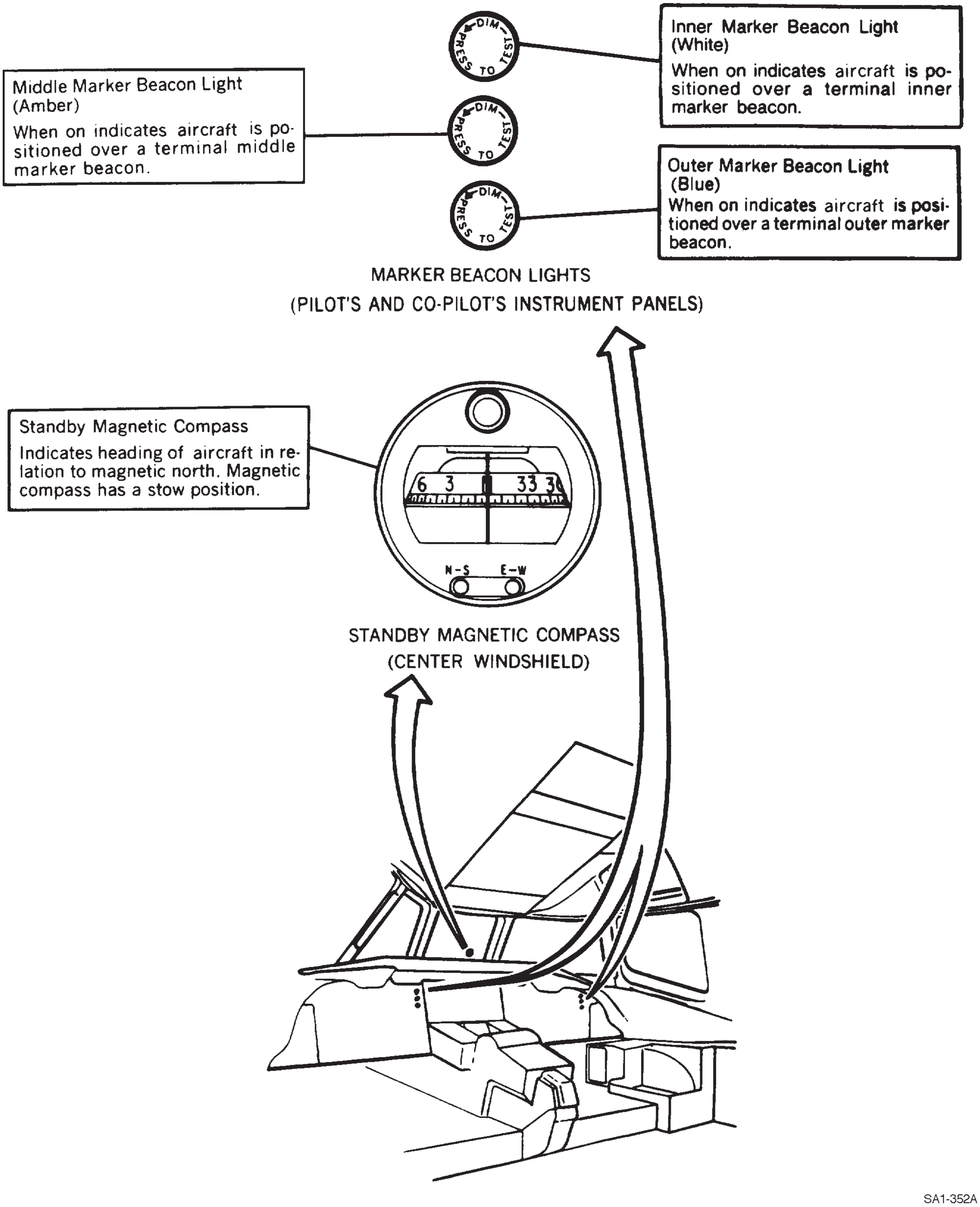
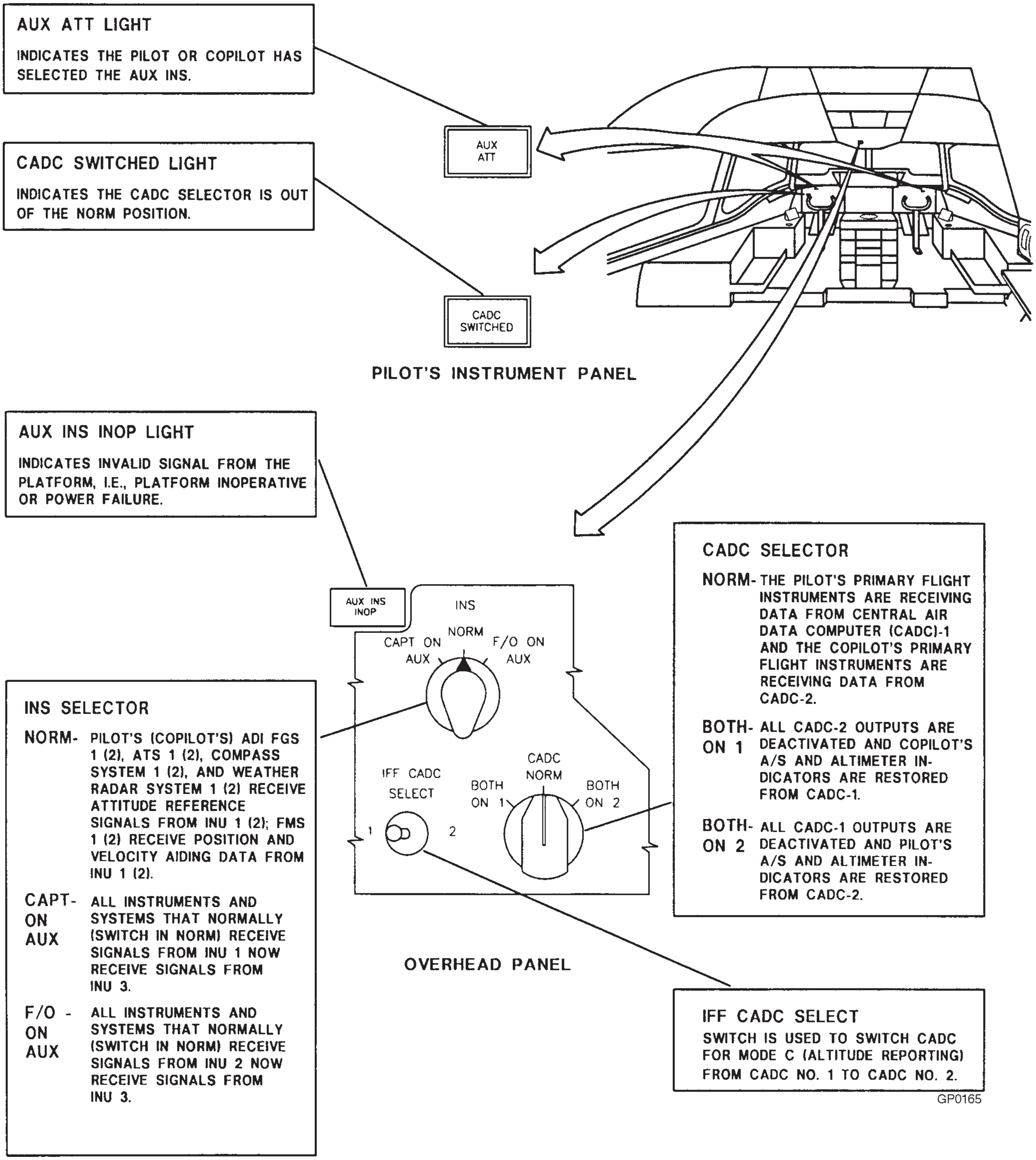


Figure 1.6-23. Marker Beacon/Standby Compass



AUX ATT LIGHT

INDICATES THE PILOT OR COPILOT HAS SELECTED THE AUX INS.

CADC SWITCHED LIGHT

INDICATES THE CADC SELECTOR IS OUT OF THE NORM POSITION.

AUX INS INOP LIGHT

INDICATES INVALID SIGNAL FROM THE PLATFORM, I.E., PLATFORM INOPERATIVE OR POWER FAILURE.

INS SELECTOR

NORM-	PILOT'S (COPILOT'S) ADI FGS 1 (2), ATS 1 (2), COMPASS SYSTEM 1 (2), AND WEATHER RADAR SYSTEM 1 (2) RECEIVE ATTITUDE REFERENCE SIGNALS FROM INU 1 (2); FMS 1 (2) RECEIVE POSITION AND VELOCITY AIDING DATA FROM INU 1 (2).
CAPT-ON AUX	ALL INSTRUMENTS AND SYSTEMS THAT NORMALLY (SWITCH IN NORM) RECEIVE SIGNALS FROM INU 1 NOW RECEIVE SIGNALS FROM INU 3.
F/O - ON AUX	ALL INSTRUMENTS AND SYSTEMS THAT NORMALLY (SWITCH IN NORM) RECEIVE SIGNALS FROM INU 2 NOW RECEIVE SIGNALS FROM INU 3.

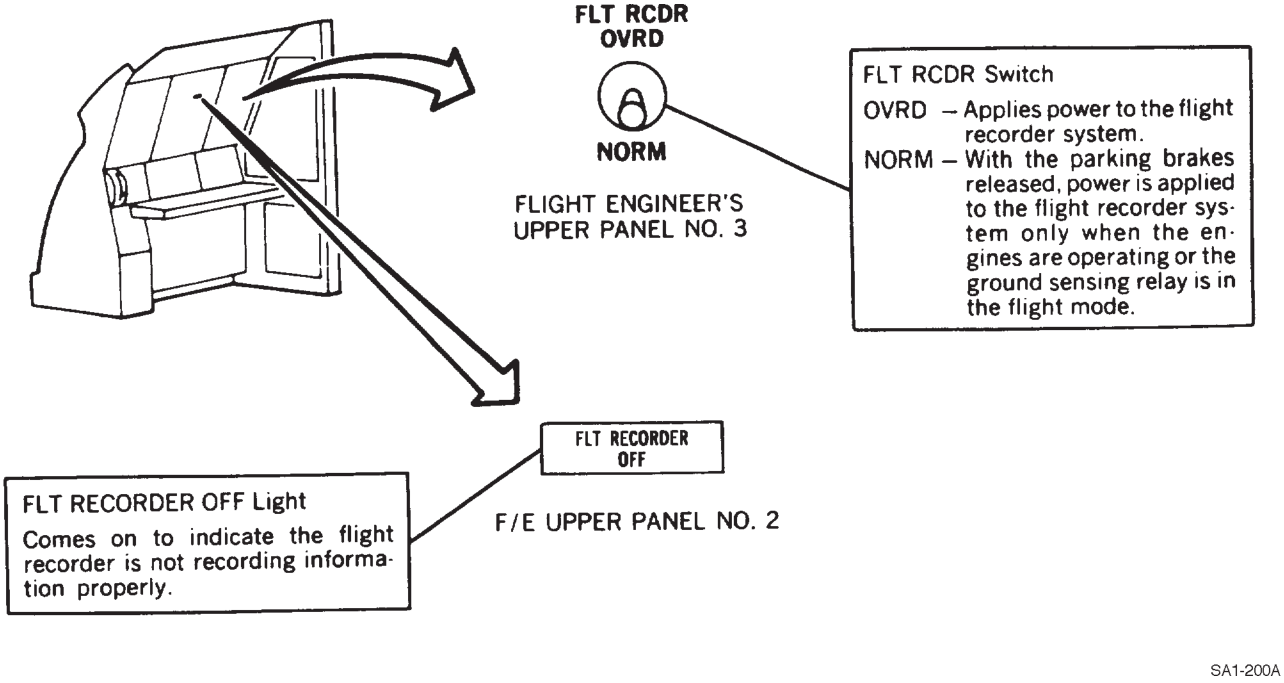
CADC SELECTOR

NORM-	THE PILOT'S PRIMARY FLIGHT INSTRUMENTS ARE RECEIVING DATA FROM CENTRAL AIR DATA COMPUTER (CADC)-1 AND THE COPILOT'S PRIMARY FLIGHT INSTRUMENTS ARE RECEIVING DATA FROM CADC-2.
BOTH-ON 1	ALL CADC-2 OUTPUTS ARE DEACTIVATED AND COPILOT'S A/S AND ALTIMETER INDICATORS ARE RESTORED FROM CADC-1.
BOTH-ON 2	ALL CADC-1 OUTPUTS ARE DEACTIVATED AND PILOT'S A/S AND ALTIMETER INDICATORS ARE RESTORED FROM CADC-2.

IFF CADC SELECT

SWITCH IS USED TO SWITCH CADC FOR MODE C (ALTITUDE REPORTING) FROM CADC NO. 1 TO CADC NO. 2.

Figure 1.6-24. INS Switch and Lights; CADC Switch and Light



FLT RCDR Switch

OVRD – Applies power to the flight recorder system.

NORM – With the parking brakes released, power is applied to the flight recorder system only when the engines are operating or the ground sensing relay is in the flight mode.

FLT RECORDER OFF Light

Comes on to indicate the flight recorder is not recording information properly.

Figure 1.6-25. Flight Recorder Switch and Light

AUTOMATIC FLIGHT

AUTOMATIC FLIGHT DESCRIPTION

The design of the KC-10 flight guidance system (figure 1.6-26) provides the capability for automatically controlled flight during climb, cruise, letdown, approach and go-around. The automatic flight system is an integral part of the aircraft. Control is centralized at the FGS control panel (figures 1.6-27, 1.6-28 and 1.6-29) on the Glareshield.

COMPONENTS

The contributing components are signal source sensors, computers, cockpit displays, flight controls, and allied subsystems. The guidance system utilizes the output of both the autothrottle computers and the flight guidance computers. Displays, in the form of commands, appear on the ADI (figure 1.6-30). The flight controls used in automatic flight are the ailerons, rudders, elevators, horizontal stabilizer, and spoilers. The throttles are controlled by the autothrottle system (ATS).

CAPABILITIES

Automatic flight capabilities include control wheel steering, turn coordination, vertical speed control, automatic pitch trim, altitude preselect, altitude hold, Mach hold, IAS hold, heading select, heading hold, flight management system navigation, VOR and TACAN tracking, ILS localizer and glideslope tracking, go-around, and turbulence penetration control. Manual override is possible at all times.

CAUTION

> When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

SENSORS

The sensors consist of compass system, inertial platform, yaw rate gyros, central air data computers, radio altimeters, accelerometers, NAV receivers, FMS navigation computers, surface position sensors and angle-of-attack transducers.

FLIGHT GUIDANCE COMPUTERS

DUAL CAPABILITY

Within the guidance group are two independent guidance systems each receiving individual sensor inputs and each capable of providing a full spectrum of guidance signals. Within each system are three guidance computers (roll, pitch, and yaw). Together with other system redundancies, the dual systems permit positive flight control even if portions of the system are not operative. Incorporated in the two independent systems are four separate yaw damper systems and two separate autopilot systems. This permits autoflight operation during cruise if only one guidance system (one yaw damper system and one autopilot system) is operative.

ADI

Each integrated autopilot/flight director system provides simultaneous and parallel outputs to its associated control surfaces and ADI. Flight director outputs are reflected in pitch and steering commands on the ADI. Autopilot outputs result in control displacement.

FLIGHT DIRECTOR (FD)

The flight director provides visual guidance to the pilot either to fly the computed flight path manually or visually monitor autopilot response to the guidance signals. The ADI is the display member of the flight director system and functions as the focal point for visual commands generated by the flight director program in the guidance computers.

V-COMMAND BARS

Roll, pitch, yaw, and speed command data from the integrated autopilot/flight director system and speed command computers are displayed. V-command bars on the face of the ADI direct the pilot to turn, climb, or descend. A Fast/Slow indicator reflects current aircraft speed in relation to speed selection on the ATS control panel (figure 1.6-28) or the computed optimum safe speed based upon angle-of-attack and aircraft configuration (ALPHA SPD). Flight director capabilities can be used with the autopilot either disengaged (OFF) or in the CWS mode. Either flight director can be engaged by moving the associated FD switch (figure 1.6-27) to the FD position. The basic engagement mode of the flight director system is HDG HOLD and ALT HOLD (or VERT SPD). With the flight director engaged, the V-command bars are indicating a response is required whenever either is displaced from the center position. In the autopilot CMD mode, the V-command bars are centered at all times monitoring autopilot operation.

AP LEVER CMD POSITION

When an autopilot lever (figure 1.6-29) is moved to the CMD position with a flight director mode conflict, the ADI V-command bars of the system that is in conflict is biased from view.

AUTOMATIC THROTTLE AND SPEED CONTROL SYSTEM

The Flight Guidance System includes an Automatic Throttle and Speed Control System (figures 1.6-28, 1.6-29, and 1.6-33). Speed control is provided from lift off to landing and automatic throttle can be used from initial power setting in the takeoff roll to landing. The Automatic Throttle System is independent of the Flight Guidance System and is designed for use in all phases of flight.

CAUTION

> Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

SPEED CONTROL SYSTEM (SCS)

The dual Speed Control System provides signals for the FD, the ADI Fast/Slow indicators, and the Automatic Throttle System (ATS). Speed Guidance signals for attitude control are displayed by the FD V-command bars during takeoff and go-around. Speed Control signals for throttle control, both manual and autothrottle, are displayed by the ADI Fast/Slow indicators.

CAUTION

> When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

SPEED GUIDANCE

During Speed Guidance operation, thrust is controlled to the selected N_1 limit either manually or by the ATS, and the FD V-command bars provide attitude commands to maintain a computed airspeed.

SPEED CONTROL

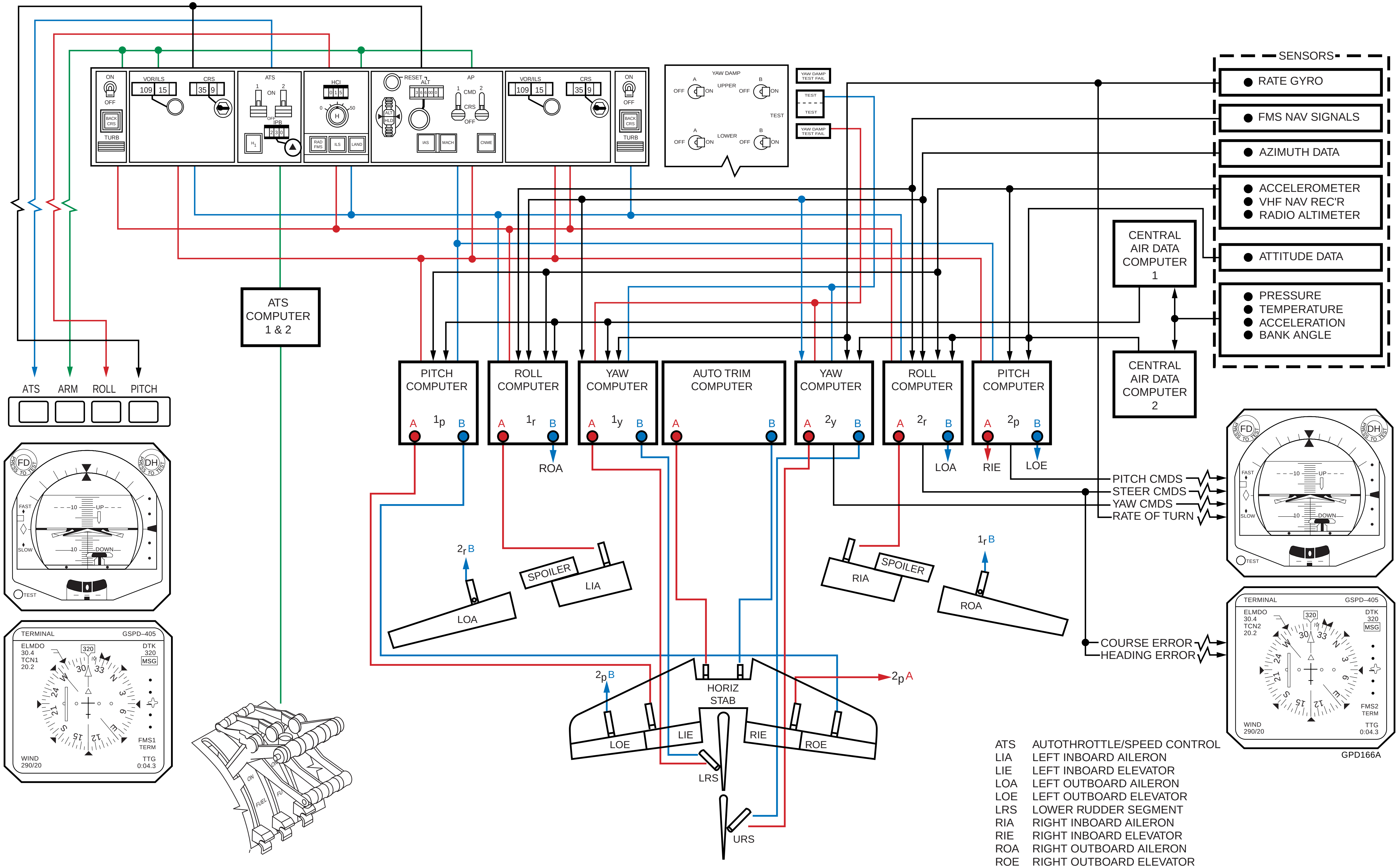
During Speed Control operation, pitch attitude is controlled by either Pilot or autopilot and the ADI Fast/Slow indicators display the airspeed error. The Pilot or ATS adjusts the throttle position to center the Fast/Slow indicators.

TAKEOFF/GO-AROUND (T/O G/A) MODES

In the takeoff and go-around modes, Speed Guidance appears as FD pitch commands to maintain V_2+10 knots for three-engine operation. For two-engine operation, the pitch commands control the following speeds upon engine failure: at or below V_2, controls to V_2; between V_2 and V_2 + 10, controls to existing speed; at or above V_2 + 10, controls to V_2 + 10. The Fast/Slow indicators also display speed guidance signals. Thrust is set by the Flight Crew or the ATS while the N_1 limit is displayed by the N_1 LIM readout on the thrust rating computer (TRC) indicator and the N_1 limit bugs on the N_1 indicator.

ATS GO-AROUND

If the ATS is in the speed mode operating at the time of go-around mode engagement, it switches to the N_1 mode and controls thrust to the G/A N_1 limit displayed. If the ATS is engaged during go-around mode operation, it engages directly into the N_1 mode and controls thrust to the G/A N_1 limit.



ATS	AUTOTHROTTLE/SPEED CONTROL
LIA	LEFT INBOARD AILERON
LIE	LEFT INBOARD ELEVATOR
LOA	LEFT OUTBOARD AILERON
LOE	LEFT OUTBOARD ELEVATOR
LRS	LOWER RUDDER SEGMENT
RIA	RIGHT INBOARD AILERON
RIE	RIGHT INBOARD ELEVATOR
ROA	RIGHT OUTBOARD AILERON
ROE	RIGHT OUTBOARD ELEVATOR
URS	UPPER RUDDER SEGMENT

Figure 1.6-26. Automatic Flight - System Interface

SPEED MODE/ALPHA SPEED

The SPEED mode provides Speed Control signals to the ADI Fast/Slow indicators to command the Pilot or ATS to adjust the throttles to maintain either the safe stall margin speed (ALPHA SPD) or the airspeed selected on the FGS panel SPD indicator, whichever is higher. The Pilot can select any desired airspeed but the Speed Control signals are limited to prevent commands which exceed flap placard speeds or are lower than safe stall margin speed. During approach conditions, computed angle-of-attack and computed gross weight information are used to determine the safe stall margins shown in figure 1.6-34. These safe stall speeds are called ALPHA SPEEDS.

The Autothrottle/Speed Command (AT/SC) function of the flight guidance system generates angle of attack information from aircraft configuration inputs and an estimated gross weight. The estimated gross weight is generated from measured aircraft acceleration inputs. The data is then used to compute alpha speed, and will be displayed on the pilot's FMAs whenever the selected speed is below the appropriate minimum maneuvering or approach selected speed.

Changes in aircraft configuration, speed, and/or maneuvering will cause the system to sense different configurations and accelerations and, therefore recompute alpha speed to a higher value than steady state value. When this occurs the annunciation may change from speed to alpha speed momentarily (if the speed had been set properly for the aircraft gross weight) until the aircraft settles down to steady unaccelerated flight path. At this time the system will again recompute alpha speed, based on the newly sensed steady state parameters, and if the set speed has not been changed, the FMA will revert to the speed annunciation.

This scenario is normal and may be observed, particularly in the descent and approach phases of flight, as the aircraft configuration is changed, the airspeed slowed, and the aircraft maneuvered to the final approach course. The likelihood of this happening is greater if these are large configuration changes, large and rapid speed reductions, or significant maneuvering being experienced. Once the aircraft returns to a stable flight path, fixed configuration and steady speed, the annunciation should return to speed.

VERTICAL SPEED

During Speed Control, vertical speed is controlled by the Pilot or by manual or ATS adjustment of throttle positions.

AUTOMATIC THROTTLE SYSTEM (ATS)

The Automatic Throttle System positions the throttles to maintain the airspeed or thrust level as defined for the operational mode and aircraft configuration. The system is engaged by moving the ATS lever (figure 1.6-28) to the ON position. The lever does not move out of OFF position until all interlocks and engage requirements are satisfied and automatically reverts to the OFF position if system monitors detect a malfunction.

CAUTION

Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

DISENGAGE

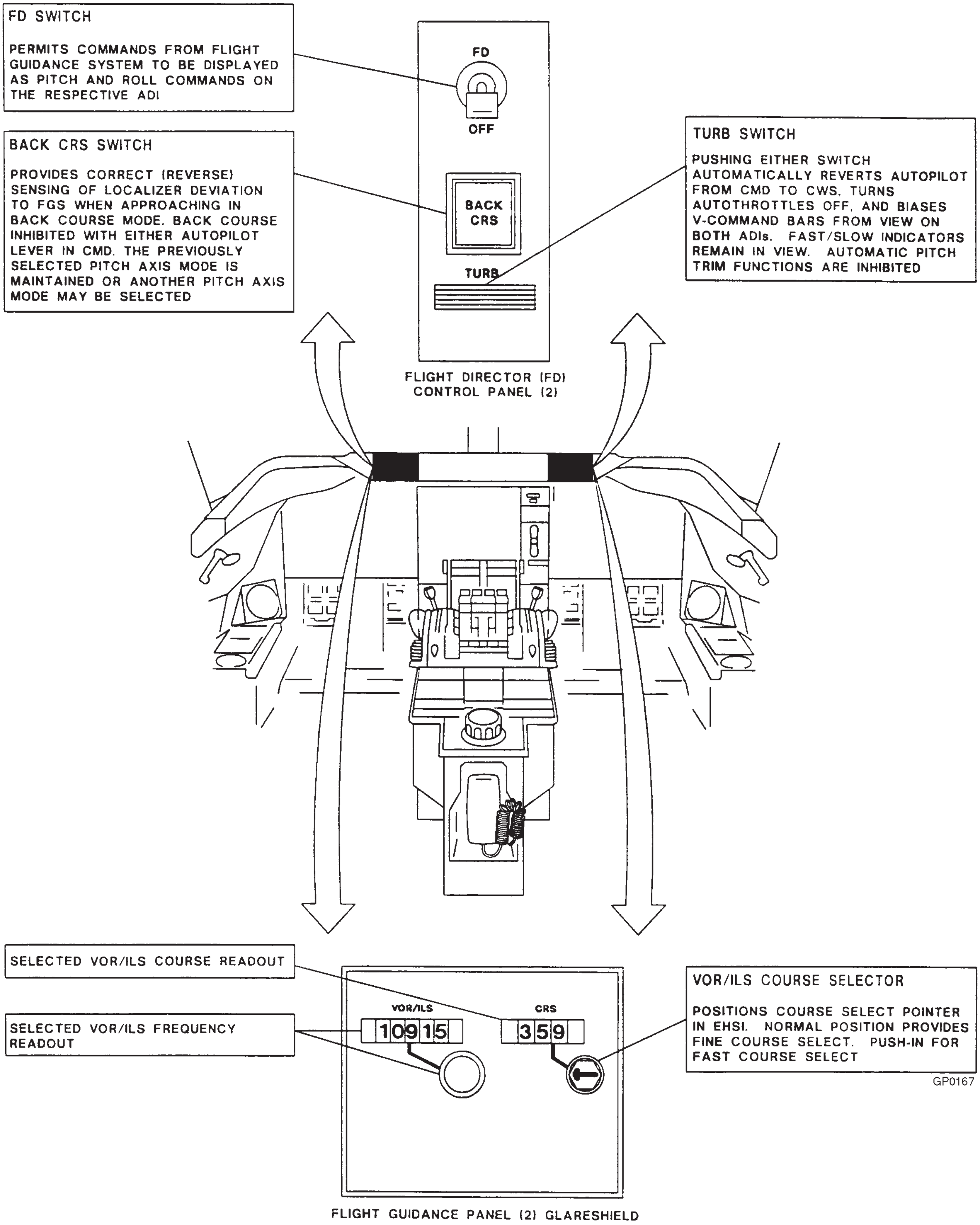
The ATS is disengaged by pushing either ATS disengage button (figure 1.6-35) on throttles 1 or 3, moving the throttles into reverse thrust, or placing the ATS lever to OFF. A red ATS fail light on each instrument panel comes on flashing if the ATS is disengaged by any means. If one ATS is disengaged with the other ATS engaged, the associated amber fail light comes on.

SPEED MODE

The SPEED mode is the basic ATS mode of operation. In this mode, the throttles seek and maintain the IAS selected on the ATS SPD readout. SPD is displayed in both ATS flight mode annunciators when the ATS is in the SPEED mode.

CAUTION

When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.



FD SWITCH

PERMITS COMMANDS FROM FLIGHT GUIDANCE SYSTEM TO BE DISPLAYED AS PITCH AND ROLL COMMANDS ON THE RESPECTIVE ADI

BACK CRS SWITCH

PROVIDES CORRECT (REVERSE) SENSING OF LOCALIZER DEVIATION TO FGS WHEN APPROACHING IN BACK COURSE MODE. BACK COURSE INHIBITED WITH EITHER AUTOPILOT LEVER IN CMD. THE PREVIOUSLY SELECTED PITCH AXIS MODE IS MAINTAINED OR ANOTHER PITCH AXIS MODE MAY BE SELECTED

TURB SWITCH

PUSHING EITHER SWITCH AUTOMATICALLY REVERTS AUTOPILOT FROM CMD TO CWS, TURNS AUTOTHROTTLES OFF, AND BIASES V-COMMAND BARS FROM VIEW ON BOTH ADIs. FAST/SLOW INDICATORS REMAIN IN VIEW. AUTOMATIC PITCH TRIM FUNCTIONS ARE INHIBITED

FLIGHT DIRECTOR (FD) CONTROL PANEL (2)

SELECTED VOR/ILS COURSE READOUT

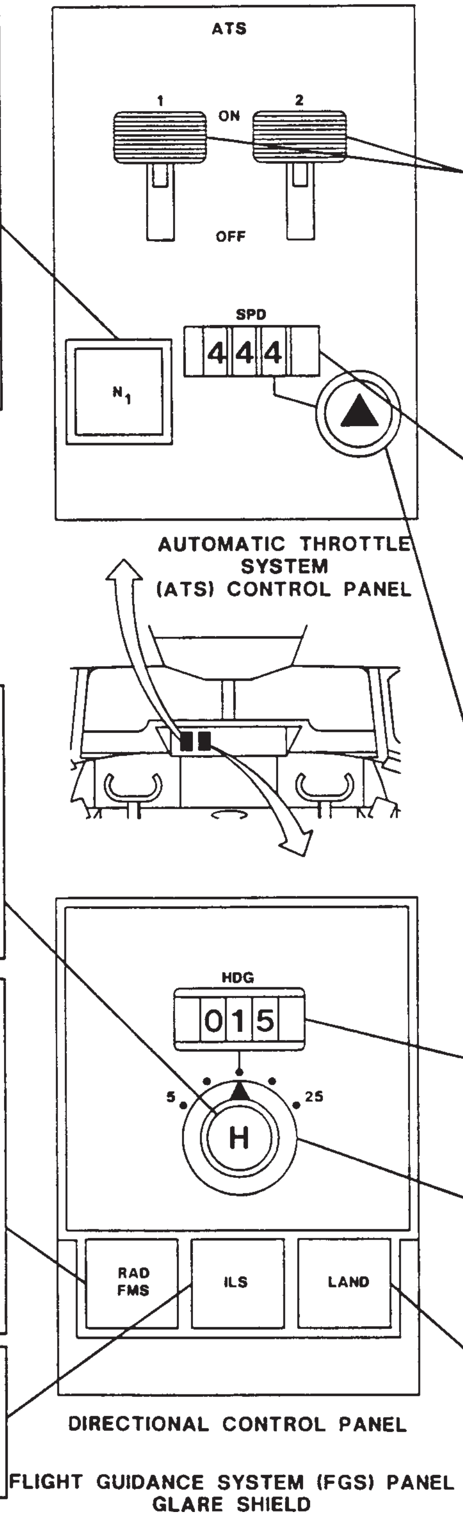
SELECTED VOR/ILS FREQUENCY READOUT

VOR/ILS COURSE SELECTOR

POSITIONS COURSE SELECT POINTER IN EHSI. NORMAL POSITION PROVIDES FINE COURSE SELECT. PUSH-IN FOR FAST COURSE SELECT

FLIGHT GUIDANCE PANEL (2) GLARESHIELD

Figure 1.6-27. Flight Director and Navigation Control Panels



N_1 SWITCH

PUSHING THE N_1 SWITCH CAUSES THE THROTTLE LEVERS TO ADVANCE TO THE N_1 LIMIT READOUT DISPLAYED ON THE THRUST COMPUTER INDICATOR. THE ATS FLIGHT MODE ANNUNCIATOR DISPLAYS N_1 (WITH ONE OR BOTH ATS LEVERS ON). FAST/SLOW INDICATORS ARE BIASED FROM VIEW EXCEPT DURING TO/GA MODE

NOTE

FAILURE TO THE THRUST COMPUTER INHIBITS USE OF THE N_1 MODE, IF ATS IS ENGAGED IN N_1 MODE AT TIME OF FAILURE. THE ATS LEVERS DROP TO OFF

ATS LEVERS (2)

CAUTION

FAILURE OF THE AUTOTHROTTLE DUPLEX SERVO MAY CAUSE UNCOMMANDED THROTTLE ADVANCES. FAILURE TO MONITOR THE THROTTLE POSITIONS, WITH THE AUTOTHROTTLES ENGAGED AND IN ANY MODE, MAY RESULT IN ENGINE OVERSPEED.

PERMITS ENGAGEMENT OF EITHER OR BOTH AUTOTHROTTLE SYSTEMS. MOVING LEVER TO ON (INFLIGHT) ENGAGES THE SPD MODE UNLESS TAKEOFF OR GA MODE IS ENERGIZED. ON THE GROUND, MOVING LEVER TO ON ENGAGES CLAMP MODE UNLESS TAKEOFF MODE IS ENERGIZED. NO AUTOMATIC MOVEMENT OF THROTTLES CAN OCCUR WITH CLAMP MODE ENGAGED.

SPD READOUT

DIGITAL READOUT OF AIRSPEED (IN KNOTS) SELECTED WITH THE SPD SELECT KNOB. AIRSPEED SET IN READOUT IS THE COMMAND SPEED FOR THE ATS WHEN OPERATING IN THE SPD MODE AND REFERENCE SPEED FOR THE FAST/SLOW POINTERS.

SPD SELECT KNOB

THREE POSITION KNOB IS SPRING-LOADED TO CENTER. PUSH IN FOR FAST SPEED ADJUSTMENT. PULL OUT TO CHANGE SPEED REFERENCE CONTROL MODE FROM N_1 TO SPD. CENTER POSITION PROVIDES FINE SPEED ADJUSTMENT. SELECTED SPEED CHANGES ARE ALSO REFLECTED ON MACH/AS INDICATOR BY REPOSITIONING THE AIRSPEED COMMAND BUG. SPD MODE ENGAGEMENT INHIBITS IAS/MACH HOLD MODE.

HDG CONTROL KNOB

INNER, EXTENDED KNOB HAS FOUR FUNCTIONS. NORMAL, SPRING-HELD POSITION FINE ADJUSTMENT OF HEADING. PUSH TO FIRST DETENT FOR FAST HEADING SELECT. PUSH FULL IN TO ENGAGE AUTOPILOT AND FD HDG HOLD AND TO CANCEL ALL ARMED OR ENGAGED LATERAL MODES. PULL OUT TO ENGAGE HDG SEL MODE. HDG KNOB ALSO POSITIONS HEADING BUGS ON EHSIs

RAD/FMS SWITCH

WITH A RADIO NAVAID SELECTED AS THE PRIMARY NAVIGATION SOURCE ON THE EHSI, PUSHING THE RAD/FMS SWITCH ARMS THE FGS TO CAPTURE AND TRACK THE TACAN, VOR OR LOCALIZER TUNED ON THE NAVIGATIONAL CONTROL PANEL. THE ARM ANNUNCIATOR DISPLAYS RAD OR LOC. WITH FMS SELECTED AS THE PRIMARY NAVIGATION SOURCE ON THE EHSI, THE FGS IS ARMED TO CAPTURE AND TRACK THE COURSE COMMANDED BY THE FLIGHT MANAGEMENT SYSTEM AND THE ARM ANNUNCIATOR DISPLAYS FMS.

ILS SWITCH

PUSHING THE ILS SWITCH ARMS THE FGS TO CAPTURE AND TRACK THE ILS TUNED ON THE NAV PANEL. THE ARM ANNUNCIATOR DISPLAYS ILS.

HDG READOUT

DIGITAL READOUT OF THE HEADING SELECTED WITH THE HDG CONTROL KNOB.

BANK ANGLE SELECTOR

OUTER CONCENTRIC KNOB PROVIDES BANK ANGLE LIMIT SELECTION FOR AUTOPILOT AND FLIGHT DIRECTOR TURNS IN ALL MODES EXCEPT LOC CAP.

LAND SWITCH (INOP)

Figure 1.6-28. ATS and Directional Control Panel

ALT Advisory RESET Button

Push to cancel the altitude preselect mode, reset the altitude alerting system, and to turn off the flashing altitude advisory light.

ALT Preselect Readout

Digital readout of the altitude preselected with the ALT preselect knob.

AP Lever (2)

CMD – Provides autopilot control for selected autoflight modes. When AP lever is moved from the OFF position to the CMD position, pressure must be released upon reaching the CWS position and then re-applied.

CWS – Permits control wheel steering.

Vertical Speed Select Wheel

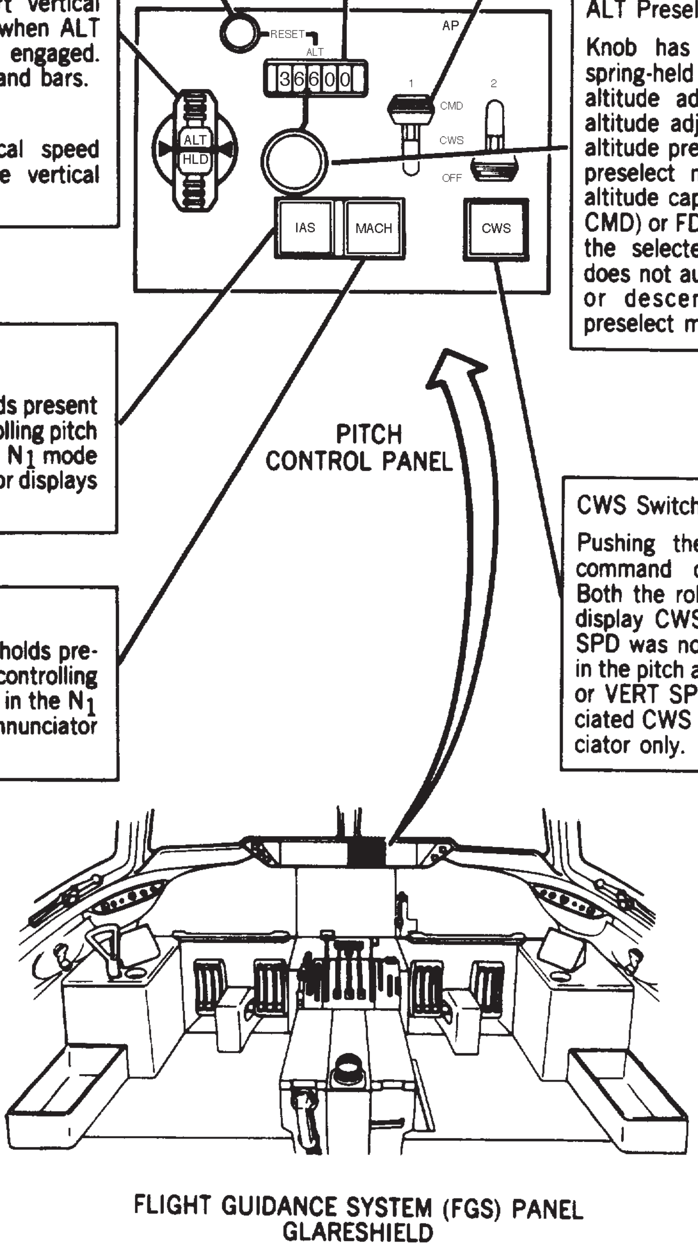
Commands selected vertical speed when FD and/or autopilot are engaged. Vertical speed select wheel is synchronized to aircraft vertical speed at all times except when ALT HOLD or VERT SPD is engaged. Positions ADI pitch command bars.

NOTE

Manual rotation of vertical speed select wheel engages the vertical speed mode.

ALT Preselect Knob

Knob has two functions. Normal, spring-held position provides fine altitude adjustment. Push for fast altitude adjustment. Pull to arm the altitude preselect mode. The altitude preselect mode provides automatic altitude capture (if an AP lever is in CMD) or FD pitch guidance to capture the selected altitude. The aircraft does not automatically start to climb or descend after the altitude preselect mode is armed.



IAS Switch

Pushing the IAS switch holds present indicated airspeed by controlling pitch attitude. ATS must be in the N_1 mode if engaged. Pitch annunciator displays IAS HOLD.

MACH Switch

Pushing the MACH switch holds present Mach number by controlling pitch attitude. ATS must be in the N_1 mode if engaged. Pitch annunciator displays MACH HOLD.

CWS Switch: With AP in CMD

Pushing the CWS switch initiates command control wheel steering. Both the roll and pitch annunciators display CWS if ALT HOLD or VERT SPD was not previously annunciated in the pitch annunciator. If ALT HOLD or VERT SPD was previously annunciated CWS is displayed in roll annunciator only.

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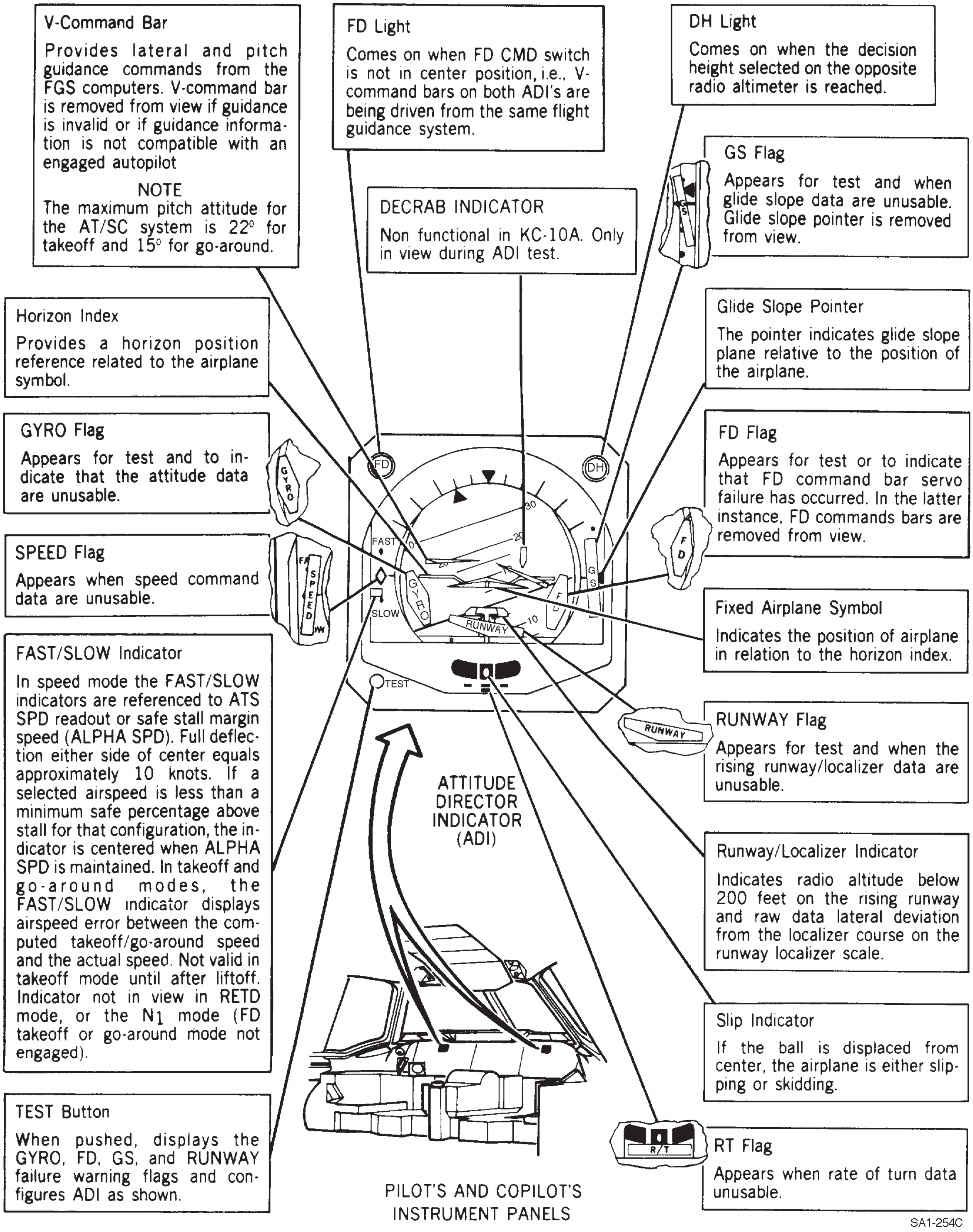
Figure 1.6-29. Pitch Control Panel



V-Command Bar

Provides lateral and pitch guidance commands from the FGS computers. V-command bar is removed from view if guidance is invalid or if guidance information is not compatible with an engaged autopilot

NOTE

The maximum pitch attitude for the AT/SC system is 22° for takeoff and 15° for go-around.

Horizon Index

Provides a horizon position reference related to the airplane symbol.

GYRO Flag

Appears for test and to indicate that the attitude data are unusable.

SPEED Flag

Appears when speed command data are unusable.

FAST/SLOW Indicator

In speed mode the FAST/SLOW indicators are referenced to ATS SPD readout or safe stall margin speed (ALPHA SPD). Full deflection either side of center equals approximately 10 knots. If a selected airspeed is less than a minimum safe percentage above stall for that configuration, the indicator is centered when ALPHA SPD is maintained. In takeoff and go-around modes, the FAST/SLOW indicator displays airspeed error between the computed takeoff/go-around speed and the actual speed. Not valid in takeoff mode until after liftoff. Indicator not in view in RETD mode, or the N$_1$ mode (FD takeoff or go-around mode not engaged).

TEST Button

When pushed, displays the GYRO, FD, GS, and RUNWAY failure warning flags and configures ADI as shown.

FD Light

Comes on when FD CMD switch is not in center position, i.e., V-command bars on both ADI's are being driven from the same flight guidance system.

DECRAB INDICATOR

Non functional in KC-10A. Only in view during ADI test.

DH Light

Comes on when the decision height selected on the opposite radio altimeter is reached.

GS Flag

Appears for test and when glide slope data are unusable. Glide slope pointer is removed from view.

Glide Slope Pointer

The pointer indicates glide slope plane relative to the position of the airplane.

FD Flag

Appears for test or to indicate that FD command bar servo failure has occurred. In the latter instance, FD commands bars are removed from view.

Fixed Airplane Symbol

Indicates the position of airplane in relation to the horizon index.

RUNWAY Flag

Appears for test and when the rising runway/localizer data are unusable.

Runway/Localizer Indicator

Indicates radio altitude below 200 feet on the rising runway and raw data lateral deviation from the localizer course on the runway localizer scale.

Slip Indicator

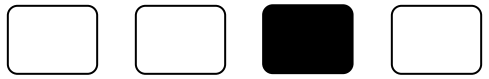
If the ball is displaced from center, the airplane is either slipping or skidding.

RT Flag

Appears when rate of turn data unusable.

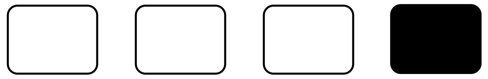
Figure 1.6-30. ADI

ROLL ANNUNCIATOR MODES



HDG SEL	Heading Select indicates the HDG control knob has been pulled out with either an autopilot and/or FD engaged. The autopilot maneuvers the aircraft to acquire and maintain the heading shown in the HDG readout, if engaged.
HDG HOLD	Heading Hold is the basic engagement mode of the autopilot and flight director and indicates magnetic heading existing at time of mode engagement is being maintained.
FMS CAP	FMS Capture indicates the inertial navigation system is providing commands through the autopilot or flight director to maneuver aircraft to capture the selected track.
FMS TRK	FMS Track indicates the aircraft is tracking the course commanded by the flight management system.
RAD CAP	RAD Capture indicates the VOR or TACAN mode has been initiated and the aircraft has entered the capture threshold.
RAD TRK	RAD Track indicates the aircraft is tracking the selected VOR or TACAN radial.
CWS	Control Wheel Steering indicates the CWS mode has been initiated by pushing the CWS switch with either AP lever in CMD and the FD Switches Off.
B/CRS CAP	Back Course/Capture indicates the back course mode has been selected and the aircraft has entered the back course threshold of the localizer beam (FD mode only).
B/CRS TRK	Back Course/Track indicates the aircraft is tracking the ILS back course of the localizer (FD mode only).
LOC CAP	Localizer Capture indicates the LOC, ILS, or Land mode has been selected and the aircraft is in the capture sequence approaching the localizer beam (within two dots on the EHSI course deviation scale).
LOC TRK	Localizer Track indicates LOC, ILS, or Land mode has been engaged and the aircraft is tracking the selected localizer centerline.
G/A	Go Around indicates the TO/GA button on number two throttle has been pushed, aircraft is in flight, and flaps are out of the full up position. If an autopilot and/or FD is engaged, the go around mode command is initiated to roll the wings level and maintain heading existing when the roll attitude is less than 3°.
TAKE OFF	Takeoff will be annunciated when the TO/GA button on number two throttle is pushed with the aircraft on the ground. The roll command bars will provide guidance after liftoff to maintain the existing magnetic heading (FD Mode only).
RAD CRS	RAD Course indicates the aircraft is over the VOR/TACAN station (zone of confusion), or is departing from a VOR/TACAN beam centerline (at a rate greater than 1/2 degree per second), or is two dots or more deviation from the beam centerline, or a new frequency and/or course has been selected. RAD CRS normally is replaced by RAD TRK any time after a minimum of 30 seconds up to a maximum of 3 minutes. After 3 minutes, if RAD TRK criteria is not satisfied, HDG HOLD is annunciated.
CWS H/SEL	Control Wheel Steering Heading Select indicates that either AP lever is in CMD, FD switches are on, HDG control knob pulled out, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to acquire and maintain the heading shown in the HDG readout. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS H/HLD	Control Wheel Steering Heading Hold indicates that either AP lever is in CMD, FD switches are on, HDG control knob is pushed in, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to maintain existing heading. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS FMS	Control Wheel Steering FMS indicates that either AP lever is in CMD, FD switches are on and system in FMS TRK mode, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to maintain the course commanded by the flight management system. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS RAD	Control Wheel Steering RAD indicates that either AP lever is in CMD, FD switches are on and system in RAD TRK mode, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to track the selected VOR/TACAN radial. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS LOC	Control Wheel Steering Localizer indicates that either AP lever is in CMD, FD switches are on and system in LOC TRK mode, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to track the selected localizer. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS G/A	Control Wheel Steering Go Around indicates that either AP lever is in CMD, FD switches are on, TO/GA button on the number two throttle has been pushed, and CWS mode has been initiated by pushing the CWS switch. The FD provides steering commands to roll the wings level and maintain heading existing when roll attitude is less than 3°. The flight path is maintained by manual control wheel inputs through the CWS mode.
CWS R/CRS	Control Wheel Steering RAD Course indicates that either AP lever is in CMD, FD switches are on and system in RAD CRS mode. CWS mode has been initiated by pushing the CWS switch, or in CWS RAD mode and at VOR or TACAN station passage the annunciator has changed to CWS R/CRS. The FD provides steering commands to recapture the VOR/TACAN course selected. The flight path is maintained by manual control wheel inputs through the CWS mode. CWS R/CRS normally is replaced by CWS RAD any time after 30 seconds and up to a maximum of 3 minutes. After 3 minutes, if VOR/TACAN tracking criteria is not satisfied, CWS H/HLD is annunciated.

PITCH ANNUNCIATOR MODES



IAS HOLD	IAS Hold indicates the IAS switch on the control panel has been pushed causing the system to maintain existing airspeed by control of pitch attitude.
MACH HOLD	Mach Hold indicates the Mach switch on the control panel has been pushed causing the system to maintain existing Mach by control of pitch attitude.
TURB	Turbulence indicates that either TURB switch has been pushed. Autothrottles revert to OFF, autopilot reverts from CMD to CWS, and pitch and roll commands are removed from both ADIs.
VERT SPD	Vertical Speed is the basic engagement mode of the autopilot and flight director and indicates that the vertical speed mode is engaged and vertical speed selected on the vertical speed select wheel is being maintained.

CAUTION

When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

ALT CAP	Altitude Capture indicates that the altitude preselect mode has been engaged and aircraft is within the capture threshold and maneuvering to capture the altitude selected in the ALT preselect readout.
ALT HOLD	Altitude Hold indicates the vertical speed selector is set in the ALT HOLD detent and the altitude existing at the time of mode engagement is being maintained.
CWS	Control Wheel Steering indicates the CWS switch has been pushed with either AP lever in the CMD position, the FD switches OFF, and ALT HOLD or VERT SPD was not previously engaged.
G/S CAP	Glide Slope Capture indicates a localizer frequency has been tuned, the ILS mode has been selected and the aircraft is entering the glide slope capture threshold. The point of annunciation is variable, a function of rate of beam closure and beam deviation.
G/S TRK	Glide Slope Track indicates ILS mode has been selected and the aircraft is aligned with the glide slope centerline and is tracking inbound.
G/A	Go Around indicates the TO/GA button on number two throttle has been pushed, aircraft is inflight, and flaps are out of the full up position. If an autopilot and/or FD is engaged the go around mode commands a pitch attitude to maintain V_2 + 10 KIAS on 3 engines. V_2 on 2 engines, or a pitch attitude limit of 15 degrees. The fast/slow indicator is centered when the stabilized airspeed corresponds to V_2 + 10 KIAS (3 engines) or V_2 (2 engines).
TAKE OFF	Takeoff is annunciated when the TO/GA button on number two throttle is pushed with the aircraft on the ground. After liftoff the Fast/Slow indicators and the pitch commands are referenced to V_2 + 10 KIAS (on 3 engines), the pitch command limits the stabilized pitch attitude to not exceed 22 degrees (FD mode only). On engine failure, FD pitch command bars provide commands controlling the following speeds: at or below V_2, controls to V_2; between V_2 and V_2 + 10, controls to existing speeds; at or above V_2 + 10, controls to V_2 + 10.
CWS IAS	Control Wheel Steering Indicated Air Speed indicates that either AP lever is in CMD, FD switches are on and system in IAS HOLD mode, and CWS mode has been initiated by pushing the CWS switch. The FD provides pitch commands to maintain the IAS number existing at time of mode engagement. The pitch attitude is maintained by manual control wheel inputs through the CWS mode.
CWS MACH	Control Wheel Steering MACH indicates that either AP lever is in CMD, FD switches are on and system in MACH HOLD mode, and CWS mode has been initiated by pushing the CWS switch. The FD provides pitch commands to maintain the MACH number existing at time of mode engagement. The pitch attitude is maintained by manual control wheel inputs through the CWS mode.
CWS G/A	Control Wheel Steering Go Around indicates that either AP lever is in CMD, FD switches are on, TO/GA button on the number two throttle has been pushed, and CWS mode has been initiated by pushing the CWS switch. The FD provides pitch commands to maintain V_2 + 10 KIAS on 3 engines and V_2 on 2 engines. The pitch attitude is maintained by manual control wheel inputs through the CWS mode.

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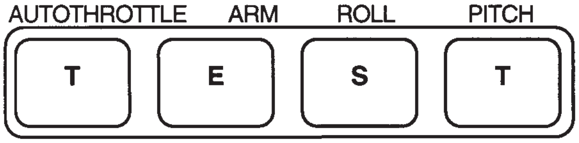
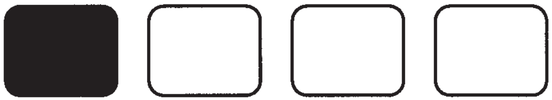
Figure 1.6-31. Flight Guidance Annunciation; Roll and Pitch Modes



TEST is annunciated when the ANNUN LT TEST button, located on the overhead panel, is pushed.
All test annunciators are green.

AUTOTHROTTLE ANNUNCIATOR MODES



SPD	Speed indicates the basic mode of autothrottle operation in which the throttles are controlled to seek and maintain the airspeed selected with the SPD selector.

CAUTION

When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

N1	N1 indicates the N1 mode has been selected with either or both ATS levers engaged. Autothrottle system controls the throttles to seek and maintain the highest N1 limit indicated on the N1 LIM readout.
ALPHA SPD	Alpha speed indicates the ATS is automatically maintaining a computed safe speed based upon established stall margins. Annunciated when minimum safe (Alpha) speed is greater than that selected in the SPD readout.
RETD	Retard indicates the throttles are being automatically retarded during a landing (at about 50 feet radio altitude). Retard mode does not engage until approach slats are extended or Land mode is engaged.
CLAMP	Clamp mode indicates ATS levers have been engaged with airplane on the ground. When takeoff mode is engaged, clamp mode changes to N1 mode. At 80 knots clamp mode re-engages and can be disengaged by pushing N1 switch or pulling out speed select knob after airplane is in flight and takeoff mode is cancelled.

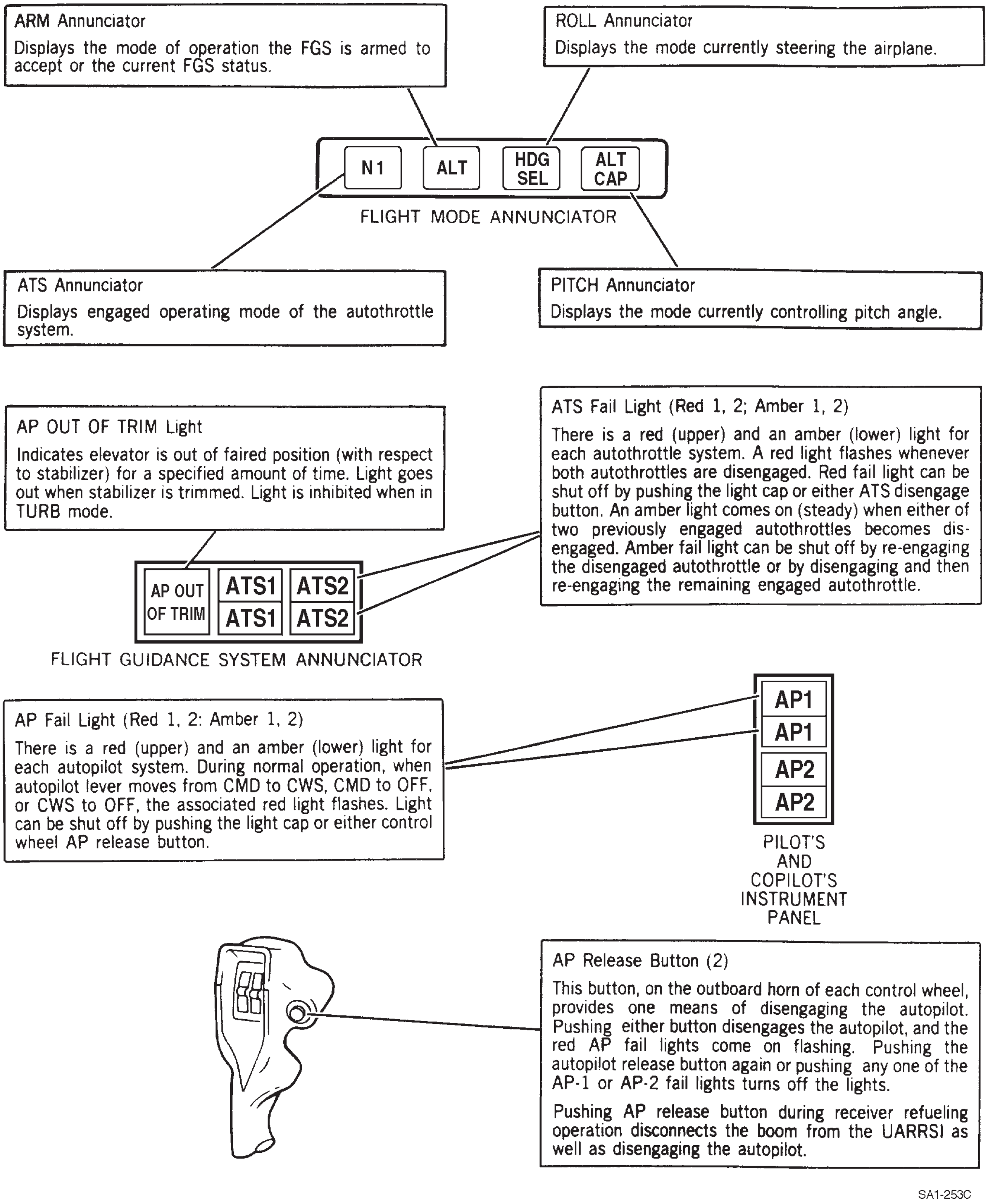
ARM ANNUNCIATOR MODES

FMS	FMS indicates the system is armed to capture and track the course commanded by the flight management system.
FMS ALT	FMS/Altitude indicates the system is armed to capture and track the course commanded by the flight management system and the altitude preselect mode is armed to capture selected altitude.
RAD	RAD indicates the system is armed to capture and track the omnirange selected on the nav panel, or TACAN as selected on the EHSI.

NOTE
The ATS, roll, and pitch FMAs are green, the arm FMAs are amber except for the E in TEST.

RAD ALT	RAD/Altitude indicates the system is armed to capture and track the omnirange selected on the nav panel or TACAN for steering and the altitude preselect mode is armed to capture selected altitude.
ALT	Altitude indicates the altitude preselect mode is armed to capture selected altitude.
B/CRS ALT	Back Course/Altitude indicates the system is armed to capture back course steering (localizer only) and the altitude preselect mode is armed to capture selected altitude (FD mode only).
B/CRS	Back Course indicates the system is armed to capture and track ILS back course (localizer only). (FD mode only).
LOC ALT	Localizer/Altitude indicates the system is armed to capture and track the selected localizer and the altitude preselect mode is armed to capture selected altitude.
LOC	Localizer indicates the system is armed to capture and track localizer only.
ILS ALT	ILS/Altitude indicates the system is armed to capture and track the selected localizer and associated glide slope and the altitude preselect mode is armed to capture selected altitude.
ILS	ILS indicates the system is armed to capture and track the selected localizer and associated glide slope.

Figure 1.6-32. Flight Guidance Mode Annunciation; Test, Autothrottle, and Arm Modes



ARM Annunciator

Displays the mode of operation the FGS is armed to accept or the current FGS status.

ROLL Annunciator

Displays the mode currently steering the airplane.

ATS Annunciator

Displays engaged operating mode of the autothrottle system.

PITCH Annunciator

Displays the mode currently controlling pitch angle.

AP OUT OF TRIM Light

Indicates elevator is out of faired position (with respect to stabilizer) for a specified amount of time. Light goes out when stabilizer is trimmed. Light is inhibited when in TURB mode.

ATS Fail Light (Red 1, 2; Amber 1, 2)

There is a red (upper) and an amber (lower) light for each autothrottle system. A red light flashes whenever both autothrottles are disengaged. Red fail light can be shut off by pushing the light cap or either ATS disengage button. An amber light comes on (steady) when either of two previously engaged autothrottles becomes disengaged. Amber fail light can be shut off by re-engaging the disengaged autothrottle or by disengaging and then re-engaging the remaining engaged autothrottle.

AP Fail Light (Red 1, 2: Amber 1, 2)

There is a red (upper) and an amber (lower) light for each autopilot system. During normal operation, when autopilot lever moves from CMD to CWS, CMD to OFF, or CWS to OFF, the associated red light flashes. Light can be shut off by pushing the light cap or either control wheel AP release button.

AP Release Button (2)

This button, on the outboard horn of each control wheel, provides one means of disengaging the autopilot. Pushing either button disengages the autopilot, and the red AP fail lights come on flashing. Pushing the autopilot release button again or pushing any one of the AP-1 or AP-2 fail lights turns off the lights.

Pushing AP release button during receiver refueling operation disconnects the boom from the UARRSI as well as disengaging the autopilot.

Figure 1.6-33. Flight Mode Annunciator

ALPHA SPEEDS

FLAP POSITION	SLAT POSITION	SAFE STALL MARGIN
UP	RET	1.50 V_S
0°	EXT TO	1.50 V_S
15°	RET	1.40 V_S
15°	EXT TO	1.45 V_S
22°	RET	1.35 V_S
22°	EXT TO	1.40 V_S
35°	RET	1.30 V_S
35°	EXT LAND	1.30 V_S
50°	RET	1.30 V_S
50°	EXT LAND	1.30 V_S

NOTE: The noted stall margin for a particular flap setting is referenced to the stall speed for that flap setting (e.g. 1.30 V_S at 35° flaps is a higher speed than 1.30 V_S at 50° flaps).

Figure 1.6-34. Alpha Speeds Table

ATS LIMITS

There are limits on the ATS operation which prevent over-boosting engines, prevent airspeeds below a safe margin above stall, and prevent commands in excess of flap placard speeds. There is no annunciation when throttle travel is restricted by N_1 limit or flap placard speed. However, when the throttles stop at the thrust setting to provide the safe stall margin speed, the ATS flight mode annunciators display ALPHA SPD. Minimum authority limit switches restrict throttle travel in the low N_1 regions.

CAUTION

- Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.
- When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

N_1 MODE

The N_1 mode of operation controls the throttles to maintain the N_1 LIM readout on the TRC indicator (figures 1.6-36 and 1.6-37). In the event of a failure of the thrust rating computer, the ATS disengages if it is in the N_1 mode and a flag covers the N_1 LIM readout.

COMPUTER FAILURE

If the thrust computer fails, SPEED mode is available but the Pilot must manually set the max limit index marker on the N_1 gage. When the thrust rating computer is valid, the logic signals from the N_1 gages are overridden internally to AT/SC computer and ATS operation is limited not to exceed the N_1 limit on the TRC indicator.

ALPHA SPEED SELECTION

The ALPHA SPD mode is automatically selected when the ATS is engaged in the SPD mode and the selected airspeed is lower than the safe stall margin speed.

MANUAL OVERRIDE

The ATS may be manually overridden. If all throttles are overridden simultaneously, the ATS readjusts the throttles to maintain the original positions except for minor adjustments. One throttle may be manually overridden and when released it maintains its relative position to the other throttles until repositioned manually or throttles are closed automatically.

RETARD MODE

The RETD mode is automatically selected during a landing when the aircraft descends through 50 feet radio-altitude. The throttles retard at a programmed rate to bleed off speed as required for flare and landing. RETD is displayed in both ATS flight mode annunciators. At main gear wheel spin-up the throttles retard rapidly from their existing position to the idle stop.

TEST

The Flight Crew can test the ATS, stall warning, and speed control circuits on the ground with the test switches on the Overhead Panel.

AUTOPILOT (AP)

There are two autopilot systems, defined as one and two, which are associated with the Pilot and Copilot respectively. The autopilots are engaged by moving the AP lever to the CWS (control wheel steering) or CMD (command) position and disengaged by pushing the AP release button on the control wheel or by moving the AP levers to the OFF position. The autopilot disengages automatically when an internal fault and/or an improper signal from the CWS sensor is detected. Aircraft control is transferred to Pilot manual control permitting appropriate action to avoid abrupt pitch and roll motions. With the AP lever(s) in the CMD (or in CWS position if TURB mode is engaged), moving the longitudinal trim handles, longitudinal trim switches, or alternate longitudinal trim switches causes the AP to disengage.

Illumination of the HYD SYS 3 ELEV OFF light on the Flight Engineer's Annunciator Panel indicates that the Hydraulic System 3 Elevator Shutoff Valve has closed and removed Hydraulic System 3 pressure from the inboard elevators. This condition will also illuminate the Pilot's and Copilot's Master Caution lights. Autopilot 2 uses only Hydraulic System 3 for pitch control.

WARNING

> With Autopilot 2 engaged, activation of the Hydraulic System 3 Shutoff Valve will cause Autopilot 2 pitch control to become inoperative. Autopilot 2 will not automatically disconnect and pitch control failure will not be indicated. Abnormal pitch conditions may be encountered, especially during approach/landing.

ALTITUDE ADVISORY SYSTEM

The altitude advisory system alerts the Flight Crew that the aircraft is approaching a preselected altitude or that it is deviating from a previously selected and acquired altitude. The system is independent of either flight director or autopilot systems. An aural tone and an amber advisory light on the primary altimeters provide the alert stimuli.

ALTITUDE SELECT

An altitude selected with the altitude select knob (figure 1.6-29) on the FGS control panel is directed to both pitch computers. A steady amber advisory light on the altimeters comes on and a momentary aural tone sounds when the aircraft is at the altitude advisory threshold. If the vertical speed of the aircraft is less than 3750 fpm, the altitude advisory threshold is 750 feet (minimum) from the selected altitude. If the vertical speed of the aircraft is 3750 fpm or greater, the altitude advisory threshold varies as a function of vertical speed (approximately 200 feet increase for each additional 1000 fpm of vertical speed). For example, if the vertical speed of the aircraft is 4750 fpm, the steady amber light on the altimeter comes on and the momentary aural tone sounds when the aircraft is 950 feet from the selected altitude. When the aircraft is within 250 feet of the selected altitude, the amber advisory light goes off. If the aircraft subsequently deviates more than 250 feet from the selected altitude, the amber advisory light flashes. Pushing the altitude advisory RESET button (figure 1.6-29) turns off the flashing altitude advisory light and resets the altitude advisory system to monitor subsequent deviations of 250 feet or more from selected altitude.

ENHANCED GROUND PROXIMITY WARNING SYSTEM

The Enhanced Ground Proximity Warning System (EGPWS) (figure 1.6-38) uses radio altitude, barometric information, attitude information, a digital terrain database with sophisticated alerting algorithms, and FMS position, track and groundspeed to determine close proximity with the ground. Inputs are also received from the glideslope receivers, flaps, and landing gear. The system provides visual and aural warnings of an unsafe flight path in relation to the ground or that the aircraft is not properly configured for descent and landing. The system also provides a warning annunciation for excessive rate of descent, excessive terrain closure rate, excessive sink rate during takeoff, insufficient terrain clearance, excessive descent below glideslope, excessive bank angle near the ground, and windshear. Additionally, a set of preprogrammed altitude callouts is provided for approach and landing. The system includes an EGPWS computer; a red GPWS annunciator light, an amber BELOW G/S switch/light, and an amber/red W/S caution/warning annunciator installed on both the pilot's and copilot's glareshield; an amber GPWS FAIL annunciator light installed on the flight engineer's upper panel No. 2; and a GND PROXIMITY WARN control panel and combined EGPWS/ETCAS powered speaker located on the aft overhead panel.

NOTE

> The EGPWS/ETCAS speaker receives power from the LEFT EMER DC BUS through the FLIGHT INPH CAPT & F/E AUDIO circuit breaker.

The EGPWS incorporates the functions of the basic ground proximity warning system with added features including the Terrain Clearance Floor, Terrain Awareness Alerting, and Obstacle Alerting.

Terrain Clearance Floor

The Terrain Clearance Floor (TCF) alert function adds an additional element of protection to the standard ground proximity warning system by alerting the pilot of possible premature descent for nonprecision approaches regardless of aircraft configuration. It creates a terrain clearance envelope around the airport to provide additional protection against controlled flight into terrain (CFIT) situations. TCF alerts are based on current aircraft location, nearest runway centerpoint position, and radio altitude. TCF is active during takeoff, cruise, and final approach. This alert mode complements the existing Mode 4 protection by providing an alert based on insufficient terrain clearance even when in the landing configuration. Alerts for TCF penetrations illuminate the GPWS warning lights and generate the audio message "TOO LOW TERRAIN". This message will repeat once when initial penetration occurs, and one time thereafter for each 20% decrease in radio altitude. The GPWS lights will remain on until the alert envelope is exited.

Terrain Awareness Alerting

Based on aircraft position, flight path angle, track and speed, Terrain Awareness Alerting (TAA) look ahead algorithms are able to project a ribbon ahead of the aircraft. This ribbon originates below the aircraft as an added margin of safety, and uses the TCF as a baseline for looking into the database. When conditions are such as to generate a terrain caution alert or terrain warning, a specific audio alert and the GPWS lights are triggered. At the start of the terrain caution alert (typically 60 seconds prior to potential terrain conflict), the terrain awareness function turns on the GPWS lights and generates the audio message "CAUTION TERRAIN, CAUTION TERRAIN". This is repeated every seven seconds as long as the aircraft is still in the caution envelope.

When conditions have been met to generate a terrain warning (typically 30 seconds prior to potential terrain conflict), the terrain awareness function turns on the GPWS lights and issues the audio message "TERRAIN, TERRAIN, PULL UP". The "PULL UP" message is then repeated continuously while the aircraft is within the warning envelope.

Obstacle Alerting

Obstacle alerting is available for the United States, U.S Pacific and Caribbean Territories, and parts of Canada and Mexico. Obstacle location information is integrated into the EGPWS terrain database and caution and warning alerts are processed in the same way as terrain alerts. The start of the obstacle caution alert (typically 60 seconds prior to potential obstacle conflict), turns on the GPWS lights and generates the audio message "CAUTION OBSTACLE, CAUTION OBSTACLE". This is repeated every seven seconds as long as the aircraft is still in the caution envelope. When conditions have been met to generate an obstacle warning (typically 30 seconds prior to potential obstacle conflict), the obstacle awareness function turns on the GPWS lights and issues the audio message OBSTACLE, OBSTACLE, PULL UP". The "PULL UP" message is then repeated continuously while the aircraft is within the warning envelope.

EGPWS Modes

The EGPWS has six warning modes and one advisory mode (Mode 6) as follows:

MODE 1 - Mode 1 provides alerts and warnings for excessive descent rates with respect to AGL altitude and is active for all phases of flight. This mode has an inner and outer alert/warning boundary. Penetration of the outer boundary activates the GPWS warning lights and results in two "SINKRATE" alert messages. Additional "SINKRATE" messages will occur if penetration increases. Penetration of the inner boundary changes the audio message to "PULL UP", which repeats continuously until the inner boundary is exited. GPWS warning lights remain illuminated. If a valid ILS glideslope front course signal is received and the aircraft is above the glideslope, the outer (sinkrate) area is desensitized to prevent nuisance alerts when the aircraft is safely capturing or repositioning to the glideslope from above.

MODE 2 - Mode 2 provides alerts and warnings to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on radio altitude and how rapidly radio altitude is decreasing (closure rate). Mode 2 exists in two forms, 2A and 2B.

> MODE 2A - Mode 2A is active during climbout, cruise, and initial descent (flaps not in landing configuration and aircraft not on glideslope). If the aircraft penetrates the Mode 2A alerting envelope, the aural message "TERRAIN, TERRAIN" is generated and the GPWS warning lights illuminate. If the aircraft continues to penetrate the envelope, the warning message "PULL UP" is repeated continuously until the warning envelope is exited. Upon exiting the warning envelope, if terrain clearance continues to decrease, the "TERRAIN" message will be given until the terrain clearance stops decreasing. The GPWS lights will remain on until the aircraft has gained 300 feet of barometric altitude, 45 seconds have elapsed, or the flap override switch is activated. In addition, the upper boundary expands as airspeed increases to provide more warning time at higher airspeeds.
>
> MODE 2B - Mode 2B provides a desensitized alerting envelope to permit normal landing approach maneuvers close to the ground without nuisance alerts. Mode 2B is automatically selected with flaps in landing configuration or when making an ILS approach with localizer and glideslope deviation less than two dots. It is also active during the first 60 seconds after takeoff. During an approach, if the aircraft penetrates the Mode 2B envelope with either the gear or flaps not in the landing configuration, the audio message "TERRAIN, TERRAIN" is generated and the GPWS lights illuminate. If the aircraft continues to penetrate the envelope, the message "PULL UP" is repeated continuously until the warning envelope is exited. If the aircraft pen-

etrates the Mode 2B envelope with both gear and flaps in the landing configuration, "PULL UP" messages are suppressed and the message "TERRAIN" is repeated until the envelope is exited.

MODE 3 - Mode 3 provides warnings for significant altitude loss after takeoff or low altitude go-around (<245 feet AGL) with gear or flaps not in landing configuration. The amount of altitude loss permitted before an alert is given is a function of the AGL altitude of the aircraft. This protection is available until the EGPWS computer determines that the aircraft has gained sufficient altitude to no longer be considered to be in the takeoff phase. Significant altitude loss after takeoff or during a low altitude go-around activates the GPWS lights and the audio message "DON'T SINK, DON'T SINK". The message is repeated if excessive altitude loss continues to accumulate. Upon reestablishing a positive rate of climb, the GPWS lights extinguish and the audio alert discontinues.

MODE 4 - Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight and speed. Mode 4 exists in three forms, 4A, 4B, and 4C. Mode 4A is active during cruise and approach with the gear up. Mode 4B is active in cruise and approach with the gear down. Mode 4C is active during the takeoff phase with either the gear or flaps not in the landing configuration. A Mode 4 alert occurs when the envelope is first penetrated.

MODE 4A - Mode 4A is active during cruise and approach with the gear up. This provides alerting during cruise for inadvertent flight into terrain where the terrain is not rising significantly or the aircraft is not descending at an excessive rate. During approach, Mode 4A provides protection against an unintentional gear-up landing. Mode 4A alerts activate the GPWS lights and the audio message "TOO LOW TERRAIN". This alert occurs at altitudes of 1000 feet and lower, depending upon aircraft speed. Subsequent alert messages occur only if penetration of the envelope increases by 20%. Below 500 feet AGL and 190 KIAS, the Mode 4A audio alert is "TOO LOW GEAR". GPWS lights extinguish and audio messages cease when the Mode 4A envelope is exited.

MODE 4B - Mode 4B is active in cruise and approach with the gear down and flaps not in the landing configuration. Mode 4B alerts activate the GPWS lights and the audio message "TOO LOW TERRAIN". This alert occurs at altitudes of 1000 feet and lower, depending upon aircraft speed (below 250 KIAS at 1000 feet AGL decreasing linearly to 160 KIAS at 245 feet AGL).

NOTE

This alert may be triggered during circling approaches at heavy gross weights.

Subsequent alert messages occur only if penetration of the envelope increases by 20%. Below 245 feet AGL and 160 KIAS, the Mode 4B alert is "TOO LOW FLAPS". GPWS lights extinguish and audio messages cease when the Mode 4B envelope is exited. The "TOO LOW FLAPS" alert can be disabled by pressing the flap override switch located on the GROUND PROXIMITY WARN panel. This precludes or silences the Mode 4B flap alert until the flap override switch is reset.

MODE 4C - Mode 4C is based on a minimum terrain clearance floor (TCF) that increases with radio altitude during the takeoff phase. It is active after takeoff or low altitude go-around (<245 feet AGL) with gear or flaps not in landing configuration. Mode 4C alerts the flight crew when terrain is rising more rapidly than the aircraft is climbing. At takeoff, the TCF is at zero feet. As the aircraft climbs, the TCF is increased to 75% of the aircraft's current (average of the last 15 seconds) radio altitude. This value is limited to 500 feet AGL when airspeed is ≤190 KIAS. If airspeed is >190 KIAS, the TCF increases linearly with increasing airspeed up to 250 KIAS. Beyond 250 knots, the TCF is limited to 1000 feet AGL. If the radio altitude decreases to the value of the TCF, the GPWS lights illuminate and the audio message "TOO LOW TERRAIN" is generated. GPWS lights extinguish and audio messages cease when the Mode 4C envelope is exited.

MODE 5 - Mode 5 provides two levels of alerting if the aircraft flight path descends below the glideslope. The first alert occurs whenever the aircraft is more than 1.3 dots below the glideslope and is called a soft alert because the audio message volume is reduced. A second alert, termed a hard alert because it is louder, occurs below 300 feet radio altitude with greater than 2 dots deviation. Mode 5 alerts activate the BELOW G/S lights and the aural message "GLIDESLOPE". Only two "GLIDESLOPE" warnings are given while in the Mode 5 outer soft envelope. If the condition worsens, two more "GLIDESLOPE" messages are given at a faster rate. This pattern continues until the inner hard envelope is penetrated, at which time the "GLIDESLOPE" messages become louder and continuous. Below 150 feet AGL, glideslope alerting is desensitized to reduce the possibility of nuisance alerts. To avoid nuisance glideslope alerts when capturing the localizer between 500 and 1000 feet AGL, the upper limit of the alert envelope is varied in the following way:

- Glideslope alerts are only enabled if the localizer is within ±2 dots.
- The upper altitude limit for the glideslope alert is modulated with vertical speed. For descent rates above 500 fpm, the upper limit is set to the normal 1000 feet AGL. For descent rates lower than 500 fpm, the upper limit is desensitized to allow a level flight capture of the localizer.

The above requirements are overridden when the aircraft descends below 500 feet AGL.

MODE 6 - The Mode 6 function provides optional advisory callouts as the aircraft descends through predefined altitudes below 2500 feet AGL or through the height reference set by the pilot on the radio altimeter. Mode 6 also provides a bank angle callout during all phases of flight. Mode 6 provides aural callouts only; no visual alerts are given. Each altitude message is annunciated only once per approach. The following radio altitude callouts are enabled:

"FIVE HUNDRED"	Occurs at 500 feet AGL
"ONE HUNDRED"	Occurs at 100 feet AGL
"FIFTY"	Occurs at 50 feet AGL
"FORTY"	Occurs at 40 feet AGL
"THIRTY"	Occurs at 30 feet AGL
"TWENTY"	Occurs at 20 feet AGL
"TEN"	Occurs at 10 feet AGL

A "MINIMUMS" callout will occur on descent based on the pilot's radio altimeter height reference bug setting. This callout is only available for bug settings between 1000 feet AGL and 10 feet AGL. The "MINIMUMS" callout has a higher priority than an altitude callout. An additional "FIVE HUNDRED" foot smart callout is designed to assist pilots conducting nonprecision approaches, while remaining silent during a precision approach. This feature is provided in addition to the standard "FIVE HUNDRED" callout when the pilot's VOR/ILS receiver is not set to a valid ILS frequency. The smart callout will also occur if on an ILS glideslope with a deviation greater than 2 dots from either the glideslope or localizer centerline.

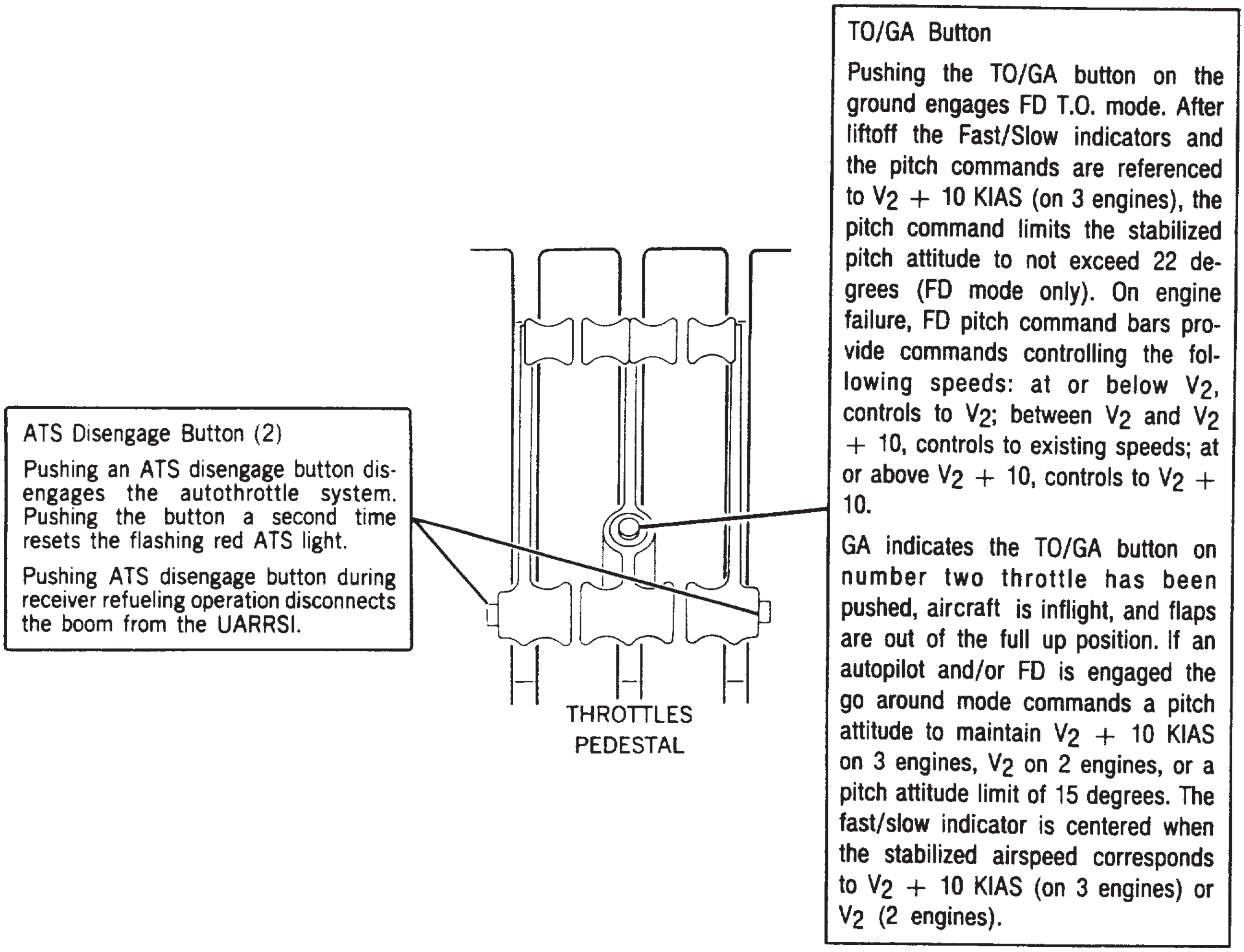
BANK ANGLE CALLOUT - The callout "BANK ANGLE, BANK ANGLE" advises of a roll attitude that is excessive for the flight conditions. Above 150 feet AGL, a bank angle alert will occur at 40° of roll. Below 150 feet AGL, the callout angle is reduced progressively with altitude from 40° at 150 feet to 10° at 30 feet. Below 30 feet, the callout occurs at 10° and is inhibited below 5 feet. The callout is repeated if roll attitude increases by 20%. If roll attitude increases to 40% above the initial callout angle, the callout repeats continuously.

MODE 7 - Mode 7 is designed to provide alerts and warnings if the aircraft encounters severe windshear. It is active between 10 and 1500 feet AGL during the initial takeoff and final approach phases of flight. Windshear caution alerts are given if the windshear consists of an increasing headwind (or decreasing tailwind) and/or a severe updraft, which may precede an encounter with a microburst. Windshear cautions activate the amber W/S caution lights and the aural message "CAUTION, WINDSHEAR". The W/S caution lights remain on for as long as the aircraft remains exposed to an increasing headwind and/or updraft condition in excess of the alert threshold. Windshear warnings are given if the windshear consists of a decreasing headwind (or increasing tailwind) and/or severe downdraft. Windshear warnings activate the red W/S warning lights and a siren sound followed by the aural message "WINDSHEAR, WINDSHEAR, WINDSHEAR". The message will not repeat unless another, separate severe windshear event is encountered. The W/S warning lights remain on for as long as the aircraft remains exposed to a decreasing headwind (increasing tailwind) and/or downdraft in excess of the alert threshold. The threshold is adjusted as a function of available climb performance, flight path angle, airspeeds significantly different from normal approach speeds, and unusual fluctuations in static air temperature (typically associated with the leading edge of microbursts). Mode 7 windshear alerting/warning is active under the following conditions:

- During takeoff - From rotation until an altitude of 1500 feet AGL has been reached.
- During approach - From an altitude of 1500 feet AGL down to 10 feet AGL.
- During missed approach - Until an altitude of 1500 feet AGL has been reached.

CONTROLS AND INDICATORS

The controls and indicators associated with automatic flight are mounted on the Overhead Panel, Glareshield, Control Wheel, Pedestal, Center Instrument Panel, and the Pilot and Copilot Instrument Panels. Illustrations of these major panels may be found by referring to Part 1, Aircraft General. The individual controls and indicators are illustrated and described elsewhere in this part.



ATS Disengage Button (2)

Pushing an ATS disengage button disengages the autothrottle system. Pushing the button a second time resets the flashing red ATS light.

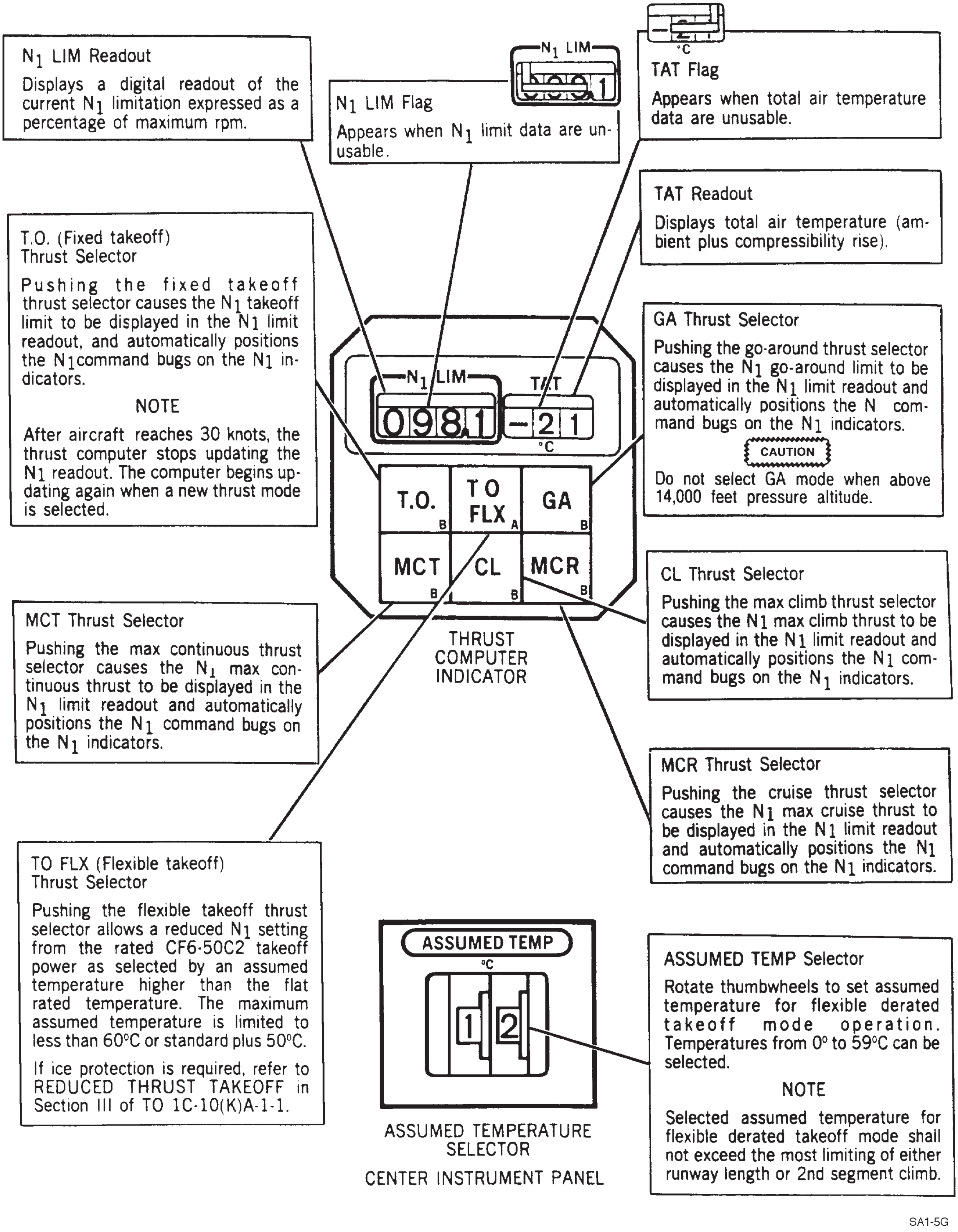
Pushing ATS disengage button during receiver refueling operation disconnects the boom from the UARRSI.

TO/GA Button

Pushing the TO/GA button on the ground engages FD T.O. mode. After liftoff the Fast/Slow indicators and the pitch commands are referenced to $V_2 + 10$ KIAS (on 3 engines), the pitch command limits the stabilized pitch attitude to not exceed 22 degrees (FD mode only). On engine failure, FD pitch command bars provide commands controlling the following speeds: at or below V_2, controls to V_2; between V_2 and $V_2 + 10$, controls to existing speeds; at or above $V_2 + 10$, controls to $V_2 + 10$.

GA indicates the TO/GA button on number two throttle has been pushed, aircraft is inflight, and flaps are out of the full up position. If an autopilot and/or FD is engaged the go around mode commands a pitch attitude to maintain $V_2 + 10$ KIAS on 3 engines, V_2 on 2 engines, or a pitch attitude limit of 15 degrees. The fast/slow indicator is centered when the stabilized airspeed corresponds to $V_2 + 10$ KIAS (on 3 engines) or V_2 (2 engines).

Figure 1.6-35. Throttles Pedestal



N_1 LIM Readout

Displays a digital readout of the current N_1 limitation expressed as a percentage of maximum rpm.

N_1 LIM Flag

Appears when N_1 limit data are unusable.

TAT Flag

Appears when total air temperature data are unusable.

TAT Readout

Displays total air temperature (ambient plus compressibility rise).

T.O. (Fixed takeoff) Thrust Selector

Pushing the fixed takeoff thrust selector causes the N_1 takeoff limit to be displayed in the N_1 limit readout, and automatically positions the N_1 command bugs on the N_1 indicators.

NOTE

After aircraft reaches 30 knots, the thrust computer stops updating the N_1 readout. The computer begins updating again when a new thrust mode is selected.

GA Thrust Selector

Pushing the go-around thrust selector causes the N_1 go-around limit to be displayed in the N_1 limit readout and automatically positions the N command bugs on the N_1 indicators.

CAUTION

Do not select GA mode when above 14,000 feet pressure altitude.

CL Thrust Selector

Pushing the max climb thrust selector causes the N_1 max climb thrust to be displayed in the N_1 limit readout and automatically positions the N_1 command bugs on the N_1 indicators.

MCT Thrust Selector

Pushing the max continuous thrust selector causes the N_1 max continuous thrust to be displayed in the N_1 limit readout and automatically positions the N_1 command bugs on the N_1 indicators.

MCR Thrust Selector

Pushing the cruise thrust selector causes the N_1 max cruise thrust to be displayed in the N_1 limit readout and automatically positions the N_1 command bugs on the N_1 indicators.

TO FLX (Flexible takeoff) Thrust Selector

Pushing the flexible takeoff thrust selector allows a reduced N_1 setting from the rated CF6-50C2 takeoff power as selected by an assumed temperature higher than the flat rated temperature. The maximum assumed temperature is limited to less than 60°C or standard plus 50°C.

If ice protection is required, refer to REDUCED THRUST TAKEOFF in Section III of TO 1C-10(K)A-1-1.

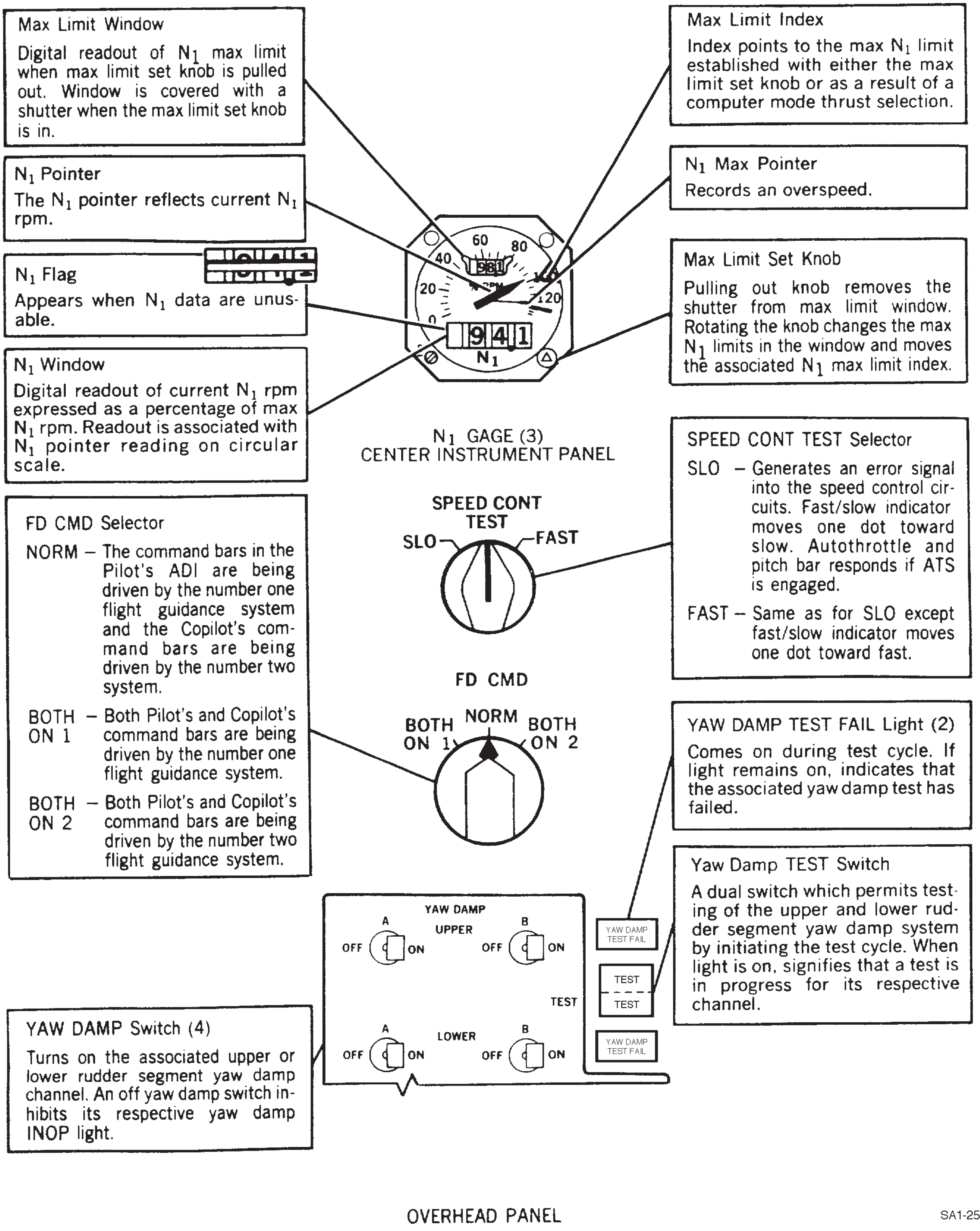
ASSUMED TEMP Selector

Rotate thumbwheels to set assumed temperature for flexible derated takeoff mode operation. Temperatures from 0° to 59°C can be selected.

NOTE

Selected assumed temperature for flexible derated takeoff mode shall not exceed the most limiting of either runway length or 2nd segment climb.

Figure 1.6-36. Thrust Computer



Max Limit Window

Digital readout of N$_1$ max limit when max limit set knob is pulled out. Window is covered with a shutter when the max limit set knob is in.

N$_1$ Pointer

The N$_1$ pointer reflects current N$_1$ rpm.

N$_1$ Flag

Appears when N$_1$ data are unusable.

N$_1$ Window

Digital readout of current N$_1$ rpm expressed as a percentage of max N$_1$ rpm. Readout is associated with N$_1$ pointer reading on circular scale.

FD CMD Selector

NORM – The command bars in the Pilot's ADI are being driven by the number one flight guidance system and the Copilot's command bars are being driven by the number two system.

BOTH ON 1 – Both Pilot's and Copilot's command bars are being driven by the number one flight guidance system.

BOTH ON 2 – Both Pilot's and Copilot's command bars are being driven by the number two flight guidance system.

YAW DAMP Switch (4)

Turns on the associated upper or lower rudder segment yaw damp channel. An off yaw damp switch inhibits its respective yaw damp INOP light.

Max Limit Index

Index points to the max N$_1$ limit established with either the max limit set knob or as a result of a computer mode thrust selection.

N$_1$ Max Pointer

Records an overspeed.

Max Limit Set Knob

Pulling out knob removes the shutter from max limit window. Rotating the knob changes the max N$_1$ limits in the window and moves the associated N$_1$ max limit index.

SPEED CONT TEST Selector

SLO – Generates an error signal into the speed control circuits. Fast/slow indicator moves one dot toward slow. Autothrottle and pitch bar responds if ATS is engaged.

FAST – Same as for SLO except fast/slow indicator moves one dot toward fast.

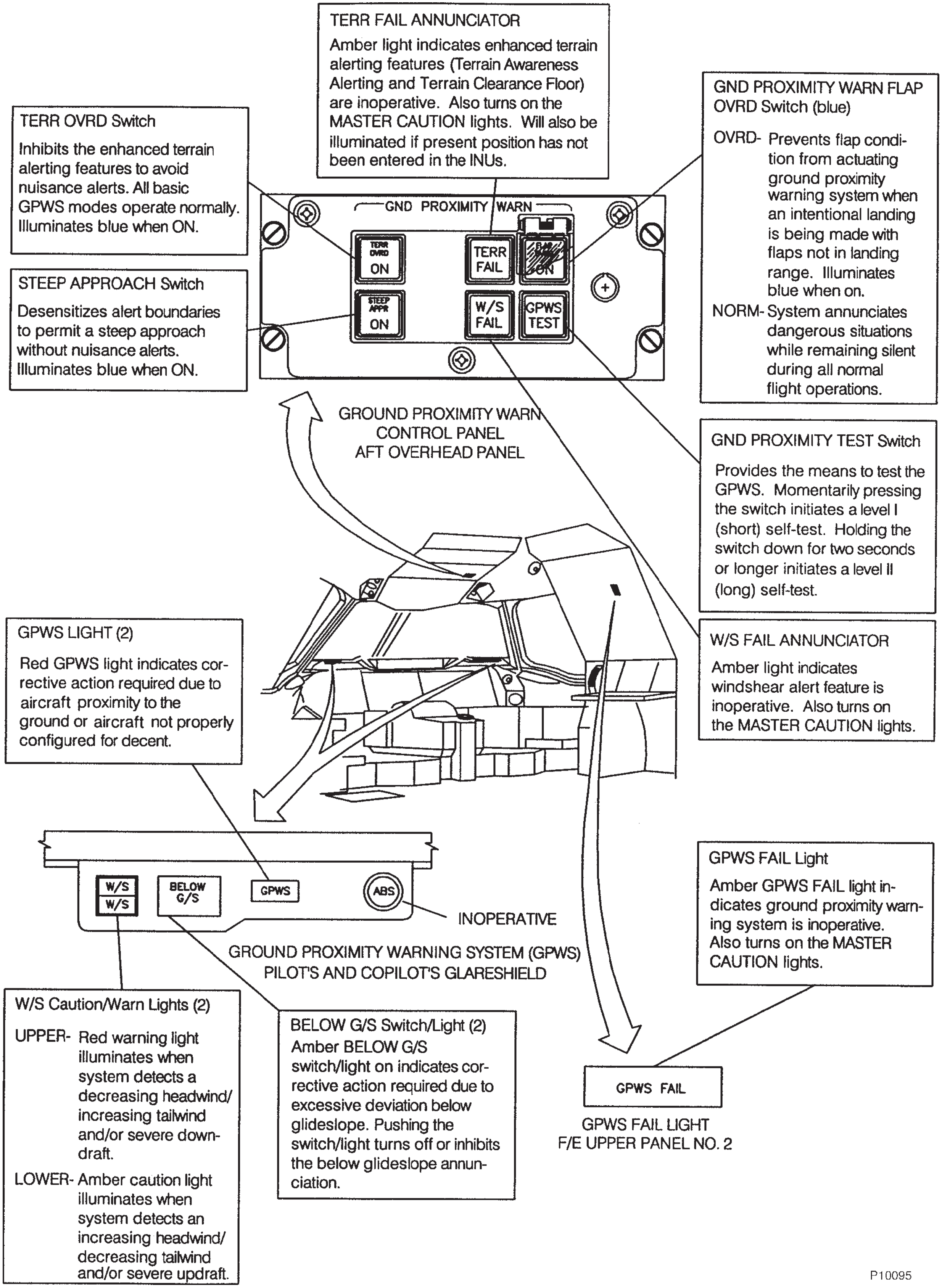
YAW DAMP TEST FAIL Light (2)

Comes on during test cycle. If light remains on, indicates that the associated yaw damp test has failed.

Yaw Damp TEST Switch

A dual switch which permits testing of the upper and lower rudder segment yaw damp system by initiating the test cycle. When light is on, signifies that a test is in progress for its respective channel.

Figure 1.6-37. N$_1$ Gage, Speed Control Selector, FD CMD Selector, and Yaw Damp Switch



TERR FAIL ANNUNCIATOR

Amber light indicates enhanced terrain alerting features (Terrain Awareness Alerting and Terrain Clearance Floor) are inoperative. Also turns on the MASTER CAUTION lights. Will also be illuminated if present position has not been entered in the INUs.

TERR OVRD Switch

Inhibits the enhanced terrain alerting features to avoid nuisance alerts. All basic GPWS modes operate normally. Illuminates blue when ON.

STEEP APPROACH Switch

Desensitizes alert boundaries to permit a steep approach without nuisance alerts. Illuminates blue when ON.

GND PROXIMITY WARN FLAP OVRD Switch (blue)

OVRD- Prevents flap condition from actuating ground proximity warning system when an intentional landing is being made with flaps not in landing range. Illuminates blue when on.

NORM- System annunciates dangerous situations while remaining silent during all normal flight operations.

GROUND PROXIMITY WARN CONTROL PANEL
AFT OVERHEAD PANEL

GND PROXIMITY TEST Switch

Provides the means to test the GPWS. Momentarily pressing the switch initiates a level I (short) self-test. Holding the switch down for two seconds or longer initiates a level II (long) self-test.

GPWS LIGHT (2)

Red GPWS light indicates corrective action required due to aircraft proximity to the ground or aircraft not properly configured for decent.

W/S FAIL ANNUNCIATOR

Amber light indicates windshear alert feature is inoperative. Also turns on the MASTER CAUTION lights.

GPWS FAIL Light

Amber GPWS FAIL light indicates ground proximity warning system is inoperative. Also turns on the MASTER CAUTION lights.

INOPERATIVE

GROUND PROXIMITY WARNING SYSTEM (GPWS)
PILOT'S AND COPILOT'S GLARESHIELD

W/S Caution/Warn Lights (2)

UPPER- Red warning light illuminates when system detects a decreasing headwind/increasing tailwind and/or severe downdraft.

LOWER- Amber caution light illuminates when system detects an increasing headwind/decreasing tailwind and/or severe updraft.

BELOW G/S Switch/Light (2)

Amber BELOW G/S switch/light on indicates corrective action required due to excessive deviation below glideslope. Pushing the switch/light turns off or inhibits the below glideslope annunciation.

GPWS FAIL LIGHT
F/E UPPER PANEL NO. 2

Figure 1.6-38. Ground Proximity Warning Systems Lights and Switches

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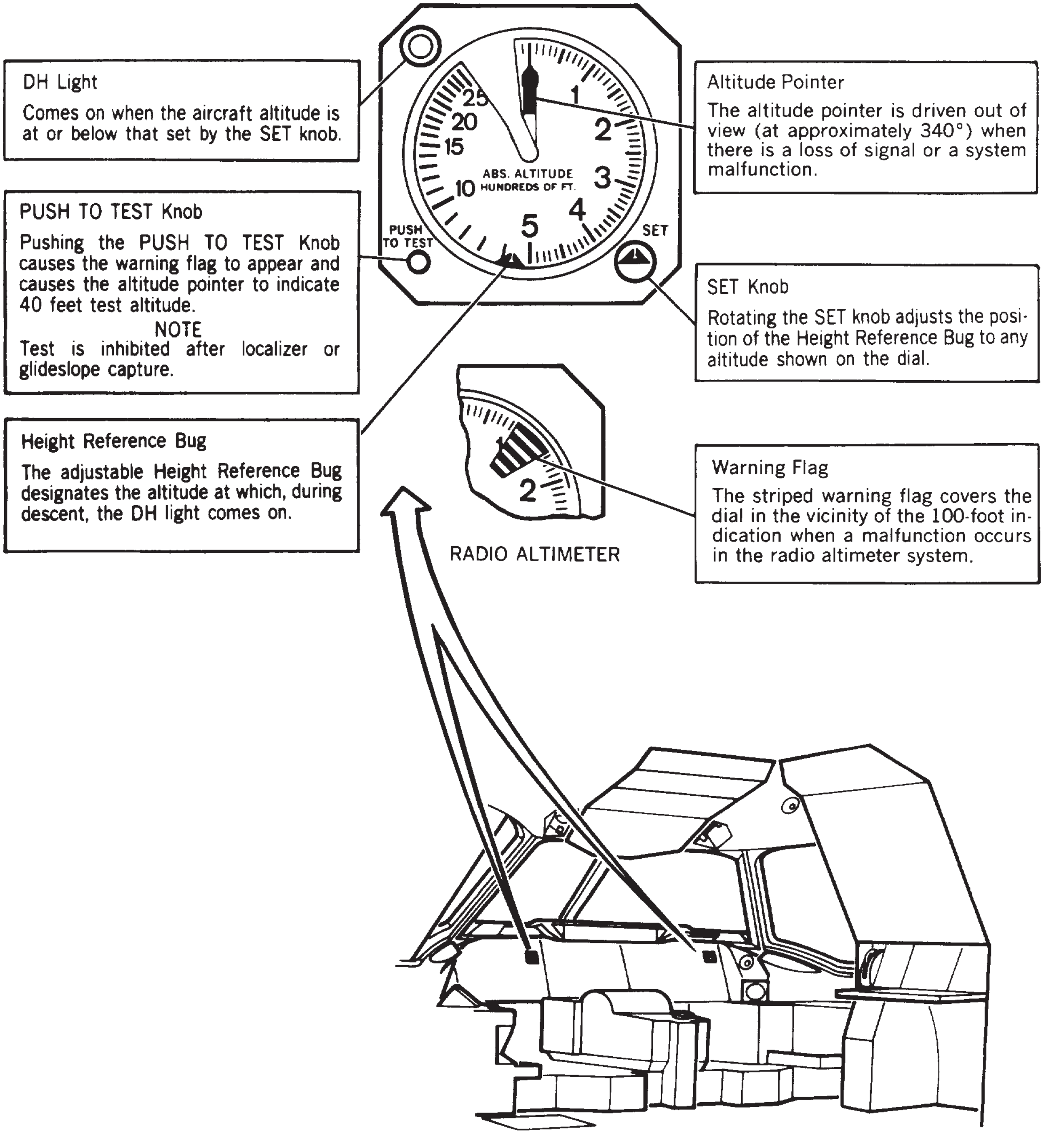


DH Light

Comes on when the aircraft altitude is at or below that set by the SET knob.

PUSH TO TEST Knob

Pushing the PUSH TO TEST Knob causes the warning flag to appear and causes the altitude pointer to indicate 40 feet test altitude.

NOTE

Test is inhibited after localizer or glideslope capture.

Height Reference Bug

The adjustable Height Reference Bug designates the altitude at which, during descent, the DH light comes on.

Altitude Pointer

The altitude pointer is driven out of view (at approximately 340°) when there is a loss of signal or a system malfunction.

SET Knob

Rotating the SET knob adjusts the position of the Height Reference Bug to any altitude shown on the dial.

Warning Flag

The striped warning flag covers the dial in the vicinity of the 100-foot indication when a malfunction occurs in the radio altimeter system.

Figure 1.6-39. Radio Altimeter

PART 7

LANDING GEAR

TABLE OF CONTENTS

LANDING GEAR

LANDING GEAR DESCRIPTION

The aircraft has a tricycle landing gear comprised of four-wheel trucks on each main gear, dual wheels on the nosegear, and a supplemental dual-wheel center gear. The landing gear and main gearwell doors are hydraulically actuated. The main and nosegear can be extended without extending the center gear. A free-fall capability is designed into the system for use if required by hydraulic failure. An electrically monitored, visual/aural indicating and warning system provides indication of gear status during phases of flight. Dual, hydraulic powered, multi-disc wheel brakes with anti-skid control systems are provided on the main and center gear. Accumulators in the system provide reserve brake pressure in the event of hydraulic system pressure loss.

LANDING GEAR SYSTEM

The landing gear and doors are retracted and extended by hydraulic system 3. If system 3 has a loss of pressure, but fluid is available, hydraulic power to retract the gear can be supplied by either the (1-3) or (2-3) reversible motor-pumps.

If no hydraulic pressure is available due to loss of fluid or complete system failure, or if the landing gear lever is jammed in the up position, the main and nosegear can be mechanically unlatched by an alternate gear extension lever (figure 1.7-1) located in the floor at the right side of the pedestal, and the center gear can be unlatched by a center gear alternate extension handle located on the floor, just forward of the lower main circuit breaker panel. This allows all gear to free-fall and mechanically latch in the down position. The main landing gear is normally held in the up position by hydraulic pressure. In the event of loss of pressure, the main gear rests on the main wheelwell doors, and the nosegear and center gear are held up by overcenter linkage. Trim cylinders maintain the truck beams perpendicular to the main gear oleo struts. A trim cylinder interlock mechanism prevents moving the gear handle to up in the event of hydraulic failure in the trim system.

NOSEGEAR STEERING SYSTEM

Nosegear steering is powered by hydraulic systems 1 and 3. Both the nosegear steering wheel (figure 1.7-1) and the rudder pedals provide steering control. The nosegear steering wheel has override authority over rudder pedal steering. The nosegear steering wheel provides steering up to 68° on either side of neutral, and full rudder pedal travel provides steering up to a maximum of 10° on either side of the neutral position. If hydraulic system 1 or 3 fails completely, nosewheel steering is limited to 25° in the direction of the inoperative hydraulic system. Rudder pedal steering is not noticeably affected by loss of one hydraulic system. Rudder pedal steering is rendered inoperative by the mechanical ground sensing mechanism during nosegear strut extension at takeoff. Nosegear steering using the nosegear steering wheel while the gear is retracted is not possible as the steering bypass valve is mechanically placed in a bypass mode upon nosegear retraction, and the nosegear is mechanically centered. This prevents inadvertent steering and possible jamming of the nosewheels in the wheelwell while retracted.

NOTE

Cans and cups in the pilot's drink receptacle or the clearview window crank may interfere with the nosegear steering tiller during taxi operations.

GROUND SENSING SYSTEM

A mechanically operated ground sensing mechanism is provided on the aircraft. It is operated by extension and compression of the nosegear strut. The system mechanically disables rudder pedal nosewheel steering, operates the gear handle anti-retraction release mechanism, and cams two switches which energize or deenergize a number of ground control relays which establish a ground or flight mode of operation for various systems.

VISUAL/AURAL INDICATING AND WARNING SYSTEM

The landing gear position indicating system (figure 1.7-1) consists of lights, aural warning, and mechanical indicating elements. Red and green lights are provided to give visual indication of the status of the landing gear in relation to landing gear handle, alternate gear extension lever, and throttles position for all phases of flight. Below 215 KIAS, with throttles retarded an aural warning horn and

GEAR Lights (Nose, Left, Right & Center) (Copilot's Instrument Panel & F/E's Upper Instrument Panel No. 3. An unsafe indication on one of the two gear indicating systems does not require a mandatory visual inspection.)

GREEN – Come on when the gear handle is down and the landing gear is down and locked. Also on when the gear handle is up and the landing gear is down and locked, if the alternate gear extension lever is raised.

RED – Come on when the landing gear is not down and locked and handle is down or when any unsafe condition exists. Also comes on when landing gear is in transit or not in agreement with gear handle, or when gear is up and locked and any throttle is retarded to idle. The CTR gear red warning light comes on when CTR gear switch is in UP position and the center gear is not up and locked regardless of the gear handle position.

OFF – When gear handle is up and gear is up and locked.

NOTE

CTR gear light is inhibited when CTR GEAR switch is in UP position, except when center gear has been lowered with the maintenance control handle in the right wheel well.

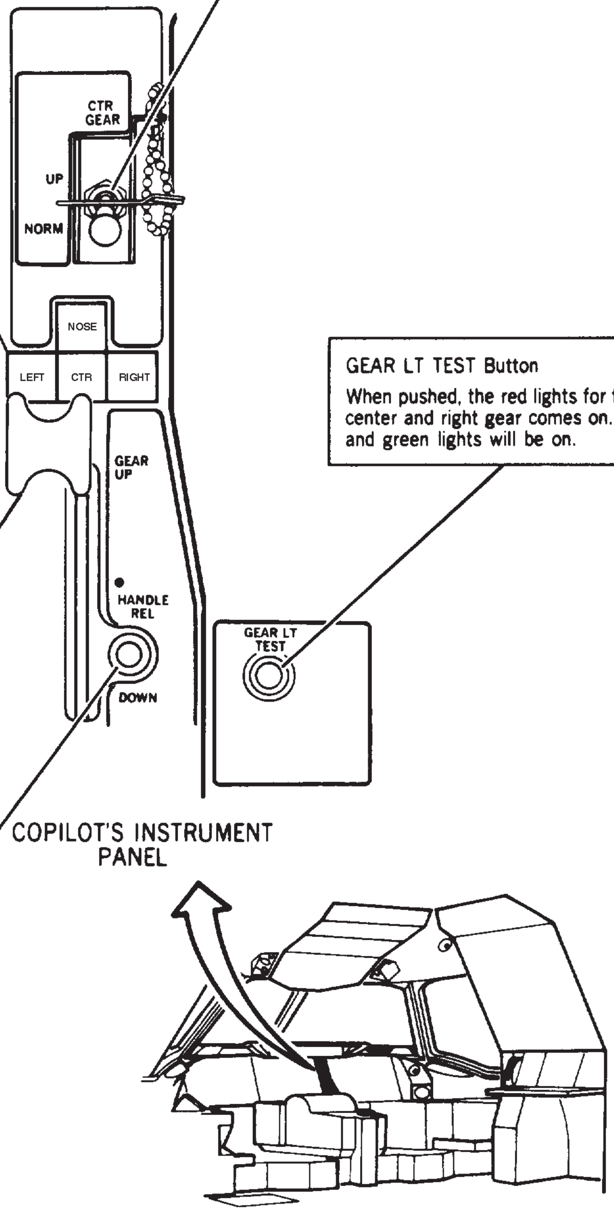
Both red and green lights for the respective main gear are on when the main gear door maintenance safety hook is installed.

CTR GEAR Isolation Switch

Permits main gear to be extended without extending center gear.

UP – Prevents center gear from being extended when main gear is extended. Center gear warning circuits are inhibited.

NORM – Center gear is extended and retracted when main gear is extended and retracted by means of GEAR handle.



GEAR LT TEST Button

When pushed, the red lights for the nose, left, center and right gear comes on. Both the red and green lights will be on.

GEAR Handle

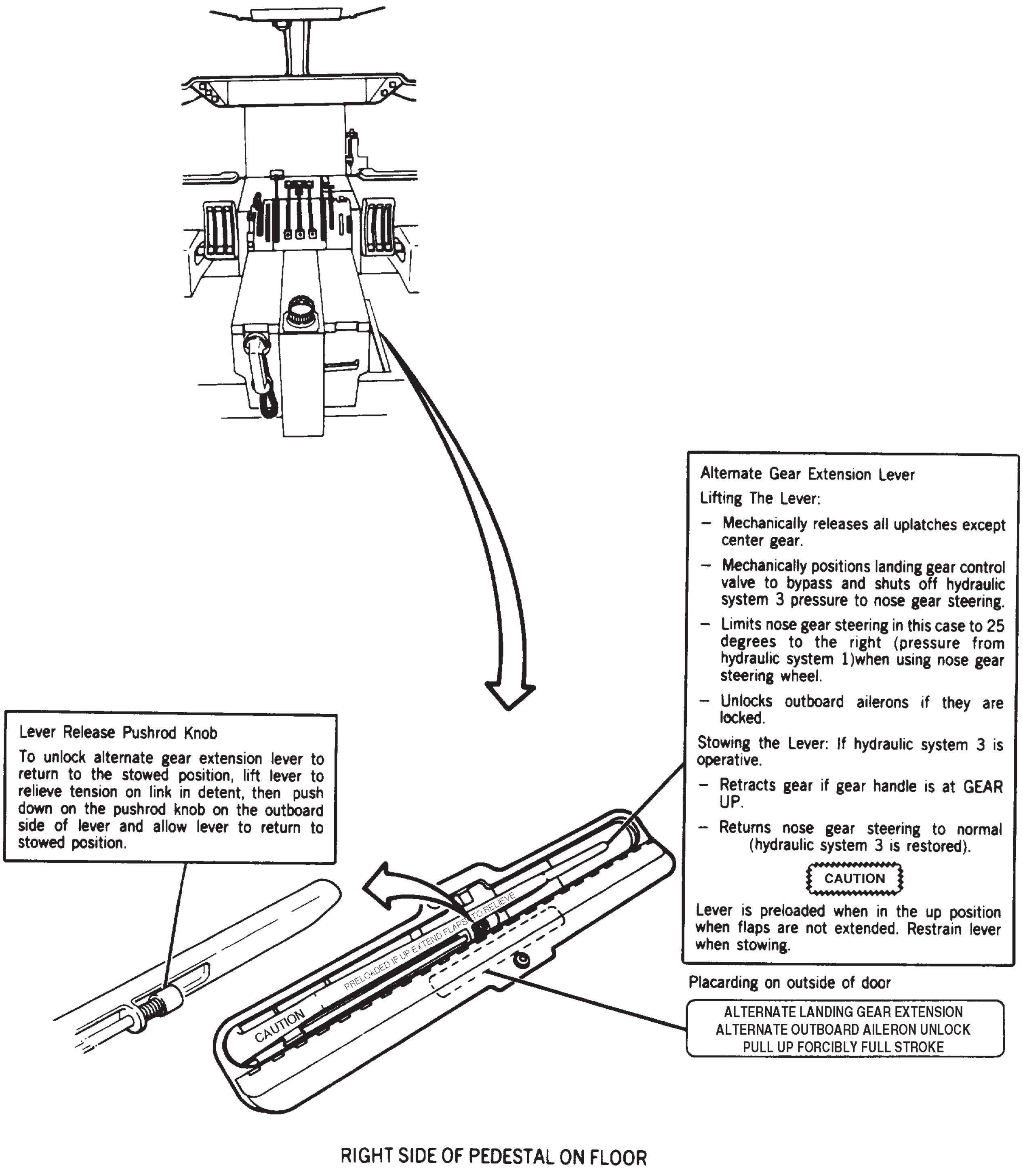
Mechanically positions the landing gear hydraulic control valve for retraction or extension of landing gear. To move handle from UP or DOWN position, it must be pulled aft.

GEAR HANDLE REL Button

Releases the anti-retraction mechanism and permits the gear handle to be placed in the UP position in the event of an anti-retraction release mechanism malfunction.

SA1-168C

Figure 1.7-1. Controls and Indicators (Sheet 1)



Lever Release Pushrod Knob

To unlock alternate gear extension lever to return to the stowed position, lift lever to relieve tension on link in detent, then push down on the pushrod knob on the outboard side of lever and allow lever to return to stowed position.

Alternate Gear Extension Lever

Lifting The Lever:

- Mechanically releases all uplatches except center gear.
- Mechanically positions landing gear control valve to bypass and shuts off hydraulic system 3 pressure to nose gear steering.
- Limits nose gear steering in this case to 25 degrees to the right (pressure from hydraulic system 1)when using nose gear steering wheel.
- Unlocks outboard ailerons if they are locked.

Stowing the Lever: If hydraulic system 3 is operative.

- Retracts gear if gear handle is at GEAR UP.
- Returns nose gear steering to normal (hydraulic system 3 is restored).

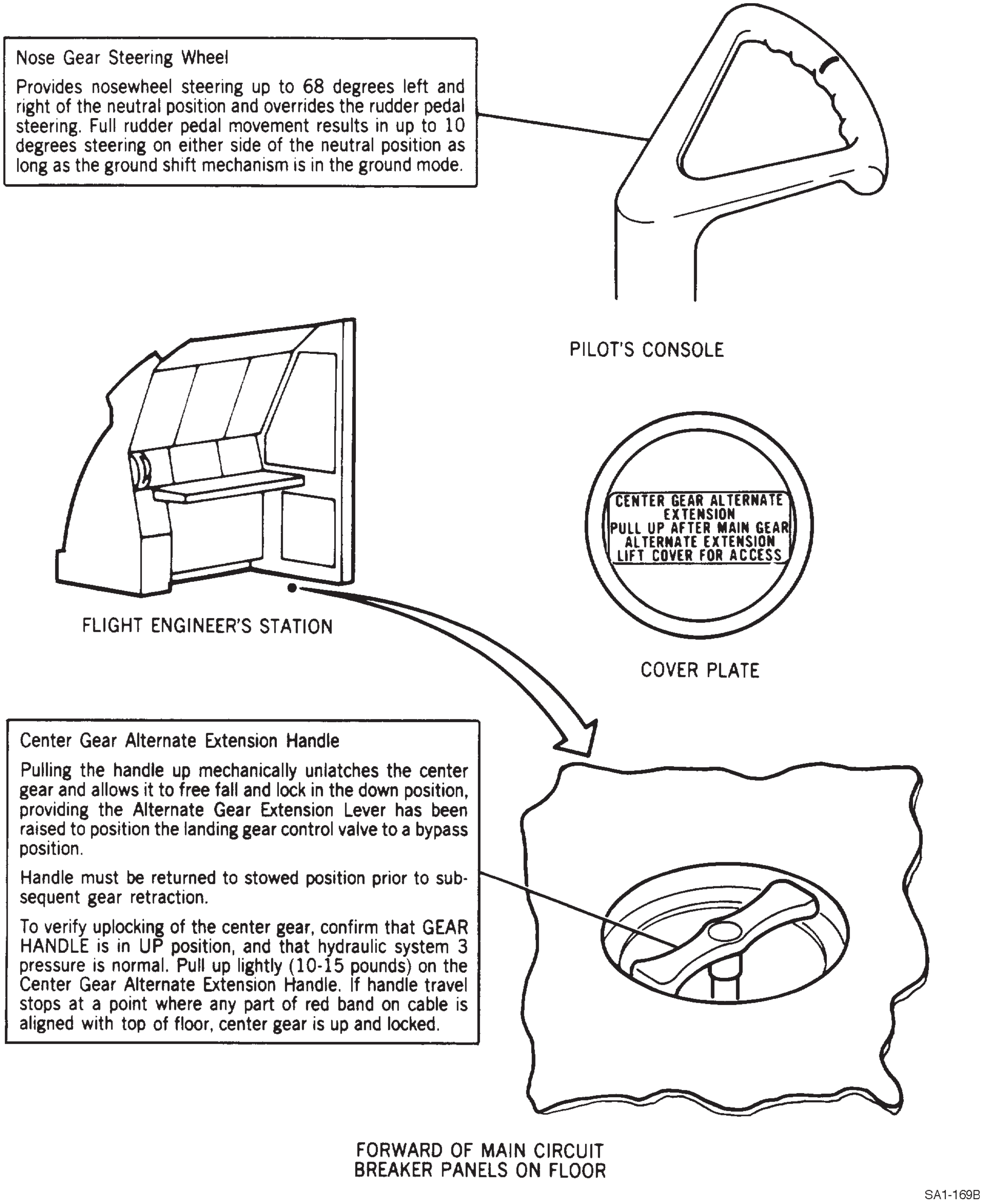
CAUTION

Lever is preloaded when in the up position when flaps are not extended. Restrain lever when stowing.

Placarding on outside of door

ALTERNATE LANDING GEAR EXTENSION
ALTERNATE OUTBOARD AILERON UNLOCK
PULL UP FORCIBLY FULL STROKE

Figure 1.7-1. Controls and Indicators (Sheet 2)


Nose Gear Steering Wheel

Provides nosewheel steering up to 68 degrees left and right of the neutral position and overrides the rudder pedal steering. Full rudder pedal movement results in up to 10 degrees steering on either side of the neutral position as long as the ground shift mechanism is in the ground mode.

Center Gear Alternate Extension Handle

Pulling the handle up mechanically unlatches the center gear and allows it to free fall and lock in the down position, providing the Alternate Gear Extension Lever has been raised to position the landing gear control valve to a bypass position.

Handle must be returned to stowed position prior to subsequent gear retraction.

To verify uplocking of the center gear, confirm that GEAR HANDLE is in UP position, and that hydraulic system 3 pressure is normal. Pull up lightly (10-15 pounds) on the Center Gear Alternate Extension Handle. If handle travel stops at a point where any part of red band on cable is aligned with top of floor, center gear is up and locked.

Figure 1.7-1. Controls and Indicators (Sheet 3)

red lights alert the pilots of any potential, or actual, abnormal landing configuration as it relates to gear position. Above 215 KIAS with the throttles retarded only red lights come on for warning. The horn can be silenced by use of a gear horn off button, except when the gear is not down and the flaps are extended beyond the approach flaps position.

It is possible to confirm that the landing gear is down and locked by observing mechanical indicators. Determination that the main gear is down and locked can be made by observing a button (figure 1.7-2) protruding from the top surface of each wing. A viewing window in the cabin floor and through the main gear wells is provided for checking that gear is up and doors are closed. Confirmation of the nosegear being down and locked or up and locked can be made by verifying the alignment of painted marks (figure 1.7-3) on the nosegear lock-link assembly. There are no provisions for visually checking the centerline gear uplock or downlock mechanisms, position sensors, or targets during flight. The gear can be checked up and locked by pulling the centerline gear alternate extension handle. If the gear is up and locked when the handle is pulled, the cable comes to a stop at which point a red band on the cable is even with the floor level. When the gear is not up and locked, the cable travels approximately 12 inches (30.5 centimeters) before reaching a stop.

BRAKE SYSTEM

There are two independent braking systems (figure 1.7-4) for each of the eight main wheels and two center wheels. Each brake system uses a separate hydraulic power system. Brake system 1 utilizes power from hydraulic system 1 and provides pressure to brakes on all main and center gear wheels. Brake system 2 is powered by hydraulic system 3 and provides pressure to brakes on all main and center gear wheels independent of brake system 1. Each brakeline is protected by a hydraulic fuse quantity limiting device to prevent losing the respective hydraulic system fluid in the event of a brakeline rupture. The fluid limiters are part of the anti-skid manifolds. Adequate braking is available with only one brake system operative. Each brake system is provided with two accumulators which apply reserve braking pressure in the event of normal hydraulic pressure failure. Fully charged accumulators provide approximately six normal manual power brake applications. Brakes are available as long as brake system pressure is above the red band on the respective brake system hydraulic pressure gage. Pedal forces required to actuate brakes are very low, and the brake pedals can actually be bottomed even though the system is functioning normally.

Brake wear indicators are provided on main and center landing gear brakes to ensure brake wear is within limits. Due to variations in brake types and measuring methods, brake wear status must be determined by reference to the Maintenance Manual (TO 1C-10(K)A-2-32).

The parking brakes are set by applying full braking pressure with toe-operated rudder pedal brakes, positioning the park brake handle (figure 1.7-5) fully aft, and then releasing the rudder pedals. This action traps braking pressure in the system. Adequate parking pressure is available if the brake system hydraulic pressure gages indicate in the white band. With parking brake set for several hours, normal hydraulic system bleed off can result in no pressure to the brakes. As long as brake pressure is indicated there is pressure at the brakes. The parking brakes may be released by fully depressing, then releasing the toe pedals. If hydraulic system(s) depressurize(s) while parking brakes are set, and brake pressure later bleeds off, then parking brakes are repressurized automatically when hydraulic system(s) is repressurized and this occurs without resetting parking brake handle. Two lights (figure 1.7-5), one on the pedestal and one on the Overhead Panel indicate when the parking brake handle is set to brake position. The takeoff warning aural signal (intermittent car horn sound, identical to cabin altitude warning) sounds when the ground shift mechanism is in the ground mode and either throttle 1 or 2 is advanced for takeoff and the parking brake is not released.

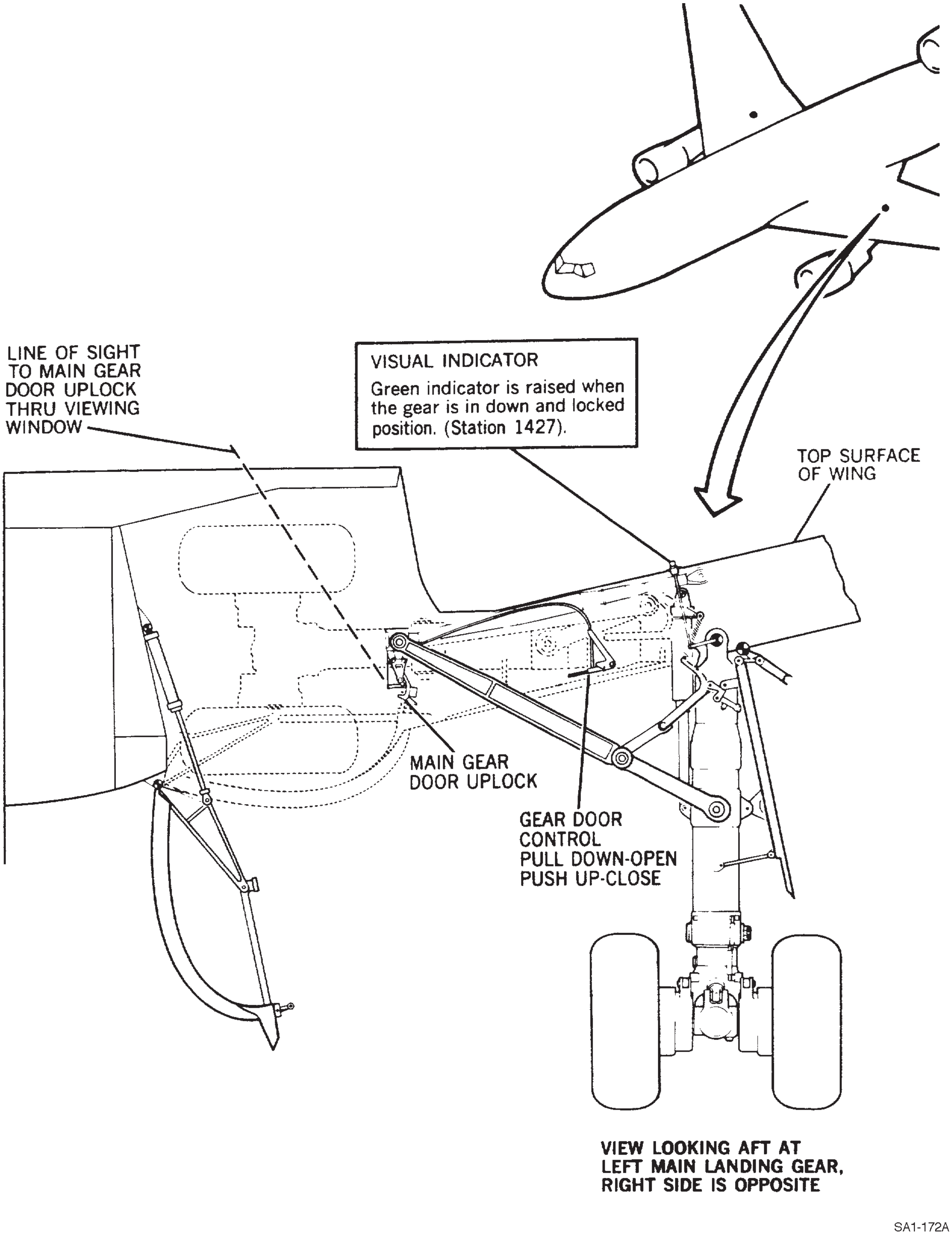
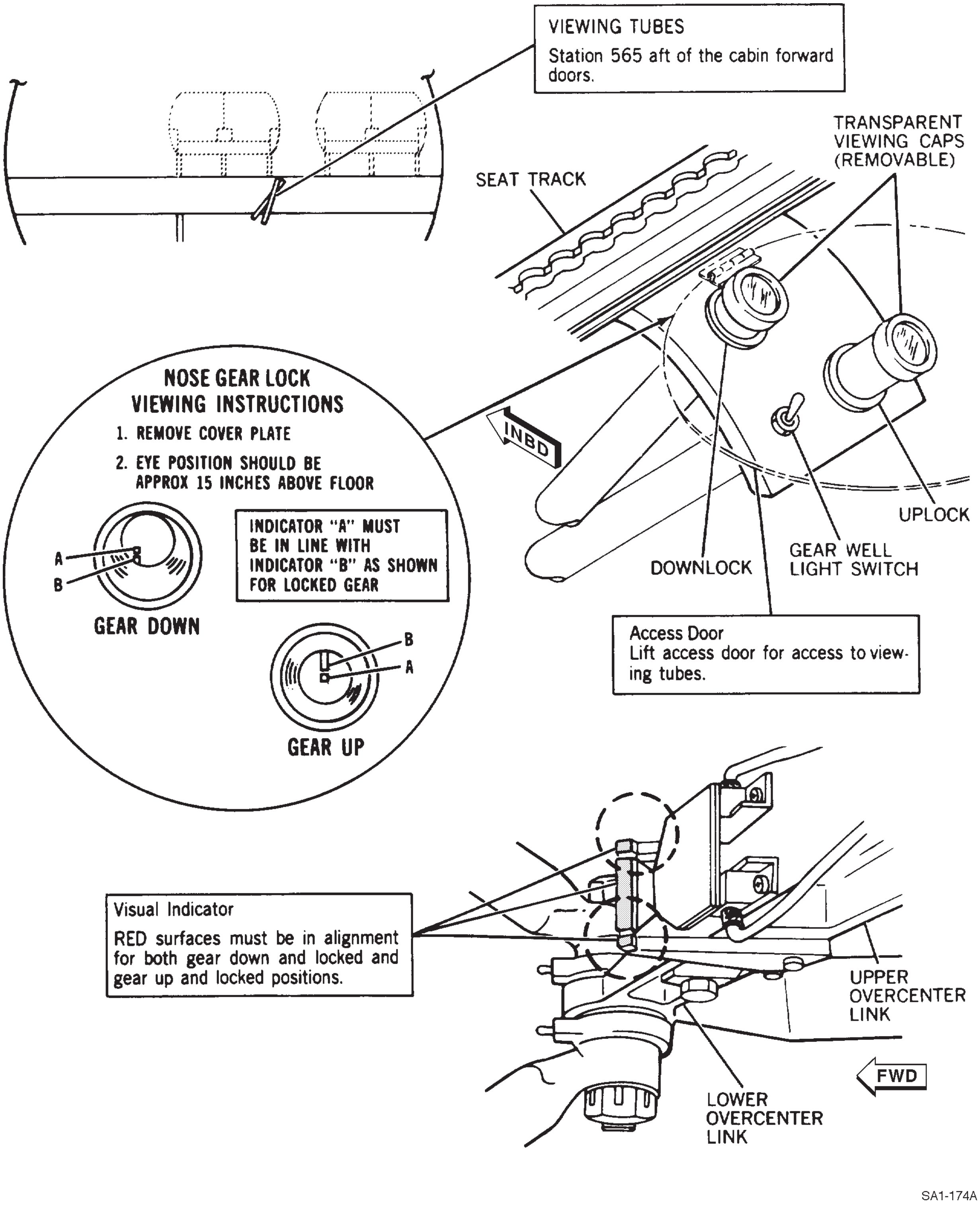


Figure 1.7-2. Main Landing Gear Visual Downlock Indicator



VIEWING TUBES
Station 565 aft of the cabin forward doors.

NOSE GEAR LOCK
VIEWING INSTRUCTIONS
1. REMOVE COVER PLATE
2. EYE POSITION SHOULD BE APPROX 15 INCHES ABOVE FLOOR

INDICATOR "A" MUST BE IN LINE WITH INDICATOR "B" AS SHOWN FOR LOCKED GEAR

Access Door
Lift access door for access to viewing tubes.

Visual Indicator
RED surfaces must be in alignment for both gear down and locked and gear up and locked positions.

Figure 1.7-3. Nosegear Visual Uplock and Downlock Indicator

MAIN WHEEL BRAKES AND ANTI-SKID SYSTEM Ground Mode

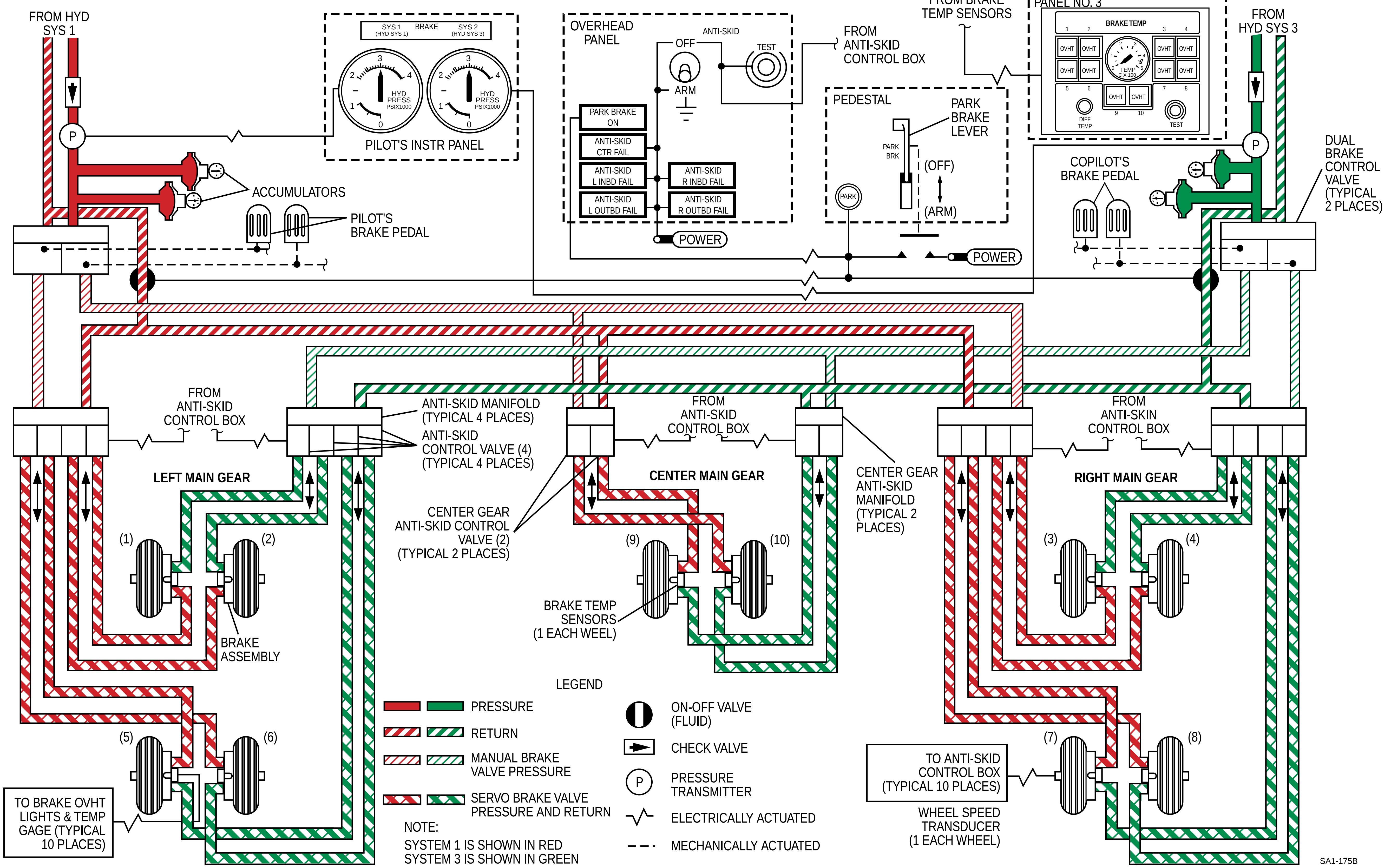
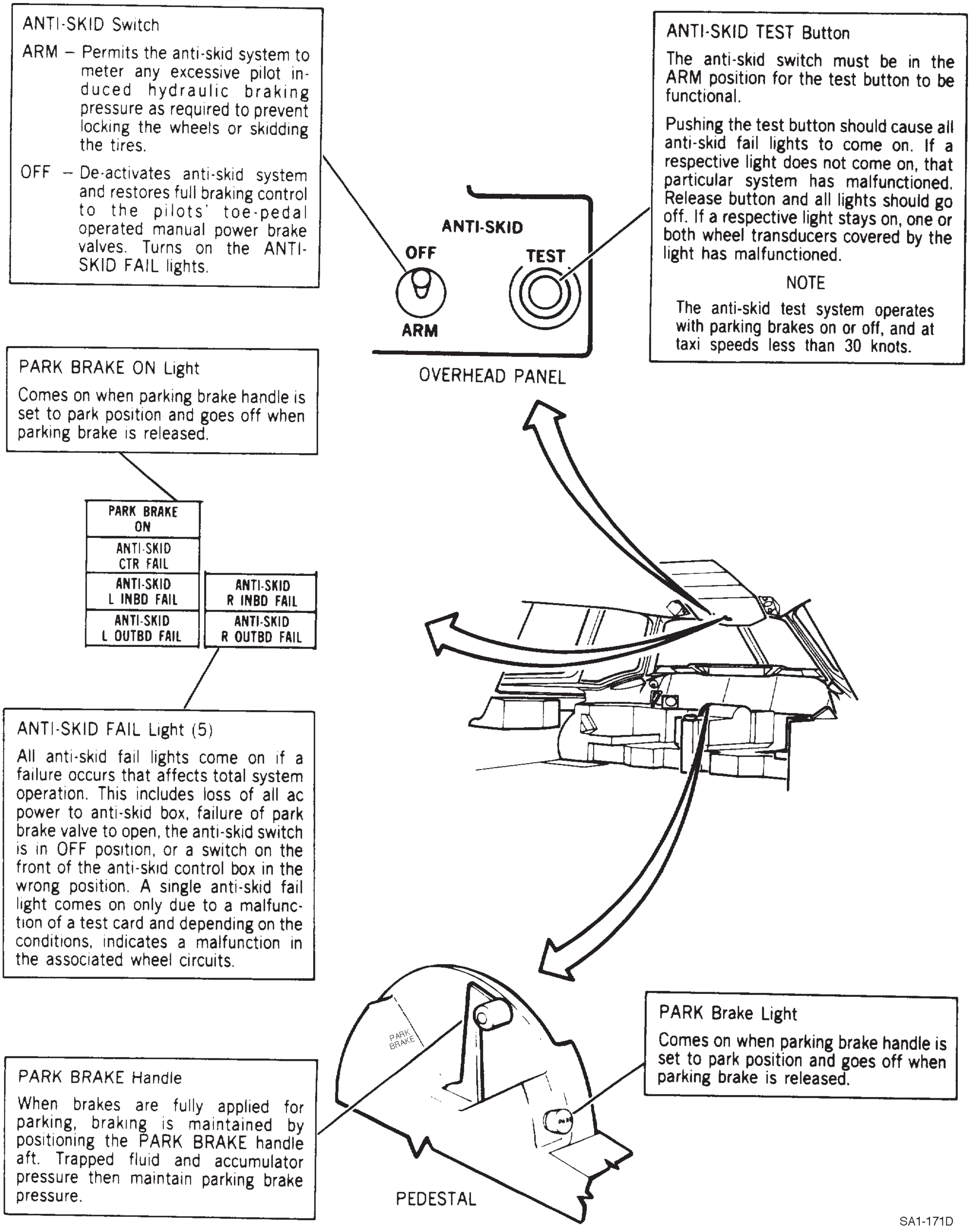


Figure 1.7-4. Main Wheel Brakes and Anti-skid System Schematic



ANTI-SKID Switch

ARM – Permits the anti-skid system to meter any excessive pilot induced hydraulic braking pressure as required to prevent locking the wheels or skidding the tires.

OFF – De-activates anti-skid system and restores full braking control to the pilots' toe-pedal operated manual power brake valves. Turns on the ANTI-SKID FAIL lights.

ANTI-SKID TEST Button

The anti-skid switch must be in the ARM position for the test button to be functional.

Pushing the test button should cause all anti-skid fail lights to come on. If a respective light does not come on, that particular system has malfunctioned. Release button and all lights should go off. If a respective light stays on, one or both wheel transducers covered by the light has malfunctioned.

NOTE

The anti-skid test system operates with parking brakes on or off, and at taxi speeds less than 30 knots.

PARK BRAKE ON Light

Comes on when parking brake handle is set to park position and goes off when parking brake is released.

ANTI-SKID FAIL Light (5)

All anti-skid fail lights come on if a failure occurs that affects total system operation. This includes loss of all ac power to anti-skid box, failure of park brake valve to open, the anti-skid switch is in OFF position, or a switch on the front of the anti-skid control box in the wrong position. A single anti-skid fail light comes on only due to a malfunction of a test card and depending on the conditions, indicates a malfunction in the associated wheel circuits.

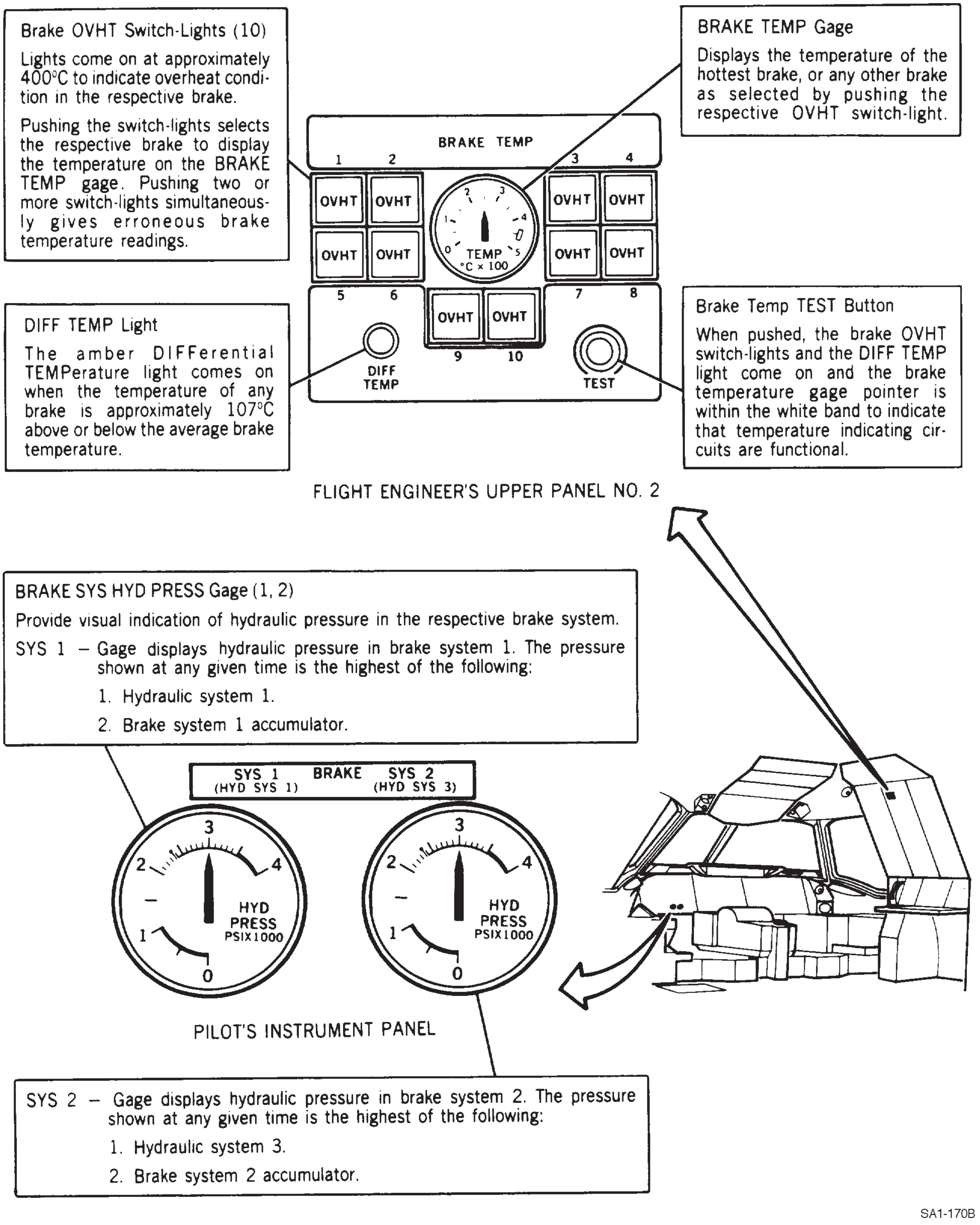
PARK Brake Light

Comes on when parking brake handle is set to park position and goes off when parking brake is released.

PARK BRAKE Handle

When brakes are fully applied for parking, braking is maintained by positioning the PARK BRAKE handle aft. Trapped fluid and accumulator pressure then maintain parking brake pressure.

Figure 1.7-5. Controls and Indicators (Sheet 1)



Brake OVHT Switch-Lights (10)

Lights come on at approximately 400°C to indicate overheat condition in the respective brake.

Pushing the switch-lights selects the respective brake to display the temperature on the BRAKE TEMP gage. Pushing two or more switch-lights simultaneously gives erroneous brake temperature readings.

BRAKE TEMP Gage

Displays the temperature of the hottest brake, or any other brake as selected by pushing the respective OVHT switch-light.

DIFF TEMP Light

The amber DIFFerential TEMPerature light comes on when the temperature of any brake is approximately 107°C above or below the average brake temperature.

Brake Temp TEST Button

When pushed, the brake OVHT switch-lights and the DIFF TEMP light come on and the brake temperature gage pointer is within the white band to indicate that temperature indicating circuits are functional.

BRAKE SYS HYD PRESS Gage (1, 2)

Provide visual indication of hydraulic pressure in the respective brake system.

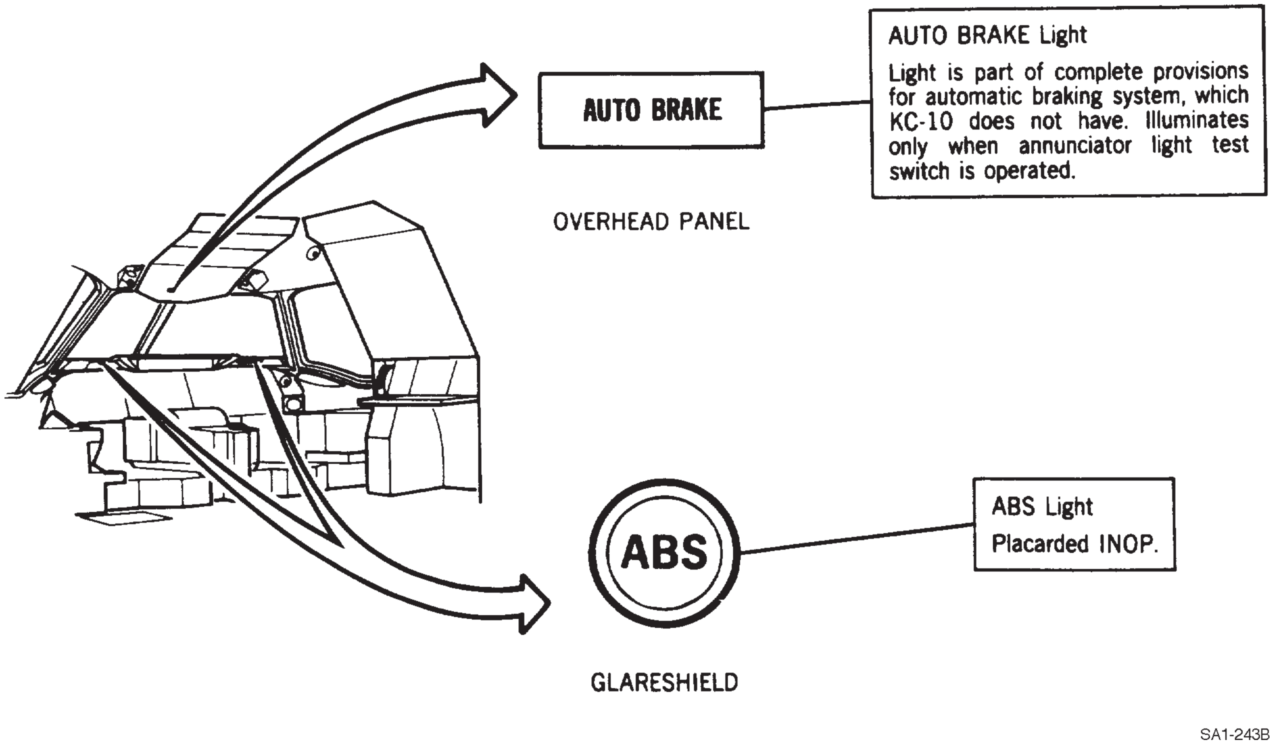
SYS 1 – Gage displays hydraulic pressure in brake system 1. The pressure shown at any given time is the highest of the following:

1. Hydraulic system 1.
2. Brake system 1 accumulator.

SYS 2 – Gage displays hydraulic pressure in brake system 2. The pressure shown at any given time is the highest of the following:

1. Hydraulic system 3.
2. Brake system 2 accumulator.

Figure 1.7-5. Controls and Indicators (Sheet 2)



AUTO BRAKE Light

Light is part of complete provisions for automatic braking system, which KC-10 does not have. Illuminates only when annunciator light test switch is operated.

ABS Light

Placarded INOP.

Figure 1.7-5. Controls and Indicators (Sheet 3)

ANTI-SKID

A fully automatic, pressure modulating anti-skid control system is installed in each of the two hydraulic power brake systems (figure 1.7-4 and 1.7-5). The system is controlled by individual wheel speed transducers, anti-skid control box, and individual anti-skid control valves for each main and center wheel brake. Pilot-induced manual brake valve pressure (as a result of toe-brake pedal deflection) is metered as necessary to provide efficient braking and prevent tire skidding. The anti-skid system will respond to steady partial pedal application, but is most efficient with full pedal application (pedals bottomed). The system incorporates locked wheel touchdown protection to prevent inadvertent landing with the brakes applied. The system automatically reverts to a manual power brake system at low taxi speeds, (below 10 knots main and approximately 3 knots center gear) but the anti-skid lights remain off. An arming switch, test button, and indicating lights (figure 1.7-5) are provided to control and monitor the system. Electrical power is removed from the anti-skid control box when the gear is retracted or the anti-skid switch is off. Therefore, a test must be performed to validate system integrity.

CAUTION

Use extreme care when stopping with ANTI-SKID FAIL lights(s) on or if the entire anti-skid system is inoperative. Tire skids may be difficult to detect. Judge braking action by sensing the deceleration of the aircraft while applying pressure to the brake pedals. Manual braking technique consists of gradually increasing the pedal force until a moderate deceleration is felt and immediately extending the spoilers (auto spoilers may be used). The pilot flying should also pace the deceleration to use most of the runway available, RCR permitting. Excess pedal pressure/deflection can result in skids, worn/blown tires and possible center gear lower drag link failure. If skidding develops and brake system pressure is normal, release brakes and reapply using the same technique. With only accumulator pressure available, avoid cycling brake pedals.

WHEELS AND TIRES

Tire pressure distribution is of great importance, particularly during heavy gross weight operation, as underinflated tires build up heat at a much faster rate during normal taxi. Due to the load carrying characteristics of the gear, it is important that adjacent tires are inflated per specification so that one tire/wheel is not carrying a greater percentage of the load on a given axle. Minimum tire inflation pressure, based on operating gross weight and ambient temperature is presented in the Maintenance Manual. Tire reinflation/removal is determined by reference to the Maintenance Manual.

If the tire is exposed to excessive brake temperature, fuse plugs in the wheel melt causing tire pressure release.

NOTE

> All wheels on the main and center gear are interchangeable. Each wheel including the nosegear is equipped with a frangible disk pressure release plug which releases tire pressure at 350 ±5 pounds of air pressure thus preventing over-pressurization of the tires. In addition, all centerline and main landing wheels each have three fusible plugs 120° apart. These melt when the temperature reaches 224 ±2°C (430 ±10°F) which releases tire pressure.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Pilot's Instrument Panels, Pedestal, and Overhead Panel. The main and nosegear alternate extension lever is located to the right of the Pedestal on the floor and the center gear alternate extension handle is on the floor forward of the Main Circuit Breaker Panels. Illustrations of the major panels are shown in Part 1, Section I. Individual controls and indicators are illustrated and described in this part.

PART 8

DOORS AND LADDERS

TABLE OF CONTENTS

DOORS

DOORS DESCRIPTION

Five cabin doors, a cockpit door, a door for each lavatory, and a cargo door are provided. The cabin doors can be operated electrically, pneumatically, or manually. The cockpit and lavatory doors are operated manually. The cargo door is manually controlled and hydraulically operated. The cargo door hydraulic system is independent of the aircraft hydraulic systems.

COCKPIT DOOR

The cockpit door (figure 1.8-1) has built-in ventilation pressure differential relief, and smoke isolation features. The door is manually operated by a standard doorknob. A key is normally required to open the door from the cabin side, if electrical power is available.

When the cockpit is occupied, the door lock may be released electromagnetically by a pushbutton on the overhead panel. The door can be opened from inside the cockpit at any time by rotating the doorknob. A cabin viewer is installed in the door to provide the flight crew with a view of the cabin area.

LAVATORY DOORS

Normally, the lavatory doors (figure 1.8-2) are manually operated from inside the lavatory by using a sliding bolt lock. The position of the lock is indicated by a VACANT/OCCUPIED sign on the cabin side of the door. Each door can be locked or unlocked from the cabin side by using a sliding knob behind the hinged LAVATORY sign.

CABIN DOORS

Five cabin doors, (figure 1.8-3) three on the right side (1R, 2R, and 4R) and two on the left side (1L and 2L), are used for normal entrance, egress and emergency egress. The two overwing doors (3L and 3R) and aft left door (4L) are deactivated.

Each cabin door is a plug type, which provides a seal for cabin pressurization, and opens by moving in and then up into the ceiling. Each door has interior and exterior controls for normal opening and closing. Doors 1L and 1R have identical interior controls, placarding, and operating procedures. Doors 2L, 2R, and 4R also have identical interior controls, placarding, and operating procedures, but the slide/raft arming levers differ from those on doors 1L and 1R. Each door is equipped with an independent high pressure emergency air reservoir actuating system. Emergency opening of each door can be accomplished from the interior or exterior of the aircraft. For detailed emergency procedures, refer to Section I, Part 11 of this manual.

The interior controls (figures 1.8-4 and 1.8-5) for normal operation of the doors consist of the slide arming lever located on the structure adjacent to each door and one toggle type door control switch. The door control switch for the left forward cabin door (1L) is located on the crew/personnel compartment control panel. Door control switches for the other cabin doors are located shoulder high, just aft, adjacent to each door (figure 1.8-6). The mid doors (2L and 2R) may or may not have slide rafts installed, depending on cargo or support personnel (passenger) configuration. The slide/raft arming lever must be disarmed before the door control switches can be used to open or close the door. When the slide/raft is disarmed, the corresponding cabin door light on the Flight Engineer's Annunciator Panel comes on plus the disarmed light adjacent to each door control switch. The slide/raft must be armed for emergency deployment after the door is closed.

The exterior controls placarding and operating procedures are identical for all cabin doors. The exterior controls (figure 1.8-7) for each door are located in a recess in the fuselage forward of the door and consist of a door handle, a door control switch, and an auxiliary handle. The door control handle is used to arm and disarm the slide/raft. The door control switch is used to open and close the door. All cabin doors can be lowered from the outside to the closed position (by free falling) using the door control handle and auxiliary handle. This is primarily a maintenance procedure.

The left forward cabin door (1L) can be opened and closed from the outside with no electrical power on the aircraft. A socket drive fitting may be operated manually or by a portable drill motor. This feature is normally used by ground maintenance personnel. Use caution during drill motor operation due to mechanical limit stops. Door 1L also contains a security lock and may be locked from the outside when the aircraft is left unattended (figure 1.8-8).

LOW PRESSURE LIGHT

Integrally lighted slide inflation cylinder low pressure lights are installed on cabin doors directly over each slide/raft stowage container (figure 1.8-6). The lights automatically come on when the inflation cylinder has insufficient pressure to inflate the slide/raft. The integrity of the indicator lights and electrical circuit may be tested by pressing the light lens. A faulty circuit is indicated by failure of the light to illuminate when pressed.

CABIN DOORS NORMAL OPERATION

All door control switches are spring loaded to the center off position. If switch is released while door is opening or closing, door will stop.

Opening Cabin Doors - Exterior Controls (Figure 1.8-7)

1. Pull door control handle out of recess and observe emergency override lever moves to SAFE position.

NOTE

Pulling door control handle outward disarms slide/raft, and provides access to the door control switch.

2. Move control switch to OPEN position and hold until door is fully opened.
3. Release door control switch.

Closing Cabin Doors - Exterior Controls (Figure 1.8-7)

1. If installed, remove and stow door barrier strap prior to closing door.
2. Move door control switch to CLOSE position, and hold until door is fully closed.
3. Observe door closes and moves outward, flush with fuselage surface.
4. Release door control switch.
5. Push door control handle into recess, and observe emergency override lever moves to EMERGENCY position.

Opening Cabin Doors - Interior Controls (Figure 1.8-4, 1.8-5 and 1.8-6)

CAUTION

- When side restraint rails between stations 794 and 1610 are in the outboard position, do not open door 2L.
- If slide rafts are installed in doors 2L & 2R, doors should be closed for cargo operations. If doors are open use caution to prevent cargo from striking slide raft.

NOTE

Doors 2L and 2R may or may not have slide/rafts installed, as required for passenger accommodation.

1. Move slide arming lever to SLIDE DISARMED POSITION, and observe DOOR DISARMED light comes on.

NOTE

Slide arming lever may be latched in SLIDE DISARMED position by moving sliding mechanical safety latch into latch position. The sliding latch is on the inside surface of the slide arming lever.

2. Move door control switch to OPEN position, and hold until door is fully open.

NOTE

- Door will move inboard then upward, and will automatically stop when fully open.
- Direction of door movement can be reversed at any time by moving control switch to CLOSE position.

3. Release door control switch.

Closing Cabin Doors - Interior Controls (Figure 1.8-4, 1.8-5, and 1.8-6)

1. If installed, remove and stow door barrier strap prior to closing door.

2. Move door control switch to CLOSE position, and hold until door is fully closed.
3. Observe door closes and moves outward, flush with fuselage surface.
4. Release door control switch.
5. Arm slide/raft as follows:

NOTE

Doors 2L and 2R may or may not have slide/rafts installed; however, slide/raft arming procedures must be accomplished on all doors.

   a. Move sliding mechanical safety latch to the unlatched position.

NOTE

Latch must be in unlatch position to permit arming the slide/raft for automatic slide/raft deployment. When latched, outside and inside slide arming lever cannot be moved to SLIDE ARMED position.

   b. Push slide arming lever to SLIDE ARMED position.
   c. Observe flag indicates SLIDE ARMED.
   d. Observe DOOR DISARM light goes off.

CAUTION

- If DOOR DISARM light remains on with slide arming lever in SLIDE ARMED position, call maintenance.
- Do not move door control switch from neutral position. Movement of door control switch will deploy slide/raft (if installed).

CABIN DOORS MANUAL OPERATION

Opening Door 1L - Exterior Controls (Figure 1.8-7)

Opening Door 1L - Exterior Controls

NOTE

Only door 1L can be opened manually from outside.

1. Pull door control handle outward from recess.

NOTE

Pulling door control handle outward disarms slide/raft.

2. Rotate door control handle counterclockwise to FREE FALL position, and hold until door movement begins.

CAUTION

If powered drive is used in step 3, do not fully open door. Door may be damaged if mechanically driven against limit stops.

3. Insert 1/4-inch square drive into socket, then rotate counterclockwise until door is opened to desired position.
4. Remove drive from socket.

Closing Door 1L - Exterior Controls (Figure 1.8-7)

NOTE

Only door 1L can be closed manually from outside.

1. If installed, remove and stow door barrier strap prior to closing door.
2. Move door control handle to FREE FALL position and hold.
3. Pull auxiliary handle out and down, and hold until door descends to floor level.
4. Release auxiliary handle.
5. Manually move door outboard to closed position with 1/4-inch square drive.
6. Release door control handle.

NOTE

Door control handle returns to neutral position, locking door closed.

7. Push door control handle into recess, and observe emergency override lever moves to EMERGENCY position.

8. Lock door 1L (if applicable).

Opening Cabin Doors - Interior Controls (Figure 1.8-4 and 1.8-5)

NOTE

- If cabin door cannot be opened by normal means, and pressure gage in viewing port (aft and above door) indicates actuating cylinder is depressurized (gage needle out of green band area), door can be opened manually without deploying slide/raft.
- With slide/raft installed, the two forward doors weigh approximately 245 pounds each and the two mid doors weigh approximately 350 each. At least two people may be required to lift door.

1. Rotate slide arming lever to emergency interlock override position and hold.
2. While holding slide arming lever in emergency interlock override position, rotate control handle to emergency open position.

NOTE

- On doors 1L and 1R, door control handle will stay in emergency open position.
- On doors 2L, 2R and 4R, door control handle will return to stowed position when released.

3. Grasp manual lift bar and pull door inboard at approximately a 45-degree angle, then lift upward.
4. Raise door to approximately shoulder height, release manual lift bar, then push door upward to full open position.

Closing Cabin Doors - Interior Controls

NOTE

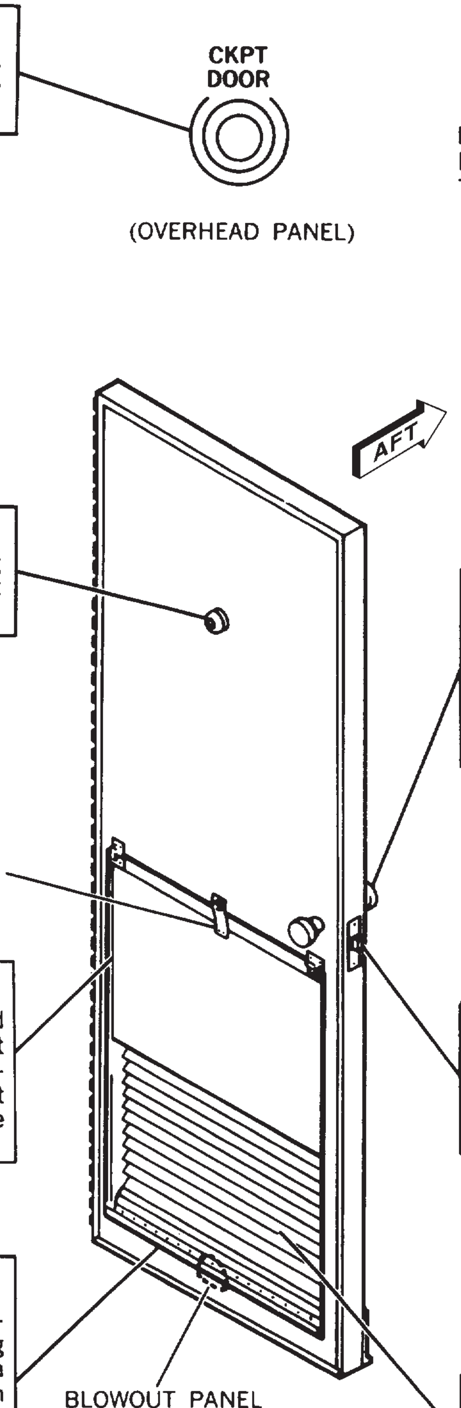
No means are provided for closing doors manually from interior. If door cannot be closed by normal operation of control switch, call maintenance.

Barrier straps (figure 1.8-3), one for each door, are secured across open doorways as a safety precaution when ramp, stairway, or ladder is not in place. The strap is not a restraining device. It provides a visual indication when no exterior ramp is in position. Barrier strap stowage receptacles are provided adjacent to each door.

WARNING

- Install door barrier strap when door is open and exterior ramp is not in position or ground egress/entry ladder is not deployed.
- Do not lean on or against door barrier strap.

The mechanical features and procedures for manual operation of the cabin doors are shown (figure 1.8-9).



CKPT DOOR Button

When pushed the button operates a solenoid control that unlocks the cockpit door.

NOTE

LOCKOUT OF COCKPIT POSSIBLE IF DOOR CLOSES WITH ELECTRICAL POWER.

Cabin Viewer

Wide angle viewing lens for viewing the cabin area aft of the cockpit door.

Keylock

The aft knob of the door requires a key to open the door from the passenger compartment side. The door can be opened at any time from the cockpit by rotating the forward knob.

Smoke Screen Quick Release Panel

The screen is lowered to the closed position to cover the louvers when it is desired not to have contaminated cabin air enter the cockpit and to aid smoke evacuation in the cockpit.

Latch

Rotary latch is installed for locking the door. The latch bolt engages a keeper in the door jamb when the door is closed.

Blowout Panel

The blowout panel is installed to prevent the cockpit door from hurtling into the cockpit in the event of a sudden differential pressure between cabin and cockpit. Relief is accomplished when the weak blowout panel relief latch releases.

Louvers

Louvers are provided for cockpit/cabin pressure equalization to enable the cockpit door to be opened.

Figure 1.8-1. Cockpit Door

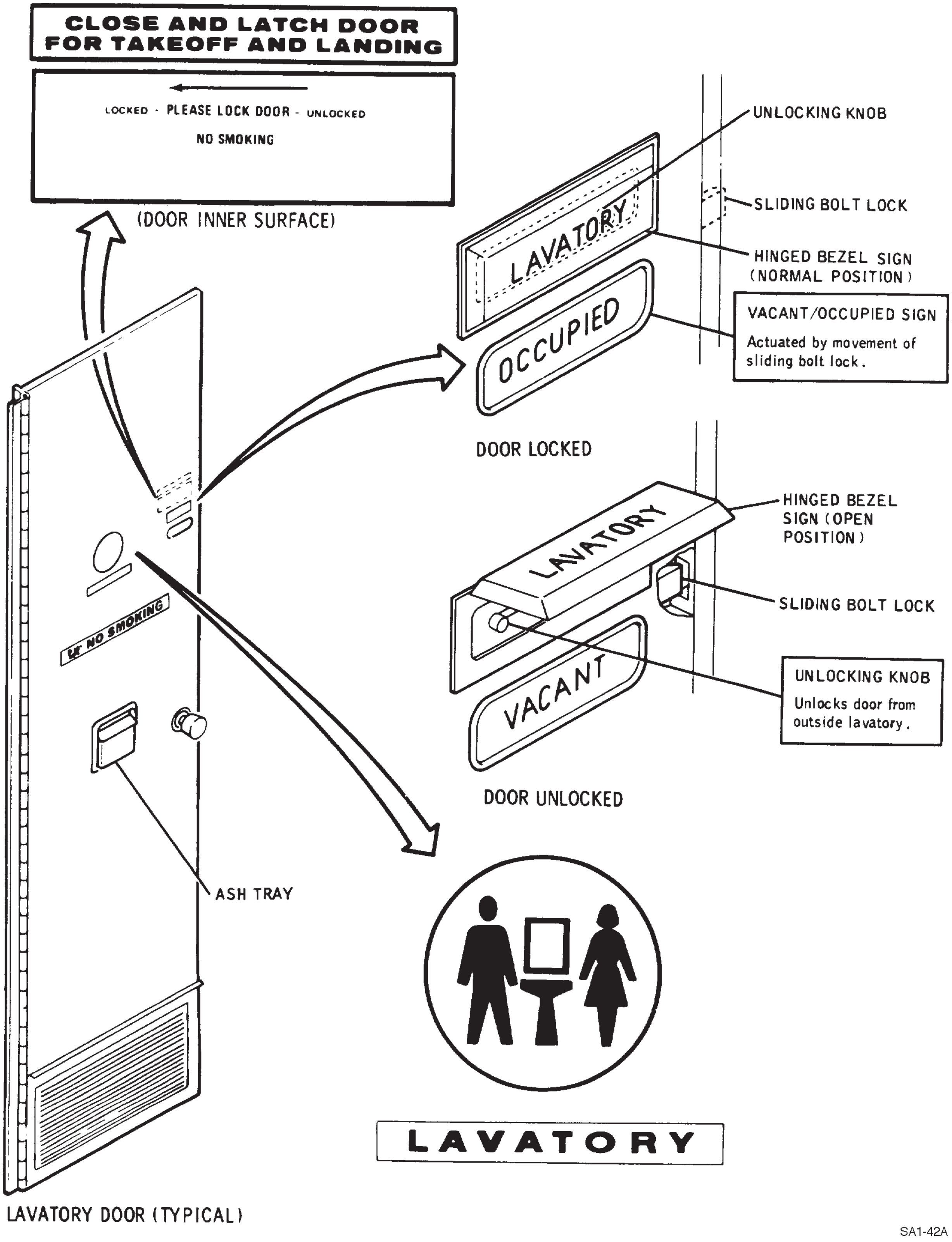
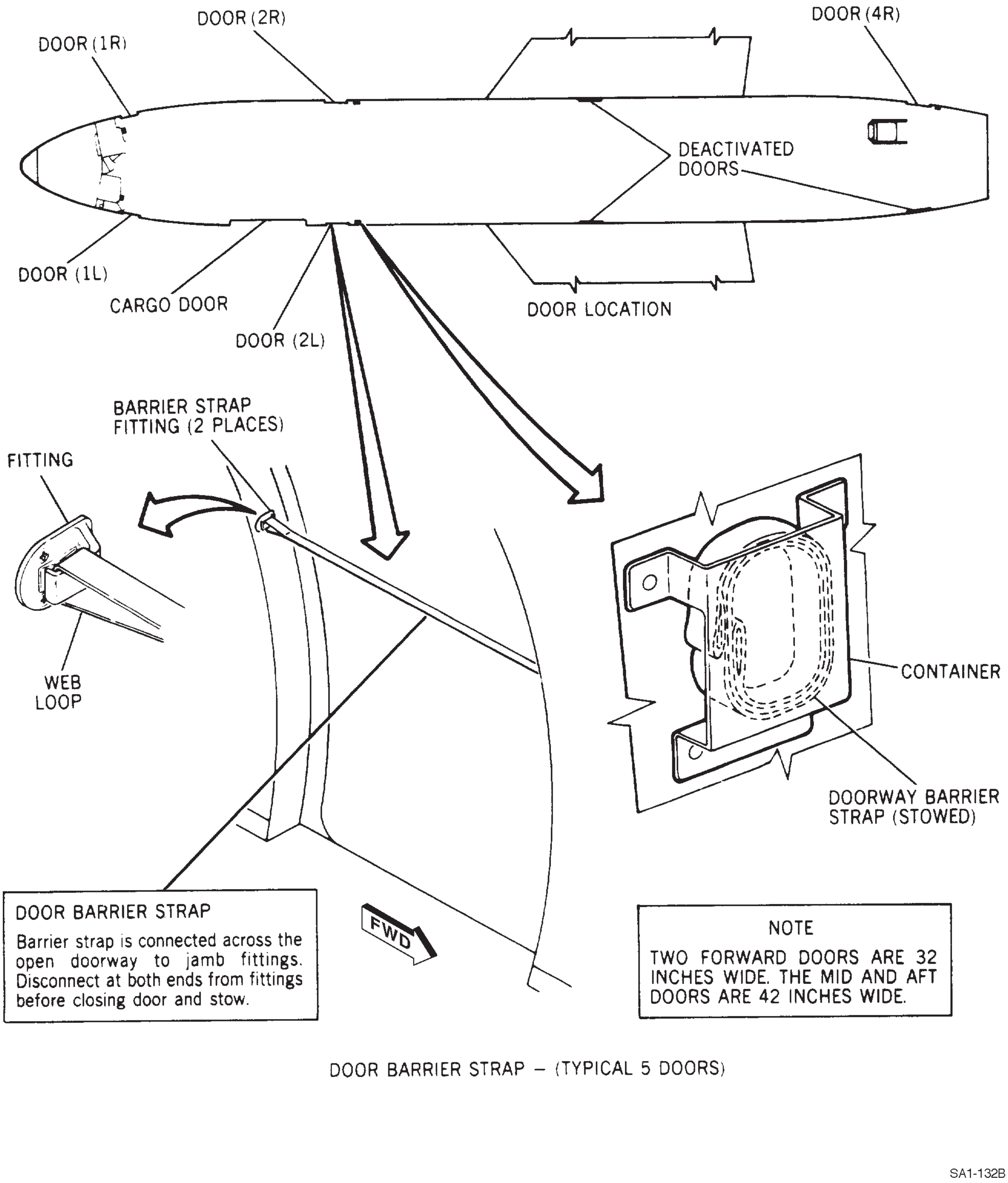


Figure 1.8-2. Lavatory Door - Typical



DOOR BARRIER STRAP

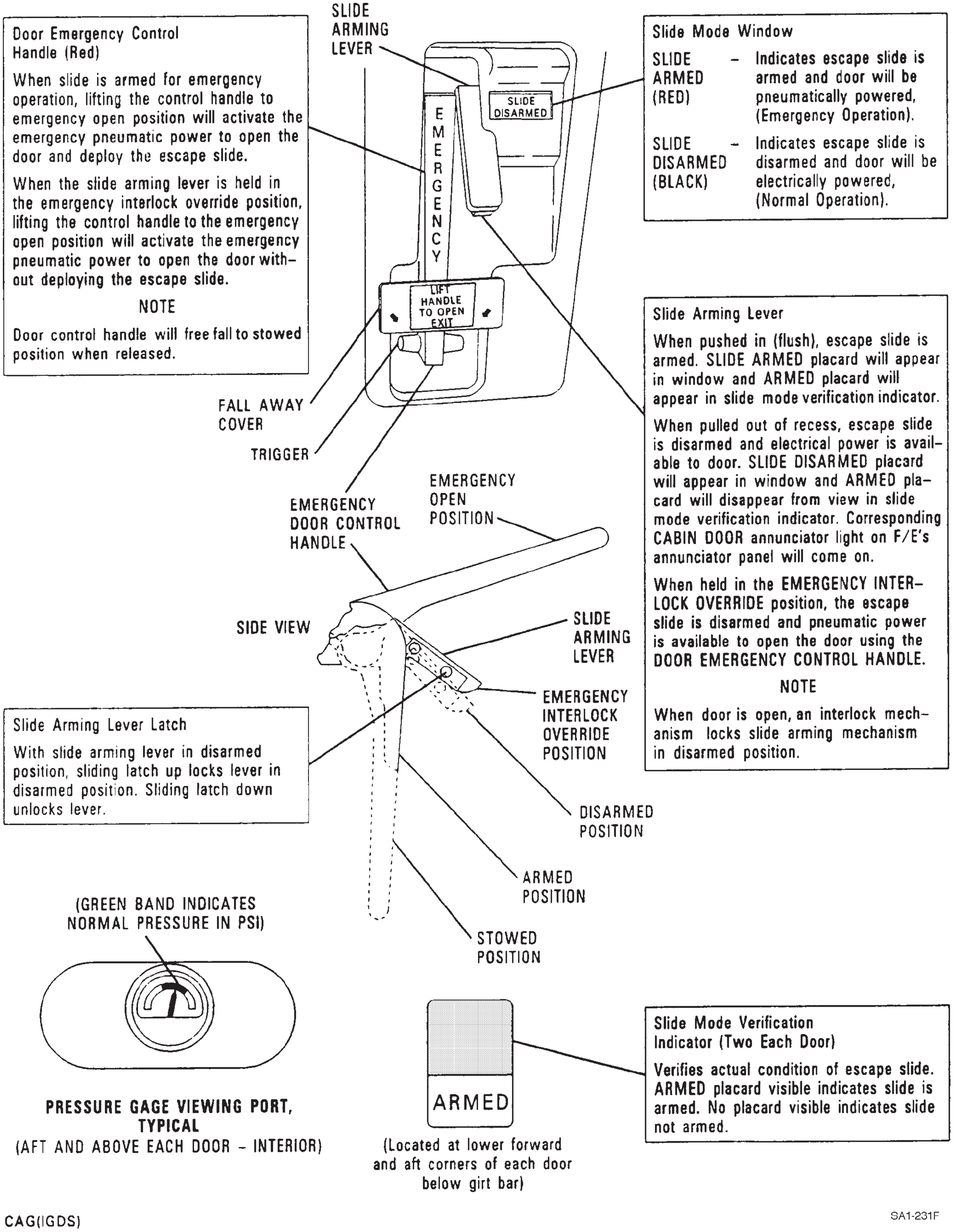
Barrier strap is connected across the open doorway to jamb fittings. Disconnect at both ends from fittings before closing door and stow.

NOTE

TWO FORWARD DOORS ARE 32 INCHES WIDE. THE MID AND AFT DOORS ARE 42 INCHES WIDE.

DOOR BARRIER STRAP – (TYPICAL 5 DOORS)

Figure 1.8-3. Cabin Doors



Door Emergency Control Handle (Red)

When slide is armed for emergency operation, lifting the control handle to emergency open position will activate the emergency pneumatic power to open the door and deploy the escape slide.

When the slide arming lever is held in the emergency interlock override position, lifting the control handle to the emergency open position will activate the emergency pneumatic power to open the door without deploying the escape slide.

NOTE

Door control handle will free fall to stowed position when released.

Slide Mode Window

SLIDE ARMED (RED)	–	Indicates escape slide is armed and door will be pneumatically powered, (Emergency Operation).
SLIDE DISARMED (BLACK)	–	Indicates escape slide is disarmed and door will be electrically powered, (Normal Operation).

Slide Arming Lever

When pushed in (flush), escape slide is armed. SLIDE ARMED placard will appear in window and ARMED placard will appear in slide mode verification indicator.

When pulled out of recess, escape slide is disarmed and electrical power is available to door. SLIDE DISARMED placard will appear in window and ARMED placard will disappear from view in slide mode verification indicator. Corresponding CABIN DOOR annunciator light on F/E's annunciator panel will come on.

When held in the EMERGENCY INTERLOCK OVERRIDE position, the escape slide is disarmed and pneumatic power is available to open the door using the DOOR EMERGENCY CONTROL HANDLE.

NOTE

When door is open, an interlock mechanism locks slide arming mechanism in disarmed position.

Slide Arming Lever Latch

With slide arming lever in disarmed position, sliding latch up locks lever in disarmed position. Sliding latch down unlocks lever.

PRESSURE GAGE VIEWING PORT, TYPICAL
(AFT AND ABOVE EACH DOOR – INTERIOR)

(Located at lower forward and aft corners of each door below girt bar)

Slide Mode Verification Indicator (Two Each Door)

Verifies actual condition of escape slide. ARMED placard visible indicates slide is armed. No placard visible indicates slide not armed.

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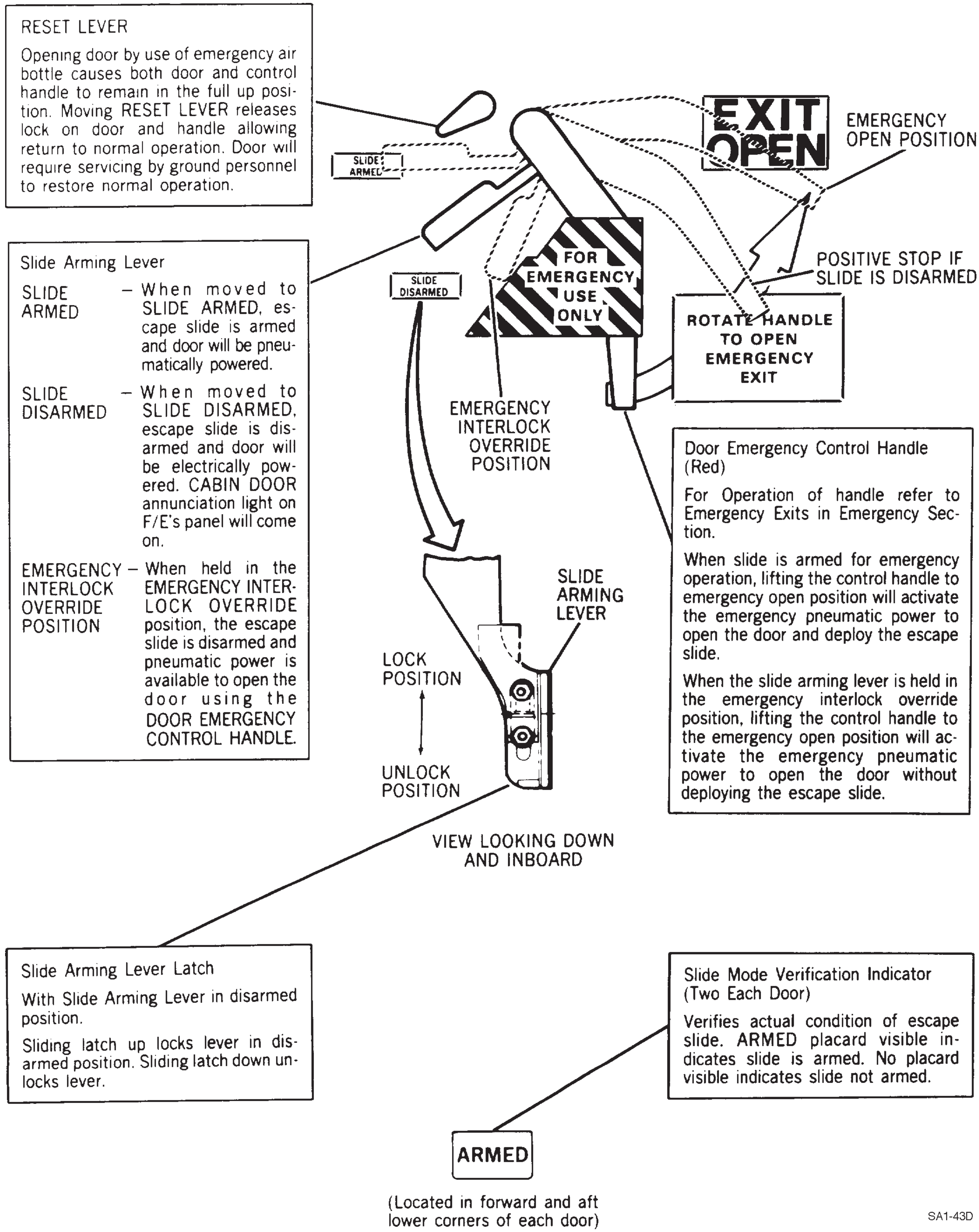
Figure 1.8-4. Cabin Door Interior Controls



RESET LEVER

Opening door by use of emergency air bottle causes both door and control handle to remain in the full up position. Moving RESET LEVER releases lock on door and handle allowing return to normal operation. Door will require servicing by ground personnel to restore normal operation.

Slide Arming Lever

SLIDE ARMED – When moved to SLIDE ARMED, escape slide is armed and door will be pneumatically powered.

SLIDE DISARMED – When moved to SLIDE DISARMED, escape slide is disarmed and door will be electrically powered. CABIN DOOR annunciation light on F/E's panel will come on.

EMERGENCY INTERLOCK OVERRIDE POSITION – When held in the EMERGENCY INTERLOCK OVERRIDE position, the escape slide is disarmed and pneumatic power is available to open the door using the DOOR EMERGENCY CONTROL HANDLE.

Door Emergency Control Handle (Red)

For Operation of handle refer to Emergency Exits in Emergency Section.

When slide is armed for emergency operation, lifting the control handle to emergency open position will activate the emergency pneumatic power to open the door and deploy the escape slide.

When the slide arming lever is held in the emergency interlock override position, lifting the control handle to the emergency open position will activate the emergency pneumatic power to open the door without deploying the escape slide.

Slide Arming Lever Latch

With Slide Arming Lever in disarmed position.

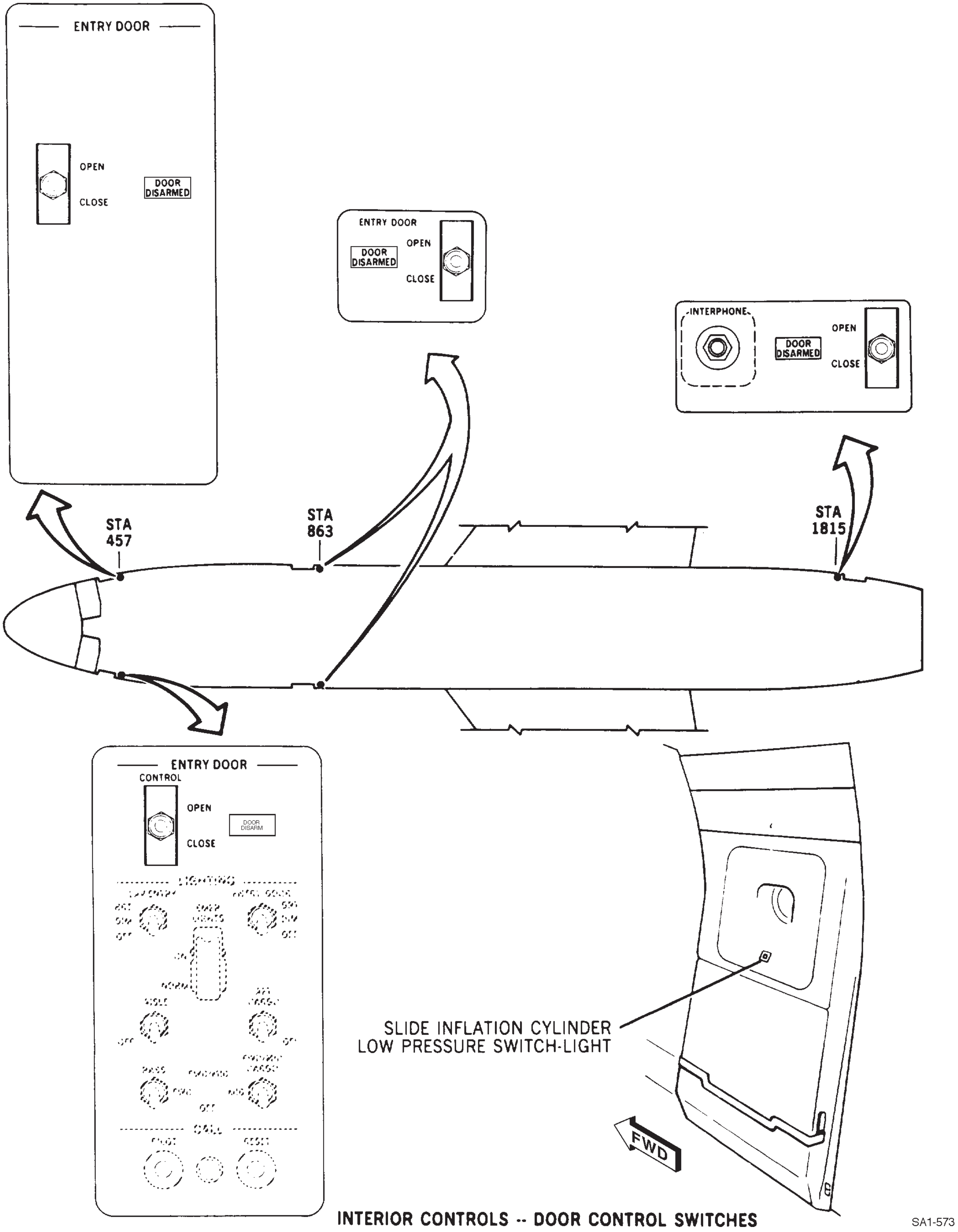
Sliding latch up locks lever in disarmed position. Sliding latch down unlocks lever.

Slide Mode Verification Indicator (Two Each Door)

Verifies actual condition of escape slide. ARMED placard visible indicates slide is armed. No placard visible indicates slide not armed.

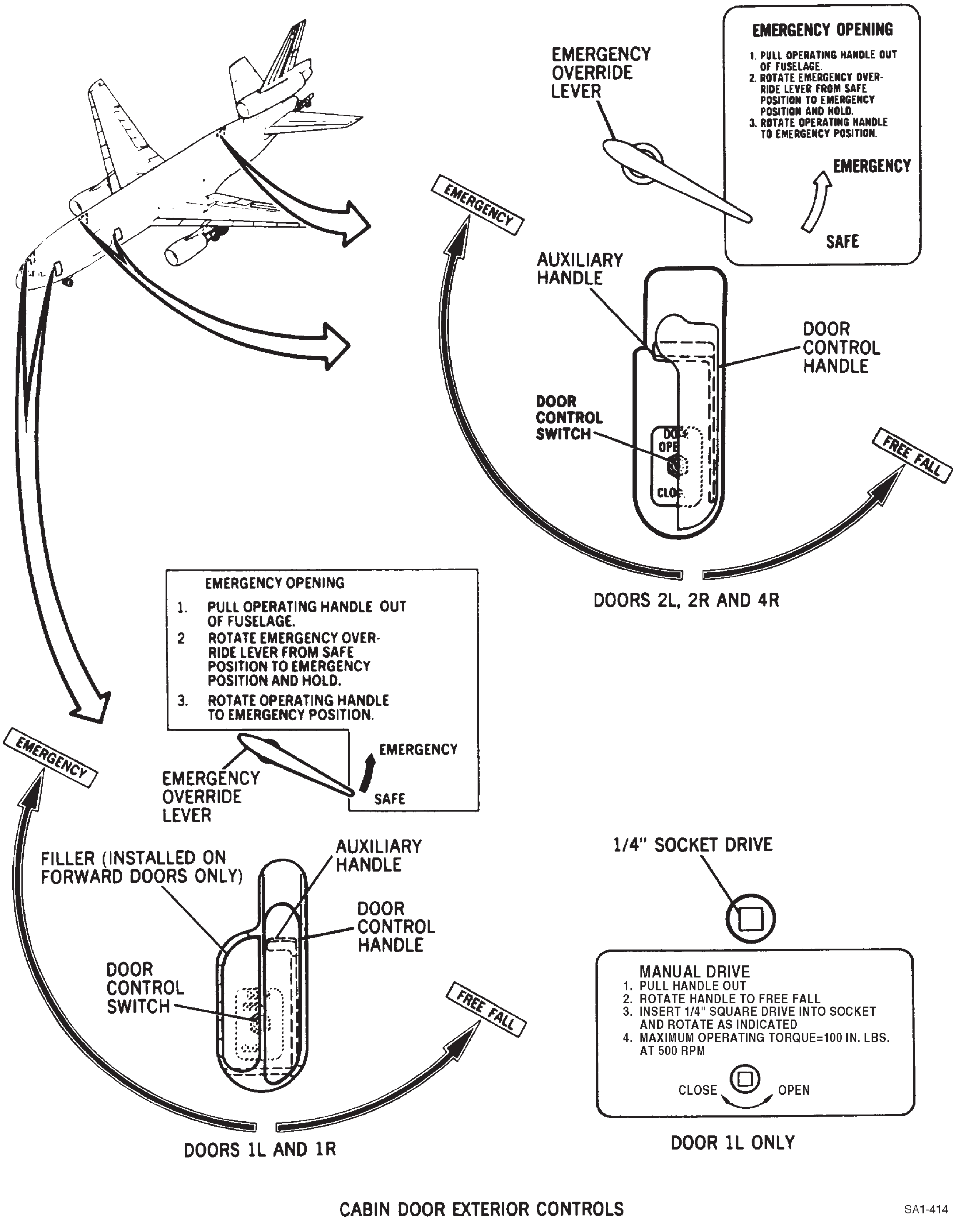
(Located in forward and aft lower corners of each door)

Figure 1.8-5. Interior Controls, Two Forward Cabin Doors



INTERIOR CONTROLS -- DOOR CONTROL SWITCHES

Figure 1.8-6. Forward, Mid And Right Aft Doors Operation



EMERGENCY OPENING

1. PULL OPERATING HANDLE OUT OF FUSELAGE.
2. ROTATE EMERGENCY OVERRIDE LEVER FROM SAFE POSITION TO EMERGENCY POSITION AND HOLD.
3. ROTATE OPERATING HANDLE TO EMERGENCY POSITION.

EMERGENCY OPENING

1. PULL OPERATING HANDLE OUT OF FUSELAGE.
2 ROTATE EMERGENCY OVERRIDE LEVER FROM SAFE POSITION TO EMERGENCY POSITION AND HOLD.
3. ROTATE OPERATING HANDLE TO EMERGENCY POSITION.

MANUAL DRIVE

1. PULL HANDLE OUT
2. ROTATE HANDLE TO FREE FALL
3. INSERT 1/4" SQUARE DRIVE INTO SOCKET AND ROTATE AS INDICATED
4. MAXIMUM OPERATING TORQUE=100 IN. LBS. AT 500 RPM

Figure 1.8-7. Cabin Door Exterior Controls

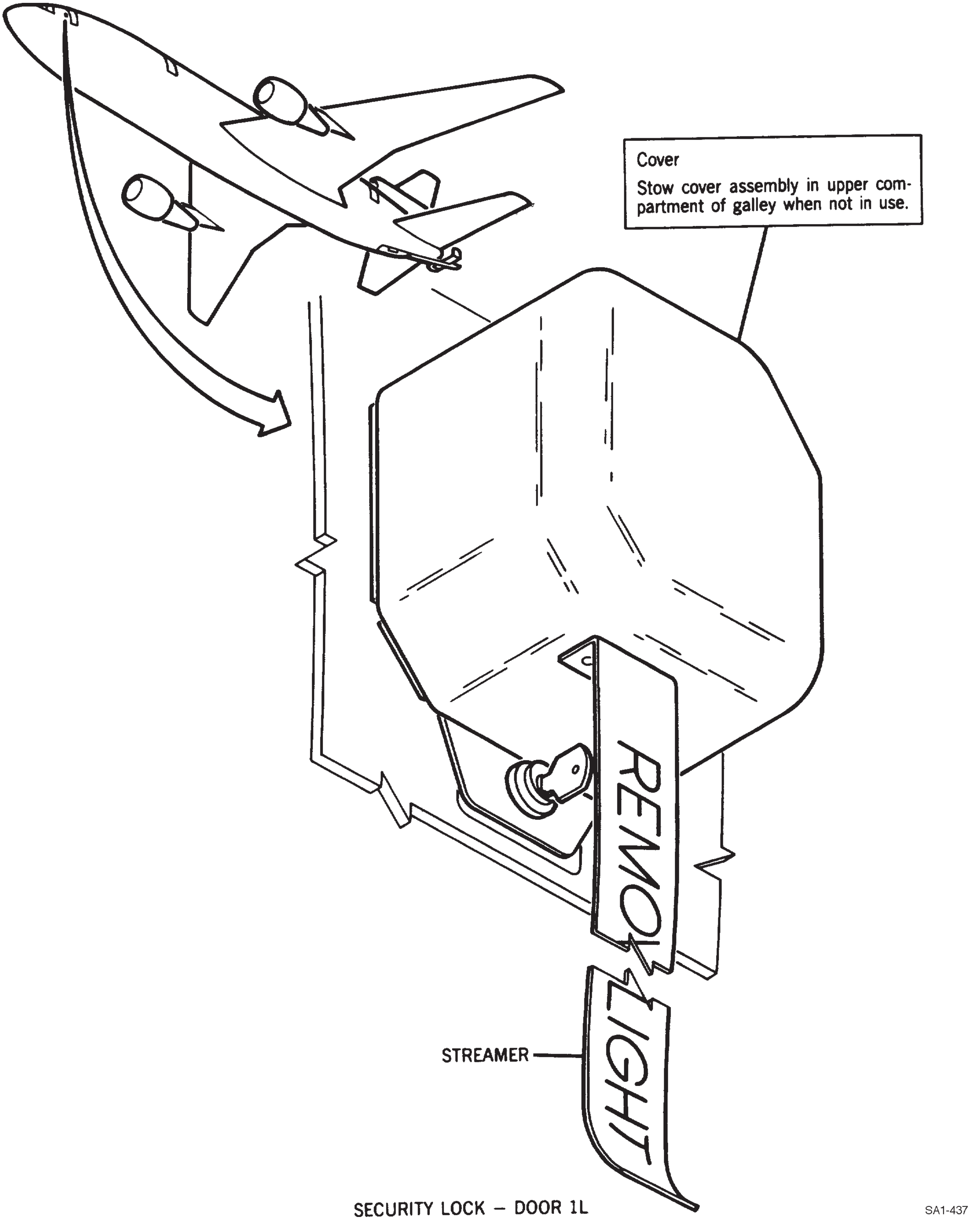


Figure 1.8-8. Security Lock - Door 1L

CARGO DOOR

The cargo door (figure 1.8-10) is located on the left side of the fuselage aft of the crew/support personnel (passenger) forward entrance door. The door is manually controlled and hydraulically operated. The hydraulic system is an independent system completely separate from the aircraft normal hydraulic system. Pressure for the system is supplied by an electrically operated motor pump. If electrical power is not available the door may be operated by hydraulic pressure from a hand pump, or manually unlatching and opening with a crane.

The door is hinged at the top and opens upward and outward. Latches along the lower edge of the door lock the door in the closed position. The latches are actuated to the open and closed positions by a hydraulic actuating cylinder. They are secured in the closed position by an overcenter mechanism and lockpins. The lockpins are disengaged from the latches by an actuating cylinder and are spring loaded to the locked position. A handle for manually unlatching the door and a mechanical door locked indicator are located on the door exterior.

An outward-opening vent door is located near the lower edge of the cargo door. The vent door is part of the lock feature of the cargo door latching system. The cargo door cannot be unlocked and unlatched until the vent door is manually opened. The vent door has interior and exterior handles and may be opened from inside or outside the aircraft.

The vent door cannot be closed and locked unless the cargo door latches are overcenter and the lockpin tube is in the locked position.

If the vent door cannot be closed or is inadvertently left open, the aircraft cannot be pressurized to more than 1 psi. The vent door exterior handle has two placarded positions, unlocked and locked. In the locked position, the exterior handle is streamlined with the fuselage.

Placards on the vent door and in the cargo door area provide operational instructions (figure 1.8-10).

Limit switches control the sequencing of the door mechanisms and also provide a visual indication on the Flight Engineer's Annunciator Panel when the cargo door is not closed and locked. A back-up test system is provided to check the integrity of the cargo door electrical annunciation system. The test switch is installed on the Flight Engineer's Upper Panel No. 2 (figure 1.8-11).

NOTE

- On aircraft 79-0433 and 79-0434, the CARGO DOOR SYS (A and B) lights, located on the Flight Engineer's Upper Instrument Panel No. 2, go off when the cargo door is closed and locked.
- On aircraft 79-1710 and subsequent, the CARGO DOOR SYS B light goes off when the cargo door is closed and locked. The CARGO DOOR SYS A light goes off only when both the cargo door and vent door are closed and locked.

The cargo door is actuated by a manually controlled hydraulic valve and is held open at the Mid Latch and Full Open Position by mechanical latches. The hook of the latch holds the door open at approximately 85° (Mid Latch Position) and 161° (Full Open Position) without hydraulic pressure. When opening of the door is stopped at either position, a roller engages the flat on the hook and prevents the door from closing. To position the door on the hold-open hook at the Mid Latch or Full Open position, the door must be opened a few degrees higher than the desired position.

CAUTION

Structural damage may occur if the cargo door is operated in winds exceeding 40 knots. In the Mid Latch or Full Open position, the door can withstand winds up to 52 knots from any direction.

CONTROLS AND INDICATORS

Controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel No. 2 and adjacent to or on each door. Individual controls and indicators are illustrated and described in this part.

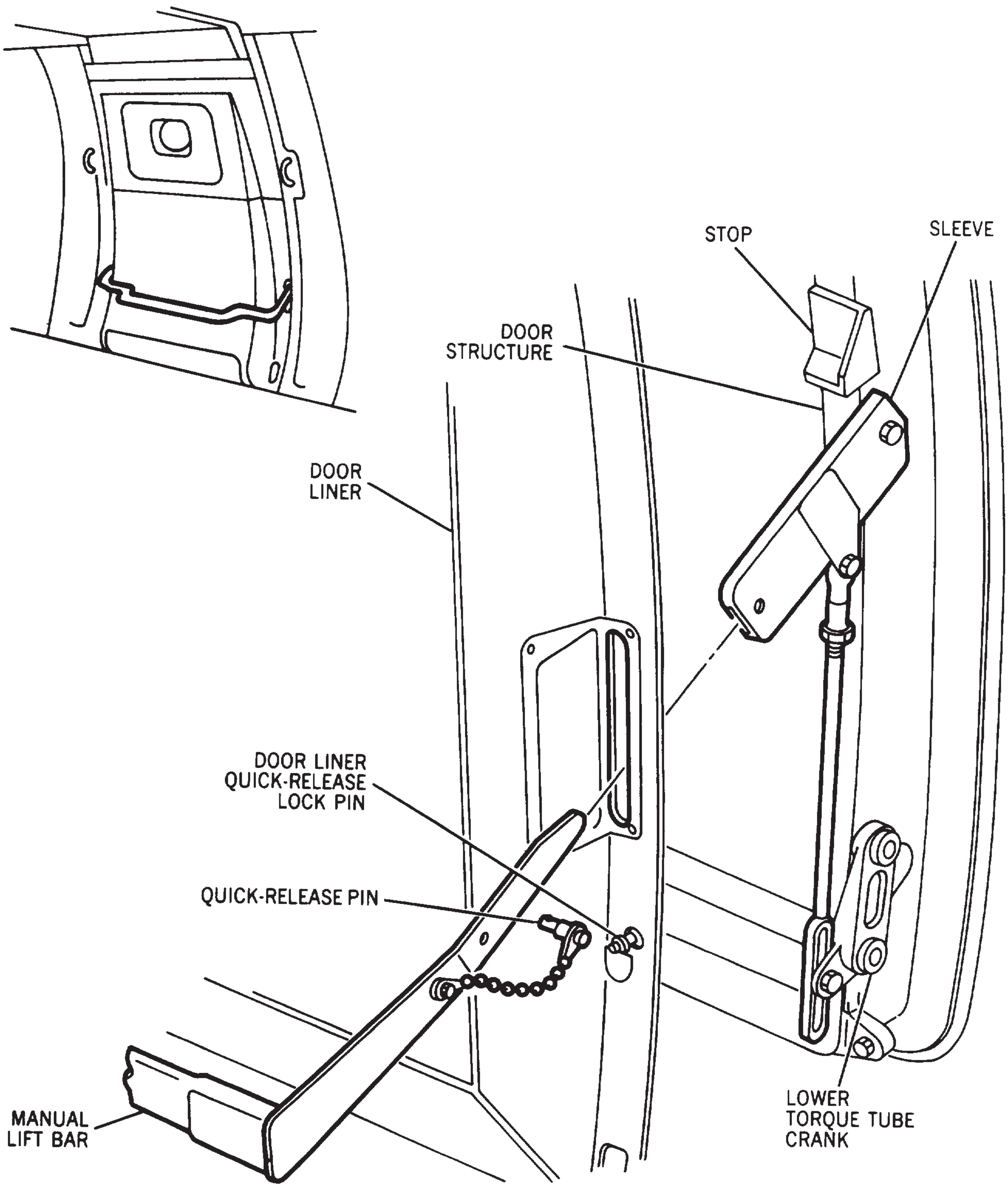
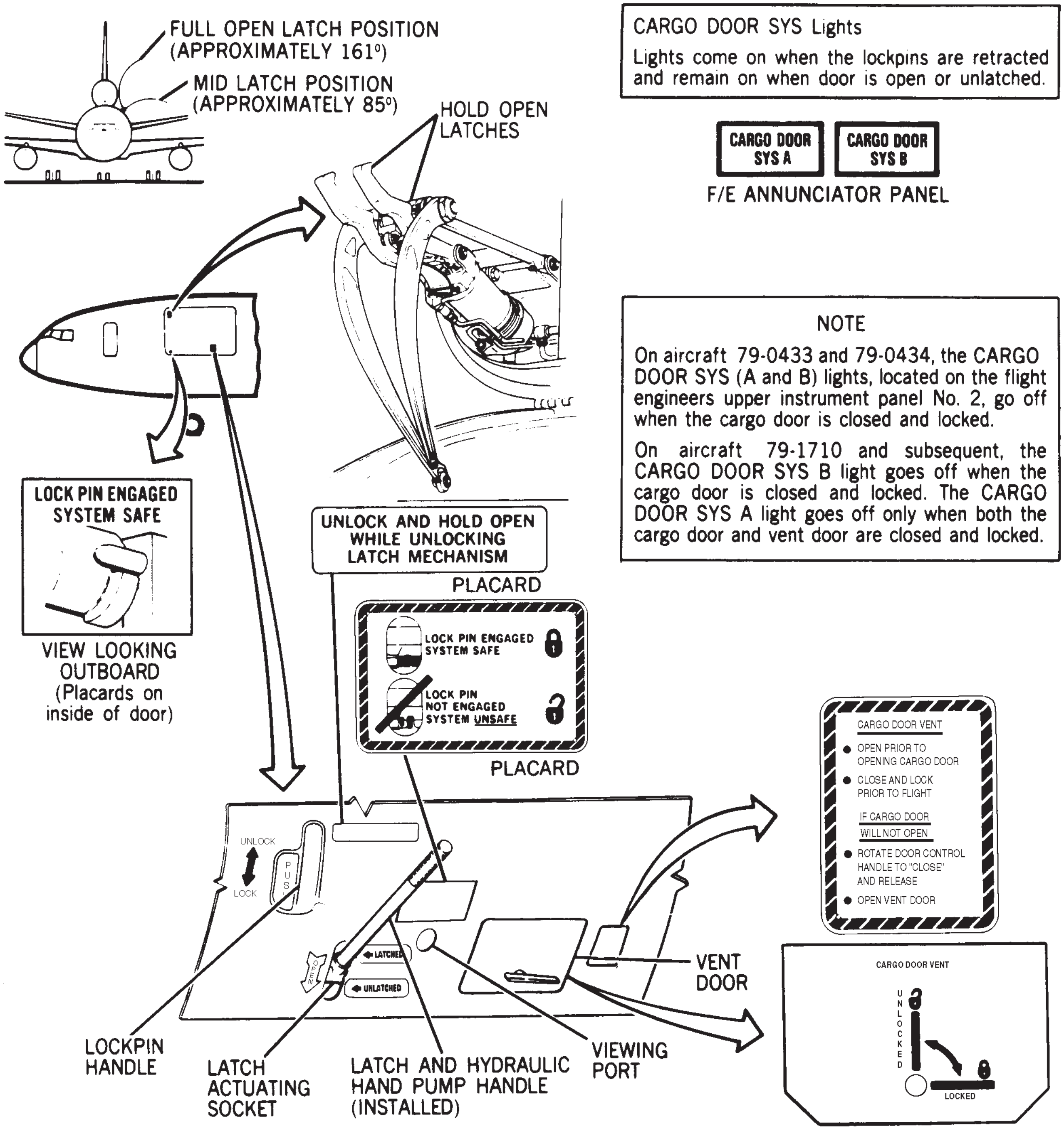


Figure 1.8-9. Cabin Doors - Manual Lift Bar



CARGO DOOR SYS Lights

Lights come on when the lockpins are retracted and remain on when door is open or unlatched.

NOTE

On aircraft 79-0433 and 79-0434, the CARGO DOOR SYS (A and B) lights, located on the flight engineers upper instrument panel No. 2, go off when the cargo door is closed and locked.

On aircraft 79-1710 and subsequent, the CARGO DOOR SYS B light goes off when the cargo door is closed and locked. The CARGO DOOR SYS A light goes off only when both the cargo door and vent door are closed and locked.

Manual Latch Controls

To Open —
1. Open vent door.
2. Pull lockpin handle up to UNLOCK and hold. Insert hydraulic hand pump handle in latch actuating socket and push down to UNLATCHED position. Release lockpin handle.

To Close —
1. Insert hydraulic hand pump handle in latch actuating socket and pull up to LATCHED position. Lockpin handle will return to LOCK position.
2. Close vent door.

CAUTION

CHECK THAT LOCKPIN HANDLE AND LATCH ACTUATING SOCKET ARE IN LOCK POSITION AND MAIN CARGO DOOR ANNUNCIATOR LIGHT IS OFF AFTER EACH LATCHING OPERATION.

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Figure 1.8-10. Cargo Door Operation (Sheet 1)

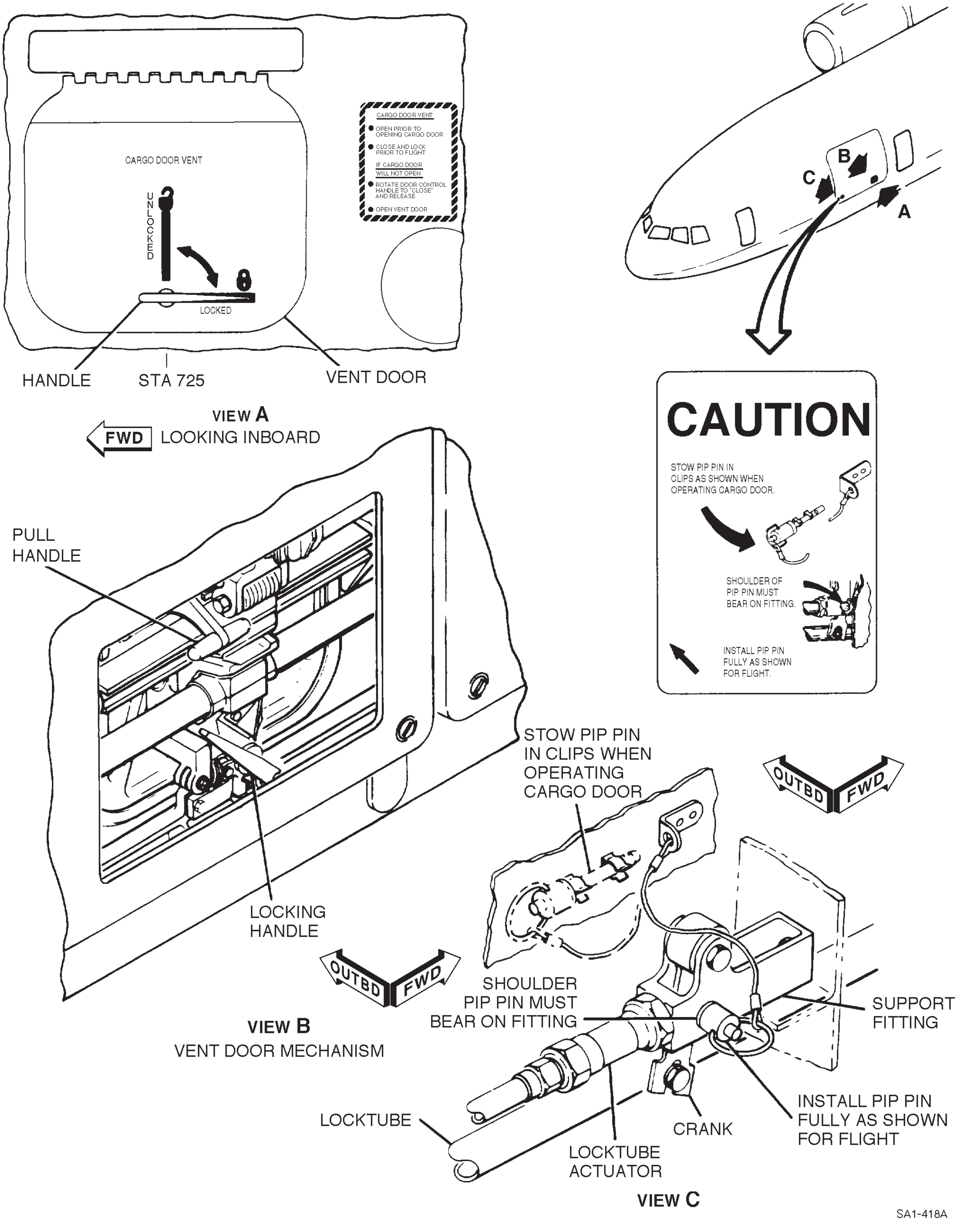
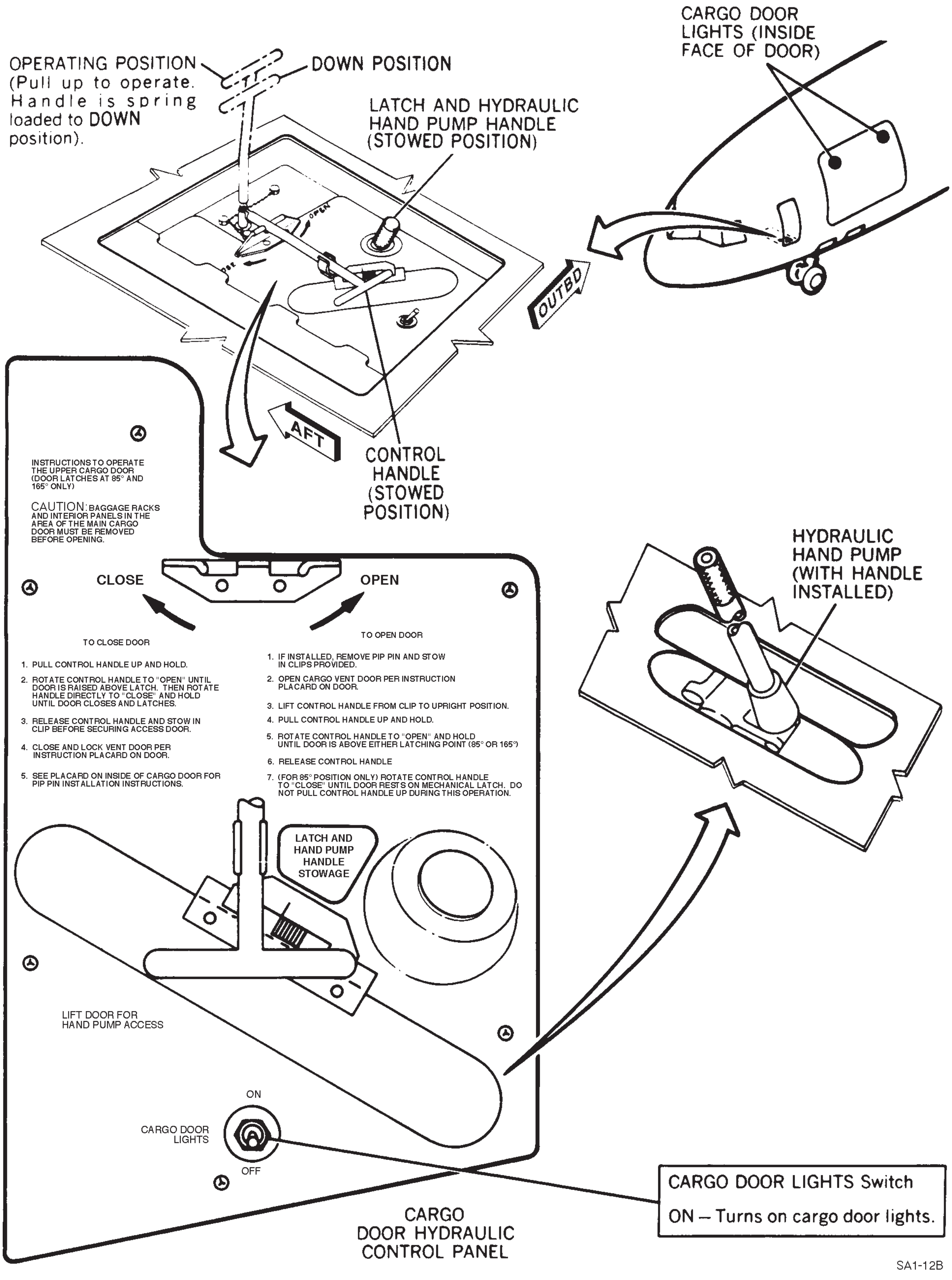


Figure 1.8-10. Cargo Door Operation (Sheet 2)



INSTRUCTIONS TO OPERATE THE UPPER CARGO DOOR (DOOR LATCHES AT 85° AND 165° ONLY)

CAUTION: BAGGAGE RACKS AND INTERIOR PANELS IN THE AREA OF THE MAIN CARGO DOOR MUST BE REMOVED BEFORE OPENING.

TO CLOSE DOOR

1. PULL CONTROL HANDLE UP AND HOLD.
2. ROTATE CONTROL HANDLE TO "OPEN" UNTIL DOOR IS RAISED ABOVE LATCH. THEN ROTATE HANDLE DIRECTLY TO "CLOSE" AND HOLD UNTIL DOOR CLOSES AND LATCHES.
3. RELEASE CONTROL HANDLE AND STOW IN CLIP BEFORE SECURING ACCESS DOOR.
4. CLOSE AND LOCK VENT DOOR PER INSTRUCTION PLACARD ON DOOR.
5. SEE PLACARD ON INSIDE OF CARGO DOOR FOR PIP PIN INSTALLATION INSTRUCTIONS.

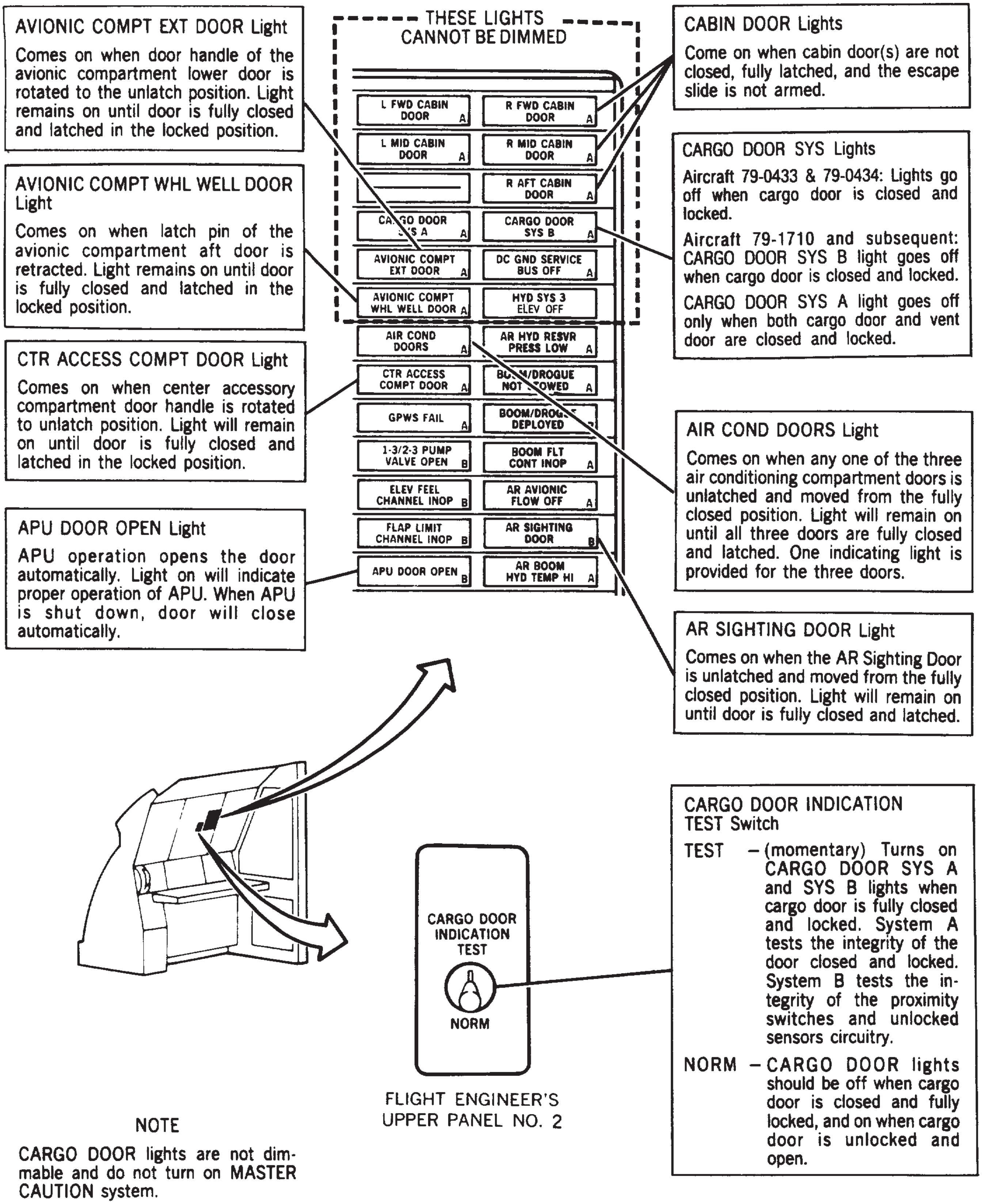
TO OPEN DOOR

1. IF INSTALLED, REMOVE PIP PIN AND STOW IN CLIPS PROVIDED.
2. OPEN CARGO VENT DOOR PER INSTRUCTION PLACARD ON DOOR.
3. LIFT CONTROL HANDLE FROM CLIP TO UPRIGHT POSITION.
4. PULL CONTROL HANDLE UP AND HOLD.
5. ROTATE CONTROL HANDLE TO "OPEN" AND HOLD UNTIL DOOR IS ABOVE EITHER LATCHING POINT (85° OR 165°)
6. RELEASE CONTROL HANDLE
7. (FOR 85° POSITION ONLY) ROTATE CONTROL HANDLE TO "CLOSE" UNTIL DOOR RESTS ON MECHANICAL LATCH. DO NOT PULL CONTROL HANDLE UP DURING THIS OPERATION.

CARGO DOOR LIGHTS Switch

ON – Turns on cargo door lights.

Figure 1.8-10. Cargo Door Operation (Sheet 3)



AVIONIC COMPT EXT DOOR Light

Comes on when door handle of the avionic compartment lower door is rotated to the unlatch position. Light remains on until door is fully closed and latched in the locked position.

AVIONIC COMPT WHL WELL DOOR Light

Comes on when latch pin of the avionic compartment aft door is retracted. Light remains on until door is fully closed and latched in the locked position.

CTR ACCESS COMPT DOOR Light

Comes on when center accessory compartment door handle is rotated to unlatch position. Light will remain on until door is fully closed and latched in the locked position.

APU DOOR OPEN Light

APU operation opens the door automatically. Light on will indicate proper operation of APU. When APU is shut down, door will close automatically.

CABIN DOOR Lights

Come on when cabin door(s) are not closed, fully latched, and the escape slide is not armed.

CARGO DOOR SYS Lights

Aircraft 79-0433 & 79-0434: Lights go off when cargo door is closed and locked.

Aircraft 79-1710 and subsequent: CARGO DOOR SYS B light goes off when cargo door is closed and locked.

CARGO DOOR SYS A light goes off only when both cargo door and vent door are closed and locked.

AIR COND DOORS Light

Comes on when any one of the three air conditioning compartment doors is unlatched and moved from the fully closed position. Light will remain on until all three doors are fully closed and latched. One indicating light is provided for the three doors.

AR SIGHTING DOOR Light

Comes on when the AR Sighting Door is unlatched and moved from the fully closed position. Light will remain on until door is fully closed and latched.

CARGO DOOR INDICATION TEST Switch

TEST – (momentary) Turns on CARGO DOOR SYS A and SYS B lights when cargo door is fully closed and locked. System A tests the integrity of the door closed and locked. System B tests the integrity of the proximity switches and unlocked sensors circuitry.

NORM – CARGO DOOR lights should be off when cargo door is closed and fully locked, and on when cargo door is unlocked and open.

NOTE

CARGO DOOR lights are not dimmable and do not turn on MASTER CAUTION system.

Figure 1.8-11. Annunciator Lights and Cargo Door Indicating Test System

LADDERS

GROUND EGRESS/ENTRY LADDER

A retractable ladder (figure 1.8-12) provides a means of entering or leaving the aircraft via door 1L without depending on auxiliary ground service equipment. The complete installation consists of three assemblies: the ladder, a handrail, and a support assembly.

The three assemblies are stowed in the retracted configuration against the aft wall of the permanently installed lavatory, and are secured to the wall panel with a strap assembly. When the ladder is deployed, the top of the ladder is secured to built-in attaching points at door 1L.

GROUND EGRESS/ENTRY LADDER DEPLOYMENT AND STOWAGE

The ground egress/entry ladder assemblies must be deployed, or removed and stowed, in a specific order. The following procedures augment the LADDER INSTRUCTIONS placard found at the ladder stowage position.

Ladder Deployment (Figure 1.8-13)

1. Open door 1L and install barrier strap.

WARNING

During the following unstowing procedures, verify that each remaining part of the ladder is left securely strapped in the stowed position so it will not fall and cause possible injury to personnel or damage aircraft equipment.

2. Unstrap support assembly and move to door 1L area.
3. Unstrap handrail assembly and move to door 1L area.
4. Lay handrail assembly on the floor with handrail brace facing down (same direction as installed on aircraft) (figure 1.8-13, sheet 2).
5. Assemble support assembly and handrail assembly as follows:
   a. Pull handrail brace lockpins from handrail assembly (figure 1.8-13, sheet 2).
   b. Unfold handrail brace and secure in extended position with handrail brace lockpins (both sides).

NOTE

Insert handrail brace lockpins from the inside (through the hold-open arm first).

   c. Remove handrail latch safety lockpins from handrail latches (both sides).
   d. Position support assembly under handrail assembly with spring arm pointed aft and pivot arms pointed vertically.
   e. Mate support assembly to handrail assembly by snapping spacer studs, on ends of support assembly, through the spring-loaded handrail latches.
   f. Install handrail latch safety lockpins (both sides).
6. Install handrail and support assemblies to doorsill as follows:
   a. Unfasten aft side of handrail strap assembly (2 places) (figure 1.8-13, sheet 4, view A).
   b. Move assemblies through door until support assembly portion is over doorsill (figure 1.8-13, sheet 3, view A).
   c. Place support assembly sill plate slots forward of four retaining studs on aircraft (figure 1.8-13, sheet 3, view A).
   d. Move assemblies aft until support assembly slots engage in four retaining studs and spring-loaded lock fitting snaps into locked position on aft upper retaining stud (figure 1.8-13, sheet 3, view B).

NOTE

Verify that the support assembly is engaged on the studs on the outside of the aircraft.

NOTE

Verify that the support assembly spring arm is positioned between girt bar hook and locking arm (figure 1.8-13, sheet 3, view B). This prevents girt bar engagement when door is closed over deployed ladder.

7. Rotate upper end of handrail assembly inboard and secure tiedown fitting into seat track to hold assembly in position (figure 1.8-13, sheet 4, view A).

WARNING

The tiedown fitting must be installed properly or it can slip out and allow the handrail assembly to swing up uncontrolled. Verify that the two end-legs of the tiedown fitting are inserted into two adjacent round slots of the seat track (figure 1.8-13, sheet 4, view A). Test for proper installation by jiggling the tiedown fitting fore and aft to verify that it cannot come out of the seat track.

8. Install ladder assembly as follows:
   a. Unstrap ladder assembly and move to door 1L area.
   b. Lay ladder assembly down on floor with padded shoes facing outboard and the narrow section of ladder assembly facing up.
   c. Remove ladder lockpins (2 places) from pivot arms on support assembly (figure 1.8-13, sheet 3, view A).
   d. Insert ladder assembly side rails into channels of pivot arms on support assembly (figure 1.8-13, sheet 4, view B).
   e. Unwind ladder control line from ladder rungs and lay line out of way, forward of ladder assembly.
   f. Using an even force to prevent hangups or cocking, push ladder assembly outboard until it stops; then install ladder lockpins (both sides).

WARNING

As the weight of the ladder assembly is concentrated on the outside of the aircraft, uncontrolled rotation of the handrail and ladder assemblies can cause injury to personnel or damage to the aircraft. Personnel should be inboard of the handrail assembly during the next step.

9. Rotate handrail and ladder assembly to upright-position by releasing tiedown fitting from seat track and controlling the rate of rotation.

10. Refasten handrail strap assembly (2 places) (figure 1.8-13, sheet 4, view C).

11. Remove door barrier strap from door 1L and stow.

12. Extend ladder assembly as follows:
    a. Pull ladder control line to release trigger cleat.
    b. Allow ladder sections to extend slowly until padded shoes contact ground.
    c. Relax tension on ladder control line to allow trigger cleat to close.
    d. Drop excess rope between ladder and aircraft so that it hangs free from rope guide fitting above cleat. This provides the means for personnel to retract or extend ladder from ground level.

WARNING

- Verify that all latches and lockpins are engaged before using ladder.
- Verify that the ladder is resting firmly on the ground.
- Ladder shall be occupied by only one person at a time.
- Maximum allowable load on ladder is 350 pounds.

CAUTION

To avoid possible damage to the aircraft and/or ladder, raise ladder to the retracted position when:

- Aircraft is to be moved.
- Ladder is not in use and wind velocities of 35 knots are anticipated.
- Aircraft is to be left unattended.

NOTE

Door 1L may be fully closed when ladder is deployed (extended or retracted), but girt bar will not lock.

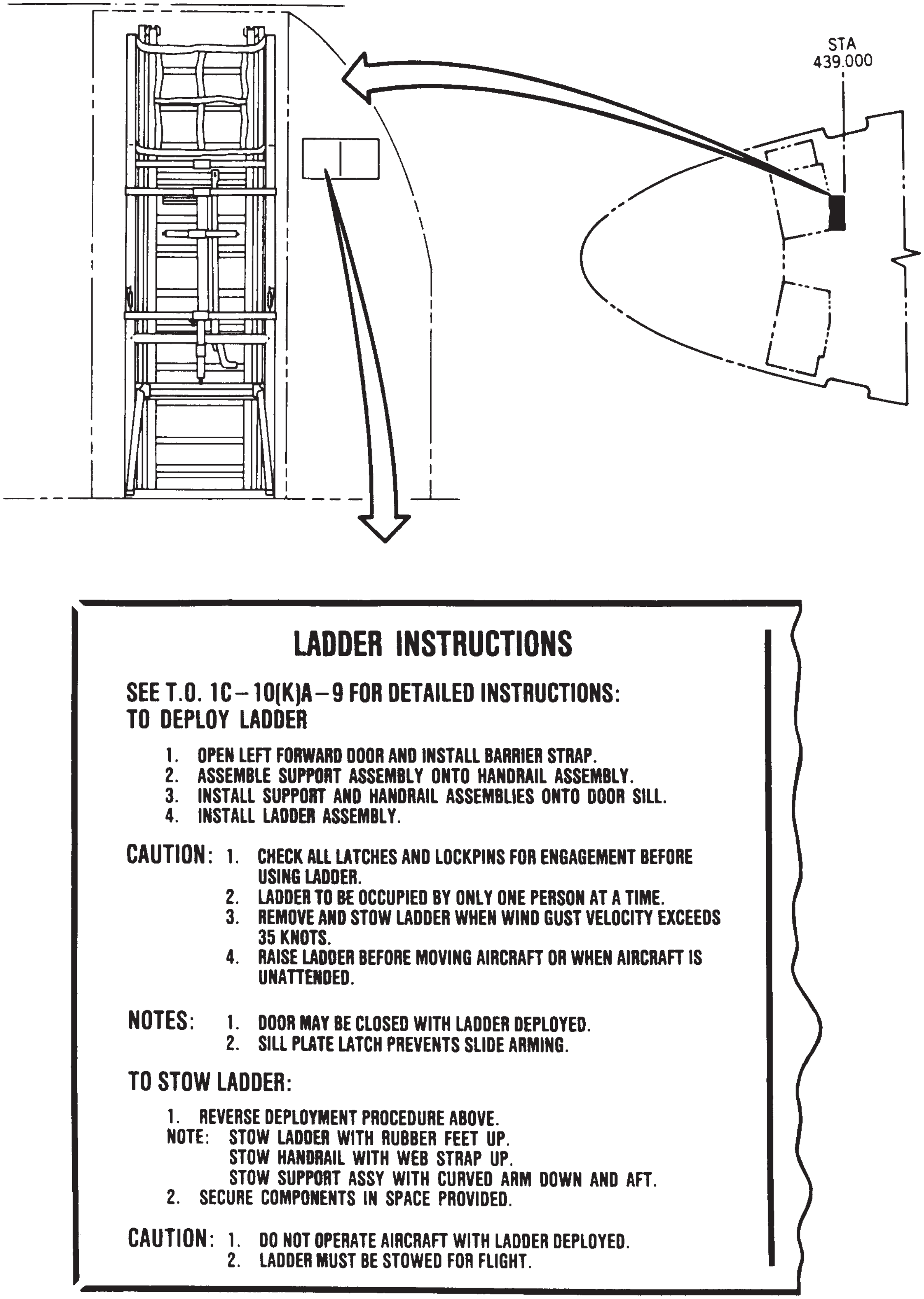
Ladder Removal and Stowage (Figure 1.8-13)

1. Raise ladder assembly to full retracted position by pulling up on ladder control line.
2. Install barrier strap across door 1L, outboard of handrail assembly.
3. Rotate upper section of handrail assembly inboard, and secure tiedown fitting into seat track (figure 1.8-13, sheet 4, view B).
4. Unfasten aft side of handrail strap assembly from handrail assembly (2 places) (figure 1.8-13, sheet 4, view B).
5. Pull ladder lockpins on pivot arms (2 places); then pull ladder assembly inboard until free pivot arm channels (figure 1.8-13, sheet 4, view B).
6. Wrap ladder control line around ladder rungs.
7. Place ladder assembly in stowage position, widest section against wall with padded shoes up (figure 1.8-13, sheet 1).
8. Strap ladder assembly securely in place.
9. Remove handrail and support assemblies from doorsill as follows:
   a. Release tiedown fitting from seat track (figure 1.8-13, sheet 4, view A).
   b. Lift spring-loaded lock fitting on support assembly; then move assemblies forward to release stud engagements (figure 1.8-13, sheet 3, view B).
   c. Lift assemblies off of four retaining studs on aircraft, and place support assembly over doorsill (figure 1.8-13, sheet 3, view A).
   d. Pull assemblies inboard and lay on floor with handrail brace facing down.
10. Remove support assembly from handrail assembly as follows:
    a. Pull handrail latch safety lockpins (figure 1.8-13, sheet 2).
    b. Open handrail latches at support assembly spacer studs and remove support assembly.
    c. Lay support assembly aside for later stowage.
    d. Install handrail latch safety lockpins on handrail latches (both sides).
11. Stow handrail assembly as follows:
    a. Refasten aft side of handrail strap assembly (2 places) (figure 1.8-13, sheet 1).
    b. Pull handrail brace lockpins from handrail assembly (both sides) (figure 1.8-13, sheet 2).
    c. Pull handrail brace against rails and secure with handrail brace lockpins (both sides).

NOTE

Insert handrail brace lockpins from the inside (through hold-open arm first).

    d. Place handrail assembly in stowage position with handrail brace down and facing away from wall (figure 1.8-13, sheet 1).
    e. Strap handrail assembly securely in place.
12. Stow support assembly as follows:
    a. Install ladder lockpins (2 places) on pivot arms.
    b. Place support assembly between rails of handrail assembly with spring arm down, and with pivot arms facing left.
    c. Strap support assembly securely in place.



LADDER INSTRUCTIONS

SEE T.O. 1C-10(K)A-9 FOR DETAILED INSTRUCTIONS:
TO DEPLOY LADDER

1. OPEN LEFT FORWARD DOOR AND INSTALL BARRIER STRAP.
2. ASSEMBLE SUPPORT ASSEMBLY ONTO HANDRAIL ASSEMBLY.
3. INSTALL SUPPORT AND HANDRAIL ASSEMBLIES ONTO DOOR SILL.
4. INSTALL LADDER ASSEMBLY.

CAUTION:
1. CHECK ALL LATCHES AND LOCKPINS FOR ENGAGEMENT BEFORE USING LADDER.
2. LADDER TO BE OCCUPIED BY ONLY ONE PERSON AT A TIME.
3. REMOVE AND STOW LADDER WHEN WIND GUST VELOCITY EXCEEDS 35 KNOTS.
4. RAISE LADDER BEFORE MOVING AIRCRAFT OR WHEN AIRCRAFT IS UNATTENDED.

NOTES:
1. DOOR MAY BE CLOSED WITH LADDER DEPLOYED.
2. SILL PLATE LATCH PREVENTS SLIDE ARMING.

TO STOW LADDER:

1. REVERSE DEPLOYMENT PROCEDURE ABOVE.

NOTE: STOW LADDER WITH RUBBER FEET UP.
STOW HANDRAIL WITH WEB STRAP UP.
STOW SUPPORT ASSY WITH CURVED ARM DOWN AND AFT.

2. SECURE COMPONENTS IN SPACE PROVIDED.

CAUTION:
1. DO NOT OPERATE AIRCRAFT WITH LADDER DEPLOYED.
2. LADDER MUST BE STOWED FOR FLIGHT.

SA1-568

Figure 1.8-12. Ground Egress/Entry Ladder

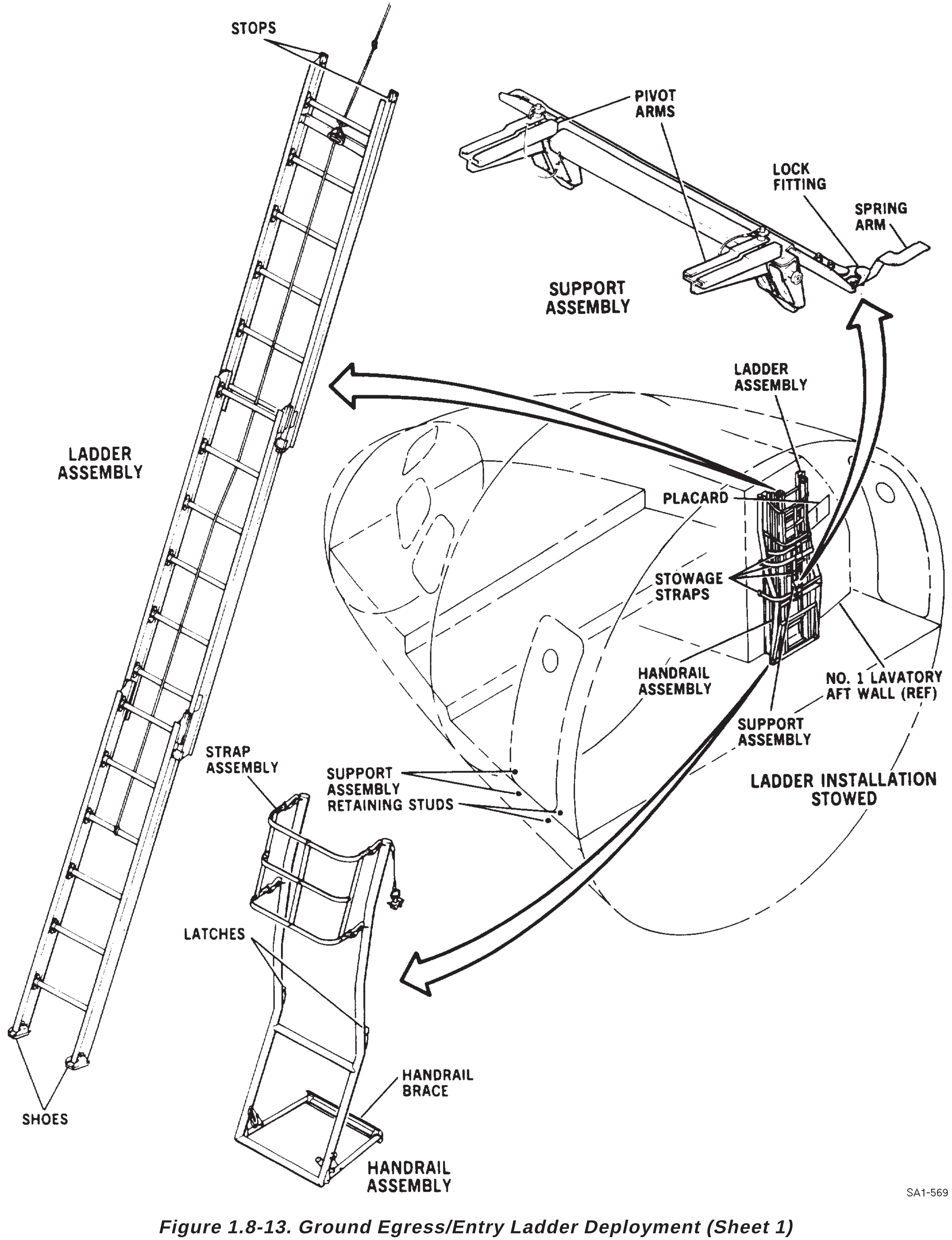


Figure 1.8-13. Ground Egress/Entry Ladder Deployment (Sheet 1)

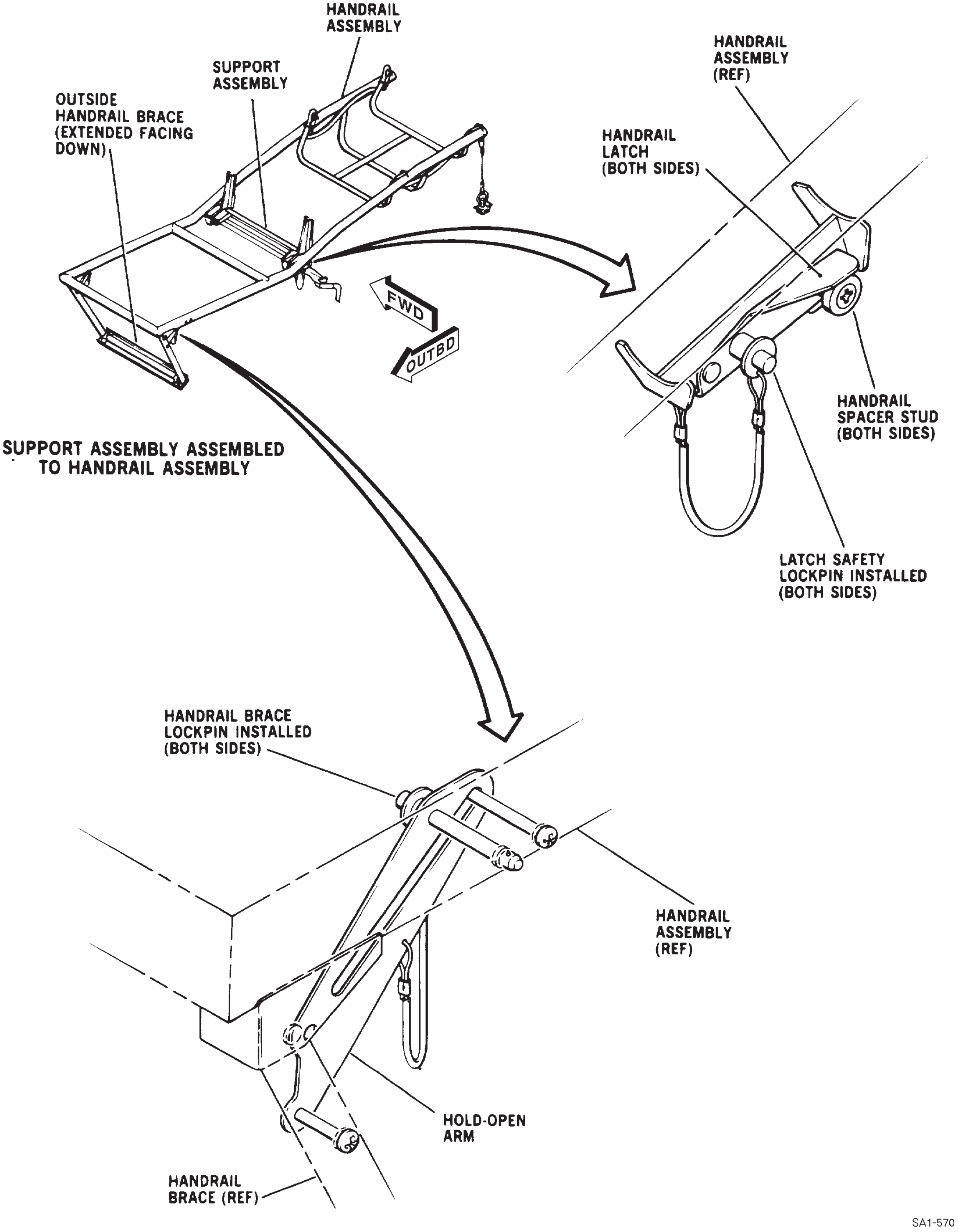


Figure 1.8-13. Ground Egress/Entry Ladder Deployment (Sheet 2)

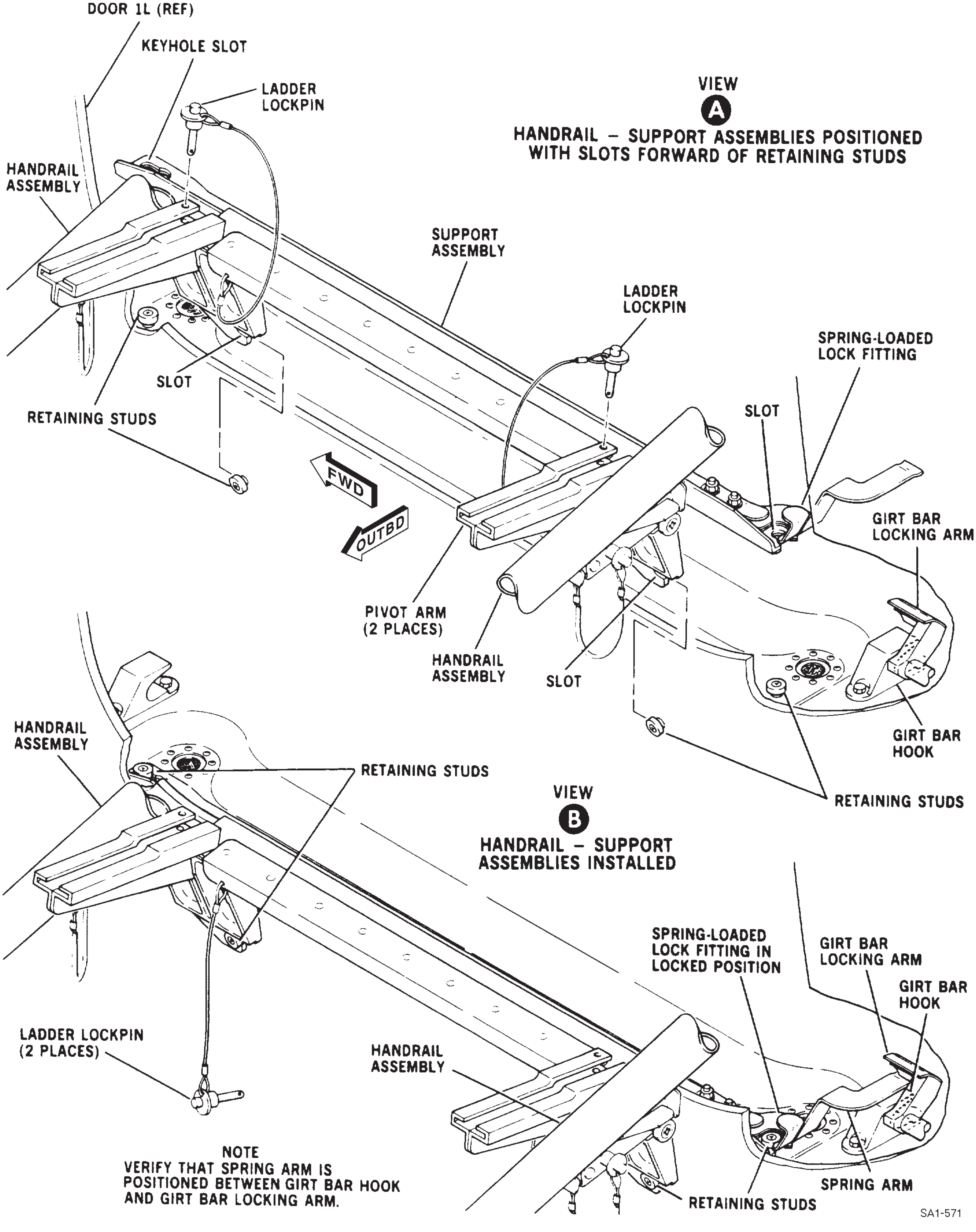


Figure 1.8-13. Ground Egress/Entry Ladder Deployment (Sheet 3)

PORTABLE LADDER ASSEMBLY

The portable ladder assembly (figure 1.8-14) is used at airfields where available boarding stairs do not reach the threshold of the aircraft cabin doors. When installed, the ladder assembly fills the void from the doorsill to the top of the stairs; thus, providing a safety/convenience aid for personnel entering or leaving the aircraft.

The ladder assembly consists of a floor plate, a five-step ladder, a fuselage standoff support, and two safety handrails. Inside the aircraft, the assembly is inverted, secured to the threshold of the open doorway, and then rotated outboard until the padded standoff support contacts the fuselage.

PORTABLE LADDER ASSEMBLY INSTALLATION AND REMOVAL

The portable ladder assembly can only be installed in the open doorway of 2L or 2R. The assembly is installed from inside the aircraft. Two people are required to safely install and/or remove the ladder assembly (Figure 1.8-14).

Installation

1. Remove stowed ladder assembly and position by door 2L or 2R (as applicable).
2. Unfold handrails (both sides) and lock into place with spring-loaded latches (4 places).
3. Unlock telescoping section of handrails by turning compression lock fittings (4 places) counterclockwise.
4. Open door 2L or 2R (as applicable).

WARNING

Before working in open doorway, make certain that an exterior ground support mobile stairway or maintenance stand/platform is positioned directly below the open door.

5. Position ladder assembly vertically in open doorway with handrails inboard.
6. Insert floorplate pivot bars into slide/raft girt bar fittings (2 places).
7. Lock floorplate pivot bars in place by holding door interlock arm outboard, then push slide arming lever to SLIDE ARMED position.
8. To insure that floorplate is fully engaged and locked in place, grasp handrails (one person each side) and rotate assembly outboard 35° to 40° from the vertical.
9. Restrain ladder assembly from further outboard rotation and pull telescoping section of handrails to internal stops (approximately 18 inches).
10. Lock handrails in extended position by turning compression lock fittings clockwise until tight.

CAUTION

Do not allow ladder assembly to free-fall outboard. Damage to the fuselage could result when the fuselage standoff support hits the fuselage during a free-fall deployment.

11. After handrails are fully extended and locked, slowly rotate ladder assembly outboard until fuselage standoff support pad contacts fuselage.

WARNING

- Verify that the four handrail compression lock fittings are tight in the locked position.
- Due to the height of the portable ladder handrails, extreme care must be exercised when loading/unloading personnel.

CAUTION

Do not close door 2L or 2R with the portable ladder assembly installed. Damage to door will result and may jam door in the closed position.

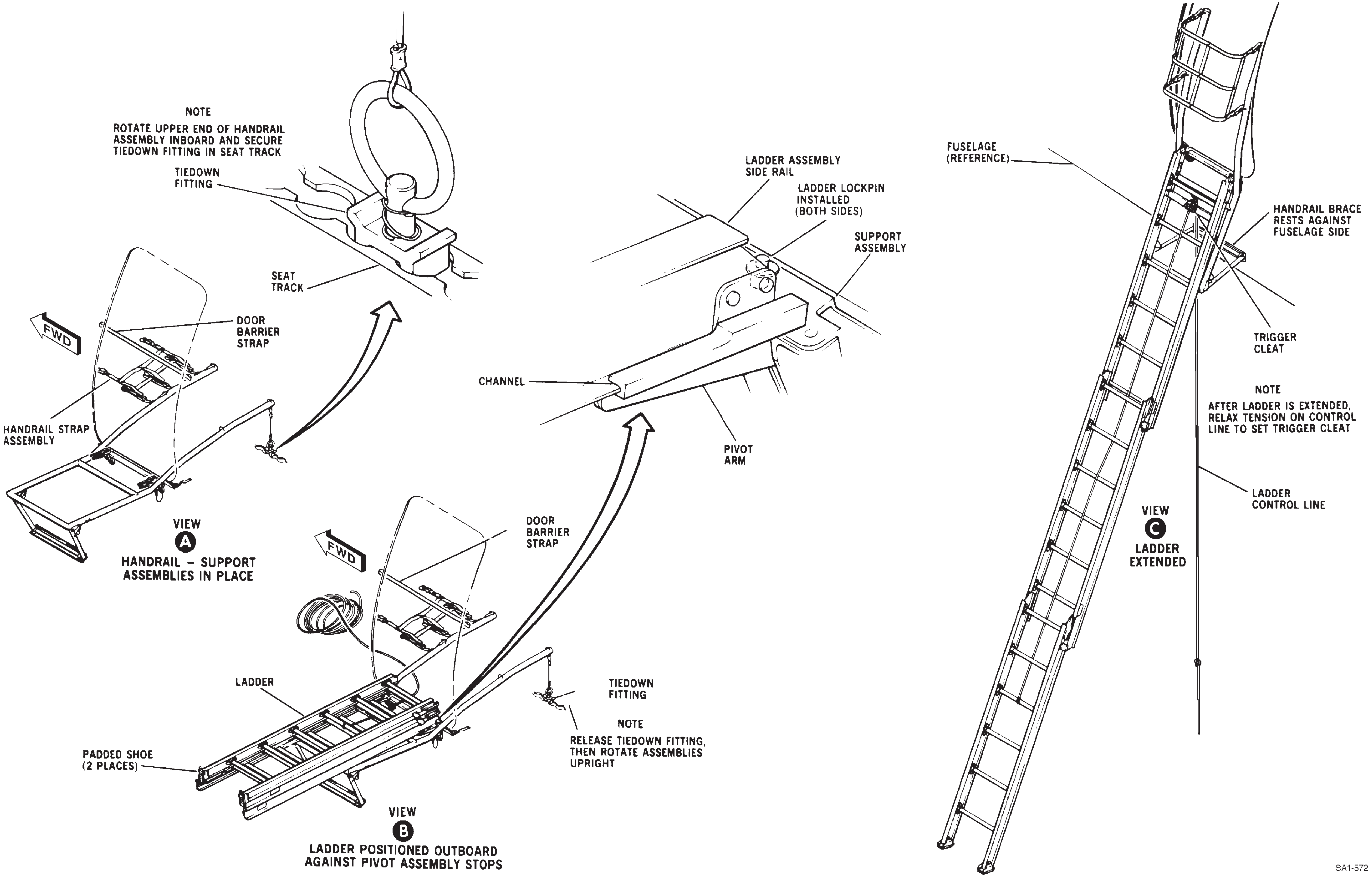


Figure 1.8-13. Ground Egress/Entry Ladder Deployment (Sheet 4)

Removal

WARNING

> Before working in open doorway, make certain that an exterior ground support mobile stairway or maintenance stand/platform is positioned directly below the open door.

1. Unlock telescoping section of handrails by turning compression lock fittings (4 places) counterclockwise.

WARNING

> When rotating ladder assembly inboard, do not place hands between ladder and fuselage standoff support. As the ladder reaches the vertical position, injury to the hands could result when the support closes up against the ladder.

2. Rotate ladder assembly inboard until handrails almost contact cargo floor.

3. Restrain ladder assembly and retract telescoping section of handrails into fixed section.

4. Lock handrails in retracted position by turning compression lock fittings clockwise until tight.

5. After handrails are retracted and locked, continue to rotate ladder assembly inboard until it reaches vertical position in doorway.

6. Unlock floorplate pivot bars from slide/raft girt bar fittings by holding door interlock arm outboard, then place door slide arming lever in SLIDE DISARMED position.

7. After floorplate is unlocked, pull ladder assembly inboard to remove floorplate pivot bars from slide/raft girt bar fittings.

8. Pull spring-loaded latches (4 places) to release handrails, then fold handrails to stowed position.

9. Close door 2L or 2R (as applicable).

10. Stow ladder assembly.

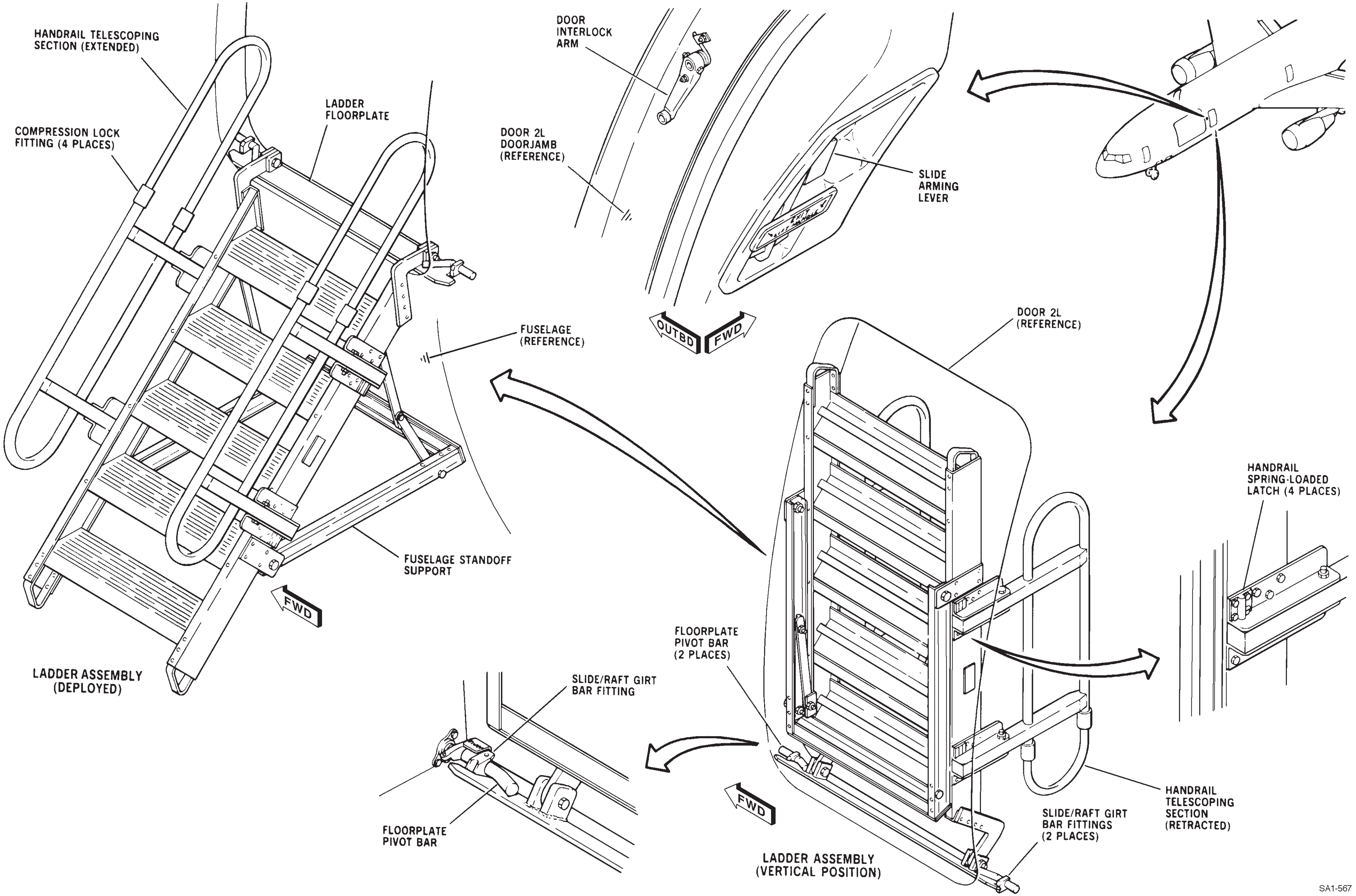


Figure 1.8-14. Portable Ladder Assembly

PART 9

PNEUMATICS

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PNEUMATICS

PNEUMATICS DESCRIPTION

The pneumatic system (figure 1.9-1) consists of controls, indicators, and components as needed to supply pneumatic power for air-conditioning, pressurization, wing anti-icing, galley and lavatory ventilation, engine starting and reversing. Pneumatic pressure is supplied from a ground external source, the APU, or engines one and three.

During normal system operation, engines one and three supply pneumatic power to their respective air-conditioning pack. Normal pneumatic source is low pressure bleed air from each engine compressor. To compensate for low power settings (such as idle descent), high pressure bleed air is automatically supplied to maintain normal operating pressure. When wing anti-ice is selected, the system automatically controls to a higher pressure limit in order to provide air at a temperature sufficient for wing anti-icing. If a pneumatic supply system control or engine failure occurs, electrically driven isolation valves provide the capability of supplying pneumatic pressure to the components of the inoperative system. Hot air for cowl anti-icing is obtained from a separate engine bleed source (figure 1.9-1). During ground operations, pneumatic service can be supplied to the pneumatic distribution system by the APU, or through either or both ground pneumatic supply connectors. The APU can provide sufficient pneumatic power to operate all air conditioning systems with the engine pneumatic supply selectors turned off, to achieve high performance takeoffs and initial climb, and has demonstrated that it can maintain an 8,000 ft cabin altitude at FL 250.

There is a manifold failure detection system. Failure of system one is detected by any of the left wing leading edge sensors, or dual detector loops in the left forward fuselage tunnel area. When a manifold failure is detected in system one, engine one pneumatic supply is shut off. The 1-3 isolation valve (figure 1.9-1) is closed and latched if an engine pneumatic selector is in OFF.

Failure of system two is sensed by a detector loop in the aft section of the fuselage. When a manifold failure is detected in system two, the APU pneumatic supply is shut off and the 1-2 isolation valve (figure 1.9-1) is closed.

Failure of system three is detected by any of the right wing leading edge sensors or a detector loop in the right forward fuselage tunnel area. When a manifold failure is detected in system three, engine 3 pneumatic supply is shut off. The 1-3 isolation valve is closed and latched if an engine pneumatic selector is in OFF.

Failure of any manifold in the center accessory compartment is detected by sensors in that area. When a failure is detected in the center accessory compartment, all pneumatic supplies (engines 1 and 3 and APU) are shut off and the 1-2 isolation valve closes.

Valve Position with Loss of Electrical Power:

1. Pressure Regulator Valve - Open and Regulating
2. High Stage Valve - Closes
3. Precooler Valve - Blows Open for Maximum Cooling
4. APU/ISOL Valve - Closes
5. 1-2, 1-3 ISOL Valve - Motor driven valves remain in last position

NOTE

> Valves can be manually positioned as long as there is no electrical power. When electrical power is recovered they automatically revert to switch position.

CONTROLS AND INDICATORS

Controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel No. 2 (figure 1.9-2), Pilot's Overhead Panel, and Glareshield. Illustrations of the major panels are in Part 1, Section I. Individual controls and indicators are illustrated and described in this part.

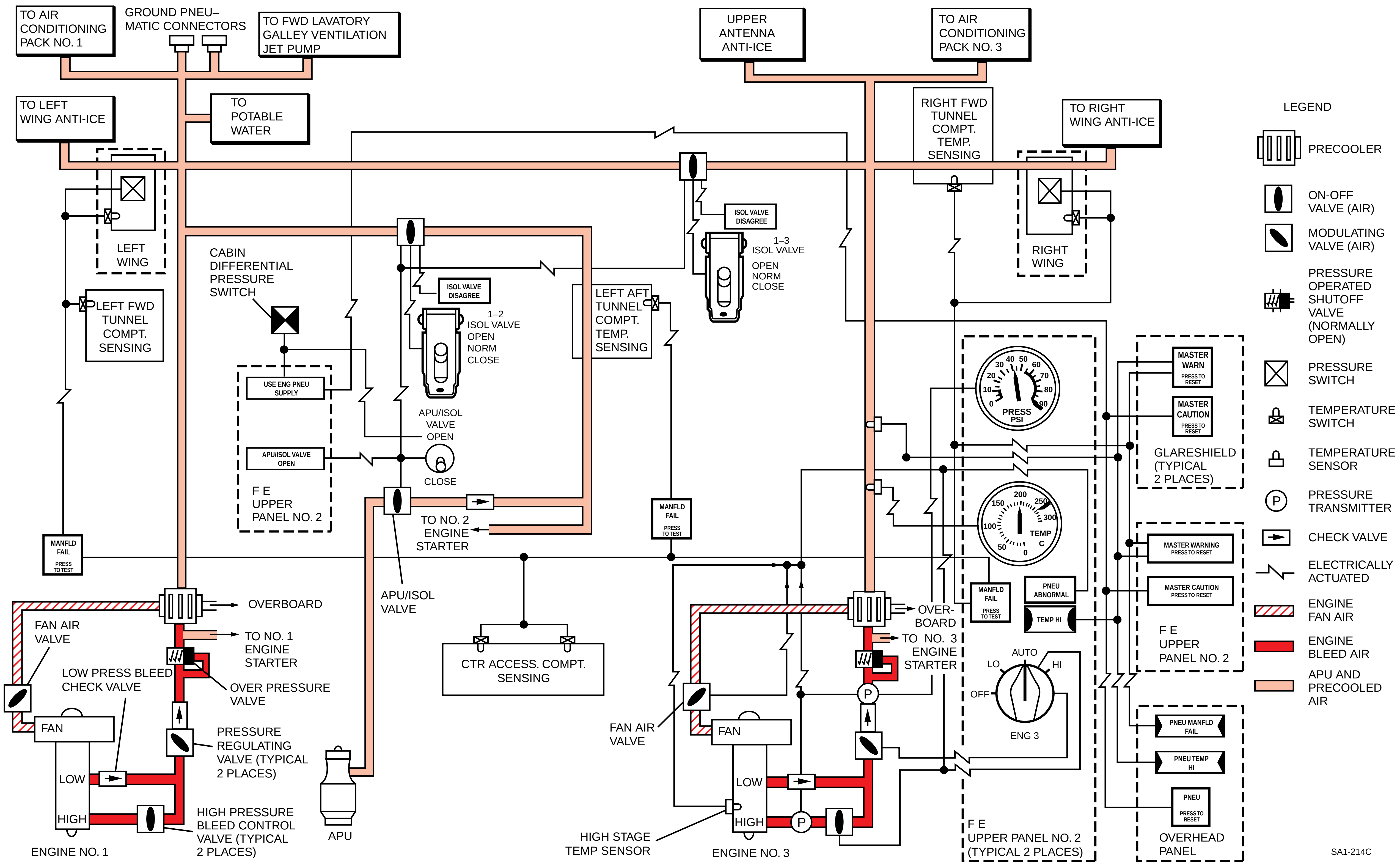


Figure 1.9-1. Pneumatic System (Sheet 1)

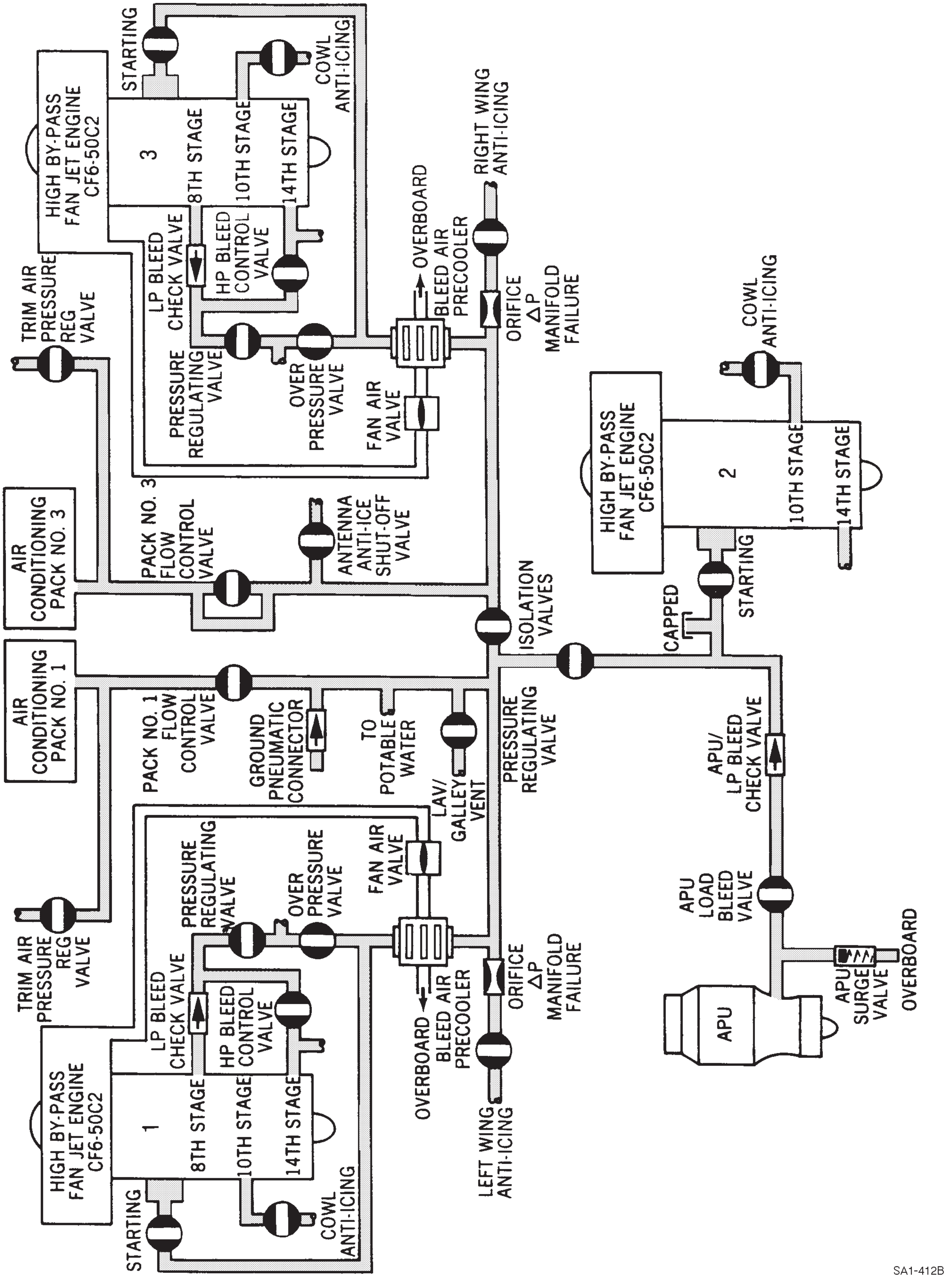
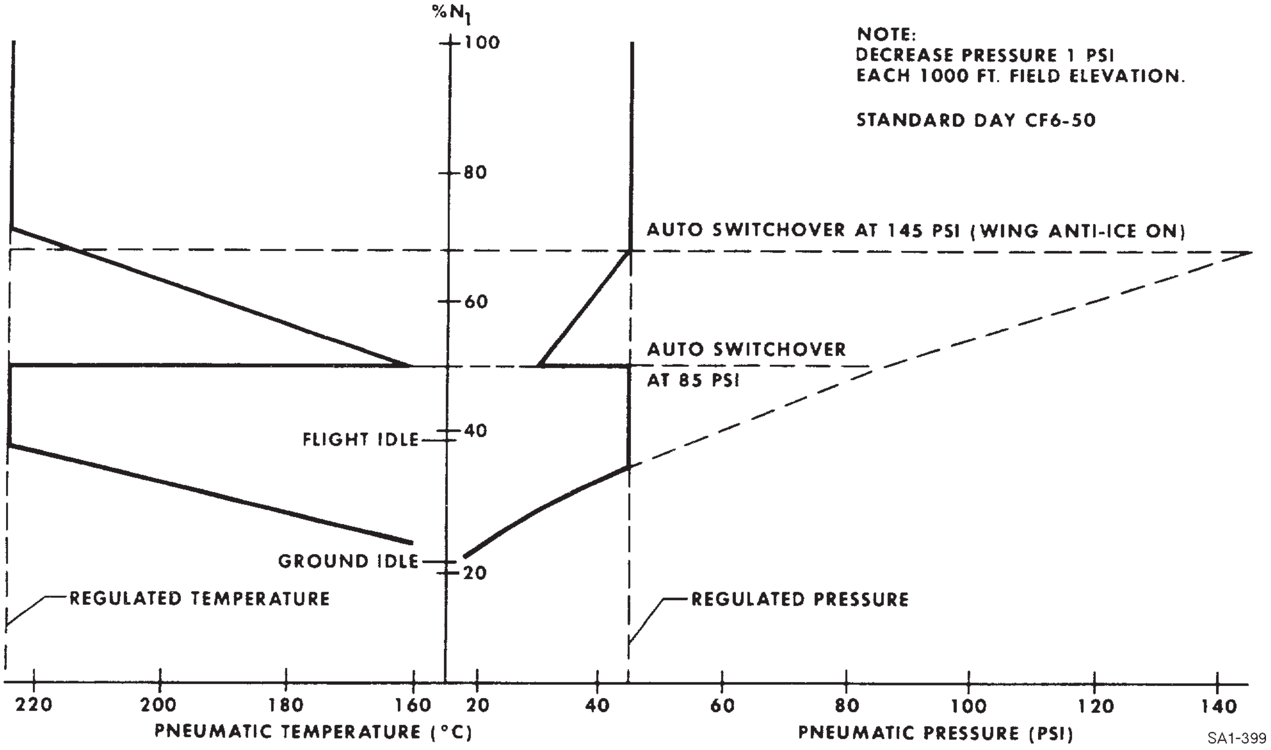


Figure 1.9-1. Pneumatic System (Sheet 2)



NOTE:
DECREASE PRESSURE 1 PSI
EACH 1000 FT. FIELD ELEVATION.

STANDARD DAY CF6-50

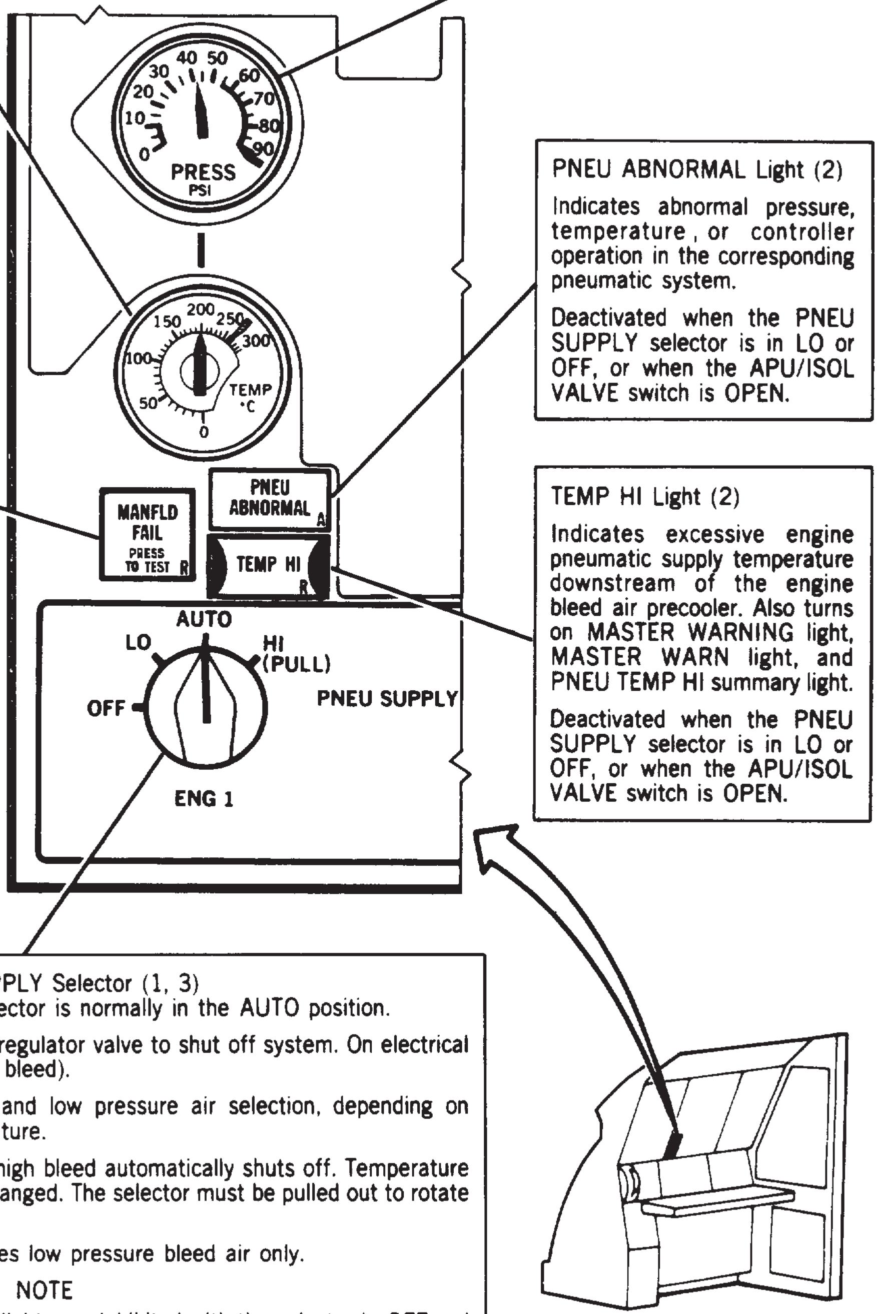
Figure 1.9-1. Pneumatic System (Sheet 3)

Pneumatic TEMP Gage (2)

Indicates pneumatic temperature downstream of each engine bleed air precooler.

Pneumatic PRESS Gage (2)

Displays pneumatic pressure downstream of the pressure regulator valve in each pneumatic manifold.



MANFLD FAIL Light (3)

Indicates high temperature within any compartment through which the applicable pneumatic manifold is routed, indicating a failed or leaking manifold. Also turns on MASTER WARNING light, MASTER WARN light, and PNEU MANFLD FAIL summary light. When light 1 is pushed to test, light 1 comes on to indicate the dual detector loops test satisfactorily. When light 2 or 3 is pushed, that respective light comes on to indicate the single detector loop tests satisfactorily. When system 1 or 3 light comes on, closes the 1-3 ISOL VALVE if any PNEU SUPPLY selector is OFF. Closes the 1-2 ISOL VALVE and APU/ISOL VALVE when system 2 light comes on.

PNEU ABNORMAL Light (2)

Indicates abnormal pressure, temperature, or controller operation in the corresponding pneumatic system.

Deactivated when the PNEU SUPPLY selector is in LO or OFF, or when the APU/ISOL VALVE switch is OPEN.

TEMP HI Light (2)

Indicates excessive engine pneumatic supply temperature downstream of the engine bleed air precooler. Also turns on MASTER WARNING light, MASTER WARN light, and PNEU TEMP HI summary light.

Deactivated when the PNEU SUPPLY selector is in LO or OFF, or when the APU/ISOL VALVE switch is OPEN.

PNEU SUPPLY Selector (1, 3)

Controls system pressure. Selector is normally in the AUTO position.

OFF	– Electrically controls pressure regulator valve to shut off system. On electrical power loss, valve opens (low bleed).
AUTO	– Automatically provides high and low pressure air selection, depending on engine pressure and temperature.
HI	– Increases pressure at which high bleed automatically shuts off. Temperature shutoff of high bleed is not changed. The selector must be pulled out to rotate to this position.
LO	– Closes high bleed and provides low pressure bleed air only.

NOTE

The PNEU ABNORMAL and TEMP HI lights are inhibited with the selector in OFF and LO positions.

When electrical power is lost, only low-bleed opens regardless of the selector switch position.

FLIGHT ENGINEER'S UPPER PANEL NO. 2

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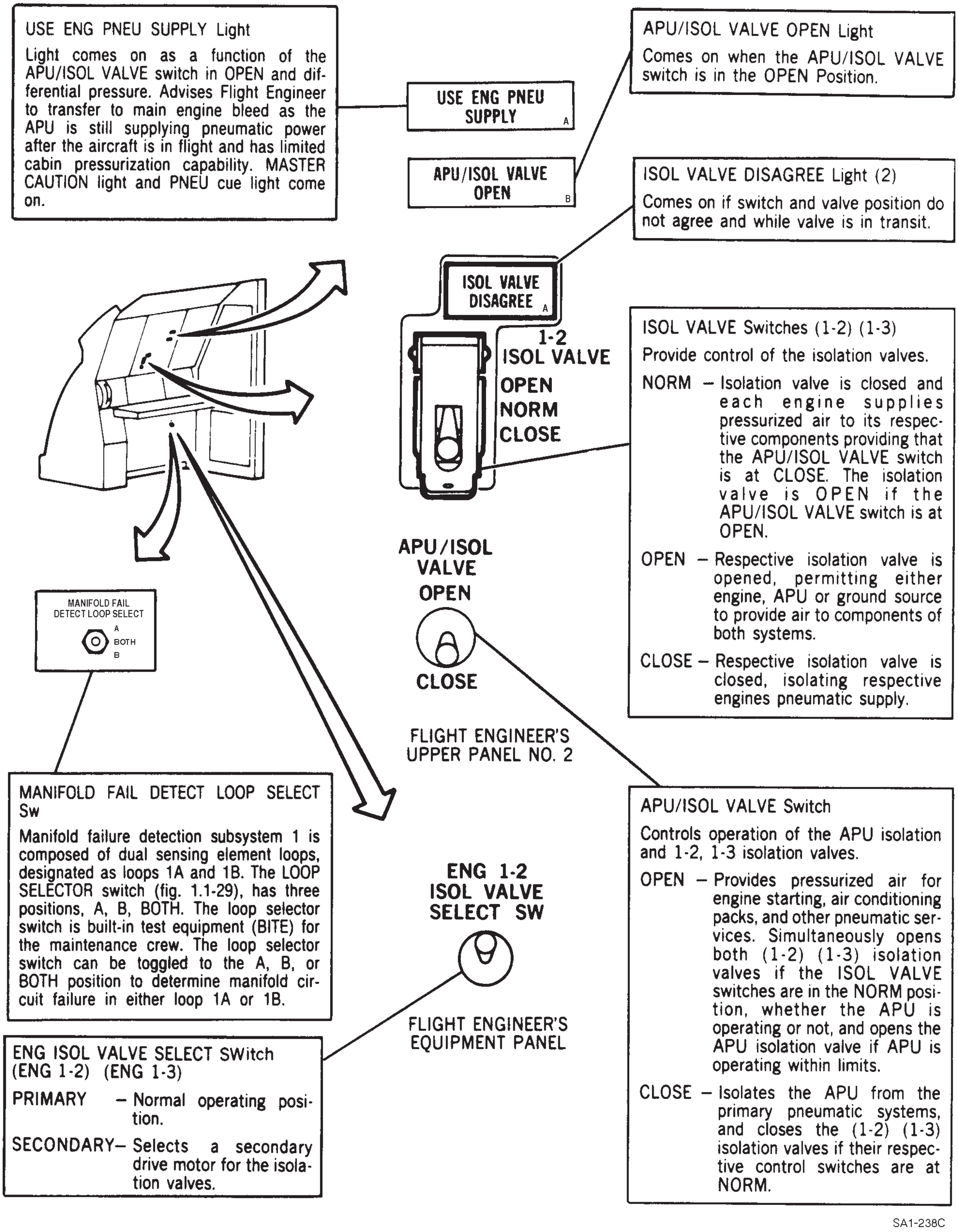
Figure 1.9-2. Pneumatics - Controls and Indicators (Sheet 1)



USE ENG PNEU SUPPLY Light

Light comes on as a function of the APU/ISOL VALVE switch in OPEN and differential pressure. Advises Flight Engineer to transfer to main engine bleed as the APU is still supplying pneumatic power after the aircraft is in flight and has limited cabin pressurization capability. MASTER CAUTION light and PNEU cue light come on.

APU/ISOL VALVE OPEN Light

Comes on when the APU/ISOL VALVE switch is in the OPEN Position.

ISOL VALVE DISAGREE Light (2)

Comes on if switch and valve position do not agree and while valve is in transit.

ISOL VALVE Switches (1-2) (1-3)

Provide control of the isolation valves.

NORM – Isolation valve is closed and each engine supplies pressurized air to its respective components providing that the APU/ISOL VALVE switch is at CLOSE. The isolation valve is OPEN if the APU/ISOL VALVE switch is at OPEN.

OPEN – Respective isolation valve is opened, permitting either engine, APU or ground source to provide air to components of both systems.

CLOSE – Respective isolation valve is closed, isolating respective engines pneumatic supply.

MANIFOLD FAIL DETECT LOOP SELECT Sw

Manifold failure detection subsystem 1 is composed of dual sensing element loops, designated as loops 1A and 1B. The LOOP SELECTOR switch (fig. 1.1-29), has three positions, A, B, BOTH. The loop selector switch is built-in test equipment (BITE) for the maintenance crew. The loop selector switch can be toggled to the A, B, or BOTH position to determine manifold circuit failure in either loop 1A or 1B.

APU/ISOL VALVE Switch

Controls operation of the APU isolation and 1-2, 1-3 isolation valves.

OPEN – Provides pressurized air for engine starting, air conditioning packs, and other pneumatic services. Simultaneously opens both (1-2) (1-3) isolation valves if the ISOL VALVE switches are in the NORM position, whether the APU is operating or not, and opens the APU isolation valve if APU is operating within limits.

CLOSE – Isolates the APU from the primary pneumatic systems, and closes the (1-2) (1-3) isolation valves if their respective control switches are at NORM.

ENG ISOL VALVE SELECT SWitch (ENG 1-2) (ENG 1-3)

PRIMARY – Normal operating position.

SECONDARY– Selects a secondary drive motor for the isolation valves.

Figure 1.9-2. Pneumatics - Controls and Indicators (Sheet 2)

PART 10

PRESSURIZATION AND AIR-CONDITIONING

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PRESSURIZATION AND AIR-CONDITIONING

PRESSURIZATION DESCRIPTION

The cockpit, forward cabin/cargo compartment, ARO compartment avionics and center accessory compartments are pressurized. Pressurization is supplied by engine bleed air and is controlled by regulating the outflow of conditioned air from the pressurized section. Cabin altitude and rate change are monitored on the FE's Center Panel (figure 1.10-1).

Cabin pressure is controlled and maintained by metered release of conditioned air in either an automatic, or manual mode. Electric power is required for all but the manual mode. The cabin pressure controller (figure 1.10-2) maintains the desired cabin pressure in relation to the altitude set on the landing altitude tape when the automatic or semiautomatic mode is selected. In the automatic mode, cabin pressurization is automatically controlled during takeoff, climb, cruise and descent conditions, to the lowest cabin altitude compatible with aircraft and flight requirements. Destination altitude is set with the ALT SET knob (figure 1.10-2) and automatically schedules depressurization during descent to 300 feet below the selected destination altitude when in the auto or semi-auto mode.

NOTE

- In AUTO mode, and at low altitude (under 5000 feet above departure field elevation), the cabin altitude may vary from the departure field elevation during extended flight periods.
- In AUTO mode, cabin altitude remains at departure airfield elevation until aircraft is 5000 feet above airfield, at which time cabin altitude changes as indicated in the Automatic Pressurization Schedule (figure 1.10-3) and Cabin Versus Aircraft Altitude Chart (figure 1.10-4). Cabin remains at that altitude until the aircraft altitude is sufficient to require cabin to climb so as not to exceed normal maximum differential pressure.
- In AUTO mode, with the rate limit selector (figure 1.10-2) at the index and at altitudes above 29,000 feet, the climb rate at low gross weights may exceed the cabin climb rate limit.
- If the cabin climb rate is exceeded, rotate the rate limit selector clockwise to increase rate of climb to maintain auto schedule. At end of climb, return the rate limit selector to the index mark.
- In AUTO mode with PACK function selectors (figure 1.10-5) in PACK OFF and/or ENG PNEU SUPPLY selectors in OFF, cabin altitude tends to follow aircraft altitude and the cabin OUTFLOW VALVE position indicator moves to close. After climb power has been set and the ENG PNEU SUPPLY selectors and PACK function selectors are in AUTO, the pneumatic PRESS and TEMP gages should indicate normally. The OUTFLOW VALVE position indicator moves toward OPEN and cabin altitude rate moves toward 0. The existing cabin altitude is maintained until aircraft altitude is 5000 feet above the existing cabin altitude; thereafter, cabin altitude changes as indicated in the Pressurization System Characterization Chart.
- If any gages or annunciator lights are not normal, refer to appropriate Abnormal Procedures under Pressurization and Air Conditioning.

If destination field elevation is above cabin altitude at start of aircraft descent, cabin altitude climbs at a rate not to exceed the selected rate limit, nominally set to 500 feet per minute, until cabin altitude is equal to 300 feet below destination field elevation. At nose gear touchdown, the outflow valve and indicator move to the full open position and the aircraft depressurizes at 350 feet per minute.

In semi-auto mode, cabin altitude is selected on the altitude-set tape by positioning the altitude-set knob to the desired altitude. Desired cabin altitude rate of change can be selected manually by adjusting the rate limit selector.

If the automatic system malfunctions, manual control of pressurization is possible by direct mechanical control of the outflow valve. The outflow valve position indicator displays the outflow valve position in all operating modes. When manual control is selected, the control wheel (figure 1.10-5) engages a locking mechanism to secure the outflow valve in its existing position. After selection, manual control is achieved by pressing the control wheel inward to disengage the control wheel locking device and rotating the wheel to position the outflow valve to attain the desired cabin altitude. When the control wheel is released, the outflow valve is again locked in its existing position. At touchdown the Flight Engineer can manually depressurize the aircraft.

One air-conditioning pack supplies adequate pressurization, even at maximum altitude.

The APU may be used as an alternate, or emergency, source of bleed air for cabin pressurization. Test flights have been conducted, up to FL250.

CABIN PRESSURE RELIEF VALVES/FLAPPER DOOR INDICATION

The cabin pressure relief valves limit cabin differential pressure. Flapper doors at each of the three relief valve overboard exhausts fair with the aircraft skin and are located on the right fuselage immediately forward of the wing-to-fuselage fillet. The flapper doors open if the respective relief valve opens. The relief valves open any time cabin pressure exceeds the white arc (8.8) on the cabin differential pressure gage and the CAB PRESS RELIEF OPEN light on the Flight Engineer's Upper Panel No.2 comes on (figure 1.10-6). The valves limit cabin pressure to 9.1 psi. When a relief valve has opened, the flapper doors are held open approximately 1/8 inch by a small rubber tab. This does not affect valve leakage or performance; it is only an indication that the relief valve has previously been open. The edge of the flapper is painted red to enhance visibility from the ground. Negative pressure is relieved through the cabin door seals.

CONTROLS AND INDICATORS

Controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel No. 2 and the Pilot's Overhead Panel. Individual controls and indicators are illustrated and described in this part.

AIR-CONDITIONING DESCRIPTION

The air-conditioning system has two air-conditioning packs (figure 1.10-7) that serve three independently controlled zones: the cockpit, forward cabin, and Air Refueling Operator's (ARO) compartment. The packs are numbered one and three in accordance with the supplying pneumatic system (pack two is not required/ installed in the KC-10A aircraft). Temperature control for automatic or manual air-conditioning of the three zones is provided by temperature selectors (figure 1.10-8) installed in the cockpit. Adjustable air outlets and independent temperature controls (figure 1.10-9) allow the Boom Operator to control the temperature and airflow into the ARO compartment. However, the temperature selector in the ARO compartment provides only minor temperature adjustments from the zone temperature selector setting controlled from the cockpit.

CABIN AIR SHUTOFF VALVES

Two cabin air shutoff valves control the air supply to the cargo compartment, ARO compartment and passenger compartment. Air is shut off by pulling the cabin air shutoff T handle (figure 1.10-10) located in the cockpit overhead. These valves are configured for all cargo or mixed passenger/cargo missions by maintenance personnel prior to flight. In the all cargo configuration, pulling the T handle closes both valves shutting off airflow to all three compartments and opens a relief valve dumping air to the outflow valve. In the cargo/passenger configuration, only one valve is closed shutting off airflow to the cargo compartment aft of the environmental curtain and to the ARO compartment.

NOTE

- In the cargo/passenger configuration, airflow is always present in the passenger compartment regardless of environmental curtain position.
- If the T handle is used in flight, valves and handles must be reset by maintenance personnel after aircraft is on the ground.

AIR-CONDITIONING SYSTEM

The two air-conditioning packs (one and three) are air cycle machines powered by pressurized air from the pneumatic manifold. The hot pressurized air supplied to the packs is cooled and then routed to a common manifold. The cooled air is then mixed with hot air that has bypassed the packs and distributed to the cockpit, forward cabin, cargo compartment ■

and ARO compartment. Ground connectors are installed to provide pre-conditioned air from a ground source to the conditioned air manifold.

Pressurized air may be supplied by the auxiliary power unit (APU), the engines, or a ground pneumatic source. The APU can supply sufficient airflow to operate both air-conditioning systems with the engine pneumatic supply selectors turned off to obtain optimum engine performance during takeoff and climb out.

The cooling or heating output of an air-conditioning pack is accomplished by automatically or manually modulating the turbine bypass valve and the cooling ram air inlet and outlet doors. To manually operate an air-conditioning pack, select the pack to be operated on the PACK IND SEL and then rotate the PACK function selector in manual until desired PACK TEMP VALVE position or discharge temperature is achieved.

NOTE

- When manual operation is necessary during initial startup of air-conditioning, pack temperature valve position indicator should be positioned between nine and twelve o'clock. When flow is established, adjust in small increments to obtain desired pack discharge temperature. If stabilized pack temperature valve position indication is to the right of twelve o'clock position, anticipate large change in pneumatic pressure or temperature upon takeoff power application and adjust pack temperature valve position approximately 25 percent toward cold.
- During descent, close monitoring is required to prevent overheating of pack(s).
- If pack function selector does not control temperature, move pack function selector to PACK OFF.

The temperature control signals from each of the zone controllers (cockpit, forward cabin, and ARO compartment) also influence the two air-conditioning pack controllers. The signals are compared by the controller to determine the lowest temperature demand. When the pack function selectors are in the AUTO position, the control of number one pack is determined by the coldest temperature demand of the cockpit, forward cabin or ARO compartment, and control of number three pack is determined by the coldest temperature demand of either the forward cabin or the ARO compartment. Individual zone temperature requirements are adjusted by mixing hot, trim air from the pneumatic duct with air from the conditioned air manifold. To manually operate compartment controls, rotate appropriate compartment temperature selector to MAN and hold HOT or COLD, as required. Observe compartment temperature valve position indicator, and compartment/duct temperature gage for normal indications. Release compartment temperature selector to STOP.

NOTE

If compartment temperature valve position indicator pointer does not move and/or compartment/duct temperature gage does not change, move trim air switch to OFF.

If the two air-conditioning packs are shut down in flight, a ram air distribution system provides a backup supply of ambient air to the conditioned air distribution system. The system located on the left side of the air-conditioning compartment, consists of ducting and a manual valve controlled by a cable attached to a T handle. The valve control T handle is in the avionic compartment immediately below the access door in the left rear cockpit floor. The T handle is lock wired and requires a strong pull to snap the lock wire and open the valve. The valve is located in pack number one and once opened, must be closed by ground maintenance personnel before pneumatic operation of pack number one can be resumed.

AVIONICS COOLING SYSTEM

The avionics cooling system consists of cooling fans, venturi, and the ducting necessary to cool the instrument panels and electronic and electrical units located in the avionics compartment. The cooling fans in the system provide the necessary airflow. When on the ground or at low cabin/ambient differential pressure all fans operate. Fans operate when differential pressure is less than 1.3 psid. In flight, when cabin/ambient differential pressure is sufficient, the Center Instrument Panel and some avionics compartment fans shut off. Avionics compartment ventilation is then provided by an overboard venturi. Center Instrument Panel cooling is accomplished with conditioned air when the fan has shut off. A valve in the duct to the avionics compartment overboard venturi is normally open in flight to permit avionic venturi operation and closed on the ground to prevent inflow. An AVIONIC FLOW OVRD switch (figure 1.10-8) is installed on the Flight Engineer's Upper Panel No. 2 to turn on the avionics cooling fan and close the avionic overboard venturi shutoff valve. This reduces cabin leakage so the cabin pressure can be maintained during single pack operation.

Individual overboard venturis are installed for positive inflight cooling if the inertial navigation units (INU) and individual fans are installed for cooling the INU's at low differential pressure and on the ground. INU fan exhaust air is discharged into the avionics compartment.

An AVIONICS FLOW OFF light, on the Flight Engineer's Annunciator Panel, comes on when the cooling airflow through the avionics compartment is below normal. An inertial navigation system (INS) 1 (2 or 3) FLOW OFF light, on the Pilot's Overhead Annunciator Panel, comes on when the cooling airflow through an inertial navigation unit is below normal. An indicator on the Center Instrument Panel provides visual indication that airflow is provided to cool Center Instrument Panel instruments.

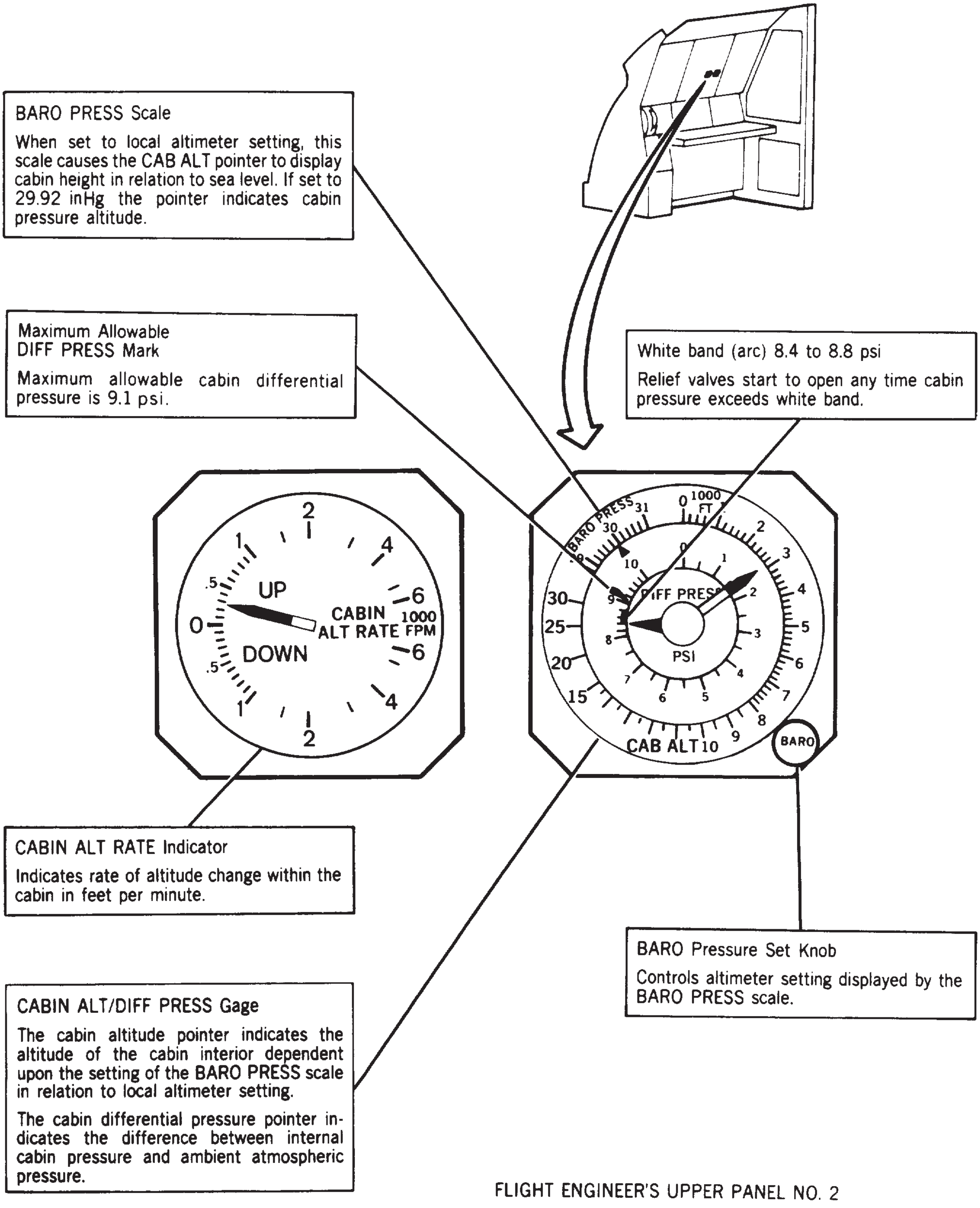
The DUCT-AVIONIC COMPT OVERHEAT light is armed when the trim air switch (figure 1.10-8), on the Flight Engineer's Upper Panel Number 2, is positioned to TRIM AIR. If an overheat condition occurs in any of the zone inlet air supply systems, thermal switches shut off the trim air and the DUCT-AVIONIC COMPT OVERHEAT light comes on. The overheat light also comes on and trim air is shut off if an overtemperture condition occurs in the avionics compartment. The overheat switch in the avionics compartment is set sufficiently high so that it functions only if an excessively high temperature occurs, such as could be caused by a trim air manifold leak.

NOTE

> AIR COND TRIM AIR PRESS HI light on indicates a trim air regulator malfunction not detectable on the pneumatic pressure gages. System design provides an adequate safety margin, permitting continued operation of the trim air system until corrective maintenance is available. Duct temperature gages may fluctuate, but no reaction should be apparent on the compartment temperature gages. Make an entry in AFTO Form 781.

CENTER ACCESSORY COMPARTMENT VENTILATION

The electrical equipment located in the center accessory compartment is cooled on the ground and in flight by a continuous duty fan drawing tunnel airflow through the compartment. Adequate airflow through the compartment is provided in flight even when the fan has failed. An amber CTR ACCESS COMPT FLOW OFF light, on the Flight Engineer's Annunciator Panel, comes on when flow through the fan circuit is abnormally low.



BARO PRESS Scale

When set to local altimeter setting, this scale causes the CAB ALT pointer to display cabin height in relation to sea level. If set to 29.92 inHg the pointer indicates cabin pressure altitude.

Maximum Allowable DIFF PRESS Mark

Maximum allowable cabin differential pressure is 9.1 psi.

White band (arc) 8.4 to 8.8 psi

Relief valves start to open any time cabin pressure exceeds white band.

CABIN ALT RATE Indicator

Indicates rate of altitude change within the cabin in feet per minute.

BARO Pressure Set Knob

Controls altimeter setting displayed by the BARO PRESS scale.

CABIN ALT/DIFF PRESS Gage

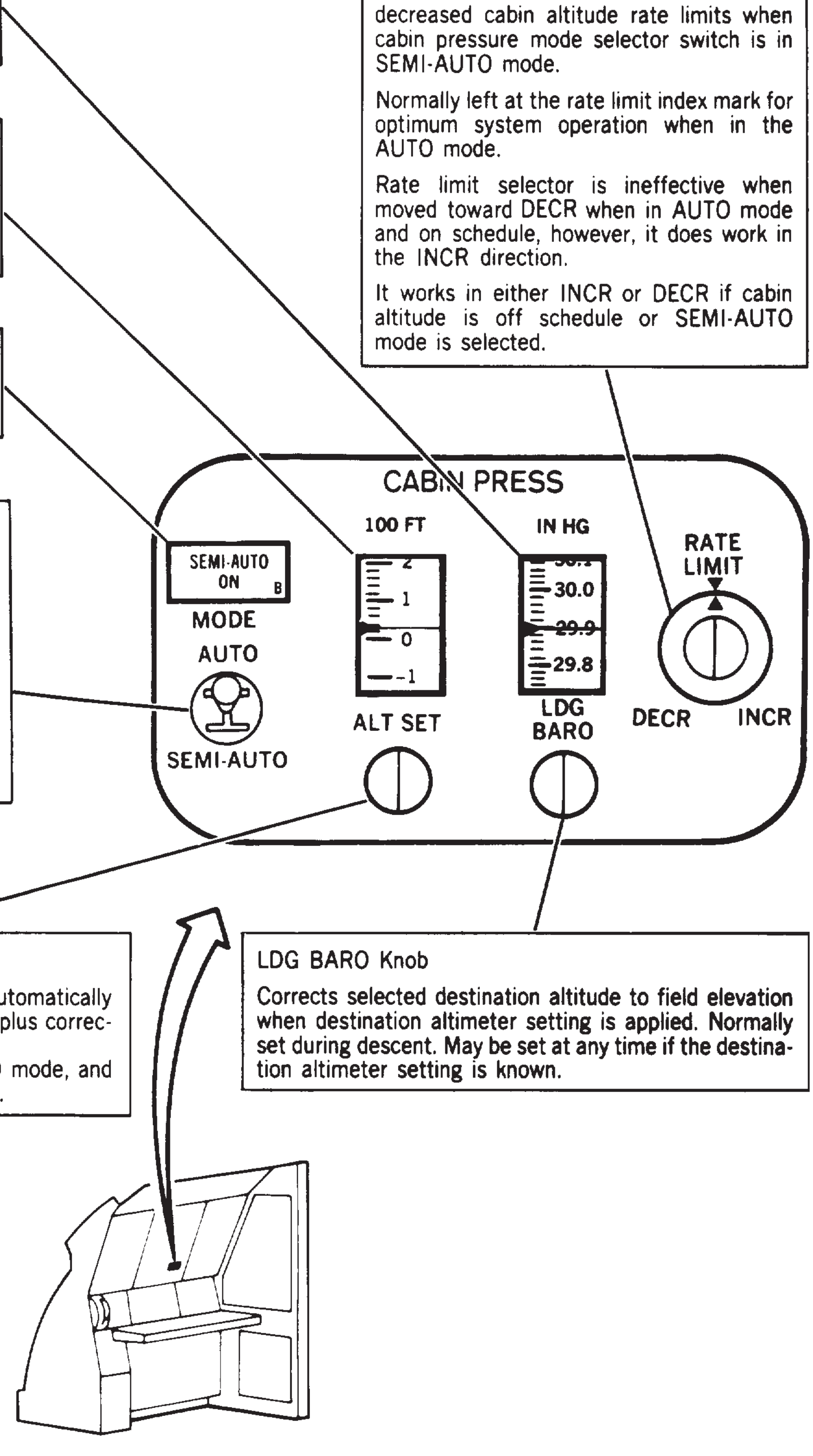
The cabin altitude pointer indicates the altitude of the cabin interior dependent upon the setting of the BARO PRESS scale in relation to local altimeter setting.

The cabin differential pressure pointer indicates the difference between internal cabin pressure and ambient atmospheric pressure.

FLIGHT ENGINEER'S UPPER PANEL NO. 2

SA1-88B

Figure 1.10-1. Cabin Altitude and Rate Indicators



LDG BARO Scale

Indicates barometric pressure setting selected by the landing barometric pressure knob.

ALT SET Scale

Indicates selected landing airport altitude when operating in AUTO mode. Indicates selected cabin altitude when operating in the SEMI-AUTO mode.

SEMI-AUTO ON Light

Light comes on when the SEMI-AUTO mode is selected.

Cabin Press MODE Switch

Switch is normally in the AUTO position.

AUTO – Automatically controls cabin pressurization schedule during climb, cruise, and descent.

SEMI-AUTO – Permits desired cabin altitude to be selected by the altitude set knob and the climb or descent schedule to be programmed by the rate limit knob selector.

RATE LIMIT Selector

Provides selection of increased or decreased cabin altitude rate limits when cabin pressure mode selector switch is in SEMI-AUTO mode.

Normally left at the rate limit index mark for optimum system operation when in the AUTO mode.

Rate limit selector is ineffective when moved toward DECR when in AUTO mode and on schedule, however, it does work in the INCR direction.

It works in either INCR or DECR if cabin altitude is off schedule or SEMI-AUTO mode is selected.

ALT SET Knob

Selects destination altitude. Controller automatically schedules depressurization to this altitude, plus correction, during descent when in AUTO mode.
Selects cabin altitude when in SEMI-AUTO mode, and desired landing altitude at start of descent.

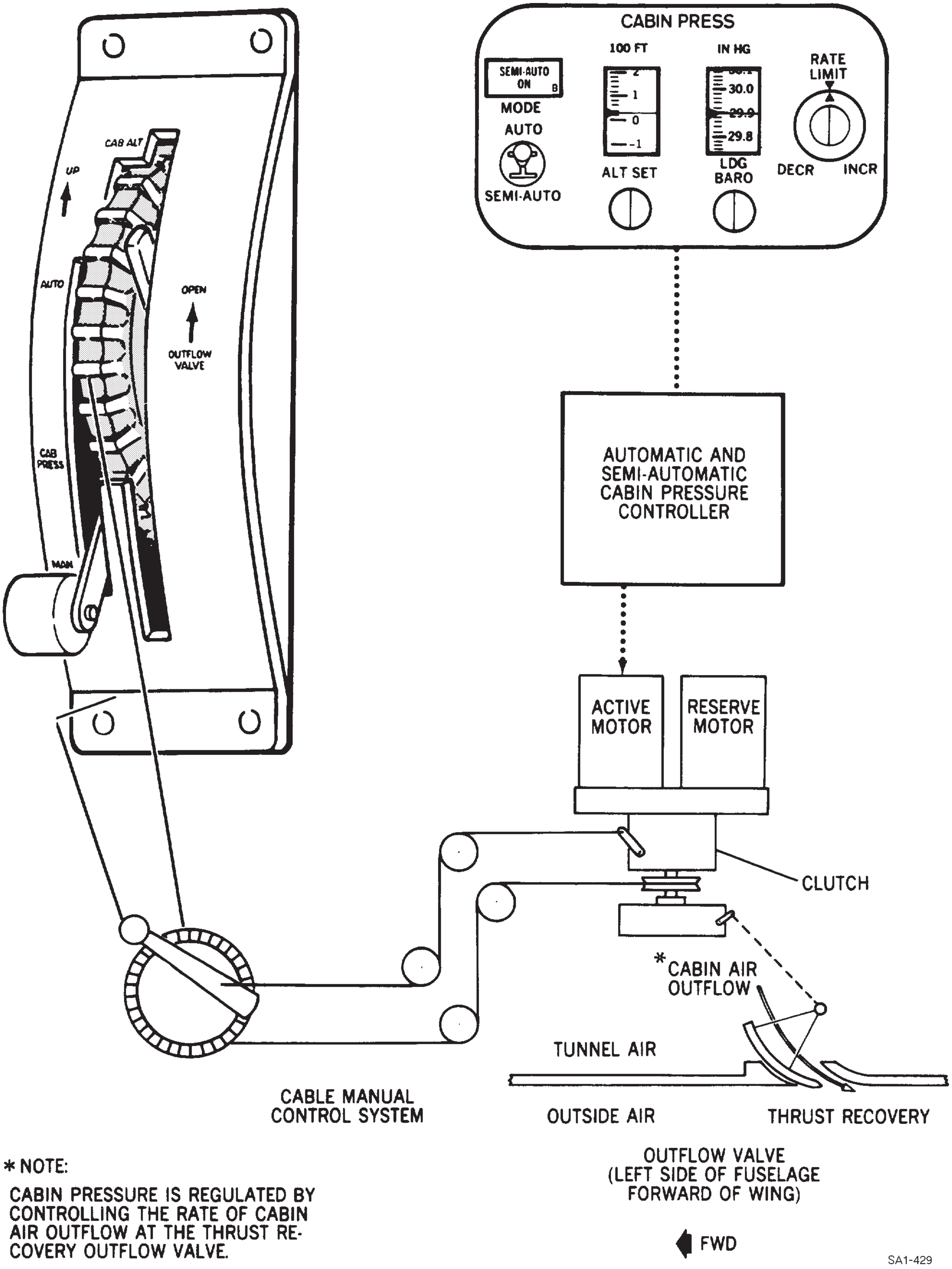
LDG BARO Knob

Corrects selected destination altitude to field elevation when destination altimeter setting is applied. Normally set during descent. May be set at any time if the destination altimeter setting is known.

FLIGHT ENGINEER'S UPPER PANEL NO. 2

SA1-87C

Figure 1.10-2. Cabin Pressurization Control (Sheet 1)



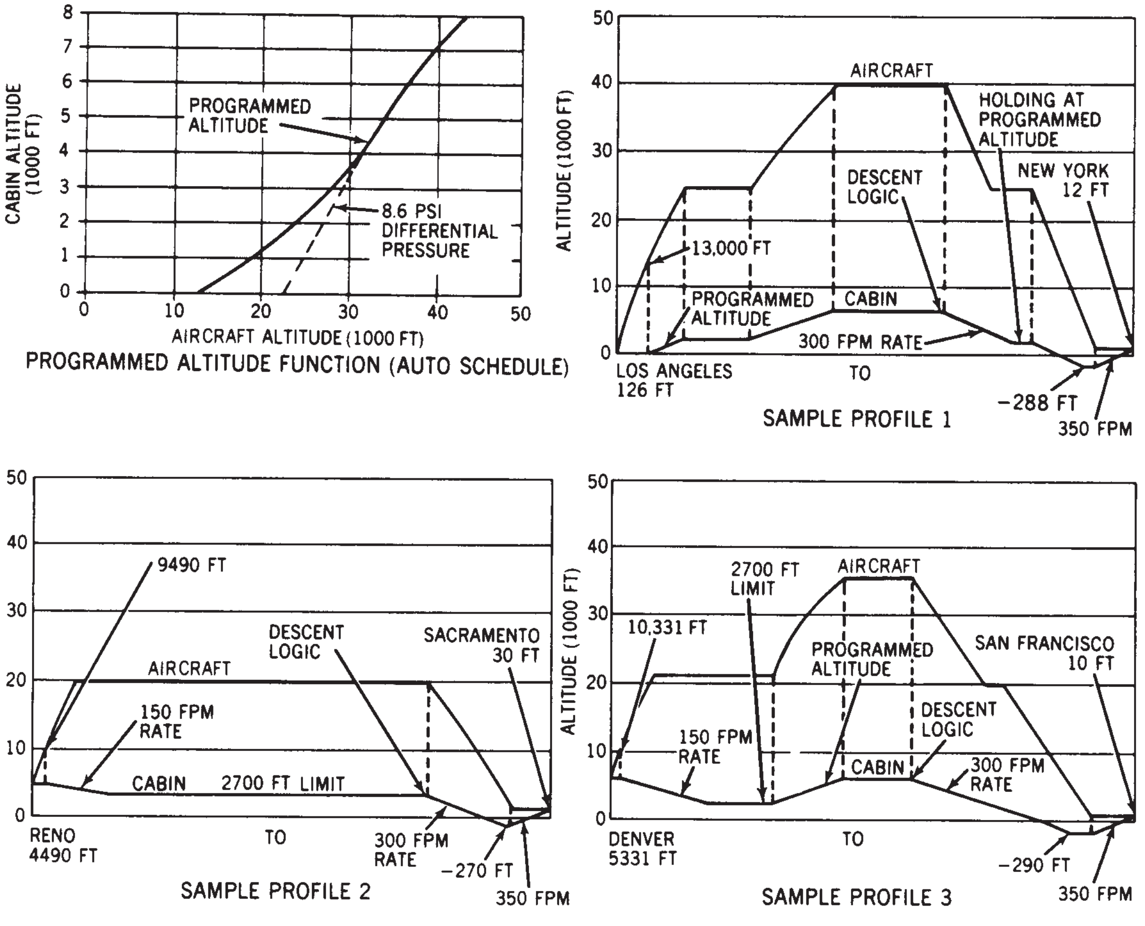
∗NOTE:

CABIN PRESSURE IS REGULATED BY CONTROLLING THE RATE OF CABIN AIR OUTFLOW AT THE THRUST RECOVERY OUTFLOW VALVE.

Figure 1.10-2. Cabin Pressurization Control (Sheet 2)

<table>
<tr><th>IMMEDIATELY AFTER TAKEOFF</th><th colspan="3">AFTER AIRCRAFT HAS CLIMBED 5000 FT</th><th>WHENEVER AIRCRAFT BEGINS A DESCENT</th><th>AT NOSE GEAR TOUCHDOWN</th></tr>
<tr><td rowspan="5">MAINTAINS TAKEOFF FIELD PRESS ALTITUDE UNTIL AIRCRAFT HAS CLIMBED 5000 FT</td><td colspan="3">CABIN ALTITUDE GOES TO ALTITUDE SHOWN BELOW, OR
PROGRAMMED ALTITUDE (SEE CHART) WHICHEVER IS HIGHER.
RATES ARE HALF OF SELECTED VALUE UNTIL PROGRAMMED ALTITUDE IS REACHED.</td><td rowspan="5">RATES EQUAL SELECTED VALUES (AT INDEX MARK: 300 FT/MIN DN; 500 FT/MIN UP) GOES TO 300 FT BELOW DEST FIELD
NOTE
IF AIRCRAFT LEVELS OFF IN DESCENT, CABIN ALTITUDE ALSO LEVELS OFF AFTER CABIN ALTITUDE DESCENDS TO PROGRAMMED ALTITUDE.</td><td rowspan="5">GOES TO DEST FIELD AT A RATE OF 350 FT/MIN</td></tr>
<tr><td>TAKEOFF FIELD ELEV</td><td>DESTINATION FIELD ELEV</td><td>CABIN ALTITUDE REACTION</td></tr>
<tr><td>BELOW 2700 FT</td><td>BELOW 2700 FT
2700 - 4500 FT
ABOVE 4500 FT</td><td>GOES TO DEST FLD ELEV
CLIMBS TO DEST FLD ELEV
CLIMBS TO 4500 FT</td></tr>
<tr><td>2700 - 4500 FT</td><td>BELOW 2700 FT
2700 - 4500 FT
ABOVE 4500 FT</td><td>DESCENDS TO 2700 FT
GOES TO DEST FLD ELEV
CLIMBS TO 4500 FT</td></tr>
<tr><td>ABOVE 4500 FT</td><td>BELOW 2700 FT
2700 - 4500 FT
ABOVE 4500 FT</td><td>DESCENDS TO 2700 FT
GOES TO DEST FLD ELEV
DESCENDS TO 4500 FT</td></tr>
</table>

PRESSURIZATION SYSTEM CHARACTERISTICS CHART



PROGRAMMED ALTITUDE FUNCTION (AUTO SCHEDULE)

SAMPLE PROFILE 1

SAMPLE PROFILE 2

SAMPLE PROFILE 3

PRESSURIZATION SAMPLE FLIGHT PROFILES

SA1-90B

Figure 1.10-3. Automatic Pressurization Schedule

MODEL: KC-10A

MAX CAB AMB Δ P	MAX A/C ALT	CABIN ALT AT MAX A/C ALT
8.6 PSIG	42,000 FT	7610 FT

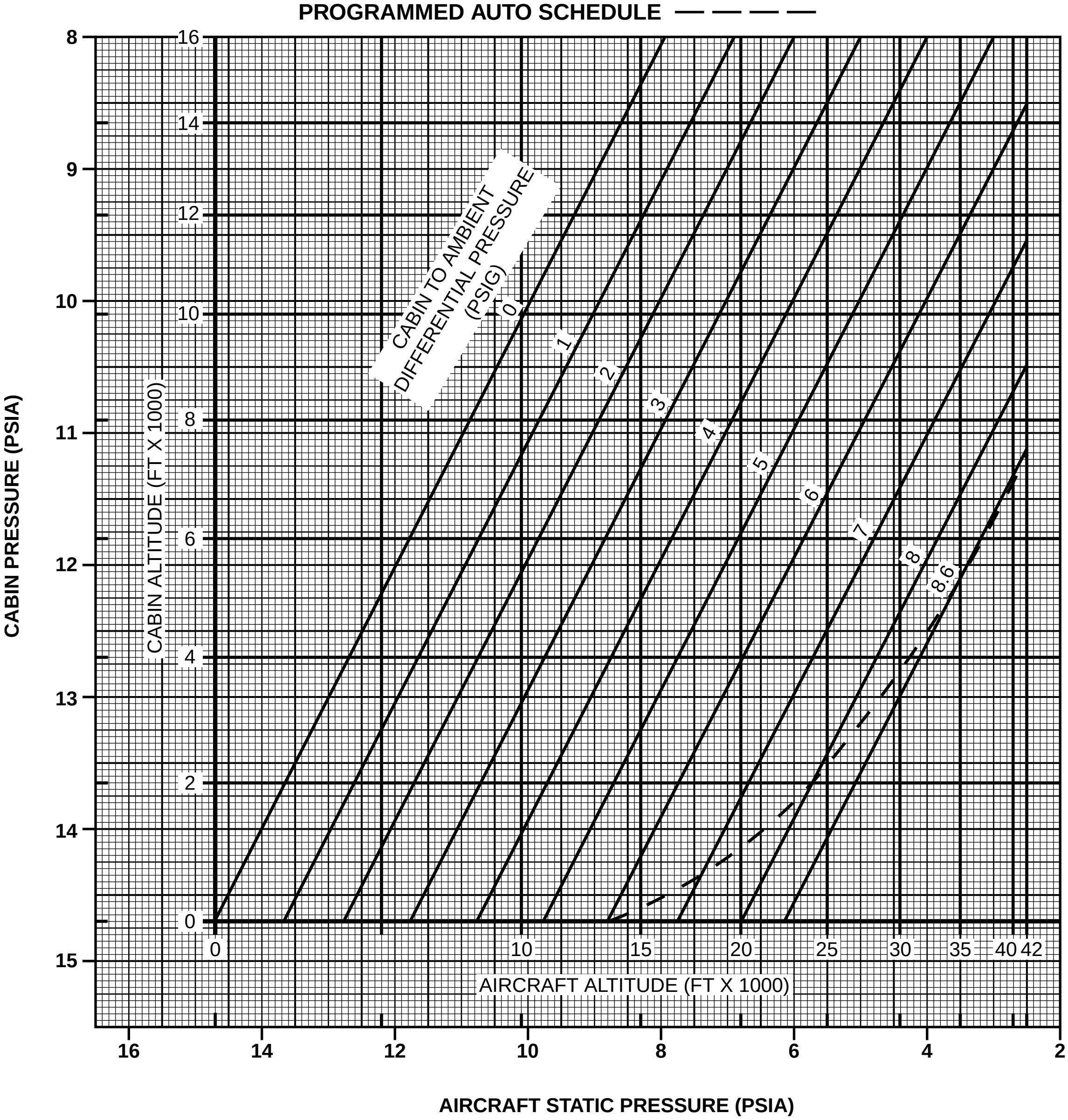
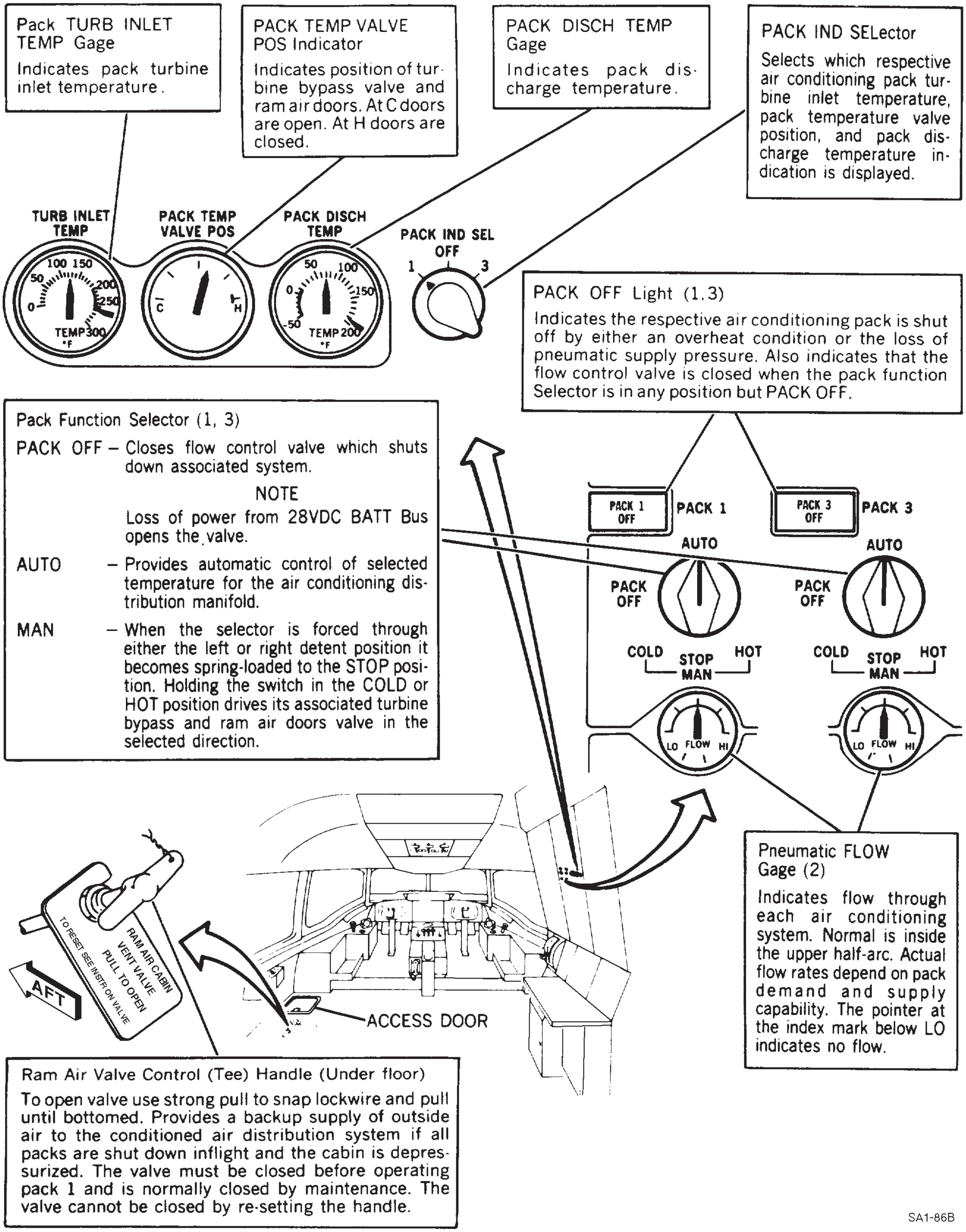


Figure 1.10-4. Cabin Versus Aircraft Altitude Chart



Pack TURB INLET TEMP Gage

Indicates pack turbine inlet temperature.

PACK TEMP VALVE POS Indicator

Indicates position of turbine bypass valve and ram air doors. At C doors are open. At H doors are closed.

PACK DISCH TEMP Gage

Indicates pack discharge temperature.

PACK IND SELector

Selects which respective air conditioning pack turbine inlet temperature, pack temperature valve position, and pack discharge temperature indication is displayed.

PACK OFF Light (1,3)

Indicates the respective air conditioning pack is shut off by either an overheat condition or the loss of pneumatic supply pressure. Also indicates that the flow control valve is closed when the pack function Selector is in any position but PACK OFF.

Pack Function Selector (1, 3)

PACK OFF – Closes flow control valve which shuts down associated system.

NOTE

Loss of power from 28VDC BATT Bus opens the valve.

AUTO – Provides automatic control of selected temperature for the air conditioning distribution manifold.

MAN – When the selector is forced through either the left or right detent position it becomes spring-loaded to the STOP position. Holding the switch in the COLD or HOT position drives its associated turbine bypass and ram air doors valve in the selected direction.

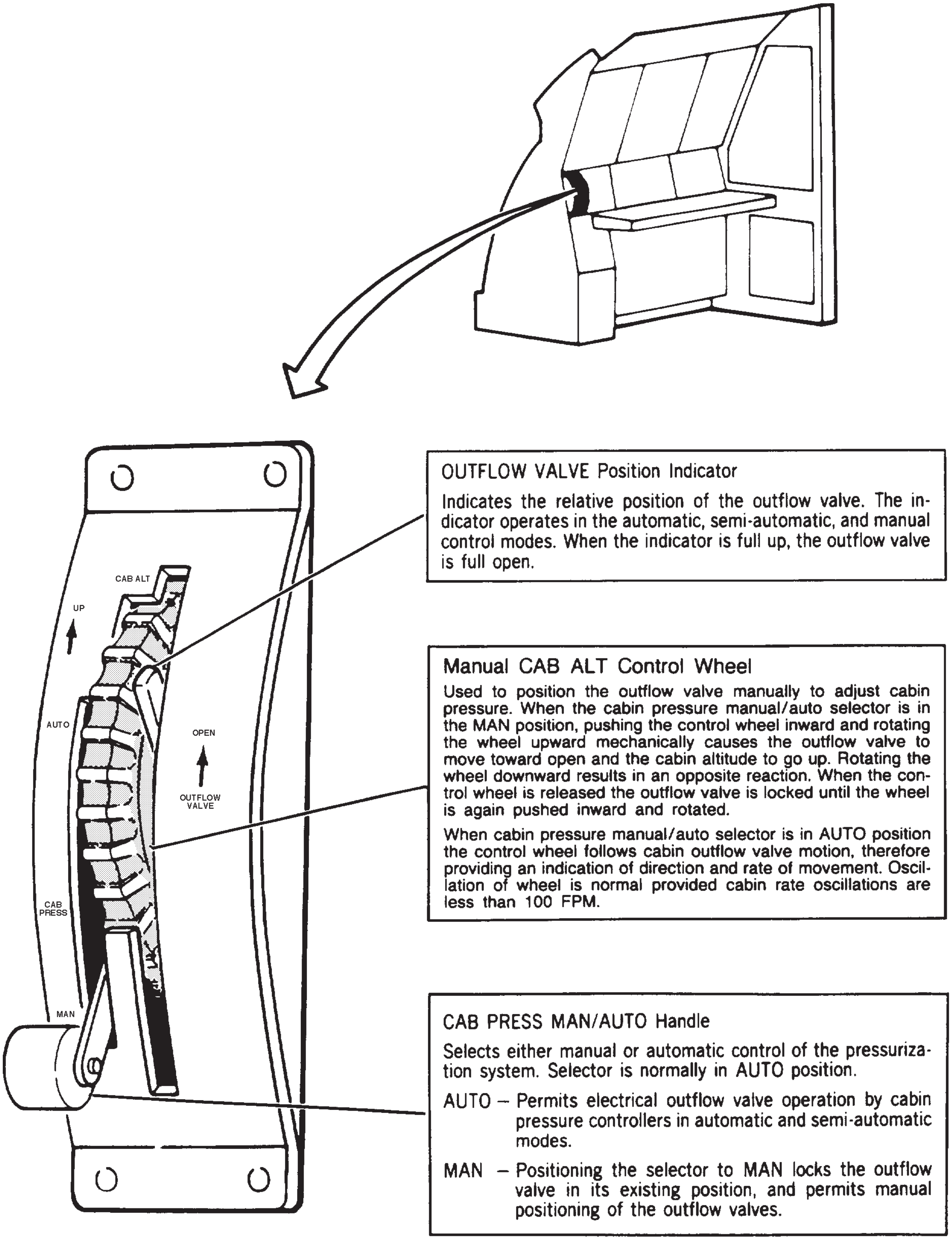
Pneumatic FLOW Gage (2)

Indicates flow through each air conditioning system. Normal is inside the upper half-arc. Actual flow rates depend on pack demand and supply capability. The pointer at the index mark below LO indicates no flow.

Ram Air Valve Control (Tee) Handle (Under floor)

To open valve use strong pull to snap lockwire and pull until bottomed. Provides a backup supply of outside air to the conditioned air distribution system if all packs are shut down inflight and the cabin is depressurized. The valve must be closed before operating pack 1 and is normally closed by maintenance. The valve cannot be closed by re-setting the handle.

Figure 1.10-5. Cabin Altitude Control (Sheet 1)



OUTFLOW VALVE Position Indicator

Indicates the relative position of the outflow valve. The indicator operates in the automatic, semi-automatic, and manual control modes. When the indicator is full up, the outflow valve is full open.

Manual CAB ALT Control Wheel

Used to position the outflow valve manually to adjust cabin pressure. When the cabin pressure manual/auto selector is in the MAN position, pushing the control wheel inward and rotating the wheel upward mechanically causes the outflow valve to move toward open and the cabin altitude to go up. Rotating the wheel downward results in an opposite reaction. When the control wheel is released the outflow valve is locked until the wheel is again pushed inward and rotated.

When cabin pressure manual/auto selector is in AUTO position the control wheel follows cabin outflow valve motion, therefore providing an indication of direction and rate of movement. Oscillation of wheel is normal provided cabin rate oscillations are less than 100 FPM.

CAB PRESS MAN/AUTO Handle

Selects either manual or automatic control of the pressurization system. Selector is normally in AUTO position.

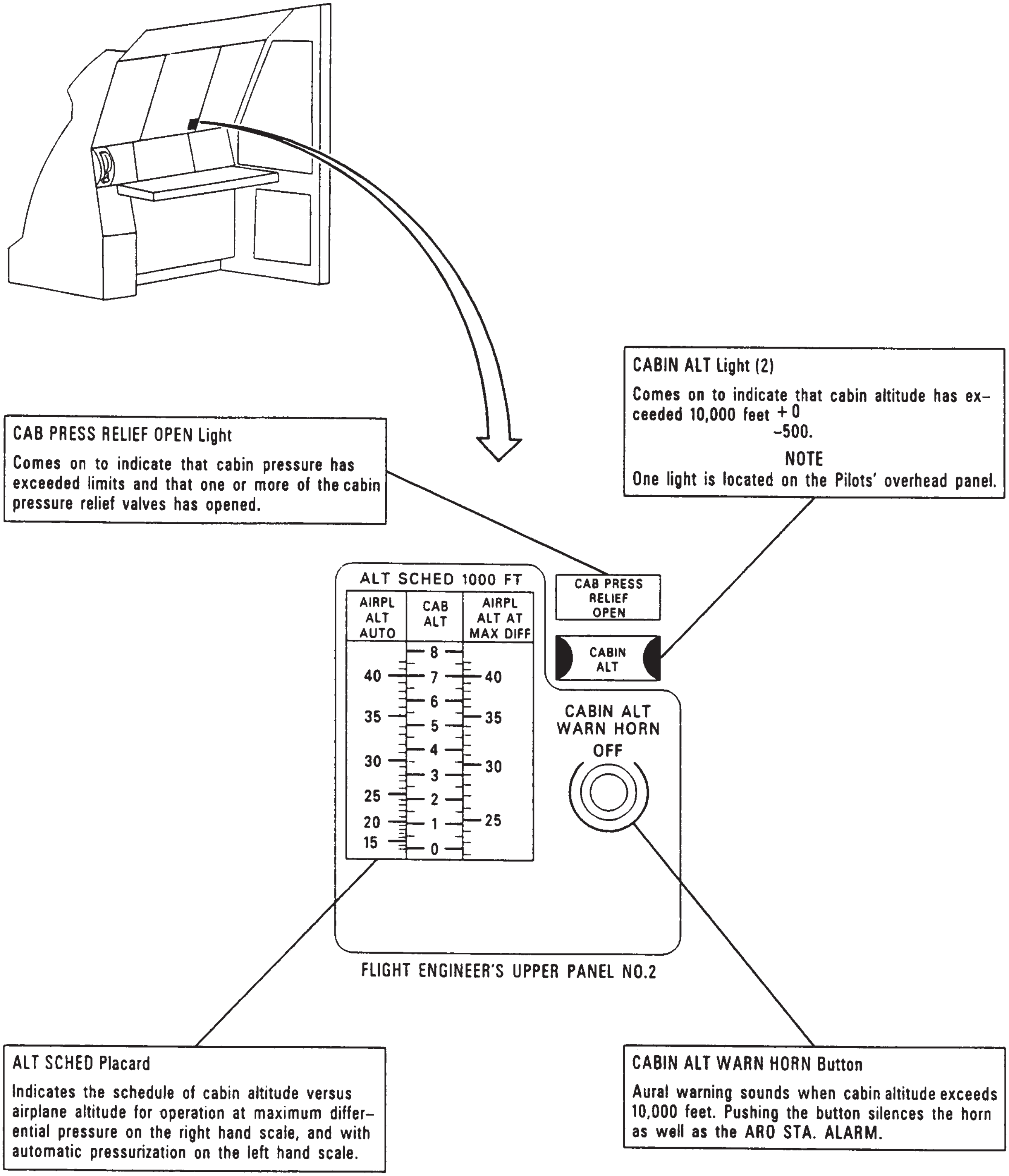
AUTO – Permits electrical outflow valve operation by cabin pressure controllers in automatic and semi-automatic modes.

MAN – Positioning the selector to MAN locks the outflow valve in its existing position, and permits manual positioning of the outflow valves.

FLIGHT ENGINEER'S LOWER PANEL

SA1-83C

Figure 1.10-5. Cabin Altitude Control (Sheet 2)



CAB PRESS RELIEF OPEN Light

Comes on to indicate that cabin pressure has exceeded limits and that one or more of the cabin pressure relief valves has opened.

CABIN ALT Light (2)

Comes on to indicate that cabin altitude has exceeded 10,000 feet $^{+0}_{-500}$.

NOTE

One light is located on the Pilots' overhead panel.

ALT SCHED Placard

Indicates the schedule of cabin altitude versus airplane altitude for operation at maximum differential pressure on the right hand scale, and with automatic pressurization on the left hand scale.

CABIN ALT WARN HORN Button

Aural warning sounds when cabin altitude exceeds 10,000 feet. Pushing the button silences the horn as well as the ARO STA. ALARM.

CAG(IGDS)

SA1-89C

Figure 1.10-6. Cabin Altitude Schedule and Advisory Lights

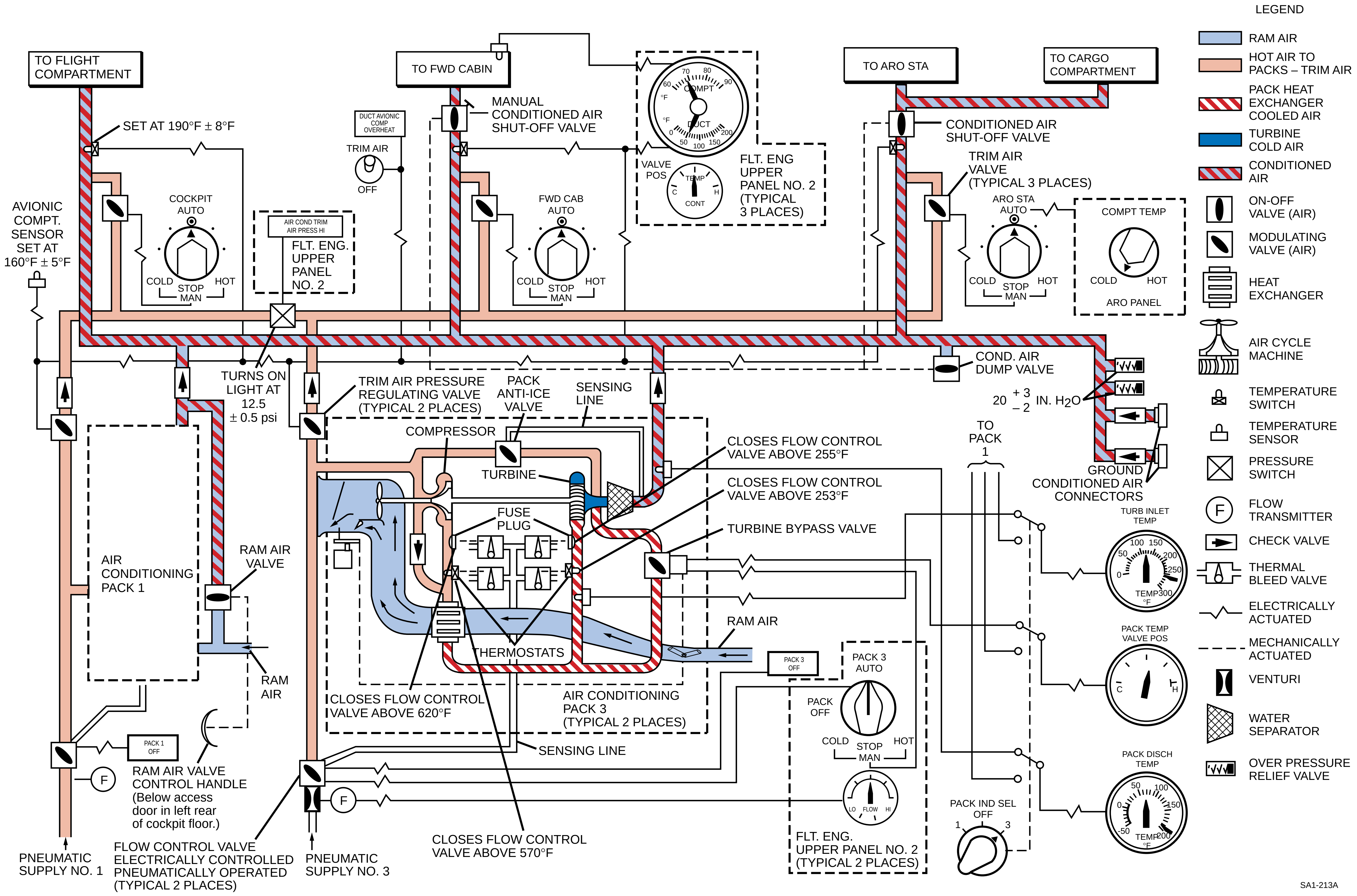
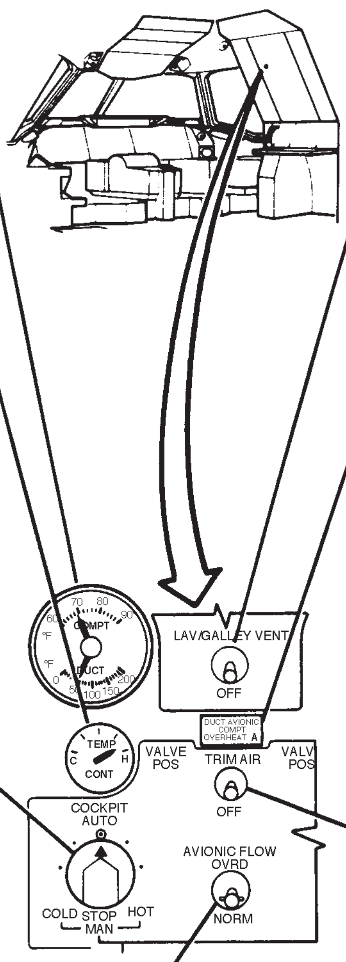


Figure 1.10-7. Air Conditioning System



COMPT/DUCT Temp Gage (3)

Dual temperature gages indicate the inlet duct and compartment temperature in °F for the respective compartment (zone).

VALVE POS Indicator (3)

Indicates the position of the trim air valve for the respective compartment (zone).

Temp Selector (3)

AUTO – Provides automatic control of selected temperature for the applicable zone. The center dot position results in a nominal 75°F (24°C) temperature. Total automatic range is approximately 65°F (18°C) to 85°F (29°C).

NOTE

ARO compartment personnel may make minor temperature adjustments when cockpit ARO STA selector is in AUTO.

MAN – When the switch is forced through either left or right detent position it becomes spring loaded to the STOP position. Holding the switch in the COLD or HOT position drives its associated trim air valve in the selected direction.

LAV/GALLEY VENT Switch

Provides control of galley and lavatory ventilation through jet pump action.

OFF – The OFF position turns off the ventilation system.

DUCT-AVIONIC COMPT OVERHEAT Light

Indicates overheat in one of the three zone inlet ducts or the avionic compartment. When overheat is sensed, trim air is automatically shut off.

TRIM AIR Switch

TRIM AIR – In the TRIM AIR normal position, hot air (modulated) is permitted to temper the air conditioning system on demand. Here, the heated air is taken from systems 1 and 3 and mixed with cooler conditioned air in the individual compartment ducts.

OFF – Prohibits hot air from entering the manifold. If the DUCT-AVIONIC COMPT OVERHEAT light comes on and remains on after the TRIM AIR switch has been placed to OFF, the DUCT-AVIONIC COMPT OVERHEAT light remaining on indicates Avionic Compt overheat still exists and the TRIM AIR switch cannot be reset in flight.

AVIONIC FLOW Switch

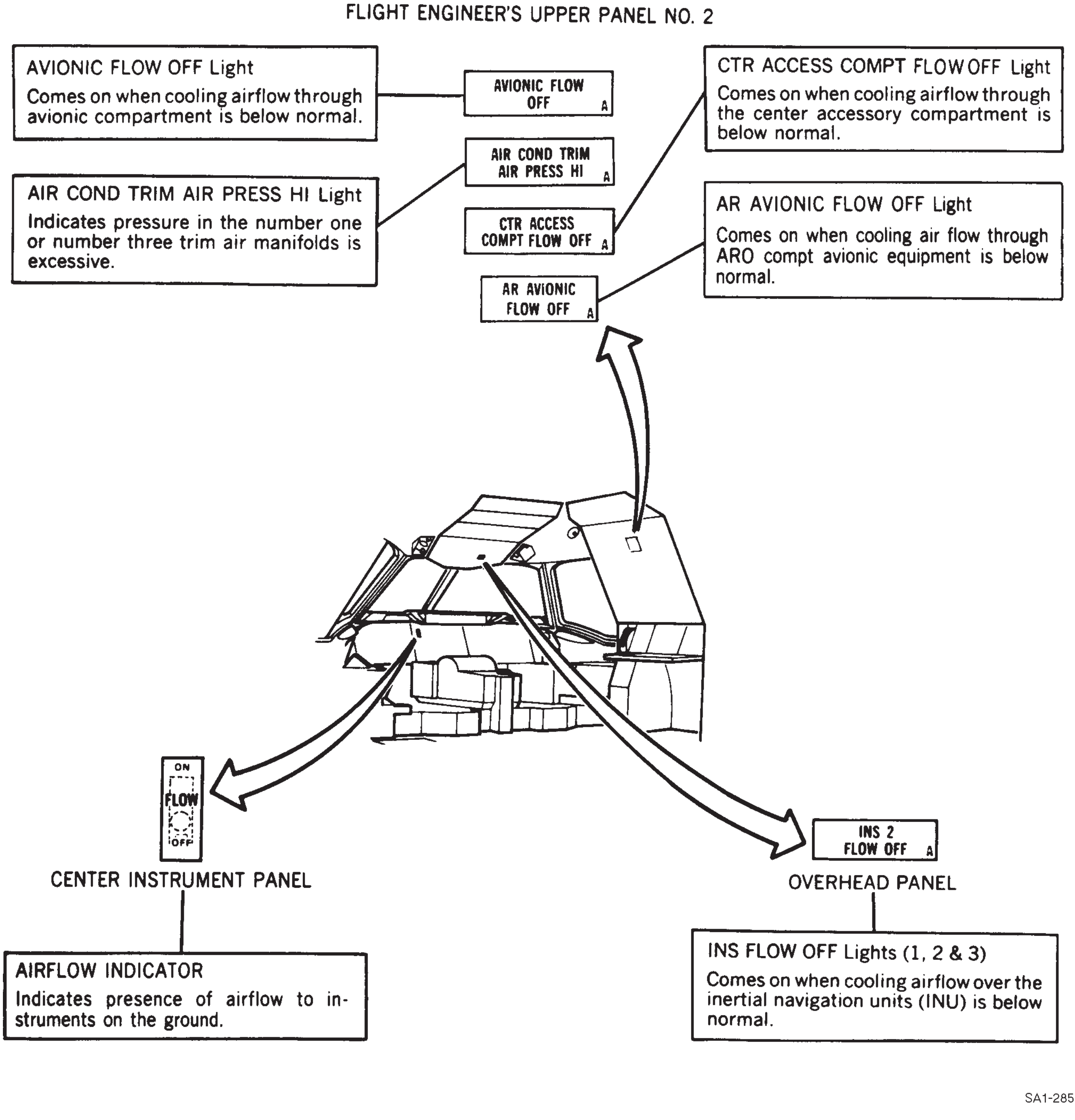
NORM – Provides automatic cooling airflow through avionics compartment.

OVRD – Provides electrical manual override to close venturi valve and turn on avionics cooling fans.

FLIGHT ENGINEER UPPER PANEL NO. 2

SA1-84B

Figure 1.10-8. Flight Compartment Temperature Controls and Indicators (Sheet 1)



FLIGHT ENGINEER'S UPPER PANEL NO. 2

AVIONIC FLOW OFF Light
Comes on when cooling airflow through avionic compartment is below normal.

AIR COND TRIM AIR PRESS HI Light
Indicates pressure in the number one or number three trim air manifolds is excessive.

CTR ACCESS COMPT FLOW OFF Light
Comes on when cooling airflow through the center accessory compartment is below normal.

AR AVIONIC FLOW OFF Light
Comes on when cooling air flow through ARO compt avionic equipment is below normal.

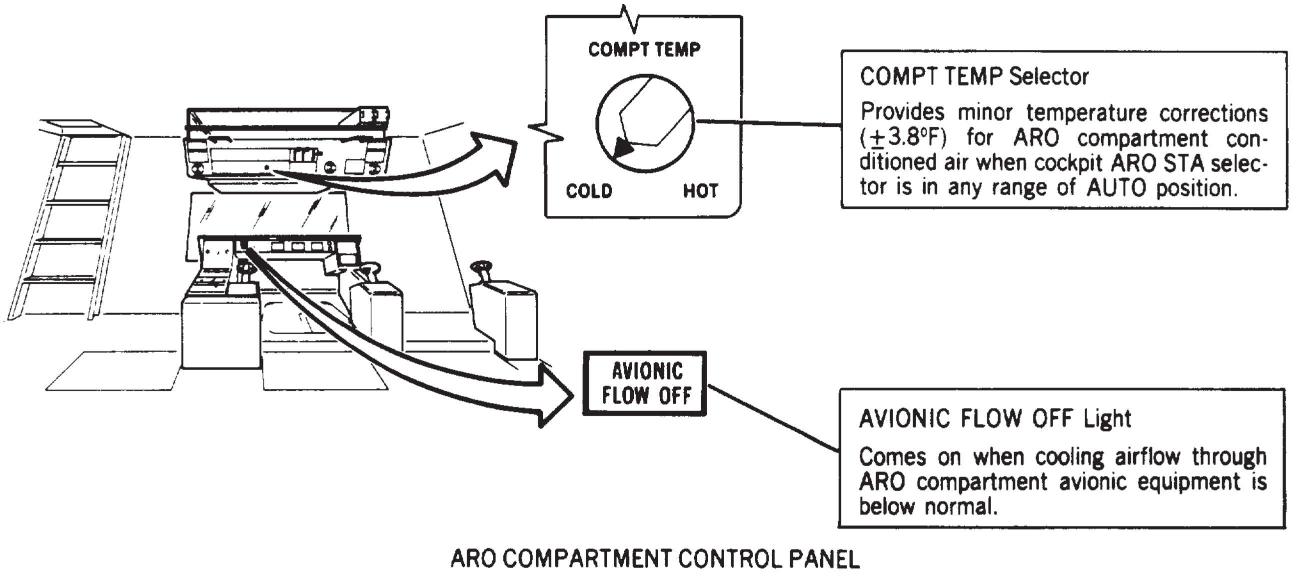
CENTER INSTRUMENT PANEL

AIRFLOW INDICATOR
Indicates presence of airflow to instruments on the ground.

OVERHEAD PANEL

INS FLOW OFF Lights (1, 2 & 3)
Comes on when cooling airflow over the inertial navigation units (INU) is below normal.

Figure 1.10-8. Flight Compartment Temperature Controls and Indicators (Sheet 2)



COMPT TEMP Selector

Provides minor temperature corrections (±3.8°F) for ARO compartment conditioned air when cockpit ARO STA selector is in any range of AUTO position.

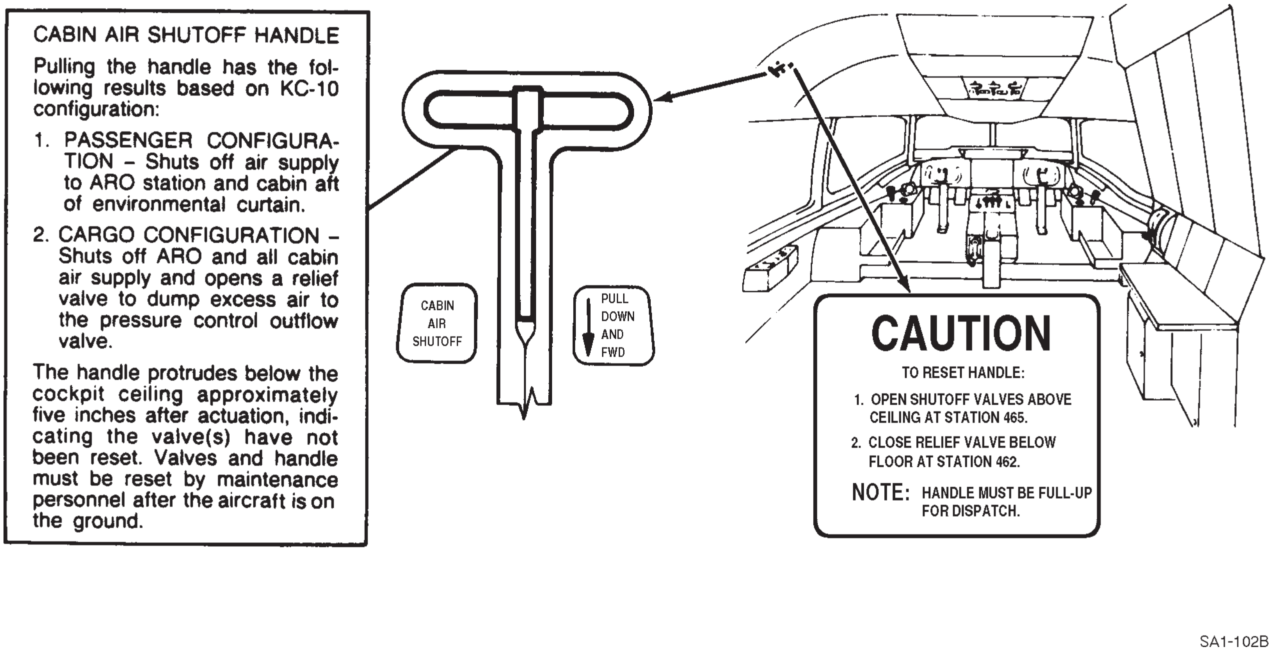
AVIONIC FLOW OFF Light

Comes on when cooling airflow through ARO compartment avionic equipment is below normal.

ARO COMPARTMENT CONTROL PANEL

SA1-85A

Figure 1.10-9. ARO Compartment Temperature Controls and Indicators



CABIN AIR SHUTOFF HANDLE

Pulling the handle has the following results based on KC-10 configuration:

1. PASSENGER CONFIGURATION – Shuts off air supply to ARO station and cabin aft of environmental curtain.
2. CARGO CONFIGURATION – Shuts off ARO and all cabin air supply and opens a relief valve to dump excess air to the pressure control outflow valve.

The handle protrudes below the cockpit ceiling approximately five inches after actuation, indicating the valve(s) have not been reset. Valves and handle must be reset by maintenance personnel after the aircraft is on the ground.

CAUTION

TO RESET HANDLE:

1. OPEN SHUTOFF VALVES ABOVE CEILING AT STATION 465.
2. CLOSE RELIEF VALVE BELOW FLOOR AT STATION 462.

NOTE: HANDLE MUST BE FULL-UP FOR DISPATCH.

SA1-102B

Figure 1.10-10. Cabin Air Shutoff Handle

PART 11

EMERGENCY EQUIPMENT

TABLE OF CONTENTS

EMERGENCY EQUIPMENT

EMERGENCY EQUIPMENT DESCRIPTION

The Emergency Equipment section describes and illustrates the system and equipment essential to the safety of the flight crew and support personnel during adverse operational conditions. These include emergency equipment locations, flight crew and support personnel oxygen systems, portable fire extinguishers, emergency lighting and escape slide/rafts, escape ropes, crash axes, flotation gear, and emergency radio beacon transmitters.

The description for emergency egress involving the emergency operation of the cabin doors, the cockpit door, the clearview window, and the emergency locator transmitter (ELT) are also discussed in this section.

OXYGEN SYSTEM

Two independent emergency oxygen systems are installed in the aircraft. One system (figure 1.11-1) is for the flight crew, and one system (figure 1.11-2) is for the support personnel. Oxygen to the cockpit crew, the ARO compartment, and the additional crew member seats are all connected to the three high-pressure oxygen storage cylinders. Also, each passenger seat is equipped with an Emergency Passenger Oxygen System (EPOS) to supplement aircraft oxygen during cabin smoke/fumes conditions and emergency evacuations. All other seats in the cabin, and the 55 seat kits for additional support personnel are supplied by individual, self-contained chemical oxygen generating/dispensing units. In addition, portable oxygen cylinders (figure 1.11-3) are located in the cockpit, personnel/ cargo compartment, lavatories, and ARO compartment. The four crew bunks (figure 1.11-4) each utilize a portable 11 cu. ft. oxygen bottle. One passenger type mask is taped to each bottle, but not plugged in.

FLIGHT CREW OXYGEN SYSTEM

The flight crew oxygen system is the automatic diluter-demand, pressure breathing type designed for use by crew members during high altitude flight, or in emergency/ abnormal situations where the use of oxygen is required for the safe operation of the aircraft. Incoming pressure from the oxygen tanks is reduced to 70 psi by a reducing assembly, then distributed to fourteen flight crew stations. Individual quick-donning masks, with attached smoke goggles, are located at each of the flight crew stations.

NOTE

> If goggles are required, they must be worn over the outside of the oxygen mask. This allows an oxygen flow into the goggles to clear any existing smoke or fumes trapped in the goggles.

The regulator (figure 1.11-5) is a lighted panel attached to a structural portion of the aircraft near each crew member station and has all controls on the panel. Breathing oxygen is delivered to the mask by means of a flexible hose attached to the outlet of the regulator. Charts (figure 1.11-6) show duration of flight crew oxygen system against inflight variables.

NORMAL OPERATION

The regulator will deliver the optimum mixture of air and oxygen for a particular cabin altitude in the quantity demanded by the crew member. With the right-hand toggle in the ON position, the center toggle in the NORMAL OXYGEN position, and the left toggle in the NORMAL position, as cabin altitude increases, the amount of cabin air in the mixture decreases until 100 percent oxygen is delivered to the mask at approximately 29,000 feet cabin altitude. With the center toggle in 100% OXYGEN position, pure oxygen is delivered, regardless of cabin altitude, in a quantity determined by inhalation of the user.

EMERGENCY OPERATION

Positive oxygen pressure can be provided to the mask at any altitude where positive pressure is not

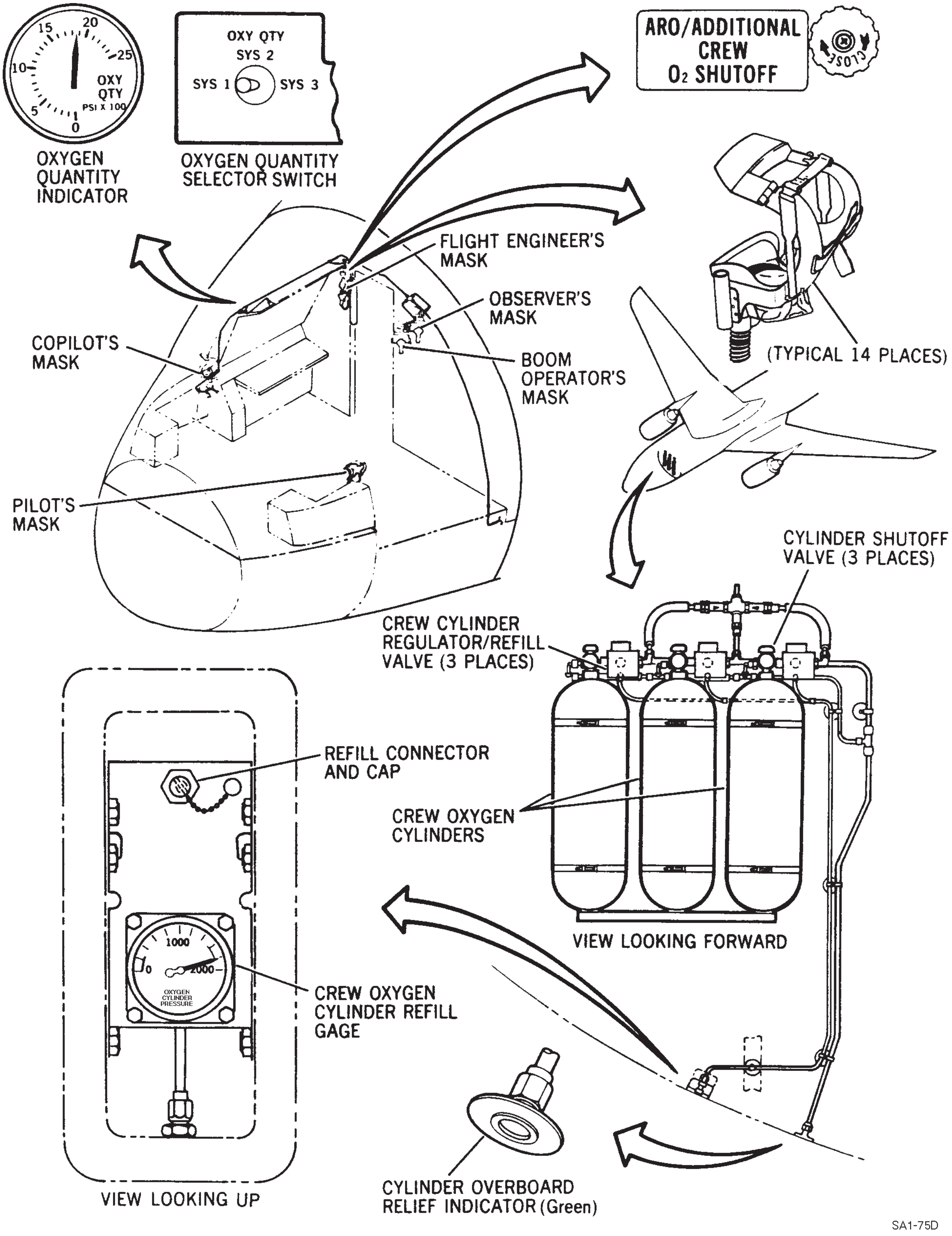


Figure 1.11-1. Flight Crew Oxygen System

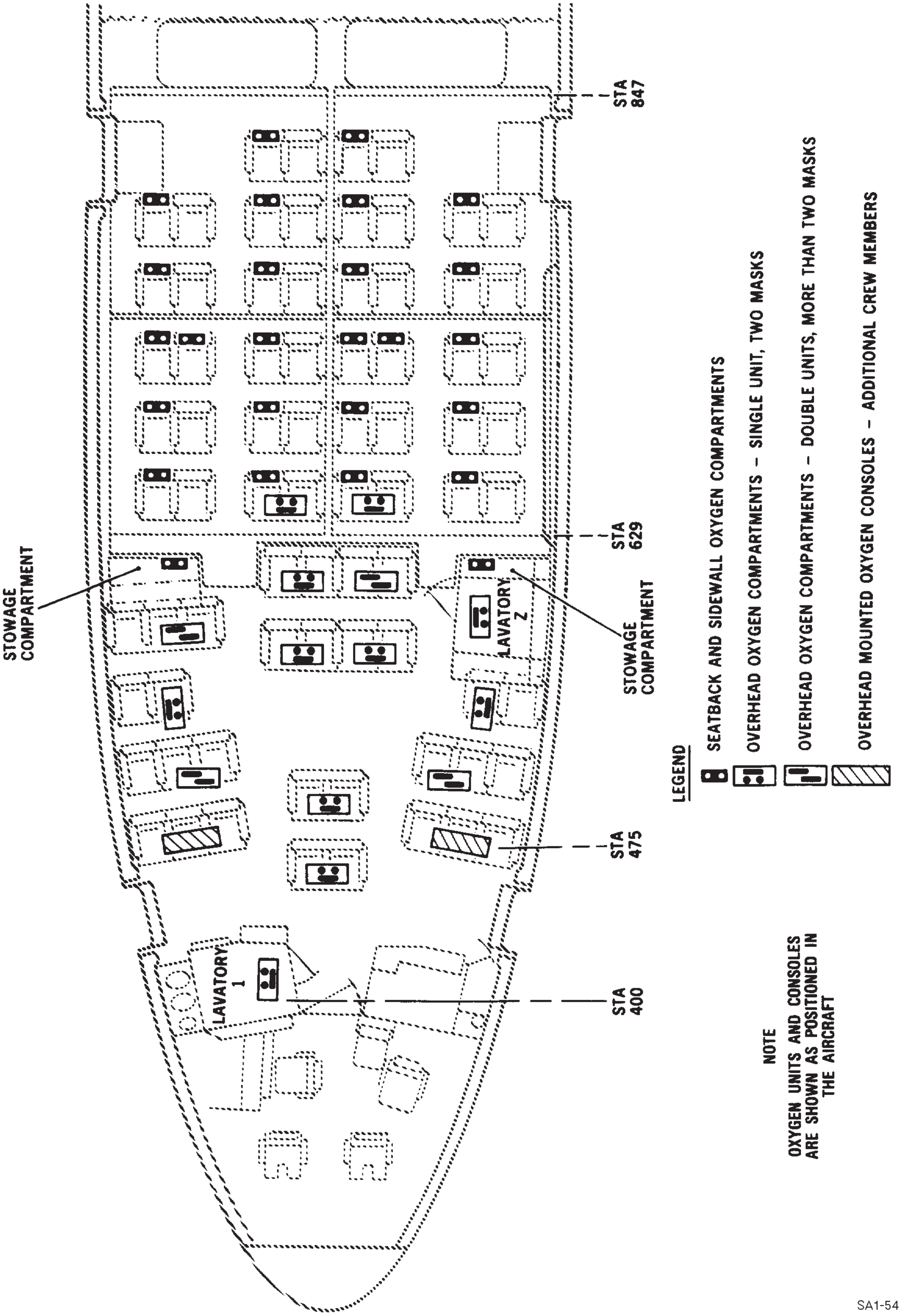
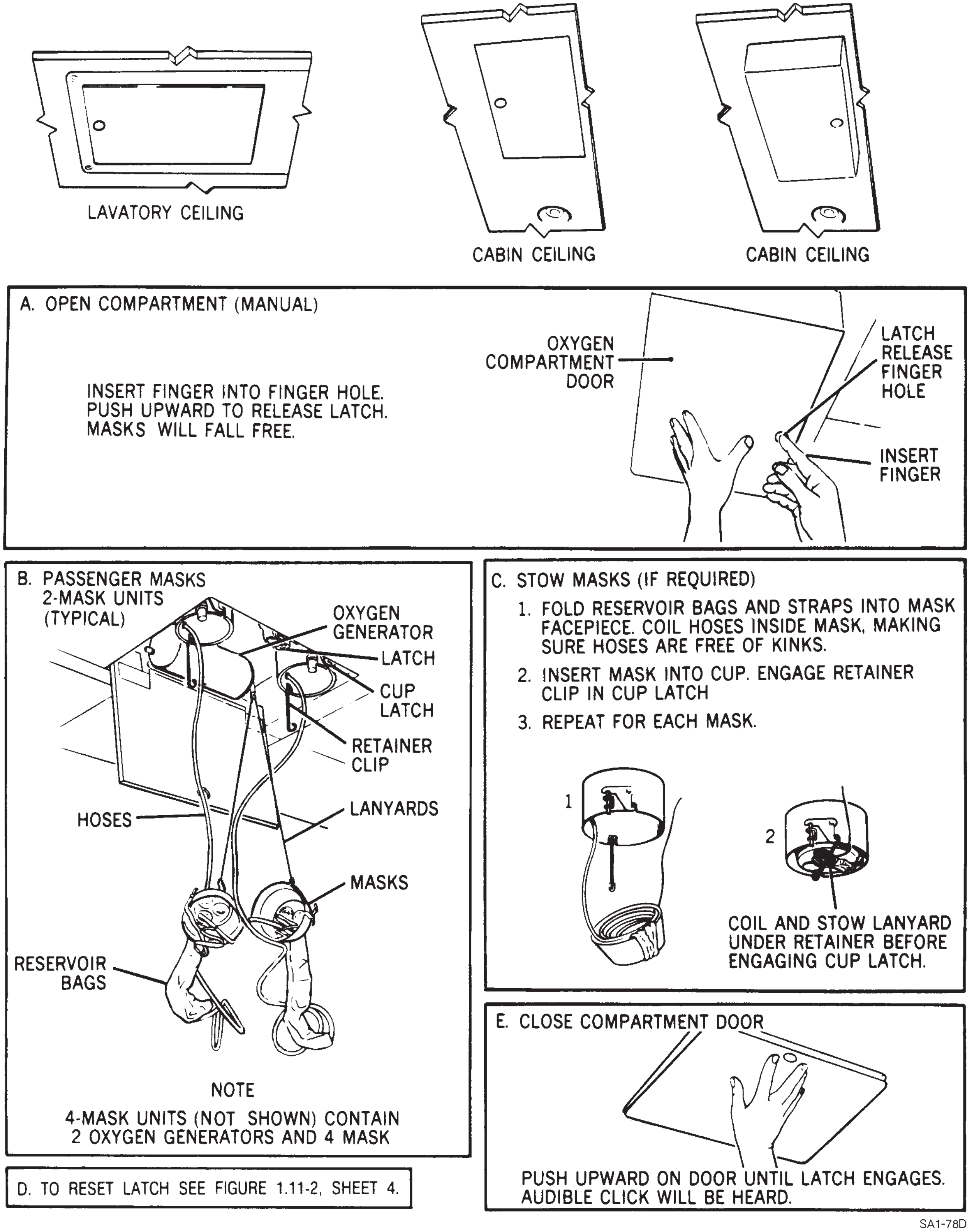


Figure 1.11-2. Oxygen Compartments (Sheet 1)



A. OPEN COMPARTMENT (MANUAL)

INSERT FINGER INTO FINGER HOLE.
PUSH UPWARD TO RELEASE LATCH.
MASKS WILL FALL FREE.

NOTE

4-MASK UNITS (NOT SHOWN) CONTAIN 2 OXYGEN GENERATORS AND 4 MASK

C. STOW MASKS (IF REQUIRED)

1. FOLD RESERVOIR BAGS AND STRAPS INTO MASK FACEPIECE. COIL HOSES INSIDE MASK, MAKING SURE HOSES ARE FREE OF KINKS.
2. INSERT MASK INTO CUP. ENGAGE RETAINER CLIP IN CUP LATCH
3. REPEAT FOR EACH MASK.

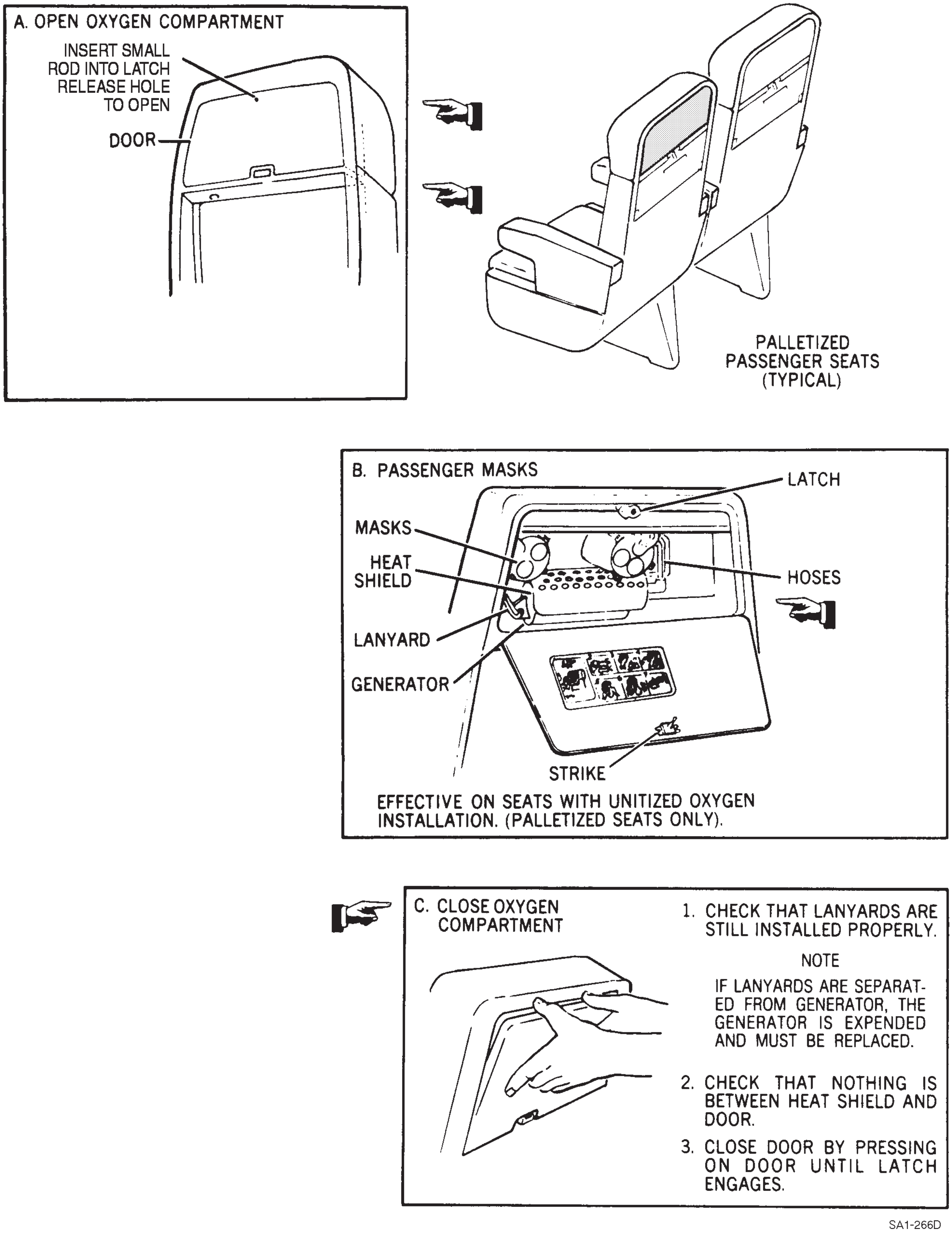
COIL AND STOW LANYARD UNDER RETAINER BEFORE ENGAGING CUP LATCH.

D. TO RESET LATCH SEE FIGURE 1.11-2, SHEET 4.

E. CLOSE COMPARTMENT DOOR

PUSH UPWARD ON DOOR UNTIL LATCH ENGAGES.
AUDIBLE CLICK WILL BE HEARD.

Figure 1.11-2. Oxygen Compartments (Sheet 2)



EFFECTIVE ON SEATS WITH UNITIZED OXYGEN INSTALLATION. (PALLETIZED SEATS ONLY).

1. CHECK THAT LANYARDS ARE STILL INSTALLED PROPERLY.

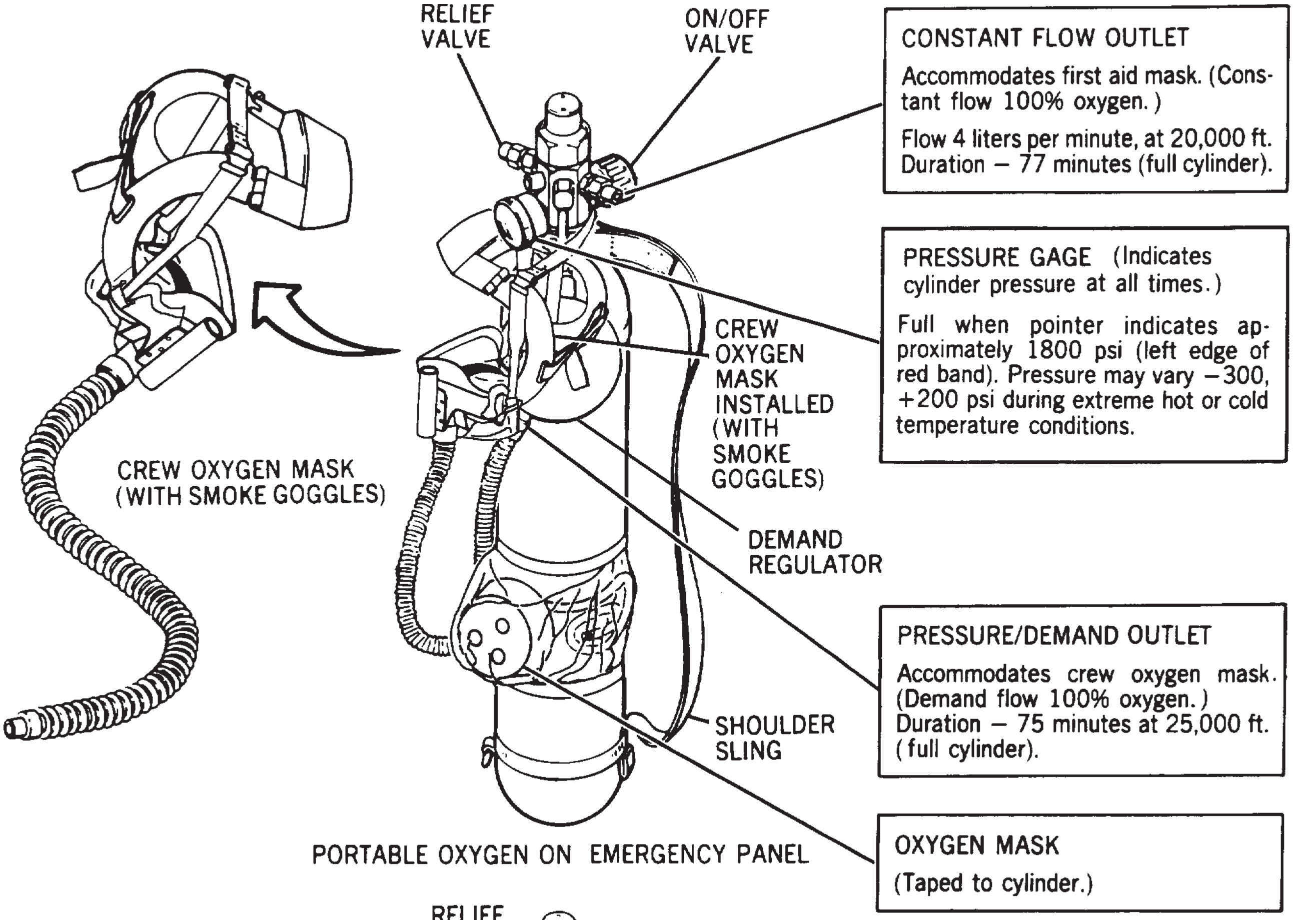
NOTE

IF LANYARDS ARE SEPARATED FROM GENERATOR, THE GENERATOR IS EXPENDED AND MUST BE REPLACED.

2. CHECK THAT NOTHING IS BETWEEN HEAT SHIELD AND DOOR.
3. CLOSE DOOR BY PRESSING ON DOOR UNTIL LATCH ENGAGES.

Figure 1.11-2. Oxygen Compartments (Sheet 3)

Page 1.11-8 is deleted.



CONSTANT FLOW OUTLET

Accommodates first aid mask. (Constant flow 100% oxygen.)

Flow 4 liters per minute, at 20,000 ft. Duration – 77 minutes (full cylinder).

PRESSURE GAGE (Indicates cylinder pressure at all times.)

Full when pointer indicates approximately 1800 psi (left edge of red band). Pressure may vary –300, +200 psi during extreme hot or cold temperature conditions.

