

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

DC-9
FLIGHT CREW OPERATING MANUAL

PUBLISHED BY

DOUGLAS AIRCRAFT CO., INC.

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DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

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DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

THIS MANUAL IS EFFECTIVE FOR THE FOLLOWING AIRPLANES

Factory Serial Numbers	Fleet Numbers	Registration Numbers
47459		D-ADIS
47450		D-ADIT
47457		D-ADIU

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(SEREIS 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 22, CHAPTER INTRO, DATED DEC 1/70
SUMMARY: MANUAL EFFECTIVITY UPDATED TO REFLECT LATEST CONFIGURATION

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I N T R O D U C T I O N

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Intro	1	4	Sep 1/69
Foreword	1	1	Dec 1/65

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DOUGLAS AIRCRAFT CO., INC.
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INTRODUCTION

The DC-9 Flight Crew Operating Manual comprises five sections. Specific Limitations information originally compiled for Section 1, has been broken down by subject matter and included with each applicable Chapter of Section 2. Section 2 contains both normal and abnormal operating procedures and limitations data. Section 3 contains systems descriptions and has been prepared as study material which may be removed from the manual in its entirety to reduce the bulk of the manual when carried aboard the airplane. Furthermore, Chapter One of Section 3 contains all of the information of interest for purposes of cabin attendant and purser training. Section 4 contains expanded emergency procedures. Section 5 of the manual presents information relative to airplane performance and flight planning.

New and revised pages for this manual will be forwarded on a scheduled quarterly basis. Additions, deletions, or changes, on text pages will be indicated by a change bar (vertical line) adjacent to the change. Changes to illustrations will be indicated on a summary sheet included in the revision package. Revision dates will appear on all new or revised pages.

Interim revisions will be forwarded between regular revisions, as deemed necessary.

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IMPORTANT INFORMATION

MANUAL FORMAT AND REVISION SERVICE

NOTE

Section and Chapter Format

Major divisions of the DC-9 Flight Crew Operating Manual consist of the Introduction and five sections. The Introduction and each section is preceded by a colored (center tab) divider. Each section of the manual (except Section 1) has a Table of Contents and is complete within itself.

Each section of the manual is divided into chapters where required. Each chapter within a section has a Table of Contents and is complete within itself. Included with each chapter is a List of Effective Pages. This list should be used to assure that the correct pages have been incorporated into the Manual. Individual instructions, regarding pages to be removed or inserted, are supplied with each revised chapter.

The format of keeping each section and each chapter complete, allows revisions to be handled on a Section or Chapter basis.

Page Identification and Code System

Purpose

The page identification and code system makes it possible to issue small blocks of revision pages without renumbering and printing a complete section or chapter of the manual. The coding system is a tool for maintaining customized manuals for individual airlines.

The system is a compromise between pagination used by various airlines and Douglas Aircraft Company requirements for handling many configuration differences. Subject and unit numbering are primarily a means of control within Douglas Publications Department.

Typical Page Identification

Section 3	← Section identification
10-5-1	← Chapter - Subject - Unit numbering
CODE 1	← Configuration identification
Page 1	← Numbers run in sequence, starting with each change in Chapter - Subject - Unit numbering.

Section Identification (Of primary value to the user.)

Section 1 -- OPERATING LIMITATIONS
All pages printed for Section 1 are inserted following the orange divider.

Section 2 -- SYSTEM OPERATIONS
All pages printed for Section 2 are inserted following the green divider.

Section 3 -- SYSTEM DESCRIPTION
All pages printed for Section 3 are inserted following the yellow divider.

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Section 4 -- EMERGENCY PROCEDURES

All pages printed for Section 4 are inserted following the red divider.

NOTE: The printed title, EMERGENCY PROCEDURES, replaces the normal Chapter-Subject-Unit breakdown, on Section 4 pages.

Section 5 -- PERFORMANCE AND FLIGHT PLANNING ALL pages printed for Section 5 are inserted following the blue divider.

Chapter Identification (Of primary value to the user.)

The first one or two digit numbers following the section identification is always used to identify a chapter within the section.

Subject Numbering (Primarily for use of Douglas Aircraft Company.)

The first one or two digit number following the chapter identification is used to break the chapter into smaller blocks of numbered pages, as a means of handling configuration differences. It has no direct value or meaning to the user.

Unit Numbering (Primarily for use of Douglas Aircraft Company.)

The first one or two digit number following subject numbering is used to further break subject matter into smaller blocks of numbered pages. It is used where subject matter may require frequent revision or contains many configuration differences. It has no direct value or meaning to the user.

Configuration Identification

A CODE number is assigned, by the Douglas Aircraft Company, to a block of pages issued for a specific configuration of the airplane. If all

DC-9 aircraft within the operators fleet are identical in configuration, the CODE number will have no direct value to the user. However, each code page must be checked against the List of Effective Pages issued for each chapter. This is to assure that the pages forwarded are applicable to your Manual. Where practical, configuration differences within an operator's fleet will be shown on art pages or defined in text pages. If this is not feasible, an additional text block with a different CODE number will be issued to cover the additional configuration.

When two or more CODES are required to cover a specific subject, within one manual, the chapter Table of Contents will list the airplane effectivity of each CODE.

SUGGESTIONS FOR HANDLING REVISIONS

1. Using the page identification system, assemble revision pages for each section separately.
2. Split the manual at one of the colored dividers designating a section.
3. Work each chapter within a section on an individual basis, using the revision instructions provided for that chapter. Use the chapter Table of Contents to determine pagination sequence. Check the revised chapter against the List of Effective Pages before starting revision of the next chapter.
4. Separate manuals are issued for various models of the DC-9. To make certain that new revision pages go into the correct manual when a customer is using more than one manual, it is

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important to remember that the CODE number for the List of Effective pages is always the same as the Table of Contents CODE number throughout each manual. Always check the List of Effective pages CODE number against the Table of Contents CODE number to preclude inserting new revision pages into the wrong manual.

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FOREWORD

The DC-9 Flight Crew Operating Manual has been published to provide descriptive and operational information to be used as a guide in operation of the DC-9 airplane. The data and operating instructions in this manual are based upon engineering information and initial operating experience of the Douglas Aircraft Company, Inc.

The DC-9 Flight Crew Operating Manual is one proper operating manual. This does not mean that there cannot be other manuals, such as the manual which the airline, in its judgment, may compile.

The style and format of this manual were developed by the Douglas Aircraft Company, Inc. This manual will be revised on a quarterly schedule to reflect new information or changes occurring since the last scheduled revision. Due to inherent delays in research, preparation, and publication of technical manuals, this publication does not necessarily reflect or include recent changes to the airplane. The data contained herein includes the latest available data as of approximately 60 days before the latest dated scheduled revision.

In the event of conflict between information contained in this manual and the FAA approved Airplane Flight Manual, the FAA approved Flight Manual shall govern.

Comments or inquiries concerning this manual should be addressed to:

A. G. Heimerdinger, Chief Pilot,
Douglas Aircraft Company, Inc., C1-270
Long Beach, California

DOUGLAS AIRCRAFT CO., INC.
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SECTION 1
OPERATING LIMITATIONS

DOUGLAS AIRCRAFT CO., INC.
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1-Op Lim	1	1	Sep 1/66

*The asterisk indicates pages revised or added by the current revision.

Sep 1/69

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Page 1

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Section 1

OPERATING LIMITATIONS

The ruling document for operation of the DC-9 airplane is the DC-9 FAA Approved Airplane Flight Manual. Certificate Limitations comprise Section I of the FAA Approved Airplane Flight Manual.

Reference data for DC-9 Operating Limitations is contained in Section 2 of this manual, and is located immediately following the Table of Contents in each chapter. The limitation data contained in this manual is comprehensive and may contain information that is not required as part of the FAA Approved Airplane Flight Manual.

In the event of conflict between information contained in this manual and the FAA Approved Airplane Flight Manual, the FAA Approved Airplane Flight Manual shall govern.

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SECTION 2
SYSTEM OPERATIONS

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Section 2

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TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 25, SECTION 2, CHAPTER 1, DATED SEP 1/71

HIGHLIGHTS:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-1-3-0 REVISED TAXI CHECK, COCKPIT CHECKLIST TO PROVIDE THE RECOMMENDATION FOR TAKEOFF WITH APU OPERATING WHEN IN HEAVY RAIN OR SLUSH. REVISED BEFORE LANDING COCKPIT CHECKLIST TO PROVIDE THE RECOMMENDATION FOR LANDING WITH APU OPERATING IN HEAVY RAIN OR SLUSH.

TEMPORARY REVISIONS 2-124 AND 2-126 HAVE BEEN INCORPORATED INTO YOUR MANUAL. PLEASE REMOVE YELLOW PAGES.

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TR #2-126		(Yellow)	None		
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CHAPTER 2-1

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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Chapter 1

AIRPLANE GENERAL

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*Illustration

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*ABNORMAL OPERATION - Passenger oxygen system Passenger oxygen masks fail to pre- sent automatically following decompression	1-25-0	1	1	A11
*ABNORMAL OPERATION - Passenger oxygen system One or more passen- ger oxygen masks doors fail to open automatically after masks presentation surge pressure is attained following decompression	1-25-1	1	1	A11

*Illustration

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AIRPLANE GENERAL -- LIMITATIONS

WING LANDING LIGHTS	
Extend/retract duty cycle	Wing landing light motors should be allowed to cool for 1 1/2 minutes after initial extension or retraction, and 3 1/2 minutes after each subsequent extension or retraction.
Lamp duty cycle	Lamps should not be operated in still, ambient air for periods of over 10 minutes, due to excessive heat build-up.

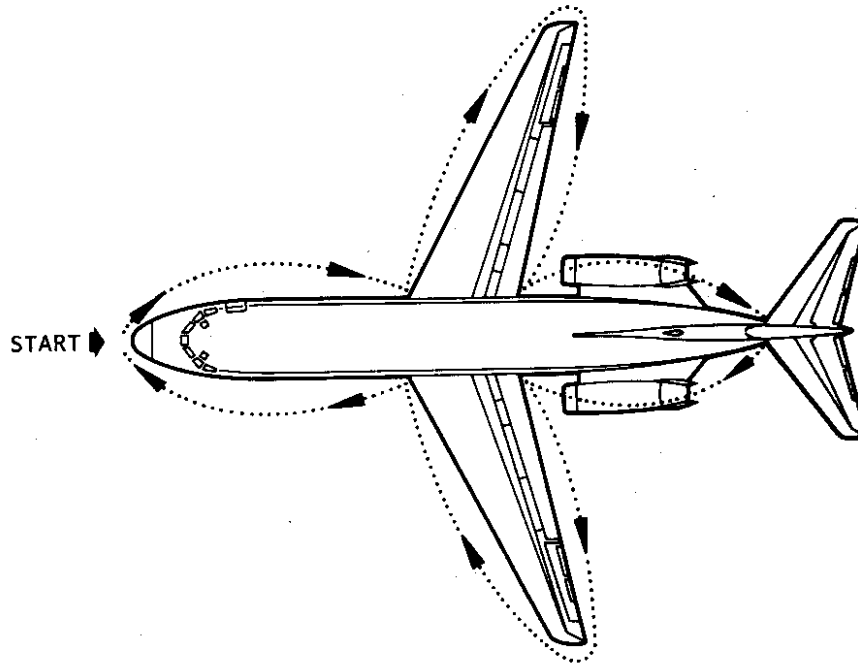
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DC-9 FLIGHT CREW WALKAROUND CHECK



BB1-976

FLIGHT CREW WALKAROUND INSPECTION

Start at nose of airplane or at any point around airplane, proceed in direction indicated, and terminate at starting point.

Right radome fasteners	Flush and locked
Right and center pitot tubes	Condition good and covers removed
RAT probe	Condition good
Nose landing and taxi lights	Filament condition good
Nose gear tires	Inflation normal, condition good, chine outboard
Nose gear chocks	In place

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Nose gear strut	Inflation normal (approximately 2 inches), no leaks
Nose gear ground shift linkage	Connected and secure
Steering bypass control	Released
Hydraulic oil leaks	Checked
Nose gear safety pin	Removed
Forward nose gear doors	Latched/Closed
Forward accessory compartment door	Closed and latched
Nose gear doors	Forward doors latched; fixed doors solidly attached
Oxygen blowout disc	Green disc in place
Water service panel (s)	Door closed
Electronic compartment access door	Door closed and latched
Stall warning vanes	General condition
Right alternate static port	Clear and unobstructed
Right static port cluster	Clear and unobstructed
Forward cargo door	Closed and latched
Oil or fuel leaks on belly	Checked
Wing leading edge floodlight	Condition good
Ground floodlight	Condition good
Fillet ram air vent	Clear
Belly fairing exhaust vent	Clear
Slats	Clear and condition good
Fuel dripless magnetic sticks	Access doors closed and latched
Vortilon	Condition good

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Fueling doors	Closed and latched
Wing vent outlet	Open (2 places)
Fuel leakage bottom of wing	Checked
Tip ram air vent	Clear
Main fuel vent	Open
Forward and aft position lights (green and white)	Lights checked and fairings intact
Wing landing light	Retracted and condition good
Latched cover, top of fin fairing on stabilizer	Closed and latched
Aileron	Full throw, clear and condition good
Aileron tabs	Condition good, no looseness
Fuel tank cap	Secured
Spoilers	Down and faired
Flap fairings	Attachment good and no leaks
Flap vanes	Condition good (not visible when up)
Overwing emergency exit(s)	Installed and flush
Engine nacelle floodlight	Condition good
Right main gear wheels and tires	Condition and inflation normal
Brakes	No leaks, brake hoses condition good, wear indication checked
Main gear strut	Inflation normal (approximately 2 inches), no leaks
Shimmy damper	Serviced
Outboard main gear door	Securely attached, condition good

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Right gear safety pin	Removed
Hydraulic lines and electric conduit	Attached, secured, condition good, no leaks
Right main gear door	Closed (after wheel well inspection if required)
Anti-collision light (bottom)	Condition good
Aft cargo compartment door	Closed and latched
Right engine inlet cover	Removed
Nacelle fairing doors	Closed and latched (4 places)
Nacelle inspection doors	Closed and fastened
Leakage check	No drips
Reverser safety latch indicator	Reversers stowed and indicator in recess
Right engine exhaust cover	Removed
Reverser safety pin and door	Safety pin stowed, lever in normal, and cover door closed
APU exhaust ventilation	Opening clear
Rudder restrictor pitot tube	Cover removed
Ground air conditioning service inlet door	Closed and securely latched
Tail bumper compression indicator	Horizontal position
Elevator augmentor service access door	Closed and latched
Tail cone	Securely latched
Tail compartment access door	Closed and fastened
Oil or fuel leakage bottom of tail	Checked
APU exhaust and shroud outlets	Clear

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Intercooler outlet	Clear
Rudder and tab	Condition good
Horizontal stabilizer	Condition good, fairings in place
Elevators and tabs	Condition good
Elevator system oil leaks	Checked
Tail cone external release	Stowed
Left engine exhaust cover	Removed
Intercooler outlet	Clear
Reverser safety latch indicator	Reversers stowed and indicator in recess
Reverser safety pin and door	Pin stowed, lever normal, and cover door closed
APU fire panel	Door closed and latched
Tail temperature sensor(s) outlet	Check valve(s) free and opening(s) clear
APU access doors	Closed and latched
Pneumatic service connector door	Closed and latched
Nacelle fairing doors	Closed and latched (4 places)
Nacelle inspection doors	Closed and fastened
Leakage check	No drips
Toilet service doors	Closed and no leaks
Cabin pressure outlets	Clear and open
Left engine inlet cover	Removed
Engine nacelle floodlight	Condition good
Overwing emergency exit(s)	Installed and flush

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Wing flap fairings and vanes	Condition good (not visible when up)
Spoilers	Down and faired
Left main gear door	Closed (after wheel well inspected if required)
Left main gear wheels and tires	Condition good, inflation normal
Brakes	No leaks, brake hoses condition good, wear indication checked
Main gear strut	Inflation normal (approximately 2 inches), no leaks
Shimmy damper	Serviced
Hydraulic lines and electric conduits	Attached, secured, condition good, no leaks
Outboard main gear door	Securely attached condition good
Left gear safety pin	Removed
Fuel leaks, bottom of wing and belly	Checked
Aileron and tabs	Condition good, aileron free
Fuel tank cap	Secured
Forward and aft position lights (red and white)	Lights checked and fairings intact
Wing landing light	Retracted and condition good
Tip ram air vent	Clear
Fuel tank vent outlet	Clear
Vortilon	Condition good
Fuel dripless magnetic sticks	Access doors closed and latched
Slats	Clear and condition good
Wing vent outlet	Open (2 places)
Fillet ram air vent	Clear

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FLIGHT CREW WALKAROUND INSPECTION (Continued)

Ground floodlight	Condition good
Wing leading edge floodlight	Condition good
Gear well door bypass handle	Latched flush
Oil or fuel leaks on belly	Checked
Cabin pressure relief valves (2)	Clear
Cabin pressure relief valve static ports (2)	Clear and unobstructed
Left static port cluster	Clear and unobstructed
Left alternate static port	Clear and unobstructed
Radio rack venturi outlet	Open
Stall warning vane	General condition
Fin ram air inlet	Clear
Left pitot tube	Condition good and cover removed
Left radome fastener	Flush and locked
Electrical ground service door	Door closed and latched

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COCKPIT CHECKLIST - EXPANDED

This expanded checklist is intended to inform the operator of the details involved in responding to individual checklist callouts. The sequence is general and first covers items to be checked on cockpit entry. Next, it covers checks necessary to establish power and air conditioning comfort. Thereafter, in a systematic manner, starting at the top of the panel, the sequence covers items from left to right across the overhead and instrument panels and terminates on the pedestal, ready for a start.

This expanded checklist is extremely detailed and should be considered as a once-a-day operation. It is intended that the operator will adjust the checklist to suit his conditions and frequency of checks. It is assumed that the airplane is in complete working order, that all circuit breakers are set, and that a flight crewmember has accomplished a walkaround inspection or its equivalent.

The items may be accomplished in any order that is convenient or required, and the checklist is to be followed only to be certain that all items are covered.

NOTE: This expanded checklist is not all inclusive, and, moreover, some of the material does not appear in other sections of this manual.

When a checklist item response is listed "as required," the response will be a callout of the applicable switch or control position.

Checklist items preceded by asterisks are applicable to both normal and battery engine starts. Certain of these items appear to be unrelated to battery engine starts and are called out to preclude pilot inconvenience after the engines have been started.

BEFORE START

*1. CIRCUIT BREAKERS..... CHECKED

Check that circuit breakers on overhead emergency panel, EPC, and Captain's lighting panel are set. Open (pull) the CAPTAIN'S/FIRST OFFICER'S & CENTER COCKPIT WINDOW ANTI-FOG circuit breaker to allow a subsequent "handfeel" check of the windshield anti-ice system.

2. GROUND SERVICE ELECTRICAL POWER PANEL..... OFF

If ground service electrical power is being used, place corresponding main bus power switches to ON and place all GROUND SERVICE ELEC PWR switches to OFF. Check frequency and voltage.

*Applicable to battery engine start.

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3. MAINTENANCE INTERPHONE..... OFF

This position isolates the service interphone stations, located in various maintenance areas, from the cabin attendant's-pilots' service interphone system and prevents the possibility of a malfunction of a remote station causing a problem.

- *4. ENGINE FIRE DETECTOR LOOP SWITCHES..... BOTH

LOOPS switches must be at BOTH to perform a normal fire warning system test.

NOTE: System will be tested later.

- *5. OXYGEN CYLINDERS..... VALVES OPEN/QUANTITY
CHECKED

Pressure gages on the supply cylinders indicate cylinder pressures with the supply valves turned on or off. Therefore, check that both crew and passenger supply valves are open. If valves are tight in counterclockwise direction, try a half turn toward closed and return to be certain valve is not jammed in closed position. Cylinder pressure is at least 1670 when considered full. If pressure is lower, review oxygen required versus passengers and time chart. Passenger oxygen supply AUTO-MANUAL valve should be in the AUTO position.

6. PORTABLE OXYGEN..... CYLINDER CHECKED

Should indicate approximately 1670 psi to be assured of 15 minutes of demand usage.

- *7. BATTERY SWITCH..... ON

- *8. GALLEY POWER..... OFF

Since there is no immediate need for galley power and the power load may be an appreciable value, the GALLEY switch should be in the OFF position.

This allows the APU, if operating, to deliver more pneumatic power to the air conditioning system. This switch may be used to rapidly reduce electrical demand on the generator system.

9. ELECTRICAL/PNEUMATIC POWER..... AS REQUIRED

Depending on availability of ground power or APU, check pneumatic pressure on start panel and select volts and frequency of external power or APU, whichever is used. If APU has not been started, use APU checklist. If external power is to be connected, refer to Electrical System, Section 2, Chapter 5.

*Applicable to battery engine start.

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COCKPIT CHECKLIST - EXPANDED (Continued)

*10. CABIN PRESSURE CONTROLLER LEVER..... AUTO

In the AUTO position the cabin pressure controller indicator should be in the aft (DECR) position. On the first flight of the day, place the cabin pressure controller lever in the manual (down) position, depress and turn the cabin pressure controller wheel and check for freedom of motion over the full range of travel. Release the wheel when the indicator is at the full forward (INCR) position, place the controller lever in AUTO position and check that the indicator returns to the aft (DECR) position.

11. PNEUMATIC CROSSFEEDS..... AS REQUIRED

If cabin temperature is 85°F (29°C) or above when planning to use the APU as the air conditioning pneumatic source, place both PNEU X-FEED VALVE levers at ON.

| If cabin temperature is below 85°F (29°C), open the left PNEU X-FEED valve and close the right PNEU X-FEED valve.

*12. APU AIR SWITCH..... AS REQUIRED

When the cabin temperature is 85°F (29°C) or higher, the AIR COND COLDER position of the AIR switch should be used for all two-system air conditioning operation when the APU is the sole pneumatic source. This switch position will reduce the workload on the APU.

If the cabin temperature is below 85°F (29°C), the APU AIR switch should be placed at ON for all single-system operation.

13. AIR CONDITIONING SUPPLY SWITCHES..... AS REQUIRED

With the cabin temperature 85°F (29°C) or above, and the APU is the sole air conditioning source, place both air conditioning SUPPLY switches at AUTO.

If the APU cycles above and below 95% rpm (as indicated by the APU PWR AVAIL light cycling on and off), modulate the right-hand PNEU X-FEED VALVE towards close until APU operation becomes stable.

If cabin temperature is below 85°F (29°C), place the left SUPPLY switch at AUTO and the right SUPPLY switch at OFF.

When on the ground, these switches also control the heat exchanger cooling fans and should be turned on one at a time due to high electrical starting loads.

In cases where ac electrical power is available but pneumatic power is not, place the righthand SUPPLY switch at HP BLEED OFF or AUTO, and the RAM AIR switch to ON to provide ventilating air.

*Applicable to battery engine start.

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COCKPIT CHECKLIST - EXPANDED (Continued)

14. COCKPIT/CABIN TEMPERATURE CONTROLS..... SET

Observe response of these settings on supply temperature valve position indicators and/or duct temperature.

15. COCKPIT VOICE RECORDER..... TESTED

Press the TEST button for approximately one-half second. The meter will deflect into the white area for the same amount of time, drop to zero, and deflect again. This indicates that all four channels are recording.

*16. CSD SWITCHES..... NORMAL

These are momentary switches, and should be in guarded position.

*17. GENERATOR SWITCHES..... RESET & ON

This will provide proper relay positioning to permit the generator to supply power to the bus as soon as proper generator speed is attained during start. (Switches need not be reset after first flight of the day.)

18. AC - DC CROSSTIE..... AUTO & OPEN

AC bus crosstie will be available for automatic assist to a dead bus by the opposite generator in flight, or on the ground, or by the APU generator in flight. The AC bus crosstie will be automatically locked out and the AC crosstie lockout light (if installed) will come on if the dead bus has a fault. The DC bus crosstie should remain in open position and will be closed manually when necessary.

19. EMERGENCY ELECTRICAL POWER..... CHECKED

To make an emergency electrical power check, place the indicator selector switch in the BATT VOLT position and turn the EMER PWR switch to ON. Check that the EMER PWR IN USE light is on and that the AC EMER BUS OFF and DC EMER BUS OFF lights are out. Survey the appropriate flight instruments to see that the warning flags are not visible. Check to see that battery voltage is 26 or higher. Next, place the indicator selector switch at BATT AMP and see that the battery ammeter indicates 10 to 35 amps to the right. Return the EMER PWR switch to the OFF position and check the ammeter to see that the battery is charging in the pulsing mode. If the battery ammeter is indicating to the left in a steady mode and it is felt that the battery has had insufficient time for charging, the crew may proceed with the checklist and engine start procedure. However, all parts of the emergency power check requirement must be met before completing the BEFORE TAKEOFF checklist.

NOTE: The emergency electrical power check may be accomplished any time that the battery switch is on and the right ac bus is energized or when ac ground service electrical power is being used.

*Applicable to battery engine start.

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COCKPIT CHECKLIST - EXPANDED (Continued)

20. FLIGHT RECORDER..... CHECKED & SET

Set in trip and date data on flight recorder. Check power lights and switches. After trip and date information has been set into the flight recorder encoder panel, the REPEAT light/button should be pushed and held for not less than 10 seconds. This action will start inscription of the trip and date data on the tape. The REPEAT light/button will remain on for approximately 15 minutes after being released to indicate that data is being recorded.

21. INSTRUMENT WARNING TEST..... TESTED

The INST WARN TEST button tests the light bulbs in both instrument warning indicators. The INST and G/A arrows will come on green and red, the A/P arrow will come on green, and all comparator lights will come on amber.

22. ANTI SKID..... ARMED, TESTED & OFF

A. ANTI SKID switch to ARM.

B. Parking brakes..... OFF (Wheels should be
checked for remainder
of test)

C. Antiskid lights off.

D. After approximately 5 seconds hold TEST CKT switch to position A for
5 seconds.

NOTE: The 5-second delay after placing the ANTI SKID switch to ARM is to allow circuit stabilization. The 5-second test is to allow sufficient time for an analysis of the test signal by the test card. These time periods are important to prevent false test results.

E. All antiskid lights should come on.

F. Release TEST CKT switch.

G. If all antiskid lights go off, test is complete. Should test fail in any part, recycle arming switch. After approximately 5 seconds, hold TEST CKT switch to position B for 5 seconds.

H. All antiskid lights should come on.

I. Release TEST CKT switch.

J. All antiskid lights should go off.

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K. ANTI-SKID switch to OFF.

L. All antiskid lights should come on.

M. Reset parking brakes.

23. STALL WARNING TEST SWITCH..... SYS 1 & SYS 2 TESTED,
& OFF

Place STALL TEST switch to SYS 1 to check the left stall warning circuits and operate the stick shakers on both control columns, both intermittent stall warning lights on the glareshield, and both intermittent stall recognition speakers.

Place STALL TEST switch to SYS 2 to check the right system in the same manner. Return switch to OFF position.

24. SPEED COMMAND..... TESTED

Momentarily operating the SPD COMD TEST switch to the SLOW and FAST positions will check the circuit and give corresponding pointer movements on the speed command indicators.

25. MACH TRIM..... TESTED & NORMAL

Hold MACH TRIM COMP switch to TEST, and notice that the Mach trim indicator on First Officer's column moves up to full extend (approximately 2 yellow bands) and the control column moves aft. Return switch to NORM. This will allow the monitor circuit to check the discrepancy between the computer and actuator. The column indicator will normally retract slightly, then stop when the MACH TRIM INOP light comes on.

Place the MACH TRIM COMP switch to OVRD position. The column indicator should retract and column will move forward. When the computer and the actuator are again in agreement, the monitor circuit will turn off the MACH TRIM INOP light. Return the switch to NORM.

26. AIR CONDITIONING TEMPERATURE SELECTOR..... CABIN

Select L DUCT and R DUCT positions and review temperatures indicated in relation to air conditioning mode. Check CABIN position last. Leave selector in CABIN position for periodic review of cabin temperature.

27. RADIO RACK SWITCH..... FAN

This switch normally operates in FAN position and provides radio rack cooling and forward cargo compartment floor heating. This permits carrying live cargo in this compartment. The radio rack fan will operate while the airplane is on the ground regardless of switch position. The RADIO FAN OFF light should remain off in either switch position.

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28. ENGINE START PUMP AS REQUIRED

To check engine start pump operation, place START PUMP switch to ON and check that R INLET FUEL PRESS LOW light goes off. This pump should be used to supply fuel to the APU if it is to be started and ac power is not available. This pump should also be used to supply fuel for an engine start if ac power is not available.

29. IGNITION..... OFF

The IGN switch should be at OFF at all times except when ready to engage the L or R START switch or when the engines are running.

30. FUEL TANKS PUMPS..... CHECKED & AS REQUIRED

To check the fuel boost pumps, the ENG FIRE shutoff handles must be in the forward position and the FUEL X FEED lever should be at OFF. Check fuel boost pumps one at a time, noting that applicable L and R INLET FUEL PRESS LOW light goes off when each pump is operated. Checking the center wing tank fuel boost pumps should cause both INLET FUEL PRESS LOW lights to go off.

NOTE: If APU is operating, leave a right main tank fuel boost pump operating after completing fuel boost pumps check.

31. CABIN PRESSURE CONTROLS..... SET

The barometric scale should be set to the field barometric setting. The proposed flight altitude plus 1000 feet should be set on the airplane altitude scale. (Not to exceed 8400 feet on cabin scale.)

The RATE INCR (or decrease) knob may be set at the dot position for all normal operations (approximately 250 fpm).

NOTE: For detailed instructions, refer to Section 2, Chapter 45, NORMAL OPERATION -- Pressurization.

32. AIR CONDITIONING AUTOMATIC SHUTOFF..... OVERRIDE

This switch should be in OVRD to prevent inadvertent shutdown of both air conditioning systems during ground operations. Attempting to make a cross bleed engine start will result in excessive pneumatic pressure if the switch is in the armed position.

33. RAM AIR..... AS REQUIRED

The RAM AIR switch may be placed in the ON position to provide ventilation in the airplane if pneumatic pressure is not available for the air conditioning system. If used on the ground, the right AIR CONDITIONING SUPPLY switch may be placed at HP BLD OFF or AUTO. Normally, the RAM AIR switch remains at OFF.

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34. CABIN EMERGENCY LIGHTS..... CHECKED & ARM

- A. Place EMER LTS switch to ON position. The EMER LIGHT NOT ARMED light will be ON. The emergency lights in the cockpit, passenger compartment, and tailcone will be on until turned off by the EMER LTS switch or until the batteries become discharged.

NOTE: Operation of the emergency lights in the ON position should be limited to a maximum of 1 minute to preserve the batteries in a charged condition and to extend bulb life.

- B. Place EMER LTS switch to ARM position. The EMER LIGHT NOT ARMED light will be OFF. In this position, a failure of the dc emergency bus will automatically turn the cabin emergency lights on, furnishing illumination of the cabin and exits.

35. NO SMOKING/SEAT BELTS..... ON

36. PITOT, STATIC, & PROBE HEATERS..... CHECKED & ON

All positions of the METER SEL & HEAT control except RAT PROBE should be checked for a meter reading to indicate a normal circuit. The METER SEL & HEAT control should be left in the CAPT position. This will be the only heated pitot if it becomes necessary to go to the emergency or battery only mode of operation. During normal flight operation, all heaters are turned on as soon as the METER SEL & HEAT control is moved out of the OFF position. The RAT probe is not heated during ground operations.

*37. AIRFOIL ANTI-ICE..... OFF

These switches should be at OFF for all ground operations until BEFORE TAKEOFF checklist is accomplished.

38. WINDSHIELD HEAT..... ON

This circuit will provide heat to both the anti-ice coating in the three windshields and the anti-fog coating in the clearview windows, and overhead windows. STEP 1 has prevented the application of heat to the anti-fogging coating for the three forward windshields. The temperature is automatically controlled, and, if the glass is cold-soaked, the anti-ice controllers will warm up at the required rate. If exposed to extremely cold-soaked temperatures, it may take up to 30 minutes to warm up thoroughly. A "handfeel" check of the three windshields should be made to check the integrity of the windshield anti-ice system. If defogging becomes necessary after "handfeel" check, the CAPTAIN'S/FIRST OFFICER'S & CENTER COCKPIT WINDOW ANTI-FOG circuit breaker should be set.

*Applicable to battery engine start.

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- *39. ENGINE ANTI-ICE..... OFF

Both the L and R ENG switches on the ICE PROTECT panel should be at OFF to prevent unnecessary engine bleed air extraction during engine starting.

40. WINDSHIELD WIPERS..... PARKED & OFF

Windshield WIPER switch should be left at OFF. Last operation should have placed the switch in PARK position (blades parallel with windshield frame). Do not operate on dry glass. Do not use repellent unless, there is moderate rain.

To park the wiper blade hold the windshield wiper control switch in the momentary park position until the blade reaches the proper park position, then release the switch. Holding the switch in the park position too long may allow the motor to creep through the park position and recycle, or may cause motor overheat.

41. ANNUNCIATOR PANEL..... TESTED

Operation of the WARN/CAUTION LTS TEST switch will give a check on all annunciator panel lights (except the blank positions), and the MASTER WARNING AND MASTER CAUTION lights.

42. REVERSER LIGHTS..... CHECKED

All reverser lights should be off. Thrust brake levers must be fully down. However, if the system had been depressurized by maintenance crew, the accumulator lights may be on and hydraulic pressure must be provided to recharge the accumulator.

CAUTION: IF THE REVERSER LIGHTS ARE ON, THE REVERSER COULD BE EXTENDED. THEREFORE, IT IS NECESSARY TO OBTAIN GROUND CLEARANCE BEFORE PRESSURIZING

43. LANDING, EXTERIOR, & POSITION LIGHTS..... AS REQUIRED

For daytime operations, the L and R WING LDG LTS switches should be at RET and OFF, and all other lights switches at OFF.

For night operations, the L and R WING LDG LTS switches should be set to EXT and OFF, POS LTS switch to ON, and the L and R GRD and WING/NACL FLOOD LTS switches to ON and R ONLY. Nose landing lights to be used for taxi, landing or takeoff, should be as required.

*Applicable to battery engine start.

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44. BRAKE SELECTOR..... BOTH

The HYD BRAKE SYS selector handle has positions LEFT, BOTH, RIGHT and should normally be left in the BOTH position. During taxi, both BRAKE HYD PRESS gages should be checked for deflection when brakes are applied to be sure that both systems are operating.

*45. FIRE SHUTOFF HANDLES..... FORWARD

The ENG FIRE shutoff handles should be full forward to assure that all control valves connected to them will be in their full open positions and that all electrical switches will be in their normal positions.

*46. FIRE DETECTORS..... TESTED

Holding the LOOPS A TEST and LOOPS B TEST buttons will test the fire warning bell and the two red lights in each ENG FIRE shutoff handle, the FIRE DETECTOR LOOP light, as well as the APU FIRE and MASTER WARNING lights. For additional testing details, refer to Section 2, Chapter 35.

*47. AGENT LOW LIGHTS..... CHECKED

Push-to-test the lights to check bulbs. These lights, when off, indicate that the two agent containers have not been discharged.

48. LANDING GEAR LIGHTS/HORN..... CHECKED

The landing gear handle can be pulled aft while in the DOWN position. This will turn off the green lights and turn on the red lights; and, if either throttle is at idle, the horn will also sound. The GEAR HORN OFF button can then be pushed to check out the silencing circuit provided the flaps are not extended beyond the takeoff position. When the handle is released into the DOWN detent notch, the red lights will go off and the green lights will come on.

49. MAX AIRSPEED WARNING..... TESTED

Push the First Officer's MAXIMUM AIRSP'D WARN red light. The red light (two bulbs) should come on, as well as the single bulb red light on the Captain's panel, and the audio clacker should sound.

*Applicable to battery engine start.

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COCKPIT CHECKLIST - EXPANDED (Continued)

50. FLIGHT INSTRUMENTS..... CHECKED & SET

A. Altimeters

Perform "handfeel" check on faces of altimeters to ascertain that vibrators are operating. Set to field barometric setting.

B. Compasses

- (1) The compass OFF flag should go out of sight approximately 2 to 3 minutes after electrical power is applied to the system
- (2) Synchronize compass system by observing polarity indicated on compass annunciator and push-to-turn synchronizing knob in the direction indicated until compass annunciator is indicating in midposition.
- (3) Observe that opposite course indicator is also indicating same heading and that its compass flag is out of sight. Make comparison with standby magnetic compass and make allowance for correction card.

NOTE: System synchronization is indicated by the compass annunciator indicating in approximately the midposition. Prolonged indication to either side of the midposition indicates the system is out of synchronization.

During taxiing, turning, and rough air, it is to be expected that deviations of a short term duration will exist.

C. Flight Director System

NOTE: Adjust mode selectors as required.

All warning flags should be out of view.

Pitch and roll attitude information on the flight director indicators should reflect the aircraft attitude on the ramp, approximately zero degrees in the pitch and roll axes.

In setting the flight director indicator command mode for takeoff, the pilot is afforded several modes of operation.

- (1) If the V-bar command display is not desired, the mode selector should be placed in the OFF position. The V-command bar will be biased out of view.
- (2) The HDG mode may be used to present heading and pitch command information as set with the PITCH CMD and HDG knob. The HDG marker is set against the azimuth card to the runway heading, and the PITCH CMD knob may be, used to preset initial climb angle.

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The compass information as displayed beneath the lubber line on the azimuth scale of the course deviation indicator should agree with the master compass system.

Set the course arrow to coincide with the published departure radial or to conform with the flight clearance.

D. Turn-and-Slip Indicators

The power OFF flag should be out of sight. During taxi operations, the turn pointer should be checked for proper response when turning the airplane.

51. RADIO ALTIMETERS..... TESTED & SET

When the airplane is on the ground, the radio altimeter should read a fixed altitude of 0 (± 5) feet. The unit can also be tested with the test switch. When the switch is depressed, the pointer should indicate approximately 100 feet, and the warning flag should be visible. The minimum decision altitude (MDA) bug should be set full counterclockwise to turn off the MDA light for the takeoff.

52. MARKER BEACON SWITCH..... LOW OR HIGH

MKR SENS switch must be on to test lights.

53. STATIC SELECTORS..... BOTH NORMAL

54. AUTOPILOT SERVOS SWITCHES..... ON

The A/P SERVOS switches, placarded AIL, ELEV, and RUD are each used to cut off a selected axis of the autopilot. Normally, they will be operated in the AIL, ELEV, and RUD positions. The yaw damper will not operate if the RUD channel switch is in the OFF position.

55. ENGINE HYDRAULIC PUMPS..... HIGH

The L and R ENG HYD PUMPS switches for the engine-driven hydraulic pumps have three positions: HI, LOW, and OFF. When HI is selected, observe a pressure rise on both HYD PRESS gages as the engines are started. HI is the normal position for all ground operations and takeoff.

56. AUXILIARY HYDRAULIC PUMP..... ON

The momentary OVRD position may be checked by operating the AUX HYD PUMPS switch and observing pump operation. The ON position is normally used, and the pump will operate unless interrupted by thermal protection.

NOTE: If a battery start has been made and engine hydraulic pumps are operating, they should be turned to OFF momentarily for this check.

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57. ALTERNATE HYDRAULIC PUMP..... ON

While the left hydraulic system is below 1800 psi, operate the alternate hydraulic pump and note left hydraulic system pressure. With no hydraulic demand the pressure will cycle over approximately a 200 psi range within an operational band of 1800 to 2500 psi. During cycling, the minimum pressure should not fall below 1800 psi. Normal input from the auxiliary pump in the right-hand hydraulic system is 3000 psi. Should the auxiliary pump output pressure be greater than 3000 psi, then the increase would be reflected by a similar increase in the cycling pressure of the alternate pump.

58. HYDRAULIC PRESSURES & QUANTITY..... CHECKED

Hydraulic pressure should come up to the 3000 psi (green arc) in the right system and 1800 psi in the left system and the L and R HYD PRESS LOW lights should be off. When the hydraulic pressure is up and the accumulators are pressurized, the fluid quantity will have dropped, but should always be above the high end of the refill red line.

59. ENGINE VIBRATION..... TEST & AFT

Hold TEST switch and observe that each VIB AMPLITUDE meter indicates in test range. ENG VIB selector switch may be placed in either FWD or AFT position during flight, however, AFT position is recommended. The AFT (turbine position) will normally give the earliest indication of a problem.

60. GEAR DOOR OPEN LIGHT..... OFF

Hydraulic pressure will fully close the doors and turn the light off. If light remains on, have the ground crew check the main gear door ground maintenance bypass lever on the underside of the fuselage for normal position.

61. PARKING BRAKES..... SET

The parking brakes are locked by depressing either set of brake pedals and pulling the knob out. The parking brakes are released by depressing either set of brake pedals; the knob will return to its original position. When the parking brakes are set, the BRAKE HYD PRESS indicators should dip and return to the same value as the system pressure indicators.

62. SPOILERS..... FORWARD & DISARMED

To check ground spoilers for manual operation in event of an aborted takeoff, lift lever up, pull aft and up to lock in armed position. Note a slight dip in both hydraulic system pressure indications. Push handle down and check that the spring moves handle full forward or advance left throttle approximately 4 inches and check that spoiler lever moves down from armed position and then full forward. Normally, one-half of the red arming band should be visible.

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The aileron control wheel should operate the spoilers in a lateral control function. Hydraulic pressure should dip slightly as the control wheel is moved in each direction.

The flight spoiler surfaces start to extend only after approximately 5 degrees of control wheel throw.

63. RUDDER POWER..... POWER, LIGHT OFF

Before placing the RUD HYD CONT lever to PWR position, operate the rudder with lever in MAN. position to check freedom of travel. With RUD HYD CONT lever in the PWR position, the RUDDER CONTROL MANUAL light should go off. Hold nosewheel steering wheel while performing this check to prevent scuffing nosewheel tires.

64. FLAPS/SLATS..... UP/RETRACTED/LIGHTS OFF

FLAPS and SLATS levers should be fastened together. FLAPS/SLATS lever should be full forward and both flap indicator pointers should be at full up. SLATS EXTEND, SLAT DISAGREEMENT and FLAP/RUDDER STOP INOP lights should be off.

NOTE: FLAP/RUDDER STOP INOP light will come on momentarily during flaps transition.

- *65. AUXILIARY HYDRAULIC PUMP..... OFF

Before turning AUX HYD PUMPS switch to OFF, check both HYD FLUID QUANTITY gages to determine that there has not been a fluid loss. Turning pump off will allow the hydraulic pressures to decay so that when the engine pumps are operating, their output can be checked.

66. ALTERNATE HYDRAULIC PUMP..... OFF

67. BRAKE TEMPERATURE GAGES..... TESTED

When the BRAKE TEMP - PRESS TO TEST switch is pressed, all gages should indicate between 270°C and 315°C. Indication should be less than 270°C if ambient temperature is 0°C or less.

68. RAT/EPR INDICATOR..... NORM-9

Set engine dash number to rating to be used for takeoff.

*Applicable to battery engine start.

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69. ENGINE INSTRUMENTS..... CHECKED & SET

Check oil quantity. Between 14 to 16 quarts is the normal indication for a full tank. Check all engine instruments for normal at rest indications as applicable.

Set engine pressure ratio indicators to appropriate setting displayed as T.O. EPR on RAT. vs EPR indicator or as required.

70. FUEL FLOW COUNTERS..... RESET

Reset FUEL FLOW counters to zero with FUEL USED RESET switch. Hold FUEL USED RESET switch until digital counter on both indicators completely stop rotating.

71. FUEL QUANTITY..... CHECKED & TESTED

The FUEL QUANTITY indicators should be tested by depressing the FUEL QTY TEST button and observing a decrease in fuel quantity indication. The FUEL QUANTITY indicators should return to their original indication when the FUEL QTY TEST button is released. Ascertain that sufficient fuel is available for flight and that fuel has been loaded within asymmetrical loading limitations.

72. RADAR/TRANSPONDER..... AS REQUIRED

A. Radar

- (1) Establish following control settings before energizing equipment initially after an inspection, after overhaul, or after a layover when control settings could have been changed.

Radar Control Panel

Radar MODE SELECT switch..... OFF
ANT TILT control..... Zero
GAIN control..... Counterclockwise
STAB switch..... ON

Radar Indicator

RANGE & MARKS selector switch..... Any
DIMMER knob..... As required
ERASE RATE knob..... Clockwise
TRACE ADJUST knob..... Counterclockwise

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- (2) Position MODE SELECT switch to STBY.

NOTE: Radar operating circuits are inoperative for a 3-minute period following this step.

- (3) Wait 3 minutes.

WARNING: DO NOT OPERATE RADAR DURING REFUELING OPERATIONS OR IN VICINITY OF TRUCKS OR CONTAINERS HOLDING FLAMMABLE OR EXPLOSIVE LIQUIDS.

CAUTION: DO NOT OPERATE THE EQUIPMENT WHILE AIRCRAFT IS IN A HANGAR, OR WITH THE ANTENNA DIRECTED TOWARD NEARBY LARGE METAL OBJECTS.

Because of the preceding WARNING and CAUTION, the remainder of the check may need to be delayed until flight.

- (4) Position MODE SELECT switch to NORM.
(5) Position RANGE & MARKS switch to any range.

NOTE: Range and range marks are selected simultaneously. These ranges are available, each having associated range marks as follows:

<u>Range in Nautical Miles</u>	<u>Number of Range Marks</u>	<u>Nautical Miles Per Range Mark</u>
30	3	10
80	4	20
180	6	30

- (6) Position TRACE ADJUST knob until range marks appear on indicator display. Sweep trace must not be visible. The most satisfactory display results when range marks are clearly visible and trace is adjusted just below painting and the display is erased just as the sweep is ready to rewrite it.
- (7) Set filter adjust knob indicator; up for an easily visible amber-yellow target picture during daylight operation, and down for a red-tinted picture during night operation. An adjustment somewhere in between full up and down allows selection of just the right tone to suit the individual operator.

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- (8) Rotate GAIN control knob to AUTO position. Targets in the area of scan may show on the display. The radar set is now ready for normal operation.