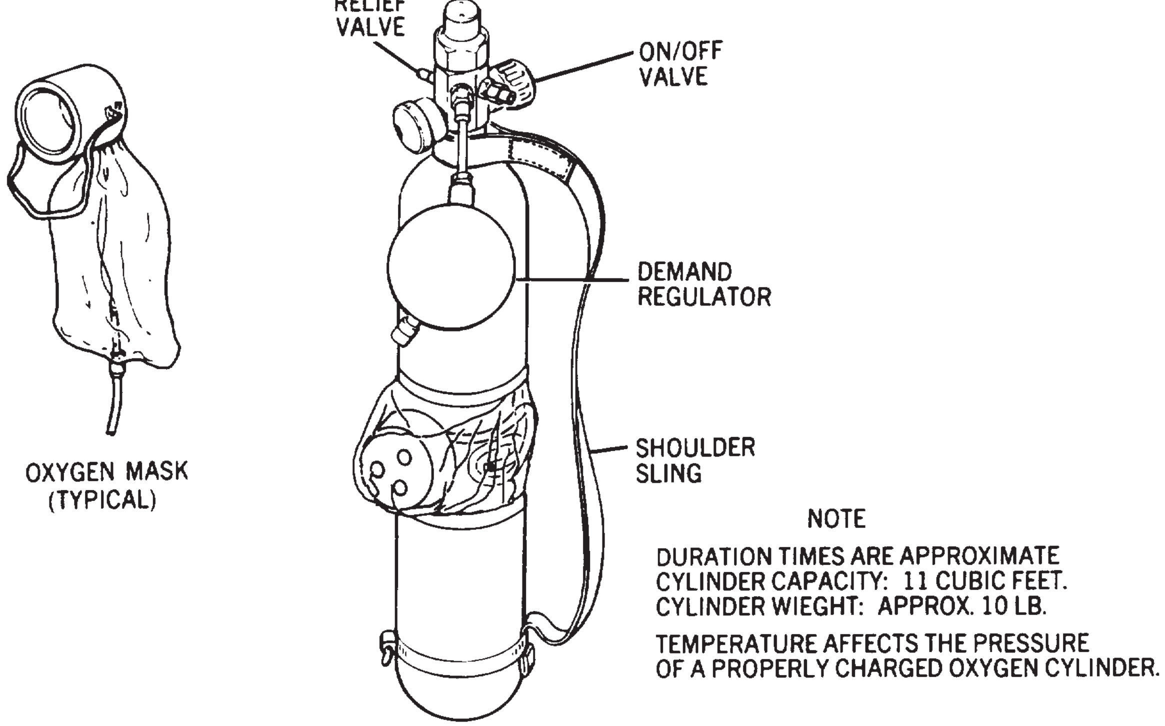
PRESSURE/DEMAND OUTLET

Accommodates crew oxygen mask. (Demand flow 100% oxygen.) Duration – 75 minutes at 25,000 ft. (full cylinder).

OXYGEN MASK

(Taped to cylinder.)

PORTABLE OXYGEN ON EMERGENCY PANEL



NOTE

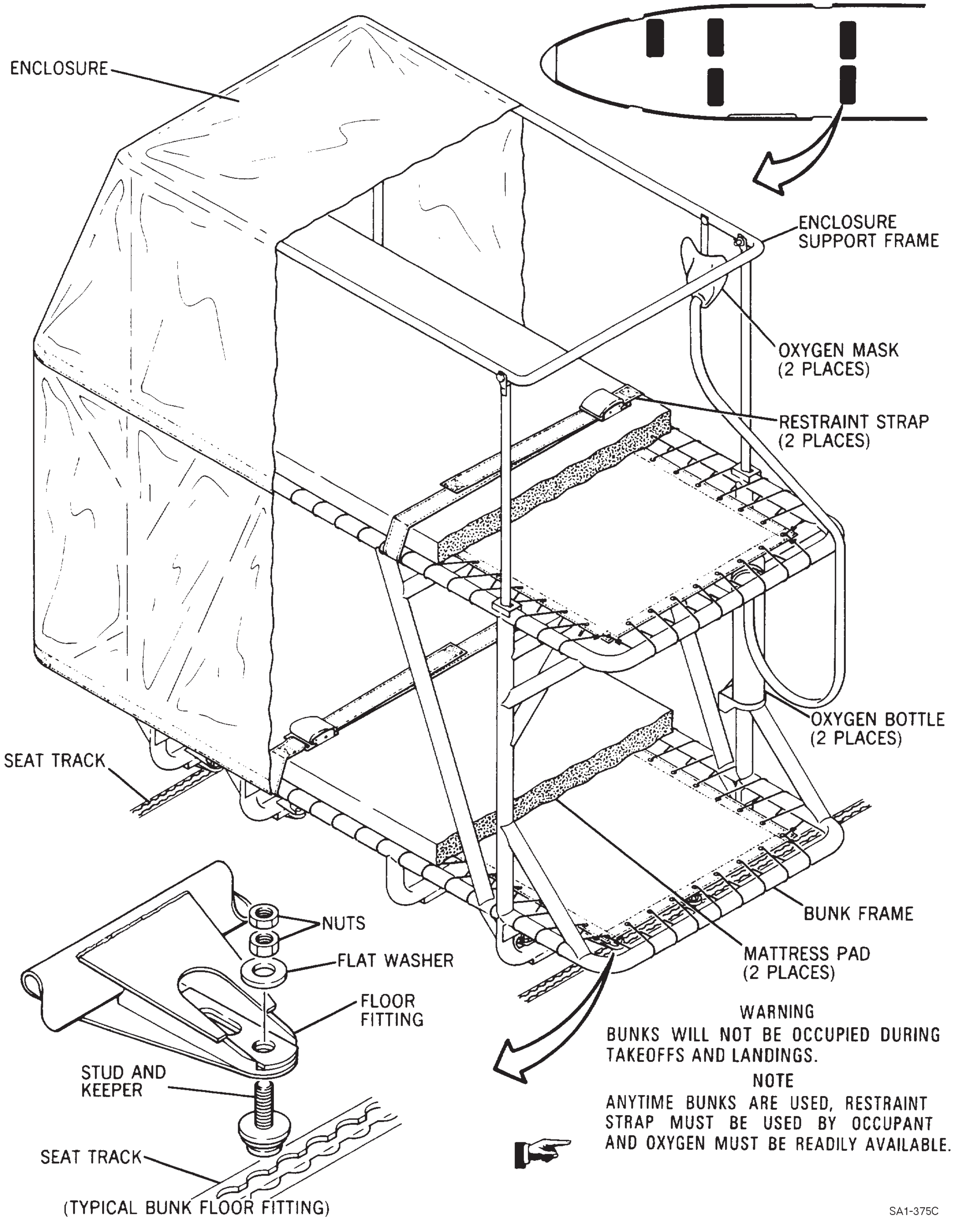
DURATION TIMES ARE APPROXIMATE
CYLINDER CAPACITY: 11 CUBIC FEET.
CYLINDER WIEGHT: APPROX. 10 LB.

TEMPERATURE AFFECTS THE PRESSURE OF A PROPERLY CHARGED OXYGEN CYLINDER.

PORTABLE OXYGEN AT CREW STATIONS, LAVATORIES, AND BUNKS

SA1-372D

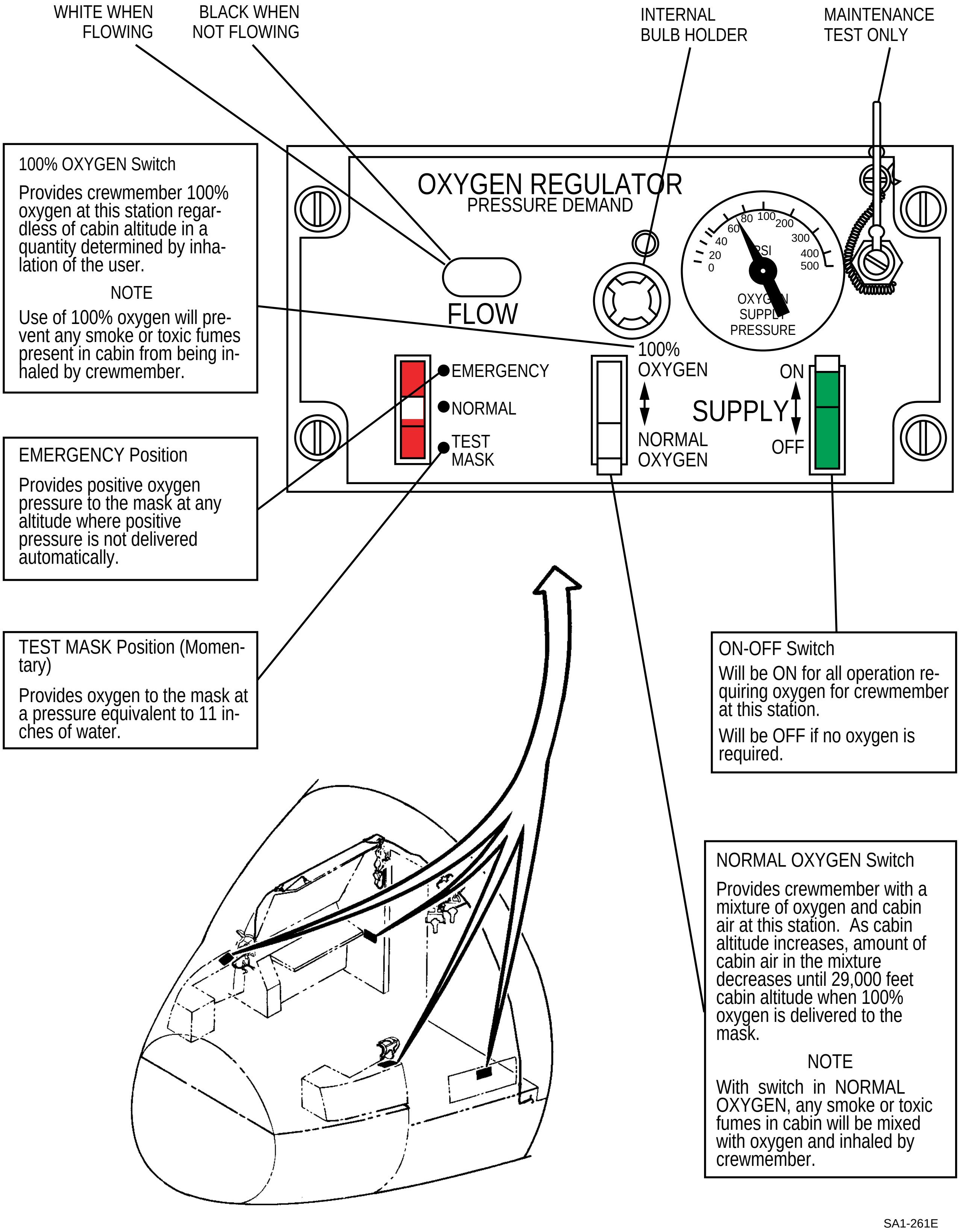
Figure 1.11-3. Portable Oxygen Cylinders And Masks



WARNING
BUNKS WILL NOT BE OCCUPIED DURING TAKEOFFS AND LANDINGS.

NOTE
ANYTIME BUNKS ARE USED, RESTRAINT STRAP MUST BE USED BY OCCUPANT AND OXYGEN MUST BE READILY AVAILABLE.

Figure 1.11-4. Bunks



100% OXYGEN Switch

Provides crewmember 100% oxygen at this station regardless of cabin altitude in a quantity determined by inhalation of the user.

NOTE

Use of 100% oxygen will prevent any smoke or toxic fumes present in cabin from being inhaled by crewmember.

EMERGENCY Position

Provides positive oxygen pressure to the mask at any altitude where positive pressure is not delivered automatically.

TEST MASK Position (Momentary)

Provides oxygen to the mask at a pressure equivalent to 11 inches of water.

ON-OFF Switch

Will be ON for all operation requiring oxygen for crewmember at this station.

Will be OFF if no oxygen is required.

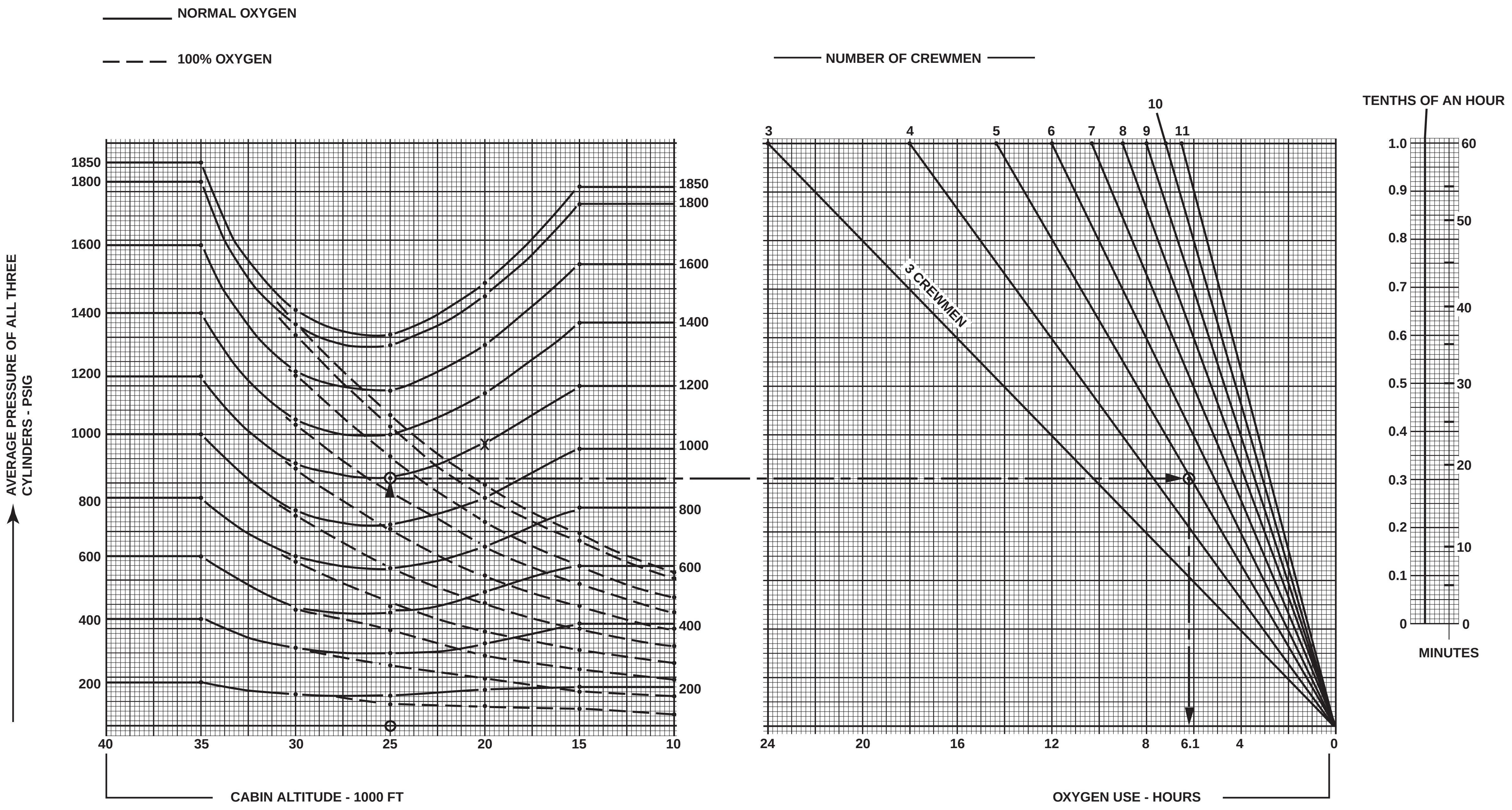
NORMAL OXYGEN Switch

Provides crewmember with a mixture of oxygen and cabin air at this station. As cabin altitude increases, amount of cabin air in the mixture decreases until 29,000 feet cabin altitude when 100% oxygen is delivered to the mask.

NOTE

With switch in NORMAL OXYGEN, any smoke or toxic fumes in cabin will be mixed with oxygen and inhaled by crewmember.

Figure 1.11-5. Flight Crew Oxygen Regulator



SA1-216

Figure 1.11-6. Flight Crew Oxygen System Duration Chart

delivered automatically. Move the left toggle lever to the EMERGENCY position to start a constant flow of oxygen to the mask at a pressure equivalent to 3.5 inches of water.

In the TEST MASK MOMENTARY position, oxygen is provided to the mask at a pressure equivalent to 11 inches of water. The toggle is spring loaded to NORMAL and must be held in TEST MASK position.

AUTOMATIC SAFETY PRESSURE FEATURE

Between 29,000 and 39,500 feet cabin altitude, a safety pressure of 0.1 to 2.0 inches of water is automatically delivered to the regulator outlet. At 40,000 feet cabin altitude and above, pressure breathing is provided by an aneroid mechanism which automatically increases the regulator outlet pressure to 2 to 15 inches of water. The oxygen pressure is dependent upon cabin altitude.

ARO/ADDITIONAL CREW O_2 SHUTOFF

A normally open oxygen shutoff valve is located in the flight deck (cockpit) ceiling above the Flight Engineer's station. When this valve is closed, oxygen supply to all crew locations outside of the cockpit will be shutoff. The valve is placarded ARO/ADDITIONAL O_2 SHUTOFF (figure 1.11-1).

PASSENGER OXYGEN SYSTEM

The passenger oxygen generating/dispensing system supplies supplemental oxygen to the support personnel/passengers in the personnel/cargo compartment on an emergency basis. Once started, the system will supply oxygen for a maximum of 22 minutes regardless of the rate of use.

Each unit includes a chemical oxygen generator, oxygen masks with reservoir transparent bags, and hoses to convey oxygen from the generator to all attached masks.

PERMANENT SEAT OXYGEN SYSTEM

The fourteen permanent seats have the oxygen masks (figure 1.11-2) mounted in the cabin ceiling. The system is comprised of an aneroid switch, a 5-second timer, a permanently installed test panel, and seven oxygen stowage containers. The aneroid switch is located in the ceiling of the passenger/cargo compartment. It senses cabin pressure, and energizes the oxygen mask eject relay in the event of loss of cabin pressure. When the cabin altitude reaches 14,150 ± 350 feet, the contact points in the switch close and will remain closed as long as the cabin altitude meets or exceeds this value. There is a hinged door held shut by a solenoid latch. When energized, the latch opens, allowing the masks to fall where they are suspended by a nylon lanyard attached to a firing pin mechanism on the oxygen generating unit. Pulling any one mask down for use pulls the firing pin lanyard from the generator and initiates the oxygen generating process.

Oxygen automatically flows through all masks attached. Using only one mask from the compartment does not extend the 22 minutes maximum time of oxygen use.

A rotary switch underneath the Flight Engineer's table will test the support personnel oxygen system wiring.

INCREASED ACCOMMODATION UNIT (IAU) SEAT OXYGEN SYSTEM

The 55 kit seats which may be installed use the same aneroid switch and 5-second timer as the permanent seat oxygen system. A separate test panel located at station 615 is used to verify the integrity of the 34 oxygen stowage containers in the system when the seat kits are installed. The additional oxygen capability will not be installed at the factory and will be changed by ground service personnel for the individual mission requirements of each flight for support personnel, since oxygen kits are contained in the back of each seat.

WARNING

> The oxygen generator surface temperature may reach 500° F (260° C) when generating oxygen. Do not touch or attempt to remove generator. Burn injury can result. If an active generator is inadvertently removed from compartment, it must be placed in a metal container such as a lavatory or galley sink. Heat will scorch other metals or fabrics.

NOTE

> Odor similar to scorched cloth may be created by activation of generators. The odor does not affect the purity of the oxygen and there is no fire hazard.

Masks are continuous flow type. No shutoff valves are provided. A small bright green compartment built into the lower section of the reservoir bag inflates immediately when oxygen starts to flow, indicating oxygen is being supplied to the mask. Oxygen pressure/flow rates are low, so oxygen reservoir bags will not inflate fully between breathing cycles. Inflation rate is dependent on cabin altitude and elapsed time since generator activation. As a backup to the automatic system, the oxygen mask switch on the Flight Engineer's Electrical Panel provides a manual override for releasing the masks. Moving the switch to EJECT will open all oxygen compartment doors.

CAUTION

> Holding the switch in EJECT position for more than 5 seconds could cause serious damage to oxygen modular door latching mechanisms.

As a backup to the automatic system, each individual oxygen compartment door also can be opened manually. Seatback-mounted compartment doors can be opened by inserting a small rod into the latch release hole in the top center area of the oxygen compartment door (figure 1.11-2).

All other oxygen compartment doors can be opened by inserting a finger into a finger hole in the door. Make contact with the latch opening mechanism, apply pressure upward to release the latch (figure 1.11-2).

IAU OXYGEN SYSTEM CIRCUIT TEST

After emergency oxygen circuits are connected to seat pallets (and all emergency oxygen units are installed), conduct the following oxygen system circuit test. The test panel is located on the aft wall of the right-hand stowage compartment, just forward of the seat pallets (figure 1.11-7).

Test (Figure 1.11-7)

1. Turn OXY SYS TEST switch to TEST position.
    a. Five green OXY SYS VALID lights should come on, indicating all circuits to four seat pallets and overhead cabin oxygen units are good.
    b. If any green OXY SYS VALID lights do not come on, determine cause of open circuit and correct, if possible.
    c. If any red OXY SYS SHORT lights come on, determine cause of short and correct, if possible.

WARNING

> If an oxygen system circuit malfunction cannot be corrected, personnel shall not occupy the affected seats during flight.

2. Return OXY SYS TEST switch to OFF position. Five green OXY SYS VALID lights should go out.

EMERGENCY PASSENGER OXYGEN SYSTEM (EPOS)

The EPOS is a self-contained protective breathing device to provide oxygen during aircraft decompressions, when smoke or toxic fumes are present, and to aid in exiting oxygen deficient smoke filled cabins. The system consists of: A hood, oxygen cylinder, carbon dioxide control, and neck seal. (Figure 1.11-12, Sheet 2).

The hood incorporates multiple layers of Kapton and Teflon film providing heat and flame resistant to 1000°C (1832°F), ease of communication, tear resistance, and durability. An Anti-Fog coating is applied to the inside of the hood.

The EPOS contains one oxygen cylinder that contains 18 liters of Aviator Grade oxygen. Once activated, the oxygen cylinder dispenses oxygen for approximately 5 minutes. The sound of oxygen can be heard flowing into the hood. Once the oxygen cylinder has been depleted, the hood will start collapsing. If the hood collapses to the point where it touches the wearer’s face, the wearer should be prepared to remove the EPOS. You should remove the EPOS when you have evacuated to a safe area, or when directed by a qualified crewmember.

Carbon dioxide is controlled by panels of lithium hydroxide mounted around the inside bottom portion of the hood.

Duration of Use:	5 minutes under moderate to heavy workload 17 minutes sedentary followed by 3 minutes of moderate to heavy workload Up to 60 minutes under sedentary conditions

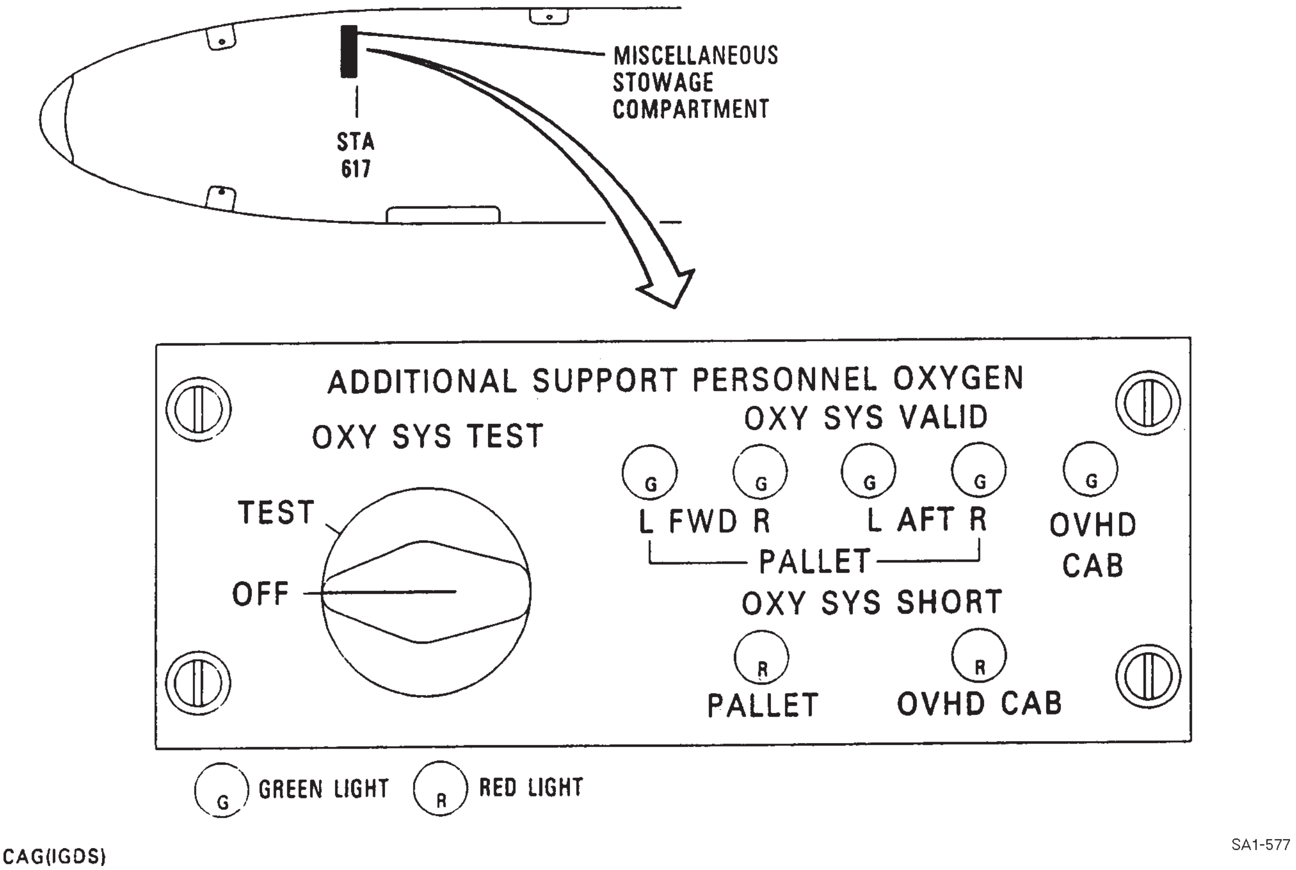


Figure 1.11-7. Oxygen System Circuit Test Panel

NOTE

The EPOS can also be used as a supplemental oxygen source in the event of a cabin depressurization.

PORTABLE OXYGEN CYLINDERS

Thirteen portable cylinders (figure 1.11-3) containing breathing oxygen provide mobility for the flight crew and additional crew if cabin pressure emergencies occur or for first aid use. Each cylinder is equipped with a carrying strap for ease of handling. The cylinders are mounted on quick-release clamps. Each cylinder weighs approximately 10 pounds and has a capacity of 11 cubic feet (figures 1.11-8 and 1.11-9).

The flight crew portable oxygen cylinder is located in the flight compartment on the forward side of the crew coatroom. Portable oxygen cylinders for use by additional crew/support personnel are located in the following locations: One in the lavatory on the aft face of the forward bulkhead, one on each of the forward and aft emergency equipment panels, one at the end of each bunk, one at each additional crew triple seat position, and three in the ARO compartment on the equipment panel. An additional portable oxygen cylinder is installed when palletized lavatory is installed. Each cylinder is equipped with a fill-check valve, relief valve, pressure gage, hand operated shutoff valve, primary pressure-demand regulator, positive pressure toggle, quick disconnect fitting, and a passenger type mask in a plastic bag.

To supply oxygen to the mask, the hose must be connected to the outlet, and the shutoff valve must be opened by turning the knob at least one-half turn.

Refer to Portable Emergency Equipment (figure 1.11-10) Diagram (Types and Location), and figures 1.11-12 and 1.11-13 for use of emergency equipment.

Emergency lighting and controls are depicted in detail (figures 1.11-14 and 1.11-15) as are the Personnel Evacuation and Slide Arrangements in the Passenger and Cargo Delivery Configurations (figures 1.11-16 and 1.11-17).

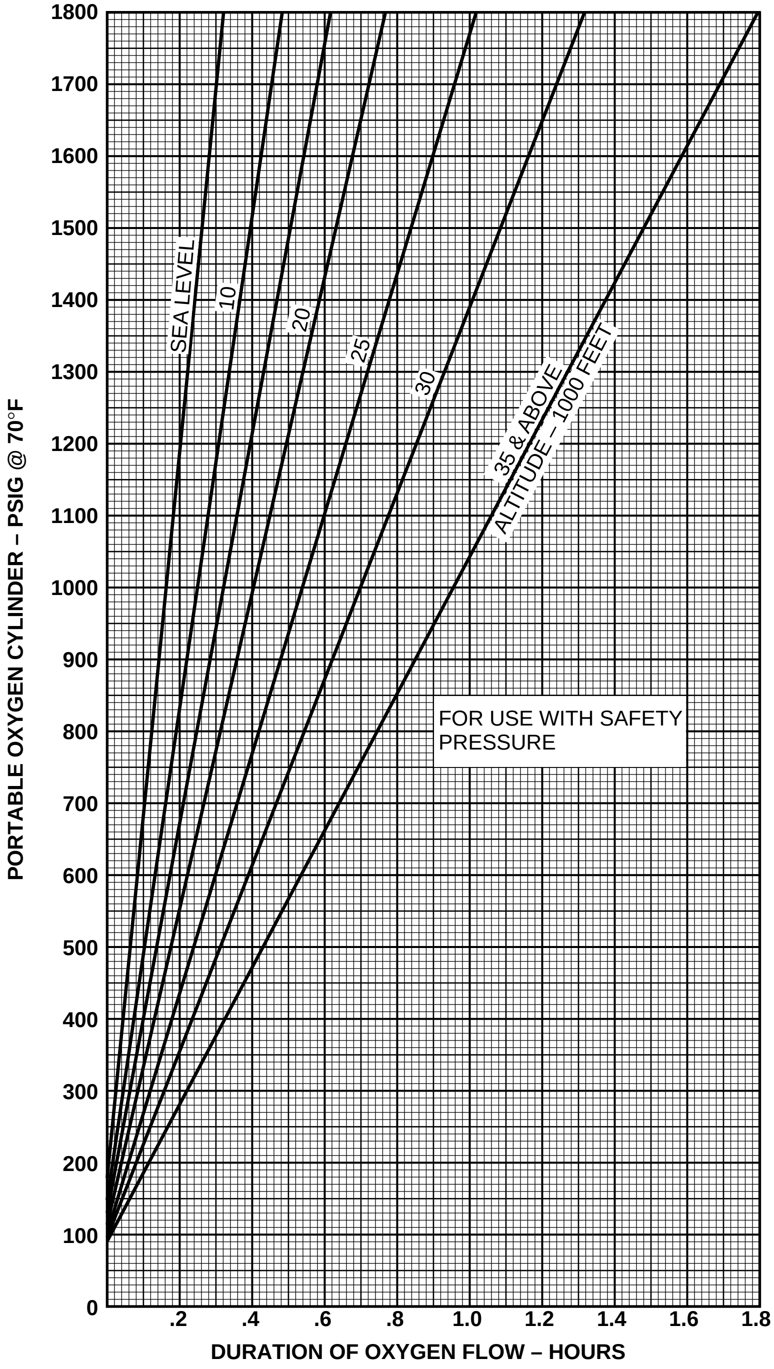
KC-10 DURATION OF CREW PORTABLE OXYGEN SUPPLY

CHART BASED ON:

ONE 11 CUBIC FOOT PORTABLE OXYGEN CYLINDER.

BREATHING 100% OXYGEN

ADDED 25% TO OXYGEN FLOW USAGE REQUIREMENTS PER MIL-D-8683A FOR SAFETY PRESSURE MARGIN.



SA1-229

Figure 1.11-8. Duration Of Crew Portable Oxygen Supply, With Safety Pressure

KC-10 DURATION OF CREW PORTABLE OXYGEN SUPPLY

CHART BASED ON:

ONE 11 CUBIC FOOT PORTABLE OXYGEN CYLINDER.

BREATHING 100% OXYGEN.

OXYGEN FLOW USAGE REQUIREMENTS PER MIL-D-8683A

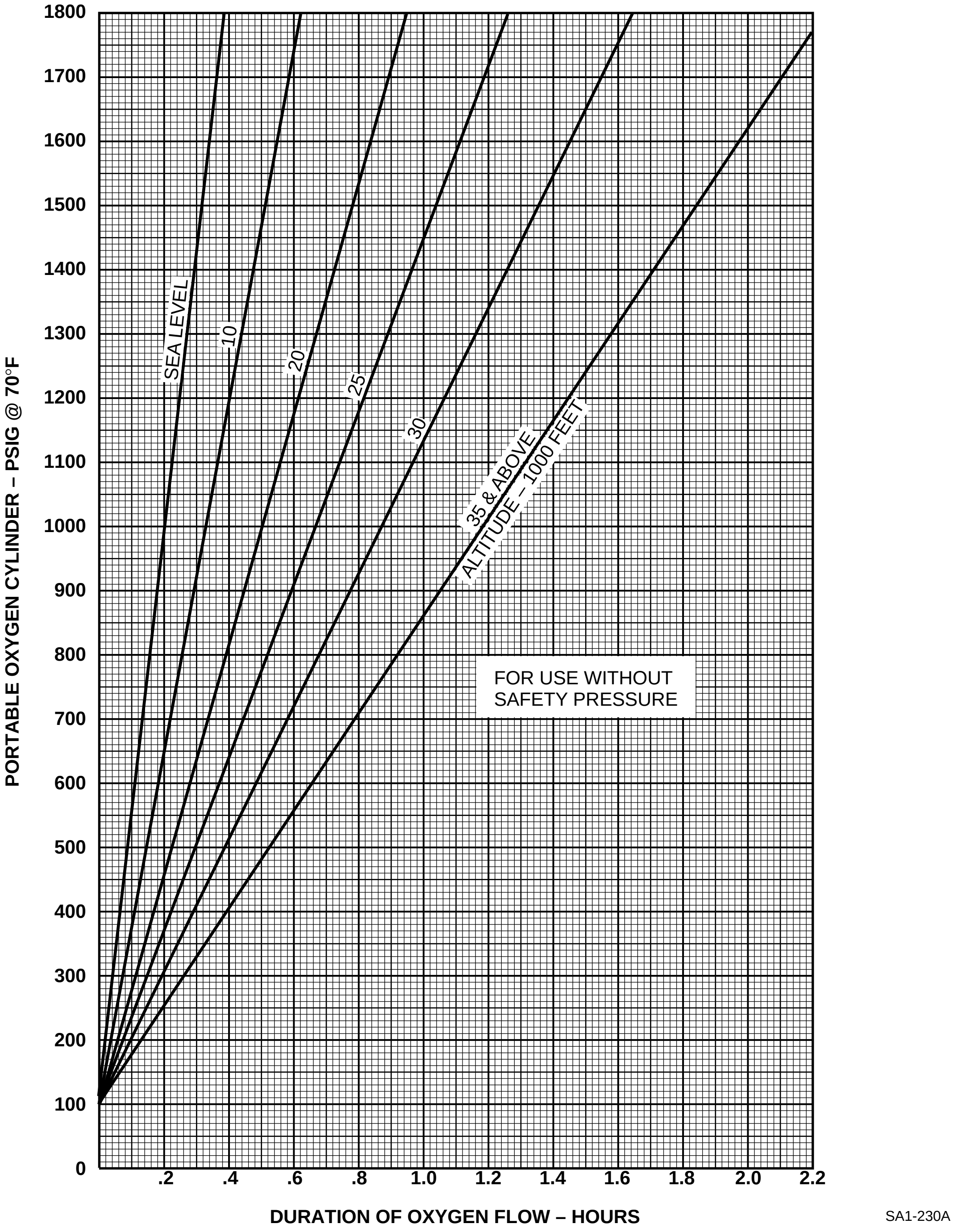


Figure 1.11-9. Duration Of Crew Portable Oxygen Supply, Without Safety Pressure

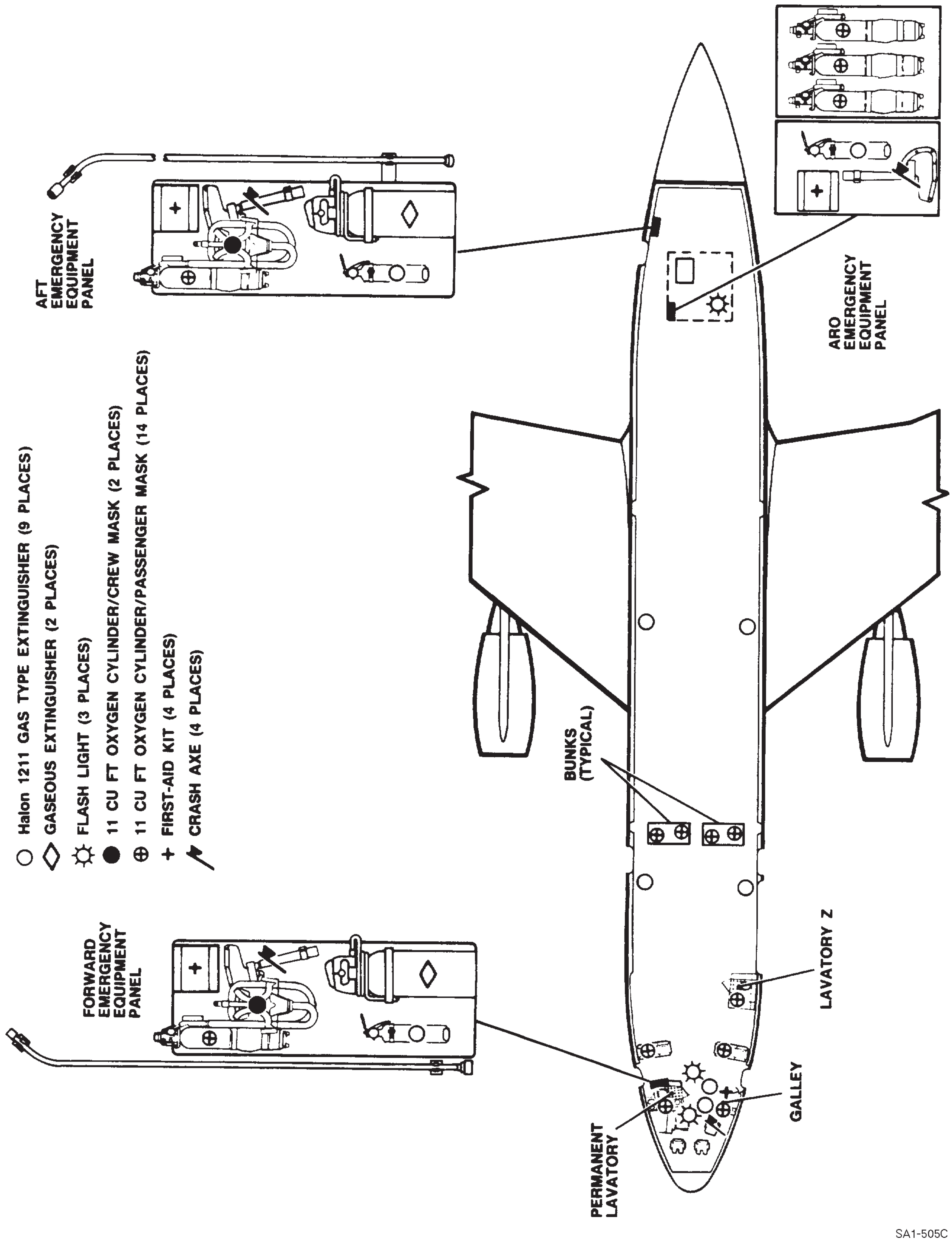


Figure 1.11-10. Portable Emergency Equipment

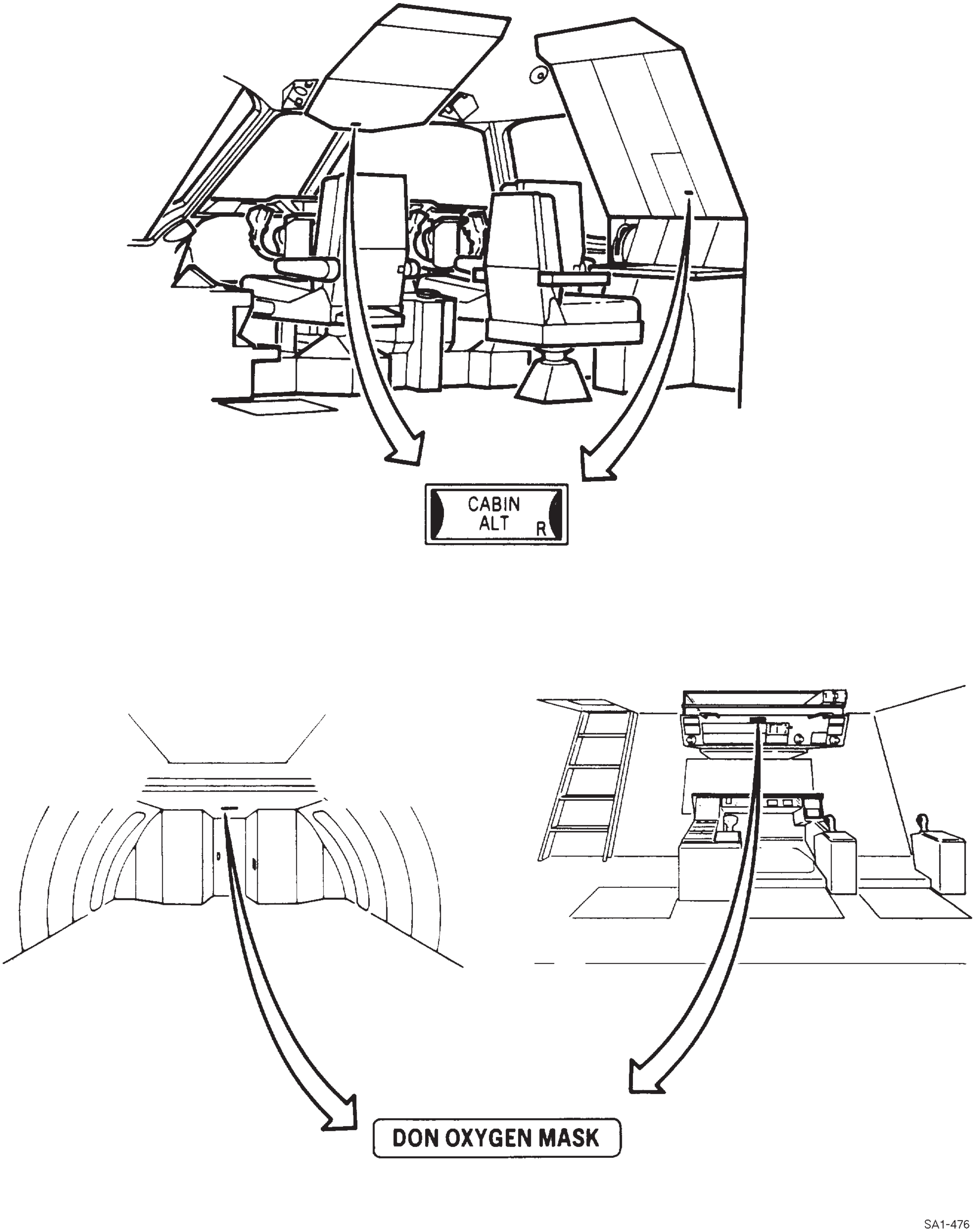
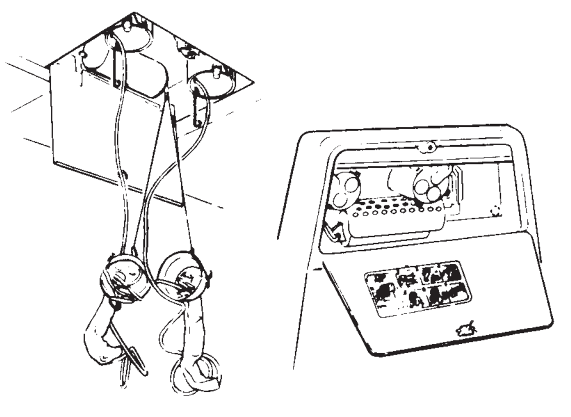


Figure 1.11-11. Oxygen Annunciator Warning Signs

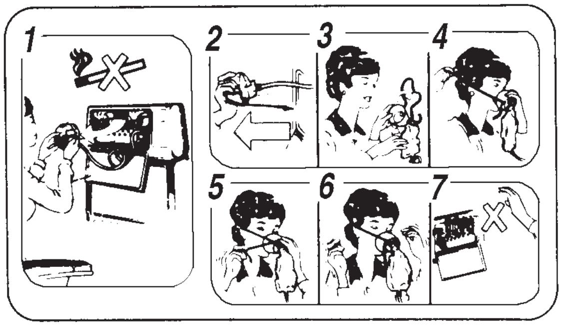
KC-10A EXTENDER

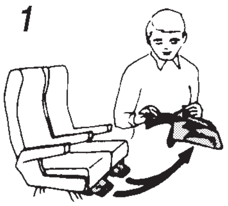
EMERGENCY EQUIPMENT AND OXYGEN USE

THE CEILING LIGHTS WILL COME ON FULL BRIGHT. PERSONNEL IN THE FRONT 3 SEATS ON EACH SIDE OF THE AIRCRAFT WILL USE CREW OXYGEN MASK/ REGULATOR LOCATED OVER THEIR HEADS. FOR ALL OTHER PERSONNEL YOUR OXYGEN MASK WILL DROP FROM THE CEILING OR THE BACK OF A SEAT OR PARTITION IN FRONT OF YOU. GRASP THE MASK AND PULL IT FIRMLY TO EXTRACT THE LANYARD PIN AND START THE OXYGEN FLOW, PLACE AND HOLD THE MASK OVER YOUR NOSE AND MOUTH, AND ADJUST THE HEAD STRAP. THE CHEMICAL GENERATORS ARE HOT DURING USE, SO DO NOT TOUCH. IF OXYGEN MASK DOES NOT WORK PROPERLY CALL A CREW MEMBER. ASSIST OTHERS IF NECESSARY.



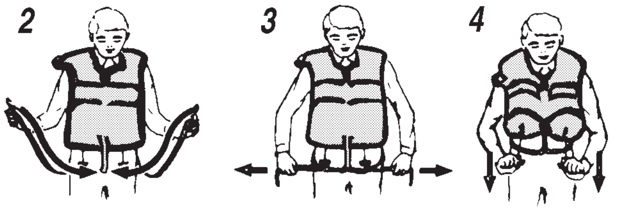
OVERHEAD TYPE **SEAT BACK TYPE**



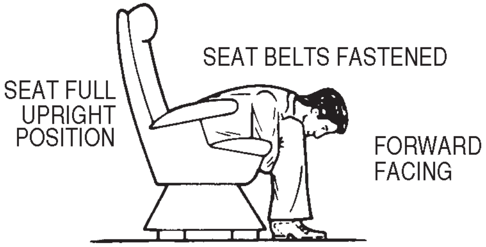


LIFE VEST

1. Remove life vest located under seat.
2. Pull straps around waist.
3. Hook strap in front.
4. Pull tabs for inflation.



BRACE POSITION FOR CRASH LANDING AND DITCHING



A life vest is stowed under each passenger seat. Seat cushion may be used as flotation device.

SEAT BELTS

PASSENGERS ARE ENCOURAGED TO WEAR SEAT BELTS AT ALL TIMES DURING FLIGHT WHILE IN THEIR SEATS TO PRECLUDE INJURY IN THE EVENT TURBULENCE IS ENCOUNTERED WITHOUT WARNING.

RADIO RECEIVERS AND ELECTRONIC DEVICES

THE USE OF PORTABLE/ELECTRONIC DEVICES IS PROHIBITED DURING TAKEOFFS AND LANDING, AND ANYTIME THE AIRCRAFT IS BELOW 10,000 FEET. PORTABLE TRANSMITTING DEVICES SUCH AS CELLULAR PHONES MAY NOT BE USED ANYTIME AIRCRAFT CABIN DOORS ARE CLOSED. NON-TRANSMITTING DEVICES, SUCH AS AUDIO AND VIDEO RECORDERS AND PLAY BACK DEVICES, COMPUTERS, PERIPHERALS, ELECTRONIC ENTERTAINMENT DEVICES AND RADIO RECEIVERS (EXCEPT HEARING AIDS) MAY ONLY BE OPERATED ABOVE 10,000 FEET AND ONLY WITH THE AIRCRAFT COMMANDER'S APPROVAL.

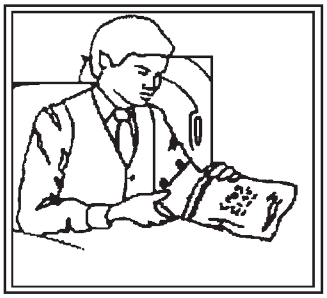
SA1-2D

Figure 1.11-12. Emergency Equipment and Oxygen Use (Sheet 1)

Emergency Passenger Oxygen System (EPOS)

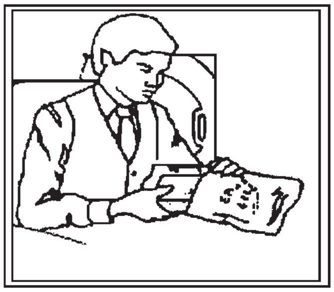
How to use the EPOS for decompression, fire, smoke or toxic fumes.

1.



Open flap on stowage pouch.

2.

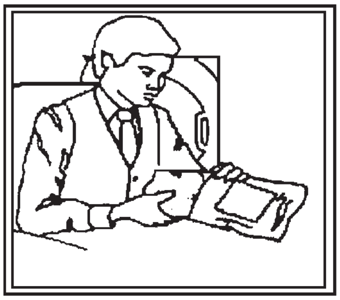


Remove bag from stowage pouch.

3.

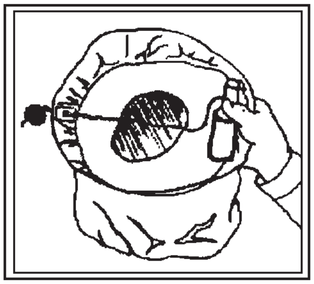
Tear open bag by **pulling** red tape.

4.



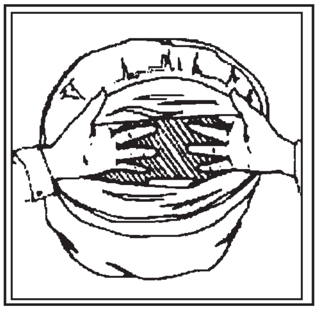
Remove EPOS hood and unfold.

5.



Pull red ball with one hand while holding the oxygen cylinder with the other hand.

6.



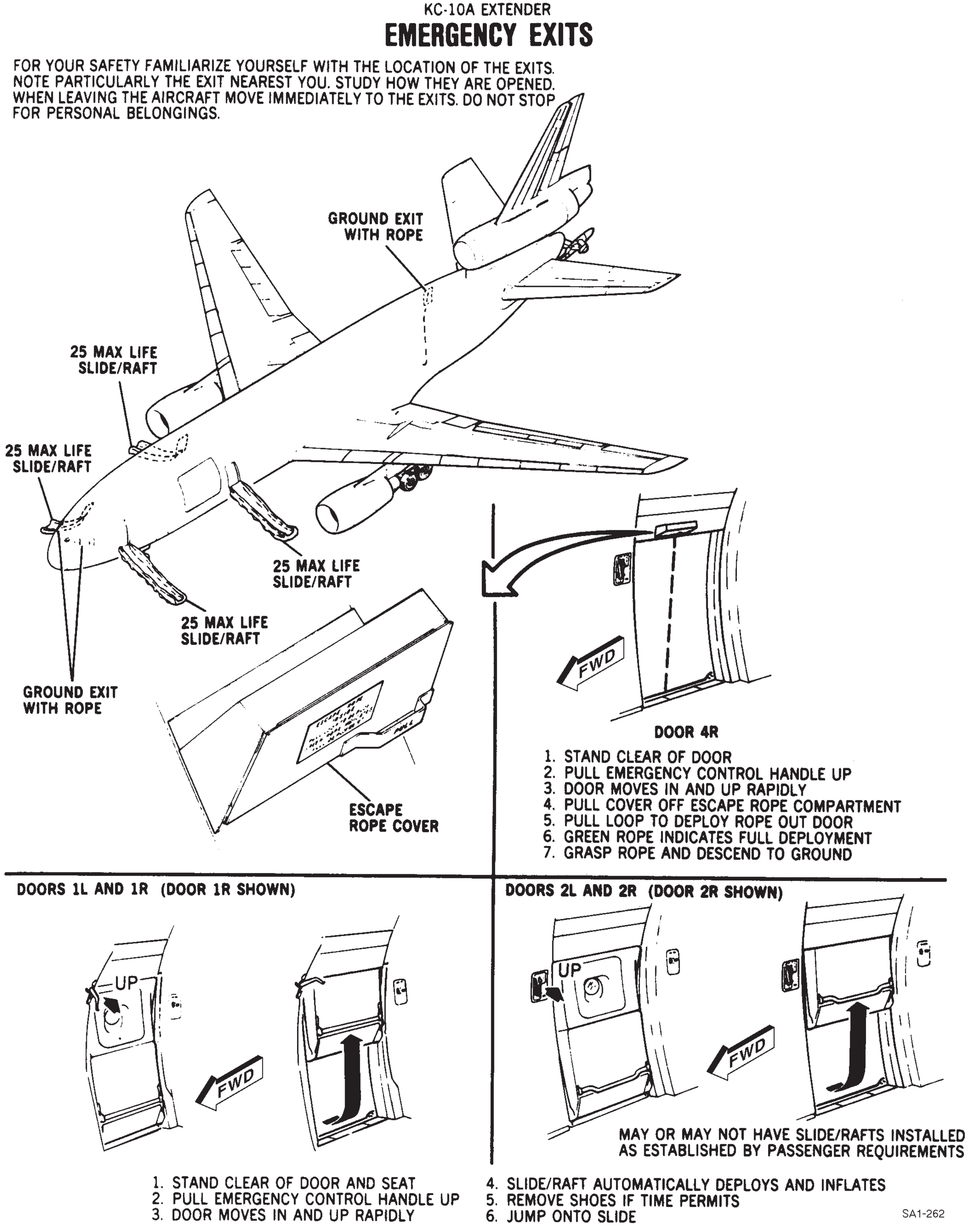
Spread neck seal open with palms facing toward each other.

7.

Pull EPOS over the head.

8. Remove hood after you are clear of hazard or when instructed by aircrew personnel.

Figure 1.11-12. Emergency Equipment and Oxygen Use (Sheet 2)



KC-10A EXTENDER

EMERGENCY EXITS

FOR YOUR SAFETY FAMILIARIZE YOURSELF WITH THE LOCATION OF THE EXITS. NOTE PARTICULARLY THE EXIT NEAREST YOU. STUDY HOW THEY ARE OPENED. WHEN LEAVING THE AIRCRAFT MOVE IMMEDIATELY TO THE EXITS. DO NOT STOP FOR PERSONAL BELONGINGS.

DOOR 4R

1. STAND CLEAR OF DOOR
2. PULL EMERGENCY CONTROL HANDLE UP
3. DOOR MOVES IN AND UP RAPIDLY
4. PULL COVER OFF ESCAPE ROPE COMPARTMENT
5. PULL LOOP TO DEPLOY ROPE OUT DOOR
6. GREEN ROPE INDICATES FULL DEPLOYMENT
7. GRASP ROPE AND DESCEND TO GROUND

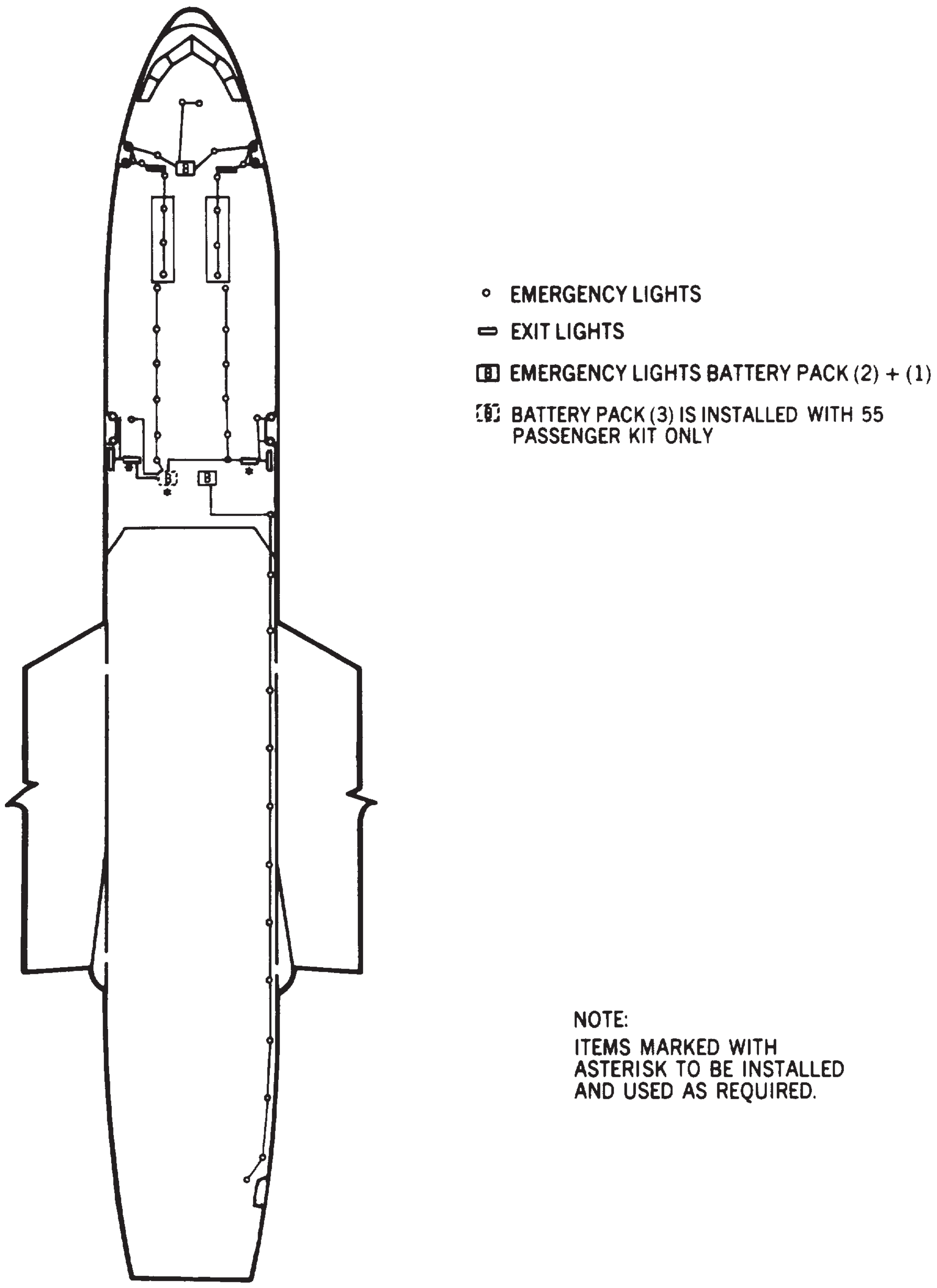
DOORS 1L AND 1R (DOOR 1R SHOWN)

DOORS 2L AND 2R (DOOR 2R SHOWN)

MAY OR MAY NOT HAVE SLIDE/RAFTS INSTALLED AS ESTABLISHED BY PASSENGER REQUIREMENTS

1. STAND CLEAR OF DOOR AND SEAT
2. PULL EMERGENCY CONTROL HANDLE UP
3. DOOR MOVES IN AND UP RAPIDLY
4. SLIDE/RAFT AUTOMATICALLY DEPLOYS AND INFLATES
5. REMOVE SHOES IF TIME PERMITS
6. JUMP ONTO SLIDE

Figure 1.11-13. Emergency Exits and Slide/Rafts



NOTE:
ITEMS MARKED WITH ASTERISK TO BE INSTALLED AND USED AS REQUIRED.

SA1-271A

Figure 1.11-14. Emergency Light Locations

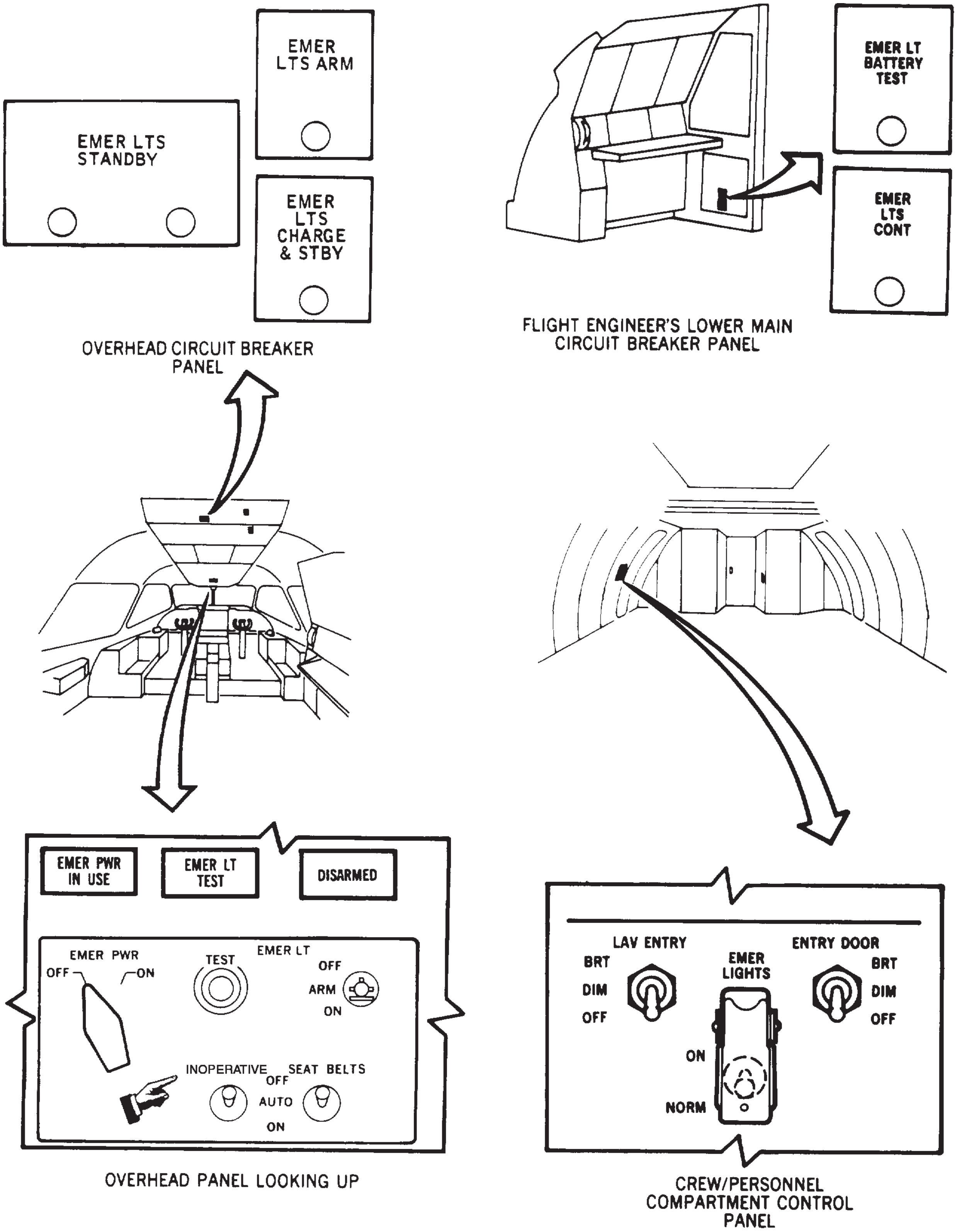
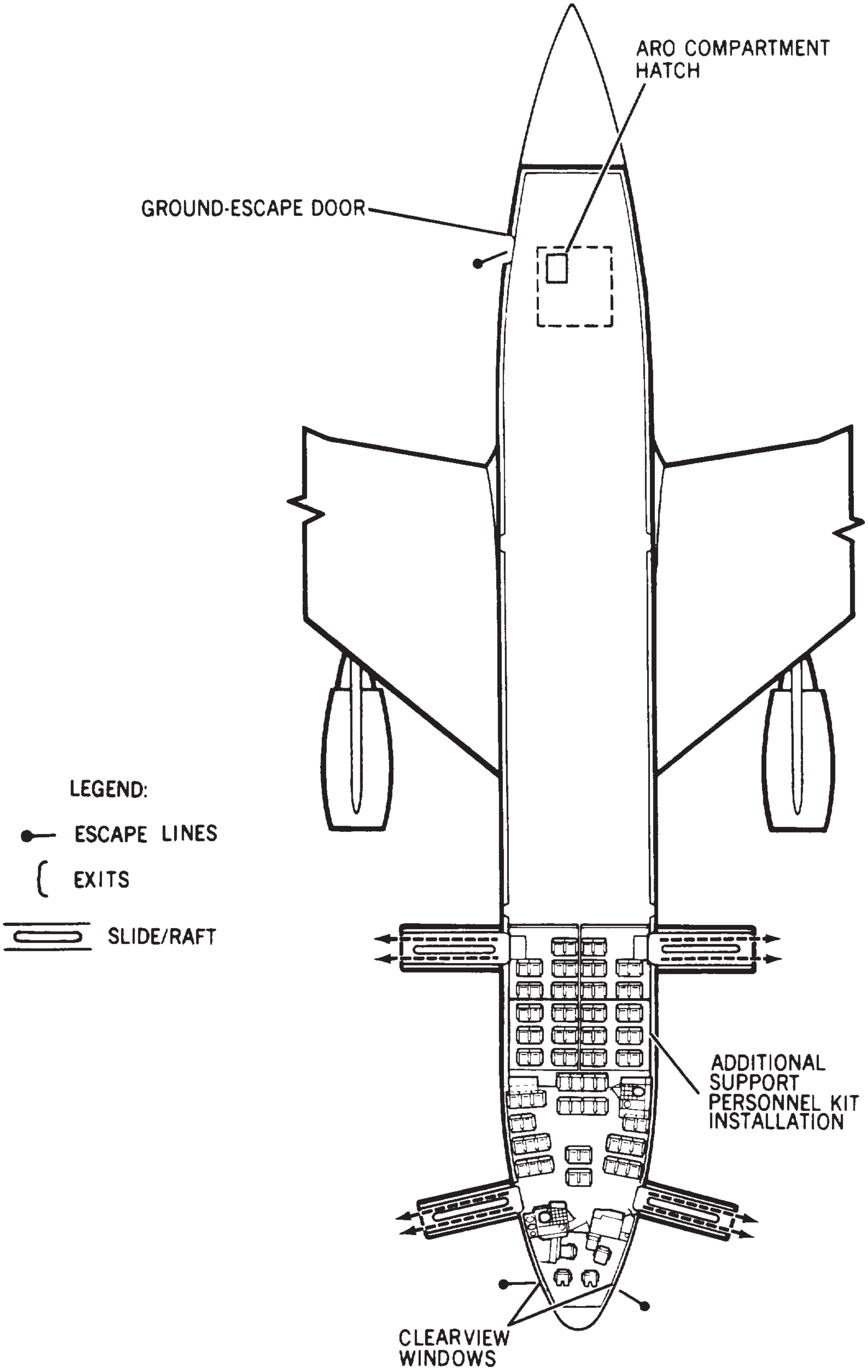


Figure 1.11-15. Emergency Light Controls



SA1-162B

Figure 1.11-16. Personnel Evacuation and Slide Arrangements, Passenger Configuration (Personnel)

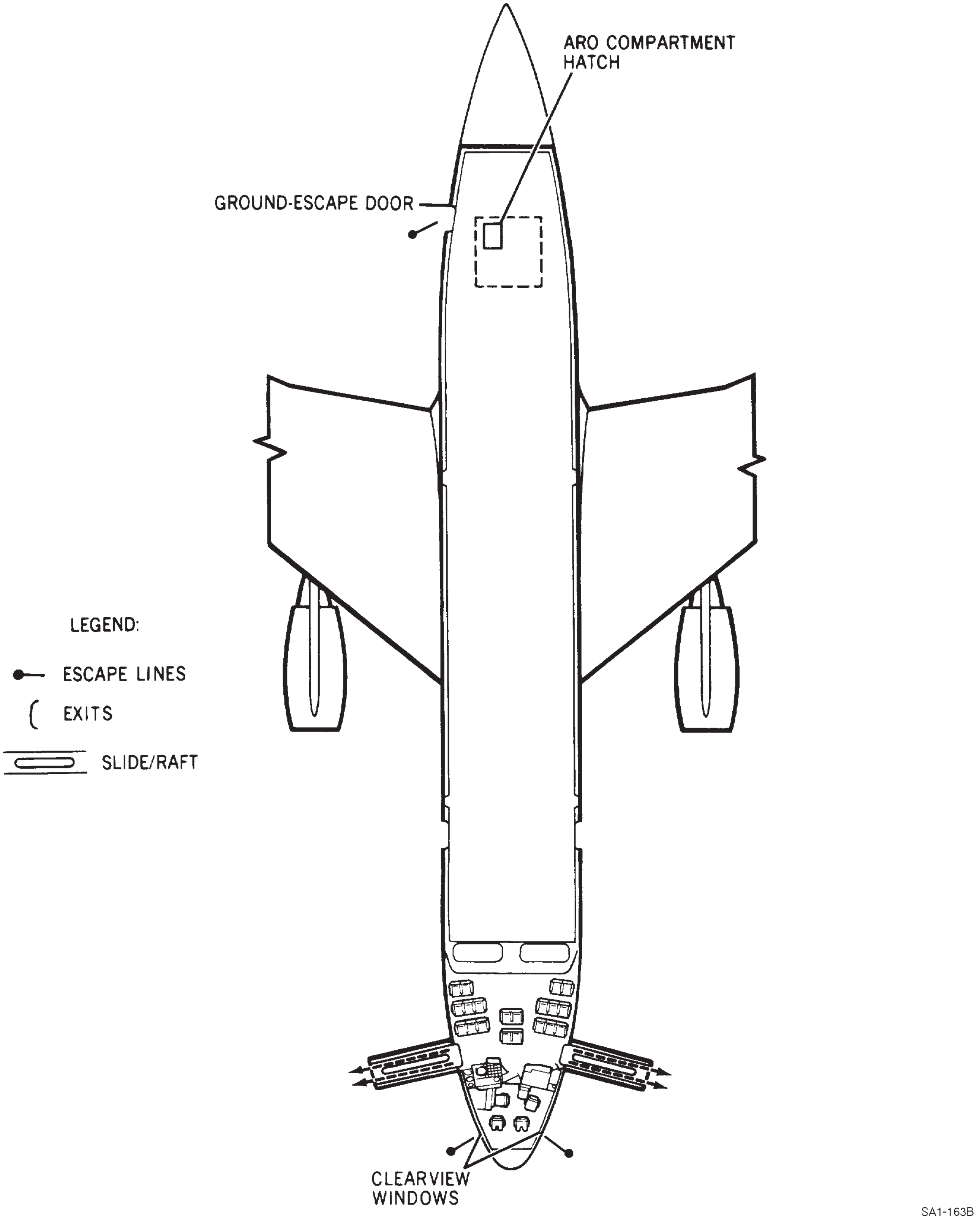


Figure 1.11-17. Personnel Evacuation and Slide Arrangement, Delivery Configuration (Cargo)

LOSS OF CABIN PRESSURIZATION

In the event of the loss of cabin pressure, the following events take place:

At a cabin altitude of 9,500-10,000 feet, a pressure-sensitive switch energizes circuits which activate the NO SMOKING/FASTEN SEAT BELT signs; forward cabin overhead lights illuminate; warning horns in the cockpit and forward passenger compartment; activate a warning bell in the ARO compartment; illuminate CABIN ALT warning

annunciators on the Overhead Panel and the Flight Engineer's Electrical Panel; illuminate DON OXYGEN MASK annunciators located on the ARO Overhead Panel (figure 1.11-11).

At a cabin altitude of approximately 14,000 feet, a pressure-sensitive switch energizes circuits which illuminate the DON OXYGEN MASK annunciators located in the ceiling of the forward passenger compartment; opens all oxygen compartment doors and masks will automatically deploy.

CONTROLS AND INDICATORS

Controls, indicators, and components are located at the flight crew members stations, and throughout the cabin and lavatories. Illustrations of the panels may be found in Part 1, Section I. Locations of components and the individual controls and indicators are illustrated and described in this part.

EMERGENCY LIGHTING

The internal emergency lighting system consists of cockpit dome lights, cabin ceiling lights, door lights, exit signs along right cargo compartment wall and one over the ARO compartment entrance. External emergency lighting consists of the lighting installed as an integral part of the escape slides.

The emergency lights (figure 1.11-14) illuminate when the primary lighting system fails, when the Pilot selects emergency lights, or when the switch at the left forward cabin door control panel is turned on.

Provisions are made to isolate the emergency lighting system to a self-contained power source when the main battery bus is used for navigation instruments in emergency conditions.

Electrical power for emergency evacuation lighting systems and operation is supplied by the aircraft electrical system from three independent battery packs located in the cabin. These battery packs are self-contained and are continuously charged. Power is provided sequentially in the following priority:

right emergency ac bus; left emergency dc bus; emergency battery packs. All packs are maintained at full charge by individual chargers powered from the aircraft.

In the automatic mode, a logic unit controls the system. In case of power interruption, the system will be switched automatically to the next available source of power.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are installed on the overhead panel in the cockpit and on the left forward cabin door control panel. Illustrations of the cockpit panel may be found in Part 1 Aircraft General, Section I. The individual controls and indicators are described in the following illustration (figure 1.11-15).

EMERGENCY EXITS

Cabin doors will be used as exits for both crew and passengers. All of the normal exits have backup systems to permit their operation during abnormal conditions. For the flight crew, alternate exit routes are provided through either the cockpit door removable blowout panel into the forward cabin or by opening the clearview windows (figures 1.11-16 and 1.11-17).

CABIN DOORS

There are five main cabin doors, three on the right side, and two on the left side of the aircraft. From outside the aircraft the operating handles are not identical but all are opened in the same manner in the event of an emergency. From inside the aircraft the three aft doors have identical handles and identical emergency opening procedures. The two forward cabin door handles are slightly different handle design, but operating logic is identical. Power for the emergency opening of all cabin doors is pneumatic. An independent air reservoir and a pressure indicator are provided at each door (1500 psi at 70° F). When using override pneumatic power to open the doors from the inside, automatic slide deployment may be prevented by holding the slide arming lever in the emergency interlock override position. A manual lift bar is installed on all cabin doors to provide a means for opening the doors from the inside the aircraft when no pneumatic power is available. The manual lift bar can only be used with the door handle in the emergency exit open position. Two people are required to open a door by the manual lift method.

COCKPIT DOOR

The cockpit door provides access to the main cabin from the cockpit. In the event the door is jammed, a blowout panel on the lower half can be removed. This provides an adequate crawl-through opening to the main cabin and the normal evacuation routes. The blowout panel may also be kicked out in an emergency.

CLEARVIEW WINDOWS

Two sliding clearview windows provide an alternate emergency escape route for cockpit flight crew. The clearview windows are adjacent to the windshield. Escape lines are provided to allow the crew to lower themselves to the ground. The boom operator's seat must be facing forward to open the pilot's clearview window. To use the clearview window for emergency egress, the pilot or copilot seat should be fully aft and outboard with the armrests raised. Verify sun visor is forward of clearview window and unlock window by lifting lever and moving it aft. Crank window to full open. Open the escape rope compartment and remove the coiled escape rope. After verifying that the rope is attached to the aircraft, throw the rope overboard. While maintaining tension on the rope, exit through the window, head and shoulders first. Step backwards slowly, maintaining such a body position as to make maximum use of the aircraft structure. When positioned favorably, slowly lower self to the ground.

INADVERTENT PNEUMATIC DISCHARGE IN FLIGHT

Inadvertent actuation of a cabin door control to Emergency (pneumatic) Open position inflight will discharge the corresponding door pneumatic bottle (figure 1.11-18). Discharging the bottle will not open the door in flight unless cabin differential pressure is less than approximately 0.75 psi. Cabin differential pressure above approximately 0.75 psi will keep the door closed, pneumatic bottle pressure will bleed off within a few seconds, leaving no residual pressure that could force door open if cabin differential pressure is relieved.

NOTE

> When operating with cabin differential pressure of less than 1 psi, ensure that unauthorized personnel remain clear of doors.

Procedures which may result in prolonged periods of operation at low differential pressure are:

1. Rapid Decompression/Emergency Descent
2. Ram Air Ventilation Operation
3. Cabin or Cockpit Smoke or Fumes
4. Preparation for Passenger Evacuation

NOTE

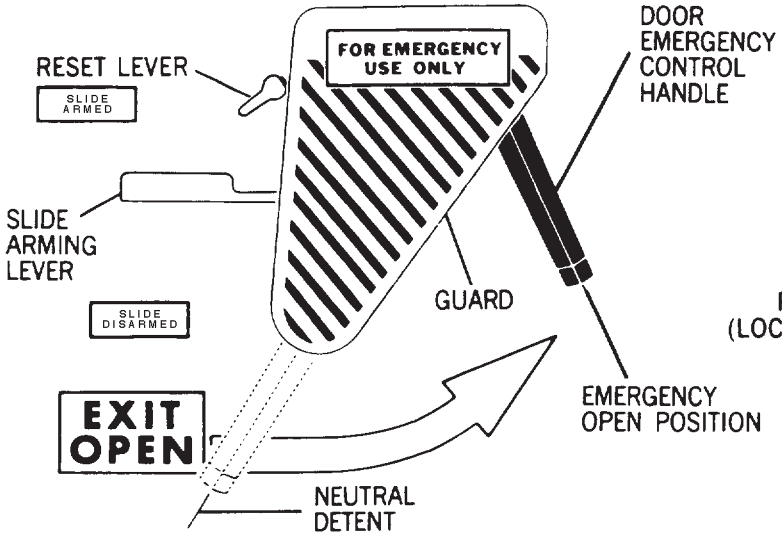
> Following inadvertent discharge of a cabin door pneumatic bottle, door control handle should be reset from emergency (pneumatic) to neutral position. This locks door in closed position until ready for subsequent operation.

EMERGENCY EXIT OPERATION

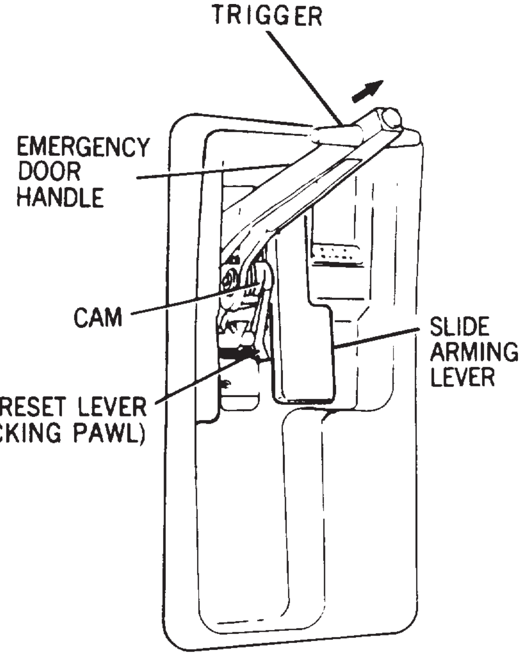
Evacuation (figure 1.11-13) during ground emergencies or ditching situations can be accomplished by using the emergency procedures for opening doors 1L and 1R. Exit the aircraft via the deployed slide/raft(s) if a ramp or stairway is not in position. When the aircraft is configured for 75 personnel, slide/rafts will be available on doors 2L and 2R. An escape rope is located at door 4R.

CABIN DOORS

There are five cabin doors; 1L and 2L; 1R, 2R, and 4R. The three aft doors, 2L, 2R, and 4R have identical controls, placarding, and operating procedures. The two forward doors, 1L and 1R have different controls and placarding, however, the operating logic is the same.



CABIN DOOR INTERIOR CONTROLS (FWD TWO)
(View Looking Forward Left Side; Right Side Opposite)



CABIN DOOR INTERIOR CONTROLS (AFT THREE)
(View Looking Outboard Left Side; Right Side Opposite)

TO RESET DOOR EMERGENCY CONTROL HANDLE

1. Hold control handle in emergency open position and rotate reset lever upward.
2. While holding reset lever up, return handle to neutral position.
3. Release reset lever.
4. Make certain slide arming lever is in SLIDE ARMED position.
5. After landing use normal operating procedures to open door.

TO RESET DOOR EMERGENCY CONTROL HANDLE

NOTE

A cam held in a rotated up position by a reset lever is visible when control handle is in the emergency open position.

1. Hold control handle in emergency open position and press bottom or pull top of reset lever to permit reset lever to clear cam.
2. While holding reset lever clear of cam, squeeze handle trigger and move handle toward neutral position, releasing reset lever when clear of cam.
3. When neutral position is reached, release handle and stow.
4. Make certain slide arming lever is in SLIDE ARMED position.
5. After landing use normal operating procedures to open door.

AFTER LANDING, IF IT IS NECESSARY TO DEPLOY SLIDE.

1. Make certain slide arming lever is in SLIDE ARMED position.
2. Move control handle to emergency open position.
3. Using manual lift bar, manually raise door to full open position. As door moves upward, slide will drop out of container and automatically deploy.

NOTE

The two forward doors weigh approximately 245 pounds each and the two mid doors weigh approximately 350 pounds each until the slide drops out.

SA1-268B

Figure 1.11-18. Cabin Doors - Inadvertent Pneumatic Discharge In Flight

Emergency Operating Mode

In the emergency operating mode, each door can be opened either pneumatically or manually (figure 1.11-19), either with slide deployment or without slide deployment.

NOTE

> Manual operating of the doors can be done only when pneumatic power is not available and the door controls are set in the emergency position.

For pneumatic operation, an air reservoir and a pressure gage are provided for each door. For manual operation, a manual lift bar is installed on each door.

Operation With Slide Deployment

1. Verify that slide is armed: slide arming lever in SLIDE ARMED position, SLIDE ARMED placard visible on slide verification indicators.
2. Stand clear of door.
3. Move door EMERGENCY control handle to open position. Door opens and slide deploys automatically. If door does not open, perform steps 3a and 3b (figure 1.11-19).

NOTE

> - Door motion cannot be stopped during pneumatic opening of door.
> - Door moves in and up rapidly, and slide/raft automatically deploys and inflates when installed.

4. Using manual lift bar, pull door inboard at approximately a 45° upward angle and then lift directly up.

NOTE

> The two forward doors weigh approximately 245 pounds each, and doors 2L and 2R weigh approximately 350 pounds each. As door moves upward, the slide is dropped out of the container and the weight of the door is decreased by the weight of the slide.

5. Release manual lift bar and push door upward to full open position.
6. Remove shoes if time permits.
7. Jump into slide.

Operation Without Slide Deployment

1. Move slide arming lever to emergency interlock position and hold.
2. Stand clear of door.
3. Move door control handle to emergency door open position. Door opens; slide is not deployed. If door does not open, perform step 4.

NOTE

> Door motion cannot be stopped during pneumatic operation of door.

4. Using manual lift bar, pull door inboard at an approximate 45° upward angle and then lift directly up.

NOTE

> The two forward doors weigh approximately 245 pounds each and the two mid doors weigh approximately 350 pounds each. Since the slide is not deployed, the weight of the door will not change.

5. Release manual lift bar and push door upward to full open position.

DOOR 4R GROUND ESCAPE ROPE DEPLOYMENT

Door 4R can be opened by pneumatic emergency power; however, this door does not contain an escape slide/raft. A ground escape rope is installed in a compartment located directly above the door (figure 1.11-13). To deploy the rope after the door is opened, proceed as follows:

Rope Deployment (Figure 1.11-13)

1. Pull cover off of ground escape rope compartment.
2. Pull loop from compartment cover.
3. Deploy rope out door.

NOTE

> When green section of rope is exposed, rope is fully deployed.

PORTABLE FIRE EXTINGUISHERS

Eleven fire extinguishers (figure 1.11-10) are located in the main cabin. Nine fire extinguishers are

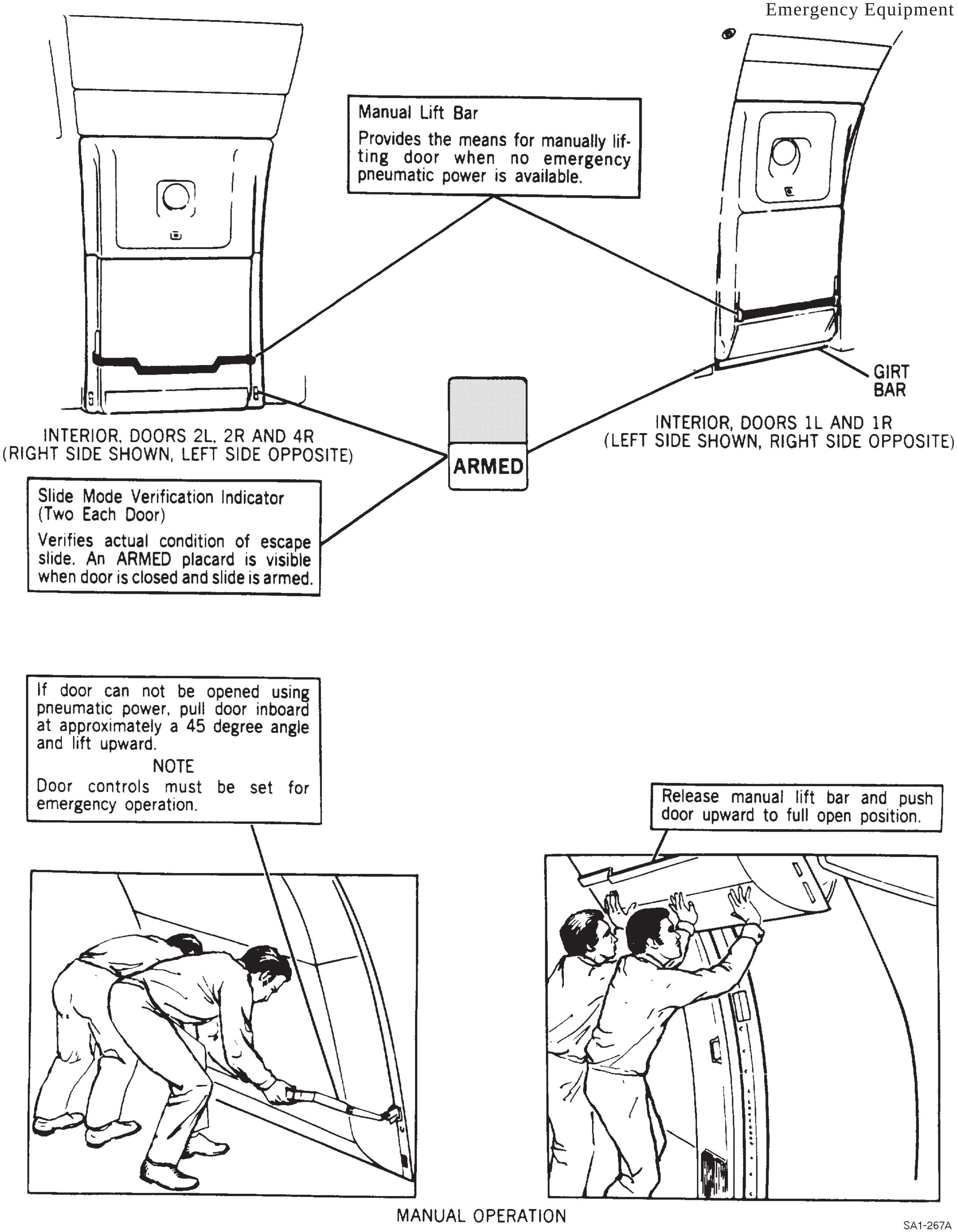


Figure 1.11-19. Cabin Doors - Manual Operation

HALON 1211 type extinguishers. The extinguishers are located as follows:

1. Forward emergency equipment panel
2. Aft emergency equipment panel
3. Flight compartment
4. Forward galley area
5. Right and left mid-cabin
6. Right and left over-wing cabin
7. ARO compartment emergency equipment panel

The nine HALON type fire extinguishers are mounted in individual supports with quick release clamps. Each extinguisher contains 2 pounds of HALON 1211 agent and weighs approximately 7 pounds when fully charged.

The two GRAVINER gaseous type extinguishers are mounted in individual supports with quick release clamps in each emergency equipment panel.

Each extinguisher is charged with 16 pounds of HALON 1211 agent and pressurized with dry nitrogen to 175 ± 5 psig and weighs approximately 34 pounds when fully charged.

WARNING

> The concentrated agent when applied to fire can produce toxic by-products. Avoid inhalation of these materials by evacuating and ventilating the area.

DISPOSABLE FIRE EXTINGUISHERS

All aircraft and Z Lavatories have a disposable fire extinguisher that is located within the sink cabinet waste compartment adjacent to the trash container in each lavatory. The system is automatic and self-contained. When the temperature at the extinguisher discharge tube tip rises to between 170° F and 177° F (76.6° C and 80.5° C) the fusible tips melt, resulting in actuation of the extinguisher. The extinguisher will discharge HALON into the trash container within 3 to 5 seconds to extinguish a fire. See figures 1.1-32 and 1.1-33.

OPERATION

For operation of GRAVINER gaseous type fire extinguisher, see figure 1.11-20, sheet 1.

For operation of the HALON 1211 type fire extinguisher, see figure 1.11-20, sheet 2.

Use the extension wand for combating fires in confined areas such as compartments or cargo with the GRAVINER gaseous type extinguisher.

FOR CLASS A B C FIRES

TO OPERATE:

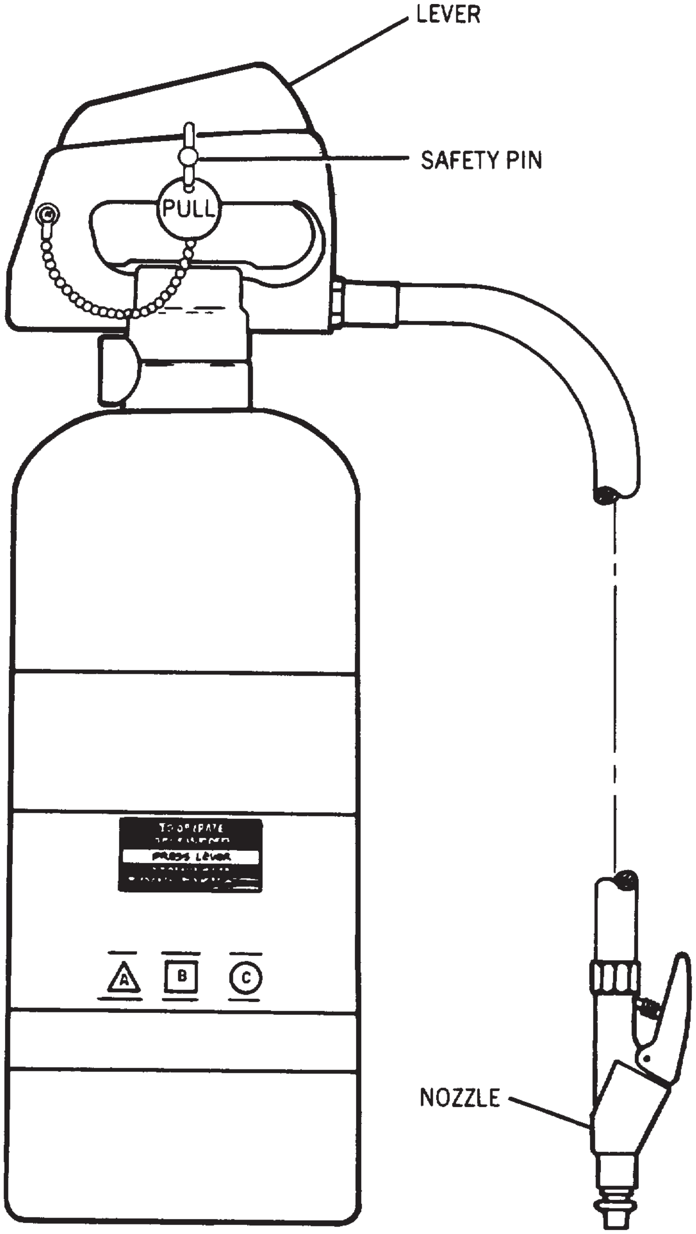
1. **REMOVE SAFETY PIN.**
2. **PRESS LEVER.**
3. **HOLD UPRIGHT AND SQUEEZE NOZZLE.**
4. **DIRECT STREAM AT BASE OF FLAMES WITH SIDE-TO-SIDE MOTION.**

WARNING

DO NOT DIRECT AT SURFACE OF BURNING LIQUID FROM CLOSER THAN EIGHT FEET.

NOTE

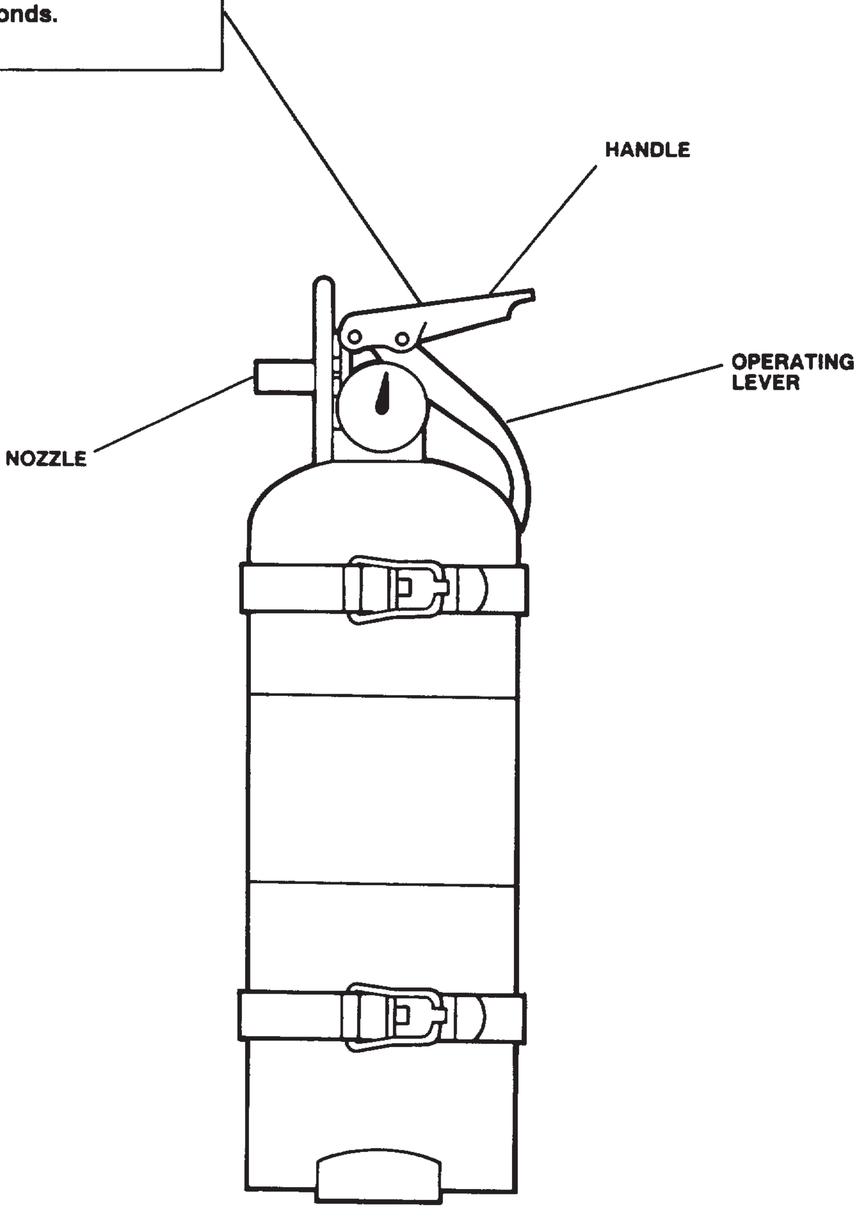
AGENT IS DISCHARGED IN AN EXPANDING ROUND STREAM TO A RANGE OF 12 TO 20 FEET FOR APPROXIMATELY 16 SECONDS.



GRAVINER GASEOUS TYPE
FIRE EXTINGUISHER

SA1-480A

Figure 1.11-20. Portable Fire Extinguisher (Sheet 1)



To Operate:

1. **Squeeze operating lever to release Halon 1211 GAS.**
2. **Direct stream at base of flame.**

NOTE:

Agent is discharged in a cone-shaped stream to a range of 20 feet for approximately 10 seconds.

HALON 1211 GAS TYPE FIRE EXTINGUISHER

SA1-504

Figure 1.11-20. Portable Fire Extinguisher (Sheet 2)

EMERGENCY RADIO BEACON TRANSMITTERS

Two slide/raft mounted radio beacon transmitters (figure 1.11-21) are provided. These are located on each of the two forward door slide/rafts.

Each transmitter provides a homing signal for search aircraft by automatically transmitting a signal simultaneously on civil and military international VHF and UHF aeronautical distress frequencies 121.5 and 243.0 MHz.

The slide/raft mounted beacon transmitter consists of a dual frequency transmitter, a switch activated battery, two antennas with indicator lights, a battery switch pin, a lanyard, and water activated switch contacts.

NORMAL ACTIVATION

The unit is designed so that activation will not occur with normal slide deployment, but will occur automatically with raft deployment. Activation of the transmitter is controlled by a battery switch pin attached to the slide/raft surface by a lanyard. Deployment of the slide/raft by inflation and unfolding will extract the battery switch pin, arming the battery pack.

Activation of the beacon occurs when the water switch contacts located in the down antenna base are immersed in water. The antenna selector switch, built into the transmitter case automatically selects the upright antenna as the radiating element.

MANUAL ACTIVATION

A manual means for activation of the beacon is provided at the base of each antenna. If activation of the beacon is required on land, the fluorescent orange pull-tab should be pulled until the pin on the attached wire is drawn into contact with the metal eyelet on the antenna base. Momentary contact will automatically activate the beacon.

INDICATOR FOR PROPER OPERATION

Illumination of the red light-emitting diode located on the base of the transmitting antenna indicates proper operation.

NOTE

> In bright sunlight this indicator is difficult to see. Cupping both hands around the antenna improves indicator visibility.

DEACTIVATION

Inserting the pin into the BATTERY SWITCH cavity interrupts the power supply and turns the unit completely off. It cannot be activated with this pin in place.

ESCAPE SLIDE/RAFT

Escape slide/rafts (figure 1.11-22) are used for emergency evacuation and ditching. Automatic inflatable escape slide/raft units are a combination escape slide and life raft. They are installed at each forward and mid cabin door (1L, 2L, 1R, 2R) as required to accommodate total number of support personnel on board. A seven man life raft is stowed in the forward galley.

Each escape slide/raft is stowed in a door-mounted container and attached to the aircraft structure at the doorway threshold by a girt bar.

OPERATION

When the slide arming lever is in the SLIDE ARMED position, the girt bar is attached to the aircraft structure and the SLIDE ARMED placard is visible on the slide mode verification indicators located at the lower corners of each door. When the slide arming lever is in the SLIDE DISARMED position, the girt bar is detached from the aircraft structure and the slide mode verification indicators are blank (figure 1.8-4).

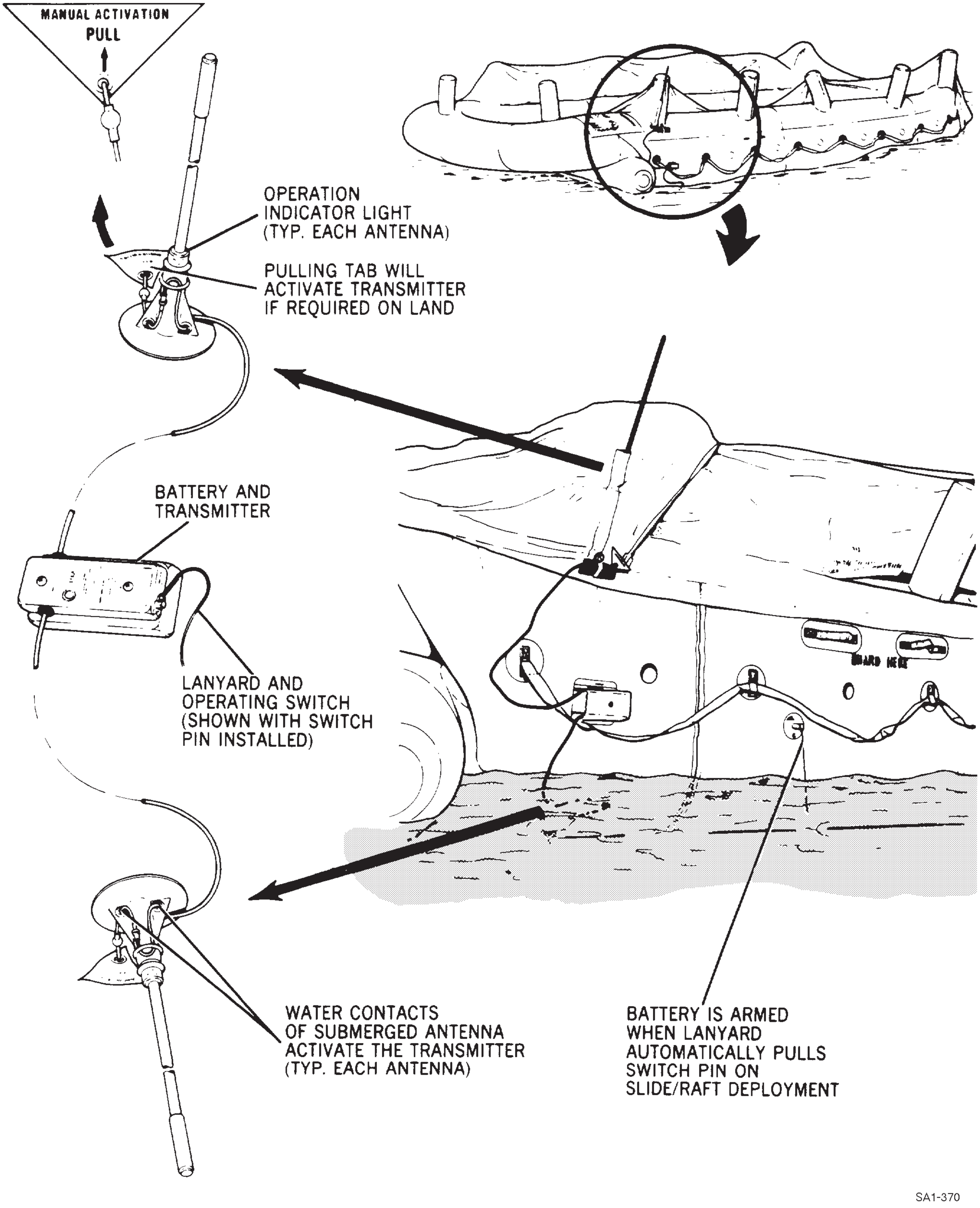
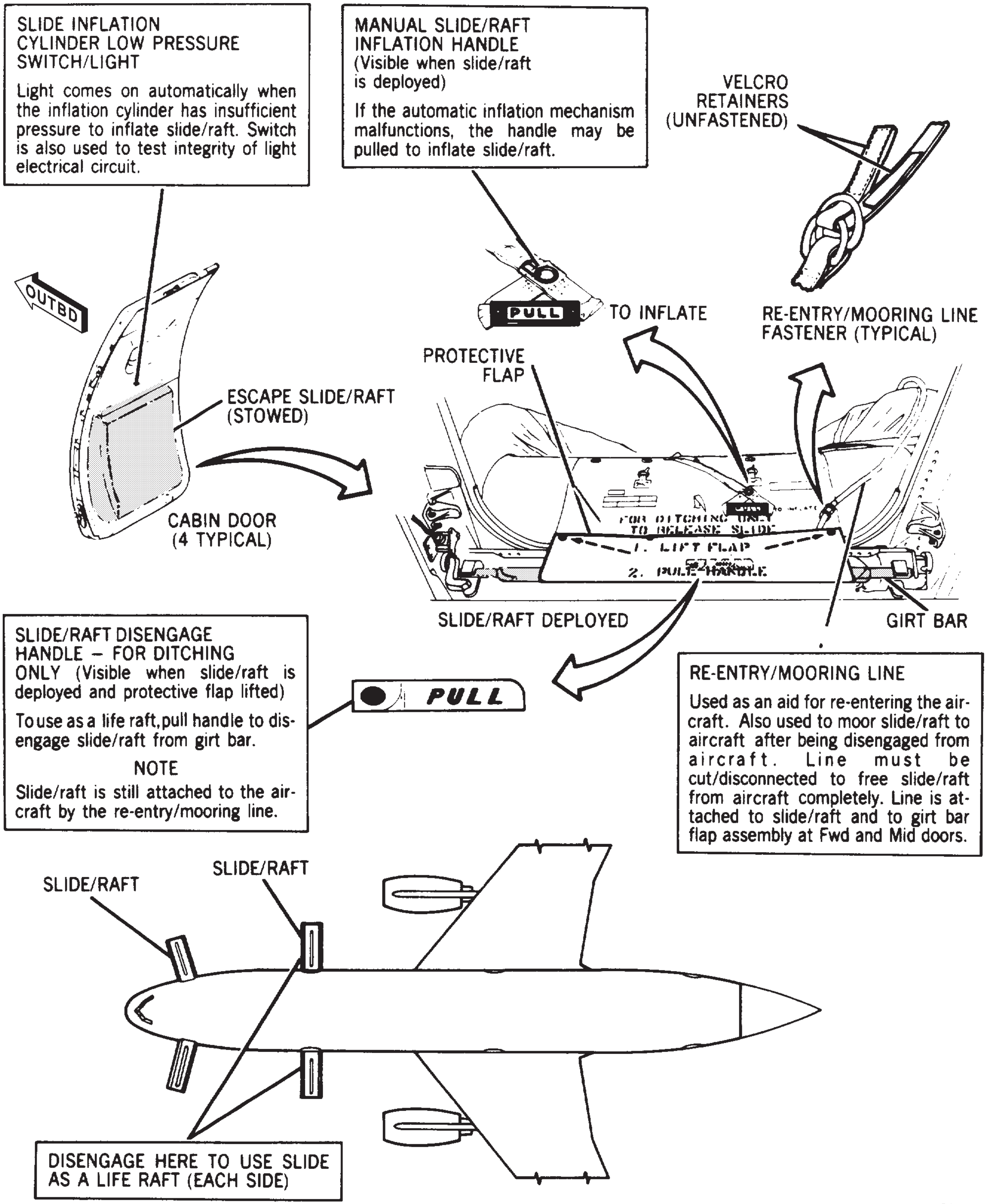


Figure 1.11-21. Emergency Radio Beacon Transmitter - Slide/Raft



SLIDE INFLATION CYLINDER LOW PRESSURE SWITCH/LIGHT

Light comes on automatically when the inflation cylinder has insufficient pressure to inflate slide/raft. Switch is also used to test integrity of light electrical circuit.

MANUAL SLIDE/RAFT INFLATION HANDLE (Visible when slide/raft is deployed)

If the automatic inflation mechanism malfunctions, the handle may be pulled to inflate slide/raft.

SLIDE/RAFT DISENGAGE HANDLE – FOR DITCHING ONLY (Visible when slide/raft is deployed and protective flap lifted)

To use as a life raft, pull handle to disengage slide/raft from girt bar.

NOTE

Slide/raft is still attached to the aircraft by the re-entry/mooring line.

RE-ENTRY/MOORING LINE

Used as an aid for re-entering the aircraft. Also used to moor slide/raft to aircraft after being disengaged from aircraft. Line must be cut/disconnected to free slide/raft from aircraft completely. Line is attached to slide/raft and to girt bar flap assembly at Fwd and Mid doors.

DISENGAGE HERE TO USE SLIDE AS A LIFE RAFT (EACH SIDE)

Figure 1.11-22. Escape Slide/Rafts (Sheet 1)

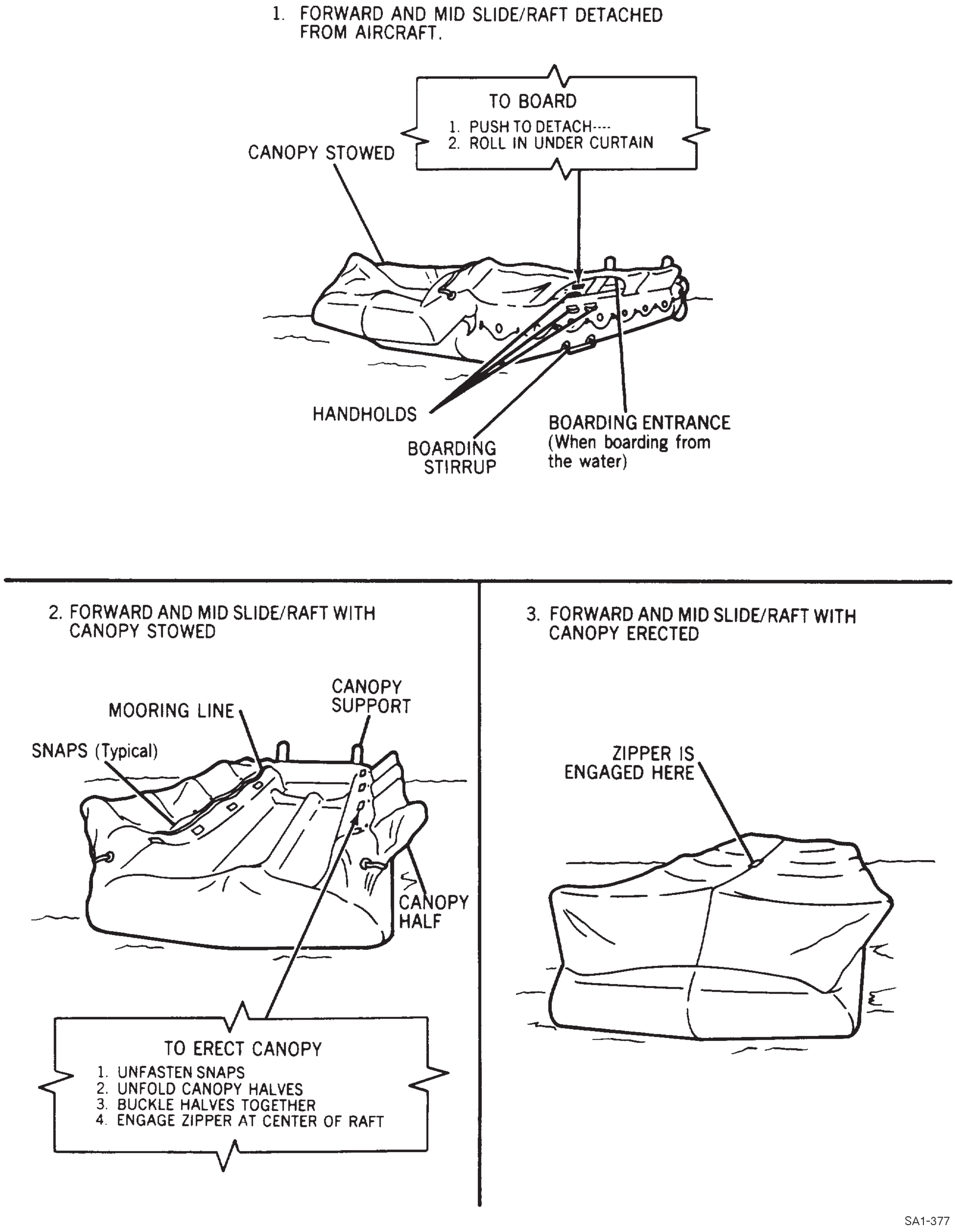


Figure 1.11-22. Escape Slide/Rafts (Sheet 2)

EMERGENCY EVACUATION

For emergency evacuation from the aircraft, the slide/raft will deploy automatically when the door is opened with the slide/raft armed. As the door moves upward toward the full open position, the slide/raft is automatically dropped from the bottom of its stowage container. It is deployed over the sill while still stowed in a fabric valise. As the valise and the slide/raft are deployed over the sill, a lanyard automatically opens the valise and the slide/raft is inflated.

If automatic inflation does not occur, a manual inflation handle is provided for initiating inflation after the slide/raft has dropped below the door threshold. The handle is clearly marked with luminous material and is located near the girt bar.

All doors are equipped with double track slide/rafts. The double tracks permit simultaneous side-by-side use by passengers.

Side handles are provided on the lower portion of the slide/raft so during a ground evacuation the first evacuees can help hold the slide/raft in position if necessary.

ILLUMINATION

Each slide/raft is equipped with self-powered electric lights which clearly define the full length of the slide/raft. The lights are activated automatically as the slide/raft deploys. Sufficient illumination will be available for a minimum of 30 minutes.

QUICK RELEASE

Each slide/raft can be released quickly from the aircraft and used as a life raft for ditching. A slide disengagement cable with an attached fabric handle is located adjacent to the girt bar. The cable and handle are protected by a flap. The free end of the flap is held in place with velcro. The slide/raft may be released by lifting the protective flap and pulling on the handle.

RE-ENTRY STATIC LINE

A re-entry static line is installed on each slide/raft. The line is used as an aid for re-entry and for mooring the slide/raft to the aircraft after being released.

The line is attached between the slide/raft and the aircraft at the doors. The line must be cut/disconnected to completely free the slide/raft from the aircraft. It is recommended that the rafts be tied together to aid in rescue operations.

SURVIVAL EQUIPMENT

Slide/rafts are equipped with foot stirrups and handholds for boarding, a canopy, floating knife, lifeline, locator light and battery, manual air inflation pump, heaving-trailing line and ring, sea anchor, and survival kit. The survival kit includes a survival manual, first aid kit, bailing bucket, sponge, knife, whistle, hole plugs, water bag, water-activated flashlight, day night signals, water purification tablets, seasickness tablets, and distress flare signals.

SLIDE/RAFT TRANSFER

During evacuation, if any slide/raft door (1L, 2L, 1R, 2R) cannot be opened or is only partially opened, the slide/raft can be removed from that door and moved to an open door.

PASSENGER CAPACITY

Slide/rafts have the following passenger capacities:

LH & RH Cabin Doors	Normal	Capacity Overload (max)
Forward (1L, 1R)	25	31
Mid (2L, 2R)	25	31
Forward Galley	7	9*

* The seven-man life raft is a standard Air Force crew life raft LRU/1/D, MIL-L-5567D, FSN 4220-5650240-LF, and weighs 82.25 pounds. It will be installed in the forward galley only when the all-cargo configuration is used. The right front door (1R) will be blocked by installation of the crew bunk. This is to satisfy FAA safety requirements for a back-up life raft system for the flight crew.

EMERGENCY TRANSMITTERS

Slide/rafts in the number one left and number one right cabin doors are equipped with an emergency locator beacon transmitter that operates automatically on 121.5 (VHF) and 243.0 (UHF).

OPERATION

Slide/Raft Deployment

Refer to the steps in the Emergency Exit section for opening cabin doors with slide deployment.

Manual Inflation

Lift manual inflation handle and pull firmly.

Disengage Slide/Raft From Aircraft

1. Lift protective flap to expose disengage handle.
2. Pull disengage handle to free slide/raft from girt bar.
3. After releasing slide/raft from girt bar, the slide/raft is still attached to the aircraft by a 25-foot long re-entry static line. This line must be cut/disconnected before the slide/raft is completely free of the aircraft.
4. If aircraft is sinking, cut/disconnect static line as soon as practicable to prevent punctures by sharp metal objects such as broken or ruptured aircraft structural members.
5. Rafts will drift rapidly before any existing wind. Sound survival practices indicate that tying rafts together as soon as possible may be the only opportunity to do so.
6. Securing rafts together will provide mutual assistance and will aid rescue attempts in spotting rafts from the air.
7. Release clamp from the pinch tube to inflate the raft's aft end section and deploy the sea anchor.

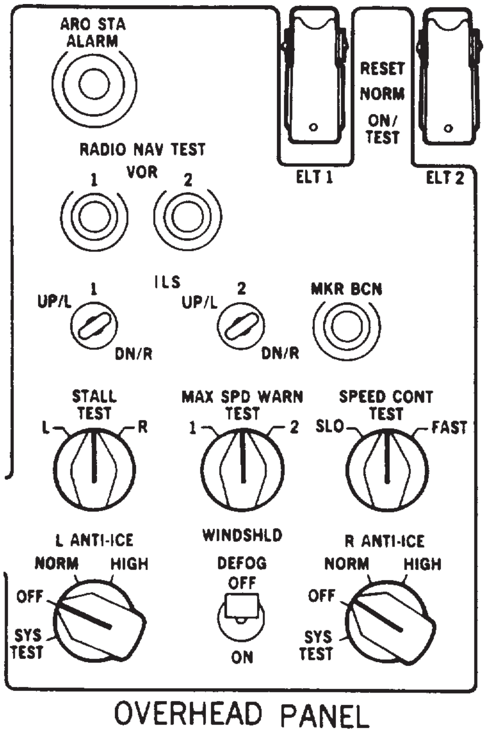
EMERGENCY LOCATOR TRANSMITTER

Two emergency locator transmitter (ELT) systems are installed. Each system provides a locating beacon in the event of a crash or ditching.

A crash sensor switch (G switch) in the ELT activates the transmitter when a G force of 2.3 ±0.3 G's or more is sensed in the longitudinal axis. A downward sweeping, repetitive audio signal is transmitted on 121.5 MHz and 243.0 MHz. Position information, provided to the ELT transmitter through the aircraft's GPS receivers, is transmitted on 406.025 MHz.

Each system includes an ELT, exterior fixed antenna, and function switch.

Both ELT's are located in the aft fuselage. ELT 1 is on the left side and ELT 2 is on the right side. The antenna for each ELT is mounted outside on the fuselage above each ELT. The function switches (figure 1.11-23) are located on the flight compartment overhead switch panel. LED Lights are located on each switch. The lights will flash to indicate the system is functioning. This will be accompanied by an audible buzzer that is mounted with the transmitter. An ARMed switch with a flashing LED and no audible buzzer is an indication of a system fault requiring maintenance support.



SA1-362A

Figure 1.11-23. ELT 1, ELT 2 Function Switch and ARO Station Alarm

ELT 1, ELT 2 FUNCTION SWITCH

Position	Function
NORM	Provides for automatic activation of ELT.
ON/TEST	Provides for manual activation for functional maintenance test or ditching.
RESET	Provides for rearming of ELT in case of inadvertent activation.

NOTE

RESET position is spring loaded to provide for momentary contact.

OPERATION

In normal operation each ELT is armed and provides for automatic activation.

To rearm an inadvertently activated ELT, lift the switch guard, move switch to RESET momentarily, return switch to NORM, and close switch guard.

To manually activate for ditching, lift switch guard and move to ON/TEST.

MISCELLANEOUS EQUIPMENT

ARO STATION ALARM

An alarm device is located in the ARO station to signal the occupants to evacuate the aircraft on the ground. Inflight it will automatically sound in the event of loss of cabin pressure, when cabin altitude exceeds 10,000 feet. The alarm may also be activated from the cockpit to notify occupants to evacuate the ARO station inflight. ARO STA ALARM can be silenced by pushing the CABIN ALTITUDE WARNING HORN Switch located on the Flight Engineer's Upper Panel No. 2 (figure 1.10-6).

Operation

Alarm is activated by a cockpit crewmember by pushing the ARO STA ALARM button (figure 1.11-23). Alarm is also activated by a pressure-sensitive switch when cabin altitude of 9,500-10,000 feet occurs.

AIRCREW EYE/RESPIRATORY PROTECTION SYSTEM

The Aircrew Eye/Respiratory Protection (AERP) System is a self-contained portable breathing device designed to provide eye and respiratory protection to the user in a toxic atmosphere. The AERP System consists of a Hood/Mask subassembly, a Breathing subassembly, a Portable Blower, and a Ground Intercommunication Unit. Blower mounting brackets and electrical connectors (figure 1.11-24), are provided for on board aircraft use.

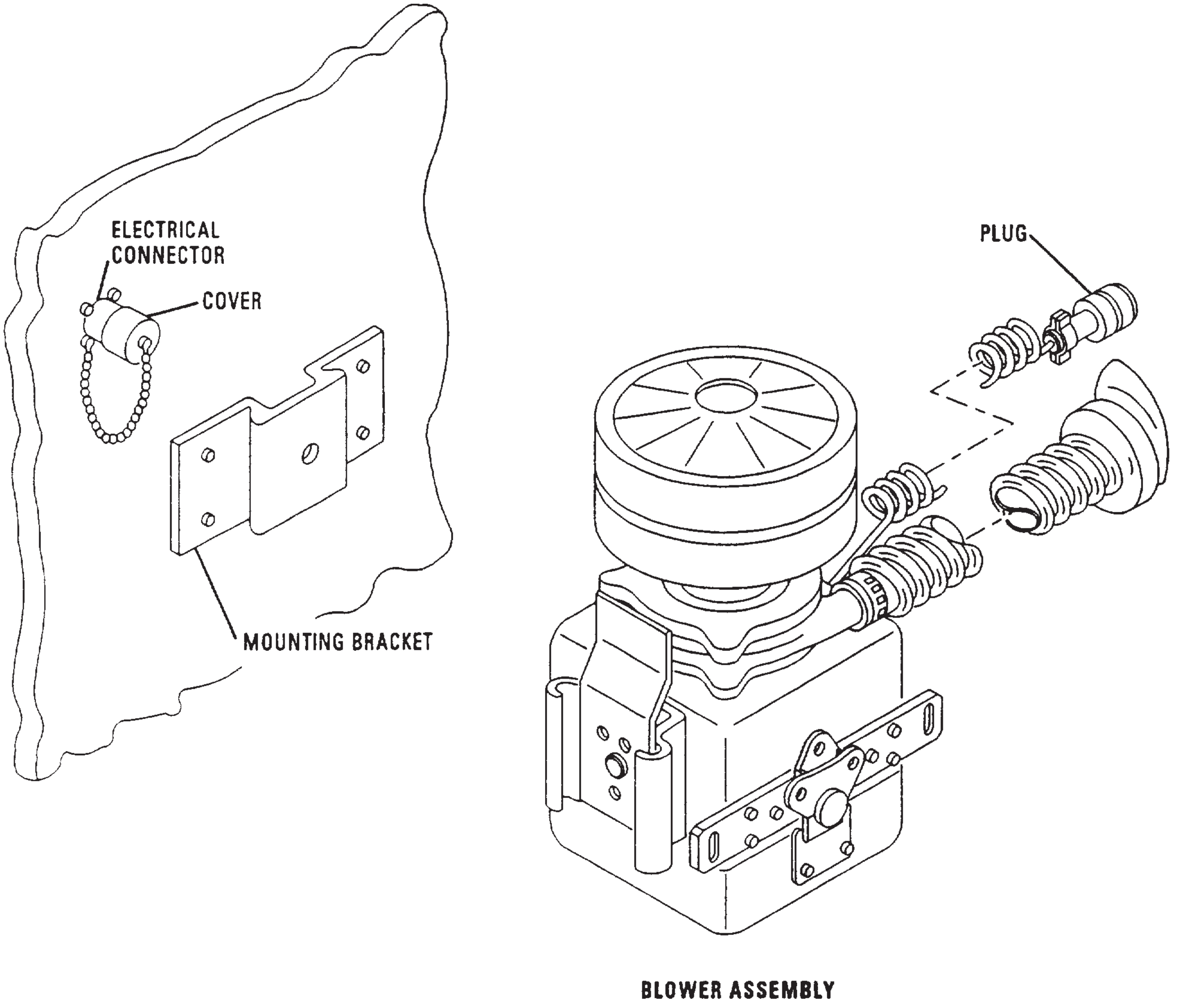
A bracket and electrical connector are located on the pilot's side console. The AERP electrical connector for the co-pilot's system is on the co-pilot side console while the blower bracket is located on the forward side of the flight engineer's station. The bracket and electrical connector for the flight engineer are on the seat pedestal of the flight engineer's seat. An electrical connector is located on the boom operator console with the associated mounting bracket on the floor just below the boom operator's console. In the ARO compartment (figure 1-15.3), an electrical connector is located on the lower left portion of the boom operator's forward side panel with a blower mounting bracket on the lower left side of the boom operator's station.

When the blower is connected to the aircraft electrical source, it operates on 28Vdc current. Circuit protection for the cockpit is provided by 5 amp circuit breakers as follows:

UPPER MAIN CIRCUIT BREAKER PANEL

LOCATION	NAME
R17	CHEMICAL DEFENSE PILOT
R18	CHEMICAL DEFENSE BOOM OP
S17	CHEMICAL DEFENSE CO-PILOT
S18	CHEMICAL DEFENSE FE

Circuit protection for the ARO Station is provided by a 5 amp circuit breaker marked CHEMICAL DEFENSE on the lower left position of ARO CIRCUIT BREAKER INSTL.



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SA1-553A

Figure 1.11-24. Portable Blower Installation Mounting Provisions

PART 12

ANTI-ICE AND RAIN PROTECTION

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ANTI-ICE AND RAIN PROTECTION

ANTI-ICE AND RAIN PROTECTION DESCRIPTION

The ice and rain protection systems consist of windshield anti-icing, windshield wipers, rain repellent, wing anti-ice, engine cowl anti-ice, and pitot/static heat system. The tail surfaces have no ice protection.

PITOT/STATIC HEAT SYSTEM

The pitot/static heat system consists of electric heating elements within the pitot tubes, static plates, angle-of-attack sensors and total air temperature (TAT) probe. The pitot tubes have dual heating elements. The elements are controlled and monitored by a single control monitor and selector (figure 1.12-1). Placing the pitot/static heat control switch to any position other than OFF will activate all systems, while in flight. On the ground, all but the (TAT) probe are energized.

WINDSHIELD ANTI-ICE AND DEFOGGING SYSTEM

The windshield anti-ice system consists of electrically heated left and right windshields, lights and associated controls. A temperature controller and temperature sensors control the electrical power required. The controller (figure 1.12-1) automatically provides stepped warm-up power to the windshield for approximately 3 to 4 minutes after the control switch is placed to either of two operating positions, to minimize thermal shock. A controller overheat protection circuit removes power from the windshield if an overheat condition occurs and turns on a WINDSHIELD ANTI-ICE INOP light. The Boom Operator's aft and lower windows are electrically heated and controlled by a switch located on the Boom Operator's Overhead Panel. The defogging system consists of heating elements in each windshield, clearview window, sensors, and controllers. The controller provides stepped warmup power to the window/windshield defogging system for approximately 4 minutes during initial turn-on to minimize thermal shock. A controller (figure 1.12-1) also provides overheat protection to the window/windshield heating elements by removing electrical power from the circuit. The DEFOG switch controls defogging for the clearview windows and the windshields.

WINDSHIELD WIPER SYSTEM

The windshield wiper system consists of two electrically powered two-speed wipers and two separate controllers (figure 1.12-1). Operation of the windshield wipers on a dry surface is not recommended.

RAIN REPELLENT SYSTEM

The rain repellent system consists of a container (figure 1.12-2), a timer, and separate nozzles for the Pilot and Copilot windshields. The system is controlled by individual pushbuttons for the Pilot and Copilot (figure 1.12-1). Operation of the rain repellent system on a dry windshield is not recommended.

WARNING

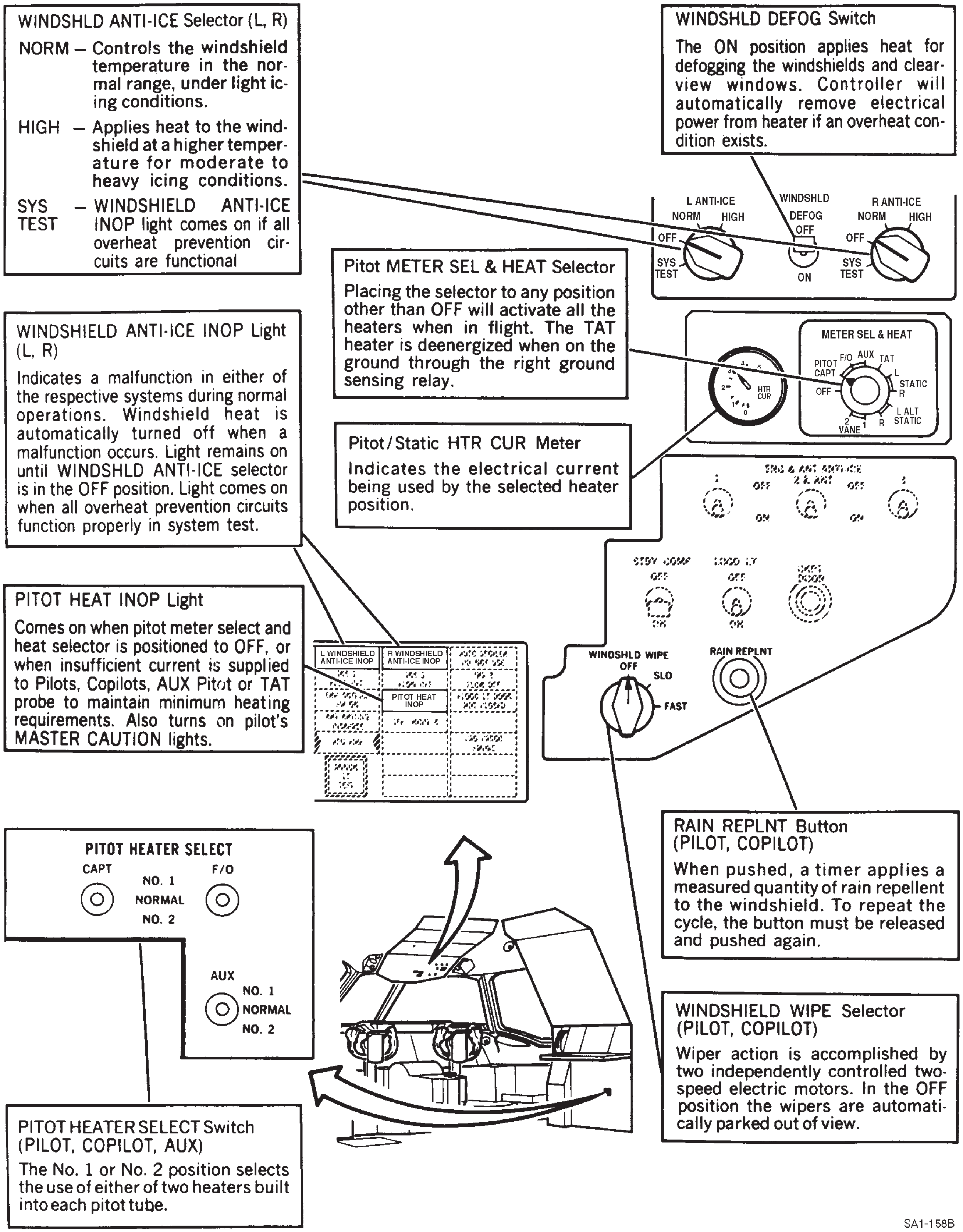
- The chemical used in rain repellent systems may cause eye or respiratory irritation. In high concentrations it is an asphyxiant and may cause cardiac sensitization.
- Some formulations of the rain repellent chemical contain an additive with a strong citrus odor. If such an odor is detected or if a leak is suspected in the rain repellent system, oxygen masks and goggles should be donned as a precaution.

CAUTION

- Do not apply repellent to a dry windshield because impaired visibility may result. Do not turn on wipers if repellent is inadvertently applied to a dry windshield.
- Do not apply repellent to second windshield until visibility has been established on first windshield.

ENGINE COWL ANTI-ICE SYSTEM

Engine cowl ice protection is supplied from a separate engine bleed port which is isolated from the normal pneumatic systems. This separate bleed air source provides adequate temperature for ice protection at all engine power settings.



WINDSHLD ANTI-ICE Selector (L, R)

NORM – Controls the windshield temperature in the normal range, under light icing conditions.

HIGH – Applies heat to the windshield at a higher temperature for moderate to heavy icing conditions.

SYS TEST – WINDSHIELD ANTI-ICE INOP light comes on if all overheat prevention circuits are functional

WINDSHLD DEFOG Switch

The ON position applies heat for defogging the windshields and clearview windows. Controller will automatically remove electrical power from heater if an overheat condition exists.

Pitot METER SEL & HEAT Selector

Placing the selector to any position other than OFF will activate all the heaters when in flight. The TAT heater is deenergized when on the ground through the right ground sensing relay.

WINDSHIELD ANTI-ICE INOP Light (L, R)

Indicates a malfunction in either of the respective systems during normal operations. Windshield heat is automatically turned off when a malfunction occurs. Light remains on until WINDSHLD ANTI-ICE selector is in the OFF position. Light comes on when all overheat prevention circuits function properly in system test.

Pitot/Static HTR CUR Meter

Indicates the electrical current being used by the selected heater position.

PITOT HEAT INOP Light

Comes on when pitot meter select and heat selector is positioned to OFF, or when insufficient current is supplied to Pilots, Copilots, AUX Pitot or TAT probe to maintain minimum heating requirements. Also turns on pilot's MASTER CAUTION lights.

RAIN REPLNT Button (PILOT, COPILOT)

When pushed, a timer applies a measured quantity of rain repellent to the windshield. To repeat the cycle, the button must be released and pushed again.

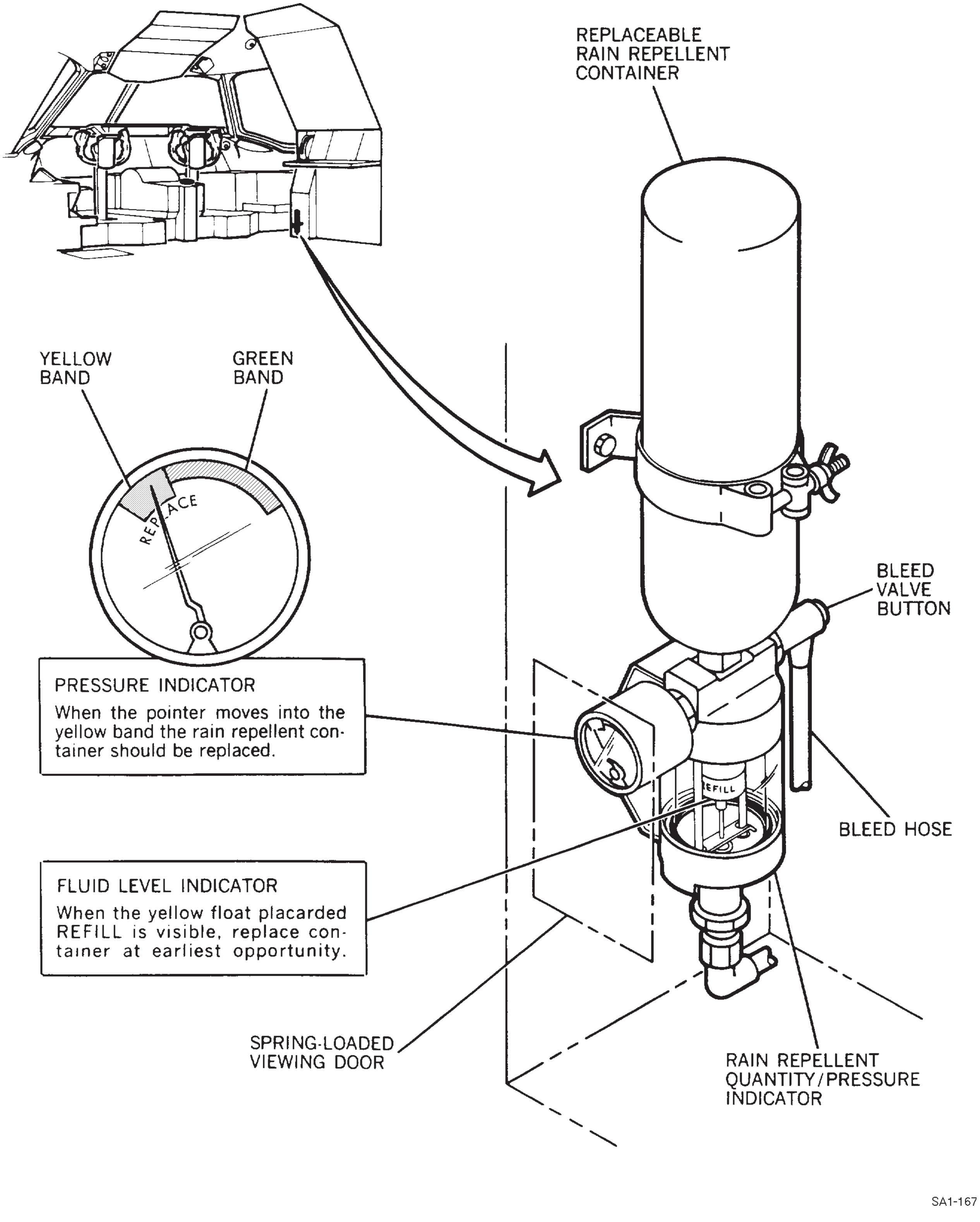
WINDSHIELD WIPE Selector (PILOT, COPILOT)

Wiper action is accomplished by two independently controlled two-speed electric motors. In the OFF position the wipers are automatically parked out of view.

PITOT HEATER SELECT Switch (PILOT, COPILOT, AUX)

The No. 1 or No. 2 position selects the use of either of two heaters built into each pitot tube.

Figure 1.12-1. Windshield Anti-ice, Defogging and Pitot/Static Heat



PRESSURE INDICATOR

When the pointer moves into the yellow band the rain repellent container should be replaced.

FLUID LEVEL INDICATOR

When the yellow float placarded REFILL is visible, replace container at earliest opportunity.

Figure 1.12-2. Rain Repellent Quantity and Pressure Indicator

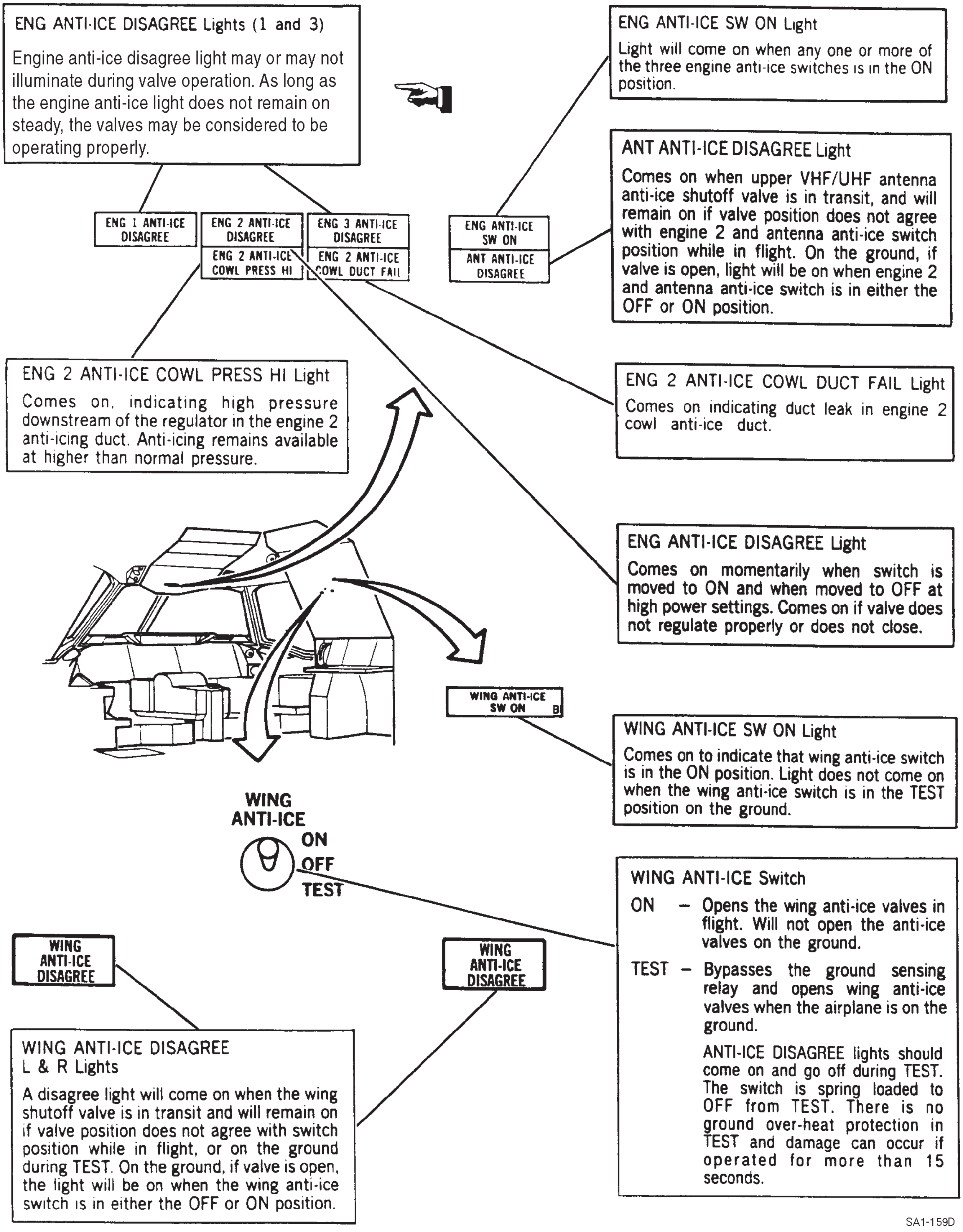
The valves open automatically to provide engine cowl anti-icing if electrical power fails. Engines 1 and 3 have automatic shutoff valves; engine 2 has a regulator valve. The regulator and shutoff valves have pressure switches which respond to engine power settings and cause the ENG 2 ANTI-ICE DISAGREE light to reflect valve operation. If the regulator valve supplies higher than normal pressure, the ENG 2 ANTI-ICE COWL PRESS HI light will come on. An ENG 2 ANTI-ICE COWL DUCT FAIL light also is installed. The light comes on when a leak in the engine 2 anti-ice cowl duct is sensed. The light, a function of temperature, stays on as long as the leak exists while the anti-ice system is on.

WING AND UPPER VHF/UHF ANTENNA ANTI-ICE SYSTEM

Wing ice protection is provided for the outboard wing slats by supplying pneumatic system air through a shutoff valve, and through a telescoping duct to the distribution ducts. Upper VHF/UHF antenna ice protection is provided from the same source through a shutoff valve. The valves close and wing and upper VHF antenna anti-icing is not available if electrical power fails. Ice protection is not provided for the inboard slats. One switch on the Flight Engineer’s Upper Panel No. 2 controls the wing anti-ice system. The ENG 2 & ANT ANTI-ICE switch controls the antenna anti-ice system (figure 1.12-3).

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Pilot’s Overhead Panel, and Flight Engineer’s Upper Panel No. 2. Illustrations of major panels are shown in Part 1 of this section. Individual controls and indicators are illustrated and described in this section.



ENG ANTI-ICE DISAGREE Lights (1 and 3)

Engine anti-ice disagree light may or may not illuminate during valve operation. As long as the engine anti-ice light does not remain on steady, the valves may be considered to be operating properly.

ENG ANTI-ICE SW ON Light

Light will come on when any one or more of the three engine anti-ice switches is in the ON position.

ANT ANTI-ICE DISAGREE Light

Comes on when upper VHF/UHF antenna anti-ice shutoff valve is in transit, and will remain on if valve position does not agree with engine 2 and antenna anti-ice switch position while in flight. On the ground, if valve is open, light will be on when engine 2 and antenna anti-ice switch is in either the OFF or ON position.

ENG 2 ANTI-ICE COWL PRESS HI Light

Comes on, indicating high pressure downstream of the regulator in the engine 2 anti-icing duct. Anti-icing remains available at higher than normal pressure.

ENG 2 ANTI-ICE COWL DUCT FAIL Light

Comes on indicating duct leak in engine 2 cowl anti-ice duct.

ENG ANTI-ICE DISAGREE Light

Comes on momentarily when switch is moved to ON and when moved to OFF at high power settings. Comes on if valve does not regulate properly or does not close.

WING ANTI-ICE SW ON Light

Comes on to indicate that wing anti-ice switch is in the ON position. Light does not come on when the wing anti-ice switch is in the TEST position on the ground.

WING ANTI-ICE Switch

ON – Opens the wing anti-ice valves in flight. Will not open the anti-ice valves on the ground.

TEST – Bypasses the ground sensing relay and opens wing anti-ice valves when the airplane is on the ground.

ANTI-ICE DISAGREE lights should come on and go off during TEST. The switch is spring loaded to OFF from TEST. There is no ground over-heat protection in TEST and damage can occur if operated for more than 15 seconds.

WING ANTI-ICE DISAGREE
L & R Lights

A disagree light will come on when the wing shutoff valve is in transit and will remain on if valve position does not agree with switch position while in flight, or on the ground during TEST. On the ground, if valve is open, the light will be on when the wing anti-ice switch is in either the OFF or ON position.

Figure 1.12-3. Wing, VHF Antenna, and Engine Anti-Ice

PART 13

COMMUNICATIONS

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COMMUNICATIONS

COMMUNICATIONS DESCRIPTION

HF, VHF and UHF communications equipment (including UHF/ADF direction finder), SATCOM, IFF/ATC transponder, passenger address (PA), interphone systems (maintenance, service and cabin), and portable Iridium Phone (**WITH TCTO 1C-10(K)A-1243**) comprise the basic communications system. The cockpit Pedestal contains controls for the VHF radio, UHF radio, and IFF/ATC systems. Flight Crew controls for the HF radio system, cockpit voice recorder, interphone call systems, and PA system are on the Overhead Panel. The Flight Engineer's Upper Instrument Panel No. 3 contains controls for the L-BAND SATCOM and the Iridium Phone Flightcell control panel (**WITH TCTO 1C-10(K)A-1243**).

HF COMMUNICATIONS SYSTEM

The HF radio (figure 1.13-1) provides air-to-air and air-to-ground communications in voice or data mode with an Automatic Communications System (ACS) that employs channel scanning and selective calling. The remote control panel associated with each of the two systems on the overhead panel provide for selection of discrete voice frequencies on upper side band voice (UV), lower side band voice (LV), and amplitude modulation equivalent (AM). The remote control panels are also capable of selecting lower side band data (LD), upper side band data (UD), and carrier wave (CW) when the aircraft are configured for these modes of operation. Both HF-1 and HF-2 may be monitored simultaneously. Interlock relays limit transmission to one system at a time. Operable HF frequencies are from 2.0000 to 29.9999 MHz in 100 Hz increments. Thirty frequencies and selected modes of operation may be preset into the system via the control panel.

WARNING

- Do not key the HF radio during ground refueling operations as arcing can occur.
- Ground operation of the HF transmitter is prohibited unless the aircraft is at least 200 feet from the following:
  - Unloaded weapons or warheads.
  - Loaded weapons in an aircraft with the bomb bay doors open.
- Do not transmit on the HF radio when the aircraft is on the ground and personnel are working on the external skin surfaces or the boom. A high voltage may build up on these surfaces due to the high power being radiated by the antenna. This voltage will shock anyone touching these surfaces.
- Do not key HF system when personnel are within 100 feet of the HF antenna.

HF-1 receives power from 115VAC Bus 1, 28VDC Bus 1 and 28VDC BATTERY Bus. HF-2 receives power from 115VAC R EMER Bus, 28VDC R EMER Bus 1 and 28 VDC BATTERY Bus. Circuit breakers are located on the forward, aft and flight engineer's overhead circuit breaker panels.

The Automatic Communications System (ACS) provides improved HF communications quality, connectivity, and reduces operator tasks required to communicate under varying propagation conditions. Establishing communications using the ACS is similar to placing calls using a telephone. An operator selects a calling station's address, initiates the call, and the communications processor automatically establishes a 2-way communications link. Operators at both ends of the link are alerted that communications can begin when the CALL indicator on the HF control panel lights and headset audio is enabled (if muted). The calling station's address is displayed on the receiving station's HF control panel to indicate who placed the call.

The basic communications process employed by ACS is known as automatic link establishment (ALE). ALE is accomplished when a scanning receive station identifies an incoming call containing its unique address and automatically exchanges data with the calling station to establish and confirm the 2-way link. Optimum channel selection is accomplished via link quality analysis (LQA) circuits within the ACS. LQA is a means of analyzing the received signal characteristics and measuring signal quality for each scanned channel. The ACS continuously updates the LQA data base, storing LQA values for all received sounding transmissions and for incoming or outgoing calls. The system automatically attempts alternate channels, based on stored LQA information and channel traffic, if a call on the initial channel fails to complete the link. To initiate an ALE call, an operator selects the desired alphanumeric station address or corresponding address index number and keys the HF system. The

ACS reviews channel LQA values for the desired address which represents recent propagation conditions and establishes a handshake between the two stations on the optimum channel. Once the 2-way link is established, the ACS alerts both operators that voice communications can begin. Once the CALL indicator lights indicating a link is established, the calling station should initiate the voice transmission. In addition to placing station-to-station calls using a specific called station address, the operator can select an all call or net address to reach all stations or a selected group of stations within a net. The ACS also provides an antijam (AJ) communication mode employing frequency-hopping techniques used to combat the effects of enemy jammers and direction finding attempts. AJ keys control the pseudorandom hopping pattern and are loaded from the remote keyfill/data load panel located on the flight engineer's equipment panel using a KYK-13 or K0I-18 keyfill device. KY-75 secure voice operation is not possible in the AJ mode if installed on the aircraft.

Limited data message transmission and reception capability is provided by the ACS. Short data messages are stored in message buffers and can be transmitted at any time once an automatic link is established with the desired station. Received data messages are also stored in a message buffer and can be read in the control panel address display field, three characters at a time. An operator is alerted that a message has been received by MR1 or MR2 appearing in the address display field. Channel presets, addresses, and other parameters must be programmed to allow automatic communications. An IBM-compatible PC device is used to datafill the system at the remote keyfill/data load panels located in the flight engineer's equipment panel under the flight engineer's table. Most parameters are stored in nonvolatile memory for power-off retention. A keep-alive circuit breaker for each system is located in the battery bus section on the pilot's overhead circuit breaker panel. The BATTERY Bus provides keep-alive voltage for the ACS.

If a short-term power outage (less than 10 seconds) occurs, programmed information is retained. If the keep-alive circuit breaker is set and a long-term power outage (more than 10 seconds) occurs, programmed information is retained. However, AJ time synchronization has to be repeated to reestablish the accurate time required for frequency hopping. If a power outage occurs for more than 10 seconds and the associated keep-alive circuit breaker is not set, AJ keys, date/time, and data messages may be lost and should be reprogrammed.

Operation

Operation of the ACS is accomplished using a menu-driven HF control panel that provides a limited number of discrete switches to perform numerous operations. The control has several display fields that can be selected by rotating the field (FLD) switch to position the cursor in the desired field. Once a particular field is selected, the value (VAL) switch is used to change the display field. Refer to figure 1.13-1, as required, to locate various display fields on the HF control panel.

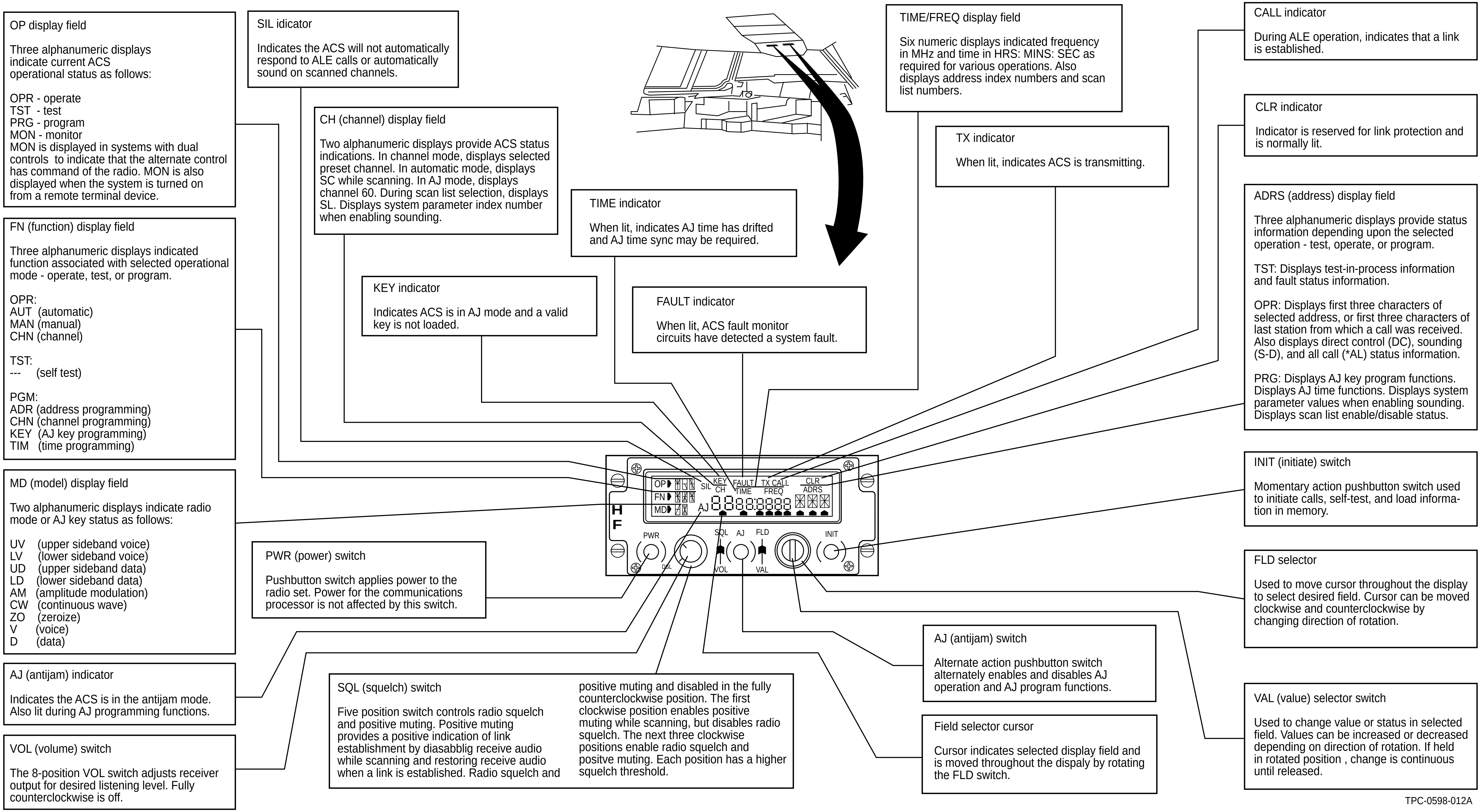
Normal Operational Modes

The ACS provides the following normal operational modes:

1. <u>Manual</u> - Manual (MAN) mode enables manual frequency and radio mode selection. Manual mode allows communications with conventional HF radio stations that do not have ALE capability. ALE calls can be made once frequency and mode are manually selected.
2. <u>Channel</u> - Channel (CHN) mode allows an operator to use selectable preset channels. The preset channel contains programmed mode and frequency information. Channel mode allows communications with conventional HF radio stations that do not have ALE capability. Channel mode can also be used to make ALE calls.
3. <u>Automatic</u> - Automatic (AUT) mode employs ALE, selective scanning, and LQA to make HF communications fully automatic. In the automatic mode, the ACS can communicate with other stations having like ALE capability.

Selective Calling (SELCAL)

Selective calling (SELCAL) alerts the flight crew of a need to communicate with the Air Traffic Control Center (ATCC) during transoceanic flights. Upon entering a control air route/space the flight crew is required to contact an ATCC using voice communication. The flight crew provides the ATCC with the aircraft's unique four-character SELCAL address. The HF-ACS system is then placed in SELCAL mode and the ATCC verifies proper operation of the ACS. The flight crew can then turn the volume down on the HF radio or enable mute to eliminate all HF noise and communication until contact by the ATCC using the aircraft SELCAL address which will cause an audible and visual notification. ALE calls will also initiate the audible and visual notification, SELCAL mode



OP display field

Three alphanumeric displays indicate current ACS operational status as follows:

OPR - operate
TST - test
PRG - program
MON - monitor
MON is displayed in systems with dual controls to indicate that the alternate control has command of the radio. MON is also displayed when the system is turned on from a remote terminal device.

FN (function) display field

Three alphanumeric displays indicated function associated with selected operational mode - operate, test, or program.

OPR:
AUT (automatic)
MAN (manual)
CHN (channel)

TST:
--- (self test)

PGM:
ADR (address programming)
CHN (channel programming)
KEY (AJ key programming)
TIM (time programming)

MD (model) display field

Two alphanumeric displays indicate radio mode or AJ key status as follows:

UV	(upper sideband voice)
LV	(lower sideband voice)
UD	(upper sideband data)
LD	(lower sideband data)
AM	(amplitude modulation)
CW	(continuous wave)
ZO	(zeroize)
V	(voice)
D	(data)

AJ (antijam) indicator

Indicates the ACS is in the antijam mode. Also lit during AJ programming functions.

VOL (volume) switch

The 8-position VOL switch adjusts receiver output for desired listening level. Fully counterclockwise is off.

SIL indicator

Indicates the ACS will not automatically respond to ALE calls or automatically sound on scanned channels.

CH (channel) display field

Two alphanumeric displays provide ACS status indications. In channel mode, displays selected preset channel. In automatic mode, displays SC while scanning. In AJ mode, displays channel 60. During scan list selection, displays SL. Displays system parameter index number when enabling sounding.

KEY indicator

Indicates ACS is in AJ mode and a valid key is not loaded.

TIME indicator

When lit, indicates AJ time has drifted and AJ time sync may be required.

FAULT indicator

When lit, ACS fault monitor circuits have detected a system fault.

TIME/FREQ display field

Six numeric displays indicated frequency in MHz and time in HRS: MINS: SEC as required for various operations. Also displays address index numbers and scan list numbers.

TX indicator

When lit, indicates ACS is transmitting.

PWR (power) switch

Pushbutton switch applies power to the radio set. Power for the communications processor is not affected by this switch.

SQL (squelch) switch

Five position switch controls radio squelch and positive muting. Positive muting provides a positive indication of link establishment by diasabblig receive audio while scanning and restoring receive audio when a link is established. Radio squelch and positive muting and disabled in the fully counterclockwise position. The first clockwise position enables positive muting while scanning, but disables radio squelch. The next three clockwise positions enable radio squelch and positve muting. Each position has a higher squelch threshold.

AJ (antijam) switch

Alternate action pushbutton switch alternately enables and disables AJ operation and AJ program functions.

Field selector cursor

Cursor indicates selected display field and is moved throughout the dispaly by rotating the FLD switch.

CALL indicator

During ALE operation, indicates that a link is established.

CLR indicator

Indicator is reserved for link protection and is normally lit.

ADRS (address) display field

Three alphanumeric displays provide status information depending upon the selected operation - test, operate, or program.

TST: Displays test-in-process information and fault status information.

OPR: Displays first three characters of selected address, or first three characters of last station from which a call was received. Also displays direct control (DC), sounding (S-D), and all call (*AL) status information.

PRG: Displays AJ key program functions. Displays AJ time functions. Displays system parameter values when enabling sounding. Displays scan list enable/disable status.

INIT (initiate) switch

Momentary action pushbutton switch used to initiate calls, self-test, and load information in memory.

FLD selector

Used to move cursor throughout the display to select desired field. Cursor can be moved clockwise and counterclockwise by changing direction of rotation.

VAL (value) selector switch

Used to change value or status in selected field. Values can be increased or decreased depending on direction of rotation. If held in rotated position , change is continuous until released.

TPC-0598-012A

Figure 1.13-1. HF Control Panel (2)

reduces the flight crew's workload by eliminating the need to monitor HF communications for voice call during long transoceanic flights.

Power is from 28VDC BUS 1 through the CAPT RAD ANN LTS circuit breaker located on the flight engineer's overhead circuit breaker panel.

SELCAL Operational Mode

When the ATCC transmits on the predetermined frequency with the aircraft's address, the ACS automatically deciphers the data. If the ACS recognizes the aircraft's address, the ACS provides the flight crew with an audible and visual notification. Upon receipt of an HF call, the interphone headset emits an audible tone and a HF CALL alert light illuminates for 30 seconds on the annunciator panel. Receive audio is automatically unmuted and squelch is disabled allowing the flight crew to communicate with the ATCC. When communication with the ATCC is completed, the ACS automatically returns to SELCAL mode and mutes receive audio until another call is received. The primary function of SELCAL is to provide the flight crew with a visual and audio alert of a need to communicate with the ATCC. A SELCAL annunciator panel is installed on the forward center pedestal for this purpose.

SELCAL operations require a datafill with information containing SELCAL address, station address, channel presets, and other operational parameters to optimize the system's automatic capabilities. Datafill is also required for the other operational modes except manual non-ALE or direct control operation. Each aircraft or station requires a unique Self Address and SELCAL Address. A remote datafill connector for the ACS system is located on the flight engineer's equipment panel and is used to serially load data into the system automatic communications processor (ACP).

Datafill

In order to optimize the automatic capabilities of the ACS, each system must be loaded with information containing addresses, channel presets, and other operational parameters. For all operational modes except manual non-ALE or direct control operation, datafill is required. Each aircraft or station requires a unique datafill. Successful ALE operation requires accurate network planning and datafill file generation. The following procedures provide ACS datafill instructions using a data transfer/fill device that has been loaded with the appropriate operational datafill files.

1. Connecting Datafill Device to ACS Remote Keyfill/Data Load Panel
    a. Locate HF-1 and HF-2 remote keyfill/data load panels located at the flight engineer's equipment panel.
    b. Remove protective cover from applicable HF DATA connector.
    c. Connect datafill cable to the datafill device.
    d. Connect other end of datafill cable to keyfill/data load panel DATA connector.
2. Perform Datafill at ACS Remote Keyfill/Data Load Panel
    a. Ensure at least 3 minutes have elapsed since setting HF circuit breakers to allow the communications processor to complete power-up self test.
    b. Turn the datafill device on and select the datafill directory.
    c. View the datafill directory and note which datafill file(s) (.FIL extension) are to be loaded.

NOTE

The DATAFILL.EXE and SELCAL.EXE programs default to comm port 1. If comm port 2 is desired, enter /COM2 following DATAFILL.EXE or SELCAL.EXE in step d. (For example, DATAFILL.EXE/COM2 or SELCAL.EXE/COM2.)

    d. Run DATAFILL.EXE.
    e. Enter operational datafill file name, including file extension, after the prompt. After approximately 20 seconds, Beginning datafill operation, press any key to abort is displayed followed by datafill parameters being loaded. The time to complete datafill depends on the size of the datafill file but is typically completed in two minutes.

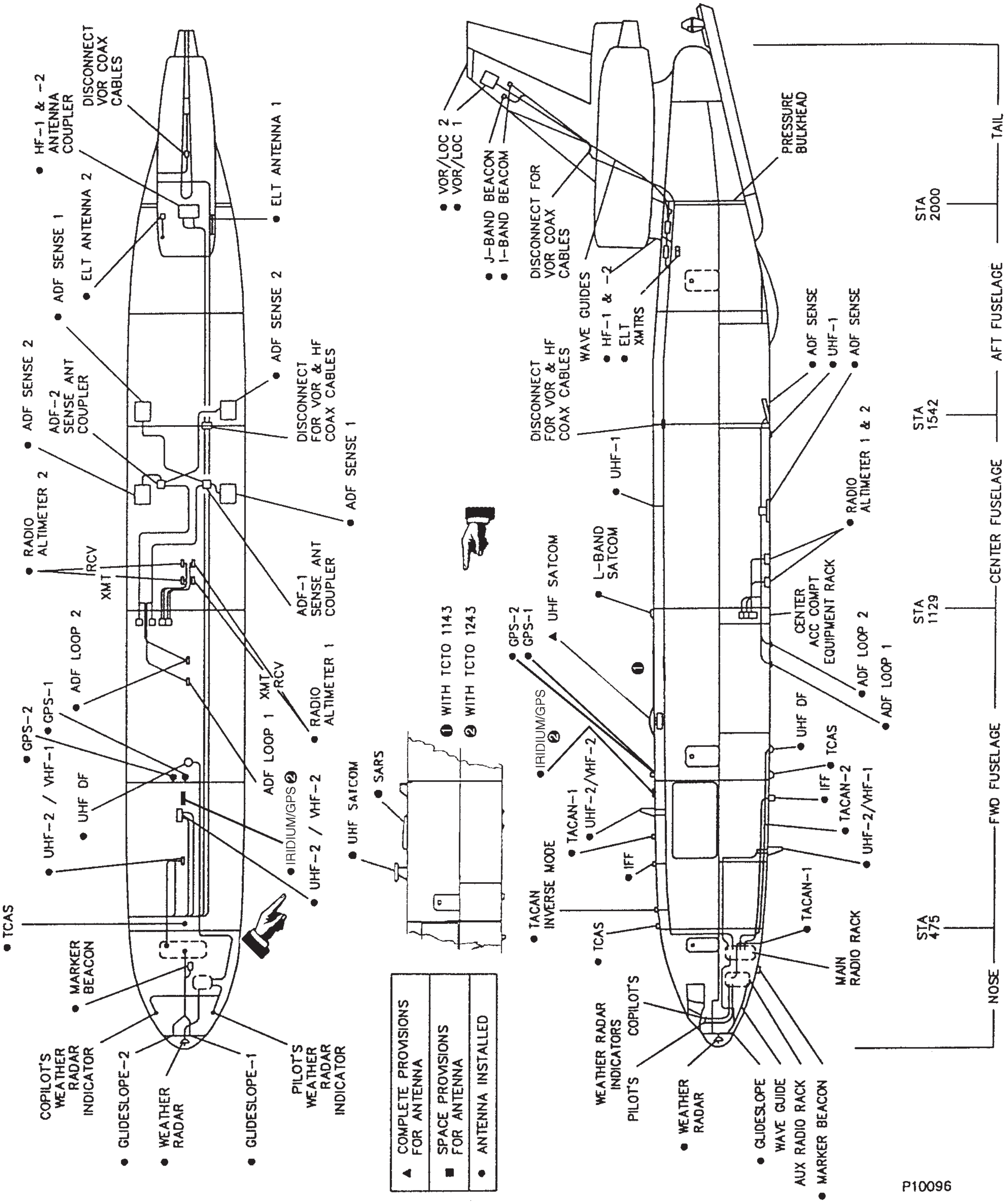


Figure 1.13-2. Antenna Locations

Page 1.13-9 is deleted.

NOTE

- If the operator wishes to abort the datafill in process, pressing any key on the datafill device causes the data transfer to halt. The PC screen displays "***ABORTING DATAFILL!***"
- If an invalid datafill command is contained in the datafill file, "***ERROR OCCURRED***" followed by "***OBSERVE LOG FILE***" is displayed on the datafill device screen. If "Fatal Error Cannot Continue Datafill" is displayed, it may be caused by a bad connection between the datafill device and the keyfill data load panel. Check the connection and repeat step 2.

f. Verify datafill device displays "***DATAFILL COMPLETE***". If the datafill file contains the SELCAL address, proceed to step j.

g. Run SELCAL.EXE.

h. Enter operational datafill file name, including file extension, after the prompt. After approximately 20 seconds, "Beginning datafill operation, press any key to abort" is displayed followed by SELCAL address being loaded. The time to complete datafill depends on the size of the SELCAL file but is typically completed in two minutes.

NOTE

- If the operator wishes to abort the datafill in process, pressing any key on the datafill device causes the data transfer to halt. The PC screen displays ***ABORTING DATAFILL!***
- If an invalid datafill command is contained in the SELCAL.EXE file, ***ERROR OCCURRED*** followed by ***OBSERVE LOG FILE*** is displayed on the datafill device screen. If "Fatal Error Cannot Continue Datafill" is displayed, it may be caused by a bad connection between the datafill device and the keyfill data load panel. Check the connection and repeat procedure.

i. When datafill device display indicates ***SELCAL ADDRESS COMPLETE***, turn off and disconnect the datafill device from the DATA connector.

j. Replace protective cover on applicable HF DATA connector.

Annunciator Panel Operation

1. Rotate the volume (VOL) knob clockwise past the OFF detent position.

2. Depress and hold the TONE/PTT knob until it actuates.

   a. Listen for a tone.

   b. Verify all three SELCAL annunciators are illuminated on the panel (SATCOM MSG, HF CALL 1 and HF CALL 2)

3. Continue to hold the TONE/PTT knob depressed.

4. Depress and release the Bright/Dim switch on the overhead annunciator panel.

   a. Verify the intensity of all three SELCAL annunciators vary from bright to dim accordingly.

5. Release the TONE/PTT knob.

   a. Verify the SATCOM annunciation extinguishes.

   b. Verify the HF CALL 1 and HF CALL 2 annunciations extinguish after 30 seconds.

6. Momentarily depress the TONE/PTT knob and simultaneously rotate the VOL knob.

   a. Verify the volume of the tone can be adjusted.

7. Momentarily depress and rotate the TONE/PTT knob several times.

   a. Verify the tone changes at the beginning of each tone burst in discrete steps.

8. Place HF-ACS in manual (MAN) mode.

NOTE

Upon entering an ATCC controlled airspace, contact the ATCC on a predetermined frequency using the manual (MAN) operational procedures. Provide the ATCC with the aircraft's valid SELCAL address.

9. Select the predetermined frequency for the ATCC operator.

10. Select SELCAL mode of operation on the operational HF system.
    a. Rotate the FLD switch to the ADRS Field.
    b. Rotate the VAL switch until -SL appears on the display.
    c. Press the radio control head INIT button.
    d. Verify that *SL appears in the ADRS Field indicating SELCAL operation has been selected.

11. Verify RCV Audio is muted unless squelch is disabled.

12. Verify proper operation by having the ATCC place a SELCAL radio check to your ACS SELCAL address.

NOTE

- If SELCAL operation fails, maintain voice communication with the ATCC.
- Upon receipt of a call, the HF CALL 1 or HF CALL 2 annunciator illuminates on the SELCAL annunciator panel, the applicable HF control head CALL indicator illuminates, and the communications link is available for use.

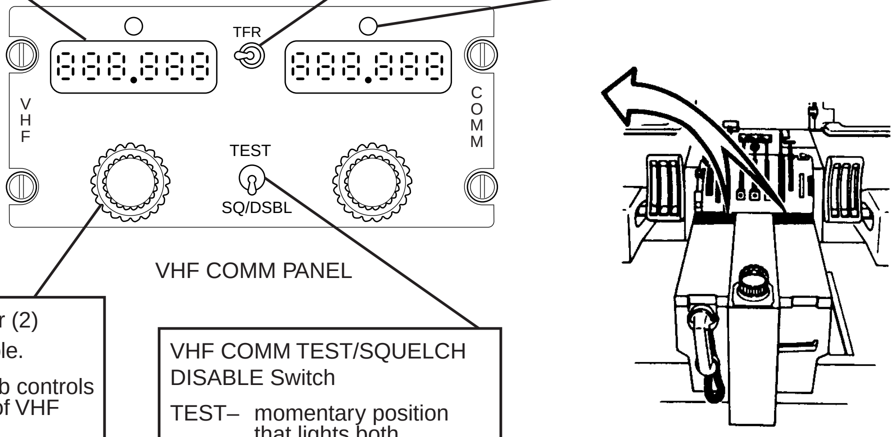
13. Reset SELCAL operation by pressing the INIT button, after communications are complete.

14. Verify *SL is still present.

15. To disable SELCAL operations, rotate the FLD switch to address field and rotate the VAL switch to select another address.

VHF COMMUNICATIONS SYSTEM

The VHF radio (figure 1.13-3) provides air-to-air and air-to-ground voice communications. Two control panels are installed on the aft pedestal. The left panel is designated VHF-1 and the right panel is designated VHF-2. There are 3720 channels available (1440 25 KHz-step channels and 2280 8.33 KHz-step channels). The frequency range is from 116.000 to 151.975 MHz. The radio provides a receive only function in the range between 116.000 and 117.975. Channel spacing of 8.33 KHz is provided only in the range between 118.000 and 137.000 MHz. An example of the expanded channel selection in the 8.33 KHz-step band is provided in figure 1.13-4. A combination UHF/VHF transmitting/receiving antenna is installed for each VHF COMM system. The UHF/VHF-2 antenna is installed on the top forward fuselage with anti-icing facilities provided. The UHF/VHF-1 antenna is installed on the bottom forward fuselage and has no anti-icing capability. VHF-1 and VHF-2 audio is muted with sidetone provided when the respective radio is transmitting. VHF-1 receives power from the 28 VDC L EMER Bus. VHF-2 receives power from the 28 VDC R EMER Bus. Circuit breakers are located on the overhead circuit breaker panel. A combination test/squelch control is provided on each VHF control panel.



VHF Frequency Display (2)

LCD display indicates selected VHF frequency.

VHF Frequency Transfer Switch

Permits operator to select either of the tuned VHF frequencies.

Selected Frequency Indicator Light (2)

Illuminates to indicate frequency in use.

VHF Frequency Selector (2)

First digit is not selectable.

Long, inner stacked knob controls second and third digits of VHF frequency.

Short outer stacked knob controls fourth, fifth and sixth digit of VHF frequency.

NOTE: Rapid rotation of the inner knob will result in a large jump in the tenths digits.

VHF COMM TEST/SQUELCH DISABLE Switch

TEST– momentary position that lights both frequency indicator lights and all segments of both displays.

Center– normal squelched operating position.

SQ/DSBL– Disbles the squelch circuit to verify VHF receiver reception.

Figure 1.13-3. VHF Control Panel (2)

UHF COMMUNICATIONS SYSTEM

One ARC-164 (figure 1.13-5) system and one ARC-171 UHF (figure 1.13-6) system, designated UHF-1 and UHF-2 respectively, are installed. The UHF-1 control panel is on the forward pedestal and the UHF-2 control panel is on the right aft pedestal (figure 1.1-22). Each UHF system operates over a frequency range of 225.00 MHz to 399.975 MHz with 25 kHz spacing. UPPER/AUTO/LOWER modes of antenna operation may be selected, the UHF/DF switching unit automatically selects the upper or lower antenna depending on which antenna was in use when the squelch was broken. Reversion logic permits transmission, while in ADF mode, over the appropriate antenna for UHF-1. The UHF/ADF DF operates with either UHF-1 or UHF-2. UHF-2 takes precedence, in the event both UHF systems are set to ADF. The UHF bearing is displayed on the Pilot's (Copilot's) RMI, when the Pilot's (Copilot's) RMI ADF-1 UHF/LF switch is set to UHF and RMI VOR/ADF selector set to ADF.

NOTE

UHF-1 provides more accurate UHF/DF information than UHF-2.

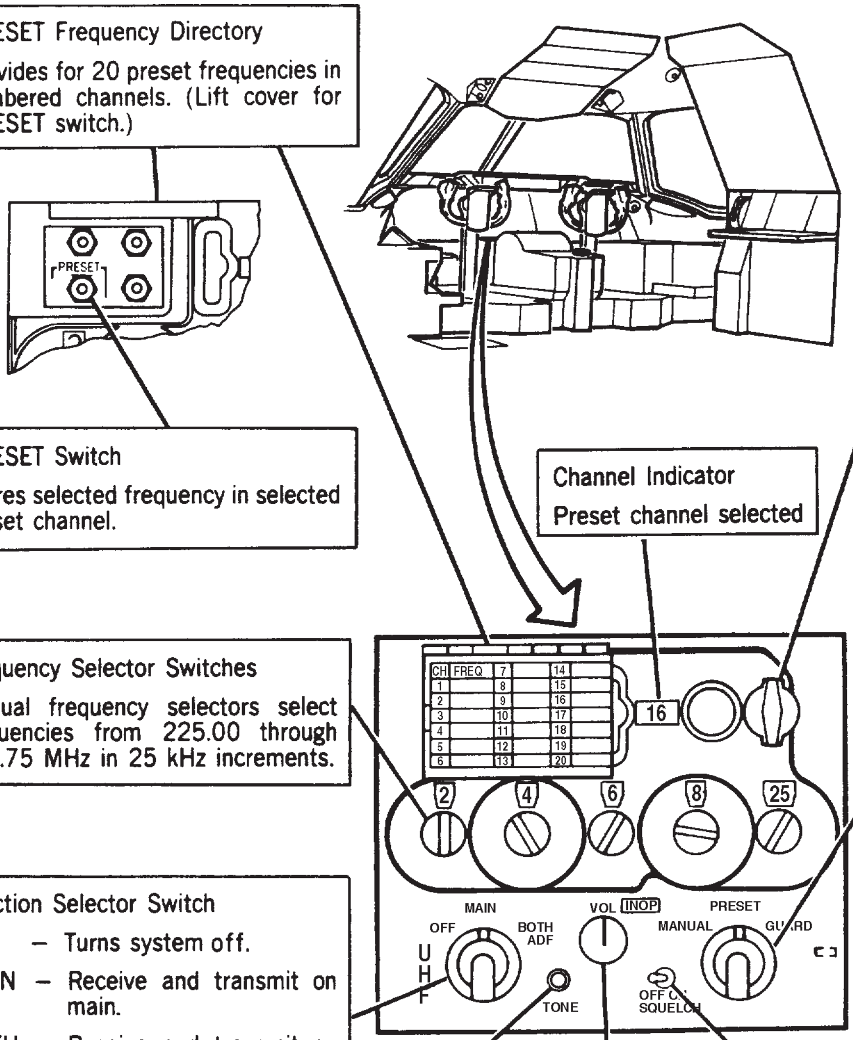
UHF-1 receives power from 28 VDC L EMER Bus. UHF-2 receives 3 phase AC power from 115VAC R EMER Bus and DC power from 28VDC R EMER Bus. Circuit breakers are located on the overhead circuit breaker panel.

Provisions for KY-58 secure voice control are installed. Either UHF system is able to operate in secure voice when installed. Isolation panels limit secure voice operation to the Pilot, Copilot, and Flight Engineer.

Provisions for UHF satellite communications are also installed. A UHF satellite antenna allows for the use of satellite communication systems which may be hand carried onto the aircraft and connected to the antenna for temporary use.

FREQUENCY (MHz)	CHANNEL SPACING	CHANNEL ID
118.0000	25/50	118.000
118.0000	8.33	118.005
118.0083	8.33	118.010
118.0167	8.33	118.015
118.0250	25	118.025
118.0250	8.33	118.030
118.0333	8.33	118.035
118.0417	8.33	118.040
118.0500	25/50	118.050
118.0500	8.33	118.055
118.0583	8.33	118.060
118.0667	8.33	118.065
118.0750	25	118.075
118.0750	8.33	118.080
118.0833	8.33	118.085
118.0917	8.33	118.090
118.1000	25/50	118.100
118.1000 etc.	8.33	118.105

Figure 1.13-4. 8.33 KHz Frequency Selection



PRESET Frequency Directory

Provides for 20 preset frequencies in numbered channels. (Lift cover for PRESET switch.)

Channel Selector

Selects one of 20 preset channels

PRESET Switch

Stores selected frequency in selected preset channel.

Channel Indicator

Preset channel selected

Frequency Mode Selector

MANUAL – Frequency is selected manually.

PRESET – Preset channel selected.

NOTE

To enter/change PRESET frequencies:

1. Rotate function selector switch to MAIN and MANUAL-PRESET-GUARD selector to PRESET.
2. Rotate channel selector to desired channel number and then rotate frequency selectors to set desired frequency.
3. Lift frequency directory cover, in upper left corner, and push PRESET switch.
4. Record preset frequency, for channel number, on directory.

GUARD – Guard frequency selected. Receive and transmit on guard.

Frequency Selector Switches

Manual frequency selectors select frequencies from 225.00 through 399.75 MHz in 25 kHz increments.

Function Selector Switch

OFF – Turns system off.

MAIN – Receive and transmit on main.

BOTH – Receive and transmit on main, receive on guard.

ADF – Enables ADF and main receiver.

TONE Switch

When pushed transmits an AM tone.

VOL Control

Volume control inoperative. Adjust UHF-1 audio level with volume control lever on the audio panel at each crew member station.

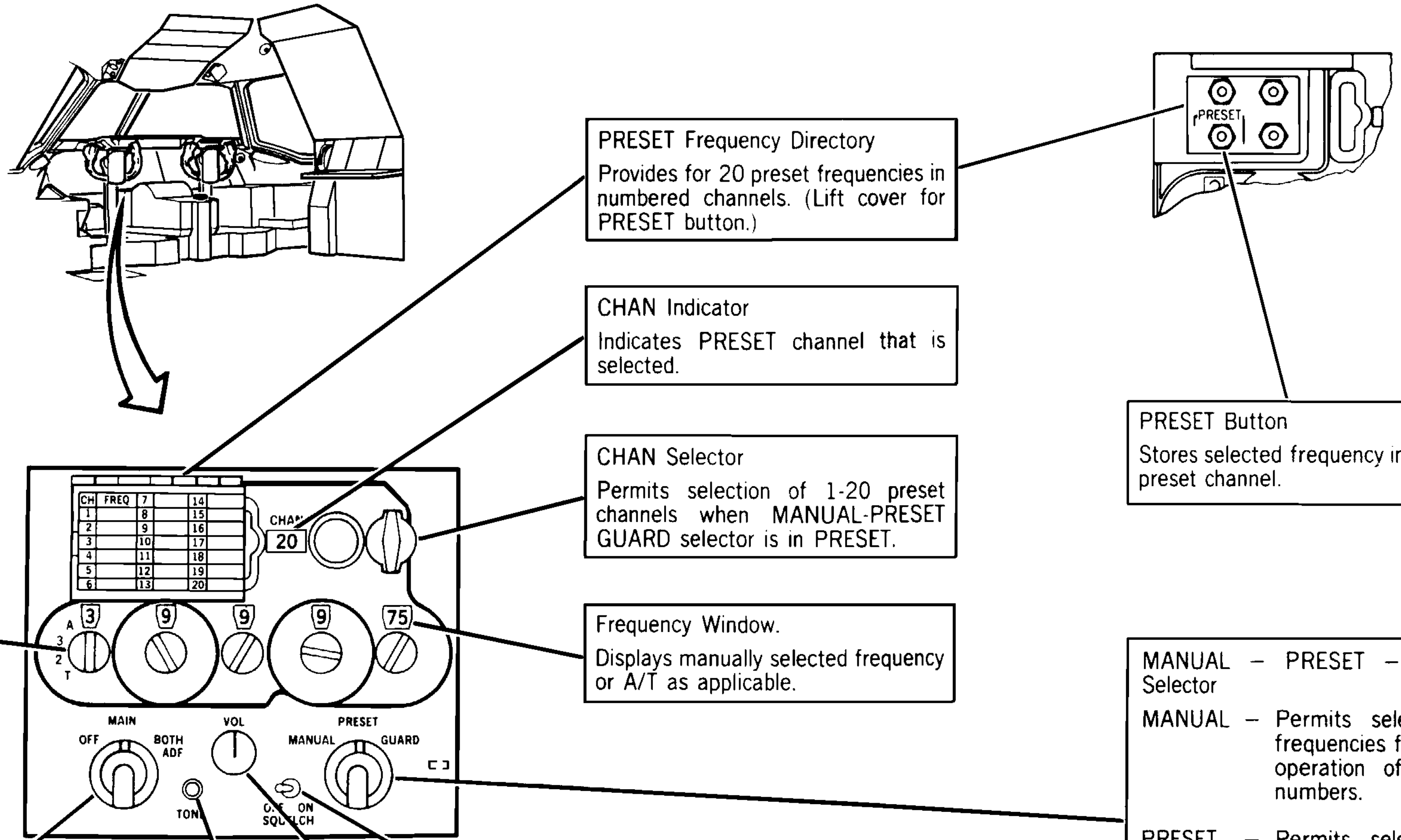
SQUELCH-Receiver Sensitivity

ON – Squelch enable

OFF – Max sensitivity

SA1-273E

Figure 1.13-5. ARC-164/COMNAV-50 (Sheet 1)



MANUAL FREQUENCY SELECTORS

Permits manual frequency selection from 225.00 through 399.975 MHz range in 25 KHz increments for normal UHF operation when MANUAL-PRESET - GUARD selector is in MANUAL or PRESET and mode selector switch is in MAIN OR BOTH.

HUNDREDTH (T-2-3-A) FREQUENCY SELECTOR

T – Selects input of a new TOD for up to 1 minute after "T" has been selected for approximately 3 seconds.

NOTE

- Selector is spring loaded and will return to position 2 when released.
- Radio will not transmit while selector is in "T."
- Selecting "T" position and pushing TONE button simultaneously will start TOD clock within radio. TOD will not be synchronized to Universal Coordinated Time (UCT) when this method is used to start clock.

2/3 – Selects hundredth digit in normal mode.

Permits WOD selection in channels 20-15 when MANUAL-PRESET- GUARD SELECTOR is in PRESET and mode selector is in MAIN or BOTH.

Permits selection of AJ net numbers (tens, unit and tenths selectors) when MANUAL-PRESET - GUARD is in MANUAL or PRESET and MODE SELECTOR IS IN MAIN or BOTH.

A – Permits operation in AJ mode providing other prerequisites have been met.

NOTE

Other selectors (4 places) are utilized during selection of normal UHF frequencies, WOD segments or net numbers as applicable.

PRESET Frequency Directory

Provides for 20 preset frequencies in numbered channels. (Lift cover for PRESET button.)

CHAN Indicator

Indicates PRESET channel that is selected.

CHAN Selector

Permits selection of 1-20 preset channels when MANUAL-PRESET GUARD selector is in PRESET.

Frequency Window.

Displays manually selected frequency or A/T as applicable.

PRESET Button

Stores selected frequency in selected preset channel.

MANUAL – PRESET – GUARD Selector

MANUAL – Permits selection of frequencies for normal operation of AJ net numbers.

PRESET – Permits selection of frequencies for normal operation or AJ net numbers in channels 1-14 and WOD in channels 20-15 for operation in AJ mode.

NOTE

Preset frequencies may also be entered in channels 15-19 if they are not required for WOD entry.

GUARD – Transmitting and receiving systems operate on guard frequency only. (Guard receiver inactivated)

NOTE

Selecting GUARD will disable AJ mode and place main receiver/transmitter on frequency 243.00 MHz.

SQUELCH-Receiver Sensitivity

ON – Squelch enable

OFF – Max sensitivity

VOL Control

Volume control inoperative. Adjust UHF-1 audio auto level with volume control lever on the audio panel at each crew member station.

MODE SELECTOR SWITCH

OFF – Turns system off.

MAIN – Receives and transmits on main.

BOTH – Transmit on main and receive in both main and guard.

NOTE

Any transmission recieved on GUARD channel will take precedence over AJ modes.

ADF – Enables ADF and main receiver.

NOTE

ADF information should not be relied on during AJ mode of operation. The system will operate; however, its accuracy is unknown and will vary with frequency hop rate.

TONE BUTTON

Transmits an AM tone prior to reception of TOD signal. After TOD is received it will transmit TOD signal first and then an AM tone.

Transmit signal to start clock within radio when used in conjunction with hundredth selector. (See "T" position of hundredth manual frequency selector).

NOTE

TOD message may be transmitted in normal or AJ mode. A complete TOD message is transmitted in normal; however, only a timing update tick will be transmitted when operating in AJ mode.

SA1-503B

Figure 1.13-5. ARC-164C/COMNAV-50 (Sheet 2)

INT (interrogate) Switch

INT switch is a push type switch with an integral indicator light and operates independently of or in conjunction with CONT switch.

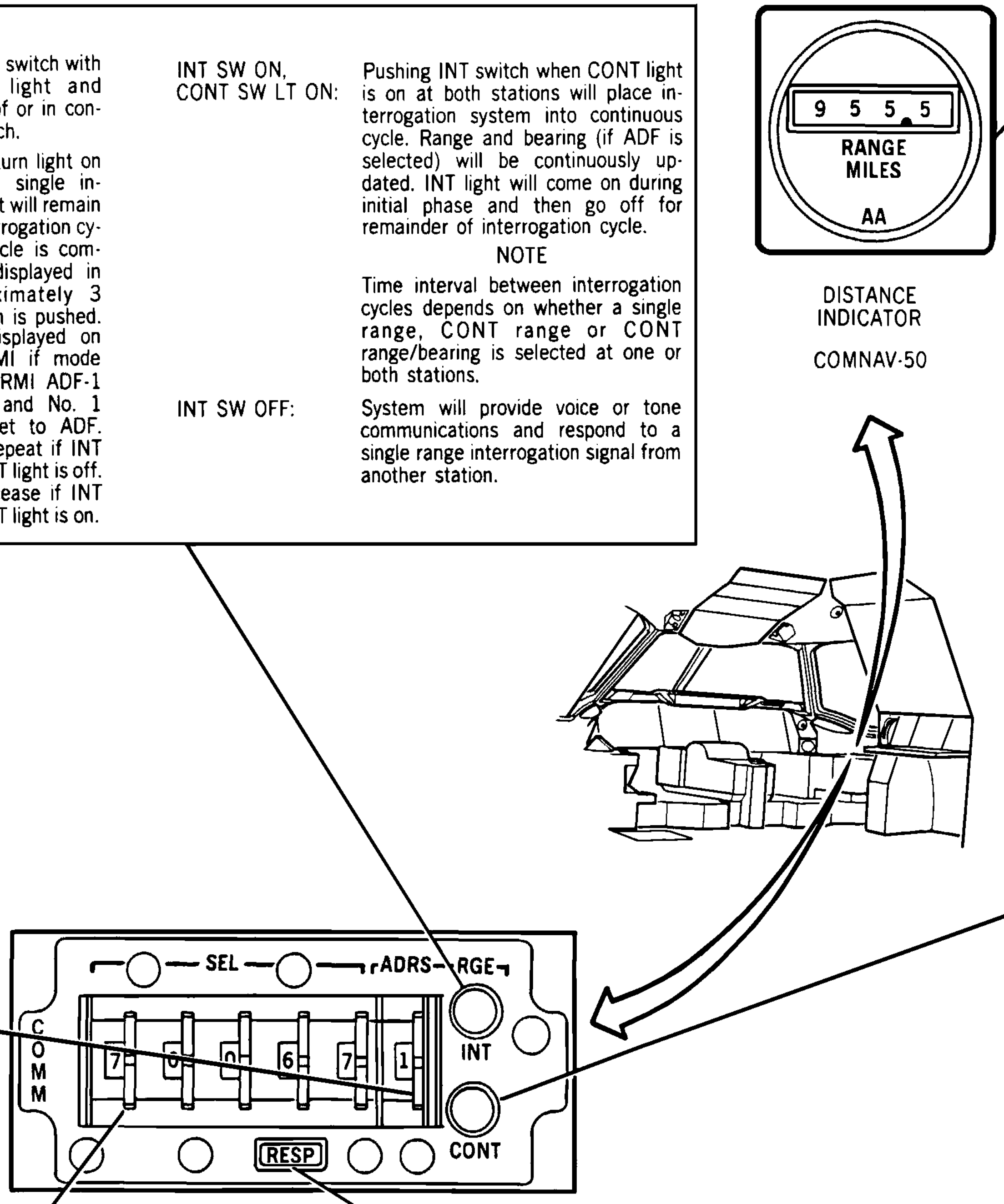
INT SW ON CONT SW LT OFF:	Pushing INT switch will turn light on and place system in a single interrogation cycle. INT light will remain on while system is in interrogation cycle and go off when cycle is completed. Range will be displayed in nautical miles approximately 3 seconds after INT switch is pushed. Bearing will also be displayed on pilot's and co-pilot's RMI if mode selector is in ADF and RMI ADF-1 switch is set to UHF and No. 1 VOR/ADF selector is set to ADF. Interrogation cycle will repeat if INT switch is pushed while INT light is off. Interrogation cycle will cease if INT switch is pushed while INT light is on.
INT SW ON, CONT SW LT ON:	Pushing INT switch when CONT light is on at both stations will place interrogation system into continuous cycle. Range and bearing (if ADF is selected) will be continuously updated. INT light will come on during initial phase and then go off for remainder of interrogation cycle. NOTE Time interval between interrogation cycles depends on whether a single range, CONT range or CONT range/bearing is selected at one or both stations.
INT SW OFF:	System will provide voice or tone communications and respond to a single range interrogation signal from another station.

ADRS Selector

Positions 1-5:	Provides 5 distinct range addresses. Distance between 2 stations may be determined if both stations have same ADRS and SEL codes selected and are operating in EXT mode.
Position A:	Range response may be obtained from any station having same SEL codes selected and operating in EXT mode. The same ADRS setting is not required; however; the system will not respond to interrogation signals from other stations.
Position 0:	Interrogate/respond capability is deactivated; however, normal communication is still possible.
Position T:	RESP, INT and CONT lights will illuminate when T (test) position is selected. Lights will remain on until selector is moved to another position. NOTE Voice and tone operation are not affected by ADRS selector position.

SEL Code Selectors

Sets/displays code selections. Communication requires another COMNAV 50 station to be operating in the EXT mode with the same SEL setting and radio frequency selection.



DISTANCE INDICATOR

COMNAV-50

MODEM CONTROL PANEL

COMNAV-50

RESP Light

Light on indicates equipment is responding to interrogation.

Distance Indicator

Displays distance in nautical miles (NM) between two interrogating stations.

CONT (Continuous) Switch

CONT switch is a two position push type switch with an integral indicator light.

Light On:	Pushing switch turns light on and selects CONT interrogating mode. Range and bearing (if ADF is selected) will be continuously updated provided both stations have CONT selected and INT is selected at either one of the stations.

NOTE

- If voice communication is required the CONT interrogation cycle may be interrupted by actuating MIC switch while RESP light is on. A short synchronization tone will occur immediately following MIC switch actuation. Voice communications may be accomplished when tone stops. Actuation of MIC switch while RESP light is off will also interrupt CONT cycle; however, voice communications will be delayed until transponding cycle is completed. CONT interrogation cycle may be resumed by pushing INT switch.
- Range indication will change to 000.0 miles when CONT interrogation is interrupted by actuation of MIC switch.

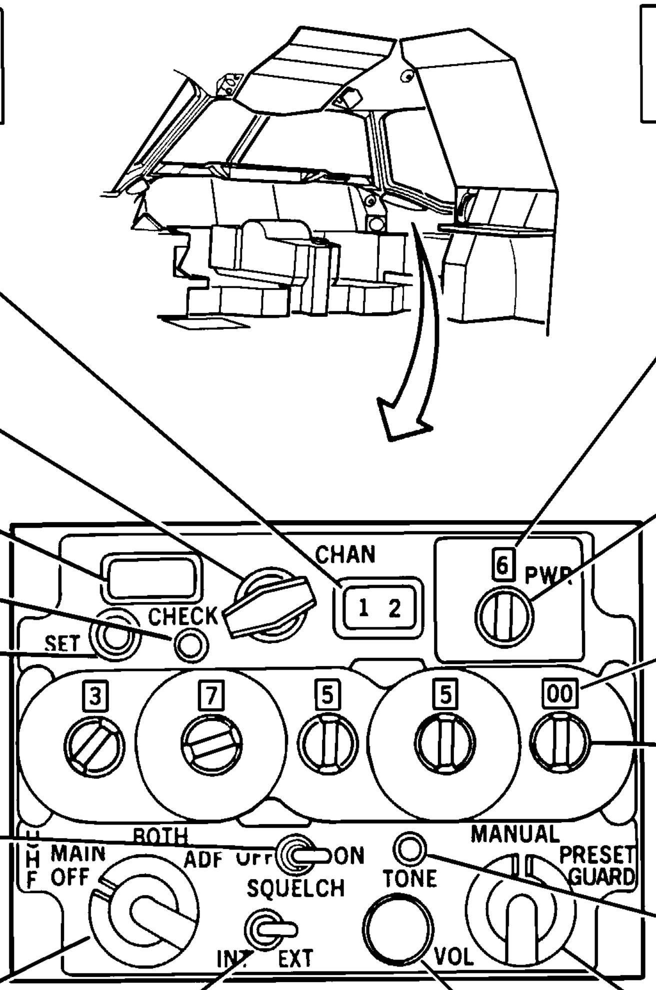
Light Off:	Pushing switch will turn light off and disable CONT interrogation mode. System is still capable of voice or tone communications, single range interrogation or responding to another station's interrogation signal.

NOTE

Last range indication will remain displayed when CONT switch is turned off.

SA1-501C

Figure 1.13-5. ARC-164C/COMNAV-50 (Sheet 3)



RADIO CONTROL PANEL

COMNAV-50

CHAN Selector

Permits selection of 1 of 20 preset channels when MANUAL-PRESET GUARD Selector is in PRESET.

CHECK Window

Indicates frequency of selected preset channel when CHECK button is pushed.

CHECK Button

Pushing button causes frequency of selected preset channel to appear in CHECK window.

SET Button

Lock desired frequency in preset channels when pushed.

SQUELCH – Receiver Sensitivity

ON – Squelch enabled
OFF – Max sensitivity

Mode Selector Switch

OFF	– Turns system off.
MAIN	– Receive and transmit on main.
BOTH	– Transmit on main and receive on main and guard.
ADF	– UHF ADF equipment is activated. Main receiving system operates through ADF antenna, except during transmissions. When transmitting system is activated, equipment is automatically switched to high-power UHF antenna. In EXT, a cooperating station is automatically commanded to extend its respond transmission time to permit determination of bearing. When mode selector switch on UHF-1 control panel is set to ADF, the ADF antenna is connected to UHF-1 system, and overrides COMNAV-50 system.

CHAN Indicator

Indicates PRESET channel that is selected.

INT/EXT Switch

INT:	Selects internal mode of operation. Functional control is provided through the Radio control panel.
EXT:	Selects external mode of operation. Functional control is provided through the Modem control panel in conjunction with the Radio control panel.

Power Window

Indicates position (power level) of PWR selector switch.

VOL Control

Adjust audio level of reception and transmitter sidetone. Audio reception level is adjustable to individual preference through the UHF-1 volume control on each audio panel.

PWR Selector Switch

INT Mode Selected	Power level increases with selection of each successive position from 1 through 5. Power level is the same in postions 5 and 6.
EXT Mode Selected	Power level increases with selection of each successive postion from 1 through 6.

Frequency Window

Displays manually selected frequency.

Manual Frequency Selector

Permits manual frequency selection from 225.00 through 399.975 MHz range in 25 KHz increments when MANUAL-PRESET GUARD selector is in MANUAL.

NOTE

Tuning occurs immediately during manual frequency selection. Operator will not hear a tuning tone.

TONE Button

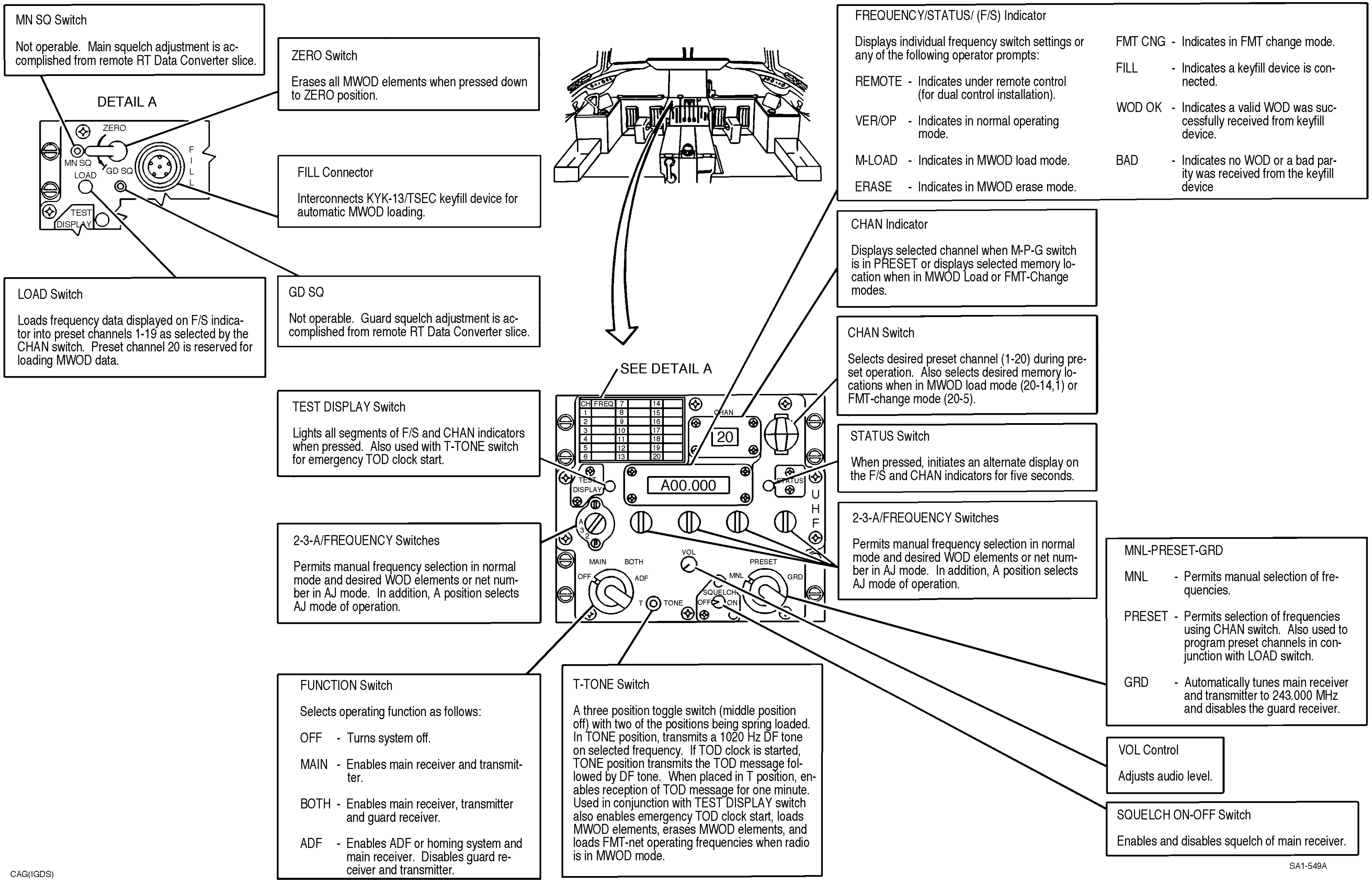
Transmits AM tone when pushed

MANUAL–PRESET GUARD Selector

MANUAL:	Permits selection of frequencies by manual frequency selector switches.
PRESET:	Permits selection of one of twenty preset channels.
GUARD:	Transmitting system and receiving system operate on guard frequency only (guard receiver inactivated).

SA1-500C

Figure 1.13-5. ARC-164C/COMNAV-50 (Sheet 4)



MN SQ Switch

Not operable. Main squelch adjustment is accomplished from remote RT Data Converter slice.

ZERO Switch

Erases all MWOD elements when pressed down to ZERO position.

FILL Connector

Interconnects KYK-13/TSEC keyfill device for automatic MWOD loading.

LOAD Switch

Loads frequency data displayed on F/S indicator into preset channels 1-19 as selected by the CHAN switch. Preset channel 20 is reserved for loading MWOD data.

GD SQ

Not operable. Guard squelch adjustment is accomplished from remote RT Data Converter slice.

TEST DISPLAY Switch

Lights all segments of F/S and CHAN indicators when pressed. Also used with T-TONE switch for emergency TOD clock start.

2-3-A/FREQUENCY Switches

Permits manual frequency selection in normal mode and desired WOD elements or net number in AJ mode. In addition, A position selects AJ mode of operation.

FUNCTION Switch

Selects operating function as follows:

OFF - Turns system off.

MAIN - Enables main receiver and transmitter.

BOTH - Enables main receiver, transmitter and guard receiver.

ADF - Enables ADF or homing system and main receiver. Disables guard receiver and transmitter.

T-TONE Switch

A three position toggle switch (middle position off) with two of the positions being spring loaded. In TONE position, transmits a 1020 Hz DF tone on selected frequency. If TOD clock is started, TONE position transmits the TOD message followed by DF tone. When placed in T position, enables reception of TOD message for one minute. Used in conjunction with TEST DISPLAY switch also enables emergency TOD clock start, loads MWOD elements, erases MWOD elements, and loads FMT-net operating frequencies when radio is in MWOD mode.

FREQUENCY/STATUS/ (F/S) Indicator

Displays individual frequency switch settings or any of the following operator prompts:

REMOTE - Indicates under remote control (for dual control installation).

VER/OP - Indicates in normal operating mode.

M-LOAD - Indicates in MWOD load mode.

ERASE - Indicates in MWOD erase mode.

FMT CNG - Indicates in FMT change mode.

FILL - Indicates a keyfill device is connected.

WOD OK - Indicates a valid WOD was successfully received from keyfill device.

BAD - Indicates no WOD or a bad parity was received from the keyfill device

CHAN Indicator

Displays selected channel when M-P-G switch is in PRESET or displays selected memory location when in MWOD Load or FMT-Change modes.

CHAN Switch

Selects desired preset channel (1-20) during preset operation. Also selects desired memory locations when in MWOD load mode (20-14,1) or FMT-change mode (20-5).

STATUS Switch

When pressed, initiates an alternate display on the F/S and CHAN indicators for five seconds.

2-3-A/FREQUENCY Switches

Permits manual frequency selection in normal mode and desired WOD elements or net number in AJ mode. In addition, A position selects AJ mode of operation.

MNL-PRESET-GRD

MNL - Permits manual selection of frequencies.

PRESET - Permits selection of frequencies using CHAN switch. Also used to program preset channels in conjunction with LOAD switch.

GRD - Automatically tunes main receiver and transmitter to 243.000 MHz and disables the guard receiver.

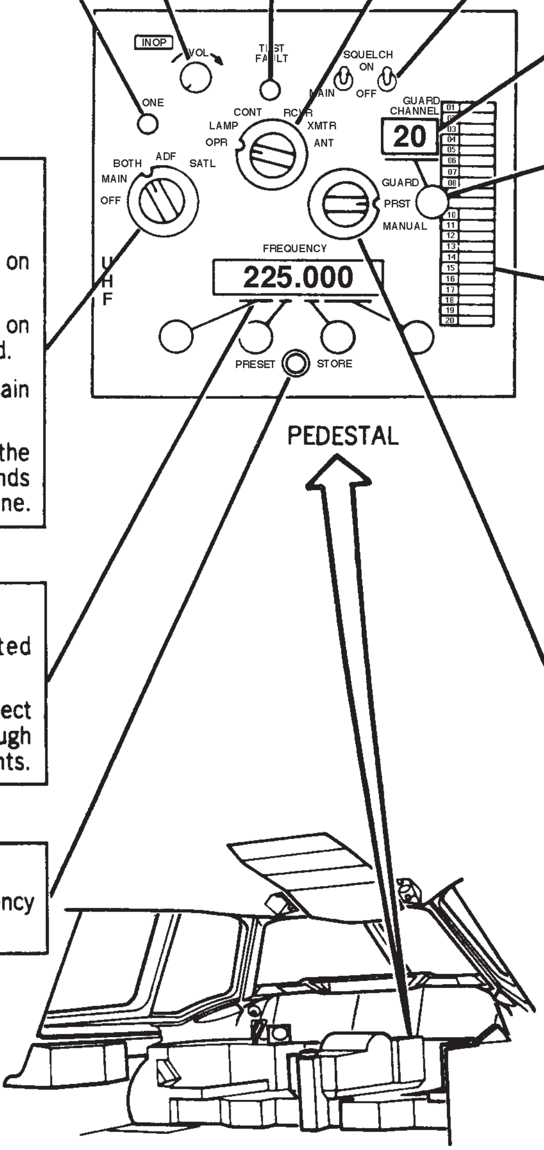
VOL Control

Adjusts audio level.

SQUELCH ON-OFF Switch

Enables and disables squelch of main receiver.

Figure 1.13-5. ARC-164C/COMNAV-50 (Sheet 5)



VOL Control

Volume control inoperative. Adjust UHF-2 audio level with volume control lever on the audio panel at each crew member station.

TONE Switch

When pushed transmits an AM tone.

Function Selector Switch

OFF – Turns system off.

MAIN – Receive and transmit on main.

BOTH – Receive and transmit on main and receive guard.

ADF – Enables ADF and main receiver.

SATL – Turns power off on the control panel and grounds the satellite preempt line.

FREQUENCY

Indicator displays the selected frequency in six digits.

Manual frequency selectors select frequencies from 225.00 through 399.75 MHz in 25 kHz increments.

PRESET-STORE Switch

Push when storing preset frequency selected for preset channel.

TEST-FAULT Lamp

Lamp lit when equipment under test is in a fault condition.

TEST Switch

OPR – Not in test
LAMP – Tests fault lamp
CONT – Tests control panel
RCVR – Tests receiver
XMTR – Tests transmitter
ANT – Tests antenna

Receiver Sensitivity

MAIN ON – Squelch enable
OFF – Max. sensitivity
GUARD ON – Squelch enable
OFF – Max sensitivity.

CHANNEL Indicator

Displays preset channel selected

CHANNEL Selector

Selects one of 20 preset channels

PRESET Frequency Directory

Provides for 20 preset frequencies in numbered channels.

Frequency Mode Selector

MANUAL – Frequency is selected manually.

PRST – Preset channel selected.

NOTE

To enter/change PRESET frequencies:

1. Rotate function selector switch to MAIN and GUARD-PRST-MANUAL selector to PRST.
2. Rotate CHANNEL selector to desired channel number and then rotate frequency selectors to set desired frequency.
3. Push PRESET/STORE switch. Illuminates momentarily, when pushed.
4. Record preset frequency, for CHANNEL number, on directory.

GUARD – Guard frequency selected. Receive and transmit on guard.

SA1-274E

Figure 1.13-6. UHF-2 Control Panel - ARC-171

ARC-164C UHF RADIO

The ARC-164 UHF radio has been replaced with an ARC-164C HAVE QUICK Anti-Jamming UHF radio (figure 1.13-5).

The HAVE QUICK system is a modified ARC-164 radio with a frequency hopping capability. Frequency hopping is a technique of changing the frequency being used on a given communication link many times per second. Three forms of frequency hopping are available in the anti-jamming (AJ) modes: A Nets for maximum anti-jamming capability; B Nets for use with E-3As; and T Nets which has the least capability and does not expose the systems ultimate anti-jamming capability.

The ARC-164C may be operated in the Normal or Anti-Jamming (HAVE QUICK) mode. Normal UHF communication/operation is essentially the same as any ARC-164 radio. Operation is available in MANUAL mode or PRESET channels 1 through 14 when hundredth manual frequency selector is on 2 or 3. Channels 15 through 19 may also be used for PRESET frequency entries if they are not required for word of day entries during HAVE QUICK operation. Anti-Jamming (AJ) operation is available with other HAVE QUICK radios that have hundredth manual frequency selector in Active (A) position and same word of day (WOD), time of day (TOD), and net number selected. A conference capability which can receive and process two simultaneous transmissions also exists in the active mode. The conference capability is available only when net number ends in 00, 50, or 75.

NOTE

> Conferencing capability is automatically disabled when operating in secure voice mode.

Synchronized TOD between communicating stations is essential. Radio transmissions/reception will be garbled if TOD is not synchronized. Garbled reception from several different radios is an indication that you need a TOD update. The radio will automatically accept the first TOD message received after it is powered up. Subsequent TOD messages will be ignored unless the hundredth selector is moved momentarily to T position. TOD update may be received with hundredth selector in normal (2/3) or AJ, (A) position. HAVE QUICK TOD may be set to any time as long as all communicating stations are synchronized. However, as a matter of convenience, Universal Coordinated Time (UCT) has been adapted as the time standard. WOD varies in length and one to six channels (20-15) may be required to complete the entry. Channels used for WOD entry cannot be used to store frequencies for use during normal mode of operation.

Net numbers are the three digits (tens, units and the tenths) following the A. They are chosen in the same manner as any operating frequency, (MANUAL/PRESET) and may be changed at any time.

Capability to operate in AJ mode exists when a WOD and TOD is programmed into the radio, hundredth selector is on A and an appropriate net number (MANUAL or PRESET) is selected. A steady tone will occur if operation in AJ mode is attempted and either a TOD has not been received, a WOD has not been entered or an invalid net number is selected.

ARC-164(V) UHF RADIO

The HAVE QUICK II system maintains basic HAVE QUICK capabilities and incorporates several improvements. Improvements include addition of NATO Frequency Managed A-Nets (FMA-Nets), Non NATO Frequency Managed A-Nets, Frequency Managed Training Nets (FMT-Nets), reserved memory for a fourth frequency table, and multiple word of day (MWOD) storage and erase. Other features include front panel liquid-crystal displays for channel and frequency information, and other operator prompts.

The ARC-164(V) may be operated in normal or anti-jam (AJ) modes. Normal UHF communication/operation is essentially the same as any ARC-164 radio. Normal operation is available in MNL or in PRESET channels 1-19. Preset channel 20 is reserved for loading WODs and MWOD operating mode data. AJ operation is available with other HAVE QUICK radios having the same word of day, time of day, and net number selected. In AJ mode, two simultaneous transmissions can be received and processed on the same net. This conference capability is enabled when the last two digits of the WOD element end with 00 or 50.

NOTE

- Conference capability is automatically disabled when operating in secure voice mode or when WOD element selected ends in 25 or 75.
- Conference capability is enabled by default when operating on a single element WOD in memory location 20 only.
- Conference capability is always enabled in FMT-Net operation.

ARC-164(V) word of day data is stored in non-volatile memory allowing preset channels previously reserved for WOD storage (channels 19-15) to be used for normal preset operation. WOD memory is accessed through preset channels 20-14. WOD length may vary and require from one to six channel locations (20-15). The seventh memory location, accessed by channel 14, stores day of month (date tag) information. This date is used in conjunction with TOD and specifies which day the WOD is to be used. Up to six WODs may be entered at one time allowing for multi-day use of the radio without entering another WOD. This capability is referred to as multiple word of day (MWOD). The six most recent entries take precedence. If a duplicate date has been entered, the new entry takes precedence as the most recent entry. When the current operational date is updated at midnight UCT, the code generator automatically reinitializes with a new WOD having the same date. The radio set also has the capability to erase all stored WODs.

NOTE

> If the radio set is powered off or if power is lost after entry of MWODs, the data is not lost. All MWOD data remains until erased.

Time of day (TOD) synchronization is necessary for communicating in AJ mode to allow frequency hopping at the same instant in time. The radio set automatically accepts the first TOD signal received after power-up. The first TOD reception must occur in normal mode; subsequent updates can be performed in normal or AJ modes. Subsequent TOD transmissions are ignored unless the radio is configured to receive a new TOD.

Net numbers enable multiple stations to operate simultaneously on a non-interfering basis while sharing a common WOD and TOD. The net number begins with A and is followed by three digits 000 to 999. The last two digits of the display (00,25,50,75) designate the frequency table being used, permitting 1,000 possible net numbers for each frequency table. Net numbers ending in 00 selects the original A-Net and B-Net frequency table; 25 selects the FMA-Net frequency table; 50 selects the Non-NATO Frequency managed A-Net frequency table. Net numbers ending in 75 are reserved for future use, and will generate an invalid net alarm (pulsating warning tone). Training mode net numbers are designated A00000 through A00400 and A00025 through A01525. Selecting any other net number while operating on a training WOD also generates the invalid net alarm.

Capability to generate in AJ mode exists whenever a TOD and WOD is programmed into the radio and an appropriate net number is selected.

NOTE

- A steady warning tone is generated when AJ mode is selected and TOD or a valid WOD has not been entered.
- A pulsating warning tone is generated when an invalid operating net is selected.

COMNAV-50 COMMUNICATIONS SYSTEM

Provisions are provided in KC-10 aircraft for installing a COMNAV-50 UHF antijam communication navigation kit (figure 1.13-5).

The radio control panel, modem control panel, and distance indicator for controlling and operating the COMNAV-50 System are located in the Copilot's briefcase well. The existing UHF antennas (upper/lower) and antenna control switch are used for COMNAV-50 radio operations. The bearing function (ADF) utilizes the existing KC-10 UHF-DF antenna.

Operation of the COMNAV-50 is usually controlled by the Copilot through the radio and modem control panels. However, the Pilot can take control by moving UHF-1 radio mode selector switch to any position other than OFF. COMNAV-50 operation will change from external (if selected) to internal mode when UHF-1 mode selector switch is moved from OFF and all radio operations including frequency selection will be controlled through the UHF-1 control panel. Control will return to COMNAV-50 control panel when UHF-1 mode selector switch is returned to OFF.

The COMNAV-50 radio has two basic modes of operations (Internal and External). Conventional narrow band AM line of sight communication is available in the internal mode with any UHF radio operating on the same frequency. Internal mode of operation including power and frequency control, INT/EXT mode selection, squelch and volume control is provided through the radio control panel. The external mode provides wide spread spectrum sideband communication with other COMNAV-50 stations operating in the external mode including range measurements, modulation and demodulation functions, code generation and establishing and maintaining synchronization with similar equipped aircraft or ground stations is provided through the modem control panel. External mode of operation also requires radio control panel of each communicating COMNAV-50 station to be in EXT mode and other switches and frequencies to be compatible.

L-BAND SATCOM

The L-BAND satellite communication system (L-BAND SATCOM) uses the Inmarsat-C satellite system to support sending and receiving message traffic. The Inmarsat-C system produces reliable, low data rate communications between aircraft and subscribers connected to the established international terrestrial telex, fax, and data networks. This is accomplished by using one of the four Inmarsat-C satellites in geostationary orbit. Each of these satellites cover one third of the earth's surface, an area known as an Ocean Region. These satellites are located over the Indian Ocean, the Pacific Ocean, the eastern part of the Atlantic and the western part of the Atlantic Ocean. Each satellite has its own identification number, or code, which is used in conjunction with the L-BAND Transceiver identification to communicate with the aircraft of choice. These codes are:

Atlantic Ocean (West)	584
Atlantic Ocean (East)	581
Indian Ocean	583
Pacific Ocean	582

These satellites are linked to airborne terminals via the use of Ground Each Stations (GESs), and give a total global coverage from 70 degrees south to 70 degrees north. Each Ocean Region is controlled by a Network Coordinate Station (NCS). The NCS is a fixed land based station which manages the allocation of central resources.

Each KC-10 aircraft has its own unique address, as each individual Transceiver in the installed L-BAND SATCOM system is commissioned with its own unique 9 digit identification number.

The Inmarsat-C system is an advanced global packet mode data system that communicates in a store and forward basis. It does not require the establishment of an end to end communication circuit between the message originator and the destination. Messages and data files are broken down into data packets. These data packets are sent over the satellite, checked for correctness upon arrival at the GES and then reassembled, before being sent to the terrestrial network. If any errors are detected in the packets, the system will automatically request a re-transmission of the packets containing the errors. In addition, coding techniques of the packets allows for some degree of error correction without re-transmission. The user can therefore be sure that the data or messages that are transmitted are correct.

The L-BAND SATCOM system is a compact lightweight system that enables crewmembers to send and receive messages and data from virtually anywhere in the world. This system is comprised of four basic elements on the KC-10 aircraft, which are:

1. Peripheral devices; a Printer unit and a Laptop IBM compatible PC.
2. A Transceiver unit
3. A High Power Amplifier/Low Noise Amplifier (HPA/LNA)
4. A Jet Blade Antenna

The printer interconnects to the transceiver for its data communications interface and with a 28 volt DC power supply. A connector is provided on the face of the printer but is not used on the KC-10 application. For the KC-10 application, a connector is installed on the forward edge of the Flight Engineer's work table, right hand side, to connect a laptop Personal Computer (PC) to the L-BAND SATCOM system for sending messages and data, and for controlling the system. The printer is mounted in the Flight Engineer's Upper Panel No. 3.

The L-BAND SATCOM system uses an IBM compatible laptop PC to allow the user control of the system. While the system does not require a PC to be connected and powered up to receive messages, the received messages will be unreadable and will not be saved by the operating software. The system does require a PC to send messages, to change system parameters, and for file management. The PC is normally hand-carried onto the aircraft prior to departure and stowed for takeoff and landing.

The transceiver is mounted in the Center Accessory Compartment, FS 1130. It interfaces with the printer, HPA/LNA, and the onboard laptop PC. It is a stand alone component and requires no interface with other aircraft communication systems.

The HPA/LNA is mounted in the overhead mid cabin area, FS 1075. It interconnects to the antenna and the transceiver. Power is supplied through the Transceiver and no other interfaces are required.

The Jet Blade Antenna completes the L-BAND SATCOM system. It is mounted on the upper aircraft fuselage at FS 1110. Its only interconnect is with the HPA/LNA.

AUDIO PANELS

Audio panels (figure 1.13-10) provide selectable monitoring of communication/navigation radio inputs and control of radio inputs and control of radio transmitter outputs. Microphone selector pushbuttons and VOR/ADF voice-ident filter switch are also provided. Audio panels are provided at the Pilot's, Copilot's, Flight Engineer's, Boom Operator's and ARO (3) stations and at the main electrical/electronics rack in the avionics compartment.

FLIGHT INTERPHONE SYSTEM

The Flight Interphone System permits communications between all the members of the flight crew located in the flight station (except 2nd Observer, whose jacks are connected in parallel with 1st Observer's station), ARO compartment, passenger/cargo compartment (Fus. Sta. 475 L/H, 772 L/H, 1330 L/H 1332 R/H, 1815 R/H), mechanic flight interphone jacks located within the external power receptacle, and on the nose landing gear.

The Service Interphone System provides communications between the flight crew and the areas of the aircraft where service and maintenance operations are most frequently performed. The service interphone amplifiers are used also in the air refueling intercom. The air refueling intercom system provides communications with the receiver aircraft through the boom signal amplifier and the audio selector panels of the audio integrating system.

The pilot can call the mechanic by pushing the MECH CALLING switch, which will illuminate the white MECH portion of the switch and sound a horn located in the nose wheel well.

The mechanic can call the flight station by pushing the PILOT CALL switch, located within the external power receptacle. This will sound a chime in the cockpit and illuminate the blue CALLING portion of the MECH CALLING switch, located on the Forward Overhead Control Panel. The calling portion of the system can be reset by pushing the RESET button located on the Forward Overhead Control Panel.

The pilot can call the Forward Attendant station, located at Fus. Sta. 462 L/H side, by pushing the FWD ATTEND CALLING switch. This will illuminate the white FWD ATTEND portion of this switch, sound a chime in the cabin, and illuminate the call light on the R1 Door Control Panel. The calling portion of the system can be reset by pushing the RESET button located on the same door control panel.

The Forward Attendant station can call the flight station by pushing the PILOT call switch, located on the R1 Door Control Panel. This will sound a chime in the cockpit and illuminate the blue CALLING portion of the FWD ATTEND CALLING switch, located on the Forward Overhead Control Panel. The calling portion of the system can be reset by pushing the RESET button located on the Forward Overhead Control Panel.

There are nineteen (19) maintenance interphone jacks located throughout the aircraft. These jacks can be isolated from the Flight Engineer station, ARO compartment, and the Avionics compartment, by placing the MAINT JACK switch to the OFF position. This switch is located on the Flight Engineer Upper Instrument Panel No. 3.

The pilot's handset, located on the aft end of the Pedestal is automatically connected to the Service Interphone System when it is removed from the cradle. The handset can be used with the Public Address System by pushing the PA switch, located on the Forward Overhead Control Panel. When the PA switch is depressed and the pilot's handset is still stowed in the cradle, the white PA portion of this switch will be illuminated and system is on. The blue ON portion of this switch will illuminate when the handset is removed from the cradle and the handset is then connected to the PA System. The handset can be switched back to the Service Interphone System by depressing either the MECH CALLING switch, FWD ATTEND CALLING switch, or replacing the handset back in the cradle.

The BOOM AUDIO Switch, located on the ARO Center Overhead Control Panel is a three-position switch PRIVATE-OFF-COMMON. When placed in PRIVATE position it isolates the ARO compartment interphone jacks from the rest of the system, and allows the Boom Operator or Instructor to transmit to the receiver aircraft on the Service Interphone System without interference from the rest of the system.

The OFF position deactivates the boom interphone system. The COMMON position allows any crewmember to transmit to the receiver aircraft on the Service Interphone System except the observer in the ARO compartment.

IFF/ATC TRANSPONDER

The APX-119 digital IFF transponder system provides automatic identification and altitude information replies to pulsed interrogations from ground stations or aircraft. The system sends a coded reply that allows surface tracking, enables friendly aircraft to identify themselves individually and provides a means of transmitting a specially coded emergency reply signal. The system receives, decodes, encodes, and transmits signals. The IFF system also, when properly keyed, recognizes a Mode 4 interrogation and transmits a reply. Operation is possible in any of six modes as follows:

Mode 1 – Security identification (32 possible two-digit codes)

Mode 2 – Discrete aircraft identification (4096 possible four-digit codes)

Mode 3/A – Position identification for air traffic control (4096 possible four-digit codes)

Mode C – Altitude reporting for air traffic control

Mode 4 – Crypto secure identification (classified codes)

Mode S – Set of individually addressed challenge/reply formats

The system consists of a transponder (receiver/transmitter) with a removable Mode 4 crypto applique, an Airborne Data Link Processor (ADLP), two blade-type antennas (top and bottom), and a control panel located in the aft pedestal. The ADLP is located on the Electrical Rack in the electronics compartment. The transponder and Mode 4 crypto applique are located on the second shelf of the Aux Radio Rack in the electronics compartment. Mode 4 is not operational unless the proper cryptographic key is loaded in the crypto applique. The IFF transponder system receives power from the 28-volt LEFT EMER DC BUS through the IFF XPNDR circuit breaker and the 115-volt LEFT EMER AC BUS through the IFF XPNDR circuit breaker.

System Built-in Test

The transponder provides a built-in test (BIT) function by generating interrogation pulse pairs for Modes 1, 2, 3/A, C, or 4. Setting the respective mode switch to TEST enables BIT in that mode. Test pulses generated within the transponder will in turn cause the transponder to generate a reply. If the reply is within required tolerances, a PASS indication is displayed. If an improper reply is received, a FAIL indication is displayed. The self-test feature will operate properly only when the MASTER switch is set to NORM, TA, or TA/RA.

Transponder Control Panel

The control panel (figure 1.13-12) contains the controls, switches, and indicators required for operation of the transponder. The panel allows the crew to select and monitor individual IFF functions, as well as Mode S functions, and ETCAS (see ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM, this part, for ETCAS description).

MASTER SWITCH. The MASTER switch applies power to all of the transponder system components except the altimetry components. The switch is a six-position rotary switch placarded OFF, STBY, NORM, TA, TA/RA, and EMER. The switch must be lifted over a detent to select EMER or OFF. Functions of the various switch positions are as follows:

MODE	**FUNCTION**
OFF	Power is removed from system.
STBY	Power is applied to the control panel and the transponder receiver. Transponder transmitter is disabled. ETCAS is placed in standby.
NORM	Enables transponder transmitter to reply to decoded interrogations, provided the appropriate mode is enabled. ETCAS remains in standby.
TA	Provides normal IFF functions plus TCAS traffic advisories.
TA/RA	Provides normal IFF functions plus TCAS traffic advisories and resolution advisories.
EMER	Causes automatic transmission of emergency reply signals to Mode 1, 2, 3/A and Mode S interrogations regardless of mode settings. Mode 3/A reply code is 7700. Modes 4 and C are enabled regardless of selector switch position, but do not transmit emergency replies. ETCAS processor will be set to TA only.

During flight ETCAS displays should be used to enhance situational awareness. It is appropriate to operate TCAS in the TA mode in circumstances where unnecessary RAs frequently occur and where such RAs are disruptive to aircraft operations. Circumstances may include:

- Formation flights, and air refueling operations;
- In visual conditions when flying in close proximity to other aircraft (e.g., VFR pattern);
- In instrument or visual meteorological conditions during approaches to closely spaced parallel runways, always use TA mode on final approach;
- Following landing and clearing the runway, STBY or OFF mode should be selected.

EIGHT-CHARACTER DISPLAY. An eight-character alphanumeric display provides a readout of IFF codes, ETCAS functions, and maintenance data. An asterisk (*) symbol in the leftmost position of the display indicates the operational mode has deviated from the typical usage.

SEL A/SEL B SWITCH. The SELect A/SELect B switch is a three-position switch spring-loaded to the center (neutral) position. The SEL A position controls the mission menu and toggles between functions that may be frequently used or modified during flight. The asterisk (*) symbol will appear in the left-most display position when mission functions are displayed if ETCAS is on, ATC is off, Broadcast is off, Mode S is disabled, or Antenna Test is enabled. The SEL B position controls the maintenance menu and toggles between functions that typically do not change during flight. Individual functions are as follows:

SEL A

M3. Data select switches S1-S4 are used to change the four digits of the code from 0 to 7. S1 changes the left-most digit, S2 changes the second digit, S3 the third digit, and S4 the last digit.

M1. Data select switches S1 and S2 are used to change the two digits of the code. S1 changes the left-most digit from 0 to 7, and S2 changes the second digit from 0 to 3. The last two digits are always 0 for Mode 1.

ETCS. The enhanced functions of ETCAS can be toggled ON or OF (off) by using any of the four data select switches. Mode S must be enabled in order to enable ETCAS.

FMCODES. Allows entry of formation member (FM) Mode 3/A codes regardless of whether the ETCAS function is on or off. Momentary actuation of any data select switch up or down will cause the display to scroll to the first FM code location. Up to 30 FM codes may be entered (see Formation Member Code Entry below).

ATC. The ATC mode is an independent function used for formation missions. Momentary actuation of any data select switch up or down will toggle the ATC function ON or OF (off). Selection of ATC OF will inhibit own transponder replies to Modes 3/A, C, and Mode S ground interrogations.

BCST. The Broadcast mode is an independent function used for formation missions. Momentary actuation of any data select switch up or down will toggle the BCST function ON or OF (off). Selection of BCST OF will inhibit own TCAS broadcast interrogation transmissions. BCST OF will not affect transponder operation.

SEL B

DISP. The display brightness value can be changed using any of the four data select switches. The display value selections are 100, 80, 53, 27, 13, .10, and .05 (defaults to 53 unless shut down at ≥53). The display value will not increment past 100, nor will it decrement past .05 (no wraparound).

M2. Data select switches S1-S4 are used to change the four digits of the code from 0 to 7. S1 changes the left-most digit, S2 changes the second digit, S3 the third digit, and S4 the last digit.

MODE S. The display function MODE S will be displayed momentarily (only available with MASTER switch in STBY). The display will then show ENABLE or DISABLE. Any of the four data select switches can be used to toggle between the two settings.

MS ADDR. The display function MS ADDR will be displayed momentarily. The display will then show the current Mode S address. In order to change the Mode S address, S1 is used to move the cursor to the left and S4 is used to move the cursor to the right. Either S2 or S3 can be used to change the selected digit from 0 to 7.

NOTE

The MS ADDR should not be changed by the crew. If inadvertently changed, cycle the master switch to OFF, then reset to desired operating mode.

MS FltID. The display function MS FltID will be displayed momentarily. The display will then show the current Mode S flight ID. In order to change the Mode S flight ID, S1 is used to move the cursor to the left and S4 is used to move the cursor to the right. Either S2 or S3 can be used to change the selected digit from 0 to 9, blank space, or A to Z.

NOTE

The MS FltID is not used at this time.

RT TYPE. The display function RT TYPE will be displayed momentarily (only available with MASTER switch in STBY). The display will then show the current RT TYPE setting. The panel can be set to operate as a model RT-1717 or RT-1157. Any of the four data select switches can be used to toggle between the two settings.

NOTE

The RT TYPE must be set to RT-1717 for Mode S to function properly.

ANT TEST. The display function ANT TEST will be displayed momentarily (only available with MASTER switch in STBY). The display will then show ENABLE or DISABLE. Any of the four data select switches can be used to toggle between the two settings. When enabled, Mode S will automatically be disabled in order to permit antenna selection with the TCAS altitude display limit switch. While enabled, ANT TEST will flash every 12 seconds when the MASTER switch is placed to NORM, TA, TA/RA, or EMER. Momentarily pressing the SEL A/B switch will disable ANT TEST.

NOTE

This function should be used by maintenance personnel only. It should be disabled during normal flight operations.

CP TEST. Any of the four data select switches can be used to initiate the control panel self-test (only available with MASTER switch in STBY).

NOTE

This function should be used by maintenance personnel only. If the test is inadvertently initiated, selecting SEL A will terminate the test.

IDENT-OUT-MIC SWITCH. The IDENT-OUT-MIC switch is a three-position toggle switch. The IDENT position is spring-loaded to the OUT position. When momentarily placed to the IDENT position and released, the transponder adds an identification of position pulse to Mode 1, 2, and 3/A replies for 15 to 30 seconds. In the MIC position, the identification of position function is activated for 15 to 30 seconds each time the UHF microphone switch is depressed, provided UHF is selected. When OUT is selected, the identification function is disabled.

S1-S4 DATA SELECT SWITCHES. The four toggle switches labeled S1, S2, S3, and S4 located just below the display area, are three-position switches spring-loaded to the center neutral position. Momentary actuation to the up (increase) position increments the digit value by one. Momentary actuation to the down (decrease) position decrements the digit value by one. Holding the switch in either position results in continuous scrolling of the digits with wrap-around.

MODE SWITCHES. The four mode switches (M-1, M-2, M-3/A, and M-C) each have OUT, ON, and spring-loaded TEST positions. The center ON position of each switch enables that mode. To test the transponder, momentarily press the mode switch for each mode to the TEST position. A display of PASS indicates proper operation of that mode. The MASTER switch must be set to NORM, TA, or TA/RA for the test function to operate.

RAD TEST SWITCH. The RAD TEST switch is a two-position toggle switch with RAD TEST and OUT positions. The RAD TEST position enables a Mode 3/A code reply to a special TEST mode interrogation from a ramp test set. It also enables a Mode 4 reply to a VERIFY 1 modified Mode 4 interrogation from a surface station or a ramp test set. The OUT position disables the RAD TEST function.

MODE 4 CONTROLS. The MODE 4 switch is a three-position toggle switch with TEST, ON, and OUT positions. Mode 4 operation is enabled by placing the MODE 4 switch to ON, provided the MASTER switch is in NORM, TA, TA/RA, or EMER. The TEST position enables Mode 4 BIT operation (code must be loaded). The OUT position disables Mode 4 operation.

The Mode 4 CODE switch is a four-position rotary switch placarded ZERO, B, A, and HOLD. The switch must be lifted over a detent to reach the ZERO position. The switch is spring-loaded to return from HOLD to the A position. The A position selects the Mode 4 code for the present code period and the B position selects the code for the succeeding period. Both codes are loaded into the transponder's Mode 4 computer via the KOI-18 keytape reader or the KYK-13 key fill device. The Mode 4 codes will automatically zeroize anytime the MASTER switch is turned to OFF or when aircraft power is removed after the aircraft has flown. To retain the codes, the CODE knob must be held to the HOLD position for 2 to 3 seconds after the aircraft has landed, but prior to shutting down aircraft power. Allow transponder power to remain on for at least 15 seconds after the knob is released, then turn off as desired. The code setting is now saved to NVM and will be retained when aircraft power is turned off. The Mode 4 codes can be zeroized anytime aircraft power is on and the MASTER switch is not OFF by turning the CODE switch to ZERO.

An AUDIO signal, the M4 REPLY light, and the IFF MODE 4 caution light (figure 1.13-12) are used to monitor Mode 4 operation. The AUDIO-LIGHT-OUT switch controls the audio signal and the M4 REPLY light, but not the IFF MODE 4 caution light. In the LIGHT position, the REPLY light comes on as Mode 4 replies are transmitted. In the AUDIO position, an audio tone in the cockpit speakers indicates that valid Mode 4 interrogations are being received and the M4 REPLY light comes on if Mode 4 replies are transmitted. In the OUT position, the audio indications and the M4 REPLY light are inoperative and the M4 REPLY light will not press-to-test.

IFF MODE 4 LIGHT. The IFF MODE 4 caution light, located on the annunciator panel (figure 1.13-12), lights to indicate that Mode 4 is not operative. The light is operative whenever aircraft power is on and the MASTER switch is not OFF. The IFF MODE 4 light indicates that (1) the Mode 4 codes have been zeroized, (2) the internal BIT function of the Mode 4 computer has detected a fault, or (3) the transponder is not replying to proper Mode 4 interrogations. If the IFF MODE 4 caution light comes on, check the MASTER switch in NORM, TA, or TA/RA, check the MODE 4 toggle switch is ON, and ensure Mode 4 codes are loaded and the CODE selector is on the proper setting for the current time period. If illumination continues, employ operationally directed flight procedures for an inoperative Mode 4.

TCAS ALTITUDE DISPLAY LIMIT SWITCH. The TCAS altitude display limit switch is a three-position altitude select toggle switch which allows the crew to select the altitude range of the targets displayed by the ETCAS processor. The ABOVE position permits only targets in the altitude range of 2700 feet below to 12,700 feet above the aircraft (climb phase); the NORM position permits only targets in the altitude range of 2700 feet below to 2700 feet above the aircraft (en route phase); the BELOW position permits only targets in the altitude range of 12,700 feet below to 2700 feet above the aircraft (descent phase). This switch also doubles as an antenna select switch when the ANT TEST function is enabled on the SEL B menu. This setting should only be used by maintenance personnel.

Formation Member Code Entry

The FMCODES selection in the SEL A mission menu provides for Mode 3/A code entry, review, and storage regardless of whether ETCAS is selected on or off. With the display indicating FMCODES, momentary actuation of any data select switch up or down will cause the display to scroll to the first formation member (FM) code location labeled #01. With the display indicating a formation member code location (#nn, where nn is a location number 01-30), the data select switches and SEL B switch are assigned the following functions:

DATA SELECT SWITCH	FUNCTION
S1	Selects add or delete function as follows: A - Add code if no code exists D - Delete code if code exists
S2	Acknowledge addition or deletion of formation member code
S3	Increment/decrement code digit
S4	Shift * symbol to digit position to be modified
SEL B	Increments display to the next FM code location

REVIEW FM CODES. From any FM code location momentary actuation of the SEL B switch will scroll the display to the next FM code. When the last entered code is encountered, the next activation of the SEL B switch will cause the display to wrap around to the first FM code (#01 nnnn). During the review process, any code can be modified by following the procedure outlined below. The FM code entry mode can be exited by momentarily selecting SEL A.

MODIFY AN FM CODE. An existing FM code can be modified by using the S4 switch to select the desired digit position. Toggling S4 up or down will cause a * symbol to appear and shift sequentially among the code digits. When the desired position is highlighted, the digit may be incremented/decremented using the S3 switch.

ADD AN FM CODE. If no code exists in the current FM code location, the display will indicate the FM code location number. To enter an FM code in the present location, momentarily actuate the S1 switch up or down to display an A in the left-most character position. This signifies the operator is about to add a Mode 3/A code. To execute this command, operator acknowledgement is required by momentarily actuating the S2 switch up or down. This will cause the display to indicate #nn 0000. The code can then be modified as described above.

DELETE AN FM CODE. To delete an existing code, momentarily actuate the S1 switch up or down to display a D in the left-most character position. This signifies the operator is about to delete the current Mode 3/A code. To execute this command, operator acknowledgement is required by momentarily actuating the S2 switch up or down. Once the code is deleted, any FM codes stored after the deleted FM code will automatically decrement by one position in the FM list and the display will update to indicate the next FM code, if any.

Altitude Reporting (Mode C)

The automatic altitude reporting function uses digital outputs from one of two central air data computers. Either computer may be selected to supply altitude by positioning the IFF CADC SELECT switch on the overhead panel to the desired setting. When 1 is selected, central air data computer No. 1 provides input to the transponder for altitude reporting. When 2 is selected, input is from central air data computer No. 2. When Mode C is enabled, the transponder replies to interrogation with coded signals indicating aircraft pressure altitude in hundreds of feet. The altitude transmitted to the interrogating station is supplied by the selected air data computer that operates the corresponding pilot's altimeter.

Preflight

Procedures for testing IFF before takeoff or inflight are as follows:

1. MASTER Switch - STBY

   Verify the following messages are displayed:
   \- - - -
   TESTING
   CP PASS
   M3 (Mode 3/A code)
   STBY (displayed intermittently every 15 seconds)

2. Allow two minutes for warm-up.
3. M4 REPLY Light - PRESS-TO-TEST
4. IDENT-OUT-MIC Switch - OUT
5. RAD TEST Switch - OUT
6. Mode 1, 2, 3A C, and 4 Enable/Test Switches - OUT
7. Mode 4 AUDIO-LIGHT-OUT Switch - OUT
8. MASTER Switch - NORM

   Mode 3/A code is displayed on the control panel.

9. M-1 Switch - TEST

   Momentarily actuate the SEL A/SEL B switch to SEL A; Mode 1 code is displayed. Hold M-1 switch to TEST momentarily, then release to ON. M1 PASS should be displayed. Return switch to OUT.

NOTE

The normal display after a mode test is M[X] PASS (X = 1, 2, 3, C, or S). If any M[X] FAIL message is displayed, see figure 1.13-13 for appropriate actions.

10. M-1 Code - SET

    Using data select switches, set Mode 1 code as required.

11. M-2 Switch - TEST

    Hold M-2 switch to TEST momentarily, then release to ON. M2 PASS should be displayed. Return switch to OUT.

12. M-2 Code - SET

    Momentarily actuate the SEL A/SEL B switch to SEL B until the Mode 2 code is displayed. Using data select switches, set Mode 2 code as required.

13. Mode 3/A Switch - TEST

Hold M-3/A switch up momentarily to TEST, then release to ON. M3 PASS is displayed first, then MS TEST, and finally MS PASS. If Mode S is disabled, MS DISABLE is displayed (see figure 1.13-13 for appropriate actions). If Mode S is enabled, TCAS self-test will be initiated. On the TVSI, observe TEST is annunciated and the four traffic symbols, green arc, and red band are displayed. At self-test completion, check TCAS displays disappear, only VSI information is displayed, and "TCAS system test OK" is announced over the speaker. Leave switch in ON.

NOTE

- With the MASTER switch set to NORM, the M-3/A switch controls Modes 3, C, and S, if enabled.
- Hold M-3/A switch up momentarily to TEST, then release to ON. M3 PASS is displayed first, then MS TEST, and finally MS PASS. If Mode S is disabled, MS DISABLE is displayed (see figure 1.13-13 for appropriate actions). If Mode S is enabled, TCAS self-test will be initiated. On the TVSI, observe TEST is annunciated and the four traffic symbols, green arc, and red band are displayed. At self-test completion, check TCAS displays disappear, Only VSI information is displayed, and "TCAS system test OK" is annunciated over the speaker. Leave switch in ON.

14. M-3/A Code - SET

Using data select switches, set Mode 3/A code as required.

15. M-C Switch - TEST

Hold M-C switch to TEST momentarily, then release to ON. MC PASS should be displayed. Return switch to OUT.

16. Mode 4 - LOAD (if applicable)

a. Load codes into Mode 4 crypto applique through applique fill port.

NOTE

Mode 4 fill pass - Indicator on the Crypto Applique will momentarily light when Mode 4 keys are properly loaded.

b. Set the MODE 4 AUDIO-LIGHT-OUT switch to OUT. Hold MODE 4 TEST-ON-OUT switch to TEST momentarily, then release to ON. M4 PASS should be displayed.

c. Both the M4 REPLY light on the control panel and the IFF MODE 4 light on the annunciator panel should be off. If either light is on, see figure 1.13-13 for appropriate actions.

d. Set MODE 4 TEST-ON-OUT switch to OUT.

e. Set MODE 4 CODE selector to A or B as required.

f. Set the MODE 4 AUDIO-LIGHT-OUT switch to AUDIO or LIGHT. M4 REPLY light comes on if interrogated. Verify IFF MODE 4 light is off.

17. Altitude Display Limit Switch - ABOVE

18. TVSI TCAS Range - CHECK

19. MASTER Switch - STBY

20. Modes 1, 2, 3/A, C, and 4 - ON (as required)

Inflight Operation

To place the IFF system in operation, perform the following:

1. IFF CADC SELECT Switch - AS DESIRED

2. MASTER Switch - STBY

   Allow set to warm up for two minutes.

3. MASTER Switch - NORM, TA, or TA/RA

4. Mode 1, 2, 3/A, and C Enable Switches ON (as required)

5. Mode 1, 2, and 3/A Codes - SET (as required)

6. Mode 4 Enable Switch - SET (as required)

WARNING

Set the MODE 4 AUDIO-LIGHT-OUT switch to AUDIO or LIGHT during combat flight operations. Do not use the OUT setting.

7. Altitude Display Limit Switch - SET (as required for phase of flight: ABOVE for departure; NORM for en route cruise; BELOW for descent)

8. TVSI TCAS Range - AS REQUIRED

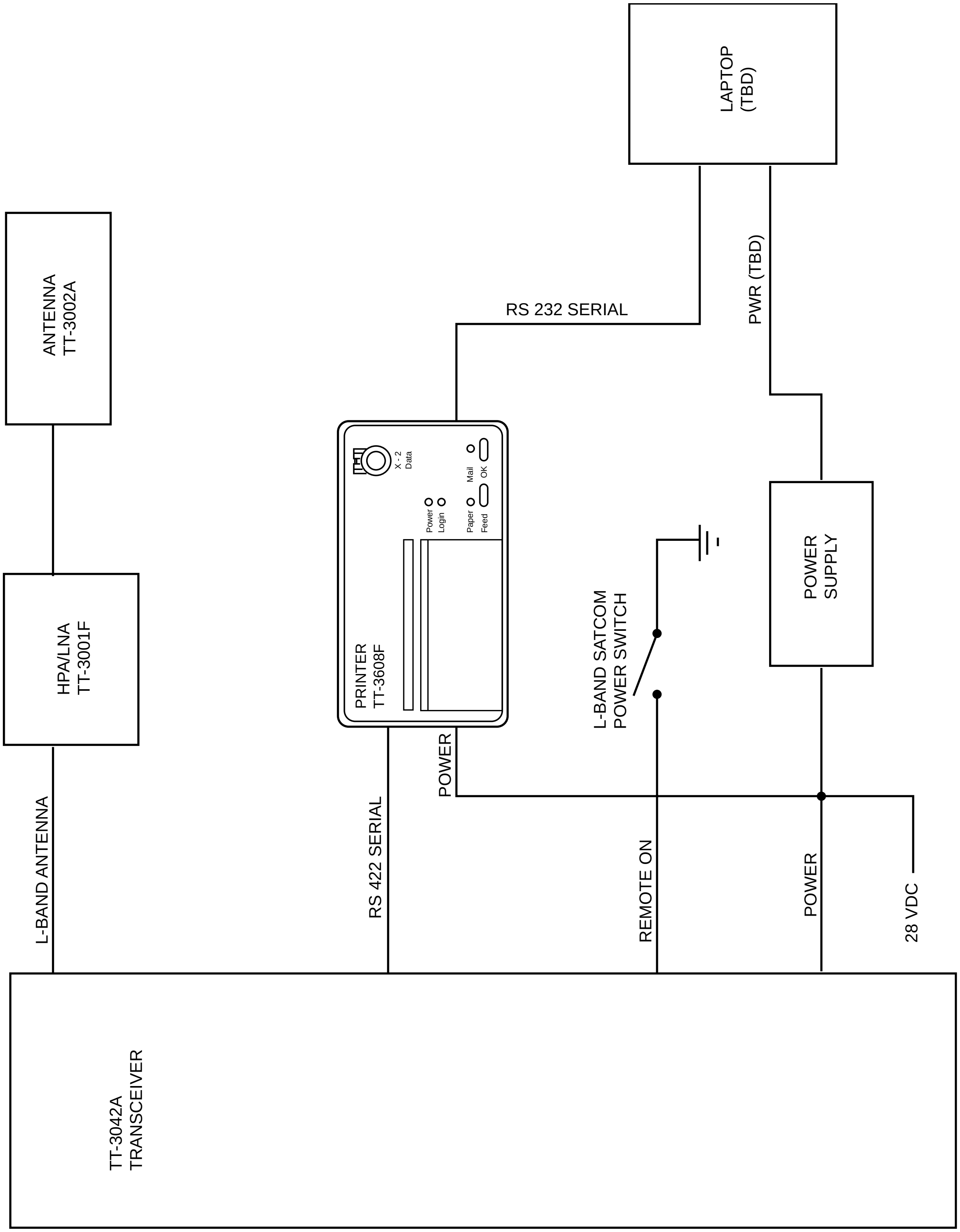
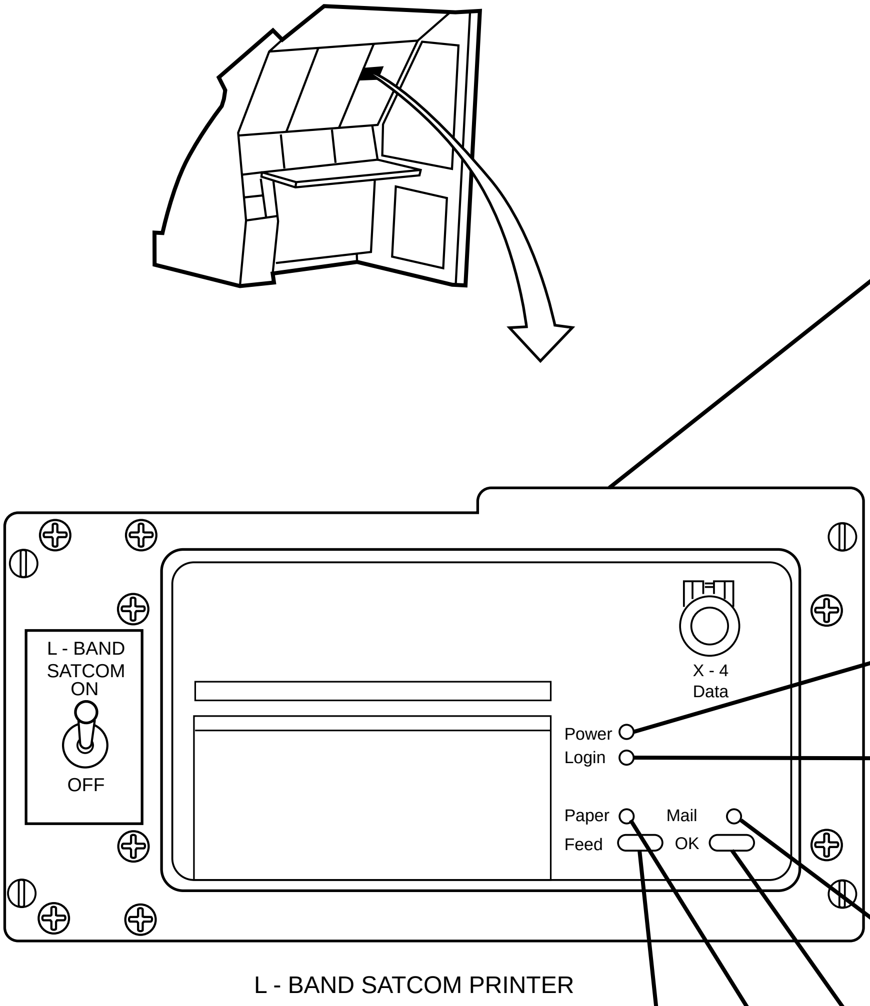


Figure 1.13-7. L-BAND SATCOM System Block Diagram



Printer

Provides hard copy of received composed, and transmitted messages.

NOTE

To load printer paper:

Position roll of paper on paper hubs, located on printer door, with paper feed from bottom of roll. Create a point on end of paper by folding 1.5 inch triangles. Insert pointed end through slot in printhead baseplate and thread paper between two pressure rollers and detent roller. Using FEED pushbutton, advance paper until full width of paper is between rollers. If necessary manually advance paper feed by rotating the right pressure roller clockwise, carefully applying thumb pressure, until full width of paper is between rollers. Use FEED pushbutton to complete paper advance, in front of paper guide, through slot, in top of door.

Power - Green LED for printer power and communication status. Indicates communication status with transceiver. Flashes to indicate fault situation.

Login - Green LED for L - Band login status. When turned on the transceiver is logged in.

Mail - Green LED for L - Band mail received indication. Indicates mail has been received by the L - Band transceiver. Pressing OK button turns light out. Mail is sent to printer.

OK - Used to reset MAIL indicator when lit by sending a receipt back to the transceiver. Pressing and holding the transceiver. Pressing and holding the OK button controls text background light level in 4 incremental steps

Paper - Red LED for printer paper low. Indicates paper is low and disables printing. Flashes for 20 seconds after paper is loaded and detected (or until OK button is depressed).

Feed - Used to remove residual printer paper and to load new printer paper.

Figure 1.13-8. L-BAND SATCOM Printer

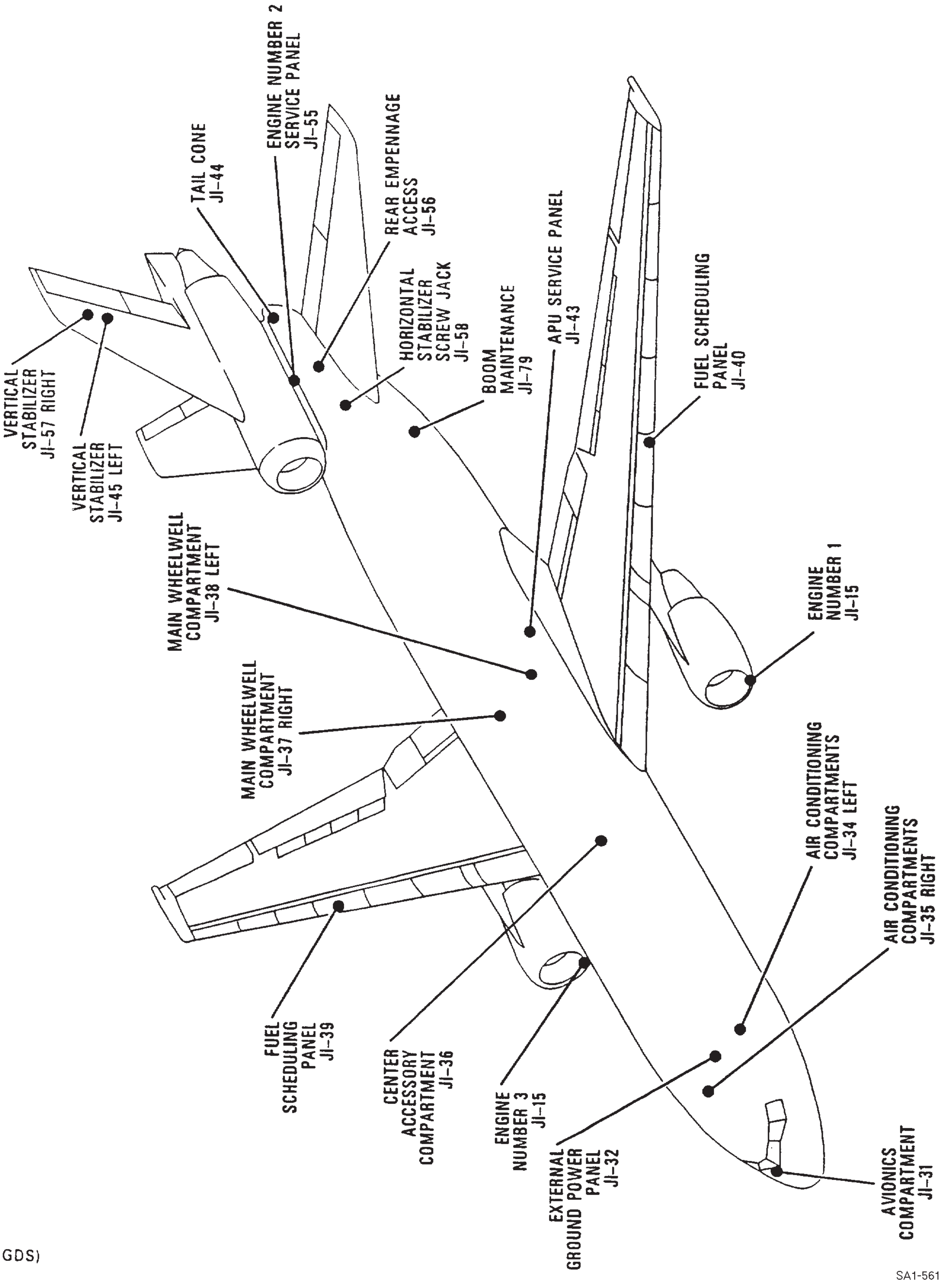


Figure 1.13-9. Maintenance Interphone Jack Locations

MICrophone SELECTOR Button (7)

Push to select transmission medium. Integral light comes on to indicate selection. Only one button can be latched down at a time.

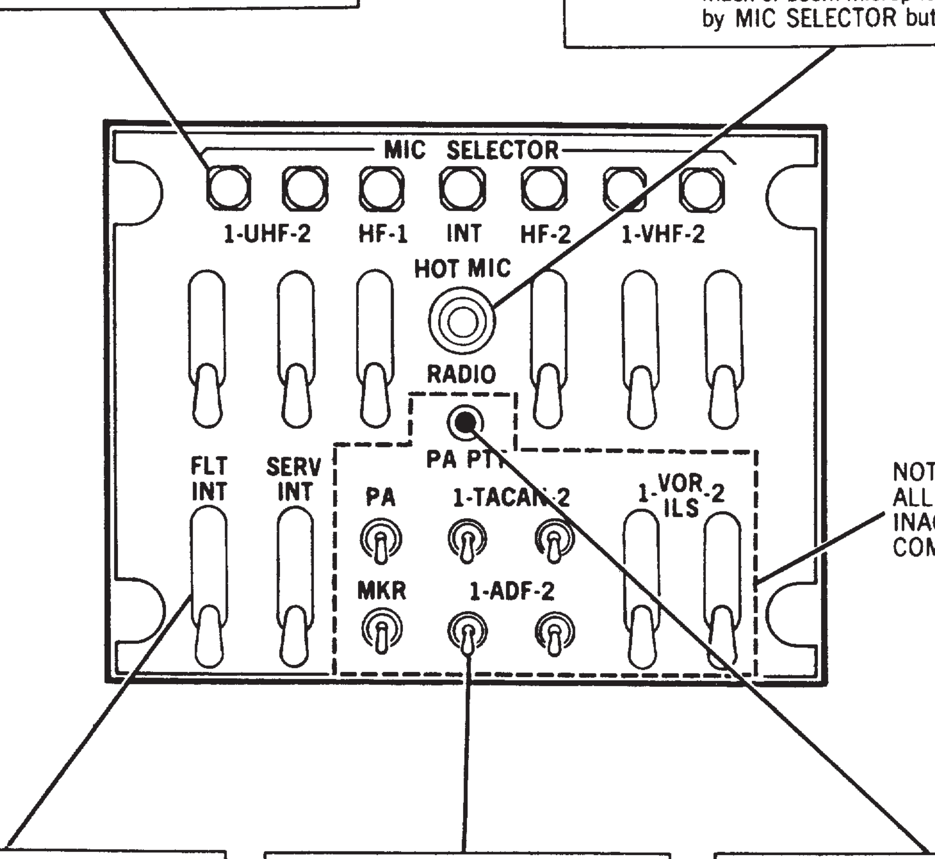
Service interphone calls from the cockpit and flight interphone calls from the ARO compartment are initiated by pushing INT and using a PTT switch in RADIO position.

HOT MIC/RADIO Switch

Momentary in RADIO position.

HOT MIC – Keys flight interphone (cockpit) or service interphone (ARO compartment) transmission for mask or boom microphone.

RADIO – Keys radio transmission circuit for mask or boom microphone, as selected by MIC SELECTOR buttons.



NOTE:
ALL SWITCHES ARE INACTIVE IN ARO COMPARTMENT

Volume Control (10)

Move lever up/forward to increase volume. All receiving media can be monitored at the same time, if desired.

Audio Select Switch (6)

Move switch up/forward to receive audio.

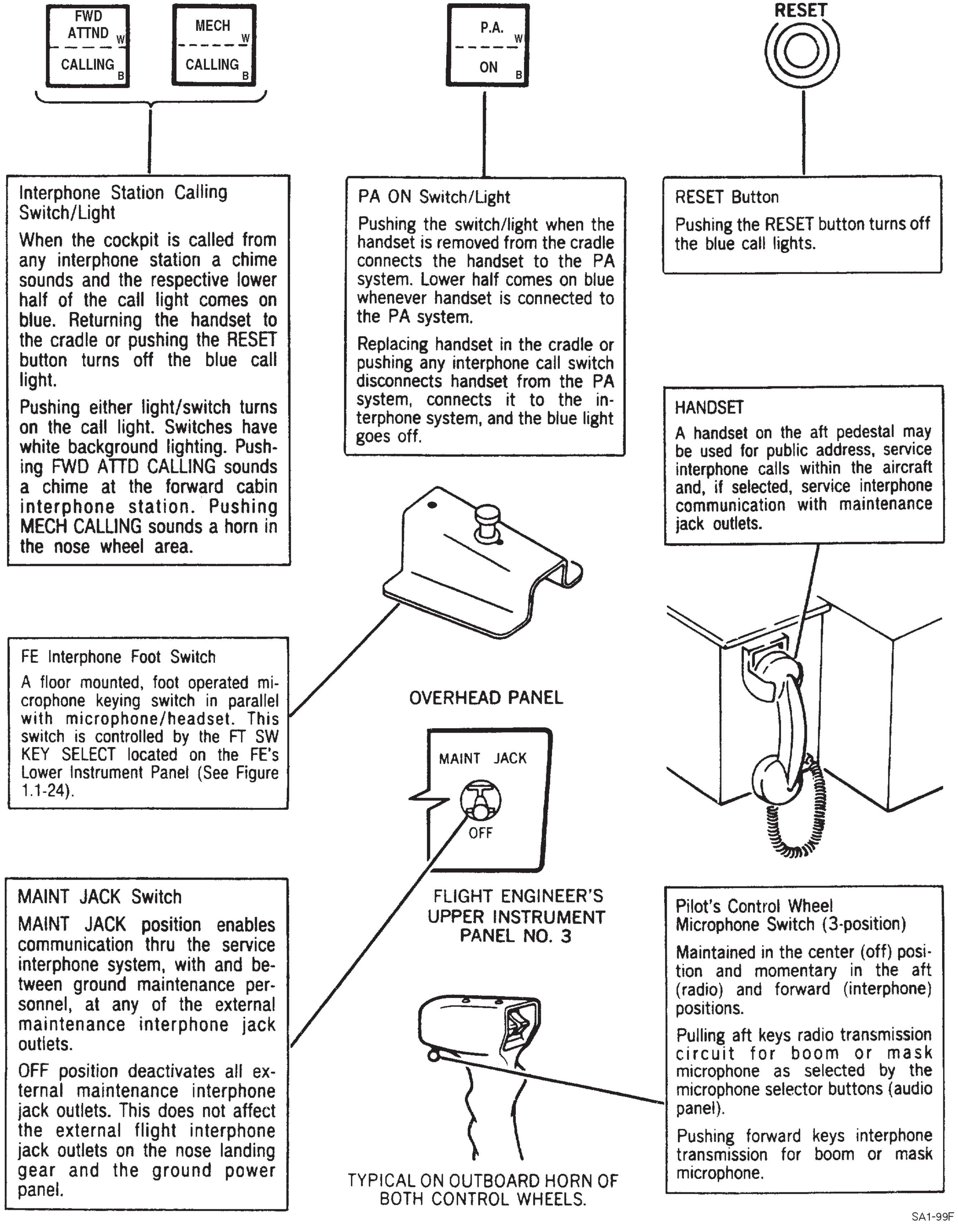
PA PTT Pushbutton

Keys PA transmissions for mask or boom microphone over speakers in cockpit, cabin and lavatory.

AUDIO PANEL (8)
(TWO ON PEDESTAL, ONE ON F/E LOWER INSTRUMENT PANEL, ONE AT BOOM OPERATOR'S STATION AND ONE AT ELECTRICAL/ELECTRONICS RACK, AND THREE IN ARO COMPARTMENT)

SA1-98C

Figure 1.13-10. Audio Panel (8)



Interphone Station Calling Switch/Light

When the cockpit is called from any interphone station a chime sounds and the respective lower half of the call light comes on blue. Returning the handset to the cradle or pushing the RESET button turns off the blue call light.

Pushing either light/switch turns on the call light. Switches have white background lighting. Pushing FWD ATTD CALLING sounds a chime at the forward cabin interphone station. Pushing MECH CALLING sounds a horn in the nose wheel area.

PA ON Switch/Light

Pushing the switch/light when the handset is removed from the cradle connects the handset to the PA system. Lower half comes on blue whenever handset is connected to the PA system.

Replacing handset in the cradle or pushing any interphone call switch disconnects handset from the PA system, connects it to the interphone system, and the blue light goes off.

RESET Button

Pushing the RESET button turns off the blue call lights.

HANDSET

A handset on the aft pedestal may be used for public address, service interphone calls within the aircraft and, if selected, service interphone communication with maintenance jack outlets.

FE Interphone Foot Switch

A floor mounted, foot operated microphone keying switch in parallel with microphone/headset. This switch is controlled by the FT SW KEY SELECT located on the FE's Lower Instrument Panel (See Figure 1.1-24).

MAINT JACK Switch

MAINT JACK position enables communication thru the service interphone system, with and between ground maintenance personnel, at any of the external maintenance interphone jack outlets.

OFF position deactivates all external maintenance interphone jack outlets. This does not affect the external flight interphone jack outlets on the nose landing gear and the ground power panel.

Pilot's Control Wheel Microphone Switch (3-position)

Maintained in the center (off) position and momentary in the aft (radio) and forward (interphone) positions.

Pulling aft keys radio transmission circuit for boom or mask microphone as selected by the microphone selector buttons (audio panel).

Pushing forward keys interphone transmission for boom or mask microphone.

Figure 1.13-11. Communications Controls and Indicators

SEL A/SEL B Switch

SEL A - Toggles between displaying/entering Mode 1 and Mode 3/A codes and ETCAS functions.

SEL B - Toggles through a series of display/entry modes not generally accessed in flight.

Mode Switches

Four mode switches M-1, M-2, M-3/A and M-C.

OUT - Mode is off.

ON - Mode enabled.

TEST - Test mode with master switch in NORM, TA, or TA/RA. Modes not being tested should be OUT.

Mode 4 CODE Switch

ZERO - Mode 4 codes zeroed. Lift switch to zero.

B - Mode 4 B code.

A - Mode 4 A code.

HOLD - Spring-loaded to A code. When required to retain Mode 4 codes, place switch to HOLD at least 15 seconds before MASTER switch or aircraft power is turned off.

Mode 4 Switch

(MASTER switch in NORM, TA, or TA/RA.)

OUT - Mode 4 disabled.

ON - Mode 4 operational.

TEST - Initiates Mode 4 self-test.

AUDIO/LIGHT/OUT switch

AUDIO - Audio tone for valid Mode 4 interrogations. REPLY light on when Mode 4 is transmitted.

LIGHT - Mode 4 REPLY light on if Mode 4 replies are transmitted.

OUT - Mode 4 REPLY light and Mode 4 audio is disabled.

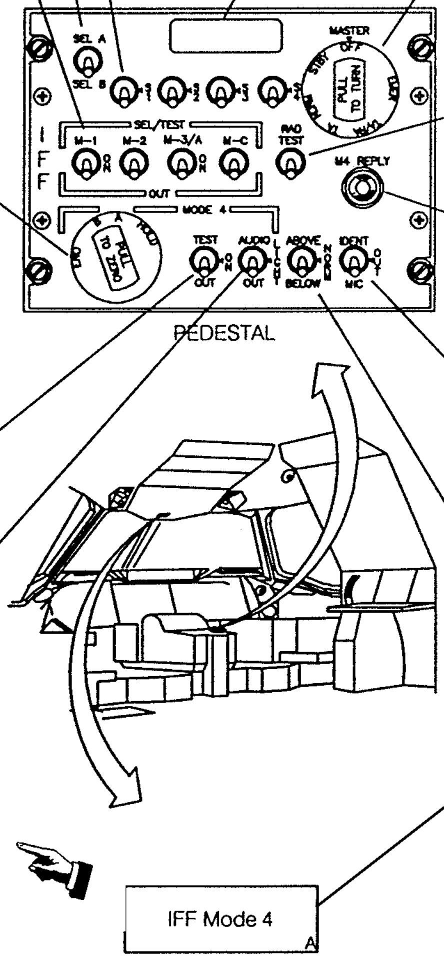
Note: Mode 4 Caution light is enabled at all times. If Mode 4 is in use, the 4 AUDIO/LIGHT/OUT switch should allways be set to LIGHT or AUDIO.

S1-S4 Data Select Switches

Spring-loaded switches that allow data selection. Momentary actuation to the up (increase) position increments the digit value by one. Momentary actuation to the down (decrease) position decrements the digit value by one. Holding the switch in either position results in continuous scrolling.

Eight-Character Display

Provides a readout of IFF codes and maintenance data.



MASTER Switch

OFF - Turns system off.

STBY - Transponder and ETCAS processor in standby.

NORM - Transponder operational at normal receiver sensitivity; ETCAS in standby.

TA - Provides normal IFF functions plus TCAS traffic advisories.

TA/RA - Provides normal IFF functions plus traffic advisories and resolution advisories.

EMER - Transponder transmits emergency replies to Mode 1, 2 or 3/A interrogations. Mode 4 and Mode C are also enabled.

Lift switch over detent to EMER position or OFF.

RAD TEST-OUT Switch

RAD TEST - Used on ramp test.

OUT - RAD TEST function disabled.

REPLY Light

Comes on as Mode 4 replies are transmitted.

Push-to-test light with AUDIO LIGHT switch in AUDIO or LIGHT.

IDENT-OUT-MIC Switch

IDENT - Adds identification pulse to Mode 1, 2, and 3/A replies for 15 to 30 seconds.

MIC - Identification function is activated for 15 to 30 seconds when UHF MIC SWITCH is pushed.

OUT - IP not enabled.

TCAS Attitude Display Limit Switch

Allows selection of the altitude range of the targets displayed by the TCAS processor.

IFF Mode 4 Light

Light comes on when not responding to Mode 4 interrogations.

P10097A

Figure 1.13-12. IFF/ATC Transponder Control - APX-119

PROBLEM	POSSIBLE CAUSE	SOLUTION
No output in any mode of operation.	No aircraft power.	Check panel lighting. Apply aircraft power.
IFF MODE 4 caution light is on.	Indicates a warning or failure of the transponder system.	Set MODE 4 AUDIO-OUT-LIGHT switch to OUT. Verify IFF MODE 4 light is out.
		Load Mode 4 code.
RT FAIL displayed on control panel.	Transponder under interrogation while warming up.	Wait 2 minutes for warm-up.
	Mode 4 computer zeroized with MODE 4 MODE 4 switch ON.	Load Mode 4 code or place switch to OUT.
	RT TYPE incorrect.	Verify RT TYPE set to RT-1717.
SER FAIL displayed on control panel.	RIT TYPE incorrect.	Verify RT TYPE set to RT-1717.
MS DISABLE on control panel.	Mode S has not been enabled.	Toggle SEL A/SEL B switch to SEL B until MODE S DISABLE is displayed. Toggle any data select switch to ENABLE Mode S.
M[X] FAIL displayed on control panel. [X] = 1, 2, 3, C, or S	MASTER switch is at STBY.	Set MASTER switch to NORM, TA, or TA/RA.
M4 FAIL displayed on control panel.	Mode 4 computer zeroized.	Load Mode 4 code.

NOTE

This is not a complete list of possible problems, but these are the only problems correctable by the flight crew. Any other problem should be referred to maintenance.

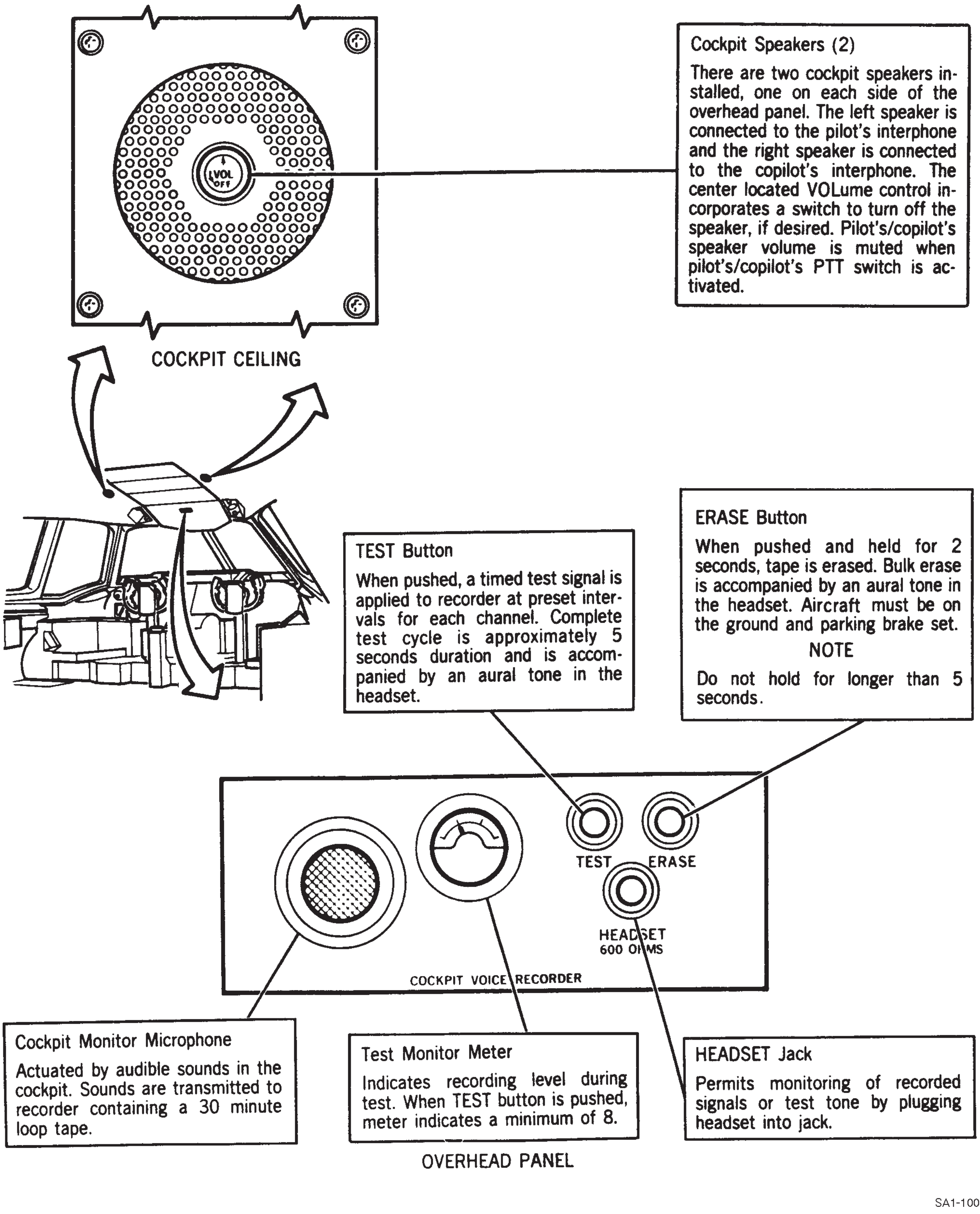
Figure 1.13-13. IFF Troubleshooting

COCKPIT VOICE RECORDER

The cockpit voice recorder (figure 1.13-14) automatically records all conversation in the cockpit, all radio transmissions sent and received, plus any interphone signals through the Pilot's, Copilot's, and Flight Engineer's audio panels, whenever electrical power is on the aircraft. System design permits bulk erase only when the aircraft is on the ground with the parking brake set.

CONTROLS AND INDICATORS

Controls, indicators (figure 1.13-11) and annunciator lights are on the pedestal, overhead panel, Flight Engineer's upper and lower instrument panels, Boom Operator's station and the ARO compartment. Illustrations of the major panels are shown in Part 1, Section I. Individual controls and indicators are illustrated and described in this part. A Communication and Electronic Equipment Chart (figure 1.13-15), outlines the type, characteristics, location and use of the electronic controls in the KC-10A.



Cockpit Speakers (2)

There are two cockpit speakers installed, one on each side of the overhead panel. The left speaker is connected to the pilot's interphone and the right speaker is connected to the copilot's interphone. The center located VOLume control incorporates a switch to turn off the speaker, if desired. Pilot's/copilot's speaker volume is muted when pilot's/copilot's PTT switch is activated.

ERASE Button

When pushed and held for 2 seconds, tape is erased. Bulk erase is accompanied by an aural tone in the headset. Aircraft must be on the ground and parking brake set.

NOTE

Do not hold for longer than 5 seconds.

TEST Button

When pushed, a timed test signal is applied to recorder at preset intervals for each channel. Complete test cycle is approximately 5 seconds duration and is accompanied by an aural tone in the headset.

Cockpit Monitor Microphone

Actuated by audible sounds in the cockpit. Sounds are transmitted to recorder containing a 30 minute loop tape.

Test Monitor Meter

Indicates recording level during test. When TEST button is pushed, meter indicates a minimum of 8.

HEADSET Jack

Permits monitoring of recorded signals or test tone by plugging headset into jack.

Figure 1.13-14. Cockpit Speakers and Voice Recorder

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
INTERPHONE	Crew communication and use with other radio equipment.	All crewmembers	Within aircraft, except when used in conjunction with other equipment.	All crew stations. Control panels located at various positions in aircraft.	Operative whenever aircraft electrical power is on.
UHF (2)	Short range, two-way voice communication.	All crewmembers	Line of sight. Range varies with altitude.	Flight compartment pedestal.	Provisions for secure voice communications.
UHF/ADF DF	Receives signals for directional bearing and homing, both air-to-air and ground-to-air.	Pilots	Line of sight. Range depends upon power of transmitting stations and conditions.	ADF position on UHF control panel in flight compartment pedestal.	Used in conjunction with ADF. Operates with either UHF-1 or UHF-2.
HF (2)	Long range, two-way voice communication.	All crewmembers	Range dependent upon mode selected, operating frequency and atmospheric condition. Up to several thousand miles.	Flight compartment overhead panel.	AM, USB, and LSB operation.
SECURE VOICE	Operational requirements	Pilots/Flight Engineer	Same as UHF	Flight compartment pedestal.	
VOR/ILS RECEIVER (2)	VOR and ILS localizer	Pilots	Unobstructed line-of-sight (Variable)	Glareshield and EHSI control panel on pedestal.	VOR-1 indication on Pilot's and Copilot's VOR/ADF RMI pointer No. 1, Pilot's ADI (localizer and glideslope) and Pilot's EHSI (CDI and glideslope); VOR-2 indication on Pilot's and Copilot's VOR/ADF RMI pointer No. 2, Co-pilot's ADI (localizer and glideslope) and Copilot's EHSI (CDI) and glideslope.
VHF (2)	Short range, two-way voice communication.	All crewmembers	Line of sight. Range depends on altitude.	Flight compartment pedestal.	
GLIDE SLOPE RECEIVER (2)	Indicates glideslope for instrument approaches.	Pilots	Short range line-of-sight.	Glareshield	Indication on Pilot's and Copilot's EHSI and ADI.
TACAN-1/TACAN-2	UHF radio navigation and A/R rendezvous.	Pilots	Line of sight bearing. Range varies with altitude, maximum 390 NM.	Flight compartment pedestal. Through FMS CDU and EHSI control panel on pedestal.	Bearing indication on Pilot's Copilot's TACAN RMI, and bearing and course deviation on Pilot's Copilot's EHSI.

Figure 1.13-15. Communication and Associated Electronic Equipment (Sheet 1)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
					Distance displayed on Pilot's and Copilot's TACAN dual distance indicator and EHSI. Air to air bearing/range capability.
ILS RECEIVER (2)	Localizer and glideslope for instrument approaches.	Pilots	Line of sight (variable).	Glareshield and EHSI control panel on pedestal.	Localizer course on Pilot's ADI runway symbol and EHSI CDI; glideslope on each ADI and EHSI.
MARKER BEACON	Receiver marker beacon signals.	Automatic	Short	Inner/outer/air way marker beacon on Pilot's and Copilot's instrument panel.	Simultaneous aural signal and light.
PUBLIC ADDRESS SYSTEM	One-way announcements with speakers. Two-way communication between maintenance interphone jacks.	All crewmembers	Within aircraft	Flight compartment pedestal, forward cabin door (1L) and maintenance interphone jacks.	Handset press to talk switch.
WEATHER RADAR	Weather, navigation and rendezvous radar.	Pilots	Up to 300 nautical miles.	Pilot's and Copilot's console.	Digital color display indicator. Beacon and short-range air-to-air capability.
RADAR BEACON (J Band/I Band)	Rendezvous/air refueling.	Pilots	Line of sight	Flight compartment overhead panel.	When interrogated, transmits replies.
IFF TRANSPONDER	Identification.	Pilots	Line of sight	Flight compartment pedestal.	Mode S function used by ETCAS.
ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (ETCAS)	Detects and tracks other transponder-equipped aircraft within predetermined radius to avoid traffic conflicts.	Pilots	40 NM	Flight compartment pedestal through IFF control panel.	Also used in formation station-keeping.
L-BAND SATCOM	Teletype communications.	Flight Engineer	Worldwide	FE's table and upper instrument panel No. 3.	Clear communications.
RADIO ALTIMETERS (2)	Determine terrain clearance from 2500 feet to touchdown.	Pilots	0-2500 feet	Pilot's and Copilot's instrument panels.	
*IRIDIUM PHONE **WITH TCTO 1C-10(K)A-1243**	Worldwide satellite RF telephone communication.	All crewmembers	Worldwide	Flight compartment ACM crewmember aft wall	Satellite RF Telephone
FLIGHT CELL DZM **WITH TCTO 1C-10(K)A-1243**	Iridium Phone Interface.	Flight Engineer	Worldwide	FE’s upper instrument panel No. 3	Satellite RF Telephone

*NOTE: Provisions – Inclusive of items allowing use of the satellite phone.

Figure 1.13-15. Communication and Associated Electronic Equipment (Sheet 2)

WITH TCTO 1C-10(K)A-1243 IRIDIUM SATELLITE PHONE SYSTEM

The fundamental component of the Iridium Satellite Phone System is the Motorola Satellite Series™ 9505 telephone, which is used on the Iridium Satellite Network for direct-dial calls using multiple Low Earth Orbit (LEO) satellites. These satellites ensure every region of the globe is covered at all times.

The Iridium Satellite Phone System is made up of six components; the Iridium satellite phone and phone mount, located on the coat closet wall aft of the Boom Operator's forward seat; the Flightcell control panel (DZM), located at the Flight Engineer's No.3 upper panel; a power supply, located on shelf 3 of the Auxiliary Radio Rack; an audio adapter within the coat closet; and an antenna. The system power supply maintains battery charge on the Iridium phone.

The Iridium phone is a carry-on, carry-off component, installed by the aircrew when mission needs dictate the use of a commercial satellite phone.

The Flightcell DZM control panel facilitates operation of the Iridium phone when installed on the aircraft and interfaces to the aircraft's intercom system. The control panel provides full interface with the satellite phone, allowing the Flight Engineer to receive and initiate calls anywhere.

The phone mount provides a fast and secure method of installing the Iridium phone for use in flight. The phone mount incorporates a two position Iridium system master power switch, electrical receptacle (for DC power to the phone), antenna coaxial connector, and an audio plug allowing connectivity to the Flightcell control panel. When in operation, this plug is plugged into the audio jack on the Iridium phone and when not in use is plugged into the audio plug stowage jack on the Iridium phone mount.

The phone mount coaxial connector mates with the antenna connector on the back of the phone.

The audio adapter consist of two audio isolation transformers installed between the Iridium phone and the Flightcell DZM. The adapter eliminates the 400 Hertz tone generated from the Flight Engineer's lighting panel controller.

Phone Installation and Power Application

Install and apply power to the Iridium phone system (figure 1.13-16) as follows:

1. Rotate phone mount security latch up (if required).
2. Press and hold antenna lock release button (on top of phone) and install Iridium phone into phone mount.
3. Rotate phone mount security latch down. Ensure security latch is completely latched in detent.
4. Remove phone mount audio plug from stowed position. Insert plug into Iridium phone audio jack receptacle.
5. Place phone mount Iridium System Master switch to ON (up).

   "Battery Charging" appears on Iridium phone screen.
6. Press Iridium phone POWER ON/OFF button.

   Iridium phone screen will indicate "Registered".

NOTE

- If the phone message "Rotate and Extend Antenna" is displayed after power-up, enter *92* to bypass the interlock. This only needs to be accomplished once per phone.
- Depending on how the Flightcell DZM was set up on shutdown, it may startup automatically. Therefore, step 7 will not be necessary.

7. Press Flightcell DZM control panel POWER/ENTER/CONNECT key.

   Flightcell initialization will take approximately 15 seconds.

NOTE

- The Iridium phone and Flightcell DZM are ready to make and receive calls. The Iridium phone audio is monitored through the service interphone. To transmit on the Iridium phone, the MIC SELECTOR must be selected to INT and the HOT MIC/RADIO switch must be held to RADIO position.
- Secure Mode can only be enabled utilizing the SAT phone keypad.
- Operation of the Iridium phone in this configuration is solely accomplished at the Flightcell control panel.

Receiving calls

When an incoming call is detected on the Iridium phone, the Flightcell DZM will emit a ring tone in the headset. To receive call, press the POWER/ENTER-/CONNECT key on the Flightcell DZM.

NOTE

> After 10 seconds incoming calls will be terminated if not answered

To end call, press 9/END SAT key.

Manual Dialing

Manual dialing is used to make calls to numbers not stored in the Flightcell DZM phonebook. Manually dial a number as follows:

1. Ensure Flightcell DZM displays Main Screen. Press 6/DIAL SAT key to manually dial a call.
2. Press and hold +/0/MENU key until "+" character appears.
3. Enter 1, area code, and phone number using the 0-9 keys.

   When dialing outside the US, enter 011 (country code) then desired number.
4. In case of error, press CANCEL key to delete last digit entered.
5. Press POWER/ENTER/CONNECT to execute call.

NOTE

> The Iridium phone audio is monitored through the service interphone. To transmit on the Iridium phone, the MIC SELECTOR must be selected to INT and the HOT MIC/RADIO switch must be held to RADIO position

6. To abort call, press CANCEL key.
7. After call is connected, press 9/END SAT key to end call.

Speed Dialing

The Flightcell DZM has a phonebook with storage capability up to nine numbers. Speed dialing allows the operator to make calls from numbers stored in the phonebook.

Speed dial a number as follows:

1. Press 3/SPD SAT key to view Flightcell DZM phonebook.
2. Press desired speed dial number (1 thru 9) to select the name/number to dial. The name/number displays on Flightcell DZM screen.

NOTE

> Pressing +/0/MENU shows last manually dialed number. Blank entries in phonebook will not show a name or number.

3. Press POWER/ENTER/CONNECT key to execute call.
4. To abort call, press CANCEL key.
5. After call is connected, press 9/END SAT key to end call.

Add/Edit Speed Dial

The operator can add or edit the speed dial names and numbers stored in the Flightcell DZM phonebook.

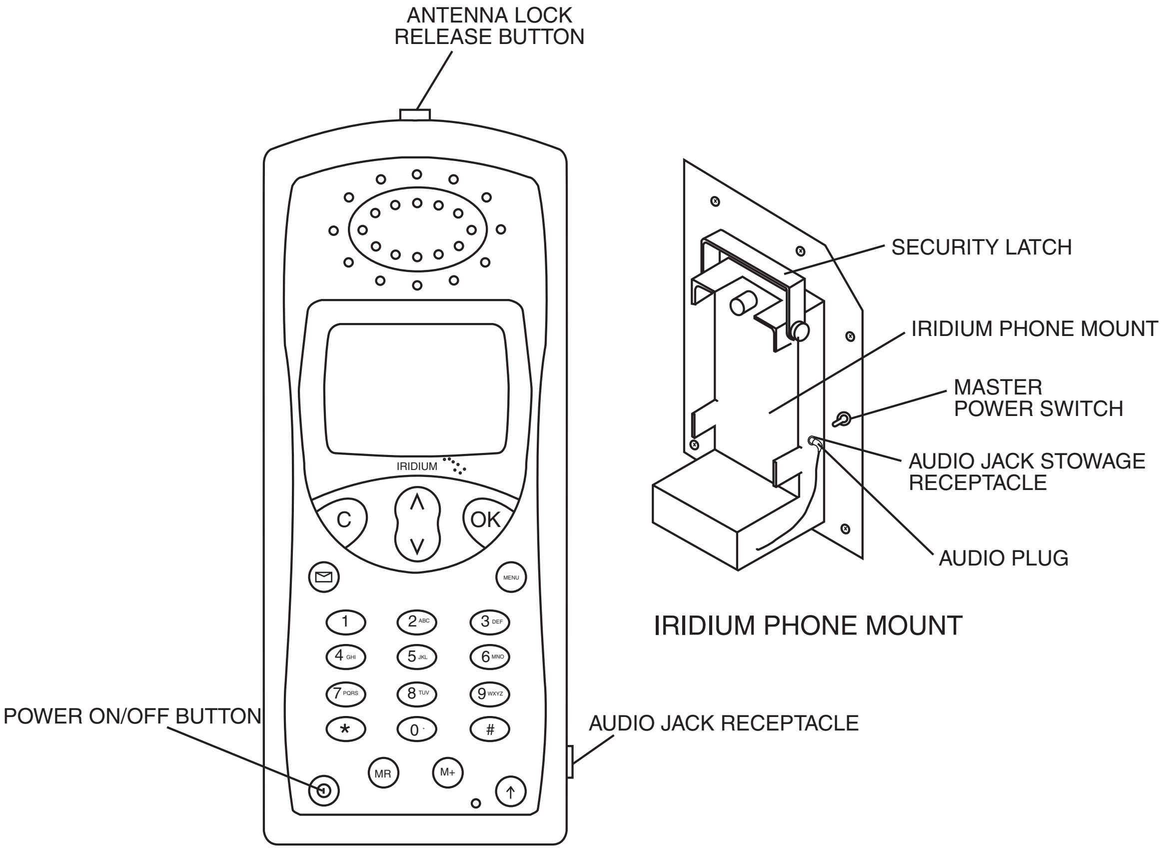
To Add/Edit a Speed dial:

1. Starting from the Main Screen, press the +/0/MENU key to enter the Menu System. Use the arrow keys to scroll down to Phonebook Menu. Press POWER/ENTER/CONNECT key, select Edit Speed Dial and press POWER/ENTER/CONNECT key.
2. Press speed dial number (1-9) to select the name and number to add or edit.

NOTE

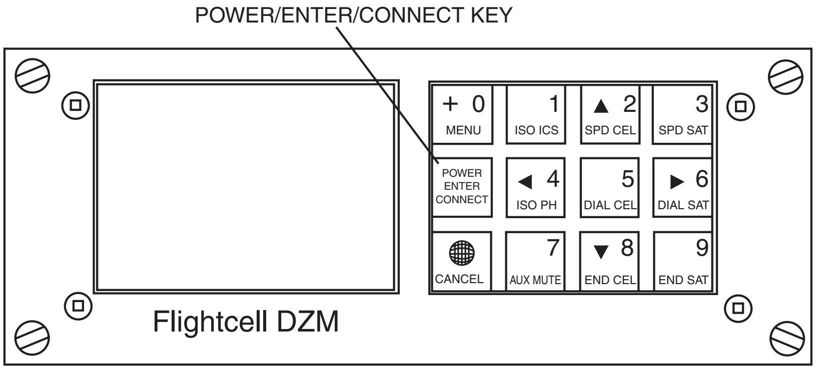
> Blank entries will not show a name or number.

3. Press the POWER/ENTER/CONNECT key to begin editing the selected phonebook entry. The operator must enter and save the name and then the phone number.
4. Enter the name by using the arrow keys. Use the up and down keys to select the letter, then the right key to move to the next letter. Press left or CANCEL key to go back and edit the previous letter.
5. Press POWER/ENTER/CONNECT key to save and continue.



IRIDIUM PHONE MOUNT

IRIDIUM PHONE



FLIGHTCELL DZM CONTROL PANEL

Figure 1.13-16. Iridium Phone and Flightcell Controls

6. Enter the phone number using the 0-9 keys. To enter the "+" symbol for international dialing prefixes, press and hold the +/0/MENU key.
7. To delete the last digit in the phone number being edited, press the CANCEL key. The maximum length of the phone number is nineteen digits.
8. Press POWER/ENTER/CONNECT key to save when complete

Iridium System Volume

The operator may change the audio volume level for incoming Iridium phone calls as follows;

1. Press +/0/MENU key to view Flightcell DZM Main Menu. Select AUDIO MENU, then select SAT PHONE VOLUME.
2. Use arrow keys to change volume level (0-100).

   Zero (0) represents lowest volume.
   100 represents highest volume.
   Default volume is 10.

Iridium System MIC Gain

The operator may change the Iridium phone microphone audio gain as follows:

1. Press +/0/MENU key to view Flightcell DZM Main Menu. Select AUDIO MENU, then select SAT PHONE MIC GAIN.
2. Use Arrow Keys to change gain level (0-100).

   Zero (0) represents lowest gain.
   100 represents highest gain.
   Default gain is 80.

Power Down and Phone Removal

Power down and remove Iridium phone system as follows:

NOTE

> While the Iridium phone is installed in the mount with the Iridium phone master switch in ON position, the charging function will remain on and the battery will remain in a constant state of charge. Therefore, when powering down the phone for intermediate periods (i.e. Receiver AR and Takeoff), use the Iridium Phone POWER ON/OFF button to conserve battery life.

1. Press and hold Flightcell DZM POWER/ENTER/CONNECT key until progress bar reaches end.
2. Press Iridium phone POWER ON/OFF button.
3. Place phone mount Iridium System Master switch to OFF (down).
4. Remove phone mount audio plug from Iridium phone. Insert plug into phone mount stowage position.

CAUTION

> Failure to remove audio plug from the phone before removing the phone from the mount, may cause damage to the audio cable.

5. Rotate phone mount security latch up.
6. Press and hold antenna lock release button (on top of phone) and remove phone from mount.

Flightcell DZM (Control Panel)

The Flightcell DZM (figure 1.13-17) integrates satellite, cell phone, and aircraft intercom (ICS) systems. Current status and menu systems are displayed on the LCD display. The multifunction keypad is used to operate and configure the Flightcell DZM.

The Flightcell DZM display is in one of two states – Main Screen or Menu System. The Main Screen shows the operating status of Flightcell DZM. This includes any phone calls that are currently active, phone signal strength, if ICS or phones are isolated, or if auxiliary input is muted. The Menu System is used to configure Flightcell DZM.

Dialing Keys

When the operator is manually dialing number (or editing a phonebook entry) the keys function as a numeric keypad as shown in figure 1.13-18.

Quick Keys

When the operator is in the Main Screen, each key has a Quick Key Function as shown in figure 1.13-19.

Menu Keys

When the operator is in the Menu System, the Menu keys have various functions as shown in figure 1.13-20.

Menu System

The Menu System is used to configure Flightcell DZM settings. Figure 1.13-21 shows a diagram of the menu structure.

To enter Menu System from the Main Screen, press the +/0/MENU key.

Use Up and Down arrow keys to navigate through the list of options.

While navigating menus, press the POWER/ENTER/CONNECT key to move one menu level deeper (enter sub-menu). Press +/0/MENU to move one level back. Press CANCEL key to exit Menu System and return to Main Screen.

Extended Menus

Extended Menus are used to configure critical system settings. To prevent accidental changes, a PIN (four digit number) is required to access these menus. Some settings should only be changed by an authorized technician.

To access extended menus from the Main Screen, press +/0/MENU key, use arrow keys to scroll down to Setup Menu. Press POWER/ENTER/CONNECT key. Select EXTENDED MENUS and press POWER/ENTER/CONNECT key.

A PIN number must be entered to edit the extended menus. Enter PIN 2468 and press POWER/ENTER/CONNECT key. This PIN number can not be changed.

Press arrow keys to enable EXTENDED MENUS. Pressing POWER/ENTER/CONNECT key accepts and saves the new value. Pressing the +/0/MENU or CANCEL keys will abort the change and return to the Setup Menu.

Factory Reset

The settings within the Flightcell DZM can be returned to factory default states with the Factory Reset Menu.

To access Factory Reset Menu from the Main Screen, press +/0/MENU key, use arrow keys to scroll down to Setup Menu. Press POWER/ENTER/CONNECT key. Select FACTORY RESET and press POWER/ENTER/CONNECT key.

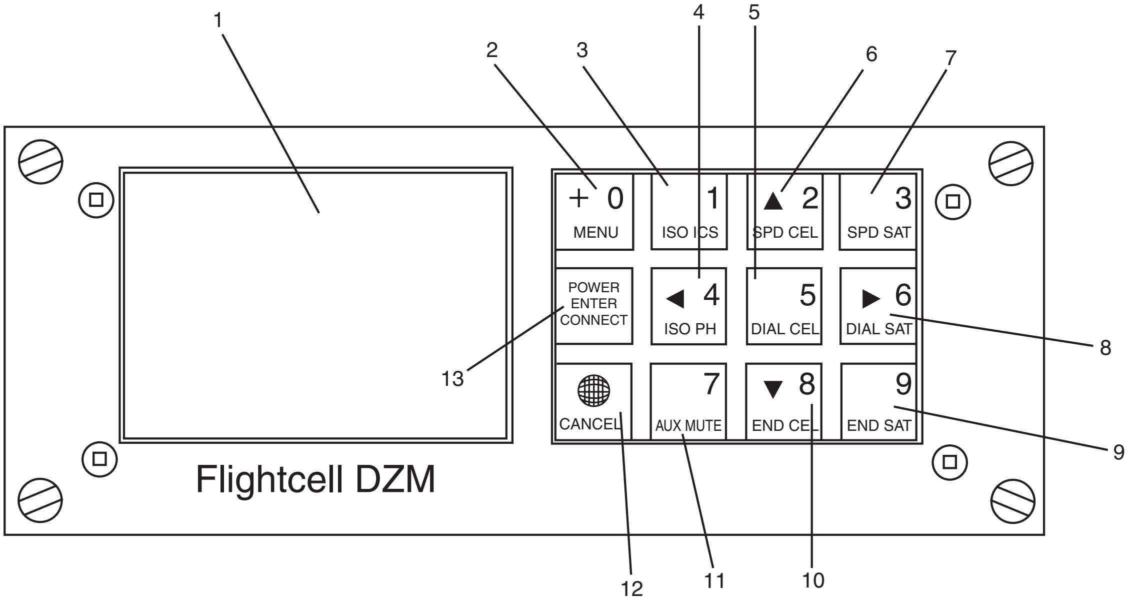
The operator will be asked to confirm whether to proceed. Press POWER/ENTER/CONNECT key to continue, and +/0/MENU or CANCEL keys to abort.

When editing settings, pressing POWER/ENTER/CONNECT key will accept and save changes. The +/0/MENU and CANCEL keys will abort the change and exit.

Menu System will timeout and return to Main Screen if no key is pressed for twenty (20) seconds.

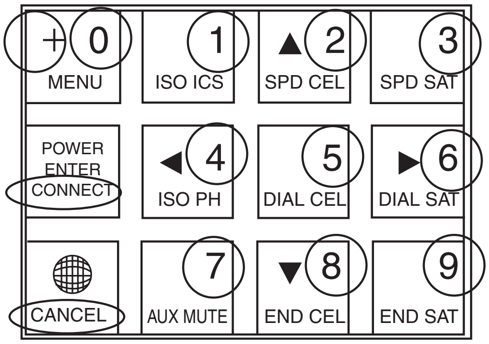
Main Menu has six items when all options are enabled.

Some menu items are hidden when the extended menus are disabled.



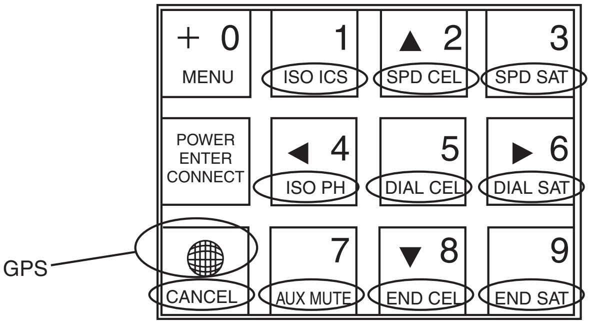
1. FLIGHTCELL DISPLAY
2. MENU KEY
3. ISO ICS KEY
4. ISO PH KEY
5. DIAL CEL KEY
6. SPD CEL KEY
7. SPD SAT KEY
8. DIAL SAT KEY
9. END SAT KEY
10. END CEL KEY
11. AUX MUTE KEY
12. CANCEL KEY
13. POWER ENTER CONNECT KEY

Figure 1.13-17. Flightcell DZM Control Panel



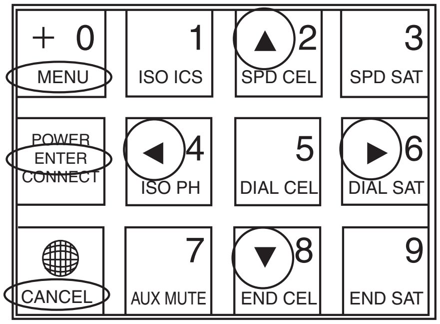
KEYS	DESCRIPTION
Numbers 0-9	Used to enter phone number, digits 0-9 are used.
+	Hold +/0/MENU key for the "+" symbol for international numbers when using GSM Networks of the Iridium Network.
CANCEL	Cancel key deletes last digit in phone number.
CONNECT	If manually dialing a number, the POWER/ENTER/CONNECT key is pressed to execute call.

Figure 1.13-18. Dialing Keys



QUICK KEY	DESCRIPTION
ISO ICS	Isolate ICS - Isolates Flightcell DZM from ICS.
ISO PH	Isolate Phone - Mutes audio out to Iridium phone. User can still hear person on other end of call.
AUX MUTE	Auxiliary Mute - Mutes auxiliary audio input.
SPD CEL	Speed Dial Cell Phone – DISABLED.
DIAL CEL	Dial Cell Phone – DISABLED.
END CEL	End Cell Phone Call – DISABLED.
SPD SAT	Speed Dial Sat Phone - Nine speed dial numbers available.
DIAL SAT	Dial Sat Phone - Prompts user to enter number to dial.
END SAT	End Sat Phone Call - Ends sat phone call.
GPS	Send GPS Position – DISABLED.
CANCEL	Cancel – Press to abort and return to previous state.

Figure 1.13-19. Quick Keys



KEY	**DESCRIPTION/FUNCTION**
MENU	Press to enter Menu System. Used to jump back a level in sub-menus.
ENTER	Press to edit a menu item, or enter sub-menu. When editing settings, press to save setting.
CANCEL	Press to exit the Menu System immediately unless editing a setting. When editing a setting, press to abort and revert to previous setting.
ARROW KEYS	When in Menu System, use arrow keys to scroll through menu items. When editing settings, arrow keys are used to adjust setting.

Figure 1.13-20. Menu Keys

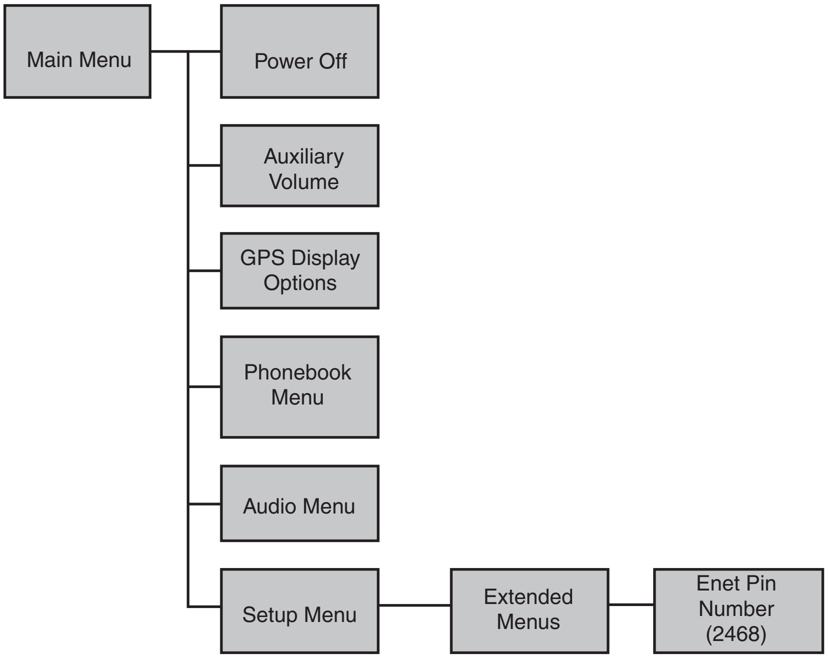


Figure 1.13-21. Flightcell DZM Menu Structure ◀

PART 14

NAVIGATION AND RADAR

TABLE OF CONTENTS

NAVIGATION AND RADAR

NAVIGATION SYSTEMS DESCRIPTION

The navigation system includes those units and components which provide time and position data to the Flight Crew. The system encompasses ground dependent, satellite dependent, and independent position indicating systems; attitude, directional, speed, temperature, and altitude instruments; those units which provide guidance during approach, landing, and taxiing; and those units which combine the various navigation inputs to compute and/or display a geographical location.

CLOCKS

NOTE

> The flight data recorder lapse time cannot be determined if the Flight Engineer's clock is inoperative.

A digital time system (figures 1.14-1 and 1.14-2) is installed which is a crystal controlled, solid state timepiece compatible with computer associated operations requiring a highly accurate and controlled real time reference. The display presents Greenwich Mean Time (GMT) in hours and minutes, Long Term Elapsed Flight Time (ELAPS) in hours and minutes, and Short Term Elapsed Time (CHRO) in minutes and seconds. Digital GMT outputs from the Flight Engineer's clock are provided to the Flight Data Acquisition Unit (FDAU).

ATTITUDE DIRECTOR INDICATOR

In addition to its flight instrument role, the Attitude Director Indicator (ADI) provides data which are used for navigation, approach, and landing operations. The command bars can provide corrections to intercept a selected VOR/LOC, TACAN, or FMS centerline.

RADIO MAGNETIC INDICATORS

The VOR/ADF Radio Magnetic Indicators (RMI) (figure 1.14-4) display relative bearing information from ADF and VOR signal sources on their respective RMI pointers, and magnetic heading from the compass system under the lubber lines. Compass system number one normally furnishes magnetic heading to the Copilot's RMI. Compass system number two normally furnishes magnetic heading to the Pilot's RMI. The TACAN RMI's (figure 1.14-5) function in the same manner as the VOR/ADF RMI's, except the signal source is from the selected TACAN station.

ELECTRONIC HORIZONTAL SITUATION INDICATOR

The Electronic Horizontal Situation Indicator (EHSI) (figures 1.14-1 through 1.14-4) displays navigation information from five different sources (TACAN, VOR, ILS, ADF, and FMS). Inputs are controlled by the NAV selector knob and the BRG pushbutton on the EHSI control panel. The EHSI presents four basic display modes: 360° HSI, 80° sectored arc, 360° map, and arc map.

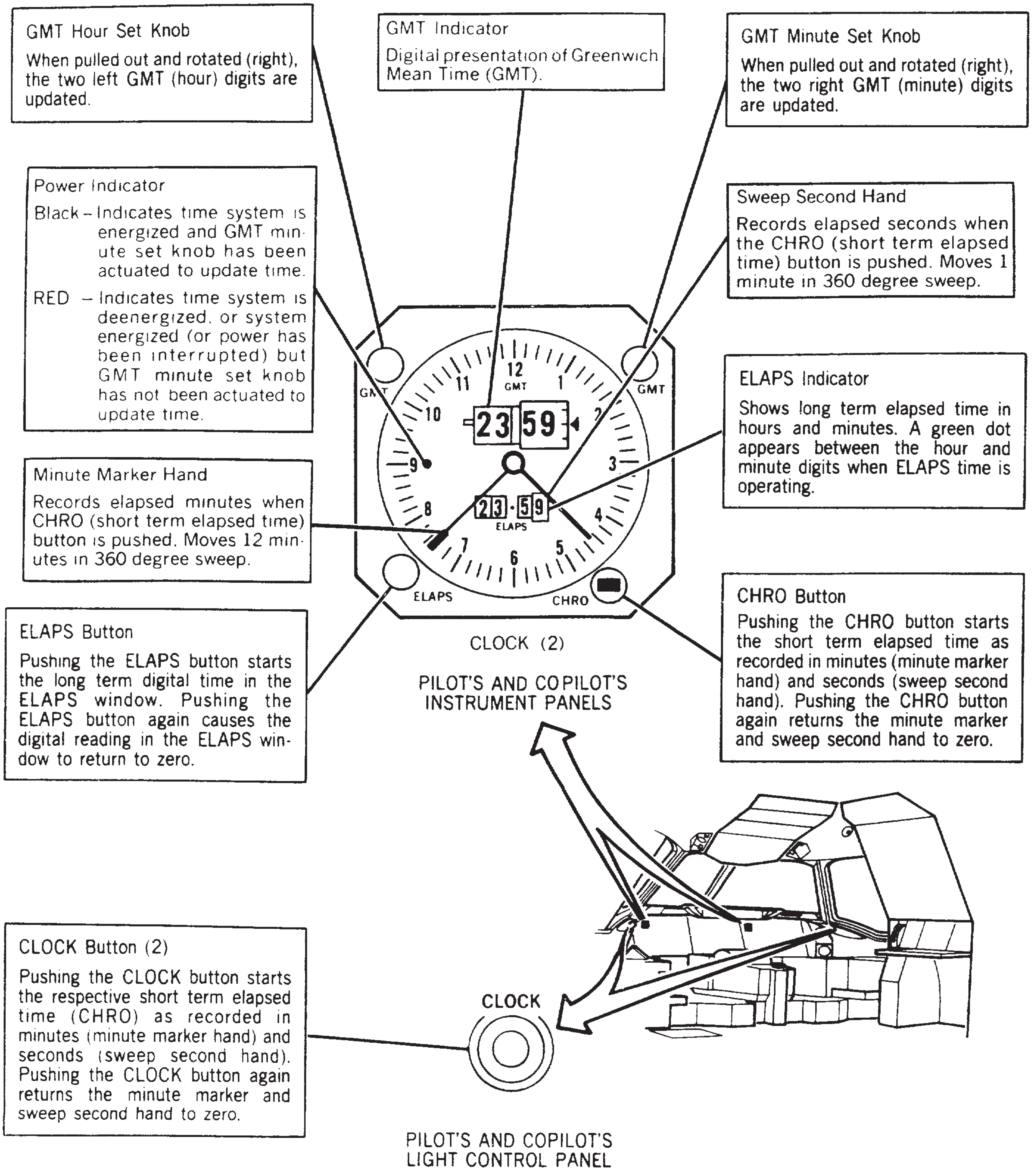
Information available for display includes magnetic or true heading, selected course or desired track, TO/FROM, indication, aircraft track, bearing to selected station or active waypoint, and crosstrack deviation. Glideslope/VNAV deviation, distance to the selected station or active waypoint, selected heading, wind, selected navigation data, and various mode and alert messages are also displayed. The pilot's EHSI receives power from the 28 VDC L EMER Bus. The copilot's EHSI receives power from the 28 VDC R EMER Bus. Circuit breakers are located on the Pilot's Overhead Circuit Breaker Panel.

MARKER BEACON SYSTEM

The pre-tuned marker beacon (figures 1.14-12 and 1.14-16) system provides visual and aural signals to the Flight Crew. Three dimmable lights on the Pilot's and Copilot's instrument panels provide visual position indications when passing over the outer, middle, or inner marker. A distinctive aural tone sounds simultaneously with each light. Audio is selected on the audio control panel.

STANDBY MAGNETIC COMPASS

The standby magnetic compass (figure 1.14-12) provides a heading reference in relation to magnetic north. Compass correction card is provided on the Copilot's Gusset Panel.



GMT Hour Set Knob

When pulled out and rotated (right), the two left GMT (hour) digits are updated.

GMT Indicator

Digital presentation of Greenwich Mean Time (GMT).

GMT Minute Set Knob

When pulled out and rotated (right), the two right GMT (minute) digits are updated.

Power Indicator

Black – Indicates time system is energized and GMT minute set knob has been actuated to update time.

RED – Indicates time system is deenergized, or system energized (or power has been interrupted) but GMT minute set knob has not been actuated to update time.

Sweep Second Hand

Records elapsed seconds when the CHRO (short term elapsed time) button is pushed. Moves 1 minute in 360 degree sweep.

ELAPS Indicator

Shows long term elapsed time in hours and minutes. A green dot appears between the hour and minute digits when ELAPS time is operating.

Minute Marker Hand

Records elapsed minutes when CHRO (short term elapsed time) button is pushed. Moves 12 minutes in 360 degree sweep.

ELAPS Button

Pushing the ELAPS button starts the long term digital time in the ELAPS window. Pushing the ELAPS button again causes the digital reading in the ELAPS window to return to zero.

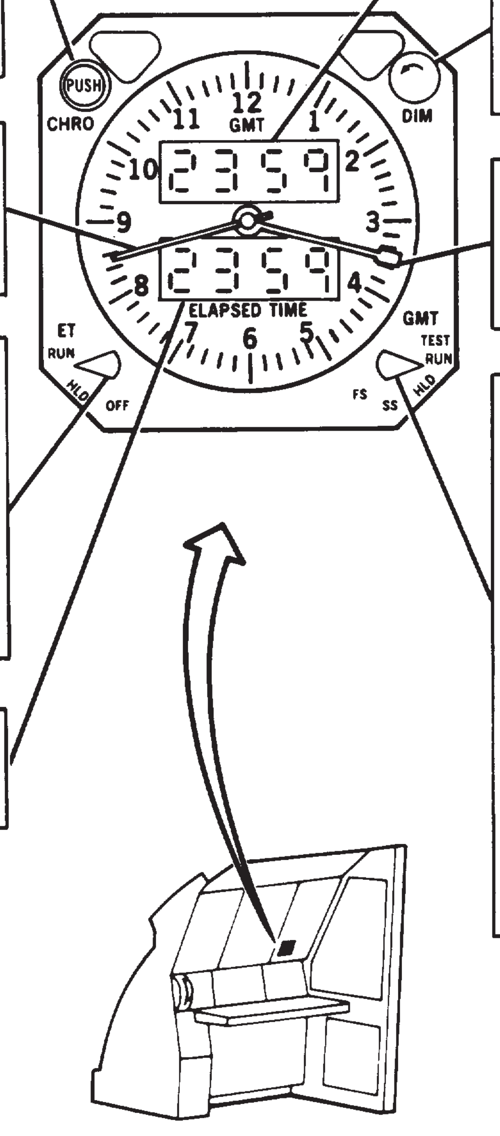
CHRO Button

Pushing the CHRO button starts the short term elapsed time as recorded in minutes (minute marker hand) and seconds (sweep second hand). Pushing the CHRO button again returns the minute marker hand and sweep second hand to zero.

CLOCK Button (2)

Pushing the CLOCK button starts the respective short term elapsed time (CHRO) as recorded in minutes (minute marker hand) and seconds (sweep second hand). Pushing the CLOCK button again returns the minute marker and sweep second hand to zero.

Figure 1.14-1. Clocks



CHRO Button

Pushing the CHRO button starts the short term elapsed time as recorded in minutes (minute marker hand) and seconds (sweep second hand). Pushing again stops the minute marker and sweep second hands. Pushing again returns the minute marker and sweep second hand to 12 o'clock.

NOTE

A minimum of one second between successive actuations of the CHRO button is required for proper operation.

Sweep Second Hand

Records elapsed seconds when the CHRO (short term elapsed time) button is pushed. Moves 1 minute in 360 degree sweep.

ET (Elapsed Time) Selector

RUN – Selecting RUN starts long term elapsed time display and update.

HLD – Selecting HLD (Hold) stops elapsed time display (no update).

OFF – Selecting OFF turns off elapsed time display and zeroes readout.

ELAPSED TIME Indicator

Digital display of long term elapsed time (hours and minutes).

GMT Indicator

Digital display of Greenwich Mean Time.

DIM Knob

Rotating CW increases brightness of GMT and ET readouts. Rotating CCW decreases brightness. Full CCW blanks the readouts.

Minute Marker Hand

Records elapsed minutes when CHRO (short term elapsed time) button is pushed. Moves 12 minutes in 360 degree sweep.

GMT Selector

TEST – Selecting TEST displays 8s in GMT and ET readouts.

RUN – Selecting RUN starts GMT display and update.

HLD – Selecting HLD (Hold) stops GMT display and maintains setting (no update).

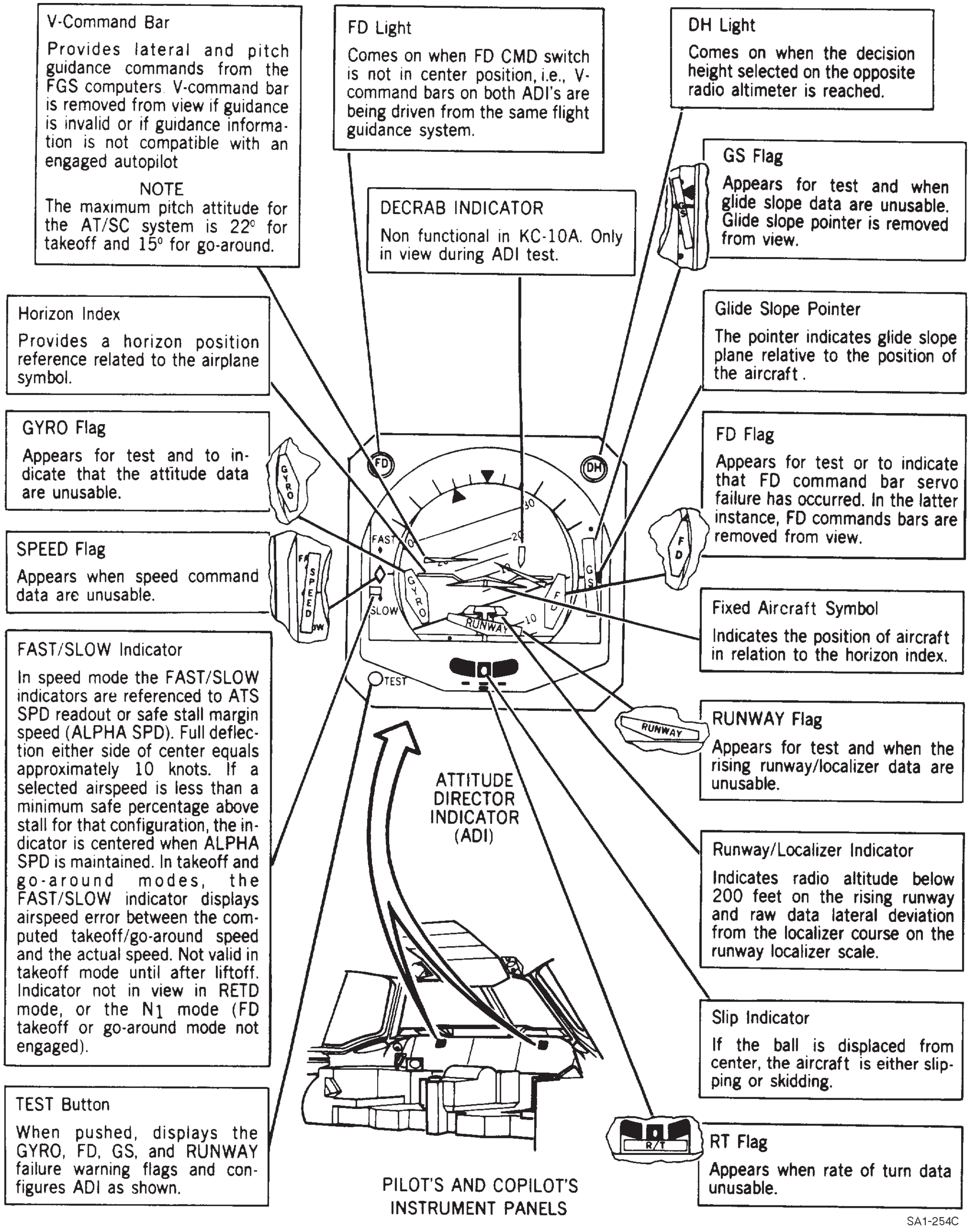
SS – Selecting SS (Slow Set) updates GMT display one minute per second.

FS – Selecting FS (Fast Set) updates GMT display one hour per second.

NOTE

Seconds are not displayed, but timekeeping automatically starts at zero seconds.

Figure 1.14-2. Flight Engineer's Clock



V-Command Bar

Provides lateral and pitch guidance commands from the FGS computers. V-command bar is removed from view if guidance is invalid or if guidance information is not compatible with an engaged autopilot

NOTE

The maximum pitch attitude for the AT/SC system is 22° for takeoff and 15° for go-around.

Horizon Index

Provides a horizon position reference related to the airplane symbol.

GYRO Flag

Appears for test and to indicate that the attitude data are unusable.

SPEED Flag

Appears when speed command data are unusable.

FAST/SLOW Indicator

In speed mode the FAST/SLOW indicators are referenced to ATS SPD readout or safe stall margin speed (ALPHA SPD). Full deflection either side of center equals approximately 10 knots. If a selected airspeed is less than a minimum safe percentage above stall for that configuration, the indicator is centered when ALPHA SPD is maintained. In takeoff and go-around modes, the FAST/SLOW indicator displays airspeed error between the computed takeoff/go-around speed and the actual speed. Not valid in takeoff mode until after liftoff. Indicator not in view in RETD mode, or the N_1 mode (FD takeoff or go-around mode not engaged).

TEST Button

When pushed, displays the GYRO, FD, GS, and RUNWAY failure warning flags and configures ADI as shown.

FD Light

Comes on when FD CMD switch is not in center position, i.e., V-command bars on both ADI's are being driven from the same flight guidance system.

DECRAB INDICATOR

Non functional in KC-10A. Only in view during ADI test.

DH Light

Comes on when the decision height selected on the opposite radio altimeter is reached.

GS Flag

Appears for test and when glide slope data are unusable. Glide slope pointer is removed from view.

Glide Slope Pointer

The pointer indicates glide slope plane relative to the position of the aircraft.

FD Flag

Appears for test or to indicate that FD command bar servo failure has occurred. In the latter instance, FD commands bars are removed from view.

Fixed Aircraft Symbol

Indicates the position of aircraft in relation to the horizon index.

RUNWAY Flag

Appears for test and when the rising runway/localizer data are unusable.

Runway/Localizer Indicator

Indicates radio altitude below 200 feet on the rising runway and raw data lateral deviation from the localizer course on the runway localizer scale.

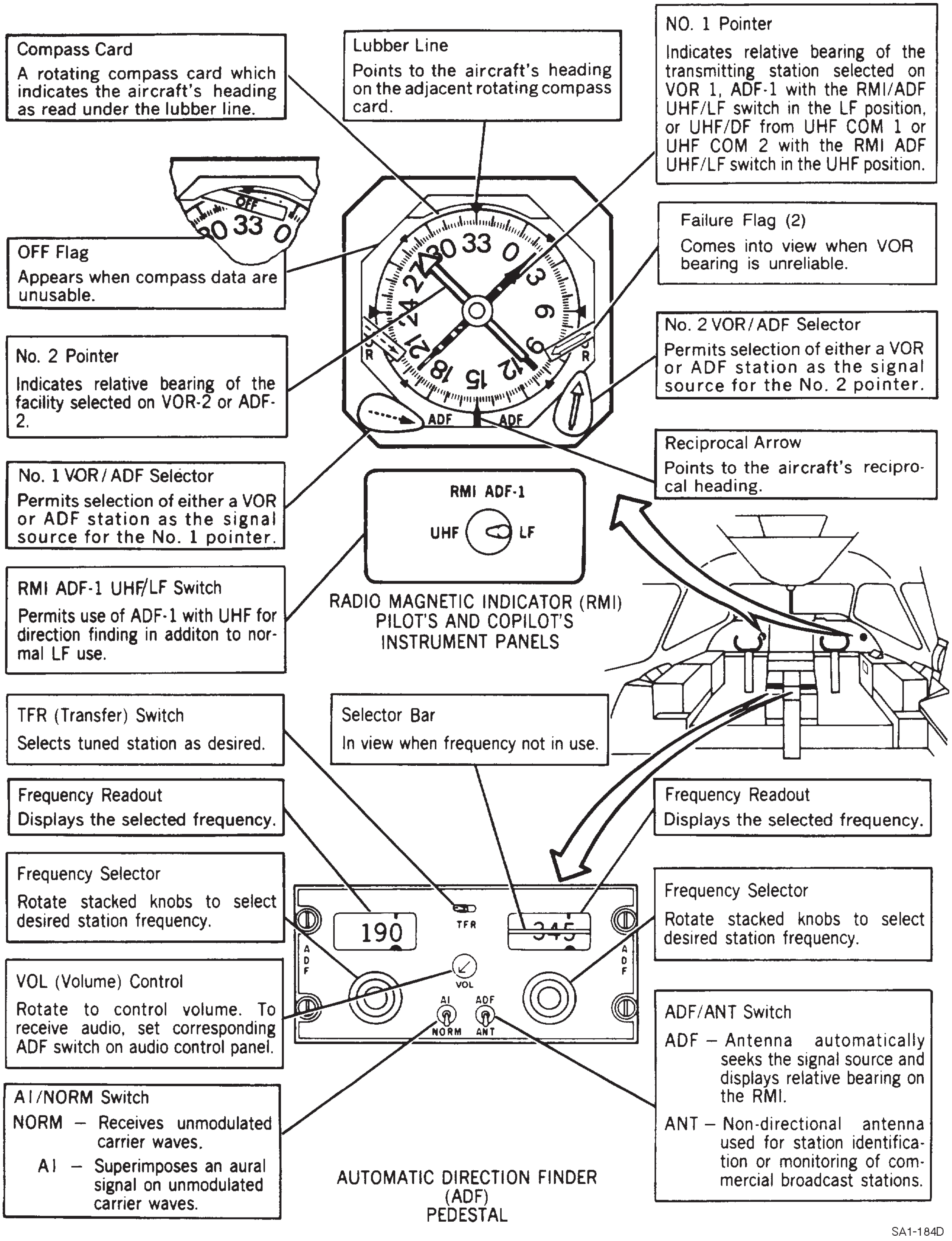
Slip Indicator

If the ball is displaced from center, the aircraft is either slipping or skidding.

RT Flag

Appears when rate of turn data unusable.

Figure 1.14-3. Attitude Director Indicator (ADI)



Compass Card

A rotating compass card which indicates the aircraft's heading as read under the lubber line.

Lubber Line

Points to the aircraft's heading on the adjacent rotating compass card.

NO. 1 Pointer

Indicates relative bearing of the transmitting station selected on VOR 1, ADF-1 with the RMI/ADF UHF/LF switch in the LF position, or UHF/DF from UHF COM 1 or UHF COM 2 with the RMI ADF UHF/LF switch in the UHF position.

OFF Flag

Appears when compass data are unusable.

Failure Flag (2)

Comes into view when VOR bearing is unreliable.

No. 2 Pointer

Indicates relative bearing of the facility selected on VOR-2 or ADF-2.

No. 2 VOR/ADF Selector

Permits selection of either a VOR or ADF station as the signal source for the No. 2 pointer.

No. 1 VOR/ADF Selector

Permits selection of either a VOR or ADF station as the signal source for the No. 1 pointer.

Reciprocal Arrow

Points to the aircraft's reciprocal heading.

RMI ADF-1

UHF LF

RMI ADF-1 UHF/LF Switch

Permits use of ADF-1 with UHF for direction finding in additon to normal LF use.

RADIO MAGNETIC INDICATOR (RMI)
PILOT'S AND COPILOT'S
INSTRUMENT PANELS

TFR (Transfer) Switch

Selects tuned station as desired.

Selector Bar

In view when frequency not in use.

Frequency Readout

Displays the selected frequency.

Frequency Readout

Displays the selected frequency.

Frequency Selector

Rotate stacked knobs to select desired station frequency.

Frequency Selector

Rotate stacked knobs to select desired station frequency.

VOL (Volume) Control

Rotate to control volume. To receive audio, set corresponding ADF switch on audio control panel.

ADF/ANT Switch

ADF – Antenna automatically seeks the signal source and displays relative bearing on the RMI.

ANT – Non-directional antenna used for station identification or monitoring of commercial broadcast stations.

AI/NORM Switch

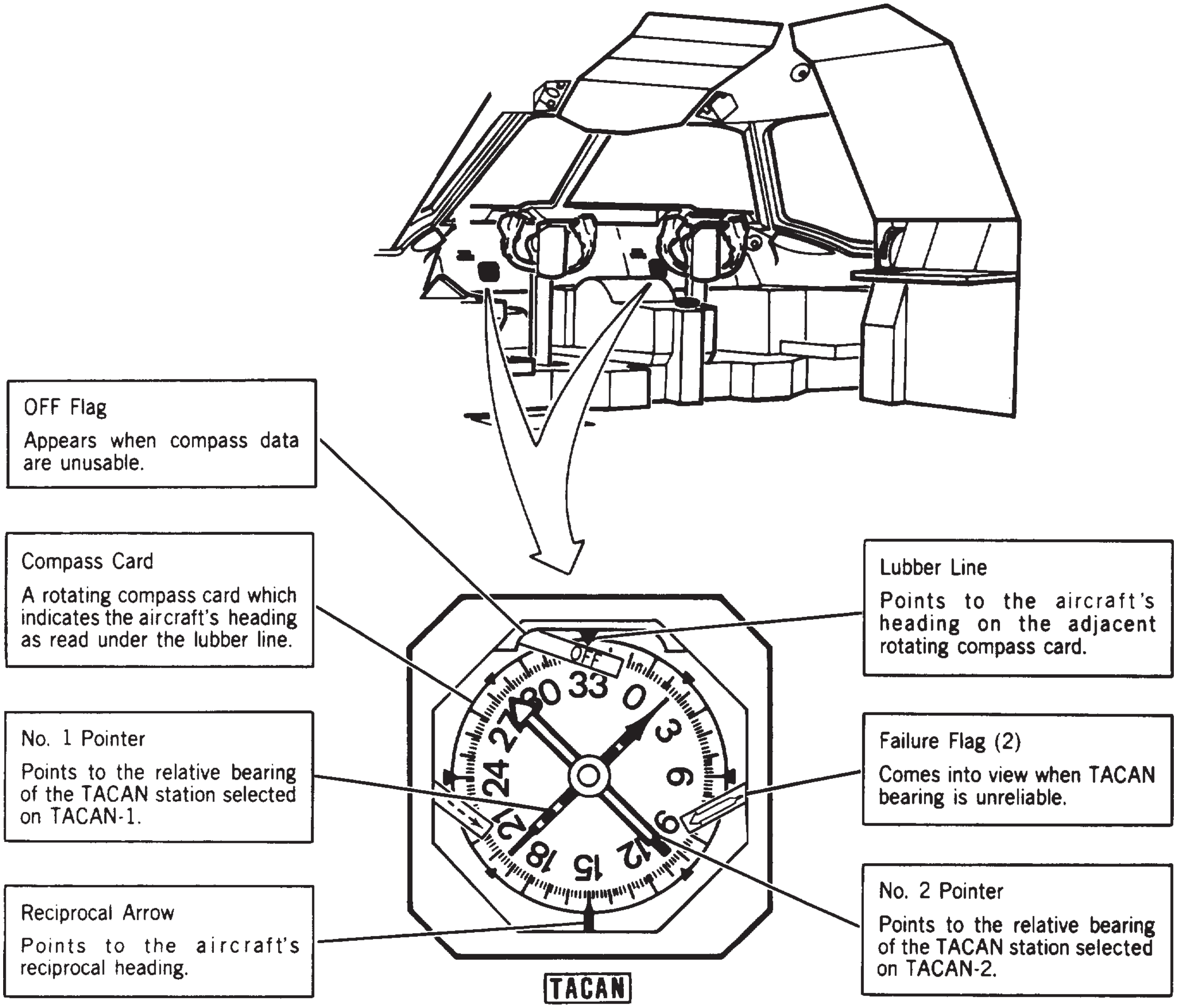
NORM – Receives unmodulated carrier waves.

AI – Superimposes an aural signal on unmodulated carrier waves.

AUTOMATIC DIRECTION FINDER
(ADF)
PEDESTAL

SA1-184D

Figure 1.14-4. RMI and ADF Systems



OFF Flag

Appears when compass data are unusable.

Compass Card

A rotating compass card which indicates the aircraft's heading as read under the lubber line.

No. 1 Pointer

Points to the relative bearing of the TACAN station selected on TACAN-1.

Reciprocal Arrow

Points to the aircraft's reciprocal heading.

Lubber Line

Points to the aircraft's heading on the adjacent rotating compass card.

Failure Flag (2)

Comes into view when TACAN bearing is unreliable.

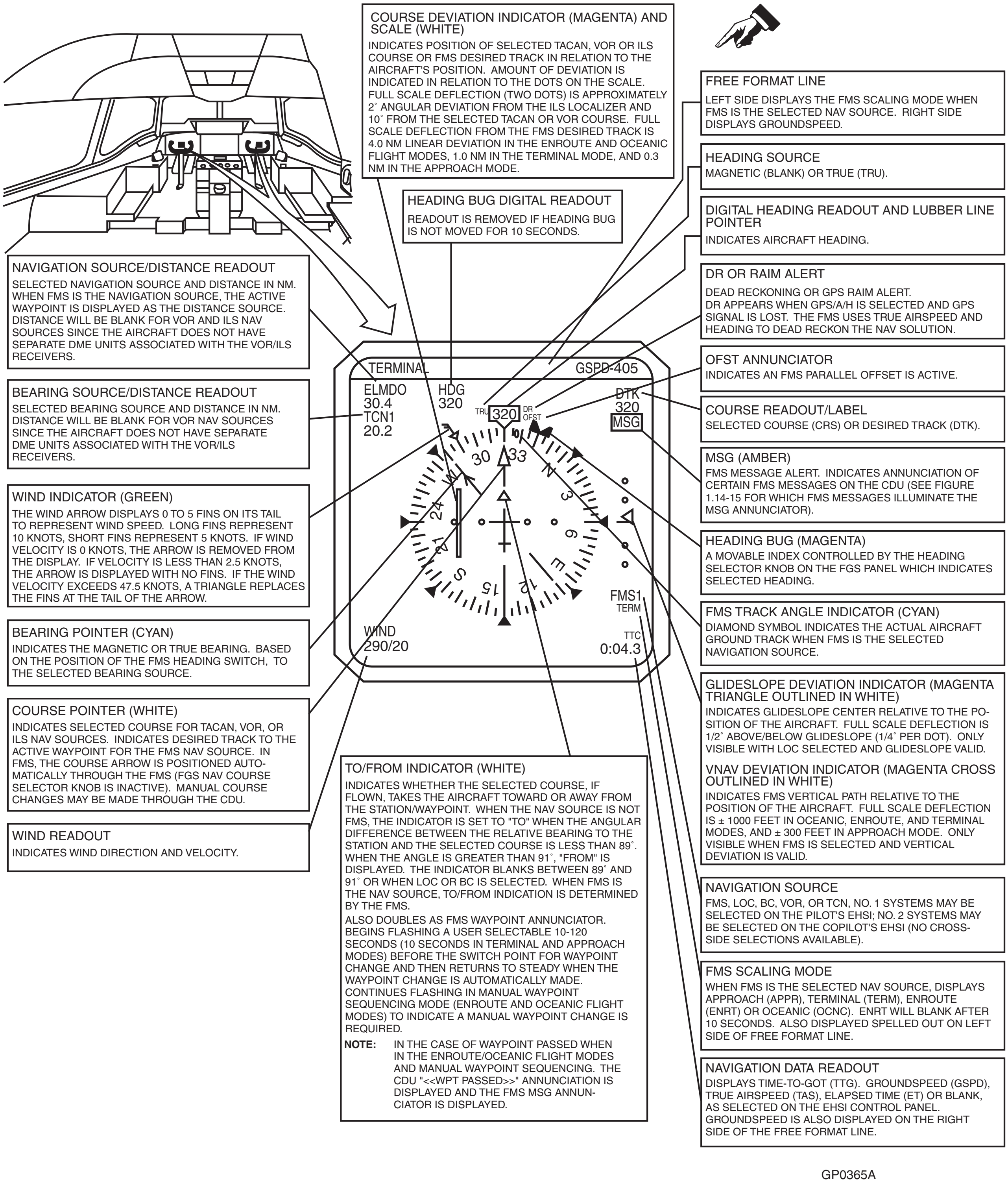
No. 2 Pointer

Points to the relative bearing of the TACAN station selected on TACAN-2.

TACAN RADIO MAGNETIC
INDICATOR
PILOT'S AND COPILOT'S INSTRUMENT PANEL

SA1-364A

Figure 1.14-5. TACAN RMI



COURSE DEVIATION INDICATOR (MAGENTA) AND SCALE (WHITE)

INDICATES POSITION OF SELECTED TACAN, VOR OR ILS COURSE OR FMS DESIRED TRACK IN RELATION TO THE AIRCRAFT'S POSITION. AMOUNT OF DEVIATION IS INDICATED IN RELATION TO THE DOTS ON THE SCALE. FULL SCALE DEFLECTION (TWO DOTS) IS APPROXIMATELY 2° ANGULAR DEVIATION FROM THE ILS LOCALIZER AND 10° FROM THE SELECTED TACAN OR VOR COURSE. FULL SCALE DEFLECTION FROM THE FMS DESIRED TRACK IS 4.0 NM LINEAR DEVIATION IN THE ENROUTE AND OCEANIC FLIGHT MODES, 1.0 NM IN THE TERMINAL MODE, AND 0.3 NM IN THE APPROACH MODE.

HEADING BUG DIGITAL READOUT

READOUT IS REMOVED IF HEADING BUG IS NOT MOVED FOR 10 SECONDS.

NAVIGATION SOURCE/DISTANCE READOUT

SELECTED NAVIGATION SOURCE AND DISTANCE IN NM. WHEN FMS IS THE NAVIGATION SOURCE, THE ACTIVE WAYPOINT IS DISPLAYED AS THE DISTANCE SOURCE. DISTANCE WILL BE BLANK FOR VOR AND ILS NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

BEARING SOURCE/DISTANCE READOUT

SELECTED BEARING SOURCE AND DISTANCE IN NM. DISTANCE WILL BE BLANK FOR VOR NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

WIND INDICATOR (GREEN)

THE WIND ARROW DISPLAYS 0 TO 5 FINS ON ITS TAIL TO REPRESENT WIND SPEED. LONG FINS REPRESENT 10 KNOTS, SHORT FINS REPRESENT 5 KNOTS. IF WIND VELOCITY IS 0 KNOTS, THE ARROW IS REMOVED FROM THE DISPLAY. IF VELOCITY IS LESS THAN 2.5 KNOTS, THE ARROW IS DISPLAYED WITH NO FINS. IF THE WIND VELOCITY EXCEEDS 47.5 KNOTS, A TRIANGLE REPLACES THE FINS AT THE TAIL OF THE ARROW.

BEARING POINTER (CYAN)

INDICATES THE MAGNETIC OR TRUE BEARING. BASED ON THE POSITION OF THE FMS HEADING SWITCH, TO THE SELECTED BEARING SOURCE.

COURSE POINTER (WHITE)

INDICATES SELECTED COURSE FOR TACAN, VOR, OR ILS NAV SOURCES. INDICATES DESIRED TRACK TO THE ACTIVE WAYPOINT FOR THE FMS NAV SOURCE. IN FMS, THE COURSE ARROW IS POSITIONED AUTOMATICALLY THROUGH THE FMS (FGS NAV COURSE SELECTOR KNOB IS INACTIVE). MANUAL COURSE CHANGES MAY BE MADE THROUGH THE CDU.

WIND READOUT

INDICATES WIND DIRECTION AND VELOCITY.

TO/FROM INDICATOR (WHITE)

INDICATES WHETHER THE SELECTED COURSE, IF FLOWN, TAKES THE AIRCRAFT TOWARD OR AWAY FROM THE STATION/WAYPOINT. WHEN THE NAV SOURCE IS NOT FMS, THE INDICATOR IS SET TO "TO" WHEN THE ANGULAR DIFFERENCE BETWEEN THE RELATIVE BEARING TO THE STATION AND THE SELECTED COURSE IS LESS THAN 89°. WHEN THE ANGLE IS GREATER THAN 91°, "FROM" IS DISPLAYED. THE INDICATOR BLANKS BETWEEN 89° AND 91° OR WHEN LOC OR BC IS SELECTED. WHEN FMS IS THE NAV SOURCE, TO/FROM INDICATION IS DETERMINED BY THE FMS.

ALSO DOUBLES AS FMS WAYPOINT ANNUNCIATOR. BEGINS FLASHING A USER SELECTABLE 10-120 SECONDS (10 SECONDS IN TERMINAL AND APPROACH MODES) BEFORE THE SWITCH POINT FOR WAYPOINT CHANGE AND THEN RETURNS TO STEADY WHEN THE WAYPOINT CHANGE IS AUTOMATICALLY MADE. CONTINUES FLASHING IN MANUAL WAYPOINT SEQUENCING MODE (ENROUTE AND OCEANIC FLIGHT MODES) TO INDICATE A MANUAL WAYPOINT CHANGE IS REQUIRED.

NOTE: IN THE CASE OF WAYPOINT PASSED WHEN IN THE ENROUTE/OCEANIC FLIGHT MODES AND MANUAL WAYPOINT SEQUENCING. THE CDU "<<WPT PASSED>>" ANNUNCIATION IS DISPLAYED AND THE FMS MSG ANNUNCIATOR IS DISPLAYED.

FREE FORMAT LINE

LEFT SIDE DISPLAYS THE FMS SCALING MODE WHEN FMS IS THE SELECTED NAV SOURCE. RIGHT SIDE DISPLAYS GROUNDSPEED.

HEADING SOURCE

MAGNETIC (BLANK) OR TRUE (TRU).

DIGITAL HEADING READOUT AND LUBBER LINE POINTER

INDICATES AIRCRAFT HEADING.

DR OR RAIM ALERT

DEAD RECKONING OR GPS RAIM ALERT.
DR APPEARS WHEN GPS/A/H IS SELECTED AND GPS SIGNAL IS LOST. THE FMS USES TRUE AIRSPEED AND HEADING TO DEAD RECKON THE NAV SOLUTION.

OFST ANNUNCIATOR

INDICATES AN FMS PARALLEL OFFSET IS ACTIVE.

COURSE READOUT/LABEL

SELECTED COURSE (CRS) OR DESIRED TRACK (DTK).

MSG (AMBER)

FMS MESSAGE ALERT. INDICATES ANNUNCIATION OF CERTAIN FMS MESSAGES ON THE CDU (SEE FIGURE 1.14-15 FOR WHICH FMS MESSAGES ILLUMINATE THE MSG ANNUNCIATOR).

HEADING BUG (MAGENTA)

A MOVABLE INDEX CONTROLLED BY THE HEADING SELECTOR KNOB ON THE FGS PANEL WHICH INDICATES SELECTED HEADING.

FMS TRACK ANGLE INDICATOR (CYAN)

DIAMOND SYMBOL INDICATES THE ACTUAL AIRCRAFT GROUND TRACK WHEN FMS IS THE SELECTED NAVIGATION SOURCE.

GLIDESLOPE DEVIATION INDICATOR (MAGENTA TRIANGLE OUTLINED IN WHITE)

INDICATES GLIDESLOPE CENTER RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS 1/2° ABOVE/BELOW GLIDESLOPE (1/4° PER DOT). ONLY VISIBLE WITH LOC SELECTED AND GLIDESLOPE VALID.

VNAV DEVIATION INDICATOR (MAGENTA CROSS OUTLINED IN WHITE)

INDICATES FMS VERTICAL PATH RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS ± 1000 FEET IN OCEANIC, ENROUTE, AND TERMINAL MODES, AND ± 300 FEET IN APPROACH MODE. ONLY VISIBLE WHEN FMS IS SELECTED AND VERTICAL DEVIATION IS VALID.

NAVIGATION SOURCE

FMS, LOC, BC, VOR, OR TCN, NO. 1 SYSTEMS MAY BE SELECTED ON THE PILOT'S EHSI; NO. 2 SYSTEMS MAY BE SELECTED ON THE COPILOT'S EHSI (NO CROSS-SIDE SELECTIONS AVAILABLE).

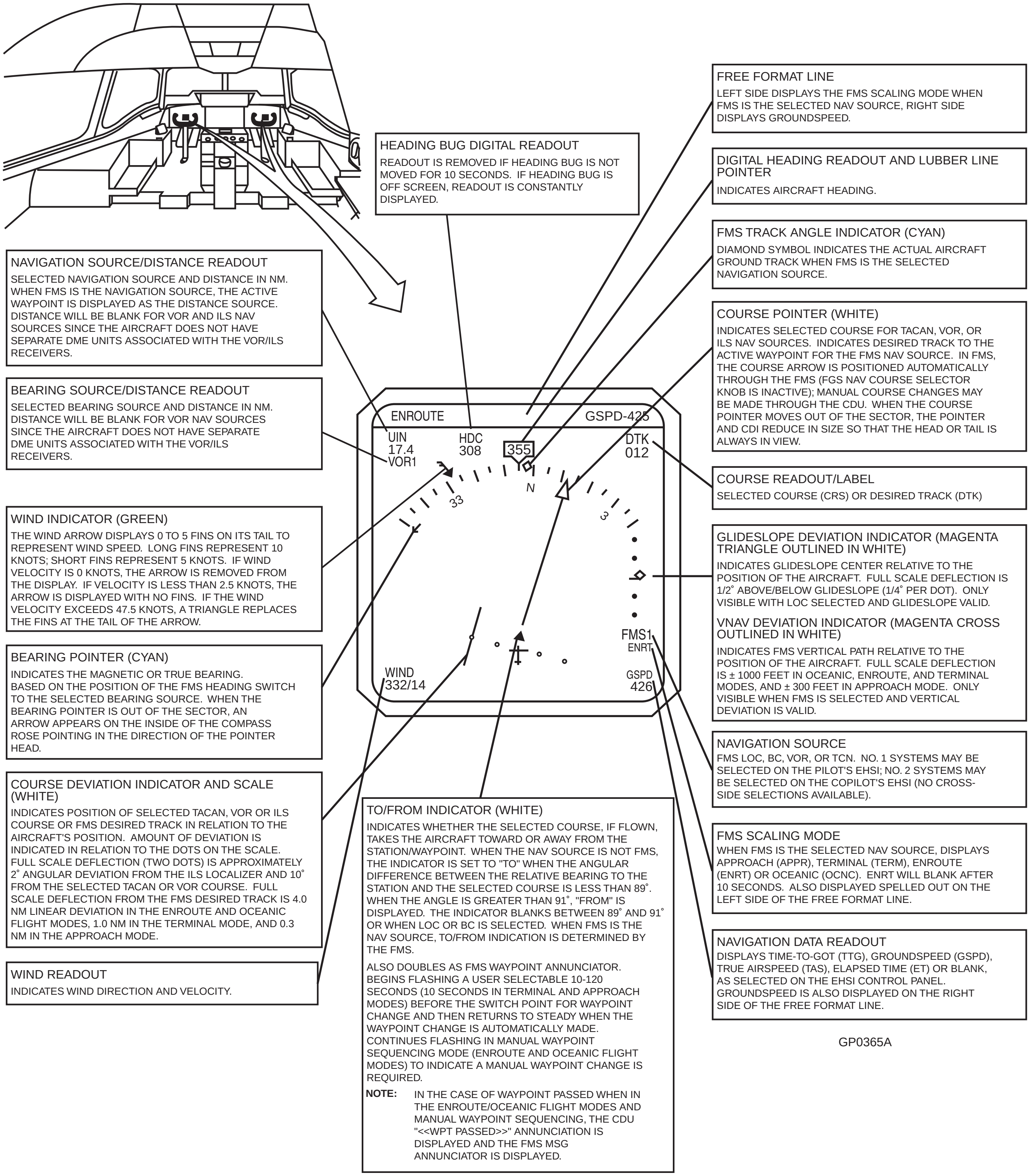
FMS SCALING MODE

WHEN FMS IS THE SELECTED NAV SOURCE, DISPLAYS APPROACH (APPR), TERMINAL (TERM), ENROUTE (ENRT) OR OCEANIC (OCNC). ENRT WILL BLANK AFTER 10 SECONDS. ALSO DISPLAYED SPELLED OUT ON LEFT SIDE OF FREE FORMAT LINE.

NAVIGATION DATA READOUT

DISPLAYS TIME-TO-GOT (TTG). GROUNDSPEED (GSPD), TRUE AIRSPEED (TAS), ELAPSED TIME (ET) OR BLANK, AS SELECTED ON THE EHSI CONTROL PANEL. GROUNDSPEED IS ALSO DISPLAYED ON THE RIGHT SIDE OF THE FREE FORMAT LINE.

Figure 1.14-6. Electronic Horizontal Situation Indicator (EHSI), 360° HSI Display Mode



NAVIGATION SOURCE/DISTANCE READOUT

SELECTED NAVIGATION SOURCE AND DISTANCE IN NM. WHEN FMS IS THE NAVIGATION SOURCE, THE ACTIVE WAYPOINT IS DISPLAYED AS THE DISTANCE SOURCE. DISTANCE WILL BE BLANK FOR VOR AND ILS NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

BEARING SOURCE/DISTANCE READOUT

SELECTED BEARING SOURCE AND DISTANCE IN NM. DISTANCE WILL BE BLANK FOR VOR NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

WIND INDICATOR (GREEN)

THE WIND ARROW DISPLAYS 0 TO 5 FINS ON ITS TAIL TO REPRESENT WIND SPEED. LONG FINS REPRESENT 10 KNOTS; SHORT FINS REPRESENT 5 KNOTS. IF WIND VELOCITY IS 0 KNOTS, THE ARROW IS REMOVED FROM THE DISPLAY. IF VELOCITY IS LESS THAN 2.5 KNOTS, THE ARROW IS DISPLAYED WITH NO FINS. IF THE WIND VELOCITY EXCEEDS 47.5 KNOTS, A TRIANGLE REPLACES THE FINS AT THE TAIL OF THE ARROW.

BEARING POINTER (CYAN)

INDICATES THE MAGNETIC OR TRUE BEARING. BASED ON THE POSITION OF THE FMS HEADING SWITCH TO THE SELECTED BEARING SOURCE. WHEN THE BEARING POINTER IS OUT OF THE SECTOR, AN ARROW APPEARS ON THE INSIDE OF THE COMPASS ROSE POINTING IN THE DIRECTION OF THE POINTER HEAD.

COURSE DEVIATION INDICATOR AND SCALE (WHITE)

INDICATES POSITION OF SELECTED TACAN, VOR OR ILS COURSE OR FMS DESIRED TRACK IN RELATION TO THE AIRCRAFT'S POSITION. AMOUNT OF DEVIATION IS INDICATED IN RELATION TO THE DOTS ON THE SCALE. FULL SCALE DEFLECTION (TWO DOTS) IS APPROXIMATELY 2° ANGULAR DEVIATION FROM THE ILS LOCALIZER AND 10° FROM THE SELECTED TACAN OR VOR COURSE. FULL SCALE DEFLECTION FROM THE FMS DESIRED TRACK IS 4.0 NM LINEAR DEVIATION IN THE ENROUTE AND OCEANIC FLIGHT MODES, 1.0 NM IN THE TERMINAL MODE, AND 0.3 NM IN THE APPROACH MODE.

WIND READOUT

INDICATES WIND DIRECTION AND VELOCITY.

HEADING BUG DIGITAL READOUT

READOUT IS REMOVED IF HEADING BUG IS NOT MOVED FOR 10 SECONDS. IF HEADING BUG IS OFF SCREEN, READOUT IS CONSTANTLY DISPLAYED.

TO/FROM INDICATOR (WHITE)

INDICATES WHETHER THE SELECTED COURSE, IF FLOWN, TAKES THE AIRCRAFT TOWARD OR AWAY FROM THE STATION/WAYPOINT. WHEN THE NAV SOURCE IS NOT FMS, THE INDICATOR IS SET TO "TO" WHEN THE ANGULAR DIFFERENCE BETWEEN THE RELATIVE BEARING TO THE STATION AND THE SELECTED COURSE IS LESS THAN 89°. WHEN THE ANGLE IS GREATER THAN 91°, "FROM" IS DISPLAYED. THE INDICATOR BLANKS BETWEEN 89° AND 91° OR WHEN LOC OR BC IS SELECTED. WHEN FMS IS THE NAV SOURCE, TO/FROM INDICATION IS DETERMINED BY THE FMS.

ALSO DOUBLES AS FMS WAYPOINT ANNUNCIATOR. BEGINS FLASHING A USER SELECTABLE 10-120 SECONDS (10 SECONDS IN TERMINAL AND APPROACH MODES) BEFORE THE SWITCH POINT FOR WAYPOINT CHANGE AND THEN RETURNS TO STEADY WHEN THE WAYPOINT CHANGE IS AUTOMATICALLY MADE. CONTINUES FLASHING IN MANUAL WAYPOINT SEQUENCING MODE (ENROUTE AND OCEANIC FLIGHT MODES) TO INDICATE A MANUAL WAYPOINT CHANGE IS REQUIRED.

NOTE: IN THE CASE OF WAYPOINT PASSED WHEN IN THE ENROUTE/OCEANIC FLIGHT MODES AND MANUAL WAYPOINT SEQUENCING, THE CDU "<<WPT PASSED>>" ANNUNCIATION IS DISPLAYED AND THE FMS MSG ANNUNCIATOR IS DISPLAYED.

FREE FORMAT LINE

LEFT SIDE DISPLAYS THE FMS SCALING MODE WHEN FMS IS THE SELECTED NAV SOURCE, RIGHT SIDE DISPLAYS GROUNDSPEED.

DIGITAL HEADING READOUT AND LUBBER LINE POINTER

INDICATES AIRCRAFT HEADING.

FMS TRACK ANGLE INDICATOR (CYAN)

DIAMOND SYMBOL INDICATES THE ACTUAL AIRCRAFT GROUND TRACK WHEN FMS IS THE SELECTED NAVIGATION SOURCE.

COURSE POINTER (WHITE)

INDICATES SELECTED COURSE FOR TACAN, VOR, OR ILS NAV SOURCES. INDICATES DESIRED TRACK TO THE ACTIVE WAYPOINT FOR THE FMS NAV SOURCE. IN FMS, THE COURSE ARROW IS POSITIONED AUTOMATICALLY THROUGH THE FMS (FGS NAV COURSE SELECTOR KNOB IS INACTIVE); MANUAL COURSE CHANGES MAY BE MADE THROUGH THE CDU. WHEN THE COURSE POINTER MOVES OUT OF THE SECTOR, THE POINTER AND CDI REDUCE IN SIZE SO THAT THE HEAD OR TAIL IS ALWAYS IN VIEW.

COURSE READOUT/LABEL

SELECTED COURSE (CRS) OR DESIRED TRACK (DTK)

GLIDESLOPE DEVIATION INDICATOR (MAGENTA TRIANGLE OUTLINED IN WHITE)

INDICATES GLIDESLOPE CENTER RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS 1/2° ABOVE/BELOW GLIDESLOPE (1/4° PER DOT). ONLY VISIBLE WITH LOC SELECTED AND GLIDESLOPE VALID.

VNAV DEVIATION INDICATOR (MAGENTA CROSS OUTLINED IN WHITE)

INDICATES FMS VERTICAL PATH RELATIVE TO THE POSITION OF THE AIRCRAFT. FULL SCALE DEFLECTION IS ± 1000 FEET IN OCEANIC, ENROUTE, AND TERMINAL MODES, AND ± 300 FEET IN APPROACH MODE. ONLY VISIBLE WHEN FMS IS SELECTED AND VERTICAL DEVIATION IS VALID.

NAVIGATION SOURCE

FMS LOC, BC, VOR, OR TCN. NO. 1 SYSTEMS MAY BE SELECTED ON THE PILOT'S EHSI; NO. 2 SYSTEMS MAY BE SELECTED ON THE COPILOT'S EHSI (NO CROSS-SIDE SELECTIONS AVAILABLE).

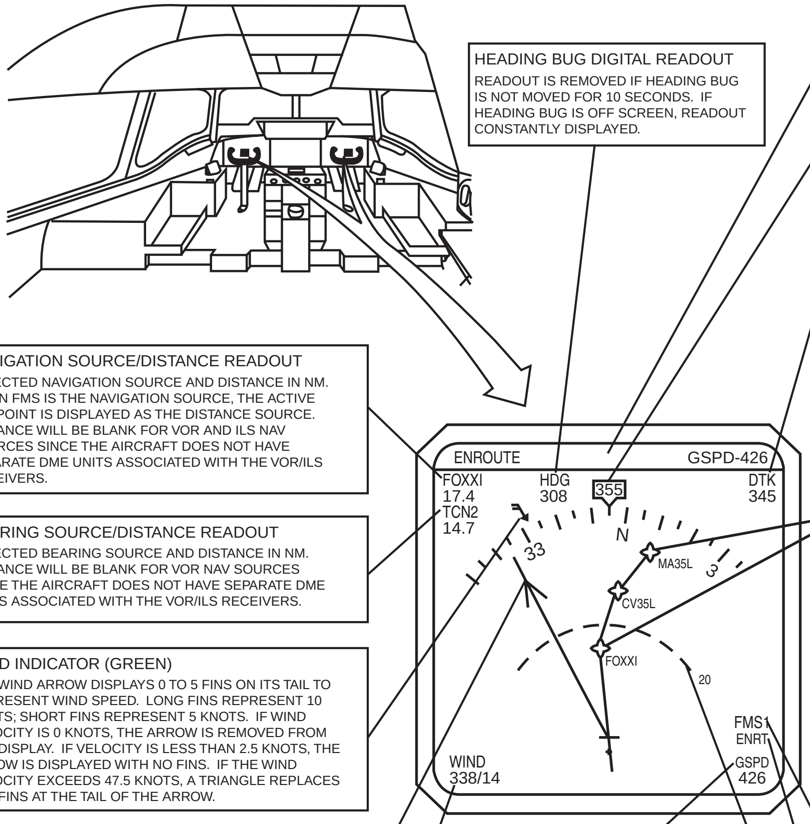
FMS SCALING MODE

WHEN FMS IS THE SELECTED NAV SOURCE, DISPLAYS APPROACH (APPR), TERMINAL (TERM), ENROUTE (ENRT) OR OCEANIC (OCNC). ENRT WILL BLANK AFTER 10 SECONDS. ALSO DISPLAYED SPELLED OUT ON THE LEFT SIDE OF THE FREE FORMAT LINE.

NAVIGATION DATA READOUT

DISPLAYS TIME-TO-GOT (TTG), GROUNDSPEED (GSPD), TRUE AIRSPEED (TAS), ELAPSED TIME (ET) OR BLANK, AS SELECTED ON THE EHSI CONTROL PANEL. GROUNDSPEED IS ALSO DISPLAYED ON THE RIGHT SIDE OF THE FREE FORMAT LINE.

Figure 1.14-7. Electronic Horizontal Situation Indicator (EHSI), 80° Sectored HSI Display Mode



HEADING BUG DIGITAL READOUT

READOUT IS REMOVED IF HEADING BUG IS NOT MOVED FOR 10 SECONDS. IF HEADING BUG IS OFF SCREEN, READOUT CONSTANTLY DISPLAYED.

NAVIGATION SOURCE/DISTANCE READOUT

SELECTED NAVIGATION SOURCE AND DISTANCE IN NM. WHEN FMS IS THE NAVIGATION SOURCE, THE ACTIVE WAYPOINT IS DISPLAYED AS THE DISTANCE SOURCE. DISTANCE WILL BE BLANK FOR VOR AND ILS NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

BEARING SOURCE/DISTANCE READOUT

SELECTED BEARING SOURCE AND DISTANCE IN NM. DISTANCE WILL BE BLANK FOR VOR NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

WIND INDICATOR (GREEN)

THE WIND ARROW DISPLAYS 0 TO 5 FINS ON ITS TAIL TO REPRESENT WIND SPEED. LONG FINS REPRESENT 10 KNOTS; SHORT FINS REPRESENT 5 KNOTS. IF WIND VELOCITY IS 0 KNOTS, THE ARROW IS REMOVED FROM THE DISPLAY. IF VELOCITY IS LESS THAN 2.5 KNOTS, THE ARROW IS DISPLAYED WITH NO FINS. IF THE WIND VELOCITY EXCEEDS 47.5 KNOTS, A TRIANGLE REPLACES THE FINS AT THE TAIL OF THE ARROW.

BEARING POINTER (CYAN)

INDICATES THE MAGNETIC OR TRUE BEARING. BASED ON THE POSITION OF THE FMS HEADING SWITCH, TO THE SELECTED BEARING SOURCE. WHEN THE BEARING POINTER IS OUT OF THE SECTOR, AN ARROW APPEARS ON THE INSIDE OF THE COMPASS ROSE POINTING IN THE DIRECTION OF THE POINTER HEAD.

WIND READOUT

INDICATES WIND DIRECTION AND VELOCITY.

NAVIGATION DATA READOUT

DISPLAYS TIME-TO-GO (TTG), GROUNDSPEED (GSPD), TRUE AIRSPEED (TAS), ELAPSED TIME (ET) OR BLANK, AS SELECTED ON THE EHSI CONTROL PANEL. GROUNDSPEED IS ALSO DISPLAYED ON THE RIGHT SIDE OF THE FREE FORMAT LINE.

FREE FORMAT LINE

LEFT SIDE DISPLAYS THE FMS SCALING MODE WHEN FMS IS THE SELECTED NAV SOURCE. RIGHT SIDE DISPLAYS GROUNDSPEED.

DIGITAL HEADING READOUT AND LUBBER LINE POINTER

INDICATES AIRCRAFT HEADING.

COURSE READOUT/LABEL

SELECTED COURSE (CRS) OR DESIRED TRACK (DTK).

FUTURE WAYPOINTS

WHEN FMS IS THE NAVIGATION SOURCE, UP TO NINE FUTURE WAYPOINTS ARE DISPLAYED IN THEIR PROPER RHO-THETA POSITION WITH RESPECT TO THE AIRCRAFT SYMBOL, DEPENDING ON THE RANGE SELECTED. THE ACTIVE WAYPOINT IS MAGENTA; REMAINING WAYPOINTS ARE WHITE. WAYPOINTS ARE CONNECTED BY SOLID MAGENTA COURSE LINES OR ARCS WHERE DME ARCS ARE PRESENT. DIFFERENT WAYPOINT SYMBOLS ARE USED TO REPRESENT DIFFERENT WAYPOINT TYPES AND ARE LABELED WITH THE FMS IDENTIFIER.

THE ACTIVE WAYPOINT SYMBOL FLASHES TO INDICATE THE AIRCRAFT IS APPROACHING THE WAYPOINT. WHEN THE WAYPOINT CHANGE IS MADE, THE FLASHING STOPS. HOWEVER, THE FLASHING WILL CONTINUE IN MANUAL WAYPOINT SEQUENCING MODE (ENROUTE AND OCEANIC FLIGHT MODES) IF THE MANUAL WAYPOINT CHANGE IS NOT MADE. ALSO, A DASHED OUTBOUND EXTENSION OF THE INBOUND COURSE WILL BE DISPLAYED AS A FURTHER REMINDER THAT A MANUAL WAYPOINT CHANGE IS REQUIRED.

NOTE: IN THE CASE OF WAYPOINT PASSED WHEN IN THE ENROUTE/OCEANIC FLIGHT MODES AND MANUAL WAYPOINT SEQUENCING, THE CDU "<< WPT PASSED >>" ANNUNCIATION IS DISPLAYED AND THE FMS MSG ANNUNCIATOR IS DISPLAYED.

WHEN TCN OR VOR IS THE NAVIGATION SOURCE, A SINGLE SOLID WHITE BEARING LINE IS DRAWN POINTING TO THE STATION. FOR TCN ONLY, IF THE STATION IS WITHIN THE RANGE SELECTED, A TACAN SYMBOL WILL BE DISPLAYED IN ITS PROPER RHO-THETA POSITION WITH RESPECT TO THE AIRCRAFT SYMBOL.

NAVIGATION SOURCE

FMS, LOC, BC, VOR, OR TCN. NO. 1 SYSTEMS MAY BE SELECTED ON THE PILOT'S EHSI; NO. 2 SYSTEMS MAY BE SELECTED ON THE COPILOT'S EHSI (NO CROSS-SIDE SELECTIONS AVAILABLE).

FMS SCALING MODE

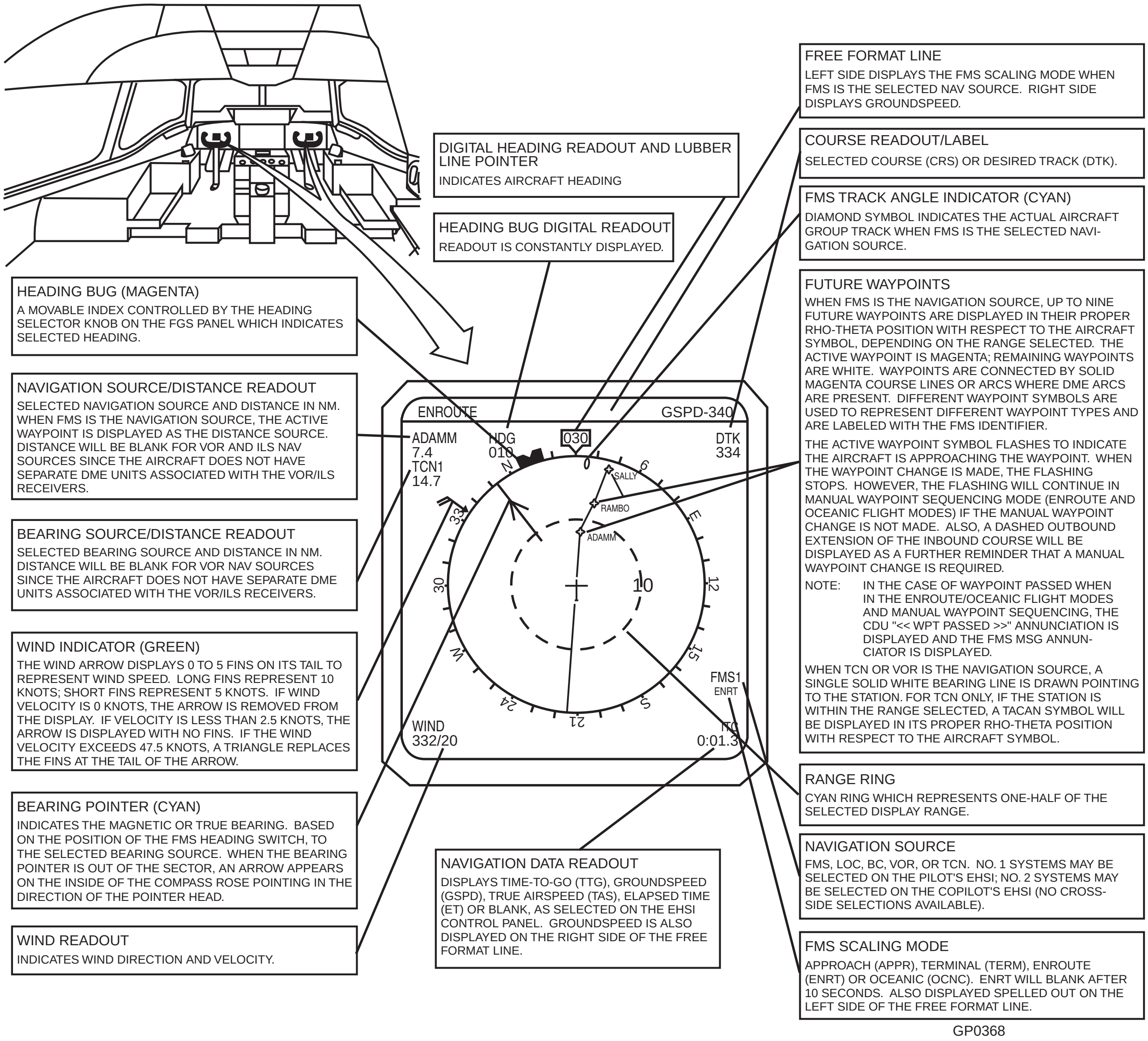
WHEN FMS IS THE SELECTED NAV SOURCE, DISPLAYS APPROACH (APPR), TERMINAL (TERM), ENROUTE (ENRT) OR OCEANIC (OCNC). ENRT WILL BLANK AFTER 10 SECONDS. ALSO DISPLAYED SPELLED OUT ON THE LEFT SIDE OF THE FREE FORMAT LINE.

RANGE ARC

CYAN ARC WHICH REPRESENTS ONE-HALF OF THE SELECTED DISPLAY RANGE.

GP0367

Figure 1.14-8. Electronic Horizontal Situation Indicator (EHSI), 80° Stored Map Display Mode



FREE FORMAT LINE

LEFT SIDE DISPLAYS THE FMS SCALING MODE WHEN FMS IS THE SELECTED NAV SOURCE. RIGHT SIDE DISPLAYS GROUNDSPEED.

DIGITAL HEADING READOUT AND LUBBER LINE POINTER

INDICATES AIRCRAFT HEADING

COURSE READOUT/LABEL

SELECTED COURSE (CRS) OR DESIRED TRACK (DTK).

FMS TRACK ANGLE INDICATOR (CYAN)

DIAMOND SYMBOL INDICATES THE ACTUAL AIRCRAFT GROUP TRACK WHEN FMS IS THE SELECTED NAVIGATION SOURCE.

HEADING BUG DIGITAL READOUT

READOUT IS CONSTANTLY DISPLAYED.

HEADING BUG (MAGENTA)

A MOVABLE INDEX CONTROLLED BY THE HEADING SELECTOR KNOB ON THE FGS PANEL WHICH INDICATES SELECTED HEADING.

FUTURE WAYPOINTS

WHEN FMS IS THE NAVIGATION SOURCE, UP TO NINE FUTURE WAYPOINTS ARE DISPLAYED IN THEIR PROPER RHO-THETA POSITION WITH RESPECT TO THE AIRCRAFT SYMBOL, DEPENDING ON THE RANGE SELECTED. THE ACTIVE WAYPOINT IS MAGENTA; REMAINING WAYPOINTS ARE WHITE. WAYPOINTS ARE CONNECTED BY SOLID MAGENTA COURSE LINES OR ARCS WHERE DME ARCS ARE PRESENT. DIFFERENT WAYPOINT SYMBOLS ARE USED TO REPRESENT DIFFERENT WAYPOINT TYPES AND ARE LABELED WITH THE FMS IDENTIFIER.

THE ACTIVE WAYPOINT SYMBOL FLASHES TO INDICATE THE AIRCRAFT IS APPROACHING THE WAYPOINT. WHEN THE WAYPOINT CHANGE IS MADE, THE FLASHING STOPS. HOWEVER, THE FLASHING WILL CONTINUE IN MANUAL WAYPOINT SEQUENCING MODE (ENROUTE AND OCEANIC FLIGHT MODES) IF THE MANUAL WAYPOINT CHANGE IS NOT MADE. ALSO, A DASHED OUTBOUND EXTENSION OF THE INBOUND COURSE WILL BE DISPLAYED AS A FURTHER REMINDER THAT A MANUAL WAYPOINT CHANGE IS REQUIRED.

NOTE: IN THE CASE OF WAYPOINT PASSED WHEN IN THE ENROUTE/OCEANIC FLIGHT MODES AND MANUAL WAYPOINT SEQUENCING, THE CDU "<< WPT PASSED >>" ANNUNCIATION IS DISPLAYED AND THE FMS MSG ANNUNCIATOR IS DISPLAYED.

WHEN TCN OR VOR IS THE NAVIGATION SOURCE, A SINGLE SOLID WHITE BEARING LINE IS DRAWN POINTING TO THE STATION. FOR TCN ONLY, IF THE STATION IS WITHIN THE RANGE SELECTED, A TACAN SYMBOL WILL BE DISPLAYED IN ITS PROPER RHO-THETA POSITION WITH RESPECT TO THE AIRCRAFT SYMBOL.

NAVIGATION SOURCE/DISTANCE READOUT

SELECTED NAVIGATION SOURCE AND DISTANCE IN NM. WHEN FMS IS THE NAVIGATION SOURCE, THE ACTIVE WAYPOINT IS DISPLAYED AS THE DISTANCE SOURCE. DISTANCE WILL BE BLANK FOR VOR AND ILS NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

BEARING SOURCE/DISTANCE READOUT

SELECTED BEARING SOURCE AND DISTANCE IN NM. DISTANCE WILL BE BLANK FOR VOR NAV SOURCES SINCE THE AIRCRAFT DOES NOT HAVE SEPARATE DME UNITS ASSOCIATED WITH THE VOR/ILS RECEIVERS.

WIND INDICATOR (GREEN)

THE WIND ARROW DISPLAYS 0 TO 5 FINS ON ITS TAIL TO REPRESENT WIND SPEED. LONG FINS REPRESENT 10 KNOTS; SHORT FINS REPRESENT 5 KNOTS. IF WIND VELOCITY IS 0 KNOTS, THE ARROW IS REMOVED FROM THE DISPLAY. IF VELOCITY IS LESS THAN 2.5 KNOTS, THE ARROW IS DISPLAYED WITH NO FINS. IF THE WIND VELOCITY EXCEEDS 47.5 KNOTS, A TRIANGLE REPLACES THE FINS AT THE TAIL OF THE ARROW.

RANGE RING

CYAN RING WHICH REPRESENTS ONE-HALF OF THE SELECTED DISPLAY RANGE.

BEARING POINTER (CYAN)

INDICATES THE MAGNETIC OR TRUE BEARING. BASED ON THE POSITION OF THE FMS HEADING SWITCH, TO THE SELECTED BEARING SOURCE. WHEN THE BEARING POINTER IS OUT OF THE SECTOR, AN ARROW APPEARS ON THE INSIDE OF THE COMPASS ROSE POINTING IN THE DIRECTION OF THE POINTER HEAD.

NAVIGATION DATA READOUT

DISPLAYS TIME-TO-GO (TTG), GROUNDSPEED (GSPD), TRUE AIRSPEED (TAS), ELAPSED TIME (ET) OR BLANK, AS SELECTED ON THE EHSI CONTROL PANEL. GROUNDSPEED IS ALSO DISPLAYED ON THE RIGHT SIDE OF THE FREE FORMAT LINE.

NAVIGATION SOURCE

FMS, LOC, BC, VOR, OR TCN. NO. 1 SYSTEMS MAY BE SELECTED ON THE PILOT'S EHSI; NO. 2 SYSTEMS MAY BE SELECTED ON THE COPILOT'S EHSI (NO CROSS-SIDE SELECTIONS AVAILABLE).

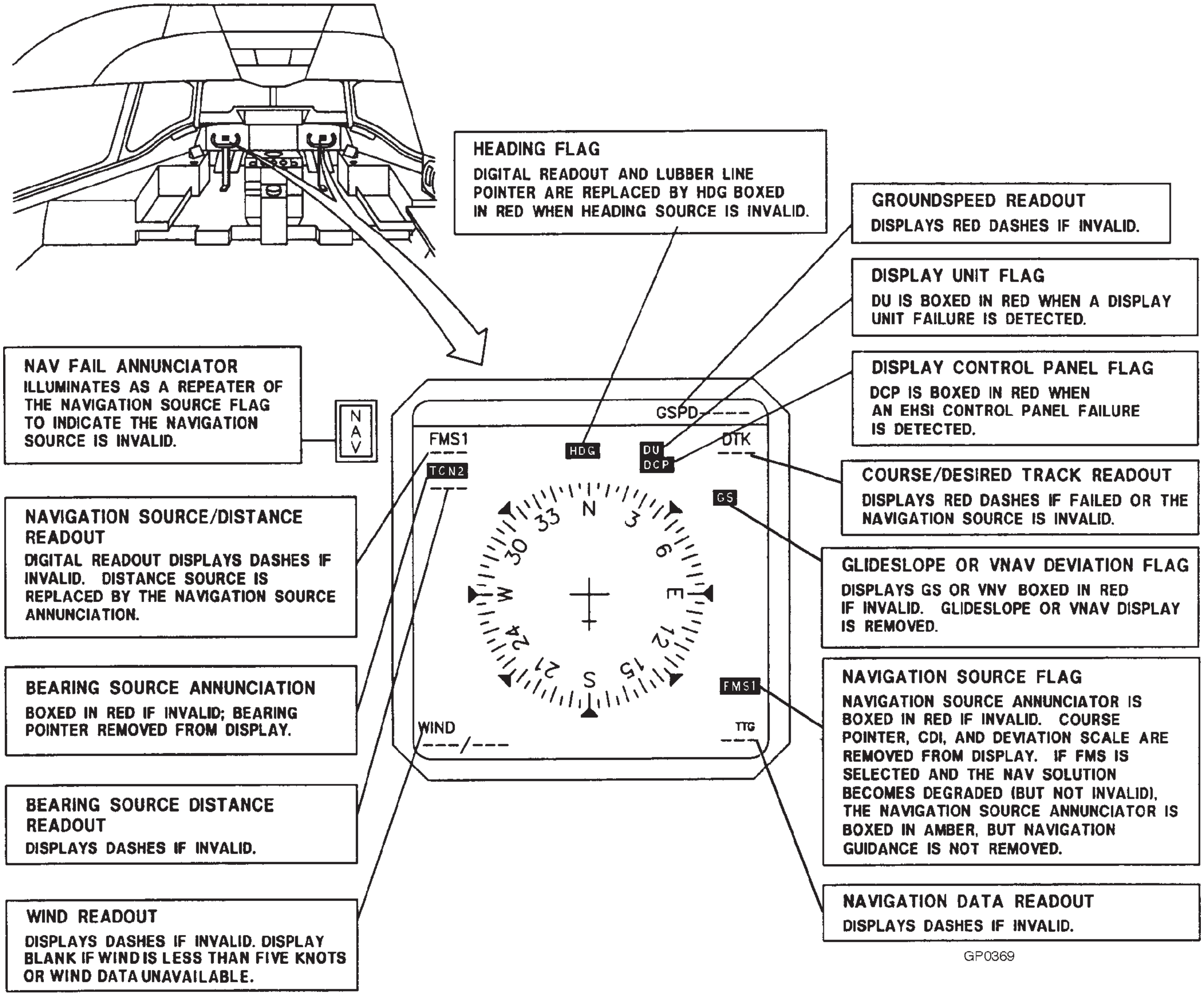
WIND READOUT

INDICATES WIND DIRECTION AND VELOCITY.

FMS SCALING MODE

APPROACH (APPR), TERMINAL (TERM), ENROUTE (ENRT) OR OCEANIC (OCNC). ENRT WILL BLANK AFTER 10 SECONDS. ALSO DISPLAYED SPELLED OUT ON THE LEFT SIDE OF THE FREE FORMAT LINE.

Figure 1.14-9. Electronic Horizontal Situation Indicator (EHSI), 360° Map Display Mode



HEADING FLAG
DIGITAL READOUT AND LUBBER LINE POINTER ARE REPLACED BY HDG BOXED IN RED WHEN HEADING SOURCE IS INVALID.

GROUNDSPEED READOUT
DISPLAYS RED DASHES IF INVALID.

DISPLAY UNIT FLAG
DU IS BOXED IN RED WHEN A DISPLAY UNIT FAILURE IS DETECTED.

DISPLAY CONTROL PANEL FLAG
DCP IS BOXED IN RED WHEN AN EHSI CONTROL PANEL FAILURE IS DETECTED.

NAV FAIL ANNUNCIATOR
ILLUMINATES AS A REPEATER OF THE NAVIGATION SOURCE FLAG TO INDICATE THE NAVIGATION SOURCE IS INVALID.

COURSE/DESIRED TRACK READOUT
DISPLAYS RED DASHES IF FAILED OR THE NAVIGATION SOURCE IS INVALID.

NAVIGATION SOURCE/DISTANCE READOUT
DIGITAL READOUT DISPLAYS DASHES IF INVALID. DISTANCE SOURCE IS REPLACED BY THE NAVIGATION SOURCE ANNUNCIATION.

GLIDESLOPE OR VNAV DEVIATION FLAG
DISPLAYS GS OR VNV BOXED IN RED IF INVALID. GLIDESLOPE OR VNAV DISPLAY IS REMOVED.

BEARING SOURCE ANNUNCIATION
BOXED IN RED IF INVALID; BEARING POINTER REMOVED FROM DISPLAY.

NAVIGATION SOURCE FLAG
NAVIGATION SOURCE ANNUNCIATOR IS BOXED IN RED IF INVALID. COURSE POINTER, CDI, AND DEVIATION SCALE ARE REMOVED FROM DISPLAY. IF FMS IS SELECTED AND THE NAV SOLUTION BECOMES DEGRADED (BUT NOT INVALID), THE NAVIGATION SOURCE ANNUNCIATOR IS BOXED IN AMBER, BUT NAVIGATION GUIDANCE IS NOT REMOVED.

BEARING SOURCE DISTANCE READOUT
DISPLAYS DASHES IF INVALID.

NAVIGATION DATA READOUT
DISPLAYS DASHES IF INVALID.

WIND READOUT
DISPLAYS DASHES IF INVALID. DISPLAY BLANK IF WIND IS LESS THAN FIVE KNOTS OR WIND DATA UNAVAILABLE.

Figure 1.14-10. Electronic Horizontal Situation Indicator Failure Indications

CURSOR CONTROL

THE CURSOR CONTROL MOVES A CROSSHAIR SYMBOL IN X-Y MOTION ON THE MAP AND MAP ARC DISPLAYS. THE BEARING/DISTANCE TO THE CURSOR IS DISPLAYED AT THE BOTTOM OF THE EHSI. A DASHED LINE CONNECTS THE AIRCRAFT SYMBOL AND CURSOR. THE CURSOR IS ACTIVE (IN VIEW) WHEN THE CURSOR CONTROL IS MOVED. AFTER 30 SECONDS OF NO MOVEMENT, THE CURSOR FUNCTION IS REMOVED FROM THE DISPLAY AND THE BEARING/DISTANCE IS RESET TO ZERO.

DU TEST BUTTON

A MOMENTARY PRESS OF THE DU TEST BUTTON ACCESSES THE DU STATUS PAGE (WEIGHT-ON-WHEELS ONLY). PRESSING AND HOLDING THE TEST BUTTON FOR TWO SECONDS DISPLAYS THE "PRESS TEST TO CONTINUE IBIT" MESSAGE. PRESSING AND HOLDING THE TEST BUTTON FOR TWO SECONDS INITIATES BIT. IF THE SECOND PRESS IS NOT MADE WITHIN FIVE SECONDS, THE COMMAND IS CANCELED AND THE CONFIRM MESSAGE IS REMOVED FROM THE DISPLAY. IBIT REQUIRES APPROXIMATELY ONE SECOND AND THE DISPLAY RETURNS TO THE DU STATUS PAGE UPON COMPLETION. PRESS THE PUSH-DIRECT BUTTON TO RETURN TO THE NORMAL DISPLAY.

BRIGHTNESS CONTROL

OUTER KNOB – INACTIVE (RESERVED FOR FUTURE SYSTEM GROWTH).

INNER KNOB – CONTROLS BRIGHTNESS OF THE EHSI DISPLAY UNIT.

CURSOR RESET BUTTON

RESETS THE CURSOR LOCATION BACK TO THE AIRCRAFT SYMBOL AND ZEROES THE BEARING/DISTANCE.

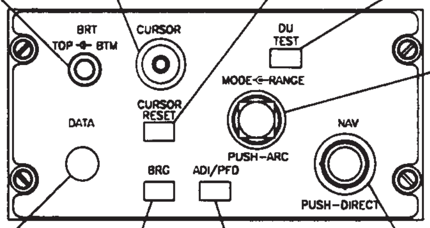
MODE CONTROLS

THE MODE SELECT KNOB IS A DUAL CONCENTRIC KNOB (MODE SELECT AND RANGE) WITH A CENTER PUSHBUTTON (ARC SELECTION).

MODE SELECTOR – THE OUTER KNOB IS A BLIND ROTARY SWITCH WHICH MAY BE TURNED IN EITHER DIRECTION AND SELECTS EITHER HSI OR MAP DISPLAY MODES.

RANGE SELECTOR – THE INNER KNOB SELECTS THE RANGE FOR DISPLAYS WHERE RANGE IS APPLICABLE. AVAILABLE FULL-SCALE RANGES ARE 2.5, 5, 10, 20, 40, 80, 160, 320, AND 640 NM. RANGE DEFAULTS TO LAST SELECTED VALUE ON POWER-UP.

ARC PUSHBUTTON – THE CENTER PUSHBUTTON SELECTS THE ARC MODE ON EITHER THE HSI OR MAP DISPLAYS.



DATA SELECTOR

BLIND SELECTOR SWITCH THAT MAY BE TURNED IN EITHER DIRECTION TO SELECT ON-SIDE FMS NAVIGATION DATA. POSSIBLE SELECTIONS INCLUDE OFF (NO NAVIGATION DATA DISPLAYED), GSPD (GROUNDSPEED), TAS (TRUE AIRSPEED), TTG (TIME-TO-GO TO NEXT WAYPOINT WHEN FMS IS THE SELECTED NAV SOURCE), ET (ELAPSED TIME FROM WEIGHT-OFF-WHEELS).

ADI/PFD BUTTON

INACTIVE (RESERVED FOR FUTURE SYSTEM GROWTH).

NAVIGATION SOURCE CONTROLS

NAV SOURCE SELECTOR – BLIND SELECTOR SWITCH THAT MAY BE TURNED IN EITHER DIRECTION TO SELECT THE PRIMARY NAVIGATION (COURSE) SOURCE. POSSIBLE SELECTIONS ARE FMS, VOR, AND TCN. THE VOR SELECTION WILL DISPLAY LOC IF THE VHF NAV RECEIVER IS TUNED TO A VALID LOCALIZER FREQUENCY. BC WILL BE DISPLAYED IF TUNED TO A VALID LOCALIZER FREQUENCY AND BACK CRS IS SELECTED ON THE FGS CONTROL PANEL. THE NUMBER SUFFIX AFTER THE NAV SOURCE REFERS TO THE PILOT'S (#1) OR COPILOT'S (#2) NAVIGATION SYSTEM. THE PILOT'S CONTROL SEQUENCES THROUGH THE #1 NAV SYSTEM SELECTIONS (FMS1, VOR1, TCN1) AND THE COPILOT'S CONTROL PANEL SEQUENCES THROUGH THE #2 NAV SYSTEM SELECTIONS (FMS2, VOR2, TCN2).

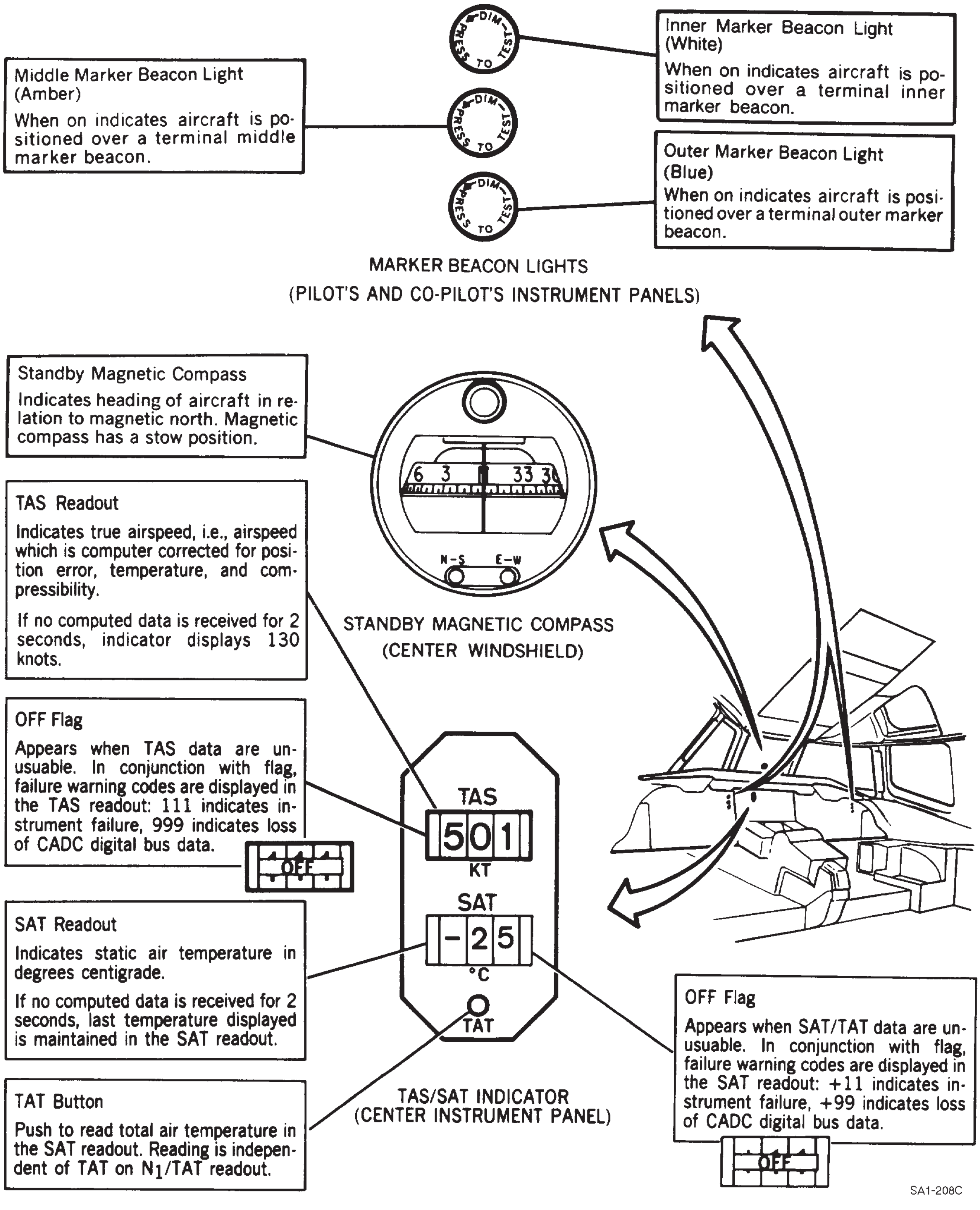
COURSE SYNC (DIRECT-TO) – THE CENTER PUSHBUTTON PROVIDES A COURSE SYNC FUNCTION. PRESSING THE BUTTON WHILE FMS IS THE NAVIGATION SOURCE PLACES THE FMS INTO A DIRECT-TO NAVIGATION MODE TO THE ACTIVE WAYPOINT.