NOTE: If no targets are available or radar operational integrity is in question, perform radar test function as outlined under Normal Operation - Radar.

Leave system in STBY position for taxi and takeoff.

B. Transponder

Transponder may be tested after at least 80 seconds of power in the STBY or ON position. The test position will check the circuit and turn on the light if the light is not already on as a result of an interrogation signal. The code selector should be set as required for the flight. Do not use codes 0000 or 3000.

NOTE: Do not use 7700 unless emergency exists.

For the takeoff, the set may be operated in LO SENS or STBY.

73. STABILIZER TRIM..... CHECKED & SET

Horizontal Stabilizer Check for First Flight of the day.

- A. While observing stabilizer indicator, hold Captain's wheel left trim switch to noseup and then to nosedown momentarily.

CAUTION: DO NOT HOLD SINGLE SWITCH POSITION LONGER THAN 3 SECONDS.

The stabilizer should not move and the aural signal should not sound. Repeat this check using Captain's right trim wheel switch. The stabilizer should not move and aural signal should not sound. (This check may be accomplished from the First Officer's wheel trim switches. Only one check is necessary.)

- B. Operate both Captain's wheel switches in the noseup and then nosedown directions and note corresponding direction of stabilizer indicator, and audible tone.
- C. Operate both First Officer's wheel switches and check stabilizer indicator and audible tone. (Moving either set of switches opposite to a set of operating switches will stop the stabilizer movement. This is not a required test. If test is used, do not exceed 3-second limit.)
- D. Operate both longitudinal trim handles in same direction and check for corresponding indicator movement and audible tone. Release handles to neutral.

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- E. While observing horizontal trim indicator, momentarily operate each alternate trim switch individually to noseup and nosedown. The stabilizer should not move and the aural signal should not sound.
- F. Operate both alternate trim switch levers, and check for direction of travel at slow rate and for audible tone.
- G. Position stabilizer to computed takeoff position.

NOTE: To obtain maximum service life, do not maintain switch positions longer than necessary to check response. If there is no response, release switches and determine cause. Should any switch or control stick or hesitate in returning to neutral, it should be corrected before flight.

Any time the longitudinal trim handles, dual longitudinal trim (wheel) switches, or alternate longitudinal trim (secondary) controls are used, they should be operated to their fully deflected position to assure both motor and brake circuits are actuated.

- 74. THROTTLES..... IDLE
- 75. AUTO THROTTLE..... DISENGAGED
- 76. FUEL CROSSFEED..... OFF

The FUEL X FEED lever should remain at OFF for all normal flight operations. Refer to Section 2, Chapter 25, for crossfeed operations.

- 77. FUEL CONTROL LEVERS..... OFF

The FUEL control levers must be at OFF before starting the engines to prevent premature fuel flow and ignition when the L and R START switches are placed to ON.

- 78. AUTOPILOT..... DISENGAGED

SERVOS ENGAGED/DISENGAGED lever should be at DISENGAGED, TURN knob in detent, and HDG SEL switch at OFF.

- 79. STABILIZER TRIM (CUTOFF) SWITCH..... NORM position

This two-position guarded switch is used only to stop a runaway stabilizer caused by the primary stabilizer trim circuit.

- 80. RUDDER/AILERON TRIM SET

Indicators should be at zero trim position. When required, a rollout may be accomplished to check for friction loads.

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81. CREW OXYGEN & INTERPHONE..... CHECKED

A. Crew Oxygen and Mask Check

- (1) SUPPLY toggle should be lockwired in the ON position.
- (2) With diluter control in the 100% OXYGEN position, inhale several times and note that oxygen FLOW blinker is operating and indicated pressure on crews demand regulator continues to indicate 50 to 75 psig.
- (3) Return diluter control to NORMAL OXYGEN position.
- (4) TEST MASK/NORMAL/EMERGENCY control..... NORMAL position

NOTE: To test mask and hose assembly for possible leaks fit mask assembly to face and move the TEST MASK/NORMAL/EMERGENCY control to the TEST MASK position. While holding a back pressure on the mask assembly by forcibly exhaling, check for mask leakage.

B. Interphone Check

The mask microphone should be checked on the interphone system.

82. NAVIGATION & COMMUNICATIONS RADIOS..... SET

Navigation and communications radio equipment should be checked and set for the anticipated takeoff requirements.

START

*1. CLEARANCE TO START..... RECEIVED

Check with ground crew and/or tower for permission to start.

*2. ANTICOLLISION LIGHTS..... ON

This will be an indication to ground crews, on this or other airplanes in close proximity, that the engines are about to be started or are operating.

*3. AIR CONDITIONING SUPPLY SWITCHES..... OFF

These switches must be off to provide the maximum pneumatic supply capabilities for starting.

*Applicable to battery engine start.

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4. PNEUMATIC PRESSURE..... CHECKED

The PNEU PRESS gage should be checked to determine that pneumatic pressure of 36 psig at sea level (subtract 1 psig per 1000 feet increase in pressure altitude) is available for engine starting.

5. FUEL BOOST PUMPS..... ON/LIGHTS OFF

After turning on a selected right and left main tank fuel boost pump, it can be ascertained that fuel boost pressure is available for engine starting by verifying that the L and R INLET FUEL PRESS LOW lights are off.

6. IGNITION..... SYS A or SYS B

Either position of the IGN switch will make high-energy ignition available through the ON position of the FUEL control levers.

7. START SWITCH..... HOLD TO ON

(Refer to Section 2, Chapter 30.)

AFTER START

1. START VALVES..... CLOSED (LIGHTS OFF)

The L and R START VALVE OPEN lights must be off to indicate that the start valves have closed. Prolonged engine operation with the start valves open will damage the starters.

2. EXTERNAL POWER/SAFETY PINS..... REMOVED

If external pneumatic and/or electrical power was used, the ground crew should be given clearance to remove carts. Electrical bus switches for the external power should be turned off. If used, landing gear safety pins should be removed at this time.

3. ELECTRICAL SYSTEM..... CHECKED

(Refer to Section 2, Chapter 5.)

Normal Engine Start

Verification of AC & DC Emergency Power Transfer Relay and AC Crosssite Relay Operation.

NOTE: To avoid cabin pressure surge, air conditioning should not be turned on until the cabin pressure air outflow valve is automatically or manually returned to the full open (DECR) position.

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4. AIR CONDITIONING SUPPLY SWITCHES..... AUTO

NOTE: If the ambient temperature is high, it may be desirable to taxi with the APU supplying one air conditioning system. The left PNEU X-FEED VALVE should be OPEN and the right PNEU X-FEED VALVE should be closed. This will lessen the need to advance throttles for increased engine bleed air and consequent usage of brakes to control taxi speed. When the APU is supplying only bleed air (APU generator not in use) to supplement one air conditioning system, it can deliver appreciably more air than the idling engine.

5. GALLEY POWER..... ON

6. IGNITION..... AS REQUIRED

It is recommended that ignition be used for all takeoffs in inclement weather and remain on until the airplane has been cleaned up and the throttle setting reduced for climb. Ignition may be used for all takeoffs and all flight operations if desired. (Duty cycle for either system is 10 minutes ON and 20 minutes OFF.)

6A. ENGINE ANTI-ICE..... AS REQUIRED

The engine anti-ice system should be turned on after initial engine start if visible moisture is present and the ambient temperature is below 6°C (42°F) or any time icing conditions exist or are anticipated. Refer to Section 2, Chapter 50 for detailed instructions.

7. HYDRAULIC PRESSURES & QUANTITY..... CHECKED

Hydraulic pressures should be at the 3000 psi green band, and the quantity should be at the same level it was when the hydraulic pumps were checked. The L and R HYD PRESS LOW lights and L and R HYD TEMP HI lights should be off.

8. DOORS..... LIGHTS OFF

9. GROUND CLEARANCE TO TAXI..... RECEIVED

Clearance to taxi will be given when all equipment is clear.

10. YAW DAMPER..... ON

Placing YAW DAMP switch to ON position will make the yaw damper available throughout the takeoff as well as during flight. During taxi operations, it may be noted that when the airplane makes a turn the rudder servo indicator will show an opposite signal as a result of the yaw damper input.

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TAXI CHECK

NOTE: At start of taxi, allow the airplane to move forward prior to initiating any maximum nosewheel turning angle. Under conditions of uneven ramp surface, positioning of nosewheels to the maximum turning angle prior to forward motion can result in the nosewheels being forced beyond the 82 degree steering range causing a mechanical overcenter steering lock condition; maintenance action is then required to reposition the nosewheels within the normal steering envelope. This condition can also occur if the nosewheels are left at the maximum towing angle when terminating a towing action.

1. FLAPS/SLATS..... SET/CHECKED/LIGHTS OFF

Flap setting should be verified by observing that flap indicators correspond to the computed takeoff data. Slats will be extended. SLATS EXTEND light should be on. SLAT DISAGREEMENT light should be off. SLAT DISAGREEMENT light should come on during the time the slats are in transit. The FLAP/RUDDER STOP INOP light will be on momentarily while flaps are in transit.

NOTE: At the flight crews discretion during taxi, for maximum protection against FOD to the engines, flaps may be set to 15 degrees. It is required that flaps be returned to the computed takeoff position prior to takeoff.

2. FLIGHT CONTROLS..... FREE

This is a double check to determine that the flight controls are free and normal. It exercises the hydraulic components of the flight control system with both engine-driven hydraulic pumps operating to check for leaks. Occasionally, in gusty, quartering, or tailwinds the elevators and their control tabs may assume an asymmetric position fully against their mechanical stops. If this occurs, the control columns will feel blocked and an elevator rollout cannot be performed. This condition is not abnormal, but will require that the rollout be delayed until the direction or velocity of the airplane with respect to the wind is changed. After heading the airplane into the wind (or taxiing fast enough to cancel any tailwind component), apply pull force to the control column until it moves to the full aft position. Forces required may be as high as 85 pounds. Determine that the ELEVATOR PWR ON light is off. Then apply full, nosedown push force to check the elevator augmentation system. The ELEVATOR PWR ON light should come on during this part of the check.

3. TAKEOFF DATA..... COMPUTED

This data should include the V_1/V_R , V_2 , for the ambient temperature and gross weight, altitude, runway slope, wind, correct EPR for the tower or runway temperature, field length needed, and flap setting to be used.

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COCKPIT CHECKLIST - EXPANDED (Continued)

4. STABILIZER & TRIM TABS..... SET

These units should have already been set, and this is a last-minute recheck to verify that the trim tabs are still at zero position and that the stabilizer is at the takeoff setting for the loaded center-of-gravity.

5. TRANSPONDER..... AS REQUIRED

6. APU MASTER SWITCH..... OFF

If the APU has been used for air conditioning, it should normally be turned off before takeoff. Place APU AIR switch to OFF if it was in use in the event a subsequent in-flight APU start is required, as use of the APU during flight is restricted to electrical output only. In order to lengthen the service life of the APU, it is recommended that the unit be allowed to idle under no-load conditions until EGT is below 400°C before placing the master switch at OFF.

NOTE: It is recommended that the APU be kept running and the APU L and R BUS power switches be left at ON if a takeoff is to be made in heavy rain or slush. The APU may be shut down when elected by the Captain after takeoff.

7. FUEL TANKS PUMPS..... ALL MAINS ON/CENTER
PUMPS OFF

For takeoff it is recommended that both fuel boost pumps in each main tank be utilized to provide a backup boost pump in the event of failure of a single pump. The center tank fuel boost pumps must be off for all takeoffs.

8. FUEL HEAT..... AS REQUIRED

Fuel heat should be employed by momentary actuation of the L and R FUEL HEAT switches for one cycle (1-minute duration) before takeoff if the indicated fuel temperature is 10°C (50°F) or below. Both FUEL HEAT switches and FUEL HEAT ON lights should be at OFF during takeoff.

9. ANTI-SKID..... ARMED

All four antiskid lights should be OFF. Check brakes in a clear area for proper low-speed operation (below approximately 15 knots). If braking action is lost, release brakes (time permitting), place ANTI-SKID switch at OFF, and reapply brakes as necessary.

BEFORE TAKEOFF

1. ALTERNATE & AUXILIARY HYDRAULIC PUMPS..... ON

This will provide an additional source of hydraulic pressure in the event of an engine failure during takeoff.

COCKPIT CHECKLIST - EXPANDED (Continued)

2. PNEUMATIC CROSSFEED VALVES..... AS REQUIRED

If there is a need for airfoil ice protection these valves should be open. For all normal operations, they should be closed. Leakage through the valves may cause an indication of pressure trapped in the crossfeed manifold when the cross feed valves are closed. This is a normal condition.

3. AIRFOIL ICE PROTECTION..... AS REQUIRED

When icing conditions are imminent, the system should be armed so that at nose strut extension the wing anti-icing system will start operations. (For detailed procedure, refer to Section 2, Chapter 50.)

4. ANNUNCIATOR PANEL..... CHECKED

RUDDER TRAVEL UNRESTRICTED light must be on. All other panel lights should be off except those of an advisory nature; such as L & R ENG ANTI-ICE ON, WING ANTI-ICE ON, RAIN REPELLANT RESERVE IN USE.

NOTE: Rain repellent may be off and if light is off, full reserve system will be available. If light is on, start of reserve use should be known and trip requirements evaluated accordingly. Use rain repellent only in moderate or heavy rain. Operate one side only and wait a few seconds for effective spreading and clearing before operation of opposite side.

5. AIR CONDITIONING AUTOMATIC SHUTOFF..... ARM

Place AIR COND AUTO SHUTOFF switch to ARM. This will arm the air conditioning circuit so that if an engine failure during takeoff is sensed by the differential pressure switch, both air conditioning systems will be turned off.

6. IGNITION..... AS REQUIRED

It is recommended that ignition be on for all takeoffs in inclement weather and remain on until airplane has been cleaned up and throttle setting reduced for climb. Ignition may be on for all takeoffs. Ignition must be on for all takeoffs with standing water or slush on the runway.

7. TAKEOFF POWER..... SET & CHECKED

After takeoff power is established, survey appropriate engine instruments.

8. ELEVATOR AUGMENTOR..... CHECKED

When a positive headwind component is achieved during the takeoff roll, the control column should be moved fully forward until the ELEVATOR PWR ON light comes on. This action assures that the elevators are symmetrical. Some degree of forward pressure may be maintained on the control column prior to rotation to prevent "pogo-stick" action of the ground shift mechanism if necessary.

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AFTER TAKEOFF

1. GEAR..... UP/UPLATCH CHECKED

Landing gear should be raised on command of the Captain after positive climb indication. Uplatch check may be accomplished when convenient but before passing through 300 knots. Refer to Section 2, Chapter 15, for detailed instructions.

2. FLAPS..... RETRACTED

Flap retraction should be initiated when airplane has been accelerated to V_2 for 5-degree flap takeoff, or V_2 plus 10 knots for 15-degree flap takeoff.

3. SLATS..... RETRACTED-LIGHTS OFF

Slat retraction should be initiated at flap retraction speed plus 25 knots.

4. AIR CONDITIONING AUTOMATIC SHUTOFF..... OVERRIDE

Place AIR COND AUTO SHUTOFF switch to OVRD, to prevent depressurization in event of engine failure. This switch must be placed to OVRD position prior to ascending above 14,000 feet altitude.

5. LANDING LIGHTS..... AS REQUIRED

Normally there will be no need for landing lights after takeoff and they should be retracted and off. When required to assist local traffic problems they may be left on. (Lights may be extended up to V_{MO} or M_{MO} .)

Nose gear landing lights are inoperative unless the landing gear handle is in the DOWN detent.

6. NO SMOKING/SEAT BELTS..... AS REQUIRED

7. FUEL TANKS PUMPS..... AS REQUIRED

If center wing tank contains fuel, the fuel can be delivered to the engines by turning on both center wing tank fuel boost pumps. One fuel boost pump in each main wing tank may be turned off when feeding the engines from the center wing tank. After the center wing tank FUEL QUANTITY indicator has indicated for 10 minutes that the tank is empty, turn center wing tank fuel boost pumps off. The remainder of the cruise portion of the flight may be conducted using either one or two fuel boost pumps in each main tank as desired.

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8. IGNITION..... AS REQUIRED

If engine inlet icing conditions are encountered before the engine anti-icing system is turned on, it is recommended that ignition be turned on to preclude the possibility of an engine flamout which might result from inlet ice ingestion when anti-ice is turned on. The IGN switch may be turned to OFF as soon as the engines have stabilized.

9. HYDRAULIC PUMPS..... ALT & AUX OFF/ENG LOW

The ALT and AUX HYD PUMPS switches should be turned to OFF (after flaps up and gear uplatch check) and the L and R ENG HYD PUMPS switches should be positioned to LOW to improve service life of the hydraulic system.

NOTE: It may take a few minutes for the system pressure to drop to the LOW green arc range, especially if there are no demands on hydraulic power.

10. RUDDER TRAVEL UNRESTRICTED LIGHT..... OFF

Should be checked after airspeed exceeds approximately 175 knots. This indicates rudder travel restrictor is operating properly.

START OF DESCENT

1. AIR CONDITIONING SUPPLY SWITCHES..... AUTO

If supply is in HP BLD OFF and air conditioning systems are functioning normally, both supply switches should be positioned to AUTO to provide sufficient air flow at low engine power settings.

2. PRESSURIZATION..... SET

Set landing field altitude on the cabin altitude scale and adjust barometric scale according to the existing landing field barometric pressure. Adjust rate as necessary to provide comfortable descent, yet prevent the cabin altitude from being overtaken by airplane altitude. (Refer to Section 2, Chapter 45.)

APPROACH DESCENT CHECK

1. ALTIMETERS..... SET

Set barometric pressure on all altimeters.

2. RADIO ALTIMETERS..... SET

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3. IGNITION..... AS REQUIRED
4. FUEL SYSTEM..... MAIN PUMPS ON/CENTER
PUMPS OFF

Both fuel boost pumps in each main tank are turned on for approach and landing to ensure boost pressure to the engines in the event of a single fuel boost pump failure. If fuel remains in the center tank, the center tank fuel boost pumps must be turned off. Check fuel quantity for ground lateral unbalance limits.

5. NO SMOKING/SEAT BELTS..... ON
6. HYDRAULIC PRESSURES & QUANTITY..... HIGH & CHECKED

Place L and R ENG HYD PUMPS switches to HI position and check both HYD PRESS gages within 3000 psi green arc. Check both HYD FLUID QUANTITY gages for indication above red line.

7. MACH TRIM..... RETRACTED

Check that Mach trim indicator on First Officer's control column is fully retracted (indicator rod flush with top of tube).

BEFORE LANDING

NOTE: If it is known that a landing is going to be made in heavy rain or slush, it is recommended that the APU be started and the APU L and R BUS power switches be at ON prior to the landing.

1. PRESSURIZATION..... CHECKED

Cabin altimeter should read airport altitude. Make appropriate changes in altitude selection.

2. ALTERNATE & AUXILIARY HYDRAULIC PUMPS..... ON

Place ALT and AUX HYD PUMPS switches to ON position. This is to provide an additional source of hydraulic pressure in the event of an engine pump failure. There will not be an appreciable indication of the pump output because the engine pumps are already at high position.

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3. BRAKE SELECTOR/PRESSURE..... SET & CHECKED

Set HYD BRAKE SYS selector handle to the BOTH position. Check that both BRAKE HYD PRESS gages are at approximately the same pressure or higher than the respective hydraulic system. In case of hydraulic system failure, place HYD BRAKE SYS selector handle to good system thus retaining the stored energy in the brake accumulator of the failed system as a secondary back up.

NOTE: Any time pressures in brake accumulators rise above 3800 psi due to thermal expansion, they may be lowered by cycling the HYD BRAKE SYS selector handle one or more times until the pressure drops to normal.

4. SPEEDBRAKES..... RETRACTED

To provide proper stall margins during approach, the speedbrakes must be retracted before lowering the flaps. The speedbrakes should also be retracted before extending the landing gear. A deflated nose gear strut can, upon gear extension, cause an errant, momentary shift of the ground sensing mechanism. This would drive the automatic spoiler motor to the ground mode and cause the possibility of mechanical interference which would prevent full speedbrake retraction.

5. GEAR..... DOWN/3 GREEN

Placing landing gear handle to DOWN position and in the detent will put the gear down and close the doors. The three green lights will come on indicating that all three gear overcenter links are in place. The main landing gear doors are closed and held closed by hydraulic pressure. GEAR DOOR OPEN light should be off.

6. FLAPS/SLATS..... SET/CHECKED/LIGHT OFF

Flap extension may be initiated directly from flaps up/slats retracted to flaps 15 degrees/slats extended. SLAT DISAGREEMENT light should come on and then go off. Thereafter, flaps should be progressively lowered, depending on the type of approach. Flaps should be full down prior to or over the outer marker or other approach fix, or when turning final. Observe FLAPS indicator to verify flap setting.

7. RUDDER TRAVEL UNRESTRICTED LIGHT..... ON

Indicates maximum rudder travel is available if required.

8. FLAP/RUDDER STOP INOP..... LIGHT OFF

Flap rudder stop inop light will come on momentarily during flap transition. If this light remains on full rudder travel will not be available.

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9. ANTI-SKID..... ARMED/LIGHTS OFF

The antiskid system may be tested but it must be remembered that, the landing gear handle must be in the DOWN detent. To test, use same procedure as used before start, except do not set parking brakes.

10. SPOILERS..... LIGHT OFF/ARMED

Do not arm the spoilers until after the landing gear has been extended. This will preclude possible inflight ground spoiler deployment if an errant ground shift signal has been caused by a deflated nose strut during the gear extension cycle.

Check that AUTO SPOILER DO NOT USE light is off. Spoiler lever should be lifted up at the forward end of the quadrant. The lever should remain up and the red marked area at the base of the lever should be visible. If the lever cannot be lifted up high enough to remain up, the auto-extension system will not be operable. This is abnormal and system will need to be operated according to abnormal procedure. (Refer to Section 2, Chapter 20.)

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AFTER LANDING
(Clear of Runway)

1. FLAPS/SLATS..... 15°/EXT
Set flaps at 15 degrees while taxiing to the ramp to help prevent FOD to the engines.
2. SPOILERS..... DISARMED & FORWARD
Pushing the lever down from its ARM position will allow the lever to spring forward and all spoilers will be retracted.
3. ALTERNATE & AUXILIARY HYDRAULIC PUMPS..... OFF
4. RADAR/TRANSPONDER..... OFF (OR STANDBY)
5. IGNITION..... OFF
6. WINDSHIELD HEAT..... AS REQUIRED
Generally, the WINDSHIELD heat switch should be turned to OFF. For short stops, during low ambient temperatures, WINDSHIELD heat switch should be left at ON to decrease temperature expansion and contraction cycles.
7. ICE PROTECTION..... OFF
This item includes engine and airfoil anti-icing.
8. PITOT HEAT..... OFF

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9. ANTI-SKID..... OFF

This precaution assures that antiskid malfunction could not cause loss of low-speed taxi braking, and should be done prior to taxiing into an area where prompt stopping may be required.

If the ANTI-SKID switch is placed at OFF with brake pedals depressed, braking proportional to existing pedal position is applied suddenly.

If braking action is lost when antiskid is armed at taxi speeds of less than approximately 15 knots, release brakes (if time permits), place ANTI-SKID switch at OFF, and reapply brakes as necessary.

10. APU..... AS REQUIRED

If operation of the APU is required for electrical and/or air conditioning while on the ramp, the APU BEFORE START checklist should be completed at this time. Start the APU in a normal manner. Make certain that either ac or dc fuel boost pump pressure is available for the APU. Open the left PNEU X-FEED valve prior to turning the APU AIR switch to the ON position. Should low pneumatic pressure be encountered, place left air conditioning SUPPLY switch to HP BLD OFF.

11. FLAPS/SLATS..... UP/RETRACTED/LIGHTS OFF

To prevent possible collision damage by ground service carts, fuel trucks, etc.

AT RAMP

NOTE: It is recommended that when parking the airplane at the ramp, the nose-wheels should be turned to approximately the center position before forward motion is stopped.

1. PARKING BRAKES..... SET
2. SEAT BELTS SIGN..... OFF
3. CABIN EMERGENCY LIGHTS..... OFF

Place the CABIN LTS EMER switch to the OFF position. The EMER LIGHT NOT ARMED light will come on. Verify that the emergency lights are disarmed by noting that the emergency lights at the top of the overhead panel are off.

NOTE: The dc emergency bus must have power.

4. EXTERNAL OR AUXILIARY POWER..... CHECKED & ON

Check frequency and voltage.

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5. FUEL TANKS PUMPS..... AS REQUIRED

All fuel boost pump switches should be at OFF except fuel pressure source for APU, if operating.

6. FUEL CONTROL LEVERS..... OFF
7. ANTICOLLISION LIGHTS..... OFF
8. RUDDER HYDRAULIC POWER..... MANUAL

BEFORE LEAVING AIRCRAFT

1. PNEUMATIC CROSSFEEDS..... AS REQUIRED

If ground service electrical power is to be used, close pneumatic crossfeed valves. This will prevent pneumatic pressure application to the air conditioning system while electrical power is interrupted or shut down.

2. AIR CONDITIONING SUPPLY SWITCHES..... AS REQUIRED

Unless this system is to be used, it should be turned off to prevent inadvertent pneumatic pressurization when the cabin air outlet valve might be in the closed position.

3. GROUND SERVICE ELECTRICAL POWER..... AS REQUIRED
4. LEFT & RIGHT AC BUS POWER SWITCHES..... AS REQUIRED
5. BATTERY SWITCH..... AS REQUIRED

The BATT switch may be turned to OFF even if it is desired to close the airplane and stow the stairs (refer to Stair Procedures, Section 2, Chapter 1). The BATT switch must be at ON if the APU is running.

NOTE: If the flight crew intends to leave the cockpit while the APU is running, it is recommended that the APU ground control panel access door be opened to make the APU shutdown and fire agent discharge switches readily available to the ground crew.

6. CABIN PRESSURE CONTROLLER LEVER AND WHEEL..... AS REQUIRED

During inclement weather, closing the cabin air outflow valve will prevent entry of rain and snow into the fuselage. To close the valve, place the cabin pressure controller lever in the manual (down) position, depress and turn the controller wheel until the indicator is at full forward (INCR) position.

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FLIGHT CREW OPERATING MANUAL

AUXILIARY POWER UNIT CHECKLIST - EXPANDED

BEFORE START
(IF AUXILIARY POWER IS USED)

APU BEFORE START

NOTE: The cabin air outflow valve must be in the full open (decrease) position prior to starting the APU to prevent pressurization of the cabin while on the ground.

A. BATTERY SWITCH.....ON

The battery switch must be placed at ON in order to energize the fire warning test circuits and APU control circuits, and to make power available for the APU starter motor circuit.

B. FIRE WARNING.....TEST

There are two fire warning test switches, one for A loops and one for B loops. The APU and engines loops selector switch should be in the BOTH position to test both loops, the master warning lights, the APU fire warning light, the engine fire shutoff handle lights, and the fire bell simultaneously. This list will also satisfy the need for the engine fire detector check.

C. FIRE CONTROL SWITCH.....NORMAL

The APU fire control switch is wired in series with the APU master switch and must be in the NORM position to effect an APU start.

D. DOORS SWITCH.....AUTO

The doors switch should be checked at AUTO to achieve automatic doors opening upon starting. The switch must be at AUTO to close the APU inlet doors upon APU shutdown.

E. APU AIR SWITCH.....OFF

Although the bleed air valve will not open until approximately 95 percent rpm is attained, the APU bleed air switch should be left at OFF until such time as it may be required, in order to reduce unnecessary loads on the APU after starting.

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

AUXILIARY POWER UNIT CHECKLIST - EXPANDED (Continued)

F. MASTER SWITCH.....OFF

The OFF position of the APU master switch will close the APU inlet doors, if they are in any undesirable open position due to any previous manual operation, and will reset the fire warning circuit if it had been previously tripped from other than test.

G. APU OIL TEMP HIGH LIGHT.....OFF

H. APU OIL PRESSURE LOW LIGHT.....OFF

I. START PUMP SWITCH.....ON

The dc pump provides fuel boost pump pressure to ensure an APU start.

APU START

A. APU.....ROTATING

To start the APU, the master switch should be placed momentarily at START and then released to the RUN position upon observing initial rise in rpm. The switch is normally released to the RUN position prior to attaining the automatic starter cutout speed of 36 to 41 percent rpm and must be released to the RUN position before attaining 100 percent rpm. The APU oil pressure low light should come ON immediately after placing the master switch at START and should remain ON until the APU accelerates to approximately 35 percent rpm.

B. APU OIL PRESSURE LOW LIGHT.....OFF

The APU oil pressure low light should go off at approximately 35 percent rpm; thus, verifying the operative status of the APU oil system.

C. APU RPM AND EGT INDICATION.....CHECKED

Observe APU rpm and EGT during starting to see that limits are not exceeded after EGT rise. Unusual starting trends or abnormalities, such as high starting or idling EGT or erratic or slow rpm rise, even if they are within maximum allowable limits, should be noted as they may indicate impending APU malfunction.

AUXILIARY POWER UNIT CHECKLIST - EXPANDED (Continued)

APU AFTER START

- A. This check is necessary to determine the operating status of the APU generator. It will be necessary to place the volts/freq. switch in the APU position for this test. If no voltage or frequency is indicated, momentarily place APU generator switch at RESET to reset generator. If generator voltage and frequency are not normal, determine whether generator or APU is at fault by checking APU rpm indicator for normal indication. If the generator is operating normally, the blue bus power available lights will be on.

- B. APU BUS SWITCHES.....ON

Before performing this step it should be determined that the APU power available light is ON. The APU left and right bus switches should be turned on, one at a time, checking that the APU blue bus in use lights come on. The APU generator ac loadmeter should be checked to assure that indication is within limits at this time.

NOTE: If ground service bus electrical power is desired:

Ground service panel APU bus switch.....ON

If operations require ground service bus electrical power only, make certain that APU power available light is on before placing ground service electrical power panel APU power switch at on. Check that APU bus in use light comes on. Electrical power distribution from the left and right ac buses, if in use, automatically has priority over APU or external power inputs to the ground service bus.

- C. PNEUMATIC PRESSURE INDICATOR (IF GROUND PNEUMATIC PRESSURE IS NOT BEING USED).....UNPRESSURIZED

This check will indicate that the APU bleed air valve is closed and that air is not leaking into the pneumatic system.

- D. APU AIR SWITCH.....AS REQUIRED

If external pneumatic pressure cart is being used, leave APU bleed air switch at off. If APU bleed air is to be used for air conditioning and/or engine starting, place bleed air switch to on.

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

AUXILIARY POWER UNIT CHECKLIST - EXPANDED (Continued)

E. PNEUMATIC PRESSURE INDICATOR

(IF APPLICABLE).....PRESSURIZED

If APU bleed air is being used, check that pneumatic pressure is within limits.

NOTE: The battery switch must be left at on to sustain APU operation.

F. RIGHTHAND MAIN OR CENTER WING

AC BOOST PUMP.....ON

G. DC START PUMP.....OFF

NOTE: If operating on the ground service bus, the start pump must be left running because the ac boost pumps are not powered.

AUXILIARY POWER UNIT PANEL
(IF SHUT DOWN OR NOT IN USE)

A. FIRE CONTROL.....NORMAL

This switch is wired in series with the APU master switch and must be in the NORM position to provide electrical power to the APU control circuit should a subsequent APU start be desired.

B. APU AIR SWITCH.....OFF

This is a cleanup item. It is not intended that APU bleed air will be used in flight during normal operation; therefore, the APU bleed air switch should be at OFF in the event that starting the APU in flight to generate ac power is required.

C. MASTER.....OFF

This check is necessary to close the APU inlet doors, as the OFF position of the master switch completes the closing circuit through the AUTO position of the APU doors switch.

NOTE: If the APU master switch is not placed at OFF but is inadvertently left in the RUN position, the APU inlet doors will be open.

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DC-9
FLIGHT CREW OPERATING MANUAL

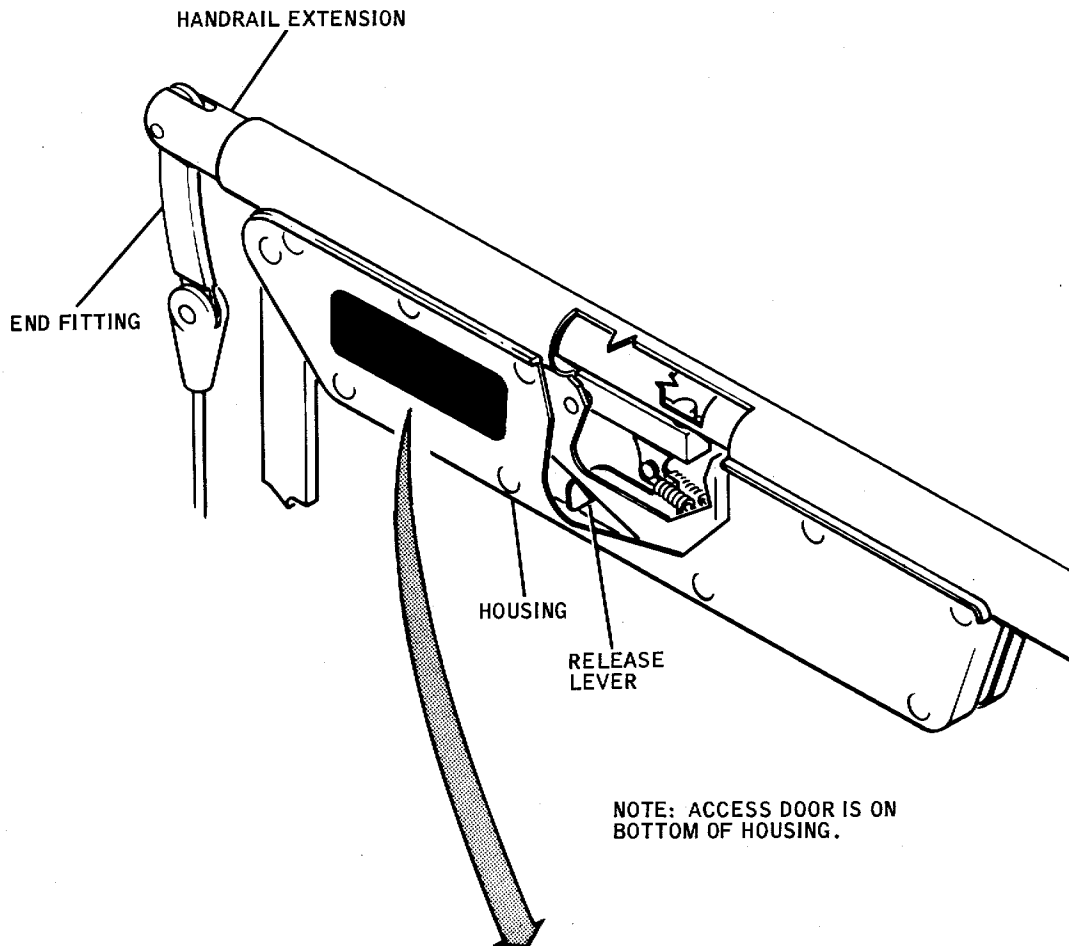
AUXILIARY POWER UNIT CHECKLIST - EXPANDED (Continued)

D. DOORS.....AUTO

This check is required to keep the APU inlet doors closed during all operations when the APU is not being used and the APU master switch is off.

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**AIRPLANE GENERAL -- NORMAL OPERATION - Passenger forward
stairway - Handrail, manual operation**



HANDRAIL OPERATING INSTRUCTIONS

TO EXTEND HANDRAIL:

1. OPEN ACCESS DOOR ON BOTTOM OF HOUSING AND PRESS RELEASE LEVER TOWARD FUSELAGE.
2. MOVE HANDRAIL EXTENSION TOWARD FUSELAGE. AFTER MOVING RAIL A FEW INCHES, LET GO OF LEVER.
3. EXTEND RAIL UNTIL LATCHED IN EXTENDED POSITION. CHECK FOR POSITIVE LATCHING BY TRYING TO MOVE HANDRAIL EXTENSION. (NOTE: WHEN PROPERLY ENGAGED, LATCH CANNOT BE DISENGAGED WITHOUT FIRST MOVING RAIL OUT).
4. CABIN ATTENDANT PANEL "STAIR DOWN" LIGHT IS "ON" WHEN BOTH RAILS ARE EXTENDED.

TO RETRACT HANDRAIL:

1. OPEN ACCESS DOOR AND PRESS RELEASE LEVER TOWARD FUSELAGE.
2. MOVE HANDRAIL EXTENSION TOWARD FUSELAGE UNTIL LATCH DISENGAGES. RESTRAINING RAIL, ALLOW IT TO RETRACT SLOWLY. AFTER A FEW INCHES OF RETRACTION, LET GO OF LEVER.
3. PUSH EXTENSION (AWAY FROM FUSELAGE) UNTIL LATCHED. CHECK FOR LATCH ENGAGEMENT BY PULLING ON RAIL.
4. DO NOT STOW STAIRWAY UNTIL BOTH HANDRAILS ARE RETRACTED AND LATCHED.

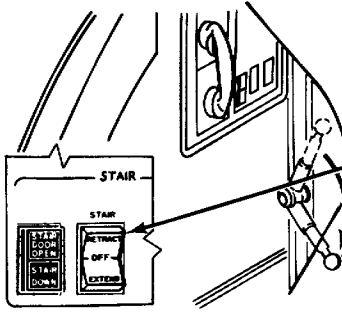
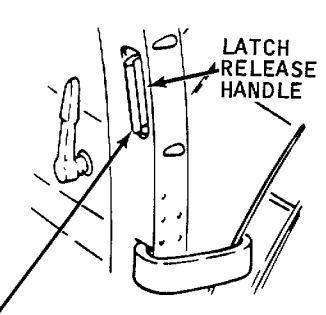
WARNING: DURING LAST TWO FEET OF RETRACTION KEEP FINGERS OUT OF AREA BENEATH HANDRAIL EXTENSION AND RESTRAIN RAIL BY HOLDING ON TO END FITTING.

BB1-3015

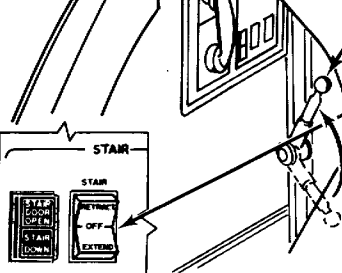
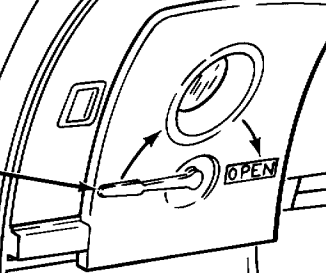
AIRPLANE GENERAL -- NORMAL OPERATION - Passenger forward stairway

★ REFER TO "WARNING", 1-10-0,
 BEFORE OPERATING HANDRAILS

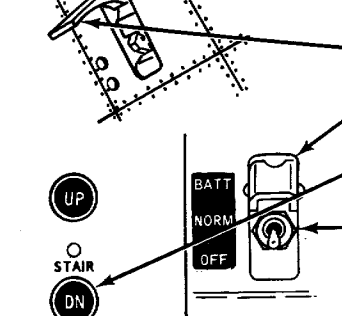
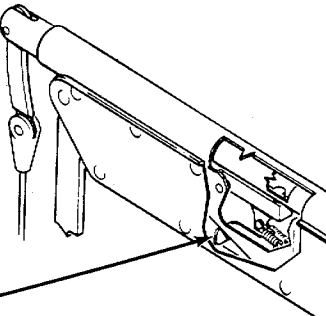
TO RETRACT PASSENGER FORWARD STAIRWAY FROM FORWARD ATTENDANT'S PANEL

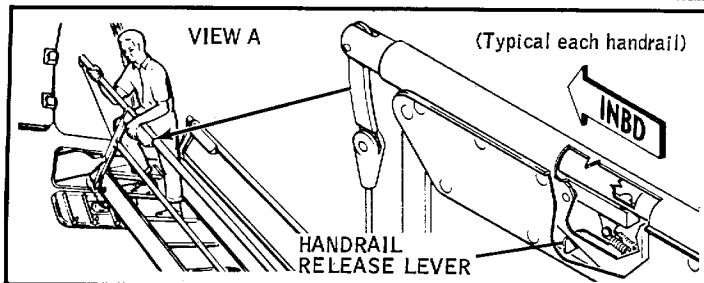
	<ol style="list-style-type: none"> 1. Push (inboard) handrail manual release lever, pull handrail up approximately 1/4-inch to disengage detent, then manually retract handrails. Hold handrail while retracting to prevent a sudden retraction. STAIR DOWN light will go off when rails start to retract. (See View A) NOTE: Stairwell door latch handle must be in the full up (unlatched) position before retracting stairway. 2. Hold stair switch in RETRACT position until stairs are fully retracted. 3. Place stairwell door latch handle to full down (latched) position. STAIR DOOR OPEN light will go off. 4. Unlatch passenger forward entrance door from the latched open position, close door and latch. 	 <p>LATCH RELEASE HANDLE</p>
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TO EXTEND PASSENGER FORWARD STAIRWAY FROM FORWARD ATTENDANT'S PANEL

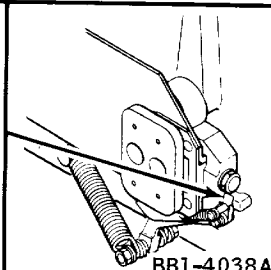
	<ol style="list-style-type: none"> 1. Unlatch passenger forward entrance door. 2. Move stairwell door handle to full up (unlatched) position. STAIR DOOR OPEN light will come on. 3. Hold stair switch in EXTEND position until stairs are fully extended. 4. Open and latch open forward passenger entrance door. 5. Push handrail manual release lever (one on each handrail) and extend handrail until detent is engaged. STAIR DOWN light will come on (See View A). 	 <p>OPEN</p>
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TO EXTEND PASSENGER FORWARD STAIRWAY FROM EXTERNAL CONTROL LOCATION

	<p>NOTE: The forward passenger entrance door must be unlatched to operate stairway.</p> <ol style="list-style-type: none"> 1. Place external handle to full up (unlatched) position to unlatch stairwell door. 2. Hold power switch in BATT position (if external or airplane power is not available). 3. Press stair DN button until stairs are fully extended. 4. Release power switch from BATT position. Switch will return to NORM. 5. Push manual release lever on handrails and manually extend Rails after entrance door has been latched to the open position. 	
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NOTE: With the stairway extended, lockable detent latch must be in the locked position if DC power is removed or not available. Place latch in unlocked position to operate stairway electrically.



AIRPLANE GENERAL -- ABNORMAL OPERATION - Passenger forward stairway operation using battery power

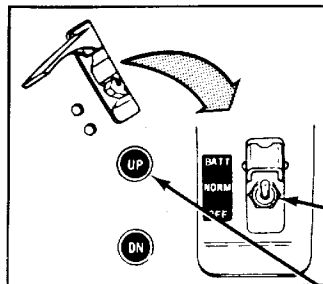
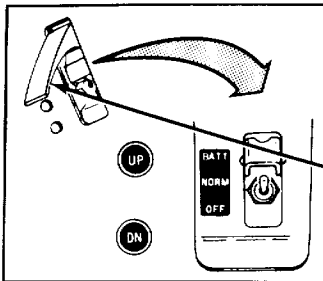
NOTE: Stairway step lights will not come on without AC power on the airplane.

CONDITION

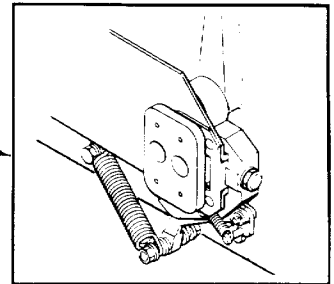
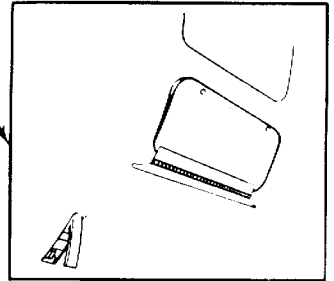
AIRPLANE ELECTRICAL SYSTEM NOT POWERED (DC Transfer bus de-energized)

TO RETRACT PASSENGER FORWARD STAIRWAY FROM EXTERNAL CONTROL STATION

ACTION

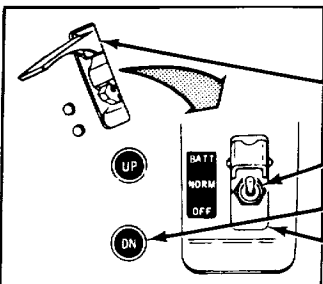


1. If extended, retract handrails in the normal manner.
2. Place detent latch in unlocked position.
3. Lift switch guard, place power switch in BATT (momentary) position and hold.
NOTE: Do not release power switch from BATT position until stair is fully retracted/extended. This would remove power from the system, allowing stair to fall.
4. Press the UP button (while holding power switch in BATT position) and hold until stairs are retracted and stairwell door is within 1/2-inch of closed.
5. Remove hand from UP switch while still holding the power switch in BATT position. Continue to hold the power switch in the BATT position and place the external stairwell latch in the halfway (approx.) down position until the door latches are engaged. The latch engagement is apparent when the door starts moving into the closed position. When latches are engaged, remove hand from power switch and close latch until door and latch are faired to the fuselage.

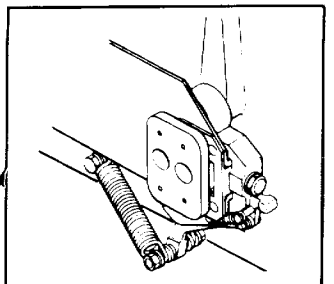


TO EXTEND PASSENGER FORWARD STAIRWAY FROM EXTERNAL CONTROL STATION

ACTION



- NOTE: The passenger forward entrance door must be unlatched before the stair can be extended.
1. Lift external handle to unlatch stairwell door.
 2. Place power switch in BATT (momentary) position and hold.
 3. Press stair DN button until stairs are fully extended.
 4. Release power switch from BATT position. Switch will return to NORM.
 5. Place detent latch in locked position.
 6. Manually extend handrails into doorway.



TO OPERATE PASSENGER FORWARD STAIRWAY FROM FORWARD ATTENDANTS PANEL

ACTION

1. Place BATT switch on Forward Overhead Switch Panel to ON position and operate stair. Operation is identical to normal operation.