BEARING SELECT BUTTON

SELECTS THE NAVIGATION SOURCE TO BE DISPLAYED ON THE EHSI BEARING POINTER. POSSIBLE BEARING SOURCE SELECTIONS ARE OFF, FMS1, FMS2, VOR1, VOR2, TCN1, TCN2, ADF1, AND ADF2.

GP0279

Figure 1.14-11. Electronic Horizontal Situation Indicator Control Panel



Middle Marker Beacon Light (Amber)

When on indicates aircraft is positioned over a terminal middle marker beacon.

Inner Marker Beacon Light (White)

When on indicates aircraft is positioned over a terminal inner marker beacon.

Outer Marker Beacon Light (Blue)

When on indicates aircraft is positioned over a terminal outer marker beacon.

MARKER BEACON LIGHTS
(PILOT'S AND CO-PILOT'S INSTRUMENT PANELS)

Standby Magnetic Compass

Indicates heading of aircraft in relation to magnetic north. Magnetic compass has a stow position.

STANDBY MAGNETIC COMPASS
(CENTER WINDSHIELD)

TAS Readout

Indicates true airspeed, i.e., airspeed which is computer corrected for position error, temperature, and compressibility.

If no computed data is received for 2 seconds, indicator displays 130 knots.

OFF Flag

Appears when TAS data are unusable. In conjunction with flag, failure warning codes are displayed in the TAS readout: 111 indicates instrument failure, 999 indicates loss of CADC digital bus data.

SAT Readout

Indicates static air temperature in degrees centigrade.

If no computed data is received for 2 seconds, last temperature displayed is maintained in the SAT readout.

TAT Button

Push to read total air temperature in the SAT readout. Reading is independent of TAT on N_1/TAT readout.

TAS/SAT INDICATOR
(CENTER INSTRUMENT PANEL)

OFF Flag

Appears when SAT/TAT data are unusable. In conjunction with flag, failure warning codes are displayed in the SAT readout: +11 indicates instrument failure, +99 indicates loss of CADC digital bus data.

Figure 1.14-12. TAS/SAT Indicator, Standby Magnetic Compass, and Marker Beacon Lights

TAS/SAT INDICATOR

True airspeed, derived from pitot system input and computer corrections for temperature, compressibility, pressure altitude, and position error, is displayed, together with static air temperature, on the TAS/SAT indicator (figure 1.14-12). Total air temperature may be read by pushing the TAT button on the TAS/SAT indicator and reading same in the SAT readout.

WEATHER RADAR SYSTEM

The weather radar (figures 1.14-13 and 1.14-14) system displays weather and ground targets with selective ranges of 5, 25, 50, 150, and 300 nautical miles. The antenna is stabilized in pitch and roll by the INS platform. Azimuth lines supply target relative bearing reference and range marks aid in distance determination. Weather and map displays are in color. Beacon mode is incorporated to provide primary rendezvous capability.

FLIGHT MANAGEMENT SYSTEM

An integrated flight management system (FMS) is installed on the aircraft to provide a multi-sensor navigation capability utilizing INU and global positioning system (GPS) sensors. In addition, the FMS provides functional control of the TACAN and ADF systems and the INUs, eliminating the need for dedicated control heads. The FMS consists of three control display units (CDUs), two bus subsystem interface units (BSIUs) which provide the interface to controlled avionics and the flight instruments/flight guidance system, and one data loader, all tied together by a MIL-STD-1553B data bus.

The FMS supplies continuous navigation data such as present position, groundspeed, desired track, distance and time to waypoint, wind speed and direction, and other pertinent information for the pilots' reference. Holding patterns, mission flight patterns including air refueling orbit/rendezvous, and nonprecision approach capability are provided in the computer program. The FMS can display horizontal and vertical navigation information on the flight instruments. Horizontal navigation information can be coupled to the flight guidance system for automatic flight.

GLOBAL POSITIONING SYSTEM

The global positioning system provides highly accurate three dimensional position, velocity, and time information to the FMS. Three GPS receivers are installed on the aircraft as modules embedded in the FMS CDUs. Only two of the receivers (CDUs 1 and 2) are connected to antennas and therefore operational. Of those two, only one may be selected as active and used as a sensor in the FMS navigation solution at any given time, although the other receiver is always operating and may be selected as the active receiver at any time. Power and functional control are provided through the FMS CDUs.

INERTIAL NAVIGATION UNIT

Three inertial navigation units (INUs) are installed on the aircraft and are controlled through three mode selector unit panels (figure 1.14-15) on the overhead panel and the three FMS CDUs. Each INU is self-contained in that it provides navigation positioning capability that is independent of external navigation aids. However, inertial platforms are subject to horizontal drift over time which degrades their accuracy. If the drift error becomes too large, the individual INU may be manually updated in-flight through the FMS CDUs.

The INUs function as navigation sensors by supplying position and velocity information to the FMS for use in its navigation solutions. The INUs also provide attitude reference signals for the ADIs, autothrottle system, and weather radar system, and azimuth stabilization signals for the compass system. INS selector and CADC selector switches (figure 1.14-16) are located on the overhead panel.

A backup battery unit provides auxiliary power for the automatic battery check during ALIGN mode and for supplying essential power to maintain INU operation during AC power interruptions. A fully charged battery unit will sustain operation of the INU for approximately 15 minutes.

CAUTION

> Operating the INU on the ground with AC power removed causes depletion of the backup battery unit and system overheat due to no air flow. An aural warning horn, located in the right air conditioning compartment, sounds if the INU is operating with the aircraft on the ground and AC power removed.

TACAN SYSTEM

Two TACAN systems, TACAN-1 and TACAN-2, furnish air-to-ground and air-to-air bearing and distance information full-time to their respective RMIs and dual DME indicators. Bearing, distance, and course data are also available for display on the respective EHSI. Magnetic bearing and slant-range distance are displayed. TACAN-2 also functions as an airborne TACAN station. Both systems can be used in rendezvous and aerial refueling operations. Control of the TACAN systems is provided through the FMS CDUs.

MAGNETIC HEADING REFERENCE SYSTEM (MHRS)

The Magnetic Heading Reference System (MHRS) provides a stabilized magnetic heading reference to the EHSI, RMI, and Flight Guidance Control Panel. The MHRS can be operated in DG or slaved mode by using the DG-SLAVED switch on the Compass Controller Panel (refer to Part 6). DG mode is used in areas with poor magnetic characteristics.

AUTOMATIC DIRECTION FINDING SYSTEM

Two independent direction finding systems furnish bearing information to their respective VOR/ADF RMIs. Relative bearing is displayed full-time on the respective VOR/ADF pointer when ADF position is selected. ADF bearing information may also be displayed on the respective EHSI. ADF-1 is used with the UHF radio for UHF direction finding. Control of the ADF systems is provided through the FMS CDUs.

ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (ETCAS)

The Enhanced Traffic Alert and Collision Avoidance System (ETCAS) is a standard TCAS II system with the enhanced capability of providing a station keeping display that may be used in formation flying. TCAS is used to detect and track other transponder-equipped airplanes in the vicinity to determine possible collision hazard. The enhanced portion of the system allows the crew to designate formation members so they may be readily identified. ETCAS visual information is displayed on a combined TCAS/Vertical Speed Indicator (TVSI). Aural alerts are broadcast through a combined EGPWS/ETCAS speaker. Control of the ETCAS is through a combined IFF/TCAS control panel located on the aft pedestal.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Pilot's, Copilot's, and Center Instrument Panels, Glareshield, Pedestal, Overhead Panel, and Flight Engineer's instrument Panels. Illustrations of these major panels are in Part 1. Individual controls and indicators are illustrated and described in this part (figure 1.14-18).

FLIGHT MANAGEMENT SYSTEM DESCRIPTION

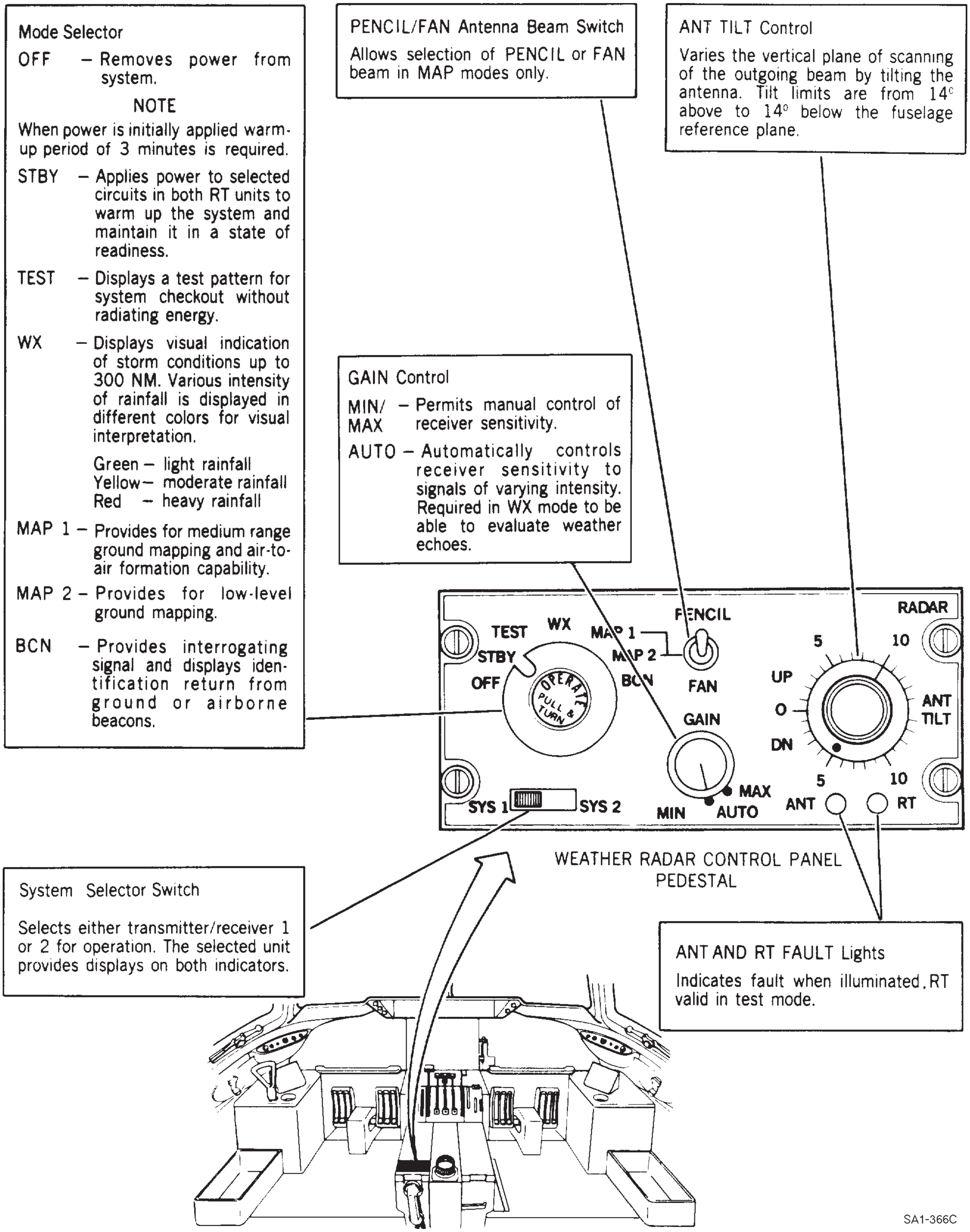
The FMS provides global navigation using pilot selectable INU, GPS, or integrated INU/GPS sensors. This FMS guidance may be used to fly published airways, direct routing, TACAN emulation procedures, and published or tactical nonprecision GPS approaches, as well as various mission flight patterns. The FMS permits preflight loading of up to 40 complete mission flight plans using a Personal Computer Memory Card International Association (PCMCIA) card (hereafter referred to as the data cartridge). It also permits the crew to generate or modify mission plans on the aircraft, using a global ICAO database of up to 120,000 waypoints and automatic flight plan calculations. In addition to its autonomous navigation guidance and flight planning capabilities, the FMS provides functional control of the INUs and the TACAN and ADF navigation radios.

SYSTEM ARCHITECTURE

FMS Equipment

A simplified block diagram of the FMS and interfaced units is shown in figure 1.14-19. Each control display unit (CDU) provides access to all system functions, except INU control (each INU is locally controlled by its respective CDU). All information is shared in common. The GPS receivers are contained on modules embedded within each CDU (only 1 and 2 are connected to an antenna and functional). There are three CDUs installed on the KC-10.

The data loader cartridge is used to load mission data into the CDUs and to act as an inflight library of ICAO waypoints. Up to 200 additional waypoints can be stored in a user-defined waypoint database and transferred to the CDUs for inflight use. The cartridge stores and loads the current worldwide magnetic variation tables automatically upon power-up and can be used to store/load GPS almanac data to



Mode Selector

OFF – Removes power from system.

NOTE

When power is initially applied warm-up period of 3 minutes is required.

STBY – Applies power to selected circuits in both RT units to warm up the system and maintain it in a state of readiness.

TEST – Displays a test pattern for system checkout without radiating energy.

WX – Displays visual indication of storm conditions up to 300 NM. Various intensity of rainfall is displayed in different colors for visual interpretation.

Green – light rainfall
Yellow – moderate rainfall
Red – heavy rainfall

MAP 1 – Provides for medium range ground mapping and air-to-air formation capability.

MAP 2 – Provides for low-level ground mapping.

BCN – Provides interrogating signal and displays identification return from ground or airborne beacons.

PENCIL/FAN Antenna Beam Switch

Allows selection of PENCIL or FAN beam in MAP modes only.

ANT TILT Control

Varies the vertical plane of scanning of the outgoing beam by tilting the antenna. Tilt limits are from 14° above to 14° below the fuselage reference plane.

GAIN Control

MIN/MAX – Permits manual control of receiver sensitivity.

AUTO – Automatically controls receiver sensitivity to signals of varying intensity. Required in WX mode to be able to evaluate weather echoes.

WEATHER RADAR CONTROL PANEL
PEDESTAL

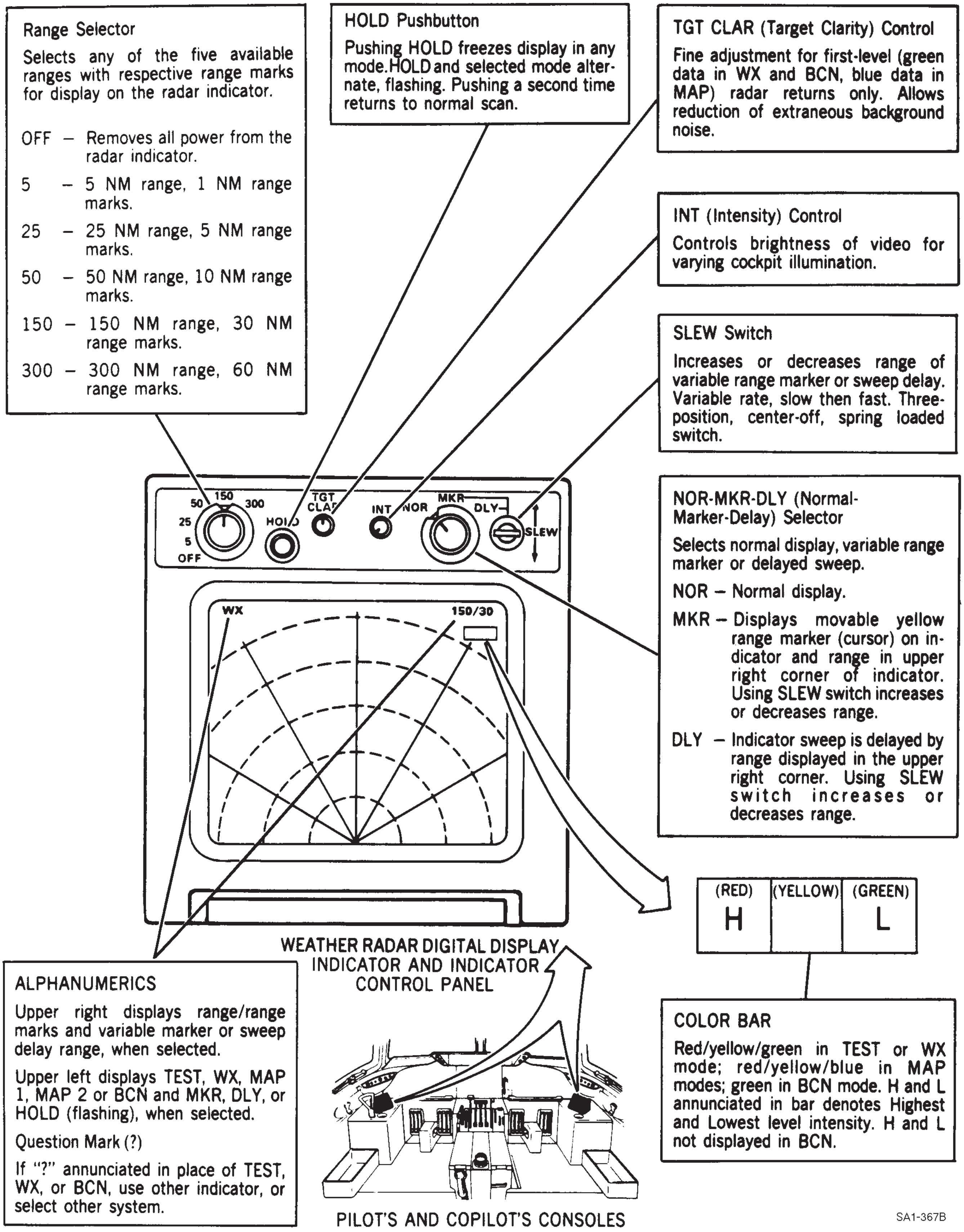
System Selector Switch

Selects either transmitter/receiver 1 or 2 for operation. The selected unit provides displays on both indicators.

ANT AND RT FAULT Lights

Indicates fault when illuminated. RT valid in test mode.

Figure 1.14-13. Weather Radar Control Panel



Range Selector

Selects any of the five available ranges with respective range marks for display on the radar indicator.

OFF – Removes all power from the radar indicator.
5 – 5 NM range, 1 NM range marks.
25 – 25 NM range, 5 NM range marks.
50 – 50 NM range, 10 NM range marks.
150 – 150 NM range, 30 NM range marks.
300 – 300 NM range, 60 NM range marks.

HOLD Pushbutton

Pushing HOLD freezes display in any mode. HOLD and selected mode alternate, flashing. Pushing a second time returns to normal scan.

TGT CLAR (Target Clarity) Control

Fine adjustment for first-level (green data in WX and BCN, blue data in MAP) radar returns only. Allows reduction of extraneous background noise.

INT (Intensity) Control

Controls brightness of video for varying cockpit illumination.

SLEW Switch

Increases or decreases range of variable range marker or sweep delay. Variable rate, slow then fast. Three-position, center-off, spring loaded switch.

NOR-MKR-DLY (Normal-Marker-Delay) Selector

Selects normal display, variable range marker or delayed sweep.

NOR – Normal display.
MKR – Displays movable yellow range marker (cursor) on indicator and range in upper right corner of indicator. Using SLEW switch increases or decreases range.
DLY – Indicator sweep is delayed by range displayed in the upper right corner. Using SLEW switch increases or decreases range.

ALPHANUMERICS

Upper right displays range/range marks and variable marker or sweep delay range, when selected.

Upper left displays TEST, WX, MAP 1, MAP 2 or BCN and MKR, DLY, or HOLD (flashing), when selected.

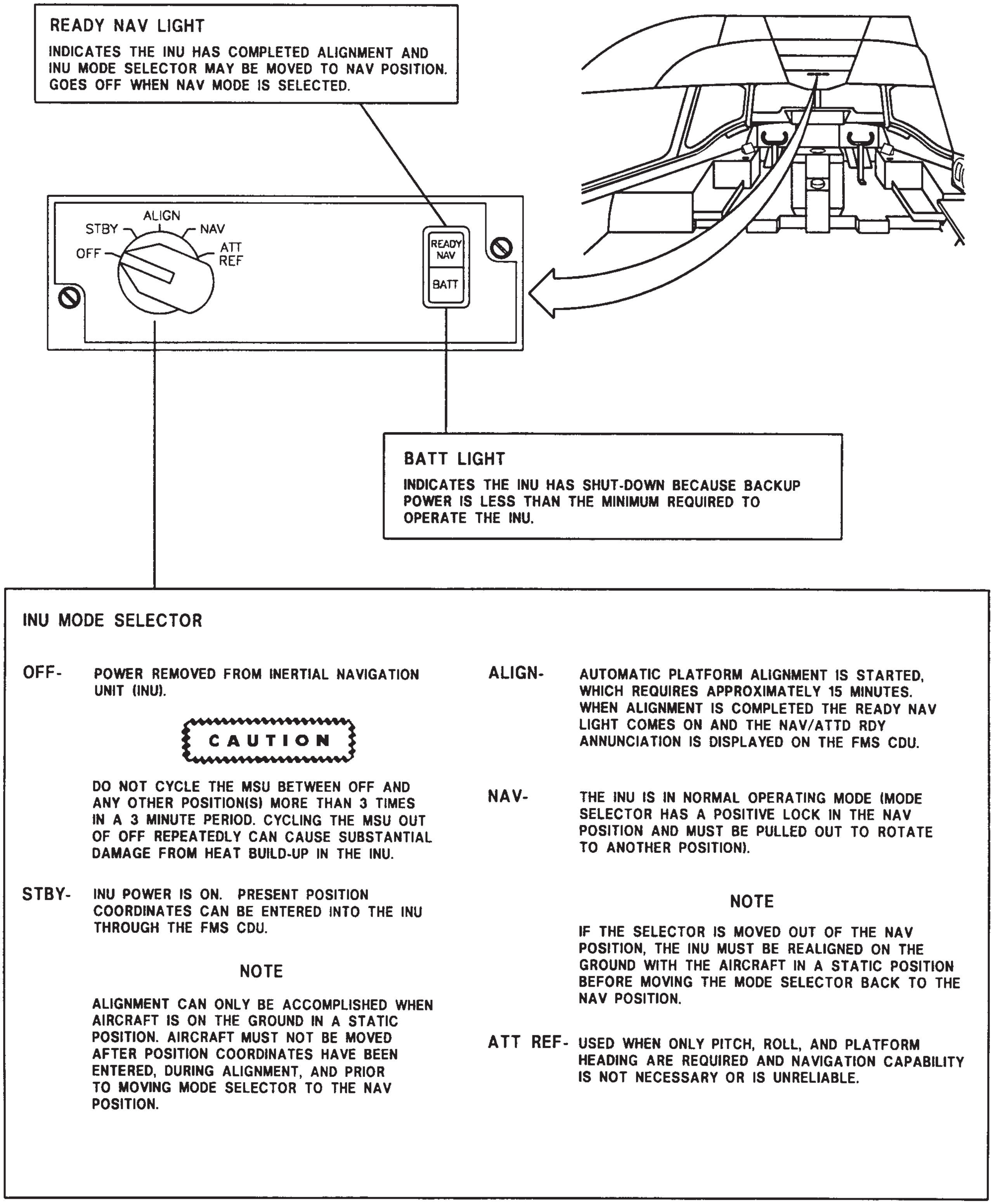
Question Mark (?)

If "?" annunciated in place of TEST, WX, or BCN, use other indicator, or select other system.

COLOR BAR

Red/yellow/green in TEST or WX mode; red/yellow/blue in MAP modes; green in BCN mode. H and L annunciated in bar denotes Highest and Lowest level intensity. H and L not displayed in BCN.

Figure 1.14-14. Weather Radar Digital Display Indicator and Indicator Control Panel



READY NAV LIGHT

INDICATES THE INU HAS COMPLETED ALIGNMENT AND INU MODE SELECTOR MAY BE MOVED TO NAV POSITION. GOES OFF WHEN NAV MODE IS SELECTED.

BATT LIGHT

INDICATES THE INU HAS SHUT-DOWN BECAUSE BACKUP POWER IS LESS THAN THE MINIMUM REQUIRED TO OPERATE THE INU.

INU MODE SELECTOR

OFF- POWER REMOVED FROM INERTIAL NAVIGATION UNIT (INU).

CAUTION

DO NOT CYCLE THE MSU BETWEEN OFF AND ANY OTHER POSITION(S) MORE THAN 3 TIMES IN A 3 MINUTE PERIOD. CYCLING THE MSU OUT OF OFF REPEATEDLY CAN CAUSE SUBSTANTIAL DAMAGE FROM HEAT BUILD-UP IN THE INU.

STBY- INU POWER IS ON. PRESENT POSITION COORDINATES CAN BE ENTERED INTO THE INU THROUGH THE FMS CDU.

NOTE

ALIGNMENT CAN ONLY BE ACCOMPLISHED WHEN AIRCRAFT IS ON THE GROUND IN A STATIC POSITION. AIRCRAFT MUST NOT BE MOVED AFTER POSITION COORDINATES HAVE BEEN ENTERED, DURING ALIGNMENT, AND PRIOR TO MOVING MODE SELECTOR TO THE NAV POSITION.

ALIGN- AUTOMATIC PLATFORM ALIGNMENT IS STARTED, WHICH REQUIRES APPROXIMATELY 15 MINUTES. WHEN ALIGNMENT IS COMPLETED THE READY NAV LIGHT COMES ON AND THE NAV/ATTD RDY ANNUNCIATION IS DISPLAYED ON THE FMS CDU.

NAV- THE INU IS IN NORMAL OPERATING MODE (MODE SELECTOR HAS A POSITIVE LOCK IN THE NAV POSITION AND MUST BE PULLED OUT TO ROTATE TO ANOTHER POSITION).

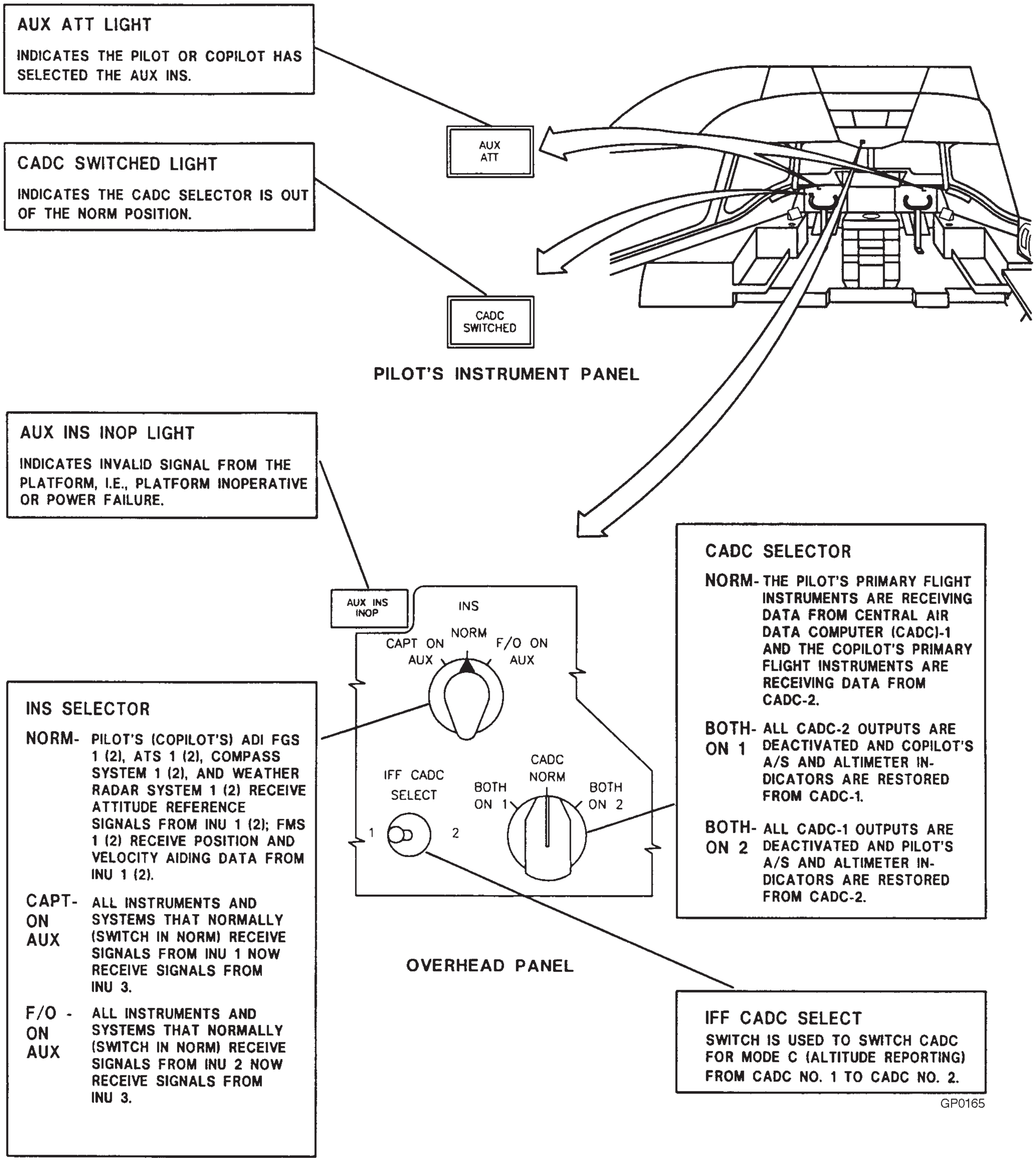
NOTE

IF THE SELECTOR IS MOVED OUT OF THE NAV POSITION, THE INU MUST BE REALIGNED ON THE GROUND WITH THE AIRCRAFT IN A STATIC POSITION BEFORE MOVING THE MODE SELECTOR BACK TO THE NAV POSITION.

ATT REF- USED WHEN ONLY PITCH, ROLL, AND PLATFORM HEADING ARE REQUIRED AND NAVIGATION CAPABILITY IS NOT NECESSARY OR IS UNRELIABLE.

INU MODE SELECTOR UNIT PANEL (3)
OVERHEAD PANEL

Figure 1.14-15. INS Mode Selector Unit Panel



AUX ATT LIGHT

INDICATES THE PILOT OR COPILOT HAS SELECTED THE AUX INS.

CADC SWITCHED LIGHT

INDICATES THE CADC SELECTOR IS OUT OF THE NORM POSITION.

AUX INS INOP LIGHT

INDICATES INVALID SIGNAL FROM THE PLATFORM, I.E., PLATFORM INOPERATIVE OR POWER FAILURE.

INS SELECTOR

NORM-	PILOT'S (COPILOT'S) ADI FGS 1 (2), ATS 1 (2), COMPASS SYSTEM 1 (2), AND WEATHER RADAR SYSTEM 1 (2) RECEIVE ATTITUDE REFERENCE SIGNALS FROM INU 1 (2); FMS 1 (2) RECEIVE POSITION AND VELOCITY AIDING DATA FROM INU 1 (2).
CAPT-ON AUX	ALL INSTRUMENTS AND SYSTEMS THAT NORMALLY (SWITCH IN NORM) RECEIVE SIGNALS FROM INU 1 NOW RECEIVE SIGNALS FROM INU 3.
F/O - ON AUX	ALL INSTRUMENTS AND SYSTEMS THAT NORMALLY (SWITCH IN NORM) RECEIVE SIGNALS FROM INU 2 NOW RECEIVE SIGNALS FROM INU 3.

CADC SELECTOR

NORM-	THE PILOT'S PRIMARY FLIGHT INSTRUMENTS ARE RECEIVING DATA FROM CENTRAL AIR DATA COMPUTER (CADC)-1 AND THE COPILOT'S PRIMARY FLIGHT INSTRUMENTS ARE RECEIVING DATA FROM CADC-2.
BOTH-ON 1	ALL CADC-2 OUTPUTS ARE DEACTIVATED AND COPILOT'S A/S AND ALTIMETER INDICATORS ARE RESTORED FROM CADC-1.
BOTH-ON 2	ALL CADC-1 OUTPUTS ARE DEACTIVATED AND PILOT'S A/S AND ALTIMETER INDICATORS ARE RESTORED FROM CADC-2.

IFF CADC SELECT

SWITCH IS USED TO SWITCH CADC FOR MODE C (ALTITUDE REPORTING) FROM CADC NO. 1 TO CADC NO. 2.

Figure 1.14-16. CADC Switch and CADC Switched Light, INS Switch, AUX INS INOP Light, and Aux ATT Light

VOR TEST BUTTON (2)

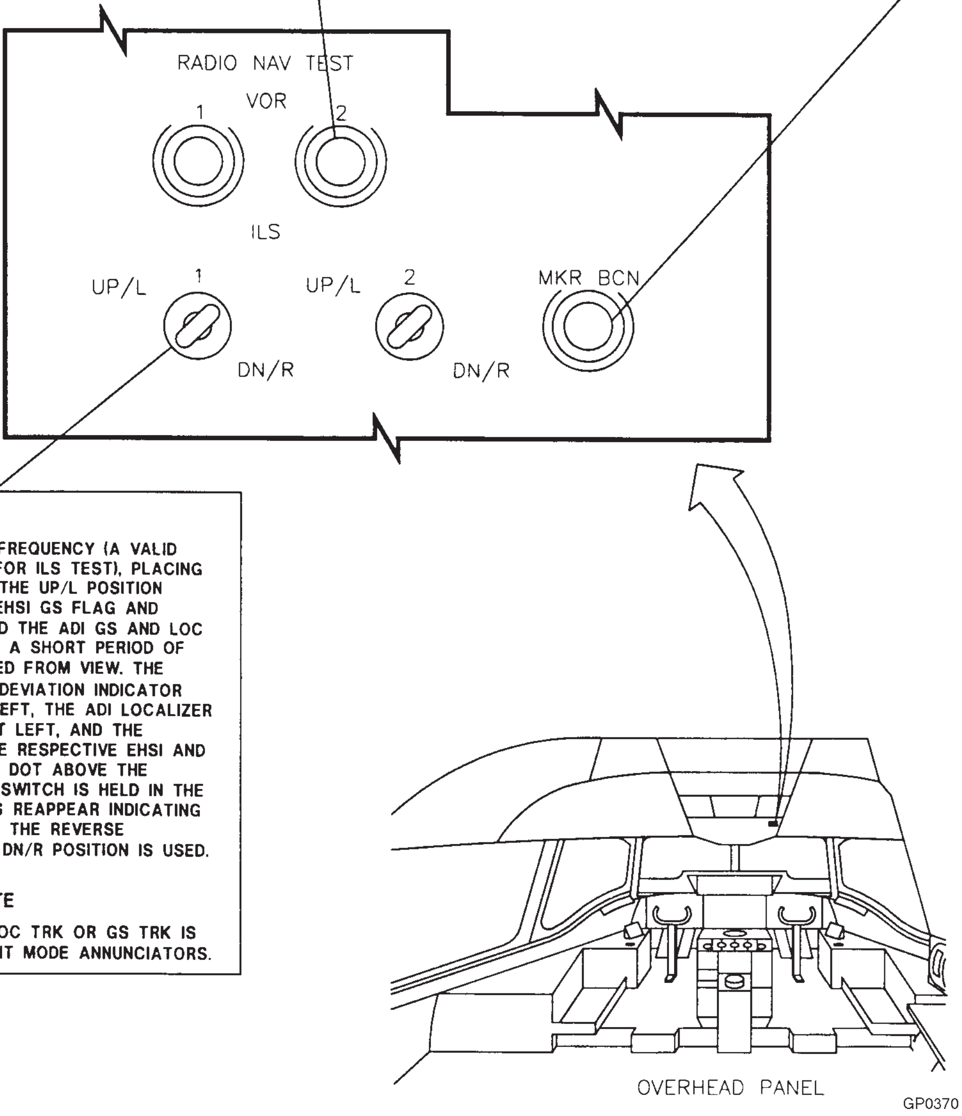
AFTER SELECTING A VOR STATION FREQUENCY (A VALID SIGNAL IS NOT REQUIRED FOR VOR TEST), AND ADJUSTING COURSE TO 180° ON THE FGS PANEL, AND SELECTING VOR AS THE NAVIGATION AND BEARING SOURCE ON THE EHSI, PUSHING THE VOR TEST BUTTON CAUSES THE RESPECTIVE VOR AND EHSI NAVIGATION FAIL FLAGS TO BE IN VIEW FOR A SHORT PERIOD OF TIME AND THEN BE REMOVED FROM VIEW. THE RESPECTIVE EHSI COURSE DEVIATION INDICATOR CENTERS, THE TO POINTERS APPEAR, AND THE RESPECTIVE VOR POINTERS ON EHSI AND RMI INDICATORS INDICATE 180° (±3°).

NOTE

VOR TEST IS INHIBITED IF LOC TRK OR GS TRK IS ANNUNCIATED IN THE FLIGHT MODE ANNUNCIATORS.

MKR BCN TEST BUTTON

PUSHING THE MARKER BEACON TEST BUTTON CAUSES THE AIRWAY, MIDDLE AND OUTER MARKER BEACON LIGHTS TO COME ON SEQUENTIALLY. WITH THE MKR SWITCH ON THE AUDIO PANEL SET FOR AUDIO RECEPTION, A TONE (RELATED TO EACH INDIVIDUAL LIGHT) IS HEARD.



ILS TEST SWITCH (2)

AFTER SELECTING AN ILS FREQUENCY (A VALID SIGNAL IS NOT REQUIRED FOR ILS TEST), PLACING THE ILS TEST SWITCH TO THE UP/L POSITION CAUSES THE RESPECTIVE EHSI GS FLAG AND NAVIGATION FAIL FLAG AND THE ADI GS AND LOC FLAGS TO BE IN VIEW FOR A SHORT PERIOD OF TIME AND THEN BE REMOVED FROM VIEW. THE RESPECTIVE EHSI COURSE DEVIATION INDICATOR MOVES ONE DOT TO THE LEFT, THE ADI LOCALIZER INDICATOR MOVES ONE DOT LEFT, AND THE GLIDSLOPE POINTER ON THE RESPECTIVE EHSI AND ADI INDICATOR MOVES ONE DOT ABOVE THE CENTERLINE. (IF THE TEST SWITCH IS HELD IN THE TEST POSITION, THE FLAGS REAPPEAR INDICATING THE TEST CYCLE IS OVER). THE REVERSE INDICATIONS OCCUR WHEN DN/R POSITION IS USED.

NOTE

ILS TEST IS INHIBITED IF LOC TRK OR GS TRK IS ANNUNCIATED IN THE FLIGHT MODE ANNUNCIATORS.

Figure 1.14-17. VOR, ILS and Marker Beacon Test

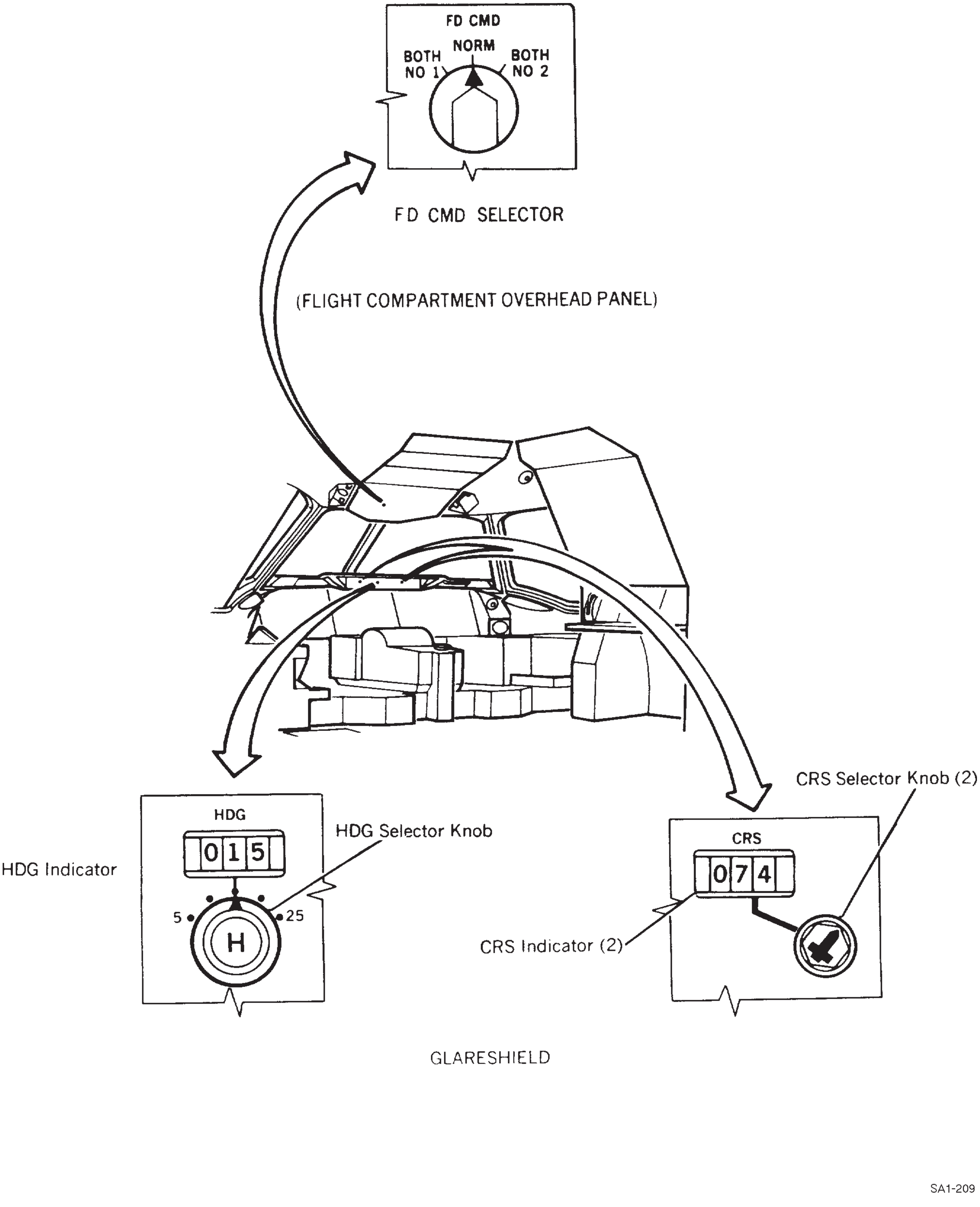


Figure 1.14-18. FD CMD Selector, CRS and HDG Indicators

reduce GPS cold start time following installation of a new GPS receiver module. The data cartridge plugs into either slot of the PCMCIA data loader mounted in the flight engineer's equipment panel. Two data cartridges may be installed simultaneously. The lower slot is the A slot; the upper slot is the B slot.

The two bus subsystem interface units (BSIUs) provide an interface between the FMS and other non-MIL-STD-1553B radios and aircraft systems. The BSIUs also perform the processing for the INU/GPS integrated navigation solution.

Two GPS key load panels are provided to load cryptographic keys into the GPS receivers. One is connected to CDU1 and the other to CDU2.

An FMS switching unit is provided to switch navigation and control signals between existing analog systems (i.e., flight director, autopilot, and compass) and the upgraded systems (FMS and EHSI1 and 2). The pilot's side of the switching unit provides switching to the No. 1 autopilot/flight director system for FMS and localizer backcourse navigation modes of operation. It also provides control switching for TACAN1 and ADF1, and INU1 warning and battery annunciation. The copilot's side provides identical switching to the No. 2 autopilot/flight director system and to TACAN2, ADF2, INU2, and INU3.

MIL-STD-1553B Data Bus Characteristics

The MIL-STD-1553B multiplexed serial digital data bus is the primary means of control and data transferral within the FMS. This bus has the following characteristics:

- Dual independent data paths (buses) between each remote terminal and the bus controller.
- Redundant bus controllers with each controller capable of full control of both data buses.
- Automatic initial selection of the active bus controller, and reversion to backup controller.
- No operator actions required for initialization or any other aspect of bus controller operation.
- A bus split switch allows the bus to be divided into two independent systems (Pilot and Copilot) in the event a component failure causes the bus to lock up.

Each CDU operates on the MIL-STD-1553B data bus as either a bus controller (BC) or a remote terminal/backup BC. Any single CDU has all the required resources to completely operate the system. The CDU that is functioning as BC performs all guidance computations, builds all page displays, communicates with all external equipment (except non-local INUs), and performs all other computations required to support FMS operation. The remote terminal CDUs process keystrokes and display pages built by the BC CDU and perform continuous built-in-test (CBIT) with the additional free processor time. The bus SPLIT switch is a guarded pushbutton switch (figure 1.14-20) located on the forward overhead panel. The switch has an integral amber annunciator that illuminates when the bus is split. When actuated, the bus is physically divided into two separate buses, Pilot's and Copilot's (figure 1.14-19). This places CDU1, BSIU1, the data loader, INU1, CADC1, TACAN1, ADF1, on the Pilot's system; CDU2, CDU3, BSIU2, INU2, INU3, CADC2, TACAN2, and ADF2 are on the Copilot's system. The bus split switch should only be used in the event of an FMS system-wide failure in an attempt to regain operation of one side of the system (see Section IIA, Flight Management System Malfunction/Failure).

CDU OPERATION

CDU data entry operations are performed with a full alphanumeric keypad, arrow keys, function keys and eight line select keys as shown in figure 1.14-21. The CDU display has eight lines of twenty-two characters each. Lines 1, 3, 5, and 7 are data lines with a line select key on both the right and left of the field. Line 2 is reserved for page title (always displayed in lower case) and line 6 is reserved as an annunciation line. Line 4 is reserved as an information line and line 8 is the scratchpad for holding all keypad entries. Each CDU provides simultaneous and independent operation. Symbolic aids are used to indicate what entries can be made, what functions are on or engaged, and what selections are possible. Figure 1.14-22 summarizes these symbols.

NOTE

FE must be aware of the possibility of inadvertently changing the weather radar tilt and pilots' audio volume controls while using CDU3.

Scratchpad

The scratchpad is a buffer to hold all data for review prior to executing the input. Incorrect scratchpad entries are cleared with the CLR key. A single press clears the last character on the right. Holding the CLR key down clears the entire scratchpad. The scratchpad is cleared automatically when the system accepts valid inputs.

Function Keys

The labeled function keys on the keyboard are used to call up specific top-level pages of the CDU and to simultaneously dedicate the line select keys to the functions indicated on that page. Exceptions are the MARK and DATA keys, which do not change the page, but initiate their respective functions and the

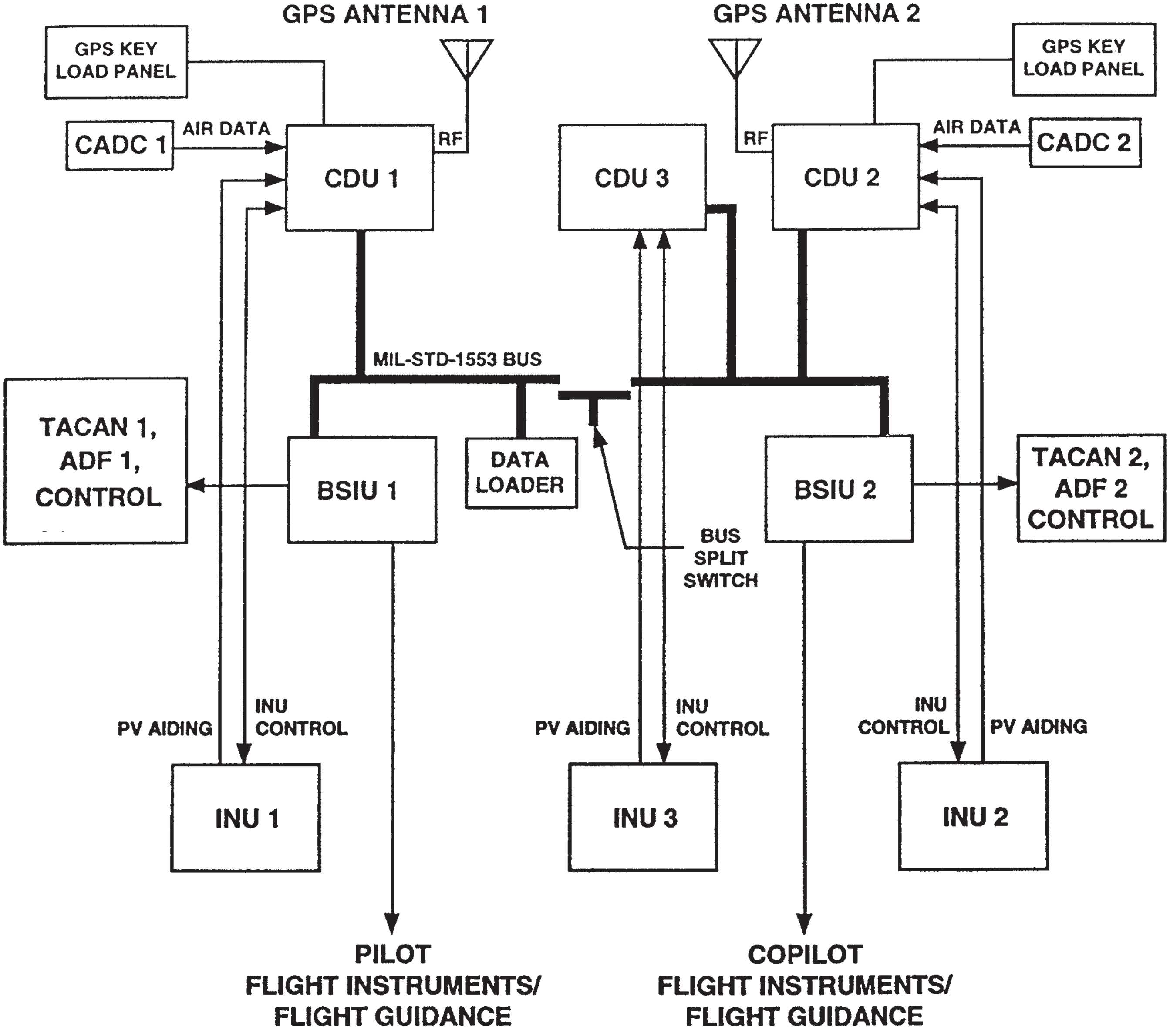


Figure 1.14-19. FMS Block Diagram

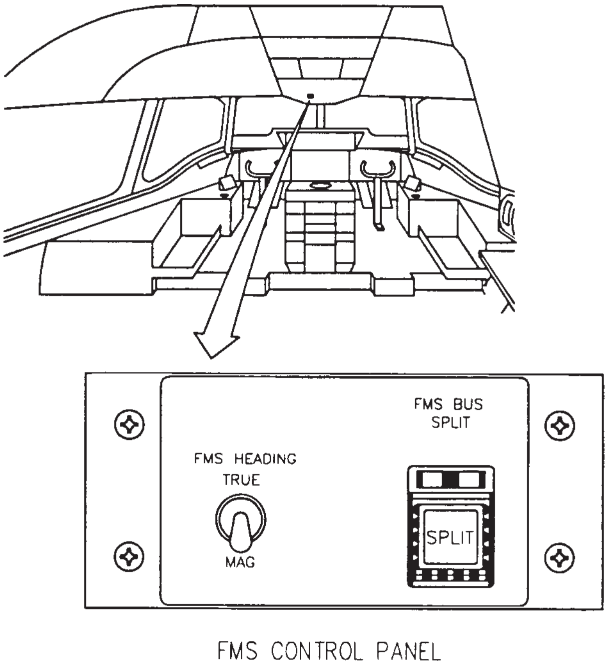


Figure 1.14-20. FMS Bus Split Switch

IFF, M3 and COM keys, which are inactive. Figure 1.14-23 identifies each of the function keys. Also, some functions which are less frequently used in flight are accessed through the index (IDX) and flight plan edit (EDIT) function keys and then via line select keys on the respective menu page. The Index 1 and 2, and Flight Plan Edit 1 and 2 pages are shown in figure 1.14-24.

Line Select Keys

Line select keys can be used to access lower level pages, toggle modes of a function, enter data in the associated field, or copy data into the scratchpad. For certain functions the line select keys may be used both for selecting mode and for input of numeric values used by the mode. If the scratchpad is blank, pressing the line select key toggles the mode. If the scratchpad is not blank, pressing the line select key does not toggle the mode, irrespective of data validity. When undefined line select keys are pressed, no operation is performed and no annunciation is displayed. The CDU responds to operator entries within one second.

Display Scrolling

Often more data is available than fits on a single display page. In these cases display scrolling is used to access all the related information. Two types of scrolling are defined: 1) page scrolling and 2) line scrolling. The arrow keys are used to execute scrolling. Holding the arrow keys causes the scrolling to continue until the key is released. Special characters (horizontal double-headed arrow↔, vertical double-headed arrow ↕, and four-headed arrow ✥) are displayed adjacent to the scratchpad to indicate the type of scrolling available.

Confirmation Function

Functions that involve erasure of significant internal data require confirmation before execution, indicated by a CONFIRM XXX message in the scratchpad (where XXX is a message unique to the item requiring confirmation). The scratchpad message is cleared by reselecting the appropriate line select to confirm the selection, or by pressing the CLR key if the function is not required.

Copying and Transferring Data

Most enterable data on the CDU can be copied into the scratchpad in its original form by pressing the adjacent line select key, except where other operations are performed which take precedence (e.g., frequency/channel selection on the Navigation Radio pages). Once copied into the scratchpad, this data may be transferred elsewhere in the FMS. For example, a waypoint may be transferred from the markpoint list to the flight plan, or the flight plan waypoint sequence may be reordered without having to reenter the waypoint data. The following paragraphs describe acceptable entry formats, valid data ranges and display formats. They are applicable to all CDU pages unless stated otherwise.

Valid Data Ranges and Units for Entry and Display

Data entry valid ranges for a given field are generally only limited by the display resolution with assumption of fixed decimal point and positive entries (i.e., a four digit numerical field with no decimal point will accept entries from 0 to 9999). However, some entered data is limited by operational considerations, e.g., baroset entries limited to 28.10-31.00 inches or 951.62-1049.83 mbars. For values which cannot be computed due to insufficient data, the CDU will display dashes (e.g., if gross weight cannot be computed because total fuel has not been specified). Asterisks (*) are displayed if the value is too large for its respective display field.

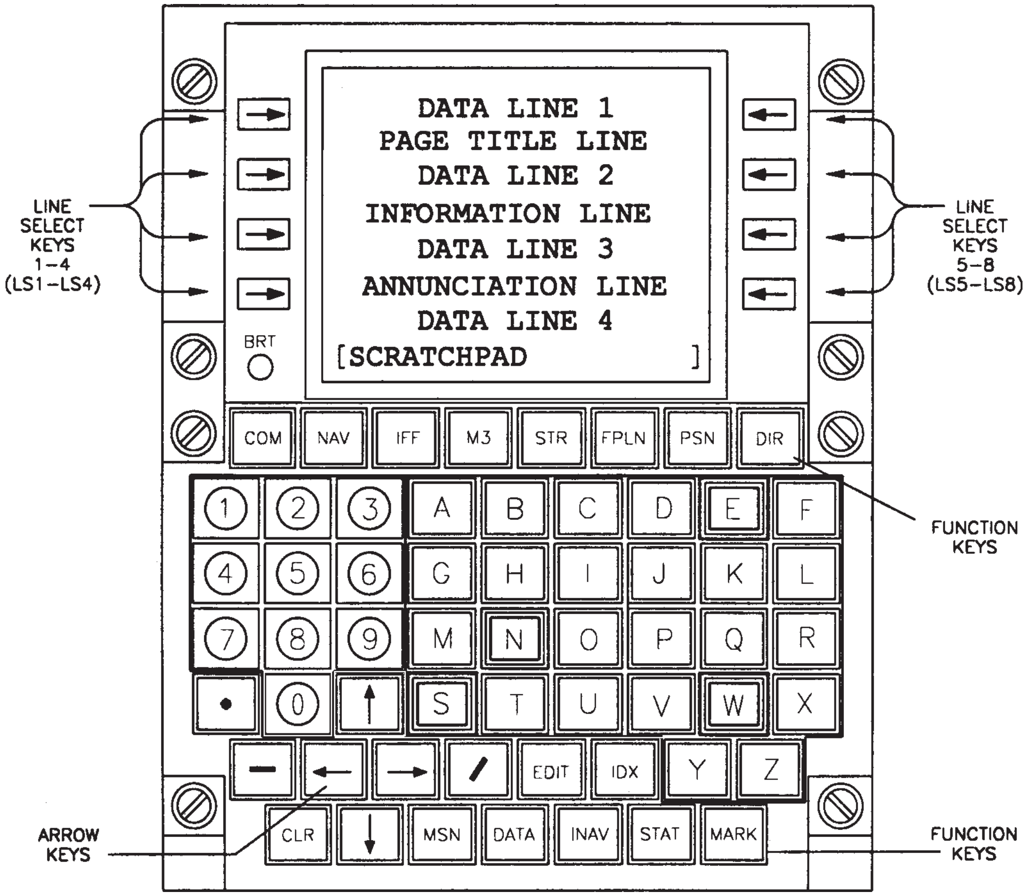
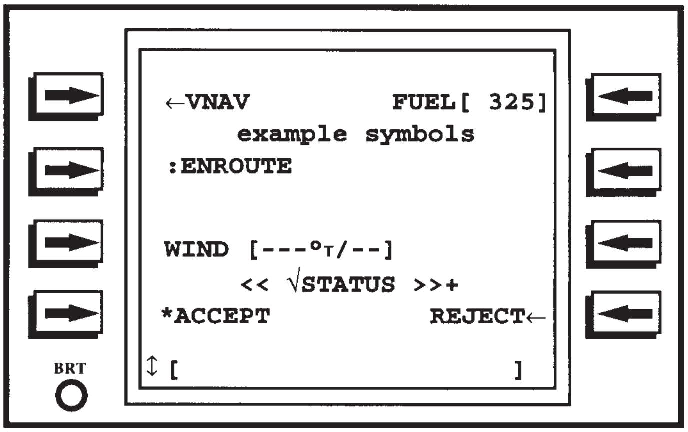


Figure 1.14-21. FMS Control Display Unit (CDU)



← →	Pushing the line select key will access the page indicated by the label.
→←	Pushing the line select key will select the item or enable the mode.
*	Function is on or enabled.
:	Alternate selection (toggle) among modes (e.g., on/off).
√	Check as in check status for equipment failures or to indicate a failed data path.
°	Reference is degrees magnetic.
°T	Reference is degrees true.
---	No computed data is available or meaningful, or power is off.
[ ]	Data entry is possible/required.
↓ ↑ ↕	Vertical page or line scrolling is possible (in direction of arrow).
↔	Lateral page scrolling is possible (in direction of arrow).
✥ ⇧↔ ↔⇩	Lateral and vertical page scrolling is possible (in direction of arrow).

Figure 1.14-22. CDU Standard Display Symbols

NOTE

Bearing, courses, and headings of due north may be entered as 000 or 360, but will be displayed as 360.

Entry and Display of Waypoints

Flight plan waypoints and other locations are entered in three basic formats:

1. Position Coordinates - as a latitude/longitude waypoint pair.
2. ICAO Identifier - up to five character alphanumeric string. The appropriate data is extracted from an onboard waypoint database of navigation aids, airports, intersections, etc.
3. Identifier/bearing/distance - position defined at the specified bearing and distance from a database waypoint with the indicated identifier.

Entry and Display of Latitude/Longitude Waypoints

Latitude/longitude waypoints are entered in the form of degrees and minutes followed by optional decimal minutes or seconds and decimal seconds. The required format is an N or S followed by four digits (with a decimal point and up to three additional

COM	Inactive.
NAV	Accesses control pages for TACAN and ADF radios.
IFF	Inactive
M3	Inactive
STR	Accesses Pilot and Copilot Steering pages.
FPLN	Accesses Flight Plan pages (active flight plan).
PSN	Accesses Pilot and Copilot Position pages (present position and track.)
DIR	Enables immediate selection of Direct-To waypoint.
EDIT	Accesses Flight Plan Edit pages.
IDX	Accesses index of additional functions not available on top-level keys.
CLR	Clears information from scratchpad and certain CDU annunciations.
MSN	Provides access to the Oceanic Reporting page.
DATA	Enables display of expanded data for any selected waypoint.
INAV	Accesses comprehensive data pages for INUs, GPS, and INU/GPS navigation solutions.
STAT	Accesses avionics LRU status pages.
MARK	Marks and stores present position or EHSI cursor position if active.

Figure 1.14-23. FMS CDU Function Keys

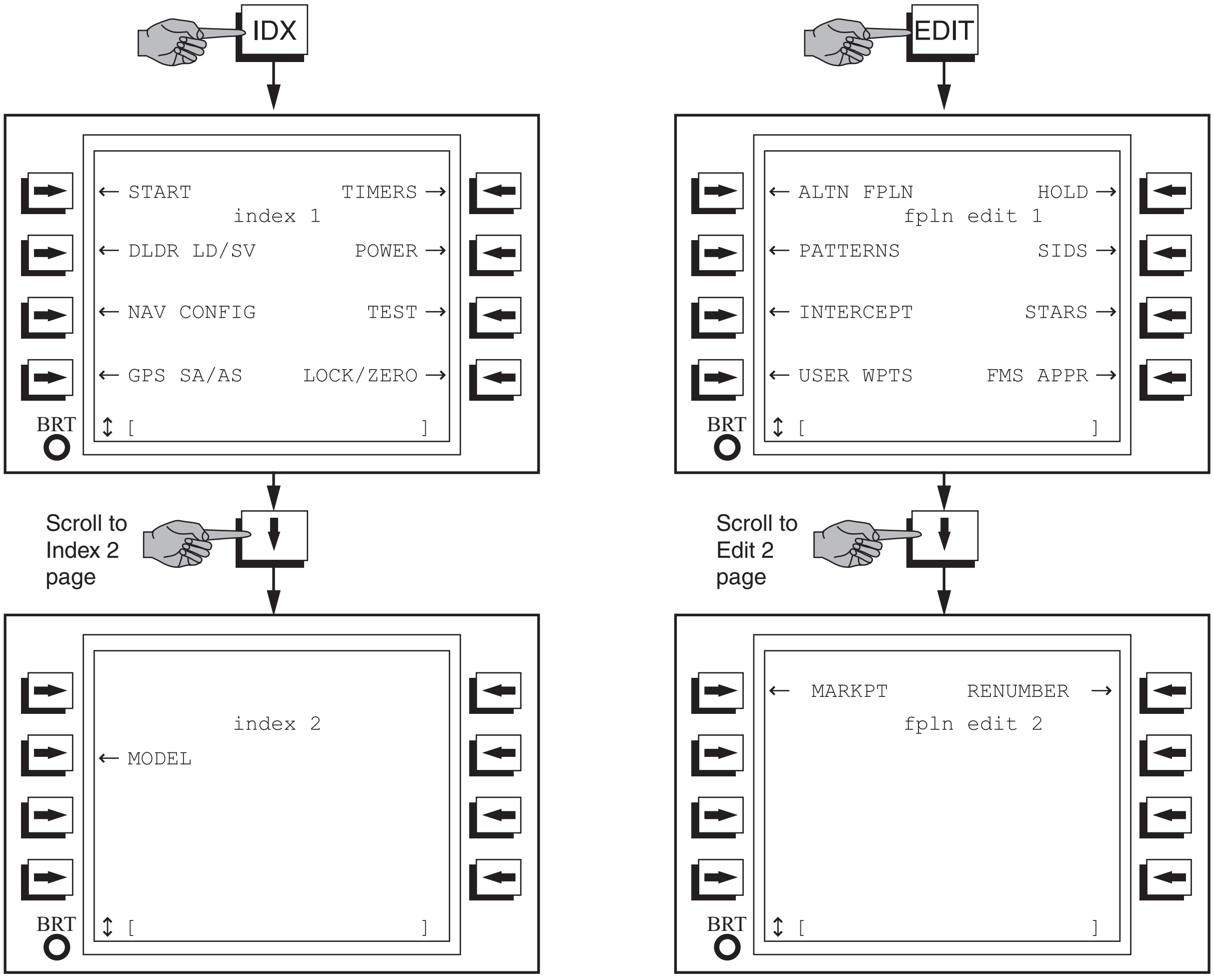


Figure 1.14-24. Index and Flight Plan Edit Pages

digits optional), followed by E or W followed by five digits (with a decimal point and up to three additional digits optional).

NOTE

> A minimum of four digits (degrees/minutes) are required for a valid entry. Leading zeros (except an initial leading zero for longitude degrees) are required as no delineators are used between degrees and minutes. Trailing zeroes after a decimal point are optional.

Latitude/longitude waypoints are displayed as whole minutes on all CDU pages except in the scratchpad when copied and on the Position, Integrated Navigation, Start 1, and Data pages where thousandths of minutes (.001) are displayed.

Entry and Display of Identifier Waypoints;

Identifiers are entered as up to five (5) alphanumerics. Identifier waypoints are displayed left justified, with alphabetic characters always written as capital letters.

Entry and Display of Identifier/Bearing/Distance Waypoints;

Identifier/bearing/distance waypoints are entered as an identifier, followed by a /, followed by the bearing, optionally followed by a T or M (true/magnetic reference), followed by a /, followed by distance. Bearings are entered as three digits optionally followed by a decimal point and an additional digit. Distances are entered as up to four digits optionally followed by a decimal point and one additional digit. If the optional T/M is not entered, the FMS heading switch input determines the format, unless the waypoint is an ICAO NAVAID station identifier. In this case, magnetic bearing is always used.

User-Defined Waypoint Labels

A user-defined, two to five character alphanumeric label may be attached to any lat/long or ident/bearing/distance waypoint in the flight plan (except user-defined waypoints which are named on the User Waypoint page). User-defined labels are entered as a / followed by two to five alphanumerics. When a label has been attached to a waypoint, only the label is displayed on the CDU. Accessing the From-To Data page will provide the original information.

Assigning a user-defined label also enters the waypoint into the user waypoint list. Once in the user waypoint list, the newly named waypoint can be modified or accessed like any other waypoint in the user database. If the user waypoint list is full when the user-defined label is applied, a USER WPT LIST FULL scratchpad message will be displayed. Access the User Waypoint List page and delete a waypoint to allow insertion of the new waypoint.

If the user-defined label already exists as a name in the user waypoint list, a DUPLICATE USER WPT scratchpad message will be displayed. Use a different name or delete the duplicate name from the user waypoint list. The FMS does not allow duplicate names to be used in the user waypoint list. However, user waypoint identifiers can be duplicates of identifiers in the ICAO database. When recalling such a duplicate, the Select Waypoint page will be accessed to allow selection of the desired waypoint. The user named waypoint is identified on the Select Waypoint page with ** as the country code.

Use of Magnetic Variation and Assigned Magnetic Variation

Magnetic variation is used in converting most azimuth angles from true to magnetic reference. The FMS normally uses internal look-up tables to determine the local magnetic variation to use in its course calculations. However, for courses into (or out of) ICAO NAVAID waypoints (and any offset waypoints described relative to these waypoints), the FMS uses the station assigned magnetic variation stored with the database waypoint rather than local magnetic variation in its computations, so the courses will match those on published IFR charts.

Entry and Display of Time and Date

Time is entered with no delineators between hours, minutes and seconds. Seconds and leading zeroes are optional, so that three to six digits are acceptable. If no time or date is available for a given field, blanks are displayed. All times are entered and displayed as Universal Coordinated Time (UTC). Dates are entered with or without / delineators and written using the military convention of day, month, then year.

Deletion of Data

Most data entry fields may have the associated data deleted by entering a - in the scratchpad and pressing the line select adjacent the desired field. In some cases, the - entry causes the data to revert to a fixed default value (e.g., wind to 360°/0).

CDU Annunciations and Scratchpad Messages

The CDU will alert the crew of avionics failures, degraded operations, system modes of operation, or operator entry errors via the CDU annunciation line and scratchpad. Three methods are used: 1) annunciations on the annunciation line of all CDUs, 2) scratchpad messages only displayed locally on the CDU causing the condition, and 3) master FMS message alert discrete provided as an external alert on the pilots' EHSIs.

Annunciations are displayed in lowercase letters; scratchpad messages are displayed in uppercase letters. The annunciation line displays only a single annunciation at a time in the format << √status >>, however, other annunciations occurring simultaneously will be stored in a wrap-around queue in priority order. A + symbol will appear to the right of the annunciation display to indicate when multiple annunciations are present. Annunciations will be removed from the queue in two ways: 1) automatically by the system when the conditions causing the activation are eliminated or 2) by pressing the CLR function key with an empty scratchpad. Each CLR key actuation will clear the highest priority annunciation and display the next one in the queue. Some annunciations will not be clearable. For these annunciations, a CLR key actuation will display the next annunciation in the queue and place the nonclearable one at the end of the queue. New annunciations will enter the queue in their priority order and the + will flash to indicate the presence of an unacknowledged annunciation.

Figure 1.14-25 gives a list of CDU annunciations and scratchpad messages. The chart also indicates if the annunciation/scratchpad message is nonclearable and if the master FMS MSG alert discrete is set by the associated condition. In addition to the annunciations and scratchpad messages listed in figure 1.14-25, the FMS will provide EHSI alert annunciations to inform the flight crew of various flight conditions as listed in Figure 1.14-26. A priority listing of CDU annunciations is provided in figure 1.14-27.

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
ADD ALTN BEFORE?	An alternate flight plan has been selected to be added to the flight plan	Clear key or insertion of the alternate flight plan into the flight plan	SP	N		
ALTN FPLN FULL	Attempt to insert more than 60 waypoints into the alternate flight plan	Clear key	SP	A		
approach	EHSI deviations and RAIM integrity performance are set for approach mode. Blinks for 10 seconds beginning at 2 nm from the FAF when conditions for transitioning from terminal mode to approach mode are met	EHSI deviations change to terminal, enroute, or oceanic mode	AL	B/N	●	
APPROACH DEFINED	Attempt to: ● Enter a VNAV parameter at the MAP or visual runway extension waypoint ● attempt to delete the V attribute at the MAP of an approach or the runway extension waypoint of a visual approach ● Attach a Hold to an IAF (with a database holding pattern) MAP, or Missed Approach Holding Point (with a databased holding pattern) ● Attach a pattern to an IAF (with a databased holding pattern), FAF/runway extension point, MAP, or Missed Approach Holding Point (with a databased holding pattern) ● Insert an offset when an approach waypoint is the active waypoint ● Enter a waypoint between the FAF/runway extension waypoint and MAP ● Attempt to perform a Direct-To to the MAP ● Attempt to enter an approach into the flight plan when an approach is already inserted	Clear key	SP	A		
APPROACH IS ACTIVE	Attempt to: ● Delete or remove the approach from the flight plan during execution (MAP is the active waypoint) ● Modify the flight plan or approach parameters or change the sequencing mode prior to the MAP when the MAP is the active waypoint	Clear key	SP	A		
ATTACH CIR AT?	A circle pattern without a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
ATTACH CRP AT?	A closed random pattern without a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
ATTACH FG8 AT?	A figure 8 pattern without a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
ATTACH HOLD AT?	A hold has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
ATTACH RFL AT?	A refuel pattern without a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 1)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
ATTACH RTK AT?	A racetrack pattern without a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
√bank limit	Bank limit is less than 25° and a refuel pattern is activated, or a holding pattern fix is passed for the first time, or within 30nm of the FAF/runway extension point or airport for the first time	Clear key or bank limit changed	AL	B		
√baroset	Within 30nm of the FAF/runway extension point for the first time	Clear key or entering a baroset on a *VNAV Steer* page	AL	B		
√gps	Loss of GPS use as an INAV source (after 5-second delay in approach mode; 25 second delay in oceanic, enroute, or terminal mode)	Clear key or reobtaining GPS or selecting an INU only INAV solution	AL	B		
√IDENT ELEVATION	An attempt to enter an identifier/bearing/ shaft range for the VOR/TCN mode on the Update pages when the identifier does not have an elevation	Clear key	SP	A		
√inu1	Presence of *INU1 Master Warning* or absence of INU1 ARINC data	Clear key or reset of condition	AL	N		●
√inu2	Presence of *INU2 Master Warning* or absence of INU2 ARINC data	Clear key or reset of condition	AL	N		●
√inu3	Presence of *INU3 Master Warning* or absence of INU3 ARINC data	Clear key or reset of condition	AL	N		●
√nav error	Downgrade in 95% probable error	Clear key or upgrade in position index	AL	B		●
√nav source	Selection of the same navigation source as the other pilot	Clear key or selection of a different navigation source	AL	B		●
√POWER	Attempt to control modes of equipment when power is disabled on *Master Power* page	Clear key	SP	A		
√speed	During a TNAV, airspeed deviates from the guidance solution's airspeed or groundspeed by the designated amount entered on the *Navigation Configuration 2* page (after 3-second delay)	Correction in airspeed or clear key	AL	B		●
√status	Detected failure of an LRU or interface signal (after 3-second delay)	Clear key or selection of the STAT key	AL	B		●
√STATUS	A request for display or operation that cannot be provided due to failure or the LRU is under test	Clear key	SP	A		
√timer 1	Down-count to zero	Clear key	AL	B		●
√timer 2	Down-count to zero	Clear key	AL	B		●
√timer 3	Down-count to zero	Clear key	AL	B		●
√version	CDU software versions incompatible	Replace or power-down unit with incorrect version	AL	B	●	●
CARTRIDGE IN USE	Attempt to access the data cartridge while data is currently being up/downloaded	Clear key	SP	A		
cir active	Circle pattern is currently being executed	Circle pattern cancelled	AL	N	●	
CIR IS ACTIVE	Attempt to delete or modify the circle fix or delete the MFP attribute or modify the flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during pattern execution	Clear key	SP	A		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 2)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
CLIMB DEFINED	An attempt to enter a leg arrival/departure fuel or a leg arrival/departure time within a climb segment	Clear key	SP	A		
compare gps	Two GPS solutions differ by the RAIM alert limits for the current phase of flight (en route, terminal, etc.)	Clear key or GPS solutions within tolerances	AL	N		
CONF LOAD XXXXXXXX	Request to load the alternate flight plan XXXXXXXX into the CDU from the data cartridge	Clear key, reselect entered altn	SP	N		
CONFIRM ADD	Request to add a new user waypoint to the database	Clear key or reselect ADD	SP	N		
CONFIRM ALTN RMV	Request to remove a pattern from the alternate flight plan	Clear key or reselect ALTN RMV	SP	N		
CONFIRM CHNG TO CIR	Request to change MFP type to circle	Clear key or selection of PTRN CHNG	SP	N		
CONFIRM CHNG TO FG8	Request to change MFP type to figure 8	Clear key or selection of PTRN CHNG	SP	N		
CONFIRM CHNG TO RTK	Request to change MFP type to racetrack	Clear key or selection of PTRN CHNG	SP	N		
CONFIRM CLEAR FPLNS	Request to clear flight plan and alternate flight plan	Clear key or reselect ALTN/ FPLN	SP	N		
CONFIRM CLEAR GPS	Request to clear GPS SA/A-S keys	Clear key or reselect GPS	SP	N		
CONFIRM CLEAR PTS	Request to clear the markpoint and user waypoint lists	Clear key or reselect MKPTS/WPTS	SP	N		
CONFIRM ERASE DATA	Request to erase flight data (*Start* 5 page)	Clear key or reselect ERASE FLT/DATA	SP	N		
CONFIRM ERASE ALTN	Request to erase alternate flight plan (*Altn Fpln* page)	Clear key or reselect ERASE ALTN	SP	N		
CONFIRM ERASE FPLN	Request to erase flight plan (*Start* 5 page)	Clear key or reselect ERASE FPLN	SP	N		
CONFIRM FPLN RMV	Request to remove a Hold, FMS approach, SID, STAR, Pattern or Intercept from the flight plan	Clear key or reselect FPLN RMV	SP	N		
CONFIRM HOLD PPSN	Request to hold at present position	Clear key or reselect HOLD PPSN	SP	N		
CONFIRM INAV RESET	Request to reset the integrated navigation solution	Clear key or reselect INAV RESET	SP	N		
CONFIRM LOAD ALMNAC	Request to load the GPS almanac data	Clear or reselect LOAD ALMANAC	SP	N		
CONFIRM LOAD ALTN	Request to load the alternate flight plan into the CDU from the data cartridge	Clear key, reselect LOAD, or reselect entered altn	SP	N		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 3)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
CONFIRM LOAD DATA	Request to load flight data (*Start* 5 page)	Clear key or reselect LOAD FLT/DATA	SP	N		
CONFIRM LOAD PTS	Request to load markpoint and user waypoint lists into the CDU from the data cartridge	Clear key or reselect LOAD MKPT/WPT	SP	N		
CONFIRM OVERWRITE	Request to replace existing information in the user waypoint database	Clear key or reselect ADD	SP	N		
CONFIRM POWER OFF	Request to remove power from all NAV radios	Clear key or reselect RADIO MASTER OFF	SP	N		
CONFIRM RENUMB FPLN	Request to renumber the flight plan	Clear key or reselect RENUMBER	SP	N		
CONFIRM RPLACE FPLN	Request to replace the flight plan with the alternate (*Start 5 and Altn Fpln* pages)	Clear key or reselect REPLACE FPLN	SP	N		
CONFIRM RVRSE ALTN	Request to reverse the alternate flight plan	Clear key or reselect RVRS ALTN	SP	N		
CONFIRM SAVE ALMNAC	Request to save the selected GPS almanac data	Clear key or reselect SAVE ALMANAC	SP	N		
CONFIRM SAVE ALTN	Request to save the alternate flight plan to the data cartridge	Clear key or reselect SAVE	SP	N		
CONFIRM SAVE PTS	Request to save markpoint and user waypoint lists to the data cartridge	Clear key or reselect SAVE MKPT/WPT	SP	N		
CONFIRM SAVE STATUS	Request to save system status to the data cartridge	Clear key or reselect SAVE STAT	SP	N		
CONFIRM SID RPLACE	Request to replace a SID in the flight plan	Clear key or reselect the line select key	SP	N		
CONFIRM STAR RPLACE	Request to replace a STAR in the flight plan	Clear key or reselect the line select key	SP	N		
CONFIRM SYSTEM TEST	Request to initiate test on all LRUs controlled by the FMS	Clear key or reselect SYSTEM	SP	N		
CONFIRM ZERO ALL	Request to zeroize the system	Clear key or reselect ZERO ALL	SP	N		
crp active	Closed random pattern is currently being executed	Closed random pattern cancelled	AL	N	●	
CRP IS ACTIVE	Attempt to delete or modify the closed random pattern fix or delete MFP attribute or modify the flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during pattern execution	Clear key	SP	A		
CRS CHANGE >90	Attempt to apply course edit greater than 90° from the current inbound course while in automatic or flyover leg sequence mode	Clear key	SP	A		
crs reversal	Generated at 3 NM from execution of a course reversal procedure (see FMS APPROACHES section for a description of databased GPS approach course reversal execution	Removed when any of the following conditions is true: ● Switch to capturing the inbound leg of the crs rvrsl (either com-	AL	N	●	

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 4)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
		pleting or terminating the crs rvrsl) ● FAF or IAF is not the active wpt (except when the crs rvrsl is active and the approach is removed so that the original IAF/ FAF waypoint is still active, but no longer a part of a defined approach; in this case, the procedure will be completed) ● Prior to active crs rvrsl; holding pattern at the active waypoint is either enabled (active waypoint is IAF) or attached (active waypoint is FAF) ● Direct-To is selected to any waypoint except the MAP ● Aircraft departs the 3 NM region around the IAF or FAF before crossing the inbound course bisector (crs rvrsl execution is not attained				
CRS RVRSL IS ACTIVE	Attempt to delete the active waypoint or modify the flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during course reversal	Clear key	SP	A		
DATA FOR?	Prompt for access to *Data* pages	Clear key or valid waypoint selection	SP	N		
db truncated	Selection of an ICAO database that contains more than 120,000 waypoints	Clear key or deselection of the ICAO database on the Start 3 Database page	A	N		
DIRECT TO CRP?	Access of *CRP* page from the Direct-To *Flight Plan* page	Clear key or selection of CRP point for Direct-To	SP	N		
DISCONTINUITY	Attempt to enter a course to waypoint when a discontinuity is the active waypoint	Clear key	SP	A		
discontinuity	A discontinuity is the active waypoint	Delete the discontinuity, delete the associated waypoint, insert a waypoint between the discontinuity and the associated waypoint, or Direct-To any waypoint	AL	N	●	●
DUPLICATE USER WPT	Attempt to assign a user waypoint identifier with the / function when the same identifier already exists in the user waypoint database	Clear key	SP	A		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 5)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
ENTER ANGLE OR RATE	Attempt to toggle between CLIMB and DESCNT when no vertical angle or rate has been entered	Clear key	SP	A		
ENTER FIX	Attempt to enter a magnetic track or toggle to a magnetic track when a target fix has not been entered on the *Intercept a* page	Clear key	SP	A		
ENTER PARAMETERS	Attempt to insert an intercept, MFP, or approach into the flight plan when defining parameters have not been entered	Clear key	SP	A		
ENTER WAYPOINT	Attempt to enter an alternate flight plan parameter prior to entering the waypoint or attempt to enter a flight plan course when no active waypoint exists	Clear key	SP	A		
enter utc	On power-up if time is not available and crew has not entered time or if bus control is switched with time not valid	Clear key or entry of time or return of valid time	AL	N		
ENTER UTC/DATE	Attempt to start one of the timers without a valid UTC and Date available in the system	Clear key	SP	A		
exiting hold	Active hold is cancelled by deletion of the H attribute	Hold fix is crossed	AL	N	●	
fg8 active	Figure 8 pattern is currently being executed	Figure 8 pattern cancelled	AL	N	●	
FG8 IS ACTIVE	Attempt to delete or modify the figure 8 fix or delete MFP attribute or modify flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during pattern execution	Clear key	SP	A		
FINAL APPR CRS XXX°	Direct-To is made to the FAF/runway extension point of an approach.	Clear key or selecting LS1 on the *Flight Plan* page CRS entry	SP	N		
FL005 FT MINIMUM	Attempt to enter a VNAV or alternate flight plan Flight Level less than 500 ft.	Clear key	SP	A		
FPLN FULL	Attempt to insert more than 60 waypoints into the flight plan	Clear key	SP	A		
GPS IS VALID	Attempt to accept an update to the integrated navigation solution when GPS is valid	Clear key	SP	A		
GROUND ONLY	Attempt to perform a ground operation during flight	Clear key	SP	A		
hold active	Hold is currently being executed	Hold cancelled	AL	N	●	
HOLD DEFINED	Attempt to attach a pattern to a waypoint with a Hold attached or an attempt to insert an offset when a holding fix is the TO waypoint	Clear key	SP	A		
HOLD IS ACTIVE	Attempt to delete the holding fix or modify the flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during hold execution	Clear key	SP	A		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 6)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
INSERT CIR BEFORE?	A circle pattern with a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
INSERT CRP BEFORE?	A closed random pattern with a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
INSERT FG8 BEFORE?	A figure 8 pattern with a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
INSERT INTR BEFORE?	An intercept has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INSERT RFL BEFORE?	A refuel pattern with a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
INSERT RTK BEFORE?	A racetrack pattern with a defined fix has been selected for insertion into the flight plan or alternate flight plan	Clear key or valid insert	SP	N		
INSERT SID BEFORE?	A SID has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INSERT STAR BEFORE?	A STAR has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INSRT G-APR BEFORE?	A GPS databased approach has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INSRT T-APR BEFORE?	A Tactical approach has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INSRT V-APR BEFORE?	A Visual approach has been selected for insertion into the flight plan	Clear key or valid insert	SP	N		
INTERCEPT DEFINED	Attempt to enter VNAV parameters for or attach a Hold or pattern to a point defined as an intercept	Clear key	SP	A		
intr active	An intercept is currently the flight plan active waypoint	Deletion of intercept point via direct-TO	AL	N	●	
INTR IS ACTIVE	Attempt to delete the intercept from the flight plan during execution (current active waypoint) or attempt to modify the flight plan course when an intercept is the active waypoint	Clear key	SP	A		
inu1 battery	*INU1* is operating on battery power	Primary power restored to *INU1*	AL	N	●	●
inu2 battery	*INU2* is operating on battery power	Primary power restored to *INU2*	AL	N	●	●
inu3 battery	*INU3* is operating on battery power	Primary power restored to *INU3*	AL	N	●	●
INVALID DELETION	Attempt to delete the intercept or approach attributes, history waypoint (if only one exists), intercept, or MFP, parameters when in the flight plan or alternate flight plan	Clear key	SP	A		
INVALID ENTRY	Attempt to insert scratchpad data which does not pass format or range test, attempt to select a function when insufficient data has been entered, or attempt to select a non-waypoint entry to call up the *Data* page	Clear key or selecting a line key for which the entry is allowed	SP	A		
key alert	GPS SA/A-S keys will expire in 2 hours in the selected GPS receiver	Clear key or entry of new keys passing time test	AL	B		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 7)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
load fail	Failure passing data to/from the data cartridge	Clear key	AL	N		
LOAD IN PROGRESS	Attempt to replace the active flight plan while the alternate flight plan is in the process of being loaded	Clear key	SP	N		
locked	Password has been entered locking the system	Entry of correct password or zeroizing the system	AL	N	●	
MAX INTRS IN FPLN	Attempt to insert more than 10 intercepts into the flight plan	Clear key	SP	A		
MAX PTRNS IN ALTN	Attempt to insert more than 20 patterns into the alternate flight plan	Clear key	SP	A		
MAX PTRNS IN FPLIN	Attempt to insert more than 20 patterns into the alternate flight plan	Clear key	SP	A		
-1000 FT MINIMUM	Attempt to enter VNAV or alternate flight plan altitude less than -1000 ft	Clear key	SP	A		
need key	Insufficient GPS SA/A-S keys in selected GPS for mission duration	Clear key or entry of keys sufficient for mission duration or shortening mission duration to fit keys available	AL	B		
no appr raim	Active when the following conditions are true: ● When a transition to GPS approach mode occurs (2 NM from FAF) and the approach predictive RAIM is not available or unable to be computed ● RAIM is not available when the MAP becomes the active waypoint ● RAIM is not available after the 5 minute no approach raim suppression period expires	Databased GPS approach disabled or removed	AL	N	●	●
no appr vnav	Insertion of a databased GPS approach with a MAP that does not terminate at the runway threshold (no vertical guidance available into MAP)	Clear key or approach removed from flight plan	AL	N	●	●
no gps appr	Active when the following conditions are true: ● Within 3nm from the databased FAF or the databased MAP is the active waypoint ● Approach is enabled ● Navigation mode set to a non-GPS based solution	Navigation mode switched to a solution with valid GPS data or databased approach disabled or MAP not the active waypoint and FAF in history or deleted	AL	N		●
NO CARTRIDGE	Attempt to access data loader data when no cartridge is installed	Clear key	SP	A		
no keys zero	Failure to zeroize GPS SA/A-S keys in both GPS receivers	Clear key or subsequent successful clear of keys	AL	B		
NO MAG VAR	Attempt to enter magnetic referenced input (course, bearing, or track) without MAGVAR tables	Clear key	SP	A		
no raim	RAIM is lost in selected GPS receiver and the no appr raim annunciation is not active or has been removed (30 second delay applies)	RAIM function is returned or no appr raim annunciaction is generated or clear key	AL	N		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 8)

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
NOT STORED	Entry not found in either database	Clear key	SP	A		
offset cncld	Parallel offset automatically cancelled	Clear key	AL	B		●
ONLOAD DEFINED	Attempt to enter extra fuel or total fuel on the *Fuel* page when an onload is defined in the alternate flight plan	Clear key	SP	A		
PATTERN DEFINED	Attempt to attach a hold or pattern at a point defined to be a pattern, attempt to insert an offset when a MFP fix is the active waypoint, or attempt to modify the pattern fix when the pattern has been inserted in the flight plan or alternate flight plan	Clear key	SP	A		
PATTERN NOT IN FPLN	Attempt to enable refuel pattern when pattern is not in active flight plan	Clear key	SP	N		
pca intercpt	The intercept solution for the active waypoint is to the point of closest approach	Clear key or non-PCA intercept solution becomes available	AL	N		
RAIM CHECK ACTIVE	Attempt to enter RAIM prediction data when automatic approach RAIM point check is in progress	Clear key or completion of point check	SP	A		
RENUMBER FPLN	Attempt to insert a waypoint between non-inserted waypoints in the flight plan when the alphanumeric Z is already in use at the associated waypoint	Clear key	SP	A		
RE-SELECT ARPT	Attempt the following immediately after data cartridge has been removed and reinserted or a data loader failure transient of more than 3 seconds occurs while the data cartridge is already inserted: ● Select a SID or associated runway and no SID is currently in the working copy ● Select a STAR or associated runway and no STAR is currently in the working copy ● Select a databased GPS approach from the *FMS Approach* page and no databased GPS approach is currently in the working copy ● Select a visual approach from the *FMS Approach* page and no databased GPS approach is currently in the working copy ● Select an IAF or insert a GPS approach and no databased GPS approach is currently in the working copy ● Insert a visual approach and no visual approach is currently in the working copy	CLR key or entry of four letter airport identifier on *SID, STAR, or FMS Approach* page	SP	N		
rfl active	Refuel pattern is currently being executed	Refuel pattern cancelled	AL	N	●	
RFL IS ACTIVE	Attempt to delete or modify the refuel fix or delete MFP attribute or modify the flight plan course or insert a PPSN hold or insert a waypoint position at the active waypoint position during pattern execution	Clear key	SP	A		
rtk active	Racetrack pattern is currently being executed	Racetrack pattern cancelled	AL	N	●	
RTK IS ACTIVE	Attempt to delete or modify the racetrack fix or delete MFP attribute or modify the flight plan course or insert a PPSN hold or insert a waypoint at the active waypoint position during pattern execution	Clear key	SP	A		

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 9)

Page 1.14-42 is deleted.

Annunciation/ SP Message	Initiating Condition	Reset Mechanism	Location	Blinking	Not Clearable	FMS MSG
safe keys	GPS SA/A-S keys on both GPS receivers are zeroized	Clear key	AL	N		
SELECT ALTN LOAD	Access the *Alternate Flight Plan Catalog* page from the *Start 3* page	Clear key or select alternate	SP	N		
select db/msn	Upon cold start, cartridge insertion (when no ICAO database or mission database has been selected), data loader source change, or data loader failure transient of more than 3 seconds and there is an ICAO database or mission data available for selection	Clear key or selection of the ICAO database and mission data on the Start 3 Database and Start 4 Mission pages	AL	N		
SELECT DB/MSN	Attempt to access ICAO database or mission data when it has not been selected	Clear key	SP			
SELECT SID/RWY	Attempt to access *SID Transitions* page without both SID and RWY selected	Clear key or selecting a SID or RWY	SP	N		
SELECT STAR/RWY	Attempt to access *STAR Transitions* page without both STAR and RWY selected	Clear key or selecting a STAR or RWY	SP	N		
UNUSED FUNCTION	Press COM, IFF or M3 function keys	Clear key	SP	A		
update magvr	Current magnetic variation data is more than 6 months old	Clear key or load new magnetic variation data	AL	N		
update nav db	Current date is later than the ICAO database effective period	Clear key or new ICAO database	AL	N		●
USER WPT LIST FULL	Attempt to add a user waypoint when the user waypoint database is full	Clear key	SP	A		
verify db/msn	Insertion of a data cartridge with available ICAO database or mission data with ICAO database or mission data already selected	Clear key	AL	N		
verify proc	When in the AUTO or FLYOVER sequencing mode and TTG is one minute before sequencing into a DISCONTINUITY or the TTG is less than one minute when the waypoint preceding a DISCONTINUITY becomes the active waypoint	Clear key or delete the discontinuity, delete the associated waypoint, insert a waypoint between the discontinuity and the associated waypoint, remove the related SID, STAR or approach, or Direct-To any waypoint, or the discontinuity becomes the active waypoint	A	N		●
VNAV IS ACTIVE	Attempt to toggle between CLIMB and DESCNT when a VNAV is active	Clear key	SP	A		
WPT MAX EXCEEDED	Attempt to enter SID or STAR with more than 30 waypoints	Clear key	SP	N		
wpt passed	Active waypoint is passed and sequencing is inhibited	Clear key or sequence waypoint	AL	N		
wrong key	Incorrect SA/A-S key received	Clear key or entry of correct key	AL	B		
xtk alert	Aircraft crosstrack deviation exceeds crew entered specified threshold (after 3-second delay)	Clear key or aircraft is maneuvered to bring the cross track deviation within the threshold or the deviation threshold is expanded	AL	B		
XXXX.XX	UTC DISPLAY enabled on the *Start 1* page	Disable UTC DISPLAY on *Start 1* page	AL	N	●	

Location: AL = Annunciation Line
SP = Scratchpad Message

Blinking: N = Non-blinking
B = Blinking
A = Alternating between SP message and entered SP data

Figure 1.14-25. CDU Annunciations and Scratchpad Messages (Sheet 10)

TYPE OF ALERT*	INITIATING CONDITION
Waypoint Alert Annunciation	Within user-selectable waypoint alert time prior to waypoint sequence when in ENROUTE and OCEANIC flight modes; 10 seconds prior to waypoint sequence when in TERMINAL and APPROACH flight modes.
Terminal Mode Annunciation	FMS in Terminal Mode.
Approach Mode Annunciation	FMS in Transition or Approach Mode.
RAIM Alert Annunciation	GPS RAIM function detects error (RAIM WARN).
FMS MSG Annunciation	See Figure 1.14-15.
Parallel OFST Annunciation	Parallel offset track has been applied to the active flight plan.
DR Mode Annunciation	FMS in dead reckon mode for more than five seconds.

*Displayed on EHSI

Figure 1.14-26. Additional Alert Annunciations

Annunciations

1. Deleted
2. Deleted
3. Deleted
4. locked*
5. √version*
6. no appr vnav
7. discontinuity*
8. verify proc
9. offset cncld
10. enter utc
11. √timer 1
12. √timer 2
13. √timer 3
14. no gps appr
15. no appr raim*
16. no keys zero
17. safe keys
18. xtk alert
19. √bank limit
20. √nav source
21. √nav error
22. √gps
23. compare gps
24. no raim
25. √inux[1]
26. inux battery[1]*
27. wpt passed
28. pca intercpt
29. crs reversal*
30. √baroset
31. approach*
32. √speed
33. √status
34. exiting hold*
35. hold active*
36. intr active*
37. crp active*
38. rfl active*
39. fg8 active*
40. rtk active*
41. cir active*
42. key alert
43. need key
44. wrong key
45. load fail
46. select db/msn
47. verify db/msn
48. update nav db
49. update magvr
50. db truncated
51. xxxx:xx[2]*

[1] X represents the associated INU (i.e., either 1, 2, or 3).
[2] XXXX:XX represents the UTC time (e.g., 0810:40).
* Indicates annunciation is not clearable with CLR key.

Figure 1.14-27. CDU Annunciation Line Priorities

FMS SYSTEM POWER

All primary FMS components (CDUs, BSIUs, and data loader) operate from 28V DC power. CDU1, BSIU1, and the data loader receive power from the L EMER DC Bus. CDU2 and BSIU2 receive power from the R EMER DC Bus. CDU3 receives power from DC Bus 3. System power is applied through three toggle switches located on the right side of the Aft Overhead Panel. An auxiliary circuit provides up to 30 seconds of backup power from the INS batteries to the CDUs and 10 seconds to the data loader in the event of temporary power loss or fluctuations. A system self-test will be performed on cold start power application. Any failures detected during the self-test will be incorporated into the continuous built-in-test (CBIT) results and will be annunciated in the same manner as CBIT failures (see Status Monitoring section).

CDU Power Control of Associated Sub-systems

Using the CDU, the crew can control the power on/off state of certain avionic subsystems managed by the FMS. These subsystems include the TACAN and ADF navigation radios. Since the GPS receiver modules are embedded in the CDUs, they are on whenever the CDUs are powered. Although used as navigation sensors by the FMS, power to the INUs is controlled individually by mode selector units (MSUs). Whenever the GPS receivers, INUs, or navigation radios are powered off, most flight crew inputs to these subsystems are inhibited and result in a √POWER message in the scratchpad. Additionally, all associated data outputs from the GPS and INUs are dashed on the CDU.

CDU Power Control Procedures

The CDU Master Power page, accessed by pressing the POWER line select key on the Index 1 page, is shown in figure 1.14-28. This page permits individual on/off control of the TACAN and ADF radios. It also provides a RADIO MASTER selection which turns all controlled radios on or off.

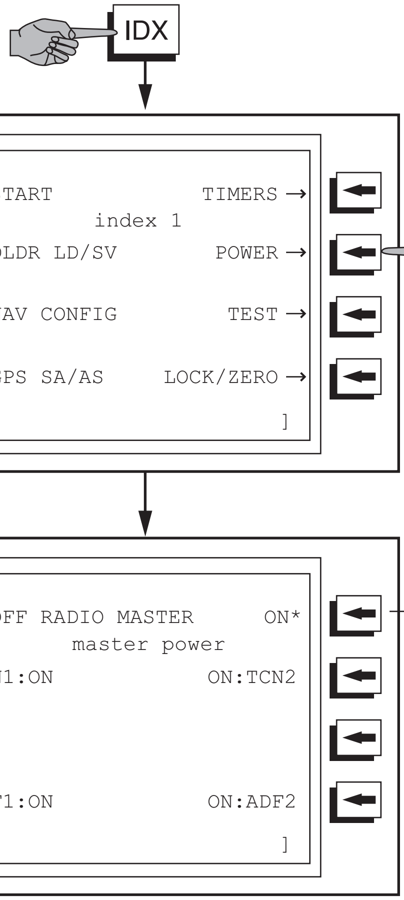
SYSTEM INITIALIZATION

The FMS preflight initialization includes entering or confirming the current position, time, and date for INU alignment and GPS initial acquisition. It also involves alignment of the INUs, verification of the data loader cartridge(s) effectivity date(s), and erasing and/or loading flight plan and other mission data.

Initialization Procedures

A normal preflight start-up procedure is as follows. Steps 1, 2, 3, 5, 5A, and 6 require operations on the Start pages. Refer to figures 1.14-29 through 1.14-32 for the Start Pages operation sequence. Step 4 requires operations on the INAV INU Control pages. Refer to figure 1.14-34 for these operations.

1. Verify or enter position, time, date, and chart datum on the Start 1 page (figure 1.14-29). Normally the GPS will provide the correct position, time, and date shortly after power is applied to the CDU.
2. If the initial position or time is erroneous, enter the correct values and initialize the GPS on the Start 2 page (figure 1.14-30).
3. Observe that the annunciation line displays the √INU1 (2,3) message. This message may be cleared on any CDU by pressing the CLR function key. These messages will be accompanied by illumination of the FMS MSG annunciator on the EHSI.
4. Access the INAV page for each INU on its corresponding CDU (Pilot/INU1; Copilot/INU2; FE/INU3) by pressing the INAV key and laterally scrolling to the appropriate INU INAV page (INU CONTROL will be displayed at LS4 on the appropriate page). Access the INU CONTROL page on each CDU via LS4 and verify that NO INU DATA is displayed on the information line. Select STBY on each INS MSU. Select POSITION (LS2) and enter present position latitude into the scratchpad as N or S followed by degrees, minutes, and tenths of minutes (decimal point is optional). Select ENTER (LS6) to send the position



Access Master Power page

Radio Master may be used to turn all controlled radios ON (LS5) or OFF (LS1).

Toggle individual radio power ON or OFF

Figure 1.14-28. FMS Master Power Page and Radio Power Control to the INU. Repeat for the present position longitude entry preceded by E or W. Select ALIGN on each MSU.

5. Return to the Start 3 page by pressing the IDX key, selecting START on the Index 1 page, and scrolling to Start 3 (figure 1.14-31). Verify the effectivity date of the ICAO database(s) is correct and select DB A or DB B as the ICAO database to be used. Scroll to the Start 4 (figure 1.14-32) page and select either the MSN A or MSN B data cartridge as the mission data to be used.

NOTE

- The ICAO database and mission data must be manually selected even if only one data cartridge is installed in the data loader.
- The <db truncated> annunciation will be displayed if the selected ICAO database contains more than 120,000 waypoints. Only the first 120,000 waypoints on the cartridge will be accessible.

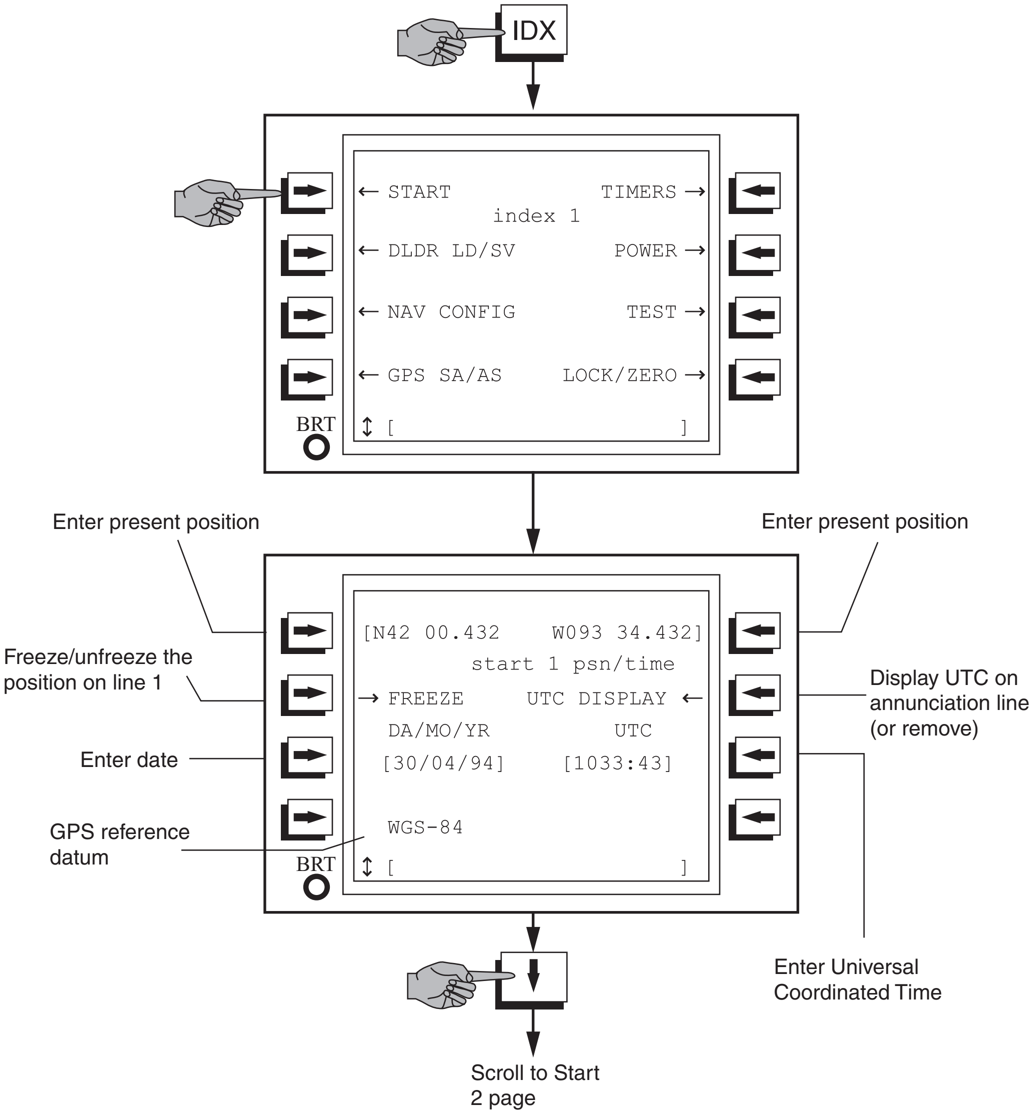
6. Scroll to the Start 5 page (figure 1.14-33). If a new flight plan and mission data are to be entered manually, select ERASE FPLN. If a new plan is to be loaded from the selected MSN data cartridge, first enter the desired flight plan number or name (if known) in the scratchpad and then select LS2. The CONFIRM LOAD ALTN message will appear alternately with the scratchpad entry. Press LS2 again to load the selected alternate flight plan into the CDU. After loading is complete, select FPLN REPLACE. This copies the alternate flight plan data into the active flight plan making both plans identical. This allows the crew more flexibility in manipulating flight plan data and the use of certain alternate flight plan features, e.g., fuel computations, without interfering with the active flight plan. However, it is not a requirement to keep the alternate flight plan the same as the active flight plan. A different alternate may be transferred into the CDU at any time. Also, the crew may select FLT/DATA LOAD (LS8) to load any markpoint/user waypoint list mission data.

7. If the alternate flight plan number or name are not known, a list of the flight plans stored on the data cartridge may be viewed by selecting ALTN CATLG.

This will access the Alternate Catalog 01-08 page. The available flight plans (up to 40) may be viewed by scrolling vertically among the five pages of the catalog. The SELECT ALTN LOAD scratchpad message will be displayed on each page and selection of a flight plan by pressing the adjacent line select key will load that flight plan into the CDU alternate flight plan slot and return to the Start 5 page. The message ALTN LOADING will be displayed on the right side of the information line during the loading process.

8. Access the Pilot and Copilot Steering pages to select the navigation solution sources for the pilot and copilot guidance displays. Normally, both pilots will select an integrated solution (INU1/GPS for the pilot and INU/GPS for the copilot). When operating in an environment where GPS spoofing is a possibility and GPS cryptographic keys are not loaded, both pilots should select OUT: GPS on Line Select Key #6 on their respective INU/GPS Integrated Navigation Page prior to encountering spoofing. After leaving the spoofing environment, both pilots should reselect USE: GPS on Line Select Key #6 on their respective INU/GPS Integrated Navigation Page to restore inputs to the Kalman Filter and integrated navigation solution.

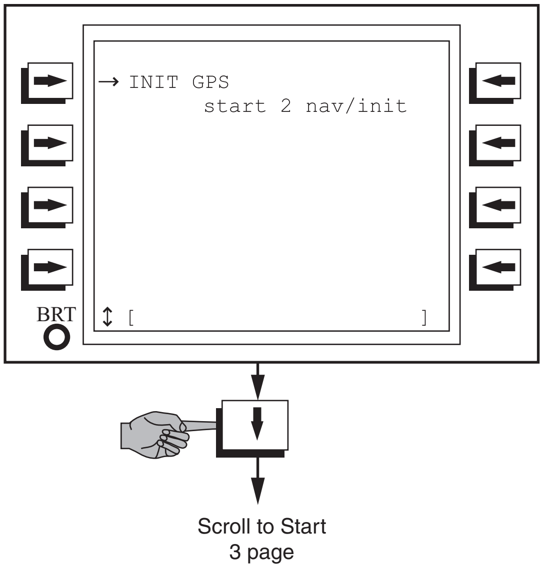
9. Access the Master Power page to turn on the navigation radios. Refer to the Navigation Radio Control section for instructions in selecting desired settings.



Position, time, and date are periodically updated with GPS data when it is valid.

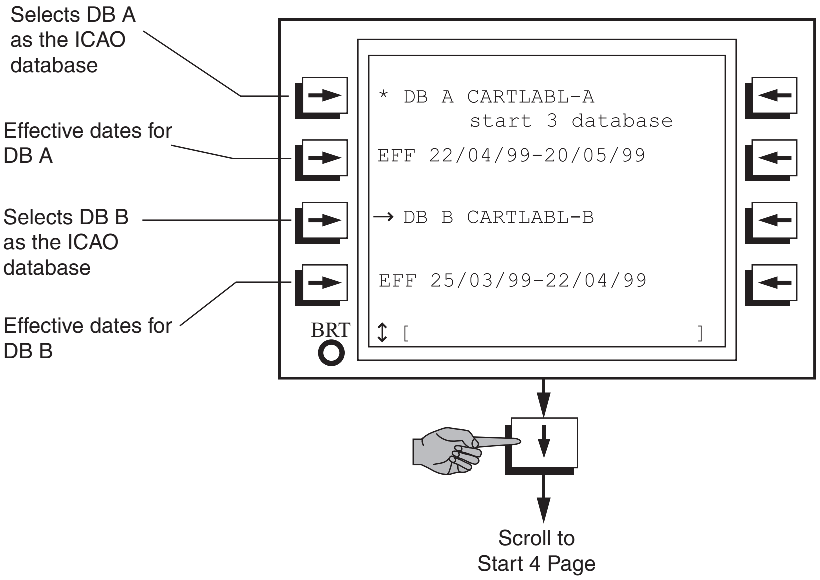
Note: The Start 1 page is initially displayed following FMS start-up.

Figure 1.14-29. Start 1 Position/Time Initialization Procedures



```
→ INIT GPS
       start 2 nav/init

↕ [                        ]
```

Figure 1.14-30. Start 2 Navigation/Initialization Procedures

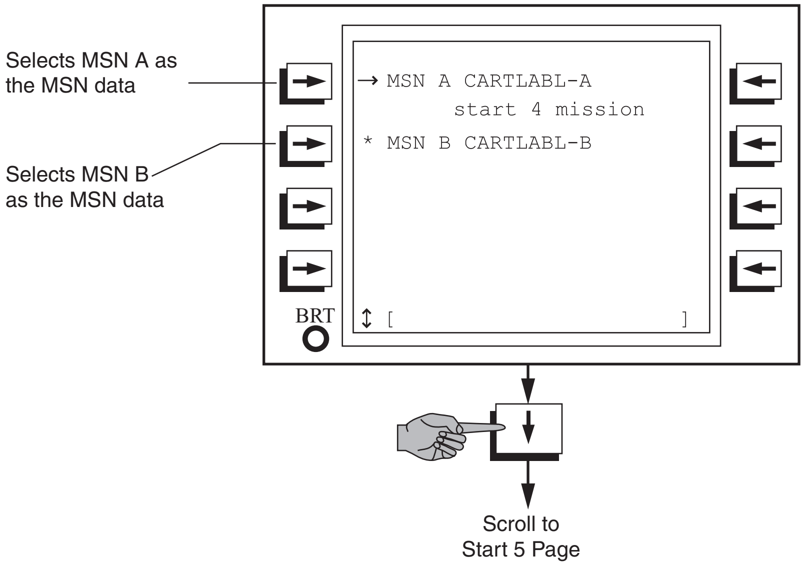


```
* DB A CARTLABL-A
       start 3 database
EFF 22/04/99-20/05/99

→ DB B CARTLABL-B

EFF 25/03/99-22/04/99
↕ [                        ]
```

Cartridge label will be dashed if no database is available.

The effectivity date will be dashed if no database is available.

Figure 1.14-31. Start 3 Database Page



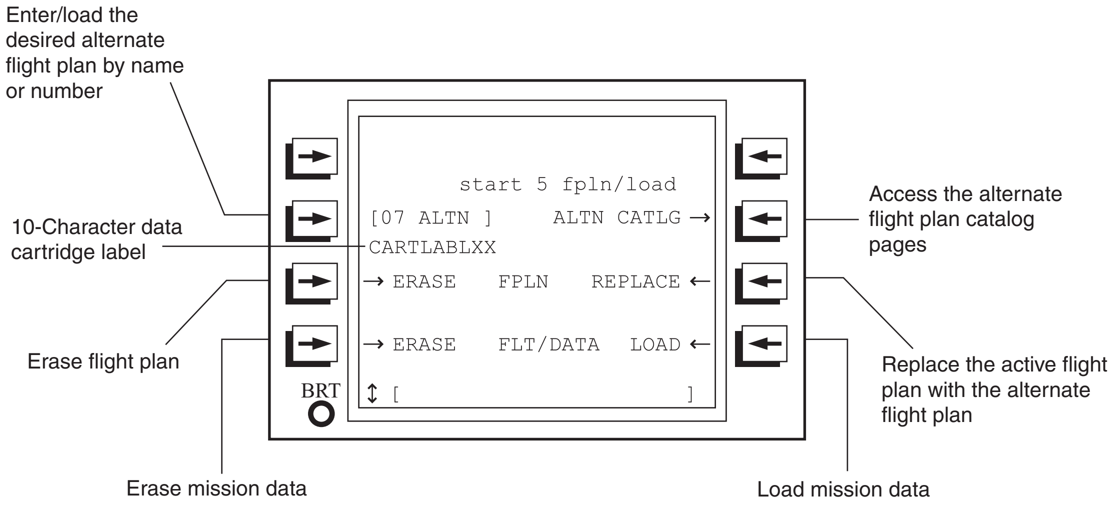
Selects MSN A as the MSN data

Selects MSN B as the MSN data

Scroll to Start 5 Page

Cartridge label will be dashed if no mission data is available.

Figure 1.14-32. Start 4 Mission Page



Enter/load the desired alternate flight plan by name or number

10-Character data cartridge label

Erase flight plan

Erase mission data

Access the alternate flight plan catalog pages

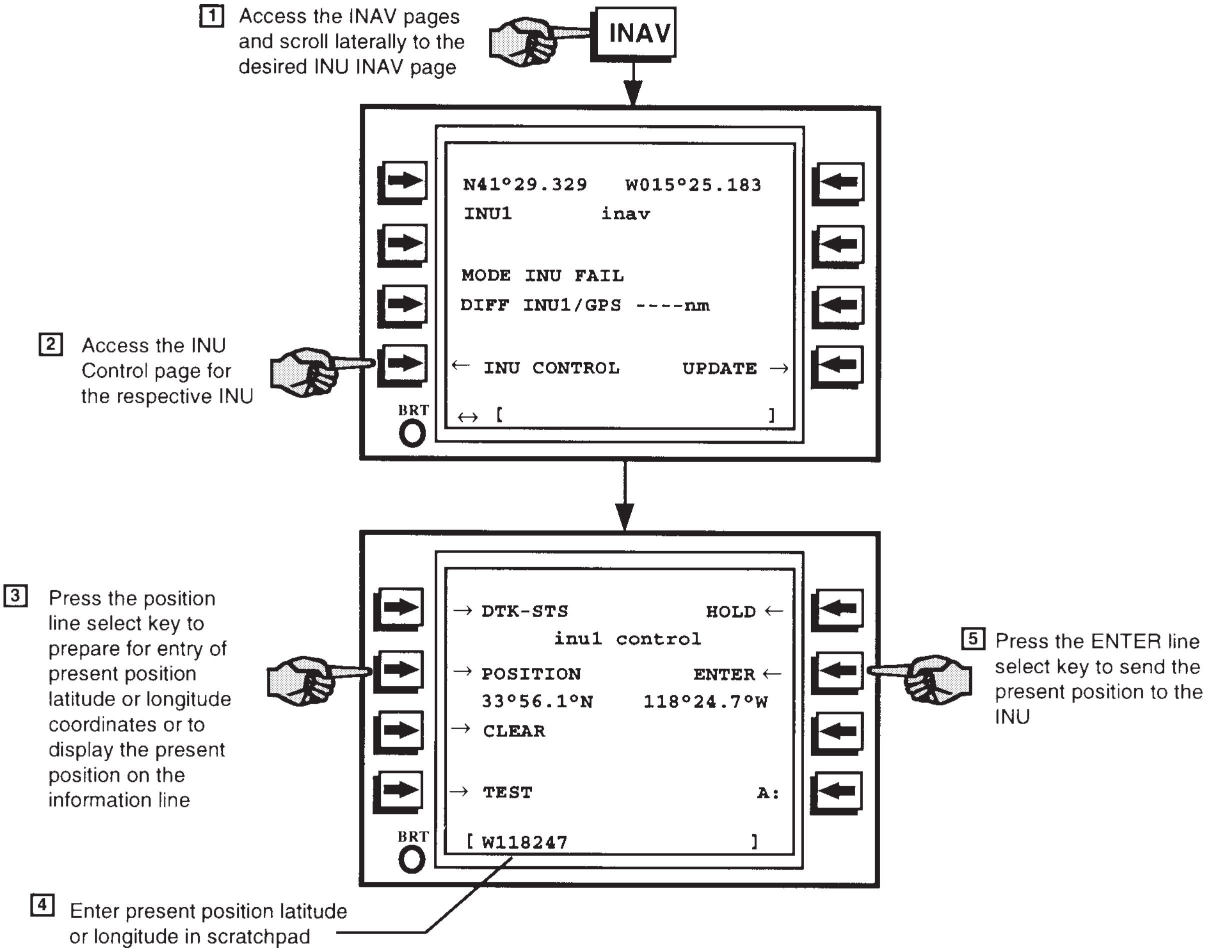
Replace the active flight plan with the alternate flight plan

Load mission data

Cartridge label will be dashed if no database is available.

Figure 1.14-33. Start 5 Flight Plan/Load Procedures

Pages 1.14-51 through 1.14-52 are deleted.



1 Access the INAV pages and scroll laterally to the desired INU INAV page

2 Access the INU Control page for the respective INU

3 Press the position line select key to prepare for entry of present position latitude or longitude coordinates or to display the present position on the information line

4 Enter present position latitude or longitude in scratchpad

5 Press the ENTER line select key to send the present position to the INU

Figure 1.14-34. LTN-72 INU Control Page

NAVIGATION CHART DATUMS

The FMS operates in the World Geodetic System of 1984 (WGS-84) reference datum since that is the reference datum used by GPS.

NOTE

> WGS-84 is a global coordinate reference system as opposed to the local datums used by most nations to chart their territory. Therefore, coordinates for a given point in WGS-84 are likely to differ, sometimes significantly from those published in a country's local datum. (This is not the case in the U.S. and Canada where the local North American Datum of 1983 is extremely close to WGS-84 values.) In order to ensure navigational precision, crews are advised to verify the accuracy (in relation to WGS-84) of any coordinates obtained from sources other than the FMS ICAO database.

FLIGHT PLAN MANAGEMENT

The active flight plan is an ordered list of up to 60 waypoints, stored in the order they are to be flown. The flight plan is maintained through addition, modification or deletion of waypoints. When a waypoint is passed, it is retained in the flight plan history list, where the last 39 such passed waypoints are maintained in order. History waypoints, denoted by a # symbol following the waypoint number, may be viewed by scrolling the Flight Plan page using the ↑ arrow key. The crew may delete history waypoints (using a - entry), but may not enter waypoints into history.

The FMS guidance function executes the flight plan by determing deviations form the desired flight plan track and controlling the sequencing of waypoints. Two forms of automatic leg advance are provided. When AUTO is selected, a switching point is determined as a function of ground speed, selected bank angle, and magnitude of course change to provide turn anticipation. When FLYOVER is selected, switching occurs at the waypoint. An external turn alert is generated for display on the EHSI prior to reaching the switching point for the next leg. The length of the alert is user-selectable between 10 and 120 seconds (defaults to 10 seconds) in the ENROUTE and OCEANIC flight guidance modes and fixed at 10 seconds in the TERMINAL and APPROACH modes.

Flight Plan Loading

There are three ways to enter flight plan data: 1) manually through the CDU active flight plan; 2) manually through the CDU alternate flight plan; and 3) automatically through the data cartridge catalog.

The PCMCIA data cartridge is a storage device capable of storing a catalog of alternate flight plans. The cartridge can be loaded at a mission planning ground station (MPGS) which can store thousands of user-defined flight plans. Up to 40 of these flight plans can be transferred from the MPGS to a data cartridge. The crew can then choose any one of these flight plans from the catalog on the selected MSN data cartridge to load into the alternate flight plan in the CDU. After loading the alternate flight plan, the crew can make changes or directly transfer the alternate flight plan to the active flight plan. If desired, the crew can also build or modify an alternate flight plan in the CDU and save it back to the selected MSN data cartridge.

Flight Plan Active Waypoint

The waypoint to which all flight instrument and CDU guidance displays are referenced is referred to as the active waypoint. Pressing the FPLN key on the CDU accesses the Flight Plan page with the active waypoint displayed under the ↓ ↓ symbol. Associated with the active waypoint are the following parameters which are displayed on the Flight Plan page:

1. Current desired inbound course measured at the waypoint (not current desired track at aircraft position)
2. Source of inbound course - computed (↓ ↓), manually entered (↓man↓), or Direct-To (↓dir↓)
3. Waypoint number in flight plan sequence
4. Flight plan sequencing mode
5. Waypoint attached attributes (hold, TNAV, etc.)
6. FROM label on the right side of the title line when on the From side of the active waypoint
7. Course and distance to the next waypoint after the active waypoint

The Flight Plan page is shown in figure 1.14-35 as it appears when initially accessed.

Numbering of Flight Plan Waypoints

A maximum of 60 future waypoints and 39 history waypoints are allowed at any time in the active flight plan. To access these future points, scroll the flight plan vertically with the ↓ arrow key. The flight plan waypoints are numbered sequentially from 01 to 99 with 00 (starting position) as the initial history waypoint. If a waypoint is added past waypoint 99, the numbering starts over at 01 or the first available number not assigned to a history, future, or active waypoint. Non-SID, STAR, approach or alternate flight plan waypoints that are inserted between existing waypoints receive an alphabetical suffix. If a SID, STAR, approach, or alternate flight plan is inserted in the flight plan, no alphabetical suffix is used. In this case the flight plan is automatically renumbered from the insertion forward starting with the next sequential number after the waypoint preceding the insertion. These features prevent the duplication of a waypoint number within the flight plan.

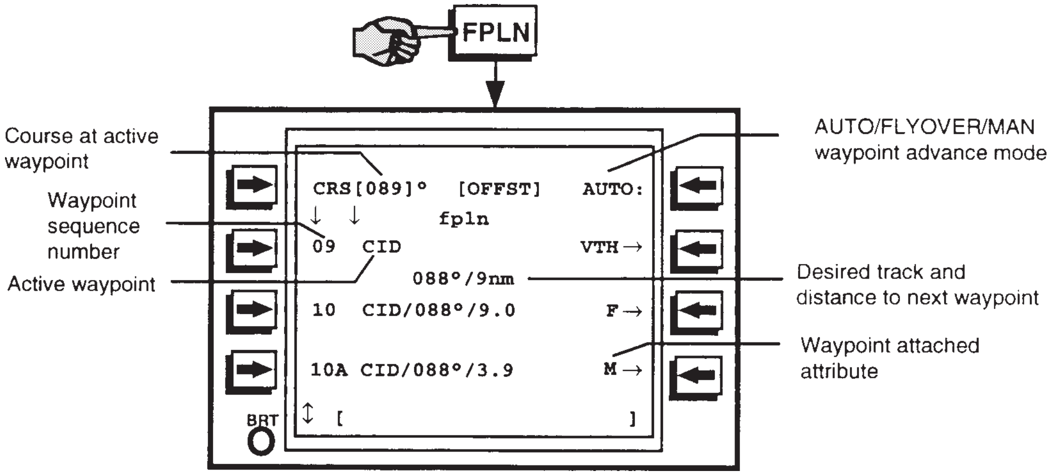


Figure 1.14-35. Flight Plan Page Displaying the Active Waypoint

Inserting Waypoints in Sequence

When the flight plan has been erased (as described in step 5 of the Initialization Procedures) the current designated pilot's navigation solution of present position is inserted as the first history waypoint and the Flight Plan page indicates *END in lieu of the active waypoint. Figure 1.14-36 illustrates insertion of the first waypoint of a new flight plan. Additional waypoints may be added in sequence at the *END prompt. The *END prompt will move down to the bottom of the page, then will remain there for entry of additional waypoints.

Inserting and Deleting Intermediate Waypoints

With some exceptions, intermediate waypoints may be inserted or deleted in the flight plan at any point that is desired. When waypoints are inserted, succeeding waypoints are automatically moved down the list. Upon insertion, the new waypoints assume the number of the immediately preceding waypoint with an alphabetical suffix, e.g., 03A, 03B, etc. There is an exception when a waypoint is inserted between two waypoints that already have an alphabetical suffix. The next character in sequence is used as the next suffix. If lettering goes as high as Z and an attempt is made to insert another waypoint, the RENUMBER FPLN scratchpad message is displayed. When waypoints are deleted (enter a - in the scratchpad and press the adjacent left line select key), the flight plan automatically eliminates all gaps by moving waypoints up the list as required. However, the flight plan is not renumbered; the missing numbers indicate where waypoints have been deleted.

There are three exceptions to the above description:

1. Inserting a new From waypoint (last history waypoint). Instead of waypoint moving down the list, the current From waypoint moves up the history list. An alphabetical suffix is added based on the preceding waypoint (former From waypoint).
2. No waypoint can be inserted between any two history waypoints.
3. The last history waypoint cannot be deleted.

The maximum number of waypoints allowed in the active flight plan is 60. The FPLN FULL message appears in the scratchpad if insertion of a 61st waypoint is attempted. Figure 1.14-37 demonstrates entry and deletion of intermediate flight plan waypoints.

WARNING

> The capability to insert or delete waypoints also applies to the TO (active) and FROM waypoint locations. Modification of these waypoints will have an immediate effect on aircraft navigation displays and flight guidance systems. If the TO waypoint is changed or deleted, the FMS computes and begins to capture a new course between the current FROM waypoint and the new TO waypoint. If the FROM waypoint is changed or deleted, the FMS computes and begins to capture a new course between the new FROM waypoint and the current TO waypoint.

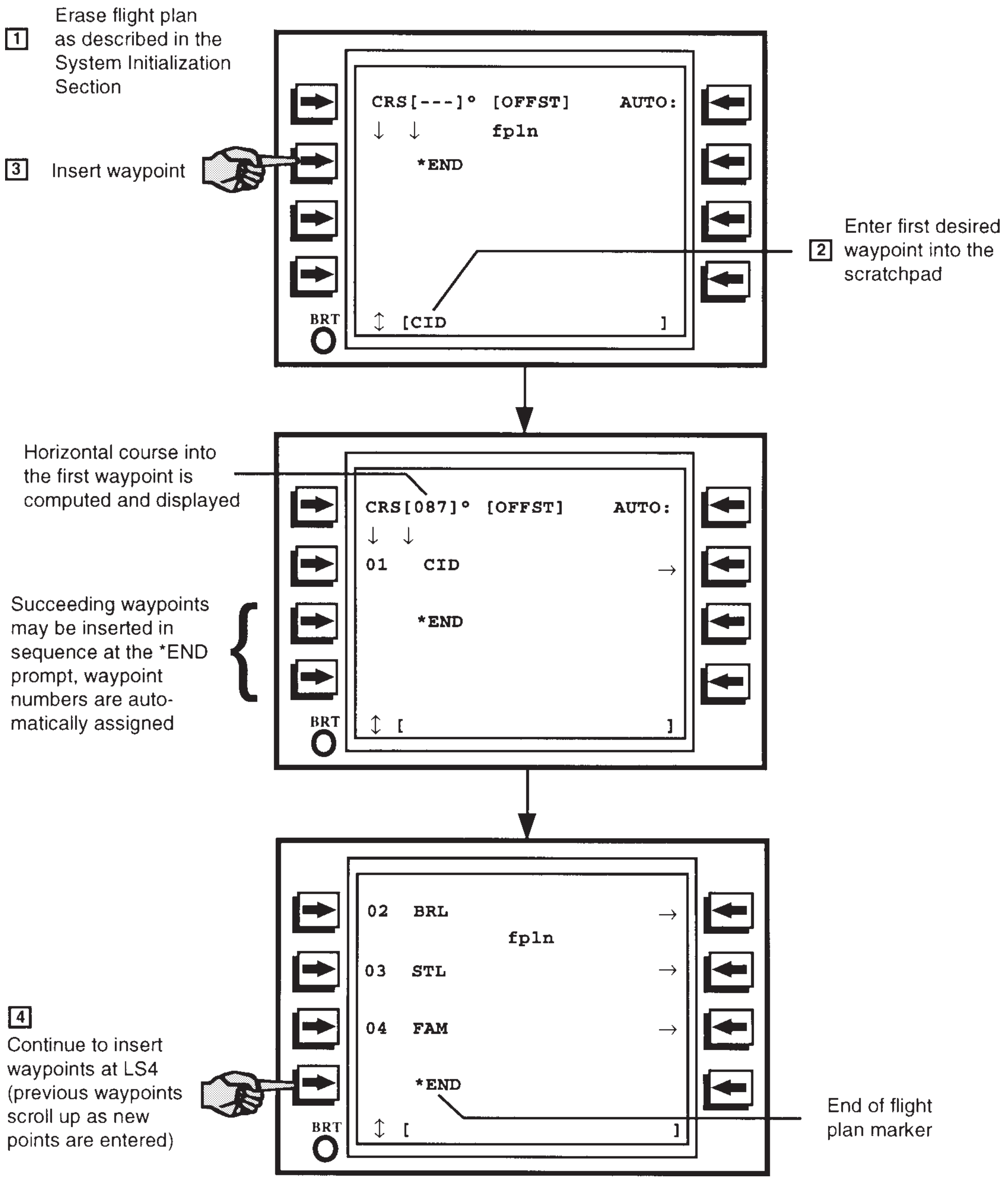
Renumbering Flight Plan Waypoints

If, after inserting or deleting waypoints, it is desirable to renumber the flight plan, access the Flight Plan Edit 2 page and then select the RENUMBER line select key (requires confirmation). This causes all future flight plan waypoints to be renumbered in sequence without alphabetic suffixes. The active waypoint is not renumbered, nor are the history waypoints renumbered.

Modifying Waypoint Location

If a bearing/distance (e.g., 050/23) is inserted at an ICAO identifier waypoint, that waypoint is displayed in the scratchpad with the bearing and distance offset attached without changing the flight plan (figure 1.14-38). If the bearing/ distance is applied to any other type of waypoint (e.g., latitude/longitude), then the FMS computes the latitude/longitude of the offset position and displays it in the scratchpad without changing the flight plan (figure 1.14-39). In either case, the new waypoint can now be inserted into the flight plan. The original waypoint may be deleted, if desired.

The offset bearing is referenced either to 1) station assigned magnetic variation, for a NAVAID waypoint, 2) true or magnetic north, for all other waypoints, depending on the position of the FMS heading switch, or 3) pilot-entered M or T suffix, which overrides the FMS heading switch for that entry only.



1 Erase flight plan as described in the System Initialization Section

3 Insert waypoint

2 Enter first desired waypoint into the scratchpad

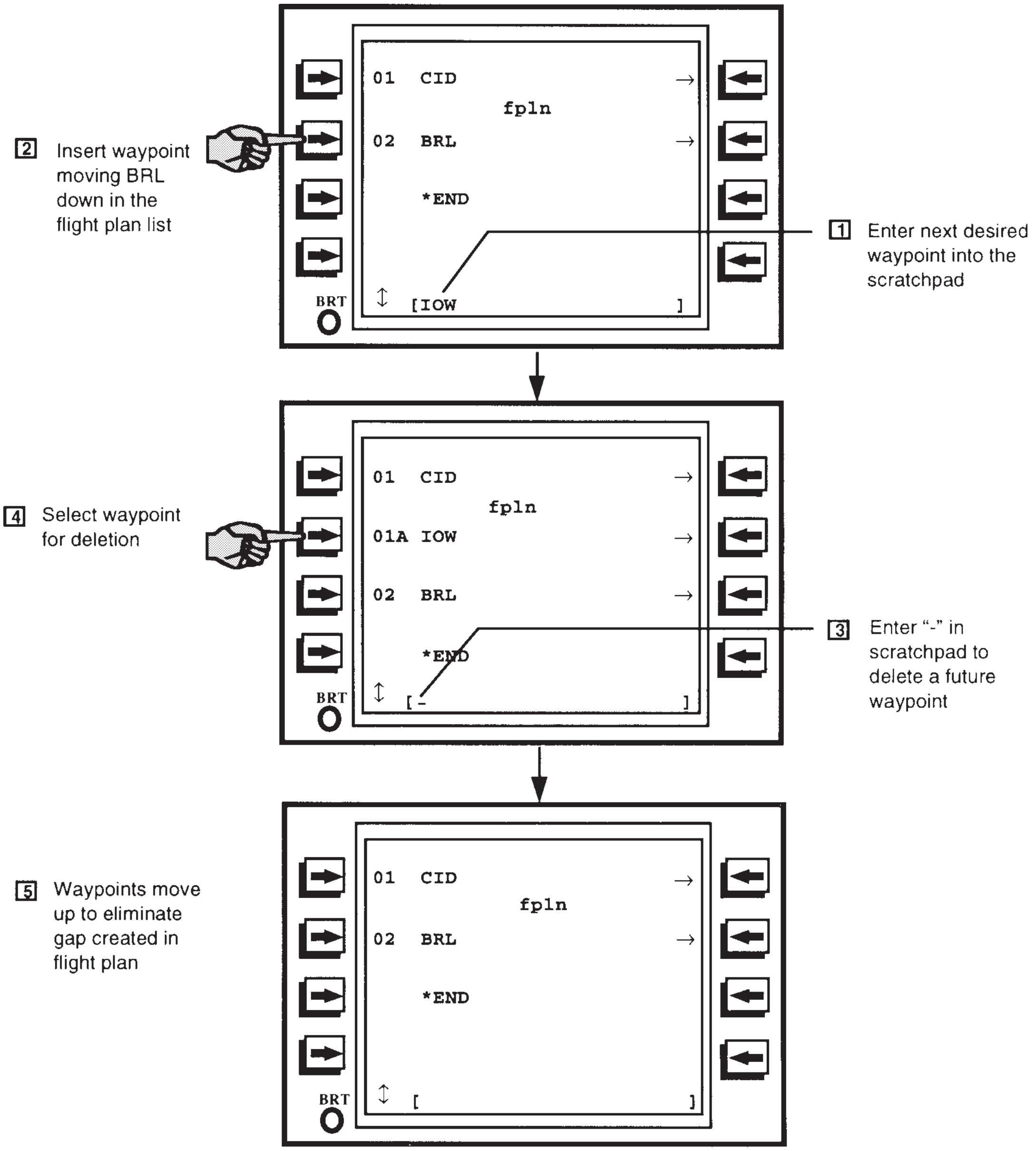
Horizontal course into the first waypoint is computed and displayed

Succeeding waypoints may be inserted in sequence at the *END prompt, waypoint numbers are automatically assigned

4 Continue to insert waypoints at LS4 (previous waypoints scroll up as new points are entered)

End of flight plan marker

Figure 1.14-36. Inserting Flight Plan Waypoint in Sequence



1 Enter next desired waypoint into the scratchpad

2 Insert waypoint moving BRL down in the flight plan list

3 Enter "-" in scratchpad to delete a future waypoint

4 Select waypoint for deletion

5 Waypoints move up to eliminate gap created in flight plan

Figure 1.14-37. Inserting and Deleting Intermediate Flight Plan Waypoints

Waypoints with Duplicate Identifiers

If a waypoint identifier is entered which is duplicated in another area of the world, the Select Waypoint page is automatically accessed (figure 1.14-40). This page displays the data for up to 20 waypoints having the same identifier (if more than two waypoints exist, the page may be scrolled to view the additional waypoints). Up to 19 duplicate identifiers will be searched for in the primary ICAO database on the cartridge. One duplicate identifier will be searched for in the User Waypoint list. The identifiers are ordered from closest to farthest in relation to the present position. Select the desired waypoint by pressing the adjacent line select key (LS1 or LS3) and the CDU will immediately return to the originating page with that waypoint inserted in the desired location. A frequency will only be displayed if the waypoint identifier is three letters long or less. Possible types of waypoints include VOR, V/T (for VORTAC), TCN (for TACAN), V/D (for VOR-DME), NDB, N/D (for NDB-DME), FIX, APT (for Airport), and DME.

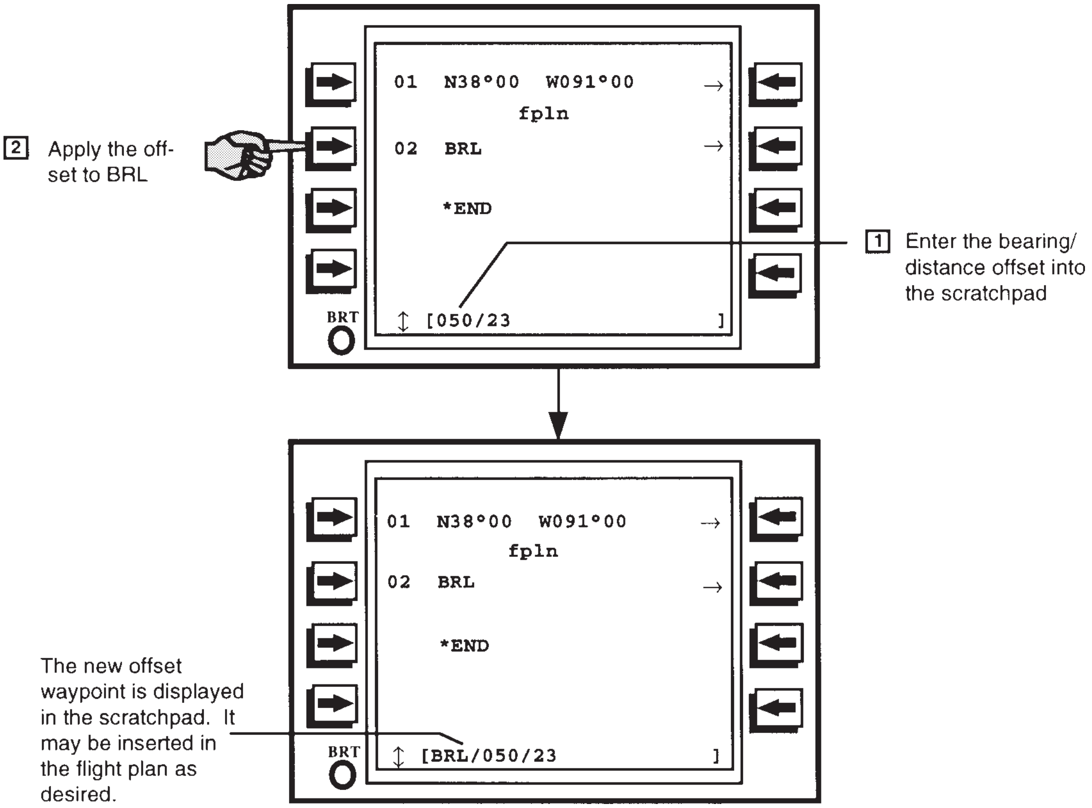


Figure 1.14-38. Modifying ICAO Identifier Locations

The title line displays the number range of the displayed duplicate identifiers (i.e., 1-2, 3-4, 5-6, etc.) and the total number of duplicate identifiers for the entered waypoint. The scratchpad retains the original waypoint identifier entry until a duplicate waypoint identifier has been selected.

The information line will display SEARCH IN PROGRESS when a search for duplicates is being conducted. If a search is interrupted, SEARCH FAILED will be displayed. An interruption of a search can be caused by removal of the cartridge, a data receptacle failure, or bus controller swap.

A listing of the country codes appears in figure 1.14-41. This list may not be all inclusive or current as the country identifiers sometimes change. Refer to ICAO Document No. 7910, Location Indicators, for a current listing.

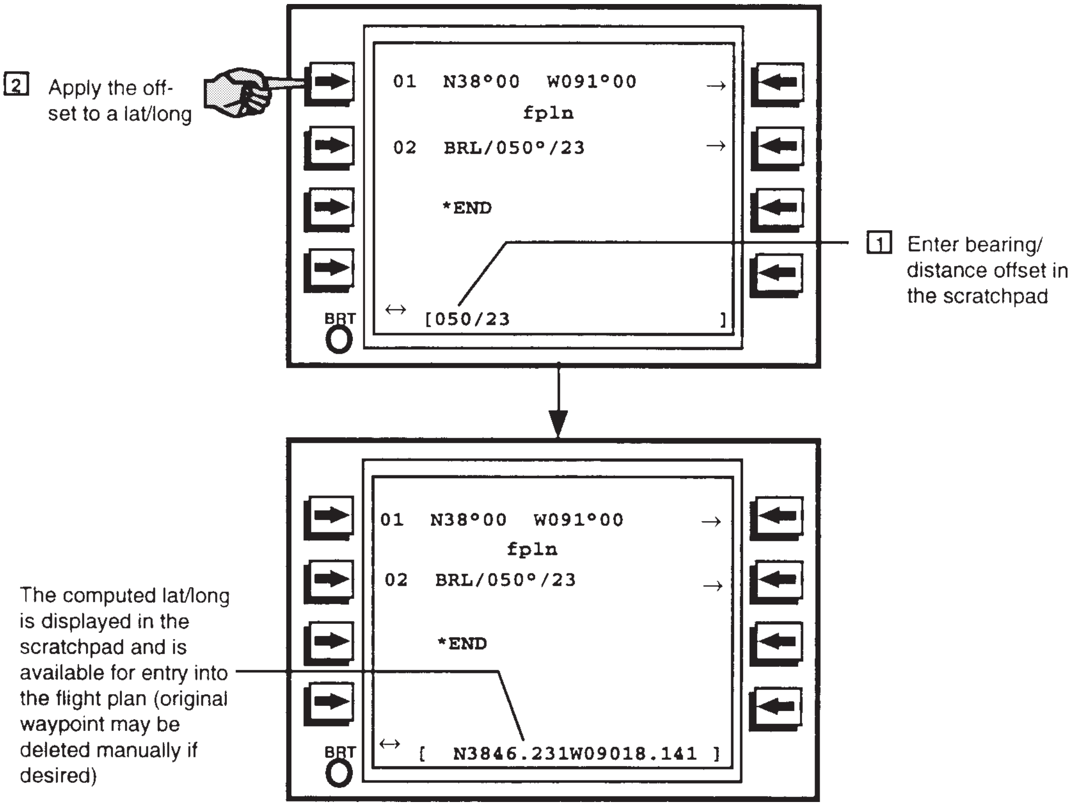


Figure 1.14-39. Modifying Latitude/Longitude Locations

Flight Plan Waypoint Attribute Designators

Letter designators are displayed on the right side of the Flight Plan page (figure 1.14-42) to indicate special attributes have been assigned to a waypoint. These provide quick reference for the pilot. They are also displayed on the individual Flight Plan Waypoint pages where selection of the adjacent line select provides direct access to the respective pattern or other defined function. These attributes (except the intercept I, SID S, STAR R, VNAV V when attached to a MAP or RWXND waypoint, and approach M, D, and F attributes) may also be deleted by entering a - in the scratchpad and selecting the line select key adjacent to the attribute to be deleted. This feature enables the crew to delete maneuvers without leaving the flight plan page. If more than one attribute is displayed, for example VH, then the one farthest to the right is deleted.

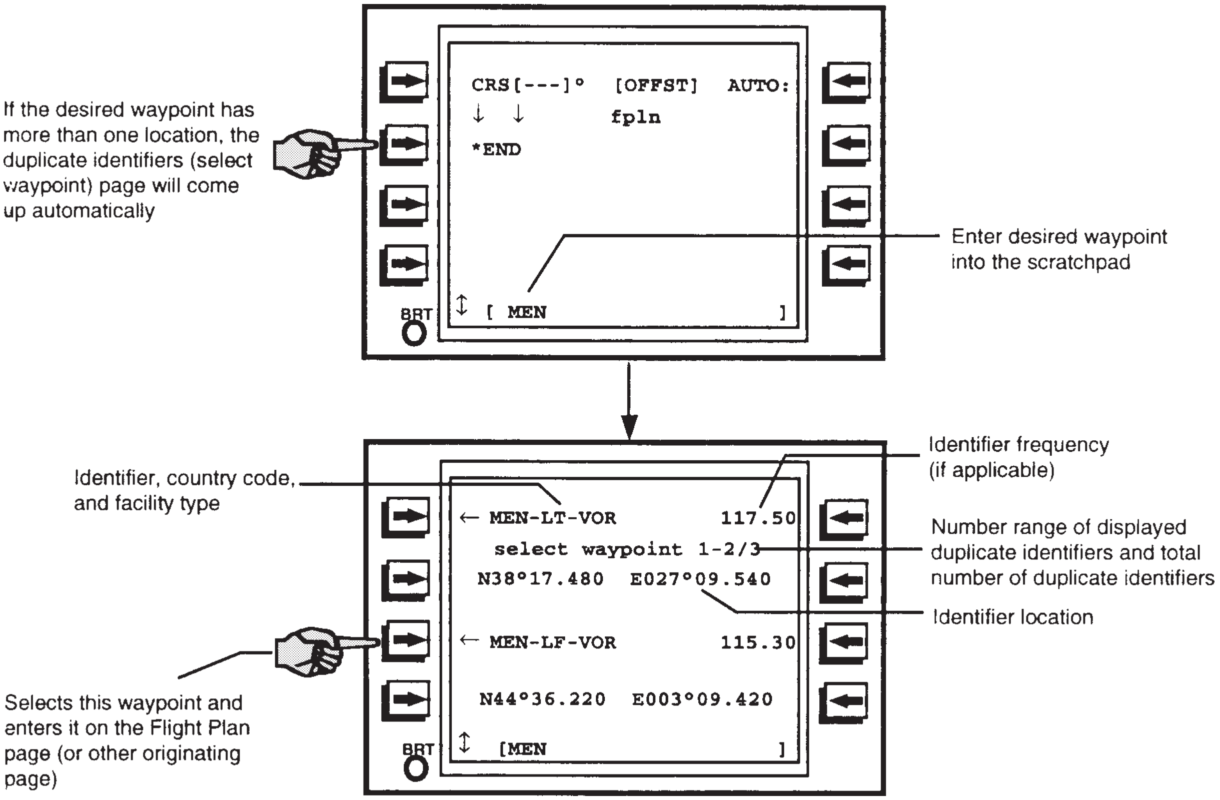


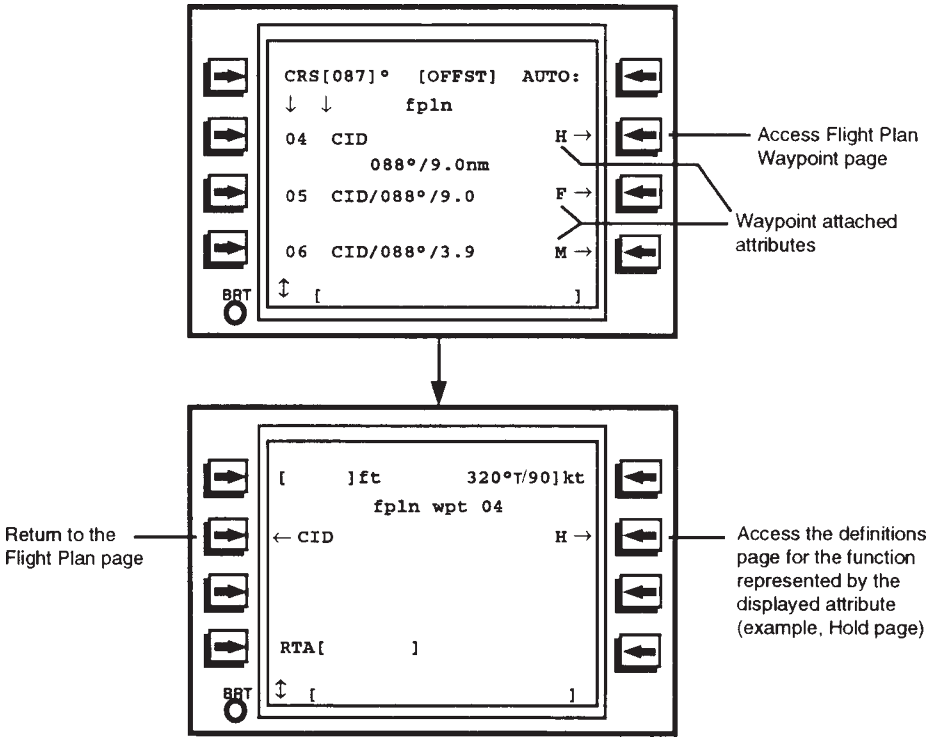
Figure 1.14-40. Duplicate Identifiers Select Waypoint Page

Up to three attributes can be assigned to each waypoint. The attribute designators and their meanings are as follows:

M	The waypoint is designated as the missed approach point (MAP).
D	A DME arc will be flown to this waypoint. DME arcs only exist in published GPS overlay approaches.
F	The waypoint is designated as the final approach fix (FAF) for a databased GPS or tactical approach.
I	The waypoint is a valid intercept or point of closest approach (PCA) solution for a moving target.
R	This waypoint is part of a STAR.
S	This waypoint is part of a SID.
T	The waypoint has a desired time of arrival associated with it. This indicates that a time navigation (TNAV) functions will be performed to obtain the required time of arrival (RTA) specified on the Flight Plan Waypoint page.

A1	Antarctica
AB	Australia
AD	Australia
AM	Australia
AP	Australia
AS	Australia
AG	Solomon Islands
AN	Nauru
AY	Papua New Guinea
BG	Greenland
BI	Iceland
CF	Canada
CU	Canada
CW	Canada
CY	Canada
CZ	Canada
DA	Algeria
DB	Benin
DF	Burkina Faso
DG	Ghana
DI	Ivory Coast
DN	Nigeria
DR	Niger
DT	Tunisia
DX	Togo
EB	Belgium
ED	Germany (W.)
EE	Estonia
EF	Finland
EG	United Kingdom
EH	Netherlands
EI	Ireland
EK	Denmark
EL	Luxembourg
EN	Norway
EP	Poland
ES	Sweden
ET	Germany (E.)
EV	Latvia
EY	Lithuania
FA	South Africa
FB	Botswana
FC	Congo
FD	Swaziland
FE	Central African Republic
FG	Equatorial Guinea
FH	Ascension Is.
FI	Mauritius
FJ	Brit. Indian Ocean Terr.
FK	Cameroon
FL	Zambia
FM	Madagascar, Comores, La Reunion, Mayotte
FN	Angola
FO	Gabon
FP	Sao Tome and Principe
FQ	Mozambique
FS	Seychelles
FT	Chad
FV	Zimbabwe
FW	Malawi
FX	Lesotho
FY	Namibia
FZ	Zaire
GA	Mali
GB	Gambia
GC	Canary Islands
GE	Melilla
GF	Sierra Leone
GG	Guinea Bissau
GL	Liberia
GM	Morocco
GO	Senegal
GQ	Mauritania
GS	Sahara Occidental
GU	Rep. De Guinee
GV	Cape Verde
HA	Ethiopia
HB	Burundi
HC	Somalia
HE	Egypt
HF	Djibouti
HH	Eritrea
HK	Kenya
HL	Libya
HR	Rwanda
HS	Sudan
HT	Tanzania
HU	Uganda
K*	USA
LA	Albania
LB	Bulgaria
LC	Cyprus
LD	Croatia
LE	Spain
LF	France
LG	Greece
LH	Hungary
LI	Italy
LJ	Slovenia
LK	Czech
LL	Israel
LM	Malta
LN	Monaco
LO	Austria
LP	Portugal
LQ	Bosnia and Herzegovina
LR	Romania
LS	Switzerland
LT	Turkey
LU	Republic of Moldova
LW	Macedonia
LX	Gibraltar
LY	Yugoslavia
LZ	Slovakia
MB	Turks and Caicos Islands
MD	Dominican Rep
MG	Guatemala
MH	Honduras
MK	Jamaica
MM	Mexico
MN	Nicaragua
MP	Panama
MR	Costa Rica
MS	El Salvador
MT	Haiti
MU	Cuba
MW	Cayman Islands
MY	Bahamas
MZ	Belize
NC	Cook Islands
NF	Fiji, Tonga
NG	Kiribati, Tuvalu
NI	Nuie Island
NL	Wallis Island
NS	Samoa
NT	French Polynesia
NV	Vanuatu
NW	New Caledonia
NZ	New Zealand
OA	Afghanistan
OB	Bahrain
OE	Saudi Arabia
IO	Iran
OJ	Jordan
OK	Kuwait
OL	Lebanon
OM	United Arab Emirates
OO	Oman
OP	Pakistan
OQ	Bosnia and Herzegovina
OR	Iraq
OS	Syria
OT	Qatar
OY	Yemen
PA	Alaska
PB	Baker Island
PC	Phoenix Island
PF	Alaska
PG	Mariana Island or Guam
PH	Hawaii
PJ	Johnston Island
PK	Marshall Islands
PL	Line Island or Kiribati
PM	Midway Island
PO	Alaska
PP	Alaska
PT	Micronesia
PW	Wake Island
RC	China (Taiwan)
RJ	Japan
RK	Korea
RP	Philippines
SA	Argentina
SB	Brazil
SC	Chile
SE	Ecuador
SF	Falkland Islands
SG	Paraguay
SK	Columbia
SL	Bolivia
SM	Surinam
SN	Brazil
SO	French Guiana
SP	Peru
SS	Brazil
SU	Uruguay
SV	Venezuela
SY	Guyana
S1	Antarctica
TA	Antigua, Barbuda
TB	Barbados
TD	Dominica
TF	French Antilles
TG	Grenada
TI	Virgin Is. (U.S.)
TJ	Puerto Rico
TK	St. Kitts – Nevis
TL	St. Lucia
TN	Netherlands Antilles, Aruba
TQ	Anguilla Island
TR	Montserrat Is.
TT	Trinidad and Tobago
TU	Virgin Is. (U.K.)
TV	St. Vincent Grenadines
TX	Bermuda
U*	Russia
UA	Kazakhstan, Kyrgyzstan
UB	Azerbaijan
UE	Russia
UG	Georgia
UH	Russia
UI	Russia
UK	Moldova, Ukraine
UL	Russia
UM	Russia, Belarus
UN	Russia
UO	Russia
UR	Russia, Kazakhstan
US	Russia
UT	Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan
UU	Russia
UW	Russia
VA	India
VE	India
VI	India
VO	India
VB	Myanmar
VC	Sri Lanka
VD	Cambodia
VG	Bangladesh
VH	Hong Kong
VL	Laos
VM	Macao
VN	Nepal
VQ	Bhutan
VR	Maldives
VT	Thailand
VV	Vietnam
VY	Myanmar
WA	Indonesia
WI	Indonesia
WP	Indonesia
WR	Indonesia
WB	Malaysia, Brunei
WM	Malaysia
WS	Singapore
Y*	Australia
YB	Australia
YM	Australia
YP	Australia
YS	Australia
ZB	China
ZG	China
ZH	China
ZL	China
ZP	China
ZS	China
ZT	China
ZU	China
ZW	China
ZY	China
ZK	Korea
ZM	Mongolia

Figure 1.14-41. Country Codes



Access Flight Plan Waypoint page

Waypoint attached attributes

Return to the Flight Plan page

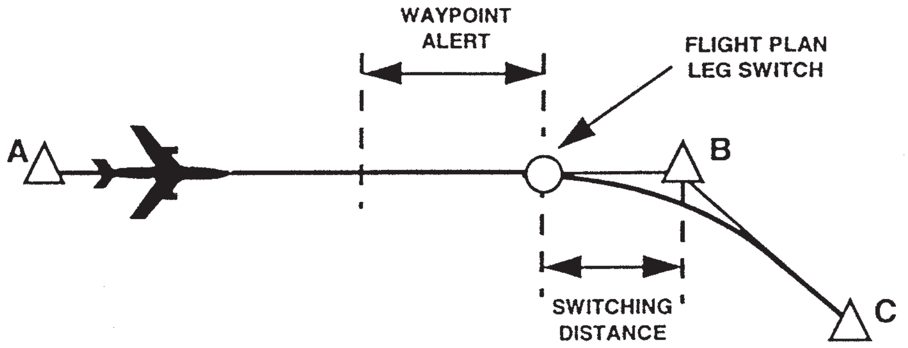
Access the definitions page for the function represented by the displayed attribute (example, Hold page)

Figure 1.14-42. Flight Plan Waypoint Attribute Designators

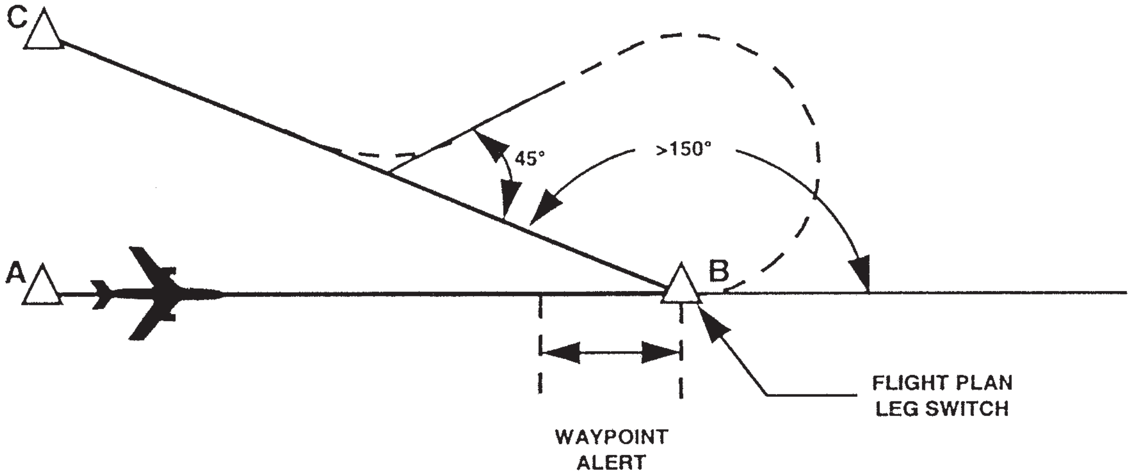
V	The waypoint has an altitude specified which will cause vertical navigation computations to be performed.
C	A course reversal is enabled at this waypoint. This attribute is displayed on the Flight Plan and Flight Plan Waypoint pages when the course reversal is enabled at the IAF.
H	A holding pattern has been attached to this waypoint. If the waypoint is an IAF or missed approach holding point (MAHP) of a databased approach with a databased holding pattern attached, this attribute is displayed on the Flight Plan page only when the holding pattern is enabled.
P	This waypoint is a fix for a mission flight pattern (MFP) which will be executed upon arrival at the point.

Automatic Leg Advance

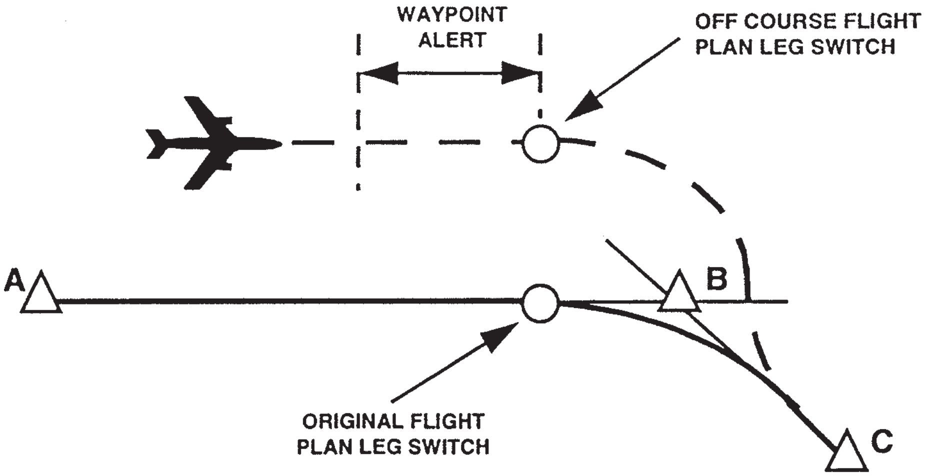
When waypoints beyond the active waypoint are in the flight plan and waypoint sequencing is in an automatic mode (AUTO or FLYOVER), the FMS computes great circle tracks between those waypoints and automatically switches from one leg to the next. To



AUTO Waypoint Advance with Angle ≤ 150 °.



AUTO Waypoint Advance with Angle > 150 °.



AUTO Waypoint Advance from OFF Course Position.

Figure 1.14-43. Lateral To-To Course Transitions in AUTO Advance Mode

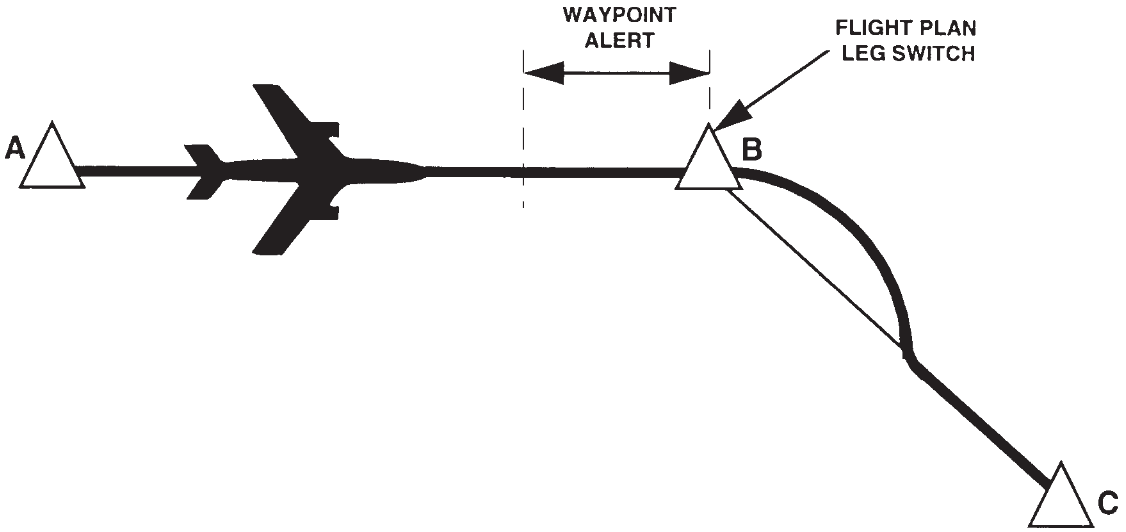


Figure 1.14-44. Lateral To-To Course Transitions in FLYOVER Advance Mode

sequence to the next waypoint, aircraft track angle must be within 90° (TKE ≤90°). Leg switching includes turn anticipation in AUTO (up to 15 nautical miles prior to the waypoint) to prevent overshoot of the next leg unless the track (course) change is greater than 150°. In this case the waypoint is overflown and a teardrop turn is made to intercept the next leg (figure 1.14-43). In FLYOVER mode, waypoint sequencing occurs at the waypoint and will always result in an overshoot unless there is no appreciable course change (figure 1.14-44). For normal operations, waypoint sequencing should be set to AUTO.

The FMS will automatically revert from FLYOVER to AUTO sequencing for procedure execution when the first SID, STAR, or approach waypoint becomes the active waypoint or the aircraft enters the terminal area. If a SID, STAR, or approach waypoint is identified in the database as a flyover waypoint, the FMS will execute the flyover, but the sequencing mode will remain in AUTO. The crew may manually override the automatic waypoint sequencing mode selections, except when the MAP is the active waypoint.

NOTE

> It is recommended that the waypoint sequencing mode remain in AUTO when the FMS is executing a SID, STAR, or approach procedure.

Operator entered course changes inbound to the active waypoint of up to 90° are permitted when operating in AUTO or FLYOVER. Enter the desired course in the scratchpad on the Flight Plan page and press LS1. The ↓ ↓ symbol will change to ↓man↓ and guidance displays will change to reference the entered course.

Prior to the leg switch point, the EHSI waypoint alert annunciation flashes (alert time is a user-selectable 10-120 seconds for ENROUTE and OCEANIC flight guidance modes; 10 seconds for TERMINAL and AP-

PROACH). The waypoint number on the Flight Plan page and the ↓to↓ indicator on the Pilot/Copilot Lateral Steering pages flash for 10 seconds prior to the switch point.

Manual Waypoint Advance

When manual waypoint advance is selected, the flight plan does not sequence to the next leg automatically. The flight plan only sequences when the crew performs one of three actions: (1) Select AUTO or (2) FLYOVER waypoint advance mode on the Flight Plan page, or (3) perform a Direct-To any other waypoint. The FMS provides guidance after crossing the active waypoint based on one of two conditions: (1) the great circle course between the last two waypoints or (2) a crew entered course on the flight plan page. This allows the crew to fly an outbound course from the active waypoint when needed.

Prior to passing over the waypoint, the normal waypoint turn alert, as described in the Automatic Leg Advance section, will occur. As the waypoint is passed, the <<wpt passed>> annunciation will be displayed on the annunciation line and the FROM indication will be displayed on the right side of the title line on the Flight Plan page.

In order to fly a desired outbound course, perform these steps: (1) select MAN waypoint advance mode, (2) if required, select (via a Direct-To) or enter a new active waypoint, and (3) enter the desired course. Selecting MAN prevents the active waypoint from being sequenced. If the aircraft is on the TO side of the waypoint after completing these steps, then the aircraft must fly to the FROM side of the waypoint before it can fly the outbound (FROM) course as selected. If the aircraft is on the FROM side of the waypoint, then the FMS will immediately initiate guidance to the desired outbound course and all TO indications will change to FROM indications.

TACAN/VOR/NDB Emulation Procedures

Since the FMS provides the capability to fly a selected course TO or FROM the active waypoint (TO-FROM navigation), this feature may be used to perform TACAN/VOR/NDB emulation using GPS navigation as shown in figure 1.14-45. The crew can enter, display, and fly the courses printed on IFR Enroute Low and High Altitude aeronautical charts for published airways or courses associated with TACANs, VORs, VORTACs, VOR-DMEs, and NDBs. In order to perform TACAN/VOR/NDB emulation, follow the same steps as for Manual Waypoint Advance except that the active waypoint must be an ICAO identifier for a TACAN, VOR, VORTAC, VOR-DME, or NDB. With the EHSI navigation source and bearing pointer set to FMS, then FMS data (bearing, desired course, distance, To/From indication, etc.) will be displayed on the flight instruments and it will appear as published on the FLIPs. If a DME arc is to be flown, the CDU Lateral Steering pages continue to show the bearing and distance to the station (waypoint) as the arc is flown.

NOTE

> Caution should be exercised if the procedure contains a noncollocated DME since FMS distance will be the direct distance to the waypoint, not the DME source.

Waypoint Steering Data

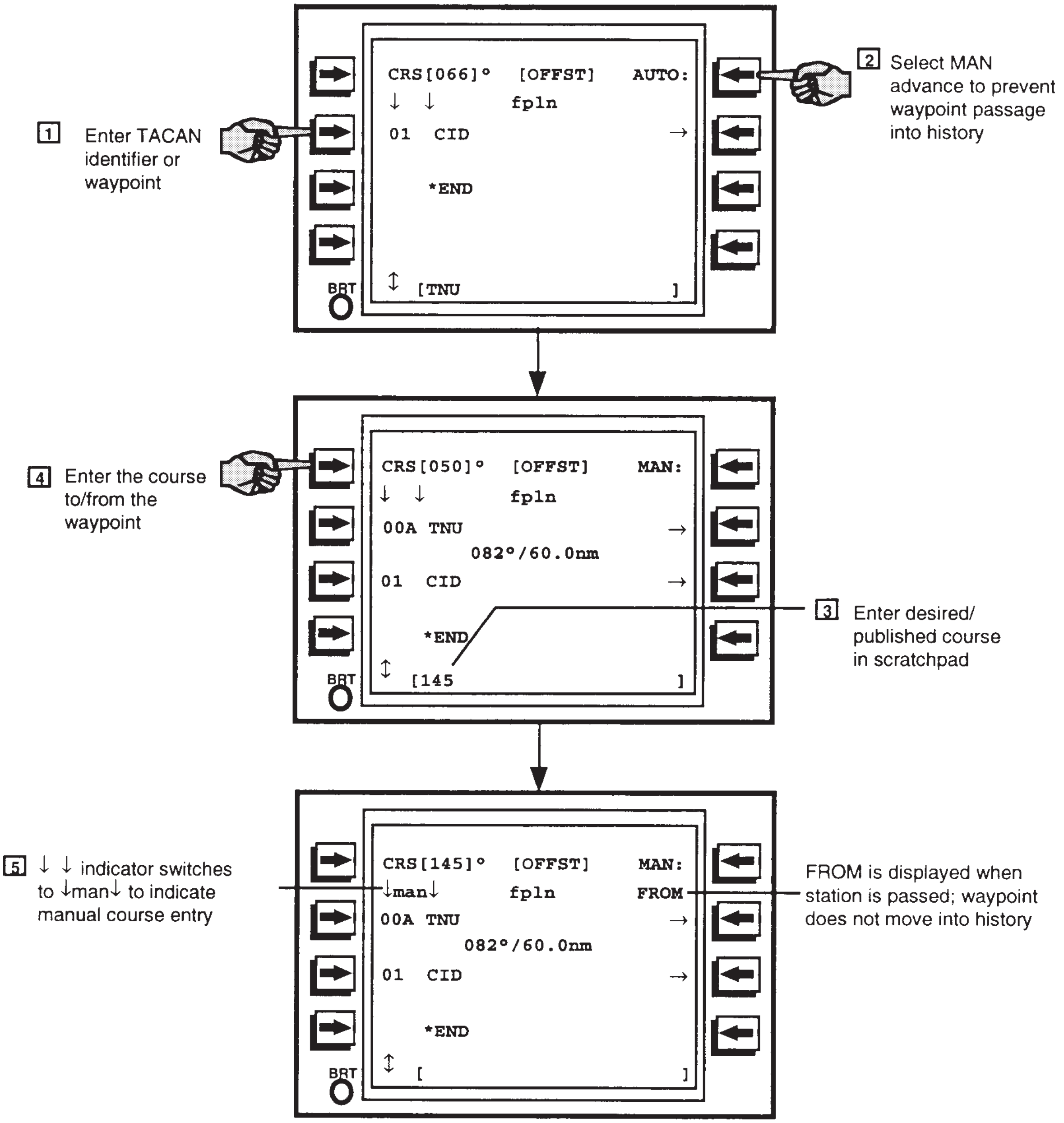
Once an active flight plan is entered with an active waypoint, the FMS computes two independent steering solutions, called the pilot's steering and copilot's steering, respectively. Both are referenced to the same active waypoint. Although any crew member may view either steering solution on his/her CDU, the nomenclatures refer to the steering data which is being output to the Pilot's and Copilot's EHSI and flight director system, respectively.

Display of Pilot and Copilot Steering Data

When the STR function key is pressed, the CDU presents either the Pilot's (or Copilot's) Lateral or Vertical Steer page, depending on which had been last viewed on that CDU (figure 1.14-46). To access the other pilot's steering solution data, scroll laterally from the STR page using the → or ← arrow keys (lateral scrolling from the VNAV pages is prohibited.

Designated Pilot's Steering Guidance

The term designated pilot refers to which pilot's steering solution (Pilot's or Copilot's) is selected to drive the autopilot. The selection is made with the autopilot switches: AP 1 selects the Pilot's solution; AP 2 selects the Copilot's solution. If neither autopilot is in use, the system defaults to the Pilot's solution. The designated pilot also determines which steering solution is used for the flight plan waypoint advance, turn anticipation calculation, markpoint function, lateral capture functions, and default startup initialization. The designated pilot selection is displayed on the Navigation Configuration 1 page (figure 1.14-47).



1 Enter TACAN identifier or waypoint

2 Select MAN advance to prevent waypoint passage into history

4 Enter the course to/from the waypoint

3 Enter desired/ published course in scratchpad

5 ↓ ↓ indicator switches to ↓man↓ to indicate manual course entry

FROM is displayed when station is passed; waypoint does not move into history

Figure 1.14-45. TACAN/VOR/NDB Emulation (Manual Advance and Course Entry)

Selection of Steering Navigation Source

There are seven possible navigation solutions computed by the FMS: INU1, INU2, INU3 (if selected to replace INU 1 or 2 via the INS selector switch), GPS, INU1/GPS, INU2/GPS, or INU3/GPS (if INU3 is selected to replace INU 1 or 2 via the INS selector switch). The pilot can select INU1, GPS, or INU1/GPS normally and INU3, GPS, or INU3/GPS with INS selector switch in CAPT ON AUX. The copilot can select INU2, GPS, or INU2/GPS normally and INU3, GPS, or INU3/GPS with the INS selector switch in F/O ON AUX. The default (power- up) selection is INU1/GPS for the pilot and INU2/GPS for the copilot (INS selector switch in NORM). Figure 1.14-46 shows the procedure for changing the Pilot's steering source as an example.

Speed Command for Required Time of Arrival

If the mission includes a required time of arrival (RTA) at one or more waypoints, these times may be entered on the Flight Plan Waypoint page as shown in figure 1.14-48. If the active flight plan was transferred from the alternate flight plan (see Alternate Flight Planning section) and a planned time of arrival (PTA) was attached to any waypoint in the alternate, then that PTA becomes an RTA in the active flight plan at that same waypoint after it is transferred. To delete an RTA, enter a - in the scratchpad and select the RTA line select key on the Flight Plan Waypoint page.

To view the computed ground speed required to make good the RTA, select the Pilot or Copilot Lateral Steer page (figure 1.14-46). The speed command is for the first waypoint with an RTA.

If the crew wishes to be alerted when the actual speed differs from the commanded speed, the desired threshold should be entered on the Navigation Configuration 2 page (figure 1.14-47). When this alert is triggered, a √speed alert will appear on the FMS annunciation line and a MSG alert will appear on the EHSIs.

Entry and Display of Bank Command Limits

The Pilot may specify a reduced bank (roll) command limit for any flight plan leg by setting the desired value with the autopilot bank angle selector. This bank angle setting will be read by the FMS and displayed on the Navigation Configuration 1 page as shown in figure 1.14-47. The turn anticipation leg switching compuations adjust according to this bank command limit.

Selection of Flight Mode

On the Navigation Configuration 1 page, the current mode of flight can be selected as shown in figure 1.14-47. The mode selection affects the EHSI CDI scaling. When powered up, the FMS defaults to TERMINAL mode until 30 NM from the origin airport, at which point it changes to ENROUTE mode. When the aircraft comes within 30 NM of the destination airport, the FMS automatically transitions back to TERMINAL mode. When the aircraft reaches the final approach fix of an approach, the FMS transitions to APPROACH mode. These automatic flight mode changes (except the APPROACH mode) can be manually over-ridden on the Navigation Configuration 1 page.

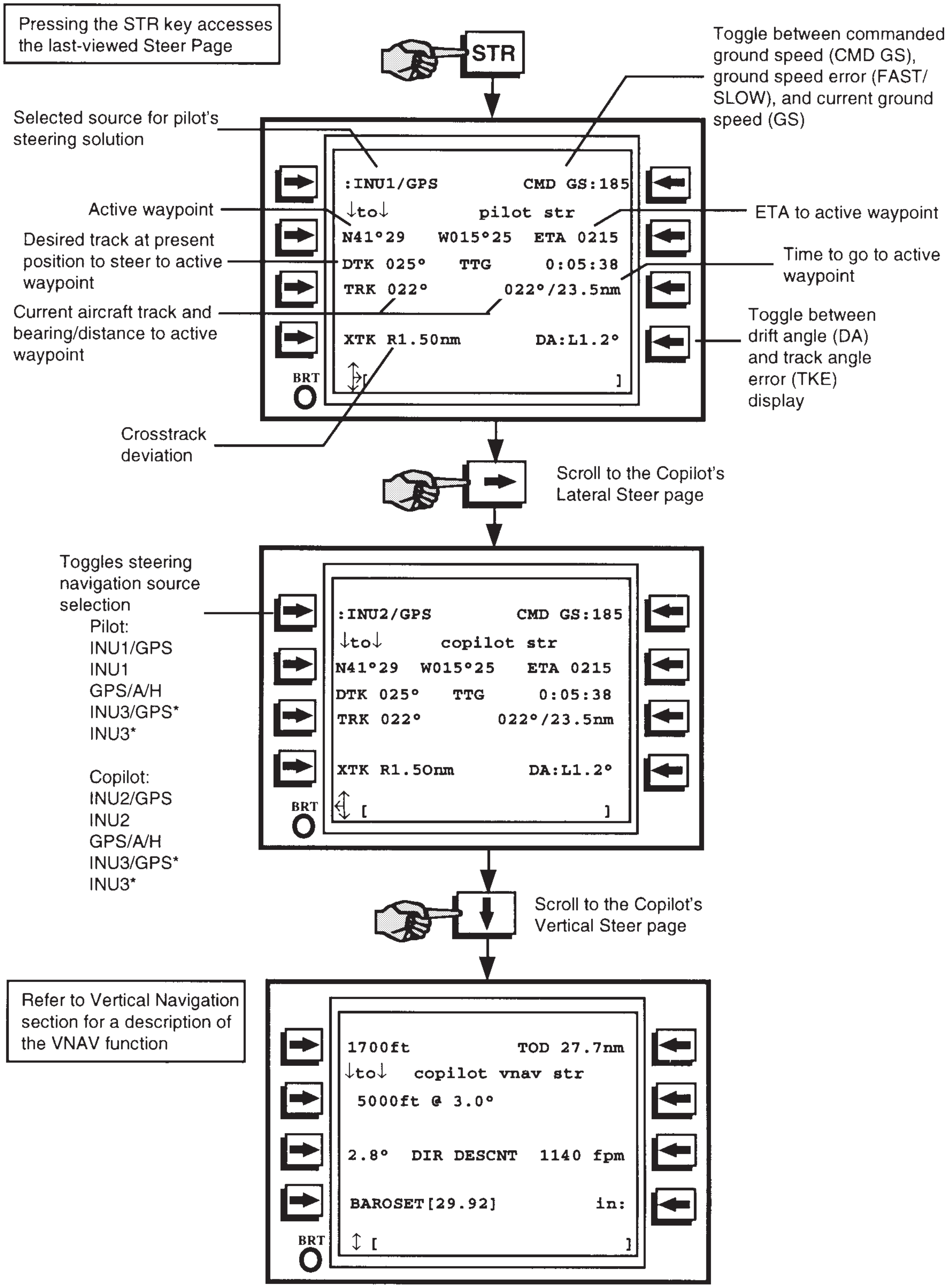
Oceanic Position Reporting

The FMS provides an oceanic flight position reporting and trip log function to simplify the task of relaying position reports. To view the Oceanic Reporting page, first press the MSN function key on the CDU. Then select the OCEANIC line select key to display the Oceanic Reporting page (figure 1.14-49). This page shows the current active flight plan waypoints in sequence with their respective ETAs or ATAs so the required position report information may be viewed without additional paging. The calculation of the active waypoint ETA is based on current true airspeed and wind; all subsequent waypoint ETAs are calculated using current true airspeed and either the current (default) wind or pilot-entered forecast wind (as entered on the Flight Plan Waypoint page for the respective waypoint).

Each time a waypoint is passed into history, the actual time of arrival (ATA) is recorded by the FMS. To view this trip log of waypoint passage times, scroll the list upward to view the history waypoints and their ATAs. If waypoints have been bypassed as a result of Direct-To operation, they show dashes for the arrival times.

DIRECT-TO OPERATIONS

Direct-To courses are used to either 1) bypass existing waypoints in the flight plan or 2) insert an impromptu waypoint, interrupting the current leg. In each case a system generated turn point is placed in the flight plan along the present track to provide turn anticipation and prevent S turns during capture of the direct course to the waypoint. However, direct courses requiring turns greater than 150° will result in an



Pressing the STR key accesses the last-viewed Steer Page

Selected source for pilot's steering solution

Toggle between commanded ground speed (CMD GS), ground speed error (FAST/SLOW), and current ground speed (GS)

Active waypoint

ETA to active waypoint

Desired track at present position to steer to active waypoint

Time to go to active waypoint

Current aircraft track and bearing/distance to active waypoint

Toggle between drift angle (DA) and track angle error (TKE) display

Crosstrack deviation

```
:INU1/GPS         CMD GS:185
↓to↓          pilot str
N41°29   W015°25   ETA 0215
DTK 025°   TTG      0:05:38
TRK 022°         022°/23.5nm

XTK R1.50nm         DA:L1.2°
↕[                          ]
```

Scroll to the Copilot's Lateral Steer page

Toggles steering navigation source selection

Pilot:
INU1/GPS
INU1
GPS/A/H
INU3/GPS*
INU3*

Copilot:
INU2/GPS
INU2
GPS/A/H
INU3/GPS*
INU3*

```
:INU2/GPS         CMD GS:185
↓to↓        copilot str
N41°29  W015°25   ETA 0215
DTK 025°   TTG      0:05:38
TRK 022°         022°/23.5nm

XTK R1.50nm         DA:L1.2°
↕ [                         ]
```

Scroll to the Copilot's Vertical Steer page

Refer to Vertical Navigation section for a description of the VNAV function

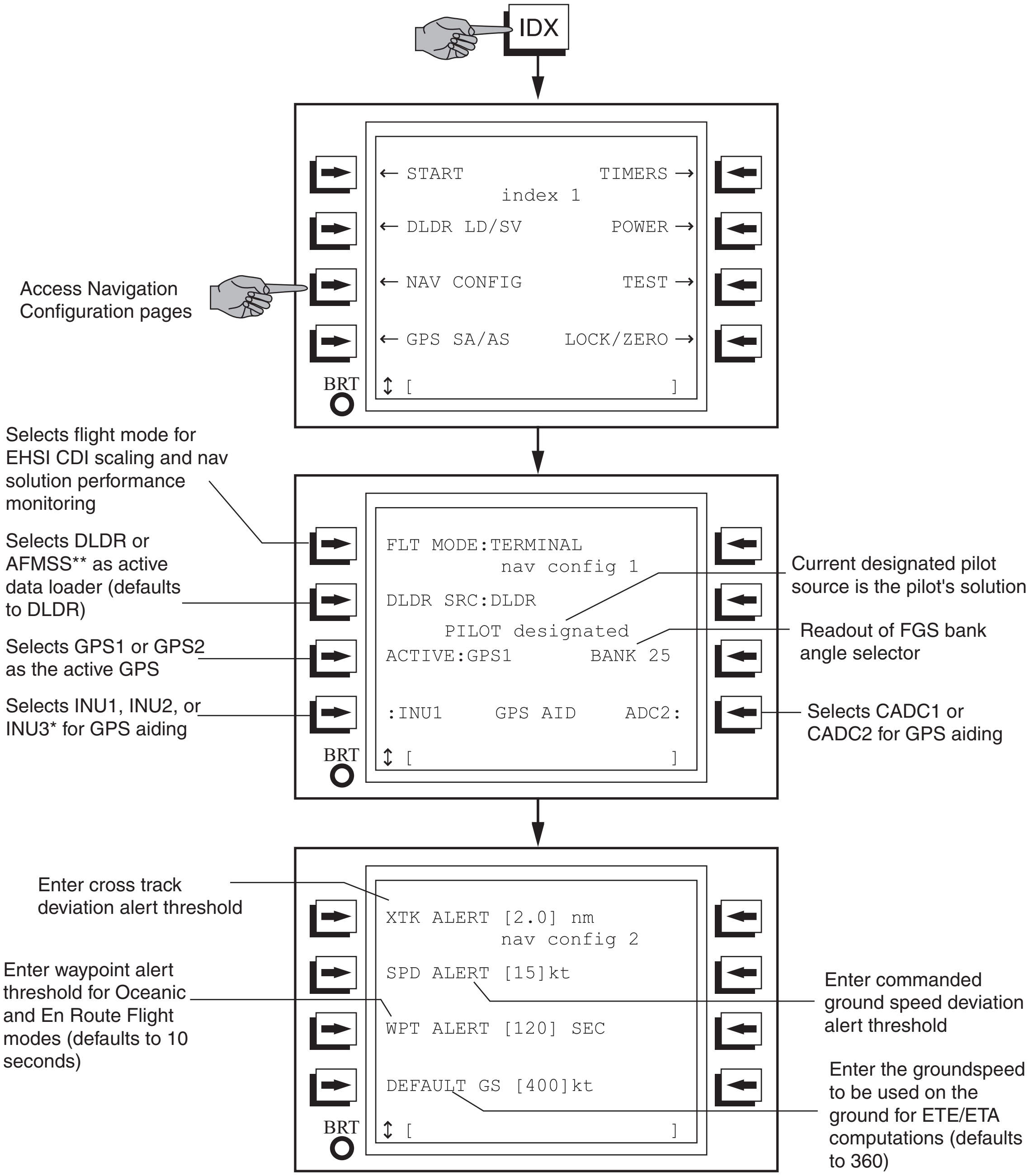
```
1700ft            TOD 27.7nm
↓to↓    copilot vnav str
 5000ft @ 3.0°

2.8°  DIR DESCNT   1140 fpm

BAROSET[29.92]           in:
↕ [                         ]
```

*NOTE: INU3 and INU3/GPS selections are only available if INU3 is selected to replace INU1 or INU2 via the INS selector switch.

Figure 1.14-46. Pilot and Copilot Lateral and Vertical Steer Pages

Page 1.14-70 is deleted.

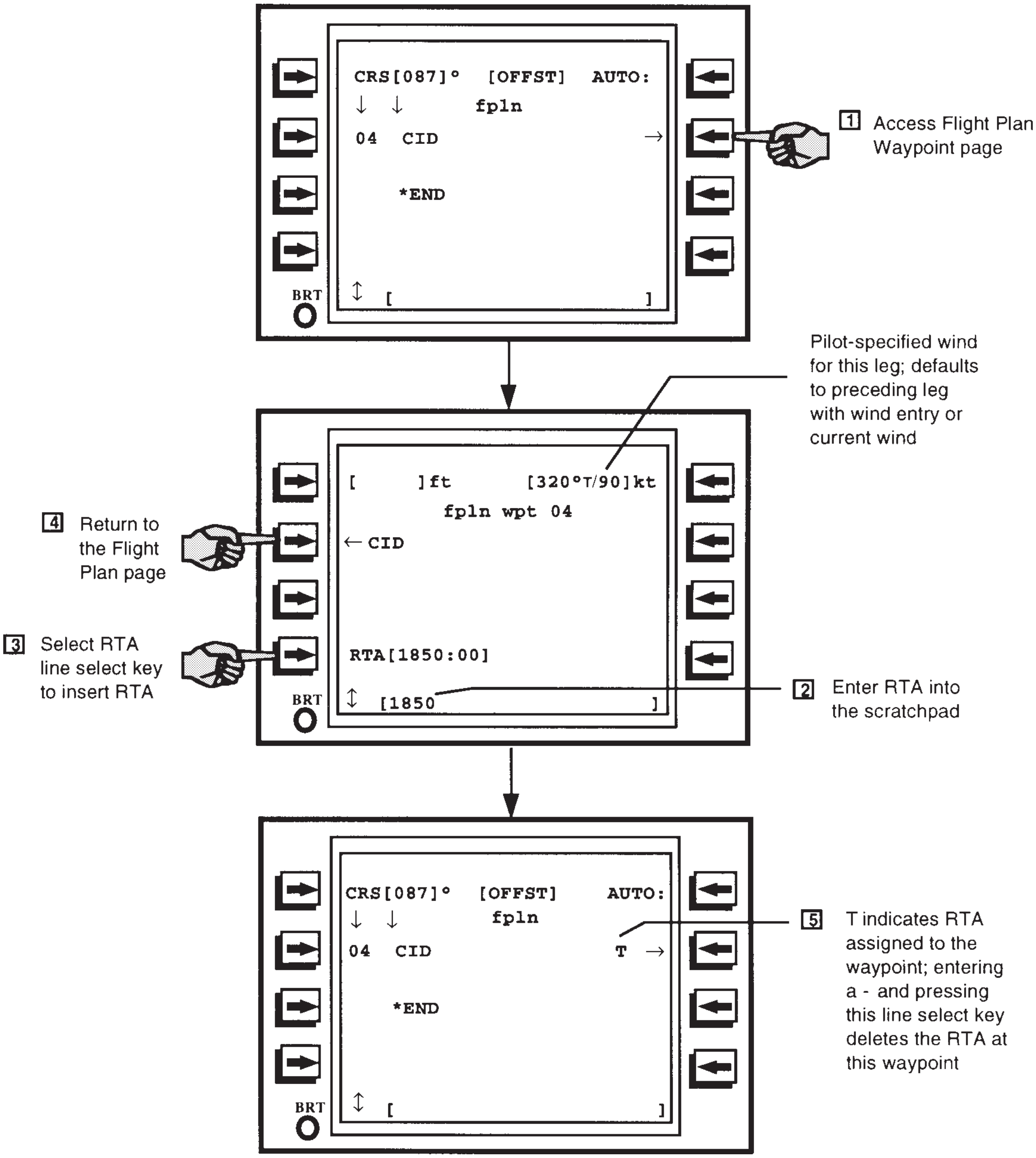
Page 1.14-70 is deleted.



*NOTE: INU3 is only available if selected by the pilot or copilot to replace INU1 or INU2 via the INS selector switch.

**NOTE: AFMSS port not installed on KC-10. The AFMSS selection is provided in the FMS software for future growth. Toggling LS2 "AFMSS" will result in a << √status>> annunciation and make the data loader inaccessible until "DLDR" is reselected.

Figure 1.14-47. Navigation Configuration Pages



```
CRS[087]°   [OFFST]   AUTO:
↓  ↓        fpln
04  CID                    →

    *END

↕ [                        ]
```

1 Access Flight Plan Waypoint page

Pilot-specified wind for this leg; defaults to preceding leg with wind entry or current wind

```
[     ]ft      [320°T/90]kt
       fpln wpt 04
←CID



RTA[1850:00]
↕ [1850                    ]
```

4 Return to the Flight Plan page

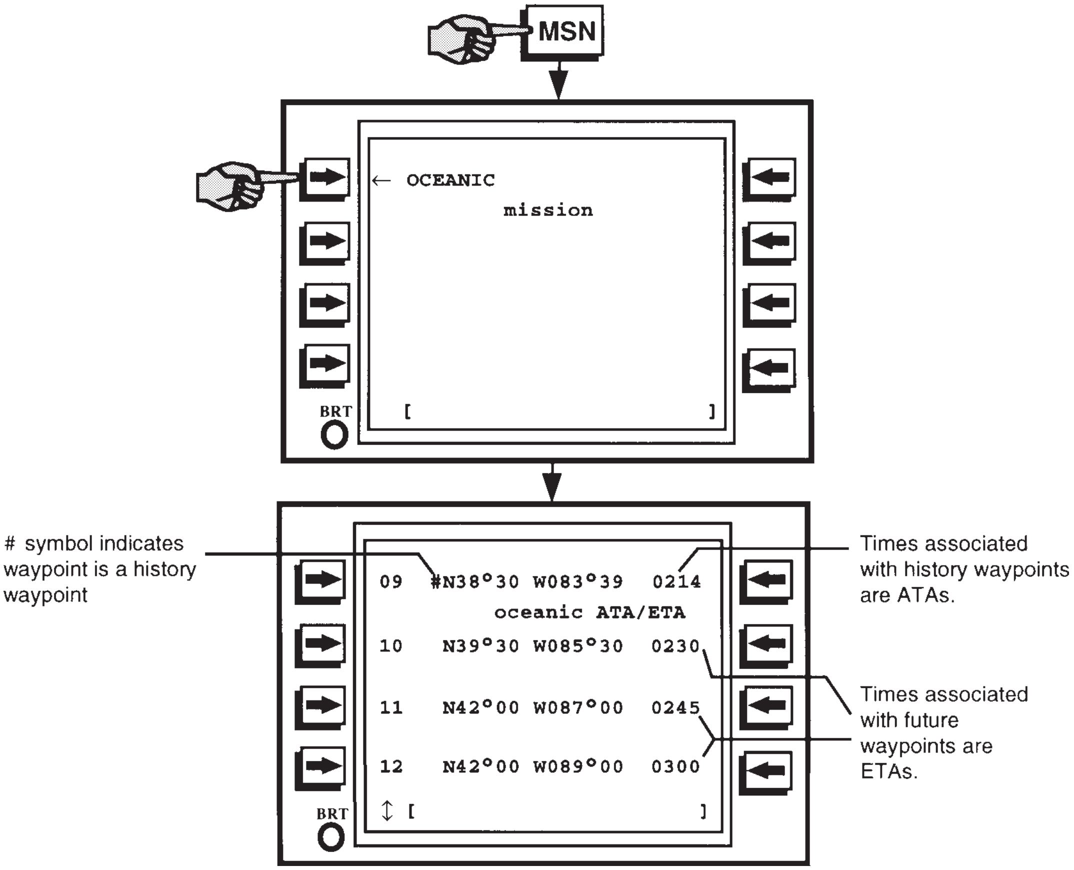
3 Select RTA line select key to insert RTA

2 Enter RTA into the scratchpad

```
CRS[087]°   [OFFST]    AUTO:
↓  ↓         fpln
04  CID                 T →

    *END

↕ [                         ]
```

5 T indicates RTA assigned to the waypoint; entering a - and pressing this line select key deletes the RTA at this waypoint

Figure 1.14-48. Waypoint Required Time of Arrival and Forecast Wind



symbol indicates waypoint is a history waypoint

Times associated with history waypoints are ATAs.

Times associated with future waypoints are ETAs.

Figure 1.14-49. Mission Page Access and Oceanic Page

overshoot and intercept of the course similar to the maneuver depicted in figure 1.14-43. The Direct-To function differs from simple active waypoint entry in that the resulting course is from aircraft present position rather than from the last history waypoint. When used in relation to vertical navigation (VNAV), the Direct-To function computes an immediate climb or descent path to a waypoint with an altitude crossing assigned. See Vertical Navigation section for the use of the Direct-To function for VNAV.

When the DIR key is pressed, the Flight Plan page is accessed with DIR TO [ ] displayed on the top line, as shown in figure 1.14-50. After selecting a waypoint for the Direct-To operation, the normal Flight Plan page display is returned.

Direct-To Flight Plan Waypoints

A Direct-To course may be initiated to any existing flight plan waypoint (except an approach MAP), including history waypoints. DIR TO [ ] remains on the top line as the flight plan is scrolled to indicate that Direct-To selections may be performed. If the waypoint selected for the Direct-To operation is a future waypoint, all intervening waypoints are moved into history. If the selected waypoint is a history waypoint, then the history waypoints following the selected Direct-To waypoint are repeated in their original sequence.

NOTE

If any manual course edits were made between waypoints while they were in the active flight plan, they are deleted when the waypoints enter history.

If the selected waypoint is the termination point of a DME arc and it is not the active waypoint, the FMS will provide guidance to intercept the arc. To proceed directly to the arc termination point, select Direct-To the arc termination point again to override the arc intercept function. Figure 1.14-51 demonstrates Direct-To operations for existing flight plan waypoints.

The EHSI provides an auxiliary single action method of initiating a Direct-To course to the active waypoint when FMS is the selected navigation source. Momentarily pressing the NAV selector knob will initiate the Direct-To. This capability is useful in situations where the pilot must deviate from course and wishes to proceed direct to the waypoint and in terminal area maneuvering in conjunction with databased GPS approaches.

Direct-To Impromptu Waypoints

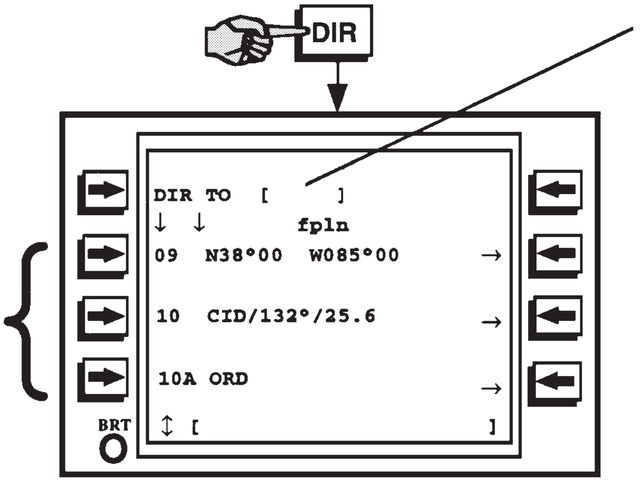
Impromptu waypoints may be inserted into the flight plan, interrupting execution of the current flight plan leg. The impromptu point may be any valid waypoint format. To proceed direct to an impromptu waypoint, first enter the desired point into the scratchpad, then press the DIR TO [ ] line select key. If the selected Direct-To waypoint is also a future waypoint, all intervening waypoints are moved into history. Thus, to fly directly to an impromptu point and then return to the flight plan, bypassing intermediate points, the impromptu point should first be entered into the flight plan at the desired location and then selected as the Direct-To waypoint. Figures 1.14-52 and 1.14-53 illustrate the two methods of executing Direct-To operations to impromptu waypoints.

Direct-To Vector From Present Position

The impromptu point may also be defined as a vector from the present position of the aircraft. Vector waypoints are handled in exactly the same manner as a normal waypoint, except that the FMS computes the waypoint position from the designated pilot's present position (figure 1.14-54).

PARALLEL COURSE OFFSETS

A parallel course offset may be applied to the flight plan, if required to meet operational requirements (e.g., weather avoidance or when assigned by ATC). The parallel offset will be specified as a distance right or left of course to the nearest tenth NM (e.g., R5.5 or L10.0). The available range is from 0.1 to 99.9 NM. When an offset is applied, all displays keyed to the



DIR TO [ ] label remains on line 1 as waypoints are scrolled to indicate that only Direct-To operations are possible

Flight plan edits (e.g., waypoint insertion/ deletion and application of a bearing/distance offset) are permitted. However, selection of LS2-4 without a scratchpad entry will initiate an immediate Direct -To.

Figure 1.14-50. Flight Plan Page Accessed by DIR Key

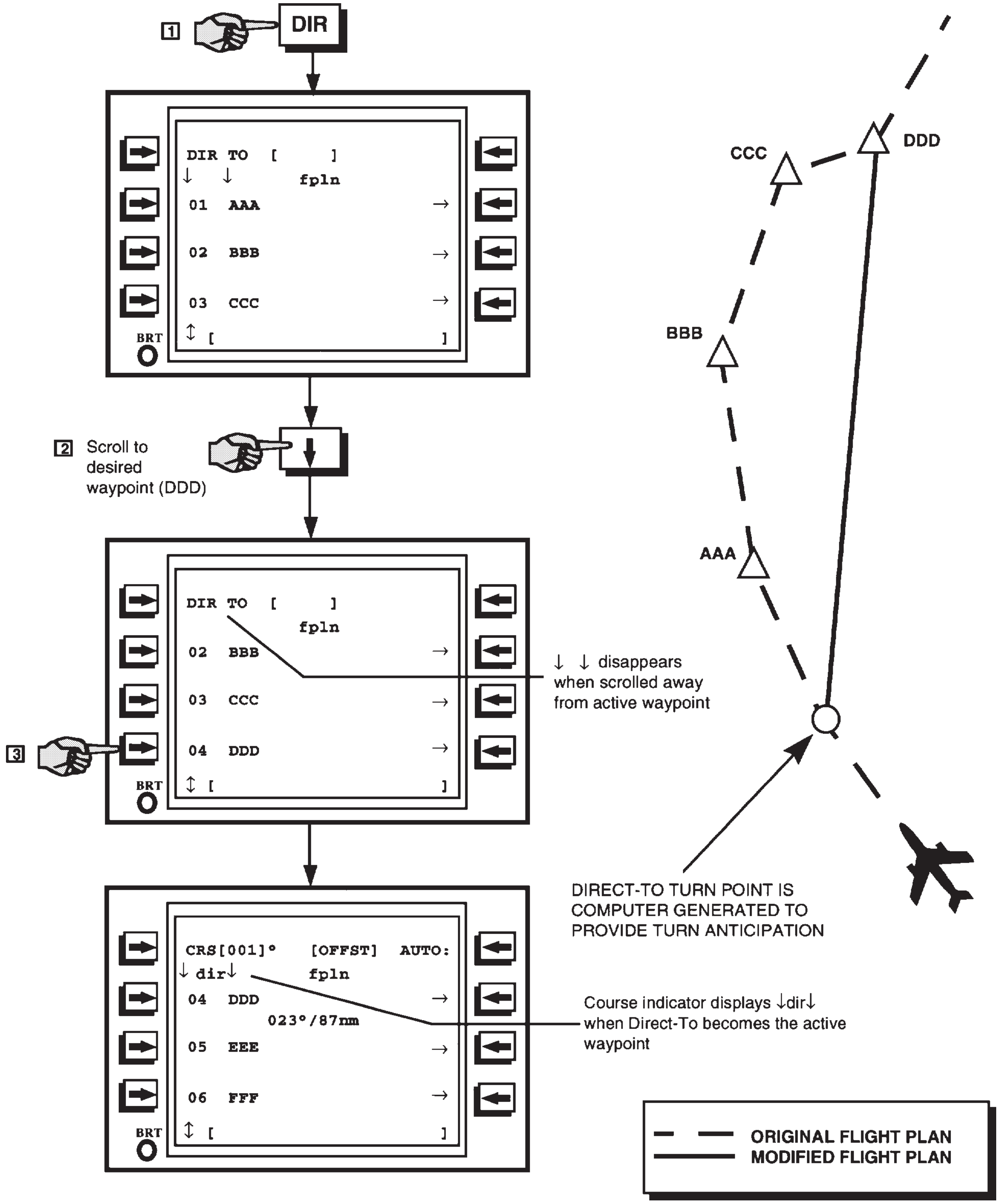
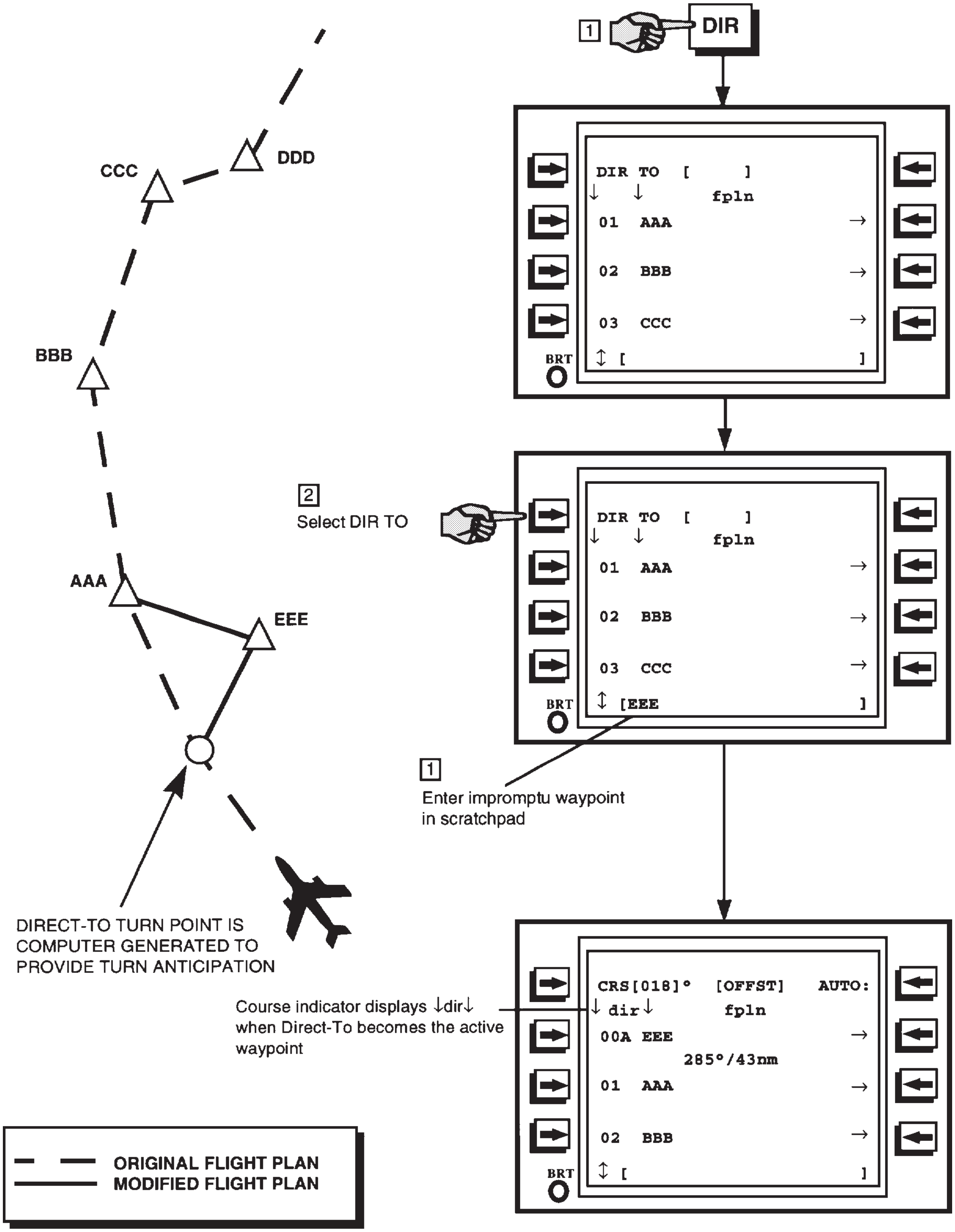


Figure 1.14-51. Direct-To a Flight Plan Waypoint



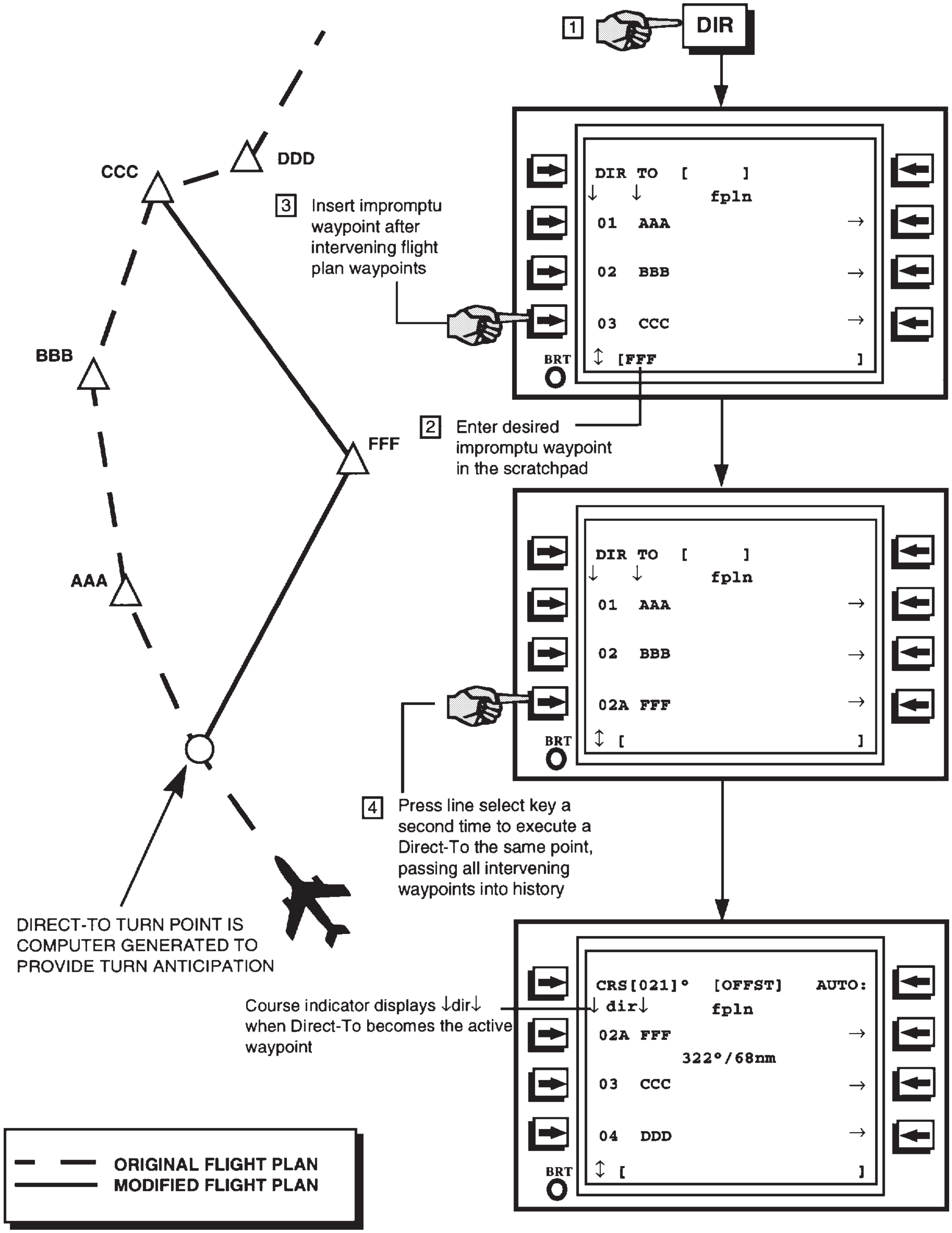
Select DIR TO

Enter impromptu waypoint in scratchpad

Course indicator displays ↓dir↓ when Direct-To becomes the active waypoint

DIRECT-TO TURN POINT IS COMPUTER GENERATED TO PROVIDE TURN ANTICIPATION

Figure 1.14-52. Direct-To an Impromptu Waypoint



3 Insert impromptu waypoint after intervening flight plan waypoints

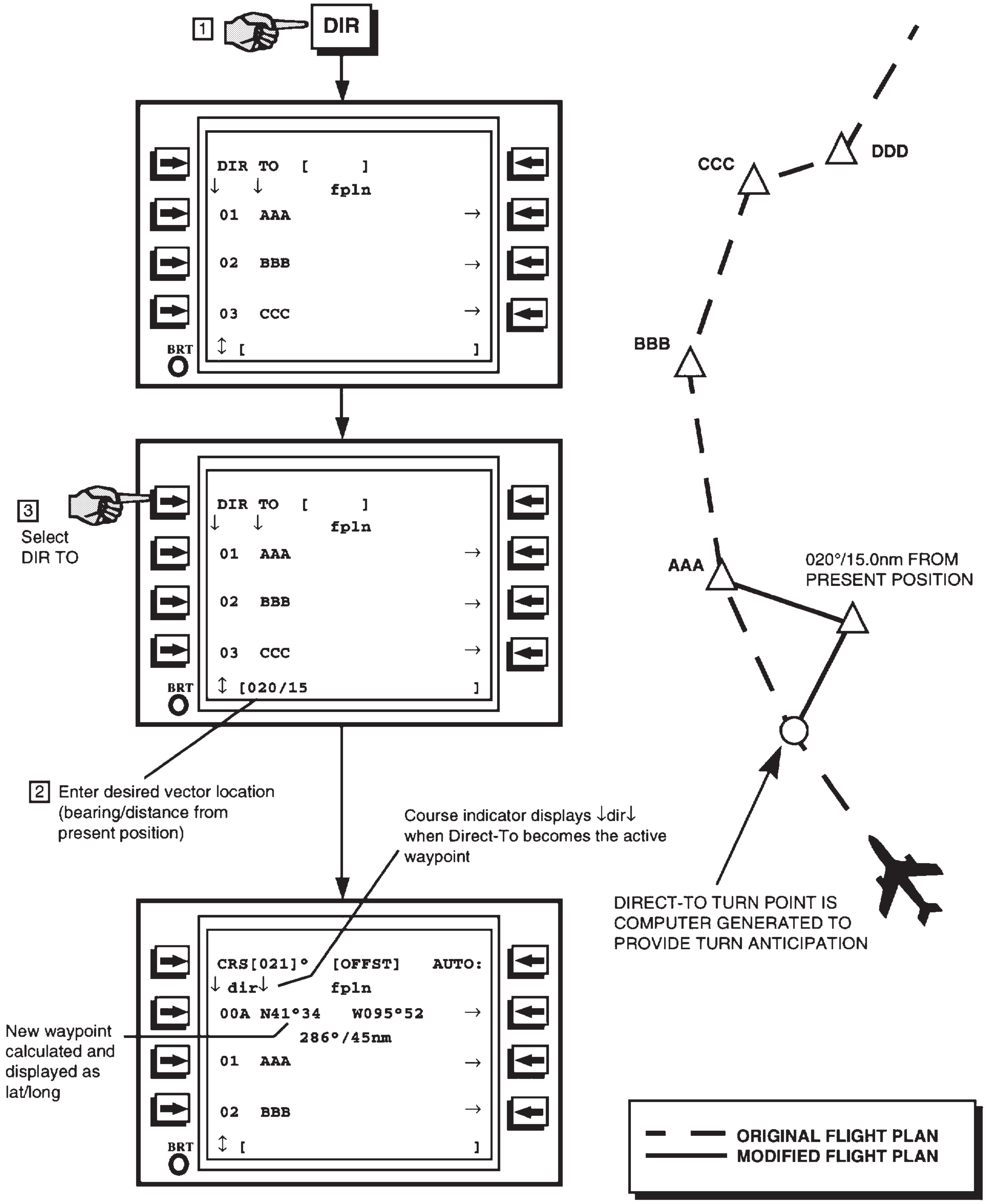
2 Enter desired impromptu waypoint in the scratchpad

4 Press line select key a second time to execute a Direct-To the same point, passing all intervening waypoints into history

DIRECT-TO TURN POINT IS COMPUTER GENERATED TO PROVIDE TURN ANTICIPATION

Course indicator displays ↓dir↓ when Direct-To becomes the active waypoint

Figure 1.14-53. Direct-To Impromptu Waypoint Inserted as a Future Flight Plan Waypoint



Select DIR TO

Enter desired vector location (bearing/distance from present position)

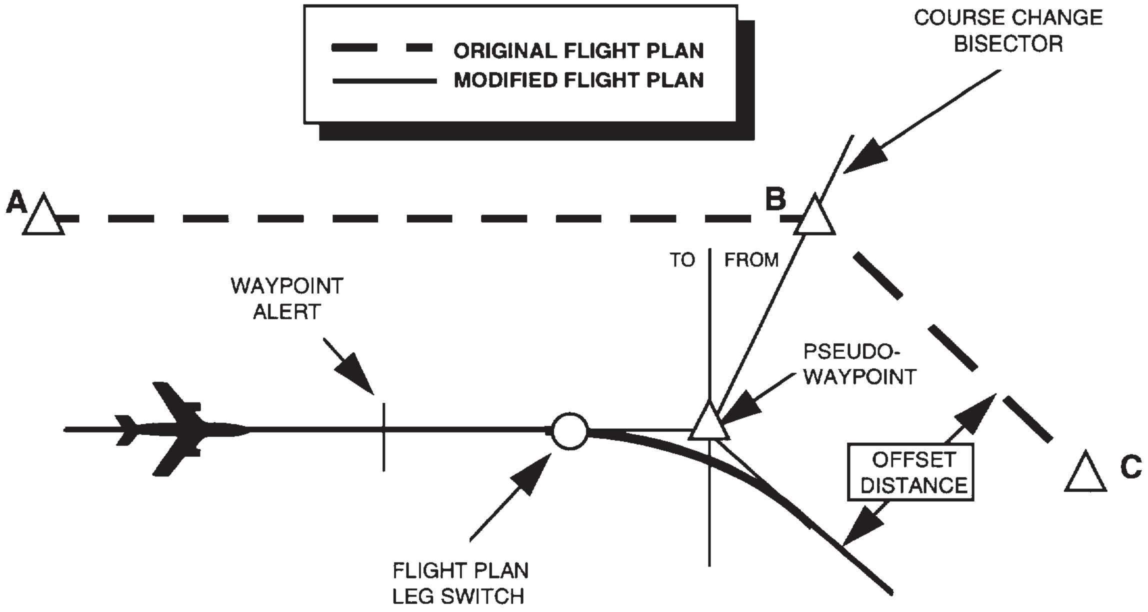
Course indicator displays ↓dir↓ when Direct-To becomes the active waypoint

New waypoint calculated and displayed as lat/long

DIRECT-TO TURN POINT IS COMPUTER GENERATED TO PROVIDE TURN ANTICIPATION

— —	**ORIGINAL FLIGHT PLAN**
——	**MODIFIED FLIGHT PLAN**

Figure 1.14-54. Direct-To Vector from Present Position



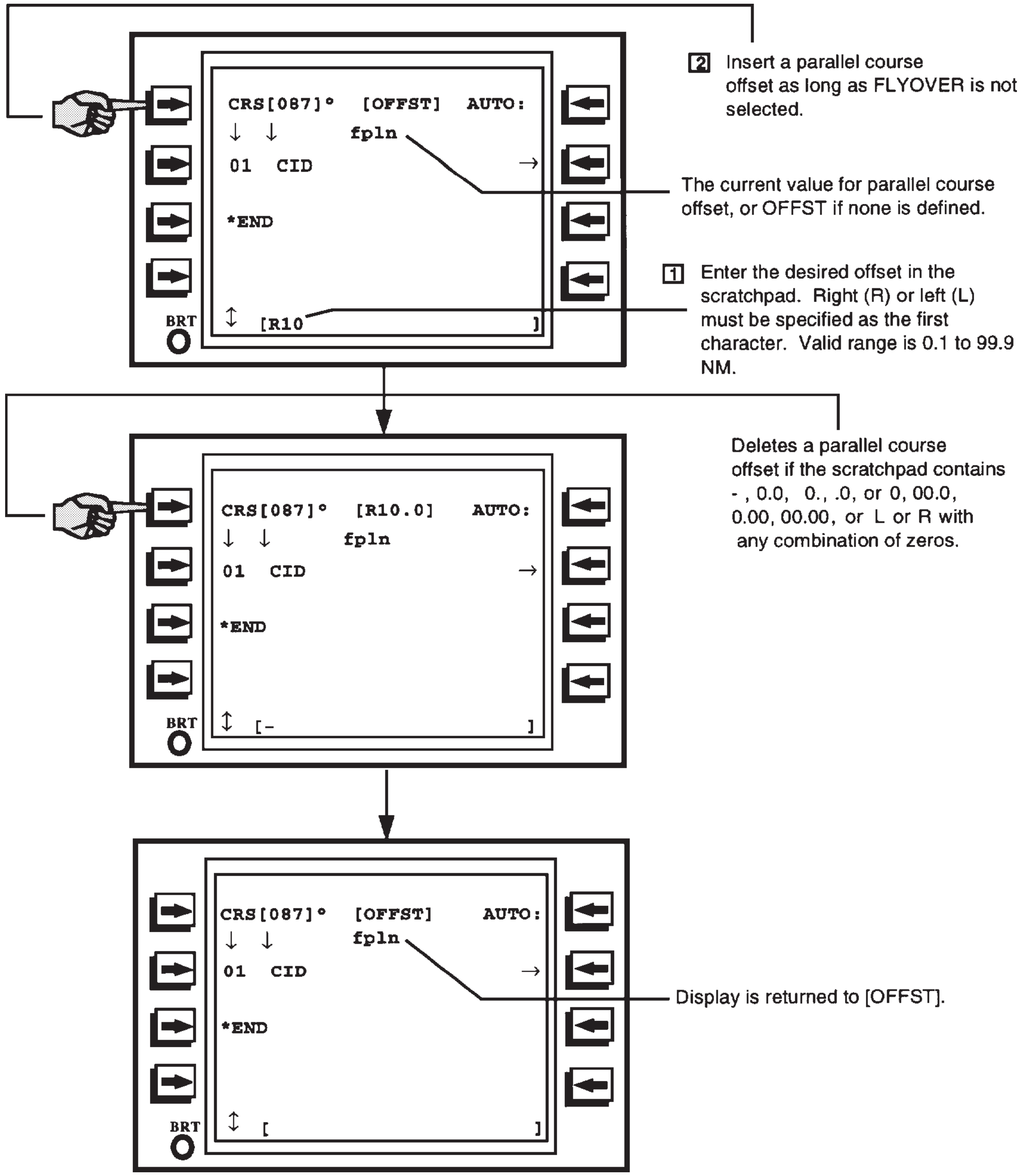
Offsets may be defined to the left or right of the original course. Once applied they remain in effect for the remainder of the flight plan unless cancelled.

Figure 1.14-55. Parallel Course Offset Geometry

active waypoint (e.g., time and distance to go, TO/FROM indicator) become referenced to the pseudo-waypoint at the intersection of the course change bisector and the offset course. Likewise the leg switch point and the associated turn alert are computed relative to the pseudo-waypoint. Crosstrack deviation is computed relative to the offset course. An OFST annunciation is displayed on the EHSI during the time an offset is active. Figure 1.14-55 illustrates the geometry associated with waypoint switching when a parallel offset is applied.

Parallel Offset Initiation, Termination or Change

Parallel course offsets may be applied, changed, or deleted any time the waypoint sequencing mode is not FLYOVER and the active waypoint is not identified as one of the following: A holding pattern (when enabled) or MFP fix; FAF, MAP, or DME arc termination point (databased or tactical approach); or runway extension point or runway point (visual approach). If an attempt is made to apply a parallel offset when any of these waypoints is the active waypoint, the offset will be inhibited and the appropriate scratchpad message will be displayed. If any of these waypoints becomes the active waypoint while a parallel offset is defined, the offset will be cancelled immediately, and the aircraft will be directed to capture the original course at a maximum intercept of 45°. If any of these special functions (holding pattern, MFP, or approach) is applied to the active waypoint with an offset applied, the offset is automatically cancelled. Initiation of the Direct-To function or selection of the FLYOVER waypoint sequencing mode also automatically cancels the parallel offset. Figure 1.14-56 illustrates application and deletion of a parallel course offset. Figure 1.14-57 provides an example of automatic cancellation of a parallel offset.



2 Insert a parallel course offset as long as FLYOVER is not selected.

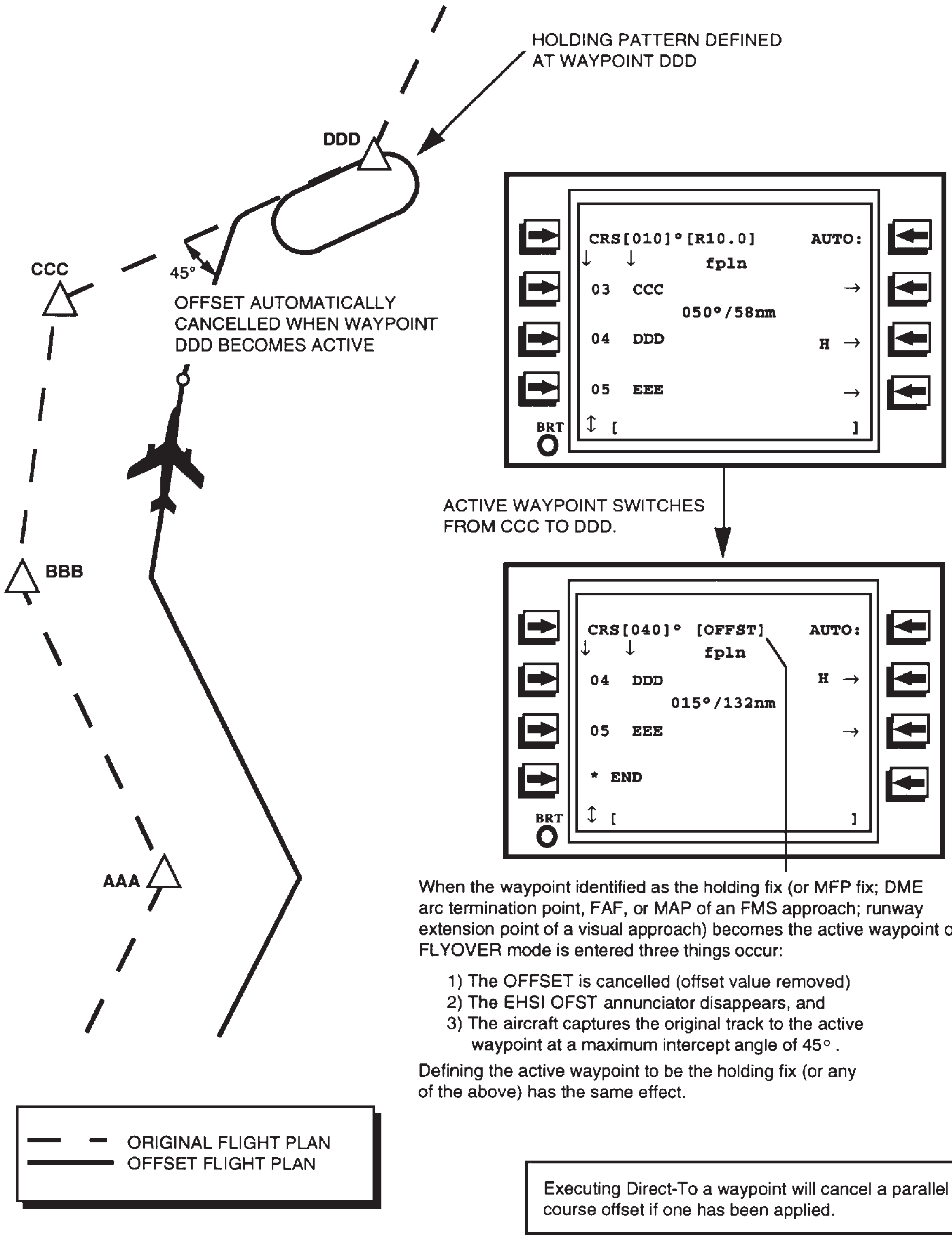
The current value for parallel course offset, or OFFST if none is defined.

1 Enter the desired offset in the scratchpad. Right (R) or left (L) must be specified as the first character. Valid range is 0.1 to 99.9 NM.

Deletes a parallel course offset if the scratchpad contains - , 0.0, 0., .0, or 0, 00.0, 0.00, 00.00, or L or R with any combination of zeros.

Display is returned to [OFFST].

Figure 1.14-56. Entering and Deleting Parallel Course Offsets



When the waypoint identified as the holding fix (or MFP fix; DME arc termination point, FAF, or MAP of an FMS approach; runway extension point of a visual approach) becomes the active waypoint or FLYOVER mode is entered three things occur:

1) The OFFSET is cancelled (offset value removed)
2) The EHSI OFST annunciator disappears, and
3) The aircraft captures the original track to the active waypoint at a maximum intercept angle of 45°.

Defining the active waypoint to be the holding fix (or any of the above) has the same effect.

Executing Direct-To a waypoint will cancel a parallel course offset if one has been applied.

Figure 1.14-57. Automatic Cancellation of Parallel Course Offsets

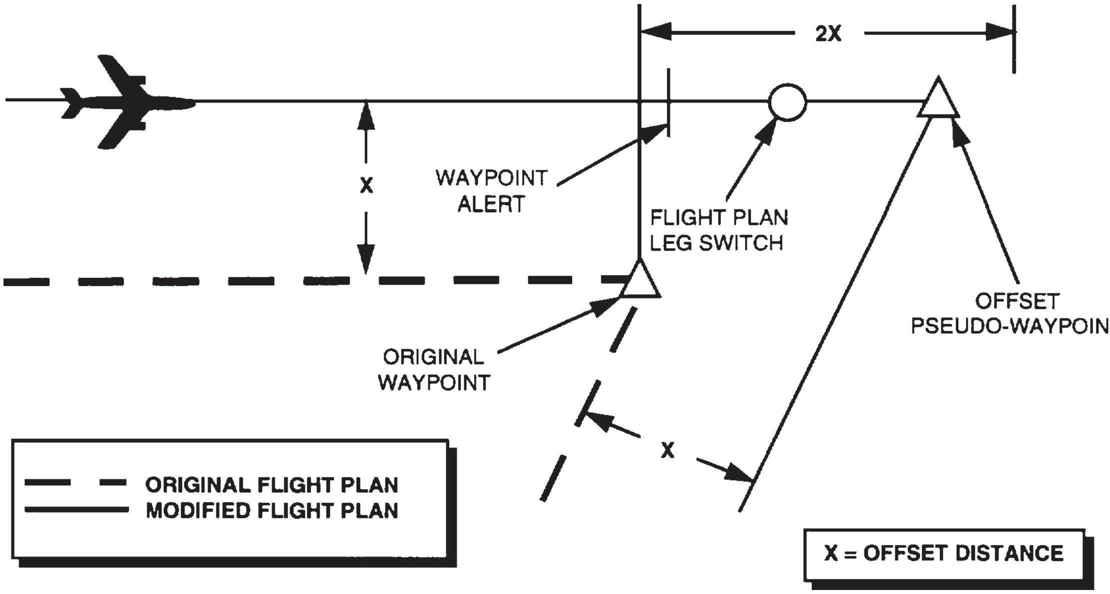


Figure 1.14-58. Normal Parallel Offset Transition

Waypoint Transition With Parallel Offsets

The parallel offset flight path may result in severe geometry at waypoints with large course changes. To resolve this condition the offset pseudo-waypoint is never displaced along the inbound leg track by more than two times the width of the offset. Figure 1.14-58 shows an offset definition where the along-track shift of the pseudo-waypoint is less than two times the offset width, resulting in a continuous offset flight path.

If a leg course change is greater than 127°, then a course discontinuity is created. Upon reaching the switch point, the new offset course for the next leg becomes active. Figure 1.14-59 shows examples with the offset both on the outside and inside of the required turn.

VERTICAL NAVIGATION

WARNING

- Crews must not rely on the FMS as the primary means of vertical navigation information to meet altitude restrictions.
- When issued QFE altimeter settings or cold weather barometric altimeter corrections are applied in accordance with the Flight Information Handbook, FMS vertical navigation information is invalid. Do not use FMS VNAV Deviation Indicator or VNAV information provided on CDU pages, even as a source of supplemental information, when cold weather barometric altimeter corrections are required.

The FMS VNAV function provides guidance for a climb or descent to an assigned altitude at a waypoint or crossing fix, such as on a SID or STAR. VNAV guidance is displayed on the vertical deviation scale of the EHSI when FMS is selected as the primary navigation source. VNAV computations are not available while a holding pattern, MFP, course reversal, DME arc, intercept, or discontinuity is active or the active waypoint is a FAF and a Type II or III course reversal is enabled. VNAV signals are not passed to the FGS.

Assigning an Altitude or Flight Level

All VNAV guidance requires first that an altitude or flight level (FL) be entered at a waypoint in the flight plan. If an alternate flight plan is transferred to the active flight plan, all altitudes assigned at waypoints are transferred also. If an altitude has been assigned to a waypoint, it is indicated by a V attribute on the right side of the Flight Plan page waypoint line. To delete this altitude assignment (except when the V is attached to a MAP or RWXND waypoint), enter a - and press the adjacent right line select key (or press LS1 with a - in the scratchpad on the Flight Plan Waypoint page).

To enter an altitude, select the Flight Plan Waypoint page for the waypoint where it is to be assigned (figure 1.14-60). Altitudes are entered in feet and are automatically referenced by the FMS to the local baroset entered on the Pilot or Copilot Vertical Steer page (figure 1.14-61). If a flight level is desired, enter FL, followed by the three-digit flight level. This indicates that the altitude is referenced to the flight level pressure datum (29.92 in. Hg) instead of the local barometric pressure. The FMS automatically computes the guidance through the transition altitude (climbs or transition flight level (descents) if the above procedure is followed, regardless of the local transition altitude/level.

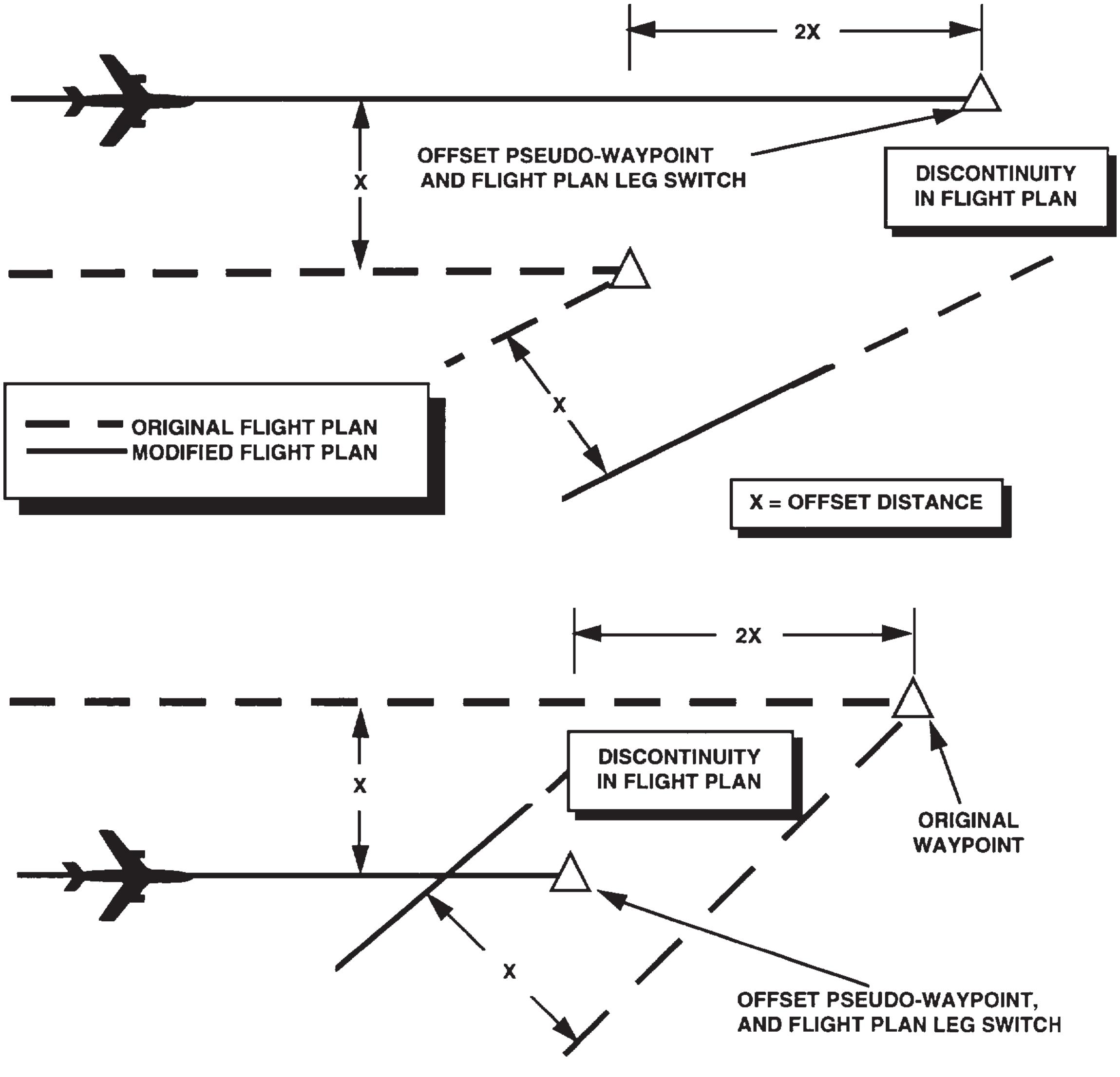
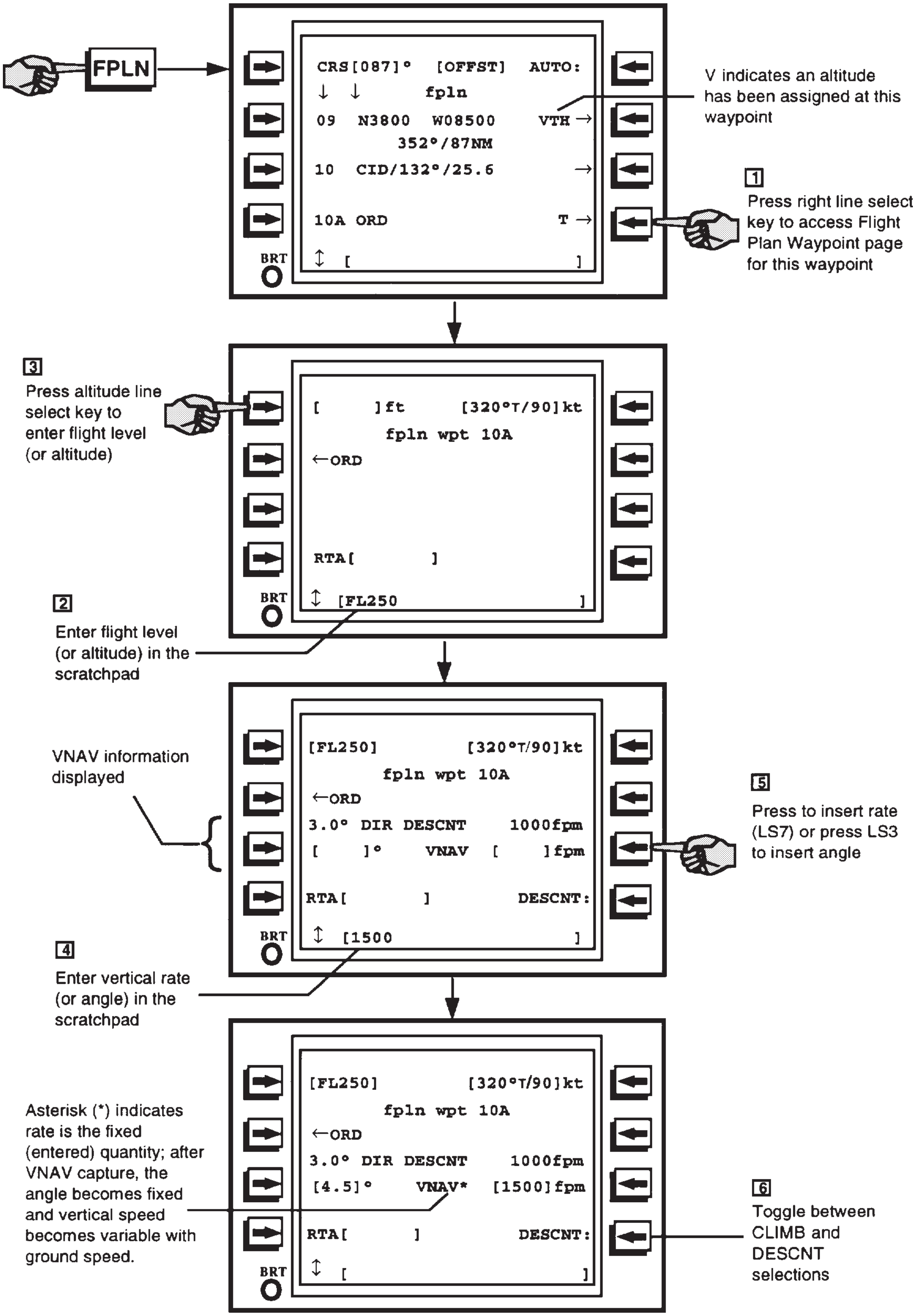


Figure 1.14-59. Parallel Offset Transition with Large Course Change



V indicates an altitude has been assigned at this waypoint

1 Press right line select key to access Flight Plan Waypoint page for this waypoint

3 Press altitude line select key to enter flight level (or altitude)

2 Enter flight level (or altitude) in the scratchpad

VNAV information displayed

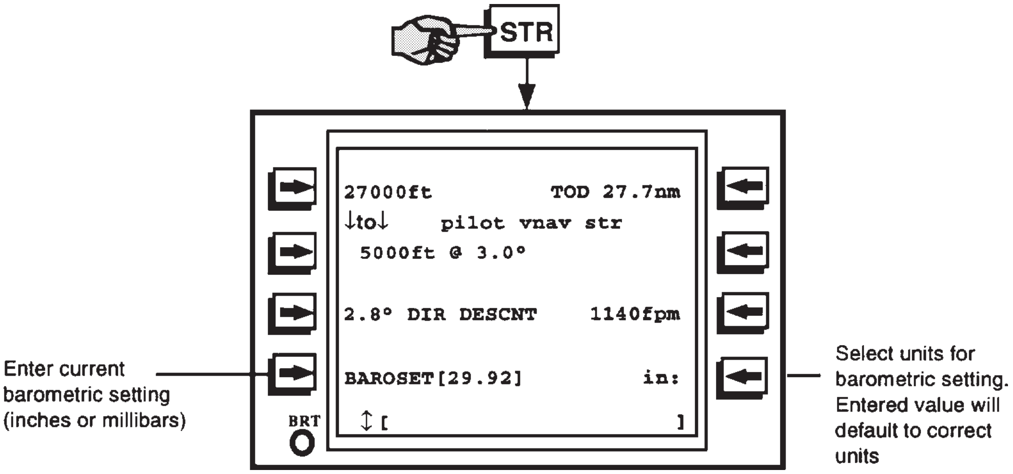
5 Press to insert rate (LS7) or press LS3 to insert angle

4 Enter vertical rate (or angle) in the scratchpad

Asterisk (*) indicates rate is the fixed (entered) quantity; after VNAV capture, the angle becomes fixed and vertical speed becomes variable with ground speed.

6 Toggle between CLIMB and DESCNT selections

Figure 1.14-60. Entry and Display of VNAV Parameters



```
27000ft          TOD 27.7nm
↓to↓    pilot vnav str
 5000ft @ 3.0°

2.8° DIR DESCNT    1140fpm

BAROSET[29.92]         in:
 ↕[                      ]
```

Enter current barometric setting (inches or millibars)

Select units for barometric setting. Entered value will default to correct units

Figure 1.14-61. Local Baroset Entry on the Vertical Steer Page

If the waypoint is an FMS approach missed approach point (MAP), a visual approach runway extension point, or an intercept, no altitude entry is permitted. If the waypoint is a MAP, an altitude equal to the threshold elevation plus 50 feet will be displayed. If the waypoint is a visual approach runway extension point, an altitude equal to the RW ELEV plus the AGL altitude shown on the Visual Approach page will be displayed.

Entry and Display of Climb or Descent Path

If only an altitude/flight level is entered and no climb or descent path is specified, the climb/descent path is undefined until that waypoint becomes the flight plan active waypoint. Then the FMS defaults to a direct climb/descent path to the waypoint with the assigned altitude. If two consecutive waypoints are assigned altitudes/flight levels, the default path is a straight-line climb or descent between them, such as for a published profile descent.

To specify a climb/descent path other than the default, first enter the desired angle (0.0 to 6.0°) or initial vertical rate (0 to 3500 fpm), then toggle the VNAV line select key to CLIMB or DESCNT as necessary on the Flight Plan Waypoint page (figure 1.14-60).

If an angle is entered, the vertical rate will be dynamically updated based on the angle during the climb/descent. An asterisk (*) will appear next to the angle value to indicate that it is fixed. If a vertical rate is initially entered, the angle is updated based on the entered rate until VNAV capture at bottom of climb (BOC) or top of descent (TOD) and the vertical rate is annotated with an asterisk (*). After capture of the vertical path, the angle becomes fixed and vertical rate becomes variable with ground speed. The asterisk moves next to the angle value to indicate it is fixed after VNAV capture.

Direct Climb or Descent Path Display

The DIRECT CLIMB/DESCNT vertical rate or angle on the Flight Plan Waypoint page (figure 1.14-60) is computed for any waypoint with an altitude assigned, not just for the active waypoint. This advisory enables the pilot to plan the climb or descent and to be apprised of the actual climb/descent rate required if, for example, ATC delays the climb/descent clearance beyond the planned BOC or TOD. This is also the value which will be inserted if the pilot were to select a VNAV Direct-To.

VNAV Direct-To

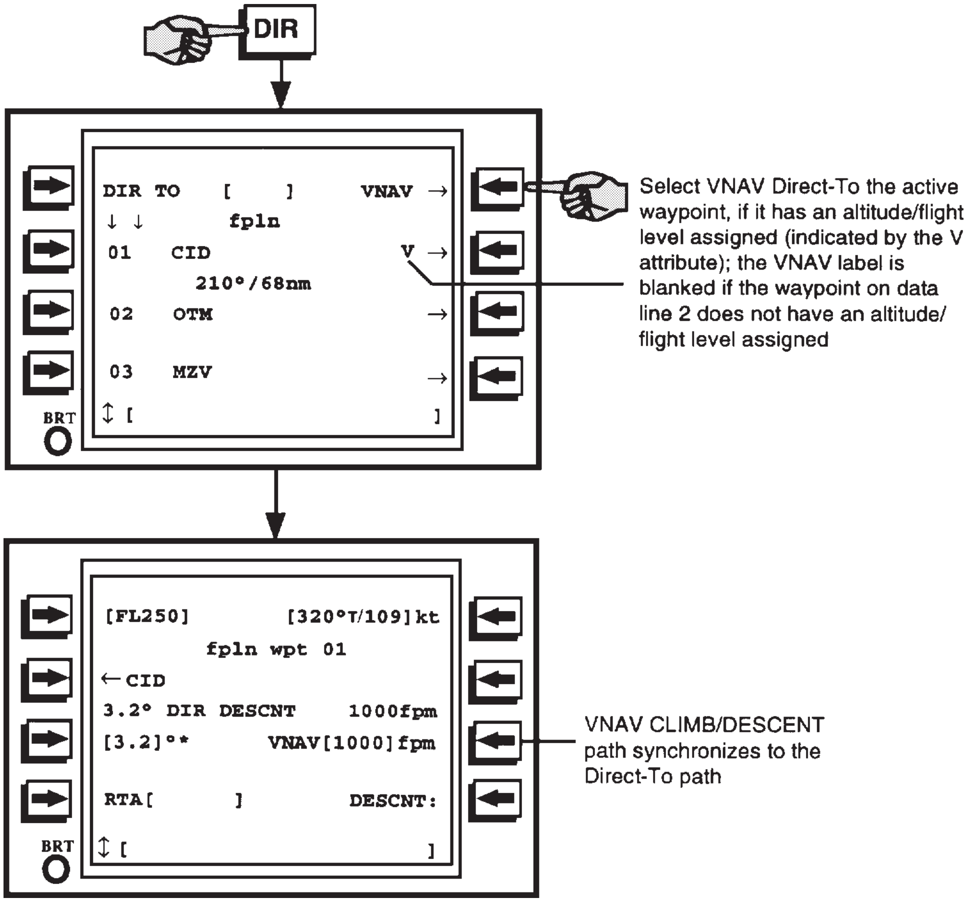
To perform a VNAV Direct-To climb or descent, press the DIR function key and follow the procedure shown in figure 1.14-62.

VNAV Guidance and Alerting

After a waypoint with an altitude becomes active, the FMS provides vertical guidance information to assist in flying the entered or default VNAV climb or descent path. On the Pilot and Copilot VNAV Steer pages (figure 1.14-63), the specified altitude/flight level and angle are displayed along with continuously updated current altitude, vertical rate and angle for direct vertical flight to the waypoint. Current aircraft altitude can be corrected by entering local barometric pressure on this page. Prior to VNAV capture, the distance to the BOC/TOD is displayed at the top right of the display. This display is dashed after the VNAV path is captured.

Figure 1.14-64 shows a typical VNAV profile along with the alerts associated with the VNAV capture and termination. Ten seconds prior to the VNAV path capture, the CDU page alerts shown in figure 1.14-65 flash. Also, at an altitude 1000 feet below/above the waypoint crossing altitude, a second alert is issued as shown.

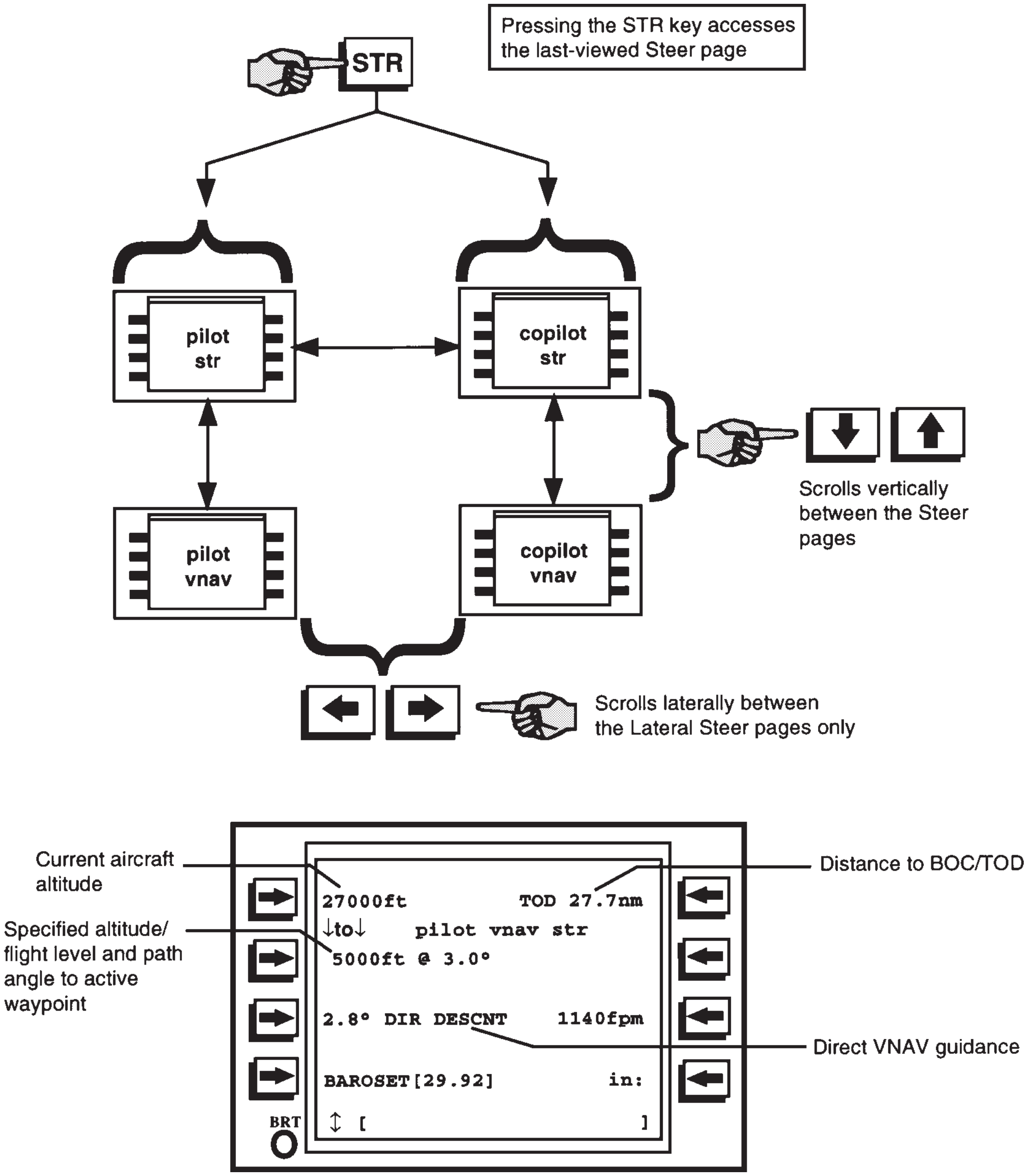
When the active waypoint for the VNAV guidance passes into history or is deleted, the VNAV steering parameters become invalid or are reset to their default values for the next vertical waypoint in the flight plan.



Select VNAV Direct-To the active waypoint, if it has an altitude/flight level assigned (indicated by the V attribute); the VNAV label is blanked if the waypoint on data line 2 does not have an altitude/flight level assigned

VNAV CLIMB/DESCENT path synchronizes to the Direct-To path

Figure 1.14-62. VNAV Direct-To



Pressing the STR key accesses the last-viewed Steer page

Scrolls vertically between the Steer pages

Scrolls laterally between the Lateral Steer pages only

Current aircraft altitude

Specified altitude/ flight level and path angle to active waypoint

Distance to BOC/TOD

Direct VNAV guidance

Figure 1.14-63. VNAV Steer Pages

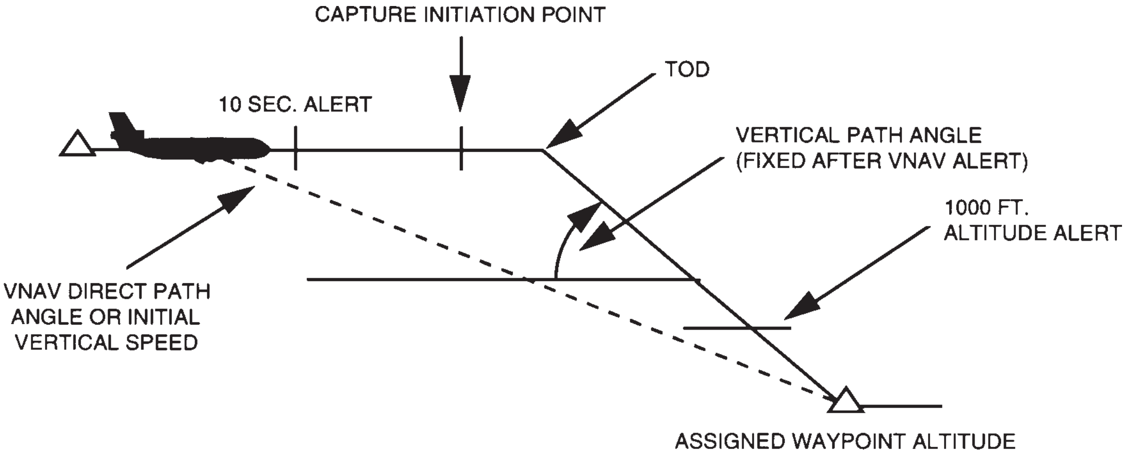
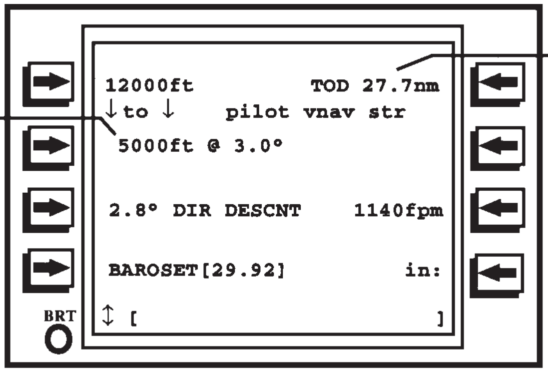


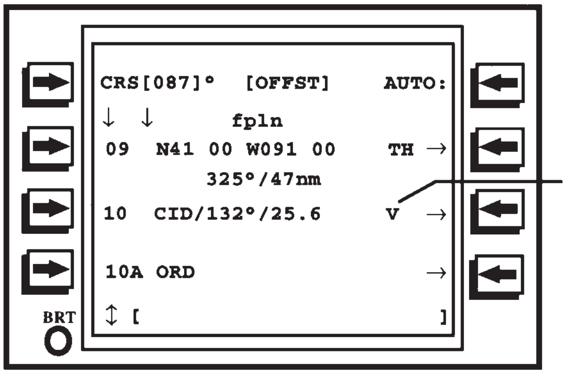
Figure 1.14-64. VNAV Profile

Altitude flashes at 1000 feet above/ below waypoint crossing altitude


```
12000ft          TOD 27.7nm
↓to ↓      pilot vnav str
 5000ft @ 3.0°

2.8° DIR DESCNT     1140fpm

BAROSET[29.92]          in:

↕ [                        ]
```

Top of Descent label flashes 10 seconds prior to VNAV capture (same for BOC)

VNAV STEERING PAGE


```
CRS[087]°  [OFFST]    AUTO:
↓  ↓        fpln
09  N41 00 W091 00    TH →
         325°/47nm
10  CID/132°/25.6     V  →

10A ORD                  →

↕ [                        ]
```

V attribute flashes 10 seconds prior to vnav capture and at 1000 feet above/ below waypoint crossing altitude

FLIGHT PLAN PAGE

Figure 1.14-65. VNAV Capture and Termination Alerts

Vertical Discontinuities

In defining a VNAV path, there is a potential to generate a vertical discontinuity that the FMS will not execute as defined. This happens when the crew specifies an altitude and a vertical angle or climb/descent rate for a future waypoint that establishes a BOC/TOD prior to the waypoint just before the one with the vertical definition. In this situation, the FMS will continue to the waypoint prior to the waypoint with the VNAV assignment before starting the climb/descent and the VNAV alert will be synchronized with the lateral turn alert.

HOLDING PATTERNS

The FMS provides lateral guidance to enter and fly holding patterns using standard FAA-approved entry procedures.

One crew-defined holding pattern may be entered into the flight plan. The holding pattern is attached to a waypoint, which becomes the holding fix. When the aircraft crosses the holding fix, holding guidance is activated, suspending normal leg advance until the holding pattern is cancelled. Three parameters define the holding pattern: 1) inbound course (defaults to current aircraft course), 2) turn direction (defaults to right turns), and 3) pattern duration or length (initially defaults to 1:00 minute with length entry dashed). Two optional parameters are provided: 1) holding speed (defaults to 230 KIAS) is used to generate the speed alert and 2) EFC time (no default - remains blank if no time is entered) is used by the FMS to update future flight plan ETAs. Holding pattern definitions are shown in figure 1.14-66.

NOTE

FMS calculation of timed holding pattern legs does not completely compensate for strong headwind/tailwind conditions. Under strong headwind/tailwind conditions the pattern timing may have to be adjusted to meet the inbound leg timing requirements.

Holding Patterns Associated with Data-based GPS Approaches

If a published GPS approach is in the flight plan, it may include up to three holding patterns as part of the procedure. Published holding patterns are enabled on the Holding Pattern page for the holding fix waypoint. To review the holding pattern parameters, select the right line select key adjacent to the IAF, FAF, or missed approach holding point (MAHP) to access the Flight Plan Waypoint page for that waypoint. Then select the right line select key for the H. This will display the Hold page (figure 1.14-67).

Holding Pattern Entry Guidance

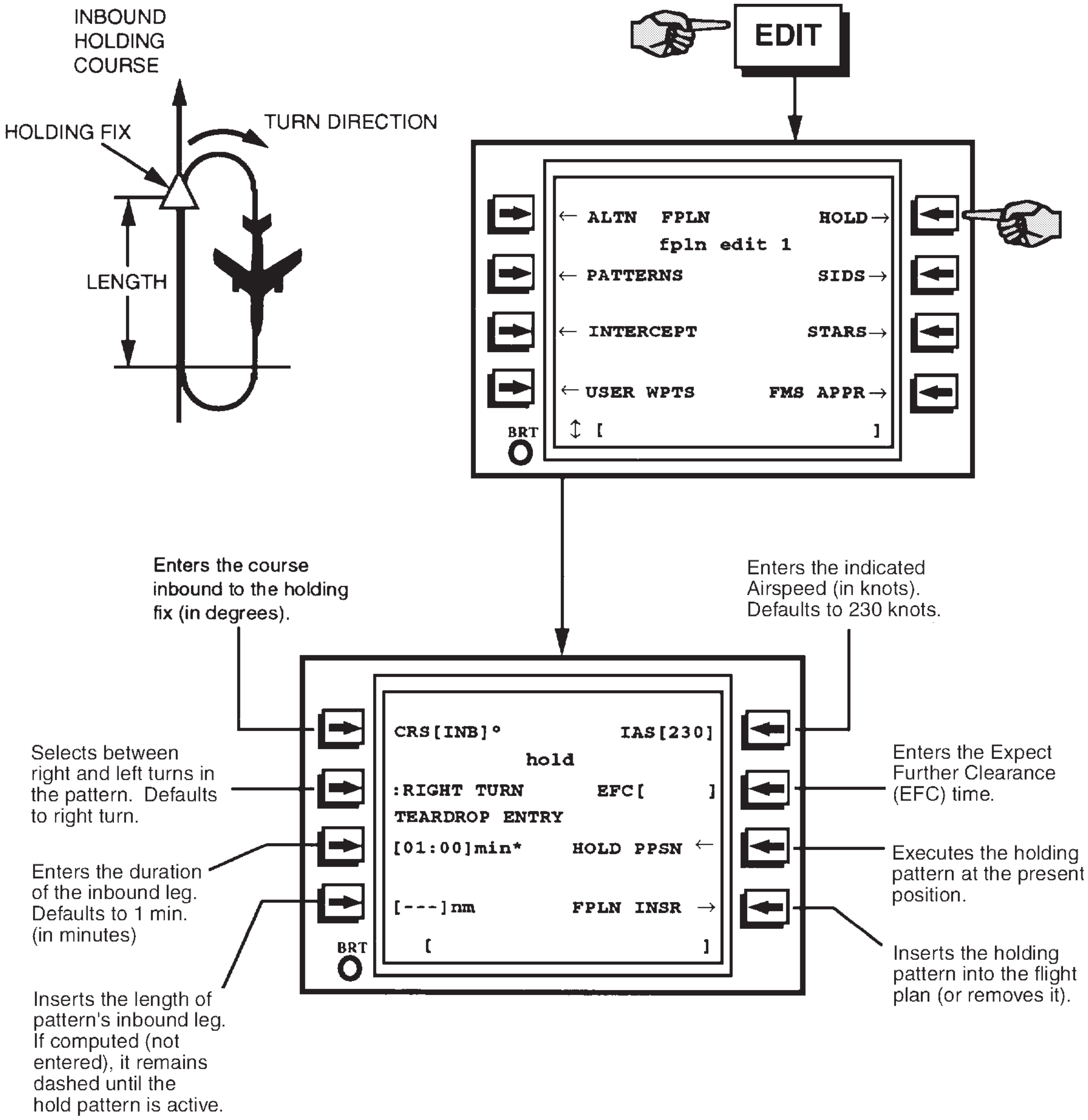
Steering guidance for the entry method is computed in accordance with FAA-approved procedures as published in the Aeronautical Information Manual and shown in figure 1.14-68, which shows the geometry for a standard (right-hand) holding pattern. For left-hand turns, a mirror image of each entry procedure applies. An advisory (DIRECT ENTRY, TEARDROP ENTRY, or PARALLEL ENTRY) is displayed on the Hold page as shown in figure 1.14-69. The entry procedure is computed twice. The first time is when the leg inbound to the holding fix becomes active. The second time occurs crossing the holding fix. The entry procedure may change crossing the holding fix if the aircraft's heading is different from the original inbound course.

NOTE

- The FMS uses single drift to compute holding pattern guidance. This may not satisfy ICAO requirements for holding.
- The FMS steering guidance in the holding pattern is to a computed ground track. Under strong crosswind conditions the aircraft may roll wings level to fly to the outbound ground track. Also, since the outbound ground track computation is based on the TAS crossing the holding fix, any increase in airspeed during the outbound turn or outbound leg may cause the aircraft to overshoot on the outbound or inbound turns.

Designation of the Holding Fix

After the holding pattern parameters have been entered, the active waypoint or a future waypoint may be designated as the holding fix. Press the FPLN INSR line select key on the Hold page to access the Flight Plan page with the message ATTACH HOLD AT? in the scratchpad. Scroll the flight plan to display the desired holding fix, and attach the holding pattern by pressing the adjacent left line select key. An H is displayed to the right of the designated waypoint as a reminder that it has been designated as the holding fix. Figure 1.14-69 illustrates the process of designating the holding fix.



Enters the course inbound to the holding fix (in degrees).

Selects between right and left turns in the pattern. Defaults to right turn.

Enters the duration of the inbound leg. Defaults to 1 min. (in minutes)

Inserts the length of pattern's inbound leg. If computed (not entered), it remains dashed until the hold pattern is active.

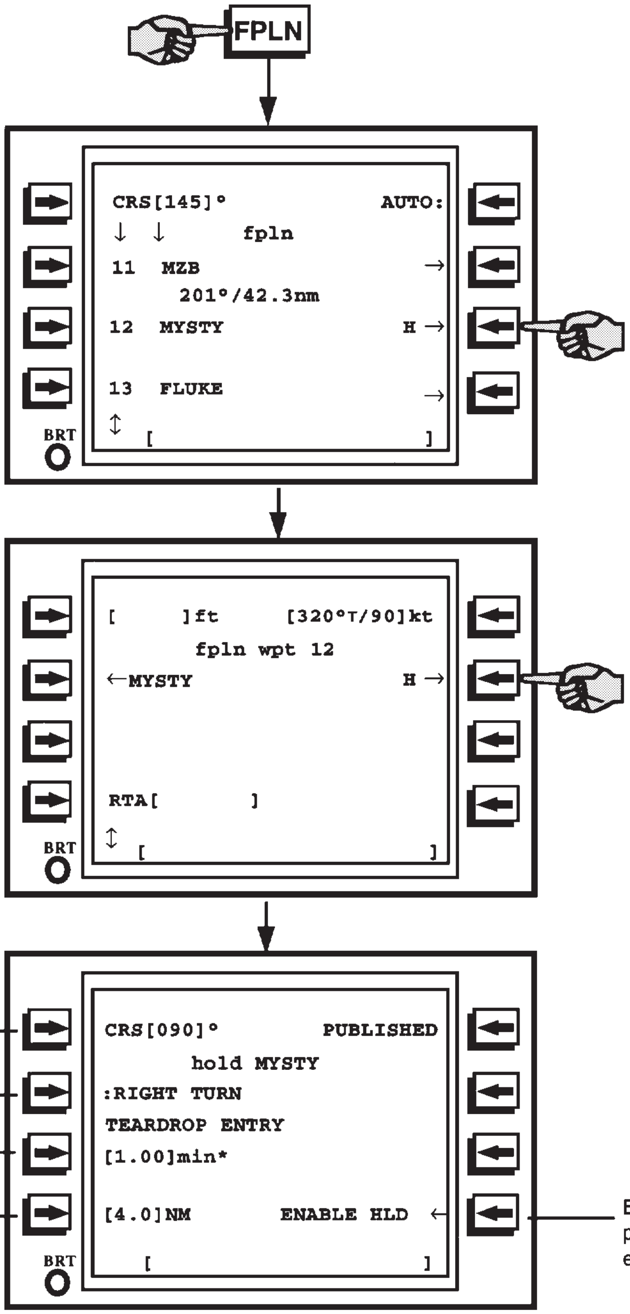
Enters the indicated Airspeed (in knots). Defaults to 230 knots.

Enters the Expect Further Clearance (EFC) time.

Executes the holding pattern at the present position.

Inserts the holding pattern into the flight plan (or removes it).

Figure 1.14-66. Crew-Defined Holding Pattern Definitions



1 Access the Flight Plan Waypoint page for the waypoint with the published holding pattern.

2 Access the Hold page by selecting the H attribute.

Initially displays published holding course. May be crew modified.

Initially displays published holding orientation. May be crew modified.

Initially displays published holding leg. May be crew modified. Asterisk (*) shows which value is fixed. Other valve is computed by FMS when in holding pattern.

Enables holding pattern for automatic entry.

Figure 1.14-67. Databased Holding Pattern Definitions

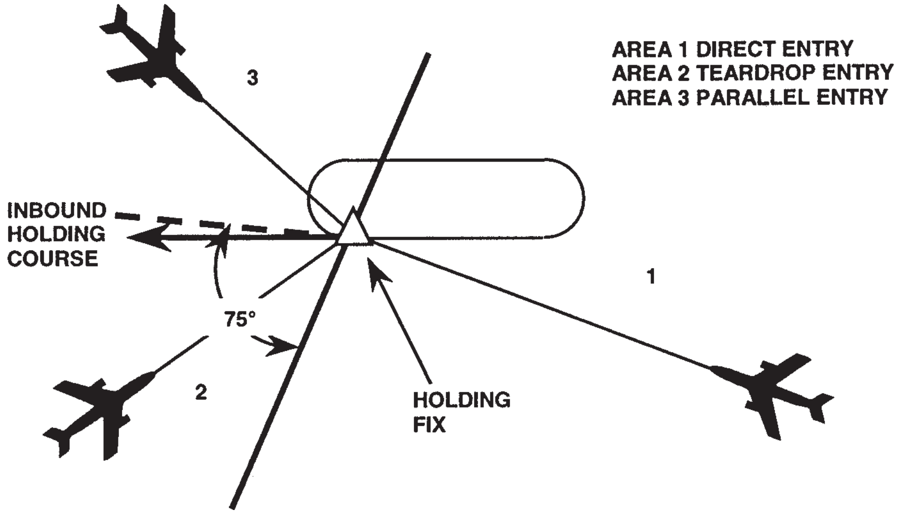


Figure 1.14-68. Holding Entry Guidance Parameters

Immediate Present Position Hold

If it becomes necessary to hold present position, 1) access the Hold page, 2) press the HOLD PSN line select key, and 3) confirm the selection by pressing it again. This procedure, illustrated in figure 1.14-70, immediately enters the aircraft present position (based on the designated pilot) into the flight plan as the active waypoint, interrupting the current flight plan leg, and activates a holding pattern at that fix with either the entered or default parameters on the Hold page. Once entered, this pattern and its holding fix are treated the same as a preplanned hold at a flight plan waypoint, and all parameters may be edited.

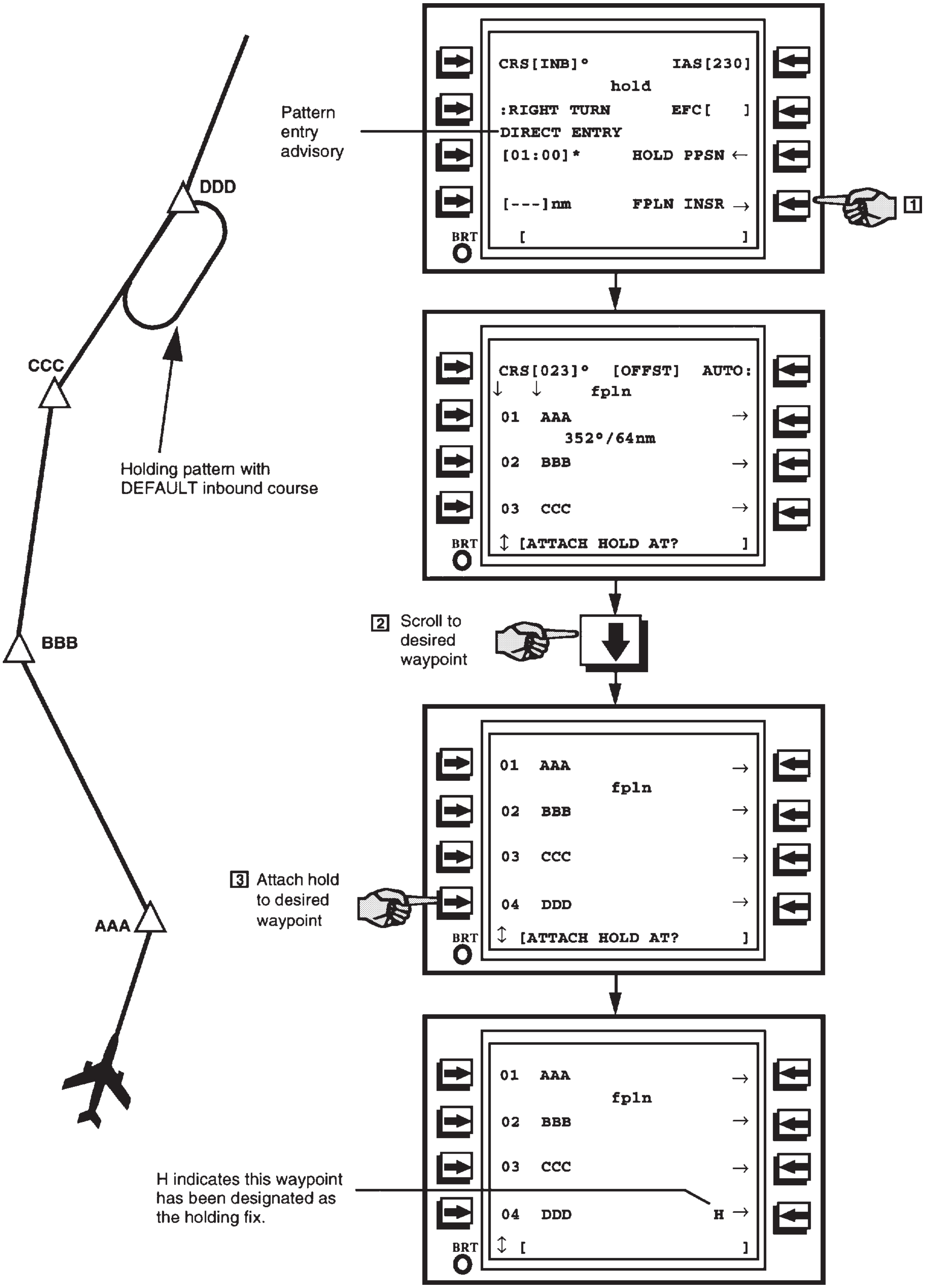
Holding Pattern Edits

Prior to pattern activation all holding parameters may be edited, and the modified parameters will take effect when the pattern becomes active. After pattern activation the inbound holding course cannot be changed on the Flight Plan page, but may be edited on the Hold page. The pattern duration, length, direction of turn, holding speed, and EFC time may also be edited on the Hold page. The holding fix (active waypoint) cannot be changed or deleted.

Holding Pattern Activation and Execution

When the holding fix is crossed for the first time, holding guidance computations are activated. At that time several changes occur, both in flight plan operation and page displays:

1. Automatic leg advance is suspended.
2. Course edits on the Flight Plan page may no longer be made. Inbound holding course edits may be made on the Hold page.
3. All displays reference the inbound course displayed on the Hold page.
4. Holding fix cannot be edited.
5. If the FGS bank angle selector is not set to 25°, the CDU will display the <<√bank limit>> annunciation.



Pattern entry advisory

Holding pattern with DEFAULT inbound course

```
CRS[INB]°              IAS[230]
             hold
:RIGHT TURN          EFC[    ]
DIRECT ENTRY
[01:00]*           HOLD PPSN ←

[---]nm            FPLN INSR →
 [                            ]
```

```
CRS[023]°  [OFFST]   AUTO:
↓    ↓       fpln
01  AAA                     →
        352°/64nm
02  BBB                     →

03  CCC                     →
↕ [ATTACH HOLD AT?          ]
```

2 Scroll to desired waypoint

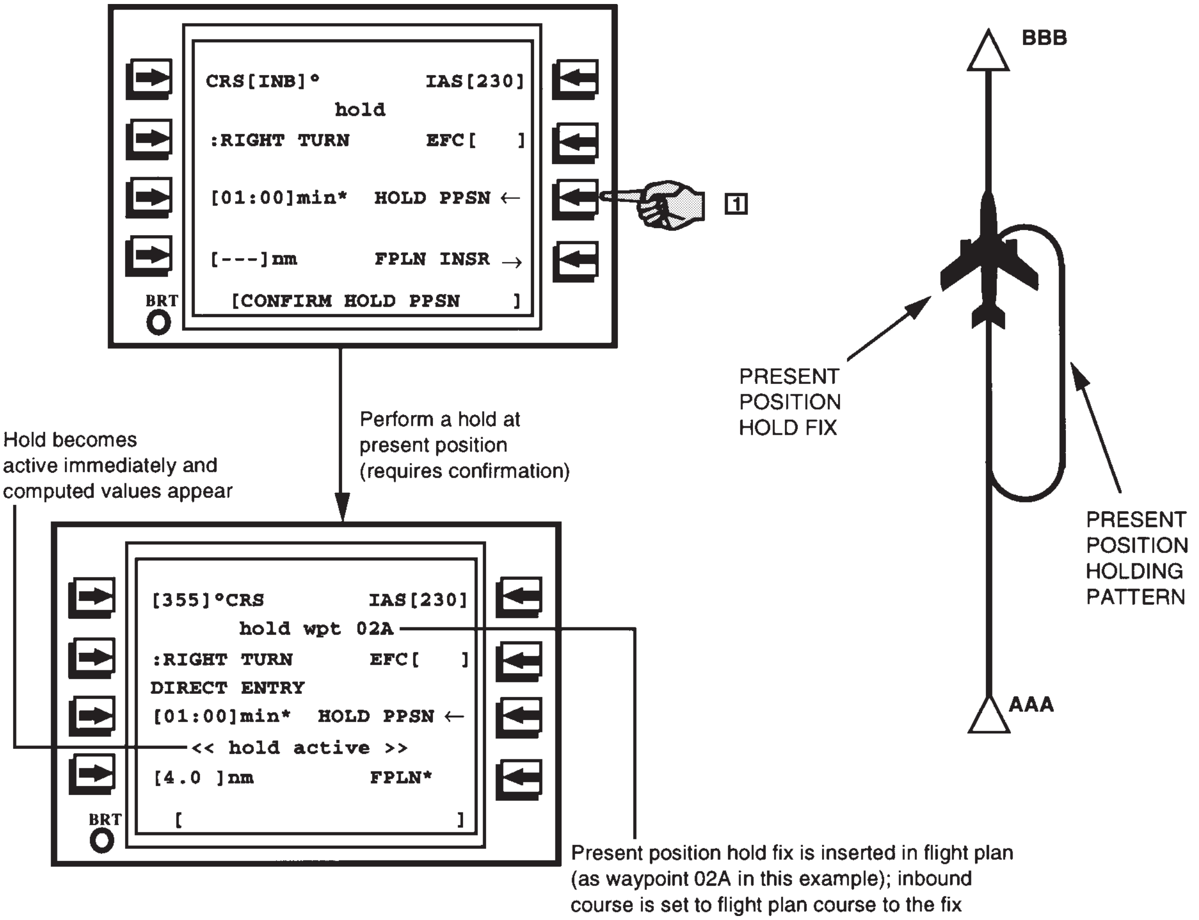
```
01  AAA                     →
             fpln
02  BBB                     →

03  CCC                     →

04  DDD                     →
↕ [ATTACH HOLD AT?          ]
```

3 Attach hold to desired waypoint

```
01  AAA                     →
             fpln
02  BBB                     →

03  CCC                     →

04  DDD                   H →
↕ [                         ]
```

H indicates this waypoint has been designated as the holding fix.

Figure 1.14-69. Designation of Holding Fix



```
CRS[INB]°          IAS[230]
          hold
:RIGHT TURN        EFC[    ]

[01:00]min*   HOLD PPSN ←

[---]nm       FPLN INSR →
  [CONFIRM HOLD PPSN     ]
```

```
[355]°CRS          IAS[230]
       hold wpt 02A
:RIGHT TURN        EFC[    ]
DIRECT ENTRY
[01:00]min*   HOLD PPSN ←
      << hold active >>
[4.0 ]nm           FPLN*
 [                        ]
```

Perform a hold at present position (requires confirmation)

Hold becomes active immediately and computed values appear

Present position hold fix is inserted in flight plan (as waypoint 02A in this example); inbound course is set to flight plan course to the fix

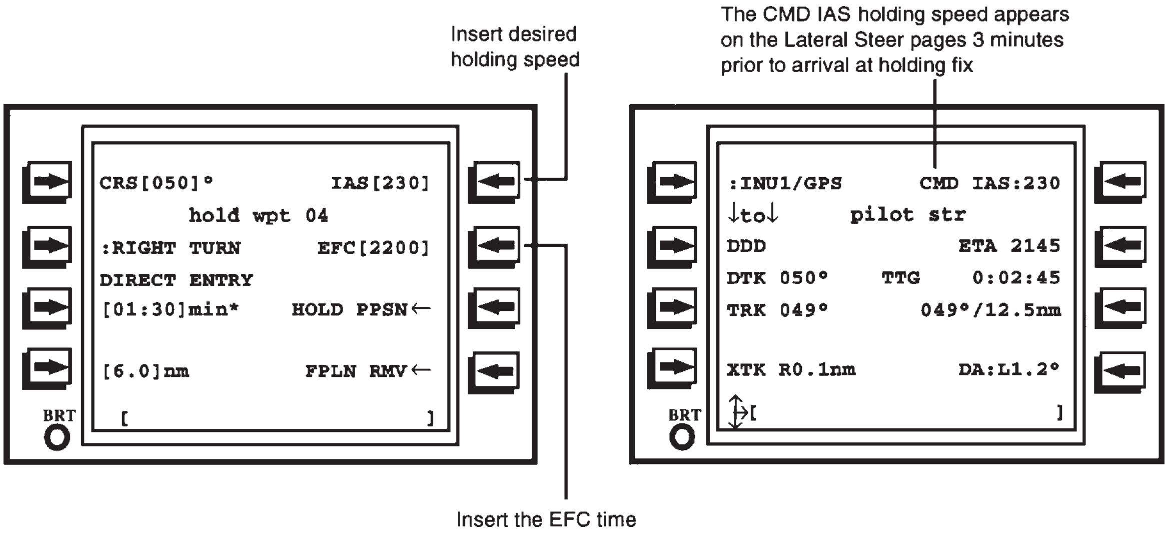
Figure 1.14-70. Holding Present Position

To edit a holding pattern once it is in the flight plan, either 1) on the Flight Plan Waypoint page, press the line select key adjacent to the H attribute, or 2) press the EDIT function key and select the HOLD line select key to access the Hold page (for crew-defined holding patterns only). If the inbound course or turn direction is changed, the FMS commands an immediate turn to the current inbound course and upon passing the holding fix, turns onto the new outbound course. If the leg length (or duration) is changed, it will take effect immediately.

When holding guidance has been activated, all course and lateral deviation displays now reference the inbound holding course, irrespective of whether the aircraft is on the inbound or outbound leg of the holding pattern. However, the 10 second turn alert will be computed on the outbound leg to alert the crew of the upcoming turn to the inbound leg.

Holding Speed and Expect Further Clearance Time

The commanded holding speed and expect further clearance (EFC) time entries and displays assist the pilot in executing a holding pattern in accordance with air traffic control procedures and permit future waypoint ETAs to be more realistically calculated.



Insert desired holding speed

The CMD IAS holding speed appears on the Lateral Steer pages 3 minutes prior to arrival at holding fix

```
CRS[050]°           IAS[230]
       hold wpt 04
:RIGHT TURN        EFC[2200]
DIRECT ENTRY
[01:30]min*     HOLD PPSN←

[6.0]nm          FPLN RMV←
 [                         ]
```

```
:INU1/GPS       CMD IAS:230
↓to↓        pilot str
DDD                ETA 2145
DTK 050°     TTG    0:02:45
TRK 049°        049°/12.5nm

XTK R0.1nm         DA:L1.2°
↕[                         ]
```

Insert the EFC time

Figure 1.14-71. Holding Airspeed and EFC Time Entry and Display

Entry and Display of Holding Speed

If no holding speed is entered or if a - is entered, this display (figure 1.14-71) defaults to 230 knots IAS. Beginning three minutes prior to arrival at the holding fix, the entered holding speed becomes the commanded speed reference on the Lateral Steering pages (figure 1.14-71) and for the speed threshold alert function (see Active Flight Plan section). Upon exiting the holding pattern, the speed command function reverts to its normal mode.

Entry and Display of EFC Time

To permit more realistic future waypoint ETAs (see Waypoint Data section), the Hold page allows an optional entry of the ATC EFC time or other planned departure time from the holding fix. If an EFC time is entered (in UTC), then all future waypoint ETAs are calculated from that holding fix departure reference. If no EFC time is entered or it is deleted, then all future ETAs are calculated as if no loiter time will be spent in the holding pattern.

Exiting the Holding Pattern

Holding patterns may be terminated in three ways:

1. By cancellation (deletion of the H attribute). In this case a leg switch to the next flight plan waypoint will occur when the fix is crossed again if an automatic (AUTO or FLYOVER) waypoint sequencing mode is selected. Holding pattern parameters are reset to default values.
2. Direct-To a waypoint other than the holding fix. This removes the holding fix waypoint from the flight plan and resets the holding pattern parameters to default values.
3. Direct-To the holding fix. This deactivates the holding pattern; however, the holding pattern will be reentered when the aircraft crosses the fix again unless the H attribute is deleted.

MISSION FLIGHT PATTERNS

The FMS allows definition of several special mission flight patterns (MFPs) to meet specific operational or contingency mission requirements. The five available MFPs include:

1. Refuel (tanker orbit/rendezvous)
2. Racetrack (orbit)
3. Figure eight
4. Circle
5. Closed random pattern (CRP)

The FMS provides flight guidance including entry procedures to execute each pattern type. Any MFP may be associated with one or more fixed waypoints in the flight plan (active or alternate). A maximum of 20 MFPs may be inserted into a given flight plan. When the aircraft crosses a pattern fix, pattern guidance is activated, suspending normal leg advance until the MFP is exited.

MFP Definition

Definition of MFPs is performed on the individual MFP pages, one for each type of pattern. To create a new MFP, access the individual MFP pages from the Patterns page as shown in figure 1.14-72. Four parameters define the racetrack and figure eight patterns: 1) inbound course (defaults to current aircraft course), 2) turn direction (defaults to left turns), 3) pattern length (defaults to 16 NM), and 4) pattern width (defaults to 8 NM). Circle patterns require all parameters listed above except for pattern length. Defining parameters for these MFPs are shown in figure 1.14-73. Refuel patterns require entry of the air refueling control point (CP), which can be an existing flight plan waypoint and air refueling initial point (IP) waypoints and the pattern length (default of 14 NM provided). Defining parameters for the refuel MFP are shown in figure 1.14-74. CRPs are special patterns made up of crew-defined points connected together to form an enclosed flight path. A CRP may be flown in repeated forward or reverse sequence. An optional ETD may be entered for any MFP in order to allow the FMS to more accurately calculate ETAs for the remainder of the flight plan.

The following paragraphs will describe the definition and execution of the individual pattern types. The racetrack, figure eight, and circle are basically variations of the same pattern, and as such are grouped together. The CRP shares some common features with these three (designation of pattern fix and pattern edits), but is different enough in definition and execution to warrant a separate description. The refuel MFP is quite different in its definition and execution, and is therefore described separately.

Designation of the Pattern Fix (Racetrack, Figure 8, Circle, and CRP)

The pattern fix can be specified either directly on the MFP pages or by attaching an MFP to a flight plan waypoint. To specify the pattern fix on the MFP page and insert it into the flight plan, define the MFP and press the FPLN INSR line select key on the MFP page. This accesses the Flight Plan page with INSERT XXX BEFORE? in the scratchpad, where XXX is FG8, RTK, CIR, or CRP depending on which type of MFP was defined. After the flight plan is scrolled to the desired location, press the line select key adjacent to the waypoint which will follow the pattern fix. This will enter the pattern fix as a flight plan waypoint and display a P to the right of the waypoint as a reminder that it is a pattern fix.

To attach an MFP to an already existing flight plan waypoint, define the MFP but leave the pattern fix blank on the MFP page. Then press the FPLN INSR key to access the Flight Plan page with the message ATTACH XXX AT? in the scratchpad, where XXX is FG8, RTK, CIR, or CRP depending on which type of MFP was defined. After the flight plan is scrolled to the desired location, press the line select key adjacent to the pattern fix. A P is displayed to the right of the designated waypoint as a reminder that it has been designated as the pattern fix.

MFP Pattern Edits (Racetrack, Figure 8, Circle, and CRP)

Once an MFP has been inserted into the flight plan, the MFP parameters can be viewed and modified by pressing the line select key adjacent to the associated P symbol (LS6) on the Flight Plan page to access the associated Flight Plan Waypoint page and then pressing LS6 again to access the MFP page. Prior to pattern activation all parameters except the pattern fix may be edited, and the modified parameters will take effect when the pattern becomes active. After pattern activation the inbound pattern course cannot be changed on the Flight Plan page, but may be edited on the respective pattern page. The pattern length, width, direction of turn, and ETD may also be edited. The pattern fix cannot be changed or deleted.

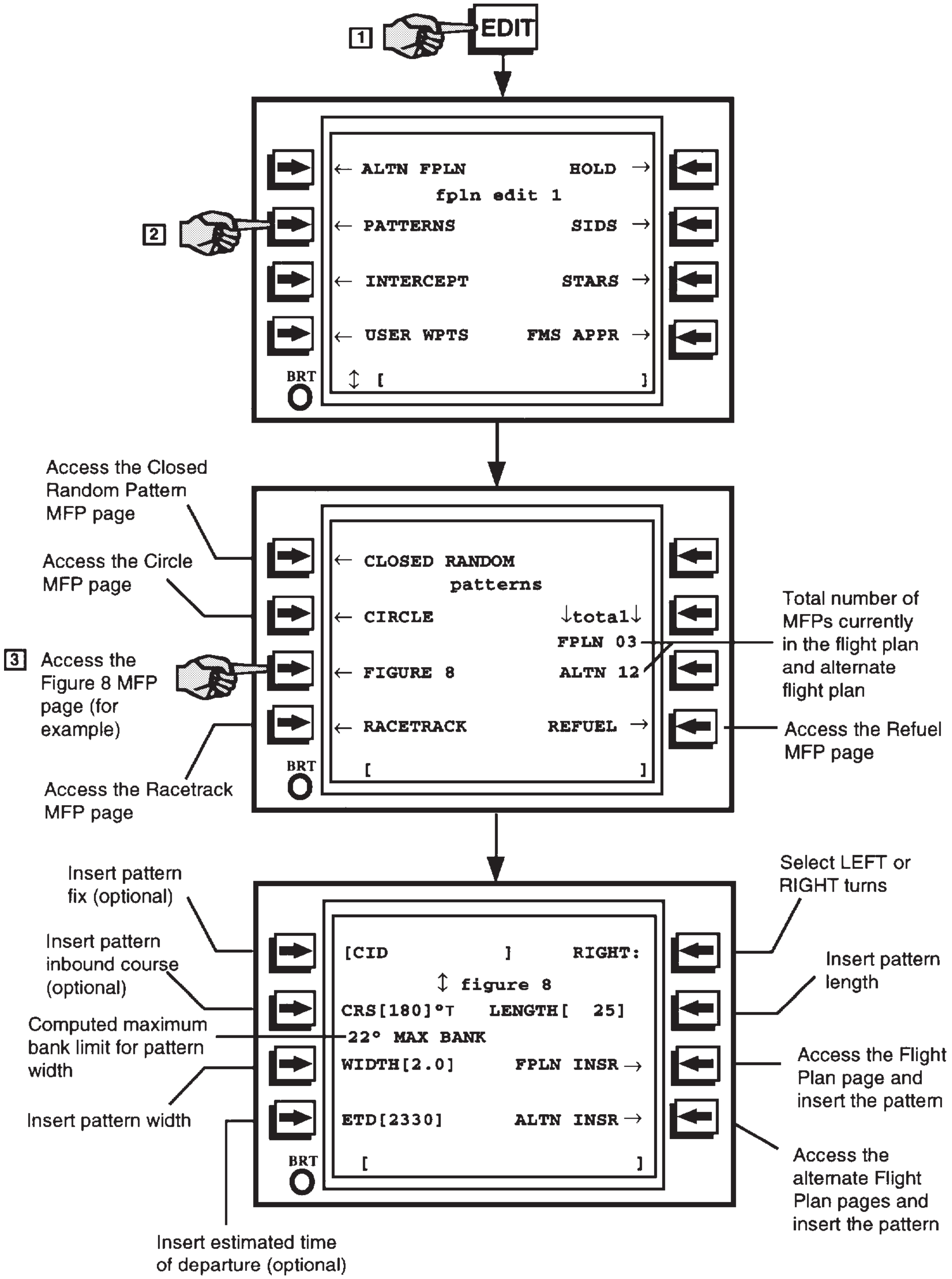


Figure 1.14-72. MFP Page Access from the Patterns Page

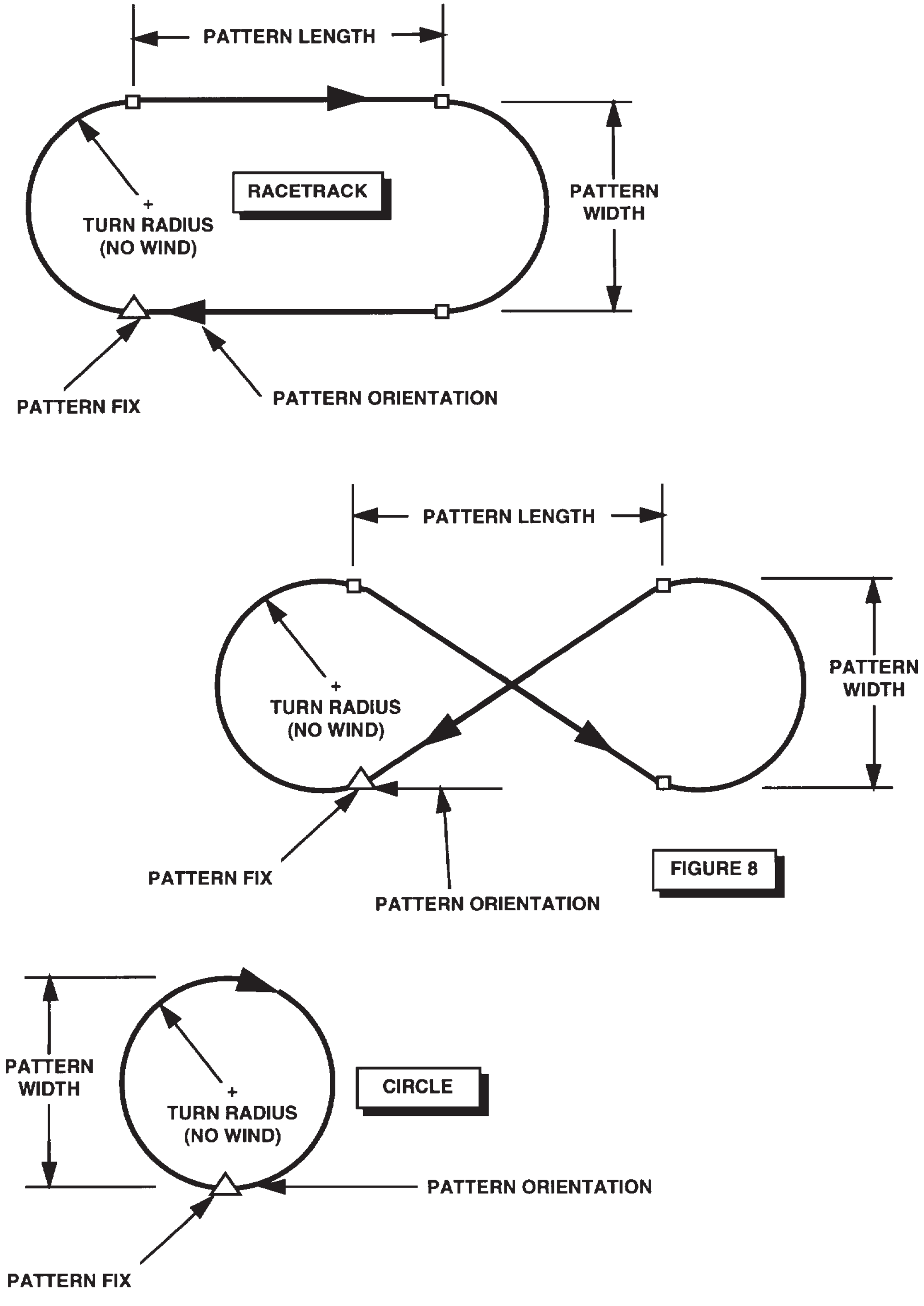


Figure 1.14-73. Racetrack, Figure 8, and Circle MFP Defining Parameters

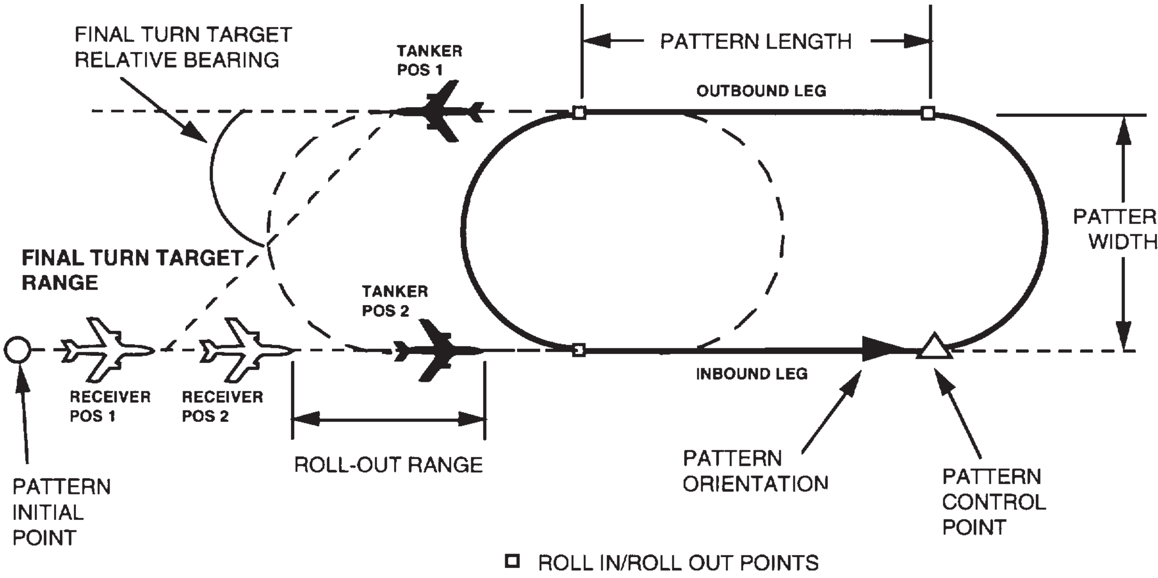


Figure 1.14-74. Defining Parameters for the Refuel MFP

MFP Activation and Execution (Racetrack, Figure 8, and Circle)

NOTE

> This section describes activation and execution of racetrack, figure eight, and circle MFPs, not CRPs. See CRP Execution and Definition section for a discussion of CRPs.

The FMS provides entry guidance into these MFPs similar to that for holding patterns (see Holding Patterns section). When the pattern fix is passed for the first time, pattern guidance computations are activated. At that time several changes occur, both in flight plan operation and page displays:

1. Automatic leg advance is suspended.
2. Course edits on the Flight Plan page may no longer be made. Inbound pattern course edits may be made on the MFP page.
3. When on the inbound leg, all displays reference the computed inbound course (not necessarily the inbound course displayed on the MFP page; for example, computed inbound course for figure eight patterns is significantly different than displayed inbound course).
4. When on the outbound leg, displays reference the computed outbound course.

If any MFP definition parameters are changed while in the pattern, the changes are applied after the aircraft passes the pattern fix (transition from TO to FROM) except for the pattern length and width, which take effect immediately if on the outbound leg.

When pattern guidance has been activated, all course and lateral deviation displays now reference the computed inbound (or outbound) course of the pattern. The 10 second turn alert will be computed both for the inbound leg pattern fix and the outbound leg turn point.

Maximum Bank Angle (Racetrack, Figure 8, and Circle)

When an MFP is inserted in the flight plan, the FMS computes and displays the maximum bank angle allowed for proper execution of the pattern based on pattern width and aircraft speed (if airborne). The maximum bank is displayed on the information line of the MFP page.

CRP Definition and Execution

CRPs are defined by entering points (i.e., identifiers, latitude-longitude positions, etc.) on the CRP MFP pages 1 through 3. Up to nine waypoints (in addition to the fix point, which is optional) may be specified. To specify the MFP fix on the CRP MFP pages, enter the position at the FIX line (waypoint 0) on CRP MFP page 1.

CRPs will only be executed upon arrival at the CRP fix if AUTO or FLYOVER waypoint sequencing mode is selected. If manual (MAN) sequencing mode is selected, the fix is overflown without activating the pattern. To execute the pattern, toggle the sequencing mode to AUTO or FLYOVER. Once the CRP is being executed, guidance is provided to each point in the CRP as if they were flight plan waypoints. An asterisk (*) is displayed adjacent to the CRP waypoint number of the current active waypoint on the associated CRP MFP page.

Refuel MFP

The refuel MFP provides the capability to define and execute a point parallel air refueling orbit/rendezvous. The default orbit is a left-hand racetrack pattern with 14 NM legs and a computed variable offset based on true airspeed, wind, and the bank angle selected on the FGS bank selector, all referenced to the turn from the outbound leg to the inbound leg. The offset is recomputed upon each passage of the CP. Execution of the refuel pattern is accomplished in five stages:

Diversion to orbit - initiated by CDU operation

Transition to orbit - automatic

Orbit - automatic

Rendezvous - initiated by CDU operation

Track - initiated by CDU operation

NOTE

> The ARCP, navpoints, and end air refueling point should be entered in sequence as flight plan waypoints or loaded from the navigation database in order to fly the track after completion of the rendezvous.

Enter Refuel Pattern Parameters

Refuel pattern parameters should be entered on the Refuel MFP pages prior to arrival at the ARCP (figure 1.14-75). To enter the required data, first press the EDIT function key and select the PATTERNS line select (LS2) to access the Patterns page. Then press the REFUEL line select (LS8) to access the Refuel A MFP page. IP and CP waypoints may be entered as lat/long coordinates or ICAO NAVAID bearing/distance identifiers. The CP may be omitted, in which case the flight plan waypoint where the pattern is attached will become the CP. If a refuel pattern is recalled from the database, the CP and IP will automatically be entered on the Refuel A MFP page. If the CP waypoint has a VNAV altitude assigned to it, then that altitude will be used for the entire pattern. Enter pattern turn direction (defaults to LEFT), length (defaults to 14 NM), and ETD (if desired). The orbit entry method selection toggles between INBOUND MP (FMS provides guidance to intercept the inbound leg), OUTBOUND MP (FMS provides guidance to intercept the outbound leg), or AUTO (default setting; FMS decides automatically which leg to intercept). With AUTO selected, the right side of the information line will display which leg of the orbit will be captured when the pattern becomes active (blanks when the leg is captured). The course displayed on the left side of the information line is the course between the IP and CP in degrees true.

Next scroll laterally to the Refuel B MFP page to complete the setup of the refuel pattern. Enter receiver TAS and select the rendezvous rollout position (defaults to LEAD), rollout range (defaults to 3 NM), and orbit offset, if desired (offset will be calculated by the FMS if no entry is made).

The refuel pattern may now be inserted into either the active or alternate flight plan by pressing the appropriate line select key. FPLN INSR will access the Flight Plan page. If a CP has been entered on the Refuel A MFP page, the scratchpad message INSERT RFL BEFORE? will be displayed; if the CP was not entered, the message ATTACH RFL AT? will be displayed. Press the line select key adjacent to the appropriate waypoint to insert the refuel pattern into the active flight plan. ALTN INSR will access the Alternate Flight Plan Leg A page. Entry procedures are the same as for the active flight plan.

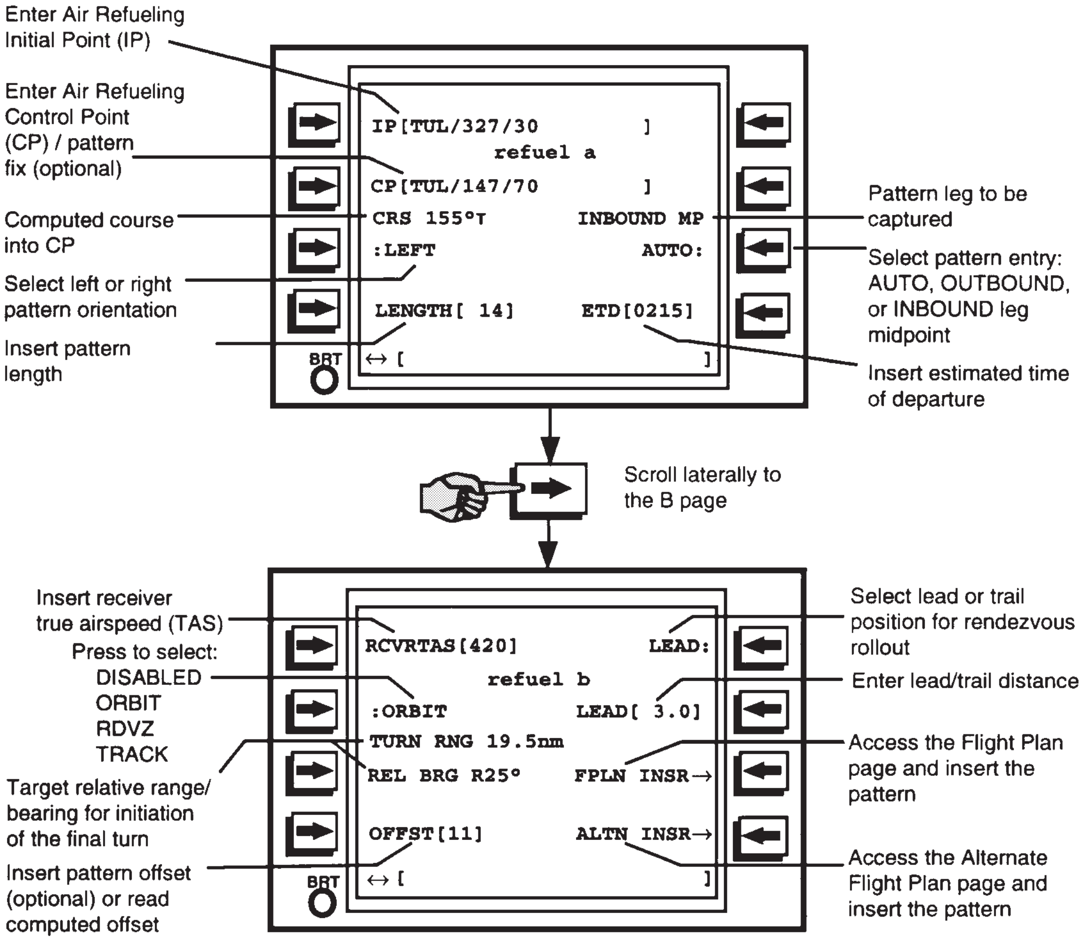


Figure 1.14-75. Refuel Pages

Diversion to Orbit/Enter Orbit

Refuel pattern execution (rfl active) begins when the ORBIT mode is selected (pattern enabled) with LS2 on the Refuel B MFP page and the CP is the active waypoint. The pattern will be entered via direct entry to the midpoint of either the inbound or outbound leg of the orbit as determined by the FMS (in AUTO) or selected by the flight crew. The criteria used by the FMS for determining the capture leg is based on the orientation of the projected track from the aircraft's present position at pattern activation to the midpoint of the inbound leg. If the projected track is on the IP side of a line bisecting the midpoint of the inbound leg perpendicular to the refuel pattern orientation, the inbound leg will be captured. If the projected track is on the CP side of the bisector, the outbound leg will be captured (figure 1.14-76).

After diversion to the orbit is initiated, the IP becomes the FROM flight plan waypoint, and the direct course from present position to the appropriate leg midpoint is computed and displayed as the desired track. CDU and flight instrument/FGS guidance outputs continue to reference this direct course until the switching point for capturing the selected pattern leg is reached. At this point the guidance outputs reference the captured leg. The EHSI turnpoint alert will flash when within the user-selected waypoint alert time prior to reaching the turnpoint.

NOTE

> The FGS bank angle selector must be set to 25° for the aircraft to properly fly the orbit. If the selector is not set to 25°, the CDU will display the <<√bank limit>> annunciation upon initial activation of orbit mode.

Orbit Mode

Once the aircraft is established in the orbit (inbound/outbound leg midpoint captured), the FMS will provide steering guidance to maintain the orbit. Orbit offset and turn range will be recomputed upon each passage of the CP or may be manually recomputed anytime by entering a - in the scratchpad and selecting LS4 on the Refuel B page. Guidance displays will reference the inbound course and CP while on the inbound leg and the outbound course and turnpoint while on the outbound leg. The EHSI waypoint alert will illuminate when within the user-selected waypoint alert time prior to reaching the turnpoint on each leg. The orbit mode will continue until a Direct-To is performed or rendezvous mode is initiated.

Rendezvous Mode

The flight crew may initiate rendezvous mode at anytime during the orbit by toggling LS2 on the Refuel B MFP page to RDVZ. One of the following actions will occur:

1. If the aircraft is on the inbound leg, it will be directed to turn immediately to capture the outbound leg.
2. If the aircraft is already on the outbound leg, it will be directed to maintain that course.
3. If the aircraft is turning outbound when the mode is switched to rendezvous, it will be directed to complete the turn and maintain the outbound course.
4. If the aircraft is turning inbound when the mode selection is made, it will be directed to continue the turn to the inbound leg, then turn immediately to capture the outbound course.

The outbound course will be maintained until the final turn is initiated or a Direct-To is performed (figure 1.14-77). Guidance displays will reference the outbound course and orbit turnpoint. There will be no waypoint alert in the rendezvous mode.

The FMS will compute and display a target relative bearing and turn range for the final turn to track when in the orbit or rendezvous mode. This calculation will be based on the desired rollout range, offset, and receiver true airspeed. These values should be used to initiate the final turn when the receiver's range and/or bearing matches the computed values as determined by air-to-air TACAN, radar, or other means.

Track Mode

The final turn to track is initiated by toggling LS2 on the Refuel B MFP page to the TRACK mode. The FMS will direct the aircraft to turn immediately to the inbound course using the bank angle set on the FGS bank angle selector. This course will be intercepted and maintained until the crew performs a Direct-To or reenters the orbit mode by selecting ORBIT on the Refuel B MFP page. Guidance displays will reference the inbound course and CP.

NOTE

> The turn to ARIP-ARCP ground track heading is based on the aircraft maintaining the bank angle selected with the FGS bank angle selector (25° is recommended). The aircraft may not roll out on track if bank angle is varied during the turn.

Refuel Pattern Edits

Once the refuel pattern has been inserted into the flight plan, no parameters except pattern length, pattern offset, and turn direction may be modified. After the pattern has been activated, no edits are permitted except to pattern length and offset (figure 1.14-78). To view or edit refueling pattern parameters, select the line key adjacent the P attribute on the Flight Plan Waypoint page (LS6) for the pattern fix (CP). This calls up the Refuel B page for the pattern.

Estimated Time of Departure

The optional estimated time of departure (ETD) entry on the various MFPs permits future waypoint ETAs to be more realistically calculated. If an ETD is entered (in UTC), then all future waypoint ETAs are calculated from that pattern fix departure reference. If no ETD is entered or it is deleted, then all future ETAs are calculated as if no loiter time will be spent in the MFP.

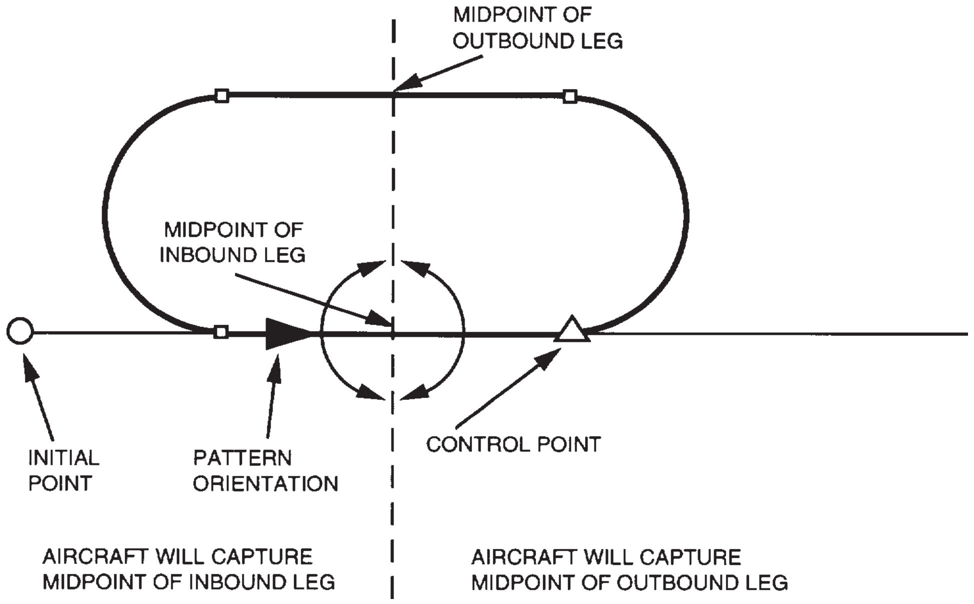


Figure 1.14-76. Refuel MFP Leg Capture with System Set to AUTO

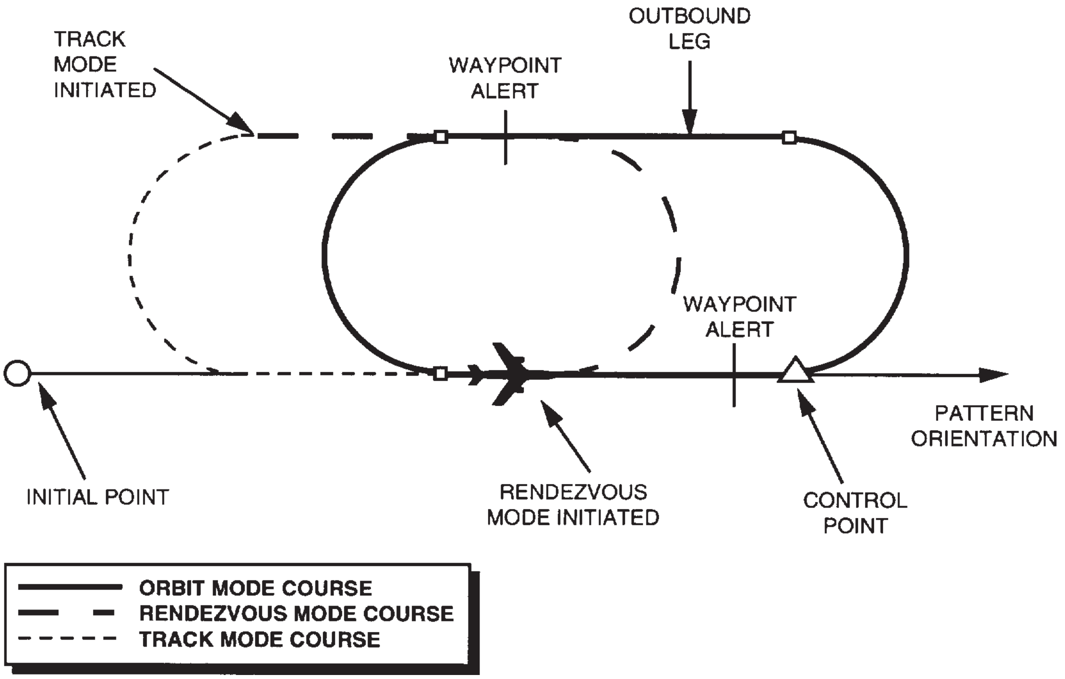


Figure 1.14-77. Refuel MFP Execution

Exiting the MFP

MFPs may only be terminated by performing a Direct-To. If the Direct-To is to any waypoint besides the pattern fix, the pattern fix waypoint is removed from the flight plan and the MFP parameters are reset to default conditions. If the Direct-To is to the pattern fix, the pattern will be deactivated, but will be reentered upon crossing the pattern fix unless the P attribute is deleted prior to arrival at the fix.

SIDS AND STARS

NOTE

> Crosscheck FMS navigation with traditional ground-based NAVAIDS in the terminal area when available. FMS navigation may be used as the sole-source of navigation information for all arrival, approach and departure procedures extracted from the aircraft database. These procedures must be flown as extracted, with no additions, changes or deletions by the aircrew.

The FMS enables the pilot to select, by name, a standard instrument departure (SID) and/or a standard terminal arrival route (STAR) for insertion into the active flight plan only. When a SID or STAR is selected, the FMS recalls the SID/STAR from the ICAO database and inserts all of the procedure waypoints in the correct sequence, along with any crossing altitude restrictions.

Two different SIDs/STARs for an airport can be maintained by the FMS. One is inserted into the flight plan and the other is referred to as the working copy. The working copy allows the pilot to select a backup SID/STAR that can be used to replace the inserted SID/STAR in case of runway change or ATC clearance amendment. The working copy definition is accessed from the Flight Plan Edit 1 page menu and displays SELECT (if no SID/STAR inserted) or MODIFY on the information line. Large arrows are used to indicate selections in the working copy. The current flight plan inserted SID/STAR definition is accessed by selecting the SID or STAR attribute from the Flight Plan Waypoint page and displays IN FPLN on the information line. Asterisks are used to indicate selections on the inserted SID/ STAR.

Once inserted into the flight plan, the SID/STAR may be deleted or replaced with another procedure from the SID/STAR pages or the working copy. Individual waypoints may also be added to or deleted from the SID/STAR sequence in the flight plan itself. SIDs, STARs and approaches may be selected for different airports so that, for example, a STAR may be flown for one destination airport and an FMS approach may be executed for another airport nearby.

SID/STAR Selection and Flight Plan Entry

To select a SID, press the SIDS line select key on the Flight Plan Edit 1 page of the CDU. This will access the SIDS page. Enter the four-letter ICAO identifier for the origin (departure) airport to display all of the available SIDs (up to 18) for that airport (figure 1.14-79).

Select the desired SID using the adjacent line key on the left side of the page. The CDU indicates the selection with a large arrow. If runways are listed on the right side of the page, then a runway selection must also be made to have the correct runway transition. After choosing the SID and departure runway (either may be selected first), select the TRANSITION line select key, to call up the en route transition (if any) for that SID. On the SID Transition page (figure 1.14-79), select the desired en route transition and press FPLN INSR to call up the flight plan page with INSERT SID BEFORE? displayed in the scratchpad. Then insert the SID at any desired location in the flight plan. The SID waypoints are automatically entered in the correct sequence and indicated as SID waypoints by the S attribute on the right side of the page.

A SID does not have to be the first waypoint in the flight plan, but can be entered after other departure waypoints. To move or change a SID in the flight plan, select the line key adjacent to the S attribute on the Flight Plan Waypoint page for any of the SID waypoints in the sequence. This action calls up the SID Transition page, which shows the flight plan SID transition. Press the FPLN RMV line select key (requires confirmation), then verify the SID has been removed from the flight plan. Afterward, another procedure, runway or en route transition may be selected and the new SID inserted into the flight plan following the above procedures.

In order to replace the current SID with the working copy definition, access the SID Transition page, then select FPLN MOD (requires confirmation) to replace the existing SID. The previous SID is erased from the flight plan and the Flight Plan page is accessed with INSERT SID BEFORE? in the scratchpad.

The S attribute may not be deleted on the Flight Plan page. In order to delete the attribute, the waypoint itself must be deleted. However, as SID waypoints are passed they lose their S attribute and become ordinary history waypoints which are not removed if the SID is removed from the flight plan.

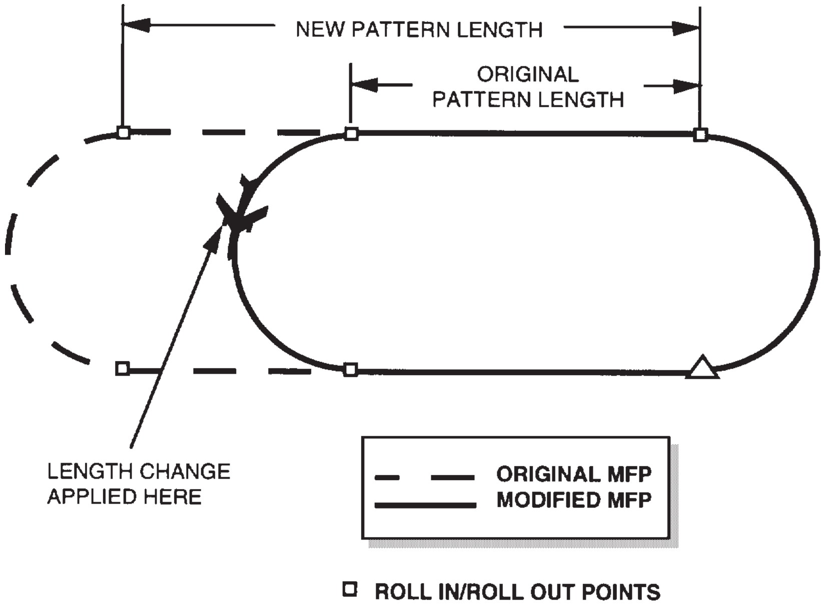


Figure 1.14-78. Refuel Pattern Length Edit While Turning Inbound

The selection, removal and flight plan operation of STARs (figure 1.14-80) is identical to that of SlDs, except:

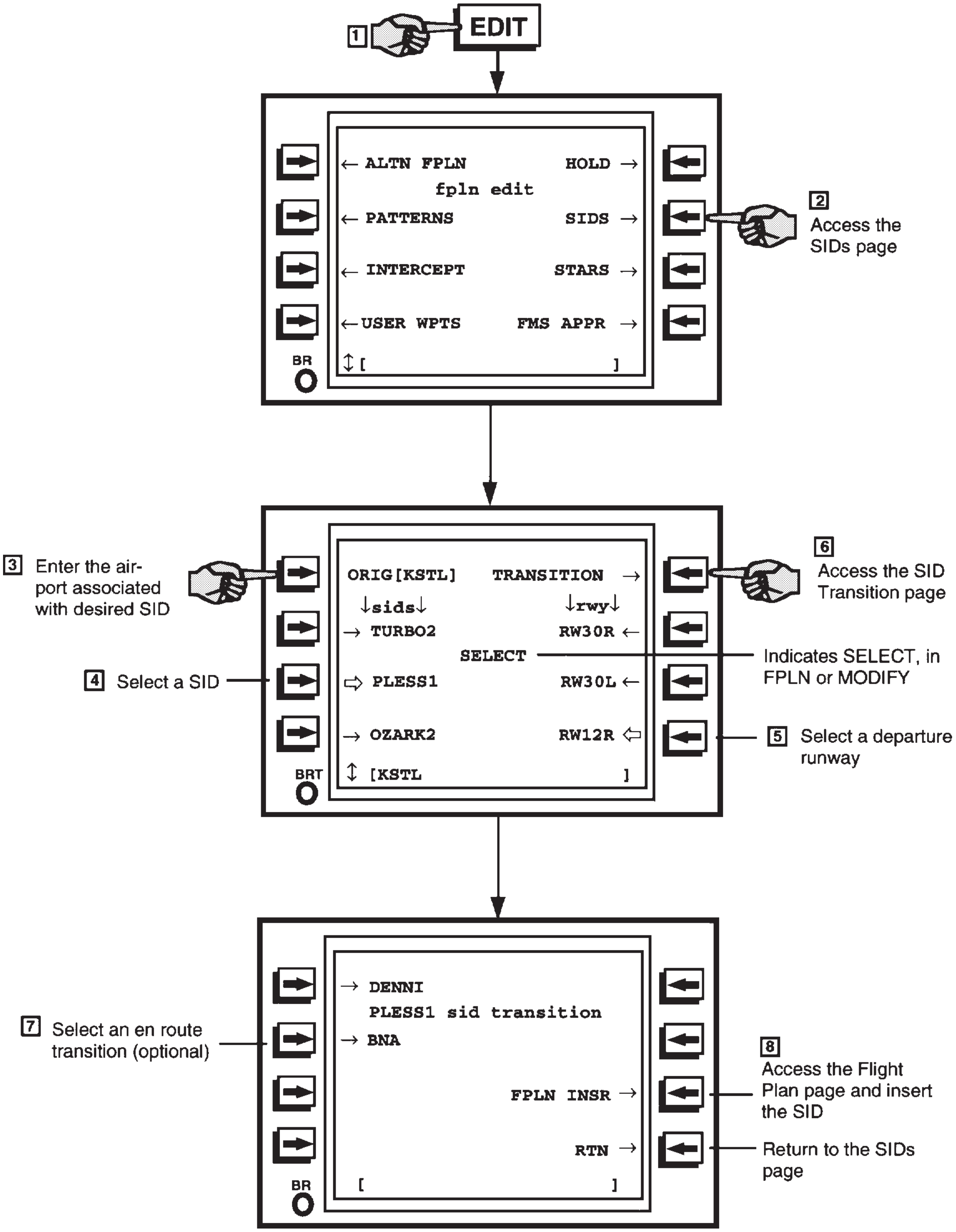
- STARs are accessed using the STAR line select key on the Flight Plan Edit 1 page.
- STARS are displayed for the entered destination airport rather than the origin airport.
- When FPLN INSR or FPLN MOD is selected, the Flight Plan page is accessed at the *END prompt.
- STAR waypoints are indicated by an R attribute on the Flight Plan page instead of an S as for a SID waypoint.

The destination airport for a STAR and approach are shared until either definition is entered into the flight plan.

SID/STAR Execution

Once a SID or STAR is in the flight plan, consult the published procedure chart for exact instructions in flying it. The procedure may include heading, altitude, speed, turn direction, or radial/distance conditional segments which require pilot action to initiate or terminate. These conditional segments may cause a discontinuity in the sequencing of the flight plan. When a flight plan DISCONTINUITY is pending, a <<verify proc>> annunciation will be provided to alert the pilot to consult the published procedure. Use the following pilot procedures to fly a SID or STAR:

- If the procedure includes direct waypoint-to-waypoint routing, then follow the EHSI course and deviation guidance exactly as presented by the FMS for that segment.
- If the procedure includes a heading segment, then fly the procedure heading rather than the displayed course for that segment.
- To intercept a procedure course or radial, enter the course on the CDU Flight Plan page and intercept it as if flying a conventional VOR or TACAN course capture.
- To fly directly to a waypoint on the SID/STAR, press the DIR function key on the CDU and then select the desired waypoint in the flight plan.
- For vertical path guidance, the FMS provides vertical speed/angle advisories to a predefined altitude



1
2 Access the SIDs page

3 Enter the airport associated with desired SID

4 Select a SID

Indicates SELECT, in FPLN or MODIFY

5 Select a departure runway

6 Access the SID Transition page

7 Select an en route transition (optional)

8 Access the Flight Plan page and insert the SID

Return to the SIDs page

Figure 1.14-79. SIDs and SID Transition Pages on the VNAV Steer page of the CDU for the climb or descent. VNAV guidance is also displayed on the VNAV deviation indicator of the EHSI.

However, since some altitude restrictions include a range of minimum and maximum altitudes, or different altitudes for different categories of aircraft, as well as airspeed restrictions, the published procedure chart should always be consulted for reference guidance.

SID/STAR Flight Plan Discontinuities

A discontinuity in the flight plan may occur when using SIDs/STARs. A discontinuity is associated with a waypoint and requires crew action to resolve in order to obtain proper flight plan sequencing. The waypoint associated with the discontinuity can be either the one preceding, following, or both. A discontinuity is inserted into the flight plan under the following conditions:

- Preceding a SID or following a STAR when it is inserted into the flight plan (DISCONTINUITY).
- When a SID/STAR has a leg the FMS can't fly, e.g., maintain heading 235° until reaching 4000 feet (LEG DISCON).
- When a SID/STAR has a leg with a specified turn direction (LEG DISCON).

Figure 1.14-81 shows an example of a Flight Plan page with a discontinuity. The <<verify proc>> annunciation and EHSI MSG alert are displayed when there is one minute to go before sequencing into the discontinuity. If the discontinuity becomes the active waypoint, a <<discontinuity>> annunciation is displayed.

The discontinuity can be resolved by one of the following methods:

- Delete the discontinuity.
- Delete the waypoint associated with the discontinuity.
- Insert a waypoint between the discontinuity and the associated waypoint.
- Remove the SID/STAR from the flight plan (unless the discontinuity is the active waypoint).
- Perform a Direct-To while in the discontinuity.

When the discontinuity becomes active, guidance displays will be invalidated and the FMS will continue wings level flight until the pilot takes action to resolve the discontinuity.

FMS APPROACHES

The FMS approach function employs GPS or INU/GPS integrated navigation to fly the following types of nonprecision approaches:

1. Published RNAV approaches.
2. Published VOR, VOR/DME, TACAN, and NDB approaches with FAA approved GPS overlay procedures.
3. Published GPS approaches.
4. Military approved tactical approaches to forward air bases.
5. Visual runway approaches (provides runway alignment information for strange field, night, or reduced visibility visual operations).

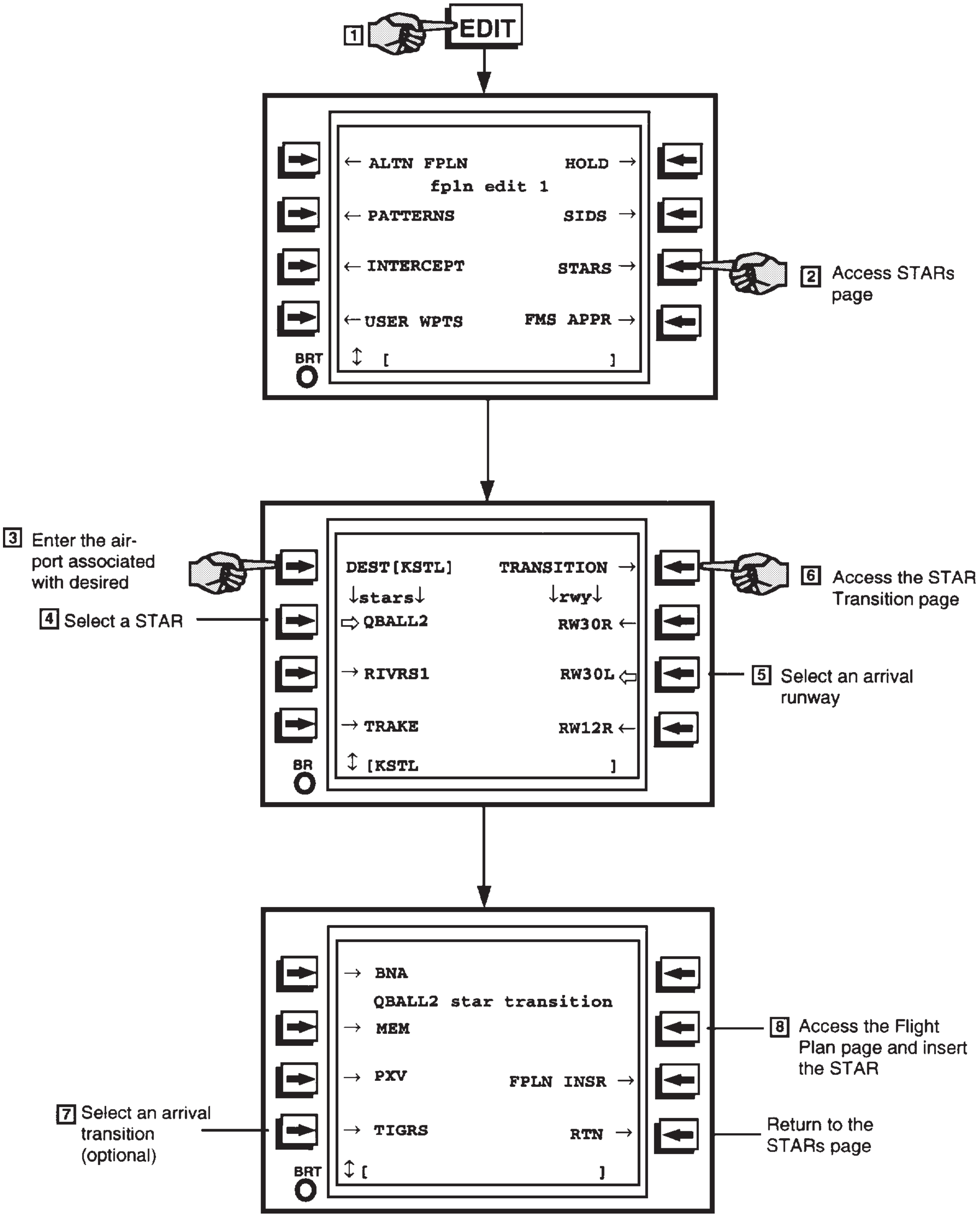
NOTE

> This aircraft is not certified for GPS precision approaches. Nonprecision and visual approach descent information can be viewed on the CDU and displayed on the EHSI. However, vertical navigation guidance commands are not sent to the flight director or autopilot.

Selection of an FMS Approach

FMS approaches can be flown using the active flight plan guidance only. They cannot not be inserted into an alternate flight plan until it is transferred to the active flight plan.

Two different FMS approaches can be maintained by the FMS. One is inserted into the flight plan the other is referred to as the working copy. The working copy allows the pilot to select a backup approach that can be used to replace the inserted approach in case of runway change or ATC clearance amendment. The working copy definition is accessed from the EDIT menu and displays SELECT (if no approach is inserted) or MODIFY in the center of the page. The current flight plan inserted approach definition is accessed by selecting the approach MAP M attribute from the Flight Plan Waypoint page and displays IN FPLN in the center of the page.



1

2 Access STARs page

3 Enter the airport associated with desired

4 Select a STAR

5 Select an arrival runway

6 Access the STAR Transition page

7 Select an arrival transition (optional)

8 Access the Flight Plan page and insert the STAR

Return to the STARs page

Figure 1.14-80. STARs and STAR Transition Pages

To select an FMS approach, press the EDIT function key on the CDU and select the FMS APPR line select key (LS8) to access the FMS Approach page (figure 1.14-82). From this page, one of three types of FMS approaches may be selected: GPS, visual, or tactical. To select either a published GPS approach or runway visual approach, first enter the destination (DEST) airport identifier at the top of the page. This calls up a listing of GPS approaches and runways available for the airport on the selected ICAO database cartidge. To build a user-defined tactical approach, no airport identifier is required, only a selection of the TACTICAL line select key (LS5).

Assignment of Approach Parameters

Using the FMS approach function requires the system to insert a sequence of waypoints into the flight plan. All approaches will have a FAF (visual has a runway extension point) and MAP. Published GPS approaches will also have an IAF and MAHP. These points are treated by the system as any other waypoint and MSL altitudes may be entered for each with the exception of the MAP and visual approach's RWXND. Note that the MAP is normally located at the threshold (approach end) of the runway.

Published GPS Approaches

After entering the destination identifier, selecting a published GPS approach accesses the IAF Select page (figure 1.14-82). Select the desired IAF, and press the FPLN INSR line select key (LS7) to access the Flight Plan page at the *END prompt. The INSRT G-APR BEFORE? scratchpad message will appear to prompt the selection of the point at which the approach is to be inserted into the flight plan. After the approach is inserted, the Flight Plan page will show the published IAF, intermediate points, the final approach fix (FAF), and the missed approach point (MAP), plus the missed approach procedure points (if any) and missed approach holding point (MAHP). The MAP of a GPS approach is either at the runway threshold, or will be collocated with the original MPA for overlay approaches. If the MAP is located at the threshold, vertical guidance will be provided to a 50 foot threshold crossing altitude. If the MAP is located anywhere else, then the published MDA for the approach will the assigned altitude at the MAP, and vertical guidance will be disabled (vertical angle is blanked on the Flight Plan Waypoint page). For these approaches, the pilot must select the MDA on the autopilot altitude preselector to initiate vertical guidance for the descent to the MDA. MAPs that are not located at the runway threshold are assigned waypoint identifiers other than the RWXX identifier.

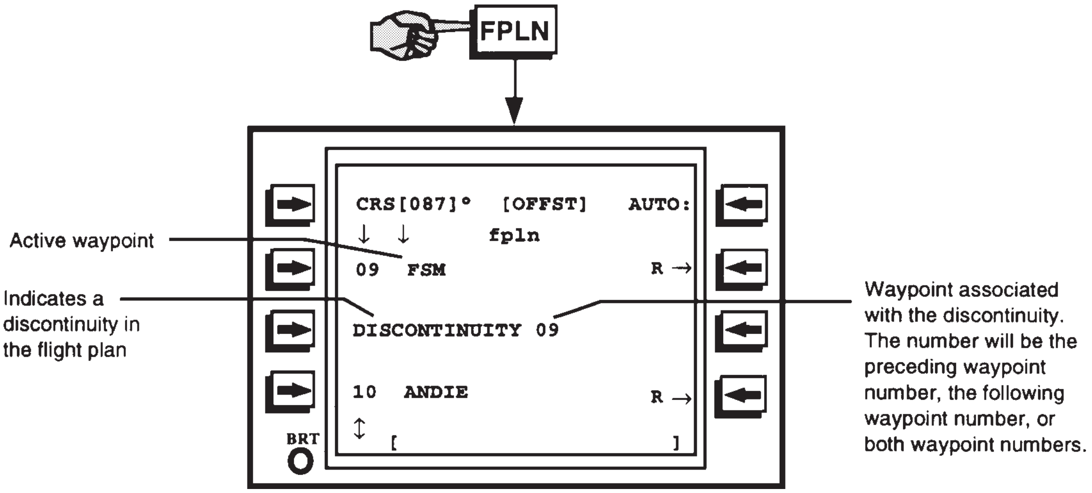
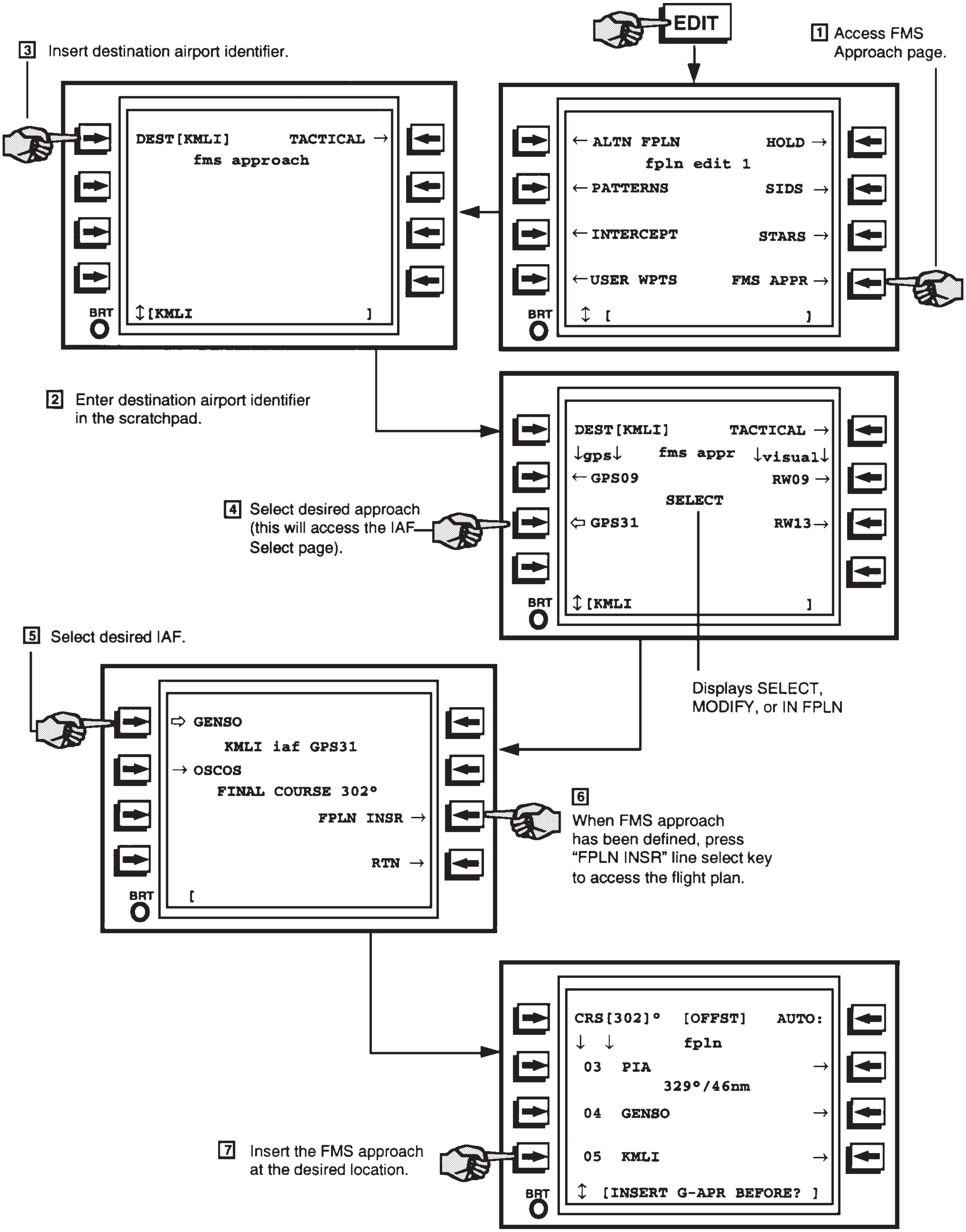


Figure 1.14-81. Flight Plan Page with DISCONTINUITY



1 Access FMS Approach page.

2 Enter destination airport identifier in the scratchpad.

3 Insert destination airport identifier.

4 Select desired approach (this will access the IAF Select page).

Displays SELECT, MODIFY, or IN FPLN

5 Select desired IAF.

6 When FMS approach has been defined, press “FPLN INSR” line select key to access the flight plan.

7 Insert the FMS approach at the desired location.

Figure 1.14-82. Databased GPS Approach Pages

If there is already a GPS approach inserted in the flight plan, and the working copy is being displayed, FPLN INSR will be replaced at LS7 on the IAF Select page with FPLN MOD. Selecting FLPN MOD (requires confirmation) will erase the currently inserted approach and access the Flight Plan page exactly like selecting FPLN INSR.

There are no user-defined entries other than the airport identifier, GPS runway selection, and the IAF selection. On the IAF Select page, the approach can be inserted without selecting an IAF. The FMS will use the IAF listed at the top of the page as the default. Published GPS approaches that have been defined without identifiable IAFs have been filtered out of the FMS database, i.e., the FMS does not recognize a GPS approach without an IAF.

Visual Approaches

Selecting a runway on the right side of the FMS Approach page accesses the Visual Approach page (figure 1.14-83). If desired, modify the default visual approach parameters, which are a 5.0 nautical mile final segment and a 3.0° glideslope, with a crossing altitude for the runway extension point (analogous to the FAF of an instrument approach) of 1,500 feet AGL. Press the FPLN INSR line select key to access the Flight Plan page at the *END prompt. The INSRT V-APR BEFORE? scratchpad message will appear to prompt the selection of the point at which the approach is to be inserted into the flight plan. Then press the line select key adjacent to the desired waypoint location. This action inserts a computed runway extension point (RWXND) and the selected runway threshold (e.g., RW09) into the flight plan in sequence at the desired point.

Tactical Approaches

To insert a user-defined tactical approach, select the TACTICAL line select key on the FMS Approach page, as shown in figure 1.14-84. Then enter the desired final approach waypoints (FAF and MAP) and parameters (glideslope and RW ELEV) and select FPLN INSR. This accesses the Flight Plan page at the *END prompt with the scratchpad message INSRT T-APR BEFORE? to prompt the insertion of the tactical approach into the flight plan. Press the line select key adjacent to the desired waypoint to insert the approach. If an attempt is made to insert the tactical approach with the FAF, MAP, or RW ELEV missing, the ENTER PARAMETERS scratchpad message will appear.

Deleting, Modifying or Replacing the FMS Approach

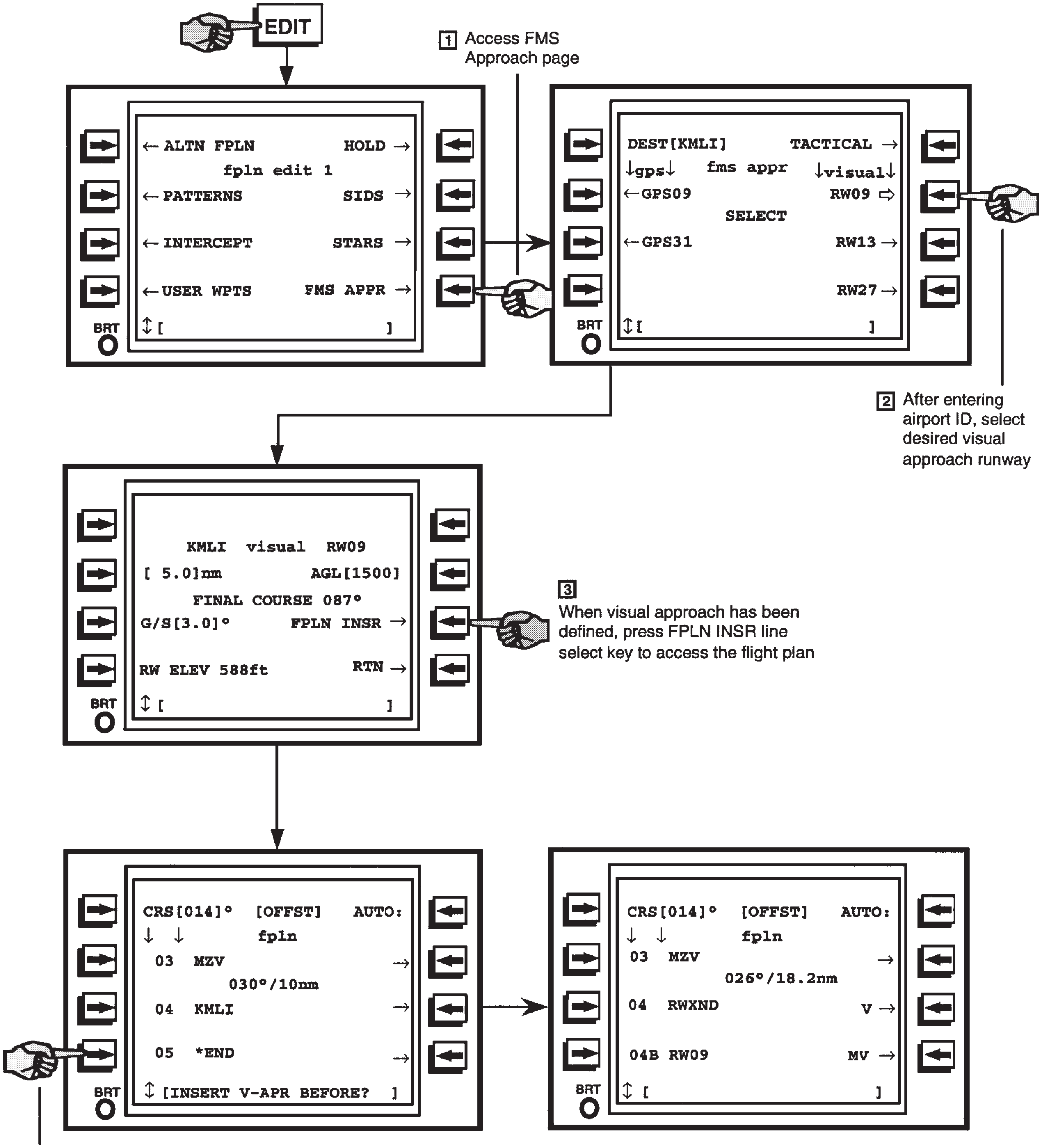
Once an FMS approach of any type is in the flight plan, it may be deleted, modified or replaced with a different approach. To access the approach currently in the flight plan, press the M attribute line key (LS6) on the Flight Plan Waypoint page for the MAP waypoint. This directly calls up the approach definition page for the inserted approach (IAF Select, Visual Approach, or Tactical Approach). To remove the approach from the flight plan, select FPLN RMV (LS7, requires confirmation). To modify the approach, select the new parameters. This brings up the working copy display and replaces the FPLN RMV selection at LS7 with FPLN MOD. Select FPLN MOD to replace the approach in the flight plan (requires confirmation). To select a different published GPS approach or visual approach, it will be necessary to select RTN (LS8) to access the FMS Approach page. The annunciation IN FPLN will be displayed on the information line until changes are made. Select the new parameters (MODIFY replaces IN FPLN) and return to the definition page to complete modifications and insert the approach into the flight plan using the FPLN MOD line select key.

Assignment of Approach Parameters

Using the FMS approach function requires the system to insert a sequence of waypoints into the flight plan. All approaches will have a FAF (visual has a runway extension point) and MAP. Published GPS approaches will also have an IAF and MAHP. These points are treated by the system as any other waypoint and MSL altitudes may be entered for each with the exception of the MAP and visual approach's RWXND. Note that the MAP is normally located at the threshold (approach end) of the runway.

Published GPS Approach Execution and Guidance (Databased Approaches)

When the aircraft reaches a point 30 NM direct distance from the FAF of a databased GPS approach, several automatic changes occur.



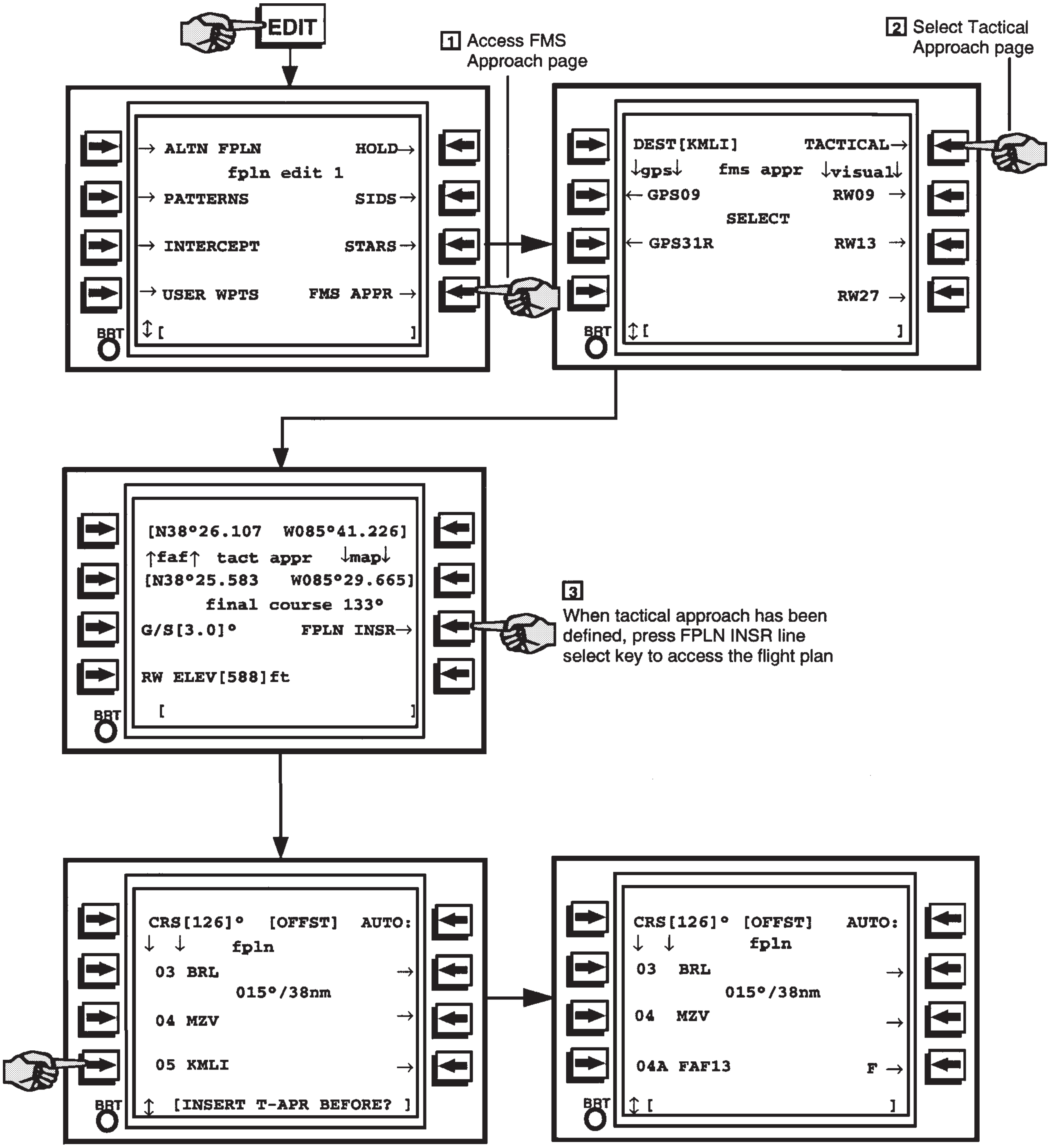
1 Access FMS Approach page

2 After entering airport ID, select desired visual approach runway

3 When visual approach has been defined, press FPLN INSR line select key to access the flight plan

4 Insert the visual approach at the desired location

Figure 1.14-83. Visual Approach Page



1 Access FMS Approach page

2 Select Tactical Approach page

3 When tactical approach has been defined, press FPLN INSR line select key to access the flight plan

4 Insert the tactical approach at the desired location

Figure 1.14-84. Tactical Approach Page

The flight guidance mode (EHSI lateral deviation display scaling and FMS integrity monitoring performance threshold) switches to TERMINAL mode and a <<√baroset>> CDU annunciation reminds the pilot to enter the reported local barometric pressure setting for the landing airport (required for VNAV guidance information). If the FGS bank angle selector is not set to 25°, the CDU will display the <<√bank limit>> annunciation. When the FAF becomes the active waypoint, the approach is enabled so that it will automatically begin to execute upon reaching the FAF. The following conditions must be met for approach activation: 1) approach enabled; 2) course reversal not to be executed; 3) aircraft track angle within 90° of the final course; 4) aircraft position within 2 NM radius of the FAF; 5) No user-defined holding pattern attached at the FAF; 6) waypoint sequencing mode not in MAN; and 7) otherwise normal waypoint sequencing criteria met.

At three (3) NM direct distance from the FAF (when FAF sequencing criteria have been met), if the selected navigation mode does not contain GPS, a <<no gps appr>> CDU annunciation and the EHSI nav flag will be displayed.

At two (2) NM direct distance from the FAF (when FAF sequencing criteria have been met), the CDI sensitivity will transition linearly from 1.0 NM full-scale (TERMINAL) so as to be at 0.3 NM full-scale (APPROACH) at the FAF and the integrity performance will switch immediately to approach mode (figure 1.14-85). The <<approach>> annunciation on the CDU flashes for 10 seconds to alert the pilot of the CDI sensitivity change and then remains on steady throughout the approach.

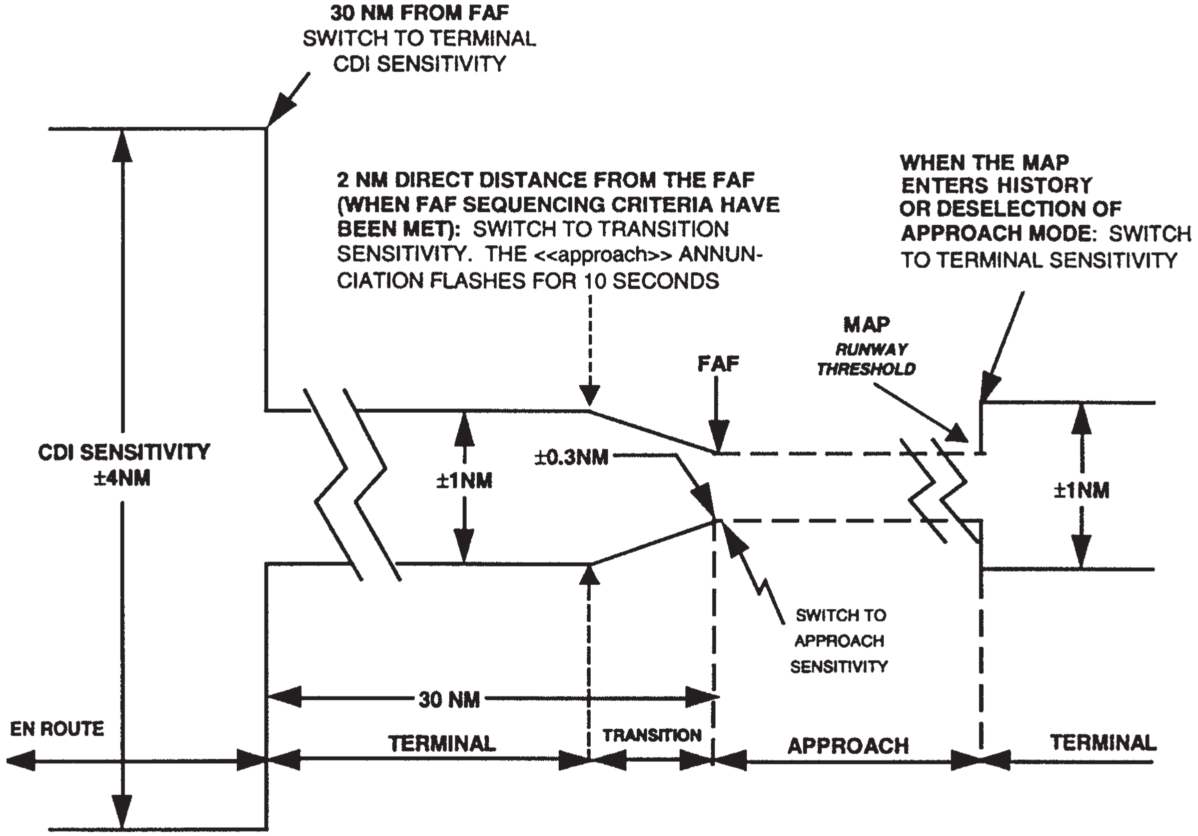


Figure 1.14-85. Databased GPS Approach Lateral Functionality

NOTE

> There is a potential failure mode for one of the go-around relays between the FMS and the FGS that, if failed, would keep the FMS from going into the approach mode, or if already in the approach mode, would cause the system to revert to the terminal mode. Crews should monitor the FMS annunciators from a point 3 NM from the FAF until reaching the MAP to ensure the system transitions to approach mode beginning 2 NM prior to the FAF. If not, the PF should execute a missed approach and select another approach aid. Crews should also ensure the system remains in approach mode until the MAP and changes back to terminal mode at the MAP or when the TO/GA button is pressed.

There are special operating rules for waypoint sequencing at the FAF. The following list describes the requirements that must be met to sequence to the next waypoint in the approach: 1) course reversal criteria not met (see below); 2) aircraft track angle within 90° of the final approach course; 3) aircraft position within 2 NM radius of the FAF; 4) no user-defined holding pattern attached at the FAF; and 5) otherwise normal waypoint sequencing criteria are met. If these requirements are not met, the FAF will not sequence and the FMS will continue to display guidance for the inbound course to the FAF. The <<wpt passed>> annunciation will be displayed when the aircraft passes the FAF and waypoint sequencing has been inhibited.

If a published GPS overlay approach contains a DME arc segment, it is indicated by a D attribute on the right side of the Flight Plan page for the waypoint at the termination of the DME arc. The CDU will display arrival course at the arc termination point, but the EHSI and flight director/autopilot guidance will direct the aircraft to follow the arc. The distance display on the EHSI while on the arc will be the direct distance to the arc termination point. The flight plan waypoint sequencing is normal. An arc segment may be exited by: 1) performing a course edit into the termination point; 2) performing a Direct-To the termination point; 3) inserting a waypoint between the two waypoints of the arc; or 4) deleting one of the two waypoints making up the arc. When a DME arc is exited, FMS guidance will return to standard great circle mode. See figure 1.14-86 for a depiction of a DME arc segment.

If a published approach contains a holding pattern at the IAF, that holding pattern will not be executed unless the pilot selects ENAB HLD on the Hold page. The holding pattern at the MAHP is defaulted to enabled. Holding parameters for databased holding patterns at the IAF or MAHP may be viewed on the Hold page by pressing LS6 on the Flight Plan Waypoint page for these waypoints.

A course reversal maneuver (holding pattern-in-lieu-of procedure turn) will be automatically enabled and performed as shown in figure 1.14-87 when the IAF is inserted as a future waypoint and has a databased procedure turn or holding pattern-in-lieu-of procedure turn attached. A C attribute will be displayed next to the IAF waypoint when the course reversal is enabled. To view the course reversal definition, press the line select key adjacent to the C attribute on the Flight Plan Waypoint page to access the Hold page for the IAF waypoint. The course reversal size (duration and length) can be modified by the crew on the Hold page, but the course and turn direction cannot be changed. Changes to the course or turn direction will disable the course reversal procedure. When the course reversal is reenabled, the published course and turn direction will be restored.

There are three types of course reversals defined by the FMS: 1) Type I - IAF course reversal (IAF is located on the TO side of the FAF); 2) Type II - IAF/FAF course reversal (IAF and FAF are collocated); and 3) Type III - extended FAF course reversal (IAF is located on the FROM side of a phantom database FAF waypoint). In the collocated IAF/FAF and extended FAF types, the course reversal is actually performed at the FAF waypoint, although course reversal definition is attached to the IAF waypoint.

WARNING

Extreme caution should be exercised when flying Type III course reversals. These approaches are overlays of no-FAF-procedure turns in which a phantom FAF waypoint has been inserted in the database to enable the FMS to execute the procedure turn. The phantom database FAF waypoint is normally located 4 NM out along the procedure turn course from the IAF, but is not depicted on the DOD FLIP or NOAA approach plates. Since the FMS displays the phantom FAF (not the IAF) as the active waypoint upon which the course reversal is based, there is a potential for the FMS (or the pilot when flying manually) to drive the aircraft out of the obstacle clearance protected airspace, particularly in the presence of a strong tailwind on the outbound leg. The crew may not be aware of the problem since the distance displayed on the EHSI and CDU will be from the phantom FAF waypoint making it difficult to monitor the required remain-within-distance published for the procedure.

NOTE

The FMS uses holding pattern entry procedures to execute all course reversals on GPS approaches. Under ICAO rules, the course reversal maneuver must be executed using the depicted procedure. Therefore, the FMS cannot be used under ICAO rules to execute course reversals on GPS approaches depicting other than holding pattern procedures such as 45/180, 80/260, or base turn procedures.

Course reversal and holding pattern procedures at the IAF/FAF waypoint are mutually exclusive. Only one procedure (course reversal or published holding pattern) can be enabled on the Hold page. To enable the published holding pattern at the IAF, select ENBL HLD (LS8) on the Hold page for the IAF. This will automatically disable the course reversal at LS7. To reenable the course reversal, press ENBL RVS. This will automatically disable the holding pattern. Similarly, if a user-defined holding pattern is attached at the FAF where a course reversal maneuver is enabled (Type II or III), the course reversal will be disabled. To reenable the course reversal, select ENBL RVS on the Hold page for the IAF.

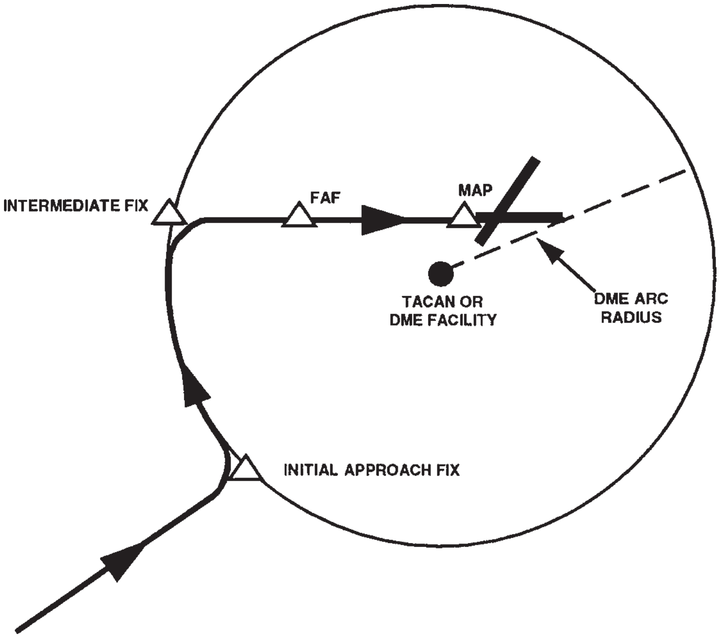
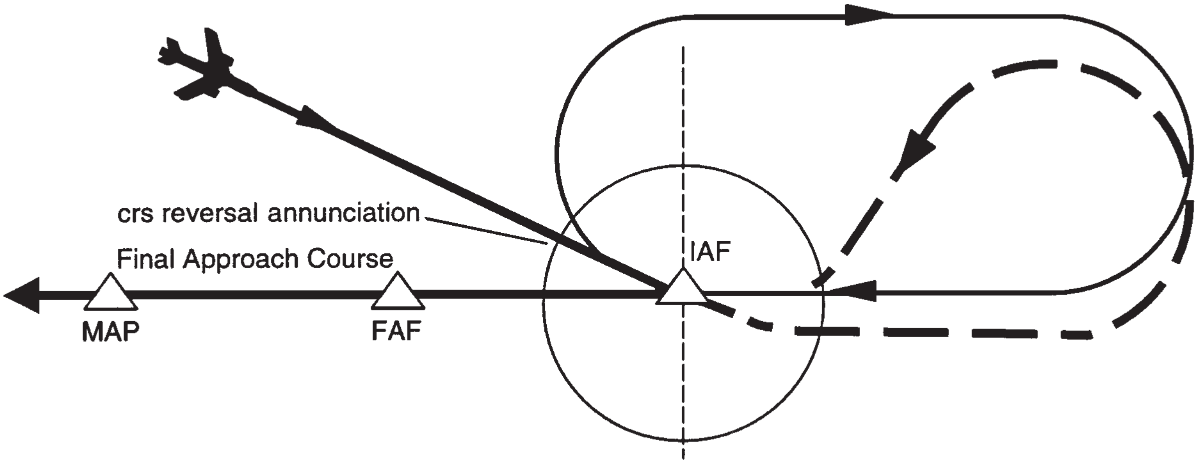
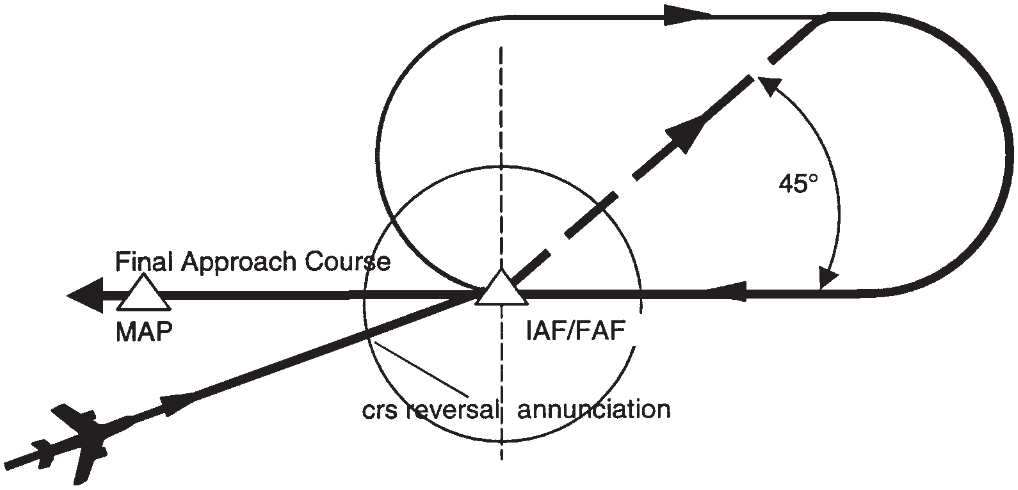


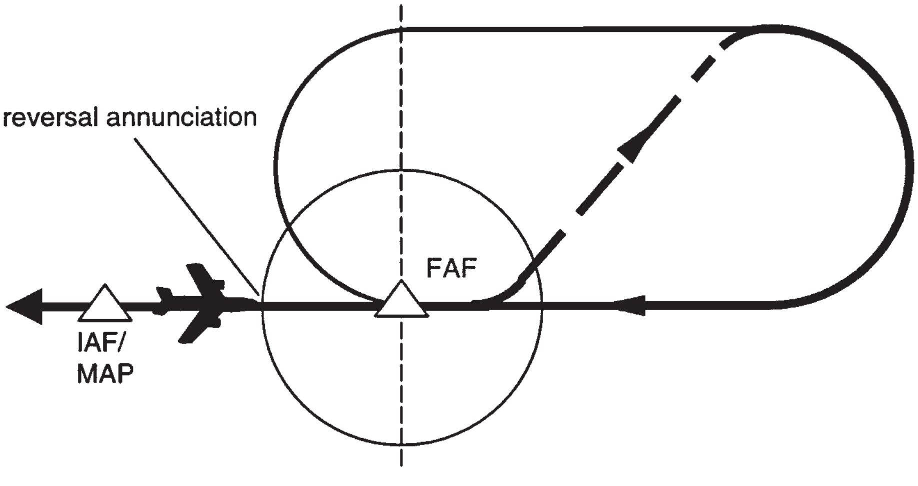
Figure 1.14-86. DME Arc Flight Path



Type I: IAF Course Reversal



Type II: Collocated IAF/FAF Course Reversal



Type III: Extended FAF Course Reversal

Figure 1.14-87. Course Reversal Examples (Databased Procedure Turn)

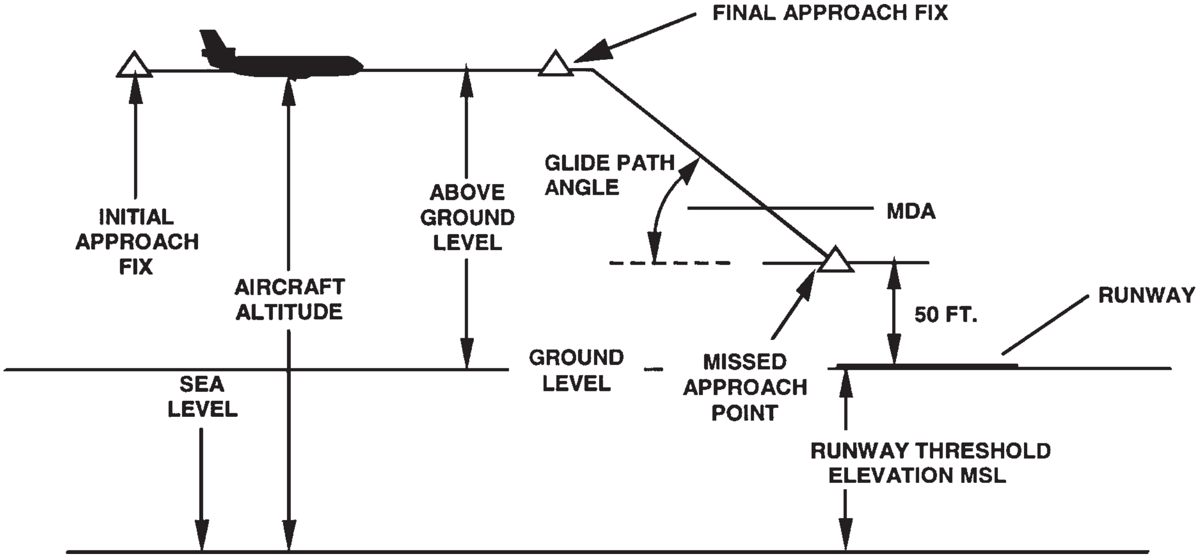


Figure 1.14-88. FMS Approach Vertical Profile

When the aircraft is within 3 NM of the IAF/FAF, the <<crs reversal>> annunciation will be given. The displayed course for the course reversal maneuver will be the published PT or holding course. The course reversal maneuver may be avoided prior to acitvation by deleting the C attribute, deleting the IAF, removing the approach, or performing a Direct-To another waypoint. After activation, deleting the C attribute or IAF, or removing the approach will not affect completion of the course reversal. Performing a Direct-To will terminate the course reversal and provide guidance to the selected waypoint. A straight-in approach may be flown by selecting Direct-To the FAF and pressing LS1 to display the published course. Vertical guidance into the FAF will be removed when a Type II or III course reversal is enabled or when any course reversal is active.

Upon passing the FAF, the following events occur: 1) EHSI scaling will be fully in approach mode; and 2) waypoint sequencing will switch to manual (MAN). The vertical profile for GPS approaches with the MAP at the runway threshold will be as shown in figure 1.14-89. Vertical guidance will not be output to the FGS, but may be monitored on the EHSI and CDU. The direct descent rate displayed on the Vertical Steer page will correspond to the computed glide path angle that, if followed, would bring the aircraft over the threshold at 50 ft. AGL. The VNAV alerts (flashing V attribute and TOD label) will be issued 10 seconds prior to the initiation of vertical path capture. This point will be computed based on the aircraft airspeed and glide path angle. Vertical discontinuities will be handled as described in the VERTICAL NAVIGATION section. Upon arrival at the MAP, the aircraft will be directed along the outbound extension of the final approach course. However, the MAP will remain the active waypoint and the waypoint sequencing mode will remain in MAN until changed by the pilot. Changing the sequencing mode back to automatic (AUTO or FLYOVER) will change the flight guidance mode to TERMINAL and sequence the flight plan to the next waypoint in the approach (the MAHP or an intermediate waypoint).

If ATC provides radar vectors to intercept the final approach course of a published GPS approach, select Direct-To the FAF. The FMS will display the scratchpad message FINAL APPR COURSE XXX°, where XXX is the final approach course, but will execute a direct course to the FAF. To intercept the final approach course, select the CRS line select key with the FINAL APPR COURSE XXX° displayed in the scratchpad. The FMS will provide lateral guidance to intercept the final approach course.

Missed Approach Guidance

The pilot may elect to disable the approach by pressing the TO/GA button on the No. 2 throttle. This action will cause the approach path to be overflown with no vertical guidance and the flight guidance mode to switch back to TERMINAL. Waypoint sequencing will remain in MAN and cannot be changed until passing the MAP. The approach may also be terminated by performing a Direct-To a waypoint other than the MAP. A Direct-To any waypoint other than the MAP will switch sequencing back to AUTO. To reenable the approach, select Direct-To the FAF or any other flight plan waypoint that would reinsert the FAF as a future waypoint.

If the navigation flag on the EHSI is displayed (red FMS annunciation and NAV FAIL annunciator on), and the EHSI RAIM alert or the <<no gps appr>> or <<no appr raim>> annunciations are active, disable the approach and go around for another approach. The RAIM alert on the EHSI indicates that the GPS solution is possibly erroneous due to satellite system failures. The <<no gps appr>> annunciation indicates that a satisfactory GPS solution is not being provided to execute the GPS approach. The <<no appr raim>> annunciation indicates that the GPS receiver is unable to determine the suitability of the satellite constellation during the approach phase of flight.

If a missed approach is executed, either perform a Direct-To the MAHP or select Direct-To the IAF or FAF (in history) and be vectored for another approach. When the MAP is the active waypoint, pressing the NAV selector knob on the EHSI control panel will command a Direct-To the MAHP rather than the MAP.

While the MAP is the active waypoint, waypoint sequencing will be inhibited on the TO side of the MAP. On the FROM side of the MAP, AUTO or FLYOVER sequencing may be selected to sequence to the next waypoint. To sequence to the MAHP or other waypoints following the MAP in the flight plan, delete the discontinuity after the MAP (otherwise the FMS will sequence into the discontinuity), then select AUTO or FLYOVER sequencing on the Flight Plan page. The next waypoint will become the active waypoint, with the inbound course established by the geometry between the MAP and the active waypoint. To change the inbound course to the new active waypoint, enter the desired CRS on the Flight Plan page. If a holding pattern is enabled at the active waypoint, the FMS will provide entry guidance into the holding pattern.

Tactical/Visual Approach Execution and Guidance

Once an approach is defined, the sequencing from the ENROUTE to the APPROACH flight guidance mode is automatic. When the aircraft is within 30 NM direct distance of the FAF or runway extension point, the flight guidance mode (EHSI lateral deviation display scaling and FMS integrity monitoring performance threshold) switches to TERMINAL mode and the <<-√baroset>> CDU annunciation reminds the pilot to enter the reported local barometric pressure setting for the landing airport (only required for VNAV guidance information). If the FGS bank angle selector is not set to 25°, the CDU will display the <<√bank limit>> annunciation. For a tactical or visual approach, upon arrival at the FAF or runway extension point, the EHSI lateral deviation display scaling and integrity monitoring performance switches to the APPROACH mode, and the flight plan switches from automatic (AUTO or FLYOVER) to manual (MAN) waypoint sequencing mode. See figure 1.14-89. VNAV parameters are computed and displayed in the same manner as for databased approaches. Waypoint sequencing remains normal (no course reversal maneuvers).

NOTE

> There is a potential failure mode for one of the go-around relays between the FMS and the FGS that, if failed, would keep the FMS from going into the approach mode, or if already in the approach mode, would cause the system to revert to the terminal mode. Crews should monitor the FMS annunciators from a point prior to the FAF until reaching the MAP to ensure the system changes to approach mode at the FAF. If not, the PF should execute a missed approach and select another approach aid. Crews should also ensure the system remains in approach mode until the MAP and changes back to terminal mode at the MAP or when the TO/GA button is pressed.

Upon arrival at the MAP, the flight guidance mode will change to TERMINAL, and the aircraft will be directed along the outbound extension of the final approach course. However, the MAP will remain the active waypoint and the waypoint sequencing mode will remain in MAN until changed by the pilot. Changing the sequencing mode back to automatic (AUTO or FLYOVER) will sequence the flight plan to the next waypoint in the approach (the MAHP or an intermediate waypoint).

If a missed approach is executed, several options are available to the pilot: 1) switch back to automatic waypoint sequencing after MAP passage and follow the planned missed approach sequence; 2) perform a Direct-To the missed approach holding fix and fly the published holding pattern; 3) select Direct-To the IAF or FAF/runway extension point (in history) and be vectored for another approach; or 4) select Direct-To any other waypoint. As long as the flight plan is not advanced to the MAHP or beyond, the complete approach procedure remains defined in the FMS and does not require reentry. If the flight plan is advanced, the approach waypoints remain in the flight plan history, but the FMS approach definitions are deleted and must be reentered.

Approach Vectoring and Procedure Turns (Tactical/Visual Approach)

If the pilot receives radar vectors to the final approach course or wishes to fly a procedure turn in conjunction with a tactical or visual approach, then the flight plan waypoint sequencing mode should be set to MAN when the FAF (runway extension point) becomes the active waypoint to preclude inadvertent FAF waypoint passage before commencing the final approach.

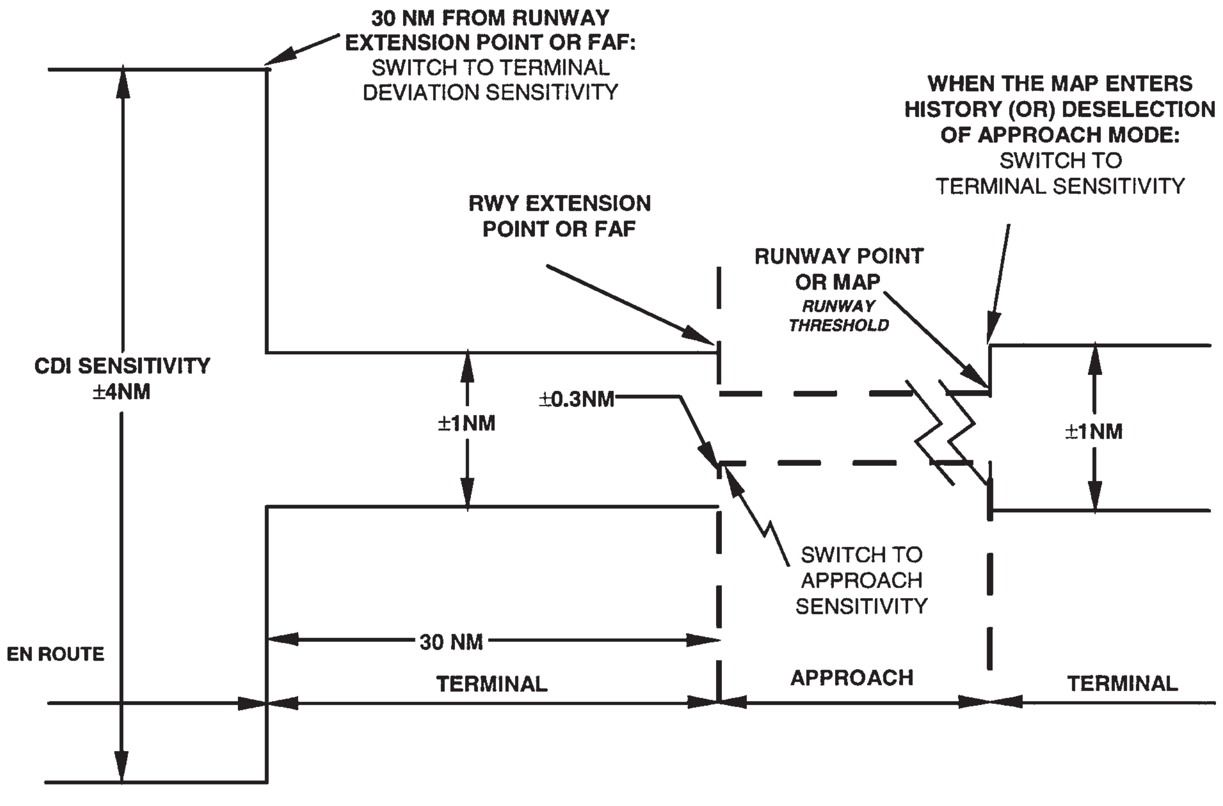


Figure 1.14-89. Visual and Tactical Approach Lateral Functionality

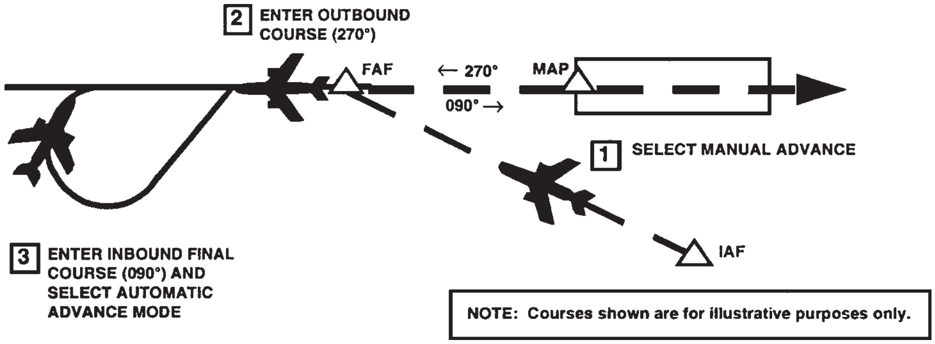
After selection, the manual waypoint sequencing mode enables the pilot to select either the procedure turn outbound course or the final inbound course to the FAF (runway extension point) by entering it on the CDU. Once cleared for the approach and positioned on the final approach course inbound to the FAF (runway extension point), reselect automatic (AUTO or FLYOVER) waypoint sequencing to commence the final approach. Refer to figure 1.14-90 for an example of a procedure turn and figure 1.14-91 for an example of approach vectoring.

Approach Flight Plan Discontinuities

A discontinuity in the flight plan may occur when executing approaches. A discontinuity is associated with a waypoint and requires crew action to resolve in order to obtain proper flight plan sequencing. The waypoint associated with the discontinuity can be either the one preceding, following, or both. A discontinuity is inserted into the flight plan under the following conditions:

- Following a MAP when inserted in the flight plan.
- Following a MAP when a Direct-To reinserts the history FAF and MAP waypoints as future waypoints.

The <<verify proc>> annunciation and EHSI MSG alert are displayed when there is one minute to go before sequencing into the discontinuity. If the discontinuity becomes the active waypoint, a <<discontinuity>> annunciation is displayed.



NOTE: Courses shown are for illustrative purposes only.

Figure 1.14-90. Executing a Procedure Turn on a Tactical Approach

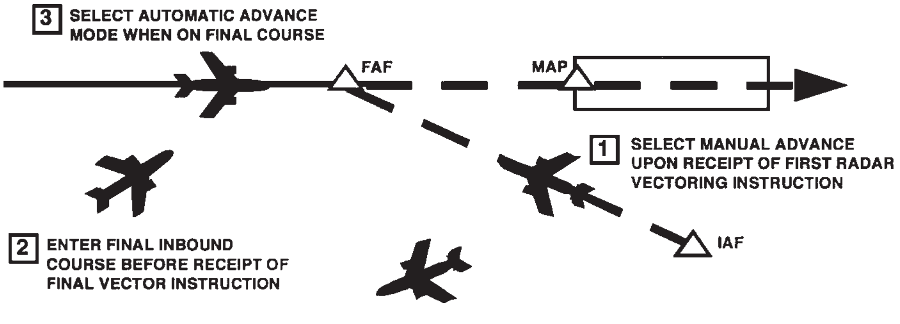
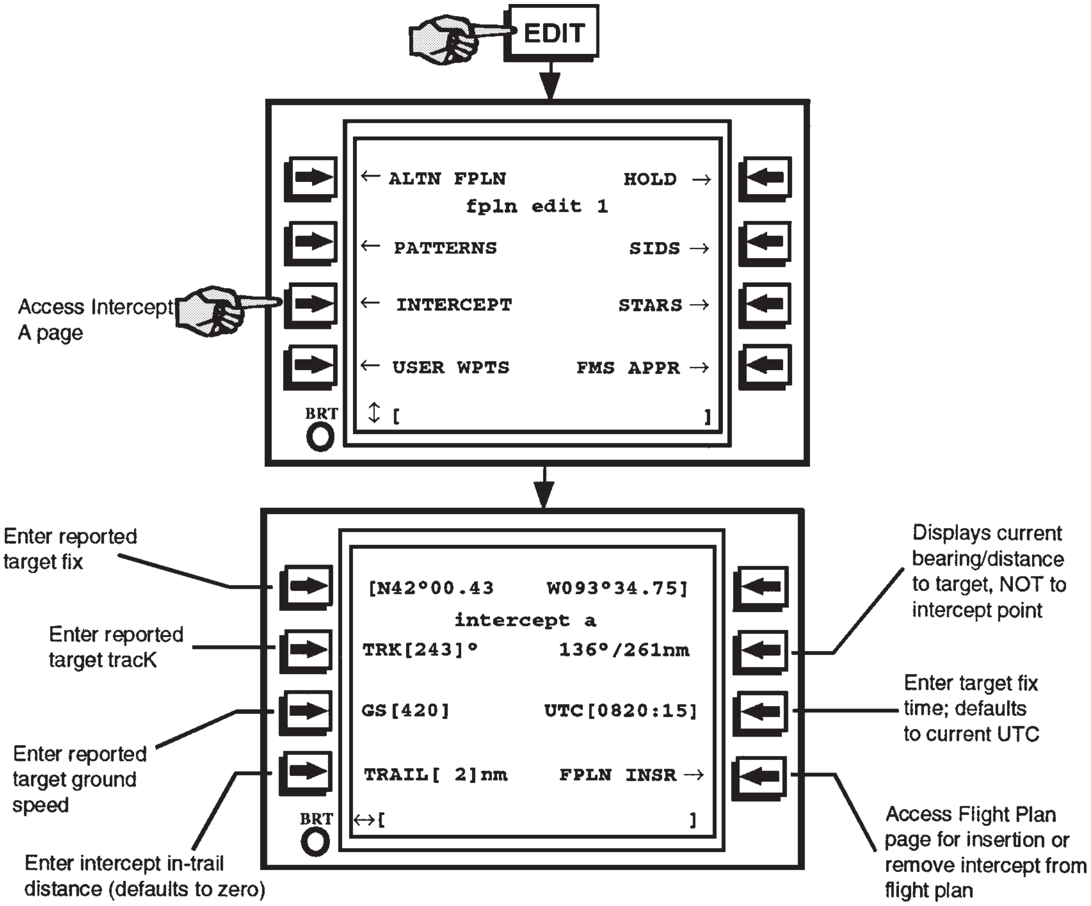


Figure 1.14-91. Approach Vectoring (Tactical and Visual Approach)



Access Intercept A page

Enter reported target fix

Enter reported target tracK

Enter reported target ground speed

Enter intercept in-trail distance (defaults to zero)

Displays current bearing/distance to target, NOT to intercept point

Enter target fix time; defaults to current UTC

Access Flight Plan page for insertion or remove intercept from flight plan

Figure 1.14-92. Intercept Definition

The discontinuity can be resolved by one of the following methods:

- Delete the discontinuity.
- Delete the waypoint associated with the discontinuity.
- Insert a waypoint between the discontinuity and the associated waypoint.
- Remove the approach from the flight plan (unless the discontinuity is the active waypoint).
- Perform a Direct-To while in the discontinuity.

When the discontinuity becomes active, guidance displays will be invalidated and the FMS will continue wings level flight until the pilot takes action to resolve the discontinuity.

INTERCEPT OPERATIONS

NOTE

> Intercept calculations presented by the FMS are not certified for flight guidance use. Crews must not rely on the FMS as the sole means of intercept information.

Up to ten moving targets may simultaneously be defined. Each intercept solution is computed independently and flown in the flight plan sequence. Intercept solutions to these targets may be used in two ways:

1. The intercept solution may be inserted as the active waypoint for immediate (i.e., Direct-To) execution.
2. The intercept solution may be inserted as a future waypoint to implement a future intercept of a moving target.

Figure 1.14-92 illustrates how to define moving waypoint parameters for use in intercept solutions.

The intercept computations determine the true minimum time intercept to the moving waypoint, not a homing type solution. If intercept is not possible, a point of closest approach (PCA) to the target fix location is computed.