BB1-2904

Section 2
 1-15-3
 CODE 1
 Page 1

AIRPLANE GENERAL -- ABNORMAL OPERATION - Passenger forward stairway (sheet 1)

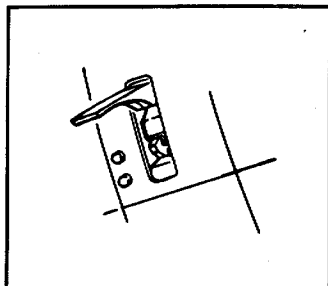
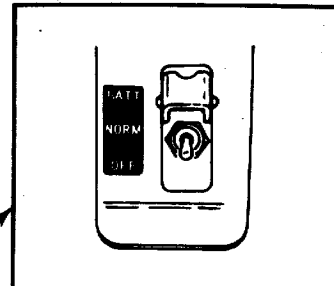
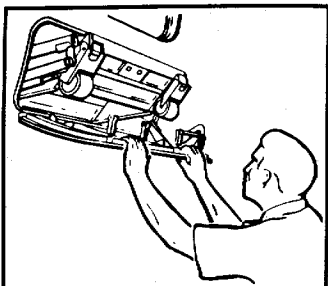
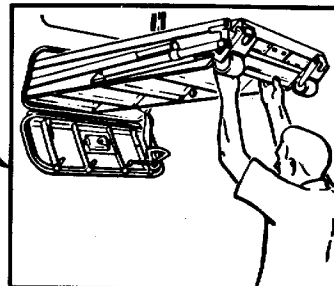
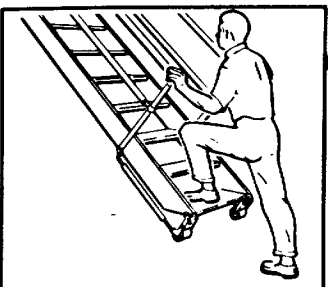
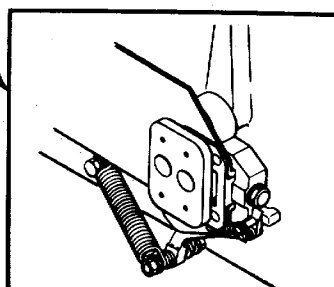
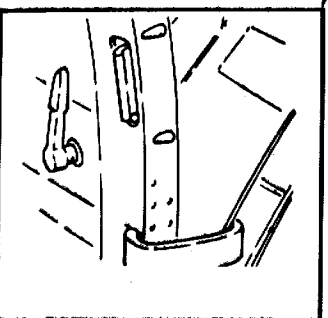
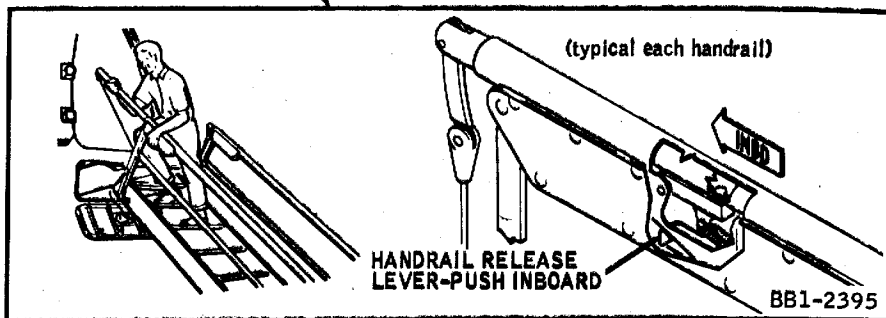
NOTE: Passenger forward entrance door must be unlatched before stairwell door can be unlatched.

CONDITION
MANUAL OPERATION OF STAIRWAY IF NO ELECTRICAL POWER IS AVAILABLE OR IF STAIRWAY ELECTRICAL SYSTEM MALFUNCTIONS.

TO MANUALLY EXTEND PASSENGER FORWARD STAIRWAY

ACTION

1. Lift external handle to unlatch stairwell door.
2. Place power switch to OFF (located under external handle).
3. Pull out on stairwell door until top step is accessible.
4. Pull stairway out horizontally until fully extended, then pull down until rollers touch the ground.
5. Step on bottom step and push handrail toward doorway until stairway is fully extended.
6. Place detent latch in locked position.
7. Latch passenger forward entrance door open.
8. Push handrail manual release lever (one on each handrail) and extend handrail into doorway until detent is engaged.



AIRPLANE GENERAL -- ABNORMAL OPERATION - Passenger forward stairway (sheet 2)

MANUAL OPERATION OF STAIRWAY IF NO ELECTRICAL POWER IS AVAILABLE OR IF STAIRWAY ELECTRICAL SYSTEM MALFUNCTIONS.

* REFER TO "WARNING", 1-10-0,
BEFORE OPERATING HANDRAILS



ACTION

1. Place external power switch to OFF
2. Push handrail manual release lever, pull handrail up approximately 1/4-inch to disengage detent, then manually retract handrails. Hold handrail while retracting to prevent a sudden retraction.
3. Close passenger forward entrance door.
4. Place detent latch in unlocked position.
5. Stand on bottom step and pull (jerk) handrail down to disengage carriage roller from detent.
6. Lift up on bottom step and push up and in until stairwell door starts closing.
7. Push in stairwell door until within 1/2 inch of faired. Push in external handle until stairwell door is latched, and both door and handle are flush to the fuselage.

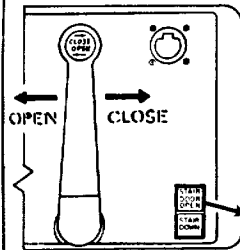
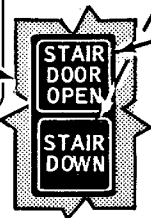
(Typical each handrail)

HANDRAIL
RELEASE
LEVER-PUSH
INBOARD

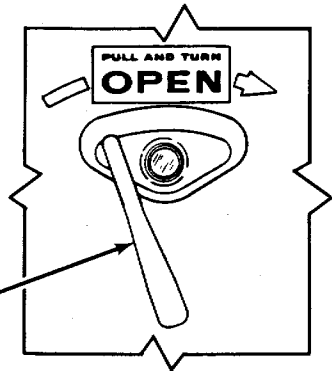
BB1-2398A

AIRPLANE GENERAL -- NORMAL OPERATION - Passenger aft stairway

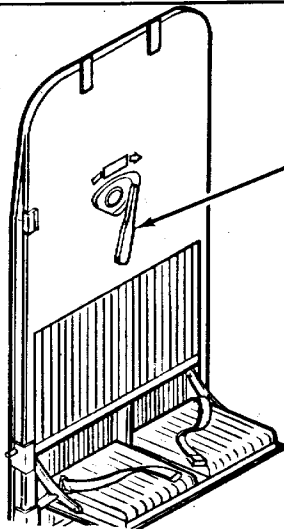
TO RETRACT PASSENGER AFT STAIRWAY FROM THE INTERIOR CONTROL PANEL



1. Place and hold aft entrance stairway control in the CLOSE position. *(See note).
- STAIR DOWN light (green) should go off.
2. When stairway is retracted STAIR DOOR OPEN light (amber) should go off.
- Release stairway control handle.
3. Close and lock aft entrance door

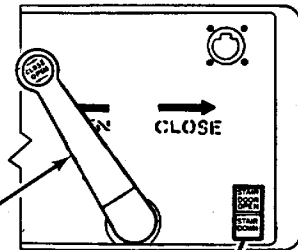
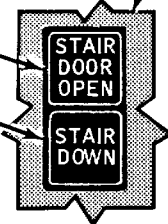


TO EXTEND PASSENGER AFT STAIRWAY FROM THE INTERIOR CONTROL PANEL.

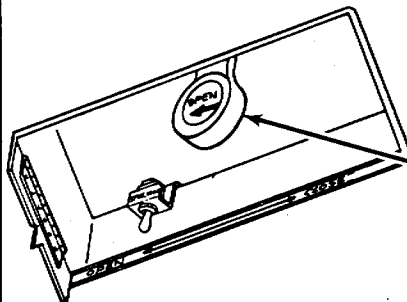


Note:
 The seat bottom automatically folds into the door recess when not in use.

1. Unlock and open aft entrance door. If the automatic feature of the seat bottom malfunctions, make certain seat bottom is folded into door recess before opening door.
2. Place and hold aft entrance stairway control in the OPEN position.
- The STAIR DOOR OPEN light (amber) should come on.
3. When stairway is extended STAIR DOWN light (green) will come on.
4. Release stairway control handle. Handle should return to neutral (vertical) position.



TO EXTEND PASSENGER AFT STAIRWAY FROM EXTERIOR CONTROL LOCATION



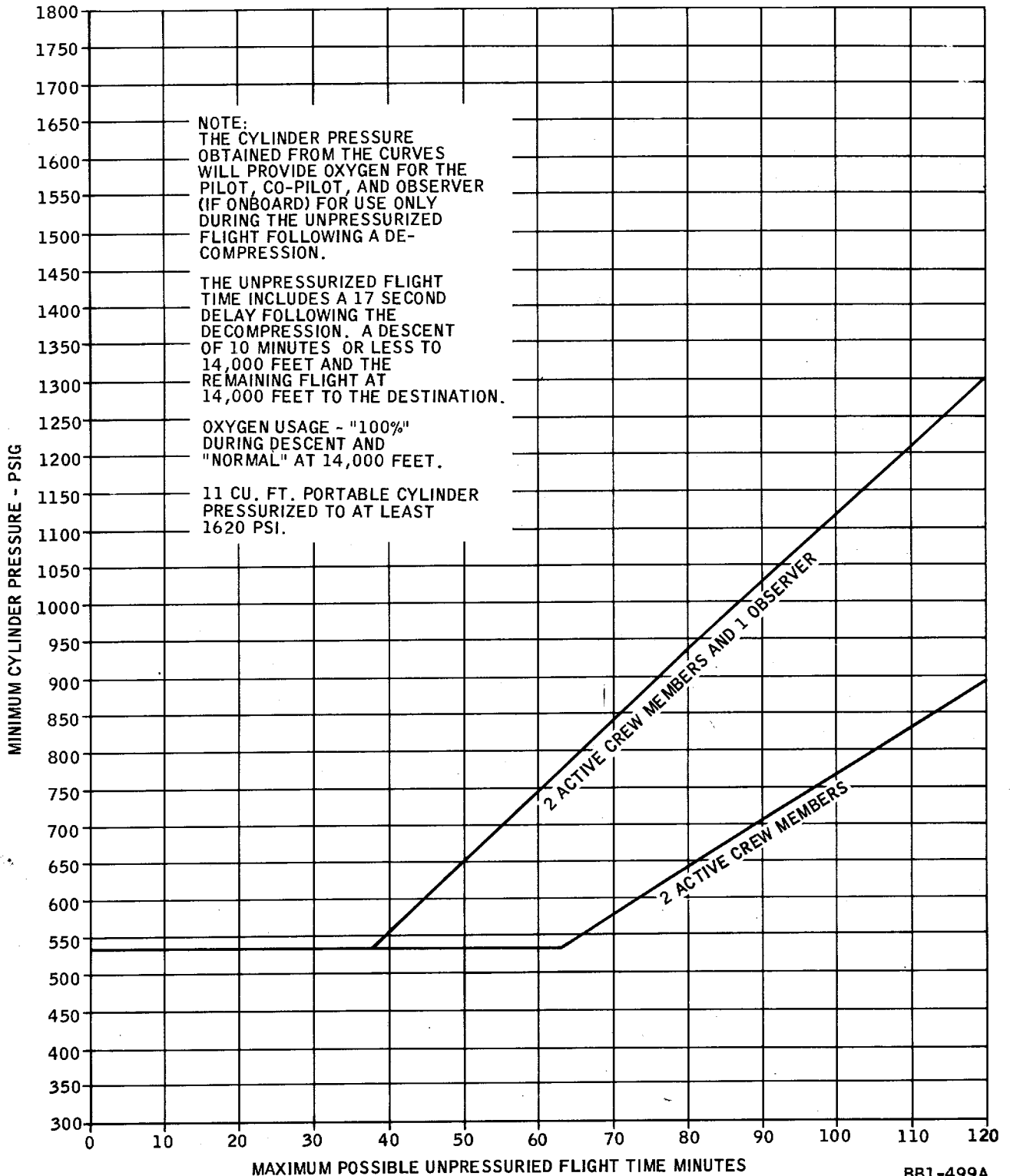
1. Place and hold aft entrance stairway control in the OPEN position.
- When stairway is extended, release stairway control handle.

*Note: Airplane hydraulic pressure is required to operate the aft stairway. If the stairway or light indications do not respond

when the control is placed in the closed or open position, request the pilot to pressurize the right hand hydraulic system.

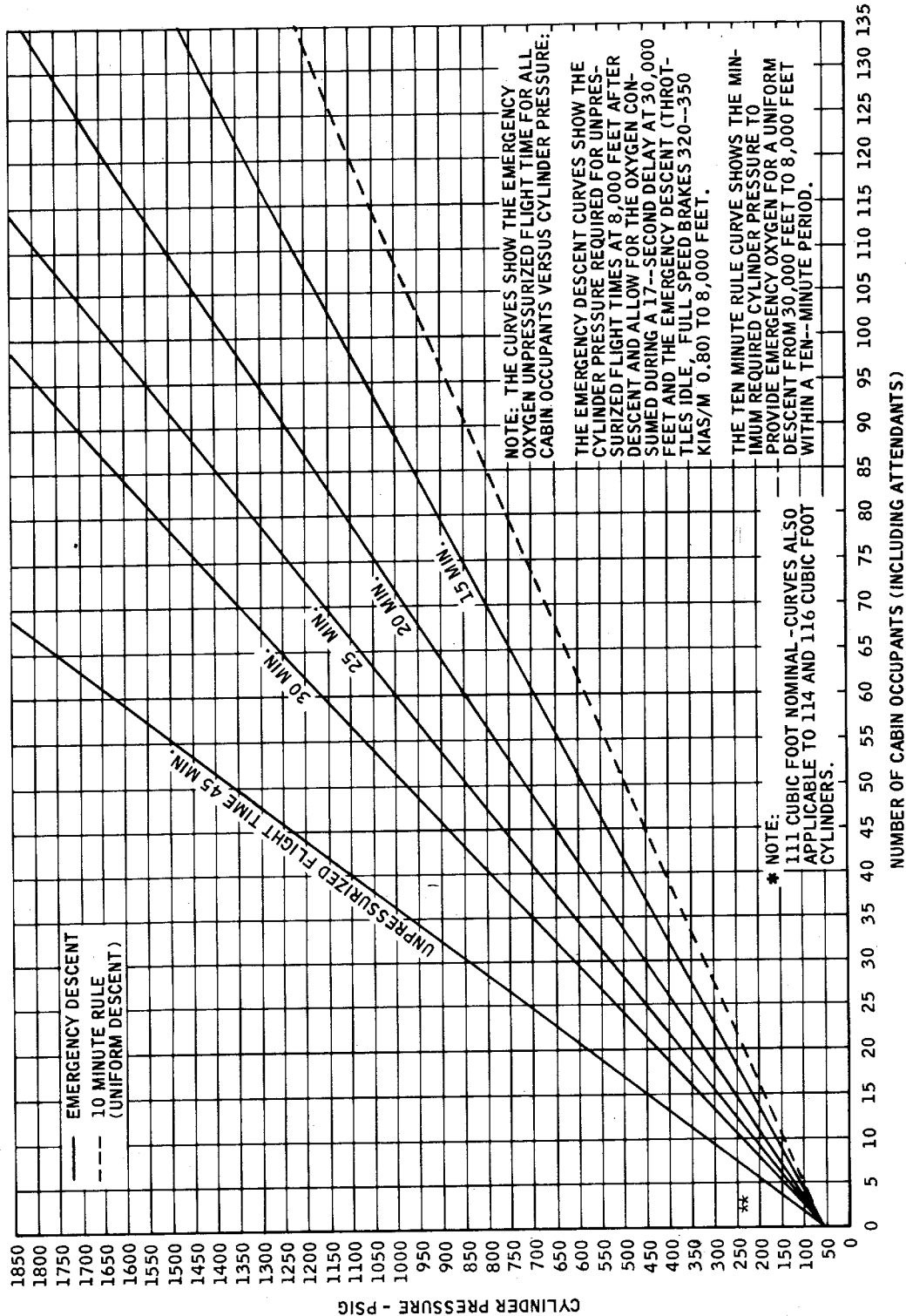
BB1-865B

**AIRPLANE GENERAL -- CREW OXYGEN CYLINDER PRESSURE
 REQUIREMENTS FOR DISPATCH TO 10,000
 FEET OR HIGHER (48 cubic foot cylinder)**



Printed in U.S.A.

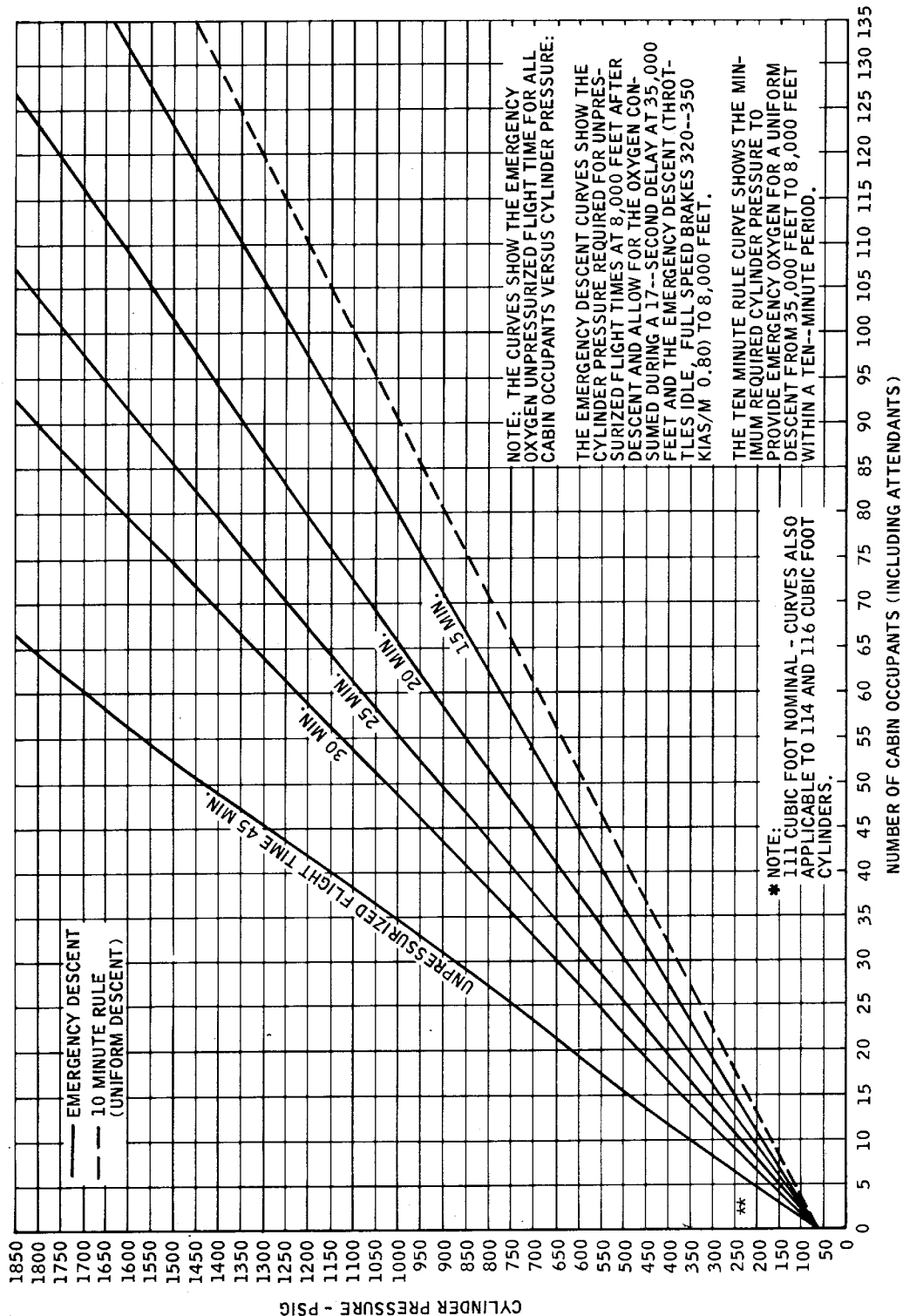
AIRPLANE GENERAL -- PASSENGER OXYGEN CYLINDER PRESSURE REQUIREMENTS FOR DISPATCH TO 30,000 FEET [*111 CUBIC FOOT CYLINDER]



****** A minimum cylinder pressure of 240 psig is required to provide adequate surge pressure for automatic passenger oxygen mask presentation.

BB1-3224B

AIRPLANE GENERAL -- PASSENGER OXYGEN CYLINDER PRESSURE REQUIREMENTS FOR DISPATCH TO 35,000 FEET. (*111 CUBIC FOOT CYLINDER)

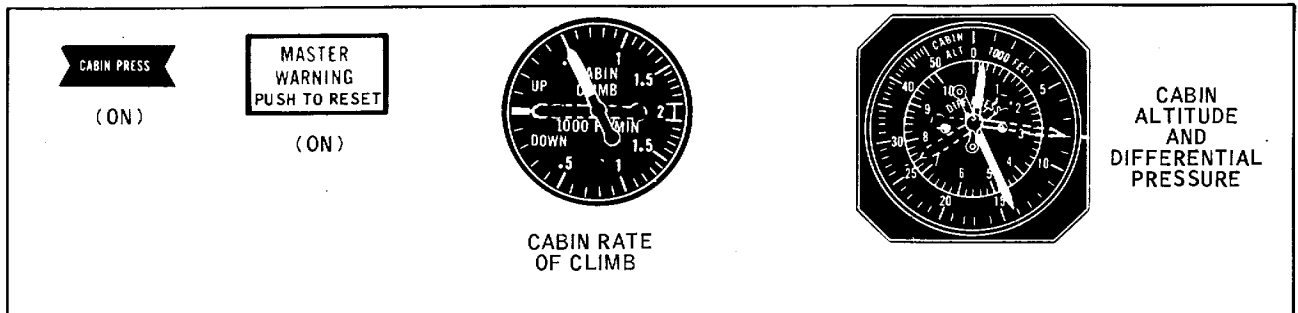


** A minimum cylinder pressure of 240 psig is required to provide adequate surge pressure for automatic passenger oxygen mask presentation.

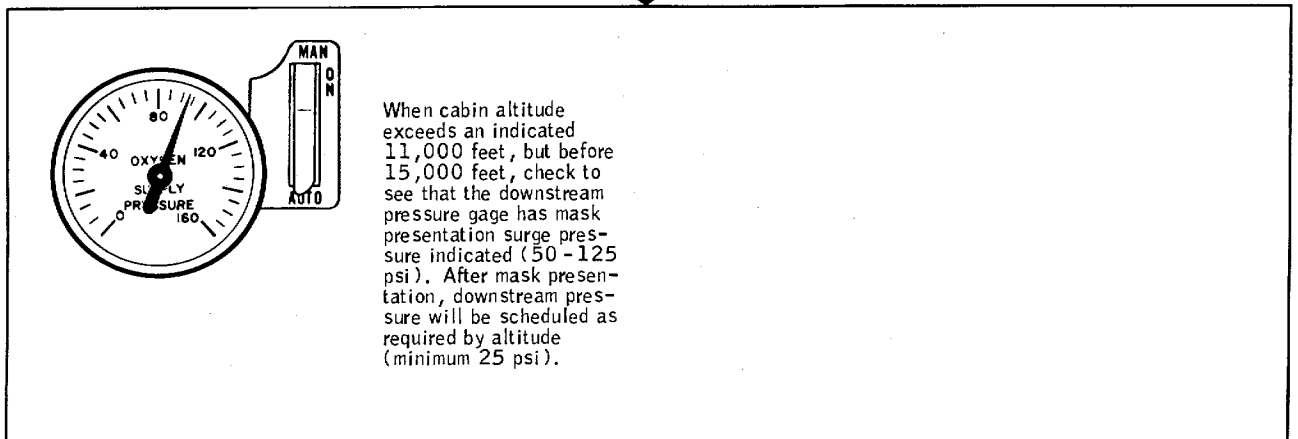
BB1-3227B

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

AIRPLANE GENERAL -- NORMAL OPERATION - Passenger oxygen system following decompression



RESET MASTER WARNING LIGHT



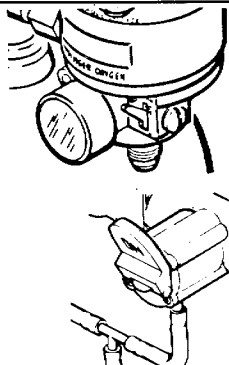
WHEN CABIN ALTITUDE HAS BEEN REDUCED TO 10,000 FEET OR LESS

IF SUPPLEMENTAL OXYGEN IS DESIRED

Place auto-manual control lever to MAN-ON position.

Place supplemental valve to the ON position.

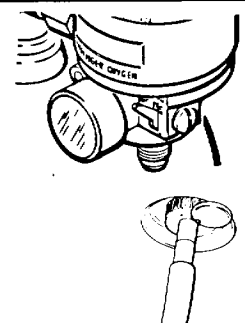
Utilize mask nearest the aisle.



IF FIRST AID OXYGEN IS REQUIRED

Place auto-manual control lever to MAN-ON position.

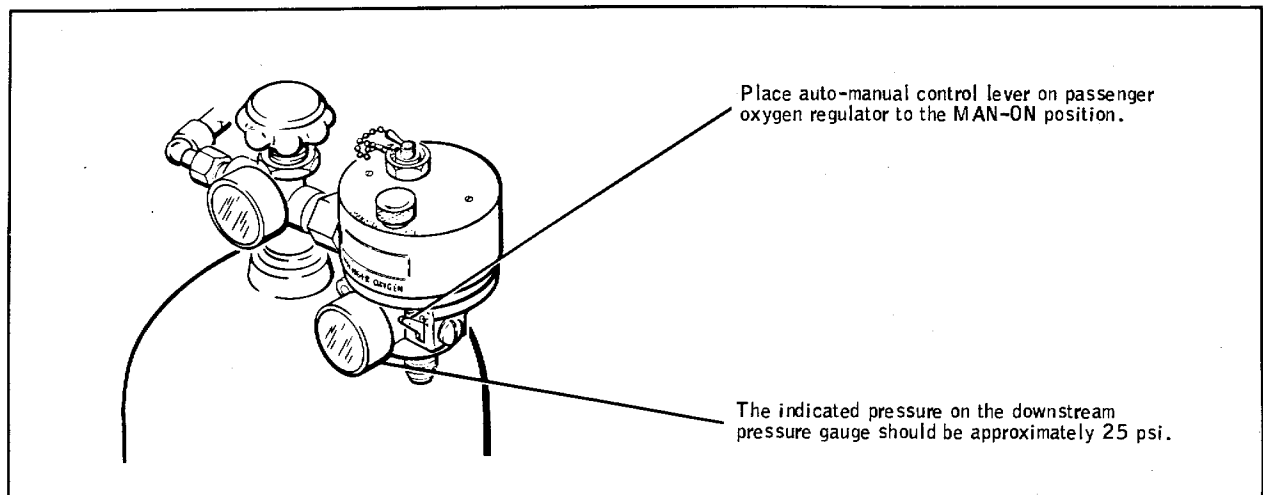
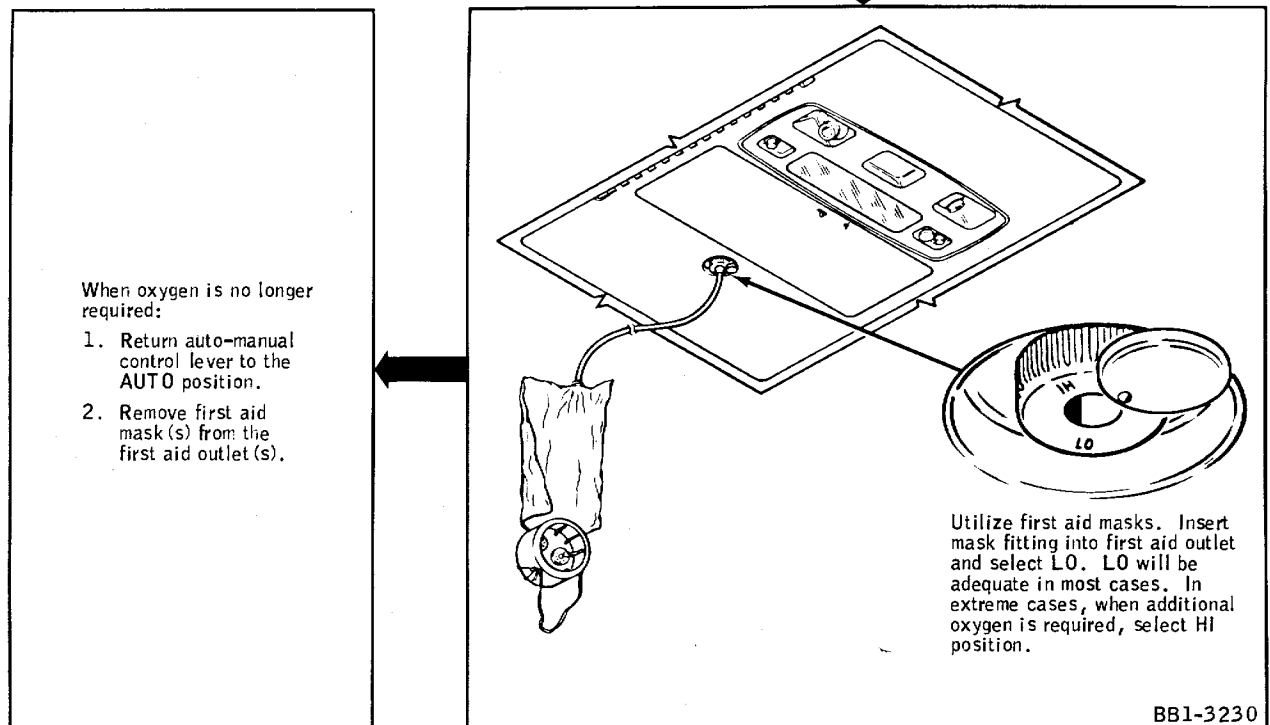
Utilize first aid masks and fittings. Select LO position. HI may be used in extreme cases if more oxygen is required.



BB1-3228A

AIRPLANE GENERAL -- NORMAL OPERATION - passenger first aid oxygen system during normal pressurized flight

NOTE: The passenger oxygen supply may be used as shown below for clinical purposes, however, there must be sufficient oxygen pressure remaining in the passenger oxygen cylinder to provide oxygen in the event of a decompression.



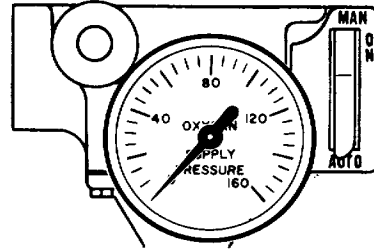
AIRPLANE GENERAL -- ABNORMAL OPERATION - Passenger oxygen system

CONDITION

PASSENGER OXYGEN MASKS FAIL TO PRESENT AUTOMATICALLY FOLLOWING DECOMPRESSION



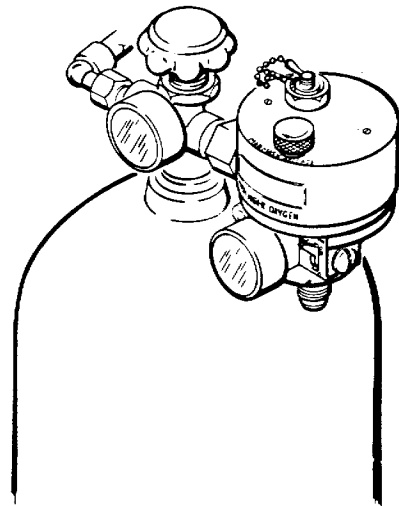
Cabin altitude rising above scheduled automatic mask presentation altitude.



No automatic mask presentation surge pressure indicated on passenger oxygen regulator downstream pressure gage.

ACTION

1. Place the auto-manual control lever on the passenger oxygen regulator to the MAN-ON position.
2. Turn manual mask release knob in the direction of the arrow (clockwise) until it stops, and hold until surge pressure of 50 psi or greater is indicated. Surge pressure should be over 50 psi within approximately 6 seconds.
3. Release the manual release knob. Leave the auto-manual control lever in the MAN-ON position until all passenger oxygen requirements have been met, then return the auto-manual lever to the AUTO position.

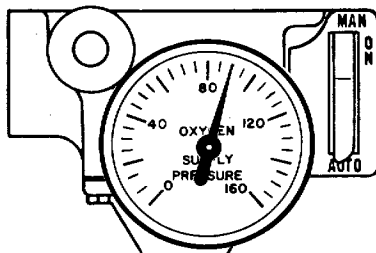


BB1-137C

**AIRPLANE GENERAL -- ABNORMAL OPERATION - Passenger
oxygen system**

CONDITION

ONE OR MORE PASSENGER OXYGEN MASKS DOORS FAIL TO OPEN AUTOMATICALLY AFTER MASKS PRESENTATION SURGE PRESSURE IS ATTAINED FOLLOWING DECOMPRESSION



Automatic mask presentation surge pressure (50-125 psi) indicated on passenger oxygen regulator downstream pressure gage.

ACTION

OXYGEN MASKS DOOR

DOOR OPEN
INDICATOR

OXYGEN MANUAL
DOOR RELEASE

Insert sharp object in outboard end of oxygen manual door release slot and pull the manual door release laterally towards the aisle.

BB1-3266A

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 22, SECTION 2, CHAPTER 5, DATED DEC 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-5-15-0 ADDED CODE 15 (SPLIT EFFECTIVITY) TO ADD AC CROSSTIE LOCKOUT ANNUNCIATOR LIGHT INDICATION DURING LOSS OF PORTION OF AC DISTRIBUTION SYSTEM DUE TO ACTION OF BUS FAULT PROTECTION.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-5-Eff	66	All	2-5-Eff	66	All
2-5-Cont	66	1 thru 3	2-5-Cont	66	1 thru 4
None			2-5-15-0	15	1 thru 5

Dec 1/70

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2-5 Summary
CODE 66
Page 1 of 1

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

*2-5-Eff	66	1	Dec 1/70
*2-5-Cont	66	1	Dec 1/70
*2-5-Cont	66	2	Dec 1/70
*2-5-Cont	66	3	Dec 1/70
*2-5-Cont	66	4	Dec 1/70
2-5-1-0	1	1	Dec 1/66
2-5-1-0	1	2	Jun 1/68
2-5-10-0	3	1	Jun 1/68
2-5-10-0	3	2	Jun 1/68
2-5-10-0	3	3	Mar 1/67
2-5-10-0	3	4	Mar 1/69
2-5-15-0	1	1	Mar 1/67
2-5-15-0	1	2	Mar 1/67
2-5-15-0	1	3	Mar 1/67
2-5-15-0	1	4	Mar 1/67
2-5-15-0	1	5	Jun 1/67
*2-5-15-0	15	1	Dec 1/69
*2-5-15-0	15	2	Dec 1/69
*2-5-15-0	15	3	Dec 1/69
*2-5-15-0	15	4	Dec 1/69
*2-5-15-0	15	5	Dec 1/69
2-5-15-3	1	1	Jun 1/70
2-5-15-5	1	1	Sep 1/67
2-5-15-5	1	2	Sep 1/67
2-5-15-5	1	3	Dec 1/68
2-5-15-10	1	1	Jun 1/68

*The asterisk indicates pages revised or added by the current revision.

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2-5-Effective Pages
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 Page 1

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

Chapter 5

ELECTRICAL SYSTEMS

TABLE OF CONTENTS

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
* <u>LIMITATIONS</u> (Sheet 1)	5-1-0	1	1	A11
(Sheet 2)	5-1-0	2	1	A11
<hr/>				
* <u>NORMAL OPERATION</u> - External power to ground service bus, or to all buses	5-10-0	1	3	A11
* <u>NORMAL OPERATION</u> - APU power to ground service bus, or to all buses	5-10-0	2	3	A11
* <u>NORMAL OPERATION</u> - Normal engine start	5-10-0	3	3	A11
* <u>NORMAL OPERATION</u> Verification of ac & dc emergency power transfer relay and ac crosstie relay operation	5-10-0	4	3	A11

*Illustration

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Section 2
5-Contents
CODE 66
Page 1

DOUGLAS AIRCRAFT CO.
DC-9
 FLIGHT CREW OPERATING MANUAL

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u> (Battery start)				
Engine start with no APU or external electrical power available	5-15-0	1	1/15	Use CODE 1 for 47450 and 47459 Use CODE 15 for 47457 and Subs
<u>*ABNORMAL OPERATION</u>				
Loss of a generator due to action of fault protection	5-15-0	2	1/15	
<u>*ABNORMAL OPERATION</u>				
Loss of portion of ac distribution system due to action of bus fault protection	5-15-0	3	1/15	
<u>*ABNORMAL OPERATION</u> (Sheet 1)				
Malfunction of constant speed drive (CSD)	5-15-0	4	1/15	
CSD oil outlet temperature increasing into caution (yellow) zone	5-15-0	4	1/15	
CSD oil outlet temperature steadily increases toward danger zone (red radial) or generator frequency is out of limits or fluctuating	5-15-0	4	1/15	

*Illustration

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DOUGLAS AIRCRAFT CO.
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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u> (Sheet 1)				
CSD oil outlet temperature increases and stabilizes in the danger (red) zone	5-15-0	4	1/15	Use CODE 1 for 47450 and 47459 Use CODE 15 for 47457 and Subs
<u>*ABNORMAL OPERATION</u> (Sheet 2)				
Malfunction of constant speed drive (CSD)	5-15-0	5	1/15	
CSD OIL PRESS LOW light comes on	5-15-0	5	1/15	
<u>*ABNORMAL OPERATION</u>				
Loss of both engine generators, or left or right engine generator and APU generator, if in use	5-15-3	1	1	A11
<u>*ABNORMAL OPERATION</u>				
AC EMER BUS OFF light comes on	5-15-5	1	1	A11
<u>*ABNORMAL OPERATION</u>				
DC EMER BUS OFF light comes on	5-15-5	2	1	A11
<u>*ABNORMAL OPERATION</u>				
DC TRANSFER BUS OFF light comes on	5-15-5	3	1	A11

*Illustration

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DOUGLAS AIRCRAFT CO.
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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Circuit breaker(s) trip(s)	5-15-10	1	1	A11

*Illustration

Section 2
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DOUGLAS AIRCRAFT CO., INC.
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 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- LIMITATIONS (sheet 1)

GENERAL

The values shown in the normal column are normal operating ranges. Indications outside the normal range indicate possible system abnormalities.

Limits shown in the allowable column should not be exceeded, and sustained operation at these limits is not recommended.

CAUTION

ANY CONDITION WHICH CAUSES ANY INDICATION IN THE ALLOWABLE COLUMN, OTHER THAN WITHIN THE NORMAL RANGE, SHOULD BE CORRECTED AT THE EARLIEST OPPORTUNITY.

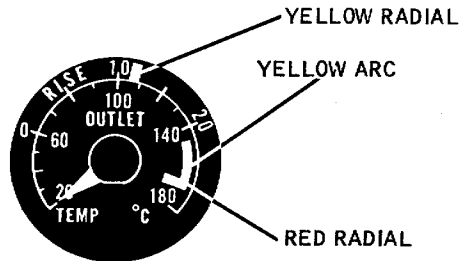
CONDITION OR ITEM	NORMAL		ALLOWABLE	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
LEFT DC LOADMETERS	THE MAXIMUM DIFFERENCE BETWEEN THE TWO INDICATIONS SHOULD NOT EXCEED 0.3 AND BOTH LOADMETERS SHOULD INDICATE SOME LOAD.		0	1.0
RIGHT DC LOADMETERS	SAME AS ABOVE			
RIGHT OR LEFT DC BUS	24V	28V	22V	30V
ENGINE GENERATORS	VOLTAGE: 112V	118V	107V	123V
	FREQUENCY: 396 CPS	404 CPS	380 CPS	420 CPS
APU GENERATOR	GROUND: 390 CPS	GROUND: 410 CPS	380 CPS	420 CPS
	FLIGHT: 395 CPS	FLIGHT: 420 CPS		
EXTERNAL POWER NOTE: IF EXTERNAL POWER IS NOT WITHIN NORMAL LIMITS, IT SHOULD BE CORRECTED AS SOON AS POSSIBLE.	VOLTAGE: 112V	118V	107V	123V
	FREQUENCY: 396 CPS	404 CPS	380 CPS	420 CPS
AC LOADMETERS OF OPERATING GENERATORS NOTE: GENERATOR OVERLOAD RATINGS FOR SHORT TIME OPERATION ARE: A. 1.5 FOR 5 MINUTES. B. OVER 1.5 FOR 5 SECONDS (THE OVERLOAD RATING OF THE GENERATOR IS 2.0 FOR 5 SECONDS.	OVER 0	UNDER 1.0	0	1.0

BB1-470C

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- LIMITATIONS (sheet 2)

CSD TEMPERATURE INDICATOR



CONDITION OR ITEM	NORMAL		ALLOWABLE	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
GENERATOR DRIVE TRANSMISSION OIL TEMPERATURE RISE.	Yellow radial on rise temp scale (11.2°C) indicates an operating point which, when exceeded, may indicate a system malfunction and should be recorded in the flight log.			
GENERATOR DRIVE TRANSMISSION OUTLET OIL TEMPERATURE	ABOVE 0	146°C	----	163°C
BATTERY VOLTAGE A. NO OTHER POWER ON AIRPLANE. NO LOAD ON BATTERY. B. BATTERY CHARGING. NOTE: BATTERY VOLTAGE MAY BE STEADY OR MAY BE FLUCTUATING, DEPENDING ON MODE OR OPERATION OF THE BATTERY CHARGER. C. EMERGENCY POWER SWITCH IN ON POSITION.	NOT LESS THAN 27 VOLTS 30 VOLTS NOTE: BATTERY CHARGING VOLT- AGES AT AMBIENT TEM- PERATURE OF 70° F. NOT LESS THAN 26 VOLTS	33 VOLTS	NOT LESS THAN 27 VOLTS 26 VOLTS NOTE: ALLOWABLE BATTERY CHARGING VOLTAGES AT AMBIENT TEMPERATURE EXTREMES OF 165° TO 0° F. NOT LESS THAN 22 VOLTS	39 VOLTS
BATTERY AMPERES A. BATTERY CHARGING NOTE: BATTERY AMPERE READING MAY BE STEADY (65 AMPERES RE- DUCING TO 40 AMPERES), PULSING AT INTERVALS OF 25 SEC- ONDS TO 20 MINUTES, OR OSCILLATING BETWEEN APPROX. 40 AND 65 AMPERES IF BATTERY IS SEVERLY DISCHARGED. B. EMERGENCY POWER SWITCH IN ON POSITION.	0 10 AMPERES TO THE RIGHT	65 AMPERES TO THE LEFT 35 AMPERES TO THE RIGHT		

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BB1-463C

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DC-9
 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- LIMITATIONS (sheet 1)

GENERAL

The values shown in the normal column are normal operating ranges. Indications outside the normal range indicate possible system abnormalities.

Limits shown in the allowable column should not be exceeded, and sustained operation at these limits is not recommended.

CAUTION

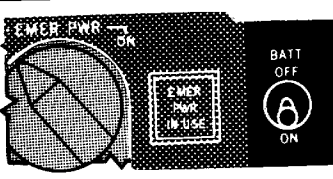
ANY CONDITION WHICH CAUSES ANY INDICATION IN THE ALLOWABLE COLUMN, OTHER THAN WITHIN THE NORMAL RANGE, SHOULD BE CORRECTED AT THE EARLIEST OPPORTUNITY.

CONDITION OR ITEM	NORMAL		ALLOWABLE	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
LEFT DC LOADMETERS	THE MAXIMUM DIFFERENCE BETWEEN THE TWO INDICATIONS SHOULD NOT EXCEED 0.3 AND BOTH LOADMETERS SHOULD INDICATE SOME LOAD.		0	1.0
RIGHT DC LOADMETERS	SAME AS ABOVE			
RIGHT OR LEFT DC BUS	24V	28V	22V	30V
ENGINE GENERATORS	VOLTAGE: 112V	118V	107V	123V
	FREQUENCY: 396 CPS	404 CPS	380 CPS	420 CPS
APU GENERATOR	GROUND: 390 CPS	GROUND: 410 CPS	380 CPS	420 CPS
	FLIGHT: 395 CPS	FLIGHT: 420 CPS		
EXTERNAL POWER NOTE: IF EXTERNAL POWER IS NOT WITHIN NORMAL LIMITS, IT SHOULD BE CORRECTED AS SOON AS POSSIBLE.	VOLTAGE: 112V	118V	107V	123V
	FREQUENCY: 396 CPS	404 CPS	380 CPS	420 CPS
AC LOADMETERS OF OPERATING GENERATORS NOTE: GENERATOR OVERLOAD RATINGS FOR SHORT TIME OPERATION ARE: A. 1.5 FOR 5 MINUTES. B. OVER 1.5 FOR 5 SECONDS (THE OVERLOAD RATING OF THE GENERATOR IS 2.0 FOR 5 SECONDS.	OVER 0	UNDER 1.0	0	1.0

BB1-470C

ELECTRICAL -- NORMAL OPERATION - External AC power to ground service bus, or to all buses

NOTE: The following procedures are to be used in conjunction with COCK-PIT CHECKLIST.



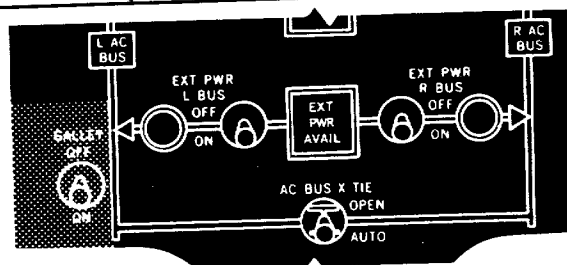
BATT Switch -- ON

DC TRANSFER BUS OFF light should be off and DC EMER BUS OFF and AC EMER BUS OFF lights should be on.

Place EXT PWR L BUS and EXT PWR R BUS switches on ELEC PWR control panel and EXT PWR switch on GROUND SERVICE ELEC PWR control to OFF positions.

EXT PWR AVAIL lights on the above panels should come on.

PROCEDURE TO POWER ALL ELECTRICAL BUSES



EXT PWR L BUS and EXT PWR R BUS Switches -- ON (one at a time)

External power in use lights should come on.

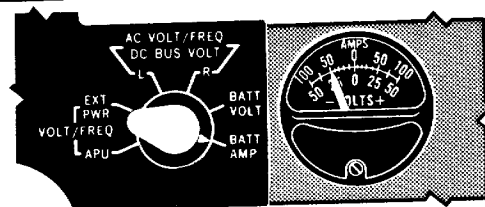
Following lights should go off:

- L AC BUS OFF
- R AC BUS OFF
- AC EMER BUS OFF
- DC EMER BUS OFF
- DC BUS OFF

DC LOAD meters should indicate some load.

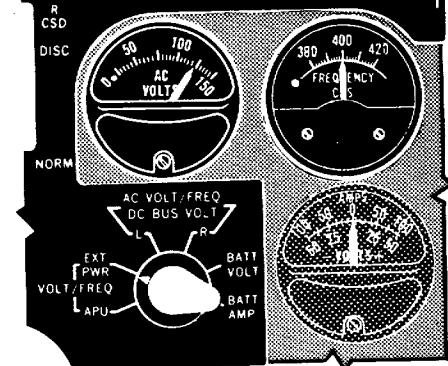
All electrical buses are now powered.

Check that the battery is charging.



Selector Switch -- BATT AMP

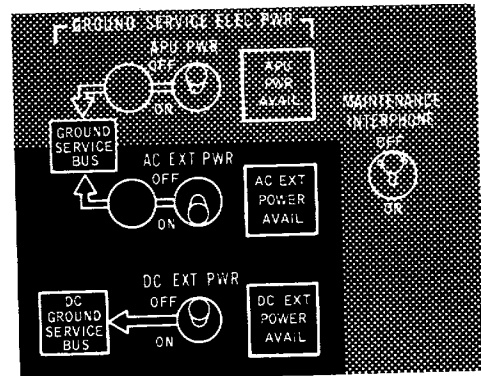
Reading should be zero to 65 amps to the left, and indication may be steady or pulsing, depending upon battery charger mode of operation.



Selector Switch -- EXT PWR VOLT / FREQ

Voltage should indicate approximately 115 volts and frequency should indicate approximately 400 cps.

PROCEDURE TO POWER GROUND SERVICE BUS ONLY

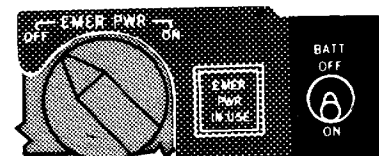


AC EXT PWR Switch -- ON

AC EXT PWR in use light should come on.

Ground service bus and dc transfer bus are now powered.

TO CHARGE BATTERY DURING GROUND SERVICE OPERATION

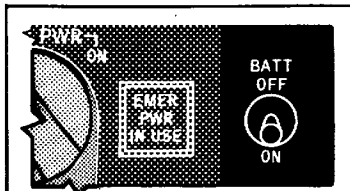


BATT Switch -- ON

Check that the battery is charging.

ELECTRICAL -- NORMAL OPERATION - APU power to ground service bus, or to all buses

NOTE: The following procedures are to be used in conjunction with COCKPIT CHECKLIST.



BATT Switch -- ON

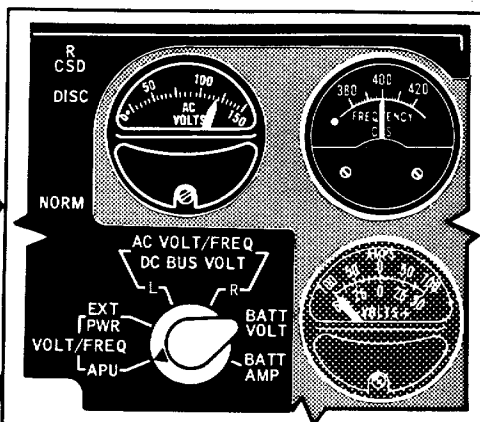
The DC TRANSFER BUS OFF light should be off, and the DC EMER BUS OFF and AC EMER BUS OFF lights should be on.

Start APU

APU PWR AVAIL lights on the ELEC PWR and GROUND SERVICE ELEC PWR control panels should come on.

NOTE: It may be necessary to place the APU GEN switch momentarily to the RESET position.

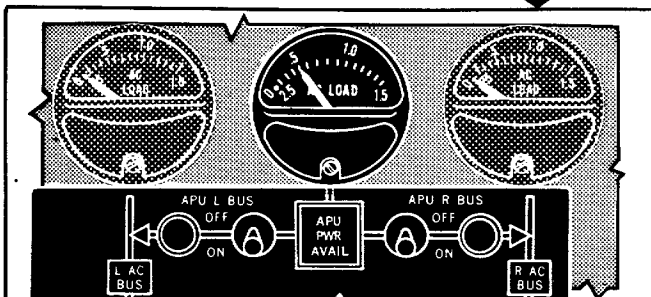
PROCEDURE TO POWER ALL ELECTRICAL BUSES



Selector Switch -- APU VOLT/FREQ

Voltage should indicate approximately 115 volts and frequency should indicate approximately 400 cps.

PROCEDURE TO POWER GROUND SERVICE BUS ONLY.



APU L BUS AND APU R BUS Switches -- ON (one at a time)

APU power in use lights should come on.

Following lights should go off:

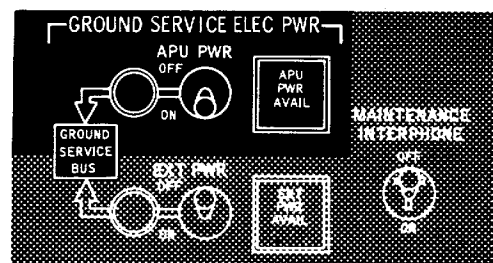
- L AC BUS OFF
- R AC BUS OFF
- AC EMER BUS OFF
- DC EMER BUS OFF
- DC BUS OFF

APU AC LOAD meter should indicate some load.

DC LOAD meters should indicate some load.

All electrical buses now powered.

Check that the battery is charging.



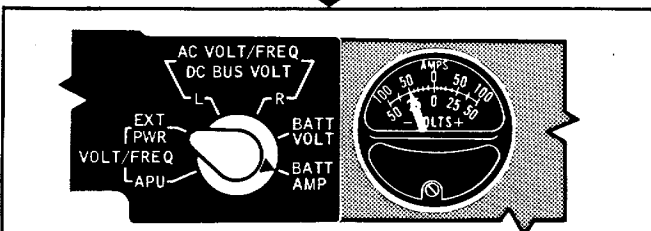
Ground Service APU PWR Switch -- ON

Ground service APU power in use light should come on.

Ground service bus and dc transfer bus are now powered.

APU AC LOAD meter should indicate some load.

CHECK THAT BATTERY IS CHARGING



Selector Switch -- BATT AMP

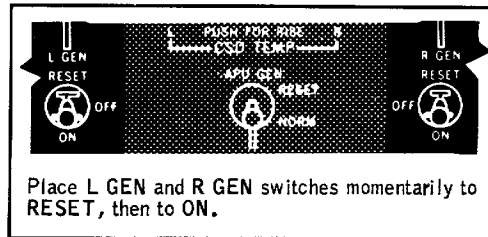
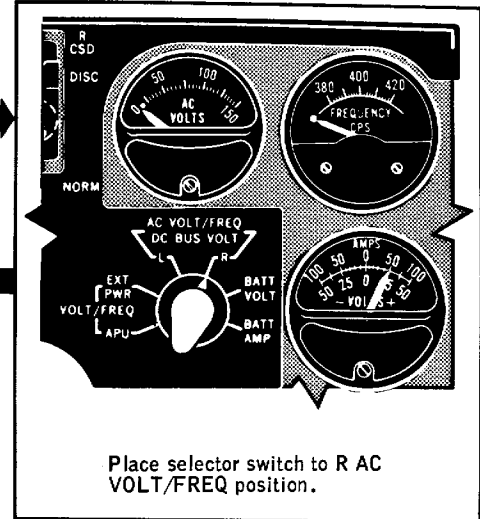
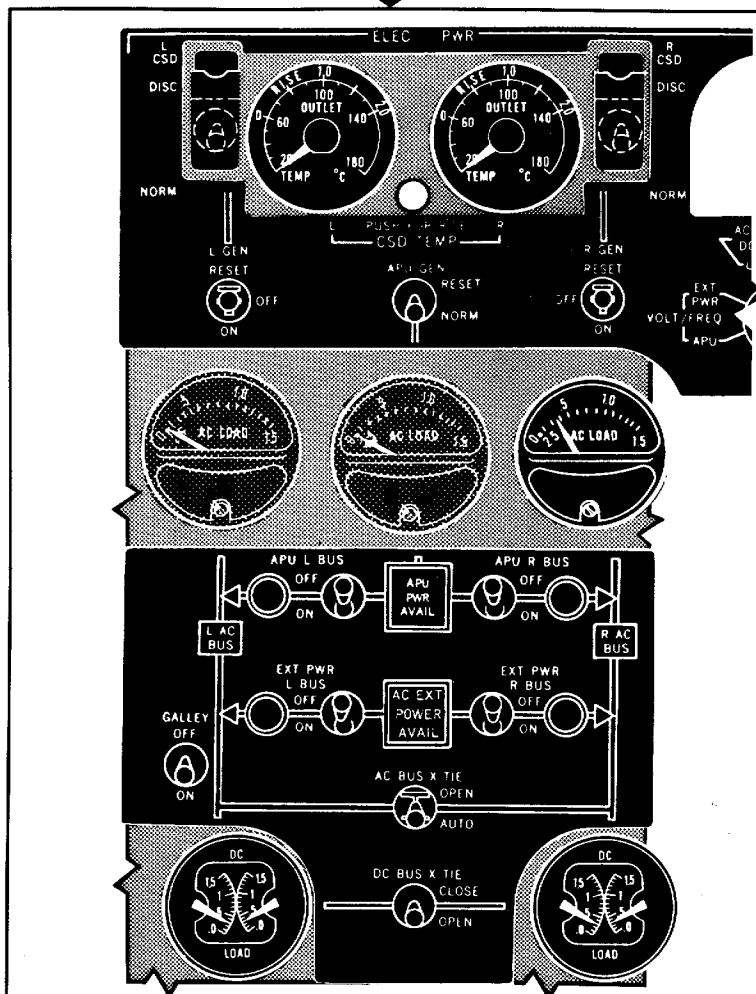
Reading should be zero to 65 amps to the left, and indication may be steady or pulsing, depending upon battery charger mode of operation.

BB1-877D

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- NORMAL OPERATION - Normal engine start

NOTE:
 Use in conjunction with COCKPIT CHECKLIST Buses are already powered by either external power or APU power. AC BUS X TIE switch should be in AUTO position. DC BUS X TIE switch should be in OPEN position.



Before starting left engine, place selector switch to L AC VOLT/FREQ position.

START LEFT ENGINE

As rpm increases, L CSD OIL PRESS LOW light should go off, and voltage and frequency should increase and stabilize at approximately 115 volts and 400 cps.

Shortly before frequency reaches 400 cps, the L GEN OFF and EXT PWR L BUS or APU L BUS power in use lights should go off. If APU generator was used, APU GEN OFF light will come on.

The left AC LOAD meter will indicate some load and all DC LOAD meters should continue to indicate dc load.

The L CSD TEMP indicator will slowly increase and stabilize in the normal range. Place the APU L BUS and APU R BUS switches or the EXT PWR L BUS and EXT PWR R BUS switches to OFF.

START RIGHT ENGINE

As rpm increases, R CSD OIL PRESS LOW light should go off, and voltage and frequency should increase and stabilize at approximately 115 volts and 400 cps.

Shortly before frequency reaches 400 cps, the R GEN OFF and EXT PWR R BUS or APU R BUS power in use lights should go off. The right AC LOAD meter will indicate some load and all DC LOAD meters will continue to indicate dc load.

The R CSD TEMP indicator will slowly increase and stabilize in the normal range.

APU GEN OFF	DC TRANSFER BUS OFF		
L AC BUS OFF	R AC BUS OFF		
L GEN OFF	R GEN OFF		
L CSD OIL PRESS LOW	R CSD OIL PRESS LOW		
DC BUS OFF		AC EMER BUS OFF	DC EMER BUS OFF

BB1-879C

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- NORMAL OPERATION

VERIFICATION OF AC & DC EMERGENCY POWER TRANSFER RELAY AND AC CROSSTIE RELAY OPERATION.

ACTION

Place the AC BUS X TIE switch to OPEN position and place the L GEN switch in OFF position.

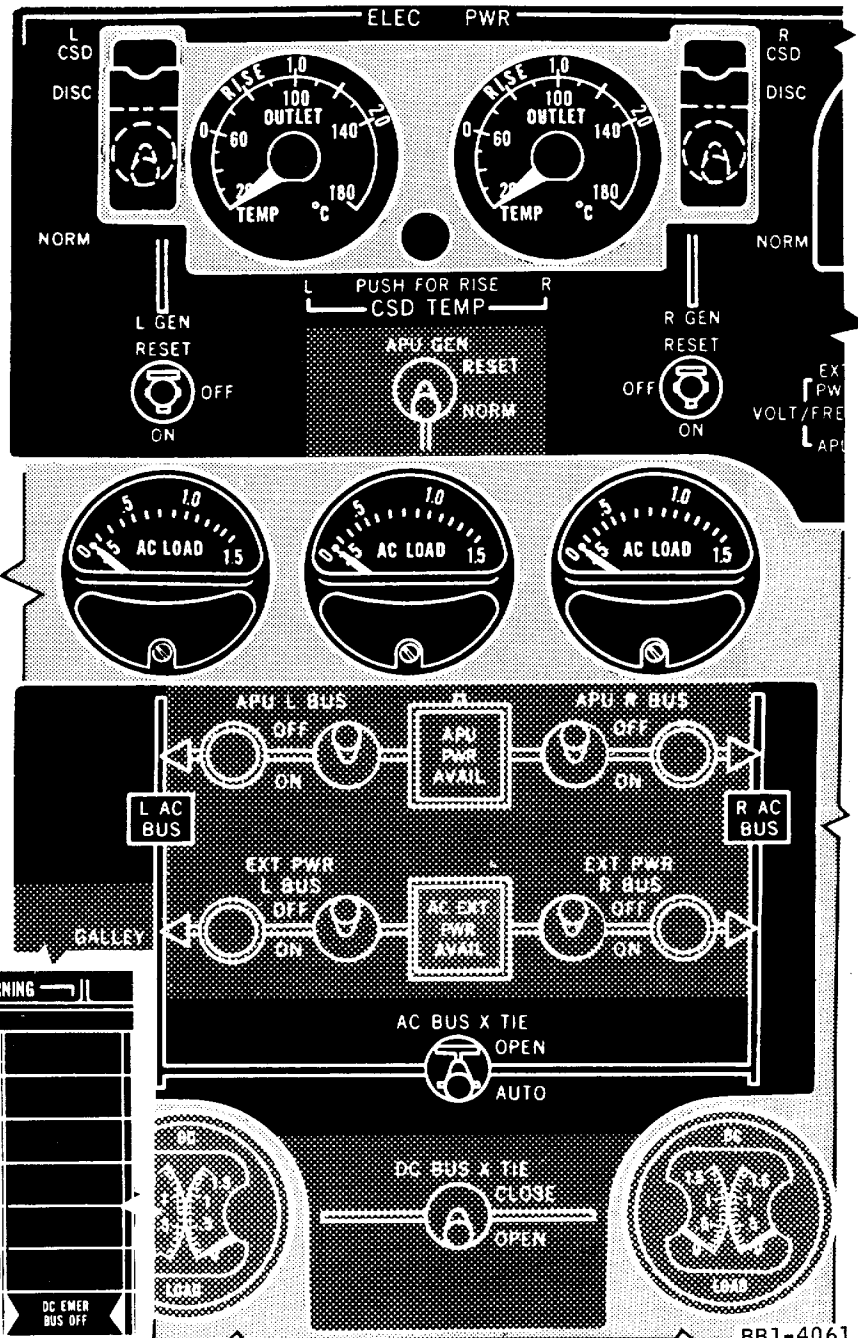
The L GEN OFF light, L AC BUS OFF light, and the DC BUS OFF light should come on.
 The AC EMER BUS OFF light and the DC EMER BUS OFF light should stay off.

Place the AC BUS X TIE switch in AUTO position. The L AC BUS OFF lights, and the DC BUS OFF light should go off. The left AC LOAD meter should indicate zero and the right AC LOAD meter indication should approximately double.

Place L GEN switch to ON. L GEN OFF light should go off. Left AC LOAD meter should increase and the right AC LOAD meter should decrease, both showing some load. All Electrical system warning and caution annunciators should be off.

NOTE:

This check should be accomplished prior to first flight of the day.
 All electrical buses must be powered by the engine-driven generators.
 If external or APU electrical power are connected, the EXT PWR and APU L and R BUS power switches must be OFF.



ELECTRIC		WARNING	
APU GEN OFF	DC TRANSFER BUS OFF		
L AC BUS OFF	R AC BUS OFF		
L GEN OFF	R GEN OFF		
L CSD OIL PRESS LOW	R CSD OIL PRESS LOW		
	DC BUS OFF	AC EMER BUS OFF	DC EMER BUS OFF

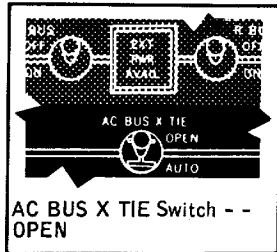
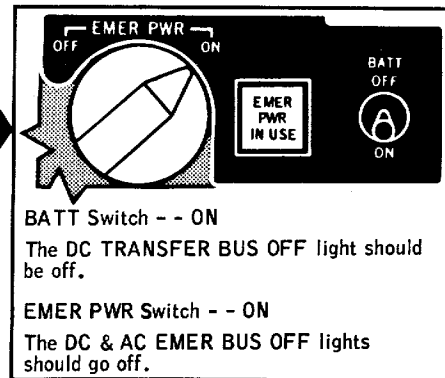
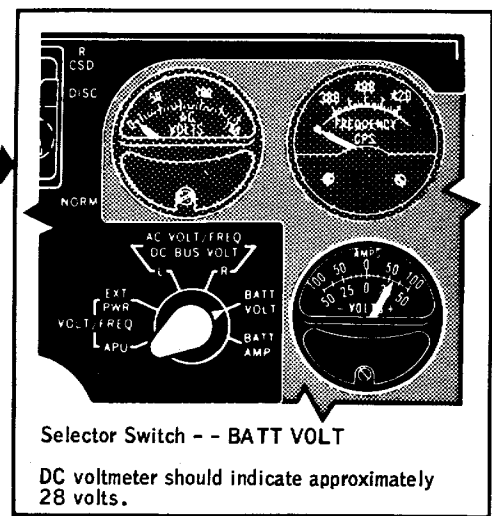
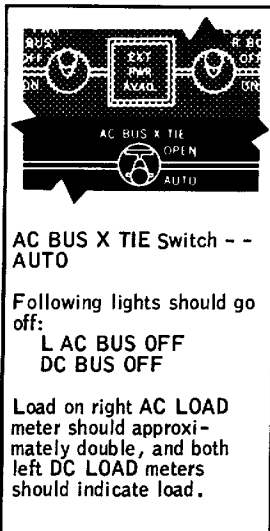
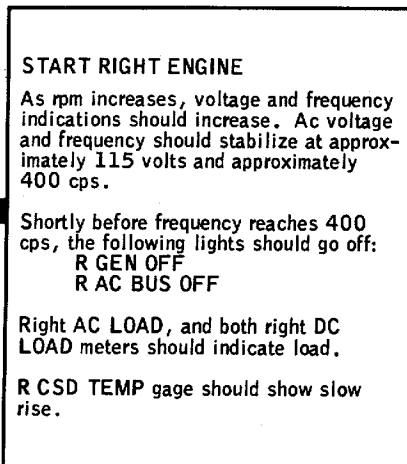
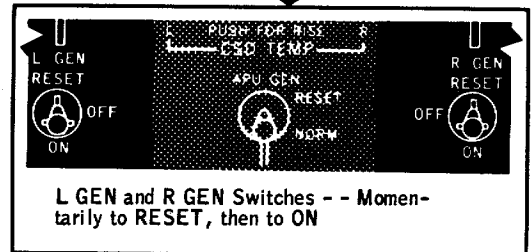
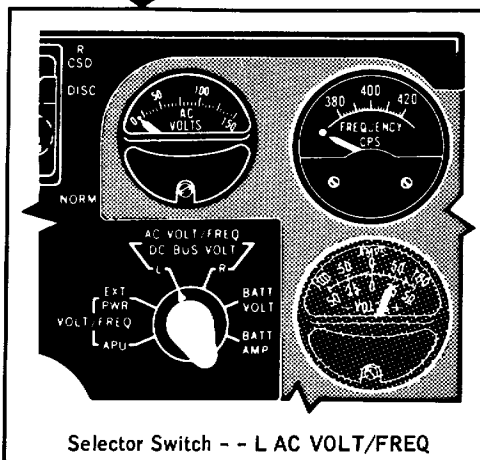
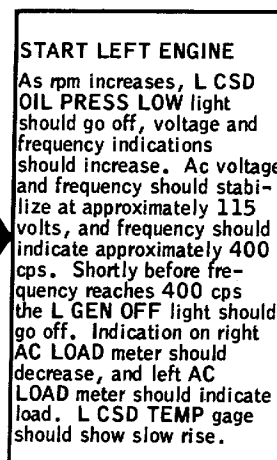
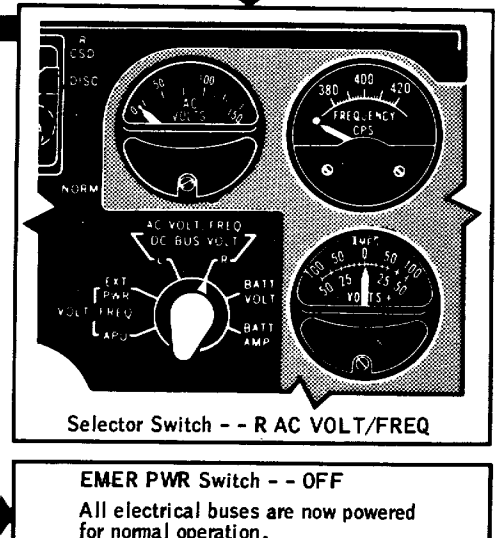
BB1-4061

ELECTRICAL -- ABNORMAL OPERATION (battery start)

NOTE:

The following procedures are to be used in conjunction with the COCKPIT CHECKLIST (battery engine start).

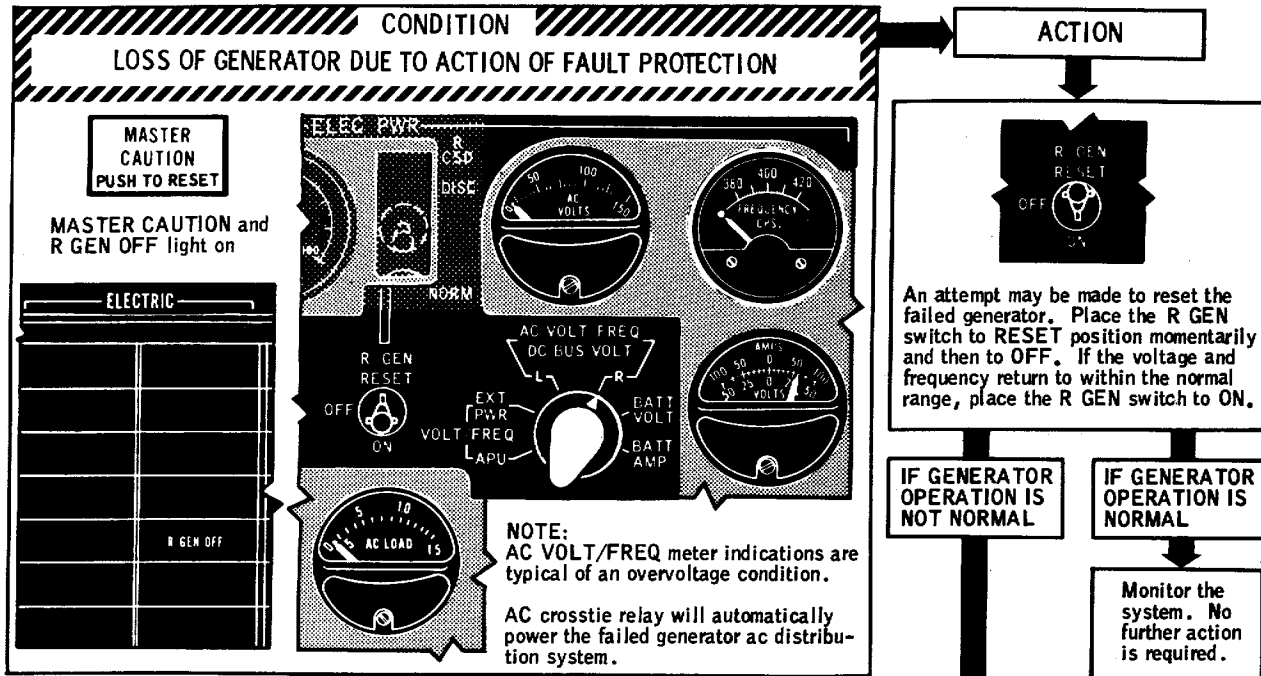
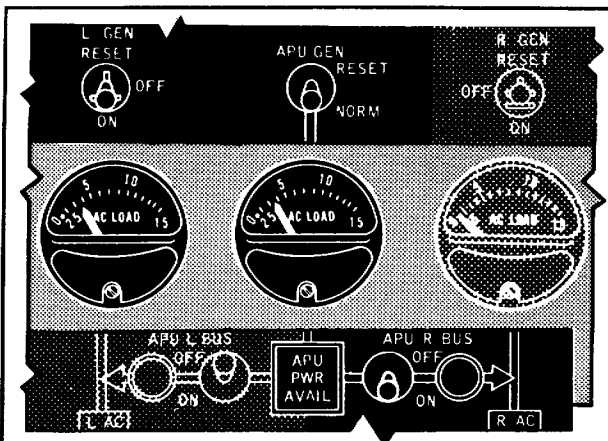
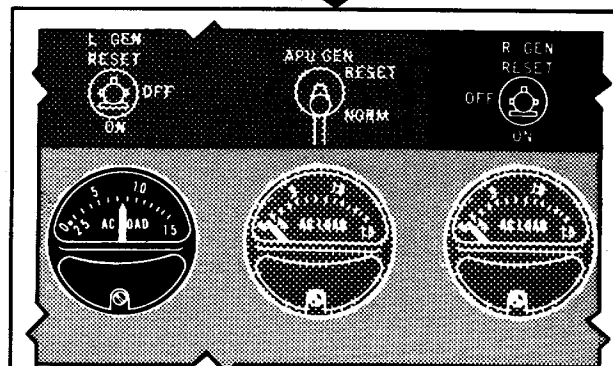
CONDITION ENGINE START WITH NO APU OR EXTERNAL ELECTRICAL POWER AVAILABLE



BB1-21E

ELECTRICAL -- ABNORMAL OPERATION

NOTE: Malfunction of right generator shown.



OR

While the airplane is airborne, the APU generator will crossfeed through the ac crosstie relay should the remaining generator fail. Prior to landing, turn on the remaining L APU BUS switch and turn left or right AIR CONDITIONING SUPPLY switch to OFF.

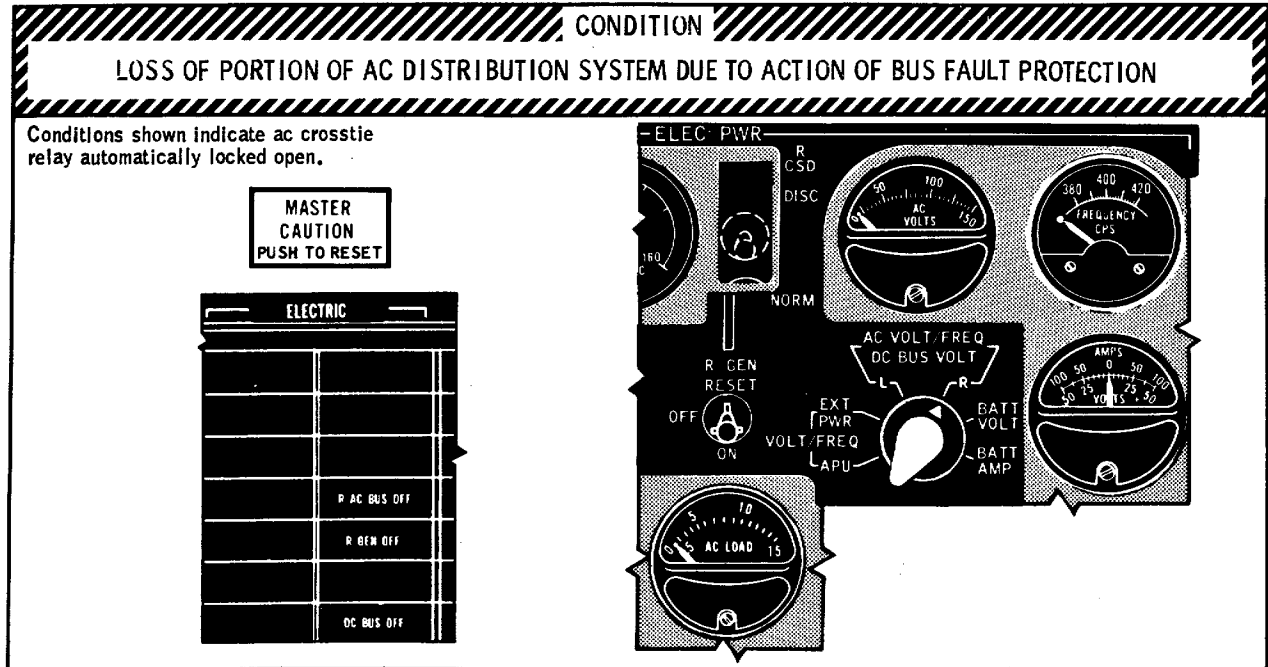
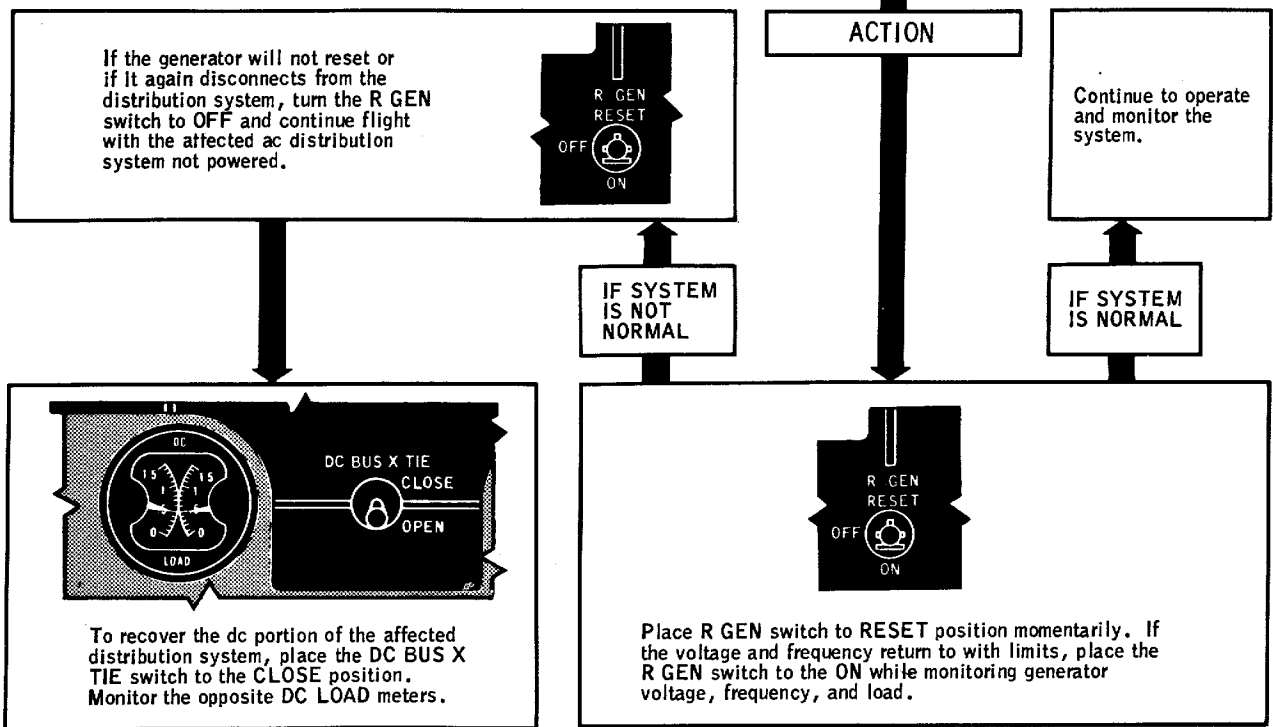
BB1-23C

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

ELECTRICAL -- ABNORMAL OPERATION

NOTES:

- A. Typical of differential fault protection action or bus fault protection action.
- B. Loss of right ac distribution system illustrated.



BB1-22C

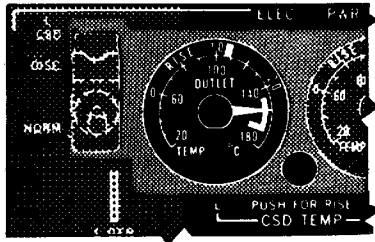
ELECTRICAL -- ABNORMAL OPERATION (sheet 1)

MALFUNCTION OF CONSTANT SPEED DRIVE (CSD)

NOTE: Malfunction of left CSD shown.

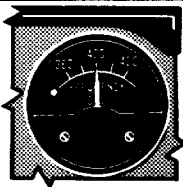
CONDITION

CSD OIL OUTLET TEMPERATURE INCREASING INTO CAUTION (YELLOW) ZONE.



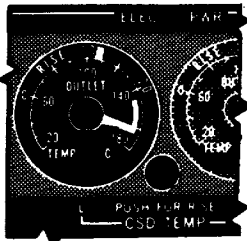
ACTION

Periodically check oil OUTLET TEMP gage and generator frequency gage. If temperature remains within caution limits and frequency remains within limits, continue operation of generator.



CONDITION

CSD OIL OUTLET TEMPERATURE STEADILY INCREASES TOWARD DANGER ZONE (RED RADIAL), OR GENERATOR FREQUENCY IS OUT OF LIMITS OR FLUCTUATING.



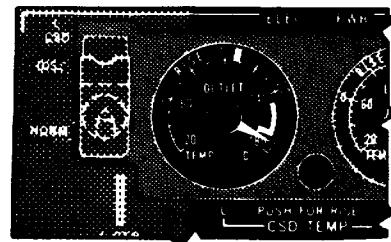
ACTION

Place L GEN switch to OFF. If CSD temperature stabilizes below the danger zone the CSD need not be disconnected.



CONDITION

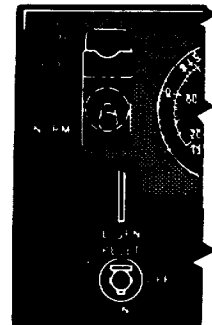
CSD OIL OUTLET TEMPERATURE INCREASES AND STABILIZES IN THE DANGER (RED) ZONE.



ACTION

Place L GEN switch to OFF. Disconnect CSD by placing L CSD switch in DISC position and hold for at least 3 seconds.

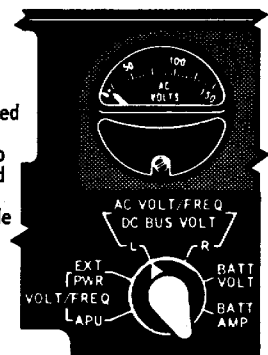
CAUTION: SWITCH ACTION IS IRREVOCABLE. MAKE CERTAIN SWITCH TO BE ACTUATED IS FOR MALFUNCTIONING CSD.



VERIFY

Verify that CSD has disconnected by the following:

- Place selector switch to L AC VOLT/FREQ and observe that ac voltage goes to extreme left side of scale.
- CSD OIL PRESS LOW light comes on.

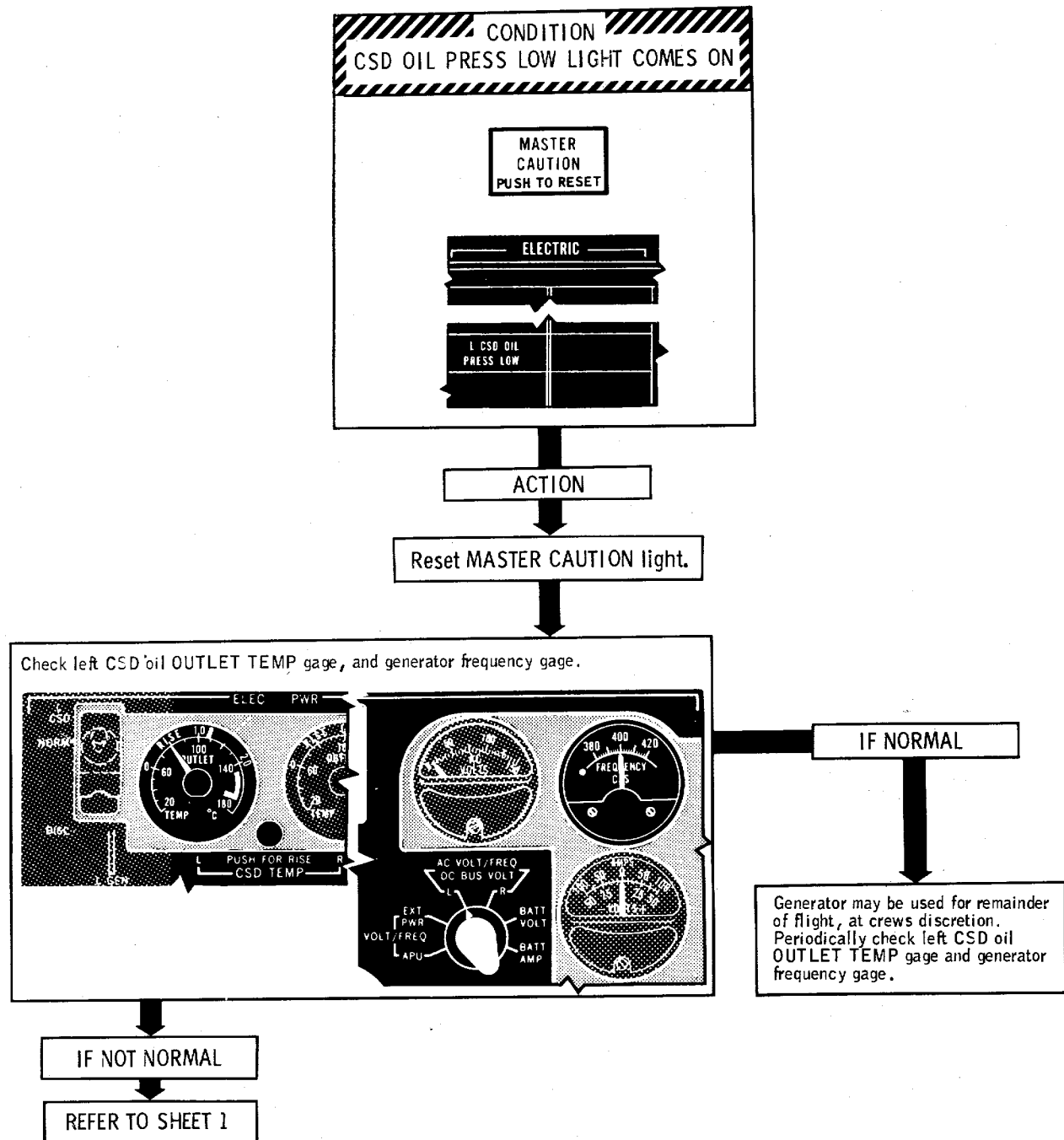


BB1-25E

ELECTRICAL -- ABNORMAL OPERATION (sheet 2)

MALFUNCTION OF CONSTANT SPEED DRIVE (CSD)

NOTE: Malfunction of left CSD shown.



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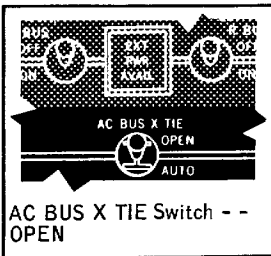
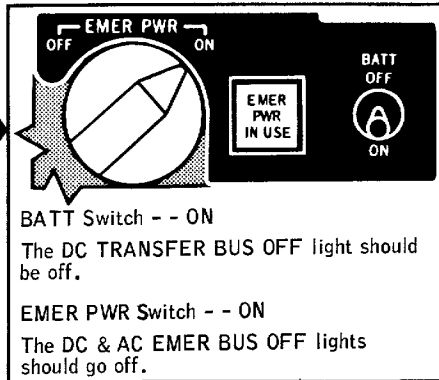
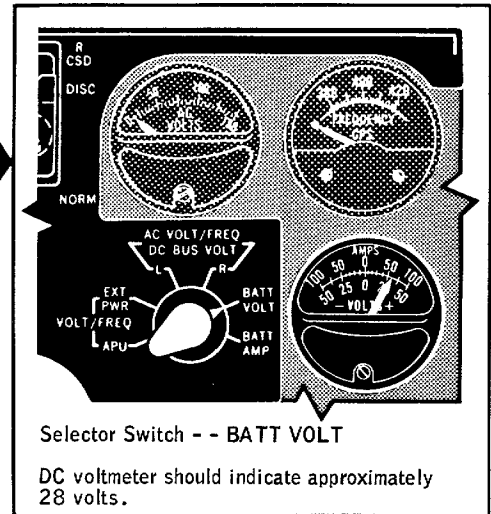
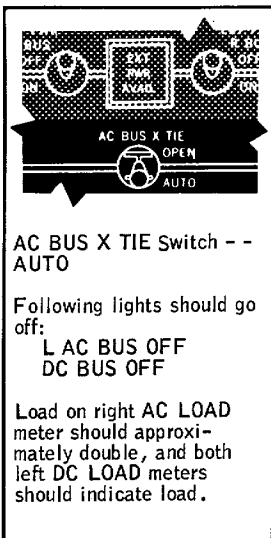
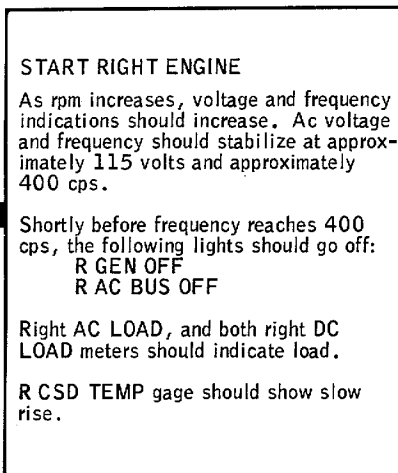
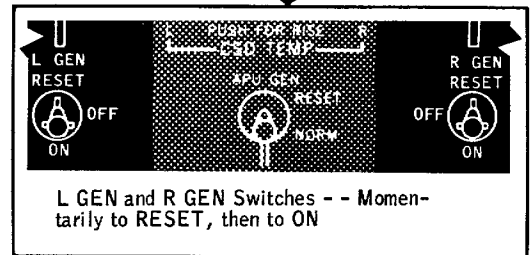
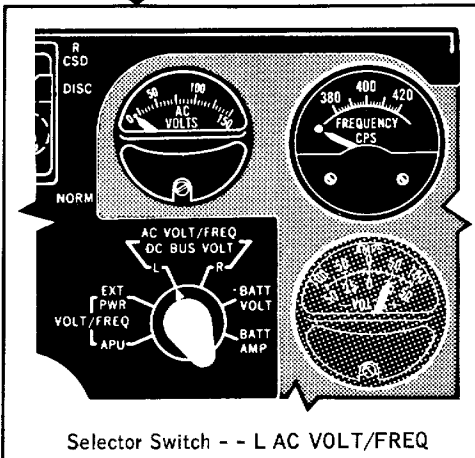
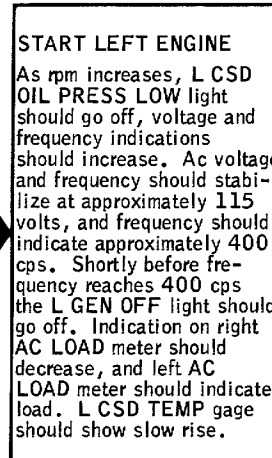
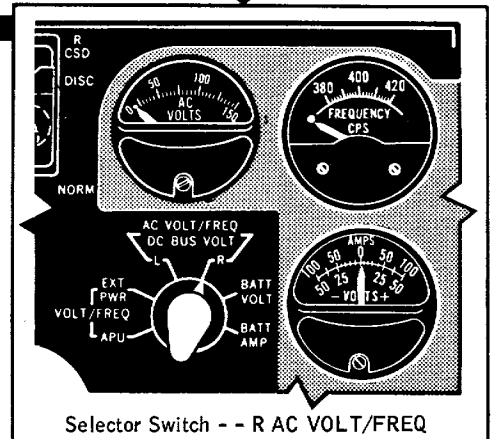
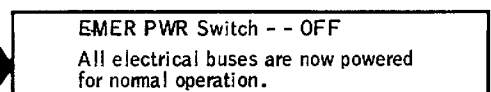
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ELECTRICAL -- ABNORMAL OPERATION (battery start)

NOTE:

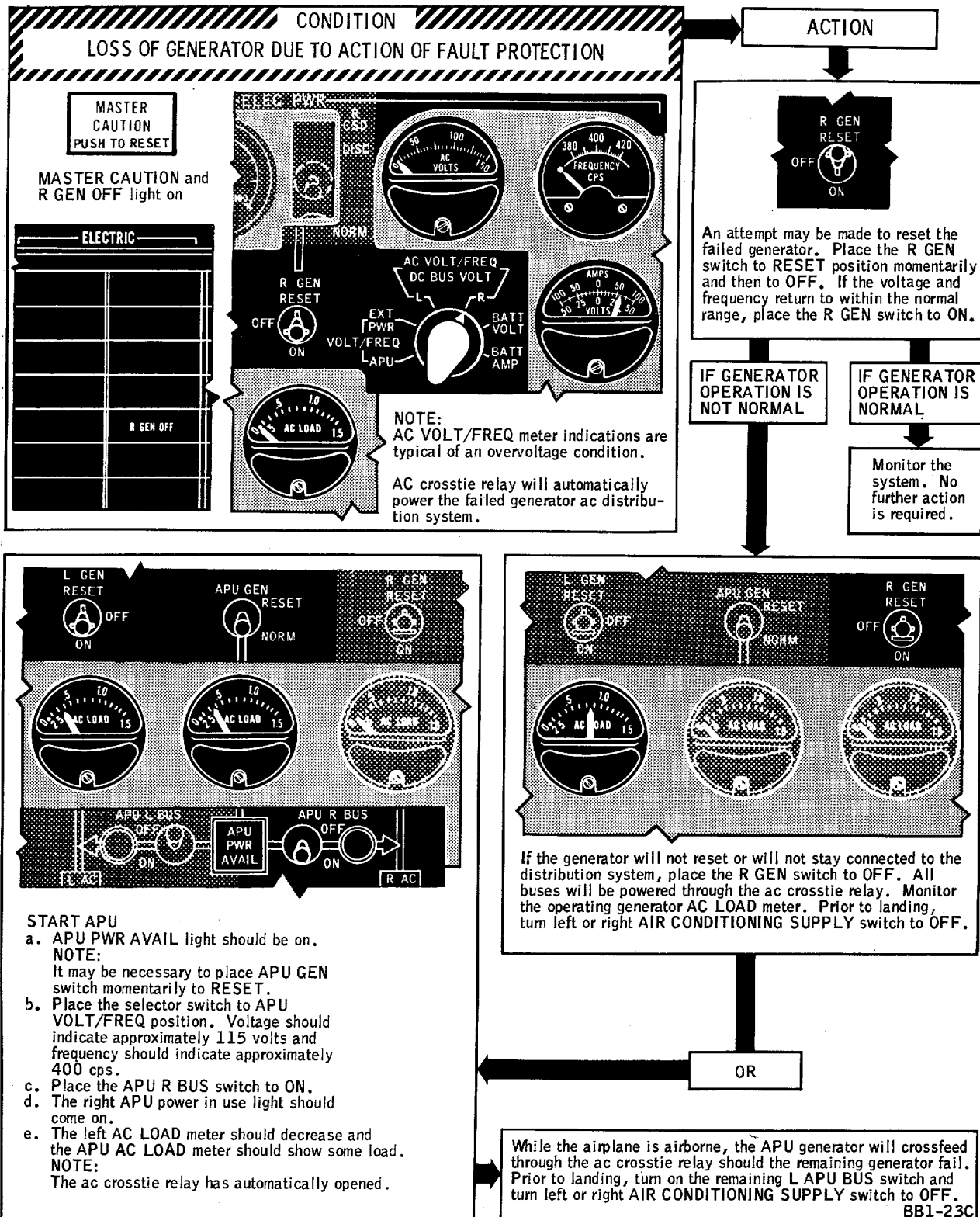
The following procedures are to be used in conjunction with the COCKPIT CHECKLIST (battery engine start).