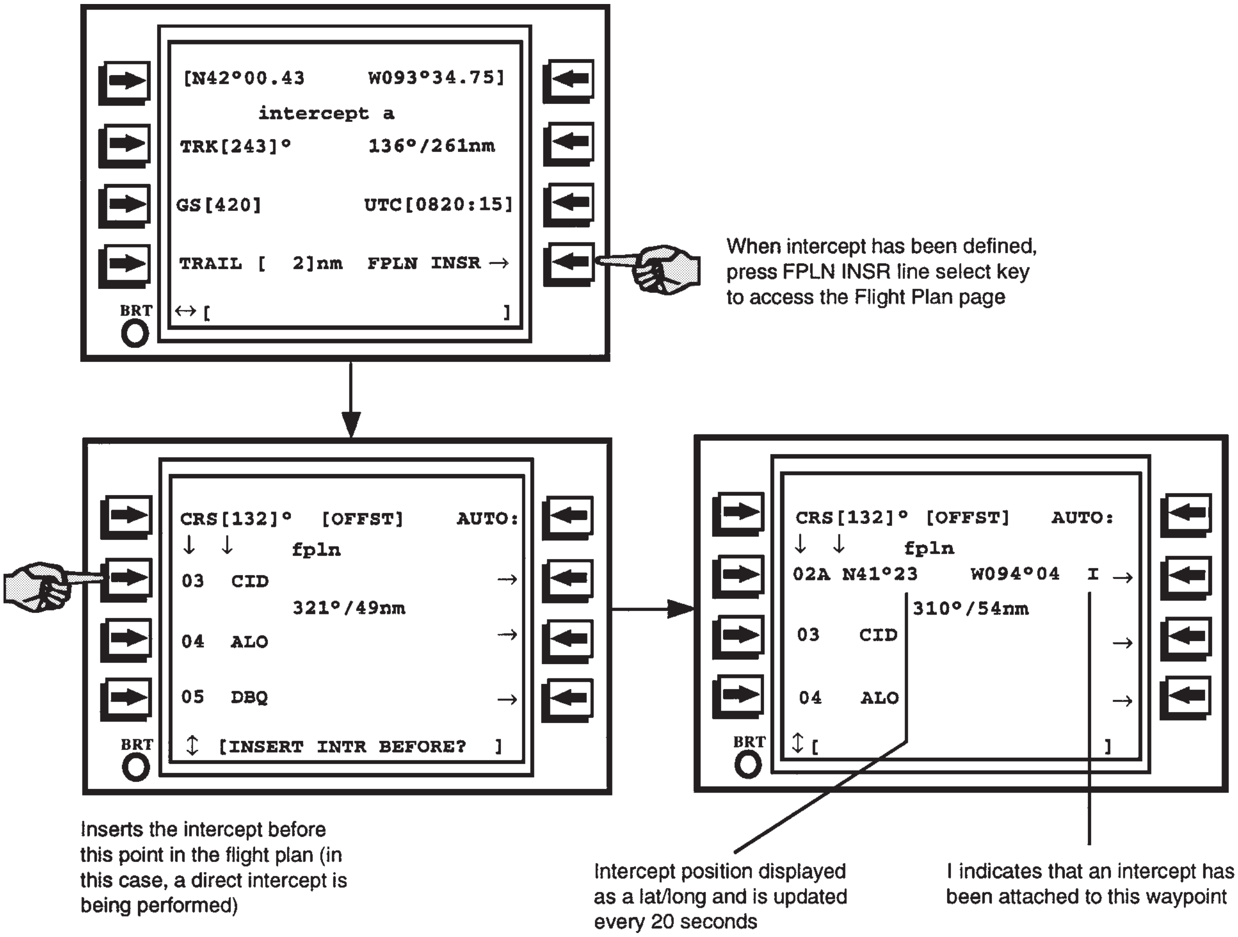
Solutions are cyclically computed for all intercepts, whether inserted in the flight plan or not. If an intercept has not been inserted, the computations are performed as Direct-To intercepts.

Direct Intercept

When an intercept is the active waypoint, the intercept location is cyclically updated based on the following:

1. Current own aircraft position and speed.
2. Moving target definition (position, track, groundspeed.
3. Current wind.

The intercept point location is adjusted as required and the inbound course is edited to match the current Direct-To course into the waypoint. To perform a direct intercept, 1) enter the desired parameters on the Intercept A page, 2) select the FPLN INSR line select key, and 3) select line select adjacent to the active waypoint location on the Flight Plan page (figures 1.14-93 and 1.14-94).



```
[N42°00.43      W093°34.75]
      intercept a
TRK[243]°       136°/261nm

GS[420]         UTC[0820:15]

TRAIL [  2]nm   FPLN INSR →
↔[                       ]
```

When intercept has been defined, press FPLN INSR line select key to access the Flight Plan page

```
CRS[132]°  [OFFST]    AUTO:
↓  ↓       fpln
03  CID                  →
        321°/49nm
04  ALO                  →

05  DBQ                  →
↕ [INSERT INTR BEFORE?  ]
```

```
CRS[132]°  [OFFST]   AUTO:
↓  ↓       fpln
02A N41°23    W094°04  I →
           310°/54nm
03   CID                 →

04   ALO                 →
↕[                      ]
```

Inserts the intercept before this point in the flight plan (in this case, a direct intercept is being performed)

Intercept position displayed as a lat/long and is updated every 20 seconds

I indicates that an intercept has been attached to this waypoint

Figure 1.14-93. Intercept Insertion (Direct Intercept Example)

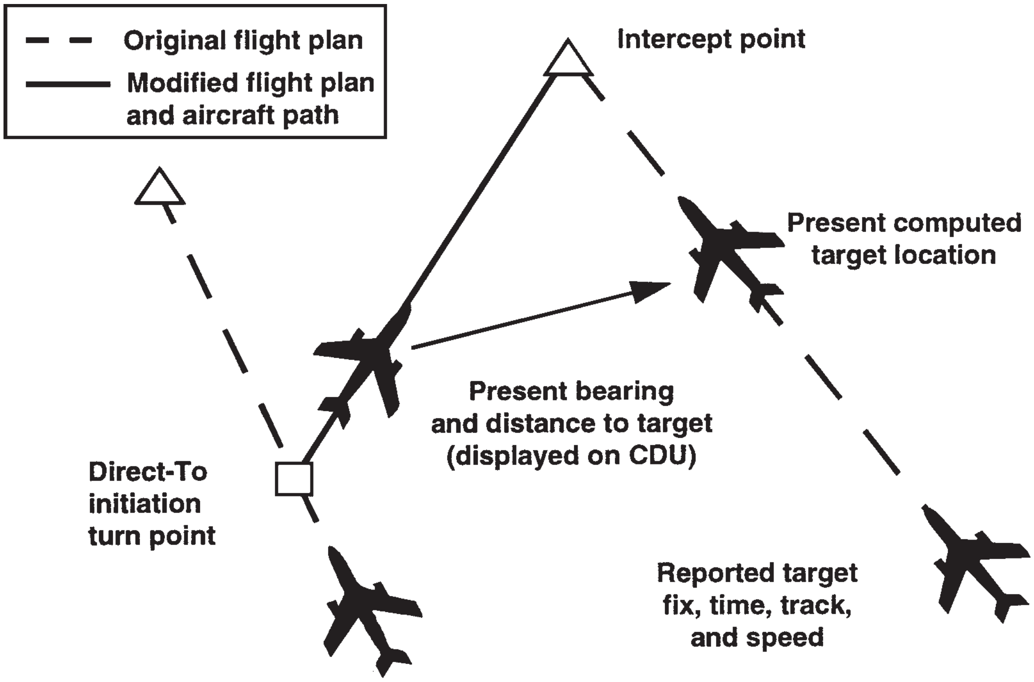


Figure 1.14-94. Intercept Insertion (Direct Intercept Example)

Planned Intercepts

When the intercept is inserted as a future waypoint, then the intercept location is cyclically updated based on the following:

1. Location of the flight plan waypoint immediately prior to the intercept.
2. Distance along the flight plan to that waypoint.
3. Current own aircraft speed.
4. Moving target definition.
5. Current wind.

The estimated time of arrival at the waypoint immediately prior to the intercept is computed. Then the intercept point is computed from that point and time in exactly the same manner as the direct case. The intercept is executed exactly as the direct intercept when it becomes active (figure 1.14-95).

Intercept Passage

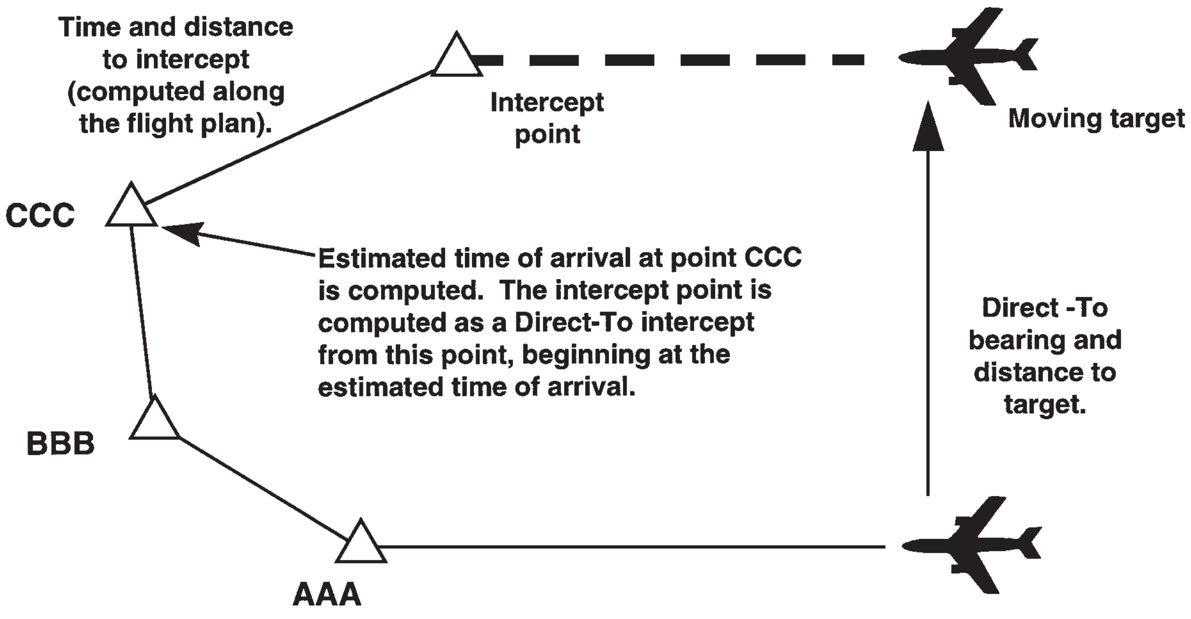
When an intercept is passed into history the latitude/longitude of the intercept at the time of waypoint passage is recorded as the flight plan history waypoint. The I attribute is removed when the waypoint passes into history.

Alternate Intercept Solution

A calculator function is provided to allow the crew to enter an alternate true airspeed and see the effect on the intercept. This calculator is available for an intercept not inserted into the flight plan and for the next intercept in the flight plan (figure 1.14-96).

MARKPOINT AND USER WAYPOINT LIST STORAGE

The FMS maintains a markpoint list of up to 10 markpoints and a user waypoint list of up to 200 manually entered waypoints. The lists are stored in nonvolatile memory. Each list is maintained on separate pages, both of which are accessed from the Flight Plan Edit pages. To access the User Waypoint List page, press the USER WPTS line select key on the Flight Plan Edit 1 page. To access the Markpoint List page, press the MARKPT line select key on the Flight Plan Edit 2 page.

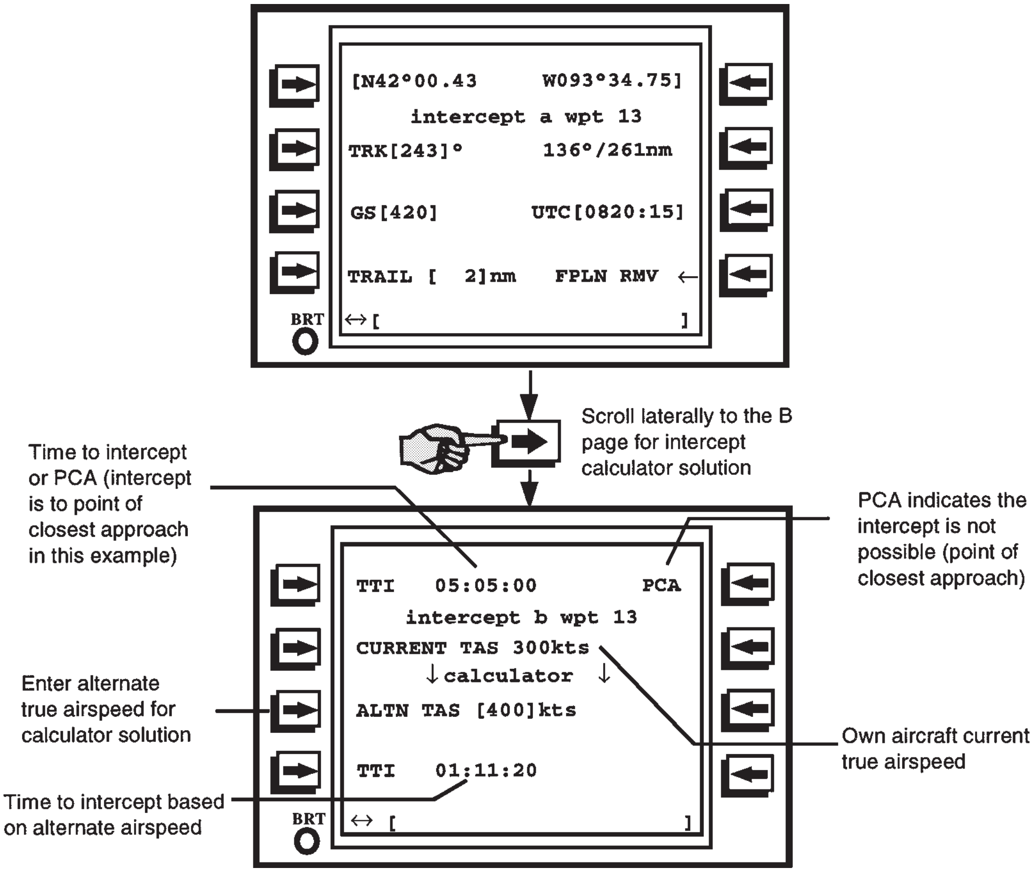


Time and distance to intercept (computed along the flight plan).

Estimated time of arrival at point CCC is computed. The intercept point is computed as a Direct-To intercept from this point, beginning at the estimated time of arrival.

Direct -To bearing and distance to target.

Figure 1.14-95. Future Intercept Geometry



```
[N42°00.43      W093°34.75]
   intercept a wpt 13
TRK[243]°       136°/261nm

GS[420]       UTC[0820:15]

TRAIL [  2]nm   FPLN RMV ←
↔[                        ]
```

Scroll laterally to the B page for intercept calculator solution

```
TTI   05:05:00          PCA
   intercept b wpt 13
CURRENT TAS 300kts
    ↓calculator   ↓
ALTN TAS [400]kts

TTI   01:11:20
↔ [                       ]
```

Time to intercept or PCA (intercept is to point of closest approach in this example)

PCA indicates the intercept is not possible (point of closest approach)

Enter alternate true airspeed for calculator solution

Own aircraft current true airspeed

Time to intercept based on alternate airspeed

Figure 1.14-96. Intercept Function Calculator

User Waypoint List

The user waypoint list gives the crew the capability to create, edit, and display user-defined waypoint information. When the user waypoint list is accessed, the first page of the list will be displayed with the SEARCH and NEW options displayed on the first line (figure 1.14-97). The user-defined waypoints are listed three to a page (up to 200 total), in alphabetical order. The title line displays the number of the displayed page and the total number of pages in the list. Vertical scrolling will access additional user waypoint pages.

To search the user waypoint list, enter the desired user identifier in the scratchpad and select SEARCH. If the user identifier exists in the database, the user waypoint list will advance to the page where the identifier is listed. To view (or modify) the waypoint definition, select the associated right line select key. This will display the User Waypoint page for the selected waypoint (figure 1.14-97).

To enter a new user-defined waypoint, select NEW. This will access a blank User Waypoint page for entering the new waypoint definition. Selection of LS3 will toggle through the list of waypoint types. The available waypoint types are FIX, VOR, VOR/DME, VORTAC, TACAN, NDB, NDB/DME, DME, and AIRPORT. Other data that can be entered is:

- User Identifier
- Position
- Frequency (not available for FIX and AIRPORT waypoints)
- Declination (for VOR, VORTAC, VOR/DME and TACAN waypoints)
- Elevation (optional)

After entering the waypoint definition, select ADD (LS8) to enter the waypoint into the user waypoint list. If the user waypoint list is full, the NEW selection will not be available.

An alternative method for defining waypoints for inclusion in the user waypoint list is available when the waypoint already exists in the flight plan. To use this method, simply attach a user-defined label to a flight plan waypoint (see User-Defined Waypoint Labels section). This action automatically adds the waypoint to the user waypoint list. Previously defined user waypoints cannot be renamed.

NOTE

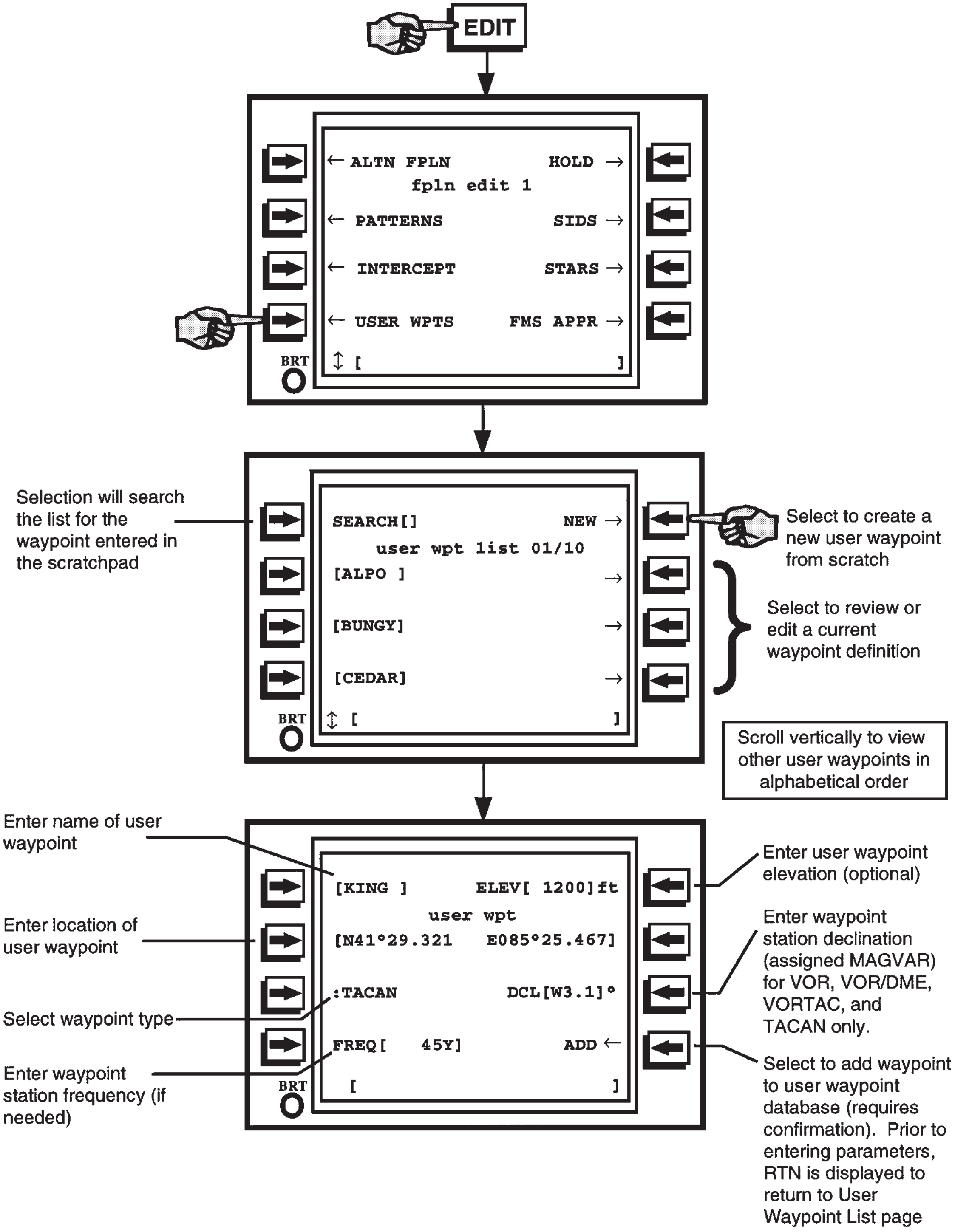
> The user waypoint list is created and stored within the CDU unless saved to the selected MSN data cartridge. If saved to the data cartridge, it will replace any user waypoint list previously stored on the cartridge. Also, transferring the user waypoint list from the selected data cartridge to the CDU replaces any waypoint list previously stored in the CDU. The FMS only accesses the waypoint list from the CDU. If a user-defined waypoint is on the data cartridge, but has not been transferred to the CDU, the system will not retrieve that waypoint for placement in the flight plan.

Markpoint List

To create a markpoint, press the MARK function key when the desired position is overflown. Pressing the MARK key writes the designated pilot's present position solution plus any active cursor position transmitted by the EHSI into the scratchpad and automatically adds the position to the markpoint list (on the Markpoint List page), assigns the markpoint a unique letter identifier (A through J), and records the mark time. The Markpoint List page does not need to be displayed to use this function (figure 1.14-98).

Once the markpoint is on the Markpoint List page, it is treated like any other waypoint and can be copied and inserted elsewhere or deleted. The marked position in the scratchpad can be inserted as a waypoint or position, or cleared with the CLR key.

If 10 markpoints exist on the Markpoint List page and another mark is performed, the new mark overwrites the first (oldest) mark in the list. A subsequent mark overwrites the second, and so on. Manual position entries are not allowed on the Markpoint List page. To store manually entered waypoints, use the Waypoint List page.



Selection will search the list for the waypoint entered in the scratchpad

Select to create a new user waypoint from scratch

Select to review or edit a current waypoint definition

Scroll vertically to view other user waypoints in alphabetical order

Enter name of user waypoint

Enter location of user waypoint

Select waypoint type

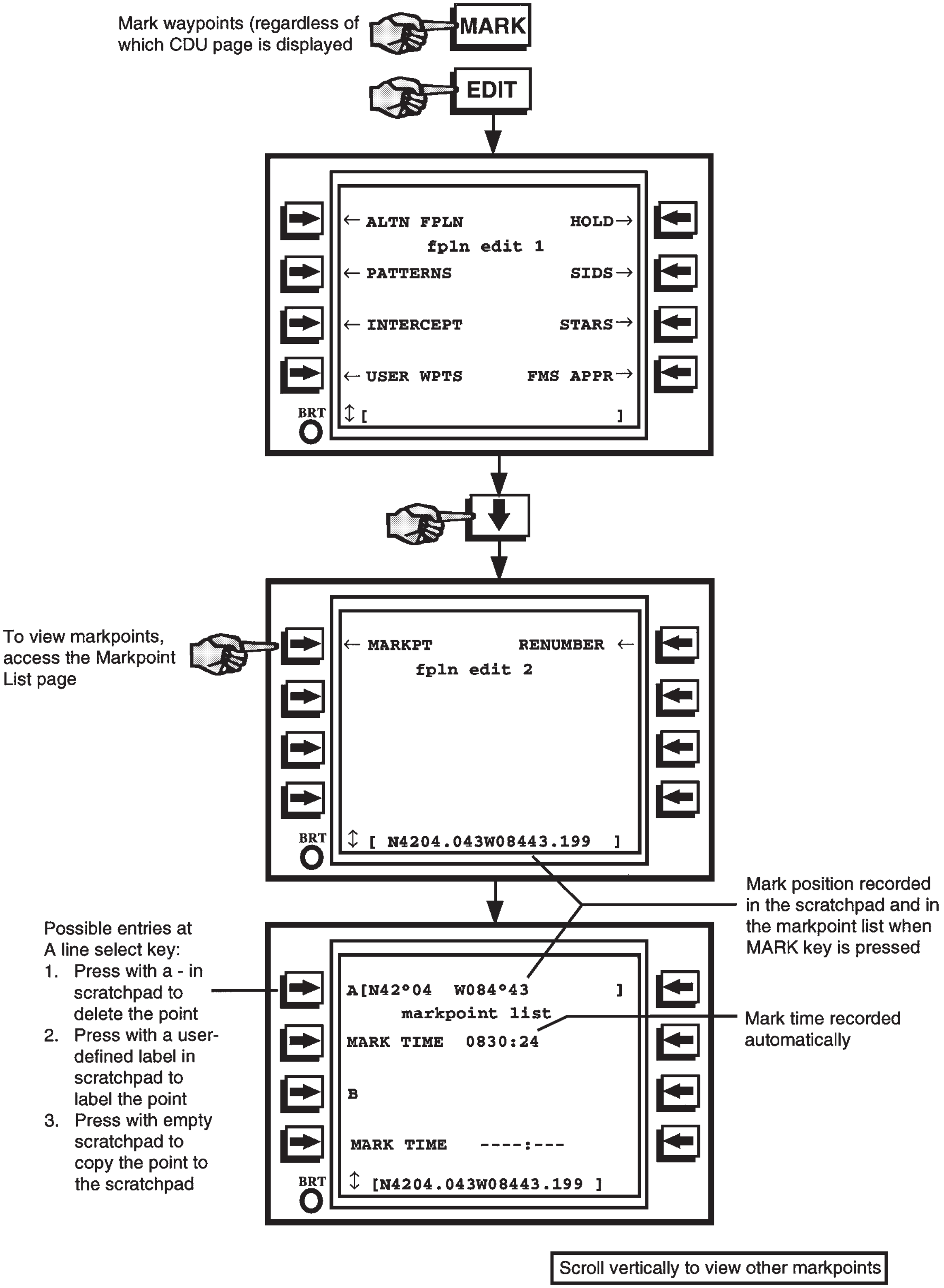
Enter waypoint station frequency (if needed)

Enter user waypoint elevation (optional)

Enter waypoint station declination (assigned MAGVAR) for VOR, VOR/DME, VORTAC, and TACAN only.

Select to add waypoint to user waypoint database (requires confirmation). Prior to entering parameters, RTN is displayed to return to User Waypoint List page

Figure 1.14-97. User Waypoint List Access and Usage



Mark waypoints (regardless of which CDU page is displayed

To view markpoints, access the Markpoint List page

Possible entries at A line select key:

1. Press with a - in scratchpad to delete the point
2. Press with a user-defined label in scratchpad to label the point
3. Press with empty scratchpad to copy the point to the scratchpad

Mark position recorded in the scratchpad and in the markpoint list when MARK key is pressed

Mark time recorded automatically

Scroll vertically to view other markpoints

Figure 1.14-98. Markpoint List Access and Usage

WAYPOINT DATA PAGES

The data function provides the capability to access two pages of additional information on any waypoint in the active or alternate flight plans. The From-To Data page is used to generate remote ranging what if? scenarios for leg computations defined by two flight plan waypoints or present position and a selected TO waypoint. The Ident Data page provides waypoint specific data such as waypoint type, NAVAID frequency, elevation, etc.

From-To Data Page

Independent of the active and alternate flight plans, the FMS will compute, on demand, the bearing/distance, distance along the active flight plan, and ETE/ETA for a variety of remote ranging options, as selected by the crew. ETE/ETA are calculated using current wind unless a wind is entered for a waypoint. If a waypoint has an assigned wind value, the assigned wind will cascade forward to all future waypoints and will be used to calculate ETE/ETA for all future waypoints. When a waypoint that has an assigned wind becomes the active waypoint, current wind will be used to compute ETE/ETA to that waypoint. Future waypoints will continue to use the assigned wind. The from-to data options include:

1. FROM any active flight plan waypoint TO the next succeeding flight plan waypoint.
2. FROM any flight plan waypoint DIRECT-TO any other flight plan waypoint.
3. FROM any flight plan waypoint DIRECT-TO a non-flight plan waypoint.
4. FROM aircraft present position DIRECT-TO any flight plan waypoint.
5. FROM aircraft present position DIRECT-TO any non-flight plan waypoint.
6. FROM aircraft present position TO any flight plan waypoint along the flight plan route.

These options are illustrated in figure 1.14-99.

From-To Data Page Access and Waypoint Selection

To access the From-To Data page, 1) press the DATA function key and 2) press the line select key adjacent to any waypoint in either the active flight plan or alternate flight plan (see figure 1.14-100 for an example of From-To Data page access). After the From-To Data page has been accessed, other TO waypoints may be selected or entered and FROM-TO display options selected as shown in figure 1.14-101.

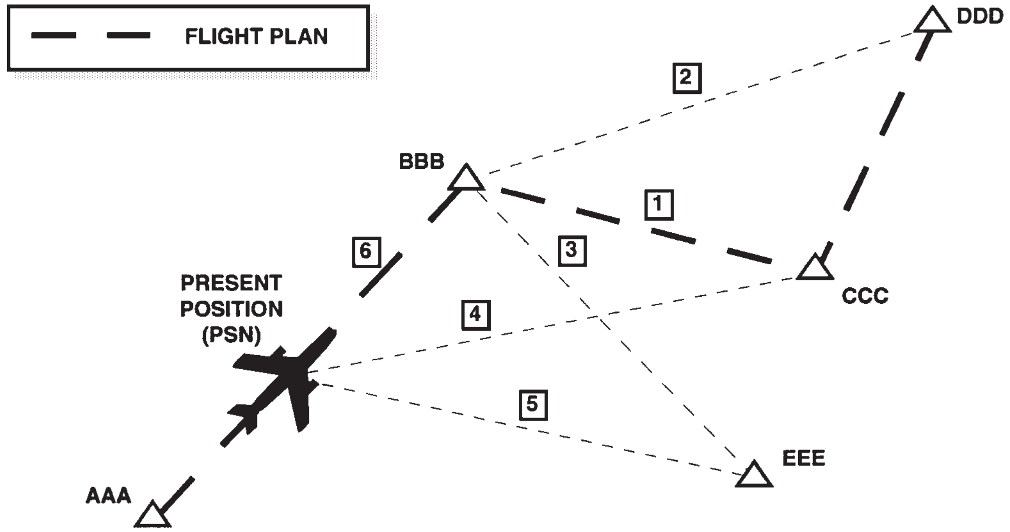
If the waypoint selected was a Flight Plan waypoint, the From-To Data page will be accessed with the selected waypoint as the TO waypoint and the preceding flight plan waypoint as the FROM waypoint. The From-To Data page will display the direct bearing/distance between the waypoints, the ETE and the ETA. The ETA will be determined from the aircraft present position, along the flight plan to the TO waypoint. The ETE will be direct between the FROM and TO waypoints. The waypoint numbers will be displayed to the left of the waypoint identifier for all flight plan waypoints. If the waypoint is a history waypoint, # will be displayed to the right of the waypoint number.

The lower left (LS4) line select key toggles between LEG and WPT. With the toggle in LEG, vertical scrolling will scroll through flight plan legs (e.g. scrolling down would move the TO waypoint to the FROM waypoint and put the next flight plan waypoint as the new TO waypoint). With the toggle in WPT, vertical scrolling will scroll the TO waypoint through the flight plan waypoints while keeping the same FROM waypoint.

The upper left (LS1) line select key toggles the FROM waypoint to PPSN DIRECT to PPSN VIA FPLN. With PPSN DIRECT selected, the bearing/distance, ETE and ETA displays are from the aircraft present position Direct-To the TO waypoint. When PPSN DIRECT or PPSN VIA FPLN is selected, the LEG/WPT toggle is removed and scrolling is inhibited.

With PPSN VIA FPLN selected, the distance, ETE and ETA displays are from the aircraft present position, along the flight plan to the TO waypoint. Bearing is not displayed

In the PPSN DIRECT and FROM waypoint modes, the From-To Data page will accept direct entry of the TO waypoint. Selection of the TO waypoint line select key (LS2), with a valid waypoint in the scratchpad, will enter that waypoint as the TO waypoint. Direct entry of the TO waypoint is not allowed in the PPSN VIA FPLN mode.



OPTION 1: BBB TO CCC (FLIGHT PLAN WAYPOINT TO NEXT FLIGHT PLAN WAYPOINT)
OPTION 2: BBB TO DDD (FLIGHT PLAN WAYPOINT DIRECT TO OTHER FLIGHT PLAN WAYPOINT)
OPTION 3: BBB TO EEE (FLIGHT PLAN WAYPOINT DIRECT TO NON-FLIGHT PLAN WAYPOINT)
OPTION 4: PSN TO CCC (PRESENT POSITION DIRECT TO FLIGHT PLAN WAYPOINT)
OPTION 5: PSN TO EEE (PRESENT POSITION DIRECT TO NON-FLIGHT PLAN WAYPOINT)
OPTION 6: PSN TO ANY FLIGHT PLAN WAYPOINT ALONG FLIGHT PLAN ROUTE

Figure 1.14-99. Remote Ranging Options for the Data Page (Example Only)

Ident Data Page Displayed Information

Lateral scrolling (← or →) on the From-To Data page will access the Ident Data page (figure 1.14-102). The Ident Data page displays the following additional information on the TO waypoint:

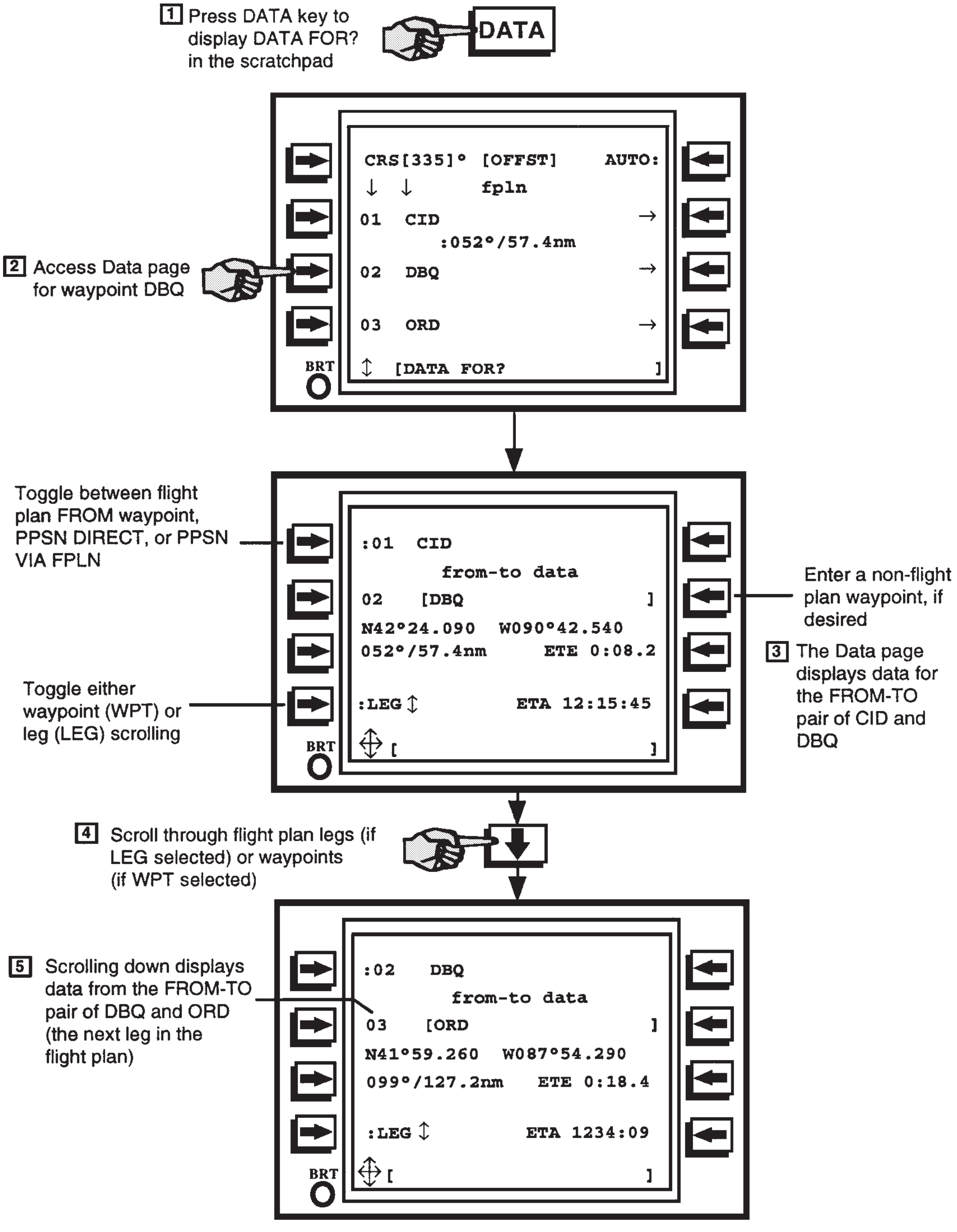
- Frequency and TACAN station number. If none is available, dashes will be displayed (------)
- Waypoint number
- Waypoint identifier
- Country code. If undefined, asterisks (**) will be displayed
- Waypoint type (FIX, AIRPORT, NDB, NDB/DME, DME, VOR, VOR/DME VORTAC, or TACAN)
- Latitude and longitude
- Elevation
- Magnetic variation (MVAR) or declination (DCL) for VOR, VOR/DME, VORTAC, or TACAN

If no information exists for an entry, it is left blank (except where noted).

FLIGHT INSTRUMENT AND AUTOPILOT/ FLIGHT DIRECTOR GUIDANCE

Flight Instrument Displays

The FMS provides lateral and vertical navigation situation information to the Pilot's and Copilot's flight displays (EHSIs). The Pilot's and Copilot's displays are driven independently using the navigation solutions selected on the Pilot and Copilot Lateral Steer pages, respectively.



1 Press DATA key to display DATA FOR? in the scratchpad

```
CRS[335]°  [OFFST]    AUTO:
↓  ↓       fpln
01  CID                   →
      :052°/57.4nm
02  DBQ                   →

03  ORD                   →
↕  [DATA FOR?             ]
```

2 Access Data page for waypoint DBQ

```
:01  CID
      from-to data
02   [DBQ                 ]
N42°24.090  W090°42.540
052°/57.4nm     ETE 0:08.2

:LEG↕          ETA 12:15:45
✥ [                       ]
```

Toggle between flight plan FROM waypoint, PPSN DIRECT, or PPSN VIA FPLN

Toggle either waypoint (WPT) or leg (LEG) scrolling

Enter a non-flight plan waypoint, if desired

3 The Data page displays data for the FROM-TO pair of CID and DBQ

4 Scroll through flight plan legs (if LEG selected) or waypoints (if WPT selected)

```
:02   DBQ
       from-to data
03   [ORD                 ]
N41°59.260  W087°54.290
099°/127.2nm   ETE 0:18.4

:LEG↕          ETA 1234:09
✥ [                       ]
```

5 Scrolling down displays data from the FROM-TO pair of DBQ and ORD (the next leg in the flight plan)

Figure 1.14-100. From-To Data Page Access and Leg or Waypoint Scrolling/Selection

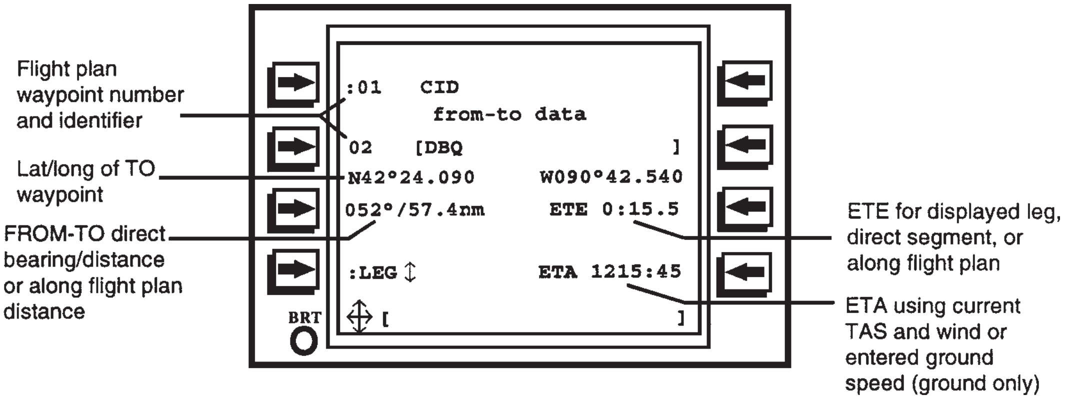
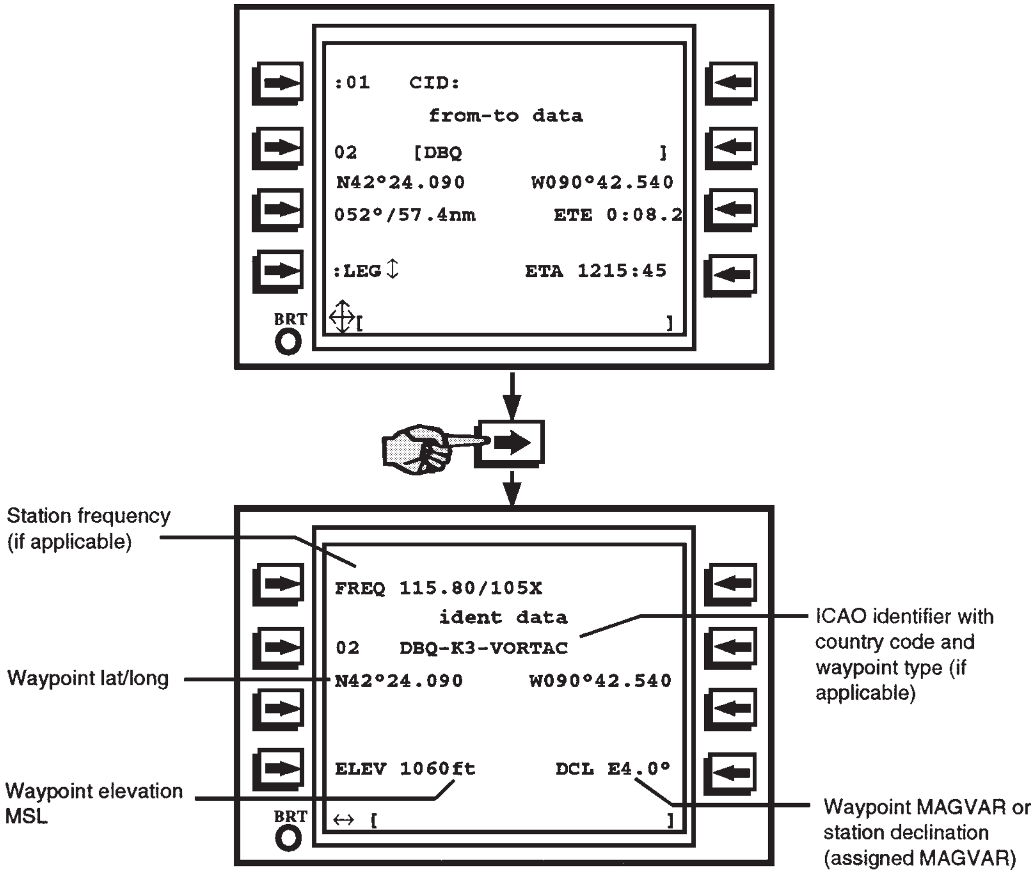


Figure 1.14-101. From-To Data Page Displayed Information

In order to display horizontal and vertical situation data on the EHSI, the Pilot must select FMS1 and the Copilot FMS2 as the navigation source with the respective EHSI NAV selector knob (cross-side selection is not available). This selection connects the EHSI course arrow (desired track), CDI (crosstrack deviation), TO/ FROM pointer, vertical deviation indicator, and waypoint alert to the FMS flight instrument outputs. FMS great circle distance is displayed in the upper left corner of the EHSI. To display waypoint bearing information, select FMS with the BRG pushbutton (cross-side selection is available). These FMS outputs always relate to the flight plan active waypoint (refer to figure 1.14-103). If no flight plan active waypoint is present, the EHSI displays are flagged as invalid.

In the automatic waypoint sequencing modes (AUTO and FLYOVER), the course pointer on the EHSI and the bearing pointer (if selected) show the great circle desired track and waypoint bearing referenced to current aircraft position along the active leg (referred to as instantaneous desired track or IDTK). This means that at any given point along the track, the local magnetic variation for that point is applied to the calculation of desired track and waypoint bearing for display on the CDU and flight instruments. This desired track value may differ significantly from the CRS display on the CDU Flight Plan page, especially when the distance to the waypoint is large or at high latitudes. The CRS display on the Flight Plan page always references the inbound (or outbound) track measured at the waypoint (referred to as arrival desired track or ADTK). Refer to figure 1.14-104. In this case, magnetic variation at the waypoint (assigned MAGVAR or declination if coded with the waypoint such as for a TACAN station) is applied to the calculation of the course. This course will also be displayed on the EHSI when the wyapoint sequencing mode is set to manual (MAN) and the pilot enters the course manually on the Flight Plan page. Waypoint bearing output to the EHSI will also be calculated using the MAGVAR at the waypoint. This feature allows the system to emulate TACAN/VOR/NDB type instrument procedures as required by the USAF GPS Integration Guide.

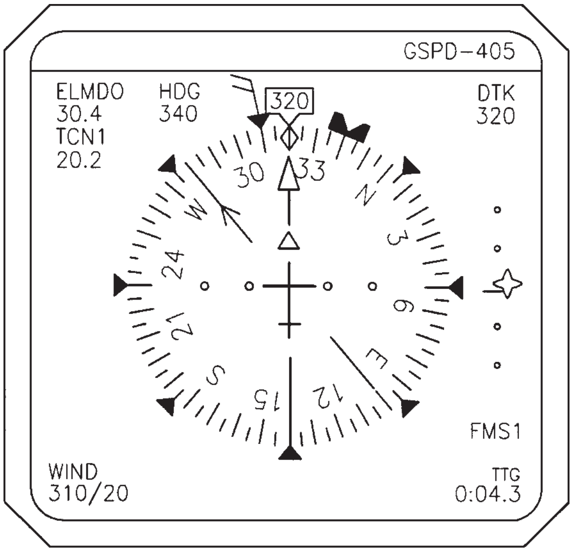
The scaling of the course deviation indicator on the EHSI is determined by the flight guidance mode of the FMS. Upon power-up, the FMS will default to the Terminal mode and, after the aircraft travels 30 NM direct distance from the starting position, will automatically transition to the En Route mode. When an



```
:01   CID:
       from-to data
02    [DBQ              ]
N42°24.090      W090°42.540
052°/57.4nm      ETE 0:08.2

:LEG ↕          ETA 1215:45
 [                          ]
```

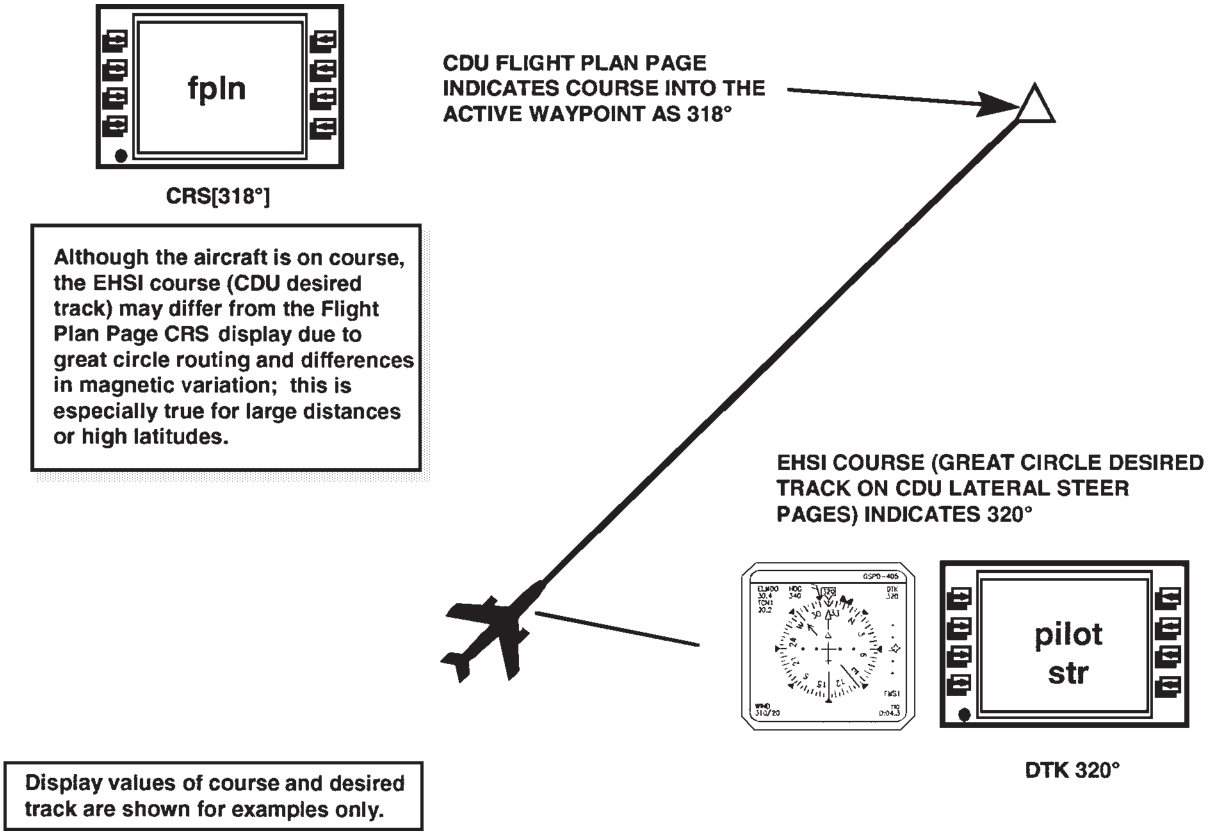
```
FREQ 115.80/105X
         ident data
02   DBQ-K3-VORTAC
N42°24.090      W090°42.540


ELEV 1060ft       DCL E4.0°
↔ [                         ]
```

Figure 1.14-102. Ident Data Page Access and Displayed Information



GP0371

Figure 1.14-103. EHSI Display



Although the aircraft is on course, the EHSI course (CDU desired track) may differ from the Flight Plan Page CRS display due to great circle routing and differences in magnetic variation; this is especially true for large distances or high latitudes.

Display values of course and desired track are shown for examples only.

Figure 1.14-104. CDU Course Display and EHSI Course (CDU Desired Track) Display

airport identifier is in the flight plan with no approach attached, the system will automatically transition to the Terminal mode when the aircraft is within 30 NM direct distance of the waypoint. If an approach is in the flight plan, the system will automatically switch flight modes several times beginning at 30 NM direct distance from the FAF as described in the FMS Approaches section. The flight guidance mode may be manually selected (except when an approach is active) on the Navigation Configuration 1 page (see Active Flight Plan section). The flight guidance modes and their full scale (two dot) linear CDI deviations are as follows:

- En route - ±4.0 nautical miles
- Oceanic - ±4.0 nautical miles
- Terminal - ±1.0 nautical mile
- Approach - ±0.3 nautical mile

The VNAV vertical deviation indicator for climb/ descent guidance relates to the FMS VNAV profile in the flight plan. It is scaled to ±1000 feet full-scale (2 dots) linear deviation for the en route and terminal modes and ±300 feet full-scale linear deviation for the approach mode.

The FMS heading switch selects either true or magnetic north reference for the EHSI heading and course information. TRU is displayed next to the heading when TRUE is selected. It also causes all non-specified CDU azimuth data to be displayed in the same reference frame. For U.S. National Airspace System (NAS) operations (and most foreign host airspace operations) the selector switch should be set to MAG so that heading, course, and bearing displays correspond to the magnetic frame of reference on which the airspace system is based. However, navigation accuracy is unaffected by this selection.

Flight Director and Autopilot Lateral (Bank) Steering

If coupled to the flight director and/or autopilot, the FMS can steer the aircraft directly through all of the possible lateral flight plan maneuvers available including holding patterns, MFPs, and FMS approaches. This interface also enables the FMS to limit the commanded bank angle to the value specified by the autopilot bank selector. Each flight director (pilot and copilot) is controlled by the respective FMS navigation solution. Autopilot 1 is controlled by the pilot's navigation solution and Autopilot 2 is controlled by the copilot's navigation solution. Flight director and autopilot vertical modes are unaffected by FMS operation.

NOTE

> The FMS commands bank angle to zeroize crosstrack errors. For small crosstrack errors, the bank commands can be on the order of one degree. If the aircraft is trimmed such that straight and level flight (not turning) is at other than wings level according to the autopilot attitude source, the system will stabilize with some crosstrack error. This is most noticeable on GPS final approach when coupled to the autopilot in FMS TRK and approach scaling is displayed (0.3 NM is full scale deflection). Attitude system errors, asymmetric thrust situations, or a mistrimmed aircraft can be causes of such crosstrack errors during FMS coupled operation.

ALTERNATE FLIGHT PLANNING

The alternate flight plan is a complete flight plan (separate from the active flight plan) for a mission or a mission segment which includes a route of up to 60 waypoints, along with calculations of courses, distances, times, and fuel requirements, including automatic reserve allocations. It includes the standard USAF flight planning data and provides an electronic hard copy of the flight plan in the FMS which may be modified or updated at any time.

Forty alternate flight plans may be stored on the data cartridge from either a mission planning ground station (MPGS) or laptop facility, or by manual entry via the CDU on the aircraft. On the aircraft, one alternate flight plan at a time may be selected and transferred into the CDU for viewing and the various operations described in this section. This alternate flight plan is separate from the active flight plan and does not sequence (no history waypoints) or change unless the crew modifies it. It can be transferred or added to the active flight plan where it operates as described in the Flight Plan Management section, but the alternate flight plan remains intact as well.

Alternate Flight Plan Structure

The alternate flight plan operates as a spreadsheet calculator where the crew inputs the flight plan routing, wind, and aircraft performance, and the FMS calculates the individual leg data and flight totals. The legs of the plan (1 through 60) are accessed by vertical scrolling on the CDU (figure 1.14-105), and the complete data for each leg may be accessed by lateral scrolling among leg pages with suffixes A, B, and C. The Alternate Flight Plan Waypoints page presents the alternate flight plan in a format similar to the active flight plan.

Alternate Flight Plan Access and Transfer

On the Alternate Flight Plan page, various top-level access and transfer options are provided (figure 1.14-106). When an alternate flight plan is transferred or added to the active flight plan, the following parameters are also transferred:

- Waypoint data
- Wind for each leg
- Altitude for each waypoint (if assigned)
- Time associated with the last entered time of arrival (becomes a TNAV in active flight plan)
- MFP for each waypoint (if assigned)

All others are calculated by the FMS using sensed data rather than the planned parameters of the alternate flight plan.

Before an alternate flight plan is added to the active flight plan, the total number of waypoints is summed. If there are more than 60, the alternate flight plan will not be added and the scratchpad message FPLN FULL will be displayed. In addition, the total number of MFPs will be summed. If there are more than 20, the alternate flight plan will not be added and the scratchpad message MAX PTRNS IN FPLN will be displayed.

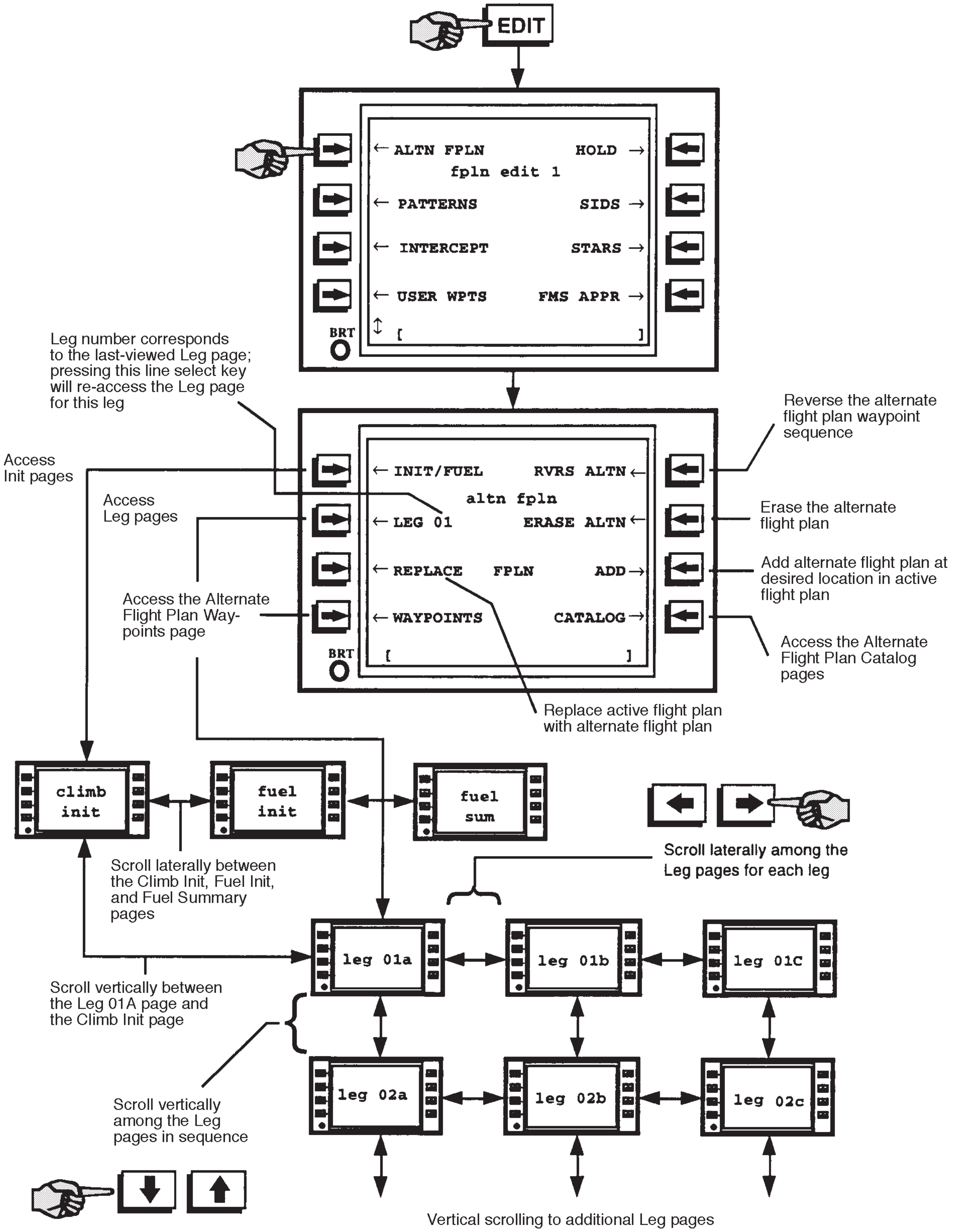


Figure 1.14-105. Alternate Flight Plan Access

Alternate Flight Plan Initial Climb and Fuel Entries

The alternate flight plan initial climb parameters (time, distance, fuel, and wind) and fuel/weight entries (figure 1.14-106) are optional. If the alternate flight plan is only to be used to load the active flight plan or added to an existing active flight plan, the crew may not desire to include these parameters.

Selecting INIT/FUEL on the Alternate Flight Plan page accesses the Alternate Climb Init and Alternate Fuel Init pages. The Alternate Climb Init page will accept time, air distance, and fuel to climb, as well as average climb wind entries (figure 1.14-106). When these parameters are entered, the FMS calculates a top of climb (TOC) leg segment that is used for fuel calculations. The TOC is displayed on the Alternate Flight Plan Leg A page for the leg that contains the top of climb point. All leg segments prior to the TOC use the climb leg calculations for fuel burn. After the TOC, the fuel burn rates for each leg are used for fuel calculations.

Lateral scrolling from the Alternate Climb Init page will access the Alternate Fuel Init page. The Alternate Fuel Init page (figure 1.14-106) allows the crew to enter total start-up fuel, ground/taxi fuel allowance, reserve fuel, approach fuel and zero fuel weight. The reserve fuel may be entered as a percentage of leg and climb fuel, fuel weight in kilo-pounds, or minutes based on the fuel burn rate of the last leg. The default will be 12 kilo-pounds of reserve fuel. The FMS uses these initial fuel figures to determine fuel remaining and gross weight along the flight plan. On initial access to the alternate flight plan, the following data is required for normal fuel/weight computations: 1) Initial position (defaults to present position, 2) zero fuel weight, and 3) initial fuel load. If desired, the initial fuel load may be left blank and the FMS will calculate the fuel load required on the Alternate Fuel Summary page.

Alternate Flight Plan Fuel Summary

The Alternate Fuel Summary page presents a summary of the fuel requirements for the alternate flight plan (figure 1.14-106). This page is accessed by lateral scrolling from the Alternate Climb Init or Alternate Fuel Init pages. If no approach (APPR) fuel is entered, then no approach time allocation is assumed. If an approach fuel is entered, a standard 15-minute time allotment is added to the total flight time, regardless of the amount of fuel entered. If an initial total fuel has been entered on the Alternate Fuel Init page, the EXTRA fuel is calculated by subtracting the required (REQ) from the TOTAL. If an EXTRA value is entered (in hours or kilo-pounds), the required initial total fuel is calculated and shown as the TOTAL. If an aerial refueling ONLOAD is entered at a waypoint in the alternate flight plan, an EXTRA entry is not permitted. The total fuel summary can be displayed in fuel quantity (klb) or endurance (hr).

WARNING

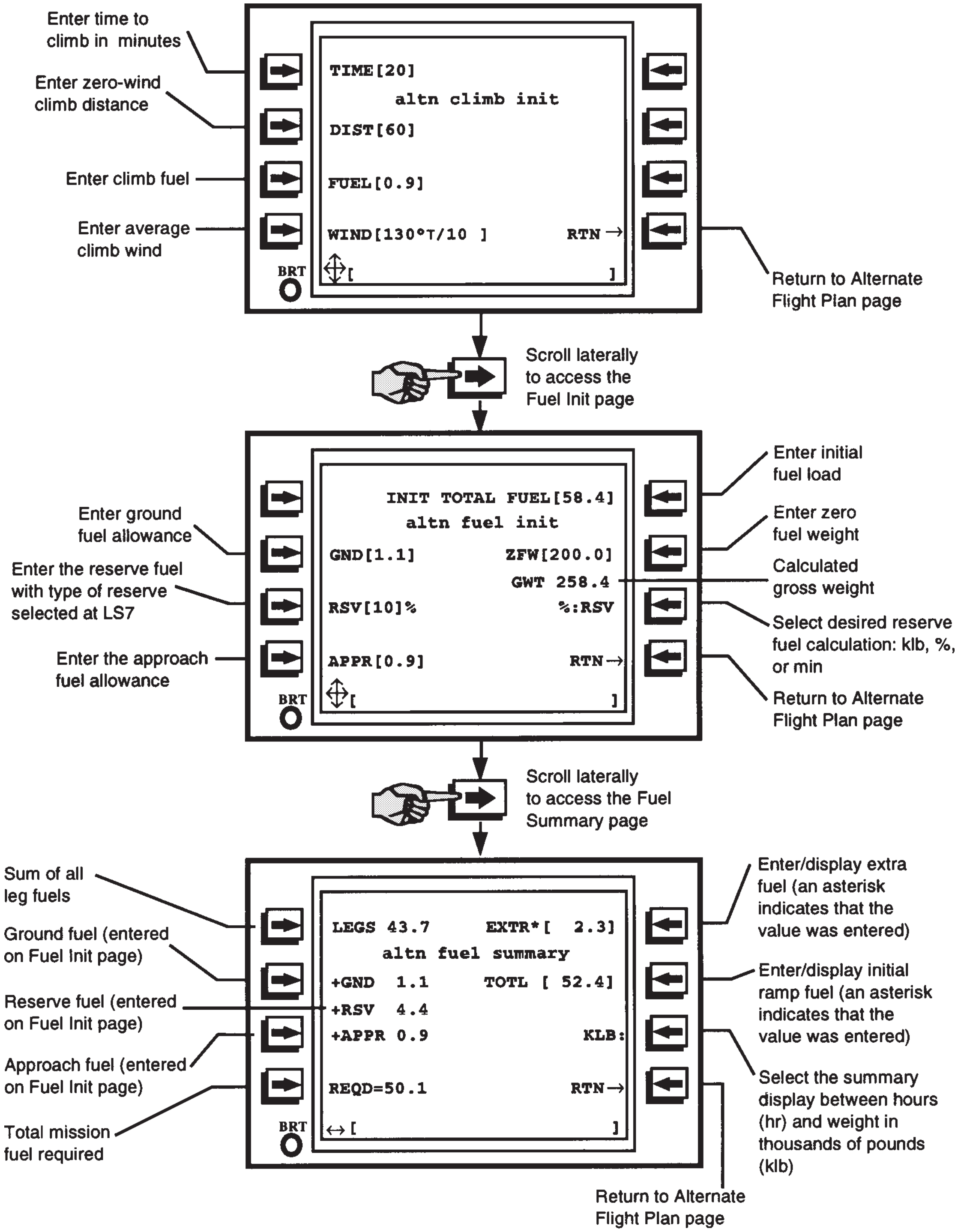
> Alternate flight plan fuel calculations should not be used when an offload is entered. Since offloads are not subtracted from usable fuel, all fuel calculations after the offload will be erroneous.

Entry and Display of Alternate Flight Plan Waypoints

The Alternate Flight Plan Waypoints page, accessed by pressing the WAYPOINTS line select on the Alternate Flight Plan page, provides a sequential list of the waypoints in the alternate flight plan. The page operates in a manner similar to the active Flight Plan page, i.e., waypoints may be added, modified, or deleted from the list in the same manner. However, when intermediate waypoints are added or deleted, the list is automatically renumbered. The first waypoint (waypoint 00) will default to the current aircraft position unless another position is entered by the crew. Up to 60 waypoints (in addition to waypoint 00) may be entered in the alternate flight plan. The ALTN FPLN FULL scratchpad message will be displayed if entry of more than 60 waypoints is attempted.

Entry and Display of Alternate Flight Plan Legs

Unless entered by the crew, the default starting point for the first leg is the current aircraft position at the time the alternate flight plan is created (figure 1.14-107). Waypoints may be entered and deleted on the Leg A pages in the same manner as for the active flight plan. The bearing displayed on the Leg A page is the outbound track FROM the starting waypoint for that leg. The leg length in NM is displayed on the right side of data line 3. This value may be toggled to display the distance from origin/distance to destination. A top-of-climb (TOC) readout will appear on the left side of the information line if a climb definition exists for that leg. The TOC represents the distance into that leg that the level-off is planned to occur, given the average climb wind and performance data entered on the Alternate Climb Init page (figure 1.14-106). Below the



```
TIME[20]
        altn climb init
DIST[60]

FUEL[0.9]

WIND[130°T/10 ]          RTN→
[                           ]
```

```
       INIT TOTAL FUEL[58.4]
         altn fuel init
GND[1.1]          ZFW[200.0]
                   GWT 258.4
RSV[10]%              %:RSV

APPR[0.9]                RTN→
[                           ]
```

```
LEGS 43.7     EXTR*[  2.3]
      altn fuel summary
+GND  1.1     TOTL [ 52.4]
+RSV  4.4
+APPR 0.9                KLB:

REQD=50.1                RTN→
↔[                          ]
```

Figure 1.14-106. Alternate Flight Plan Init and Fuel Summary Pages

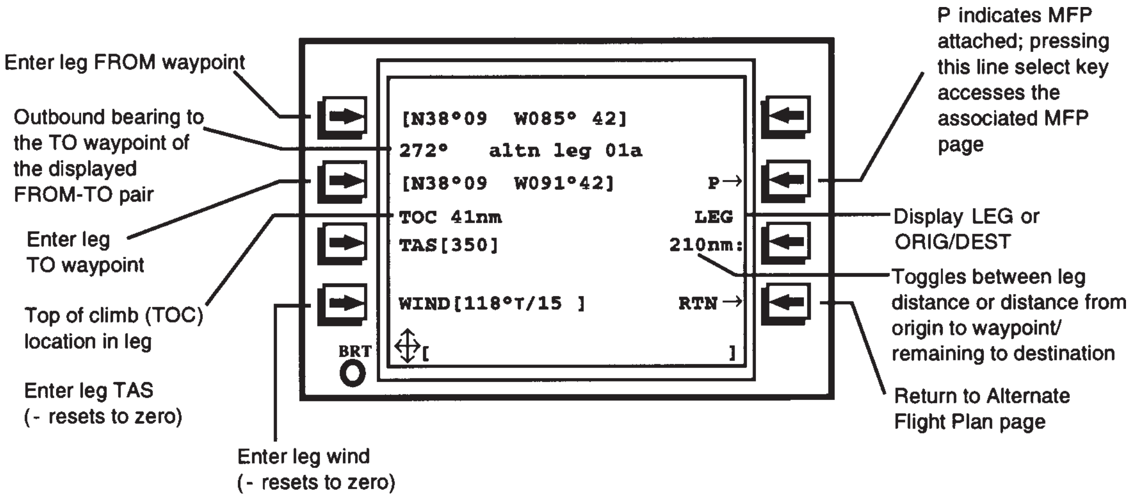


Figure 1.14-107. Alternate Flight Plan Leg A Page

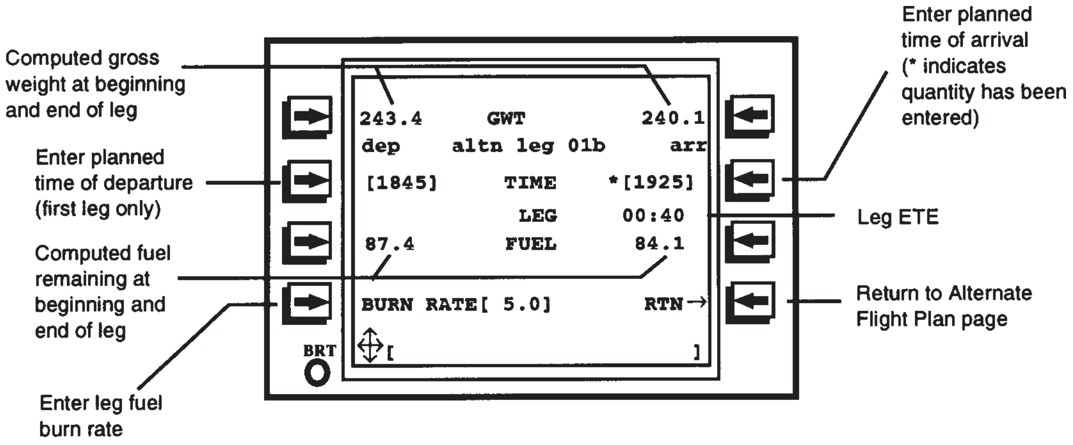


Figure 1.14-108. Alternate Flight Plan Leg B Page

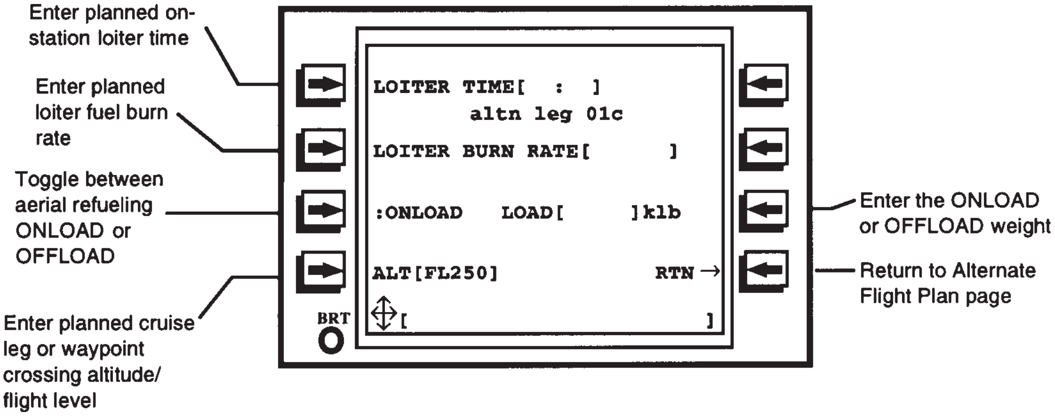


Figure 1.14-109. Alternate Flight Plan Leg C Page

leg length on the right side is displayed the total distance from the alternate flight plan origin to that waypoint, followed by the remaining distance to go from that point to the end of the flight plan.

If time and/or fuel calculations are desired, then enter the TAS and forecast wind at the cruising altitude on this page. If no following leg TAS or wind exists, then this leg's entry will also copy to the following legs. Mission flight patterns may also be inserted or attached to waypoints in the alternate flight plan. A P on the right side of data line 2 indicates a pattern is present and also allows direct access to that pattern's definition page.

Entry and Display of Alternate Flight Plan Leg Time, Fuel, and Weight

Scrolling laterally from the Leg A page to the Leg B page (figure 1.14-108), the crew may enter parameters to compute the time, fuel, and gross weights for that leg.

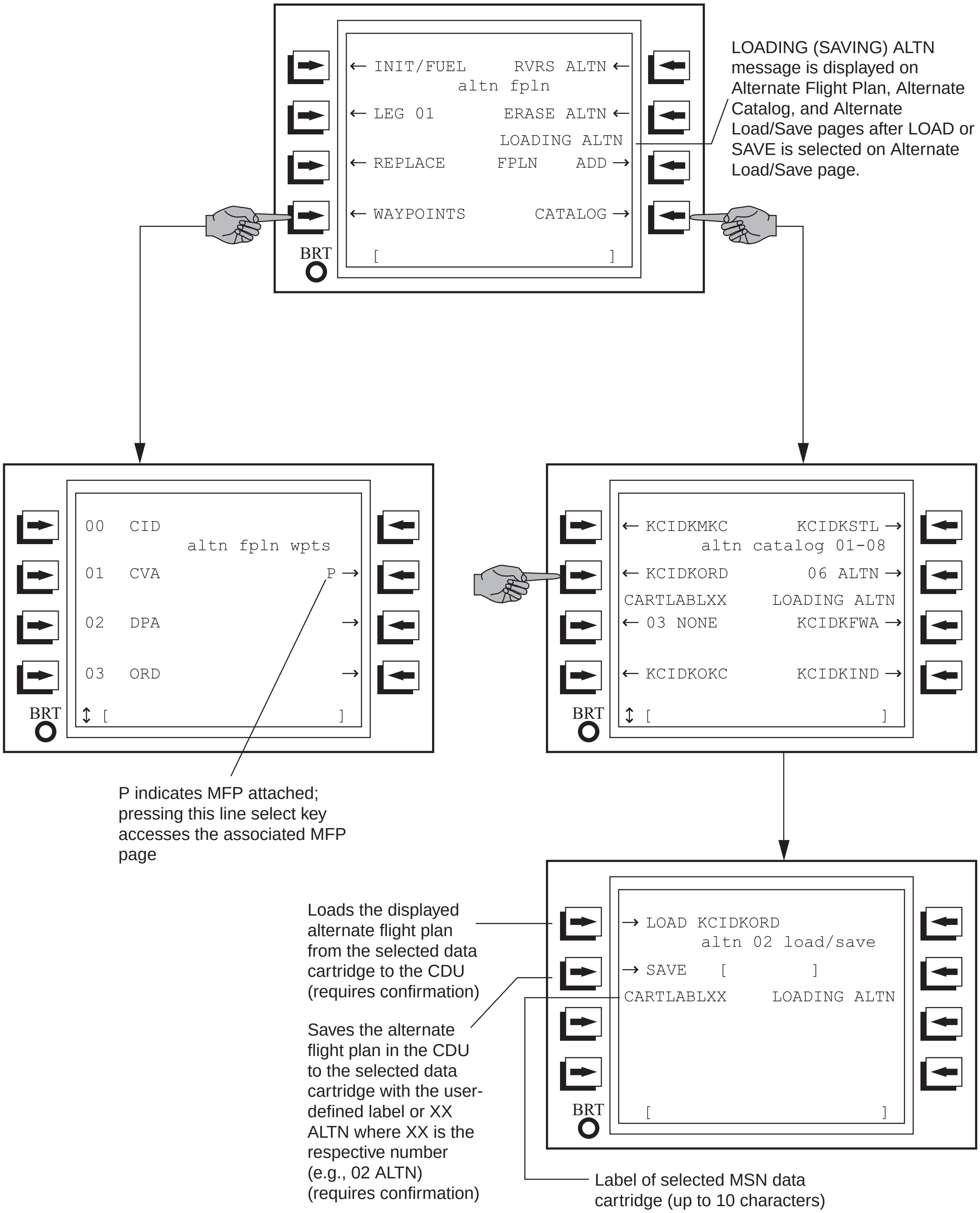
The waypoint departure and arrival times for each leg show elapsed time from takeoff (i.e., they assume a default takeoff time of 00:00) unless a required departure or waypoint arrival time is entered, in which case they are UTC. Only one required time may be in the alternate flight plan, either the first departure time or any waypoint arrival time. The asterisk (*) indicates an entered required time versus a computed departure or arrival time. If a loiter/ hold/pattern on-station elapsed time is entered on the Leg C page (figure 1.14-109), the arrival and departure times for subsequent waypoints will differ by that planned loiter time. Likewise, if a fuel onload or offload is entered at a waypoint, the arrival and departure fuel and/or gross weight will differ by the entered amount.

Entry and Display of Planned Altitude and Loiter Time and Fuel Parameters

On the Leg C page (figure 1.14-109), optional entry of the planned cruise altitude/flight level may be made. This altitude/flight level entry is transferred to the active flight plan when the alternate flight plan is transferred.

If the planned mission includes a holding pattern, aerial refueling pattern, or other MFP, the crew may enter the planned loiter time and fuel burn rate on the Leg C page (figure 1.14-109). This will cause the total mission time and fuel calculations to accommodate the planned loiter. If an intermediate landing without refueling is planned, enter the ground time with no fuel burn (or use another alternate flight plan for the next segment). If refueling is planned during an intermediate stop, the fuel ONLOAD feature may be used to record the amount of fuel loaded, if desired, or a new alternate flight plan my be used.

AFTER TCTO 1172



LOADING (SAVING) ALTN message is displayed on Alternate Flight Plan, Alternate Catalog, and Alternate Load/Save pages after LOAD or SAVE is selected on Alternate Load/Save page.

P indicates MFP attached; pressing this line select key accesses the associated MFP page

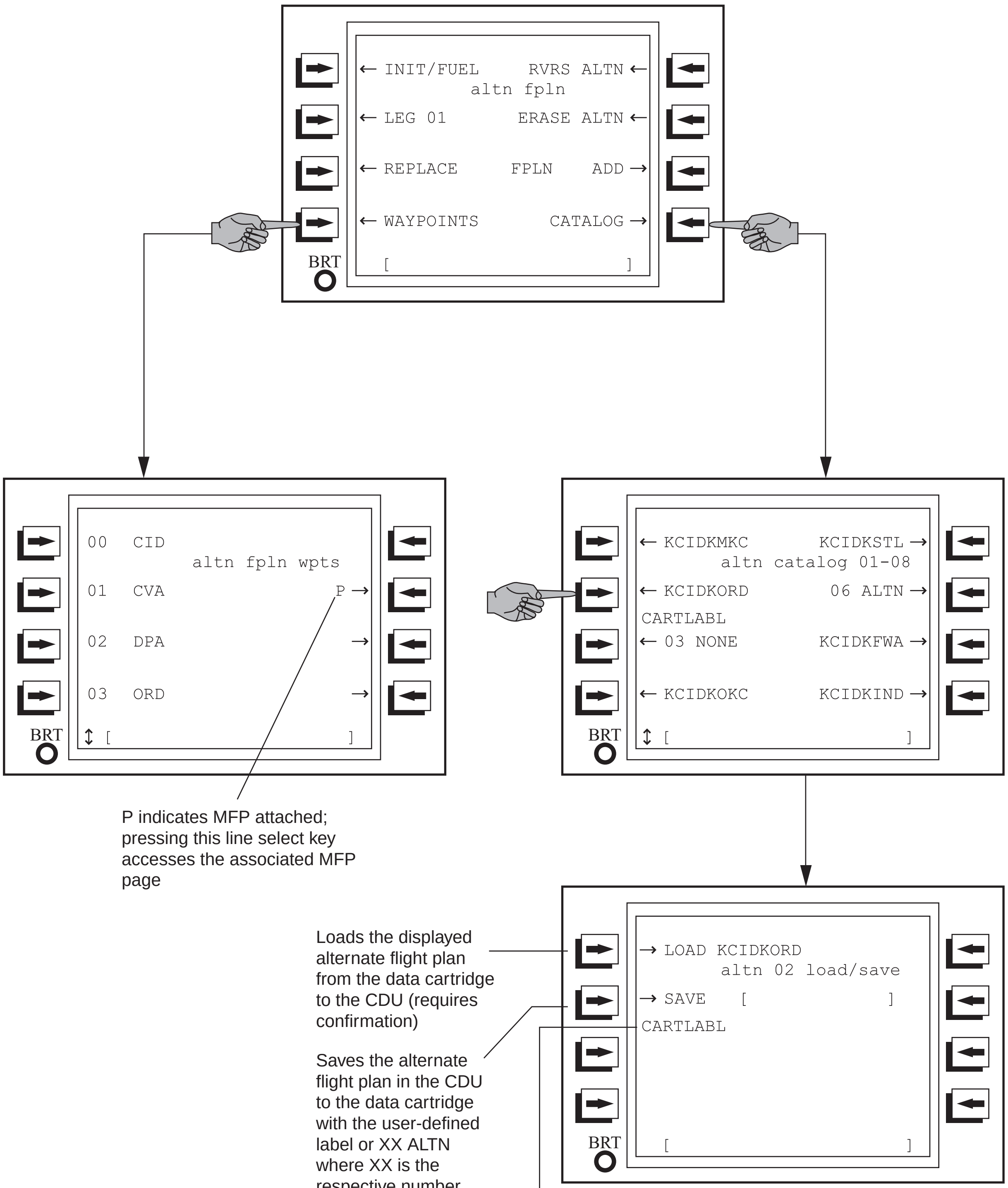
Loads the displayed alternate flight plan from the selected data cartridge to the CDU (requires confirmation)

Saves the alternate flight plan in the CDU to the selected data cartridge with the user-defined label or XX ALTN where XX is the respective number (e.g., 02 ALTN) (requires confirmation)

Label of selected MSN data cartridge (up to 10 characters)

Figure 1.14-110. Alternate Flight Plan Waypoints Page and Alternate Flight Plan Catalog Pages (Sheet 1) ◀

BEFORE TCTO 1172



P indicates MFP attached; pressing this line select key accesses the associated MFP page

Loads the displayed alternate flight plan from the data cartridge to the CDU (requires confirmation)

Saves the alternate flight plan in the CDU to the data cartridge with the user-defined label or XX ALTN where XX is the respective number (e.g., 02 ALTN) (requires confirmation)

Label of installed data cartridge (up to 10 characters)

Figure 1.14-110. Alternate Flight Plan Waypoints Page and Alternate Flight Plan Catalog Pages (Sheet 2) ◀

Entry and Display of Fuel Onload/Offload

If an aerial refueling is planned, then 1) toggle the LS4 key on the Leg C page to ONLOAD or OFFLOAD for the waypoint where it is to occur (figure 1.14-109), 2) enter the onload/ offload quantity in the scratchpad, and 3) press the LOAD line select key.

If an onload is entered, the FMS assumes that the loaded quantity is usable fuel and increments both the departure gross weight and fuel remaining at that waypoint (figure 1.14-109). In this case, the REQUIRED and TOTAL (mission) fuel on the Alternate Fuel Summary page will be greater than the initial total fuel loaded on the Alternate Fuel Init page (figure 1.14-106). If an offload is entered, the FMS is unable to distinguish between a cargo/airdrop payload or a tanker aerial refueling offload, i.e., it reduces the gross weight, but not the usable fuel remaining at that waypoint.

WARNING

> Alternate flight plan fuel calculations should not be used when an offload is entered. Since offloads are not subtracted from usable fuel, all fuel calculations after the offload will be erroneous.

Alternate Flight Plan Loading To/From the Data Cartridge

The alternate flight plan may be transferred to or from one of the 40 alternate flight plan files located on the selected data cartridge.

NOTE

> The System Initialization section describes the initial preflight loading of an alternate flight plan on the Start 5 page via either the alternate flight plan number/label or the Alternate Catalog page.

A list of the flight plans stored on the selected MSN data cartridge may be viewed by selecting the CATALOG line select on the Alternate Flight Plan page (figure 1.14-110). This will access the Alternate Catalog 01-08 page. The available flight plans may be viewed by scrolling vertically among the five pages of the catalog. Empty slots will display NONE by the flight plan number. Selection of a stored flight plan by pressing the adjacent line select will access the Alternate Flight Plan Load/Save page for that alternate. This flight plan may then be loaded into the CDU in the alternate flight plan slot by pressing the LOAD line select (requires confirmation). Conversely, the alternate flight plan in the CDU may be stored in the specified file slot on the selected cartridge by pressing the SAVE line select (requires confirmation). If desired, a name may be assigned to the alternate by entering it into the scratchpad prior to selecting SAVE.

While a load or save of an alternate flight plan is in progress, LOADING ALTN or SAVING ALTN will be displayed on the information line of the Alternate Flight Plan, Alternate Flight Plan Catalog, and Alternate Flight Plan Load/Save pages.

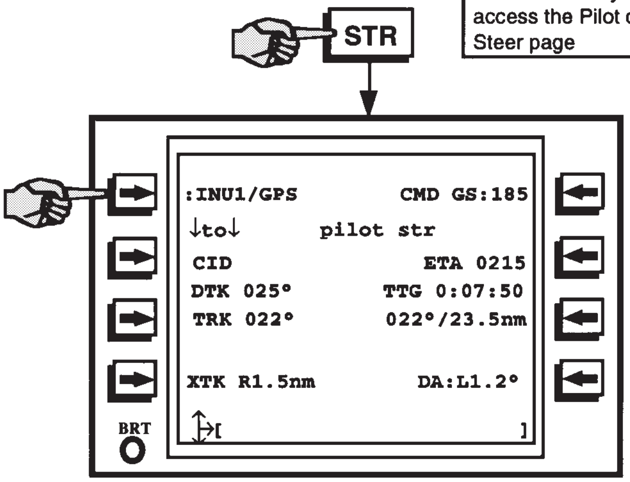
FMS MULTI-SENSOR NAVIGATION CAPABILITIES

The FMS makes use of the aircraft's three INUs and its two embedded GPS receiver modules (only one may be active at a time) as available sensors for its multi-sensor navigation function. Using these sensors, the FMS supplies seven possible independent navigation solutions for the Pilot's and Copilot's steering functions. These navigation solutions are INU1, INU2, INU3 (if selected to replace INU1 or INU2 with the INS Selector switch), GPS, INU1/GPS, INU2/GPS, INU3/GPS (if INU3 is selected to replace INU1 or INU2 with the INS Selector switch). The pilot can select INU1, GPS, or INU1/GPS normally and INU3, GPS, or INU3/GPS with the INS selector switch in CAPT ON AUX. The copilot can select INU2, GPS, or INU2/GPS normally and INU3, GPS, or INU3/GPS with the INS selector switch in F/O ON AUX. The default (power-up) selection is INU1/GPS for the pilot and INU2/GPS for the copilot (INS selector switch in NORM).

The optimum navigation configuration of the FMS is the integrated INU/GPS navigation mode. When operating in the INU/GPS mode, the FMS provides mixing of navigation data from the selected INU and GPS sensors to provide the best computed position. This best position is accomplished by applying corrections to the INU data in a feed-forward mechanization, not by position updating the INU. These corrections are obtained by using a KALMAN filter to estimate the INU errors by comparing the INU data to GPS data. The Kalman filter also statistically weights the GPS and INU sensor data to take advantage of the complementary characteristics of the sensors. For example, GPS position error does not grow over time, but may be corrupted with high frequency noise, multipath

Pressing the STR key accesses the last-viewed Steer page; laterally and/or vertically scroll if necessary to access the Pilot or Copilot Lateral Steer page

Toggles navigation source for pilot steering:
- INU1/GPS
- INU3/GPS*
- INU1
- INU3*
- GPS



*NOTE: INU3 and INU3/GPS selections are only available if INU3 is selected to replace INU1 via the INS selector switch

Similar selections available for copilot steering on Copilot STR page

Figure 1.14-111. Multi-Sensor Navigation Source Selections on Pilot Lateral Steer Page

errors, and terrain masking which cause short term effects. The INU position error, on the other hand, grows over time, typically at a rate of about 1-2 NM per hour CEP. The weighted combination of the INU and GPS data provides an integrated solution with good short term response characteristics using INU data, as well as long term stability through the error corrections provided by GPS.

Should GPS fail (INU/---), the Kalman filter continues to maintain and apply the INU error corrections to improve the quality of the INU data. Therefore, an intermittent or short term GPS loss is relatively transparent to the operator. The integrated navigation solution accuracy during extended GPS outages is also improved over a stand-alone INU provided GPS has been available for a sufficient amount of time (about half an hour) to allow the Kalman filter to properly estimate the INU errors. Since the integrated navigation solution is nominally based on the INU, the INU/GPS solution cannot produce valid data without the INU (i.e., a failure of the selected INU causes a failure of the integrated solution and would require the crew to switch in the auxiliary INU or select another available navigation solution).

The navigation sources being used for the Pilot's and Copilot's steering are indicated on the Pilot and Copilot Lateral Steer pages as shown in figure 1.14-111. These selections may be changed on the respective steering pages by toggling the adjacent line select key (LS1).

Position, Track, and Air Data Displays

The steering selections determine the sources of the position data for the Pilot and Copilot Position pages shown in figure 1.14-112. The air data shown on these pages comes from CADC1 or CADC2 as selected on the Nav Configuration page.

The wind is displayed as the current wind direction/velocity, headwind/tailwind component, and crosswind component. For the headwind/tailwind component, a ↑ indicates a tailwind and a ↓ indicates a headwind.

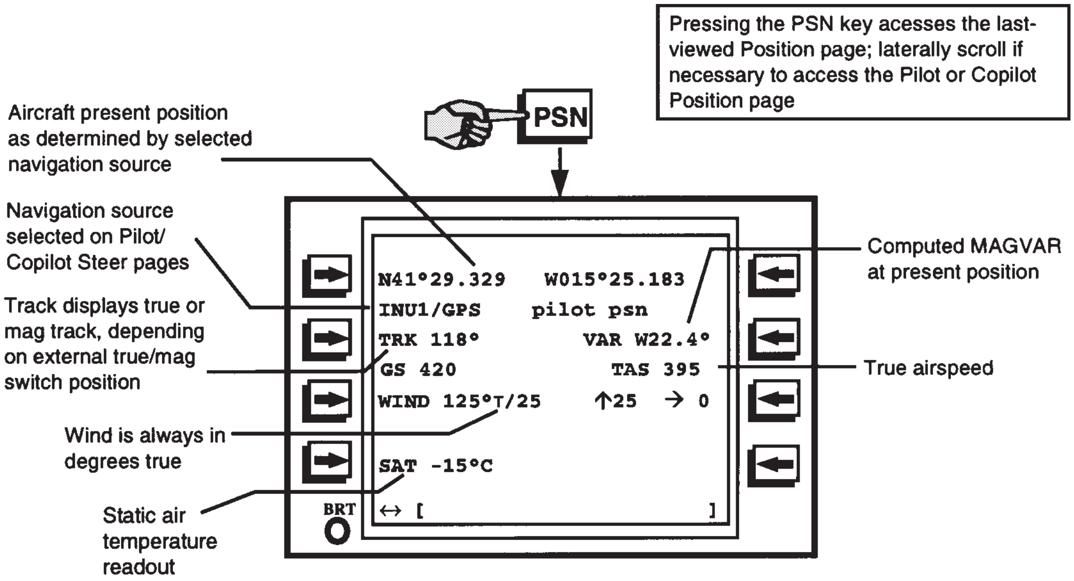


Figure 1.14-112. Pilot Position Page

If the FMS is not receiving a computed wind, the wind can be manually entered. Brackets ([ ]) will be displayed when the wind can be manually entered.

The status and validity of the selected navigation sources are indicated on the title lines of the Pilot and Copilot Position pages. Figure 1.14-113 shows the indications and their meanings. Any automatic downgrading of the navigation source is annunciated on the CDU. The EHSI navigation flags are dependent on 1) the status of the selected navigation sensors and 2) the 95% error compared to a threshold determined by the current flight guidance mode: Oceanic, En route, Terminal, or Approach.

NOTE

> These 95% error alert levels are established to comply with the FAA Advisory Circular 20-130A for multi-sensor navigation systems using GPS and the USAF GPS Integration Guide.

Navigation Source Data Displays

Each navigation source (whether selected for Pilot/ Copilot steering or not) has its own Integrated Navigation (INAV) page to display its current position and navigation status (refer to figure 1.14-114).

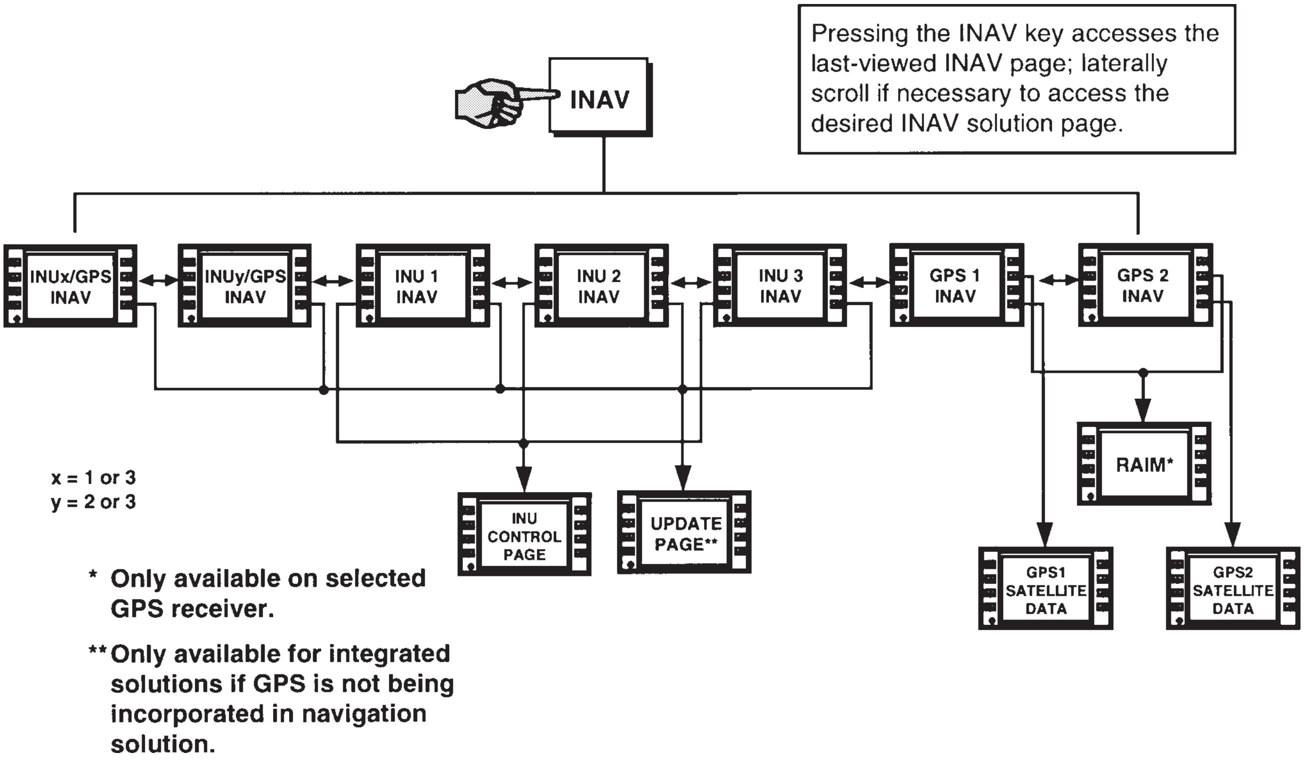
INU1/GPS, INU2/GPS, and INU3/GPS Displays

The INU1/GPS, INU2/GPS, and INU3/GPS INAV pages show the computed present position of those integrated navigation solutions, along with a 95% error figure of merit for the probable system accuracy given the current INU alignment and GPS satellite navigation solution quality (figure 1.14-115). This page also shows the difference between its navigation position solution and that of the designated pilot's selected steering solution.

If, due to a grossly misaligned INU or other anomalous condition, the position shown is incorrect when compared with the known aircraft position (greater than 100 NM), the INAV RESET line select key may be used to zero the Kalman filter error estimates and restart its calculation process. This action requires confirmation. The INAV RESET will not degrade normal navigation accuracy, but it will eliminate the benefit of the INU error estimates if GPS data should become unavailable before they can be reestimated (usually about half an hour after resetting). If GPS data becomes unavailable en route, the previously computed INU corrections will continue to be applied to this navigation solution, so it will be more accurate than the uncorrected INU solution. However, to en-

SELECTED MODE	DISPLAYED MODE	CONDITIONS FOR DISPLAY
INU1/GPS	INU1/GPS	INU1 and GPS are being used in the INU1/GPS integrated solution
INU1/GPS	INU1/---	GPS is not being incorporated into the INU1/GPS integrated solution
INU1/GPS	---1/---	INU1 navigation data is invalid
INU2/GPS	INU2/GPS	INU2 and GPS are being used in the INU2/GPS integrated solution
INU2/GPS	INU2/---	GPS is not being incorporated into the INU2/GPS integrated solution
INU2/GPS	---2/---	INU2 navigation data is invalid
INU3/GPS	INU3/GPS	INU3 and GPS are being used in the INU3/GPS integrated solution
INU3/GPS	INU3/---	GPS is not being incorporated into the INU3/GPS integrated solution
INU3/GPS	---3/---	INU3 navigation data is invalid
INU1	INU1	INU1 navigation data is valid
INU1	---1	INU1 navigation data is invalid
INU2	INU2	INU2 navigation data is valid
INU2	---2	INU2 navigation data is invalid
INU3	INU3	INU3 navigation data is valid
INU3	---3	INU3 navigation data is invalid
GPS	GPS/A/H	GPS navigation data is being smoothed with airspeed and heading
GPS	GPS/-/H	GPS navigation data is being smoothed with ground speed and heading
GPS	GPS/-/-	GPS is not being smoothed with airspeed and heading data
GPS	---/A/H	GPS is invalid; FMS is dead reckoning with airspeed and heading
GPS	---/-/-	GPS is invalid and heading or airspeed is invalid
MODEL	MODEL	The model aircraft function is providing the navigation solution.

Figure 1.14-113. Display of Navigation Mode on Position Page



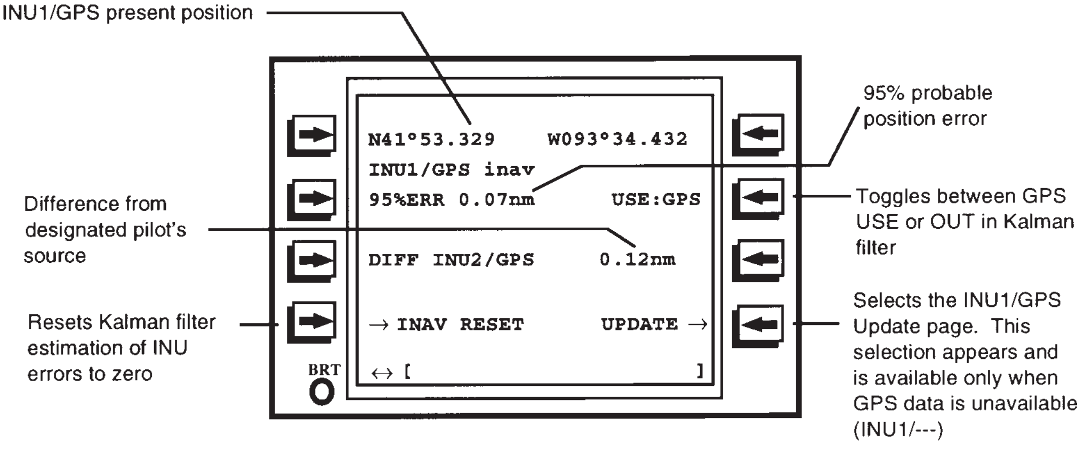
Pressing the INAV key accesses the last-viewed INAV page; laterally scroll if necessary to access the desired INAV solution page.

x = 1 or 3
y = 2 or 3

*** Only available on selected GPS receiver.**

****Only available for integrated solutions if GPS is not being incorporated in navigation solution.**

Figure 1.14-114. INAV Page Access


```
N41°53.329     W093°34.432
INU1/GPS inav
95%ERR 0.07nm       USE:GPS

DIFF INU2/GPS     0.12nm

→ INAV RESET      UPDATE →
↔ [                      ]
```

INU1/GPS present position

95% probable position error

Difference from designated pilot's source

Toggles between GPS USE or OUT in Kalman filter

Resets Kalman filter estimation of INU errors to zero

Selects the INU1/GPS Update page. This selection appears and is available only when GPS data is unavailable (INU1/---)

Figure 1.14-115. INU/GPS Integrated Navigation Page

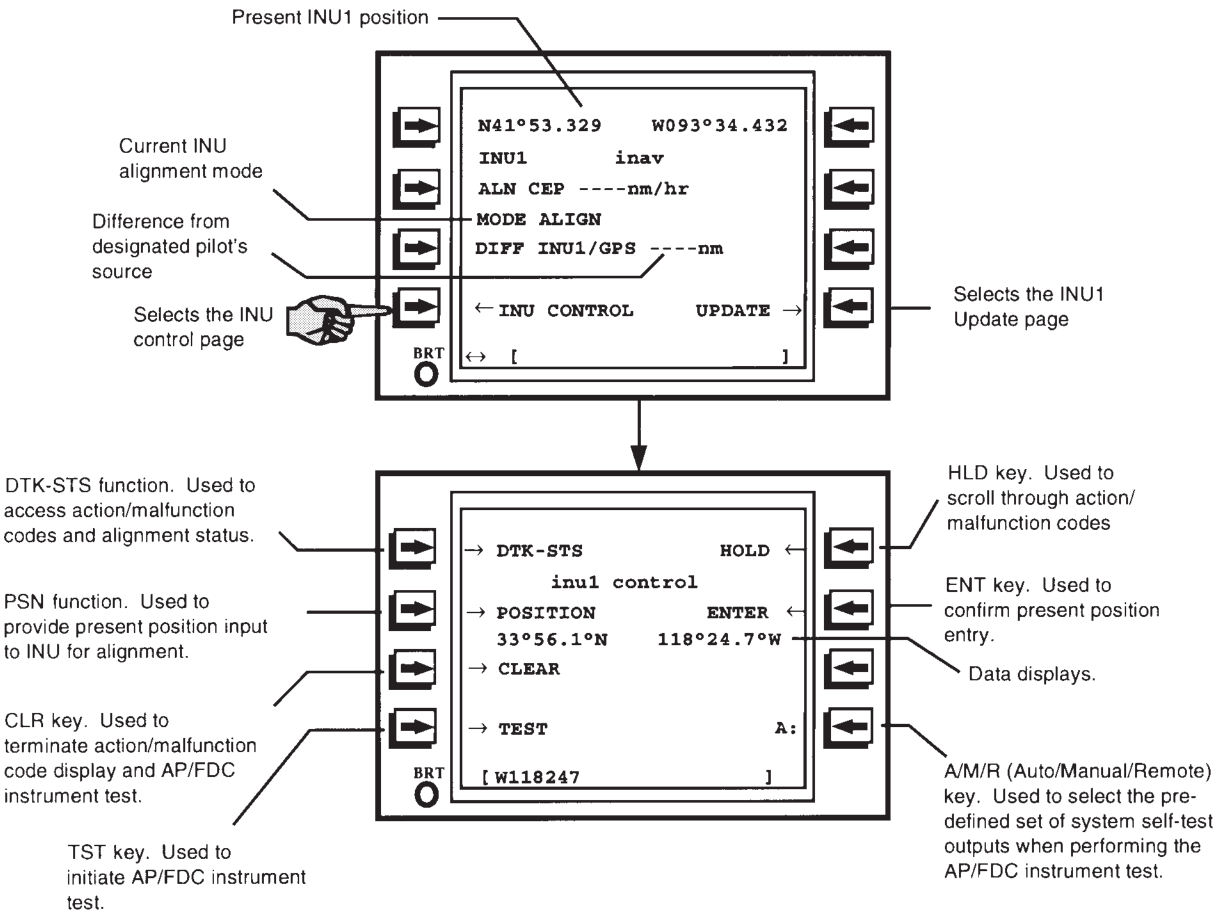


Figure 1.14-116. INU Integrated Navigation and INU Control Pages

able the crew to manually update the solution if necessary, the UPDATE line select key becomes available and may be used as necessary to update the INU (refer to Position Updates, this section).

GPS can be manually removed from the INU/GPS solution by toggling the GPS line select key from USE to OUT. To enable the inputs again, toggle back to USE.

INU1, INU2, and INU3 Displays

The INU1, INU2, and INU3 INAV pages show the present position from the respective INUs, along with the alignment circular error probable (ALN CEP) (refer to figure 1.14-116). The current alignment mode (NAV, ALIGN, or INU FAIL) is also displayed. Dashes will be displayed if communication with the INU has been lost (i.e., unit is unpowered or interface has failed). The DIFF readout shows the difference between the INU position and the designated pilot's selected steering solution.

Selection of LS4 will access the respective INU Control page as shown in figure 1.14-116. This page is designed to control initialization/alignment functions and to provide access to alignment status and action/ malfunction code information. Each INU is controlled locally by its respective FMS CDU (i.e., CDU1 provides exclusive control/display for INU1). The information line will provide a display of system information, and the individual line select keys will perform the functions indicated in figure 1.14-116. In the event that display data from the INU is unavailable or invalid, the message NO INU DATA will be displayed on the information line.

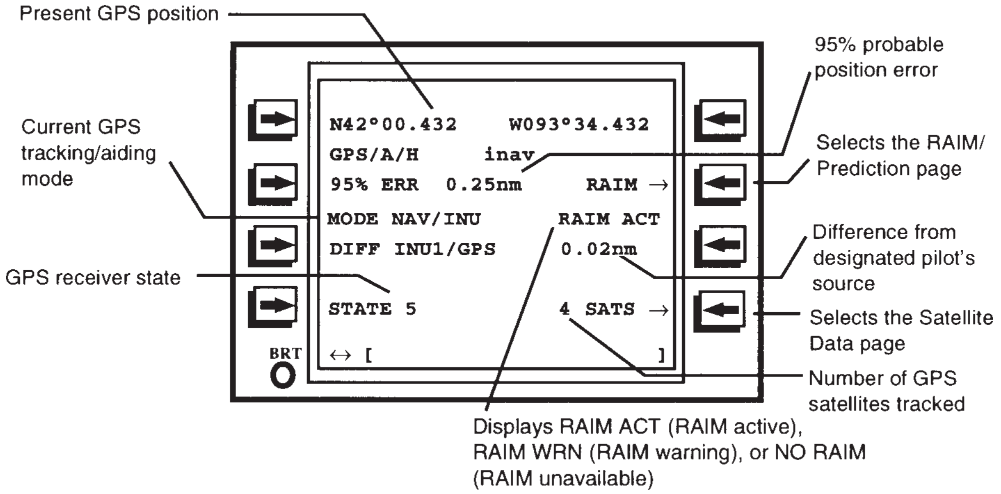


Figure 1.14-117. GPS Integrated Navigation Page

GPS Displays

There are two GPS INAV pages, one for each GPS receiver. The active GPS INAV page will display GPS/A/H on the title line, and the alternate GPS INAV page will have GPS 1 or GPS 2 (as appropriate) on the title line.

The GPS INAV page shows the present position output from the GPS receiver (active or alternate), along with a 95% error figure of merit for the probable system accuracy, given the current GPS satellite navigation solution quality (satellite tracking state and geometry) as shown in figure 1.14-117. If GPS/A/H is indicated on the title line (active GPS only), the FMS is using airspeed and heading sensor inputs to smooth the GPS data. This smoothing data is required to have a valid bank (roll) command output to the flight director and autopilot.

The MODE indicates the current GPS receiver operating/filter mode: INIT, TEST, NAV/INU, or NAV/PVA. When GPS is operating with INU filtering (NAV/INU), satellite tracking performance is enhanced over the PVA (position, velocity, and acceleration) filtering mode in the presence of interference/jamming and while maneuvering.

The STATE indicates the lowest composite tracking state of the four primary satellite tracking channels: STATE 5 is code and carrier lock (no interference/jamming), STATE 3 is code track only (in interference/jamming), and - if three or less satellites are tracked in state 5 and no satellites are tracked in state 3.

The RAIM (receiver autonomous integrity monitoring) line select (available for the active GPS receiver only) accesses the RAIM/Prediction page (figure 1.14-118). This page allows the crew to obtain a prediction of whether RAIM will be available for a GPS approach at a specific location and arrival time. The function is accessed by entering a valid waypoint on data line 1 and an ETA on data line 2. The result is displayed on the information line as either APPR RAIM AVAILABLE or APPR RAIM UNAVAILABLE. The RAIM function may also be turned on or off from this page (LS3). See GLOBAL POSITIONING SYSTEM, this part, for a further discussion of the RAIM function.

The number of SATS (satellites) being tracked for primary navigation purposes is indicated on data line 4; the normal fully determined number is four (4). Less than four may result in GPS data invalidity. Pressing the SATS line select will access the GPS1(2) Satellite Data page (figure 1.14-119).

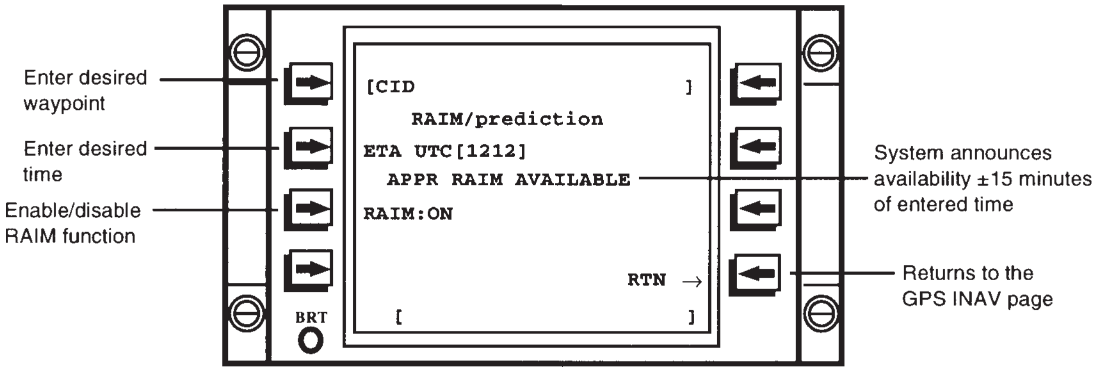


Figure 1.14-118. GPS RAIM/Prediction Page

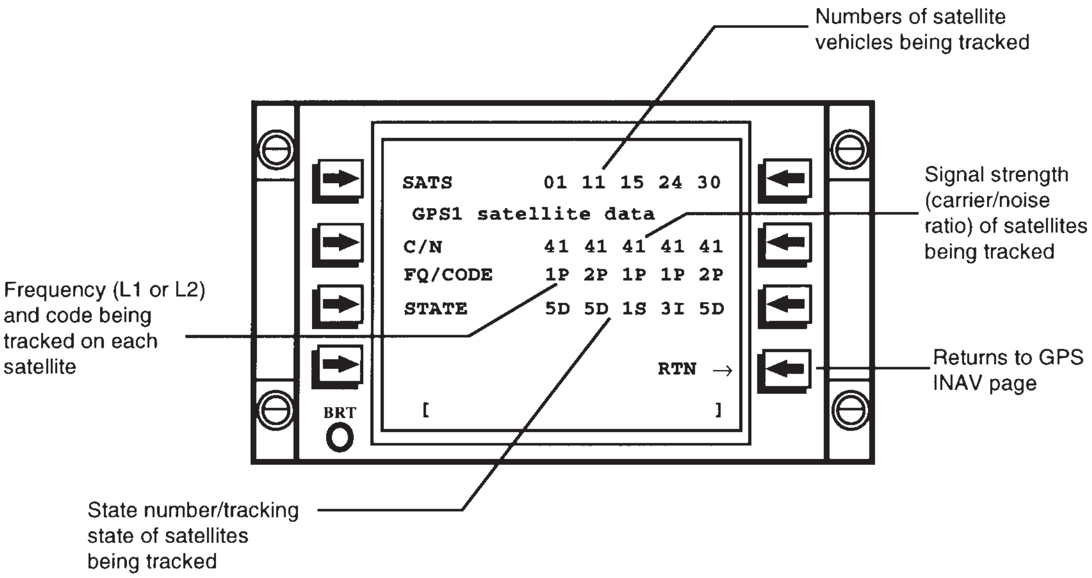
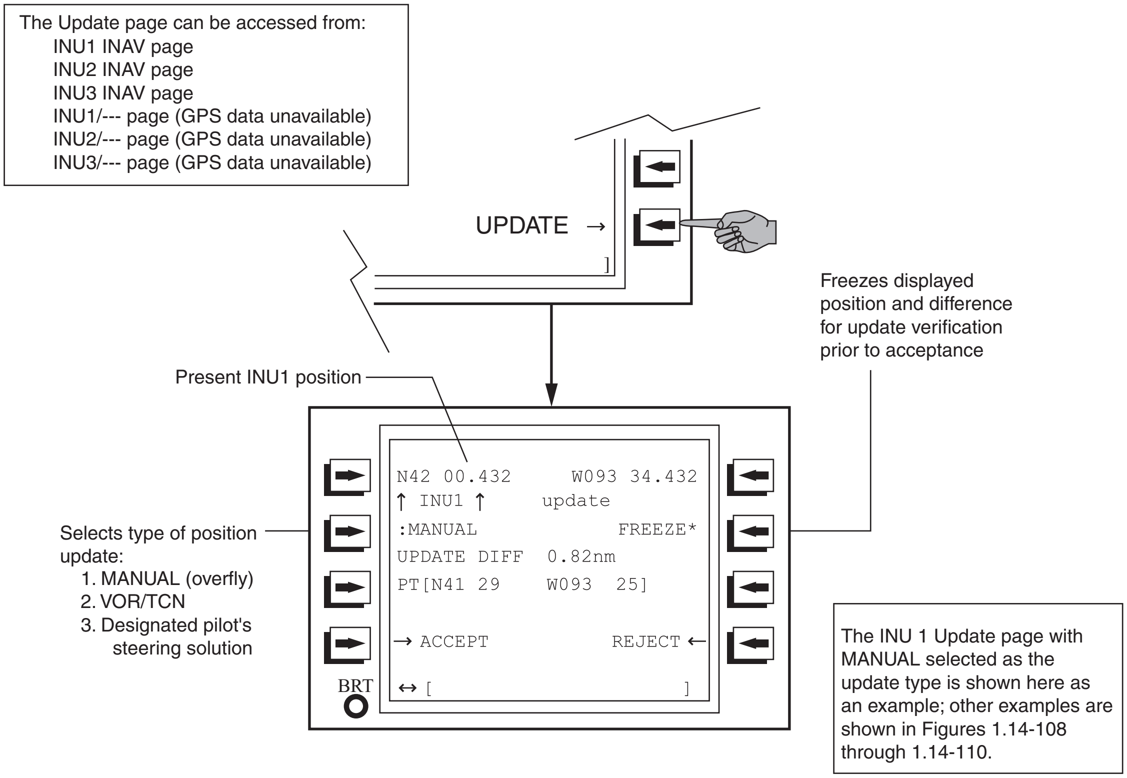


Figure 1.14-119. GPS1 Satellite Data Page



The Update page can be accessed from:
- INU1 INAV page
- INU2 INAV page
- INU3 INAV page
- INU1/--- page (GPS data unavailable)
- INU2/--- page (GPS data unavailable)
- INU3/--- page (GPS data unavailable)

Present INU1 position

Freezes displayed position and difference for update verification prior to acceptance

Selects type of position update:
1. MANUAL (overfly)
2. VOR/TCN
3. Designated pilot's steering solution

The INU 1 Update page with MANUAL selected as the update type is shown here as an example; other examples are shown in Figures 1.14-108 through 1.14-110.

Figure 1.14-120. Performing Navigation Position Updates

The GPS1(2) Satellite Data page shows the satellites being tracked, and provides information on signal strength, the frequency/code being tracked, and the tracking state of each satellite. The carrier/noise (C/N) numbers on data line 2 indicate the level of signal strength.

NOTE

> When crews suspect any electromagnetic interference (e.g., jamming), CDU 3 should be set to the GPS Satellite Data page to monitor C/N levels. C/N indications of 40-41 are normal. If C/N numbers drop significantly, electromagnetic interference may be present and the crew should monitor estimated position accuracy on the INAV page.

The FQ/CODE indicators on the information line show the frequency and code being tracked for each satellite. The numbers (1 or 2) denote the L1 or L2 signal and the letters (C or P) stand for C/A-code or P-code.

The STATE indicators on data line 3 show the state number and tracking state of each satellite. Possible tracking states include:

S - Search for the satellite signal (states 1 and 2)

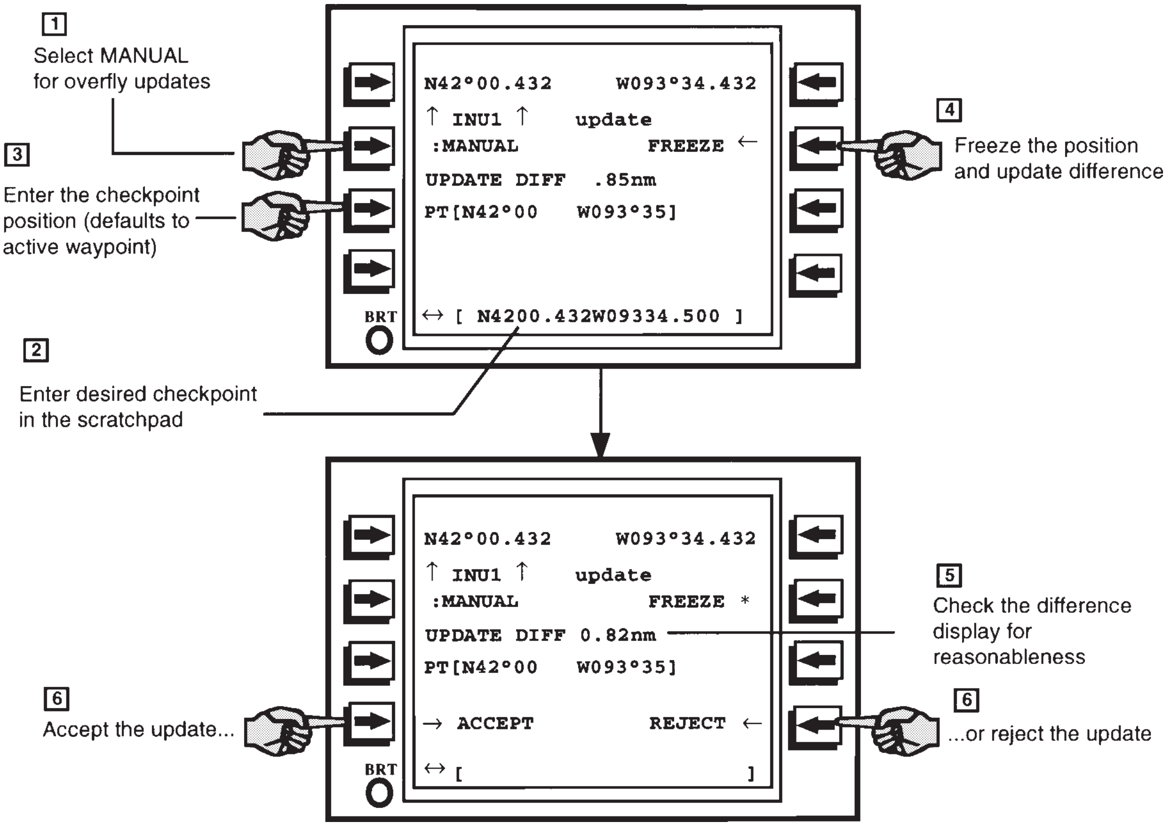
T - Satellite signal is being tracked (states 4 and 6)

I - Satellite signal track is degraded due to interference, jamming, or partial obscuration (state 3)

D - Satellite signal is being tracked and data is being collected (state 5)

R - Satellite signal has been lost and recovery operations are being attempted (state 7)

Page 1.14-152 is deleted.



```
N42°00.432      W093°34.432
↑ INU1 ↑    update
 :MANUAL         FREEZE ←
UPDATE DIFF  .85nm
PT[N42°00   W093°35]

↔ [ N4200.432W09334.500 ]
```

```
N42°00.432      W093°34.432
↑ INU1 ↑    update
 :MANUAL         FREEZE *
UPDATE DIFF 0.82nm
PT[N42°00   W093°35]

→ ACCEPT         REJECT ←
↔ [                      ]
```

Figure 1.14-121. Manual Overfly Position Update

INU and Integrated Navigation Position Updates

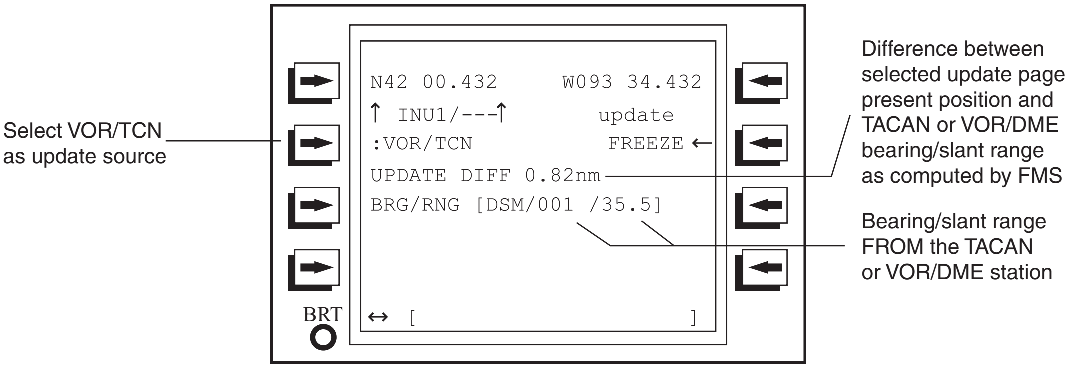
To update the INUs or the INU/GPS navigation solutions, select the UPDATE line select key on the respective INAV page (figure 1.14-120) to access the Update page. INU/GPS navigation solutions may only be updated when GPS is unavailable. If GPS is available, the UPDATE indication will not be displayed. From the Update page, select the type of update desired using LS2 as shown. The three types of updates are as follows:

1. MANUAL. Updates present position (on data line 1) to the entered checkpoint (PT) position displayed on line 5.
2. VOR/TCN. Updates present position to the manually entered TACAN or VOR/DMW bearing/slant range position with automatic slant range/altitude correction.
3. DESIGNATED PILOT'S NAVIGATION SOLUTION. Updates present position to INU1/GPS, INU2/GPS, INU3/GPS, INU1, INU2, INU3, or GPS (whichever is currently selected as the designated pilot's steering solution).

Manual Overfly Updates

To perform a manual overfly update:

1. Toggle LS2 to MANUAL on the Update page. The PT coordinates automatically default to the current active waypoint in the flight plan.
2. If another checkpoint is desired, enter the coordinates, identifier, or identifier/ bearing/distance checkpoint as the PT, as shown in figure 1.14-121. To return to the active waypoint default, enter a - at the PT line select key.



```
N42 00.432      W093 34.432
↑ INU1/---↑       update
:VOR/TCN          FREEZE ←
UPDATE DIFF 0.82nm
BRG/RNG [DSM/001 /35.5]

↔ [                       ]
```

Select VOR/TCN as update source

Difference between selected update page present position and TACAN or VOR/DME bearing/slant range as computed by FMS

Bearing/slant range FROM the TACAN or VOR/DME station

Figure 1.14-122. Update Page with TACAN as the Update Source

3. Freeze the display when the aircraft is visually over the checkpoint by selecting FREEZE and review the displayed update difference (UPDATE DIFF) for reasonableness.
4. Press the ACCEPT line select key to accept the updated position difference correction or the REJECT line select key to reject it.

VOR/TCN Updates (Manually Entered)

VOR/TCN updates provide the ability to update position using radial/DME information from TACAN or VOR/DME. Given the manually entered radial bearing and slant range from the TACAN or VOR/DME equipment and the location of the NAVAID station from the ICAO waypoint database, the FMS can compute the present position of the aircraft. This computed position can be used to update the selected navigation solution displayed on the Update page.

To perform a manually entered VOR/TACAN update (refer to figure 1.14-122):

1. Toggle LS2 to VOR/TCN on the Update page.
2. Enter the TACAN (or VOR/DME) identifier/bearing/slant range FROM the selected station.
3. FREEZE the position and update difference (UPDATE DIFF) displays, and verify reasonableness.
4. ACCEPT or REJECT the difference for update of the selected navigation solution.

NOTE

- VOR/TACAN updates are not possible unless the TACAN (or VOR/DME) identifier is in the FMS database.
- An attempt to enter an identifier/bearing/slant when the identifier does not have an elevation will result in a √IDENT ELEVATION scratchpad message and the entry will be inhibited.
- An attempt to enter an identifier/bearing/slant when the aircraft altitude data is invalid will result in a √STATUS scratchpad message and the entry will be inhibited.

Updates Using Designated Pilot Solution Position

To update the navigation solution to that of the current designated pilot's steering solution (refer to figure 1.14-123):

1. Toggle LS2 to show the current designated pilot's solution (e.g., INU1/ GPS).
2. Freeze the position and update difference (UPDATE DIFF) displays.
3. Verify the reasonableness of the difference displayed.
4. ACCEPT or REJECT the difference correction.

NOTE

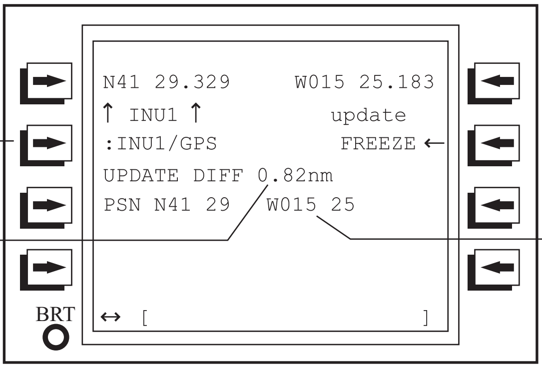
If GPS data is not available and the pilot desires to update all six remaining valid navigation solutions (INU1, INU2, INU3, INU1/---, INU2/---, and INU3/---) to the same position, the optimum procedure is to first update the selected designated pilot steering solution using a MANUAL or VOR/TCN update, then update the other five individually to that solution. This will make all six solutions exactly the same.

GPS Aiding

The crew may control which of the two available GPS receivers is used for active navigation calculations and Kalman filter INU corrections on the Navigation Configuration 1 page (figure 1.14-124).

Whichever GPS is selected as active, the other one will be automatically used as a monitor. If the difference in positions between the two GPS solutions exceeds the integrity limit for the current phase of flight, a <<compare gps>> annunciation will be displayed. If the active GPS fails, the other GPS must be manually selected as active; there is no automatic switching.

Also on the Navigation Configuration 1 page, the crew may select the INU to be used for velocity aiding of the GPS receivers, and the air data source to be used for altitude aiding. The defaults for these are INU1 and ADC1 respectively.

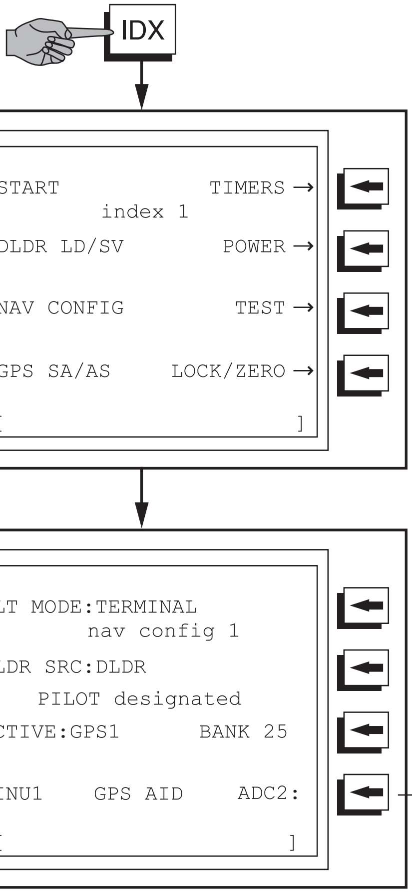


Select Designated Pilot's navigation solution as update source

Difference between selected update page present position and Designated Pilot's solution present position

Designated pilot's solution present position

Figure 1.14-123. Update Page with Designated Pilot as the Update Source



Access Navigation Configuration page for display of aiding data

Selects INU to be used as aiding source for GPS (INU3 will only appear as a selection if switched in to replace INU1 or INU2)

Selects air data source for GPS aiding

Figure 1.14-124. Selection of Aiding Sources for GPS

NAVIGATION RADIO CONTROL

The FMS provides control of the following functions from any CDU:

For the ADF radios:

- ADF frequency selection
- ADF mode selection
- ADF aural identification tone

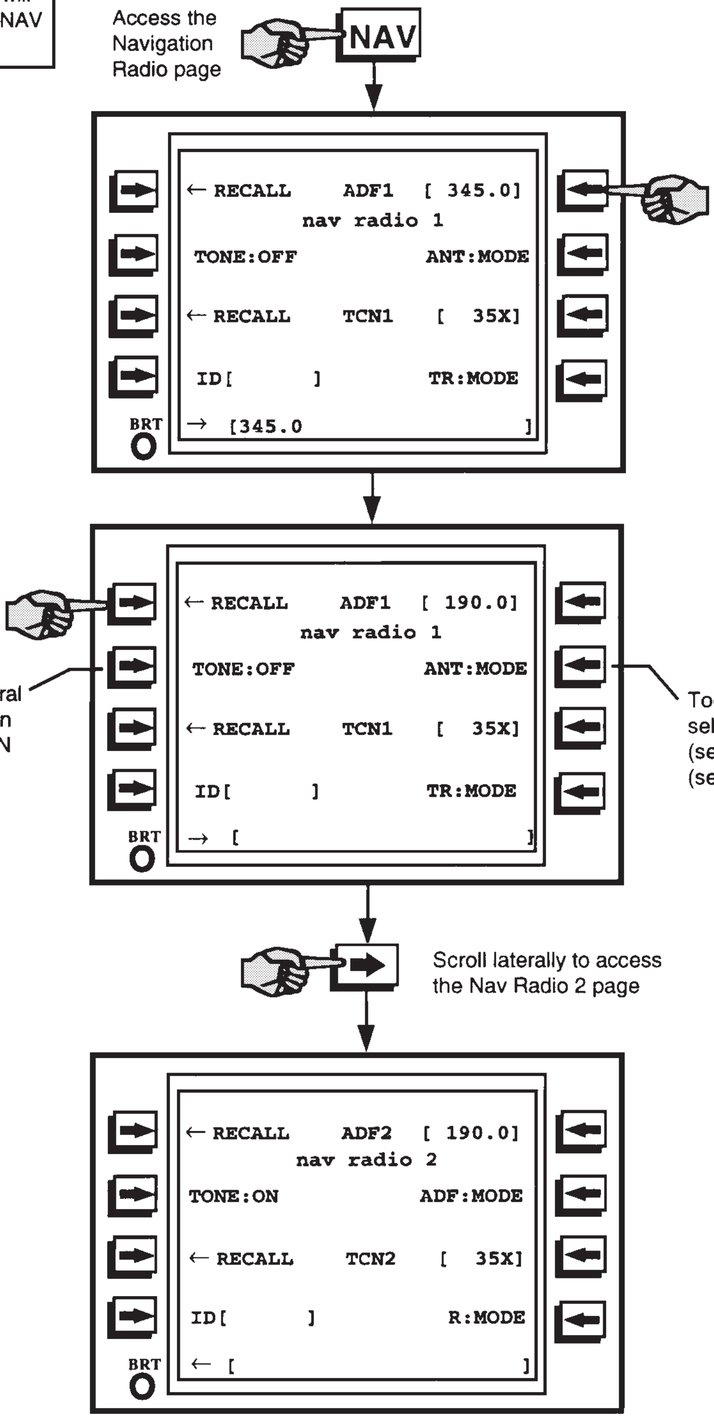
For the TACAN radios:

- TACAN channel selection (manual)
- TACAN channel selection (paired VOR)
- TACAN receiver mode selection

Control of these functions is available on the Navigation Radio 1 and 2 pages accessed via the NAV function key. The Nav Radio 1 page controls ADF1 and TACAN1; the Nav Radio 2 page controls ADF2 and TACAN2.

If the FMS cannot interface with a radio for any reason (i.e., LRU failure, data bus failure, etc.), a checkmark (√) will be displayed to the left of the title line of all pages corresponding to that radio. Power to the TACAN and ADF radios is controlled via the Master Power page.

The Navigation Radio page that was last displayed will be accessed when the NAV key is pressed.



Access the Navigation Radio page

Manually tune the ADF by entering a frequency in the scratchpad and pressing the frequency line select key.

Return the ADF to the previous frequency

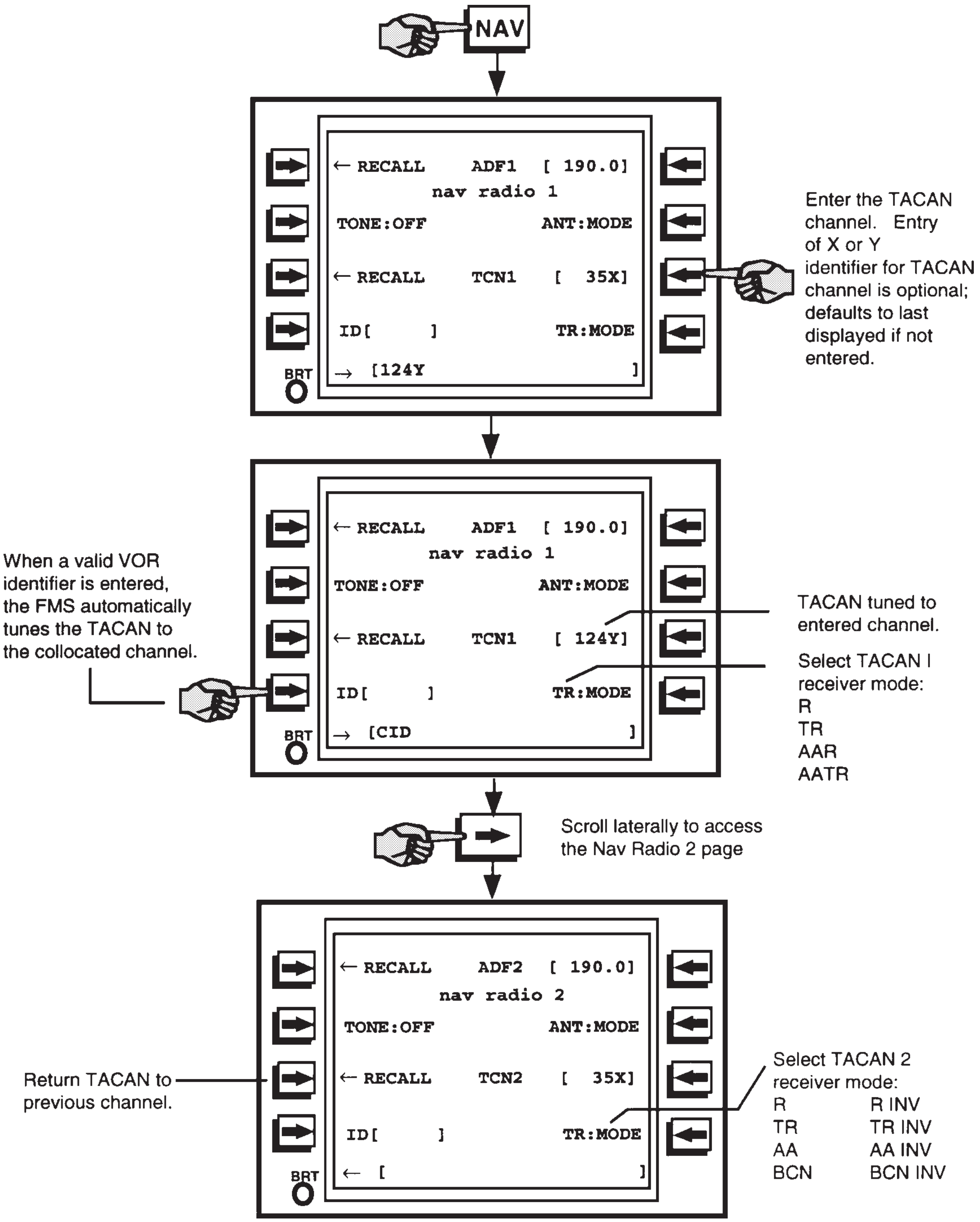
Toggles aural identification between ON and OFF

Toggles antenna mode select between ANT (sense antenna) and ADF (sense and loop antennas).

Scroll laterally to access the Nav Radio 2 page

The Navigation Radio 2 page operates similarly.

Figure 1.14-125. ADF Control from the Navigation Radio Page



Enter the TACAN channel. Entry of X or Y identifier for TACAN channel is optional; defaults to last displayed if not entered.

When a valid VOR identifier is entered, the FMS automatically tunes the TACAN to the collocated channel.

TACAN tuned to entered channel.

Select TACAN I receiver mode:
R
TR
AAR
AATR

Scroll laterally to access the Nav Radio 2 page

Return TACAN to previous channel.

Select TACAN 2 receiver mode:

R	R INV
TR	TR INV
AA	AA INV
BCN	BCN INV

Figure 1.14-126. TACAN Control from the Navigation Radio Page

ADF CONTROL

ADF Frequency Selection

Enter the desired frequency in the scratchpad and press the ADF frequency line select key (LS5). Refer to figure 1.14-125. When the crew changes the ADF frequency, the FMS saves the previous frequency and allows the crew to return to that frequency by pressing the RECALL line select key.

ADF Receiver Mode Selections

ADF receiver mode selections are provided on data line 2. The aural identification tone may be toggled ON or OFF with LS2. The antenna mode may be toggled between ANT and ADF using LS6.

TACAN CONTROL

TACAN Channel Selection

Enter the channel number in the scratchpad and press the TACAN channel line select key (LS7). Refer to figure 1.14-126. The FMS defaults to the X or Y identifier currently displayed unless a different one is specified with the channel number. Alternatively, the FMS provides a TACAN channel pairing function which allows the crew to call up the desired TACAN channel by entering the associated VOR ICAO identifier at LS4. When the crew changes the TACAN channel, the FMS saves the previous channel and allows the crew to return to that channel by pressing the RECALL line select key.

TACAN Mode Selection

To select the TACAN operating modes, toggle the MODE line select key. The possible selections for TACAN1 are: receive (R), transmit/ receive (TR), air-to-air receive (AAR), and air-to-air transmit/receive (AATR). Possible selections for TACAN2 are: receive (R), transmit/receive (TR), air-to-air (AA), beacon (BCN), receive inverse (R INV), transmit/receive (TR INV), air-to-air inverse (AA INV), and beacon inverse (BCN INV).

Pages 1.14-161 and 1.14-162, including Figures 1.14-127 and 1.14-128, are deleted.

DATA LOADER OPERATION

The FMS data loader provides an interface to the data cartridge(s) for data storage and retrieval capability. With the data loader and cartridge(s) the crew can perform the following functions:

1. Load preplanned flight plan and other flight data.
2. Save selected flight data, including system status information.
3. Access the ICAO identifier database.
4. Load a 200 waypoint user database.

In addition, current magnetic variation (MAGVAR) tables can be loaded on the data cartridge and automatically transferred to CDU nonvolatile memory upon selection of the ICAO identifier database.

If this file already exists in CDU memory, the FMS determines whether or not the file on the cartridge is more current than the one in CDU memory. If it is, the FMS overwrites the old file with the current file.

NOTE

- The Jeppeson database has not been verified by the DoD. Therefore, all data taken from the database must be verified by the flight crew prior to use for primary navigation.
- If a new CDU is installed, the magnetic variation tables will need to be loaded. Since the MAGVAR tables cannot be transferred from another CDU, the data loader must be used.
- If the data loader is inoperative, no new MAGVAR tables or user waypoint database can be loaded into the CDU. Stored flight plans and the ICAO database will also be inaccessible. The crew will only be able to access waypoints residing in a previously loaded user waypoint database (if any) or manually enter waypoints by lat/long. VOR/TCN updates to the INUs will not be possible unless the TACAN (or VOR/DME) waypoint is stored in the user waypoint database. MAGVAR tables previously stored will continue to be used with negligible impact. If no MAGVAR tables are stored in the CDU, all track/course information will be computed and displayed in true, regardless of the position of the FMS heading switch. In this case, magnetic heading/course information will only be available with the EHSI navigation source set to a radio NAVAID (i.e., TACAN or VOR/ILS).

Access to the selected MSN data cartridge mission files is performed from the DLDR Load/Save page, the Start 5 page, or the Alternate Flight Plan Catalog pages. Operations on the Start 5 page and the Alternate Flight Plan Catalog pages are described in the System Initialization and Alternate Flight Planning sections, respectively. Points from the selected ICAO identifier database can be requested from any page where waypoint entry is permitted.

NOTE

The <db truncated> annunciation will be displayed if the selected ICAO database contains more than 120,000 waypoints. Only the first 120,000 waypoints on the cartridge will be accessible.

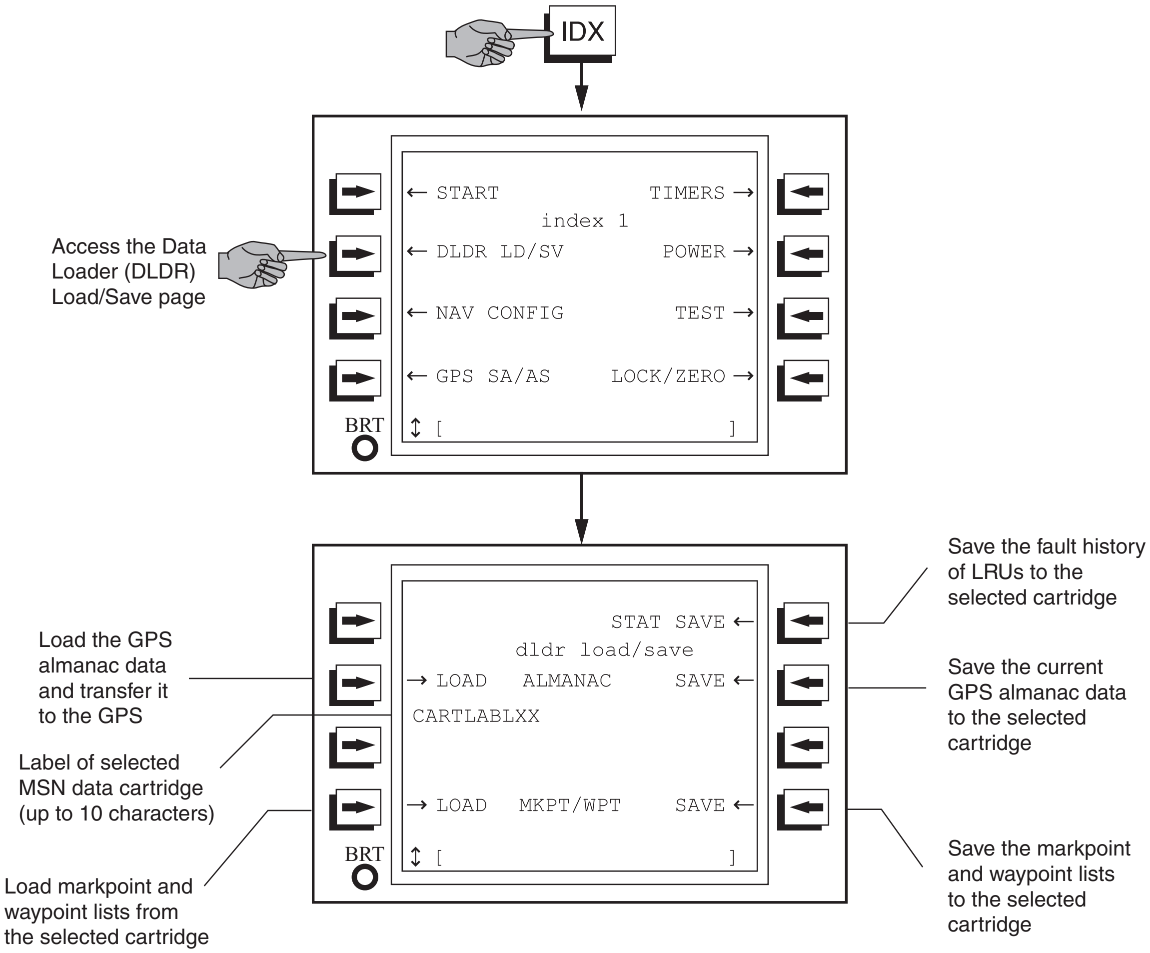
Refer to figure 1.14-129 for a description of how to access and use the DLDR Load/Save page.

Loading Flight Data

The following data can be loaded from the selected MSN data cartridge, if available:

- Any one of up to 40 alternate flight plans with a maximum of 60 waypoints each
- Markpoint list of up to 10 markpoints and user waypoint list of up to 200 waypoints
- GPS almanac data

Each of these files (except the alternate flight plans) can be loaded from the DLDR Load/Save page as illustrated in figure 1.14-129. Alternate flight plans must be loaded from either the Start 5 page or the Alternate Flight Plan Load/Save page (Figures 1.14-33 and 1.14-110).



All load/save selections require confirmation prior to execution by pressing the same key a second time to acknowledge the confirmation message.

Figure 1.14-129. DLDR Load/Save Page Access and Usage

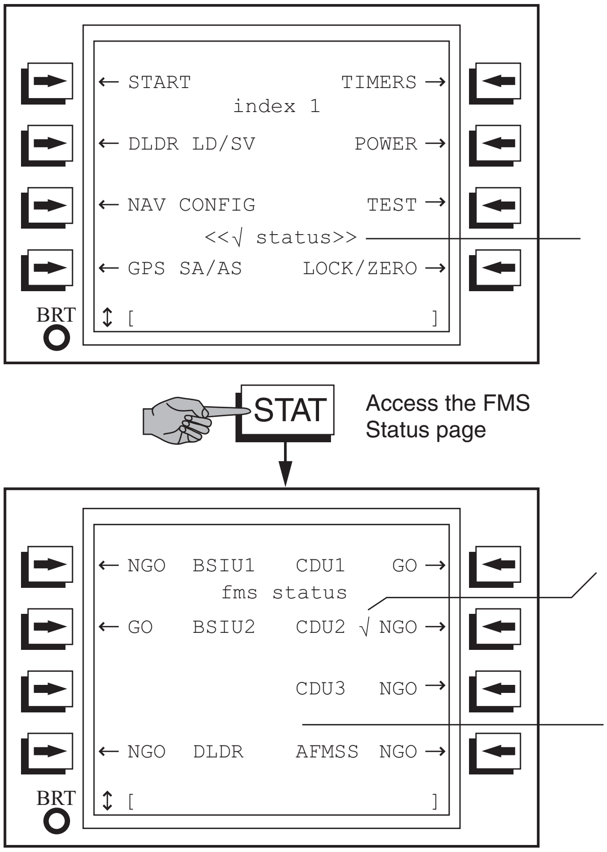
Saving Flight Data

The following data can be saved individually to the selected MSN data cartridge as shown in figure 1.14-129 (see figures 1.14-33 and 1.14-110 for alternate flight plans):

- Up to 40 alternate flight plans with a maximum of 60 waypoints each
- Markpoint list of up to 10 markpoints and user waypoint list of up to 200 waypoints.
- GPS almanac data
- System fail history of all avionics LRUs including continuous BIT fail history, most recent initiated BIT results, and bus status fail history

Accessing the ICAO Identifier Database

ICAO identifiers stored on the data cartridge are accessed by entering the identifier into the scratchpad and pressing a waypoint entry line select key (i.e., a line select key on a CDU page allowing entry of waypoints, for example, the Flight Plan page). Once the line select key is pressed, the FMS searches for the entered identifier, first in the selected data cartridge ICAO database, then the user waypoint data-



√ status indicates that a failure has occurred. Alert is displayed regardless of CDU page displayed.

Access the FMS Status page

√ indicates that CDU2 has reported a failure and the detailed CDU2 Status page has not been accessed since the failure. CDU3 has previously failed, but the CDU3 Status page has already been accessed.

√ status annunciation is cleared when FMS Status page is accessed. It can also be cleared with **CLR** key while on other pages.

Line select keys access the respective detailed status page. Vertically scroll to access Navigation Sensor and Navigation Radio Status pages.

NOTE: AFMSS will always show --- since there is no AFMSS port installed in the aircraft.

Figure 1.14-130. Top-Level FMS Status Page

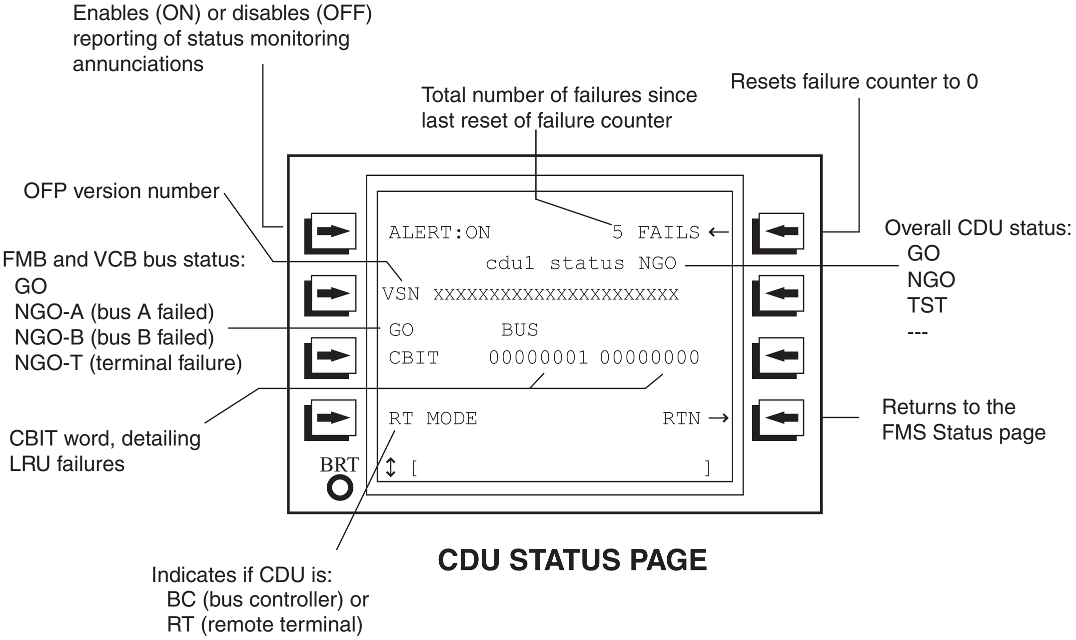
base in the CDU if not found. If the identifier is found, the corresponding information is transferred with the identifier to the CDU (i.e., waypoint type, latitude/longitude, elevation, station assigned magnetic variation, etc.). If the identifier is not found in either database, the FMS informs the crew that the identifier is not in the database with the NOT STORED scratchpad message.

If the identifier is a duplicate (one that has more than one location), the FMS will automatically access the Duplicate Identifiers page (refer to Flight Plan Management section, Waypoints with Duplicate Identifiers).

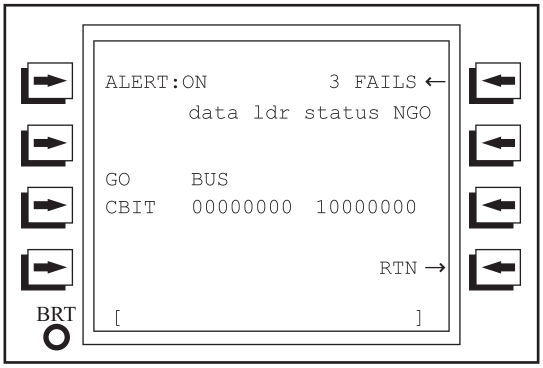
SYSTEM STATUS

The FMS continuously monitors the status of each of the interfaced avionics LRUs that have continuous built-in-test (CBIT) capability. The bus controller CDU will monitor the status of these LRUs and display a status summary. When an LRU reports a failure with its internal CBIT routines, a <<√status>> annunciation appears on the annunciation line and the EHSI MSG annunciator is illuminated.

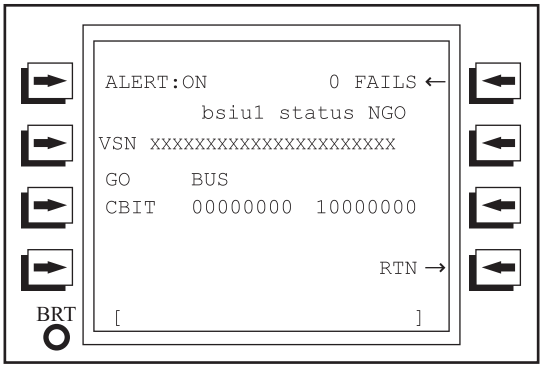
Pages 1.14-166 through 1.14-168 are deleted.



CDU STATUS PAGE

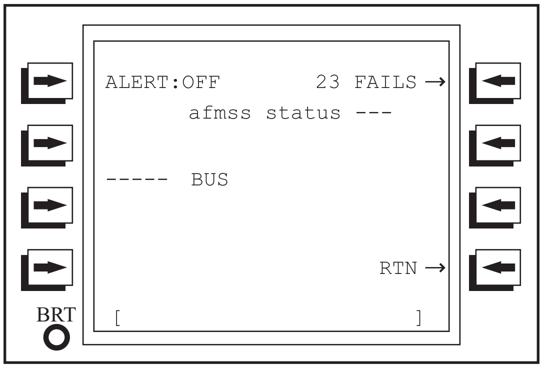


DATA LOADER STATUS PAGE



BSIU STATUS PAGE

Displays for all redundant components are identical except for the number on the title line (e.g., CDU1, CDU2, etc.).



AFMSS STATUS PAGE

Figure 1.14-131. Detailed FMS Status Pages

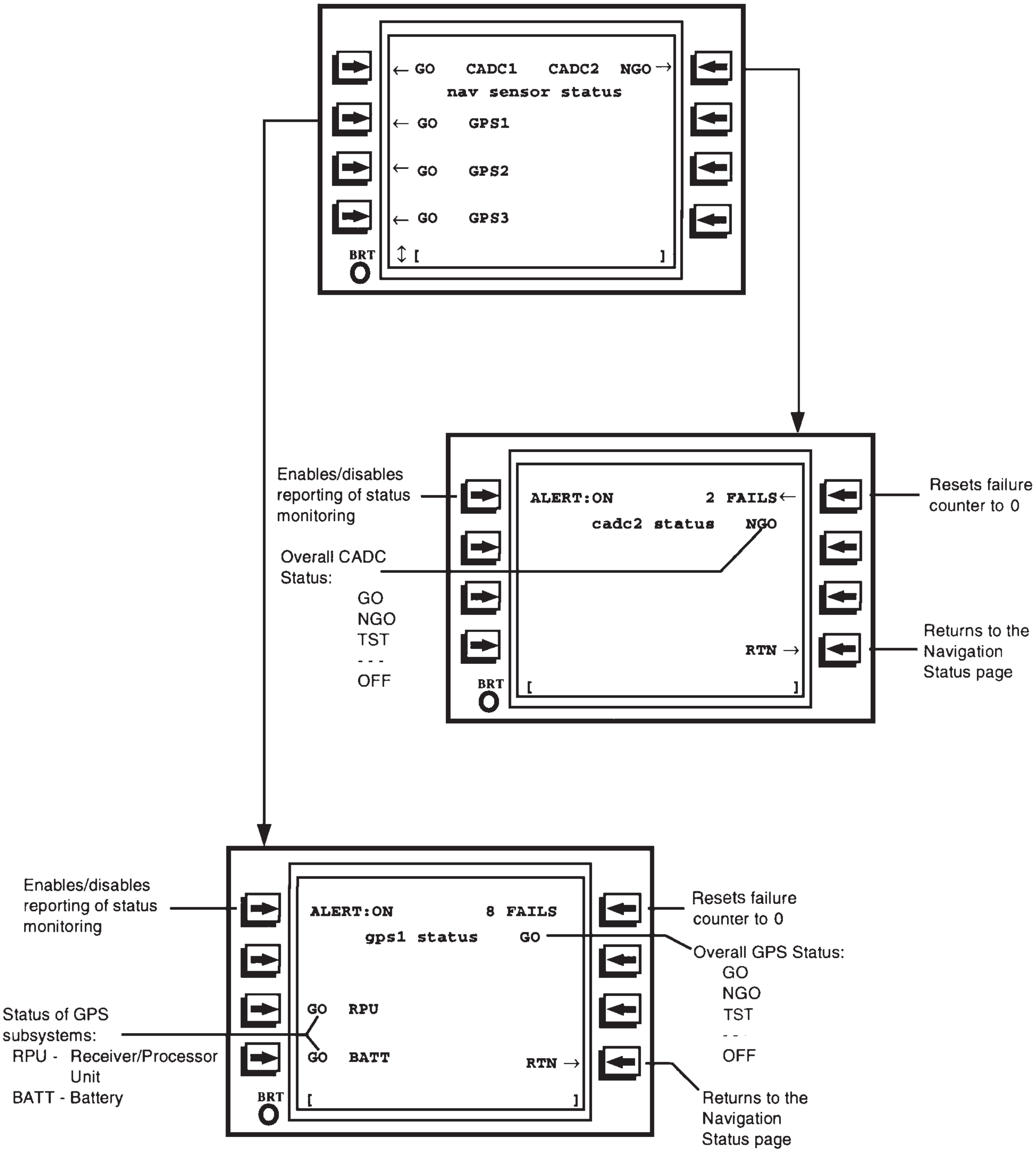


Figure 1.14-132. NAV Sensor Status Pages

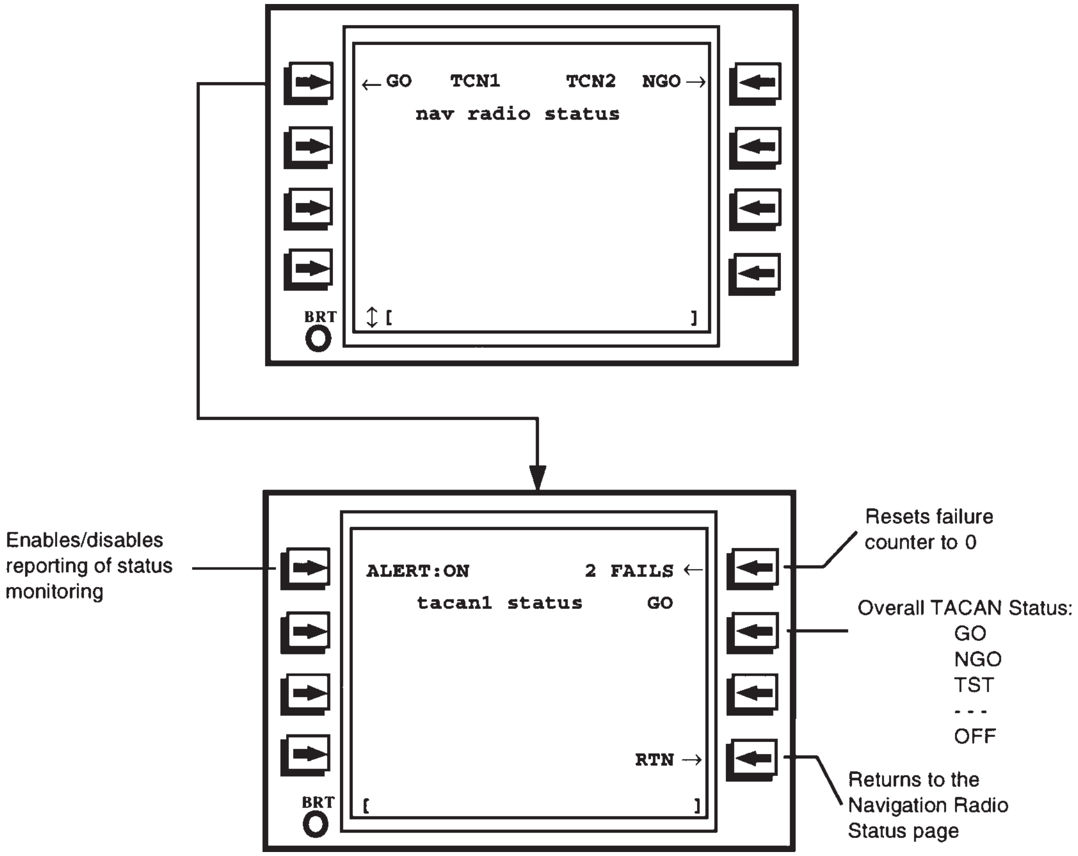


Figure 1.14-133. NAV Radio Status Pages

Reporting CBIT Results

Results from CBIT routines are compiled and reported to the LRU level on the FMS Status, Navigation Sensor Status, and Navigation Radio Status pages. Additionally, a detailed status page is available for each LRU providing expanded results both for the LRU itself and the MIL-STD-1553B data bus status for each LRU on the bus.

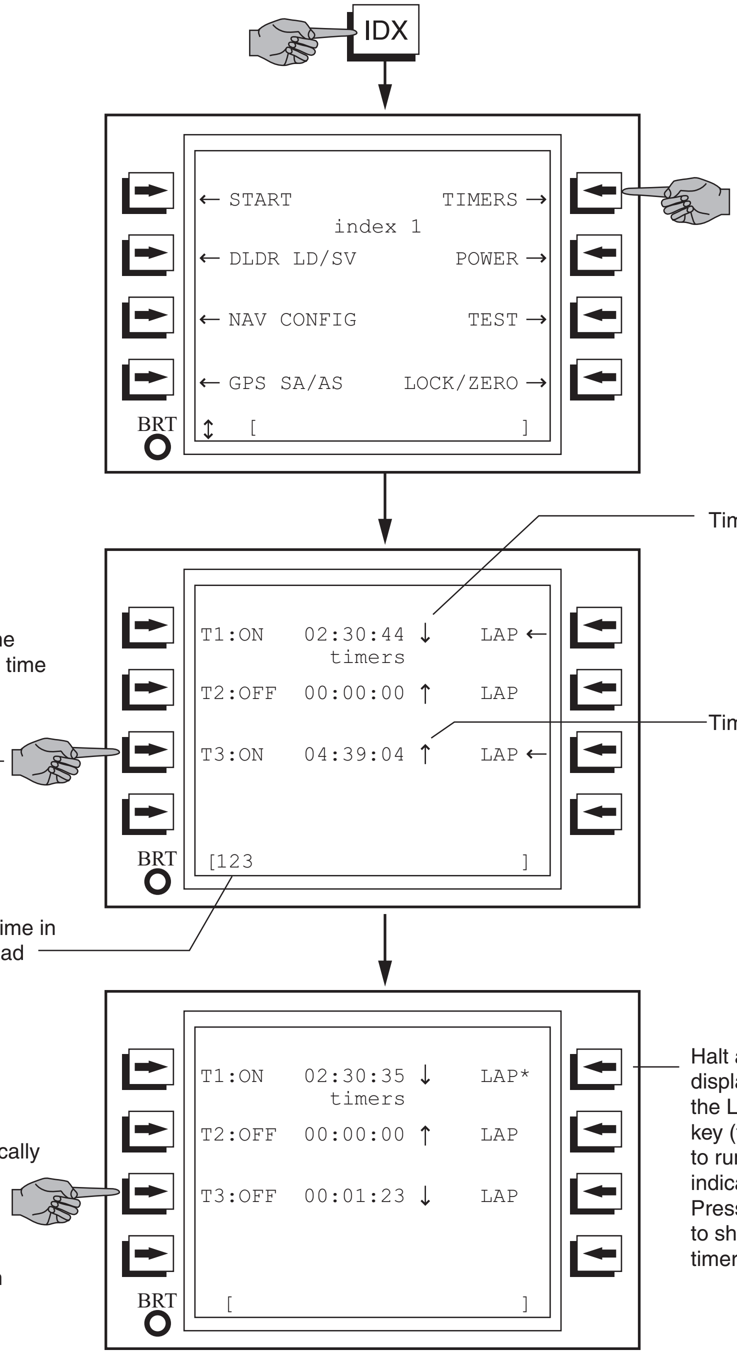
System Status Pages

The top-level Status pages display the status of all the CBIT-capable LRUs in the system and provide access to the individual LRU detailed status pages. Checkmarks designate which LRU caused the <<√status>> annunciation when a failure is detected. The LRU checkmark is cleared when the detailed status page for the failed LRU is accessed. Figure 1.14-130 shows the FMS Status page and its operations. The Navigation Sensor Status and Navigation Radio Status pages operate in a similar manner and are shown in figures 1.14-132 and 1.14-133.

Individual LRU Detailed Status Pages

The individual results of CBIT by each LRU are displayed on the respective detailed status pages (figures 1.14-131, 132, and 133) which are accessed by pressing the line select key adjacent to the respective LRU displayed on the top-level Status pages.

Unknown status (i.e., bus controller is unable to communicate with an LRU) is indicated with dashes in the top-level status field. A failure counter is provided on all detailed status pages to indicate the total num-



Access Timers page

Timer 1 is counting down

2 Set timer 3 to the new countdown time

Timer 3 is counting up

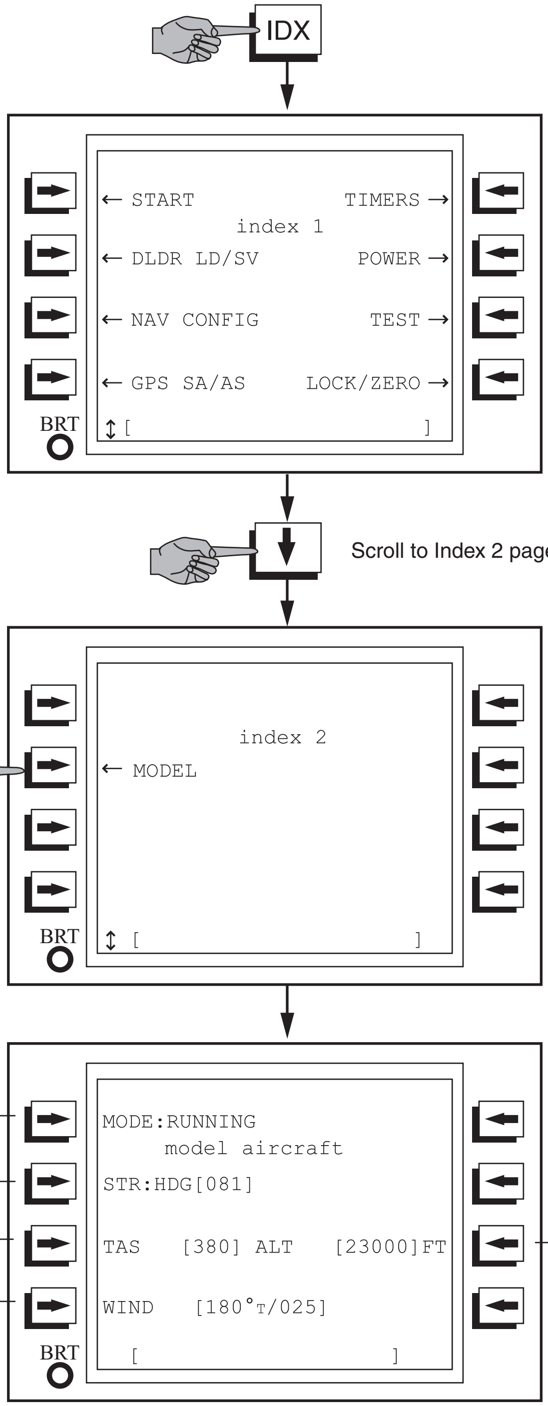
1 Enter a new countdown time in the scratchpad

Halt an active timer display by pressing the LAP line select key (timer continues to run internally); an * indicates lap function. Press the key again to show the active timer display

3 Timer 3 is automatically toggled to OFF and set to the new time; press the line select key again to start the countdown

Figure 1.14-134. Timer Page Access and Usage

Pages 1.14-173 through 1.14-174 are deleted.



Scroll to Index 2 page

Access Model Aircraft page

Toggle mode between RUNNING and STOPPED

Enter the heading; toggle heading mode between flight plan steering (STR) and heading hold (HLD)

Enter the model altitude

Enter the model true airspeed (defaults to 360)

Enter the model wind

Figure 1.14-135. Model Aircraft Page Access and Usage ber of hardware and MIL-STD-1553B data bus failures. Status monitoring may be disabled for any LRU on its individual status page (for example, if an intermittent failure is causing nuisance alerts).

MISCELLANEOUS FUNCTIONS

The FMS provides the following miscellaneous functions:

1. Timers. Three independent stopwatch lap counters are available complete with time-out annunciations.
2. Model aircraft. The model emulates heading, altitude, wind, and true airspeed into the navigation equations for real-time flight simulation.

Timer Function

Access the timers by pressing the TIMERS line select key on the Index 1 page. The three timers can be used independently to display elapsed time (counting up to 23:59:59) or countdown to 00:00:00, and can be halted at any time. Figure 1.14-134 shows an example of how to use the timer function.

Model Aircraft Function

The model aircraft is a real-time mission simulation capable of following all flight plan maneuvers to include holding patterns, vertical navigation, and mission flight patterns. The model aircraft can only be operated when the weight-on-wheels discrete indicates the aircraft is on the ground. The ability of the model to correctly navigate is limited to the mid latitude (<70°) regions and airspeeds above 10 knots. Higher latitudes and low airspeeds may produce unexpected results in system response due to instabilities in the model.

Prior to accessing the Model Aircraft page, the desired initial present position should be entered on the Start 1 page. Access the Model Aircraft page by pressing the MODEL line select key on the Index 2 page (figure 1.14-135). Toggle the MODE line select key to RUNNING to run the model. All FMS CDU steering displays will reflect guidance information as though the aircraft were flying and executing the flight plan. Toggle the MODE line select key to STOPPED to stop the model.

The heading/track and speed values on the Model Aircraft page will correctly reflect the current aircraft model state and can be changed to different values. Two modes of heading are available as well: steering mode (STR) and heading hold mode (HLD). When STR mode is selected, the model's bank steering dynamically changes the heading and drives the solution back to the flight plan to capture the inbound course. When HLD mode is selected, the model maintains the entered heading. Toggle the HDG line select key on the Model Aircraft page to select the desired mode. Altitude may be entered to any desired value. When the desired vertical path has been captured the model tracks the vertical flight plan. When no altitude has been assigned, level altitude is maintained.

WARNING

> Do not use model aircraft function on the ground with the autopilot engaged. The flight controls will move if the hydraulic system is pressurized.

POSTFLIGHT OPERATIONS

Clearing GPS Selective Availability/Anti-Spoofing Keys

The GPS selective availability/anti-spoof (SA/A-S) key functions are controlled on the GPS SA/AS page which is accessed from the Index 1 page (figure 1.14-136). The GPS SA/AS page indicates whether or not the GPS contains keys and the current mission duration as reported by the GPS. This value will be the number of days of valid keys remaining for a weekly cryptovariable (CVw) key. For a group unique variable (GUV) key, this value will be zero (0) until the GPS receiver has downloaded the navigation message, and then it will change to one (1). GUVs are valid for one year. If the GPS receiver is not responding or incorrect keys are loaded, the days display will be dashed and the right side of the applicable data line will be blank. To enter a specific mission duration for CVw users, enter the number of days in the scratchpad and press the DAYS line select key on the GPS SA/A-S page.

Unless zeroized, GPS SA/A-S keys are retained in receiver nonvolatile memory (NVM) as long as the receiver battery is good. To zeroize the SA/A-S keys, access the Lock/Zeroize page and press the GPS line select key (requires confirmation). If, after a zeroize attempt, the GPS SA/A-S keys were not zeroized for any reason, a <<no keys zero>> annunciation appears. Otherwise, a <<safe keys>> annunciation is displayed.

NOTE

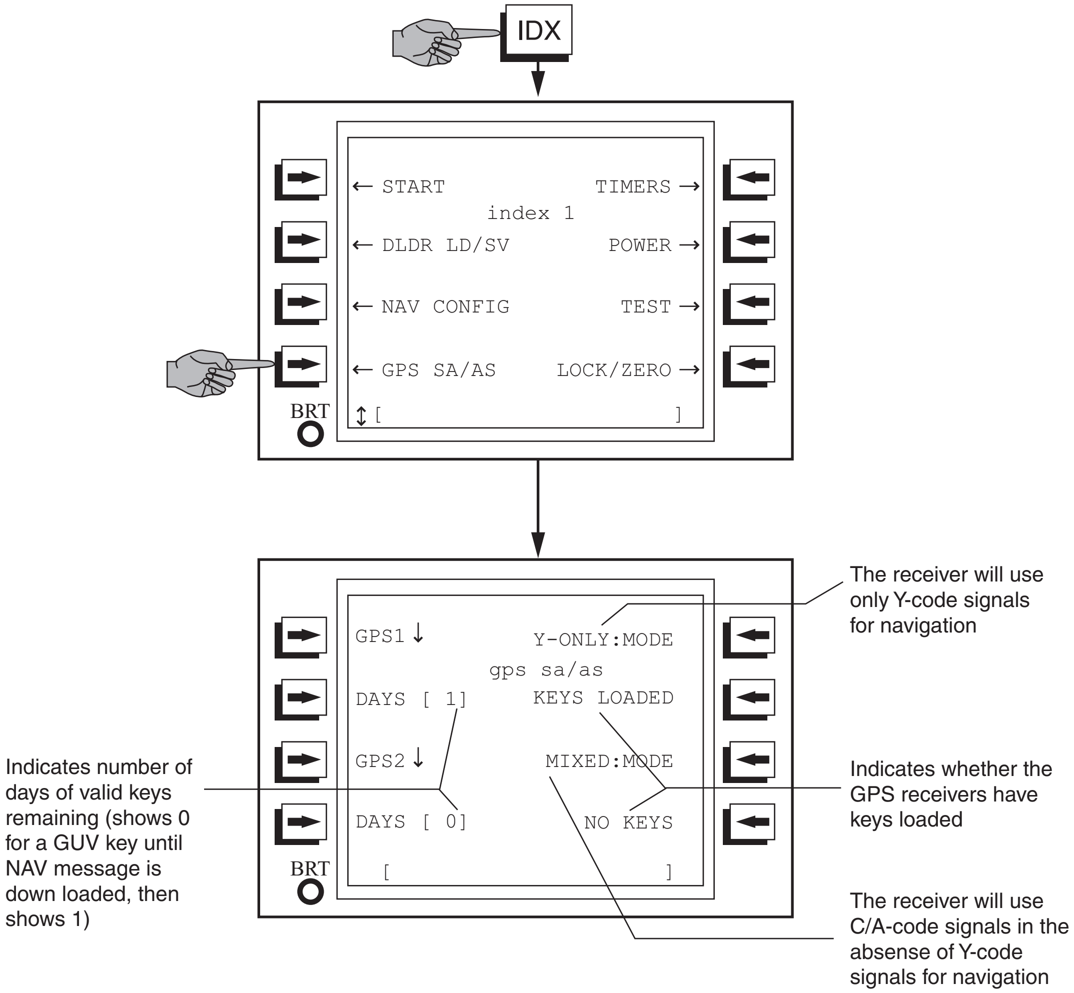
> Although a keyed receiver is not classified because of the tamper resistant design of the module where the keys reside, GPS SA/A-S keys themselves are classified CONFIDENTIAL and must be safeguarded as such. It is not necessary to zeroize the keys unless command directed.

Saving GPS Almanac Data

Saving the GPS almanac data to the selected MSN data cartridge can ensure current almanac data is available to reduce satellite acquisition time for ensuing flights. To save the GPS almanac data, access the DLDR Load/Save page and press the ALMANAC SAVE line select key (requires confirmation).

Saving System Status Data

The FMS maintains an in-flight fail history in CDU NVM of all avionics LRUs including CBIT, IBIT, and bus status failures for later examination by maintenance personnel. To save this status data to the selected MSN data cartridge, access the DLDR Load/Save page and press the STATUS SAVE line select key (requires confirmation). The fail history file contains start and end dates of the record. A new fail history record will begin whenever the crew saves the status data to the cartridge.



The receiver will use only Y-code signals for navigation

Indicates number of days of valid keys remaining (shows 0 for a GUV key until NAV message is down loaded, then shows 1)

Indicates whether the GPS receivers have keys loaded

The receiver will use C/A-code signals in the absense of Y-code signals for navigation

Figure 1.14-136. GPS SA/AS Page

Page 1.14-178 is deleted.

Shutdown of FMS-Controlled Avionics

As part of postflight operations, use the CDU Master Power page to turn off the TACAN and ADF radios. The GPS receivers will automatically power-off when power is removed from the CDUs. Refer to Leaving Aircraft Checklist, Section IV, for INU Accuracy Check and Shutdown procedures.

Zeroizing System Data

The Lock/Zeroize page permits selective deletion of data within CDU non-volatile memory in addition to selective deletion, a single key (ZERO ALL) commands a master zeroize of all data stored in the system (except on the data cartridge(s)), including flight plans, markpoint and user waypoint lists, and the GPS SA/A-S keys.

Figure 1.14-137 shows the Lock/Zeroize page and its associated operations in deleting different portions of the system memory.

Locking the System

NOTE

> Crews will NOT lock the system unless command directed.

The FMS provides a system lock function to prevent tampering or unauthorized use of system data while the aircraft is on the ground. The system lock, when activated with a password entry (ground only), disables the CDU function keys with the exception of two line select keys: one which unlocks the system with the entry of the same password, and one which performs a zeroization of system data.

To lock the system, access the Lock/Zeroize page (refer to figure 1.14-137), enter a three character password in the scratchpad, and press the LOCK line select key. All CDUs will display the Lock/Zeroize page and display the <<locked>> annunciation, indicating the system is locked. No function keys or line selects (other than the LOCK and ZERO ALL line select keys) are operational at this point.

Once the system is locked, it can only be unlocked (and full functionality restored to the CDUs) by:

1. Reentering the same password in the scratchpad of any CDU and pressing the LOCK line select key.
2. Pressing the ZERO ALL line select key (requires confirmation) on any CDU to zeroize system data.

GROUND MAINTENANCE AND TEST

Performing System Initiated Tests

The FMS controls execution of subsystem IBIT upon operator command. IBIT can only be commanded when the weight-on-wheels discrete indicates ground. Results from IBIT routines are compiled and reported to the LRU level (except for those LRUs that don't return IBIT status, i.e., TACAN and ADF) on the FMS and Navigation Sensor Test pages. Additionally, a detailed test page is available for those LRUs which require expanded reporting. The results of the latest IBIT received from the LRU are displayed.

While an LRU IBIT is in progress, a TST indicator is displayed next to the LRU name on the LRU detailed test page and on all corresponding status pages. Also during IBIT, dashes (--) appear in all test result fields of the LRUs detailed status page. If IBIT has not been requested since the last application of power, then all test result fields display dashes (---).

Test Pages

The FMS and Navigation Sensor Test pages display the latest recorded IBIT results (GO, NGO, or dashes) for all the IBIT-capable LRUs in the system (except TACAN and ADF which show dashes) and provide access to the individual LRU detailed test pages. An example of accessing and using the FMS Test page is shown in figure 1.14-138. The Flight Instruments/ Alert Lights Test page functions are inoperative.

Individual LRU Detailed Test Pages

The results of IBITs on all avionic LRUs are displayed on the respective detailed test pages which are accessed by pressing the line select adjacent the respective LRU display on the Test pages. Initiated test for these LRUs is commanded on their respective detailed test page. No detailed test pages exist for the TACANs or ADFs. IBIT for the TACANs and ADFs is commanded directly from a top-level test page (the Navigation Sensor Test page). Figures 1.14-139 and 1.14-140 show examples of individual detailed test pages.

System Test

To perform IBIT on all interfaced avionics system LRUs, access the FMS Test page and press the SYSTEM line select key. This function requires confirmation by pressing the line select key a second time. The system IBIT systematically commands IBIT on each of the IBIT-capable avionics LRUs, and requires approximately 3 minutes to complete.

NOTE

> System IBIT is not recommended for use by the flight crew since it ties up the system for the duration of the test and cannot be terminated.

Software Version Compatibility

The bus controller CDU periodically compares its OFP version number with that of the remote terminal CDUs. When a version incompatibility is detected a nonclearable <<√version>> annunciation is displayed on the CDU to alert the operator.

In order to prevent data corruption, the bus controller CDU does not send data to update the nonvolatile memory in remote terminal CDUs unless the OFP versions are identical. The remote terminal CDUs will attempt to continue displaying pages and processing keypad and line selections regardless of version compatibility.

GLOBAL POSITIONING SYSTEM DESCRIPTION

The Navstar Global Positioning System (GPS) is a satellite-based radio positioning system capable of providing worldwide position fixing data on a continuous basis, regardless of weather. GPS satellites in orbit transmit data which is decoded by the airborne receiver to provide the required positioning data for navigation. The satellite network is controlled by a system of ground stations, strategically located around the earth, which transmit the necessary signals to keep the satellite network functioning properly. With a properly equipped receiver and a fully operational satellite network, the system can provide positioning data to a 3D accuracy of approximately 10 meters spherical error probable (SEP), as well as an accurate time reference. (SEP is a 50% probability measure.)

SYSTEM COMPONENTS

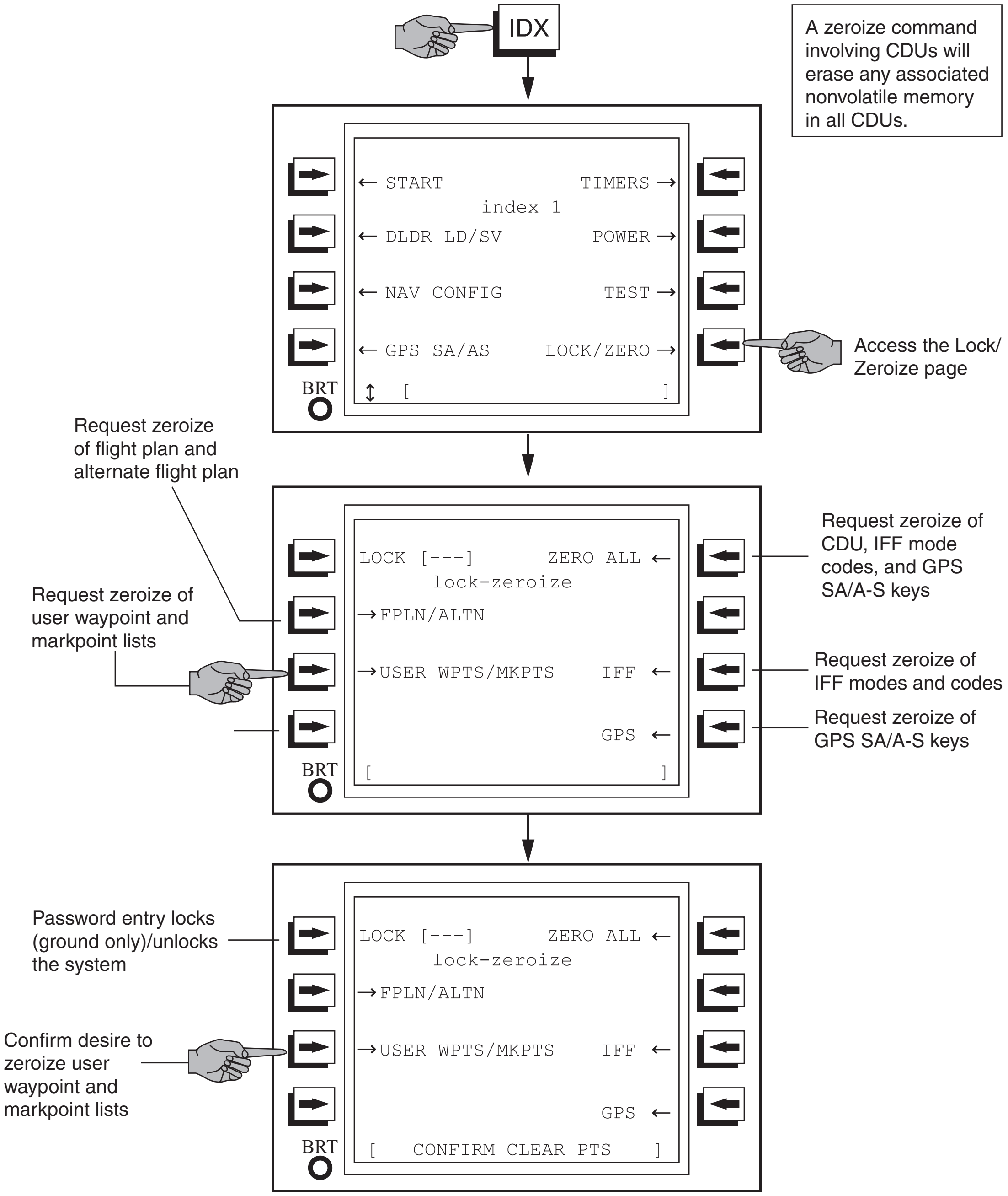
The Global Positioning System is comprised of three major elements: the satellite constellation, the ground stations, and the user receiver set as shown in figure 1.14-141.

Satellite Constellation

The satellite constellation has 24 satellites, four satellites in each of six 10900 nautical mile circular orbits. The satellites have an approximate 12-hour orbital period. Ideally, six to eleven satellites should be in view at any time over a large portion of the earth. Each satellite broadcasts radio-frequency (RF) ranging codes and a navigation data message on two L-band frequencies called Link-1 (L1) and Link-2 (L2). The precision code (P-code) provides a highly accurate level of service termed the precise positioning service (PPS). It is encrypted for security (called Y-code when encrypted) and available only to authorized users. The coarse/acquisition code (C/A-code) provides a less accurate level of service called the standard positioning service (SPS) which is available to all users. The navigation message contains GPS system time of transmission, a hand-over word for the transition from C/A- to P-code tracking, almanac data, satellite health status, and ephemeris and clock data for the particular satellite being tracked. Almanac data is a gross position forecast for the satellite constellation on a six-month projection updated once each day by the control center. The almanac enables a receiver to know where in the sky to look for satellites. Ephemeris and clock data give the precise orbital location and system time (as measured by the satellite's atomic clock) and are updated once every 24 hours (unless required more often for an individual satellite) by ground station transmissions to each satellite. Although each satellite transmits almanac data for all satellites, no satellite transmits ephemeris or clock data for any satellite other than itself.

Ground Control System

The ground control system tracks the satellites, monitors and controls satellite orbits, and updates the satellite navigation data message. The ground control system consists of a master control station (MCS) at Falcon AFB, Colorado, and monitor stations around the world at Ascension Island, Diego Garcia, Kwajalein, and Hawaii. Monitor stations are un-



A zeroize command involving CDUs will erase any associated nonvolatile memory in all CDUs.

Access the Lock/ Zeroize page

Request zeroize of flight plan and alternate flight plan

Request zeroize of user waypoint and markpoint lists

Request zeroize of CDU, IFF mode codes, and GPS SA/A-S keys

Request zeroize of IFF modes and codes

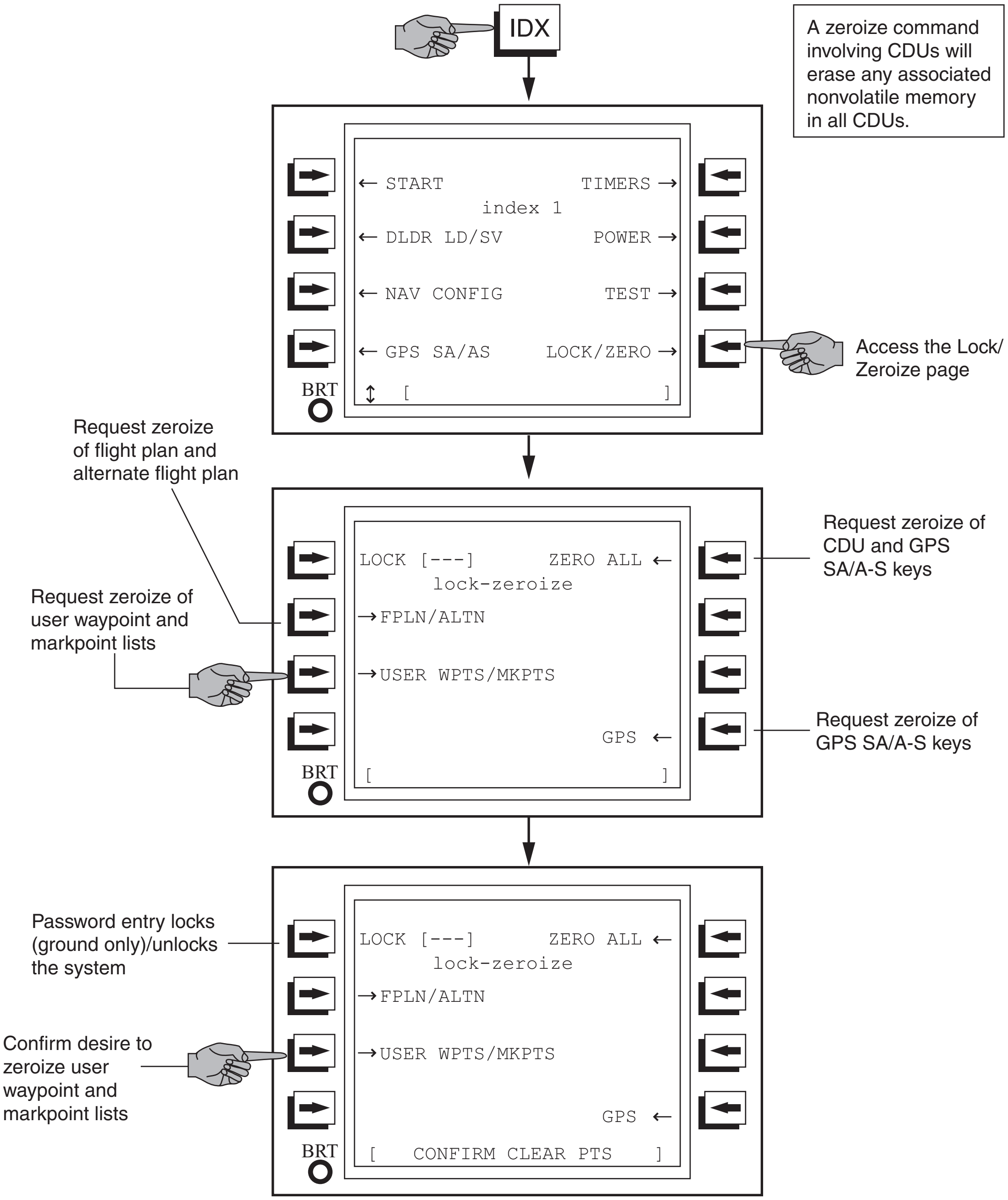
Request zeroize of GPS SA/A-S keys

Password entry locks (ground only)/unlocks the system

Confirm desire to zeroize user waypoint and markpoint lists

Figure 1.14-137. Zeroizing or Locking Up System Data

Page 1.14-182 is deleted.



A zeroize command involving CDUs will erase any associated nonvolatile memory in all CDUs.

Access the Lock/ Zeroize page

Request zeroize of flight plan and alternate flight plan

Request zeroize of CDU and GPS SA/A-S keys

Request zeroize of user waypoint and markpoint lists

Request zeroize of GPS SA/A-S keys

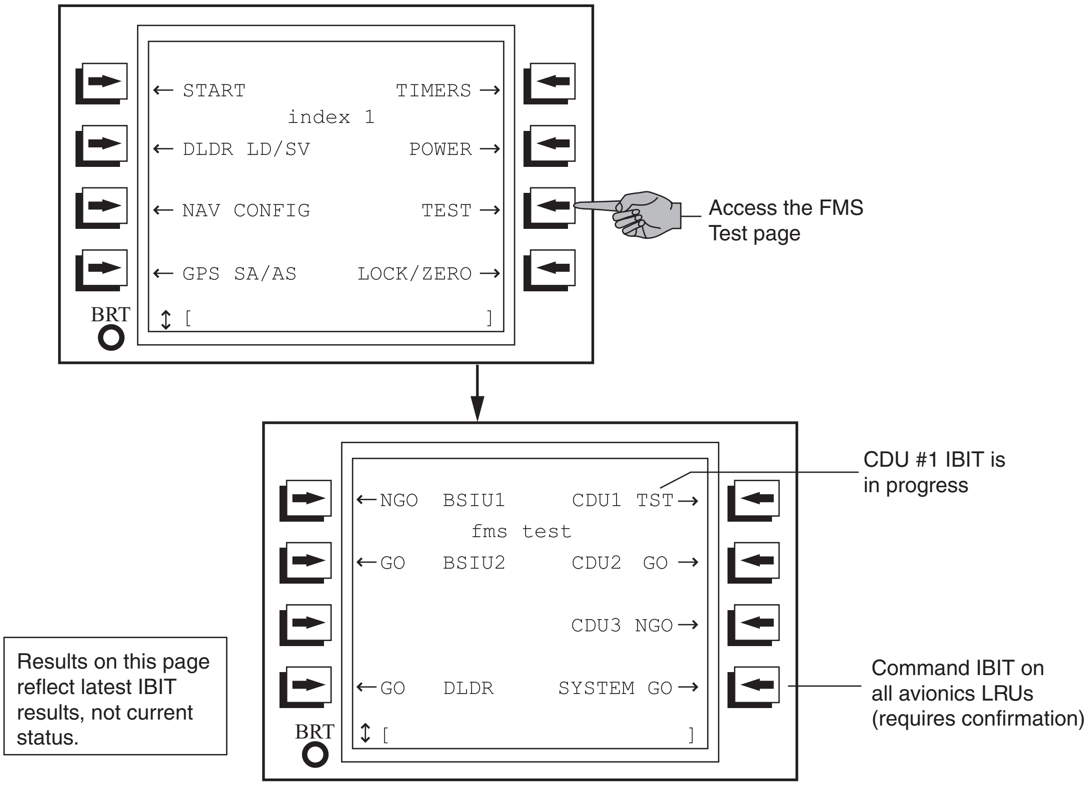
Password entry locks (ground only)/unlocks the system

Confirm desire to zeroize user waypoint and markpoint lists

Figure 1.14-137. Zeroizing or Locking Up System Data (Sheet 2) manned and use special GPS receivers to track the satellites. The tracking information is sent to the MCS where both ephemeris/clock data and almanac data are computed. Ephemeris/clock data is then sent out to ground uplink stations where transmitters send the data to the satellites. Satellites are never out of sight of an uplink station for more than a 2-hour interval.

Receiver Module

The GPS receiver module embedded in the FMS CDU is a passive (receive only) dual frequency P(Y)-code receiver. It receives signals on five separate channels which allows tracking five satellites simultaneously. The best four signals are used for the navigation solution. When fewer than four satellites are available, useful information can still be obtained, but operation is degraded. When more than four satellites are available, the receiving set software automatically decides which four to use for best position fixing. The optimum situation occurs when one of the satellites is directly overhead and the other three are each 10 degrees above the horizon and 120 degrees apart in azimuth. In order to lock-on to individual satellite signals in a reasonable amount of time, the receiver must know how to locate each satellite in view. This information is provided to the receiver in the almanac data broadcast by the satellites and is normally retained in the receiver's memory from one mission to the next.



Access the FMS Test page

CDU #1 IBIT is in progress

Results on this page reflect latest IBIT results, not current status.

Command IBIT on all avionics LRUs (requires confirmation)

Vertically scroll to access Navigation Sensor and Flight Instruments/Alert Lights Test.

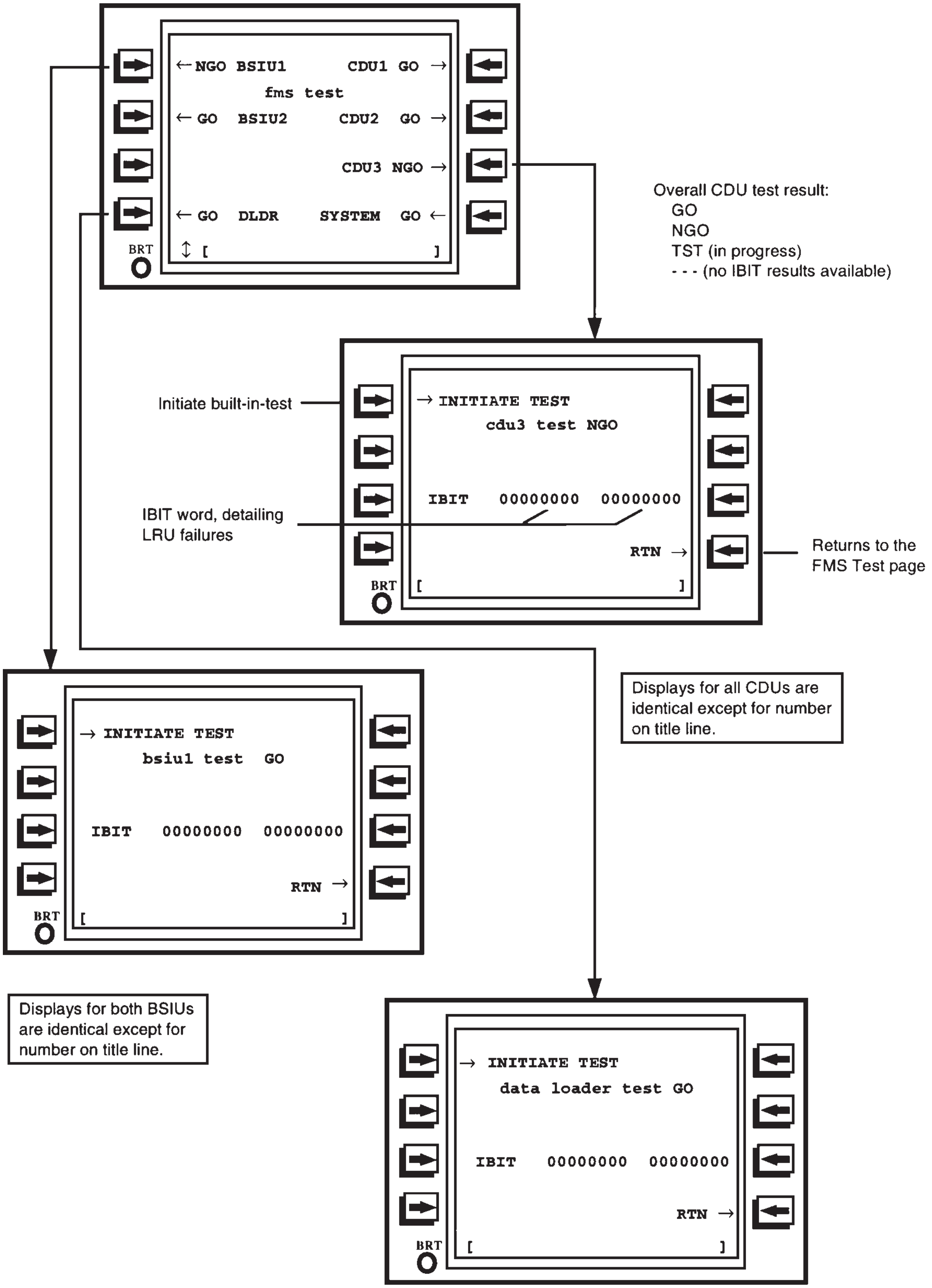
Figure 1.14-138. FMS Test Page

If the receiver almanac is missing or more than six months old, startup time is increased, first to do a random search to find a satellite, and then to load the almanac. If the receiver almanac data is current, then the satellites are usually found quickly and only ephemeris/clock data has to be received from each satellite.

Even though a GPS receiver is contained in each of the three FMS CDUs, only the pilot and copilot receivers are connected to antennas and therefore functional. Of those two receivers, only one may be selected for navigation at a time. GPS antenna locations are shown in figure 1.13-1.

GPS THEORY OF OPERATION

Each of the four satellites used in the navigation solution may be considered to provide the information necessary to remove the uncertainty about one of four dimensions necessary to establish a position (or velocity) in four dimensional space-time. If the receiver clock remained perfectly synchronized with the satellites, then accurate position (including altitude) could still be obtained with only three satellites available. Four satellites are required to accurately provide both position (including altitude) and time. Use of four satellites by receivers eliminates the requirement for receivers to be equipped with atomic clocks.



Overall CDU test result:
GO
NGO
TST (in progress)
- - - (no IBIT results available)

Initiate built-in-test

IBIT word, detailing LRU failures

Returns to the FMS Test page

Displays for all CDUs are identical except for number on title line.

Displays for both BSIUs are identical except for number on title line.

Figure 1.14-139. Detailed FMS Test Pages

All the satellite clocks are synchronized by the ground control system. The following paragraphs explain how the receiver uses four satellite signals to synchronize its own navigation clock with the satellites, and to compute estimated position error. The computed distance (range) of a receiver from a satellite is the difference in time between transmission and reception of a signal multiplied by the speed of light. The time of satellite signal transmission (according to the satellite clock) is digitally encoded in the satellite transmission and is read by the receiver. The time of signal reception is also measured by the receiver's own clock.

A range from each of three different satellites establishes a three-dimensional position for the receiver. In a group of four satellites there are four combinations of three satellites (1,2,3 -- 1,2,4 -- 2,3,4 -- 3,4,1), and from each combination of three satellites an independent position (point) is computed. With no errors the four points would all be the same point. Since, usually, the four points are not the same point, this indicates that there is error in the system. The most likely source of error is the receiver clock. Adjusting the receiver clock can usually move the points closer together, and the best correction to the clock is found in this manner.

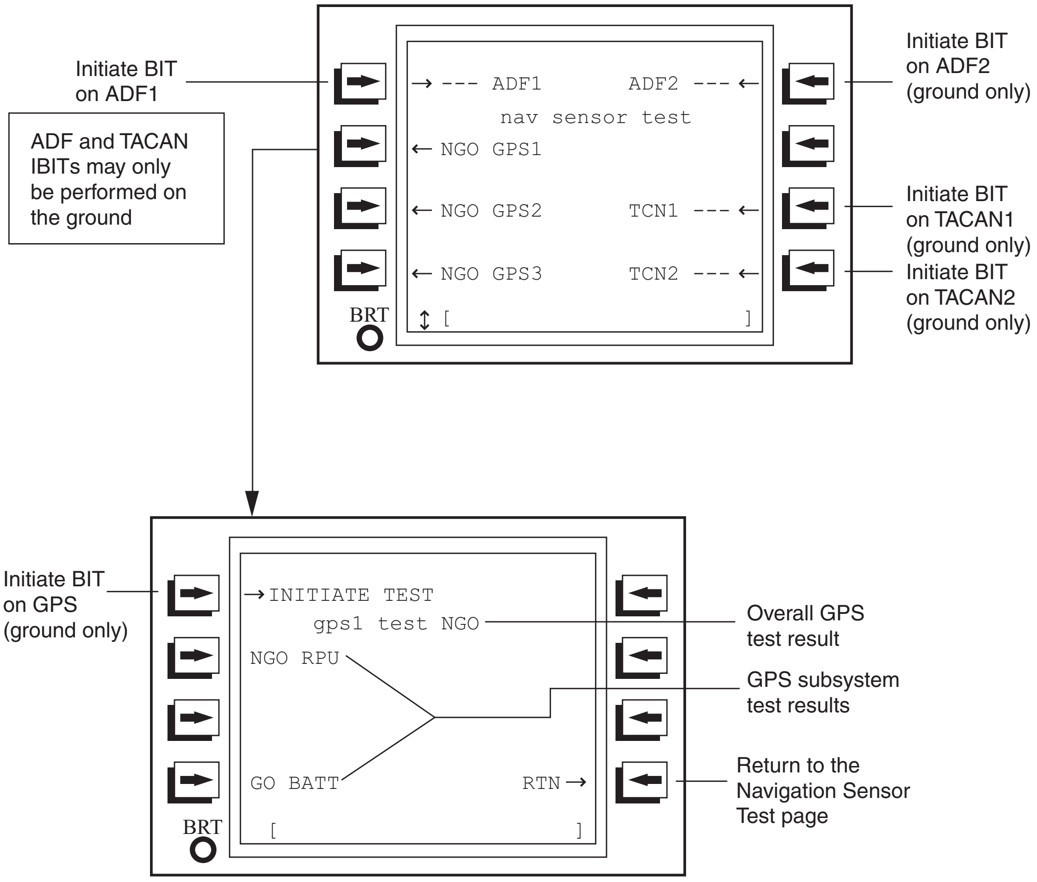


Figure 1.14-140. Navigation Sensor Test Pages

Page 1.14-188 is deleted.

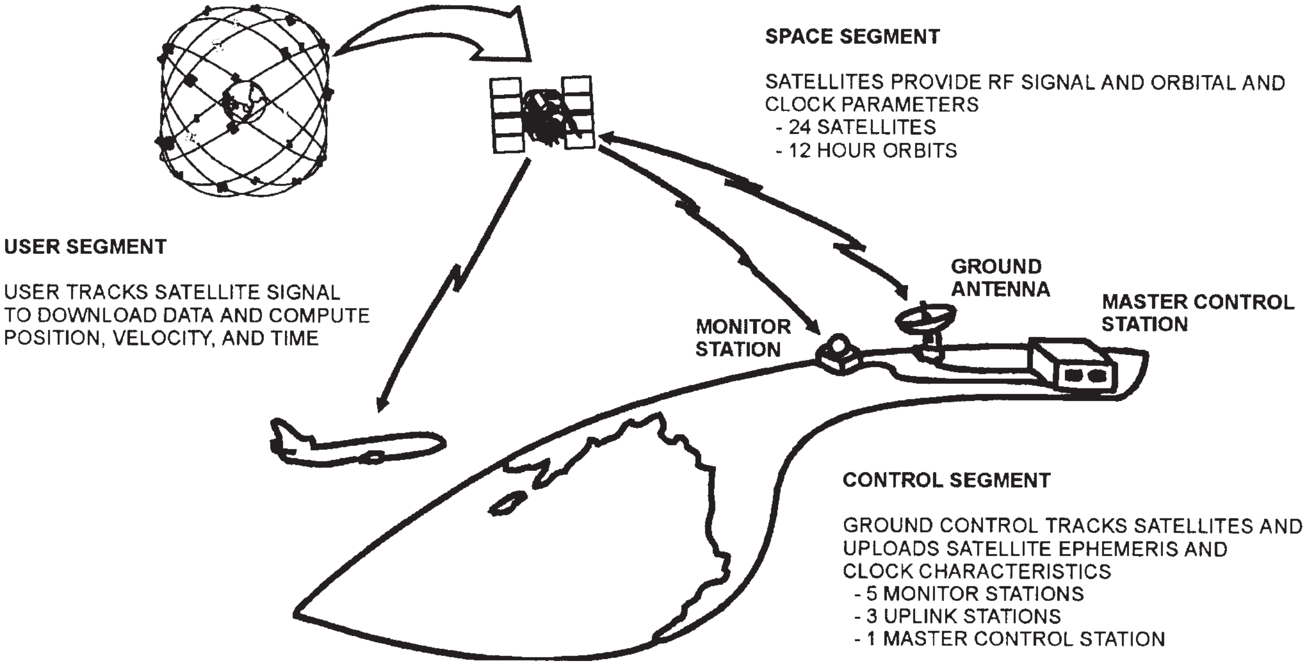


Figure 1.14-141. Global Positioning System Concept

After the receiver clock is corrected as much as possible, the four points are very close together. Using a preprogrammed probability model, an exact position is predicted inside the remaining envelope, and the size of the remaining envelope defined by the four points gives an exact limit on estimated position (and time) errors. The solution is implemented in the form of four equations with four unknowns which have a four dimensional solution. The envelope is four dimensional, encompassing estimated time error as well as estimated altitude and two dimensional (latitude and longitude) position errors.

Two independent kinds of navigation information are computed from GPS signals. The previous description pertains primarily to position measurement. GPS can also compute velocity in a similar manner by computing the doppler radial speed (called range rate) relative to each satellite. Similar arguments to those given in the preceding description of position measurement and accuracy also apply to velocity measurement.

TYPES OF ERROR AND CORRECTION METHODS

The process of computing satellite range is called ranging. For satellite ranging to provide accurate position the system must correct the following three types of errors:

a. Satellite clock and satellite position errors

b. Navigation set (receiver) clock error

c. Atmospheric delay of satellite signals

Satellite Position and Clock Error Correction

Satellite position and clock error corrections are received in the ephemeris/clock data transmitted by each satellite in the navigation message.

Receiver Clock Error Correction

Navigation set (receiver) clock error is computed continually by the receiver when four satellites are available.

Atmospheric Error Correction

Atmospheric delay of the satellite signal is different for each satellite and depends upon the angle at which the signal penetrates the atmosphere and other factors. There are two regions of atmospheric delay, tropospheric and ionospheric. Atmospheric corrections can amount to as much as 30 meters, although the combined tropospheric and ionospheric correction is usually less than 5 meters.

The troposphere is the lower region of the atmosphere. Tropospheric delay can be predicted from the receiver's altitude and the elevation angle of the satellite. The receiver must compute the altitude to use in determining the tropospheric correction, which in turn is necessary to compute the altitude again. This results in an iterative altitude computation which usually converges toward the correct altitude, but can result in altitude instability in a poor GPS environment. This, in conjunction with the fact that vertical position error is usually high because most satellites used in the navigation solution have low elevation angles, makes altitude the least stable of position measurements.

The ionosphere is the very upper atmosphere from 60 to 300 miles high. Ionospheric delay is usually more significant than the tropospheric delay. The delay and a certain amount of refraction of the GPS signal is caused by the charged particles in this layer of the atmosphere. The ionosphere experiences seasonal and hourly variations. The amount of delay for a given geometry varies with the thickness of the ionosphere, recent solar activity, whether the signal crosses the magnetic equator, day or night, and other factors. Ionospheric delay is computed by the receiver for each satellite in the following manner: Each satellite broadcasts two signals at different frequencies which are phase-correlated. Since the amount of ionospheric delay is frequency dependent, the receiver can estimate the amount of total atmospheric delay for both signals by the difference in phase shift between the actual signals received and a phase shift predicted by a fixed signal model.

SIGNAL STRUCTURE

Each satellite broadcasts two L-band signals referred to as L1 (1575.42 MHz) and L2 (1227.60 MHz). Special broadcast techniques enable all satellites to simultaneously transmit on the same two frequencies. Both L1 and L2 are continuously modulated with the navigation data message. The navigation data message contains ephemeris and clock data for only the transmitting satellite, almanac and health data for all satellites, and a hand-over word used in acquiring the precision code.

L1 only is modulated periodically (once each millisecond) with the coarse/acquisition (C/A) code. The C/A-code is available to all users. The C/A-code is a short group of intense pulses in the L1 message. C/A-code provides less accurate positioning, but is easier to acquire and track than the precision code. The C/A-code is unique for each satellite and initially identifies each satellite.

Both L1 and L2 are modulated on a 10 millisecond cycle by the precision (P) code which provides for more accurate positioning. The P-code is a 267 day long code sequence, and each satellite is assigned a unique seven day segment that repeats each week. The P-code can be encrypted for U.S. military operations to deny access to other users, in which case it is called Y-code instead of P-code. Only authorized users have access to the P(Y)-code when it is encrypted.

SATELLITE TRACKING

There are three levels of satellite reception: 1C, 1P, 2P. Each received satellite is given a weighting in the Kalman filter depending, in part, upon its level of reception. Thus, overall position accuracy is affected, in part, by the level of reception of individual satellites. The levels of reception for each satellite normally advance sequentially as follows:

During startup the receiver acquires the first satellite C/A code. This is reception level 1C for that satellite. Normally, reception of every satellite signal starts at level 1C. Use of only C/A-code (from all satellites) enables standard positioning service (SPS) with a 95% 2D accuracy of about 100 meters (3D accuracy is approximately 156 meters).

After acquiring the C/A code, the receiver uses a hand-over word in the navigation message, in conjunction with the C/A code, to switch from the C/A code to the L1 P-code (or L1 Y-code) for that satellite. This is reception level 1P. Level 1P on any navigation channel (1 through 4) is the most desired reception level and provides full navigation accuracy on that channel. The use of the P(Y)-code is called precise positioning service (PPS) regardless of how many of the P-codes are actually received/tracked and can result in a 2D accuracy of about 20 meters and a 3D accuracy of about 30 meters (95%).

If successful in tracking the L1 P-code, the set then looks for the L2 P-code (on all five channels). Reception of the L2 P-code is reception level 2P. In order to make atmospheric corrections for a given satellite (which occurs on channel 5 only), the receiver must acquire the P-code from both the L1 and L2 frequencies for that satellite on channel 5. Level 2P (just before advancing to another satellite) is the most desired reception level on channel 5.

There are five tracking channels. The receiver does not use channel 5 for navigation. The four satellites used in the navigation solution are tracked on channels 1 through 4. Channel 5 cycles through all satellites which the almanac says are visible (or uses a fixed search sequence when almanac is not loaded) and computes and records quality parameters for each satellite so that the receiver can decide which satellites to use on channels 1 through 4 for navigation.

Channel 5 is the only channel which usually uses the L2 signal in computations for any particular satellite. L2 is used by channel 5 to compute and record the atmospheric corrections for a particular satellite. Channel 5 periodically updates atmospheric corrections for each satellite. Although L2 is received by all channels, it is only used in the navigation solution under conditions when L1 becomes unusable for some reason.

After locking on to the first (and any subsequent) satellite's C/A-code, the almanac data is examined to determine if the almanac needs to be updated in the receiver, and if so, almanac recording occurs which takes about 12 1/2 minutes. Recording of the almanac occurs on one of the five reception channels and does not interrupt satellite tracking nor prevent the search for subsequent satellites from proceeding if there is an older almanac already loaded which is adequate. An older almanac is not erased until a newer almanac is completely loaded.

DEGRADED OPERATION

To produce a navigation solution the receiver processor desires reception from at least four satellites. If fewer than four satellites are available, and inertial aiding is not available, the system degrades as follows:

When three satellites are available, the processor gives up computation of time corrections, and solution accuracy is dependent upon internal navigation clock drift rate. Each nanosecond of internal clock error introduces about a foot of position error. If fewer than three satellites are received, the system enters great circle dead reckoning navigation mode. This mode is not useful for navigation, however, it aids the receiver in keeping the initialization position/velocity within the restart envelope.

NAVIGATION DATA PROCESSING AND OUTPUT

The receiver processes the navigation data and provides output to the FMS. The FMS converts the navigation solution to map coordinates that are meaningful to the user. Maps are referenced to a particular earth model. The earth is irregular in shape, but is modeled as an ellipsoid. An ellipsoid is slightly larger in diameter at the equator, and flatter at the poles, than a sphere. Since the earth is irregular in shape, different regions of the earth are more closely fit with ellipsoids having slightly different dimensions. An ellipsoid assigned to some particular part of the earth is called a local geodetic datum. However, GPS normally provides navigation in a global reference rather than a local reference. The DoD uses the World Geodetic System of 1984 (WGS-84) as the default global earth model.

GPS TIME AND UTC TIME

GPS system time is not the same as UTC. There is an approximate nine second difference between the two. The receiver computes UTC time automatically by applying, to the internal receiver navigation clock time, a conversion factor which is transmitted in the satellite navigation message. This is the time that is displayed on data line 3 of the CDU Start 1 page and, if selected, on the annunciation line of all CDU pages.

GPS RAIM IMPLEMENTATION

One of the requirements of an air navigation system is to provide a timely warning to the pilot when the system should not be used for navigation due to exceeding safety limits. This feature is known as system integrity. Integrity requirements become progressively more restrictive with the phase of flight from en route through approach operations. For example, for a nonprecision approach, the requirement is to provide this warning within 10 seconds. For a TACAN or VOR approach this is accomplished by placing a ground monitor near the NAVAID to monitor the signal. If the signal varies by more than one degree from its established alignment, the monitor detects the error and either rings an alarm or shuts down the NAVAID.

One approved method for GPS to meet this integrity requirement is through the use of receiver autonomous integrity monitoring (RAIM). RAIM is an internal receiver algorithm that makes use of comparisons between five or more satellite positions to detect and exclude a bad satellite from the navigation solution. Five satellites are required for simple fault detection (FD); six or more are required to isolate and exclude a bad satellite (FDE) so navigation may be continued.

The FMS CDU receiver modules contain an FDE RAIM algorithm; however, only the selected receiver's RAIM results are monitored and reported by the FMS. When the RAIM algorithm detects that the horizontal position error exceeds the limits in the GPS Integrity Performance Requirements table (figure 1.14-142), the FMS will illuminate the RAIM annunciator on the pilots' EHSIs. If the RAIM function is not available, the FMS will display the <<no raim>> CDU annunciation.

When a GPS databased approach is flown, a predictive RAIM operation, projected 5 minutes into the future and based on the MAP waypoint location, will be performed when the aircraft reaches a point 2 NM from the FAF. If the predictive RAIM function fails or is not available, or predictive RAIM determines that RAIM will not be available at the MAP, then a <<no appr raim>> CDU annunciation will be displayed along with the FMS MSG annunciator, and the nav flag will appear on the EHSI until the approach is disabled or removed. Following a successful approach predictive RAIM, when the MAP is the active waypoint and RAIM becomes unavailable, the FMS will suppress the <<no raim>> and <<no appr raim>> annunciations for five minutes. If, after five minutes, the RAIM function continues to be unavailable, the nav flag will appear on the EHSI until the approach is disabled or the RAIM function again becomes available. The <<no raim>> and <<no appr raim>> annunciations will be active again following the five minute suppression period. During approach mode operation (final approach segment), the EHSI nav flag and RAIM annunciator will be displayed when a RAIM integrity failure is detected.

The crew should take the following actions based on the phase of flight and RAIM indications:

<u>EHSI RAIM annunciator illuminated</u>:

En Route and Oceanic - Monitor position (position should be verified every 15 minutes using another IFR-approved navigation system).

Terminal - Cross-compare using another IFR-approved navigation system.

Approach - Execute missed approach; select another approach aid or attempt another approach with GPS if RAIM alert clears.

<u>CDU <<no raim>> annunciation</u>:

En Route and Oceanic - Monitor position (position should be verified every 15 minutes using another IFR-approved navigation system).

Terminal - Cross-compare using another IFR-approved navigation system.

<u>CDU <<no appr raim>> annunciation accompanied by FMS MSG annunciator</u>:

Approach (Nav Fail Annunciator and Navigation Source Flag illuminated, CDI not in view) - Abandon approach; hold until RAIM is available or select another approach aid.

The receiver will also have the capability to perform an approach RAIM prediction for a manually entered location. The operator enters the location and desired time and the receiver calculates whether approach RAIM will be available at the requested location within ±15 minutes of the requested time.

When the difference between the two GPS receivers' navigation solutions exceeds the alarm limits specified in figure 1.14-142 for the current phase of flight, a <<compare gps>> CDU annunciation will be displayed.

PROTECTIVE FEATURES

GPS incorporates several security features which protect against unauthorized usage, interference, jamming, and spoofing.

Jamming and Interference

The GPS signal-in-space is a very weak signal. In fact, it is actually weaker than the normal background noise level making it very susceptible to jamming or interference. The receiver knows no difference between jamming and interference. Jamming is noise intentionally generated by an enemy to degrade the signal to noise ratio. Jamming, by definition, does not contain deceptive intelligence, only noise. Interference is unintentional noise from any source. Regardless of the source of noise, the effect on the receiver is the same - eventual loss of the ability to track individual satellite signals and resultant degradation of the GPS navigation solution. The receiver has only a limited capability to operate in a jamming/interference environment without the installation of an antenna capable of detecting and nulling out the source of the noise. The installation does not include such an antenna. However, from a system standpoint, the FMS should be able to coast through an area of jamming/interference using inertial position/velocity information.

Selective Availability and Anti-Spoofing (SA/A-S)

Selective Availability (SA) and Anti-Spoofing (A-S) are two separately enabled transmission features which require the intended receiver to have decryption capability and the appropriate cryptovariables.

Selective availability reduces the accuracy of GPS navigation signals by introducing position and clock errors which cannot be corrected even if the unauthorized receiver has a precision time source. SA introduces intentional errors into the transmitted signals which can only be removed by applying corrections obtained by decoding portions of the navigation message. Standard positioning service (without SA) has an inherent 3D accuracy of about 65 meters. DOD has made agreements with the civil sector that during peacetime operations, SA will not be used to degrade accuracy to greater than 100 meters (2D) or 156 meters (3D) on a 95% basis.

Spoofing is the introduction of false signals which mimic the GPS satellite signals. If used by the receiver, the result would be a degradation of GPS position accuracy. Anti-spoofing, when enabled, encrypts the P-code, which performs two functions: 1) it denies the unauthorized user access to the precise positioning service, and 2) it enables the authorized user to identify and ignore an enemy signal which contains false information. It is this latter capability which gives A-S its name. The receiver has two A-S modes of operation (see figure 1.14-146). The Y-ONLY mode forces the receiver to use only Y-code signals for navigation, thus providing a greater degree of protection in a spoofing environment. The MIXED mode allows the receiver to use C/A-code signals for navigation if it is unable to track Y-code signals. A-S does not deny any receiver access to the standard positioning service. If the user is authorized, that is, has the correct cryptovariables, he/she has no way of knowing that either SA or A-S is enabled. If the user is unauthorized, and A-S is enabled, signal reception level for all satellites drops to 1C.

GPS AIRBORNE SYSTEM COMPONENTS

Two complete GPS systems are installed on the aircraft. Each airborne system is comprised of a top-mounted antenna, FMS control display unit (CDU), a CDU-embedded receiver module (CGEM), and a crypto key load panel. The CGEM contains a tamper-resistant crypto module, the PPS-SM, which allows the receiver to decode the encrypted SA error corrections and Y-code signals. The tamper resistance of this module allows the receiver to remain unclassified even when keyed.

Control Display Unit

Flight crew interface with the GPS receiver is through the FMS CDUs installed in the flight compartment pedestal. The CDU allows input of data and control commands and display of navigation solution or receiver status.

Receiver Module

The CGEM contains the radio frequency (RF) receiver, processor unit, navigation clock, low power clock, and critical memory. The receiver is capable of tracking five satellites at once. Four satellites are used for navigation. The fifth channel tracks the next best satellite signal to be used in case one of the primary four becomes unusable or moves to a worse geometric position. It decodes satellite signals and provides navigation solution display to the CDU.

GPS Antenna

The antennas are mounted on the top of the fuselage near the centerline at FS 805 as shown in figure 1.13-1. The antenna type is a commercial fixed radiation pattern antenna (FRPA). The antenna provides omnidirectional line-of-sight reception throughout a 160° wide cone above the aircraft, fixed to aircraft vertical. Since the antenna reception pattern is fixed to the aircraft, turns can temporarily affect GPS reception due to bank angle; low satellites on the outside of a turn fall out of the reception pattern, and surface reflections can be received on the inside of a turn.

GPS Crypto Key Load Panel

A GPS crypto key load panel (figure 1.14-143) is provided for each GPS receiver to allow connection of a KYK-13 or KOI-18 cryptovariable device for the loading of crypto keys into the receiver modules. The panels are located on the Flight Engineer's equipment panel. This capability is included to allow decryption of the GPS signals during periods when the GPS satellites broadcast encrypted data.

Battery For Critical Memory

Critical memory is retained after power-down by one 3.6 VDC backup battery located in a compartment on the right side of the FMS CDU. The battery is normally replaced by maintenance every 365 days. Critical memory contains almanac and present position necessary for a normal startup, as well as the selected configuration and unit options and the SA/A-S cryptographic keys. The same battery powers the low power clock which provides date and approximate time, also necessary for normal startup.

INERTIAL NAVIGATION SYSTEM DESCRIPTION

There are three independent LTN-72 inertial navigation systems (INS) installed on the aircraft. Each INS provides a lightweight, self-contained navigation capability without reference to external navigation aids. The INS consists of three components: A Mode Selector Unit (MSU), an Inertial Navigation Unit (INU), and a Battery Unit (BU). Functional control of the INS is accomplished through the FMS CDUs (figure 1.14-144) and the INUs are used as navigation sensors for the FMS (refer to FLIGHT MANAGEMENT SYSTEM DESCRIPTION, this part). The INUs provide position and velocity information to the FMS, and the FMS performs all navigation computations and interfaces with the flight instruments and FGS.

The MSUs are located on the flight compartment Overhead Panel; the INUs are located in the avionics compartment navigation rack; the BUs are located on the auxiliary radio rack. INS-1 receives power from 115 VAC Bus 1 and 28 VAC L EMER Bus. INS-2 receives power from 115 VAC R EMER Bus and 28 VAC R EMER Bus. INS-3 receives power from 115 VAC Bus 3 and 28 VAC Bus 3. The Attitude Monitoring Switching Unit selects power from alternate sources when INS-3 is selected to replace INS-1 or INS-2. Circuit breakers are located on the forward and aft Overhead Circuit Breaker Panels and the Flight Engineer's Overhead Circuit Breaker Panel.

FUNCTIONS

The Mode Selector Unit controls the application of power to the INS and the selection of the four modes of operation: STBY (standby), ALIGN, NAV (navigate), and ATT REF (attitude reference).

The MSU mode selector switch and two annunciators function as follows:

MODE	FUNCTION
OFF	Turns INU power off; MSU panel edge lighting is not affected.

CAUTION

Do not cycle the MSU between OFF and any other position(s) more than 3 times in a 3-minute period. Cycling the MSU out of OFF repeatedly can cause substantial damage from heat buildup in the INU.

STBY	Turns INU power on and selects STBY mode. The aircraft's present position latitude and longitude is entered. The system is not affected by aircraft movement while in STBY.
ALIGN	The ALIGN mode is selected after present position coordinates have been entered. The system enters an automatic alignment process and turns on the READY NAV annunciator light when the INU is ready to navigate.

NOTE

If the aircraft is moved when in ALIGN mode, the alignment sequence is voided and a new alignment is required.

NAV	The NAV mode is selected for normal in-flight operations and must be selected prior to moving the aircraft or starting engines.
ATT REF	The ATT REF (attitude reference) position is used when only attitude and heading signals are required. If selected during flight, the INU requires realignment on the ground before the navigation mode can be used again.

ANNUNCIATOR LAMPS

READY NAV (Green)	The READY NAV light comes on at status 02, when the alignment is accomplished with the mode selector at ALIGN, and remains illuminated until NAV is selected.
BATT (Red)	The BATT (battery) light comes on when primary power has been lost and the INU has been operating on its backup battery, and the voltage has become too low to sustain INU operation. When this occurs, the INU automatically shuts down.

	Performance Item			
Phase of Flight	Alarm Limit	Max Allowable Alarm Rate	Time to Alarm	Minimum Probability
En Route, Oceanic	2.0 NM	0.002/hr	30 seconds	0.999
Terminal	1.0 NM	0.002/hr	10 seconds	0.999
Nonprecision Approach	0.3 NM	0.002/hr	10 seconds	0.999

Figure 1.14-142. GPS Integrity Performance Requirements

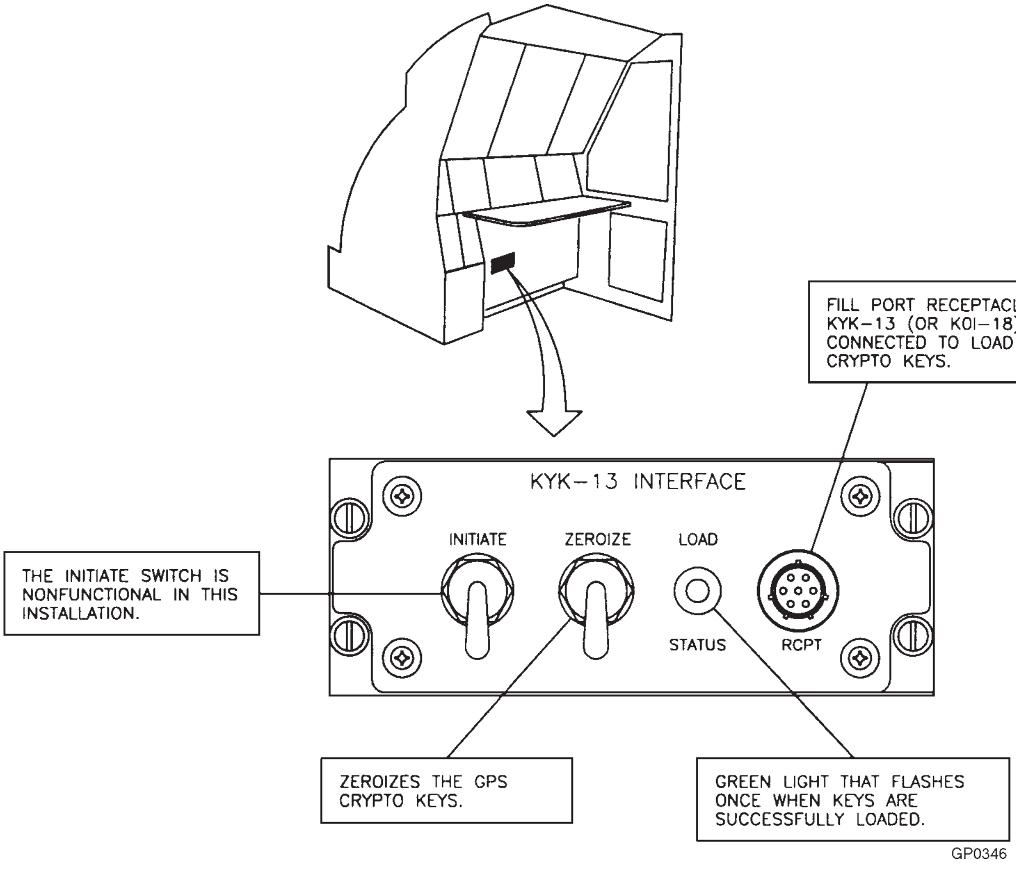


Figure 1.14-143. GPS Crypto Key Load Panel

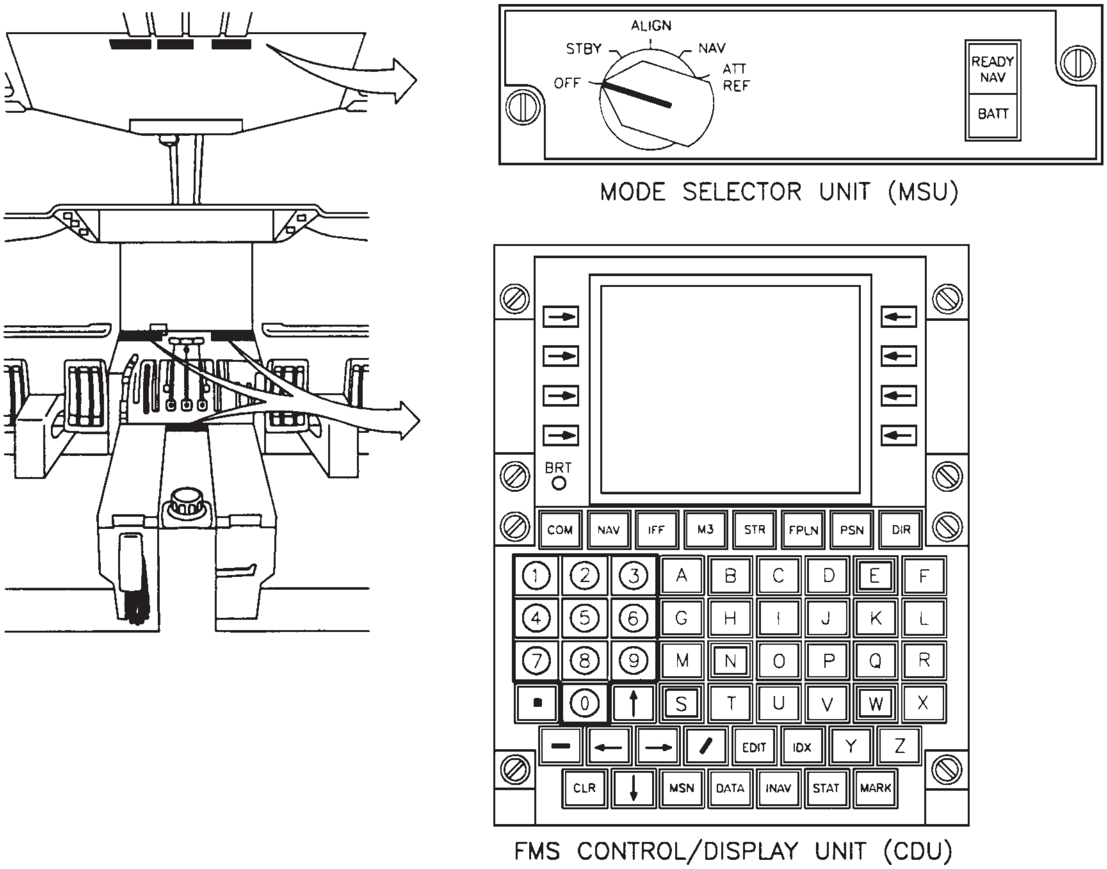


Figure 1.14-144. Mode Selector Unit and FMS Control Display Unit

PREDEPARTURE

General

The inertial platform must be turned on and aligned before the INU can be used as a navigation sensor. The alignment procedure requires entry of the aircraft present position, and alignment can only be performed with the aircraft on the ground. Alignment is not affected by passenger and cargo loading or light gusty winds. The alignment progress can be monitored, and the flight crew is signaled when the alignment is completed.

WARNING

> Moving the aircraft after initiating the alignment procedure can result in unacceptable navigation errors or failure of the alignment. If the aircraft is moved during alignment, turn off the INU and start alignment procedure again.

The INU will shut down if the platform temperature reaches 185° F, and the internal temperature monitor will prevent turn-on until the temperature is below 160° F. Typically it takes approximately 20 minutes for a thermally tripped INU to cool enough to be turned on again. Although this provides some means of protection, it does not preclude the possibility of damage to the gyros and other platform components.

INU Startup and Present Position Entry

The aircraft's present position must be entered into each INU individually before the inertial platform can be aligned (figure 1.14-145).

1. Position the CDU power switches to ON.

2. Rotate mode selectors to STBY (figure 1.14-144).

CAUTION

Do not cycle the MSU between OFF and any other position(s) more than 3 times in a 3 minute period. Cycling the MSU out of OFF repeatedly can cause substantial damage from heat buildup in the INU.

NOTE

Both primary AC power and DC backup battery power must be available for turn-on.

3. Push to test MSU READY NAV (green) and BATT (red) annunciators (figure 1.14-144) and observe the light comes on.

4. Observe that the annunciation line on the FMS CDUs display the <<√inu1(2,3)>> message. These messages may be cleared on any CDU by pressing the CLR function key. These messages will be accompanied by illumination of the FMS MSG annunciator.

5. Access the INAV page for each INU on its corresponding CDU (Pilot/INU1; Copilot/INU2; FE/INU3) by pressing the INAV key and laterally scrolling to the appropriate INU INAV page (INU CONTROL will be displayed at LS4 on the appropriate page).

6. Access the INU CONTROL page on each CDU via LS4. Verify that NO INU DATA is displayed on the information line.

7. Select POSITION (LS2) and verify that 72. 33° 0.1° is displayed. Enter the present position latitude to the nearest tenth of a minute in the scratchpad preceded by N or S (decimal point is optional).

8. Verify data entry is correct. If not, push the CDU CLR function key to clear the scratchpad; then push the CLEAR line select key (LS3) and reenter correct data.

NOTE

LS3 does not erase the lat/long on the information line. Selection of N, S, E, or W deletes the data so the new position can be input.

9. Select ENTER (LS6) to send the position to the INU.

10. Repeat steps 4-6 for the present position longitude entry using E or W.

    If incorrect present position latitude (N/S) is entered, alignment may be halted causing the <<√inu1(2,3)>> CDU annunciation to appear. Present position must then be reentered, resulting in a 10 to 15 minute delay. Incorrect longitude (E/W) entries do not delay alignment or cause the <<√inu1(2,3)>> annunciation to appear, but do cause incorrect data to be displayed throughout the flight unless corrected on the ground.

11. Rotate the mode selectors to ALIGN when present position has been entered in all three INUs.

NOTE

- If present position coordinates are not entered within 3 minutes after turn-on, the <<√inu1(2,3)>> annunciation is displayed.
- Selecting ALIGN starts automatic platform alignment which requires approximately 15 minutes, during which time the aircraft must not be moved. Normal movement from loading and servicing is acceptable. Excessive movement may delay completion of the alignment. Alignment cycle does not progress beyond initial leveling sequence until present position coordinates are entered. When the alignment cycle is complete, the READY NAV annunciator light comes on.

Alignment Status Check

1. On the INU1(2,3) CONTROL page, select the DTK-STS line select and observe the alignment status number on the right side of the information line (figure 1.14-146). Status number starts at 90 and decrements to 02 as alignment progresses. Attitude becomes valid at 80; true heading is valid at 50; alignment is complete at 02.

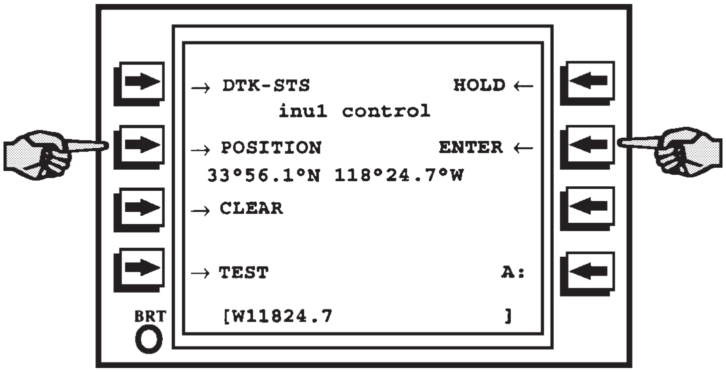


Figure 1.14-145. Present Position Entry

2. With the mode selector set to ALIGN, the READY NAV annunciator light comes on at status 02.

NOTE

- The mode selector may be set to NAV when the READY NAV annunciator light comes on.
- The INU continues to refine its alignment after status 02 is reached if the mode selector is left in ALIGN.
- If desired, MSU mode selector may be moved directly to NAV from STBY after present position has been inserted. System automatically enters NAV mode upon completion of minimum alignment and, in this case, READY NAV light does not come on. If moving MSU directly to NAV mode prior to status 02 being achieved, fault codes for incorrect present position will not be annunciated.

3. Verify that the READY NAV annunciator light goes out, and the alignment status number changes to 01 when the mode selector is set to NAV.

NOTE

After status 01 (NAV mode) has been achieved, do not set the mode selector out of NAV. Setting the mode selector out of NAV destroys the alignment of the inertial platform and the complete alignment sequence must be repeated on the ground.

INU Warning Indications

If the <<√inu1(2,3)>> annunciation comes on during the alignment sequence, proceed as follows:

1. On the INU1(2,3) CONTROL page, select the DTK-STS line select and observe the action code and status number on the right side of the information line.

NOTE

The recommended action for each action code, 1 through 8, is provided in the table of Action and Malfunction Codes (figure 1.14-147).

2. Perform recommended action indicated by the action code.
3. If action does not correct the malfunction, maintenance is required.
4. Push the HOLD line select to display malfunction code(s).

NOTE

More than one malfunction code can exist. Repeated pushing of the HOLD line select key gives a sequential display of malfunctions.

5. Record the action/malfunction codes, and status number for use by maintenance personnel.

NOTE

Malfunction display is cancelled by pushing the CLEAR line select key.

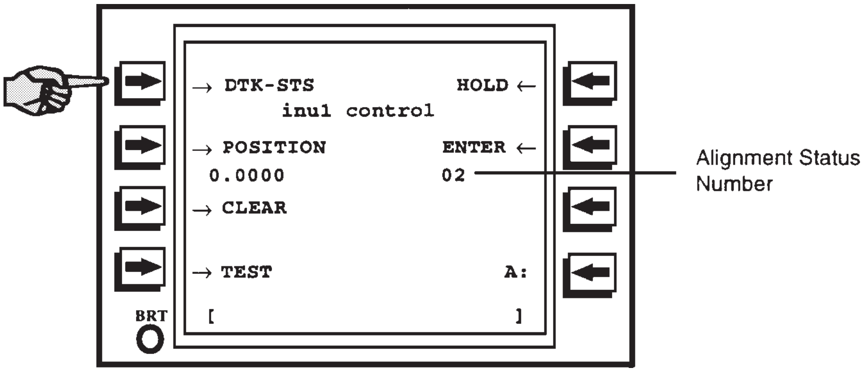


Figure 1.14-146. Alignment Status

Check Present Position Entry

1. On the INU1 (2,3) CONTROL page, press the POSITION line select key and observe present position coordinates displayed on the information line.
2. Compare displayed coordinates with coordinates of ramp position. Verify displayed coordinates are correct.
3. If the coordinates are not within ±0.1 minute, rotate mode selector to STBY, enter present position coordinates correctly, and reselect ALIGN.

NOTE

Reselecting ALIGN restarts the alignment sequence. Attainment of READY NAV status is delayed by the time needed for the realignment.

Navigate Status

1. Check INU alignment status on the right side of the information line on each CDU.

With the mode selector set to ALIGN press the DTK-STS line select key. The left side of the information line shows 000.0 and the right side shows the alignment status number. Status decreases from 90 to 02 as the alignment cycle progresses.

NOTE

The MSU READY NAV annunciator light comes on when system status reaches 02 and a preset time has elapsed.

2. Observe READY NAV annunciator light on each MSU panel. If READY NAV light is on, rotate mode selector to NAV (figure 1.14-144).

NOTE

- When READY NAV light comes on, alignment is complete. Excessive movement of the aircraft during loading can cause the alignment to deteriorate from 02. If the status stays above 02 for 2 minutes or more, the READY NAV light goes off. Do not select NAV until READY NAV light comes on again.
- Do not move the aircraft until alignment is complete and NAV has been selected.
- Do not pull mode selector out when switching from ALIGN to NAV. Pulling out on mode selector could cause inadvertent selection of ATT REF, which would destroy the alignment. Realignment would be required.

3. Access the INAV pages by pressing the INAV function key. Scroll laterally to select the INAV page for each available navigation solution and check for validity (no dashes in title). Compare present position readouts (should all agree within ±0.1 minute. For each integrated navigation solution (INU1/GPS, INU2/GPS), briefly select the auxiliary INU(3) with the INS Selector switch and observe validity and correct present position.

ACTION AND MALFUNCTION CODES			
ACTION CODE	RECOMMENDED ACTION	MALF CODE	INU ANNUN-CIATION
1	REMOVE SYSTEM. MAINTENANCE REQUIRED	11-18	ON
2	CYCLE SYSTEM THROUGH OFF-ON SEQUENCE REENTER PRESENT POSITION	19-21 23	ON
3	CYCLE SYSTEM BACK TO STBY. REENTER PRESENT POSITION	22	ON
4	DO NOT USE INU FOR FMS GUIDANCE TO EHSI OR STEERING. CHECK ALL ASSO-CIATED 26V, 400HZ CIRCUIT BREAKERS.	04-10	OFF
5	RE-ALIGN AFFECTED INU	03	OFF
6	TURN OFF. CHECK INS CIRCUIT BREAKERS AND RESTART.	24	ON

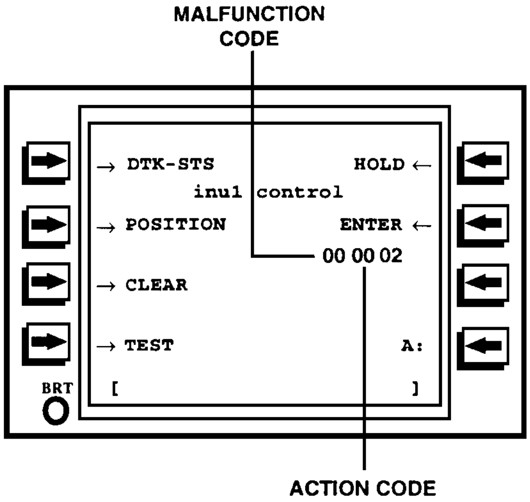


Figure 1.14-147. Action and Malfunction Codes

Attitude Reference Mode Operation

In the attitude reference (ATT REF) mode of operation the INU provides pitch, roll, and platform heading outputs. The ATT REF mode can be selected at any time. When ATT REF is selected in flight, the navigation capability of the INU is cancelled until another alignment is performed on the ground. If the <<√inu1(2,3)>> CDU annunciation appears while operating in the NAV mode during flight, signifying loss of INU navigation capability, the INU automatically enters the ATT REF mode. If this occurs, manual selection should follow.

1. Pull mode selector (figure 1.14-144) and rotate to ATT REF.

WARNING

> If ATT REF is selected during preflight because navigation capability is not required, valid attitude reference output data is available in approximately five minutes. Do not use the INU attitude outputs until warm-up time has elapsed because erroneous INU outputs could occur.

2. If the <<√inu1(2,3)>> CDU annunciation remains on or attitude flags are present, pull mode selector out and rotate to OFF.

POSTFLIGHT

Refer to Leaving Aircraft Checklist, Section IV, for INU Accuracy Check and Shutdown procedures.

TACAN DESCRIPTION

The airborne TACAN consists of two systems: TACAN-1 and TACAN-2. Both systems provide the normal air-to-ground slant range distance and magnetic bearing. In air-to-air modes both systems transmit and receive distance information and receive bearing information, but only TACAN-2 transmits bearing information. Both systems are usable in rendezvous and refueling operations. There are 252 channels available for use, consisting of 126 X mode channels and 126 Y mode channels, with a channel separation of 1 Mhz. Both systems supply course deviation information to the autopilot. As TACAN is limited by line-of-sight, operating range is dependent on aircraft altitude. Maximum operating range is 390 nautical miles.

TACAN-1 receives power from 115 VAC Bus 1 and 28 VDC Bus 1. TACAN-2 receives power from 115 VAC Bus 3 and 28 VDC Bus 3. Circuit breakers are located on the Flight Engineer's Overhead Circuit Breaker Panel.

TACAN-1

In air-to-ground modes, TACAN-1 operates between tanker and a surface beacon to calculate and display relative bearing, slant-range distance, course deviation and To/From indication. In air-to-air modes, TACAN-1 calculates and displays relative bearing to a receiver, or tanker, that is transmitting bearing information. TACAN-1 transmits interrogation and range replies to a limited number of receivers, or tankers, and calculates and displays range to the nearest aircraft.

NOTE

Bearing and slant-range distance can be received from another TACAN equipped aircraft, operating in BEACON/INVERSE mode.

TACAN-2

In air-to-ground modes, TACAN-2 functions the same as TACAN-1, except TACAN-2 can also derive a bearing from a DME only surface beacon. In air-to-air modes, TACAN-2 functions the same as TACAN-1, except TACAN-2 has INV (inverse) mode, with rotating antenna, and BCN (beacon) mode to produce bearing information.

NOTE

- Beacon mode transmits unmodulated squitter for bearing information.
- Inverse mode activates the rotating antenna, modulates incoming squitter to determine bearing to the transmitter and modulates its own transmitted squitter to give bearing to receivers or tankers.
- If the tanker and TACAN station (surface or airborne) are both operating with a rotating (modulating) antenna any displayed bearing is unreliable.

OPERATIONAL MODES

TACAN operational modes are selected through the FMS CDUs located on the flight compartment pedestal (see FLIGHT MANAGEMENT SYSTEM DESCRIPTION, this part, for description of TACAN functional control). TACAN operational modes are shown below:

AIR TO GROUND						AIR TO AIR	
TACAN-1		OFF	ON	R	TR	AAAR	AATR
TACAN-2	NORMAL	OFF	ON	R	TR	AA	BCN
TACAN-2	INVERSE	OFF	ON	R INV	TR INV	AA INV	BCN INV

TACAN-1 AND TACAN-2 OPERATIONAL MODES DESCRIPTION

TACAN-1 mode functions are as follows:

MODE	FUNCTION
OFF	Power removed from system.
ON	Power applied to system.
R	In R (receive) mode TACAN-1 determines bearing from the aircraft (tanker) to the selected TACAN surface beacon (station). Aural station identification is received. The fundamental bearing output from the TACAN and the input from the aircraft compass are used to provide relative bearing to the surface beacon, deviation from the selected course, and whether selected course leads to or from the beacon. Course, course deviation, and To/From indication are displayed by Pilot's EHSI when TCN1 is selected as navigation source. Relative bearing is displayed by No. 1 pointer of TACAN RMI and can be displayed by the EHSI bearing pointer if selected.
TR	In TR (transmit/receive) mode, bearing information is the same as described in R mode. In this mode TACAN-1 also interrogates and receives range replies from a TACAN surface beacon to compute and display slant-range distance, from the tanker to the beacon, on No. 1 DME indicator and EHSI, if selected.

MODE	FUNCTION

NOTE

- In all TACAN systems there is the possibility of interference from IFF, transponder, and DME signals when operating in the air-to-air modes. To minimize interference, use Y-channels 12 through 57 and 75 through 120.
- In air-to-air modes, coordination of TACAN channels is required between tanker and receiver. This is done by radio contact or by using predetermined channels. Channel separation of 63 MHz is required. This separation duplicates the spacing between transmit and receive frequencies when using a surface beacon for bearing information. For example, tanker uses channel 75 and receiver uses channel 12.

MODE	FUNCTION
AAR (AGC ON)	In AAR (air-to-air receive) mode with AGC ON, TACAN-1 operates with a receiver, or tanker, that has bearing transmitting capability, to receive and display bearing information. Bearing information is the same as described in R mode except it is referenced to the transmitting aircraft.
AAR (AGC OFF)	Bearing information is not usable with AGC disabled.
AATR (AGC ON)	In AATR (air-to-air transmit/receive) mode with AGC ON, bearing information is the same as described in AAR AGC ON. In AATR AGC ON, TACAN-1 transmits range replies to maximum of five receivers or tankers, with 4:1 range ratio and receives and displays slant-range distance, to/from nearest aircraft, on No. 1 TACAN DME indicator and EHSI, if selected.
AATR (AGC OFF)	Bearing information is not useable with AGC disabled. In AATR mode with AGC OFF, TACAN-1 slant-range distance information is the same as described in ATTR AGC ON except the range ratio is 30:1.

TACAN-2 mode functions are as follows:

MODE	FUNCTION
OFF	Power is removed from system.
ON	Power is applied to system.
R	In R (receive normal) mode, TACAN-2 bearing information is the same as described in TACAN-1 R, except relative bearing is displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected.
R INV	In R INV (receive/inverse) mode, TACAN-2 derives bearing from a DME only surface beacon. Bearing information is the same as described in TACAN-1 R, except the relative bearing is displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected.
TR	In TR (transmit/receive normal) mode, TACAN-2 bearing and distance information is the same as described in TACAN-1 TR, except the relative bearing is displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected. Slant-range distance is displayed on No. 2 TACAN DME indicator and EHSI, if selected.
TR INV	In TR INV (transmit/receive inverse) mode, bearing information is the same as described in R INV mode. In TR INV, distance information is the same as described in TR mode.
AA (AGC ON)	In AA (air-to-air normal) mode with AGC ON, TACAN-2 bearing and distance information is the same as described for TACAN-1 AATR AGC ON, except the relative bearing is displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected. Slant-range distance is displayed on No. 2 TACAN DME indicator and EHSI, if selected.

MODE	**FUNCTION**
AA (AGC OFF)	Bearing information is not useable with AGC disabled. In AA AGC OFF, TACAN-2 distance information is the same as described for TACAN-1 AATR AGC OFF, except the slant-range distance is displayed on No. 2 TACAN DME indicator and EHSI, if selected.
AA INV (AGC ON)	In AA INV (air-to-air inverse) mode with AGC ON, TACAN-2 derives and displays bearing from a receiver, or tanker, transmitting squitter (BCN). Bearing information is the same as described for TACAN-1 R, except the relative bearing is referenced to the transmitting aircraft and displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected. In AA INV AGC ON, distance information is the same as described for TACAN-1 AATR, except the slant-range distance is displayed on No. 2 TACAN DME indicator and EHSI, if selected.
AA INV (AGC OFF)	Bearing information is not useable with AGC disabled. In AA INV AGC OFF, TACAN-2 distance information is the same as described for TACAN-1 AATR AGC OFF, except the slant-range distance is displayed on No. 2 TACAN DME indicator and EHSI, if selected.
BCN (AGC ON)	In BCN (beacon normal) mode with AGC ON, TACAN-2 bearing and distance information, is the same as described for AA AGC ON. BCN AGC ON also provides bearing information (squitter) for use by another tanker.
BCN (AGC OFF)	Bearing information received/ displayed is not usable with AGC disabled. BCN AGC OFF provides bearing information (squitter) for use by another tanker. In BCN AGC OFF, TACAN-2 distance information is the same as described for AA AGC OFF.
BCN INV (AGC ON)	In BCN INV (beacon inverse) mode with AGC ON, TACAN-2 derives and displays bearing from tanker, or receiver that is transmitting squitter (BCN). TACAN-2 also transmits bearing information for use by receivers or tankers. Bearing information is the same as described for TACAN-1 R but is displayed by No. 2 pointer of TACAN RMI and EHSI bearing pointer, if selected.

NOTE

- In BCN INV, TACAN-2 functions as an airborne TACAN station.
- In BCN INV AGC ON, TACAN-2 transmits range replies to a maximum of five receivers, or tankers, within 4:1 range ratio and displays slant-range distance to nearest aircraft on No. 2 TACAN DME indicator and EHSI, if selected.

BCN INV (AGC OFF)	Bearing information received/ displayed is not usable with AGC disabled. BCN INV AGC OFF transmits bearing information for use by receivers or tankers. In BCN INV AGC OFF, TACAN-2 distance information is the same as BCN INV AGC ON except the range ratio is 30:1.

ANTENNA

TACAN-1 has two omnidirectional antennas, one on the lower and one on the upper fuselage. TACAN-2 has an omnidirectional antenna on the lower fuselage and a rotatable antenna on the upper fuselage.

NOTE

- In INV mode the TACAN-2 upper antenna rotates. In all other modes the antenna is stationary, functioning as an omnidirectional antenna.
- On aircraft with SL KC10-146, Rev 1 incorporated, TACAN-2 has an omnidirectional antenna on the lower fuselage and a solid state non-rotatable antenna on the upper fuselage.

ANTENNA SELECT SWITCHES

Antenna select switches (figure 1.14-148) are located on the flight compartment Overhead Panel.

These switches enable selection of UPPER, AUTO or LOWER positions. AUTO positions enable a signal search function that alternately selects top and bottom antennas at approximately five second intervals until a usable signal is found. When a usable signal is found, the system stays on that antenna until loss of signal, manual selection of a different antenna, or change of operational mode.

NOTE

- TACAN-2 antenna select function is disabled when TACAN-2 is in the INV mode. INV mode selects TACAN-2 upper antenna and enables motor drive for antenna rotation.
- On aircraft with SL KC10-146, Rev 1 incorporated, the TACAN-2 upper antenna is non-rotatable.

AUTOMATIC GAIN CONTROL

In air-to-air modes, automatic gain control (AGC) can be disabled to increase range-ratio capability.

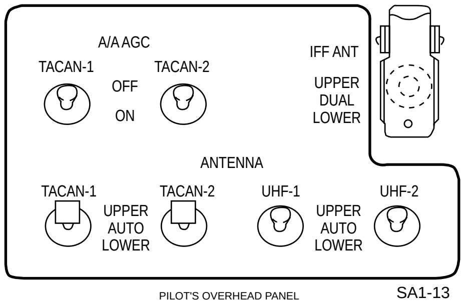


Figure 1.14-148. Antenna Select Switches TACAN-1/TACAN-2

AGC On

When interrogated and supplying distance information to more than one receiver, the tanker provides range to maximum of five receivers, provided: range to farthest receiver does not exceed four times the range of the nearest receiver.

AGC Off

When interrogated and supplying distance information to more than one receiver, the tanker provides range to maximum of five receivers, provided: range to farthest receiver does not exceed thirty times the range of the nearest receiver.

TACAN VOLUME CONTROL

Separate Pilot and Copilot Nav Radio Volume control panels located on the forward pedestal provide manual control of TACAN station identification signal audio level (figure 1.14-149). Select TACAN-1 or TACAN-2 position on the audio select panel to receive audio.

TURN ON, WARM-UP, AND TEST

1. Select the FMS Master Power page and toggle TACAN-1 (TACAN-2) to ON.

NOTE

Allow 90 seconds for the R/T unit to warm up.

2. Select the FMS Nav Radio 1 (2) page and toggle the operating mode to TR. Set desired channel.

NOTE

Channels 01X to 126X or 01Y to 126Y can be selected. Self-test can be performed on any channel; a receivable channel is not required.

3. Select TACAN as the navigation (NAV) source and bearing pointer (BRG) source on the EHSI control panel.

NOTE

Pilot's EHSI navigation source should read TCN1 and the Copilot's TCN2.

4. For TACAN self-test, rotate NAV course selectors to 180°.

WARNING

Even though the FMS has a test GROUND ONLY inhibit, do not attempt to perform self-test while in flight with the autopilot engaged in TACAN NAV mode. If the GROUND ONLY inhibit fails, bearing outputs during self-test can cause the autopilot to abruptly maneuver the aircraft.

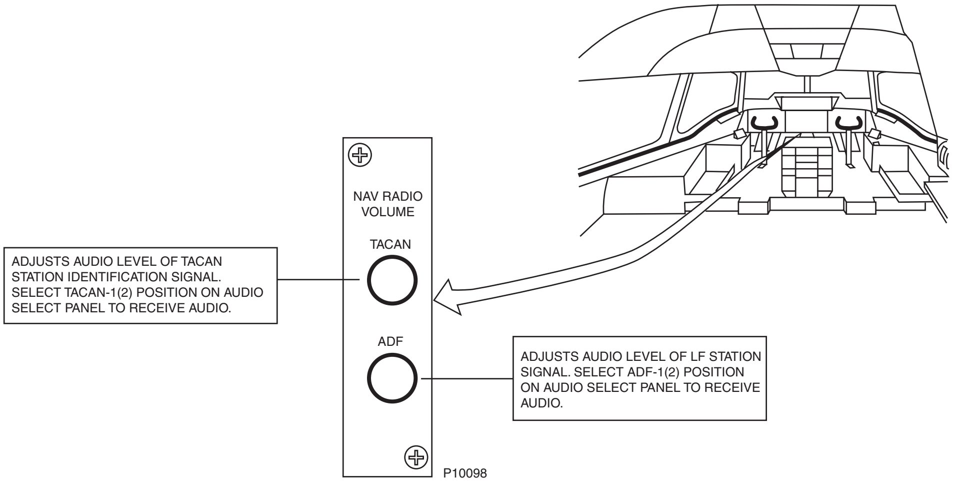


Figure 1.14-149. NAV Radio Volume Control Panel

5. Select the FMS Nav Sensor Test page. Momentarily press the TCN1 (TCN2) line selects and observe TST indication showing self-test is in progress.
6. For approximately 7 seconds, observe TACAN DME indicators are barred, EHSI Nav Fail flags are in view; EHSI and TACAN RMI bearing pointers indicate 270°.
7. After the preceding 7 second interval, observe TACAN DME indicators read 000.0 ±0.5 nm, Nav Fail flags are removed from view, EHSI course deviation bars are centered, To/From indicators indicate TO, and EHSI and TACAN RMI bearing pointers indicate 180 ±3°.
8. After 15 seconds, observe the TACAN DME striped warning bars and EHSI Nav Fail flags come back into view, unless usable signal is present.
9. If the TST indicator goes off, distance, bearing, course deviation, and To/From information is valid.

NOTE

- If the TST indicator remains on, repeat the test in R mode.
- If the TST indicator remains on in both TR and R modes, distance, bearing, course deviation, and To/From information is invalid.
- If the TST indicator remains on in TR but not in R, distance information is invalid and bearing, course deviation, and To/From information is valid.

AIR-TO-GROUND

1. Select the FMS Master Power page and toggle (verify) TACAN-1 (TACAN-2) ON.
2. Select the FMS Nav Radio 1 (2) page and toggle the operating mode for TACAN-1 (TACAN-2) to desired mode, for example, TR.
3. Set desired X channel for TACAN-1 (TACAN-2) on the FMS Nav Radio 1 (2) page.

4. Verify TACAN-1 (TACAN-2) antenna select switch set to AUTO.

5. Select TACAN-1 (TACAN-2) on Audio control panel and verify aural identification. Adjust volume on the Nav Radio Volume control panel.

6. Observe TACAN-1 (TACAN-2) relative bearing displayed by EHSI bearing pointer and No. 1 (No. 2) TACAN RMI pointer. Observe slant range distance on EHSI and No. 1 (No. 2) TACAN DME indicator.

AIR-TO-AIR RENDEZVOUS

NOTE

Methods of air-to-air TACAN Range/Bearing acquisition are provided in Tables 1 and 2 (figure 1.14-150).

Provide Bearing and Range for Receiver(s)

1. Select the FMS Nav Radio 2 page and toggle the operating mode to BCN INV.

NOTE

TACAN-2 antenna select function is disabled when an INV mode is selected.

2. Verify TACAN-2 A/A AGC switch set to ON.

NOTE

A/A AGC OFF position expands range capability.

3. Set desired Y (X) channel for TACAN-2 on the FMS Nav Radio 2 page.

NOTE

If operating channels with required 63 MHz have not been established, use radio communications to coordinate channel use.

Provide Range for Receiver(s)

1. Select the FMS Nav Radio 1 (2) page and toggle the operating mode for TACAN-1 (TACAN-2) to AATR (TR).

2. Verify TACAN-1 (TACAN-2) A/A AGC switch is set to ON.

NOTE

A/A AGC OFF position expands range capability.

3. Verify TACAN-1 (TACAN-2) antenna select switch set to AUTO.

4. Set desired Y (X) channel for TACAN-1 (TACAN-2) on the FMS Nav Radio 1 (2) page.

NOTE

Operating channels with required separation must be established for air-to-air use.

5. Observe slant range distance to nearest cooperating aircraft on No. 1 (No. 2) TACAN DME indicator and EHSI, if selected.

Derive Bearing from Receiver

1. Select the FMS Nav Radio 2 page and toggle the TACAN-2 operating mode to AA INV or BCN INV.

2. Verify TACAN-2 A/A AGC switch is set to ON.

NOTE

Bearing information is not usable with AGC OFF.

3. Set desired Y (X) channel for TACAN-2 on the FMS Nav Radio 2 page.

NOTE

Operating channels with the required separation must be established for air-to-air use.

4. Observe relative bearing to receiver displayed by the TACAN RMI No. 2 pointer (and EHSI bearing pointer if TCN2 is selected for bearing display).

NOTE

In AA INV AGC ON and BCN INV AGC ON, slant-range distance to nearest cooperating aircraft is displayed on No. 2 TACAN DME indicator (and EHSI if TCN2 is selected as bearing or navigation source).

TANKER

		A/A REC AGC ON	A/A REC AGC OFF	A/A T/R AGC ON	A/A T/R AGC OFF	A/A NORM AGC ON	A/A NORM AGC OFF	A/A INV AGC ON	A/A INV AGC OFF	BCN NORM AGC ON	BCN NORM AGC OFF	BCN INV AGC ON	BCN INV AGC OFF
RCVR	A/A REC	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	B	B
	A/A T/R	▨	▨	R	R	R	R	R	R	R	R	B/R	B/R

Table 1. Receiver equipped with AN/ARN 118(V) or equivalent.

		A/A REC AGC ON	A/A REC AGC OFF	A/A T/R AGC ON	A/A T/R AGC OFF	A/A NORM AGC ON	A/A NORM AGC OFF	A/A INV AGC ON	A/A INV AGC OFF	BCN NORM AGC ON	BCN NORM AGC OFF	BCN INV AGC ON	BCN INV AGC OFF
RECEIVER	A/A REC AGC ON	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	B	B
	A/A REC AGC OFF	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	A/A T/R AGC ON	▨	▨	R	R	R	R	R	R	R	R	B/R	B/R
	A/A T/R AGC OFF	▨	▨	R	R	R	R	R	R	R	R	R	R
	A/A NORM AGC ON	▨	▨	R	R	R	R	R	R	R	R	B/R	B/R
	A/A NORM AGC OFF	▨	▨	R	R	R	R	R	R	R	R	R	R
	A/A INV AGC ON	▨	▨	R	R	R	R	R	R	B/R	B/R	R	R
	A/A INV AGC OFF	▨	▨	R	R	R	R	R	R	R	R	R	R
	BCN NORM AGC ON	▨	▨	R	R	R	R	R	R	R	R	B/R	B/R
	BCN NORM AGC OFF	▨	▨	R	R	R	R	R	R	R	R	R	R
	BCN INV AGC ON	▨	▨	R	R	R	R	R	R	B/R	B/R	R	R
	BCN INV AGC OFF	▨	▨	R	R	R	R	R	R	R	R	R	R

Table 2. KC-10A, or receiver equipped with AN/ARN 139(V) or equivalent.

Note:

1. Table 1 and 2 are based on air-to-air modes only.
2. Enter the table using modes selected by Tanker and Receiver.
3. Each table shows what information is available to the Receiver.

Example: Tanker selects BCN INV AGC ON; Receiver selects A/A T/R or, A/A T/R AGC ON; Bearing and Range are available to the Receiver.

▨	NO INFORMATION AVAILABLE
B	BEARING
R	RANGE
B/R	BEARING AND RANGE

SA1-9A

Figure 1.14-150. TACAN Range/Bearing Available By Mode

WEATHER RADAR DESCRIPTION

The Bendix RDR-1FB Airborne Radar is a dual system multimode X-Band radar (equivalent to military I-Band, AN/APS-133) that operates in weather, beacon, and map modes, for use in weather avoidance, beacon interrogation and reception, and navigation. The system includes the antenna, control panel, dual receiver/transmitters, and dual indicators. The radar control panel (figure 1.14-151) provides for mode selection, system selection, antenna pencil or fan beam selection, antenna and R/T fault indication, receiver gain control and antenna tilt control. The indicator (figures 1.14-152 and 1.14-153) gives a video display in color and annunciates selected system mode and range in alphanumerics. The intensity of the returns is color coded and annunciated on the indicator. Each indicator operates independently and has an integral control panel for selection of range, display intensity, target clarity, display hold, variable range marker, and sweep delay. The antenna is stabilized in pitch and roll by the INS.

The radar system receives power from 115 VAC Bus 1. Circuit breakers are located on the Flight Engineer's Overhead Circuit Breaker Panel.

FUNCTIONS

Standby Mode

STBY (standby) applies power to the system and initiates the three minute time delay required for warmup. After completion of the warmup and test, or after inflight operation, STBY maintains the system in a state of readiness.

Test Mode

CAUTION

> The radar antenna may be damaged if the function switch is moved to OFF while the aircraft is in motion.

TEST provides a color video test pattern to visually check the radar system performance. The receiver/transmitter unit has self-test and integrity monitoring. If any of the monitored system functions fall below standard, the R/T or ANT fault lights illuminate and/or video test band(s) are absent.

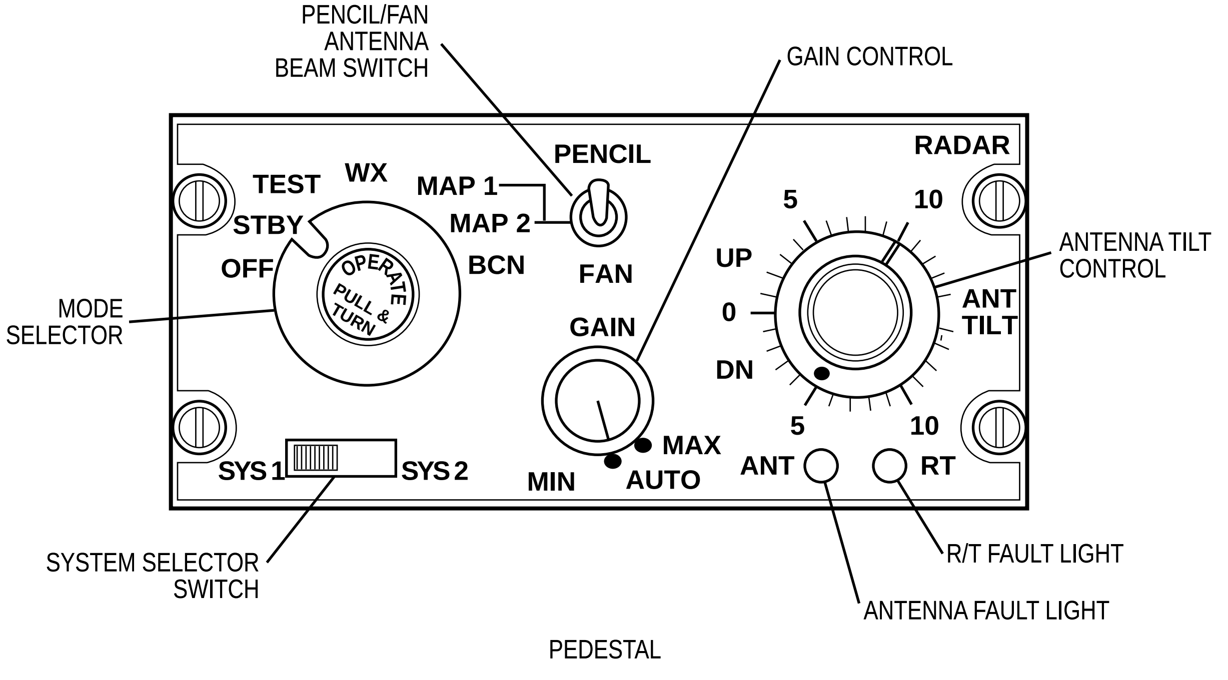


Figure 1.14-151. Weather Radar Control Panel.

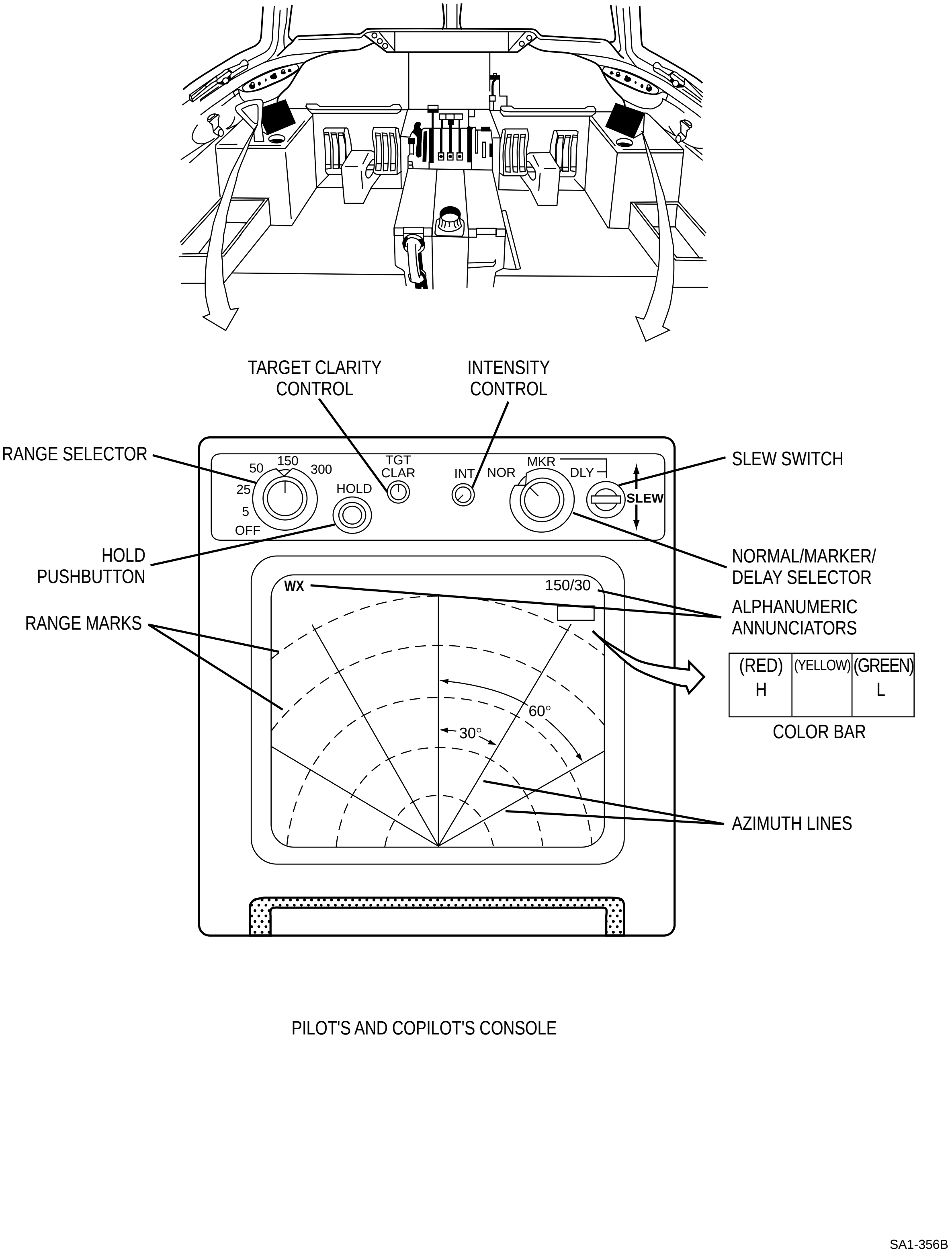


Figure 1.14-152. Weather Radar Indicator and Indicator Control Panel

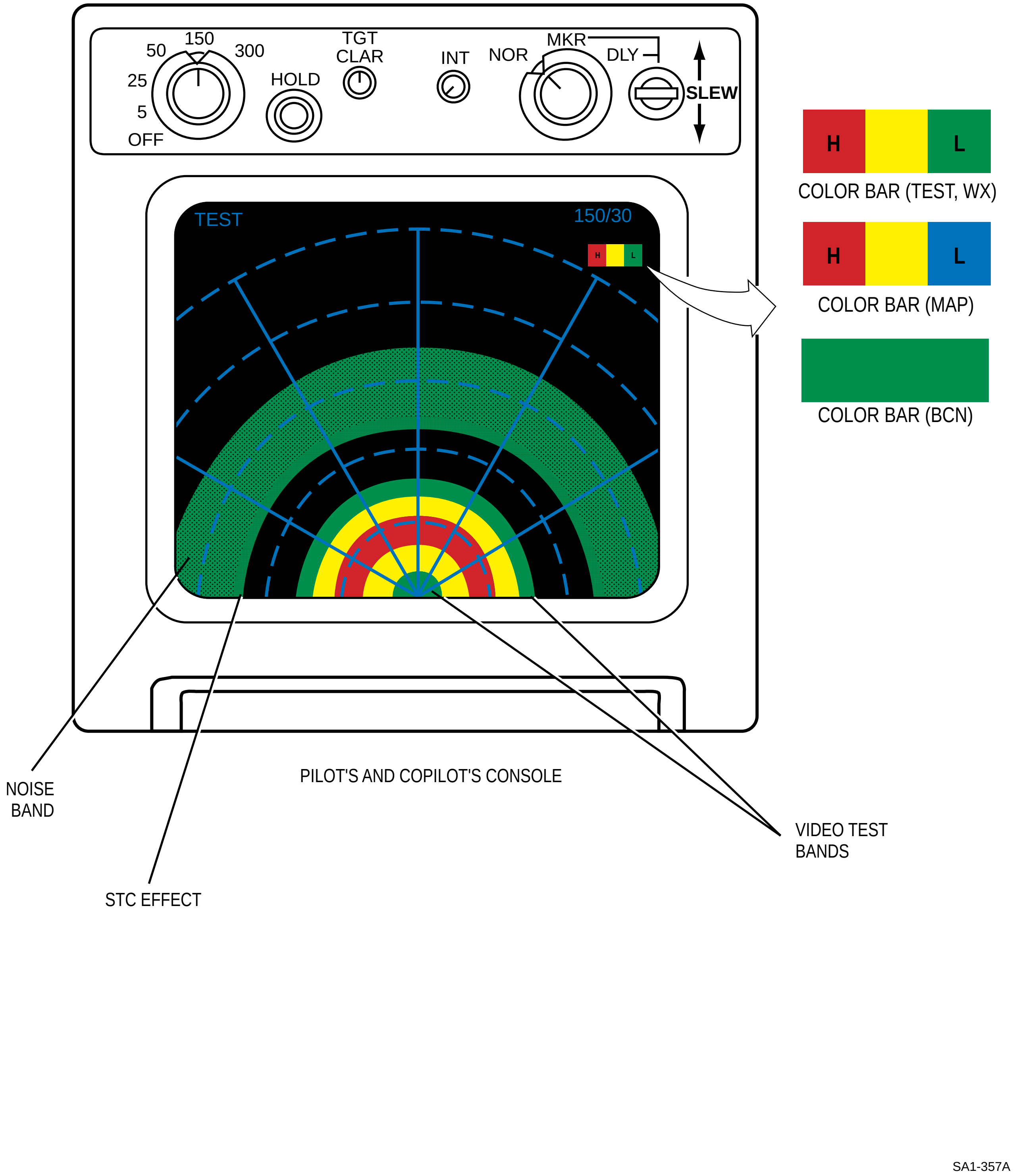


Figure 1.14-153. Weather Radar Indicator Test Pattern

Weather Mode

WX (weather) provides a visual display of significant weather at ranges out to 300 NM. Significant storms, at ranges out to 80 NM, are presented in a normalized display by circuits that eliminate the apparent size difference between equal targets at different ranges. Rainfall is displayed in red, yellow, and green, based on predetermined rates, to identify heavy, moderate, and light levels. It also provides long range, over 100 NM, ground mapping capability.

Map Modes

MAP 1 provides medium range ground mapping capability, point target examination, and air-to-air operation. A plan picture of prominent landmarks and features such as mountains, lakes, shorelines, rivers, and cities is displayed. Terrain features are displayed in red, yellow, and blue, depending on the reflectivity of the target.

Map 2 is used for low level ground mapping.

Beacon Mode

BCN (beacon) provides for rendezvous with airborne beacons and homing on ground beacons. The system transmits an interrogating signal and receives and displays the pulse-coded identification return.

CONTROL PANELS

Weather Radar Control Panel

MODE	FUNCTION
OFF	All power is removed from the system.

NOTE

To rotate selector from TEST to WX, pull and turn. Rotate to select other positions.

MODE	FUNCTION
STBY	Applies power to selected circuits in both R/T units to warm up the system and maintain it in a state of readiness. Three minute time delay is energized.

NOTE

Applying power to the system energizes the three minute time delay, regardless of the mode selected.

MODE	FUNCTION
TEST	Test circuits are energized and monitored. Transmitter radiates into a dummy load located on the R/T mounting base.
WX	System is activated for weather (WX) display. Pencil beam is activated.
MAP 1	System is activated for medium range ground mapping and air-to-air formation capability. Pencil or fan beam can be selected. STC is inhibited.

NOTE

Nominal detection range, when skin painting, is 5 NM for KC-135 size aircraft. Targets can be tracked to a minimum range of 0.5 NM.

MODE	FUNCTION
MAP 2	System is activated for low-level ground mapping. STC is enabled to prevent target smearing and reduce strength of returns. Pencil or fan beam can be selected.

NOTE

STC - time varying gain control for decreasing the sensitivity of nearby targets. This maintains the same display intensity of near targets as for similar far targets.

MODE	FUNCTION
BCN	System is activated for beacon interrogation and reception. Fan beam is activated.

CONTROL	FUNCTION
GAIN	Provides AUTO position, fully clockwise in detent, for WX mode operation. AUTO is calibrated for heavy-moderate-light levels of intensity of rainfall. When moved out of AUTO, manual control of gain/performance is provided to obtain the best target definition for MAP and BCN modes.
ANT TILT	Controls angle of elevation of radar antenna. Tilts antenna radar beam from 15° up to 15° down. Amount of tilt is shown in 1° increments.

NOTE

When adjustments are made to ANT TILT, allow at least one complete antenna scan for update of the display.

PENCIL/ FAN	Two position switch enables selection of PENCIL or FAN beam in MAP modes only.

NOTE

When changing from PENCIL to FAN beam, about 2° UP tilt is needed to compensate for the changed beam.

ANT	Indicates antenna fault in TEST when illuminated.
RT	Indicates receiver-transmitter fault when illuminated. Valid in TEST mode.
SYS1/ SYS2	Position of selector determines whether System 1 or System 2 is activated. The unselected system remains in standby.

Indicator Control Panel

Range Selector	Controls application of power and selection of ranges as follows:
OFF	Indicator turned off.
5	5 NM range, 1 NM range marks.
25	25 NM range, 5 NM range marks.
50	50 NM range, 10 NM range marks.
150	150 NM range, 30 NM range marks.
300	300 NM range, 60 NM range marks.
INT (Intensity)	Continuously variable knob controls brightness of video display.
HOLD	Pushing HOLD pushbutton freezes display in any mode. HOLD mode is indicated by an alternating display of HOLD and selected radar system mode in upper left corner of indicator. Pushing HOLD a second time returns display to scan. Indicator is always in scan at startup.
TGT CLAR (Target Clarity)	Fine adjustment for first-level (green data in WX and BCN, blue data in MAP) radar returns only. Allows reduction of extraneous background noise.

NOTE

Permits fine adjustment to reduce noise level/ background, to enhance return. Rotating CCW decreases threshold, CW increases.

NOR-MKR-DLY (Normal-Marker-Delay)	NOR	Normal display. No variable range marker or sweep delay.
	MKR	Yellow marker is displayed on the indicator. The marker range is displayed in the upper right corner of the display. Marker range is increased/decreased using the SLEW switch.
	DLY	Indicator sweep is delayed by the range displayed in the upper right corner of the display. Sweep delay range is increased/decreased using the SLEW switch.

NOTE

In MKR and DLY positions, range resolution is 0.1 NM in the 5 NM range and 1 NM for all other ranges.

↑ (SLEW) ↓	Variable rate SLEW switch. Increases or decreases range of variable marker or sweep delay, in MKR and DLY modes, respectively.

NOTE

- SLEW switch is spring loaded to center off position.
- The yellow marker moves slowly at first and then fast, when the SLEW switch is held in position.

Indicator (CRT)

Alphanumerics	Upper right corner of indicator displays selected range and range marks. Displays range of variable marker or sweep delay, when selected. Upper left corner of indicator displays selected radar system mode. MKR and DLY, when selected, are also displayed.

NOTE

- Alphanumerics are green in MAP and blue in WX and BCN modes.
- When a question mark (?) is displayed in place of the selected system mode, select the other radar system or use the other indicator, as required.

Color Bar	The color bar is displayed in the upper right corner of the indicator, identifying the intensity of radar returns. Loss of a color from the color bar indicates loss of the corresponding color band from the indicator. An H and L are displayed within the bar, on the left and right respectively, to identify color with intensity.

NOTE

H and L are not annunciated in BCN.

In TEST the color sequence is red-yellow-green.

In WX the color sequence is red-yellow-green for heavy-moderate-light rainfall returns.

In MAP the color sequence is red-yellow-blue for high-intermediate-low reflectivity target returns.

In BCN the bar is green for beacon returns.

Azimuth Lines	Electronically generated in all modes indicating aircraft heading, 30° and 60° left and right of aircraft heading.

NOTE

Azimuth lines are green in MAP and blue in WX and BCN modes.

RANGE Marks	Five range marks are electronically generated and displayed in all modes. Selected range and distance between range marks are annunciated on the indicator.

NOTE

Range marks are green in MAP and blue in WX and BCN modes.

PREDEPARTURE

Turn On, Warmup and Test

1. Rotate mode selector knob to STBY.

WARNING

Do not select WX, MAP 1, MAP 2, or BCN unless personnel are clear of antenna radiation area. Do not direct energy beam toward inhabited structures, personnel, or aircraft refueling/defueling areas. Do not operate radar during refueling.

2. Move system selector switch to SYS 1.
3. Rotate GAIN control knob to AUTO.
4. Rotate ANT TILT control knob to full UP.
5. Rotate INT control knob to the midrange position.
6. Rotate TGT CLAR control knob to the midrange position.
7. Rotate range selector knob to 150 NM.
8. Rotate mode selector knob to TEST, adjust INT, and observe test pattern on indicator. Observe five distinct video color bands; green, yellow, red, yellow, green in the lower one-third of the indicator with blue alphanumerics, azimuth lines and range marks. Absence of color band(s) indicates a fault either in the R/T or indicator.

NOTE

- The three minute time delay must expire before the test pattern can be interpreted.
- In TEST the transmitter output is switched into a dummy load to protect ramp personnel and to eliminate RF interference to other equipment.

9. Observe coarse green noise band/return between 80 and 100 NM range. Rotate TGT CLAR control knob and observe that the noise level in the noise band varies.

NOTE

Absence of graduated increase of green noise from 50 to 80 NM range indicates STC malfunction. Absence of entire noise band indicates fault in either the R/T or ANT.

10. Move system selector switch to SYS 2 and repeat steps 8 and 9.
11. Rotate mode selector knob to STBY.
12. Select SYS 1 or SYS 2 as desired.

Taxi

Verify mode selector knob set to STBY.

Before Takeoff

Aircraft taxied to takeoff position (weather avoidance operation).

1. Verify mode selector knob set to WX.
2. Verify GAIN control knob set to AUTO.
3. Verify NOR-MKR-DLY selector knob set to NOR.
4. Verify range selector knob set to desired range.
5. Rotate ANT TILT control knob to paint ground clutter.
6. Rotate INT control knob for desired intensity.
7. Rotate ANT TILT control knob to slowly tilt antenna to full UP and then back to 0°, observing the indicator for weather targets. If weather targets are observed, select best tilt setting for weather display and plan weather avoidance prior to takeoff.

NOTE

> ANT TILT adjustments of 1/4° can make a significant change in weather return presentation. Make slight tilt adjustments to obtain greatest signal return from storm(s).

Aircraft taxied to takeoff position (ground mapping operation).

1. Verify mode selector knob set to MAP 1.
2. Verify NOR-MKR-DLY selector knob set to NOR.
3. Verify range selector knob set to desired range.
4. Move PENCIL/FAN antenna beam switch to FAN.
5. Rotate ANT TILT control knob for best terrain presentation.

DEPARTURE

WX Mode

After takeoff it may be necessary to readjust ANT TILT to keep radar beam on weather target. Make slight tilt adjustments, as altitude increases, until cruise altitude is reached. After course change of 45° or more, slowly tilt antenna to full UP and then down until ground clutter shows in outer part of the weather display. Continue observing weather targets and plan weather avoidance.

MAP Mode

To maintain ground mapping returns during climb to cruise altitude, antenna tilt adjustments may be necessary. Adjust antenna tilt in 1/2° increments. Allow sufficient time between adjustments for at least one complete antenna scan to allow the indicator to display new data. Continue adjusting the antenna tilt until desired ground/terrain return is displayed.

CRUISE

WX Mode

To evaluate weather in the flight path, select the shortest range to be used and tilt the antenna down until ground returns appear at the outer edge of the indicator display. Repeat through each succeeding range to the longest range to be used, observing/evaluating the weather returns. Repeat procedure if a course change of 45° or more is made.

CAUTION

> Precipitation-induced X-Band radar attenuating limits the ability of airborne weather radar to detect the extent and intensity of weather disturbances. Attenuation is the loss of radar signal as the signal travels through precipitation. The precipitation diffuses the signal and reduces the receiver's ability to detect the signal return. The amount of signal dissipation is directly proportional to the rate of rainfall. It is possible for a storm cell to mask another cell, which could be larger and/or more intense.

NOTE

> Select the shortest range for the weather to be evaluated. The shortest range gives the best resolution of weather echoes.

WX mode detects and displays droplets of precipitation which are generally associated with areas of turbulence and severe weather. The various levels of precipitation are displayed on the indicator as heavy, moderate, and light. The red contoured areas are heavy rainfall, over 12 mm/hr, yellow is moderate rainfall, from 4-12 mm/hr; and green is light rainfall, from 1-4 mm/hr.

NOTE

- Mountains, cities and other targets frequently return echoes strong enough to cause the contour circuit to paint red.
- Black represents no return, or signal below minimum discerning threshold.
- Radar echoes that have a thin line between the contour portion and the outer edge of the echo are usually associated with more severe turbulence.
- Storm associated turbulence can extend several thousand feet above a storm and outward more than 20 miles.
- Some shapes are strong indicators of hail shafts, such as U-shape, thin protruding fingers, scalloped edges, and hooks, and change very rapidly.

Map (Navigation) Mode

Medium Range Ground Mapping.

1. Rotate mode selector knob to MAP 1.
2. Verify GAIN control knob set to AUTO.

NOTE

> Compare initial returns, using AUTO GAIN, to returns using manual GAIN. Under some conditions, manually adjusting GAIN improves range and returns. Use the position that gives the best results.

3. Move PENCIL/FAN antenna beam switch to FAN.
4. Rotate range selector knob to desired range, out to a maximum of 150 NM.

NOTE

> Use WX mode for ground mapping for ranges over 100 NM.

5. Rotate ANT TILT control knob in 1/2° increments and adjust for best terrain presentation, depending on altitude and area of coverage desired.

NOTE

> Smooth water such as bays, lakes, and large rivers have little reflectivity and appear as dark areas. At normal cruise altitude fields and farms appear as blue (green in WX mode) returns; hills and small towns appear as yellow returns; and mountains and large cities appear as red returns.

Low Level Ground Mapping.

1. Rotate mode selector knob to MAP 2.
2. Verify GAIN control knob set to AUTO.

NOTE

> Compare initial returns, using AUTO GAIN, to returns using manual GAIN. Under some conditions, manually adjusting GAIN improves range and returns. Use the position that gives the best results.

3. Verify PENCIL/FAN antenna beam switch set to FAN.
4. Rotate range selector knob to desired range.
5. Rotate ANT TILT control knob in 1/2° increments to obtain most uniform display of terrain.

Short Range Air-to-Air Operation.

1. Rotate mode selector knob to MAP 1.
2. Verify GAIN control knob set to AUTO.
3. Verify PENCIL/FAN antenna beam switch set to FAN.
4. Set ANT TILT to 5° UP if target is at same flight level, or slightly above. As target's position changes, adjust ANT TILT UP or DN for strongest target return.

NOTE

As range closes, the vertical angle between the aircraft changes. Adjust ANT TILT to keep beacon within the radar beam.

5. Rotate range selector knob to 25 NM.

6. Verify TGT CLAR control knob set to midrange. Adjust to slight overall background noise level as needed.

NOTE

As target range closes, the return changes from blue to yellow to red. To reduce sensitivity and prevent target return from smearing, manually reduce GAIN to provide a yellow or blue return.

BCN Mode

Rendezvous Operation

1. Rotate mode selector knob to BCN.

2. Verify NOR-MKR-DLY selector knob set to NOR.

3. Verify GAIN control knob set to AUTO.

4. Verify TGT CLAR control knob set to midrange. Adjust to slight overall background noise level as needed.

5. Rotate range selector knob to 300 NM, unless beacon is known to be a shorter range.

NOTE

Minimum acquisition range of APN-69, APX-78, or equivalent performance I-band transponders, is 150 NM.

6. Rotate ANT TILT control knob to 0°. Adjust UP or DN as required for strongest beacon return.

7. Rotate range selector knob to 150 NM, when beacon range is less than 150 NM. As beacon range decreases, select appropriate indicator range to keep beacon return in upper half of display.

NOTE

- To prevent smearing of beacon returns at ranges of 5 NM or less, manually reduce GAIN, or tilt antenna UP.
- Select DLY function to expand beacon returns for identification.

When target range is 5 NM or less, short range air-to-air operation may be used to skin paint KC-135 size aircraft.

MKR/DLY Function

When MKR (marker) is selected, a yellow variable range marker (cursor) is generated and displayed on the indicator. The cursor can be moved a distance of 0.1 NM up to 300 NM by use of the SLEW switch. The upper left corner of the indicator displays system mode and MKR. The upper right corner of the indicator displays the range of the cursor. The range is in increments of 0.1 NM between 0.3 and 5 NM in the 5 NM range and in increments of 1 NM from 5 to 300 NM ranges.

When DLY (delay) is selected, the sweep is delayed so that it starts at the range where the variable range marker (cursor) was located when in MKR. The display shows returns over the range selected, starting from the sweep delay range. The upper left corner of the indicator displays system mode and DLY. The upper right corner of the indicator displays the sweep delay range.

DLY provides an expansion for viewing returns in fine detail at any range. Figure 1.14-154 illustrates a BCN return and MKR operation with the cursor at 25 NM with 50 NM range selected on the indicator. Selecting DLY and 5 NM range expands the presentation starting at the sweep delay range of 25 NM, allowing finer definition for BCN code examination.

NOTE

- Range to the beacon is measured to the first pulse of the code group.
- In DLY the sweep delay range is changed by the SLEW switch, but the cursor is not displayed.

DESCENT/APPROACH

Prior to descent note tilt setting. Adjust the antenna tilt up 1° for each 10,000 feet of descent to keep the display relatively clear of ground clutter. At approximately 15,000 feet, when flying over exceptional terrain, such as mountains, cities, etc. it may be necessary to adjust tilt up 1° for each 5,000 feet of descent.

After Landing

Rotate mode selector knob to STBY.

CAUTION

> The radar antenna may be damaged if the function switch is moved to OFF while the aircraft is in motion.

Post Flight/Shutdown

Rotate mode selector knob to OFF.

OPERATING LIMIT

The altitude operating limit for the R/T's and indicators is 20,000 feet maximum unpressurized. The antenna is limited to 55,000 feet maximum with internal waveguide pressurized to 10,000 feet maximum cabin altitude.

I-BAND AND J-BAND RADAR TRANSPONDER SYSTEMS DESCRIPTION

The I-band and J-band radar transponder (figure 1.14-155) systems provide a navigation aid for receiver aircraft to rendezvous with the tanker. The transponder receives interrogations and transmits reply pulses for display on the receiver's radar indicator. The receiver's beacon display can provide identification and range and bearing to the tanker. Identification code selection is provided on the transponder control panel. The transponder operating transmit and receive frequencies are preset by the factory/shop. Operation of the system can only be checked by the flight line test, or confirmed by radio communication during use.

Each system consists of a transponder control unit on the Overhead Panel, receiver/transmitter in the aft fuselage, and antenna with interconnecting waveguide in the vertical stabilizer.

I-band receives power from 28 VDC Bus 1 and J-band from 28 VDC Bus 3. Circuit breakers are located on Flight Engineer's Overhead Circuit Breaker Panel.

FUNCTIONS

I-band has both ENCODE and DECODE capability. DECODE provides for verification of the interrogation before any reply is transmitted. The DECODE selector allows selection of either a single interrogation pulse (position 1), or one of ten different dual pulses, that have different pulse spacings. ENCODE provides for selection of either a single-pulse reply (position 1), or one of five different dual pulse replies, that have different pulse spacings. J-band has only ENCODE capability and responds to all interrogations on the pretuned frequency. ENCODE provides for selection of either a single pulse reply (position 1), or one of fifteen different mnemonic time-spaced pulse-coded replies. The replies can have as many as five pulses. For example, code 14 represents mnemonic 2-1-2 and consists of two pulses, space, one pulse, space and two pulses.

OPERATION

1. If possible, rotate POWER selector knob to standby (STBY), approximately five minutes before initiation of rendezvous.

NOTE

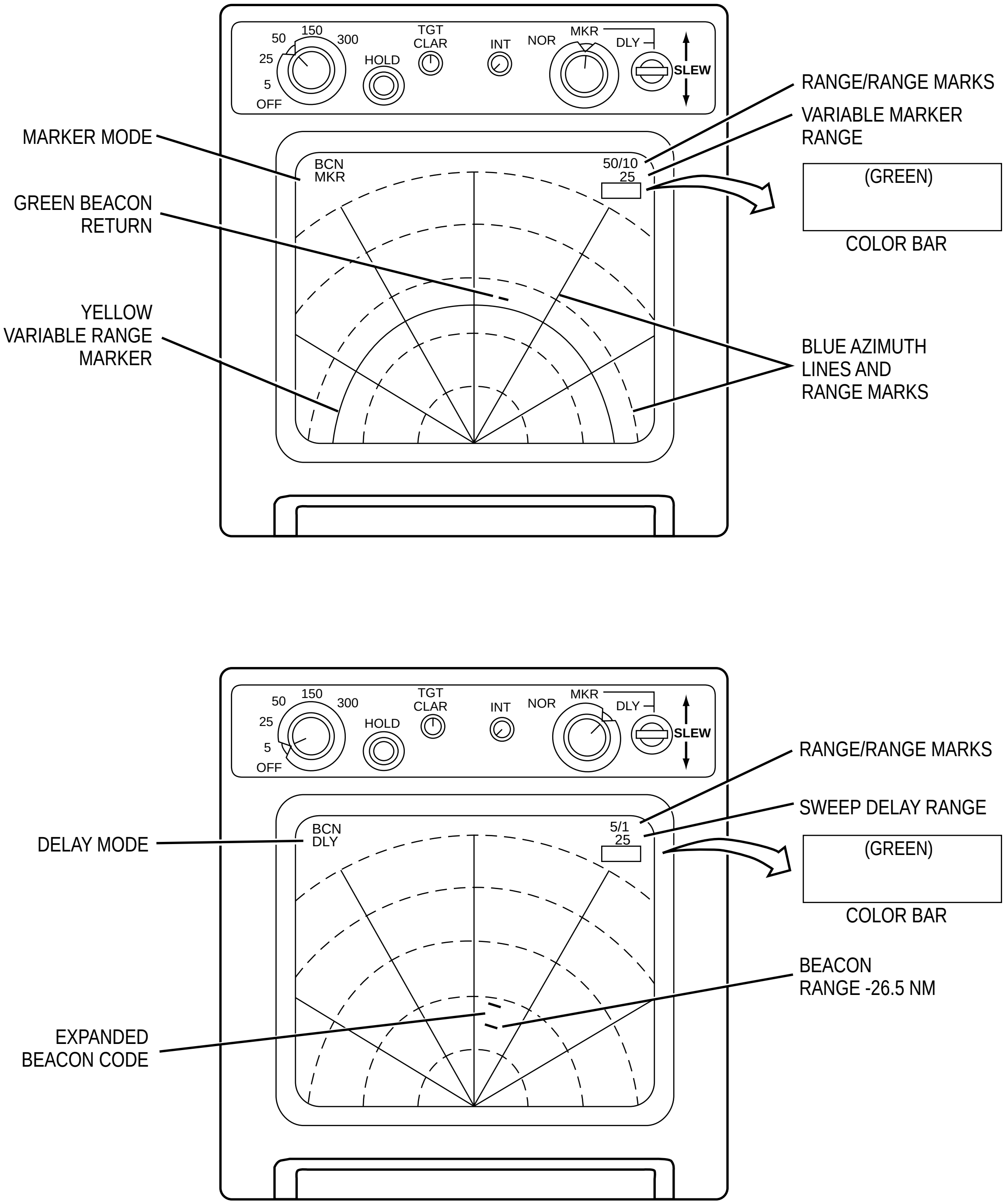
> If the POWER selector is rotated from OFF to OPR, a 2-minute time delay prevents operation of the transponder, until it has warmed up and stabilized.

2. Rotate ENCODE and DECODE (ENCODE only for J-band) selector knob(s) to desired setting(s).

NOTE

> Mnemonic time-spaced pulse-coded replies are preset in the transponder control unit.

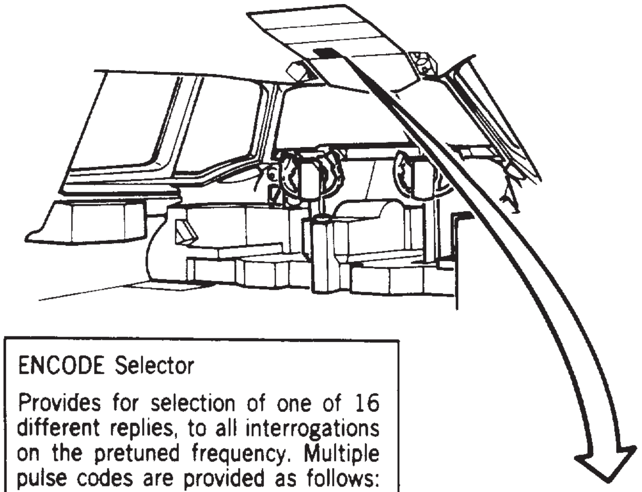
3. Rotate POWER selector knob to operate (OPR), at initiation of rendezvous.
4. Rotate POWER selector knob to OFF when receiver has visual contact.



PILOT'S AND COPILOT'S CONSOLE

SA1-358B

Figure 1.14-153. Variable Range Marker and Delay Mode Display



ENCODE Selector

Provides for selection of one of 16 different replies, to all interrogations on the pretuned frequency. Multiple pulse codes are provided as follows:

CODE	REPLY PULSE
1	1-0-0
2	1-0-1
3	1-0-2
4	1-0-3
5	2-0-1
6	2-0-2
7	1-1-1
8	1-1-2
9	1-1-3
10	1-2-1
11	1-2-2
12	1-3-1
13	2-1-1
14	2-1-2
15	2-2-1
16	3-1-1

POWER Selector

OFF – Removes power from system.

STBY – Allows system to warm up and stabilize.

OPR – Transponder responds to appropriate interrogation pulses.

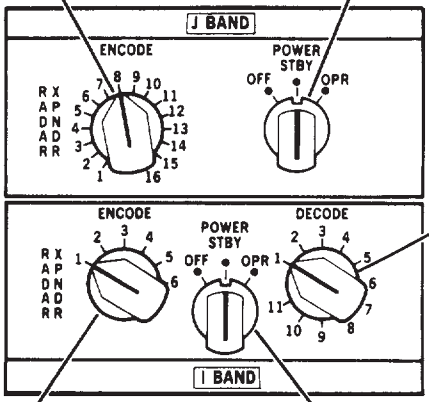
NOTE

If POWER selector set directly to OPR, a two minute time delay keeps system in standby to warm up and stabilize.

DECODE Selector

Provision for verification of 11 different interrogation pulses, before reply is transmitted.

CODE	RADAR TARGET WIDTH
1	0.25 inch
2	0.35 inch
3	0.45 inch
4	0.55 inch
5	0.65 inch
6	0.75 inch
7	0.85 inch
8	0.95 inch
9	1.05 inch
10	1.15 inch
11	1.35 inch



OVERHEAD PANEL

ENCODE Selector

Provides for selection of one of 6 different replies, to decoded interrogation pulses. The encoding (reply) pulses are as follows:

CODE	NOMINAL SPACING
1	(Single Pulse)
2	4 miles
3	6 miles
4	8 miles
5	10 miles
6	12 miles

POWER Selector

OFF – Removes power from system.

STBY – Allows system to warm up and stabilize.

OPR – Transponder responds to appropriate interrogation pulses.

NOTE

If POWER selector set directly to OPR, a two minute time delay keeps system in standby to warm up and stabilize.

SA1-408C

Figure 1.14-155. I-Band/J-Band Radar Transponders

AUTOMATIC DIRECTION FINDING SYSTEM DESCRIPTION

There are two independent automatic direction finding systems, ADF-1 and ADF-2. Each system includes an ADF receiver, FMS control software, loop antenna, sense antenna coupler, radio magnetic indicator (RMI), and RMI ADF-1 UHF/LF switch (figure 1.14-156). ADF-1 receives power from 28 VAC Bus 1 and 28 VDC Bus 1. ADF-2 receives power from 28 VAC Bus 3 and 28 VDC Bus 3. Circuit breakers are located on the Flight Engineer's Overhead Circuit Breaker Panel. The UHF direction finding function is used in conjunction with the ADF.

FUNCTIONS

Each system provides for selection of LF ranges and commercial broadcast stations and is controlled separately through the FMS CDU (see FLIGHT MANAGEMENT SYSTEM DESCRIPTION, this part, for functional control description).

NOTE

> VOR/ADF selector knobs on each RMI must be rotated to ADF to display ADF bearing information. EHSI bearing source may be set to ADF to display ADF bearing information.

Two antenna selections are available: ADF or nondirectional ANT. An aural signal can be selected to aid in station identification. Volume control is provided through the Nav Radio Volume control panel located on the forward pedestal (figure 1.14-149).

The UHF direction finding function uses RMI ADF-1 pointer when UHF is selected on RMI ADF-1 UHF/LF switch.

NOTE

> VOR/ADF-1 selector is rotated to ADF to provide DF relative bearing. UHF function selector on UHF radio panel is set to ADF.

ADF mode functions are as follows:

MODE	FUNCTION
OFF	Power removed from system.
ON	Power applied to system.
ANT	Nondirectional antenna used for station identification or monitoring of commercial broadcast stations.
ADF	Antenna automatically seeks signal and continuously displays relative bearing on RMI and EHSI.
TONE OFF	Unmodulated signals are received.

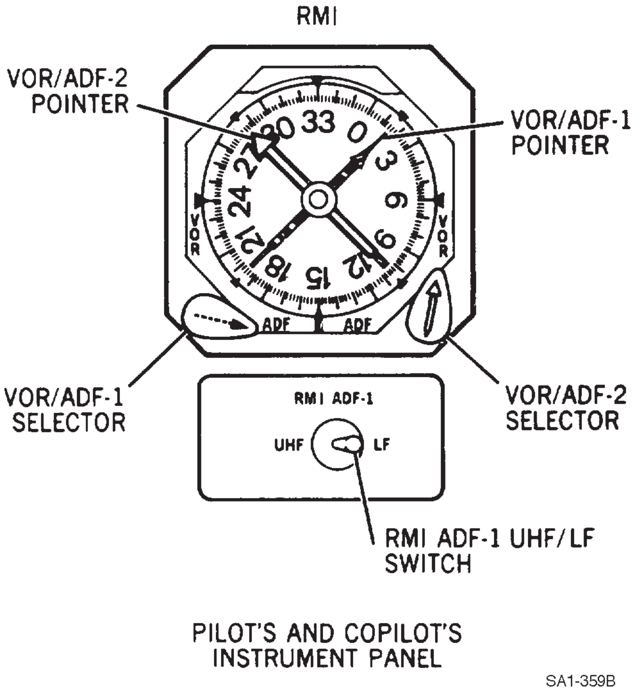


Figure 1.14-156. Pilot's and Copilot's RMI and RMI ADF-1 UHF/LF Switch

TONE ON	An aural signal is superimposed on the unmodulated carrier waves to aid in station identification.

OPERATION

1. Select the FMS Master Power page and toggle ADF1 (ADF2) to ON.
2. Select the FMS Nav Radio 1 (2) page and toggle the ADF1 (ADF2) MODE to ANT.
3. Set the desired frequency for ADF1 (ADF2).
4. Select ADF1 (ADF2) audio on the audio control panel (figure 1.14-157).
5. Adjust volume as desired on the Nav Radio Volume control panel (figure 1.14-149).
6. Verify RMI ADF-1 UHF/LF switch is set to LF. Select ADF as the bearing source on the EHSI, if desired.
7. Toggle ADF1 (ADF2) TONE to ON as needed and verify aural identification signal is the tuned station.
8. Toggle the ADF1 (ADF2) MODE to ADF and rotate the RMI VOR/ADF selectors to ADF. Observe RMI bearing pointers move to station relative bearing.

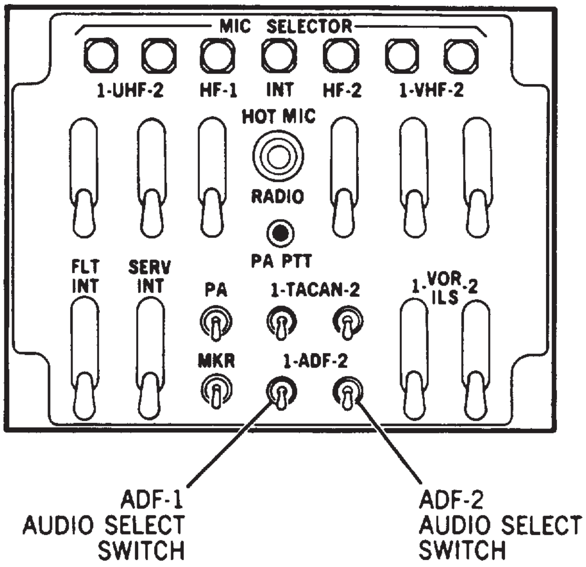


Figure 1.14-157. Audio Control Panel

ENHANCED TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (ETCAS)

The ETCAS is a standard TCAS II system with the enhanced capability of providing a station keeping display that may be used in formation flying. TCAS is used to detect and track other transponder-equipped aircraft in the vicinity to determine possible collision hazard. The enhanced portion of the system allows the crew to designate formation members so they may be readily identified. Intruding aircraft without operating transponders will not be detected by the TCAS. The system interrogates other aircraft transponders and analyzes the replies to determine range, bearing, rate of closure, and (if the other transponders are reporting altitude) the vertical speed and relative altitude of the other aircraft. The system then computes the time to and separation from the intruder at the closest point of approach (CPA). If the computation predicts a violation of certain programmed safe boundaries, a visual and aural traffic advisory (TA) is issued to the flight crew. If the intruding aircraft continues to close, the system issues a visual and aural resolution advisory (RA) to maintain safe vertical separation.

RAs are based on the least amount of deviation from the flight path while providing safe vertical separation. The system expects a five-second crew reaction time to an initial RA, and may require an approximately ±0.25G maneuver to satisfy the advisory. The system also reacts to changes in intruding aircraft movement and will issue an RA reversal command (change from climb to descent, and vice versa) or an increased rate of climb or descent, as required to ensure safe vertical separation. A subsequent command for an increased of rate of climb or descent, or a reversal from a climb to a descent requires a 2.5 second reaction time and may require up to a ±0.35G maneuver to satisfy the advisory.

NOTE

> The ETCAS processor is programmed with the maximum altitude at which the aircraft can climb at 1500 feet per minute or greater (set at 32,000 feet). CLIMB or INCREASE CLIMB RAs will be inhibited when the desired maneuver would exceed this capability.

The crew should not initiate evasive maneuvers based only on the TVSI traffic display or only on TA without visually sighting the traffic; however, during climb or descent, modest changes in vertical speed based on traffic display information are not considered evasive maneuvering. If a TCAS RA is issued, maneuver the aircraft to place the TVSI vertical speed pointer within the green arc. Notify ATC you are maneuvering in response to a TCAS RA. ATC clearance deviations are authorized to the extent necessary to comply with the TCAS RA.

WARNING

> Always comply with a TCAS RA unless the pilot considers it unsafe to do so or has better information about the source of the RA and can maintain safe separation.

When traffic has cleared (aural "Clear of Conflict" advisory), expeditiously return to the applicable ATC clearance unless otherwise directed by ATC.

The system can track up to 45 aircraft, display up to 12, and can coordinate an RA for up to three intruders simultaneously. The system automatically scans within an approximately 40 NM radius of the aircraft and up to 12,700 feet above and below the aircraft; in a high-density area, the scan area of the aircraft may be reduced to approximately 15 NM. The system calculates the closure rate of intruding aircraft and derives the CPA; if there is no closure rate, the system may issue no TA or RA unless the traffic is very close (within approximately 1/4 mile). However, traffic at a conflicting altitude far ahead may generate an RA because of a very rapid closure rate.

If a conflict occurs between TCAS-equipped aircraft, the systems will coordinate RAs using the Mode S transponder link. This ensures complementary advisories are issued to each aircraft; that is, if one system issues a CLIMB advisory, the other will issue a DESCEND advisory. The systems will share the required maneuver; that is, if a 1000 fpm rate of vertical separation is required for collision avoidance, one system may issue a 500 fpm CLIMB advisory, and the other a 500 fpm DESCEND advisory.

WARNING

> Do not maneuver in the opposite direction of an RA, since there is no way of knowing whether or not the intruding aircraft is TCAS-equipped; failure to comply with the RA could further complicate the collision avoidance problem and interfere with safe vertical separation.

The ETCAS consists of an upper and lower antenna, an ETCAS processor, a combined IFF/Mode S transponder, an IFF/ETCAS control panel (figure 1.13-2), a combined EGPWS/TCAS cockpit speaker, and two TCAS/Vertical Speed Indicators (TVSIs). All ETCAS visual advisories are displayed on the TVSIs (figure 1.14-158) located on the pilot's and copilot's instrument panels. These multifunction electronic indicators replace the standard vertical speed indicators. The TVSI range pushbuttons allow range selections of 1, 3, 5, 10, 20, and 40 NM. Aural advisories are heard from the cockpit speaker.

The ETCAS processor receives input signals from the IFF/Mode S transponder, enhanced ground proximity warning system (EGPWS), central air data computers, radio altimeters, INU attitude and heading, and landing gear lever position.

The ETCAS processor receives power from the 115-volt AC BUS 1. The pilot's TVSI receives power from the 115-volt LEFT EMERGENCY AC BUS; the copilot's TVSI receives power from the 115-volt RIGHT EMERGENCY AC BUS.

TCAS Aural Advisories

Simultaneously with the visual advisories, appropriate computer-generated aural advisories are transmitted through the cockpit speaker. See figure 1.14-159 for a summary of aural advisories.

NOTE

- All TCAS aural warnings are inhibited below 900 feet radio altitude on approach and up to 1100 feet radio altitude on departure.
- Enhanced Ground Proximity Warning System (EGPWS) aural warnings will have precedence over TCAS aural advisories. In case of simultaneous aural requirements, the TCAS will enter the TA-only mode and the TVSI will annunciate TA ONLY in blue at the lower left of the display.

TCAS Visual Advisories

Visual advisories consist of traffic symbols with associated alphanumeric and graphic information. The traffic symbols change shape and color to indicate increasing levels of urgency. Tagged formation members are identified by a box around the applicable traffic symbol.

If the intruding aircraft's transponder is reporting altitude, the altitude of the intruding aircraft relative to your aircraft will be displayed immediately adjacent to the traffic symbol; the altitude preceded by a plus sign (+) will be displayed above the traffic symbol if the traffic is above your aircraft, and beneath the symbol preceded by a minus sign (-) when the traffic is below your aircraft. If the intruding aircraft is climbing or descending at 500 feet per minute or greater, an arrow will appear to the right of the traffic symbol to indicate direction of altitude change.

If an intruding aircraft's transponder is not reporting altitude, the TCAS will display range and bearing only; the system can issue a TA based on range and direction of flight, but will not generate RAs without altitude information. Non-altitude reporting aircraft will not be displayed when your aircraft is above 14,500 feet.

In the ETCAS mode, if the intruding aircraft (or formation member) idents, the corresponding traffic symbol blinks for 15 seconds.

If TCAS direction finding techniques fail to locate the azimuth of an intruding aircraft, a NO BEARING message will be displayed on the TVSI.

NOTE

- Since the nose gear would interfere with bearing determination, the TCAS switches the lower antenna to a nondirectional mode when the landing gear is down. In this case a NO BEARING message will be displayed when traffic is detected below the aircraft.

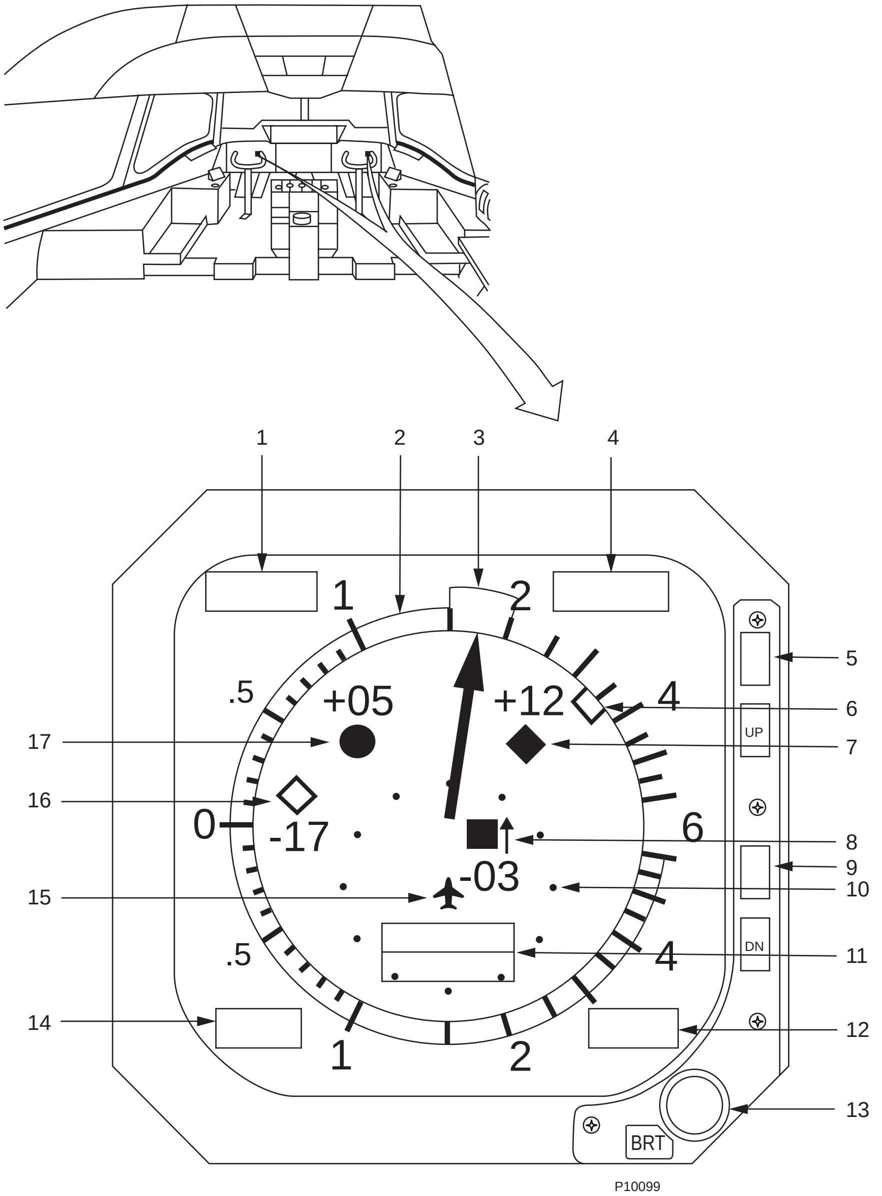
- Non-threat traffic is defined as traffic with a relative altitude greater than ±1200 feet or a distance beyond 6 NM; it is indicated by an open white diamond and associated white alphanumerics.
- Proximity intruder traffic is defined as traffic with a relative altitude within ±1200 feet and within 6 NM range; it is indicated by a solid white diamond and associated white alphanumerics.
- A Traffic Advisory (TA) is indicated by a solid yellow circle and associated yellow alphanumerics, and represents traffic that the system considers a potential hazard. Above 30,000 feet, a TA will be displayed when the conflicting traffic relative altitude is within ±1200 feet; below 30,000 feet, the relative altitude limit is reduced to ±850 feet. Depending on altitude, a TA will be displayed when the time to CPA is between 20 and 48 seconds, and will normally precede an RA (if required) by 10 to 15 seconds. The first displayed TA will be accompanied by an associated "Traffic, Traffic" aural advisory; subsequent additional TAs will have a single "Traffic" advisory.
- A Resolution Advisory is indicated by a solid red square and associated red alphanumerics, and represents traffic that the system has projected to be a collision threat. Depending on altitude, the time to CPA will be between 15 and 35 seconds.

An RA will also be accompanied by a vertical separation maneuver display (red and green arcs) on the TVSI and a matching aural warning.

NOTE

- All RAs are inhibited below 900 feet descending or 1100 feet ascending (TA ONLY will be annunciated on the TVSIs).
- INCREASE DESCENT RAs are inhibited below 1450 feet AGL.

Examples of TA and RA displays (along with appropriate aural advisories) are shown in figure 1.14-160.



1. ABOVE/BELOW DISPLAY AREA
2. RA RED ADVISORY ARC
3. RA GREEN ADVISORY ARC
4. TCAS RANGE DISPLAY AREA
5. RANGE UP PUSHBUTTON
6. OUT-OF-RANGE TRAFFIC SYMBOL
7. PROXIMITY INTRUDER TRAFFIC SYMBOL (WHITE)
8. RESOLUTION ADVISORY (RA) TRAFFIC SYMBOL (RED)
9. RANGE DOWN PUSHBUTTON
10. TWO MILE RANGE MARKS (BLUE)
11. NO BEARING MESSAGE BLOCKS
12. VSI FAILURE DISPLAY AREA
13. BRIGHTNESS CONTROL
14. TCAS MODE AND FAILURE DISPLAY AREA
15. AIRPLANE SYMBOL
16. NONTHREAT TRAFFIC SYMBOL (WHITE)
17. TRAFFIC ADVISORY (TA) TRAFFIC SYMBOL (YELLOW)

Figure 1.14-158. TCAS Vertical Speed Indicator (TVSI)

CONDITION	MESSAGE	MEANING
TRAFFIC ADVISORY (TA)	"Traffic, Traffic" ❶	An intruding aircraft is detected which is a potential hazard. (A matching yellow TA traffic symbol is displayed on the TVSI.)
RESOLUTION ADVISORY (RA)	(AS DESCRIBED BELOW)	An intruding aircraft is detected which is a potential collision threat. (A matching red RA traffic symbol is displayed on the TVSI.)
RA CLEARED	"Clear of Conflict"	Intruding aircraft traffic no longer represents a collision threat.
INITIAL ADVISORIES		
CLIMB	"Climb, Climb"	Vertical separation from an intruding aircraft can best be accomplished by climbing at the rate commanded on the TVSI.
DESCENT	"Descend, Descend"	Vertical separation from an intruding aircraft can best be accomplished by descending at the rate commanded on the TVSI.
CROSSOVER CLIMB	"Climb, Crossing Climb. Climb, Crossing Climb"	Your aircraft will climb through the altitude of the intruding aircraft. Vertical separation can best be accomplished by climbing at the rate commanded on TVSI.
CROSSOVER DESCENT	"Descend, Crossing Descend. Descend, Crossing Descend"	Your aircraft will descend through the altitude of the intruding aircraft. Vertical separation can best be accomplished by descending at the rate commanded on the TVSI.
VERTICAL SPEED RESTRICTED (CLIMBING OR DESCENDING)	"Adjust Vertical Speed, Adjust"	Issued when already climbing/descending and intruding aircraft is above/below your altitude. To ensure safe separation, reduce rate of climb/ descent as commanded on the TVSI.
ANY WEAKENING OR SOFTENING OF AN RA	"Adjust Vertical Speed"	The urgency of the RA has lessened to the point where a smaller adjustment is required.
PREVENTATIVE ADVISORY	"Monitor Vertical Speed"	Your current vertical speed is outside of the red arc unsafe area on the TVSI. Maintain a vertical speed outside of the red arc.

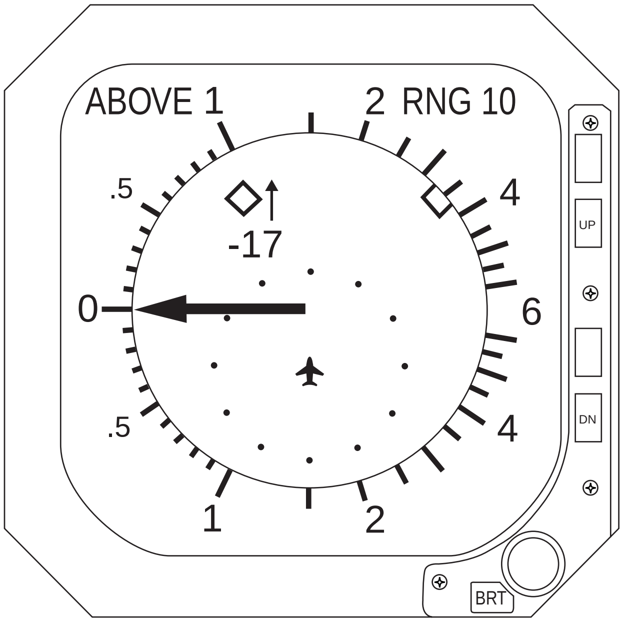
❶ "Traffic" is heard only once if second TA appears.

Figure 1.14-159. TCAS Aural Advisories (Sheet 1)

CONDITION	MESSAGE	MEANING
RESOLUTION ADVISORY (Cont)		**INITIAL ADVISORIES (Cont)**
MAINTAIN EXISTING VERTICAL SPEED	"Maintain Vertical Speed, Maintain"	Vertical separation from the intruding aircraft can best be accomplished by maintaining the current vertical speed as commanded on the TVSI.
MAINTAIN EXISTING VERTICAL SPEED WHILE CROSSING THREAT'S ALTITUDE	"Maintain Vertical Speed, Crossing Maintain"	Your aircraft will climb/descend through the altitude of the intruding aircraft. Vertical separation from intruding aircraft can best be accomplished by maintaining the current vertical speed as commanded on the TVSI.
CHANGE ADVISORIES		
CHANGE FROM CLIMB TO DESCENT (REVERSAL MANEUVER)	"Descend, Descend NOW. Descend, Descend NOW"	The previously computed safe separation command is no longer valid due to a change in the relationship of your aircraft and the intruder. Immediately change from climb to the descent rate commanded on the TVSI.
CHANGE FROM DESCENT TO CLIMB (REVERSAL MANEUVER)	"Climb, Climb NOW. Climb, Climb NOW"	The previously computed safe separation command is no longer valid due to a change in the relationship of your aircraft and the intruder. Immediately change from descent to the climb rate commanded on the TVSI.
INCREASE CLIMB RATE	"Increase Climb, Increase Climb"	The previously computed safe separation command is no longer valid due to a change in the relationship of your aircraft and the intruder. Immediately change rate of climb to that commanded on the TVSI.
INCREASE DESCENT RATE	"Increase Descent, Increase Descent"	The previously computed safe separation command is no longer valid due to a change in the relationship of your aircraft and the intruder. Immediately change rate of descent to that commanded on the TVSI.

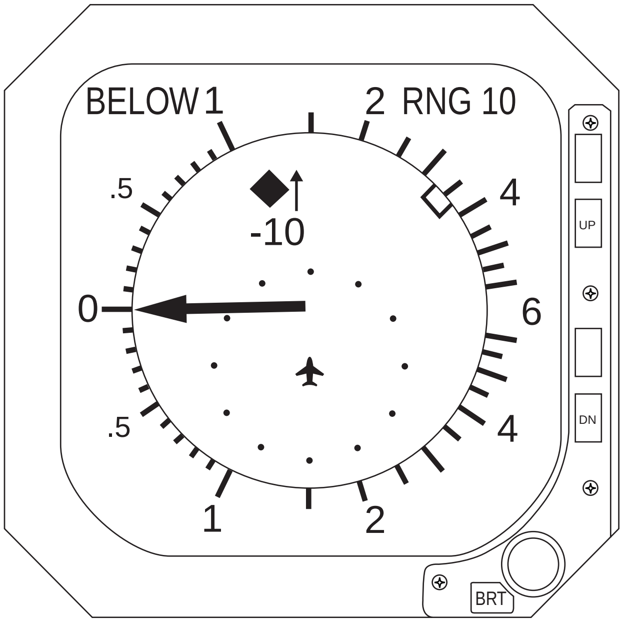
Figure 1.14-159. TCAS Aural Advisories (Sheet 2)

NON-THREAT TRAFFIC



Open white diamond indicates intruder's relative altitude is greater than ±1200 feet or range beyond 6 NM. Display shows intruder is 1700 feet below your aircraft, climbing at 500 fpm or greater. (An example of non-altitude reporting off-scale traffic is shown at the one o'clock position of the miniature aircraft.)

PROXIMITY INTRUDER TRAFFIC

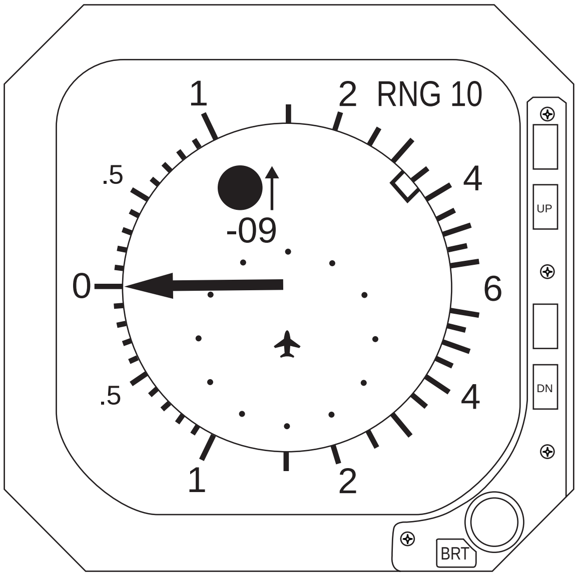


Solid white diamond indicates intruder's relative altitude is within ±1200 feet and within 6 NM, but is still not considered a threat. Display shows intruder is 1000 feet below your aircraft, still climbing at 500 fpm or greater.

P10100

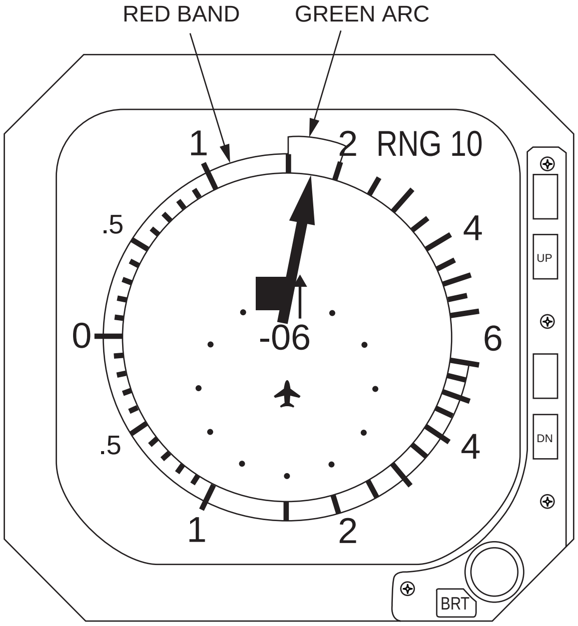
Figure 1.14-160. TCAS Display Examples (Sheet 1)

TRAFFIC ADVISORY (TA)



Solid yellow circle indicates intruder is potential hazard. Depending on altitude, TA will be displayed when time to CPA is 20 to 48 seconds. Display shows intruder is 900 feet below your aircraft, still climbing at 500 fpm or greater. Aural warning of "TRAFFIC, TRAFFIC" will be heard.

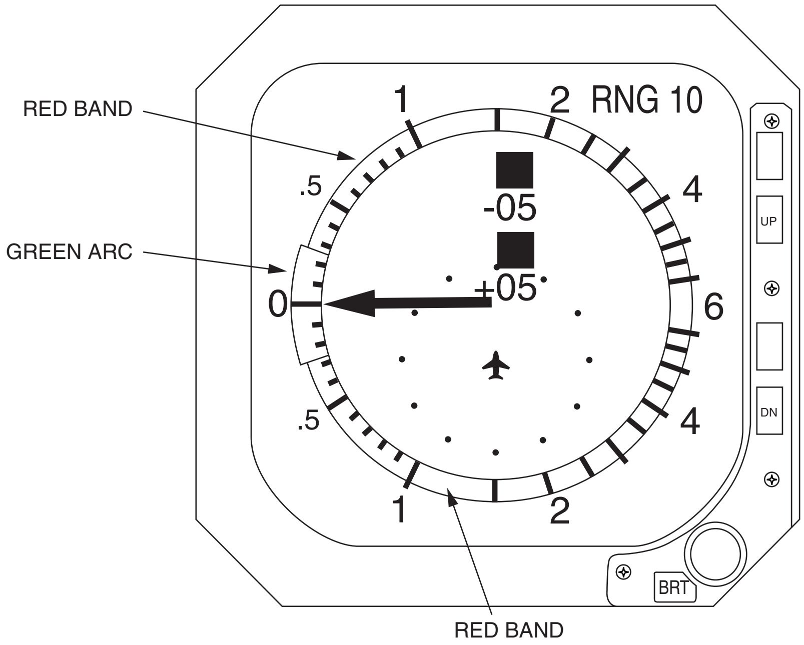
RESOLUTION ADVISORY (RA) - (CLIMB COMMANDED)



Solid red square indicates intruder is potential collision threat. Depending on altitude, time to CPA is now 15 to 35 seconds. Display shows intruder is 600 feet below your aircraft, still climbing at 500 fpm or greater. Aural warning of "CLIMB, CLIMB, CLIMB" will be heard. Computed recommended rate of climb will be displayed as a green arc segment on the TVSI. The advisory against any descent, or any rate of climb less than recommended, is indicated by the red band outside of the vertical speed scale.

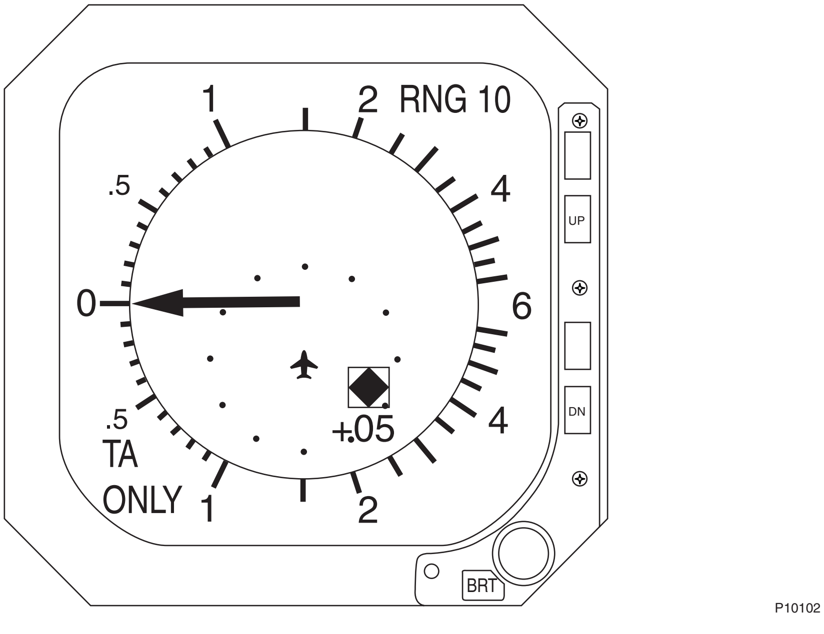
Figure 1.14-160. TCAS Display Examples (Sheet 2)

RESOLUTION ADVISORY (RA)
(MAINTAIN ALTITUDE COMMAND)



Solid red squares indicate collision threats. Depending on altitude, time to CPA is now 15 to 35 seconds. Display shows multiple intruders, one 500 feet below your aircraft and the other 500 feet above your aircraft. Aural warning of "MONITOR VERTICAL SPEED" will be heard. Computed maximum permissible rate of climb or descent is displayed as a green arc segment on the TVSI. The advisory against any rate of descent or climb greater than recommended is indicated by the red band outside of the vertical speed scale.

PROXIMITY FORMATION TRAFFIC



Boxed traffic symbol indicates tagged formation member. Non-threat and proximity traffic symbols are blue; TA and RA symbols continue to be displayed as yellow and red, respectively.

Figure 1.14-160. TCAS Display Examples (Sheet 3)

PART 15

AIR REFUELING BOOM/HOSE

TABLE OF CONTENTS

AIR REFUELING BOOM/HOSE

AIR REFUELING SYSTEM

The KC-10A is equipped to transfer fuel in flight to a receiver aircraft by means of the flying boom/ centerline hose reel or wing pod hose reel systems (With TCTO 1C-10(K)A-956).

AIR REFUELING (AR) FUEL SYSTEM DESCRIPTION

The air refueling (AR) fuel system routes fuel from the forward, center wing, and aft body tanks to the boom, centerline drogue, or wing mounted pods (With TCTO 1C-10(K)A-956). Fuel in the number 1, 2, and 3 main wing tanks may be transferred to AR body tanks through the use of the main tank transfer pumps and the crossfeed manifold controls located on the Flight Engineer's Panel.

The AR system consists of six hydraulically operated pumps, one boom shutoff valve, one drogue shutoff valve, two hydraulically operated bypass valves, one pressure relief valve, and one drogue shutoff valve at each wing tip (With TCTO 1C-10(K)A-956).

FUEL PRESSURE CONTROL SYSTEM

The fuel pressure control system maintains the required fuel pressure at the boom nozzle, centerline drogue, or crossfeed manifold for the wing pod system by varying the speed of the fuel pumps (With TCTO 1C-10(K)A-956). Fuel pressure indicators on the Boom Operator's Instrument Panel (figure 1.15-12) and the Flight Engineer's Fuel Panel (figure 1.3-5) indicate fuel pressure during refueling operations. Pump low pressure lights provide an indication of abnormally functioning refueling pumps as well as low pressure.

CAUTION

Fuel pumps should be turned off when the low pressure lights come on. Operating the fuel pumps with the low pressure lights on will shorten the useful life of the fuel pumps.

AIR REFUELING (AR) PUMP OPERATION

During normal boom air refueling operations, the AR pumps are turned on after a contact has been acknowledged by the boom operator. Each of the six air refueling pumps can be armed by placing either the boom or drogue master power switch on the Boom Operator's Panel to the PWR position and pushing the desired AR pump switch on the Flight Engineer's Fuel Panel. If there is fuel available in the selected tank, the low level float switch will be closed and the AR pump LOW light will come on, indicating the pump is able to run. The AR pump will pump fuel from the selected tank when the tanker makes contact with a receiver aircraft.

For drogue (centerline or wing pod) refueling, internal transfer, or fuel dumping, it is recommended that the AR pumps be operated by arming the desired pump as written in the preceding paragraph. Pump start is accomplished by pressing AR pump OVRD switch. For wing pod refueling and pod system operation, the AR pumps must be turned on and the wing pod pressurized prior to hose deployment (With TCTO 1C-10(K)A-956).

NOTE

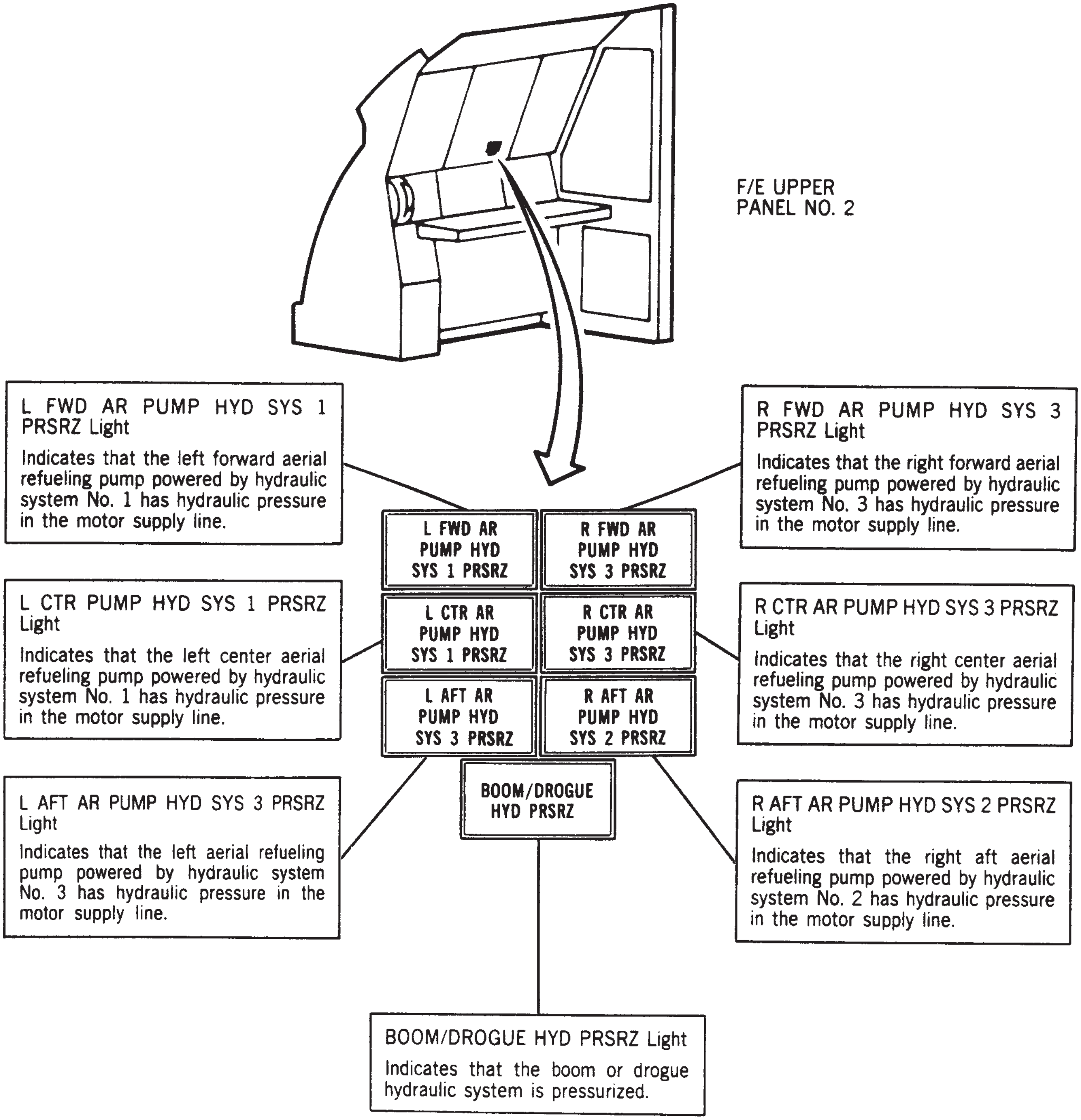
AR fuel in the body tanks should be equalized by selective offloading rather than by internal transfer of fuel among the body tanks or between the body tanks and the main tanks.

When all fuel in the FWD tank is to be offloaded, the AR PUMP OVRD action should be taken before the FWD tank is depleted to 15,000 pounds of fuel. The AR isolation valve should be opened prior to hookup and left open during offloading operation from the center wing tank. This reduces the probability of failure to take this action and also reduces the number of switch actions to be taken after each hookup.

NOTE

- During offloading, the AR pumps in the CTR WING tank will not turn on if the AR isolation valve is closed.
- Crossfeed valves should be closed when AR pumps are used for internal transfer to the main tanks.

Pumps and valves should be turned off when their function is no longer required.



L FWD AR PUMP HYD SYS 1 PRSRZ Light

Indicates that the left forward aerial refueling pump powered by hydraulic system No. 1 has hydraulic pressure in the motor supply line.

R FWD AR PUMP HYD SYS 3 PRSRZ Light

Indicates that the right forward aerial refueling pump powered by hydraulic system No. 3 has hydraulic pressure in the motor supply line.

L CTR PUMP HYD SYS 1 PRSRZ Light

Indicates that the left center aerial refueling pump powered by hydraulic system No. 1 has hydraulic pressure in the motor supply line.

R CTR AR PUMP HYD SYS 3 PRSRZ Light

Indicates that the right center aerial refueling pump powered by hydraulic system No. 3 has hydraulic pressure in the motor supply line.

L AFT AR PUMP HYD SYS 3 PRSRZ Light

Indicates that the left aerial refueling pump powered by hydraulic system No. 3 has hydraulic pressure in the motor supply line.

R AFT AR PUMP HYD SYS 2 PRSRZ Light

Indicates that the right aft aerial refueling pump powered by hydraulic system No. 2 has hydraulic pressure in the motor supply line.

BOOM/DROGUE HYD PRSRZ Light

Indicates that the boom or drogue hydraulic system is pressurized.

Figure 1.15-1. Air Refueling Hydraulic Pressurization Lights

FUEL PRESSURE CONTROL UNIT (FPCU)

The primary unit used to control the overall operation of the AR pumps is the Fuel Pressure Control Unit (FPCU), a microprocessor. Data supplied to the FPCU by the various manually operated switches, fuel level float switches, valve status switches, fuel pressure transducers, and signals from the Boom and Hose control units are translated by the FPCU into signals which effectively control the activation, speed, and shutdown of the AR pumps and, the fuel pressure within the system during AR pump operation. The FPCU consists of two essentially identical channels. The "left" channel controls the three AR pumps designated as the left pumps. The "right" channel controls the three right AR pumps. Thus, one FPCU channel controls one AR pump in each of the three AR body tanks (forward, center, and aft).

Fuel pressure transducers in the Air Refueling Boom (ARB) nozzle, in the hose reel system or in the crossfeed manifold (figure 1.3-2) provide a signal to the FPCU servo control unit which controls the speed of the hydraulic pump motors, controlling the refueling pressure. Each system has two transducers with each transducer controlling three pumps, one in each tank. The two pressure transducers for the boom are contained in the nozzle, but for the hose reel system the pressure transducers sense pressure drop through a venturi which is designed to simulate the pressure drop through the hose thus representing the fuel pressure at the coupling. With TCTO 1C-10(K)A-956, the wing pod system has two pressure transducers which sense the pressure in the wing crossfeed line. There are also two pressure transducers in the AR manifold, which are active during pump operation when both the boom and drogue valves are closed such as fuel dump, internal transfer, or reverse refuel operations. During these operations, the AR pumps are regulated by the FPCU to maintain the AR manifold pressure at 40 ±5 psig.

The boom transducers monitor and control the pressure at the end of the boom to 50 ±5 psi and are activated when the boom shutoff valve is open. The centerline drogue transducers monitor and control the pressure at the venturi throat to 50 ±5 psi (this represents a pressure similar to that found at the end of the hose). These transducers are activated when the centerline drogue shutoff valve is open.

With TCTO 1C-10(K)A-956, the crossfeed transducers monitor and control the crossfeed manifold to 50 ±5 psi for wing pod operation. These transducers are active when both the alternate transfer valve and isolation valve in either the forward fuselage tank or the aft fuselage tank are open and either or both wing drogue valves are open. If the centerline drogue valve is opened, with both alternate transfer valves closed, control reverts back to the centerline transducer control.

With TCTO 1C-10(K)A-956, the crossfeed pressure of 50 psi is needed to maintain a minimum of 10 psi at the pod inlet for all flow rates from 0 to maximum. The wing pods have their own fuel pump and control to maintain the 50 ±5 psi at the wing pod reception coupling.

NOTE

> Under normal conditions, with AR pumps used for wing pod system, do not open engine crossfeed valves.

During the refueling sequence, the various signals are fed to the FPCU. The FPCU logic circuits control the opening and closing of the solenoid valves which supply hydraulic power to the AR PUMP drive motors. The FPCU controls the turn-on sequence of the pumps, when two or more pumps are armed prior to contact with a receiver aircraft. The speed of the pumps and their output is controlled by the FPCU.

FUEL OFFLOAD

Select AR PUMPS by the following priority:

Hydraulic System 3

R FWD, R CTR, L AFT

Hydraulic System 1

L FWD, L CTR

Hydraulic System 2

R AFT

If possible, limit AR PUMP selection from hydraulic system 3 to 2 pumps.

A delay in starting may occur when AR PUMPS from the same side are selected.

PUMP ACTIVATION

The AR pump start sequence logic contained within the FPCU is as follows:

One pump on each channel may be started at the same time.

Pump Sequencing

If BOOM/DROGUE ENGAGED or AR OVERRIDE selected, the first pump selected will start first, then the aft most pump, then the remaining pump on each channel.

If pumps are selected prior to boom/drogue engagement or AR override selected, the sequence will be AFT, CENTER, FORWARD.

Pumps take approximately six seconds to start after initiation.

Two seconds - Hydraulic system pressure (blue) light comes on (figure 1.15-1).

Four seconds - Servo valve current initiation.

Six seconds - motor positioned for breakout torque.

If LOW PRESSURE light is not extinguished (fuel pressure is greater than 10 psi) in seventeen seconds, the pump will shut down and require a restart. The next pump will be initiated when control pressure is reached, but no sooner than seventeen seconds, nor later than thirty-four seconds (even if pressure is not up to control) after pump initiation. If automatic shutdown occurs, all pumps will have to be selected OFF and ON for restart.

PUMP DEACTIVATION

Low Level

An air refueling (AR) pump may be deactivated by several factors. When the fuel in a selected AR tank reaches a preselected low level, the tank low level float switch will open, causing both pumps in the tank to shut down. The pump switch LOW lights will come on. The pump switch should be deactivated when this happens.

Overpressure

Pumps controlled by a given FPCU channel will be shut down when the FPCU senses an AR system overpressure condition. The FPCU selects two transducers to the servo system circuits. It also selects one transducer to monitor the system for excessive fuel pressure, and one transducer to check the validity of the monitoring transducer. If the two transducers are not within certain limits, a pulse is triggered which shuts down the three pumps controlled by the channel.

BOOM/HOSE REEL CENTER TRANSDUCER FAILURE

Failure of a boom or hose reel transducer will shut down the three associated pumps for one channel, but only during refueling phases requiring a boom or hose reel transducer. Failure of a boom transducer will not affect pumps during internal fuel transfer or during a drogue refueling operation.

FUEL TANK SCAVENGE

After AR pump shutdown from the low level float switch, the remaining fuel in the body tanks can be transferred to the main tanks for engine consumption by use of the transfer pump. Fuel trapped in each cell bay of the forward and aft tank is scavenged to the transfer pump inlet at the aft cell of each tank by jet pumps. The jet pumps are activated by the transfer pumps.

OFFLOAD FUEL FLOW QUANTITY INDICATORS

The offload fuel flow quantity indicators provide an indication of the aerial refueling flow rate in pounds per minute and the total quantity of fuel offloaded in pounds. Identical fuel flow indicators are located on the Flight Engineer's Fuel Panel, and the Boom Operator's Instrument Panel. The total fuel offloaded dial at each location is resettable to zero.

AIR REFUELING (AR) PUMPS

The AR pumps are driven by three different hydraulic systems (figure 1.15-1). The forward fuselage tank left hand pump is driven by hydraulic system 1. The right hand pump is driven by hydraulic system 3. The center wing tank left hand pump is driven by hydraulic system 1 and the right hand pump by hydraulic system 3. The aft fuselage tank left hand pump is driven by hydraulic system 3. The right hand pump is driven by hydraulic system 2.

FILL/TRANSFER ISOLATION VALVES

The fill/transfer isolation valves prevent fuel in the main tanks from inadvertently being mixed with fuel in the forward and aft fuselage tanks and the center wing tanks. This allows the KC-10A to carry a different type fuel in the AR system.

The valves are electrically operated by switches on the Flight Engineer's Fuel Panel, and are interlocked through the master isolation switch to provide a dual action to avoid mixing different grades of fuel. These valves automatically open with the fill valve switches at the ground refuel control panel if the master isolation switch is in the NORM position (unlocked).

BOOM/DROGUE SHUTOFF VALVES

The boom/drogue shutoff valves (figure 1.15-2) control the flow of fuel to the boom and hose as needed. Each valve is controlled by its respective switch located on the Flight Engineer's Lower Instrument Panel (figure 1.1-25). Power for valve operation is provided through the respective system master switches located on the boom/drogue control panels. Each valve may be opened manually by disconnecting the cannon plug and moving the manual override handle (figure 1.15-2) to the desired position.

The boom valve is interlocked with the fuel bypass valves and will not open unless both bypass valves are closed. Valve control is automatic during AR operations if the control switch on the Flight Engineer's Fuel Panel is armed. It is powered closed during READY/FREEFLIGHT and DISC/FREEFLIGHT modes and any time a retract command is generated. Valve operation is independent of AR SIG SYS configuration when BOOM FLT CONT switch is OFF.

The drogue valve is interlocked through the fuel range position switch and will open automatically after the hose is pushed in approximately 5 feet, and the control switch on the Flight Engineer's Fuel Panel is ARMED. It is powered closed when drogue position is forward or aft of the refueling limits. Valve operation may be controlled as desired by DROGUE VALVE switch when drogue is stowed. The REEL RESP RESET must be held in RESET if it becomes necessary to open the drogue valve when the hose is in full trail.

DUAL BYPASS VALVE

Two dual bypass valves (figure 1.15-2), with a single inlet and outlet, are provided to prevent fuel pressure buildup during boom retraction. The displaced fuel is routed from the boom, through the bypass valves, into the aft body tank. Each valve is spring loaded closed and hydraulically opened. Hydraulic power is provided by the number two hydraulic system and controlled by the boom HYD SEL handle and the primary or secondary fuel bypass valve solenoid control valve.

Primary solenoid valve operation is normally powered/controlled through the BCU. The bypass valves are powered open through the primary solenoid valve any time the boom flight control switch is on and the contact light is off, or a retract command is generated. Both the primary and secondary solenoid valves are powered any time the Emergency Telescope Retract Switch is activated.

Bypass valve operation is controlled through the secondary solenoid valve when a failure of the primary solenoid occurs. Failure of the primary solenoid valve will not affect boom telescoping control. However, the fuel bypass valves will not open during boom retraction unless the telescope control stick is held in the full retract position and the Emergency Telescope Retract Switch is activated.

Each fuel bypass valve is equipped with an override handle and can be closed manually. Closure is accomplished by pulling and rotating the override handle(s) in the direction indicated to a vertical position. The override handles should be horizontal for normal valve operation. The override handle(s) can be moved to the closed or open position only when hydraulic power is available and a valve powered open condition exists. Access to the fuel bypass valves is provided through a door in the right sidewall of the ARO compartment (figure 1.15-2). The BYPASS DISAGR light(s) located on the Flight Engineer's Fuel Panel will come on steady if the actual valve position does not agree with the commanded position.

MANIFOLD/BOOM SCAVENGE

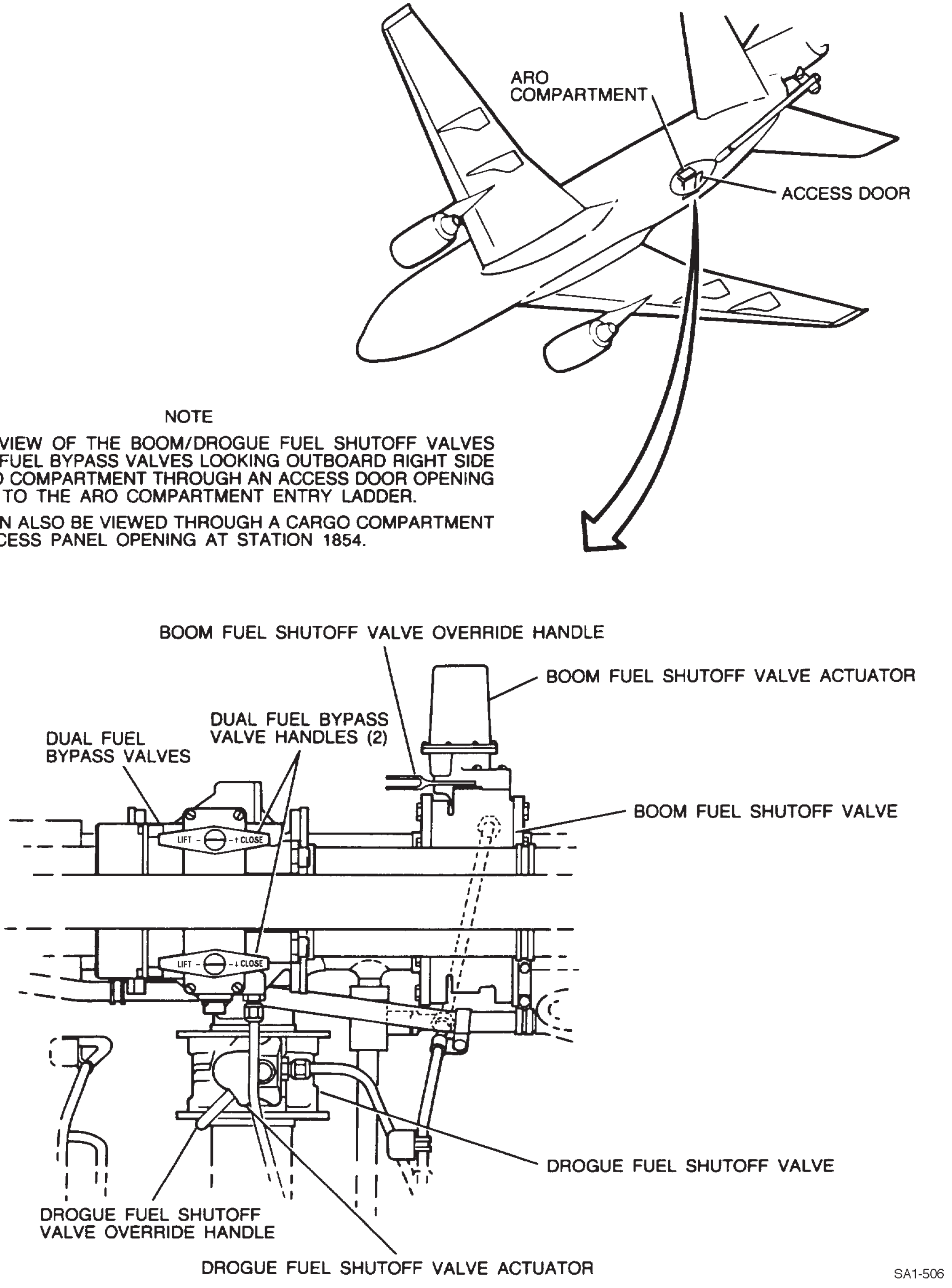
The Air Refueling Off Load Manifold, the Aerial Receiving Manifold from UARRSI to the front spar and the boom can be drained of fuel after refueling, offloading or onloading is complete.

Drainage of the manifolds and boom reduces the unusable fuel and also reduces the hazard of fuel spillage during a crash landing.

BOOM LIGHTNING PROTECTION

WARNING

> The boom shall be maintained full of fuel when the departure, enroute or arrival flight path may place the aircraft in the vicinity of lightning. This is necessary as a precaution against fuel vapor ignition from lightning strikes (see Section VII for boom filling procedures).



NOTE

- THIS IS A VIEW OF THE BOOM/DROGUE FUEL SHUTOFF VALVES AND DUAL FUEL BYPASS VALVES LOOKING OUTBOARD RIGHT SIDE IN THE ARO COMPARTMENT THROUGH AN ACCESS DOOR OPENING ADJACENT TO THE ARO COMPARTMENT ENTRY LADDER.
- VALVES CAN ALSO BE VIEWED THROUGH A CARGO COMPARTMENT FLOOR ACCESS PANEL OPENING AT STATION 1854.

Figure 1.15-2. Boom/Drogue Shutoff Valves And Dual Bypass Valves

AIR REFUELING OPERATOR (ARO) COMPARTMENT DESCRIPTION

The Air Refueling Operator (ARO) compartment (figure 1.15-3) is located at the rear of the aircraft, below the cargo/passenger compartment floor level. It is accessible by lifting a door in the right rear of the cargo compartment floor. Entry to the ARO compartment is provided by a ladder through the opening in the floor. The ARO compartment provides seating for the Boom Operator, Instructor, and Observer. Each position has an oxygen regulator (figure 1.15-4) panel with oxygen piped from the central oxygen system to the control panel. Each position has a communication panel with intercom hook-up to the aircraft receiving fuel and other crew stations in addition to radio frequencies available to the ARO (figure 1.15-5). Hand controls (figure 1.15-6) for the Air Refueling Boom (ARB) are provided at the Boom Operator and the Instructor Boom Operator position. A window is installed for aft viewing of refueling operations. Sideview mirrors are provided to observe formation areas off the wing tips. The Boom Operator has a complete set of lighting controls for interior lighting (figure 1.15-7) of the ARO compartment and exterior lights (figure 1.15-8) for use during night air refueling operations. Controls for the Boom, Drogue, hydraulic selector, window heat, and compartment temperature controls are located on the Boom Operator's Overhead Panel (figure 1.15-8).

VENTILATION

Adjustable air outlets and independent temperature controls allow the Boom Operator control of the temperature and airflow into the ARO compartment.

STATUS/TEST PANEL (STP)

The Status Test Panel (STP) (1.15-9) is located on the Boom Operator's Overhead Panel. The STP has the capability of assessing, monitoring, and displaying Built-In-Test Equipment (BITE) information provided from the Boom Control Unit (BCU). The STP provides the Boom Operator with a display of commands and questions. It provides the capability to recall failures stored in memory, perform preflights and maintenance tests and view sensor readout values. Specific portions of the tests can be bypassed, if desired. STP operation is electrically controlled through the AR MASTER PWR switch and the ground sensing relay.

Readout Window

The STP has the capability of displaying 32 alphanumeric characters. The message readout window allows two lines of 16 characters each. A message requiring more than 32 characters is truncated. Words are not broken between two lines.

STP Features

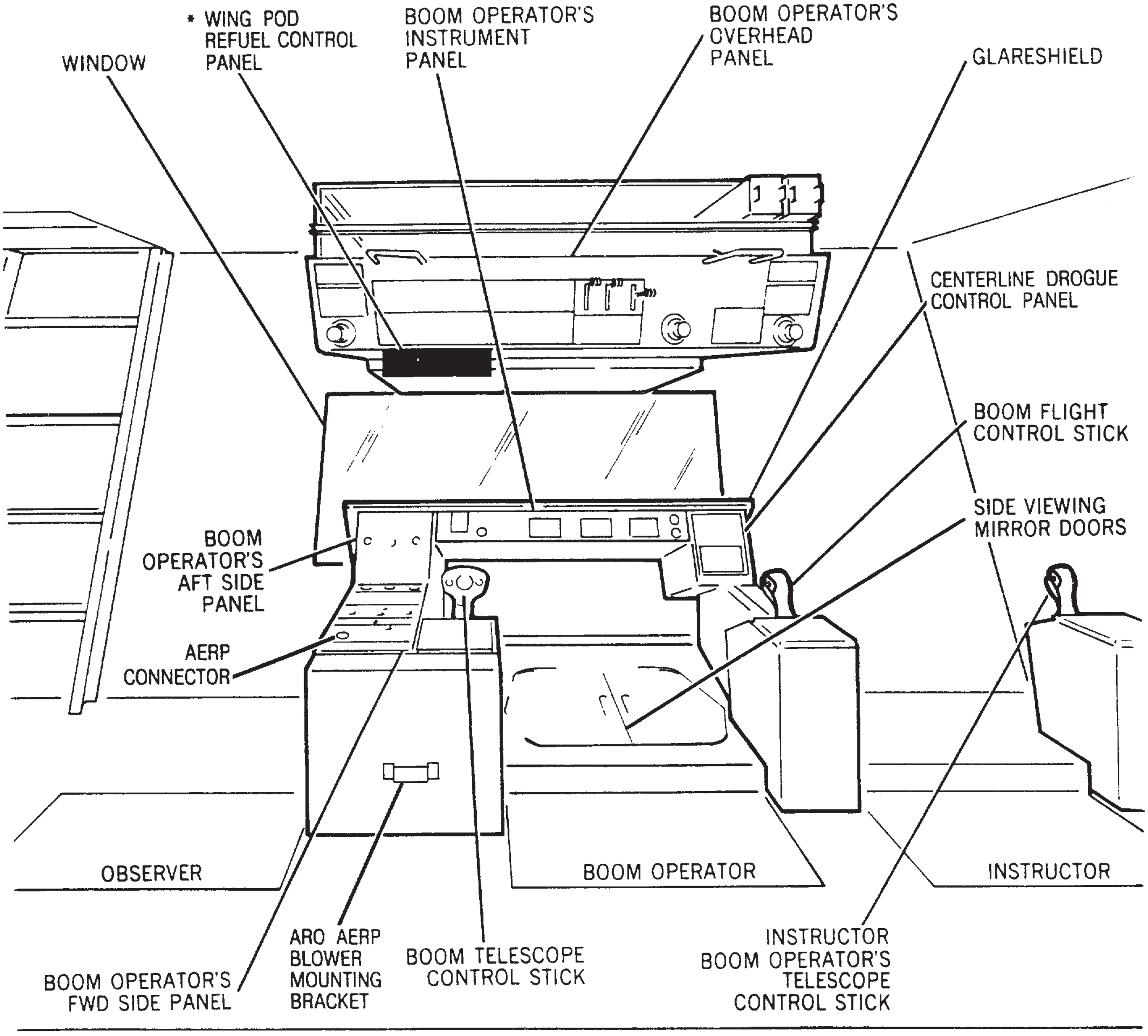
Operation of the STP is standardized, so that a given response has the same meaning throughout the testing sequence. Tests are organized into sections that may be bypassed in order to reduce access time for any specific test sequence. Test repetition features are provided to improve testing flexibility.

STP Operation

Upon initial application of power to the STP, all 32 segments will be displayed as small red triangles for several seconds to verify all segments are operable. If a failure has been logged, the message MAINT REQD MSG RECALL VRFY will be displayed. If a failure has not been logged within the memory of the BCU, the message PRE-FLIGHT TEST-VRFY will be displayed. The Boom Operator has the option to proceed or bypass a test query. For example, if the STP displays MAINT REQD MSG RECALL VRFY, and the operator does not wish to review the messages, press the Forward space (FSPCE) key meaning NO. Otherwise, pressing the VERIFY pushbutton meaning YES would be the response and the operator would proceed with the test.

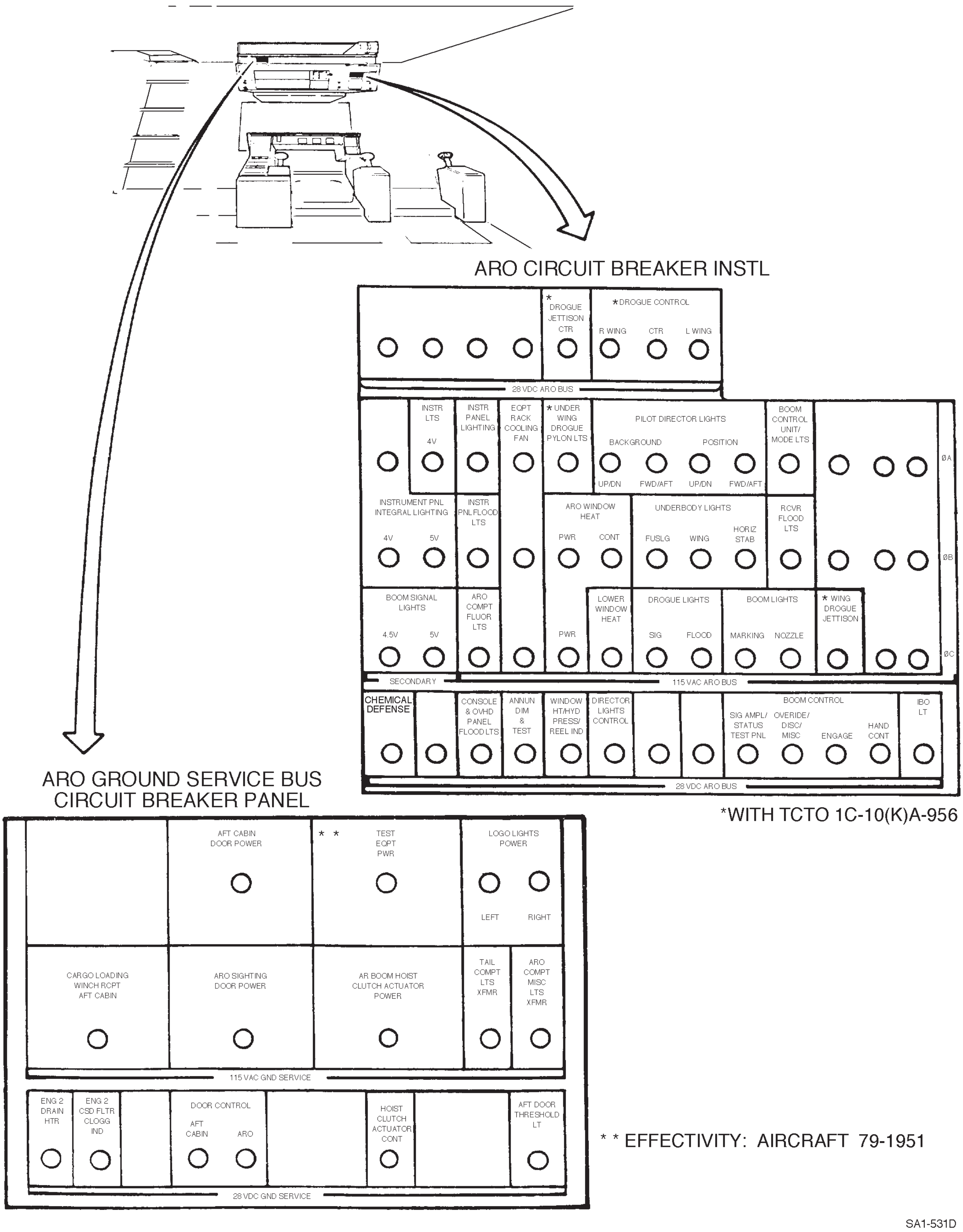
Pre-Flight Test

The Pre-Flight Test provides information to the Boom Operator and/or ground maintenance personnel regarding the status of the Boom Control System (BCS), its operation, and any malfunctions. The Pre-Flight Test is performed in various stages. Hydraulic power is required to perform the Pre-Flight Test. The Pre-Flight Test can be performed only when the aircraft is on the ground, with the nose gear strut compressed. At the conclusion of the Pre-Flight Test, SYSTEM FAIL END OF TEST will be displayed if system malfunctions exist or SYSTEM READY END OF TEST if no system failures exist.



*WITH TCTO 1C-10(K)A-956

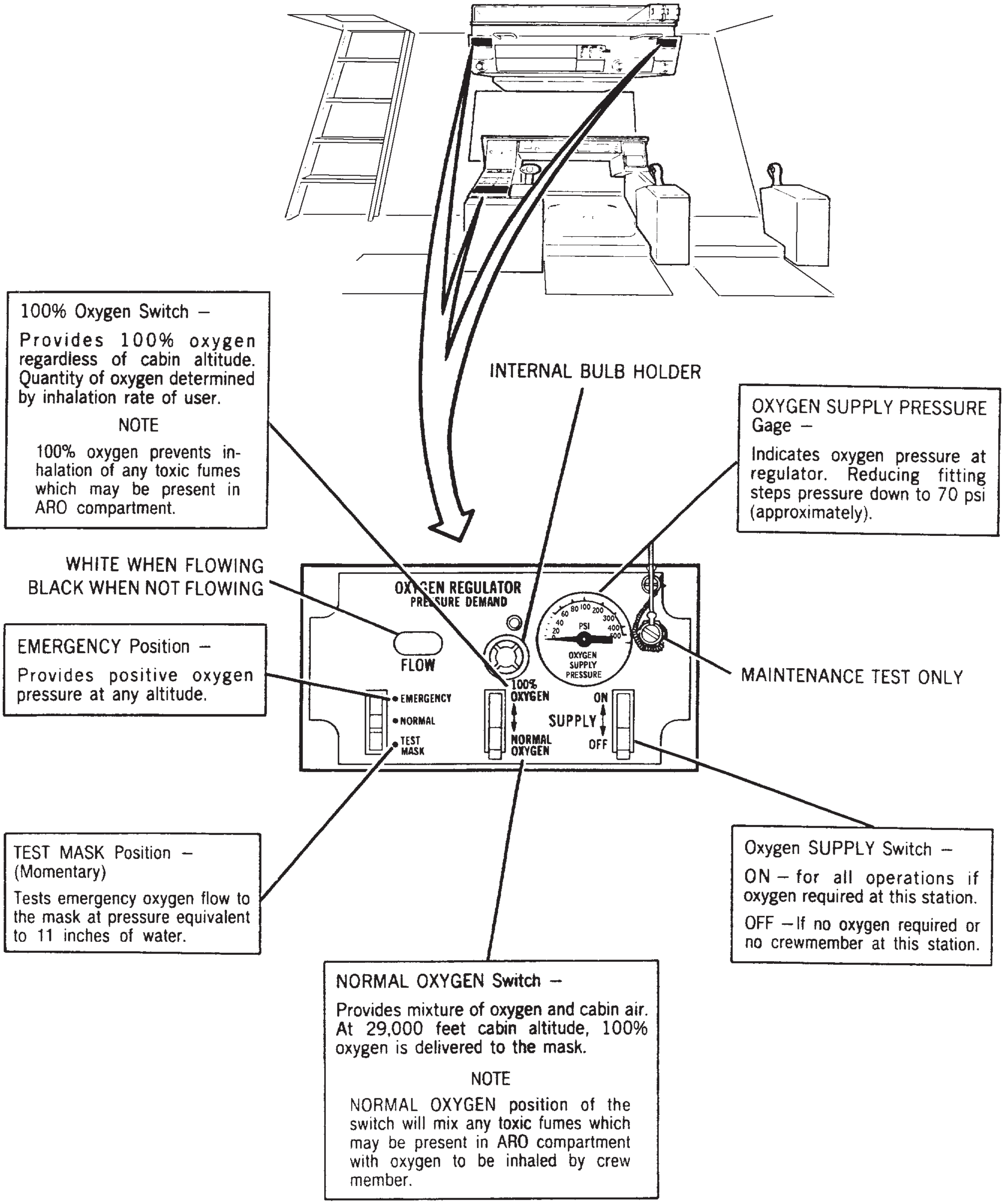
Figure 1.15-3. ARO Compartment (Sheet 1)



*WITH TCTO 1C-10(K)A-956

* * EFFECTIVITY: AIRCRAFT 79-1951

Figure 1.15-3. ARO Compartment (Sheet 2)



100% Oxygen Switch –

Provides 100% oxygen regardless of cabin altitude. Quantity of oxygen determined by inhalation rate of user.

NOTE

100% oxygen prevents inhalation of any toxic fumes which may be present in ARO compartment.

INTERNAL BULB HOLDER

OXYGEN SUPPLY PRESSURE Gage –

Indicates oxygen pressure at regulator. Reducing fitting steps pressure down to 70 psi (approximately).

WHITE WHEN FLOWING
BLACK WHEN NOT FLOWING

EMERGENCY Position –

Provides positive oxygen pressure at any altitude.

MAINTENANCE TEST ONLY

TEST MASK Position – (Momentary)

Tests emergency oxygen flow to the mask at pressure equivalent to 11 inches of water.

Oxygen SUPPLY Switch –

ON – for all operations if oxygen required at this station.

OFF – If no oxygen required or no crewmember at this station.

NORMAL OXYGEN Switch –

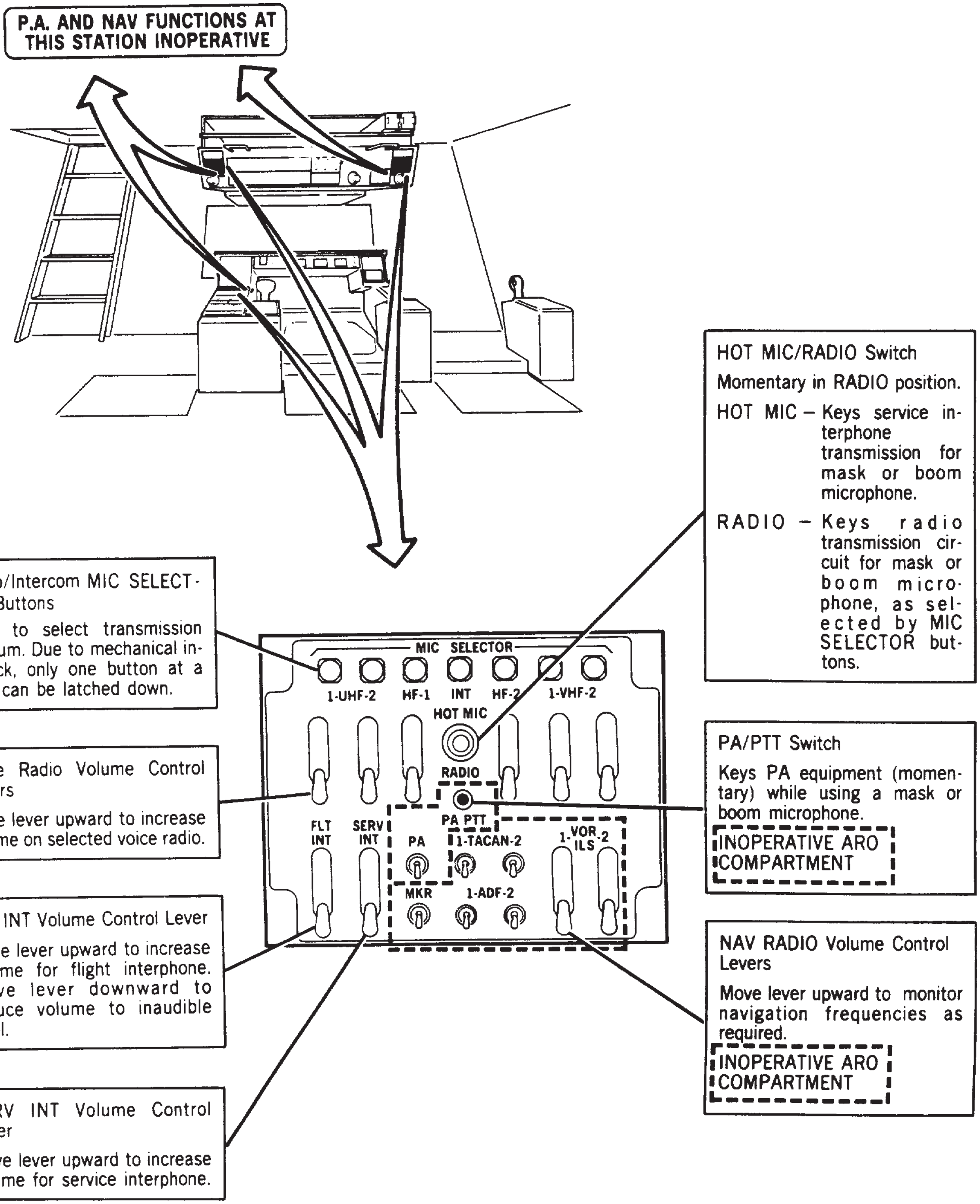
Provides mixture of oxygen and cabin air. At 29,000 feet cabin altitude, 100% oxygen is delivered to the mask.

NOTE

NORMAL OXYGEN position of the switch will mix any toxic fumes which may be present in ARO compartment with oxygen to be inhaled by crew member.

SA1-395B

Figure 1.15-4. Oxygen Regulators - ARO Compartment



P.A. AND NAV FUNCTIONS AT THIS STATION INOPERATIVE

Radio/Intercom MIC SELECTOR Buttons

Push to select transmission medium. Due to mechanical interlock, only one button at a time can be latched down.

Voice Radio Volume Control Levers

Move lever upward to increase volume on selected voice radio.

FLT INT Volume Control Lever

Move lever upward to increase volume for flight interphone. Move lever downward to reduce volume to inaudible level.

SERV INT Volume Control Lever

Move lever upward to increase volume for service interphone.

HOT MIC/RADIO Switch

Momentary in RADIO position.

HOT MIC – Keys service interphone transmission for mask or boom microphone.

RADIO – Keys radio transmission circuit for mask or boom microphone, as selected by MIC SELECTOR buttons.

PA/PTT Switch

Keys PA equipment (momentary) while using a mask or boom microphone.

INOPERATIVE ARO COMPARTMENT

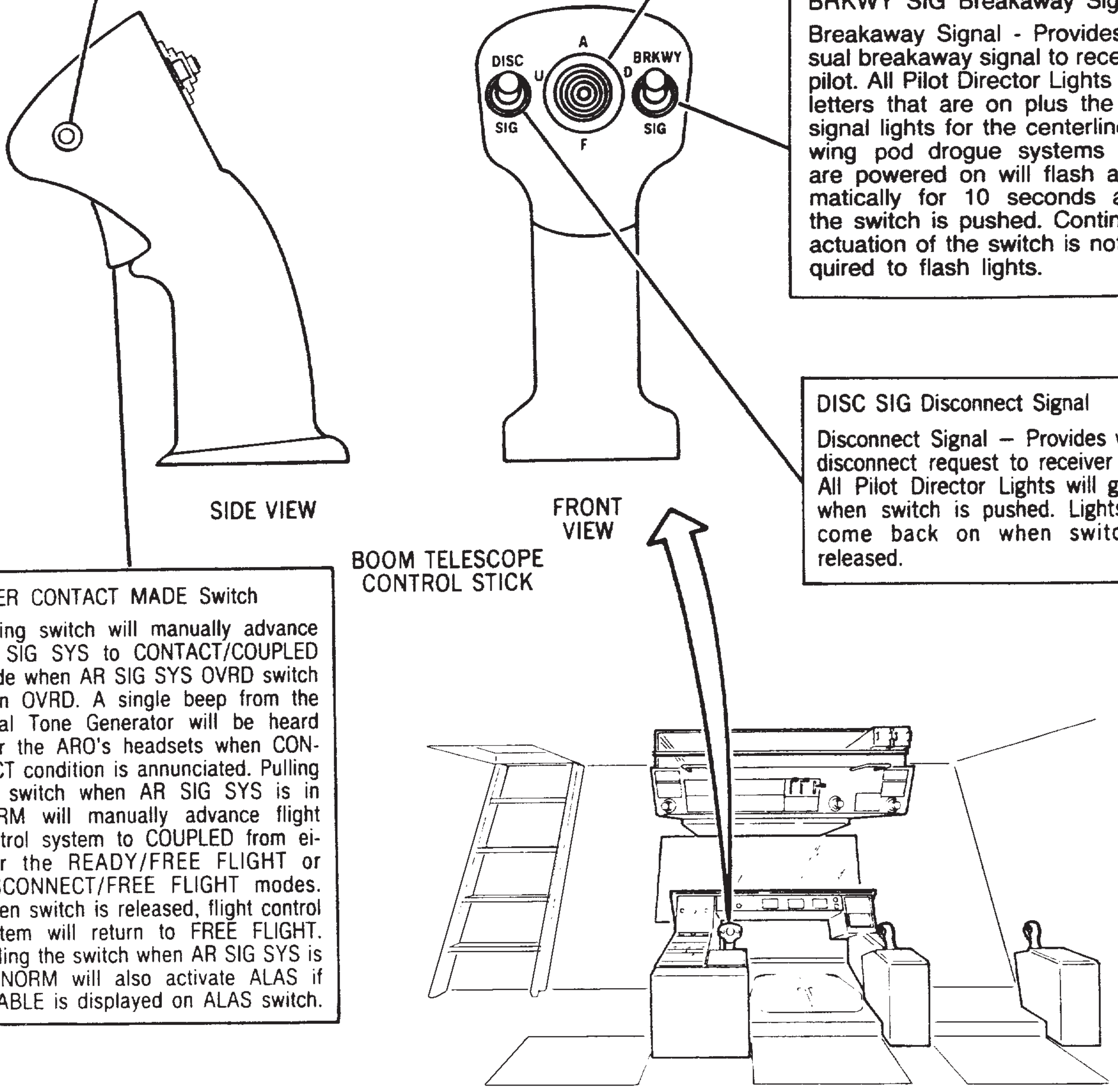
NAV RADIO Volume Control Levers

Move lever upward to monitor navigation frequencies as required.

INOPERATIVE ARO COMPARTMENT

SA1-393B

Figure 1.15-5. Audio Panels - ARO Compartment



RESET TO READY Button

Resets AR SIG SYS to READY/FREE FLIGHT from either the CONTACT/COUPLED or DISCONNECT/FREE FLIGHT mode when pushed. Also turns the INDEP DISC light off and returns toggle latches to extended position if IDS has been actuated. All AR SIG SYS lights go off when button is pushed and the READY/FREE FLIGHT mode light comes on when button is released.

PDL Light Coaching Switch

Moving the switch to a position designated by a letter will illuminate the corresponding red panel and white letter at the end of each pilot director light row. Positioning switch between two letters will illuminate both corresponding letters and panels.

BRKWY SIG Breakaway Signal

Breakaway Signal - Provides visual breakaway signal to receiver pilot. All Pilot Director Lights and letters that are on plus the red signal lights for the centerline or wing pod drogue systems that are powered on will flash automatically for 10 seconds after the switch is pushed. Continued actuation of the switch is not required to flash lights.

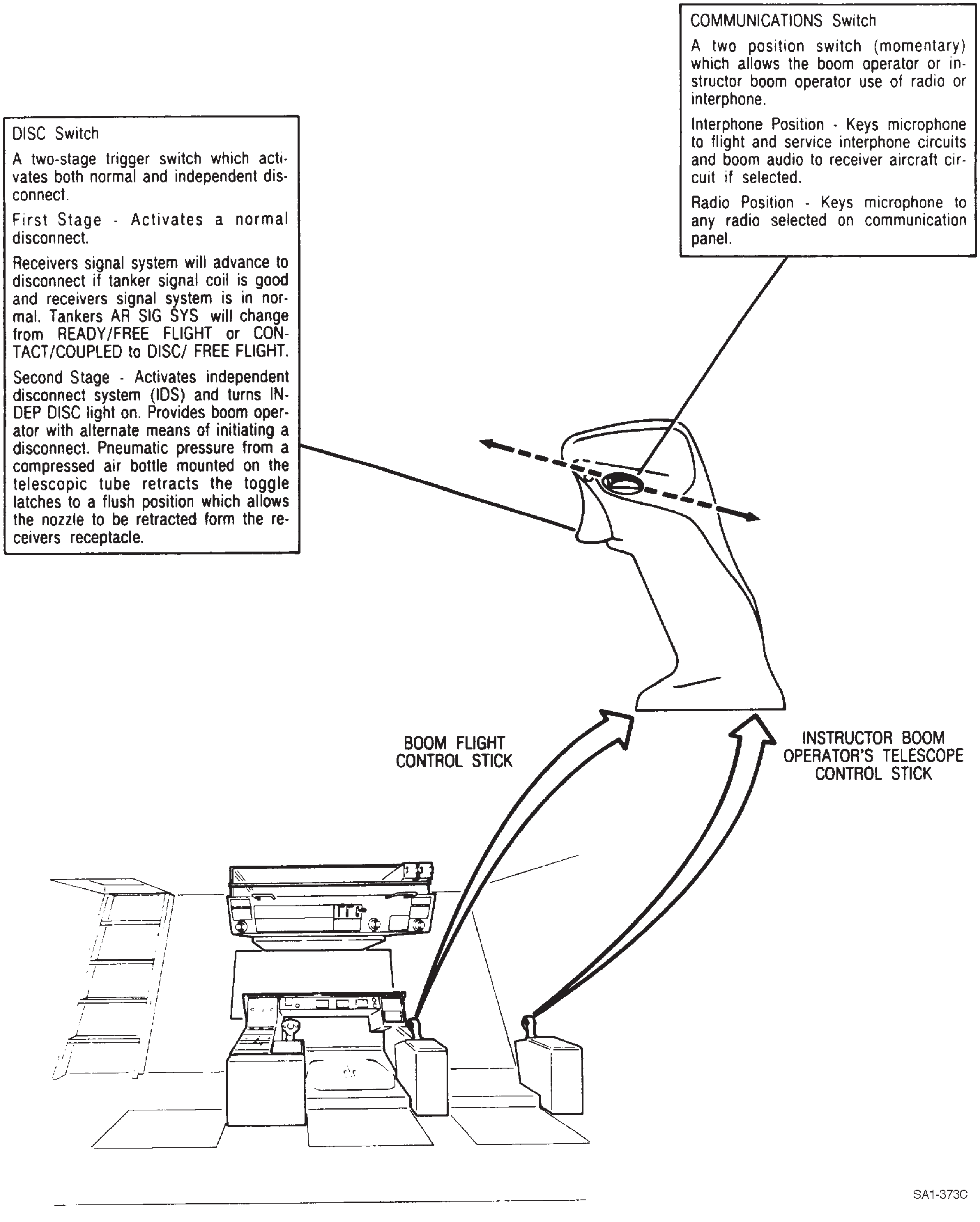
DISC SIG Disconnect Signal

Disconnect Signal – Provides visual disconnect request to receiver pilot. All Pilot Director Lights will go off when switch is pushed. Lights will come back on when switch is released.

EMER CONTACT MADE Switch

Pulling switch will manually advance AR SIG SYS to CONTACT/COUPLED mode when AR SIG SYS OVRD switch is in OVRD. A single beep from the Aural Tone Generator will be heard over the ARO's headsets when CONTACT condition is annunciated. Pulling the switch when AR SIG SYS is in NORM will manually advance flight control system to COUPLED from either the READY/FREE FLIGHT or DISCONNECT/FREE FLIGHT modes. When switch is released, flight control system will return to FREE FLIGHT. Pulling the switch when AR SIG SYS is in NORM will also activate ALAS if ENABLE is displayed on ALAS switch.

Figure 1.15-6. Boom Controls - ARO Compartment (Sheet 1)



COMMUNICATIONS Switch

A two position switch (momentary) which allows the boom operator or instructor boom operator use of radio or interphone.

Interphone Position - Keys microphone to flight and service interphone circuits and boom audio to receiver aircraft circuit if selected.

Radio Position - Keys microphone to any radio selected on communication panel.