CONDITION **ENGINE START WITH NO APU OR EXTERNAL ELECTRICAL POWER AVAILABLE**



ELECTRICAL -- ABNORMAL OPERATION

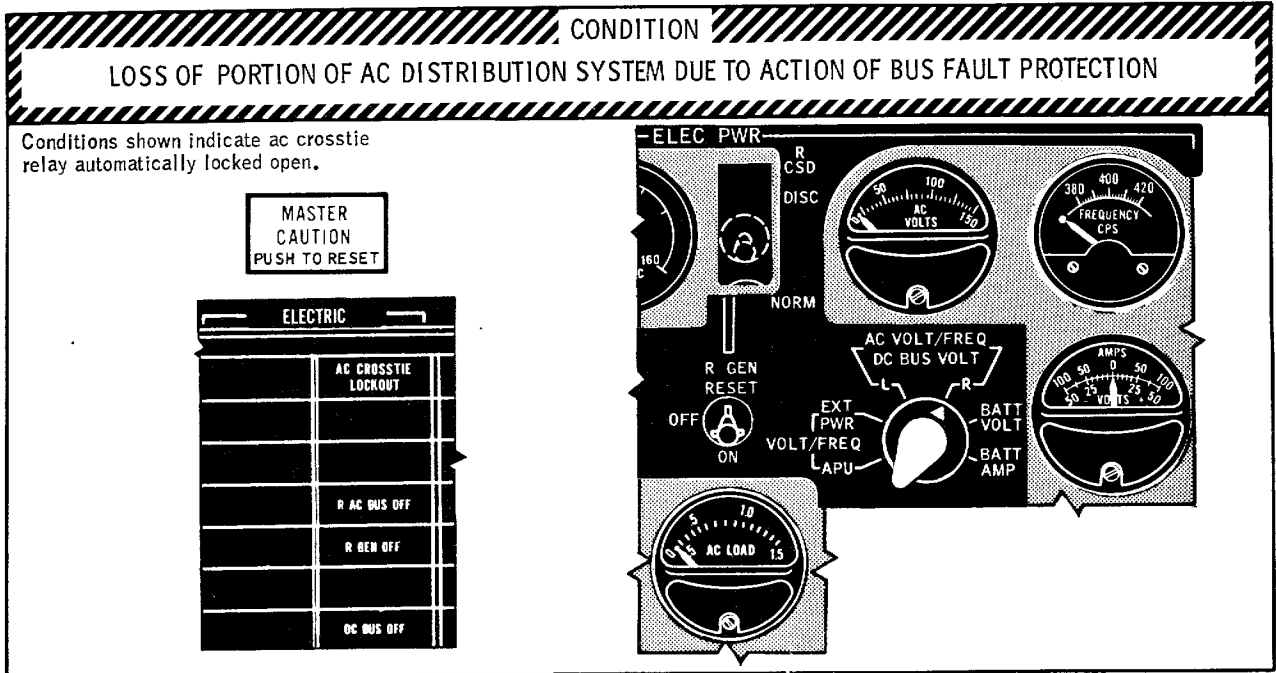
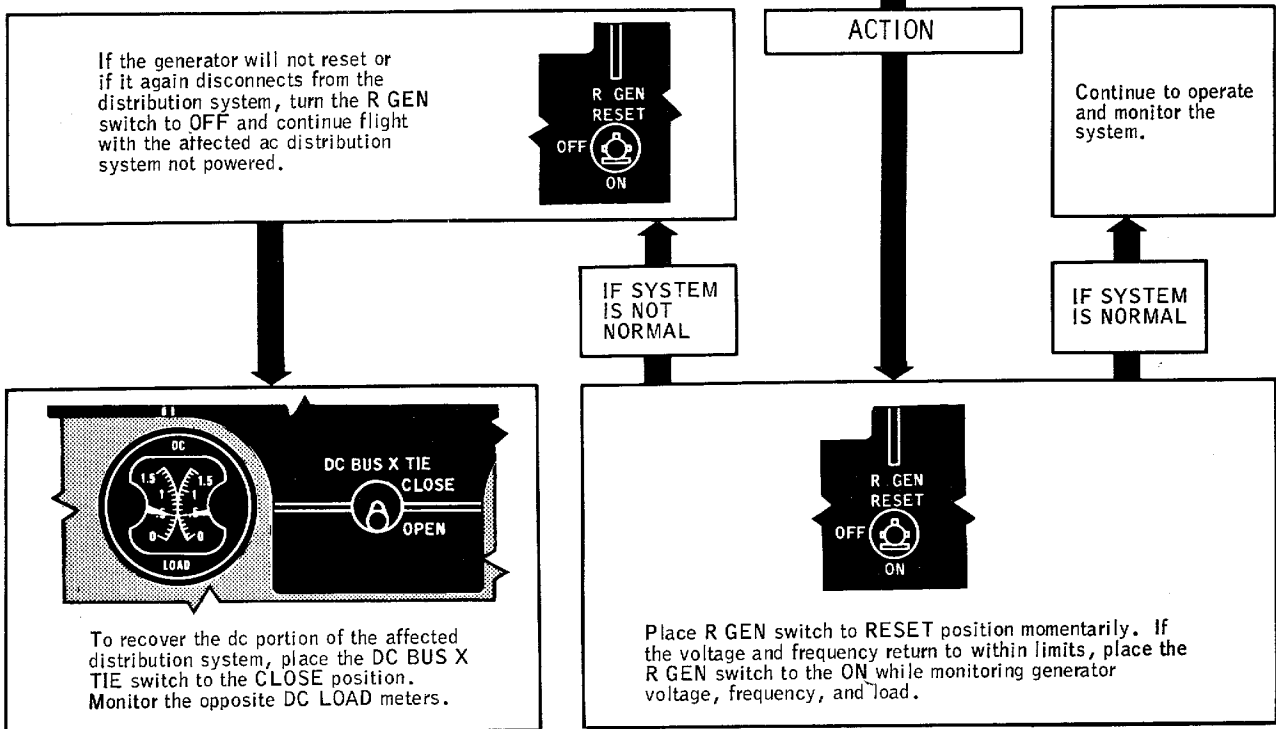
NOTE: Malfunction of right generator shown.



ELECTRICAL -- ABNORMAL OPERATION

NOTES:

- A. Typical of differential fault protection action or bus fault protection action.
 B. Loss of right ac distribution system illustrated.

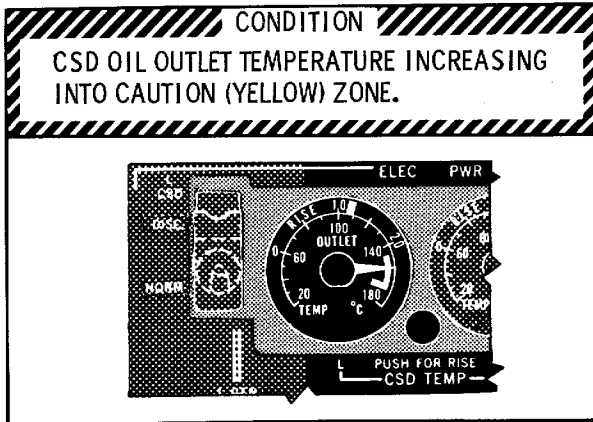


BBI-4335

ELECTRICAL -- ABNORMAL OPERATION (sheet 1)

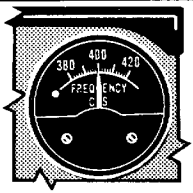
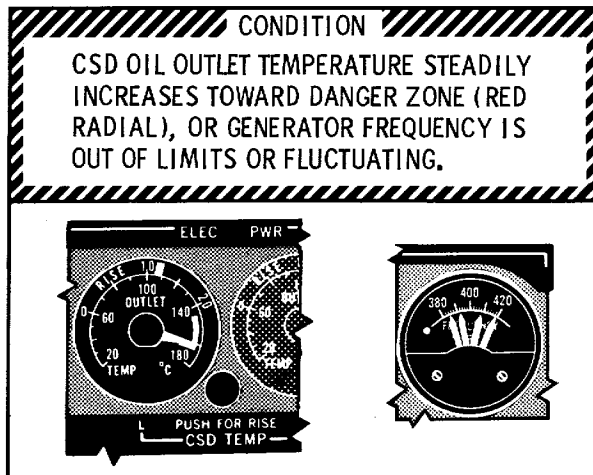
MALFUNCTION OF CONSTANT SPEED DRIVE (CSD)

NOTE: Malfunction of left CSD shown.



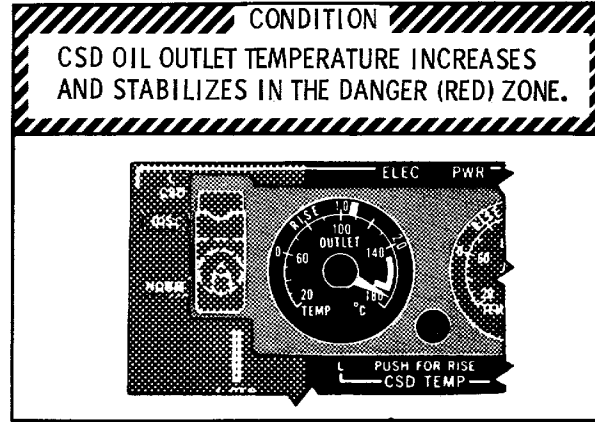
ACTION

Periodically check oil OUTLET TEMP gage and generator frequency gage. If temperature remains within caution limits and frequency remains within limits, continue operation of generator.



ACTION

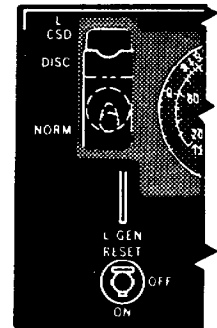
Place L GEN switch to OFF. If CSD temperature stabilizes below the danger zone the CSD need not be disconnected.



ACTION

Place L GEN switch to OFF. Disconnect CSD by placing L CSD switch in DISC position and hold for at least 3 seconds.

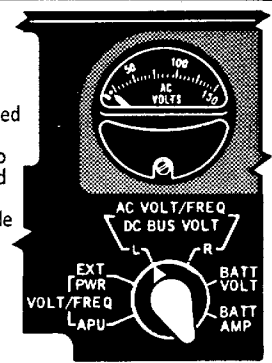
CAUTION: SWITCH ACTION IS IRREVOCABLE. MAKE CERTAIN SWITCH TO BE ACTUATED IS FOR MALFUNCTIONING CSD.



VERIFY

Verify that CSD has disconnected by the following:

- Place selector switch to L AC VOLT/FREQ and observe that ac voltage goes to extreme left side of scale.
- CSD OIL PRESS LOW light comes on.

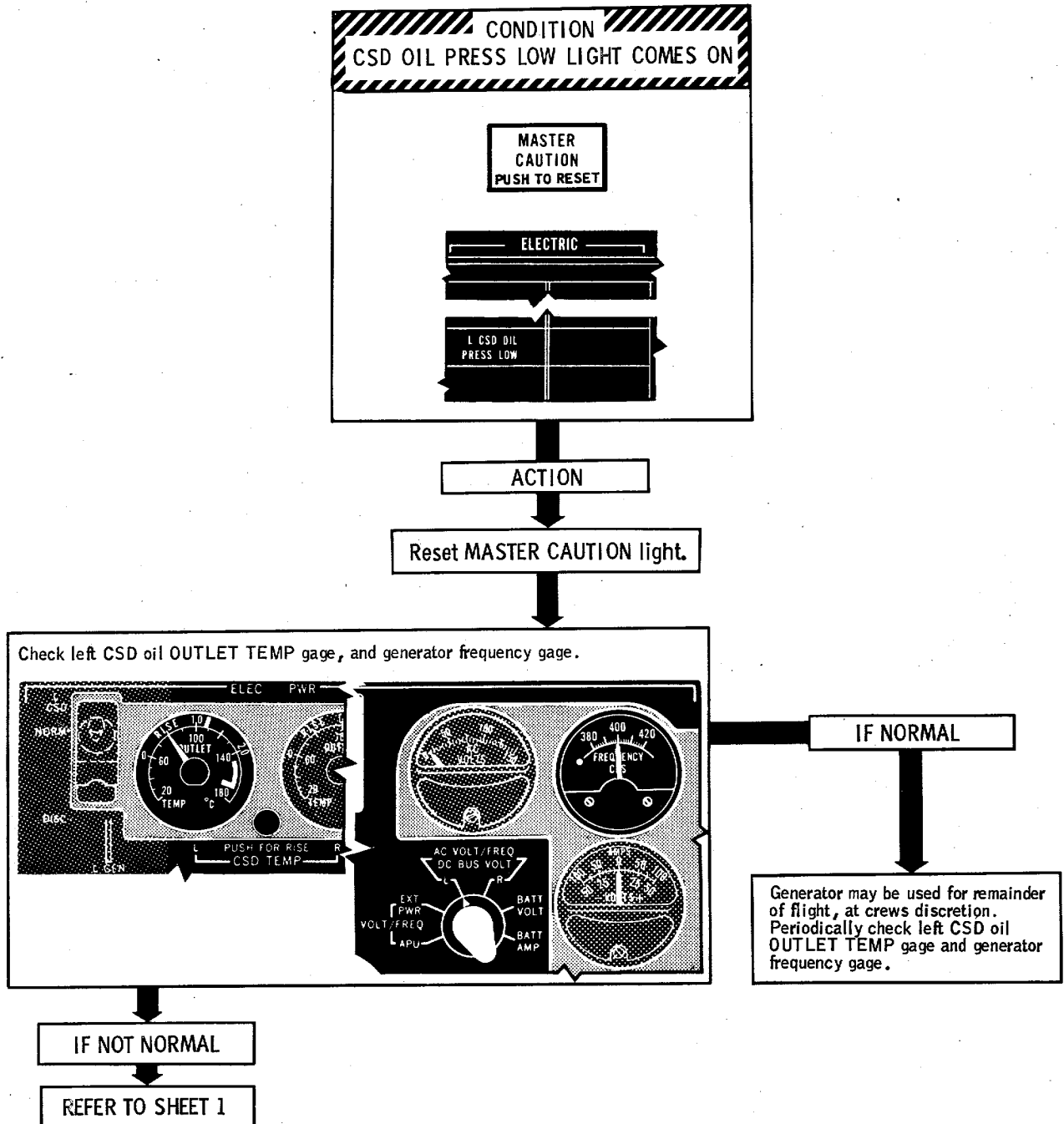


BB1-25E

ELECTRICAL -- ABNORMAL OPERATION (sheet 2)

MALFUNCTION OF CONSTANT SPEED DRIVE (CSD)

NOTE: Malfunction of left CSD shown.



BB1-473D

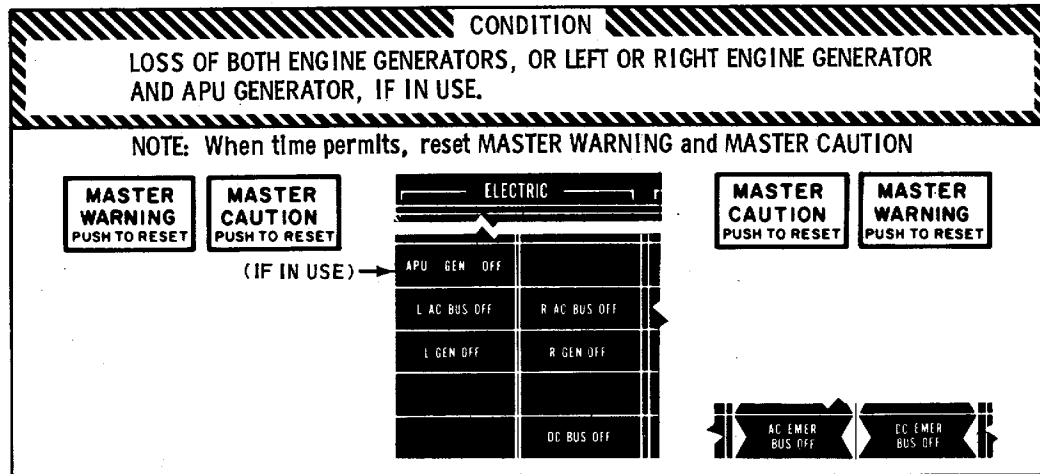
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ELECTRICAL -- ABNORMAL OPERATION



ACTION

EMER PWR switch. **ON**
The DC and AC EMER BUS OFF lights should go off.

THNDRSTRM LIGHT switch. **ON**
Captain's and First Officer's instrument panel white incandescent floods and the overhead switch panel white incandescent flood should come ON.

NOTE: At Captain's discretion and/or when time permits, the intensity of the illumination can be controlled by turning on the white flood controls (small knobs), then turning the THNDRSTRM switch to OFF and then regulating the intensity as desired.

BATT switch. **(CHECK) ON**
The DC TRANSFER BUS OFF light should be OFF.

NOTE: Buses that are powered with the BATT switch and EMER PWR switch ON are: Battery Direct Bus, Battery Bus, DC Transfer Bus, AC Emergency Bus, and DC Emergency Bus. The batteries, if fully charged, will power all of the equipment listed on the overhead emergency circuit breaker panel for approximately 45 minutes. The pilot should use only that equipment essential to flight. The flight instruments may take up to approximately 3 minutes erection time before warning flags will disappear. During this time, the airplane should be flown straight and level.

CABIN PRESS controller. **MANUAL**
Manually lock cabin pressure control in position to maintain a zero rate-of-climb or descent.

CABIN TEMP switch. **MANUAL**
Manually control temperature for desired output. The cabin temperature indicator and the valve position indicators are inoperative when on emergency power. Therefore, any temperature adjustments should be made in momentary increments, waiting to observe the results between adjustments.

AC BUS X-TIE switch. **OPEN**

GALLEY switch. **OFF**

LEFT GEN (or APU GEN) switch. **RESET/ON (NORMAL)**

RIGHT GEN (or APU GEN) switch. **RESET/ON (NORMAL)**

An attempt may be made to reset the failed generator(s). Place the L GEN SWITCH to RESET position momentarily and then to OFF. Place the selector to L AC VOLT/FREQ position. If the voltage and frequency return to within the normal range, place the L GEN SWITCH to ON. Attempt to reset the R GEN or APU GEN in the same manner.

If generator operation is NOT normal.

Position L & R GEN switches to OFF.
Attempt APU airstart using windmill RPM. Refer to section 2, chapter 32.
Start APU. APU PWR AVAIL light should be ON.

NOTE: After start, it may be necessary to place APU GEN switch to RESET.

Place the selector to APU VOLT/FREQ position. Voltage and frequency should indicate in the normal range. Place the APU L BUS switch to ON. The L APU power in use light should come on. Place the APU R BUS switch to ON. The R APU power in use light should come ON.

NOTE: Prior to landing, turn left or right air conditioning SUPPLY switch to OFF.

If either or both generator operation is NORMAL

AC X-TIE switch	AUTO
CABIN PRESS	AUTO
CABIN TEMP	AUTO
THNDRSTRM LT switch	OFF
EMER PWR switch	OFF
GALLEY switch (if electrical load permits)	ON

Continue operation and monitor the system.

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ELECTRICAL -- ABNORMAL OPERATION

CONDITION

AC EMER BUS OFF LIGHT COMES ON

NOTE: A false indication of an AC EMER BUS OFF light will occur if the EMERGENCY AC BUS SENSING circuit breaker, located on the EMERGENCY AC BUS trips, or if the sensing circuit senses an open circuit.

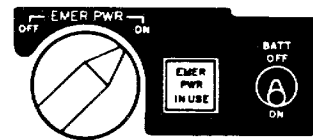


ACTION

Reset MASTER WARNING light.

MASTER
WARNING
PUSH TO RESET

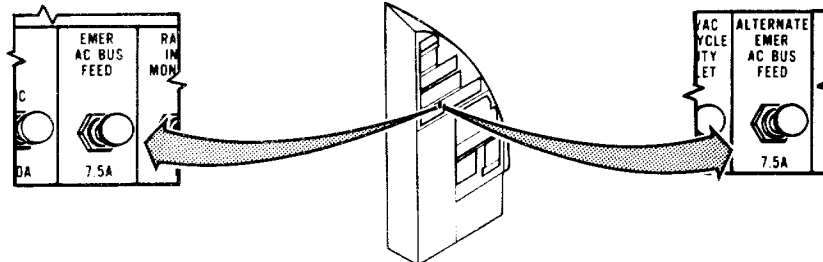
If both the Captain's and First Officer's instrument power has been affected, place the EMER PWR switch to ON.



NOTE: Operation with the EMER PWR switch in the ON position will power the EMERGENCY AC BUS, EMERGENCY DC BUS, and DC TRANSFER BUS. The batteries, if fully charged, will power certain emergency equipment for approximately 45 minutes. The pilot should use only that equipment that is essential to flight.

If First Officer's instrument power has not been affected, continue flight with the unaffected instruments.

Check EMER AC BUS FEED and ALTERNATE EMER AC BUS FEED circuit breakers.



If circuit breakers have tripped, attempt reset of ALTERNATE EMER AC BUS FEED circuit breaker first.
Attempt to reset ALTERNATE EMER AC BUS FEED circuit breaker one time only.

If ALTERNATE EMER AC BUS FEED circuit breaker trips again, or will not reset:

Do not attempt to reset EMER AC BUS FEED circuit breaker.
Do not turn on EMER PWR switch. A bus fault possibly exists.

If ALTERNATE AC EMER BUS FEED circuit breaker, has not tripped, continue operations with the affected equipment inoperative or, at the pilot's option, place the EMER PWR switch to ON.

NOTE: Operation with the EMER PWR switch in the ON position will power the EMERGENCY AC BUS, the EMERGENCY DC BUS, and the DC TRANSFER BUS. The batteries, if fully charged, will supply certain emergency equipment for approximately 45 minutes. The pilot should use only that equipment essential to flight.

NOTE: The flight instruments may take up to approximately 3 minutes erection time before warning flags will disappear. During this time, the airplane should be flown straight and level.

If the EMER AC BUS OFF light is still on, place the EMER PWR switch to OFF and continue flight with the unaffected equipment.

BB1-2626B

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ELECTRICAL -- ABNORMAL OPERATION

CONDITION
DC EMER BUS OFF LIGHT COMES ON

NOTE:
A false indication of a DC EMER BUS OFF light will occur if the EMERGENCY DC BUS SENSING circuit breaker, located on the EMERGENCY DC BUS circuit breaker panel, trips, or if the sensing circuit senses an open circuit.

DC EMER
BUS OFF

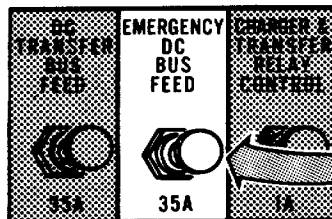
ACTION

Reset MASTER WARNING light

MASTER
WARNING
PUSH TO RESET

Continue operation with affected
equipment inoperative.

When time permits, check EMERGENCY DC
BUS FEED circuit breaker.



If circuit breaker has tripped,
reset one time only.

If circuit breaker trips again,
or if it will not reset,
do not turn on EMER PWR switch.
A bus fault possibly exists.

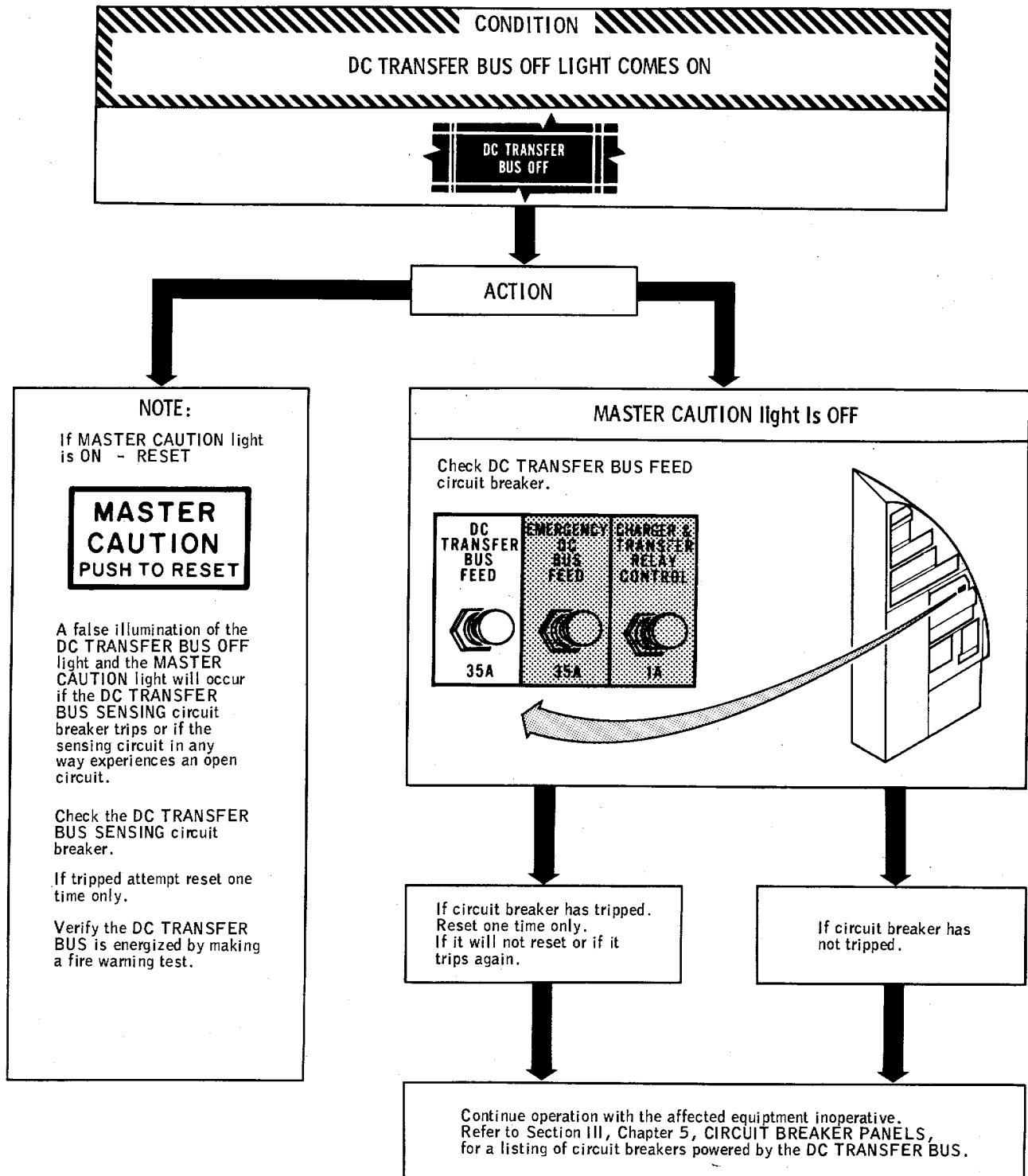
If circuit breaker has not tripped, continue operation with
affected equipment inoperative or, at the pilot's option,
place EMER PWR switch to ON position.

NOTE:

Operation with the EMER PWR switch in the ON position will power the EMERGENCY AC BUS, the EMERGENCY DC BUS, and the DC TRANSFER BUS. The batteries, if fully charged, will supply power for certain emergency equipment for approximately 45 minutes. Only equipment essential for safe flight should be used.

BB1-3216

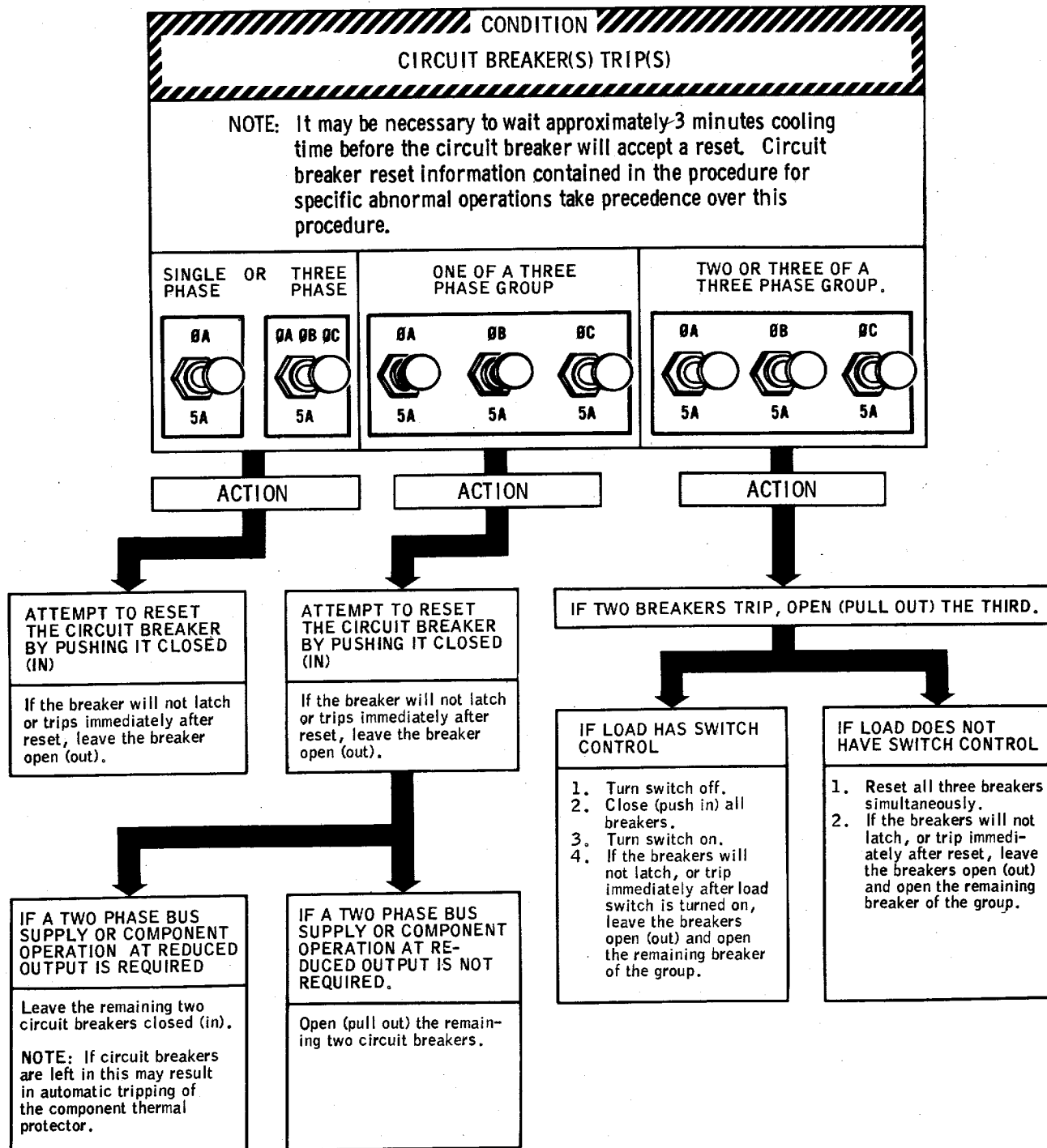
ELECTRICAL -- ABNORMAL OPERATION



BB1-2549B

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ELECTRICAL -- ABNORMAL OPERATION



NOTE: All circuit breakers protecting a single phase are trip-free. Manually holding in a breaker which will not latch, will not complete a circuit.

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2-10-Cont	66	1	Sep 1/69				
2-10-1-0	2	1	Jun 1/69				
2-10-10-0	5	1	Mar 1/69				
2-10-10-0	5	2	Sep 1/66				
2-10-15-0	6	1	Jun 1/66				
2-10-15-0	6	2	Jun 1/69				
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*The asterisk indicates pages revised or added by the current revision.

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Chapter 10

HYDRAULIC SYSTEM

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<u>*NORMAL OPERATION -</u> Flight	10-10-0	2	5	A11
<u>*ABNORMAL OPERATION -</u> Flight				
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<u>*ABNORMAL OPERATION -</u> Flight				
Quantity indication low or dropping	10-15-0	2	6	A11
<u>*ABNORMAL OPERATION -</u> Flight				
Engine hydraulic pump switch at low position but pressure indication is in 3000 psi green arc and AUX pump switch is off	10-15-0	3	6	A11
Left or right hydraulic temperature light on	10-15-0	3	6	A11

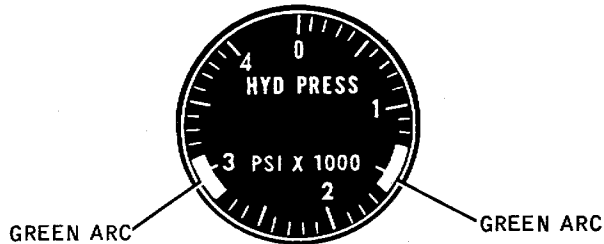
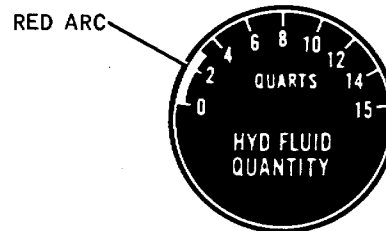
*Illustration

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HYDRAULIC -- LIMITATIONS



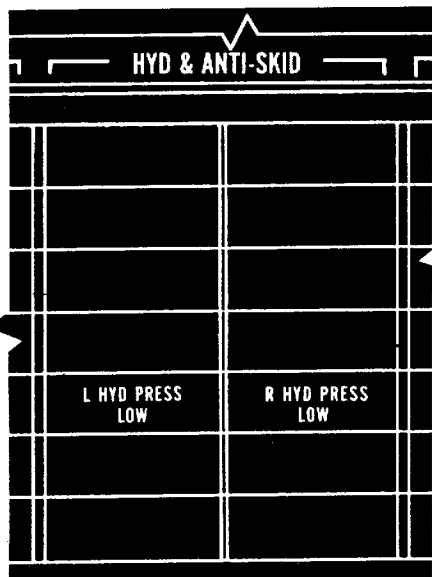
HYDRAULIC PRESSURE GAGE

2800 to 3100 psi (Green arc)
 (Electric pump and engine
 pump high mode).

1300 to 1600 psi (Green arc)
 (Engine pump low mode).

HYDRAULIC QUANTITY GAGE

0 to 3.25 quarts (Red arc)
 (Refill range)



ANNUNCIATOR PANEL LIGHTS

LIGHT GOES OFF --- When pressure
 increases to
 maximum of
 1200 psi.
 LIGHT COMES ON --- When pressure
 decreases to
 900 $\pm$ 100 psi.

ALTERNATE HYDRAULIC MOTOR/PUMP

For functional check
 3000 psi input from
 Right Hydraulic System,
 1800 - 2500 psi to
 Left Hydraulic System.
 (Left Engine Pump OFF.)

BBI-1656D

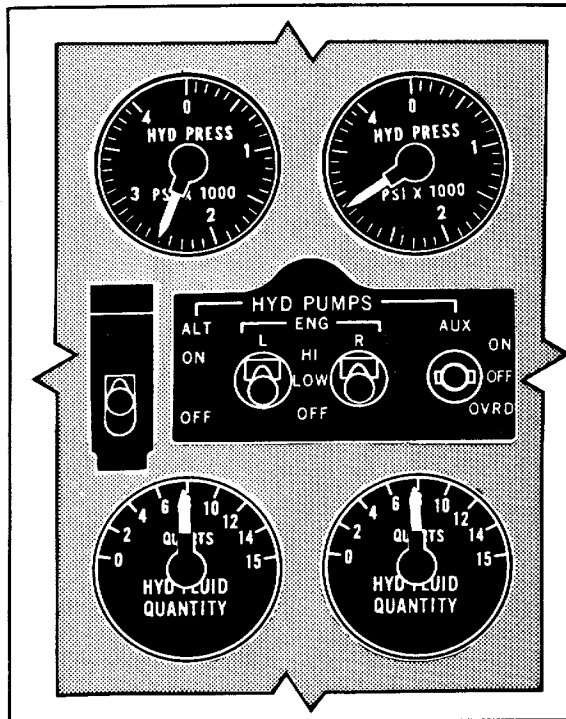
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HYDRAULIC -- NORMAL OPERATION - Hydraulic preflight check



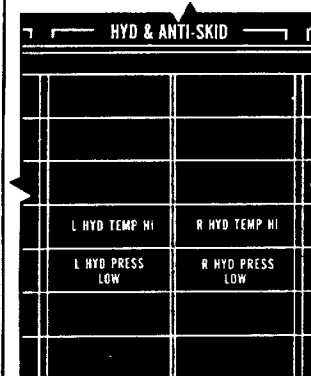
AUXILIARY HYDRAULIC PUMP OPERATION CHECK -- PREFLIGHT

Note: Low pressure lights should be on when pumps are OFF and pressure has bled down.

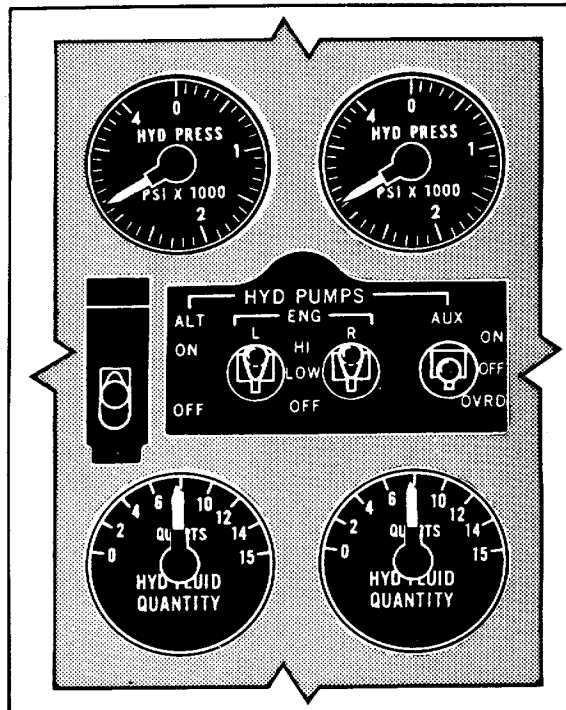
1. Check HYD FLUID QUANTITY gages - above red arc.
2. AUX and ALT HYD PUMPS -- ON.
3. Check right HYD PRESS gage -- within 3000 psi green arc.
4. Check left HYD PRESS gage --- 1800 psi minimum.
5. Check L & R HYD PRESS LOW lights -- OFF.

Note: If HYD PRESS LOW light is not off, recheck spoiler ground depressurization valve for SPOILER ON position.

6. AUX and ALT HYD PUMPS -- OFF.



ENGINE PUMPS CHECK -- ENGINE START

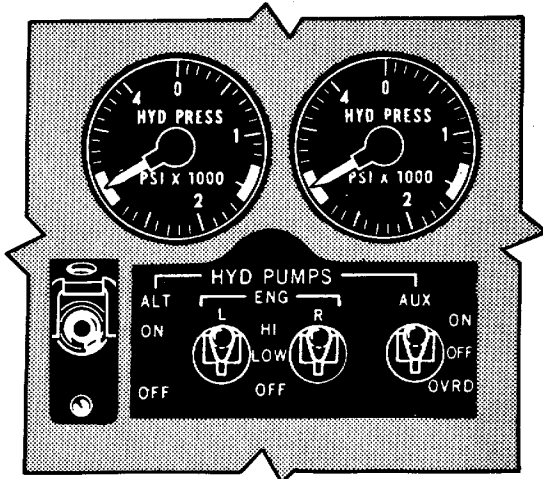


1. AUX HYD PUMP switch -- OFF
2. HYD SYSTEM PRESS -- Less than 3000 PSI green arc.
3. L & R ENG HYD PUMPS switches -- HIGH
4. During engine start, check HYD SYSTEM PRESS -- Within 3000 PSI green arc.
5. Operate any hydraulic subsystem except landing gear. Check pressure response.
6. HYD QUANTITY -- Above REFILL.
7. HYD TEMP HI & HYD PRESS LOW lights -- off.