DISC Switch

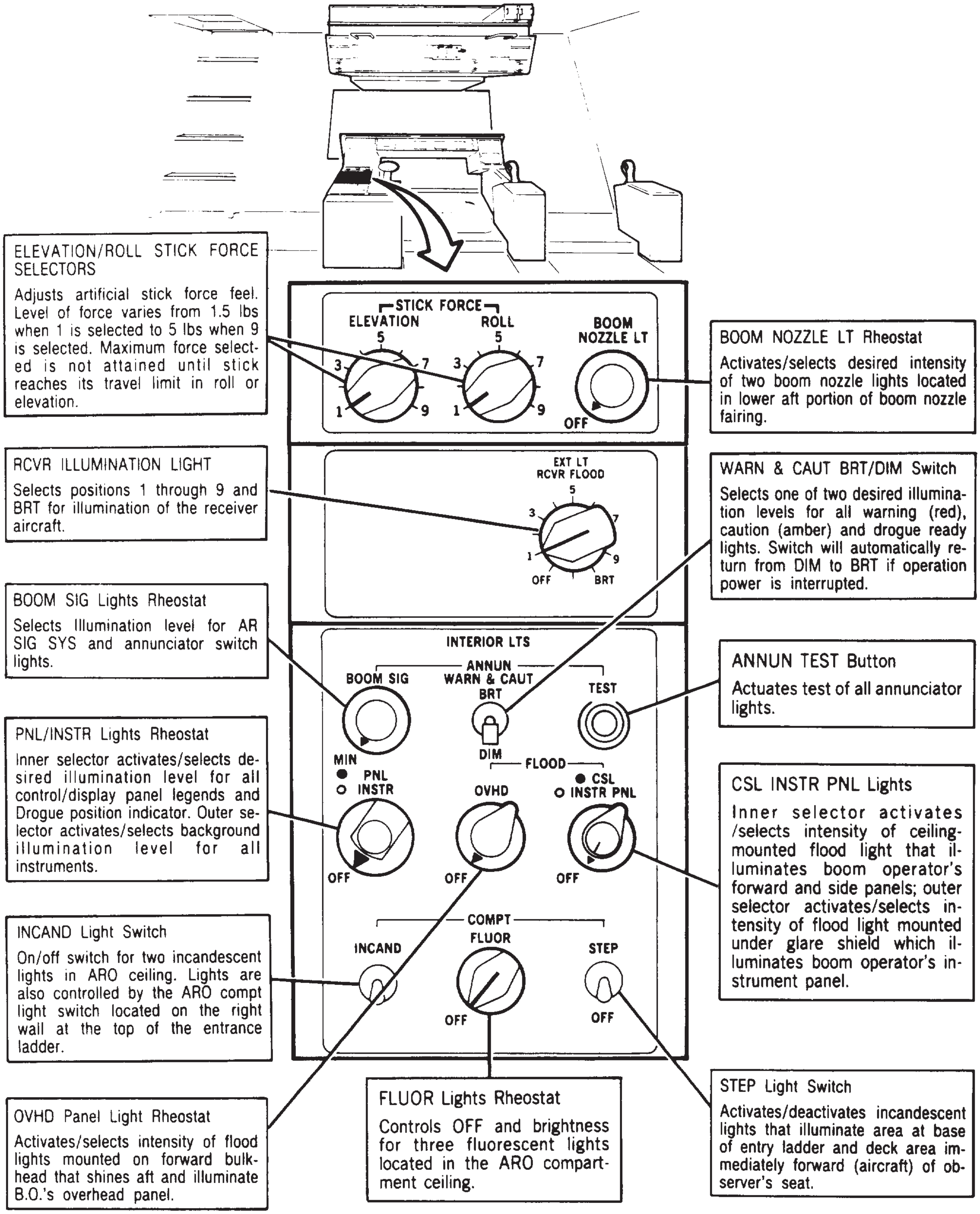
A two-stage trigger switch which activates both normal and independent disconnect.

First Stage - Activates a normal disconnect.

Receivers signal system will advance to disconnect if tanker signal coil is good and receivers signal system is in normal. Tankers AR SIG SYS will change from READY/FREE FLIGHT or CONTACT/COUPLED to DISC/ FREE FLIGHT.

Second Stage - Activates independent disconnect system (IDS) and turns INDEP DISC light on. Provides boom operator with alternate means of initiating a disconnect. Pneumatic pressure from a compressed air bottle mounted on the telescopic tube retracts the toggle latches to a flush position which allows the nozzle to be retracted form the receivers receptacle.

Figure 1.15-6. Boom Controls - ARO Compartment (Sheet 2)



ELEVATION/ROLL STICK FORCE SELECTORS

Adjusts artificial stick force feel. Level of force varies from 1.5 lbs when 1 is selected to 5 lbs when 9 is selected. Maximum force selected is not attained until stick reaches its travel limit in roll or elevation.

RCVR ILLUMINATION LIGHT

Selects positions 1 through 9 and BRT for illumination of the receiver aircraft.

BOOM SIG Lights Rheostat

Selects Illumination level for AR SIG SYS and annunciator switch lights.

PNL/INSTR Lights Rheostat

Inner selector activates/selects desired illumination level for all control/display panel legends and Drogue position indicator. Outer selector activates/selects background illumination level for all instruments.

INCAND Light Switch

On/off switch for two incandescent lights in ARO ceiling. Lights are also controlled by the ARO compt light switch located on the right wall at the top of the entrance ladder.

OVHD Panel Light Rheostat

Activates/selects intensity of flood lights mounted on forward bulkhead that shines aft and illuminate B.O.'s overhead panel.

BOOM NOZZLE LT Rheostat

Activates/selects desired intensity of two boom nozzle lights located in lower aft portion of boom nozzle fairing.

WARN & CAUT BRT/DIM Switch

Selects one of two desired illumination levels for all warning (red), caution (amber) and drogue ready lights. Switch will automatically return from DIM to BRT if operation power is interrupted.

ANNUN TEST Button

Actuates test of all annunciator lights.

CSL INSTR PNL Lights

Inner selector activates /selects intensity of ceiling-mounted flood light that illuminates boom operator's forward and side panels; outer selector activates/selects intensity of flood light mounted under glare shield which illuminates boom operator's instrument panel.

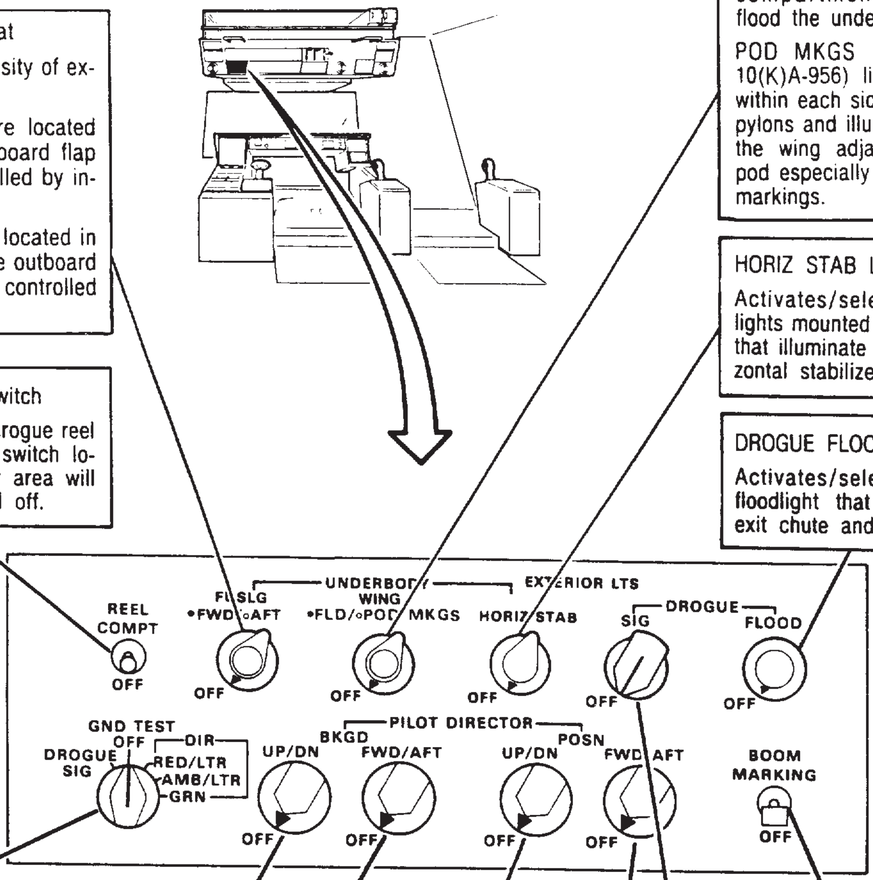
FLUOR Lights Rheostat

Controls OFF and brightness for three fluorescent lights located in the ARO compartment ceiling.

STEP Light Switch

Activates/deactivates incandescent lights that illuminate area at base of entry ladder and deck area immediately forward (aircraft) of observer's seat.

Figure 1.15-7. Interior Light Control Panel, Stick Force And Boom Nozzle Light Panel



FUSLG Lights Rheostat

Activates/selects intensity of exterior lights.

FWD FUSLG lights are located in leading edge of inboard flap hinges and are controlled by inner selector.

AFT FUSLG lights are located in the inboard side of the outboard flap hinges and are controlled by outer selector.

REEL COMPT Light Switch

Activates/deactivates drogue reel compartment light. A switch located in sighting door area will also turn light on and off.

DROGUE SIG/PILOT DIR Light GND TEST Switch

Provides ground test capability for drogue signal and pilot director lights.

PILOT DIRECTOR BKGD UP/DN Lights Rheostat

Activates/selects illumination level of background lights for UP/DN PDI letters colored panels.

PILOT DIRECTOR BKGD FWD/AFT Lights Rheostat

Activates/selects illumination level of background lights for FWD/AFT PDI letters and white panels.

PILOT DIRECTOR POSN UP/DN Lights Rheostat

Activates/selects illumination level of position lights for UP/DN PDI letters and colored panels.

PILOT DIRECTOR POSN FWD/AFT Lights Rheostat

Activates/selects illumination level of position lights for FWD/AFT PDI letters and colored panels.

WING Lights Rheostat

Activates/selects intensity of external lights.

FLD lights are mounted within fairing immediately aft of ARO compartment that illuminate/flood the underside of wings.

POD MKGS (With TCTO 1C-10(K)A-956) lights are mounted within each side of the wing pod pylons and illuminate the area of the wing adjacent to the wing pod especially the red alignment markings.

HORIZ STAB Lights Rheostat

Activates/selects intensity of lights mounted near cone section that illuminate underside of horizontal stabilizers.

DROGUE FLOOD Light Rheostat

Activates/selects intensity of floodlight that illuminates hose exit chute and hose.

BOOM MARKING Lights Switch

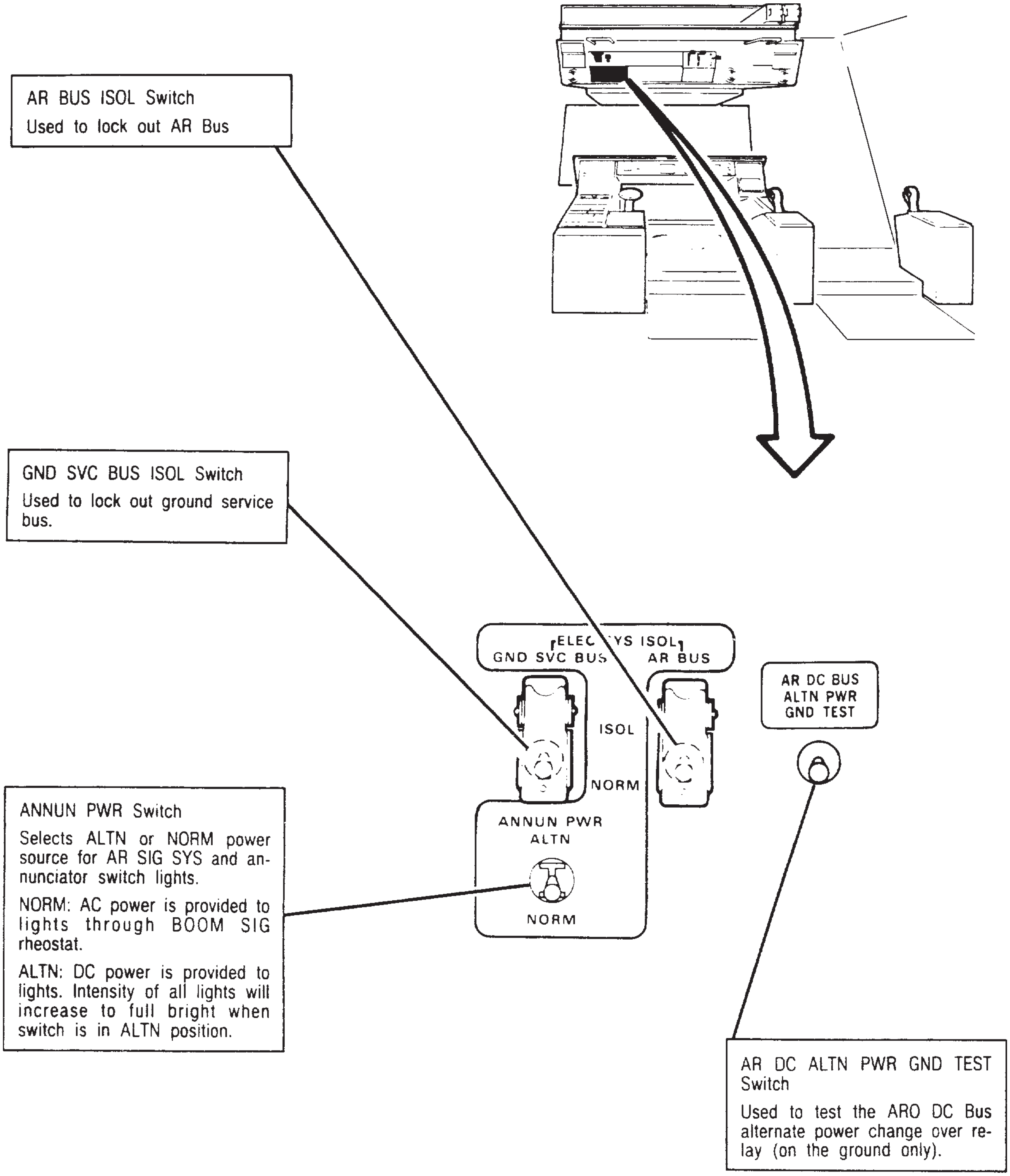
Activates two ultraviolet lights located in the upper aft portion of the boom nozzle fairing. The lights excite the luminous boom markings which makes then visible at night.

DROGUE SIG Light Rheostat

Activates/selects intensity of the Green, Amber, and Red DROGUE SIG Lights, located in the fuselage, just aft of drogue exit chute.

SA1-387G

Figure 1.15-8. Boom Operator's Overhead Panel (Sheet 1)



AR BUS ISOL Switch
Used to lock out AR Bus

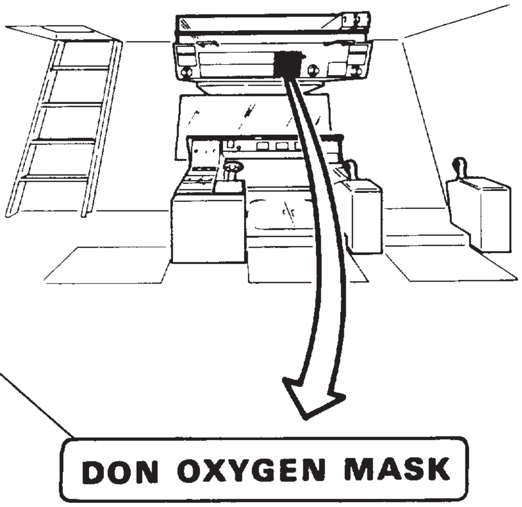
GND SVC BUS ISOL Switch
Used to lock out ground service bus.

ANNUN PWR Switch
Selects ALTN or NORM power source for AR SIG SYS and annunciator switch lights.
NORM: AC power is provided to lights through BOOM SIG rheostat.
ALTN: DC power is provided to lights. Intensity of all lights will increase to full bright when switch is in ALTN position.

AR DC ALTN PWR GND TEST Switch
Used to test the ARO DC Bus alternate power change over relay (on the ground only).

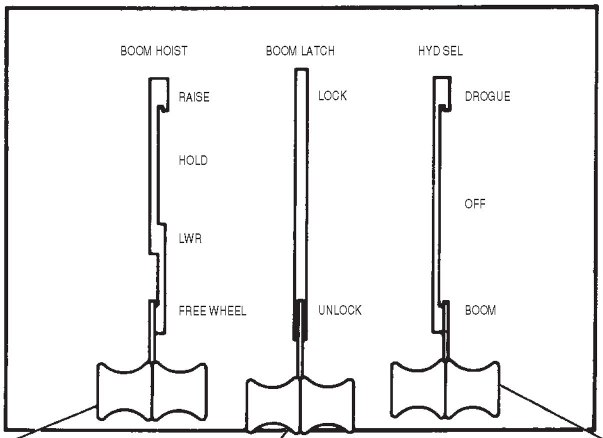
SA1-541

Figure 1.15-8. Boom Operator's Overhead Panel (Sheet 2)



DON OXYGEN MASK Light

Comes on to indicate need for crew oxygen masks. Activated by cabin altitude aneriod switch when cabin altitude reaches approximately 10,000 ft. The alarm bell in the ARO station will ring and an aural warning tone in the operators headset will occur.



BOOM HOIST Lever

Controls the direction and rate of flow to or from the hoist motor. Disengages hoist motor from the cable drum when lever is in FREE WHEEL position.

BOOM LATCH Lever

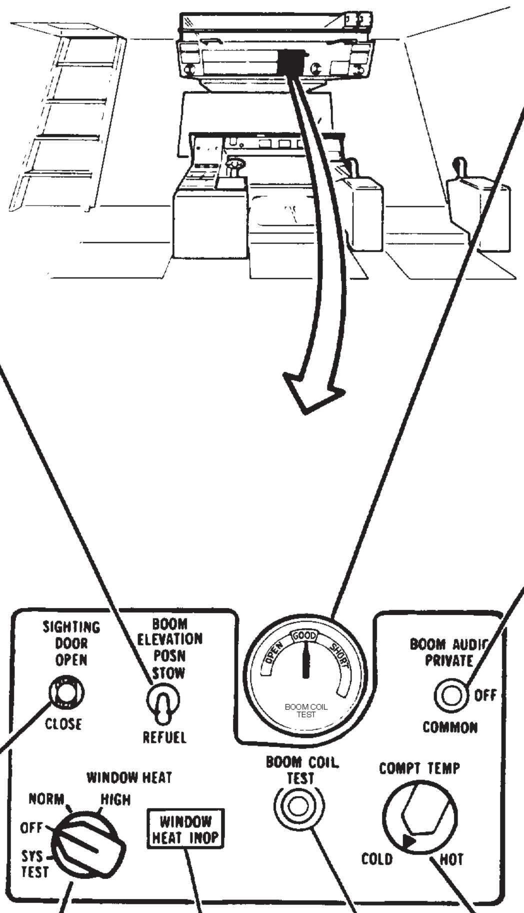
Controls a cable and mechanical lever linkage which secures the boom in the stowed position. Boom must be in stowed position before lever can be moved form UNLOCK to LOCK.

HYD SEL Lever

DROGUE	– Provides hydraulic power for drogue operations. Lever is retained in DROGUE position by an over center cam.
OFF	– Isolates boom and drogue systems from aircraft system.
BOOM	– Provides hydraulic power for boom, cable tension motor and fuel bypass valve operation. Also completes electrical circuit to BOOM HYD PRESS LOW light. Lever is retained in BOOM position by an over center cam and lock detent.

SA1-388D

Figure 1.15-8. Boom Operator's Overhead Panel (Sheet 3)



BOOM ELEVATION POSITION Switch

STOW POSN – When switch is moved from REFUEL to STOW the boom trail position changes to 0° elevation, the FLT CONT MAINT REQD light will come on if a failure is stored in MAINT MEMORY and the boom will automatically retract. AR SIG SYS will not advance to COUPLED mode with switch in stow.

REFUEL POSN – (Boom hoist lever must be in FREE WHEEL and the boom below +10° elevation for switch to be active.) When switch is moved from STOW to REFUEL, the boom trail position changes to approximately 30°, FLT CONT MAINT REQD light is deactivated and AR SIG SYS will advance to COUPLED mode when a signal is generated.

SIGHTING DOOR Switch

Provides electrical power to operate AR sighting door. Door movement will stop when switch is released.

OPEN – Unlatches and moves door to full open position.

CLOSE – Moves door to full closed and latched position.

WINDOW HEAT Selector

NORM – Controls the temperature for the ARO and lower window in the normal range, under light icing conditions.

HIGH – Applies heat to the windows at a higher temperature for moderate to heavy icing conditions.

SYS TEST – WINDOW HEAT INOP light comes on if all overheat prevention circuits are functional.

WINDOW HEAT INOP Light

Indicates a malfunction in ARO station window heat system during normal operation. Window heat is automatically turned off when a malfunction occurs. Light remains on until WINDOW HEAT selector is in the OFF position. Light comes on when all overheat prevention circuits in ARO station window function properly in SYS TEST.

BOOM COIL TEST Indicator

Indicates boom signal coil status during test.

BOOM AUDIO Switch

Controls communication capability with receiver aircraft through boom interphone system.

PRIVATE – Boom operator or instructor boom operator can transmit to receiver on service interphone by actuating interphone communications switch. Interphone transmissions on HOT MIC are not transmitted to the receiver.

OFF – Boom interphone system is deactivated.

COMMON– Any crewmember with access to an audio panel (except the observer position in the ARO station) can transmit to the receiver on service interphone. The observer in the ARO station cannot transmit on interphone to the receiver in either configuration.

COMPT TEMP

Provides minor temperature corrections (± 3.8°F) for ARO compartment conditioned air when cockpit ARO STA selector is in AUTO.

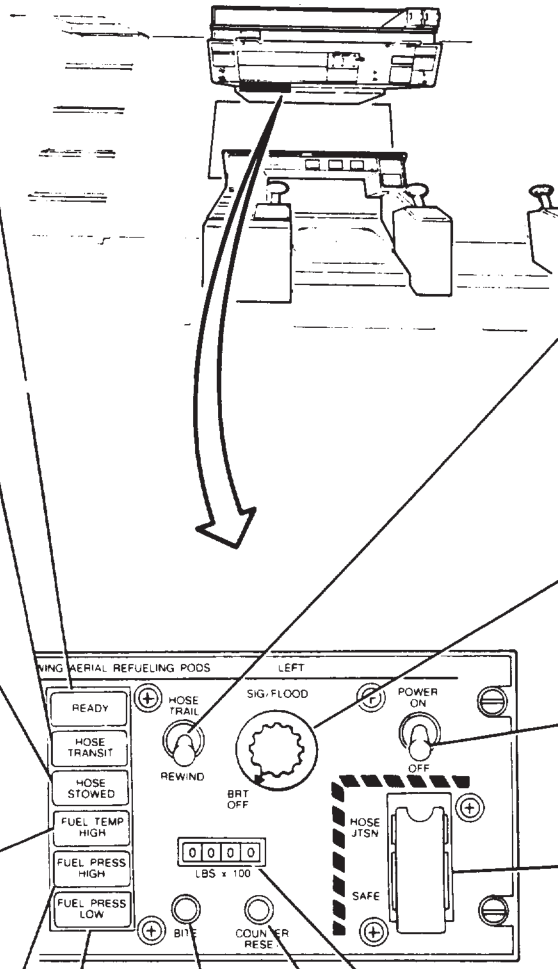
The ARO compartment door should be closed to ensure proper function of the temperature controller.

BOOM COIL TEST Button

Actuates boom signal coil test when depressed. Instrument lights will also come on if INST light rheostat is not in the OFF position.

SA1-540B

Figure 1.15-8. Boom Operator's Overhead Panel (Sheet 4)



READY Light

A blue (READY) annunciator light comes on when the hose reaches full trail. Light goes off when receiver pushes the drogue in 5 feet. Light flashes when forward limit is exceeded. The light will go out when BREAKAWAY signal is active.

HOSE TRANSIT Light

A blue (HOSE TRANSIT) annunciator light flashes each time hose length changes 2 feet.

HOSE STOWED Light

A blue (HOSE STOWED) annunciator light comes on when hose is stowed. Light flashes after hose is stowed if the RAT speed exceeds 2,000 RPM.

FUEL TEMP HIGH Light

An amber (FUEL TEMP HIGH) annunciator light will come on when wing pod fuel pump temperature exceeds prescribed temperature limit of 120°C. It goes off when fuel temperature returns to less than 50°C. The hot fuel spill valve will open and allow fuel to dump into the wing fuel tank.

FUEL PRESS HIGH Light **

An amber (FUEL PRESS HIGH) annunciator light comes on when fuel offload pressures exceed prescribed limits. The light will flash when the drogue is deployed and the RAT speed exceeds 7000 rpm for 5 seconds or exceeds 7500 rpm with no time delay.

FUEL PRESS LOW Light **

An amber (FUEL PRESS LOW) annunciator will come on when the fuel pressure to wing pod drops below 6 PSI. If the light stays on continuously for 10 seconds the POD status will change to "FAIL". The light will flash when the drogue is deployed and the RAT speed exceeds 7000 rpm for 5 seconds or exceeds 7500 rpm with no time delay.

BITE Button

Pressing and holding the BITE button for more than 2 seconds initiates the BITE check. Also, it advances the BITE check sequence when the check is stopped for manual intervention or when fault occurs. Pressing and holding the BITE button for less than 2 seconds in flight will allow operator to view RAT rpm or fuel temp in the OFFLOAD COUNTER.

HOSE TRAIL/REWIND Switch

Controls hose and drogue assembly extension and retraction. During trail, if the hose is out more than 12 feet, the switch can be reversed and cause the hose to rewind. During rewind, the switch can be reversed and allow the hose to trail.

SIG/FLOOD Switch

Controls the intensity at which the pod signal lights, and the hose floodlights are lit.

POD POWER Switch

Activates/deactivates POD System power.

HOSE JTSN/SAFE Switch

Enables boom operator to jettison hose and drogue assembly. The hose can only be jettisoned with hose at full trail. All pod power goes off while switch is held. The switch should be held for no longer than 0.5 seconds.

Fuel Offload Counter

Display registers fuel quantity offloaded in units of 100 lbs. FAIL is displayed if the pod control system fails. BITE check display code is shown during BITE check. RAT speed and pod fuel temp can be monitored if desired.

COUNTER RESET Switch

Resets the fuel offload (LBS X 100) display to read zero and resets BITE check sequence.

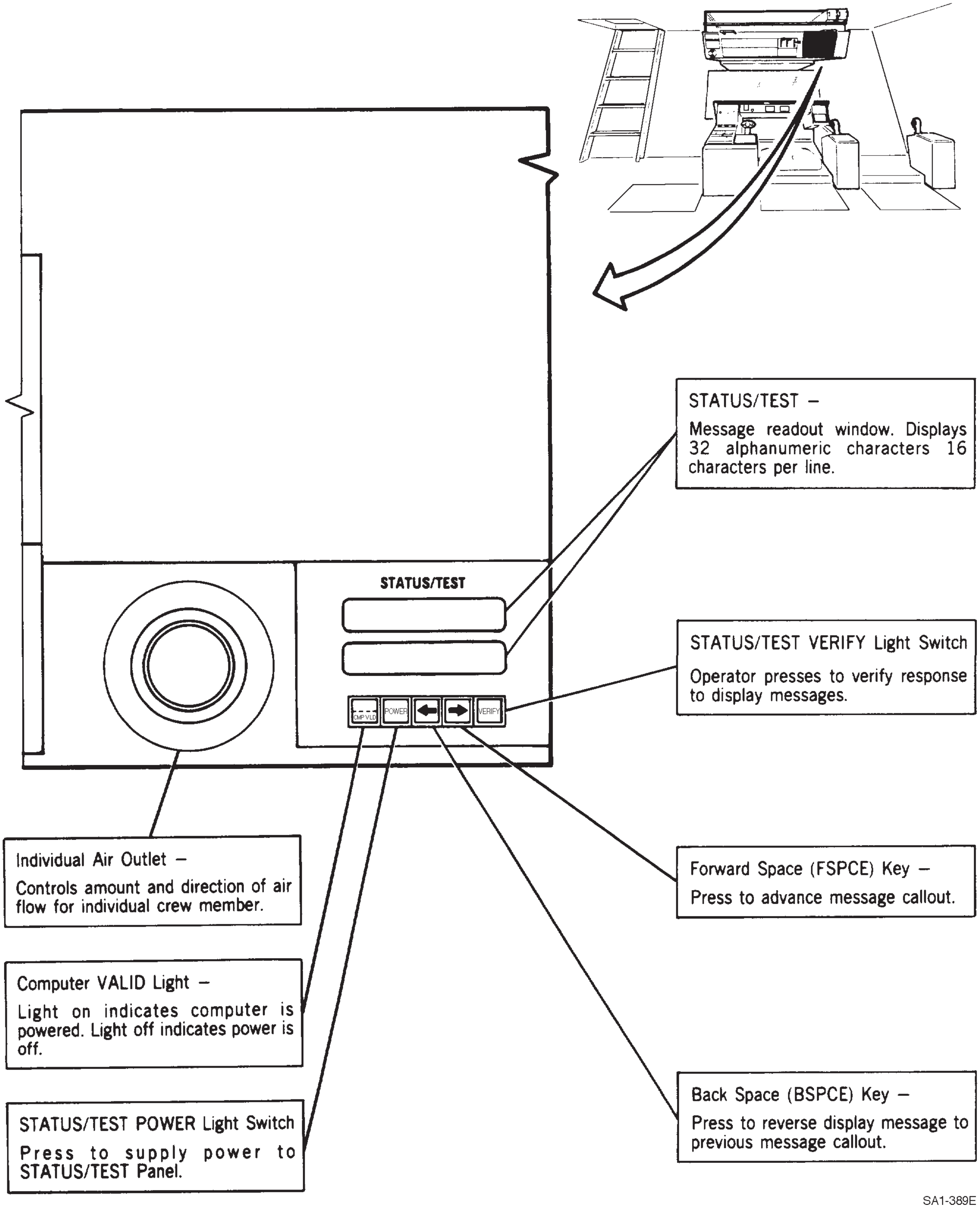
* Right-hand panel is reversed: all functions are identical.

** These lights flash when RAT overspeed occurs.

WITH TCTO 1C-10(K)A-956

SA1-562A

Figure 1.15-8. Boom Operator's Overhead Panel (Sheet 5)



STATUS/TEST –

Message readout window. Displays 32 alphanumeric characters 16 characters per line.

STATUS/TEST VERIFY Light Switch

Operator presses to verify response to display messages.

Forward Space (FSPCE) Key –

Press to advance message callout.

Back Space (BSPCE) Key –

Press to reverse display message to previous message callout.

Individual Air Outlet –

Controls amount and direction of air flow for individual crew member.

Computer VALID Light –

Light on indicates computer is powered. Light off indicates power is off.

STATUS/TEST POWER Light Switch

Press to supply power to STATUS/TEST Panel.

SA1-389E

Figure 1.15-9. Boom Operator's STATUS/TEST Panel

Maintenance Test

The Maintenance Test is a command response type test requiring operator participation to perform specific action as displayed on the STP. The maintenance test is the most comprehensive and is normally used after a major maintenance action has been performed affecting the Boom Control System. Hydraulic power is required to perform the Maintenance Test.

The Maintenance Test provides tests of all Boom Control System display information on the Boom Operator's Control Panel including lights and aural devices. The maintenance test includes all Boom Operator selectable inputs including pushbuttons, switches, lights and indicators. The values of input sensors for roll, telescope, and elevation for the boom may be checked.

During the Maintenance Test, failures are displayed immediately. The initial message upon entry into a failure is a message ending in the word FAIL. Pressing the VERIFY pushbutton will cause the failure message to disappear and the next failure message to appear. If there is no other failure messages, a message giving the operator the option to proceed to the next test or retest failure(s) indicated will appear.

Pressing the FSPCE button will advance the display to the next test. Pressing the BSPCE button will return the display to the previous test or repeat the last test if RETEST/BACK STEP is displayed.

When the Maintenance Test is completed, the STP will display SYSTEM READY - END OF TEST if check was satisfactory. SYSTEM FAILED END OF TEST will be displayed if a failure was detected. If the complete maintenance preflight is not accomplished, test completion will be indicated by END OF TEST appearing on LED display.

Sensor Readout

Sensor readout provides the status of ARB electrical components. Descriptions of sensor readouts are contained in the appropriate maintenance technical orders.

AIR REFUELING (AR) ANCILLARY SYSTEMS

HYDRAULIC ALTERNATE SUPPLY SYSTEM

The hydraulic alternate supply system consists of an auxiliary reservoir, an accumulator and gage, a check valve, a one-way restrictor, a reservoir pressure gage, a high temperature switch, a boom/drogue selector valve, a manifold, hydraulic lines and pressure switches. The indication system consists of an auxiliary reservoir pressure low light and a temperature high light on the Flight Engineer's Annunciator Panel. A main hydraulic pressure low light and boom hydraulic pressure low light are also located on the Boom Operator's Instrument Panel.

The hydraulic alternate supply system provides a source of hydraulic power to prevent loss of hydraulic pressure to the boom or drogue during number 2 main hydraulic system failure. During normal operation (2-3 pump on), the boom or drogue is powered by hydraulic system number 2 and the alternate supply system. If number 2 engine driven hydraulic pumps fail, the 2-3 reversible motor pump will supply hydraulic power to both hydraulic system number 2 and the alternate supply system. In the event fluid is lost from number 2 main hydraulic system, the alternate supply system will retain the capability of providing hydraulic power to the boom or drogue system using the 2-3 pump.

During normal boom or drogue operation, hydraulic fluid passes through the auxiliary reservoir before entering number 2 return system. If loss of fluid occurs in number 2 main hydraulic system the number 2 hydraulic reservoir low level switch will close the shutoff valve on the system 2 side of the 2-3 pump. This will isolate the 2-3 pump and auxiliary hydraulic reservoir fluid for boom or drogue operation only. The 2-3 pump will shutoff, rendering the boom/drogue hydraulic system inoperative, whenever the auxiliary reservoir low level switch detects low auxiliary reservoir fluid quantity.

HYDRAULIC SYSTEM PRESSURE INDICATOR

Low pressure in the ARO hydraulic system will cause both Pilot's Master Caution lights on the glareshield, the Master Caution light on the Flight Engineer's Panel, and the Hydraulic Cue light on the Pilot's Overhead Panel to come on. A hydraulic pressure gage is installed in the left wheel well for maintenance use.

HYDRAULIC SELECTOR VALVE

The hydraulic selector valve provides hydraulic power to either the boom or drogue as selected by the Boom Operator for refueling requirements. When the selector is in boom, hydraulic power is also supplied to the cable tension motor. The hydraulic selector valve will also shut off both boom and drogue hydraulic systems.

ACCUMULATOR

The accumulator stores a reserve supply of hydraulic fluid under pressure and also absorbs pressure surges. The accumulator smooths out any momentary lag in pump response to system demands for greater fluid flows. The accumulator permits a gradual rise in system pressure, thereby absorbing the shock of pump surges, and relieving the pressure lines of high impact loads. When the hydraulic pumps are not operating, the accumulator provides system pressure at a diminishing rate until a quantity equal to the stored volume of fluid in the accumulator has been used. A dial-type pressure gage is provided to indicate the gas pressure in the accumulator.

SHUTOFF VALVE

The motor operated shutoff valve prevents hydraulic fluid from the 2-3 reversible hydraulic pump from entering into the maintenance line. The normally closed shutoff valve is opened by the guarded SYS 3 ISOL switch on the forward overhead panel. The valve may be manually operated by the override arm. The arm is opened for ground maintenance only.

ARO SIGHTING DOOR

Opening the ARO sighting door (figure 1.15-10) permits the boom operator, observer, and instructor to view the refueling operation. Opening and closing the door is controlled by the SIGHTING DOOR SWITCH located on the Boom Operator's Overhead Panel.

The OPEN position unlatches and moves the door to the fully open position. The CLOSE position moves the door to the fully closed position. The switch must be held until the door reaches the full limits of travel. Releasing the switch before the door reaches full travel causes the door to stop when the switch is released.

There are no speed or altitude restrictions for opening or closing the ARO sighting door. A handle driven auxiliary drive is attached to the left end of the electric actuator and extends through the side of the viewing housing. The Boom Operator can crank the door open or closed in the event of a power failure.

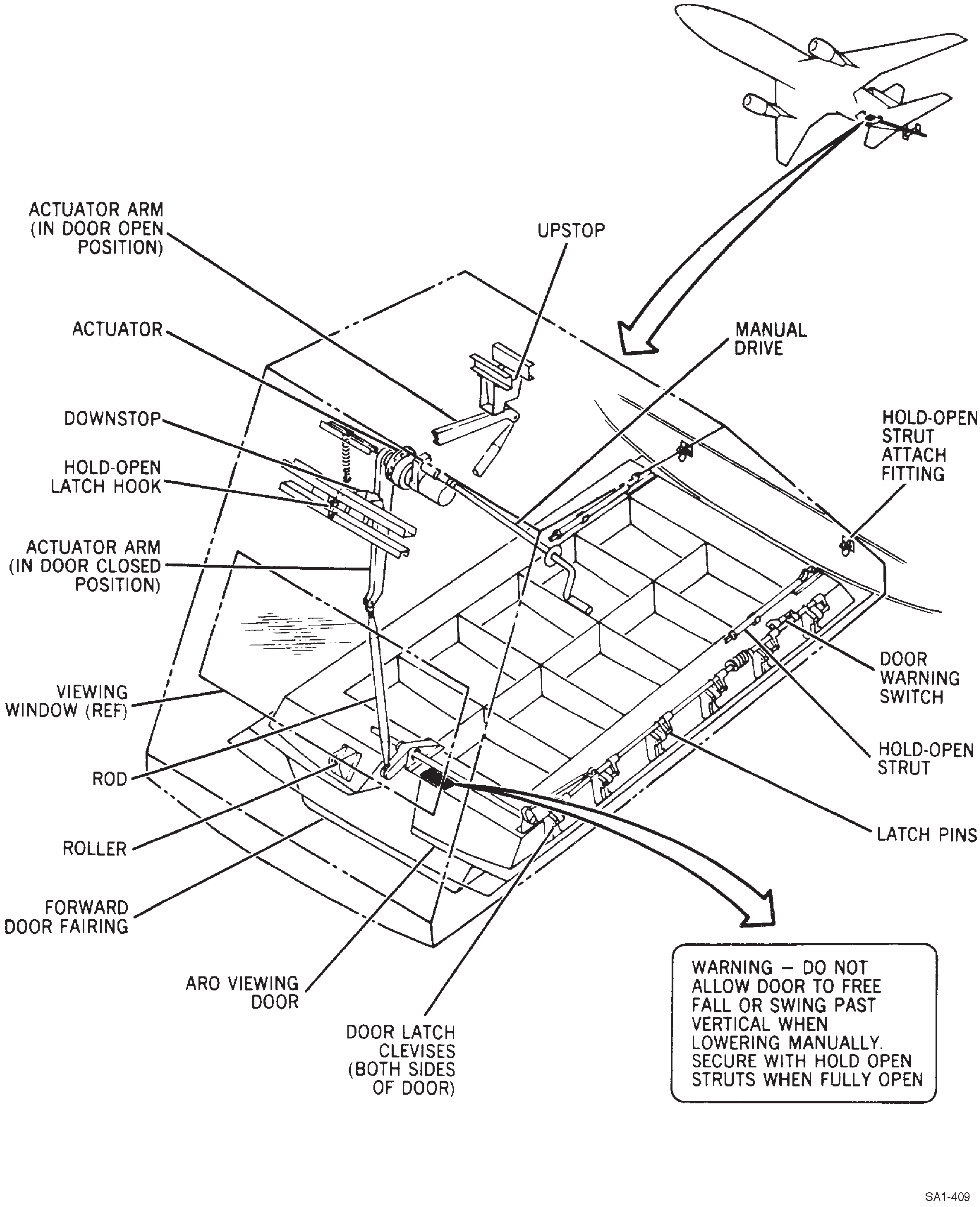
AIR REFUELING BOOM (ARB) HOIST AND LATCH SYSTEM

The hoist lever on the Boom Operator's Overhead Panel (figure 1.15-8) has RAISE-HOLD-LOWER-FREEWHEEL positions. The hoist lever controls the direction and rate of fluid flow to and from the hoist motor. With the hoist lever in the RAISE position, the motor raises the boom. The HOLD position hydraulically locks the hoist motor. In the LOWER position, the lever allows the motor to rotate in the reverse direction as gravity lowers the boom. A flow limiter prevents the boom from lowering too fast. The FREEWHEEL position permits free movement of the boom to follow elevator and rudder action. A detent in the FREEWHEEL position prevents the inadvertent movement of the hoist lever into the HOLD position. The FREEWHEEL position activates the clutch actuator and disengages the hoist motor. When the hoist motor is disengaged, the cable tension motor will maintain constant pressure on the hoist cable to prevent slack occurring when the boom is being maneuvered.

The boom latching lever with LOCK-UNLOCK positions controls a cable and mechanical lever linkage extending from the ARO STATION aft to the boom latch which secures the boom in the stowed position. Electrical warning lights interface with the BOOM LATCHED position. The BOOM DEPLOYED indication light is on when the boom is not stowed and latched. The BOOM NOT STOWED light is on when the boom is not stowed and latched and the landing gear is deployed. The lights are turned off when the boom is stowed and latched.

BOOM MECHANICAL SYSTEM

The boom mechanical system provides telescopic action of the boom and routes fuel from the tanker to the receiver aircraft. The boom consists of two aerodynamically faired tubes, one telescoping within the other. The telescoping tube is supported by rollers within the outer tube. A fixed fuel tube is located inside the telescoping tube. A sliding seal provides passage of fuel without leakage. The boom is



WARNING – DO NOT ALLOW DOOR TO FREE FALL OR SWING PAST VERTICAL WHEN LOWERING MANUALLY. SECURE WITH HOLD OPEN STRUTS WHEN FULLY OPEN

Figure 1.15-10. ARO Sighting Door

attached to the tanker by a gimbal unit. The boom is free to move throughout the operating envelope. A fuel line swivel and flexible fuel line provide passage of fuel from the aerial refuel line across the boom pitch and roll axis through the fixed tube at the forward end of the boom. An inflated surge boot dampens fuel surges during coupled flight or disconnect. The tail cone assembly aft of the boom provides fairing for the nozzle when the boom is retracted and supports the lights.

HYDRAULIC SELECTOR LEVER

The HYD SEL lever provides hydraulic power to either the boom or drogue as selected. The selector lever will also shut off both boom and drogue hydraulic systems.

BOOM FLIGHT CONTROL SURFACES

The boom flight control surfaces consist of two fin/rudder assemblies, attached to the elevator tips. The Boom Operator controls the positioning of the boom during refueling operations with the Boom Control Unit (BCU).

BOOM FLIGHT CONTROL ACTUATION

The boom flight control actuation system provides control of the boom during refueling operation. The system consists of the elevation and roll controller, elevation and rudder control surfaces, flight control surface actuators, position indicators and annunciator lights. The boom flight control actuation system enables the Boom Operator to maneuver the boom in free flight to effect a contact with the receiver. When coupled with the receiver aircraft the Automatic Load Alleviation System (ALAS) reduces and maintains the radial forces on the nozzle and receptacle to a minimum value without Boom Operator inputs. Axial loads are also automatically limited by the telescoping system.

The Boom Operator selects the proper disconnect limits and telescope-at-disconnect switch positions during preparations for precontact operations. Once a receiver aircraft is in proper position within the refueling envelope, and alignment of the boom nozzle and receiver is achieved, the Boom Operator extends the boom to insert the nozzle into the receptacle. When insertion is completed, the control system advances to the coupled mode. The ALAS mode, if preselected, is automatically actuated. Automatic disconnects will occur if preselected limits are exceeded. If preselected, automatic retraction will occur at the time of disconnect.

NOZZLE LOAD ALLEVIATION

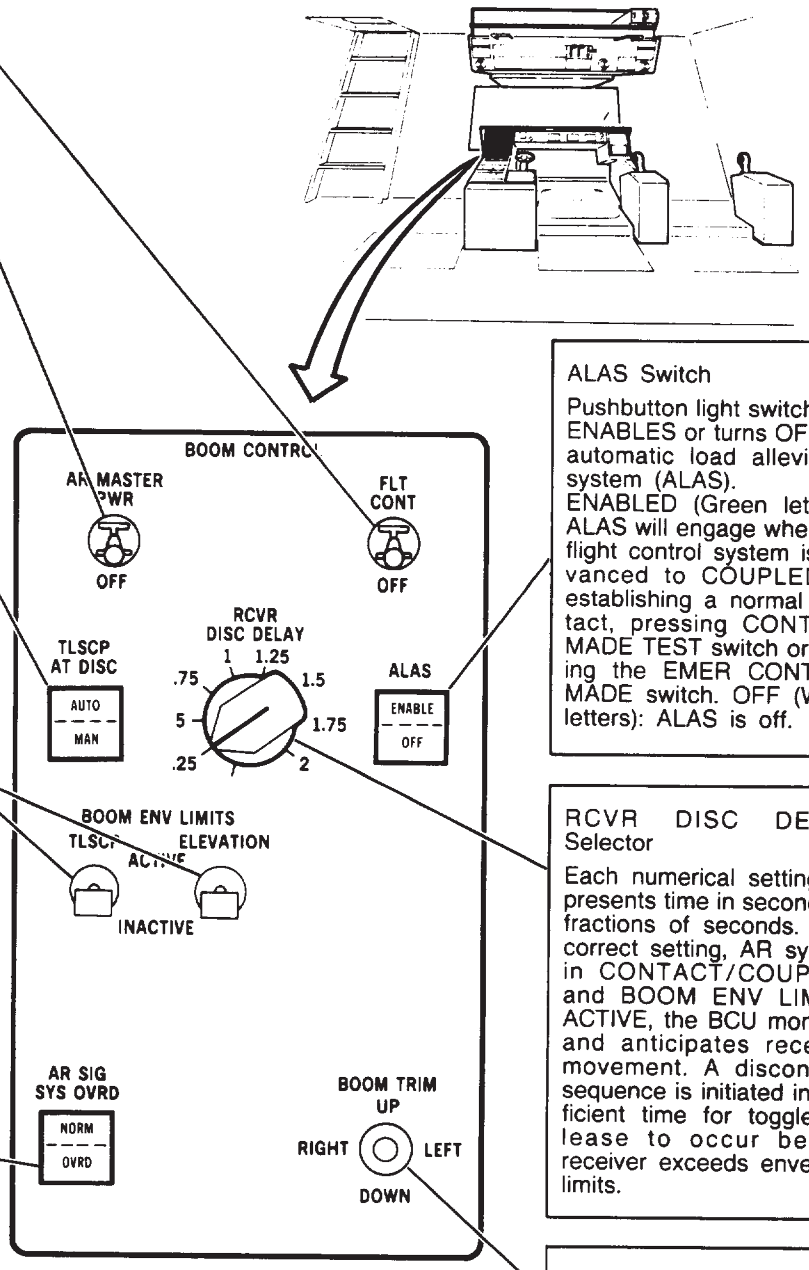
Receiver tracking/nozzle load alleviation is accomplished through two methods: Coupled flight control law logic and automatic load alleviation system (ALAS). Coupled flight control laws are active anytime the flight controls are in the COUPLED mode. ALAS is active anytime the ALAS switch displays ENABLE and the flight control system is in COUPLED mode. The flight control system can be advanced to COUPLED by establishing a contact; pressing the CONTACT MADE TEST switch; or pulling and holding EMER CONTACT MADE switch. The flight control system will also advance to COUPLED whenever sustained nozzle loads greater than 500 pounds are experienced; however, ALAS is not active during this condition.

Coupled Flight Control Law

The COUPLED mode of the flight control system is designed to partially alleviate nozzle loads and allow the boom to follow receiver movements. Receiver tracking/nozzle load alleviation is accomplished by utilizing boom position information to generate commands to back drive the flight control stick to approximate boom position in relation to the receiver. Boom operator assistance may be required to minimize loads to an acceptable level.

Automatic Load Alleviation System (ALAS)

Receiver tracking/nozzle load alleviation is accomplished through the detection of nozzle loads by the nozzle load sensor assembly and back driving the flight control stick to align boom with the receiver. ALAS will maintain nozzle loads at an acceptable level without boom operator assistance. However, the boom operator can override ALAS. It takes approximately one second after contact is established or the EMER CONTACT MADE switch is pulled to transition the flight control laws from FREE FLIGHT to COUPLED logic, and to back drive the controller to correspond with Boom position. After one second; ALAS is turned on, the stick shaker is armed, the stick forces are increased to their maximum value and the COUPLED light comes on. The increased stick forces and stick shaker are designed to reduce inadvertent Boom



FLT CONT Switch

Activates/deactivates ARB control System.

AR MASTER PWR Switch

Activates/deactives ARO station electrical power.

TLSCP AT DISC Switch

Push button light switch selects boom retraction mode . AUTO (Green letter): boom automatically retracts at maximum rate (10 FPS) until fully retracted following disconnect. MAN (White letters): boom retraction remains under control of boom telescope controller stick.

BOOM ENV LIMTS Switches

ACTIVE: boom TLSCP/ELEVATION disconnect limits are active. INACTIVE: boom TLSCP/ELEVATION limits are inactive.

AR SIG SYS OVRD Switch

Pushbutton light switch that selects NORM (Normal) or OVRD (Manual) operation. NORM (Green letters): AR SIG SYS automatically advances to CONTACT/COUPLED condition when contact is established. OVRD (Amber letters): bypasses signal amplifier requiring AR SIG SYS be advanced manually to CONTACT/COUPLED condition by pulling EMER CONTACT MADE switch. Boom envelope disconnect limits are active in NORM and OVRD.

ALAS Switch

Pushbutton light switch that ENABLES or turns OFF the automatic load alleviation system (ALAS). ENABLED (Green letters): ALAS will engage when the flight control system is advanced to COUPLED by establishing a normal contact, pressing CONTACT MADE TEST switch or pulling the EMER CONTACT MADE switch. OFF (White letters): ALAS is off.

RCVR DISC DELAY Selector

Each numerical setting represents time in seconds or fractions of seconds. With correct setting, AR system in CONTACT/COUPLED and BOOM ENV LIMITS ACTIVE, the BCU monitors and anticipates receiver movement. A disconnect sequence is initiated in sufficient time for toggle release to occur before receiver exceeds envelope limits.

BOOM TRIM Switch

Adjusts boom position in elevation and roll axes by biasing boom rudders and elevators. Cycling the FLT CONT Switch will remove trim bias.

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Figure 1.15-11. Boom Operator's Aft Side Panels/Boom Control Panel (Left)

Operator inputs into the flight control system when ALAS is active. Moving the flight control stick from its commanded position will activate the stick shaker which will vibrate/shake the flight control stick.

ALAS will continue to alleviate nozzle loads after a disconnect is initiated (DISC light on) until the selected RCVR DISC DELAY time has elapsed. At the end of the RCVR DISC DELAY time setting; the COUPLED light will go off, ALAS will cease to alleviate nozzle loads, the stick shaker will be deactivated, the control stick forces return to their selected values, the controller back drive is frozen in the last commanded position for two seconds and the flight control laws start transitioning from COUPLED to FREE FLIGHT over a one second period.

An ALAS failure is indicated by the ROLL ALAS INOP and/or ELEVATION ALAS INOP lights illuminating. The two axes are independent of each other and receiver tracking and the stick shaker will continue to function in the operational axis.

Both the coupled flight control law logic back drive and ALAS are inoperative when a failed stick condition exists. Failure of the flight control stick is indicated by: the ROLL ALAS INOP and/or ELEVATION ALAS INOP light(s) illuminating, a five second audible tone in the operator's headset, and the control stick going limp in the failed axis.

TELESCOPIC ACTUATION

The telescopic actuation system provides extension and retraction of the telescoping tube during freeflight and controls receiver push/pull forces in the coupled mode. The system consists of a telescoping tube, a closed loop chain-cable drive, a hydraulic servo motor, two telescope control sticks, a position indicator and annunciator lights. Telescope control is provided through two telescope control sticks; one each at the Boom Operator's and Instructor Boom Operator's position. Each stick will extend or retract the boom, however, commands from the instructor's stick will override inputs from the Boom Operator's position.

BOOM POSITION INDICATING SYSTEM

The boom position indicators are located in the Boom Operator's Instrument Panel. They provide boom position for roll, extension and elevation.

Roll Indicator

The roll position indicator (figure 1.15-12) shows the boom position in degrees from tanker vertical axis (0 degrees). The indicator has adjustable rotary cursors to permit selection of the right and left roll disconnect limits. The limits are selectable in 2° increments from 11° to 25°. The selected limits are identified by triangular indicators on the outer perimeter of the indicator dial.

Telescope Indicator

The boom telescope position indicator (figure 1.15-12) has fixed limits. It indicates the boom extension in feet. The fixed cursors indicate the inner and outer disconnect limits.

Elevation Indicator

The elevation position indicator (figure 1.15-12) shows boom position in degrees from the tankers 0° horizontal reference. The indicator has an adjustable rotary cursor that permits selection of the upper elevation disconnect limit in 1° increments from 20° to 27°. The lower elevation limit is fixed. The selected limits are identified by triangular indicators on the outer perimeter of the indicator dial.

RECEIVER DISCONNECT DELAY SELECTOR

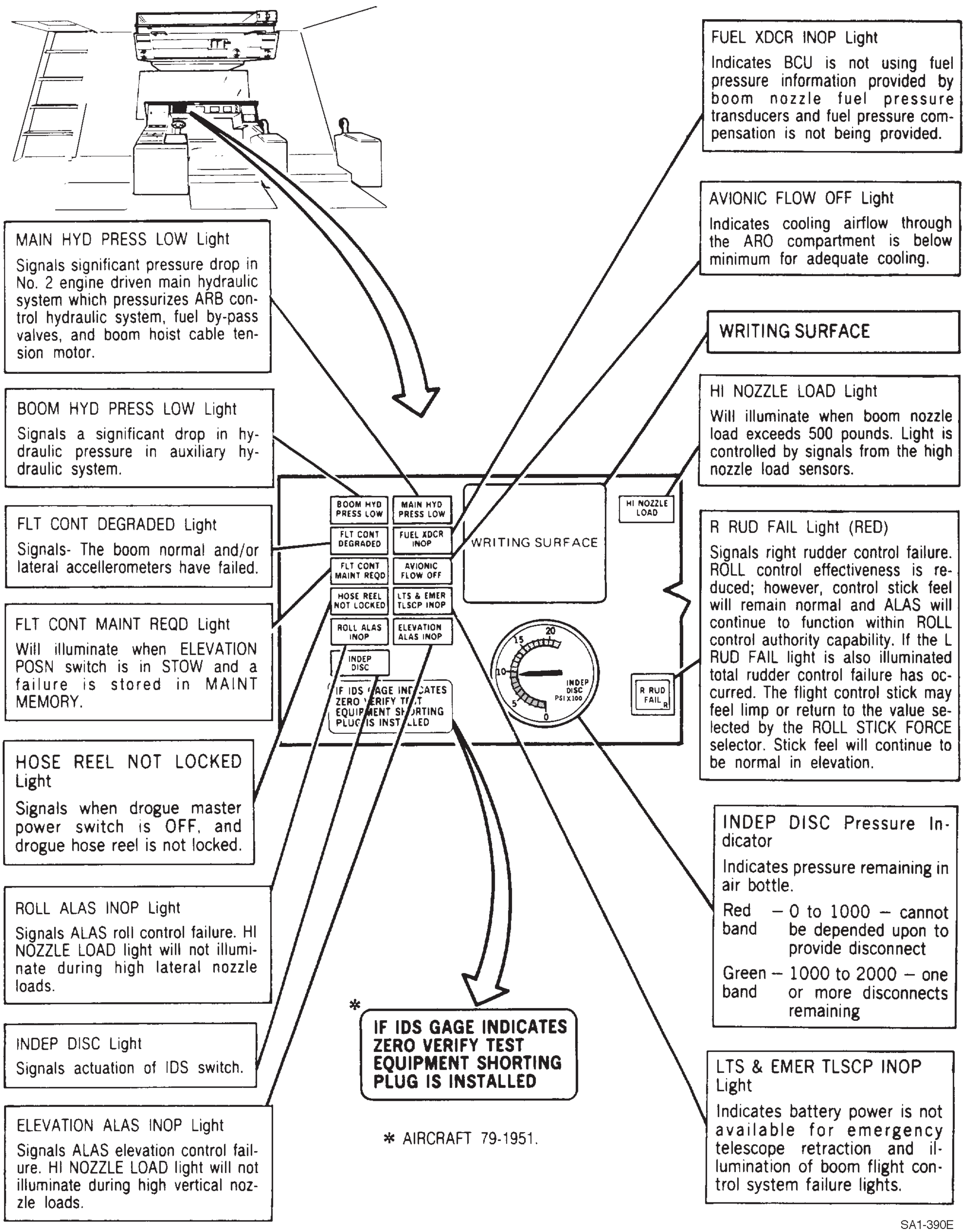
With the Receiver Disconnect Delay set, the boom control unit will compute when to initiate a disconnect so the nozzle will be free of the receiver receptacle before the disconnect limit is exceeded.

PUSH-TO-TALK (PTT) CIRCUITS

Parallel wiring is installed between the push-to-talk circuits on the Boom Operator's control stick, the audio panel (figure 1.15-5) and two foot controlled switches on the floor of the ARO compartment.

The center foot-switch operates radio PTT circuits and the right foot-switch (aircraft left) operates the interphone PIT circuits.

Parallel wiring is installed between the Instructor Boom Operator's telescope control stick and the Instructor's Audio Panel. The Observer's position has an audio panel only.



MAIN HYD PRESS LOW Light

Signals significant pressure drop in No. 2 engine driven main hydraulic system which pressurizes ARB control hydraulic system, fuel by-pass valves, and boom hoist cable tension motor.

BOOM HYD PRESS LOW Light

Signals a significant drop in hydraulic pressure in auxiliary hydraulic system.

FLT CONT DEGRADED Light

Signals- The boom normal and/or lateral accellerometers have failed.

FLT CONT MAINT REQD Light

Will illuminate when ELEVATION POSN switch is in STOW and a failure is stored in MAINT MEMORY.

HOSE REEL NOT LOCKED Light

Signals when drogue master power switch is OFF, and drogue hose reel is not locked.

ROLL ALAS INOP Light

Signals ALAS roll control failure. HI NOZZLE LOAD light will not illuminate during high lateral nozzle loads.

INDEP DISC Light

Signals actuation of IDS switch.

ELEVATION ALAS INOP Light

Signals ALAS elevation control failure. HI NOZZLE LOAD light will not illuminate during high vertical nozzle loads.

FUEL XDCR INOP Light

Indicates BCU is not using fuel pressure information provided by boom nozzle fuel pressure transducers and fuel pressure compensation is not being provided.

AVIONIC FLOW OFF Light

Indicates cooling airflow through the ARO compartment is below minimum for adequate cooling.

WRITING SURFACE

HI NOZZLE LOAD Light

Will illuminate when boom nozzle load exceeds 500 pounds. Light is controlled by signals from the high nozzle load sensors.

R RUD FAIL Light (RED)

Signals right rudder control failure. ROLL control effectiveness is reduced; however, control stick feel will remain normal and ALAS will continue to function within ROLL control authority capability. If the L RUD FAIL light is also illuminated total rudder control failure has occurred. The flight control stick may feel limp or return to the value selected by the ROLL STICK FORCE selector. Stick feel will continue to be normal in elevation.

INDEP DISC Pressure Indicator

Indicates pressure remaining in air bottle.

Red band – 0 to 1000 – cannot be depended upon to provide disconnect

Green band – 1000 to 2000 – one or more disconnects remaining

*
IF IDS GAGE INDICATES ZERO VERIFY TEST EQUIPMENT SHORTING PLUG IS INSTALLED

LTS & EMER TLSCP INOP Light

Indicates battery power is not available for emergency telescope retraction and illumination of boom flight control system failure lights.

* AIRCRAFT 79-1951.

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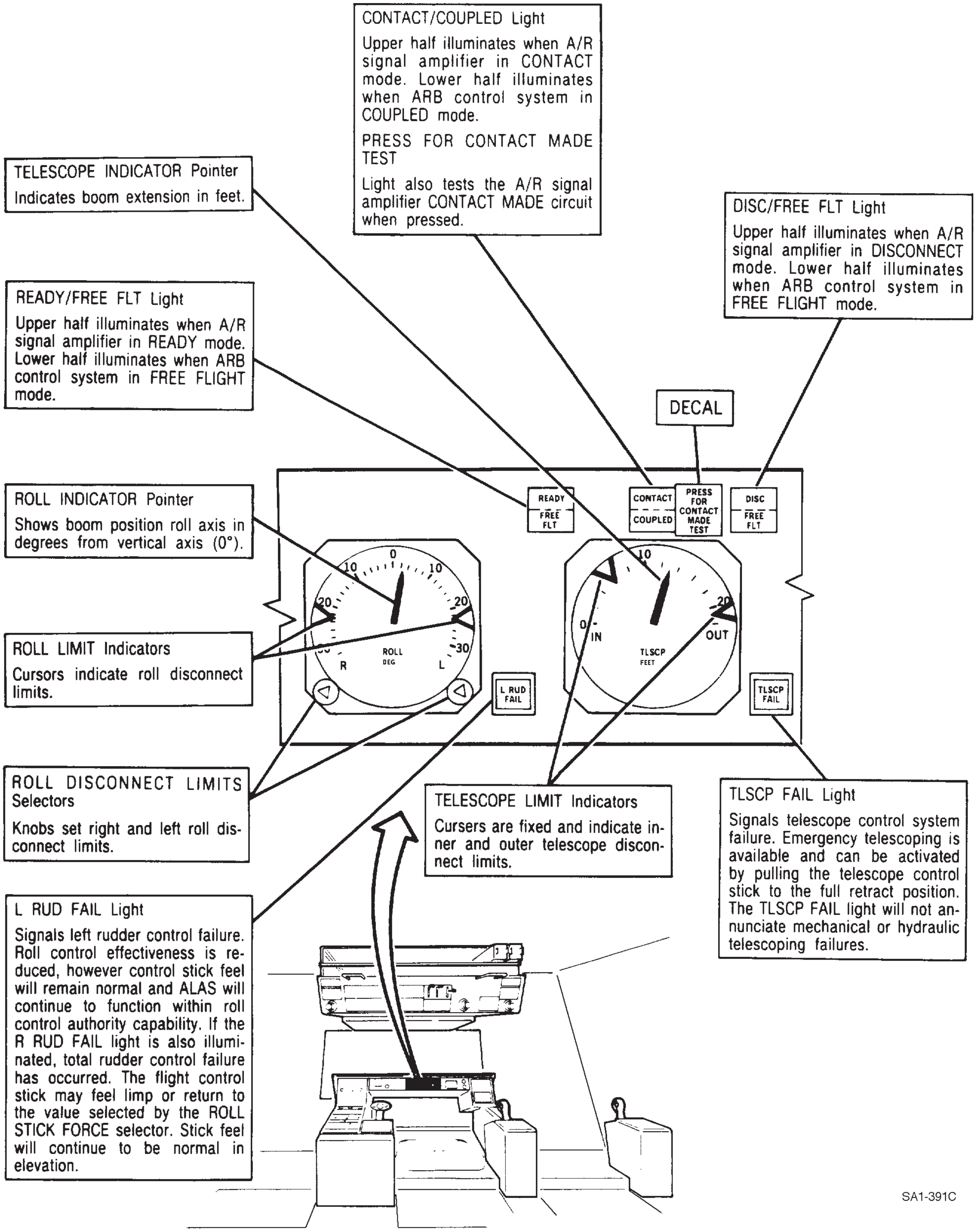
Figure 1.15-12. Boom Operator's Instrument Panel (Sheet 1)



CONTACT/COUPLED Light

Upper half illuminates when A/R signal amplifier in CONTACT mode. Lower half illuminates when ARB control system in COUPLED mode.

PRESS FOR CONTACT MADE TEST

Light also tests the A/R signal amplifier CONTACT MADE circuit when pressed.

TELESCOPE INDICATOR Pointer

Indicates boom extension in feet.

DISC/FREE FLT Light

Upper half illuminates when A/R signal amplifier in DISCONNECT mode. Lower half illuminates when ARB control system in FREE FLIGHT mode.

READY/FREE FLT Light

Upper half illuminates when A/R signal amplifier in READY mode. Lower half illuminates when ARB control system in FREE FLIGHT mode.

ROLL INDICATOR Pointer

Shows boom position roll axis in degrees from vertical axis (0°).

ROLL LIMIT Indicators

Cursors indicate roll disconnect limits.

ROLL DISCONNECT LIMITS Selectors

Knobs set right and left roll disconnect limits.

TELESCOPE LIMIT Indicators

Cursers are fixed and indicate inner and outer telescope disconnect limits.

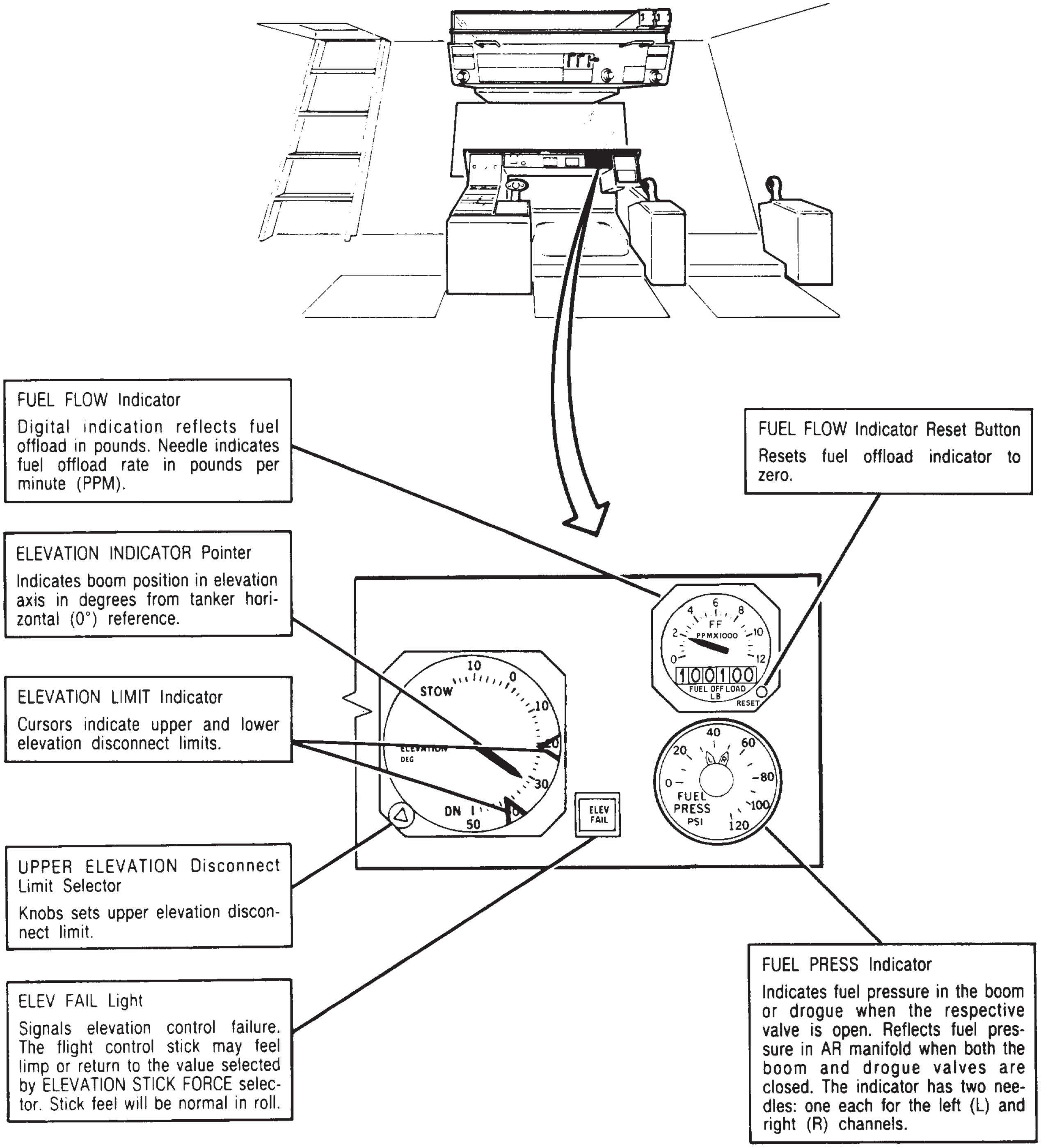
TLSCP FAIL Light

Signals telescope control system failure. Emergency telescoping is available and can be activated by pulling the telescope control stick to the full retract position. The TLSCP FAIL light will not annunciate mechanical or hydraulic telescoping failures.

L RUD FAIL Light

Signals left rudder control failure. Roll control effectiveness is reduced, however control stick feel will remain normal and ALAS will continue to function within roll control authority capability. If the R RUD FAIL light is also illuminated, total rudder control failure has occurred. The flight control stick may feel limp or return to the value selected by the ROLL STICK FORCE selector. Stick feel will continue to be normal in elevation.

Figure 1.15-12. Boom Operator's Instrument Panel (Sheet 2)



FUEL FLOW Indicator

Digital indication reflects fuel offload in pounds. Needle indicates fuel offload rate in pounds per minute (PPM).

FUEL FLOW Indicator Reset Button

Resets fuel offload indicator to zero.

ELEVATION INDICATOR Pointer

Indicates boom position in elevation axis in degrees from tanker horizontal (0°) reference.

ELEVATION LIMIT Indicator

Cursors indicate upper and lower elevation disconnect limits.

UPPER ELEVATION Disconnect Limit Selector

Knobs sets upper elevation disconnect limit.

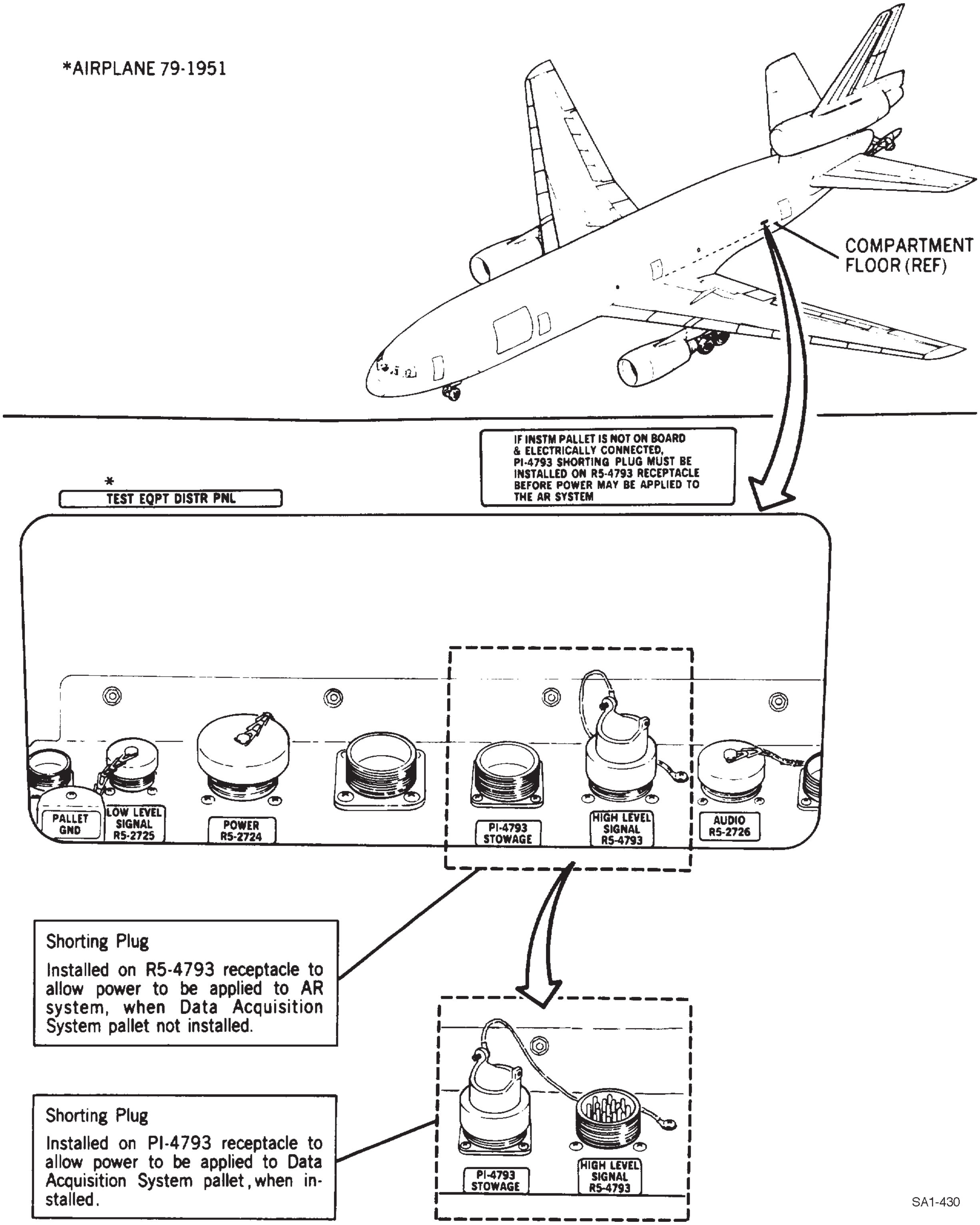
ELEV FAIL Light

Signals elevation control failure. The flight control stick may feel limp or return to the value selected by ELEVATION STICK FORCE selector. Stick feel will be normal in roll.

FUEL PRESS Indicator

Indicates fuel pressure in the boom or drogue when the respective valve is open. Reflects fuel pressure in AR manifold when both the boom and drogue valves are closed. The indicator has two needles: one each for the left (L) and right (R) channels.

Figure 1.15-12. Boom Operator's Instrument Panel (Sheet 3)



IF INSTM PALLET IS NOT ON BOARD & ELECTRICALLY CONNECTED, PI-4793 SHORTING PLUG MUST BE INSTALLED ON R5-4793 RECEPTACLE BEFORE POWER MAY BE APPLIED TO THE AR SYSTEM

Shorting Plug

Installed on R5-4793 receptacle to allow power to be applied to AR system, when Data Acquisition System pallet not installed.

Shorting Plug

Installed on PI-4793 receptacle to allow power to be applied to Data Acquisition System pallet, when installed.

Figure 1.15-13. Test Equipment Distribution Panel

The Boom Operator transmits on flight and service interphone when the interphone PTT switch on the flight control stick or floor is actuated. The instructor transmits on flight and service interphone when interphone PTT switch on the instructor telescope control stick is actuated.

RECEIVER QUALIFICATION DATA ACQUISITION SYSTEM

On aircraft 79-1951 a receiver qualification data acquisition system is installed. If the pallet is not installed the shorting plug (figure 1.15-13) must be installed on the HIGH LEVEL SIGNAL connector, and if the pallet is installed, the shorting plug must be installed on the STOWAGE connector.

NOZZLE ENGAGE/DISENGAGE INDICATION SYSTEM DESCRIPTION

The nozzle engage/disengage indication system consists of three dual indicator lights, located on the Boom Operator's Instrument Panel (figure 1.15-12). The READY/FREE FLIGHT, the CONTACT/ COUPLED, and the DISC/FREE FLIGHT lights indicate the status of the nozzle engage system to the Boom Operator. The top half of the lights reflect the A/R signal system status and is controlled by the A/R Master Switch. The bottom half reflects the flight control system and is controlled by the flight control switch. The intensity of these lights is controlled from full off to full on by the dimmer control on the bottom of the Boom Operator's Lower Side Panel. The DISC/FREE FLIGHT light illuminates when the AR signal amplifier is in the disconnect mode.

AIR REFUELING BOOM SIGNAL COIL

The boom signal coil is located in the boom nozzle.

The boom coil test indicator is located on the ARO overhead panel (fgure 1.15-8). The indicator measures and indicates the resistance of the signal coil on the boom nozzle. A press-to-test button located below the indicator, when actuated, will indicate any fault in the circuit by indicating OPEN, GOOD, or SHORTED.

AIR REFUELING SIGNAL SYSTEM (Amplifier Control)

The tanker signal system is an electrical system that works in conjunction with the signal system in the receiver airplane through the signal coil in the boom nozzle. This system provides the logic to the Boom Control Unit (BCU) to cycle the signal system through its three states of operation: READY, CONTACT, and DISCONNECT. The BCU also provides logic to the boom hydraulic and fuel systems for each state of operation. The system is normally used in the automatic (NORMAL) mode, but can be switched to a manual override (OVERRIDE) mode by means of a push-button switch.

When the air refueling (A/R) master switch is first moved to the PWR position while on the ground (figure 1.15-11), the signal system will be in the READY state. While inflight and in the READY state with the A/R signal system override switch in the NORMAL position the A/R pumps are de-energized, the boom envelope limit switches are deactivated, and the flight control system is in the FREE FLIGHT mode (Figure 1.15-12). The FREE FLIGHT/COUPLED/FREE FLIGHT modes are only activated when the Flight Control Switch is placed to FLT CONT (figure 1.15-11).

In the normal contact condition a signal is sent from the receiver airplane’s signal coil through the boom signal coil to the BCU, advancing the tanker signal system from READY to CONTACT. This condition energizes the A/R pump relays switching on the A/R pumps (if armed), activates the boom limit switches, turns on the receiver pilot director lights, arms the stick shaker, increases flight control stick gradient forces to their maximum value, illuminates the pilot’s boom engaged light, and switches the flight controls to the COUPLED mode.

The A/R signal system can also be advanced to CONTACT/COUPLED by depressing the A/R signal amplifier contact made test switch. This switch tests the A/R signal system contact made circuits by advancing the signal system from READY/FREEFLIGHT to CONTACT/COUPLED, allowing an operational check of the system. Caution must be exercised when selecting this mode, as the boom flight controls become extremely sensitive and boom structural limitations can quickly be exceeded.

The A/R signal system can be advanced from CONTACT to DISCONNECT by any one of the following inputs: by the boom operator depressing the disconnect trigger on the flight control stick, a signal from the receiver airplane through the signal coil, or automatically by the BCU if a boom envelope limit is neared or exceeded. Once a disconnect has been initiated, the flight control system will return to the FREE FLIGHT mode once the selected disconnect delay time has passed, the boom will be retracted at its maximum rate if the telescope-at-disconnect switch is in AUTO, the A/R pumps will de-energize, the flight control stick gradient forces will return to the selected value, the pilot's boom engaged light will go out, and the receiver pilot director lights will remain illuminated and follow boom movements until the system is reset.

The signal system can be returned to the READY/FREEFLIGHT condition at any time by depressing the A/R system reset switch on the Boom Telescope Control Stick (figure 1.15-6).

SIGNAL AMPLIFIER OVERRIDE

The signal system override serves as a secondary system in the event of a failure of the normal system. The emergency override switch on the boom operators control panel, when configured for OVERRIDE (figure 1.15-11) will allow manual control of the A/R signal system by the boom operator, thus replacing the signal amplifier function.

CONTACT is established by depressing the signal system Emergency Contact Made Trigger (figure 1.15-6) on the Boom Telescope Control Stick as soon as the boom nozzle is properly seated in the receiver receptacle. With the tanker signal system in OVERRIDE and in CONTACT/COUPLED all normal boom system components are functional. If the boom signal coil tests GOOD, depressing the A/R Signal System Override Switch will restore NORMAL function of the signal amplifier.

AURAL TONE GENERATOR

Provisions are included for installation of the ARO Aural Tone Generator. Aural tones are generated as a supplemental indication when the KC-10A Signal System advances to CONTACT and DISCONNECT conditions.

A tone is generated when a discrete input is received from the Aerial Refueling Boom (ARB) Signal System. One beep is heard for the annunciated CONTACT condition and three beeps represent the DISCONNECT condition. The beep tones are heard over the head sets in the ARO station through the Audio System.

NOTE

- With the AR SIG SYS in NORM, four beeps will be heard if DISC is selected from a READY condition.
- With the AR SIG SYS in OVRD, three beeps will be heard if DISC is selected from a READY condition.

PILOT DIRECTOR LIGHTS DESCRIPTION

The pilot director lights (figure 1.1-37; controls, figure 1.15-8) consist of rows of lights located forward of the wing root. Relative elevation position is provided by the left row and the right row provides telescoping position. The elevation row contains one green, two amber, two red triangular panel, and two white letters; U at the forward end for UP, and D at the aft end for DOWN. The colored panels and letters are dimly illuminated by background lights. The telescoping row contains one green, two amber, two red, four white rectangular panels, and two white letters; A at the forward end for AFT, and F at the aft end for FORWARD. The colored panels are not background lighted; however, the letter at each end of the row is dimly illuminated. Separation is provided by the white panels. Operation of the pilot director lights is controlled through the BCU. The elevation lights adjust automatically to the size of the air refueling envelope selected by the boom operator and provide guidance to the receiver pilot during contact and disconnect. To provide more response time, the appropriate panel and letter are illuminated in anticipation of receiver movement. The boom operator can illuminate the red panel and adjacent letter at the ends of each row by moving the pilot director light coaching switch to the appropriate position. The coaching switch is powered during all AR SIG SYS configurations.

BOOM MARKER LIGHTS

The boom marker light assembly illuminates the boom extension marker on the telescopic section of the boom. The assembly consists of two fluorescent lights, located on the boom tail cone, two ballasts and a boom marking switch located on the Boom Operator's Overhead Panel.

NOZZLE LIGHTS

Two nozzle lights illuminate the boom nozzle and receptacle area to aid the Boom Operator in accomplishing a contact with receiver aircraft. Light intensity is controlled by a switch on the Boom Operator's Lower Side Panel. A left (aircraft right) foot-operated switch allows the Boom Operator to override the dimmer switch and intensifies the nozzle lights to full bright.

BOOM STOWING AND HOIST SYSTEM DESCRIPTION

The boom stowing and hoist system provides a means to lower, raise, hold, free-wheel, and stow the boom. The system consists of a hydraulic motor driven hoist, winch cable, shock absorber, latch assembly and cable tension motor. Controls and indicators for the system are located in the ARO compartment.

BOOM HOIST WINCH

The boom hoist winch winds the cable to raise the refueling boom and allows the boom to lower through gravity.

BOOM SHOCK ABSORBER

The rechargeable shock absorber cushions the boom against the aircraft when the boom is in the stowed position. The shock absorber is recharged manually with compressed air or dry nitrogen through the air valve by ground service personnel.

DISCONNECT

NORMAL DISCONNECT

The disconnect switch is operated with the AR SIG SYS in NORM or OVRD. Depressing the disconnect switch will advance the tanker AR SIG SYS to DISC/ FREEFLIGHT from either the READY/FREEFLIGHT or CONTACT/COUPLED mode. The receiver's system will advance to disconnect if the boom signal is good and the receiver's signal system is in normal.

INDEPENDENT DISCONNECT SYSTEM (IDS)

The Independent Disconnect System (IDS) is an electrically controlled, pneumatically actuated system located in the nozzle assembly. Pneumatic pressure is supplied from a compressed air reservoir mounted on the telescope tube. The IDS is operated by depressing the disconnect switch through the second detent. When the system is activated pneumatic pressure retracts the toggle latches on each side of the nozzle to a flush position. This allows the boom to be retracted from the receiver aircraft while its toggles are in the latched/ extended position.

The toggle latches have a holding circuit installed that will retain the toggles in the retracted position, after IDS actuation, until the RESET TO READY button is pushed.

Indicating System

An Independent Disconnect Pressure Indicator is installed on the Boom Operator's Instrument Control Panel (figure 1.15-12). It indicates pressure remaining in the air bottle.

CENTERLINE HOSE AND DROGUE SYSTEM DESCRIPTION

The centerline hose and drogue system is used for refueling a probe equipped receiver aircraft. There are five subsystems; Hose and Drogue, Reel Actuation, Position Indicating, Guillotine, and Lighting.

The hydraulically actuated hose reel and drogue is located off center from the ARO viewing tunnel on the right side of the tanker. This offset provides clearance between the boom and drogue.

HOSE REEL BLEED VALVE

Hose Reel Bleed Valve operation is controlled automatically through the fuel range position switch. It is powered closed when drogue is within refueling range and powered open when drogue is forward or aft of its refueling range limits.

PARADROGUE

The paradrogue provides the receiver aircraft with an aerodynamically stable target to contact. The paradrogue consists of arms connected to a circular base ring on one end and to a nylon canopy on the other. The canopy becomes inflated when the hose is extended into the airstream, giving it stability. The paradrogue is collapsible to minimize storage space when stowed. The receiver, or open end of the housing, is cone shaped to guide the entrance of the mating probe attached to the receiver aircraft. The ball-shaped housing encloses an internal pressure regulator and surge suppression device for the protection of the receiver aircraft.

REEL ACTUATION

The reel actuation system operates and controls the trail rewind and stowage functions of the hose reel and drogue.

SWITCHES (HOSE REEL)

Trail Limit Switch

The trail limit switch actuates the full trail relay which locks in reference pressure for hose tension.

Drogue Stop Switch

The drogue stop switch turns off the reel operation and stops the drogue in the stowed position during the rewind operation.

Reel Locked Switch

The reel locked switch deactivates the HOSE REEL NOT LOCKED annunciator light on the ARO panel when the hose reel is locked.

Forward Limit Switch

Activation of the forward limit switch will cause the external amber ready light to flash notifying the receiver pilot that the forward limit has been exceeded. Operations will return to normal when the receiver moves back into the refueling range.

Fuel Range Position Switch

The fuel range position switch is a single switch and defines the forward and aft drogue refueling ranges. It is active when hose is approximately 5 feet forward of full trail and deactivated when hose is pushed in beyond the forward range position or pulled aft to approximately 5 feet forward of full trail. Pushing the hose in approximately 5 feet will cause external amber and internal blue ready lights to go off and hose reel bleed valve to close. The AR pumps will start up and drogue valves will open if armed.

Exceeding forward fuel range position will turn AR pump(s) off (if AR Pump OVRD SW is off), close drogue valve and open hose reel bleed valve. The AR pump(s) will continue to operate if the AR Pump OVRD switch is in OVRD. However, the drogue valve will close and hose reel bleed valve will open.

The external amber and internal blue ready lights will come on, hose reel bleed valve will open and drogue valve will close when aft refueling range position is exceeded. The AR pumps will also shut off if AR Pump OVRD switch is off. Operations return to normal when receiver moves back into refueling range.

ANNUNCIATOR LIGHTS (INTERNAL)

Hyd Press Low Light

An amber (HYD PRESS LOW) annunciator light on the drogue control panel (figure 1.15-14) comes on if there is a pressure drop in the drogue hydraulic system.

Ready Light

A blue (READY) annunciator light on the drogue control panel comes on when the drogue is in the full trail position and ready for the receiver aircraft.

Resp Inop Light

An amber annunciator light is located on the HOSE REEL MONITOR Panel (figure 1.15-14). This light comes on if the reel response is or becomes improperly set when the hose is deployed and DROGUE CONTROL HOSE switch is in TRAIL.

NOTE

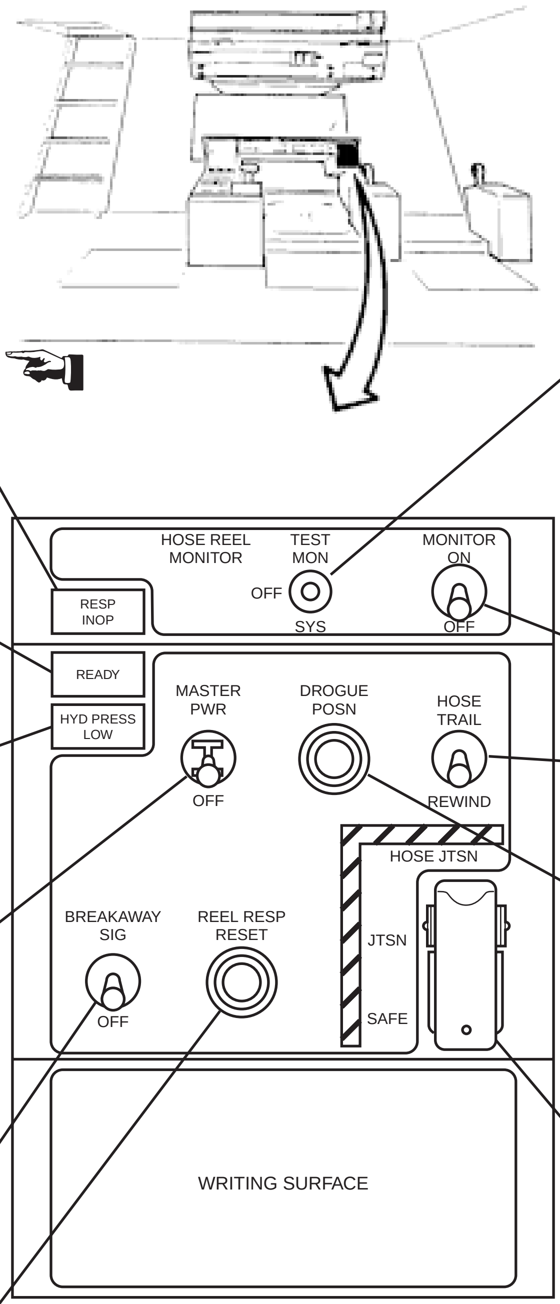
> This light may flicker during initial receiver engagement or when receiver moves the hose between aft limit and full trail position (READY light on). This is considered normal.

DROGUE POSITION INDICATOR

A Drogue Position Indicator (figure 1.15-14) on the drogue control panel indicates whether the hose and drogue are in the stow, transit or trail position.

GUILLOTINE SYSTEM

The guillotine system allows the Boom Operator to jettison the hose and drogue in the event of an emergency. The guillotine is installed on the hose reel and the refueling hose travels back and forth through its aperture. The breech, chamber, and cap assembly extend below the tube. The guillotine is designed so that when it is fired, the blade severs the hose and simultaneously both free ends of the hose are clamped shut, preventing fuel spillage. One clamp secures the hose that is attached to the drum, and remains with the guillotine. The other clamp secures the hose attached



RESP INOP Light

ON (Hose Stowed):
Hose Reel Monitor System is inoperative

ON (Hose Deployed):
Reel response improperly set for current flight conditions.

External red Drogue Signal Light is illuminated.

OFF (Hose Deployed):
Reel response set for current flight conditions.

Drogue READY Light

Signals system is ready for receiver to engage drogue. Light comes on approximately 5 seconds after hose reaches full trail position.

Drogue HYD PRESS LOW Light

Signals a significant drop in auxiliary hydraulic system pressure.

Drogue MASTER PWR Switch

Activates/deactivates drogue system power.

Drogue BREAKAWAY SIG Switch

Provides visual breadaway signal to receiver pilot. The red external HYD PRESS LOW light for the centerline drogue the red POD NOT READY light for the wing pods, and the Pilot Director Lights and letters for the boom will flash for 10 seconds after switch actuation when any system is powered on. Switch is spring loaded to OFF.

REEL RESP RESET Button

Readjusts drogue reel tension to accommodate changes in hose/drogue drag resulting from changes in tanker airspeed, altitude, atmospheric conditions, etc. READY Light goes off when button is pushed and comes back on approximatley 5 seconds after button is released and external red Drogue Signal Light goes out.

HOSE REEL TEST Switch

MON (Hose Stowed):
Tests hose reel monitor (BITE) system circuits. When switch is momentarily moved to MON, RESP INOP light comes on approximately for one second and goes off. System is operating properly.

OFF:
Test switch spring loaded to OFF.

SYS (Hose Deployed).
Tests hose reel response system. When switch is momentarily moved to SYS, READY light goes off, hose rewinds to forward limit then redeploys to trail, READY light on approximately 5 seconds after hose reaches full trail.

NOTE

SYS position is inoperative when READY light is off.

HOSE REEL MONITOR Switch

Activates/deactivates Hose Reel Monitor System.

HOSE TRAIL/REWIND Switch

Controls hose extension and retraction.

Drogue POSN Indicator

Indicates drogue position STOW and TRAIL are displayed for respective hose position. A barber pole is displayed when hose is in an intermediate position or when the Drogue MASTER PWR switch is off. A barber pole will also be displayed when hose is jettisoned.

DROGUE/HOSE JTSN Switch

Enables boom operator to jettison drogue assembly.

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Figure 1.15-14. Boom Operator's Aft Side Panels - Drogue Control Panel And Hose Reel Monitor Panel (Right) to the drogue and is subsequently jettisoned with that portion of the hose. The guillotine is equipped with two Mark II Mod I cartridges which are fired simultaneously by a 28-volt electrical signal routed through the guillotine harness assembly. The cartridges are configured to fire together. If only one is fired electrically, the other will fire sympathetically.

HOSE REEL MONITOR SYSTEM

The HOSE REEL MONITOR System continuously monitors/compares current hose reel response setting with existing flight conditions. If a reel response discrepancy occurs, the Boom Operator is alerted by the RESP INOP light coming on. The external READY light is inhibited when the RESP INOP light is on.

NOTE

- Reel response discrepancies that occur subsequent to an acceptable reel response being set will not affect external READY light operation until reel response is reset.
- External READY light is inhibited when HOSE REEL MONITOR switch is ON and HOSE REEL MONITOR system is inoperative.

HOSE AND DROGUE ILLUMINATION SYSTEM

A white floodlight illuminates the hose and drogue markings in the aft fuselage area. The intensity of the floodlights is controlled by a rheostat (figure 1.15-8) located on the Boom Operator's Overhead Panel in the ARO compartment.

The drogue contains four lights to aid in identifying drogue position during night refueling. The lights are powered by a self-contained air driven generator located in the drogue fairing. The lights are on at all times when the hose is in TRAIL, however, they will not be visible during day operations.

HOSE AND DROGUE SIGNAL LIGHTS (EXTERNAL)

Red, green and amber signal lights located on the aft fuselage are clearly visible to the pilot of the receiver aircraft during all phases of refueling operations. The intensity of the signal lights is controlled by a rheostat on the overhead panel in the ARO compartment.

Red Signal Light

The red signal light illuminates steady when the hydraulic pressure is too low to operate the hose reel. The red signal light is controlled by a pressure switch on the hose reel.

The light is also illuminated whenever the RESP INOP Light is illuminated. Resetting the reel response system with turn the signal light off.

The red signal light can be flashed on and off to signal drogue breakaway. The flashing mode is controlled by the drogue breakaway switch on the Boom Operator's Drogue Control Panel.

Fuel Flow Light

The green (FUEL FLOW) signal light turns on steady when fuel is being transferred from the drogue to the receiver aircraft. The green signal light is controlled by signals from the flow meter.

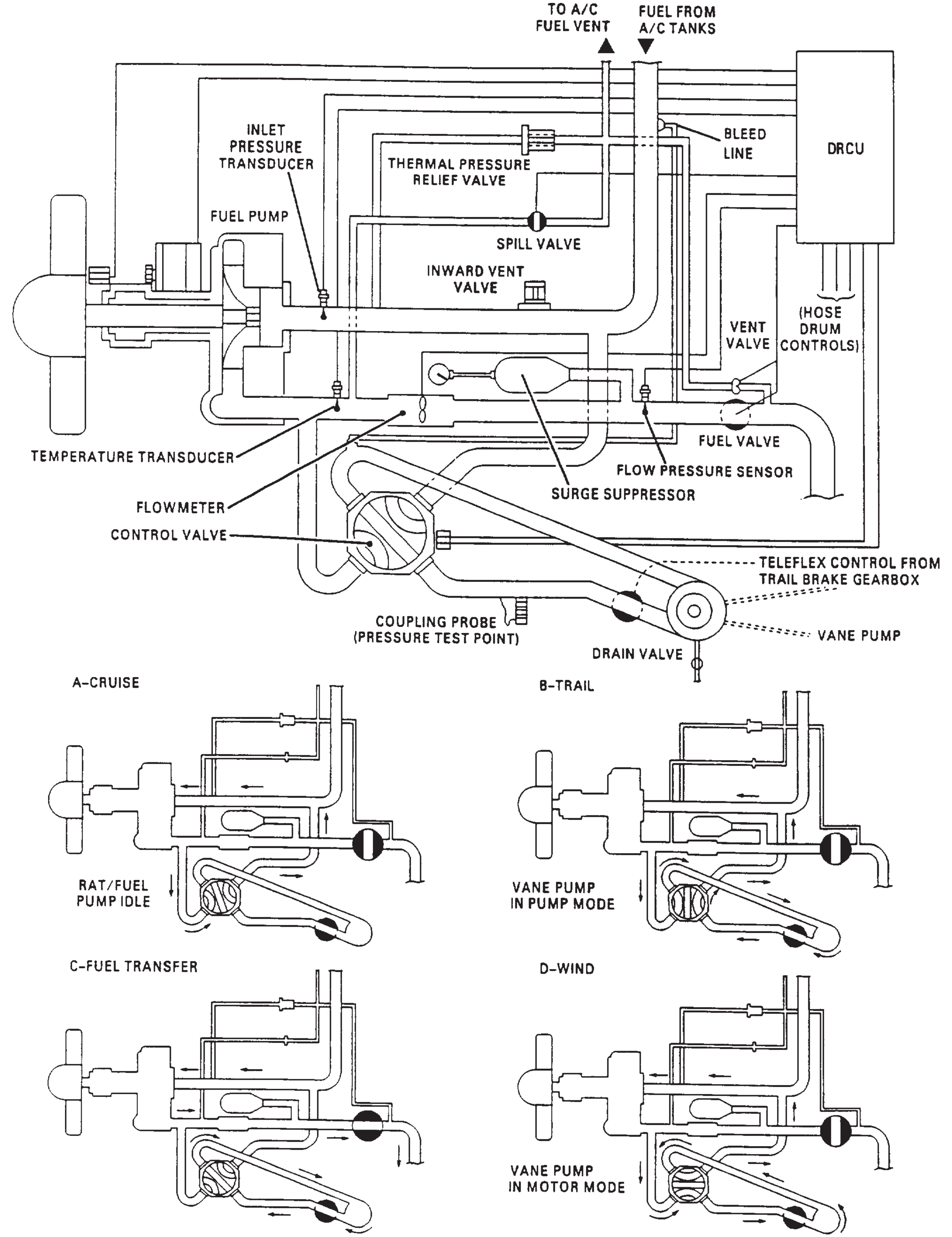
Ready Light

The amber (READY) signal light turns on steady when the drogue is in full trail position provided the reel response is properly set for current flight conditions. The amber light goes off when the receiver aircraft pushes the drogue in approximately five feet. The amber light will flash on and off when the forward limit is exceeded.

WING POD HOSE AND DROGUE SYSTEM DESCRIPTION (WITH TCTO 1C-10(K)A-956)

The Wing Aerial Refueling System (figure 1.15-15) provides multipoint refueling for probe equipped receiver aircraft. It consists of one externally mounted hose and drogue pod located on the underside of each wing near the wing tip. The pods are self-contained, except for electrical power required for control and signal information. The pods are attached to the wing by means of a pylon and receive fuel through a fuel line exiting through the lower wing skin and contained within the pylon.

Fuel can be delivered to the wing mounted aerial refueling pods through the aircraft fill/transfer manifold. Fuel should normally be used from the body tanks by using the aerial refuel pumps and routing through the alternate transfer valves and appropriate ISOL VALVE into the wing crossfeed manifold. An electrically operated shutoff valve on each outboard section controls the flow of fuel to the appropriate (LH or RH) wing pod. An alternate means of fuel transfer would be the use of the electric engine tank/transfer pumps in the wing and/or body tanks.



CAG(IGDS) WITH TCTO 1C-10(K)A-956

SA1-563

Figure 1.15-15. Wing Pod Fuel System

WING POD FUEL VALVES

The wing pod fuel valves are located in the wing pods and control the flow of fuel from the pod fuel pump to the receiver. Each valve is controlled by its respective switch located on the Flight Engineer's control panel. Power for valve operations is provided through the respective power switch located on the left or right wing aerial refueling pods control panel. The pod fuel valves are also interlocked through the fuel range position switch and will open automatically after hose is pushed in 5 feet to 25 feet forward of full trail if the control switch on the Flight Engineer's panel is armed. The valves are powered closed when drogue position is forward or aft of refueling range limits. The valve will also close automatically if a failure is detected and pod shutdown occurs. The signal for controlling the aerial refueling pumps is provided by two fuel pressure transducers located in the fuel crossfeed manifold. These two transducers are active during wing drogue air refueling provided: the valves for the boom are closed and a minimum of one WING DROGUE VALVE, ISOL VALVE and ALTN TRANS VALVE are open. Any combination between the left or right WING DROGUE VALVES and ALTN TRANSFER VALVES is acceptable; however, one of each must be open. Fuel pressure is maintained at 50 ±5 psi at the center of the wing fill/transfer manifold when controlling signal is provided by the crossfeed manifold transducers.

WING POD

Each wing pod contains a Ram Air Turbine (RAT) and fuel pump, a hose and reel system, a reception coupling and paradrogue, signal lights, a control system and the required fuel system components (figure 1.15-16).

RAM AIR TURBINE AND FUEL PUMP

The Ram Air Turbine is driven by a two bladed 25 inch diameter propeller, whose pitch angle can be varied by a spring loaded ball screw mechanism driven by an electric motor. The variable blade angle allows for adjustment of the rpm necessary to drive the fuel pump which provides the fuel pressure needed for fuel delivery as well as hose trail and rewind. The RAT is feathered for normal cruise flight, however it rotates slowly at 600-1200 rpm for minimum drag and fuel pump lubrication.

HOSE AND REEL

The hose is 2.0 inch I.D. and 79 feet in length, 5 feet of which remain within the pod, giving a fully trailed length of 74 feet. It is constructed of a rubber inner tube, a helical wire spring, braided wire mesh and an outer rubber tube. The outer cover is black with white and orange band markings to identify significant lengths. A buffer spring surrounds the outer end of the hose at the reception coupling. This buffer spring serves two functions: initially thrusting the reception coupling and the paradrogue into the slipstream in the trail mode, and absorbing the impact shock in the rewind mode. The hose is stowed on a grooved cylindrical reel which can be driven in either direction for hose trail or rewind. The reel is chain driven from a vane pump, which is powered by fuel pressure.

RECEPTION COUPLING AND PARADROGUE

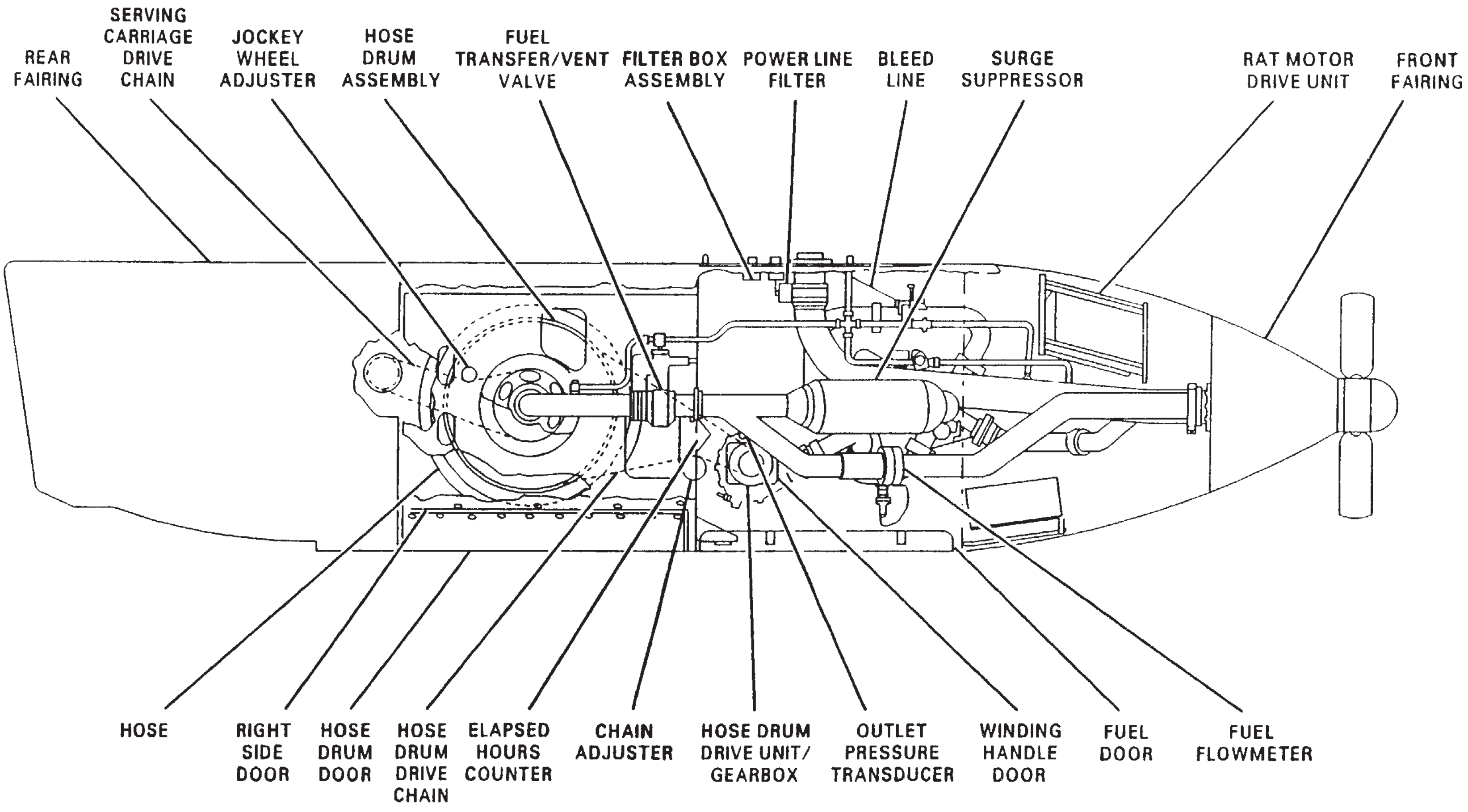
An MA-4 coupling is installed at the end of the hose. This provides dual redundant secondary pressure regulation of the fuel flow into the receiver aircraft and also provides surge protection for the receiver aircraft. The paradrogue is attached to the aft end of the reception coupling. The paradrogue consists of arms connected to a circular base ring and a nylon canopy at the outer ends. The paradrogue provides the drag force necessary to pull the hose out in the trail mode, stabilizes the end of the hose and is an aiming point and guide for the probe of the receiver.

The drogue contains four lights to aid in identifying drogue position during night refueling. The lights are powered by a self-contained air driven generator located inside the MA-4 coupling shroud. The lights are on at all times when the hose is in trail, however, they will not be visible during day operations. The lights illuminate the reflective tape on the drogue arms.

POD SIGNAL LIGHTS

Red, amber, and green signal lights (figure 1.15-17) are located on the underside of the aft tailcone fairing. They are set up in pairs for redundancy and are clearly visible to the receiver pilot. The intensity of the green and amber lights can be adjusted from BRIGHT for day operations to DIM for night operations. The red lights are always bright.

The red (WARNING) signal lights are illuminated whenever the WARP power switch is on and the pods



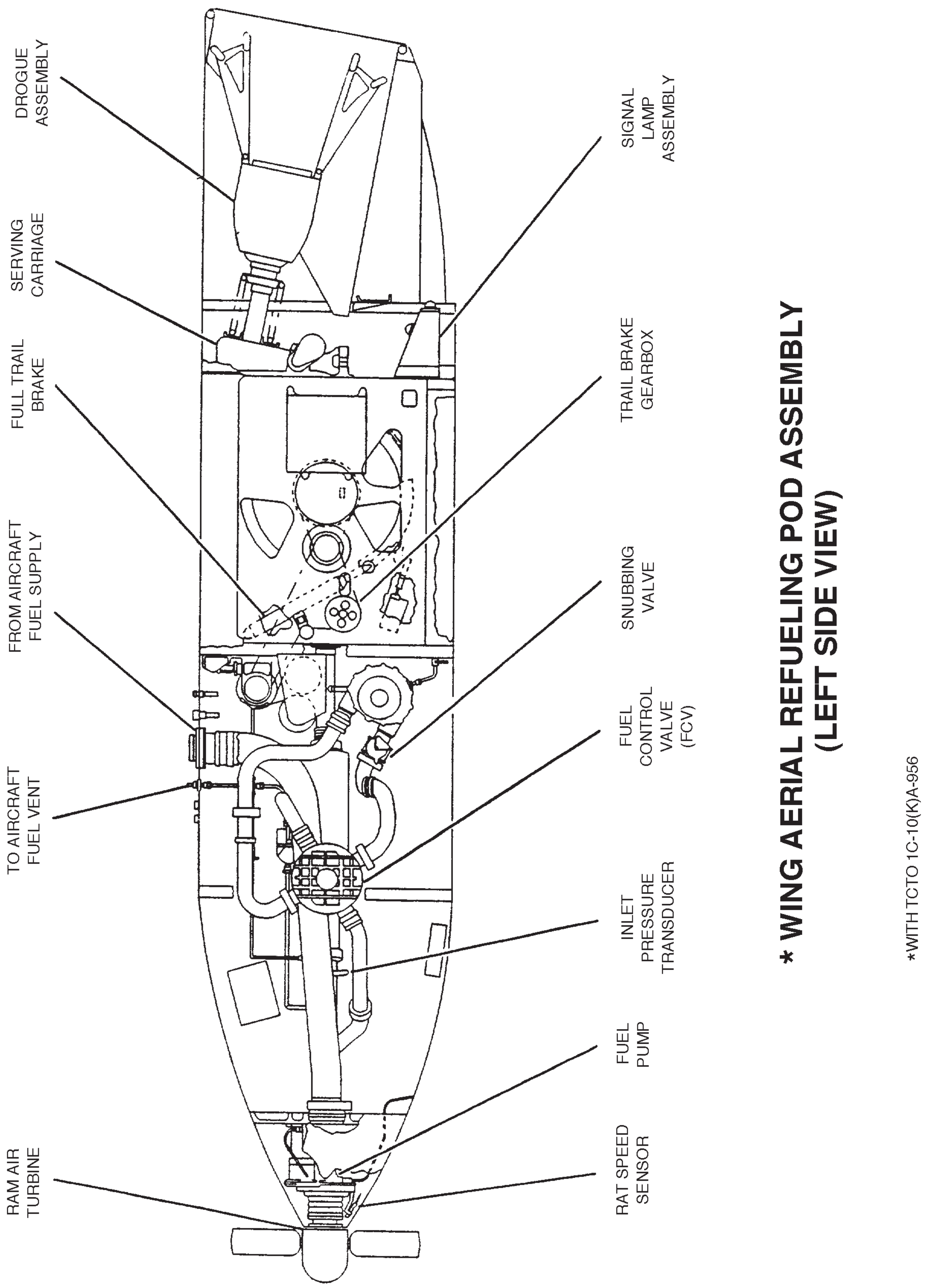
***WING AERIAL REFUELING POD ASSEMBLY**
(RIGHT SIDE VIEW)

*WITH TCTO 1C-10(K)A-956

CAG(IGDS)

SA1-556

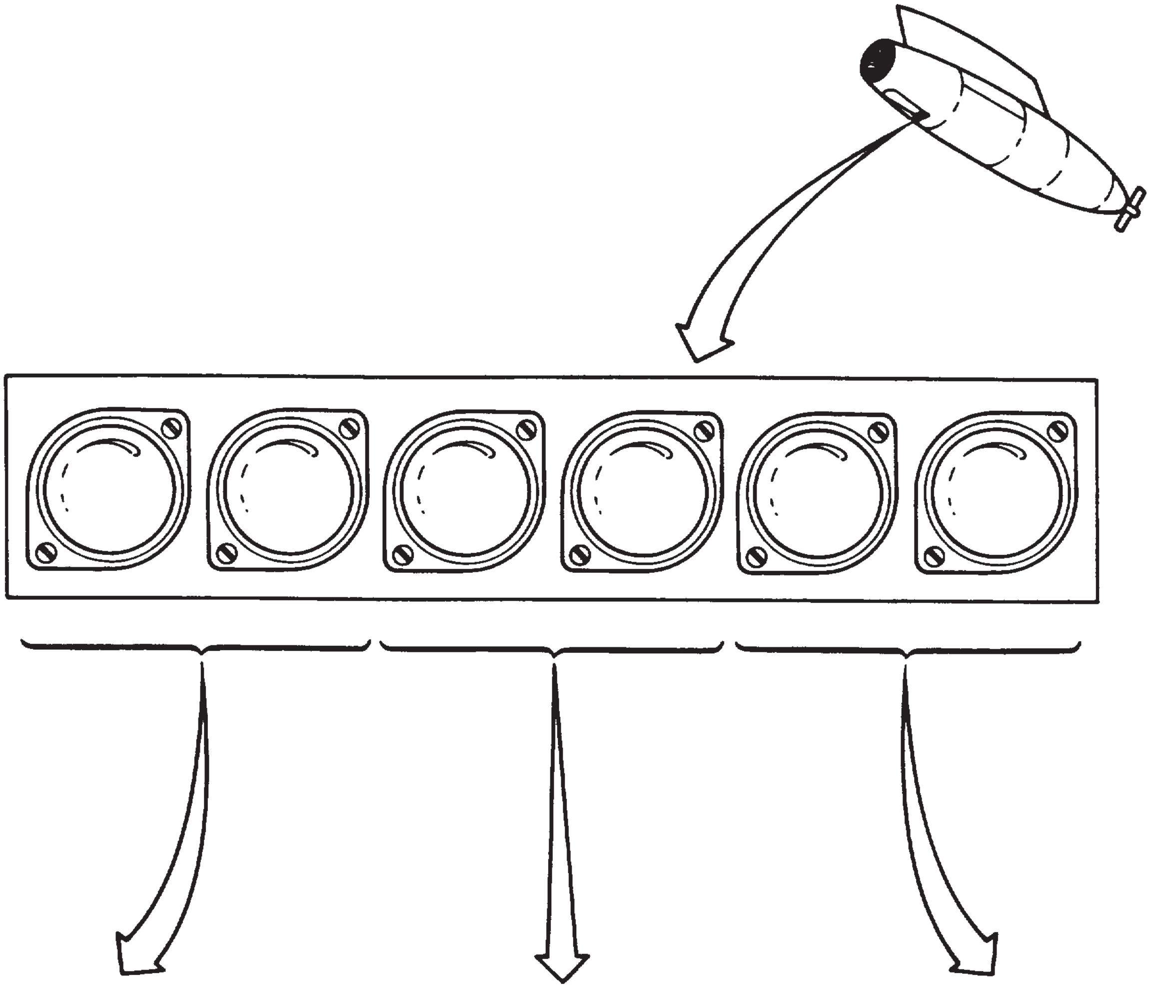
Figure 1.15-16. Aerial Refueling Pod Assembly (R.H.) (Sheet 1)



CAG(IGDS)

SA1-557

Figure 1.15-16. Aerial Refueling Pod Assembly (R.H.) (Sheet 2)



READY LIGHTS

Two amber lights come on when the drogue is in full trail position. They go off when the receiver pushes the drogue in approximately 5 feet. These lights will flash on and off when the forward limit of the refuel range is being approached.

POD WARNING LIGHTS

Two red lights are on whenever pod "PWR" is on and the hose is not ready for receiver contact. They remain on during the trailing phase and go off when full trail is reached. They will come back on when rewind is selected. They will flash when the boom operator energizes the breakaway switch if the hose is in full trail or in refuel range.

FUEL FLOW LIGHTS

Two green lights come on steady when fuel is being transferred to the receiver aircraft. The green lights are controlled by a signal from the wing pod flow meter.

WITH TCTO 1C-10(K)A-956

SA1-564

Figure 1.15-17. Wing Pod Signal Lights are not ready for receiver contact. The red lights also flash if the hose is at full trail or in refuel range to signal breakaway. Both left and right pods and the centerline hose/drogue signal red signal lights are controlled from a common breakaway switch on the centerline hose/drogue control panel, and alternately by the breakaway switch on the boom controller. The pods will enter a passive mode when either breakaway switch is activated.

The amber (READY) signal lights illuminate when the hose reaches 70 ft during trail and the hose has stopped moving. They do not indicate that the hose has reached full trail of 74 feet. When the receiver pushes the hose in 5 feet from full trail, to 69 feet trail (refuel range), the amber lights will go off. When the receiver pushes the hose in to 57 feet of trail, the amber lights will flash, indicating that the inner refueling limit (48 feet of trail) is being approached. If the receiver pulls the hose back out to more than 57 feet, the amber lights will stop flashing.

The green (FUEL FLOW) signal lights illuminate when fuel is being transferred to the receiver at a rate of 50 GPM or greater. The green signal lights go out and fuel transfer is stopped if the receiver pushes the hose in to the inner refueling limit of 47 feet or less. If the receiver pulls the nose back out to 49 feet or greater, the fuel transfer resumes and the green signal lights turn back on.

POD MARKINGS

Three red guide lines are provided at each wing pod location to aid the receiver pilot with alignment prior to contact with the drogue. One line is painted on each side of each wing pod on the underside of the wings several feet away from the pods. A third line is located on the bottom of each wing pod and is used as a center for receiver aircraft alignment.

ACTIVE TRAIL MODE

Hose trail is normally accomplished by positioning the hose trail/rewind switch to trail, which releases the motor operated parking brake allowing the compressed buffer spring to thrust the drogue coupling and paradrogue into the slipstream. Then the drag force from the drogue pulls the hose from the reel.

CAUTION

> After selecting Trail, do not select Rewind until the hose reaches the full trail position. If rewind is selected damage may occur to the parking brake mechanism. If the hose fails to reach the full trail position, refer to the appropriate abnormal checklist.

The vane pump automatically provides variable braking to the hose reel to maintain a trail speed of 5 ft/sec. Starting at approximately 46 feet of trail, the tensator springs begin to wind onto a spool, preloading them for quick response upon receiver contact. At a trail of 69 feet or greater, the ready light is illuminated, the red signal lights on the pods are extinguished and the amber signal lights are illuminated. As full trail is approached, the vane pump control valve restriction increases, slowing the rate of trail from 5 ft/sec to approximately 2 ft/sec. When full trail is reached at 74 feet, a microswitch is closed, enabling the hose jettison system. A full trail brake is activated as the hose reel approaches the fully trailed position creating a mechanical stop to prevent over extension. The hose will trail as described above if trail is initiated at speeds between 230 and 300 KIAS. If trail is initiated at a speed lower than 230 KIAS, the hose may not reach full trail, due to the lack of sufficient drag on the paradrogue. If this occurs, the ready light will not illuminate, and fuel transfer will not be possible. In addition, the hose jettison system will not be enabled. Thus the aircraft speed should be increased to 230 KIAS or higher, increasing the drag on the paradrogue, and pulling the hose to the full trail position. Once this is accomplished, the ready light will illuminate, and the hose jettison system will be enabled. After reaching full trail the aircraft can be slowed to 200 KIAS for receiver refueling.

CAUTION

> When the receiver pushes the hose to approximately 46 foot trail, the tensator take up system stops and a DEAD hose will result which can form a loop.

PASSIVE TRAIL MODE

Fault conditions which occur during the trail or rewind mode cause the WARP control panel to display a FAIL indication, the pod red signal lights will remain lit, and the hose will slowly (approximately 2 ft/sec) move to full trail. The vane pump control valve provides more resistance in this condition than it does in the normal active trail condition, resulting in the slow extension. On reaching full trail of 74 feet, the pod red signal lights will go off and the ready light will come on provided the fault is cleared. The drogue jettison function is enabled, since the hose has gone to full trail.

REWIND MODE

Hose rewind is normally accomplished with the hose at full trail by positioning the TRAIL/REWIND switch to REWIND. An electric motor drives the Fuel Control Valve (FCV) to port fuel through the vane pump in the opposite direction. This will drive the hose drum to rewind the hose at a maximum of 8 ft/sec. The HOSE TRANSIT light flashes each time the hose moves 2 feet. As the hose reaches 12 feet of trail, the parking brake is driven into position. When the hose is within 1 foot of stowed and the hose transit speed stops, the control panels will indicate stowed. During the rewind cycle, the switch can be moved to TRAIL allowing the hose to retrail.

BREAKAWAY OPERATION

When the boom operator determines to have the receiver clear the tanker, he can initiate a breakaway signal. This can be accomplished by actuation of the breakaway switch on the fuselage drogue control panel or the breakaway switch on the boom telescope control stick. The pod breakaway signal is indicated by the flashing red pod signal lights. If actuated at the full trail position, the lights will flash for 10 seconds. If actuated in the refuel position, the lights will continue to flash until the hose moves to the full trail position. The pod breakaway lights will not flash in the stowed position.

DIGITAL REFUELING CONTROL UNIT (DRCU)

The pod functions are controlled by an electronic digital system through the DRCU. The control unit adjusts the Fuel Control Valve (FCV) and the RAT to provide for hose trail and rewind, and for fuel delivery pressure to the receiver aircraft. The pressure is controlled to provide 50 ±5 psi coupling pressure at all flows from 0 to maximum (approximately 420 GPM). The RAT is limited to 6900 rpm. If the rpm exceeds 7500 rpm, the pod will shut down and a warning signal will be given the boom operator on the ARO control panel. If the pod inlet pressure falls below 10 psi, the RAT will slow the fuel delivery to maintain a satisfactory operation.

ARO CONTROL PANELS/ANNUNCIATOR LIGHTS

Ready Light

A blue (READY) annunciator light (figure 1.15-8) comes on when the hose is within 5 feet of full trail and remains on after full trail is reached. It will go off when the receiver aircraft pushes the drogue in approximately 5 feet. The light will flash on and off when the forward limit of the fuel range is being approached. This light turns on and off at the same time as the external amber light.

Hose Transit Light

A blue (HOSE TRANSIT) annunciator light (figures 1.15-8 and 1.15-18) flashes each time hose length changes by approximately 2 feet during deployment, retraction, or receiver movement.

Hose Stowed Light

A blue (HOSE STOWED) annunciator light (figures 1.15-8 and 1.15-18) comes on when the hose is stowed. The light will flash after hose is stowed if RAT speed exceeds 2000 rpm.

Fuel Temp High Light

An amber (FUEL TEMP HIGH) annunciator light (figures 1.15-8 and 1.15-18) will come on when the wing pod fuel pump temperature exceeds prescribed temperature limit. The fuel spill valve will open and dump hot fuel into the appropriate fuel tank (No. 1 main for the left pod, and No. 3 main for the right pod).

Fuel Press High Light

An amber (FUEL PRESS HIGH) annunciator light (figures 1.15-8 and 1.15-18) will come on when fuel offload pressures exceed prescribed limits. The fuel spill valve will open and dump the fuel into the appropriate fuel tank (No. 1 main for the left pod and No. 3 main for the right pod). Both the FUEL PRESS HIGH and FUEL PRESS LOW lights will flash when the drogue is deployed and the RAT speed exceeds 7000 rpm for 5 seconds, or exceeds 7500 rpm with no time delay. At this time, the pod red signal light will

NOTES

1. Hose transit indicator flashed, e.g. to show hose movement at all times, except when fuel temperature high or fuel pressure high/low indicator is ON.
2. If control system fails (all pod modes, when hose is deployed),
   red signal lights remain ON/go ON.
   yellow/green signals lights OFF.
   AROCP ready indicator OFF.
   Hose moves to full trail in passive trail.
   Pod fuel system will not cause a passive condition.
3. Functions occur when deployed hose length is < 68 ft, when hose is pushed-in.
4. Green signal ON and RAT energized, when 50 Gal/Min sensed by flowmeter.
5. Yellow signal lights/ready indicator flash when deployed hose lenth is < 56 ft, when hose is pushed-in, and extinguish when hose is pulled-out > 58 ft.
6. Functions occur when deployed hose length is < 47 ft, when hose is pushed-in. With hose deployed > 49 ft, when hose is pulled-out, green signal light ON, pod fuel valve open, RAT energized.
7. Functions occur when deployed hose length is > 70 ft, when hose is pulled-out.
8. Vent line opens when fuel valve closes (all pod modes).
9. Hose stowed indicator flashes, if RAT speed greater than 2000 rpm.
10. With drogue not stowed, indicator is lit when u/c selected down.

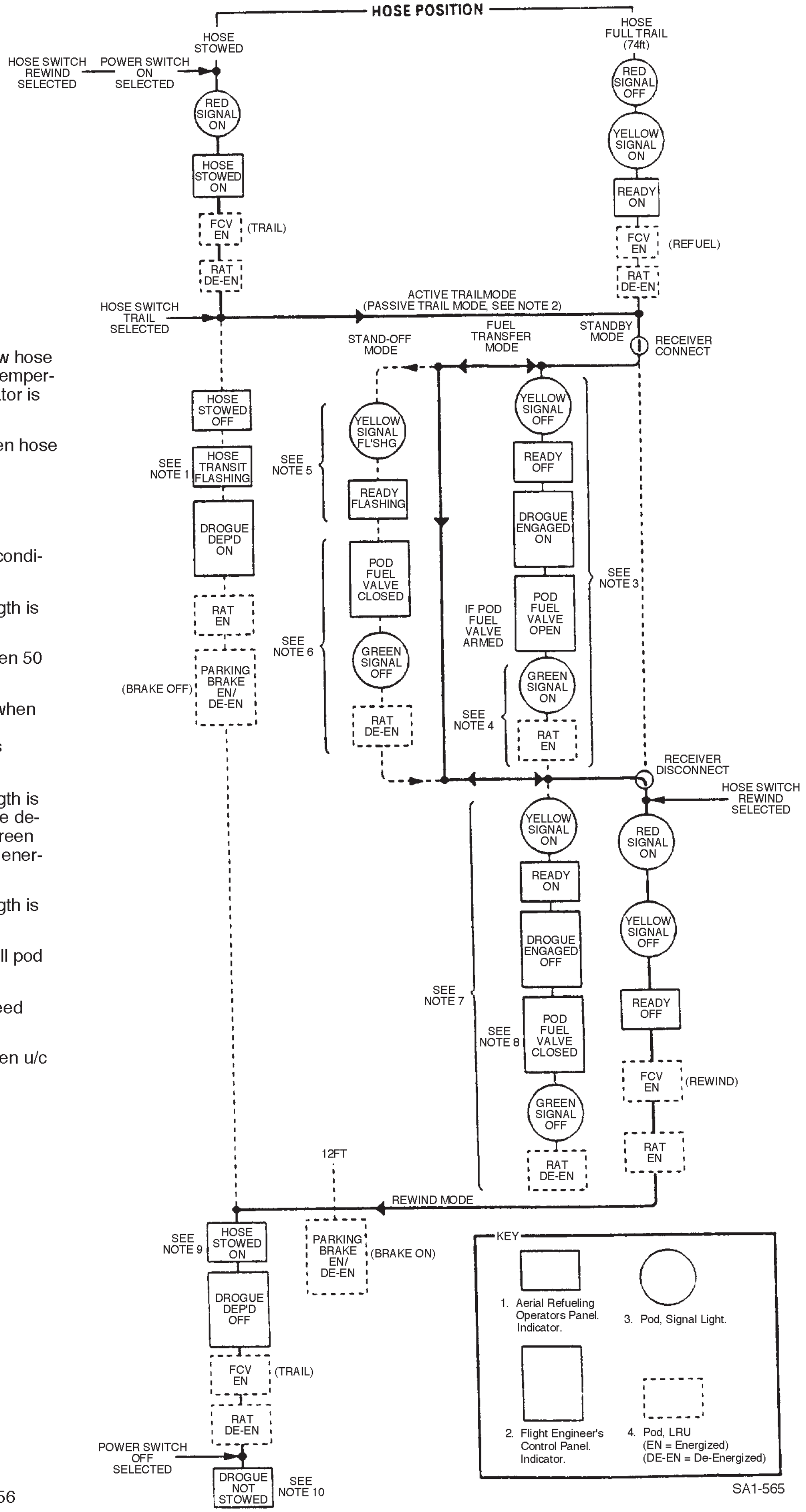


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Figure 1.15-18. Wing Pod Hose Position Operational Sequence illuminate (steady), the pod Fuel Control Valve (FCV) will close, the fuel spill vent valve will open and if the hose is not stowed, it will slowly creep out to fulltrail (passive mode).

Fuel Press Low Light

An amber (FUEL PRESS LOW) annunciator light (figures 1.15-8 and 1.15-18) comes on when fuel pressure to wing pod drops below 6 psi, while the associated annunciator on the FE panel comes on at 10 psi. The FUEL INLET PRESSURE LOW light on the FE panel provides a warning of low fuel pressure to the wing pod. The FUEL PRESS LOW light on the ARO control panel remains on as long as the pressure remains at or below 6 psi.

Fuel Offload Display

The fuel offload counter display consists of four lamps providing a four digit display. When the pod control system is functioning in the fail mode, the word FAIL is registered on the four digit display. When a fuel transfer is implemented, the display registers the fuel quantity off loaded to the receiver aircraft in units of 100 lbs. Example: 150 represents a 15,000 lb. offload.

The display is also capable of registering RAT speed and fuel temperature. Pressing the BITE button for less than 2 seconds displays RAT speed in increments of 100 RPM prefixed by the letter r. Example: r-65 represents 6500 RPM.

Another press of the BITE button for less than 2 seconds will display fuel temperature in increments of 1°C, prefixed by the letter t. Example: t-9 represents 9°C. The COUNTER RESET must be pressed to return the display register to fuel offload quantity.

FE CONTROL PANEL/ANNUNCIATOR LIGHTS

The WING AERIAL REFUEL panel (figure 1.3-8) is located on the Flight Engineer's Upper Instrument Panel No. 3. It contains the fuel offload/BITE displays and display reset buttons, switches for the wing drogue and pod fuel valves, and annunciators for the wing pod drogue and low fuel pressure.

Fuel Offload Displays

Two FUEL OFFLOAD displays indicate fuel quantity offloaded in 100 pound units from the left and right wing pods. During the BITE test by ARO the displays indicate BITE. The COUNTER RESET must be pressed to return the display register to fuel offload quantity.

Drogue Lights

The DROGUE ENGAGED light (blue) comes on when the respective wing pod hose is transferring fuel. The DROGUE DEPLOYED light (blue) comes on when the wing pod hose is in any deployed position. The DROGUE NOT STOWED light (amber) comes on if the wing pod hose is not properly stowed and the landing gear handle is in the DOWN position.

Fuel Inlet Pressure Low Light

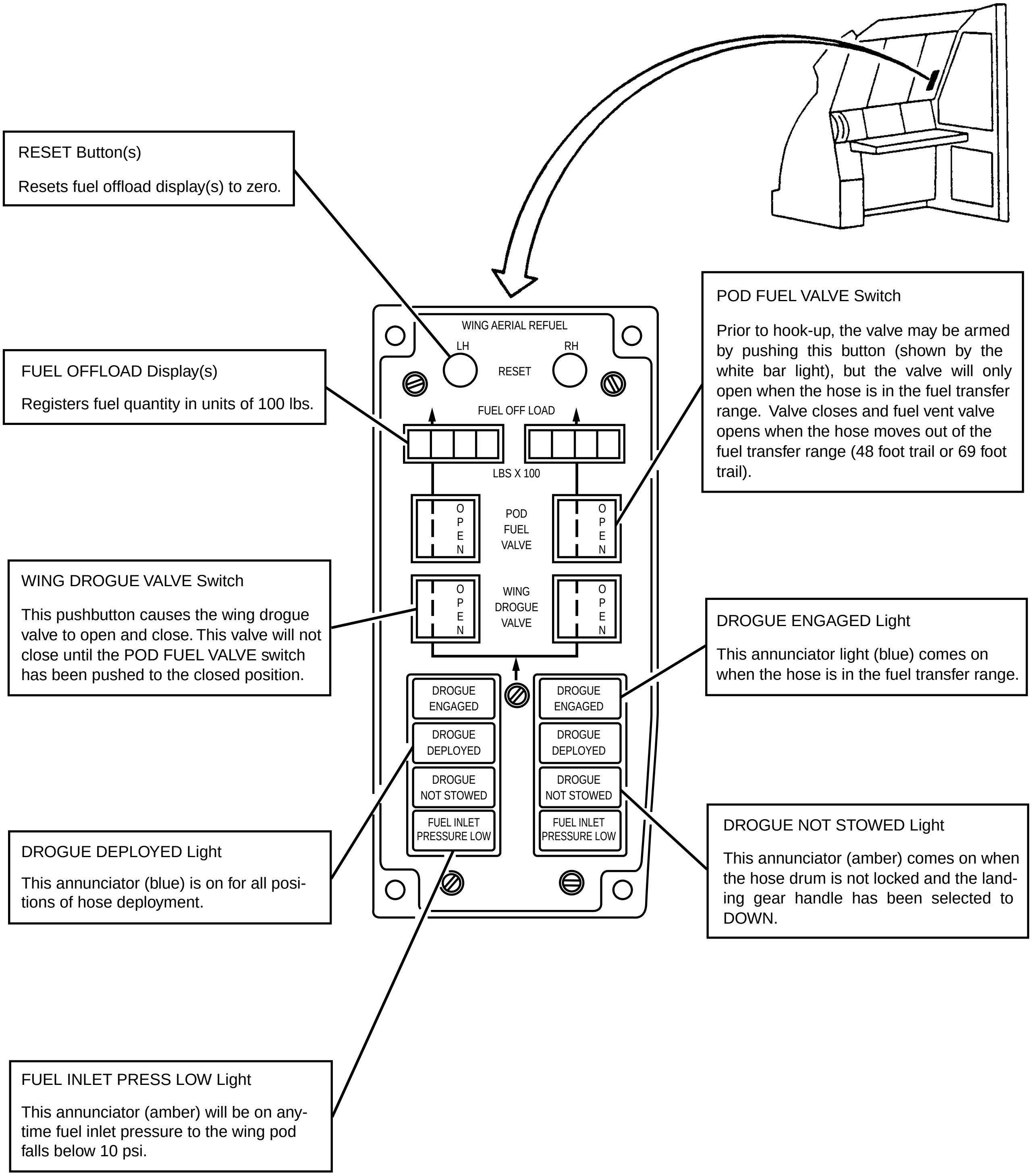
The FUEL INLET PRESSURE LOW light (amber) comes on when the fuel inlet pressure to the wing pod is below 10 psi. It is associated with the FUEL PRESS LOW light on the ARO's overhead panel.

PILOTS INSTRUMENT PANEL/ANNUNCIATOR LIGHTS

Amber LH DROGUE ENGAGED, BOOM/DROGUE ENGAGED, and RH DROGUE ENGAGED lights come on whenever the appropriate system is active and the receiver has pushed the hose of the respective pod into the refuel range. The light will not illuminate if the receiver is engaged but out of the refueling range.

WING POD HOSE JETTISON

A hose-jettison capability is available to release a hose that cannot be retracted from the full trail position. This switch (figure 1.15-8) activates an electromechanical disconnect.



RESET Button(s)

Resets fuel offload display(s) to zero.

FUEL OFFLOAD Display(s)

Registers fuel quantity in units of 100 lbs.

WING DROGUE VALVE Switch

This pushbutton causes the wing drogue valve to open and close. This valve will not close until the POD FUEL VALVE switch has been pushed to the closed position.

DROGUE DEPLOYED Light

This annunciator (blue) is on for all positions of hose deployment.

FUEL INLET PRESS LOW Light

This annunciator (amber) will be on anytime fuel inlet pressure to the wing pod falls below 10 psi.

POD FUEL VALVE Switch

Prior to hook-up, the valve may be armed by pushing this button (shown by the white bar light), but the valve will only open when the hose is in the fuel transfer range. Valve closes and fuel vent valve opens when the hose moves out of the fuel transfer range (48 foot trail or 69 foot trail).

DROGUE ENGAGED Light

This annunciator light (blue) comes on when the hose is in the fuel transfer range.

DROGUE NOT STOWED Light

This annunciator (amber) comes on when the hose drum is not locked and the landing gear handle has been selected to DOWN.

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WITH TCTO 1C-10(K)A-956

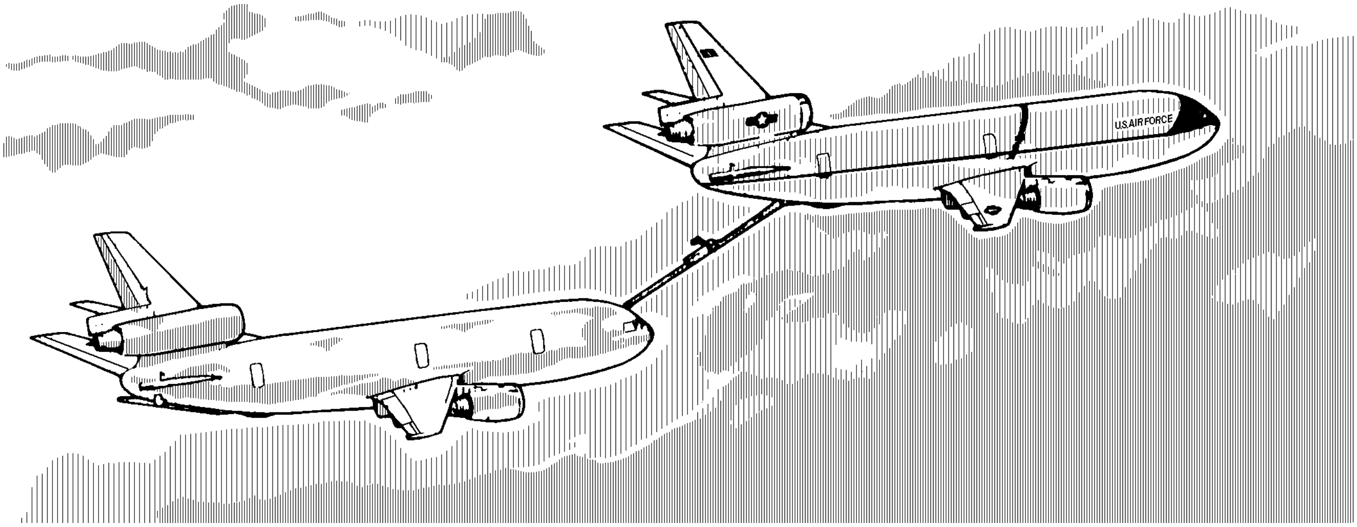
SA1-558

Figure 1.15-19. Flight Engineer's Control Panel

TO 1C-10(K)A-1
VOLUME 2

FLIGHT MANUAL

USAF SERIES
KC-10A
AIRCRAFT



Prepared by HEBCO, INC.
GS-35F-0148K

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Commanders are responsible for bringing this publication to the attention of all affected Air Force Personnel.

Refer to Technical Order Index TO 0-1-1-3 or https://toindex-s.robins.af.mil/toindex for current status of flight manuals, safety and operational supplements, and applicable checklists.

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SECTION II

EMERGENCY PROCEDURES

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INTRODUCTION

This section provides the best possible emergency operating instructions under most circumstances. Multiple emergencies may require modification of procedures contained herein.

CREW COORDINATION

An emergency requires the full, coordinated effort of each crewmember. Emergency procedures should be practiced at every opportunity so the crew will become proficient in every procedure. A well trained crew will know the problem and if properly indoctrinated, will react correctly and effectively under any condition.

NOTE

- The amplified checklists describe in detail the actions to be taken. Certain emergency situations require immediate corrective action. These steps are boxed items and must be committed to memory by the crewmember and performed in proper sequence without direct reference to the checklist.
- When fire is discovered in the aircraft by any crewmember, notify the pilot at once and proceed with the proper fire control procedure.

EMERGENCY SIGNALS

If time and circumstances permit, the crew should be warned of the emergency, given instructions, and acknowledgement received by interphone.

CAUTION

All intermittent system failure lights will be treated the same as steady lights.

Crewmembers should silence any aural warning as soon as the cause of the warning is recognized. Silencing of aural warnings is normal crew action and is not always listed in the procedures.

Crewmembers should check circuit breakers and test lights when appropriate. Checking circuit breakers and testing lights is normal crew action and is not listed in the procedure unless there is a specific requirement.

One reset of a tripped circuit breaker may be attempted. If the circuit breaker retrips, do not attempt another reset.

DON OXYGEN MASK signs will illuminate and chimes sound throughout the aircraft when oxygen is required.

EMERGENCY CHECKLIST PROCEDURES

A crewmember detecting an existing or impending emergency condition will immediately inform the pilot. The pilot will take necessary action to establish and/or maintain control of the aircraft and call for the appropriate checklist. On this command, the crewmember(s) designated on the checklist will accomplish their memory (bold type) items.

NOTE

Crewmembers are responsible for ALL the memory (bold type) items contained in emergency checklists for which they are required to accomplish ANY memory (bold type) item(s). This is necessary for effective crew coordination and to ensure that memory (bold type) items are accomplished in the appropriate sequence.

The engineer will then read aloud in sequence each checklist item requiring a response including the response, starting with the memory items.

Following the reading of a memory checklist item the designated crewmember will confirm that the item was accomplished and call out the response. Example: (FE) “Fuel Lever ...OFF”. The pilot checks that fuel lever in OFF and responds: “OFF”.

As each non-memory item requiring a response is read aloud, the designated crewmember will perform the required action and call out the response when the action is completed. Example: (FE) “Autopilot OFF”. The pilot disengages the autopilot and responds: “OFF”.

Applicable items of amplification on the abbreviated checklist should also be read aloud. The appropriate crewmember will acknowledge the item with a suitable response. Example: (FE) “Crosswind limitation 15 knots”. The pilot will acknowledge with a phrase such as, “Understand 15 knots” or “Roger 15 knots”.

Upon completion of a checklist, the engineer reading will announce “__________ CHECKLIST COMPLETED”.

LOSS OF ALL ENGINES/GENERATORS

NOTE

- *Use this checklist for All Engine Flameout Conditions.*
- *A loss of all generators can be recognized by all buses dead, ADI and engine instrument flags in view EHSIs blank, and all BUS OFF lights, except BAT BUS OFF light ON.*
- *Pilot refer to standby instruments. Use longitudinal trim handles as required.*

EMER PWR SW . . . . ON (PNF)

Refer to pilot's flight instruments and engine instruments as flags retract.

NOTE

When emergency power is the only source for the pilot's flight instruments, the pilot's INU and associated attitude and compass systems will be unreliable when INS batteries are discharged.

OVRD & AIRSTART SW . . . . OVRD & AIRSTART (PNF)

ENGINE OPERATION . . . . DETERMINE (ALL)

YES — ALL N_2 GAGES BELOW 45% — NO

YES:

ADG. . . . . DEPLOY (FE)

ADG Sw . . . . HYD (FE)

Aux pump 1 is turned on to supply hydraulic system 3 pressure for flight controls. The motor pumps are inoperative with the ADG deployed and the switch in HYD.

WARNING

With ADG as the sole hydraulic power source, trim with the long trim handles. Use trim sparingly and for short periods.

CONTINUED

NO:

REFER TO LOSS OF ALL GENERATORS PORTION OF THIS CHECKLIST

LOSS OF ALL ENGINES/GENERATORS (cont)

AC BUS TIE Sws (ALL) . . . . NORM (FE)
IGNITION Sw . . . . Continuous System A (FE)

NOTE

The use of Continuous A ignition may aid engine restart.

CAB PRESS MAN/AUTO Handle . . . . MAN (FE)
OUTFLOW VALVE Position Ind . . . . CLOSED (FE)
ENG 1 and 3 HYD PUMP Sws . . . . OFF (FE)

Turning off the pumps will allow a higher engine windmill RPM.

Throttles (All) . . . . "IDLE" (PF)
Airspeed . . . . IAS TO ACHIEVE 10% N_2 (PF)

WARNING

- *If engine 1 or 3 does not restart within approximately 45 seconds, immediate consideration should be given to restarting engine 2. Observe minimum airspeed from the following table for gross weight and configuration. This will provide hydraulic power for controls.*
- *Do not operate flaps/slats.*

MINIMUM AIRSPEED FOR CONTROL WITH ALL ENGINES FLAMED OUT (KIAS)

FLAP/ SLAT CONFIG	GROSS WEIGHT (1,000 LB)																
	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600
0°/RET	178	181	187	192	198	203	208	214	219	224	228	233	238	242	246	250	254
0°/EXT	155	155	157	162	167	171	176	180	184	188	192	196	200	204	209	213	217
15°/EXT	155	155	155	155	155	158	162	165	169	173	178	182	186	191	195	199	203
22°/EXT	155	155	155	155	155	155	159	162	166	170	174	178	182	185	189	192	196
NOTE: ALWAYS MAINTAIN AT LEAST 155 KIAS																	

YES — ANY ENGINE RESTARTS — NO

Attempt restart No. 2 engine.
ENG 1 & 3 HYD PUMP Sws (ONE ON EACH SYS) . . . . ON (FE)
ENG 2 HYD PUMP Sws . . . . BOTH OFF (FE)
MOTOR PUMP Sws . . . . BOTH OFF (FE)
ADG Sw . . . . R EMER ELEC (FE)

This will provide power to TANK 2 L AFT pump and ignition system B.

IGNITION Sw . . . . Continuous System B (FE)

NOTE

The use of Continuous B ignition may aid engine restart.

CONTINUED

CONTINUED

LOSS OF ALL ENGINES/GENERATORS (cont)

CONTINUED

CONTINUED

ANY ENGINE RESTARTS

YES

NO

Continue attempts to restart any engine. If unsuccessful, maintain speeds from minimum airspeed chart in this checklist. When landing is imminent, continue with procedures.

ADG Sw	HYD	(FE)
ENG 2 L HYD PUMP Sw	ON	(FE)

Extend gear using alternate gear extension. Move gear handle to DOWN after gear are down and locked.

END

CAB PRESS MAN/AUTO Handle	AUTO	(FE)

NOTE

- *Select appropriate cabin altitude as required.*
- *When below 18,000 ft, consideration should be given to starting the APU for pneumatics, altitude and time permitting.*

Assoc ENG HYD PUMP Sws	ON	(FE)
Assoc HYD PRESS Gage	CHECK (WHITE BAND)	(FE)
DC TIE 3 Sw	CLOSE	(FE)

Provides power for DC bus 3 when ADG switch is moved to "R EMER ELEC".

ADG Sw	R EMER ELEC	(FE)

Allows the hydraulic motor pumps to operate (if required).

Motor PUMP Sws	ARM	(FE)
EMER PWR Sw	"OFF"	(PNF)
OVRD & AIRSTART Sw	"OFF"	(PNF)

NOTE

- *Time permitting attempt to restart remaining engines. Then complete appropriate checklist(s).*
- *ADG cannot be retracted in flight. Range will be decreased by approximately 1%.*

END

LOSS OF ALL ENGINES/GENERATORS (cont)

LOSS OF ALL GENERATORS PORTION

APU GEN BUS Sws (If Applicable) (All) . . . . OFF (FE)

AC BUS TIE SWS (ALL) . . . . ISOL (FE)

Observe all AC BUS TIE ISOL lights come on.

GEN SWS (ALL) . . . . RESET/ON (FE)

NOTE

While performing this step, do not reset a generator more than once for a given fault.

ELEC SYS RESET Sws (All) . . . . GEN RLY/BUS TIE RLY LOCKOUT (FE)

YES — GEN BUS 1 OR 3 OPERATING — NO

ADG REL Han . . . . DEPLOY (FE)
ADG Sw . . . . "R EMER ELEC" (PNF)

NOTE

- *When ADG is operating with ADG switch in R EMER ELEC, right emergency AC and DC buses are powered by ADG.*
- *If only generator 2 is operating and ADG is powering the right emergency buses, use emergency power only as required.*

No. 2 TANK Pumps (All) . . . . ON (FE)

NOTE

The fuel pressure low lights and fuel pressure gages are inoperative without normal power.

YES — ENGINE NO. 2 OPERATING — NO

Refer to Abnormal Procedures, ENGINE RESTART.

AFTER STARTING

GEN 2 Sw . . . . RESET/ON (FE)

YES — ANY GEN BUS RESTORED — NO

EMER PWR Sw . . . . "AS REQ'D" (PNF)

Land at nearest suitable airfield.

CONTINUED

CONTINUED

LOSS OF ALL ENGINES/GENERATORS (cont)

CONTINUED

CONTINUED

NOTE

- *With EMER PWR switch ON, battery cannot be relied upon for more than 30 minutes. Attempting an APU start will discharge the battery.*
- *If all generators are inoperative and ADG is powering the right emergency buses, use emergency power only as required, to conserve battery. Refer to CP's flight instruments. With right emergency buses powered, CP's LOC and GS are available for ILS and No. 2 FMS CDU (with GPS2 and INU2 sensors) is available for navigation.*
- *With a failure of all generator buses the following equipment will be affected (major items only):*
  - *Longitudinal trim is available only through the longitudinal trim handles.*
  - *Automatic or manual operation of the elevator feel is inoperative. Load feel remains functional at the force level prior to the electrical failure.*
  - *Flaps may not extend into the land range.*
  - *Windshield anti-ice is inoperative.*
  - *Ground spoilers are available only if manually extended.*
  - *Landing and navigation lights are inoperative.*
  - *Anti-skid is inoperative.*
  - *Thrust reversers are inoperative.*

END

EMER PWR Sw (If Not Req'd)	"OFF"	(PNF)
OVRD & AIRSTART Sw	"OFF"	(PNF)
Generator Buses	CHECK	(FE)

CONTINUED

LOSS OF ALL ENGINES/GENERATORS (cont)

YES — ALL GEN BUSES RESTORED — NO

No. 2 TANK Pumps . . . . AS REQ'D (FE)

Land as soon as practical.

END

Electrical Sys . . . . EVALUATE (FE)

If the malfunction causing the loss of all generators can be identified/isolated, an attempt to restore the other generator buses may be accomplished at the Pilot's discretion. Use generator bus failure checklist. If generator bus failure checklist is used, end this checklist here.

YES — GEN BUS 1 AND/OR 3 RESTORED — NO

DC TIE Sws (All). . . . . CLOSE (FE)
Electrical Sys . . . . EVALUATE (FE)

If GEN BUS 3 cannot be restored, consider using ADG.

If GEN BUS 1 cannot be restored, consider using APU generator. Before attempting APU start, ensure battery is fully charged.

If GEN BUS 1 cannot be restored, move CAB PRESS MAN/AUTO handle to MAN.

Refer to the end of this procedure for listing of affected circuits.

Land as soon as practical.

END

GEN BUS 2 ONLY RESTORED,
DC TIE Sws (All). . . . . CLOSE (FE)
FUEL QTY IND PWR Sw . . . . ALTN (FE)
CAB PRESS MAN/AUTO Handle . . . . MAN (FE)

Consider using ADG as power source for FMS CDU No. 2 (with GPS2 and INU2 sensors) and copilot's instruments.

Land at nearest suitable airfield.

NOTE

- *With EMER PWR switch in ON, battery cannot be relied upon for more than 30 minutes. Attempting an APU start will discharge battery.*
- *The following aircraft systems will be affected if the generator bus cannot be repowered.*

LOSS OF GENERATOR BUS 1 (DC TIE 1 SWITCH IN CLOSE):

OIL PRESS IND ENG 1
FUEL PRESS IND ENG 1
BRAKE HYD PRESS IND 1
HYD PRESS IND 1
HYD QTY IND 1
FUEL FLOW IND ENG 1
OIL QTY IND ENG 1
FUEL PUMP CONTROL
FLO IND PACK 1
TRIM AIR VALVE POSITION IND

HF COMM 1
ATTITUDE 3
COCKPIT VOICE RECORDER
FLT GDNC MODE ANN 1
FLIGHT GUIDANCE 1
RADIO ALTIMETER 1
AT SC STALL WARN 1
ELEV LOAD FEEL & FLAP LIM 1
GND PROXIMITY WARN
INU 1

CONTINUED

LOSS OF ALL ENGINES/GENERATORS (cont)

LOSS OF GENERATOR BUS 1 (DC TIE 1 SWITCH IN CLOSE) (cont):

L ANGLE ATTACK HEAT
L SURFACE POS IND
ELEV LOAD FEEL IND
TAT & THRUST RATING IND
CAPT TACAN RMI HEADING & BEARING
FO RMI HEADING
CAPT ADI RADIO & CMD INFO
ADF-1
CAPT & F/O RMI UHF/ADF BEARING
TACAN 1
WEATHER RADAR 1
ENG VIB MONITOR
CABIN PRESS AUTO CONT
PNEU SYS CONTR ENG 1
MANIFOLD FAILURE DET LOOP 1
L WINDSHIELD DEFOG
L CLEAR VIEW DEFOG
L WINDSHIELD ANTI-ICE
L STATIC PORT HEAT
GRD SPOILER ACTUATOR
ANTI SKID CONT
LEFT LANDING LIGHT
CAPT SEAT POWER

LOSS OF GENERATOR BUS 2 (DC TIE 1 & 3 SWITCHES IN CLOSE):

OIL PRESS IND ENG 2
FUEL PRESS IND ENG 2
HYD PRESS IND 2
HYD QTY IND 2
PACK VALVE POSITION IND
FUEL FLOW IND ENG 2
OIL QTY IND ENG 2
MANIFOLD FAILURE DET LOOP 2
LAV DRAIN MAST HEAT
AUX PITOT HEAT
TAT PROBE HEAT
COCKPIT AUTO TEMP CONT
CABIN MANUAL TEMP CONT
BRAKE TEMP MONITOR
PARKING BRAKE VALVE
NOSE LANDING & TAXI LIGHT
BEACON LIGHTS LOWER
FLIGHT ENGINEER SEAT POWER

LOSS OF GENERATOR BUS 3 (DC TIE 3 SWITCH IN CLOSE):

OIL PRESS IND ENG 3
FUEL PRESS IND ENG 3
BRAKE HYD PRESS IND 3
HYD PRESS IND 3
HYD QTY IND 3
FLOW IND PACK 3
R ANGLE ATTACK HEAT
R SURFACE IND
FLIGHT RECORDER HEADING & GMT CLOCK
TAS/SAT IND
F/O TACAN RMI HEADING & BEARING
CAPT RMI HEADING
F/O ADI RADIO & CMD INFO
ADF 2
ATTITUDE 3
CONTROLS & BRAKE PED POS XMTRS
TACAN 2
WEATHER RADAR 2
FLIGHT RECORDER
FLT GDNC ANN 2
FLIGHT GUIDANCE 2
RADIO ALTIMETER 2
AT SC STALL WARN 2
ELEV LOAD FEEL & FLAP LIM 2
INU 3
FUEL FLOW IND ENG 3
OIL QTY IND ENG 3
PNEU SYS CONT ENG 3
MANIFOLD FAILURE DET LOOP 3
R WINDSHIELD DEFOG
R CLEAR VIEW DEFOG
R WINDSHIELD ANTI-ICE
R STATIC PORT HEAT
COCKPIT MANUAL TEMP CONT
CABIN AUTO TEMP CONT
ANTI SKID CONT
RIGHT LANDING LIGHT
FIRST OFFICER SEAT POWER

END

SMOKE AND FUMES

OXYGEN MASKS . . . . ON/100%/EMER (ALL)

Don oxygen masks and verify dilute selector is in 100%.

NOTE

When oxygen regulator EMERGENCY position is no longer required, move the NORMAL/ EMERGENCY selector to NORMAL.

Smoke Goggles (If Req'd) . . . . On (ALL)

Don smoke goggles if required and verify mask vent-valve is OPEN, if required.

NOTE

The absence of smoke and/or fumes in the cockpit should be sufficient justification to move the mask vent-valve CLOSED if not required.

Locate/Access source of smoke . . . . Located (P,CP,FE,BO)

Accomplish appropriate checklist:

AIR CONDITIONING SMOKE	Page 2-10
CABIN CARGO SMOKE AND/OR LIGHT ON	Page 2-12
ELECTRICAL SMOKE OF UNKNOWN ORIGIN	Page 2-15
ELECTRICAL SMOKE/FUMES OF UNKNOWN ORIGIN IN ARO COMPARTMENT	Page 2-19
CABIN FUEL FUMES	Page 2-20
SMOKE OR FUMES REMOVAL	Page 2-21
FUEL/FUEL FUMES IN ARO COMPT	Page 2-23

END

AIR CONDITIONING SMOKE

NOTE

- *Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.*
- *To be performed when smoke is entering through air conditioning system. If this condition occurs while using APU, discontinue use of APU air.*

Crew Comm (If Req'd) . . . . ESTABLISH (ALL)
ENG 1 PNEU SUPPLY Sel . . . . OFF (FE)

YES — SMOKE DECREASES — NO

YES:

Confirms ENG 1 as smoke source.

Continue flight with ENG 1 PNEU SUPPLY OFF.

Refer to Abnormal Procedures OPERATION WITH SINGLE PNEUMATIC SYSTEM.

END

NO:

CONTINUED

AIR CONDITIONING SMOKE (cont)

ENG 1 PNEU SUPPLY Sel . . . . AUTO (FE)
ENG 3 PNEU SUPPLY Sel . . . . OFF (FE)
Cockpit Door Smoke Screen . . . . AS REQ'D (FE)

SMOKE DECREASES

YES

Confirms ENG 3 as smoke source.

Continue flight with ENG 3 PNEU SUPPLY OFF.

Refer to Abnormal Procedures, OPERATION WITH SINGLE PNEUMATIC SYSTEM.

END

NO

Both ENG 1 and ENG 3 are smoke source. At Pilot's discretion:

ENG 1 PNEU SUPPLY Sel . . . . OFF (FE)

NOTE

- *Descend as required.*
- *Consider use of APU pneumatics.*
- *Consider the use of passenger oxygen system/EPOS.*

END

APU FIRE

NOTE

- *This checklist may be accomplished by any crewmember in the absence of the Flight Engineer.*
- *The APU will normally shutdown automatically when an APU fire signal occurs. Moving the APU fire control switch to APU OFF/AGENT ARM assures APU shutdown. This also turns off APU FIRE light (FE panel), if fire condition no longer exists, and arms the fire agent circuits.*
- *Only engine 2 fire agent bottles are available to the APU. Using both bottles will deny their use to engine 2.*

APU FIRE CONTROL Sw . . . . APU OFF/AGENT ARM (FE)

NOTE

The APU LOOP A and B lights, MASTER WARNING and APU FIRE summary lights come on, and external horn sounds for ground notification of an APU fire.

APU FIRE AGENT CYL Sw . . . . DISCHARGE (FE)

Observe associated engine 2 AGT LOW light comes on to indicate agent discharge.

APU ISOL VALVE Sw . . . . CLOSED (FE)

AFTER 30 SECONDS:

CONTINUED

APU FIRE (cont)

YES — APU FIRE LT ON — NO

Second APU FIRE AGENT CYL Sw .... DISCH (FE)

Observe associated engine 2 AGT LOW light comes on to indicate agent discharge.

APU MASTER Sw.. OFF (FE)

NOTE

If APU fire control switch is returned to NORM sooner than one minute after the APU master switch is moved to OFF, APU FIRE light will come on even if no APU fire exists.

Land as soon as practical.

END

CABIN CARGO SMOKE AND/OR LIGHT ON

NOTE

- *Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.*
- *Light concentrations of cabin cargo smoke may not activate the cabin cargo smoke detection equipment.*
- *The absence of smoke and/or fumes in the cockpit should be sufficient justification to move the NORMAL/EMERGENCY selector to NORMAL and extend usable oxygen time.*

Crew Communications .... "ESTABLISH" (ALL)

Notify the boom operator to evacuate the ARO station, then investigate the cargo compartment and report condition.

YES — SMOKE/FIRE CONDITION EXISTS — NO

Assume smoke detection equip malfunction.

END

Don Emergency Passenger Oxygen System (If Req'd) .... INITIATE (P,BO)
Passenger OXY MASK SW (If Req'd) .... EJECT, HOLD 3-5 SEC (P,FE)

WARNING

- *If power to any electrical bus has been interrupted, recycle the passenger oxygen mask switch to EJECT after power is restored.*
- *Once started, the passenger oxygen system will supply oxygen for a maximum of 22 minutes, regardless of the rate of use.*

NOTE

If it was determined that passenger oxygen is not required at this time, the crew should remain alert to its need throughout the remainder of this checklist.

Initiate fire fighting procedures.

CONTINUED

CABIN CARGO SMOKE AND/OR LIGHT ON (cont)

WARNING

The concentrated agent, when applied to fire, can produce toxic by-products. Avoid inhalation of these materials by evacuating and ventilating the area.

PACK Function Sels	ONE PACK OFF	(FE)
CABIN AIR SHUTOFF Handle	PULL DOWN AND FORWARD	(FE)

The cabin air shutoff handle is above and behind the second observer’s station. Pulling the handle shuts off conditioned airflow into the cargo compartment.

CAUTION

If the cabin air shutoff handle is pulled with two packs operating, excess air will be dumped into the avionics compartments. This may result in major damage to the air conditioning ducts.

NOTE

Cabin air shutoff handle cannot be reset in flight.

Cockpit Air Outlets	OPEN	(ALL)
Cockpit Door Smoke Screen	CLOSE	(FE)
Lav/Galley Vent	OFF	(FE)
ARO Temp Cont	MANUAL FULL COLD	(FE)

WARNING

Perform the following only after all crewmembers have returned to the cockpit or are known to be using portable oxygen equipment, are informed of the actions and passenger oxygen masks have been deployed.

NOTE

If it was determined that passenger oxygen is not required at this time, the crew should remain alert to its need throughout the remainder of this checklist.

ARO/Additional Crew Oxygen Shutoff Valve (All Cargo Configuration Only)	CLOSE	(FE)
CAB PRESS MAN/AUTO Handle	MAN CONTROL CAB PRESS AS REQ’D	(FE)

YES — AIRPLANE ALTITUDE ABOVE 27,000 FT — NO

Cabin Altitude	Raise to 25,000 feet	(FE)

Using manual control, raise the cabin at a rate of 1000-2000 FPM.

Maintain 0.5 PSI differential pressure		(FE)

Land as soon as practical.

CONTINUED

CABIN CARGO SMOKE AND/OR LIGHT ON (cont)

Just prior to landing:

Manual CAB ALT Control Wheel . . . . OUTFLOW VALVE 2/3 OPEN (FE)

NOTE

Selection of more than 2/3 open can result in the doors becoming unseated, allowing airflow into the cabin.

Immediately after landing, to ensure opening of clearview windows and/or doors:

Manual CAB ALT Control Wheel . . . . OUTFLOW VALVE/FULL OPEN (FE)

Refer to Emergency Procedure, PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION.

If required, refer to Emergency Procedure, SMOKE OR FUMES REMOVAL.

END

ELECTRICAL SMOKE OF UNKNOWN ORIGIN

NOTE

Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.

Don Emergency Passenger Oxygen System (If Req'd)	INITIATE	(P,BO)
Passenger OXY MASK Sw (If Req'd)	EJECT, HOLD 3-5 SEC	(P,FE)

WARNING

- *If power to any electrical bus has been interrupted, recycle the passenger oxygen mask switch to EJECT after power is restored.*
- *Once started, the passenger oxygen system will supply oxygen for a maximum of 22 minutes regardless of the rate of use.*

NOTE

If it was determined that passenger oxygen is not required at this time, the crew should remain alert to its need throughout the remainder of this checklist.

Crew Communications (If Req'd)	ESTABLISH	(ALL)
THNDRSTRM LT Sw (If Req'd)	"ON"	(PNF)

NOTE

In a darkened cockpit, turning on bright lighting may facilitate identification of smoke source.

Main TANK PUMP Sws (All)	ON	(FE)

NOTE

All main tank pumps are operated to ensure at least one pump in each fuel system continues to operate during this procedure.

ATS Levers	"OFF"	(PF)

NOTE

Autothrottle levers may be moved to ON when all electrical buses are restored.

Autopilot 1	"AS REQ'D"	(PF)

NOTE

Use of autopilot 1 will assure normal autopilot operation during electrical bus isolation.

AC BUS TIE 3 Sw	ISOL	(FE)
GEN 3 and APU GEN BUS 3 Sws	OFF	(FE)

CONTINUED

ELECTRICAL SMOKE OF UNKNOWN ORIGIN (cont)

NOTE

- *When AC and DC bus power is removed from electrical system 3, the CP's flight instruments and flight guidance system 2 are inoperative.*
- *Cockpit standby lights come on when DC bus 3 is off.*

DC TIE 1 and DC X TIE Sws	CLOSE	(FE)

NOTE

The DC TIE switches are in CLOSE to ensure that only one DC system is inoperative during this procedure.

DC TIE 3 Sw	OPEN	(FE)

Pause. Observe smoke until convinced source was not generated in electrical system 3.

NOTE

When electrical power is removed from the smoke source, there should be a noticeable decrease in smoke concentration due to the ventilation system.

YES — SMOKE DECREASES — NO

Continue with electrical system 3 inop.

END

GEN 3 or APU GEN BUS 3 Sw	ON	(FE)
AC BUS TIE 3 Sw	NORM	(FE)
DC TIE 3 Sw	CLOSE	(FE)
AC BUS TIE 2 Sw	ISOL	(FE)
GEN 2 and APU GEN BUS 2 Sw	OFF	(FE)

NOTE

When all AC and DC power is removed from system 2, most cabin systems are inoperative, and emergency lights will be on. Side panel lights are available.

YES — SMOKE DECREASES — NO

Continue with electrical system 2 inop.

END

GEN 2 or APU GEN BUS 2 Sw	ON	(FE)
AC BUS TIE 2 Sw	NORM	(FE)

WARNING

Verify CP's flight instruments are normal, before proceeding.

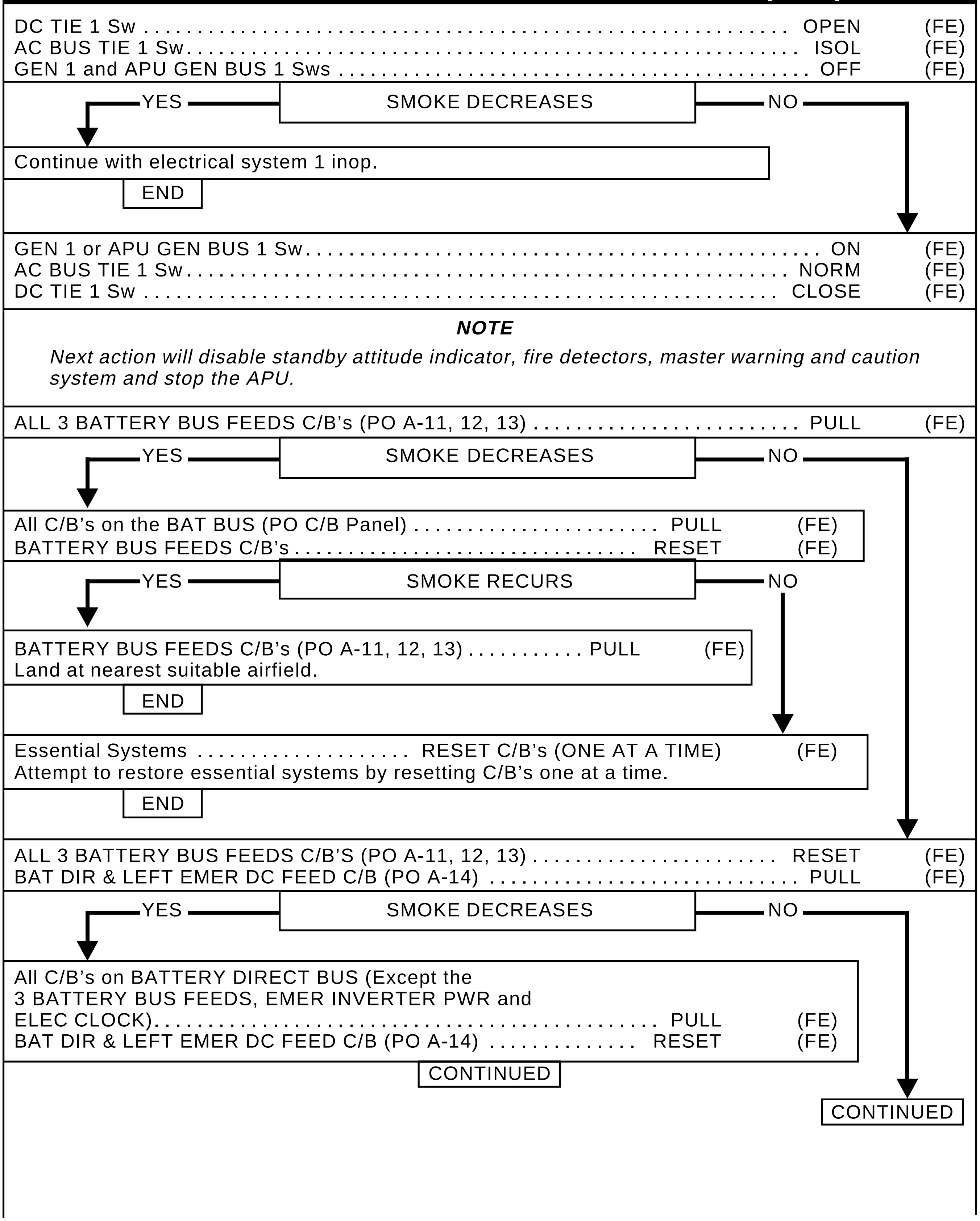
Autopilot 2	"AS REQ'D"	(PF)

NOTE

Use of autopilot 2 will assure normal autopilot operation during electrical bus isolation.

CONTINUED

ELECTRICAL SMOKE OF UNKNOWN ORIGIN (cont)



DC TIE 1 Sw . . . . OPEN (FE)
AC BUS TIE 1 Sw . . . . ISOL (FE)
GEN 1 and APU GEN BUS 1 Sws . . . . OFF (FE)

Continue with electrical system 1 inop.

GEN 1 or APU GEN BUS 1 Sw . . . . ON (FE)
AC BUS TIE 1 Sw . . . . NORM (FE)
DC TIE 1 Sw . . . . CLOSE (FE)

NOTE

Next action will disable standby attitude indicator, fire detectors, master warning and caution system and stop the APU.

ALL 3 BATTERY BUS FEEDS C/B's (PO A-11, 12, 13) . . . . PULL (FE)

All C/B's on the BAT BUS (PO C/B Panel) . . . . PULL (FE)
BATTERY BUS FEEDS C/B's . . . . RESET (FE)

BATTERY BUS FEEDS C/B's (PO A-11, 12, 13) . . . . PULL (FE)
Land at nearest suitable airfield.

Essential Systems . . . . RESET C/B's (ONE AT A TIME) (FE)
Attempt to restore essential systems by resetting C/B's one at a time.

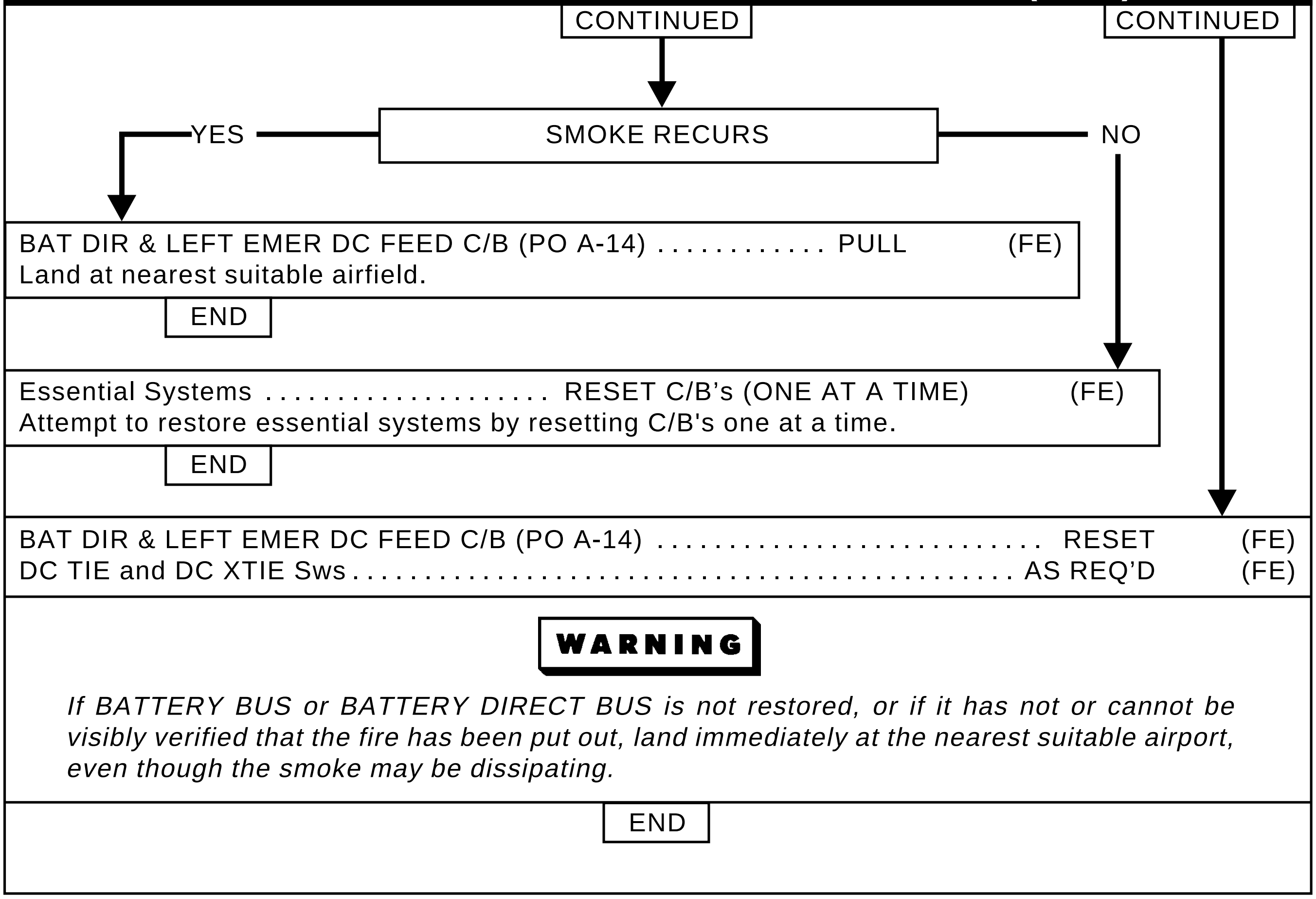
ALL 3 BATTERY BUS FEEDS C/B'S (PO A-11, 12, 13) . . . . RESET (FE)
BAT DIR & LEFT EMER DC FEED C/B (PO A-14) . . . . PULL (FE)

All C/B's on BATTERY DIRECT BUS (Except the 3 BATTERY BUS FEEDS, EMER INVERTER PWR and ELEC CLOCK). . . . . PULL (FE)
BAT DIR & LEFT EMER DC FEED C/B (PO A-14) . . . . RESET (FE)

CONTINUED

CONTINUED

ELECTRICAL SMOKE OF UNKNOWN ORIGIN (cont)



BAT DIR & LEFT EMER DC FEED C/B (PO A-14) . . . . PULL (FE)
Land at nearest suitable airfield.

END

Essential Systems . . . . RESET C/B's (ONE AT A TIME) (FE)
Attempt to restore essential systems by resetting C/B's one at a time.

END

BAT DIR & LEFT EMER DC FEED C/B (PO A-14) . . . . RESET (FE)
DC TIE and DC XTIE Sws . . . . AS REQ'D (FE)

WARNING

If BATTERY BUS or BATTERY DIRECT BUS is not restored, or if it has not or cannot be visibly verified that the fire has been put out, land immediately at the nearest suitable airport, even though the smoke may be dissipating.

END

ELECTRICAL SMOKE/FUMES OF UNKNOWN ORIGIN IN ARO COMPARTMENT

NOTE

Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.

Disconnect	INITIATE (If Applicable)
Boom/Drogue	RETRACT/REWIND (As Applicable)
Pilot	NOTIFY

NOTE

All lights within the ARO compartment will go off when GND SVC and AR BUS ISOL switches are moved to ISOL. The flight control warning lights and audible tone will come on.

GND SVC and AR BUS ISOL Switches	ISOL

When smoke clears and at operators discretion.

AR BUS ISOL Sw	NORM

YES — SMOKE/FUMES RECURS — NO

NO:

Continue air refueling mission.

NOTE

When GND SVC BUS ISOL switch is in ISOL, electrical power is removed from AR sighting door motor and boom hoist actuator motor control relay. Electrical power is required to reposition boom hoist actuator when boom hoist lever is moved from free-wheel to raise. Drogue operation is not affected by position of the GND SVC BUS ISOL switch.

END

YES:

Discontinue air refueling mission.

AR BUS ISOL Sw	ISOL
GND SVC BUS ISOL Sw	NORM
Post Air Refueling Checklist	ACCOMPLISH

END

CABIN FUEL FUMES

NOTE

Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.

Crew Communications (If Req'd)	ESTABLISH	(ALL)
Boom Operator	NOTIFY	(P)

NOTE

- *If oil quantity changes refer to ABNORMAL OIL QUANTITY INDICATION Checklist.*
- *Stop fuel transfer and refueling operations.*
- *Notify the Boom Operator to stow the boom/drogue(s) and evacuate the ARO station.*
- *Do not use the AR pumps. Do not transfer fuel from the forward tank unless necessary for continuation of flight to destination.*

Don Emergency Passenger Oxygen System (If Req'd)	INITIATE	(P,BO)
Passenger OXY MASK Sw (If Req'd)	EJECT, HOLD 3-5 SEC	(P,FE)

WARNING

- *If power to any electrical bus has been interrupted, recycle the passenger oxygen mask switch to EJECT after power is restored.*
- *Once started, the passenger oxygen system will supply oxygen for a maximum of 22 minutes regardless of the rate of use.*

NOTE

If it was determined that passenger oxygen is not required at this time, the crew should remain alert to its need throughout the remainder of this checklist.

PACK Function Sels	AUTO OR MAN	(FE)
Cockpit Door Screen	CLOSE	(FE)
Seat Belt Sw	ON	(PNF)
Galley Power C/B (UM A-21)	PULL	(FE)
Cabin Press Man/Auto Handle	MAN	(FE)
Cabin Press	REDUCE	(FE)

NOTE

Maintain differential pressure to approximately 2. 0 PSIG subject to the following restrictions.

Do not exceed a cabin altitude of 9,000 feet because of activation of the warning bell in the ARO station.

Maintain approximately 2.0 PSIG differential pressure on descent. Do not land with more than 0.5 PSIG differential pressure.

Land as soon as practical, do not start the APU.

Refer to Emergency Procedure, PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION, this section.

NOTE

The requirement to land with no more than 0.5 PSIG differential pressure ensures that the cabin door can be opened

END

SMOKE OR FUMES REMOVAL

NOTE

- *Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.*
- *If smoke or fumes are entering through the air-conditioning system, refer to AIR-CONDITIONING SMOKE or appropriate checklist prior to completing this checklist.*

Don Emergency Passenger Oxygen System (If Req'd) . . . . INITIATE (P,BO)
Passenger OXY MASK Sw (If Req'd) . . . . EJECT, HOLD 3-5 SEC (P,FE)

WARNING

- *If power to any electrical bus has been interrupted, recycle the passenger oxygen mask switch to EJECT after power is restored.*
- *Once started, the passenger oxygen system will supply oxygen for a maximum of 22 minutes regardless of the rate of use.*

NOTE

If it was determined that passenger oxygen is not required at this time, the crew should remain alert to its need throughout the remainder of this checklist.

SMOKE OR FUMES ASSOCIATED WITH AIR CONDITIONING

YES

NO

PACK Function Sels . . . . AUTO OR MAN (FE)

NOTE

Operation of both packs is desired in order to establish maximum airflow.

Cockpit Air Outlets (All) . . . . "OPEN" (P,CP,FE)
Cockpit Door Smoke Screen . . . . CLOSE (FE)

AIRCRAFT PRESSURIZED

YES

NO

Descend to 12,000 feet (terrain permitting).
Cabin Pressure . . . . REDUCE (FE)

NOTE

Use semi-automatic, or manual controls to maintain cabin rate of 1,000 to 2,000 fpm up.

CONTINUED

CONTINUED

SMOKE OR FUMES REMOVAL (cont)

CONTINUED

CONTINUED

After the aircraft has been depressurized,

CABIN PRESS MAN/AUTO Handle . . . . MAN (FE)
Manual CAB ALT Control . . . . OUTFLOW VALVE FULL OPEN (FE)
Smoke or Fumes Source . . . . EVALUATE (ALL)

YES — CABIN SOURCE — NO

AVIONICS COMPARTMENT FAN C/B's (UM L-17, 18, 19) . . . . PULL (FE)

SMOKE SEVERE IN COCKPIT

Communications . . . . ESTABLISH (ALL)

NOTE

When clearview window is opened (next action), communication will be difficult unless headsets are used.

IAS . . . . "205 KTS MAX" (PF)

NOTE

- *Determine MIN MAN speed. Extend slats and flaps if required to maintain a maximum of 205 KTS.*
- *Opening window too wide produces excessive noise.*

Cockpit Door Smoke Screen . . . . OPEN (FE)
Clearview Window . . . . "OPEN/CLOSED AS REQ'D" (PF,PNF)

To prevent vision impairment to the PF, the PNF should open his/her clearview window. Either window may be opened periodically for ventilation if airspeed does not exceed 205 KTS.

Land as soon as practical.

END

FUEL/FUEL FUMES IN ARO COMPT

WARNING

Reposition only the electrical switches necessary to stow boom or rewind drogue(s). Moving switches in a fuel vapor environment can result in an explosion.

NOTE

Accomplish the SMOKE AND FUMES procedure prior to initiating this checklist.

Disconnect . . . . INITIATE (if applicable)
Pilot . . . . NOTIFY
A/R Pumps . . . . OFF (FE)

A	BOOM AIR REFUELING
B	DROGUE AIR REFUELING

A BOOM AIR REFUELING

BOOM . . . . STOW
FLT CONT Switch . . . . OFF
HYD SEL . . . . OFF

NOTE

Leave all other switches/levers as set.

Pilot . . . . NOTIFY (BO, P)

Report "Boom stowed, leaving position." Transfer primary oxygen source from the aircrew regulator to a portable oxygen cylinder.

Oxygen Regulator OFF/100%
ARO Compartment . . . . EVACUATE

END

B DROGUE AIR REFUELING

Hose(s) . . . . STOW
HYD SEL (If Applicable) . . . . OFF
Drogue MASTER/WARP POWER Switches . . . . OFF

NOTE

Leave all other switches/levers as set.

Pilot . . . . NOTIFY (BO, P)

Report "Drogue(s) stowed, leaving position." Transfer primary oxygen source from the aircrew regulator to a portable oxygen cylinder.

Oxygen Regulator OFF/100%
ARO Compartment . . . . EVACUATE

END

DUAL HYDRAULIC SYSTEM FAILURE

WARNING

Do not air refuel with dual hydraulic system failure.

Boom Operator	NOTIFY (IF REQ'D)	(FE)
Affected HYD Pump Sws	ALL OFF	(FE)
Operative Sys HYD Pump Sws	BOTH ON	(FE)
MOTOR PUMP Sws	BOTH OFF	(FE)
AUX PUMP Sws	STOP	(FE)
RUD STBY PWR Sw	ARM	(FE)
AP Levers	"OFF"	(PF)
ATS Levers	"OFF"	(PF)

NOTE

- *Autothrottles may be used except for approach and landing with flaps less than 35°.*
- *If remaining system is powered by a windmilling engine, refer to Emergency Procedures, OPERATION USING SINGLE HYDRAULIC SYSTEM POWERED BY A WINDMILLING ENGINE.*
- *Land at nearest suitable airfield.*
- *Minimize use of more than one hydraulic powered control at a time.*

EFFECTS ON CONTROLLABILITY

	SYS 1 REMAINS	SYS 2 REMAINS	SYS 3 REMAINS
AILERONS	Left inboard and right outboard inoperative. Left outboard available after flaps or slats extension or after main gear alternate extension lever is raised.	Right inboard inoperative. Both outboard available after flap extension or main gear alternate extension lever is raised.	Left outboard inoperative. Right outboard available after slats or flaps are extended, or when alternate landing gear lever is raised.
ELEVATORS	Left inboard inoperative.	Right inboard inoperative.	Left and right outboard inoperative.
SPOILERS	Effect reduced. Only panels 2 and 4 left and right operative. Pilots control wheel may not be centered laterally, due to spoiler panel float.	Effect reduced. Only panels 1 and 5 left and right operative. Pilots control wheel may not be centered laterally, due to spoiler panel float.	Effect reduced. Only panel 3 left and right operative.
STAB TRIM	Reduced to half normal rate.	Reduced to half normal rate or inoperative (if RUD STBY PWR OFF LT is ON).	Reduced to half normal rate. Use sparingly.
RUDDERS	Covered in appropriate procedure.		

GO TO APPROPRIATE PROCEDURES AS FOLLOWS:

A	**SYS 1 & 2 INOP**
B	**SYS 1 & 3 INOP**
C	**SYS 2 & 3 INOP**

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

A SYS 1 & 2 INOP

The upper rudder is inop.

V_{MCA} - 157 KIAS

Max X-WIND component - 15 Kts

RUD STBY PWR OFF LIGHT ILLUMINATED

YES

NO

Lower Rudder Operation . . . . "VERIFY" (PF)

Verify operation of lower rudder with gentle application of rudder pedal while maintaining wings level with aileron.

LOWER RUDDER OPERATIVE

YES

NO

No additional warning of complete rudder failure is given.

RUD STBY PWR Sw . . . . OFF (FE)

NOTE

- *Both rudders are inop.*
- *Directional control is available through asymmetric thrust and remaining lateral control. Landing should be planned at a field with minimal or no crosswind due to loss of rudder directional control. After landing, directional control will be limited to asymmetrical thrust, differential braking and nosewheel steering.*

If, during remainder of flight the RUD STBY PWR OFF light illuminates, accomplish the above procedure.

Approach/Landing Procedures . . . . REVIEW (P, CP, FE)

EFFECTS ON AIRCRAFT CONFIGURATION	
FLAPS	Inop. If extended, they should remain in last position.
SLATS	- If FLAPS and/or SLATS are extended, land using the existing configuration. - If retracted, SLATS will extend upon speed reduction. Plan 0°/EXT landing.
GEAR	Use alternate gear extension system.
BRAKES	System 2 and accumulators available.
NOSE GEAR STEERING	Left system inoperative. Right system available if main gear alternate extension lever is returned to stowed position. Steering to left limited to 25° and right is normal (68°); rudder pedal steering is normal.

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

Gross Weight . . . . REDUCE (P,FE)

Prior to configuring, dump fuel to reduce landing weight and speeds to lowest practical. Consider effect on landing distance based on worst likely configuration.

- LANDING DISTANCE (0°/EXT) -

ANTI-SKID BRAKING	OPERATIVE SPOILER PANELS (NO. 3)
FULL REVERSE THRUST	STD DAY/SEA LEVEL (FOR EACH 1,000 FT ABOVE SEA LEVEL. INCREASE LANDING DISTANCE BY 4%).

GWT or 1,000 LB	300	320	340	360	380	400	420	440	460	480	500
LDG DISTANCE (DRY)	4,610	4,632	4,868	5,139	5,406	5,666	5,942	6,204	6,497	6,783	7,060
LDG DISTANCE (WET)	7,310	7,406	7,820	8,278	8,731	9,183	9,651	10,111	10,604	11,088	11,573

Plan to configure aircraft earlier than normal. Extend slats only when in stabilized flight.

Crew Briefing. . . . . "COMPLETE" (PF)
Landing Data/V-Bugs . . . . "SET" (P,CP)
Radio Altimeters . . . . "SET" (P,CP)
Windshield Anti-Ice . . . . AS REQ'D (FE)
Altimeters. . . . . "SET/X-CHECKED" (P,CP)
Pressurization . . . . "SET" (FE)

When ready to configure aircraft for landing,

V_{MM} For Existing Configuration. . . . . "ACHIEVE" (PF)
AUX PUMP Sws . . . . "START" (FE)

NOTE

The inoperative system(s) may be reinstated for landing if there is quantity indicated.

FAILURE OCCURRED WITH SLATS RETRACTED

YES

NO

FLAP/SLAT Handle . . . . "0°/EXT" (PNF)

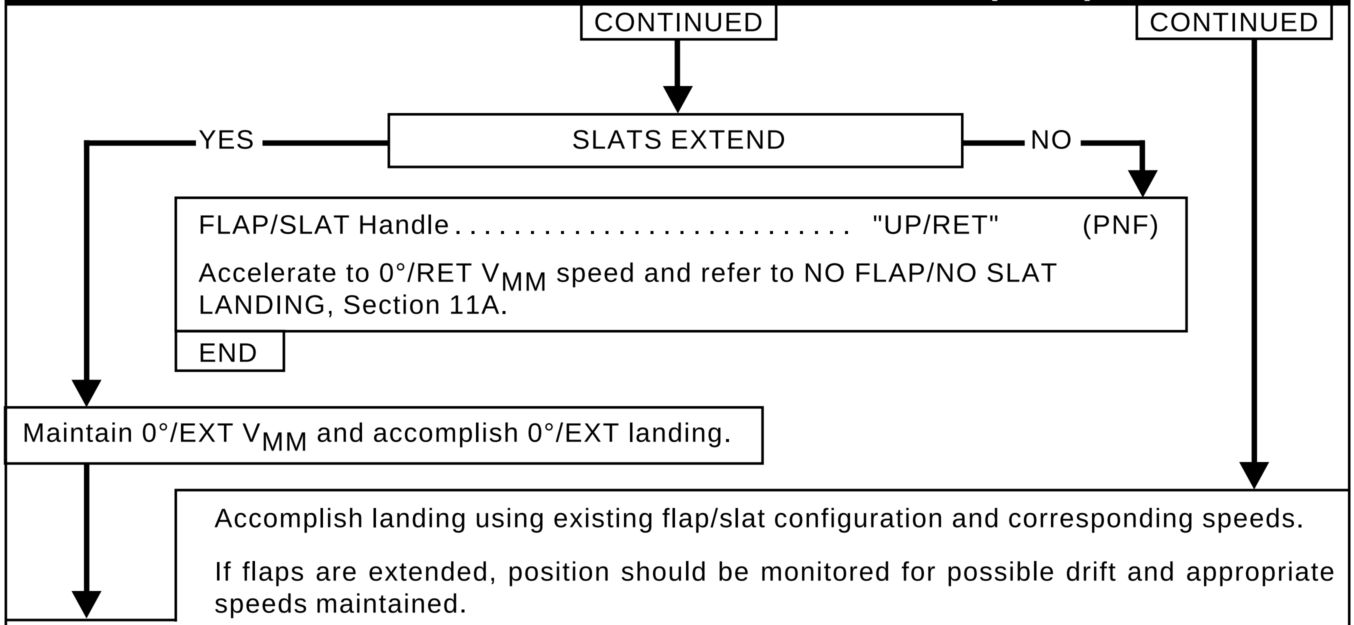
If necessary, airspeed may be slowly reduced to 1.3 V_S 0°/RET to assist in slat extension.

SPEEDS (KIAS)													
FLAP/SLAT CONFIGURATION		GROSS WEIGHT (1,000 LB)											
		280	300	320	340	360	380	400	420	440	460	480	500
0°/RET	$1.3V_S$	175	181	187	193	198	204	209	214	219	224	229	233

CONTINUED

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)



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SLATS EXTEND

YES

NO

FLAP/SLAT Handle . . . . "UP/RET" (PNF)

Accelerate to 0°/RET V_{MM} speed and refer to NO FLAP/NO SLAT LANDING, Section 11A.

END

Maintain 0°/EXT V_{MM} and accomplish 0°/EXT landing.

Accomplish landing using existing flap/slat configuration and corresponding speeds.

If flaps are extended, position should be monitored for possible drift and appropriate speeds maintained.

Fuel Panel	SET	(FE)
Exterior Lts	SET	(FE)
Cabin Signs	ON	(FE)
CDUs, EHSIs, Radio Aids	"AS REQ'D"	(P,CP,FE)
Altimeters	"SET/X-CHECKED"	(P,CP)
Thrust Computer	"GA"	(PNF)
Annunciator Panels	"CHECKED"	(P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button	OFF	(FE,BO)

WARNING

- *Do not reduce speed to below V_{MCA} (157 KIAS) until landing is assured.*
- *If both rudders are inoperative and thrust is asymmetric, a missed approach should not be attempted.*

NOTE

- *Plan a long final for speed stabilization.*
- *In case of missed approach, it is recommended that landing gear not be raised. If gear retraction is necessary, delay until the aircraft is clear of obstacles and slats are retracted.*

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

FINAL CHECKLIST

IAS	"RESTRICT TO 230 KTS"	(PF)
Main Gear Altn Ext Lever	"RAISE/LATCH"	(CP)
Gear Lts	"3 GREEN"	(CP)

CAUTION

- *If hydraulic system no. 3 has less than 6 gallons remaining, lowering the landing gear may cause a loss of quantity in the reservoir sufficient to trip the Hydraulic System 3 Elev Off light, which may cause the elevator shutoff valve to close, removing power from the elevator and rudder.*
- *After alternate extension of the main gear, wait until gear is extended (3 GREEN Lts) before next action.*
- *After gear extension do not exceed 260 KIAS.*

CTR Gear Altn Ext Handle	PULL	(FE)
Gear Lts	"4 GREEN"	(P,CP,FE)
Gear Handle	"DOWN"	(CP)
Main Gear Altn Ext Lever	"AFTER 2 MINUTES/STOW"	(CP)

NOTE

This will provide nose wheel steering for landing roll-out.

Flaps/Slats	"_ _ _°/_ _ _°/_ _ _°"	(P,CP,FE)
GND PROXIMITY WARN FLAP OVRD Sw	"OVRD/ON" (IF REQD)	(FE)
Spoilers	"ARM"	(P)
Anti-Skid/Brake Pressure	CHECKED	(FE)

Make normal approach. When threshold is crossed, use slight flare to diminish sink rate. Reduce thrust and fly to positive touchdown.

After touchdown posivitely lower nose gear to runway and immediately apply reverse thrust.

NOTE

SPOILERS will not automatically deploy to 2/3 position on main wheel spin-up unless flaps are equal to or greater than 30°. When flaps are less than 30°, they must be manually deployed. When final flap position is greater than 30°, the spoiler handle must be manually assisted during its last portion of travel.

END

DUAL HYDRAULIC SYSTEM FAILURE (cont)

B SYS 1 & 3 INOP

RUD STBY PWR OFF LIGHT ILLUMINATED

YES

RUD STBY PWR Sw . . . . OFF (FE)

Upper rudder is inoperative. V_{MCA} is 157 KIAS and the max X-WIND component is 15 kts.

Plan stabilizer inoperative landing.

Place ELEV FEEL sel to MAN then use MANUAL SLEW sel to reduce elevator feel force.

NO

BOTH RUDDERS ARE AVAILABLE

Approach/Landing Procedures . . . . REVIEW (P,CP,FE)

EFFECTS ON AIRCRAFT CONFIGURATION	
SLATS	- INOP. Should remain in last position selected. May tend to drift and SLAT DISAGREE light may come on. - If extended in the TAKEOFF position, accomplish 22°/EXT landing. - If extended in the LAND position, accomplish 35°/EXT landing.
FLAPS	- Will extend as selected. If slats are retracted consider flap placard speeds.
GEAR	Use alternate extension system.
BRAKES	Accumulators ONLY. Move Anti-Skid switch to OFF.
NOSE GEAR STEERING	INOP.

Gross Weight . . . . REDUCE (P, FE)

Prior to configuring, dump fuel to reduce landing weight and arrival speeds to lowest practical. Gross weights up to 439,000 pounds will allow sufficient speed reduction for normal flap operation. If slats are retracted, consider effect on landing distance based on worst likely configuration.

- LANDING DISTANCE (22°/RET) -

CAUTION

Use extreme caution when braking with ANTI-SKID FAIL light(s) on or if the entire anti-skid system is inoperative. Tire skids may be difficult to detect. Consider reducing gross weight. Judge braking action by sensing the deceleration of the aircraft while applying pressure to the brake pedals. Manual braking technique consists of gradually increasing the pedal force until a moderate deceleration is felt and immediately extending the spoilers. The pilot flying should also pace the deceleration to use most of the runway available, RCR permitting. Excess pedal pressure/deflection can result in skids, worn/blown tires and possible center gear lower drag link failure. With only accumulator pressure available, avoid cycling brake pedals.

NOTE

22°/RET charts are provided as a worst case scenario. A 35°/RET landing will result in a shorter landing distance.

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

MANUAL BRAKING	OPERATIVE SPOILER PANELS (NO. 1 AND 5)
FULL REVERSE THRUST	STD DAY/SEA LEVEL (FOR EACH 1,000 FT ABOVE SEA LEVEL, INCREASE LANDING DISTANCE BY 4%).

RUNWAY CON-DITION	GROSS WEIGHT (1,000 LB)										
	300	320	340	360	380	400	420	440	460	480	500
	LANDING DISTANCE (FT)										
DRY	9,150	9,800	10,550	11,300	12,100	12,850	13,710	14,500	15,350		
WET	9,750	10,550	11,300	12,100	12,900	13,750	14,600	15,400			

Plan to configure aircraft earlier than normal. Extend flaps only when in stabilized flight.

Crew Briefing . . . . "COMPLETED" (PF)
Landing Data/V-Bugs . . . . "SET" (P,CP)
Radio Altimeters . . . . "SET" (P,CP)
Windshield Anti-ice . . . . AS REQ'D (FE)
Altimeters . . . . "SET/X-CHECKED" (P,CP)
Pressurization . . . . SET (FE)

When ready to configure aircraft for landing,

V_{MM} For Existing Configuration . . . . "ACHIEVE" (PF)

NOTE

The inoperative system(s) may be reinstated for landing if there is quantity indicated.

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

FAILURE OCCURRED WITH SLATS RETRACTED

YES

FLAP/SLAT Handle	"SPLIT"	(CP)

Accomplish 22°/RET or 35°/RET (flap limiting speed permitting) landing and use corresponding speeds.

On final, expect a lower than normal pitch attitude.

NO

If slats are in the TAKEOFF position, accomplish 22°/EXT landing. If in the LAND position, accomplish 35°/EXT landing.

Fuel Panel	SET	(FE)
Exterior Lts	SET	(FE)
Cabin Signs	AUTO	(FE)
CDUs, EHSIs, Radio Aids	"SET"	(P,CP,FE)
Altimeters	"SET/X-CHECKED"	(P,CP)
Thrust Computer	"GA"	(PNF)
Annunciator Panels	"CHECKED"	(P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button	OFF	(FE,BO)

WARNING

If upper rudder is inop do not reduce speed to below V_{MCA} (157 KIAS) until landing is assured.

NOTE

- *Plan a long final for speed stabilization.*
- *Avoid high sink rate on final if the stab is inop.*

FINAL CHECKLIST

IAS	"RESTRICT TO 230 KTS"	(PF)
Main Gear Altn Ext Lever	"RAISE/LATCH"	(CP)
Gear Lts	"3 GREEN"	(CP)

CAUTION

- *After alternate extension of the main gear, wait until gear is extended (3 GREEN lights) before next action.*
- *After gear extension do not exceed 260 KIAS.*

CTR Gear Altn Ext Handle	PULL	(FE)
Gear Lts	"4 GREEN"	(P,CP,FE)
Gear Handle	"DOWN"	(CP)
Flaps/Slats	"___°/___°/___°/"	(P,CP,FE)
GND PROXIMITY WARN FLAP OVRD Sw	"OVRD/ON" (IF REQD)	(FE)
Spoilers	"ARM"	(P)
Anti-Skid Sw	OFF	(FE)

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

Brake Pressure . . . . CHECKED (FE)

After touchdown positively lower nose gear to runway and immediately apply reverse thrust.

WARNING

- *If upper rudder is inop do not reduce speed to below V_{MCA} (157 KIAS) until landing is assured.*
- *Use manual braking and avoid cycling pedals.*

CAUTION

When braking without anti-skid protection extreme care is required to avoid skids, worn/blown tires and possible center gear drag link failure.

NOTE

SPOILERS will not automatically deploy to 2/3 position on main wheel spin-up unless flaps are equal to or greater than 30°. When flaps are less than 30°, they must be manually deployed. When final flap position is greater than 30°, the spoiler handle must be manually assisted during its last portion of travel.

END

C SYS 2 & 3 INOP

Lower rudder is inop.

- Max X-WIND component - 15kts
- Determine V_{MCA} from the following chart:

MIN CONT SPD (KIAS)							
LDG WT (LB X 1,000)	260	270	280	290	300	310	320 & ABOVE
V_{MCA}	201	196	190	184	179	175	172

Approach/Landing Procedures . . . . REVIEW (P,CP,FE)

EFFECTS ON AIRCRAFT CONFIGURATION	
FLAPS/SLATS	Will extend as selected. Plan 35°/EXT landing.
GEAR	Use alternate extension system.
BRAKES	System 1 and accumulators available.
NOSE GEAR STEERING	L - normal R - 25°

Gross Weight . . . . REDUCE (P,FE)

■ Prior to configuring, dump fuel to reduce landing weight and arrival speeds to lowest practical. Gross weight up to 439,000 pounds will allow sufficient speed reduction for normal flap/slat operation.

- LANDING DISTANCE 35°/EXT -

ANTI-SKID BRAKING
FULL REVERSE THRUST

OPERATIVE SPOILER PANELS (NO. 2 AND 4)
STD DAY/SEA LEVEL (FOR EACH 1,000 FT ABOVE SEA LEVEL, INCREASE LANDING DISTANCE BY 4%).

GROSS WEIGHT (X 1,000 LB)	300	320	340	360	380	400	420	440	460	480	500
■ LANDING DISTANCE (DRY)	4,803	4,813	4,829	4,839	4,848	4,856	4,878	4,888	4,898	4,906	4,911
LANDING DISTANCE (WET)	7,229	7,307	7,406	7,502	7,607	7,702	7,789	7,871	7,944	8,014	8,074

Plan to configure aircraft earlier than normal. Extend flaps only when in stabilized flight.

CONTINUED

DUAL HYDRAULIC SYSTEM FAILURE (cont)

Crew Briefing	"COMPLETED"	(PF)
Landing Data/V-Bugs	"SET"	(P,CP)
Radio Altimeters	"SET"	(P,CP)
Windshield Anti-ice	AS REQ'D	(FE)
Altimeters	"SET/X-CHECKED"	(P,CP)
Pressurization	SET	(FE)

When ready to configure aircraft for landing,

V_{MM} For Existing Configuration	ACHIEVE"	(PF)

NOTE

Do not extend flaps more than 35° to minimize effects of possible spoiler float.

Fuel Panel	SET	(FE)
Exterior Lts	SET	(FE)
Cabin Signs	ON	(FE)
CDUs, EHSIs, Radio Aids	SET	(P,CP,FE)
Altimeters	"SET/X-CHECKED"	(P,CP)
Thrust Computer	"GA"	(PNF)
Annunciator Panels	CHECKED"	(P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button	OFF	(FE,BO)

WARNING

Do not reduce speed to below charted V_{MCA} until landing is assured.

NOTE

Plan a long final for speed stabilization.

FINAL CHECKLIST

IAS	"RESTRICT TO 230 KTS"	(PF)
Main Gear Altn Ext Lever	"RAISE/LATCH"	(CP)
Gear Lts	"3 GREEN"	(PNF)

CAUTION

- *After alternate extension of the main gear, wait until gear is extended (3 GREEN lights) before next action.*
- *After gear extension do not exceed 260 KIAS.*

CTR Gear Altn Ext Handle	PULL	(FE)
Gear Lts	"4 GREEN"	(P,CP,FE)
Gear Handle	"DOWN"	(CP)
Flaps/Slats	"___°/___°/___°/"	(P,CP,FE)
Spoilers	"ARM"	(P)
Anti-Skid/Brake Pressure	CHECKED	(FE)

After touchdown positively lower nose gear to runway and immediately apply reverse thrust.

NOTE

SPOILERS will not automatically deploy to 2/3 position on main wheel spin-up unless flaps are equal to or greater than 30°. When flaps are less than 30°, they must be manually deployed. When final flap position is greater than 30°, the spoiler handle must be manually assisted during its last portion of travel.

END

OPERATION USING SINGLE HYDRAULIC SYSTEM POWERED BY A WINDMILLING ENGINE

Airspeed	ESTABLISH	(PF)

Airspeed should be sufficient to maintain minimum of 5% N_2 on windmilling engine and not less than °/RET minimum maneuvering speed (whichever is higher).

GWT (X 1,000)	260	280	300	320	340	360	380	400	420	440	460	480	500
0°/RET V_{MM}	194	201	208	215	222	228	234	240	246	252	257	263	268

MOTOR PUMP Sws	OFF	(FE)
ENG FIRE Handle (Windmilling Engine)	NORM	(FE)
One of the two ENG HYD Pump Sws (Windmilling Engine)	OFF	(FE)
YAW DAMP Sws (4)	OFF	(P)
GND PROXIMITY WARN FLAP OVRD Sw	OVRD/ON	(FE)
AC BUS TIE Sws	NORM	(FE)
CSD Disconnect Button (Windmilling Engine)	PUSH	(FE)

NOTE

- *Autothrottles may be used except for approach and landing with flaps less than 35°/EXT.*
- *Rudder, aileron, and stabilizer trim are available.*
- *Make stabilizer trim changes using short duration inputs.*
- *Aileron effectiveness is reduced and control forces are increased.*
- *Rudder control is normal if engine 2 is supplying hydraulic power. Use rudder for yaw control only.*
- *Plan a NO FLAP/NO SLAT approach and landing.*
- *When landing is assured, extend landing gear by free fall.*

Prior to initiating speed reduction for landing:

Pneumatic Source	ESTABLISHED	(FE)
Ignition Override and Airstart Sw	OVRD & AIR START	(FE)
Starter, Windmilling Engine	ENGAGE	(FE)

Activate starter on windmilling engine (with pneumatics from an operating engine or APU) to maintain N_2 rpm as airspeed is reduced.

CAUTION

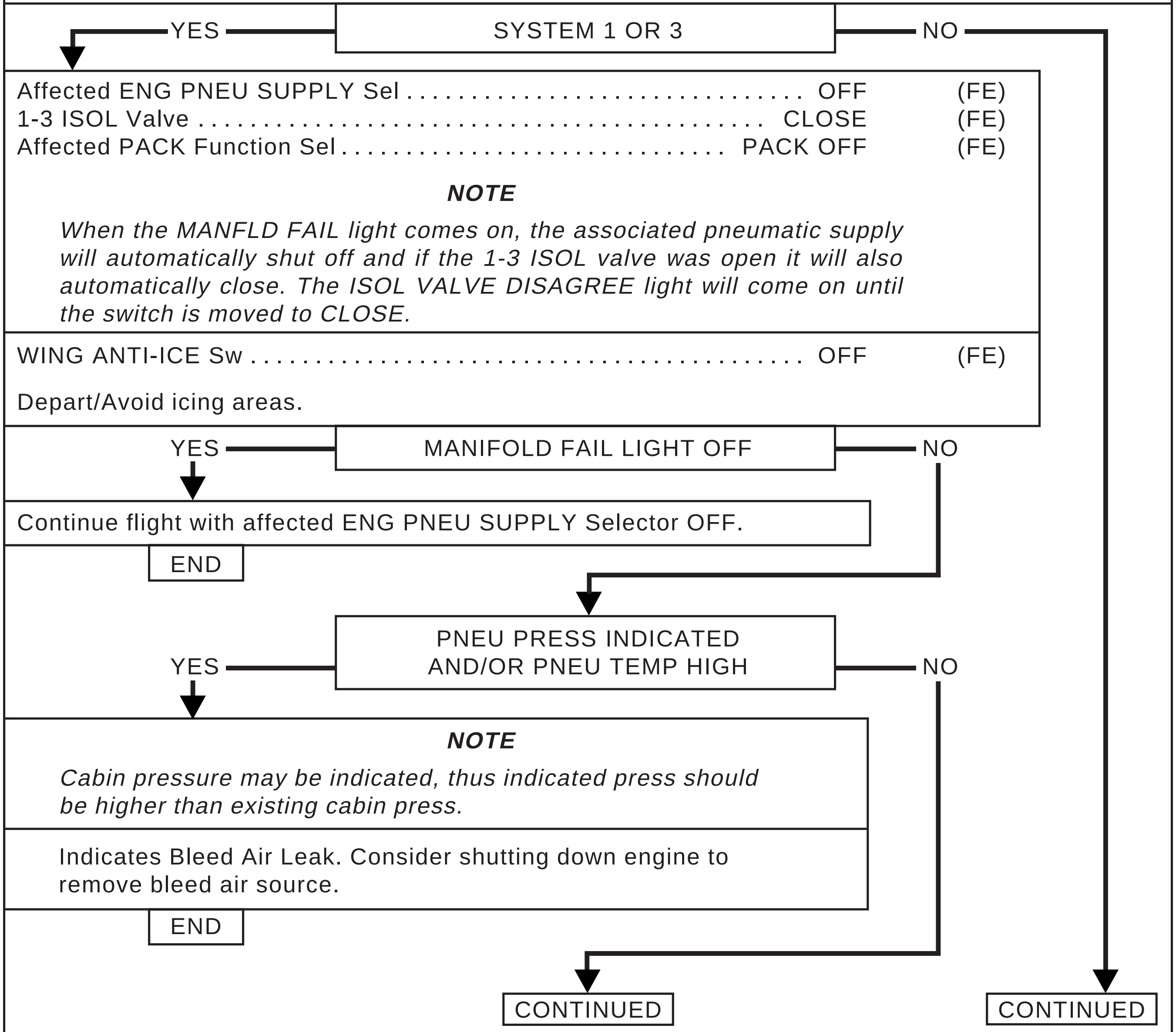
Do not attempt starter reengagement above 30% N_2 rpm. Starter damage may occur.

END

PNEUMATIC MANIFOLD FAILURE

NOTE

- *If only system 2 light illuminates, close APU and 1-2 ISOL valve. Discontinue use of APU pneumatics.*
- *If the 1-2 ISOL valve was open when the MANFLD FAIL light came on, the valve will automatically close and the ISOL VALVE DISAGREE light will come on until the switch is moved to CLOSE. If the APU/ISOL VALVE switch was OPEN, the APU ISOL valve will also automatically close.*



YES — SYSTEM 1 OR 3 — NO

Affected ENG PNEU SUPPLY Sel	OFF	(FE)
1-3 ISOL Valve	CLOSE	(FE)
Affected PACK Function Sel	PACK OFF	(FE)

NOTE

When the MANFLD FAIL light comes on, the associated pneumatic supply will automatically shut off and if the 1-3 ISOL valve was open it will also automatically close. The ISOL VALVE DISAGREE light will come on until the switch is moved to CLOSE.

WING ANTI-ICE Sw	OFF	(FE)

Depart/Avoid icing areas.

YES — MANIFOLD FAIL LIGHT OFF — NO

Continue flight with affected ENG PNEU SUPPLY Selector OFF.

END

YES — PNEU PRESS INDICATED AND/OR PNEU TEMP HIGH — NO

NOTE

Cabin pressure may be indicated, thus indicated press should be higher than existing cabin press.

Indicates Bleed Air Leak. Consider shutting down engine to remove bleed air source.

END

CONTINUED

CONTINUED

PNEUMATIC MANIFOLD FAILURE (cont)

CONTINUED

#1 — SYS #1 OR #3 — #3

Unknown condition. Land at nearest suitable airport.

END

Move MANIFOLD FAIL DETECT LOOP Select switch to A/B positions in an attempt to extinguish MANIFOLD FAIL light by utilizing an independent loop.

YES — MANIFOLD FAIL LIGHTS OUT — NO

Continue flight with NUMBER 1 PNEUMATIC Selector OFF.

END

Unknown condition. Land at nearest suitable airport.

END

CONTINUED

ALL THREE SYSTEMS

ENG PNEU SUPPLY Sels (1 and 3) . . . . OFF (FE)

NOTE

During the period that all ENG PNEU SUPPLY Sels are off, the aircraft will depressurize at approximately 1,500 FPM.

Avionic Flow Sw . . . . OVRD (FE)

WING ANTI-ICE Sw . . . . OFF (FE)
PACK FUNC Sels . . . . BOTH OFF (FE)
LAV GALLEY VENT Sw . . . . OFF (FE)
1-3 ISOL Valve . . . . CLOSED (FE)

Depart/Avoid icing areas.

YES — MANIFOLD FAIL LIGHT(S) OUT — NO

Manifold Pressure Decay Check . . . . Perform (FE)

Momentarily rotate each ENG PNEU SUPPLY selector to AUTO one at a time and allow the pneumatic pressure to increase and stabilize. After the pneumatic pressure has stabilized, rotate the ENG PNEU SUPPLY selector to OFF and note the pressure and decay rate. If MANIFOLD FAIL light illuminates or pressure stabilizes at lower than normal for engine power level, discontinue use of that pneumatic system.

CONTINUED

CONTINUED

PNEUMATIC MANIFOLD FAILURE (cont)

CONTINUED

CONTINUED

ENG PNEU SUPPLY Sel (With slowest pressure drop)	AUTO	(FE)
Affected PACK Function Sel	AUTO/MAN	(FE)
LAV GALLEY VENT Sw	ON (If Applicable)	(FE)
Avionic Flow Sw	NORMAL	(FE)

NOTE

Continue flight with selected system supplying air conditioning and pressurization requirements.

END

SYSTEM 1

YES

NO

Move MANIFOLD FAIL DETECT LOOP Select Switch to A/B positions in an attempt to extinguish MANIFOLD FAIL LIGHT by utilizing an independent loop.

MANIFOLD FAIL LIGHT OUT

YES

NO

Continue flight with Number 1 Pneumatic Selector OFF.

END

PNEU PRESS INDICATED AND/OR
PNEU TEMP HIGH

YES

NO

NOTE

Cabin press may be indicated, thus indicated press should be higher than existing cabin pressure.

Indicates bleed air leak. Consider shutting down engine to remove bleed air source.

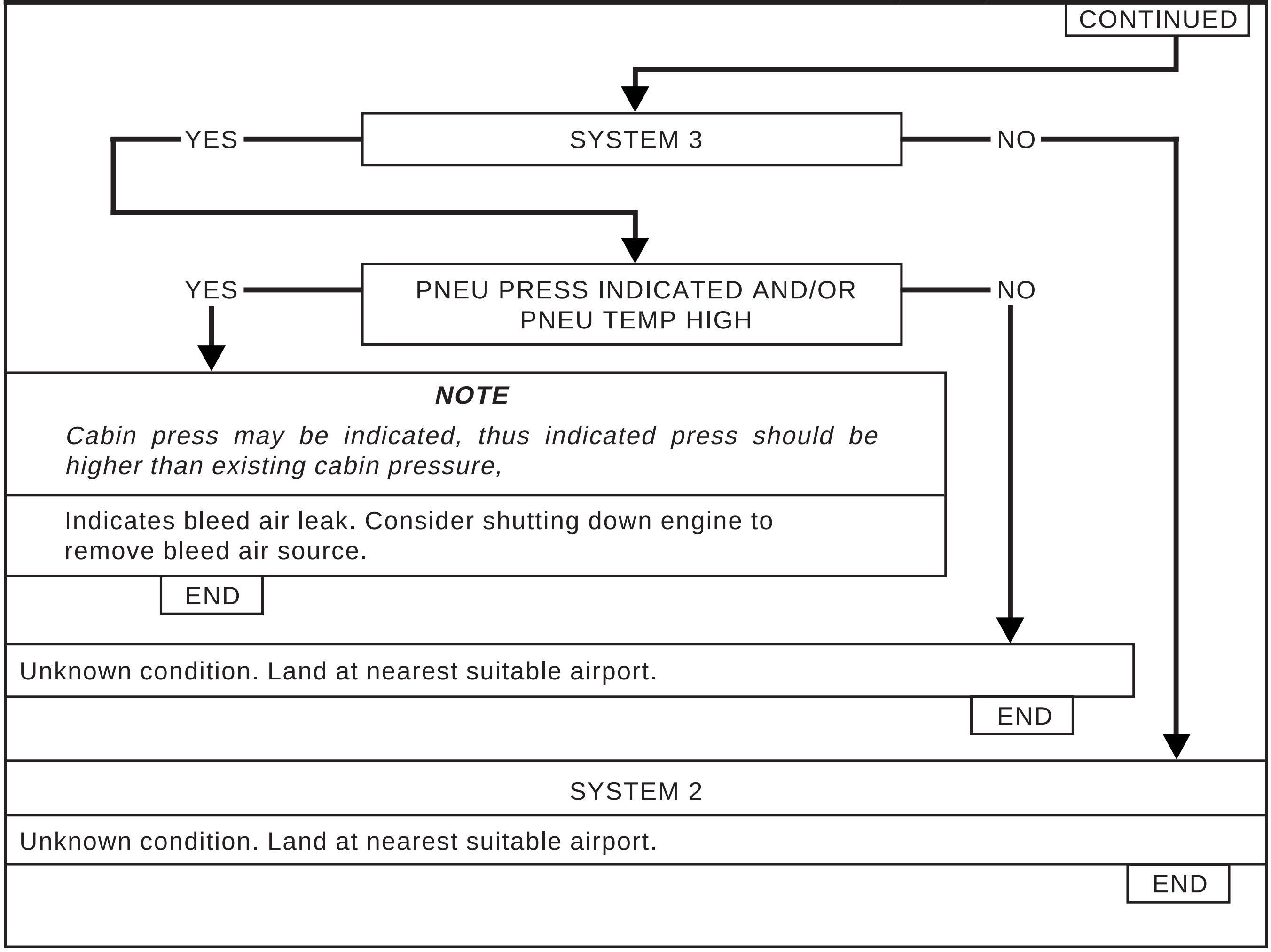
END

Unknown condition. Land at nearest suitable airport.

END

CONTINUED

PNEUMATIC MANIFOLD FAILURE (cont)



NOTE

Cabin press may be indicated, thus indicated press should be higher than existing cabin pressure,

Indicates bleed air leak. Consider shutting down engine to remove bleed air source.

Unknown condition. Land at nearest suitable airport.

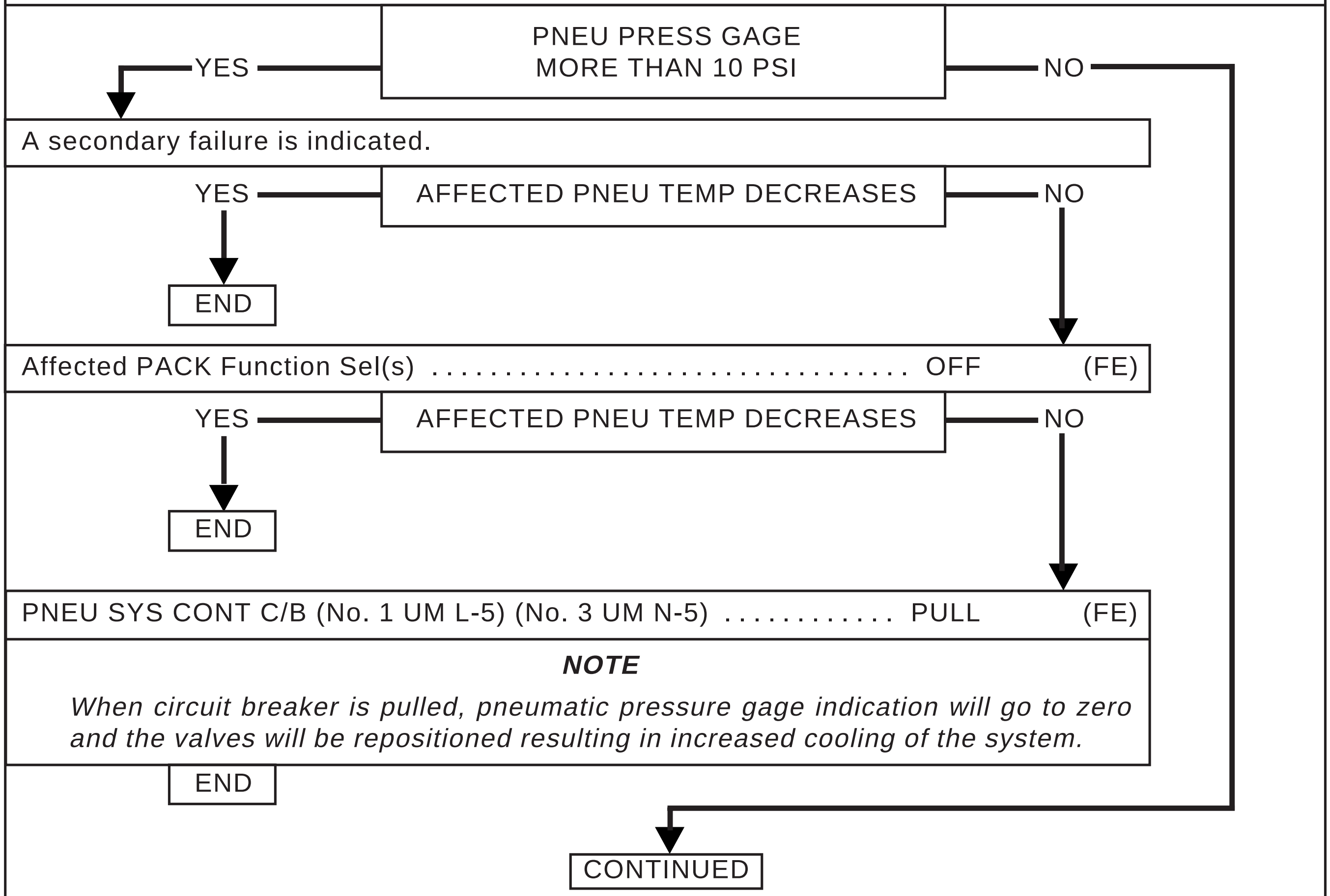
Unknown condition. Land at nearest suitable airport.

PNEU TEMP HI LIGHT ON/OR PNEU TEMP GAGE HIGH

ENG PNEU SUPPLY SEL . . . . OFF (FE)

NOTE

- *Pneumatic TEMP HI light is deactivated when ENG PNEU SUPPLY selector is in OFF. Pneumatic temperature gage indication will decrease slowly when there is no flow.*
- *Ensure 1-3 ISOL Valve is closed prior to checking pneumatic pressure.*



PNEU PRESS GAGE MORE THAN 10 PSI

A secondary failure is indicated.

AFFECTED PNEU TEMP DECREASES

Affected PACK Function Sel(s) . . . . OFF (FE)

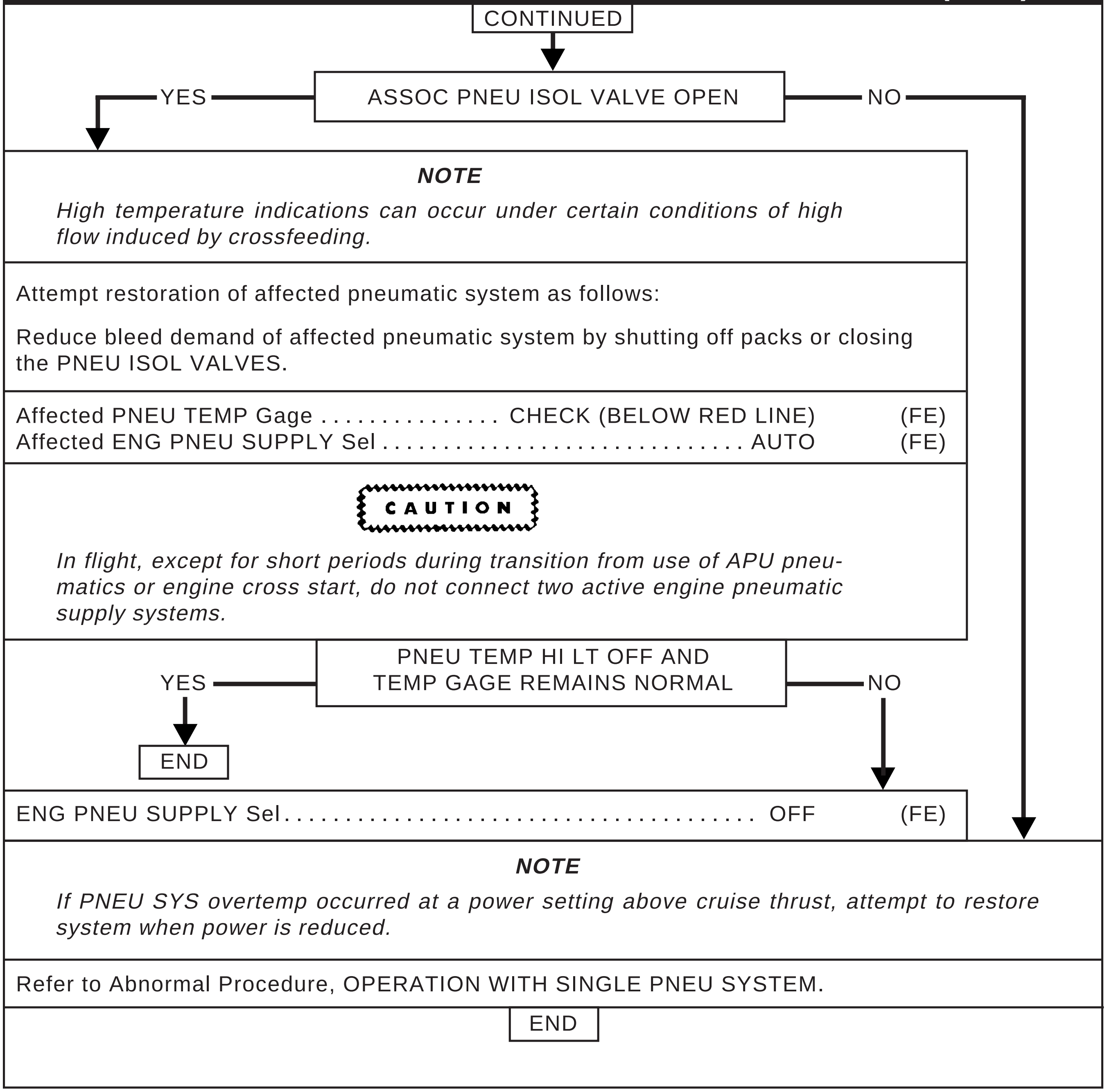
AFFECTED PNEU TEMP DECREASES

PNEU SYS CONT C/B (No. 1 UM L-5) (No. 3 UM N-5) . . . . PULL (FE)

NOTE

When circuit breaker is pulled, pneumatic pressure gage indication will go to zero and the valves will be repositioned resulting in increased cooling of the system.

PNEU TEMP HI LIGHT ON/OR PNEU TEMP GAGE HIGH (cont)



NOTE

High temperature indications can occur under certain conditions of high flow induced by crossfeeding.

Attempt restoration of affected pneumatic system as follows:

Reduce bleed demand of affected pneumatic system by shutting off packs or closing the PNEU ISOL VALVES.

Affected PNEU TEMP Gage . . . . CHECK (BELOW RED LINE) (FE)
Affected ENG PNEU SUPPLY Sel . . . . AUTO (FE)

CAUTION

In flight, except for short periods during transition from use of APU pneumatics or engine cross start, do not connect two active engine pneumatic supply systems.

ENG PNEU SUPPLY Sel . . . . OFF (FE)

NOTE

If PNEU SYS overtemp occurred at a power setting above cruise thrust, attempt to restore system when power is reduced.

Refer to Abnormal Procedure, OPERATION WITH SINGLE PNEU SYSTEM.

ENGINE FIRE OR SEVERE DAMAGE

NOTE

- *When FIRE or SEVERE DAMAGE is indicated during takeoff, this checklist should not be initiated until reaching a minimum of 400 AGL.*
- *Using both fire agent bottles for engine 2 will deny their use to the APU.*

THROTTLE . . . . IDLE (PNF)

FUEL LEVER . . . . OFF (PNF)

ENG FIRE HANDLE/AGENT . . . . DOWN/DISCH (FE)

NOTE

- *Twisting while pulling the engine fire handle may result in premature discharge of extinguishing agent.*
- *Agent will not discharge unless handle is held in full forward position while rotating. Moderate force is required to overcome spring load on handle at full forward position.*

YES — AFTER 30 SECONDS FIRE HANDLE LT OUT — NO

At Pilot's Discretion:
Second Agent . . . . DISCHARGE/CHECK (FE)

CAUTION

If both fire agent bottles for engine 2 have been discharged, do not start APU.

NOTE

If APU is required, leave one tank 2 aft or APU fuel pump switch in ON in next action.

Assoc TANK PUMPS Sws . . . . OFF (FE)
Approp ENG PNEU SUPPLY Sel . . . . OFF (FE)
Approp Pneu ISOL VALVE Sw . . . . SET (AS REQ'D) (FE)

YES — PNEU TEMP AND PRESS NORMAL — NO

Pneu ISOL VALVE Sw . . . . CLOSE (FE)

NOTE

Abnormal temperature or pressure indications associated with severe damage to the engine may indicate damage to the pneumatic components.

CONTINUED

ENGINE FIRE OR SEVERE DAMAGE (cont)

Approp MOTOR PUMP Sws . . . . AS REQ'D (FE)

Move appropriate hydraulic motor pump switches to ARM, ON or OFF as required.

NOTE

- *If two engines are shut down, operate motor pumps in a manner to provide at least two operative hydraulic systems.*
- *Motor pump switches should be in OFF for noncritical phases of flight and in ARM for approach and landing.*
- *After any engine failure/shutdown (N_2 rpm less than 45%) both motor pumps are automatically turned on when the motor pump switches are in ARM.*

ENG HYD PUMP Sws (Affected Engine). . . . . OFF (FE)
■ Hyd Quantity (Assoc Sys) . . . . MONITOR (FE)

If the Assoc Pneu Sys is required, refer to Abnormal Procedures, OPERATION WITH SINGLE PNEU SYSTEM, Section IIA. Time permitting, TWO ENGINE OPERATION Procedures, Section II, should be reviewed.

Land at nearest suitable airfield.

END

TWO ENGINE OPERATION

Throttles . . . . "MCT" (PF)

NOTE

Below 14,000 feet, 10 minutes of go-around power is permissible, if required.

Altitude/Airspeed . . . . CHECK/MAINTAIN (PF,FE)

Determine TWO ENGINE ALTITUDE/IAS from the following chart. Descend if required, then maintain charted IAS.

TWO ENGINE CAPABILITY

NOTE: 99% MAX RANGE

GROSS WEIGHT (X 1,000 LB)	ALTITUDE (X 1,000 FT)						OPTIMUM ALTITUDE (X 1,000 FT)
	20	25	27	29	31	33	
	KIAS						
275	259	256	254	253	252	250	39.4
300	269	263	262	261	260	258	37.4
325	278	270	271	270	268	265	35.7
350	286	281	279	278	275	272	34.4
375	294	289	288	285	281	278	32.7
400	304	297	294	291	288	285	31.2
425	312	306	300	298	-	-	30
450	319	311	307	303	-	-	28.8
475	326	318	313	-	-	-	27.8
500	333	323	319	-	-	-	27
525	339	-	-	-	-	-	26
550	344	-	-	-	-	-	24.5
575	350	-	-	-	-	-	23

NOTE

- *Refer to the Performance Manual, Section V for additional two engine performance.*
- *If the associated pneumatic system is required, refer to OPERATION WITH SINGLE PNEUMATIC SYSTEM Procedures, page 2A-127.*
- *Time permitting, SINGLE ENGINE OPERATION, page 2-42 and SECOND ENGINE FAILS ON FINAL APPROACH Procedures, page 2-42, should be reviewed.*

CONTINUED

TWO ENGINE OPERATION (cont)

Consider Navigation and Advise ATC	ACCOMPLISH	(PNF)
Fuel Dump	CONSIDER	(P,FE)
Approp Normal Checklists	ACCOMPLISH	(P,CP,FE)

WARNING

Once the aircraft is configured for landing, go-around capability may not exist at high gross weights and extreme ambient conditions with an additional engine failure.

NOTE

- *For 2-engine landing, use 35° flaps.*
- *Delay slat/flap and landing gear extension as long as practical to minimize exposure to a second engine failure during final approach.*
- *Delay descent through 2,000 feet AGL to minimize exposure to a second engine failure during final approach.*
- *Increase charted 22°/EXT MIN MAN and 35°/EXT TH speeds by 10 KIAS until landing is assured to minimize exposure to second engine failure on final. Use normal wind additives, but approach speed should not exceed charted 35°/EXT TH plus 20 KIAS.*
- *Do not use autopilot for go-around during engine out operation.*
- *If second engine failure occurs prior to landing gear extension, accomplish SINGLE ENGINE OPERATION Procedure.*
- *If second engine failure occurs after landing gear extension, accomplish SECOND ENGINE FAILS ON FINAL Procedure.*
- *If both rudders are inoperative directional control is available through asymmetric thrust and remaining lateral control. Landing should be planned at a field with minimal or no crosswind due to loss of rudder directional control. If a wing engine is inoperative a missed approach should not be attempted. After landing, directional control will be limited to asymmetrical thrust, differential braking, and nosewheel steering.*

END

INADVERTENT THRUST REVERSAL OR ANY REVERSER LIGHT ON IN FLIGHT

YES — AIRCRAFT BEHAVIOR NORMAL — NO

Autothrottles . . . . "OFF" (PF)

Continued use of affected engine at the Aircraft Commander’s discretion.

CAUTION

- *Do not use the autothrottles for the remainder of the flight.*
- *If REV U/L light is a result of confirmed or suspected engine cowl damage, consider engine shutdown unless needed for flight. THRUST REVERSER should not be used on affected engine.*
- *If REV U/L or REV PRESS light for engine 1 or 3 illuminates, reduce the affected throttle to idle and land as soon as practical.*

Autopilot . . . . AS DESIRED (PF)

END

Buffet, trim change, or performance degradation:

Take immediate corrective action as necessary to maintain aircraft control.

Autopilot/Autothrottles . . . . "OFF" (PF)

Affected Throttle . . . . "IDLE" (PF)

Reverser Levers . . . . "FULL DOWN (FWD IDLE)" (PF)

YES — AIRCRAFT BEHAVIOR NORMAL AND ALL LIGHTS OFF — NO

Continued use of affected engine at the Aircraft Commander’s discretion.

CAUTION

- *Do not use the autothrottles for the remainder of the flight.*
- *If REV U/L or REV PRESS light for engine 1 or 3 illuminates, reduce the affected throttle to idle and land as soon as practical.*

Autopilot . . . . AS DESIRED (PF)

END

Aircraft behavior abnormal or one or more lights on:

Affected Engine . . . . SHUT DOWN (P,CP,FE)

Refer to Abnormal Procedures, ENGINE SHUTDOWN IN FLIGHT, SECTION IIA.

Autopilot and Autothrottles . . . . AS REQUIRED (PF)

Gross Weight . . . . REDUCE, AS REQUIRED (P,FE)

Use 35° flaps for landing.

END

SECOND ENGINE FAILS ON FINAL APPROACH

If during a two engine final approach after the landing gear is extended, a second engine fails, select flaps to 22° and continue the approach at a speed of 35°/EXT V_{TH} +10 knots. Use go-around power as required to continue the approach. The FE will monitor go-around power and adjust to N_1 limit upon Pilot's command.

THROTTLES . . . . GA (AS REQ'D) (PF)

FLAPS . . . . 22° (PNF)

NOTE

When flaps are moved to 22°, it will be necessary to place the Ground Proximity Warning System to OVRD/ON to silence the warning horn.

SPEED . . . . 35°/EXT V_{TH} + 10 (PF)

END

SINGLE ENGINE OPERATION
(UNLESS COMMITTED ON FINAL)

NOTE

- *Initiate this checklist when second engine fails unless aircraft is on final approach for landing with flaps/slats extended and gear is down.*
- *If on final approach with flaps/slats extended but gear is not down when second engine fails, initiate this checklist and go around if necessary.*
- *If flaps/slats are extended and gear is down on final approach when second engine fails, initiate SECOND ENGINE FAILS ON FINAL APPROACH checklist.*

THROTTLES . . . . MCT (PF)

NOTE

Below 14,000 feet, 10 minutes of go-around power is permissible, if required.

FLAPS . . . . UP (PNF)

SPEED . . . . DRIFTDOWN OR
0°/RET MIN MAN (PF)

GEAR . . . . UP (PNF)

NOTE

Delay gear retraction until flaps are up.

SLATS . . . . RETRACT (PNF)

CONTINUED

SINGLE ENGINE OPERATION (cont)

YES — DRIFTDOWN REQUIRED — NO

Min Safe Altitude . . . . CHECK (PNF)
Fuel Dump . . . . CONSIDER (P, FE)

ALTITUDE CAPABILITY

NOTE

- Ice protection off.
- Max Continuous Thrust.
- Reduce Altitude capability by 1,000 feet for engine plus wing anti-ice ON.

INSTANTANEOUS GROSS WEIGHT (X 1,000 LB)	AT DRIFTDOWN SPEED	
	TO STD + 15°C	STD + 20°C
	ALTITUDE (FT)	
300	16,500	16,300
320	14,700	14,100
340	12,700	12,000
360	10,800	10,000
380	10,000	9,100
400	8,500	6,800
420	6,600	4,300
440	4,600	1,800
460	2,500	0
480	0	0

Cabin Press MODE Sw . . . . SEMI-AUTO (FE)
ALT SET Scale . . . . 10,000 FT (FE)

NOTE

Cabin Altitude Warning Horn may sound with pressure set at 10,000 feet.

ENG PNEU SUPPLY Sel 10,000 Ft and Below . . . . OFF (FE)

CAUTION

If icing conditions exist or are anticipated, leave associated engine PNEU SUPPLY selector in AUTO. Use N_1 thrust charts to set thrust.

Approp Engine Shutdown Procedures . . . . COMPLETED (FE)
Altimeters . . . . "SET/X-CHECKED" (P,CP)
APU . . . . AS REQ'D (FE)

NOTE

APU is available for pneumatics and electrics. However, range and go-around capability must be considered.

Refer to SINGLE ENGINE OPERATION, LANDING LOCATION DECISION.

CONTINUE TO PAGE 2-46

CONTINUED

SINGLE ENGINE OPERATION (cont)

CONTINUED

AVIONIC FLOW Sw (if No. 2 engine operating) . . . . OVRD (FE)
DRIFTDOWN Speed Schedule . . . . CHECK/MAINTAIN (PF,FE)

DRIFTDOWN SPEED SCHEDULE

ALTITUDE (X 1,000)	GROSS WEIGHT (X 1,000 LB)											
	300	325	350	375	400	425	450	475	500	525	550	575
	KIAS											
SL	213	222	231	239	247	254	262	269	276	282	289	296
5	214	223	232	240	248	255	263	270	277	284	291	297
10	215	224	233	241	249	256	264	271	278	285	292	299
15	216	225	233	242	250	257	265	272	279	286	293	300
20	216	225	234	242	251	258	267	274	280	288	295	304
25	218	227	236	244	253	261	269	276	284	291	298	306
30	219	228	238	246	255	263	271	279	287	295	302	310
35	221	231	240	250	259	268	276	284	293	300	308	-
40	224	234	244	254	264	272	282	-	-	-	-	-
42	226	236	247	256	266	-	-	-	-	-	-	-

Min Safe Altitude . . . . "CHECK" (P,CP)
Fuel Dump . . . . CONSIDER (P,FE)

Refer to the following chart to determine altitude capability after driftdown. Refer to TO 1C-10(K)A-1-1, Section XI, to determine terrain clearance capability.

ALTITUDE CAPABILITY AFTER DRIFTDOWN

NOTE

- Ice protection off.
- Max Continuous Thrust.
- Reduce Altitude capability by 1,000 feet for engine plus wing anti-ice ON.
- Valid for start of Driftdown altitudes 29,000 feet and above.

GROSS WEIGHT AT SECOND ENGINE FAILURE (1,000 LB)	AT DRIFTDOWN SPEED	
	TO STD + 15°C	STD + 20°C
	ALTITUDE (FT)	
300	-	-
320	-	-
340	-	-
360	12,000	11,600
380	10,300	10,000
400	9,000	8,400
420	8,000	6,600
440	6,200	4,700
460	4,500	2,500
480	2,600	-
500	-	-

CONTINUED

SINGLE ENGINE OPERATION (cont)

Consider Navigation and Advise ATC . . . . (PNF)
Altitude Preselect . . . . "SET/ARM" (PNF)
Altimeters . . . . "SET/X-CHECKED" (P,CP)
Oxy Masks . . . . ON/NORMAL (IF REQ'D) (ALL)

WARNING

If cabin pressure cannot be maintained, passenger oxygen masks should automatically deploy at approximately 14,000 feet cabin altitude. If masks do not deploy automatically, manually hold EJECT switch for 3-5 seconds; 22 minutes of oxygen available. Increase driftdown to reach 13,000 feet within 22 minutes of mask deployment. If power to any electrical bus has been interrupted, recycle the passenger OXY MASK switch to EJECT after power is restored.

APU . . . . AS REQ'D (FE)

NOTE

APU is available for pneumatics and electrics. However, range and go-around capability must be considered.

Approp Eng Shutdown Procedures . . . . COMPLETED (FE)
PACK Function Sel (either) . . . . MAN HOT/PACK OFF (FE)

Rotate and hold appropriate PACK Function Selector to MAN/HOT. When pack temperature valve position indicator is in full hot position, rotate PACK Function selector to PACK OFF.

NOTE

The full hot position ensures pack ram air inlet/outlet doors are closed, reducing drag.

LEVEL OFF AT OR BELOW
10,000 FEET

YES

NO

Cabin Press Mode Sw . . . . SEMI-AUTO (FE)
ALT SET SCALE . . . . SET 10,000 FT (FE)

NOTE

Cabin Altitude Warn Horn may sound with pressure set at 10,000 feet.

When Below 10,000' ENG PNEU SUPPLY Sels (All) . . . . OFF (FE)

CAUTION

If icing conditions exist or are anticipated, leave associated ENG PNEU SUPPLY selector in AUTO. Use N_1 thrust setting charts to set thrust.

PACK Function Sels . . . . PACK OFF (FE)

NOTE

If ram air ventilation is required refer to Section IIA, RAM AIR VENTILATION SYSTEM OPERATION.

Bottom of Driftdown . . . . MAINTAIN ALT/ACCELERATE TO 270 KIAS (PF)

Maintain altitude at bottom of driftdown and allow aircraft to accelerate to 270 KIAS as gross weight is reduced by fuel burnoff.

CONTINUED

SINGLE ENGINE OPERATION (cont)

At 270 KIAS . . . . CRUISE/CLIMB (PF)

Upon reaching 270 KIAS, start cruise/climb at 270 KIAS.

NOTE

For cruise climb data, refer to TO 1C-10(K)A-1-1, Section XI.

CRUISE CLIMB EXCEEDS
10,000 FEET

YES

Level off at 10,000 feet and maintain 270 KIAS until cruise climb weight with one air-conditioning pack is attained.

ENG PNEU SUPPLY Sel . . . . AUTO (FE)

NOTE

If ram air ventilation was used, do not operate PACK No. 1.

PACK Function Sel (Either) . . . . MAN/HOT PACK OFF (FE)
PACK Function Sel for Remaining Pack . . . . AUTO (FE)
Cabin Press MODE Sw/Altitude . . . . AUTO OR SEMI-AUTO SET (FE)
Cabin Press Man/Auto Handle . . . . AUTO (FE)

NO

LANDING LOCATION DECISION

NOTE

- *The closest runway may not be the best choice to land a single engine aircraft. Therefore, consider the following during the destination options evaluation:*
  - *Distance to available landing locations*
  - *Remaining hydraulic systems*
  - *Landing considerations (RCR, crosswind, length of runway)*
  - *Ceiling and visibility*
  - *Availability of a precision approach*
- *The procedures for a single engine approach force the pilot to commit to landing at 1000 feet above airfield elevation. The aircraft commander must take into account the poor handling characteristics of the aircraft and the restrictions to go around capability when deciding on acceptable minimums for ceiling, visibility, and crosswinds at the landing destination.*

When desired, accomplish DESCENT/APPROACH checklist.

- DESCENT/APPROACH CHECKLIST -

Approach and Final Procedures . . . . REVIEW (P,CP,FE)

- APPROACH PROCEDURES -

APPROACH SPEEDS

CONFIGURATION	LANDING WEIGHT (X 1,000 LB)									
	260	280	300	320	340	360	380	400	420	440
MIN MAN 0°/RET	192	201	208	215	222	228	234	240	246	252
APPR 0°/EXT	167	173	179	185	191	196	202	207	212	217
THRES 0°/EXT	142	147	152	157	162	167	171	176	180	184

CONTINUED

SINGLE ENGINE OPERATION (cont)

LANDING DISTANCE: Compute for FLAPS/SLATS 0°/EXT, center gear retracted, spoilers extended, no reverse thrust.

LANDING DISTANCE CHART

NOTE

- *Std Day/Sea Level (For each 1,000 ft above sea level, increase landing distance by 4%).*
- *Center Gear Retracted*
- *No Reverse Thrust*
- *Spoilers Extended*
- *FLAPS/SLATS 0°/EXT*

RUNWAY CONDITION	GROSS WEIGHT (1,000 LB)									
	260	280	300	320	340	360	380	400	420	440
	LANDING DISTANCE									
DRY	4,500	4,750	5,000	5,300	5,600	5,800	6,100	6,300	6,700	7,200
WET	7,400	7,800	8,400	8,800	9,300	9,700	10,400	10,800	-	-

Gross Weight . . . . REDUCE TO MIN PRACTICAL (P,FE)

APPROACH
- Maintain 0°/RET min man until established on straight-in approach, 1,500 feet AGL minimum.
- Starting descent select 0°/EXT and reduce to single engine approach speed.
- Anticipate a higher than normal rate of descent due to the faster than normal speeds involved. Also, anticipate a higher than normal pitch attitude.
- At 1,000 feet above airfield elevation (Commit Height) and landing is assured lower gear.
- 1,000 feet above airfield elevation is minimum commit height for go-around. This point is a performance limit.
- Bleed speed to cross threshold at V_{TH}.
- Zero rudder trim before touchdown.

LANDING
- As the threshold is attained, flare slightly to reduce sink rate, reduce thrust, and fly to a positive touchdown.
- Use reverse thrust as required, directional control permitting.
- Spoilers deploy on reverser actuation (use all 3 levers). It will be necessary to manually assist spoiler handle during last portion of travel.

Missed Approach Procedures . . . . REVIEW (P,CP,FE)

- MISSED APPROACH BRIEFING -

WARNING

Do not attempt single engine missed approach under any of the following conditions.
- *Less than 1,000 feet above airfield elevation.*
- *Weight, press alt, and temp exceed charted capability.*
- *Airspeed below single engine approach speed.*
- *Gear is extended.*

CONTINUED

SINGLE ENGINE OPERATION (cont)

FOR GO-AROUND

- Set go-around power
- Retract slats
- Continue descent and accelerate to 0°/RET minimum maneuver speed
- Climb at 0°/RET minimum maneuver speed

SINGLE ENGINE MISSED APPROACH CAPABILITY

NOTE

- *Ice Protection OFF.*
- *Reduce weight by 1.6% with APU operating.*

ALT	AMBIENT TEMPERATURE °C																
	-54	-20	10	15	20	25	30	32	34	36	38	40	42	44	46	48	50
	GROSS WEIGHT (X 1,000 LB)																
SL	458	461	464	464	465	465	461	451	442	435	425	418	410	401	395	387	380
2	441	443	446	446	447	447	428	420	411	405	397	390	382	374	369		
4	421	425	427	428	428	416	397	391	383	377	369	362	356				
6	402	404	407	407	402	387	370	365	357	350	343						
8	381	384	385	385	372	360	344	338	331								
10	360	362	365	358	346	333	318										

Crew Briefing	"COMPLETED"	(PF)
Landing Data/V-Bugs	"SET"	(P,CP)
CTR Gear ISOL Sw	"UP"	(CP)
Radio Altimeters	"SET"	(P,CP)
Windshield Anti-ice	AS REQ'D	(FE)
Altimeters	"SET/X-CHECKED"	(P,CP)
APU	OFF (IF THRUST IS CRITICAL)	(FE)
Pressurization	SET	(FE)
Aux Pumps	"AS REQ'D"	(FE)
Fuel Panel	SET	(FE)
Exterior Lts	SET	(FE)
Cabin Signs	ON	(FE)
CDUs/EHSIs/Radio Aids	"SET"	(P,CP,FE)
Thrust Computer	"GA"	(PNF)
Annunciator Panels	"CHECKED"	(P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button	OFF	(FE,BO)
GND PROX FLAP WARN OVRD Sw	OVRD/ON	(FE)
Hyd Sys/MOTOR PUMP Sws	CHECK/ARM	(FE)

- FINAL CHECKLIST -

FLAP/SLAT Handle	"0°/EXT"	(PNF)
Airspeed	"APPROACH SPEED"	(PF)

CONTINUED

SINGLE ENGINE OPERATION (cont)

COMMIT HEIGHT
(1,000 FEET MINIMUM)
CONTINUE APPROACH

YES

Gear Handle/Lts	"DOWN/THREE GREEN"	(P,CP,FE)
Brake Sys HYD PRESS Gages	WHITE BAND	(FE)
Spoilers	"ARMED"	(P)
RUD STDBY PWR Sw-Lt	ARM/OFF	(FE)

NOTE

- *Zero rudder trim before touchdown.*
- *Reduce to V_{TH} when landing assured.*

Before Landing Checklist	"COMPLETE"	(FE)

END

NO

GO-AROUND

Go-Around Power	"SET"	(PF,FE)
FLAP/SLAT Handle	"UP/RET"	(PNF)
Airspeed	"MIN MAN 0°/RET"	(PF)

NOTE

Climb at Minimum Maneuver 0°/RET speed.

END

DECOMPRESSION/EMERGENCY DESCENT

Performed when the aircraft is above 10,000 feet MSL and the cabin altitude warning horn sounds or the cabin altitude is rapidly increasing.

OXYGEN MASKS	**ON/100%/EMER**	**(ALL)**
CABIN OUTFLOW VALVE	**CLOSED**	**(FE)**

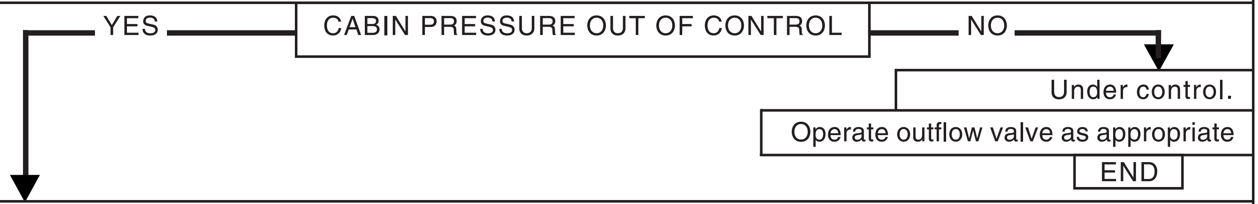
NOTE

When oxygen regulator EMERGENCY position is no longer required, move the NORMAL/ EMERGENCY selector to NORMAL. Verfiy mask vent valve is closed if not required.

Verify cabin outflow valve is closed.

Observing the cabin outflow valve in closed position indicates normal valve operation and that aircraft has a large pressurization leak, or the pressurization source is inoperative. In this case, make no further attempts to close outflow valve. Continue with emergency action procedures. If cabin outflow valve is not closed, move cabin pressure manual/automatic handle to MAN and push and rotate manual cabin altitude control wheel downward. Observe outflow valve position indicator move to CLOSE.

Crew Communications	ESTABLISHED	(ALL)


CABIN PRESSURE OUT OF CONTROL

YES

NO

Under control.

Operate outflow valve as appropriate

END

ATS Lever(s)	"OFF"	(PF)
Throttles	"IDLE"	(PF)
Spoiler Handle	"SPD BRK FULL"	(PF)
Descent	"STARTED" (MAX PITCH 10°/MAX BANK 30°)	(PF)
Airspeed	"MACH 0.82 - 0.85/320-350 KIAS"	(PF)

NOTE

- *Known failures that affect structural integrity and/or turbulence might dictate other speed profiles and entry maneuvers.*
- *Autopilot CMD or CWS mode may be used during descent.*

CAB ALT WARN Horn Button	PUSH	(FE)
Passenger OXY MASK Sw	EJECT, HOLD 3-5 SEC	(FE)

WARNING

If cabin pressure cannot be maintained, passenger oxygen masks should automatically deploy at approximately 14,000 feet cabin altitude. If masks do not deploy automatically, manually hold eject switch for 3-5 seconds; 22 minutes of oxygen available. Increase descent to reach 13,000 feet within 22 minutes of mask deployment. If power to any electrical bus has been interrupted, recycle the passenger OXY MASK switch to EJECT after power is restored.

NOTE

A minimum of 5 additional minutes of oxygen is available using the EPOS equipment.

IFF (Unless Otherwise Required)	"EMER"	(PNF)
AVIONIC FLOW Sw	OVRD	(FE)
Min Safe Alt	"CHECK"	(PNF)
Altitude Advisory	"PRESET & ARM"	(PNF)

NOTE

Establish level flight at 10,000 feet or minimum safe altitude, whichever is higher.

END

BREAKAWAY PROCEDURES

Relative position of both aircraft must be closely monitored by all crewmembers during all phases of air refueling. When either a tanker or receiver crewmember determines that a condition exists which requires an immediate separation of the aircraft, they will transmit the breakaway call on the air refueling frequency. The aircraft do not necessarily have to be in contact-mode to call a breakaway. During loss of interplane communications, the crewmember desiring a breakaway, or observing the tanker initiating a breakaway, will transmit the breakaway call on interphone.

For all breakaways, transmit the tanker's call sign and the word, "Breakaway" three times (Example: "Gucci 22, breakaway, breakaway, breakaway") and simultaneously take the following actions, as indicated.

TANKER PILOT (PF): Advance throttles to N_1 limit and accelerate in level flight. Maintain wings level or established bank angle if in a turn. If notified by the Boom Operator "clear to climb" begin a slow climb maintaining current bank angle. Do not allow the airspeed to decrease below that indicated at the start of climb. When the aircraft are well clear, coordinate with the Boom Operator to terminate the procedure.

TANKER COPILOT (PNF): Turn the BEACON LT Master Sw to "Both". If necessary (i.e. visual contact is lost between the receiver and tanker) turn on/up other equipment to aid the receiver in acquiring the tanker such as A/A TACAN, Rendezvous Beacon, NAV lights, etc.

BOOM OPERATOR: IF BOOM REFUELING: Initiate a disconnect (if applicable) and push the BREAKAWAY SIG Sw. Move the boom clear and inform the pilot of the receiver's position. If necessary, notify the pilot "clear to climb" to ensure vertical separation. Stow the boom if applicable.

NOTE

- When BREAKAWAY SIG Switch is pushed, the pilot director lights will flash for 10 seconds.
- For any system (Boom, Centerline Drogue or Wing Pod Drogue) which is powered on, the BREAKAWAY SIG Switch (on the CTR DROGUE panel) or the BRKWY SIG switch (on the Boom Telescope Control Stick) will automatically flash each system's corresponding signal lights for 10 seconds.

IF DROGUE REFUELING: Move the BREAKAWAY SIG Sw (on the CTR DROGUE panel) to BREAKAWAY. Inform the pilot of the receiver's position and stow the drogue if applicable. If necessary, notify the pilot "clear to climb" to ensure vertical separation.

RECEIVER PILOT (PF): Press the Auto-Pilot release button or the Auto-Throttle disengage button (releases boom from UARRSI), position throttles to IDLE and establish a positive rate of descent. Extend speedbrakes if necessary, drop AFT of tanker until entire tanker is in sight and monitor flight instruments.

WARNING

- The receiver pilot should use caution not to overrun the tanker. If overrunning does occur, under no conditions should a turn, either right or left, be made until positive separation has been attained.
- If the receiver loses sight of the tanker at any time, the receiver shall establish a positive rate of descent to 1000 feet below air refueling altitude until the receiver is definitely positioned aft of the tanker and has the tanker in visual contact.

NOTE

Buffet characteristics in the clean configuration are discussed in the Limitations section of this manual.

RECEIVER COPILOT (PNF): Press the Auto-Pilot release button, (releases boom from UARRSI), maintain a visual contact with the tanker until clear. If a visual contact is lost, attempt to establish radar contact with the tanker. Turn on beacon lights when clear.

KC-10A TWO-ENGINE REFUELING

Two-engine receiver air refueling may only be conducted in accordance with command directives. Refer to TO 1C-10(K)A-1-1, sections 5 and 7. All performance parameters remain the same regarding air refueling envelopes, airspeeds, and altitudes, except as noted below.

CAUTION

Due to limited power availability with only two engines operating, it is not recommended to refuel to weights above 436,000 pounds or above 25,000 feet.

NOTE

- All three throttles should be used when refueling with an engine shutdown.
- Recommended two-engine refueling altitude is 20,000 feet.

TOWING FIGHTERS

NOTE

Receiver pilot's request to be towed must be acknowledged by the tanker pilot and boom operator.

Boom ENV LIMIT Sw(s) . . . . INACTIVE

NOTE

The RCVR DISC delay system will not advance AR SIG SYS to disconnect when boom ENV limit switches are inactive.

Contact . . . . ESTABLISH

Clear receiver to tow position.

NOTE

- *Receiver movement to tow position shall be accomplished very slowly to prevent brute force disconnect.*
- *Disconnects can be accomplished by boom operator or receiver pilot. However, coordination is required prior to initiating disconnect.*

END

PRESSURE REFUELING

NOTE

Pressure boom refueling will not be attempted except when an emergency fuel shortage exists aboard the receiver aircraft.

AR SIG SYS OVRD Sw . . . . OVRD

TLSCP AT DISC Sw . . . . MAN

ALAS Sw . . . . ENABLE

Receiver Pilot . . . . BRIEF

"(Receiver Call Sign)," the following contacts will be made using boom extend pressure. After contact is established, a slight power increase may be required to prevent being pushed beyond outer limit. If an inadvertent disconnect occurs, be prepared to reduce power immediately to prevent a possible closure overrun, "(Tanker Call Sign), Ready."

CAUTION

The boom flight controls are extremely sensitive in the CONTACT/COUPLED mode. If the nozzle should disengage from the receptacle prior to fuel transfer completion, reset AR SIG SYS to ready before attempting to re-establish contact.

Contact . . . . ESTABLISH

Insert nozzle into receiver receptacle, hold slight extend pressure.

EMER CONTACT MADE Sw . . . . PULL

Pull EMER CONTACT MADE Sw, observe CONTACT/COUPLED lights are on and state, "(Tanker Call Sign), Contact."

NOTE

- *Apply only minimum extend pressure necessary to maintain nozzle/receptacle seal. Excessive pressure may place undue stress on boom telescoping mechanism or push receiver beyond outer limit.*
- *Retract nozzle clear of receptacle prior to receiver exceeding a disconnect limit.*

Extend Pressure . . . . RELIEVE

After fuel transfer is complete, notify receiver you are relieving extend pressure.

Disconnect . . . . INITIATE

END

MISCELLANEOUS

CONTROLLABILITY CHECK

If damage has occurred to any portion of the airplane structure sufficient to change the airplane normal flight and control characteristics, or the aircraft experiences in flight control malfunctions, or there is an uncorrectable fuel imbalance, a controllability check in the planned landing configuration should be considered. This check is conducted to determine the air worthiness of the aircraft and the minimum safe airspeed to maintain during approach all the way to touchdown.

Conduct a preliminary check for aircraft damage.

Conduct the controllability check at 10,000 to 15,000 feet AGL if possible.

Use prudent judgment in making speed and configuration changes, gradually slow the aircraft while evaluating the control capabilities in turns and simulated landing approaches.

WARNING

- Never allow speed to decrease to the point at which full control deflection is required about any axis since there may be no recovery capability beyond this point. If control authority degrades rapidly or required control input approaches the limits of authority about any axis, with configuration change and/or airspeed variations, immediately return to a configuration and speed at which adequate control authority is known to exist.
- If both rudders are inoperative directional control is available through asymmetric thrust and remaining lateral control. Landing should be planned at a field with minimal or no crosswind due to loss of rudder directional control. If a wing engine is inoperative a missed approach should not be attempted. After landing, directional control will be limited to asymmetrical thrust, differential braking, and nosewheel steering.

As airspeed and configuration are varied, be alert for aircraft buffet. Do not decrease below the minimum configuration maneuvering speed.

Once the limiting configuration and minimum safe speed have been determined, fly that speed plus 10 knots during approach all the way to touchdown. Refer to abnormal landing configuration procedures as appropriate.

LOOSE CARGO

Notify pilot of situation. Secure cargo to prevent further movement and determine aircraft center of gravity (CG). If CG is within limits secure cargo for landing. If the CG is not within limits, shift the affected cargo to bring the CG within limits. After securing the cargo notify the pilot the cargo compartment is secure.

WARNING

- Do not shift cargo in flight except when necessary to maintain aircraft control. Brief Pilots prior to moving cargo.
- Minimize deck angle changes unless absoultely necessary for safety of flight.

If CG cannot be maintained within limits, or structural damage is suspected, a controllability check should be performed.

DITCHING

Ditching Preparations

On the Pilot's command, the Copilot will transmit Mayday, the estimated position, course, speed, altitude, situation, intention, type of aircraft and request Air Sea Rescue intercept using prevailing air-to-ground frequency. Copilot will set IFF to emergency and, if practical, set a course to the nearest ship. Copilot will alert the crew and passengers to prepare for ditching and order all loose equipment in the airplane stowed.

The flight crew will accomplish the DITCHING checklist.

The Pilot should plan to touchdown on the windward side and parallel to waves or swells if possible. The Pilot will rotate the aircraft approximately 10° nose up, maintain airspeed and minimum rate of descent with available thrust.

Immediately prior to touchdown, the Flight Engineer will place the FUEL levers to OFF, pull the engine fire handles and discharge the engine fire bottles.

NOTE

- For maximum protection against structural collapse and for rapid evacuation, the airplane should be completely depressurized before contacting the water.
- Empty fuel tanks are an aid to buoyancy.
- Ditching should take place while power is still available.
- When a water landing must be made, the principle objectives of the flying technique are to touch the water at minimum forward and sinking speeds and in the most favorable attitude to avoid excessive decelerations and provide maximum controllability. On contact, the nose should be up slightly to give the best planing action of the wings and fuselage, thereby distributing the landing shock. To achieve this, the KC-10A should be ditched using fully extended wing flaps, gear retracted,

and normal approach speeds until quite close to the water; whereupon speed should be reduced to the minimum possible without encountering stall buffeting or losing directional control in asymmetrical power situations. This requires a pitchup attitude at touchdown. In case of complete power failure, a higher approach speed should be used to retain more kinetic energy which can be traded for reduced sinking speed in the final flare maneuver. Under no circumstances should the aircraft be stalled in from a steep angle of approach as the severe impact will stave in the bottom of the fuselage and also cause the nose to bury itself because of rapid deceleration.

- When making contact with water, care should be taken to land straight ahead and avoid any angle of crab. Particular attention must be exercised to avoid this condition when landing with one wing mounted engine inoperative.
- A second or third impact is usually encountered during ditching. The first impact is on contact with the water, and the other impacts can result from porpoising. To avoid injury, all personnel must remain braced until the aircraft comes to rest.
- The aircraft may float for a considerable time if not damaged excessively by the landing impact. However, safety dictates that all aboard be evacuated as rapidly as possible.
- Flight crews should be prepared as individuals to function at any key point in the evacuation movement, irrespective of their assigned responsibilities, if the requirements of the emergency dictate.
- Primary exit(s) for ditching is 1L and/or 1R door. When increased accommodations kit is installed, 2L and 2R doors will have slide/rafts installed.

After Landing

When the aircraft has come to rest, the Pilot will direct the crew to initiate their evacuation duties as briefed: open emergency exits, secure emergency equipment and launch slide/rafts.

PILOT/COPILOT	ENGINEER	BOOM OPERATOR
Proceed to (No. 2L & 2R) doors and direct evacuation if slide/rafts are installed.	Proceed to forward (No. 1R) door and direct evacuation.	Proceed to (No. 1L) door and direct evacuation.
When slide/rafts have been loaded, make a quick check of the area, then assume command of the slide/raft. Disengage the slide/raft from the girt bar using the Slide Disengage handle. The slide/raft will still be connected to the aircraft by the re-entry line. To free the slide/raft from the aircraft, cut the re-entry line using the knife located in a pocket adjacent to the re-entry line attach point. Assist other rafts. Tie rafts together using the heaving lines; adjust line length to avoid jerking and chafing between rafts. Equalize raft loads. To convert the slide/raft to the raft configuration, release the clamp from the pinch tube to inflate the aft end section. Folding back the secondary floor at the girt end will expose the Survival Kit which contains the Raft Manual. Follow the instructions in the Raft Manual.		

Concurrent Boom Operator Duties

Unplanned

Boom Operator will -

- Instruct passengers to don life vest (children should inflate their vests prior to evacuation).
- Attempt to open appropriate exits that are above the water line.
- Initiate the evacuation and loading of the slide/rafts, as required.
- After the slide/rafts are loaded (passengers are out), make a quick check of their area, then board a slide/raft.

Planned

Whenever possible, adequate time should be allowed for the Boom Operator/Engineer to brief the passengers and complete the Ditching Checklist.

During preparation for ditching the Boom Operator(s) will -

- Prepare the cabin.
- Brief the passengers.
- Assign some passengers specific duties.
- Brief passengers on removal of shoes, bracing position, when to evacuate and exit assignments, when to inflate vest, buddy system, forewarning against opening any exit that is below water line, etc.
- Direct passenger evacuation in the manner described for an unplanned ditching.

SEA TABLE

WIND VELOCITY KNOTS	SEA INDICATORS	HEIGHT OF WAVES, FEET
0	Like a mirror	0
1 to 3	Ripples with the appearance of scales	1/2
4 to 6	Small wavelets; crests have glossy appearance and do not break	1
7 to 10	Large wavelets; crests begin to break. Foam of glossy appearance; few very scattered whitecaps	2
11 to 16	Small waves, becoming longer. Fairly frequent whitecaps	5
17 to 21	Moderate waves taking a pronounced long form; many whitecaps	10
22 to 27	Large waves begin to form; white foam crests are more extensive; some spray	15
28 to 33	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of waves	20
34 to 40	Moderately high waves of greater length; edges of crests break into spindrift; foam blown in well marked streaks in the direction of the wind	25
41 to 47	High waves. Dense streaks of foam; sea begins to roll; spray affects visibility	30
48 to 55	Very high waves with overhanging crests; foam in great patches blown in dense white streaks. Whole surface of sea takes on a white appearance. Visibility is affected	35

DITCHING

Crew . . . . "NOTIFY" (P)
IFF . . . . "EMER" (PNF)
ATC . . . . "ADVISE" (PNF)

Report identification, ground speed, position, altitude and true course. Describe nature of emergency, state intentions and request assistance.

Fuel Quantity . . . . REDUCE (P,FE)

Reduce fuel to minimum consistent with requirements dictated by the selected ditching plan.

V-Bugs . . . . "SET" (P,CP,FE)
APU MASTER Sw . . . . OFF (FE)
ENG PNEU SUPPLY Sels . . . . BOTH OFF (FE)

The ENG PNEU SUPPLY selectors are moved to OFF to prevent cabin repressurization.

CAB PRESS MAN/AUTO Handle . . . . MAN (FE)
Manual CAB ALT Control . . . . DEPRESSURIZE THEN CLOSE (FE)

Push in and rotate manual cabin altitude control wheel upward until the outflow valve position indicator is in the open position.

After aircraft is depressurized, push in and rotate manual cabin altitude control wheel downward until the outflow valve position indicator is in the closed position.

WARNING

Cabin doors may not open for evacuation if cabin is pressurized.

PACK Function Sels . . . . BOTH MAN/HOT (FE)
PACK TEMP VALVE POS Ind (1,3) . . . . HOT (FE)

When pack temperature valve position indicates H, ram air scoops (below water line) mechanically close.

TO/LDG CAB PRESS AURAL WARN C/B (LM C-12) &
GND PROXIMITY WARN C/B (FO B-19) . . . . PULL (FE)
FLAP/SLAT Handle . . . . "50°/EXT" (PNF)
GEAR Handle/Lts . . . . "UP/OFF" (PNF)
Cabin Signs . . . . ON (FE)
Loose Equipment . . . . STOW (FE,BO)

Stow all loose equipment in lavatory.

EMER Lt Sw . . . . "ON" (PNF)
First Aid and Survival Equipment . . . . STOWED (FE,BO)

CONTINUED

DITCHING (cont)

Verify first aid, survival gear and flashlights are stowed and are accessible for evacuation. Verify ditching preparations are completed and passengers are wearing life vests and have seat belts fastened.

Crew Vests, Belts & Harness . . . . "ON/FASTEN" (ALL)
Boomer's Seat . . . . FACING FORWARD (BO)
Crew/Passenger Briefing . . . . "COMPLETED" (ALL)
(WITH TCTO 1C-10(K)A-1243) Iridium Phone Power ON/OFF Button . . . . OFF (FE,BO)
Crew Ditching Preparation Checklist . . . . "COMPLETED" (FE)

NOTE

When beginning final approach advise crew and passengers to brace for impact and not to release harness until aircraft has come to complete stop.

IMMEDIATELY PRIOR TO TOUCHDOWN:
Fuel Levers . . . . OFF (FE)

On Pilot's command move fuel lever to OFF.

ENG Fire Handle/Agent . . . . DOWN/DISCHARGED (FE)

END

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION

NOTE

- *If emergency condition is due to unsafe gear indication, refer to amplified LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION.*
- *This procedure is to be used when an emergency condition exists that may cause aircraft structural damage on landing and/or emergency evacuation is required immediately after landing.*

Crew . . . . ADVISE (P)

Advise the crew of the following:

- Cause of emergency
- Type of landing
- Time remaining before landing
- Condition that may affect the use of any exit

Passenger Briefing/Cabin Preparation . . . . INITIATE (P)

Direct boom operator to brief passengers for emergency landing/aircraft evacuation. Prepare cabin and stow all loose equipment. Use EPOS equipment for evacuation if smoke/fumes are or may be present during the evacuation.

CONTINUED

Gross Weight . . . . REDUCE (P,FE)

If time permits, dump excess fuel down to maximum landing weight or less, as required.

Additional Crewmembers/Observers . . . . RESEATED IN CABIN (P,BO)

If time permits, move additional crewmembers/observers to seats in the cabin.

NOTE

Use additional crewmembers to assist boom operator during passenger briefing and evacuation.

Loose Cockpit Equipment . . . . STOWED (ALL)

Stow all cockpit loose equipment.

Cabin Report . . . . "READY" (BO)

Loose equipment report ready.

Approach and Landing Procedures . . . . REVIEW (P,CP,FE)

APPROACH

Crew Briefing . . . . "COMPLETED" (PF)
Landing Data/V-Bugs . . . . "SET" (P,CP)
Radio Altimeters . . . . "SET" (P,CP)
Windshield Anti-ice . . . . AS REQUIRED (FE)
Altimeters . . . . "SET/X-CHECKED" (P,CP)
PACK Function Sels . . . . "OFF" (FE)
Cabin Press Man/Auto Handle . . . . MANUAL (FE)
Outflow Valve Position Ind . . . . FULL OPEN (FE)
Differential Press Gage . . . . ZERO (FE)

WARNING

Cabin doors may not open for evacuation if cabin is pressurized.

Fuel Panel . . . . SET (FE)
Exterior Lts . . . . SET (FE)
Cabin Signs . . . . ON (FE)

Verify SEAT BELT switch is in the ON position.

CDUs/EHSIs/Radio Aids . . . . "SET" (P,CP,FE)
Thrust Computer . . . . "GA" (PNF)
Annunciator Panels . . . . "CHECKED" (P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button . . . . OFF (FE,BO)
APU Master Sw (Unless Req'd) . . . . OFF (FE)

If the APU is not required for electrical power, move APU Master switch to OFF and observe APU rpm and exhaust temperature gages show a decrease.

CONTINUED

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION (cont)

Flap Override Sw	AS REQUIRED	(FE)

If final flap setting is 22° or less, select OVRD/ON on the GND PROXIMITY WARN FLAP OVRD panel.

FINAL

Landing Gear Handle/Gear Lts	"DOWN/___GREEN"	(P,CP,FE)
Spoiler Handle	"ARMED"	(P)
Anti-Skid/Brake Press	CHECK	(FE)
Flaps/Slats	"___/___/___"	(P,CP,FE)
PA announcement	COMPLETED	(FE)

At 250 feet AGL Flight Engineer announce "BRACE FOR LANDING".

AFTER LANDING

Accomplish Ground Evacuation Checklist, if required.

END

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION (cont)

PLANNED EMERGENCY LANDING/DITCHING PASSENGER BRIEFING

Time permitting, brief passengers using the following guide. (Use PA system.)

May I have your attention please. We will be making an emergency landing at ____(airport)____ ____(type of landing)____ due to ____(reason)____ . Estimated time of landing is ________ .

(DITCHING) We will be ditching in approximately ____________ minutes.

Please return to your seats. (At this time reseat as many passengers as possible near the door exits.)

(DITCHING) Don your life vests, DO NOT inflate them yet.

Fasten your seat belt tightly and raise your seatback to an upright position.

In preparation for an orderly and safe aircraft evacuation, please follow instructions carefully.

(CRASH LANDING/IF REQ.) At this time, reach under your seats and remove the Emergency Passenger Oxygen System. Tear open the bag using the red tape; remove EPOS and unfold.

When instructed, pull red ball with one hand while holding the oxygen cylinder with your other hand. Spread neck seal open with palms facing towards each other. Pull EPOS over your head. Remove hood when clear of hazard or instructed by an aircrew member.

(DITCHING) If EPOS is used, remove the EPOS as soon as you have left the aircraft.

When instructed to brace just before touchdown, assume and hold the following bracing position until the aircraft stops moving.

Sit well back in your seat. Lean forward as far as possible, resting the side of your head on your knees and stretch your feet forward. Wrap your arms underneath your legs. If you are unable to assume this position, cross your wrists, place them on the seat back in front of you and rest your forehead on your wrists. (Demonstrate this position as many times as necessary to all occupants.)

Evacuate the aircraft as quickly as possible after it has come to a stop by unfastening your seatbelt and moving to your briefed exit. Do not take any personal belongings with you. If your seat neighbor needs any help, please assist during the evacuation.

(DITCHING) Inflate your life vest upon leaving the aircraft. Children should inflate theirs just prior to evacuation.

Jump onto the slide quickly in a sitting position. Ladies will remove high-heeled shoes before jumping onto the slide.

(DITCHING) Move to the end of the slide/raft and sit down.

After leaving the aircraft, assemble at a safe distance away from the aircraft. There will be no smoking during or immediately after the evacuation. (N/A Ditching)

Study the passenger information card that is in the seat back in front of you for exit operating instructions.

I will be in the cabin to explain any points you may have missed and to assist and brief you in every possible way.

CONTINUED

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION (cont)

BRIEFING FOR EVACUATION ASSISTANCE

Whenever passengers are carried and there are not enough qualified crewmembers available to man all cabin doors, complete this briefing prior to engine start.

To assist the crew in passenger evacuation, select two responsible persons for each door to be used as assistants during the evacuation. Selection preference should be given to a person familiar with the aircraft, i.e., extra crewmember, crew chief, or maintenance personnel. Assign one person the primary responsibility to open the door and command evacuation. The second person should be briefed to take command if the primary person is unable to go to his/her assigned door. Reseat assistants near their assigned doors. Use the following guide to brief assistants:

- You will open this door and command evacuation.

- Wait until aircraft has come to a complete stop.

- Unfasten seat belt and proceed to this door.

- First look for fire out this window.

- If fire, do not open door.

  Hold people back.

  Shout out problem.

  Redirect passengers to nearest exit.

  Direct your commands to those in the rear of the group.

  Shout out: “GO THAT WAY, TURN AROUND, GO ACROSS, CROSS OVER, USE THAT DOOR.”

  When area is clear - leave the aircraft.

- IF NO FIRE

  Open door by jamming this handle (door emergency control handle) up.

  Slide will inflate automatically.

  Stand here (forward of doors one right and left, aft of doors two right and left).

- Repeat command: JUMP - TWO AT A TIME, STAY ON YOUR FEET, JUMP INTO THE SLIDE JUMP.

- After area is clear, leave the aircraft.

CONTINUED

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION (cont)

CREW EVACUATION RESPONSIBILITIES

PILOT - ASSIST IN CABIN

- After Ground Evacuation Checklist is completed, immediately go to cabin and assess conditions.
- Proceed through the cabin, assisting and directing evacuation as necessary to maintain an orderly and rapid passenger evacuation.
- Check entire cabin to ensure that all passengers have evacuated. Then leave the aircraft.
- Assemble passengers away from aircraft.

COPILOT - ASSIST IN CABIN

- After Ground Evacuation Checklist is completed, immediately go to the cabin and assess conditions.
- Proceed to any usable cabin door (1L, 1R, 2L, or 2R) NOT IN USE. If conditions permit, open door and direct evacuation; otherwise, redirect passengers to nearest usable exit.
- When all passengers are out, make a quick check of the cabin, then leave the aircraft.
- Assemble passengers away from aircraft.

FLIGHT ENGINEER - ASSIST IN CABIN

- After Ground Evacuation Checklist is completed, immediately go to cabin and assess conditions.
- Proceed to any usable cabin door (1L, 1R, 2L, or 2R) not in use. If conditions permit, open door and direct evacuation; otherwise, redirect passengers to nearest usable exit.
- When area is clear, leave the aircraft.
- Assemble passengers away from aircraft.

BOOM OPERATOR - CABIN DUTIES

- After aircraft has come to a complete stop and aircraft evacuation order is given, proceed to cabin door one left. (If door one left is unusable, proceed to door one right.)
- Open door and direct evacuation.
- When all passengers are out, make a quick check of the cabin, then leave the aircraft.
- Assemble passengers away from aircraft.

CONTINUED

PREPARATION FOR EMERGENCY LANDING AND/OR EVACUATION (cont)

MINIMUM TIME TO PREPARE
BOOM OPERATOR
(IN FLIGHT)

EMERGENCY LANDING/EVACUATION

- Use PA to announce emergency condition.
- Seat belts fastened (Passenger).
- Seat backs up; tables up and locked.
- Take assigned seat, fasten seat belt.
- Shout BRACE or GRAB ANKLES.

ON THE GROUND or AFTER LANDING

- After aircraft comes to a complete stop and evacuation order is given, shout, UNFASTEN SEAT BELTS.
- Assess conditions.
- Check door armed.
- Open door.
- When slide fully inflates, shout COME THIS WAY, LEAVE EVERYTHING.
- Brief a selected passenger to stand by the bottom of the slide to catch passengers and direct away from the aircraft.
- Check cabin to ensure all passengers evacuated.
- Leave the aircraft.
- Assemble passengers away from aircraft.

END

GROUND EVACUATION

TOWER (Time Permitting)	CALL	(CP)
Emergency Power Sw	"ON"	(P)
Emergency Lights SW	"ON"	(P)
Parking Brakes	"SET"	(P)
Fuel Levers	"OFF"	(P)
Engine Fire Handles/Agent (If Req'd)	DOWN/DISCHARGE	(FE)
Communications (If Req'd)	ESTABLISH	(P/FE)

The Pilot or Flight Engineer will use UHF 1 or VHF 1, if required.

Aircraft Evacuation	INITIATE	(P)

After the aircraft has come to a complete stop and the engines have been shut down, the Pilot will use the PA to advise the Boom Operator to initiate evacuation by stating, "Evacuate Aircraft" at least three times.

NOTE

If ground evacuation is the result of an external fire, the Pilot will advise the Boom Operator not to open the cabin doors on the side where the fire exists.

APU (If Operating)	SHUT DOWN	(FE)
BAT Sw	OFF	(FE)
EMER PWR Sw	OFF	(FE)

END

LANDING WITH DROGUE/BOOM IN TRAIL

DROGUE

YES

Landing .... COMPLETE (PF)

If unable to jettison the hose or the decision is made to land with it in trail: land at slowest practical speed. Clear runway as required and stop for maintenance action.

END

NO

Boom Scavenge .... COMPLETE (FE)

The BO/FE will coordinate and accomplish this action, anytime prior to descent.

Fuel Qty in AFT Body Tank 15,000 Lbs min (If Available) .... VERIFY (FE)
Boom Operator .... NOTIFY (P)

When ready to start the final approach to landing, notify the boom operator to complete his checklist. (BO will complete the checklist and return to forward position for landing.)

Landing .... COMPLETE (PF)

Make a normal 35°/EXT approach and landing with normal reverse thrust and braking. Stop on the runway for maintenance action.

NOTE

Do not use 50°/EXT with maximum braking in an effort to minimize landing roll or reduced braking to give a smooth slow deceleration.

END

SECTION IIA

ABNORMAL PROCEDURES

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AIR CONDITIONING

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ABNORMAL PROCEDURES

INTRODUCTION

An abnormal procedure describes actions necessary to cope with failure of an aircraft system. These procedures are presented in alphabetical order.

Although certain abnormal conditions result from deteriorating situations, abnormal conditions can be recognized and identified by the aural and visual warning systems or by specific annunciators or instrument indications.

The master warning system is more typically identified with emergency procedures, but in certain conditions an abnormal procedure is appropriate.

The master caution system is typically identified with abnormal procedures. When the master caution lights come on, any crewmember not directly controlling the aircraft should scan the overhead annunciator panel. If a cue light is on, the faulty system is readily identifiable and the specific condition will be annunciated on the FE's panel. The cue light should be reset; this will rearm the cue light and the master caution system. When the master caution lights come on without a cue light, the specific condition will be annunciated on the pilot's overhead annunciator panel, and the FE's master caution light will not be on. The master caution light should always be reset by the appropriate crewmember as soon as practicable.

As soon as an abnormal condition is detected by any crewmember, the Pilot will be informed, and will coordinate for identification of the failure and selection of the appropriate checklist by the involved crewmembers.

The FE will read the checklist items (Challenge and Response) and the appropriate crewmember will perform the action and give verbal confirmation. The appropriate crewmember will also acknowledge the procedural or advisory items given in the checklist.

Upon completion of the checklist, the FE will announce – "…..CHECKLIST COMPLETED".

These procedures assume that circuit breakers, warning lights and indicators or gages will be checked at any time in a particular procedure, if appropriate.

AVIONIC FLOW OFF LT ON

YES — AIRCRAFT INFLIGHT — NO

AVIONIC FLOW Sw . . . . OVRD (FE)

NOTE

If the AVIONIC FLOW OFF light remains on, avionic compartment FAN failure is indicated, move the AVIONIC FLOW switch to NORM. Avionics cooling is provided by differential pressure through the overboard venturi.

END

ON THE GROUND

Non-essential Avionics Equipment. . . . . “OFF” (P,CP,FE)

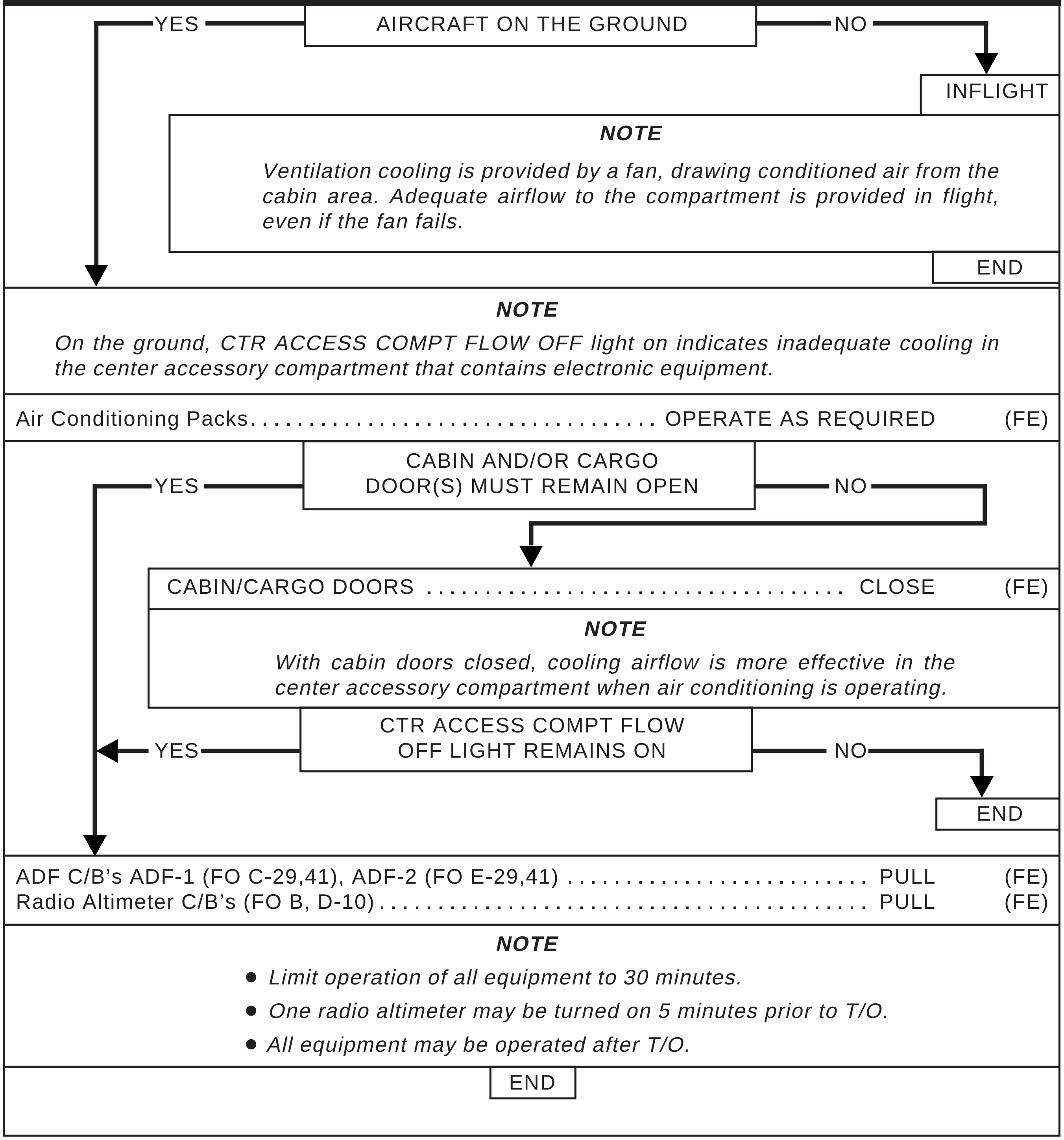
NOTE

- *Non-essential equipment:*
  - *RADAR (may be operated for not more than 5 minutes before takeoff.)*
  - *TACAN*
  - *IFF*
  - *HF RADIOS*

  All equipment may be turned on after takeoff.
- *Limit operation of all avionics equipment to 60 minutes.*

END

CTR ACCESS COMPT FLOW OFF LT ON



NOTE

Ventilation cooling is provided by a fan, drawing conditioned air from the cabin area. Adequate airflow to the compartment is provided in flight, even if the fan fails.

NOTE

On the ground, CTR ACCESS COMPT FLOW OFF light on indicates inadequate cooling in the center accessory compartment that contains electronic equipment.

Air Conditioning Packs. . . . . OPERATE AS REQUIRED (FE)

CABIN/CARGO DOORS . . . . CLOSE (FE)

NOTE

With cabin doors closed, cooling airflow is more effective in the center accessory compartment when air conditioning is operating.

ADF C/B’s ADF-1 (FO C-29,41), ADF-2 (FO E-29,41) . . . . PULL (FE)
Radio Altimeter C/B’s (FO B, D-10) . . . . PULL (FE)

NOTE

- *Limit operation of all equipment to 30 minutes.*
- *One radio altimeter may be turned on 5 minutes prior to T/O.*
- *All equipment may be operated after T/O.*

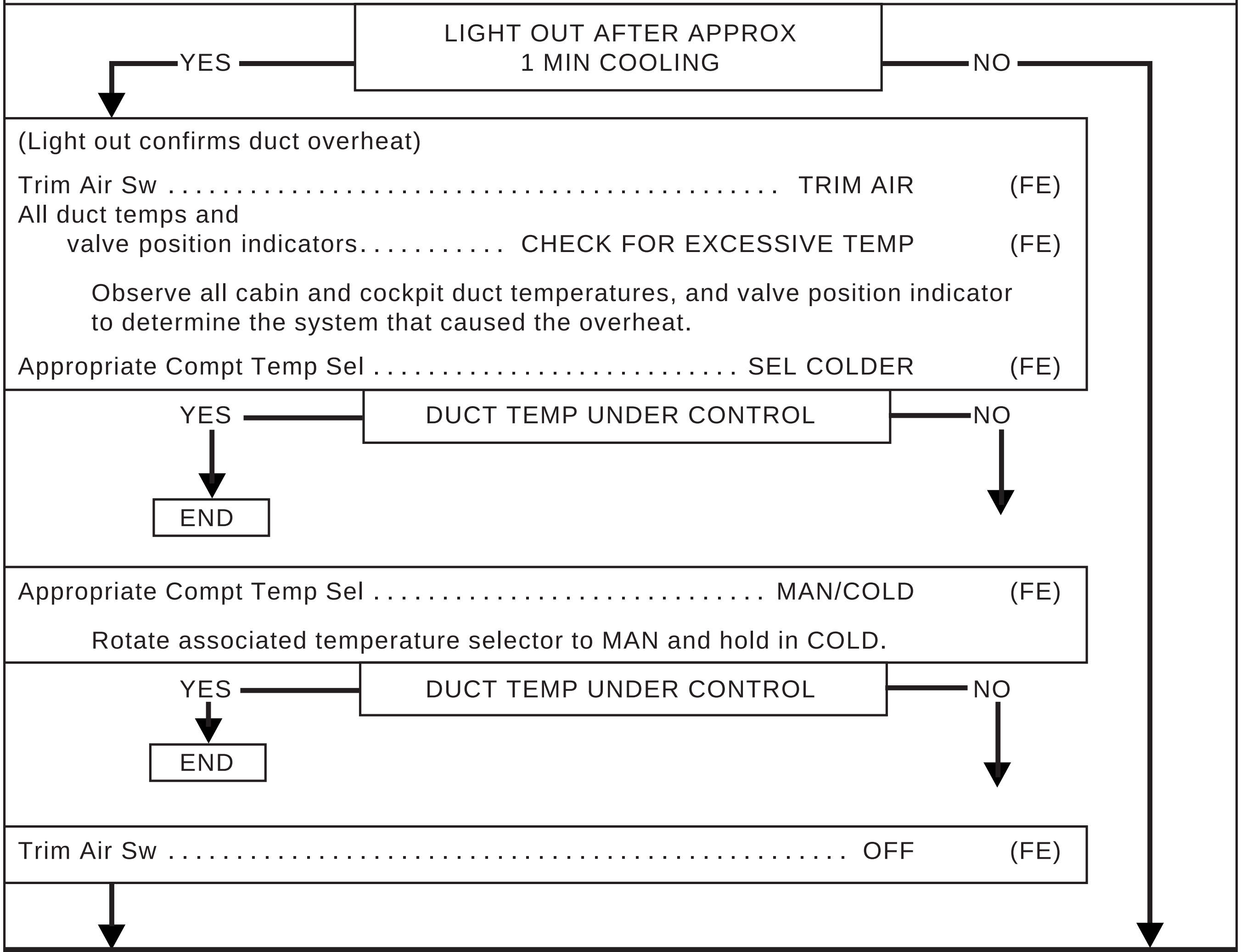
END

DUCT-AVIONIC COMPARTMENT OVERHEAT LIGHT ON

Trim Air Sw . . . . OFF (FE)

NOTE

When overheat is sensed, trim air is automatically shut off. A cooling period of approximately 1 minute may be required before trim air can be restored. The trim air switch, when moved to OFF and back to TRIM AIR, resets and restores trim air if overheat was in compartment duct. Trim air cannot be reset if overheat was in avionics compartment.



LIGHT OUT AFTER APPROX 1 MIN COOLING

YES

NO

(Light out confirms duct overheat)

Trim Air Sw . . . . TRIM AIR (FE)

All duct temps and
valve position indicators. . . . . CHECK FOR EXCESSIVE TEMP (FE)

Observe all cabin and cockpit duct temperatures, and valve position indicator to determine the system that caused the overheat.

Appropriate Compt Temp Sel . . . . SEL COLDER (FE)

DUCT TEMP UNDER CONTROL

YES

END

NO

Appropriate Compt Temp Sel . . . . MAN/COLD (FE)

Rotate associated temperature selector to MAN and hold in COLD.

DUCT TEMP UNDER CONTROL

YES

END

NO

Trim Air Sw . . . . OFF (FE)

TRIM AIR INOPERATIVE

Cockpit Temp Sel . . . . AUTO (FE)

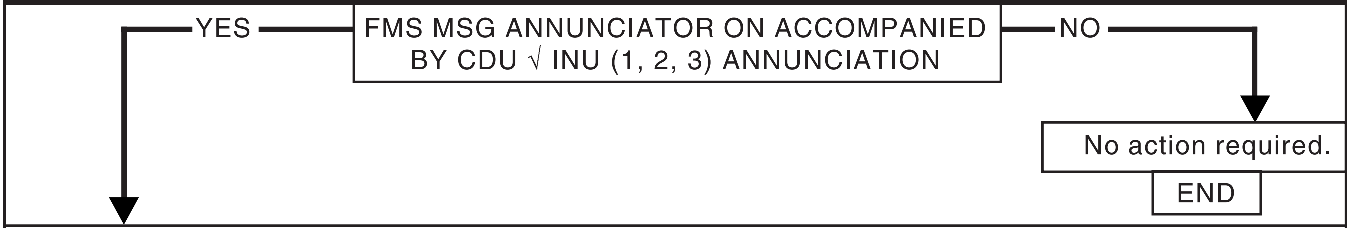
Adjust the cockpit temperature selector to regulate cockpit temperature.

ARO STA Temp . . . . MAN/STOP (FE)

Adjust the FWD cabin temperature selector as required for the best compromise between FWD cabin and ARO Station.

END

INS FLOW OFF LIGHT ON



(INU being used for navigation.)

INU STATUS . . . . CHECK (PNF)

INS Sw (If Required) . . . . "(CAPT ON AUX) OR (F/O ON AUX) AS REQ'D" (P)

NOTE

If INS 1 or 2 indicates failure, select INU 3 to replace the inoperative INU. INS switch selects INU 3 as a substitute for normal INU source and illuminates blue AUX ATT annunciator.

MODE Sel (Malfunctioning System) . . . . "OFF" (PNF)

NOTE

- *When mode selector is moved from NAV, the navigation mode cannot be recovered in flight.*
- *ATT REF may be selected for final approach. After selecting ATT REF, maintain wings level and constant speed for at least 5 minutes to allow time for gyro stabilization.*

END

PACK OFF LIGHT ON

YES — PNEU PRESS NORMAL — NO

Assoc ENG PNEU SUPPLY Sel . . . . OFF (FE)

Refer to Abnormal Procedures, OPERATION WITH SINGLE PNEUMATIC SYSTEM, page 2A-127.

END

PACK Ind Sel . . . . AFFECTED PACK (FE)
PACK Temp Valve Pos Ind . . . . CHECK (FE)
PACK Function Sel. . . . . MAN HOT/COLD AS REQ'D
TO SHIFT VALVE TO
ELEVEN O'CLOCK POS (FE)
PACK Function Sel. . . . . MAN/STOP (FE)

NOTE

The system will not reset until the TURBINE INLET TEMP is below the RED line.

YES — PACK OFF LT GOES OUT — NO

Thermal Fuse must be reset. Pack maintenance required.

END

PACK Function Sel. . . . . MAN HOT/COLD AS REQ'D (FE)

Monitor pack temperature and flow indications.

END

RAM AIR VENTILATION SYSTEM OPERATION

NOTE

May be performed after driftdown with two engines inoperative and it is necessary to shut down remaining pneumatic systems to obtain satisfactory one engine operative gradient performance or when no pack is operable.

Aircraft Altitude . . . . 10,000 FT MSL OR LESS (FE)
Cabin Altitude . . . . SAME AS FLIGHT LEVEL (FE)

Establish cabin altitude to existing flight level by means of semi-auto cabin pressure control as required.

PACK Function Sel(s) . . . . PACK OFF (FE)
ENG PNEU SUPPLY Sel(s) . . . . OFF (FE)

CAUTION

If icing conditions exist or are anticipated, leave appropriate engine PNEU SUPPLY selector in AUTO.

NOTE

- *With PACK Function selectors in OFF, normal cabin leakage should provide cabin depressurization at an acceptable rate if differential pressure exists.*
- *Cabin altitude warning may sound depending on aircraft altitude.*

After Cabin differential pressure is at zero,

CAB PRESS MAN/AUTO Handle . . . . MAN (FE)
OUTFLOW VALVE POSITION Indicator . . . . FULL OPEN (FE)

Push and rotate manual cabin altitude control until cabin outflow valve position indicator is at FULL OPEN.

RAM AIR VALVE Tee Handle . . . . PULL OPEN (FE)

Open avionic compartment access door in cockpit floor and pull tee handle to full forward position (approximately 5 inches). Release handle and close door.

NOTE

There is no speed restriction associated with this operation. Activation of tee handle locks ram air ventilation valve in full open position. Do not reestablish pneumatic supply to PACK 1 until valve is reset by maintenance.

PACK IND Sel . . . . PACK 1 (FE)
PACK 1 Function Sel . . . . MAN/HOT OR COLD (FE)

Rotate PACK Function Selector to MAN/HOT or MAN/COLD and hold as required to drive PACK 1 TEMP valve indicator to one o’clock position.

PACK 1 TEMP VALVE POS Indicators . . . . ONE O’CLOCK (FE)

CONTINUED

RAM AIR VENTILATION SYSTEM OPERATION (cont)

PACK 1 Function Sel . . . . PACK OFF (FE)

Rotate PACK Function selector to PACK OFF when pack temperature valve position indicator drives to reference mark at one o'clock position.

PACK 3 TEMP VALVE POS Indicator . . . . FULL HOT (FE)

Rotate pack indicator selector to PACK 3. Verify PACK 3 TEMP valve position at full HOT.

NOTE

- *If PACK 3 TEMP valve position indication is not at HOT, rotate PACK 3 Function selectors to MAN/HOT, and hold as required. Release pack function selector when PACK 3 Temperature valve position indicator pointer is at full HOT.*
- *The full HOT position ensures ram air inlet and outlet doors are closed, reducing drag.*

PACK 3 Function Sel . . . . PACK OFF (FE)

Rotate PACK 3 Function selector to PACK OFF.

PACK IND Sel . . . . PACK 1 (FE)

Monitor ram air supply temperature.

NOTE

If ram air supply temperature is too cold, rotate PACK 1 Function selector to MAN, and modulate as required to control.

END

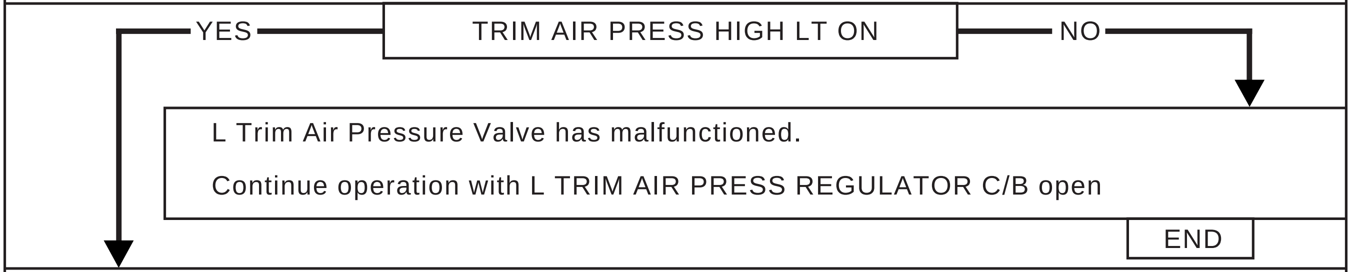
TRIM AIR PRESS HIGH LIGHT ON

NOTE

- *Light indicates a trim air regulator malfunction not detectable on the pneumatic pressure gages.*
- *Adequate safety margins exist for continued operation until corrective maintenance is available.*

Continue with the following procedure to identify the faulty Trim Air Pressure Regulator Valve.

L TRIM AIR PRESS REGULATOR C/B (UM P-12) . . . . PULL (FE)



L Trim Air Pressure Valve has malfunctioned.

Continue operation with L TRIM AIR PRESS REGULATOR C/B open

END

Rt Trim Air Pressure Valve has malfunctioned.

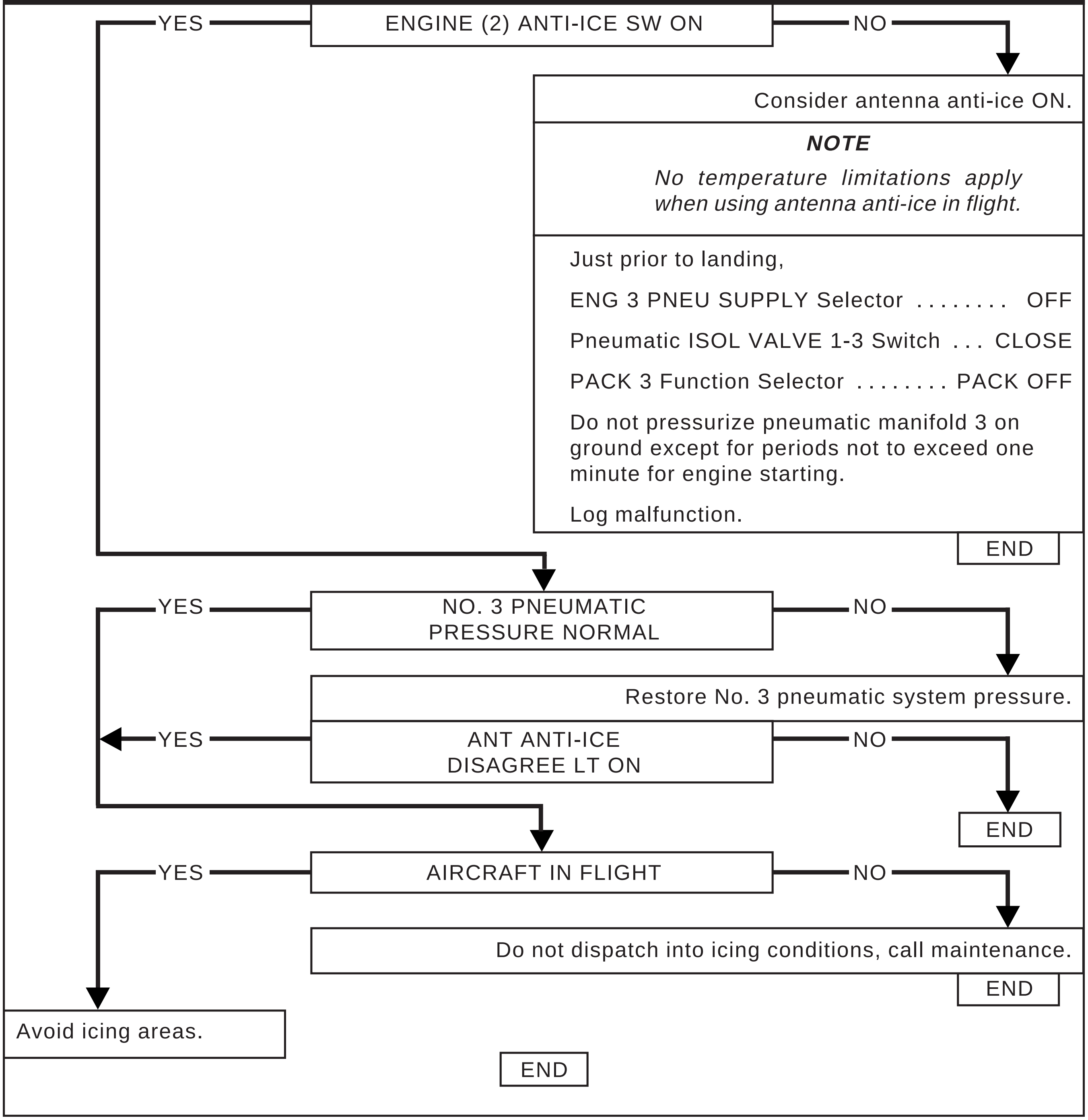
L TRIM AIR PRESS REGULATOR C/B (UM P-12) . . . . RESET (FE)
R TRIM AIR PRESS REGULATOR C/B (UM S-12) . . . . PULL (FE)

Continue operation with R TRIM AIR PRESS REGULATOR C/B open.

Record in AFTO Form 781.

END

ANTENNA ANTI-ICE DISAGREE LIGHT ON



ENGINE (2) ANTI-ICE SW ON

Consider antenna anti-ice ON.

NOTE

No temperature limitations apply when using antenna anti-ice in flight.

Just prior to landing,

ENG 3 PNEU SUPPLY Selector . . . . OFF

Pneumatic ISOL VALVE 1-3 Switch . . . CLOSE

PACK 3 Function Selector . . . . PACK OFF

Do not pressurize pneumatic manifold 3 on ground except for periods not to exceed one minute for engine starting.

Log malfunction.

NO. 3 PNEUMATIC PRESSURE NORMAL

Restore No. 3 pneumatic system pressure.

ANT ANTI-ICE DISAGREE LT ON

AIRCRAFT IN FLIGHT

Do not dispatch into icing conditions, call maintenance.

Avoid icing areas.

ENG 2 ANTI-ICE COWL DUCT FAIL LT ON

NOTE

If practical, avoid icing areas to minimize operating time with ENG 2 ANTI-ICE COWL DUCT FAIL light on.

END

PITOT HEAT INOP LT ON

NOTE

If light is illuminated on the ground, refer to 1C-10(K)A-1-2.

Affected System . . . . DETERMINE (CP)

Rotate pitot meter selector and heat selector to CAPT, F/O, AUX and TAT to determine the system which does not indicate current flow.

YES — TAT — NO

TAT PROBE HEAT C/B (UM M-26) . . . . CHECK/RESET (IF REQ'D) (FE)

If the circuit breaker was not tripped or does not remain set, the system cannot be restored. The following equipment will be affected if TAT inputs become erroneous.

TRC
ATS N_1 MODES
TAS
SAT
FMS TAS & SAT READOUTS

END

PITOT

Appropriate Pitot Heat C/B . . . . CHECK/RESET (IF REQ'D) (FE)

CAPT PITOT HEAT	PO E-6
FO PITOT HEAT	PO E-21
AUX PITOT HEAT	UM M-25

YES — PITOT HEAT INOP LT OFF — NO

END

Pitot Heater Select switch (FE Equipment Panel) . . . . SELECT OTHER SYS (FE)
Appropriate Pitot Heat C/B . . . . RESET (IF REQ'D) (FE)

NOTE

- *With the Pitot Sw in NORMAL, No. 2 system is automatically selected inflight by the ground sensing mechanism.*
- *An additional reset of the affected C/B is allowed because of the dual power sources to the heater elements.*

YES — PITOT HEAT INOP LT OFF — NO

END

If the light remains on or the circuit breaker does not remain set, the system cannot be restored. There is a probable short between the circuit breaker and probe heater.

END

WINDSHIELD ANTI-ICE INOP LT ON

Assoc ANTI-ICE Sel . . . . “OFF, THEN NORM” (CP)

NOTE

Rotating ANTI-ICE selector to OFF may reset the system. Some windshield heat malfunctions are self-clearing.

YES — WINDSHIELD ANTI-ICE INOP LT ON — NO

END

Same ANTI-ICE Sel . . . . “OFF” (CP)

END

WINDSHIELD/WINDOW FAILURE

Window/Windshield . . . . DETERMINE (CP)

YES — CLEARVIEW WINDOW CRACKED AND/OR ARCING — NO

Assoc Clearview Defog C/B (UM L-21 OR N-21) . . . . PULL (FE)

END

NOTE

There are no inflight altitude or pressurization limitations required for either anti-ice or defog ply cracks.

YES — WINDSHIELD ANTI-ICE ON — NO

Assoc Windshield Anti-ice Sel . . . . OFF (CP)
Avoid icing areas.
IF ARCING CONTINUES:

Assoc Windshield Defog C/B (UM L-20 OR N-20) . . . . PULL (FE)

IF ARCING STOPS:
Assoc Windshield Anti-ice Sel . . . . AS REQ (FE)

END

WING ANTI-ICE DISAGREE LT(S) ON

YES — AIRCRAFT INFLIGHT — NO

ON THE GROUND

Approp ENG PNEU SUPPLY Sel . . . . OFF (FE)
Assoc ISOL Valve . . . . CLOSE (FE)

CAUTION

Damage to slats can result if wing anti-ice is operated on the ground for more than 15 seconds.

END

YES — WING ANTI-ICE SW ON — NO

WING ANTI-ICE SW OFF

Assume Anti-ice is on and carry out the following just before landing.

Approp ENG PNEU SUPPLY Sel . . . . OFF (FE)
Assoc ISOL Valve . . . . CLOSE (FE)

CAUTION

Damage to slats can result if wing anti-ice is operated on the ground for more than 15 seconds.

END

C/B's (UM P-24) . . . . RESET (FE)
Wing Anti-Ice Sw . . . . OFF (FE)
Approp ENG PNEU SUPPLY Sel . . . . HIGH (FE)

NOTE

ENG PNEU SUPPLY selector should be moved to HI prior to moving wing anti-ice switch to ON so that pressure fluctuation by pneumatic pressure gages 1 and/or 3 will be indicative of left and right wing anti-ice valve opening only.

Wing Anti-ice Sw . . . . ON (FE)
Pneu Press On Affected Side . . . . CHECK DROP/RECOVERY (FE)

CONTINUED

WING ANTI-ICE DISAGREE LT(S) ON (cont)

YES — PRESS DROPS/RECOVERS — NO

YES:

This confirms wing anti-ice operation.

ENG PNEU SUPPLY Sel . . . . AUTO (FE)

END

NO:

PRESSURE STEADY

Confirms disagree light indication.

ENG PNEU SUPPLY Sel . . . . AUTO (FE)
Wing Anti-Ice . . . . OFF (FE)

CAUTION

Depart icing area as soon as possible.

END

ARO WINDOW HEAT INOP LIGHT ON

WINDOW HEAT Sel . . . . CYCLE (OFF/NORM)

NOTE

Cycling WINDOW HEAT selector may reset system. Some window heat malfunctions are self clearing.

YES — LIGHT OFF — NO

YES:

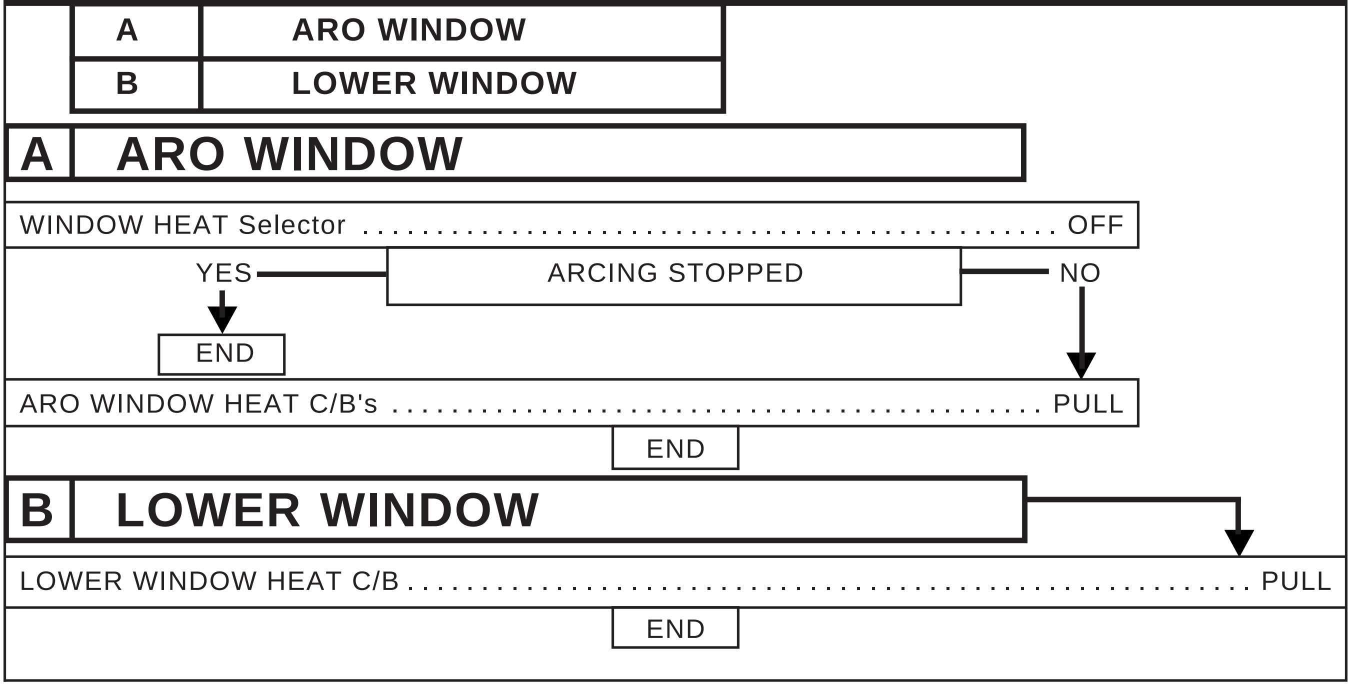
END

NO:

WINDOW HEAT Sel . . . . OFF

END

ARO OR LOWER WINDOW CRACKED/ARCING



A	ARO WINDOW
B	LOWER WINDOW

A ARO WINDOW

WINDOW HEAT Selector . . . . OFF

ARCING STOPPED

YES → END

NO ↓

ARO WINDOW HEAT C/B's . . . . PULL

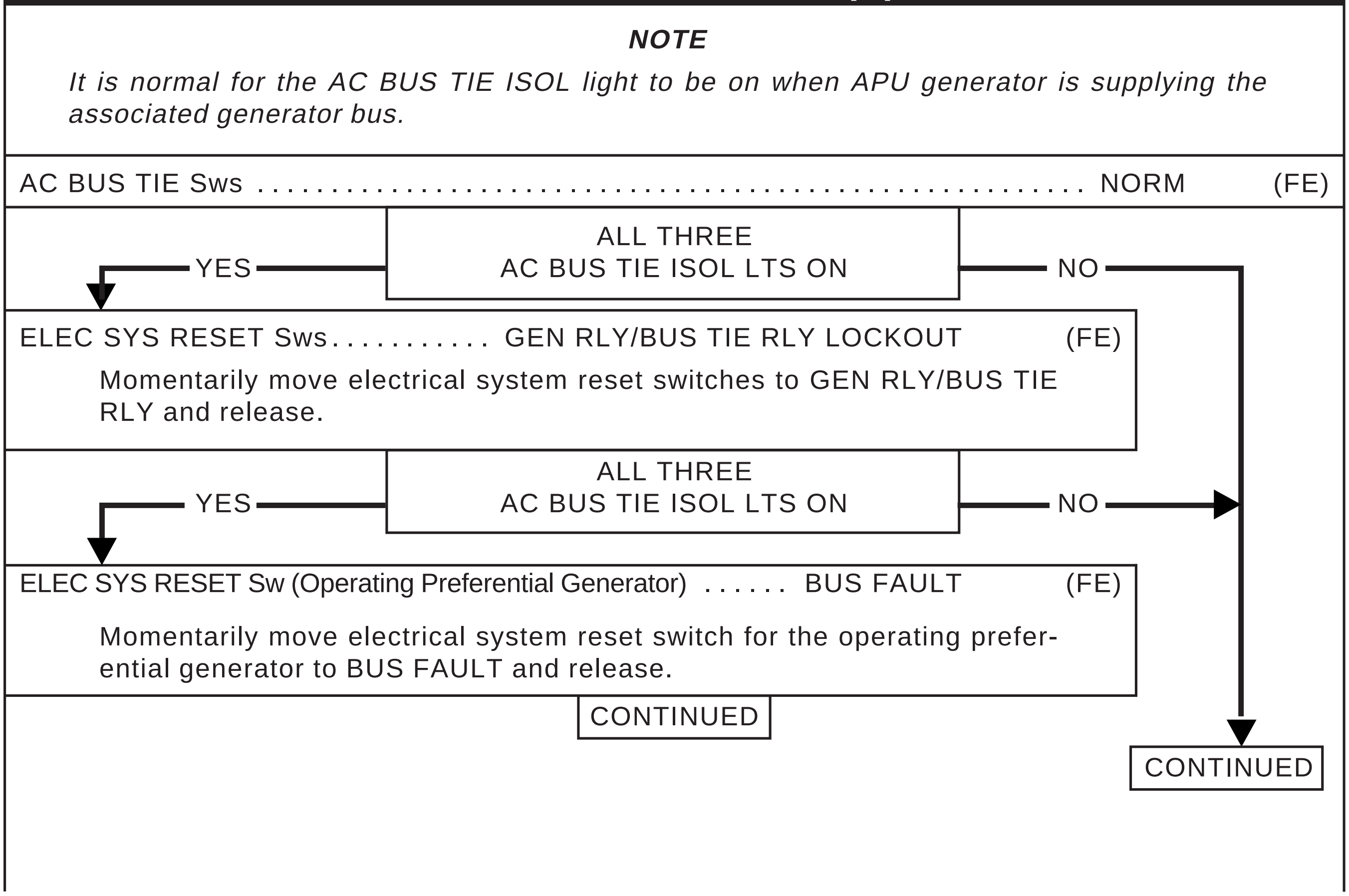
END

B LOWER WINDOW

LOWER WINDOW HEAT C/B . . . . PULL

END

AC BUS TIE ISOL LIGHT(S) ON



NOTE

It is normal for the AC BUS TIE ISOL light to be on when APU generator is supplying the associated generator bus.

AC BUS TIE Sws . . . . NORM (FE)

ALL THREE
AC BUS TIE ISOL LTS ON

YES ↓ NO → CONTINUED

ELEC SYS RESET Sws. . . . . GEN RLY/BUS TIE RLY LOCKOUT (FE)

Momentarily move electrical system reset switches to GEN RLY/BUS TIE RLY and release.

ALL THREE
AC BUS TIE ISOL LTS ON

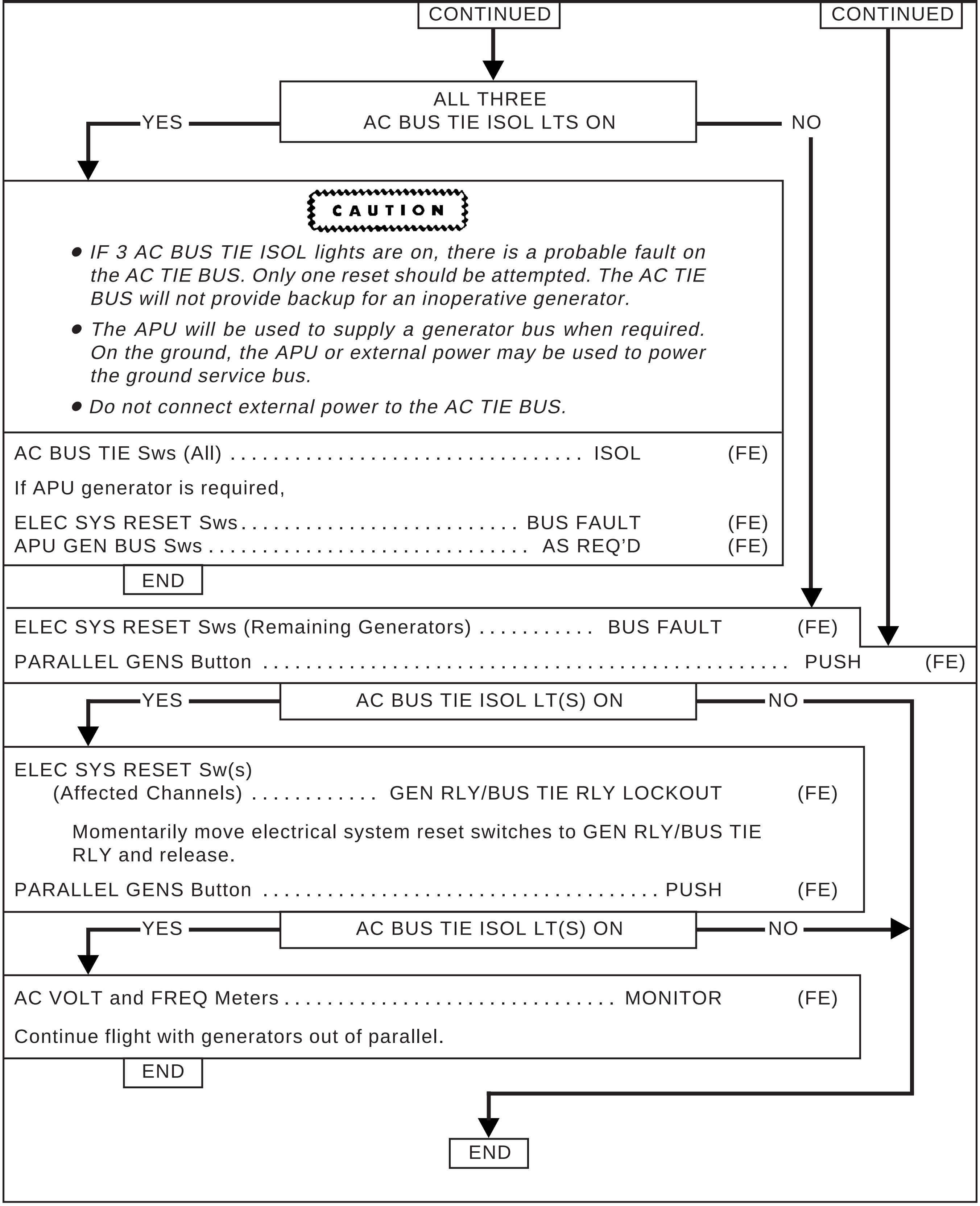
YES ↓ NO → CONTINUED

ELEC SYS RESET Sw (Operating Preferential Generator) . . . . . . BUS FAULT (FE)

Momentarily move electrical system reset switch for the operating preferential generator to BUS FAULT and release.

CONTINUED

AC BUS TIE ISOL LIGHT(S) ON (cont)



CAUTION

- *IF 3 AC BUS TIE ISOL lights are on, there is a probable fault on the AC TIE BUS. Only one reset should be attempted. The AC TIE BUS will not provide backup for an inoperative generator.*
- *The APU will be used to supply a generator bus when required. On the ground, the APU or external power may be used to power the ground service bus.*
- *Do not connect external power to the AC TIE BUS.*

AC BUS TIE Sws (All) . . . . ISOL (FE)

If APU generator is required,

ELEC SYS RESET Sws . . . . BUS FAULT (FE)
APU GEN BUS Sws . . . . AS REQ'D (FE)

END

ELEC SYS RESET Sws (Remaining Generators) . . . . BUS FAULT (FE)

PARALLEL GENS Button . . . . PUSH (FE)

ELEC SYS RESET Sw(s)
(Affected Channels) . . . . GEN RLY/BUS TIE RLY LOCKOUT (FE)

Momentarily move electrical system reset switches to GEN RLY/BUS TIE RLY and release.

PARALLEL GENS Button . . . . PUSH (FE)

AC VOLT and FREQ Meters . . . . MONITOR (FE)

Continue flight with generators out of parallel.

END

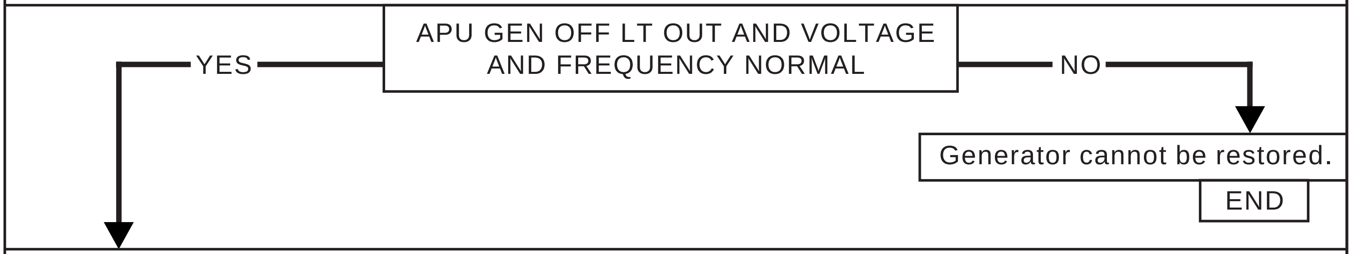
END

APU GEN OFF LT ON (AC LOAD ZERO)

APU GEN BUS Sws . . . . OFF (FE)
VOLT/AMP/FREQ Sel . . . . APU (FE)
APU GEN RESET Sw . . . . RESET (FE)

NOTE

Reset should be attempted one time only.



APU GEN OFF LT OUT AND VOLTAGE AND FREQUENCY NORMAL

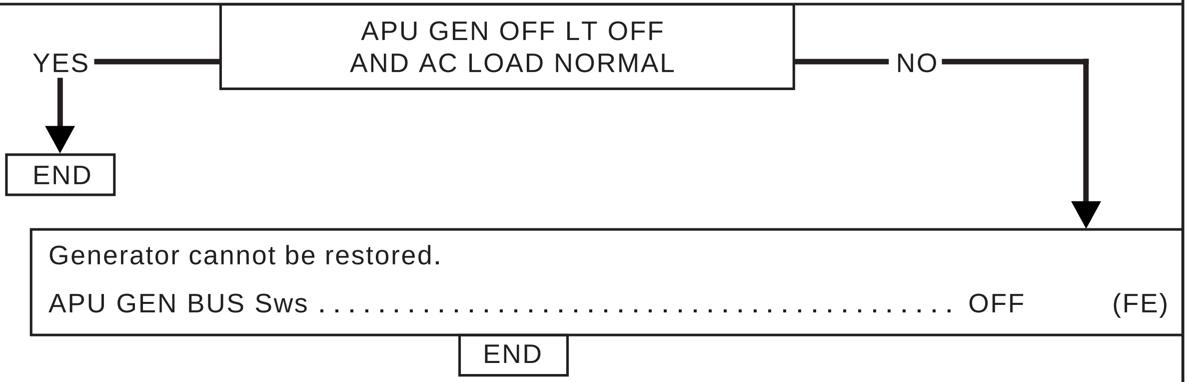
YES

NO

Generator cannot be restored.

END

APU GEN BUS Sws (One At A Time) . . . . ON (FE)



APU GEN OFF LT OFF AND AC LOAD NORMAL

YES

END

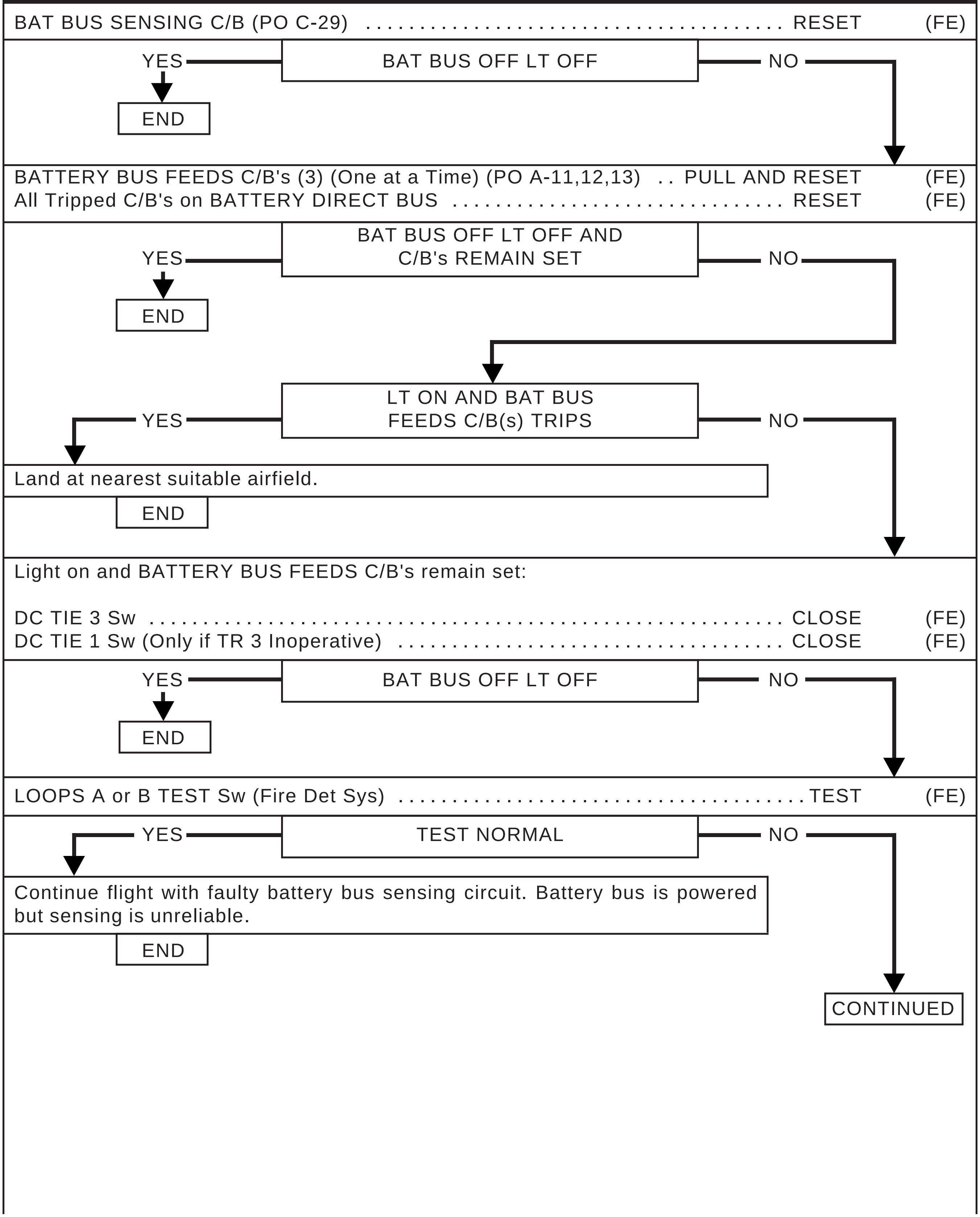
NO

Generator cannot be restored.

APU GEN BUS Sws . . . . OFF (FE)

END

BAT BUS OFF LT ON



BAT BUS SENSING C/B (PO C-29) . . . . RESET (FE)

BATTERY BUS FEEDS C/B's (3) (One at a Time) (PO A-11,12,13) . . PULL AND RESET (FE)
All Tripped C/B's on BATTERY DIRECT BUS . . . . RESET (FE)

Land at nearest suitable airfield.

Light on and BATTERY BUS FEEDS C/B's remain set:

DC TIE 3 Sw . . . . CLOSE (FE)
DC TIE 1 Sw (Only if TR 3 Inoperative) . . . . CLOSE (FE)

LOOPS A or B TEST Sw (Fire Det Sys) . . . . .TEST (FE)

Continue flight with faulty battery bus sensing circuit. Battery bus is powered but sensing is unreliable.

BAT BUS OFF LT ON (cont)

CONTINUED

Land at nearest suitable airfield.

NOTE

Loss of battery bus will disable:

- AC bus cont
- Air data inst switch unit
- APU advisory lts
- APU cont and fuel valve
- APU door cont
- APU fire horn
- APU generator control
- APU inlet and exhaust doors
- APU start pump
- ATS advisory and off lt 1 and 2
- Autopilot advisory and off lts 1 and 2
- Aux hyd pump cont and lts
- Battery bus sensing
- Boom/Drogue deploy/stowing
- Boom emer ret/fail annun
- Capt radio switching
- CSD disconnect
- DC bus, DC pwr off lts
- Emer bus warn lt protect relay
- Emergency lts arm
- Eng fire and ovrspd ARO aural warn
- Eng gnd/flt idle cont
- Eng hyd pumps cont left and right
- Eng ignition override
- Eng oil low press warn lt
- Eng start and ignition cont
- Eng start override
- Eng 2 and APU fire agent disch lt
- Firebell cutoff loop test
- Fire detectors loop "A" eng 1-2-3-APU
- Fire detectors loop "B" eng 1-2-3-APU
- Firex control agent 1 and 2 lts
- Firex handle and fuel lever lts eng 1-2-3
- FE APU fire warn lt:
- FE flood lts
- Flow control valve shut-off and pack off lts 1 to 3
- Fuel tank fill valve and bat bus sensing
- Fuel tank fill valve – main tanks – ctr and fus tanks
- Fuel vapor vent
- Galley overheat caution
- Hyd motor pumps cont and lts 1-3, 2-3
- IFF xpndr comptr
- INS switch unit
- Left overhead flood lts
- Main inst panel flood lts
- Master caution and cue lts
- Master fire warn lt
- Master warn lts
- RCCS backup power
- Right emer AC and DC bus cont
- Standby horizon
- Yaw damper inop lts lwr and upper

END

CSD OIL OUTLET TEMP HI

NOTE

To be performed when CSD oil outlet temperature gage is in yellow band

GEN Sw . . . . OFF (FE)

Observe GEN OFF light comes on and AC BUS TIE ISOL light goes off.

CSD TEMP PUSH FOR RISE Button/CSD TEMP Gage . . . . PUSH/OBSERVE (FE)

Push CSD temperature push-for-rise button and observe rise temperature indication. Release button and observe outlet temperature indication.

TEMP STABILIZED OR DECREASING IN YELLOW BAND(S)

YES

Monitor CSD and generator indications, continue flight with generator OFF.

END

NO

Temp increasing in yellow band(s) or exceeds outlet limit.

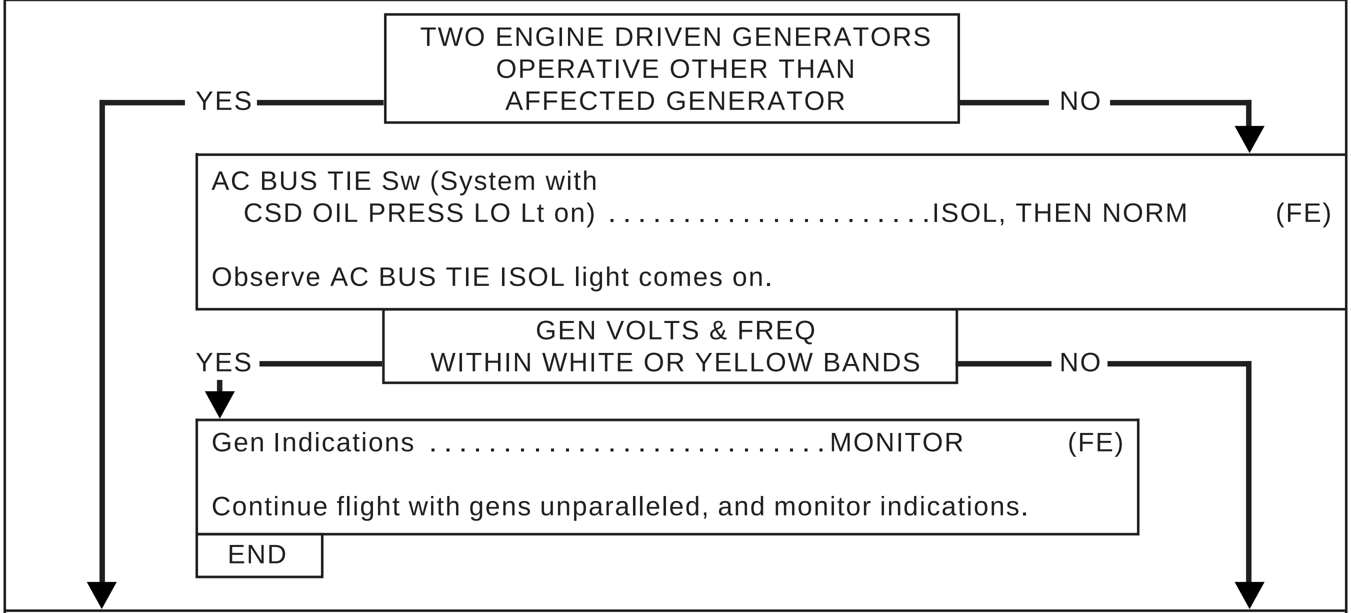
CSD Disconnect Button . . . . PUSH/HOLD FOR 3 SEC (FE)
GEN VOLTS & FREQ . . . . BELOW SCALE (FE)

NOTE

- *If volts and frequency indicate after disconnect button is pushed, continue engine operation with generator off Monitor affected system.*
- *CSD oil temperature may exceed red limit mark. However, because the input shaft will shear if CSD or generator seizes, engine shutdown is not necessary.*

END

CSD OIL PRESS LO LIGHT ON



TWO ENGINE DRIVEN GENERATORS OPERATIVE OTHER THAN AFFECTED GENERATOR

YES

NO

AC BUS TIE Sw (System with CSD OIL PRESS LO Lt on) . . . . .ISOL, THEN NORM (FE)

Observe AC BUS TIE ISOL light comes on.

GEN VOLTS & FREQ WITHIN WHITE OR YELLOW BANDS

YES

NO

Gen Indications . . . . .MONITOR (FE)

Continue flight with gens unparalleled, and monitor indications.

END

GEN Sw . . . . .OFF (FE)

Move associated generator switch to OFF. Observe amber AC BUS TIE ISOL light is off.

CSD Disconnect Button . . . . .PUSH/HOLD FOR 3 SEC (FE)
GEN VOLTS & FREQ . . . . BELOW SCALE (FE)

NOTE

- *If volts and frequency indicate after disconnect button is pushed, continue engine operation with generator off. Engine shutdown is not necessary because the input shaft will shear if CSD or generator seizes. Monitor affected system.*
- *When only one engine generator is in operation it is recommended that the APU be started to be available for electrical power. This should be accomplished as soon as practical if the remaining generator is unstable or not later than the approach checklist.*
- *Refer to Abnormal Procedure, SINGLE GENERATOR (ENG) OPERATION.*

END

DC GND SERVICE BUS OFF LT ON

NOTE

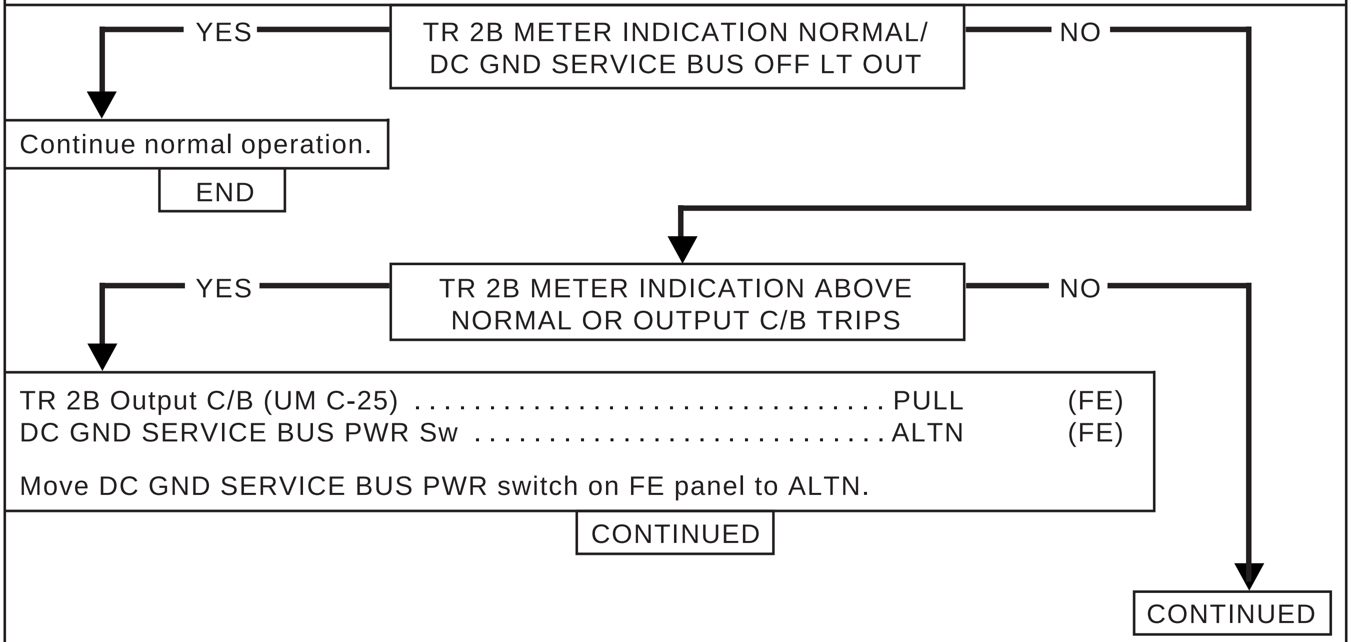
- *If other lights(s) are on, refer to the appropriate procedure.*
- *Loss of AC or DC ground service bus power will cause the DC GND SERVICE BUS OFF light to come on. Pull and reset the following circuit breakers before continuing with this procedure.*
  - *– AC GND SERVICE TIE RELAY CONT (UM C-20)*
  - *– COCKPIT GROUND SERVICE BUS (UM A-19)*
  - *– DC GROUND SERVICE BUS (UM D-23)*
- *TR 2B load meter will indicate zero or slightly above zero with loss of DC GROUND SERVICE BUS.*

Go to appropriate procedure as follows:

A	**TR 2B LOAD METER INDICATES AT OR NEAR ZERO**
B	**TR 2B LOAD METER INDICATES ABOVE ZERO**

A TR 2B LOAD METER INDICATES AT OR NEAR ZERO

TR 2B Output and Input C/B's (Output UM C-25) (Input LM G-16) . . . . PULL/RESET (FE)



Continue normal operation.

END

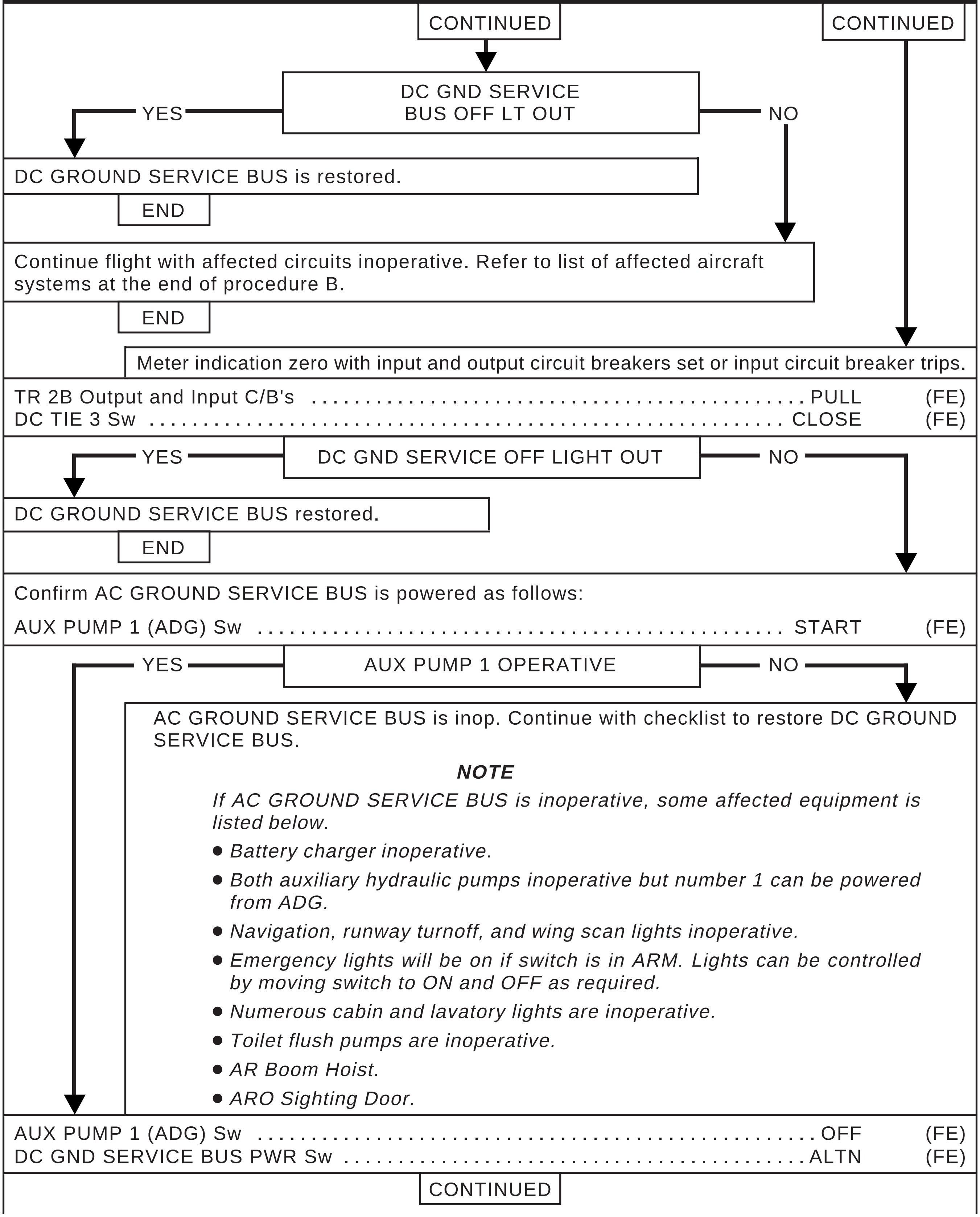
TR 2B Output C/B (UM C-25) . . . . PULL (FE)
DC GND SERVICE BUS PWR Sw . . . . ALTN (FE)

Move DC GND SERVICE BUS PWR switch on FE panel to ALTN.

CONTINUED

CONTINUED

DC GND SERVICE BUS OFF LT ON (cont)



CONTINUED

CONTINUED

DC GND SERVICE BUS OFF LT OUT

YES

DC GROUND SERVICE BUS is restored.

END

NO

Continue flight with affected circuits inoperative. Refer to list of affected aircraft systems at the end of procedure B.

END

Meter indication zero with input and output circuit breakers set or input circuit breaker trips.

TR 2B Output and Input C/B's . . . . PULL (FE)
DC TIE 3 Sw . . . . CLOSE (FE)

DC GND SERVICE OFF LIGHT OUT

YES

DC GROUND SERVICE BUS restored.

END

NO

Confirm AC GROUND SERVICE BUS is powered as follows:

AUX PUMP 1 (ADG) Sw . . . . START (FE)

AUX PUMP 1 OPERATIVE

YES

NO

AC GROUND SERVICE BUS is inop. Continue with checklist to restore DC GROUND SERVICE BUS.

NOTE

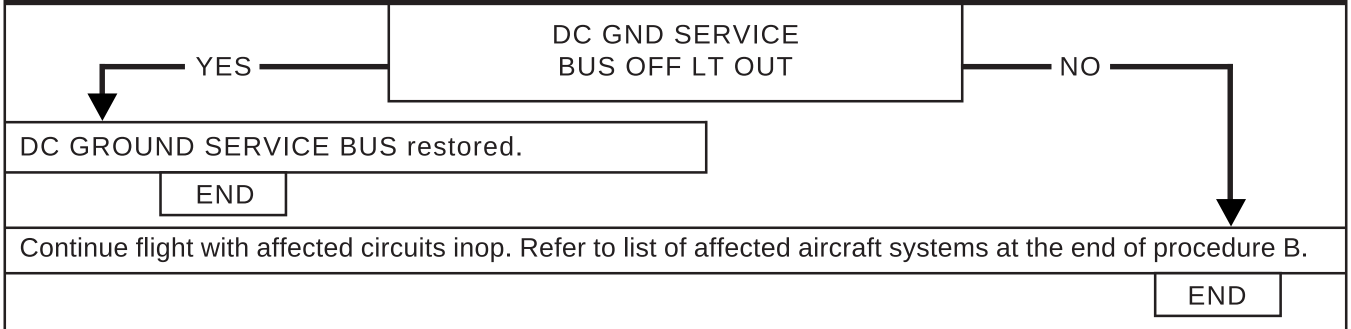
If AC GROUND SERVICE BUS is inoperative, some affected equipment is listed below.

- *Battery charger inoperative.*
- *Both auxiliary hydraulic pumps inoperative but number 1 can be powered from ADG.*
- *Navigation, runway turnoff, and wing scan lights inoperative.*
- *Emergency lights will be on if switch is in ARM. Lights can be controlled by moving switch to ON and OFF as required.*
- *Numerous cabin and lavatory lights are inoperative.*
- *Toilet flush pumps are inoperative.*
- *AR Boom Hoist.*
- *ARO Sighting Door.*

AUX PUMP 1 (ADG) Sw . . . . OFF (FE)
DC GND SERVICE BUS PWR Sw . . . . ALTN (FE)

CONTINUED

DC GND SERVICE BUS OFF LT ON (cont)



DC GND SERVICE BUS OFF LT OUT

YES

DC GROUND SERVICE BUS restored.

END

NO

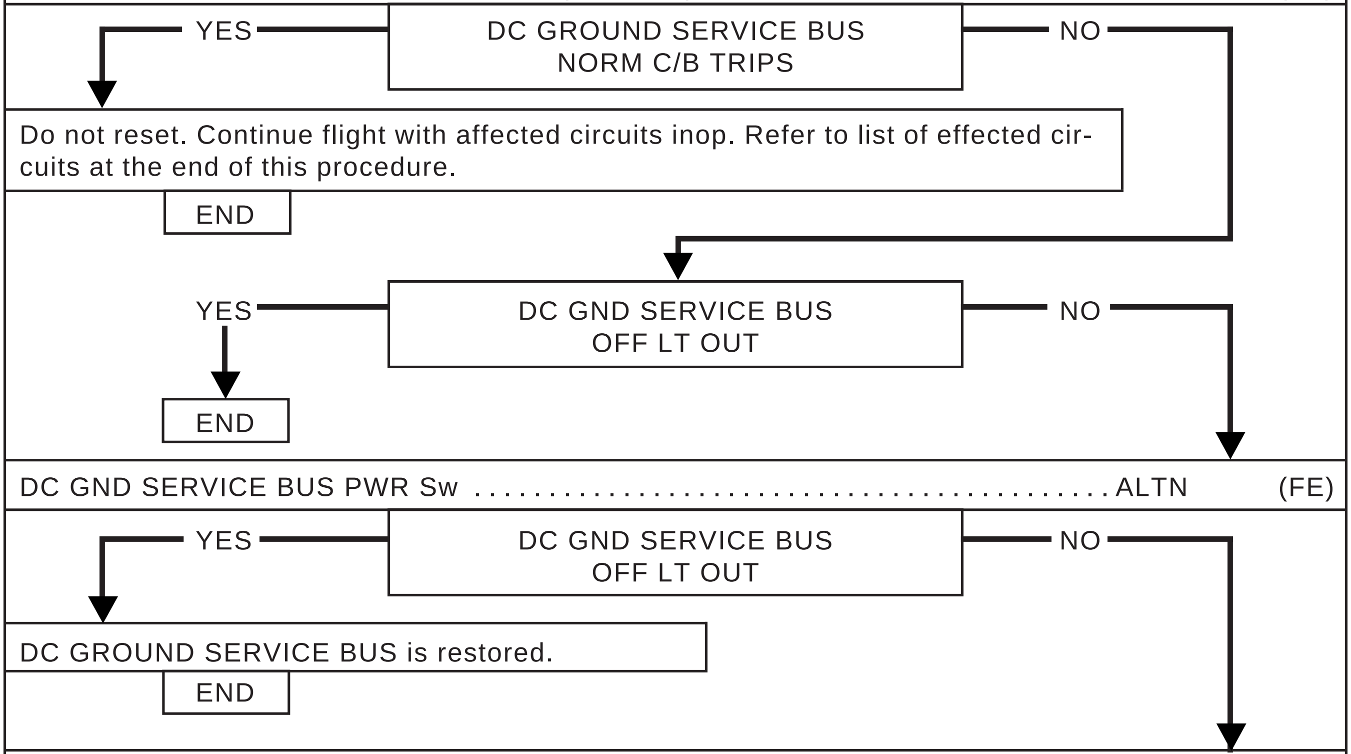
Continue flight with affected circuits inop. Refer to list of affected aircraft systems at the end of procedure B.

END

B TR 2B LOADMETER INDICATES ABOVE ZERO

AC GND SERVICE BUS SENSING C/B (LM G-14) . . . . PULL/RESET (FE)

DC GROUND SERVICE BUS NORM C/B (UM D-23) . . . . PULL/RESET (FE)



DC GROUND SERVICE BUS NORM C/B TRIPS

YES

Do not reset. Continue flight with affected circuits inop. Refer to list of effected circuits at the end of this procedure.

END

NO

DC GND SERVICE BUS OFF LT OUT

YES

END

NO

DC GND SERVICE BUS PWR Sw . . . . ALTN (FE)

DC GND SERVICE BUS OFF LT OUT

YES

DC GROUND SERVICE BUS is restored.

END

NO

Continue flight with affected circuits inop.

NOTE

The following aircraft systems will be inoperative with the loss of DC GROUND SERVICE BUS.

Left and right Cabin Door Power/Control.
Left and right Runway Turnoff Lights.
Left and right Wing Scan Lights.
Emergency Light Control.
Cargo Loading System Power/Control.
AR Boom Hoist.
ARO Sighting door.

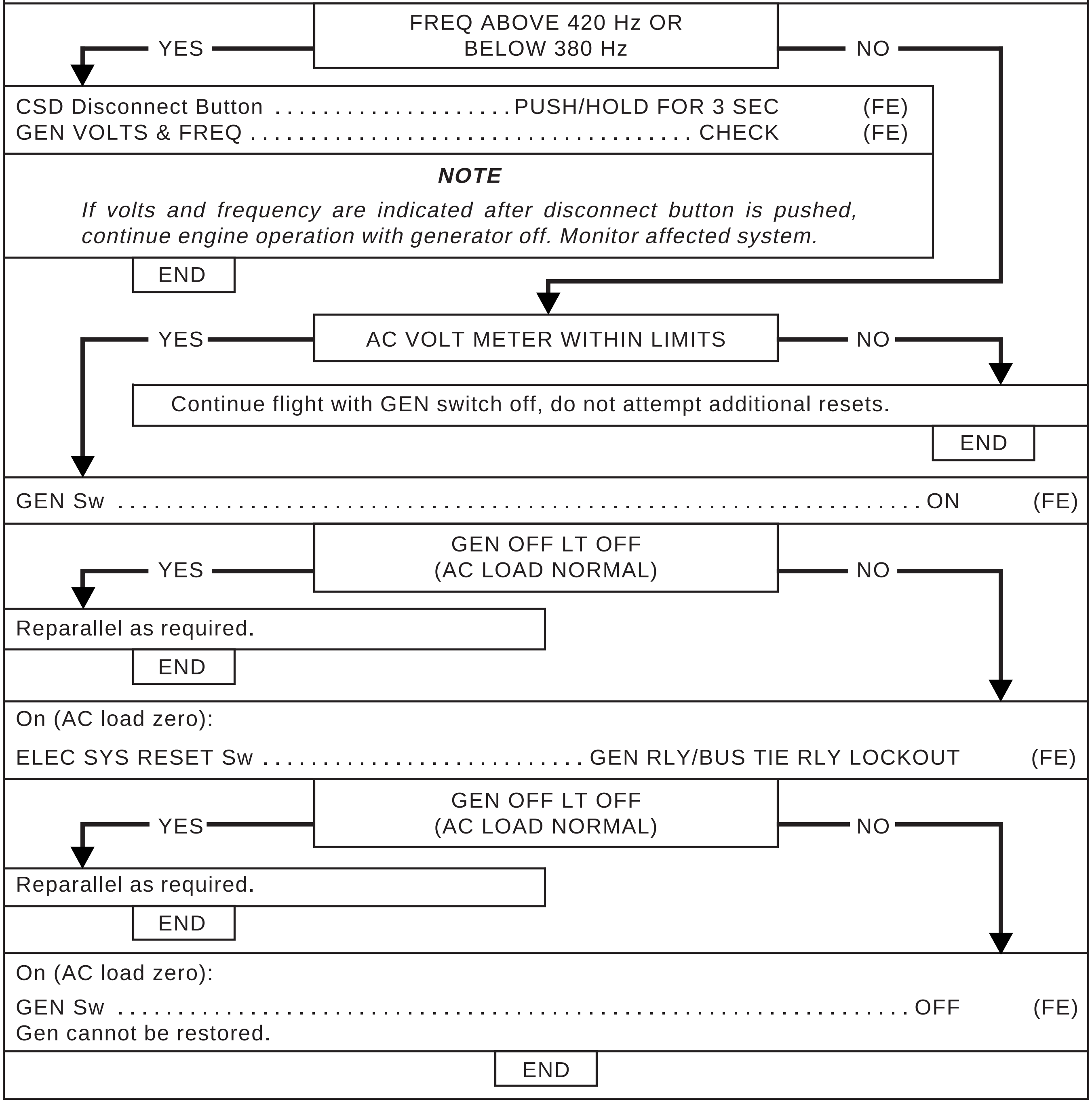
END

ENG GEN OFF LT ON (AC LOAD ZERO)

NOTE

- *Inadvertent partial actuation of associated engine fire handle can cause a generator to trip off the line.*
- *If the GEN OFF light is accompanied by the CSD OIL PRESS LO light, refer to Abnormal Procedures, CSD OIL PRESS LO LT ON.*

VOLT/AMP/FREQ Sel . . . . AFFECTED AC GEN/DC BUS (FE)
GEN Sw . . . . RESET/OFF (FE)



FREQ ABOVE 420 Hz OR BELOW 380 Hz

YES

NO

CSD Disconnect Button . . . . PUSH/HOLD FOR 3 SEC (FE)
GEN VOLTS & FREQ . . . . CHECK (FE)

NOTE

If volts and frequency are indicated after disconnect button is pushed, continue engine operation with generator off. Monitor affected system.

END

AC VOLT METER WITHIN LIMITS

YES

NO

Continue flight with GEN switch off, do not attempt additional resets.

END

GEN Sw . . . . ON (FE)

GEN OFF LT OFF (AC LOAD NORMAL)

YES

NO

Reparallel as required.

END

On (AC load zero):

ELEC SYS RESET Sw . . . . GEN RLY/BUS TIE RLY LOCKOUT (FE)

GEN OFF LT OFF (AC LOAD NORMAL)

YES

NO

Reparallel as required.

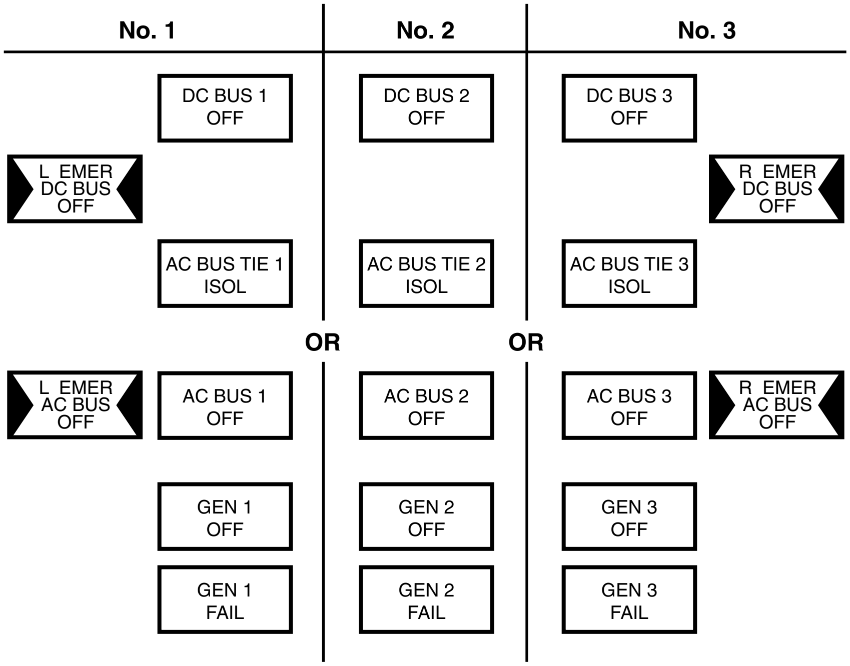
END

On (AC load zero):

GEN Sw . . . . OFF (FE)
Gen cannot be restored.

END

GENERATOR BUS FAILURE



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NOTE

GEN fail light may be on in association with GEN BUS failure.

ATS Levers . . . . "OFF" (PF)

Verify autothrottle levers are in OFF. Push ATS fail light(s) as required and observe lights go off.

NOTE

Autothrottle lever(s) may be moved to ON when all BUS OFF lights are off.

YES — PILOT'S FLT INST NORMAL — NO

NOTE

Flags will appear in engine instruments and left pilot's flight instruments if left emergency AC bus not powered.

EMER PWR Sw (if phase of flight is critical) . . . . "ON" (PNF)

CONTINUED

CONTINUED

GENERATOR BUS FAILURE (cont)

CONTINUED

CONTINUED

NOTE

- *Use emergency power as long as phase of flight is critical. When no longer critical, or if instruments are not restored, rotate EMER PWR switch to OFF.*
- *With EMER PWR switch in ON, battery cannot be relied upon for more than 30 minutes.*

Assoc DC Tie Sw(s) . . . . CLOSE (FE)

NOTE

- *If a DC tie switch had been in CLOSE due to a previous TR failure, it may be necessary to move all DC tie and DC cross-tie switches to CLOSE.*
- *With a generator bus 2 failure, DC BUS 2 OFF light will remain on. DC bus 2 and DC ground service bus cannot be powered while AC bus is without power.*
- *If caused by a loss of all generators, leave AC bus 1 or 3 isolated until the status of the tie bus can be determined.*

AC BUS TIE Sws (All) . . . . .NORMAL (FE)

GEN FAIL LT ON

YES

Assoc GEN Sw . . . . OFF (FE)
CSD DISC Sw . . . . .PUSH/HOLD FOR 3 SEC (FE)

NOTE

If volts and frequency are indicated after disconnect button is pushed, continue engine operation with generator off. Monitor affected system.

To restore generator bus, complete Sub-Procedure **B** for AC tie bus, or Sub-Procedure **C** for APU.

NO

IF GENERATOR BUS HAD BEEN SUPPLIED BY -

- ITS OWN GENERATOR .... GO TO PROCEDURE **A**
- AC TIE BUS... GO TO PROCEDURE **B**
- APU .... GO TO PROCEDURE **C**

A TO SUPPLY BUS BY GEN

VOLTS/AMP/FREQ Sel . . . . .AFFECTED GEN (FE)
GEN Sw . . . . RESET/OFF (FE)

CONTINUED

GENERATOR BUS FAILURE (cont)

YES — VOLT/FREQ WITHIN LIMITS — NO

GEN Sw . . . . ON (FE)
ELEC SYS RESET Sw . . . . . GEN/RLY BUS TIE RLY LOCKOUT (DOWN) (FE)

Momentarily move electrical system reset switch to GEN RLY/BUS TIE RLY LOCKOUT (down) and release.

YES — GEN OFF LT OUT (AC LOAD NORM) — NO

Generator bus is powered by engine generator.

ELEC SYS RESET Sw . . . . BUS FAULT (UP) (FE)

CAUTION

Do not attempt a bus fault reset more than once.

Lift guard and momentarily move electrical system reset switch to BUS FAULT (up) and release. This will ensure that the AC BUS TIE ISOL RELAY LOCKOUT is released. This will allow the generator to parallel when desired.

PARALLEL GENS Button . . . . PUSH (FE)
DC TIE Sw(s) . . . . OPEN AS REQ'D (FE)
ATS . . . . "AS REQ'D" (PF)
EMER PWR Sw . . . . "AS REQ'D" (PNF)

END

B TO SUPPLY GENERATOR BUS BY AC TIE BUS

ELEC SYS RESET Sw . . . . . GEN RLY/BUS TIE RLY LOCKOUT (DOWN) (FE)

Momentarily move electrical system reset switch to GEN RLY/BUS TIE RLY LOCKOUT (down), and release.

GEN Sw . . . . OFF (FE)

YES — AC BUS TIE ISOL LT OUT — NO

Gen bus is powered by AC TIE BUS.

DC TIE Sws . . . . OPEN AS REQ'D (FE)
ATS . . . . "AS REQ'D" (PF)
EMER PWR Sw . . . . "AS REQ'D" (PNF)

END

CONTINUED

GENERATOR BUS FAILURE (cont)

CONTINUED

ELEC SYS RESET Sw	BUS FAULT (UP)	(FE)

Lift guard and momentarily move electrical system reset switch to BUS FAULT (up) and release.

CAUTION

Do not attempt bus fault reset more than once.

YES — AC BUS TIE ISOL LT OUT — NO

DC TIE Sws	OPEN AS REQ'D	(FE)
ATS	"AS REQ'D"	(PF)
EMER PWR Sw	"AS REQ'D"	(PNF)

END

There is a probable fault on the generator bus. Continue flight with affected circuits inoperative. Refer to effects of generator bus failure notes at end of Sub-Procedure **C**.

CAUTION

Do not attempt additional reset for the affected channel.

EMER PWR Sw	"AS REQ'D"	(PNF)

END

C TO SUPPLY BUS BY APU

APU GEN BUS Sws (All)	OFF	(FE)
APU GEN RESET Sw	RESET	(FE)

YES — APU GEN OFF LT OUT — NO

YES — APU PWR AVAIL LT ON — NO

Gen bus cannot be powered by APU. Refer to Sub-Procedure **B** if able to power gen bus from AC TIE BUS.

END

CONTINUED

GENERATOR BUS FAILURE (cont)

CONTINUED

Affected APU GEN BUS Sw . . . . ON (FE)
ELEC SYS RESET Sw . . . . GEN RLY/BUS TIE RLY LOCKOUT (DOWN) (FE)

Momentarily move electrical system reset switch to GEN RLY/BUS TIE RLY LOCKOUT (down) and release.

YES — AC BUS TIE ISOL LT OUT — NO

Generator bus is powered by AC TIE BUS.

Affected APU GEN BUS Sws . . . . OFF (FE)
Other APU GEN BUS Sws . . . . ON AS REQ'D (FE)
DC TIE Sws . . . . OPEN AS REQ'D (FE)
ATS . . . . "AS REQ'D" (PF)
EMER PWR Sw . . . . "AS REQ'D" (PNF)

END

YES — APU PWR IN USE LT ON — NO

ELEC SYS RESET Sw . . . . BUS FAULT (UP) (FE)

Lift guard and momentarily move electrical system reset switch to BUS FAULT (up) and release.

CAUTION

Do not attempt bus fault reset more than once.

YES — AC BUS OFF LT OUT — NO

Probable fault on generator bus.

Affected APU GEN BUS Sw . . . . OFF (FE)

CAUTION

Do not attempt additional resets for the affected channel.

APU GEN RESET Sw (If Req'd) . . . . RESET (FE)
Other APU GEN BUS Sws . . . . ON AS REQ'D (FE)

Continue with affected circuits inoperative. Refer to effects of generator bus failure notes at the end of this procedure.

END

CONTINUED

GENERATOR BUS FAILURE (cont)

CONTINUED

APU GEN BUS Sws	ON AS REQ'D	(FE)
DC TIE Sws	OPEN AS REQ'D	(FE)
ATS	AS REQ'D	(PF)
EMER PWR Sw	AS REQ'D	(PNF)

NOTE

The following list identifies the equipment affected by a GENERATOR BUS FAILURE. Refer to the appropriate generator bus failure.

GENERATOR BUS 1 FAILURE (DC TIE 1 SWITCH IN CLOSE):

- AC bus 1, left emergency AC bus, and cabin bus 1 are de-energized.
- A single generator bus failure will not disable the passenger oxygen release circuits.
- Left emergency AC bus can be restored by moving emergency power switch to ON. Use only as required. When emergency power switch is in ON, battery is not connected to battery charger.
- INS-1 units fail when the integral battery is discharged; the emergency power switch will not restore the captain's attitude and compass instruments.
- Automatic cabin pressure control is inoperative. Automatic and high pneumatic supply functions (engine 1) are inoperative. Isolation valve 1-3 control and air conditioning pack manual controls are operative only when left emergency AC bus is restored.
- Fuel system tank pumps; tank 1 forward, tank 2 forward, tank 3 transfer, forward tank transfer and right upper compartment center wing tank are inoperative. Move fuel quantity indicating power switch to ALTN.
- Ground proximity warning is inoperative.
- Automatic ground spoilers are inoperative.

GENERATOR BUS 2 FAILURE (DC TIE 1 AND 3 SWITCHES IN CLOSE):

- AC bus 2, DC bus 2, AC ground service bus, and DC ground services buses are de-energized.
- A single generator bus failure will not disable the passenger oxygen release circuits.
- Battery charger is inoperative. Cabin emergency lights will be on; integral batteries are not being charged but are available for emergency power if required.
- When on the ground, attempt to restore power to the ground service buses at ground service panel. APU generator or main external power must be available. This is necessary to provide electrical power for cabin and cargo doors.

CONTINUED

GENERATOR BUS FAILURE (cont)

- The cockpit temperature selector automatic control is inoperative.
- Pilot's landing gear warning is inoperative. Lights will be off and warning horn may sound with gear down.
- Fuel system tank pumps; tank 1 transfer, tank 2 right aft, tank 3 aft, and upper and lower compartment left center wing tank are inoperative without annunciation. Tank 1 tip pump is inoperative.
- Engine 2 crossfeed control is inoperative. Disagreement light is inoperative.
- Pilot's control wheel trim switches are inoperative.
- Engine 2 thrust reverser is inoperative.
- Engine 2 oil pressure and temperature indicators are inoperative (OIL PRESS LO annunciator light is operative).
- CSD-2 OIL PRESS LO light and CSD outlet temperature are inoperative (RISE is operative).

GENERATOR BUS 3 FAILURE (DC TIE 3 SWITCH IN CLOSE):

- AC bus 3, right emergency AC bus, and cabin bus 3 are de-energized.
- A single generator bus failure will not disable the passenger oxygen release circuits.
- Right emergency AC bus can be restored by releasing the air-driven generator and moving ADG switch to R EMER ELEC. ADG drag penalty is approximately 1% (loss of range/increase fuel flow).
- INS 2 and 3 units will fail when integral batteries are discharged. INS-2 will not fail if the right emergency AC bus is restored before the battery is discharged.
- Cabin pressure aural warning is inoperative. Automatic and high pneumatic supply functions (engine 3) are inoperative. Isolation valve 1-2 control is operative only when right emergency AC bus is restored. Air conditioning packs 1 and 3 automatic control is inoperative. Cockpit temperature selector manual control is inoperative.
- Fuel system tank pumps; tank 1 aft, tank 2 transfer, tank 2 left aft, tank 3 forward, tank 3 tip pump, aft tank transfer, and right lower compartment center wing tank are inoperative. Tank 2 left aft is restored if the right emergency AC bus is restored.

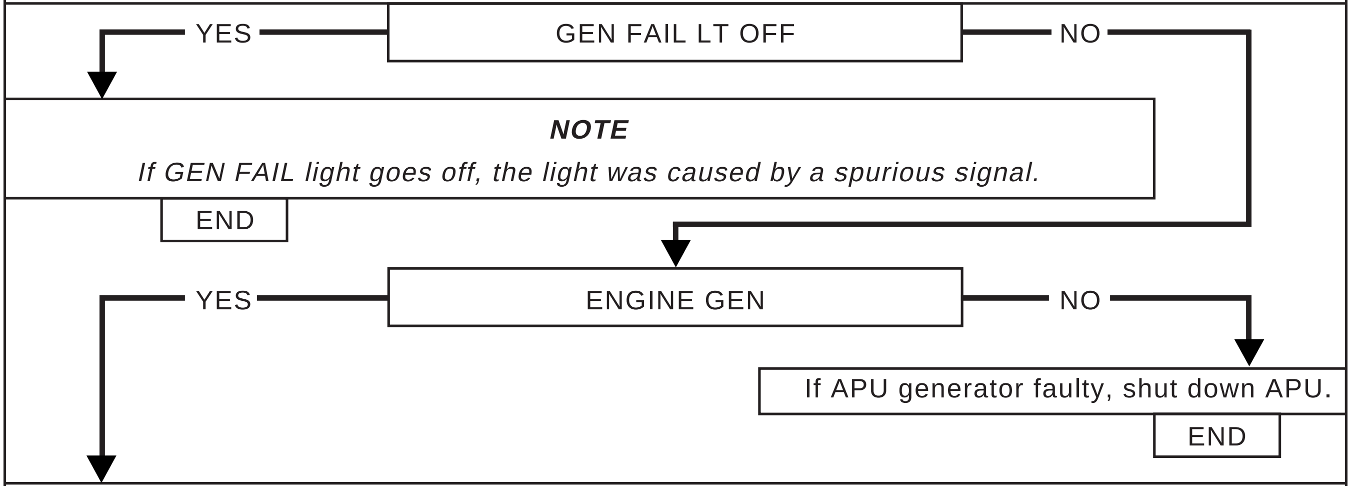
END

GEN FAIL LIGHT ON (ENG OR APU)

NOTE

GEN FAIL light on condition may result in a generator bus failure. If AC BUS TIE ISOL, AC BUS OFF, and GEN OFF lights all come on, disconnect CSD and refer to Abnormal Procedures, GENERATOR BUS FAILURE.

GEN FAIL RESET Button . . . . RESET (FE)



NOTE

If GEN FAIL light goes off, the light was caused by a spurious signal.

If APU generator faulty, shut down APU.

GEN Sw (Faulty Generator) . . . . OFF (FE)
CSD Disconnect Button (Faulty Generator) . . . . PUSH/HOLD FOR 3 SEC (FE)
GEN VOLTS & FREQ . . . . BELOW SCALE (FE)

NOTE

- *If volts and frequency indicate after disconnect button is pushed, continue engine operation with generator off. Engine shutdown is not necessary because the input shaft will shear if CSD or generator seizes. Monitor affected system.*
- *Once disconnected, CSD cannot be reset in flight.*

AC Load (Normal Generators(s)) . . . . MONITOR (FE)

NOTE

Subsequent takeoff must be with CSD disconnected, APU shut down, or with serviceable generator installed.

END

GEN FREQ HI

NOTE

When accelerating through 70% N_2, transitory frequency excursions are acceptable and are not cause for concern.

AC BUS TIE Sws (Operating Gens) . . . . ISOL, THEN NORM (FE)

Move AC bus tie switches for operating generators to ISOL and return to NORM to unparallel generators.

VOLT/AMP/FREQ Sel . . . . .OPERATING AC GEN/DC BUS (FE)

Rotate volts ampere frequency selector to each operating generator and check generator frequency.

For gen with freq above 420 Hz,

Assoc GEN Sw . . . . OFF (FE)
CSD Disconnect Button (Faulty Gen) . . . . .PUSH/HOLD FOR 3 SEC (FE)
GEN VOLTS & FREQ . . . . BELOW SCALE (FE)

NOTE

If voltage and frequency indicate after disconnect button is pushed, continue engine operation with generator off. Monitor affected system.

END

GENERATORS WILL NOT PARALLEL

NOTE

- *This checklist is intended for ground use.*
- *Prior to performing this checklist, accomplish all applicable procedures listed in Section IV, NORMAL PROCEDURES.*
- *If all three AC BUS TIE ISOL lights are on, refer to Abnormal Procedure, AC BUS TIE ISOL LIGHT(S) ON.*
- *To be performed with generators 1, 2, and 3 operating.*
- *The prescribed AC BUS TIE ISOL light indications must be achieved. This check ensures the proper generator will power the AC tie bus and generator buses after generator(s) shut down. Preferential order is 2-1-3.*

AUTO PARALLEL C/B (LM A-15, B-15, C-15) . . . . RESET (FE)

If AUTO PARALLEL circuit breakers were tripped, attempt to parallel generators after resetting affected circuit breakers.

CONTINUED

GENERATORS WILL NOT PARALLEL (cont)

APU GEN BUS Sws (All)	OFF	(FE)
EXT PWR Sw	OFF	(FE)
AC BUS TIE Sws (All)	NORM	(FE)
AC BUS TIE 1 and 3 Sws	ISOL, THEN NORM	(FE)
AC BUS TIE 2 ISOL Lt	OFF	(FE)
AC BUS TIE 1 and 3 ISOL Lts	ON	(FE)

NOTE

Generator 2 is powering the AC TIE BUS and generator bus 2.

GEN 2 Sw	OFF	(FE)
AC BUS TIE 1 and 2 ISOL Lts	OFF	(FE)

NOTE

Generator 1 is powering the AC TIE BUS and generator buses 1 and 2.

GEN 1 Sw	OFF	(FE)
AC BUS TIE 1, 2, and 3 ISOL Lts	OFF	(FE)

NOTE

Generator 3 is powering the AC TIE BUS and generator buses 1, 2, and 3.

GEN 1 and 2 Sws	ON	(FE)
GEN OFF Lts (All)	OFF	(FE)
AC BUS TIE 1 and 2 ISOL Lts	ON	(FE)

NOTE

Generator 3 is powering the AC TIE BUS and generator bus 3.

GEN 3 Sw	OFF	(FE)
AC BUS TIE 2 and 3 ISOL Lts	OFF	(FE)

NOTE

Generator 2 is powering the AC TIE BUS and generator buses 2 and 3.

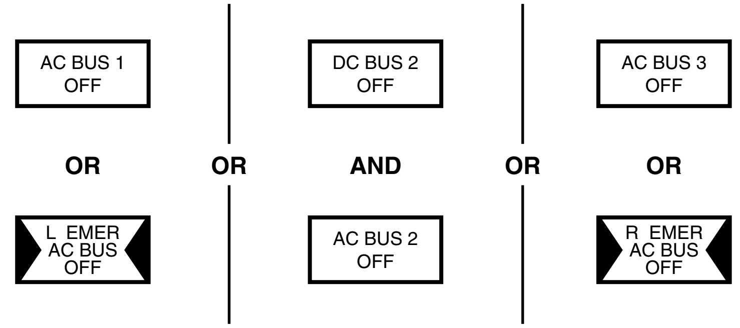
GEN 3 Sw	ON	(FE)
AC BUS TIE 2 ISOL Lt	OFF	(FE)
AC BUS TIE 1 and 3 ISOL Lts	ON	(FE)

NOTE

Generator 2 is powering the AC TIE BUS and generator bus 2.

END

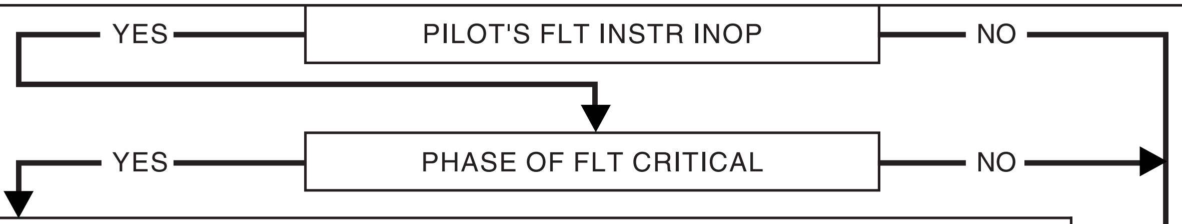
PARTIAL ELECTRICAL FAILURE - AC



NOTE

Sensing for these lights is from a single phase of each AC feed. If the applicable circuit breaker does not trip the only indication of a partial electrical failure will be apparent failures in various systems.

ATS Levers . . . . OFF (PF)



CAUTION

If L EMER AC BUS feed C/B (UM B-21) trips, do not use EMER PWR switch to restore L EMER AC BUS.

EMER PWR Sw . . . . "ON" (IF REQ'D) (PNF)

NOTE

- *Use emergency power as long as phase of flight is critical. When no longer critical or if instruments are not restored, rotate EMER PWR switch to OFF.*
- *With EMER PWR switch ON, battery cannot be relied upon for more than 30 minutes. Use emergency power only as required.*
- *Autothrottles may be operated only if all electrical buses are restored.*

Affected Bus Sensing C/B . . . . RESET (FE)
Affected Bus Feeder C/B . . . . PULL/RESET (FE)

	SENSING C/B	FEED C/B
R EMER AC BUS	PO E22	UM D-21
L EMER A BUS	PO E7	UM B-21
AC BUS 1	LM A-16	UM B-17, 18, 19
AC BUS 2	LM B-16	UM C-17, 18, 19
AC BUS 3	LM C-16	UM D-17, 18, 19

CONTINUED

PARTIAL ELECTRICAL FAILURE – AC (cont)

AFFECTED BUS LTS OUT
AND C/B'S REMAIN SET

YES

EMER PWR Sw . . . . OFF (PNF)

END

NO

Continue flight with affected circuits inop. Refer to the following note for the effect on aircraft systems with the loss of an AC bus.

NOTE

In addition to the systems listed below, other systems may be affected. Review circuit breaker panel of affected system.

EFFECTS OF LOSS OF L EMER AC BUS

INU 1
VOR 1
VERT GYRO 1
AIR DATA CMPTR 1
COMPASS 1
ISOL VALVE CONTROL 1 TO 3
ENGINE IGNITION A IGNITORS ENG 1, 2, 3
LOWER YAW DAMPER A & B
N_1 TACH IND ENG 1.

EFFECTS OF LOSS OF AC BUS 1

FUEL QTY NORM PWR
MANIFOLD FAILURE DET LOOP 1
L ANGLE ATTACK HEAT
L STATIC PORT HEAT
L WINDSHIELD ANTI-ICE
LEFT LANDING LIGHT.

EFFECTS OF LOSS OF AC BUS 2 & DC BUS 2

MANIFOLD FAILURE DET LOOP 2
OXYGEN RELEASE
TAT PROBE HEAT
NOSE LANDING & TAXI LIGHT
ALT ALERT HOR STAB AUTOPILOT AURAL WARN
N_1 TACH IND ENG 2
PRIMARY HORIZ STAB TRIM
FUEL X-FEED CONT LT 2
REVERSING CONT/LTS ENG 2
MANIFOLD FAILURE DET LT LOOP 2
ANT ANTI-ICE VALVE ENG 2
PNEU PRESS REGULATOR ENG 2
LDG WARN.

CONTINUED

PARTIAL ELECTRICAL FAILURE – AC (cont)

EFFECTS OF LOSS OF AC BUS 3

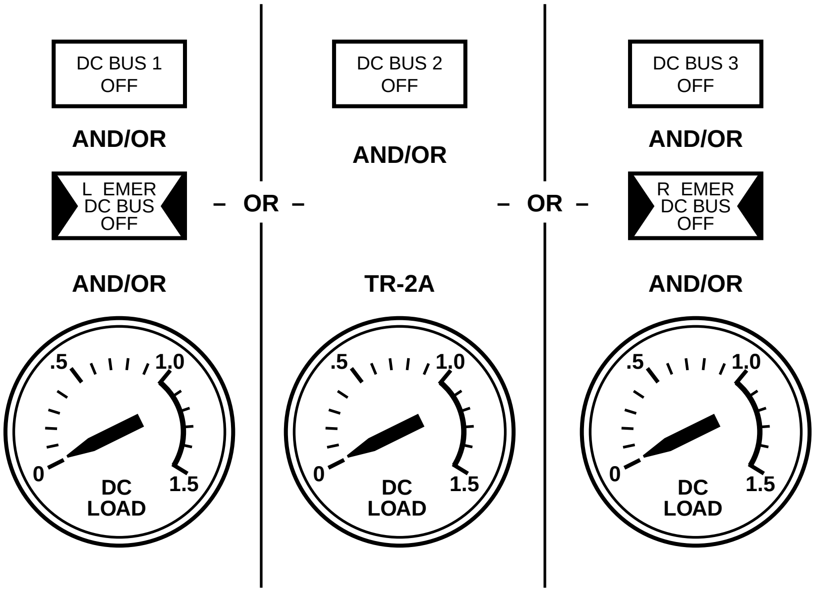
INU 3 DIR GYRO 3
INU 3 VERT GYRO 3
MANIFOLD FAILURE DET LOOP 3
R ANGLE ATTACK HEAT
R STATIC PORT HEAT
R WINDSHIELD ANTI-ICE
RIGHT LANDING LIGHT
TO/LDG CAB PRESS AURAL WARN.

NOTE

- *If AC BUS 1 cannot be restored, select MANUAL on Cabin Press Control and move the fuel quantity indicator power switch to ALTN.*
- *ATS may be re-engaged if the TRC information is valid or ATS is in speed mode with N_1 limit bugs manually set and TRC is INOP.*

END

PARTIAL ELECTRICAL FAILURE – DC



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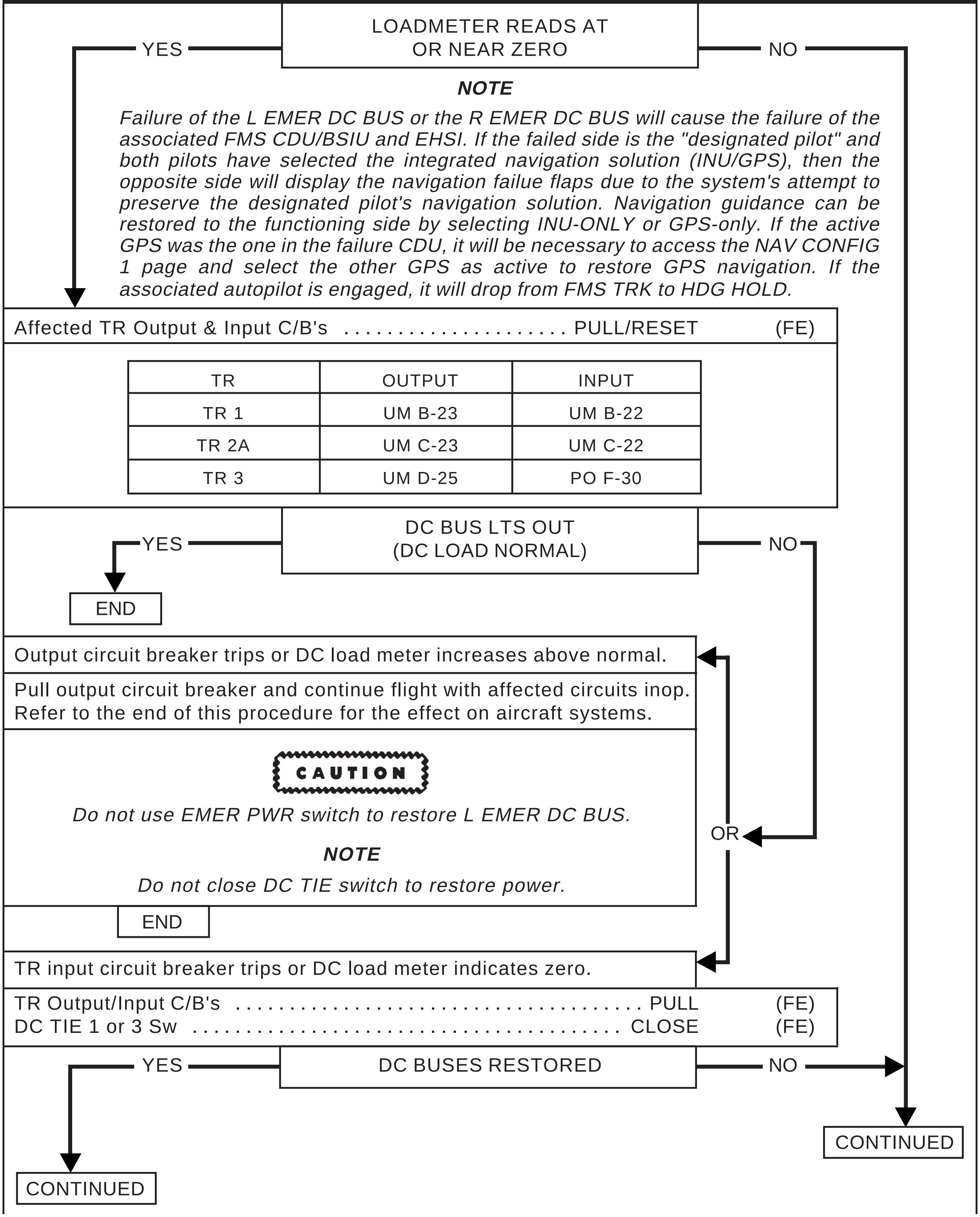
PARTIAL ELECTRICAL FAILURE – DC (cont)



LOADMETER READS AT OR NEAR ZERO

NOTE

Failure of the L EMER DC BUS or the R EMER DC BUS will cause the failure of the associated FMS CDU/BSIU and EHSI. If the failed side is the "designated pilot" and both pilots have selected the integrated navigation solution (INU/GPS), then the opposite side will display the navigation failue flaps due to the system's attempt to preserve the designated pilot's navigation solution. Navigation guidance can be restored to the functioning side by selecting INU-ONLY or GPS-only. If the active GPS was the one in the failure CDU, it will be necessary to access the NAV CONFIG 1 page and select the other GPS as active to restore GPS navigation. If the associated autopilot is engaged, it will drop from FMS TRK to HDG HOLD.

Affected TR Output & Input C/B's .... PULL/RESET (FE)

TR	OUTPUT	INPUT
TR 1	UM B-23	UM B-22
TR 2A	UM C-23	UM C-22
TR 3	UM D-25	PO F-30

DC BUS LTS OUT
(DC LOAD NORMAL)

END

Output circuit breaker trips or DC load meter increases above normal.

Pull output circuit breaker and continue flight with affected circuits inop. Refer to the end of this procedure for the effect on aircraft systems.

CAUTION

Do not use EMER PWR switch to restore L EMER DC BUS.

NOTE

Do not close DC TIE switch to restore power.

END

TR input circuit breaker trips or DC load meter indicates zero.

TR Output/Input C/B's .... PULL (FE)
DC TIE 1 or 3 Sw .... CLOSE (FE)

DC BUSES RESTORED

CONTINUED

CONTINUED

PARTIAL ELECTRICAL FAILURE – DC (cont)

CONTINUED CONTINUED

Monitor DC load meters.

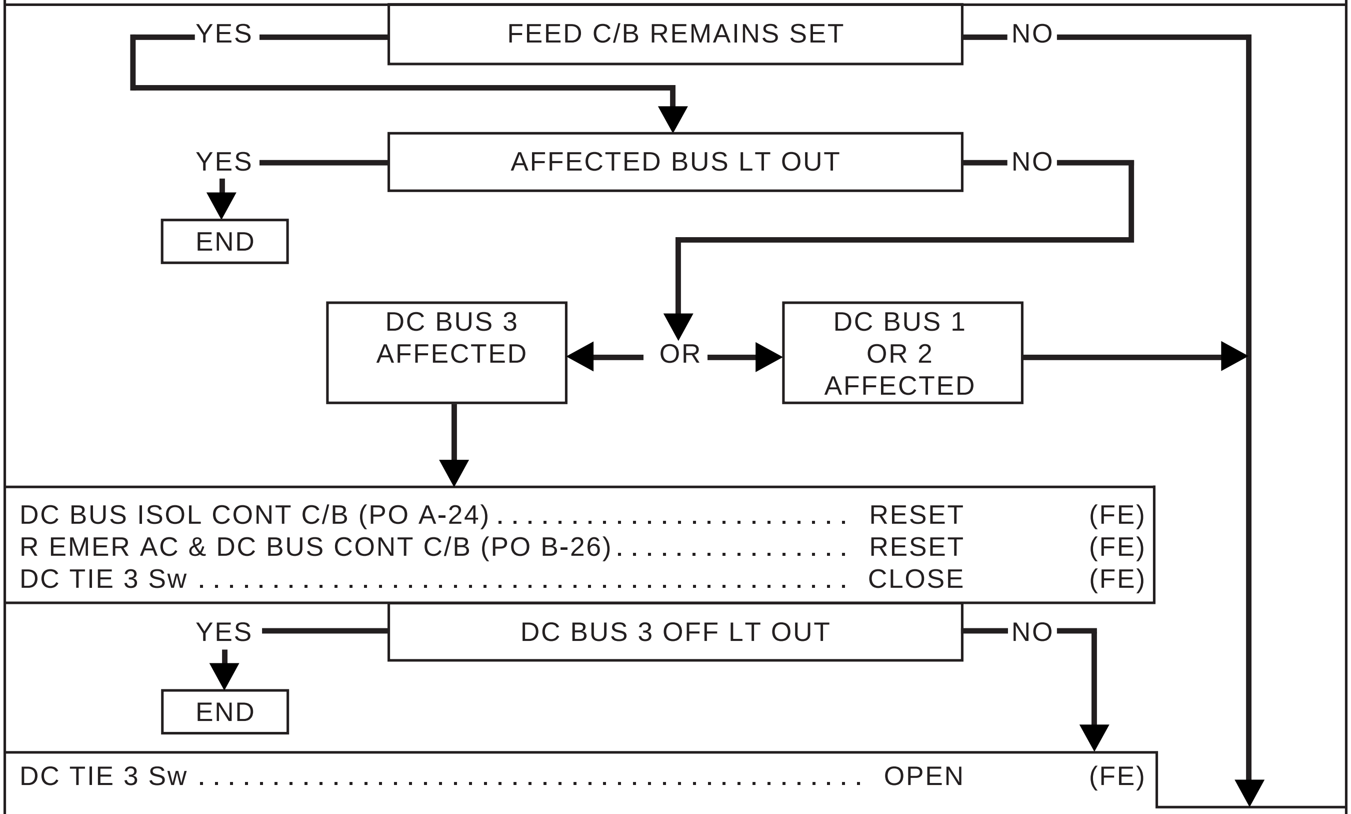
NOTE

It may be necessary to close 1 and 3 DC TIE switches or DC X TIE to avoid high individual loads.

END

Affected Bus Sensing C/B . . . . RESET (FE)
Affected Bus Feed C/B . . . . RESET (FE)

BUS	SENSING C/B	FEED C/B
L EMER DC BUS	PO D-7	–
R EMER DC BUS	PO D-22	–
DC BUS 1	LM D-16	UM B-26
DC BUS 2	LM E-16	UM C-26
DC BUS 3	LM F-16	UM D-26



DC BUS ISOL CONT C/B (PO A-24) . . . . RESET (FE)
R EMER AC & DC BUS CONT C/B (PO B-26) . . . . RESET (FE)
DC TIE 3 Sw . . . . CLOSE (FE)

DC TIE 3 Sw . . . . OPEN (FE)

Continue flight with affected circuits inop. Do not reset tripped circuit breaker more than once. Consider effect of inop circuits.

CONTINUED

PARTIAL ELECTRICAL FAILURE – DC (cont)

EFFECTS OF LOSS OF DC BUS 1

HF COMM 1
ADF-1
TACAN 1
CAPT STICK SHAKER
FLIGHT GUIDANCE 1
AUTO PITCH TRIM A
AT SC 1
HOR STAB TRIM RATE CONT
ELEV LOAD FEEL & FLAP LIM
FUEL DUMP VALVE CONT
FUEL CROSSFEED VALVE LT 1
#1 OIL PRES GAGE
#1 PNEU GAGE
LEFT DUMP VALVE
REVERSER VALVE LTS
REVERSER CONT ENG 1
REVERSING LTS ENG 1
FIRE AGENT DISCHARGE LT ENG 1
L GROUND SENSING
MANIFOLD FAILURE DET LT LOOP 1
ENGINE ANTI-ICE VALVE ENG 1
PNEU PRESS REGULATOR ENG 3
PNEU HP BLEED V CONT ENG 1
CENTER GEAR CONTROL
SLAT POSITION SYS 1
#1 FUEL PRES GAGE
FE ANNUN TEST
FMS BUS SPLIT SWITCH

EFFECTS OF LOSS OF DC BUS 2

PRIMARY HORIZ STAB TRIM
FUEL X-FEED CONT LT 2
REVERSING CONT ENG 2
REVERSING LTS ENG 2
MANIFOLD FAILURE DET LT LOOP 2
ANT ANTI-ICE VALVE ENG 2
PNEU PRESS REGULATOR ENG 1
LDG GEAR WRN
FUEL DUMP VALVE INDICATION
FUEL DUMP LOW LEVEL SHUTOFF
BOOM/DROGUE FUEL VALVE ELECTRICAL CONTROL AND INDICATION

EFFECTS OF LOSS OF DC BUS 3

FO STICK SHAKER
AUTO PITCH TRIM B
AT SC
HOR STAB TRIM RATE CONT 2
ELEV LOAD FEEL & FLAP LIM 2
R FUEL DUMP VALVE CONT
FUEL X-FEED VALVE LT 3
REVERSING CONTROL ENG 3
REVERSING LTS ENG 3
FIRE AGENT DISCHARGE LT ENG 3
FMS CDU 3
GROUND SENSING
MANIFOLD FAILURE DET LT LOOP 3
ENG ANTI-ICE VALVE ENG 3
PNEU HP BLEED V CONT ENG 3
F/E LANDING GEAR WARN
AUTO SLAT EXTEND CONT
FGS SPIN-UP LOGIC SPOIL WARN SPD BK LT
SLAT POSITION SYS 2
WHEEL SPIN-UP SENSING

CONTINUED

PARTIAL ELECTRICAL FAILURE – DC (cont)

EFFECTS OF LOSS OF L EMER DC BUS

VOR 1
VHF COMM 1
UHF COMM 1
IFF X PNDR
N_1 TACH SENSOR ENG 1
CAPT RAD/FMS SWITCHING
LOWER YAW DAMPERS A & B

FMS CDU 1
FMS BSIU 1
FMS DATA LOADER
EHSI 1

EFFECTS OF LOSS OF R EMER DC BUS

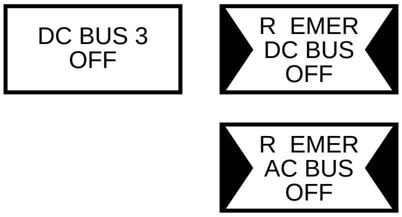
VOR 2
VHF COMM 2
UHF COMM 2
N_1 TACH SENSOR ENG 3
FO RAD/FMS SWITCHING
UPPER YAW DAMPER A & B

FMS CDU 2
FMS BSIU 2
EHSI 2

END

R EMER BUSES FAILURE

R EMER AC BUS OFF & R EMER DC BUS OFF & DC BUS 3 OFF LIGHTS ON



SA1-536A

DC TIE 3 Sw . . . . CLOSE (FE)

This will repower DC BUS 3 & the R EMER DC BUS.

TR-3 INPUT C/B (PO F-30) . . . . PULL (FE)
R EMER AC BUS Feed C/B (UM D-21) PULL AND RESET (FE)

R EMER AC OFF LT OFF

YES → END

NO ↓

NOTE

If R EMER AC BUS OFF light remains on, or feed circuit breaker trips continue flight with affected circuits inoperative. Consider effect of inop circuits.

EFFECTS OF LOSS OF R EMER AC BUS

F/O PITOT HEAT
N_1 TACK IND ENG 3
UHF COMM 2
SAT COMM
HF COMM 2
F/O ALTIMETER
F/O VERT SPEED IND
AIR DATA CMPTR 2
F/O EHSI HEADING
F/O EHSI CRS HDG SELECT
VOR 2
ILS 2
ISOL VALVE CONT 1 TO 2 (PNEU)
ENG IGN B IGNITORS
FUEL PUMP TK 2 LEFT AFT
INS 2
TR 3

END

SINGLE GENERATOR (ENG) OPERATION

AC LOAD Meter	CHECK	(FE)
Loads	REDUCE (AS REQ'D)	(FE)

Reduce all non-essential loads, i.e., auxiliary hydraulic pumps, and fuel pumps.

NOTE

Two fuel pumps on are required for engine 2.

APU GENERATOR AVAILABLE

YES — go to APU START below.

NO

AC LOAD Meter	MONITOR	(FE)

Operate with AC BUS TIE switches in NORM to supply AC power to all generator buses. Monitor AC LOAD meter of operating generator.

END

APU	START	(FE)

Start APU. After APU is started, observe APU PWR AVAIL light is on.

APU GEN BUS Sws (All)	ON	(FE)
APU PWR IN USE Lts	OBSERVE	(FE)

Observe appropriate APU PWR IN USE lights come on and AC BUS OFF and DC BUS OFF lights are off. AC BUS TIE switches should remain in NORM. Monitor AC LOAD meters.

NOTE

When only one engine generator is in operation it is recommended that the APU be started to be available for electrical power. This should be accomplished as soon as practical if the remaining generator is unstable or not later than the Approach checklist.

END

ENG/APU FIRE DETECT LOOP LIGHT ON WITHOUT FIRE WARNING

Notify Pilot that one LOOP light is on, and identify affected engine or APU	"NOTIFY"	(FE)
Approp LOOPS Sw	SET TO LOOP NOT LIGHTED	(FE)
Approp LOOPS TEST Sw	TEST	(FE)

NOTE

- *When loop is normal, test switch will cause a normal fire warning in system tested. Normal fire warning indications for an engine fire are an alarm bell, ENGINE FIRE light on, selected ENG FIRE handle light on, fuel lever light on, and all tested LOOP (A or B) light(s) on.*
- *Normal fire warning indications for an APU fire are APU FIRE lights on, MASTER WARNING lights on, and all tested LOOP (A or B) light(s) on.*

CONTINUED

ENG/APU FIRE DETECT LOOP LIGHT ON WITHOUT FIRE WARNING (cont)

YES — TEST INDICATIONS SATISFACTORY — NO

Release test switch and observe lights go off. Continue flight with selector in LOOPS position successfully tested.

NOTE

Detection system is now limited to a single loop but retains normal warning capability.

No further action required. Continue with single loop detection system.

END

Approp LOOPS Sw . . . . "SET TO OPPOSITE LOOP POSITION" (FE)

If fire warning is received, refer to Emergency Procedures, APU FIRE, or
ENGINE FIRE OR SEVERE DAMAGE . . . . (P,PNF,FE)

TAILPIPE FIRE

FUEL LEVER . . . . "OFF" (P)

YES — STARTER ENGAGED — NO

Allow N_2 rpm to decrease to 20%,
Verify ENG IGNITION selector is in START (A or B).

ENG START Switch . . . . IN/LIGHT ON (P)

After fire is extinguished;
ENG START Switch . . . . PULL/LIGHT OFF (P)

Maintenance is required

END

ASYMMETRIC FLAPS OR NO FLAP LANDING WITH SLATS

NOTE

Do not use autothrottles or speed control system (speed schedule may not be valid).

AP/ATS Levers (All) . . . . "OFF" (PF)

FLAP/SLAT Handle . . . . "RETURN TO LAST POSITION WHERE FLAPS WERE SYMMETRICAL" (PNF)

YES — FLAPS SYMMETRIC — NO

YES:

Plan landing using resulting flap setting.

ATS may be used when landing with 35° or more flaps.

The ATS system does not compute threshold or final approach speeds for other than normal landing flaps. For less than normal landing flaps, the ATS will not permit the aircraft to decelerate below the appropriate minimum maneuvering or alpha speed.

AP may be used if flaps are symmetric.

If asymmetry occurred during retraction, further extension may be attempted.

NO:

Find the most symmetrical configuration and use airspeed associated with the minimum flap setting indicated.

Approach and Landing Procedure . . . . REVIEW (P,CP,FE)

CAUTION

If final flap selection is less than 35° it is possible the boom will contact the runway at 13° body angle, struts extended and 11° struts compressed.

Gross Weight . . . . REDUCE TO MIN PRACTICAL (P,FE)

ESTIMATED LANDING DISTANCE FOR 0°/EXT - BRAKES ONLY
(NO REV THRUST, SPOILERS & CTR GEAR EXTENDED)

GR, WT. X 1,000 LBS	300	350	400	450	500
LANDING DIST FT	4,250	4,800	5,500	6,100	6,750

Approach Normal Checklist. . . . . PERFORM (P,CP,FE)

NOTE

- *Do not use ATS.*
- *If final flap setting is 22° or less, move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.*
- *Time permitting refer to asymmetrical flaps or no flap landing with slats text on the following page.*

END

FLIGHT CONTROLS/FLIGHT INSTRUMENTS/AUTO-FLIGHT

ASYMMETRIC FLAPS OR NO FLAP LANDING WITH SLATS

This procedure is required when flaps do not extend or flap asymmetry occurs on initial extension. If asymmetry is evident when initially selecting flaps, immediately move the flap/slat handles to the 0°/EXT position and effect the approach and landing in the 0°/EXT configuration. If asymmetry occurs in a setting greater than the 22° flap selection, do not retract flaps to zero but only to the point where asymmetry occurred. Modify the landing procedure and use the threshold speed shown for that configuration. If flap symmetry cannot be obtained, find the position that provides the most symmetrical configuration and use the speeds associated with the least (in degrees) flap position indicated. The following procedures should be used for approach and landing with 0°/EXT configuration:

Consider landing distance and, if required, dump fuel to reduce gross weight. Obtain threshold speed for 0°/EXT from the Abnormal checklist.

Plan a slightly wider pattern and a longer final.

Extend slats as the pattern (vector) is entered and maintain minimum maneuver speed for 0°/EXT.

When turning base (final vector heading), bleed off 10 KIAS in level flight.

When stabilized on the final approach heading, further bleed off airspeed to the approach (1.3 V_S) speed for 0°/EXT.

Fly a normal glideslope angle. Do not attempt to fly a flat approach. Anticipate a higher than normal (800-1000 fpm) rate of descent due to the faster than normal speeds involved.

As the threshold is attained, reduce sink rate slightly (do not flare), retard the throttles to idle, and fly to a positive touchdown.

Lower the nose positively to the runway to reduce lift and increase braking capability. Use immediate reverse thrust for assistance in stopping and to provide auto spoiler deployment. See asymmetric flaps or no flap landing with slats profile (figure 5-24).

NOTE

At threshold speed in 0°/EXT configuration, the body angle (with a 2.75° glide path) approximates 8° ANU.

ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS

NOTE

Do not use autothrottles or speed control system (speed schedule may not be valid).

AP and ATS Levers (All) . . . . "OFF" (PF)

NOTE

- *ATS alpha speed protection may be erroneous with SLAT DISAGREE light on.*
- *ATS may be used when the SLAT DISAGREE light extinguishes.*

FLAP/SLAT Handle . . . . "RETURN TO LAST POSITION WHERE SLATS WERE SYMMETRICAL" (PNF)

YES — ASYMMETRIC CONDITION OCCURRED DURING RETRACTION — NO

SLAT DISAGREE Light/Slat Symmetry . . . . OBSERVE/DETERMINE (FE)

YES — SLAT DISAGREE LT OFF SYMMETRY REGAINED — NO

Plan landing using normal flap/slat settings and speeds.

END

DURING EXTENSION

FLAP/SLAT Handle Position . . . . OBSERVE (PNF)

YES — 22°/EXT OR MORE — NO

FLAP/SLAT Handle . . . . "22°/EXT" (PNF)

NOTE

Do not attempt to split FLAP/SLAT handles. Plan a 22°/EXT landing.

Approach and Landing Procedure . . . . REVIEW (P,CP,FE)
GND PROXIMITY WARN FLAP OVRD Sw . . . . OVRD/ON (FE)

NOTE

After touchdown, positively lower nose gear to runway and immediately apply reverse thrust. With spoiler handle in ARM, spoilers extend automatically by reverser lever actuation.

END

LESS THAN 22°/EXT

FLAP/SLAT Handle . . . . "UP/RET" (PNF)
FLAP/SLAT Handle . . . . "SPLIT" (PNF)

Loosen thumbscrew on mechanical FLAP/SLAT handle interlock, rotate interlock out of the way, and retighten thumbscrew.

Lift and hold slat handle, lift and pull flap handle only to the 0° detent, and release.

CONTINUED

ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS (cont)

NOTE

- *Check gross weight. Reduce as required. Land with maximum 35° flaps. Recommended approach/landing speeds may exceed flap placard speeds for 22° approach/35° landing configurations. Under these conditions, 15° approach/22° landing should be considered. Maximum tire speed of 204 knots should be considered.*
- *If landing with 22°/RET move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.*

Approach and Landing Procedure . . . . REVIEW (P,CP,FE)

NOTE

Time permitting refer to asymmetrical slats or no slats landing with flaps text on the following page.

APPROACH

FLAP/SLAT Handle . . . . "22°/RET" (PNF)
IAS . . . . "MANEUVERING SPD 22°/RET" (PF)

Maintain IAS of at least maneuvering speed 22°/RET.

Approp Normal Checklist . . . . PERFORM (P,CP,FE)

FINAL

FLAP/SLAT Handle . . . . "35°/RET" (PNF)
Reduce airspeed 10 knots.

IAS . . . . "APPROACH SPEED FOR 35°/RET" (PF)
GND PROXIMITY WARN FLAP OVRD Sw . . . . (IF REQ'D) OVRD/ON (FE)
Approp Normal Checklist . . . . PERFORM (P,CP,FE)

NOTE

- *Make a normal approach. Nose attitude is lower than normal. When threshold is crossed, use slight flare to diminish sink rate. Reduce thrust to prevent floating. Avoid holding aircraft off at touchdown.*
- *With flaps 22°, spoilers extend automatically on reverser lever actuation. With flaps 35°, spoilers extend automatically on main wheel spinup.*

END

ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS

Whenever slat asymmetry occurs, always attempt to regain symmetry by returning to the last position where the slats were symmetrical.

If, on initial slat selection, the slats do not extend or if asymmetry is evident, place the flap/slat handles in the UP/RET detent and split the handles leaving the slat handle in the RET detent. Regardless of whether slat symmetry is gained or asymmetry is still evident use the procedure outlined here.

For landing gross weights up to 360,000 pounds use 35° flaps as 50°/RET approach speeds exceed the 50° flap placard speed. For landing gross weights in excess of 360,000 pounds use 22° flaps as 35°/RET approach speeds exceed the 35° flap placard speed.

If slat asymmetry occurs when flaps are at a greater setting than 22° (landing slats), do not retract the slats and split the flap/slat handle. Return to the 22° flap position and effect the landing using the 22°/EXT configuration and associated speeds regardless of slat symmetry. The no-slat-with-flaps procedure is most demanding. The procedure is as follows:

Place the flap handle in the zero detent and leave the slat handle at the RET position (split the handles).

Consider landing distance and reduce gross weight by fuel dumping, if required.

Obtain the minimum maneuver speed for 22°/RET and threshold speed for 22°/RET and 35°/RET from the Abnormal checklist.

Plan a wider pattern (vector) to provide a longer final for speed stabilization.

When entering the pattern, select flaps 22° lower the gear, and maintain minimum maneuver speed for 22°/RET.

When turning base (final vector), set flaps to 35° or 22° as required and bleed off 10 knots in level flight.

When stabilized on the final approach heading (course) and still in level flight, further reduce KIAS to approach speed for 35°/RET or 22°/RET.

Fly a normal glideslope angle (600-900 fpm rate of descent). Do not attempt to flatten approach or drag aircraft in.

The aircraft will be in a flat or nose down attitude. When the threshold is crossed, use a slight flare to diminish the sink rate and raise the nose of aircraft to at least a level attitude. Reduce thrust. Avoid holding off the aircraft at touchdown.

Immediately use reverse thrust while holding forward pressure on the control column to reduce lift and increase braking capability.

Spoilers deploy automatically upon touchdown with 35° flap and upon selection of reverse thrust if 22° flaps are used. (See figure 5-25.)

AUTO SPOILER DO NOT USE LT ON/AUTO SPOILERS INOP

NOTE

Use this procedure when AUTO SPOILER DO NOT USE light is on or has been on at any time during flight, if spoiler handle will not arm, or if spoilers are to be extended manually on landing.

SPOILER Handle . . . . "RET/IN" (P)
Approach and Landing Procedures . . . . REVIEW (P,CP,FE)

NOTE

When auto ext system of ground spoilers is inop, increase the runway landing field length.

AUTO SPOILER ARMING FEATURE INOP LANDING ROLL PENALTY

Flaps 35°/slats extended, SL STD conditions.

RUNWAY CONDITION	GROSS WEIGHT (1,000 LB)											
	280	300	320	340	360	380	400	420	440	460	480	500
	LANDING ROLL PENALTY (FT)											
DRY	653	676	698	720	741	761	781	796	814	834	852	870
WET	751	778	803	828	852	875	898	915	937	959	980	1,000

EFFECT OF WIND:

DRY: +/- 54 ft for every 10 KT tailwind/headwind.
WET: +/- 62 ft for every 10 KT tailwind/headwind.

Approp Normal Checklists. . . . . PERFORM (P,CP,FE)
After Nose Gear Touchdown, SPOILER Handle . . . . "FULL AFT/UP" (FE)

After nose gear touchdown, Pilot command "Ground spoilers", FE move SPOILER handle full aft and up.

NOTE

With auto spoilers inop the in-flight spoiler lockout gate prevents moving the spoiler handle aft until after nosewheel contact.

END

FLAP POS TAPE(S) DO NOT MOVE AS SELECTED

NOTE

- *A FLAP DISAGREE flag indicates disagreement between left and right inboard flap position. Refer to Abnormal Procedures, ASYMMETRIC FLAPS OR NO FLAP LANDING WITH SLATS.*
- *The FLAP/SLAT indicator is dual powered. Failure of one power source could indicte a false asymmetric condition. Asymmetric flap tapes without a FLAP DISAGREE flag and no rolling tendencies could be a malfunction of the electronic sensing mechanism. Refer to normal landing procedures.*

Airspeed . . . . "REDUCE" (PF)

NOTE

Reduce airspeed below 221 KIAS (limiting airspeed for landing slats), but not below 1.3 V_S 0°/EXT.

WEIGHT (X 1,000)

LBS	260	280	300	320	340	360	380	400	420	440	460	480	500
0°/EXT (1.3 V_S)	142	147	152	157	162	167	171	176	180	184	188	192	196

FLAP/SLAT Handle . . . . "MOMENTARILY 50°/EXT, THEN DESIRED POSITION"

In the event the flap control valve does not open as selected, this action will position the pilot override clapper mechanism and may force the flap control valve to the selected position.

NOTE

FLAP/SLAT handle load will be higher than normal.

YES — FLAPS EXTEND AS DESIRED — NO

Approp Normal Procedures Checklist . . . . PERFORM (P,CP,FE)

END

NOTE

If unable to achieve further flap extension into landing range, flap limiter may be inoperative. Rotate flap limit selector to OVRD 1 or 2, after a slight delay observe FLAP LIMIT OVRD light on. Observe flap limit speeds and attempt to extend flaps. If unsuccessful, continue procedure.

FLAP Position . . . . VISUALLY INSPECT (FE,BO)

YES — FLAPS IN DESIRED POSITION — NO

Disregard faulty indicator.

Approp Normal Procedures Checklist . . . . PERFORM (P,CP,FE)

END

CONTINUED

FLAP POS TAPE(S) DO NOT MOVE AS SELECTED (cont)

Both inboard and outboard flaps fail to extend, or inboard flaps (only) are at selected position, or flap position cannot be visually determined.

FLAP/SLAT Handle .... "LAST POSITION WHERE FLAPS WERE NORMAL" (PNF)

When landing is desired, land with maximum flap/slat selection that provides equal extension of both inboard and outboard flaps, and agreement with handle position. If final flap setting is 22° or less, move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.

NOTE

If a no flap landing with slats is required refer to Abnormal Procedures, ASYMMETRIC FLAPS OR NO FLAP LANDING WITH SLATS.

Approp Normal Procedures Checklist .... PERFORM (P,CP,FE)

END

FLIGHT INSTRUMENT(S) MALFUNCTION/FAILURE

NOTE

- *Do not use this checklist if the left and/or right emergency AC buses, as appropriate, are not powered. Failure of the L EMERG AC bus will cause a failure of the pilot's instruments and a failure of the R EMERG AC bus will cause a failure of the copilot's instruments. Standby airspeed and altimeter will still be available.*
- *The select flap limit OVRD and select elevator MAN caution lights may illuminate due to discrepancy in airspeeds received from CADC 1 and 2. If affected systems can not be restored, refer to appropriate checklist. If affected system is regained, pull and reset the following circuit breakers on the flight engineer's overhead CB panel. B15, C15, D15, and E15. This action resets the warning systems and extinguishes the lights.*
- *Illumination of a single warning flag may indicate instrument failure.*

AP LEVERS .... "OFF" (PF)
ATS LEVERS .... "OFF" (PF)
AFFECTED SYSTEM(S) .... DETERMINE (P,CP,FE)
AIRCRAFT CONTROL (IF APPROPRIATE) .... TRANSFER (PF, PNF)

PILOT OR COPILOT AIRSPEED VSI AND ALTIMETER WARNING FLAGS IN VIEW

YES

Indicates Complete CADC Failure

APPROPRIATE CADC CIRCUIT BREAKER .... CHECK (FE)

NOTE

CADC circuit breakers are on the pilot's overhead CB panel. CADC 1 (F6), and CADC 2 (F21).

CONTINUED

NO

CONTINUED

FLIGHT INSTRUMENT(S) MALFUNCTION/FAILURE (cont)

CONTINUED

CONTINUED

AFFECTED CADC SYSTEM
INOP 1 OR 2

#1

#2

Indicates CADC 1 FAILURE

CADC SW	BOTH ON 2	(PNF)
FD SW	BOTH ON 2	(PNF)

CAUTION

With a thrust computer failure, N_1 limits will fail to approximately 90% N_1. If use of Autothrottle System is desired, compute N_1 limit and set that limit manually on each N_1 gauge.

ATS	USE 2	(PF)
AP	USE 2	(PF)
IFF CADC SW	2	(PNF)
ADC SENSOR AID ON NAV CONFIG 1 PAGE (LS8)	SELECT ADC2	(PNF)

NOTE

CADC 1 Failure Effects:
- *Pilot's TVSI will be inoperative.*
- *FMS navigation solutions that use CADC 1 display incorrect or no data associated with true airspeed and altitude input.*
- *TAT failure. TAT can be obtained from the SAT gage when the TAT button is depressed.*
- *Pilot Flight Director failure. With FD SW to both on 2, command bars will return to view but will be repeater of #2 system.*
- *Boom flight controls degraded. Refer to appropriate checklist in TO 1-1C-1-33.*
- *ATS is available only in speed mode.*

END

Indicates CADC 2 Failure

CADC SW	BOTH ON 1	(PNF)
FD SW	BOTH ON 1	(PNF)
ATS	USE 1	(PF)
AP	USE 1	(PF)
IFF CADC SW	1	(PNF)

NOTE

CADC 2 Failure Effects:
- *Copilot's TVSI will be inoperative.*
- *FMS navigation solutions that use CADC 2 display incorrect or no data associated with true airspeed and altitude input.*
- *TAS and SAT failure. Temperature can be read off the TAT gage on the TRC.*
- *Copilot Flight Director failure. With FD SW to both on 1, command bars will return to view but will be repeater of #1 system.*
- *Boom flight controls degraded. Refer to appropriate checklist in TO 1-1C-1-33.*

END

CONTINUED

FLIGHT INSTRUMENT(S) MALFUNCTION/FAILURE (cont)

CONTINUED

ONE PILOT'S OR COPILOT'S AIRSPEED INDICATOR IN ERROR, ALTIMETER AND VSI NORMAL FOR CONDITIONS

YES

NO

PITOT SYSTEM MALFUNCTION

AIRSPEED INDICATORS	"CHECKED"	(P,CP,FE)
CADC/FD SWs	BOTH ON 1 OR 2	(PNF)

NOTE

If the malfunction is in the pilot's airspeed indicator, place the switches to "BOTH ON 2". If the malfunction is in the copilot's airspeed indicator, place the switches to "BOTH ON 1".

PITOT HEATER SELECT SW	AS REQUIRED	(FE)
ATS	USE NORMAL SYSTEM AS REQUIRED	(PF)
AP	USE NORMAL SYSTEM AS REQUIRED	(PF)
FMS	USE NORMAL SYSTEM AS REQUIRED	(PF)

NOTE

- *With a complete pitot blockage, airspeed will INCREASE in a climb and DECREASE in a descent provided static port is unblocked. Refer to OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION procedure.*
- *Selecting CADC both on 1 or 2 will not affect the overspeed warning systems, ATS, or autopilot systems. Pulling the ENG FIRE, OVSPEED & ARO AURAL WARN CB (pilot's overhead: B3) to deactivate the overspeed warning will also silence the ENG FIRE detection system. A test of the ENG FIRE detection lights is required to ensure valid operation of the warning system.*
- *Pulling the affected CADC circuit breaker on the pilot's overhead CB panel (F6 for CADC 1, and F21 for CADC 2) will also silence the overspeed warning system; however, it will also deactivate the CADC. If the CADC circuit breaker is pulled, refer to failure of CADC portion of this checklist.*
- *Select Flap Limit OVRD and ELEV MAN Feel lights may be on, if so, pull and reset appropriate circuit breakers (flight engineer's overhead CB panel. B15, C15, D15, and E15). Normal systems operation will be regained only if CADC is deactivated.*
- *Boom flight controls degrade light may illuminate. Refer to appropriate checklist in TO 1-1C-1-33.*

END

CONTINUED

FLIGHT INSTRUMENT(S) MALFUNCTION/FAILURE (cont)

CONTINUED

STATIC SYSTEM MALFUNCTION

WARNING

If the static system is blocked, altimeter and VSI will show level flight regardless of aircraft's pitch attitude and power settings. With a static system leak, altimeter and VSI will display erroneous information.

NOTE

With a pilot/copilot static system blockage, airspeed will DECREASE in a climb and INCREASE in a descent. In addition, the altimeter will not change and the VSI will indicate zero.

INSTRUMENTS . . . . CHECKED (P,CP,FE)
APPROPRIATE STATIC SW . . . . ALTERNATE (P,CP)
PITOT/STATIC HTR CUR METER . . . . CHECKED (FE)

NOTE

Select Flap Limit OVRD and Elev MAN Feel lights may be on; if so, pull and reset appropriate circuit breakers (flight engineer's overhead CB panel: B15, C15, D15, and E15). Normal system operation will be regained.

INSTRUMENTS RETURN TO NORMAL

YES → END

NO → ALTERNATE STATIC SOURCE BLOCKED

ALTERNATE STATIC SOURCE BLOCKED

WARNING

As long as a pitot/static source remains blocked, the AP and ATS can only be used with the good system, i.e. pilot's source blocked, use AP 2 and ATS 2; copilot's source blocked, use AP 1 and ATS 1.

NOTE

- *If icing is the suspected cause of pitot/static blockage and pitot/static heat is inoperative, depart icing conditions. Find warmer air and increase TAT if possible.*
- *FMS CDU 1 and FMS CDU 2 normally receive inputs from CADC 1 and CADC 2 respectively. Do not rely on FMS for TRUE AIRSPEED or ETE/ETA when it is receiving bad information from the malfunctioning CADC.*
- *With the INS selector on "CAPT ON AUX", all instruments and systems that normally (switch in NORM) receive signals from INU 1, now receive signals from INU 3.*
- *With the INS selector on "F/O ON AUX", all instruments and systems that normally (switch in NORM) receive signals from INU 2, now receive signals from INU 3.*

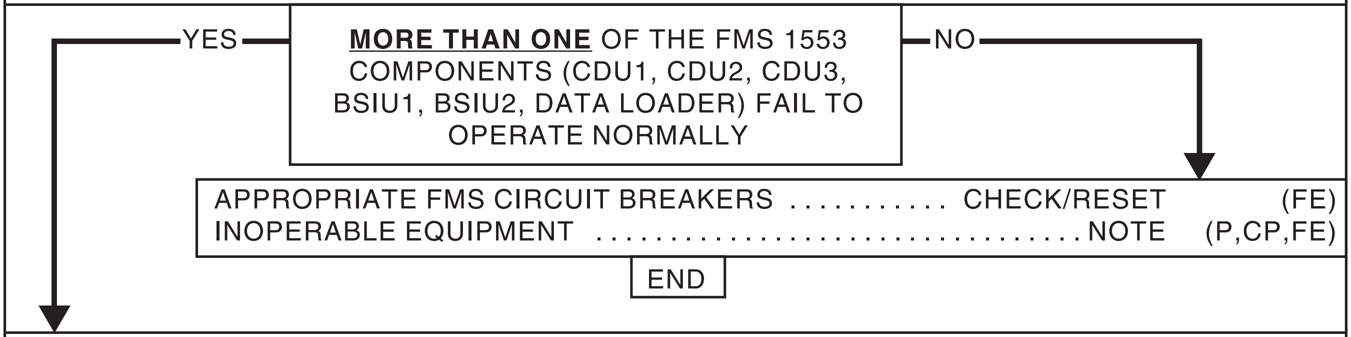
END

FMS BUS MALFUNCTION/FAILURE

NOTE

- *Do not use this checklist if system abnormalities are caused by aircraft electrical power distribution failures.*
- *If only one CDU fails, refer to CDU Malfunction/Failure checklist this section.*
- *CDU1 failure will make GPS1 and INU1 unavailable for navigation.*
- *CDU2 failure will make GPS2 and INU2 unavailable for navigation.*
- *CDU3 failure will make INU3 unavailable for navigation.*
- *BSIU1 failure will result in the loss of the pilot's FMS flight instrument displays and TACAN and ADF #1 control.*
- *BSIU2 failure will result in the loss of the copilot's FMS flight instrument displays and TACAN#2 and ADF#2 control.*
- *Data Loader failure will prevent any further download from the data cartridge(s).*

FLIGHT GUIDANCE ROLL MODE	"HDG SEL" OR "HDG HLD"	(PF)
FMS STEERING SOLUTION(S)	SELECT ALTERNATE (IF REQ'D)	(PF)
AIRCRAFT CONTROL	TRANSFER (IF REQ'D)	(PF,PNF)
AFFECTED SYSTEM(S)	DETERMINE	(P,CP,FE)



MORE THAN ONE OF THE FMS 1553 COMPONENTS (CDU1, CDU2, CDU3, BSIU1, BSIU2, DATA LOADER) FAIL TO OPERATE NORMALLY

APPROPRIATE FMS CIRCUIT BREAKERS	CHECK/RESET	(FE)
INOPERABLE EQUIPMENT	NOTE	(P,CP,FE)

END

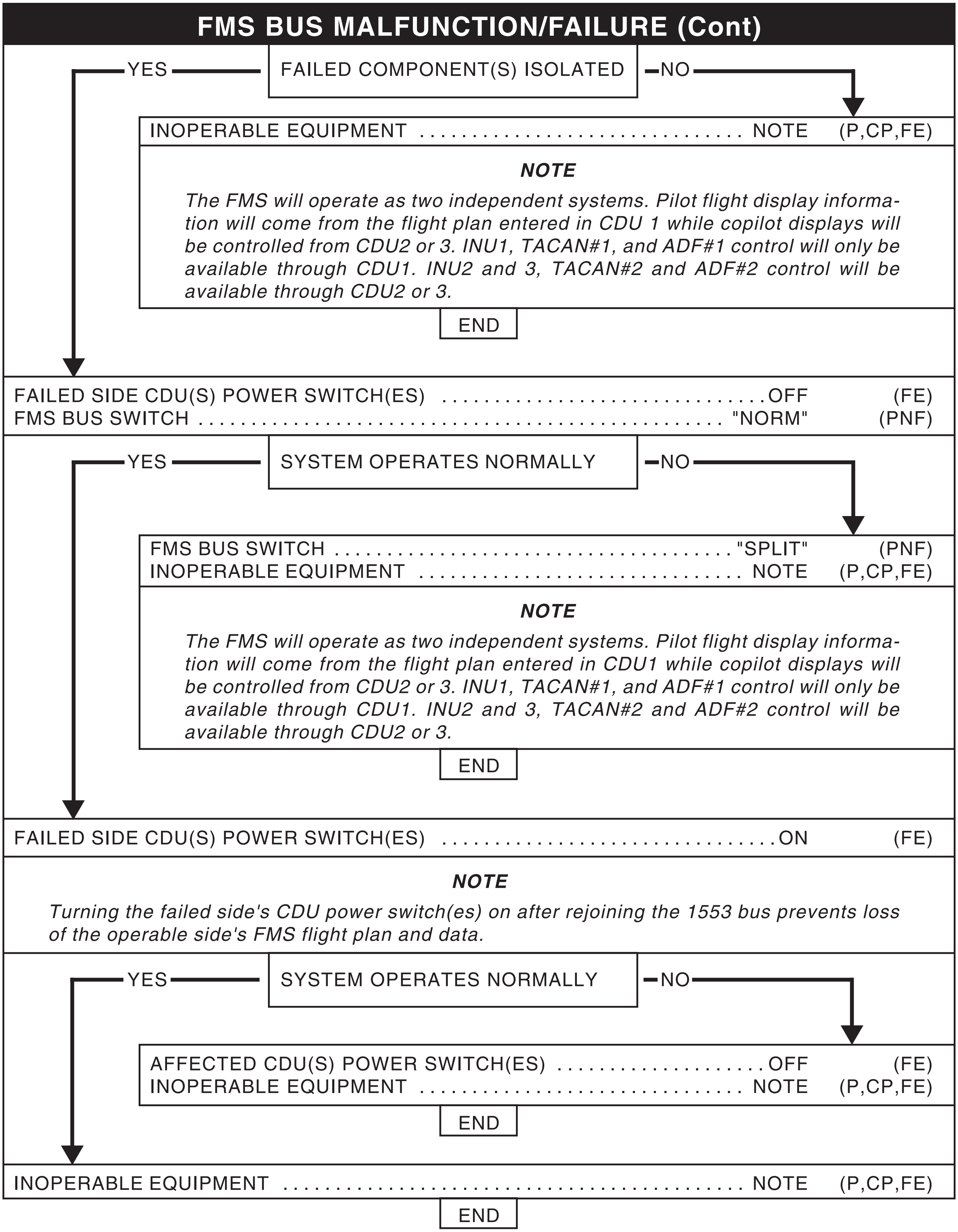
FMS BUS SWITCH	"SPLIT"	(PNF)
FAILED COMPONENT(S)	ISOLATE	(P,CP,FE)

NOTE

- *With the FMS 1553 Bus System "SPLIT", CDU1, BSIU1, and the Data Loader operate together as the left (pilot's) system and CDU2, CDU3, and BSIU2 operate together as the right (copilot's) system. Splitting the bus should return one of the systems to normal operation, however it may be necessary to manually select the restored side's GPS receiver as the active receiver.*
- *To isolate the faulty component(s), individually remove power from failed side components until that side's CDU(s) returns to normal operation. If operation is not restored, remove power from the CDU itself and leave it off. Leave the failed component(s) unpowered (power switches off or circuit breaker(s) pulled). System circuit breakers are located on the Pilot's overhead CB panel, rows D and E and the FE overhead CB panel rows D and E.*

CONTINUED

FMS BUS MALFUNCTION/FAILURE (Cont)



YES — FAILED COMPONENT(S) ISOLATED — NO

INOPERABLE EQUIPMENT . . . . NOTE (P,CP,FE)

NOTE

The FMS will operate as two independent systems. Pilot flight display information will come from the flight plan entered in CDU 1 while copilot displays will be controlled from CDU2 or 3. INU1, TACAN#1, and ADF#1 control will only be available through CDU1. INU2 and 3, TACAN#2 and ADF#2 control will be available through CDU2 or 3.

END

FAILED SIDE CDU(S) POWER SWITCH(ES) . . . . .OFF (FE)
FMS BUS SWITCH . . . . "NORM" (PNF)

YES — SYSTEM OPERATES NORMALLY — NO

FMS BUS SWITCH . . . . "SPLIT" (PNF)
INOPERABLE EQUIPMENT . . . . NOTE (P,CP,FE)

NOTE

The FMS will operate as two independent systems. Pilot flight display information will come from the flight plan entered in CDU1 while copilot displays will be controlled from CDU2 or 3. INU1, TACAN#1, and ADF#1 control will only be available through CDU1. INU2 and 3, TACAN#2 and ADF#2 control will be available through CDU2 or 3.

END

FAILED SIDE CDU(S) POWER SWITCH(ES) . . . . .ON (FE)

NOTE

Turning the failed side's CDU power switch(es) on after rejoining the 1553 bus prevents loss of the operable side's FMS flight plan and data.

YES — SYSTEM OPERATES NORMALLY — NO

AFFECTED CDU(S) POWER SWITCH(ES) .OFF (FE)
INOPERABLE EQUIPMENT . . . . NOTE (P,CP,FE)

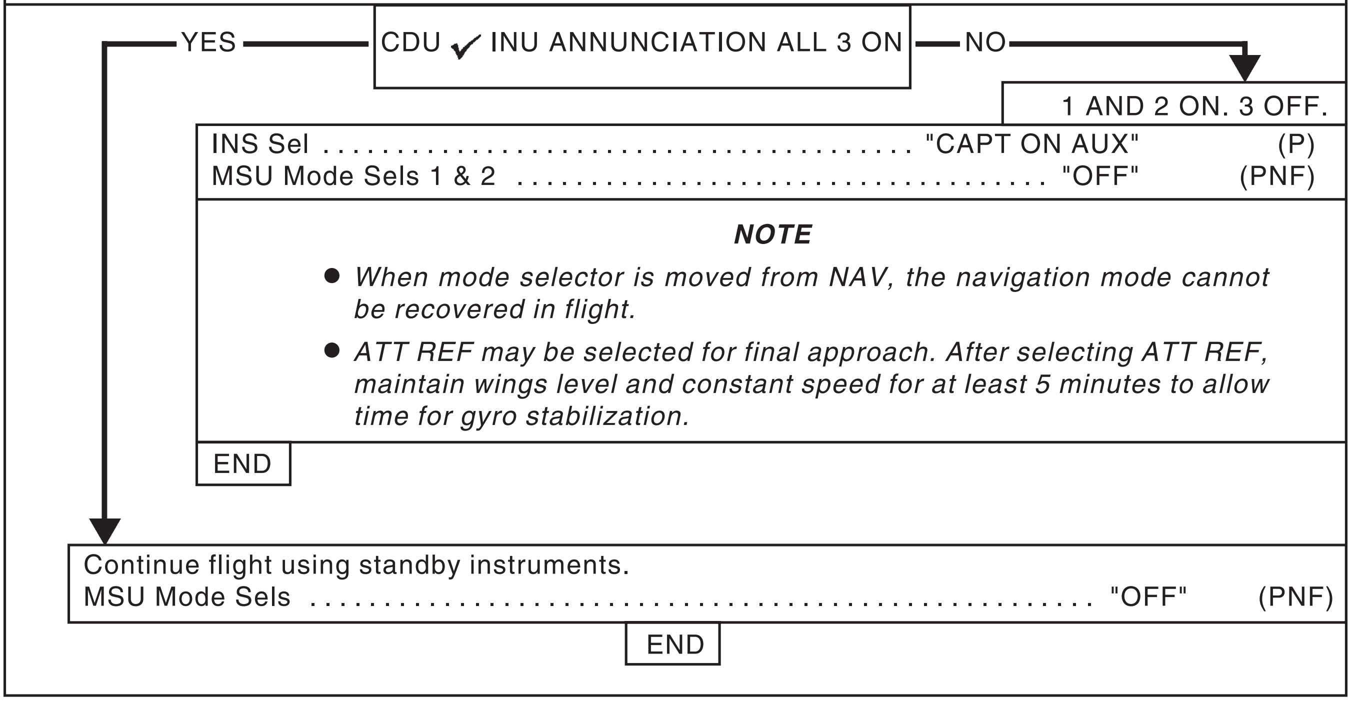
END

INOPERABLE EQUIPMENT . . . . NOTE (P,CP,FE)

END

LOSS OF ALL ATTITUDE INDICATIONS

Refer to standby instruments.



CDU ✓ INU ANNUNCIATION ALL 3 ON

1 AND 2 ON. 3 OFF.

INS Sel . . . . "CAPT ON AUX" (P)
MSU Mode Sels 1 & 2 . . . . "OFF" (PNF)

NOTE

- *When mode selector is moved from NAV, the navigation mode cannot be recovered in flight.*
- *ATT REF may be selected for final approach. After selecting ATT REF, maintain wings level and constant speed for at least 5 minutes to allow time for gyro stabilization.*

END

Continue flight using standby instruments.
MSU Mode Sels . . . . "OFF" (PNF)

END

GPS MALFUNCTION/FAILURE

NOTE

- *Do not use this checklist if system abnormalities are caused by aircraft electrical power distribution failures.*
- *CDU 1 failure will make GPS 1 and INU 1 unavailable for navigation.*
- *CDU 2 failure will make GPS 2 and INU 2 unavailable for navigation.*
- *If any CDU fails, refer to the CDU Malfunction/Failure checklist.*

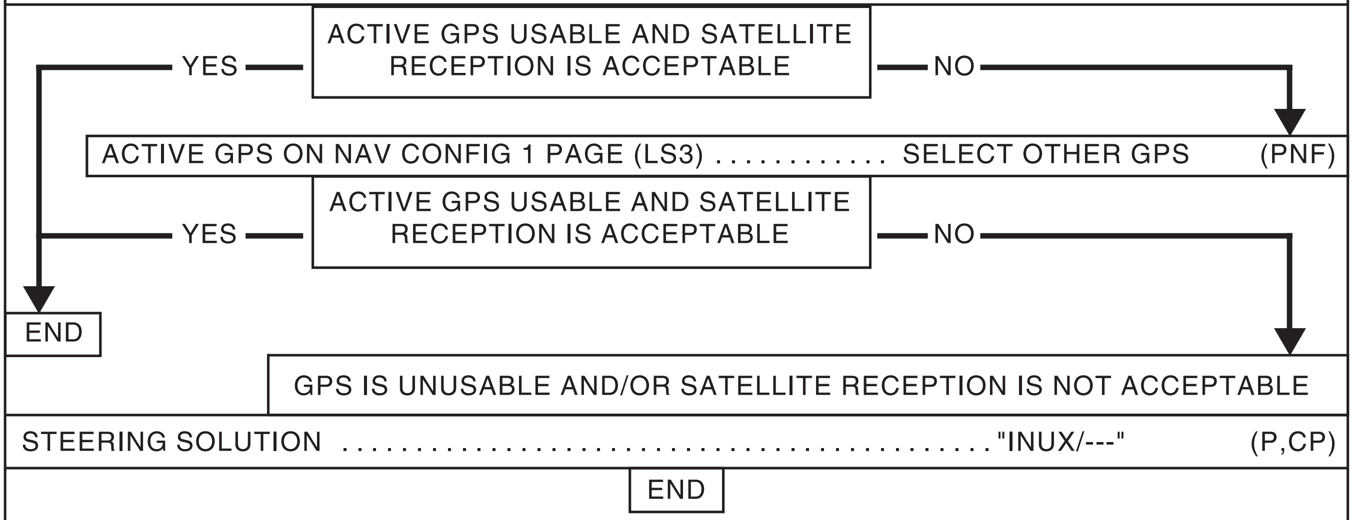
FLIGHT GUIDANCE ROLL MODE .... "HDG SEL" OR "HDG HOLD" (PF)
AIRCRAFT CONTROL .... TRANSFER (IF REQ'D) (PF,PNF)
GPS STATUS .... DETERMINE (PF,PNF,FE)
SATELLITE STATUS .... DETERMINE (PF,PNF,FE)

CAUTION

- *Do not manually update INU(s). This can cause adverse effects to the Kalman filter models, temporarily degrading the Kalman filtered navigation solution.*
- *Do not use "INAV RESET". This will eliminate the benefit of the INU error estimates provided by the Kalman filter.*

NOTE

- *Should GPS fail ("INUX/---" displayed), the Kalman filter continues to maintain and apply the INU error corrections to improve the quality of the INU data.*
- *The integrated navigation solution accuracy during extended GPS outages is also improved over a stand alone INU provided GPS has been available for a sufficient amount of time (about 30 minutes) to allow the Kalman filter to properly estimate the INU errors.*



ACTIVE GPS ON NAV CONFIG 1 PAGE (LS3) .... SELECT OTHER GPS (PNF)

GPS IS UNUSABLE AND/OR SATELLITE RECEPTION IS NOT ACCEPTABLE

STEERING SOLUTION .... "INUX/---" (P,CP)

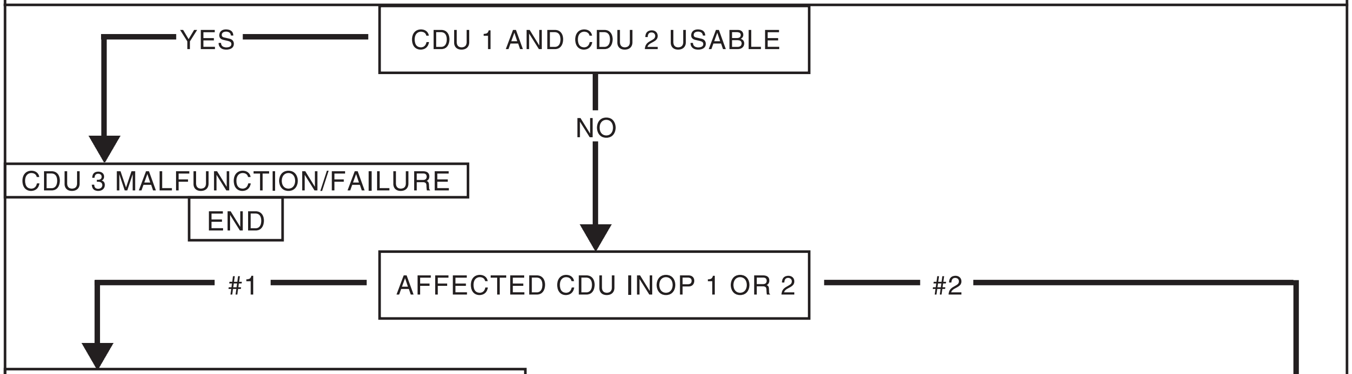
END

CDU MALFUNCTION/FAILURE

NOTE

- *Do not use this checklist if system abnormalites are caused by aircraft electrical power distribution failures.*
- *CDU 1 failure will make GPS 1 and INU 1 unavailable for navigation.*
- *CDU 2 failure will make GPS 2 and INU 2 unavailable for navigation.*
- *CDU 3 failure will make INU 3 unavailable for navigation.*
- *If more than one CDU fails, refer to the FMS Bus Malfunction/Failure checklist.*

FLIGHT GUIDANCE ROLL MODE	"HDG SEL" OR "HDG HOLD"	(PF)
AIRCRAFT CONTROL	TRANSFER (IF REQ'D)	(PF,PNF)
CDU STATUS	DETERMINE	(P,CP,FE)



CDU 1 MALFUNCTION/FAILURE

AP	USE 2	(PF)
INS SEL SW	"CAPT ON AUX"	(PNF)
ACTIVE GPS ON NAV CONFIG 1 PAGE (LS3)	SELECT GPS 2	(PNF)
INU SENSOR AID ON NAV CONFIG 1 PAGE (LS4)	SELECT INU 2	(PNF)
ADC SENSOR AID ON NAV CONFIG 1 PAGE (LS8)	SELECT ADC 2	(PNF)

END

CDU 2 MALFUNCTION/FAILURE

AP	USE 1	(PF)
INS SEL SW	"FO ON AUX"	(PNF)
ACTIVE GPS ON NAV CONFIG 1 PAGE (LS3)	SELECT GPS 1	(PNF)
INU SENSOR AID ON NAV CONFIG 1 PAGE (LS4)	SELECT INU 1	(PNF)
ADC SENSOR AID ON NAV CONFIG 1 PAGE (LS8)	SELECT ADC 1	(PNF)

END

INU MALFUNCTION/FAILURE

NOTE

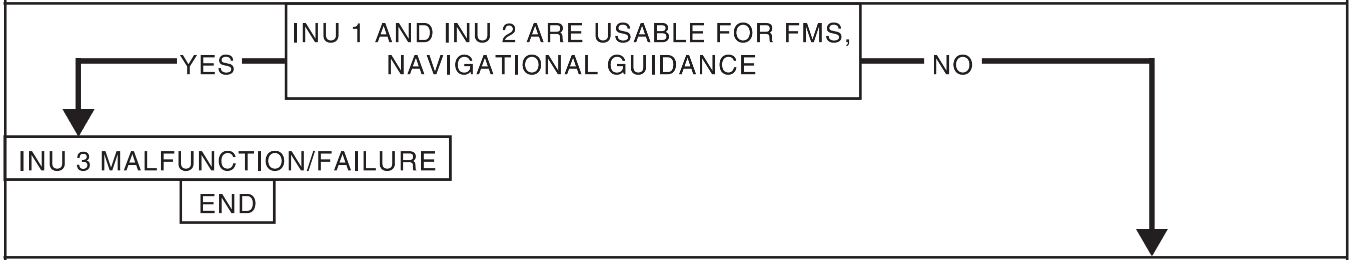
- *Do not use this checklist if system abnormalities are caused by aircraft electrical power distribution failures.*
- *CDU 1 failure will make GPS 1 and INU 1 unavailable for navigation.*
- *CDU 2 failure will make GPS 2 and INU 2 unavailable for navigation.*
- *CDU 3 failure will make INU 3 unavailable for navigation.*
- *If any CDU fails, refer to the CDU Malfunction/Failure checklist.*
- *If more than one INU fails, refer to the FMS Bus Malfunction/Failure checklist.*

FLIGHT GUIDANCE ROLL MODE	"HDG SEL" OR "HDG HOLD"	(PF)
AIRCRAFT CONTROL	TRANSFER (IF REQ'D)	(PF,PNF)
DTK-STS (LS1) ON INU 1(2,3) CONTROL PAGE	SELECT	(P,CP,FE)

NOTE

- *More than one malfunction code can exist. Repeated pushing of the Hold key (LS5) gives a sequential display of malfunctions.*
- *Malfunction display is cancelled by pushing the clear line select key (LS3).*

HOLD KEY (LS5)	SELECT	(PNF)
ACTION/MALFUNCTION CODES	RECORD	(PNF)
STATUS OF AFFECTED SYSTEM	DETERMINE	(PNF)



INS SEL SW	"CPT(FO) ON AUX"	(PNF)
"INU3/GPS" STEERING SOLUTION (AFFECTED SYSTEM) STR PAGE (LS1)	VERIFY	(PNF)

ACTION AND MALFUNCTION CODES

MALF CODE	ACTION CODE	RECOMMENDED ACTION	INU ANNUNCIATION
11-18	1	REMOVE SYSTEM. MAINTENANCE REQUIRED	ON (E)
19-21 23	2(B)	CYCLE SYSTEM THROUGH OFF-ON SEQUENCE REENTER PRESENT POSITION	ON
22	3(B)	CYCLE SYSTEM BACK TO STBY. REENTER PRESENT POSITION	ON
04-08 10	4(C)	DO NOT USE INU FOR FMS GUIDANCE TO EHSI OR STEERING. CHECK ALL ASSOCIATED 26V, 400HZ CIRCUIT BREAKERS	OFF
03	5(D)	NO ACTION RECOMMENDED	OFF
24	6(B)	TURN OFF. CHECK INS CIRCUIT BREAKERS AND RESTART	ON
02	7	CHECK FOR REMOVAL OF ATTITUDE SLEW TEST CONNECTOR	ON
01	8(A)	DO NOT USE INU SOLUTION FOR FMS GUIDANCE TO EHSI OR STEERING	OFF (F)

END

LOSS OF CONTROL BY CONVENTIONAL PILOT INPUTS

If conventional control inputs are not possible, alternate control (with autopilot) may be effected as follows:

NOTE

- *Aircraft are occasionally subjected to conditions beyond those normally encountered or considered for certification. The KC-10 has certain inherent and unique safety features which help accommodate these conditions, but which may not be readily apparent to the operators.*
- *For example, the autopilot may remain operative although extensive damage has occurred to the primary manual control system. If, in the judgment of the flight crew, they are unable to control the aircraft by use of conventional pilot operated controls, it may be possible to control the aircraft through the autopilot during subsequent phases of flight. This capability is a result of the isolated overhead location of the autopilot wiring and the fact that the wiring terminates at integral servo valves mounted directly on primary control system actuators.*
- *All flight crew members should be aware of the capabilities of the appropriate functional autopilot modes to recover and direct the aircraft to a safe landing if conventional control is lost.*

ATS Lever . . . . "ON" (PF)
AP Lever . . . . "CMD" (PF)

Move an autopilot lever to CMD. Observe autopilot roll aircraft to wings level (if not already level) and maintain existing heading and vertical speeds.

NOTE

- *If AP lever will not remain in CMD, or control is not regained, move other AP lever to CMD.*
- *Hydraulic system 2 must be operative for autopilot 1 to be operative.*
- *Hydraulic systems 1 and 3 must be operative for autopilot 2 to be operative.*
- *Hydraulic systems 1 or 2 must be operative before autopilot automatic pitch trim will function.*

Vertical Speed/Heading . . . . "SET" (PF)

Manually rotate vertical speed select wheel to maintain or establish desired vertical speed. Pitch FMA will display VERT SPD or ALT HOLD.

NOTE

If heading select mode is not engaged, verify desired heading is set in heading readout. Pull heading control knob and observe HDG SEL in roll FMA's.

GEAR Handle/Lts . . . . "DOWN/4 GREEN" (P,CP,FE)

Lower landing gear using appropriate procedure. Observe green gear lights on.

CONTINUED

LOSS OF CONTROL BY CONVENTIONAL PILOT INPUTS (cont)

On approach,

FLAP/SLAT Handle . . . . "FINAL APPROACH SETTING" (PNF)

Using appropriate procedure, move FLAP/SLAT handle to final approach setting prior to start of descent.

SPD Readout . . . . "FINAL APPROACH SPEED" (PF)

Rotate speed control knob so desired final approach speed appears in speed readout.

Verify landing preparation complete.

At final approach descent point,

Vertical Speed Select Wheel . . . . "600 FPM DESCENT" (PF)

Rotate vertical speed select wheel to establish approximately 600 fpm rate of descent (or as required).

Approximately 50 feet above landing runway, reduce descent to provide landing attitude.

After main gear contacts runway, rotate vertical speed select wheel to a descent to lower nose gear to runway.

After nose gear contacts runway,

AUTOPILOT REL Button . . . . "PUSH" (PF)

Push autopilot release button twice (to disengage autopilot and turn off flashing AP fail lights).

Manually maintain runway alignment.

Throttles . . . . "REVERSE THRUST" (PF)

Rotate throttle levers into reverse thrust. Observe autothrottle levers drop to OFF.
Push autothrottle disengage button to turn off flashing ATS fail lights.

NOTE

- *If a coupled ILS approach is desired, set ILS frequency and course in appropriate readouts. Push ILS mode switch when inbound on localizer intercept heading. Complete coupled approach procedure.*
- *Use vertical speed select wheel to place aircraft in a flare attitude at approximately 50 feet above the runway. Manual rotation of vertical speed select wheel will disengage the ILS mode, and roll and pitch FMA's display HDG HOLD and VERT SPD.*

END

NO FLAP/NO SLAT LANDING

Gross Weight .... REDUCE (P,FE)

NOTE

When dumping fuel to obtain the lowest practical gross weight, maximum tire speed of 204 kts should be considered.

IAS .... DETERMINE MIN MAN & THRESHOLD SPEEDS FOR 0°/RET CONFIGURATION (FE)

Plan wide pattern for speed stabilization on final.

IAS .... "230 KTS MAXIMUM" (PF)

Reduce to gear free fall speed (230 KIAS maximum).

Alternate Gear Extension Lever - Main Gear .... "RAISE/LATCH" (CP)

NOTE

- *Use of the main gear alternate extension lever is required to unlock the outboard ailerons.*
- *With alternate gear extension lever in raised position, nose gear steering to the right is limited to 25°.*

GEAR Lts .... "3 GREEN" (P,CP,FE)

CAUTION

- *After alternate extension of main gear, wait until gear is extended (3 GREEN lights) before next action.*
- *After alternate gear extension, do not exceed 260 KIAS.*

Alternate Gear Extension Handle - Center Gear .... PULL (FE)
GEAR Lts .... "4 GREEN" (P,CP,FE)
GEAR Handle .... "DOWN" (CP)
GND PROXIMITY WARN FLAP OVRD Sw .... OVRD/ON (FE)
Approp Normal Checklist .... COMPLETE (P,CP,FE)
IAS (for approach) .... "MIN MAN & THRESHOLD SPEED FOR 0°/RET" (PF)

NOTE

- *Fly min man speed until turn to base leg. Reduce speed 10 knots on base leg in level flight.*
- *After stabilization on final approach, further reduce speed (in level flight) until approach speed is achieved.*
- *Fly a normal glideslope. At threshold, retard throttles to idle, and use a slight flare. Do not hold aircraft off the ground.*
- *Attempts to hold the aircraft off results in float, waste of runway, and the possiblity of tail strike.*
- *Auto slats may deploy during the flare.*

CONTINUED

NO FLAP/NO SLAT LANDING (cont)

NO FLAP/NO SLAT LANDING
RESULT OF DUAL FAILURE
OF HYD SYSTEMS 1 & 2

YES

NO

When landing is assured, release main gear alternate extension lever spring latch and hold aft of approximately 45° raised position until touchdown to keep the outboard ailerons unlocked. After aircraft is firmly on the ground, restow alternate gear extension lever to make nose gear steering availabe for remaining rollout.

On touchdown, positively lower nose gear to runway, and immediately apply reverse thrust and brakes as required. Full reverse thrust may be used to complete stop, if necessary.

Verify spoilers extend to ground spoiler position.

After landing rollout, stow Altn Gear Ext lever to restore full NG steering.

NOTE

Time permitting, refer to No Flap/No Slat Landing text.

END

NO FLAP/NO SLAT LANDING

If multiple malfunctions occur that prevent the use of both flaps and slats for landing, use the following procedure.

Review Emergency Checklist (DUAL HYDRAULIC SYSTEM FAILURE) to determine effect on aircraft systems and controllability.

Reduce gross weight by dumping fuel to the lowest practical level. Obtain minimum maneuvering and threshold speed for 0°/RET. Limiting tire speed may be a factor.

Plan a wide pattern, if visual, or use a longer than normal intercept for ILS localizer.

Extend the gear with the alternate gear extension lever, IAS 230 KTS or less. This unlocks the outboard ailerons. Lowering the gear aids in speed stabilization.

Maintain minimum maneuvering speed throughout the pattern (vectors) until the base turn begins. Bleed off 10 knots on base leg (final vector) in level flight.

When stabilized on the final approach heading (course), further decelerate while in level flight until threshold speed for 0°/RET is achieved. A final approach that provides a level portion (for speed stabilization) must be employed. Deceleration will be slow and acceleration rapid.

Fly a normal glideslope angle. Do not fly a flat approach or attempt to drag in the aircraft. This complicates finding the correct target touchdown point.

When the threshold is attained, an increase in control effectiveness due to ground effect is apparent, especially in elevator control.

Reduce the throttles to idle and use a slight flare to diminish the sink rate. Do not hold the aircraft off. Flaring results in float and waste of runway.

On touchdown, take positive action to lower the nose gear to the runway. This permits spoiler deployment and No. 2 engine reverse thrust.

Use reverse thrust immediately. Reverse thrust is most effective at high speeds and provides auto-spoiler deployment. For no flap/no slat landing profile see figure 5-26.

SELECT ELEV FEEL MAN LT ON

ELEV FEEL Sel . . . . "MAN" (P)
ELEV FEEL Ref IAS . . . . "SET" (P)

Rotate MAN SLEW selector so elevator feel reference IAS pointer approximates the aircraft IAS.

NOTE

- *The elevator feel must be manually changed by use of the manual slew selector to maintain approximate agreement with aircraft IAS.*
- *The SELECT ELEV FEEL MAN light on indicates a failure of the automatic feel system to maintain the elevator feel reference IAS in an acceptable relationship to aircraft IAS.*

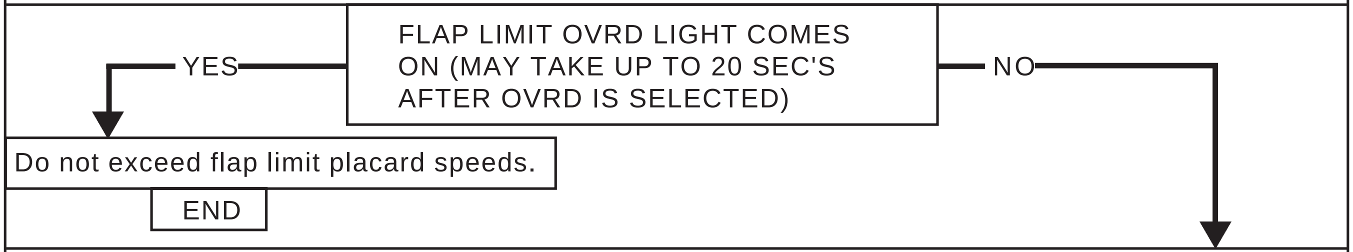
END

SELECT FLAP LIMIT OVRD LT ON

CAUTION

- *Structural damage may occur if flap limit airspeeds are exceeded.*
- *If final flap selection is less than 35° it is possible the boom will contact the runway at 13° body angle, struts extended and 11° struts compressed.*

FLAP LIMIT Sel . . . . "OVRD 1" (P)

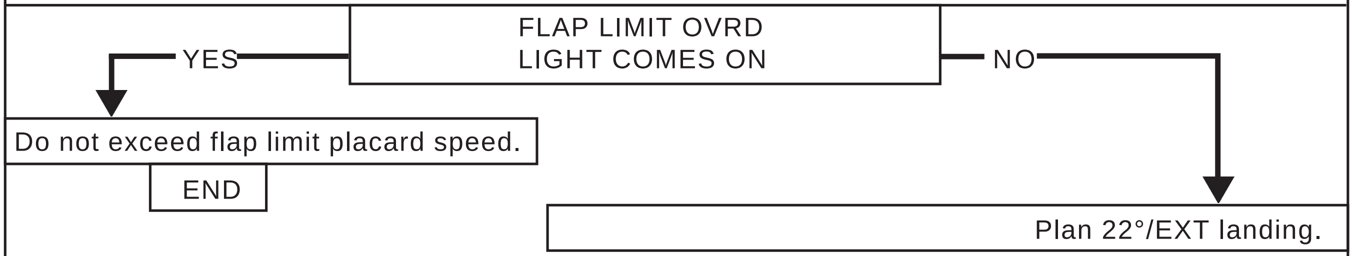


FLAP LIMIT OVRD LIGHT COMES ON (MAY TAKE UP TO 20 SEC'S AFTER OVRD IS SELECTED)

Do not exceed flap limit placard speeds.

END

FLAP LIMIT Sel . . . . "OVRD 2" (P)



FLAP LIMIT OVRD LIGHT COMES ON

Do not exceed flap limit placard speed.

END

Plan 22°/EXT landing.

NOTE

- *Do not use ATS.*
- *If final flap setting is 22° or less, move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.*
- *When landing with less than 35° flaps automatic spoiler extension with main gear spinup is inoperative. Spoilers will extend automatically with reverse lever actuation.*

END

SLAT DISAGREE LIGHT COMES ON DURING TAKEOFF AFTER V_1

SPEED . . . . .0°/RET ATTAIN/MAINTAIN (PF)

Accelerate to and/or maintain V_2+10 until reaching minimum acceleration height. At level off altitude, reduce pitch attitude and accelerate to 0°/EXT MIN MAN. Retract flaps and continue acceleration to 0°/RET MIN MAN.

NOTE

- *Although V_2 +10 may be in the stick shaker range, it should provide adequate margin to continue climbing to the level off altitude.*
- *V_2+10 should provide adequate control wheel effectiveness in maintaining lateral controllability if slat asymmetry exists. Do not engage autopilot or autothrottles, speed control may not be valid. As speed increases, if slat asymmetry exists, control wheel deflection to maintain wings level may increase or decrease, and may possibly include a reversal in direction.*

SLATS . . . . .RETRACT AND INSPECT (PNF,BO)

SLATS OPERATE NORMAL

YES

Continue with normal operations, maintenance required after flight.

END

NO

Accomplish the appropriate checklist (i.e. ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS, or SLAT DISAGREE LIGHT ON.

Land as soon as practical.

END

SLAT DISAGREE LIGHT ON

CAUTION

During takeoff or go-around, do not move FLAP/SLAT handle until a safe altitude and airspeed has been attained.

NOTE

- *If slat asymmetry is indicated at any time by a trim change, return the FLAP/SLAT handle to the last position where slats were symmetrical and refer to ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS.*
- *During slat retraction, if the SLAT DISAGREE light remains on, do not exceed 270 KIAS or 0.55M whichever is less. If desired, cycle the FLAP/SLAT handle to the previous position and return. Observe the SLAT DISAGREE light. If the light remains on, continue with this procedure.*

FLAP/SLAT Handle .... "RETURN TO LAST POSITION WHERE SLAT DISAGREE LIGHT WAS OFF" (PNF)
AP Levers .... "OFF" (PF)
ATS Levers .... "OFF" (PF)

NOTE

Do not use autothrottles or speed control system (speed schedule may not be valid).

YES — SLAT RESET SWITCH-LIGHT ON — NO

Refer to Abnormal Procedures, UNSCHEDULED AUTO SLAT EXTENSION.

END

FLAP/SLAT Handle Selection when SLAT DISAGREE Light came ON .... DETERMINE (P,CP,FE)

YES — DURING EXTENSION — NO

FLAP/SLAT Handle Position .... OBSERVE (PNF)

YES — HANDLE POSITION UP/RET (SLAT DISAGREE LIGHT ON OR OFF) — NO

Refer to ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS.

END

22°/EXT (SLAT DISAGREE light on or off).

Land with FLAP/SLAT handle in 22°/EXT, using 22°/EXT speeds.

NOTE

When retracting slats, they will not retract beyond the commanded position, so returning the handle to 22°/EXT position ensures a known configuration.

GND PROXIMITY WARN FLAP OVRD Sw .... OVRD/ON (FE)

NOTE

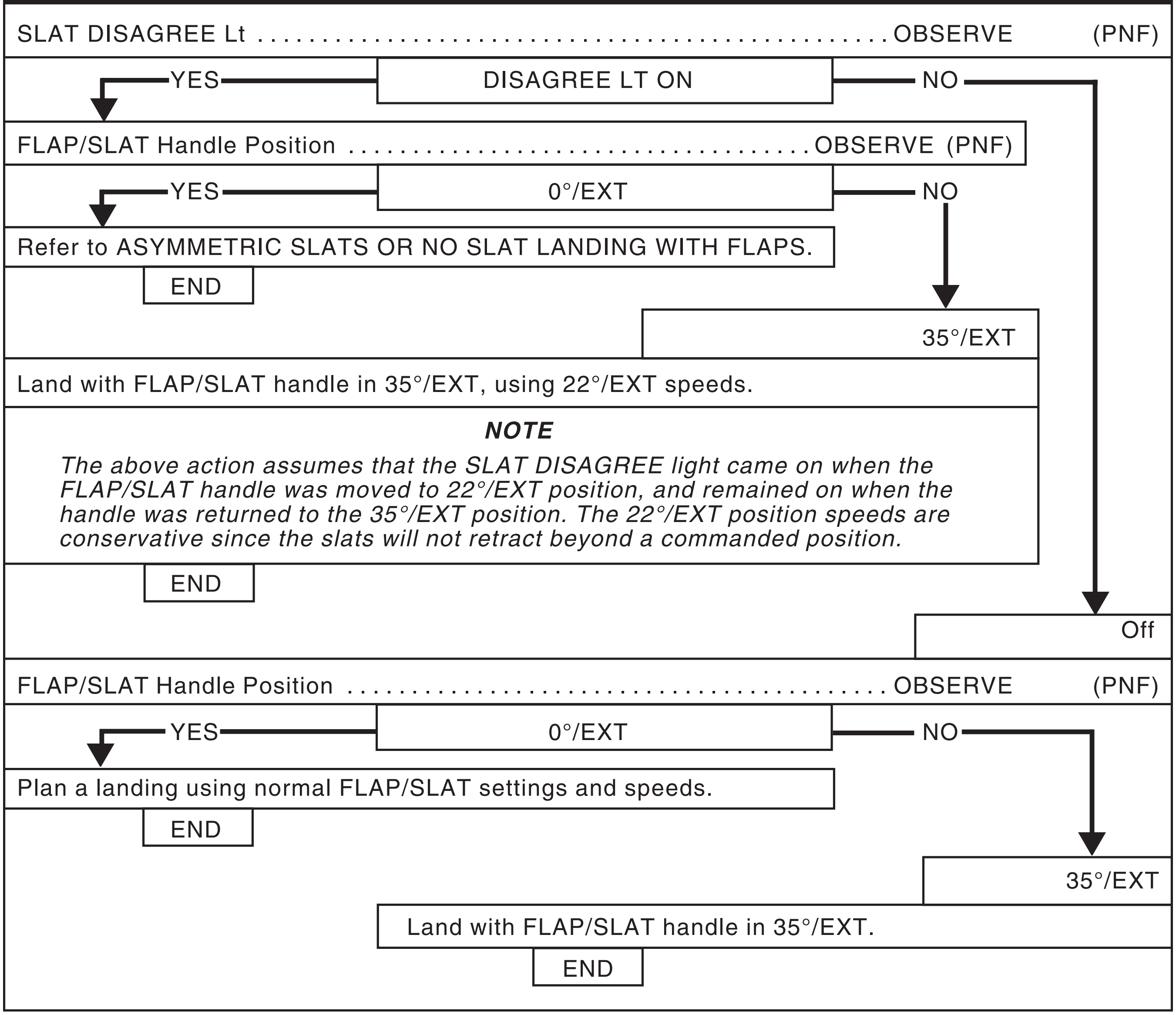
After nose gear is on runway with spoiler handle in ARM, spoilers extend automatically by reverser lever actuation.

END

DURING RETRACTION

CONTINUED

SLAT DISAGREE LIGHT ON (cont)



SLAT DISAGREE Lt . . . . OBSERVE (PNF)

FLAP/SLAT Handle Position . . . . OBSERVE (PNF)

Refer to ASYMMETRIC SLATS OR NO SLAT LANDING WITH FLAPS.

END

Land with FLAP/SLAT handle in 35°/EXT, using 22°/EXT speeds.

NOTE

The above action assumes that the SLAT DISAGREE light came on when the FLAP/SLAT handle was moved to 22°/EXT position, and remained on when the handle was returned to the 35°/EXT position. The 22°/EXT position speeds are conservative since the slats will not retract beyond a commanded position.

END

FLAP/SLAT Handle Position . . . . OBSERVE (PNF)

Plan a landing using normal FLAP/SLAT settings and speeds.

END

Land with FLAP/SLAT handle in 35°/EXT.

END

STABILIZER INOPERATIVE

NOTE

This procedure applies when it is determined that the stabilizer is inop by use of the CONTROL WHEEL TRIM switches, ALTN TRIM switches and LONG TRIM handles.

Reduce elev feel force as desired,

ELEV FEEL Sel . . . . "MAN" (P)
MAN SLEW Sel . . . . HOLD IN DECR UNTIL DESIRED ELEV FEEL FORCE IS ATTAINED (P)
AP Levers . . . . CWS IF DESIRED (PF)

CAUTION

CWS disengagement due to excessive control inputs will require prompt action by the pilots.

NOTE

Engaging CWS mode reduces control pressure required by pilots due to out of trim condition. Use of CWS for landing will be at discretion of Pilot.

Make approach and landing with FLAP/SLAT handle 35°/EXT.

NOTE

If flaps are at 50° and aircraft is trimmed, land with 50° flaps.

CG Position . . . . TRANSFER FUEL TO OBTAIN OPTIMUM FOR MIN SPD ADDITIVE (FE)
Speed Additive . . . . DETERMINE (FE)

THRESHOLD SPEED ADDITIVE (KIAS) FOR STABILIZER INOP LANDING							
CG-% MAC	26	0	0	0	0	0	0
	24	4	0	↓	↓	↓	↓
	22	8	4	↓	↓	↓	↓
	20	11	8	0	↓	↓	↓
	18	16	11	3	↓	↓	↓
	16	20	15	7	0	↓	↓
	14	24	19	10	4	0	↓
	12	28	23	14	7	1	↓
	10	34	27	18	10	4	0
	8	37	31	21	14	7	1
STAB. ANGLE		-1 AND	0	+2 ANU	+4	+6	+8

GEAR Handle/Lts . . . . "DOWN/____GREEN" (P,CP,FE)
FLAP/SLAT Handle . . . . "35°/EXT" (PNF)
IAS (For Approach and Landing) . . . . "35° FLAPS V_{TH} SPD PLUS SPD INCREMENT" (PF)
Approp Normal Checklists . . . . PERFORM (P,CP,FE)

CAUTION

Avoid high sink rate. Maintain thrust until flare is accomplished. Elevator may be partially displaced and aircraft response may be slower than normal. Be prepared to use maximum control column force for flare.

NOTE

If go around is required, use normal procedure but do not allow airspeed to go below 35° flaps threshold speed plus speed increment.

END

UNSCHEDULED AUTO SLAT EXTENSION

NOTE

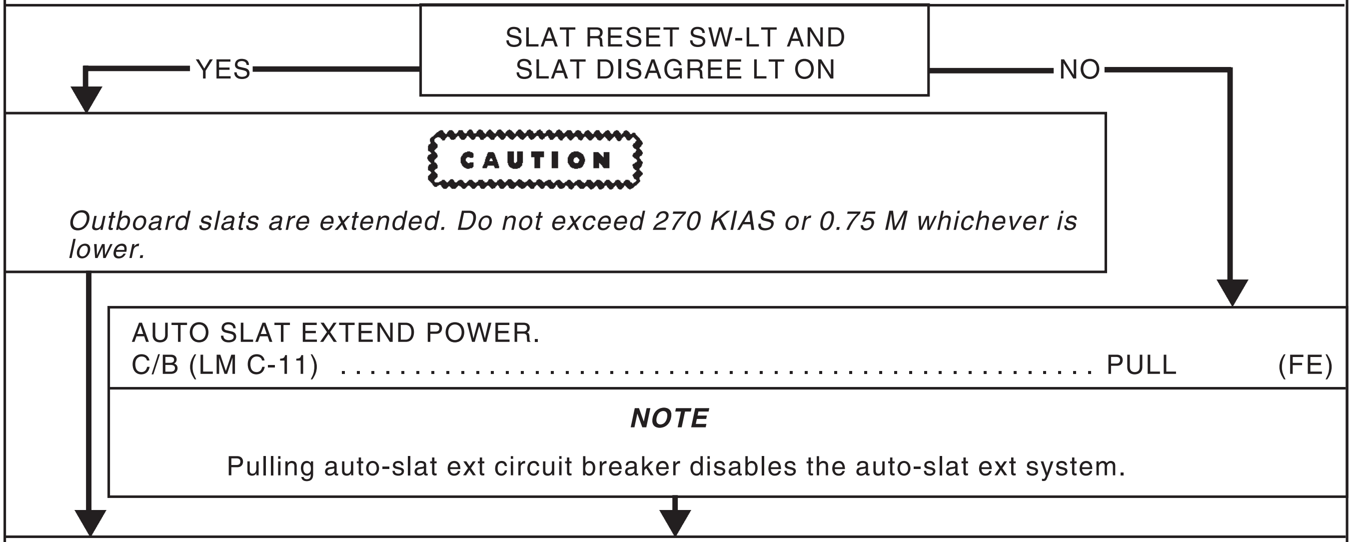
Unscheduled automatic slat extension is most likely to result from a malfunction in the stall warning system. In such cases, operation of the stick shaker may be expected.

AT/SC STALL WARN C/B's (2) (FO B, D-13) . . . . PULL (FE)

NOTE

Pulling circuit breakers deactivates auto throttle, speed control and stall warning systems.

AUTO SLAT EXTEND CONT C/B (LM F-11) . . . . PULL/RESET (FE)
SLAT RESET Sw-Lt . . . . "PUSH" (PNF)



SLAT RESET SW-LT AND
SLAT DISAGREE LT ON

YES

CAUTION

Outboard slats are extended. Do not exceed 270 KIAS or 0.75 M whichever is lower.

NO

AUTO SLAT EXTEND POWER.
C/B (LM C-11) . . . . PULL (FE)

NOTE

Pulling auto-slat ext circuit breaker disables the auto-slat ext system.

AT/SC STALL WARN C/B (FO B, D-13) . . . . .RESET (FE)

NOTE

- *Resetting of circuit breakers may return autothrottle, speed control and stall warning systems to normal. If the unscheduled automatic slat extension resulted from a malfunction of the stall warning system, operation of the stick shaker may be expected if the malfunction is still present.*
- *If stick shaker is activated, pull the AT/SC STALL WARN circuit breaker that stops the stick shaker. AT/SC STALL WARN circuit breakers control separate circuits of a dual system. If stick shaker stops when one circuit breaker is pulled, assume malfunctioning system has been identified. Resetting of the AUTO SLAT EXTEND POWER circuit breaker (if pulled) is not recommended.*

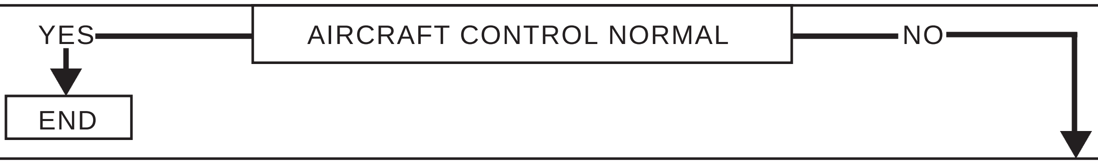
END

UPPER/LOWER YAW DAMP INOP LT(S) ON

NOTE

- *There is no limitation associated with all yaw dampers inoperative. Smooth flying technique will prevent inadvertent dutch roll.*
- *Any one yaw damp switch in ON and yaw damper operative will permit either autopilot lever to be engaged in CWS or CMD.*

YAW DAMP Sws (Upr OR Lwr) . . . . "OFF" (P)
YAW DAMP Sw A (Affected Sys) . . . . "ON" (P)



YAW DAMP Sw A . . . . "OFF" (P)
YAW DAMP Sw B . . . . "ON" (P)

YAW DAMP Sw B . . . . "OFF" (P)

Continue with affected system inop.

END

ALL FUEL QUANTITY INDICATORS INOPERATIVE

FUEL QTY IND PWR Sw . . . . ALTN (FE)

END

ALTN TRANS VALVE DISAGREE LIGHT ON

ALTN TRANS VALVE CLOSED

YES

Continue flight, use other ALTN TRANS VALVE as required.

NOTE

If fuel dump is required, the flow rate will be reduced from the tank with the failed closed ALTN TRANS VALVE.

END

NO

NOTE

- *Fuel cannot be transferred into affected tank simultaneously with offload.*
- *Fuel transfer will fill AR manifold and a portion of that fuel may become unusable. Fuel scavenged from the AR manifold will transfer into No. 2 and aft tank. If the aft alternate transfer valve is inoperative in the open position, scavenging the fuel in the AR manifold will only result in the fuel scavenged into the No. 2 tank being available for use. The fuel scavenged to the aft tank will only refill the AR manifold when the aft tank boost pump is selected on.*

END

AIR REFUELING RECEIVER SYSTEM DOES NOT ADVANCE TO LATCHED

Prior to initiating this checklist, recycle receptacle door to ensure hydraulic pressure is available to UARRSI.

AR Signal System Override Sw . . . . OVRD

CAUTION

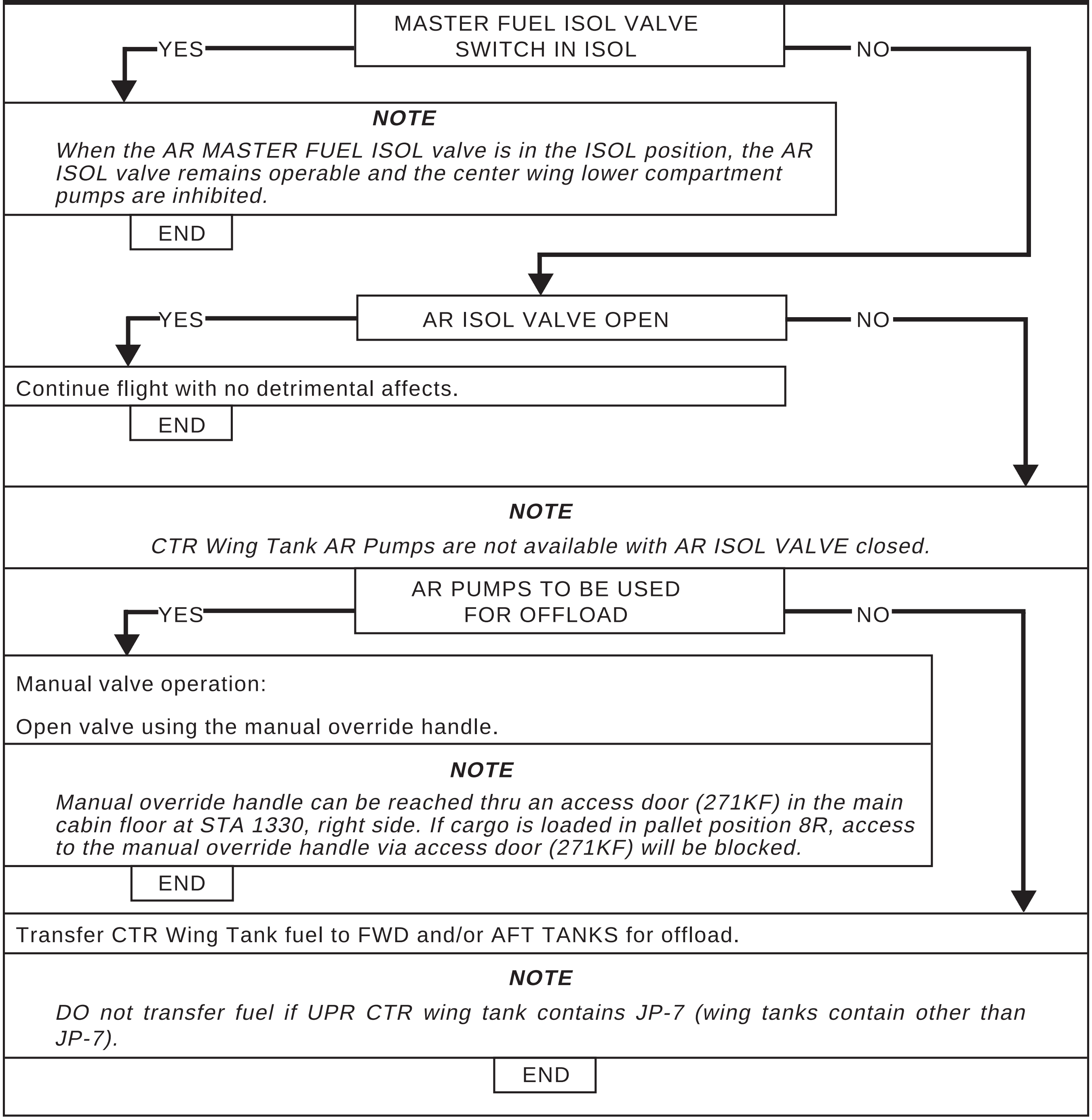
When operating in manual boom latching mode (override) the receiver must initiate all disconnects.

NOTE

- *This action will bypass the signal amplifier and switch the system power from BUS NO. 1 to BUS NO. 3.*
- *Interphone function between tanker and receiver is not affected.*
- *The OVRD switch should be selected whenever the signal amplifier has failed.*

END

AIR REFUELING ISOL VALVE DISAGREE LIGHT ON



NOTE

When the AR MASTER FUEL ISOL valve is in the ISOL position, the AR ISOL valve remains operable and the center wing lower compartment pumps are inhibited.

Continue flight with no detrimental affects.

NOTE

CTR Wing Tank AR Pumps are not available with AR ISOL VALVE closed.

Manual valve operation:

Open valve using the manual override handle.

NOTE

Manual override handle can be reached thru an access door (271KF) in the main cabin floor at STA 1330, right side. If cargo is loaded in pallet position 8R, access to the manual override handle via access door (271KF) will be blocked.

Transfer CTR Wing Tank fuel to FWD and/or AFT TANKS for offload.

NOTE

DO not transfer fuel if UPR CTR wing tank contains JP-7 (wing tanks contain other than JP-7).

AIR REFUELING MASTER VALVE STUCK OPEN/CLOSED

NOTE

When AR MASTER switch is selected the associated light (in switch) does not indicate the selected position.

YES — VALVE POSITION OPEN — NO

YES:

Continue flight with no detrimental affects.

NOTE

- *Fuel transfer will fill aerial refueling manifold which requires scavenge to make fuel usable.*
- *If desired, valve can be closed by use of manual override handle located in right main cabin wall at STA 1145. (See figure below.)*

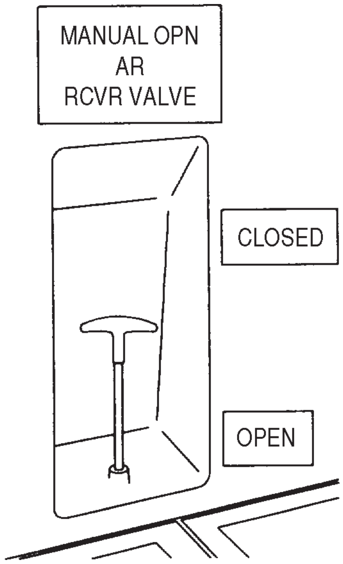
END

NO:

Valve . . . . OPEN MANUALLY (FE,BO)

NOTE

- *Manual override handle is located in right main cabin wall at STA 1145. (See figure below.)*
- *Manual operation of the valve is also possible by entering the center accessory compartment and manually position the valve to OPEN. The valve is located on the forward side of CTR TANK bulkhead, left side of compartment.*
- *If valve remains closed, no aerial refueling onload is possible.*
- *Once actuated to open or close the AR MASTER valve, the T-handle will return to the neutral position.*



CAG(IGDS)

SA1-547

END

BODY TANK FILL VALVES AND ISOL VALVES WILL NOT OPEN

NOTE

With FILL/ISOL VALVE switch selected to open, flow indicator light comes on, but associated OPEN light does not come on, or ISOL VALVE DISAGREE light is on steady.

When fuel transfer/onload is desired,
Body Tank FILL VALVE Sw(s) . . . . OPEN (FE)

Push the desired FILL VALVE switch and observe the flow indicator light comes on.

BATTERY BUS SENSING C/B (PO C-29) . . . . PULL (FE)

NOTE

- *Pulling the BATTERY BUS SENSING circuit breakers forces the fill valve control onto the BAT DIRECT BUS.*
- *BATTERY BUS SENSING is inoperative while circuit breaker is pulled BAT BUS OFF light comes on.*

BODY TANK VALVE OPEN LT ON
AND ISOL VALVE DISAGREE
LT IS OFF

YES

Transfer or onload as required:

When transfer/onload is complete,

BODY TANK FILL VALVE Sw(s) . . . . CLOSE (FE)
BATTERY BUS SENSING C/B . . . . .RESET (FE)

END

NO

OPEN light(s) remain off and ISOL VALVE DISAGREE lights on steady

BODY TANK FILL VALVE Sw(s) . . . . .CLOSE (FE)
BATTERY BUS SENSING C/B . . . . .CLOSE (FE)

Transfer/onload fuel into main tanks only.

NOTE

- *Transfer from CTR WING tanks to main tanks is available.*
- *Fuel transfer from FWD and AFT TANKS only by manually opening the forward tank isolation valve, (located in the fuselage tank access compartment) and opening the alternate transfer valves.*

END

FWD TANK FILL VALVE WILL NOT OPEN

NOTE

Flow indicator light on, OPEN light off, CTR WING and AFT TANK FILL valves will open.

FWD TANK FILL Valve . . . . MANUALLY CONTROL (BO,FE)

BO go to forward fuselage tank compartment via access door 251VF, fuselage station 1059 (figure 2A-1), establish interphone communication with FE, remove forward tank fill valve cover per following procedures, manually open and close forward tank fill valve as requested by FE, by pressing/releasing MANUAL OVERRIDE BUTTON.

NOTE

If cargo is loaded in pallet position 5R, access to forward fuselage tank via access door 251VF will be blocked.

Loosen and remove clamp.
Remove cover and O-ring from forward tank fill valve.
Press/release MANUAL OVERRIDE BUTTON as requested by FE.

NOTE

If fill valve fails to open when MANUAL OVERRIDE BUTTON is pressed, proceed as follows:

BO request FE to remove fuel pressure from forward tank fill valve.

CAUTION

Do not use excess force on center shaft of fill valve.

Remove lockwire and using either a 5/16-inch thin-wall socket or common screw driver, turn center shaft of fill valve clockwise until against a positive stop.
BO request FE apply fuel pressure to fill tank.

CAUTION

Do not allow fuel tank to fill to maximum capacity.

FE removes fuel pressure when desired fuel quantity is attained.

CAUTION

Do not use excess force on center shaft of fill valve.

Turn center shaft of fill valve counterclockwise until against a positive stop. Ensure that forward fuselage tank FILL VALVE OPEN light goes off.
Enter discrepancy and action taken in AFTO Form 781A.

END

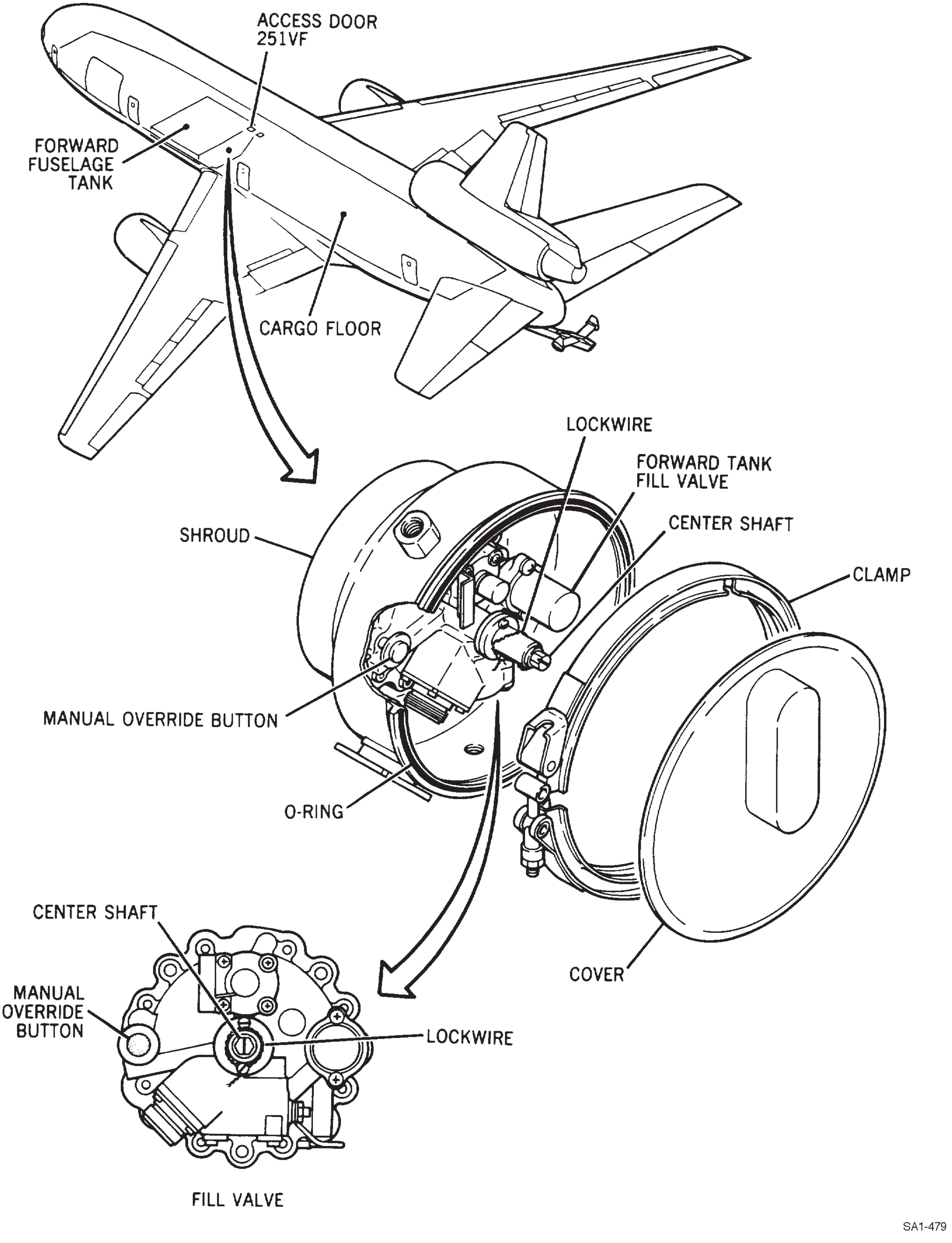


Figure 2A1. Forward Fuel Tank Fill Valve

FUEL DUMP

NOTE

- *Fuel dump in response to a takeoff emergency should not be initiated prior to reaching TWO ENGINE ACCELERATION HEIGHT.*
- *In case of emergency, FUEL DUMP procedures may be reviewed after fuel dumping has been initiated.*
- *The fuel dump rate will vary depending on the number and combination of air refueling and electric pumps that are utilized. However, the appropriate time required to dump a given amount of fuel can be estimated using the following dump rates:*
  - *Air Refueling and Electric pumps - 6,000 lbs/min*
  - *Electric pumps only - 5,000 lbs/min*
  - *Increase fuel dump time by 5 minutes when dumping fuel below 90,000 pounds total fuel quantity. This correction accounts for decreasing dump rates that occur at low fuel quantities.*
- *Max fuel dump speeds*
  - *325 KIAS below 28,000 feet*
  - *.82 Mach above 28,000 feet*

YES ← BODY TANK(S) FUEL DUMP REQ'D → NO

ISOL Valves . . . . OPEN (AS REQ'D) (FE)
BODY TANK TRANS Pump(s) . . . . ON (AS REQ'D) (FE)
FUEL DUMP Sw/DUMP VALVE OPEN Lts . . . . PUSH/ON (FE)

WARNING

Do not use AR pumps for fuel dump with less than two normal operating hydraulic systems.

YES ← AR PUMPS AVAILABLE → NO

NOTE

AR pumps are selected for dump whenever possible to ensure body tanks are emptied first. AR pumps operate at a higher pressure than transfer or tank pumps and will therefore result in a dump priority regardless of other selections.

X-FEED Valves . . . . CLOSE (FE)
FWD & AFT Tank ALT TRANS Valves . . . . .OPEN (FE)
AR ISOL Valve . . . . .OPEN (FE)
AR PUMP OVRD Sw . . . . OVRD (FE)

WARNING

With AR PUMP OVRD selected, FWD TANK fuel will continue to dump below 15,000 pounds.

AR Pumps(s) (one each FWD, CTR WING &
AFT BODY TANK containing fuel) . . . . ON (AS REQ'D) (FE)

CONTINUED

CONTINUED

FUEL DUMP (cont)

CONTINUED

CONTINUED

NOTE

- *If No. 3 engine is inoperative, select both AUX PUMPS from hydraulic system 3.*
- *If any engine is inoperative, or there is a loss of a hydraulic system, comply with AR pumps operating restrictions as prescribed in Section III.*
- *If an AR Pump(s) shuts off, due to low hydraulic press, DO NOT reset.*

Monitor fuel quantity gages to ensure CG remains within limits.

WHEN BODY TANK FUEL DUMP IS COMPLETE OR AR PUMP SHUTOFF (low fuel level cutoff) OCCURS:

AR Pumps(s)	OFF	(FE)
AR PUMP OVRD	OFF	(FE)
AR ISOL Valve	CLOSE	(FE)
ALT TRANS Valves	CLOSE	(FE)

FUEL DUMP COMPLETED

YES

NO

TRANS PUMP OVRD Sw	AS REQ'D	(FE)

WARNING

With TRANS PUMP OVRD selected, main tank pumps will continue to dump until TANK 2 is empty and TANKS 1 and 3 reach approximately 4,000 pounds each.

NOTE

Structural limitations requiring wing tanks to be full with gross weights exceeding 556,000 pounds or ZFW in excess of 414,000 pounds do not apply when dumping fuel for an emergency or abnormal condition.

All Main Tank Pumps	ON	(FE)
X-FEED Valves	OPEN	(FE)
FUEL DUMP Sw/DUMP VALVE OPEN Lts	PUSH/ON	(FE)

WHEN FUEL DUMP IS COMPLETE,

X-FEED Valves	CLOSE	(FE)
Main Tank FWD Pumps	OFF	(FE)

FUEL DUMP Sw/DUMP VALVE OPEN Lts	PUSH/OFF	(FE)
Fuel TRANS PUMP Sw(s)	OFF	(FE)
ISOL Valves	OFF (AS REQ'D)	(FE)

NOTE

- *If FUEL DUMP VALVE OPEN light remains ON, do not open X-FEED valves or turn on TRANS pumps for remainder of flight.*
- *If time permits, transfer fuel to achieve normal fuel schedule prior to landing.*

END

FUEL ISOL VALVE DISAGREE LIGHT ON

YES — VALVE POSITION OPEN — NO

NOTE

- *The associated FILL VALVE switch must be selected to close before the ISOL VALVE will close.*
- *There is a 10 second time delay between switch actuation and valve closure.*

Continue flight with no detrimental affects.

END

NOTE

- *If MASTER FUEL ISOL valve is selected to ISOL, condition is normal.*
- *If CTR WING TANK ISOL valve is the malfunctioning valve, no fuel can be added to that tank. Transfer from the tank or offload is not affected.*
- *Leakage rate into FWD TANK with manifold pressurized and ISOL VALVE open is approximately 100 pounds in 1 1/2 minutes.*

If FWD or AFT TANK transfer is required, use alternate path,
ISOL Valve (opposite tank) . . . . OPEN (FE)
ALTN TRANS Valves . . . . BOTH OPEN (FE)

NOTE

This cannot be done simultaneously with offload.

END

FUEL FILTER PRESS DROP LIGHT ON

Continue Flight . . . . MONITOR ENG INSTRUMENTS (FE)

NOTE

FUEL FILTER PRESS DROP light on indicates a differential pressure, (caused by clogging) across fuel filter and impending bypass. In the event more than one FUEL FILTER PRESS DROP light illuminates, sufficient cause exists to suspect contaminated fuel and a landing should be made as soon as possible.

END

FUEL SCHED LIGHT ON

FWD TANK FUEL SCHED LT ON

Transfer remaining fuel from the FWD TANK to MAIN TANKS.

END

TANK 1 OR 3 FUEL SCHED LT ON

TANKS 1 and 3 Qty . . . . OBSERVE (FE)

YES — TANK 1 OR 3 AND QTY LESS THAN 10,500 LBS — NO

NOTE

Automatic transfer of fuel from the outboard compartment of the affected tank to the inboard compartment is inoperative.

When TANKS 1 and 3 quantity indicates approximately 8,500 pounds,

TRANS PUMP OVRD Sw . . . . PUSH/OVRD (FE)

After both TIP PUMP LOW LTS illuminate steady,

TRANS PUMP OVRD Sw . . . . PUSH/OFF (FE)

NOTE

- *When TRANS PUMP OVRD switch is selected to OVRD, TIP PUMPS will operate and transfer fuel from outboard compartments to inboard compartments of TANKS 1 and 3. The transfer is complete in approximately 6 minutes, and is recognized by a steady pump low pressure lights.*
- *With transfer pump override selected TRANS PUMP of FWD TANK will operate (if selected) even when the fuel quantity in that tank is less than 15,000 pounds.*

END

Transfer fuel from inboard compartment to outboard compartment of the affected tank.

Assoc TRANS PUMP Sw . . . . PUSH/ON (FE)
Assoc FILL VALVE Sw . . . . OPEN/HOLD (FE)

CONTINUED

FUEL SCHED LIGHT ON (cont)

YES — ASSOC FILL VALVE OPEN LT OFF — NO

Assoc FILL VALVE Sw . . . . RELEASE TO CLOSE (FE)
Assoc MANIFOLD DRAIN & OUTBD FILL Sw . . . . DRAIN/FILL (FE)

Approx 10 minutes after FUEL SCHED light goes off,

Assoc MANIFOLD DRAIN & OUTBD FILL Sw . . . . NORM (FE)
Assoc TRANS PUMP Sw . . . . OFF (FE)

END

Approx 2 minutes after FUEL SCHED light goes off,
Assoc FILL VALVE Sw . . . . CLOSE (FE)
Assoc TRANS PUMP Sw . . . . OFF (FE)

END

TANK TRANS PUMP INOPERATIVE

CAUTION

Do not reset any tripped fuel pump circuit breakers.

NOTE

When TRANS PUMP is selected, the flow indicator light comes on, but LOW light comes on and stays on.

Affected TRANS Pump . . . . OFF (FE)
Do not use the pump for the remainder of flight.
Affected TRANS Pump Control C/B . . . . PULL (FE)

CIRCUIT BREAKER	LOCATION
TANK 1 XFR	UM F-14
TANK 2 XFR	UM G-15
TANK 3 XFR	UM E-16
FUS FWD XFR	UM E-12
CTR WING L LWR	UM F-13
CTR WING L UPR	UM F-12
CTR WING R LWR	UM G-13
CTR WING R UPR	UM E-13
FUS AFT XFR	UM G-12

CONTINUED

TANK TRANS PUMP INOPERATIVE (cont)

NOTE

Opening the CTR WING UPR pump C/B will also render the associated LWR pump inop. If the CTR WING LWR pump is inoperative, open only one associated C/B (Left UM F-13, Right UM G-13).

NO — MAIN TANK PUMP — YES

NO:

FUSELAGE or CENTER WING TANK

Attempt to transfer fuel when required using an alternate route (i.e. A/R Pumps or remaining XFR Pump in CTR Wing Tanks)

END

YES:

When fuel transfer is required from the affected main tank,

FWD and AFT Pumps (Supply Tank) . . . . ALL ON (FE)

X-FEED (Supply Tank) . . . . .OPEN (FE)

FILL Valve (Receiving Tank) . . . . .OPEN (FE)

END

TANK PUMP PRESS LO LT(S) ON

CAUTION

Do not reset any tripped fuel pump circuit breakers.

TANK PUMP Sw
(Remaining Pump In Same Tank) . . . . ON/OBSERVE (FE)

YES — TANK PUMP PRESS LO LT OFF — NO

YES:

(Confirms tank pump failure for pump with light on.)

TANK PUMP Sw (Malfunctioning Pump) . . . . OFF (FE)

Malfunctioning TANK PUMP Control C/B . . . . PULL (FE)

TANK 1	FWD	UM E-14
TANK 1	AFT	UM G-14
TANK 2	FWD	UM E-15
TANK 2	LT AFT	PO G-30
TANK 2	RT AFT	UM F-15
TANK 3	FWD	UM G-16
TANK 3	AFT	UM F-16

CONTINUED

NO:

CONTINUED

TANK PUMP PRESS LO LT(S) ON (cont)

CONTINUED

NOTE

- *If pump failure is in TANK 1 or 3 turn on the associated transfer pump and open the associated crossfeed valve for approach and landing.*
- *The TANK 2 LT AFT fuel pump is powered from the RT EMER AC BUS and does not have a control circuit breaker. Open all power circuit breakers for this pump.*

END

TANK PUMP PRESS LO light on or cycling (indicates low fuel in associated tank):

TRANS PUMP Sws (Unaffected Tanks) . . . . ON (FE)

Observe transfer TANK PUMP PRESS LO lights come on momentarily and go off.

X-FEED VALVE (Tank With Suspected Low Fuel) . . . . .OPEN (FE)
FUEL QTY TEST Button . . . . .PRESS (FE)
AFFECTED FUEL QTY GAGE . . . . OBSERVE (FE)

The fuel quantity gage will blank if an indicator malfunction is detected. In this case, consider the fuel tank empty.

While monitoring the engine fuel pressure gage, continue fuel crossfeed. Calculate fuel remaining by subtracting fuel consumed (consider fuel onloaded/offloaded) from takeoff fuel. Using calculated remaining fuel, distribute fuel using reliable gages. Plan remainder of flight accordingly.

YES — FUEL QUANTITY CHANGES — NO

Problem tank indicates empty:

Assume fuel indicating system is reliable.

While observing engine fuel pressure gage, continue fuel crossfeed/transfer as required to regain normal schedule.

END

Problem tank indication is unreliable:

While observing engine fuel pressure gage, continue fuel crossfeed. Calculate fuel remaining by subtracting fuel consumed (consider fuel onloaded/offloaded) from takeoff fuel. Using calculated remaining fuel, distribute fuel using reliable gages. Plan remainder of flight accordingly.

END

TANKS 1, 2 AND 3 FILL VALVES WILL NOT OPEN

NOTE

Flow indicator lights on, OPEN light off.

When fuel transfer/onload is required,

Main Tank FILL VALVE Sws . . . . OPEN (FE)

Push the main tank FILL VALVE switches and observe the flow indicator light comes on.

BATTERY BUS SENSING C/B (PO C-29) . . . . PULL (FE)

NOTE

- *Battery bus sensing will be inoperative and BATT BUS OFF light will be on.*
- *Pulling the BAT BUS SENSING circuit breaker forces the fill valve control onto the BATTERY DIRECT bus.*

YES — MAIN TANK FILL VALVE LT ON — NO

Transfer/onload fuel into main tanks as required.

When transfer/onload is complete,
Main Tank FILL VALVE Sws . . . . CLOSE (FE)
BATTERY BUS SENSING C/B . . . . .RESET (FE)

END

Off (Valve closed)

Main Tank FILL Valve Sws . . . . CLOSE (FE)
BATTERY BUS SENSING C/B . . . . .RESET (FE)
Fuel Requirements . . . . .DETERMINE (FE)

YES — ONLOAD — NO

TRANSFER

Open X-FEED valves and feed fuel directly to engines from body tanks. If desired, to maintain outboard compartments full, fuel may be transferred into TANKS 1 and 3 by opening the MANF DRAIN & OUTBD FILL valves, transfer rate will be approximately 1/4 of normal.

NOTE

When using MANF DRAIN & OUTBD FILL switches to transfer fuel, transfer should be terminated when TANK QTY is approximately 3,000 pounds below full to avoid inadvertent fuel venting.

END

CONTINUED

TANKS 1, 2 AND 3 FILL VALVES WILL NOT OPEN (cont)

MANF DRAIN & OUTBD FILL Sws . . . . .OPEN (FE)

NOTE

- *With MANF DRAIN & OUTBD FILL valves open, fuel will be onloaded into TANKS 1 and 3 at a slow rate.*
- *When using MANF DRAIN & OUTBD FILL switches to onload fuel, onload into those tanks should be terminated when TANK QTY is approximately 3,000 pounds below full to avoid inadvertent fuel venting.*

Using normal procedures, onload fuel into body tanks as required.

WARNING

With main tanks less than full, the aircraft gross weight must not exceed 556,000 pounds and the zero fuel weight plus body tank fuel weight will not exceed 414,000 pounds.

NOTE

Onload rate into body tanks only will be approximately 3200 lbs/min.

When onload is complete,

Establish fuel management as required.

MANF DRAIN & OUTBD FILL Sws . . . . AS REQ'D (FE)

NOTE

Maintain TANKS 1 and 3 approximately 3,000 pounds below full by transferring through the MANF DRAIN & OUTBD FILL valves or by crossfeed operation. When transfer is complete close the MANF DRAIN & OUTBD FILL valves.

END

TANK 1 OR 3 FILL VALVE WILL NOT OPEN

NOTE

Flow indicator light on, OPEN light off.

Fuel Requirement . . . . DETERMINE (FE)

YES — TRANSFER TO TANK 1 OR 3 — NO

MANF DRAIN & OUTBD FILL Sws . . . . OPEN AS REQ'D (FE)

Open one or both MANF DRAIN & OUTBD FILL valves as required to maintain lateral balance.

NOTE

- *When using MANF DRAIN & OUTBD FILL switches to transfer fuel, transfer should be terminated when TANK QTY is approximately 3,000 pounds below full to avoid inadvertent fuel venting.*
- *If desired, increase rate of fuel usage from body tank(s) by opening X-FEED valves and feeding fuel directly to the engine(s).*

When fuel transfer is complete,

FUEL X-FEED Sws . . . . VERIFY CLOSED (FE)
MANF DRAIN & OUTBD FILL Sws . . . . CLOSE (FE)

END

ONLOAD

TANK 1 & 3 FILL VALVE Sws . . . . CLOSE (FE)
MANF DRAIN & OUTBD FILL Sws . . . . BOTH OPEN (FE)

NOTE

When using MANF DRAIN & OUTBD FILL switches to transfer fuel, transfer should be terminated when TANK QTY is approximately 3,000 pounds below full to avoid inadvertent fuel venting.

TANK 2 FILL VALVE Sw . . . . AS REQ'D (FE)

WARNING

With main tanks less than full, the aircraft gross weight must not exceed 556,000 pounds and the zero fuel weight plus body tank fuel weight will not exceed 414,000 pounds.

NOTE

- *Onload fuel into body tanks as required.*
- *With TANKS 1 and 3 less than full, CG will move forward. Monitor onload to avoid exceeding limits.*

CONTINUED

TANK 1 OR 3 FILL VALVE WILL NOT OPEN (cont)

When onload is complete,

Establish fuel management as required.

MANF DRAIN & OUTBD FILL Sws . . . . AS REQ'D (FE)

NOTE

Maintain TANKS 1 and 3 approximately 3,000 pounds below full by transferring through the MANF DRAIN & OUTBD FILL valves or by crossfeed operation. When transfer is complete close the MANF DRAIN & OUTBD FILL valves.

END

FUEL QUANTITY FLUCTUATION - FWD OR AFT BODY TANK

CONDITION . . . . IDENTIFY (FE)

Fuel bladder collapses are revealed by moderate to large fluctuations in fuel quantity from a previously know value, when a fuel transfer/offload has not taken place. Fuel quantity fluctuations may be as low as 3,000 lbs, and as high as 12,000 lbs. The fluctuation normally presents itself shortly after takeoff, during climbout when the aircraft is at a high deck angle, but it can be identified at any time during the flight.

WARNING

For CG computations, use the last known quantity in the tank. Consider this unusable fuel.

NOTE

A fuel bladder collapse may cause damage to fuel probe mounts and dip sticks. With a fuel probe free floating in the fuel tank, wide fluctuations of fuel quantity may be observed.

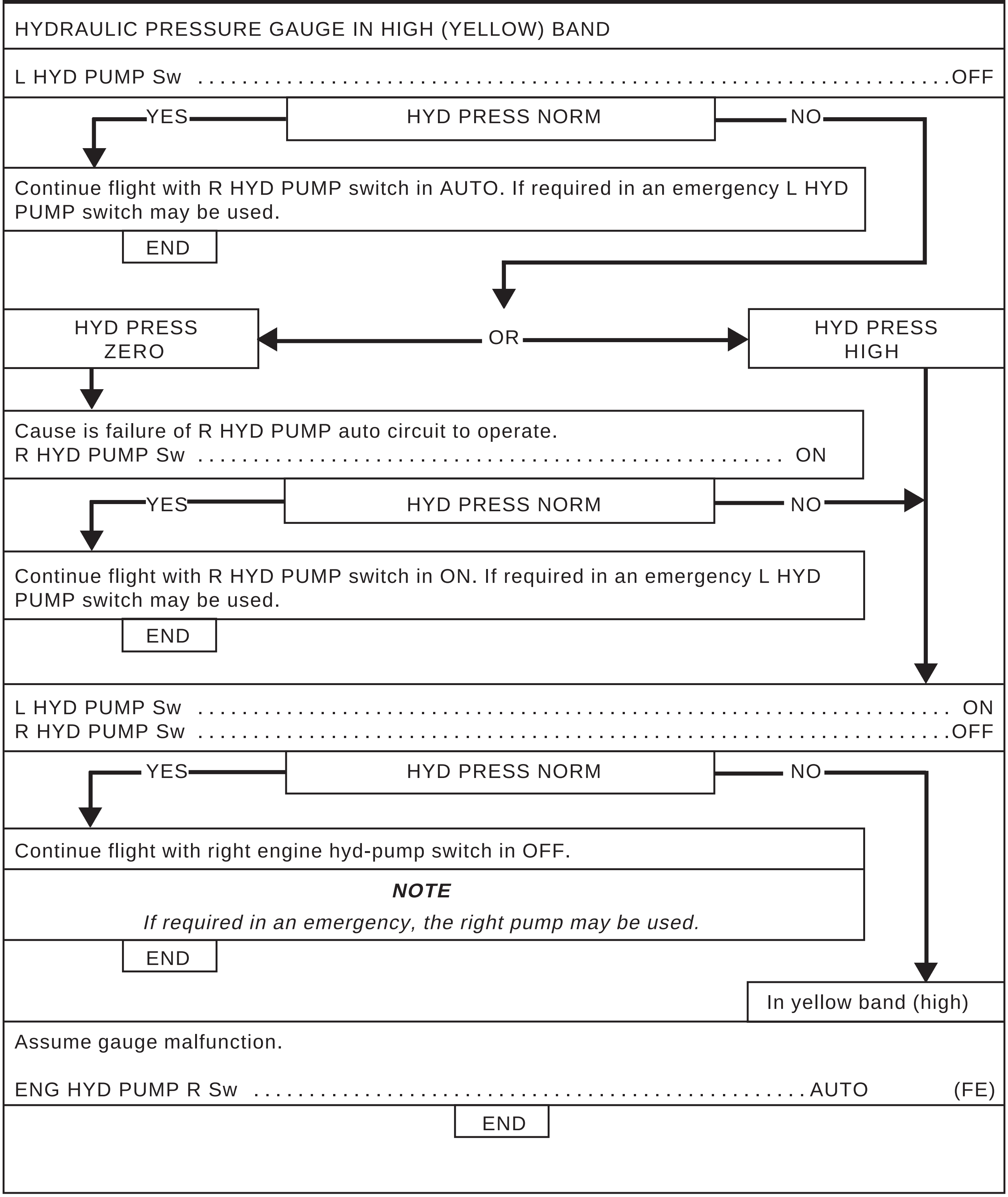
FUEL TRANSFER . . . . AS REQ'D (FE)

WARNING

Do not transfer fuel into fuel tank. Do not transfer fuel out of the fuel tank unless Center of Gravity (CG) limitations will be exceeded. All fuel must be transferred out of tank once fuel transfer has started.

END

HYDRAULIC PRESSURE HIGH



HYDRAULIC PRESSURE GAUGE IN HIGH (YELLOW) BAND

L HYD PUMP Sw . . . . OFF

HYD PRESS NORM

Continue flight with R HYD PUMP switch in AUTO. If required in an emergency L HYD PUMP switch may be used.

HYD PRESS ZERO

HYD PRESS HIGH

Cause is failure of R HYD PUMP auto circuit to operate.
R HYD PUMP Sw . . . . ON

HYD PRESS NORM

Continue flight with R HYD PUMP switch in ON. If required in an emergency L HYD PUMP switch may be used.

L HYD PUMP Sw . . . . ON
R HYD PUMP Sw . . . . OFF

HYD PRESS NORM

Continue flight with right engine hyd-pump switch in OFF.

NOTE

If required in an emergency, the right pump may be used.

In yellow band (high)

Assume gauge malfunction.

ENG HYD PUMP R Sw . . . . AUTO (FE)

HYDRAULIC PRESSURE LOW

WARNING

FE notify BO to disconnect (if applicable) and discontinue refueling until hydraulic status is determined.

AP Levers . . . . "OFF" (PF)

NOTE

- *Loss of a hydraulic system does not cause the associated autopilot to automatically disconnect or otherwise annunciate an autopilot failure.*
- *If No. 1 system press fails (and RUD STBY PWR is available) AP 1 may be used.*
- *If No. 2 system press fails use AP2.*
- *If No. 3 system press fails use AP1.*

YES — HYD QTY LOW OR DECREASING — NO

Affected ENG HYD PUMP Sws . . . . OFF (FE)
Appropriate Motor PUMP Sw(s) . . . . OFF (FE)

Refer to Abnormal Procedures, HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS.

END

QTY NORMAL

NOTE

With right HYDRAULIC PUMP switch in AUTO, a hydraulic pressure gage low indication (accompanied by both hydraulic PRESS LO lights) indicates a failure of the automatic circuit.

ENG HYD PUMP R Sw . . . . ON (FE)
Hydraulic Pressure Gage . . . . OBSERVE (FE)

YES — HYD PRESS NORMAL — NO

Continue flight with ENG HYD PUMP R switch in ON.

ENG HYD PUMP L Sw . . . . OFF (FE)
Monitor system.

END

PRESSURE Low

Approp Motor Pump Sw(s) . . . . AS REQ'D (FE)

Monitor system.

NOTE

Motor pump switches should be in off for non-critical phases of flight, and in ON or ARM as required for approach and landing.

END

HYD PRESS LO LT ON

WARNING

FE notify BO to disconnect (if applicable) and discontinue refueling until hydraulic status is determined.

NOTE

Do not use this procedure if hydraulic PRESS LO light is accompanied by HYDRAULIC TEMP HI light(s) on. Refer to Abnormal Procedures, HYD TEMP HI LT (L or R) ON OR HYD TEMP GAGE HIGH (YELLOW BAND).

HYD QUANTITY LOW
OR DECREASING

YES

ENG HYD PUMP Sws . . . . OFF (FE)
Approp Motor Pump Sw(s) . . . . OFF (FE)

Refer to Abnormal Procedure, HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS.

END

NO

HYD PRESS LOW

YES

Refer to Abnormal Procedures, HYDRAULIC PRESSURE LOW.

END

NO

ENG HYD PUMP L Sw . . . . OFF (FE)

NOTE

If desired, pump may be turned on for landing.

END

HYDRAULIC SYS 3 ELEV OFF LIGHT ON

Hydraulic System 3 Quantity .... CHECK (FE)

AUTOPILOT 2 .... OFF (PF)

YES — SYSTEM 3 QUANTITY ZERO — NO

ENG 3 HYD PUMP Switches .... BOTH OFF (FE)

Accomplish HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS checklist,
System 3 inop.

END

CAUTION

With Hydraulic System 3 in this configuration, the inboard elevator will be powered by a single hydraulic system. Autopilot 2 is inoperative, but will not automatically disconnect or otherwise annunciate the autopilot failure.

Hydraulic Systems 1 and 2 Quantity .... DETERMINE (FE)

YES — NORMAL — NO

END

CAUTION

- *If Hydraulic System 1 is not operating, the right inboard elevator will be inoperative.*
- *If Hydraulic System 2 is not operating, the left inboard elevator will be inoperative and the lower rudder will be inoperative even though the Rud Stby Pwr Off light is off and both autopilots are inop.*

SYSTEM 1 OR 2 QUANTITY LOSS INDICATED

Accomplish HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS checklist,
System 1 or System 2 inop.

END

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS

WARNING

FE notify BO to disconnect (if applicable) and discontinue refueling until hydraulic status is determined and A/R fuel pumps are reselected.

Assoc ENG HYD PUMP Sws . . . . OFF (FE)
Approp MOTOR PUMP Sws . . . . OFF (FE)
AUX PUMP Sws . . . . OFF (FE)
AP Levers . . . . "OFF" (PF)
Affected Sys . . . . DETERMINE (FE)

Go to appropriate procedure as follows:

1	**SYSTEM 1 INOP**
2	**SYSTEM 2 INOP**
3	**SYSTEM 3 INOP**

1 SYSTEM 1 INOP

AP 1 . . . . "USE AS REQ'D" (PF)

EFFECT ON SYSTEMS

Spoilers - Panels #2 and #4, left and right, inoperative.

Nosewheel steering - LEFT/25° RIGHT/Normal.

FLAPS/SLATS - should extend as selected.

Air Refueling - FWD TANK L AR pump - inoperative
CTR WING TANK L AR pump - inoperative
UARRSI Toggles - inoperative

RUD STBY PWR OFF LT ON

YES

Upper rudder inop.

- Auto Stab trim inop

- Stab trim rate reduced.

V_{MCA} 157 KIAS

MAX X-WIND component - 15 knots

CONTINUED

NO

Both rudders operative.

CONTINUED

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

NOTE

- *The inoperative system may be reinstated for landing if there is quantity indicated.*
- *Land with flaps at a maximum of 35° to minimize effect of possible spoiler float.*

Approp Normal Checklist . . . . .PERFORM (P,CP,FE)

When ready to configure for landing:
Slat Position . . . . OBSERVE (FE)

YES — SLATS EXTENDED — NO

FLAP/SLAT Handle . . . . "15°/EXT" (PNF)

After flaps extend, airspeed may be slowly reduced to 1.3 V_S 15°/RET to assist in slat extension.

If slats do not extend,
FLAP/SLAT Handle . . . . . "22°/EXT (FLAP PLACARD SPD PERMITTING) (PNF)

After flaps extend, airspeed may be slowly reduced to 1.3 V_S 22°/RET.

SPEEDS (KIAS)													
FLAP/SLAT CONFIG-URATION		GROSS WEIGHT (1,000 LB)											
		280	300	320	340	360	380	400	420	440	460	480	500
15°/RET	1.3V_S	168	175	181	187	192	197	202	207	212	217	222	226
22°/RET	1.3V_S	163	170	176	182	187	192	197	202	207	212	217	221

YES — SLATS EXTEND — NO

Further flap/slat extension should be normal.

Before Landing Checklist . . . . PERFORM (P,CP,FE)

When Directed:
FLAP/SLAT Handle . . . . "35°/EXT" (PNF)

YES — FLAPS/SLATS INDICATE 35°/LAND — NO

Make a 35°/EXT landing

END

Flaps indicate 35°/SLAT DISAGREE light on.

Move flap/slat handle to 22°/EXT and use corresponding threshold speed for configuration.

GND PROXIMITY WARN FLAP OVRD Sw . . . . OVRD/ON (FE)

END

CONTINUED

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

CONTINUED

FLAP/SLAT Handle . . . . "UP/RET" (PNF)

FLAP/SLAT Handle . . . . "SPLIT" (PNF)

Loosen thumbscrew on mechanical FLAP/SLAT handle interlock, rotate interlock out of the way, and retighten thumbscrew.

Lift and hold slat handle, lift and pull flap handle only to the 0° detent, and release.

NOTE

- *Check gross weight. Reduce as required. Land with maximum 35° flaps. Recommended approach/landing speeds may exceed flap placard speeds for 22° approach/35° landing configurations. Under these conditions, 15° approach/22° landing should be considered. Maximum tire speed of 204 knots should be considered.*
- *If landing with 22°/RET move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.*

Approach and Landing Procedure . . . . REVIEW (P,CP,FE)

NOTE

Time permitting refer to asymmetrical slats or no slats landing with flaps text on page 2A-53.

APPROACH

FLAP/SLAT Handle . . . . "22°/RET" (PNF)
IAS . . . . "MANEUVERING SPD 22°/RET" (PF)

Maintain IAS of at least maneuvering speed 22°/RET.

Approp Normal Checklist . . . . PERFORM (P,CP,FE)

FINAL

FLAP/SLAT Handle . . . . "35°/RET" (PNF)

Reduce airspeed 10 knots.

IAS . . . . "APPROACH SPEED FOR 35°/RET" (PF)
GND PROXIMITY WARN FLAP OVRD Sw . . . . (IF REQ'D) OVRD/ON (FE)
Approp Normal Checklist . . . . PERFORM (P,CP,FE)

NOTE

- *Make a normal approach. Nose attitude is lower than normal. When threshold is crossed, use slight flare to diminish sink rate. Reduce thrust to prevent floating. Avoid holding aircraft off at touchdown.*
- *With flaps 22°, spoilers extend automatically on reverser lever actuation. With flaps 35°, spoilers extend automatically on main wheel spinup.*

END

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

2 SYSTEM 2 INOP

AP 2 . . . . "USE AS REQ'D" (PF)

CAUTION

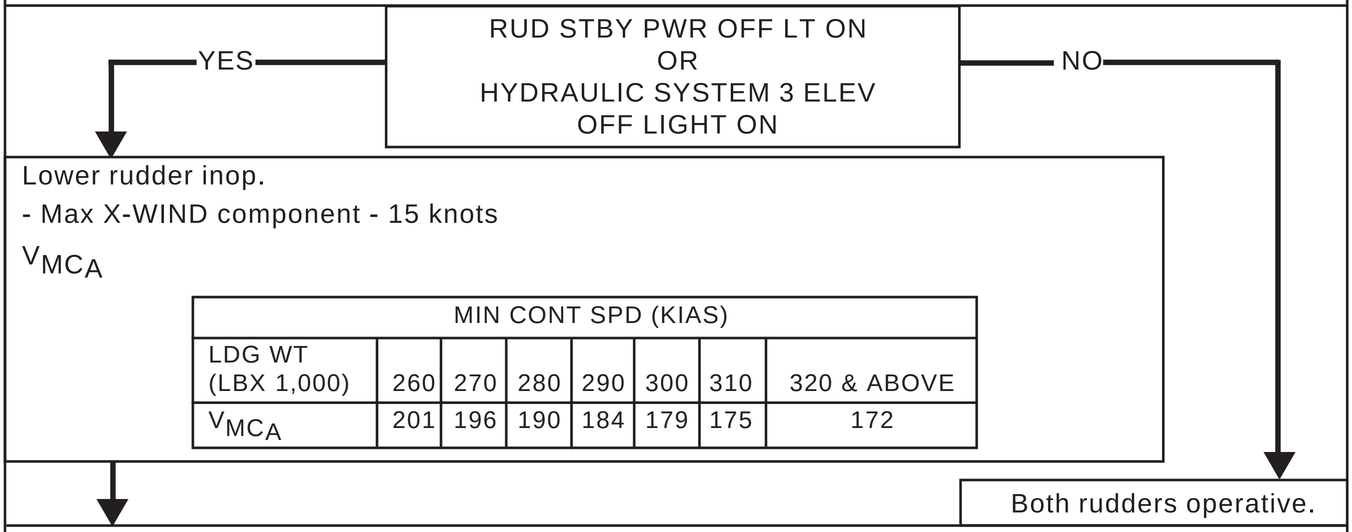
With the Hydraulic System 3 Elev Off Light On the #2 autopilot is inoperative.

EFFECT ON SYSTEMS

Spoilers - Panels #1 and #5, left and right, inoperative

Flaps should extend as selected

Air Refueling -
- AR boom and drogue hydraulic systems may be inoperative.
- AFT TANK R AR pump - inoperative.
- Refuel only if AR HYD RESVR PRESS LOW light is off with the 2-3 motor pump ON.



RUD STBY PWR OFF LT ON
OR
HYDRAULIC SYSTEM 3 ELEV
OFF LIGHT ON

Lower rudder inop.

- Max X-WIND component - 15 knots

V_{MCA}

MIN CONT SPD (KIAS)							
LDG WT (LBX 1,000)	260	270	280	290	300	310	320 & ABOVE
V_{MCA}	201	196	190	184	179	175	172

Both rudders operative.

NOTE

- *The inoperative system may be reinstated for landing if there is quantity indicated.*
- *Land with flaps at a maximum of 35° to minimize effect of possible spoiler float.*

END

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

3 SYSTEM 3 INOP

AP 1 . . . . "USE AS REQ'D" (PF)

EFFECT ON SYSTEMS

Spoiler - Panels #3 left and right, inoperative
Stab trim rate reduced.
Landing gear cannot be retracted and must be extended using alternate extension procedures.
Nose wheel steering - L/normal R/25°.
Slats should extend as selected.
Air Refueling - AR boom hoist - inoperative.
- FWD TANK R AR pump - inoperative.
- CTR WING TANK R AR pump - inoperative.
- AFT TANK L AR pump - inoperative.

Approp Normal Checklist . . . . PERFORM (P,CP,FE)

When ready to configure for landing:
Slat Position . . . . OBSERVE (FE)

YES — SLATS EXTENDED — NO

FLAP/SLAT Handle . . . . "15°/EXT" (PNF)

After flaps extend, airspeed may be slowly reduced to 1.3 V_S 15°/RET to assist in slat extension.

If slats do not extend,
FLAP/SLAT Handle . . . . "22°/EXT" (FLAP PLACARD SPD PERMITTING) (PNF)

After flaps extend, airspeed may be slowly reduced to 1.3 V_S 22°/RET.

SPEEDS (KIAS)													
FLAP/SLAT CONFIGURATION		GROSS WEIGHT (1,000 LB)											
		280	300	320	340	360	380	400	420	440	460	480	500
15°/RET	1.3V_S	168	175	181	187	192	197	202	207	212	217	222	226
22°/RET	1.3V_S	163	170	176	182	187	192	197	202	207	212	217	221

YES — SLATS EXTEND — NO

When Gear Extension is Desired:
IAS . . . . "RESTRICT TO 230 KNOTS MAXIMUM" (PF)
Main Gear Altn Ext Lever . . . . "RAISE/LATCH" (CP)
Gear Lts . . . . "3 GREEN" (CP)

CAUTION

- *After alternate extension of the main gear, wait until gear is extended (3 GREEN lights) before next action.*
- *After gear alternate extension do not exceed 260 KIAS.*

CONTINUED

CONTINUED

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

CONTINUED

CONTINUED

CTR Gear Altn Ext Handle . . . . PULL (FE)
Gear Lts . . . . "4 GREEN" (P,CP,FE)
Gear Handle . . . . "DOWN" (CP)
Before Landing Checklist . . . . PERFORM (P,CP,FE)

NOTE

The inoperative system may be reinstated for landing if there is quantity indicated.

END

FLAP/SLAT Handle . . . . "UP/RET" (PNF)
FLAP/SLAT Handle . . . . "SPLIT" (PNF)

Loosen thumbscrew on mechanical FLAP/SLAT handle interlock, rotate interlock out of the way, and retighten thumbscrew.

Lift and hold slat handle, lift and pull flap handle only to the 0° detent, and release.

NOTE

- *Check gross weight. Reduce as required. Land with maximum 35° flaps. Recommended approach/landing speeds may exceed flap placard speeds for 22° approach/35° landing configurations. Under these conditions, 15° approach/22° landing should be considered. Maximum tire speed of 204 knots should be considered.*
- *If landing with 22°/RET move GND PROXIMITY WARN FLAP OVRD switch to OVRD/ON.*

Approach and Landing Procedure . . . . REVIEW (P,CP,FE)

NOTE

Time permitting refer to asymmetrical slats or no slats landing with flaps text on page 2A-53.

APPROACH

FLAP/SLAT Handle . . . . "22°/RET" (PNF)
IAS . . . . "MANEUVERING SPD 22°/RET" (PF)

Maintain IAS of at least maneuvering speed 22°/RET.

Appropriate Normal Checklist . . . . PERFORM (P,CP,FE)

CONTINUED

HYDRAULIC SYSTEM QUANTITY LEAK OR LOSS (cont)

CONTINUED

When Gear Extension is Desired:

IAS	"RESTRICT TO 230 KNOTS MAXIMUM"	(PF)
Main Gear Altn Ext Lever	"RAISE/LATCH"	(CP)
Gear Lts	"3 GREEN"	(CP)

CAUTION

- *After alternate extension of the main gear, wait until gear is extended (3 GREEN lights) before next action.*
- *After gear alternate extension do not exceed 260 KIAS.*

CTR Gear Altn Ext Handle	PULL	(FE)
Gear Lts	"4 GREEN"	(P,CP,FE)
Gear Handle	"DOWN"	(CP)

NOTE

The inoperative system may be reinstated for landing if there is quantity indicated.

FINAL

FLAP/SLAT Handle	"35°/RET"	(PNF)

Reduce airspeed 10 knots.

IAS	"APPROACH SPEED FOR 35°/RET"	(PF)
GND PROXIMITY WARN FLAP OVRD Sw	(IF REQ'D) OVRD/ON	(FE)
Approp Normal Checklist	PERFORM	(P,CP,FE)

NOTE

- *Make a normal approach. Nose attitude is lower than normal. When threshold is crossed, use slight flare to diminish sink rate. Reduce thrust to prevent floating. Avoid holding aircraft off at touchdown.*
- *With flaps 22°, spoilers extend automatically on reverser lever actuation. With flaps 35°, spoilers extend automatically on main wheel spinup.*

END

HYD TEMP HI LT(S) ON OR HYD TEMP GAGE HIGH (YELLOW BAND)

WARNING

FE notify BO to disconnect (if applicable) and discontinue refueling until hydraulic status has been determined.

NOTE

- *Do not use this procedure during takeoff or landing if both HYD TEMP HI lights are on, since the procedure may deactivate hydraulic system.*
- *If safety of flight requires, system may be used regardless of abnormal temperature indications.*
- *During ground operation, if high ambient temperatures exist, cycling the flight controls (with the affected engine hydraulic pumps operating) will circulate and cool the hydraulic fluid and may cause the HYD TEMP HI light(s) to go off. If light(s) remain on maintenance is required, log in AFTO Form 781.*

ONE TEMP HI LT ON OR ONE TEMP HI LT ON AND HYD TEMP GAGE HIGH

YES

NO

Both TEMP HI Lts on or HYD TEMP GAGE HIGH

Both ENG HYD PUMPS Sws . . . . OFF (FE)
Approp MOTOR PUMP Sw(s) . . . . OFF (FE)

NOTE

MOTOR PUMP switch(s) should be in OFF for non-critical phases of flight and in ON for approach and landing.

END

Affected Sys . . . . DETERMINE (FE)

SYS 2

YES

NO

MOTOR PUMP 2-3 Sw Position . . . . DETERMINE (FE)

In the event the 2-3 motor pump is operating, it can supply pressure high enough to dead-head the No. 2 engine driven pump(s), causing the No. 2 hydraulic system temperature to increase.

CONTINUED

CONTINUED

HYD TEMP HI LT(S) ON OR HYD TEMP GAGE HIGH (YELLOW BAND) (cont)

CONTINUED

CONTINUED

ON OR ARM AND
ANY ENGINE SHUTDOWN

YES

NO

Assoc ENG HYD PUMP Sw . . . . OFF (FE)
Other ENG HYD PUMP Sw . . . . ON (FE)

END

MOTOR PUMP 2-3 Sw . . . . OFF (FE)
Assoc ENG HYD PUMP Sw . . . . OFF (FE)
Other ENG HYD PUMP Sw . . . . ON (FE)

After 5 minutes,
Sys 2 TEMP HI Lt/HYD TEMP Gage . . . . OBSERVE (FE)

TEMP HI LT OFF AND/OR
HYD TEMP
GAGE DECREASING

YES

NO

NOTE

MOTOR PUMP 2-3 switch should be in OFF for non-critical phases of flight and in ON for approach and landing.

END

TEMP HI LT REMAINS ON AND/OR HYD TEMP GAGE DOES NOT DECREASE.

Both ENG HYD PUMP Sws . . . . OFF (FE)
Approp MOTOR PUMP Sw(s) . . . . OFF (FE)

NOTE

MOTOR PUMP switch(s) should be in OFF for non-critical phases of flight and in ON for approach and landing.

END

AR BOOM HYD TEMP HI LIGHT ON

WARNING

FE notify BO to disconnect (if applicable) and discontinue refueling until hydraulic status has been determined.

NOTE

- *Do not use this procedure if the #2 HYD TEMP HI LT(S) are on or #2 HYD TEMP GAGE is high (yellow band). Refer to Abnormal Procedures, HYD TEMP HI LT(S) ON OR HYD TEMP HIGH (YELLOW BAND).*
- *The AR BOOM HYD TEMP HI light may be caused by a high temperature from the #2 system or the BOOM/DROGUE HYD SEL in BOOM or DROGUE for an extended period of time.*
- *If the BOOM/DROGUE HYD SEL is in DROGUE due to a centerline stow/lock problem, and conditions permit, give consideration to trailing the Centerline Drogue and move the BOOM/DROGUE HYD SEL to OFF. Prior to landing, repressurize the AR system and stow the drogue. If conditions do not permit leaving the drogue in trail with the BOOM/DROGUE HYD SEL in OFF, and damage to the aircraft hydraulic system appears imminent, consideration must be given to jettisoning the Centerline Drogue.*

BOOM/CENTERLINE . . . . STOWED (FE/BO)
BOOM/DROGUE HYD SEL . . . . .OFF (FE/BO)

CAUTION

Do not take the BOOM/DROGUE HYD SEL out of the DROGUE position if the Centerline Drogue is partially stowed or stowed but not locked. The hose may extend rapidly and separate from the aircraft.

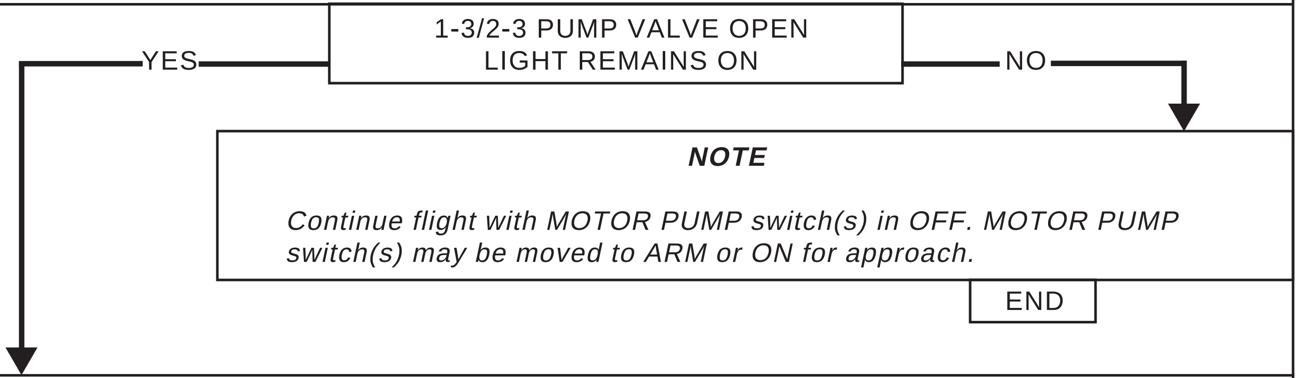
END

1-3/2-3 PUMP VALVE OPEN LT ON

NOTE

Disregard this procedure if either of the MOTOR PUMP switch(s) are in ON or MOTOR PUMP switch(s) are in ARM and any of the three engines are not in operation (loss than 45% N_2).

MOTOR PUMP Sws . . . . OFF (FE)



NOTE

Continue flight with MOTOR PUMP switch(s) in OFF. MOTOR PUMP switch(s) may be moved to ARM or ON for approach.

END

Hyd TEMP Gages . . . . MONITOR (FE)
HYD MOTOR PUMPS CONT and LTS C/B's (PO A-4, 5) . . . . CHECK/CLOSED (FE)

NOTE

- *Increasing hydraulic temperature may occur if operating with a total hydraulic quantity loss and the 1-3/2-3 PUMP VALVE OPEN light is on.*
- *If a condition of system overtemperature is observed, the affected hydraulic system should be depressurized; reactivate the system prior to landing. Refer to Emergency Procedure, DUAL HYDRAULIC SYSTEM FAILURE.*

END

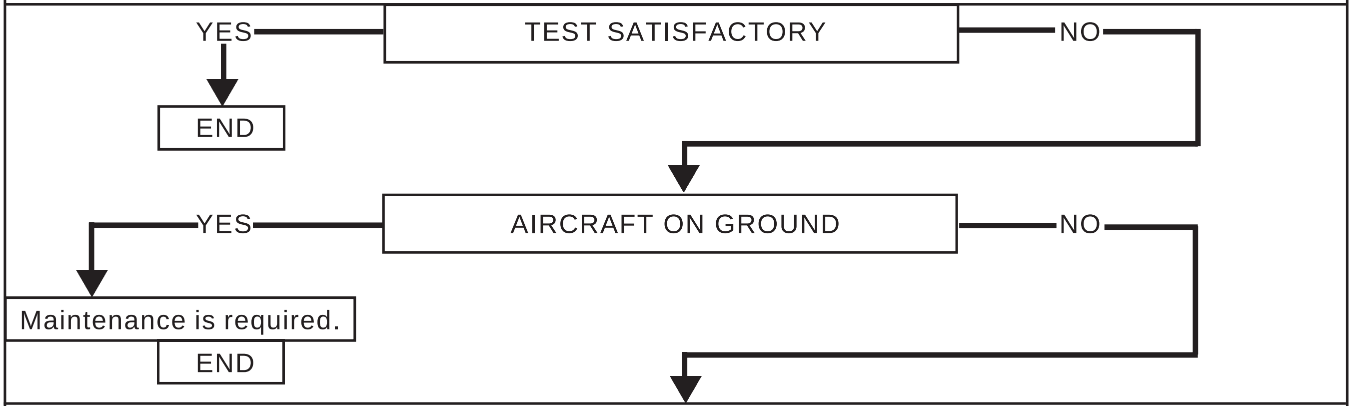
ANTI-SKID FAIL LT(S) ON (GEAR DOWN, GREEN LTS ON)

PARKING BRAKE LEVER . . . . VERIFY OFF (P, FE)
ANTI-SKID Sw . . . . OFF/THEN ARM (FE)

Observe all ANTI-SKID FAIL lights come on with switch in OFF and go off when switch is returned to ARM.

ANTI-SKID Sys . . . . TEST (FE)

Observe ANTI-SKID FAIL lights come on. Release button and observe lights go off.



WARNING

If the anti-skid braking system is inoperative, the landing ground roll is increased significantly. Refer to TO 1C-10(K)A-1-1, Section IX, to compute landing distance.

CAUTION

Use extreme caution when braking with ANTI-SKID FAIL light(s) on or if the entire anti-skid system is inoperative. Tire skids may be difficult to detect. Consider reducing gross weight. Leave the anti-skid armed. Judge braking action by sensing the deceleration of the aircraft while applying pressure to the brake pedals. Manual braking technique consists of gradually increasing the pedal force until a moderate deceleration is felt and immediately extending the spoilers The pilot flying should also pace the deceleration to use most of the runway available, RCR permitting. Excess pedal pressure/deflection can result in skids, worn/blown tires and possible center gear lower drag link failure. If skidding develops and brake system pressure is normal, release brakes and reapply using the same technique. With only accumulator pressure available, avoid cycling brake pedals.

AFTER LANDING ROLL ANTI-SKID Sw . . . . OFF (FE)

END

ABNORMAL BRAKE

NOTE

- *Accomplish this checklist after an ABORTED TAKEOFF or MAXIMUM EFFORT STOP, anytime the brakes are subjected to abnormally high or prolonged use, or anytime brake temperatures are uncharacteristically high for conditions.*
- *If this checklist is initiated for a HIGH ENERGY STOP (any stop initiated in excess of 130 knots) make AFTO Form 781A entry documenting the following data after completing the checklist: airfield, runway, and runway condition; brakes actuation speed; gross weight and center of gravity; was maximum braking used (full brake application, pedals bottomed)?; was fluid loss noted?; estimated actual stopping distance and runway remaining after stopping; tire failures occurring (do not include fuse plug activation after aircraft has stopped).*

YES — AFTER TAKEOFF — NO

WARNING

- *If the BRAKE TEMP OVHT light(s) come on or BRAKE TEMPERATURE is above 400° C;*
- *Extend the landing gear when performance conditions permit.*
- *Leave the landing gear extended until brake temperature is below 360° C and BRAKE OVHT light(s) is off.*
- *Wheel fuse plugs may activate and deflate fires.*

NOTE

Brake(s), wheel(s), and tire(s) will require maintenance inspection before next flight.

END

Brake Temperature/ Energy Zone . . . . DETERMINE (FE)

NOTE

- *If the Brake Temperature Monitoring System (BTMS) is inoperative, refer to Brake Energy Chart located at the end of this procedure to determine Brake Energy Zone.*
- *Brake Temperature/Energy Zones are defined as:*

NORMAL - Less than 400° C indicated Brake Temperature [420 x (10^6 FT LB) Brake Energy] and BRAKE OVHT LT(S) off.

CAUTION - 400° C or more indicated Brake Temperature [420 x (10^6 FT LB) Brake Energy] but less than 500° C indicated Brake Temperature [603 x (10^6 FT LB) Brake Energy] and/or Brake OVHT LT(S) on.

DANGER - 500° C or more indicated Brake Temperature [603 x (10^6 FT LB) Brake Energy].

GO TO APPROPRIATE PROCEDURE AS FOLLOWS: . . . . (P, FE)

A	**NORMAL ZONE**
B	**CAUTION ZONE**
C	**DANGER ZONE**

CONTINUED

ABNORMAL BRAKE (Cont)

A NORMAL ZONE

Refer to Brake Energy Chart located at the end of this procedure to forecast peak Brake Energy. Use Brake Temperature prior to Brake application speed. Refer to Brake Cooling Chart located at the end of this procedure before next takeoff.

NOTE

Brakes may require 15 to 25 minutes to peak after braking has stopped.

END

B CAUTION ZONE

WARNING

- *Do not attempt takeoff if BRAKE TEMP OVHT light(s) is on.*
- *Use caution. Move aircraft to clear active runway or ramp.*
- *Do not set parking brake.*
- *Keep personnel clear of the main gear area.*
- *If a 400° C temperature exists for more than 5 minutes, wheel fuse plugs may activate and deflate the tire(s).*
- *Refer to GROUND EVACUATION checklist, if appropriate, page 2-62.*

NOTE

Brake(s), wheel(s), and tire(s) will require maintenance inspection before next flight. Replace brake(s), wheel(s), and tire(s) if fuse plug activates.

END

C DANGER ZONE

WARNING

- *Immediately move aircraft to clear active runway or ramp.*
- *Do not set parking brake.*
- *Be prepared to evacuate the aircraft. Refer to GROUND EVACUATION checklist, page 2-62.*
- *Fire is possible within 30 minutes. Alert fire fighting personnel for possible hydraulic fluid, grease, or tire fire.*
- *Keep unnecessary personnel clear of landing gear area.*
- *After 30 minutes, fog or foam may be used to reduce cooling time. Approach inflated tires cautiously from front or rear only.*

NOTE

Replace brake(s), wheel(s) and tire(s). Bogie beam(s) and axle(s) must be inspected for heat damage before next flight.

END

CONTINUED

ABNORMAL BRAKE (CONT)

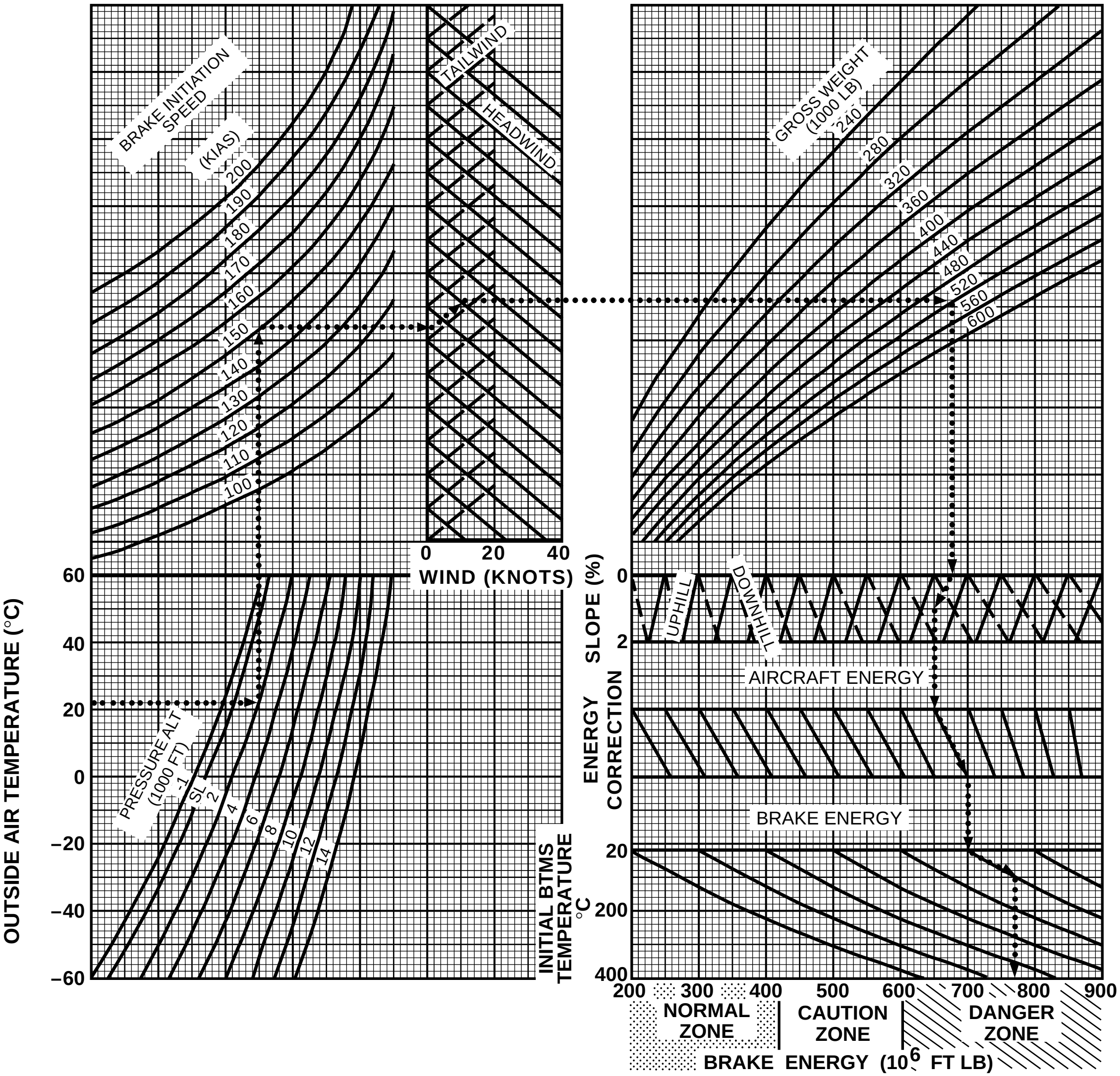
MODEL: KC-10A
ENGINES: CF6-50C2
DATE: 1 OCTOBER 1983
DATA BASIS: FLIGHT TEST

BRAKE ENERGY

EXAMPLE:
GIVEN:
INITIAL BTMS TEMPERATURE = 100°C
GROSS WEIGHT = 520,000 LB
PRESSURE ALTITUDE = 2000 FT
OUTSIDE AIR TEMPERATURE = 22°C.
TAILWIND = 10 KNOTS
SLOPE = 1 PERCENT UPHILL
BRAKE INITIATION SPEED = 150 KIAS
FIND:
BRAKE-LIMITATION ZONE
SOLUTION:
DANGER ZONE

NOTE:

1. CENTER GEAR EXTENDED.
2. ALL BRAKES OPERATING.
3. SPOILERS DEPLOYED.
4. NO REVERSE THRUST.
5. DOWNHILL SLOPE CORRECTION IS BASED ON RCR = 23. FOR RCR < 23 BUT RCR ≥10 DOUBLE THE DOWNHILL SLOPE CORRECTION. WHEN RCR < 10 OR WHEN THERE IS A RSC, TRIPLE THE DOWNHILL SLOPE CORRECTION.
6. VALID FOR ALL FLAP SETTINGS.
7. USE BTMS TEMPERATURE PRIOR TO BRAKE APPLICATION.
8. IF THE BTMS IS INOPERATIVE, ASSUME AN INITIAL BTMS TEMPERATURE IS 100°C.
9. ALWAYS USE ACTUAL OUTSIDE AIR TEMPERATURE.
10. USE ACTUAL WIND CONDITIONS.



CONTINUED

SA1-483B

Figure 2A-2. Brake Energy Chart

ABNORMAL BRAKE (CONT)

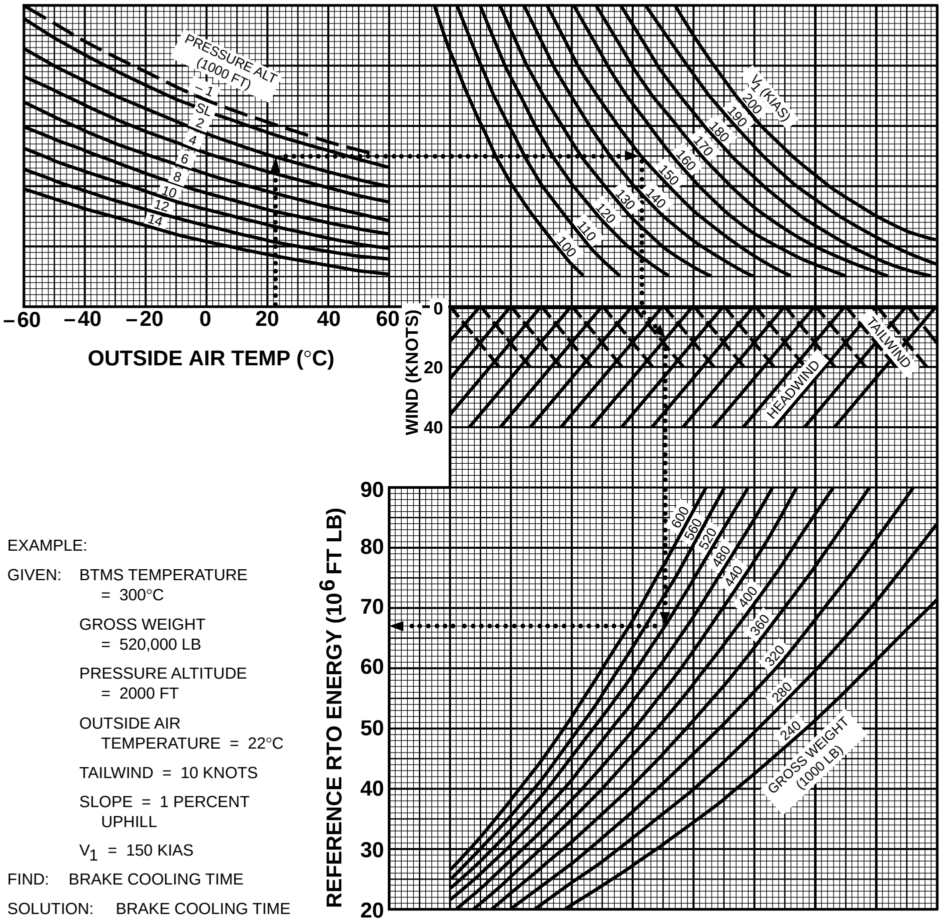
MODEL: KC-10A

ENGINES: CF6-50C2
DATE: 1 OCTOBER 1983
DATA BASIS: FLIGHT TEST

BRAKE-COOLING TIME

NOTE:

1. READ BTMS AFTER PEAK VALUE IS REACHED (APPROXIMATELY 15-20 MINUTES AFTER LANDING).
2. SPOILERS DEPLOYED.
3. NO REVERSE THRUST.
4. CENTER GEAR EXTENDED.
5. ALL BRAKES OPERATING.
6. DOWNHILL SLOPE CORRECTION IS BASED ON RCR = 23. FOR RCR < 23 BUT RCR ≥ 10 DOUBLE THE DOWNHILL SLOPE CORRECTION. WHEN RCR < 10 OR WHEN THERE IS A RSC, TRIPLE THE DOWNHILL SLOPE CORRECTION.
7. VALID FOR ALL FLAP SETTINGS.
8. ALWAYS USE ACTUAL OUTSIDE AIR TEMPERATURE.



EXAMPLE:

GIVEN: BTMS TEMPERATURE = 300°C

GROSS WEIGHT = 520,000 LB

PRESSURE ALTITUDE = 2000 FT

OUTSIDE AIR TEMPERATURE = 22°C

TAILWIND = 10 KNOTS

SLOPE = 1 PERCENT UPHILL

V_1 = 150 KIAS

FIND: BRAKE COOLING TIME

SOLUTION: BRAKE COOLING TIME = 45 MINUTES

CONTINUED

SA1-518A

Figure 2A-3. Brake Cooling Time (Sheet 1)

ABNORMAL BRAKE (CONT)

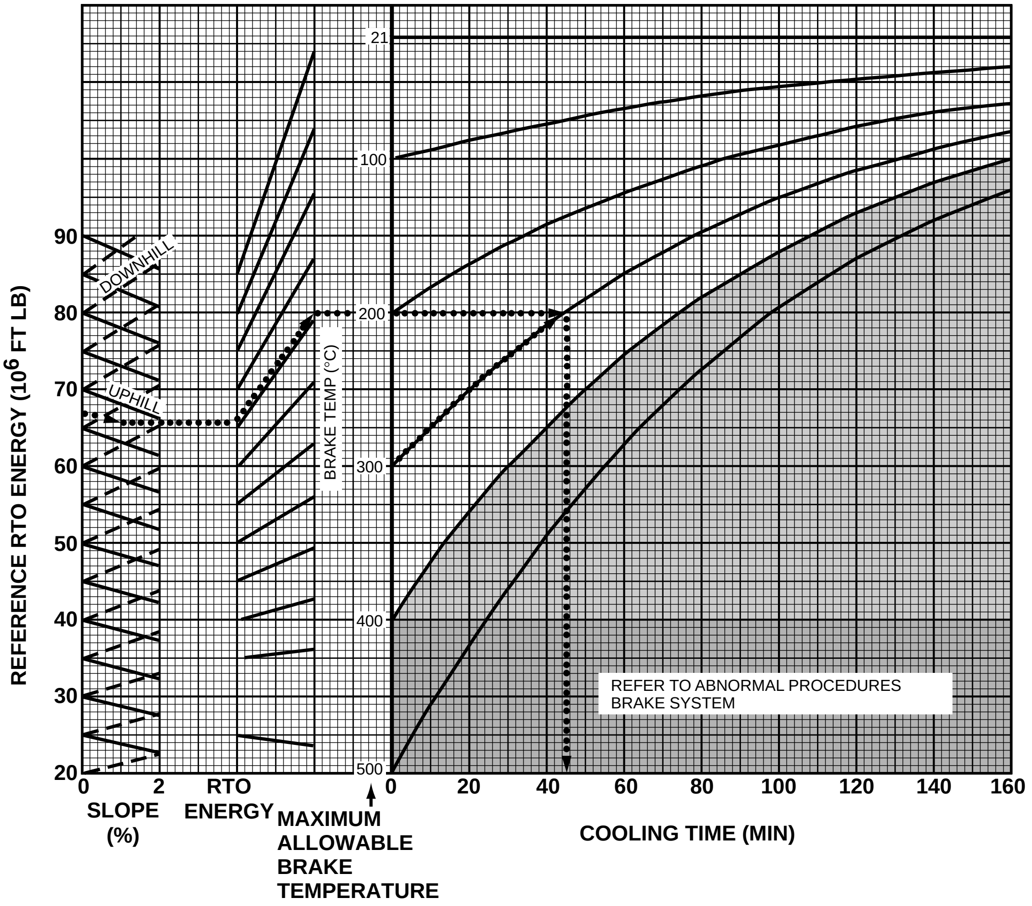
MODEL: KC-10A

ENGINES: CF6-50C2
DATE: 1 OCTOBER 1983
DATA BASIS: FLIGHT TEST

BRAKE-COOLING TIME

NOTE:

1. READ BTMS AFTER PEAK VALUE IS REACHED (APPROXIMATELY 15-20 MINUTES AFTER LANDING).
2. SPOILERS DEPLOYED.
3. NO REVERSE THRUST.
4. CENTER GEAR EXTENDED.
5. ALL BRAKES OPERATING.
6. DOWNHILL SLOPE CORRECTION IS BASED ON RCR = 23. FOR RCR < 23 BUT RCR ≥ 10 DOUBLE THE DOWNHILL SLOPE CORRECTION. WHEN RCR < 10 OR WHEN THERE IS A RSC, TRIPLE THE DOWNHILL SLOPE CORRECTION.
7. VALID FOR ALL FLAP SETTINGS.
8. ALWAYS USE ACTUAL OUTSIDE AIR TEMPERATURE.



REFER TO ABNORMAL PROCEDURES BRAKE SYSTEM

END

SA1-519B

Figure 2A-3. Brake Cooling Time (Sheet 2)

GEAR HANDLE WILL NOT MOVE TO DOWN POSITION

IAS . . . . "230 KTS MAX" (P)

Verify speed is at or below maximum free fall speed (230 KIAS).

Alternate Gear Ext Lever-Main Gear . . . . "RAISE/LATCH" (CP)

Main gear doors remain open, and the outboard ailerons are mechanically unlocked.

CAUTION

- *Main gear alternate extension lever must be left in the raised position to prevent inadvertent gear retraction.*
- *Do not exceed 260 KIAS.*

Gear Lts . . . . "3 GREEN" (P,CP,FE)

CAUTION

After alternate extension of main gear, wait until gear is extended (3 GREEN lights) before next action.

NOTE

The required delay between main gear and center gear extension allows gear hydraulic system bypass to be effective, and will prevent temporary hydraulic blockage of the center gear alternate extension handle.

Alternate Gear Ext Handle-Center Gear . . . . PULL (FE)
Gear Lts . . . . "4 GREEN" (P,CP,FE)

NOTE

Nose gear steering to the right is limited to 25° when using nose gear steering wheel.

END

GEAR HANDLE WILL NOT MOVE TO UP POSITION

NOTE

This malfunction may be caused by the ground sensing mechanism remaining in the ground mode or loss of hydraulic pressure to landing gear trim system.

YES — NOSE GEAR STEERING WHEEL CENTERED — NO

Nose Gear Steering Wheel .... CENTER/RELEASE (P)

YES — NOSE GEAR STEERING STAYS CENTERED AND TAT INDICATES HEAT — NO

WARNING

If nose gear steering wheel index and index on console are not aligned or there is reason to suspect nosewheel tire damage (unusual vibration at liftoff, ground observation, etc.), do not make further attempts to retract gear.

NOTE

If TAT heat is not normal, refer to NOTE at and of this procedure.

GEAR HANDLE/Lts .... VERIFY DOWN/4 GREEN (P,CP,FE)
IAS Gear Down .... 300 KIAS/MAX (PF)

END

IAS .... "230 KTS MAX" (PF)
Gear HANDLE REL Button .... "PUSH/HOLD" (CP)
Gear Handle .... "UP" (CP)

YES — GEAR HANDLE MOVES TO UP — NO

Landing gear trim failure is indicated.

GEAR Handle/Lts ...."DOWN/4 GREEN" (P,CP,FE)
GEAR Down Speed .... OBSERVE (PF)

NOTE

Failure should have no adverse affect on landing.

END

Gear HANDLE REL Button ...."RELEASE" (CP)
Gear Lts ...."OFF" (CP)

CONTINUED

GEAR HANDLE WILL NOT MOVE TO UP POSITION (cont)

NOTE

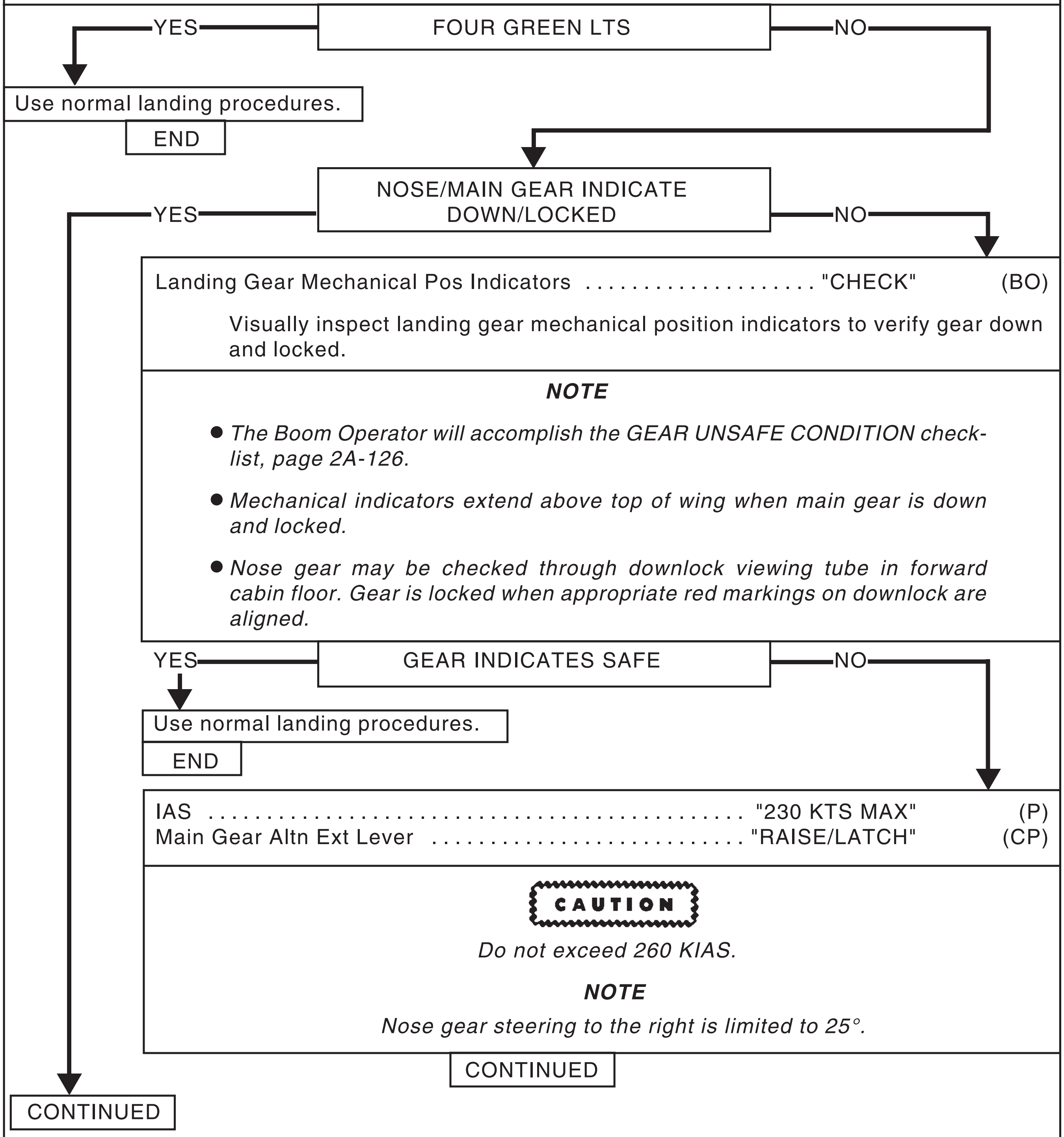
- *If desired, normal inflight mode may be recovered for all systems except auto slats by pulling GROUND SENSING circuit breakers (UM (Left) P-1 and (Right) S-1). Reset GROUND SENSING circuit breaker prior to landing to provide normal engine 2 reversing, and automatic cabin depressurization.*

- *When ground sensing mechanism does not shift to flight mode, some system effects are noted below:*
  - Cabin does not pressurize normally.
  - Pilot heat and angle of attack heater current does not increase.
  - TAT heater current is zero.
  - Water drain mast heating is in low.
  - SPEED BRAKE light is inoperative.
  - Takeoff warning is armed.
  - Engine 2 in-flight reverse interlock is released.
  - Engine failure detector system remains armed.
  - Autothrottle speed mode cannot be engaged.
  - Go around mode cannot be engaged but pushing TO/GA button causes TAKEOFF to be annunciated in pitch and roll FMA's.
  - Stall warning is inhibited.
  - Stick shakers are inoperative.
  - Auto slats are inoperative.
  - Wing and antenna anti-ice systems are inoperative.

END

GEAR UNSAFE LT(S) ON WITH GEAR HANDLE DOWN (CONFIRMED ON BOTH PANELS)

HYD SYS 3 Press . . . . CHECK NORMAL (FE)
Landing Gear Handle . . . . "CYCLE UP/DOWN" (CP)



FOUR GREEN LTS

YES: Use normal landing procedures. END

NO:

NOSE/MAIN GEAR INDICATE DOWN/LOCKED

YES: CONTINUED

NO:

Landing Gear Mechanical Pos Indicators . . . . "CHECK" (BO)

Visually inspect landing gear mechanical position indicators to verify gear down and locked.

NOTE

- *The Boom Operator will accomplish the GEAR UNSAFE CONDITION checklist, page 2A-126.*
- *Mechanical indicators extend above top of wing when main gear is down and locked.*
- *Nose gear may be checked through downlock viewing tube in forward cabin floor. Gear is locked when appropriate red markings on downlock are aligned.*

GEAR INDICATES SAFE

YES: Use normal landing procedures. END

NO:

IAS . . . . "230 KTS MAX" (P)
Main Gear Altn Ext Lever . . . . "RAISE/LATCH" (CP)

CAUTION

Do not exceed 260 KIAS.

NOTE

Nose gear steering to the right is limited to 25°.

CONTINUED

GEAR UNSAFE LT(S) ON WITH GEAR HANDLE DOWN (CONFIRMED ON BOTH PANELS) (cont)

CONTINUED

CONTINUED

GEAR INDICATES SAFE

YES

Use normal landing procedures.

END

NO

Refer to Abnormal Procedures, LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION.

END

CTR GEAR UNSAFE

NOTE

No visual check is provided to verify center gear is down and locked.

CENTER GEAR REQUIRED FOR LANDING (Gross Weight >400,000 lbs)

YES

NO

NOTE

If center gear is not required for landing, consider retracting landing gear and isolating the center gear. Lower gear with Center Gear isolated. Accomplish Before Landing Checklist. Aircraft Performance and limitations must be considered.

END

IAS . . . . "230 KTS MAX" (P)
Main Gear Altn Ext Lever . . . . "RAISE/LATCH" (CP)

CAUTION

- *After alternate extension of main gear, wait until gear is extended (3 GREEN lights), before next action.*
- *Do not exceed 260 KIAS.*

NOTE

- *The required delay between main gear and center gear extension allows gear hydraulic system bypass to be effected, and will prevent temporary hydraulic blockage of the center gear alternate extension handle.*
- *Nose gear steering to the right is limited to 25°.*

CTR GEAR Altn Ext Handle . . . . PULL (FE)

CONTINUED

GEAR UNSAFE LT(S) ON WITH GEAR HANDLE DOWN (CONFIRMED ON BOTH PANELS) (cont)

YES — FOUR GREEN LTS — No

Use normal landing procedures.

END

If possible, retract/isolate center gear.

NOTE

Main Gear Altn Ext Lever must be stowed before gear can be retracted.

Consider effect of center gear retracted on aircraft landing performance and limitations.

Accomplish normal landing procedures.

END

GEAR UNSAFE LT(S) ON WITH GEAR HANDLE UP (CONFIRMED ON BOTH PANELS)

HYD SYS 3 Press . . . . CHECK NORMAL (FE)
IAS . . . . 260 KTS MAX (PF)
Gear . . . . VISUALLY INSPECT (BO)

The Boom Operator will accomplish the GEAR UNSAFE CONDITION checklist, page 2A-126.

Observe main gear through viewing ports in aft cabin floor, and nose gear through uplock viewing tube in the forward cabin floor to ensure damage has not occurred due to gear door or other failure. Obtain confirmation from a ground observer or chase aircraft if possible.

CAUTION

If gear does not appear normal (for example, if main gear retraction is blocked by gear door) or if condition of gear cannot be determined, do not attempt additional gear retraction.

YES — GEAR VISUALLY APPEARS NORMAL — NO

GEAR HANDLE/LTS . . . . DOWN/4 GREEN (P,CP,FE)

Do not exceed 260 KIAS. Maintenance action required. Accomplish normal landing procedures.

END

GEAR HANDLE/Lts . . . . DOWN/4 GREEN (P,CP,FE)
IAS . . . . 230 KTS MAX (PF)
GEAR HANDLE . . . . UP (CP)

YES — GEAR LTS OFF — NO

Continue normal operation, annotate AFTO Form 781A.

END

Gear . . . . VISUALLY INSPECT (BO)

The Boom Operator will accomplish the GEAR UNSAFE CONDITION checklist, page 2A-126.

Observe main gear through viewing ports in aft cabin floor, and nose gear through uplock viewing tube in forward cabin floor. Gear are up and locked when appropriate red markings are aligned. To determine position of center gear, pull center gear alternate extension handle. If handle travel stops at a point where any part of red band on the cable is aligned with top of floor, center gear is up and locked.

YES — UP AND LOCKED — NO

Continue normal operation, annotate AFTO Form 781A.

END

IAS . . . . 260 KTS MAX (PF)
GEAR HANDLE/Lts . . . . DOWN/4 GREEN (P,CP,FE)

Do not exceed 260 KIAS. Maintenance action required. Accomplish normal landing procedures.

END

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION

NOTE

- *Land with center gear retracted and as many other gear extended as possible.*
- *This procedure is based on the assumption that all methods to extend the landing gear have been unsuccessful.*
- *Fly a power on approach on computed approach speed, carrying power to touchdown, if required, so as to contact the runway as gently as possible.*
- *All slide rafts will be usable with aircraft stopped in any failed landing gear configuration.*

YES — CENTER GEAR EXTENDED — NO

Main Gear Altn Ext Lever . . . . "STOW" (CP)
GEAR HANDLE . . . . "UP" (CP)
CTR Gear ISOL Sw . . . . "UP/SAFTY PIN INSTALLED" (CP)
GEAR HANDLE . . . . "DOWN" (CP)

Crew . . . . ADVISE (P)

Advise the crew of the emergency, type of landing to be made, time remaining before landing and any special problems that may confront the crew or affect the use of any exits.

Passenger Briefing/Cabin Preparation . . . . INITIATE (P,BO)

Direct boom operator to brief passengers for emergency landing/aircraft evacuation. Prepare cabin and stow all loose equipment.

Fuel Quantity . . . . REDUCE (P,FE)

Reduce fuel to minimum required.

APU MASTER Sw . . . . OFF (FE)

Observe RPM and EGT decrease.

Additional Crewmembers . . . . RESEATED IN CABIN (P)

If seats are available, move additional crewmembers to seats in the cabin.

NOTE

Use additional crewmembers to assist boom operator during passenger briefing and evacuation.

Loose Equipment . . . . STOW (ALL)

Cabin Report . . . . "READY TO LAND" (BO)

When boom operator has completed passenger emergency landing/evacuation briefing and has secured all loose equipment, report "Ready to land."

CONTINUED

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION (cont)

Approach and Landing Procedures	REVIEW	(P,CP,FE)

Plan a 50°/EXT Landing.

APPROACH

Crew Briefing	"COMPLETED"	(PF)
Landing Data/V-Bugs	"SET"	(P,CP)
Radio Altimeter	"SET"	(P,CP)
Windshield Anti-Ice	"AS REQUIRED"	(CP)
Altimeters	"SET"	(P,CP)
Pack Function Sel	OFF	(FE)
Cabin Press Man/Auto Handle	MANUAL	(FE)
Outflow Valve Position Ind	FULL OPEN	(FE)
Differential Press Gage	ZERO	(FE)
Fuel Panel	SET	(FE)
Exterior Lts	SET	(FE)
Cabin Signs	ON	(FE)
CDU's/EHSI/Radio Aids	"AS REQUIRED"	(P,CP,FE)
Thrust Computer	"GA"	(PNF)
Annunciator Panels	"CHECKED"	(P,CP,FE)
(**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button	OFF	(FE,BO)
TO/LDG CAB PRESS Aural Warn C/B (Lower Main C-12)	PULL	(FE)
If Nose Gear Unsafe Indication, GPWS C/B (FE Overhead, B-19)	PULL	(FE)
Landing Configuration	DETERMINE	(P,CP,FE)

Go to the appropriate procedure as follows:

A	**LANDING WITH NOSE GEAR PARTIALLY OR FULLY RETRACTED.**
B	**LANDING WITH NOSE GEAR EXTENDED AND BOTH MAIN GEAR PARTIALLY OR FULLY RETRACTED.**
C	**LANDING WITH ONE MAIN GEAR PARTIALLY OR FULLY RETRACTED.**
D	**LANDING WITH ONE MAIN GEAR AND THE NOSE GEAR PARTIALLY OR FULLY RETRACTED.**
E	**LANDING WITH ALL GEAR RETRACTED.**

A LANDING WITH NOSE GEAR PARTIALLY OR FULLY RETRACTED.

FINAL

Fly a normal glide path and flare to touchdown.

GEAR HANDLE/Gear Lts	"DOWN/___GREEN"	(P,CP,FE)
Spoiler Handle	"ARMED"	(P)

CONTINUED

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION (cont)

Anti-Skid/Brake Press . . . . CHECKED (FE)
Flaps/Slats . . . . "50°/EXT" (P,CP,FE)
PA Announcement . . . . COMPLETE (FE)

At 250 feet AGL Flight Engineer announce "BRACE FOR LANDING".

At touchdown,
Longitudinal Trim . . . . TRIM TO NOSE UP (PF)

At touchdown begin actuating longitudinal trim to NOSE UP to assist in holding nose off runway.

Lower nose to runway while elevator control is still effective.

NOTE

Do not use engine reverse thrust.

After nose contact,

Maintain directional control with rudder and differential braking.

After aircraft comes to a complete stop, accomplish GROUND EVACUATION Checklist, if required.

END

B LANDING WITH NOSE GEAR EXTENDED AND BOTH MAIN GEAR PARTIALLY OR FULLY RETRACTED.

FINAL

GEAR HANDLE/Gear Lts . . . . "DOWN___/GREEN" (P,CP,FE)
Spoiler Handle . . . . "DOWN" (P)

NOTE

Do not arm the spoilers.

Flaps/Slats . . . . "50°/EXT" (P,CP,FE)
PA Announcement . . . . COMPLETE (FE)

At 250 feet AGL, Flight Engineer announce "BRACE FOR LANDING".

Fly a normal glidepath and flare to touchdown.

As aircraft settles onto runway, maintain wings level attitude.

CONTINUED

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION (cont)

Directional Control . . . . "MAINTAIN" (PF)

Maintain directional control as long as possible with rudder and nosewheel steering and thrust if available.

Associated Fuel Lever . . . . OFF (PNF)

After aircraft comes to a complete stop, accomplish GROUND EVACUATION Checklist, if required.

END

C LANDING WITH ONE MAIN GEAR PARTIALLY OR FULLY RETRACTED.

FINAL

GEAR HANDLE/Gear Lts . . . . "DOWN___/GREEN" (P,CP,FE)
Spoiler Handle . . . . "DOWN" (P)

NOTE

Do not arm the spoilers.

Anti-Skid/Brake Press . . . . CHECKED (FE)
Flaps/Slats . . . . "50°/EXT" (P,CP,FE)
PA Announcement . . . . COMPLETE (FE)

At 250 feet, AGL Flight Engineer announce "BRACE FOR LANDING".

NOTE

Do not use reverse thrust on engine 2 or on the side with abnormal gear.

Fly a normal glidepath and flare to touchdown.

After touchdown, maintain the pitch attitude of 6°-8° while holding the wings level until nearly all lateral control is used. This will be the minimum practical speed to lower the wing to the ground (while maintaining pitch attitude) and then promptly lower the nosewheel to the runway.

After the wing is on the ground (pod contacts runway), extend ground spoilers to aid in deceleration.

Associated FUEL Lever . . . . "OFF" (PNF)
Directional Control . . . . "MAINTAIN" (PF)

Maintain directional control by using opposite engine reverse thrust, brakes, and nosewheel steering.

After aircraft comes to a complete stop, accomplish GROUND EVACUATION Checklist, if required.

END

CONTINUED

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION (cont)

D LANDING WITH ONE MAIN GEAR AND THE NOSE GEAR PARTIALLY OR FULLY RETRACTED.

FINAL

GEAR HANDLE/Gear Lts . . . . "DOWN___/GREEN" (P,CP,FE)
Spoiler Handle . . . . "DOWN" (P)

NOTE

Do not arm the spoilers.

Anti-Skid/Brake Press . . . . CHECKED (FE)
Flaps/Slats . . . . "50°/EXT" (P,CP,FE)
PA Announcement . . . . COMPLETE (FE)

At 250 feet, AGL Flight Engineer announce "BRACE FOR LANDING".

Fly a normal glidepath and flare to Touchdown.

At touchdown,
Longitudinal Trim . . . . "TRIM TO NOSE UP" (PF)

At touchdown begin actuating longitudinal trim to NOSE UP to assist in holding nose off runway.

After touchdown, maintain the pitch attitude of 6°-8° while holding the wings level until nearly all lateral control is used. This will be the minimum practical speed to lower the wing to the ground (while maintaining pitch attitude) and then gently lower wing and nose to runway before control is lost.

As engine pod contacts runway,

Associated FUEL Lever . . . . "OFF" (PNF)
Directional Control . . . . "MAINTAIN" (PF)

Maintain directional control by using brakes and rudder to control swerve.

After aircraft comes to a complete stop, accomplish GROUND EVACUATION Checklist, if required.

END

CONTINUED

LANDING WITH ABNORMAL LANDING GEAR CONFIGURATION (cont)

E LANDING WITH ALL GEAR RETRACTED.

FINAL

Spoiler Handle . . . . "DOWN" (P)

NOTE

Do not arm the spoilers.

Flaps/Slats . . . . "50°/EXT" (P,CP,FE)
PA Announcement . . . . COMPLETE (FE)

At 250 feet, AGL, Flight Engineer announce "BRACE FOR LANDING".

NOTE

Aircraft will touch down on aft fuselage and engine pods.

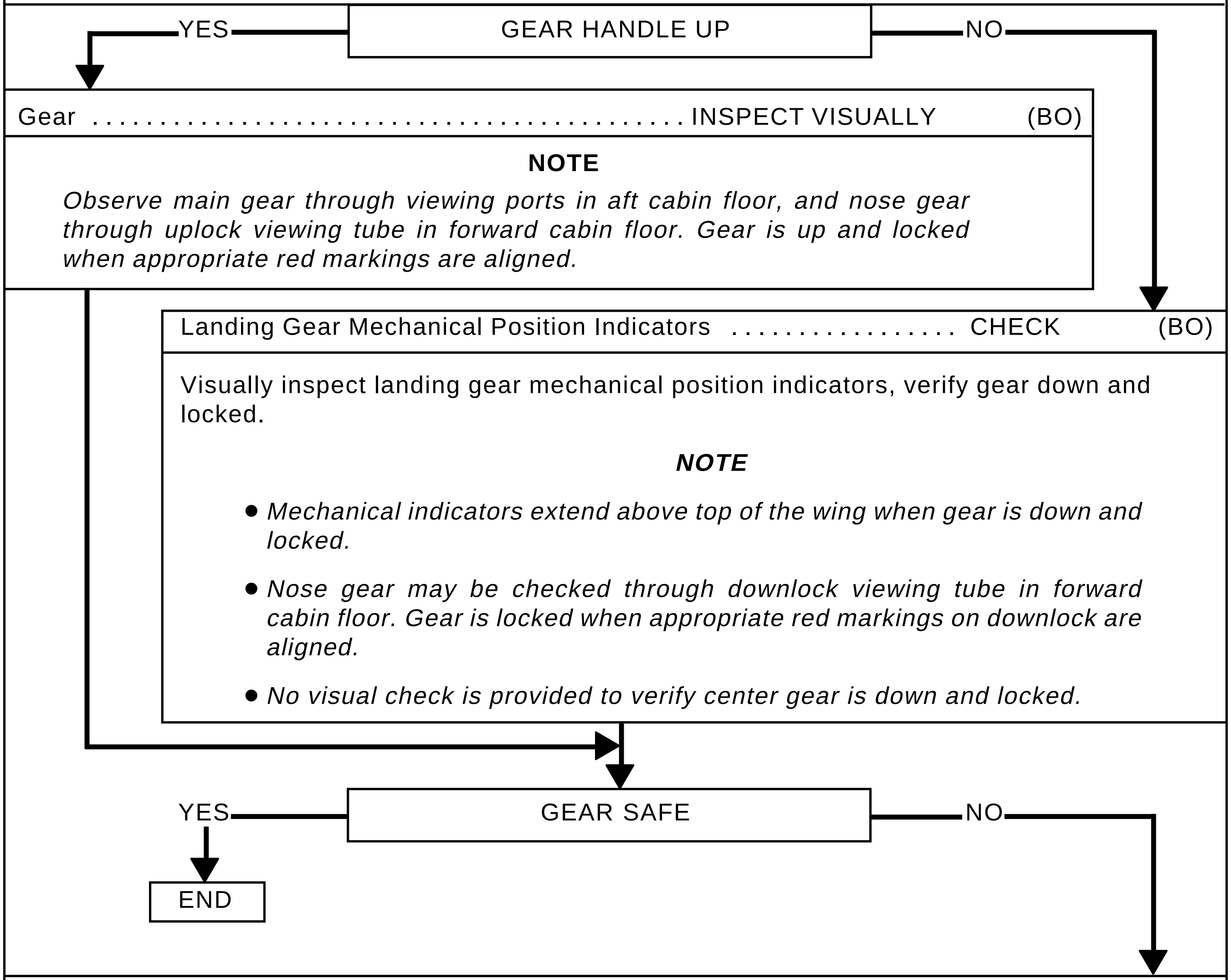
As soon as aircraft contacts runway,
FUEL Levers . . . . "OFF" (PNF)

After aircraft comes to a complete stop accomplish GROUND EVACUATION Checklist, if required.

END

GEAR UNSAFE CONDITION

When notified by the FE, accomplish the following inspections and coordinate your observations.



Gear . . . . INSPECT VISUALLY (BO)

NOTE

Observe main gear through viewing ports in aft cabin floor, and nose gear through uplock viewing tube in forward cabin floor. Gear is up and locked when appropriate red markings are aligned.

Landing Gear Mechanical Position Indicators . . . . CHECK (BO)

Visually inspect landing gear mechanical position indicators, verify gear down and locked.

NOTE

- *Mechanical indicators extend above top of the wing when gear is down and locked.*
- *Nose gear may be checked through downlock viewing tube in forward cabin floor. Gear is locked when appropriate red markings on downlock are aligned.*
- *No visual check is provided to verify center gear is down and locked.*

When notified by the FE, accomplish the following items and coordinate accomplishment.

Cabin Occupants . . . . NOTIFY (BO)

Notify cabin occupants of the situation to allow time for preparation.

Loose Equipment . . . . STOW
Cabin Report . . . . .COMPLETE (BO)

Notify FE when the cabin preparation is completed.

END

OPERATION WITH SINGLE PNEUMATIC SYSTEM

CAUTION

Do not pressurize pneumatic systems which have been de-activated due to a manifold failure, except for engine starting.

Wing Anti-ice Required

YES

PACK Function Sel (PACK 1 or 3) . . . . PACK OFF (FE)
Pneumatic ISOL VALVE 1-3 Sw . . . . OPEN (FE)

Observe the pneumatic ISOL VALVE DISAGREE light comes on and goes off.

AVIONIC FLOW Sw . . . . OVRD (FE)
WING ANTI-ICE Sw . . . . ON (FE)

During descent, maintain approximately 35 psi pneumatic pressure by advancing appropriate throttle.

END

NO

Pneumatic ISOL VALVE 1-3 Sw . . . . OPEN (FE)

Observe the pneumatic ISOL VALVE DISAGREE light comes on and goes off.

CAUTION

Do not operate more than one air conditioning pack with power set at or above MCT.

PACK Function Sels . . . . AS REQ'D (FE)

NOTE

- *When operating with only one air conditioning pack select OVRD on the AVIONIC FLOW switch.*
- *The APU is available as a pneumatic or electrical source.*
- *When using the APU for pneumatic power, do not interconnect two active pneumatic sources. Therefore, if system 1 is the operating system the APU may not be used for pneumatic power.*

END

PNEU ABNORMAL LIGHT ON

Affected ENG PNEU SUPPLY Sel . . . . OFF (FE)

NOTE

Malfunction may or may not be visible on pneumatic pressure or temperature gages.

AFFECTED SYSTEM REQUIRED FOR AIR CONDITIONING AND PRESSURIZATION OR WING ANTI-ICING.

YES

NO

Refer to OPERATION WITH SINGLE PNEUMATIC SYSTEM, page 2A-127.

END

1-3 ISOL VALVE Sw . . . . NORM (FE)

Verify 1-3 ISOL VALVE Switch is in NORM, and observe 1-3 ISOL VALVE DISAGREE light is off.

NOTE

The connecting pneumatic isolation valve switch should be in NORM, to prevent interconnecting two active engine pneumatic systems.

ENG PNEU SUPPLY Sel (Sys with PNEU ABNORMAL Lt ON) . . . . AUTO (FE)

Rotate engine pneumatic supply selector to AUTO, to evaluate system performance.

SYS. REQ'D FOR AIR COND OR PRESS

YES

NO

PACK Function Sel . . . . AUTO (FE)

PNEUMATIC PRESS AND TEMP GAGE ABOVE NORMAL

YES

NO

ENG PNEU SUPPLY Sel . . . . OFF (FE)

NOTE

Consider the APU as a possible pneumatic source.

END

Engine throttle (with affected Pneumatic Supply) . . . . VARY (FE)

Vary throttle setting to obtain actuation of high-stage bleed valve. Observe pneumatic pressure gage to verify a well defined pressure change as throttle is moved.

CONTINUED

CONTINUED

PNEU ABNORMAL LIGHT ON (cont)

CONTINUED

CONTINUED

ENG PNEU PRESS CHANGES

YES

NO

ENG PNEU SUPPLY Sel . . . . OFF (FE)

NOTE

Consider the APU as a possible pneumatic source.

END

Continue using system. Monitor pressure and temperature.

END

REQUIRED FOR ICE PROTECTION

WING ANTI-ICE Sw . . . . ON (FE)

Evaluate pneumatic system performance.

Pneumatic PRESS and TEMP Gages . . . . .OBSERVE (FE)

FLIGHT MODE	ALTITUDE (1,000 FT)	AIRCRAFT GROSS WT. (1,000 LB)	ENG PNEU SUPPLY PRESS MIN (psig)	ENG PNEU SUPPLY TEMP MIN (° C)
Takeoff/Climb	0-30	All	35	200
Departure Hold	0-22	All	35	*134-200
Cruise	0-22	All	35	*134-200
Cruise/Hold	Above 22	All	30	200
Hold	0-10	Below 420	35	180**
	10-22	Below 420	35	200
	0-22	Above 420	35	*134-200
Descent	30-0	All	*20-35	*175-180

* Varies linearly between specified altitudes.

** If S.A.T. is below zero, subtract 1.5 from 180 for every degree S.A.T. is below zero.

PNEU, TEMP & PRESS EQUAL TO OR GREATER THAN TABLE MINS

YES

NO

Continue operation. Monitor system.

END

ENG PNEU SUPPLY Sel . . . . OFF (FE)

Depart icing area.

END

PNEU ISOL VALVE DISAGREE LIGHT ON

Appropriate ENG ISOL VALVE SELECT Sw .... SECONDARY (FE)

Open door on FE equipment panel and move appropriate engine isolation valve switch to SECONDARY.

Pneumatic ISOL VALVE DISAGREE Lt .... OFF (FE)

Observe pneumatic ISOL VALVE DISAGREE light goes off.

NOTE

- *The secondary position selects an alternate motor to drive the isolation valve.*
- *Both motors receive circuit protection through a common circuit breaker (PO G-9, 24).*

END

ABNORMAL OIL QUANTITY INDICATION

ENGINE OIL QUANTITY DECREASE

Slight increase/decrease in oil quantity is normal. Continue operation provided oil pressure and temperature remain in the normal range.

NOTE

Low oil pressure at altitude with recovery to normal or near normal pressure levels during descent and low altitudes is indicative of loss of oil tank pressurization. This could be caused by improper oil tank cap installation, equipment malfunctions, or remote fill ports left uncapped.

If engine oil pressure/temperature become abnormal, shut down affected engine. Refer to Abnormal Procedures, ENGINE SHUTDOWN IN FLIGHT.

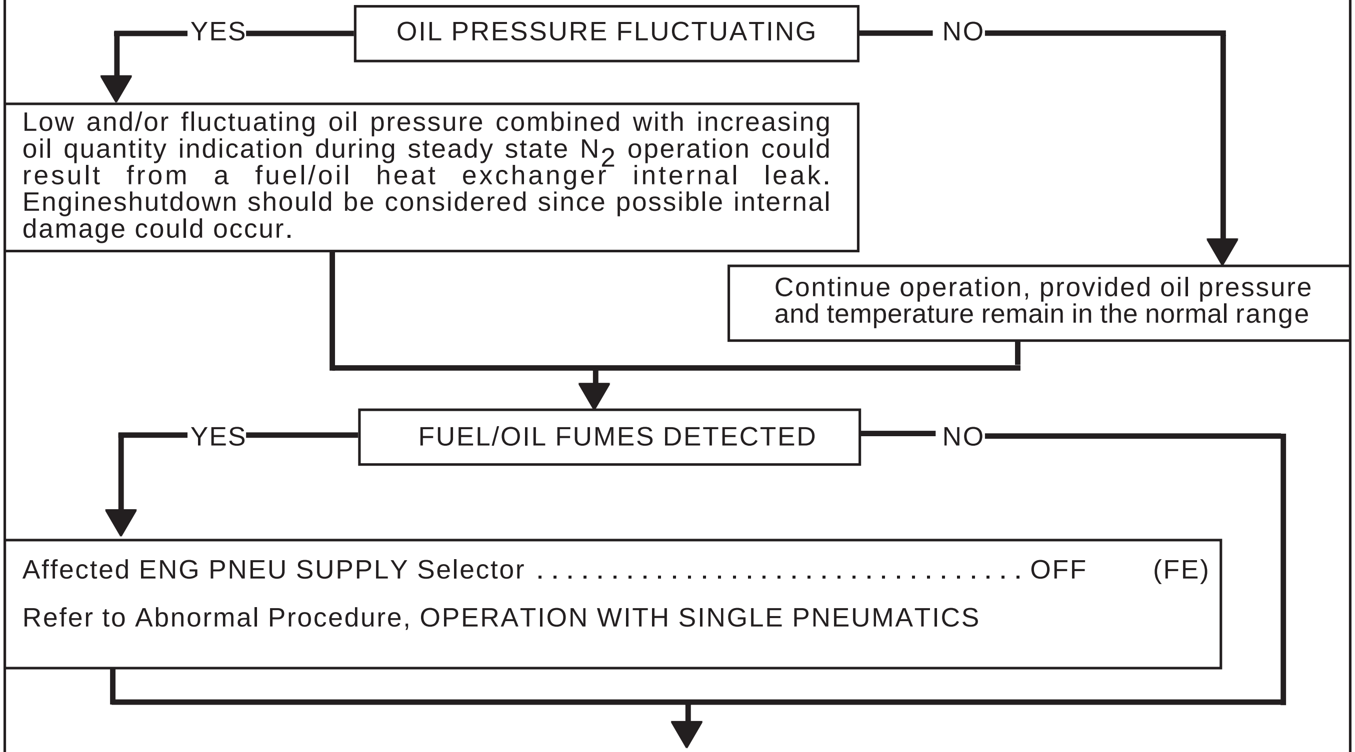
NOTE

Engines that contain no oil may continue to operate for some time with no unusual oil pressure or temperature indications. If a zero oil quantity indication situation is accompanied by pressure fluctuations, serious consideration should be given to engine shutdown regardless of whether or not pressure is in the normal range.

END

ENGINE OIL QUANTITY INCREASE

Slight increase/decrease in oil quantity is normal. Use this procedure when continuous oil quantity increase is observed, oil quantity increase is accompanied by secondary indications, oil quantity exceeds 19 qts, or fuel/oil fumes are detected.



Low and/or fluctuating oil pressure combined with increasing oil quantity indication during steady state N_2 operation could result from a fuel/oil heat exchanger internal leak. Engineshutdown should be considered since possible internal damage could occur.

Continue operation, provided oil pressure and temperature remain in the normal range

Affected ENG PNEU SUPPLY Selector . . . . OFF (FE)

Refer to Abnormal Procedure, OPERATION WITH SINGLE PNEUMATICS

If engine oil pressure/temperature becomes abnormal, shut down affected engine. Refer to Abnormal Procedures, ENGINE SHUTDOWN IN FLIGHT.

END

ABNORMAL START

FUEL Lever . . . . "OFF" (P)
ENG START Sw . . . . "IN/LT ON MOTOR FOR 30 SECONDS" (P)

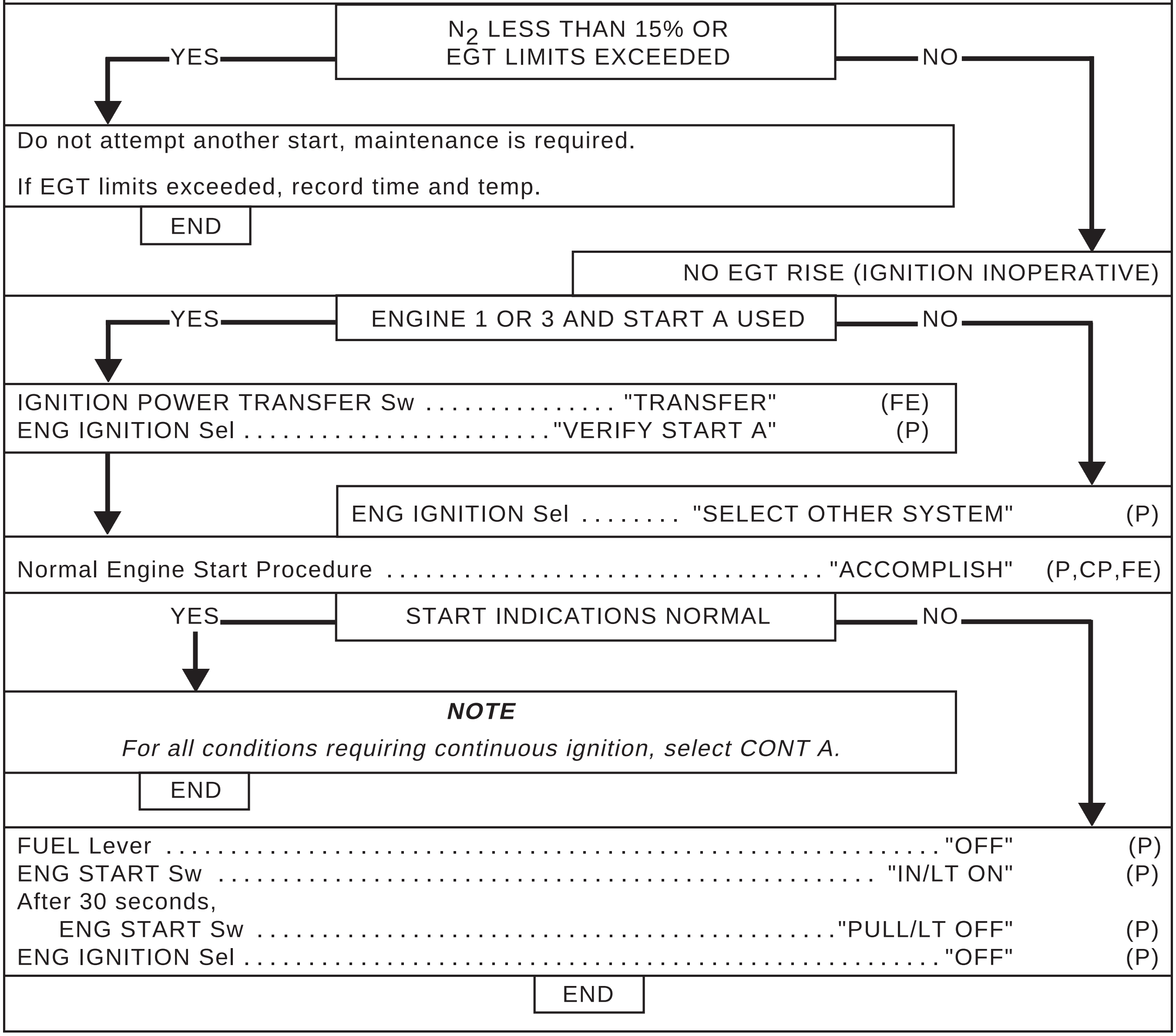
CAUTION

- *Do not select alternate ignition before completion of 30 second motoring period.*
- *If fuel flow was above 700 PPH, a second attempt may result in a hot start.*

NOTE

If pneumatic pressure is low, or a check valve leak is suspected (evidenced by a slow, hung or hot start), rotate all PNEU SUPPLY Sel to OFF for next start.

Indications during ABNORMAL start . . . . DETERMINE (P,CP,FE)



Do not attempt another start, maintenance is required.

If EGT limits exceeded, record time and temp.

END

NO EGT RISE (IGNITION INOPERATIVE)

IGNITION POWER TRANSFER Sw . . . . "TRANSFER" (FE)
ENG IGNITION Sel . . . . "VERIFY START A" (P)

ENG IGNITION Sel . . . . "SELECT OTHER SYSTEM" (P)

Normal Engine Start Procedure . . . . "ACCOMPLISH" (P,CP,FE)

NOTE

For all conditions requiring continuous ignition, select CONT A.

END

FUEL Lever . . . . "OFF" (P)
ENG START Sw . . . . "IN/LT ON" (P)
After 30 seconds,
ENG START Sw . . . . "PULL/LT OFF" (P)
ENG IGNITION Sel . . . . "OFF" (P)

END

BATTERY START

WARNING

Ensure wheels are chocked. The hydraulic system may have insufficient pressure to maintain adequate braking during engine start.

NOTE

Ensure all steps of the FE's Exterior/Interior Initial Inspection Checklist, up to starting the APU, are completed prior to initiating this checklist.

VOLT/AMP/FREQ Sel . . . . BAT & EMER AC (FE)

Verify DC volt/amp meter voltage indication is above limit mark. If meter indicates less than minimum voltage, do not attempt start.

GROUND PNEUMATIC SOURCE

YES

Pilot direct maintenance to connect ground pneumatic power.

NOTE

- *The pneumatic pressure gages do not indicate pressure until the appropriate bus is powered by an engine generator.*
- *Start engine 1 first if pneumatic system 1 is pressurized. If engine 3 is started first, move pneumatic system valve 1-3 switch to OPEN.*

NO

APU

Pilot direct maintenance to manually open APU isolation valve and pneumatic isolation valve 1-2.

EMER PWR Sw . . . . ON (FE)

Observe EMER PWR IN USE light comes on and L EMER DC BUS OFF and the L EMER AC BUS OFF lights are off.

NOTE

- *With only emergency power in use, communication with ground is available at nose flight interphone jack, and Pilot's and FE's audio panels only.*
- *Complete the start procedure without delay. Power electrical buses as soon as possible to prevent battery discharge.*

ENG IGNITION Sel . . . . "START A" (P)
PACK Sels . . . . PACK OFF (FE)

NOTE

- *ENGINE START switch-light will not come on until electrical buses are powered.*
- *Oil pressure and fuel flow gages are inop during a battery start. Monitor OIL PRESS LO light until AC bus is powered.*

CONTINUED

BATTERY START (cont)

Start engine using normal start procedures.

After engine stabilizes at ground idle rpm.

GEN 1 OFF Lt . . . . OFF (FE)

Observe GEN 1 OFF light is off and appropriate buses are powered.

EMER PWR Sw . . . . "OFF" (P)

After appropriate electrical buses are powered move EMER PWR switch to OFF.

Procedures . . . . ACCOMPLISH (P,CP,FE)

Accomplish all applicable procedures through BEFORE START checklist before starting remaining engines.

END

COMPRESSOR STALL

NOTE

Compressor stalls are caused by aerodynamic disturbance of airflow through the engine. Indications of compressor stall are abnormal engine noises, sluggish throttle response fluctuation and/or high EGT or rapid EGT rise.

YES — THROTTLE MOVING — NO

Throttle . . . . "IDLE" (PF)

EGT & N_2 Gages . . . . "OBSERVE" (P,CP,FE)

Slowly advance throttle to determine if stall recurs. Observe N_1, N_2, and EGT indications follow throttle movement.

When Stall Clears, Throttle . . . . "SLOWLY ADVANCE" (PF)

YES — STALL RECURS — NO

Continue normal operation, review notes at end of this procedure.

CAUTION

Continued operation of an engine that exhibits stall tendencies must be done with extreme caution. If high or rapid rise in EGT occurs or increase in vibration level is noted, shut down engine.

END

CONTINUED

CONTINUED

COMPRESSOR STALL (cont)

CONTINUED

CONTINUED

Shut down engine if required, or operate at minimum thrust if required.

NOTE

- *After a compressor stall, an engine is unserviceable for flight dispatch until applicable maintenance action has been completed.*
- *Provide maintenance with as much operational information as possible. Include TAT, altitude, airspeed, percent* N_1 *and weather conditions in the write-up.*

Maintenance is required.

END

CROSS BLEED ENGINE START

NOTE

Procedure requires an increase in power from the supplying engine. Advancing the throttle too far forward will cause the pneumatic system to switch to low bleed.

ENG PNEU SUPPLY Sel (Supplying Engine) . . . . AUTO (FE)
ENG PNEU SUPPLY Sel (Receiving Engine(s)) . . . . OFF (FE)
Appropriate Pneumatic ISOL VALVE Sw . . . . OPEN (FE)
PACK Function Sels . . . . PACK OFF (FE)
Throttle (Supplying Engine) . . . . "SLOWLY ADVANCE" (P)
Pneumatic PRESS Gage . . . . "____PSI" (FE)

Start engine using normal start procedures.
After engine is started,
Throttle (Supplying Engine) . . . . "IDLE" (P)
Pneumatic ISOL VALVE Sws . . . . NORM (FE)
ENG PNEU SUPPLY Sels . . . . AUTO (FE)
PACK Function Sels . . . . AUTO (FE)

END

ENGINE OIL PRESSURE HIGH

NOTE

An oil pressure increase of more than 10 psi during steady state N_2 operation may be caused by constrictions in the lubricating system due to contamination. The oil strainer clog light may be illuminated. However, contamination in some areas can result in an increase in pressure without the light being illuminated.

Monitor oil quantity, oil temperature, and engine vibration readings. If oil temperature becomes excessive, or abnormal vibration occurs, shut down engine. Refer to Abnormal Procedures, ENG SHUTDOWN IN FLIGHT.

END

ENGINE OIL PRESSURE LOW

NOTE

- *Simultaneous loss of oil pressure and N_2 indication indicates a failed lube pump. Continued operation could cause engine damage.*
- *Low and/or fluctuating oil pressure combined with increasing oil quantity indication during steady-state N_2 operation, could result from a fuel/oil heat exchanger internal leak. Engine shutdown should be considered since possible engine damage could result.*
- *Oil pressure decrease more than 10 psi during steady-state N_2 operation may be due to restricted oil supply, system leakage, or loss of oil tank pressurization.*
- *Low oil pressure at altitude with recovery to normal or near normal pressure levels during descent and low altitudes is indicative of loss of oil tank pressurization. This could be caused by improper oil tank cap installation, equipment malfunction, or remote fill ports left uncapped.*

Engine Oil Pressure and PRESS LOW Lt . . . . OBSERVE (P,FE)

OIL PRESS BELOW RED LINE
AND OIL PRESS LO LT ON

YES

Affected Engine . . . . SHUTDOWN (PNF,FE)

Refer to Abnormal Procedure, ENG SHUTDOWN IN FLIGHT.

END

NO

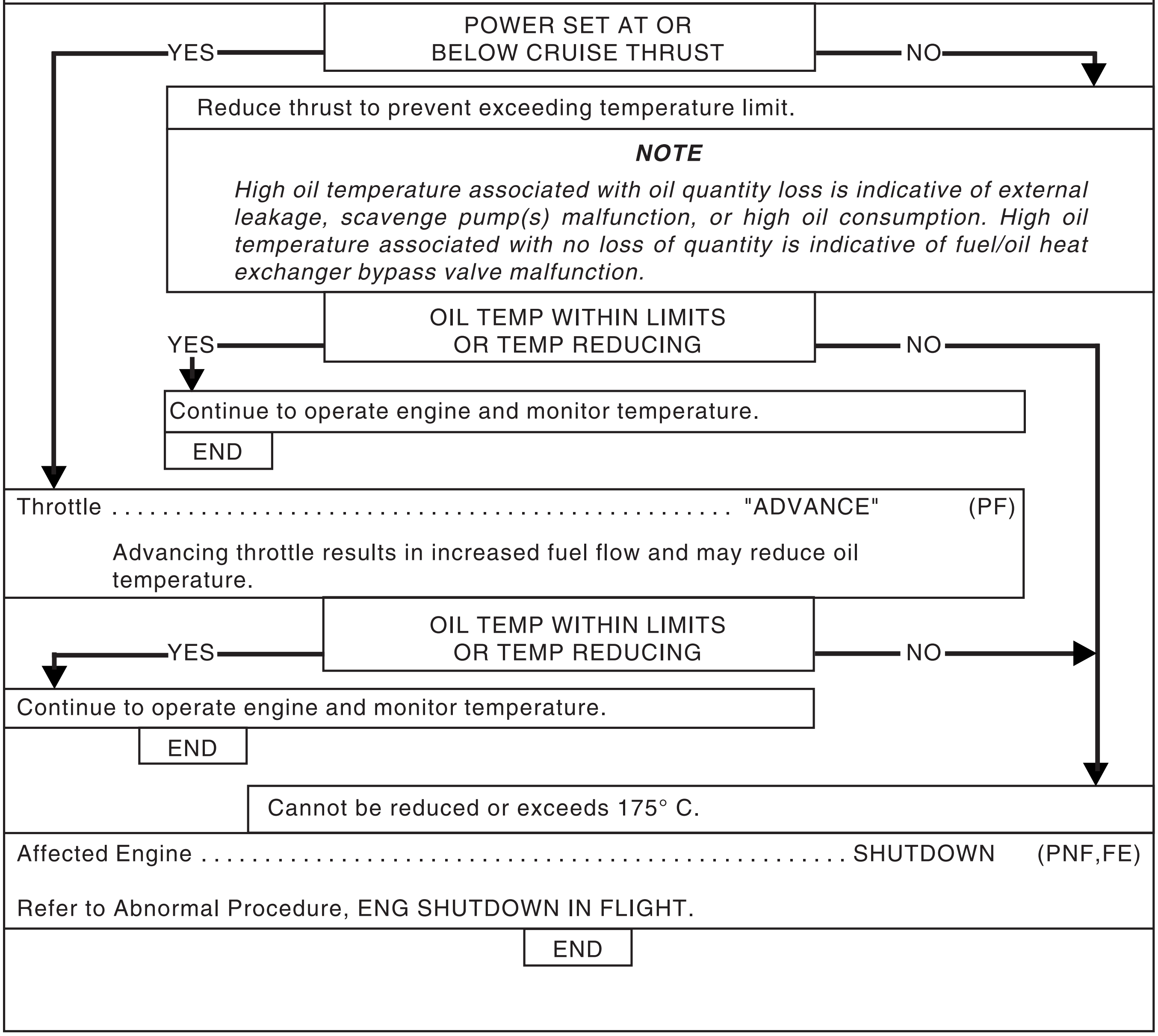
Oil Qty, Temp, and Press . . . . MONITOR (P,CP,FE)

END

ENGINE OIL TEMPERATURE HIGH

NOTE

Operation in CAUTION range is permissible for 15 minutes.



POWER SET AT OR BELOW CRUISE THRUST

YES — NO

Reduce thrust to prevent exceeding temperature limit.

NOTE

High oil temperature associated with oil quantity loss is indicative of external leakage, scavenge pump(s) malfunction, or high oil consumption. High oil temperature associated with no loss of quantity is indicative of fuel/oil heat exchanger bypass valve malfunction.

OIL TEMP WITHIN LIMITS OR TEMP REDUCING

YES — NO

Continue to operate engine and monitor temperature.

END

Throttle . . . . "ADVANCE" (PF)

Advancing throttle results in increased fuel flow and may reduce oil temperature.

OIL TEMP WITHIN LIMITS OR TEMP REDUCING

YES — NO

Continue to operate engine and monitor temperature.

END

Cannot be reduced or exceeds 175° C.

Affected Engine . . . . SHUTDOWN (PNF,FE)

Refer to Abnormal Procedure, ENG SHUTDOWN IN FLIGHT.

END

ENGINE RESTART

NOTE

If engine failed or flamed out for an unknown reason, do not attempt restart unless required for safety of flight.

Throttle	"IDLE"	(PF)
FUEL Lever	OFF	(FE)
MAIN TANK PUMP Sws	ON	(FE)
Approp MOTOR PUMP Sw	ON	(FE)
ENG HYD PUMP Sws	OFF	(FE)

Turning off ENG HYD PUMPS increases windmilling RPM.

ENG PNEU SUPPLY (ENG 1 or 3)	OFF	(FE)
OVRD & AIR START Sw	"OVRD & AIR START"	(PNF)

NOTE

- *Engine Start Envelope:*
- *Unrestricted below 15,000 feet*
- *Above 220 KIAS from 15,000 to 30,000 feet*
- *Engines may not restart above 30,000 feet*
- *The use of continuous A or B may aid in engine restart.*

N_2 RPM	"CHECK"	(P,CP)

YES — 10% OR MORE — NO

LESS THAN 10%

Max One Pack Per Operating Pneu Supply	VERIFY	(FE)
WING ANTI-ICE Sw	OFF	(FE)
Pneu ISOL VALVE Sw	OPEN	(FE)

NOTE

The 1-3 ISOL valve receives electrical power from the left emergency AC bus and the 1-2 ISOL valve receives power from the right emergency AC bus. If unable to open the valve due to loss of bus power, increase airspeed to obtain at least 10% rpm.

ENG START Sw	"PUSH/LT ON"	(FE)
FUEL Lever	"ON"	(FE)
Start Indications	MONITOR	(P,CP,FE)

CONTINUED

ENGINE RESTART (cont)

YES — NORMAL AND STABILIZED AT IDLE — NO

ABNORMAL OR NO EGT RISE WITHIN 45 SEC.

FUEL Lever	"OFF"	(FE)

Other start attempts may be made. If not successful, refer to Abnormal Procedures, ENG SHUTDOWN IN FLIGHT.

OVRD & AIR START	"OFF"	(PNF)
ENG HYD PUMP Sws	L, ON/R, AUTO	(FE)

END

NORMAL AND STABILIZED AT IDLE

NOTE

Observe 1 minute warmup time unless flight safety is endangered.

ENG HYD PUMP Sws	L, ON/R, AUTO	(FE)
Approp MOTOR PUMP Sw	ARM	(FE)
ENG PNEU SUPPLY Sel	AUTO	(FE)
OVRD & AIR START Sw	"AS REQ'D"	(PNF)
ENG IGNITION Sel	AS REQ'D	(FE)

Return hydraulic, electrical, pneumatic, and air conditioning systems to normal operation.

END

ENG SHUTDOWN IN FLIGHT

NOTE

To be performed when an engine fails or a precautionary shutdown is desired.

Throttle . . . . "IDLE" (PNF)

NOTE

Conditions permitting, operate engine at idle for 3 minutes before shutdown.

FUEL Lever . . . . "OFF" (FE)

NOTE

Subsequent to moving the fuel lever to OFF, the fuel flow gage, after a short period of correct indication, may give a false rate of fuel flow. If this occurs, pull the circuit breaker for the affected gage. This action will prevent an engine fuel used readout error.

TANK PUMP Sws (affected eng) . . . . OFF (FE)
Transfer fuel to maintain lateral balance.
Approp MOTOR PUMP Sw . . . . AS REQ'D (FE)

NOTE

- *Motor pump switches should be in OFF for non-critical phases of flight and in ARM for approach and landing.*
- *If two engines are shut down, operate motor pumps in a manner to provide at least two operative hydraulic systems.*
- *Windmilling climb and low speed cruise operation within the following envelope may result in accelerated oil consumption:*

  N_2 rpm 1.5 to 12%.

  Body angles (nose up) greater than plus 11° for a wing engine or 9.5° for tail engine.
- *If it is not practical to avoid above conditions, operation of engine hydraulic pumps will minimize oil consumption.*

Hydraulic Pres . . . . CHECK (FE)

Observe hydraulic pressure is normal for pump selection.

Pneu ISOL VALVE Sw(s) . . . . OPEN AS REQ'D (FE)
Assoc ENG PNEU SUPPLY Sel . . . . OFF (FE)
OVRD and AIRSTART Sw . . . . AS REQ'D (FE)
Use APU generator as appropriate.

NOTE

Refer to the appropriate procedure, TWO ENGINE OPERATION or SINGLE ENGINE OPERATION.

END

OIL STRAINER CLOG LT ON

Affected Throttle . . . . "IDLE" (PNF)

Retard the throttle to idle to determine if the light will go out.

YES — ENG OIL STRAINER CLOG LT OFF — NO

Indicates that oil is not bypassing the strainer.

Operate engine below thrust level which turns light on.

If the oil strainer clog light goes OFF when the throttle is retarded, the throttle may be readvanced to a setting below that which caused the light to illuminate. Continue to monitor closely for abnormal symptoms associated with lubricating system malfunctions. If high oil temperature, high or low oil pressure, and/or increased vibration is evident, or if the oil strainer clog light again illuminates; the engine should be shut down.

END

Affected Engine . . . . SHUTDOWN (PNF,FE)

Refer to Abnormal Procedure, ENG SHUTDOWN IN FLIGHT, page 2A-140.

END

STARTER VALVE MANUAL OPERATION

WARNING

When manually operating a wing engine starter control valve, hand and arm coverage must be worn. Heat from starter exhaust air could result in injury to personnel. The temperature of the starter valve T-Handle may cause severe burns if hands are not protected. Brief ground crew accordingly.

CAUTION

To prevent damage to starter shutoff valve diaphragms, do not operate valve manually unless system is pressurized.

Prior to initiating this procedure, conduct a detailed briefing with the ground maintenance crew.

ENG IGNITION Sel . . . . "START (A or B)" (P)
Engine Starter Valve . . . . "OPEN STARTER VALVE" (P)

Receive verbal confirmation from maintenance "Roger, opening starter valve. ...Starter valve open."

ENG START Sw-Lt . . . . VERIFY ON (P)
ENG START Sw . . . . PUSH (P)
ENG Fuel Lever (15% N_2) . . . . "FUEL LEVER ON" (P)

CONTINUED

STARTER VALVE MANUAL OPERATION (cont)

Engine Starter Valve (45% N2) . . . . "CLOSE STARTER VALVE" (P)

Receive verbal confirmation of starter valve closure from maintenance, "Roger, closing starter valve. ...Starter valve closed"

ENG START Sw-Lt . . . . VERIFY OFF (P)

Monitor engine indications for completion of normal engine start.

NOTE

If light remains on, advise maintenance that valve remains open. If unable to close, shut off appropriate pneumatic system and shut down engines.

END

THRUST REVERSER FAILURE TO STOW

Should a thrust reverser fail to stow while on the ground, continue to taxi with unaffected engines. Shut down the affected engine following the recommended cool down period.

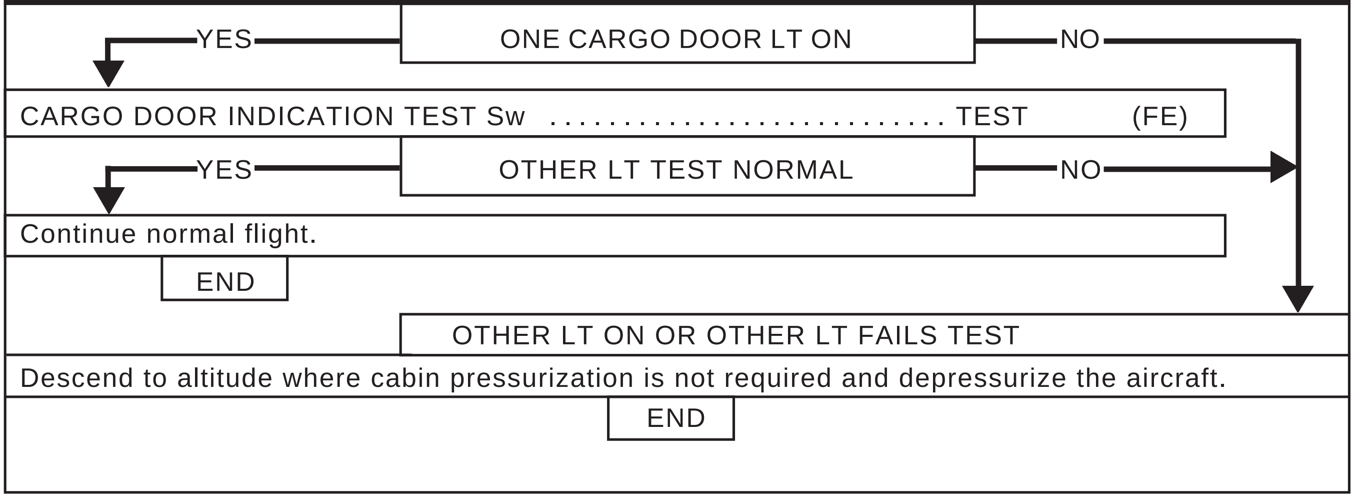
CAUTION

To prevent transcowl clevis damage, do not attempt to stow a thrust reverser when failure to stow is noted during ground operations.

END

Pages 2A-143 and 2A-144 are deleted in their entirety.

CARGO DOOR LIGHT(S) ON (IN FLIGHT)



ONE CARGO DOOR LT ON

YES

CARGO DOOR INDICATION TEST Sw . . . . TEST (FE)

OTHER LT TEST NORMAL

YES

Continue normal flight.

END

NO

OTHER LT ON OR OTHER LT FAILS TEST

Descend to altitude where cabin pressurization is not required and depressurize the aircraft.

END

AIR REFUELING

BRUTE FORCE DISCONNECT

There are two types of brute force disconnect: inadvertent and controlled tension (coordinated).

NOTE

Enter any brute force disconnect as a discrepancy in the AFTO Form 781. The entry will specify which type of brute force disconnect occurred.

INADVERTENT DISCONNECT

An inadvertent brute force disconnect is defined as any unplanned disconnect which is the result of one of the following:

- The receiver aircraft moving rapidly to the aft limit causing mechanical tanker/receiver separation
- Boom pullout occurs at 38 degrees elevation or below

CAUTION

Air refueling will be terminated except during fuel emergencies or when continuation of air refueling is dictated by operational necessity.

CONTROLLED TENSION DISCONNECT

A controlled tension brute force disconnect is defined as an intentional, coordinated disconnect occurring above 38 degrees elevation, accomplished by gradual movement of the receiver aircraft to the aft limit, and ending with a smooth tension boom pull out. Coordination between the receiver pilot and the boom operator is required to ensure as smooth a disconnect as possible. The receiver pilot will maintain contact altitude and gradually reduce power to establish a positive separation rate. Disconnect will occur when boom reaches maximum extension.

CAUTION

- A controlled tension brute force disconnect will be accomplished only as a last resort, after all other normal and emergency methods of disconnect have failed.
- The receiver pilot must not jerk the boom out with rapid thrust change toward IDLE; to do so may cause serious structural damage. Gradual power reduction will suffice to effect a disconnect.
- Fly stabilized at contact altitude until certain the nozzle is clear of the receptacle and slipway.
- Air refueling for the receiver which required controlled tension disconnect will be terminated except during fuel emergencies or when continuation of air refueling is dictated by operational necessity.

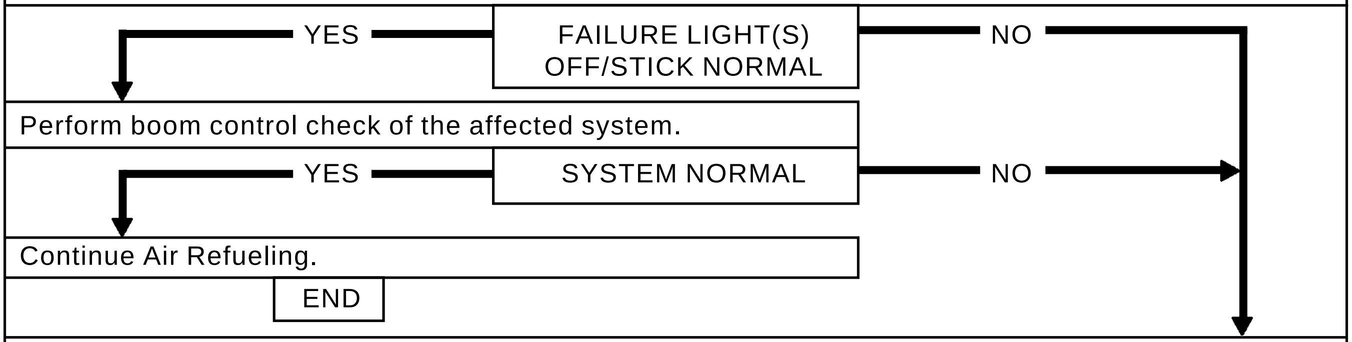
BOOM SYSTEM FAIL LIGHT ON / FLIGHT CONTROL STICK FAILURE

Notify receiver of boom flight control malfunction, direct receiver to safe position, align flt control stick and disconnect as applicable.

WARNING

If a limp flight control stick condition occurs, align stick to correspond with boom position immediately. Control authority will start to return in 1 second and boom will move to stick commanded position, unless corresponding control surface failure light is on.

FLT CONT Sw . . . . CYCLE (OFF/ON)



FAILURE LIGHT(S) OFF/STICK NORMAL

YES

NO

Perform boom control check of the affected system.

SYSTEM NORMAL

YES

NO

Continue Air Refueling.

END

Go to appropriate procedure as follows:

A	**ELEVATOR**
B	**RUDDER**
C	**TELESCOPE**
D	**FLIGHT CONTROL STICK**

A ELEVATOR FAIL LT ON

Discontinue Air Refueling Operations.

Boom . . . . STOW

The boom will not fly up when the ELEV POSN Sw is moved to STOW. Use the boom hoist to stow the boom.

END

CONTINUED

BOOM SYSTEM FAIL LIGHT ON / FLIGHT CONTROL STICK FAILURE (cont)

B RUDDER FAIL LIGHT(S) ON

With a single RUD FAIL Light on, continue air refueling as dictated by operational necessity. (Refer to MAJCOM Directives.)

NOTE

- *Rudder effectiveness will be reduced. Determine roll capability by accomplishing a flight control check at air refueling airspeed.*
- *Adjust roll limits to less than maximum attained during the flight control check, or receiver limit, whichever is less.*

Boom . . . . STOW

END

C TLSCP FAIL LIGHT ON

Discontinue air refueling operations.

CAUTION

Receiver pilot should not attempt to push the boom in during telescope failure.

Retract boom using EMER TLSCP.

CAUTION

- *Do not allow boom to strike retract shock absorber when using emergency retract on the ground or when boom is stowed.*
- *A hard landing with the boom extended in the stowed position may cause damage to the boom and/or latching assembly.*

Boom . . . . STOW

END

D FLIGHT CONTROL STICK FAILURE

Flight Control Stick Failure is identified by; audible tone and ROLL/ELEVATION ALAS Light(s) on and stick limp in the failed axis.

Stick abnormal (limp), ALAS INOP lights on.

Discontinue boom air refueling except in an emergency.

WARNING

During limp flight control stick condition, the stick does not have back drive or centering force feel in the failed axis. Large control inputs which could cause boom or receiver damage are easily applied.

NOTE

Set roll limits to 15° if boom air refueling will be continued.

Boom . . . . STOW

END

FLIGHT CONTROLS DO NOT RESPOND TO COMMAND INPUTS OR CONTROL SURFACES ARE ERRATIC

Disconnect	INITIATE (If Applicable)
Boom	RETRACT (If Able)
Flt Cont Sw	OFF
Boom	STOW

NOTE

The boom will not fly up when the ELEV POSN SW is moved to STOW. Use the boom hoist to stow the boom.

Discontinue boom air refueling.

END

FLT CONTROL DEGRADED LIGHT ON

Continue AR. Complete this checklist prior to subsequent contacts.

Disconnect	INITIATE (If Applicable)
FLT CONT Sw	CYCLE (OFF/ON)

YES — LIGHT OFF — NO

YES: Continue boom air refueling.

END

NO:

Boom flight controls	CHECK

Perform a flight control check to determine boom control/stability.

CAUTION

Boom flight controls will operate normally in CONTACT/COUPLED mode. In the FREE FLIGHT mode, boom sensitivity and response will be degraded. Precise boom control may be difficult.

YES — BOOM CONTROLLABLE/STABLE — NO

YES: Continue boom air refueling.

NOTE

Adjust roll limits to less than maximum attained during the flight control check, or receiver limit, whichever is less.

END

NO: Discontinue boom air refueling.

Boom	STOW

END

INFLIGHT BCU REPLACEMENT

NOTE

Use this procedure only if boom air refueling is required.

FLT CONT Sw . . . . OFF
AR MASTER PWR Sw . . . . OFF
BCU . . . . REPLACE

Remove and replace BCU, stow failed BCU in spare tray.

AR MASTER PWR Sw . . . . ON
FLT CONT Sw . . . . ON
Boom . . . . EXTEND 12 FT
Boom Flight Controls . . . . CHECK

Verify the boom can be controlled smoothly through the envelope of 18° to 40° in elevation and 0° to 25° in left and right roll.

NOTE

If the boom fails to attain the prescribed positions but all other indications are normal, continue the mission and initiate disconnects as applicable prior to receiver reaching the maximum position attained during the check. Adjustable limits may be reset to within the position attained during Boom Flight Controls check.

ALAS SW . . . . OFF
AR SIG SYS OVRD Sw . . . . NORM
TLSCP at DISC Sw . . . . MAN
AR SIG SYS . . . . CONTACT/COUPLED

CAUTION

Boom controls are sensitive in the coupled mode and large rapid inputs may cause boom to exceed limit(s).

Advance AR SIG SYS to CONTACT/COUPLED by depressing the CONTACT MADE TEST switch. Verify disconnect limits are operational by maneuvering boom through an elevation, a roll, and a telescope limit. Accomplish one of the limit disconnects with TLSCP at DISC switch in AUTO to insure boom will retract automatically.

NOTE

Refueling may be continued with inoperative disconnect limit(s), however, the boom operator must initiate disconnects for the failed limit(s).

Preparation for Contact Checklist . . . . COMPLETE (As Applicable)

END

FLT CONT MAINT REQ’D LIGHT ON

Flight control performance is not affected, boom air refueling may be accomplished.

END

ROLL/ELEVATION ALAS INOP LIGHT ON

YES — AIRCRAFT ON GROUND — NO

Maintenance Required.

END

Disconnect . . . . INITIATE (If Applicable)

FLT CONT Sw . . . . CYCLE (OFF/ON)

YES — ALAS INOP LT OFF — NO

Continue Air Refueling Mission.

END

Continue mission as dictated by operational necessity. (Refer to MAJCOM Directives.)

Roll Limits . . . . SET 15°

ALAS Sw . . . . ENABLE

CAUTION

Excessive boom misalignment may generate nozzle loads of sufficient force to prevent retracting the nozzle from the receptacle or cause damage to receiver after nozzle is free of receptacle.

NOTE

- *Continue with ALAS system in ENABLE mode and manually perform receiver tracking and nozzle load alleviation in the failed axis or axes. The increased stick force gradient that occurs after contact is established reduces manual load alleviation task.*
- *If an ALAS INOP light is on, the HIGH NOZZLE LOAD Light and the stick shaker are inoperative in the failed axis or axes.*

END

LTS AND EMER TLSCP INOP LT ON

Disconnect . . . . INITIATE (If Applicable)
Have FE check C-1 C/B on Pilot's Overhead C/B Panel.

WARNING

When the LTS and EMER TLSCP INOP Light is ON; Emergency telescoping, ALL 4 SYSTEM FAIL Lights, and the AURAL WARNING HORN are inoperative.

NOTE

- *If C/B is OPEN, close C/B. If C/B is closed, PULL/RESET C/B. Continue Boom air refueling if LTS AND EMER TLSCP INOP light extinguishes.*
- *If LTS AND EMER TLSCP INOP LIGHT remains on, discontinue boom air refueling except in an emergency.*

Discontinue Boom Air Refueling Except in an Emergency.

END

HYD PRESS LOW LIGHT ON

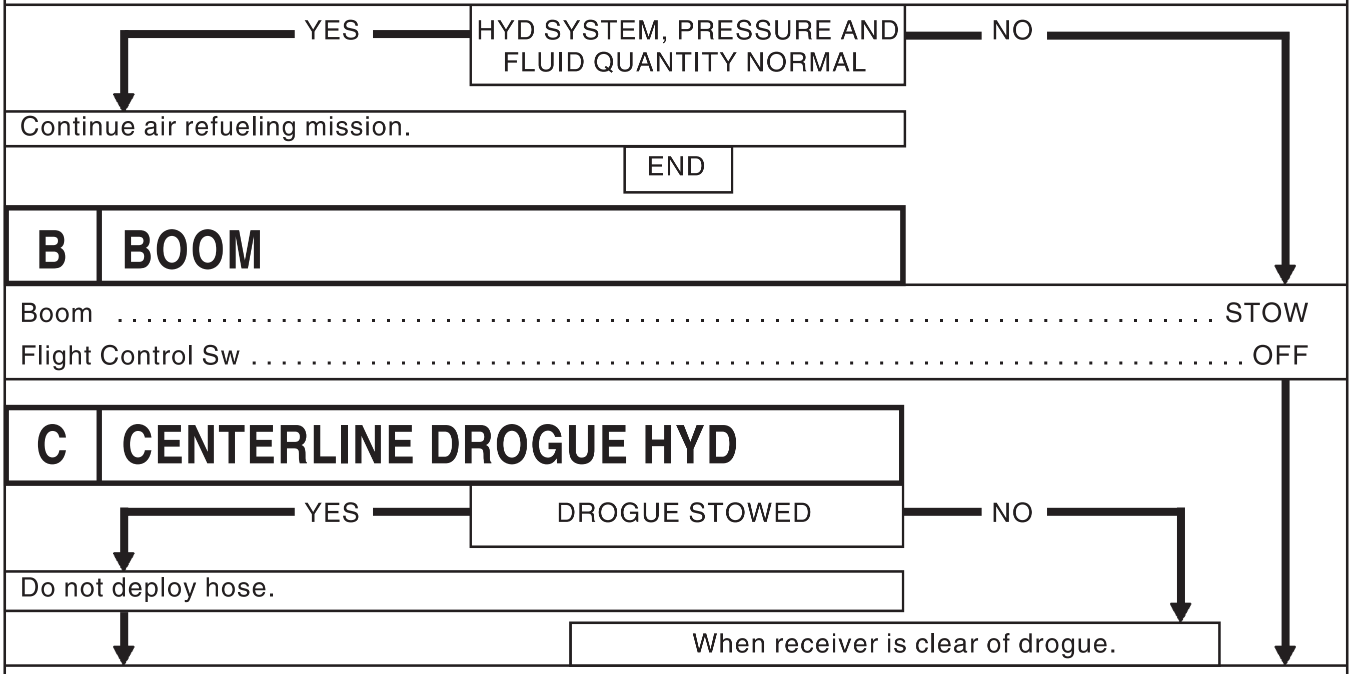
Disconnect . . . . INITIATE (If Applicable)

Go to appropriate procedure as follows:

A	**MAIN**
B	**BOOM**
C	**CENTERLINE DROGUE**

A MAIN HYD

Confirm status of number 2 HYD SYS with FE.



HYD SYSTEM, PRESSURE AND FLUID QUANTITY NORMAL

YES: Continue air refueling mission.

END

NO: go to Boom.

B BOOM

Boom . . . . STOW

Flight Control Sw . . . . OFF

C CENTERLINE DROGUE HYD

DROGUE STOWED

YES: Do not deploy hose.

NO: When receiver is clear of drogue.

HYD SEL . . . . OFF

Notify FE that HYD SEL is off.

NOTE

- *Analysis of hydraulic system will determine if air refueling can be continued. If AR is continued complete preparation for contact checklist as required.*
- *Momentary cycling of BOOM HYD PRESS LOW light may occur if hydraulic pressure for boom air refueling is being supplied by 2-3 reversible motor pump.*

END

2-3 PUMP VALVE VERIFICATION

FE notify the BO to stow the boom/drogue.

2-3 Motor Pump SW . . . . OFF (FE)
AP 1 . . . . OFF (P)
AP 2 . . . . USE AS REQ’D (P)
#2 ENG HYD PUMP SWS . . . . OFF (FE)

NOTE

#2 Eng Hyd Press Low Lights should be on at this time. #2 Hyd System Pressure Gage should read zero.

2-3 Motor Pump SW . . . . ON (FE)
#2 HYD PRESS . . . . CHECK (FE)

NOTE

If the #2 Hyd pressure is not in the normal range, the 2-3 motor pump is inoperative. Place the 2-3 pump switch to off. Do not refuel unless an emergency exists.

#2 ENG HYD PUMP SWS . . . . ON/AUTO (FE)

CAUTION

If the operation of the pump is confirmed, leave the 2-3 motor pump switch in the on position until air refueling is complete. If the 2-3 motor pump switch is placed out of the on position, the pump must be rechecked prior to additional air refueling.

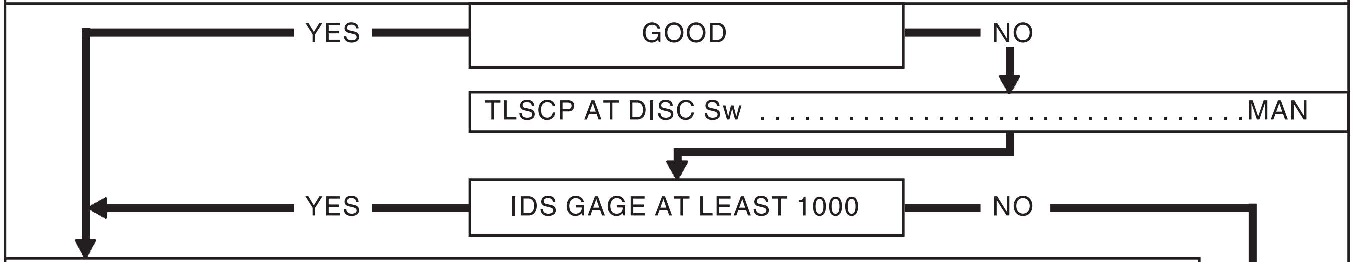
END

AR SIGNAL SYSTEM FAILURE

AR SIG SYS OVRD Sw . . . . OVRD

Signal Coil . . . . TEST

If a normal disconnect is not obtained treat a GOOD coil reading as OPEN/SHORTED.



Disconnect capability exists. Continue Mission.

NOTE

The tanker and receiver AR SIG SYS's will advance to disconnect if a boom envelope disconnect limit is exceeded and the boom signal coil is GOOD. If boom signal coil is OPEN or SHORTED, the boom operator shall initiate an IDS disconnect prior to receiver reaching a normal limit to disengage nozzle from receptacle. Receiver initiated disconnects, when feasible, will extend operational capability of the IDS.

END

No disconnect capability exists. Continue mission as dictated by operational necessity. (Refer to MAJCOM Directives)

Receiver Pilot . . . . BRIEF

"(Receiver Call Sign)," the following contacts will be made in tanker manual override. Receiver's air refueling system will remain in normal and receiver pilot must initiate all disconnects, "(Tanker Call Sign), Ready."

CAUTION

The tanker's AR SIG SYS will advance to disconnect if a boom envelope disconnect limit is exceeded. However, the boom operator shall call for a disconnect prior to receiver reaching a normal limit to disengage nozzle from receptacle.

To establish a manual contact:

When the receiver is stable in the contact position, insert nozzle into the receptacle, pull the EMER CONTACT MADE Sw, observe the CONTACT/COUPLED lights are on and state, "(Tanker Call Sign) Contact."

No tanker disconnect capability exists when the signal coil tests OPEN or SHORTED, and the IDS gage reads less than 1000. (Refer to MAJCOM Directives)

END

MANUAL BOOM LATCHING

INDEP DISC Gage . . . . CHECK

YES — IDS GAGE AT LEAST 1000 — NO

No disconnect capability exists. Continue mission as Dictated by operational necessity. (Refer to MAJCOM Directives)

AR SIG sys OVRD Sw . . . . OVRD

TLSCP AT DISC Sw . . . . .MAN

Receiver Pilot . . . . BRIEF

"Receiver Call Sign," the following contacts will be made in manual boom latching and receiver pilot must initiate all disconnects, "(Tanker Call Sign), Ready."

Contact . . . . ESTABLISH

Hold slight extend pressure after nozzle is inserted into receptacle.

EMER CONTACT MADE Sw . . . . PULL

Observe CONTACT /COUPLED lights are on and state, “(Tanker Call Sign), Contact."

Extend Pressure . . . . .RELIEVE

Relieve extend pressure when receiver pilot acknowledges contact made.

CAUTION

Tanker’s AR SIG SYS will advance to disconnect if a boom envelope disconnect limit is exceeded. However, the boom operator shall call for or initiate an IDS disconnect prior to receiver reaching a normal limit to disengage nozzle from receptacle.

NOTE

Receiver initiated disconnects, when feasible, will extend operational capability of the IDS.

END

BOOM REMAINS AT ZERO DEGREES ELEVATION AFTER ELEVATION POSN SWITCH MOVED TO REFUEL

Continue air refueling as dictated by operational necessity.

NOTE

The boom will not lower to the trail position unless the BOOM HOIST lever is in FREE WHEEL and BOOM ELEVATION POSN switch is in REFUEL.

Flight Control Stick . . . . .FULL DOWN

Flight Control Switch . . . . CYCLE (OFF/ON)

NOTE

Repeat the above procedure until the boom descends to 35 degrees elevation. With the boom at 35 degrees elevation, cycle the FLT CONT switch (OFF/ON). Before attempting contact with receiver, advance AR SIG SYS to CONTACT/COUPLED mode by pushing the CONTACT TEST MODE switch.

YES — AR SIG SYS ADVANCE TO CONTACT/COUPLED MODE THEN DISC/FREE FLIGHT — NO

Continue boom air refueling

END

CONTINUED

BOOM REMAINS AT ZERO DEGREES ELEVATION AFTER ELEVATION POSN SWITCH MOVED TO REFUEL(cont)

CONTINUED

Fly boom to a position lower than 35 degrees and cycle FLT CONT switch (OFF/ON). Advance AR SIG SYS to CONTACT/COUPLED mode by pushing the CONTACT TEST MODE switch.

CAUTION

Do not fly the boom below 40 degrees elevation.

YES — AR SIG SYS ADVANCE TO CONTACT/COUPLED MODE THEN DISC/FREE FLIGHT — NO

YES: Continue boom air refueling

END

NO:

Boom . . . . STOW

NOTE

The boom may not fly up when the ELEV POSN SW is moved to STOW. Use the boom hoist to stow the boom.

Discontinue boom air refueling.

Complete the Boom Post AR Checklist. Write-up in 781 for maintenance action.

END

BROKEN BOOM HOIST CABLE

Disconnect . . . . INITIATE (If Applicable)

YES — WILL BROKEN CABLE DAMAGE BOOM OR RECEIVER AIRCRAFT — NO

YES: Discontinue boom air refueling except in an emergency.

NO: Continue mission as dictated by operational necessity.

Stow the boom using the following procedures.

Inform the pilot when ready to stow the boom and coordinate the following prior to attempting boom stowage procedures.

NOTE

- *Increase airspeed as required (300 KIAS or higher) to stow the boom.*
- *The boom may not fly to stowed position above 20,000 feet or while the aircraft is in a turn.*

ELEVATION POSN Sw . . . . STOW

Fly the boom to the stowed position and hold it in the stowed position until latched.

CAUTION

Avoid applying abrupt up commands after placing the ELEVATION POSN switch in STOW.

Flight Control Stick . . . . NEUTRAL

YES — BOOM LATCHED — NO

NOTE

Repeated attempts may be required.

YES: Complete the Boom Post AR Checklist.

END

NO: Refer to LANDING WITH BOOM IN TRAIL Checklist.

END

BOOM LATCH FAILURE

Boom . . . . STOW

BOOM HOIST Lever . . . . RAISE

BOOM HOIST lever will remain in the RAISE position to prevent the boom from creeping down.

Crew . . . . NOTIFY

Notify crew that latch failure has occurred, and boom support sling must be installed prior to depressurizing number 3 hydraulic system.

CAUTION

With the boom unlocked, depressurizing number 3 hydraulic system will cause the boom to fall.

NOTE

BOOM/DROGUE DEPLOYED annunciator light will be ON. After the landing gear is lowered, the BOOM/DROGUE NOT STOWED annunciator light will also be ON.

END

LANDING WITH THE BOOM IN TRAIL

NOTE

- *Coordinate with the engineer to scavenge the boom. Flying the boom above 0 degrees will aid scavenging.*
- *If an extended period of time exists until final approach, move ELEV POSN Switch to REFUEL.*
- *Do not turn the FLT CONT Sw OFF until ready for final approach to landing.*

Elevation POS Sw . . . . STOW (If Applicable)
FLT CONT Sw . . . . OFF
HYD SEL . . . . OFF
Boom Audio Sw . . . . OFF
AR EXT Lts . . . . OFF
A/R Master Sw . . . . OFF
Sighting Door . . . . CLOSE
Oxygen Regulator OFF/100%

Return to Cockpit for landing.

END

REVERSE AIR REFUELING PROCEDURES

Use normal tanker procedures to rendezvous and hook up with aircraft designated to provide fuel.

NOTE

Unless there is a specific reason to divert all the fuel into the AFT body tank, the boom operator should not hold the telescope control stick in the retract, or partial retract position during reverse air refueling. This action will open the fuel bypass valves thus diverting the incoming fuel into the AFT body tank.

When boom contact is made (BOOM/DROGUE ENGAGED light is on)

BOOM VALVE	OPEN	(FE)
ALTN TRANS VALVE(s)	OPEN	(FE)
TANKS TO BE REFUELED	DETERMINE	(FE)

FWD AND/OR AFT TANK(S)

YES

Associated FILL VALVES	OPEN	(FE)
On Load	MONITOR	(FE)

NO

MAIN TANKS AND/OR CTR WING TANK WILL BE REFUELED.

ISOL VALVES	OPEN	(FE)
FILL VALVE(S) (TANKS TO BE FUELED)	MONITOR	(FE)

NOTE

If any tank is to be filled to near maximum capacity, perform a high level float test. AR master switch shall be on to energize high level float test button.

Notify receiver to start fuel transfer.

When fuel onload is completed, notify receiver to stop transfer and boom operator to disconnect.

FILL VALVES	CLOSE	(FE)
ISOL VALVES	CLOSE	(FE)
ALTN TRANS VALVES	CLOSE	(FE)
BOOM VALVE	CLOSE	(FE)
Manifold Scavenge	COMPLETE	(FE)

Resume normal fuel management.

END

ARO STATION AVIONIC FLOW OFF LIGHT ON

YES — AIRCRAFT ON THE GROUND — NO

Maintenance Required.

END

Mission . . . . Continue

NOTE

The computer will tolerate lack of air flow for several hours with moderate temperatures.

AR MASTER PWR Sw . . . . OFF

Turn AR MASTER PWR switch OFF when not required, to prevent computer heat buildup.

END

FUEL XDCR INOP LIGHT ON

Continue air refueling. Use caution as under certain conditions fighter aircraft may move forward in the air refueling envelope when AR pumps are turned OFF.

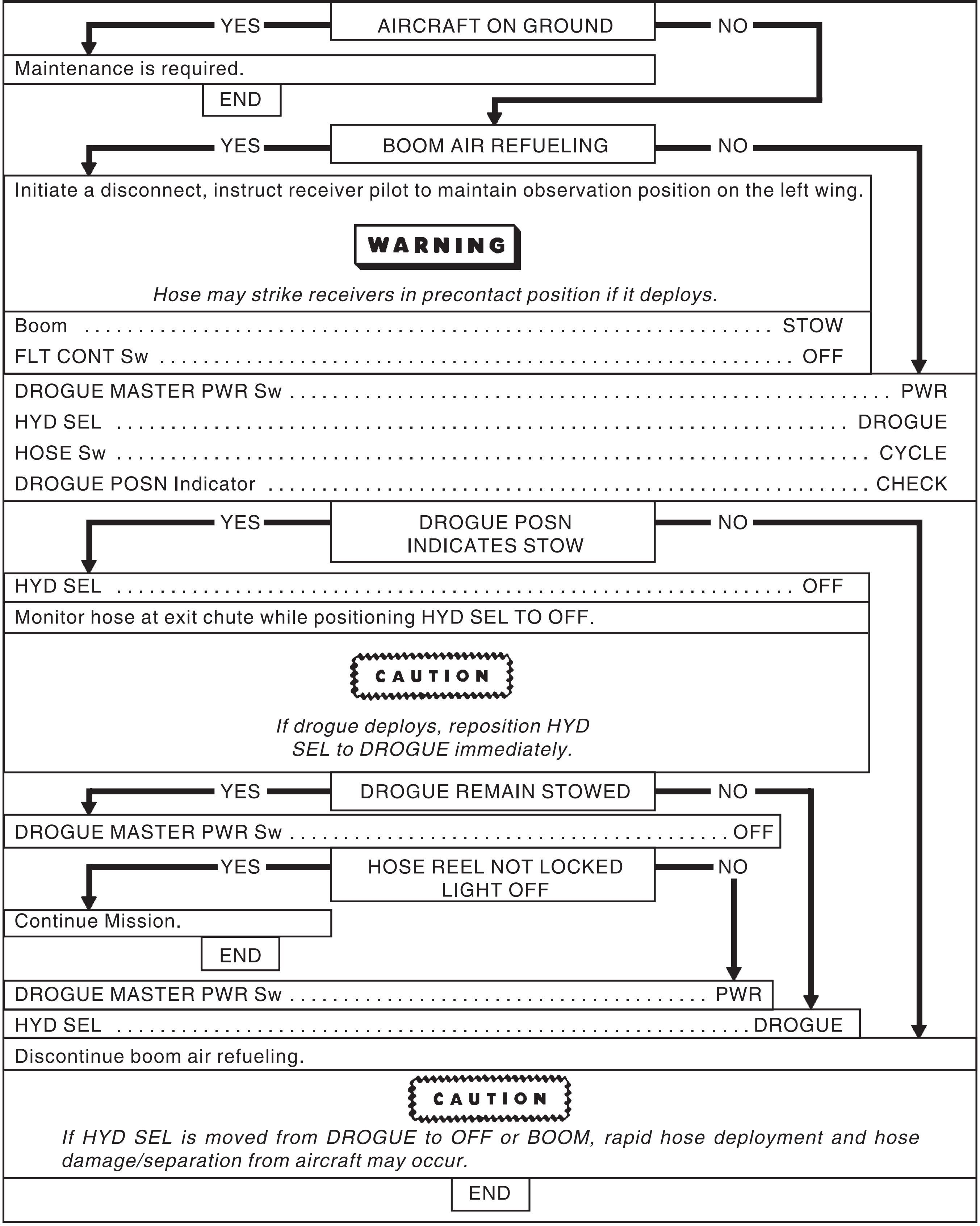
NOTE

Power limited receivers may not be able to stay within the telescoping envelope.

Continue Air Refueling Mission.

END

CENTERLINE HOSE REEL NOT LOCKED/LIGHT ON



YES — AIRCRAFT ON GROUND — NO

Maintenance is required.

END

YES — BOOM AIR REFUELING — NO

Initiate a disconnect, instruct receiver pilot to maintain observation position on the left wing.

WARNING

Hose may strike receivers in precontact position if it deploys.

Boom . . . . STOW

FLT CONT Sw . . . . OFF

DROGUE MASTER PWR Sw . . . . PWR

HYD SEL . . . . DROGUE

HOSE Sw . . . . CYCLE

DROGUE POSN Indicator . . . . CHECK

YES — DROGUE POSN INDICATES STOW — NO

HYD SEL . . . . OFF

Monitor hose at exit chute while positioning HYD SEL TO OFF.

CAUTION

If drogue deploys, reposition HYD SEL to DROGUE immediately.

YES — DROGUE REMAIN STOWED — NO

DROGUE MASTER PWR Sw . . . . OFF

YES — HOSE REEL NOT LOCKED LIGHT OFF — NO

Continue Mission.

END

DROGUE MASTER PWR Sw . . . . PWR

HYD SEL . . . . DROGUE

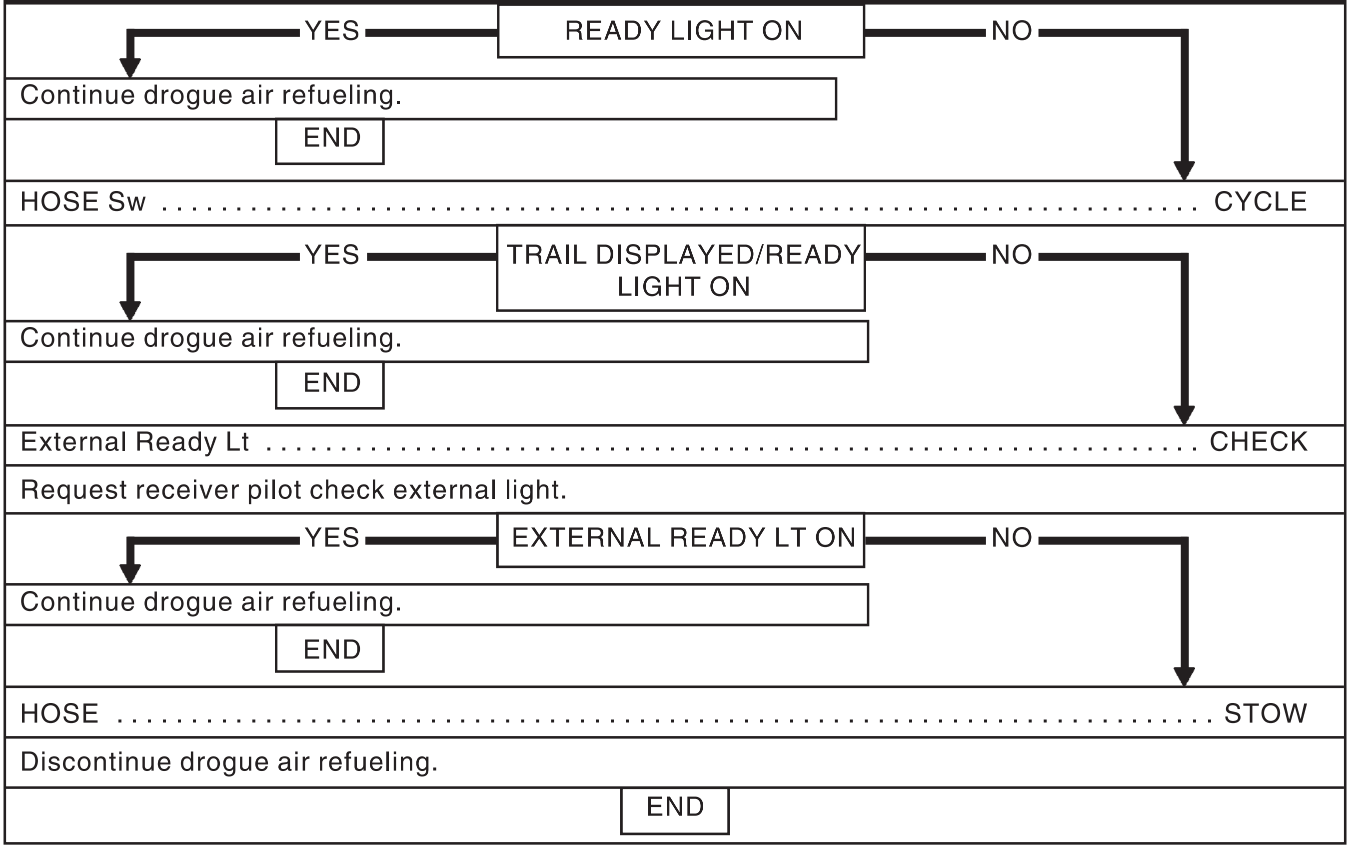
Discontinue boom air refueling.

CAUTION

If HYD SEL is moved from DROGUE to OFF or BOOM, rapid hose deployment and hose damage/separation from aircraft may occur.

END

CENTERLINE DROGUE POSN INDICATOR HAS BARBER POLE OR STOW DISPLAYED



READY LIGHT ON

YES

Continue drogue air refueling.

END

NO

HOSE Sw . . . . CYCLE

TRAIL DISPLAYED/READY LIGHT ON

YES

Continue drogue air refueling.

END

NO

External Ready Lt . . . . CHECK

Request receiver pilot check external light.

EXTERNAL READY LT ON

YES

Continue drogue air refueling.

END

NO

HOSE . . . . STOW

Discontinue drogue air refueling.

END

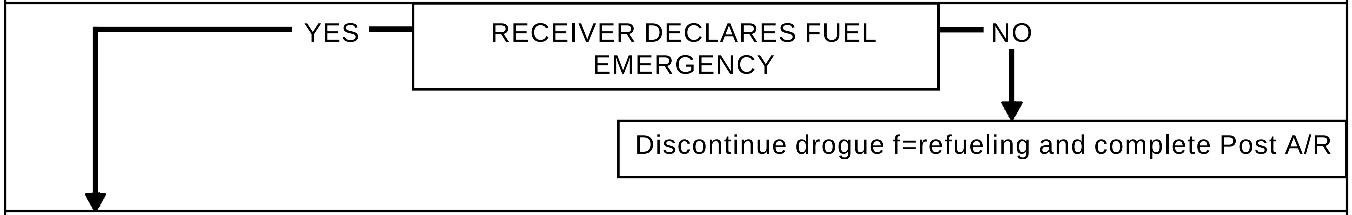
CENTERLINE DROGUE HOSE SLACK OR WHIP AFTER RECEIVER/DROGUE ENGAGEMENT

Disconnect . . . . INITIATE

Notify receiver to disconnect and remain clear of hose.

WARNING

Discontinue drogue air refueling, except in an emergency.



RECEIVER DECLARES FUEL EMERGENCY

YES

NO

Discontinue drogue f=refueling and complete Post A/R

REEL RESP RESET Button . . . . PUSH

REEL RESP SYSTEM . . . . TEST (BO)

After the READY light comes on, place the hose test switch to the SYS position. Observe the drogue READY light goes off, hose rewinds to the forward limit of the refueling range, then deploys to the full range, the drogue ready light comes on approximately 5 seconds after the hose is in full trail and the RESPONSE INOP light remains off. If RESP INOP light illuminates after receiver makes contact, it is an indication failure not a system failure. No receiver disconnect is required. Continue AR and cycle REEL RESP RESET switch after receiver has disconnected and prior to next receiver contact.

REEL RESP RESET BUTTON . . . . PUSH

RECEIVER PILOT . . . . BRIEF

"(Receiver Call Sign), the Hose Reel Response is inoperative. Hose whip or hose failure may occur during contact. Use slowest closure rate practical. (Tanker Call Sign), Ready".

Monitor approach to contact with extreme caution and be prepared to call a breakaway.

END

LOSS OF CENTERLINE DROGUE

Instruct receiver(s) to stay clear of hose.

WARNING

Severe hose oscillation may occur after drogue separates from hose.

REEL RESP RESET Button . . . . PUSH

Push REEL RESP RESET button as soon as drogue separation is visible, as rapid hose rewind may occur with hose switch in TRAIL

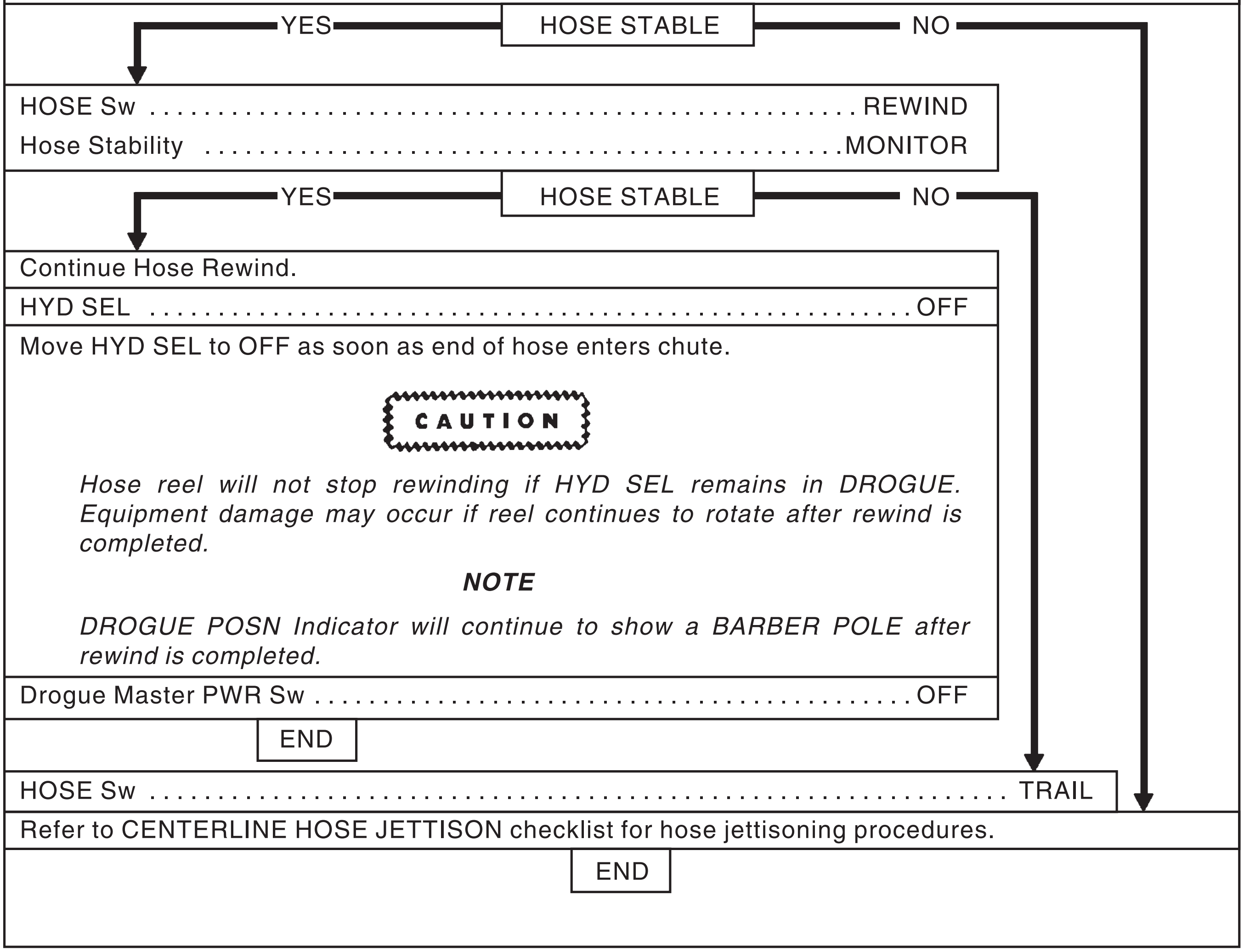
CAUTION

Complete rewinding of hose may cause damage to equipment or aircraft empennage.

Drogue Valve . . . . CLOSE (BO,FE)

Airspeed . . . . DECREASE (BO,P)

Request Pilot decrease airspeed as slow as possible without lowering flaps to reduce or lessen hose oscillation and notify receiver pilot(s).



YES — HOSE STABLE — NO

HOSE Sw . . . . REWIND

Hose Stability . . . . MONITOR

YES — HOSE STABLE — NO

Continue Hose Rewind.

HYD SEL . . . . OFF

Move HYD SEL to OFF as soon as end of hose enters chute.

CAUTION

Hose reel will not stop rewinding if HYD SEL remains in DROGUE. Equipment damage may occur if reel continues to rotate after rewind is completed.

NOTE

DROGUE POSN Indicator will continue to show a BARBER POLE after rewind is completed.

Drogue Master PWR Sw . . . . OFF

END

HOSE Sw . . . . TRAIL

Refer to CENTERLINE HOSE JETTISON checklist for hose jettisoning procedures.

END

CENTERLINE HOSE WILL NOT REWIND

HOSE Sw . . . . TRAIL

Drogue Valve . . . . CLOSE (BO,FE)

YES — HYD PRESS AVAILABLE — NO

Airspeed . . . . Reduce (P,BO)

Request pilot reduce airspeed as slow as practical (80 Knots or greater)

NOTE

- *If required, airspeed may be increased and Reel Response reset at the higher speed before starting airspeed reduction.*
- *Continue to reduce speed after rewind starts until hose is stowed.*
- *Ascertain visually hose is stowed. Drogue Position Indicator will depict “TRAIL” until Drogue Master PWR SW is moved to “OFF”.*

YES — DROGUE REWINDS/STOWED — NO

HYD SEL . . . . OFF

Monitor drogue at exit chute while positioning “HYD SEL” to “OFF”.

CAUTION

If drogue deploys reposition "HYD SEL" to Drogue immediately.

DROGUE MASTER PWR Sw . . . . OFF

END

Hose Jettison or Land in TRAIL . . . . DETERMINE

If the hose is stable, consideration should be given to landing with hose in trail.

YES — HOSE JETTISON — NO

Refer to CENTERLINE HOSE JETTISON checklist for hose jettisoning procedures.

HYD SEL . . . . OFF

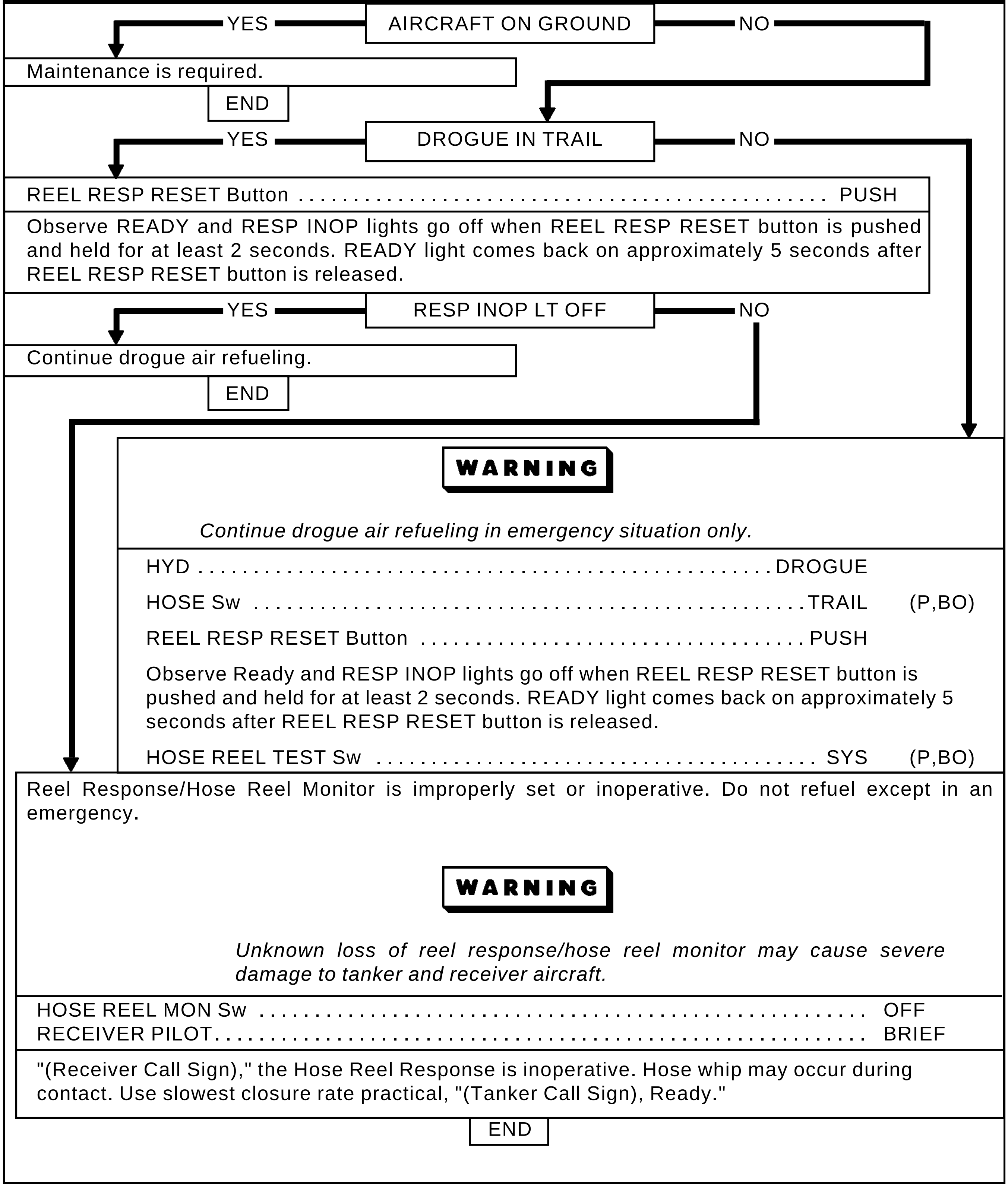
DROGUE MASTER PWR Sw . . . . OFF

Sighting Door . . . . CLOSE

Return to forward position.

END

CENTERLINE RESP INOP LIGHT ON



AIRCRAFT ON GROUND

YES

Maintenance is required.

END

NO

DROGUE IN TRAIL

YES

REEL RESP RESET Button . . . . PUSH

Observe READY and RESP INOP lights go off when REEL RESP RESET button is pushed and held for at least 2 seconds. READY light comes back on approximately 5 seconds after REEL RESP RESET button is released.

RESP INOP LT OFF

YES

Continue drogue air refueling.

END

NO (RESP INOP LT OFF)

NO (DROGUE IN TRAIL)

WARNING

Continue drogue air refueling in emergency situation only.

HYD . . . . DROGUE

HOSE Sw . . . . TRAIL (P,BO)

REEL RESP RESET Button . . . . PUSH

Observe Ready and RESP INOP lights go off when REEL RESP RESET button is pushed and held for at least 2 seconds. READY light comes back on approximately 5 seconds after REEL RESP RESET button is released.

HOSE REEL TEST Sw . . . . SYS (P,BO)

Reel Response/Hose Reel Monitor is improperly set or inoperative. Do not refuel except in an emergency.

WARNING

Unknown loss of reel response/hose reel monitor may cause severe damage to tanker and receiver aircraft.

HOSE REEL MON Sw . . . . OFF

RECEIVER PILOT. . . . . BRIEF

"(Receiver Call Sign)," the Hose Reel Response is inoperative. Hose whip may occur during contact. Use slowest closure rate practical, "(Tanker Call Sign), Ready."

END

CENTERLINE HOSE JETTISON

Receivers .... CLEAR

Verify receivers are clear (if applicable).

WARNING

Hose should not be jettisoned over a populated area unless aircraft safety requires immediate action.

When cleared by the pilot:

HOSE JTSN Sw .... JTSN

HOSE JETTISONED

YES

HYD SEL ....OFF

DROGUE MASTER PWR Sw ....OFF

END

NO

HYD SEL .... OFF

DROGUE MASTER PWR Sw .... OFF

Sighting Door .... CLOSE

Return to forward position.

END

* WING POD HOSE WILL NOT REWIND

WARNING

Do not accomplish checklist until just prior to landing if FUEL TEMP HIGH light is on or a RAT overspeed or possible overspeed condition exists unless aircraft/crew safety is paramount. Fuel circulating capability for pod fuel pump cooling is inhibited after hose is jettisoned or WARP power switch is turned off.

NOTE

- *If the hose will not rewind due to a fail indication that does not clear itself, cycling the pod power switch may clear the fault, allowing the hose to be stowed.*
- *Prior to accomplishing WING POD HOSE WILL NOT REWIND checklist, ensure airspeed is below 280 KIAS and reattempt rewind. If hose rewinds accomplish normal post refueling procedures.*

HOSE Sw . . . . TRAIL

POD FUEL VALVE Sw . . . . CLOSE (BO,FE)

WING DROGUE VALVE Sw . . . . CLOSE (BO,FE)

Verify hose is in full trail.

NOTE

- *Hose shall be in full trail for hose jettisoning system.*
- *Unless aircraft safety is compromised, the hose should not be jettisoned.*

HOSE JETTISON OR LAND IN TRAIL . . . . DETERMINE

YES — HOSE JETTISON — NO

Receivers . . . . CLEAR

Verify receivers are clear (if applicable).

WARNING

Hose should not be jettisoned over a populated area unless aircraft/crew safety requires immediate action.

When cleared by Pilot.

HOSE JTSN Sw . . . . JTSN

WARNING

If hose does not jettison immediately, the potential exists for the hose to jettison at any time with no further aircrew action.

CAUTION

JTSN solenoid will be damaged if switch is held in JTSN position.

YES — HOSE JETTISONED — NO

WARP POWER Sw . . . . OFF

END

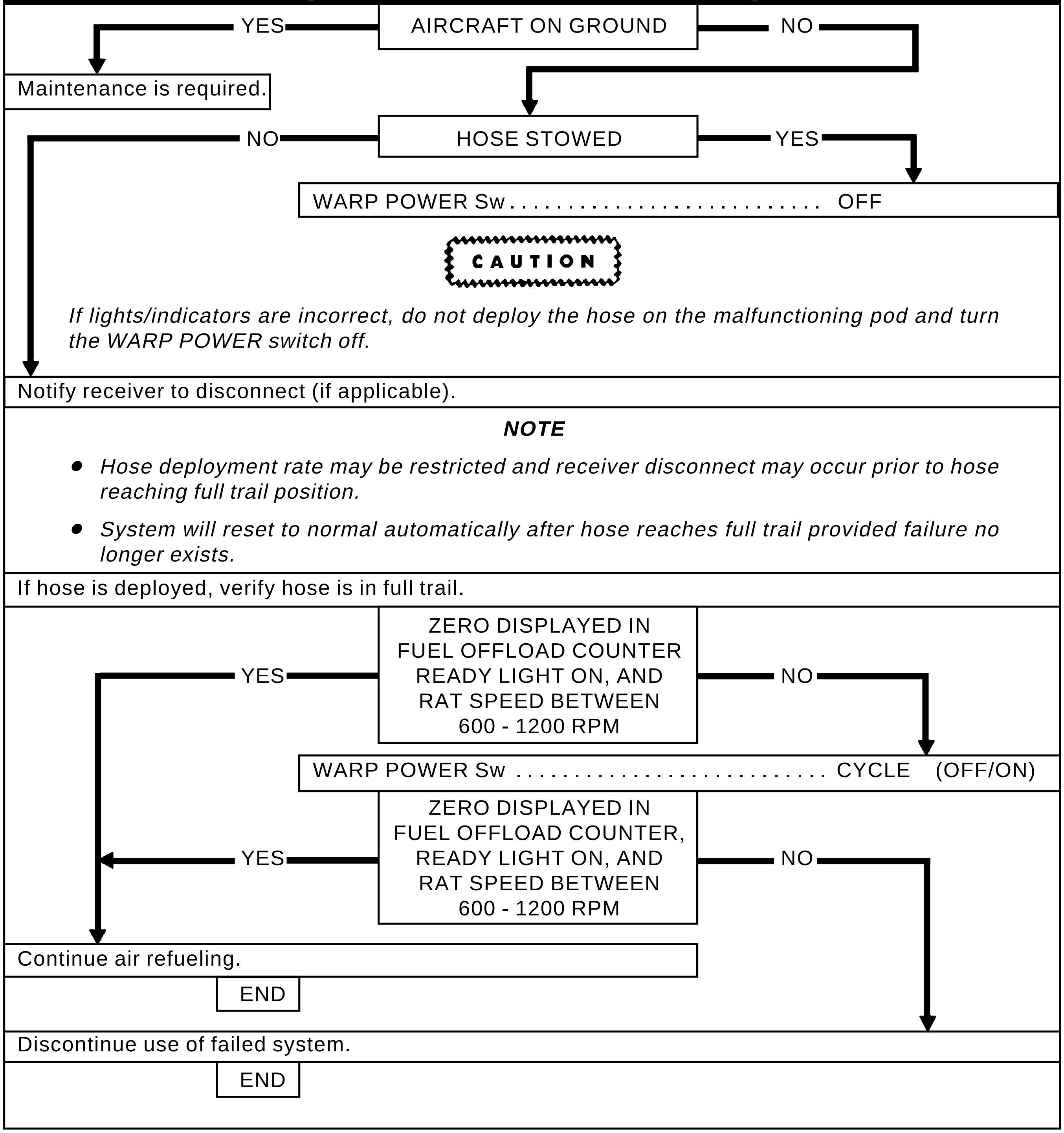
WARP POWER Sw . . . . OFF

LAND WITH HOSE IN TRAIL.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

FAIL INDICATION IN FUEL OFFLOAD COUNTER (AFTER TCTO 1C-10(K)A-956)



If lights/indicators are incorrect, do not deploy the hose on the malfunctioning pod and turn the WARP POWER switch off.

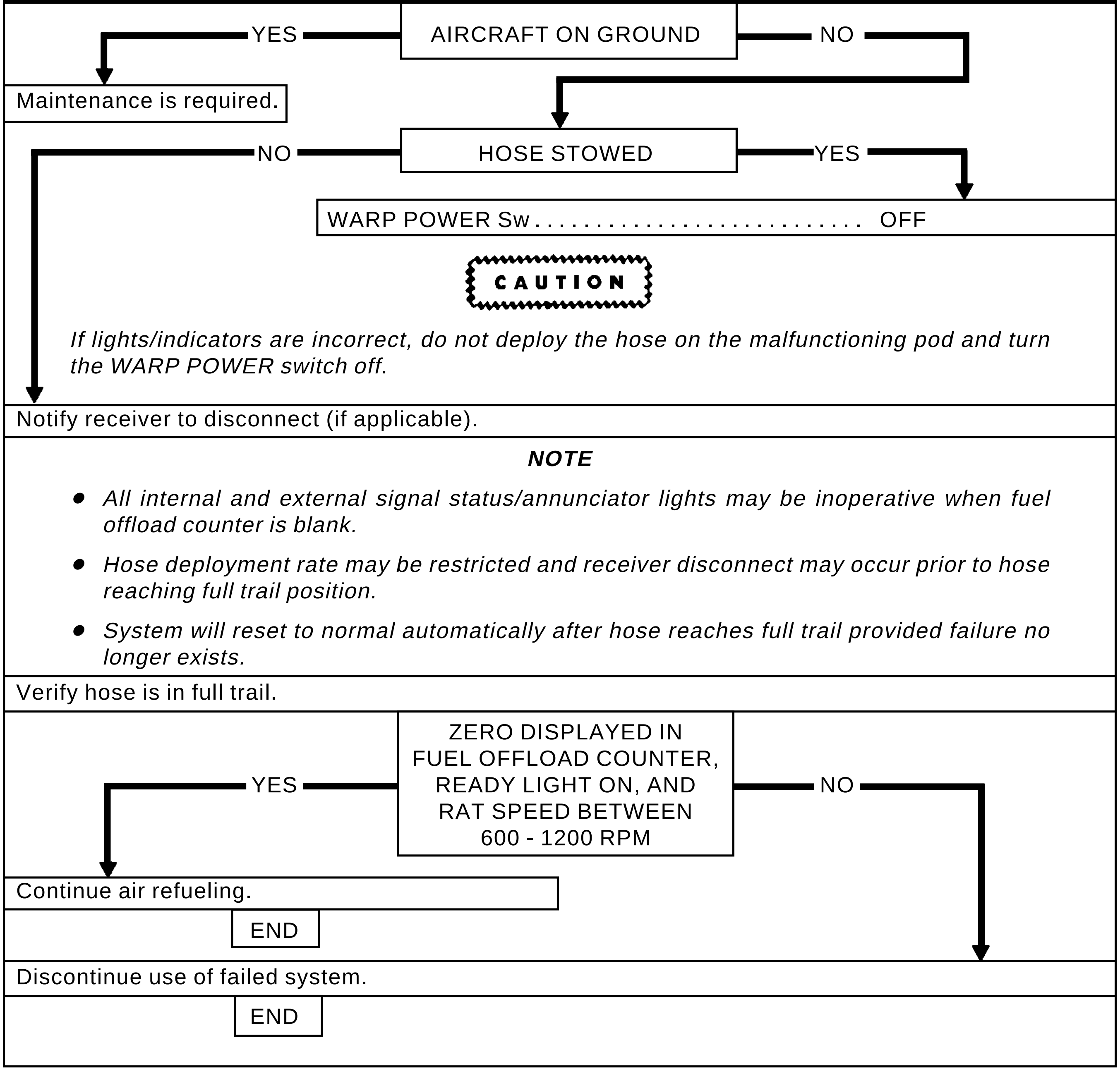
Notify receiver to disconnect (if applicable).

NOTE

- *Hose deployment rate may be restricted and receiver disconnect may occur prior to hose reaching full trail position.*
- *System will reset to normal automatically after hose reaches full trail provided failure no longer exists.*

If hose is deployed, verify hose is in full trail.

BLANK FUEL OFFLOAD COUNTER INDICATION (AFTER TCTO 1C-10(K)A-956)



AIRCRAFT ON GROUND

YES

Maintenance is required.

NO

HOSE STOWED

YES

WARP POWER Sw . . . . OFF

CAUTION

If lights/indicators are incorrect, do not deploy the hose on the malfunctioning pod and turn the WARP POWER switch off.

NO

Notify receiver to disconnect (if applicable).

NOTE

- *All internal and external signal status/annunciator lights may be inoperative when fuel offload counter is blank.*
- *Hose deployment rate may be restricted and receiver disconnect may occur prior to hose reaching full trail position.*
- *System will reset to normal automatically after hose reaches full trail provided failure no longer exists.*

Verify hose is in full trail.

ZERO DISPLAYED IN FUEL OFFLOAD COUNTER, READY LIGHT ON, AND RAT SPEED BETWEEN 600 - 1200 RPM

YES

Continue air refueling.

END

NO

Discontinue use of failed system.

END

*WING POD HOSE STOWED AND/OR FUEL PRESS HIGH AND FUEL PRESS LOW LIGHTS FLASHING

NOTE

RAT overspeed indication can occur when hose is stowed or deployed. An overspeed condition will be annunciated by the HOSE STOWED light and the FUEL PRESS HIGH and FUEL PRESS LOW lights flashing simultaneously when the hose is stowed. Only the FUEL PRESS HIGH and FUEL PRESS LOW lights will flash if an overspeed condition occurs when hose is deployed.

Notify receiver to disconnect (if applicable).

NOTE

Hose deployment rate may be restricted and receiver disconnect may occur prior to hose reaching full trail.

RAT SPEED/FUEL TEMPERATURE . . . . CHECK

PILOT . . . . NOTIFY

NOTE

Pressing the BITE button for less than 2 seconds displays RAT speed in the fuel counter window. Pressing the BITE button again will display fuel temperature. Pressing the COUNTER RESET will return the display back to fuel off-load.

Notify pilot of RAT overspeed condition and the indicated rpm and fuel temperature.

AIRSPEED . . . . DECREASE (BO,P)

WARNING

- *Land as soon as possible if fuel temperature cannot be maintained below 200°C.*
- *Blade separation may occur if RAT speed exceeds 10,000 rpm. RAT speed should be maintained below 10,000 rpm unless tanker and/or receiver safety will be affected.*

NOTE

- *RAT speed and fuel temperature may be reduced by decreasing airspeed.*
- *Monitor RAT speed and fuel temperature during airspeed adjustments to ensure maximum limits are not exceeded.*

YES — HOSE STOWED — NO

HOSE Sw . . . . REWIND (BO,P)

Do not deploy hose.

RAT SPEED/FUEL TEMPERATURE . . . . CHECK

YES — RAT SPEED LESS THAN 2000 RPM AND FUEL TEMP LESS THAN 50°C — NO

NOTE

Leave WARP power switch ON to monitor RAT speed and Temp if continuing to refuel with the other WARP.

POD FUEL VALVE Sw . . . . OFF (BO,FE)

WING DROGUE VALVE Sw . . . . CLOSED (BO,FE)

WARP POWER Sw . . . . OFF

END

CONTINUED

*WING POD HOSE STOWED AND/OR FUEL PRESS HIGH AND FUEL PRESS LOW LIGHTS FLASHING (cont)

CONTINUED

Verify the following:

WING DROGUE VALVE Sw	OPEN	(BO,FE)
X-FEED MANIFOLD	PRESSURIZE	(BO,FE)
POD FUEL VALVE Sw	CLOSE	(BO,FE)
WARP POWER Sw	ON	

WARNING

Fuel pressure shall be maintained in X-feed manifold to prevent excessive heat buildup in pod fuel pump.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

* FUEL PRESSURE LOW LIGHT ON

Notify receiver to disconnect (if applicable).

Verify hose is in full trail.

Confirm with FE that wing drogue valve is open and X-feed manifold is pressurized.

NOTE

If the FUEL PRESS LOW light is on and the hose is deployed, the hose cannot be stowed.

YES — FUEL PRESS LOW LT OFF — NO

YES: Continue air refueling.

END

NO: Discontinue use of failed system.

Refer to WING POD HOSE WILL NOT REWIND checklist (if applicable).

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

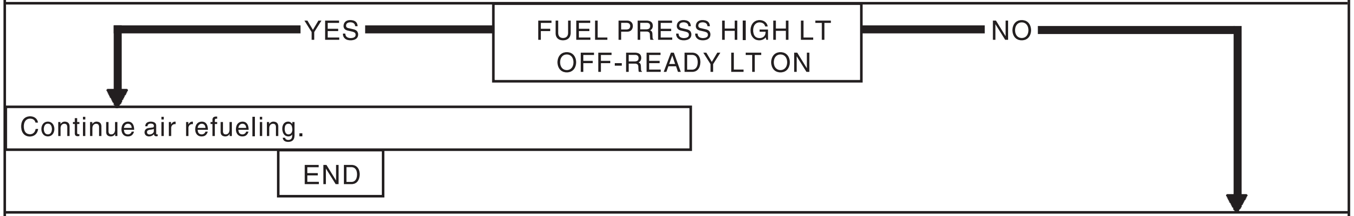
* FUEL PRESSURE HIGH LIGHT ON

Notify receiver to disconnect (if applicable).

NOTE

- *Hose deployment rate may be restricted and receiver disconnect may occur prior to hose reaching full trail.*
- *System will reset to normal automatically provided failure no longer exists.*

Verify hose is in full trail.



FUEL PRESS HIGH LT
OFF-READY LT ON

YES:

Continue air refueling.

END

NO:

HOSE Sw . . . . REWIND

Discontinue use of failed system.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

* FUEL TEMP HIGH LIGHT ON

Notify receiver to disconnect (if applicable).

YES ― HOSE STOWED ― NO

DO NOT DEPLOY HOSE.

WARP POWER Sw . . . . CYCLE (OFF/ON)

YES ― FUEL TEMP HIGH LT OFF AND READY LT ON ― NO

Continue air refueling.

END

HOSE Sw . . . . REWIND

RAT SPEED/FUEL TEMPERATURE . . . . CHECK

NOTE

Pressing the BITE button for less than 2 seconds displays RAT speed in the fuel counter window. Pressing the BITE button again will display fuel temperature. Pressing the COUNTER RESET will return the display back to fuel off-load.

YES ― RAT SPEED LESS THAN 2000 RPM AND FUEL TEMP LESS THAN 50°C ― NO

POD FUEL VALVE Sw . . . . CLOSE (BO,FE)

WING DROGUE VALVE Sw . . . . CLOSE (BO,FE)

WARP POWER Sw . . . . OFF

END

AIRSPEED . . . . DECREASE (BO,P)

Request Pilot decrease airspeed until RAT speed is below 2000 rpm and fuel temperature is below 200° C.

WARNING

Land as soon as possible if fuel temperature CANNOT be maintained below 200° C.

NOTE

- *RAT speed and fuel temperature may be decreased by decreasing airspeed.*
- *Monitor RAT speed and fuel temperature during airspeed adjustments to ensure RAT rpm and fuel temperature maximum limits are not exceeded.*

CONTINUED

* FUEL TEMP HIGH LIGHT ON (cont)

RAT SPEED LESS THAN 2000 RPM AND FUEL TEMP LESS THAN 50°C

YES

POD FUEL VALVE Sw . . . . CLOSE (BO,FE)
WING DROGUE VALVE Sw . . . . CLOSE (BO,FE)
WARP POWER Sw . . . . OFF

END

NO

WING DROGUE VALVE Sw . . . . OPEN (BO,FE)
X-FEED MANIFOLD . . . . PRESSURIZE (BO,FE)
POD FUEL VALVE Sw . . . . CLOSE (BO,FE)
WARP POWER Sw . . . . ON

WARNING

Fuel pressure shall be maintained in X-feed manifold to prevent excessive heat buildup in the pod fuel pump.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

* LOSS OF WING POD DROGUE

Instruct receivers to stay clear of hose.

CAUTION

- *Severe hose oscillation may occur after drogue separates from hose.*
- *Hose oscillation will increase to the point where damage to the aircraft may occur if the FLAPS/SLATS are extended. If possible, a NO FLAP/NO SLAT approach and landing should be accomplished.*

NOTE

- *The hose will rewind automatically until approximately 46 ft of hose is deployed. The hose cannot be stowed or jettisoned in this condition. It must be in full trail to be jettisoned.*
- *Fuel spillage will occur as hose rewinds through refueling range if pod fuel valve is armed.*

POD FUEL VALVE Sw . . . . CLOSE (BO/FE)

WING DROGUE VALVE Sw . . . . CLOSE (BO/FE)

AIRSPEED . . . . DECREASE (IF REQ'D) (BO/P)

NOTE

Request Pilot decrease airspeed to as slow as possible, without lowering flaps, to reduce or lessen hose oscillation.

WARP POWER Sw . . . . OFF

Land with hose in trail.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

* INTERNAL WING POD READY LIGHT NOT ON

Fuel transfer is not possible and the hose jettison system is not enabled.

NOTE

- *If the hose reaches full trail and the ready light does not illuminate, cycle the WARP POWER switch.*
- *If the hose fails to reach full trail and the ready light does not illuminate, increase airspeed (Not to exceed 300 KIAS).*

SPEED . . . . INCREASE (BO,P)

HOSE REACHES FULL TRAIL

YES

Continue Air Refueling

END

NO

HOSE SWITCH . . . . REWIND (BO,P)

Discontinue use of affected system.

CAUTION

Do not select rewind unless the drogue is stable and not moving in or out.

END

* ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION

Loss of a major portion of the nose radome on the KC-10 may disrupt the airflow over the pitot probes, thereby affecting the measured total pressure. Should this occur, those functions dependent on total pressure from the pitot probes (such as indicated airspeed and Mach number, overspeed warning, certain autopilot functions, elevator load feel and flap limiter programming, etc.) may become erroneous or inoperative. Damage or loss of a radome will be accompanied by an increase in noise level and a relatively small loss in aircraft performance. No significant change will occur in aircraft handling characteristics, stall, or buffet onset speeds due to radome damage.

Hail encounter, in addition to causing radome and/or pitot tube damage, may also cause damage to the wing leading edges, thereby resulting in an increase in aircraft stall speeds and degraded handling characteristics at, or near, stall. (Certain types of damage can cause aircraft stall prior to stall warning.) Further, the angle-of-attack probes may be damaged, thereby invalidating stall warning.

The terminal area and final approach speeds shown in the following tables contain an arbitrary margin to account for the degree of wing leading edge damage nominally occurring due to hail encounter. The final approach speeds should be taken into consideration when determining landing field length requirements.

Loss of a major portion of the nose radome is usually accompanied by noise and low frequency buffeting that is distinguishable from stall buffet in that it does not change greatly with changes in speed or attitude. Once the problem is identified, and airspeed appears suspect, no difficulties should be encountered as long as pitch attitude is used as the primary reference and indicated airspeed readings are disregarded.

Information for pitch attitude flying is contained in the following tables and may be used anytime airspeed indications are suspect. Linear interpolation for the target pitch attitude corresponding to the appropriate gross weight is permissible.

NOTE

All computations are based on standard temperature for the given altitude and CF6-50C2 engines.

CONTINUED

OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION (cont)

Refer to the following tables by flight condition:

Flight Condition . . . . DETERMINE (ALL)

A	**CLIMB**
B	**CRUISE**
C	**DESCENT/HOLDING/APPROACH**
D	**GO-AROUND**

A CLIMB

	Flap/ Slat (deg)	**Altitude (ft)**	**Weight (1000 lb)**	**Target Pitch Attitude (deg)**	**Approx. N_1 Required (%)**	**Approx. Airspeed (KIAS)***	**Approx. Rate of Climb (fpm)**
MAX CLIMB ($1.5V_S$ + 10 KIAS) Fly to Pitch Attitude	0°/RET	SL	300	18.5	100.1	218	5,280
			350	15.5	100.2	235	4,590
			450	12.5	100.6	265	3,570
			550	10.5	100.9	292	2,830
		5,000	300	16.5	101.8	218	4,910
			350	14.0	102.0	235	4,260
			450	11.5	102.4	265	3,260
			550	9.5	102.8	292	2,560
		10,000	300	14.5	102.1	218	4,320
			350	12.5	102.4	235	3,690
			450	10.0	102.9	265	2,760
			550	8.5	103.4	292	2,110
		15,000	300	12.5	102.5	218	3,700
			350	11.0	102.8	235	3,110
			450	8.5	103.4	265	2,270
			550	7.5	104.0	292	1,670
	0°/EXT	SL	300	21.0	99.8	190	4,540
			350	18.0	99.9	204	3,920
			450	14.5	100.2	230	2,980
			550	12.5	100.4	252	2,290
		5,000	300	19.0	101.5	190	4,200
			350	16.5	101.6	204	3,610
			450	13.5	101.9	230	2,680
			550	11.5	102.2	252	2,010
		10,000	300	16.5	101.8	190	3,640
			350	14.5	102.0	204	3,080
			450	12.0	102.3	230	2,200
			550	10.5	102.7	252	1,570
		15,000	300	14.5	102.1	190	3,060
			350	12.5	102.3	204	2,540
			450	10.5	102.7	230	1,720
			550	9.5	103.2	252	1,130

* Actual speeds may be limited by IAS/MACH limits

OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION (cont)

B CRUISE

Altitude (ft)	Weight (1,000 lb)	Target Pitch Attitude (deg)	Approximate N_1 rpm Required (%)	Approximate Speed (KIAS)
20,000	300 400 500	1.5 2.5 4.0	81.0 84.3 88.0	300
25,000	300 400 500	1.5 2.5 3.5	85.1 88.4 92.1	300
30,000	300 400 500	1.0 2.0 3.0	88.9 91.9 96.1	300
35,000	300 400	1.5 2.5	90.8 95.7	285

OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION (cont)

C DESCENT/HOLDING/APPROACH

	Flap/ Slats (deg)	Alt (ft)	Weight (1,000 lb)	Target Pitch Attitude (deg)	Approx. N_1 rpm Required (%)	Approximate Speed (KIAS)	Approx. Rate of Descent (fpm)
DESCENT Fly to pitch Attitude	0°/RET	5,000	300 400 500	-2.0 0.0 1.0	Idle Thrust	300	2,010 1,690 1,620
	↓	15,000	300 400 500	-2.0 -0.5 1.0	↓	300	2,280 2,120 1,820
	↓	25,000	300 400 500	-2.0 -0.5 1.0	↓	300	2,670 2,230 2,110
	↓	35,000	300 400 500	-1.5 -0.5 0.5	↓	285	2,590 2,340 2,500
HOLDING Adjust power to maintain pitch attitude, level flight	0°/RET	10,000	300 400 500	5.0 5.0 5.0	65.3 73.8 79.0	211 243 272 Slats Retract Holding Speed	0 0 0
TERMINAL AREA FLIGHT Adjust power to maintain pitch attitude, level flight	0°/RET	0	300 400 500	4.5 5.0 5.0	57.9 66.9 72.9	218 250 279 - $1.5V_S$ +10	0 0 0
	0°/EXT	0	300 400 500	8.0 8.5 8.5	59.3 68.2 75.2	184 211 234	0 0 0
	22°/EXT	0	300 400 500*	5.0 5.0 -	64.5 73.4	167 191	0 0
FINAL APPROACH Based on 3° glide slope. Adjust power to maintain pitch attitude. Fly glide slope or, if not available fly to rate of descent.	35°/EXT	0	300 400 500	2.5 3.0 3.5	60.6 69.0 75.5	145 166 182 $1.3V_S$ +15 V_{TH} + 15)	770 870 960
	50°/EXT	0	300 400 500*	1.5 2.0 -	70.5 78.8	141 161	750 850

* Exceeds Flap Placard Speed

OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION (cont)

D GO-AROUND

	Flap/ Slat (deg)	Altitude (ft)	Weight (1,000 lb)	Target Pitch Attitude (deg)	Approx. N_1 Required (%)	Approx. Airspeed (KIAS)*	Approx. Rate of Climb (fpm)
GO-AROUND (V_2 + 20 KIAS) Fly to Pitch Attitude	15°/EXT	SL	300	26.0	110.4	151	4,830
			350	22.5	110.5	161	4,150
			450	18.5	110.7	180	3,120
			550	16.0	110.9	200	2,430
		5,000	300	23.5	112.7	151	4,360
			350	20.5	112.8	162	3,710
			450	17.0	113.0	182	2,740
			550	14.5	113.2	202	2,090
		10,000	300	20.9	114.5	151	3,800
			350	18.0	114.6	162	3,180
			450	15.0	114.9	184	2,320
			550	12.5	115.2	206	1,710
	22°/EXT	SL	300	24.5	110.4	148	4,660
			350	21.5	110.5	158	3,970
			450	17.5	110.7	176	2,940
			550	13.0	110.8	195	2,240
		5,000	300	22.0	112.7	148	4,190
			350	19.5	112.7	158	3,540
			450	16.0	112.9	178	2,560
			550	13.5	113.2	198	1,900
		10,000	300	19.5	114.5	148	3,630
			350	16.5	114.6	158	2,910
			450	13.5	114.8	180	2,140
			550	11.0	115.1	201	1,520

* Actual speeds may be limited by IAS/Mach limits

SECTION III

LIMITATIONS

TABLE OF CONTENTS

LIMITATIONS

INTRODUCTION

Section III covers all important limitations that must be observed during normal operation of the aircraft and engines. It is not construed that Section III contains all limitations, as some limitations are covered in sections dealing with that particular specialized phase of flight. Conversely, the instrument markings illustration should be closely studied for area of normal operation and limitations, as these limitations may not be mentioned in other sections of the manual. The operating limitations contained in this section takes precedence over all other limitations mentioned elsewhere in this manual.

NOTE

> When operating with less than fully operable equipment, refer to the MEL for further guidance.

MINIMUM CREW REQUIREMENTS

The minimum flight crew to fly the aircraft will consist of the Pilot, Copilot, and Flight Engineer.

SYSTEMS LIMITATIONS

NOTE

> Observance of these limitations will increase the service life and prevent damage to equipment.

INSTRUMENT LIMIT MARKINGS

See figure 3-1.

Maximum and minimum limits	Red radial line
Precautionary ranges	Yellow arc

CABIN PRESSURIZATION

Maximum relief valve differential pressure	9.1 psi
Maximum differential pressure at takeoff and landing	0.5 psi

INERTIAL NAVIGATION SYSTEM

Do not cycle the MSU out of OFF more than 3 times in a 3 minute period. Cycling the MSU out of OFF repeatedly can cause substantial damage from heat build-up in the INU.

ENGINE ANTI-ICE

When temperatures are below 6°C (42°F), and visible moisture in any form is present; such as, clouds (inflight), fog, rain, snow, sleet, or ice crystals; or when temperatures are below 6°C (42°F), and the temperature-dewpoint spread is 3°C (5°F) or less, engine anti-ice will be turned on immediately after engine start and used continuously until icing conditions cease to exist. In flight engine anti-ice will be turned on when TAT is below 6°C and visible moisture in any form is present.

WING ANTI-ICE

While on the ground, do not hold the wing anti-ice switch in TEST more than 15 seconds.

WINDSHIELD HEAT

The windshield anti-ice selectors should be in NORM for flight when icing conditions are imminent. The windshield anti-ice should be in HIGH only for the duration of moderate to heavy icing.

WINDSHIELD RAIN REPELLANT

Apply rain repellant only in heavy rain. Do not apply rain repellent to second windshield until repellency is established on first windshield. Do not turn on wipers if repellent is inadvertently applied to a dry windshield.

ELECTRICAL INSTRUMENT READING

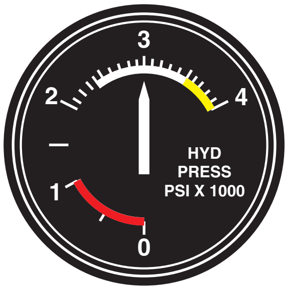
Normal and allowable operating ranges are marked on various electrical system indicators. Indications outside normal ranges (white or green) indicate possible system abnormalities. The yellow ranges should not be exceeded. Sustained operation within this range is not recommended.

Electrical Load Limits

Normal DC load limit	1.0
Maximum DC load limit	1.0 to 1.5 for 5 minutes
Normal AC load limit	Up to 1.0 per generator continuously

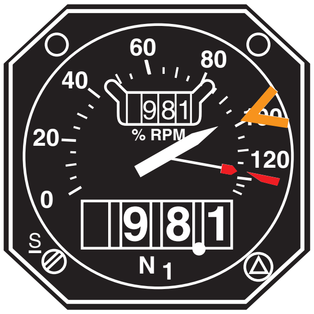
MACH/AIRSPEED INDICATOR

▨ V_{MO} POINTER
⬜ AIRSPEED POINTERS
4 AIRSPEED SET POINTS
🟥 AIRSPEED COMMAND BUG



BRAKE AND HYDRAULIC PRESSURE GAGE

🟥 0 - 1000 PSI
⬜ 2400 - 3500 PSI
🟨 3500 - 4000 PSI

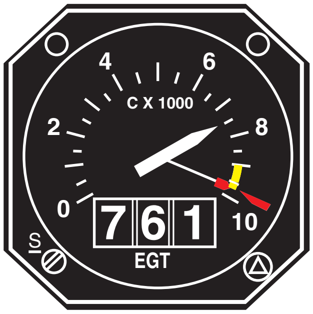


ENGINE N_1 SPEED INDICATOR

🟥 LIMIT MARK AT 118.5%
🟧 LIMIT INDEX
🟥 MAXIMUM LIMIT POINTER

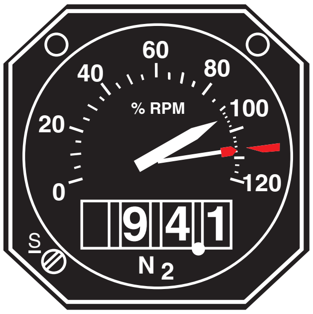
NOTE

The 120 marking on the N_1 gage is offset from its logical location and is easily misread. This could result in incorrect procedures being applied in an engine overspeed situation.



ENGINE EXHAUST GAS TEMPERATURE

🟥 LIMIT MARK AT 960 C
🟨 910 - 960 C
🟥 MAXIMUM LIMIT POINTER

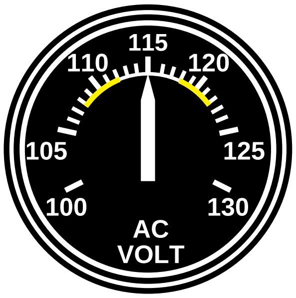


ENGINE N_2 SPEED INDICATOR

🟥 LIMIT MARK AT 109.5%
🟥 MAXIMUM LIMIT POINTER

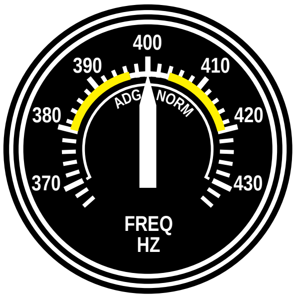
SA1-401B

Figure 3-1. Instrument Markings (Sheet 1)



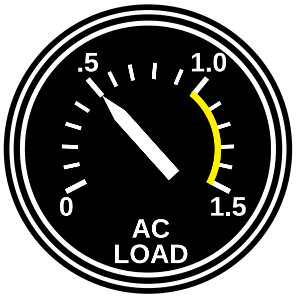
AC VOLTMETER

🟨 108 – 112 AND 118 – 122 VOLTS
⬜ 112 – 118 VOLTS



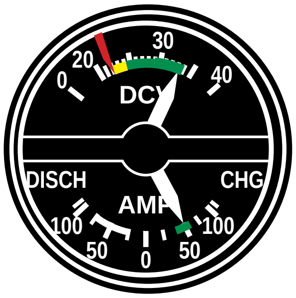
AC FREQUENCY METER

🟨 380 – 396 AND 404 – 420 CPS
⬜ 396 – 404 CPS



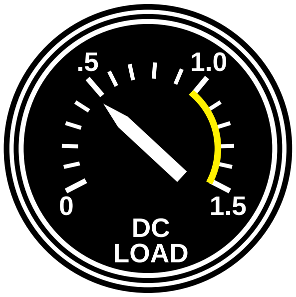
AC LOADMETER

🟨 1.0 — 1.5



DC VOLTMETER

🟥 LIMIT MARK AT 22 VOLTS
🟨 22 — 24 VOLTS
🟩 24 — 29 AND 29 — 34 VOLTS
35 — 65 AMPS
⬜ 26 — 29 VOLTS
25 — 75 AMPS

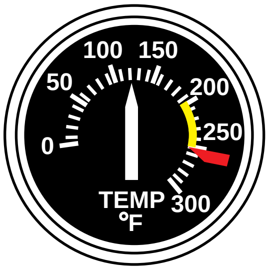


DC LOADMETER

🟨 1.0 — 1.5

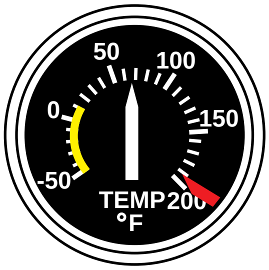
SA1-402A

Figure 3-1. Instrument Markings (Sheet 2)



TURBINE INLET TEMPERATURE

🟥 LIMIT MARK AT 250˚F
🟨 200 — 250˚F

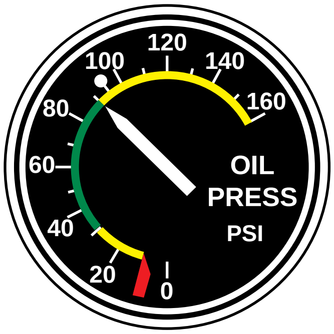


PACK DISCHARGE TEMPERATURE

🟥 LIMIT MARK AT 190˚F
🟨 -50 — +10˚F

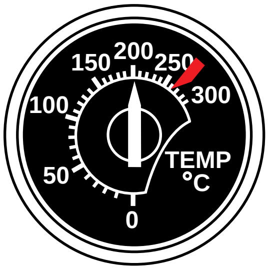
PNEUMATIC SUPPLY PRESSURE

🟥 LIMIT MARK AT 90 PSI
🟨 0 — 10 AND 55 — 90 PSI



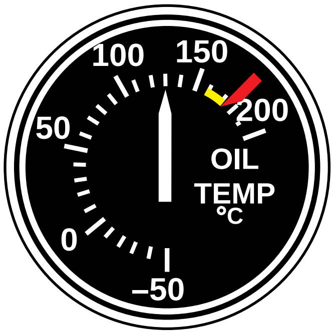
ENGINE OIL PRESSURE

🟥 LIMIT MARK AT 10 PSI
🟨 10 — 30 AND 90 — 160 PSI
🟩 30 — 90 PSI



PNEUMATIC TEMPERATURE

🟥 LIMIT MARK AT 260˚C

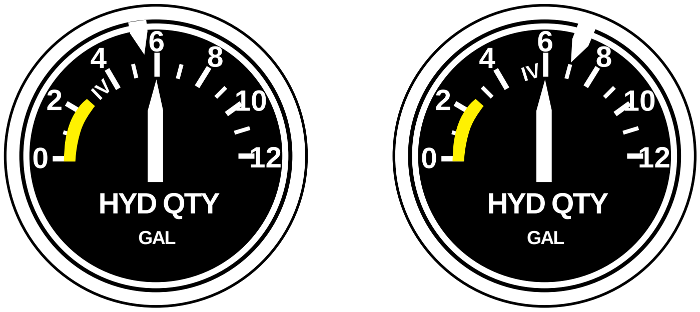


ENGINE OIL TEMPERATURE

🟥 LIMIT MARK AT 175˚C
🟨 160 — 175˚C

SA1-403A

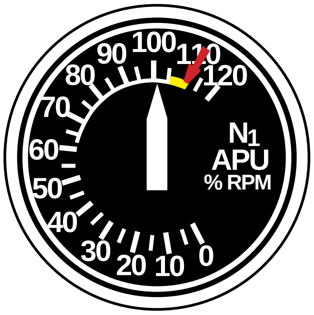
Figure 3-1. Instrument Markings (Sheet 3)



HYD SYS 1 & 2 HYD SYS 3

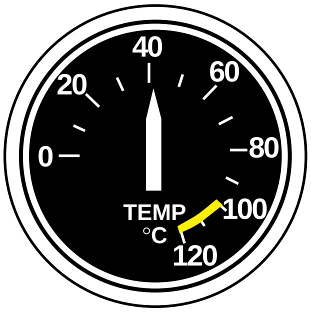
HYDRAULIC OIL QUANTITY

🟨 0 — 2.5 GALS.



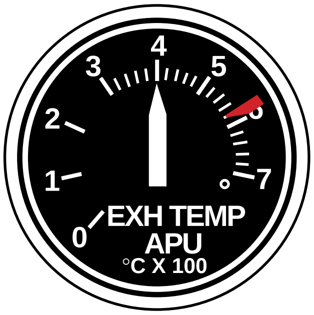
N1 TACHOMETER — A.P.U.

🟥 LIMIT MARK AT 110%
🟨 105 — 110%
⬜ 63 — 105%



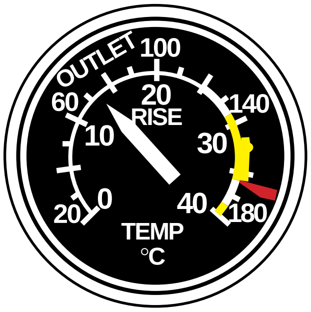
HYDRAULIC OIL TEMPERATURE

🟨 100 — 120°C



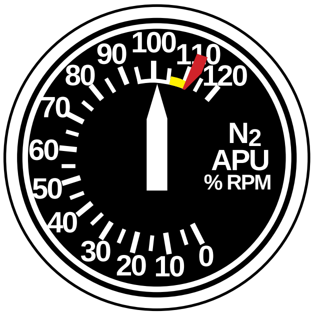
EXHAUST GAS TEMPERATURE — A.P.U.

🟥 LIMIT MARK AT 585°C



CONSTANT SPEED DRIVE TEMPERATURE

🟥 LIMIT MARK AT 163°C
🟨 RISE SCALE 25 — 40°C
OUTLET SCALE 146 — 163°C

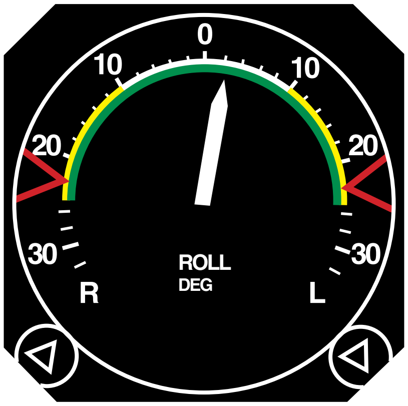


N2 TACHOMETER — A.P.U.

🟥 LIMIT MARK AT 110%
🟨 105 — 110%
⬜ 95 — 105%

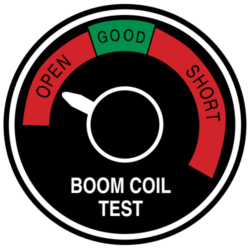
SA1-404E

Figure 3-1. Instrument Markings (Sheet 4)

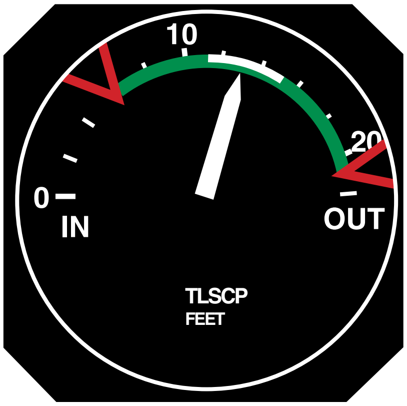


ROLL INDICATOR

🟥 LIMIT INDEX
🟩 25°L — 25°R
🟨 25° — 10°L AND 25° — 10°R
⬜ 10°L — 10°R

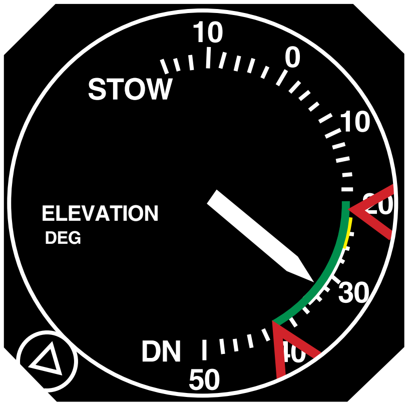


BOOM COIL TEST INDICATOR



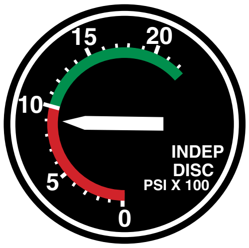
TLSCP INDICATOR

🟥 LIMIT INDEX
🟩 6' — 21'
⬜ 11' — 15'



ELEVATION INDICATOR

🟥 LIMIT INDEX
🟩 20° — 40°
🟨 20° — 27°
⬜ 25° — 35°



IDS GAGE

🟥 0—1000 PSI
🟩 1000—2200 PSI

SA1-405A

Figure 3-1. Instrument Markings (Sheet 5)

Maximum AC load limit	1.0 to 1.5 per generator for 5 minutes
Maximum AC load input	Allowed to exceed 1.5 per generator for 5 seconds
Maximum APU generator frequency fluctuation:	
NORM mode	±2 Hz within normal operating band
STBY mode	±20 Hz

CAUTION

> Any condition causing a sustained indication outside the normal range should be corrected at the earliest opportunity.

HYDRAULICS

The No. 1 Auxiliary Pump Switch must be operational for dispatch. Both Aux Hydraulic Pumps are equipped with an interchangeable wiring harness. Refer to TO 1C-10(K)A-1-2 (MEL) for procedures and guidance.

PNEUMATICS

Maximum recommended operation for any single engine pneumatic supply in addition to lavatory/galley vent is:

Engine Cross-Start: One pack.

Takeoff, Go-Around, or MCT Power: One pack plus wing anti-ice (both wings).

After Power Reduction Below MCT: Two packs, or one pack plus wing anti-ice (both wings).

NOTE

> In flight, do not interconnect two active engine pneumatic supply systems, except for short periods during transition from use of APU pneumatics or engine cross-start.

KC-10A DRY ICE CARGO CAPABILITIES

Dry Ice may be carried in the KC-10A Cargo Compartment under the following aircraft operating conditions:

1. No environmental curtain - (27 pallet all-cargo configuration): A safe load of Dry Ice is 2,295 pounds with Both air conditioning packs operating. This weight is reduced to 1,251 pounds when One air conditioning pack is operating. If One air conditioning pack is lost in flight, then accomplish emergency procedures for smoke or fumes removal section II, beginning at Smoke or Fumes Associated with Air Conditioning - (no side) portion of procedure. Do not place cabin pressure control in manual. Increase cabin flow through partial depressurization by raising cabin altitude. Do not depressurize above 10,000 feet unless passengers are not aboard and adequate crew oxygen is available. Land as soon as practical.

2. Environmental curtain at station 615: A safe load of Dry Ice is 1,782 pounds with Both air-conditioning packs operating. This weight is reduced to 969 pounds when One air-conditioning pack is operating.
3. Environmental curtain at station 879: A safe load of Dry Ice is 1,204 pounds with Both air-conditioning packs operating. This weight is reduced to 653 pounds when One air-conditioning pack is operating.
4. Environmental curtain at station 615 or 879: If One air-conditioning pack is lost in flight, then accomplish emergency procedures for smoke or fumes removal, Section II, same as 1. above.
5. During Cargo Loading, the following conditions must be followed to minimize Carbon Dioxide Concentration.
   - (a) Ensure APU is running and Both air-conditioning packs should be running.
   - (b) Open number 4 passenger service door for additional ventilation.
   - (c) Open all air inlets in the aerial refueling operators station and close aerial refueling operators hatch.
   - (d) Dry Ice should be loaded in the aft portion of the cargo compartment for flight.
   - (e) Ensure environmental curtain is closed before flight.

POWER PLANT

Engine Starting (figure 3-2).

The starter motor must be cooled for at least 30 seconds for each minute of operation and may be operated continuously for as long as 5 minutes. Following two consecutive 5 minute cycles, a 10 minute cooling period is required between additional 5 minute cycles.

Starter re-engagement should be made at the lowest practical N_2 rpm in order to reduce potential for starter crash engagements. Normally re-engagement should be made with N_2 rpm below 20%. Under emergency conditions such as an engine fire indication, re-engagement may be made with N_2 rpm as high as 30%.

CAUTION

> Do not attempt starter re-engagement above 30% N_2 rpm. Starter damage may occur.

The normal EGT limit is 750°C. Maximum EGT limit is 900°C. EGT peaks between 750°C and 900°C are limited to 40 seconds. EGT in excess of 750°C requires a 781 form entry.

One start is allowed in the 800°C to 900°C range and the intended flight may be completed before maintenance action. Advise maintenance of temperature reached and request approval for delayed inspection and availability of maintenance next stop.

CF6-50C2 Performance/Operating Limits (figure 3-3).

G.E. CF6-50 SERIES ENGINES

OVERSPEED OVERTEMPERATURE RANGE			RECOMMENDED PILOT ACTION (Based on speed/ temperature conditions for brief period)
N_1 (%)	N_2 (%)	EGT (°C)	
118.6 to 125	109.6 to 111.3	960 to 1000	Reduce to below redline and continue.
Above 125	Above 111.3	Above 1000	Reduce to idle. Use higher thrust only at pilot's discretion

NOTE

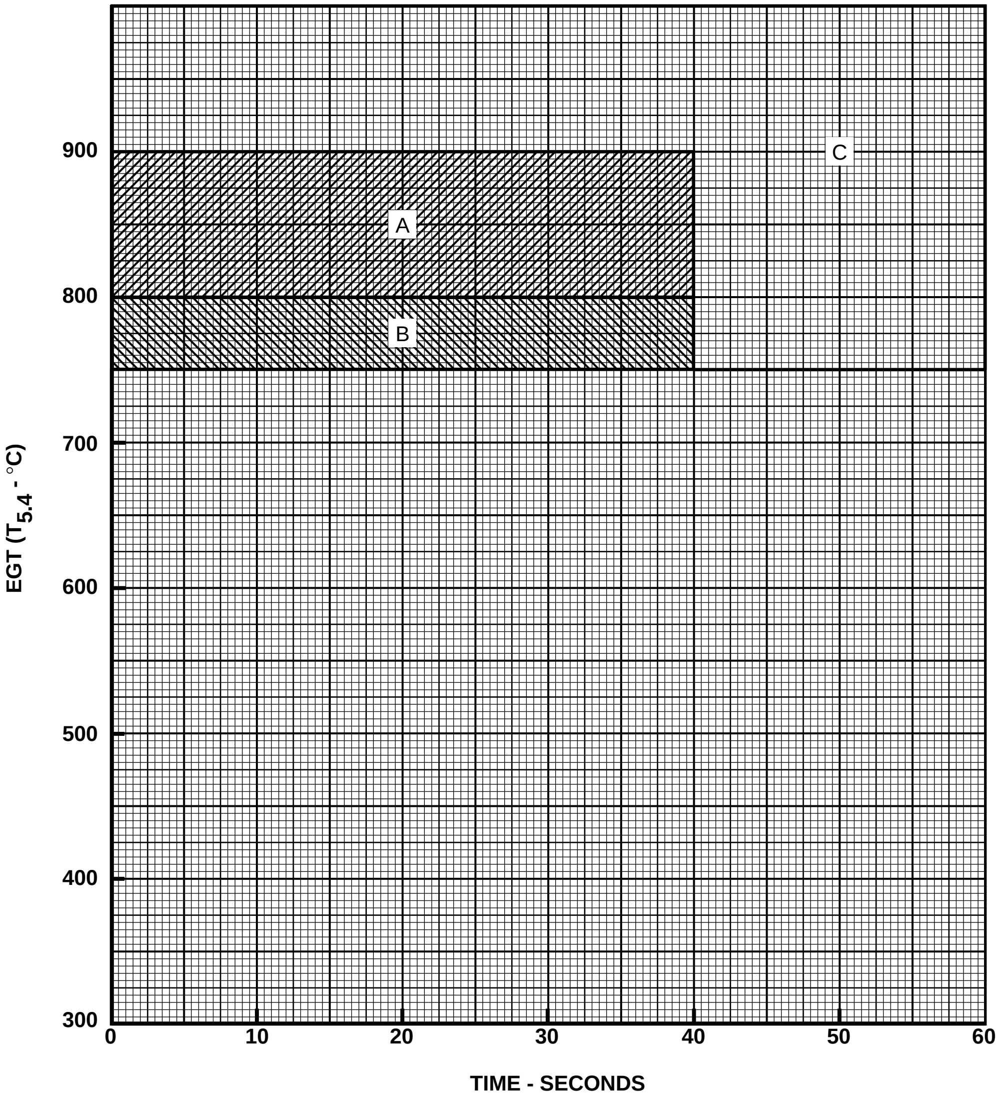
- If any engine indications are abnormal at minimum thrust, a precautionary engine shutdown should be considered.
- All overspeed and/or overtemperature occurences require a 781 form entry.

STARTS IN AREA A MUST BE RECORDED AND MAINTENANCE ACTION MUST BE TAKEN PRIOR TO THE NEXT START. (INTENDED FLIGHT MAY BE COMPLETED.)

STARTS IN AREA B MUST BE RECORDED. REPETITIVE STARTS IN THIS AREA ARE CAUSE FOR CORRECTIVE ACTION.

STARTS IN AREA C MUST BE DISCONTINUED. CORRECTIVE MAINTENANCE MUST BE PERFORMED PRIOR TO NEXT START ATTEMPT.

NOTE:
THESE LIMITS MAY OCCUR AT ANY TIME DURING THE START CYCLE.



SA1-380A

Figure 3-2. Indicated Exhaust Gas Temperature Limits - Starting

MODEL: KC-10A

ENGINES: CF6-50C2
DATE: DECEMBER 1981
DATA BASIS: FLIGHT TEST

PERFORMANCE		INSTALLED OPERATING LIMITS						
THRUST SETTING	THRUST POUNDS	DURATION MINUTES	MAX. EGT°C	MAX. N_1%	MAX. N_2%	OIL PSI	MAX. OIL TEMP	
							CONT	15 MIN
TAKEOFF FLAT-RATED TO 30°C	51,800	††2 ††5	960 945	118.5	109.5	**	160°C	175°C
MAX. CONT. FLAT-RATED TO 30°C	46,300	CONTINUOUS FOR EMERG. PURPOSES	910	118.5	109.5	**	160°C	175°C
MAX. CLIMB		CONTINUOUS	885	118.5	109.5	**	160°C	175°C
MAX. CRUISE		CONTINUOUS	885	118.5	109.5	**	160°C	175°C
FLIGHT IDLE		CONTINUOUS		*	*	10 MINIMUM	160°C	175°C
GROUND IDLE		CONTINUOUS	* * *	*	*	10 MINIMUM	160°C	175°C
STARTING			†900			10 MINIMUM AT STAB. IDLE		

NOTE

OUT OF LIMIT OPERATIONS - DURATION AND EXTENT OF ANY OPERATIONS BEYOND THE STATED LIMITS SHALL BE RECORDED IN THE 781.

LANDINGS AND UNPLANNED GO-AROUNDS ARE ALLOWED AT OUTSIDE AIR TEMPERATURES UP TO A MAXIMUM OF 55°C.

* IDLE - FOR FLIGHT IDLE AND GROUND IDLE N_1 AND N_2 LIMITS, REFER TO MAINTENANCE MANUAL.

* * * IDLE - FOR GROUND IDLE EGT LIMITS, REFER TO MAINTENANCE MANUAL.

† EGT CURVES - STARTING - (SEE FIGURE 3-2).

†† TAKE OFF TIME/TEMPERATURE LIMITS - THE CERTIFIED TIME/TEMPERATURE LIMITS APPLY WHEN THE MAXIMUM CONTINUOUS EGT LIMIT IS EXCEEDED.

THE NORMAL TAKEOFF THRUST DURATION OF 5 MINUTES MAY BE EXTENDED TO 10 MINUTES FOR ENGINE-OUT CONTINGENCY. IF THIS CONTINGENCY TIME LIMIT IS UTILIZED, THE APPLICABLE MAINTENANCE REQUIREMENTS MUST BE COMPLIED WITH.

THE 2 MINUTE EGT TRANSIENT FOR ACCELERATION MAY OCCUR AT ANY TIME DURING TAKEOFF CYCLE.

* *OIL PRESSURE - FULL-SCALE PRESSURE SURGES MAY OCCUR DURING COLD SOAK, SUB-ZERO TEMPERATURE STARTS.

UNDER EXTREME COLD CONDITIONS, WITH BOTH OIL AND FUEL AT LOW TEMPERATURE, THE OIL PRESSURE COULD EXCEED 90 PSI AT RATED CORE ENGINE SPEED. UNDER THESE CONDITIONS THE HIGH OIL PRESSURE IS ACCEPTABLE AND TAKEOFF IS PERMISSIBLE WITHOUT A WARM-UP PERIOD.

FLIGHT AND GROUND IDLE NORMAL OIL PRESSURE IS 15 PSI OR ABOVE. LESS THAN 10 PSI DURING IDLE OPERATION REQUIRES ENGINE SHUTDOWN. DURING OTHER CONDITIONS, REFER TO ABNORMAL PROCEDURE FOR ENGINE OIL PRESSURE LOW.

OIL PRESSURE:	ANY DEVIATION GREATER THAN 10 PSI DURING STEADY STATE N_2 MAY INDICATE PENDING ENGINE FAILURE
OIL CONSUMPTION:	NORMAL .35 QTS PER HOUR MAX .55 QTS PER HOUR

SA1-381D

Figure 3-3. CF6-50C2 Performance and Operating Limits

ENVIRONMENTAL ENVELOPE

The KC-10A has been certified for operation within the temperature/altitude envelope (figure 3-4). Two envelopes are shown for takeoff and landing. The envelope extending to 8,500 feet altitude is the standard certified envelope. The envelope extending to 14,000 foot altitude is approved and is used for operational performance in TO 1C-10(K)A-1-1.

Runway slope ±2%.

Limiting tailwind component is 10 knots.

MAXIMUM OPERATING SPEEDS

(figure 3-5)

The maximum operating limit speed V_{MO} may not be deliberately exceeded in any regime of flight (climb, cruise, or descent).

Full application of rudder and aileron controls, as well as maneuvers that involve angles of attack near the stall, should be confined to speeds below V_A.

The autoslat extension maximum speed is 270 KIAS or 0.55M whichever is lower. If the autoslats cannot be retracted, continued flight is allowed at speeds up to 270 KIAS or 0.75M whichever is lower.

CENTER-OF-GRAVITY LIMITATIONS

Figure 3-7 depicts aircraft gross weight CG limits. The gross weight of the aircraft must be maintained within the design CG envelope during all flight operations. Maintaining the CG as far aft as possible minimizes fuel consumption and improves aircraft performance. To facilitate this objective, it is desirable that cargo be loaded such that the zero fuel weight CG of the aircraft falls within the DESIRABLE CG ENVELOPE FOR CARGO/DUAL ROLE MISSIONS (shaded area).

NOTE

- In the cargo configuration, zero fuel weight, CG forward of 23.8% allows transfer of all forward tank fuel to wing tanks.
- This is not a mandatory requirement; however, it is a mission objective to achieve optimum aircraft performance.

BUFFET CHARACTERISTICS IN CLEAN CONFIGURATION

After flights where moderate-to-heavy buffet has been encountered by inadvertent speed reduction, a Heavy Buffet for Clean Configuration inspection must be made (AFTO Form 781 entry).

NOTE

At the minimum air refueling speed under normal conditions, a bank angle of over 25° can result in moderate buffet.

MAXIMUM LANDING AND INFLIGHT LIMITING WEIGHTS

The maximum unrestricted landing weight (MLW) of the KC-10A is 436,000 pounds at the design R/D at touchdown of 10 feet per second (600 fpm). With anti-skid inoperative or with the center gear retracted the MLW's are 411,000 and 400,000 pounds, respectively.

Landing at weights over MLW is defined as an emergency-overweight landing and the R/D at touchdown must not exceed 6 feet per second (360 fpm). Landing at any weight at a R/D at touchdown in excess of 600 fpm is defined as a hard landing. After either an emergency-overweight or hard landing an aircraft overweight/hard landing inspection must be made (AFTO Form 781).

CAUTION

- Planned overweight landings are not recommended. Overweight landings may be accomplished when operational necessity dictates or in the case of emergency. Under these conditions, use a maximum of 35° flaps.
- During landings at weights over MLW the R/D at touchdown must not exceed 360 fpm and a flap overspeed/overweight as well as an aircraft overweight landing inspection must be performed (AFTO Form 781).
- During training approaches, flap settings greater than 25° are not permitted at inflight weights over 439,000 pounds.

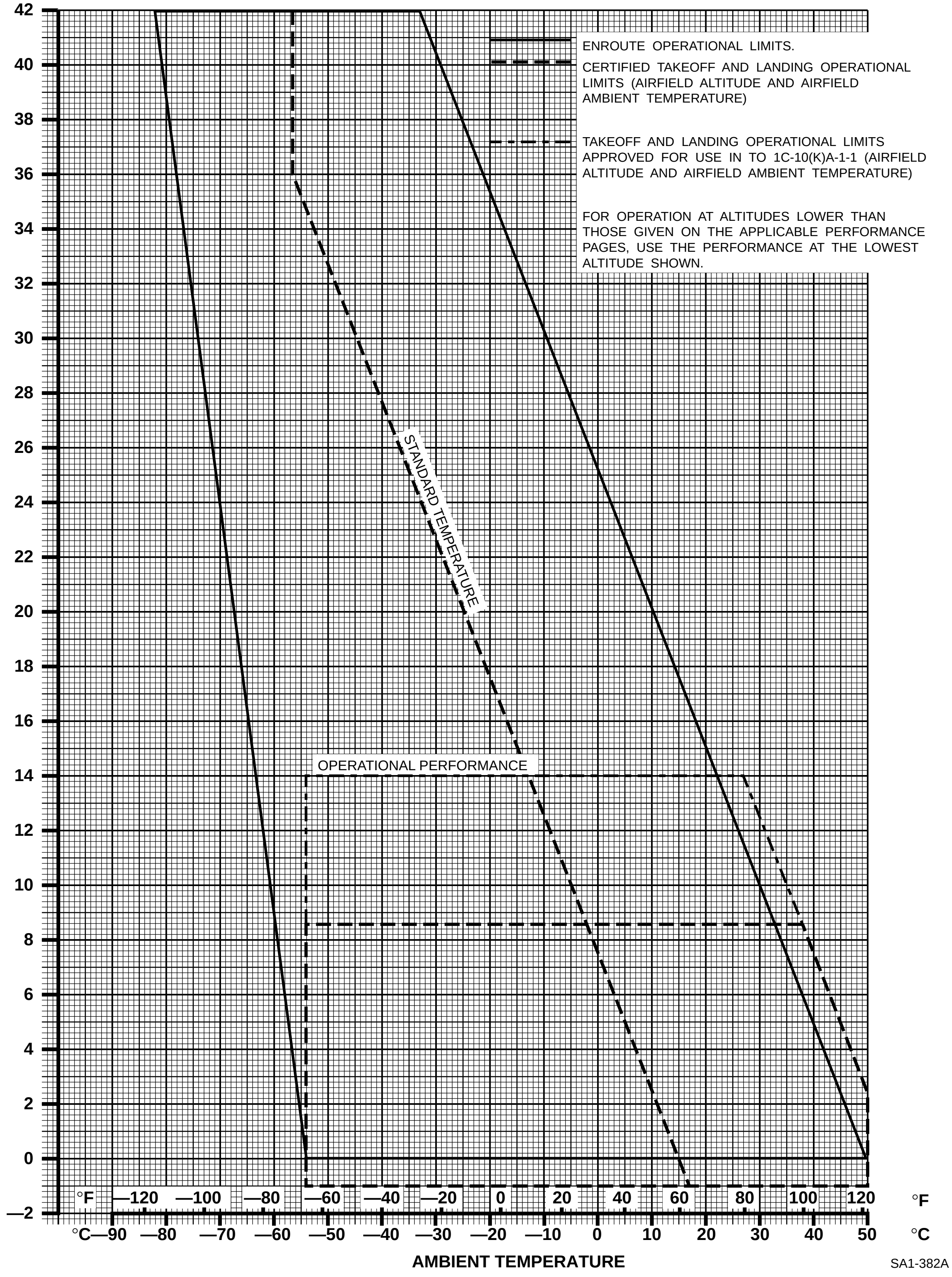
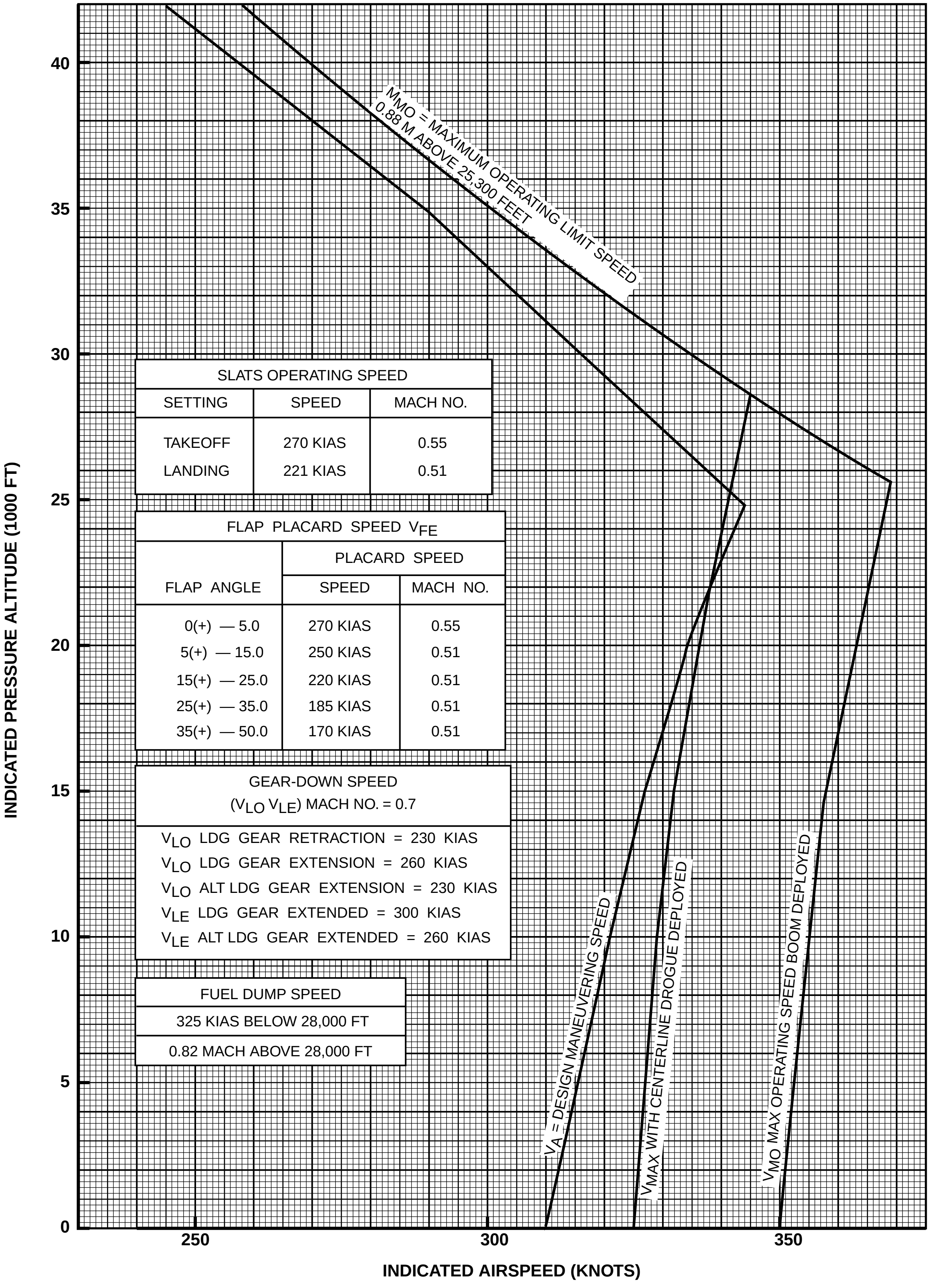


Figure 3-4. Environmental Envelope



SLATS OPERATING SPEED		
SETTING	SPEED	MACH NO.
TAKEOFF	270 KIAS	0.55
LANDING	221 KIAS	0.51

FLAP PLACARD SPEED V_{FE}		
	PLACARD SPEED	
FLAP ANGLE	SPEED	MACH NO.
0(+) — 5.0	270 KIAS	0.55
5(+) — 15.0	250 KIAS	0.51
15(+) — 25.0	220 KIAS	0.51
25(+) — 35.0	185 KIAS	0.51
35(+) — 50.0	170 KIAS	0.51

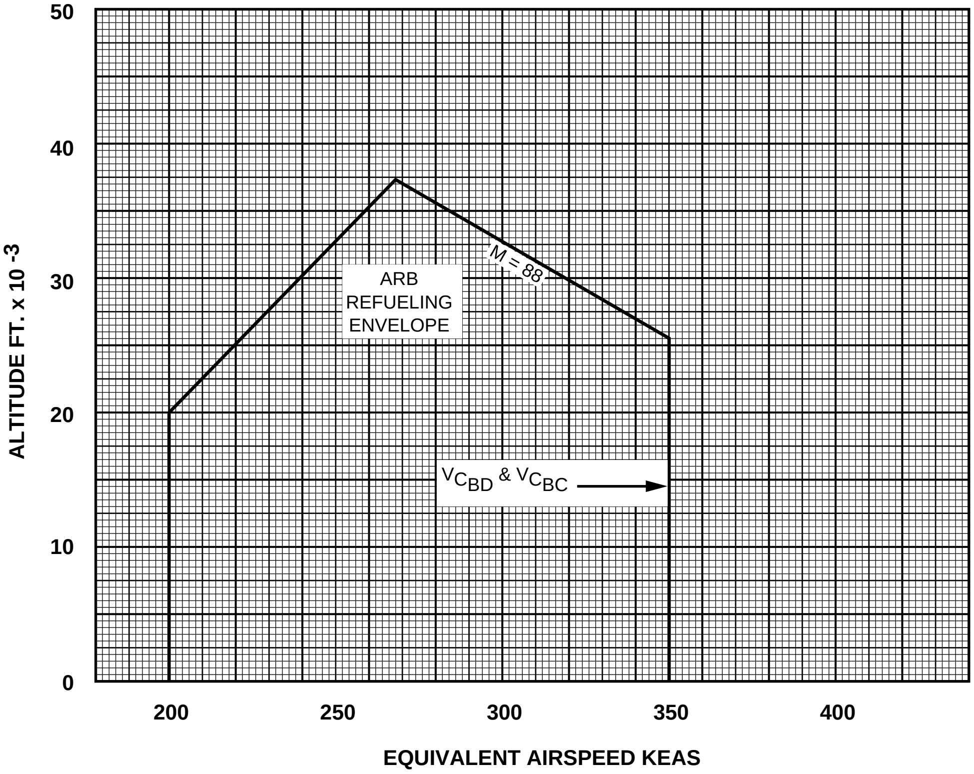
GEAR-DOWN SPEED
(V_{LO} V_{LE}) MACH NO. = 0.7

V_{LO} LDG GEAR RETRACTION = 230 KIAS
V_{LO} LDG GEAR EXTENSION = 260 KIAS
V_{LO} ALT LDG GEAR EXTENSION = 230 KIAS
V_{LE} LDG GEAR EXTENDED = 300 KIAS
V_{LE} ALT LDG GEAR EXTENDED = 260 KIAS

FUEL DUMP SPEED
325 KIAS BELOW 28,000 FT
0.82 MACH ABOVE 28,000 FT

Figure 3-5. Maximum Operating Speeds

ARB DESIGN SPEEDS PLACARD



LEVEL FLIGHT MAXIMUM SPEEDS

$V_{C_{BC}}$ BOOM COUPLED

$V_{C_{BD}}$ BOOM DEPLOYED AND UNCOUPLED

CAG(IGDS)

SA1-576

Figure 3-6. ARB Design Refueling Envelope

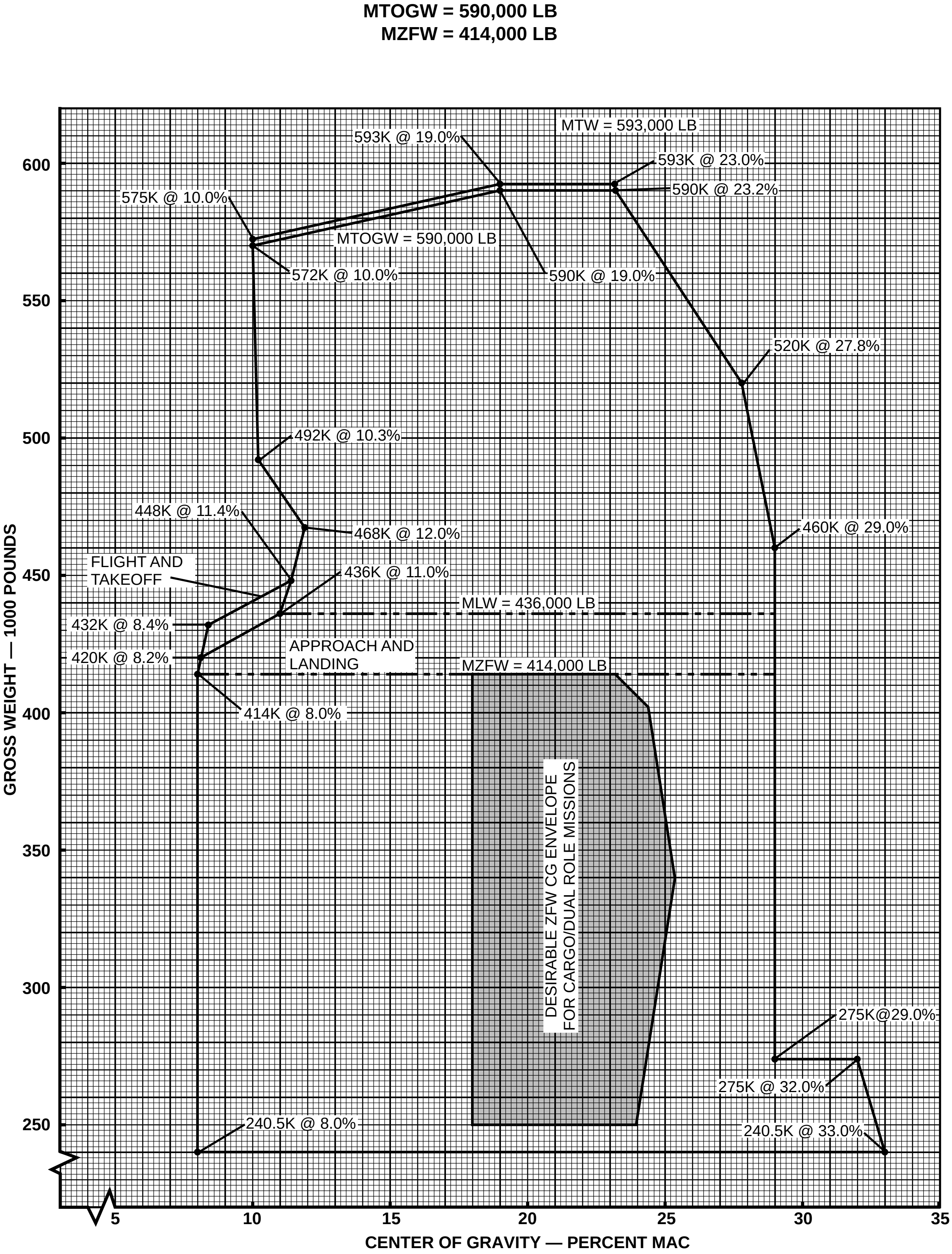


Figure 3-7. Center-of-Gravity Envelope

MAXIMUM WEIGHT – POUNDS

	RAMP/ TAXI	START OF TAKEOFF	INFLIGHT LANDING FLAPS	LANDING	ZERO FUEL
NORMAL OPERATION	593,000	590,000	439,000	436,000	414,000
ANTI-SKID INOPERATIVE	503,000	500,000	439,000	411,000	391,000
CENTER GEAR RETRACTED	463,000	460,000	439,000	400,000	380,000
NOTE: Maximum taxi and takeoff weights are applicable with 28 ply, or higher, tires installed on all main gear and center gear wheels.					

WARNING

Maximum inflight gross weight is 590,000 pounds.

NOTE

- Overweight landings could result in exceeding flap placard, tire speed, or brake energy limits. These limits should be checked whenever circumstances permit.
- An aircraft log should be maintained to record the frequency of overweight landings and include weight, altitude, temperature, indicated vertical speed at touchdown, as well as a summary of speeds and brake energy requirements.

APU

The APU starter duty cycle should not exceed 1 minute on, followed by 5 minutes off for cooling. A maximum of four start attempts within a 20 minute period must be followed by a cooling period of no less than 1 hour.

APU START ENVELOPE

Normal control mode – Unrestricted up to 25,000 feet.

Standby control mode – Acceptable starting up to 10,000 feet.

APU OPERATING CONDITIONS
(Starting, Ground, In-flight)

Time Limit	Continuous
Maximum EGT	585° C
Maximum Rotor Speeds N_1 N_2	 110% 110%

APU INFLIGHT OPERATING ENVELOPE

(figure 3-8)

STBY mode is a conditional mode recommended only in case of a NORM mode failure.

The APU is not to be used for WING ANTI-ICE. The APU will not provide a sufficient pneumatic air temperature or volume to effectively prevent ice build-up on the wings. The APU will not be used during any aerial refueling operation or with a known fuel leak in the boom pivot area.

CARGO SYSTEM LIMITATIONS

CARGO DOOR

The cargo door, in the mid and full open position, can withstand wind up to 52 knots in any direction.

MODEL: KC-10A
DATE: FEBRUARY 1981
DATA BASIS: ESTIMATED

1. NORMAL CONTROL MODE
   - ● APU MAY SHUT DOWN IF ELECTRICAL GENERATOR LOAD IS ABOVE 67 PERCENT
   - ● PNEUMATICS NOT RECOMMENDED ABOVE 18,000 FEET

2. STANDBY CONTROL MODE
   - ● ELECTRICAL GENERATOR LOAD NOT RECOMMENDED
   - ● PNEUMATICS NOT RECOMMENDED ABOVE 18,000 FEET

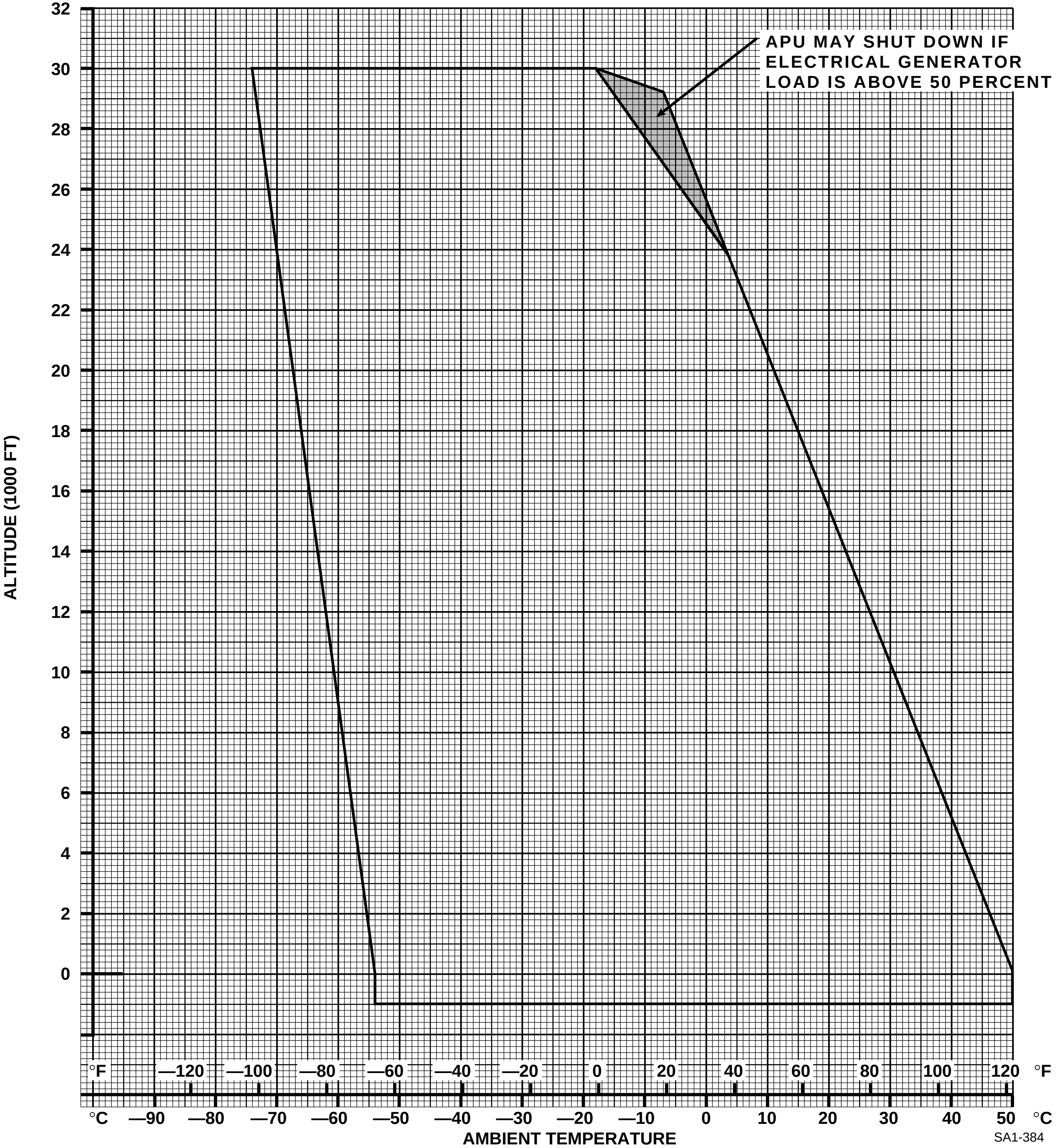


Figure 3-8. APU Inflight Operating Envelope

WARNING

Install cargo door barrier net if door is to remain open without an exterior platform adjacent to entrance and an observer is not supervising the door area. Do not lean on or against barrier net.

CAUTION

Do not operate cargo door if wind velocity exceeds 40 knots from any direction. Structural damage could occur.

INCREASED ACCOMMODATION UNIT INSTALLED

1. Verify electrical hook-up of oxygen for additional support personnel/passengers.
2. Cabin crewmembers must be provided with demand crew oxygen masks adaptable to the demand regulators on the portable oxygen units.

CARGO LOADING LIMITATIONS

Do not exceed the following during cargo loading:

1. Maximum allowable gross weight.
2. Compartment load limitations.
3. Ground center of gravity limitations.
4. Zone load limitations.

CAUTION

When computing weight and balance for heavyweight departures, consider zone loading factors when placing cargo in the aircraft. When approaching maximum aft body fuel tank capacity, even lightweight cargo can exceed zone loading limitations

Details for loading of cargo are contained in TO 1C-10(K)A-9, Cargo Loading Manual.

AIR REFUELING LIMITATIONS

AIR REFUELING BOOM

Do not exceed the boom structural limits (figure 3-5). The roll limits are 5° L & R when the boom is above 0° elevation, 18° L & R when the boom is between 0° and 18° elevation, 27° L & R when boom elevation is between 18° and 40°, and 24° L & R when boom is below 40°. The elevation structural limit is 42°. Movement of the boom beyond these limits may cause structural damage.

To ensure pressurization is maintained move HYD SEL to BOOM for approximately 2 minutes (number 2 hydraulic system pressurized) prior to takeoff and each eight hours thereafter. Computer check during preflight and system usage during boom air refueling will satisfy pressurization requirements provided the 8-hour limits are not exceeded.

CAUTION

- Boom flight control surface flutter may occur after failure of number 2 hydraulic system if the flight control actuator reservoirs are not pressurized.
- If an aircraft overspeed occurs, initiate a disconnect immediately (if applicable) and stow the boom.

AIRSPEED

The aerial refueling operation airspeed/altitude envelope for boom refueling shall be as follows:

Minimum: 180 KIAS from sea level to 20,000 ft MSL and then linear to 0.88 MACH to 37,000 ft MSL.

CAUTION

- Although the boom may be operated at speeds as low as 180 KIAS from sea level to 20,000 feet MSL, at speeds below 200 KIAS the boom's response to control inputs is slightly reduced.
- The slower response is more noticeable during rapid up commands when boom is above 30° elevation. Boom damping is also degraded and overshoots of 2 to 3° will occur during rapid/evasive maneuver commands.

Maximum: 350 KIAS or 0.88 MACH whichever is lower, up to a maximum altitude of 37,000 ft MSL.

The aerial refueling operation airspeed/altitude envelope for centerline hose/drogue refueling shall be as follows:

Minimum: 200 KIAS from sea level to 20,000 ft MSL and then linear to 0.88 MACH to 37,000 ft MSL.

Maximum: 280 KIAS or 0.88 MACH whichever is lower, up to a maximum altitude of 35,000 ft MSL.

CENTERLINE AND WING POD HOSE AND DROGUE

Report all significant events during hose drogue refueling. A significant event is defined as: (1) an observable hose whip/sine wave or "dead hose" after contact; (2) a refueling contact or attempt to contact that results in damage to the tanker or receiver aircraft or drogue basket.

WARNING

Air Refueling will be discontinued after a significant event unless there is an emergency. Hose stability/reliability is unknown after a significant event, and the hose could fail any time during refueling operations.

WING PODS HOSE/DROGUE EXTENSION/ RETRACTION ENVELOPE (WITH TCTO 1C-10(K)A-956)

The hose may be extended at speeds above 230 KIAS and may be retracted at a maximum of 280 KIAS.

WING PODS HOSE/DROGUE REFUELING ENVELOPE (WITH TCTO 1C-10(K)A-956)

Minimum: 230 KIAS from sea level to 33,000 ft MSL and then linear to 0.74 MACH at 35,000 ft (figure 3-9).

Maximum: 300 KIAS up to a maximum altitude of 35,000 ft (figure 3-9).

CAUTION

- Do not deploy the WARP hose/drogue from the stowed position or fully retract the WARP hose/drogue with flaps/slats extended. Doing so may cause damage to the lower wing surface.
- The centerline drogue will not be used in conjunction with either WARP drogue.

NOTE

Maximum speed with hose/drogue extended is 350 KIAS.

WING PODS HOSE/DROGUE ENVIRONMENTAL LIMITATIONS (WITH TCTO 1C-10(K)A-956)

Icing

The use of the Mk 32B-752 pod in icing conditions should be avoided except in cases of fuel emergency. If icing conditions are encountered and the receiver confirms or reports ice on any portion of the hose/drogue or pod assembly, recover hose as soon as conditions allow. In this case, air refueling should be terminated except when continuance is dictated by operational necessity. The hose should not be trailed again for a period of 5 minutes after being rewound.

Hose Trailed Temperature Limits

If the Static Air Temperature (SAT) at altitude is between -47 and -58°C, then the hose must not remain trailed for longer than 15 minutes prior to fuel transfer. On completion of fuel transfer, the hose must be wound in unless a further fuel transfer is about to commence. If the SAT is less than -58°C, then the hose must not be trailed except in cases of fuel emergency.

WING POD LIGHTNING PROTECTION (WITH TCTO 1C-10(K)A-956)

WARNING

The wing air refueling pod fuel system, including the hose, must be kept full of fuel to decrease the risk of lightning strike damage and for proper fuel pump lubrication.

MANDATORY AFTO FORM 781 WRITEUPS (A/R SYSTEMS)

1. Brute force disconnects.
2. Exceeded boom structural limits.
3. Drogue jettisoned.
4. Boom retracted against the stops using emergency retract.
5. Boom will not trim to 0° roll and/or 30° elevation.
6. Manifold scavenge system inoperative (TNK/RCVR).
7. Sustained slat oscillation.
8. Significant events encountered on centerline drogue or wing pod systems.

AIR REFUELING RECEPTACLE

The Universal Air Refueling Receptacle Slipway Installation (UARRSI) hydraulic shutoff valve must remain closed for all flight operations except when required for refueling operations.

REVERSE REFUELING

Although reverse refueling is not a normal operation, it is available during air refueling operations to return fuel to the tanker, as required for operational necessity.

The maximum allowable reverse refueling rate from receiver to tanker is 300 GPM (approximately 2,000 PPM). Only one (1) AR pump is required to obtain limiting flow rate. Selecting more than one AR pump will produce higher flow rates and may produce unacceptable surge pressures if a tension disconnect should occur.

AIR REFUELING PUMPS

With one engine inoperative or with fluid loss from one hydraulic system:

1. Refueling operations shall not be conducted in weather conditions exceeding light turbulence.
2. Air refueling pumps and pump combinations other than those shown shall not be operated.

ENGINE NO. 1 OUT or HYD SYS NO. 1 FLUID LOSS	ENGINE NO. 2 OUT or HYD SYS NO. 2 FLUID LOSS	ENGINE NO. 3 OUT or HYD SYS NO. 3 FLUID LOSS
Hyd Sys No. 2 Pump: Aft Tank R AR Pump AND One Hyd Sys No. 3 Pump: Fwd Tank R AR Pump Ctr Wing Tank R AR Pump OR Aft Tank L AR Pump	One Hyd Sys No. 1 Pump: Fwd Tank L AR Pump OR Ctr Wing Tank L AR Pump AND One Hyd Sys No. 3 Pump: Fwd Tank R AR Pump Ctr Wing Tank R AR Pump OR Aft Tank L AR Pump	Hyd Sys No. 2 Pump: Aft Tank R AR Pump ON AND One Hyd Sys No. 1 Pump: Fwd Tank L AR Pump OR Ctr Wing Tank L AR Pump

FUEL

Aviation Gasoline Limitations. The use of aviation gasoline in the following grades is permitted for emergency use only, provided that the fuel conforms to ASTM Specifications for the following grades; 80/87, 100/130, and 115/145. The use of aviation gasoline is restricted to periods not exceeding 3 flight-hours at a time, from sea level to 20,000 feet, at 24° C maximum fuel tank temperature. Tank temperatures of aviation gasoline in excess of 24° C can cause engine fuel pump cavitation resulting in possible engine malfunction. Aircraft fuel boost pump must be used at all times when operating on aviation gasoline.

Total cumulative operation on aviation gasoline must not exceed 10 hours between hot section inspections. It is necessary to maintain a record in the Aircraft Flight Log and the Engine Records of all operations using aviation gasoline.

FUEL LOADING

Fuel density must be within the range of 6.0 to 7.1 lbs/gal. When below 6.5 lbs/gal, refer to figure 3-10 for maximum takeoff gross weight limits.

Fuel may be loaded into the tanks in any sequence except:

1. When gross weight after refueling will exceed 556,000 pounds or the sum of zero fuel weight and fuel to be loaded in body tanks will exceed 414,000 pounds, MAIN tanks 1, 2 and 3 must be filled prior to reaching 556,000 pounds.
2. The aircraft CG envelope must not be exceeded during fuel loading.

Maximum lateral fuel unbalance at completion of fueling must not exceed 4,000 pounds. The allowable fuel unbalance is reduced 100 pounds for every 10,000 pounds of main deck cargo.

At completion of fueling, the fuel quantity in the No. 2 MAIN tank must not be less than that in No. 1 or No. 3 MAIN tank.

FUEL GRADE AND LIMITS

The recommended fuel is JP-8 (Specification MIL-T-83133) and its NATO equivalent F34 (figure 3-11). If fuel is required at a field where the recommended fuel is not available, certain other fuels may be used as alternates, until a source of recommended fuel is reached.

FUEL MANAGEMENT

CAUTION

- If manifold scavenge valve circuit breaker trips, do not reset until maintenance personnel can ensure solenoid housing is intact and that the solenoid coil is not shorted to the solenoid case.
- Do not reset any tripped fuel pump circuit breakers.

A minimum of one aft pump of No. 2 MAIN tank must be ON for engine number 2 operation:

When using JET B or JP-4 fuels at temperatures above 40° C, (104° F), two aft tank pumps in main tank number 2 must be on for engine number 2. The aft tank pump in tanks 1 and 3 must be on for wing engines.

Fuel may be used from tanks in any sequence except:

1. If gross weight exceeds 556,000 pounds or the sum of zero fuel weight and weight of fuel in body tanks exceeds 414,000 pounds, the MAIN tanks 1, 2 and 3 must be maintained full.
2. Maximum allowable lateral unbalance is 4,000 pounds. The allowable fuel unbalance is reduced 100 pounds for every 10,000 pounds of main deck cargo.

WARNING

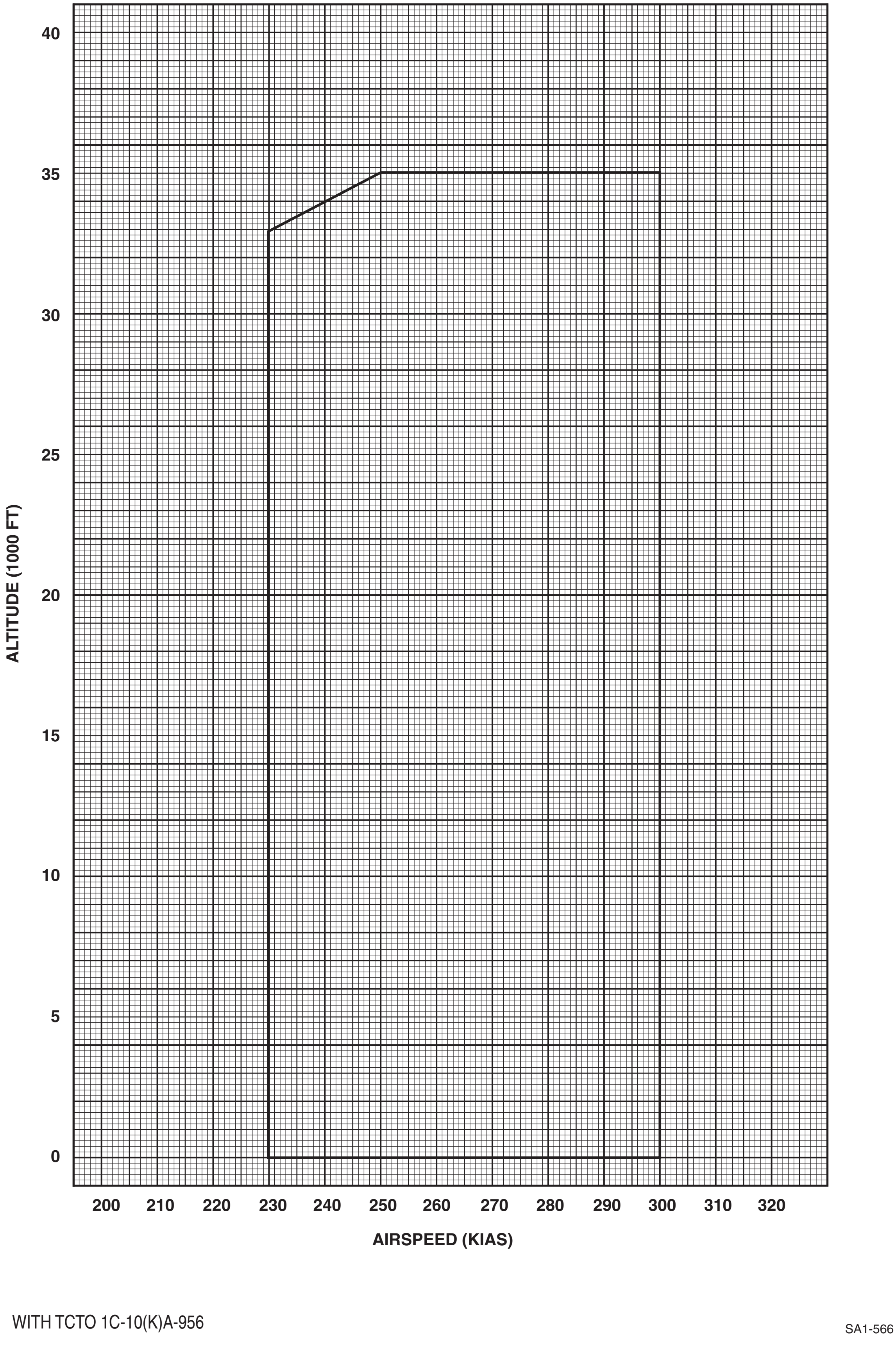
Maximum lateral fuel unbalance is 4,000 pounds for gross weights less than 556,000 pounds and 2,000 pounds for gross weights of 556,000 pounds or more.

CAUTION

When aircraft gross weight exceeds 556,000 pounds or the sum of the zero fuel weight and fuel in the body tanks exceeds 414,000 pounds, the main tanks must be maintained full for structural reasons.

3. Fuel quantity in MAIN tank No. 2 should not be less than that in MAIN tank No. 1 or No. 3.
4. The center wing lower compartment should be emptied as soon as possible.
5. CG location must be maintained within limits.
6. When CG location requires balance fuel in the FWD FUSELAGE tank, maintain the required amount of balance fuel in the FWD FUSELAGE tank until 1 or 3 MAIN tank fuel is 5,000 pounds or less.
7. Figure 3-12 describes the fuselage tank loading conditions under which a 0.4-Hz yaw aircraft oscillation could occur. This oscillation is caused by fuel slosh in the forward fuselage tank and usually occurs at speeds above Mach 0.85, the oscillation is not detrimental to KC-10A safety. If yaw oscillation is encountered, the recommended procedure is to transfer fuel out of the forward fuselage tank, preferably to the aft fuselage tank, until oscillation is reduced to an acceptable amplitude or is eliminated.

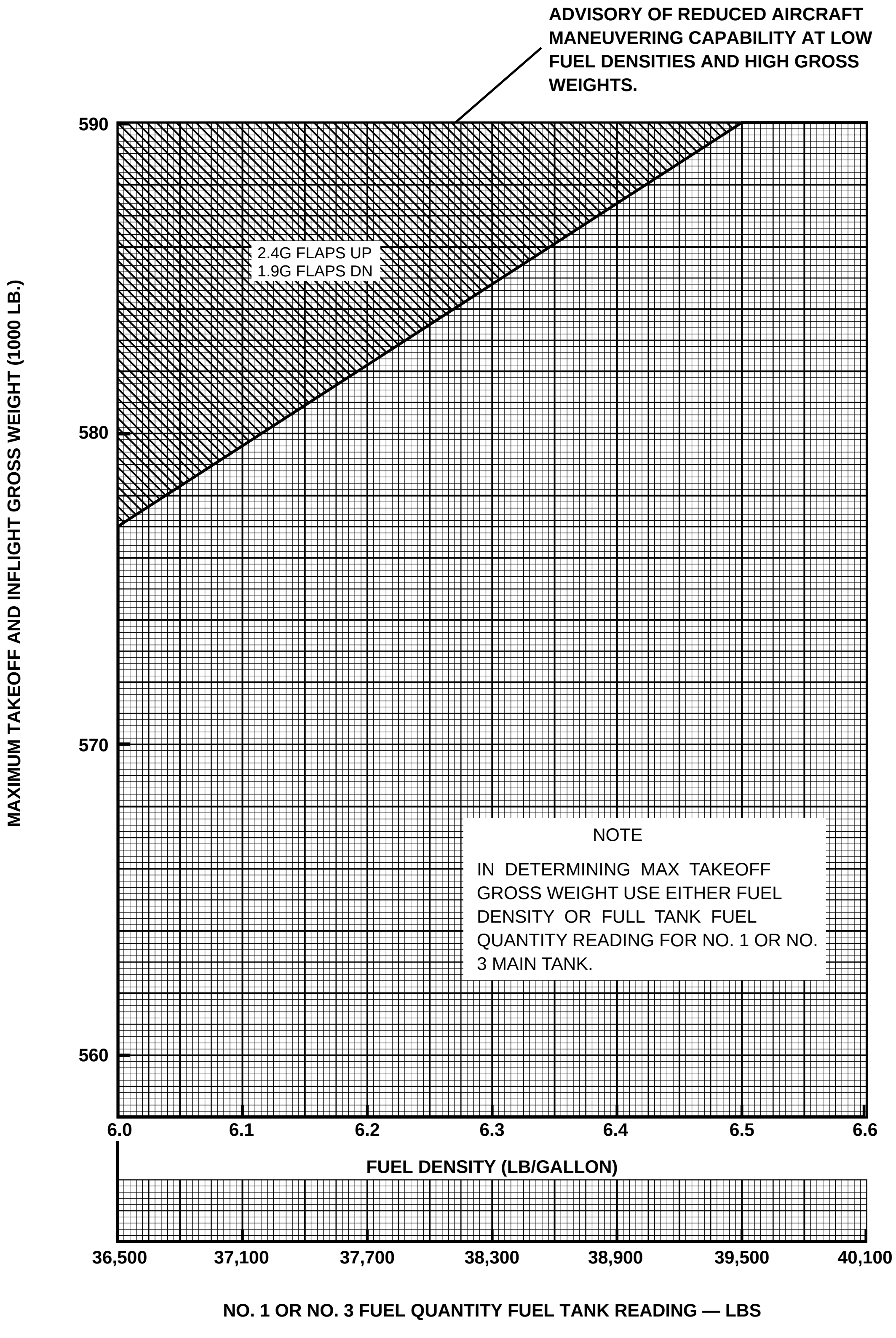
With a normal operative quantity indicator system, fuel remaining in fuel tanks when the quantity indicator reaches ZERO must be considered unusable fuel.



CAG(IGDS) WITH TCTO 1C-10(K)A-956

SA1-566

Figure 3-9. Wing Pod Hose/Drogue Refueling Envelope Clean Wing (Up/Ret)



NOTE

IN DETERMINING MAX TAKEOFF GROSS WEIGHT USE EITHER FUEL DENSITY OR FULL TANK FUEL QUANTITY READING FOR NO. 1 OR NO. 3 MAIN TANK.

SA1-386B

Figure 3-10. Maximum Takeoff and Inflight Gross Weight for Fuel Density Below 6.5 lb/gal

FUEL			NATO CODE	FLIP CODE	U.S. MILITARY SPEC	U.K. SPEC	SPECIFIC GRAVITY (MAX-MIN AT 60°F)	FREEZE POINT °C (°F)	FUEL DENSITY P/LB	LIMITS
USE	GRADE	TYPE								
RECOM-MENDED FUEL	JP-8	KEROSENE	F-34	J8	MIL-T-83133	DERD 2453	0.840 - 0.775	-47 (-53)	6.7	②⑥
ALTER-NATE FUELS	JP-4	(WIDE CUT) GASOLINE TYPE	F-40	J4	MIL-T-5624	DERD 2454	0.802 - 0.751	-58 (-72)	6.4	⑤⑥
	JP-5 (HIGH FLASH)	KEROSENE	F-44	J5	MIL-T-5624	DERD 2498	0.845 - 0.788	-46 (-51)	6.8	② ⑥
	JP-5B		F-42		MIL-T-5624	DERD 2488	0.845 - 0.788	-40 (-40)	6.8	②⑥
	JET A COMMER-CIAL		F-30	A	NONE	DERD 2482 ASTM D1655-59T	0.840 - 0.775	-40 (-40)	6.8	②③⑥
	JET A-1 COMMER-CIAL		F-34	A1	NONE	DERD 2494 ASTM D1655-59T	0.840 - 0.775	-50 (-58)	6.7	②③⑥
	JET B COMMER-CIAL	(WIDE CUT) GASOLINE TYPE	F-45	B	NONE	ASTM D1655-59T	0.802 - 0.751	-50 (-58)	6.4	②③⑤⑥
	RUSSIAN TS-1	KEROSENE		N/A			0.845 - 0.788	-60 (-76)	6.6	②③
EMER-GENCY FUELS	JP-7 (LOW VO-LATILITY)	KEROSENE	NONE	J7	MIL-T-38219		0.806 - 0.779	-44 (-46)	6.6	②
	80/87	AVIATION GASOLINE (AVGAS)	F-12		MIL-G-5572		0.706	-60 (-76)	6.0	①
	100/130		F-18		MIL-G-5572		0.702	60 (-76)	6.0	①
	108/135		F-18		MIL-G-5572		0.0707	-60 (-76)	6.0	①
	115/145		F-22		MIL-G-5572		0.706	-60 (-76)	6.0	①

① Follow limitations in Section III of this manual or G.E. Specific Operating Instructions G.E.K. 28467 Section 3. Refer to TO 42B1-1-14 for additional fuel usage data.

② Avoid flying at altitudes where indicated fuel temperature is lower then 6° C above freeze point of fuel.

③ Prior to using commercial fuel, obtain freeze point from vendor or airline supplying fuel, then follow limit 2 above. Aircraft commander should exercise caution if he suspects or observes improper fuel handling procedures. If there is any indication that cleanliness is not up to standard, a fuel sample should be taken in a glass container and observed for fogginess, presence of water, or rust. Since commercial fuels may not contain icing inhibitors that retard the formation of ice at fuel temperatures below 32° F, the aircraft commander must consider the absence of icing inhibitors when flight planning. The vendor should be able to advise if an icing inhibitor is in the fuel and if it conforms to MIL-1-27686.

④ Average value limits are not controlled by specifications.

⑤ A minimum of two pumps in tank two will be ON for engine two operation when using Jet B or JP-4 fuels at temperatures above 40° C.

⑥ Fuel conforming to commercial jet fuel specification ASTM D1655-65T (Jet A, A1 & B), Military Specification MIL-T-6524H(Grades JP-4 and JP-5), or Military Specification MIL-T-83133 (JP-8), are authorized for unlimited use. Primary fuel is JP-8, with other listed fuels being acceptable alternates. The engine will operate satisfactorily with any of the foregoing fuels or any mixture thereof. Main engine control adjustments are not required when switching between any of the above fuels.

WARNING

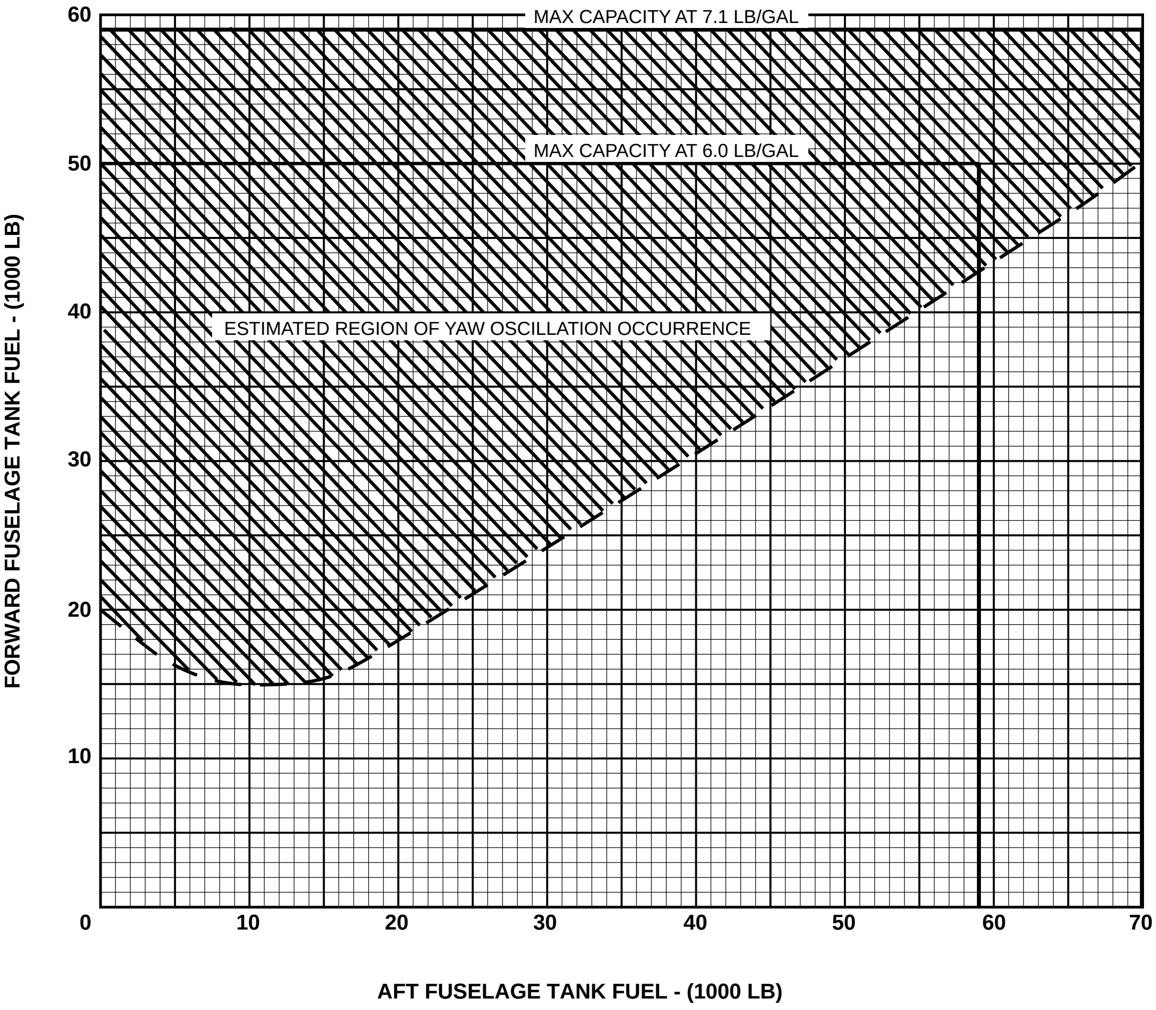
JP-7 will not be used in KC-10 engines except under emergency conditions.

NOTE

The above fuel usage/mixture allowance applies only to KC-10A for engine consumption only and does apply to off loading to other aircraft.

SA1-291D

Figure 3-11. Fuel Grade and Limits



SA1-426

Figure 3-12. Fuel Loading Conditions for Possible Yaw Oscillations

FLIGHT MANEUVERING ACCELERATION LIMITS

Flaps Up and Slats Retracted	+2.5 g to –1.0 g
Flaps/Slats Extended	+2.0 g to 0.0 g

The positive maneuvering limit load factors limit the angle of bank in turns and limit the severity of pullup maneuvers.

TAKEOFF WARNING

Slat function of the takeoff warning system must be operative for takeoff.

YAW DAMPER

Any two channels must be operating prior to the start of takeoff.

ELEVATOR LOAD FEEL

Use of elevator switch is limited to AUTO position except for an abnormal condition.

SPEEDBRAKES

Used only in the fully retracted flap configuration, with or without slats extended.

REVERSE THRUST

WARNING

> Movement and use of reverse thrust are prohibited in flight.

Reverse thrust will not be used to back up the aircraft.

GROUND SPOILERS

Do not extend during flight.

FLIGHT GUIDANCE

AUTOPILOT GENERAL

The autopilot must be disengaged when operating on emergency power.

If an automatic pilot is deactivated for flight by removing computers, both the pitch and roll computers on side 1 or 2 must be removed. The yaw computer associated with the removed computers can remain installed. The following items are inoperative on the side from which the pitch and roll computers are removed:

1. The autopilot/flight director.
2. The VOR/ILS receiver self test.
3. Radio altimeter self test.
4. The altitude advisory.

If the yaw computer associated with the removed computer is removed, the following items are inoperative in addition to those listed above:

1. Rate-of-turn on the associated ADI.
2. Yaw damper from the removed computer.

The autopilot must be disengaged and the autopilot pitch trim (APT) disabled when an AP OUT OF TRIM light is illuminated continuously in excess of 3 seconds after the aircraft is stabilized and tracking the glideslope. Prior to re-engagement of the autopilot without APT, the aircraft must be manually trimmed and tracking the glideslope at the final approach speed.

AUTOPILOT ILS COUPLED APPROACHES

Do not automatically capture glideslope above 250 knots. Excessively high airspeeds can cause pitch instability.

Autopilot Go-Around Mode

Do not use autopilot go-around with an engine failure. Do not use autopilot go-around during touch and go landings.

FLIGHT DIRECTORS

Pilots should be aware that when executing takeoffs with derated thrust settings and using speeds limited by V_{MCG} for maximum thrust, the flight director may command incorrect airspeed/pitch attitude if an engine failure occurs and the remaining engines thrust is increased. The flight director may also command incorrect airspeed/pitch attitude when V_2 speed has been corrected for aircraft center of gravity.

FLIGHT MANAGEMENT SYSTEM

Navigation functions of the FMS-800 meet the intent of and have been certified to FAA Advisory Circular (AC) 20-130A and Technical Standard Order (TSO) C-129 for departure, enroute, terminal, and non-precision approach operations. Additionally, it includes a psuedorange step error detection feature and satellite selection feature (healthword checking) as specified in TSO C-129a. The FMS meets the performance requirements for RNP-4 in accordance with RTCA/DO-236 with no restriction on mission duration. It also meets the requirements for Basic Area Navigation (BRNAV) in accordance with FAA AC 90-96 with no restriction on mission duration when operating in SPS mode. The FMS supports GPS predictive Receiver Autonomous Integrity Monitoring (RAIM).

Each CDU in the system must be loaded with software version (VSN) number 613-9466-011 KC10. This number is displayed on the CDU Status page. The three digit suffix may be a higher number reflecting a later software version, but the version identifier must specify the KC-10 aircraft.

During periods of dead reckoning when GPS is the selected navigation solution (---/A/H), another valid navigation solution will be selected or the FMS will not be used for navigation.

The FMS does not fly all SID or STAR procedural legs. Unsupported procedural legs will be displayed as a discontinuity in the flight plan. The pilot must intervene when LEG DISCON is displayed to insure the procedure is correctly flown.