BBI-1676C

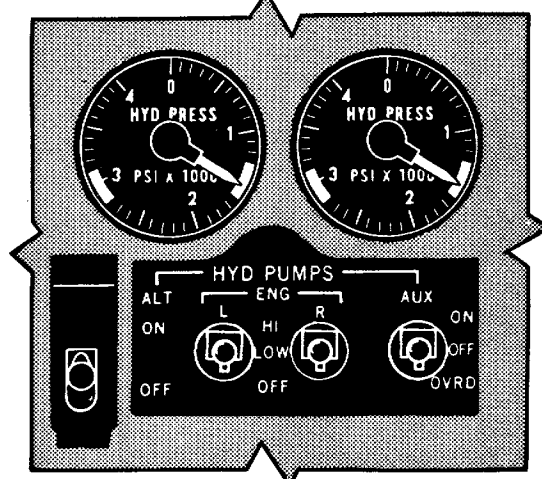
HYDRAULIC -- NORMAL OPERATION - Flight

TAKEOFF



1. ENG HYD PUMPS switches -----HIGH
2. AUX & ALT HYD pump-----ON
3. HYD TEMP HI & HYD PRESS LOW lights----- OFF

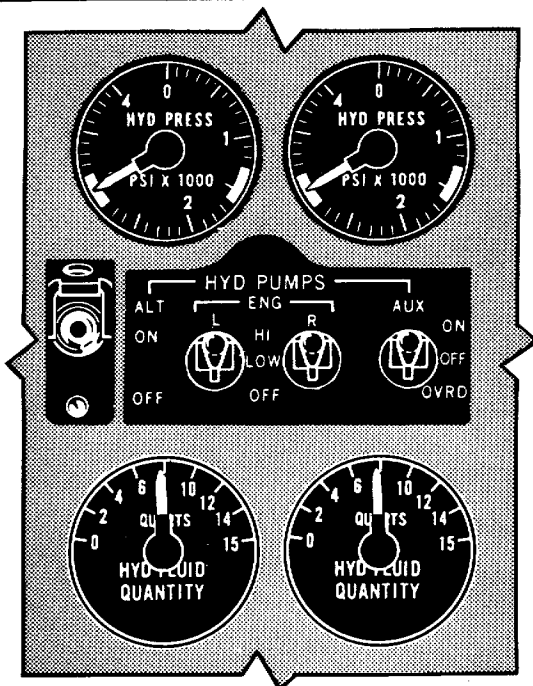
CLIMB AND CRUISE



After gear and flaps are up

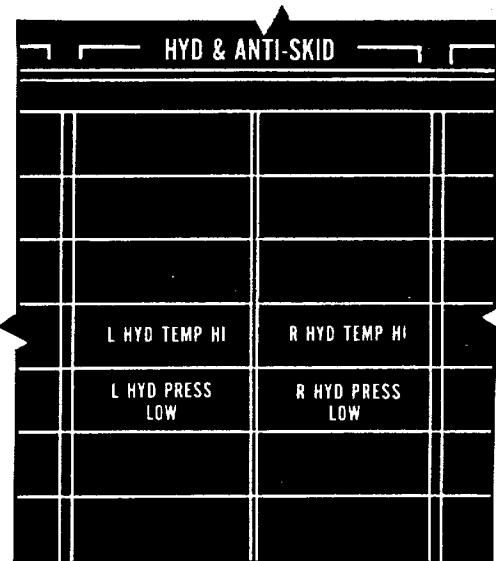
1. ALT HYD PUMP-----OFF
2. AUX HYD PUMP-----OFF
3. ENG HYD PUMP-----LOW
4. Check HYD PRESS gages ----- 1500 psi green arc
5. HYD TEMP HI & HYD PRESS LOW lights----- OFF

APPROACH AND LANDING



1. ENG HYD PUMPS -----HIGH
2. HYD PRESS gages -----3000 psi green arc
3. AUX & ALT HYD PUMPS -----ON
4. Check HYD TEMP HI & HYD PRESS LOW lights-OFF
5. Check HYD FLUID QUANTITY----- above red arc

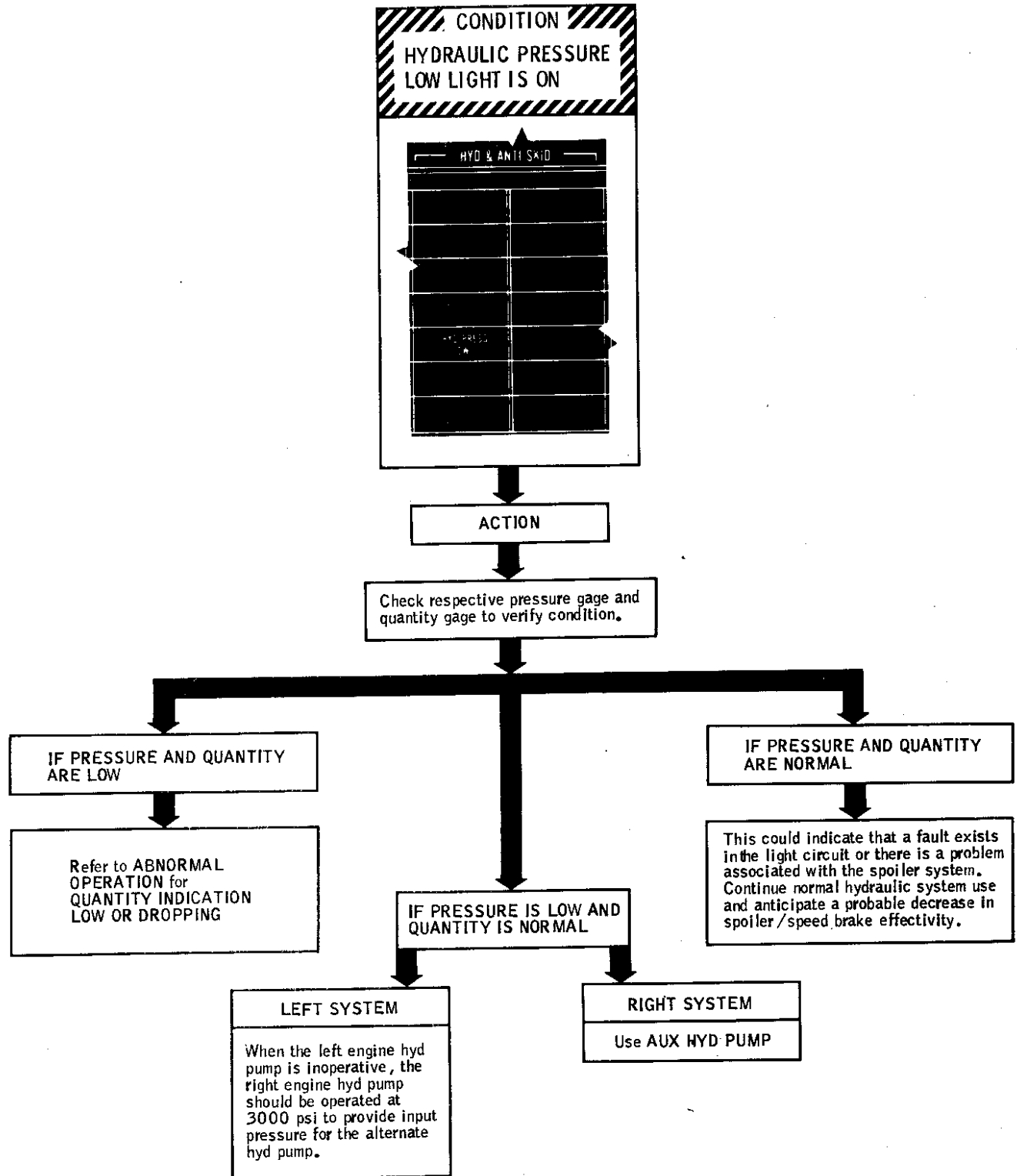
ANNUNCIATOR PANEL LIGHTS



Should remain OFF

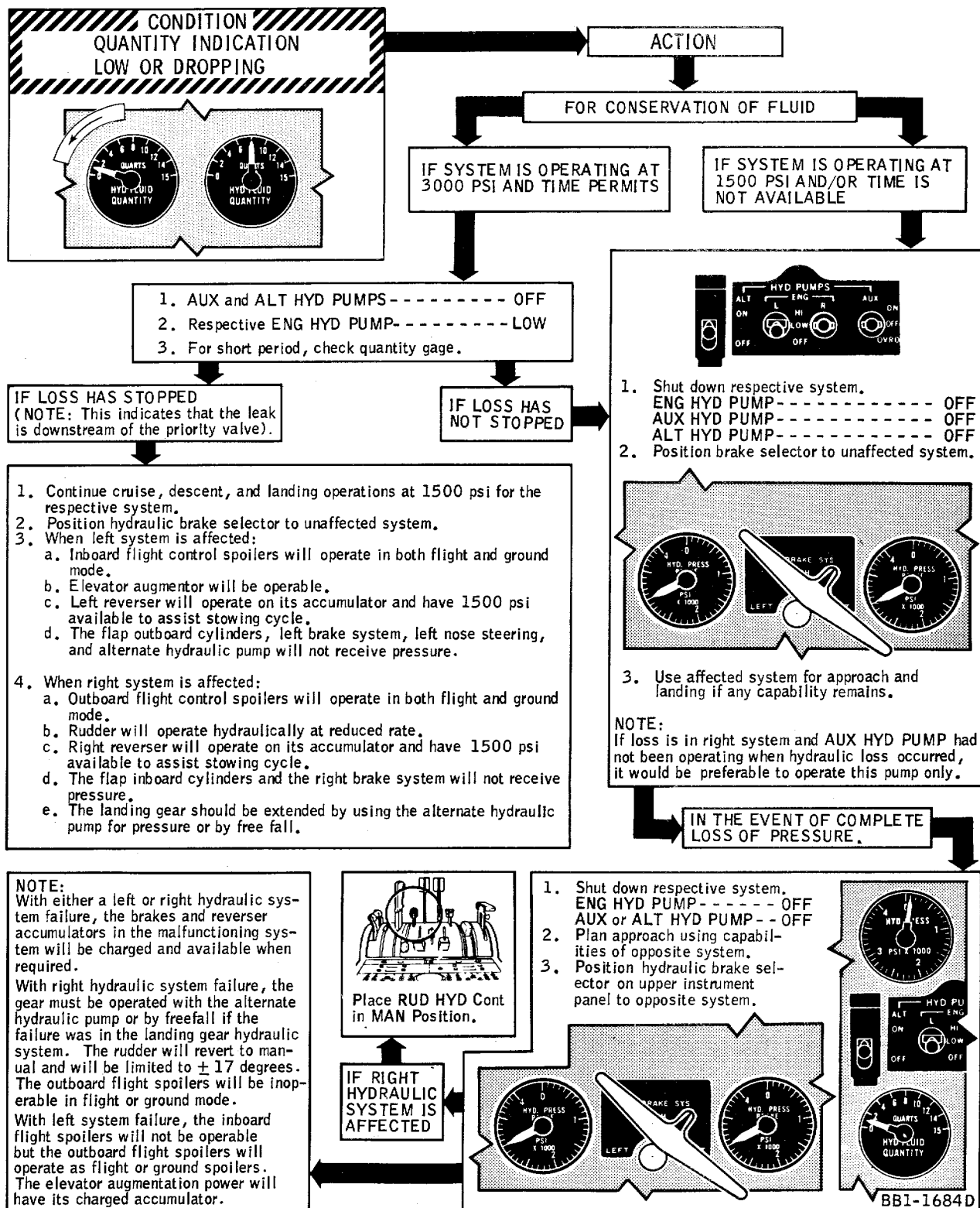
BB1-1677A

HYDRAULIC - ABNORMAL OPERATION - Flight



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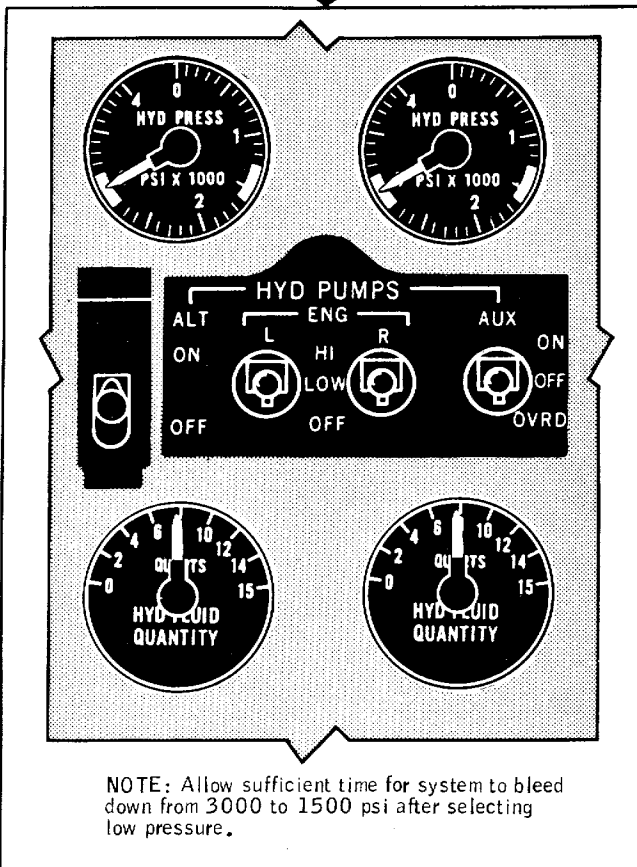
HYDRAULIC -- ABNORMAL OPERATION - Flight



BB1-1684D

HYDRAULIC -- ABNORMAL OPERATION - Flight

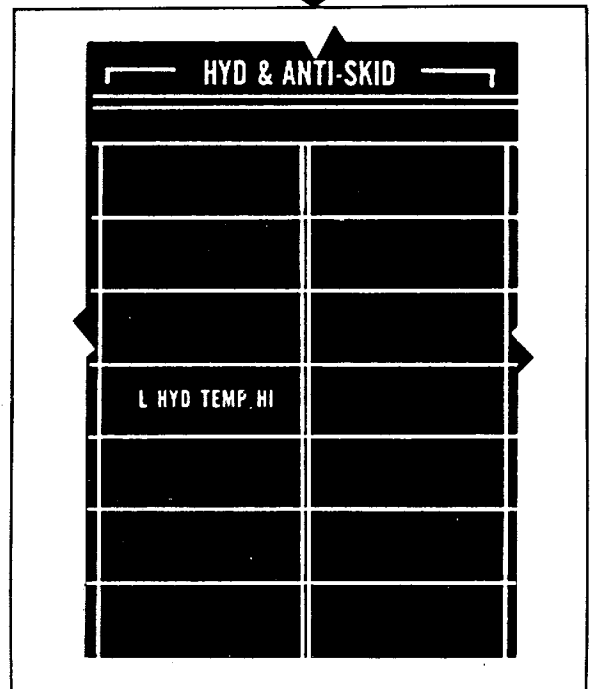
CONDITION
 ENG HYD PUMP SWITCH AT LOW POSITION BUT
 PRESSURE INDICATION IS IN 3000 PSI GREEN
 ARC AND AUX PUMP SWITCH IS OFF.



ACTION

1. Check and/or reset pump control circuit breaker.
2. If no response, place ENG PUMP at HIGH and continue to operate at full system pressure.

CONDITION
 LEFT OR RIGHT HYDRAULIC TEMPERATURE
 LIGHT ON



ACTION

1. Shutdown respective system.
 ENG HYD PUMP----- OFF
 AUX or ALT HYD PUMP----- OFF
2. Allow cooling period. If temperature light goes out reinstate hydraulic system, monitoring pressure, to check for possible regulator malfunction. This would be indicated by pressure at relief valve level of 3400-3500 psi. Use auxiliary, alternate or engine pump, whichever appears to give the most normal operation.
3. Use the system for landing, closely monitoring pressure and quantity.

BB1-1683A

Section 2
 10-15-0
 CODE 6
 Page 3

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 18, SECTION 2, CHAPTER 15, DATED DEC 1/69

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-15-15-0 REVISED ILLUSTRATION TO CORRECTLY DEPICT BRAKE TEMPERATURE GAGES.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-15-Eff	66	All	2-15-Eff	66	All
2-15-15-0	19	5 and 6	2-15-15-0	19	5 and 6

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
The following pages are effective for ATL Series 30 Aircraft.							
*2-15-Eff	66	1	Mar 1/70				
2-15-Cont	66	1	Sep 1/69				
2-15-Cont	66	2	Sep 1/69				
2-15-1-0	4	1	Dec 1/68				
2-15-10-0	2	1	Dec 1/66				
*2-15-15-0	19	1	Mar 1/70				
2-15-15-0	19	2	Sep 1/68				
2-15-15-0	19	3	Sep 1/69				
2-15-15-0	19	4	Sep 1/67				
2-15-15-0	19	5	Dec 1/68				
*2-15-15-0	19	6	Dec 1/69				

*The asterisk indicates pages revised or added by the current revision.

DOUGLAS AIRCRAFT CO.
DC-9
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Chapter 15

LANDING GEAR/BRAKE SYSTEMS

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

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<u>*GEAR AND BRAKES - LIMITATIONS</u>	15-1-0	1	4	A11
<u>*NORMAL OPERATION</u>	15-10-0	1	2	A11
<u>*ABNORMAL OPERATIONS</u>				
Alternate gear extension required after right hydraulic pressure loss	15-15-0	1	19	A11
After use of alternate hydraulic pump switch green lights not on	15-15-0	1	19	A11
<u>*ABNORMAL OPERATIONS</u>				
Landing gear control handle jammed in UP position	15-15-0	2	19	A11
<u>*ABNORMAL OPERATIONS</u>				
Gear handle down, right hydraulic system pressure 3000 psi, one or more red lights on	15-15-0	3	19	A11
<u>*Illustrations</u>				

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Chapter 15

LANDING GEAR/BRAKE SYSTEMS

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<u>*ABNORMAL OPERATIONS</u>				
Gear handle down, right hydraulic system pressure 3000 psi, one or more red lights on	15-15-0	3	19	A11
<u>*Illustrations</u>				

DOUGLAS AIRCRAFT CO.
DC-9
 FLIGHT CREW OPERATING MANUAL

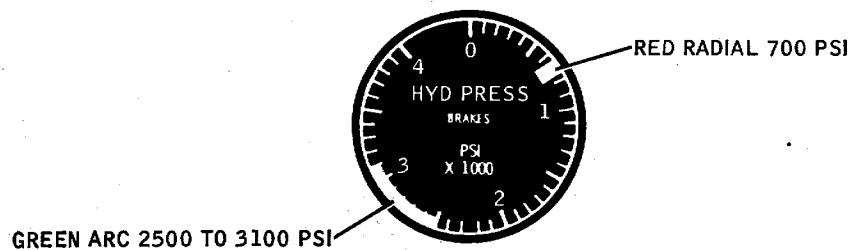
Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATIONS</u>				
Unable to raise landing gear control handle after takeoff	15-15-0	4	19	A11
Unsatisfactory uplatch check	15-15-0	4	19	A11
Red light on during cruise with landing gear control handle in UP position	15-15-0	4	19	A11
<u>*ABNORMAL OPERATIONS</u>				
During approach with gear down one or more antiskid caution lights are on	15-15-0	5	19	A11
<u>*ABNORMAL OPERATIONS</u>				
One or more brake temperature gages indicate a tempera- ture of 200° - 315°C	15-15-0	6	19	A11
One or more brake tem- perature gages indicate a temperature of 315°C or greater	15-15-0	6	19	A11

*Illustration

Section 2
 15-Contents
 CODE 66
 Page 2

LANDING GEAR -- GEAR & BRAKES - Limitations

BRAKE PRESSURE GAGE



Gear up	8.5 seconds
Gear down	15 seconds
Free fall (Flaps 0 degrees, speed 165 knots)	45 seconds
Alternate gear actuation system (RETRACTION)	60 seconds
Gear extension and full down speed	300 Knots or Mach 0.7
Gear retraction speed	250 Knots
Brake pressure at wheels	0 to 3000 pounds
Parking brake pressure at wheels	1400 to 1700 psi minimum to assure at least 8 hours parking time.
Gear load limit	10 feet/second for maximum landing weight 6 feet/second for maximum takeoff weight
Brake temperature indicator (prior to takeoff or prior to landing)	205°C (401°F).

BB1-1827D

Section 2
15-1-0
CODE 4
Page 1

Dec 1/68

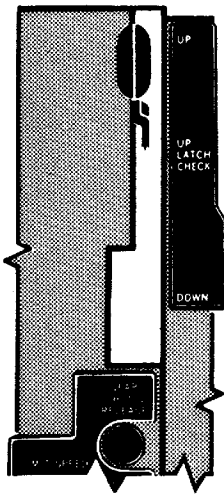
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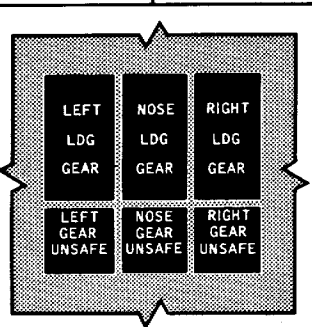
LANDING GEAR -- NORMAL OPERATION

AFTER TAKEOFF

1. After takeoff at positive climb indication place landing gear control handle UP.

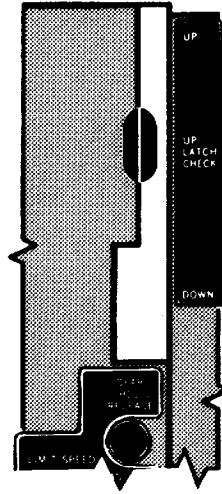


Landing gear handle up. Green lights should go out. Red lights should go out when gear is retracted and doors are latched. Gear door open amber light will also go out.

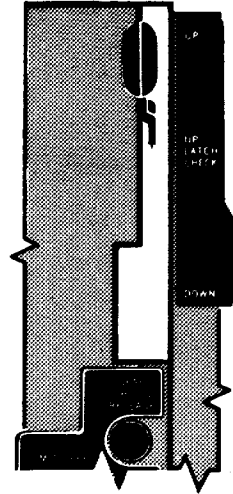


2. Prior to reaching 300 knots or MACH 0.7 place handle at UPLATCH CHECK.

Green and red lights should remain out.

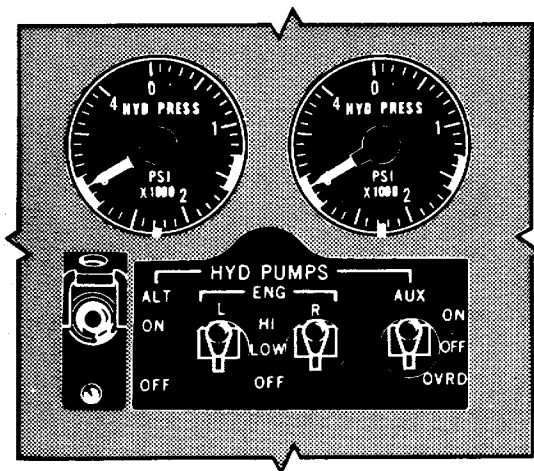


3. Return handle to UP position

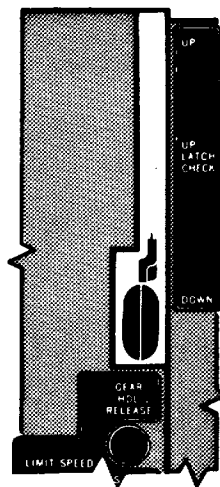


DURING APPROACH

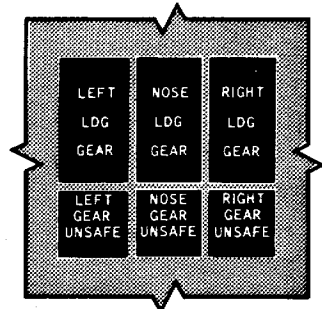
1. Check hydraulic pressure.



2. Landing gear handle DOWN.



3. Check for 3 green lights

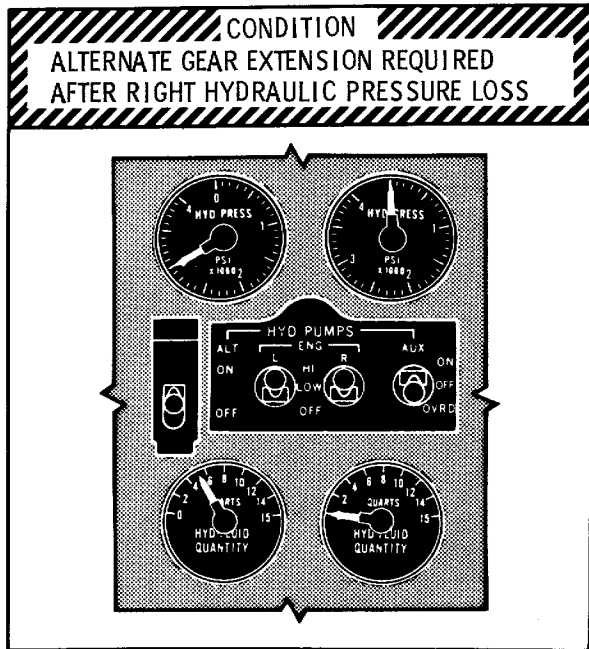


4. Gear door open light off.



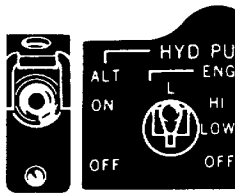
BB1-709C

LANDING GEAR -- ABNORMAL OPERATION

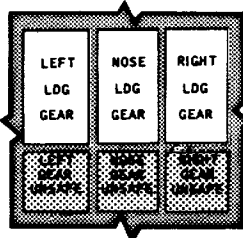


ACTION

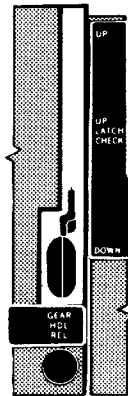
Place ALT hydraulic pump switch to the ON position, with L ENG pump switch at HI.



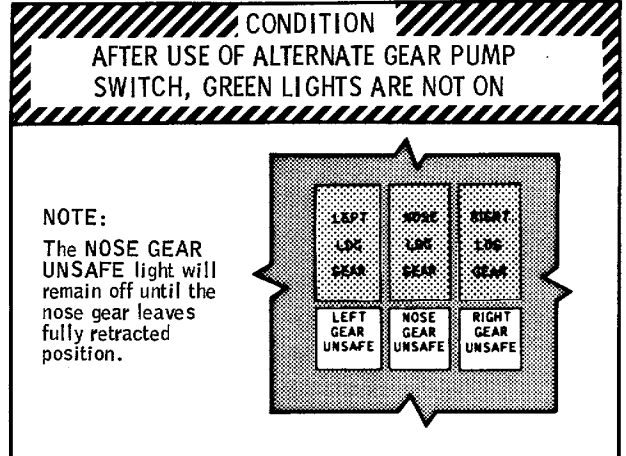
After approximately 35 seconds check for normal three green lights ON.



Place landing gear control lever to DOWN position.



GEAR DOOR OPEN amber light will be OFF.

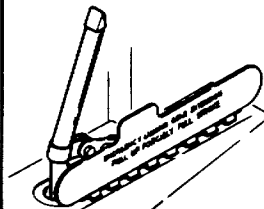
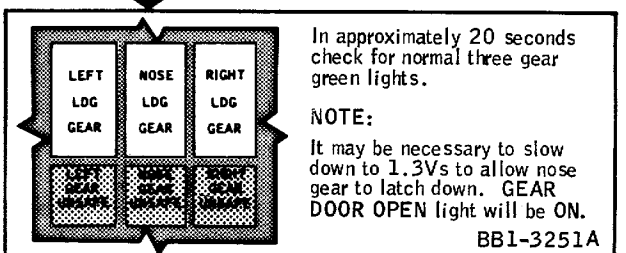


ACTION

Place ALT hydraulic pump switch to OFF position.



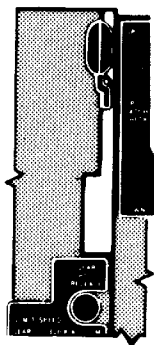
If still not in the down position, raise floor cover over the emergency landing gear extension lever. Pull emergency lever full up and check that holding latch is fully engaged.



LANDING GEAR -- ABNORMAL OPERATION

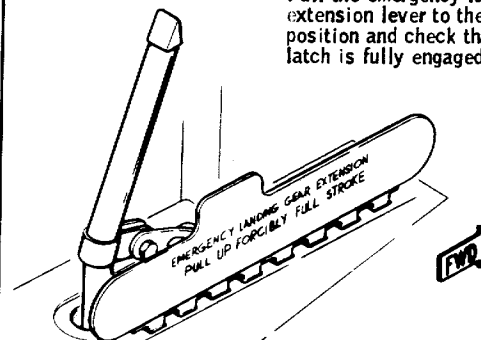
CONDITION

LANDING GEAR CONTROL HANDLE JAMMED
IN THE UP POSITION



ACTION

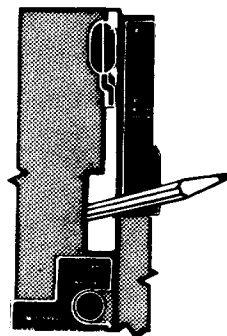
Pull the emergency landing gear extension lever to the full UP position and check that holding latch is fully engaged.



Recheck landing gear down locks visually on all gear positions.

Landing gear warning horn will come on after flaps are selected beyond approach position and cannot be silenced by landing gear horn off button. The horn may be silenced by pulling the circuit breaker placarded **LANDING GEAR WARNING**.

NOTE: Pulling the **LANDING GEAR WARNING** circuit breaker may also restore the antiskid braking system to normal operation. This can be verified by making a self-test of the antiskid system.



Again try to place the control handle to the down position. If unsuccessful, the green lights will not come on, and the nose landing lights and antiskid system will be inoperative.

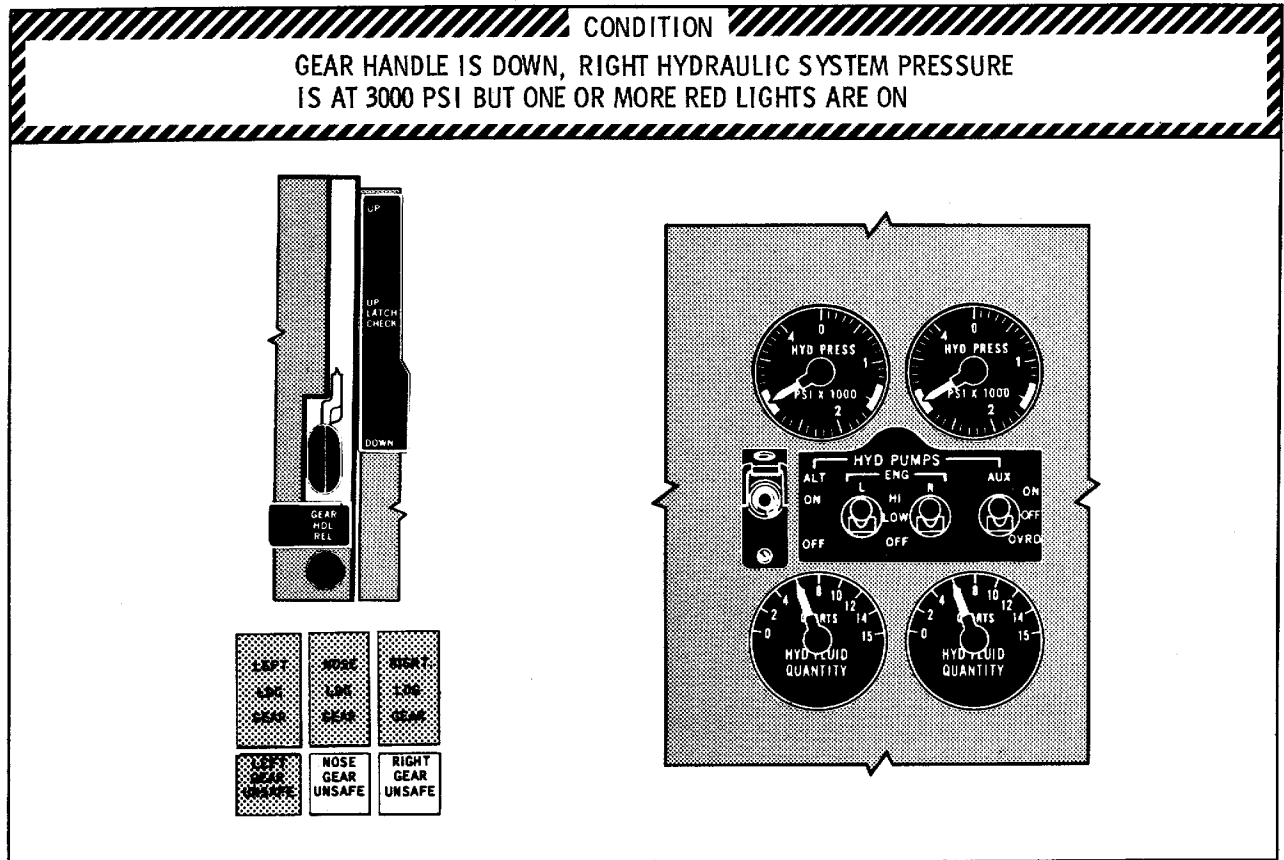
NOTE: The detent switch can be activated by use of a pencil or similar object to check the **LDG GEAR** green lights.



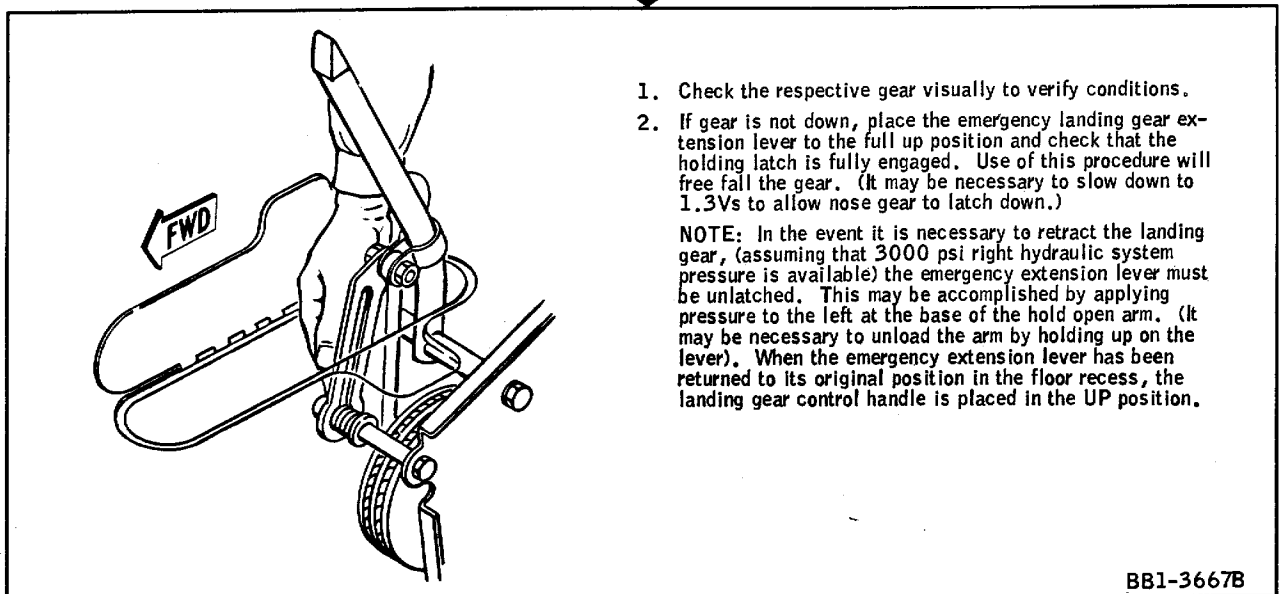
GEAR DOOR OPEN
light will be on.

BB1-1144C

LANDING GEAR -- ABNORMAL OPERATION



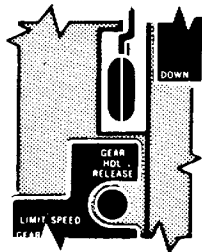
ACTION



BB1-3667B

LANDING GEAR -- ABNORMAL OPERATION

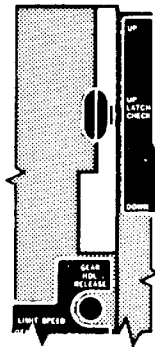
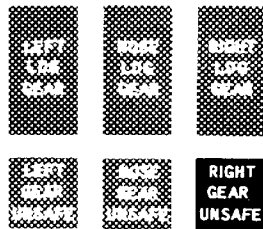
CONDITION
 UNABLE TO RAISE LANDING
 GEAR CONTROL HANDLE
 AFTER TAKEOFF.



ACTION

1. Check nosewheel steering with NORMAL force on wheel.
2. If wheel does not turn and indice (if installed) is centered, a malfunction of the gear anti retract mechanism is indicated. In this event push the gear handle release button and raise the landing gear handle.
3. **DO NOT RETRACT** landing gear if wheel is steerable as there is no assurance that the nosewheel will center, and remain centered, during retraction. Limit speed to applicable gear extend limitations.
4. If electrical circuits (auto pressurization, takeoff warning after flaps up) indicate that ground shift is in ground mode, Pull ground control circuit breakers to place circuits in flight mode.
5. On next landing, during rollout (above approximately 20 kts.) momentarily release brakes and place the anti-skid switch to OFF and operate brakes manually.
NOTE: IF GEAR HAS NOT BEEN RETRACTED PRIOR TO LANDING, GROUND SPOILERS MUST BE OPERATED MANUALLY.
6. Reset ground control circuit breakers during taxi and verify that electrical circuits (auto pressurization, air conditioning, ground blowers) are in the ground mode.

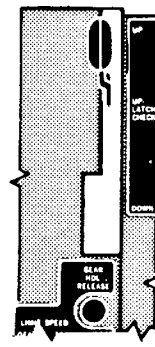
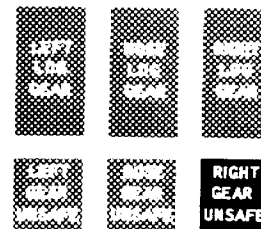
CONDITION
 UNSATISFACTORY UPLATCH
 CHECK (INDICATED BY RED
 LIGHT ON WHEN GEAR
 HANDLE IS PLACED IN UP-
 LATCH POSITION).



ACTION

1. Return lever to UP position. Limit speed to 300 Kts. (Mach 0.7) or below.
2. Decelerate aircraft to 250 Kts maximum and recycle the landing gear.
3. Repeat uplatch check.
4. If uplatch check is again unsatisfactory:
 - a. Return or,
 - b. The flight may continue provided the landing gear extension speed of 300 Kts. (Mach 0.7) is not exceeded. If continuing, place landing gear control handle at UP and operate the right hydraulic system at 3000 psi output. This will hydraulically hold the gear in retract position.

CONDITION
 RED LIGHT ON DURING
 CRUISE WITH LANDING
 GEAR CONTROL HANDLE
 IN UP POSITION.

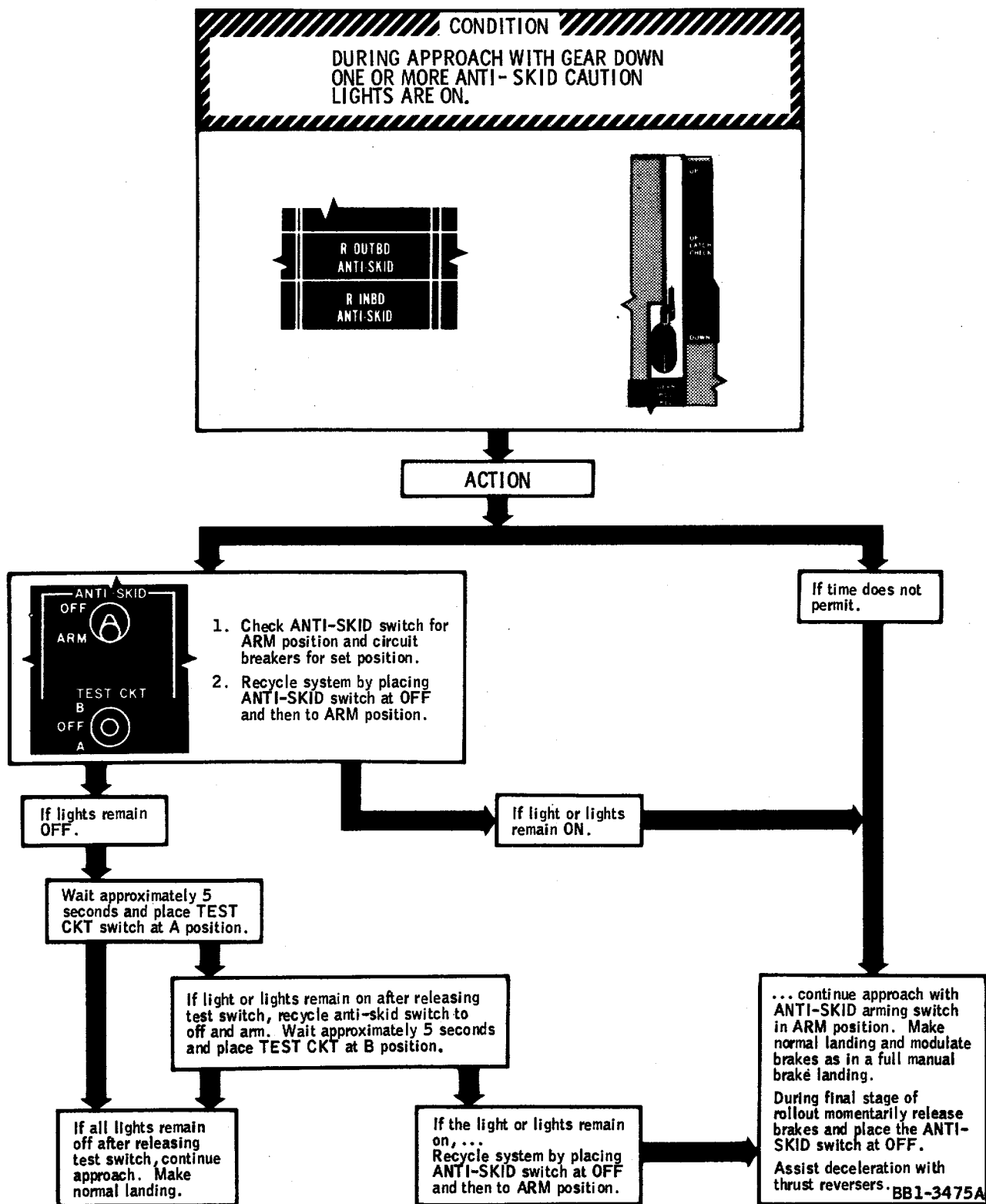


ACTION

1. Operate right hydraulic system at 3000 psi output and decelerate aircraft to landing gear extension limitation speed of 300 kts. (Mach 0.7).
2. If light remains on decelerate to 250 knots for sufficient time for landing gear to retract.
3. Continue flight without exceeding landing gear extension speed of 300 kts. (Mach 0.7). Place landing gear control handle at UP position and continue to operate the right hydraulic system at 3000 psi output.

BB1-75E

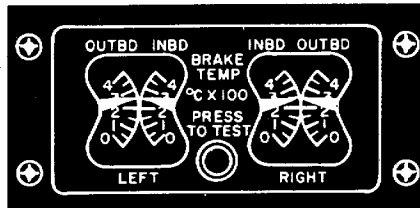
LANDING GEAR -- ABNORMAL OPERATION - Anti-skid



LANDING GEAR -- ABNORMAL OPERATION

CONDITION

ONE OR MORE BRAKE TEMPERATURE GAGES INDICATE A TEMPERATURE OF 200°C-315°C.



ACTION

AFTER TAKEOFF

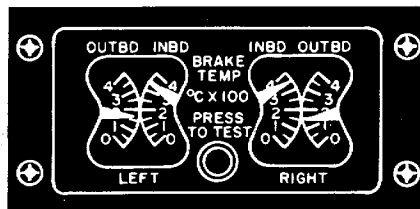
1. Landing gear may be retracted.
2. If any gage still indicates a temperature of 200°C or greater after 5 minutes, decelerate to gear extension speed, lower gear for cooling period of ten minutes or until gages indicate temperature lower than 200°C.

AFTER LANDING OR ABORTED TAKEOFF

1. Allow brakes to cool until all gages indicate a temperature below 200°C.

CONDITION

ONE OR MORE BRAKE TEMPERATURE GAGES INDICATE A TEMPERATURE OF 315°C OR GREATER.



ACTION

AFTER TAKEOFF

1. Unless performance requirements dictate otherwise, leave gear extended until gages indicate temperature lower than 200°C.
2. If gear has been retracted, decelerate to gear extension speed and lower gear for cooling as above.

AFTER LANDING OR ABORTED TAKEOFF

1. Brakes and wheels will require maintenance attention prior to further flight.

WARNING: KEEP ALL PERSONNEL CLEAR OF LANDING GEAR AREA, ESPECIALLY IN LINE WITH LANDING GEAR AND WING TIP. IF TEMPERATURE OF 315°C EXISTS FOR APPROXIMATELY 5 MINUTES, THE MECHANICAL FUSE PLUGS SHOULD ACTIVATE AND DEFLATE THE TIRES TO RELIEVE THE BURST POTENTIAL.

BB1-1149E

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 25, SECTION 2, CHAPTER 20, DATED SEP 1/71

HIGHLIGHTS:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-20-15-0 REVISED ART IN ABNORMAL OPERATIONS TO ADD AN ADDITIONAL STEP UNDER
"IF SPOILER PANEL RETRACTS, CONTINUE FLIGHT WITH:"

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-20-Eff	66	A11	2-20-Eff	66	A11
2-20-15-0	24	6A	2-20-15-0	24	6A

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 2-20

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

*2-20-Eff	66	1	Sep 1/71
2-20-Cont	66	1	Dec 1/70
2-20-Cont	66	2	Dec 1/70
2-20-Cont	66	3	Dec 1/70
2-20-1-0	4	1	Sep 1/70
2-20-15-0	24	1	Dec 1/70
2-20-15-0	24	2	Dec 1/70
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2-20-15-0	24	6	Dec 1/70
*2-20-15-0	24	6A	Sep 1/71
2-20-15-0	24	7	Dec 1/70
2-20-15-0	24	8	Dec 1/70
2-20-15-0	24	9	Dec 1/70
2-20-15-0	24	10	Dec 1/70

*The asterisk indicates pages revised or added by the current revision.

Sep 1/71

Printed in U.S.A.

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DOUGLAS AIRCRAFT CO.
DC-9
 FLIGHT CREW OPERATING MANUAL

Chapter 20

FLIGHT CONTROLS

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*LIMITATIONS</u>	20-1-0	1	4	A11
<hr/>				
<u>*ABNORMAL OPERATION -</u> Rudder				
During flight RUDDER CONTROL MANUAL light comes on	20-15-0	1	24	A11
During flight above 175 knots RUDDER TRAVEL UNRESTRICTED light is on	20-15-0	1	24	A11
Rudder restricted during landing	20-15-0	2	24	A11
During flight FLAP/ RUDDER STOP INOP light comes on	20-15-0	3	24	A11
<u>*ABNORMAL OPERATION -</u> Stabilizer				
The horizontal stabi- lizer becomes inopera- tive in flight	20-15-0	4	24	A11

*Illustration

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Dec 1/70

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DC-9
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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION -</u> Mach Trim				
During flight the Mach trim compen- sator malfunctions (indicator failed to extend, failed to retract, or is oscillating)	20-15-0	5	24	A11
<u>*ABNORMAL OPERATION -</u> Directional control				
(During flight) Air- plane oscillating or displaced in yaw	20-15-0	6	24	A11
(During flight) Powered rudder is inoperative	20-15-0	6	24	A11
<u>*ABNORMAL OPERATION -</u> Spoilers/speedbrake				
Spoiler panel stuck in an extended position	20-15-0	6A	24	A11
During approach unable to arm spoilers or AUTO SPOILER DO NOT USE light is on	20-15-0	7	24	A11
During flight the spoiler/speedbrake lever is not fully down in ground spoiler disarmed position (red arming placard is partially exposed)	20-15-0	7	24	A11

*Illustration

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 FLIGHT CREW OPERATING MANUAL

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION -</u> Slats				
SLAT DISAGREEMENT light remains on	20-15-0	8	24	A11
<u>*ABNORMAL OPERATION -</u> Stall Indication				
During flight STALL INDICATION FAILURE light comes on	20-15-0	9	24	A11
<u>*ABNORMAL OPERATION -</u> Overspeed Warning System				
Overspeed warning system malfunctions by sounding earlier than scheduled	20-15-0	10	24	A11

*Illustration

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FLIGHT CONTROLS -- LIMITATIONS

LOAD FACTOR -- Flaps up +2.5 G., -1 G
Flaps down +2 G., -0 G

V_{Mo} -- 350 KIAS - Sea level to 25,850 ft.
 M_{Mo} -- 0.84 Mach above 25,850 ft.

AILERON FULL THROW LIMIT
245 KIAS Sea level
270 KIAS at 30,000 ft.
255 KIAS at 35,000 ft

V_B -- Mach 0.79 and 285 KIAS at all altitudes and weights

RUDDER TRAVEL UNRESTRICTED LIMITS
Light ON -- 148 KIAS Minimum
Light OUT -- 175 KIAS Maximum
FLAP/RUDDER
STOP INOP -- Light must be OUT for takeoff

YAW DAMPER -- Maximum ± 1.7 degrees hingewise

HORIZONTAL STABILIZER -- 2.0 degrees airplane nose down (Maximum).
-- 12.25 degrees airplane nose up (Maximum).

FLAP SPEED LIMITS
5 degrees -- 280 KIAS or 0.57 Mach
15 degrees -- 240 KIAS or 0.57 Mach
25 degrees -- 210 KIAS or 0.57 Mach
50 degrees -- 180 KIAS or 0.57 Mach

STALL WARNING MARGIN -- Minimum 105% V_S

GROUND GUST LOADS -- Up to 65 Knots

MTC operation starts at 0.80 Mach.

CROSSWIND LIMIT -- 38 Knots

DO NOT USE SPEED BRAKE UNLESS FLAPS ARE UP.

SLAT SPEED LIMIT -- 280 KIAS

OVERSPEED WARNING LIMITS

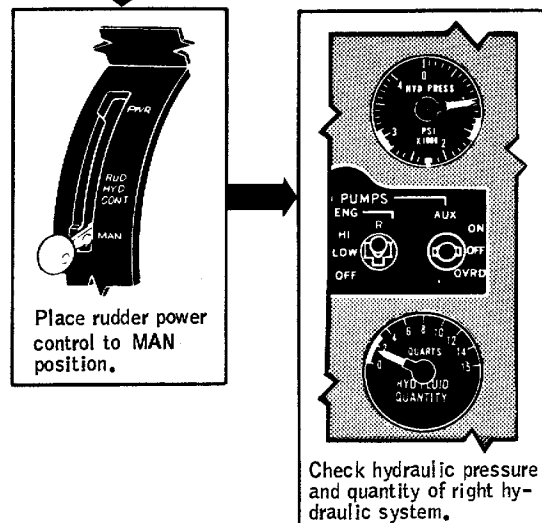
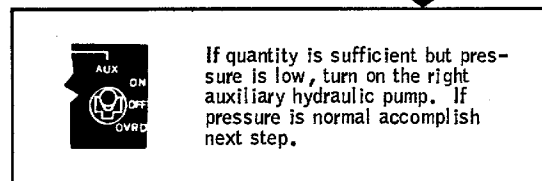
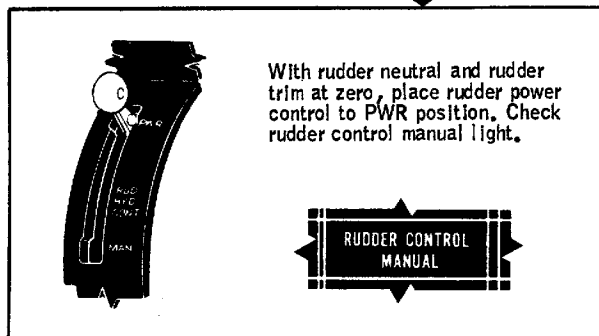
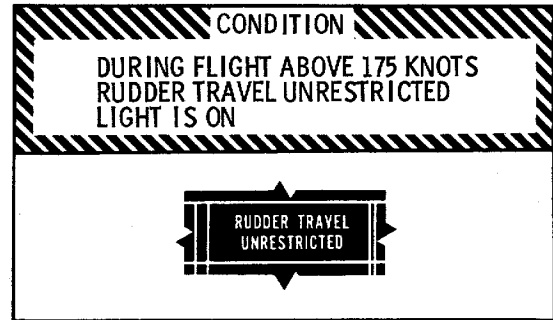
V_{Mo} -- 350 +6, -0 knots
 M_{Mo} -- 0.84 +0.01, -0.00 Mach.

BB1-2296E

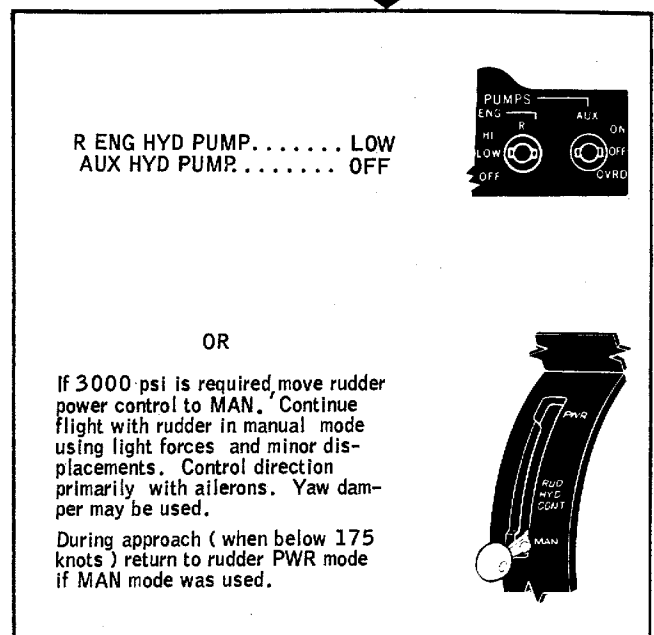
FLIGHT CONTROLS -- ABNORMAL OPERATION - Rudder



ACTION

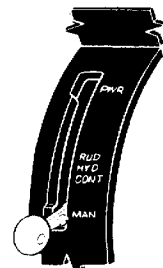


ACTION



If light is not out place rudder power control to MAN position and continue operation in manual mode.

NOTE: If the rudder control manual light is on because of a failure in the right hydraulic system; the rudder travel will be controlled by the Q limiter at higher airspeeds, and will be limited to a maximum of 17° by action of the flap controlled rudder limiter at all airspeeds.



BB1-2297C

FLIGHT CONTROLS -- ABNORMAL OPERATION - Rudder

CONDITION

RUDDER RESTRICTED DURING LANDING

Rudder travel unrestricted light does not come on during landing. The rudder travel unrestricted light should come on while slowing down at speeds between 160 and 148 knots. Press to test the annunciator panel light to check the integrity of the light indication.

ACTION

ASSUME RUDDER RESTRICTED IF PRESS TO TEST PANEL LIGHT FUNCTIONS

The two main areas of concern with the rudder restricted are crosswind landing capability and controllability with asymmetric thrust. The following restrictions assume the rudder is limited to the maximum restriction and would limit the rudder pedal travel to approximately one inch.

APPROACH

Approach speed $1.3 V_s + 5$ knots IAS in the landing configuration but not less than a minimum approach speed of 135 knots IAS until landing is assured.

GO-AROUND

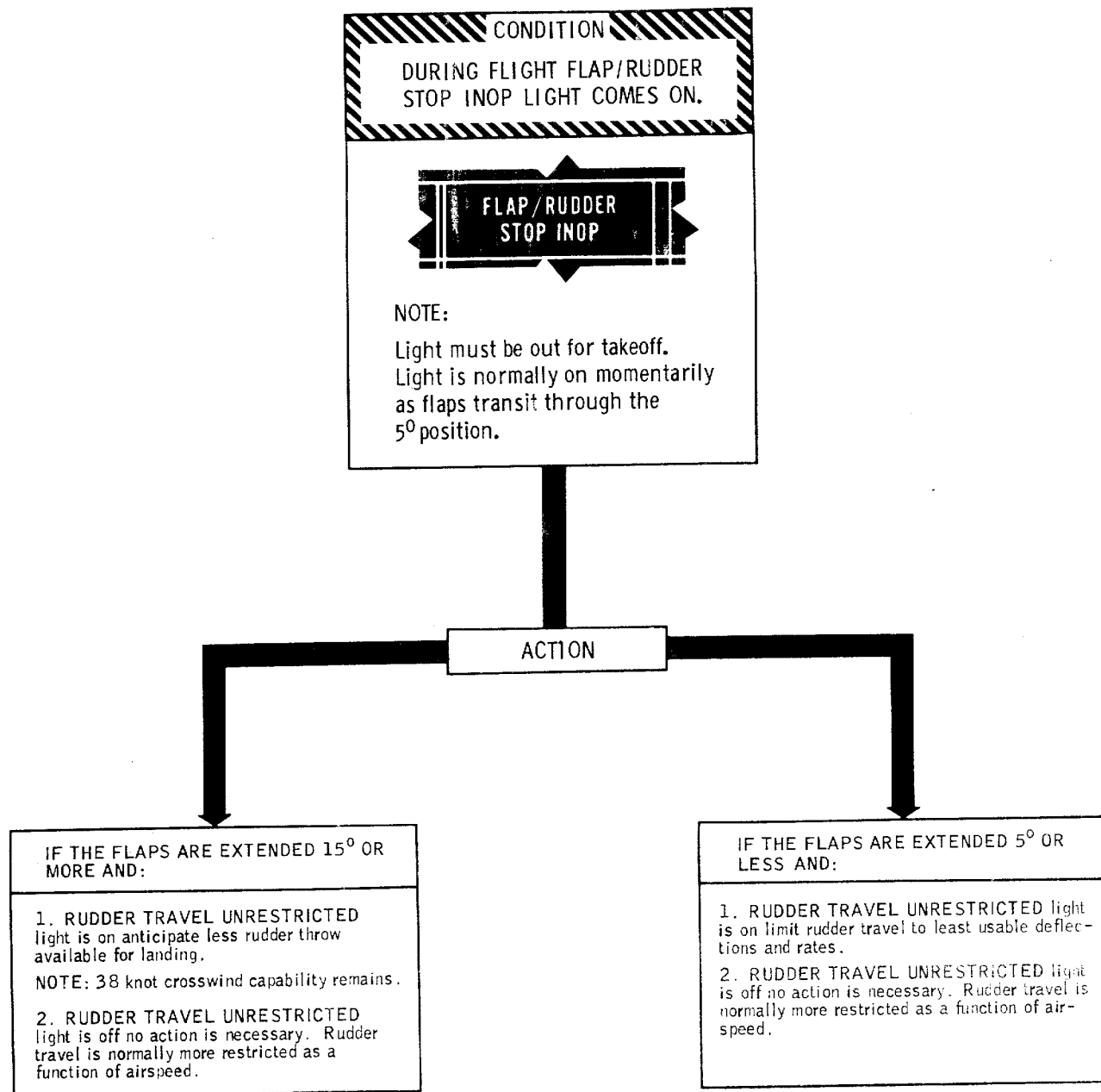
During an engine out go-around it may require up to approximately 8° of bank in the direction of the good engine to maintain a constant heading at V_2 speed or 135 knots IAS, whichever is the highest airspeed.

CROSSWIND LANDING

Observe crosswind landing limitation of 12 knots. Approximately 5° of crab will be necessary for this amount of crosswind. Touchdown can be made with 5° of crab.

BB1-3548E

FLIGHT CONTROLS -- ABNORMAL OPERATION - Rudder



BB1-3052A

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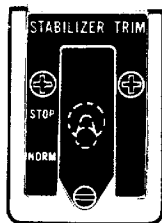
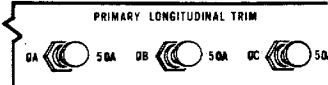
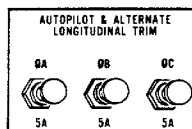
FLIGHT CONTROLS -- ABNORMAL OPERATION - Stabilizer

CONDITION

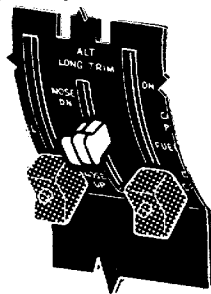
THE HORIZONTAL STABILIZER
BECOMES INOPERATIVE IN FLIGHT

ACTION

1. Verify that the primary stabilizer trim (red guarded) switch is at NORM position and guarded. Check and/or reset circuit breakers labeled PRIMARY LONGITUDINAL TRIM and AUTOPILOT & ALTERNATE LONGITUDINAL TRIM.



2. If the primary trim system fails to move the horizontal stabilizer by use of either the wheel trim switches or the longitudinal trim (suitcase handles) use the alternate trim switches to control the stabilizer. Allow for slower operation using this system.



IF THE HORIZONTAL STABILIZER IS STILL INOPERATIVE CONSIDER THE STABILIZER TO BE JAMMED

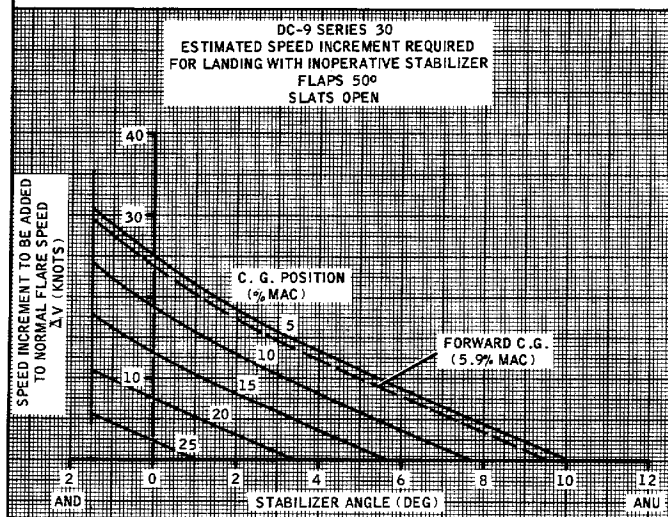
NOTE: Do not use the AFCS

If an approach and landing must be made without stabilizer trim, add the following speed increments to the landing flare speed.

Five knots if the stabilizer becomes inoperative during a normal approach.

Twenty knots if the stabilizer becomes inoperative during a normal climb, cruise or descent.

If the approximate C.G. is known and time and conditions permit, the speed increment to be added to the landing flare speed may be determined from the chart below.



NOTE: If both the primary and alternate trim systems malfunction it is not possible to change the angle of incidence of the horizontal stabilizer. However, if this remote possibility occurred (even a runaway to the extreme nosedown position and full forward limit C.G.) it is still possible to offset the mistrim by elevator deflection. High rates of descent and steep body angles must be avoided as it is possible to lose elevator control if large changes in pitch are required.

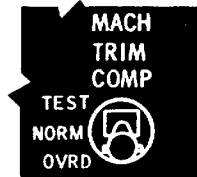
BB1-3451

FLIGHT CONTROLS -- ABNORMAL OPERATION - Mach Trim

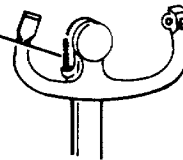
CONDITION (DURING FLIGHT)

DURING FLIGHT THE MACH TRIM COMPENSATOR MALFUNCTIONS (INDICATOR FAILED TO EXTEND, FAILED TO RETRACT, OR IS OSCILLATING).

ACTION



MACH TRIM INDICATOR



Use OVRD position of MACH TRIM COMP switch and verify mach trim indicator is at retract position.

DURING FLIGHT

If indicator is retracted, leave the MACH TRIM COMPENSATOR switch in the OVRD position. Observe a mach limitation of .78.

If unable to retract, reset the MACH TRIM OVERRIDE circuit breaker located on the overhead emergency dc bus circuit breaker panel. If mach trim compensator still cannot be retracted, leave the switch in the OVRD position and pull the MACH TRIM OVERRIDE circuit breaker. This will prevent an inadvertent retraction.

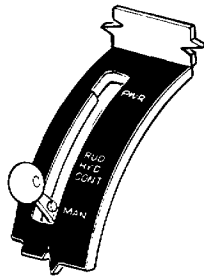
Retrim the aircraft longitudinally and limit Mach number to .78. Use normal techniques during landing.

FLIGHT CONTROLS -- ABNORMAL OPERATION - Directional control

CONDITION (DURING FLIGHT)
 AIRPLANE OSCILLATING
 OR DISPLACED IN YAW

ACTION

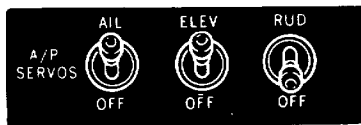
1. IMMEDIATELY:



A. Place rudder power control to MAN position.



B. Place yaw damper to OFF position.



C. Place rudder servo switch to OFF position.

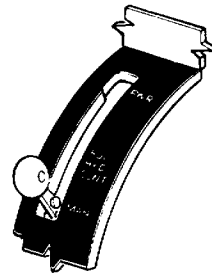
2. After condition is corrected, one at a time

A. Place rudder servo switch to ON.

B. Place yaw damper switch to ON.

CONDITION (DURING FLIGHT)
 POWERED RUDDER
 IS INOPERATIVE

ACTION



Place rudder power control to MAN position. Continue all operations using manual control.

**RUDDER CONTROL
 MANUAL**

Light will come on

NOTE:

There may be a small amount of lost motion at neutral.

If yaw damp function is normal, continue all operations with the rudder power control at MAN.

If yaw damp function is abnormal, trim out rudder if required and rudder power control may be used.

NOTE: Yaw damper is limited to approximately 1 3/4 degrees streamwise displacement. Therefore a severe hardover involving more than this amount of rudder would indicate a hydraulic rudder problem and flight should be continued in manual operation.

BB1-2298B

FLIGHT CONTROLS -- ABNORMAL OPERATION - Spoilers/speedbrake

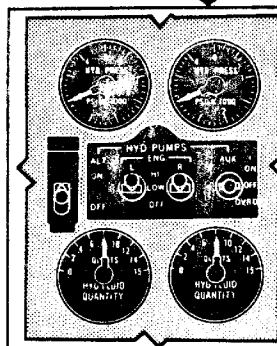
CONDITION
 SPOILER PANEL STUCK IN AN EXTENDED POSITION.

ACTION

DETERMINE WHICH WING HAS A SPOILER PANEL EXTENDED BY CONTROL INPUT REQUIRED TO MAINTAIN WINGS LEVEL FLIGHT. PERFORM A VISUAL INSPECTION OF SPOILER PANELS IF POSSIBLE.

NOTE: IF THE EXTENDED PANEL IS LOCATED OUT-BOARD, THE SOURCE OF SYSTEM PRESSURE IS THE RIGHT HYDRAULIC SYSTEM. IF AN IN-BOARD PANEL, IT IS PRESSURIZED BY THE LEFT HYDRAULIC SYSTEM.

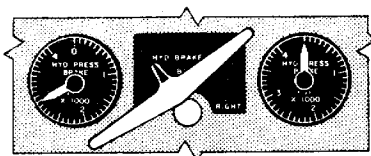
TIME PERMITTING



1. CHECK HYDRAULIC SYSTEM PRESSURE AND QUANTITY.
2. CYCLE SPEED BRAKES WITH SYSTEMS PRESSURIZED. IF SPOILER PANEL RETRACTS, CONTINUE WITH STEP NO. 3 (THREE) ONLY.
3. PLACE AFFECTED SYSTEM HYDRAULIC PUMP SWITCH TO OFF.
4. MOMENTARILY CYCLE SPEED BRAKE CONTROL HANDLE TO DE-PRESSURIZE AFFECTED HYDRAULIC SYSTEM.

IF THE SPOILER PANEL DOES NOT RETRACT:

1. RETURN AFFECTED HYDRAULIC PUMP SWITCH TO HIGH OR LOW AS DESIRED.
2. CHECK HYDRAULIC PRESSURE AND QUANTITY.



IF SPOILER PANEL RETRACTS, CONTINUE FLIGHT WITH:

1. AFFECTED ENGINE HYDRAULIC PUMP SWITCH OFF.
 2. ALTERNATE GEAR PUMP OFF (IF AN INBOARD SPOILER WAS AFFECTED).
 3. PLACE BRAKE SELECTOR HANDLE TO THE UNAFFECTED SYSTEM.
 4. SPOILERS MAY BE ARMED BY SPOILER CONTROL HANDLE PRIOR TO LANDING.
 5. PLAN APPROACH AND LANDING WITH REMAINING HYDRAULIC SYSTEM.
- NOTE: ANTICIPATE A LONGER GROUND ROLL-OUT, AS ONLY 1/2 GROUND SPOILERS WILL BE AVAILABLE.

TIME DOES NOT PERMIT

SPOILER PANEL STUCK IN THE EXTENDED POSITION AND LANDING PLANNED WITH PANEL EXTENDED.

1. TRIM AIRCRAFT UTILIZING AILERON TRIM AND WHEEL DISPLACEMENT AS REQUIRED.
- NOTE: SOME RUDDER TRIM MAY BE REQUIRED TO COUNTER-ACT SPOILER DRAG AND EFFECT OF COMPENSATING AILERON TRIM.
2. USE SINGLE ENGINE LANDING FLAPS FOR LANDING (25°).
 3. COMPUTE FLARE SPEED (V_{REF}) FOR 25° FLAPS + 5 KTS. (1.3 V_S + 5 KTS. FOR 25° FLAPS OR 1.3 V_S + 15 KTS. FOR 50° FLAPS).
 4. DURING APPROACH, THE SPOILER CONTROL HANDLE MAY BE PLACED TO THE ARM POSITION.

NOTE:
 APPROXIMATELY 120 DEGREES OF CONTROL WHEEL ANGLE IS AVAILABLE. EXPECT TO USE FULL LATERAL TRIM AND UP TO APPROXIMATELY 60 TO 70 DEGREES OF WHEEL ANGLE AT APPROACH SPEED.

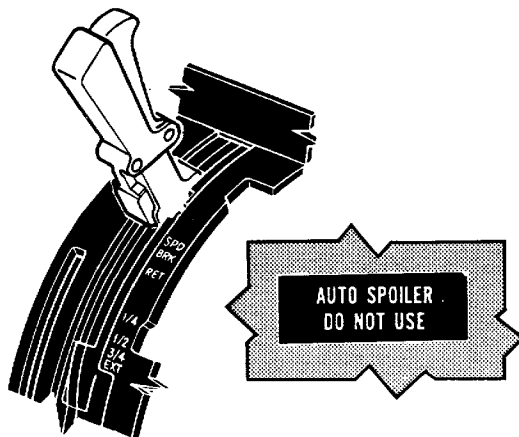
BB1-4475B

FLIGHT CONTROLS -- ABNORMAL OPERATION - Spoilers/speedbrake

SPOILER

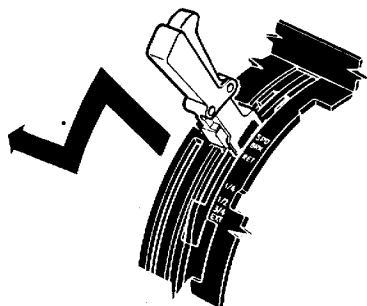
CONDITION

DURING APPROACH UNABLE TO ARM SPOILERS OR AUTO SPOILERS DO NOT USE LIGHT IS ON.



ACTION

Add 435 feet to the landing distance on a dry runway (500 feet on a wet runway).
 Do not arm spoilers before landing.
 Make normal approach and landing.
 Spoilers should be extended manually on ground contact by moving lever up, aft, and up.



SPEEDBRAKE

CONDITION

DURING FLIGHT THE SPOILER/ SPEEDBRAKE LEVER IS NOT FULLY DOWN IN GROUND SPOILER DIS-ARMED POSITION (RED ARMING PLACARD IS PARTIALLY EXPOSED) .

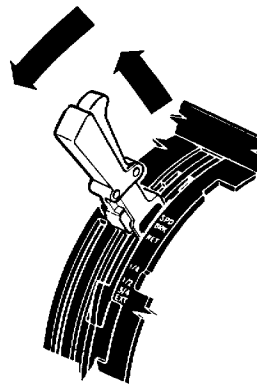
Note 1: This could be caused by failure of the ground spoiler actuator to retract after the landing gear has been retracted.

Note 2: Until the landing gear is retracted after takeoff the red arming placard is partially exposed.

ACTION

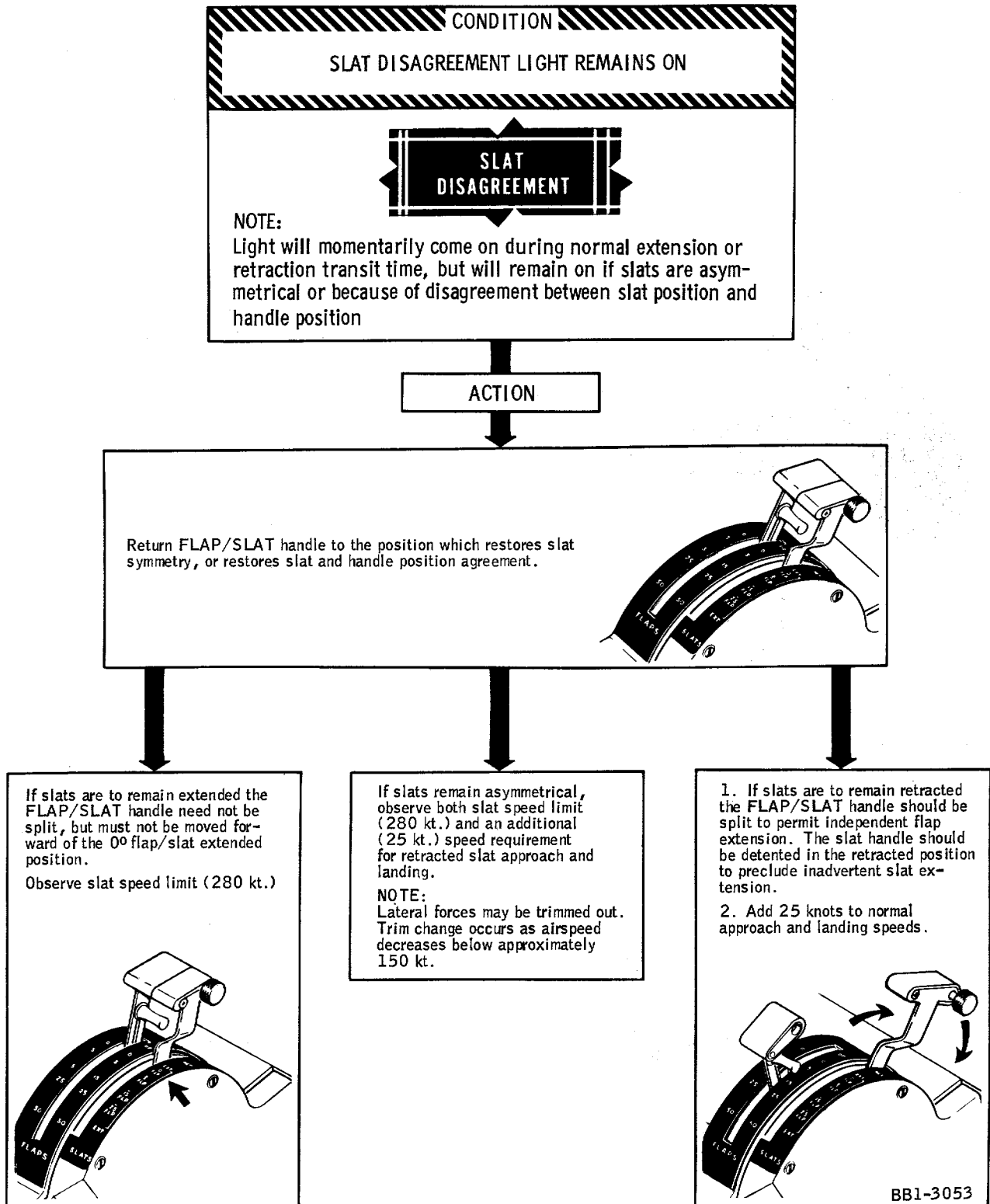
1. When speedbrakes are required, pull lever up and aft to the approximate speedbrake stop position. The handle must be held in this position as long as speedbrakes are required.

CAUTION: If the speed brake handle is not fully down the speed brakes aft stop and intermediate notches will not be engaged. Caution should be exercised to ensure that the lever is not inadvertently moved to the full aft position as this would permit the speedbrakes to extend to the full 60 degree position.

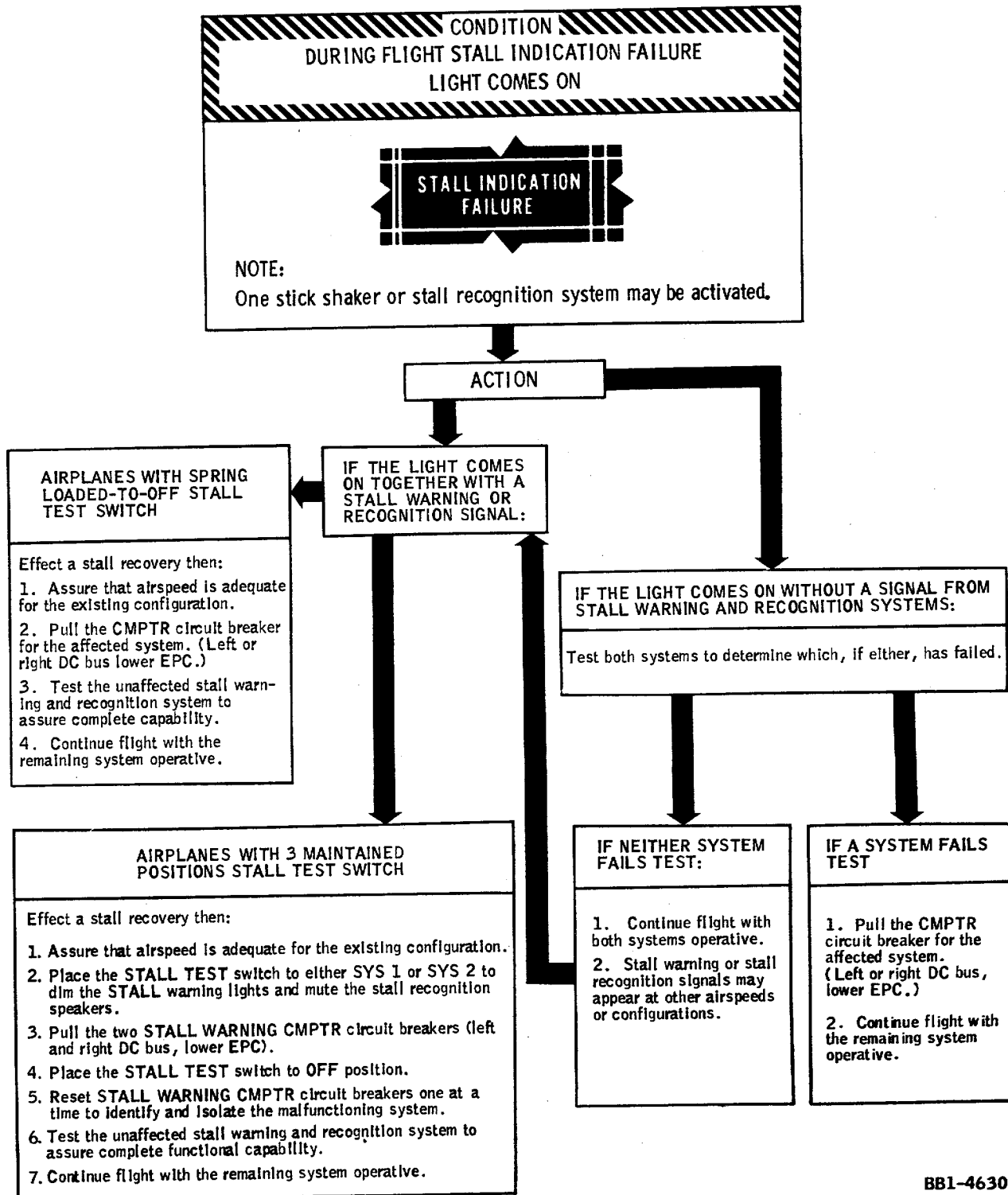


BBI-4420

FLIGHT CONTROLS -- ABNORMAL OPERATION - Slats

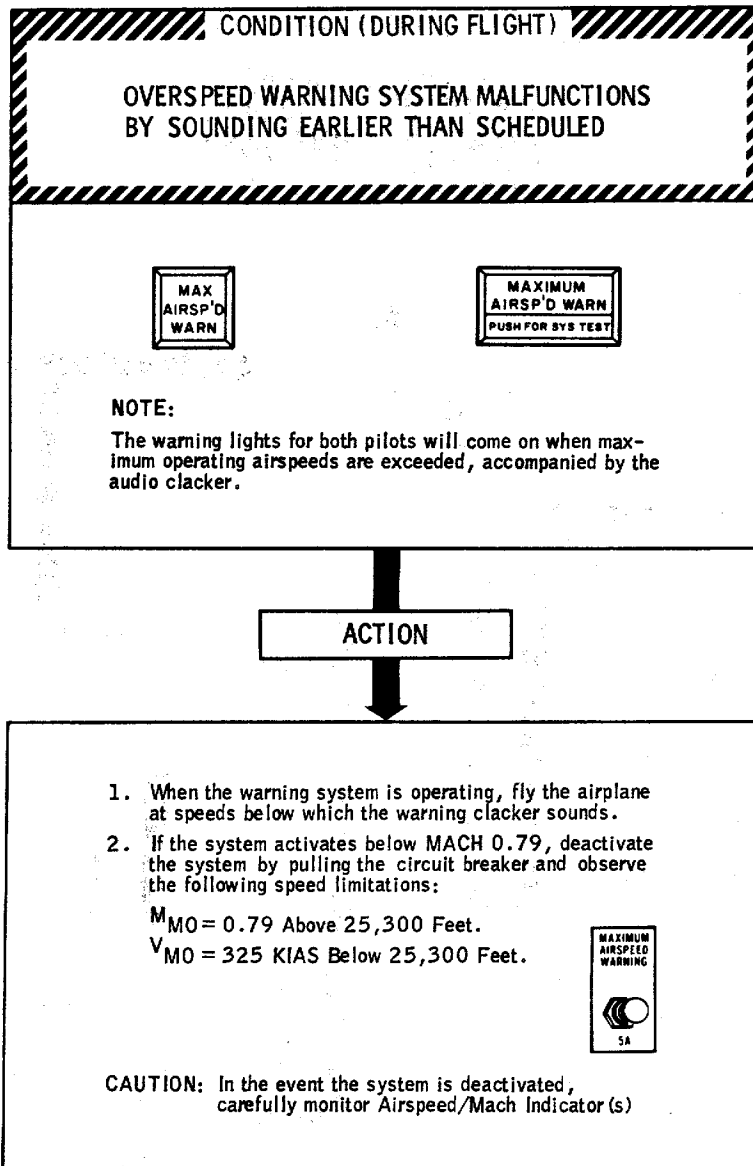


FLIGHT CONTROLS -- ABNORMAL OPERATION - Stall indication



BB1-4630

FLIGHT CONTROLS -- ABNORMAL OPERATION - Overspeed Warning System



BB1-4512

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 2-25

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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2-25-Cont	66	1	Sep 1/69
2-25-Cont	66	2	Sep 1/69
2-25-1-0	3	1	Sep 1/68
2-25-10-0	6	1	Jun 1/67
2-25-10-0	6	2	Jun 1/67
2-25-15-0	1	1	Aug 15/65
2-25-15-0	1	2	Dec 1/67
2-25-15-0	1	3	Dec 1/65
2-25-15-0	1	4	Mar 1/66
2-25-15-0	1	5	Aug 15/65
2-25-15-0	1	6	Jun 1/68

*The asterisk indicates pages revised or added by the current revision.

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Chapter 25

FUEL SYSTEM

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(SERIES 30)

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* <u>LIMITATIONS</u>	25-1-0	1	3	A11
* <u>NORMAL OPERATION</u> - Fuel management schedule	25-10-0	1	6	A11
* <u>NORMAL OPERATION</u> - Pressure fueling	25-10-0	2	6	A11
* <u>ABNORMAL OPERATION</u> Inflight crossfeed operation	25-15-0	1	1	A11
* <u>ABNORMAL OPERATION</u> - INLET FUEL PRESSURE LOW light comes on	25-15-0	2	1	A11
* <u>ABNORMAL OPERATION</u> During center tank fuel usage, center tank quantity does not decrease, main tank quantity decreases	25-15-0	3	1	A11
* <u>ABNORMAL OPERATION</u> - Fuel tank quantity indicator erroneous	25-15-0	4	1	A11
* <u>ABNORMAL OPERATION</u> - Ground fuel transfer	25-15-0	5	1	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Fuel management procedure				
Making an approach with less than 1,000 pounds indicated fuel load in either main tank	25-15-0	6	1	A11

*Illustration

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FUEL -- LIMITATIONS

PRESSURE FUELING

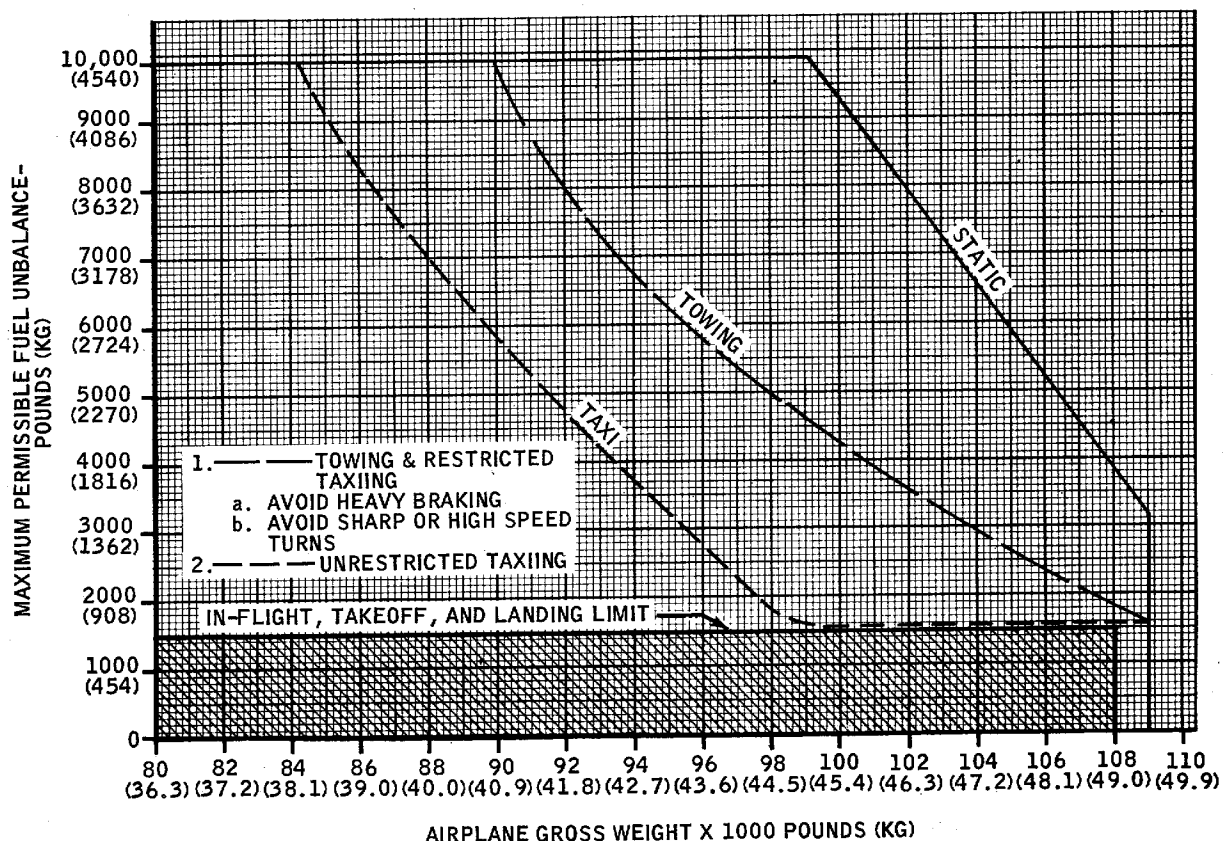
50 PSI maximum

	USABLE FUEL			APPROXIMATE TANK CAPACITIES		
	U. S. GALLONS	IMP. GALLONS	LITERS	U. S. GALLONS	IMP. GALLONS	LITERS
Left Main	1386	1154	5246	1393	1160	5272.5
Right Main	1386	1154	5246	1393	1160	5272.5
Center	907	755	3433	913	760	3456
TOTAL	3679	3063	13,925	3699	3080	14,001

FUEL MANAGEMENT

Takeoff with each engine receiving fuel from its respective main tank. For all takeoffs and landings two pumps should be operating in each main tank, center pumps must be off. Maximum unsymmetrical fuel loading between main tanks under all in-flight operating conditions should not exceed 1500 pounds (680 Kg.) including one engine out operation. Ground maneuvering and towing limitations are shown on the Maximum Permissible Fuel Unbalance chart.

MODEL DC-9-32 MAXIMUM PERMISSIBLE FUEL UNBALANCE CHART



FUELING SCHEDULE

All fuel tanks may be filled simultaneously and need only be monitored during fueling to assure that final quantities conform to the required fuel loading.

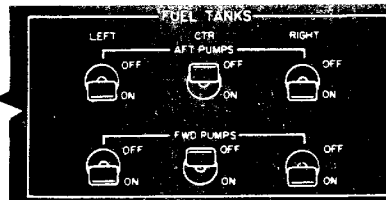
BB1-3069B

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FLIGHT CREW OPERATING MANUAL

FUEL -- NORMAL OPERATION - Fuel management schedule

- NOTE: It is not recommended that a takeoff be initiated with less than 2400 pounds indicated fuel in each main tank.
- NOTE: Before or after engine start, all fuel pumps (of tanks containing fuel) may be individually checked to verify pump operation.

AFTER ENGINE START, DURING TAXI, AND TAKEOFF



1. FUEL CROSSFEED LEVER OFF
2. Main tank boost pumps ON.
3. Center tank boost pumps OFF.

Note: Center wing tank fuel should not be used during takeoff.

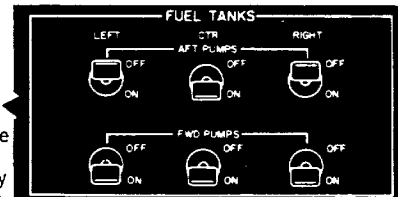
AFTER FIRST POWER REDUCTION WHEN AIRPLANE IS CLEANED UP FOR CLIMB, DURING CLIMB, AND CRUISE.

1. Both center wing tank boost pumps ON.

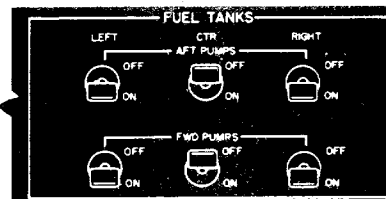
NOTE: If contaminated fuel is suspected one engine may be operated receiving fuel from the center wing tank to verify the supply. This is accomplished by turning on only one center wing tank pump and turning off all pumps in one main wing tank. After supply verification, fuel management should be returned to normal. This procedure may be accomplished after engine start, during taxi, or after takeoff when the airplane is cleaned up for climb and normal center wing fuel usage is scheduled.

2. One boost pump in each main tank ON.
3. When the center wing tank quantity indicator indicates zero fuel for 10 minutes, turn the center boost pumps OFF

NOTE: The use of either fuel boost pump in each main tank may be used alternately on individual flights. Both main tank boost pumps may be used, if desired.



DESCENT, APPROACH, AND LANDING



1. For all landings, two pumps should be operating in each main tank.
2. Center wing tank boost pumps should be OFF for approach and landing.

AFTER ENGINE SHUTDOWN

All boost pump switches OFF.

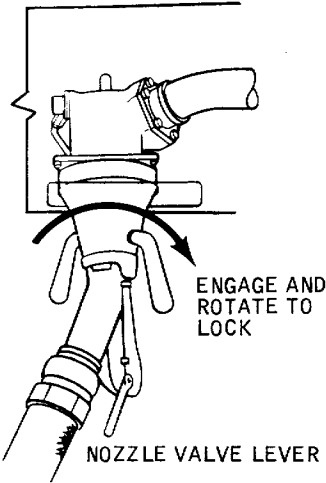
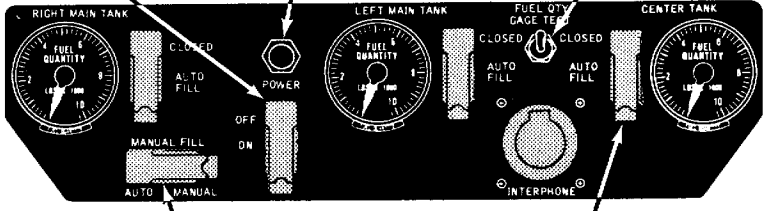
BB1-229D

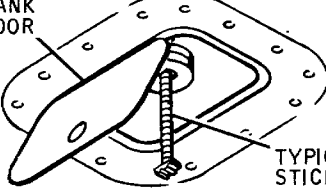
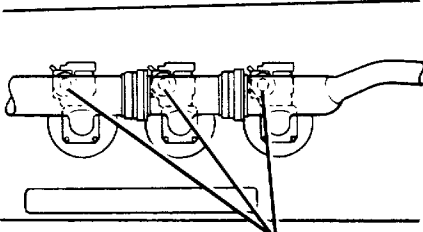
DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

FUEL -- NORMAL OPERATION - Pressure fueling

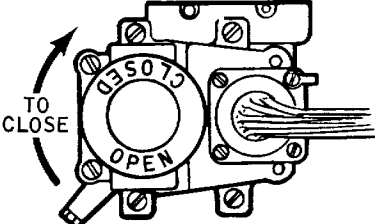
WITH ELECTRICAL POWER AVAILABLE

- NOTE: 1. Maximum fueling pressure 50 psi.
 2. For detailed procedure steps and general fueling safety precautions, reference DC-9 Maintenance Manual.