Instrument approaches flown in IMC must be accomplished in accordance with approved instrument approach procedures that are retrieved from the FMS ICAO database. The FMS database must incorporate the current update cycle.

1. Instrument approaches must be accomplished in the FMS approach mode and GPS integrity monitoring (RAIM) must be available at the final approach fix.
2. GPS tactical approaches will only be flown in VMC.

The required time of arrival (RTA) feature will not be used to comply with ATC clearances containing time instructions.

ENHANCED GROUND PROXIMITY WARNING SYSTEM

The EGPWS has the following constraints:

1. If there is no terrain data in the database for a particular area, then Terrain Awareness Alerting is not available for that area.
2. If there is no obstacle data in the database for a particular area, then Obstacle Alerting is not available for that area.
3. In the event that the accuracy of the FMS position data to the EGPWS does not meet the requirements of the Terrain Clearance Floor, Terrain Awareness Alerting, and Obstacle Alerting, those functions will automatically be inhibited and the TERR FAIL light will illuminate. This will not affect the basic GPWS functions (Modes 1-6) or Mode 7 windshear detection.

NOTE

The accuracy of the FMS navigation data provided to the EGPWS may be insufficient without GPS in the navigation solution (GPS FAIL or INU-only selected). Estimated time for the accuracy to degrade and turn on the TERR FAIL light is 15-30 minutes, but could be longer based on INU drift rate. The EGPWS computer uses the pilot's navigation solution as primary and the copilot's solution as backup if the pilot's is unavailable.

4. If the Terrain Awareness Alerting and Terrain Clearance Floor features of the EGPWS have been inhibited (TERR OVRD ON), the EGPWS will revert to basic GPWS protection (Modes 1-6). In this configuration, the system may give little or no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. If the aircraft is flown toward obstructing terrain, the GPWS will give no warnings if all of the following conditions apply:
   a. The aircraft is in landing configuration.
   b. The aircraft is in a stabilized descent at a normal approach descent rate.

c. There is no ILS glideslope signal being received by the EGPWS (i.e., there is no ILS available or the glideslope receiver being used by the EGPWS computer is not turned to the appropriate ILS frequency).

NOTE

For the above conditions, the only alerts available are the Mode 6 advisory callouts and Mode 7 windshear alerts.

5. Terrain clearances or descent rates during radar vectoring that are not compatible with those required by the minimum regulatory standards for ground proximity warning equipment may cause nuisance warnings or alerts.
6. The EGPWS windshear caution/warning uses onboard measurements of air mass parameters and aircraft acceleration for the detection of windshear. This is a reactive system and cannot predict windshear, which may be ahead of the aircraft.
7. In order to avoid nuisance alerts, the Terrain Awareness Alerting and Terrain Clearance Floor features must be inhibited by selecting the TERR OVRD switch to ON when within 15 NM of an airport not contained in the EGPWS airport database. Refer to AlliedSignal document 060-4267-000 for airports contained in the database.

AUTOTHROTTLES

CAUTION

Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

Ensure autothrottles are disconnected after touchdown during touch and go landings.

EVACUATION SLIDES

Each door arming handle for the emergency evacuation system must be in the SLIDE ARMED position prior to removing the airstairs/ramp, and remain in position until arrival at the unloading ramp and stand or ramp is in position. After the door is SLIDE ARMED it must be verified that the girt bar is locked in place.

A minimum of two operable slide rafts are required for all KC-10 missions. Exception: With only one operable raft, a one time flight may be made to a repair facility provided this flight is not an extended over water flight. The operable raft must be installed in a forward door and total flight/ground crew will be 12 or less. Extended over water is defined as flight further than gliding distance to land, with an all engine flameout. Refer to M.E.L. for additional guidance.

WARNING

If only one slide raft is operable, the cockpit door should be latched open during takeoffs and landings, since cockpit windows may become the primary exits resulting from a subsequent slide/raft failure.

SECTION IV

NORMAL PROCEDURES

TABLE OF CONTENTS

SECTION IV

NORMAL PROCEDURES

FLIGHT CREW PREFLIGHT AND PREPARATION FOR FLIGHT

SCOPE

In general, the purpose of this section is to establish a proper sequence of events and to set forth those procedures which must be performed in a prescribed manner during a complete flight under normal conditions. The sequence begins when the flight crew arrives at the aircraft and does not end until the aircraft is left parked on the ramp. This provides a comprehensive picture of the requirements of a typical mission.

NOTE

> This section contains Pilot's, FE's and BO's amplified guides and checklists. The guides provide the detailed information to complete all phases of normal procedures. Checklists usually follow the procedure guides to verify completed actions. Only those items deemed critical in nature will be on checklists.

The FE, BO and Pilot's Interior Inspection is accomplished by a scan pattern. For safety reasons, the associated checklists confirm that essential items have been properly completed.

To show which crewmember is normally responsible for each step, code letters appear after the response as follows: (P) Pilot, (CP) Copilot, (PF) Pilot Flying, (PNF) Pilot Not Flying, (FE) Flight Engineer, and (BO) Boom Operator. The designations P and CP are used to show responsibilities are assigned to the pilot seated on the respective side. The designations PF and PNF are used to show responsibilities are assigned to the pilot flying and pilot not flying without regard to which pilot seat the PF and PNF occupy. When more than one code letter appears after the response, coordination is required between those crewmembers to accomplish that step. When a checklist item is followed by a crew position designation, (P), (CP), (FE), etc., that crewmember takes the action, and if the action is in quotes, he reports that action. The Flight Engineer will read all checklists. The Boom Operator's checklist is separate. Those items that have been accomplished by other crewmembers and confirmed by the crew member reading the checklist need not be read aloud. The terms As Required and As Desired as used in the checklist indicate equipment operation or settings which may vary according to prevailing conditions. In practice, the response to these items will be the required switch or control position.

Dagger (†) items will be accomplished by a qualified cargo loading Boom Operator when assigned to perform aircraft loading, passenger handling and offloading duties.

If a checklist is interrupted by maintenance or circumstances require action from another checklist, all appropriate checklists will be reviewed and the applicable items accomplished.

To prevent undue complications, the Boom Operator's normal procedures follow the Pilots' and Flight Engineer's procedures within this section. The Boom Operator's amplified checklists are also presented by phase of flight. A separate abbreviated checklist is provided for the Pilots and Flight Engineer, and for the Boom Operator.

Thru-flight operations may be used during intermediate stops, when crew rest is not involved, and no crew change occurs. Exception, thru-flight operations may be used during on-aircraft crew changes. For thru-flight operations, both Pilots will accomplish their INTERIOR INSPECTION scan pattern. The Flight Engineer will accomplish the EXTERIOR/INTERIOR INITIAL INSPECTION and INTERIOR INSPECTION scan pattern. Steps requiring system checkout, need not be accomplished. The Pilots and Flight Engineer must verify proper switch position and equipment configuration. If a system requires maintenance during an intermediate stop, any pre-flight steps pertaining to that system will be accomplished in its entirety. In addition, the Flight Engineer will accomplish the EXTERIOR INSPECTION. The Boom Operator will perform the appropriate asterisk items (Thru-flight items) of the Boom Operator's Pre-flight and Preparation checklist.

FLIGHT RESTRICTIONS

Aircraft limitations described in Section III take precedence over all others.

BRIEFING

All crewmembers will be thoroughly briefed on all phases of the mission. The Pilot and Crew shall review the takeoff emergency procedures just prior to engine start or takeoff. The Flight Engineer and Boom Operator will inform the Pilot of the aircraft status when arriving at the aircraft. The Pilot will inform the Flight Engineer and Boom Operator of mission weather and any changes to planned mission.

PROCEDURES

The amplified guides, checklists, and scan patterns (figures 4-1 through 4-4) described herein are mandatory and shall be performed in the prescribed manner, except when deviations are required in the interest of flying safety.

When a Boom Operator is not required as a part of the crew, the Flight Engineer will be responsible for weight and balance, cabin security, and ensuring that the boom flight controls are hydraulically pressurized for 2 minutes prior to flight. (Refer to Boom Operator's normal procedures.)

STANDBY FORCE (ALERT)

Generally, the procedures and techniques used in a standby force and launch situation are the same as those used during normal operation of the aircraft. The following procedures allow crews to accomplish scramble operations in minimum time without sacrificing safety of flight.

PROCEDURES/TECHNIQUES

The checklist procedures contained in this manual have been arranged to permit their use for normal training missions, operational missions or conditions including ground alert and subsequent launch. Integrating the crew’s normal and standby force procedures requires repeating some items. Response of “NOT APPLICABLE” or “NOT REQUIRED” may be given to those items.

AIRCRAFT ACCEPTANCE

After maintenance has declared an aircraft ready for standby force, an initial acceptance check (cocking) by the aircrew will consist of the following:

1. Flight Engineer.
   a. Exterior/Interior Initial Inspection Scan.
   b. Interior Inspection Scan.
   c. Exterior Inspection Scan.
2. Boom Operator.
   a. Cabin Inspection Checklist.
   b. ARO Station Inspection Checklist.
   c. Final Preparation Checklist.
3. Pilot’s Interior Inspection Scan.

POWER OFF COCKING PROCEDURES

Cocking is a coordinated effort. All crewmembers will remain at the aircraft until the aircraft commander determines it is complete. In those instances where the crew remains at the aircraft on cockpit alert, a constant state of readiness may be established with power maintained on the aircraft by the APU or an external power source.

Once the aircraft is cocked, complete the following procedures before leaving the aircraft:

1. Chocks/Gear Pins ...... INSTALLED (FE,BO)
2. Parking Brakes .... RELEASED (P)
3. MSU, CDU Switches (3)........ OFF (P,CP,FE)
4. Emergency Light Switch........ OFF (FE)
5. PACK Function Selectors........... MAN HOT/OFF (FE)

NOTE

Pack function selectors will be held in the MAN/HOT position until the ram air doors are closed, then set to off.

6. Cabin Outflow Valve .. MAN/CLOSED (FE)
7. Clock.................. FULL DIM (FE)
8. APU......................... OFF (FE)
9. Bat Switch .... OFF (FE)
10. VOLT/AMP/FREQ Selector ...... APU (FE)
11. Aircraft Forms .... ANNOTATED (P,FE)

NOTE

Document preflight completion time with the names and crew positions for each preflight crewmember on AFTO FORM 781A.

12. All Hatches/Windows/Doors .... CLOSED (P,CP, FE,BO)

NOTE

If air stairs or a suitable stand is not available, the ladder may be installed with door 1L closed.

13. Power Off Cocking Procedures Checklist .... "COMPLETED" (FE)

PREFLIGHT

When cocking the aircraft for alert, the crew preflight will remain valid for 48 hours from time of completion or the expiration of the maintenance TO 1C-10(K)A-6 preflight, whichever comes first.

If the aircraft must be uncocked for maintenance, the crew will perform an initial acceptance check (cocking) using normal preflight checklists and scans once maintenance declares the aircraft ready.

SCRAMBLE PROCEDURES

The following scramble procedures will be completed when responding to an alert notice. Scramble Procedures checklist will be accomplished by the Flight Engineer who will confirm the completed actions. Asterisk(*) items may be accomplished by the Crew Chief with Flight Engineer coordination. Once this procedure is complete, accomplish all normal checklist items starting with the Cockpit Preparation Checklist.

*1. Gear Pins .... REMOVED (FE)

*2. PITOT/ENG Covers ..... REMOVED (FE)

WARNING

Prior to the initial application of electrical power and after fuel servicing, ensure that the center accessory compartment has been inspected for fuel leaks.

3. CAC .... CHECKED (FE)

4. VOLT/AMP/FREQ
Selector .... BAT & L EMER AC (FE)

5. Battery Switch .... ON (FE)

6. Electric Power
(APU/EXTERNAL) .... ON (FE)

7. Cabin Outflow Valve ... AUTO/OPEN (FE)

8. PNEU/AIR CONDITIONING SYS .. ON (FE)

9. CDU Power Switches (3) .... ON (P,CP,FE)

10. MSU's .... STBY/PRESENT
POSITION/NAV/01 (P,CP,FE)

NOTE

Priority should be moving the MSU's to NAV, as it could take up to 15 minutes before taxi can be achieved.

11. Present Position/ICAO
Database .... CHECKED/SELECTED (P,CP)

12. Mode 1,2,4
Codes .... CHECKED/LOADED (P,CP)

NOTE

Codes may be loaded after take-off.

13. HYD SYS Pressure
(All) .... ESTABLISHED/OFF (FE,BO)

NOTE

Coordination between the Flight Engineer and Boom Operator is required for boom system pressurization.

14. AR MASTER PWR Switch ..... PWR (BO)

15. HYD SEL to BOOM .... 2 MIN/OFF (BO)

NOTE

Coordination between the Flight Engineer and Boom Operator is required to ensure boom system pressurization is maintained.

16. Wing Pod Control
Panel .... CHECKED (FE,BO)

17. Parking Brake .... SET (P)

*18. Wheel Chocks .... REMOVED (FE)

19. Cabin Doors .... CLOSED/ARM/
CHECKED (BO)

NOTE

If engines are started prior to closing door 1L, ensure that the ladder is removed and all cabin doors are CLOSED/ARMED prior to taxi. Taxi will not be delayed to disassemble/stow the ladder.

20. CLOCKS .... SET (P,CP,FE)

21. Standby Attitude Indicator .. CHECKED (P)

22. Scramble Procedures
Checklist .... "COMPLETED" (FE)

WARNING

- Prior to starting the wing engines, the crew will ensure that engine start will not cause a hazard to responding crewmembers.
- When responding, crewmembers must approach the entry ladder from the nose of the aircraft and avoid the engine intake danger area (20 foot radius).

UNCOCKING

When removing the aircraft from a standby force posture, the crew will complete the AFTER LANDING/PARKING and LEAVING AIRCRAFT checklist before releasing the aircraft to maintenance.

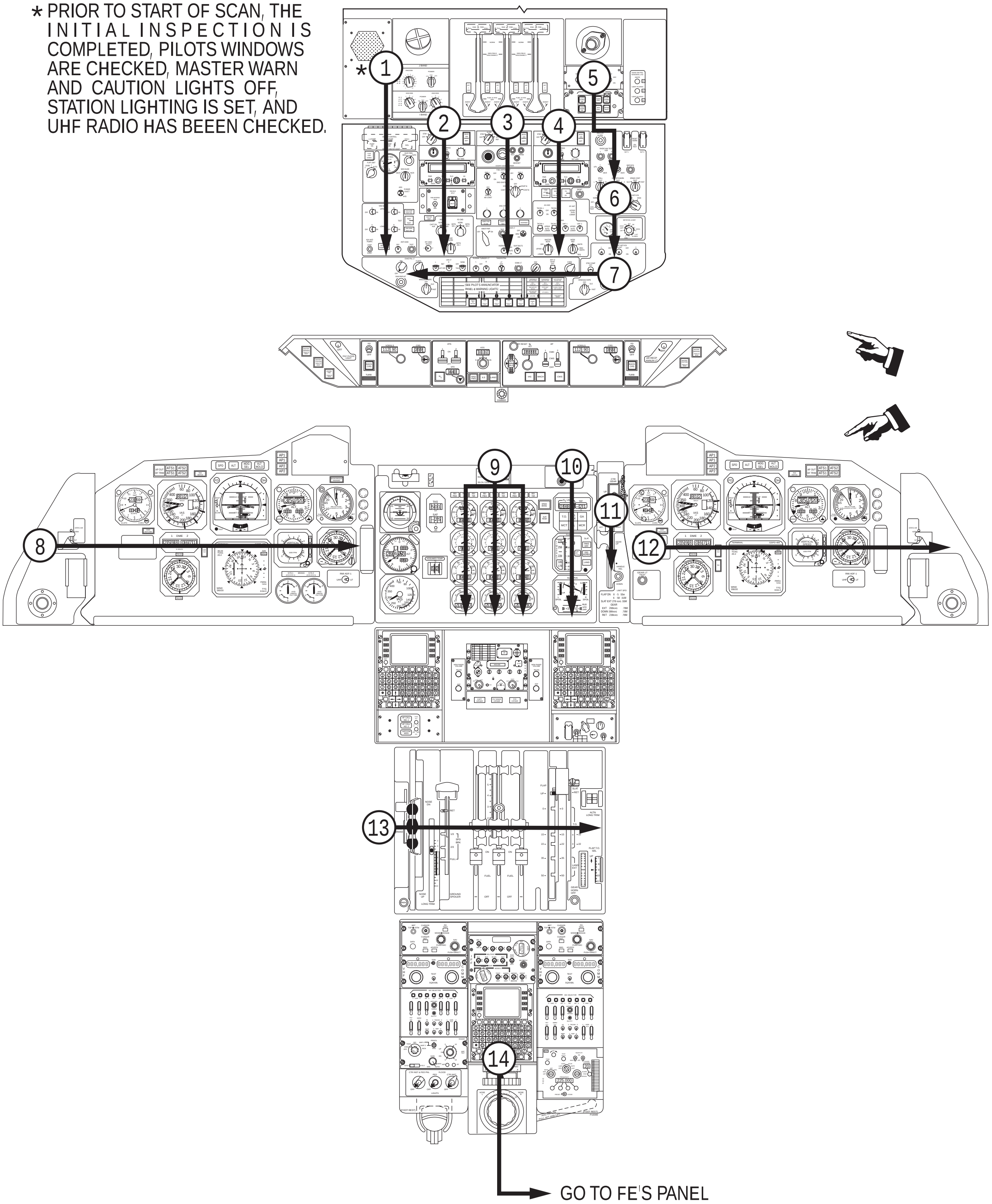


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Figure 4-1. Flight Engineer Interior Inspection Scan Pattern (Sheet 1)

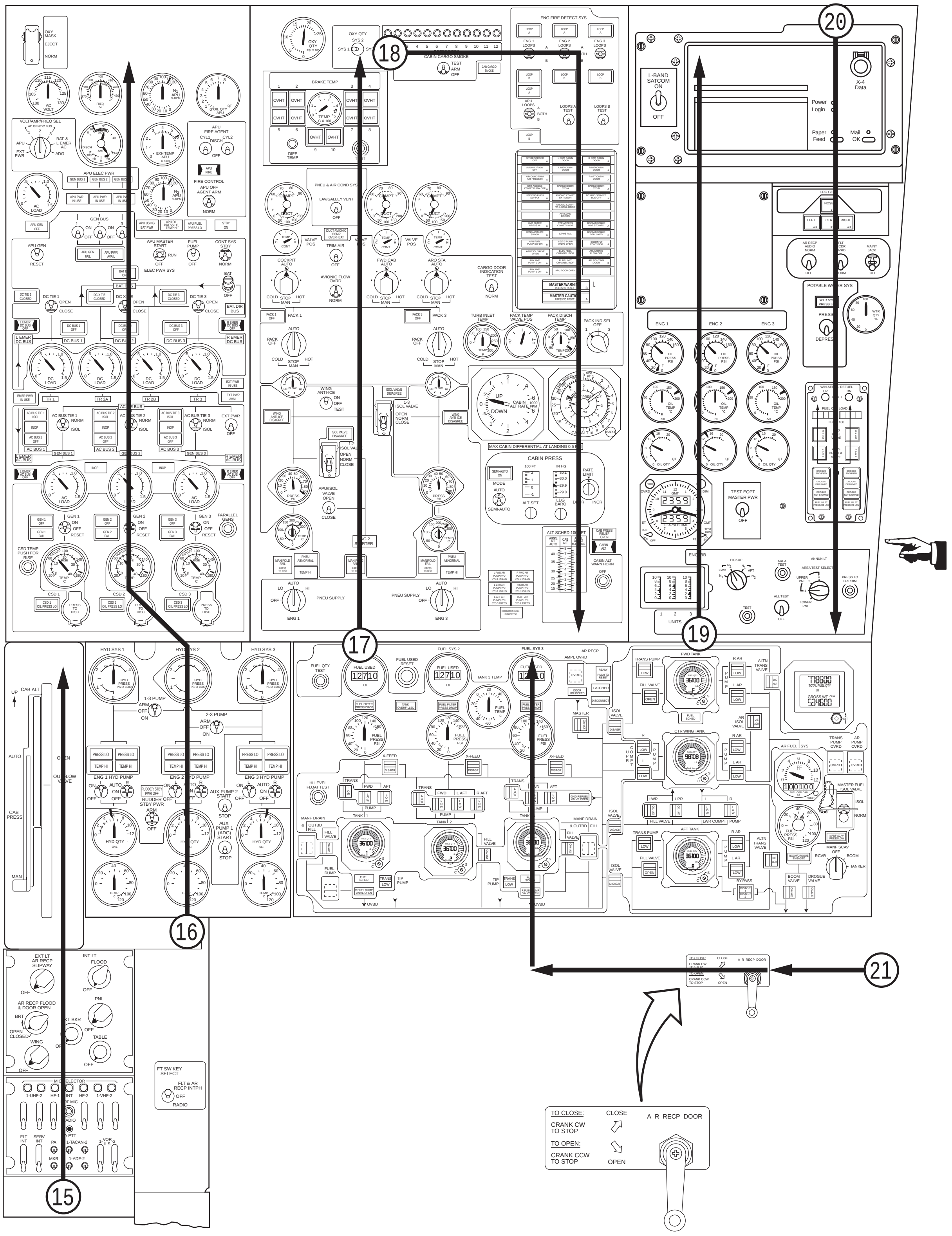

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Figure 4-1. Flight Engineer Interior Inspection Scan Pattern (Sheet 2)

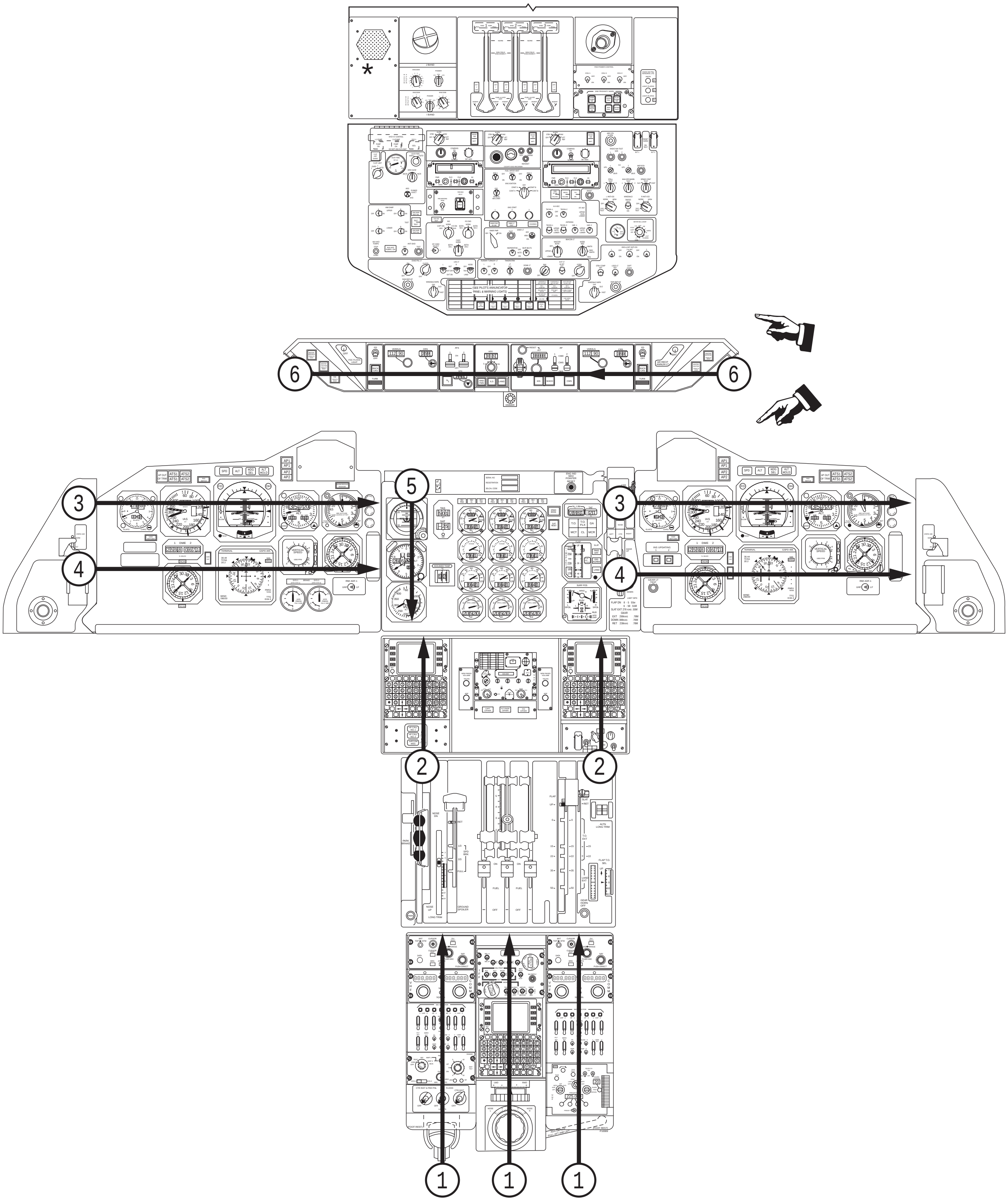

Figure 4-2. Pilot's Interior Inspection Scan Pattern

FLIGHT ENGINEER'S CHECKLIST

EXTERIOR/INTERIOR INITIAL INSPECTION

Wheel Chocks . . . . IN PLACE
Landing Gear Doors . . . . CHECK
Flight Control Surfaces . . . . CLEAR
APU Inlet/Exhaust Areas . . . . CLEAR
Boom & Drogue . . . . STOWED
Pitot & Inlet Covers . . . . REMOVED
AFTO Form 781 . . . . REVIEWED
BATTERY SWITCH/ VOLTAGE . . . . BAT/LOCK/CHECKED
FUEL DUMP Switch Cover . . . . CLOSED/SAFETIED
L-BAND SATCOM Power Switch . . . . OFF
SPOILER Handle . . . . RET/DISARMED
FLAP/SLAT Handle . . . . CHECK
Landing Gear Handle . . . . DOWN
UHF/VHF Radio(s) . . . . CHECK/SET
Cabin Air Shutoff Handle . . . . STOWED
APU & Engine Fire Detection System . . . . TEST
APU . . . . START
Electrical Power (APU/External) . . . . ON
CAB PRESS MAN/AUTO Handle . . . . . . AUTO
OUTFLOW VALVE POSITION IND . . . . OPEN
EXT/INT LIGHTS . . . . SET
FE Equipment Panel . . . . CHECK
CBs/ELEC SYS RESET Switches/FUEL QTY IND PWR Switch . . . . . . CHECK/SAFETIED/NORMAL
Hydraulic System . . . . CHECK
Manifold Fail/Supply Lockout . . . . CHECK
Pneu & Air Cond System . . . . ON (AS REQ'D)
TRIM AIR Switch . . . . TRIM AIR
FE Annunciator Lights . . . . TEST
CDU Power Switches (3) . . . . ON
MSUs . . . . STBY
READY NAV/BATT Lights . . . . TEST
FMS . . . . INITIALIZE

FLIGHT ENGINEER'S INTERIOR INSPECTION

Pilot's Windows . . . . CHECK
MASTER WARN & MASTER CAUTION Lights . . . . RESET AS REQ'D
RADAR X-PONDER Selectors . . . . AS REQ'D
HYD FLT CONTROL Lights . . . . OFF
FLAP LIMIT Selector . . . . AUTO
Elevator Feel System . . . . TEST
ADG Switch . . . . HYD
Yaw Damp System . . . . TEST
Anti-Skid System . . . . OFF/ARM/TEST
Compasses . . . . SLAVED & SYNCHRONIZED
HF Radios . . . . AS REQ'D
INS/FD CMD/CADC Selectors . . . . NORM
IFF CADC Select Switch . . . . AS DESIRED
Voice Recorder . . . . TEST
Engine Start Panel . . . . CHECK
EMER PWR Switch . . . . ON/OFF
Emergency Lights . . . . TEST
SEAT BELTS Switch . . . . AUTO
Antenna Switches . . . . SET
BEACON LT MASTER Selector . . . . OFF
Ground Proximity Warning System . . . . CHECK/TEST
ARO Station Alarm . . . . CHECK
ELT 1 & ELT 2 Switches . . NORM/GUARDED
Stall Warning System . . . . TEST
MAX SPEED WARN System . . . . TEST
Speed Control . . . . TEST
Windshield Anti-Ice . . . . AS REQ'D
WINDSHLD DEFOG Switch . . . . ON
Pitot METER SEL & HEAT Selector . . . . CHECK
ENG & ANT ANTI-ICE Switches . . . . OFF
Lights . . . . SET AS REQ'D
Pilot's Annunciator Lights . . . . TEST
Pilot's Instrument Panel . . . . CHECK
REV PRES, REV U/L, & REV THR Lights . . . . OFF
Engine Instruments . . . . CHECK

FLIGHT ENGINEER'S CHECKLIST (Continued)

FE'S INTERIOR INSPECTION (CONT'D)

SPEED BRAKE & SLAT RESET Lights	OFF
Thrust Computer & TAT	SET/CHECK
FLAP/SLAT Position Indicator	TEST
SURF POS Indicator	TEST
Gear Lights & Warning Horn	TEST
Copilot's Instrument Panel	CHECK
Copilot's Windows	CHECK
Longitudinal Trim System	TEST
Parking Brakes	RELEASE
SPOILER Handle	RET DETENT
Takeoff Warning Horn	TEST
Parking Brakes	SET
FUEL Levers	OFF/RELEASE BUTTON EXTENDED
FLAP/SLAT Handle	UP/RET
FLAP T.O. Selector	CHECK
IFF/ETCAS	STBY
WX Radar	STBY
Aileron Trim	CHECK/ZERO
Rudder Trim	CHECK/ZERO
ADG Release Handle	DOWN/SAFETIED
Passenger Address System	TEST
Audio Panel	SET
Ext/Int Lights	SET
Hydraulic System	CHECK
Electrical System	CHECK
OXY MASK Switch Guard	DOWN
Pneu & Air Cond System	CHECK

FE'S INTERIOR INSPECTION (CONT'D)

Brake Temperature System	TEST
OXY QTY Switch (1,2,3)	CHECK
Cabin Cargo Smoke Detectors	TEST
Annunciator Panel	CHECK
Pressurization	SET
Engine Vibration	TEST/AFT (IF REQ'D)
Clock	SET
Engine Instruments	CHECK
Laptop Computer Cable	CONNECTED
L-BAND SATCOM POWER Switch	ON
Laptop Computer	ON
L-BAND SATCOM Communications	ESTABLISHED
Gear Lights	CHECK
A/R RECP Audio Switch	OFF
FLT RCDR Switch	NORM
MAINT JACK Switch	OFF
POTABLE WATER System	CHECK
A/R RECP DOOR Handle	CLOSED
Fuel System	CHECK
Hydraulic Motor Pump Switches	OFF
AUX HYD Pumps	STOP
Oxygen Mask, Regulator & Interphone	CHECK
A/R RECP Shutoff Valve	CLOSED

PILOT'S CHECKLIST

PILOT'S INTERIOR INSPECTION (Cont'd)

KG/IFF Mode 4 Code . . . . INSERTED (CP)
FMS . . . . LOAD/INSERT (CP)
MASTER WARN &
  MASTER CAUTION
  Lights . . . . . RESET (AS REQ'D) (P,CP)
Station Lighting . . . . SET (P,CP)
Oxygen Mask, Regulator &
  Interphone . . . . CHECK (P,CP)
WX Radar . . . . TEST (P,CP)
UHF Comm . . . . SET (P,CP)
Audio Panels . . . . SET (P,CP)
VHF Comm . . . . CHECK (P,CP)
  IFF/ETCAS . . . . CHECK/SET (P,CP)
Present Position . . . . CHECK (P,CP)
  NAV Radios . . . . SET (P,CP)
ADF . . . . CHECK (P,CP)
TACAN . . . . TEST (P,CP)
Clocks . . . . SET (P,CP)
MACH/AS Indicator . . . . . . CHECK (P,CP)
ADIs . . . . TEST/CHECK (P,CP)
Altimeters . . . . SET (P,CP)
Radio Altimeters . . . . TEST (P,CP)
TACAN RMI, VOR & ADF RMI,
  EHSI . . . X-CHECK HDG & FLAGS (P,CP)

PILOT'S INTERIOR INSPECTION (Cont'd)

  TVSIs . . . . CHECK (P,CP)
Standby Attitude Indicator . CHECK (P)
Standby Altimeter . . . . SET (P)
Standby Airspeed Indicator . . . CHECK (P)
TAS/SAT . . . . CHECK (P)
FD Switches . . . . FD (P,CP)
VOR/ILS Control Panels . . . . . SET (P,CP)
ATS Panel . . . . SET (P)
HDG Readout/FD Roll
  Bars . . . . SET/CHECK (P)
Vertical Speed Selector/V-Command
  Bars . . . . CHECK (P,CP)
Altitude Advisory System . . CHECK (P,CP)
ALT Readout . . . . SET (P)
Autopilot Levers . . . . OFF (P)
Radio Navigation . . . . TEST (P,CP)
FMS Heading Source . . . . . CHECK (P,CP)
HF-ACS Radios . . . SET AS REQ'D (CP)
FMS . . . . LOAD FLIGHT PLAN (P,CP)
Exterior Lights . . . . AS REQ'D (CP)
Seat, Belts, Harness &
  Rudder Pedals . . . . SET (P,CP)
Parking Brake . . . . AS REQ'D (P,CP)
COMNAV-50 . . SET (If Applicable) (CP)

EMERGENCY TAXI PROCEDURES

EMERGENCY TAXI CHECKLIST

This checklist procedure permits taxi of the KC-10 in minimum time without sacrificing safety.

NOTE

> This procedure assumes that the Flight Engineer has completed the exterior safety check of the aircraft in accordance with the Exterior Initial Inspection procedures contained in this manual.

Preparation

1. Nose Gear Pins (2) . . . . "REMOVED" (FE)
2. Engine Covers (1 and 3 minimum) Ground Wires . . . . "REMOVED" (FE)
3. AFTO Form 781 . . . . "CHECKED" (FE)
4. APU . . . . "STARTED" (FE)
5. Anti-Skid . . . . ARMED (FE)
6. Exterior Lights . . . . "SET" (P,FE)
7. Preparation Checklist . . . . "COMPLETED" (FE)

Before Start

1. Beacon Light Selector . . . . BOTH (P)
2. Aux Hydraulic Pumps . . "STARTED" (FE)
3. Parking Brake . . . . "SET" (P)
4. Fuel Levers . . . . "OFF" (P)
5. Pack Selectors . . . . "OFF" (FE)
6. Engine Ignition . . . "START (A or B)" (P)
7. Pneumatic Pressure . . . . . "_____PSI" (FE)
8. Fuel Pumps . . . . "ON" (FE)
9. Cabin Door Lights . . . . . "CHECKED" (FE)
10. Before Start Checklist . . . . "COMPLETED" (FE)

Before Taxi

1. Anti-Ice . . . . "AS REQUIRED" (P)
2. Ground Equipment . . . . . . REMOVED (P,FE)
3. Before Taxi Checklist . . . . "COMPLETED" (FE)

PREFLIGHT AND COCKPIT PREPARATION

FE'S EXTERIOR/INTERIOR INITIAL INSPECTION

The Exterior/Interior Initial Inspection consists of actions necessary to verify aircraft is safe and to establish electrical, pneumatic, and hydraulic power.

1. Wheel Chocks .... IN PLACE
2. Landing Gear Doors .... CHECK

   Observe main gear door handle position agrees with main gear door position.

   WARNING

   If door position and main gear door handle position are not in agreement, do not pressurize hydraulic system 3.

3. Flight Control Surfaces .... CLEAR

   Observe position of movable surfaces and check condition.

   WARNING

   If any flight control area is not clear, do not pressurize the hydraulic systems.

4. APU Inlet/Exhaust Areas............. CLEAR

   WARNING

   If APU exhaust area is not clear, do not start the APU.

5. Boom and Drogue .... STOWED

   WARNING

   If the Boom and/or Drogue are not stowed, do not pressurize the Hydraulic and/or Fuel systems unless cleared by maintenance.

6. Pitot & Inlet Covers .... REMOVED

   If cocking or preflighting the aircraft for alert, pitot/inlet covers may remain installed until scramble operations.

7. AFTO Form 781 .... REVIEWED

   To ensure that the aircraft is safe to receive electrical power, review AFTO Form 781 for aircraft status prior to electrical power being applied and systems operated.

   WARNING

   Prior to the initial application of electrical power and after fuel servicing, ensure that the center accessory compartment has been inspected for fuel leaks.

8. BATTERY SWITCH/
   VOLTAGE .... BAT/LOCK/CHECKED

   Observe BAT BUS OFF light is off. Rotate switch to the horizontal (locked) position.

   NOTE

   - BAT BUS OFF light comes on momentarily when switch is moved to BAT if no power is on the aircraft.
   - Cockpit standby lights (partial floods at reduced intensity) come on when battery bus is powered and normal AC electrical power is off.
   - Cockpit standby lights will go off when normal AC electrical power comes on. Pre-positioning the FE's FLOOD INT LT knob ensures the cockpit will remain illuminated.

9. FUEL DUMP Switch Cover . . . . CLOSED/SAFETIED

WARNING

Do not turn on AC electrical power unless FUEL DUMP switch cover is safetied.

10. L-BAND SATCOM Power Switch . . . . OFF

11. SPOILER Handle . . . . RET/DISARMED

12. FLAP/SLAT Handle . . . . CHECK

Verify FLAP/SLAT handle position is according to flap/slat positions observed during exterior check.

WARNING

If the handle position does not agree with observed flap/slat position, do not pressurize hydraulic system or move handle until cleared by ground crew.

13. Landing Gear Handle . . . . DOWN

14. UHF Radios . . . . CHECKED AND SET

NOTE

Make radio check with ground or tower. If AC electrical power is not available, UHF-1 or VHF-1 may be used by turning EMER PWR SW to ON, or waiting until APU/GND power is available.

a. Rotate MODE SELECTOR switch to BOTH and tune desired frequency.

b. Verify SQUELCH switch is in ON.

c. Select UHF-1/2 with MIC SELECTOR on Pilot's or Flight Engineer's audio panel and adjust volume.

d. Make UHF radio check, monitor receiver audio over headset or cockpit speakers.

NOTE

Ensure KY 58 remote control head POWER switch is OFF and the C/RAD/PLAIN switch is set to PLAIN.

15. VHF-1 Radio . . . . CHECKED AND SET

a. Set VHF TFR Switch and tune desired frequency.

b. Select VHF-1 with MIC SELECTOR on Pilot's or Flight Engineer's audio panel and adjust volume.

c. Make VHF radio check, monitor receiver audio over headset or cockpit speakers.

16. Cabin Air Shutoff Handle .... STOWED

CAUTION

Operation of air conditioning packs without proper reset of cabin air shutoff valves could result in major damage to air conditioning ducts. If abnormal noise occurs when air conditioning systems are actuated, turn pack function selectors to PACK OFF. Maintenance is required.

NOTE

If cabin air shutoff handle is not fully stowed, maintenance is required.

17. APU and Engine Fire Detection System .... TEST
    a. MASTER WARNING and MASTER CAUTION Lights .... OFF
    b. ENG (1, 2 and 3) LOOPS and APU LOOPS Switches .... BOTH
    c. LOOPS A and LOOPS B Test Switches...................... TEST

       Observe FE's LOOP, MASTER WARNING, and APU FIRE lights on.

       Observe all Pilot's ENG FIRE handle lights are on, handles stowed, and engine 2 AGT LOW lights are off, APU FIRE light is on, MASTER WARN lights are on, ENGINE FIRE light is on, fuel lever lights are on and engine fire bell sounds.
    d. Test Switches................. RELEASE

       Observe all lights go off and bell stops ringing.

NOTE

If one (or more) LOOP light(s) does not come on during test, maintenance is required.

18. APU .... START

CAUTION

- After an unsuccessful start, do not attempt another start until APU shutdown cycle is complete and APU DOOR OPEN light goes off. A start attempt before APU DOOR OPEN light goes off may result in a hung start and excessive exhaust temperatures.
- For complete fire protection during all APU operations, BAT switch must be in BAT (on).
- Avoid moving APU CONT SYS switch between NORM and STBY during APU operation. Possible transfer relay damage due to electrical transients may result.

NOTE

- This procedure may be used for ground or in-flight starts.
- Consistent APU starting is provided up to 25,000 feet.

a. APU GEN BUS Switches .... OFF
b. APU FIRE CONTROL Switch ..... NORM
c. APU CONT SYS Switch .... NORM
d. APU/ISOL VALVE Switch......... CLOSE

e. Fuel Pump .... ON

NOTE

- If AC electrical power is supplying buses, turn on tank 2R AFT TANK pump.
- If AC electrical power is not supplying buses, turn on APU FUEL pump.
- After AC electrical power is supplying buses, turn on tank 2R AFT TANK pump, and turn off APU FUEL pump switch.

f. APU MASTER Switch............... RUN

Observe APU FUEL PRESS LO light is off and APU GEN OFF light is on. Observe APU USING BAT PWR and APU DOOR OPEN lights come on in approximately 20 seconds.

CAUTION

Do not attempt or continue start if low oil pressure light is not illuminated during initial start sequence until cause of difficulty is determined.

NOTE

If APU OIL PRESS LO/TEMP HI light comes on flashing, discontinue start and move APU master switch to OFF. A flashing APU OIL PRESS LO/TEMP HI light indicates failure of the oil pressure indicating system, inhibiting an APU start.

g. APU MASTER Switch....... START/RUN

Momentarily move APU master switch to START and release to RUN. Observe APU OIL PRESS LO/TEMP HI light comes on. Observe APU % RPM N_2, APU EXH TEMP, and APU % RPM N_1 gages indicate an increase. As N_2 RPM increases, observe APU OIL PRESS LO/TEMP HI light goes off. When APU is in normal operating range, observe APU USING BAT PWR light goes off.

CAUTION

Do not restart if APU has automatically shut down with APU OIL PRESS LO/TEMP HI light or APU FIRE light(s) on.

NOTE

- After AC electrical power is supplying the buses, check for any oil quantity indication above 2 quarts.
- When APU is in normal operating range, APU GEN OFF light goes off and APU PWR AVAIL light comes on.
- If APU will not start, has automatically shut down, or operation is erratic, move APU MASTER switch to OFF and determine if operation in standby mode is appropriate.
- Standby control is an abnormal mode in flight and its usage is recommended only in case of normal mode malfunction. Starting in standby mode up to 10,000 feet is acceptable.
- If APU FUEL PRESS LO light was on after APU automatically shut down with APU MASTER switch in RUN, fuel pump failure is indicated. Select another pump from tank 2 and attempt another start with APU CONT SYS switch in NORM.
- If standby mode is to be used, move APU CONT SYS switch to STBY. Start APU, using same procedures as in start with APU CONT SYS switch in NORM. APU % RPM N_2, APU EXH TEMP, and APU % RPM N_1 gages should be monitored as electrical and pneumatic load is applied.
- If N_1 and N_2 RPM are rising and approaching upper limit and/or if APU EXH TEMP indication rises to maximum allowable temperature, reduce pneumatic and/or electrical load on APU until RPM and/or APU EXH TEMP indication is normal.
- N_1 does not automatically increase to 97% with the selection of START A or START B ignition, as in APU normal operation. When higher RPM is required for engine start, increase electrical load on APU generator.
- When STBY is selected, N_1 speed may vary with applied electrical load. Monitor to prevent overload condition developing. Overload is indicated by OVERSPEED or OVERTEMP condition. All automatic shutdown protection features are still operational.

APU ELECTRICAL POWER

19. Electrical Power (APU/EXTERNAL) ...... ON

    a. APU GEN FAIL Light .... OFF

    b. APU PWR AVAIL Light .... ON

NOTE

If APU PWR AVAIL light is off and APU GEN OFF light is on, move APU GEN RESET switch to RESET and release. Observe APU GEN OFF light goes off and APU PWR AVAIL light comes on. Continue procedure.

    c. APU GEN BUS Switches .... ON

    Observe APU PWR IN USE lights come ON.

NOTE

- APU generator may be used to power ground service bus. Cabin ground service panel is in storage area forward of left forward cabin door.
- If one or more APU PWR IN USE light(s) is off, observe appropriate AC BUS OFF light is off.

EXTERNAL ELECTRICAL POWER

Use of external power will be at the discretion of the crew.

a. EXT PWR AVAIL Light .... ON

b. EXT PWR Switch .... EXT PWR

Observe EXT PWR IN USE light comes on. Verify AC BUS TIE switches in NORM. Observe AC BUS TIE ISOL lights are off (unless powered by APU or engine driven generator).

NOTE

- If EXT PWR IN USE light is off, verify external power is applied to aircraft buses by observing AC BUS OFF light(s) are off and, if not, use APU if available.
- AC BUS TIE switches must be in NORM to provide external power for generator buses. External power source may be used to power the ground service bus for miscellaneous service requirements. Ground service bus control switches are located on the cabin ground service bus panel and the external power receptacle.

20. CAB PRESS MAN/AUTO Handle ...... AUTO

21. OUTFLOW VALVE POSITION Indicator .... OPEN

22. Lighting .... SET

    a. On FE's panel, rotate CKT BKR LT, PNL LT, TABLE LT, and FLOOD LT knobs to set desired intensity.

    b. Verify the exterior lights are off unless required.

23. FE Equipment Panel .... CHECK

    a. TEST SELECT Selector .... OFF

    b. TEST CONFIGURATION Selector .... OFF

    c. IGNITION EXCITER POWER TRANSFER Switches .... NORMAL

    d. AUTO SLAT EXTEND Switch .... OFF

    e. DC GND SERVICE BUS PWR Switch .... NORM

    f. FE INSTR LIGHTING C/Bs .... CHECK

    g. FE CKT BKR Lightplates .... CHECK

    h. MANIFOLD FAIL DETECT LOOP SELECT Switch .... BOTH

    i. PITOT HEATER SELECT Switches .... NORMAL

    j. ENG ISOL VALVE SELECT Switches .... PRIMARY

    k. Switch Flow Line Annun Pwr Supply Switch .... NORM

    l. SUPPORT PERSONNEL OXYGEN .... CHECK

    Rotate OXY SYS TEST selector to TEST and verify green OXY SYS VALID lights illuminate. If OXY SYS SHORT light illuminates personnel cannot occupy seats in the forward cabin that are equipped with drop down oxygen masks until corrective maintenance is performed.

24. Circuit Breakers/ELEC SYS RESET Switches/FUEL QTY IND PWR Switch .... CHECK/ SAFETIED/NORMAL

Observe all circuit breaker panels and verify all circuit breakers are set (in), electrical system reset switch guards are down and safetied, and fuel quantity indicator power switch is in NORM.

CAUTION

- Indiscriminate pulling or resetting of circuit breakers for systems or components may cause unanticipated results because of systems interrelationship.
- If manifold scavenge valve circuit breaker trips, do not reset until maintenance personnel can ensure solenoid housing is intact and that the solenoid coil is not shorted to the solenoid case.

NOTE

Some circuit breakers may be open (out) and placarded or collared as required. Refer to circuit breaker listing in Section 1 (Electrical).

25. Hydraulic System .... CHECK

NOTE

Minimum acceptable hydraulic pressure for check of the hydraulic system is 2400 PSI, less 3 PSI for each 1°C of hydraulic system temperature above 0°C.

a. Motor PUMP 1-3 and PUMP 2-3 Switches .... OFF

b. Motor PUMP 1-3 Switch .... ARM

Observe 1-3/2-3 PUMP VALVE OPEN light comes on and goes off.

c. Motor PUMP 1-3 Switch .... OFF

Observe 1-3/2-3 PUMP VALVE OPEN light comes on and goes off.

d. Motor PUMP 2-3 Switch .... ARM

Observe 1-3/2-3 PUMP VALVE OPEN light comes on and goes off.

e. Motor PUMP 2-3 Switch .... OFF

Observe 1-3/2-3 PUMP VALVE OPEN light comes on and goes off.

NOTE

If 1-3/2-3 PUMP VALVE OPEN light operation is not normal, maintenance is required.

f. RUDDER STBY PWR Switch .... ARM

NOTE

RUDDER STBY PWR switch in ARM arms the nonreversible motor pumps to supply back-up hydraulic power to the upper rudder and longitudinal trim or lower rudder (as appropriate) in the event of a hydraulic failure.

g. AUX PUMP 1 (ADG) .... START

Observe HYD SYS 3 HYD PRESS gage indicated in white band (or minimum acceptable pressure) and the 1-3/2-3 PUMP VALVE OPEN light is off.

NOTE

- If system 3 HYD PRESS gage does not indicate in white band (or minimum acceptable pressure) move AUX PUMP 1 (ADG) switch to STOP; maintenance is required.
- Verify lower rudder position indicator moves toward center if displaced. This action verifies operation of the 3-2 nonreversible motor pump.

h. AUX PUMP 2 .... START

i. Motor Pump 2-3 Switch .... ARM

Observe HYD SYS 2 and HYD SYS 3 HYD PRESS gages indicate in white band (or minimum acceptable pressure) and 1-3/2-3 PUMP VALVE OPEN light is on.

NOTE

- ARM position enables reversible motor pump switches to operate when there is a difference of pressure between appropriate systems and any engine N_2 is below 45% RPM.
- If system 2 or 3 hydraulic pressure gages do not indicate in white band, (or minimum acceptable pressure) or the 1-3/2-3 PUMP VALVE OPEN light is off, move the Motor PUMP 2-3 switch to OFF, maintenance is required.
- Verify upper rudder position indicator moves to the center if displaced. This action verifies operation of the 2-1 nonreversible motor pump.

j. Motor Pump 1-3 Switch .... ARM

Observe HYD SYS 1 and HYD SYS 3 PRESS gages indicate in white band (or minimum acceptable pressure).

k. Hydraulic TEMPs .... BELOW YELLOW BAND

l. HYD QTYs........... ABOVE MINIMUM QUANTITY MARK

m. QUANTITY BUGS................... SET

Set quantity bugs to match quantity pointers.

n. RUD STBY PWR OFF Light .... OFF

NOTE

If RUD STBY PWR OFF light is on, maintenance is required.

o. ALL ENGINE HYD PUMP L Switches.................... OFF

p. ENG HYD PUMP R Switches ...... AUTO

q. All Hydraulic TEMP HI Lights .... OFF

r. All HYD PRESS LO Lights .... ON

26. MANFLD FAIL/Supply Lockout .... CHECK

Sys 1

a. APU/ISOL VALVE Switch......... CLOSE

b. Eng 1 PNEU SUPPLY Selector ..... AUTO

c. Eng 3 PNEU SUPPLY Selector .... OFF

d. 1-3 ISOL VALVE Switch .... OPEN

e. 1-2 ISOL VALVE Switch .... NORM

f. Both ISOL VALVE DISAGREE Lights .... OFF

g. Press and hold Number 1 MANFLD FAIL light. Observe Number 1 MANFLD FAIL, PNEU MANFLD FAIL, and 1-3 ISOL VALVE DISAGREE lights come ON.

h. Release MANFLD FAIL light - Observe Number 1 MANFLD FAIL and PNEU MANFLD FAIL lights go OFF and 1-3 ISOL VALVE DISAGREE light remains ON.

i. 1-3 ISOL valve is closed and latched. To reset the 1-3 ISOL valve, place both PNEU SUPPLY selectors to AUTO. 1-3 ISOL VALVE DISAGREE light goes OUT.

Sys 3

a. APU/ISOL VALVE Switch......... CLOSE

b. Eng 3 PNEU SUPPLY Selector ..... AUTO

c. Eng 1 PNEU SUPPLY Selector .... OFF

d. 1-3 ISOL VALVE Switch .... OPEN

e. Both ISOL VALVE
DISAGREE Lights .... OFF

f. 1-2 ISOL VALVE Switch .... NORM

g. Press and hold Number 3 MANFLD FAIL light. Observe Number 3 MANFLD FAIL, PNEU MANFLD FAIL, and 1-3 ISOL VALVE DISAGREE lights come ON.

h. Release MANFLD FAIL light - Observe Number 3 MANFLD FAIL and PNEU MANFLD FAIL lights go OFF and 1-3 ISOL VALVE DISAGREE light remains ON.

i. 1-3 ISOL valve is closed and latched. To reset the 1-3 ISOL valve, place both PNEU SUPPLY selectors to AUTO. 1-3 ISOL VALVE DISAGREE light goes OUT.

j. Rotate PNEU SUPPLY selector No. 3 to OFF and back to AUTO.

Sys 2

a. APU/ISOL VALVE Switch.......... OPEN

b. 1-3 ISOL VALVE Switch .... OPEN

c. 1-2 ISOL VALVE Switch .... NORM

d. Both ISOL VALVE
DISAGREE Lights .... OFF

e. Press and hold Number 2 MANFLD FAIL light. Observe Number 2 MANFLD FAIL, PNEU MANFLD FAIL, and 1-2 ISOL VALVE DISAGREE lights come ON.

f. Release MANFLD FAIL light and observe Number 2 MANFLD FAIL and PNEU MANFLD FAIL lights go OFF and 1-2 ISOL VALVE DISAGREE light remains ON.

g. To reset 1-2 ISOL VALVE, place APU/ISOL VALVE switch to CLOSE. Observe 1-2 ISOL VALVE DISAGREE light goes OFF. Observe instrument panel flow indicator for air flow. Return APU/ISOL VALVE switch to OPEN and observe 1-2 ISOL VALVE DISAGREE light momentarily ON, then OFF.

NOTE

The instrument panel flow indicator is a visual indication of air flow through the instrument panel. The indicator position is significant only when on the ground with normal electrical power applied and the air supply off. Under the above conditions, flow off indicates failure of the center instrument cooling fan.

h. 1-3 ISOL VALVE Switch .... NORM

27. Pneumatic and Air
Conditioning Systems .... ON (AS REQ'D)

NOTE

If air conditioning is not available and avionics equipment is to be operated for long periods while on the ground, open sliding clearview windows or avionics compartment exterior access door. Pull (trip) circuit breakers for those instruments and avionic units not required. Verify outflow valve position indicator is in full open.

APU PNEUMATIC USE (APU operating and electrical power in use)

a. APU/ISOL VALVE Switch.......... OPEN

Verify 1-2 and 1-3 ISOL VALVE switches are in NORM, and observe pneumatic ISOL VALVE DISAGREE lights come on and go off. Observe pressure gages increase to normal operating range.

b. PACK Function Selectors .... AUTO

c. Temperature Selectors .... AUTO

GROUND PNEUMATIC USE

a. Request ground crew to connect ground pneumatic power to aircraft.

Observe pneumatic pressure gage 1 indicates in normal operating range.

b. APU/ISOL VALVE Switch.......... OPEN

Observe both pneumatic pressure gages indicate pressure.

c. PACK Function Selectors .... AUTO

d. Temperature Selectors .... AUTO

NOTE

If pneumatic pressure gages do not indicate in normal operating range, move APU/ISOL VALVE switch to CLOSE and operate only those systems powered by ground pneumatics.

GROUND AIR CONDITIONING USE

a. PACK Function Selectors ...... PACK OFF

b. Request ground crew to initiate air conditioning from ground source.

If cocking or preflighting the aircraft for power off alert, hold the PACK Function selectors in the MAN HOT position until the ram air doors are closed and then to OFF. Manually close the cabin outflow valve prior to leaving the aircraft.

28. TRIM AIR Switch .... TRIM AIR

Observe DUCT-AVIONIC COMPT OVERHEAT light is off.

a. LAV/GALLEY VENT Switch....... LAV/GALLEY VENT

29. FE's Annunciator Lights................ TEST

a. MASTER WARNING and MASTER CAUTION Lights .... RESET (AS REQ'D)

b. ALL TEST Switch .... ALL TEST

Observe all FE's panel annunciator lights are on, except ENG FIRE DETECT SYS, DIFF TEMP and OVHT lights.

NOTE

- The FLT RECORDER OFF light will be on at this time, regardless of ALL TEST switch position.
- The MASTER WARNING, MASTER CAUTION, cue, and summary lights, except APU FIRE and CABIN ALT on Pilot's panels also come on. MASTER CAUTION and cue lights have a short delay built into system.
- AREA TEST button provides capability to test selected areas when test of all areas is not desired.

c. PRESS BRT/DIM Switch .... AS REQ'D

NOTE

DOOR OPEN, MASTER WARNING, MASTER CAUTION, BOOM/DROGUE NOT STOWED, and DC GND SERVICE BUS OFF lights cannot be dimmed.

d. ALL TEST Switch .... OFF

Observe lights return to pre-test display.

30. CDU Power Switches (3)................. ON

31. MSUs................................ STBY

CAUTION

Do not cycle the MSU between OFF and any other position(s) more than 3 times in a 3 minute period. Cycling the MSU out of OFF repeatedly can cause substantial damage from heat buildup in the INU.

NOTE

- Normal electrical power must be on and the avionic cooling system must be operating.
- Selecting STBY starts gyro warm-up and automatic self-leveling of the inertial platform. ADI ATT flag and compass indicator heading flags go out of view approximately one minute after STBY is selected.
- Both primary AC power and DC backup battery power must be available for turn on.

32. READY NAV/ BATT Lights .... TEST

Press-to-test the lights adjacent to each MSU selector switch and check for proper illumination.

33. FMS .... INITIALIZE

a. FMS Heading Switch .... MAG (or AS REQ/D)

b. FMS BUS SPLIT Switch-Light .... EXTINGUISHED

c. FMS Software Version .... VERIFY

Press the STAT key on any CDU to access the FMS Status page. Access the CDU Status page for each CDU in turn and check that the software version (VSN) number reads 613-9466-011 KC10. The three digit suffix may be a higher number (012, 013, etc.) indicating a later version, but KC10 must be specified.

d. START 1 Page . . . . ACCESS/VERIFY

Press the IDX key on any CDU to access the Index 1 page and press LS1 to access the Start 1 page. Verify or enter position, date, and time. Normally, the GPS will provide the correct position, time, and date shortly after power is applied to the CDUs. Observe that the annunciation line on the CDU displays the <<√inu1(2,3)>> message. This message may be cleared on any CDU by pressing the CLR function key. These messages will be accompanied by illumination of the FMS MSG annunciator.

NOTE

Ensure the WGS-84 datum is displayed. This datum will be used for all FMS operations.

e. START 2 Page . . . . ACCESS/
INITIALIZE GPS
(IF REQ'D)

If the initial position or time on the Start 1 page is erroneous, vertically scroll to the Start 2 page on any CDU and initialize GPS number 1 and 2 by selecting LS1. The → will change to a * for several seconds and then change back.

NOTE

GPS initialization will cancel any RAIM prediction in progress and prevent any RAIM prediction request.

f. INAV Page . . . . ACCESS

Access the INAV page for each INU on its corresponding CDU (Pilot/INU1, Copilot/INU2, FE/INU3) by pressing the INAV key and laterally scrolling to the appropriate INU INAV page. When the appropriate page is displayed, INU CONTROL will be displayed at LS4.

g. INU CONTROL Page . . . . ACCESS

Access the INU Control page on each CDU via LS4.

h. POSITION . . . . SELECT/ENTER

On each CDU, select POSITION (LS2) and verify that 72. 33° 0.1° is displayed. Enter the present position latitude in each CDU scratchpad as N or S followed by degrees, minutes, and tenths of minutes (decimal point is optional). Select ENTER (LS6) to send the present position latitude to the INU. Repeat this procedure for the present position longitude using the W or E coordinate. If a mistake is made while attempting to enter the data, press LS3 (CLEAR), and begin again.

WARNING

If incorrect present position latitude (N/S) is entered, alignment may be halted causing the <<√inu1(2,3)>> CDU annunciation to appear. Present position must then be reentered, resulting in a 10 to 15 minute delay. Incorrect longitude (E/W) entries do not delay alignment or cause the <<√inu1(2,3)>> annunciation to appear, but do cause incorrect data to be displayed throughout the flight unless corrected on the ground.

NOTE

Scratchpad does not automatically clear when lat/long data is inserted.

i. MSUs . . . . ALIGN

NOTE

- Selecting ALIGN starts automatic platform alignment, requiring approximately 15 minutes. During this time the aircraft must not be moved. Normal movement from loading and servicing is acceptable. Excessive movement may delay completion of alignment. Alignment cycle does not progress beyond initial leveling sequence until present position coordinates are inserted. When alignment cycle is complete, the READY NAV annunciator on MSU comes on.
- If desired, MSU mode selector may be moved directly to NAV from STBY after present position has been inserted. System automatically enters NAV mode upon completion of minimum alignment and, in this case, READY NAV light does not come on. If moving MSU directly to NAV mode prior to status 02 being achieved, fault codes for incorrect present position will not be annunciated.

j. DTK-STS (2 CDUs) . . . . SELECT/ MONITOR

With the mode selector set to ALIGN press the DTK-STS line select key (LS1) on any two CDUs. The left side of the information line shows 000.0 and the right side shows the alignment status number. Status decreased from 90 to 02 as the alignment cycle progresses.

k. RADIO MASTER POWER . . . . ON

On the remaining CDU, press the (IDX) key to access the Index 1 page. Then press LS6 (POWER) to access the Power page. Then press LS5 (RADIO MASTER ON).

l. FMS SYSTEM STATUS . . . . CHECK

On the remaining CDU, press the STAT key. Vertically scroll up or down to check the status of all the CBIT capable LRUs in the system. Scroll through the FMS Status pages, the NAV Sensor Status pages, and the Nav Radio Status page. Verify all systems indicate GO. A √ indicates that the LRU has reported a failure and the detailed status page has not been accessed since the failure. Detailed status pages can be accessed via the line select keys adjacent to each system. If a √ or a NGO is indicated, access the detailed status page for that system and record the fault code. Attempt to clear the failure by the use of the CLR key. If the item still indicates NGO, maintenance is required to investigate the cause of the condition.

m. DTK-STS (Remaining CDU) . . . . SELECT/ MONITOR

Press the INAV key to access the INAV pages. Scroll laterally to the appropriate INU INAV page (INU CONTROL will be displayed at LS4). Press LS4 to access the INU Control page. Press LS1 (DTK-STS). The left side of the information line shows 000.0 and the right side shows the alignment status number. Status decreased from 90 to 02 as the alignment cycle progresses.

NOTE

- With MSU mode selector set to ALIGN, READY NAV light comes on at status 02. Mode selector may be set to NAV when READY NAV light comes on. Except for unusual circumstances, mode selector should remain in ALIGN until just before engine start or before moving aircraft.
- If desired, MSU mode selector may be moved directly to NAV from STBY after present position has been inserted. System automatically enters NAV mode upon completion of minimum alignment and, in this case, READY NAV light does not come on. If moving MSU directly to NAV mode prior to status 02 being achieved, fault codes for incorrect present position will not be annunciated.

FE's INTERIOR INSPECTION

1. Pilot's Windows .... CHECK

   Observe general condition of pilot's window.

2. MASTER WARN &
   MASTER CAUTION
   Lights .... RESET AS REQ'D

   Observe MASTER WARN light is off.

   NOTE

   If MASTER WARN light is on, push to reset light and observe summary and specific red annunciator lights.

   Observe MASTER CAUTION light is off.

   NOTE

   If MASTER CAUTION light is on, observe cue lights. If cue light(s) is on, push to reset cue light and observe FE's panel. If cue light(s) is off, push to reset MASTER CAUTION light and observe annunciator lights and FE's panel.

   Adjust the following light-switches to set desired intensity - BRIEFCASE, FLOOR, MAP, FLOOD, PNL & FMA, and AR RECP ANNUN.

3. RADAR X-PONDER Selectors ..... AS REQ'D

   Ensure power selectors are OFF. Insert J BAND and/or I BAND code(s) at this time, if required.

4. HYD FLT CONTROL Lights .... OFF

   NOTE

   If one or more lights are on, maintenance is required to determine reason for switch selection.

5. FLAP LIMIT Selector .... AUTO

6. Elevator Feel System .... TEST

   a. ELEV FEEL Selector .... AUTO

      Observe ELEV FEEL REF IAS pointer is in white band.

   b. ELEV FEEL Selector .... MAN

   c. MAN SLEW Selector .... INC (first dot)

      Observe ELEV FEEL REF IAS pointer indicates an increase.

   d. MAN SLEW
      Selector .... DECR (second dot)

      Observe ELEV FEEL REF IAS pointer indicates a decrease. Release selector and observe pointer remains in last position.

   NOTE

   MAN SLEW selector functions only when ELEV FEEL selector is in MAN. It is a five-position selector, spring-loaded to the neutral position. The four dots indicate positions for using two different motors for redundancy and do not signify rate change.

   e. ELEV FEEL Selector .... AUTO

      Observe ELEV FEEL REF IAS pointer returns to white band.

7. ADG Switch .... HYD

   NOTE

   In flight, when deployed, ADG will power only AUX PUMP 1 (ADG) to supply hydraulic power for operation of the flight controls without moving AUX HYD PUMPS switch to START.

8. YAW DAMP System .... TEST

   a. All YAW DAMP Switches .... ON

      Observe YAW DAMP TEST FAIL, TEST, and UPPER/LOWER YAW DAMP INOP lights are off.

   NOTE

   If any light is on, cycle appropriate YAW DAMP switch to OFF and ON. Observe lights go off.

b. YAW DAMP TEST Switch-light ..... PUSH

Observe all lights come on. Approximately 20 seconds later observe that all lights are off.

NOTE

- If either YAW DAMP TEST FAIL light is on, move both switches for affected channel to OFF. Observe all lights are off. Move switch A to ON and observe lights are off. Retest the system. Observe lights are off.
- If the YAW DAMP TEST FAIL light remains on, move switch A to OFF. Observe light goes off. Move switch B to ON. Observe light remains off. Retest the system. Observe lights are off.

9. ANTI-SKID System .... OFF/ARM/TEST

a. ANTI-SKID Switch ...... OFF THEN ARM

Observe all ANTI-SKID FAIL lights are off.

NOTE

- Anti-skid test must be performed within 1 minute after moving anti-skid switch to ARM.
- If anti-skid system fails the test, maintenance action is required.

b. ANTI-SKID TEST Button .... PUSH and HOLD

Observe all ANTI-SKID FAIL lights come on.

c. ANTI-SKID TEST Button .... RELEASE

Observe all ANTI-SKID FAIL lights go off.

10. COMPASSES .... SLAVED and SYNCHRONIZED

a. COMPASS Switches .... SLAVED

Observe synchronization indexes are aligned.

NOTE

EHSI and RMI headings may be resynchronized after INS has completed alignment. Moving COMPASS switch from, and returning to SLAVED engages fast synchronization. Alignment occurs within a few seconds.

11. HF-Radios .... AS REQ'D

a. Ensure HF system(s) AC and DC circuit breakers are set (including ACS keep-alive circuit breakers). If AC circuit breakers were not set, set breakers and wait 3 minutes while the processor performs self-test before performing next step; otherwise, proceed to step b.

NOTE

If the HF control panel PWR switch is depressed prior to the 3 minute time-out after AC circuit breakers are set, the system runs a self-test or defaults to direct control operation. The self-test takes approximately 90 seconds to complete and starts by lighting all segments of the control panel display for approximately 15 seconds. After approximately 30 seconds, 01 is displayed in the ADRS field followed by 02, OK, 03, and finally OK+. After OK+ is displayed, perform step c. During direct control operation, D C is displayed in the address field. To exit direct control operation, depress PWR switch until display blanks, and momentarily depress PWR switch again. See HF-ACS Default Mode in Pilot's Interior Inspection for more information pertaining to direct control operation.

b. Depress and release PWR switch on HF control panel. All display segments light momentarily and then current operational status is displayed.

WARNING

Ensure radio is not in automatic (AUT) mode to prevent inadvertent RF transmission.

c. Move cursor to FN field using FLD selector and temporarily select CHN in the FN field using VAL selector.

NOTE

During power-up the relationship between the processor and control initializes the control display.

12. INS/FD CMD/CADC Selectors .... NORM

Observe AUX INS INOP light is off.

13. IFF CADC Select Switch . . . . AS DESIRED

14. Voice Recorder . . . . TEST

Push TEST button and observe meter needle stays in green range.

15. Engine Start Panel . . . . CHECK

    a. FUEL VAPOR VENT Switches . . . . OFF

    b. OVRD & AIR START Switch . . . . OFF

    c. ENG IGNITION Selector . . . . OFF

    d. ENG START
    Switches . . . . OUT/LIGHTS OFF

16. EMER PWR Switch . . . . ON/OFF

    a. Rotate EMER PWR switch to ON. Observe that EMER PWR IN USE lights come on, L EMER DC BUS OFF and L EMER AC BUS OFF lights are off. Observe flags in compass 1, Captain's altimeter and TVSI are out of view. Verify the VOLT/AMP/FREQ selector is in the BAT and L EMER AC position, and observe the AC VOLT and FREQ Hz meters indicate in white or yellow bands. Observe DC VOLT meter pointer is in white band and DC AMP meter pointer is in white discharge band.

    b. Rotate EMER PWR switch to OFF. Observe EMER PWR IN USE lights go off, and L EMER DC BUS OFF and L EMER AC BUS OFF lights remain off.

    c. Observe DC VOLT meter pointer is in green band and DC AMP meter pointer is in the green charge band.

CAUTION

Do not engage Autopilot 1 with the EMER PWR switch on. Flight controls will cycle erratically.

NOTE

If normal AC buses are not powered by APU or external power at this time, L EMER DC BUS OFF and L EMER AC BUS OFF lights will come on. If the above check is not successfully accomplished, maintenance action is required prior to takeoff.

17. Emergency Lights . . . . TEST

    a. EMER LT Switch . . . . ARM

    Observe DISARMED light goes off.

NOTE

The DISARMED light will be on when switch is in either ON or OFF.

    b. EMER LT TEST
    Button . . . . PUSH and HOLD

    Observe EMER LT TEST light comes on.

NOTE

Pushing EMER LT TEST causes emergency lights to come on and test condition of integral batteries under load. EMER LT TEST light will come on when all four circuits and batteries are satisfactory. Test requires approximately 5 seconds.

    c. EMER LT TEST Button . . . . RELEASE

    Observe EMER LT TEST light goes off.

    If cocking or preflighting the aircraft for power off alert, return the EMER LT switch to OFF until scramble operations.

18. SEAT BELTS Switch . . . . AUTO

NOTE

When passengers are onboard the aircraft, the seat belt switch will be placed ON and remain on until the boom operator has checked the cargo for security and the aircraft commander has determined it is safe for passenger movement.

19. Antenna Switches . . . . SET

    a. TACAN-1 and TACAN-2
    A/A AGC Switches . . . . ON

    b. TACAN-1, TACAN-2, UHF-1 and
    UHF-2 ANTENNA
    Switches . . . . AUTO

20. BEACON LT MASTER Selector.......... OFF

21. Ground Proximity
Warning System .... CHECK/TEST

   a. Switches/Annunciators .... CHECK

   Verify TERR OVRD, STEEP APPR, and FLAP OVRD switches are off and FLAP OVRD switch is guarded. Check all other GPWS annunciators off.

   b. GPWS TEST Pushbutton........... PRESS

NOTE

Do not hold the GPWS TEST pushbutton down. Depressing the switch for two seconds or longer will result in the system initiating a Level II (long) self-test. If the Level II self-test is inadvertently initiated, holding the switch down for longer than two seconds will terminate the test.

Momentarily depress the GPWS TEST pushbutton and observe the following:

(1) GPWS FAIL, W/S FAIL, and TERR FAIL annunciators and MASTER CAUTION lights turn on.
(2) BELOW G/S annunciators turn on.
(3) One GLIDESLOPE message annunciated.
(4) BELOW G/S annunciators turn off.
(5) GPWS lights turn on.
(6) One PULL UP message annunciated.
(7) GPWS lights turn off.
(8) W/S warn (red) annunciators turn on.
(9) Siren followed by WINDSHEAR, WINDSHEAR, WINDSHEAR message is annunciated.
(10) W/S warn (red) annunciators turn off.
(11) W/S caution (amber) annunciators turn on.
(12) W/S caution (amber) annunciators turn off.
(13) GPWS lights turn on.
(14) One TERRAIN TERRAIN, PULL UP message is annunciated.
(15) GPWS lights turn off.
(16) GPWS FAIL, W/S FAIL, and TERR FAIL annunciators and MASTER CAUTION lights turn off.

22. ARO Station Alarm .... CHECK

Push ARO STA ALARM button and release.

NOTE

This item must be coordinated with the Boom Operator and may be accomplished at any time during the Interior Inspection.

23. **WITH TCTO 1248** ELT 1 and ELT 2
Switches .... ARM ◀

24. Stall Warning System .... TEST

   a. STALL TEST Selector......... HOLD IN L

   Approximately 5 to 8 seconds, observe control columns vibrate.

   b. STALL TEST Selector.......... RELEASE

   c. Repeat steps a and b above with selector in R.

25. MAX SPEED WARN System .... TEST

   a. MAX SPD WARN
   TEST Selector .... HOLD in 1

   Observe clacker sound is audible.

   b. MAX SPD WARN
   TEST Selector .... RELEASE

   c. Repeat steps a and b above with selector in 2.

26. Speed Control . . . . TEST

    a. SPEED CONTROL TEST Selector . . . . HOLD in SLOW

       Observe fast/slow indicators on both ADIs move to 1/2 scale toward SLOW.

    b. SPEED CONTROL TEST Selector . . . . RELEASE

       Observe fast/slow indicators return to full scale SLOW.

    c. SPEED CONTROL TEST Selector . . . . HOLD in FAST

       Observe fast/slow indicators on both ADIs move to 1/2 scale toward FAST.

    d. SPEED CONTROL TEST Selector . . . . RELEASE

       Observe fast/slow indicators return to full scale SLOW.

NOTE

If fast/slow indicator touches the full scale mark during test, maintenance is required.

27. Windshield Anti-Ice . . . . AS REQ'D

NOTE

- If icing conditions exist or are anticipated, rotate (L,R) ANTI-ICE selectors to NORM. Observe WINDSHIELD ANTI-ICE INOP lights are off.
- Selectors should be in HIGH only for duration of moderate to heavy icing conditions.

28. WINDSHLD DEFOG Switch . . . . ON

29. Pitot METER SEL & HEAT Selector . . . . CHECK

    a. METER SEL & HEAT Selector . . . . . . CAPT

       Observe PITOT HEAT INOP light goes off.

    b. Each position of METER SEL & HEAT Selector . . . . SELECT

       Observe current flow for each position.

NOTE

- PITOT HEAT INOP light monitors PITOT CAPT, F/O, and AUX positions and TAT position. PITOT HEAT INOP light will also be on when selector is in OFF.
- TAT position will not show current flow while aircraft is on the ground.
- The heater current indications will vary between components. Any reading on the HTR CUR meter indicates the components are operable.

    c. METER SEL & HEAT Selector . . . . OFF

30. ENG & ANT ANTI-ICE Switches . . . . OFF

    Observe ENG ANTI-ICE DISAGREE and ANT ANTI-ICE DISAGREE lights are off.

31. Lights . . . . SET AS REQ'D

    Verify lights switches and selectors are set:

    a. LOGO Lt . . . . AS DESIRED
    b. STBY COMP . . . . AS DESIRED
    c. FORM . . . . OFF
    d. HI-INT . . . . OFF
    e. NAV . . . . SET
    f. THNDRSTRM . . . . OFF
    g. (L & R) RUNWAY TURNOFF Lt . . . . AS REQ'D
    h. NOSE . . . . OFF
    i. (L & R) LDG Lt . . . . RET

32. Pilot's Annunciator Lights . . . . TEST

    a. ANNUN LT TEST Switch-light . . . . PUSH and HOLD

       Observe all overhead, glareshield, instrument panel annunciators and AR RECP ANNUN lights are on.

       Observe FMA's display T-E-S-T.

b. ANNUN LT TEST Switch-light . . . . RELEASE

Observe all annunciators are normal for present conditions.

33. Pilot's Instrument Panel . . . . CHECK

a. Verify pilot's instrument panel fasteners are in locked position.

b. Verify general condition of the flight instruments and that the appropriate flags are removed from view.

NOTE

If aircraft is parked in a position where NAV radio reception is weak; the ADI GS and RUNWAY flags, and HSI GS and NAV FAIL flags may be in view.

c. Verify pilot and copilot static source selectors are in NORM.

34. REV PRES, REV U/L, and REV THR LIGHTS . . . . OFF

CAUTION

If the REV U/L or REV PRESS light for engine 1 or 3 is illuminated or is inoperative, maintenance action will be taken to correct the discrepancy or the affected thrust reverser will be deactivated and secured in the stowed position prior to takeoff.

35. Engine Instruments . . . . CHECK

a. Observe engine indicator maximum pointers do not indicate more than the maximum engine limits and readouts are logical.

b. Observe N_1, EGT, N_2 and fuel flow gages indicate static conditions.

NOTE

- Verify that all max pointers are aligned with the red limit and that the EGT amber lights are off. (If any max pointer indicates above the red limit, check the AFTO Form 781 for writeups; if none, reset the max pointer.)
- The max pointers on the N_1, N_2, and EGT gages are positioned at the maximum limit mark when the engine indicator maximum pointer reset button is pushed.

36. SPEED BRAKE and SLAT RESET Lights . . . . OFF

37. Thrust Computer and TAT . . . . SET/CHECK

a. TAT and SAT Readouts . . . . CHECK

Observe TAT readout on thrust computer indicator shows approximately same temperature as on TAS/SAT indicator and both are approximately same as reported ambient, unless aircraft is exposed to a bright warm sun. In this event TAT and SAT may be well above ambient.

b. T.O. Thrust Select Switch . . . . PUSH

Observe N_1/LIM readout shows N_1 % of RPM allowable for takeoff. Observe N_1 maximum limit indexes on respective N_1 gages are driven to same setting as in N_1 LIM readout. Observe N_1 limit is within 0.5% of value shown on appropriate N_1 Setting - Takeoff Thrust chart, entering with TAT shown on thrust computer. This item can be accomplished any time prior to takeoff by either closing the 1-3 ISOL VALVE, APU ISOL VALVE, or a PACK function selector.

NOTE

- If thrust computer N_1 readout is different by more than 0.5% N_1 when compared to appropriate thrust setting chart, use chart value to set engine thrust.
- If thrust computer is not to be used or if a N_1 maximum limit index has not driven to the N_1 limit, set N_1 RPM limit on N_1 gage(s) by pulling the N_1 maximum limit set knob (which exposes an upper digital readout on the N_1 gage). Rotate set knob to desired N_1 limit in the upper readout and observe maximum limit index(es) indicates the same as the digital readout on the thrust computer indicator.

38. FLAP/SLAT Position Indicator .... TEST

    a. T (test) Button .... PUSH and HOLD

    Observe FLAP/SLAT position indicator shows flaps extended to 10° (blue test mark), flap handle indicators extended to 30° (blue test mark), FLAP DISAGREE flag comes in view, and all slat position lights come on.

    b. T (test) Button .... RELEASE

    Observe indications return to pre-test display.

39. SURF POS Indicator................... TEST

    a. TEST Button .... PUSH and HOLD

    Observe SURF POS indicators align with magenta test marks.

    b. TEST Button .... RELEASE

    Observe SURF POS indicators return to original position.

    c. Observe control surface position indicated on SURF POS indicator corresponds to control position.

40. Gear Lights & Warning Horn .... TEST

    a. GEAR Handle .... PULL and HOLD

    Observe four gear lights change from green to red, and gear warning horn sounds.

NOTE

- With throttles at idle stop, warning horn will sound while GEAR handle is pulled.
- If CTR GEAR isolation switch is in UP, and the center gear is up and locked, the CTR gear lights will be off.
- If red CTR light is on while center gear isolation switch is in UP, maintenance may have extended center gear with maintenance gear handle in right wheelwell.
- Center gear position should be changed to up or down by maintenance personnel while on the ground.

    b. GEAR HORN OFF Button .... PUSH

    Observe horn is silenced.

    c. Gear Handle................... RELEASE

    Observe four gear lights change from red to green.

NOTE

If four green gear lights are not on, verify center gear isolation switch is in NORM.

41. Copilot's Instrument Panel .... CHECK

Verify copilot's instrument panel fasteners are in locked position.

Verify general condition of flight instruments and that appropriate flags are removed from view.

NOTE

If parked in a position where navigation radio reception is weak, the ADI GS and RUNWAY flags, and the HSI GS and NAV fail flags may be in view.

42. Copilot's Windows .... CHECK

Observe general condition of windows.

43. Longitudinal Trim System.............. TEST

NOTE

Checking longitudinal trim systems while boom preflight is in progress may cause a fault indication in the boom preflight due to high hydraulic pressure demands.

    a. Pilot's LONG TRIM
    Switches ...... (both) NOSE UP/NOSE DN

    Observe LONG TRIM handles and indicator move in same direction as switches. Note horn sounds after 1° of stabilizer movement.

    b. Pilot's LONG TRIM
    Switches .... (both) RELEASE

    Observe handles and switches return to neutral and horn is silenced.

    c. Pilot's Left LONG
    TRIM Switch .... NOSE UP/NOSE DOWN, RELEASE

    Observe left LONG TRIM handle moves in same direction as switch, LONG TRIM indicator does not move, and the horn does not sound.

    Observe switch and handle returns to neutral.

d. Pilot's right LONG TRIM Switch . . . . NOSE UP/NOSE DOWN, RELEASE

Observe right LONG TRIM handle moves in same direction as switch, LONG TRIM indicator does not move, and the horn does not sound.

Observe switch and handle returns to neutral.

e. LONG TRIM Handles (both) . . . . 1/2 FORWARD

Observe LONG TRIM indicator moves toward NOSE DN.

NOTE

With handles in half deflection position, one hydraulic trim motor is running. Stabilizer will move at a slow rate.

f. LONG TRIM Handles (both) . . . . FULL FORWARD

NOTE

With handles full forward, both hydraulic trim motors are running. The stabilizer will move at a faster rate. Rate differential may not be perceptible during this test because of the volume output of both auxiliary pumps. This will be indicated by a further drop in hydraulic pressure.

g. LONG TRIM Handles . . . . RELEASE

Observe handles return to neutral.

h. ALT LONG TRIM Switches . . . . NOSE UP/NOSE DN, RELEASE

Observe LONG TRIM handles and indicator moves in the same direction as switches.

i. CP's LONG TRIM Switches . . . . NOSE UP/NOSE DN, RELEASE

Repeat steps a and b above using CP's LONG TRIM switches. There is no need to listen for horn.

If cocking or preflighting the aircraft for alert, return the LONG TRIM to 2° NOSE UP until scramble operations.

44. Parking Brakes. RELEASE

45. SPOILER Handle . . . . RET DETENT

Observe L SPOIL and R SPOIL position indexes on SURF POS indicator show DN.

46. Takeoff Warning Horn . . . . TEST

NOTE

To test the slat function of the takeoff warning system, the park brake must be off, stabilizer in green band, spoiler handle in RET, and flap/slat handle in UP/RET.

a. Throttle 1 . . . . FULL FORWARD

Observe warning horn sounds.

b. Throttle 1 . . . . IDLE

Observe warning horn is silenced.

c. Throttles 2 and 3. . . . . FULL FORWARD

Observe warning horn sounds.

d. Throttles 2 and 3. . . . . IDLE

Observe warning horn is silenced.

NOTE

- If the takeoff warning horn does not sound, maintenance action is required prior to takeoff.
- The warning horn is actuated by throttles 1 or 2 in the takeoff range with the slats not in T.O. EXT range, flaps in landing range, spoiler handle not fully forward, stabilizer setting not in green band, or when parking brake handle is in PARK.
- The warning horn will not indicate improper stabilizer trim takeoff position specified for actual center of gravity and flap position, or improper wing flaps position specified for actual takeoff speeds and performance limits.
- The warning horn will not indicate improper flap takeoff settings between 0°/EXT and 5°/EXT or between 20°/EXT and 25°/EXT, which includes the 22°/EXT gate.

47. Parking Brakes .... SET

NOTE

- To minimize the structural loads and relieve noises associated with strut compression of the centerline gear, it is recommended that the wheels be adequately chocked and the parking brake released while refueling or when a significant amount of cargo is being loaded.
- To set parking brakes, push and hold down on the brake pedals. Observe brake systems 1 and 2 hydraulic pressure gages indicate in the white band. Pull the parking brake handle to the aft (PARK) position. Release foot pressure on the brake pedals and observe pedals remain down and the handle remains aft. Observe brake systems 1 and 2 hydraulic pressure gages indicate in the white band.

Parking brakes should be set for brake check on exterior inspection.

48. FUEL Levers .... OFF/RELEASE BUTTON EXTENDED

49. FLAP/SLAT Handle .... UP/RET

WARNING

If FLAP/SLAT handle is not in UP/RET, contact ground crew for clearance before moving.

Observe flap handle position indicators show UP, flap position tapes show UP, FLAP DISAGREE warning flag is not in view, and slat position lights are off. Verify mechanical flap/slat interlock is in position and thumbscrew is secure.

50. FLAP T.O. Selector .... CHECK

Verify selector movement is free, and FLAP T.O. SEL readout indicates movement.

51. IFF/ETCAS........................... STBY

NOTE

If the transponder is already on, cycle to OFF and back to STBY.

Verify the following messages are displayed:

- - - -
TESTING
CP PASS
M3 (Mode 3/A code)
STBY (displayed intermittently every 12 seconds)

52. WX Radar........................... STBY

Rotate WX RADAR mode selector to STBY.

53. Aileron Trim .... CHECK/ZERO

Rotate AIL trim knob to 4LWD, 4RWD and position 0. Observe on SURF POS indicator that aileron positions indicate L WING DN, R WING DN, and neutral, respectively.

NOTE

- With hydraulic system pressure, movement of AIL trim knob will move ailerons and movement will be reflected on SURF POS indicator and control wheels. Control surface areas should be clear.
- Spoilers should not extend until aileron trim has been moved approximately 5°. If spoiler movement is noted prior to 5° cycling the ailerons several times may relieve this condition. If condition persists maintenance is required.

54. Rudder Trim.................. CHECK/ZERO

Hold nose gear steering wheel and rotate rudder trim knob to 5° NOSE L, 5° NOSE R, and 0°. Observe SURF POS indicator shows 5° left, 5° right, and 0°, respectively.

NOTE

With hydraulic system pressure, movement of the rudder trim knob will move rudders and movement will be reflected on SURF POS indicator and rudder pedal displacement. Control surface areas should be clear.

55. ADG Release Handle ...... DOWN/SAFETIED

NOTE

Raising the air-driven generator release handle mechanically deploys the air-driven generator into the airstream. There is no provision for retraction without ground crew assistance.

56. Passenger Address System . . . . TEST
    a. Handset . . . . REMOVE
    b. PA ON Switch-light . . . . PUSH
    c. Test Announcement . . . . MADE/MONITORED
    d. Handset . . . . STOWED
57. Audio Panel . . . . SET
    a. Set interphone and radio volume control as desired.
    b. Select INT microphone selector button and transmit by moving HOT MIC/RADIO switch to HOT MIC or RADIO.

NOTE

If communication with the ground is desired, push MECH CALLING switch-light. When mechanic answers over flight interphone, communicate using headset or oxygen mask microphone.

58. EXT/INT Lights . . . . SET
    a. AR RECP SLIPWAY . . . . OFF
    b. AR RECP FLOOD & DOOR CONT . . . . CLOSED
    c. WING . . . . OFF
    d. INT LT Selectors . . . . AS DESIRED
    e. UPR FUSLG Lights . . . . AS DESIRED

NOTE

Illumination of upper fuselage lights is for nighttime taxi and/or inflight refueling only.

59. Hydraulic System . . . . CHECK

NOTE

If BO has completed his preflight check, hydraulic motor pumps and Aux pumps may be shut down at this time.

    a. TEMP Gages . . . . NORMAL
    b. Hyd QTY Gages . . . . NORMAL

       Should indicate approximately the same as when system was pressurized.

    c. TEMP HI Lights . . . . OFF
    d. PRESS LO Lights . . . . ON
    e. HYD PRESS Gages . . . . NORMAL
60. Electrical System . . . . CHECK
    a. CSD OIL PRESS LO Lights . . . . ON
    b. CSD Switch-guards . . . . CLOSED/ SAFETIED
    c. CSD TEMP Gages . . . . NORMAL
    d. GEN FAIL Lights . . . . OFF
    e. GEN OFF Lights . . . . ON
    f. GEN Switches . . . . ON
    g. AC LOAD Meters 0
    h. L and R EMER AC BUS OFF Lights . . OFF
    i. AC BUS OFF Lights . . . . OFF
    j. AC BUS TIE ISOL Lights . . . . ON with APU power
       OFF with EXT power
    k. AC BUS TIE Switches . . . . NORMAL

NOTE

- If EMER AC BUS OFF lights or any AC BUS OFF lights are on, verify appropriate generator bus is powered.
- If external power is in use, observe EXT PWR AVAIL light is on and EXT PWR IN USE light is on.

    l. EMER PWR IN USE Light . . . . OFF
    m. DC LOAD Meters . . . . Less than 1.0

NOTE

- If DC load is in excess of 1.0 verify DC TIE and DC X-TIE switches are in OPEN.
- If DC load is in excess of 1.0, pull associated TR OUTPUT circuit breaker (upper main circuit breaker panel). Maintenance is required.

    n. L and R EMER DC BUS OFF and DC BUS OFF Lights . . . . OFF

o. DC TIE and DC X-TIE Switches . . . . OPEN

p. DC TIE CLOSED,
DC X-TIE CLOSED, and
BAT BUS OFF Lights . . . . OFF

q. BAT Switch . . . . BAT/LOCKED

r. VOLT/AMP/FREQ
Selector . . . . BAT AND L EMER AC

Observe AC VOLT and FREQ meters indications are normal (voltages in wide green band; amps approximately zero or if charging, in green band).

NOTE

- The DCV scale may indicate a charge condition slightly below charge band (wide green band) if the aircraft has ground heat soaked for a prolonged period at ambient temperature of 38° C or higher.
- While battery is charging, AMP meter pointer may be steady or pulsing in CHG (green) band. The DISCH (white) band indicates normal discharge rate during emergency power operation.
- If ammeter indicates a charge in excess of the charge band, pull battery charger circuit breaker on upper main circuit breaker panel. Maintenance is required.

61. OXY MASK Switch Guard . . . . DOWN

62. PNEUMATIC & AIR
CONDITIONING Systems . . . . CHECK

a. All Pneu & Air Cond
System Lights . . . . OFF

NOTE

- If one or both PACK OFF Lights are on, rotate PACK function selector to PACK OFF. Maintenance is required.
- Automatic circuit will turn off air conditioning pack when pack temperature is excessive.
- If AVIONIC FLOW OFF light is on, refer to Abnormal Procedures, Avionic Flow Off Light On.
- If DUCT-AVIONIC COMPT OVERHEAT light is on, move TRIM AIR switch to OFF. Maintenance is required.
- Maintenance action will be necessary to reset the trim air system if overheat was in avionics compartment.

b. ENG PNEU SUPPLY Selectors . . . . . AUTO

c. Pneumatic TEMP Gages . . . . NORMAL

NOTE

Due to location of temperature sensors, temperature indications will not be accurate when using APU or ground pneumatics.

d. Pneumatic PRESS Gages . . . . NORMAL

e. 1-2/1-3 ISOL
VALVE Switches . . . . AS REQ'D

f. WING ANTI-ICE Switch . . . . OFF

CAUTION

TEST position of WING ANTI-ICE switch is for ground test of wing anti-ice valves (normally a maintenance function). No ground overheat protection is available in the test position and serious damage to the slats can occur if operated for more than 15 seconds.

g. Pneumatic FLOW Gages . . . . NORMAL

h. PACK Function Selectors . . . . AUTO

i. PACK IND SEL 1/3

Observe TURB INLET TEMP, PACK TEMP VALVE POS, and PACK DISCH TEMP gages indicate normal in each position.

j. Compartment Temperature
Selectors . . . . AUTO

k. AVIONIC FLOW Switch . . . . NORM

l. TRIM AIR Switch . . . . TRIM AIR

NOTE

TRIM AIR switch, when in TRIM AIR, makes hot trim air from 1 and 3 pneumatic systems available to all compartments.

m. Compartment Temperature
Selectors . . . . AS DESIRED

n. VALVE POS Gages . . . . AS DESIRED

o. COMPT/DUCT
Temperature Gages. . . . . AS DESIRED

Adjust compartment temperature selectors as desired to control temperatures.

NOTE

If VALVE POS indicator does not respond to adjustment of temperature selector, rotate compartment temperature selector to MAN and adjust HOT or COLD, as desired. Observe VALVE POS indicator movement.

p. LAV/GALLEY VENT Switch . . . . UP

63. Brake Temperature System . . . . TEST

a. DIFF TEMP and OVHT Lights . . . . OFF

b. Brake TEMP Gage . . . . NORMAL

NOTE

- OVHT light on indicates brake temperature is above 400°C.
- Pushing any one OVHT switchlight results in TEMP gage readout of that brake temperature.
- Pushing 2 or more OVHT switchlights simultaneously results in erroneous TEMP gage readings.
- If one or more OVHT lights are on, maintenance is required.

c. BRAKE TEMP TEST
Button . . . . PUSH and HOLD

Observe DIFF TEMP and OVHT lights come on and TEMP gage reads in white band.

d. BRAKE TEMP TEST
Button . . . . RELEASE

Observe all lights go off and TEMP gage returns to pretest indication.

64. OXY QTY Switch (1, 2, 3) . . . . CHECK

Observe the OXY QTY gage indication in each position.

NOTE

To determine if oxygen quantity is adequate for scheduled flight, refer to Oxygen Duration Chart in Flight Manual, Section I, Part 11.

65. Cabin Cargo Smoke Detectors . . . . TEST

a. CABIN CARGO SMOKE
Switch . . . . TEST and HOLD

Observe all smoke DETECTOR lights, CAB CARGO SMOKE light and MASTER CAUTION light on FE's panel come on. Pilot's MASTER CAUTION and CAB CARGO SMOKE light also come on.

b. CABIN CARGO SMOKE
Switch . . . . ARM

Observe all tested lights go off.

66. Annunciator Panel . . . . CHECK

Observe light indications are logical for conditions.

67. Pressurization . . . . SET

a. CABIN ALT RATE Indicator 0

b. BARO Pressure Knob . . . . SET 29.92

Observe DIFF PRESS gage shows approximately 0.

c. Cabin Pressure MODE Switch . . . . . . AUTO

d. ALT SET Knob . . . . . SET DEST FLD ELEV

e. RATE LIMIT Selector . . . . . . INDEX MARK

f. CAB PRESS RELIEF OPEN
and CABIN ALT Lights . . . . OFF

68. Engine Vibration . . . . TEST/AFT, IF REQ'D

a. ENG (1, 2, 3) VIB UNITS Scales 0

b. ENG VIB PICKUP Selector . . . . . . FWD N_2

c. ENG VIB
TEST Button . . . . PUSH and HOLD

Observe all ENG VIB UNITS scales indicate 6.

d. ENG VIB TEST Button .... RELEASE

e. ENG VIB PICKUP Selector .... AFT N_1

f. Repeat steps c and d above.

69. Clock.................................... SET

NOTE

The flight engineer's clock should be set as accurately as possible. This clock sets the time base data of the Flight Data Recorder.

70. Engine Instruments .... CHECK

Observe OIL QTY gages indicate above 12 quarts, OIL TEMP gages are normal for static conditions, and OIL PRESS gages indicate approximately zero.

NOTE

- Twelve quarts of oil will provide an adequate oil supply for the engine for a 21 hour flight at the cruise maximum oil consumption rate.
- With engine not operating, indicated oil quantity for a full tank is 18 U.S. quarts.

71. Laptop Computer Cable .... CONNECTED

Connect the power and communication cable.

NOTE

L-BAND SATCOM system power-up and reporting is not required for local missions. For missions other than locals, power up the system and send an On-Station Report during preflight. On-Station reports are only required during initial power up at the beginning of a crew duty day. It is not necessary to transmit on-station reports at intermediate stops throughout the day. For missions operating out of or into locations without an AMC C2 presence, transmit Departure and Arrival messages. If landing at a location with a mobile AMC C2 presence, transmit a Three Hour Out message to the TALCE.

72. L-BAND SATCOM POWER Switch .... ON

NOTE

Check all indicator lights flash or come on steady when power switch is placed to ON.

a. Printer Power Indicator Light - ON

The power light flashes during initial power-up then comes on steady when data bus communication is established with the receiver.

b. Printer LOGIN Indicator - ON

The transceiver will login automatically. The LOGIN light will flash during login sequence then come on steady when the system is logged onto the satellite network.

c. Paper Indicator - CHECKED

If light on check paper supply.

d. Printer OK Button - DEPRESSED

Press and hold the OK button for 20 seconds. The printer prints the entire character set and the settings on the printer.

e. Spare Printer Paper - ADEQUATE FOR MISSION

Paper Loading Procedures:

(1) Open roll holder and remove remaining roll kernel.

(2) Press the Paper Feed switch to remove remaining paper.

(3) Take off the seal paper on the new paper roll and pull out 2 inches.

(4) Cut the edge of the new roll to form an arrow.

(5) Insert the edge of the paper in the paper feeding slots and press the Paper Feed switch.

(6) Insert paper roll and close the roll holder.

73. Laptop Computer......................... ON

74. L-BAND SATCOM
Communications . . . . ESTABLISHED

Start the Falcon program and send a preformatted on-station report

a. Click twice on CDT Icon.

b. Click on Mail then Create. Select ON-Station from pull down menu.

c. Select each tab and update applicable fields. When the transceiver field indicates XCVR Ready, send the message.

NOTE

L-BAND SATCOM System power-up and reporting is not required for local missions. For missions other than locals, power up the system and send an On-Station Report during preflight. On-station messages are only required during initial power up at the beginning of the crew duty day. It is not necessary to transmit on-station reports at intermediate stops throughout the day.

75. Gear Lights . . . . CHECK

NOTE

If center gear isolation switch is in UP and center gear is up and locked, CTR gear lights will be off.

76. A/R RECP Audio Switch . . . . OFF

77. FLT RCDR Switch . . . . NORM

NOTE

- With the FLT RCDR switch in NORM, the flight recorder will turn on when any engine is started and the parking brake is off.
- With the FLT RCDR switch in OVRD, the flight recorder will operate with parking brake on and engines shutdown.
- The FLT RECORDER OFF light will be on any time the flight recorder is not operating.

78. MAINT JACK Switch . . . . OFF

79. POTABLE WATER System . . . . CHECK

a. WTR QTY . . . . ADEQUATE

b. PRESS/DEPRESS Switch . . . . PRESS

c. WTR SYS PRESS LOW Light . . . . OFF

80. Deleted.

81. A/R RECP DOOR Handle . . . . CLOSED

82. FUEL System . . . . CHECK

CAUTION

Fuel System annunciator lights are not push-to-test circuits. Pushing in on the FUEL SCHED or FUEL DUMP VALVE OPEN light disengages the circuit and renders the light inoperative; malfunction would not be annunciated.

NOTE

- Annunciator lights can be tested by either the ALL TEST switch or the ANNUN LT AREA TEST SELECT switch and pushing the AREA TEST pushbutton.
- Recommend that the A/R pumps not be operated for internal transfer with a crossfeed valve open.

a. All Fuel System Lights . . . . OFF

NOTE

- FILL VALVE OPEN light(s) on with flow indicator light off indicates refueling is in progress. Delay test until refueling is completed. External control of the fill valves overrides FE's FILL VALVE switches, when off.
- Perform during the airplane preflight and after each ground refueling operation. Do not test the system while the aircraft is being refueled.

b. With FUEL QTY IND PWR switch in NORM, observe fuel quantity values.

c. Compare individual gage readings to total fuel quantity value on Totalizer/Gross Weight indicator.

d. Press and release the FUEL QTY TEST button and monitor the following sequence of events:

  (1) All main and body tank LCD Segments and Totalizer/Gross Weight indicator LCD segments illuminate for 4 seconds. The Totalizer/Gross Weight indicator displays 888880. The Main and Body Tank indicators display 188880.

  (2) Next, all LCD Segments blank for 1 second.

  (3) Last, the Main, Forward Body, and Aft Body Tank indicators display 99900 and the Center Body Tank indicator displays 199900. All indicators will display for 5 seconds.

NOTE

The Totalizer/Gross Weight indicator is not tested by the FUEL QTY TEST button, however, it will display Total Fuel Quantity based on the test values displayed on the individual indicators.

  (4) After test completion, all indicators return to previous values.

  (5) Position FUEL QTY IND PWR switch to ALTN and observe individual indicator displays do not change.

  (6) Return FUEL QTY IND PWR switch to NORM and observe individual indicators do not change.

e. FUEL QTY
Values . . . . RECORD/COMPARE

Record, as required, FUEL QTY values. Compare individual fuel gage totals with TOTAL FUEL QTY. Compare actual fuel against planned fuel. Check servicing record, if applicable.

f. Tanks 1, 2, and 3 AFT
PUMP Switches . . . . PUSH

Observe fuel pressure LOW lights come on and go off, and FUEL PRESS gages indicate normal. Leave AFT TANK PUMPS on until Exterior Inspection is complete.

NOTE

When engine is not operating, fuel pump pressure should be 15 PSI minimum.

g. TANK 3 FUEL Temp . . . LOGICAL VALUE

h. FUEL USED
RESET Button . . . . PUSH and HOLD

Observe FUEL USED readouts decrease to 00000.

i. FUEL USED RESET Button . . . . . RELEASE

j. MANF SCAV Selector . . . . OFF

k. A/R FUEL PRESS and FUEL
FLOW Gages . . . . NORMAL

l. MASTER FUEL ISOL VALVE
Switch . . . . NORM/PINNED

NOTE

The MASTER FUEL ISOL VALVE switch should be in NORM, except when special fuel is required to be isolated.

m. GROSS WT Indicator . . . . SET

Insert ZFW in GROSS WT indicator, release SET ZFW knob and observe GROSS WT indication increases to and stops at aircraft gross weight.

n. AR Boom . . . . FILL (IF REQ'D)

NOTE

Fill AR boom using boom fill procedures from Section VII.

o. Manifold
Scavenge . . . . RCVR/TANKER/OFF

CAUTION

If manifold scavenge system is inoperative, maintenance actions are required prior to flight.

Rotate MANF SCAV selector switch to RCVR and scavenge the UARRSI manifold. After the MANF SCAV PRESS LOW light illuminates, rotate the selector switch to TANKER and scavenge the tanker A/R manifold. After the MANF SCAV PRESS LOW light illuminates, rotate the selector switch to OFF. No more than 10 minutes should be required to scavenge the manifold. If the Pressure Low light does not illuminate within 10 minutes, maintenance is required. Ensure manifold is drained prior to flight.

NOTE

MANF SCAV PRESS LOW light will come on and stay on if system has been previously scavenged. If either manifold scavenge system is inoperative, make AFTO Form 781 entry. Ensure manifold is drained prior to flight.

* p. WING POD CONTROL PANEL . . . . CHECK (FE,BO)

WARNING

Wing Air Refueling pods must be kept full of fuel to decrease the risk of lightning strike potential, and for proper fuel pump lubrication.

NOTE

- Depressurize cross wing manifold if it cannot be determined that manifold was depressurized before starting this preflight item. Pressure may be relieved to obtain Fuel Inlet Pressure Low Lights by opening Wing Drogue Valve(s), then closing.
- Fuel Offload indicators should read zero. If not, a failure is indicated and maintenance is required.

(1) WING POD POWER Switch(es) . . . . ON (BO)

FE and Boom Operator verify FUEL INLET PRESSURE LOW/FUEL PRESS LOW lights are illuminated and LBS X 100 indicators display zeros.

(2) Any TRANSFER PUMP . . . . . . ON(FE)

(3) WING DROGUE VALVES . . OPEN(FE)

Drogue Valve Open Lights should illuminate and FUEL INLET PRESSURE LOW lights should extinguish.

(4) WING DROGUE VALVES . . . . CLOSED(FE)

(5) TRANSFER PUMP . . . . OFF(FE)

WING DROGUE VALVE Open Lights and FUEL INLET PRESSURE LOW lights should remain extinguished.

(6) WING POD POWER Switch(es) . . . . OFF(BO)

83. Hydraulic Motor Pump Switches . . . . OFF

NOTE

Do not accomplish this step until BO and FE have coordinated that the FLT CONT INOP light illuminates and extinguishes, and the ARO station computer preflight is complete.

a. MOTOR PUMP 2-3 Switch . . . . OFF

Observe HYD SYS 2 HYD PRESS gage indication decreases and 1-3/2-3 PUMP VALVE OPEN LIGHT remains on.

b. MOTOR PUMP 1-3 Switch . . . . OFF

Observe HYD SYS 1 HYD PRESS gage indication decreases and 1-3/2-3 PUMP VALVE OPEN light goes off.

NOTE

If 1-3/2-3 PUMP VALVE OPEN light operation is not normal, maintenance is required.

84. AUXILIARY HYDRAULIC Pumps . . . . . STOP

a. AUX PUMP 1 (ADG) Switch . . . . STOP

Observe system 3 HYD PRESS gage indicates in white band (or minimum acceptable pressure) and AUX HYD PUMP 1 ON light goes off.

b. AUX HYD PUMPS Switch . . . . STOP

Observe AUX HYD PUMPS ON light goes off and system 3 HYD PRESS gage indicates a drop in pressure.

85. Oxygen Mask, Regulator & Interphone . . . . CHECK

a. Set audio panel for operation. Set interphone and radio volume controls as desired.

b. Position regulator supply lever on and diluter lever to 100% and observe OXYGEN SUPPLY PRESSURE gage indicates approximately 70 PSI.

c. Don oxygen mask/smoke goggles and adjust as required. Ensure mask vent-valve is closed.

d. Move emergency oxygen toggle lever to EMERGENCY and observe oxygen flow under slight pressure. Take a few breaths to ensure blinker operation, then take deep breath and hold. A white blinker indicates a leak.

The emergency oxygen toggle lever may be held in TEST MASK to assist in checking mask to face seal.

e. Open the mask vent-valve and ensure positive flow. Keep mask vent-valve open for flight.

f. Move emergency oxygen toggle lever to NORMAL.

g. Test mask transmit capability by making test call on interphone and monitoring on headset or speakers.

h. Position regulator SUPPLY valve to OFF and attempt to breathe normally.

NOTE

Ability to breathe unrestricted on the first attempt indicates a faulty mask or regulator.

i. Remove and stow mask.

WARNING

To prevent inadvertent tripping of circuit breakers, ensure the nose piece is facing away from the circuit breaker panel when stowed. Critical system circuit breakers may be inadvertently opened.

86. AR RECP Shutoff Valve . . . . CLOSED

FE's EXTERIOR INSPECTION

NOTE: Suggested scan pattern is shown. The exterior inspection may be started at any convenient point provided all required items are inspected.

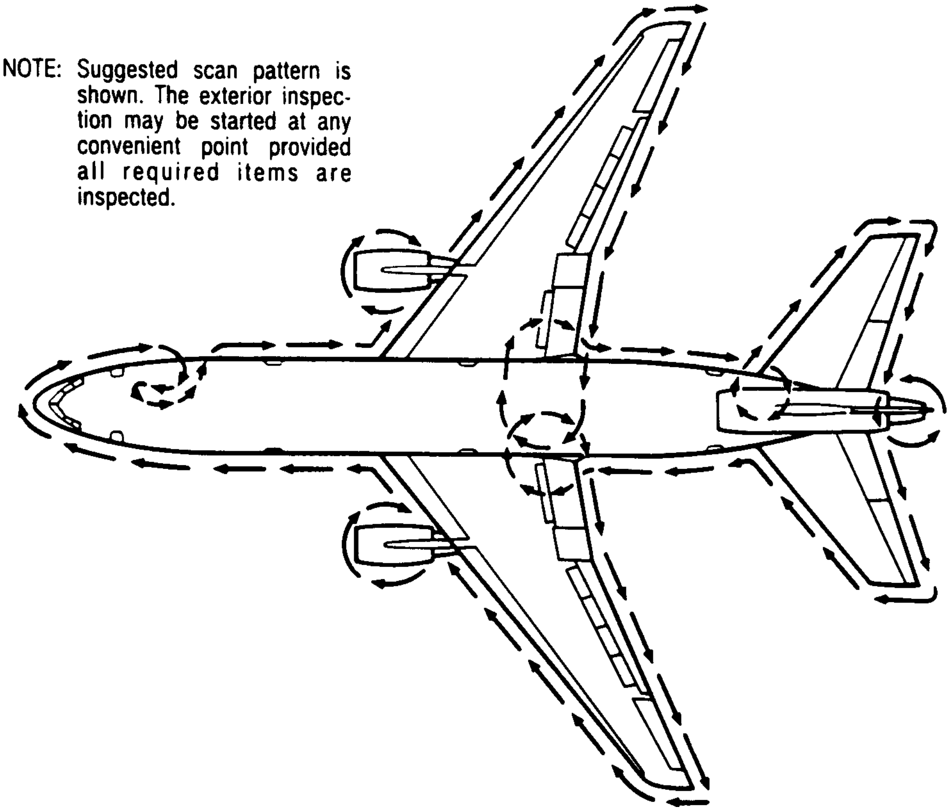

Figure 4-3. Exterior Inspection

1. NOSE SECTION

Pack Inlet and Exit Doors
L Angle of Attack Sensor
Pitot Tubes
Windshield Wipers
Skin and Radome
R Angle of Attack Sensor
TAT Tube

2. NOSE GEAR AND WHEEL WELL

Tires
Linkage (engaged)
Gear Safety Pin
Steering Bypass Pin
Landing/Taxi Lights
General Condition of Wheel Well and Bulkhead Door Closed
Leaks

3. RIGHT FORWARD FUSELAGE

Fwd Passenger Door
Landing Light
Static Ports
Mid Passenger Door
Cabin Pressure Relief Valves (door flush)
Skin (all panels closed and fastened)
Wing and Turnoff Lights

4. RIGHT WING AND ENGINE

Inboard Slat
Fuel Level Sticks and Panels
Engine 3 (panels closed and fastened)
Ground Wires (Removed)
Outboard Slat
Fuel Vent
Wing Air Refueling POD (if installed)

a. Panels closed and fastened.
b. RAT cover removed.
c. Strake on outboard side of POD.
d. Hose and basket stowed.
e. Light assembly retaining clip installed.
f. Retract crank removed.
g. Check for fuel leaks/POD damage.

Wing Tip and Lights
Outboard Aileron and Trailing Edge
Fuel Dump
Outboard Flap
Inboard Aileron
Inboard Flap

5. RIGHT LANDING GEAR

Tires
Strut
Gear and Wheel Well Area
Ground Lock Pin
Leaks
Brakes

6. CENTER GEAR

Tires
Strut
Strut Press Gage Normal
Linkage (engage)
Gear Safety Pin
General Condition of Wheel Well
Brakes

7. CAC SHROUD, FWD TANK, and AFT TANK LEAK SENSE DRAINS (Reference Figure 4-4)

Coordinate with ground crew to push drains and record findings in AFTO Form 781A and/or leak check log. Confirm any detected leaks do not exceed allowable rate in accordance with TO 1C-10(K)A-2-28.

NOTE

- Always use a collection device when pushing fuel leak sense drains. This ensures accurate and continuous leak check information.
- Enter date, time, and amount drained (even if zero).
- Not required if ground crew accomplished during maintenance preflight of aircraft.

8. RIGHT AFT FUSELAGE

Right Aft Exit Door
Fuselage Skin (all panels closed and fastened)
APU Compartment Door
APU Inlet Doors (closed and clear if not operating)
APU Exhaust Area Clear
Boom and ARO Station Windows

9. EMPENNAGE AND CONTROL SURFACES

All Fixed and Movable Control Surfaces (panels closed and fastened)
Elevator Surfaces (both inboard fasteners secured)
Tail Cone
Engine 2 (panels closed and fastened)
Fan Exhaust Thrust Reversers
Rudder Surfaces
Boom and Drogue Area
Leaks

10. LEFT AFT FUSELAGE

Inspection Same as Right Aft Fuselage
(except Exit Door)

11. LEFT LANDING GEAR

Inspection Same as Right Landing Gear APU Ground Control Panel

12. LEFT WING AND ENGINE

Inspection Same as Right Wing and Engine, to include WARP POD if installed.

13. LEFT FORWARD FUSELAGE

Inspection Same as Right Forward Fuselage
Outflow Valve (full open)
Ground Pneumatic Connectors
Oxygen Blowout Disc (normal)
Water/Oxygen Service Panel Closed
Avionic Venturi Discharge Clear
Cargo Door and Vent Valve (flush and closed)

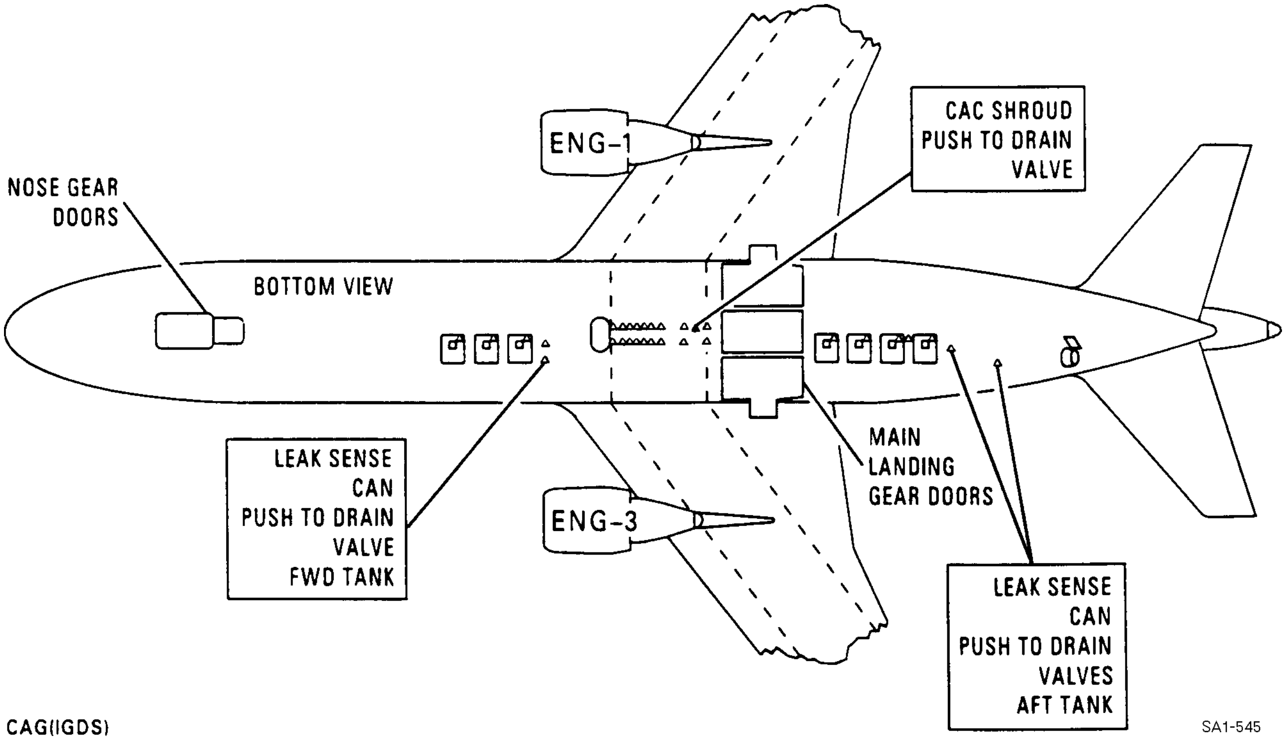

Figure 4-4. CAC Shroud, FWD Tank and AFT Tank Leak Sense Drains

PILOT'S INTERIOR INSPECTION

1A. KY-58/KG-35/IFF
Mode 4 Code . . . . INSERTED (CP)

NOTE

This item may be accomplished by any crewmember at any time before takeoff.

Insert the IFF Mode 4 code into the integral KI-1C transponder computer in avionics compartment.

KY-58 SETUP AND LOADING PROCEDURES

Successful secure voice communications depends on correct loading procedures and having the correct keying tapes. The Navy uses different keying tapes than the Air Force. Coordinate with combat crew communications personnel and receiver units to ensure all aircraft/vessels involved are using the same codes. Use your frag/air tasking order to determine communication requirements. Ensure:

a. Appropriate keying tapes are used.

b. Diphase/Baseband requirements (DPV or BBV).

c. Frequencies.

d. EMCON levels.

Circuit Breakers Check (COCKPIT)

Ensure the following circuit breakers are closed:

a. Secure voice (FE overhead CB panel, E-32).

b. FLT INPH CAPT & FE audio (pilot overhead CB panel, D-12).

c. F/O OBS & avionics audio (pilot overhead CB panel, D-27).

d. UHF COMM-1 (pilot overhead CB panel, D-15).

e. UHF COMM-2 (pilot overhead CB panel, D-29).

f. UHF COMM-2/SATCOM (pilot overhead CB panel, E-27).

KY-58 Setup (AVIONICS COMPARTMENT)

a. Power switch . . . . ON

b. Volume control . . . . . 1 O'CLOCK POSITION

c. Mode switch C

d. DPV/BBV switch . . . . DPV or BBV

NOTE

Coordinate with receivers on DPV or BBV. All aircraft must be in the same position (DPV or BBV). This switch is located on the lower end of the KY-58 unit. Use a small screwdriver to make your selection.

e. Filter switch . . . . IN if using DPV,
OUT if using BBV

f. KYK-13 . . . . OFF

Press the PTT switch on the KYK-13. The red light on the KYK-13 should blink indicating that it is loaded.

g. KYK-13 . . . . CONNECT TO KY-58

NOTE

Connect the KYK-13 directly to the KY-58 or through a cable. If using a cable, moisten the O-ring to ease cable installation. Align red dot on the KYK-13/KY-58 with flat side of cable connector. Push in and turn clockwise 1/4 turn.

h. KYK-13 . . . . ON

KY-58 Loading Procedures (COCKPIT)

Use a headset when loading the KY-58. Secure voice cannot be heard over the cockpit speaker and can only be used from the pilot, copilot, and flight engineer audio panels. The secure voice radio cannot be used from either boom operator position (cockpit or ARO compartment).

a. DP/BB switch .... DP or BB

NOTE

This switch is located on the back of the KY-58 remote control head (cockpit). Use a screwdriver to remove the control head from the panel and to make your selection. The selected position must coincide with the DPV/BBV switch selection on the KY-58 unit in the avionics compartment (DP for DPV, and BB for BBV).

b. UHF radio .... ON (BOTH)

c. C/RAD/
Plain switch .... C/RAD 1 or C/RAD 2

d. Delay switch .... OFF (DOWN)

e. Mode switch .... LD (LOAD)

f. Fill position .... 1 or as required

g. Headset .... Connected and ON

h. Power switch .... ON

The alarm should beep when power is turned on.

i. UHF 1 or 2 .... KEY

This action clears the alarm tone and gives you a steady tone. If in C/RAD 1 use UHF #1. If in C/RAD 2 use UHF #2.

j. UHF 1 or 2 .... KEY

This action clears steady tone and provides a beep.

k. UHF 1 or 2 .... KEY

A total of 2 beeps should be heard; one beep when keyed, and one beep when released.

l. Load additional codes .... AS REQ'D

(1) Fill position switch (KYK-13):2 or as required.

(2) Fill position switch (KY-58):2 or as required.

(3) UHF 1 or 2:key.

NOTE

The KY-58 will transfer the codes from the KYK-13's current fill position only. If a different code is desired, then go to the avionics compartment and select a new fill position on the KYK-13. Select the fill position to be loaded on the control head in the cockpit, and then transfer the code (key the mike as in step #i). The same code can be transferred to all 6 fill positions by repeating steps l(2) and l(3) above or load 6 different codes by repeating steps l(1), l(2), and l(3).

m. Mode switch .... OP

Key UHF 1 and check for a preamble beep (BE-BOP). Check quality of sidetone (it should be clear). If sidetone quality is unsatisfactory, adjust volume on secure voice audio panel in the cockpit. When C/RAD switch is in C/RAD 1 or 2, the volume control for the UHF radio selected is inhibited and volume is controlled by the secure voice audio panel. If sidetone is still unsatisfactory, adjust volume control in avionics compartment.

NOTE

- A single beep is heard at the beginning of each secure voice transmission. The BE-BOP tone will be heard again when the system has been turned off then on again. BE-BOP tone should cease after the radio is keyed again to transmit.
- If the radio does not operate properly in the secure mode, try cycling the KY-58 remote power switch (in the cockpit) OFF then back to ON. Key the radio to transmit to clear the continuous BE-BOP, then try secure operation again.

n. KYK-13 .... OFF

NOTE

The KYK-13 can remain connected to the KY-58 (in the avionics compartment) in case the codes are lost and have to be reloaded, however, do not leave the KYK-13 power switch on or the battery will deplete in about 10-15 minutes

KY-58 Zeroize Procedures (Cockpit)

a. Zeroize cover . . . . RAISE

b. Zeroize switch . . . . PUSH FORWARD

c. Zeroize cover . . . . CLOSE

d. Power switch . . . . OFF

NOTE

This action zeroizes all fill positions. If desired, the power switch may be placed to off without zeroizing and the codes will remain, unless the battery in the KY-58 unit (in the avionics compartment) is depleted.

1B. (**WITH TCTO 1C-10(K)A-1243**) Iridium Phone . . . INSTALLED/INITIALIZED (CP)

a. Rotate phone mount security latch up (if required).

b. Press and hold antenna lock release button and install Iridium phone into phone mount.

c. Rotate phone mount security latch down. Ensure security latch is completely latched in detent.

d. Remove phone mount audio plug from stowed position. Remove rubber cap and insert plug into Iridium phone audio jack receptacle.

e. Place phone mount Iridium System Master switch to ON (up).

f. Press Iridium phone POWER ON/OFF button.

Iridium phone screen will indicate "Registered".

NOTE

- If the phone message "Rotate and Extend Antenna" is displayed after power-up, enter *#92# to bypass the interlock. This only needs to be accomplished once per phone.
- Depending on how the Flightcell DZM was previously set up on shutdown, it may startup automatically. There fore, step g. will not be required.

g. Press Flightcell DZM control panel POWER/ENTER/CONNECT key.

Flightcell initialization will take approximately 15 seconds.

2. FMS . . . . LOAD/INSERT (CP)

a. On CDU3, select IDX, then LS4 to access the GPS SA/AS page.

b. GPS Crypto Keys . . . . LOAD (IF REQ'D)

(1) Set the KYK-13 address switch to the appropriate fill position.

(2) Check the KYK-13 mode switch OFF and connect it to the GPS1 fill port.

(3) Set KYK-13 mode switch to ON, then OFF. The load status light will flash once and the CDU3 GPS SA/AS page will show DAYS [1] or [2] KEYS LOADED.

NOTE

- If DAYS [0] or NO KEYS is displayed, GPS crypto keys are not loaded.
- The GPS will erroneously accept some codes such as a mode 4, or corrupt code and display "DAYS [1]" without warning via a dashed "DAYS" display or "WRONG KEY" display. Absence of a GPS signal can be confirmed on the satellite data page (select INAV LS8). If the absence of a signal is caused by erroneous codes, GPS navigation is not possible until the GPS codes are zeroized.
- If out of date or incorrect keys are loaded, the DAYS display will be dashed and WRONG KEY will be displayed.

(4) Disconnect KYK-13 from the fill port.

(5) Repeat steps (1) through (5) for GPS2.

c. Data Cartridge(s) . . . . INSERT

Insert the data cartridges(s) into the data loader receptacle mounted in the flight engineer's equipment panel and then close and secure the door.

NOTE

Slot A is the bottom slot.

3. MASTER WARN & MASTER CAUTION Lights . . . . RESET AS REQ'D (P,CP)

Observe MASTER WARN light is off.

NOTE

If MASTER WARN light is on, push to reset MASTER WARN light. Observe summary and specific red annunciator lights.

Observe MASTER CAUTION light is off.

NOTE

If MASTER CAUTION light is on, observe cue lights. If cue light(s) is on, push to reset cue light(s) and observe FE's panel. If cue light(s) is off, push to reset MASTER CAUTION light and observe annunciator lights and FE's panel.

4. Station Lighting . . . . SET (P,CP)

   a. Adjust the following light-switches to desired intensity - BRIEFCASE, FLOOR, MAP, FLOOD, and PNL & FMA.

   b. Adjust FGS light-switch (under FGS panel) for desired light intensity of FGS panel. Adjust PNL and FLOOD control knobs on OVHD PNL LT panel to desired intensity.

5. Oxygen Mask, Regulator
   & Interphone . . . . CHECK (P,CP)

   a. Set audio panel for operation. Set interphone and radio volume controls as desired.

   b. Position regulator supply lever on and diluter lever to 100% and observe OXYGEN SUPPLY PRESSURE gage indicates approximately 70 PSI.

   c. Don oxygen mask/smoke goggles and adjust head band required. Ensure mask vent-valve is closed.

   d. Move emergency oxygen toggle lever to EMERGENCY and observe oxygen flow under slight pressure. Take a few breaths to ensure blinker operation, then take deep breath and hold. A white blinker indicates a leak.

      The emergency oxygen toggle lever may be held in TEST MASK to assist in checking mask to face seal.

   e. Open the mask vent-valve and ensure positive flow. Keep mask vent-valve open for flight.

   f. Move emergency oxygen toggle lever to NORMAL.

   g. Test mask transmit capability by making test call on interphone and monitoring on headset or speakers.

   h. Position regulator supply valve to OFF and attempt to breathe normally.

NOTE

Ability to breathe normally unrestricted indicates a faulty mask or regulator.

   i. Remove and stow mask.

6. WX Radar . . . . TEST (P,CP)

   a. WX Radar Mode Selector . . . . STBY

NOTE

STBY causes both receiver-transmitter units to be moved to the standby mode. A 3-minute warmup period is required for proper operation.

   b. SYS Select Switch . . . . SYS 1

NOTE

When WX, MAP 1, MAP 2, or BCN mode is selected, the unselected R/T unit remains in standby.

   c. GAIN Control Knob . . . . AUTO

   d. ANT TILT Control . . . . FULL UP

   e. INT and TGT CLAR
      Controls . . . . MIDRANGE

   f. Range Selector 150

   g. WX Radar Mode Selector . . . . TEST

      Adjust INT and rotate TGT CLAR as required and observe test pattern on scope.

   h. SYS Select Switch . . . . SYS 2

      Repeat step g.

NOTE

If test pattern is improper, maintenance is required.

   i. WX Radar Mode Selector . . . . STBY

7. UHF Comm . . . . SET (P,CP)

   a. UHF-1 Mode Selector . . . . BOTH/SET

      (1) TOD/WOD/Net

Number . . . . SET (If Applicable) (P)

TOD is set by tuning radio to a frequency transmitting a UTC time signal.

NOTE

- Initial TOD reception must be accomplished in normal operation mode.
- On initial ARC-164(V) power-up, the first TOD message received is automatically accepted. Subsequent TOD transmissions are ignored.
- Transmission of TOD must be requested if frequency/station selected is not transmitting a constant time signal.
- If time is being automatically beaconed, the ARC-164(V) will accept the first TOD message received within one minute of selecting T position.
- If UTC signal is not available, start clock within radio by selecting T on hundredth selector and simultaneously pushing TONE button. Release TONE button prior to releasing hundredth selector from T position to preclude transmission of time signal. If required, this time signal may be transmitted as initial TOD signal to other aircraft on frequency by pushing and holding TONE button approximately 3 seconds. The other aircraft must select T first if a previous TOD had been received.
- If UTC signal is not available for ARC-164(V) TOD synchronization, a WOD or MWOD must be entered, then perform TOD emergency clock start. A date tag must be entered if MWODs have been entered. Set CHAN switch to 1 and select frequency switches in the format XAB.XXX (AB equals day of month, 01-31, and X equals don't care). Set T-Tone switch to TONE momentarily. Set CHAN switch to 20 and M-P-G switch to PRESET. Set frequency switches to 220.000, then press and release LOAD pushbutton. Press STATUS switch and VER/OP is displayed on F/S indicator. Set M-P-G switch to MNL, and T-TONE switch to T while pressing TEST DISPLAY switch, then release.
- If a TOD update is required (ground/inflight), place hundredth selector to T for approximately 3 seconds, then return it to assigned frequency and request a TOD signal from another aircraft or ground station. TOD will be updated if signal is received within one minute after selecting T. A momentary tone will occur when update signal is received.
- If a TOD update is required for ARC-164(V), set frequency switches or CHAN switch to a predesignated frequency. Momentarily select T position on T-TONE switch. Request TOD from another station.
- To provide a TOD update for another station with ARC-164(V), set frequency switches or CHAN switch to a predesignated frequency in normal mode, or net number in AJ mode. Set T-TONE switch to TONE momentarily.

WOD is entered by:

Rotating MANUAL-PRESET GUARD selector to PRESET and CHAN selector to 20.

NOTE

A single or double BEEP will occur when channel 20 is selected.

Set desired WOD segment starting with hundredth manual frequency selector. Lift preset frequency directory and push PRESET button to enter WOD segment into normal (nonvolatile) PRESET channel memory. Select next lower channel and repeat process until complete WOD segment is entered into nonvolatile memory. After WOD entry is completed, reselect channel 20 to transfer WOD from nonvolatile to Have Quick (volatile) memory. A single or double beep will occur when channel 20 is selected. If a single beep occurs, progressively select next lower channel until a double beep occurs. A single beep indicates WOD was accepted and an additional segment exists in next lower channel. A double beep indicates all WOD segments have been transferred into volatile memory.

NOTE

Switching radio off or selecting channel 20 with MANUAL-PRESET GUARD switch in PRESET will cause WOD segment to revert to nonvolatile memory. Repeat above transfer procedure to retransfer WOD from nonvolatile back to volatile memory.

ARC-164(V) single WOD is entered by:

Set M-P-G switch to PRESET and CHAN to 20. Set frequency switches to select WOD element. Lift access cover and press LOAD switch. Set CHAN switch to next lower channel and repeat process until all WODs are entered. Initialize radio set by setting CHAN to 20, and listen for a single beep. Progressively switch to next lower channel until a double beep is heard, indicating all WODs are transferred to nonvolatile memory. Set M-P-G switch to MNL.

Once TOD and WOD have been entered, a valid active net number may be set in the three frequency digits following the A by using manual frequency selectors.

ARC-164(V) MWODs may be entered either manually or by using KYK-13/TSEC keyfill device. MWODs are entered manually by:

Set CHAN switch to 20 and set M-P-G switch to PRESET. Set frequency switches to 220.025 (MWOD Load command code); press and release LOAD pushbutton. Set M-P-G switch to MNL and CHAN switch to 20. Set five frequency switches to enter the first WOD element. Set T-TONE switch to TONE then release. Note all audible tone. Set CHAN switch to 14 and set frequency switches to enter date tag. Set T-TONE switch to TONE momentarily. One complete WOD is now entered. Remaining WOD elements are loaded in memory locations 19-15 by repeating above procedure.

MWODs are entered using KYK-13/TSEC by:

Set CHAN switch to 20 and frequency switches to 220.000. Lift access cover and press Load. Set M-P-G to MNL, lift access cover and remove FILL connector cover. Set KYK-13 mode switch to OFF/CHECK. Install KYK-13 on FILL connector. Set KYK-13 mode switch to ON and observe F/S indicator displays FILL. Set KYK-13 address switch to applicable channel (1-6). Press radio set LOAD switch. A series of beeps are heard and F/S indicator displays WOD OK.

NOTE

- The CHAN indicator steps down from memory location 20 to 14, then displays memory location one while KYK-13 is connected and turned on. This allows entry of date tag, if required. The date tag must match the date code of one WOD being loaded with the KYK-13.
- If F/S indicator displays BAD, KYK-13 must be reloaded and procedure repeated.

Set KYK-13 address switch to next channel and press LOAD for each remaining WOD to be loaded. Load date tag by pressing the STATUS switch, then select date on frequency switches in format XAB.XXX. Set T-TONE switch to TONE momentarily. Set KYK-13 mode switch to OFF/CHECK and unplug the device. Install connector cover and close access cover.

b. UHF-2 Selector . . . . BOTH/SET

c. Bite Test Selector . . . . LAMP

Observe TEST FAULT light comes on.

d. Bite Test Selector . . . . OPR

Observe light goes off.

NOTE

If TEST FAULT light remains on, maintenance is required.

e. SQUELCH Switches . . . . ON

f. UHF-2 (audio panel) . . . . SET

Make UHF radio check, using control wheel microphone switch or HOT MIC/RADIO switch on audio panel. Monitor receiver audio over headset or cockpit speakers. This item need not be accomplished unless radio maintenance has been accomplished.

NOTE

- UHF-2 preset frequencies may be changed by rotating mode selector to MAIN and the GUARD - PRST - MANUAL selector to PRST. Turn PRESET CHANNEL selector to desired channel and set desired frequency in readout, using manual FREQUENCY selector knobs. Push PRESET STORE button and observe light (in switch) comes on, then goes off when button is released.
- Record new preset frequency on frequency chart adjacent to appropriate channel number.

g. Secure Voice
(KY-58) . . . . SET/CHECK
(If Applicable) (P,CP)

8. Audio Panels . . . . SET (P,CP)

a. Push desired microphone selector.

b. Set volume control levers as desired.

c. Set audio switches as desired.

NOTE

- If transmission is desired using oxygen or boom microphone, move HOT MIC/ RADIO switch to HOT MIC or RADIO, as appropriate, or use microphone switch on control wheel.
- If communication with ground crew using flight interphone is desired, push the MECH CALLING switch-light. When mechanic answers over flight interphone, communicate using headset or oxygen mask microphone.
- If communication with the ground crew using service interphone is desired, use the handset on the aft pedestal (ensure the maintenance jack switch is in the MAINT JACK position). Communications with the ground crew over the service interphone can also be accomplished by pushing the INT microphone selector button on the audio panel and either moving the HOT MIC/ RADIO switch to RADIO or pulling aft on the microphone switch on the control wheel.

9. VHF Comm . . . . CHECK (P,CP)

a. VHF Frequency Selectors . . . . .SET

b. VHF TFR Switch . . . . .SET

c. SQ/DISABLE Switch . . . . AS REQ'D

Verify audio panel is set for VHF radio transmission and make VHF radio check using headset or oxygen mask microphone. Monitor receiver audio over headset or cockpit speakers. This item need not be accomplished unless radio maintenance has been accomplished.

10. EHSIs . . . . TEST (P,CP)

a. Push DU TEST button to access the DU Status page. If any item is annunciated Red, perform steps B, C, and D. If not, continue with step E.

b. Press the DU TEST button for two seconds until the PRESS TEST TO CONTINUE IBIT message is displayed.

c. Press the DU TEST button for two seconds while the IBIT confirmation message is displayed. If not pressed within five seconds, the IBIT command is cancelled.

d. If the annunciated item remains Red maintenance is required.

e. Press PUSH-DIRECT button on EHSI control panel to return to normal display.

11. IFF/ETCAS . . . . CHECK/SET (P,CP)

a. M4 REPLY Light . . . . .PRESS-TO-TEST

b. Verify IDENT/OUT/MIC, RAD TEST, Mode 4 AUDIO/LIGHT/OUT, and each Mode SEL/ TEST switch in OUT position.

c. MASTER Switch . . . . NORM

Mode 3/A code is displayed on the control panel.

d. M-1 Switch . . . . TEST

Momentarily actuate the SEL A/SEL B switch to SEL A; Mode 1 code is displayed. Hold M-1 switch to TEST momentarily, then release to ON. M1 PASS should be displayed. Return switch to OUT.

NOTE

The normal display after a mode test is M[X] PASS (X = 1, 2, 3, C, or S). If any M[X] FAIL message is displayed, see figure 1.13-13 for appropriate actions.

e. M-1 Code . . . . .SET

Using data select switches, set Mode 1 code as required.

f. M-2 Switch . . . . TEST

Hold M-2 switch to TEST momentarily, the release to ON. M2 PASS should be displayed. Return switch to OUT.

g. M-2 Code . . . . .SET

Momentarily actuate the SEL A/SEL B switch to SEL B until the Mode 2 code is displayed. Using the data select switches, set Mode 2 code as required.

h. Mode 3/A Switch .... TEST

Hold M-3/A switch up momentarily to TEST, then release to ON. M3 PASS is displayed first, then MS TEST, and finally MS PASS. If Mode S is disabled, MS DISABLE is displayed (see figure 1.13-13 for appropriate actions). If Mode S is enabled, TCAS self-test will be initiated. On the TVSI, observe TEST is annunciated and the four traffic symbols, green arc, and red band are displayed. At self-test completion, check TCAS displays disappear, only VSI information is displayed, and TCAS system test OK is announced over the speaker. Leave switch in ON.

NOTE

- With the MASTER switch set to NORM, the M-3/A switch controls Modes 3, C, and S, if enabled.
- TCAS self-test will FAIL if Mode 4 switch is ON without Mode 4 keys loaded. M-C self test will fail if M-3/A switch is in OUT.

i. M-3/A Code ....SET

Using data select switches, set Mode 3/A code as required.

j. M-C Switch .... TEST

Hold M-C switch to TEST momentarily, then release to ON. MC PASS should be displayed. Return M-C and Mode 3/A switches to OUT.

k. Mode 4 TEST/ON/OUT Switch ...... TEST

Hold MODE 4 TEST/ON/OUT switch to TEST momentarily, then release to ON. M4 PASS should be displayed. Both the M4 REPLY light on the control panel and the IFF MODE 4 light on the annunciator panel should be off. If either light is on, see figure 1.13-13 for appropriate actions.

l. Mode 4 TEST/ON/OUT Switch .... OUT

m. Mode 4 CODE

Selector .... A OR B AS REQ'D

NOTE

- If cocking or preflighting the aircraft for alert, the Mode 4 codes will automatically hold when aircraft power is turned off.
- If the aircraft has flown (ground sensing has been cycled), the Mode 4 codes will automatically zeroize unless the MODE 4 CODE selector is moved to HOLD at least 15 seconds before the MASTER switch or aircraft power is turned off.

n. Mode 4 AUDIO/LIGHT/OUT
Switch .... AS DESIRED

NOTE

IFF MODE 4 caution light on pilots' overhead annunciator panel will come on if Mode 4 is not operative. Light is operative when aircraft power is on and IFF MASTER switch is not in OFF. IFF MODE 4 caution light will come on to indicate (1) Mode 4 codes have zeroed, (2) self-test function of KI-1C transponder computer has detected a fault, or (3) the transponder is not replying to proper Mode 4 interrogations.

o. MASTER Switch .... STBY

p. Modes
1, 2, 3/A, C, & 4 ....ON (AS REQ'D)

12. Present Position/
Effectivity Date .... CHECK (P,CP)

a. Access the Start 1 page on any CDU and compare displayed GPS present position coordinates with coordinates of ramp position and verify correct.

b. Scroll vertically to the Start 3 page. Verify the effectivity date of the ICAO database(s) is correct (date is displayed as day/month/year) and select DB A or DB B as the ICAO database to be used. If no database is available, data line(s) 2 and/or 4 will display dashes. Scroll to the Start 4 page and select the MSN A or MSN B data cartridge as the mission data to be used.

c. Ensure each MSU mode selector is in ALIGN.

d. Access the INAV page for each INU on its corresponding CDU (Pilot/INU1, Copilot/INU2, FE/INU3) by pressing the INAV key and laterally scrolling to the appropriate INU INAV page. When the appropriate page is displayed. INU CONTROL will be displayed at LS4. Observe present position coordinates on the information line.

e. Compare displayed INU coordinates with coordinates of ramp position and verify correct.

NOTE

Present position must be correct. INU aligns to any longitude (E/W) without alignment delay or warning. Entering incorrect latitude (N/S) may result in halting alignment. If coordinates are not within ±0.1 minute, rotate MSU mode selector to STBY, enter present position coordinates correctly, and reselect ALIGN.

13. AV Radios .... SET (P,CP)

a. Access the FMS Nav Radio pages and set ADF/ANT mode to ANT. Set desired LF station frequency.

b. Set TACAN operating mode to TR and select desired channel.

14. ADF .... CHECK (P,CP)

a. ADF (Audio Panels) .... AUDIO SELECT

Identify selected station. Volume may be adjusted on the NAV RADIO VOLUME control panel. Set tone on or off as necessary to facilitate station identification.

b. RMI ADF-1 Switch .... LF

c. ADF/VOR Selectors .... ADF

Observe RMI bearing pointers move to the 9 o'clock position.

d. EHSI Bearing Pointer .... ADF

Select ADF1 as the bearing source on the pilot's EHSI and ADF2 on the copilot's EHSI. Observe that the bearing pointers point to the 9 o'clock position.

e. ADF/ANT Mode .... ADF

Observe RMI and EHSI bearing pointers move to the correct station bearing.

f. ADF .... TEST

. Access the Test pages by pressing the IDX key and selecting TEST (LS7). Scroll vertically to the NAV Sensor Test page. Press the ADF1 and ADF2 line select keys (LS1 and LS5). Observe the dashes next to ADF1 and ADF2 change to TST and the RMI and EHSI bearing pointers move to 45° left of the lubber line for 10 seconds.

15. TACAN .... TEST (P,CP)

NOTE

Allow 90 seconds for receiver transmitter unit to warm up after power is initially applied on the FMS Master Power page. Channels 01X to 126X or 01Y to 126Y may be selected. Self-test may be performed on any channel; a receivable channel is not required.

a. EHSI Navigation Source .... TCN

Observe the EHSI navigation source annunciator indicates TCN1 on the pilot's EHSI and TCN2 on the copilot's EHSI, and the TRU annunciator is not displayed.

b. EHSI Bearing Pointer .... TCN

Observe the EHSI bearing source annunciator indicates TCN1 on the pilot's EHSI and TCN2 on the copilot's EHSI.

c. Course Selectors . . . . 180°

Rotate navigation control panel course selectors to 180° in preparation for TACAN self-test.

WARNING

Even though the FMS has a test GROUND ONLY inhibit, do not attempt to perform self-test while in flight with autopilot engaged and in TACAN NAV mode. If the FMS GROUND ONLY inhibit fails, bearing outputs during self-test can cause autopilot to maneuver aircraft abruptly.

d. TCN1/TCN2 Line Selects (NAV Sensor Test page) . . . . PRESS

Observe TST indication beside TCN1 and TCN2 indicating self-test in progress.

For approximately 7 seconds, observe DME distance indicators are barred (EHSI distance shows 0.0), EHSI NAV and bearing fail flags are in view, TACAN RMI bearing pointers indicate 270°, NAV FAIL annunciator is illuminated, and EHSI bearing pointers and CDIs are removed from view.

Following the 7 second interval, observe DME distance indicators read 000.0 ±0.5 NM (EHSI distance shows 0.0), NAV fail flags and annunciator are removed from view, EHSI course deviation bars are centered, TO/FROM indicators indicate TO, and TACAN RMI and EHSI bearing pointers indicate 180 ±3°.

After 15 seconds, observe DME bars, NAV FAIL annunciator, and EHSI NAV fail flags come back into view, unless a usable signal is present.

If TST indicator goes off, the distance, bearing, course deviation, and TO/FROM information is valid.

NOTE

- If TST indicator remains on, repeat test in R mode.
- If TST indicator remains on in both TR and R modes, the distance, bearing, course deviation, and TO/FROM information is invalid.
- If TST indicator remains on in TR but not in R, the distance information is invalid, and the bearing, course deviation, and TO/FROM information is valid.

16. Deleted

17. Clocks . . . . SET

NOTE

The flight engineer's clock should be set as accurately as possible. This clock sets the time base data of the Flight Data Recorder.

a. GMT Readout . . . . CHECK

NOTE

If time is incorrect, set correct time with GMT set knob.

b. ELAPS Button . . . . PRESS TO ZERO ELAPS TIME

c. CHRO Button . . . . PRESS TO RESET HANDS

18. MACH/AS Indicator . . . . CHECK (P,CP)
Observe MACH/AS indicator for normal indications.

NOTE

Normal static indications at sea level; airspeed pointer approximately 0, V_{MO} pointer approximately 350 knots, MACH readout 0.150, and no flags.

19. ADIs . . . . TEST/CHECK (P,CP)

    a. Observe attitude indication is normal and flags are out of view.

    b. ADI TEST Button . . . . . . PUSH AND HOLD

    Observe the following:

    - Attitude - Climbing right turn, 10° (±5°) pitch and 20° (±5°) bank. GYRO flag in view.
    - V-Command Bar - Commands climbing right turn. FD flag in view.
    - Decrab Indicator - Deflected to right edge of aircraft symbol.
    - Runway/Localizer Indicator - Indicator centered and at 100 feet (halfway up). RUNWAY flag in view.
    - Glideslope Pointer - At bottom of glideslope scale. G/S flag in view.

    c. ADI TEST Button . . . . RELEASE

    Observe rate of turn indicator is centered and RT flag not in view.

    Crosscheck slip indicators for agreement and normal indication.

20. Altimeters . . . . SET (P,CP)

21. Radio Altimeters . . . . TEST (P,CP)

    a. DH Bug . . . . SET 15 FEET

    Observe DH lights on radio altimeter and ADI are on.

    NOTE

    If LOC TRK or G/S TRK is annunciated in FMA, the associated radio altimeter test is inhibited. Moving the FD switch to OFF and back to FD, if applicable, will enable the test.

    b. PUSH-TO-TEST Knob . . . . TEST

    Observe pointer indicates 40 feet, warning flag is in view, and both DH lights go off.

    c. PUSH TO TEST Knob . . . . RELEASE

    Observe pointer returns to zero, warning flag goes out of view, and both DH lights come on.

    d. DH Bug . . . . SET BELOW ZERO

    Observe DH lights go off.

22. TACAN RMI, VOR/ADF RMI, and EHSI . . . . X-CHECK HDG AND FLAGS (P,CP)

    a. Compare TACAN RMI, VOR/ADF RMI, and EHSI headings with standby compass heading.

    NOTE

    FMS heading switch must be in MAG to make a comparison.

    b. Verify HDG flags are not in view.

    c. Set FMS Heading switch to TRUE and verify TRU annunciator is displayed by EHSI lubber line.

    d. Verify °T symbol is displayed adjacent to TRK display on the FMS PSN or STR page.

    e. Set FMS Heading switch to MAG and verify TRU annunciator is removed from EHSI.

    f. Verify ° symbol is displayed adjacent to TRK display on the FMS PSN or STR page.

23. TVSIs . . . . CHECK (P,CP)

    Observe standard vertical speed indicator is displayed (no TCAS) and amber VSI flag is not in view.

24. Standby Attitude Indicator . . . . CHECK (P)

    a. Observe flag is out of view.

    b. Pull knob to cage standby attitude indicator, then release knob.

c. Rotate set knob to adjust pitch indication as desired.

NOTE

In the event of errors caused by extended bank or fore/aft acceleration, the aircraft should be brought to wings level attitude and the indicator should be momentarily caged while avoiding a snap release of the Caging/Pitch Trim Control. If the error exceeds 3 degrees, maintenance is required.

25. Standby Altimeter . . . . SET (P)

26. Standby Airspeed Indicator . . . . CHECK (P)

Observe indicator pointer for a stable reading.

27. TAS/SAT . . . . CHECK (P)

Observe indicator OFF warning flags are not in view.

NOTE

When TAT button on indicator is pushed, TAT will be shown in SAT readout. It is independent of TAT on N_1/TAT indicator.

28. FD Switches . . . . FD (P,CP)

NOTE

Roll annunciator will display HDG HOLD and pitch annunciator ALT HOLD.

29. VOR/ILS Control Panels . . . . SET (P,CP)

a. Verify EHSI navigation source and bearing source are set to VOR1 for the pilot and VOR2 for the copilot.

b. Select VOR frequency to be used for VOR test.

NOTE

A receivable frequency is not required for VOR test.

c. Verify 180° is set in CRS readout.

30. ATS Panel . . . . SET (P)

a. ATS Levers . . . . OFF

b. SPD Select . . . . SET V_2 SPEED

Observe command airspeed bugs and pilot's and copilot's MACH/AS indicators agree with SPD readout.

31. HDG Readout/FD Roll Bars. . . . . SET/CHECK (P)

a. Rotate HDG control knob until aircraft heading appears in HDG readout.

b. Momentarily pull HDG control knob and observe HDG SEL appears in FMA roll channel.

c. Rotate HDG control knob clockwise, then counterclockwise, and observe flight director V-command bars respond accordingly.

d. Rotate bank angle selector to 15°.

e. Push HDG control knob in fully and observe HDG HOLD appears in FMA roll channel.

32. Vertical Speed Selector/
V-Command Bars . . . . CHECK (P,CP)

a. Rotate vertical speed selector to a climb and observe pitch FMAs display VERT SPD and flight director V-command bars indicate fly-up.

b. Rotate vertical speed selector to a descent and observe pitch FMAs display VERT SPD and flight director V-command bars indicate fly-down.

c. Rotate vertical speed selector to ALT HOLD detent and observe V-command bars center on fixed aircraft symbol in ADIs, and the pitch FMAs display ALT HOLD.

33. Altitude Advisory System . . . . . . CHECK (P,CP)

a. Rotate BARO set knob on pilot's or copilot's altimeter to the barometric pressure at the field elevation.

b. Rotate ALT preselect knob to 1,000 feet above field elevation and pull. Observe ALT appears in FMA arm channel.

NOTE

If preselected altitude is previously at 1,000 feet above field elevation, rotate altitude preselect knob away from, and then back to, desired altitude.

c. Slowly rotate BARO set knob on either altimeter clockwise, and observe that at approximately 750 feet from the preselected altitude the advisory light on the altimeter comes on and a 2 second aural tone sounds; at approximately 250 feet from the selected altitude, observe steady amber light goes off. After leveling, rotate BARO set knob counterclockwise and observe that at approximately 250 feet from the selected altitude, the altitude advisory light comes on flashing.

d. Push altitude advisory RESET button and observe flashing amber light goes off.

e. Return BARO set knob on altimeter to reported altimeter setting.

34. ALT Readout . . . . SET (P)

35. Autopilot Levers . . . . OFF (P)

36. Radio Navigation . . . . TEST (P,CP)

a. RMI VOR/ADF Selectors . . . . VOR

b. VOR Test
Buttons . . . . . PUSH (SIMULTANEOUSLY)

Observe VOR failure flags in the RMI, the NAV FAIL annunciator, and the NAV fail flag in the EHSI appear for a short period of time and then go out of view.

Observe EHSI course deviation indicator centers, the TO/FROM indicator shows TO, and VOR/ADF RMI pointers and EHSI bearing pointer indicate 180° (±3°).

NOTE

If LOC TRK or GS TRK is annunciated in the FMA, the associated VOR and ILS tests are inhibited. Moving FD switches to OFF and back to FD, if applicable, will enable the tests.

c. VOR Test Buttons . . . . RELEASE

Observe VOR RMI and EHSI indications are normal.

d. ILS Frequency . . . . BOTH SET

NOTE

A receivable frequency is not required for an ILS test. If a nonreceivable frequency is tuned, the GS and runway flags in the ADIs and GS and Nav flags in the EHSIs will be in view before and after the test.

e. ILS Test Switches . . . . UP/L

Observe GS and RUNWAY flags appear in both ADIs, both NAV FAIL annunciators illuminate, GS, LOC Nav Source, and VOR Bearing fail flags appear in both EHSIs and remain for several seconds. Observe flags go out of view and glide slope indicators move one dot up and ADI localizer indicator and EHSI CDI move one dot left. Continue to hold test switches in UP/L until GS, RUNWAY, and Nav fail indications come into view again (approximately 5 seconds).

f. ILS Test Switches .... RELEASE

Observe pretest indications.

g. ILS Test Switches .... DN/R

Observe same sequence as in preceding, except that indicators move down and right one dot.

h. ILS Test Switches .... RELEASE

Observe indicators and glideslope pointers return to normal indications.

i. MKR BCN Test Button .... PUSH

Observe inner, outer, and middle marker lights come on and go off in sequence.

j. MKR BCN TEST Button .... RELEASE

37. HF Radios .... AS REQ'D (CP)

Preliminary Setup

The following preliminary setup procedures should be performed after power-on in FE interior inspection and prior to normal operation.

WARNING

- Ensure radio is not in automatic (AUT) mode to prevent inadvertent RF transmission.
- This equipment includes an ALE communications processor. If not in the silent mode or if silent mode turned off, ALE-equipped radios sound and reply to ALE calls automatically. Any time flight directives forbid HF emissions, ensure HF-1 and HF-2 systems are set to silent mode or turned off.
- Do not key the HF radio during ground refueling operations as arcing can occur.
- Ground operation of the HF transmitter is prohibited unless the aircraft is at least 200 feet from the following:
  - Unloaded weapons or warheads.
  - Loaded weapons in the aircraft with the bomb bay doors open.
- Do not key the HF radio when the aircraft is on the ground and personnel are working on the external skin surfaces or the boom. A high voltage may build up on these surfaces due to the high power being radiated by the antenna. This voltage shocks anyone touching these surfaces.
- Do not key on the HF system when personnel are within 100 feet of the HF antenna.

a. Set interphone controls for HF operation.

NOTE

Steps b through n are used to enable sounding when scanning in the automatic mode. If sounding is not desired, proceed to step o.

b. Move cursor to FN field using FLD selector and select CHN using VAL selector, if not already selected.

c. Move cursor to OP field using FLD selector and then rotate VAL selector clockwise to select PRG in OP field.

d. Move cursor to FN field using FLD selector and select ADR using VAL selector.

e. Move cursor to ADRS field so three cursors light and rotate VAL selector until 90 is displayed just left of the ADRS field.

f. Depress and release the INIT switch. System parameter 1 is displayed in the channel field (approximate center of display).

g. Move cursor to channel field (cursor position above SQL silk-screened on the control panel) using FLD selector and rotate VAL selector counterclockwise to select system parameter 33 in channel field.

h. Move cursor to ADRS field using FLD selector so that only one of the three ADRS field cursors is lit.

i. If not already displayed, rotate VAL selector to select EN (enabled) in ADRS field.

j. Depress and release INIT switch.

k. Move cursor to OP field using FLD selector and then rotate VAL selector clockwise to select OPR in OP field.

l. Move cursor to FN field using FLD selector and select AUT using VAL selector.

m. Move cursor to ADRS field so three cursors light and then rotate VAL selector to select S-D in ADRS field.

n. Depress and release INIT switch. The radio system automatically starts sounding (transmitting short bursts of data) on each scanned channel. As the radio sounds on each scanned channel the TX indicator lights momentarily. The length of time sounding takes depends on the number of scanned channels. When sounding is complete, the TX indicator remains off and the CH field indicates SC or steps through channel numbers. It is not necessary to wait for sounding to be completed to place ALE calls. Sounding continues after the calls are completed.

NOTE

While operating the ACS system, the OP field should remain set to OPR (operate) unless directed to select PRG (program) or TST (test). If PRG or TST are selected, inadvertent movement of controls could result in changes to or loss of programmed information or timed lockout from system operation.

o. Set SQL fully counterclockwise (positive muting disabled) and then set VOL as desired.

NOTE

When both HF systems are used at the same time, one system should be set for silent operation. This does not apply when one system is operated in direct control.

p. Move cursor to OP field using FLD selector and then rotate VAL selector counterclockwise to alternately enable and disable silent operation. SIL is displayed when silent operation is enabled and goes out when silent operation is disabled.

q. Rotate VAL selector clockwise to select OPR in OP field if not already selected.

r. Move cursor to FN field using FLD selector and select desired operating mode (AUT, CHN, or MAN) using VAL selector. Refer to appropriate paragraph heading for further operating instructions.

Manual (MAN) Operation

Ensure power up in FE interior inspection and preliminary setup procedures have been performed and proceed as follows:

NOTE

In manual mode, the HF radio system operates conventionally. The operator manually selects radio mode and frequency prior to placing a call. The system can also send and receive ALE calls in the manual mode.

a. Move cursor to FN field using FLD selector and select MAN in FN field using VAL selector.

b. Move cursor to MD field using FLD selector and select desired radio mode in MD field using VAL selector.

c. Move cursor to MHz FREQ field using FLD selector and select desired MHz frequency digit(s) (2 through 29) using VAL selector.

d. Select and set remaining frequency digits in the FREQ field for desired operating frequency using FLD and VAL selectors.

e. Rotate SQL switch two positions clockwise from the DSBL position; this is the recommended SQL setting in the manual mode. Receiver noise quiets. If the radio breaks in and out of squelch, select the fourth or fifth detent.

f. For conventional HF (non-ALE) communications, momentarily depress mic push-to-talk switch and allow system to tune. When tune tone ceases, depress mic push-to-talk switch and begin communication. If manual ALE communications are desired, proceed to step g; otherwise, no further action is required for manual non-ALE communications.

NOTE

If an ALE net call or all call is desired, refer to Calling Options.

g. For manual ALE communications, move cursor to ADRS field so all three cursors light using FLD selector and then select desired station address using the VAL selector. As the VAL selector is toggled, the ADRS field will display all programmed addresses. If the desired three-character address is not programmed, proceed to step h; otherwise, proceed to step j.

h. To manually select an address, rotate VAL selector so that S-D or *AL are not displayed in ADRS display and then rotate FLD selector so a single cursor is under the left ADRS field position. Rotate VAL switch to select first address character. Addresses greater than three characters cannot be manually selected at the control.

i. Select and set remaining two address characters using FLD and VAL selectors.

j. Momentarily depress INIT switch on HF control panel. When CALL indicator lights, the link is established. The amount of time it takes for the CALL indicator to light varies. If CALL indicator does not light in approximately 30 seconds, or if the CALL indicator lights but voice communications are not successful, repeat steps c through j on a different calling frequency.

k. When CALL indicator lights, depress mic push-to-talk switch and begin voice communications. Once communications are complete, the system automatically terminates the link after a programmed period of time. The CALL indicator extinguishes when the link is terminated.

NOTE

If an ALE call is received, the CALL indicator lights along with the calling station's address. The FREQ field indicates calling frequency. The operator at the receiving station should wait for the caller to make the first transmission. To answer the call, depress mic push-to-talk switch and begin voice communications.

Channel (CHN) Operation

Ensure power up in FE interior inspection and preliminary setup procedures have been performed and proceed as follows:

NOTE

In channel mode, the HF radio system operates conventionally. The operator selects a preset channel that has been programmed with mode and frequency information to place a call. The system can also send and receive ALE calls in the channel mode.

a. Move cursor to FN field using FLD selector and select CHN in FN field using VAL selector.

b. Move cursor to CH field using FLD selector and select desired preset channel using VAL selector. FREQ field indicates operating frequency for selected preset channel and MD field indicates programmed radio mode.

c. Rotate SQL switch two positions clockwise from the DSBL position; this is the recommended SQL setting in the channel mode. Receive noise quiets. If the radio breaks in and out of squelch, select the fourth or fifth detent.

NOTE

In channel mode, tuning information is stored in memory the first time a preset channel is tuned. Once learned, preset tune time is very short and a tune tone may not be audible when keying the mic switch.

d. For non-ALE communications, momentarily depress mic push-to-talk switch and allow the radio to tune. When tune tone ceases, depress mic push-to-talk switch and begin communication. For ALE communications in the channel mode, proceed to step e.

NOTE

If an ALE net call or all call is desired, refer to Calling Options.

e. For channel ALE communications move cursor to ADRS field so three cursors light using FLD selector and then select desired station address using VAL selector. As the VAL selector is toggled, the ADRS field displays all programmed addresses. If the desired three-character address is not programmed, proceed to step f; otherwise, proceed to step h. Addresses greater than three characters cannot be manually entered at the control.

f. To manually select an address, rotate VAL selector so that S-D or *AL are not displayed in ADRS display and then rotate FLD selector so a single cursor is under the left ADRS field position. Rotate VAL switch to select first address character.

g. Select and set remaining two address characters using FLD and VAL selectors.

h. Momentarily depress INIT switch. When CALL indicator lights, the link is established. The amount of time it takes for the CALL indicator to light varies. If CALL indicator does not light in approximately 30 seconds, or if the CALL indicator lights but voice communications are not successful, repeat steps b through h on a different channel.

i. When CALL indicator lights, depress mic push-to-talk switch and begin voice communications. Once communications are complete, the system automatically terminates the link after a programmed period of time. The CALL light extinguishes when the link is terminated.

NOTE

If an ALE call is received, the CALL indicator will light along with the calling station's address. The CH display indicates channel number and FREQ display indicates calling frequency. The operator at the receiving station should wait for the caller to make the first transmission. To answer the call, depress mic push-to-talk switch and begin voice communications.

Automatic (AUT) Operation

Ensure power up in FE interior inspection and preliminary setup procedures have been performed.

NOTE

- If an ALE net call or all call is desired, refer to Calling Options.
- In the automatic mode, receive audio is muted until a link is established. Positive muting prevents an operator from having to listen to noise and/or traffic on scanned channels. With positive muting enabled, an operator does not have to monitor the CALL indicator to verify a link is established. When a link is established, headset audio is restored and the CALL indicator lights. Positive muting is disabled if the SQL switch is rotated fully counterclockwise.

a. Move cursor to FN field using FLD selector and then select AUT in FN field using VAL selector.

b. Rotate SQL switch one position clockwise from the DSBL position; this is the recommended squelch switch setting in the automatic mode. Headset audio is muted until a communications link is established.

c. Move cursor to ADRS field so all three cursors light using FLD selector and then select desired station address using VAL selector. As the VAL selector is toggled, the ADRS field displays all programmed addresses. If the desired three-character address is not programmed, proceed to step d; otherwise, proceed to step f. Addresses greater than three characters cannot be manually selected from the control.

d. To manually select an address, rotate VAL selector so that S-D or *AL are not displayed in ADRS field and then rotate FLD selector so a single cursor is under the left ADRS field position. Rotate VAL selector to select first address character.

e. Select and set remaining two address characters using FLD and VAL selectors.

f. Momentarily depress INIT switch. As a link attempt is made on each programmed channel, the CH field displays calling channel number, the FREQ field displays calling frequency, and TX light comes on momentarily. When CALL indicator lights and headset audio is restored, the link is established. The time it takes for the CALL indicator to light varies. Typically the CALL indicator lights in approximately 30 seconds but can take as long as 3 minutes. If a link is unsuccessful, the ACS returns to scan after a programmed time-out.

g. When the CALL indicator lights, depress mic push-to-talk switch and begin voice communications. The calling station should make the first transmission. Once communications are complete, the system automatically terminates the link and returns to scan after a programmed period to time. The CALL indicator extinguishes when the link is terminated. After returning to scan, the operator may select another address, or place another call to the same address.

h. To interrupt a calling sequence or terminate a link prior to the programmed time-out, move cursor to FN field using FLD selector. Momentarily select CHN or MAN using VAL selector, then return to AUT.

NOTE

- If an automatic all is received, the CALL indicator lights along with the calling station's address. The CH field indicates channel number and FREQ field indicates calling frequency. The operator at the receiving station should wait for the caller to make the first transmission. To answer the call, depress mic push-to-talk switch and begin voice communications.

- If the CALL indicator lights after placing a call but voice communications are unsuccessful, return to scan per step h and attempt the call again by repeating steps f and g.

Scan List Selection

The following steps provide instructions for enabling/ disabling scan lists. When programmed, up to 20 scan lists are available and can be activated simultaneously.

a. Move cursor to OP field using FLD selector and rotate VAL selector clockwise until OP field displays PRG.

b. Move cursor to function FN field using FLD selector and rotate VAL selector to select CHN.

NOTE

In the CH field, SL is located between channels 99 and 0. Depending on what number is displayed, it may be quicker to rotate the VAL selector counterclockwise to reach SL in step c.

c. Move cursor to CH field using FLD selector and rotate VAL selector to select SL in CH field.

d. The MHz FREQ field displays scan list index number 1 and 100 Hz FREQ field displays 0. If 0 is not displayed in the 100 Hz FREQ field, use FLD and VAL switches to select 0 and then move cursor back to the MHz FREQ field.

e. Rotate VAL switch to step through scan lists 1 through 20. ADRS field shows ∗EN (scan list enabled) or ∗DI (scan list disabled) for each scan list number. If no changes are required, proceed to step j. To enable or disable scan lists, proceed to step f.

f. Move cursor to MHz FREQ field and select desired scan list number (1 through 20) using VAL switch.

g. Move cursor to ADRS field so all three cursors light using FLD selector and rotate VAL selector to EN (enable) or DI (disable) the scan list.

h. Depress and release INIT switch; an asterisk appears (∗EN or ∗DI) to indicate the selected scan list is enabled or disabled.

NOTE

Multiple scan lists can be activated depending upon operational requirements. When enabling a new scan list, remember to disable scan list(s) that are no longer required.

i. Repeat steps f through h, until all desired scan lists are enabled or disabled.

j. Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select OPR in OP field.

k. Move cursor to FN field using FLD selector and momentarily select CHN or MAN before returning to AUT using VAL selector.

Default Mode - Direct Control (DC)

If the communications processor fails or is removed from the HF system, the system defaults to direct control operation. When the system has defaulted to direct control, the address display indicates D, followed by a blank, followed by a C. In direct control, the HF radio system operates conventionally without ALE or AJ capability. For operation in direct control, refer to manual or channel non-ALE operation. Automatic and silent operation are not possible in direct control.

Silent (SIL) Operation

Silent operation is used to prevent the ACS from automatically sounding or responding to ALE calls during periods of HF emission control (HF EMCON) or when directives restrict such emissions. During silent operation, the ACS does not transmit unless an operator intervenes or keys the system.

Normally each aircraft within a net is assigned a unique self-address shared by both HF systems on board the aircraft. In order to prevent missed calls due to the shared antenna, one system must be set for silent operation as directed in the HF-ACS Preliminary Setup. To enable or disable silent operation, proceed as follows:

a. To enable silent operation, move cursor to OP field using FLD selector and rotate VAL selector counterclockwise to alternately enable and disable silent operation. SIL is displayed just to the right of OPR in the OP field when silent operation is enabled and goes out when silent operation is disabled.

b. Move cursor to FN field using FLD selector and select AUT, CHN, or MAN using VAL selector.

Tri-Service Anti-Jam Mode

The tri-service anti-jam (AJ) mode employs a frequency hopping technique to combat the effects of communications jammers. Tri-service AJ communication is possible during manual operation only. No AJ capability exists during direct control operation.

Tri-Service AJ Preflight Setup

In order to communicate in the tri-service AJ mode, AJ time must be set, AJ keys must be loaded, AJ tuning and AJ time synchronization must be performed. It is recommended that these procedures be performed prior to a mission.

a. Tri-service (military-standard) AJ time. The following procedures provide instructions for programming the processor with coarse time (Universal Coordinated Time (UTC) ±5 seconds) and current date information.

(1) Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select OPR in OP field.

(2) Move cursor to FN field using FLD selector and select man in FN field using VAL selector.

(3) Move cursor to FREQ field using FLD selector and select a frequency to provide UTC using VAL selector. Adjust volume and interphone controls as required to monitor time reference.

(4) Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select PRG in OP field.

(5) Move cursor to FN field using FLD selector and select TIM in FN field using VAL selector.

(6) If AJ indicator is not lit, depress and release AJ switch. The address field displays _ _C.

(7) Move cursor to address field so three cursors light using FLD selector and select _ _M in address field using VAL selector. The TIME field displays programmed military time or zeroes if no time has been programmed.

NOTE

Time entered is UTC ±5 seconds.

(8) If time is correct go to step (10). If time is incorrect or is not ticking, use FLD and VAL selectors to enter correct 24-hour military time to next whole minute.

(9) While listening to time tick, depress and release INIT switch at start of next whole minute. The time displayed in the TIME field starts advancing.

NOTE

Julian date consists of five numbers representing the year and the day of the year. For example: the 100th day of 1992 is 92100.

(10) Move cursor to address field so three cursors light using FLD selector and select _JD in address field using VAL selector. TIME field displays current Julian date if previously loaded, or zeroes if no date has been programmed.

(11) If Julian date is correct, go to step (12). If the Julian date is incorrect, use FLD and VAL selector to enter correct Julian date in TIME field and proceed to step (12).

(12) Depress and release INIT switch; _ _M appears in address field and time is displayed. Time programming is complete.

NOTE

Perform either step b or step c depending on which keyfill device is used.

b. Tri-service AJ key loading from a KYK-13 keyfill device (KFD).

NOTE

The fill cable for the KYK-13 may be used while loading AJ keys into the processor, but is not required.

(1) Set KYK-13 Z-ON-OFF/ CHECK switch to OFF/ CHECK.

(2) Connect KYK-13 to FILL connector on applicable HF remote keyfill/data load panel in flight engineer's equipment panel.

(3) Ensure power-up procedures have been performed.

(4) Set KYK-13 Z-ON-OFF/ CHECK switch to ON.

(5) Set KYK-13 fill switch to switch position containing primary AJ key to be loaded.

(6) Move cursor to OP field using FLD selector and rotate VAL selector clockwise until OP field displays PRG.

(7) Move cursor to function FN field using FLD selector and rotate VAL selector to select KEY.

(8) If AJ indicator is not lit, depress and release AJ switch; AJ indicator lights and _XP (external primary AJ key) is displayed in address field.

(9) To load primary AJ key, depress and release INIT switch; _XA (external alternate AJ key) appears in the ADRS field and the KEY indicator goes off. If an alternate AJ key is to be loaded proceed to step (10); otherwise, proceed to step (12).

(10) Turn KYK-13 fill switch to switch position containing alternate key to be loaded if an alternate key is desired.

(11) To load alternate AJ key, depress and release INIT switch; _ZA appears in the ADRS field.

(12) Turn KYK-13 Z-ON-OFF/ CHECK switch to OFF/CHECK and disconnect KYK-13 from fill panel.

c. Tri-service AJ key loading from a KOI-18 keyfill device (KFD).

(1) Connect KOI-18 fill cable to FILL connector on applicable HF remote keyfill/ data load panel on flight engineer's equipment panel.

(2) Ensure power-up procedures have been performed.

(3) Move cursor to OP field using FLD selector and rotate VAL selector clockwise until OP field displays PRG.

(4) Move cursor to function FN field using FLD selector and rotate VAL selector to select KEY.

(5) If AJ indicator is not lit, depress and release AJ switch; AJ indicator lights and _XP (external primary AJ key) is displayed in the address field.

(6) To load primary AJ key, depress and release INIT switch and insert tape leader into KOI-18 slot marked IN. Ensure smaller holes line up with white dots on KOI-18 and pull tape through KOI-18 at a steady rate. If keyfill is successful, _XA (external alternate AJ key) appears in the address field and KEY indicator goes off. If keyfill fails, --- is displayed in the address field; repeat step (6). To load an alternate AJ key, proceed to step (7); otherwise, proceed to step (8).

(7) To load alternate AJ key, depress and release INIT switch and insert tape leader into KOI-18 slot marked IN. Ensure smaller holes line up with white dots on KOI-18 and pull tape through KOI-18 at a steady rate. If keyfill is successful, _ZA appears in the address field and the KEY indicator goes off. If keyfill fails, --- is displayed in the address field. If keyfill fails, select _XA in the address field and repeat step (7).

(8) Disconnect KOI-18 from fill panel.

d. Tri-service AJ tuning.

The frequency hopping employed during AJ communications requires the radio be pretuned on each of the AJ frequencies. Up to 14 AJ frequency lists can be stored and each list contains numerous frequencies. Only one AJ frequency list can be activated at a time and is normally selected as part of the datafill operation. When AJ tuning is performed per the following procedure, all programmed AJ frequencies are tuned, regardless of which list is activated.

(1) Move cursor to OP field using FLD selector and rotate VAL selector clockwise until OP field displays TST.

(2) Depress and release INIT switch. The ACS performs a receive self-test which takes approximately 90 seconds. After approximately 20 seconds, the address field displays 01, OK, 02, and then OK if the test is successful. If receive self-test fails, FAULT is displayed in the upper center of the display. Clear the fault by setting OP field to OPR, FN field to MAN, change any digit in the FREQ field momentarily, and repeat steps (1) and (2). If the fault was erroneous, it will not recur. If the fault recurs, call maintenance.

(3) Momentarily key radio and allow radio to tune.

(4) Depress and hold mic push-to-talk key and momentarily depress AJ switch. The AJ indicator comes on and the ACS runs AJ self-test and tunes AJ frequency list for AJ. During self-test, address field displays 03, TUN, and finally OK or OK+, if AJ tests/tuning are successful. If one or more of the AJ frequencies fails to tune, _UT (untuned) is displayed in the address field.

(5) Release mic push-to-talk key when OK, OK+ or _UT appear in address field. If _UT is displayed, repeat steps (3) and (4).

e. Tri-service (military-standard) AJ time synchronization. The frequency hopping employed during AJ communications requires extremely accurate time synchronization (time-sync). The following procedures provide instructions for fine-tuning the previously entered coarse time by performing a time-sync (handshake data transmission) with a master time station. This ensures all units required to interoperate in the tri-service AJ mode are precisely synchronized from the same time standard.

NOTE

If power outage of more than 10 seconds occurs, the following time-sync procedures have to be repeated once power is restored in order to reestablish AJ communications.

(1) For the station designated as the master time station perform steps (2) through (9) only. For the station designated as the secondary time station, perform steps (10) through (15) followed by steps (2) through (9). For all other stations, perform steps (10) through (15) only.

(2) Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select PRG in OP field.

(3) Move cursor to FN field using FLD selector and select TIM in FN field using VAL selector.

(4) If AJ indicator is not lit, depress and release AJ switch.

(5) Move cursor to address field so three cursors light using FLD selector. For master time station, select _MM (military-standard master time station) in ad-

dress field using VAL selector. For secondary time station, select _SM (secondary military-standard time station) in address field using VAL selector.

(6) Depress and release INIT switch. Address field displays ∗MM for master time station or ∗SM for secondary time station.

(7) Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select OPR in OP field.

(8) Move cursor to FN field using FLD selector and select MAN in FN field using VAL selector.

NOTE

If the AJ indicator is already lit, press and release the INIT switch so that the AJ indicator extinguishes before performing step (9).

(9) Depress and release AJ switch. AJ indicator lights and channel 60 is displayed along with AJ center frequency. No further action is required by the master time station.

For all stations other than the master time station, proceed as follows:

(10) Move cursor to OP field using FLD selector and rotate VAL selector clockwise to select PRG in OP field.

(11) Move cursor to FN field using FLD selector and select TIM in FN field using VAL selector.

(12) If AJ indicator is not lit, depress and release AJ switch.

(13) Move cursor to address field so three cursors light using FLD selector and then select _RM (request military-standard AJ time) in address field using VAL selector.

(14) Depress and release INIT switch. Time display stops advancing and the TX (transmit) indicator lights as transmission is made requesting time from the master or secondary time station.

(15) When the clock starts running (typically 5 seconds), time-sync is complete. If time-sync fails, --- is displayed in the address field. If time-sync fails, repeat steps (13) through (15).

Tri-Service AJ Operation

To communicate in the tri-service AJ mode, ensure tri-service AJ preflight setup is complete and proceed as follows:

a. Move cursor to OP field using FLD selector and then use VAL selector to select OPR in OP field.

b. Move cursor to FN field using FLD selector and select MAN using VAL selector.

c. Move cursor to MD field using FLD selector and select UV in MD field using VAL selector.

d. Depress and release AJ switch. AJ indicator lights and channel 60 is displayed along with the AJ channel center frequency. AJ communications can begin.

NOTE

- Each time mic push-to-talk is keyed, a short preamble of audio tones in transmitted. After pressing mic switch, wait for audio tones (present in headset) to cease before beginning communications. The CALL indicator lights when the preamble is complete and communications can begin. When receiving an AJ call, wait for the CALL indicator to extinguish before keying the radio to respond.
- To disable AJ communications, depress and release the AJ switch. The AJ indicator extinguishes, signifying AJ communications are disabled.

Calling Options

In addition to placing station-to-station ALE calls, the ACS provides the option of placing net calls or all calls. Net calls are used to place a call to a preplanned group of stations that have been programmed with a common net address. All calls are generally used in an emergency to broadcast a call to all comparably equipped ALE stations. The following operating procedures describe address selection only and are used in conjunction with manual, channel, and automatic ALE operations described earlier.

a. Net calls.

(1) Move cursor to ADRS field so three cursors light using FLD selector and select desired net address (201 through 220) using VAL selector. As VAL selector is toggled, the ADRS field steps through all programmed addresses. In the automatic mode, corresponding index numbers are displayed to the left of the ADRS field.

(2) Depress and release the INIT switch and follow normal operating instructions for selected mode.

(3) When a net call is received, the receiving station CALL indicator lights and the calling station address is displayed in the ADRS field.

b. All calls.

NOTE

Each station is permanently programmed with the military-standard all call address (∗AL) at index number 299 and is not user programmable.

(1) Move cursor to ADRS field so all three cursors light using FLD selector and select the military standard all call address ∗AL (index number 299) in the ADRS field using VAL selector. As the VAL selector is toggled, the ADRS field steps through all programmed addresses. In the automatic mode, corresponding index numbers are displayed to the right of the ADRS field.

(2) Depress and release the INIT switch and follow normal operating instructions for selected mode.

(3) When a military-standard all call is received, the CALL indicator lights. The address field does not change to display the standard ∗AL all call address.

Data Messages

The ACS provides the capability to send and receive text messages up to 408 characters in length once a link is established. Four message buffers are available for processing data messages. Normally message buffers 1 and 2 store received data messages, and buffers 3 and 4 store transmit messages. All four buffers can be used to store transmit data messages; however, any received data messages overwrite transmit messages stored in buffers 1 and 2. To read received data messages and transmit programmed data messages, proceed as follows:

a. Data message transmitting.

(1) To transmit a programmed data message, a link must be established as indicated by the CALL indicator being lit.

(2) Move cursor to ADRS field so all three cursors light using FLD selector and then select programmed message number (M-1, M-2, M-3, or M-4) in ADRS field using VAL selector.

(3) Depress and release INIT switch to begin transmission of data message. The TX indicator lights. When transmission is complete, the TX indicator turns off and the system reverts to previously selected status.

b. Data message receiving. If a data message is received, MR1 or MR2 is displayed in the ADRS field. To read a received data message proceed as follows:

(1) Move cursor to OP field using FLD selector and then use VAL selector to select PRG in OP field.

(2) Move cursor to FN field using FLD selector and select ADR in FN field using VAL selector.

(3) Move cursor to ADRS field so all three cursors light using FLD selector and then select address index number 91 for MR1 or 92 for MR2, using VAL selector. Index numbers are displayed just to the left of the ADRS field.

(4) Messages are read in the ADRS display, three characters at a time. For example, if the received data message is MISSION COMPLETE, a message nibble number (00-135) is displayed in the TIME field and the first three characters of the message are displayed in the ADRS field as shown below. To read the next three message characters, place cursor under nibble number and rotate VAL selector to increase value of nibble number from 00 to 01. The next three message characters are displayed in the

ADRS field. Continue selecting next higher nibble number until entire message is read as shown below.

Nibble number in TIME field	Message characters in ADRS field
00	MIS
01	SIO
02	N C
03	OMP
04	LET
05	E

NOTE

A received message writes over the message currently stored in address indexes 91 or 92 (MR1 or MR2). The oldest message is written over first.

(5) To return to normal operation, move cursor to OP field using FLD selector and then use VAL selector to select OPR in OP field.

(6) Move cursor to FN field using FLD selector and use VAL selector to select AUT, CHN, or MAN in OP display.

38. FMS .... LOAD FLIGHT PLAN (P,CP)

a. Access the Lock-Zeroize page by pressing the IDX key and selecting LOCK/ZERO on the Index 1 page. Zeroize the user waypoint and mark-point lists by selecting LS3.

NOTE

- Waypoint list may be retained if coordinates are verified prior to use.
- It is advisable to zero out the Flight Plan and Alternate Flight Plan FPLN/ALTN before loading any new points into a flight plan. This should help avoid any confusion with waypoints that may remain from a prior flight.
- To save a flight plan to the selected MSN data cartridge, the flight plan must initially be loaded as an alternate flight plan and then saved to the data cartridge. Additionally, it must then be transferred into the active flight plan.

b. Access the Start 5 page by pressing the IDX key, selecting START, and scrolling vertically to Start 5. If a new flight plan and mission data are to be entered manually, select ERASE FPLN. Access the Flight Plan page by pressing the FPLN key and enter waypoints into the scratchpad (either by ICAO identifier or lat/long coordinates) and insert into the flight plan at the *END prompt.

c. If a new flight plan is to be loaded from the selected MSN data cartridge, first enter the desired flight plan number or name (if known) in the scratchpad and then select LS2. The CONFIRM LOAD ALTN message will appear alternately with the scratchpad entry. Press LS2 again to load the selected alternate flight plan into the CDU. After loading is complete, select FPLN replace. This copies the alternate flight plan data into the active flight plan making both plans identical. This allows the crew more flexibility in manipulating flight plan data and the use of certain alternate flight plan features, e.g., fuel computations, without interfering with the active flight plan. However, it is not a requirement to keep the alternate flight plan the same as the active flight plan. A different alternate may be transferred into the CDU or the alternate may be modified at any time. Select FLT/DATA LOAD to load any preplanned markpoint/ waypoint list mission data, if desired.

d. If the alternate flight plan number or name are not known, a list of the flight plans stored on the selected MSN data cartridge may be viewed by selecting ALTN CATLG. This will access the Alternate Catalog 01-08 page. The 40 available flight plans may be viewed by scrolling laterally among the five pages of the catalog. The SELECT ALTN LOAD scratchpad message will be displayed on each page and selection of a flight plan by pressing the adjacent line select key will load that flight plan into the CDU and return to the Start 5 page.

39. Exterior Lights .... AS REQ'D (CP)

40. Seat, Belts, Harness & Rudder Pedals .... SET (P,CP)

41. Parking Brake . . . . AS REQ'D (P,CP)
If cocking or preflighting the aircraft for alert, ensure chocks are installed and release the parking brake.

42. COMNAV-50 . . . . SET (If Applicable) (CP)

    a. UHF-1 Mode Selector . . . . OFF

    b. COMNAV-50 Mode Selector . . . . BOTH

    c. FREQUENCY/MODEM CODES . . . . SET

    d. MODEM ANNUN Lights . . . . TEST

    Placing the ADRS Selector to T (test) will cause the RESP, INT and CONT lights to illuminate.

    e. Audio Panel (UHF-1) . . . . SET

    f. COMNAV-50 . . . . CHECKED

    With INT/EXT switch to INT, make a normal UHF check using control wheel microphone switch or HOT MIC/RADIO switch on audio panel. Monitor receiver audio over headset or cockpit speakers.

    If a compatible ground station is available, place INT/EXT switch to EXT and make a radio check. Push CONT and INT switches to ON. Range and bearing (if ADF is selected) will be displayed. Upon completion of check, place CONT and INT switches OFF and place INT/EXT switch to INT.

    g. UHF-1 Mode Selector . . . . AS DESIRED

NOTE

- Internal mode may be used immediately after radio is turned on. However a 10 minute warmup period is required before operation in the external mode.
- COMNAV-50 preset frequencies may be changed by rotating mode selector switch to MAIN or BOTH and the MANUAL - PRESET - GUARD selector to PRESET. Turn channel selector and frequency selectors to desired channel and frequency. Push SET button to lock frequency in; next push CHECK button and verify desired frequency appears in frequency CHECK indicator window. Manual frequency selection may be accomplished by setting MANUAL-PRESET-GUARD selector to MANUAL and rotating manual frequency selector until desired frequency appears in frequency windows.
- Control for internal mode of operation may be transferred to UHF-1 control panel by rotating UHF-1 mode selector to MAIN or BOTH. The UHF-1 mode selector must be turned off and control transferred back to COMNAV-50 radio/ modem control panels if external mode of operation is desired.
- In order to communicate in the EXT mode, both stations must be in EXT with the same SEL settings and radio frequency selections.
- To avoid cycling between antennas, ensure UHF-1 antenna is in the upper or lower position when utilizing the EXT mode.

COCKPIT PREPARATION

1. Takeoff Data/N_1 Limit/V-Bugs . . . "CHECKED/SET" (P,CP,FE)

Aircraft commander will ensure the takeoff data has been checked in accordance with instructions in Section V.

Verify computed takeoff data coincides with actual computed takeoff weight and balance.

Verify that correct takeoff N_1 is shown on thrust computer and/or maximum limit indexes.

Reset ZFW if zero fuel weight has changed from pre-flight value.

Set speed bugs to V_1, V_R, V_{FR} and V_{SR}, and 0°/RET minimum maneuver. Verify speed readout and associated salmon bug is set to V_2.

Set altitude reference bug on the barometric altimeter to 2 engine MSL acceleration height.

Rotate FLAP T.O. selector to the computed flap setting if variable flaps are to be used.

2. Altimeters . . . . "SET" (P,CP))

3. FMS/INU Present Position/ Flight Plan . . . . "LOADED" (P,CP)

Verify that present position has been correctly determined and entered. Verify that flight plan data has been properly entered and crosschecked.

During scramble operations, waypoint entry may be delayed until after engine start or airborne, if necessary.

4. Oxygen System . . . . "ON/100%" (ALL)

WARNING

With the regulator in the OFF position, the mask may allow ambient air to enter after initial attempt to breathe. Ensure regulator is in the 100% and ON position at all times during flight when position is occupied.

5. Compasses . . . . "SLAVED" (P,CP)

During power off scramble operations, move compass switch from and return to SLAVED to engage fast synchronization. Alignment occurs within a few seconds.

6. YAW Dampers . . . . ON (FE)

Verify YAW DAMP switches are on and FAIL lights are off.

7. Anti-Skid . . . . ARMED (FE)

Verify ANTI-SKID switches are on and FAIL lights are off.

8. Emergency Lts . . . . ARMED (FE)

Verify EMER LT switch is in ARM and DISARMED light is off.

9. Stall/Speed Warn/ Speed Control . . . . CHECKED (FE)

Flight Engineer will verify that these systems were previously checked.

10. Windshield Anti-Ice/Defog . . . . "NORM/ON" (CP)

Windshield ANTI-ICE will be placed to NORM and the DEFOG switch will be placed to ON. Observe WINDSHIELD ANTI-ICE INOP lights are off. Selectors should be placed in HIGH only for duration of moderate to heavy icing conditions.

If cocking the aircraft for power-on alert, return the windshield ANTI-ICE/DEFOG switches to OFF until scramble operations.

11. Pitot Heat . . . . "TAT" (CP)

NOTE

The selection of TAT provides indication of current flow to TAT when aircraft is airborne.

Verify that pitot METER SEL & HEAT selector is in TAT with a zero reading on the meter and PITOT HEAT INOP light is off.

If cocking the aircraft for power-on alert, return the pitot METER SEL & HEAT selector to OFF until scramble operation.

12. Exterior Lts . . . . "SET" (CP,FE)

Navigation lights should be set to full bright and LOGO lights as required. LOGO lights are normally on for night lights. If required, FE turn on overwing lights.

13. Cabin Cargo Smoke Sw . . . . ARMED (FE)

14. Avionic Flow Sw . . . . NORMAL (FE)

15. Pressurization . . . . SET (FE)

Select mode desired for mission.

NOTE

Select SEMI-AUTO for touch-and-go landings.

16. Cockpit Preparation Checklist . . . . "COMPLETED" (FE)

At the completion of this checklist, the aircraft may be considered cocked for a constant state of readiness posture. If power off alert is to be maintained, complete the POWER OFF COCKING PROCEDURES Checklist.

PUSH-BACK/TOWING

This checklist will be used when aircraft push-back or tow is required. Prior to any push-back or towing operations, the Cockpit Preparation checklist will be completed.

Push-back/towing requires close coordination with ground towing personnel. The tow supervisor and aircraft commander share responsibility for the safe execution of this procedure.

If engine shutdown during push-back becomes necessary, immediately notify towing personnel. After the aircraft has come to a complete stop, set the parking brake and accomplish appropriate checklists.

1. Tow Team Briefing . . . . Completed (P)

   The aircraft commander will coordinate the following items with the towing supervisor prior to pushback:

   - Communication method between the pilot and tow supervisor will be the aircraft interphone system.
   - Emergency hand signals to be used in the event an immediate stop is required and the aircraft interphone system fails.
   - Route of travel during push-back/tow.
   - Notification to aircrew when the NLG torque links are connected/disconnected or steering bypass pin is inserted/removed.

2. INUs . . . . “NAV” (P, CP, FE)

   Verify that all inertial navigation units are in NAV mode (alignment status 01) prior to aircraft movement.

3. Parking Brake/Steering
   Bypass Pin . . . . “SET/INSTALLED” (P, GROUND)

   Release or set parking brake only when directed by towing personnel. Confirm with towing supervisor that steering bypass pin is installed.

If engine(s) will not be started, proceed to Step 5.

4. Before Start Checklist . . . . COMPLETE (P, CP, FE, BO)

   Do not start engines until the tow vehicle is connected and cleared by towing supervisor.

5. Push-back/Tow Clearance . . . . “RECEIVED” (P)

   Contact appropriate ATC facility for push-back or tow clearance.

6. Cabin Ready . . . . “READY” (BO)

   Prior to aircraft movement, verify cabin is properly secured.

7. Hydraulic System . . . . “SET” (FE)

   Verify hydraulic power is available and that both brake pressures are in the white band.

8. Parking Brake . . . . “RELEASED, CLEARED TO TOW” (P, GROUND)

   Release or set parking brake only when directed by towing supervisor. Ensure a marshaller directs movement of the aircraft. In congested areas, use wing walkers.

When push-back/towing is complete:

9. Parking Brake/Steering
   Bypass Pin . . . . “SET/REMOVED” (P, GROUND)

   When directed by towing personnel, set the parking brake and clear the tow team to disconnect the tow bar. Towing personnel will notify the pilot when the NLG torque links are reconnected and steering bypass pin is removed.

10. Push-Back/Towing
    Checklist . . . . “COMPLETED” (FE)

ENGINE STARTING

BEFORE START

1. INUs . . . . "NAV" (P,CP,FE)

   Verify that all inertial navigation units are in NAV mode (alignment status 01) prior to aircraft movement.

2. BEACON LT Selector . . . . "BOTH" (CP)

3. Parking Brake . . . . "SET" (P)

   Pilot verify parking brake is on and check brake pressure above minimum.

4. Fuel Levers . . . . "OFF" (P)

5. Fuel Pumps . . . . ON (FE)

   For tanks 1, 2, and 3, push AFT PUMP switches and observe pressure LOW light comes on and goes off, and flow indicator light comes on.

   NOTE

   - Tank 2 right aft pump will normally be on when APU is operating.
   - Aft pumps are selected in order to provide scavenging in the lowest part of the tank.

6. PACK FUNCTION
   Selectors . . . . PACK OFF (FE)

7. ENG IGNITION
   Selector . . . . "START (A OR B)" (P)

   Verify OVRD & AIR START switch is in OFF. Rotate ENG IGNITION selector to START A on odd numbered days or START B on even numbered days.

   NOTE

   When START A or START B is selected APU N_1 will increase to approximately 97% rpm to provide greater pneumatic capability for starting. START A or START B also arms ENG START switches.

8. Pneumatic Pressure . . . . __PSI (FE)

   Observe pneumatic PRESS gages 1 and 3 indicate in normal range.

   NOTE

   - With temperatures below 0°F (-18°C), 35 PSI will give assurance of a satisfactory start.
   - If all pneumatic PRESS gages are less than 25 PSI with the start valve closed, rotate all ENG PNEU SUPPLY selectors to OFF and observe pneumatic PRESS gages indicate normal pressure. If pneumatic PRESS gages continue to indicate less than 25 PSI and operational conditions necessitate the use of lower pneumatic pressure, a start may be made as low as 15 PSI. Closely monitor steady increase in N_2 during start.
   - A pressure drop of 5 PSI is normal when the start valve opens.
   - With the pneumatic pressure less than 25 PSI, expect a longer time for the engine to accelerate to idle.

9. Boom Operators
   Preparation . . . . "COMPLETED" (BO)

   This verifies that the cabin is ready for engine start.

10. Cargo Door Lights . . . . CHECKED (FE)

    Observe the CARGO DOOR lights are off, then place the CARGO DOOR INDICATION switch to TEST and hold; observe that the CARGO DOOR SYS A and SYS B lights come on. Release switch and observe both lights go off.

11. Cabin Door Lights . . . . OFF (FE)

    FE observe all cabin door lights are off.

    NOTE

    - Except for scramble operations, all doors must be closed and slides armed prior to starting engines to ensure maximum evacuation capability in an emergency.
    - Door light off does not indicate installation of slide/raft. Installation of slide/rafts must be verified by maintenance or AFTO Form 781.

During scramble operations, if engines are started prior to closing the number 1L door, ensure that the ladder is removed and all cabin door lights are off prior to taxi. Do not delay taxi to disassemble/stow ladder.

12. Before Start
    Checklist . . . . "COMPLETED" (FE)

STARTING ENGINES

Engine starting order is 3-1-2. Engine 2 is normally started by the FE. However, the engine start sequence may be changed as required by circumstances.

During scramble operations, engine 2 and 3 may be started simultaneously. Once all crewmembers have responded, start engine number 1.

WARNING

- Prior to starting the wing engines, the crew will ensure that engine start will not cause a hazard to responding crewmembers.
- When responding, crewmembers must approach the entry ladder from the nose of the aircraft and avoid the engine intake danger area (20 foot radius).
- Special consideration should be accorded engine 2 start. If buildings are more than one story high, injury or damage could result if engine 2 blast pattern encompasses elevated portions.

PILOT	COPILOT	FLIGHT ENGINEER
		Report "Before Start Checklist Complete"
Confirm ground and tower clearance. Call, Ready to Start No. ____ Engine.		Call, "Ready to Start No. ____". Observe pneumatic pressure is 25 psi or more. **NOTE** A pressure drop of 5 PSI is normal when the valve opens.
Push and release Engine Start switch and observe light comes on.		Verify adequate pneumatic pressure.

(Continued)

PILOT	COPILOT	FLIGHT ENGINEER
Observe N_2 gage indicates rotation.	Observe N_2 gage indicates rotation.	
At 15% N_2, FUEL Lever to ON. Call, "Fuel Lever ON".	Start clock sweep second hand.	Monitor engine starting.
Observe fuel flow gage indicates normal fuel flow and EGT rises within 25 seconds.		
Monitor EGT gage and call, "EGT".	Reset clock sweep second hand.	
Check normal EGT rise and peak EGT does not exceed start limits.		
Observe engine start switch pops out and light goes off.		Check oil pressure, OIL QTY and temperature are normal.
Observe that N_2 has stabilized at idle rpm (approx. 65%), N_1 rpm has stabilized (approx. 25%), EGT gage indicates normal and ENG OIL PRESS LO light is off.		Observe all HYD PRESS gages indicate in white band. Move all left hydraulic pump switches to ON. Observe associated hydraulic PRESS LO lights go off, and all HYD PRESS gages continue to indicate in white band. Confirm that one engine hydraulic pump in each system provides at least 2800 PSI. Set OIL QTY bug when each engine is stabilized in idle.
For Abnormal Starts refer to ABNORMAL START procedure, Section 2A.		

NOTE

- If engine start switch pops out each time switch is pushed in and switch-light comes on and goes off as switch pops out, push and hold engine start switch. Observe switch-light comes on. Continue procedure.
- If N_2 gage indicates no rotation. Pilot, pull engine start switch and observe switch-light goes off.
- During extreme cold conditions, oil pressure peaks to full indicator scale may occur. If oil pressure remains above the normal range after oil temperature stabilizes, engine should be shut down and cause investigated.
- An initial fuel flow of over 700 PPH may cause a hot start. Normal fuel flow prior to light-off is approximately 550 PPH.
- If EGT gage does not show an increase within 25 seconds, move fuel lever to OFF. Continue to motor engine for 30 seconds, then pull engine start switch. Refer to Abnormal Procedures for Abnormal Start.

NOTE

- If EGT exceeds 750°C for more than 40 seconds or rises rapidly above 750°C and is likely to exceed 900°C, terminate start by moving fuel lever to OFF. Continue to motor engine for 30 seconds, then pull engine start switch and observe switchlight goes off. One start is allowed in the 800 to 900°C range and the intended flight may be completed before maintenance action. Advise maintenance of temperature reached and request approval for delayed inspection and availability of maintenance at next stop. Refer to Abnormal Procedures for Abnormal Start.
- If engine start switch pops out before N_2 gage indicates approximately 45% rpm, allow engine rotation to decay to below 20% rpm, then push and hold switch in and observe switchlight comes on.
- At 45% N_2, if engine start switch is being held in manually, Pilot release switch and observe switchlight goes off. Turn motor pump switches to ON for critical phases of flight.
- At 45% N_2, if engine start switch is in and switchlight is on, Pilot pull switch out and observe switchlight goes off. See unscheduled motor pump operation, sixth dot note of this page.
- If engine start switch is out and switchlight remains on, order ground crew member to manually close starter valve. Observe switchlight goes off. Continue Engine Start Procedure. If ground crew member is unable to close valve manually, rotate engine pneumatic supply selector to OFF, turn off pneumatic supply to engine, and move fuel lever to OFF.
- Unscheduled reversible motor pump operation may occur if the engine start circuit fails to release automatically (start switch has to be pulled out). To check for unscheduled motor pump operation, all three engines must be operating and the 1-3/2-3 motor pumps must be in the ARM position. If 1-3/2-3 PUMP VALVE OPEN light is on, move the motor pump switches to OFF and observe light. If light goes off, motor pump switches should be moved to ON for critical phases of flight and OFF for remainder of flight unless required for particular flight condition. If light remains on after motor pump switches are moved to OFF, maintenance is required.
- When making starts at low ambient temperatures (below 0°F/–18°C), long acceleration times (up to 2 minutes) from lightoff to idle can be expected and are acceptable provided EGT is within limits.
- If oil pressure gage does not indicate 10 PSI by the time N_2 gage indicates ground idle, and ENG OIL PRESS LO light is on, FE call out, No oil pressure. Pilot move fuel lever to OFF and observe EGT indication.
- If N_2 gage hangs up at less than idle rpm, move fuel lever to OFF. Continue to motor engine for 30 seconds, then pull engine start switch and observe switchlight is off. Refer to Abnormal Procedures for Abnormal Start.
- If N_1 gage does not indicate by the time N_2 rpm is stabilized at idle, continue to operate engine at ground idle speed for 30 seconds. If N_1 gage is still not indicating after 30 seconds, move fuel lever to OFF, observe N_2 gage indicates zero and restart engine monitoring N_1 gage. If N_1 gage does not indicate within 30 seconds after N_2 gage indicates idle, move fuel lever to OFF and investigate cause.

CAUTION

Do not exceed ground idle operation until normal N_1 indication and operation are confirmed.

NOTE

With hydraulic pump pressures less than 2800 PSI, slat extension is marginal when operating with only one hydraulic system.

TAXI AND TAKEOFF

BEFORE TAXI

1. Windows .... "OVERCENTER/ LOCKED" (P,CP)

   Verify cockpit windows are closed (carriage roller is against track bumper) and the window locklatch handle is full down, (forward) and locked in the detent.

   NOTE

   If window is open, push inward on window crank and rotate until window is closed. Observe the carriage roller is against track bumper. Press down on window locklatch handle and maintain pressure while rotating handle down and full forward. Release pressure and verify handle is locked by lifting up.

2. Anti-Ice .... "AS REQ'D" (CP,FE)

   Observe ENG ANTI-ICE DISAGREE lights are off.

   NOTE

   - When temperatures are below 6°C (42°F), and visible moisture in any form is present; such as fog, rain, snow, sleet, or ice crystals; or when temperatures are below 6°C (42°F), and the temperature-dewpoint spread is 3°C (5°F) or less, engine anti-ice will be turned on immediately after engine start and used continuously until icing conditions cease to exist.
   - Moving ENG 2 and ANT ANTI-ICE switch to ON before takeoff arms antenna anti-ice system to function automatically on rotation and the ANT ANTI-ICE DISAGREE LIGHT will cycle on and off.
   - For extended ground operations in icing conditions, advance power to 60% N_1 for a period of 30 seconds each 30 minutes.
   - Wing anti-ice switch should be moved to ON when icing conditions are expected after takeoff. This opens the wing anti-ice valve inflight. This will not open the anti-ice valves on the ground.

3. Hydraulic System................. "SET" (FE)

   NOTE

   Place 2-3 motor pump switch to ARM.

4. Pneumatics and Air Conditioning .... SET (FE)

   a. Scan pneumatic panel and observe pneumatic lights are off and pneumatic TEMP and PRESS gages are normal.

5. Ground Equipment/ Gear Pins .... "REMOVED" (P,FE)

   a. Pilot notify ground crew to remove all ground equipment.

   b. Ground crew indicate to pilot that aircraft is clear to be moved.

   c. Pilot acknowledge the signal.

   d. Flight Engineer ensure that gear pins have been removed and stowed. This may be accomplished during the FE's Exterior Inspection.

   During scramble operations, verify that all ground equipment/personnel are clear, the ladder is removed and all doors are closed/armed prior to taxi.

6. Before Taxi Checklist .... "COMPLETED" (FE)

FUEL MANAGEMENT

FUEL LOADING/USAGE

It may be necessary to load or use body tank fuel in unequal quantities in order to maintain CG aft of 24% for optimum aircraft performance.

Certain cargo and fuel/cargo loading conditions can create a tail heavy condition which can cause the aircraft to tip on its tail. Proper coordination is necessary prior to fuel load/transfer and cargo onload/offload.

WARNING

- After fuel is transferred to meet tipping requirements, do not transfer fuel while cargo is being loaded or offloaded.
- The above restriction does not preclude concurrent servicing provided tipping analysis has been accomplished prior to onload/transfer.

NORMAL USAGE - NO OFFLOAD

The fuel supply to engines during all phases of flight is normally from the associated main fuel tank to the engine (tank 1 to engine 1, etc.). Since a single tank pump will supply more than enough fuel even when operating at maximum power, only one pump is used to supply engines 1 and 3. Because of the location of engine 2, a second tank 2 pump is always used as a precaution against engine flameout in the event of a pump failure. During an approach when main tank fuel is low, all tank pumps are operated. Tank 2 pump 2L is powered by the right emergency bus.

WARNING

The boom shall be maintained full of fuel when the departure, enroute or arrival flight path may place the aircraft in the vicinity of lightning. This is necessary as a precaution against fuel vapor ignition from lightning strikes (See Section VII for boom filling procedures).

FUEL CROSSFEED

Fuel crossfeed is not considered a normal method of fuel management. It may be used to supply fuel to an engine when the tank pumps are inoperative, or to manage fuel when an engine is shut down, or to increase rate of transfer when required to meet timing requirements.

WARNING

If crossfeed valves are open and main fuel tanks are below automatic dump shutoff level approximately 11,500 pounds for main tanks, actuation of either the TRANS PUMP OVRD switch, dump switch, boom switch or drogue switch will close all crossfeed valves.

FUEL TRANSFER

WARNING

Maximum lateral fuel unbalance is 4000 pounds for gross weights less than 556,000 pounds and 2000 pounds for gross weights of 556,000 pounds or more.

CAUTION

When aircraft gross weight exceeds 556,000 pounds or the sum of the zero fuel weight and fuel in the body tanks exceeds 414,000 pounds, the main tanks must be maintained full for structural reasons.

The Flight Engineer should transfer fuel prior to takeoff to achieve the most aft center of gravity practical for the gross weight. This includes any combination of fuel in the fwd, aft and center wing tanks while respecting forward and aft zone loading limits and main tank structure limits.

The primary sequence of fuel transfer is from the LWR COMPT of the CTR wing tank to the UPR COMPT until LWR COMPT is empty, then from any body tank/tanks as CG permits. When transfer from the body tanks is complete, transfer from tank 2 until it is equal to tanks 1 and 3. Transfer may be accomplished using any combination of transfer pumps or no more than one air refueling pump. If an air refueling pump is used for internal fuel transfer all crossfeed valves should be closed. Drain the tanker air refueling manifold if used for internal transfer.

When balance fuel is required, use normal transfer procedures but do not transfer balance fuel until main tanks are depleted to an amount that will maintain the CG limits (approximately 5000 pounds in each main tank), then transfer balance fuel equally to the three main tanks. Fuel carried in the body tanks is, for all practical purposes, cargo. To reduce stress on the airframe structure, fuel not required for offload or ballast should be transferred into the main tanks as soon as practical.

NORMAL USAGE – OFFLOAD SCHEDULED

Normal fuel management procedures apply and the following additional actions shall be taken.

Fuel will normally be pre-positioned in the body tanks in sufficient quantity to complete the offload respecting CG limits, fore and aft zone limits, and main tank structural limit for weight in excess of 414,000 pounds ZFW or 556,000 pounds gross weight. Large offloads using transfer pumps should not normally be planned. A/R pump selection is based on rate of offload CG control and the A/R pump hydraulic priority table.

*Fuel offload to the wing mounted pods will be accomplished by the AIR REFUELING pumps in the forward and aft body tanks. Fuel is delivered to the pods by means of the CROSSFEED MANIFOLD.

NOTE

Under normal conditions, when using AIR REFUELING Pumps for wing pod refueling, do not open the ENGINE CROSSFEED valves.

ISOLATED FUEL OFFLOAD PROCEDURES FROM THE CENTER WING TANK

WARNING

- Only JP-7 type fuel will be offloaded on SR-71 refueling missions.
- JP-7 type fuel will not be used in KC-10 engines except under emergency conditions.

a. Pull safety pin on MASTER FUEL ISOL VALVE and move switch to NORM.

b. Open A/R ISOL VALVE and transfer center wing fuel using AR pumps.

c. The lower center wing tank is to remain empty when special fuel is added to the upper center wing tank. The lower center wing tank is to be emptied of fuel, and the center wing left and right lower fuel pump power circuit breaker must be pulled and collared. After final refueling is completed, reset lower fuel pump power circuit breakers to allow transfer of fuel which may have, filtered to lower center wing tank.

CAUTION

Prior to pressurizing the crossfeed manifold or receiving fuel as a receiver, assure that forward, center, and aft tank ISOL Valves are closed.

Select A/R PUMPS by the following priority:

Hydraulic System 3

R FWD, R CTR, L AFT

Hydraulic System 1

L FWD, L CTR

Hydraulic System 2

R AFT

If possible, limit A/R PUMP selection from hydraulic system 3 to 2 pumps.

A delay in starting may occur when A/R pumps from the same side are selected.

NOTE

Approximately 2,800 pounds in the forward and aft tanks and 3,300 pounds in the center wing tank are not available for A/R pump offload due to A/R pump low level shutoffs. This fuel, plus any required ballast fuel, must be considered when planning offload requirements.

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*With TCTO 1C-10(K)A-956

BEFORE TAKEOFF

1. Flaps/Slats . . . . "__°__° T.O." (P,CP,FE)

   Move flap/slat handle to flap detent, observe SLAT TAKEOFF light is on, SLAT DISAGREE light is off, and the flap position tapes agree with preselected degrees of flaps.

   WARNING

   The Takeoff Warning System does not provide notification of flaps being set to zero during takeoff.

   NOTE

   If SLAT DISAGREE light is on and SLAT TAKEOFF light is off, recycle flap/slat handle and observe SLAT TAKEOFF light is on and SLAT DISAGREE light is off.

2. Flight Controls . . . . "CHECKED" (P,CP)

   CP rotate control wheel to full left, then full right. Observe wing deflection pointer shows full displacement and spoiler position indicator shows spoiler extended on down wing to the full extended position. Recognize control feel is normal.

   CP rotate wheel to neutral position and observe surface position indicator returns to neutral.

   CP move control column full forward and full aft then neutral, while observing corresponding indication on the elevator position indicator.

   Pilot hold nose steering wheel in neutral and operate rudder pedals full left, full right, then neutral while observing the upper and lower rudder position indicators for corresponding indications.

3. Trim . . . . "CHECKED" (P,CP,FE)

   Copilot set stabilizer trim. Pilot, Copilot and Flight Engineer ensure stabilizer, aileron and rudder trim indicators are at appropriate settings.

4. Spoilers . . . . "ARMED" (P)

   Observe AUTO SPOILER DO NOT USE light is off.

   NOTE

   If AUTO SPOILER DO NOT USE light is on or has been on at any time, do not arm automatic spoilers. Light on indicates a malfunction of the automatic spoiler system and the spoilers must be manually operated.

   Move spoiler handle to ARM (up). Observe handle remains in ARM.

   NOTE

   If handle does not remain in ARM, use manual spoilers for rejected takeoff (if required).

5. CDUs/EHSIs/Radio Aids . . . . . "SET" (P,CP,FE)

   a. Normally the integrated navigation solution (INU/GPS) will be selected on the Pilot and Copilot Steer (STR) pages.

   b. CDUs should be set to display the Pilot/Copilot Steer (STR) page, Flight Plan (FPLN) page, and Pilot/Copilot Position (PSN) page.

   NOTE

   Wind direction and velocity as well as headwind/tailwind and crosswind component is available on the Position (PSN) page on data line 3.

   c. When using the CDI for course guidance, the Pilot flying shall set EHSI to full HSI mode and the Pilot not flying may set EHSI to MAP mode.

   d. Tune, identify and monitor correct VOR, TACAN and ADF stations for departure. Select appropriate EHSI navigation and bearing sources.

   e. Rotate course select knob to position EHSI course arrow for departure, if required.

f. Check VOR/ADF selectors set for departure.

6. Flight Instruments .... "CHECKED" (P,CP)

a. Crosscheck RMI and EHSI headings and ensure that heading indicators indicate correct movement in turns.

b. Check and ensure turn needle indicates proper direction of turn.

c. Check the slip indicator for freedom of movement.

7. Thrust Computer .... "SET" (P,CP,FE)

Ensure that the proper thrust computer mode is selected for the type of takeoff being made.

When using the TO FLX (Flexible Takeoff) Mode of the Thrust Computer, set the takeoff assumed temperature in the ASSUMED TEMP selector. If engine anti-ice is used, set the assumed temperature used to determine the Reduced Thrust Takeoff N_1 Setting.

8. Crew Briefing .... "COMPLETED" (PF)

NOTE

It is recommended that this briefing be accomplished prior to engine start, if time permits.

All crew members should acknowledge any changes to takeoff procedures and/or clearances.

9. Number 2 Engine .... STARTED (FE)

a. If number 2 engine was not started previously, the Flight Engineer will start the engine during taxi. Prior to start, verify the Engine Ignition selector is in START A or B and pneumatic pressure is adequate for start.

b. After engine has been started rotate Engine Ignition selector to OFF.

10. Hydraulic System .... CHECKED (FE)

a. Observe hydraulic TEMP gages are in normal range and HYD QTY gages indicate above minimum mark. Verify RUDDER STBY PWR switch is in ARM and RUD STBY PWR OFF light is OFF.

b. Observe hydraulic TEMP HI lights are off.

c. Observe hydraulic PRESS LO lights off, all HYD PRESS gages indicate in white band.

d. Place motor PUMP 2-3 and PUMP 1-3 switches to ARM.

NOTE

Motor pumps are armed to ensure adequate pressure in all systems in the event of engine failure during takeoff.

e. Observe 1-3/2-3 PUMP VALVE OPEN and AUX HYD PUMP (1,2) ON lights are off.

NOTE

If 1-3/2-3 PUMP VALVE OPEN light is on, move motor pump switches to OFF and observe light. If light goes off, motor pump switches should be moved to ON for takeoff and landing, and OFF for remainder of flight. If light remains on after motor pump switches are moved to OFF, maintenance is required. In either case, an AFTO Form 781 entry is required.

11. Electrical System . . . . CHECKED (FE)

a. If not previously accomplished, scan electrical panel and observe CSD OIL PRESS LO lights off, CSD oil OUTLET temperature below yellow band, GEN FAIL and GEN OFF lights off, and AC LOAD meter indicates below yellow band.

NOTE

- If GEN OFF light is on or AC LOAD is zero, move VOLT/ AMP/FREQ SEL to appropriate AC GEN/DC BUS position. Move appropriate GEN switch to RESET and release to OFF. Observe AC VOLTS and FREQ meters indicate in normal range. Move GEN switch to ON. Observe GEN OFF light goes off and AC LOAD meter indicates below yellow band.
- If GEN OFF light remains on, or AC LOAD remains zero, move associated ELEC SYS RESET switch momentarily to GEN RLY/ BUS TIE RLY LOCKOUT. Observe GEN OFF light goes off and AC LOAD meter indicates below yellow band.

b. Verify EXT PWR switch is in OFF and EXT PWR IN USE light is off.

c. Observe one AC BUS TIE ISOL amber light is off.

NOTE

- If APU generator is in use during engine start, the first engine generator to power its generator bus will also power the AC TIE BUS (AC BUS TIE ISOL light will go off).
- If main external power is in use during engine start, external power will remain on AC TIE BUS (three amber AC BUS TIE ISOL lights will be on). When external power is removed from the AC TIE BUS, the preferential generator (2-1-3) will power the bus (AC BUS ISOL light will go off).

d. Push and release PARALLEL GENS button and observe all AC BUS TIE ISOL lights go off.

NOTE

- The generators cannot be paralleled if external power is on the AC TIE BUS, APU generator is on any generator bus, or if AC BUS TIE switches are in ISOL.
- If AC BUS TIE ISOL lights remain on, rotate VOLT/AMP/ FREQ SEL to affected generator(s) and observe voltage and frequency are in normal range. Advance and retard throttles slightly. Observe all AC BUS TIE ISOL lights are off.
- If AC BUS TIE ISOL light(s) remain on, observe (3) AC load meters are in the 0.2 or greater load range. If the AC load(s) is less than 0.2, increase the AC load (for example, turn on all operable main tank fuel boost pumps, turn on operable hydraulic aux pumps, etc.).
- If AC BUS TIE ISOL light(s) remain on, move associated ELEC SYS RESET switch(es) (momentarily) to GEN RLY/ BUS TIE RLY LOCKOUT (Upper Main Circuit Breaker Panel). Push and release PARALLEL GENS button. Observe AC BUS TIE ISOL lights are off.
- If AC BUS TIE ISOL light(s) still remain on, operate system unparalleled. Refer to Abnormal Procedures GENERATORS WILL NOT PARALLEL.
- If stabilized generator frequency is above 420 Hz, refer to Abnormal Procedures for Generator Frequency High.

e. Continue scan of electrical panel. Observe all annunciator lights are off (unless appropriate for APU/EXTERNAL power), verify APU GEN BUS switches in OFF (unless appropriate), verify VOLT/AMP/FREQ SEL in BAT & L EMER AC BUS, verify DC VOLT/ AMP meter DCV pointer indicates in wide green band, and AMP pointer indicates zero or an occasional pulse to green band.

NOTE

Pulsing is an indication of normal battery condition and battery charger operations. A steady charge indicates normal battery charger operation when battery is not fully charged.

12. APU .... AS REQ'D (FE)

If APU is not required,

Move APU GEN BUS switches to OFF, APU ISOL VALVE switch to CLOSE, APU master switch to OFF and after 90 seconds delay, observe APU rpm and EGT gages show a decrease.

NOTE

The APU will automatically continue running for 90 seconds after the APU ISOL VALVE switch is moved to CLOSE.

13. MANFLD FAIL/
Supply Lockout .... CHECKED (FE)

a. Both ENG PNEU SUPPLY
Selectors .... AUTO

b. APU/ISOL VALVE
Switch ....CLOSE

c. 1-2, 1-3 ISOL VALVE
Switches .... NORM

d. PNEU
SYS 1 and 3 .... PRESS NORM

e. Press MANFLD FAIL light 1. Observe MANFLD FAIL light comes on and pressure in Pneu Sys 1 decays. Release MANFLD FAIL light. MANFLD FAIL light 1 goes off and pressure in Sys 1 remains at ZERO.

f. To reset the engine PNEUMATIC SUPPLY valve, rotate the PNEU selector to OFF and back to AUTO. System pressure restores.

g. Repeat for Sys 3.

14. L-BAND SATCOM ....SET (FE)

a. Laptop Computer ....SECURED

Secure laptop computer prior to takeoff.

15. HF Radios .... "AS REQ'D" (CP)

a. Automatic (AUT) mode may be selected, if desired.

16. Fuel Systems ....SET (FE)

Observe FUEL USED counters indicate normal usage.

Observe X-FEED DISAGR and flow indicator lights are off.

Observe AFT PUMP flow indicator lights are on and pressure LOW lights are off.

Observe FUEL PRESS gage indication is within normal range.

17. FGS/ALT
Preselect ...."SET/ARMED" (P,CP)

a. Push takeoff/go-around button and observe roll and pitch FMAs display TAKEOFF.

b. Verify altitude preselect readout shows desired altitude. Pull altitude preselect knob and observe ALT on arm FMA.

NOTE

- Electrical power transients occurring during engine start and while aircraft generators are going on line, will cause flight guidance system to reset itself to basic HDG HOLD and ALT HOLD modes.
- Pushing TO/GA button while on the ground will cancel whatever is displayed in arm, roll, and pitch FMAs and provide display of TAKEOFF in both roll and pitch FMAs.
- HDG SEL and/or VERT SPD modes may be used for take-off.
- Position of fast/slow indicators and flight director V-command (pitch) bar (while in TAKEOFF mode) are not predictable while static on the ground. After reaching 60 KIAS on takeoff roll, flast/slow indictor will show full fast and flight director V-command bar will command approximately 6° pitch up.
- Flight director V-command bar and fast/slow indicators are not valid until after rotation.
- If TAKEOFF is displayed in roll FMAs, flight director V-command (roll) bar will remain centered while on the ground. After rotation V-command bars will provide guidance to maintain existing magnetic heading. The airspeed indicator is considered the primary reference system for maintaining the reference airspeeds presented in TO 1C10(K)A-1-1.

c. Verify bank angle is set to 15°.

18. Brake Temperature(s) . . . . CHECKED (FE)

Observe the BRAKE TEMP OVHT light(s) is off and the DIFF TEMP light is off.

NOTE

- Observe the BRAKE TEMP OVHT light(s) is off, the DIFF TEMP light is off, and the BRAKE TEMP gage indicates less than the maximum allowable brake temperature determined from the Brake Cooling Time Chart in Section IIA.
- To determine brake energy after an aborted take-off use the brake temperature gage reading prior to brake application.
- If BRAKE TEMP OVHT light(s) is on or BRAKE TEMP gage indicates more than 400°C, refer to Section IIA, Abnormal Brake Procedures.
- The DIFF TEMP light, when on, indicates temperature(s) of one brake is significantly different from the average temperature of the others. If DIFF TEMP is on, press each BRAKE TEMP OVHT switch-light and observe BRAKE TEMP gage to identify brake(s) with significant temperature difference.
- High brake temperature may indicate a dragging brake. Cold brake temperature may indicate an inoperative brake.

19. Cabin Report . . . . "CABIN READY" (BO)

When a second Boom Operator is assigned to perform cargo/passenger duties he will report Cabin Ready. This report will be accomplished by the primary Boom Operator when a second Boom Operator is not assigned.

19A. (**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button . . . . OFF (FE,BO)

ACCOMPLISH THE FOLLOWING STEPS WHEN CLEARED FOR TAKEOFF:

20. Pneumatic System . . . . AS REQ'D (FE)

For normal takeoff, verify that both PNEU SUPPLY selectors are in AUTO, and both pack selectors are on.

If a bleeds off takeoff is required/computed, rotate both PNEU SUPPLY selectors to OFF.

WARNING

Wing anti-ice will not be available with the engine pneumatic supply selectors off.

Verify APU ISOL/VALVE switch is in CLOSE unless air conditioning PACKS are to be operated by the APU.

CAUTION

For takeoff, go-around, or MCT power, do not operate more than one pack, both wing anti-ice systems, and lavatory/galley vent from any one engine pneumatic supply.

NOTE

For a bleeds off takeoff when wing anti-ice is required, takeoff will be made with PACK function selectors OFF, both engine PNEU SUPPLY selectors ON and WING ANTI-ICE switch ON. The thrust rating computer will not be usable and autothrottles will not be used. The takeoff setting must be computed from the Performance Manual charts.

21. Radar . . . . "SET" (FE)

Rotate weather RADAR selector to desired mode.

22. IFF/ETCAS . . . . "AS REQ'D" (FE)

Select TA/RA mode for normal operations. Select TA mode to preclude unnecessary RAs when intentionally operating near other aircraft (e.g. VFR pattern). Set ETCAS range as desired.

WARNING

Always comply with a TCAS RA unless the pilot considers it unsafe to do so or has better information about the source of the RA and can maintain safe separation.

23. HI-INT/Landing Lights . . . . AS REQ'D (FE)

Set HI-INT light as required. Set L and R and NOSE LDG LT switches as required.

NOTE

During night operation, the high intensity light switch should be in OFF when flying through clouds, or other restrictions to visibility, to preclude flight crew disorientation.

24. Annunciator Panels . . . . "CHECKED" (P,CP,FE)

WARNING

If the REV U/L or REV PRESS light for engines 1 or 3 illuminates or is inoperative, maintenance action will be taken to correct the discrepancy, or the affected thrust reverser will be deactivated and secured in the stowed position prior to takeoff.

NOTE

For takeoff with one or both wing thrust reversers deactivated, refer to part 12 of TO 1C-10(K)A-1-1 to determine the required takeoff distance and/or maximum allowable takeoff weight

25. Before Takeoff Checklist . . . . "COMPLETED" (FE)

The FE will challenge each Before Takeoff Checklist item and confirm the proper response. The FE will position his seat so that he may easily perform all takeoff duties and monitor engine instruments during takeoff.

TAKEOFF

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
Release brakes, advance throttles to approximately flight idle and command "SET TAKEOFF POWER". Maintain hand on throttles until reaching V_1.	Monitor engine instruments during initial advancement.	Upon command, set takeoff power to target N_1, and monitor engine instruments.

CAUTION

- Do not takeoff over a raised approach end cable that has been reported as slack or loose. This will preclude damage to the cable or the aircraft.
- If takeoff warning horn sounds while advancing throttles, discontinue takeoff. After discontinuing takeoff, verify flap/slats in takeoff range, trim set in takeoff range, SPOILER handle in RET (forward), and PARK BRAKE handle is released (off).
- Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

- Engines should be operated at idle power for a minimum of 3 minutes before takeoff. Power required for normal taxiing including short power applications, is considered equivalent to idle power for warm-up purposes.
- Advancing throttles to approximately flight idle is to ensure approximate symmetrical spool up. The pilot flying will then advance throttles to approximate takeoff position.
- FLIGHT IDLE thrust (approximately 40-45% N_1) should be set by the end of the line up distance to ensure computed takeoff performance will be achieved.
- Some decrease in oil quantity is normal at takeoff thrust. As thrust is reduced, oil quantity will rise proportionately.
- If autothrottle system is to be used for takeoff and flight director mode is engaged, PNF move both ATS levers to ON when takeoff power is desired. Observe ATS FMA's display N_1.
- The FE will set the clock to record time at takeoff power and flight time.

<table>
<tr><th>PILOT FLYING</th><th>PILOT NOT FLYING</th><th>FLIGHT ENGINEER</th></tr>
<tr><td colspan="3">

CAUTION

Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

- If autothrottle system is to be used for takeoff and flight director is not engaged, PNF move both ATS levers to ON and observe ATS FMA's display clamp.
- The PNF must push ATS N_1 switch and observe ATS FMA's switch to N_1 and throttles drive to thrust computer N_1 limit.

</td></tr>
<tr><td>Maintain directional control by use of rudder pedals.</td><td>Monitor control and airspeed indicator.</td><td>Make a continuous scan of engine instruments.</td></tr>
<tr><td colspan="3">

NOTE

- Analog presentation should be monitored during the initial power setting and digital readout for fine adjustments.
- A system malfunction that affects the FE panel, including engine oil pressure low, will be indicated by the appropriate annunciator, cue, caution, and warning lights.
- N_1 indications follow the throttles and maintain the takeoff power set prior to 80 KIAS. During the takeoff and acceleration phase, the indications may decrease slightly, after approximately 2 minutes.
- With intermixed fuel control, expect an increased throttle stagger and different spool-up characteristics.

</td></tr>
<tr><td></td><td></td><td>Adjust throttles as required.</td></tr>
<tr><td colspan="3">

CAUTION

Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

- Do not adjust throttles (N_1) after 80 knots, except to prevent exceeding engine limits.
- Thrust is affected by temperature and altitude changes; 80 KIAS is selected as the adjustment cutoff to provide both a constant, predictable takeoff performance and to avoid exceeding engine limits.
- If the Autothrottle system FMA's do not switch from N_1 to CLAMP at 80 knots, PNF call out, "No Clamp". Pilot flying push the Autothrottle Disengage buttons twice and continue the takeoff with manual throttle control.

</td></tr>
<tr><td>Cross-check airspeed indicator.</td><td>Call "80 KNOTS", "V_1", "ROTATE", and "V_2" as these speeds are reached during takeoff.</td><td>Call "POWER SET".</td></tr>
</table>

(Continued)

<table>
<tr><th>PILOT FLYING</th><th>PILOT NOT FLYING</th><th>FLIGHT ENGINEER</th></tr>
<tr><td colspan="3">WARNING
If takeoff power is not set by 80 knots, charted takeoff performance may not be achieved.</td></tr>
<tr><td>At rotation speed, rotate. Use a smooth continuous rotation, (approximately 4 seconds) to establish pitch attitude required to maintain the correct airspeed.</td><td>Monitor rotation.</td><td>Monitor engine instruments and winds on CDU 3. Advise pilot flying of any significant wind deviations (10 knots headwind/tailwind component or a rapid change in direction of 20° or more).</td></tr>
<tr><td colspan="3">WARNING
• Do not use flight director ALT HOLD mode for takeoff.
• If flight director TAKEOFF mode is not used (disengaged), PF rotate aircraft at V_R, using a smooth continuous rotation which will require approximately 4 seconds to establish a pitch attitude required to maintain the correct speed.
CAUTION
After becoming airborne, with the pitch annunciator in TAKEOFF and the autothrottle annunciator in CLAMP, if the ATS SPEED knob is pulled, the ATS annunciator will blank. When the knob is released, N_1 will be annunciated. The ATS will direct N_1 power that is indicated on the TRC, and an engine overspeed is possible.
NOTE
The fast/slow indicators will reflect the speed error between SPD readout and actual IAS.</td></tr>
<tr><td colspan="2">• If flight director TAKEOFF mode is engaged, rotate aircraft at V_R using a continuous rotation to center V-command bars after becoming airborne.
• A smooth continuous rotation (approximately 4 seconds) is desired, to an attitude at which V_2 + 10 knots (all engines) or V_2 (two engines) can be maintained. Pitch attitude will vary with gross weight and ambient conditions.
• Fast/slow indicators and flight director V-command bars are not valid until after rotation.
• Maximum pitch-up command that flight director TAKEOFF mode can command is 22°.</td><td></td></tr>
</table>

(Continued)

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
Confirm liftoff and a positive rate of climb is established. After positive rate of climb is confirmed on the TVSI, radio altimeter, and altimeter call "GEAR UP."	Confirm positive rate of climb on the TVSI, radio altimeter, and altimeter and acknowledge command by stating "POSITIVE RATE OF CLIMB, GEAR UP." Place Gear Lever UP. Check for normal indications.	Observe gear lights go off. Disarm spoilers after observing gear lights go off.
For Noise Abatement: At 1500 feet AGL (Obstacle height permitting)		
Request PNF to select climb thrust on thrust computer indicator.	Push CL thrust select switch on. Observe N_1 LIM and N_1 maximum limit indexes on N_1 gages agree.	Set climb power and establish pressurization: ENG PNEU SUPPLY Sels . . . AUTO PACK Function Sels (one at a time) . . . . AUTO Observe pneumatic flow gages indicate normal flow and PACK OFF lights are off.
At 3,000 feet AGL or when aircraft is clear of obstacles, manually rotate vertical speed select wheel to reduce rate of climb to approximately 1,000 fpm to allow acceleration to flap/slat retraction speeds. At heavy gross weights and/or hot days, it may be necessary to reduce rate of climb to 500 fpm.	Monitor aircraft control and assist as requested.	Assist as required/requested.

When noise abatement is not a factor, the minimum three engine pressure height for acceleration is 800 feet above the runway. The minimum pressure height for acceleration with an engine inoperative is 400 feet above the runway. If the minimum acceleration height does not provide sufficient obstacle clearance, the pressure height for acceleration is based on the obstacle clearance height.

NOTE

- Pitch FMA's display VERT SPD after manually rotating vertical speed select wheel.
- Manual rotation of vertical speed select wheel disengages flight director TAKEOFF mode.

NOTE

- If HDG SEL was used for takeoff, roll FMA's continue to display HDG SEL after flight director TAKEOFF mode is disengaged.
- Manual or automatic engagement of another pitch mode, disengages flight director TAKEOFF mode.
- If TAKEOFF was displayed in roll FMA's during takeoff, roll FMA's will display HDG HOLD after flight director TAKEOFF mode disengagement.
- If IAS HOLD mode is desired for climb, push IAS switch when on desired climb airspeed and observe pitch FMA's display IAS HOLD.

<table>
<tr><th>PILOT FLYING</th><th>PILOT NOT FLYING</th><th>FLIGHT ENGINEER</th></tr>
<tr><td colspan="2">NOTE
Engaging IAS HOLD mode cancels flight director TAKEOFF mode. If roll FMA's displayed TAKEOFF, pushing IAS switch causes roll FMA's to switch to HDG HOLD.</td><td></td></tr>
<tr><td rowspan="2">At flap retract speed call "FLAPS UP".</td><td>Observe flap position indicator, altitude, airspeed and ADI, advise pilot flying of non-normal indications.</td><td></td></tr>
<tr><td>If normal, move FLAP/SLAT handle to zero degrees detent. Observe flap position indicator moves to UP and flap position tapes start to move symmetrically toward up.</td><td>Monitor</td></tr>
<tr><td colspan="2">NOTE
If asymmetric flap condition exists, maintain control of aircraft and fly within flap limit speed. Refer to Abnormal Procedures, Asymmetric Flaps or No Flap Landing With Slats.</td><td></td></tr>
<tr><td>At slat retraction speed, call "SLATS RETRACT".</td><td>Observe slat position lights, airspeed and ADI, advise pilot flying of any non-normal indications.
If normal, move FLAP/SLAT handle to UP/RET and observe slat TAKEOFF light goes off.</td><td rowspan="2"></td></tr>
<tr><td colspan="2">WARNING
For after takeoff clean-up, limit bank angle to 15 degrees until minimum maneuvering speed for existing flap/slat configuration. With less than minimum maneuvering speed for the next configuration, delay clean-up if bank angle greater than 15 degrees is a priority or conversely limit bank angle to 15 degrees if acceleration is a priority.</td></tr>
</table>

(Continued)

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
NOTE • If slat asymmetry is indicated by a trim change, return the FLAP/SLAT handle to the last position where slats were symmetrical and refer to Abnormal Procedures, Asymmetric Slats or No Slat Landing With Flaps. • If slats cannot be retracted, continue to observe slat extended airspeed limits. Refer to Abnormal Procedures for Slat Disagree Light On.		
Use the same pitch attitude as used during flap/slat retraction until 250 knots or clean configuration minimum maneuvering speed, whichever is higher is attained.		Rotate the FLAP T.O. selector to the zero degree stop.
Adjust vertical speed select wheel to control airspeed as required. After accelerating to desired climb speed, PF command, "IAS HOLD." PNF push IAS switch and observe pitch FMA displays IAS HOLD. When reaching desired Mach, push MACH switch and observe pitch FMA's display MACH HOLD. Normally IAS/MACH HOLD mode of the flight director is used with an N_1 setting to control airspeed during climbout. The vertical speed selector and the speed select knob may also be used. **WARNING** If the vertical speed selector and speed select knob are used to command climb rate and IAS, it is possible to command a climb rate in excess of aircraft capability. This may result in insidious loss of airspeed and possible stall.		
NOTE • With IAS or MACH HOLD engaged, the autopilot (if in CMD) will automatically adjust pitch attitude. If flight director is being used, the V-command bar will furnish guidance to maintain IAS or Mach existing at time of mode engagement. • IAS HOLD or MACH HOLD cannot be selected in autothrottle SPD mode.		

(Continued)

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
Manual rotation of the vertical speed select wheel will cancel IAS HOLD or MACH HOLD. Rotate bank angle selector to 25°.		
NOTE If ATS was engaged in N_1 mode at time of thrust computer failure and ATS levers dropped to OFF, set desired airspeed in SPD readout, engage ATS levers, and observe FMA displays SPD. **CAUTION** • Engaging autothrottle(s) immediately after takeoff while thrust computer is in T.O. can result in engine overboost. Such an overboost results from engine bleed changes (wing anti-ice, air-conditioning, etc.). This overboost condition does not occur when in thrust computer GA mode. • Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.		**NOTE** If N_1 LIM readout is covered by a red failure flag, compute desired N_1 percent and manually set.
Rotate SPD select knob until desired climb speed is displayed in SPD readout.		
NOTE Climb speed is set at this time for reference only.		
Move both ATS levers to ON (as desired). Observe FMA's.		
If ATS is not engaged, request FE to set climb thrust.		Set throttles to desired thrust.
Altitude Pre-Select. . . . SET/ARMED		SEAT BELTS Switch. . . . . SET
		Exterior Lights . . . . SET **NOTE** When turbulence is anticipated, SEAT BELTS switch should be in ON.
		Complete the After Takeoff Checklist.

TAKEOFF ABORT PROCEDURES

PILOT'S DECISION

The crewmember recognizing a malfunction will clearly and concisely state the nature of the malfunction. The decision to continue or abort the takeoff must be timely, and is the ultimate responsibility of the pilot in command. He will announce continue or abort and direct the appropriate actions.

A. The takeoff is aborted before V_1 if a serious emergency/loss of thrust occurs.

CAUTION

Use extreme caution when braking with ANTI-SKID FAIL light(s) on or if the entire anti-skid system is inoperative. Tire skids may be difficult to detect. Judge braking action by sensing the deceleration of the aircraft while applying pressure to the brake pedals. Manual braking technique consists of gradually increasing the pedal force until a moderate deceleration is felt and immediately extending the spoilers (auto spoilers may be used). The pilot flying should also pace the deceleration to use most of the runway available, RCR permitting. Excess pedal pressure/deflection can result in skids, worn/blown tires and possible center gear lower drag link failure. If skidding develops and brake system pressure is normal, release brakes and reapply using the same technique. With only accumulator pressure available, avoid cycling brake pedals.

NOTE

Although there may be a number of reasons to abort a takeoff, as you approach V_1 the decision to abort should be based upon an increased level of criticality. In those cases where the decision to stop or go may be borderline, experience shows that more difficulty is encountered in attempting to abort than in attempting to continue. It is recommended that emphasis be placed on continuing the takeoff in borderline situations.

B. If an emergency occurs after V_1 is reached, the takeoff is committed.

WARNING

Takeoff will not be aborted after V_1 unless, in the opinion of the pilot, the emergency renders the aircraft incapable of flight. In those cases where the pilot attempts to abort after V_1, he must accept the fact that he will probably fail to stop within the confines of the runway.

(Continued)

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
THROTTLES - Rapidly retard to idle position.	Hold control column slightly forward of neutral to keep nosewheel firmly on ground.	
BRAKES - Simultaneously apply maximum braking. The anti-skid system responds most efficiently with full brake application (pedals bottomed).		
REVERSE THRUST - Maximum Allowable (Runway conditions may dictate limiting asymmetric thrust actuation.)	Maintain wings level.	Monitor engine instruments. Advise Pilot of any limits being approached or other abnormalities.
SPOILER HANDLE - AUTO.	Call tower and announce aborted takeoff.	Observe spoiler handle moves aft. If handle does not move aft, call "NO SPOILERS." Pull handle aft and lift (latch and engage).
Maximum use of all deceleration devices, (brakes, reversers, spoilers) is required to effect a safe stop on the runway. Complete appropriate normal landing roll procedures.		
-- AT TAXI SPEED OR STOPPED --		
Initiate appropriate procedures or actions as required by the abort. Taxi clear of the active runway if possible. Avoid unnecessary use of brakes.	Call tower and advise of intentions.	Monitor BRAKE TEMP gage and BRAKE TEMP OVHT lights. Refer to Section IIA, ABNORMAL BRAKE Procedures, page 2A-108.

ENGINE FAILURE AFTER V_1 PROCEDURE

Takeoff performance (TRT or Reduced Thrust) is based on the loss of a wing engine after V_1. During a Reduced Thrust takeoff, power on the remaining engines may be advanced to Takeoff Rated Thrust, if necessary, only after reaching 135 KIAS (worst case wet/icy V_{MCG}/V_{RMIN}).

WARNING

- During a Reduced Thrust takeoff, since V_{MCG} is calculated using assumed temperature, if power is advanced prior to reaching 135 KIAS, there may not be sufficient lateral control to keep the aircraft on the runway.
- To reduce liability of loss of a second engine (TRT or Reduced Thrust takeoff), do not advance power beyond Takeoff Rated Thrust unless needed to maintain flight.

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
	Call or verify ENGINE FIRE or ENGINE FAILURE and engine number.	Call or verify ENGINE FIRE or ENGINE FAILURE and engine number.
Fly the aircraft. Maintain directional control.	If required, call "ROTATE", and "V2" as these speeds are reached.	Scan Flight Engineer's panel for abnormal indications.
Confirm liftoff and a positive rate of climb is established. After positive rate of climb is confirmed on the TVSI, radio altimeter, and altimeter call "GEAR UP."	Confirm positive rate of climb on the TVSI, radio altimeter, and altimeter and acknowledge command by stating "POSITIVE RATE OF CLIMB, GEAR UP." Place GEAR lever UP; check for normal indications.	
Climb at V_2; limit bank angle to 15° at airspeeds below V_2 + 10.*		Monitor forward engine instrument panel.
Command initiation of appropriate checklist. Accomplish actions as appropriate.	Assist pilot flying as directed.	Accomplish actions of appropriate checklist.
At acceleration height accelerate to flap retraction speed and call "flaps up" observing flap retraction schedule.	Place flap/slat lever to 0/EXT. Check for proper flap/slat indications.	Scan panel for abnormal indications.
Accelerate to slat retraction speed, call "SLATS RETRACT" and climb to safe operating altitude at slat retraction speed.	Place Flap/Slat Lever to UP/ RET. Check for proper Flap/Slat indications.	Scan panel for abnormal indications.
Complete appropriate checklist.	Complete appropriate checklist.	Read appropriate checklists and complete appropriate checklist items.
Determine next course of action.	On command, notify ATC and advise of next course of action.	On command, set climb, MCT or go-around thrust as required.

(Continued)

<table>
<tr><th>PILOT FLYING</th><th>PILOT NOT FLYING</th><th>FLIGHT ENGINEER</th></tr>
<tr><td colspan="3">Do not use the flight director takeoff mode pitch commands as primary reference under the following conditions (use the airspeed indicator):
● Following the loss of an engine, during an obstacle limited takeoff, when V_2 speed is corrected for aircraft center of gravity.
● When rotation speed (V_R) is bumped to minimum rotation speed (V_{Rmin}).
If an engine failure occurs prior to V_2 maintain V_2 up to height required for obstacle clearance. If an engine failure occurs after V_2, maintain the speed that has been attained when engine failure occurs. Under no circumstances should airspeed be reduced unless obstacle clearance is a factor.</td></tr>
</table>

CLIMB AND CRUISE

AFTER TAKEOFF/CLIMB

This checklist should be initiated after the first power reduction and is to be accomplished by the Flight Engineer, who will confirm the completed actions, and upon completion so advise the pilot.

NOTE

If a landing is accomplished immediately after takeoff, the DOWNWIND Checklist may be accomplished in lieu of the AFTER TAKEOFF/CLIMB, DESCENT and APPROACH Checklists.

1. Landing Gear .... UP (PNF)

NOTE

During gear retraction, hydraulic pressure may momentarily decrease to below 2000 PSI. Hydraulic PRESS LO lights in system 3 may momentarily flash.

Observe the GEAR handle is up and lights are off.

2. Thrust Computer .... SET (PNF)

Observe the thrust computer indicator is set as required.

3. N_1 Max Limit Knobs .... AUTO (PNF)

Observe N_1 maximum limit knobs are in AUTO, and N_1 maximum limit index agrees with the limit displayed by the thrust computer.

4. Pressurization .... CHECKED (FE)

If takeoff was made bleeds off, rotate PNEU SUPPLY selectors to AUTO one at a time.

If takeoff was made with bleeds on verify that aircraft is pressurizing normally.

5. Spoilers .... DISARMED (FE)

With flat of hand, push spoiler handle down to disarmed.

6. Flaps/Slats .... UP/RETRACT (PNF)

Verify that Flap/Slats are in UP/retracted. Observe that flap tapes and flap disagree flag are not in view and that slat DISAGREE and TAKEOFF lights are off.

7. FLAP Takeoff Selector ..... RETRACTED (FE)

If FLAP T.O. selector was used to set flap stop for computed variable flap setting dial selector to zero degree stop.

8. Boom Operator/
Exterior Lights &
Seat Belt Sw ...... NOTIFIED/SET (P, FE, BO)

Notify the boom operator when aircraft altitude is above 10,000 feet MSL. Select landing light switches to RET OFF. Set other exterior lights as required. After the boom operator completes the cargo inspection and with the aircraft commander's concurrence turn seat belt switch OFF.

9. Altimeters .... SET (P, CP)

Verify 29.92 is set by pilots when passing transition altitude.

10. L-BAND SATCOM .... SET (FE)

    a. Departure Message .... AS REQUIRED

NOTE

- L-BAND SATCOM System power-up and reporting is not required for local missions. For missions operating out of locations without an AMC C2 presence, transmit departure message.
- Do not manually print any messages received when the computer is off or FALCON program is closed. Messages printed in this configuration are illegible and will not be saved by the operating software.

10A. (**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF
Button .... ON (FE,BO)

11. After Takeoff/Climb
Checklist................ "COMPLETED" (FE)

CLIMB INFORMATION

BANK ANGLE SELECTOR

Rotate bank angle selector to desired bank angle.

NOTE

Bank angle selection may be as PF desires. As a general rule, during maneuvering, a selection of 25° is desired.

NAVIGATION

NOTE

Crosscheck FMS navigation with traditional ground-based NAVAIDS in the terminal area when available. FMS navigation may be used as the sole-source of navigation information for all arrival, approach and departure procedures extracted from the aircraft database. These procedures must be flown as extracted, with no additions, changes or deletions from the aircrew.

ANTI-ICE OPERATION

CAUTION

ENGINE and WING ANTI-ICE will be used anytime in flight when icing conditions are expected or encountered. When TAT is below 6°C (42°F), and visible moisture in any form is present; such as clouds, fog, rain, snow, sleet, or ice crystals; engine and wing anti-ice will be used.

NOTE

- Wing anti-ice should be on for flight when icing conditions are expected. The following general rules may be used to assist in determining icing condition:
- Icing conditions can exist when TAT is below 6°C and there is visible moisture in the air.
- The higher the temperature (up to 6°C), the higher the cloud liquid water content and the more severe the icing condition.
- At temperatures below -20°C, icing conditions encountered should be less severe.
- In addition to TAT below 6°C and visible moisture in the air, be alert for ice buildup on unheated portions of aircraft visible from cockpit.
- The above apply, in general. However, heavy icing has, on occasion, been reported at temperatures as low as -60°C. Unusual icing conditions can occur and the only simple rule to follow is - when in doubt, turn on ice protection.

One at a time, move ENG 1 & 3 ANTI-ICE and ENG 2 & ANT ANTI-ICE switches to ON.

NOTE

- In flight, verify normal engine operation before moving next anti-ice switch to ON.
- If one or more ENG ANTI-ICE DISAGREE lights are on, depart icing area as soon as possible, maintaining cruise thrust to the extent practical. If light(s) is off, observe ENG 2 ANTI-ICE COWL PRESS HI light is off.
- ENG 2 ANTI-ICE COWL PRESS HI light may come on momentarily when ENG 2 & ANT ANTI-ICE switch is moved to ON. If light remains on, make entry in AFTO Form 781A.

When engine and antenna anti-ice is no longer required, move ENG & ANT ANTI-ICE switches to OFF. Observe ENG ANTI-ICE DISAGREE lights and ANT ANTI-ICE DISAGREE lights are off.

NOTE

ENG 2 ANTI-ICE DISAGREE light will come on momentarily only at high power settings.

Move WING ANTI-ICE switch to ON and observe WING ANTI-ICE DISAGREE lights come on and go off.

NOTE

No correction to engine power (climb, maximum cruise, maximum continuous thrust) settings is required if thrust computer is used to set N_1.

When wing anti-ice is no longer required, move WING ANTI-ICE switch to OFF. Observe WING ANTI-ICE DISAGREE lights cycle on and off.

CAUTION

If WING ANTI-ICE switch is in OFF and one or both disagree lights remain on, consider appropriate wing anti-ice system(s) on. Just prior to landing, rotate appropriate ENG PNEU SUPPLY selector (1 and/or 3) to OFF, and move connecting pneumatic ISOL VALVE switches to CLOSE.

ENGINE AND AUTOTHROTTLES

FE, as duties permit (at least every 5,000 feet during climb), monitor N_1, EGT, and N_2 gages to ensure that all are within normal operating ranges and do not exceed limits. Check that fuel flow gages are normal for the phase of flight.

WARNING

If the vertical speed selector and speed select knob are used to command climb rates and IAS, it is possible to command a rate of climb exceeding the aircraft capabilities. This may result in a loss of airspeed and resultant stall condition. Damage to the elevator may result.

CAUTION

- When climbing with autothrottles off, the engines may overboost if the throttles are not adjusted for lapse rate temperature deviation.
- PF will announce to the crew whenever the AP/ATS is disengaged for any reason. This will be acknowledged by the PNF/FE.
- Engine damage may occur if the engine overspeeds in any phase of flight.
- Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

- If any N_1, EGT, or N_2 gage indication is not as desired, or exceeds the limit mark, adjust the affected throttle(s) as desired.
- The autothrottles may be manually overridden. However, if all throttles are overridden simultaneously, the autothrottle system will return the throttles to their original position (except minor adjustments) when released.
- One throttle may be manually overridden, and when released it will maintain the same position relative to the other throttles.

HYDRAULIC

Observe hydraulic TEMP, HYD PRESS, and HYD QTY gage pointers are in normal range, and annunciator lights are off.

NOTE

> During cruise, with a normal operating hydraulic system, system temperature gages may indicate as low as 0° C or as high as 60° C. For temperatures above 60° C, make AFTO Form 781 entry.

ELECTRICAL AND APU

FE scan electrical and APU panels for normal indications.

NOTE

> When DC TIE CLOSED or DC X-TIE CLOSED lights are on with the appropriate switches in OPEN, the affected systems may be operating paralleled. This should be noted in AFTO Form 781, but requires no change in operating procedures.

Verify VOLT/AMP/FREQ selector is in BAT & L EMER AC.

Observe DC VOLT/AMP meter DCV pointer indicates in wide green band and AMP meter pointer indicates zero or an occasional pulse to the green band.

FUEL

Observe FUEL QTY indicators show normal usage, and balance of fuel between tanks 1 and 3 is within 4,000 pounds.

Observe remaining fuel panel gages and annunciator lights for normal indications.

NOTE

> - If one or more fuel used readouts shows abnormal usage, crosscheck with other FUEL USED readouts and/or FUEL QTY indicators. If fuel totalizer is in error, determine actual total fuel by summing all FUEL QTY indications. Compute actual gross weight by summing actual total fuel and zero fuel weight.
> - If fuel pressure gage(s) indication(s) is low after a period of normal operation, evaluate engine FUEL PRESS and fuel flow gages, FUEL USED readouts, and other engine performance indicators.
> - If fuel pressure problem shows up as erratic engine operation, decreased fuel flow, or surging, consider an engine shutdown.

PNEUMATIC AND AIR CONDITIONING

Scan PNEU & AIR COND SYS panel gages and annunciator lights for normal indications.

NOTE

> If one or more COMPT/DUCT temperature gages is not indicating as desired, rotate the appropriate compartment temperature selector to increase or decrease the compartment temperature. Should it become necessary to operate with only one pack, select the OVRD position of AVIONIC FLOW switch.

OXYGEN AND PRESSURIZATION

Observe OXY QTY gage indication is normal.

Observe CABIN ALT RATE and CAB ALT indications are normal and DIFF PRESS indication is not above the normal range mark.

WARNING

> During initial pressurization after takeoff, if unable to maintain normal cabin altitude schedule using AUTO or manual pressurization and if OUTFLOW VALVE position indicator indicates full closed, immediately initiate descent and depressurization, unless operational requirements dictate otherwise.

ANNUNCIATOR PANEL

Observe all FE annunciator lights are off.

ENGINE AND APU FIRE DETECTION

Observe all engine/APU fire detection system lights are off.

NOTE

If one or more fire detector lights are on without a fire warning, refer to Abnormal Procedures for Engine/APU Fire Detection Loop Light On Without Fire Warning.

ENGINES

Observe OIL QTY, OIL TEMP and OIL PRESS gage indications are normal.

CRUISE DATA

Not later than 1,000 feet below cruise altitude, determine engine parameters for expected initial cruise conditions.

CRUISE SPEED AND THRUST LIMIT (ATS)

Copilot rotate SPD select knob to set desired cruise airspeed in SPD readout.

CAUTION

- When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.
- Failure of the Autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

If autothrottle system is in N_1 mode and ALT CAP engages, or when on selected IAS, pull SPD select knob and observe ATS FMA displays SPD.

PRESELECTED ALTITUDE

With autopilot in CMD mode, verify desired altitude is set in ALT readout, and ALT is displayed in ARM FMA. If correct altitude is not set or ALT preselect mode is not armed, set desired altitude and/or pull ALT preselect knob to engage ALT preselect mode. Observe ALT displayed in arm FMA.

NOTE

- The ALT preselect mode provides automatic capture of a preselected altitude. The flight guidance system may be in any available pitch mode except TURB mode. When the selected altitude is approached, an amber light on the altimeter comes on and a momentary aural warning sounds. Closure rate determines the amount of warning time prior to reaching the preselected altitude. ALT preselect mode automatically captures the preselected altitude or provides V-command bar guidance and reverts to ALT HOLD mode.
- Altitude advisory is available when the pitch computer is powered.

At completion of climb, push CR thrust select switch and observe N_1 maximum limit indexes automatically position themselves to same N_1 maximum as displayed on thrust computer indicator.

At level-off and after stabilized on selected airspeed, crosscheck actual performance against predicted and adjust as necessary.

CRUISE INFORMATION

FUEL MANAGEMENT

Observe FUEL QTY, TOTAL FUEL QTY, and FUEL USED indications. Verify FUEL QTY values in tanks 1 and 3 are approximately equal.

NOTE

- If fuel quantity values are approaching maximum lateral unbalance or for any reason requiring fuel transfer, transfer fuel as required to regain lateral balance.
- If FILL VALVE OPEN light remains on, consider fill valve open and do not open any crossfeed or operate any transfer pump unless fuel transfer is acceptable in that tank.
- If TANK OVERFILLED light comes on during tank transfer, discontinue tank transfer and manually control transfer as required to maintain tanks approximately 2000 pounds below full.

ENGINES

Observe engine vibration scale indicates normal.

NOTE

Test indicator and observe ENG VIB scale indicates 6, test is normal. Make AFTO Form 781 entry and monitor system when:

- Any ENG VIB indicator indicates more than 5.0 in FWD or AFT N_1.
- Any ENG VIB indicator indicates more than 6.0 in AFT N_2 below 80% N_2.
- Any ENG VIB indicator indicates more than 4.0 in AFT N_2 above 80% N_2.
- Upward shift over 2.0 Units (based on Trend Monitoring).

No maintenance action should be performed based on indicator readings at FWD N_2 frequency position because the No 1. bearing (FWD) does not provide reliable core vibration indications.

CAUTION

ENGINE and WING ANTI-ICE will be used anytime in flight when icing conditions are expected or encountered. When TAT is below 6°C (42°F), and visible moisture in any form is present; such as clouds, fog, rain, snow, sleet, or ice crystals; engine and wing anti-ice will be used.

NOTE

The number two throttle cable may experience binding due to condensation/moisture entering a crack in the throttle cable casing and freezing at altitude. If the number two throttle binds at altitude and a frozen throttle cable is suspected, consider descending to a lower/warmer altitude to melt the ice (consider fuel requirements before descending). If unable to maintain the engine within normal operating parameters, consider shutting down the engine.

VOR TACAN MODE, RADIAL CAPTURE AND TRACK

With one autopilot lever in CMD, or flight director mode only engaged, rotate VOR frequency and CRS select knobs until the desired frequency and course appears in respective readouts.

NOTE

- RAD CAP and RAD TRK are applicable to VOR and TACAN modes.
- When a new VOR frequency is selected without passing through an ILS frequency during selection, the VOR mode will remain engaged (if previously in VOR mode) and the Roll FMA will display RAD CRS.
- When a new course is selected while in RAD/CRS mode, the aircraft will turn to the new course automatically if the autopilot is engaged in CMD, or the FD V-command bar will provide guidance to the new course.

Rotate heading control knob until desired intercept heading appears in the heading readout.

NOTE

> If not already in HDG SEL mode, pull heading control knob and observe Roll FMA displays HDG SEL.

Verify EHSI navigation source selected is VOR, ILS, or TCN.

NOTE

> EHSI navigation source must be VOR, ILS, or TCN before the FGS can be armed or engaged in one of these modes.

Push RAD/FMS switch, and observe RAD appears in Arm FMA.

NOTE

> When a new VOR frequency is selected (on side with AP lever in OFF), push RAD/FMS switch again.

L-BAND OPERATION

Transmit advisories and position reports as required. During long cruise periods the laptop computer may be turned off when not used for sending messages. Do not turn off the L-BAND SATCOM power switch until the Leaving Aircraft Checklist.

If required, send Three Hour Out message to TALCE units.

(1) Click on Mail then Create. Select 3 Hour Out from the pull down menu.

(2) Select each tab and update applicable fields. When the transceiver field indicates XCVR Ready, send the message.

NOTE

> Do not manually print any messages received when the computer is off or falcon program is closed. Messages printed in this configuration are illegible and will not be saved by the operating software.

FLIGHT MANAGEMENT SYSTEM

Selection of FMS flight mode affects CDI sensitivity and integrity performance of GPS navigation solutions based on phase of flight. The flight guidance modes and their full scale (two dot) linear CDI deviations are as follows:

- En route - ±4.0 nautical miles
- Oceanic - ±4.0 nautical miles
- Terminal - ±1.0 nautical mile
- Approach - ±0.3 nautical mile

While the mode of operation can be manually selected for the active waypoint, most flight mode selections are made automatically. When the system is powered up, the FMS defaults to TERMINAL mode until the aircraft has left the 30 NM radius terminal area around the origin airport. At that point, it automatically switches to ENROUTE mode and remains there until the aircraft reaches a point 30 NM from an airport or FAF waypoint, where it switches back to TERMINAL mode. When the aircraft reaches the FAF of an FMS approach (2 NM prior to the FAF of a databased GPS approach), the FMS automatically switches to the APPROACH mode until the TO/GA button is pressed, a DIRECT-TO operation is performed, or AUTO waypoint sequencing is selected after passing the MAP. Any of these actions will automatically switch the system back to the TERMINAL mode.

There may be certain instances where the crew may find the FMS defaulted to a flight mode that is not appropriate to the phase of flight, e.g., operation in a terminal area without the airport waypoint or an approach in the flight plan or operation in the oceanic environment. In these cases, the crew should manually select the appropriate mode based on the phase of flight.

AUTOPILOT – CMD CWS MODE

1. AP Lever (1 or 2) . . . . CMD

CAUTION

- The autopilot will not be used during high rates of climb (more than 4,000 feet per minute) or high rates of descent (more than 8,000 feet per minute). The vertical speed select wheel will physically lock up beyond these command limits and selection of another pitch mode will not be possible.
- When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.
- The emergency power switch should never be moved to ON while autopilot 1 is engaged and is being powered by an aircraft generator.
- An autopilot lever engaged in CMD will not drop to OFF if the respective hydraulic system fails (climb, cruise, or descent).

NOTE

Any manual operation of the longitudinal trim switches or handles while the autopilot(s) is engaged in CMD will cause the autopilot(s) lever(s) to drop to OFF.

2. CWS Switch . . . . PUSH

WARNING

- Control column manual forces, which exceed the control wheel steering override threshold, will cause the engaged autopilot lever to drop to CWS and the red AP fail lights to come on flashing.
- In the event of an uncommanded pitch maneuver during autopilot controlled flight, the pilot should firmly grasp the control wheel and disconnect the autopilot.

NOTE

- If pitch axis is in vertical speed or altitude hold mode and roll axis is not in a capture mode, observe that CWS and the applicable flight director mode is annunciated in the roll axis only.
- If a pitch mode other than vertical speed or altitude hold mode is engaged, and roll and/or pitch axis is not in a capture mode, observe that CWS and the applicable flight director mode is annunciated in both roll and pitch axis.
- The flight director V-command bar will continue to display the engaged mode commands and may not be centered during this phase.
- If flight director switch(es) are in OFF, CWS will be annunciated in respective pitch and roll FMA's.
- During a capture phase, CWS annunciation will switch to appropriate capture phase such as FMS CAP, ALT CAP, etc.; annunciation and normal control wheel steering control is replaced by supervisory override control.
- If supervisory override control is desired during a capture phase (CWS switch has been pushed), apply manual override force to the control wheel or column and maneuver aircraft as desired.
- When it is desirable to maintain an input while exercising supervisory override control function, it is necessary to return appropriate control to near neutral and hold some pressure on the control to prevent response from appropriate autopilot inputs signals.

NOTE

- When using supervisory override, 15° may be added to the roll axis input applied by the autopilot. There is no limit to the additive capability in pitch axis.
- Supervisory override terminates when FMS TRACK, LOC TRACK, GS TRACK, or ALT HOLD is annunciated and supervisory override force is removed.
- Command control wheel steering (autopilot lever in CMD) also terminates in roll and/or pitch when any of the following modes are selected: IAS hold, Mach hold, heading select, or heading hold.

FMS Navigation

Refer to Section I, Part 14, Navigation and Radar, for FMS operation.

AIR REFUELING

Refer to TO 1-1C-1, TO 1-1C-1-32, TO 1-1C-1-33, and Section I of this manual.

DESCENT AND LANDING

DESCENT INFORMATION

GENERAL

Descent schedule charts are provided in the performance manual. Type descents are Long Range, Enroute, and Penetration. Long Range and Enroute descents are the preferred method. Fuel economy is improved with these types of descents. The recommended thrust setting for achieving the charted descent schedule is idle. The KC-10 engines produce ample bleed for all anti-ice systems and pressurization at flight idle. A minor pressurization surge occurs, when adding power from idle or decreasing thrust.

NOTE

Crosscheck FMS navigation with traditional ground-based NAVAIDS in the terminal area when available. FMS navigation may be used as the sole-source of navigation information for all arrival, approach and departure procedures extracted from the aircraft database. These procedures must be flown as extracted, with no additions, changes or deletions from the aircrew.

DESCENT TECHNIQUES

Initiate the descent by selecting a target vertical speed that will allow the aircraft to accelerate or decelerate, as necessary, to achieve the target descent MACH/ IAS. If MACH HOLD descent is desired, push MACH switch when on desired MACH. Push IAS switch when on desired indicated airspeed. MACH HOLD or IAS HOLD will be displayed, as appropriate, in the pitch FMA's. Adjust throttles to maintain desired rate.

If a constant rate descent is desired, rotate vertical speed select wheel to initiate descent and adjust throttles to maintain desired descent airspeed.

For all descent profiles, rotate SPD select knob until desired speed is displayed in SPD readout. Throughout approach maneuvers, reset the speed indicator for the desired airspeed.

TYPE DESCENTS

LONG RANGE DESCENT

The long range descent is accomplished in a clean configuration with idle thrust on all engines. The speed schedule is MACH .82 until reaching 250 KIAS (39,766 feet pressure altitude) and maintaining 250 KIAS at all lower altitudes. Approximate descent profile is 2.75° (275 feet per NM).

ENROUTE DESCENT

The enroute descent is accomplished in a clean configuration with idle thrust on all engines. The speed schedule is MACH .82 until reaching 320 KIAS (28,857 feet pressure altitude). Maintain 320 KIAS down to 10,000 feet indicated altitude, then 250 KIAS below 10,000 feet. Approximate descent profile is 3° (300 feet per NM).

PENETRATION

Above 20,000 feet pressure altitude, the configuration and speed schedule for the penetration descent is the same as for the long range descent. Below 20,000 feet, drag devices are used as required to meet altitude restrictions on the penetration.

DRAG DEVICES

Drag devices are not normally required/used during enroute or long range descents, however, delays in obtaining descent clearance may dictate their use. Speed brakes, slats, and/or landing gear may be used to increase the descent profile. The following guidelines can be used in pre-planning the use of thrust and drag devices to achieve desired profiles at a constant airspeed.

Idle Thrust	-	300 feet per NM
Speed Brakes	-	150 feet per NM
Landing Gear	-	150 feet per NM
Slats	-	150 feet per NM

CAUTION

- Observe maximum slats extend speed of 270 IAS or .55 MACH.
- Observe maximum landing gear extension/extended speed of 260/300 IAS or .70 MACH.

NOTE

- Operate spoiler handle with care to avoid abrupt pitch changes.
- Roll response is increased with speed brakes extended.
- In flight, with the flap handle at 5° or more, speed brake selection is mechanically inhibited unless speed brakes were extended prior to flap extension.
- If spoiler handle is out of RET when FLAP/SLAT handle is moved aft of zero degree position, SPEED BRAKE light will flash continuously until condition is corrected.

HOLDING

For best fuel economy, holding should be conducted in a clean configuration. Start to reduce airspeed within three minutes of the holding fix to arrive over the fix at holding speed.

HYDRAULIC SYSTEM/MOTOR PUMP SWITCHES

FE will scan hydraulic panel and observe hydraulic TEMP and HYD QTY gages indicate in normal range.

FE will observe all hydraulic TEMP HI and PRESS LO lights are off. Verify MOTOR PUMP switches are in ARM, and observe HYD PRESS gages indicate in normal operating range.

PNEUMATIC AND AIR CONDITIONING SYSTEMS

Monitor pneumatic and air conditioning system for any abnormal indications.

NOTE

- If engine pneumatics supply system fluctuations are excessive and causing disagreeable air conditioning noise, rotate ENG PNEU SUPPLY selector(s) to HI.
- During certain flight conditions, such as holding patterns, or when autothrottles are engaged in turbulent air, engine thrust setting may cause switching between high and low stage pneumatic bleed supply.
- When engine thrust or aircraft altitude is changed, rotate affected ENG PNEU SUPPLY selector(s) to AUTO.

DESCENT

The descent checklist may be accomplished prior to initiating descent.

1. Landing Data/V-Bugs . . "CHECKED/SET" (P,CP)

The Flight Engineer shall compute the landing data based on the anticipated landing weight, flap setting, and weather information IAW TO 1C-10(K)A-1-1.

NOTE

Forecast data may be used to compute landing data, however, prior to landing this data shall be confirmed and the landing data card and reference groundspeed updated.

Set V-Bugs on minimum maneuver speeds for 0°/RET, 0°/EXT, 22°/EXT and threshold speed (V_{TH}) for landing flaps setting. The pilot will verify these speeds using the checklists.

The speeds represent the minimum safe margin above stall for each weight/configuration. The white bugs are set by each pilot and crosschecked for accuracy. When higher than minimum speeds are desired, or when requested by ATC, the salmon bug is set by, or at the command of the pilot flying. Place the salmon bug at the desired speed. This will program the autothrottles, when engaged, and provide the pilot with the appropriate slow-fast reference when using throttles manually. Approach speed (salmon bug setting) is always threshold speed plus wind additives. The single-engine approach and landing is an exception.

NOTE

- Maximum additive for steady state or gust conditions is 20 knots.
- Add all of the gust to V_{TH} speed (1.3 V_S).
- Add 1/2 of the steady state wind above 20 knots to V_{TH} speed (1.3 V_S).

Example:

Computed V_{TH} = 130 knots.
Wind = 30 knots gusts to 40 knots.
30 knots - 20 knots = 10 knots.
10 knots x 1/2 = 5 knots.
10 knot gust + 5 knots = 15 knots.
130 V_{TH} + 15 knots = 145 knots.

The FE will compute landing distance for the first landing.

If an approach and landing are to be made in an abnormal configuration; aircraft gross weight is greater than the maximum unrestricted landing weight; the runway is wet or contaminated; or with any other condition that increases landing ground roll, the FE will recompute the landing speeds and landing distance when preparing a landing data card for that approach and landing.

2. Crew Briefing . . . . "COMPLETED" (PF)

Review the planned penetration and approach. This review will include navigation aid frequencies, minimum and emergency safe altitudes, descent rates, minimums for the approach to be flown, missed approach procedures and airfield sketch. As a minimum, the pilot flying the approach will brief the crew on the descent rate, emergency and minimum safe altitudes, MDA/DH/VDP and missed approach procedures for the planned approach. Coordinate lost communications procedures, if required. During the descent and approach other crewmembers will back up the pilot flying and report any deviation from prescribed procedures.

GPWS ACTIVATION

WARNING

> When immediate visual reference to the surrounding terrain is not available, GPWS warning requires prompt and decisive action. Do not waste time attempting to determine aircraft position/configuration or verifying the validity of the warning. Do not ignore short duration warnings. Consider the flight to be in jeopardy; take immediate and aggressive escape action.

The flight crew should be familiar with the following sequence of actions and upon activation of an aural or visual GPWS warning, initiate the following procedure when immediate visual reference to the surrounding terrain is not available (except during air refueling or formation flight).

Pilot flying:

Thrust: Disengage the autothrottles and aggressively apply necessary thrust to ensure adequate aircraft performance. Addition of power to go-around, MCT, or mechanical stop limit may be necessary. Avoid engine overboost unless necessary to avoid ground contact. When aircraft safety has been ensured, adjust thrust to maintain engine parameters within normal limits.

Autopilot: Disengage the autopilot.

Pitch: Level wings and retract speedbrakes if extended to assure maximum aircraft performance. Immediately rotate the aircraft at a rate of 3 degrees per second (similar to a normal takeoff rotation rate) to a 20 degree pitch attitude. Trade airspeed for climb performance. If necessary (to prevent ground contact), continue to increase pitch attitude until stick shaker actuates. Limit pitch increase to the onset of stick shaker and disregard flight director commands. In this situation, consider use of engine overboost by moving throttles to their mechanical limits.

Pilot not flying:

Monitor airspeed and notify ATC of any deviation from assigned clearance including reason for deviation.

Flight Engineer:

Monitor radio altimeter and call out height above terrain.

Crew:

Once GPWS warning ceases, verify terrain clearance, sink rate, and proper gear and flap configuration.

WARNING

> GPWS is not a Traffic Collision Alert and Avoidance System (TCAS). The inherent features of the GPWS may cause activation if another aircraft flies directly underneath the KC-10. If this occurs during air refueling or formation flight, the crew must use all available resources, including radios and radio altimeter, to ascertain the situation and take appropriate action. Indiscriminate climbs as a result of GPWS activation during air refueling or formation flight may constitute a danger to other aircraft.

Reference groundspeed should be monitored during all approaches. The pilot will compute reference groundspeed and advise the crew. The Flight Engineer shall monitor winds and ground speed and advise the pilot flying of any significant deviations (10 knots ground speed, headwind/tailwind component or a rapid change in direction of 20° or more).

WARNING

> - Below 500 feet, if indicated ground speed differs more than 20 knots from reference ground speed, the approach shall be discontinued. Refer to Section VII, Landing in Windshear Conditions.
> - Consider executing a go around/missed approach any time an EGPWS windshear warning is annunciated.
> - Execute a go around/missed approach if an EGPWS windshear warning is annunciated below 500 feet AGL.

3. Approach RAIM . . CHECKED (IF REQ'D) (PNF)

   If a GPS approach is planned check RAIM availability by entering the airfield identifier and expected approach time on the GPS/A/H page (select inav LS6).

4. Radio Altimeters .... "SET" (P,CP)

Pilot and Copilot rotate set knob and position height reference bug to height above touchdown for planned approach.

NOTE

The radio altimeter indicates absolute altitude only and should not be used as the primary decision height altitude indication except for published radio altitude (RA) approaches.

5. Windshield Anti-Ice .... NORM (FE)

Selectors should be placed to HIGH only for the duration of moderate to heavy icing conditions. Observe (L,R) WINDSHIELD ANTI-ICE INOP lights are off.

NOTE

Use of windshield heat when descending into high humidity conditions will prevent visual impairment due to possible moisture accumulation on the outside surface of the windshield.

6. HF Radios .... "SILENT" (PNF)

WARNING

- Ensure radio is not in automatic (AUT) mode to prevent inadvertent RF transmission.
- HF radio systems can cause improper operation and/or failure of the flight director system while operating in navigation or approach modes. This electromagnetic interference (EMI) can occur when an HF transmitter is operated at certain subharmonics of the VOR/ILS navigation frequency (3.100 Mhz, 15.000 Mhz, 23.800 Mhz, and 29.999 Mhz, approximately .050 Mhz about each). The EMI can cause the following indications in the ADI and EHSI:
  - Navigation, glideslope, and computer flags fluctuate during HF transmission.
  - Movement of glideslope pointer.
  - Movement of command bar or bars driven from view.

7. Pressurization .... SET (FE)
   a. Verify destination field elevation is set on ALT SET scale.
   b. Adjust LDG BARO knob until destination altimeter setting shows on LDG BARO scale.
   c. Select SEMI-AUTO for touch-and-go landings.

8. L-BAND SATCOM .... AS REQ'D (FE)

NOTE

- Secure laptop prior to landing.
- Do not manually print any messages received when the computer is off or Falcon program is closed. Messages printed in this configuration are illegible and will not be saved by the operating software.

9. Altimeters .... "SET/X-CHECKED" (P,CP)

Verify 29.92 is set by pilots or when cleared below or crossing the transition level, ensure that the altimeters are set to the correct barometric setting for landing. Crosscheck respective readouts.

Both pilots set MDA/DH on altitude reference bug on barometric altimeter.

Flight Engineer crosscheck altimeter readings.

10. FMS Baroset .... SET (IF REQ'D) (FE)

If an FMS approach has been defined or the last waypoint in the flight plan is an ICAO airport identifier, the <<√baroset>> annunciation will be displayed on the FMS CDUs. Enter the local altimeter setting on the VNAV Steer page or press the CLR key on the CDU.

WARNING

When issued QFE altimeter settings or when cold weather barometric altimeter corrections are applied in accordance with the Flight Information Handbook, FMS vertical navigation information is invalid. Do not use FMS VNAV Deviation Indicator or VNAV information provided on CDU pages, even as a source of supplemental information.

11. Descent Checklist ...... "COMPLETED" (FE)

APPROACH INFORMATION

GENERAL

ILS raw data indications should always be monitored on the ADI and HSI to assure integrity of steering computer command guidance.

The Flight Engineer will monitor the flight instruments, especially altitude and airspeed during the approach, and will assist in maintaining a watch for traffic, in addition to making any required calls.

During instrument approaches in low visibility conditions, all crew members, particularly the pilot flying, will monitor the flight instruments continuously until the lights of the runway threshold or the runway itself are called in sight.

NOTE

- The Pilot flying will set the EHSI to full HSI mode and the Pilot not flying may set EHSI to MAP mode. The Pilot flying may use the ARC mode for Surveillance Radar or RMI only approaches.
- Normally, do not exceed 2000 fpm descent when below 2000 feet AGL.

MANEUVERING FLAPS

Normal maneuvering flap/slat configurations is 22°/EXT; however, fuel efficient descents and approaches should be planned/flown as much as possible. Plan to arrive at 22°/EXT configuration just prior to maneuvering flaps being required (that is entering downwind, radar vectored turns to final approach etc.).

NOTE

This aircraft is considered category D for TERPS criteria. If maneuvering to land at a speed of 166 KTAS or more, use category E minimums.

LANDING FLAPS

Final flap selection should be made in sufficient time to ensure a stabilized final approach. Establish final landing configuration no later than intercepting glide slope on a precision approach or the final approach fix on a non-precision approach.

WARNING

- Steep, high speed final approaches may result in long, hot landings.
- Below 1000 feet AGL, the aircraft should be stabilized on the approach in landing configuration.
- FMS Tactical Approaches are created within the FMS with no regard to TERPS criteria. These approaches may be used as a backup for a visual approach and will be flown in VMC only.
- FMS Visual Approaches will be flown in VMC only.

NOTE

- For visual/circling approaches, 35° flap selection may be delayed until starting final turn.
- For visual/circling approaches, 50° flap selection should be delayed until rolling out on final.
- On all approaches with 50° flaps, airspeed must be monitored closely, as aircraft response to power adjustements is slower than normal.

APPROACH

NOTE

This checklist is normally accomplished after passing 14,000 feet MSL.

1. Fuel Panel . . . . SET (FE)

Scan fuel panel and observe all annunciator lights are off. Verify aft pumps are on and crossfeeds are closed. For full stop landings, turn all tank pumps on.

WARNING

Missed approach is not recommended if fuel in any main tank is 1,500 pounds or less.

CAUTION

Use of crossfeed or transfer during low fuel approach and landing (below 2,000 pounds in tank 2) may cause manifold drain valve in tank 2 to open, allowing fuel to transfer into tank 2. Any attempt to supply this fuel to engines 1 or 3 may reduce fuel pressure to engine 2.

NOTE

- Two tank pumps on in tank 2 assures an uninterrupted fuel supply to engine 2.
- If fuel quantity in any main tank is below 5,000 pounds, verify forward tank pumps for all tanks are on. Manage fuel in main tanks to approximately equal level, so crossfeed or transfer is not required during approach. Verify all main tank pumps are on.
- If FWD tank pressure LOW lights come on, do not turn off pump. Verify X-FEED flow indicator and DISAGR lights are off.
- Avoid pitch-up attitude in excess of that required for safe climb gradient.

Scavenging of the tanker manifold by use of the scavenge selector will result in maximum usable fuel being available.

2. Boom Operator/Exterior Lights . . . . NOTIFIED/SET (FE, BO)

Notify the boom operator when the aircraft is passing 10,000 feet MSL. Ensure all appropriate lights are set prior to passing this altitude.

3. Cabin Signs . . . . ON (FE)

Verify SEAT BELTS switch is in the ON position.

4. Thrust Computer . . . . "GA" (PNF)

Push GA thrust select switch on thrust computer indicator and observe GA switch-light comes on. Observe maximum limit indexes on N_1 gage agree with N_1 LIM readout on thrust computer indicator.

CAUTION

- Do not select GA on the thrust computer indicator until below 14,000 feet pressure altitude.
- Failure of the autothrottle duplex servo may cause uncommanded throttle advances. Failure to monitor the throttle positions, with the autothrottles engaged and in any mode, may result in engine overspeed.

NOTE

If N_1 maximum limit indexes do not agree with thrust computer readout, set N_1 maximum limit indexes manually.

ACCOMPLISH THE FOLLOWING STEPS PRIOR TO COMMENCING THE APPROACH:

5. CDUs/EHSI/Radio Aids . . . . . "SET" (P,CP,FE)

Number 3 CDU will be used to monitor wind direction/velocity and headwind/tailwind component. The FE will monitor wind throughout the approach and advise the pilot of significant wind deviations (10 knots headwind/tailwind or a rapid change in direction of 20° or more).

NOTE

CDU1 or CDU2 will be set to the Flight Plan page when flying a GPS approach.

When using the CDI for guidance, the Pilot flying shall set the EHSI to full HSI mode and the

Pilot not flying may set EHSI to MAP mode. The Pilot flying may use ARC mode for Surveillance Radar or RMI only approaches. Verify appropriate EHSI navigation and bearing source are selected for desired approach - VOR, ILS or TCN for radio navigation approach; FMS for GPS approach.

6. Altimeters .... "SET/X-CHECKED" (P,CP)
7. Annunciator Panels .... "CHECKED" (P,CP,FE)

7A. (**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button .... OFF (FE,BO)

ANTICIPATED GPWS WARNINGS INSIDE THE FINAL APPROACH FIX

If the aural Glide Slope or visual Below G/S warning occurs while flying an ILS approach, immediately communicate the cause of the GPWS activation to the crew and return the aircraft to glide slope or execute a missed approach. If the aural Glide Slope or visual Below G/S warning occurs while flying any approach other than an ILS (including visual approaches and ILS approaches using localizer only procedures) and no safety hazard exists, communicate the cause for the GPWS activation to the crew, deactivate the Glide Slope warning, and continue the approach.

PREPARE FOR ILS OR LOCALIZER ONLY MODE TRACKING

NOTE

AP lever may be in CMD for a coupled approach, or in CWS or OFF for a flight director approach.

a. Tune both navigation radios to the same ILS frequency.

b. Set the same ILS front inbound course in both CRS readouts.

c. Prior to localizer capture, verify EHSI navigation source is set to LOC1 for the pilot and LOC2 for the copilot.

d. Push ILS switch and observe arm FMAs display ILS.

NOTE

- If localizer only tracking is desired, push RAD/FMS switch and observe arm FMAs display LOC.
- When LOC CAP mode engages, arm FMAs will go blank.
- Use localizer only mode when localizer tracking is desired without glide slope capture.

PREPARE FOR ILS BACK COURSE APPROACH

a. Autopilot engaged in CWS or OFF.

b. Tune both navigation radios to same ILS frequency and identify station.

c. Set same ILS front inbound course in both CRS readouts.

d. Verify EHSI navigation source is set to BC1 for the pilot and BC2 for the copilot.

e. Rotate SPD select knob to set desired speed in readout (commensurate with flap position).

f. If autothrottle system is desired, move either or both ATS lever(s) to ON.

g. Push either BACK CRS switch and observe arm FMAs display B/CRS.

NOTE

- Arm FMAs will go blank when B/CRS CAP mode engages. Pitch FMAs will display ALT HOLD or VERT SPD as appropriate.
- AP lever must be in CWS or OFF before B/CRS mode can be engaged.
- In B/CRS mode:
  - ADI glideslope pointer is removed from view.
  - ADI localizer display is reversed to provide proper deviation polarity.
  - EHSI glideslope pointer blanks.

Localizer Capture

NOTE

- ILS test and radio altimeter test function is inhibited after flight guidance system engages into LOC CAP or G/S CAP.
- FMAs will display LOC CAP as EHSI course bar moves through 2-dot displacement toward on course.
- Moving FD CMD switch to BOTH ON 1 or BOTH ON 2 will disengage ILS mode.
- Localizer capture may be assisted by using supervisory override, which becomes effective when a manual (CWS switch has been pushed) force is applied to control wheel.

Observe roll FMAs display LOC TRK after achieving localizer center line.

NOTE

LOC TRK mode will not engage until below 2,500 feet as measured by radio altimeter.

8. Approach Checklist . . . . . "COMPLETED" (FE)

BEFORE LANDING INFORMATION

MISSED APPROACH OR REJECTED LANDING

Flap Settings

A flap setting of 22° is provided for a missed approach or go-around.

When the decision for go-around is made, the pilot flying will advise the crew of the go-around and command "GO-AROUND POWER" and "FLAPS 22°". The pilot flying will advance the throttles to the approximate setting for go-around thrust and press the TO/GA button. The pilot not flying will set the flaps to the appropriate go-around setting. The Flight Engineer will refine the thrust setting and disarm the spoilers.

NOTE

- Flaps must be out of the UP position before the go-around mode can be engaged.
- The thrust computer will switch to GA thrust selection when the TO/GA button is pushed, if not previously selected.

If the autopilot is engaged, the pilot flying will verify that the autopilot rolls the aircraft to wings level and rotates to a pitch attitude that will provide a minimum of selected approach speed. This speed equates to V_2 Plus 10 knots for 3 engine operation.

Do not use autopilot for go-around during engine out operation. Disconnect autopilot if used during the approach, and adjust attitude to maintain go-around speed. The FD commands V_2 speed for 2 engine operation. Autothrottles may be used if desired.

NOTE

The aircraft will maintain the heading being flown at the time the TO/GA button is depressed. If the aircraft is in a bank, pressing the TO/GA button will roll the aircraft to a wings level attitude and maintain the heading that the aircraft is on when the wings are leveled.

If the autopilot is not engaged, the pilot flying will rotate the aircraft to center the pitch command bar. Maintain a centered pitch command bar to ensure proper attitude and go-around speed.

NOTE

- Maximum pitch attitude while in flight director or autopilot go-around mode is 15°.
- If the pitch attitude required to maintain V_2 Plus 10 knots is greater than 15°, the fast/slow indicators will show fast when the flight director command bars are centered.

When a positive rate of climb is indicated on the TVSI, radio altimeter, and altimeter the pilot flying will command "POSITIVE RATE OF CLIMB, GEAR UP". The pilot not flying will confirm a positive rate of climb on the TVSI, radio altimeter, and altimeter and acknowledge the command by stating "POSITIVE RATE OF CLIMB, GEAR UP" then move the gear handle to the up position. Execute the appropriate missed approach procedure and continue climbout using pitch and power to maintain go-around airspeed. When reaching assigned or published missed approach altitude or clear of obstacles, decrease pitch and raise the flaps after speed exceeds the minimum flap retraction speed. Retract the slats after speed exceeds minimum slat retraction speed. If another approach is to be made, configure the aircraft as desired. Observe minimum maneuver speeds.

If obstacle clearance is not a factor, the flaps and slats may be retracted during the climbout. The pilots must ensure the aircraft is accelerating past minimum retraction speeds and the aircraft is climbing at a rate that exceeds the vertical velocity required for the go-around procedure. Observe minimum maneuver speeds. See figures 5-21, 5-22 and 5-23 for missed approach/rejected landing.

LANDING

The aircraft must be stabilized in the slot to effect a normal landing. The slot begins approximately one mile from the runway at approximately 300 feet. To be stabilized, the following conditions must be met:

a. Proper sink rate and on glide path.

b. Proper speed for existing conditions.

c. Proper runway alignment.

d. Final landing configuration.

e. Aircraft trimmed with stable thrust setting.

WARNING

Initiate a missed approach/go-around if the aircraft is not stabilized on the approach, in final landing configuration, no later than DH on a precision approach, MAP on a non-precision approach, or 300 feet on a visual/ circling approach.

Plan to cross the threshold, on speed, with a wheel height of 50 feet (radio altimeter). An approximate aimpoint of 1,500 to 1,800 feet down the runway will provide a no flare touchdown of 1,000 feet with normal landing configurations. The nominal touchdown point is 1,500 feet down the runway within the desired touchdown zone of 1,000 to 2,000 feet down the runway.

If the airplane should bounce, hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. Avoid rapid pitch rates in establishing a normal landing attitude.

WARNING

An uncontrollable or overspeeding wing engine may result in loss of directional control. If an engine overspeeds or is uncontrollable during landing or ground roll, it should be shut down as soon as possible.

CAUTION

- Do not land prior to an approach end cable that has been reported as slack or loose. Do not land on any cable. Damage to aircraft or cable can occur.
- Tail strikes or nosewheel structural damage can occur if large forward or aft control column movements are made prior to touchdown.
- When a high, hard bounce occurs, initiate a go-around. Apply go-around thrust and use normal go-around procedures. Do not retract the landing gear until a positive rate of climb is established.

Spoilers

Flight Engineer observe that SPOILER handle moves aft to the 2/3 position on main wheel spin up and then all the way aft on nose gear touchdown.

When the spoilers are armed prior to landing for automatic deployment, inputs from the MLG speed transducers of the anti-skid system are provided through the ground spoiler control unit to the spoiler control electric actuator. At MLG wheel spin up, the spoilers deploy two-thirds of full extension and at subsequent NLG touchdown, deploy to full extension. If the time from MLG spin up to NLG touchdown exceeds eight seconds, the Auto Spoiler Do Not Use light will illuminate. Therefore, in the event that only the MLG contacts the runway with the Auto Spoiler armed during a Touch and Go maneuver, and this light illuminates, the system will indicate a malfunction as designed.

NOTE

- If the SPOILER handle does not move aft, Flight Engineer advise Pilot and on his command manually deploy the spoilers.
- If the number 2 engine throttle is not at idle at main gear wheel spin-up it is possible that the automatic ground spoilers will initially deploy and then immediately retract. If this occurs the ground spoilers must be manually extended.

Reverse Thrust

WARNING

After reverse thrust is initiated, a full stop landing will be made.

Reverse thrust is recommended for all landings because it assists in a smooth, safe slowdown while reducing brake wear and heat buildup. Because reverse thrust is most effective at higher speeds, immediate and positive reverse thrust should be employed on touchdown.

On main gear touchdown bring the reverse levers to the interlock position observing all AMBER REV U/L lights come on while simultaneously lowering the nose wheel to the runway.

WARNING

> An uncontrollable or overspeeding engine may result in loss of directional control. If an engine overspeeds or is uncontrollable during thrust reverse operation, it should be shut down before returning the thrust levers to forward idle.

NOTE

> Engine 2 reverse lever will not go beyond reverse idle until the nose strut is compressed.

The initial hand action is more up than aft. Maintain a slight pull force to assist in knowing when the interlocks release.

The FE should call Reverse Available when the green REV THR lights illuminate.

When all three interlocks are released, bring the reverse levers to the full aft position (mechanical stop), holding them there or metering less thrust if desired.

NOTE

> A mechanical stop is incorporated at the fuel control which limits the reverse thrust attainable to 95% N_2. This equates to 95% N_1 at sea level on a 0° C day. When applying reverse thrust, do so until reaching the maximum reverse stop or 95% N_1, whichever occurs first.

The following procedures apply for coming out of reverse:

The FE calls out 80 and 60 knots during landing roll. Reverse thrust operation is normally limited to 60 seconds. When practical, stowing (unreversing) should be initiated from idle reverse. When using thrust reversers, allow time for full reverse positioning (wait until green lights are illuminated) before returning the reverse levers to forward idle. This will preclude partial cycling.

CAUTION

> If the thrust reverser for engine 1 or 3 fails to stow, maintenance action will be taken to correct the discrepancy, or the affected thrust reverser will be deactivated and secured in the stowed position prior to takeoff.

Starting at 80 knots move reverse thrust levers to the reverse idle position so as to reach reverse idle by 60 knots and forward idle by turnoff speed.

Reverse thrust is not authorized for normal taxi operations. Reverse thrust is permitted, at the Pilot's discretion, during emergency or abnormal situations such as brake failure or controllability difficulties on icy taxiways. If reverse thrust is necessary under these conditions, the thrust level and time in reverse must be restricted to the minimum requirements.

Whenever asymmetric thrust reversal or other directional control difficulties become apparent, such as skidding on icy or wet runways, immediately revert to the forward idle configuration.

These procedures should be closely adhered to because the high reverse power and low speed combination is conducive to causing compressor stalls necessitating an engine hot section inspection.

BEFORE LANDING

The Flight Engineer should position his seat so that he may easily perform all landing and go around duties. He should make at least one final scan of his panel prior to landing.

1. Landing Gear .... "DOWN__GREEN" (P,CP,FE)

NOTE

- Pilot flying will command "GEAR DOWN." Pilot not flying will acknowledge this command by stating "GEAR DOWN," then move the gear handle to the down position.
- The center gear is normally used for all landings.
- If operational requirements establish that center gear is not required, remove lock pin and move center gear isolation switch to UP, and replace lockpin. With center gear isolation switch in UP, the centerline gear is disconnected from the gear aural warning system and its associated lights will be off.
- During gear extension, hydraulic pressure may momentarily decrease to below 2000 PSI. Hydraulic PRESS LO lights in system 3 may momentarily flash.
- If appropriate green gear lights are not on and/or red gear lights are on. PNF verify with FE that appropriate green gear lights on FE's panel are on. An unsafe indication on one of the two gear indicating systems does not require a mandatory visual inspection.
- When red gear light(s) on CP's instrument panel are on and airspeed is below approximately 215 KIAS, the landing gear warning horn sounds if any throttle is at idle. It may be silenced by pushing the GEAR HORN OFF button. If flaps are extended 30° or more, the gear horn cannot be silenced with the GEAR HORN OFF button.
- An unsafe indication on the CP's instrument panel will cause an EGPWS "Too Low-Gear" warning to be announced below 500 feet AGL and 190 KIAS.
- If red gear light indications on both panels are the same, refer to Abnormal Procedures for Gear Unsafe Light(s) On With Gear Handle Down.

2. Landing Lights .... ON (FE)

Ensure landing lights are on.

3. Spoilers .... "ARMED" (P)

Do not arm spoilers until landing gear is down.

a. Observe AUTO SPOILER DO NOT USE light is off.

NOTE

If light is on or has been on at any time during flight, do not arm automatic spoilers. It will be necessary to extend spoilers manually after touchdown.

b. Pull SPOILER handle to armed (up) position and observe handle remains up.

NOTE

If handle does not remain up, it will be necessary to extend spoilers manually after touchdown.

4. ANTI-SKID/Brake Pressure/ Temperature .... CHECKED (FE)

a. Verify the ANTI-SKID switch is in ARM, then test the system.

b. Observe BRAKE SYSTEMS 1 and 2 HYD PRESS gages indicate in white band.

NOTE

If one or both HYD PRESS gage(s) indication is not in white band, verify hydraulic system is normal.

c. Note the BTMS reading.

5. Flaps/Slats . . . . . "__ °/ __ ° LAND" (P,CP,FE)

Final flap setting is normally 35°. Use of 50° is recommended on short, wet, or contaminated runways (covered by snow, ice, or slush) when in the opinion of the Pilot, landing distance will be adversely affected.

Final flap selection from maneuvering should be made just prior to the glide slope or the final approach fix depending upon the type approach flown.

NOTE

- For two engine landing, use 35° flaps.
- Alpha speed is minimum safe speed for existing FLAP/SLAT configuration, and is annunciated when it is greater than speed selected in speed readout with autothrottle system engaged.
- Fast/slow indicators are referenced to Alpha speed when logic requires it, if autothrottle system is engaged or disengaged.
- V_S and aircraft attitude will be affected with flaps retracted and slats extended.

Rotate HDG control knob until missed approach heading appears in HDG readout, and set bank limit selector to 15°. Rotate ALT preselect knob until either missed approach altitude, or an altitude which provides warning of approach to a minimum descent altitude, is set in ALT readout. Just before glideslope capture, rotate SPD knob until final approach speed (threshold plus additives, up to a maximum of 20 knots) appears in SPD readout. Observe ATS FMA's display SPD.

During all approaches, the PNF (backed up by FE) will announce "1,000 FEET TO DH/MDA" when 1,000 feet above DH/MDA, "500 FEET TO DH/MDA" when 500 feet above DH/MDA, and "100 FEET TO DH/MDA" when 100 feet above DH/MDA.

a. Precision Approaches (PAR, ILS): At DH the PNF will announce "Decision Height." Upon making a decision to land or execute a missed approach, the PF will announce "LANDING" or "GOING AROUND."

b. Category II ILS: Normally, the Copilot flies the automatic approach and the Pilot lands the aircraft. Upon making the "100 FEET TO DH" call, the Pilot will direct his attention outside the cockpit seeking the runway environment. At or prior to DH, the Pilot will announce "LANDING, I HAVE THE AIRCRAFT" if a decision is made to land. If the Pilot has not announced his intentions upon reaching DH, the Copilot will announce "MINIMUMS, GOING AROUND" and execute the missed approach. If neither the Pilot nor the Copilot has made a call passing DH, the FE will make a positive callout, "GOING BELOW MINIMUMS."

c. Non-precision Approaches: PNF will announce reaching "MDA," "VDP," and "MAP." Acknowledgement of calls is required by PF. Upon making decision to land or execute a missed approach, the PF will announce "LANDING" or "GOING AROUND."

Observe FMA's during entire approach. If an FMA goes blank, push the annunciator light TEST button (pilot's overhead panel) and observe TEST appears in the FMA's.

NOTE

- When G/S CAP is displayed in FMA's and ILS mode has been armed, arm FMA will go blank.
- Glideslope can be captured from above or below.
- Pitch FMA's change to G/S TRK 20 seconds after G/S CAP mode engages.
- Altitude preselect mode cannot be armed after G/S TRK mode has become engaged.
- Capturing glideslope (G/S TRK) with altitude preselect mode armed, will cause altitude preselect mode to be disarmed.
- Supervisory Override in roll ends when LOC TRK is annunciated (LOC TRK will not be annunciated even after established on localizer until control wheel pressure is released).
- Deviation from localizer or glideslope beam will be apparent by observing flight director command bars or raw data display on HSI's or ADI's. Deviations will not cause flight mode annunciations to change.

CATEGORY II ILS PROCEDURES

Required Equipment

For all Category II approaches the following equipment must be operative:

Instrument failure warning system (Glideslope, Localizer, Autopilot, etc.)

Pilot and Copilot Flight Director displays

Pilot and Copilot Radio Altimeters (if required for approach)

Pilot and Copilot Decision Height (DH) lights

Marker Beacon Receivers (if required for approach)

Dual ILS and Glideslope Receivers

Missed Approach Attitude Guidance (flight director or ADI)

Autothrottles (recommended)

Rain Removal Capability (wipers or repellant)

Operating Rules and Limitations

The following rules and limitations must be enforced when performing a CAT II ILS approach:

All engines will be operating

Coupled Approach (autothrottles optional)

Maximum Wind (including gusts), 25 knots,

Crosswind, 15 knots

Tailwind, 10 knots

All altitude callouts will be off the barometric altimeter to 100 feet above DH and off the radio altimeter below that altitude.

Decision Height will be determined from reference to the radio altimeter or inner marker as appropriate.

Category II Decision Regime

From the "500 FEET TO DH" call to the "100 FEET TO DH" call, deviation beyond the limits in the Decision Regime require an immediate correction to be made to bring the aircraft back within the specified limits. From the "100 FEET TO DH" call to the runway, any violation of the Decision Regime mandates a go-around. At or above DH, the Pilot will command the Copilot to execute the go-around. Below DH, the Copilot will advise of deviations beyond performance limits and the Pilot will execute the go-around.

Performance limits in the decision regime:

a. Airspeed plus 10 or minus 5 knots.

b. Glideslope - not to exceed 1/2 dot high or low.

c. Localizer - 1/2 dot right or left on raw data.

d. Autopilot, Flight Director, Navigational Equipment Warning lights or flags - none allowable.

e. Raw data must match up with computed data.

f. Rate of Descent 1,000 FPM maximum.

g. GPWS Activation none allowable.

CAUTION

During low visibility or night approaches, the touchdown point may not be visible to the pilot at decision height. Be aware of the tendency to Duck under the glideslope in this situation.

NOTE

During very low visibility approaches, landing lights may be turned off at Pilot's discretion.

6. Before Landing Checklist .... "COMPLETED" (FE)

AFTER LANDING AND PARKING

AFTER LANDING

The pilot in command taxiing the aircraft will ensure the aircraft is clear of the active runway before initiating this checklist.

1. IFF/WX RADAR .... STBY/STBY (FE)
   a. Place the IFF to OFF or STBY for thru-flight operations. Place the WX RADAR to STBY.

CAUTION

The radar antenna may be damaged if the function switch is moved to OFF while the aircraft is in motion.

   b. If J or I BAND transponders have been used, verify that they are off.

1A. (**WITH TCTO 1C-10(K)A-1243**) Iridium Phone Power ON/OFF Button................... AS REQ'D (FE,BO)

2. APU .... AS REQ'D (FE)

   Place all APU GEN BUS switches to ON.

3. HI-INT/Landing Lts..................... OFF/AS REQ'D (FE)

4. Anti-Ice .... AS REQ'D (FE)
   a. Move WING ANTI-ICE switch to OFF and observe WING ANTI-ICE DISAGREE lights are off and WING ANTI-ICE SW ON light is off.
   b. Move ENG & ANT ANTI-ICE switches to OFF, and observe ENG ANTI-ICE DISAGREE lights come on and go off, and ANT ANTI-ICE DISAGREE light remains off.

NOTE

If TAT is below 6°C and visible moisture is present, leave engine anti-ice on until after engines are shutdown.

5. Spoilers .... "RET" (P)

   Hit top of SPOILER handle (down) and observe handle moves to RET and (L,R) SPOIL position tapes are in DN.

6. Flaps/Slats.................. "UP/RET" (CP)

   Move FLAP/SLAT handle to UP/RET detent and observe FLAP/SLAT position indicator shows flaps are up and slat position light is off.

CAUTION

If landing approach is made in icing conditions or landing is made with snow or slush on runway, move FLAP/SLAT handle to 22°/EXT. Observe FLAP/SLAT position indicator shows flaps 22° and slat TAKEOFF light on.

7. Trim .... "2° NOSE UP" (CP)

   Move control wheel trim switches to position LONG TRIM indicator to 2° NOSE UP.

NOTE

Positioning stabilizer at 2° nose up closes a large opening in the fuselage adjacent to the stabilizer and prevents entry of water and debris.

8. Hydraulic Sys............... CHECKED (FE)
   a. Motor Pump Switches .... OFF

NOTE

If hydraulic system 1 or 3 is pressurized by PUMP 1-3 or 2-3, leave appropriate motor PUMP 1-3 or PUMP 2-3 switch in ARM or ON as required to maintain full nosewheel steering and both brake systems.

   b. ENG HYD Pump L Switch .... OFF

      Observe pressure on right pumps and left pump low pressure light on.

   c. ENG HYD PUMP L Switch .... ON
   d. ENG HYD PUMP R Switches........ OFF

Observe System PRESS GAGE indication.

e. ENG HYD PUMP R Switches...... AUTO

Observe system PRESS GAGE indication.

NOTE

Write up any hydraulic pump not supplying a pressure of at least 2800 PSI. Takeoff is permitted if either pump in a system provides at least 2800 PSI.

9. Number 2 Fuel Lever .... AS REQ'D (FE)

If thrust is not required for taxiing, and Pilot decides to shut down number 2 engine, Flight Engineer move number 2 FUEL lever to OFF. Observe EGT and fuel flow gages for a decrease.

NOTE

- Engines should be operated at or near idle power for a minimum of 3 minutes before shutting engine down. The 3 minute timing should commence when the thrust reversers are returned to the forward position. Power required for normal taxiing, including short/momentary power applications, is considered equivalent to idle power for cool-down purposes.
- If the FUEL lever does not positively shut off the fuel at the engine, pulling ENG FIRE handle full down will close the shutoff valve at the fuel tank.

FE verify all APU GEN BUS switches are in ON. Observe AC BUS 2 OFF light remains off and AC BUS TIE 2 ISOL light comes on. Verify APU accepts bus 2.

NOTE

- If APU generator does not pick up generator bus 2, as indicated by AC BUS TIE 2 ISOL light off, attempt to power other generator buses with APU generator or ground external power before shutting down all engines.
- When APU is not available, the AC TIE BUS will automatically provide power to generator bus 2.

FE turn all tank PUMP switches in tank 2 to OFF except one for APU (right aft pump is preferred).

FE observe fuel system 2 FUEL PRESS gage remains in normal range.

10. Brake
Press/Temp .... CHECKED (FE)

Observe BRAKE SYSTEMS 1 and 2 HYD PRESS gages indicate in white band, BRAKE TEMP OVHT lights are off and BRAKE TEMP gage indication is in normal range.

NOTE

- If one brake HYD PRESS gage indication is decreasing or below white band, taxi with caution.
- Adequate braking is available with single brake system.
- If heavy braking was accomplished, or if brake temperatures are uncharacteristically high for conditions, refer to Brake Energy Chart to forecast peak brake energy.
- If BRAKE TEMP OVHT light(s) is on or BRAKE TEMP gage indicates 400° C or more, refer to ABNORMAL BRAKE Procedures.
- If another takeoff is planned, refer to Brake Cooling Time chart.

Flight Engineer monitor and report brake pressure and temperature when taxiing in congested areas, especially when approaching parking area.

11. After Landing
Checklist .... "COMPLETED" (FE)

PARKING - ENGINE SHUTDOWN

1.Parking Brakes .... "SET" (P)

a. Observe BRAKE SYSTEMS 1 and 2 HYD PRESS gages indicate in white band.

b. Push and hold brake pedals. Observe BRAKE SYSTEMS 1 and 2 HYD PRESS gages indicate in white band.

c. Pull PARK BRAKE handle to aft (PARK) position. Release pressure on brake pedals and observe pedals remain down and handle remains aft. Observe PARK BRAKE ON and PARK lights are on.

NOTE

If PARK BRAKE handle and/or pedals release, attempt to reset parking brakes as in previous actions.

2. AUX Hydraulic Pump....................... AS REQ'D (FE)

If chocks are not readily available, start at least one AUX HYD PUMP.

3. Elec Power .... APU/EXT (FE)

a. If not previously accomplished, verify APU PWR AVAIL light is on and APU GEN BUS switches are in ON.

NOTE

If external electrical power is desired, observe EXT PWR AVAIL light is on, move EXT PWR switch to EXT PWR (on), and observe EXT PWR IN USE light comes on. Verify AC BUS TIE switches are in NORM.

b. Observe all AC and DC BUS OFF lights remain off.

4. Fuel Levers .... "OFF" (P)

Move FUEL levers to OFF. Observe EGT and fuel flow gages for decrease.

5. Exterior Lights .... "AS REQ'D" (CP, FE)

Move all EXT LT switches to OFF, and rotate BEACON LT selector to OFF.

NAV light selector may be set as desired for safety during parking/maintenance operations.

6. Fuel Panel .... SET (FE)

a. Push all fuel PUMP switches and observe flow indicator light goes off and associated fuel pressures decrease to zero.

NOTE

One tank 2 pump must be on to supply fuel to the APU, if it is operating.

b. Verify all fuel panel switches are returned to normal.

7. Seat Belts Switch .... "OFF" (CP)

8. Parking Checklist....... "COMPLETED" (FE)

LEAVING AIRCRAFT

1. Parking Brakes . . . . "AS REQ'D" (P)

   If adequate chocks are not available or high winds are anticipated the brakes should be left on. Normally they will be released.

2. INUs . . . . "CHECKED/OFF" (P,CP,FE)

NOTE

INUs may be left on during short time thru-flight operations.

INU Accuracy Check

Maintain a record of the accuracy of each INU. Accuracy check can be made with updates made through the FMS or with non-updated data. The following procedures should be used to establish INU accuracy prior to shutdown.

If no position updates have been made (or updated position accuracy check desired):

a. The residual groundspeed for each INU may be determined by selecting INU1 as the Pilot's steering source and INU2 as the Copilot's steering source on the appropriate Lateral Steering pages and then observing the displayed GS on the EHSI or the information line on the appropriate Position page. To check INU3, either the Pilot or Copilot must be in AUX ATT and have INU3 selected as the navigation source.

NOTE

If the system error is greater than 3 NM/HR or the residual groundspeed is greater than 15 knots, an AFTO Form 781A entry will be made.

b. On the designated pilot's Lateral Steering page, toggle the navigation solution to GPS.

c. Select each INU (1/2/3) INAV page.

d. The drift rate in NM/HR for each INU may be determined by dividing the DIFF distance by the number of hours and tenths of hours that INU was in NAV mode (flight time may be used if NAV was selected just prior to starting engines). Record results in the INU log.

If position updates have been made and the pure inertial (non-updated) position accuracy is required:

a. On the designated pilot's Lateral Steering page, toggle the navigation solution to GPS.

b. Access the INU1(2, 3) CONTROL page, press the POSITION line select key and observe the present position coordinates displayed on the information line. This is the pure inertial position exclusive of any updates that may have been made.

c. Enter the present position coordinates for each INU as a waypoint in the active flight plan.

d. Select Direct-To each INU waypoint in turn, and read the distance to each waypoint on the designated pilot's Lateral Steering page. This will be the difference between the pure inertial position and the aircraft present position as determined by GPS.

e. The drift rate in NM/HR for each INU may be determined by dividing the DIFF distance by the number of hours and tenths of hours that INU was in NAV mode (flight time may be used if NAV was selected just prior to starting engines).

f. The residual groundspeed for each INU may be determined by selecting, in turn, each INU as the Pilot or Copilot steering source (on the Lateral Steering pages) and then observing the displayed GS at LS5.

NOTE

If the system error is greater than 3 NM/HR or the residual groundspeed is greater than 15 knots, an AFTO Form 781A entry will be made.

Shutdown

Pull out mode selectors and rotate to OFF.

3. WX RADAR . . . . OFF (FE)

4. IFF/Mode 4
Codes . . . . OFF/ZEROIZED (FE)

If uncocking the aircraft from alert posture, zeroize Mode 4 codes by lifting and moving the Mode 4 CODE Switch to ZERO.

If the aircraft has flown (ground sensing has been cycled), the Mode 4 codes will automatically zeroize unless the MODE 4 CODE selector is moved to HOLD at least 15 seconds before the MASTER switch or aircraft power is turned off.

5. FMS Radio
Master Power . . . . OFF (FE)

Remove power from the TACANs and ADFs by selecting the RADIO MASTER OFF line select on the FMS Master Power page.

6. Oxy Regulators. . . . . "OFF" (P,CP,FE)
   a. Supply Lever . . . . OFF
   b. Diluter Lever 100%

7. Radios . . . . "OFF" (P,CP)
   a. Zeroize HF AJ keys, if applicable.
      (1) Move cursor to OP field using FLD selector and then use VAL selector to select PRG in OP field.
      (2) Move cursor to FN field using FLD selector and select KEY in FN field using VAL selector.
      (3) Move cursor using FLD selector to lower left corner of display just left of ZO (zeroize) display in mode field.
      (4) Depress and release INIT switch. The display blinks and the KEY indicator lights to indicate all keys are zeroized.
   b. Verify WOD channels are declassified, if applicable.
   c. Turn HF and UHF radios OFF.
   d. Zeroize KY-58 secure voice codes, if applicable.
   e. If APU will be operating, set ground control frequency in one VHF radio.

NOTE

MWODs are erased by lifting front panel access cover, pressing ZERO switch downward, then return to normal position. ERASE is displayed on F/S indicator. Close panel access cover.

8. GPS Crypto Keys . . . . ZEROIZED
(IF REQ'D) (P,CP)

Normally, GPS crypto keys may be retained in the receiver. However, if desired, keys may be zeroized via the FMS Lock-Zeroize page or with the ZEROIZE switch on the respective GPS KEY LOAD panel.

9. CDU Power Switches (3) . . . . OFF (FE)

10. Panel Lts . . . . "OFF" (P,CP,FE)

11. Emergency Lts . . . . AS REQ'D (FE)

Move EMER LT switch to OFF, and observe DISARMED light is on.

NOTE

Leave the EMER LT switch in ARM if cargo and/or passengers are to be ON/OFF loaded.

12. Windshield Anti-Ice/Defog . . . . OFF (FE)

13. Pitot Heat .... OFF (FE)

Rotate pitot METER SEL & HEAT selector to OFF, and observe PITOT HEAT INOP light comes on.

14. Eng Anti-Ice .... OFF (FE)

15. ANTI-SKID Switch .... OFF (FE)

16. AUX HYDRAULIC PUMPS .... OFF (FE)

17. CABIN CARGO SMOKE Sw .... OFF (FE)

18. L-BAND SATCOM .... OFF/SECURE (FE)

a. Laptop Computer .... OFF

To exit Falcon program, select file exit. To shut down the laptop computer, select Start and follow shutdown instructions. Turn off laptop computer, disconnect power and communication cable, and secure laptop computer.

NOTE

Do not leave laptop computer unsecured on the aircraft.

b. Printed Messages ....REMOVED

c. L-BAND SATCOM
Power Switch .... OFF

The transceiver will automatically log out.

19. (**WITH TCTO 1C-10(K)A-1243**)
Iridium Phone .... REMOVED (IF INSTALLED) (P,CP,FE)

NOTE

While the Iridium phone is installed in the mount with the Iridium phone master switch in ON position, the charging function will remain on and the battery will remain in a constant state of charge. Therefore, when powering down the phone for intermediate periods (i.e. Receiver AR and Takeoff), use the Iridium Phone POWER ON/OFF button to conserve battery life.

a. Press and hold Flightcell DZM POWER/ENTER/CONNECT key until progress bar reaches end.

b. Press Iridium phone POWER ON/OFF button to turn off phone (if required).

c. Place phone mount Iridium System Master switch to OFF (down).

d. Remove phone mount audio plug from Iridium phone. Insert plug into phone mount stowage position.

CAUTION

Failure to remove audio plug from the phone before removing the phone from the mount, may cause damage to the audio cable.

e. Rotate phone mount security latch up.

f. Press and hold antenna lock release button and remove Iridium phone from mount.

20. APU .... AS REQ'D (FE)

Move APU/ISOL VALVE switch to CLOSE and observe pneumatic PRESS gage indication decreasing.

Move APU MASTER switch to OFF.

NOTE

- After a 90 second delay, observe APU PERCENT RPM and APU EXH TEMP gages show a decrease.
- To ensure proper cooling, APU will continue running for 90 seconds after APU/ ISOL valve switch has been moved to CLOSE.

Move the fuel pump switch (APU FUEL PUMP of SYS 2 TANK PUMP switch) supplying APU, to OFF. Move APU GEN BUS switches to OFF. Verify APU Fire Control switch is in NORM.

21. BAT Sw .... AS REQ'D (FE)

NOTE

If APU is operating, verify BAT switch is on and locked, to provide fire detection for the APU.

Rotate BAT switch knob to unlock (vertical) position, pull out, and move switch to OFF.

22. FMS Data Cartridge(s) .... REMOVED (IF REQ'D) (FE)

23. Exterior Walk Around..... COMPLETED (FE)

WARNING

Ensure the center accessory compartment is inspected for fuel leaks. If leaks are present, immediately notify maintenance of the leakage, remove all electrical power and do not reapply power until situation is corrected. Make appropriate write-up.

24. Leaving Aircraft
Checklist .... "COMPLETED" (FE)

LOCAL PATTERN CHECKLISTS

The Local Pattern Checklists may be used in lieu of the normal Descent, Approach, Before Landing and Before Takeoff Checklists when a series of approaches, touch and go landings, or full stop taxi backs are to be performed.

If the normal After Takeoff/Climb Checklist has been accomplished, the normal sequence of checklists will be accomplished for the first landing, after that, the Local Pattern Checklists may be used, when accomplishing multiple approaches/landings.

If After Landing Checklist has been accomplished, it will be necessary to accomplish the normal checklists prior to flight.

After final landing use normal After Landing and Parking Checklists.

FULL STOP TAXIBACK

This checklist will serve as both After Landing and Before Takeoff Checklist when used as described. For amplification of individual items see normal Before Takeoff Checklist.

NOTE

Complete the Full Stop Taxi Back Checklist to the dashed line prior to taking the runway for takeoff.

1. Radar/IFF .... STBY (FE)
2. Takeoff Data/N_1 Limit/V-Bugs ..... "CHECKED/SET" (P,CP,FE)
3. Thrust Computer .... "SET" (P,CP,FE)
4. Trim .... "CHECKED" (P,CP,FE)
5. Flaps/Slats .... "__°/__°T.O." (P,CP,FE)
6. Spoilers .... "ARMED" (P)
7. FGS/ALT Preselect .... "SET/ARMED" (P,CP)
8. Crew Briefing .... "COMPLETED" (PF)
9. Brake Temperatures .... CHECKED (FE)

NOTE

- Observe the BRAKE TEMP OVHT light(s) is off, the DIFF TEMP light is off, and the BRAKE TEMP gage indicates less than the maximum allowable brake temperature determined from the Brake Cooling Time Chart in Section IIA.
- To determine brake energy after an aborted takeoff, use the brake temperature gage reading prior to brake applications.
- If BRAKE TEMP OVHT light(s) is on or BRAKE TEMP gage indicates more than 400°C, refer to Section IIA, Abnormal Brake Procedures.
- The DIFF TEMP light, when on, indicates temperature(s) of one brake is significantly different from the average temperature of the others. If DIFF TEMP is on, press each BRAKE TEMP OVHT switchlight and observe BRAKE TEMP gage to identify brake(s) with significant temperature difference.
- High brake temperature may indicate a dragging brake. Cold brake temperature may indicate an inoperative brake.

10. Fuel Panel .... "SET" (FE)
11. FMS Flight Plan .... LOAD (IF REQ'D) (P,CP,FE)
12. CDUs/EHSIs/Radio Aids .... "SET" (P,CP,FE)
    a. Normally the integrated navigation solution (INU/GPS) will be selected on the Pilot and Copilot Steer (STR) pages.
    b. CDUs should be set to display the Pilot/Copilot Steer (STR) page, Flight Plan (FPLN) page, and Pilot/Copilot Position (PSN) page.

NOTE

Wind direction and velocity as well as headwind/tailwind and crosswind component is available on the Position (PSN) page on data line 3.

    c. When using the CDI for course guidance, the PF shall set EHSI to full HSI mode and the PNF may set EHSI to MAP mode.
    d. Tune, identify and monitor correct VOR, TACAN and ADF stations for departure. Select appropriate EHSI navigation and bearing sources.
    e. Rotate course select knob to position EHSI course arrow for departure, if required.
    f. Check VOR/ADF selectors set for departure.

----

13. Pneumatic Sys .... AS REQ'D (FE)
14. Radar/IFF/ETCAS .... "SET" (FE)

Rotate IFF/ETCAS MASTER switch to TA/RA. Set ETCAS range as desired.

15. HI-INT/Landing Lts . . . . AS REQ'D (FE)
16. Annunciator Panels . . . . "CHECKED" (P,CP,FE)
17. Full Stop Taxi Back Checklist . . . . "COMPLETED" (FE)

DOWNWIND

Complete the Downwind Checklist on downwind or equivalent time to allow full attention to the approach.

1. Landing Data/V-Bugs .... "SET" (P,CP,FE)

   Ensure landing data computations are correct for weather and every 20,000 pounds of gross weight change. Set V-bugs as required.

2. Crew Briefing .... "COMPLETED" (PF)

   Brief type of approach, missed approach, simulated emergenices, etc. at this time.

3. Flap Takeoff Selector ..... RETRACTED (FE)
4. CDUs/EHSIs/Radio AIDS ... "SET" (P,CP,FE)

   Select NAVAIDs as required for type of approach to be flown.

5. Radio Altimeter .... "SET" (P,CP)
6. Thrust Computer .... "GA" (PNF)
7. Fuel Panel .... CHECKED/SET (FE)
8. Seat Belt Switch .... AUTO (FE)
9. Downwind Checklist .... "COMPLETED" (FE)

BEFORE LANDING

The Before Landing Checklist is unchanged from the Normal Procedures and Checklist. It is included for continuity only.

1. Landing Gear ...... "DOWN . . ___ GREEN" (P,CP,FE)
2. Landing Lights .... ON (FE)
3. Spoilers .... "ARMED" (P)
4. Anti-Skid/Brake Press/Temp . . CHECKED (FE)
5. Flaps/Slats .... "___°/___° LAND" (P,CP,FE)
6. Before Landing Checklist .... "COMPLETED" (FE)

TOUCH AND GO LANDINGS

Touch and go landing procedures are not different from normal landings up to the point of touchdown, except during training the pilot in command may elect not to arm the landing spoilers.

Touch and go landings should normally be made with the spoilers in automatic extension to show the pitch effect as they first extend on landing and retract as the throttles go forward. Reverse thrust is never used on touch and go landings.

The pilot in command will brief the crew on commands, duties and actions during the touch and go, including go-around and abort procedures. All crewmembers must positively know that the landing is to be a touch and go.

WARNING

- After reverse thrust is initiated, a full stop landing will be made.
- If at anytime during a touch and go landing, the reverse thrust lever is moved from the stowed position, the takeoff will be aborted.

NOTE

A touch and go landing is a critical and time-compressed activity. The pilot in command must be cognizant of aircraft configuration and be situationally aware throughout the maneuver, regardless of which pilot is flying the aircraft.

PILOT FLYING	PILOT NOT FLYING	FLIGHT ENGINEER
At main gear touchdown, maintain aircraft control and smoothly, but positively lower nosewheel to the runway. Disconnect the autothrottles, if used.		
When ready to reconfigure the aircraft, the pilot flying will call "FLAPS 22° CHECK TRIM IN THE GREEN"		
After nosewheel touchdown maintain aircraft control. Ensure flap handle and stab trim have been reset.	On command, select flaps 22° and reset stab trim in green band, if necessary. Ensure autothrottles disconnected.	After nosewheel touchdown, confirm all three engines are operating properly, flap handle and trim are properly set and autothrottles disconnected.
When ready to start the takeoff phase, the pilot not flying will call "PUSH THEM UP".		
Advance throttles to approximately 12 O'clock position.		Ensure spoiler handle is retracted. Confirm all three engines are accelerating equally.

<table>
<tr><th>PILOT FLYING</th><th>PILOT NOT FLYING</th><th>FLIGHT ENGINEER</th></tr>
<tr><td colspan="3">NOTE
• If the spoilers were used, the spoiler handle should reset with an audible sound as the throttles are moved forward.
• If the ground spoilers are extended, the thrust should not be advanced until the nosewheel is on the runway, otherwise the pitch down effect may drop the nose heavily to the runway. During touch and go landing, the flight engineer will ensure that the spoiler handle returns to RET when the throttles are advanced for takeoff.</td></tr>
<tr><td colspan="3">After engines stabilize at the 12 o'clock position the pilot in command will call "SET TAKEOFF POWER".</td></tr>
<tr><td>Advance power to desired takeoff thrust.</td><td></td><td>Adjust throttles as required.
Call "POWER SET"</td></tr>
<tr><td colspan="3">NOTE
Approximately 100% N_1 may be used for takeoff thrust. If runway length and ambient conditions require, an N_1 setting up to Go-Around power may be used.
NOTE
General Electric has determined that the preferred technique of power application during a touch and go landing is to push throttles up to the 12 o'clock position and allow engines to stabilize prior to advancing them to a touch and go power setting.</td></tr>
<tr><td>Push the TO/GA button and at a speed no less than indicated by the salmon bug, rotate.</td><td>Call "ROTATE" accelerating through the salmon bug speed.</td><td></td></tr>
<tr><td colspan="3">NOTE
• Pilot should rotate to center pitch command bar or to an attitude to climb out at the threshold speed plus additives.
• When the TO/GA button is pushed with main and nosewheels on the runway, "TAKEOFF" will be annunciated in pitch and roll. Flight director will command a maximum pitch of 22°.
• If the TO/GA button is pushed with the nosewheel off the runway, "GA" will be annunciated, the flight director will command a maximum pitch of 15°. (This may also happen even with the nosewheel on the runway if the TO/GA button is pushed early due to a ground sensing time delay.
• When the throttles are advanced, the takeoff warning horn may sound momentarily due to the slats/flaps and spoilers being in transit (not fully configured). The pilot in command should confirm that everything is correctly positioned and advise the crew. Following the sequence as outlined above should preclude this from occurring.</td></tr>
</table>

At touchdown the pilot flying will smoothly but positively lower the nosewheel to the runway. The pilot not flying will select flaps 22° and, if necessary, reset stabilizer trim in the green-band. The pilot flying will disconnect the autothrottles, if used.

The pilot not flying will ensure that the flaps and trim have been properly reset and the autothrottles are disconnected, then will tap the hand of the pilot flying and/or call "PUSH THEM UP" as a signal to begin slowly advancing the throttles toward takeoff thrust. If the spoilers were used, the spoiler handle should reset with an audible sound as the throttles are moved forward.

NOTE

> If the ground spoilers are extended, the thrust should not be advanced until the nosewheel is on the runway, otherwise the pitch down effect may drop the nose heavily to the runway. During touch and go landing, the flight engineer will ensure that the spoiler handle returns to RET when the throttles are advanced for takeoff.

After confirming all three engines are operating properly, flaps and trim are properly set and autothrottles are disconnected, the pilot in command will call set takeoff power. The pilot flying will advance the throttles and the flight engineer will set and refine the desired thrust setting. Approximately 100% N_1 may be used for takeoff thrust. If runway length and ambient conditions require, an N_1 setting up to go-around power may be used. The flight engineer refines the thrust setting to the desired value.

At a speed not less than indicated by the salmon bug, the pilot not flying calls "ROTATE". The pilot flying pushes the TO/GA button on No. 2 throttle and rotates to center the pitch command bar or, if unavailable, controls attitude to climb out at the threshold speed plus additives. When the TO/GA button is pushed with main and nosewheels on the runway, "TAKEOFF" will be annunciated in pitch and roll. The flight director will command a maximum pitch of 22°. If the button is pushed with the nosewheel off the runway, "GA" will be annunciated. The flight director will command a maximum pitch of 15°. (This may also happen even with the nosewheel on the runway if the TO/GA button is pushed early due to a ground sensing time delay.)

NOTE

> When the throttles are advanced, the takeoff warning horn may sound momentarily due to the slats/flaps and spoilers being in transit (not fully configured). The pilot in command should confirm that everything is correctly positioned and advise the crew. Following the sequence as outlined above should preclude this from occurring.

BOOM OPERATOR PROCEDURES

BOOM OPERATOR PRE-FLIGHT AND PREPARATION

Dagger (†) items will be accomplished by a qualified cargo loading boom operator when assigned to perform aircraft loading, passenger handling, and offloading duties.

During an intermediate stop, it is not necessary to perform all of the pre-flight check on the cabin inspection or ARO station inspection. Only those items identified by an asterisk (*) or items on which maintenance has been performed are required. Unmarked items may be checked at the discretion of the boom operator. Double asterisks (**) to be accomplished when wing air refueling pods are installed (With TCTO 1C-10(K)A-956).

CABIN INSPECTION

1. AFTO Form 781 . . . . CHECK (FE,BO)

WARNING

Prior to the initial application of electrical power and after fuel servicing, ensure that the center accessory compartment has been inspected for fuel leaks.

Review AFTO Form 781A to determine servicing and equipment status.

†2. Electrical/Air Conditioning . . . . . . ESTABLISH

When FE or qualified ground support personnel are not available, determine whether external power or APU is required.

NOTE

Use external power (if available) to power the ground service bus unless air conditioning is required.

A. External Power (External Pwr Panel)

(1) EXT PWR AVAIL Light . . . . ON

(2) EXT PWR NOT IN USE Light . . . . ON

(3) Ground Service EXT PWR Switch . . . . ON

(4) Cabin Door . . . . OPEN

(5) FUEL DUMP Sw . . . . CLOSED/SAFETIED

WARNING

Do not turn on AC electrical power unless FUEL DUMP switch cover is safetied.

(6) Landing Gear Handle . . . . DOWN

(7) BAT Switch . . . . BAT/LOCK

(8) Ext Power (FE Panel) . . . . ON

(9) Radio Check . . . . COMPLETE

(10) Emergency Lights . . . . ARM/TEST

(11) Ext Power (FE Panel) . . . . OFF - (if cockpit power is not required)

B. APU

(1) APU INLET/EXHAUST Areas . . . . CLEAR

WARNING

If APU exhaust area is not clear, do not start the APU.

NOTE

If external power is not available, enter aircraft through nose gear area or center accessory compartment.

(2) BAT Switch . . . . BAT/LOCK

Observe BAT BUS OFF light is OFF. Rotate switch to the horizontal (locked) position.

CAUTION

For complete fire protection during all APU operations, BAT switch must be in BAT (on).

NOTE

- BAT BUS OFF light comes on momentarily when switch is moved to BAT if no power is on the aircraft.
- Cockpit standby lights (partial floods at reduced intensity) come on when battery bus is powered and normal AC electrical power is off.

NOTE

- Cockpit standby lights will go off, when normal AC electrical power comes on. Prepositioning the FE's FLOOD INT LT knob ensures the cockpit will remain illuminated.

(3) FUEL DUMP Switch Cover .... CLOSED/SAFETIED

WARNING

Do not turn on AC electrical power unless FUEL DUMP switch cover is safetied.

(4) Landing Gear Handle .... DOWN

(5) Radio .... CHECK

NOTE

Make radio check with Ground Control or Tower. If external power is not available, UHF-1 or VHF-1 may be used by turning EMER POWER switch on, or you may wait until APU is supplying power.

(6) Cabin Air Shutoff Handle ..... STOWED

CAUTION

Operation of air conditioning packs without proper reset of cabin air shutoff valves could result in major damage to air conditioning ducts. If abnormal noise occurs when air conditioning systems are actuated, turn PACK function selectors to PACK OFF. Maintenance is required.

NOTE

If cabin air shutoff handle is not fully stowed, maintenance is required.

(7) APU and Engine Fire Detection System.............. TEST

(a) MASTER WARNING and MASTER CAUTION Lights .. OFF

(b) ENG (1, 2, and 3) LOOPS and APU LOOPS Switches ...... BOTH

(c) LOOPS A and LOOPS B Test Switches .... TEST

Observe FE's LOOP, MASTER WARNING, and APU FIRE Light on.

Observe all pilot's ENG FIRE handle lights are on, handles stowed and engine 2 AGT LOW lights are off, APU FIRE light is on, MASTER WARN lights are on, ENGINE FIRE light is on, fuel lever lights are on and engine fire bell sounds.

(d) Test Switches .... RELEASE

Observe all lights go off and bell stops ringing.

NOTE

- If one (or more) LOOP light(s) does not come on during test, maintenance is required.
- If only one APU LOOP light is on and maintenance is not available or time does not permit maintenance action, move APU LOOPS switch to the LOOP light that came on during the test. Move affected LOOP test switch to TEST. Observe APU LOOP light (one being tested), APU FIRE light, and MASTER WARNING lights come on. (If system test is normal, system is operable as a single loop system.)

(8) APU GEN BUS Switches........ OFF

(9) APU FIRE CONTROL Switch .... NORM

(10) APU CONT SYS Switch ...... NORM

CAUTION

Do not move APU CONT SYS switch between NORM and STBY during APU operation. Possible transfer relay damage due to electrical transients may result.

(11) APU/ISOL VALVE Switch .... CLOSE

(12) FUEL PUMP .... ON

NOTE

- If AC electrical power is supplying buses, turn on tank 2R AFT TANK PUMP.
- If AC electrical power is not supplying buses, turn on APU FUEL PUMP.
- After AC electrical power is supplying buses, turn on tank 2R AFT TANK PUMP and turn off APU FUEL PUMP.

(13) APU MASTER Switch .... RUN

Observe APU FUEL PRESS LO light is off and APU GEN OFF light is on. Observe APU USING BAT PWR and APU DOOR OPEN lights come on in approximately 20 seconds.

CAUTION

Do not attempt or continue start if low oil pressure light is not illuminated during initial start sequence until cause of difficulty is determined.

(14) APU DOOR OPEN Light .... ON

(15) APU MASTER Switch .... START/RUN

Move APU MASTER switch momentarily to START then release to RUN.

(16) Start Indication .... OBSERVE

Observe APU OIL PRES LO/TEMP HI light comes on. Observe APU % RPM N_2, APU EXH TEMP, and APU % RPM N_1, gages indicate an increase. As N_2, RPM increases, observe APU OIL PRESS LO/TEMP HI light goes off. When APU is in normal operating range, observe APU USING BAT PWR light goes off.

CAUTION

- Do not restart if APU has automatically shut down with APU OIL PRES LO/TEMP HI light or APU FIRE light(s) on.
- After an unsuccessful start, do not attempt another start until APU shut down cycle is complete and APU DOOR OPEN light goes off. A start attempt before APU DOOR OPEN light goes off may result in a hung start and excessive exhaust temperatures.

NOTE

When APU is in normal operating range, APU GEN OFF light goes off and APU PWR AVAIL light comes on.

If APU OIL PRESS LO/TEMP HI light comes on flashing, discontinue start and move APU MASTER switch to OFF. A flashing APU OIL PRESS LO/TEMP HI light indicates failure of the oil pressure indicating system inhibiting an APU start.

NOTE

- If APU will not start, has automatically shut down, or operation is erratic, move APU MASTER switch to OFF.
- If APU FUEL PRESS LO light was on after APU automatically shut down with APU MASTER switch in RUN, fuel pump failure is indicated. Select another pump from tank 2 and attempt another start.

(17) APU GEN FAIL Light .... OFF

If light is on, push GEN FAIL RESET Button, if light goes off, continue checklist, if light stays on, shut down APU.

(18) APU PWR AVAIL Light .... ON

NOTE

If APU PWR AVAIL light is off and APU GEN OFF light is on, move APU GEN RESET switch to RESET and release. Observe APU GEN OFF light goes off and APU PWR AVAIL light comes on. If first attempt is unsuccessful, maintenance is required.

(19) APU GEN BUS Switches .... ON

Turn switches on one at a time and observe APU PWR IN USE lights come on.

NOTE

- If one or more APU PWR IN USE light is off, observe appropriate AC BUS OFF light is off.
- If APU PWR AVAIL light goes off and APU GEN OFF light comes on, turn APU GEN BUS switches off before attempting reset.

(20) Oil Quantity .... CHECK

After AC electrical power is supplying the buses, check for any oil quantity indication above 2 quarts.

NOTE

If air conditioning is not required, ARM/TEST emergency lights, turn on APU fuel pump switch, turn off tank 2R AFT TANK pump switch, turn off APU GEN BUS switches and use APU PWR SW on the cabin ground service panel. Continue cargo checklist.

(21) MANFLD FAIL Lights.......... OFF

WARNING

Do not establish pneumatic supply(s) if a MANFLD FAIL light is on.

(22) CABIN PRESSURE MAN/AUTO Handle.......... AUTO

(23) 1-2, 1-3 ISOL Valve Switches .... NORM

(24) APU/ISOL Valve Switch .... OPEN

Observe pneumatic ISOL VALVE DISAGREE lights come on and go off. Observe pressure gages increase to normal operating range.

NOTE

If pneumatic pressure gages do not indicate in the normal operating range, move APU/ISOL VALVE switch to CLOSE.

(25) PACK Function Selectors ..... AUTO

(26) Temperature Selectors .... AUTO

(27) TRIM AIR Switch .... TRIM AIR

Observe DUCT-AVIONIC COMPT OVERHEAT light is off.

(28) Emergency Lights .... ARM/TEST

(a) Emergency Lights .... ARM

Observe DISARMED light goes off.

NOTE

The DISARMED light will be on when switch is in either ON or OFF.

(b) EMER LT TEST Button .... PUSH AND HOLD

Observe EMER LT TEST light comes on.

NOTE

Pushing EMER LT TEST causes emergency lights to come on and test condition of integral batteries under load. EMER LT TEST light will come on when all four circuits and batteries are satisfactory. Test requires approximately 5 seconds.

(c) EMER LT TEST Button .... RELEASE

Observe EMER LT TEST light goes off.

3. Oxygen Mask, Regulator, & Interphone....................... CHECK

a. Set audio panel for operation. Push INT microphone selector button, and set interphone and radio volume controls as desired.

b. Position regulator supply lever ON, diluter lever to 100% and observe OXYGEN SUPPLY PRESSURE gage indicates approximately 70 PSI.

c. Don oxygen mask/smoke goggles and adjust as required. Ensure mask vent-valve is closed.

d. Move emergency oxygen toggle lever to EMERGENCY and observe oxygen flow under slight pressure. Take a few breaths to ensure blinker operation, then take a deep breath and hold. A white blinker indicates a leak.

The emergency oxygen toggle lever may be held in TEST MASK to assist in checking mask to face seal.

e. Open the mask vent-valve and ensure positive flow. Keep mask vent-valve open for flight.

f. Move emergency oxygen toggle lever to NORMAL.

g. Test mask transmit capability by making a test call on the interphone and monitoring it over the headset or speakers.

h. Position regulator supply lever to OFF and attempt to breathe normally.

NOTE

Ability to breathe unrestricted on the first attempt indicates a faulty mask or regulator.

i. Remove and stow mask.

j. Ensure portable oxygen bottle indicates approximately 1,800 PSI (left edge of red band), and ON/OFF valve is OFF and DEMAND/PRESSURE DEMAND selector is in DEMAND.

NOTE

- If portable oxygen bottle is low, maintenance is required.
- The pressure of a properly charged oxygen cylinder may vary -300 to +200 PSI during extreme hot or cold temperature conditions.

4. Observer Position .... CHECK

Check observer position is in satisfactory condition and oxygen regulator is in NORMAL, 100% and OFF.

5. Cargo Compartment Lighting Console .... CHECK

Verify switches on the Lighting Console are positioned as required and the EMER LIGHTS switch is guarded in the NORM position. Ensure that the Interphone switch on the lower sidewall is in center position. If cargo loading/unloading operations are being conducted, leave lighting as set.

NOTE

The EMER LIGHTS switch should be in NORM except when emergency lights are needed.

6. Passenger Address System .... TEST

Push microphone switch on hand mike and make a test announcement. Monitor announcement on speakers.

7. Additional Crewmember Oxygen Regulator .... NORMAL/100%/and OFF

Verify additional crewmembers oxygen regulators are in NORMAL, 100%, and OFF and observe OXYGEN SUPPLY PRESSURE gage indicates approximately 70 PSI.

8. Seats & Life Support Equipment ..... CHECK

Ensure sufficient seats (with safety belts and passenger information cards) are available to accommodate planned number of passengers. If IAU is installed, complete an oxygen system circuit test of the IAU.

ARO STATION INSPECTION

NOTE

ARO station inspection may be accomplished using the scan pattern depicted in figure 4-5.

1. Compartment Lights .... ON

   Position ARO station incandescent light switch to ON.

2. Portable Oxygen Bottles............. CHECK

   Ensure the portable oxygen bottle(s) indicate approximately 1,800 PSI (left edge of red band) and ON/OFF valve is OFF and DEMAND/PRESSURE DEMAND selector is in DEMAND.

   NOTE

   - If portable oxygen pressure is low, maintenance is required.
   - The pressure of a properly charged oxygen cylinder may vary -300, +200 PSI during hot or cold temperature conditions.

3. Circuit Breakers .... SET

   Verify circuit breakers on overhead panel are set.

4. Oxygen Mask, Regulator
   & Interphone....................... CHECK

   a. Set audio panel for operation. Push INT microphone selector button, and set interphone and radio volume controls as desired.
   b. Position regulator supply lever ON, diluter lever to 100% and observe OXYGEN SUPPLY PRESSURE gage indicates approximately 70 PSI.
   c. Don oxygen mask/smoke goggles and adjust as required. Ensure mask vent-valve is closed.
   d. Move emergency oxygen toggle lever to EMERGENCY and observe oxygen flow under slight pressure. Take a few breaths to ensure blinker operation, then take a deep breath and hold. A white blinker indicates a leak.

      The emergency oxygen toggle lever may be held in TEST MASK to assist in checking mask to face seal.
   e. Open the mask vent-valve and ensure positive flow. Keep mask vent-valve open for flight.
   f. Move emergency oxygen toggle lever to NORMAL.
   g. Test mask transmit capability by making a test call on the interphone and monitoring it over the headset or speakers.
   h. Position regulator supply lever to OFF and attempt to breathe normally.

   NOTE

   Ability to breathe unrestricted on the first attempt indicates a faulty mask or regulator.

   i. Remove and stow mask.

5. Annunciator Lights .... TEST

   Push TEST button and observe warning, caution and annunciator lights come on.

   NOTE

   - Prior to testing annunciator lights, ensure BOOM SIG light rheostat is set to a position other than MIN.
   - If warning, caution, or annunciator light fails to come on, maintenance is required.

6. Stick Force .... SET(5)

   Rotate ELEVATION and ROLL STICK FORCE selectors to 5.

*7. AR MASTER PWR Switch .... PWR

   Move AR MASTER PWR switch to PWR (on) and observe the READY light comes on.

---

*Through Flight

NOTE

AR MASTER PWR switch is to remain in PWR until after landing.

8. TLSCP-AT-DISC Switch .... AUTO
9. BOOM ENV LIMITS Switches ...... ACTIVE

   Verify BOOM ENV LIMITS TLSCP and ELEVATION switches are in the ACTIVE position.

10. AR SIG SYS OVRD Switch .... OVRD
11. RCVR DISC DELAY ..... SET (2 SECONDS)
12. ALAS Switch .... ENABLE
13. FLT CONT Switch...................... OFF
14. Annunciator Panel .... CHECK

    Observe annunciator lights are off (except MAIN HYD PRESS LOW light). If any light is on, refer to appropriate abnormal procedures checklist.

15. INDEP DISC Gage .... CHECK

    Observe pointer on INDEP DISC gage indicates a minimum of 1,500 PSI.

NOTE

- The INDEP DISC gage is a direct pressure reading gage and will indicate 2,000 PSI when the air bottle is fully serviced.
- If INDEP DISC gage indicates zero on aircraft 79-1951 verify TEST EQUIPMENT SHORTING PLUG (sta 1810) is installed.
- If IDS is below 1500 PSI and cannot be serviced, Refer to TO 1C-10(K)A-1-2 for additional guidance.

16. Roll Disconnect Limits .... SET (25°)

    Verify L and R ROLL limits indexes are set to 25°.

17. Upper Elevation Disconnect Limit .... SET (20°)
18. HOSE JTSN Switch .... SAFE

    Verify HOSE JTSN switch cover is closed and safetied.

19. DROGUE MASTER PWR Switch .... PWR
20. HOSE REEL MONITOR Switch.......... ON
21. HOSE REEL TEST Switch............. MON

    Move HOSE REEL TEST switch momentarily to the MON position and observe RESP INOP light comes on for approximately 1 second and goes off. System is operating normally.

NOTE

If RESP INOP light remains on after HOSE REEL TEST switch is released to OFF, refer to the appropriate abnormal checklist.

22. HOSE REEL MONITOR Switch......... OFF
23. DROGUE MASTER PWR Switch .... OFF
24. HOSE Switch .... REWIND
25. BREAKAWAY Switch .... OFF
26. Observer Oxygen Regulator and Interphone .... CHECK

    Check regulator is NORMAL, 100% and OFF. Ensure the HOT MIC/RADIO switch is in the center position.

27. Electrical System Isolation Switches............................ NORM

    Verify A/R BUS and GND SVC BUS switches are in NORM (guard closed).

28. ANNUN PWR Switch .... NORM

    Verify the ANNUN PWR switch is in NORM.

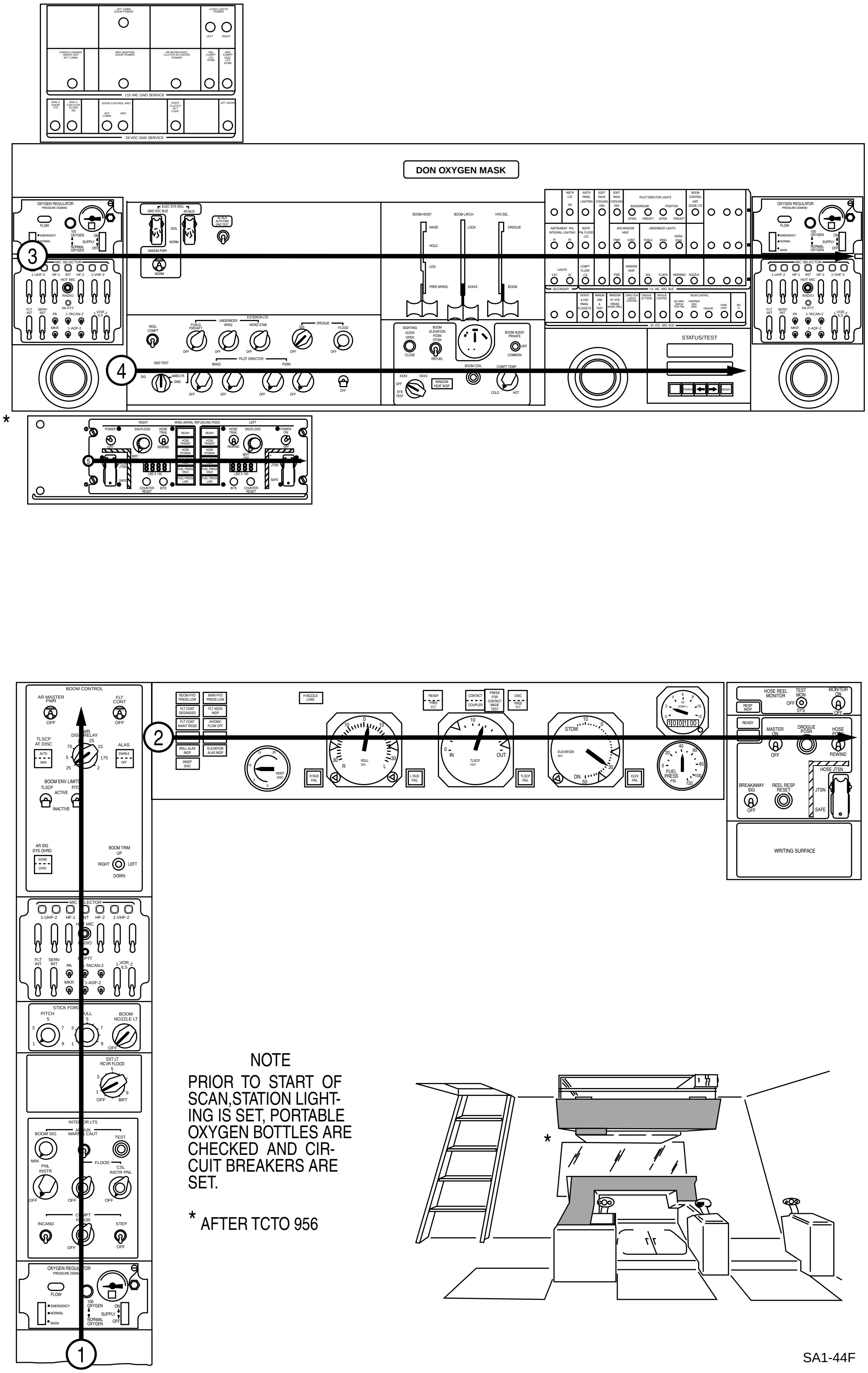
29. AR BUS ALTN PWR .... TEST

    Move AR BUS ALTN PWR switch to GND TEST and observe that all DC powered lights remain on.

NOTE

- All DC powered lights will blink momentarily when the AR BUS ALTN PWR switch is moved to GND TEST.
- If the DC powered lights fail to remain on with AR BUS ALTN PWR switch in GND TEST, maintenance is required.

30. BOOM HOIST Selector .... HOLD
31. BOOM LATCH Selector............... LOCK



NOTE

PRIOR TO START OF SCAN,STATION LIGHTING IS SET, PORTABLE OXYGEN BOTTLES ARE CHECKED AND CIRCUIT BREAKERS ARE SET.

* AFTER TCTO 956

Figure 4-5. Boom Operators ARO Station Inspection Scan Pattern

*32. HYD SEL .... OFF

CAUTION

Boom flight control surface flutter may occur if the flight control actuator reservoirs are not pressurized.

To ensure pressurization is maintained move HYD SEL to BOOM for approximately 2 minutes (number two hydraulic system pressurized) prior to takeoff and each 8 hours thereafter. Computer check during preflight and system usage during boom air refueling will satisfy pressurization requirements provided the 8 hour limits are not exceeded.

NOTE

During scramble operations or for through flight operations, ensure pressurization is maintained by moving HYD SEL to BOOM for approximately two minutes.

33. Instructor Oxygen Regulator and Interphone .... CHECK

Check regulator is NORMAL, 100% and OFF. Ensure HOT MIC/RADIO switch is in center position.

34. AR EXTERIOR Lights .... OFF

Verify the REEL COMPT light switch is set as required.

35. Sighting Door .... OPEN

36. BOOM ELEVATION POSN Switch.... STOW

37. WINDOW HEAT Selector .... TEST/AS REQ'D

Move to SYS TEST and check that WINDOW HEAT INOP light illuminates.

NOTE

- If WINDOW HEAT INOP light fails to illuminate, maintenance is required.
- Use of window heat switch in HIGH position should be considered any time the ARO compartment is below 32°F.
- Window heat selector may be placed in NORM if required for de-icing, defogging or to aid in warm-up of the ARO compartment.

38. BOOM COIL......................... TEST

Push the BOOM COIL TEST button and observe BOOM COIL TEST needle indicates in the GOOD band.

NOTE

If BOOM COIL TEST needle indicates OPEN or SHORT, maintenance is required.

39. COMPT TEMP Selector .... SET

Verify the COMPT TEMP selector is set to approximately 12 o'clock position.

NOTE

The ARO compartment door should be closed to ensure proper function of the temperature controller.

40. Air Refueling Computer .... TEST

Confirm hydraulic pressure is available with FE.

WARNING

If maintenance is being performed in the boom area, ensure area is clear. Injury or damage may occur to personnel or equipment in the vicinity of boom during the computer pre-flight.

CAUTION

Do not retract boom using emergency retract when aircraft is on the ground or the boom is stowed. Damage to boom and boom retract shock absorber will occur if boom is retracted against the stops using emergency retract.

NOTE

The ARO MAIN HYD PRESS LOW light will be on whenever HYD SYS 2 is OFF/INOPERATIVE.

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*Through Flight

Push the STATUS/TEST POWER switch and observe the POWER, CMPVLD, both arrows and VERIFY lights come on, and all LED segments come on for 3 seconds.

The ROLL ALAS INOP, ELEVATION ALAS INOP, R RUD FAIL, L RUD FAIL, TLSCP FAIL, and ELEV FAIL will illuminate.

NOTE

- If POWER and CMPVLD lights do not come on, maintenance is required.
- If the computer pre-flight is terminated for any reason, verify FLT CONT switch is off prior to turning STATUS/TEST power off.
- If the BCU should shut down during the AR computer test, turn the FLT CONT switch OFF, place the HYD SEL OFF, turn the status test panel OFF and cycle the AR MASTER PWR switch. Reconfigure switches and controls for stage 1 and reinitiate the test. If a second shutdown occurs, call maintenance.
- Items 41 through 45 are accomplished when WARP's are installed.

**41. HOSE TRAIL/
REWIND Switch(es) . . . . REWIND

**42. SIG/FLOOD Switch(es) . . . . BRT/OFF

**43. HOSE JTSN Switch(es) . . . . SAFE

Verify HOSE JTSN switch cover(s) are closed and safetied.

**44. WING POD CONTROL
PANEL . . . . CHECK (BO,FE)

a. WING POD POWER
Switch(es) . . . . ON (BO)

Observe FUEL PRESSURE LOW Lights are on and LBS X 100 indicators display zero.

WARNING

Wing air refueling pods must be kept full of fuel to decrease the risk of lightning strike potential, and for proper fuel pump lubrication.

NOTE

FUEL OFFLOAD indicators should read zero, if not a failure is indicated and maintenance is required.

b. WING DROGUE
Valves . . . . OPEN (FE)

Drogue Valve Open Lights should illuminate and Fuel Pressure Low Lights should extinguish.

**c. WING POD POWER
Switch(es) . . . . OFF (BO)

WING POD POWER switches will be turned off after the FE has confirmed that the WING DROGUE VALVE switch(es) are operational.

45. ARO Station Alarm . . . . CHECK (BO,FE)

NOTE

This item is coordinated with the flight engineer and may be accomplished at any time during the ARO inspection.

46. AR MASTER PWR Switch . . . . AS REQ'D

If cocking or preflighting the aircraft for power on alert, return the AR MASTER PWR switch to OFF until scramble operation.

NOTE

When ARO inspection is complete, inform FE that you are through with hydraulics.

47. Sighting Door . . . . CLOSED

WARNING

Ensure boom sighting door area is clear before closing door.

**With TCTO 1C-10(K)A-956.

Observe LED display and accomplish actions as required:

LED DISPLAY	ACTIONS
MAINT REQ'D MSG RECALL VRFY.	Push the VERIFY switch, review each message as it appears, then push forward directional arrow to continue. **NOTE** Notify maintenance of any discrepancies after computer test is completed.
PRE-FLIGHT TEST VRFY.	Push the VERIFY Switch.
LED DISPLAY STAGE 1 CONTROLS SET VRFY.	Set controls for stage 1 or push VERIFY switch if controls were previously set. **NOTE** ● When VRFY appears on LED display, the VERIFY switch must be pushed if it is desired to accomplish the displayed item. If VRFY appears on LED display with a required action, the VERIFY switch must be pushed after the item is completed. Computer will sense completion of those items that VRFY does not appear with and automatically continue the pre-flight as they are accomplished. ● When VERIFY switch is pushed the ROLL ALAS INOP and ELEVATION ALAS INOP lights will extinguish.
STAGE 1 CONTROLS SET VRFY.	STAGE 1 CONTROLS SET CHECKLIST Roll & Elevation Stick Force Sels - 5 AR Sig Sys Ovrd Sw - OVRD Boom Env Limits - ACTIVE TLSCP-at-Disc-Sw - AUTO Rcvr Disc Delay - 2 ALAS Sw - ENABLE Flt Cont Sw - OFF R & L Roll Disc limits - 25° Upper Elev Disc Limits - 20° Boom Elev Posn Sw - STOW Hyd Sel - OFF Push the VERIFY switch.

(Continued)

LED DISPLAY	ACTIONS
	NOTE LED display will indicate TEST IN PROGRESS or next action to be completed.
Movement of a switch or control is directed.	Observe position of switch or control, move it to proper position if required. If switch or control is in proper position push VERIFY switch, record message then push VERIFY switch to continue.
Movement of a switch or control is directed followed by VRFY.	Observe position of switch or control, move it to proper position if required and push VERIFY switch. If switch or control is in proper position push VERIFY switch, record message then push VERIFY switch to continue. If NEXT TEST/VRFY or RETEST/BACK STEP appears in the LED display, push VERIFY switch to continue or reverse direction arrow if you desire to retest the previous step.
PULL DISC SW DISC LIGHT ON.	Pull DISC switch, observe DISC light comes on, and listen for three beep tones over the headset. Release DISC switch and observe A/R SIG SYS READY light comes on momentarily, DISC light goes off momentarily, then comes on steady.
SET TLSCP AT DISC TO MAN.	Push TLSCP AT DISC switch, observe MAN light comes on, AUTO light goes off, and observe A/R SIG SYS READY light comes on.
PULL EMER CONT MADE SW LIGHT ON.	Pull EMER CONT MADE SW, observe CONTACT light comes on, and listen for one beep tone over the headset. READY light goes off.
PUSH READY/RESET READY LIGHT ON.	Push READY RESET button, observe READY light comes on and CONTACT light goes off.

(Continued)

LED DISPLAY	ACTIONS
SET FLT CONT SW ON.	MOVE FLT CONT switch to FLT CONT (on).
SET AR SIG SYS OVRD TO NORM.	Push AR SIG SYS OVRD switch, observe NORM light comes on and OVRD light goes off.
STAGE 2 HOLD TLSCP FULL EXTD.	Move boom telescope control stick slowly to full extend. Observe TLSCP instrument indicator and telescope control stick move smoothly to full extend and TLSCP instrument indicates 22 feet.
TLSCP FULL RETR.	Move boom telescope control stick slowly to full retract and hold until next action item appears. Observe TLSCP instrument indicator and telescope control stick move smoothly to full retract, TLSCP instrument indicates 0 and TEST IN PROGRESS appears in LED display.
HOLD STICK FULL DOWN.	Move boom flight control stick slowly to full down. Observe ELEVATION indicator and flight control stick move smoothly to full down and ELEVATION instrument indicates 50°.
HOLD STICK FULL UP.	Move boom flight control stick slowly to full up. Observe ELEVATION indicator and flight control stick move smoothly to full up and ELEVATION instrument indicates +15°.
HOLD STICK FULL RIGHT.	Move boom flight control stick slowly to full right. Observe ROLL indicator and flight control stick move smoothly to full right and ROLL instrument indicates 30° right.
HOLD STICK FULL LEFT	Move boom flight control stick slowly to full left. Observe ROLL indicator and flight control stick move smoothly to full left and ROLL instrument indicates 30° left.
CHECK METERS VRFY.	Push VERIFY switch. **NOTE** • If any binding is felt in the boom flight control stick movements, contact maintenance. • If meters did not follow boom telescope or flight control stick movements. Record discrepancy and push VERIFY switch.

(Continued)

LED DISPLAY	ACTIONS
STAGE 3 HYD SEL BOOM VRFY.	Move HYD SEL to BOOM, then push VERIFY switch. **NOTE** ● After VERIFY switch is pushed BOOM RUD/ELEV TEST IN PROGRESS will appear on the LED display. When test is completed, BOOM TLSCP TEST IN PROGRESS will appear. ● Telescope, rudder, and elevator fail lights will go off during respective test.
SET FLT CONT SW OFF.	Move FLT CONT switch to OFF.
SET HYD SELL OFF VRFY.	Move HYD SEL to OFF and push VERIFY switch.
STAGE 4 ANNUN LIGHTS ON VRFY.	Observe FLT CONT DEGRADED, FLT CONT MAINT REQ'D, ROLL ALAS INOP, FUEL XDCR INOP, LTS & EMER TLSCP INOP, ELEVATION ALAS INOP, R RUD FAIL, L RUD FAIL, TLSCP FAIL, ELEV FAIL, HIGH NOZZLE LOAD, FREE FLIGHT, and COUP-LED lights are on. Verify with FE that FLT CONT INOP is on and push VERIFY switch.
ALL BCU ANNUN LIGHTS OFF VRFY.	Verify with FE the FLT CONTROL INOP light is off, and all BCU ANNUN lights are off, push VERIFY switch.
5 SECOND AURAL WARNING.	Verify aural warning sounds, push VERIFY switch. **NOTE** Sounding of the warning horn during operational use is aural notification that a boom flight control system failure has occurred.
SYSTEM READY END OF TEST.	Push the STATUS/TEST POWER switch and observe the POWER light, CMPVLD light and LED display go off.
SYSTEM FAIL END OF TEST.	Push the STATUS/TEST POWER switch and observe the POWER light, CMPVLD light and LED display go off. Call maintenance if computer required for mission. **NOTE** FAIL lights and aural warning will come on if the FLT CONT switch is on when STATUS/TEST power is turned off.

FINAL PREPARATION

†1. Cargo & Loose Equipment.......... SECURE

Secure cargo and loose equipment as outlined in cargo loading manual. Following this check of the cargo compartment, personnel will not proceed aft of the cargo barrier net without coordination with the primary boom operator.

Verify galley equipment is secure prior to taxi.

Verify cargo barrier net and environmental curtain are properly installed prior to taxi, if applicable.

If cargo or pallets are on board, or the aircraft is departing home station with the purpose of picking up cargo at another location, visually inspect and perform operational checks of the cargo handling system components to ensure the system is operational, not damaged, properly installed and configured to accept planned loading.

WARNING

Proper location and condition of all cargo handling components are necessary to ensure integrity of the system. A damaged cargo handling system has lost some of its structural integrity thus reducing its restraint capability which jeopardizes safety of flight.

CAUTION

Visual inspection and operational checks of components are important to the success of the mission. Obstructed or malfunctioning mechanisms, bent or misaligned conveyors and restraint rails or improperly installed components can be seriously damaged during loading operation.

Verify that hazardous materials protective equipment kit is onboard and serviceable.

†2. Cargo Door .... CLOSE/VENT DOOR LOCKED (IF APPLICABLE)

NOTE

MAIN CARGO DOOR SYS (A & B) lights off indicate safe closing and locking of cargo door on 79-1710 and subsequent aircraft. A visual inspection is required to determine if the vent door is closed on aircraft 79-0433 and 79-0434.

†3. Passengers .... BOARD/BRIEF

WARNING

Cabin doors without airstairs/ramp in place will have slide/rafts armed prior to passenger boarding.

NOTE

- All passengers will be briefed at their point of departure.
- If passengers are required to occupy additional crewmember seats, they will be briefed separately on oxygen use.
- Accomplish passenger briefing using the following guide. Briefing should be completed prior to engine start.

DEPARTURE BRIEFING

WELCOME ABOARD. I am ________ your boom operator. Also working with me is/are ________. Our destination is ________ and the mission duration is ________ hours.

We'd like your attention for a few minutes as the crewmembers in the cabin demonstrate the safety features of the KC-10 aircraft. An information card has been provided in the seat pocket in front of you. Please follow along as we point out these safety features.

PAUSE FOR DEMONSTRATION

As we prepare for takeoff, fasten your seat belts, bring your seat backs to the full upright position, and ensure your tray table is stowed. Place carry on luggage completely under the seat in front of you. If it does not fit under the seat notify a crewmember following this briefing.

It is an Air Force requirement to comply with the personnel advisory signs. They are located (**INDICATE LOCATIONS**) in the forward cabin, on the back side of the storage containers and in the rest rooms. For your safety, we encourage you to keep your seat belts fastened at all times while seated. At no time are you allowed behind the gray environmental curtain without crewmember supervision.

The use of portable/electronic devices is prohibited during takeoffs and landing, and anytime the aircraft is below 10,000 feet. Portable transmitting devices, such as cellular phones, may not be used at anytime aboard USAF aircraft. Non-Transmitting devices, such as audio and video recorders and playback devices, computers, peripherals, electronic entertainment devices and radio receivers, may only be operated above 10,000 feet and only with the aircraft commander's approval.

There are ________ clearly marked exit doors on our aircraft, each equipped with a slide raft (**INDICATE LOCATIONS**) which may be used during ditching. In the unlikely event of an evacuation, leave all hand carried items at your seat and depart the aircraft in a sitting position. Once on the ground assemble away from the aircraft, stay together, and watch for responding emergency vehicles.

FOR OVERWATER FLIGHTS

Your life vest is located in a pouch under your seat. Please do not remove it unless advised to do so by a crewmember. To use the life vest, pull it over your head and take the long strap around your waist. Attach the buckle into the fitting at the bottom center of the life vest and pull the loose end until the strap is snug around your waist. Snug means being able to put your closed fist between the strap and your waist.

PAUSE FOR DEMONSTRATION

Adults do not inflate the vest inside the aircraft. After leaving the aircraft, inflate the vest by pulling down on the two red tabs on the front of the vest. The vest can also be inflated by blowing into the tubes located at both shoulders. Your seat cushion may also be used as a flotation device.

INCLUDE THE FOLLOWING WHEN SMALL CHILDREN ARE ABOARD:

For children wrap the strap around the child's waist as many times as it will go then attach the clip and pull snug; then inflate one cell of the life preserver before departing the aircraft.

An oxygen mask is located in either a seat-back in front of you, a bulkhead in front of you, or in an overhead compartment (**INDICATE LOCATIONS**). If there is a sudden change in cabin pressure, the cabin lights will come on full bright, and the mask compartment will open automatically. Reach for the nearest mask and pull firmly toward you. This action starts the flow of oxygen. Place the yellow cup over your nose and mouth and secure with the white elastic band. It may be tightened by pulling the tabs located on either side of the mask. Continue to breathe normally.

PAUSE FOR DEMONSTRATION

Even though oxygen is flowing, the plastic bag may not inflate. If you are traveling with or seated next to a child, put your mask on first - then assist the child.

In addition to our passenger oxygen provisions, this aircraft is equipped with the Emergency Passenger Oxygen System (EPOS). The EPOS is intended for use in the event of an inflight or ground egress emergency in a smoke or toxic fume environment. Each seat is equipped with an EPOS located (state location, i.e., under the seat, in seat pouch, etc...). Please direct your attention to________, who will demonstrate the donning of the EPOS. When directed to don the EPOS, open the storage pouch, then open the vacuum sealed bag by pulling the red tape. Remove the EPOS hood from the bag and unfold it. Hold the EPOS hood with the neck seal (silver end) facing you. Pull the red ball with one hand while holding the oxygen cylinder with the other hand. The red ball and lever must pull free of the oxygen bottle. Spread the neck seal with your palms facing towards each other, then push both hands inside and stretch it open. Pull the hood over your head and neck, and breathe normally. While wearing the hood, an audible hiss lets you know that oxygen is flowing. If you do not hear a hissing sound after donning the unit, immediately remove it from your head.

Oxygen will cease flowing in approximately 5 minutes, however, do not remove a properly functioning unit from your head until directed to do so by aircrew personnel. As with other oxygen equipment, ensure that you have your own EPOS on and operating correctly before attempting to assist others. If used on an infant, pull the neck seal down to the infant's waist.

If there are any questions now or at any time during the flight, do not hesitate to ask. Thank you for your attention, we will be airborne shortly.

DISTRIBUTE INFANT COTS AND BRIEF USE (If required)

NOTE

Infant cots are for children (under 18 months or 30 lbs.)

4. Weight and Balance ...... COMPUTE/CHECK/ COORDINATE (P, FE, BO)

May be initiated sooner if required data is known. Compute actual zero fuel weight and C.G. Coordinate this data with the flight engineer. Obtain adjusted fuel gage readings from Flight Engineer and compute takeoff gross weight and C.G. Coordinate this data with the flight engineer. If takeoff C.G. differs by more than 1%, Boom Operator and Flight Engineer will recheck both computations

If preplanned, cross-check planned basic weight and moment against the last entry in the Chart C of TO 1-1B-50. Compare planned data against actual aircraft loading and make required corrections and coordinations.

5. CABIN DOORS .... CLOSE/ARM/CHECK

Cabin door/or doors may be selectively closed/ armed prior to completing final preparation checklist.

NOTE

- Arm all doors, number 2 left and right doors may or may not have slide rafts installed as established by passenger requirements.
- Remove and stow barrier strap prior to closing door.
- Before closing number 1 left door, remove Entry/Exit ladder if installed.

Move DOOR CONTROL switch to CLOSE until door is fully closed. Observe door closes and moves outward. Release DOOR CONTROL switch.

Move sliding mechanical safety latch to unlatched position.

To arm slide/raft, push slide arming lever to the SLIDE ARMED position for the forward doors, flush position for all other doors. Observe ARMED is displayed on the slide mode verification indicators. Observe DOOR DISARM light goes off .

CAUTION

The door disarming light on with the arming lever in ARM indicates electrical power is available to the door control switch. Moving the switch to OPEN will open the door and deploy the slide/raft.

NOTE

When the arming lever is in ARM electrical power to the door control switch is disconnected.

If slide/rafts are installed in doors, observe slide/ raft cylinder low pressure light is off. Push slide/ raft pressure low light switch and observe light comes on.

NOTE

If low pressure light is on or fails to come on when pressure low light is pushed, maintenance is required.

Observe pointer in door air pressure reservoir gage indicates in the green band.

NOTE

If pointer does not indicate in green band, maintenance is required.

During scramble operations, if engines are started prior to closing door 1L, ensure that the ladder is removed and all cabin doors are CLOSED/ARMED prior to taxi. Taxi will not be delayed to disassemble/stow the ladder.

WARNING

- Prior to starting the wing engines, the crew will ensure that engine start will not cause a hazard to other responding crewmembers.
- When responding, crewmembers must approach the entry ladder from the nose of the aircraft and avoid the engine intake danger area (20 foot radius).

6. Boom Operator Preparation .... "COMPLETED" (BO, FE)

This verifies that the cabin/cargo is ready for engine start.

BEFORE TAKEOFF

†1. Passenger & Extra Crewmember Briefing . . . . COMPLETE (IF REQ'D)

BEFORE TAKEOFF BRIEFING

May I have your attention. We have been cleared for takeoff, at this time please ensure your seat belt is securely fastened, seat backs are in the full upright position, and all tray tables are stowed THANK YOU.

2. Oxygen Regulator . . . . "ON/100%" (BO)

WARNING

With regulator in the OFF position, the mask may allow ambient air to enter after initial attempt to breathe. Ensure regulator is in the 100% and ON position at all times during flight when position is occupied.

Verify supply lever is ON and diluter lever is at 100%.

†3. Cabin Report . . . . "CABIN READY" (BO)

A second Boom Operator assigned to the flight to perform aircraft loading and offloading duties, will report for the passenger/cargo compartment, Cabin ready for takeoff. Verify with personnel occupying extra crewmember seating that oxygen regulators are ON and 100%. If PA system is inoperative, cabin interphone will be monitored to provide cockpit/cabin liaison. Cabin report maybe given by either boom opertor.

NOTE

Ensure all extra crewmembers and passengers are ready for takeoff before giving report.

4. Radios . . . . MONITOR

Monitor clearance and takeoff instructions, if occupying cockpit position.

AFTER TAKEOFF - CLIMB

1. Departure . . . . MONITOR

   In addition to instructions contained in Section V, the boom operator will act as safety observer.

†2. PASSENGER/CARGO
   Compartment . . . . CHECK (IF REQ'D)

   Check passenger and/or cargo compartment for general condition. This check not required if passengers and/or cargo not being transported.

3. Passenger
   Briefing . . . . . . COMPLETE (IF REQ'D) (FE, BO)

   Flight engineer will advise boom operator when passing 10,000 feet MSL. Boom operator will complete the following briefing after passing 10,000 feet MSL and the seat belt signed has been turned off.

AFTER TAKEOFF-CLIMB BRIEFING

May I have your attention. The seat belt sign has been turned off, you are free to move about the cabin. However, throughout the flight, keep your seat belt fastened while seated. At this time you are allowed to use approved portable electronic devices.

Self-serve coffee is available at the galley, please no more than three people at the galley at one time.

Restrooms are located (**INDICATE LOCATIONS**). Please help us keep the restrooms clean.

The bunks in the rear of the cabin are reserved for crewmember use only.

Customer quality survey cards are located in the seat back in front of you. We would appreciate your comments. THANK YOU.

CRUISE

†1. CARGO/CARGO Area .... CHECK (IF REQ'D)

Conduct periodic checks of cargo and cargo area any time hazardous materials, vented equipment, and fueled vehicles are transported. Observe for leakage and spillage. Attempt to contain the leakage/spillage with the hazardous materials protective kit.

A check of cargo should be conducted if turbulence is such that it may compromise the security of the cargo.

The environmental curtain must be properly installed, except, when crew movement into and out of the cargo area is necessary.

†2. Passengers .... SUPERVISE

The maximum assistance/supervision will be provided by the boom operator(s) assigned to perform cargo/passenger handling duties and/or by a qualified crewmember to assure the comfort and safety of the passenger(s).

Passenger(s) are not authorized aft of the cargo barrier net or environmental curtain unless sufficient oxygen capability, seating and supervision exists.

Passengers may move about the cabin once the seat belt light is turned off. However, for their safety, it is recommended seat belts be kept fastened when seated.

During aerial refueling operations, seat belts will be fastened.

Inflight meals and beverages must not be distributed anytime the seat belt sign is illuminated.

If possible, schedule meal distribution during normal eating time. Check meal receipt that was issued with boarding pass and inform passenger(s) to remain seated until everyone is served.

NOTE

Announcements will be made keeping passengers informed about personnel advisory signs, air refueling, meal distribution, turbulence, descent, etc.

3. Passenger Briefing .... COMPLETE (IF REQ'D)

MEAL BRIEFING

May I have your attention please. In approximately ________ minutes, we will begin meal service. If you ordered a meal, please have your boarding pass ready for review. THANK YOU.

DESCENT/BEFORE LANDING PREPARATION

†1. Parking CG . . . . COMPUTE (IF REQ'D)

Not required if passengers and/or cargo are not carried. Compute the aircraft CG to include landing fuel and passenger/cargo offloading requirements. Coordinate with the FE, fuel transfer requirements to ensure the aircraft CG remains within limits during the offloading operations.

WARNING

For loading/offloading operations do not allow the aircraft CG to exceed station 1430 (40%) MAC.

†2. Landing Notification . . . . COMPLETE

a. Provide pilot with following information so coordination with the receiving/shipping agency can be accomplished.

Provide cargo/passenger downloading data to include any special handling requirements.

Provide customs, agriculture, immigration and public health requirements if applicable. Verify applicable requirements are completed prior to landing.

Provide any other special service information to meet inbound/outbound requirements.

b. Flight engineer will advise boom operator when passing 10,000 feet MSL. Boom operator will complete the following checklist.

DESCENT BRIEFING

May I have your attention please. We have started our descent for landing at ________. The temperature is ____ degrees and the weather is ________ (clear, raining, etc.). Local time is ________. At this time all portable electronic devices must be turned off. As the cabin pressurization changes, some of you may have difficulty clearing your ears, please let me know if this occurs.

We will be coming around with a trash bag to collect refuse before landing. Please assist us by placing all trash that is in your area in the bag as we pass by. THANK YOU.

†3. Cargo & Loose Equipment . . . . CHECK

Verify cargo and loose equipment are properly secured.

Verify cargo barrier net and/or environmental curtain are properly installed (if required).

4. Penetration and Approach(s) . . . MONITOR

In addition to instructions contained in Section V, the boom operator will act as safety observer.

a. When established on final approach complete the following checklist:

APPROACH BRIEFING

May I have your attention please. We have started our final approach. Please ensure your seat belts are securely fastened, tray tables stowed and all hand carried items are stowed under the seat in front of you. We will be landing shortly. THANK YOU.

AFTER LANDING/PARKING

1. Oxygen Regulator OFF/100%

†2. Passenger Briefing . . . . COMPLETE (IF REQ'D)

AFTER LANDING BRIEFING

May I have your attention please. Please remain seated until the aircraft comes to a complete stop and the seat belt sign has been turned off. You will be advised when it is safe to deplane. THANK YOU.

3. ARO Station . . . . ALL SWITCHES OFF

Verify WINDOW HEAT and UNDERBODY light selectors are off.

Observe the FLT CONT MAINT REQ'D light is off.

NOTE

If FLT CONT MAINT REQ'D light is on, enter discrepancy in AFTO Form 781.

Move the A/R MASTER PWR switch to OFF.

4. Cabin Doors . . . . DISARM/OPEN (AS REQ'D)

NOTE

Cabin doors may by selectively disarmed after landing as long as sufficient armed doors are available for emergency egress if stand is unavailable. Number 2 L and R doors may or may not have slide/rafts installed as established by passenger requirements.

Move slide arming lever to SLIDE DISARMED and observe DOOR DISARM light is on.

NOTE

The lever may be latched in SLIDE DISARMED by moving the sliding mechanical safety latch into the latch position. This will latch the slide arming lever in SLIDE DISARMED.

Move DOOR CONTROL switch to OPEN and hold until door is full open. Release the DOOR CONTROL switch.

If stand is unavailable the Crew/Entry Exit Ladder may be installed.

†5. Cargo/Passenger . . . . OFFLOAD

Offload cargo/passengers as outlined in TO 1C-10(K)A-9.

†6. Electrical/Air Conditioning . . . . SHUTDOWN (IF REQ'D)

When FE or qualified ground support personnel are not available, complete the following procedures:

NOTE

- If external power is not available, close cabin doors prior to APU shutdown.
- If external power is available, close cabin door when leaving aircraft.

A. APU

(1) EMER LT Switch . . . . OFF

Move EMER LT switch to OFF, and observe DISARMED light is on.

(2) TRIM AIR Switch . . . . OFF

(3) PACK Function Selectors . . . . OFF

(4) APU/ISOL VALVE Switch . . . . CLOSE

Move APU/ISOL VALVE switch to CLOSE and observe pneumatic PRESS gage indication decreasing.

(5) APU FUEL PUMP Switch . . . . ON

(6) #2 R AFT FUEL PUMP Switch . . . . OFF

(7) APU GEN BUS Switches . . . . OFF

Observe APU PWR IN USE lights go off.

(8) APU MASTER Switch .... OFF

NOTE

- To ensure proper cooling, APU will continue running for 90 seconds after APU/ISOL VALVE has been moved to CLOSE.
- After a 90 second delay, observe APU PERCENT RPM and APU EXH TEMP gages show a decrease.

(9) APU FUEL Pump .... OFF

Move the fuel pump switch to OFF.

(10) BAT Switch .... OFF

Rotate BAT switch to unlock (vertical) position, pull out, and move switch to OFF.

NOTE

Prior to moving BAT switch to OFF, check APU DOOR OPEN LT is OFF.

B. EXTERNAL POWER

(1) EMER LT Switch .... OFF

(2) BAT Switch .... OFF

Rotate the battery switch to unlock (vertical) position, pull out and move the switch to the OFF position.

(3) EXT PWR Switch (FE Panel) .... OFF

(4) Ground Service EXT PWR Switch (EXT PWR Panel) .... OFF

Verify the EXT PWR NOT IN USE light illuminates.

†7. Cabin Doors ...... CLOSE (IF APPLICABLE)

Move DOOR CONTROL switch to CLOSE until door is fully closed. Observe door closes and moves outward. Release DOOR CONTROL switch.

NOTE

Electrical power is required to fully close cabin doors.

AIR REFUELING PROCEDURES

TANKER/RECEIVER RENDEZVOUS

1. Rendezvous Equipment ..... "SET" (PF,PNF)

RECEIVER

At least 30 minutes prior to ARCT/RZ, turn on RADAR XPONDER, set the ADF RMI for UHF DF, and set A/A TACAN NLT 15 minutes prior to ARCT/RZ.

Rotate WX Radar function selector to BCN, adjust ANT TILT knob as required to obtain tanker rendezvous beacon. For positive identification, cross check the A/A TACAN DME and bearing (if applicable) with the range and relative position of the tanker's rendezvous beacon.

TANKER

If receivers have beacon reception capability and when no less than 30 minutes from ARCT/RZ, verify the radar transponder J BAND or I BAND ENCODE selector is as scheduled and rotate the appropriate POWER selector to OPR. Set the ADF RMI for UHF DF, set A/A TACAN (no later than 15 minutes prior), RADAR function switch as required.

Comparing the beacon distance of the receiver to the A/A TACAN DME/TCAS range is an effective method of establishing positive identification.

2. High Intensity Lights .... ON (FE)
3. Anti-Ice .... "AS REQ'D" (CP,FE)
4. Altimeters .... "SET" (PF,PNF)

Verify altimeters are set to 29.92 or as briefed/reported.

NOTE

An altimeter setting of 29.92 HG will be used for air refueling operations at or above transition altitude or when over water and operating in accordance with ATP-56B and ICAO procedures. For all other air refueling operations, the briefed/reported altimeter setting will be used.

5. Radios/Interphone ...... "SET" (PF,PNF,FE)

When no less than 30 minutes from the ARCT/RZ, pilots monitor UHF and flight engineers monitor HF backup air refueling frequency.

NOTE

UHF Guard shall be monitored at all times unless this presents a hazard to safe operation. When both UHF radios are operating properly, Guard channel will be turned off on the radio used for air refueling. When only one UHF radio is available, UHF Guard should be monitored on the radio being used for air refueling unless this presents a hazard to safe operations.

At least one UHF radio will be set to the designated refueling frequency. All primary crewmembers will monitor the air refueling frequency. During air refueling, this radio should be selected on the audio panel.

When refueling from a tanker that has boom interphone system, ensure AR Recp Audio SW is placed in NORM. Boom interphone capability is provided on all KC-10 and KC-135 Tankers.

Fifteen minutes prior to the ARCT/RZ, the receiver will contact the tanker and will relay the following:

a. Receiver's call sign.
b. Receiver's altitude (ALT STG if applicable).
c. Receiver's timing ("on time; minutes early; minutes late").

If the receiver(s) are not at the correct rendezvous altitude at 15 minutes prior to the ARCT/RZ, they will be required to make an additional radio call when established at the correct rendezvous altitude.

Tanker will relay the following:

a. Tanker's call sign.
b. Air refueling altitude (ALT STG if applicable).
c. Tanker's timing ("on time; minutes early; minutes late").

6. CG . . . . CHECK (FE)

   Check and verify the aircraft CG in preparation for fuel onload.

7. UARRSI hydraulic system manual shutoff valve . . . "OPEN" AS REQ'D (BO,FE)

8. Rendezvous Checklist . . . . "COMPLETED" (FE)

KC-10 Receiver Only

No later than the ARIP begin descent, if necessary, to an altitude 1000 ft below assigned air refueling altitude using approximately 2500-FPM rate of descent. Establish Mach 0.87 or 325 KIAS, whichever is lower, and maintain this speed through level off to a point 2 NM from the tanker.

WARNING

In the event weather conditions may affect the accomplishment of the rendezvous, a capable receiver will be specifically designated to maintain radar weather watch and will have the primary responsibility of ensuring that all aircraft in the formation are directed (within capabilities) clear of hazardous weather.

NOTE

- If tanker or receiver uses an increased air refueling schedule, increase entire speed schedule by the same amount.
- During deceleration, it is imperative that the speed schedule be maintained.
- If rendezvous position is more than 4 NM in trail, the airspeed may be increased for closure. When 3 NM in trail, the normal airspeed schedule will be resumed.
- Rendezvous closure will not be continued inside 1 NM range (2 NM for receiver or tanker formation), unless visual contact is established with the tanker(s). Air refueling will not be conducted when flight visibility is deemed insufficient for safe air refueling operation.

At 2 NM, maintain Mach 0.87 or 325 KIAS, whichever is lower. At 1 NM, maintain Mach 0.85 or 305 KIAS, whichever is lower. If in visual contact, start a gradual climb to pre-contact with a minimum 500 foot separation at 1/2 mile.

NOTE

- Rendezvous altitude will be maintained until it is ascertained overrunning will not occur.
- In the case of rendezvous overrun, the receiver will reduce airspeed to no less than 0/RET minimum maneuvering airspeed and maintain track and altitude. The tanker will increase airspeed to 335 KCAS, maintain altitude, adjust track as required, and overtake the receiver. After overtaking the receiver, the tanker will reduce airspeed to 290 KCAS (or refueling airspeed) for final receiver closure.
- During deceleration, pilot not flying shall call out range.
- If the receiver loses sight of the tanker at any time after overrunning, the receiver shall establish a positive rate of descent to 1000 feet below air refueling altitude until the receiver is definitely positioned aft of the tanker and has the tanker in visual contact From this point normal closure procedures shall be used.

At 1/2 NM, maintain Mach 0.84 or 300 KIAS, whichever is lower (or briefed refueling speed plus 10 knots). If in visual contact with the tanker continue climb to contact position.

TANKER/RECEIVER PREPARATION FOR CONTACT

1. SEAT BELTS Switch .... ON (FE)

   FE inform passengers - We are about to begin air refueling operations. Fasten seat belts.

2. IFF/ETCAS .... AS REQ'D (PNF,FE)

   As a receiver turn IFF/ETCAS to STBY when within 3 NM of the tanker and when visual contact can be maintained with the tanker, but no later than 1/2 NM. As a tanker, turn IFF/ETCAS to TA only as the receiver closes within 3 miles.

3. Navigation/Formation/High Intensity Lights .... DIM/AS REQ'D/OFF (FE)

   Formation lights should be on at night with fighters on the wing.

4. BEACON LT Selectors .. AS REQ'D (FE)

   During receiver AR the beacon lights should be LOWER/RED. Normally during tanker AR, the beacon lights will be set to UPPER/RED. If any aircraft will be flying visual wing formation, turn beacon lights OFF. In this case the last (outside) aircraft will have anti-collision lights on.

5. (**WITH TCTO 1C-10(K)A-1243**) Radios/Interphone /Iridium Phone ..... "SET" (PF,PNF,FE,BO)

NOTE

UHF Guard shall be monitored at all times unless this presents a hazard to safe operation. When both UHF radios are operating properly, Guard channel will be turned off on the radio used for air refueling. When only one UHF radio is available, UHF Guard should be monitored on the radio being used for air refueling unless this presents a hazard to safe operations.

Tanker radio settings:

a. HF Radios .... SILENT MODE (FE)

b. UHF Radios ...AS REQUIRED (PF,PNF)

Tanker (**WITH TCTO 1C-10(K)A-1243**) and Receiver:

c. Iridium Phone Power ON/OFF Button .... AS REQUIRED (FE,BO)

d. Service Interphone ...... AS REQUIRED (PF,PNF,FE)

6. Thrust Computer .... "MCT" (PNF)

NOTE

Go to the appropriate steps as follows:

A	RECEIVER (PF, PNF, FE)
B	TANKER (PF, PNF, FE)

A PREPARATION FOR CONTACT - RECEIVER - (PF, PNF, FE)

7. Radar Transponder .... OFF (FE)

8. Fuel Panel/Quantity .. SET/CHECKED (FE)

NOTE

When conducting dry contacts with aircraft gross weight of 556,000 lbs or greater or when zero fuel weight is above 414,000 lbs, one transfer pump may be used to maintain wing tanks full. Coordinate with tanker to ensure the boom valve is closed prior to initiating this procedure.

a. ALTN TRANS/X-FEED Valves ....CLOSE

b. TRANS Pumps .... OFF

NOTE

When required by structural limitations one transfer pump may be used to maintain wing tanks full. Coordinate with tanker to ensure that boom valve is closed prior to initiating this procedure.

c. AR MASTER Switch .... ON

d. Tanks ....SELECT

Position applicable main tank FILL VALVES and body tank ISOL/FILL VALVES as required to receive fuel.

NOTE

- When gross weight is scheduled to exceed 556,000 pounds or zero fuel weight plus weight of fuel in FWD, CTR WG and AFT body tanks is scheduled to exceed 414,000 pounds, main tank fill valves will remain open to maintain normal fuel management procedures as required by the flight manual.
- If any tank is to be filled to near maximum capacity, perform a high level float test after fuel onload is started.

9. AR Receptacle Door . . . . OPEN (FE)

10. AR RECP/AR RECP FLOOD/WING LIGHTS/EXT LT UPR FSLG/UARRSI LGTS* . . . . AS REQ'D (FE)

Set lights full bright. At night, approaching precontact, lights should be dimmed. Further adjustment will be made at the boom operator's request

11. Flight Director Switches . . . . . "OFF" (PNF)

12. Radar . . . . "AS REQ'D" (PNF)

When radar is no longer needed for the rendezvous, place in STBY (ensure radar is in STBY upon reaching 1/2 NM).

WARNING

Do not select WX, MAP 1, MAP 2, OR BCN while in close proximity to the tanker aircraft. Do not operate radar during receiver air refueling.

13. Auto Pilot/Auto Throttles . . . . "AS REQ'D/OFF" (PF)

14. TACAN . . . . "AS REQ'D" (PNF)

WARNING

Turn TACAN to REC or T/R when no longer needed for A/A, to prevent interference with other aircraft that may be rendezvousing in the same A/R track or area at a different altitude or minimum time interval.

15. Ready Light . . . . "ON" (PF,PNF)

WARNING

If both AT/SC circuit breakers are opened, the ATS disconnect buttons on the throttles are inop for A/R disconnect

NOTE

If one or both Autothrottle/Speed Control systems are malfunctioning and the "Ready" light will not stay on, open associated AT/SC circuit breaker. System may be regained.

16. Preparation for Contact Checklist . . . . "COMPLETED" (FE)

B PREPARATION FOR CONTACT - TANKER - (PF, PNF, FE)

7. Hyd Pumps/Motor Pumps . . . . . . SET (FE)
   a. ENG HYD PUMP L Switches . . . . ON
   b. ENG HYD PUMP R Switches . . . . . . AUTO
   c. AUX PUMP 1 and 2 . . . . OFF
   d. Motor Pumps . . . . .ARM

   For boom or drogue refueling, when BOOM/DROGUE HYD PRSRZ light comes on, move the 2-3 PUMP switch to ON.

NOTE

- If the 1-3 and 2-3 PUMP VALVE OPEN light does not come on, or flickers continuously, verify pump operation by following the "2-3 Pump Valve Verification" procedures outlined in the Abnormal Section of this manual. Do not attempt to refuel unless it can be verified that the 2-3 PUMP operates satisfactorily or a fuel emergency exists.
- If any HYD PRESS gage indication fluctuates between 3000 and 2400 at regular intervals, move the ENG HYD PUMP R switch to ON.
- If any HYD PRESS gage indication drops below 2400, move ENG HYD PUMP R switch to ON, start AUX PUMPS and move the 1-3 PUMP switch to ON.

NOTE

If the HYD PRESS gage continues to indicate below 2400 or an abnormal temperature increase occurs, turn off the AR PUMPS that are powered by that system.

8. Fuel Panel .... SET (FE)

BOOM REFUELING

a. AR pumps (as applicable) .... ARM (FE)

NOTE

- When operating in AR PUMP OVRD, AR pumps should be turned on after BOOM valve is OPEN and BOOM/ DROGUE ENGAGED light is on.
- When operating transfer pumps for AR offload, pumps should be turned on after ALT TRANS VALVE(S) and BOOM valve are open and BOOM/DROGUE ENGAGED light is on.

b. BOOM VALVE .... AS REQ'D (FE)

CENTERLINE DROGUE REFUELING

a. AR PUMP OVRD Switch ... OVRD (FE)

b. AR PUMPS (as applicable) ..... ON (FE)

c. DROGUE VALVE .... ARM (FE)

NOTE

The drogue and hose bleed valves are interlocked through the fuel range position switch. The drogue valve may be prearmed prior to contact, however, it will not open until the hose is pushed in approximately 5 feet from full trail position. During disconnect the drogue valve will close and the hose bleed valve will open when the hose is extended to the trail position.

WING POD DROGUE REFUELING (ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956)

a. ALT TRANS/ISOL Valves (FOR TANK SYS TO BE USED) ....OPEN (FE)

NOTE

If both pods are to be used, open both fwd and aft tank systems.

b. AR PUMP OVRD Switch ... OVRD (FE)

c. AR PUMPS (as applicable) ..... ON (FE)

NOTE

- Transfer/engine feed pumps may be used as an alternate supply of fuel to the wing pods if appropriate considering the fuel type separation.
- Center wing AR pumps can be used for refueling through the wing pods, however the additional pressure could cause pump shutdown.

d. WING DROGUE VALVE (As Applicable) ....OPEN (FE)

NOTE

Under normal conditions, when using the air refueling pumps for wing pod refueling, do not open the engine crossfeed valves.

e. POD "FUEL INLET PRESSURE LOW" Light .... VERIFY OFF (FE)

f. POD FUEL VALVE .... ARM (FE)

NOTE

- Valve will not open until contact has been made and receiver has pushed the hose in approximately 5 feet.
- If pod "FUEL INLET PRESSURE LOW" light comes on during refueling, activate additional pump(s).

9. Radar . . . . "AS REQ'D" (PNF)

If no longer needed for rendezvous, station keeping, etc., set radar for weather watch.

10. TACAN . . . . "AS REQ'D" (PNF)

When no longer needed for A/A, turn TACAN to REC or T/R to prevent interference with other aircraft that may be rendezvousing in the same A/R track or area at a different altitude or minimum time interval.

11. Autopilot Nav Modes . . . "DISABLED" (PF,PNF)

WARNING

Do not use navigation modes of the autopilot during air refueling.

12. Auto throttles . . . . "AS REQ'D" (PF,PNF)

13. Preparation for Contact
Checklist . . . . "COMPLETED" (FE)

TANKER/RECEIVER POST AIR REFUELING

When air refueling operations are terminated, the receiver will decelerate and descend to clear the tanker. The following steps are accomplished at termination.

1. BEACON LT
   Selectors . . . . BOTH/AS REQ'D (FE)

   Set beacon colors as required.

2. Navigation/Formation/High Intensity
   Lights . . . . AS REQ'D (FE)
3. Thrust Computer . . . . . "AS REQ'D" (PNF)
4. IFF/TCAS . . . . "AS REQ'D" (PNF,FE)

   Select TA Only for formation flight or TA/RA Mode for single aircraft flights.

5. Radar . . . . "AS REQ'D" (PNF)
6. Flight Director
   Switches . . . . ON/AS REQ'D (PNF)
7. Altimeters . . . . "SET" (PF,PNF)
8. Rendezvous Beacon . . . "AS REQ'D" (PF)
9. Post Air Refueling
   Report . . . . "COMPLETED" (PF)

   Upon completion of air refueling, give the following information as soon as possible, if not previously accomplished.

   a. Fuel transferred (if other than scheduled/briefed).
   b. ARTCC frequency, mode 3 setting and instructions.
   c. Position at end of refueling, if requested.
   d. Additional information as requested or required.

10. (**WITH TCTO 1C-10(K)A-1243**) Radios/
    Interphone/Iridium
    Phone . . . . "SET" (PF,PNF,FE,BO)

    Set VHF, UHF and HF radios as required. If boom interphone was needed, place AR Recp Audio SW to OFF. Press Iridium Phone Power ON/OFF button.

11. Hydraulic System . . . . SET (FE)

    Set Hyd Pumps/Motor Pumps/Aux Pumps as required.

12. Fuel Panel/CG/MANF
    SCAV . . . SET/CHECKED/COMPLETE (FE)

AS A RECEIVER:

Rotate the MANF SCAV selector to RCVR

NOTE

When MANF SCAV PRESS LOW light comes on steady, rotate the MANF SCAV selector to OFF. No more than 10 minutes will be required.

Establish normal fuel management procedures.

NOTE

If JP-7 or other type of fuel requiring isolation was onloaded, place MASTER ISOL switch, AR ISOL valve and the FWD, CTR WING and AFT TANK ISOL VALVES as applicable to ISOL.

AS A TANKER:

a. AR/ISOL VALVES closed. Push the BOOM/DROGUE VALVE switch and observe the fuel flow indicator and OPEN lights are off.
b. Initiate manifold scavenge operation.
c. If boom or drogue refueling was used, rotate MANF SCAV selector to TANKER.

d. When MANF SCAV PRESS LOW light comes on steady, rotate the selector to OFF. No more than 10 minutes should be required.

NOTE

- The light may flicker. This does not necessarily represent a malfunction.
- On aircraft modified by TCTO 1C-10(K)A-956, if wing pod drogue refueling system was used, coordinate with the boom operator after the fuel panel is set, to allow boom operator to shut down the system.

Establish normal fuel management procedures.

NOTE

Normal fuel transfer (if required) may be started while manifold is being scavenged since different fuel lines are used during transfer.

13. AR Receptacle Door . . . . CLOSED/AS REQ’D (FE)
14. UARRSI Hydraulic System Manual Shutoff Valve . . . . "CLOSED"AS REQ’D (BO,FE)
15. AR RECP/AR RECP FLOOD/WING LIGHTS/EXT LT UPR FSLG/UARRSI LGTS* . . . . OFF/AS REQ’D (FE)
16. SEAT BELTS Switch . . . . AUTO (FE)
17. Post Air Refueling Checklist . . . . "COMPLETE" (FE)

AS A TANKER

If the boom operator reports HOSE WILL NOT REWIND, an airspeed reduction of 80 knots or more may effect hose rewind and drogue stowage using the Reel Response feature of the hose/drogue system. Initiate the Abnormal Procedure IAW Section V.

WARNING

Do not allow the aircraft to decelerate below 1.2G buffet speed as corrected in accordance with TO 1C-10(K)A-1-1.

REVERSE FLOW AIR REFUELING PROCEDURES

Use normal receiver procedures to rendezvous and hook up with aircraft designated to receive fuel.

1. Fuel Pumps . . . . AS REQUIRED (FE)

CAUTION

The Maximum allowable reverse refueling rate from Receiver to tanker is 300 GPM (approximately 2000 PPM). High rates may produce unacceptable surge pressures if a tension disconnect should occur.

2. Fuel Isolation Valves . . . . AS REQUIRED (FE)
3. AR Receiver Valve Master Sw . . . . OPEN (FE)

NOTE

BOOM OPERATOR go to appropriate Tanker Preparation for Contact steps as follows:

A	**(BOOM)**
B	**(Centerline Drogue)**
C	**(Wing POD Drogue)**

A PREPARATION FOR CONTACT - TANKER - (BOOM)

Prior to receiver(s) reaching 1 NM in trail, complete preparation for contact checklist up to establishing radio contact. When using buddy refueling procedures, complete checklist a minimum of 5 minutes before ARCT.

1. Oxygen Regulator (ARO Station).... ON/100%
2. Command Radio................. MONITOR

   Normally, the UHF radios will be used for refueling. With MIC switch in hot mic, boom operators have hot microphones between the selected positions of the ARO station.

3. Sighting Door........................ OPEN

   Move the sighting door switch to open and hold until door is full open. If the door fails to open, open door manually by turning crank in the direction indicated. A thump can be heard as the door is latched in the full open position and the forces required to turn the handle will decrease slightly.

CAUTION

Do not continue to operate the crank after the sighting door is open.

4. Boom Coil........................... TEST

   If boom coil test needle indicates OPEN or SHORT, refer to appropriate Abnormal Procedures Checklist.

NOTE

- With OPEN or SHORT in boom coil, normal signal system cannot be used. Tanker cannot initiate a disconnect except through the independent disconnect system. Interphone communication with receiver will not be possible.
- Pushing the BOOM COIL TEST button when in contact mode will advance the receivers A/R signal system to disconnect.

5. HYD SEL........................... BOOM
6. Side Viewing Doors .... AS DESIRED

   Move side viewing doors to open if desired.

7. STICK FORCE.......................... SET

   Adjust STICK FORCE ROLL and ELEVATION to desired level.

8. AR SIG SYS OVRD Switch........... NORM

   Verify the AR SIG SYS OVRD NORM light is on.

NOTE

Air refueling signal system should be in NORM except when mission requirements and system performance dictate use of override.

9. BOOM ENV Limits................ ACTIVE
10. TLSCP-AT-DISC Switch ..... AS REQUIRED

    Verify the TLSCP-AT-DISC switchlight displays AUTO/MAN.

NOTE

Verify the TLSCP-AT-DISC switch indicates MAN when: C-130, fighters or F-111s are being refueled; the tanker is operating without normal disconnect capability; or the receiver is using manual boom latching (MBL). For all other receivers and conditions, it will indicate AUTO.

11. ALAS Switch .... ENABLE

    Verify the ALAS (automatic load alleviation system) switch displays ENABLE, and observe ROLL ALAS INOP and ELEVATION ALAS INOP lights are off.

CAUTION

The flight control stick shall be guarded to insure boom structural limits are not exceeded when the ENABLE mode is selected, while the boom is in trail and the flight control system is in the COUPLED Mode.

12. FLT CONT Switch. . . . . ON

Observe the FREE FLIGHT light comes ON and the RUD FAIL, TLSCP FAIL, ELEV FAIL, and system CAUTION lights are OFF.

NOTE

- The L&R RUD FAIL and ELEV FAIL lights with aural warning will come on when the FLT CONT switch is moved to ON if the HYD SEL is in OFF or DROGUE. To return system to normal, move HYD SEL to BOOM and cycle FLT CONT switch from ON to OFF and back ON.
- If any FAIL or system CAUTION light is still on, refer to appropriate abnormal checklist.

13. INDEP DISC. . . . . CHECK

Observe INDEP DISC gage indicates in the green band.

NOTE

If indication is out of green band, the system may function but should not be depended upon to provide a disconnect

14. RCVR DISC DELAY and Limits . . . . SET

Set RCVR DISC delay and envelope limits as listed in Section VII.

NOTE

- Delay settings from 0.25 to 2 seconds may be selected. The type of receiver dictates the setting required.
- When refueling multiple types of receivers, reset disconnect delay and limits prior to refueling each type.

15. FUEL OFFLOAD Gage. . . . . ZERO

NOTE

- If gage does not indicate zero, rotate RESET knob clockwise and observe counters decrease to zero.
- During reset on some indicators, the counter will advance approximately 2000 pounds before decreasing to zero. Reset may require up to 30 seconds to complete operation.

16. AR EXT LIGHTS. . . . . AS REQUIRED

Set the PILOT DIRECTOR LIGHTS to full bright for day and dim or as requested by receiver pilot for night.

Accomplish the following for night AR only:

a. Set all UNDERBODY lights to full bright.
b. Move BOOM MARKING light switch to on.
c. Set BOOM NOZZLE lights selector to desired setting.
d. Set RCVR FLOOD light to desired setting.

As the receivers approach the precontact or observation position, dim the UNDERBODY lights or set as requested by the receiver pilot.

NOTE

The BOOM NOZZLE LT also has a foot switch that will cause the light to come on full bright when pushed, provided the selector is not in the OFF position.

17. BOOM ELEVATION POSN Switch. . . . STOW

18. BOOM AUDIO
Switch . . . . AS REQUIRED (PF,BO)

When refueling a receiver that is boom interphone capable, move BOOM AUDIO switch to COMMON or PRIVATE. Notify pilot of setting. When refueling a receiver that is not boom interphone capable, verify BOOM AUDIO switch is in OFF.

19. Boom . . . . LOWER (PF,BO)

a. Notify pilot before lowering boom.
b. Move the BOOM HOIST lever to RAISE.
c. Move the BOOM LATCH lever to UNLOCK.
d. Move the BOOM HOIST lever to LWR; guard flight control stick to prevent uncommanded control inputs while boom is being lowered.

CAUTION

- Do not apply DOWN command to flight control stick with hoist lever in LOWER. Excessive force loads generated by control surface movement may cause hoist cable failure.

- Do not cycle HYD SEL from BOOM to OFF when boom is deployed and BOOM HOIST Lever is in FREE WHEEL. This causes interruption of hydraulic pressure to cable tension motor and could result in damage to boom hoist cable and motor. If HYD SEL is inadvertently placed in OFF position while boom is deployed, do not reposition HYD SEL to BOOM until slack is removed from hoist cable. Remove slack in hoist cable by placing boom hoist lever to RAISE. When hoist cable is taut, HYD SEL may be moved to BOOM and hoist lever returned to HOLD or FREE WHEEL as required.

e. After boom stops its downward movement (approximately 0 degrees), move the BOOM HOIST lever to FREE WHEEL.

f. Move the BOOM ELEVATION POSN switch to REFUEL and observe boom goes to trail position.

NOTE

- The boom may deploy very rapidly from 14 degrees below 0 degrees elevation to the trail position when airspeed is below 200 KIAS.
- The boom will not lower to the trail position unless the BOOM HOIST lever is in FREE WHEEL and BOOM ELEVATION POSN switch is in REFUEL.
- If the boom remains at 0 degree elevation, apply a full down command with the BOOM FLIGHT CONTROL STICK and cycle the FLT CONT switch from ON to OFF and back ON. Repeat procedure until boom descends to 35 degree elevation. With boom at 35 degree elevation cycle FLT CONT switch from ON to OFF to ON. Before attempting contact with receiver verify AR SIG SYS will advance to contact/coupled mode by pushing the CONTACT TEST MODE switch. If AR SIG SYS fails to advance to contact/coupled mode fly boom to a position lower than 35 degrees and repeat procedure.

NOTE

If boom does not trail at 0 degrees roll and 30 degrees elevation, move the BOOM TRIM switch UP, DOWN, LEFT or RIGHT as applicable, to position the boom at 0 degrees roll and 30 degrees elevation.

20. Boom Flight Controls . . . . CHECK

Move and hold the boom telescope control stick to extend until boom extension is 12 feet. Verify the boom can be controlled smoothly through the envelope of 18 to 40 degrees in elevation and 0 to 25 degrees in left and right roll.

CAUTION

Damage to boom telescoping mechanism may occur if RESET TO READY switch is pushed when boom is extending or retracting.

NOTE

- Adjust stick force, as necessary, after the boom flight control check. If multiple air refuelings are scheduled for the mission, only one boom flight control check is required.
- If the boom fails to attain the prescribed positions but all other indications are normal, continue the mission and initiate disconnects as applicable prior to receiver reaching the maximum position attained during the check. Adjustable limits may be RESET to within the position attained during Boom Flight Controls Check.

21. Preparation for Contact
Checklist . . . "CONFIRM Completed" (PF,BO)

22. Radio Check . . . . COMPLETE (AS REQ'D)

Emission Option 2 will be the normal rendezvous and air refueling procedure. Visual signals will be used as much as possible; however, if receiver request or conditions dictate, the boom operator can provide verbal assistance. For Emission Option 1 and 2, the boom operator will make a precontact check and the receiver will acknowledge. Example: Boom operator will say "25,27" and the receiver will reply "25".

NOTE

- Locate receiver(s) as soon as possible and keep pilot informed of their positions. Advise receiver(s) if their rate of closure is excessive or visual contact is about to be lost.
- The precontact radio check may be accomplished anytime the receiver is between 1/2 mile and the precontact position.

23. Receiver Clearance ...... BRIEF (AS REQ'D)

If required, when receiver is stabilized in precontact position, state "(Receiver call sign) cleared to contact".

Monitor receiver's approach to contact.

An Aural Tone Generator provides supplemental aural tone indications over the ARO station headsets when the AR SIG SYS advances to the CONT and DISC conditions.

With the AR SIG SYS in NORM or OVRD mode, one beep is heard for an annunciated CONT condition and three beeps represent an annunciated DISC condition.

If system failure and/or caution lights come on, initiate action as required and refer to appropriate abnormal checklist. Monitor receivers position and boom position instruments.

Observe air refueling system failure and caution lights.

Observe fuel flow and pressure.

CAUTION

Failure of the boom position instrument will not disable the associated boom envelope disconnect limits. However, that portion of the air refueling envelope associated with the failed instrument may be reduced to its smallest adjustable size. Air refueling operations will be discontinued in the event of a boom position instrument failure, except in a case of emergency.

NOTE

- Due to the roll characteristics of the boom, contact should not be attempted beyond 10 degrees roll.
- With the AR SIG SYS in NORM, four beeps will be heard if DISC is selected from a READY condition.
- With the AR SIG SYS in OVRD, three beeps will be heard if DISC is selected from a READY condition.
- If a momentary DC electrical power interruption occurs, the two flight control status lights that are not on will come on and go off, the AR SIG SYS status light that is on will go off and come back on and a small transient will occur in the boom flight control stick. If the power interruption causes the boom control unit to shut down, the two flight control status lights that were not on will illuminate and in addition, all four FAIL lights and aural warning will come on, the AR SIG SYS status lights will go off, and the flight control stick will go limp.
- If a momentary AC electrical power interruption occurs, all boom position instruments will move toward their nonpowered position, both ALAS INOP lights and all four FAIL lights will come on and go off, all annunciator lights, and AR SIG SYS f flight control status lights that are on will go off and come back on, and a small transient will occur in the boom flight control stick. If the power interruption causes the boom control unit to shut down, all boom position instruments will go to their non-powered position, both ALAS INOP lights, all four fail lights and the aural warning will come on, the AR SIG SYS flight control status lights and annunciator lights will go off, and the flight control stick will go limp.
- To reset boom control unit after shutdown due to power interruption, move FLT CONT switch to OFF and cycle AR MASTER PWR switch.
- If fuel flow or pressure indication is zero, advise FE.

B PREPARATION FOR CONTACT - TANKER - (CENTERLINE DROGUE)

Prior to receivers reaching 1 NM in trail, complete preparation for contact checklist up to establishing radio contact.

When using buddy refueling procedures, complete checklist a minimum of 5 minutes before ARCT.

1. Oxygen Regulator (ARO Station) ON/100%
2. Command Radio . . . . MONITOR

   Normally, the UHF radios will be used for refueling. With mic switch in HOT MIC, boom operators have hot microphones between the selected positions of the ARO station.

3. Sighting Door . . . . OPEN

   Move the sighting door switch to open and hold until door is full open. If the door fails to open, open door manually by turning crank in the direction indicated. A thump can be heard as the door is latched in the full open position and the forces required to turn the handle will decrease slightly.

CAUTION

Do not continue to operate the crank after the sighting door is open.

4. Side Viewing Doors . . . . AS DESIRED
5. Drogue MASTER PWR Switch . . . . PWR

   Move Drogue Master PWR Switch to PWR and observe Drogue POSN indicator displays STOW and HYD PRESS LO light comes on.

6. HOSE REEL MONITOR Switch . . . . ON
7. HOSE REEL TEST Switch . . . . MON

   Move HOSE REEL TEST switch momentarily to MON position and observe RESP INOP light comes on for approximately 1 second and then goes off.

NOTE

If RESP INOP light remains on, refer to appropriate abnormal checklist.

8. HYD SEL . . . . DROGUE

   Move HYD SEL to DROGUE and observe HYD PRESS LOW light is off.

NOTE

- If maintenance manual release valve is in GROUND position, the drogue will cycle between STOW and 5 feet extension when the HYD SEL is moved to DROGUE position. Hose deployment and behavior during refueling will be normal after hose switch is moved to TRAIL position.
- If HYD PRESS LOW light is on, refer to appropriate abnormal checklist.

9. Hose . . . . TRAIL (PF,BO)

   a. Notify pilot "Trailing hose."

   b. Move HOSE TRAIL/REWIND switch to TRAIL; observe DROGUE POSN indicator displays a barber pole and that the hose is being released.

   c. As soon as hose can be seen, determine if the paradrogue canopy is inflated and the hose is trailing smoothly during deployment.

NOTE

If paradrogue canopy does not inflate, move HOSE TRAIL/REWIND switch to REWIND, observe the DROGUE POSN indicator displays STOW and abort the drogue refueling mission.

   d. Observe the DROGUE POSN indicator displays TRAIL and the READY light comes on approximately 5 seconds after the hose is in trail.

NOTE

If RESP INOP light comes on, DROGUE POSN indicator does not display TRAIL or the READY light does not come on, refer to appropriate abnormal checklist.

10. HOSE REEL TEST Sw .... SYS

Accomplish a hose response system check prior to the first refueling, and after each hose deployment.

a. After the READY light comes on place the HOSE REEL TEST switch to the SYS position. Observe the drogue READY light goes off, hose rewinds to the forward limit of the refueling range, then redeploys to full range, the drogue READY light comes on approximately 5 seconds after the hose is in full trail and the RESP INOP light remains off.

WARNING

Do not refuel if the Hose Response System fails except in an emergency.

NOTE

- REEL RESP INOP light may flicker while hose is transitioning.
- If RESP INOP light came on, press RESET button to clear. If light remains on, refer to appropriate abnormal checklist.

11. REEL RESP RESET Button .... RESET

If inflight refueling is to be accomplished, reset the reel response system after establishing altitude, attitude, and airspeed for refueling. Observe the READY light goes off when the button is pushed and comes on approximately 5 seconds after the button is released.

NOTE

- If the READY light comes on immediately when the REEL RESP reset button is released, push and hold the button in RESET position for approximately 5 seconds. This will ensure reel response is properly set. RESP INOP light will come on if reel response is improperly set for current flight conditions.
- The hose may rewind partially during tanker deceleration. Push the REEL RESP RESET button and redeploy the hose to trail position before full rewind occurs.

12. FUEL OFFLOAD Gage................ ZERO

NOTE

If gage does not indicate zero, rotate RESET knob clockwise and observe gage decreases to zero.

13. AR EXT LIGHTS............ AS REQUIRED

For day refueling, set DROGUE SIG lights on bright and floodlights OFF. For night refueling, set DROGUE SIG to DIM and floodlights ON. Set UNDERBODY lights to bright to aid in visual sighting. As the receivers reach the observation/precontact position, dim UNDERBODY lights or set lighting as requested by the receiver pilot.

14. Preparation for Contact Checklist..... "CONFIRM COMPLETED" (PF,BO)

15. Radio Check .... COMPLETE (AS REQ'D)

Emission Option 2 will be the normal rendezvous and air refueling procedure. For Emission Option 1 and 2, the boom operator will make a precontact check and the receiver will acknowledge. Example: Boom operator will say "25, 27" and the receiver will reply "25".

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NOTE

- Locate receiver(s) as soon as possible and keep pilot informed of their position. Advise the receivers if their rate of closure is excessive or visual contact is about to be lost.
- The precontact radio check may be accomplished anytime the receiver is between 1/2 mile and the precontact position.

16. RECEIVER Clearance/3 Knot Closure Limitation .... BRIEF (AS REQ'D)

    The boom operator will ensure the receiver flight lead is informed of the 3 knot closure speed limitation. During all missions when EMCON/ COMMUNICATIONS requirements allow, the boom operator will advise the receiver if excessive closure rates are observed. Visual signals will be used as much as possible; however verbal communications necessary for safety of flight situations or to ensure mission success will be used. If required, when receiver is stabilized in precontact position, state "(Receiver call sign), cleared to contact."

17. Normal Contact Events .... MONITOR

    Observe drogue control panel annunciator lights, position indicator and hose reel monitor annunciator.

WARNING

Do not move the HOSE REEL TEST switch to SYS while receiver is connected to drogue.

CAUTION

Air refueling will be terminated when a crimp and/or fuel leak is observed in the hose, except in case of emergency or when dictated by operational necessity.

NOTE

- Accomplish a hose response system check prior to the first refueling, and after each hose deployment.
- Reset REEL RESP prior to each contact and insure READY light comes on prior to clearing the receiver to the contact position.
- If CAUTION lights come on, initiate required action(s) and refer to appropriate abnormal checklist.
- The RESP INOP light may flicker during initial receiver engagement or when receiver moves the hose between aft limit and full trail position (READY light on). This is considered normal.
- Centerline reel response is marginal when the receiver is low in the air refueling envelope.

Clear receiver(s) from pre-contact to contact, as applicable.

Monitor receiver(s) approach to the drogue, contact, and disconnect.

Coordinate receivers contact/disconnect condition with FE, as required.

Observe fuel flow/pressure and amount of fuel transferred.

NOTE

- Advise FE when fuel flow or pressure is zero.
- Power limited receivers may experience difficulty making an effective contact if the hose remains pressurized following normal/inadvertent disconnects. The boom operator will coordinate with flight engineer to depressurize the hose to allow subsequent contacts, if necessary.
- Trapped fuel pressure in hose may prevent receiver contact. If normal hose bleed system is not relieving pressure adequately, the trapped pressure can be relieved by opening the drogue valve and scavenging the AR manifold until the pressure indication is less then 10 psi. REEL RESP RESET button must be held in the RESET position if operation of drogue valve is required while the hose is full trail. Return MANF SCAV selector to OFF after fuel pressure is relieved. Closing the drogue valve prior to the receiver disconnecting can prevent trapped pressure for subsequent contacts.

C PREPARATION FOR CONTACT - TANKER - (WING POD DROGUE)

Prior to receivers reaching 1 NM in trail, complete preparation for contact checklist up to establishing radio contact.

When using buddy refueling procedures, complete checklist a minimum of 5 minutes before ARCT.

1. Oxygen Regulator (ARO Station) ON/100%
2. Command Radio . . . . MONITOR

   Normally, the UHF radios will be used for refueling. With mic switch in HOT MIC, boom operators have hot microphones between the selected positions of the ARO station.

3. Sighting Door . . . . OPEN

   Move the sighting door switch to open and hold until door is full open. If the door fails to open, open door manually by turning crank in the direction indicated. A thump can be heard as the door is latched in the full open position and the forces required to turn the handle will decrease slightly.

CAUTION

Do not continue to operate the crank after the sighting door is open.

4. Slide Viewing Doors . . . . AS DESIRED
5. Fuel Press Available . . . . CONFIRM (BO,FE)

   Confirm with FE that fuel pressure is available to wing pod(s) as applicable.

6. WARP POWER Switch(es) . . . . . ON (BO,FE)
7. ANNUNCIATOR Lights . . . . CHECK (BO,FE)

   Observe FUEL PRESS LOW light(s) are off; HOSE STOWED lights are on and Fuel Offload counters display zero. Verify FE's WING AERIAL REFUEL panel FUEL INLET PRESSURE LOW light(s) are off and FUEL OFFLOAD display(s) indicate zero.

CAUTION

If lights/indications are incorrect, do not deploy the hose on the malfunctioning pod and turn the WARP POWER switch off.

8. Wing Hose(s) . . . . TRAIL (PF,BO)

   Notify pilot "Trailing left or right hose" (as applicable).

   Move WING HOSE switch to TRAIL and after 5-second delay observe:

   HOSE STOWED light goes off, paradrogue canopy inflates, hose deployment is stable and HOSE TRANSIT light flashes until hose movement stops. Observe READY light comes on when hose reaches full trail.

NOTE

- If the hose reaches full trail and the ready light does not illuminate, cycle the WARP POWER switch. If the hose fails to reach full trail and the ready light does not illuminate, increase airspeed (not to exceed 300 KIAS).
- If an abnormal condition is observed, refer to the appropriate abnormal checklist. Discontinue use of the failed system if the condition cannot be corrected.

9. FUEL OFFLOAD COUNTERS . . . . ZERO

NOTE

Failure of the Fuel Control Valve (FCV) RAT blade control or ARINC 429 data bus will be annunciated by a FAIL indication in the fuel offload counter. A blank fuel offload counter display indicates failure of the WARP processor. Refer to appropriate abnormal checklist if either indication appears.

10. AR EXT Lights . . . . AS REQUIRED

    For day refueling, set the DROGUE SIG lights BRT and floodlights OFF. For night refueling, set DROGUE SIG to DIM and floodlights ON. Set UNDERBODY lights to bright to aid in visual sighting. As the receivers approach observation/precontact dim underbody lights and set lighting as requested by the receiver pilot.

NOTE

With the SIG/FLOOD switch in the BRT/OFF position the signal lights are full bright and the floodlight is OFF when the WARP POWER switch is turned ON. Rotating the knob clockwise dims the signal lights and increases the intensity of the floodlight.

11. Preparation for Contact Checklist . . . . . . "CONFIRM COMPLETED" (PF,BO)

12. Radio Check . . . . COMPLETE (AS REQ'D)

Emission Option 2 will be the normal rendezvous and air refueling procedure. However, the boom operator will ensure the receiver flight lead is informed of the maximum 3 knot closure speed limitation. During all missions when EMCON/Communications requirements allow, the boom operator will advise the receiver if excessive closure rates are observed. Visual signals will be used as much as possible; however, if the receiver requests, the boom operator can provide verbal assistance. For Emission Option 1 and 2, the boom operator will make a precontact check and the receiver will acknowledge. Example: Boom operator will say "25, 27" and the receiver will reply "25".

NOTE

- Locate receiver(s) as soon as possible and keep pilot informed of their position. Advise the receivers if their rate of closure is excessive or if visual contact is about to be lost.
- The precontact radio check may be accomplished anytime the receiver is between 1/2 mile and the precontact position.

13. RECEIVER Clearance . . . . BRIEF (AS REQ'D)

If required when receiver is stabilized in precontact position, state "(Receiver call sign), cleared to contact right/left drogue (as applicable)."

14. Normal Contact Events . . . . MONITOR

Observe WARP control panel annunciator lights, fuel offload counters, and receivers position within the envelope.

WARNING

Do not move the hose TRAIL/REWIND switch to REWIND, while the receiver is connected to the drogue.

CAUTION

- Reel response is only effective from approximately 46 ft to full trail. If the receiver pushes the hose inside the inner limit a "Dead Hose" will result. A loop will form that could cause damage to the receiver aircraft.
- If the drogue is contacted off center or stabbed by the receiver it could result in the drogue becoming unstable. If aircraft damage will result from retracting the drogue, initiate hose jettison procedures or land with the drogue in trail as applicable.

NOTE

If caution lights come on, initiate required action and refer to the appropriate abnormal checklist.

Clear receiver(s) from pre-contact to contact, as applicable.

Coordinate receiver's contact/disconnect condition with FE, as required.

NOTE

BOOM OPERATOR go to appropriate Tanker Post Air Refueling steps as follows:

A	**(BOOM)**
B	**(Centerline Drogue)**
C	**(Wing POD Drogue)**

A POST AIR REFUELING (BOOM)

1. Boom . . . . STOW

Move BOOM ELEVATION POSN switch to STOW; observe boom retract (if extended) and move toward stowed position.

After boom stops upward movement (approximately 0 degrees), move BOOM HOIST lever to RAISE. Observe plus 15 degrees on the ELEVATION instrument when the boom is seated in the chock.

Move BOOM LATCH lever to LOCK, then move the BOOM HOIST lever to LWR and observe the ELEVATION instrument for indication of movement.

WARNING

Avoid applying abrupt commands after elevation switch is placed in stow.

NOTE

- While boom is moving toward stowed position, guard controls to prevent boom from rising too rapidly.
- If ELEVATION gage confirms boom is stowed, move the BOOM HOIST lever to HOLD.
- If ELEVATION gage indicates movement, move BOOM LATCH lever to UNLOCK, repeat stowing procedures.
- If it becomes necessary to fly the boom to the stowed position, refer to the BROKEN BOOM HOIST CABLE abnormal procedure.

2. FLT CONT Switch . . . . OFF
3. HYD SEL . . . . OFF
4. BOOM AUDIO Switch . . . . OFF
5. AR EXT LIGHTS . . . . OFF

Set the PILOT DIRECTOR light selectors to OFF.

Accomplish the following for night AR only:

a. Set the UNDERBODY light selectors to OFF.

b. Move BOOM MARKING switch to OFF.

c. Set the BOOM NOZZLE LT selector to OFF.

d. Set the RCVR FLOOD LT to OFF.

NOTE

If additional refuelings will be conducted, the lights may be left on until completion of the last refueling.

6. Side Viewing Doors (If Applicable) . . . CLOSE
7. Sighting Door . . . . CLOSE

Move the sighting door switch to close and hold until door is fully closed. If the door fails to close, close door manually by turning crank in the direction indicated.

CAUTION

Do not continue to operate crank after sighting door is closed.

8. Oxygen Regulator (ARO station) . . . OFF/100%
9. Leaving Position . . NOTIFY PILOT (PF,BO)

Notify pilot, "Boom stowed, leaving position."

B POST AIR REFUELING (CENTERLINE DROGUE)

1. Hose .... STOW

   Move hose control switch to REWIND, observe READY light goes off and barber pole shows in DROGUE POSN indicator and hose is rewinding. Observe DROGUE POSN indicator changes to STOW.

   NOTE

   - If hose does not fully rewind, deploy hose to TRAIL position and repeat REWIND procedures. Reduction in airspeed may be required to stow hose.
   - If HOSE WILL NOT REWIND notify pilot and initiate the Abnormal Procedure IAW, Section IIA.

   NOTE

   If maintenance release valve is in GROUND position, the hose will rewind normally. When DROGUE POS indicator indicates STOW, move HYD SEL to OFF. If hose starts to deploy, move HYD SEL to DROGUE to rewind hose. When STOW indication is observed, move HYD SEL to OFF. Repeat this procedure until drogue remains stowed.

2. HYD SEL............................. OFF

   CAUTION

   If drogue deploys, reposition HYD SEL to DROGUE immediately.

3. HOSE REEL MONITOR Switch......... OFF

4. Drogue MASTER PWR Switch.......... OFF

5. AR EXT Lights......................... OFF

   Set UNDERBODY light selectors to OFF (night AR only).

   Verify DROGUE SIG and FLOOD light selectors are OFF.

   NOTE

   If additional refuelings will be conducted, the lights may be left on until completion of the last refueling.

6. Side Viewing Doors (If Applicable) ... CLOSE

7. Sighting Door .... CLOSE

   Move the sighting door switch to close and hold until door is fully closed. If the door fails to close, close door manually by turning crank in the direction indicated.

   WARNING

   Do not continue to operate crank after sighting door is closed.

8. Oxygen Regulator (ARO Station)... OFF/100%

9. Leaving Position .. NOTIFY PILOT (PF,BO)

   Notify pilot, "Drogue stowed, leaving position."

C POST AIR REFUELING (WING POD DROGUE)

1. Hose(s) . . . . STOW

   Move hose control switch to REWIND.

   Observe READY light goes off and HOSE TRANSIT light flashes until hose is stowed.

   Observe HOSE STOWED light(s) come on steady.

NOTE

If hose does not fully rewind, deploy hose to TRAIL position and repeat REWIND procedures. Reduction in airspeed may be required to stow hose.

2. WARP POWER Switch(es) . . . . OFF (BO,FE)

NOTE

Coordinate with FE that the fuel panel has been set prior to turning WARP POWER switch(es) OFF.

3. AR EXT Lights . . . . OFF

   Set UNDERBODY light selectors to OFF (night AR only).

   Verify DROGUE SIG/FLOOD light selector is BRIGHT/OFF.

NOTE

If additional refuelings will be conducted, the lights may be left on until completion of the last refueling.

4. Side Viewing Doors (If Applicable) . . . CLOSE

5. Sighting Door . . . . CLOSE

   Move the sighting door switch to close and hold until door is fully closed. If the door fails to close, close door manually by turning crank in the direction indicated.

CAUTION

Do not continue to operate crank after sighting door is closed.

6. Oxygen Regulator (ARO Station) . . . OFF/100%

7. Leaving Position . . . NOTIFY PILOT (BO,PF)

   Notify pilot, "Drogue stowed, leaving position."

SECTION V

MISSION PREPARATION

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PART 1

MISSION PREPARATION - CREW DUTIES

CREW DUTIES DESCRIPTION

The purpose of this part is to provide a compact collection of material wherein each crewmember can readily determine his or her duties in relation to the accomplishment of the overall mission. It contains rules and procedures required, by each crew and specific crewmember, for the operation of the KC-10A. Instructions relating to the crew duties in this part do not include information which is already covered in other sections.

CREW COORDINATION

Coordination of actions within a crew is of prime importance to ensure the optimum degree of mission success and safety. Coordination is not necessarily limited to actions alone. Complete familiarity with one’s crew position, the responsibilities thereof, and a working knowledge of the other crewmembers' duties will contribute immeasurably toward crew coordination. Each crewmember must be constantly on the alert and will notify the responsible crewmember of any deviation or discrepancy which will affect successful accomplishment of the mission. Liaison between individuals concerned must be established prior to initiating any action or procedure which will alter aircraft configuration or require correlation of activities between crewmembers. Prior to flight, the pilot must ensure that all crewmembers are thoroughly familiar with all aspects of the assigned mission that pertains to their crew specialty to include:

1. Applicable instruction in the Flight Information Publications.
2. Departure routes, altitudes, obstructions, and traffic procedures.
3. Route of flight.
4. Air refueling information.
5. Cargo and/or passenger information.
6. Normal and emergency communication procedures.
7. Any special instructions or procedures pertaining to the mission.

WARNING

All cockpit crewmembers will monitor all altitudes being flown to ensure there are no deviations from air traffic clearances and sufficient terrain separation is provided. If descent is inadvertently continued below an assigned/published level-off altitude, immediately notify the Pilot of the deviation.

NOTE

- It is imperative that the Pilot, Copilot, and Flight Engineer be thoroughly knowledgeable with the penetration, approach, missed approach, landing patterns, altitudes, and obstructions at both destination and alternate airfields. Available aids such as current FLIP Terminal and approach charts must be studied. A complete set of current approach charts must be available for inflight use by both Pilots and the Flight Engineer. The Flight Engineer, as well as the Pilot not actually flying the aircraft, will closely monitor all departures, penetrations, and approaches. The Pilot flying the aircraft will be notified immediately of any deviation from published procedures or air traffic clearances.
- During any critical phase of flight, especially under night or instrument conditions, the Pilot not flying the aircraft will closely monitor his night instruments and cross-check them against the instruments of the Pilot. If an apparent error in aircraft attitude is detected, the Pilot flying the aircraft will be advised immediately and appropriate action will be initiated.

Positive measures must be taken to ensure that safety of personnel and the aircraft are not jeopardized. The flight attitude of the aircraft must be carefully monitored by either Pilot or Copilot at all times. Verbal coordination between applicable crewmembers is required when:

1. Control of the aircraft is transferred between Pilot and Copilot.
2. A crewmember leaves position or leaves interphone.
3. A crewmember goes off or on oxygen.
4. The pilot intends to perform any critical maneuver, at which time all crewmembers will be secured in their respective positions.
5. If the Autopilot/Autothrottle system is disengaged for any reason.

WARNING

Pilots will not exchange seats during flight if only two Pilots are aboard the aircraft.

All applicable crewmembers will acknowledge that the intended course of actions is understood prior to actual accomplishment and will conduct themselves accordingly. All crewmembers will monitor ATC frequency during the departure, descent, and landing phases of flight. Any discrepancies will be brought to the Pilot's attention. Extreme care must be exercised by the Pilots, when leaving seats, to avoid inadvertent actuation of switches or controls on the flight compartment overhead panel.

Required Crew Advisory Calls

In addition to those contained in the approach section of this TO, the following advisory calls are required. All advisory calls will be acknowledged by the other pilot and the flight engineer.

Climbout

Departing X-altitude for X-altitude (PF)
Transition altitude (PNF)
1000 feet below assigned altitude (PNF)

Descent

Departing X-altitude for X-altitude (PF)
Transition level (PNF)
1000 feet above assigned altitude (PNF)
100 feet above procedure turn altitude (PNF)
100 feet above IAF altitude (PNF)
100 feet above FAF altitude (PNF)

Deviations

Any crewmember noting an apparent error in aircraft altitude, heading, or airspeed, or any condition which may impact safety of flight, will immediately notify the pilot flying the aircraft.

Other Required Advisory Calls

When altitude is changed in the altitude select window, the pilot making the change will state "____ Set and Armed" (e.g. "210 set and armed").

Autopilot OFF/ON (PF)

Autothrottles OFF/ON (PF)

ON/OFF Interphone (any crewmember)

WARNING

- Except for brief periods during non-critical phases of flight, only one (1) pilot at a time will operate the FMS. Pilots will coordinate by having the pilot about to operate the FMS state “I’m on the FMS.” Acknowledgement by the other pilot is required.
- Due to the design of the FMS, any CDU can be used to input navigation data to the flight directors and autopilot. Care must be taken to avoid inadvertent inputs which may result in unintended aircraft maneuvering.

CAUTION

PF will announce to the crew whenever the AP/ATS is disengaged for any reason. This will be acknowledged by the PNF and FE.

If the required calls are not made by the pilots, the FE will ensure they are made. Additionally, the FE will call "100 feet" on the radio altimeter (omitted on Category II ILS if DH is RA 100 or less), then "50 feet", "40 feet", "30 feet", "20 feet" and "10 feet".

RULES TO BE ENFORCED

USE OF INTERPHONE

Except when accomplishing crew duties that preclude interphone use, the Pilot, Copilot, Flight Engineer, and Boom Operator will be on headset and monitor the appropriate radios during critical phases of aircraft operation; i.e., ground start, takeoff, rendezvous, air refueling, approach, and landing.

INTERPHONE PROCEDURES

Effective use of the interphone by each crewmember is essential for good crew coordination. Its use will be held to the minimum required for safe and effective conduct of the mission. When establishing contact, the crew position being called will be identified in the initial call to avoid confusion or the possibility of the call being missed. Unless an immediate call is mandatory, the crewmembers will ensure that other crewmembers are not transmitting or receiving on either the interphone or the command radios.

PILOT

The Pilot is the aircraft commander and is responsible for the aircraft and crew. The successful accomplishment of the mission is of prime importance; however, in no instance will safety be compromised. The Pilot is responsible for the issuance of instructions governing all phases of flight operation. In addition, the Pilot will perform the following:

1. Mission planning
    - a. Coordinate with other crewmembers on exact mission requirements, including items pertinent to individual crew procedures. Supervise the procurement or preparation of all required forms, charts, logs, etc., in accordance with existing directives.
    - b. Attend required briefings.
2. Pre-Takeoff
    - a. Conduct specialized crew briefing. The Pilot and crew will review the mission profile to include any mission changes and forecast weather. The briefing should also include but not be limited to the following items: Special clothing requirements, a review of crash landing and ditching procedures and a discussion of departure and approach procedures, including EGPWS considerations. The Pilot will review normal and emergency takeoff and initial climb considerations with the Copilot and Flight Engineer prior to takeoff.
    - b. The aircraft commander will ensure takeoff data prepared by the Flight Engineer is checked prior to takeoff. In checking data, computations will be based on temperature/assumed temperature and flap setting used by the primary flight engineer. As a minimum, check takeoff N_1 setting, stabilizer setting and V speeds and ensure aircraft performance will be appropriate for takeoff conditions as listed on the Told Card Worksheet. This should be done by calculating CFL and comparing to runway available (or by calculating MAW and comparing to actual TOGW if takeoff is V_{MCG} limited) and calculating climb gradient (if required), i.e., for significant obstacles and comparing to actual aircraft climb gradient.

NOTE

The climb gradient chart in Section XII of the Performance Manual will not be used to compute/verify the climb capability data computed in Section III of the Performance Manual.

    - c. Before each overwater flight, the Pilot will confirm that the required ditching equipment is aboard the aircraft and is stowed in the proper places.

COPILOT

The Copilot will assist the Pilot as directed to accomplish the assigned mission. He must be thoroughly familiar with normal, abnormal, and emergency procedures as they pertain to the aircraft and his duties as Copilot. He will attend all required briefings.

FLIGHT ENGINEER

The Flight Engineer will:

- a. Perform inspections as required and report to the aircraft commander the condition of the aircraft and assist in determining mission capability.
- b. Coordinate aircraft weight and balance with the Boom Operator. Particular emphasis will be directed toward fuel load distribution and limitations, CG movement, and CG computation.
- c. Compute all aircraft performance data for the mission and as requested by the aircraft commander. All performance data will be computed in accordance with TO 1C-10(K)A-1-1.

d. Inflight, operate and monitor the various systems to ensure successful mission accomplishment. Accomplish inflight analysis of systems malfunctions to determine the impact on the mission and to provide maintenance with sufficient documentation for troubleshooting.

e. Monitor the aircraft fuel status and keep the aircraft commander advised. Assist the aircraft commander with mission planning and inflight replanning of fuel requirements.

f. Assist other crewmembers, as required, and be thoroughly familiar with Normal, Abnormal, and Emergency Procedures as they pertain to Flight Engineer duties.

g. Complete forms, logs, etc., in accordance with existing directives.

BOOM OPERATOR

The Boom Operator is responsible for inspection and safe operation of the air refueling and cargo/passenger handling equipment. He will be knowledgeable in cargo/passenger handling procedures and compute weight and balance data. He will assist other crewmembers, as required, and be thoroughly familiar with Normal, Abnormal, and Emergency Procedures as they pertain to his duties.

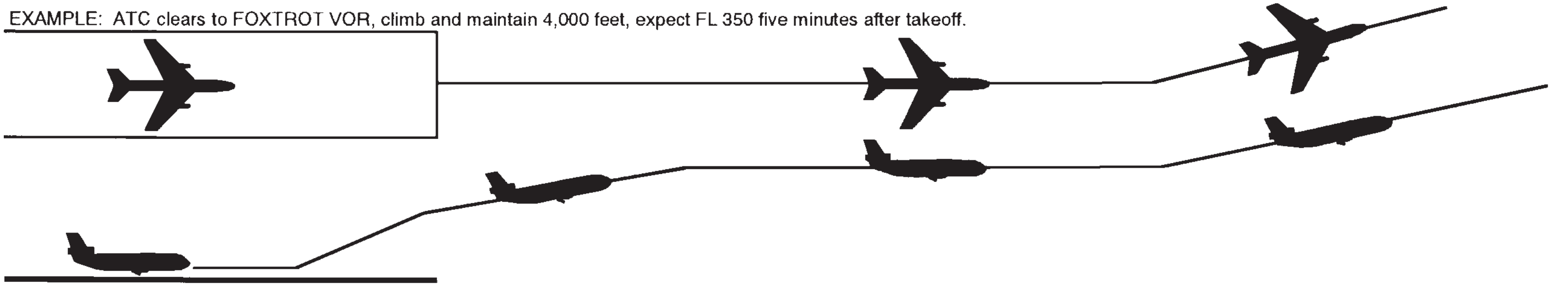
PART 2

MISSION PREPARATION - OPERATING TECHNIQUES

OPERATING TECHNIQUES

This part contains the procedures for operating the aircraft for varying takeoff conditions, enroute climb, and for descent and approach.

Illustrations are provided to show operating techniques used for Takeoff and Climb, figure 5-1, sheets 1 and 2; Altitude Preselect and Advisory, figure 5-2; Turbulence Penetration, figure 5-3; Descent Profile, figure 5-4, sheets 1 and 2; Holding Pattern, figure 5-5; FMS Holding Pattern, figure 5-6; Flight Director Manual ILS Approach, figure 5-7; Go-Around From Flight Director Approach, figure 5-8, CMD CWS During ILS Approach - Autopilot Lever in CMD, figure 5-9, Flight Guidance System Back Course Approach, figure 5-10; and Flight Guidance system GPS approach, figure 5-11.



EXAMPLE: ATC clears to FOXTROT VOR, climb and maintain 4,000 feet, expect FL 350 five minutes after takeoff.

TAKEOFF

CLAMP	ALT	HDG SEL	TAKE OFF

FD Sw .... FD
EHSI Nav Source .... As Desired
FMS or a radio NAVAID may be selected depending upon the initial departure fix.
CRS Readout .... SET
Set course readout as desired for initial departure.
SPD Readout .... SET
Set V_2 speed in readout.

HDG Readout .... SET
Rotate to runway heading.
Bank Angle Limit .... SET
Set 15 °
ALT Readout .... SET
Rotate to 4,000 feet.
T.O. Thrust Select Sw .... PUSH
TO/GA Button .... PUSH
Existing modes will be canceled and TAKEOFF will appear in roll and pitch annunciators.
ALT .... ARM
HDG Select .... ENGAGE
AP Lever .... As Desired
OFF or CWS
ATS Levers .... ON
Throttles advance to N_1 limit displayed in Thrust Computer readout. (N_1 in ATS annunciator). The ATS Clamp Mode will engage at 80 knots and the ATS annunciator will change from N_1 to CLAMP. 1,500 feet AGL (Noise Abatement) or minimum acceleration height - thrust change.
CL Thrust Select Sw .... PUSH
N_1 Sw .... PUSH
ATS FMA changes from CLAMP to N_1.

FLAP/SLAT RETRACTION

N_1	ALT	HDG SEL	VERT SPD

Accomplish following actions passing 3,000 feet AGL:

Vertical Speed Sel .... SET
vertical speed + 1,000 FT/MIN
Setting VERT SPD to +1,000 ft/min changes TAKEOFF to VERT SPD and disengages the FD T.O. mode.
FGS Roll Mode .... As Desired
Arm FMS or RAD by pressing the appropriate switch on the directional control panel. FMS or RAD will appear in the ARM FMA unless the aircraft is in the capture or track zone.
AP Lever .... CMD
IAS Sw .... PUSH
at 250 KIAS or V_{MM} whichever is higher.

4000 FOOT LEVEL OFF SEGMENT

SPD		HDG SEL	ALT HOLD

At level off:

SPD SEL Knob .... SET/PULL
At 4,000 ft (armed ALT), AP engaged, AP levels off the aircraft and VERT SPD changes to ALT HOLD. Armed ALT annunciator blanks. Pulling out on SPD select knob disengages N_1 and now ATS adjusts SPD to speed set in readout, V_2.

ENROUTE CLIMB SEGMENT BELOW 10,000 FEET

N_1	ALT	HDG SEL	IAS HOLD

ATC clears for climb to FL 350:

Alt Readout .... SET
Rotate to 35,000 feet and pull out to arm.
ATS N_1 Sw .... PUSH
Verify CL switch is illuminated.
IAS Sw .... PUSH
Push IAS switch immediately after selecting ATS N_1 mode. Autopilot will adjust pitch attitude to maintain the existing speed. Climb at 250 KIAS or $1.5V_S$ whichever is higher.

SPD	ALT	HDG SEL	VER SPD

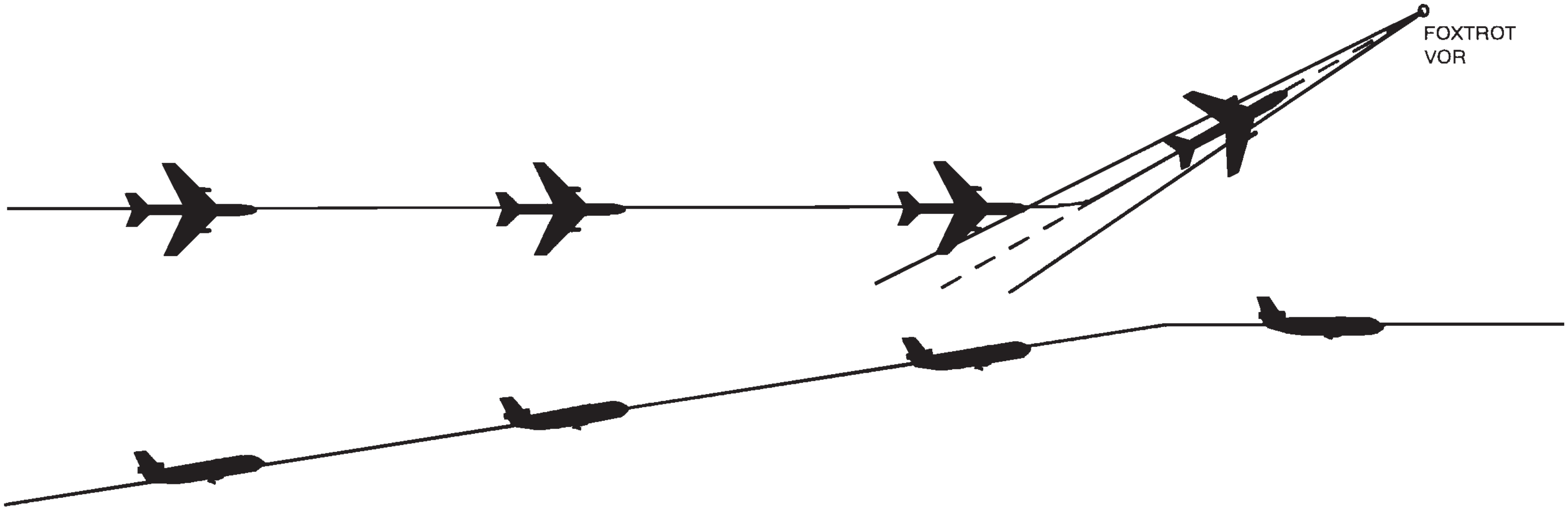
SPD Sel Knob .... SET/PULL

Vertical Speed Sel .... SET

WARNING

If vertical speed selector and speed select knob are used to command climb rate and IAS, it is possible to command a climb rate in excess of aircraft capability. This may result in insidious loss of airspeed and possible aircraft stall.

Figure 5-1. Takeoff And Climb (Sheet 1)



TRANSITION 10,000 FEET

N_1	ALT	FMS TRK	VERT SPD

Rotate vertical speed selector toward down at 10,000 feet to allow aircraft to accelerate to enroute climb speed. VERT SPD will replace IAS HOLD in pitch mode.

EHSI Nav Source .... FMS
RAD/FMS Sw .... PUSH
(ALT in arm annunciator)

If aircraft is on course centerline FMS will not be displayed in arm annunciator. FMS TRK will be displayed in roll annunciator.

ENROUTE CLIMB

N_1	ALT	FMS TRK	IAS HOLD

ATC clears for normal navigation after intercepting airway.

IAS Switch .... PUSH
when enroute climb speed is reached.

SPD	ALT	FMS TRK	VERT SPD

SPD Readout .... SET

Vertical Speed Selector .... SET

WARNING

If vertical speed selector and speed select knob are used to command climb rate and IAS, it is possible to command a climb rate in excess of aircraft capability. This may result in insidious loss of airspeed and possible aircraft stall.

ENROUTE CLIMB (Continued)

N_1	ALT	FMS TRK	MACH HOLD

MACH Switch .... PUSH
when desired climb MACH is reached.

SPD Readout .... SET

After altitude capture or altitude hold, when aircraft has accelerated to desired cruise speed, pull out on the SPD select knob to engage speed mode.

CRUISE

SPD		FMS TRK	ALT HOLD

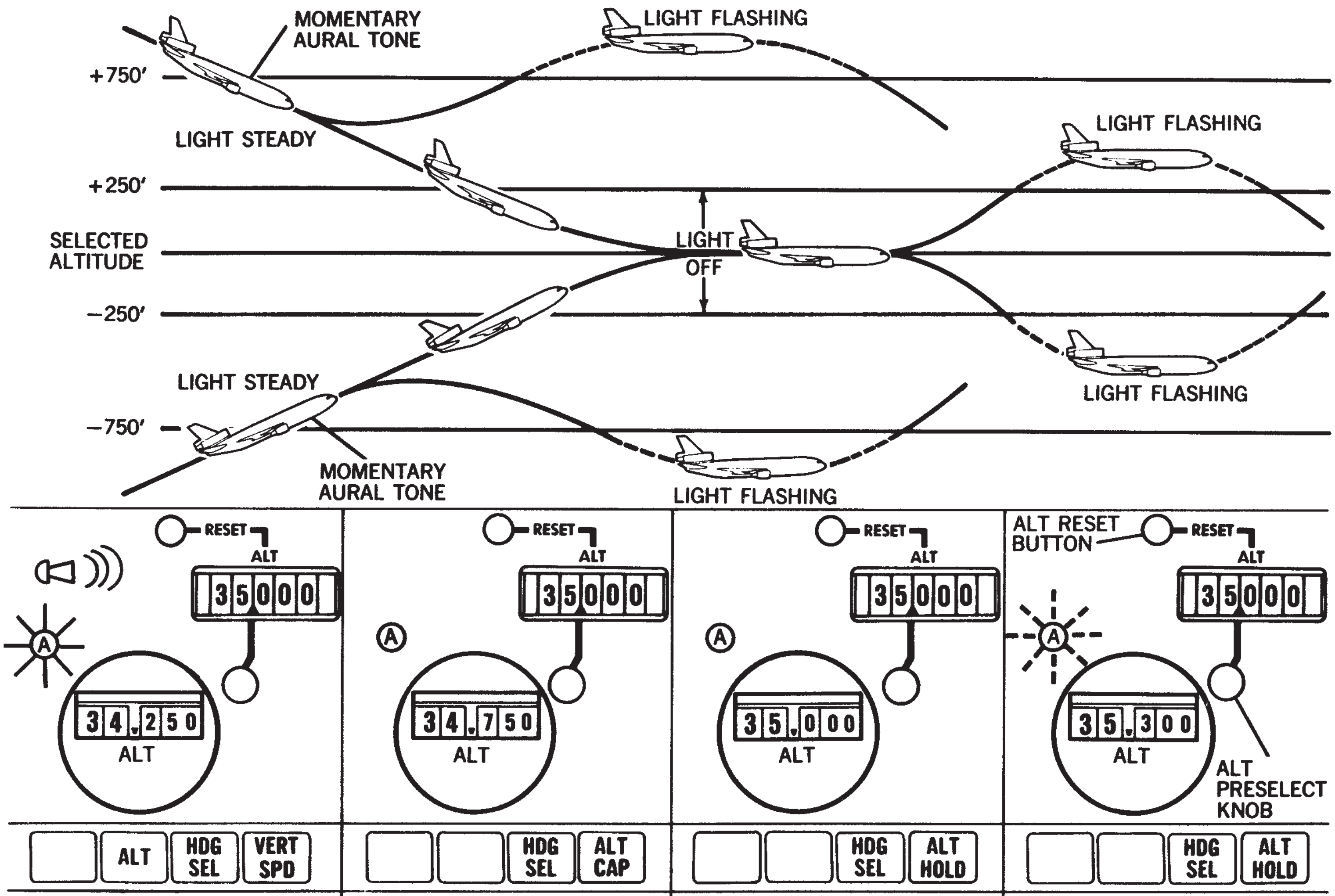
As aircraft approaches the selected altitude the pitch annunciator will change to "ALT HOLD".

After altitude capture or altitude hold, when aircraft has accelerated to desired cruise speed, pull out on the SPD select knob to engage speed mode.

MCR Thrust Select Sw............ PUSH

(Establishes max N_1 limit for cruise)

Figure 5-1. Takeoff And Climb (Sheet 2)



A momentary aural tone and a steady advisory light comes on no closer than 750' of the preselected altitude. The advisory light will flash if aircraft deviates from 750' prior to reaching 250' of the preselected altitude.

The advisory light goes off 250' prior to reaching the preselected altitude. The pitch annunciator changes to "ALT CAP" when the level off point is reached.

As aircraft levels (manually or automatically) at the preselected altitude, the pitch annunciator changes to "ALT HOLD."

The advisory light remains off provided the aircraft maintains the selected altitude ±250'.

The advisory light flashes if aircraft deviates more than ±250' from selected altitude. Light will go out when aircraft returns within the ±250' band or by pushing the ALT RESET button, or selecting a new altitude in ALT readout.

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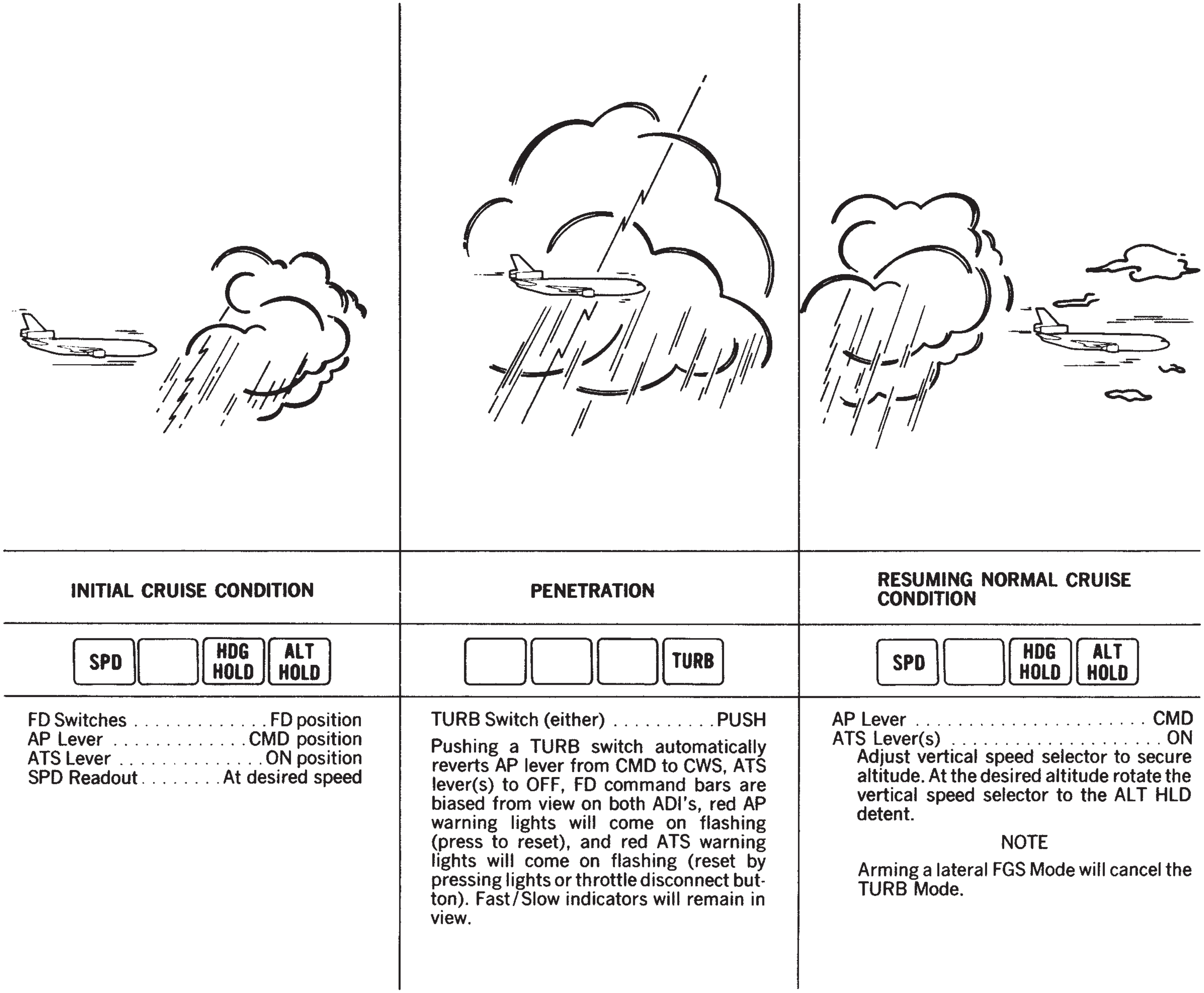
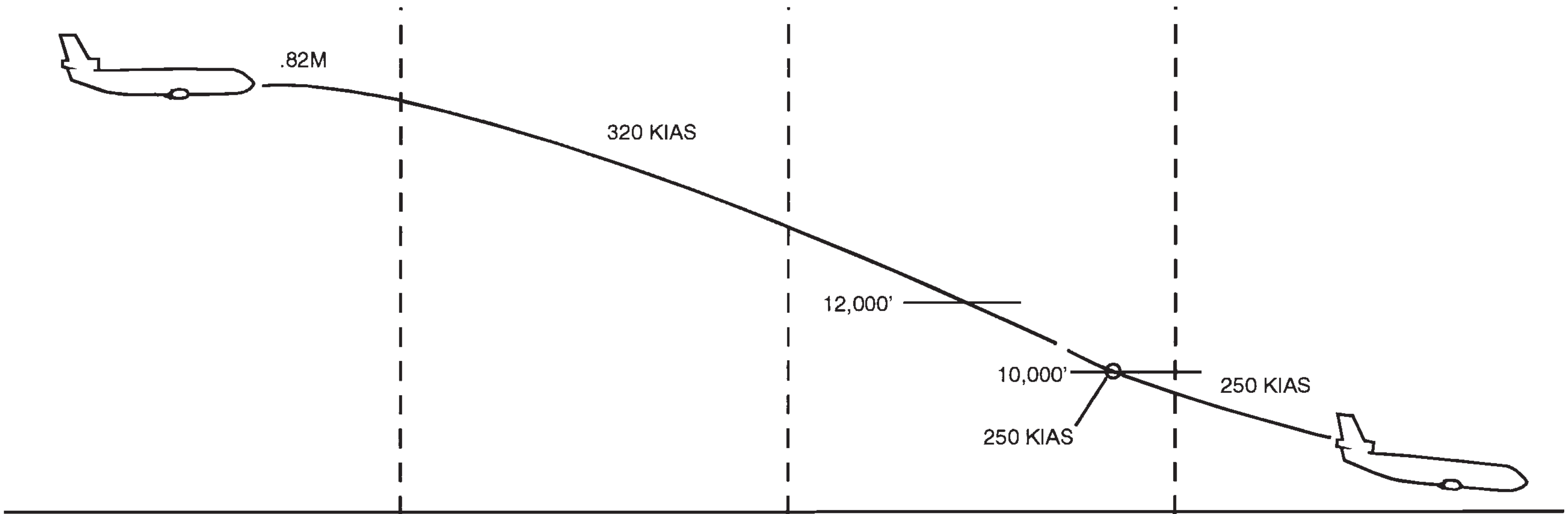
Figure 5-2. Altitude Preselect And Advisory



INITIAL CRUISE CONDITION	PENETRATION	RESUMING NORMAL CRUISE CONDITION
FD Switches . . . . FD position AP Lever . . . . CMD position ATS Lever . . . . ON position SPD Readout . . . . At desired speed	TURB Switch (either) . . . . PUSH Pushing a TURB switch automatically reverts AP lever from CMD to CWS, ATS lever(s) to OFF, FD command bars are biased from view on both ADI's, red AP warning lights will come on flashing (press to reset), and red ATS warning lights will come on flashing (reset by pressing lights or throttle disconnect button). Fast/Slow indicators will remain in view.	AP Lever . . . . CMD ATS Lever(s) . . . . ON Adjust vertical speed selector to secure altitude. At the desired altitude rotate the vertical speed selector to the ALT HLD detent. NOTE Arming a lateral FGS Mode will cancel the TURB Mode.

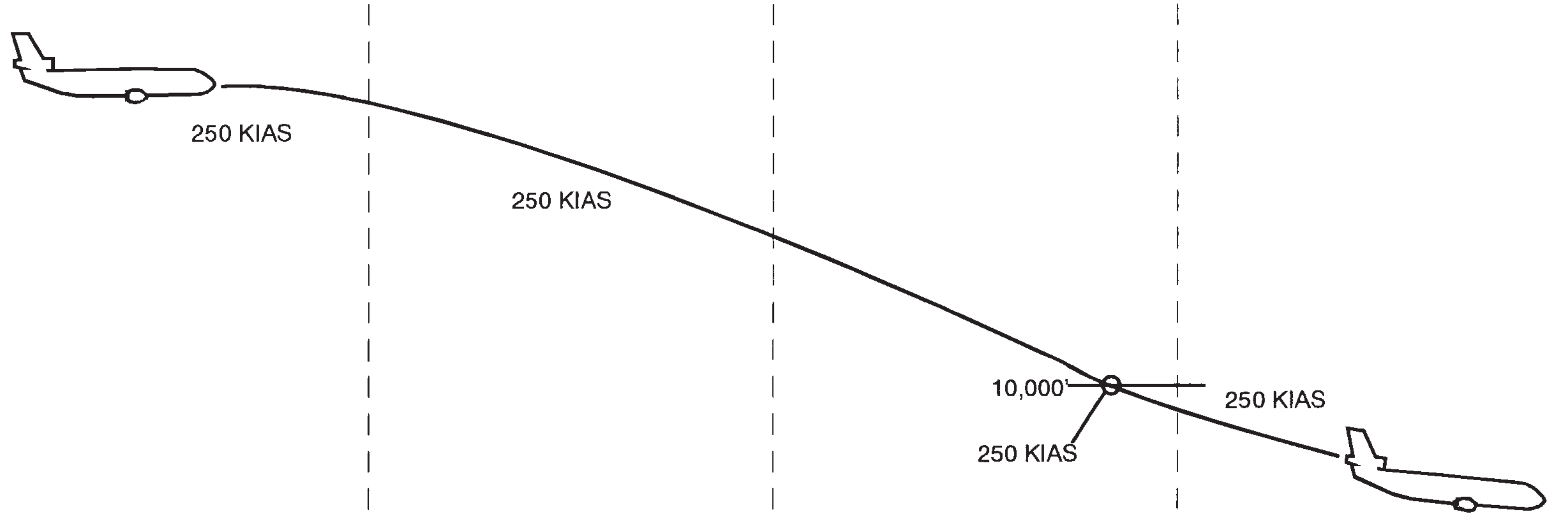
Figure 5-3. Turbulence Penetration



MACH SPEED SCHEDULE	SPEED SCHEDULE	TRANSITION TO 250 KIAS	DESCENT AT 250 KIAS
☐ ALT FMS TRK MACH HOLD	☐ ALT FMS TRK IAS HOLD	☐ ALT FMS TRK VERT SPD	☐ ALT HDG SEL IAS HOLD
FD Switches .... ON AP Lever .... CMD, CWS, or OFF (May be flown manually using FD commands) ALT Readout .... SET/ARM for cleared altitude. ATS Levers .... OFF MACH HOLD .... Engage Select at .82 Mach Throttles .... IDLE	SPD Readout .... SET Set 320 KIAS ATS Levers .... OFF IAS HOLD .... Engage Select IAS HOLD upon intercepting 320 KIAS (approximately 27,000') Drag Devices as required	At 12,000 feet SPD Readout .... SET V_{mm} or 250 KIAS Vertical Speed Selector .... Rotate to 750'/min. rate of descent (Rotate as required to slow to 250 KIAS at 10,000) Drag Devices as required.	IAS HOLD .... Engage Select IAS HOLD upon intercepting 250 KIAS SPD Readout .... SET Set V_{mm} or 250 KIAS ATS Levers .... ON Engage ATS Levers after ALT CAP is annunciated. Slow as required to configure for approach.

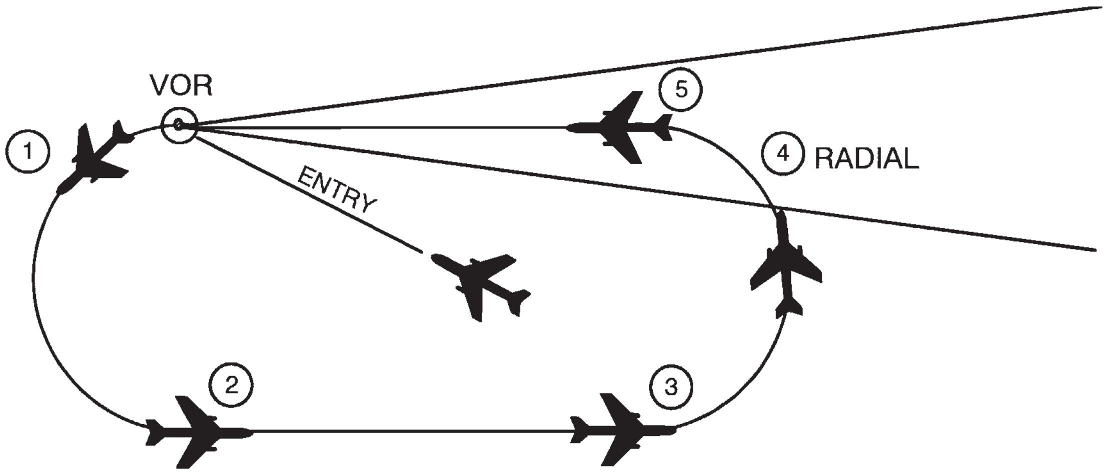
OR
(SEE SHEET 2)

Figure 5-4. Descent Profile (Sheet 1)



MACH SPEED SCHEDULE	SPEED SCHEDULE	TRANSITION TO 250 KIAS	DESCENT AT 250 KIAS
☐ ALT | FMS TRK | VERT SPD	☐ ALT | FMS TRK | IAS HOLD	☐ ALT | FMS TRK | VERT SPD	SPD | ILS | HDG SEL | ALT HOLD
FD Switches . . . . ON AP Lever . . . . CMD, CWS, or OFF (May be flown manually using FD commands) ALT Readout . . . . SET/ARM for cleared altitude. ATS Levers . . . . OFF Throttles . . . . IDLE VERT SPD . . . . Descent Begin slow descent when approaching 250 KIAS	ATS Levers . . . . OFF IAS HOLD . . . . Engage Select IAS HOLD upon intercepting 250 KIAS Drag Devices as required.	Continue descent through 10,000' at or below 250 KIAS. Drag Devices as required.	Continue descent to desired/clearance altitude at 250 KIAS SPD Readout . . . . SET Set V_{mm} or 250 KIAS. ATS Levers . . . . ON Engage ATS Levers after ALT CAP is annunciated. Slow as required to configure for approach.

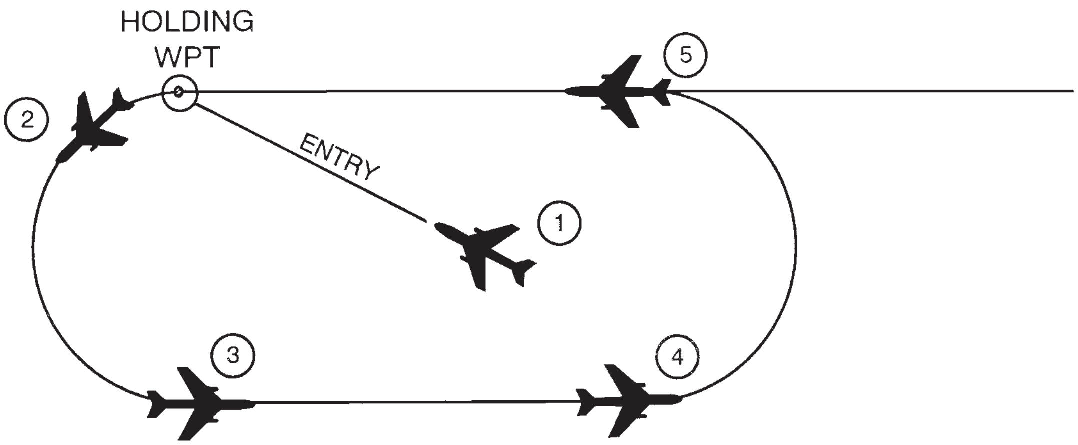
Figure 5-4. Descent Profile (Sheet 2)



① CROSSING FIX	② OUTBOUND LEG	③ TURNING INBOUND WITH ALTITUDE CHANGE	④ INTERCEPTING INBOUND LEG	⑤ INBOUND LEG
SPD ☐ HDG SEL ALT HOLD	SPD ☐ HDG SEL ALT HOLD	SPD RAD ALT HDG SEL VERT SPD	SPD ALT RAD CAP VERT SPD	SPD ☐ RAD TRK ALT HOLD
FD Switches .... ON AP Lever .... CMD or OFF ATS Levers .... ON HDG Select Mode .... ENGAGE to turn to outbound heading (Do not select reciprocal heading until after aircraft is established in turn). SPD Readout .... SET at desired speed	Aircraft flies selected heading.	HDG Select .... Begin turn to an intercept heading to inbound leg. ALT Readout .... SET/ARM for new altitude Vertical Speed Selector .... Rotate to descent EHSI Nav Source .... VOR RAD/FMS Switch .... PUSH	FGS captures inbound track.	FGS tracks inbound track and at selected altitude "ALT CAP" and then "ALT HOLD" will be annunciated in pitch mode.

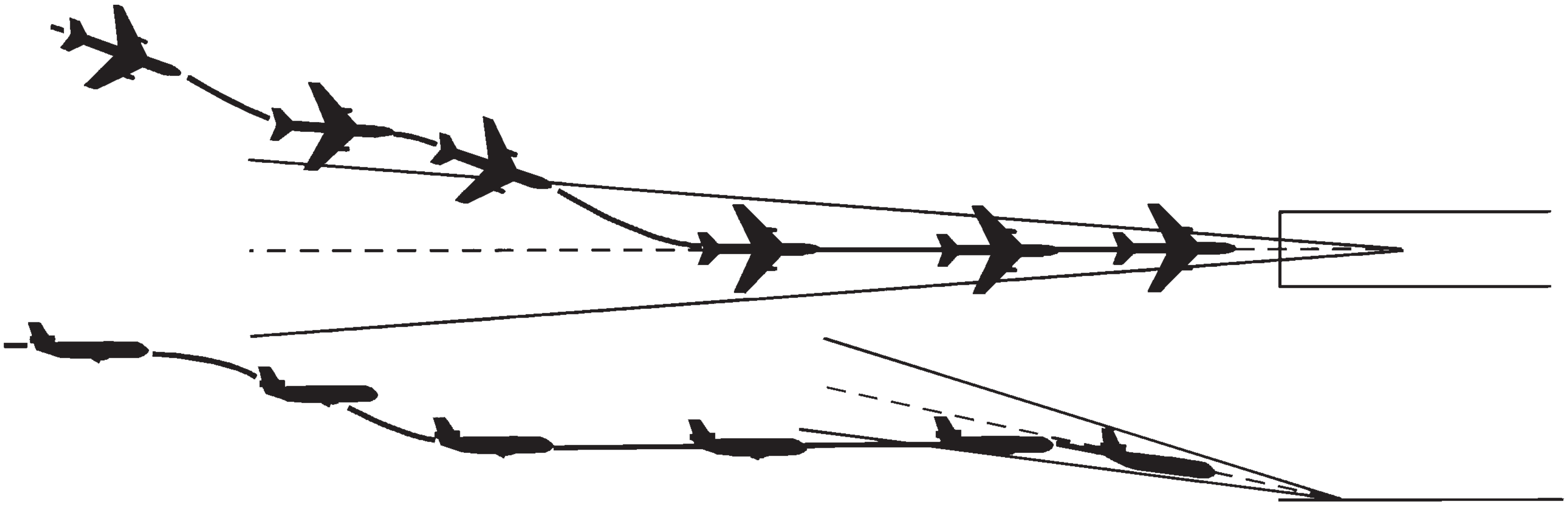
CMD CWS mode may be used (AP lever in CMD) by pushing the CWS switch prior to RAD TRK being annunciated. With "ALT HOLD" or "VERT SPD" annunciated in pitch mode and CWS H/SEL will be annunciated in the roll mode. When entering the capture zone "supervisory override" will be available while RAD CAP is annunciated.

Figure 5-5. Holding Pattern



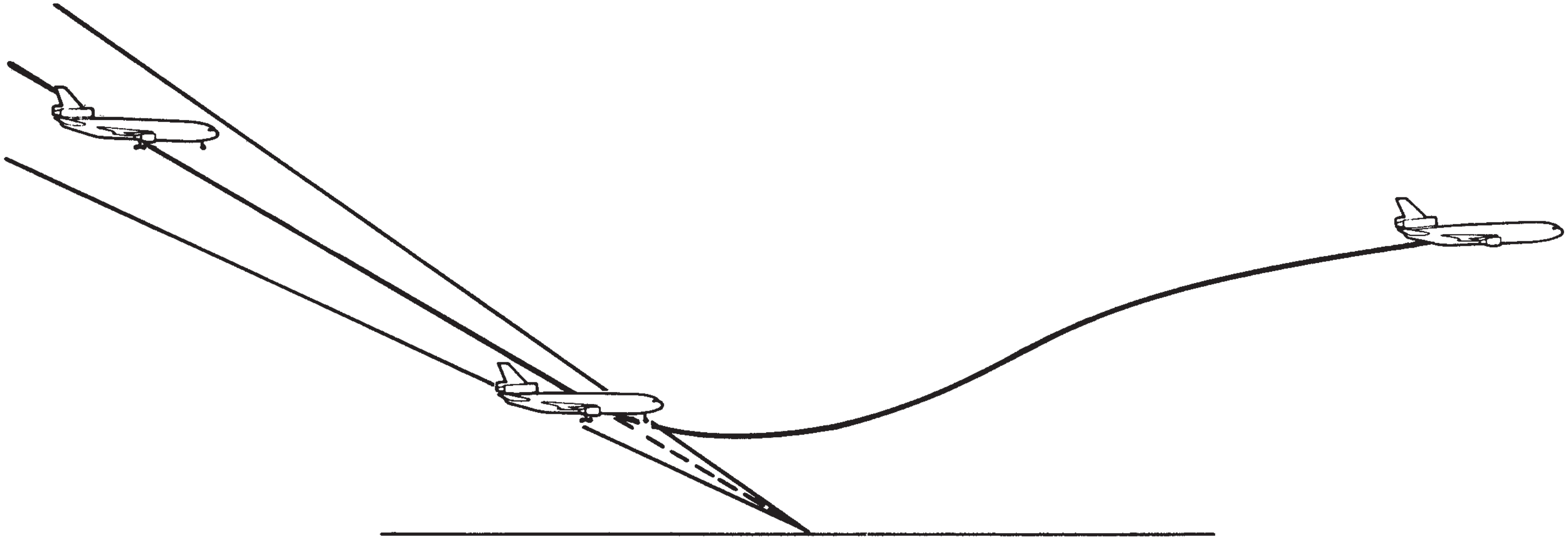
① CROSSING FIX	② TURNING OUTBOUND	③ OUTBOUND LEG	④ TURNING INBOUND WITH ALTITUDE CHANGE	⑤ INBOUND LEG
SPD FMS TRK ALT HOLD	SPD FMS TRK ALT HOLD	SPD FMS TRK ALT HOLD	SPD ALT FMS TRK VERT SPD	SPD FMS TRK ALT HOLD
FD Switches . . . . ON AP Lever . . . . CMD or OFF ATS Levers . . . . ON EHSI Nav Source . . . . FMS RAD/FMS SWITCH . . . . PUSH SPD Readout . . . . SET at desired speed	FGS steers aircraft to intercept outbound leg.	FGS steers aircraft along outbound track.	FGS steers aircraft to intercept inbound track. ALT Readout . . . . SET/ARM for new altitude Vertical Speed Selector . . . . Rotate to descent	FGS steers aircraft along inbound track and at selected altitude "ALT CAP" and then "ALT HOLD" will be annunciated in pitch mode.

Figure 5-6. FMS Holding Pattern



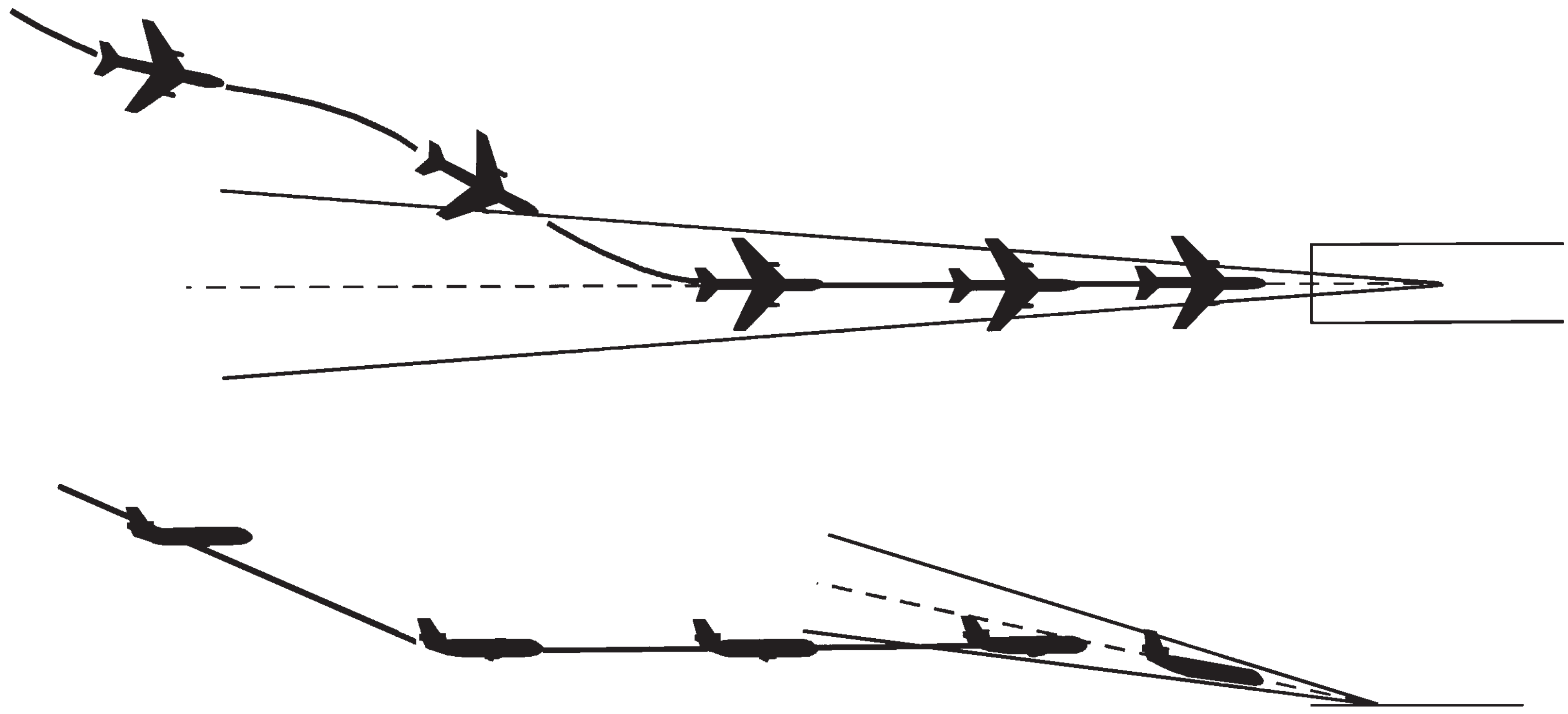
INITIAL CONDITION	MANEUVERING	INTERCEPT	LOC CAP/TRK	GS CAP/TRK
SPD | ☐ | HDG SEL | ALT HOLD	SPD | ALT | HDG SEL | VERT SPD	SPD | ILS | HDG SEL | ALT HOLD	SPD | ILS | LOC CAP | ALT HOLD	SPD | ☐ | LOC TRK | G/S TRK
FD Switches . . . . ON ATS Levers . . . . ON HDG Select Mode . . . . ENGAGED EHSI Nav Source . . . . LOC NOTE EHSI navigation source will be VOR prior to selecting an ILS frequency.	ILS frequency and front inbound course tuned and identified. ALT Readout . . . . SET/ARM for initial approach altitude. Vertical Speed Selector . . . . Rotate as required for descent. HDG Select . . . . As required for maneuvering Aircraft is manually flown to Flight Director commands.	Aircraft has captured selected altitude and FD commands turn to final intercept heading. ALT Readout . . . . SET (but not armed) for missed approach altitude. GA Switch (Thrust Computer) . . . . PUSH (Establishes max N_1 limit for go-around) ILS Switch . . . . PUSH Verify EHSI navigation source is LOC.	At capture, "LOC CAP" is annunciated in roll mode and FD commands turn on course. SPD | ILS | LOC TRK | ALT HOLD When established on localizer, roll annunciator changes to "LOC TRK." (LOC TRK mode will not engage until aircraft is below 2500 feet radio altitude.) SPD Readout . . . . SET Final approach speed. (ALPHA SPD replaces SPD in ATS annunciator until flaps are in final approach setting.) The FAST/SLOW indicator is referenced to ALPHA SPD whenever logic requires it.	At glide slope intercept, "G/S CAP" is annunciated in the pitch mode, after 20 seconds "G/S TRK" is annunciated. NOTE If steer commands are not followed and aircraft departs the localizer or glide slope, the mode annunciators will still show "LOC TRK" and "G/S TRK." FD pitch and roll commands and raw data will indicate the deviation.

Figure 5-7. Flight Director Manual ILS Approach



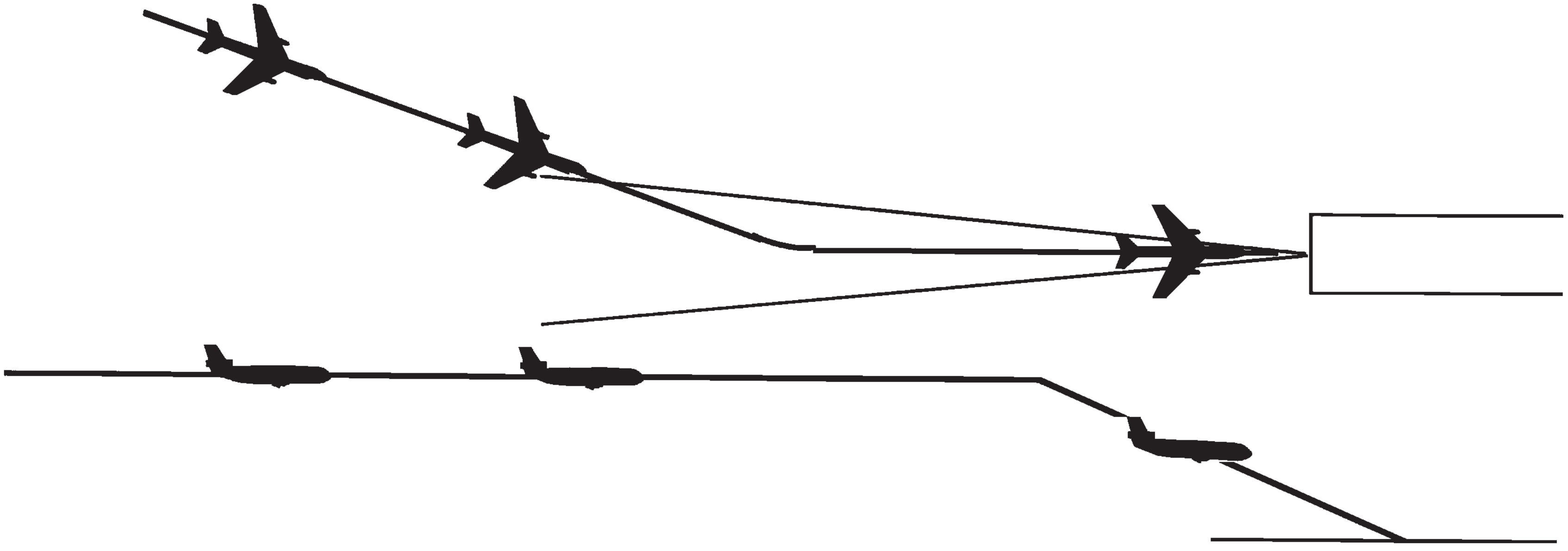
APPROACH	TO/GA BUTTON PUSHED AT DECISION HEIGHT	GO AROUND MANEUVER	MISSED APPROACH PROCEDURE
☐ ☐ LOC TRK G/S TRK	☐ ☐ G/A G/A	☐ ☐ G/A G/A	☐ ALT HDG HOLD VERT SPD
FD Switches . . . . ON AP Lever . . . . OFF ATS Lever(s) . . . . Optional ALT Readout . . . . SET Arming inhibited Flaps . . . . Out of UP detent	Pilot manually advances the throttles and pushes the TO/GA button. (If the ATS is on, after releasing pressure on throttles, the ATS will refine the GA thrust setting.) Thrust Rating Computer automatically switches to GA if not previously selected.	FD commands fly up. (Max 15° ANU) Pitch commands of V2 + 10 for all engines operating or V2 for one engine inoperative. FD commands wings level and then maintains heading existing when the roll attitude is less than 3°. Pilot maneuvers aircraft to satisfy pitch and roll commands.	ALT Preselect Mode . . . . . ARM Vertical Speed Selector . . . Rotate as required for guidance to accelerate for flap/slat retraction. CL Switch (Thrust Computer) . . . . PUSH SPD Readout . . Set as desired If an immediate climbing turn is requied, engage HDG Select mode and maintain G/A in pitch axis. (Bank angle limit set 15º) Example: ☐ ALT HDG SEL G/A

Figure 5-8. Go-Around From Flight Director Approach



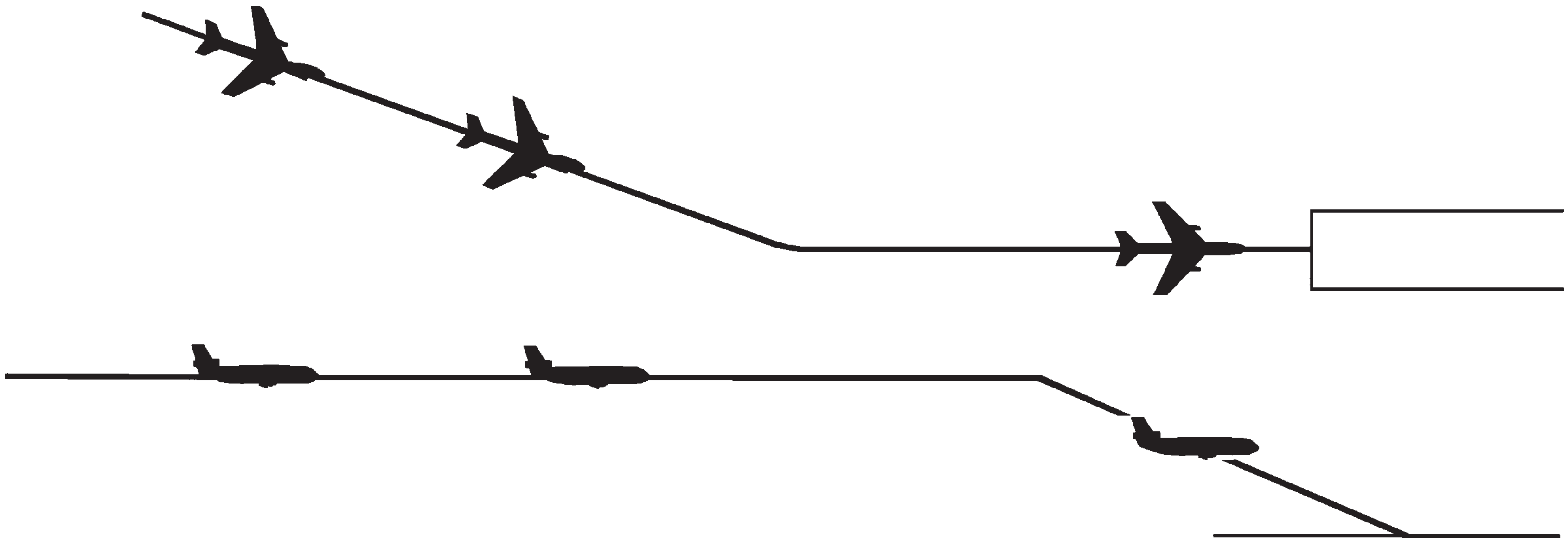
INITIAL CONDITION			
SPD ILS CWS H/SEL ALT HOLD	SPD ILS LOC CAP ALT HOLD	SPD LOC TRK G/S CAP	SPD LOC TRK G/S TRK
FD Switches .... ON ATS Lever(s) .... ON AP Lever .... CMD HDG Select Mode .... ENGAGED EHSI Nav Source .... LOC ILS Switch .... PUSHED CWS Switch .... PUSHED (Outside of capture zone, normal roll CWS is available to maneuver the aircraft. The autopilot is in CWS mode and the flight director is in heading select mode.)	As aircraft captures localizer, "LOC CAP" is annunciated and "supervisory override" is available to override the AP automatic capture. System remains armed for ILS capture. Applying two pounds of pressure to control wheel engages the supervisory override mode.	"Supervisory override" in roll ends when LOC TRK is annunciated. (LOC TRK will not be annunciated, even after established on localizer until control wheel pressure is released.) "Supervisory override" in pitch is available at G/S CAP.	"Supervisory override" in pitch ends when G/S TRK is annunciated. (G/S TRK will not be annunciated, even after established on glide slope until control column pressure is released.)

Figure 5-9. CMD CWS During ILS Approach - Autopilot Lever In CMD



INITIAL CONDITION	INTERCEPT	TRACK
SPD | B/CRS | HDG SEL | ALT HOLD	SPD | | B/CRS CAP | ALT HOLD	SPD | | B/CRS TRK | VERT SPD
FD Switches .... ON ATS Lever(s) .... ON HDG Select Mode .... ENGAGED AP Lever .... CWS/OFF EHSI Nav Source .... VOR ILS Frequency and Front Inbound Course .... SET Verify EHSI navigation source changes to LOC. Either BACK CRS Sw .... PUSHED Verify EHSI navigation source changes to BC.	Flight director system provides back course guidance commands. Aircraft flown manually to roll commands with autopilot in CWS or OFF.	SPD Readout .... SET as required Vertical Speed Selector .... Rotate as required to establish descent profile. When established on back course, "B/CRS TRK" is annunciated.

Figure 5-10. Flight Guidance System Back Course Approach



INITIAL CONDITION	INTERCEPT	TRACK
SPD FMS HDG SEL ALT HOLD	SPD FMS CAP ALT HOLD	SPD FMS TRK VERT SPD
FD Switches . . . . ON ATS Lever(s) . . . . ON HDG Select Mode . . . . ENGAGED AP Lever . . . . CMD/OFF EHSI Nav Source . . . . FMS GPS Approach . . . . SELECT RAD/FMS Switch . . . . PUSH	Flight guidance system provides steering commands to intercept and track the final approach course. Aircraft flown manually to FD roll commands or autopilot steers aircraft in CMD.	SPD Readout . . . . SET as required Vertical Speed Selector . . . . Rotate as required to establish descent profile. When established on final approach course, "FMS TRK" is annunciated.

Figure 5-11. Flight Guidance System GPS Approach

TAKEOFF

Illustrations are provided to show techniques used for Rejected Takeoff, figure 5-12, Normal Takeoff, figure 5-13, and continued takeoff with Engine Failure After Passing V_1, figure 5-14.

THRUST SETTING PROCEDURES

Static Takeoff (Static position on runway with brakes set) - For a static takeoff the engines are set approximately to the takeoff limit percent N_1 value.

ENROUTE CLIMB

Two climb schedules are recommended for use above 10,000 feet or the MEA; long range, and high speed. A combination of the two schedules may be used.

WARNING

If the vertical speed selector and speed select knob are used to command climb rates and IAS, it is possible to command a rate of climb exceeding the aircraft capabilities. This may result in a loss of airspeed and resultant stall condition. Damage to the elevator may result.

CAUTION

When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed due to gross weight and high altitudes.

NOTE

Close monitoring of climb thrust is required, since N_1 tends to increase during climb. Use of the ATS in the N_1 mode reduces this tendency, monitoring is still required.

DESCENT, APPROACH, AND LANDING

Illustrations are provided to show techniques for Three- and Two-Engine VFR Approach and Landing, figure 5-15; Single Engine VFR Approach and Landing, figure 5-16; Three- and Two-Engine Non-Precision Approach and Landing (Straight In), figure 5-17; Three- and Two-Engine Low Visibility Circling Approach, figure 5-18; Three- and Two-Engine ILS, Approach and Landing (Manual or Single Autopilot), figure 5-19; Three-Engine ILS, Approach and Landing (Category II), figure 5-20; Missed Approach or Rejected Landing (Manual), figure 5-21; Missed Approach or Rejected Landing (Auto), figure 5-22; Asymmetric Flaps or No Flap Landing with Slats, figure 5-24; Asymmetric Slats or No Slat Landing with Flaps, figure 5-25; No Flap/No Slat Landing, figure 5-26.

The illustrations in this section are intended for reference only. Refer to the applicable sections in the "Procedures" chapters of this volume for detailed procedures for accomplishing the maneuvers depicted herein.

CLIMB SPEEDS

CLIMB	REMARKS	SPEEDS
Second segment		1.15V_{S1g}
Three engine enroute	Below 10,000 ft	Greater of V_{MM} or 250 KIAS
	Above 10,000 ft	330 KIAS to 27,402 ft, then at M equals 0.82
Two engine enroute	Below 10,000 ft	Greater of V_{MM} or 250 KIAS
	Above 10,000 ft	300 KIAS to 27,993 ft, then at M equals 0.76
Three engine derated	Below 10,000 ft	Greater of V_{MM} or 250 KIAS
	Above 10,000 ft	330 KIAS to 27,402 ft, then at M equals 0.82

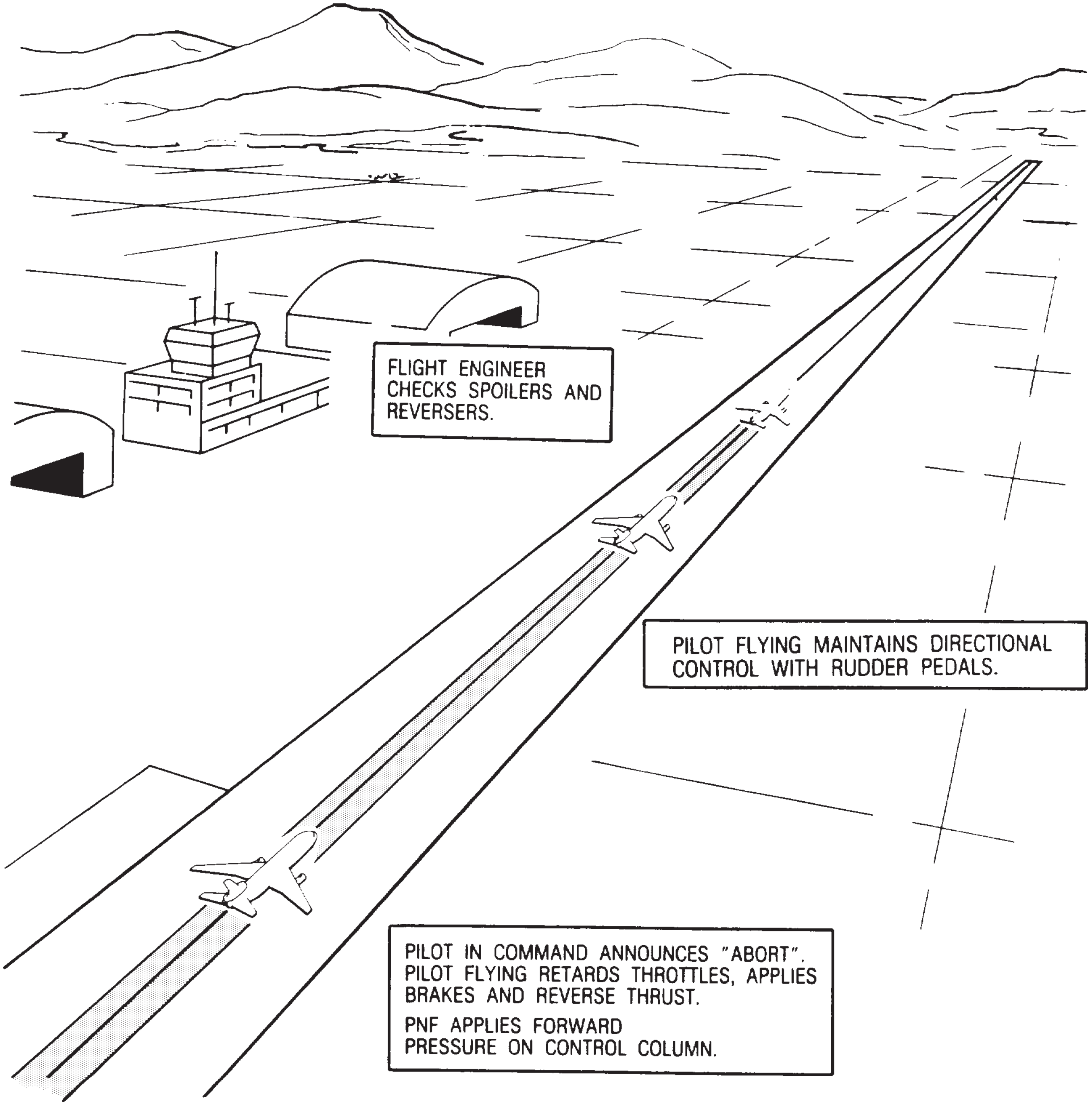


Figure 5-12. Rejected Takeoff

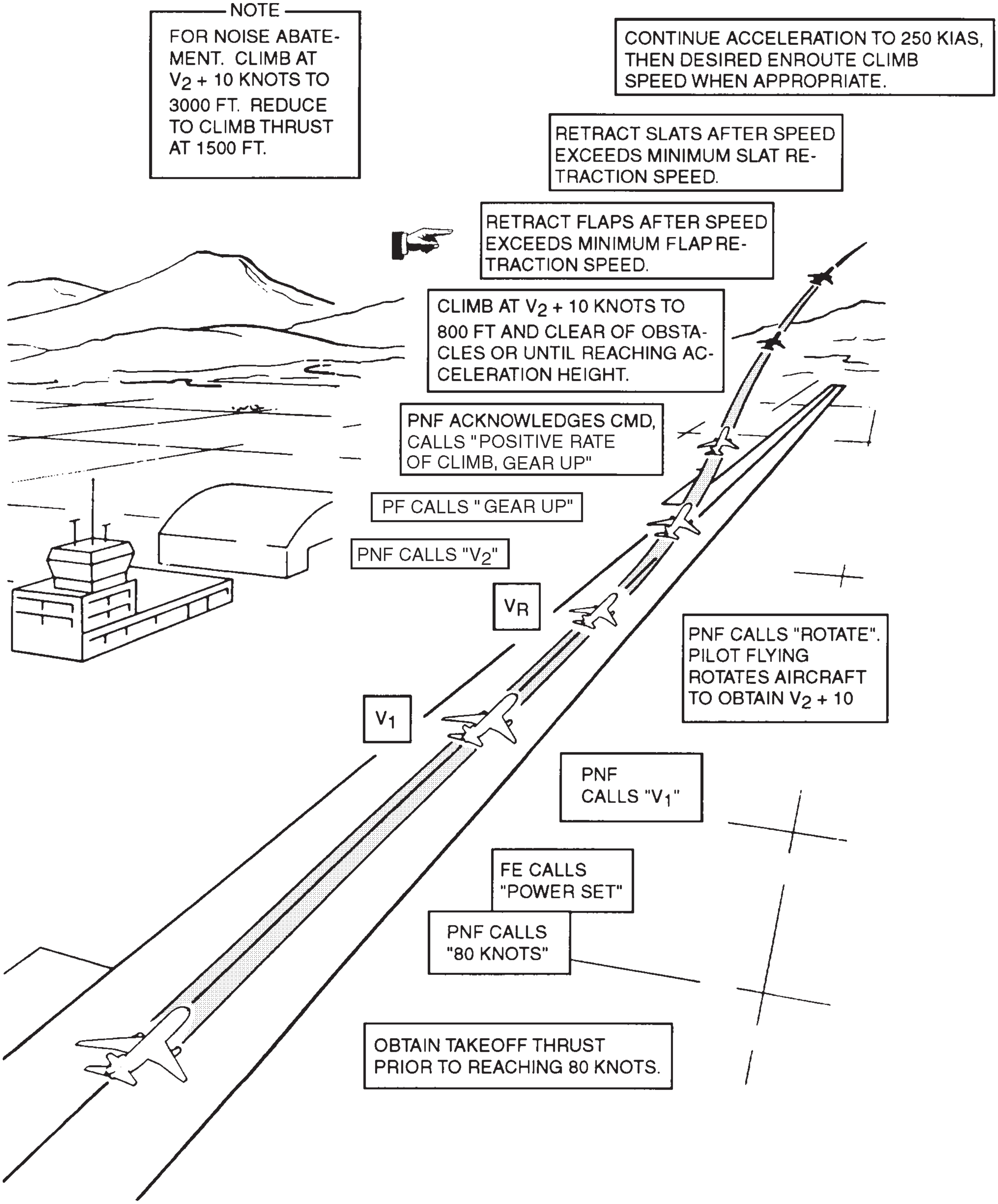
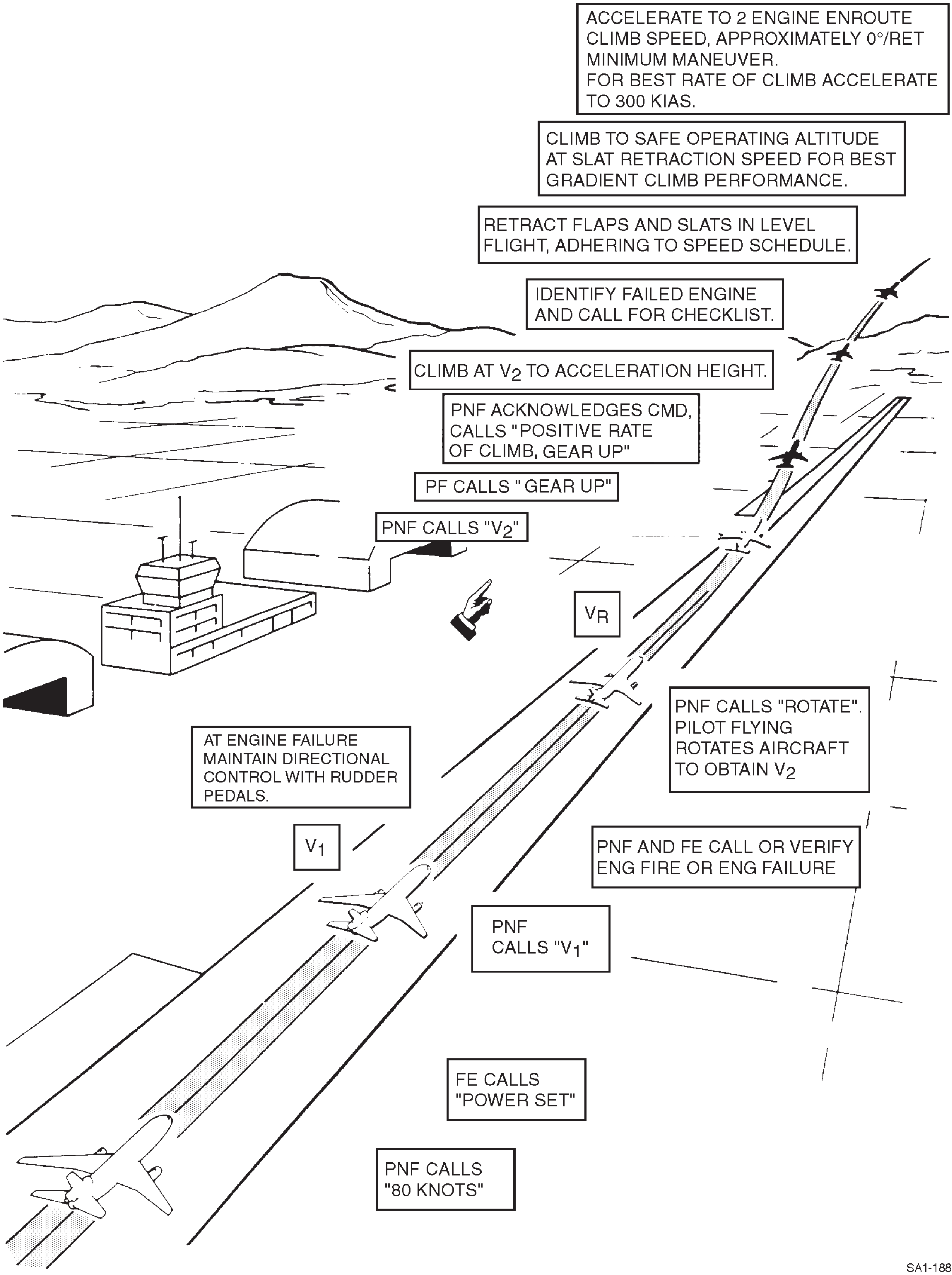


Figure 5-13. Normal Takeoff



ACCELERATE TO 2 ENGINE ENROUTE CLIMB SPEED, APPROXIMATELY 0°/RET MINIMUM MANEUVER.
FOR BEST RATE OF CLIMB ACCELERATE TO 300 KIAS.

CLIMB TO SAFE OPERATING ALTITUDE AT SLAT RETRACTION SPEED FOR BEST GRADIENT CLIMB PERFORMANCE.

RETRACT FLAPS AND SLATS IN LEVEL FLIGHT, ADHERING TO SPEED SCHEDULE.

IDENTIFY FAILED ENGINE AND CALL FOR CHECKLIST.

CLIMB AT V$_2$ TO ACCELERATION HEIGHT.

PNF ACKNOWLEDGES CMD, CALLS "POSITIVE RATE OF CLIMB, GEAR UP"

PF CALLS " GEAR UP"

PNF CALLS "V$_2$"

PNF CALLS "ROTATE". PILOT FLYING ROTATES AIRCRAFT TO OBTAIN V$_2$

AT ENGINE FAILURE MAINTAIN DIRECTIONAL CONTROL WITH RUDDER PEDALS.

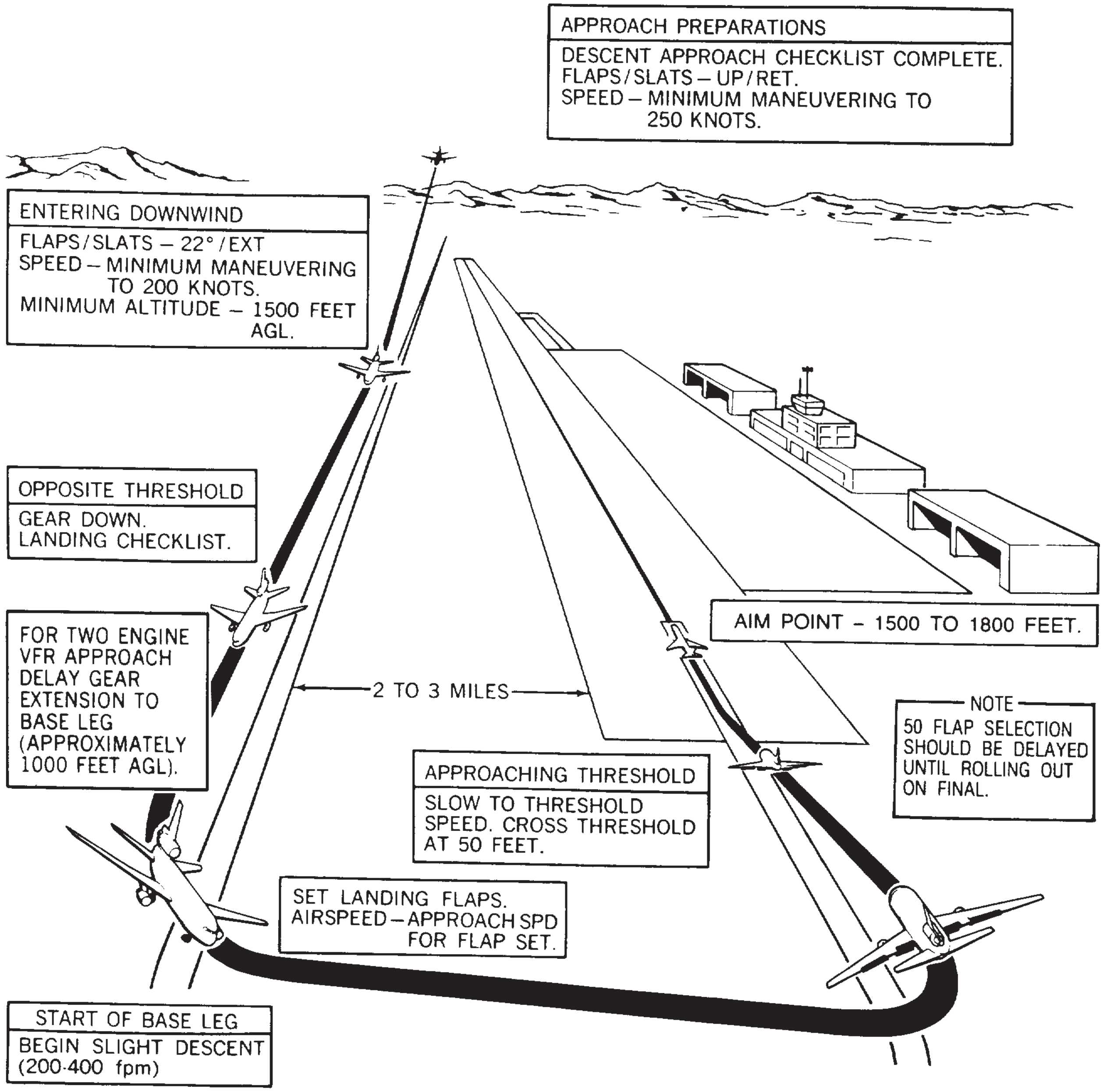
PNF AND FE CALL OR VERIFY ENG FIRE OR ENG FAILURE

PNF CALLS "V$_1$"

FE CALLS "POWER SET"

PNF CALLS "80 KNOTS"

Figure 5-14. Engine Failure After Passing V$_1$



APPROACH PREPARATIONS

DESCENT APPROACH CHECKLIST COMPLETE.
FLAPS/SLATS – UP/RET.
SPEED – MINIMUM MANEUVERING TO 250 KNOTS.

ENTERING DOWNWIND

FLAPS/SLATS – 22°/EXT
SPEED – MINIMUM MANEUVERING TO 200 KNOTS.
MINIMUM ALTITUDE – 1500 FEET AGL.

OPPOSITE THRESHOLD

GEAR DOWN.
LANDING CHECKLIST.

FOR TWO ENGINE VFR APPROACH DELAY GEAR EXTENSION TO BASE LEG (APPROXIMATELY 1000 FEET AGL).

AIM POINT – 1500 TO 1800 FEET.

NOTE

50 FLAP SELECTION SHOULD BE DELAYED UNTIL ROLLING OUT ON FINAL.

APPROACHING THRESHOLD

SLOW TO THRESHOLD SPEED. CROSS THRESHOLD AT 50 FEET.

SET LANDING FLAPS.
AIRSPEED – APPROACH SPD FOR FLAP SET.

START OF BASE LEG

BEGIN SLIGHT DESCENT (200-400 fpm)

NOTE

- For 2-engine landing, use 35° flaps.
- Delay slat/flap and landing gear extension as long as practical to minimize exposure to a second engine failure during final approach.
- Delay descent through 2000 ft AGL to minimize exposure to a second engine failure during final approach.
- Increase charted 22/EXT MIN MAN and 35/EXT TH speeds by 10 KIAS until landing is assured to minimize exposure to second engine failure on final. Use normal wind additives, but approach speed should not exceed charted 35/EXT TH plus 20 KIAS.
- If second engine failure occurs prior to landing gear extension, accomplish SINGLE ENGINE OPERATION Procedure.
- If second engine failure occurs after landing gear extension, accomplish SECOND ENGINE FAILS ON FINAL Procedure.

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Figure 5-15. Three- and Two-Engine VFR Approach and Landing

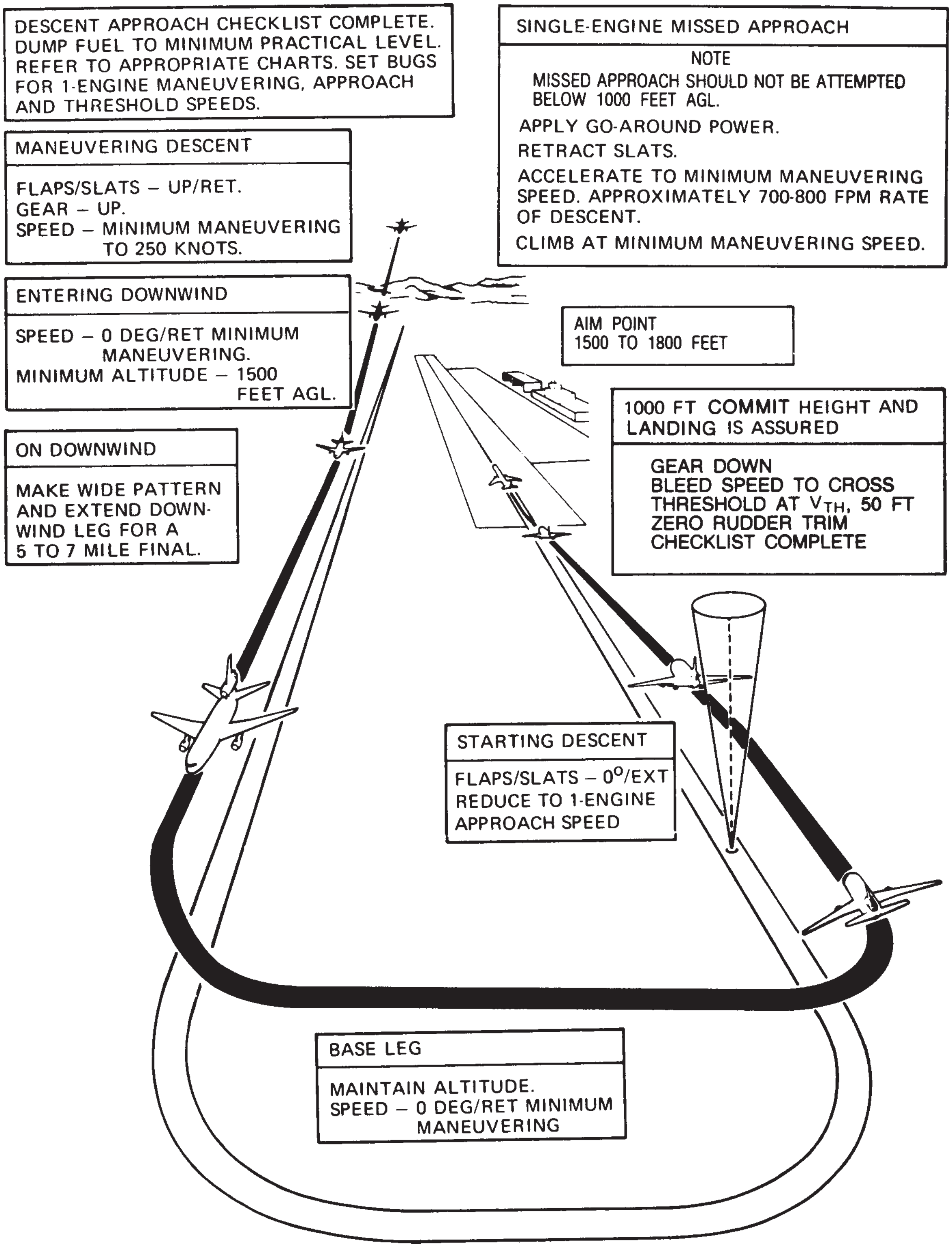
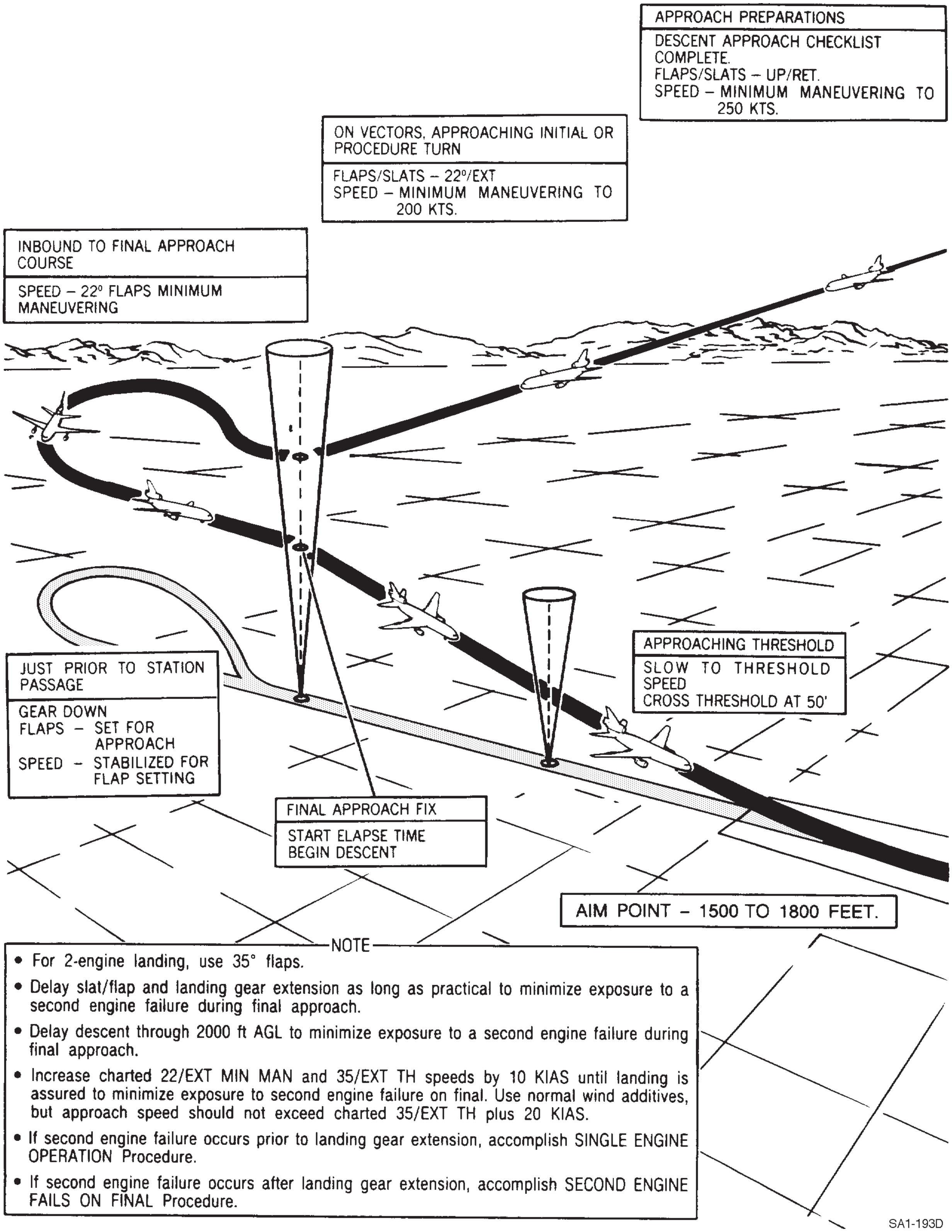


Figure 5-16. Single-Engine VFR Approach and Landing



APPROACH PREPARATIONS

DESCENT APPROACH CHECKLIST COMPLETE.
FLAPS/SLATS – UP/RET.
SPEED – MINIMUM MANEUVERING TO 250 KTS.

ON VECTORS, APPROACHING INITIAL OR PROCEDURE TURN

FLAPS/SLATS – 22°/EXT
SPEED – MINIMUM MANEUVERING TO 200 KTS.

INBOUND TO FINAL APPROACH COURSE

SPEED – 22° FLAPS MINIMUM MANEUVERING

JUST PRIOR TO STATION PASSAGE

GEAR DOWN
FLAPS – SET FOR APPROACH
SPEED – STABILIZED FOR FLAP SETTING

APPROACHING THRESHOLD

SLOW TO THRESHOLD SPEED
CROSS THRESHOLD AT 50'

FINAL APPROACH FIX

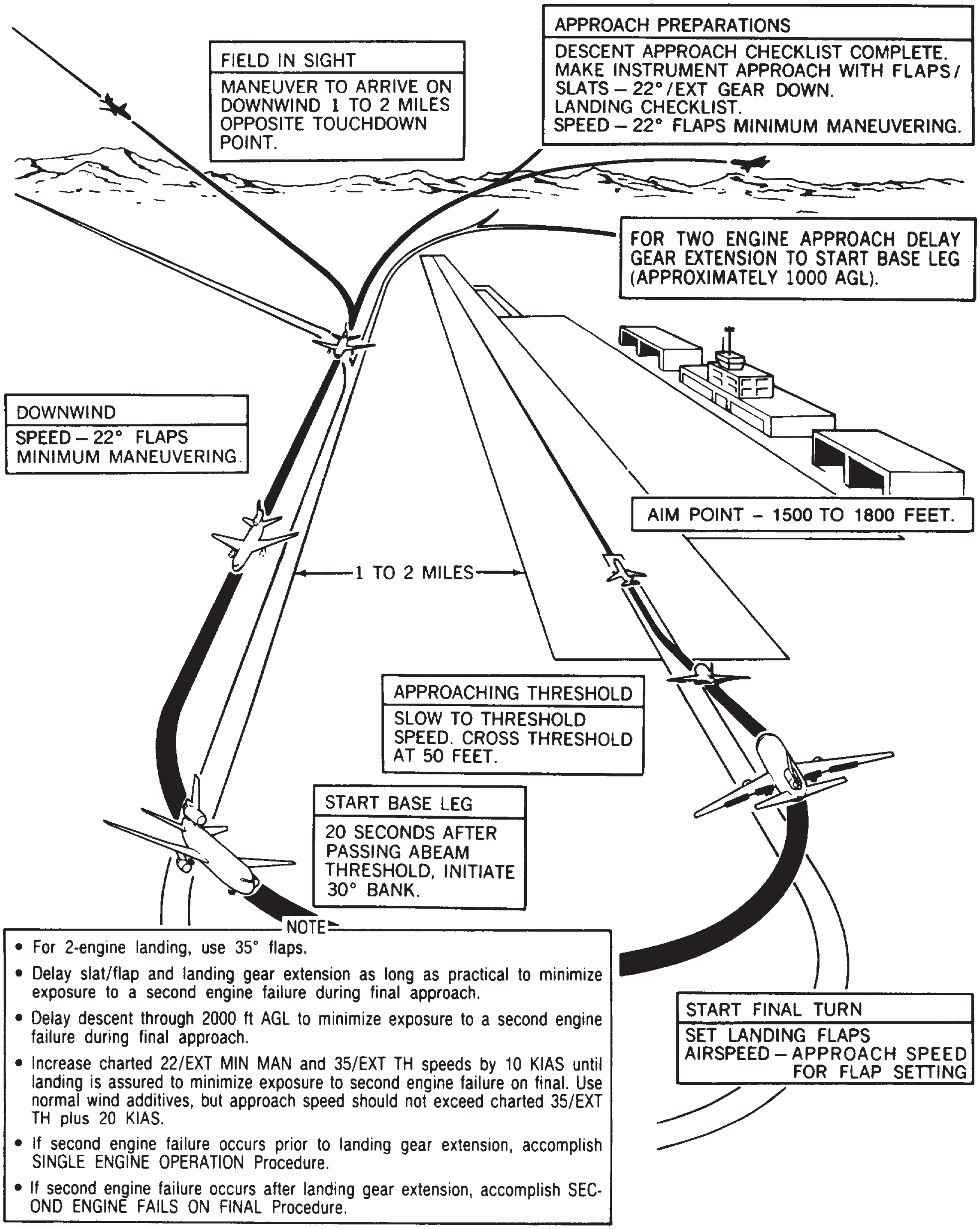
START ELAPSE TIME
BEGIN DESCENT

AIM POINT – 1500 TO 1800 FEET.

NOTE

- For 2-engine landing, use 35° flaps.
- Delay slat/flap and landing gear extension as long as practical to minimize exposure to a second engine failure during final approach.
- Delay descent through 2000 ft AGL to minimize exposure to a second engine failure during final approach.
- Increase charted 22/EXT MIN MAN and 35/EXT TH speeds by 10 KIAS until landing is assured to minimize exposure to second engine failure on final. Use normal wind additives, but approach speed should not exceed charted 35/EXT TH plus 20 KIAS.
- If second engine failure occurs prior to landing gear extension, accomplish SINGLE ENGINE OPERATION Procedure.
- If second engine failure occurs after landing gear extension, accomplish SECOND ENGINE FAILS ON FINAL Procedure.

Figure 5-17. Three- and Two-Engine Non-Precision Approach and Landing (Straight In)



FIELD IN SIGHT

MANEUVER TO ARRIVE ON DOWNWIND 1 TO 2 MILES OPPOSITE TOUCHDOWN POINT.

APPROACH PREPARATIONS

DESCENT APPROACH CHECKLIST COMPLETE.
MAKE INSTRUMENT APPROACH WITH FLAPS/SLATS – 22°/EXT GEAR DOWN.
LANDING CHECKLIST.
SPEED – 22° FLAPS MINIMUM MANEUVERING.

FOR TWO ENGINE APPROACH DELAY GEAR EXTENSION TO START BASE LEG (APPROXIMATELY 1000 AGL).

DOWNWIND

SPEED – 22° FLAPS MINIMUM MANEUVERING.

AIM POINT - 1500 TO 1800 FEET.

APPROACHING THRESHOLD

SLOW TO THRESHOLD SPEED. CROSS THRESHOLD AT 50 FEET.

START BASE LEG

20 SECONDS AFTER PASSING ABEAM THRESHOLD, INITIATE 30° BANK.

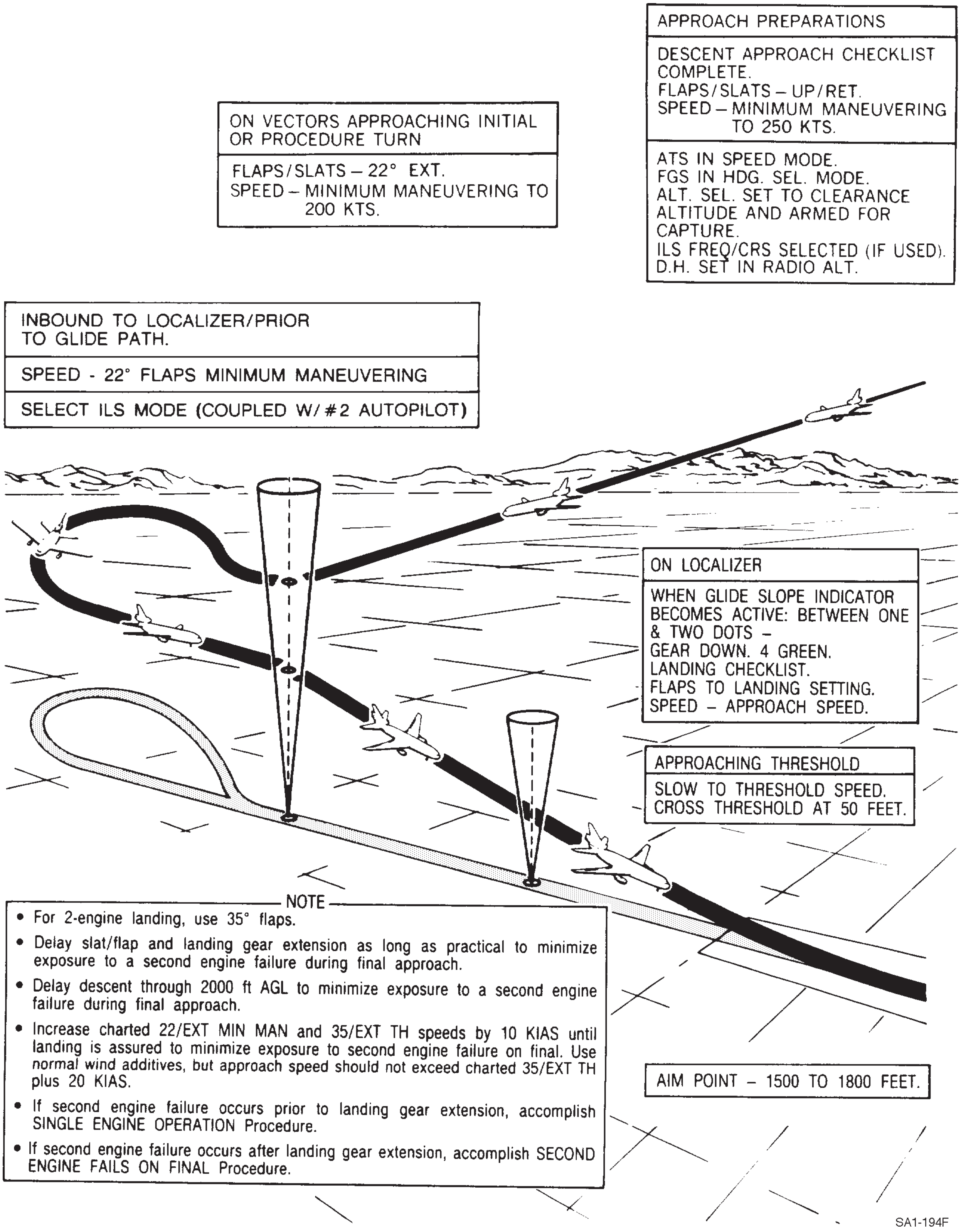
NOTE

- For 2-engine landing, use 35° flaps.
- Delay slat/flap and landing gear extension as long as practical to minimize exposure to a second engine failure during final approach.
- Delay descent through 2000 ft AGL to minimize exposure to a second engine failure during final approach.
- Increase charted 22/EXT MIN MAN and 35/EXT TH speeds by 10 KIAS until landing is assured to minimize exposure to second engine failure on final. Use normal wind additives, but approach speed should not exceed charted 35/EXT TH plus 20 KIAS.
- If second engine failure occurs prior to landing gear extension, accomplish SINGLE ENGINE OPERATION Procedure.
- If second engine failure occurs after landing gear extension, accomplish SECOND ENGINE FAILS ON FINAL Procedure.

START FINAL TURN

SET LANDING FLAPS
AIRSPEED – APPROACH SPEED FOR FLAP SETTING

Figure 5-18. Three- and Two-Engine Low Visibility Circling Approach



APPROACH PREPARATIONS

DESCENT APPROACH CHECKLIST COMPLETE.
FLAPS/SLATS – UP/RET.
SPEED – MINIMUM MANEUVERING TO 250 KTS.

ATS IN SPEED MODE.
FGS IN HDG. SEL. MODE.
ALT. SEL. SET TO CLEARANCE ALTITUDE AND ARMED FOR CAPTURE.
ILS FREQ/CRS SELECTED (IF USED).
D.H. SET IN RADIO ALT.

ON VECTORS APPROACHING INITIAL OR PROCEDURE TURN

FLAPS/SLATS – 22° EXT.
SPEED – MINIMUM MANEUVERING TO 200 KTS.

INBOUND TO LOCALIZER/PRIOR TO GLIDE PATH.

SPEED - 22° FLAPS MINIMUM MANEUVERING

SELECT ILS MODE (COUPLED W/ #2 AUTOPILOT)

ON LOCALIZER

WHEN GLIDE SLOPE INDICATOR BECOMES ACTIVE: BETWEEN ONE & TWO DOTS -
GEAR DOWN. 4 GREEN.
LANDING CHECKLIST.
FLAPS TO LANDING SETTING.
SPEED – APPROACH SPEED.

APPROACHING THRESHOLD

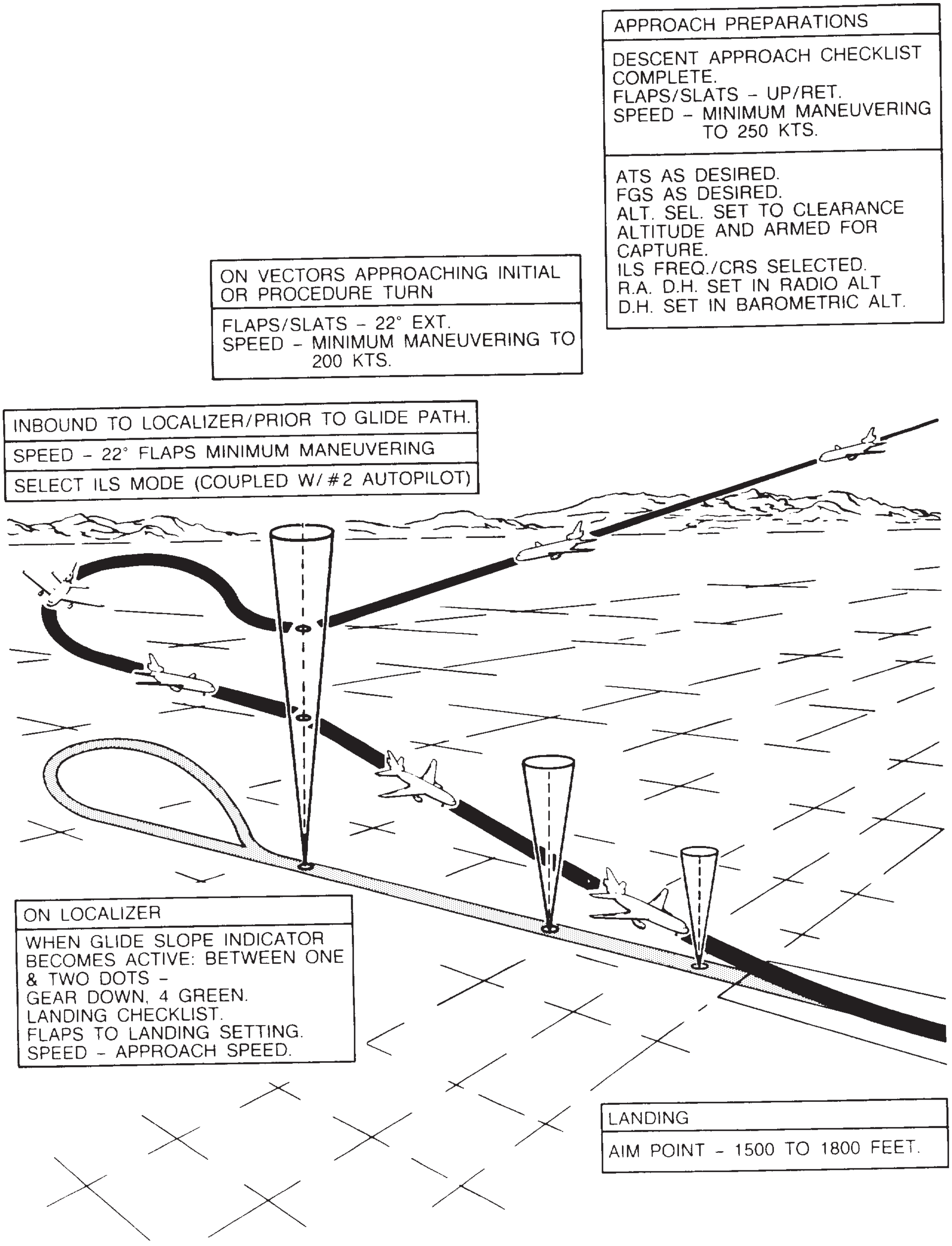
SLOW TO THRESHOLD SPEED.
CROSS THRESHOLD AT 50 FEET.

NOTE

- For 2-engine landing, use 35° flaps.
- Delay slat/flap and landing gear extension as long as practical to minimize exposure to a second engine failure during final approach.
- Delay descent through 2000 ft AGL to minimize exposure to a second engine failure during final approach.
- Increase charted 22/EXT MIN MAN and 35/EXT TH speeds by 10 KIAS until landing is assured to minimize exposure to second engine failure on final. Use normal wind additives, but approach speed should not exceed charted 35/EXT TH plus 20 KIAS.
- If second engine failure occurs prior to landing gear extension, accomplish SINGLE ENGINE OPERATION Procedure.
- If second engine failure occurs after landing gear extension, accomplish SECOND ENGINE FAILS ON FINAL Procedure.

AIM POINT – 1500 TO 1800 FEET.

Figure 5-19. Three- and Two-Engine ILS Approach and Landing (Manual or Single Autopilot)



APPROACH PREPARATIONS

DESCENT APPROACH CHECKLIST COMPLETE.
FLAPS/SLATS – UP/RET.
SPEED – MINIMUM MANEUVERING TO 250 KTS.

ATS AS DESIRED.
FGS AS DESIRED.
ALT. SEL. SET TO CLEARANCE ALTITUDE AND ARMED FOR CAPTURE.
ILS FREQ./CRS SELECTED.
R.A. D.H. SET IN RADIO ALT
D.H. SET IN BAROMETRIC ALT.

ON VECTORS APPROACHING INITIAL OR PROCEDURE TURN

FLAPS/SLATS – 22° EXT.
SPEED – MINIMUM MANEUVERING TO 200 KTS.

INBOUND TO LOCALIZER/PRIOR TO GLIDE PATH.

SPEED – 22° FLAPS MINIMUM MANEUVERING

SELECT ILS MODE (COUPLED W/ #2 AUTOPILOT)

ON LOCALIZER

WHEN GLIDE SLOPE INDICATOR BECOMES ACTIVE: BETWEEN ONE & TWO DOTS –
GEAR DOWN, 4 GREEN.
LANDING CHECKLIST.
FLAPS TO LANDING SETTING.
SPEED – APPROACH SPEED.

LANDING

AIM POINT – 1500 TO 1800 FEET.

Figure 5-20. Three-Engine ILS Approach and Landing (Category II (Typical))

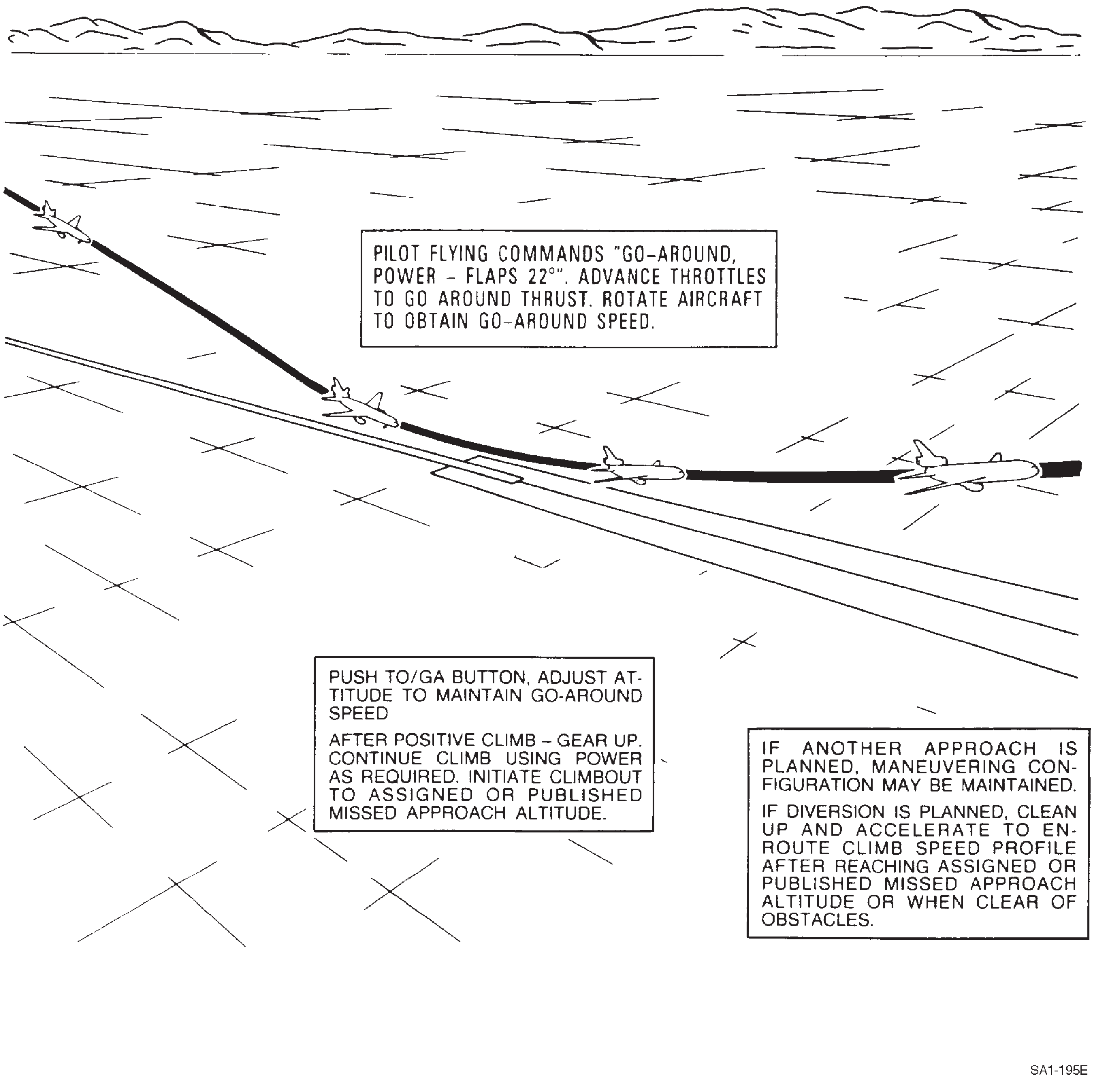
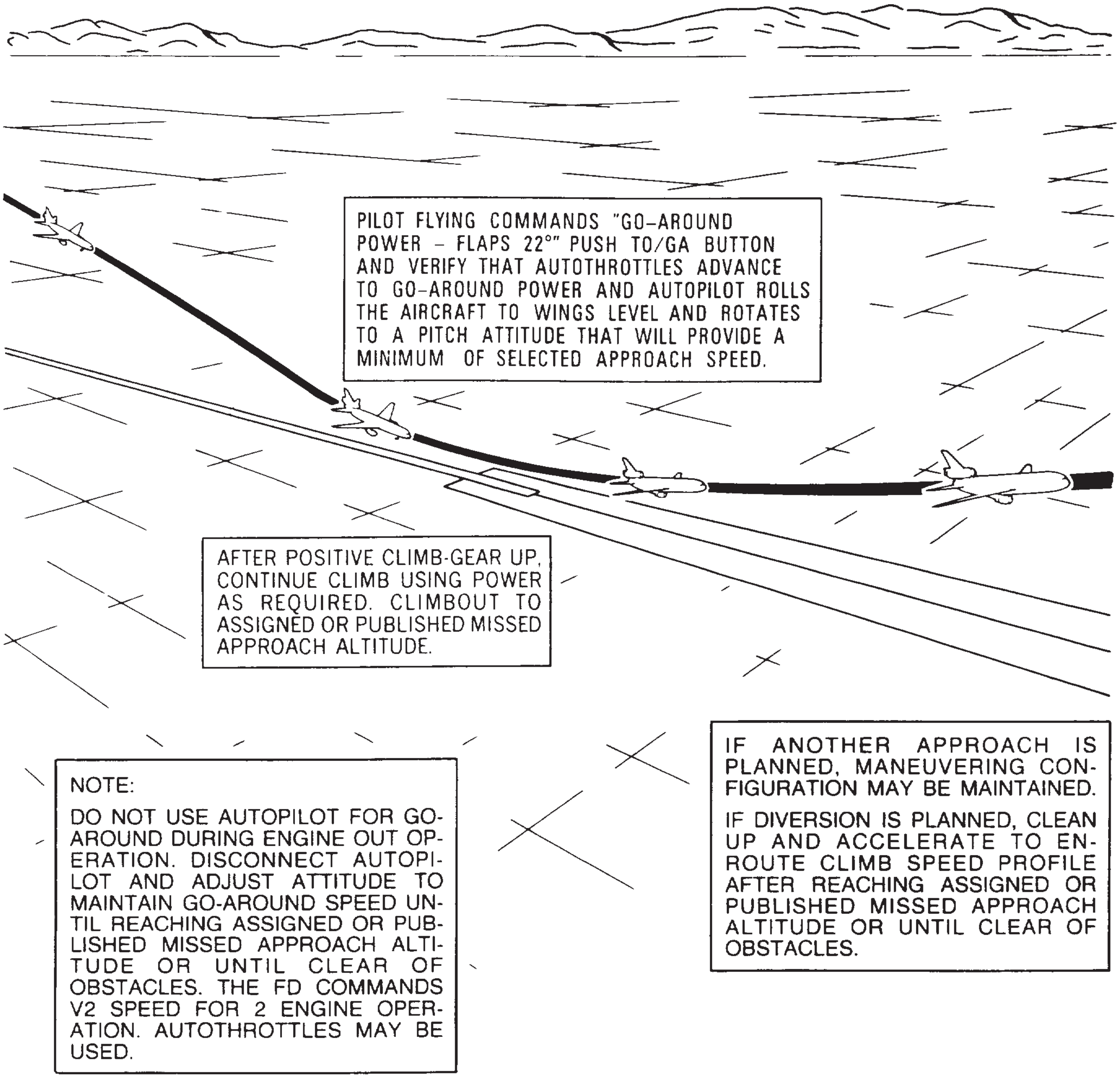


Figure 5-21. Missed Approach or Rejected Landing (Manual)



PILOT FLYING COMMANDS "GO-AROUND POWER – FLAPS 22°" PUSH TO/GA BUTTON AND VERIFY THAT AUTOTHROTTLES ADVANCE TO GO-AROUND POWER AND AUTOPILOT ROLLS THE AIRCRAFT TO WINGS LEVEL AND ROTATES TO A PITCH ATTITUDE THAT WILL PROVIDE A MINIMUM OF SELECTED APPROACH SPEED.

AFTER POSITIVE CLIMB-GEAR UP, CONTINUE CLIMB USING POWER AS REQUIRED. CLIMBOUT TO ASSIGNED OR PUBLISHED MISSED APPROACH ALTITUDE.

IF ANOTHER APPROACH IS PLANNED, MANEUVERING CONFIGURATION MAY BE MAINTAINED.

IF DIVERSION IS PLANNED, CLEAN UP AND ACCELERATE TO ENROUTE CLIMB SPEED PROFILE AFTER REACHING ASSIGNED OR PUBLISHED MISSED APPROACH ALTITUDE OR UNTIL CLEAR OF OBSTACLES.

NOTE:

DO NOT USE AUTOPILOT FOR GO-AROUND DURING ENGINE OUT OPERATION. DISCONNECT AUTOPILOT AND ADJUST ATTITUDE TO MAINTAIN GO-AROUND SPEED UNTIL REACHING ASSIGNED OR PUBLISHED MISSED APPROACH ALTITUDE OR UNTIL CLEAR OF OBSTACLES. THE FD COMMANDS V2 SPEED FOR 2 ENGINE OPERATION. AUTOTHROTTLES MAY BE USED.

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Figure 5-22. Missed Approach or Rejected Landing (Auto)

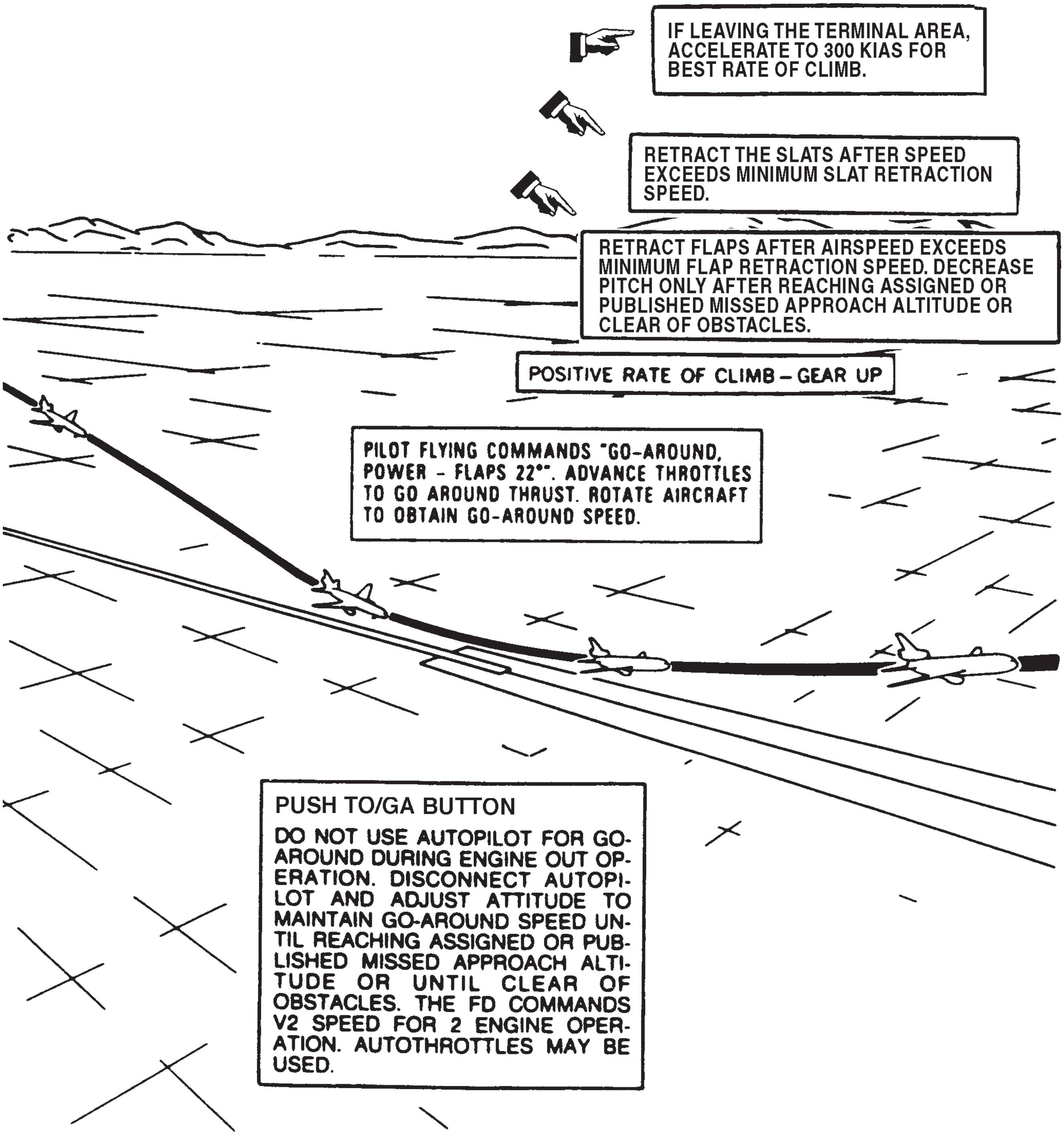


Figure 5-23. Two Engine Missed Approach or Rejected Landing

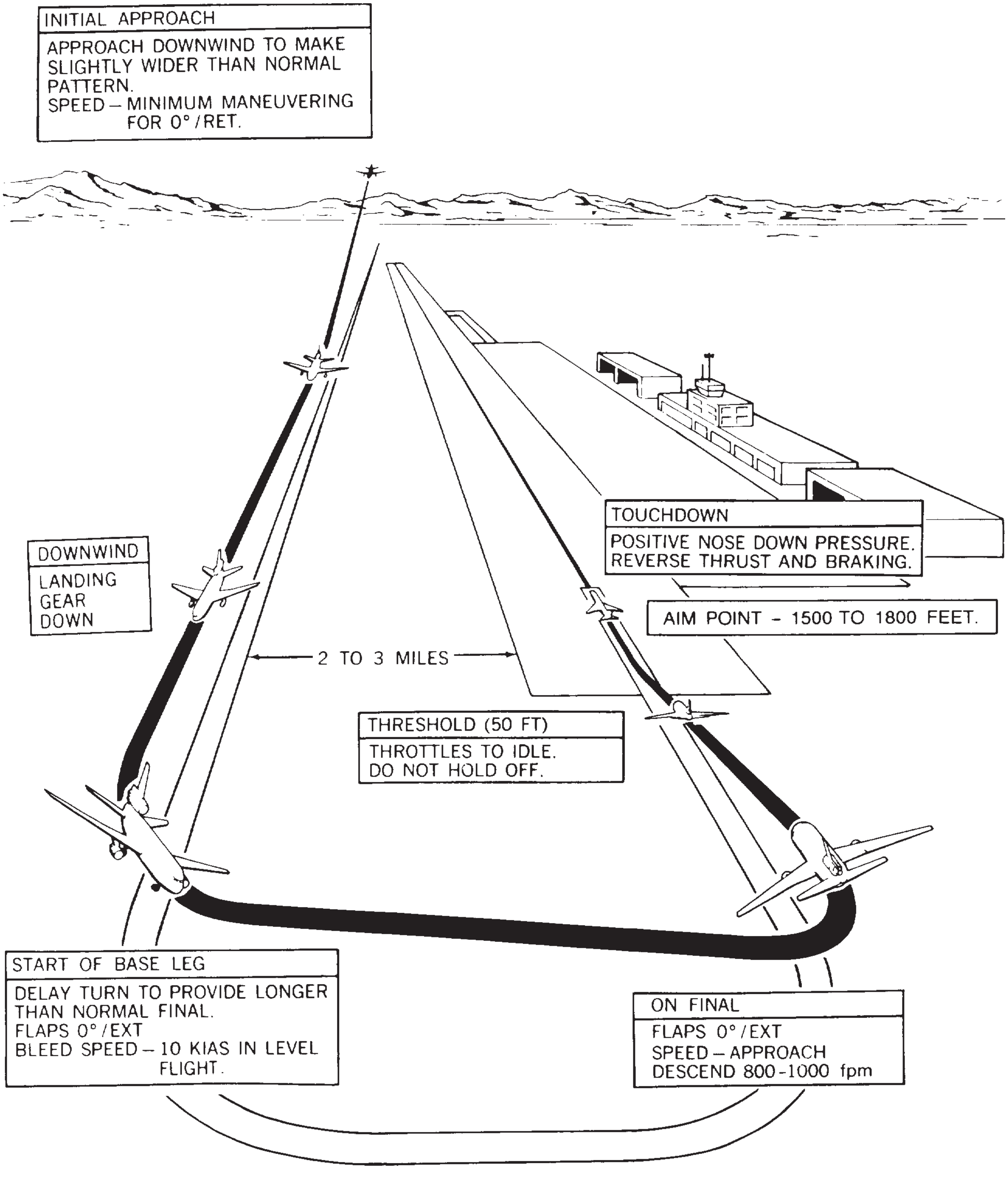


Figure 5-24. Asymmetric Flaps or No Flap Landing With Slats

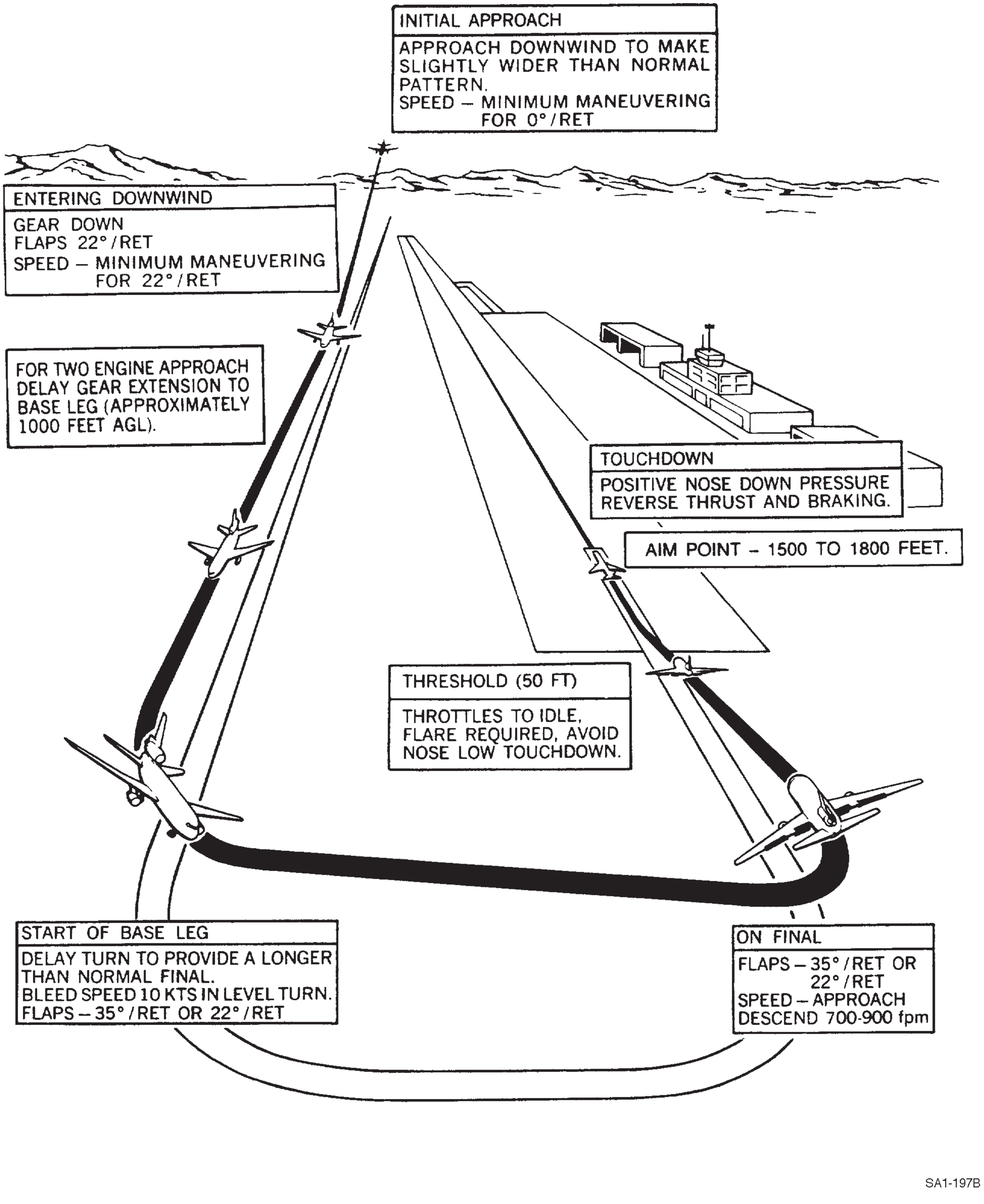
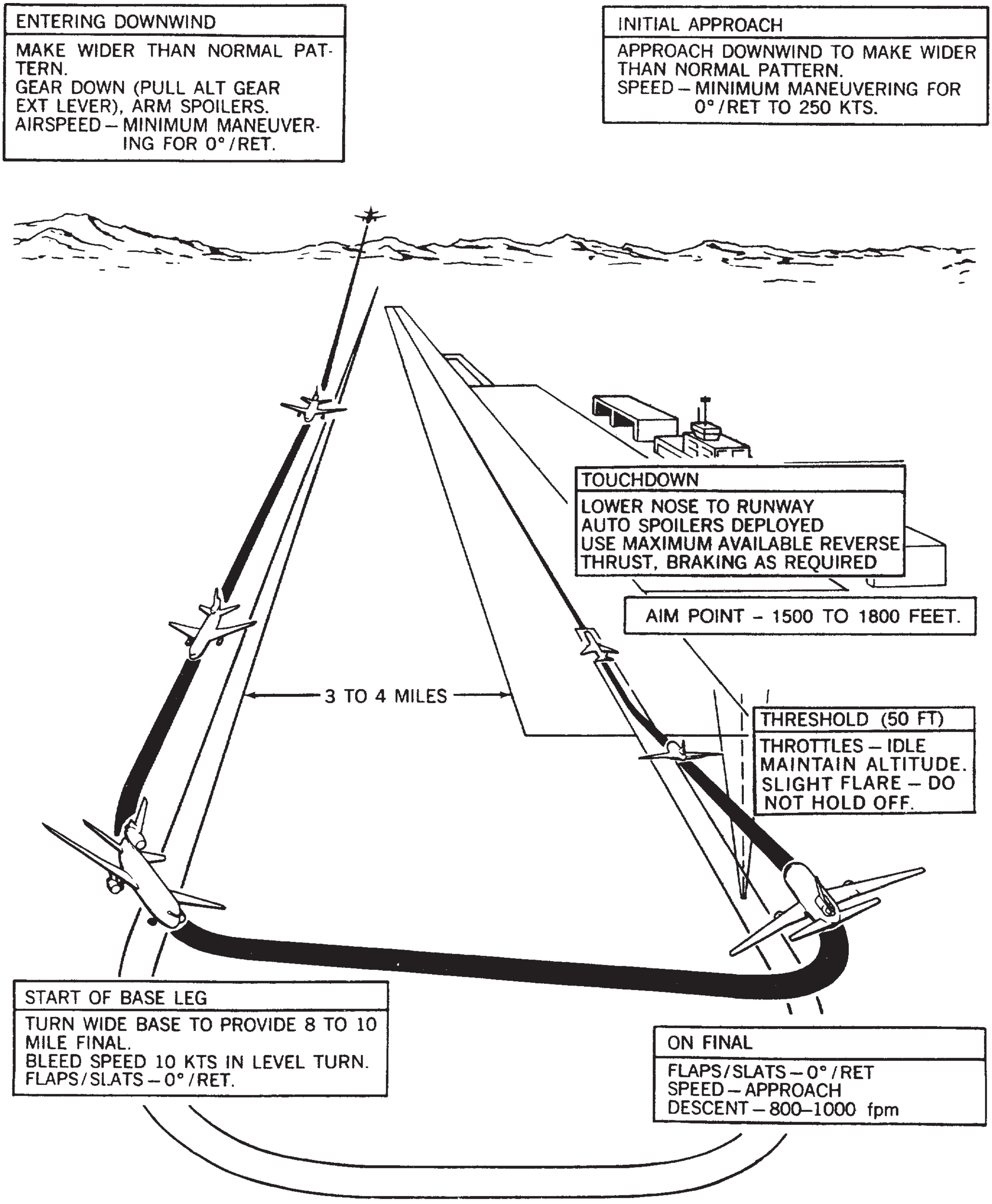


Figure 5-25. Asymmetric Slats or No Slat Landing With Flaps



ENTERING DOWNWIND

MAKE WIDER THAN NORMAL PATTERN.
GEAR DOWN (PULL ALT GEAR EXT LEVER), ARM SPOILERS.
AIRSPEED – MINIMUM MANEUVERING FOR 0°/RET.

INITIAL APPROACH

APPROACH DOWNWIND TO MAKE WIDER THAN NORMAL PATTERN.
SPEED – MINIMUM MANEUVERING FOR 0°/RET TO 250 KTS.

TOUCHDOWN

LOWER NOSE TO RUNWAY
AUTO SPOILERS DEPLOYED
USE MAXIMUM AVAILABLE REVERSE THRUST, BRAKING AS REQUIRED

AIM POINT - 1500 TO 1800 FEET.

THRESHOLD (50 FT)

THROTTLES – IDLE
MAINTAIN ALTITUDE.
SLIGHT FLARE – DO NOT HOLD OFF.

START OF BASE LEG

TURN WIDE BASE TO PROVIDE 8 TO 10 MILE FINAL.
BLEED SPEED 10 KTS IN LEVEL TURN.
FLAPS/SLATS – 0°/RET.

ON FINAL

FLAPS/SLATS – 0°/RET
SPEED – APPROACH
DESCENT – 800–1000 fpm

Figure 5-26. No Flap/No Slat Landing

SECTION VI

FLIGHT CHARACTERISTICS

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FLIGHT CHARACTERISTICS

STALL CHARACTERISTICS DESCRIPTION

Stall characteristics of the KC-10A aircraft are excellent in all configurations throughout the operating weight and center of gravity (CG) range. The characteristics are generally the same at both forward and aft CG. No adverse rolling or pitch-up tendencies occur and controllability approaching the stall is excellent. As in all swept-wing aircraft with present design concepts, the inboard sections of the wings fly at a higher angle of attack than do the outboard sections. The slat deflection is also designed so that when the aircraft is flown into a stall, the inboard sections of the wings stall prior to the outboard sections, assuring a pitch-down.

STALL WARNING

For good stall warning characteristics in all configurations, it is desirable that a clear and distinctive warning be provided prior to the actual stall. The aircraft has some pre-stall aerodynamic buffet prior to the stall in all configurations. The intensity of the aerodynamic buffet is greatest in the clean configuration, gradually decreasing as slats and flaps are extended. Even though some aerodynamic buffet is known to exist in all flap settings, at landing flap settings, the flap buffet level will increase to a point where it may mask the aerodynamic stall buffet.

In addition to the aerodynamic stall buffet, the KC-10A has an artificial stall warning system consisting of two angle-of-attack sensors or probes, one on each side of the nose of the aircraft, and two stall warning computers which function as part of the autothrottle/ speed control computer units. Schedules of angle of attack versus configuration for stick shaker actuation are programmed into the computers. When the probe angle-of-attack information matches the preprogrammed angle of attack for stall warning, the control column stick shaker is actuated.

CAUTION

> When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

AUTOMATIC SLAT EXTENSION (ASE)

In the clean configuration, the approach to the stall may be characterized by more lateral control activity. Considerable buffeting will be noted. The ASE system has been incorporated to eliminate the tendency for wing-dropping in the stall. This single-actuated system is designed so that at an angle-of-attack less than the actual clean configuration stall angle-of-attack, only the slats outboard of the engines will extend automatically to a predetermined position, and the stick shaker will be actuated. As previously mentioned, this will occur only for the clean configuration and not at speeds in excess of the maximum slats extended speed. Lateral control with ASE is excellent up to and through the stall. The buffet intensity will increase as the angle of attack is increased, and provides a positive deterrent to continuing to increase angle of attack beyond the stall. The actual speeds at which shaker and ASE actuate are equal to, or greater than, the required percentage above the minimum FAA stall speeds.

RECOVERY FROM APPROACH TO STALL

At first indication of approach to stall, immediately disengage autopilot and autothrottles, be alert for possible mistrim condition, simultaneously apply maximum available thrust, level wings and adjust pitch as required to minimize altitude loss. In an emergency situation (i.e., encountering a downdraft or decreased performance wind shear condition), positive climb performance and limited maneuver margins still exist at or near stick shaker actuation speed. High pitch attitudes are to be expected; however, pitch attitude should not be increased so rapidly that airspeed decreases below stick shaker actuation speed.

First indication of approach to stall may be one or any combination of the following:

- Rapid decrease of airspeed below bug setting.
- Rapid decrease of climb rate during takeoff or go-around.
- Rapid increase of sink rate during approach.
- Stick shaker or initial stall buffet.

If ground contact is imminent, apply maximum available thrust (up to throttle mechanical stops) for the time required to recover from the situation.

NOTE

> After a maximum thrust application (overboost), those engine parameters which exceeded the time limits and the duration will require an AFTO Form 781 entry.

Below 15,000 feet, approach to stall is usually annunciated first by stick shaker.

Between 15,000 and 25,000 feet, stick shaker may be preceded by low speed buffet.

CAUTION

> When climbing in the Vertical Speed mode, the airspeed must be closely monitored. In the Vertical Speed mode, the autopilot will attempt to maintain the programmed climb rate, regardless of airspeed or Mach number. The autopilot will command the stabilizer trim and elevator to maintain this rate of climb and the engines may not produce sufficient thrust to maintain the airspeed, due to gross weight and high altitudes.

Above 25,000 feet, stall can occur prior to stick shaker with buffet serving as the only stall warning.

Special buffet recovery procedures are required for speeds between 0.81 and 0.84 M. The buffet curves peak at approximately 0.825 M. When operating near these peaks, small increases in Mach may result in high speed (Mach) buffet, while small decreases can result in low speed (stall) buffet. If buffet occurs at these speeds, level wings. If buffet persists, descent to a lower altitude at 0.82 - 0.83 is recommended.

Buffet occurring at speeds above 0.84 M is not an indication of an impending stall. In this case, level wings and reduce speed to not less than 0.825 M to eliminate high speed buffet. Again, if buffet persists, descent to a lower altitude at 0.82 - 0.83 M is recommended.

Clean Configuration

First indication of approach to stall:

1. Apply maximum available thrust.
2. Adjust pitch as required to minimize altitude loss.
3. Extend slats (below IAS/MACH slat limit).
4. Accelerate to appropriate airspeed.

At altitudes where performance is limited:

1. Accept an altitude loss while accelerating to clean minimum maneuvering speed.
2. Adjust configuration as appropriate, then return to desired altitude and airspeed.

NOTE

> Premature recovery may result in a secondary stall or inability to accelerate to cruise Mach with thrust available.

Takeoff, Approach, Landing, or Go-Around Configuration

First indication of approach to stall:

1. Apply maximum available thrust.
2. Adjust pitch as required to minimize altitude loss or to provide obstacle clearance. Do not reduce speed below stick shaker actuation.

3. Maintain existing flap/slat and gear configuration.
4. If ground contact is imminent, apply maximum thrust (up to throttle mechanical stops).
5. Accelerate to minimum maneuvering speed for existing configuration, then adjust configuration as desired.

CRUISE-CONFIGURATION BUFFET

The inherent aerodynamic characteristics of the KC-10A aircraft provide excellent warning of approach to published buffet boundary limits in all configurations throughout the operating weight and center-of-gravity (CG) ranges. Buffet intensity is greatest in the cruise configuration, gradually decreasing as slats and flaps are extended. In the cruise configuration, these inherent characteristics provide early warning of approach to the published buffet boundary followed by strong buffet which should preclude driving further into buffet. Adequate buffet protection is provided by adhering to the 1.2g buffet-speed limit with the appropriate speed additives and CG corrections as presented in TO 1C-10(K)A-1-1. Cruise configuration buffet characteristics are also discussed in Section III, Limitations.

CAUTION

Operation in regions of moderate to heavy aircraft buffet should be avoided. Airframe damage could result.

AERODYNAMIC STRAKES

On each wing-mounted engine nacelle is found a small and slightly unusual feature of the KC-10A. Protruding from the outside of the nacelle leading edge, at 45° from the vertical on each side, is a pair of ear-like devices called strakes (figure 6-1). These are really second cousins to the small vortex generators found in rows on the wing and tail surfaces of some jet aircraft. These strakes produce strong vertices which sweep over the top of the wing, counteracting the wind-nacelle-pylon airflow interference at high angles of attack; this helps to reduce the stalling speed and improve the drag in the critical second segment phase of takeoff. The favorable effect of these vertices was discovered in the wind tunnel, but the final configuration (size and location) was developed in flight tests. The cruise drag resulting from the strakes amounts to less than 0.1 percent of the total drag; this is negligible, especially when considering the improved low-speed performance with the strakes.

The principle of the strake is that as the angle of attack increases, a vortex is shed from the strake and sweeps over the pylon/wing intersection. On moist days, this vortex can be seen at high angles of attack. As the wing approaches the stall, this vortex lies right down on the upper wing surface resulting in an aerodynamic cleaning action, delaying separation. The stall speeds achieved in flight test with the strakes were slightly better than predicted with landing flaps, and the stall speeds were several knots better than originally predicted with takeoff flap settings.

SPINS

Spins are a prohibited maneuver in this aircraft. If a spin is entered inadvertently, recovery shall be started immediately. Inadvertent spins can best be avoided by recovering immediately from any stall condition. Maintain adequate speed margin above stall and avoid large yaw rates during engine(s) out flight.

NORMAL SPINS

In case a spin is entered inadvertently, initiate the following spin recovery procedure. Reduce thrust to idle and immediately apply full rudder against spin. Retract speedbrakes (speedbrakes are no help in a spin). Position the flap/slat handle to 0°/EXTEND. Move the landing gear handle to UP. Apply down elevator and roll aileron into spin direction. If spin rotation does not stop, apply asymmetric thrust against the spin rotation.

As spin rotation stops, neutralize the rudder to avoid entering a spin in the opposite direction. Return the throttles to idle, if asymmetric thrust was applied. Recover from the dive attitude by using elevator and stabilizer trim as necessary. Extend the speedbrakes to prevent speed from building up rapidly during the recovery.

UPSET RECOVERY

The following techniques represent a logical progression for recovering the aircraft. The sequence of actions is for guidance only and represents a series of options to be considered and used, depending on the situation. Not all the actions may be necessary once recovery is underway. If needed, use pitch trim sparingly. Careful use of the rudder to aid in roll control should be considered only if the roll control is ineffective and the aircraft is not stalled.

These techniques assume the aircraft is not stalled. If the aircraft is stalled, recovery from the stall must be accomplished using the stall recovery procedures in this section.

RECOVERY TECHNIQUES

An upset can generally be defined as unintentionally exceeding one or more of the following conditions.

- Pitch attitude greater than 25° nose up or 10° nose down.
- Bank angle greater than 45°.
- Within the above paramaters, but flying at airspeeds inappropriate for the conditions.

NOSE HIGH RECOVERY

At the first indication of a nose high upset:

1. Recognize and confirm situation.
2. Disconnect autopilot and autothrottles.
3. Apply as much as a full nose down elevator.
4. Apply appropriate nose down stabilizer trim.
5. Thrust as appropriate.
6. Roll (adjust bank angle to as much as 60°) to obtain a nose down pitch rate.
7. Complete the recovery;
    a. When approaching the horizon, roll wings level.
    b. Check airspeed and adjust thrust.
    c. Establish pitch attitude.

WARNING

Excessive use of pitch trim or rudder may aggravate an upset situation or may result in loss of control and/or high structural loads.

NOSE LOW RECOVERY

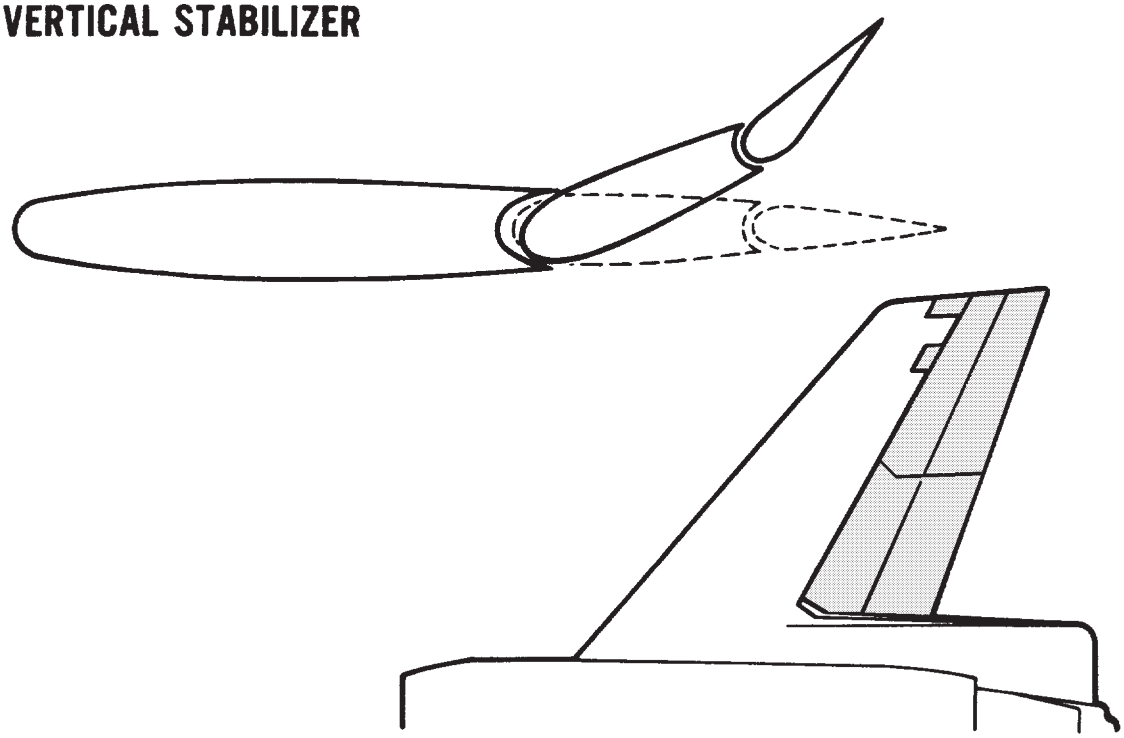
At the first indication of a nose low upset:

1. Recognize and confirm situation.
2. Disconnect autopilot and autothrottles.
3. Roll in the shortest direction to wings level (unload and roll if bank angle is more than 90°).
4. Recover to level flight:
    a. Apply nose up elevator.
    b. Apply nose up trim, if required.
    c. Adjust thrust and drag as required.

WARNING

Excessive use of pitch trim or rudder may aggravate an upset situation or may result in loss of control and/or high structural loads.

VERTICAL STABILIZER



AERODYNAMIC STRAKES

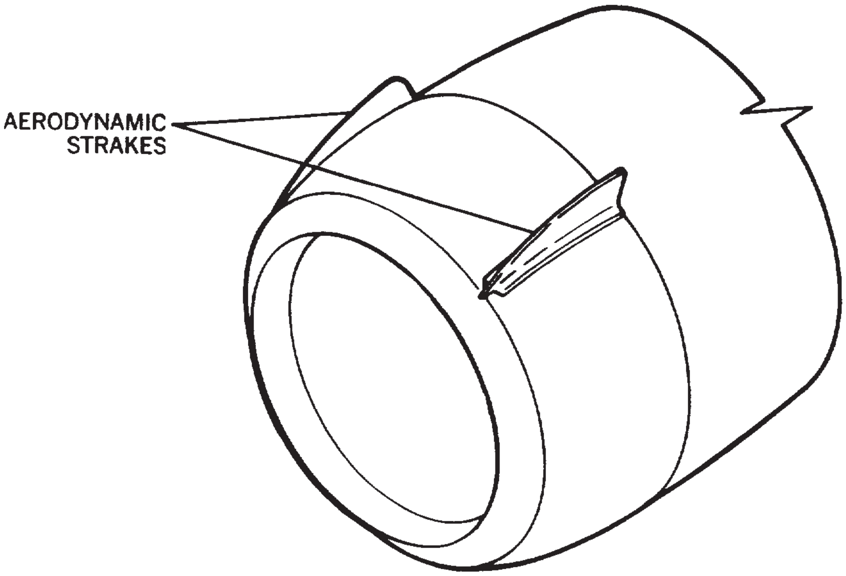


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Figure 6-1. Vertical Stabilizer/Aerodynamic Strakes

STABILITY CHARACTERISTICS DESCRIPTION

Aircraft stability characteristics result from the inherent static and dynamic design. The inherent stability of the aircraft determines its reaction to a disturbance from trimmed flight either from external conditions such as gusts, or from internally generated pilot inputs. The higher the stability of the aircraft, the greater the tendency to remain in or return to the trimmed condition and, therefore, the greater force or control position change required to deviate from that trimmed condition. There is an optimum balance of stability and controllability which will result in satisfactory flying qualities and also minimize pilot workload both in trimmed and maneuvering flight. The KC-10A may be described as having excellent stability characteristics and controllability throughout the normal flight envelope.

Definitions of the various stability terms and stability characteristics are presented in the following paragraphs.

STATIC STABILITY

The static stability of an aircraft is defined as the initial tendency to return to a trimmed condition following some disturbance from that condition. The actual movement of the aircraft is not considered. If the aircraft only tends to return to trim, it has a positive static stability (sometimes referred to as statically stable). If the aircraft tends to continue departing from the original trimmed condition it then demonstrates negative static stability (statically unstable). If, however, it remains steady at the disturbed position and with no divergent tendencies, the aircraft has neutral static stability (statically neutral).

DYNAMIC STABILITY

The dynamic stability of an aircraft is determined by the time history of the resultant aircraft motion following a disturbance from trimmed flight.

The first three dynamic stability modes described are referred to as non-oscillatory modes (figure 6-2). If the aircraft has negative static stability, it will continue to diverge from the trimmed condition and will also have negative dynamic stability (dynamically unstable). This behavior is termed divergence. If the aircraft has neutral static stability, the disinclination for motion also indicates neutral dynamic stability. If an aircraft has positive static stability, any of four dynamic stability modes may occur. If the aircraft returns to and maintains the trimmed condition after the initial disturbance without overshooting, it has positive dynamic stability. This specific behavior is usually called subsidence or deadbeat return. If the aircraft passes through the original trim condition after its initially stable static reaction, any of three oscillatory dynamic modes may ensure. First, if the aircraft regains the trim condition after one or more overshoots of decreasing amplitude, positive dynamic stability is being exhibited. Second, if the aircraft continues undampened oscillation around the trim point without any amplitude change, the aircraft has neutral dynamic stability. Finally, if the aircraft continues oscillating about the trim point while increasing its displacement from time to time, it has negative dynamic stability. These six modes are shown in figure 6-2.

LONGITUDINAL STABILITY

As previously discussed, static and dynamic longitudinal stability are a measure of the tendency of the aircraft to return to trim after a disturbance and the characteristic motion in doing so. Static longitudinal stability causes the aircraft to resist any displacement force such as gusts or pilot inputs and so, the more stable the aircraft, the less its tendency to deviate from trimmed conditions. For a stable aircraft, incremental push or pull forces are required to fly at speeds above or below the trim speed. Good flying characteristics result from a combination of static and dynamic longitudinal stability sufficient to ensure that the aircraft remains at the desired trim conditions while simultaneously retaining an ease of maneuverability.

There are many factors influencing the longitudinal stability of an aircraft. Power effects, fuselage, engine nacelles, and wing all contribute to the stabilizing or destabilizing effects. The horizontal tail, however, provides the greatest stabilizing influence. The KC-10A has been designed so that positive static and dynamic longitudinal stability characteristics exist throughout the normal operating envelope.

TRANSONIC TUCK

At speeds below critical Mach number, the pressure distribution over the wings is such that the center of lift approximates the 25 percent chord position. As flight speed increases above the critical Mach number into the transonic range and supersonic flow occurs on the wing, with its attendant shock waves, the pressure distribution changes and the center of lift starts to move rearward. This change tends to introduce a gradually increasing nosedown pitching moment, the magnitude of which will depend on aircraft stability, as well as other factors. Additional effects may also occur and contribute to this condition although the pressure change is the most prominent cause. The overall effect of these pressure changes is generally destabilizing in terms of required counterforce and the phenomenon has come to be known as transonic tuck. In some aircraft, as Mach number is further increased, stability may tend to become more positive. If the conditions were such that the aircraft continued to diverge (stability continued to be negative) and the Pilot took no action, the aircraft would continue to nose over and, with increasing speed, become continuously more unstable.

Flight tests have shown that the problem of transonic tuck does not exist and the aircraft does not become unstable within the flight envelope. Because of this, no mechanical compensation is required.

LATERAL/DIRECTIONAL STABILITY

Some of the basic discussion on longitudinal stability applies as well to lateral/directional stability. Lateral and directional stability are usually considered together as a result of their influence upon each other. There is also some effect on longitudinal motion but this discussion pertains only to the more obvious and familiar lateral-directional effects. In general, the KC-10A has excellent overall lateral-directional stability characteristics.

Static lateral and directional stability is positive throughout the normal operating range of the aircraft. Of interest in this discussion is the dihedral effect or roll due to yaw which is covered in a subsequent paragraph.

Dynamic lateral-directional stability is particularly important for a high-speed jet transport. The two modes of motion of interest in connection with dynamic stability are the Dutch roll and spiral modes which will also be discussed.

DIHEDRAL EFFECT

The rolling tendency of an aircraft due to yaw, referred to as dihedral effect, is desirable because of the tendency for the wings to return to a level condition after a lateral upset. The ability to pick up a wing with rudder as a result of yawing the aircraft (i.e., producing sideslip) is also desirable. The swept wing aircraft usually has positive dihedral effect because during yaw the leading wing has less effective sweep than the trailing wing. This condition provides higher lift on the leading wing thus rolling the aircraft in a motion which will tend to subsequently return the aircraft to a wings level balanced flight condition. In addition, some actual wing dihedral is usually provided to ensure an adequate dihedral effect level.

Dihedral effect is considered to be positive by definition because the aircraft rolls in the direction of induced yaw, i.e., using the left rudder to start a left yaw will induce a tendency to roll left (or opposite to the direction of sideslip). This position dihedral effect is strongest at slower speeds (highest lift configuration - but not stalled). At higher speeds, however, it is possible for this characteristic to reverse, resulting in negative dihedral effect or roll opposite to the induced yaw. The reason for this reversal is that when aircraft Mach number is sufficiently high, the effective Mach number on the leading wing increases during a lateral upset or induced yaw. Attendant with this increase in effective Mach number is an increase in compressibility effects which will result in loss of lift due to shock-induced separation. In the KC-10A, dihedral effect is positive throughout the normal operating envelope of the aircraft.

DUTCH ROLL

One of the more familiar dynamic stability modes is the Dutch roll or lateral/directional oscillatory motion. This is a rolling and yawing motion of an aircraft which generally follows a disturbance about the roll or yaw (directional) axis. Dutch roll is usually encountered on high-performance aircraft with considerable wing sweep and high wing loading while operating at maximum altitudes. It is also sometimes referred to as a nuisance mode because in most instances, the motion is not deliberately initiated by the pilot, but is inadvertently introduced by external disturbances.

The KC-10A is controllable under all normal operating conditions without stability augmentation. As the maximum operating altitude is approached, the Dutch roll stability will become less positive and, although controllable by the pilot, would be uncomfortable for the passengers. For ease of operation and increased passenger comfort at very high altitudes, series yaw damping has been provided.

SPIRAL STABILITY

Another facet of dynamic stability is the spiral mode which is interrelated with the Dutch roll mode. The two are never compatible because a number of aerodynamic parameters which improve the Dutch roll adversely affect the spiral mode and vice-versa. The design of an aircraft is usually a median compromise of the two stability requirements. Although the tendency is to design for greater positive Dutch roll stability at the sacrifice of some spiral stability, the aircraft has excellent spiral stability characteristics and is always spirally stable with the yaw dampers operating.

SPEED STABILITY

The term speed stability is sometimes mistakenly used to describe static longitudinal stability as measured by the variation of column force versus speed. Speed stability, more accurately, defines the tendency of an aircraft to return to an initially stabilized speed after a disturbance, by virtue of the variations in thrust and drag with speed (holding a constant flight path angle and throttle setting).

Positive speed stability results from a deceleration with increasing speed and an acceleration with decreasing speed. From drag considerations, an aircraft generally has positive speed stability above the minimum drag speed and negative speed stability below the minimum drag speed. However, the thrust at a fixed throttle position also varies with speed, decreasing as speed increases. Neutral speed stability exists where the thrust and drag curves have the same slope. The speed for neutral stability is therefore slightly slower than the minimum drag speed as shown in figure 6-2 at point A.

Operating in conditions of negative speed stability where a reduction in speed results in a deceleration is commonly referred to as operating on the back side of the drag curve. In this region (figure 6-2, point B) it is necessary to advance the throttles to regain lost airspeed and retard throttles to lose excess airspeed while maintaining the glideslope or level flight. Increased pilot workload is the usual result.

Operation at minimum A/R speeds, holding speeds and/or maximum endurance speeds may be conducted at or slightly below the minimum drag speeds in the negative stable speed regime.

Speed stability is of utmost importance during the approach and landing phases. The KC-10A approach speeds are at (or very close to) the minimum drag speeds in the neutral speed stability region. Because the flare speeds are the slowest airspeeds flown during the landing approach, operation in regions of noticeable negative stability should never be encountered.

SLAT OSCILLATION

Slat Oscillation is an inherent phenomenon of the slat system. Flight tests have shown that this oscillation occurs when the aircraft maintains a specific angle of attack (AOA) of approximately 8.5° with slats extended. Wing pods accelerate/intensify this condition. The cumulative effects of slat cable stretching due to extended flight with slats extended contributes to slat oscillation problems. Flight testing verified that small changes in AOA normally eliminate slat oscillation.

Clean Aircraft

Aircraft without WARPs should not normally experience slat oscillation. If a non-WARP equipped aircraft experiences slat oscillation, follow the Slat Oscillation Corrective Steps to eliminate the oscillation. Slat oscillation on a non-wing pod equipped aircraft is abnormal and an AFTO FORM 781A entry shall be made, as slat-rigging maintenance is required.

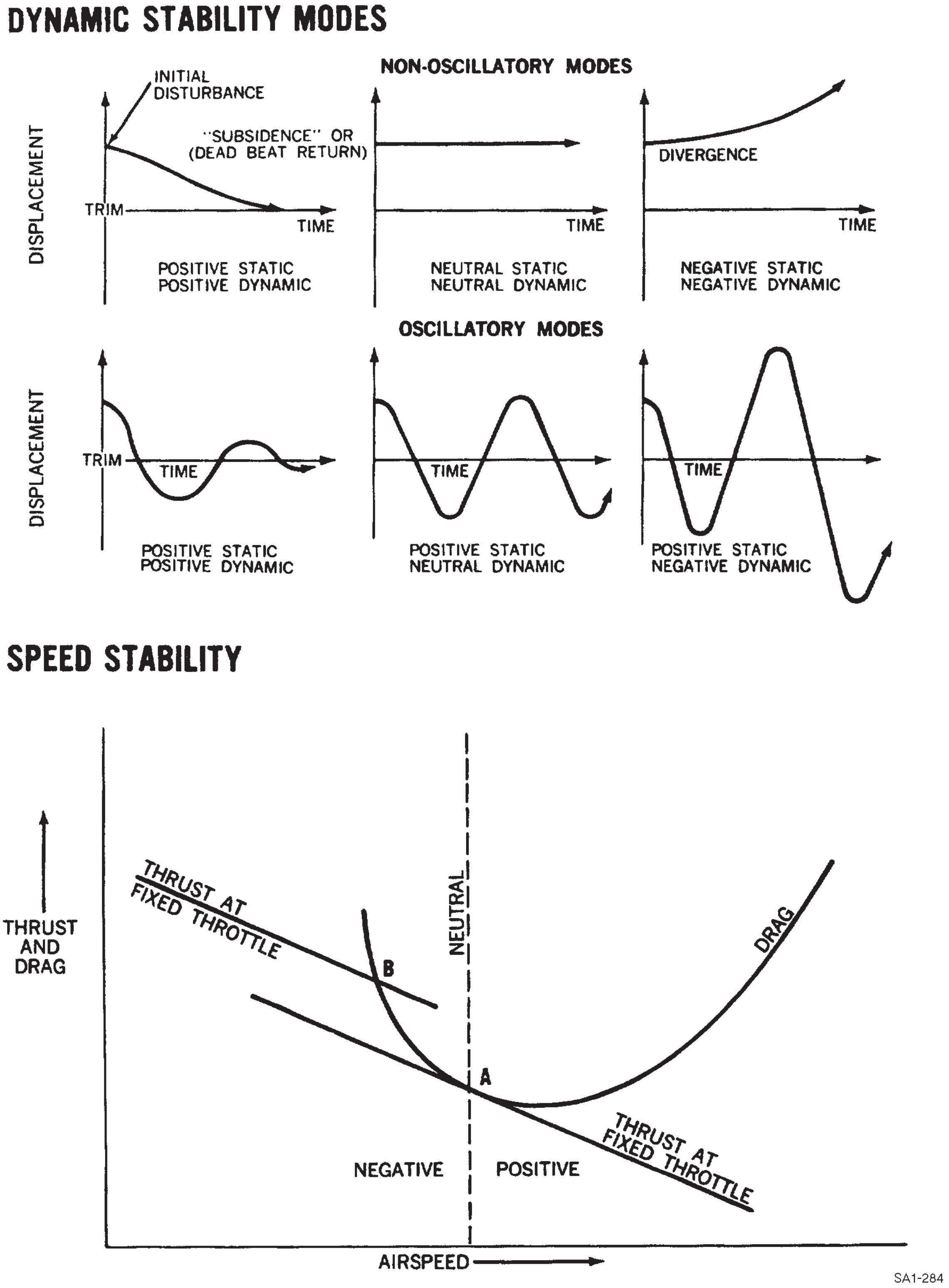

Figure 6-2. Dynamic Stability Modes/Speed Stability

Aircraft with Wing Pods Installed

For aircraft with wing pods installed, slat oscillation at approximately 8.5° AOA is considered normal. If an aircraft with wing pods installed experiences slat oscillation, follow the Slat Oscillation Corrective Steps to eliminate the oscillation. No AFTO FORM 781A entry is required provided the oscillation is eliminated. If oscillation cannot be stopped using one of these steps, accelerate to a speed that permits slats to be retracted. In such case, an AFTO FORM 781A entry is required.

Slat Oscillation Corrective Steps

CAUTION

> If sustained slat oscillation cannot be eliminated, accelerate to an airspeed that permits slats to be retracted. Discontinue further operations requiring excessive periods with slats extended. Enter discrepancy in AFTO FORM 781A as slat-rigging maintenance is required.

Anytime sustained slat oscillation is encountered; follow these steps to eliminate the oscillation:

1. Increase airspeed by 3-5 knots (if possible). This will decrease the aircraft AOA.
2. If increasing airspeed is not possible, or does not eliminate the slat oscillation, decrease airspeed by 3 - 5 knots (if possible). This will increase the aircraft AOA.
3. If changing airspeed does not work, extend 5° of flaps (if possible). This will decrease the aircraft AOA.

NOTE

> Decreasing airspeed will eliminate slat oscillation temporarily. As fuel is off-loaded and burned, the 8.5° AOA will be encountered again, leading to slat oscillation. Attempt corrective steps again to eliminate oscillation.

Slow Speed Flight

Because slat oscillation is dependent on aircraft AOA, slow speed air refueling and radar pattern operations are the most likely times to encounter it. Operators will make every effort to minimize exposure to protracted flights with slats extended. Crews should accelerate and change configuration between slow speed air refuelings when receivers require speeds that dictate use of slats.

KC-10 Rudder Characteristics

The rudder designed for DC-10 series aircraft is designed to provide sufficient directional control of asymmetric thrust after an engine failure on takeoff and to provide suitable crosswind capability for both takeoff and landing. As the airplane flies faster, less rudder is needed for directional control and the available rudder deflection is reduced. This reduction in rudder deflection is achieved through rudder limiting. Rudder pedal force is a function of rudder pedal deflection, so less force will be required to achieve maximum available rudder deflection as the airspeed increases.

Maneuvering the airplane using the rudder will result in a yaw and then a roll response. This roll response is the result of sideslip. As the pilot applies more rudder, more sideslip is generated, and a greater roll response will result. Large, abrupt rudder inputs can generate very large sideslip angles, much larger than encountered in a steady state sideslip (that which is reached with a slow pedal input and held for a period of time). This “over yaw” can amplify the roll rate. It is important to use the rudder carefully so that unintended large sideslip angles and resulting roll rate do not develop. Because sideslip must build up to generate roll, there is a time lag between the pilot making a rudder input and the pilot perceiving roll rate. This lag has caused some pilots to be surprised by the abrupt roll onset and in some cases to interpret the rapid onset of roll as being caused by an outside element not related to their rudder pedal input. If the pilot reacts to this abrupt roll onset with another large rudder input in the opposite direction, large amplitude oscillations in roll and yaw can result. The resulting loads can result in structural damage.

The pilot does not need to be concerned about how fast or how hard to push the rudder pedal in one direction, from zero to full available pedal deflection throughout the flight envelope (from a structural capability standpoint). However, full authority rudder reversals may not be within the structural design limits of the airplane, even if the airspeed is below the design maneuvering speed. There are no procedures that require this type of pilot input. It should also be pointed out that excessive structural loads may be generated in other areas of the airplane, such as engine struts, from this type of control input. In addition, large sideslip angles may cause engine surging at high power settings. It is important to note that use of full rudder for control of engine failures and crosswind takeoffs and landings is well within the structural capability of the airplane.

Flight tests have demonstrated entry and recovery from full stalls without the need for rudder. It is strongly recommended that the rudder not be used in a stall recovery, and that stall recovery should be accomplished before proceeding with any unusual attitude recovery. Once the stall recovery is complete, the ailerons/spoilers should provide adequate rolling moment for unusual attitude recovery. Unless the airplane has suffered significant loss of capability due to system or structural failure (such as a loss of a flap or thrust reverser deployment), rudder input is generally not required. The rudder is typically used for trim, engine failure and crosswind takeoff and landing. A rudder input is never the preferred initial response for events such as a wake vortex encounter, windshear encounter, or to reduce bank angle preceding an imminent stall recovery.

SECTION VII

ADVERSE WEATHER CONDITIONS

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ADVERSE WEATHER CONDITIONS

COLD WEATHER OPERATION

Operating the aircraft in cold weather conditions and on standing water, slush, or snow-covered runways may present additional problems as a result of several outside conditions. The majority of cold weather operating difficulties are encountered on the ground. The following instructions are intended to supplement or amplify the normal procedures and should be observed, as applicable. The procedures outlined prior to engine start are for flight crew guidance in monitoring pre-departure preparation. Since weather conditions will vary, these procedures may not fit all situations. For that reason, it remains the responsibility of the operator to evaluate the existing conditions and take the necessary action to ensure safe operation. No attempt is made to define methods of deicing that normally fall into the maintenance category, only end result precautions.

AIRCRAFT GROUND DEICING/ANTI-ICING PROCEDURES

WARNING

- The use of Commercial Type II deicing/anti-icing fluid is only approved for full power takeoffs (no derating).
- A fluid/water mix of 50/50 (Type II or IV fluid) shall not be used for the anti-icing step of a cold soaked wing as indicated by frost or ice on the lower surface of the wing in the area of the fuel tank. Cold-soaked fuel may render the use of a 50/50 mix ineffective.

CAUTION

More than one application of Type II or Type IV, without subsequent application of Type I or hot water, should be avoided whenever practical. Failure to do so may cause residue to collect in aerodynamically quiet areas. This residue may rehydrate and freeze under certain temperature, high humidity, and/or rain conditions. This residue may block or impede critical flight control systems. This residue may require removal.

NOTE

- The following guidelines have been prepared using Association of European Airlines (AEA) anti-icing code: Recommendations for Deicing/Anti-icing of Aircraft on Ground and the Society of Automotive Engineers (SAE) Aerospace Recommend Practice ARP4737: Aircraft Deicing/Anti-icing Methods with Fluids for Large Transport Aircraft.
- The takeoff performance of the aircraft is not affected by the application of MIL SPEC or Commercial Type IV deicing/anti-icing fluids.

These procedures establish the minimum requirement for deicing/anti-icing of aircraft on ground to provide an aerodynamically clean aircraft for takeoff.

Deicing is the procedure to remove frost, ice, or snow from the aircraft to provide clean surfaces.

Anti-icing is the procedure which provides protection against the formation of frost or ice and accumulation of snow or slush on clean surfaces of the aircraft for a limited period of time (holdover time).

A deicing/anti-icing code has been established to provide flight crews and ground crews with a common code. The deicing/anti-icing code describes the quality of the treatment the aircraft has received, and consists of four elements:

Element A: Specifies type of fluid used (e.g. MIL SPEC Type I, Commercial Type II, or Type IV).

Element B: Specifies percentage fluid to percentage water (e.g. 100/0=100% fluid/0% water, 75/25=75% fluid/25% water, etc.).

NOTE

The concentration of any mixture is measured by volume. The percent of deicing/anti-icing fluid is always called out first.

Element C: Specifies local time (24-hour clock) that final deicing/anti-icing began.

Element D: Specifies date (23 December 1994).

NOTE

Maintenance personnel will record deicing/anti-icing code information on the AFTO Form 781 or report this information directly to the aircraft commander.

Example: Commercial Type I, 75/25-1850 hr - 23 December 1995.

Holdover time is the established time that deicing/anti-icing fluid will prevent the formation or accumulation of frost, ice, or snow on the protected surfaces of an aircraft under average weather conditions. MIL SPEC Type I or Commercial Type I fluids are unthickened fluids. They mainly provide protection against refreezing when no further precipitation occurs (inferior holdover time). Commercial Type II and Type IV fluids are thickened fluids. They provide protection against refreezing even when further precipitation occurs (superior holdover time).

NOTE

- Holdover times are published by the FAA. These tables are used for departure PLANNING ONLY, and must be used in conjunction with a visual inspection immediately prior to takeoff (within five (5) minutes). There is no holdover time data for MIL SPEC fluids.
- Type II and Type IV anti-icing fluids applied with forced air deicing system equipment will have a lower viscosity and may be unduly aerated. These two factors may result in lower-than-published holdover times.

MIL SPEC Type I and Type II designations have an entirely different meaning than SAE, ISO, or AEA designations. A MIL SPEC Type II fluid does not indicate that the fluid has a longer holdover time than a MIL SPEC Type I fluid. Holdover times have not been established for MIL SPEC fluids.

WARNING

- When operating in continuous icing conditions, takeoff must be made as soon as possible after the application of deicing/anti-icing fluid. Regardless of the type of fluid used, a visual inspection must be made immediately prior to takeoff (within five (5) minutes). This inspection should be an external inspection performed by qualified personnel and should be a walk around inspection and/or an inspection from a high lift type vehicle. As a last resort, crews may perform the visual inspection from inside the aircraft utilizing doors 2L, 2R, and 4R as well as the overwing windows. The wings and right horizontal stabilizer are the only areas readily visible to crew members from inside the aircraft. Since these are the largest flat areas on the aircraft, if no contamination is found on these surfaces, it may be assumed that the remainder of the aircraft is free of contamination. If there is any doubt as to whether the aircraft is free of contamination, then an external inspection (from outside the aircraft) must be made. Prior to opening any door, ensure door area is clear of potential FOD and that proper hearing protection is worn. Open only one door at a time when an IAU is installed.
- Protection time will be shortened in heavy weather conditions. High wind velocity and jet blast may cause degradation of protective film. If these conditions occur, time of protection may be shortened considerably. This is also possible when fuel temperature is significantly lower than OAT.
- Ingestion of deicing or anti-icing solutions into operating engines, used as environmental control air sources, can cause smoke and vapors to enter cabin areas.
- Glycol solutions are flammable. Uncontrolled ingestion of combustible deicing solutions is a potential fire hazard and can cause internal damage to engines and APU hot section parts.

BEFORE ENTERING THE AIRCRAFT

Even though the preflight has been accomplished by maintenance, the aircraft commander will verify that maintenance has accomplished the following checks. If maintenance personnel are unavailable, the flight crew will accomplish the following checks:

Verify that all protective covers are removed and that all N_1 rotors are free to rotate.

Verify that all engine inlets have been inspected for any evidence of ice or snow accumulation. If, since the time the engine inlets were inspected, the aircraft has been parked/exposed to continuous icing conditions (freezing rain, snow, sleet, etc.) for any period of time which would enable ice or snow to accumulate in the engine inlets, do not start engines until the inlet inspection has been re-accomplished.

In addition to the procedures in Section IV, the flight crew will perform a close visual inspection of the aircraft fuselage, wings, control surfaces, surface actuators, external cargo, cabin door controls, landing gear, gear doors, and engine inlets. Maintenance will accomplish the inspection of the number two engine inlet in accordance with TO 1C-10(K)A-2-12. The aircraft commander will verify this inspection has been completed. Ice, frost, or snow must be cleared from those areas.

WARNING

Ice, snow, or frost, must be removed from the fuselage, wings, flight controls, tail surfaces and the refueling boom prior to takeoff, except as outlined in the following note.

CAUTION

- Special consideration must be given to the top of the fuselage and inlet of Engine 2. If the aircraft has been parked during icing conditions (freezing rain, snow, sleet, etc.) for any period of time which will enable ice or snow to accumulate on the aircraft in the area of Engine 2, an inspection of the top of the fuselage and the full length of the Engine 2 inlet for the presence of ice and snow accumulation must be accomplished prior to starting engines. Remove accumulated ice and snow prior to starting Engine 2.
- If any accumulation of snow, slush, or ice is present in the cavity areas forward of flight control surfaces, or on the wing leading edge behind the slat structures, it must be removed prior to powering up hydraulic systems. Failure to do so could result in serious damage to control surfaces or adjacent structures.
- Water can collect in engine intakes from snow accumulation after the aircraft has been in a hangar. There have been cases where this water has re-frozen and this ice was later ingested on takeoff resulting in engine failure.

NOTE

- A light coating of loose, dry, powdery snow (which would blow off during the takeoff roll) is acceptable provided that the surfaces beneath the snow are free of adhering ice or snow that may have accumulated due to melting and refreezing.
- A thin coating of frost is acceptable on the upper surface of the fuselage only, provided all vents or ports are clear. Thin frost is defined as a uniform white deposit of fine crystalline texture through which surface features such as paint lines, markings or letters can be distinguished; this must not be confused with rime ice that may form on windward surfaces in freezing fog conditions and which is not acceptable.
- During snow and ice conditions, snow/ice can migrate through the engine exhaust via the engine bypass and accumulate in the engine inlet area regardless of whether inlet covers are installed.

The area around pitot tubes, static ports, vanes, etc., should be carefully inspected and verified to be clear, even though these items are electrically heated.

Air conditioning pack inlets and outflow valves, cabin air outflow valves, cabin pressure relief valves, and windshields should have any ice or snow formations completely removed.

The removal of snow from the fuselage should be accomplished before prolonged heating of the interior, since after melting, subsequent refreezing of water on the fuselage may occur.

The use of heated air for snow removal should be carefully monitored. Unless proper precautions are taken, the use of heat will cause the resultant water to refreeze on some other, perhaps more critical, portion of the aircraft. If heat is used, it should be applied for a sufficiently long period to dry the area completely. Extreme care must be taken to prevent overheat damage to the aircraft.

If conditions require the use of deicing/anti-icing fluids or heat on exposed surfaces, the control surfaces shall be visually inspected for evidence of snow or ice accumulations. All accumulations of snow, ice, and heavy frost must be removed from the control surfaces. During the application of fluid, the horizontal stabilizer should be positioned 2 degrees nose up with all other control surfaces set to neutral and the flaps and slats configured for takeoff (if possible). Do not chip or scrape ice from the surfaces. After fluid application, check control surfaces for freedom of movement, and work the controls several cycles to allow drainage of the fluid and water.

WARNING

> Snow or ice accumulation can increase takeoff distances and adversely affect climbout performance, stalling speed, and handling characteristics. Inflight structural damage can result from vibrations induced by unremoved accumulation.

CAUTION

- If deicing/anti-icing fluid is used, care should be taken to prevent it from coming in contact with plexiglas or plastic since it will tend to craze or soften these materials.
- Deicing/anti-icing with the APU running is permitted. Ensure the air conditioning packs are turned off prior to applying deicing fluid to avoid ingestion of fluid or spray into the bleed system which may contaminate the air conditioning system. Avoid spraying deicing fluid into the APU inlet door and exhaust duct.

Deicing fluid, if allowed to enter the engine inlet ducts or APU inlet duct will cause white acrid smoke to enter the aircraft via the air conditioning system, if these pneumatic sources are operating. Ensure that both air conditioning packs are turned off prior to the application of deicing fluids. When deicing procedures are complete, allow the APU and engines to run a minimum of 3 minutes after application before using any pneumatic source for air conditioning/pressurization. When deicing around the engines and APU exhaust areas, use deicing fluid sparingly to avoid accumulations that could ignite when engines are started.

Frosting of the underside of the wings below the fuel tanks will occur when the fuel temperature is low, the outside air temperature is above freezing and humidity is high. This type of frost re-forms after removal on the ground. Takeoff with ice or frost on the lower wing surface is permitted, provided it is caused by fuel cooling of the adjacent air and that the thickness of the frost or ice is not excessive. A coating of frost thicker than 1/8 inch (3.2 mm) or ice thicker than 1/16 inch (1.6 mm) should be removed before departure. Where a coating remains on the underside of the wing in the fuel tank region, the second segment limiting weight penalties are 0.8% for 1/8 inch (3.2 mm) of frost and 1.2% for 1/16 inch (1.6 mm) of ice. Operations with adhering frost or ice on other than the wing lower surface fuel tank are not permitted.

ON ENTERING THE AIRCRAFT

Operation of the APU is adversely affected by ice accumulations in the inlet areas and by ingestion of ice or foreign materials.

WARNING

- Extreme cold (below -45°F for 6 hours or more) or light snow, ice, or frost deposits may compromise certain aspects of the aircraft's emergency escape and safety equipment.
- Batteries for the escape slide lights as well as the emergency lights throughout the aircraft will likely be low in charge or actually dead. Alternate means of illuminating the slides or for movement through the aircraft should be readily available (e.g., flashlights, etc., that have been kept warm). Normal lighting will be available when the aircraft interior has warmed to 20°F.
- Doors and clear view windows can freeze closed. Check the hatches, doors and windows to ensure that they will open freely.

The following procedures are required after extended cold soak to restore normal systems operation:

1. Install aircraft batteries.
2. Start APU.

   The APU may not start on first attempt due to low ambient temperatures. If this occurs, place the APU MASTER switch to OFF. Wait at least 5 seconds after the APU DOOR OPEN light is extinguished and then attempt APU start. The second attempt should be successful.

3. Initiate aircraft interior warm up.

   Place APU/ISOL VALVE to OPEN (the 1-2 and 1-3 isol valves will be in manual OPEN from cold weather shutdown). The PACK switches will be in MAN and inlet/outlet doors in the hot (closed) position. Operate the packs in the manual mode and monitor pack temperatures to protect against overheat (PACK TEMP VALVE POS indicator approximately 2:00 to 2:30 position).

4. Start hydraulic systems.

NOTE

Monitor hydraulic pressures and quantity closely, until temperatures have stabilized.

   a. Start AUX PUMP 1 and allow pressure and quantity to stabilize, then start AUX PUMP 2.

   b. Place 1-3 PUMP switch to ON. Allow pressure and quantity to stabilize prior to completing next step.

   c. Place 2-3 PUMP switch to ON. Allow pressure and quantity to stabilize.

CAUTION

Upon startup of hydraulic systems after exposure to extreme low temperatures, be alert for signs of severe cavitation of the auxiliary pumps or reversible motor pumps or engine pumps. Violent pressure fluctuations or failure of pressure to build up, and considerable heating may indicate occurrence of serious cavitation that can result in ending or shortening the life of the pump. The affected hydraulic system should be promptly shut down. Intermittent brief restart attempts may ultimately produce normal operation. Other cases, however, may require more extensive corrective action, e.g., heating of reservoir, pump, or inlet lines; remedying suction blockage, etc.

NOTE

If hydraulic leaks occur, cycle the affected component and, if needed, apply heat directly from a ground source.

After clearing the aircraft of ice or snow, perform a flight control check by moving the controls through their full range of travel. Select flaps zero/takeoff extend to unlock the outboard ailerons and while performing the check, do not assist movement of the flight controls by hand. The flaps and slats should be operated through a minimum of four complete cycles.

Coordinate with the ground crew when operating the flight controls.

5. Air Conditioning

   Operate the air conditioning ram air inlet and outlet doors through their full range of travel. Move each pack function selector to MAN. Hold selector in HOT or COLD and confirm full scale movement of pack temperature valve by observing indicator, or visually checking positions.

   Operate cabin outflow valve through the full range of travel. Select MAN with the manual auto handle. Push and rotate manual cabin altitude control to full open and full close.

6. INS

Install INS batteries and begin INS alignment as soon as possible. Alignment process may take an additional 4.8 minutes, due to cold-soaked components.

NOTE

- Any equipment BIT test required may not function properly until equipment has reached normal operating temperature.
- If first test is not successful, allow equipment to warm up, then re-initiate. A second attempt should be successful.

7. ARO

   The boom hydraulic selector (HYD SEL) should be moved to BOOM for 30 minutes prior to the start of ARO compartment preflight. The ARO compartment preflight should not be initiated until ARO compartment temperature reaches 32° F.

NOTE

If ARO compartment sighting door is open, the warmup time for the ARO compartment will be significantly increased.

CAUTION

Upon startup of hydraulic systems after exposure to extreme low temperatures, be alert for signs of severe cavitation of the auxiliary pumps or reversible motor pumps or engine pumps. Violent pressure fluctuations or failure of pressure to build up, and considerable heating may indicate occurrence of serious cavitation that can result in ending or shortening the life of the pump. The affected hydraulic system should be promptly shut down. Intermittent brief restart attempts may ultimately produce normal operation. Other cases, however, may require more extensive corrective action, e.g., heating of reservoir, pump, or inlet lines; remedying suction blockage, etc.

ENGINE START

When parked on a slippery area, make sure that chocks are applied to nosewheel and main wheels both in front and behind prior to starting engines. Chocks may not hold on slippery areas unless they are sanded. When crossbleed starting is to be used, more stringent precautions will be required. When chocks are not available for start, use sand or similar material and clear aircraft for potential movement. Further, make sure that the tires are not frozen to the ground.

Hydraulic system pressure must be established prior to engine start to prevent pump cavitation. Hydraulic systems must be pressurized for 30 minutes prior to takeoff.

Generator switches will be OFF for engine start.

NOTE

After engine start, place generator switches ON when the frequency has stabilized in the normal range.

CAUTION

- Special consideration must be given to the top of the fuselage and inlet of Engine 2. If the aircraft has been parked during icing conditions (freezing rain, snow, sleet, etc.) for any period of time which will enable ice or snow to accumulate on the aircraft in the area of Engine 2, an inspection of the top of the fuselage and the full length of the Engine 2 inlet for the presence of ice and snow accumulation must be accomplished prior to starting engines. Remove accumulated ice and snow prior to starting Engine 2.
- If snow, slush, or ice is present in seal or control areas forward of control surfaces, it must be removed prior to powering up hydraulic systems. Failure to do this could result in serious damage to control surfaces.

Whenever the possibility of ice or snow accumulation in an engine fan duct exists, ensure that fan rotation is indicated prior to moving fuel lever to ON.

Use normal engine start procedures, except that pneumatic pressures need to be at least 30 PSI at sea level. A slight increase above this level will greatly assist the start.

If an engine has been cold soaked for an extended period, white smoke may appear during start. This is unburned fuel vapor and should soon disappear.

When engine oil temperature is low, extremely high oil pressure may be experienced immediately after engine start. This should not be considered abnormal if the oil pressure eventually indicates in the normal range as the oil temperature rises.

CAUTION

When temperatures are below 6°C (42°F), and visible moisture in any form is present; such as, fog, rain, snow, sleet, or ice crystals; or when temperatures are below 6°C (42°F), and the temperature-dewpoint spread is 3°C (5°F) or less, engine anti-ice will be turned on immediately after engine start and used continuously until icing conditions cease to exist.

NOTE

On the ground, when operating the engines at idle in icing conditions, advance power to 60% N_1 for a period of 30 seconds each 30 minutes.

WARMUP AND GROUND TESTS

Check instruments for normal operation and monitor slat and flap operation.

WARNING

In cold weather, make sure all instruments have warmed up sufficiently to ensure normal operations.

TAXIING

While taxiing out from an area covered with snow or slush, a slightly higher thrust setting is required to initiate aircraft movement. At high gross weights, advance power to approximately 40% and allow a few seconds for aircraft response. If the aircraft does not move, advance power until it does. High engine power should be avoided, if possible, to prevent blowing slush against other aircraft or equipment. Also, consider the vacuum cleaner capability of the wing-mounted engines.

Taxi speed should be as low as practical on slippery surfaces and taxi speed of 5 knots or less is recommended while turning.

During taxi, to prevent ice and slush from accumulating between slats, flaps, flap vanes, and wing, leave the slats and flaps retracted as long as possible prior to moving into takeoff position. When making the flap/slat takeoff selection, the flap position indicators should be closely observed for positive movement. If the flaps should stop, the flap handle should be placed immediately in the same position as indicated to prevent damage to the flap system.

The required flight control check should be delayed until the flaps and slats are extended.

Exercise the flight controls frequently to check freedom of movement.

NOTE

- The nosewheel steering must be used with care or nose wheel skidding will occur on all types of surfaces. This problem is accentuated on surfaces with low RCR. Turns must be entered with low taxi speeds and moderate rates of steering input. Turns can be performed with a nose wheel deflection of 68°; however, the steering input must be applied smoothly and at a moderate rate. The nose wheel should be closely monitored to decrease the angle at the first indication of nose wheel skidding. CG for taxi on contaminated runways should be 23% MAC or less. This improves nose wheel steering during taxi operations.
- Taxi time on snow and ice will be longer than under normal conditions, so plan the shortest possible route to takeoff point to conserve fuel and reduce the amount of ice fog generated by jet engines. This fog could delay takeoff by lowering the visibility below takeoff minimums.

The following points are valid during all taxi operations on surfaces affected by snow/slush/ice:

1. Be aware that blasted snow or ice can cause damage at considerable distances.
2. Adjust speed to surface conditions. Brake effectivity is reduced. Excessive speed will present problems in stopping and making turns.
3. A crowned slippery taxiway or runway can cause sidewise slipping. Taxi as far as possible on the centerline under these conditions.
4. Maintain increased separation behind other aircraft. Expect them to also require an engine run to combat ice formation.

Do not taxi through deep snow or slush covered areas.

DEICING

If deicing is to be accomplished in the hammerhead just prior to takeoff, contact maintenance to determine whether the engines will be running or shut down. The normal configuration will be engines shutdown with APU running. Both air conditioning packs and bleeds must be off to preclude fume ingestion. Allow the APU and engines to run a minimum of 3 minutes after application before using any pneumatic source for air conditioning/pressurization.

A. Use the Dash One checklist (KC-10 PROCEDURES FOR DRIVE THROUGH DEICE SPRAY FACILITY) if deicing is to be conducted with engines running.

B. The aircraft will normally be configured with the flaps and slats retracted. If the airplane is covered by ice or snow of extreme thickness, ice or snow may adhere to the fixed leading edge below the slats. In this case, the aircraft shall be deiced with the slats in the takeoff position. The flaps and slats will be extended just prior to takeoff.

NOTE

Deicing the aircraft with the flaps and slats in the takeoff configuration exposes the flap and slat drive mechanisms to deicing fluids. Heated deicing fluid tends to strip away the lubricants on control cables, brackets, etc., and will require additional repetitive maintenance. If the aircraft is deiced with flaps and/or slats extended the aircrew will make an appropriate entry in the AFTO Form 781A. After deicing is complete, cycle flaps/slats to 0/RET then to desired takeoff setting.

C. Once the deicing is completed, maintenance will advise the aircraft commander as to the time the deicing was started, type and concentration of fluid used.

KC-10 PROCEDURE FOR DRIVE THROUGH DEICE SPRAY FACILITY (Checklist assumes temperature below 6 degrees and Engine ANTI-ICE Switches are ON.)

A. Prior to engine start.

Remove snow, ice or slush from all engine inlets and leading edges and/ice accumulation on the top of the fuselage in the vicinity of No. 2 engine.

B. After loading aircraft and starting all engines, accomplish the BEFORE TAXI CHECKLIST. Taxi to spray facility.

C. Allow sufficient time for APU cool down.

APU/ISOL VALVE. . . . . CLOSE

APU MASTER . . . . OFF

D. Just prior to reaching spray area:

BOTH PNEU SUPP Sel. . . . . OFF

BOTH PACK
Function Sel . . . . MAN/FULL HOT/OFF

LAV GALLEY/VENT . . . . OFF

CAB PRESS MAN/AUTO Handle . . . . MAN

OUTFLOW VALVE POSITION
Indicator . . . . CLOSED

Wind conditions may dictate air conditioning shutdown prior to entry into deice facility to prevent fumes from previous aircraft spray operation from entering the aircraft.

E. Position aircraft as required.

Preferred configuration would be 0°/RET, unless specific problems are present such as snow or slush in flaps or slats area, which may require additional spraying. Set stabilizer at 2 degrees ANU.

F. Proceed with spraying.

DO NOT SPRAY INTO ENGINES

To the greatest possible extent:

Avoid spraying into outflow valve opening.
Avoid spraying into ram air inlets.

G. Taxi clear of area.

H. After clear of area.

Purge pneumatic ducts.

BOTH ISOL VALVES . . . . OPEN

NO. 1 PNEU SUPPLY . . . . AUTO

WING ANTI-ICE . . . . TEST FOR 10 SECS

NO. 1 PNEU SUPPLY . . . . OFF

NO. 3 PNEU SUPPLY . . . . AUTO

WING ANTI-ICE . . . . TEST FOR 5 SECS

BOTH PNEU SUPPLY SEL . . . . AUTO

BOTH ISOL VALVES . . . . NORM

CAUTION

To prevent inadvertent pressurization of the aircraft on the ground, ensure the following two steps are accomplished prior to establishing airflow.

CAB PRESS MAN/AUTO HANDLE . . . . . AUTO

OUTFLOW VALVE POSITION
Indicator . . . . OPEN

BOTH PACKS . . . . AUTO

LAV GALLEY/VENT . . . . ON

FLAPS/SLATS. . . . . CYCLE TO 50°/LAND AND THEN SET FOR TAKEOFF

FLIGHT CONTROLS. . . . . CYCLED

I. Accomplish BEFORE TAKEOFF checklist

TAKEOFF

WARNING

When operating in continuous icing conditions, takeoff must be made as soon as possible after the application of deicing/anti-icing fluid. Regardless of the type of fluid used, a visual inspection must be made immediately prior to takeoff (within five (5) minutes). This inspection should be an external inspection performed by qualified personnel and should be a walk around inspection and/or an inspection from a high lift type vehicle. As a last resort, crews may perform the visual inspection from inside the aircraft utilizing doors 2L, 2R, and 4R as well as the overwing windows. The wings and right horizontal stabilizer are the only areas readily visible to crew members from inside the aircraft. Since these are the largest flat areas on the aircraft, if no contamination is found on these surfaces, it may be assumed that the remainder of the aircraft is free of contamination. If there is any doubt as to whether the aircraft is free of contamination, then an external inspection (from outside the aircraft) must be made. Prior to opening any door, ensure door area is clear of potential FOD and that proper hearing protection is worn. Open only one door at a time when an IAU is installed.

WARNING

Protection time will be shortened in heavy weather conditions. High wind velocity and jet blast may cause degradation of protective film. If these conditions occur, time of protection may be shortened considerably. This is also possible when fuel temperature is significantly lower than OAT.

Normal procedures should be used when taking off from precipitation covered runways. Advance all throttles to twelve o’clock, check that N_1 gages are in approximately equal positions and allow engines to accelerate. This minimizes thrust asymmetry caused by differences in individual engine acceleration, aids in preventing overshooting the desired thrust setting, and eliminates engine surge caused by a crosswind. During the start of takeoff run, further advance the throttles smoothly to takeoff thrust. Final takeoff thrust adjustments between 40 and 80 knots are made by the Flight Engineer.

During takeoffs on icy or snow-covered runways, the lag in nose gear steering and the possibility of nose gear skidding must be realized by the Pilot and corrections anticipated. Increased directional control may be obtained by the use of the ailerons between 60 and 100 knots.

NOTE

CG for takeoff on contaminated runways should be 23% MAC or less. This improves nosewheel steering during takeoff roll.

Deflection of the control wheel in the desired direction of turn will provide an amount of aerodynamic turning moment which will aid in maintaining aircraft directional control on the runway. The amount of aileron deflection necessary will depend on the aircraft velocity at the time.

CAUTION

- On a slippery runway, apply some nose down elevator. This will improve the steering characteristics of the nose gear. To maintain the heading during rolling takeoff, detect the initial heading deflection and correct by small rudder pedal steering inputs.
- Nose gear steering of 3° or more may cause the nose gear to slip on the icy (wet) runway.
- Do not use differential thrust.

NOTE

- Cycling landing gear after takeoff in slush or wet snow when clear of obstacles may further reduce accumulations and will reduce the possibility of gear door freeze up.
- Cycle UARRSI doors as soon as practical after takeoff to eliminate moisture and prevent freezing.

In the event of a rejected takeoff (RTO) it is possible to experience substantial wing engine foreign object damage while using reverse thrust at low speeds on snow and ice covered runways. It is a natural tendency to carry thrust reversing to a lower speed and use less brakes when the braking action is expected to be poor. However, runways which have been cleared with snow removal equipment usually have chunks of ice and snow remaining and/or sand applied. Under these conditions the wing engines are especially susceptible to blade damage. Because of the large quantities of air being moved through the engine by the fan section, the vacuum cleaner effect is much stronger than on previous non-fan jet engines. To minimize reingestion damage potential, the procedures for reverse thrust operations should be strictly followed unless aircraft safety dictates otherwise.

WARNING

Takeoffs shall not be attempted with over 1/2 inch of wet snow, slush and/or water or 4 inch of dry snow on the runway.

The second effect to be considered when planning a takeoff with slush on the runway is possible damage to the aircraft from the impingement of slush.

CAUTION

Slush on the runway can cause significant structural damage to the aircraft, particularly at high speeds. Water puddles and slush should be avoided if possible.

When using the wing anti-ice system, the thrust computer will automatically correct for bleed air extraction and present a compensated value. With the thrust computer operative and with proper verification of the displayed limit value, use the thrust setting displayed. With the computer inoperative, adjust thrust settings by the corrections specified in the performance manual.

The wing anti-ice system will not activate until rotation, consequently a reduction in thrust occurs due to the increased bleed demand on the supplying engines. Compensating for the thrust loss will result in engine overspeed and, therefore, is not permitted.

CAUTION

- If snow is left on the radome, it will tend to blow back on the windshield during takeoff and will restrict visibility during that critical period. Also ice or hard snow accumulations remaining on the fuselage may dislodge inflight and impact the empennage or number 2 engine with possible damage.
- ENGINE and WING ANTI-ICE will be used anytime in flight when icing conditions are expected or encountered. When TAT is below 6°C (42°F), and visible moisture in any form is present; such as clouds, fog, rain, snow, sleet, or ice crystals; engine and wing anti-ice will be used.

SAT is not used as a reference for icing conditions in flight. If possible, the systems should be turned on before icing conditions are encountered regardless of temperature. Windshield heat should be selected to NORM when icing conditions are imminent and the HIGH only for the duration of moderate to heavy icing. The defog system is normally ON at all times. Engine anti-ice systems should be turned on one time prior to entering icing conditions. If ice accumulates on the nose cowl leading edge through system malfunction exceeding the system anti-ice capability the engine should be operated at the minimum power practical until the ice accumulation is ingested. This procedure will minimize the possibility of compressor damage.

CAUTION

The engine anti-icing system is designed as an anti-icing system rather than a deicing system; therefore, during potential icing conditions the system must be utilized before ice buildups can occur.

NOTE

If ENG ANTI-ICE is turned on in anticipation of icing conditions, an N_1 penalty is applied by the TRC until TAT is below 8°C.

If required to enter a holding pattern in icing conditions, the slats will normally be retracted. However, there are no configuration restrictions while operating in icing conditions nor is there a requirement to remove ice prior to retracting flaps or slats.

INDUCTION ICING

Induction icing is a phenomenon which can occur in clear or moist air. Conditions which contribute to this include one or more of the following: TAT between +10° and -40°C, visible moisture, high relative humidity, slow speed, and high angle of attacks (AOA). The ENGINE ANTI-ICE system provides anti-icing protection for the inlet cowl only and not the N_1 fan blades or spinner cone. Ice may build up on fan/spinner during moderate to severe icing conditions regardless of whether ENGINE ANTI-ICE is ON or OFF. Ice accumulation on the fan blades and spinner may shed into adjacent acoustical panels causing panel damage. Make a 781A entry after encountering conditions favorable to induction icing for an extended period of time.

CAUTION

- Elements of slow speed air refueling (High AOA and Low Speed) in visible moisture with near freezing temperatures for extended periods of time with the use of engine anti-ice may cause induction icing damage in high bypass turbofan engines.
- Prior to encountering icing conditions, turn anti-icing ON. If anti-icing is inoperative, climb or descend to an altitude where the TAT is warmer than +6°C or colder than -20°C. If possible, avoid clouds where the TAT is between 0° and -20°C. Fly above 400 KTAS.

ICE SHEDDING PROCEDURES

The ENGINE ANTI-ICE system provides anti-icing protection for the inlet cowl only and not the N_1 fan blades or spinner cone. Ice may build up on fan/spinner during moderate to severe icing conditions. This ice can damage the mid-span acoustical panels when it is shed by the engine. Operating engines at thrust settings greater than 70% N_1 provides the most effective protection from this type of build up.

WARNING

Do not accomplish this procedure with receiver aircraft in the pre-contact position or closer. Notify receiver prior to accomplishing this procedure.

CAUTION

Flight in freezing rain or severe icing will be avoided. For operations in moderate to severe icing conditions that cannot be avoided, accomplish ice shedding procedures to prevent ice buildups sufficient to damage engine acoustic panels.

If moderate to severe icing conditions are encountered with prolonged N_1 settings below 70% (i.e. Cruise, Holding, Descent) accomplish the following ice shedding procedure every 10 minutes until clear of icing conditions.

A. Ignition OVRD & AIRSTART . . . . ON

B. Throttle . . . . Reduce to idle, then slowly advance to a minimum of 70% N_1 for 10 to 30 seconds

CAUTION

Reduce the throttle to idle ONE ENGINE AT A TIME ONLY.

C. If fan/spinner ice is shed, N_1 vibration may increase as thrust is first applied, but should return to normal as shedding occurs.

D. Ignition OVRD & AIRSTART . . . . OFF

CRUISE/AIR REFUELING

There are no provisions for deicing the ARB during flight. Air refueling may be accomplished during icing conditions, however, a flight control check should be accomplished to determine boom stability and control effectiveness when ice forms on the boom or control surfaces. Additional ice buildup may reduce boom flight control effectiveness. Air refueling should be terminated except when continuance is dictated by operational necessity.

NOTE

- If air refueling is continued with reduced control effectiveness, adjust envelope limits to less than maximum attained during control check or receiver limits, whichever is less.
- If flight controls do not respond to command inputs or control surfaces are erratic, refer to appropriate abnormal checklist.

WING PODS HOSE/DROGUE ENVIRONMENTAL LIMITATIONS (WITH TCTO 1C-10(K)A-956)

Icing

The use of the Mk 32B-752 pod in icing conditions should be avoided except in cases of fuel emergency. If icing conditions are encountered and the receiver confirms or reports ice on any portion of the hose/drogue or pod assembly, recover hose as soon as conditions allow. In this case, air refueling should be terminated except when continuance is dictated by operational necessity. The hose should not be trailed again for a period of 5 minutes after being rewound.

Hose Trailed Temperature Limits

If the Static Air Temperature (SAT) at altitude is between -47 and -58°C, then the hose must not remain trailed for longer than 15 minutes prior to fuel transfer. On completion of fuel transfer, the hose must be wound in unless a further fuel transfer is about to commence. If the SAT is less than -58°C, then the hose must not be trailed except in cases of fuel emergency.

DESCENT

Follow normal procedures for descent, including ice protection system operation if required. Turn on engine anti-ice before entering icing conditions. If icing is unexpectedly encountered, turn anti-ice on for one engine at a time. The ingestion of ice accumulation may result in engine instability.

If icing is encountered, turn on wing anti-ice to deice wing before extending slats.

The engine and airfoil ice protection systems are capable of preventing ice buildup at flight idle thrust. Therefore, it is not necessary to maintain a power in excess of idle to obtain adequate protection in flight.

LANDING

Final flap setting is normally 35°. Use of flaps 50° is recommended on short, wet, or contaminated run ways (covered by snow, ice, or slush) when in the opinion of the pilot, landing distance will be adversely affected.

NOTE

CG for landing on contaminated runways should be 23% MAC or less. This improves nosewheel steering during landing rollout.

When landing on slippery runways, fly a stabilized approach without excessive airspeed. Touch down at proper point and avoid holding aircraft off.

Execute a missed approach if zero drift condition cannot be established prior to touchdown.

Blowing or drifting snow in a crosswind condition may create a false impression of the aircraft's movement over the ground. It is thus possible to have an impression of no drift when in fact a considerable drift exists. When landing under these conditions, runway markers or runway lights can supply the necessary visual reference.

During landing in blowing or loose snow, use reverse thrust commensurate with visibility conditions. Reverse thrust, when continued below 60 knots on dry snow, can result in loss of forward visibility, and can melt dry snow which can impinge and freeze on cold surfaces.

Immediately lower the nose to the runway and maintain wheel loading by forward pressure on the column.

Activate spoilers as soon as possible after main gear touchdown. Be prepared to manually deploy spoilers because wheel spinup may be delayed.

Maintain directional control primarily with rudder and nosewheel steering. Use differential braking as needed.

If directional control becomes a problem while in reverse thrust, reduce reverse thrust on engines and, if necessary, return them to forward idle.

Braking effectiveness is significantly reduced on wet, slush covered, or icy runways. To obtain optimum braking from the anti-skid system, smoothly apply full brake pressure and do no attempt to modulate; hold constant brake pressure until speed has reduced to a safe taxi speed.

On initial brake application, the anti-skid system modulates the applied brake pressure to determine skid threshold. On detecting a wheel deceleration (impending skid) the anti-skid system releases brake pressure sufficiently to avoid skidding.

On slippery surfaces the optimum applied brake pressure is appreciably reduced. The effect of the initial releases is more pronounced. The varying runway surface conditions associated with ice and snow will result in additional antiskid system brake releases. These combined with the reduced optimum brake pressure will significantly increase stopping distance. Modulating the brake pedals will only aggravate the conditions.

At slower speeds on slippery surfaces, the effect of the anti-skid system brake releases is even more pronounced.

TAXI IN

If the approach was made through icing conditions or if the runway was covered by slush or snow, retract flaps to 22°.

CAUTION

Damage to the flaps/slats could occur if ice is present and flaps/slats are fully retracted.

Inspection after parking will show whether the necessity to deice flaps exists. After inspection, flaps and slats should be moved to 0°/RET. Check the aircraft exterior for damage due to ice impingement, particularly in the vicinity of the landing gear.

PARKING

Parking brakes should be off and wheels double blocked.

Avoid parking with nosewheel in a turn. It is always best to allow nosewheel to be centered and aircraft to roll forward a few feet to eliminate all side loads on main gear and nose shock struts.

If parking for an extended period and cold soak will be severe, consider parking on sand or small twigs to prevent freeze down.

Have wheel chocks in place so parking brakes can be released; if moisture has entered brake assembly around brake shoes, leaving parking brakes released will forestall possibility of brakes freezing in position. Have aircraft serviced with fuel and oil and all sumps drained before condensates reach freezing point. Check that all plugs and protective covers for intakes, exhausts, pitot tubes, landing gear, etc., are installed if there is the slightest possibility of blowing or drifting snow. Remove ice and dirt from shock struts. If freezing, and aircraft is not to be heated, have all water systems drained. Ethylene glycol automotive antifreeze can be mixed with the toilet tank charge.

If layover of several days is anticipated, the nicad batteries for the aircraft should be removed if expected to be subjected to temperatures of less than -29° C (-20° F) for 4 hours or more. Cold soaking reduces battery output and prevents satisfactory charging until the battery is warmed.

AIRCRAFT PREPARATION FOR COLD SOAK

If the expected layover exceeds 4 hours and temperatures are expected to be below 0° F, the following procedures shall be accomplished in addition to other actions required in this section.

1. Place 1-2 and 1-3 ISOL VALVE switches to manual OPEN.
2. Place engine generator (GEN 1, GEN 2, GEN 3) switches to OFF.
3. Ensure all doors, windows, and hatches are closed.
4. Open the following circuit breakers:
    a. EMER LTS CHARGE & STBY (FO F-22)
    b. ARO EQUIP RACK COOLING FAN (ARO)
    c. CENTER ACCESS COMPT FAN (UM M-19)
    d. INS battery circuit breakers
5. Remove the INS batteries and store in area where temperature will be above 0°F.
6. Use manual (MAN) switch to position air-conditioning inlet/outlet doors to full HOT.

RAIN/SLUSH OPERATION

WARNING

In rain, visibility through the windshield may be reduced. In heavy rain the PF should remain on instruments until reaching minimums regardless of whether the PNF has the runway in sight or not. Pilots should always be prepared to go around when any portion of the approach is in doubt.

ENGINE OPERATION IN HEAVY PRECIPITATION

With extremely heavy rain conditions, N_1 indications may momentarily increase or decrease up to 6%. Water ingestion, up to a certain level (saturation point) will reduce the compressor inlet temperature and increase the airflow demand for the high pressure compressor (N_2). The increased airflow will result in an increase in N_1. Continued or increased water ingestion beyond the compressor and combustion sections results in reduction of the cycle temperature of the engine, which in turn reduces the work available to drive the fan. Consequently N_1 will decrease.

In heavy precipitation, place the ignition switches in CONT A or B. No other action is required unless thrust reduction is necessary to maintain N_1 within limits. Throttle movements should be made in a slow, deliberate manner. Readjust thrust as required when rain decreases.

TIRE HYDROPLANING

The possibility of partial or total hydroplaning during aircraft takeoff and landing exists whenever water or slush stands on the runway. If directional control becomes a problem while in reverse thrust, reduce reverse thrust on engines and, if necessary, return them to forward idle.

Reverse thrust is an effective method of minimizing the effects of hydroplaning. However, use of reverse thrust in high crosswind conditions on contaminated runways induces both a braking vector (parallel to runway centerlne) and a side vector (parallel to and in the same direction as the crosswind component.

CAUTION

- Depending upon runway conditions, tire hydroplaning can occur in depths less than 0.1 inch of slush or water. Hydroplaning can render the aircraft partially or totally uncontrollable anytime during takeoff or landing.

CONDITIONS FOR HYDROPLANING

Hydroplaning will occur whenever a rolling or skidding tire does not displace water or slush at a rate fast enough to permit the complete tire footprint area to contact the runway surface. As the aircraft ground speed increases on takeoff, a wedge of water gradually extends into the tire footprint area, decreasing the contact area between the tire and the ground. The portion of the tire footprint being kept off the runway surface by a film of fluid gradually increases as aircraft speed increases. As the wedge of water penetrates the tire footprint area, hydrodynamic pressure is built up between the tire and pavement which lifts the tire from the runway surface. Hydroplaning is a gradual process, and partial hydroplaning exists long before total hydroplaning occurs. At total hydroplaning speed, the aircraft tires will ride entirely on the film, and tire contact with the runway will be lost.

EVIDENCE OF HYDROPLANING

During takeoff in water or slush, a bow wave forms in front of the nosegear and main gear wheels. The retarding effect of water or slush on the wheels and aircraft structure increases as aircraft ground speed increases until the aircraft reaches hydroplaning speed. At hydroplaning speed the bow wave disappears because the wheels have risen on top of the fluid, and the retarding force of water or slush therefore decreases. Once total hydroplaning is initiated, it will tend to continue even when the aircraft speed has fallen below the beginning speed for total hydroplaning.

FACTORS INFLUENCING HYDROPLANING

A number of factors influence the extent of aircraft hydroplaning. These include tire tread design and depth, depth of water or slush on the runway, the roughness of the runway surface, the tire inflation pressure, and the aircraft forward speed.

Indications are that hydroplaning will occur at lower speeds on dimpled or smooth tires than on ribbed tread tires. Grooves in the tire tread allow escape of water or slush from the tire footprint area. If no grooves exist in the tire tread, the water or slush will have less chance to squeeze out of the tire footprint area, Also, when the water or slush on the runway surface exceeds the depth of the tire grooves, the effect will be the same as for a smooth tire.

On dry runway surfaces the coefficient of friction is unaffected by tire wear. On wet runways, however, braking effectiveness is seriously degraded when the tire becomes badly worn. Use of ribbed tires with good tread depth is therefore recommended on wet runways. Even during partial hydroplaning, braking traction on rib tread may be expected to be better than for smooth tread tires.

The minimum depth of fluid on the runway required for hydroplaning depends upon the tire tread design and the roughness of the pavement surface. Hydroplaning will occur with smooth tires on smooth pavement. Hydroplaning is less likely to occur with ribbed tread tires operating on grooved or textured pavement.

The possibility of hydroplaning conditions existing on a crowned runway will be less than on an uncrowned one. The crown allows water to drain off rapidly and usually prevents a deep accumulation except during heavy downpours.

Slush will not drain off as readily as water, and hydroplaning in slush can be expected even on crowned runways.

Reverted rubber hydroplaning is caused by a skid which boils water on the runway, causing heated rubber to revert to its natural latex state, thus sealing tire grooves which prevents water dispersal. This type of hydroplaning results in near zero braking coefficients and has been known to continue almost to the point of zero ground speed. Runway surface texture has little effect on the alleviation of reverted rubber hydroplaning.

EFFECTS OF HYDROPLANING

Hydroplaning results in a marked loss of coefficient of friction between tires and runway surface. The loss in coefficient of friction also reduces the effectiveness of nose wheel steering, and consequently the ability of the pilot to cope with crosswinds. If the aircraft begins to hydroplane, expect it to slide in an arc toward the downwind side of the runway even though the aircraft will yaw (weathervane) toward the upwind side.

Stopping distances increase considerably when braking traction is lost. Applying brakes to wheels which have already slowed down or nearly stopped due to hydroplaning will not improve the coefficient of friction between the tire and runway. Tests have indicated that at high ground speeds on a wet runway, braking effectiveness is only about one-third that on a dry runway. In slush, braking effectiveness drops about one-fifth that which could be expected on a dry runway.

Steering and cornering of aircraft tires is dependent upon tire contact with the runway surface. If tires lift completely off the pavement, ability to steer the aircraft will be lost. Thus, the tires will be unable to develop resistance needed to counteract crosswinds. Unless aerodynamic controls are used and are effective, the pilot under these circumstances may be unable to keep the aircraft from veering off the pavement.

NOTE

CG for taxi, takeoff and landing on contaminated runways should be 23% MAC or less. This improves nose wheel steering during taxi, takeoff, and landing operations.

WINDSHIELD RAIN REPELLANT

WARNING

- The chemical used in rain repellent systems may cause eye or respiratory irritation. In high concentrations it is an asphyxiant and may cause cardiac sensitization.
- Some formulations of the rain repellent chemical contain an additive with a strong citrus odor. If such an odor is detected or if a leak is suspected in the rain repellent system, oxygen masks and goggles should be donned as a precaution.

CAUTION

Do not apply repellent to a dry windshield because impaired visibility may result. Do not turn on wipers if repellent is inadvertently applied to a dry windshield.

One RAIN REPLNT Button .... PUSH

Push one RAIN REPLNT button, observe repellent application and release button.

CAUTION

Do not apply repellent to second windshield until visibility has been established on first windshield.

When visibility has been established on first windshield,

Remaining RAIN REPLNT Button .... PUSH

Push remaining RAIN REPLNT button, observe repellent application and release button.

VOLCANIC ASH ENCOUNTERS

WARNING

Flight through known volcanic ash clouds is not recommended and should be avoided, if at all possible. Careful judgment and planning must be exercised by the pilot in determining the capability to circumnavigate areas of known volcanic activity.

VOLCANIC ASH EFFECTS ON THE ENGINES

Volcanic ash is a highly abrasive material and, depending on the engine RPM and ash cloud density, can erode the tips of the rotating airfoils in less than one minute. For this reason, the N_2 compressor and turbine will suffer the most damage. The N_1 compressor and turbine will also suffer damage to a lesser degree.

The heaviest erosive damage in the engines tends to occur at the N_2 turbine blade tips. Blade tip clearances are tightly controlled and the combination of volcanic ash, high turbine temperatures and the higher N_2 speeds all combine to rapidly grind the blade tips away. This results in approximately a 7 percent loss of turbine efficiency. This damage may result in slower accelerations, higher EGTs during engine starts and an upward shift in EGT during subsequent operations.

While the erosive characteristics of volcanic ash are severe, a more immediate concern is the ash melting in the combustors, then resolidifying on the first stage N_2 turbine nozzles. Volcanic ash can melt at temperatures below 750 degrees C. The actual melting point varies with the composition of the ash.

If the combustor exhaust temperature is high enough to melt the ash, the molten ash will resolidify on the first stage N_2 turbine guide vanes. As this occurs, it tends to build up and effectively chokes the engine, reducing the stall margin. At high power settings the engine will stall and roll back to flight idle or lower and EGTs may rise toward the red line limit. This event may occur in less than one minute after application of climb thrust.

Lower throttle settings will reduce combustor temperatures, slowing or preventing molten ash buildup on the turbine nozzles. Reducing thrust when an ash cloud is encountered will also delay or prevent an engine stall. Engine stall margin can be increased by increasing the pneumatic bleed air load.

Pitot probe contamination is common during an ash cloud encounter and can result in abnormally low airspeed indications. For this reason, it is recommended that the autothrottle system not be used, as it may command higher thrust settings. This will increase the combustor temperatures and contribute to a rapid buildup of molten ash on the N_2 turbine nozzle vanes.

GENERAL GUIDELINES

Detection of a volcanic ash cloud is extremely difficult, and nearly impossible during times of darkness. The weather radar may not detect the cloud, depending upon the density of the ash. Typically ash clouds will appear as a normal overcast.

The following guidelines are indications of an ash cloud:

1. Outside environment is darker than normal.
2. Smoke or dust entering the aircraft through the air conditioning system.
3. Odors similar to electrical smoke.
4. White or orange glow from the engine inlets due to static discharges.
5. St. Elmos Fire or an abnormally high rate of static discharges.

AIRBORNE GUIDELINES

1. Avoid flights near known volcanic activity.
2. Remain on the upwind side of any active volcano or reported ash cloud.

ASH CLOUD ENCOUNTERS

1. Immediately reduce thrust to the lowest practicable, preferably flight idle, if conditions permit.

2. Place OVRD and AIR START switch to OVRD and AIR START.
3. Immediately exit the cloud via the shortest route.
4. Turn the autothrottle system OFF, be aware of erroneous airspeed indications.
5. Turn on all available bleed air powered systems:
   - Wing and Engine Anti-Ice to ON
   - Pneumatic selectors to HIGH
6. All crew members should don their oxygen masks and use 100%. Consider using smoke goggles.

WARNING

If erroneous airspeed indications occur or are suspected, refer to OPERATION WITH SEVERELY DAMAGED NOSE RADOME AND/OR SUSPECT AIRSPEED INDICATION, Section IIA, Abnormal Procedures.

CAUTION

A precautionary landing should be accomplished if damage to the aircraft has occurred, or abnormal engine operation was observed.

ENGINE RESTARTS

If an engine must be shut down due to exceeding limits, refer to ENGINE SHUTDOWN INFLIGHT procedures. Should an engine flameout, attempt engine restart using ENGINE RESTART procedure.

Crews should be aware that an engine restart and acceleration at altitude will be slower than normal ground starts. If an engine does not restart, reattempt the airstart.

WARNING

If all engines flameout, refer to LOSS OF ALL ELECTRICAL POWER, Section II, Emergency Procedures.

NOTE

Repeated restart attempts help to dislodge resolidified ash deposits on the N_2 turbine nozzles.

If a restart hangs or is aborted due to high EGT, an immediate restart attempt should be accomplished. In this case, the normal EGT limit may be exceeded provided the EGT does not exceed 945 degrees C. Should the EGT approach or exceed this EGT limit, the start should be aborted followed by an immediate restart attempt (fuel lever OFF, then back to ON as soon as the EGT decreases). The engine will tend to have a more successful restart than allowing the EGT to climb above the established limits while stalled or hung.

NOTE

After exiting the volcanic cloud, avoid rapid throttle movements. A marked upward shift in EGT and fuel flow will be noticed.

GROUND OPERATIONS

NOTE

The following recommendations are for engines which have not ingested volcanic ash while operating. These apply to starting and ground operations on airfields which are contaminated with volcanic ash.

PREFLIGHT

1. Remove all protective covers, pitot, static ports and engine inlet and exhaust covers.
2. Ensure the engine inlets and exhaust areas are cleared of all volcanic ash. This may be accomplished with brooms or vacuum cleaners.
3. Inspect and clean away any ash within a 25 foot radius of the engine inlets.

STARTING ENGINES

1. Dry motor the engine for a minimum of 2 minutes. After 2 minutes and while the engine is motoring, place the fuel lever to ON. Expect a cooler than normal start EGT.

TAXIING

1. Consider towing the aircraft to the departure runway.
2. Do not exceed 40% N_1 for breakaway thrust or during taxi. This will minimize the formation of inlet vortices and subsequent ingestion of ash deposits. Consider using the number 2 engine.
3. Be aware of loose ash being blown by preceding aircraft engine exhaust. Maintain adequate separation.

TAKEOFF

1. Use rolling takeoff procedures.
2. Avoid applying or using takeoff rated thrust settings below 30 knots.

WARNING

Do not use the autothrottle system for takeoff; airspeed indications may not be reliable.

LANDING

1. Minimize the use of reverse thrust.

WARNING

Forward visibility may be reduced due to the abrasiveness of volcanic ash impacting the windshields.

NOTE

Reverse thrust greater than idle should be avoided below 60 knots, unless required for safety.

BEFORE LEAVING THE AIRCRAFT

Follow established procedures for HOT WEATHER AND DESERT OPERATIONS of this section.

In addition, the following are recommended:

1. Install pitot tube covers.
2. Install ALL engine inlet covers and if possible cover the exhaust with plastic bags taped to the cowling.
3. Close all doors, hatches and windows.
4. Close the air conditioning pack inlet and exhaust doors.
5. Close the cabin outflow valve.
6. Cover all static ports.

REQUIRED AFTO FORM 781 WRITEUPS

1. Location and time of the encounter.
2. Altitude and airspeed.
3. Phase of flight.
4. Engine power level (N_1, N_2, EGT).
5. General weather conditions (IMC/VMC).
6. Duration of the encounter.
7. ATC or other assistance (PIREPS, Advisories, etc.).
8. Cockpit indications of the encounter.
9. Actions taken (power and altitude change, turns and bleed air configuration).
10. Unusual aircraft and/or engine response, (compressor stalls, restart problems or erratic instrument indications).

HOT WEATHER AND DESERT OPERATIONS

High ambient temperatures on the ground have important effects on performance, crew and operating efficiency. High temperatures, alone or coupled with high humidity or blowing sand and dust, will complicate normal operations. Proper protection and inspection of the aircraft while it is on the ground, and observance of the precautions covered in this section, will assure the most successful operation.

High temperatures inflict performance penalties which must be taken into account on the ground before takeoff. When combined with short runways, performance penalties may affect the payloads which can be carried. Examine Performance Data Manual, TO 1C-10(K)A-1-1 critically to determine the adverse effects of high temperature on aircraft performance.

Every effort to keep the interior of the aircraft as cool as possible is important. All doors to the aircraft should be kept closed as much as possible, and the cargo door should not be left open any longer than necessary. Consideration should be given to reducing the heat being generated in the cabin and cockpit during short stops on through flights. Window heat and electronic equipment which contribute to a high temperature level might be turned off while the aircraft is exposed to high airport temperatures at transit stops.

BEFORE ENTERING THE AIRCRAFT

Inspect more closely the tires and shock struts for proper inflation, and accumulators for proper air charge. Be alert for hydraulic leaks. Clean dust and sand from struts and other hydraulic pistons and from limit switches. Inspect door seals for deformation and damage due to high temperatures. Remove all protective covers and dust plugs. Be sure that the aircraft is positioned to avoid sandblasting other equipment during start and run-up.

AFTER ENTERING THE AIRCRAFT

Check instruments and electrical equipment for excessive moisture due to high humidity. If operating in a dusty location, check for accumulated dust at control, instrument, and electronic equipment areas inside the aircraft. Check that survival kits appropriate to the climate are stowed aboard, if required.

STARTING ENGINES

Complete as much of the preflight as possible before starting the engine ground operation. Use normal starting procedures.

TAXIING

Use the brakes as little as possible during taxiing since brake cooling is retarded by high ambient temperatures. Keep sufficient distance between aircraft to prevent sand and dust from blowing into the engines.

TAKEOFF

Strict adherence to recommended takeoff and climbing speeds is necessary during extreme high temperature operations because aircraft performance decreases with temperature rise. Takeoff distances increase significantly as the temperature rises.

CLIMB

Use normal climb procedure.

NOTE

> Temperatures above standard day conditions will decrease overall aircraft performance. Rate of climb will decrease while climb time, climb fuel, and climb range increase.

APPROACH AND LANDING

NOTE

> Landings and unplanned go-arounds are allowed at outside air temperatures up to a maximum of 55°C.

During extremely high temperatures, be careful to adhere to the normal landing procedures. Since the air is less dense, true airspeeds are higher at the same indicated airspeed and true stall and touchdown speeds will be higher. Do not attempt approaches at less than recommended V_{TH} speed over the end of the runway. Anticipate longer ground rolls. Excessive use of brakes should be avoided to prevent overheating.

PARKING

If blowing dust or sand is anticipated, park the aircraft with the nose pointed into the prevailing or forecasted wind (flaps and slats retracted). This precaution may reduce the accumulation of dust and sand along the trailing edges of the wings and on the actuating mechanisms for the ailerons, flaps, and spoilers.

STOPPING ENGINES

Use the normal procedure for stopping the engines. Have the wheel chocks inserted as soon as the parking position has been reached and release the parking brakes to aid in brake cooling.

WARNING

> After chocks are in place following maximum performance landings or excessive braking, personnel should stay clear of the main landing gear areas until the brakes have cooled. Use the brake temperature indicators to determine temperatures.

BEFORE LEAVING THE AIRCRAFT

Have all protective plugs and covers installed. Except in dusty or rainy weather, leave the doors open for ventilation and open the nose and main landing gear wheel well doors.

NOTE

> In dusty locations, if it is necessary to leave hatches or doors opened, all equipment inside the aircraft should be protected with dust proof covers where possible to keep out blowing dust and sand.

TURBULENCE AND THUNDERSTORMS

WARNING

> Flight through thunderstorm activity, or known severe turbulence, is not recommended and should be avoided if at all possible. Careful judgment must be used by the Pilot in determining capability to safely enter or circumnavigate areas of such weather activity.

Pilots should be aware that it is possible, when flying in severe turbulence, to impose excessive structural loads on the aircraft, and that aircraft attitude may reach undesirable extremes. Turbulence penetration procedures have been established to minimize attitude excursions as much as possible and to maintain structural loads within acceptable limits. The flexible sweptback wing and high wing loading of the aircraft make it highly possible that any structural damage which might occur in severe turbulence will be the result of aircraft upset and recovery maneuvers in combination with turbulence, rather than the effects of turbulence alone. Retention of fuel in the outboard compartment of the wing tanks until its use is required, or until the last portion of the mission, will improve the wing spanwise loading distribution.

AIRSPEED AND FLAPS

Turbulent air penetration speed is selected to provide optimum controllability and low speed/high speed buffet margin in turbulent air. While flight at low speeds is satisfactory in moderate turbulence, there are several disadvantages to flying at low speeds in severe turbulence. First, the aircraft is closer to stall buffet and, since the angle-of-attack changes caused by severe turbulence can be high, there is a greater chance of encountering strong and alarming buffeting. This buffeting will be accompanied by high drag resulting in loss of altitude and will tempt the Pilot to make undesirable thrust changes. Aircraft trim changes due to thrust changes are greater at low speed compounding the difficulty of maintaining adequate altitude control. Second, it is easier for the aircraft to be laterally and directionally upset at lower speeds when turbulence is severe.

Because of the disadvantages of low speed flight, a penetration speed sufficiently high has been selected to provide adequate attitude control without subjecting the aircraft to excessive structural loads. Target airspeed is within the range of 290-310 KIAS or Mach 0.80-0.85, whichever is lower. These speeds are for severe turbulence such as that encountered in a thunderstorm. They provide fully adequate structural margins and aircraft control. At high altitudes, however, most turbulence encounters are not severe turbulence and do not require an airspeed reduction. A reduction from Mach 0.85 to Mach 0.82 only reduces the true airspeed approximately 15 knots when at 35,000 feet. From the Pilot’s standpoint, the aircraft control is better at the higher Mach numbers and less time is spent in the turbulent area. The speed range for severe turbulence allows a greater latitude of speed reduction while providing the required maneuvering and structural limit margins.

The best airspeed and wing configuration to use in the presence of severe turbulence is that which affords ample protection both from stall and from structural deformation. The aircraft can withstand higher gust intensity with flaps retracted. Flap extension in an area of known turbulence should be delayed as long as possible. Diversion to another area is the best policy if severe turbulence persists.

ATTITUDE

In extreme turbulence, pitch attitude must be controlled using only small to moderate elevator control inputs to avoid overcontrolling or overstressing the aircraft structure. The natural stability of the aircraft will work in a direction to minimize the loads imposed by turbulence. The Pilot should rely to a major extent on this natural stability and not become too overly concerned about pitch attitude variations. Since there is always an uncertainty of the direction, timing, and size of the next gust, it is often better to do nothing at all than to attempt to control aircraft pitch attitude too rigidly. Ideally, elevator control should be applied smoothly in a direction to resist motions away from the desired attitude, and the elevator should be returned to neutral when the aircraft is progressing toward the desired attitude. This technique will help prevent overcontrolling, reduce the size of pitch attitude excursions, and result in less g loads than a technique which very closely controls pitch attitude.

Pitch attitude should be controlled solely with the elevator, never with stabilizer trim. Rapid changes in airspeed and attitude due to extreme gusts make stabilizer trim difficult to apply effectively. If trim has been applied to counter the first gust, the second gust, which will likely be in the opposite direction will exaggerate the out-of-trim condition. It is therefore considered desirable to leave the stabilizer trim alone in severe turbulence.

THRUST

The most desirable thrust setting is one which will provide near-level flight at the recommended penetration speeds in smooth air. The most important objective is to obtain an initial thrust setting reasonably close to the correct one. Once the proper thrust setting for the speed recommended for penetration is achieved, it is undesirable to make thrust changes during severe turbulence. Large variations in airspeed and altitude are certain to occur in severe turbulence.

NOTE

> Throttle movements at high altitude should be made smoothly and slowly from stabilized thrust settings. Do not retard throttles and then advance them while the engines are decelerating; conversely, do not advance throttles and then retard them while engines are accelerating.

ALTITUDE

Because of high velocity updrafts and downdrafts in severe turbulence, large variations in altitude are certain to occur. Too much concern about these variations will merely lead to excessive control manipulations causing large structural load variations and unwanted airspeed excursions. Altitude should be allowed to vary within reasonable bounds.

TURBULENCE PROCEDURES

The following procedures are to be used for flight in severe turbulence:

a. AIRSPEED - Approximately 290-310 KIAS or approximately Mach 0.80-0.85, whichever is lower. Severe turbulence will cause large and often rapid variations in indicated airspeed. Do not chase airspeed.

b. AUTOPILOT - Engage autopilot and select TURB mode. Yaw dampers must be engaged at all times. Do not aid or resist lateral control motion.

c. THRUST - Engine ignition switches should be in CONTINUOUS A or B.

d. ATTITUDE - Maintain wings level, and smoothly control pitch attitude. Use attitude indicator as the primary instrument. In extreme drafts, large attitude changes may occur. Do not use sudden or large control inputs.

e. ALTITUDE - Allow altitude to vary. Large altitude variations are possible in severe turbulence. Sacrifice altitude in order to maintain the desired attitude and airspeed. Do not chase the altimeter.

f. SAFETY BELTS - Check that all occupant safety belts are fastened. Personnel must be advised to fasten safety belts in sufficient time to firmly strap in before entering areas of forecast or suspected turbulence.

NOTE

> Visual sighting, when possible, and correct use of the search radar for early detection of thunderstorm activity is essential for determining a course of action in order to circumnavigate detected disturbances. As the thunderstorm is approached, variations in function, range, antenna tilt, and radar beam pattern may be necessary for optimum radar scope presentation.

BOOM FILLING PROCEDURES

WARNING

> The boom shall be maintained full of fuel when the departure, enroute or arrival flight path may place the aircraft in the vicinity of lightning. This is necessary as a precaution against fuel vapor ignition from lightning strikes.

CAUTION

Coordination with the boom operator is required prior to filling the boom, due to possible boom extension.

NOTE

The A/R MASTER PWR switch is required to be on.

1. Boom Valve .... OPEN (FE)
2. Fuel Valves .... OPEN AS REQ'D (FE)

   Select appropriate alternate transfer valve and isolation valve, if required, to fill boom using a selected transfer pump.

3. Fuel Transfer Pump .... ON (FE)

   Pressurize boom to 15-20 psi.

4. Fuel Transfer Pump .... OFF (FE)

NOTE

If fuel pressure exceeds a constant 20 psi or a momentary pressure spike of 25 psi, verify that boom is not extended. Retract boom if necessary, then repeat steps 3 and 4.

5. Fuel Valves .... CLOSED (FE)
6. Boom Valve .... CLOSED (FE)
7. Manifold Scavenge........ TANKER/OFF (FE)

NOTE

Rotate MANF SCAV selector switch to TANKER and scavenge A/R manifold. After the MANF SCAV PRESS LOW light illuminates, rotate the selector switch to OFF. No more than 10 minutes should be required to scavenge the manifold. If the Pressure Low light does not illuminate within 10 minutes, maintenance is required.

WINDSHEAR/SEVERE WINDSHEAR

Windshear is a change of wind speed and/or direction over a short distance along the flight path. Vertical wind activity (up or down drafts) can occur in a windshear environment. Severe windshear is a rapid change in wind direction and/or velocity that results in airspeed changes greater than 15 knots, or vertical speed changes greater than 500 feet per minute.

Windshear and/or vertical wind activity may be experienced in thunderstorm areas, fronts, low level jet streams, mountain waves, thermals, or may be produced by terrain irregularities or buildings close to the runway. Windshear and/or vertical wind activity can present a potential hazard when flying near the ground. If the aircraft is exposed to a diminishing headwind (or increasing tailwind) and/or downdrafts, corrective action must be taken promptly to avoid high rates of descent. In severe conditions, go-around thrust and flying well above the normal go-around attitude close to stick shaker activation speeds may be required. It should be remembered that any attempt to accelerate back to the bug speed when in windshear and/or downdraft conditions will significantly reduce the rate of climb capability. It may be necessary to slowly reduce speed in order to obtain a temporary increase in rate of climb or decrease in rate of descent. Pitch corrections should be made smoothly and maneuvering should be kept to a minimum while penetrating a windshear. The following items must be considered to identify in a timely manner and successfully negotiate windshear conditions:

a. Be thoroughly familiar with the meteorological conditions that could produce a horizontal windshear (head, tail or cross windshear) and/ or severe vertical wind activity. Remember that the tower reported wind may not indicate the actual conditions on takeoff or final approach.

b. Know the performance and handling characteristics of your aircraft, especially between the bug speed and the stick shaker activation speed. Remember that good climb performance is available at stick shaker speeds if takeoff or go-around thrust is used. Be familiar with the acceleration characteristics of your aircraft during the takeoff roll.

c. Use good instrument scanning techniques including all flight instruments for earliest possible identification of windshear.

d. The Pilot not flying should monitor all flight instruments until the initiation of the flare, regardless of meteorological conditions or landing aids used. Follow established cockpit procedures and alert the Pilot flying on altitude, airspeed, glideslope, localizer and vertical speed deviations.

e. Do not knowingly penetrate a severe windshear and/or intense downdraft when below 500 feet or with an engine inoperative. Stay clear of thunderstorm cells and heavy precipitation.

f. Use of the FMS for groundspeed and drift angle readout is very useful. Monitoring FMS groundspeed and drift angle would indicate onset of a headwind or tailwind shear. A comparison of the FMS groundspeed, airspeed and drift angle data early on final approach with the tower reported winds may also indicate the presence of a low altitude windshear.

g. Monitor the EGPWS W/S annunciators for presence and type of windshear.

DEFINITIONS:

Windshear: Any rapid change in wind direction and/or velocity that results in an airspeed change of more than 10 knots.

WARNING

When windshear conditions exist or are forecasted, apply Takeoff Into Suspected Windshear procedures.

Severe Windshear: A rapid change in wind direction and/or velocity that results in airspeed changes greater than 15 knots, or vertical speed changes greater than 500 feet per minute.

Gain Shear: A rapid increase in runway headwind component or a rapid decrease in runway tailwind component resulting in rapid gain in indicated airspeed, a significant gain in lift, and a rapid change in vertical velocity.

Loss Shear: A rapid decrease in runway headwind component or a rapid increase in the runway tailwind component resulting in a rapid loss in indicated airspeed, a significant loss of lift, and a rapid change in vertical velocity.

WARNING

Takeoff will not be attempted when:

- Severe loss shear conditions exist or are forecast at or below 2000 feet AGL.
- Windshear conditions are associated with convective activity.

Examples:

1. A reported/forecasted rapid change in wind direction and/or velocity that results in an airspeed change of 10 knots or less: Accomplish Normal Takeoff/Performance procedures unless in the opinion of the aircraft commander other conditions exist that necessitate the use of Takeoff Into Suspected Windshear procedures.
2. A reported/forecasted rapid change in wind direction and/or velocity that results in an airspeed change of 11 to 15 knots: Accomplish Takeoff Into Suspected Windshear procedures.

TAKEOFF INTO SUSPECTED WINDSHEAR

If takeoff into a suspected windshear condition is necessary:

a. Compute performance data in accordance with TO 1C-10(K)A-1-1, Section 3.

b. The use of autothrottles and/or autopilot is not recommended.

c. Flight directors will be turned off. Flight director command bars are invalid in takeoff mode when using performance limited speeds.

AFTER LIFTOFF

a. With an inoperative engine, fly to performance limited gross weight V_2.

b. With all engines operating, fly to the performance limited gross weight V_2 + 10 knots.

c. If an extreme windshear condition is encountered, implement the Maximum Performance Maneuver as necessary to maintain safe flight.

NOTE

- Maximum Performance Maneuver - Increase pitch as required to control vertical speed and altitude. Increase pitch attitude only to that necessary to maintain a positive rate of climb. The increase should be limited to the onset of stick shaker and thereafter intermittent stick shaker to ensure that proper stall margin is maintained.
- Thrust increase, when required, should be immediate to the go-around limit and, if necessary, the throttles should be pushed to mechanical stops.
- When flying to the performance limited speeds, a push force can be expected to maintain nosewheel contact with the runway to V_R and to maintain the second segment speed.

TAKEOFF INTO UNSUSPECTED WINDSHEAR

If inadvertently exposed to severe tail windshear and/or intense downdraft, control responses must be made immediately as the situation develops.

a. Rotation at V_R to higher than normal liftoff attitudes may be required to unstick.

b. When on initial climbout, do not permit pitch attitude reduction when airspeed decreases unexpectedly. If above stick shaker speed, implement the Maximum Performance Maneuver.

c. Do not make any stabilizer trim inputs until stabilized conditions have again been established.

d. Be prepared for penetration of additional areas of horizontal wind changes and vertical wind activity.

e. If the extreme situation cannot be countered prior to descent through or below 500 feet using techniques described above, consider use of emergency overboost by moving the throttles to mechanical limits.

WARNING

In windshear conditions, disregard the flight director command bars or impact with the ground will occur.

f. Do not change aircraft configuration until a positive rate of climb can be maintained.

LANDING IN WINDSHEAR CONDITIONS

The comparison of actual groundspeed (displayed on the FMS CDU or the EHSI) and reference groundspeed during approach is a proven procedure for detecting and coping with low level windshear.

NOTE

Reference speed is computed by subtracting the headwind component (adding tailwind component) from the approach TRUE AIRSPEED. When the actual ground speed differs from reference ground speed, a wind change or shear will occur during the approach (see reference ground speed examples).

Serious consequences may result on an approach when windshear is encountered close to the ground after power adjustments have already been made to compensate for wind. Figure 7-1 illustrates the situations when power is applied or reduced to compensate for the change in aircraft performance caused by windshear.

If windshear conditions are anticipated on final approach, use the following procedures:

The crew will use all indications (convective activity, frontal passage, virga, pilot reports, forecasts) to determine if the potential for windshear exists.

a. Use 35° flaps, runway length permitting.

b. Compute reference groundspeed. Monitor the EGPWS W/S annunciators and take appropriate action based on the type of alert.

c. The No. 3 FMS CDU will be used to monitor wind direction/velocity and headwind/tailwind component. The Flight Engineer shall advise the Pilot of any significant deviations (10 knots ground speed, headwind/tailwind component or a rapid change in direction of 20° or more).

NOTE

FMS wind information may be erroneous below a TAS of 130 knots which corresponds to a gross weight of approximately 300,000 pounds.

d. The Pilot and Copilot will monitor groundspeed on their EHSIs.

e. Approach IAS and reference groundspeed are minimum speeds on final prior to slowing for landing. If either speed decreases below its computed value, the PF will make an appropriate pitch/power correction.

WARNING

- If an IAS speed margin in excess of V_{APP} + 20 knots is required to maintain reference groundspeed, serious consideration should be given to NOT attempting the approach or discontinuing the approach once initiated.
- Below 500 feet, if an IAS speed margin in excess of V_{APP} + 20 knots is required to maintain reference groundspeed, the approach will be discontinued.
- Consider executing a go around/missed approach any time an EGPWS windshear warning is annunciated.
- Execute a go around/missed approach if an EGPWS windshear warning is annunciated below 500 feet AGL.

NOTE

Reference groundspeed should be updated during the approach for changing conditions.

f. Use of autothrottles or autopilot is not recommended. If used, the pilots should be alert to override the autothottles if response to increase thrust is too slow. Conversely, N_1 should not be allowed to get too low during the late stages of the approach as this will increase the time needed to accelerate.

If inadvertently caught in a severe tail windshear and/or downdraft:

a. Simultaneously disengage the autothrottles, if applicable, and aggressively apply go-around thrust. Disengage the autopilot and rotate smoothly toward a target pitch attitude of 15°. Discontinue rotation when flight path is under control. If the aircraft continues to descend, slowly increase pitch attitude to maintain a positive rate of climb or level flight. Stop rotation immediately if stick shaker or buffet should occur. From this point on, pitch attitude should be limited to the onset of stick shaker and thereafter intermittent stick shaker with as smooth a pitch change as possible. Power should be increased to the mechanical stops to maintain flight as necessary.

b. Do not change aircraft configuration until a positive rate of climb can be maintained. Do not retrim the aircraft until stabilized conditions have been established.

c. Be prepared for penetration of additional areas of horizontal wind changes and/or vertical wind activity during go-around.

WARNING

The flight director command bars will attempt to maintain V_2 + 10 knots during go-around and will automatically call for trading altitude for airspeed if the aircraft is below V_2 + 10 knots. With the autopilot in CMD and GA in the pitch FMA, impact with the ground could result if the autopilot is not disengaged or the command bar guidance is followed.

REFERENCE GROUND SPEED

a. Use charted threshold speed and normal wind additives (from reported runway winds) to compute approach IAS.

b. Use computed approach IAS and appropriate procedure/technique (i.e. ICE-T, smoe, etc.) to compute approach TAS.

NOTE

Approach IAS and approach TAS may be significantly different at high pressure altitudes and temperature deviations.

c. Use reported runway winds to compute runway headwind (tailwind) component. If winds are variable, use lowest headwind component without headwind gust (highest tailwind component with tailwind gust).

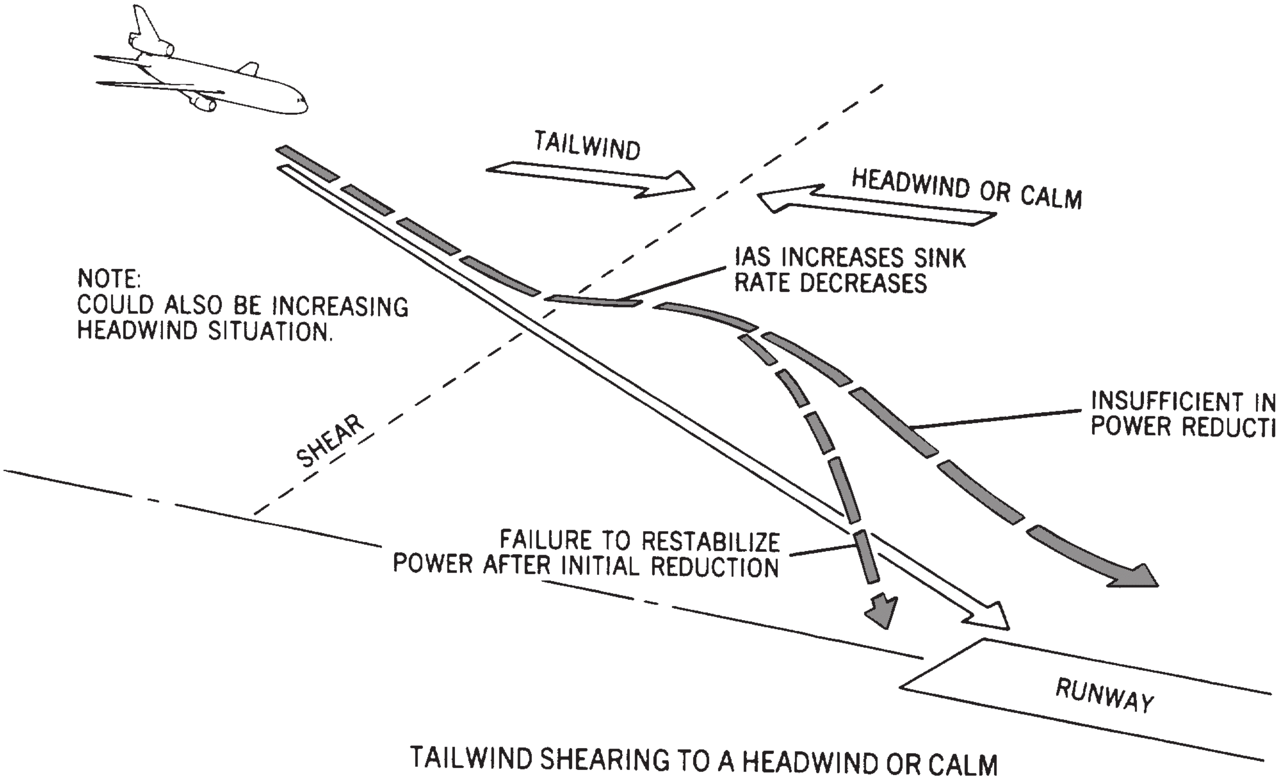
d. Use approach true airspeed and runway headwind (tailwind) component to compute reference ground speed.

e. Compute reference ground speed by subtracting runway headwind (adding runway tailwind) component from (to) approach true airspeed.

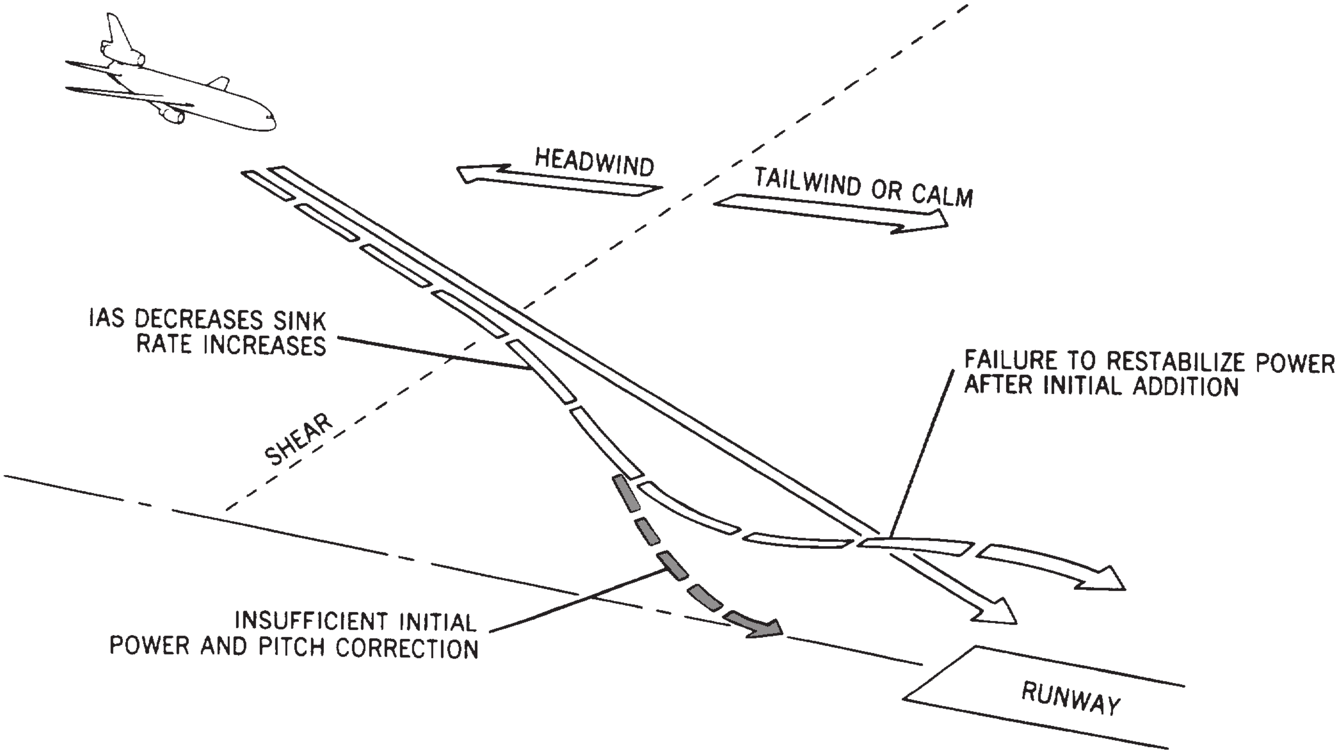
f. After encountering wind change/shear, and aircraft is stabilized on glidepath and safe landing is assured, maintain approach IAS until initiation of the landing flare.

NOTE

Increased threshold speeds may increase landing ground roll due to higher landing ground speeds.



TAILWIND SHEARING TO A HEADWIND OR CALM



HEADWIND SHEARING TO A TAILWIND OR CALM

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Figure 7-1. Windshear

EXAMPLE 1		EXAMPLE 2	
Runway Heading:	180°	Runway Heading:	180°
Gross Weight:	295M	Gross Weight:	295M
Pressure Altitude:	4300FT	Pressure Altitude:	100FT
Temperature:	25° C	Temperature:	20° C
Winds:	120V150/28G34	Winds:	060V080/11G14
Charted Threshold Speed:	130 Knots	Charted Threshold Speed:	130 Knots
Normal Wind Additives:	+10 Knots	Normal Wind Additives:	3 Knots
Approach IAS:	140 Knots	Approach IAS:	133 Knots
ICE-T, Smoe, etc:	x1.1	ICE-T, Smoe, etc:	nil
Approach TAS:	154 Knots	Approach TAS:	133 Knots
Runway Headwind Component:	-14 Knots	Runway Tailwind Component:	+7 Knots
Reference Ground Speed:	140 Knots	Reference Ground Speed:	140 Knots
Indicated Ground Speed:	120 Knots	Indicated Ground Speed:	160 Knots
If shear is abrupt, IAS loss will be 20 knots. Increase IAS to maintain 140 knots reference ground speed.		If shear is abrupt, IAS will increase by 20 knots. Maintain approach IAS. Resist temptation to pull off power.	

SECTION VIII

RECEIVER/TANKER AIR REFUELING

TABLE OF CONTENTS

PART 1

GENERAL OPERATIONS

TABLE OF CONTENTS

GENERAL OPERATIONS

MISSION PLANNING

Both tanker and receiver crews must be thoroughly familiar with all aspects of the refueling in order to adequately plan the mission. Planners and crews will be thoroughly familiar with mission requirements as prescribed in the appropriate command directives.

Crewmembers will become thoroughly familiar with the weather forecast for the air refueling area so that alternate plans can be utilized when the primary track is unsuitable. Tanker crews should become familiar with the receiver's flight plan from departure base to the air refueling track, if possible, so late changes to orbit or air refueling tracks, when required, might be passed on to the receiver more readily. Tankers should have a plan to accommodate late receivers.

Planned air refueling track/anchor with altitude limitations, ARIP/Entry Point, ARCP/Anchor Point, RZ and RZIP (if applicable), and EAR/Exit Point will be annotated on a crew chart.

The base air refueling altitude should be at least 2000 feet below the receiver optimum altitude for air refueling with a single tanker. In a two tanker formation, the leader should be at least 2500 feet below the receiver optimum altitude. In a three tanker formation, the leader should be at least 3000 feet below the receiver optimum altitude.

CAUTION

> Normally, 25,000 feet will be used as the base altitude for tanker orbit and air refueling. However, altitudes up to 2000 feet below receiver's end A/R optimum gross weight altitude may be used. Do not refuel as a receiver above 31,000 feet.

NOTE

> For purposes of this manual, receivers with 3 or more engines will be considered multiengine (large) receivers.

Fuel which does not contain a Fuel System/Icing Inhibitor (FSII) will not be offloaded without coordination with the receiver(s).

FORMATION TAKEOFF/ CLIMBOUT PROCEDURES

For KC-10/KC-10 or KC-10/KC-135 formation departures, the normal planned climb speed below 10,000 feet MSL is 250 KIAS, unless a higher speed is required to accommodate the V_{MM} of the heaviest aircraft in the formation. Above 10,000 feet MSL, for KC-10/KC-10 or KC-10/KC-135 formation departures, the normal planned climb speed is 290 knots (NOTE: this equates to 295 KIAS in the KC-135) for formations with KC-10s less than 500,000 pounds gross weight and 310 knots (NOTE: this equates to 315 KIAS in the KC-135) for formation with KC-10s equal to or greater than 500,000 pounds gross weight. Planned climb speeds apply to the lead aircraft only. Following aircraft may exceed/lag these speeds as necessary to accomplish the rejoin and maintain proper formation position. In all cases, formation leaders may adjust the climb speed schedule as mission requirements and aircraft performance dictate. Planned climb speed will not be less than V_{MM} of the heaviest aircraft in the formation. Climb speed schedules which result in KC-10s climbing with slats extended will be avoided.

For formation departures, TCAS should be placed in the TA/RA mode prior to takeoff. During join up TA mode may be selected to prevent RAs.

REFUELING SPEEDS FOR MAXIMUM OPERATIONAL CAPABILITY

To establish the minimum air refueling speed, use the appropriate cruise buffet-onset boundary chart to determine the 1.2g buffet speed and then add 5 knots (10 knots if wing air refueling pods are installed). Maximum bank angle when using this speed shall be 15 degrees.

NOTE

> Buffet Characteristics in the clean configuration are discussed in the Limitations Section of this manual.

COMMUNICATIONS

Unless directed otherwise, communications capability between tankers and receivers will be maintained during all normal rendezvous and air refueling operations. Voice transmissions, however, will be held to an absolute minimum during rendezvous and air refueling to be in accordance with the Emission Option being used. Communication requirements should be established prior to flight. EMCON 2 will be used as the normal rendezvous and air refueling procedure.

The assigned air refueling frequency will normally remain the interplane frequency during air refueling operations.

WARNING

- Do not transmit on the HF radio when in contact with, or in close proximity to the KC-10A air refueling boom.
- Transmitting on HF may cause uncommanded KC-10A air refueling boom movement, endangering the tanker or receiver aircraft and crews.

CAUTION

If radio communication capability is lost or unreadable between the boom operator and receiver pilot, contacts will not be attempted, except during an emergency fuel situation.

NOTE

- UHF Guard shall be monitored at all times. When both UHF radios are operating properly, Guard channel will be turned off on the radio being used for air refueling. During air refueling, the pilot flying and the boom operator should limit their monitoring to interphone and the air refueling frequency.
- When only one UHF radio is available, UHF Guard should be monitored on the radio being used for air refueling unless it presents a hazard to safe operations.
- **WITH TCTO 1C-10(K)A-1243** The Iridium phone is monitored/operated from the service interphone system. The service interphone volume control is the default volume control for the Iridium phone.
- Primary crewmembers should refrain from talking on the Iridium phone during AR activities except for operational necessity. ◀
- Crews will monitor threat frequencies as directed.
- With the exception of breakaway calls, crewmembers may shorten individual tactical call signs using only the number. Example: Tank 11 would be 11.
- If tankers and receivers are in contact with a common facility providing rendezvous assistance, then radio contact between the tankers receivers may be delayed to accomplish the rendezvous.

Mandatory calls by the receivers are as follows:

a. Initial radio contact a minimum of 15 minutes prior to rendezvous control time.

b. Notify the tanker when established on the proper rendezvous altitude, if not at the proper rendezvous altitude at the 15 minute prior to the ARCT/RZ call.

c. Precontact call (acknowledgment) (for fighter aircraft, only required by flight lead).

d. Notify boom operator prior to using manual/emergency/override boom latching.

VISUAL SIGNALS

Radio silent air refueling can be conducted by use of visual signals provided the following precautions and procedures are observed:

a. During boom air refueling, the pilot director red light panel(s) and adjacent illuminated letter(s) will be actuated by the boom operator to aid the receiver in attaining the contact position. A steady red light indicates a large correction, and a flashing red light indicates a small correction in the direction indicated by the pilot director red light panel(s) and adjacent illuminated letter(s).

b. During boom air refueling, pressing the emergency breakaway switch will cause the pilot director lights to automatically flash for 10 seconds signaling breakaway to the receiver. To signal a request for a disconnect, the disconnect signal switch will be held in the depressed position; this will extinguish all pilot director lights. Hold until receiver initiates disconnect and the boom nozzle is free of the receptacle.

c. During drogue air refuelings, holding the breakaway signal switch in the "BRKWY SIG" position will cause the red external DROGUE HYD PRESS LOW light to flash, signaling a breakaway to the receiver.

LIGHTING

While accomplishing a rendezvous, the KC-10A will have navigation lights full bright, high intensity and beacon lights (both) on, and formation lights on (if required). These lights will be turned on at least 15 minutes prior to the latest known receiver ETA for the rendezvous point.

The KC-10A tanker recommended Wing Pod Air Refueling night light settings are contained in figure 8.1-1. Required night lighting (if applicable) will be on prior to receiver(s) reaching 1 NM in trail. After the receiver has established visual contact and has closed to ½ NM in trail, the tanker will turn lower beacon and high intensity lights off. When the receiver reaches the observation/precontact position, the tanker will adjust exterior lights as required or as requested by the receiver. The receiver will adjust his lights as requested by the boom operator (see figure 8.1-2).

Single tanker performing a rendezvous will always display red/white in the upper and lower beacon lights. Tanker formation identification lighting is as follows:

TANKER	LIGHT COLOR	
NUMBER	UPPER	LOWER
1	Red	Red
2	White	White
3	Red-White	Red-White

To further aid in identification, KC-135 tanker position lights will be BRIGHT and FLASHING for numbers 1 and 3 and will be BRIGHT and STEADY for number 2. After the receiver has established visual contact and has closed to 1/2 NM in trail, tankers will turn position lights to STEADY and DIM and turn lower rotating beacon lights off (see figure 8.1-3).

PILOT DIRECTOR LIGHTS - KC-135

The pilot director lights consist of two rows of lights located forward of the wing root. Relative elevation position is provided by the left row and the right row provides telescoping position. The elevation row contains one striped green, two solid green and two red triangular shaped panels and two white letters; "U" at the forward end for UP, and "D" at the aft end for DOWN. The colored panels are dimly illuminated by background lights. The telescoping row contains one striped green, two solid green, two red and four white rectangular panels and two white letters; "A" at the forward end for AFT, and "F" at the aft end for FORWARD. The colored panels are not background lighted. Separation is provided by the white panels. The white letters located at the ends of each row are also illuminated. The pilot director lights provide guidance during contact made and disconnect. The red panel at the ends of each row are illuminated by the boom operator to aid the receiver in attaining the contact position (see figure 8.1-4).

PILOT DIRECTOR LIGHTS - KC-10A

The pilot director lights consist of two rows of lights located forward of the wing root. Relative elevation position is provided by the left row and the right row provides telescoping position. The elevation row contains one green, two amber and two red triangular panels and two white letters: "U" at the forward end for UP, and "D" at the aft end for DOWN. The colored panels and letters are dimly illuminated by background lights. The telescoping row contains one green, two amber, two red and four white rectangular panels and two white letters; "A" at the forward end for AFT, and "F" at the aft end for FORWARD. The colored panels are not background lighted; however, the letter at each end of the row is dimly illuminated. Separation is provided by the white panels. The pilot director lights adjust automatically to the size of the air refueling envelope selected and provide guidance during contact and disconnect.

To provide more response time, the appropriate panel and letter are illuminated in anticipation of receiver movement. The red panel and letter at the ends of each row are illuminated by the boom operator to aid the receiver in attaining the contact position (see figure 8.1-5).

KC-10 EXTERIOR LIGHTING	RENDEZVOUS	OBSERVATION POSITION	REFUELING POSITION
NAVIGATION (FE)	ON	ON-DIM	ON-DIM
HIGH-INTENSITY LIGHTS (FE)	ON	OFF	OFF
FORMATION (FE)	ON-25 PERCENT	ON-25 PERCENT	ON-25 PERCENT
WING AND ENGINE SCAN (FE)	ON	OFF	OFF
WING ILLUMINATION (BO)	ON	ON-25 PERCENT	ON-25 PERCENT
AFT FUSELAGE UNDERBODY (BO)	ON	OFF	OFF
ANTI-COLLISION (FE)	ON	OFF	OFF
HORIZONTAL STABILIZER (BO)	ON	AS REQUESTED	AS REQUESTED
TAIL LOGO (FE)	ON	AS REQUESTED	AS REQUESTED
POD FLOOD (BO)	ON	AS REQUESTED	AS REQUESTED
POD INTERNAL (BO)	ON-50-75 PERCENT	ON-50-75 PERCENT	ON-50-75 PERCENT

NOTE

(CREW POSITION) FOLLOWING THE LIGHT INDICATES CREW MEMBER THAT CONTROLS THE LIGHT.

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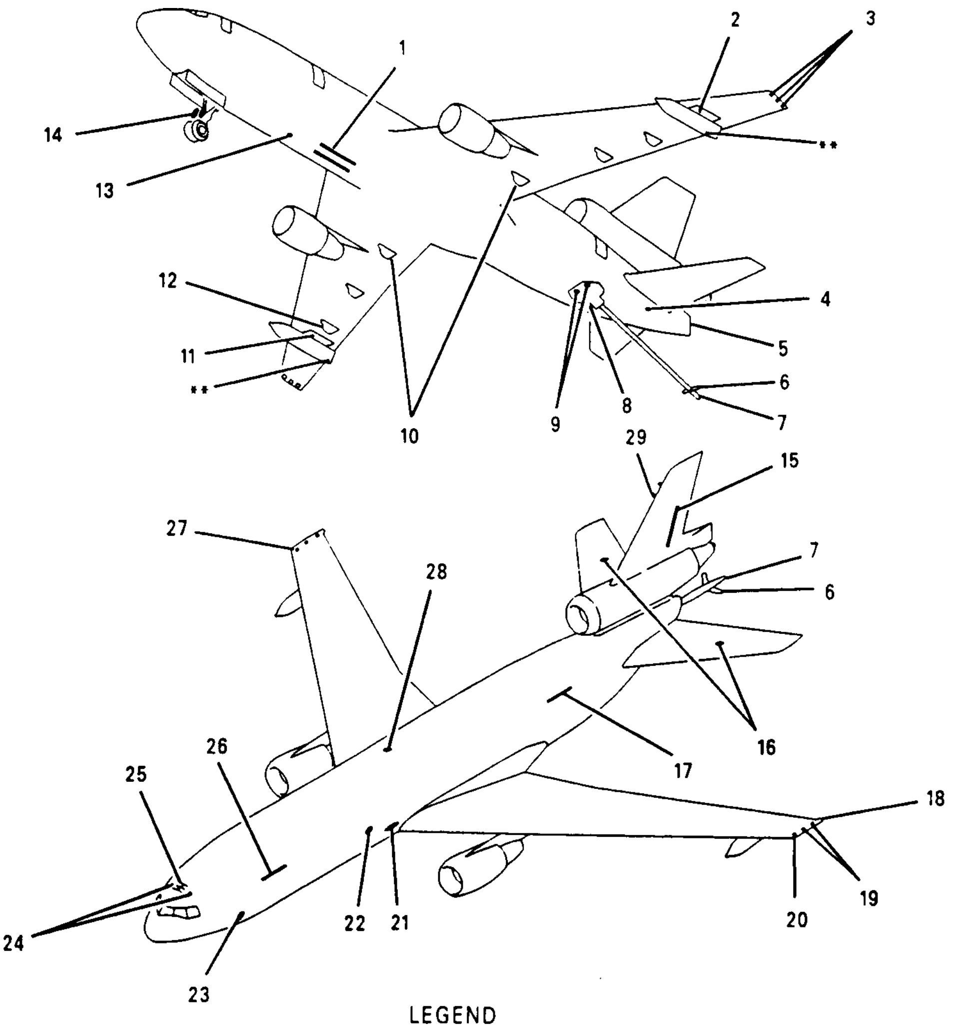
Figure 8.1-1. KC-10 Wing Pod Air Refueling Recommended Exterior Light Setting

HOSE/DROGUE SIGNAL LIGHTS/MARKINGS

Red, green, and amber signal lights provide system status to the receiver pilot. The red signal light illuminates steady when the hydraulic pressure is too low to operate the hose reel. The signal light also illuminates steady when the RESP INOP light is illuminated. The red light can also be flashed by the boom operator to signal an emergency breakaway. The green signal light turns on when fuel is being transferred. The amber signal light is on steady when the drogue is in full trail position. The centerline system must also have the reel response set properly for the amber light to come on. The amber light goes out when the receiver pushes the drogue in approximately 5 feet and flashes when the forward limit of the refuel range is being approached.

Centerline Drogue Markings

The centerline hose is 80 feet long and is black marked in 10-foot intervals with a 12-inch white band. The fueling range is marked by 12-inch white bands at 5-foot intervals. The fuel flow initiation position, the recommended refueling position, and the inner limit position are each marked by a 24-inch white band. The fueling range is approximately 5 feet from the full trail to 40 feet from full trail (see figure 8.1-6).



LEGEND

1. DIRECTOR LIGHTS
2. OUTBOARD POD MARKINGS ILLUMINATION LIGHT***
3. HIGH INTENSITY SUPPLEMENTAL LIGHTS (TYPICAL)
4. HORIZONTAL STABILIZER ILLUMINATION LIGHT (TYPICAL)
5. RECEIVER AIRCRAFT FLOODLIGHTS
6. BOOM MARKER LIGHTS (FLUORESCENT)
7. BOOM NOZZLE LIGHTS
8. HOSE/DROGUE SIGNAL LIGHTS
9. WING ILLUMINATION LIGHTS
10. FORWARD FUSELAGE UNDERBODY LIGHTS
11. INBOARD POD MARKINGS ILLUMINATION LIGHT***
12. AFT FUSELAGE UNDERBODY LIGHT (TYPICAL) (INBOARD SIDE OF OUTBOARD FLAP HINGE FAIRING)
13. LOWER ANTI-COLLISION/ RENDEZVOUS LIGHT
14. NOSE LANDING GEAR LIGHTS
15. FORMATION LIGHT (TYPICAL)
16. LOGO LIGHTS
17. FORMATION LIGHT (TYPICAL)
18. AFT POSITION LIGHT WHITE (TYPICAL)
19. FORMATION LIGHTS (TYPICAL)
20. FORWARD POSITION LIGHT, RED
21. TAXI AND RUNWAY TURNOFF LIGHT - GROUND FLOOD (TYPICAL)
22. WING AND ENGINE SCAN LIGHT (TYPICAL)
23. FUSELAGE LANDING LIGHT (TYPICAL)
24. SLIPWAY FLOOD LIGHTS
25. LEAD-IN STRIPES/UARRSI ELECTROLUMINESCENT LIGHTING SYSTEM*
26. FORMATION LIGHT (TYPICAL)
27. FORWARD POSITION LIGHT, GREEN
28. UPPER ANTI-COLLISION/ RENDEZVOUS LIGHT
29. UPPER FUSELAGE FLOODLIGHTS

*AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-957
** WING POD SIGNAL LIGHTS
***ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

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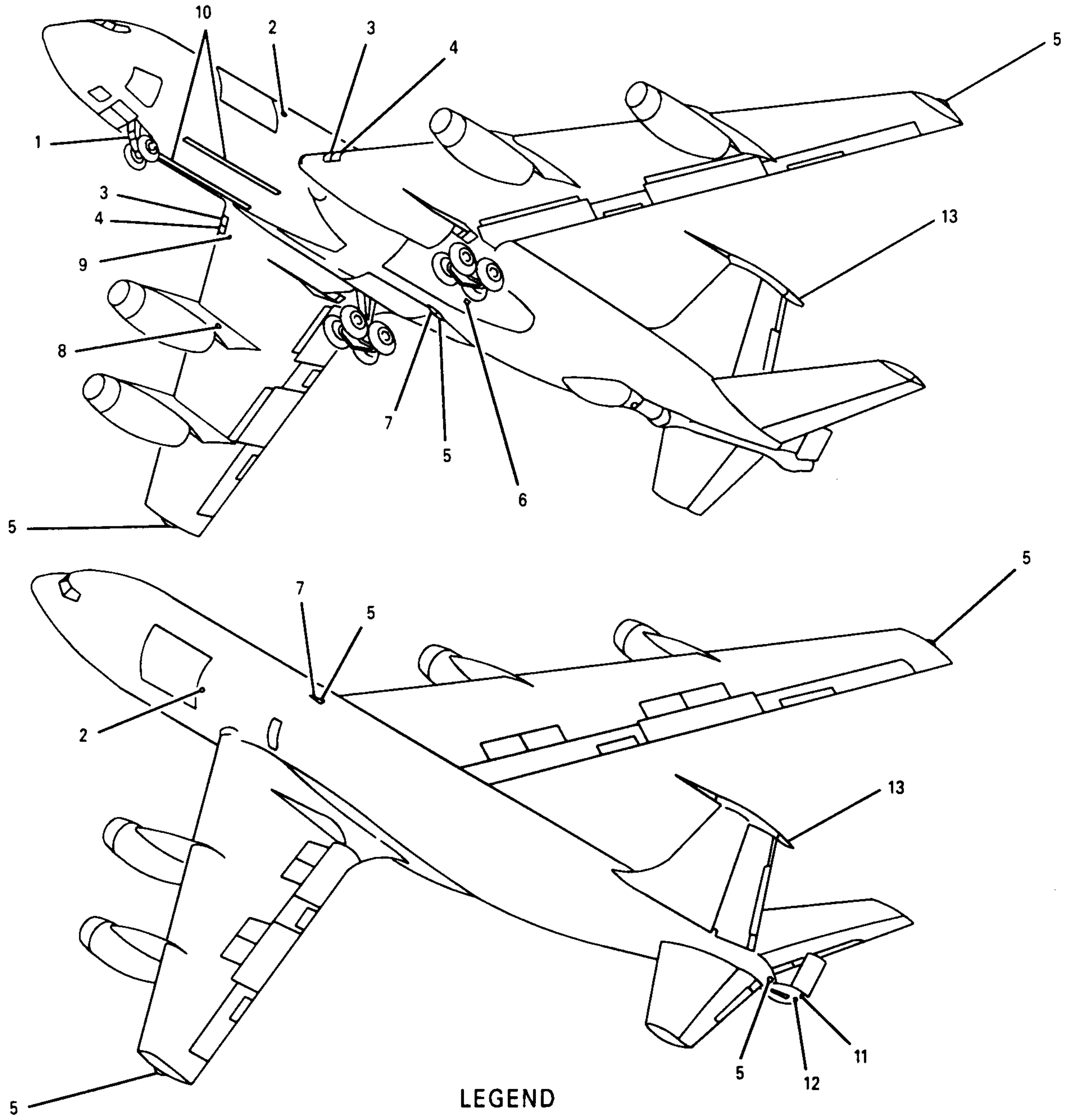
Figure 8.1-2. KC-10A Exterior Lighting



LEGEND

1. NOSE LANDING AND TAXI LIGHT
*2. NACELLE ILLUMINATION LIGHT (TYPICAL) (2 PLACES)
3. TAXI LIGHT (2 PLACES)
4. LANDING LIGHT (FIXED) (2 PLACES)
*5. NAVIGATION/POSITION LIGHTS (7 PLACES)
6. UNDERWING ILLUMINATION LIGHT (TYPICAL)
7. ROTATING/RENDEZVOUS BEACON LIGHTS (2 PLACES)
*8. UNDERBODY ILLUMINATION LIGHT (TYPICAL)
9. TERRAIN LIGHT (RETRACTABLE)
*10. RECEIVER PILOT DIRECTOR LIGHTS
11. BOOM MARKER LIGHTS (FLUORESCENT)
*12. BOOM NOZZLE LIGHT
*13. A/R FLOOD LIGHTS

*DESIGNATES ADJUSTABLE LIGHTING

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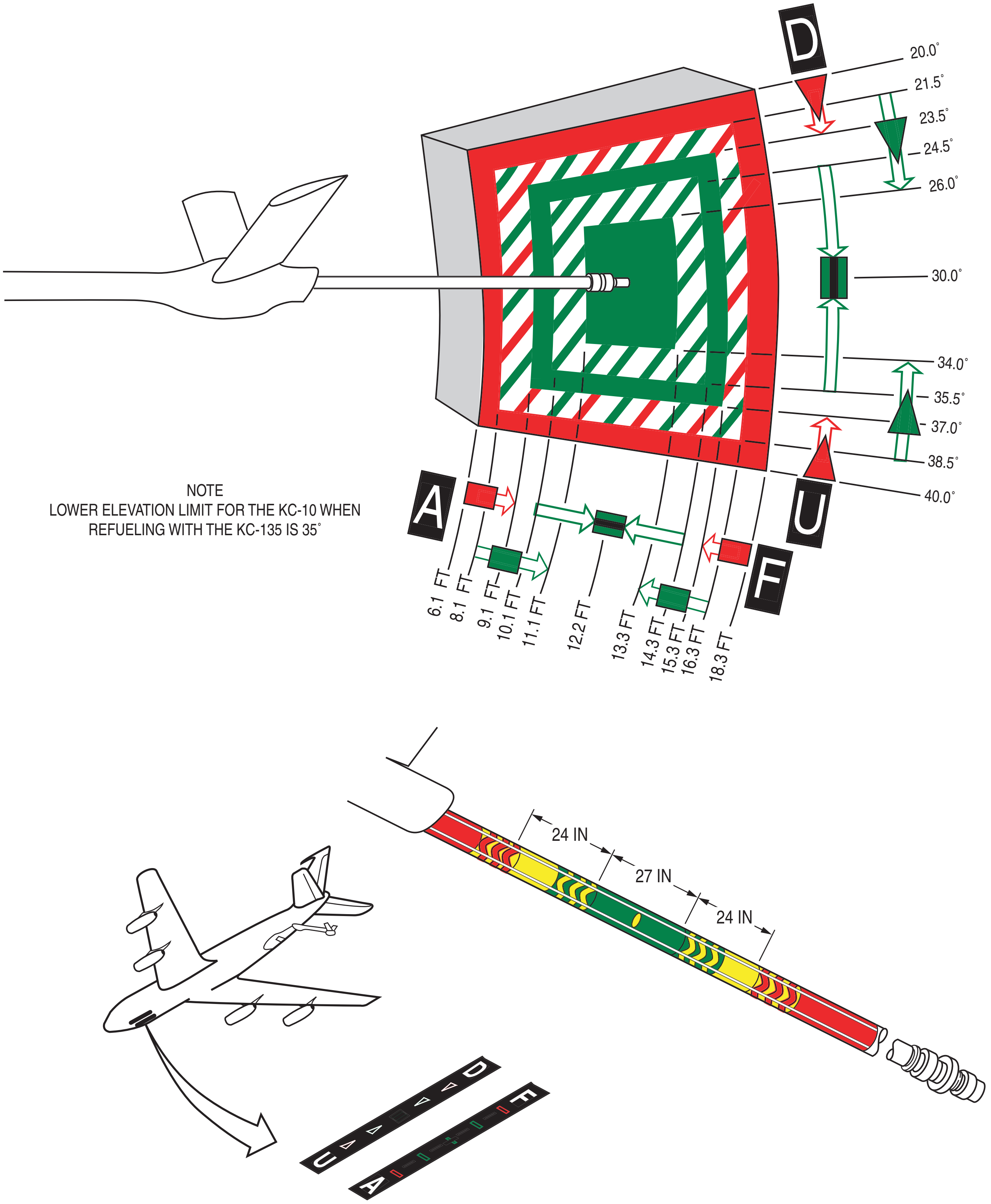
Figure 8.1-3. KC-135 Exterior Lighting



NOTE
LOWER ELEVATION LIMIT FOR THE KC-10 WHEN
REFUELING WITH THE KC-135 IS 35°

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Figure 8.1-4. Pilot Director Lights Illumination Profile (KC-135)

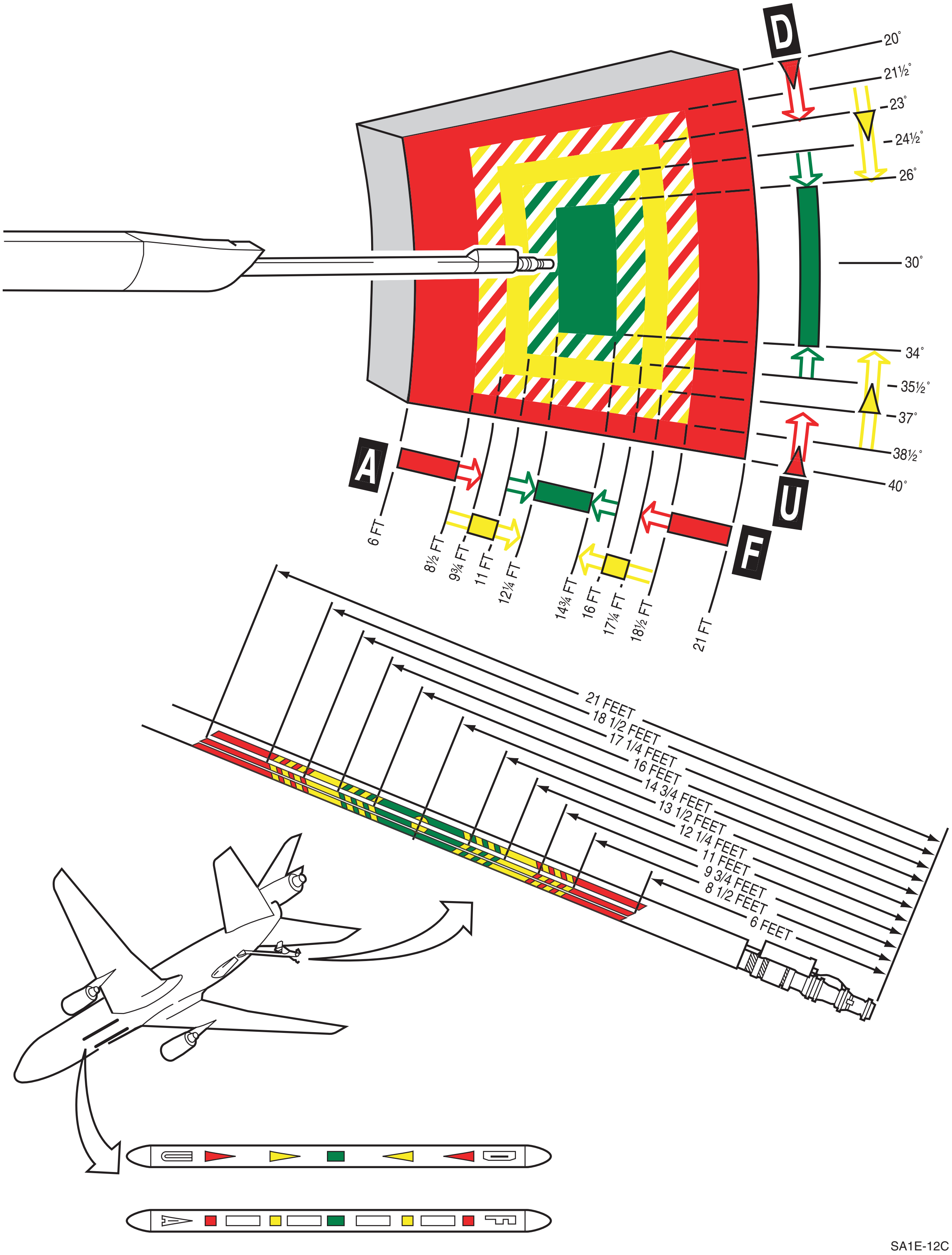

Figure 8.1-5. Pilot Director Lights Illumination Profile (KC-10A)

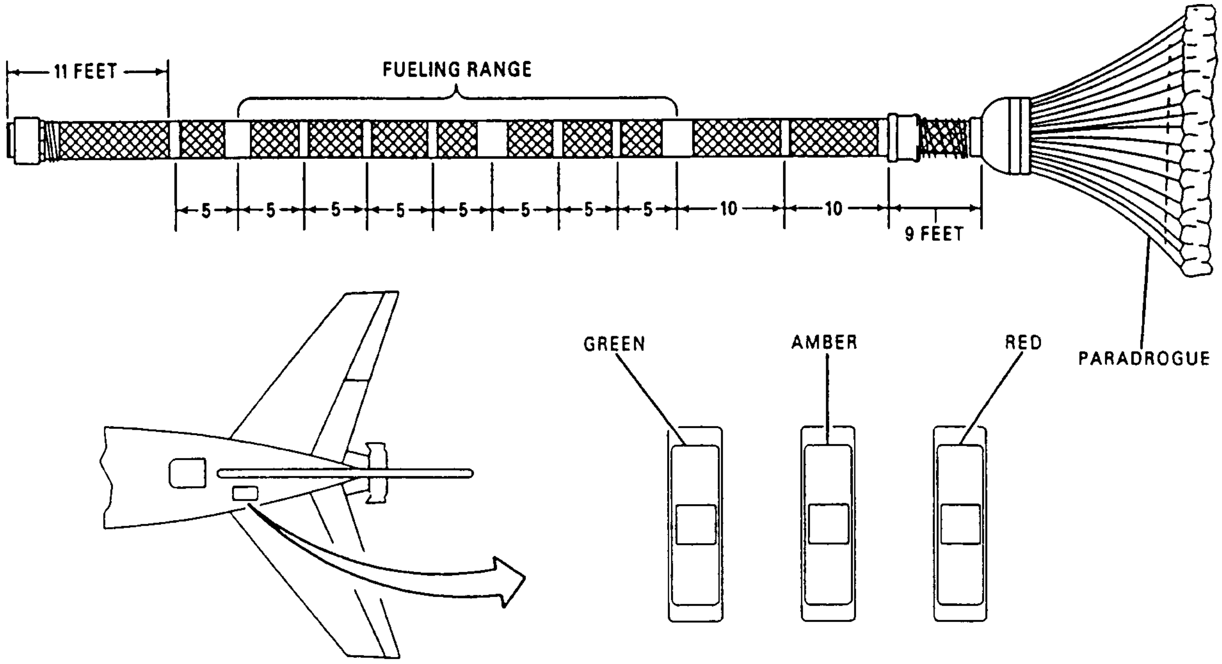

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Figure 8.1-6. Centerline Hose/Drogue Signal Lights/Markings

Wing Pod Drogue Lights/Markings

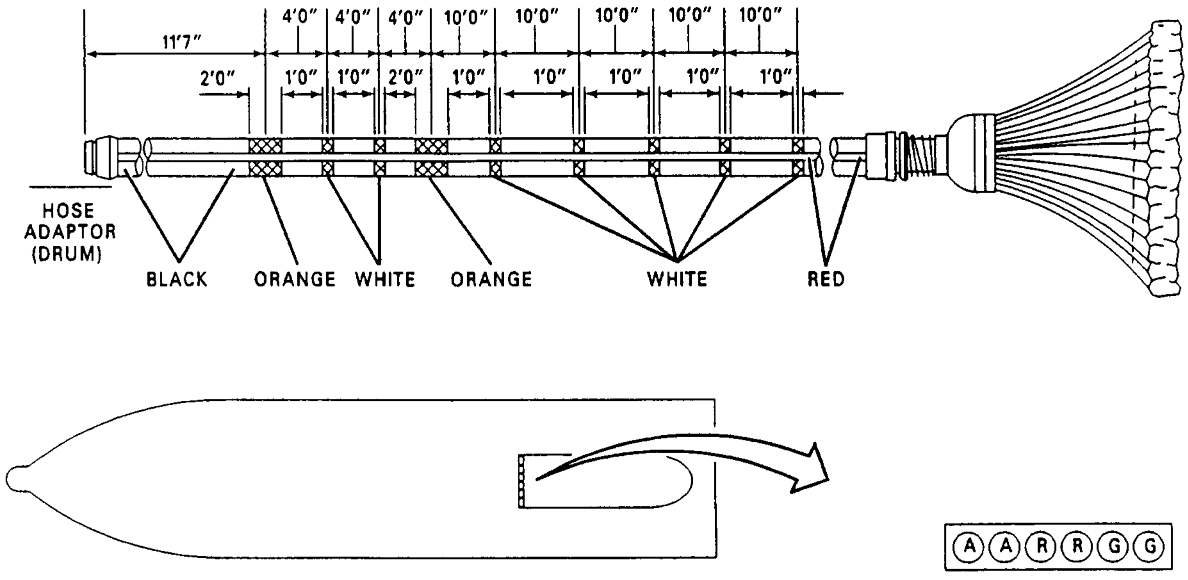
On aircraft modified by TCTO 1C-10(K)A-956, the wing pod hose is 79 feet long and is black with white and orange bands as shown in figure 8.1-7. The amber light goes out when the receiver pushes in 5 feet and flashes when the receiver has pushed in an additional 12 feet of hose. The fuel flow valve will close after an additional 9 feet, thus providing approximately 21 feet refueling range (figure 8.1-8).

KC-10A Night Air Refueling

During night air refueling training missions, it is recommended that both tanker and receiver use all available external lighting. The KC-10A receiver should have the upper fuselage floodlight and receptacle light operable. The setting of these two lights will be at the discretion of the tanker boom operator. On aircraft modified by TCTO 1C-10(K)A-957, UARRSI Electroluminescent Lights (EL) should also be used.

CAUTION

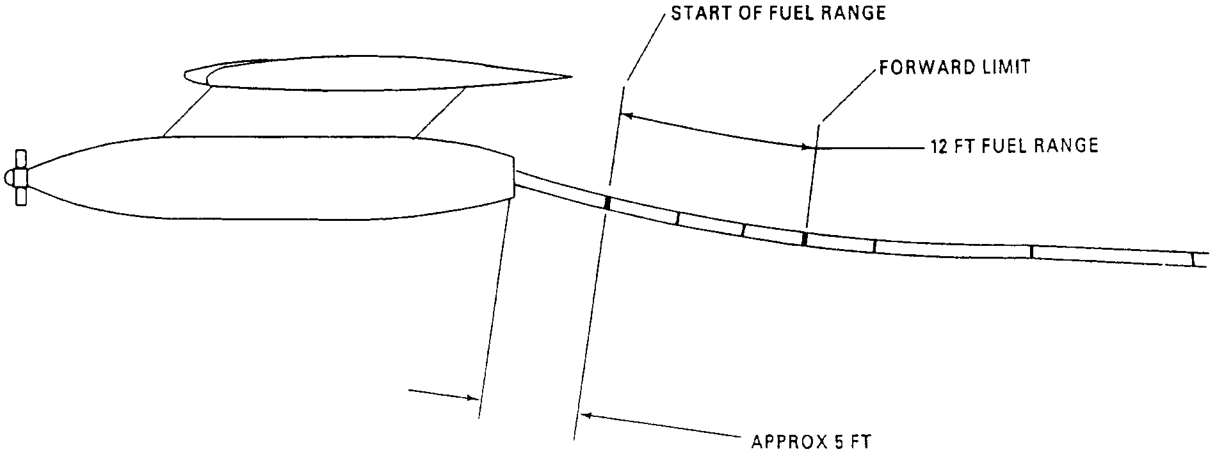
When refueling with less than optimum lighting, extreme care shall be exercised, due to the reduced depth perception and lack of visual cues available to the boom operator.



*ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

CAG(IGDS) SA1D-129A

Figure 8.1-7. *Wing Pod Hose/Drogue Signal Lights/Markings



*ON AIRCRAFT MODIFIED BY TCTO 1C-10(K)A-956

CAG(IGDS) SA1D-130A

Figure 8.1-8. *Wing Pod Hose Position at Full Trail

BOOM ENVELOPE LIMITS

The envelope limits are set well within the mechanical limits of the boom so that disconnect will normally take place before any structural damage occurs (see figure 8.1-9). During receiver pilot demonstration of air refueling envelope limits, the boom operator will state the boom limit and give the boom position for the limit being demonstrated in increments of 2 and notify the receiver pilot when the receiver aircraft in approaching a boom limit.

CAUTION

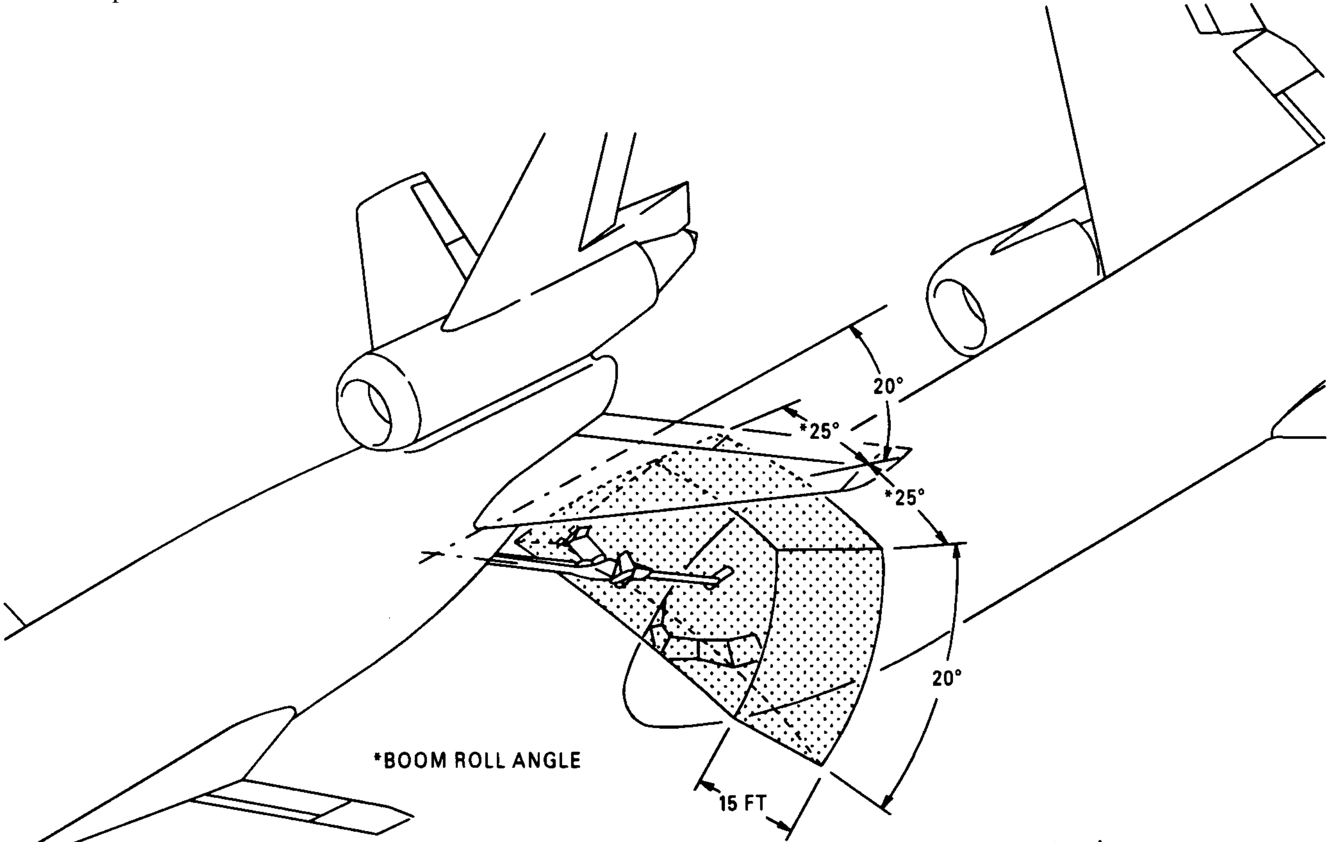
Approaching boom limits at relatively high velocity can cause structural damage as a result of an inability to disconnect due to binding action of the boom nozzle.

POST AIR REFUELING

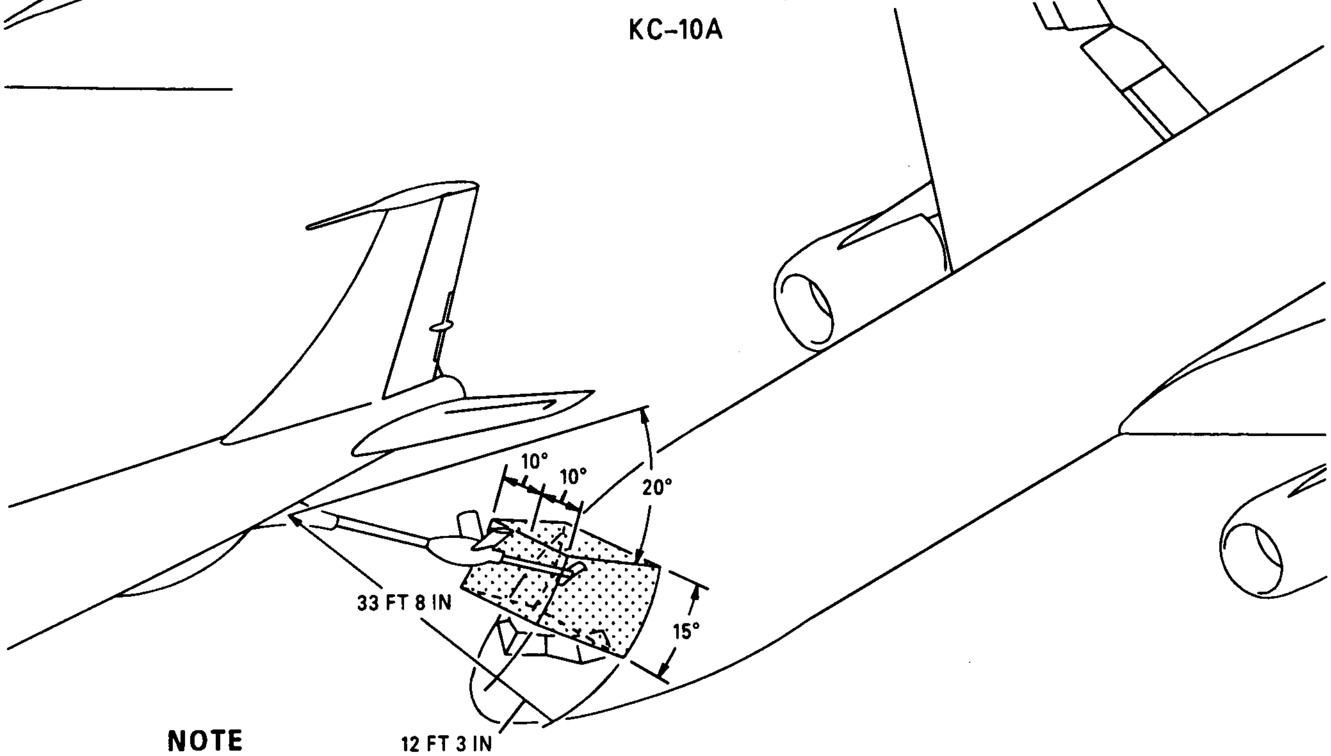
When time between air refueling exceeds 10 minutes, the boom/hose will be stowed.

WARNING

When receivers are required to accelerate and climb on air refueling heading following completion of air refueling operations, tankers should exercise extreme caution and avoid flying through the receiver jetwash.



KC-10A



NOTE

LOWER ELEVATION LIMIT IS 35°WHEN REFUELING WITH THE KC-135. AUTOMATIC DISCONNECT WILL NOT OCCUR UNTIL 40° ELEVATION IS REACHED.

KC-135

SA1E-30

Figure 8.1-9. Boom Envelope Limits KC-10A and KC-135

PART 2

RENDEZVOUS PROCEDURES

TABLE OF CONTENTS

RENDEZVOUS PROCEDURES

GENERAL

The normal tanker orbit pattern (see figure 8.2-1) is a racetrack pattern to the left, using 2-minute legs and 25-degree bank turns with the ARCP/Anchor Point at the downstream end of the leg that coincides with the receiver's inbound track to the ARCP/Anchor Point. The tanker orbit altitude will be the assigned refueling altitude. The standard tanker orbit pattern airspeed is 275 KIAS or Mach 0.78, whichever is lower, but not below AR orbit speed. The standard tanker orbit pattern airspeed for A-10 refueling is 255 KIAS to facilitate the rendezvous slowdown to the A-10 air refueling speed. This may require a configuration of 0/EXT. If an extensive delay is anticipated, use performance manual holding procedures. All receivers will normally air refuel in level flight; however, if the receiver becomes power limited, a descending flight path may be required (refer to Section VIII, TOBOGGAN).

NOTE

- Additional ATC clearance will be required if drift and true airspeed place the aircraft greater than 18 NM from the ARIP to ARCP track, or if a right-hand orbit is used.
- If no air refueling orbit delay is anticipated, 275 KIAS (255 KIAS with A-10) or maximum endurance speed, whichever is greater, may be used for the rendezvous turn.

Normally, lead responsibilities pass from number one to number two to number three; however, all pilots must be prepared to assume full responsibility for the formation at any time. When it is necessary to transfer lead responsibilities, all airplanes in the affected formation will be notified when the new leader assumes responsibility for the formation. After rendezvous and throughout the air refueling operations, the lead tanker will maintain radar weather watch and will have the primary responsibility of ensuring all aircraft are directed clear of hazardous weather.

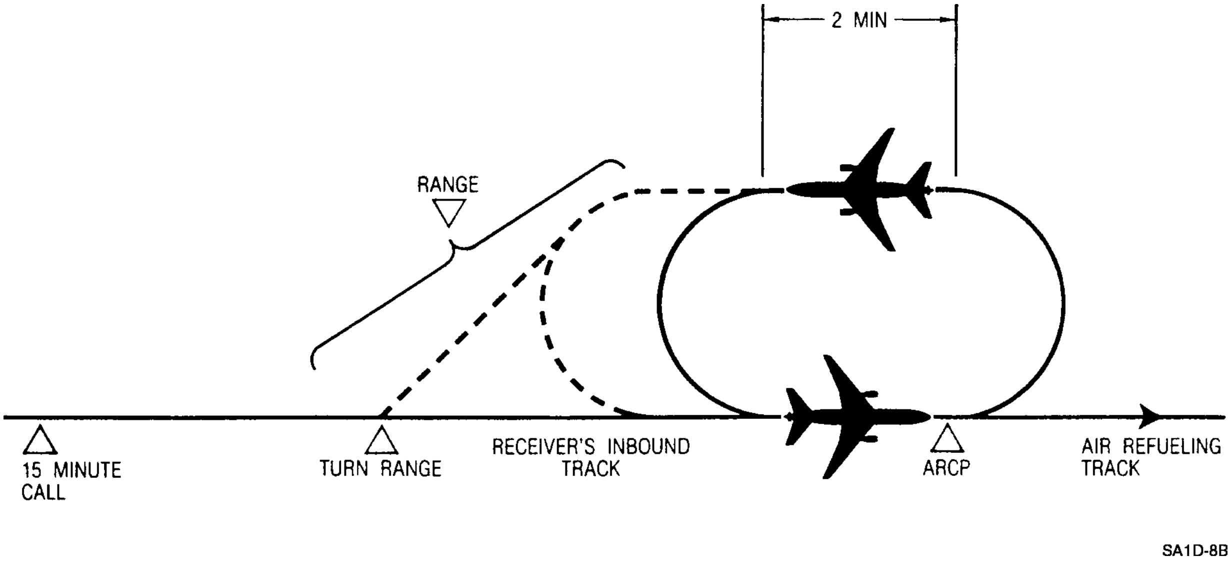


Figure 8.2-1. Typical Tanker Orbit Pattern

RENDEZVOUS EQUIPMENT

All appropriate equipment should be operating a minimum of 30 minutes (15 minutes for A/A) prior to rendezvous control times (ARCT, RZ, etc.).

a. KC-135: UHF/DF; TACAN A/A (DME)

b. KC-10A: I-Band (double pulse) Rendezvous Beacon; UHF/DF; TACAN A/A (Bearing and DME)

RENDEZVOUS MEANS

KC-135s utilize the FMS (includes all navigation means), and A/A TACAN as primary. KC-10As will use the Flight Management System (FMS) combined with TACAN in the beacon inverse mode as primary.

The crews will be prepared to use alternate means at all times. Alternate procedures will include the combined use of all equipment that can be used to effect a rendezvous. Such equipment includes airborne radar and beacon, UHF/ADF radio, TCAS, common ground TACAN/VORTAC stations, FAA/GCI facilities, and timing. Alternate means versus EMCON requirements must be weighed.

TIMING

When utilizing point parallel rendezvous procedures, tankers will make every effort to arrive at the ARCP 15 minutes prior to the ARCT. If radio contact has not been established between aircraft prior to the ARCT, the tankers will be over the ARCP at the ARCT and will delay a minimum of 10 minutes after the ARCT or as specified by operational directives. Comply with MISSED RENDEZVOUS PROCEDURES.

EARLY ARRIVAL OF RECEIVER(S)

In the event receiver(s) arrive at the ARCP before the tanker(s), the following procedures will apply:

a. Receiver(s) will orbit over the ARCP in the same pattern and timing prescribed for tankers.

b. Receivers will orbit at an altitude that insures a 1000 foot separation between the highest receiver and the lowest tanker, with the receiver at the lowest altitude.

c. Upon arrival of the tanker(s), and after visual contact has been established, the receiver(s) will join in orbit to precontact position and will accomplish contact after rolling out on the refueling track.

POINT PARALLEL RENDEZVOUS PROCEDURES

Receivers will monitor the range. The tanker will turn inbound to the ARCP at the turn range and adjust to appropriate air refueling speed when rolled out toward the ARCP. The receiver is the maneuvering aircraft.

WARNING

- To help insure safe operation when range between aircraft is not known and the receiver has to descend through air refueling altitude, tankers will not initiate final turn to refueling track unless receiver aircraft has confirmed level at the proper rendezvous altitude.
- When close interval stream operations are conducted, do not use orbit delays to control timing.

The tanker FMS will be the primary means of maintaining the offset and the A/A TACAN will be the primary for range information. To provide A/A ranging, the tanker and the receiver (one aircraft per formation) will tune the assigned A/A TACAN channels no later than 15 minutes prior to the ARCT. The receiver will set the numerically lower Y-channel and the tanker will set the higher Y-channel. As a receiver, use beacon-inverse mode with a KC-135 tanker and beacon-normal mode with a KC-10A tanker. KC-10A tankers will use beacon-inverse mode while rendezvousing with another KC-10A.

NOTE

- Normally, the tanker will orbit in a left hand pattern at a speed of 275 KIAS. A KC-10A tanker may need to maintain a higher orbit speed due to gross weight. This information should be coordinated prior to flight.
- When more than one tanker is involved, add 1 NM to the turn range for each additional tanker.

NOTE

- Single ship fighter-type receivers may request use of common ground TACAN for the rendezvous. In any event, the receiver should inform the tanker prior to departing the ARIP that alternate means will be used.
- In the event of a right-hand orbit/final turn, it is necessary to reverse the drift correction inbound to the ARCP prior to determining the charted turn range/offset.
- If the receiver's rendezvous CAS/TAS was not precoordinated, convert the tanker's overrun CAS for that receiver to TAS. This TAS should ensure a turn range/offset error of less than 1 NM. Refer to figure 8.2-2 for KCAS to KTAS conversion.

Using the charted turn range and offset, A/A TACAN, and radar, the receiver will closely monitor the progress of the rendezvous. Once the tanker is in the turn, range estimates should be based on forward range using radar skin paint and not slant range using A/A TACAN. Radar skin paint should be attempted as soon as practical. If an overrun situation is detected, take appropriate action. If skin paint is not possible, continue rendezvous using the beacon mode. The receivers will not depart the rendezvous altitude until visual contact is established with the tanker(s). Rendezvous closure will be discontinued when visual contact cannot be maintained between receiver and tanker at the range designated for the specific aircraft in ATP56B.

When acting as a receiver, a KC-10A will maintain rendezvous altitude separation until 1 NM from the tanker and visual contact is established. The receiver will then start a gradual climb to the precontact position with a minimum altitude separation of 500 feet at 1/2 NM.

When in formation, the last tanker in formation will turn his beacon to operate, single code, on rollout to rendezvous/refueling heading.

VERTICAL AIRSPACE REQUIREMENTS

Three consecutive altitudes will be requested for rendezvous and air refueling. Normally, the tanker will be at the middle altitude and the receiver at the bottom altitude, providing a minimum of 1000 feet between the receiver and the tanker during rendezvous and 1000 feet above and below the refueling formation once rendezvous is complete. During rendezvous with fighters, request four consecutive altitudes to allow 1000 feet below the fighters for maneuvering to the tanker. If four altitudes are not available, position the tanker at the top of the block and the fighters at an altitude to provide 1000 feet between the receivers and the tanker, and 1000 feet below the fighters for maneuvering.

When rendezvous and air refueling with tanker/receiver formations or multiple fighter elements, additional altitudes should be requested to provide a minimum of 1000 feet between the highest receiver and the lowest tanker and 1000 feet above and below the refueling formation once rendezvous is complete. If 1000 feet below fighters is not available during rendezvous, the receivers will be notified.

The above procedures do not apply when aircraft are operating on an Altitude Reservation (ALTRV), or when clearance has been granted for aircraft to operate as an enroute formation. In these cases, the altitude block will provide airspace necessary to accommodate the type of formations being used (standard or nonstandard), with at least 1000 feet between the highest receiver and lowest tanker during rendezvous, and at least 1000 feet below the air refueling formation once the rendezvous is complete.

NOTE

- FOR EACH °C BELOW STD DAY TEMP SUBTRACT 1 KNOT FROM STD DAY TAS
- FOR EACH °C ABOVE STD DAY TEMP ADD 1 KNOT TO STD DAY TAS

PRESSURE ALTITUDE 1000'	STD DAY TEMP	KCAS																				
		200	220	240	250	255	265	275	280	285	290	295	300	305	310	315	320	325	330	335	340	350
6	+3	215	238	259	272	277	288	299	304	309	314	319	325	331	336	342	348	354	360	366	372	381
8	-1	222	245	266	279	285	296	307	312	318	323	329	335	340	346	352	358	364	370	376	382	391
10	-3	230	253	274	287	293	304	315	321	327	332	338	344	349	355	361	367	373	379	385	391	400
12	-7	237	261	282	296	302	313	324	330	336	341	347	353	358	364	370	376	382	388	394	400	409
13	-11	240	264	286	300	306	318	329	335	341	346	352	358	363	369	375	381	387	393	399	404	414
14	-13	244	269	291	305	312	324	335	341	347	352	358	364	369	375	381	387	393	399	405	410	420
15	-15	248	273	295	310	317	329	340	347	353	358	364	370	375	381	387	393	399	405	411	416	426
16	-17	254	279	301	315	322	334	345	352	358	363	369	375	381	387	393	399	405	411	417	422	432
17	-19	258	283	305	319	327	339	350	357	363	368	374	380	386	392	398	404	410	416	422	428	438
18	-21	262	287	310	324	332	344	355	362	368	373	379	385	391	397	403	409	415	421	427	434	444
19	-23	266	293	316	330	336	349	361	367	373	378	384	390	397	403	409	416	422	428	434	440	451
20	-25	269	296	320	334	340	353	366	373	379	384	390	396	403	409	415	422	428	434	440	446	458
21	-27	273	300	324	338	345	359	372	378	385	391	398	405	411	417	423	429	435	442	449	455	466
22	-29	276	304	328	342	349	363	376	383	390	396	403	410	417	423	430	437	442	449	456	462	473
23	-31	280	310	335	349	354	367	380	386	393	400	406	412	419	426	432	439	445	452	459	466	480
24	-33	284	314	340	354	360	374	388	394	401	407	413	419	426	433	439	446	453	461	469	476	489
25	-35	289	319	346	361	368	382	396	402	409	415	422	428	435	442	449	455	461	468	473	480	493
26	-37	294	324	352	366	374	387	402	408	415	422	429	435	442	449	456	462	468	475	482	488	502
27	-38	301	332	360	374	381	395	410	417	424	431	438	444	451	458	464	470	477	484	490	496	510
28	-40	307	338	365	380	388	401	415	423	431	438	445	452	459	466	473	479	486	493	499	505	518
29	-42	313	344	373	388	396	408	423	431	439	446	452	459	466	473	481	487	494	501	508	515	528
30	-44	318	350	378	395	402	416	430	437	444	451	459	466	473	480	487	494	501	508	515	523	536
32	-48	330	362	392	407	415	429	443	452	460	469	476	484	490	497	504	510	517	525	533	541	554
34	-52	342	374	405	419	426	442	456	464	472	481	488	496	503	510	517	523	530	537	545	553	567
36	-56	352	384	418	432	442	458	472	478	485	494	502	509	517	524	532	539	547	555	563	570	584

CAG(IGDS)

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Figure 8.2-2. True Airspeed Chart

TURN RANGE - KC-10A

	TAS RCVR + TNKR	ARIP TO ARCP DRIFT							NOTES
		15L	10L	5L	0	5R	10R	15R	
CLOSURE RATE	1000	26	28	30	32	34	36	39	3 NM ROLLOUT RANGE
	975	25	27	28	30	32	34	36	
	950	24	26	27	29	31	33	35	
	925	23	24	26	28	29	31	33	
	900	22	23	25	27	28	30	32	
	875	21	23	24	26	27	29	31	
	850	20	21	23	24	26	27	29	
	825	19	20	21	23	24	26	27	
	800	18	19	21	22	23	25	26	
	775	17	18	19	21	22	23	25	
	750	16	17	18	20	21	22	24	
	725	15	16	17	18	20	21	22	
	700	15	15	16	17	18	19	20	
	675	12	13	14	15	15	16	17	1/2 NM ROLLOUT RANGE (A-10)
	650	11	12	13	14	15	15	17	
	625	10	11	12	13	14	15	16	
	600	9	10	11	12	13	14	15	
	575	9	10	10	11	12	13	14	
	550	8	9	9	10	11	12	12	
	525	7	8	8	9	10	11	11	
	500	7	7	8	8	9	10	11	
	475	6	7	7	8	8	9	10	
	575	8	9	10	11	11	12	13	1NM ROLLOUT BEHIND C-130
	550	7	8	9	10	11	12	13	
	525	6	7	8	9	10	11	12	
	500	6	6	7	8	9	10	11	
	475	5	6	6	7	7	8	9	

OFFSET - KC-10A

		ARIP TO ARCP DRIFT							NOTES
		15L	10L	5L	0	5R	10R	15R	
TANKER TAS	520	11	13	15	17	20	22	26	25° BANK
	500	10	12	14	16	18	21	23	
	480	9	11	13	15	17	19	21	
	460	9	10	12	13	15	18	20	
	440	8	9	11	12	14	16	18	
	420	7	8	10	11	13	15	17	
	400	6	7	9	10	12	13	15	
	380	6	7	8	9	11	12	14	
	360	5	6	7	8	9	11	12	
	340	5	5	6	7	8	10	11	
	320	4	5	6	6	7	9	10	
	300	4	4	5	6	7	8	9	
	280	3	4	4	5	6	7	8	
	260	3	3	4	4	5	6	7	
	240	2	3	3	4	5	5	6	

SA1D-102

Figure 8.2-3. Turn Range/Offset Chart

ALTERNATE RENDEZVOUS MEANS

When primary means are not available, or are lost, alternate means may be utilized to perform the rendezvous. When using alternate means, the tankers and receivers will fly the same profiles as described in the previous paragraphs entitled BASIC RENDEZVOUS PROCEDURES. The following are some suggested alternate means for conducting the rendezvous. The various alternate means should be used in conjunction with each other when equipment availability permits, and when practical, to ensure a successful rendezvous (i.e., UHF/ ADF DF, common VORTAC/TACAN DME or timing, and FAA/GCI advisories, etc.). Every effort should be made to minimize radio calls as much as practical.

NOTE

- If, after commencing the rendezvous using alternate procedures, primary means are established, the tanker/receiver will be notified and the primary means will be used to accomplish the rendezvous.
- If radar skin paint can be obtained during the final phase of an alternate rendezvous, the receiver/tanker will be notified and final closure will be accomplished utilizing skin paint.
- If alternate rendezvous procedures are unsuccessful, missed rendezvous procedures will be initiated.

a. FAA/GCI facilities, when available, may be used for vectors and separation advisories.

b. DME/radial information from a common TACAN/ VORTAC may be exchanged, with the final turn to refueling track being accomplished when the DME difference equals the computed turn range.

c. FMS distance. When both receiver and tanker have a reliable INS, or navigation equipment of comparable accuracy, the ARCP or any other common point may be inserted as a waypoint to help determine the range between aircraft.

d. UHF/ADF/DF means may be utilized providing the tanker is so advised prior to the receiver reaching a point 40 NM upstream of the rendezvous point.

e. Timing should be used as a back-up for all other rendezvous means, if feasible; however, it should only be used as a last resort for the primary means of rendezvous. Timing begins or is updated when reliable nose-to-nose separation is obtained with tanker on reciprocal heading (see figure 8.2-4).

When the receivers depart the ARIP, the tanker(s) will turn to or continue to fly the reciprocal of the receiver's inbound track. For DF steers, receivers will use the tone button or MIC switch without talking. The receiver will transmit on the air refueling frequency approximately 10 seconds out of every 20 second period, ending each transmission with the receiver's call sign. When the receiver bearing shows the computed bearing shown on the FMS or 26° left (NO WIND) of the tanker heading, the tanker will notify the receiver starting turn to the refueling track. This approximates a 21 NM turn range with a nominal tanker offset of 9.5 NM (see figure 8.2-5). After starting turn to refueling track, the tanker will take over the radio transmission for DF steers until radar contact/visual sighting is made.

f. In the event that the tanker's A/A TACAN and radar are not usable, the receiver radar may be used as the primary means for rendezvous. This is commonly referred to as a receiver directed rendezvous. The tanker will turn toward the receiver when the receiver crosses the ARIP. The tanker is responsible for computing and maintaining the proper offset. The receiver will fly the inbound track from the ARIP to the ARCP and the tanker will initiate the rendezvous turn when directed by the receiver.

DISTANCE		30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	TURN RANGE
CLOSURE SPEED	700	1:07	1:33	1:58	2:24	2:50	3:15	3:41	4:06	4:32	4:58	5:24	5:49	6:15	6:41	7:06	17
	720	1:00	1:25	1:50	2:15	2:40	3:05	3:30	3:55	4:20	4:45	5:10	5:35	6:00	6:25	6:50	18
	740	:54	1:18	1:42	2:06	2:30	2:55	3:19	3:43	4:08	4:32	4:56	5:21	5:45	6:09	6:34	19
	760	:47	1:11	1:35	1:58	2:21	2:45	3:09	3:33	3:56	4:20	4:44	5:07	5:31	5:55	6:18	20
	780	:42	1:05	1:28	1:50	2:13	2:36	3:00	3:23	3:46	4:09	4:32	4:55	5:18	5:42	6:04	21
	800	:36	:59	1:21	1:43	2:05	2:28	2:51	3:13	3:36	3:59	4:21	4:44	5:06	5:29	5:51	22
	820	:31	:53	1:15	1:37	1:58	2:20	2:42	3:04	3:26	3:48	4:10	4:32	4:54	5:16	5:38	23
	840	:26	:47	1:09	1:30	1:51	2:12	2:34	2:55	3:17	3:38	4:00	4:21	4:43	5:04	5:25	24
	860	:21	:42	1:03	1:24	1:44	2:05	2:26	2:47	3:08	3:29	3:50	4:11	4:32	4:53	5:13	25
	880	:16	:37	:57	1:18	1:38	1:58	2:19	2:39	3:00	3:20	3:40	4:01	4:21	4:42	5:02	26
	900	:12	:32	:52	1:12	1:32	1:52	2:12	2:31	2:52	3:12	3:31	3:52	4:11	4:32	4:52	27
	920	:08	:27	:47	1:07	1:26	1:46	2:05	2:24	2:44	3:04	3:23	3:43	4:02	4:22	4:41	28
	940	:04	:23	:42	1:01	1:20	1:40	1:58	2:18	2:37	2:56	3:15	3:34	3:53	4:12	4:31	29
	960	:00	:19	:38	:56	1:15	1:34	1:52	2:11	2:30	2:48	3:08	3:26	3:45	4:03	4:22	30
	980	-	:15	:33	:51	1:10	1:28	1:46	2:04	2:23	2:41	3:00	3:18	3:36	3:55	4:13	31
	1000	-	:11	:29	:47	1:05	1:23	1:41	1:59	2:17	2:35	2:53	3:11	3:29	3:47	4:05	32

Figure 8.2-4. Timing Chart (No Wind)

NO WIND BEARING	SLANT RANGE
005°	100 NM
007°	80 NM
009°	60 NM
011°	50 NM
014°	40 NM
018°	30 NM
022°	25 NM
026°	21 NM
028°	20 NM
047°	13 NM

Figure 8.2-5. UHF/ADF/TACAN Cross Check Bearing Chart (9.5 NM Offset) (Alternate Rendezvous)

EMISSION OPTION 3

MISSION PLANNING

The elimination of the 15 minute prior call increases the element of risk. The following guidelines should enhance safety considerations.

a. If possible, accomplish only when clear of clouds.

b. If unable to remain clear of clouds, tanker and receiver aircraft will immediately confirm altitudes.

c. Receiver and tanker tracks inbound to the RZ/ARIP should be separated by a minimum of 30°.

d. Receiver and tanker inbound legs to the RZ/ARIP should be a minimum of 40 NM in length.

An enroute rendezvous should be accomplished at the RZ/ARIP with both aircraft using the same RZ time. The receiver should rendezvous 1000 feet below the tanker. An ETE from the ARIP to the ARCP should be planned which permits an airspeed that falls near the middle of the aircraft's speed performance envelope. It is essential that crews/planners coordinate certain items during mission planning/development. Minimum items include:

a. Rendezvous altitudes.

b. RZ time and ARCT.

c. Inbound courses to the RZ/ARIP.

d. Radio silent termination time in the event of a missed rendezvous.

RECEIVER TURN-ON RENDEZVOUS

Turn-on rendezvous will be conducted IAW Joint Regulations and Instructions. Receivers will maintain 1000 feet below air refueling base altitude until visual contact is established with the tanker(s).

DESCENT AND CLOSURE PROCEDURES

WARNING

- Tankers will maintain applicable contact air refueling airspeed during receiver closure. If within 1 NM closure, the tanker is off airspeed by more than 10 knots and required to decelerate or accelerate to obtain contact airspeed, the receiver pilot will be informed prior to tanker airspeed change.
- Pilots shall use extreme care in those cases when the speedbrakes are required for deceleration. Ascertain that the receiver will not overrun the tanker prior to speedbrake actuation.

The KC-10A receiver will begin descent to rendezvous altitude (1000 feet below the assigned air refueling altitude) no later than the ARIP (see figure 8.2-6). The KC-10A receiver should descend at approximately 2500 fpm. The rendezvous altitude will be maintained until 1 NM from the tanker and visual contact has been established at which time a gradual climb to precontact position will be initiated arriving at 1/2 NM in trail with a minimum altitude separation of approximately 500 feet. After passing the ARIP the receiver will maintain 0.87 Mach or 325 KIAS, whichever is lower, until the following ranges versus airspeed apply:

1 NM	Mach 0.85 or 305 KIAS, whichever is lower.
1/2 NM	Mach 0.84 or 300 KIAS, whichever is lower.
Contact	Mach 0.83 or 290 KIAS, whichever is lower.

During deceleration, it is imperative that the airspeed schedule be maintained. The receiver will respond to the boom operator's precontact radio check.

NOTE

- If the KC-10A receiver is more than 4 NM in trail with the tanker, the airspeed may be increased for closure. The normal speed schedule will be resumed at 3 NM in trail.
- Rendezvous altitude will be maintained until it is ascertained overrunning will not occur.
- If initial air refueling airspeed has been changed, maintain the same relative speed schedule.
- When utilizing one tanker to one or more receivers (single formation refueling), if the tanker rolls out at greater distance ahead than desired during the rendezvous, the rate of closure may be increased by having the tanker accomplish a series of doubledrift-type turns.
- When more than one tanker per refueling is used (multiple formation refueling), the only procedure authorized to increase the closure rate during the rendezvous is differential airspeed.

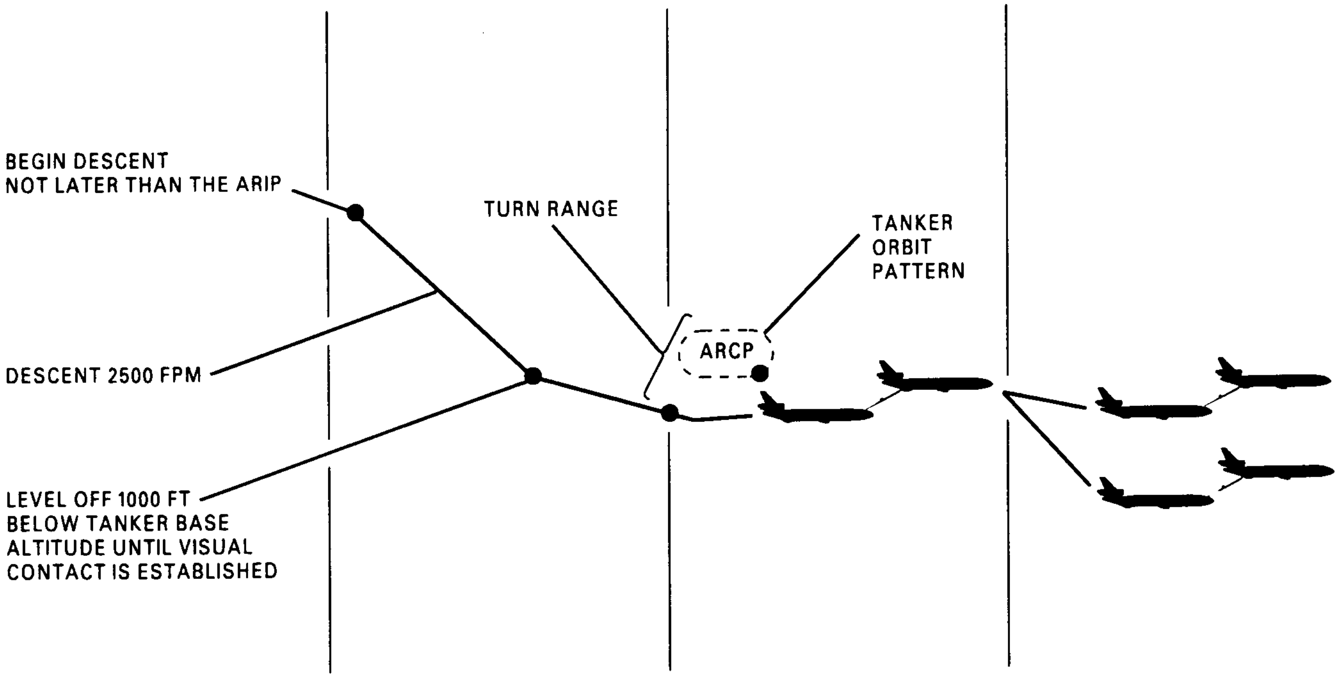

Figure 8.2-6. Receiver Descent, Orbit, Closure, and Contact Air Refueling

RENDEZVOUS OVERRUN PROCEDURES

The following procedures will be utilized in the event of the receiver overrunning the tanker. After the aircraft are separated, the receiver will reduce airspeed to no less than 0/RET minimum maneuvering airspeed. The receiver will then maintain track and altitude. The tanker will increase the airspeed to 335 KCAS, maintain altitude, adjust track as required, and overtake the receiver. After overtaking the receiver, the tanker will reduce the airspeed to 290 KCAS for final receiver closure.

NOTE

> 0/RET minimum maneuvering speeds can be found in the KC-10A Landing Speeds Chart in TO 1C-10(K)A-1CL-1. When used above 14,000 feet, these speeds, though not corrected for altitude, will provide at least 25° bank protection, provided the aircraft is not above the standard day cruise ceiling. Adequate buffet protection will be provided if these speeds are adhered to.

MISSED RENDEZVOUS PROCEDURES

If contact is not established, the tanker will arrive at the ARCP at the ARCT. When either aircraft arrives at the ARCP and does not have visual contact with the other, a left-hand orbit should be entered and controlled to be over the ARCP at intervals of every 8 minutes after the ARCT. While in the orbit, every attempt should be made to establish visual contact with the other aircraft. The length of the delay and decision when to terminate radio silence should be determined during mission planning/development prior to flight.

PART 3

RECEIVER AIR REFUELING PROCEDURES

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RECEIVER AIR REFUELING PROCEDURES

GENERAL

This section contains air refueling information and information to be used from arrival in the precontact position until the completion of air refueling operations.

PILOT TECHNIQUES

The receiver pilot will establish a rate of deceleration in sufficient time so as to stabilize at the precontact position. The use of a higher than normal refueling airspeed due to receiver gross weight must be coordinated between tanker and receiver prior to flight.

WARNING

- The receiver will stabilize in the precontact position with a zero rate of closure. If the receiver fails to attain stabilized position, or it becomes apparent that a closure overrun will occur, a breakaway will be initiated. Failure to initiate a breakaway under closure overrun conditions can result in a midair collision.
- Because of the magnitude of interrelated aerodynamic effects, flying two aircraft in close vertical proximity is not safe. Upwash and downwash effects may occur, drawing the aircraft together. Low pressure areas created by an overrunning receiver flying under the tanker will affect static ports causing possible erroneous airspeed and altitude indications to both aircraft. The tanker autopilot may sense the low pressure as a climbing indication and initiate a descent into the lower aircraft.

NOTE

- Flight test results indicated an airspeed of 320 KCAS was optimum at 590,000 pounds. A technique that has proved to be effective is to begin air refueling and allow the tanker to accelerate during fuel transfer without changing power on the tanker until reaching 320 KCAS (equals approximately 325 KIAS on the KC-135 tankers, and 320 KIAS on the KC-10A tankers).
- KC-135 aircraft with standard speed booms are restricted to 330 KCAS (335 KIAS).

Once the precontact position is attained, the receiver pilot should make the necessary corrections to line up with the tanker's fuselage centerline and dampen all relative lateral movement of the receiver aircraft. When stabilized in the precontact position, the receiver pilot will visually confirm that the READY light is on and that the tanker is ready for contact. Closure from precontact to the contact position should be made very slowly to enable the tanker and the receiver to compensate for the required trim changes. The receiver pilot should use the tanker's forward fuselage, wings, and receiver director lights as necessary to establish and maintain proper position in the air refueling envelope. Any time lateral movement, pitch oscillations, or rate of closure become excessive, reduce power and move back into precontact position and stabilize the aircraft. As the receiver reaches the contact position, the receiver pilot should stabilize until the LATCHED light illuminates.

NOTE

- If the pilot director lights fail to illuminate when contact is established, and refueling is continued, verbal corrections from the boom operator may be requested.
- Attempts to effect a contact during loss of any air refueling lighting that results in less than desired illumination will be at the discretion of the boom operator.

Rough usage of controls on the part of either the receiver or tanker pilot will cause a chain reaction with progressively larger corrections required to maintain position; therefore, development of a smooth technique is necessary. Extreme azimuth/roll and elevation disconnects should be avoided at all times.

CAUTION

Approaching boom limits at relatively high rates can result in an inability to disconnect due to binding action of the boom nozzle. If nozzle binding is not relieved prior to disconnect, structural damage and possible FOD ingestion in the number 2 engine could result.

Turns and banks may be made during contact without disconnects provided no large or abrupt motions or throttle movements are made by either tanker or receiver.

The contact position is best maintained by making small, well-anticipated corrections. As a guide, the movement of the nose of the tanker may be used to gauge required elevator inputs. Lateral control is accomplished by proper aileron inputs to maintain a parallel wing condition with the tanker, small amounts of rudder input may be used as necessary to maintain alignment with the center stripe painted on the bottom of the tanker fuselage. Power corrections are based upon the magnitude and direction of any movement fore or aft relative to the tanker.

NOTE

> Improper and/or excessive rudder inputs can create lateral alignment problems.

Closure from 1 NM in trail can be complicated by non-optimum weather conditions. Effects of sun position, cloud formations, precipitation, and other phenomena can increase the potential for closure overrun or cause the receiver to lose visual contact. The receiver pilot must take positive measures to insure safe separation is maintained. If it is not possible while in the contact position, call for/initiate disconnect and if needed request the boom operator to provide assistance in backing out to a safe distance. If possible, efforts should be made to eliminate the adverse conditions by having the tanker alter course, altitude, or refueling track location.

WARNING

- Maneuvering to a position within the boom envelope to avoid sun/glare should be accomplished with caution since aerodynamic effects on the boom may cause tanker airspeed and position changes relative to the receiver. Serious consideration should be made to terminate refueling if conditions cannot be improved by maneuvering the tanker.
- Air refueling will be discontinued when inflight visibility is deemed insufficient for safe air refueling operations

KC-135 DIGITAL AUTOPILOT

KC-135 aircraft are equipped with AN/ASW-48 digital autopilot. Receiver pilots must be aware that situations which induce sudden large out-of trim conditions, i.e., large power or airspeed changes, rapid movement of large receiver aircraft, may exceed the KC-135 autopilot capability. The sudden, inadvertent disengagement of the KC-135's autopilot may be caused by a combination of high airspeed, bank angle, and bow wave affecting the tail of the KC-135. The combined effect of these factors can over-torque the autopilot and cause uninitiated disconnect.

WARNING

> Heavy aircraft receiver pilots should exercise extreme caution refueling behind a KC-135. A sudden, uninitiated disconnect of the tanker's autopilot may result in the tanker abruptly descending into the receiver's flight path. Receiver pilots must be prepared to execute a breakaway if necessary.

PILOT FATIGUE

One of the greatest potential hazards during air refueling is fatigue. If fatigued, obtain disconnect, drop back and let the other pilot fly the aircraft in the precontact position for a few minutes. The time spent in stabilizing and resting will result in better air refueling in a shorter time, since fewer disconnects will be experienced.

DISCONNECT

There are two major classifications of disconnects: planned and inadvertent. Planned disconnects may be initiated by the receiver pilot, copilot, or tanker boom operator. An inadvertent disconnect may be caused by exceeding a boom envelope limit, high receiver rates of movement, excessive fuel pressure surge or system malfunctions.

When a disconnect occurs, the DISCONNECT light will illuminate, the LATCHED light will go out, and the boom operator will retract the boom. If additional contacts are required, the signal amplifier must be reset. To reset the signal amplifier, depress and release the A/R reset button after the boom is clear of receptacle. This will illuminate the READY light, and the DISCONNECT and LATCHED lights will go out. The receiver pilot and copilot will be prepared to actuate the A/R disc button at all times during the air refueling operations.

CAUTION

- Remain stabilized in the contact position until the PNF visually confirms that the disconnect annunciator is illuminated and the boom is clear.
- The boom operator will insure that the boom is clear of the receiver during free flight conditions

NOTE

- Normal backout from the contact position should be accomplished smoothly and slowly to prevent adverse trim changes to both receiver and tanker.
- In the event of failure to obtain a contact and after each disconnect, the receiver will move aft and stabilize in the precontact position. Reset the air refueling system and visually confirm that the READY light is illuminated and that the tanker is ready for contact before returning to the contact position.
- During air refueling, whenever an emergency, or abnormal condition occurs that will affect aircraft controllability, immediately disconnect and remain clear of the tanker until the condition is corrected.

The KC-10A air refueling boom is controlled by a digital fly-by-wire system. Certain failure conditions of this system may cause one or more axes of the boom control system to become inoperative. Should this occur, the boom operator may not be able to maneuver the boom to avoid striking the receiver aircraft. When disconnecting in this situation, the boom operator will issue instructions to direct the receiver to a position where a safe disconnect can be effected.

WARNING

- When notified that a KC-10A boom flight control system failure has occurred, do not initiate a disconnect unless directed by the boom operator.
- Follow the boom operator's instruction explicitly. To reduce the probability of boom strike after disconnect, it may be necessary to remain in a stabilized position to allow for aerodynamic fairing of the boom control surfaces.

PART 4

TANKER AIR REFUELING PROCEDURES

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TANKER AIR REFUELING PROCEDURES

GENERAL

This section contains information to be used from the receiver's arrival in the observation/precontact position until the completion of the air refueling operations. During final closure and air refueling operations, the effects of the environment, and other phenomena can increase the potential for closure overrun or cause the receiver to lose visual contact. The tanker should attempt to eliminate the adverse conditions by altering course, altitude, or refueling track location.

WARNING

- Serious consideration should be made to terminate refueling if conditions cannot be improved by maneuvering the tanker.
- Air refueling will be discontinued when inflight visibility is deemed insufficient for safe air refueling operations
- The pilot flying the aircraft during air refueling operations with the autopilot engaged will keep one hand on the control column and the other hand available for immediate throttle operation, in order that prompt action can be taken in the event of an autopilot malfunction or breakaway.

The autopilot, if operational, shall be engaged for all refueling operations except during authorized autopilot-off training or demonstration maneuvers.

WARNING

- Except in an emergency do not engage or disengage the autopilot while the receiver is in the contact position as unscheduled attitude changes can occur.
- Do not use navigation modes of the autopilot during air refueling.

CONTACT AND AIR REFUELING PROCEDURES

During all phases of the air refueling operation, the following precautions and procedures must be observed.

Autothrottles may be used during refueling with most receivers, however this is not recommended with large receivers. They should not be used in turbulence. Check that you are above ALPHA speed before engaging. Autothrottles should be disengaged if a breakaway is initiated.

WARNING

- When using autothrottles for air refueling, speed changes should be made slowly and deliberately (1 knot increments) to preclude rapid throttle movements.
- Particular attention should be given when using the heading select knob with autothrottles engaged. The close proximity to and similarity with the speed knob creates the potential for inadvertent speed changes.
- Because of the magnitude of interrelated aerodynamic effects, flying two aircraft in close vertical proximity is not safe. Upwash and downwash effects may occur drawing the aircraft together. Low pressure areas created by an overrunning receiver flying under the tanker will affect static ports causing possible erroneous airspeed and altitude indications to both airplanes. The tanker autopilot may sense the low pressure as a climbing indication and initiate a descent into the lower aircraft.
- The receiver will stabilize in the precontact position. If the receiver fails to attain stabilized position, or it becomes apparent that a closure overrun will occur, breakaway procedures will be initiated. Failure to do so can result in a mid-air collision.

CAUTION

Disconnect or breakaway procedures will be initiated any time the receiver becomes erratic within the air refueling envelope or damage to either aircraft appears imminent.

NOTE

- When an emergency or abnormal condition occurs during air refueling that will adversely affect platform stability or aircraft controllability, disconnect immediately and advise the receiver to remain clear until the condition is corrected.
- Care should be exercised when using the HEADING SELECT mode during air refueling due to the abrupt bank angle changes that can occur when the reference heading is changed. If the HEADING SELECT mode is used, the bank selector should be set at 5 degrees until a turn is initiated. Change reference heading slowly until desired bank angle is achieved. Return the bank selector to 5 degrees when the turn is completed.

BOOM AIR REFUELING

The KC-10A air refueling boom is controlled by a digital fly-by-wire system. Certain failure conditions of this system may cause one or more axes of the boom control system to become inoperative. Should this occur, the boom operator may not be able to maneuver the boom to avoid striking the receiver aircraft. In this situation, the boom operator will keep the flight control stick aligned with the boom and issue instructions to direct the receiver to a safe position where a disconnect can be effected.

NOTE

Receiver safe position, during partial or complete control system failure, is defined as when the receiver is approximately 0 degree roll and moving down and back. However, during a partial control system failure, functioning axis should be considered when determining a safe position.

OBSERVATION POSITION

Normally when air refueling two or more receivers with one tanker, the receiver leader will close in the precontact position. Subsequent receivers will remain in the observation position until visually clear and then move to the precontact position.

PRECONTACT POSITION

After the receiver has stabilized in the precontact position, the receiver will move to the contact position.

CAUTION

The boom operator will ensure that the boom is clear of the receiver during free flight conditions.

NOTE

- Close proximity tracking should not be performed with the AR SIG SYS in the CONTACT/COUPLED or DISCONNECT/FREE flight mode.
- Boom operators should be alert to the possible activation of the receiver afterburner. During night air refueling, flames from the afterburner will be visible.

CONTACT POSITION

Communications will be in accordance with Emission Option 2 procedures or as approved to complete essential mission requirements. If the receiver is having difficulty maintaining position, the receiver may request verbal assistance from the boom operator in maintaining position.

During night air refueling operations, maintain the boom in a position that will prevent the boom nozzle light from distracting or blinding the receiver pilot (a position left or right of center is recommended). The boom must be slowly and accurately extended into the receptacle to avoid damage to the receiver. The possibility of nozzle cocking is minimized if the receiver is stabilized in the proper contact position. If the AR SIG SYS remains in READY/FREE-FLIGHT after nozzle is inserted into the receiver's receptacle, initiate disconnect procedures (if no oscillation is present), or pull and hold EMER CONTACT MADE switch (until nozzle is free of receptacle) and initiate disconnect procedures as applicable. Provide verbal instructions as required to ensure receiver stays within AR envelope until nozzle/receptacle separation is attained.

CAUTION

Boom controls are extremely sensitive in the COUPLED mode. Large abrupt control inputs may cause boom to exceed a structural limit or strike the tanker or receiver aircraft.

NOTE

- Pulling and holding the EMER CONTACT MADE switch will increase the stick forces to their maximum values, engage the ALAS, and arm the stick shaker.
- Boom oscillation may occur if nozzle is pinned in receiver's receptacle and flight control system remains in FREEFLIGHT.
- The automatic disconnect limits and pilot director lights are not active in READY/ COUPLED mode.
- Due to roll characteristics of the boom, contact should not be attempted beyond 10 degrees of roll.

The air refueling receptacle on fighter aircraft and aircraft equipped with UARRSI presents a small target requiring a precision contact. The UARRSI slipway may be unusable and cause nozzle cocking which prevents contact. The boom operator will effect contact after the receiver has stabilized.

NOTE

- If pilot director lights fail to illuminate when contact is established, and refueling is continued, the receiver pilot may request verbal corrections.
- Attempts to effect a contact during loss of any air refueling lighting that results in less than desired illumination will be at the discretion of the boom operator.

The boom operator will guard the boom flight control stick in the event of a boom flight control system malfunction.

WARNING

If excessive fuel spillage occurs, initiate a disconnect. Discontinue refueling except in an emergency or when dictated by operational requirements.

CAUTION

- Do not attempt to maneuver the receiver with the boom flight control stick or boom telescope control stick.
- The boom operator will monitor the receiver's position closely and be prepared to initiate a disconnect or breakaway before the receiver gets into a position where nozzle binding could occur.
- Failure of a boom position instrument will not disable the associated boom envelope disconnect limits. However, that portion of the air refueling envelope associated with the failed instrument may be reduced to its smallest adjustable size. Air refueling operations will be discontinued in the event of a boom position instrument failure, except in case of an emergency.

NOTE

- If a small amount of fuel spray occurs, notify the receiver pilot; refueling will continue at the receiver pilots discretion.
- If fuel siphoning occurs notify FE to turn air refueling pumps off. Notify receiver pilot of condition; refueling will continue at the receiver pilots discretion.

DISCONNECT

Disconnect can be initiated by either the boom operator or receiver pilot. The receiver pilot will remain stabilized in the contact position until the boom operator or receiver crewmember has visually confirmed that the nozzle has cleared the receiver. If the nozzle remains captured in the receptacle after a normal disconnect is initiated, initiate IDS procedures. If oscillation is present, pull and hold EMER CONTACT MADE switch (until nozzle is free of receptacle), and initiate disconnect procedures as applicable. Provide verbal instructions as required to insure receiver stays within AR envelope until nozzle/receptacle separation is attained.

WARNING

If excessive fuel spillage occurs, initiate a disconnect. Discontinue refueling except in an emergency or when dictated by operational requirements.

CAUTION

- Any time the TLSCP-AT-DISC switch is in MAN, avoid excessive retraction rates to prevent pulling the receiver forward if boom release is not obtained.
- Boom controls are extremely sensitive in the COUPLED mode. Large abrupt control inputs may cause boom to exceed a structural limit or strike the tanker or receiver aircraft.
- Binding of the boom nozzle in the receiver's receptacle is possible, even with a disconnect signal. While nozzle binding can occur in most disconnect positions, it is most likely at high receiver roll and low boom elevation. If nozzle binding occurs or is suspected, neutralize boom flight control inputs. Avoid abrupt boom flight control inputs.
- Tanker breakaway capability may be degraded because of limited acceleration capability at pressure altitudes above 20,000 feet, gross weights in excess of 570,000 pounds and at low speeds near the 1.2g buffet-onset boundary speeds. Under these conditions the receiver should be made aware that the breakaway effectiveness will depend upon receiver actions.

NOTE

- Boom oscillation may occur if nozzle remains captured in receptacle after flight control system has advanced to FREEFLIGHT.
- Boom flight control system will begin switching from COUPLED mode to FREEFLIGHT mode when the EMER CONTACT MADE switch is released. At the end of the RECVR DISC DELAY time settings ALAS will cease to alleviate nozzle loads, the stick shaker will be disengaged and the stick force feel will return to the values determined by the position of the STICK FORCE selectors.
- In the event of failure to obtain a contact and after each disconnect, the receiver will move aft to the precontact position or a stabilized position in trail of the boom, and await clearance from the boom operator to return to the contact position.
- A small amount of fuel spray is normal at disconnect.

DROGUE AIR REFUELING

Success of the probe and drogue air refueling operation depends upon the proficiency of the receiver pilot, atmospheric conditions (visibility, turbulence, etc.), stability of the tanker and drogue, and loading of the receiver. Light turbulence causes random drogue movement of 1 foot below 250 KIAS and 2 to 3 feet above 250 KIAS. The hose and drogue when at 35,000 feet and above 250 KIAS has a tendency to oscillate elliptically at 0.5 cycles per second with an amplitude of 2 feet.

During planning for deployment/redeployment refueling operations, the aircrew and planning agency will contact the receiver unit prior to the mission. Drogue engagement rates and limitations of the reel response system must be communicated and understood. Planning agencies will not plan missions requiring refueling speeds in excess of optimum air refueling speeds. 280 knots is the maximum speed for air refueling due to the inability of the reel response system to function effectively at higher speeds. Avoid refueling at higher buddy cruise speed.

CAUTION

If the drogue is contacted off center or stabbed by the receiver it could result in the drogue becoming unstable resulting in damage to the tanker or receiver aircraft.

OBSERVATION POSITION

Normally when air refueling two or more receivers on one tanker, the receiver leader will close to the precontact position. Subsequent receivers will remain in the observation position until the previous receiver has cleared the drogue. When clear, each receiver will move to the precontact position in briefed order.

PRECONTACT POSITION

After the receiver has stabilized in the precontact position, and the tanker visually indicates ready for contact, the receiver pilot will then move forward and contact the drogue.

CONTACT POSITION

After the receiver pilot has contacted the drogue, the air refueling will be conducted utilizing the drogue signal system status lights. If a reel response reset is required due to a negative contact or an airspeed adjustment the boom operator may visually send the receiver to precontact (move and hold the DROGUE SIGNAL/PIL DIR light signal switch to DROGUE SIG position) until the reel response reset is completed. It is recommended that only the first 20 feet of hose travel be used to preclude nose/tail overlap. Contacts are improbable when the hose is pressurized or when the drogue is hit off center above 275 KIAS.

WARNING

- Receivers will close to contact with the centerline drogue at no greater than 3 knots closure speed.
- Do not push the REEL RESP RESET button while the receiver is in contact with the drogue.

CAUTION

- Air refueling will be terminated when a crimp and/or fuel leak is observed in the hose, except in case of emergency or when dictated by operational necessity.
- No contacts will be attempted when the red signal light and/or amber HYD PRESS LOW annunciator is on.
- Centerline reel response is marginal when the receiver is low in the air refueling envelope.
- WARP reel response is only effective from approximately 46 ft to full trail. If the receiver pushes the hose inside the inner limit a "Dead Hose" will result. A loop will form that could cause damage to the receiver aircraft.

NOTE

- A small amount of fuel spray during contact is normal. If spray continues, notify the receiver pilot. Air refueling will be continued at the receiver pilots discretion.
- Power limited receivers may experience difficulty making an effective contact if the hose remains pressurized following normal/ inadvertent disconnects. The boom operator will coordinate with the flight engineer to depressurize the hose to allow subsequent contacts, if necessary.
- Trapped fuel pressure in the hose may prevent receiver contact. If normal hose bleed system is not relieving pressure adequately, the trapped pressure can be relieved by opening the drogue valve and scavenging the AR manifold until the pressure indication is less than 10 psi. REEL RESP RESET button must be held in the RESET position if operation of drogue valve is required while the hose is in full trail. Return MANF SCAV selector to OFF after fuel pressure is relieved. Trapped pressure for subsequent contacts can be prevented by closing the drogue valve prior to the receiver disconnecting.

DISCONNECT

For planned disconnects, the receiver will reduce power and move back to effect the disconnect.

NOTE

- Contact may be reattempted at the receiver pilots discretion following a disconnect or failed contact if the READY light is on.
- A small amount of fuel spray is normal at disconnect. If spray continues, notify receiver pilot. Air refueling will continue at the receiver pilot's discretion.
- Fuel may gravity flow to receivers when they are within the refueling range and the drogue valve is open. The external green fuel flow light will illuminate if this condition occurs.

TOBOGGAN

When receiver thrust requirements begin to exceed thrust available, a TOBOGGAN will be necessary. This condition may be encountered as receiver gross weight increases or changes in altitude and atmospheric conditions occur (see figure 8.4-1).

The toboggan technique is a coordinated effort between the tanker pilot and the receiver pilot.

a. The receiver pilot must signal for a toboggan before reaching full military power.

b. The tanker pilot will very gently reduce power and initiate a rate of descent of approximately 300 FPM while maintaining the air refueling airspeed.

c. If the receiver's power requirements continue to exceed the thrust capability, an increased rate of descent must be requested by the receiver pilot.

d. If hookup is to be maintained at the level-off altitude, the tanker pilot must make a very gentle change of attitude and a gentle power increase.

e. Should it become necessary for an element to toboggan while in formation, the tanker leader will direct the entire formation to toboggan.

WARNING

Drogue Air Refueling will not be conducted while tobogganing except in case of emergency.

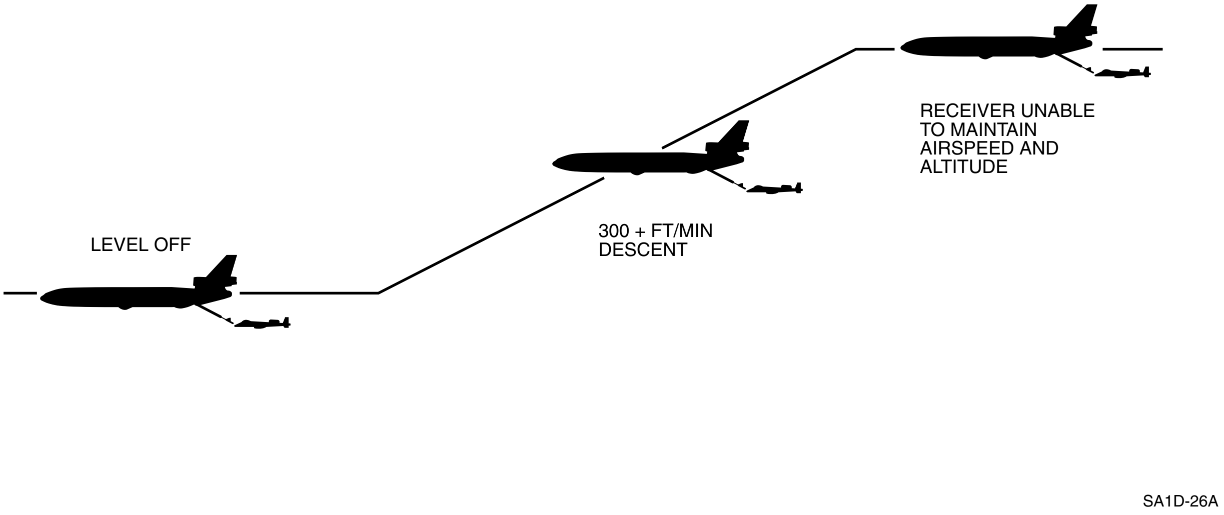

Figure 8.4-1. Toboggan

GLOSSARY

PURPOSE

The glossary will provide reference for commonly used terms in discussing the operation of high speed jet cargo/tanker aircraft. Some of the terms pertain to the operation of the KC-10A, although all terms will not appear in this manual. In general, as each term is encountered in the various manuals it will be defined. Subsequent use will be by abbreviation or symbol only.

a	Speed of Sound.
ADG	Air Driven Generator. Provides emergency electrical and hydraulic power. Pull handle located at base of pedestal in flight compartment to deploy ADG into slipstream. Once deployed, ADG cannot be reset in flight.
ADLP	Airborne Data Link Processor. Compiles airborne data from multiple input sources (CADCs, INUs, FMSs, Autopilot Control Panel) and communicates this data to the digital IFF transponder during Mode S operations.
Alpha Speed	A reference speed representing the safe stall margin speed maintained by the autopilot for all configurations.
AR	Aerial Refueling.
ARB	Aerial Refueling Boom.
ARO	Aerial Refueling Operator.
ATS	Automatic Throttle System.
BSIU	Bus Subsystem Interface Unit (FMS component). Provides interface for output of the FMS to other aircraft avionics, e.g., the flight instruments, autopilot/flight director, TACAN, IFF, and ADF. Also provides the Kalman filtered integrated INU/GPS navigation solution.
BU	Battery Unit (FMS Component).
CAS	Calibrated Airspeed. Indicated airspeed corrected for instrument error and position error.
CBIT	Continuous Built-In Test.
CDU	Control Display Unit (FMS Component).
CG	Center of Gravity.
CMD	Engage position of autopilot.
Cue Light	Calls attention of both pilots and flight engineer to a system fault in ELECTRICAL, FUEL, HYDRAULIC, or PNEUMATIC system which requires corrective action. Both MASTER CAUTION lights on pilot's glareshield and MASTER CAUTION light on flight engineer's annunciator panel will illuminate. Push cue light to turn off cue light, warning lights (3 locations) and re-arm system for additional fault detection capability.
CWS	Control Wheel Steering. Autopilot mode which allows pilot to maneuver aircraft using conventional flight controls while autopilot is engaged.
EAS	Equivalent Airspeed. Calibrated Airspeed corrected for compressibility. EAS is always equal to or less than CAS.
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature.
ETCAS	Enhanced Traffic Alert and Collision Avoidance System
FD	Flight Director. Provides visual guidance for the pilot to fly the computed flight path manually as displayed on the ADI, or visually monitor autopilot response to computed flight path commands from flight guidance system.
F/F	Fuel Flow.
FMS	Flight Management System. A multisensor navigation system which uses pilot selectable GPS, INU, or integrated INU/GPS navigation sensors. Provides navigation and guidance data to the flight instruments, autopilot, and flight director. Also provides multicrew control of the TACAN, ADF, and IFF radios.

FPCU	Fuel Pressure Control Unit. Maintains constant fuel pressure of approximately 50 psi at boom nozzle or drogue by varying fuel pump speed as required.
g	Normal gravitational weight equal to weight of an object at rest.
GPS	Global Positioning System. A satellite-based radio positioning system capable of providing highly accurate position, velocity, and time information for use in navigation systems.
GPS Emulation	Single waypoint To-From navigation using a GPS waypoint to upon which the instrument procedure is based. Instrument displays and operational procedures closely resemble those used with the original equipment.
GPS Overlay	A combination of To-To and To-From navigation which allows an aircraft with FAA-approved GPS equipment to overfly an existing TACAN, VOR, or NDB instrument procedure using GPS. The approach plate must be annotated with GPS in the procedure title, e.g., VOR or GPS RWY 13.
IBIT	Initiated Built-In Test.
ICAO	International Civil Aviation Organization.
INAV	Integrated Navigation solution.
INS	Inertial Navigation System. A self-contained navigation sensor which provides navigation data input to the aircraft flight management system. Also provides the attitude platform for the aircraft flight instruments and other systems.
INU	Inertial Navigation Unit (INS Component)
INVERSE TACAN MODE	Broadcasts TACAN distance and bearing information in the same manner as a TACAN ground station.
KIAS	Indicated Airspeed in knots.
L/D	Lift to drag ratio.
M	Mach Number. The ratio of TAS to the speed of sound under given conditions. M = TAS/a.
MAGVAR	Magnetic Variation.
MAHP	Missed Approach Holding Point.
Manufacturers Empty Weight	Weight of the aircraft, including the structure, powerplants, furnishings, systems and other items of equipment that are considered an integral part of a particular aircraft configuration. This is a dry weight, including only those fluids contained in closed system such as the hydraulic system.
Maximum Fuel Unbalance Weight	The maximum permissible lateral unbalance caused by uneven fuel distribution.
Maximum Gross Weight	The maximum weight authorized by the flight manual for an aircraft and its contents under specific conditions (ramp weight, takeoff weight, landing weight, etc.).
Maximum Landing Weight	The maximum aircraft weight permitted for a touchdown with a sink rate of 10 feet per second. This may also be further restricted by performance requirements.
Modulated	To vary the amplitude frequency or phase of a radio frequency carrier wave with another signal such as voice, tone, or visual signals.
NAM/LB	Nautical air miles per pound of fuel.
N_1 (N_2)	Low (and high) pressure rotor. Speeds are normally expressed as a percent of RPM of a maximum limiting value.
Operating Empty Weight	The manufacturer's empty weight of the aircraft plus the weight of the oil, trapped fuel, Crew, crew baggage, passenger equipment and emergency equipment.
Orbit/ Rendezvous Mode	A separate computer program to steer the aircraft to a predetermined orbit pattern and rendezvous for refueling operations.
PF	Pilot flying.

PNF	Pilot not flying.
PSID	Pounds per Square Inch Differential
RA	Resolution Advisory
Radio Update	Method used to refine accuracy of Inertial Navigation position using range and bearing from TACAN.
RAIM	Receiver Autonomous Integrity Monitoring. A method of insuring the integrity of the GPS satellite signals at the receiver by comparing position solutions determined with different sets of four satellites. Five satellites are required to detect an erroneous signal and six are required to detect and isolate an erroneous signal.
RNAV	Area Navigation. A method of navigation that permits aircraft operations along any desired course within the coverage of externally referenced navigation signals or within the limits of self-contained system capability.
SA/A-S	Selective Availability/Anti-Spoofing. Protective features of the Global Positioning System. SA provides the capability to selectively degrade the accuracy of GPS signals. A-S proves the capability to deny the use of the P-code signals which prevents an enemy from broadcasting false P-code signals. Both features use cryptographic techniques which require authorized users to have the proper crypto keys for access.
SAT	Static Air Temperature.
SFC	Specific Fuel Consumption. The amount of fuel consumed in pounds per hour, divided by the thrust of the engine in pounds.
STP	Status Test Panel. Provides boom operator and/or ground maintenance personnel information regarding status, operation, and malfunction of Boom Control System (BCU), using display panel of 32 alphanumeric characters in readout window with two lines of 16 characters each.
Squitter	Random firing, intentional or otherwise, of a transponder transmitter in the absence of interrogation.
TA	Traffic Advisory
TAS	True Airspeed. EAS corrected for density altitude effects. TAS equals EAS at sea level at standard day conditions.
TAT	Total Air Temperature. Outside air temperature plus ram air temperature.
TCAS	Traffic Alert and Collision Avoidance System
TNAV	Time Navigation. The capability to compute and display the necessary information to meet a required time of arrival (RTA) at a specified waypoint.
TVSI	TCAS/Vertical Speed Indicator
Update	Method used to refine accuracy of Inertial Navigation System position.
V_A	Design maneuvering speed. The maximum speed for which the aircraft is designed for rapid full control deflection.
V_{APP}	Approach Speed.
V_B	Design speed for maximum gust intensity.
V_C/M_C	Design cruising speed. In the KC-10 $V_C/M_C = V_{MO}/M_{MO}$.
V_{CL}	Climb speed.
V-Command Bars	Display data from the integrated autopilot/flight director system on the Attitude Director Indicator. In Flight Director mode, V-Command Bars indicate a response required by the pilot to fly the computed flight path manually. In the CMD mode, V-Command Bars monitor the guidance signals from the autopilot/flight guidance system as it follows the computed flight path.
V_D/M_D	Design diving speed.
V_{FE}/M_{FE}	Design flap limit speed.

V_L/D	Airspeed for maximum ratio of lift to drag. The minimum speed for speed stability generally, under cruise conditions, is expressed as percentages above this speed.
V_{LE}/M_{LE}	Maximum landing gear extended speed. The maximum speed at which it is safe to fly with landing gear locked in the extended position.
V_{LO}/M_{LO}	Maximum landing gear speed. Maximum speed at which the landing gear may be extended or retracted. The KC-10A has separate extend and retract limit speeds.
V_{LOF}	Liftoff speed.
V_{MAN}	Maneuvering Speed.
V_{MC_A}	Minimum control speed in the air with the critical engine inoperative, full rudder input, and a maximum bank angle of 5° away from the engine which has failed.
V_{MCG}	Minimum control speed on the ground with the critical engine operative.
V_{MO}/M_{MO}	Maximum operating speed. The maximum speed permitted for any operation.
V_{MU}	The minimum demonstrated unstick speed. This is the minimum speed at which it is possible to lift off without undue hazard, and continue a takeoff.
VNAV	Vertical Navigation. The capability to compute and provide guidance to follow a specified vertical path.
V_R	Takeoff rotation speed.
V_S	Stalling speed.
V_{TH}	Threshold speed.
V_1	Takeoff decision speed.
V_2	Takeoff safety speed.
Waypoint	FMS steerpoint represented by geographical coordinates of latitude and longitude, a databased name of up to five characters, or a bearing/ distance from another waypoint.
WGS-84	World Geodetic System 1984.
W_{MC}	Weight at which minimum control speed affects takeoff speeds and takeoff field lengths.
WT or GW	Aircraft gross weight.
Zero Fuel Weight	Maximum weight authorized for an aircraft with no disposable fuel and oil.

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DATED 22 February 2008

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7. (U) PURPOSE: THIS SUPLEMENT ADDS A CAUTION FOLLOWING THE FIRST NOTE IN THE COMPRESSOR STALL SECTION.

8. (U) INSTRUCTIONS: THE FOLLOWING INSTRUCTIONS APPLY:

PAGE 2A-134, AFTER THE COMPRESSOR STALL NOTE, ADD CAUTION TO READ: "CAUTION: COMPRESSOR STALLS CAN RESULT IN SEVERE DAMAGE TO THE ENGINE."

9. (U) STATUS PAGE:

A. CHECKLISTS AFFECTED:

NONE

B. SAFETY AND OPERATIONAL SUPPLEMENTS:

T.O. 1C-10(K)A-1S-163	22 FEB 08	COMPRESSOR STALL CAUTION

C. RECINDED SUPPLEMENTS:

NONE

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//SIGNED//

GREGG EVANS, CHIEF
TANKER/AIRLIFT ENGINEERING DIVISION
544 ACSS

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