<p>1. Connect and lock fuel supply pressure adapter.</p> 	<p>2. Fuel panel POWER switch ON.</p>	<p>3. Check (blue) power available light on.</p>	<p>4. Hold FUEL QTY GAGE TEST switch in test position (down) and observe that the FUEL QUANTITY indicators decrease. Release test switch and observe that the indicators increase to initial quantities.</p>
			
<p>5. Place MANUAL FILL switch to AUTO position.</p>		<p>6. Place tank fill switches (3) on tanks to be fueled at AUTO FILL position. NOTE: On tanks that are not to be fueled, place tank fill switches to CLOSED position.</p>	

<p>CENTER TANK ACCESS DOOR</p>  <p>TYPICAL DRIPLESS STICK (LOWERED)</p>	<p>7. During fueling observe FUEL QUANTITY gages or fuel measuring drippless sticks if gages are inoperative. As each tank reaches the desired quantity, place the respective tank fill switch to CLOSED position.</p> <p>NOTE: When tanks are to be filled to full capacity, the fill control circuit will automatically close the respective fuel tank fill valves.</p>
 <p>FILL VALVES</p>	<p>NOTE: With one or more tank fill valve motors inoperative, prior to or during fueling, the MANUAL FILL switch should be placed to MAN (manual) position. Under this condition the fuel tank fill valves should be manually controlled to open and close the respective tank fill valves.</p> <p>8. After completion of fueling, place panel switches to guarded position and check that (blue) power available light is out.</p> <p>NOTE: When using airplane battery power only, unnecessary use of this refueling power electrical source will drain battery capabilities.</p>

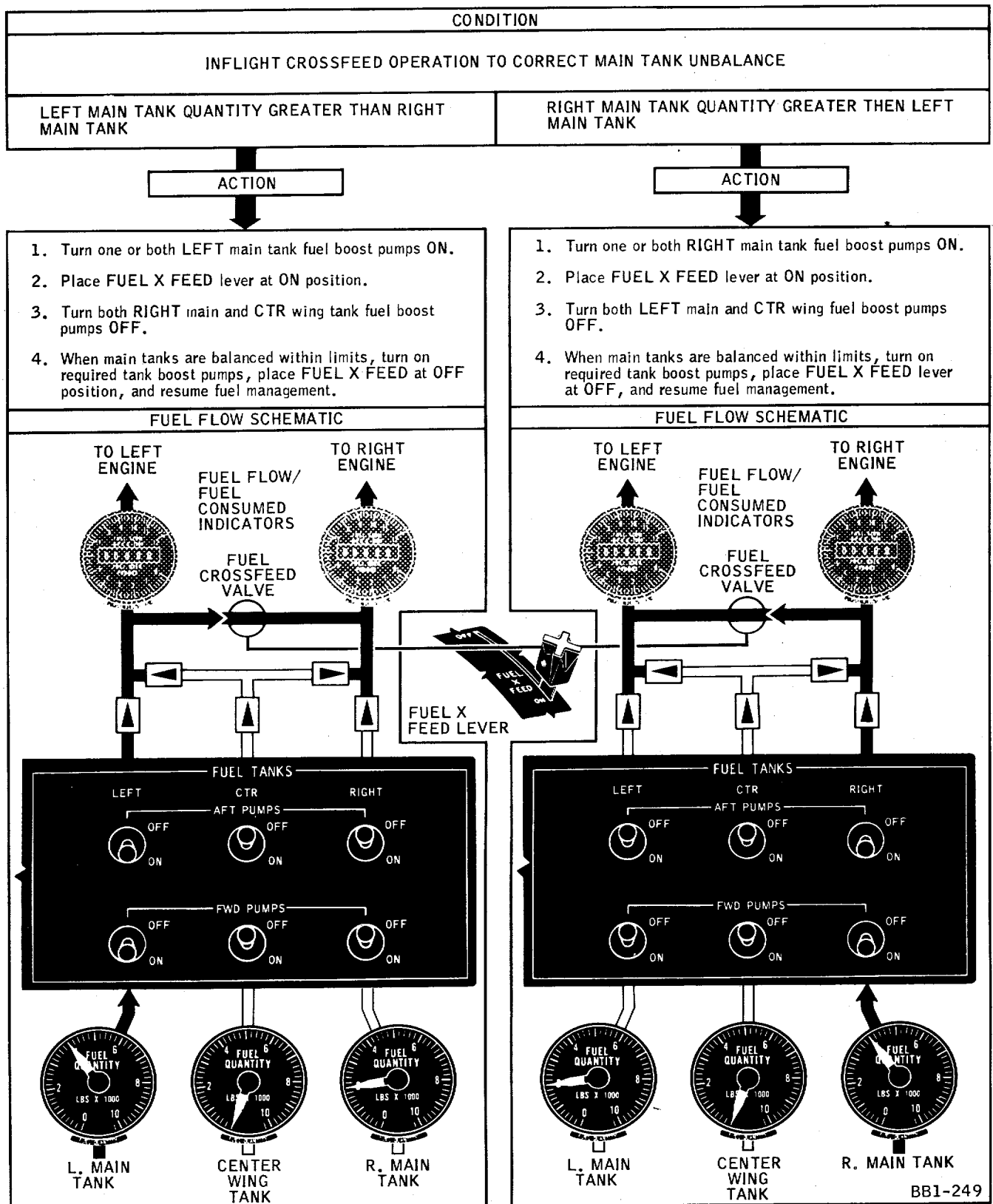
WITHOUT ELECTRICAL POWER AVAILABLE

 <p>FILL VALVE MANUAL CONTROL (RED) LEVER (Shown open)</p>	<p>The above steps may be omitted. Manual control of fill valves is necessary to fill and to shutoff fuel when desired tank quantity is reached. Quantity is measured by observing the respective drippless stick. At completion of fueling check that all guarded switches are in guarded position.</p>
---	--

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BB1-1598A

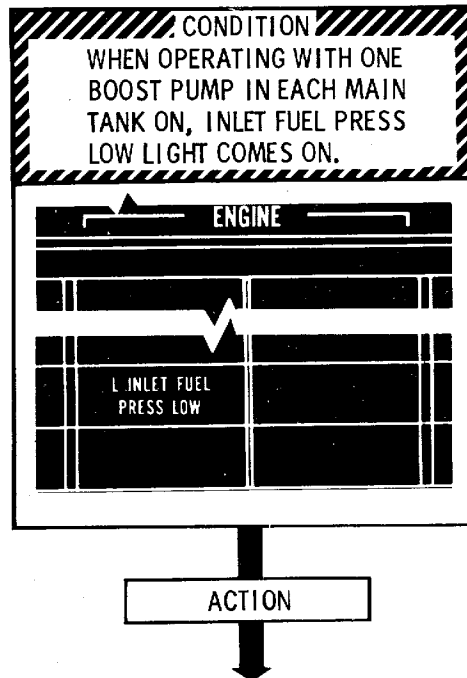
FUEL -- ABNORMAL OPERATIONS



BB1-249

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FUEL -- ABNORMAL OPERATION



1. Turn remaining boost pump ON in respective main tank.
2. If INLET FUEL PRESS LOW light remains ON, check applicable C/B, fuel management, and tank quantity.
3. Verify that no fuel feed system leak has occurred by crosschecking tank quantity and fuel consumption.

NOTE:

- A. When using kerosene the engines will operate on suction feed throughout the airplane operating envelope.
- B. When using JP-4 the engines will operate on suction feed below 25,000 ft. with indicated fuel temperatures of 25°C or less. As fuel temperature increases, the altitude for satisfactory suction feed reduces as follows:

30°C - 24,000 ft.

35°C - 22,500 ft.

40°C - 18,500 ft.

45°C - 10,000 ft.

Under all fuel temperature conditions the altitude for satisfactory suction feed is increased with an increase in fuel flow. If only suction feed is available at high altitude, a descent should be made with speed brakes extended and high engine power, consistent with descent requirements, to at least the altitude noted above. When operating on suction feed, the INLET FUEL PRESS LOW light will remain on.

IF FUEL CONSUMED VS. FUEL QTY IS NORMAL

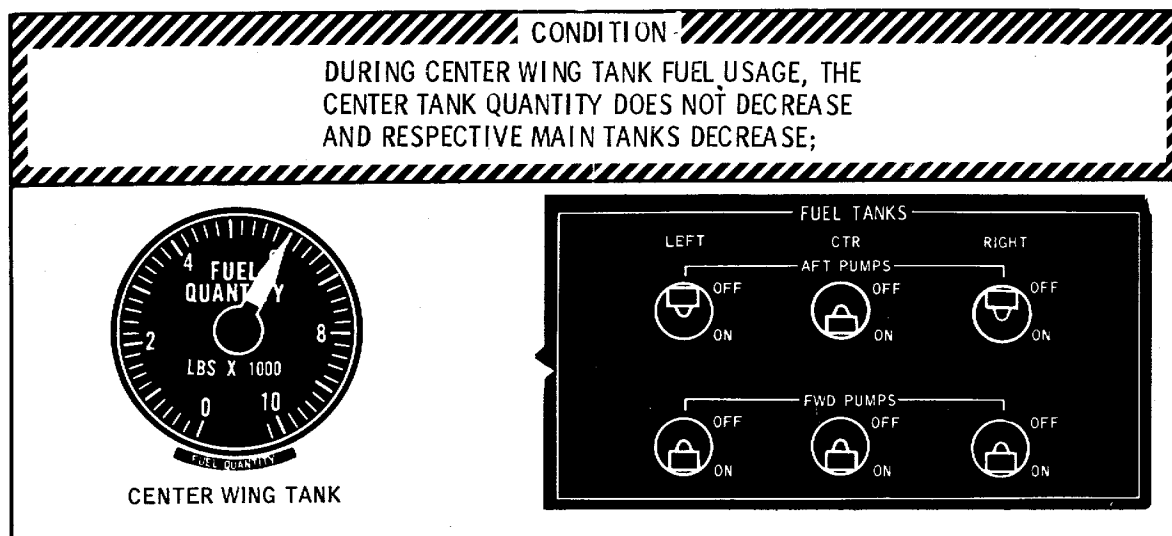
The fuel pressure from the opposite system may be used through the crossfeed valve to verify boost pressure or inlet low pressure light fault. If the affected INLET FUEL PRESS LOW light remains on and no other abnormal indications appear, assume faulty light circuit, close fuel cross feed valve and resume normal fuel management.

IF FUEL CONSUMED VS. FUEL QTY IS NOT NORMAL

Assume fuel feed line leak, shutdown affected engine, and pull but do not rotate the applicable fire shutoff handle.

BB1-453B

FUEL -- ABNORMAL OPERATION



ACTION

1. Check boost pumps switches:
 Center tank Both ON
 Main tanks One or both ON
2. Check center tank boost pumps circuit breakers.
 Attempt reset if tripped.

IF NOT CORRECTED

3. Both fuel boost pumps OFF in one main tank.
4. Observe engine fuel flow instruments for supply stabilization.

IF INLET FUEL PRESS LOW LIGHT COMES ON

Assume center wing tank fuel unavailable and return main tanks pump switches to ON. Plan remainder of flight using main tanks fuel only.

IF INLET FUEL PRESS LOW LIGHT DOES NOT COME ON

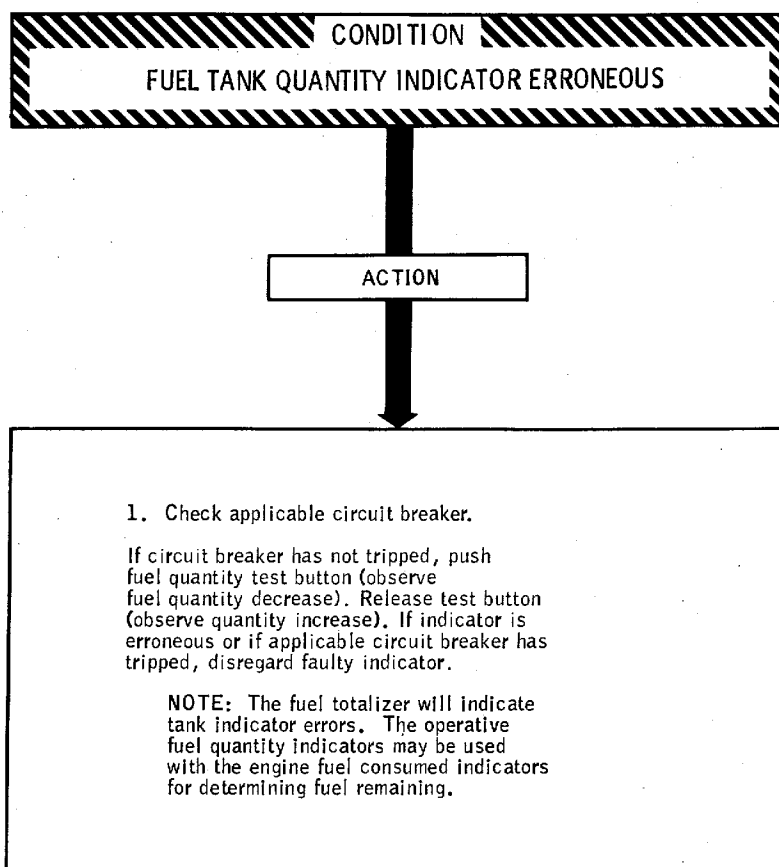
5. Place both fuel boost pump switches OFF in other main tank.
 6. Observe center wing tank quantity decreasing.
- NOTE: When center wing tank has approximately 500 lbs. remaining, accomplish steps 7 & 8 in order to supply one engine from the center wing tank and the opposite engine from its respective main tank.
7. Turn ON boost pump in main tank with greater quantity.

8. If necessary to maintain main tank balance within limits, reverse main tank pump operation in step 7.

NOTE: When either INLET FUEL PRESS LOW light comes on, turn respective main tank boost pump (or both if required) ON.

BB1-451A

FUEL -- ABNORMAL OPERATIONS



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FUEL -- ABNORMAL OPERATIONS

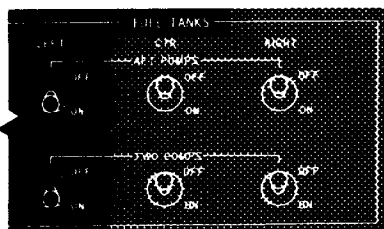
CONDITION
 GROUND FUEL TRANSFER REQUIRED
 TO CORRECT MAIN TANK FUEL
 UNBALANCE OR OFF SCHEDULE FUEL
 TANK LOADING

ACTION

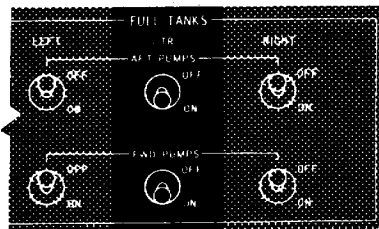
Note: For detailed procedures and safety precautions, reference the DC-9 Maintenance Manual.

1. Establish interphone contact with ground crew for coordination of remote fueling controls prior to fuel transfer.
2. Tank with excessive fuel, fuel boost pumps ON.
3. All other fuel boost pumps OFF.

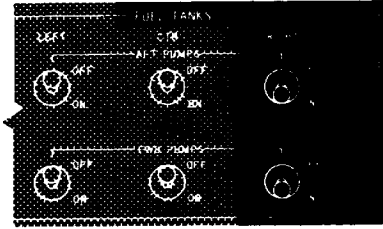
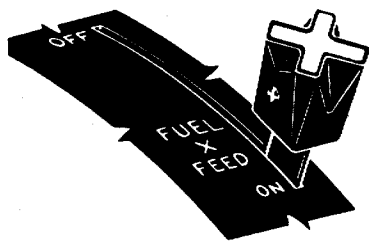
Transfer from left main tank



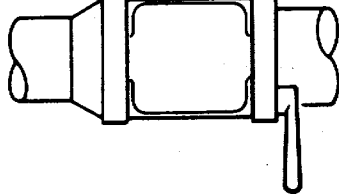
Transfer from center main tank



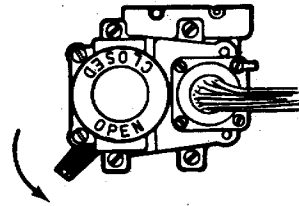
Transfer from right main tank



Place FUEL X FEED valve ON



Open defueling valve



Open fill valve on tank to be filled.
 (Manual or electrical).

When fuel tank levels are on schedule, secure the system as follows:

1. Turn fuel boost pumps OFF.
2. Place FUEL X FEED valve OFF.
3. Close defueling valve and access.
4. Close tank fill valve and access (Manually or electrically).

Monitor cockpit and/or remote fueling panel tank quantity gages and/or magnetic dripless sticks.

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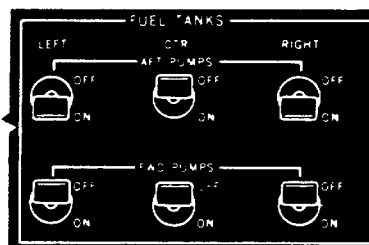
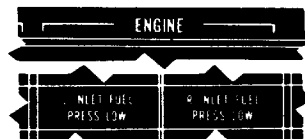
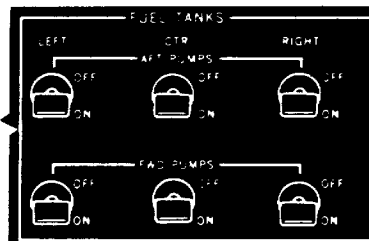
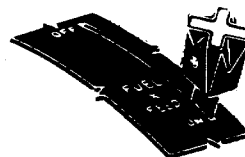
FUEL -- ABNORMAL OPERATION - Fuel management procedure

CONDITION

MAKING AN APPROACH WITH LESS THAN 1000 POUNDS
 INDICATED FUEL LOAD IN EITHER MAIN TANK

ACTION

1. Turn AFT boost pump ON in each main tank.
2. Turn FWD boost pump OFF in each main tank.
3. Turn both boost pumps OFF in the CTR tank.
4. Observe that neither L or R INLET FUEL PRESS LOW light comes on which verifies that the AFT pumps are operating.
5. Turn all operable fuel boost pumps ON.
6. Place FUEL X FEED lever at ON position.
7. Turn engine ignition on.



MINIMUM FUEL GO AROUND

(Minimum is defined as less than 1000 pounds indicated in either main tank)

NOTE: It is not recommended that a go around be executed with less than 500 pounds indicated in either main tank.

**IF AFT PUMP IN EITHER
 OR BOTH MAIN TANKS
 IS OPERATING**

1. Check all main tank pumps . . ON
2. Check FUEL X FEED lever . . ON
3. Avoid excessive or sustained nose up attitudes in excess of 10°

**IF AFT PUMP IN BOTH MAIN TANKS
 IS INOPERATIVE WITH LESS THAN
 1000 POUNDS INDICATED IN EITHER
 MAIN TANK**

GO AROUND IS NOT RECOMMENDED

BB1-1248B

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 21, SECTION 2, CHAPTER 30, DATED SEP 1/70
SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-30-1-0 ENGINE -- ENGINE LIMITATIONS (JT8D-9)

CHANGED PERMISSIBLE DURATION OF OIL TEMPERATURE TRANSIENTS IN EXCESS OF 120°C TO 157°C FROM 10 MINUTES TO 15 MINUTES.

2-30-15-1 ENGINE -- ABNORMAL OPERATION

CHANGED PERMISSIBLE DURATION OF OIL TEMPERATURE TRANSIENTS IN EXCESS OF 120°C TO 157°C FROM 10 MINUTES TO 15 MINUTES.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-30-Eff	66	All	2-30-Eff	66	All
2-30-1-0	13	1 and 2	2-30-1-0	13	1 and 2
2-30-15-1	9	3 and 4	2-30-15-1	9	3 and 4

Sep 1/70

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2-30 Summary
CODE 66
Page 1 of 1

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MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 2-30

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

DOUGLAS AIRCRAFT CO., INC.
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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

*2-30-Eff	66	1	Sep 1/70
2-30-Cont	66	1	Sep 1/69
2-30-Cont	66	2	Sep 1/69
2-30-Cont	66	3	Sep 1/69
*2-30-1-0	13	1	Sep 1/70
2-30-1-0	13	2	Dec 1/67
2-30-2-0	1	1	Dec 1/65
2-30-10-0	8	1	Mar 1/70
2-30-10-0	8	2	Mar 1/69
2-30-10-1	1	1	Dec 1/68
2-30-15-0	3	1	Jun 1/66
2-30-15-0	3	2	Mar 1/67
2-30-15-0	3	3	Sep 1/67
2-30-15-0	3	4	Jun 1/70
2-30-15-1	9	1	Mar 1/69
2-30-15-1	9	2	Mar 1/69
*2-30-15-1	9	3	Sep 1/70
2-30-15-1	9	4	Mar 1/69
2-30-15-2	3	1	Sep 1/67
2-30-15-2	3	2	Sep 1/67

*The asterisk indicates pages revised or added by the current revision.

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2-30-Effective Pages
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Chapter 30

ENGINE SYSTEMS

TABLE OF CONTENTS

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
* <u>LIMITATIONS</u> - JT8D-7	30-1-0	1	13	A11
* <u>LIMITATIONS</u>	30-1-0	2	13	A11
* <u>ENGINE</u> - Hazard areas	30-2-0	1	1	A11
* <u>NORMAL OPERATION</u> - Starting (Sheet 1)	30-10-0	1	8	A11
(Sheet 2)	30-10-0	2	8	A11
* <u>NORMAL OPERATION</u> - Ground reversing during landing	30-10-1	1	1	A11
* <u>ABNORMAL OPERATION</u> - Starting				
Starter valve fails to function	30-15-0	1	3	A11
No rotation N ₁ tachometer	30-15-0	1	3	A11
No rotation N ₂ tachometer	30-15-0	1	3	A11
Erroneous initial fuel flow	30-15-0	1	3	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION -</u> Starting				
EGT does not indicate normal range	30-15-0	2	3	A11
OIL PRESSURE LOW light on after start	30-15-0	2	3	A11
START VALVE OPEN light stays on after start	30-15-0	2	3	A11
<u>*ABNORMAL OPERATION -</u> Starting				
Hung start	30-15-0	3	3	A11
No oil pressure rise during starting	30-15-0	3	3	A11
<u>*ABNORMAL OPERATION -</u> Starting				
External Electrical Power and APU Generator Power Not Available	30-15-0	4	3	A11
<u>*ABNORMAL OPERATION</u>				
EPR erratic or fixed	30-15-1	1	9	A11
EGT inoperative or reads high	30-15-1	1	9	A11
N ₁ /or N ₂ overspeed	30-15-1	1	9	A11
<u>*ABNORMAL OPERATION</u>				
Fuel flow inoperative or reads high	30-15-1	2	9	A11
FUEL FILTER PRESS DROP light comes on	30-15-1	2	9	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Oil quantity decreasing or increasing	30-15-1	3	9	A11
High oil temperatures	30-15-1	3	9	A11
Low oil pressure and/ or OIL PRESSURE LOW light on	30-15-1	3	9	A11
High oil pressure	30-15-1	3	9	A11
<u>*ABNORMAL OPERATION</u>				
OIL STRAINER CLOGGING light on	30-15-1	4	9	A11
Continuous surging or popping in forward thrust	30-15-1	4	9	A11
<u>*ABNORMAL OPERATION - Thrust reverser</u>				
ENGINE REVERSE UNLOCK light comes on in flight	30-15-2	1	3	A11
REVERSER ACCUMULATOR LOW light comes on in flight	30-15-2	1	3	A11
<u>*ABNORMAL OPERATION - Thrust reverser</u>				
Inadvertent in-flight thrust reversing	30-15-2	2	3	A11
Thrust reverser inter- lock will not release, or returns thrust reverser lever to a reduced reverse thrust range	30-15-2	2	3	A11

*Illustration

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ENGINE -- ENGINE LIMITATIONS (JT8D-9)

ENGINE THRUST

Takeoff, Maximum Continuous, and Maximum Climb Thrust levels are established by appropriate EPR values for the ambient pressure and engine inlet total temperature conditions.

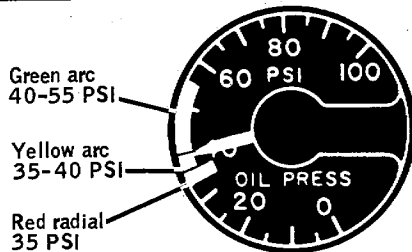
OPERATING CONDITIONS	OPERATING LIMITS					
	Time Limit	Max. Observed EGT °C	*Minimum Oil Pressure PSIG	**Oil Temp °C	Static S. L. Thrust/Lbs. Std. Day	Maximum Rotor Speeds
Takeoff	5 minutes	580	40	120	***14,500	N ₁ 12,250 RPM (100%)
Maximum Continuous	Continuous	540	40	120	12,600	N ₂ 8,600 RPM (100.1%)
Maximum Climb	Continuous	540	40	120	12,600	
Idle	Continuous	480	40	120		
Starting	Momentary	350 TO 420****	--			
Acceleration	2 Minutes	580	40	120		

*** Takeoff rating of the JT8D-9 engine is available up to 84°F ambient temperature.

OIL GRADE

Pratt and Whitney Spec. 521 (As revised).

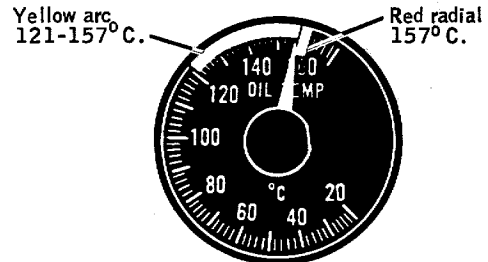
OIL PRESSURE



* Normal oil pressure is 40-55 PSIG. Oil pressure between 35 and 40 PSIG are permissible for sustaining flight preferably at reduced power settings.

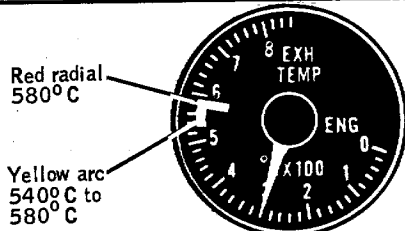
* Oil pressures below 35 PSIG are unsafe.

OIL TEMPERATURE



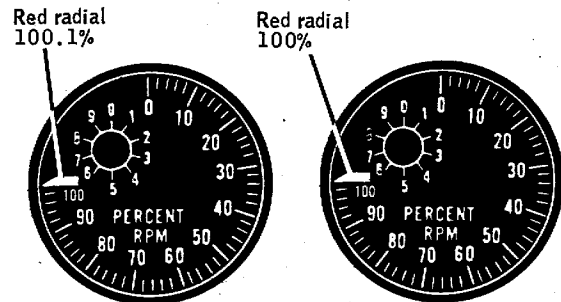
** Oil temperature in excess of 120°C but not over 157°C is allowed for a maximum period of 15 minutes.

EGT



*** 350°C. applies at ambient temperatures of 59°F. (15°C.) and below. 420°C. applies at ambient temperatures of 60°F. (15.6°C.) and above. These temperatures are time limited to momentary for starting. If maximum allowable starting EGT is exceeded, the engine should be shut down and inspected in accordance with instructions in the Pratt and Whitney maintenance manual.

N₁ & N₂ ROTOR RPM



N₁

N₂

BB1-2625C

DOUGLAS AIRCRAFT CO., INC.
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ENGINE -- LIMITATIONS

IGNITION

For optimum life of the ignition system components, the duty cycle is 10 minutes ON and 20 minutes OFF. However, when adverse flight conditions are encountered, such as ice or water ingestion, air turbulence at the inlet, or others which could result in engine flame-out, it is recommended that the two halves of the 20 joule, AC ignition system be used in alternating 10 minute periods for as long as needed to insure against engine flame-out. It should be recognized that prolonged use of the ignition system reduces its overhaul life.

STARTER

DUTY CYCLE

Starting 1 minute ON
30 seconds OFF
1 minute ON
1 minute OFF
May be repeated as often as required

FUEL GRADE

Pratt and Whitney Spec. 522 (As revised).

FUEL HEAT

Fuel heat should be turned on for one minute just prior to takeoff whenever the fuel temperature is 10°C (50°F) or below. Fuel heat SHOULD NOT be used during takeoffs.

ANTI-ICING

ENGINE ANTI-ICING MUST BE TURNED ON FOR TAKEOFF IF ICING CONDITIONS EXIST OR ARE ANTICIPATED.

When setting takeoff power with ambient temperatures below 10°C (50°F), EPR loss due to engine anti-ice should be recovered. Above 10°C (50°F), EPR corrections must be applied.

During takeoff, when airfoil ice protection becomes effective the drop in EPR should not be recovered.

When operating at maximum continuous, maximum climb, or maximum cruise limits, EPR loss due to engine anti-ice and/or airfoil ice protection should not be recovered.

THROTTLE MANAGEMENT

Inadvertant reverse thrust is possible if the throttle levers are slammed to idle in a violent manner. Such unusual throttle management could cause the reverse thrust lever to fly up to the reverse thrust detent as a result of inertia. When retarding throttles, the hand should be placed on the throttle knob, rather than using the fingers or other devices on the throttle post when simulating engine failure.

REVERSERS

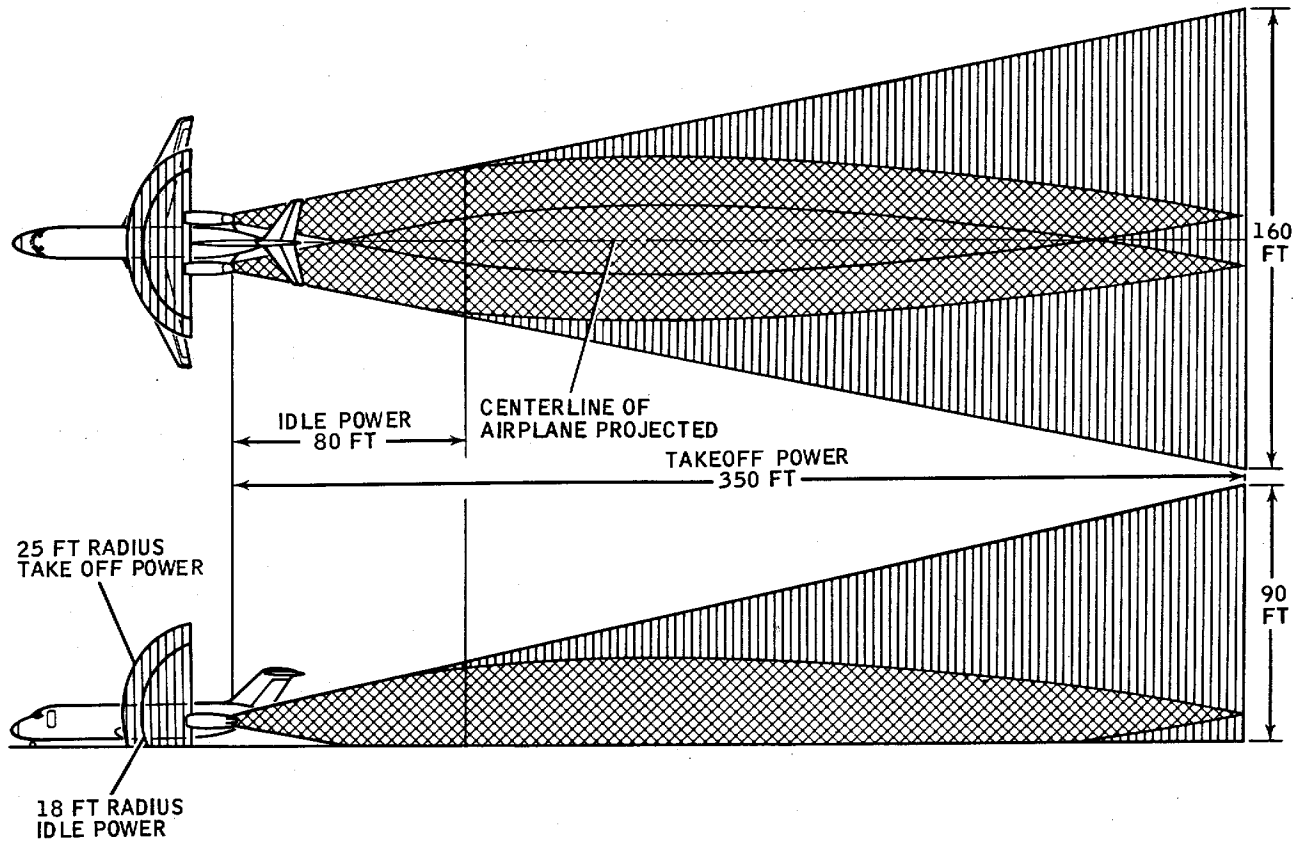
IN-FLIGHT REVERSING IS NOT PERMITTED.

REVERSE TAXIING IS NOT PERMITTED.

BB1-1655A

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ENGINE -- HAZARD AREAS



DISTANCE BEHIND EXHAUST EXIT		75 FT	100 FT	200 FT	350 FT
AT START OF TAXI ROLL	BLAST PRESSURE-PSF	18	8	3	2
	VELOCITY-KNOTS	75	50	30	20
	TEMPERATURE RISE (1)	50° F	30° F	5° F	
		28° C	17° C	3° C	
AT IDLE	VELOCITY-KNOTS	40	25	20	10
	TEMPERATURE RISE (1)	30° F	10° F	5° F	
		17° C	6° C	3° C	
	VELOCITY-KNOTS	165	125	60	36
AT TAKE-OFF	TEMPERATURE RISE (1)	90° F	70° F	20° F	20° F
		50° C	39° C	11° C	11° C

NOTE:
 (1) Temperatures are above ambient conditions.

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ENGINE -- NORMAL OPERATION - Starting (Sheet 1)

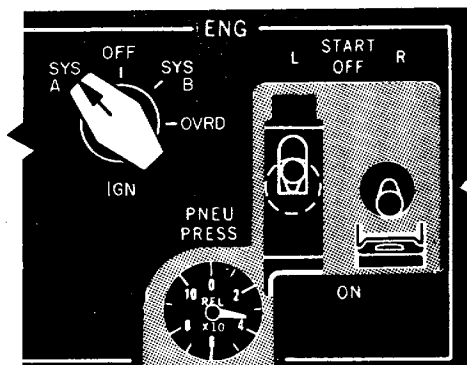
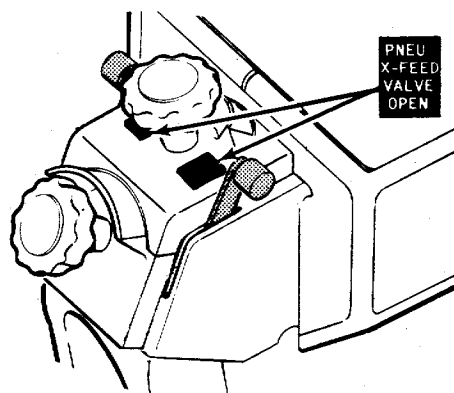
STARTING SEQUENCE

Before start checklist..... Completed
 PNEU PRESS..... Checked 36 PSI or higher (may be
 1 psi less for each 1000 foot
 increase in pressure altitude above SL)
 PNEU X FEED levers prior to start..... OPEN
 INLET FUEL PRESS LOW lights..... Off
 IGN switch..... SYS A or SYS B
 START switch..... Hold to ON
 N₂ RPM..... Rotation checked
 OIL PRESS..... Rising
 N₁ RPM..... Rotation checked
 FUEL control lever (at 15% N₂ RPM min. - 20% desired)..... ON
 Initial FUEL FLOW..... Approximately 800 PPH

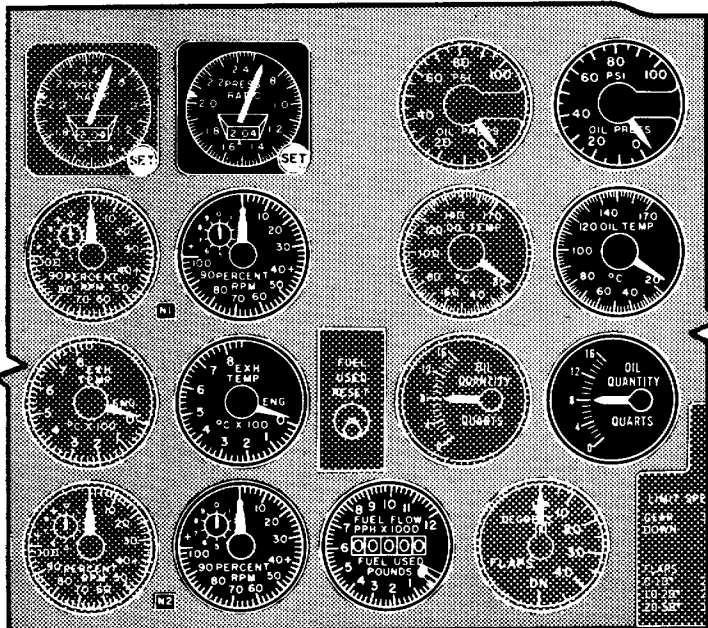
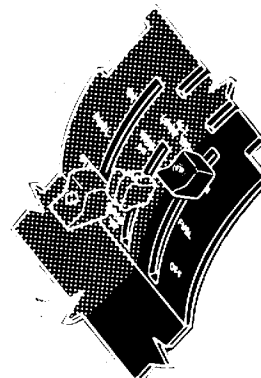
CAUTION

A starting FUEL FLOW indication of 1100 PPH (or more) is an indication of an impending hot start. FUEL control lever should be placed at OFF immediately, before a hot start is experienced.

EGT..... Rising
 START switch..... Release after 30% N₂ & before 40% N₂
 START VALVE OPEN light..... Off
 OIL PRESS LOW light..... Off
 Idle stabilized..... Observe following:
 N₂ RPM 50.5 - 57%
 EGT -- 300 - 480°C
 FUEL FLOW 800 - 1100 PPH
 OIL PRESS 40 - 55 PSI
 IGN switch..... OFF



ENGINE	
L START VALVE OPEN	R START VALVE OPEN
L OIL PRESS LOW	R OIL PRESS LOW
L INLET FUEL PRESS LOW	R INLET FUEL PRESS LOW



BB1-1961C

Section 2
 30-10-0
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 Page 1

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ENGINE -- NORMAL OPERATION - Starting (sheet 2)

STARTING PROCEDURES

ENG. PNEU CROSS START

1. PNEU X-FEED levers Both OPEN
2. Ramp check Engine hazard area clear
3. Oper eng throttle . . Advance to obtain required pneu press
4. Proceed with normal starting procedures on inoperative engine.

UNSATISFACTORY START PROCEDURE

1. FUEL control lever. OFF
2. If starter is still engaged, continue rotation for 10-15 seconds to clear engine of fuel
3. START switch OFF
4. Ignition switch OFF

NOTE:

If starter did not remain operating for at least 10 seconds after FUEL control lever was placed to OFF position, a 30 second draining period should be allowed or, if required, proceed to engine clearing procedure before attempting another start.

CLEARING PROCEDURE

1. FUEL control lever OFF
2. Throttle IDLE
3. N₂ Tachometer. Indicates rotation has ceased
4. IGN switch OFF
5. START switch ON, Hold 20 secs.

INFLIGHT START PROCEDURE

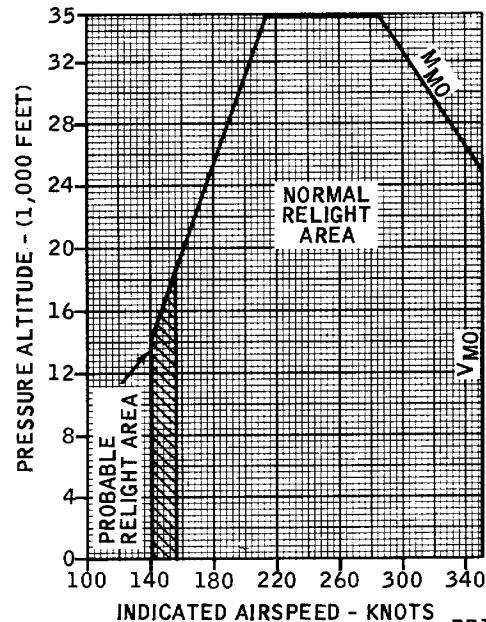
Throttle IDLE
 FUEL control lever OFF
 ENG FIRE shutoff Full forward
 ENG anti-ice OFF
 Main tank boost pumps . . one on (INLET FUEL PRESS LOW light out)
 Airspeed Per inflight relight chart below
 Oil pressure Indicating
 IGN switch OVRD (duty cycle - 10 min. on)
 FUEL control lever ON
 Engine instruments Stabilized
 IGN switch as required

NOTE:

If EGT and RPM rise does not occur within 20 seconds after FUEL control lever has been placed to ON position, discontinue air start. Proceed to emergency procedures phase III engine failure.

Fuel flow indications and EGT indications may indicate lower values during air starts depending upon altitude.

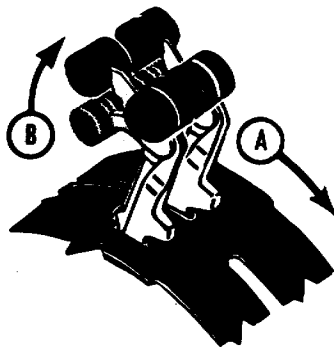
INFLIGHT RELIGHT ENVELOPE BASED ON SINGLE IGNITER OPERATION



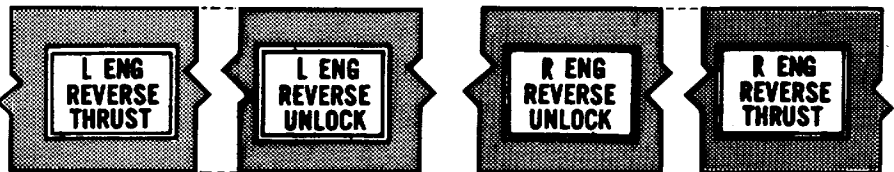
ENGINE -- NORMAL OPERATION - Ground reversing during landing

INFLIGHT REVERSING IS NOT PERMITTED

REVERSE TAXIING IS NOT PERMITTED



1. When the main landing gear is firmly on the ground:
 - A. Place the throttles to forward idle thrust position and,
 - B. Place thrust reverser levers to the interlock stop position.
2. Observe that the ENG REVERSE UNLOCK lights come on, and that the ENG REVERSE THRUST lights come on approximately two seconds later.

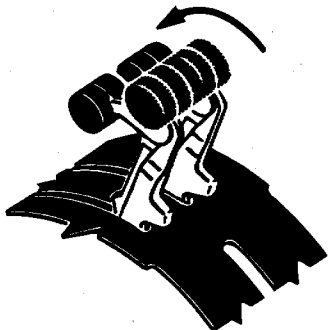


3. When the interlock stop releases, the thrust reverser levers may be adjusted to obtain the desired reverse thrust up to maximum continuous for deceleration.

NOTE: Limit thrust below 60 knots to 1.2 EPR, and above 60 knots to 1.6 EPR unless use of higher thrust is dictated by existing conditions.

Use of reverse thrust up to takeoff EPR is permissible if emergency conditions warrant its use.

At lower speeds, avoid high thrust settings that cause engine compressor stalls.



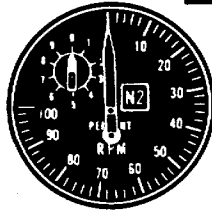
4. As airplane decelerates, reduce reverse thrust settings to avoid engine surging or popping.
5. When reverse thrust is no longer required, place the reverse thrust levers to the forward thrust position and observe that the ENG REVERSE THRUST and ENG REVERSE UNLOCK lights go out.

NOTE: When using reverse thrust levels above the interlock stop position rapid selection to forward thrust may result in undesirable forward thrust levels while the engine is decelerating to idle rpm.

It is not recommended that reverse thrust be used during taxi or when static if possibility of ingestion of debris exists.

ENGINE -- ABNORMAL OPERATION - Starting

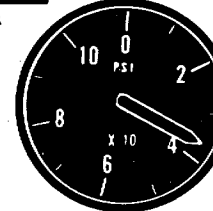
CONDITION
STARTER VALVE FAILS TO FUNCTION
 (PNEUMATIC PRESS AVAILABLE, PNEU X-FEED OPEN)



NO ROTATION

START VALVE OPEN

Light remains off

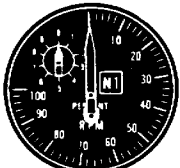


NO PNEU PRESS DROP

ACTION

- Check circuit breakers
 If unable to electrically open starter valve proceed with manual opening start procedure.
1. Before start check list completed.
 2. Place maintenance interphone switch ON.
 3. Request ground crewman who will operate starter valve manually to plug in interphone head set at the reverser dump valve access area interphone receptacle.
NOTE: Personnel operating the starter valve will need hand and arm cover protection as some of the hot starter exhaust air will exit through the starter valve access door.
 4. When ready to start, Pilot will command on interphone "ENERGIZE STARTER", start valve light will come on as starter valve opens.
 5. Fuel control lever on at 15% N₂ RPM.
 6. After EGT rise, as speed of 30-40% N₂ RPM is obtained, simultaneously close starting engine "PNEUX-FEED" and command ground crewman to "CLOSE STARTER VALVE".
 7. Obtain ground clearance prior to starting other engine.

CONDITION
NO ROTATION N₁ TACHOMETER

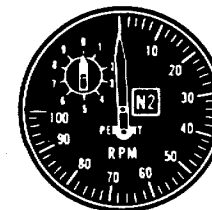


(Tachometer circuits do not require aircraft elect. power)

ACTION

1. Discontinue start (possible N₁ rotor seizure).
2. Confirm N₁ rotor rotation with ground crew.
3. If N₁ rotor rotation is normal, proceed with normal start utilizing N₂ and remaining engine indications.

CONDITION
NO ROTATION N₂ TACHOMETER
 (START VALVE LIGHT ON)

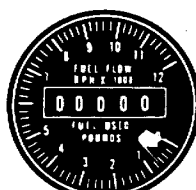
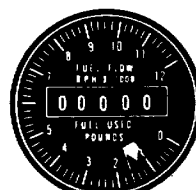


(Tachometer circuits do not require aircraft elect. power)

ACTION

1. Check N₁ Tachometer and/or oil pressure for indication of rotation. If rotation is confirmed, continue start, use 5 percent of N₁ RPM for fuel on.
2. Start switch OFF at 12 to 20 percent N₁ RPM.

CONDITION
ERRONEOUS INITIAL FUEL FLOW
 BELOW 700 PPH TO ZERO OR ABOVE 1000 PPH

ACTION

1. Continue start, anticipate abnormal exhaust gas temp. indications. Do not exceed starting EGT limits.
2. With engine stabilized at idle, check fuel flow circuit breakers and/or check with ground crew for possible engine fuel leakage.
NOTE: Normal initial fuel flow should indicate between 750 PPH and 850 PPH.
NOTE: Erroneous initial fuel flow rise indications may be faulty Xmitter/gage circuit or abnormal fuel control operation.

BB1-933B

ENGINE -- ABNORMAL OPERATION - Starting

CONDITION

EGT DOES NOT INDICATE NORMAL RANGE

(EGT circuit does not require aircraft elect. power)



DOES NOT RISE BELOW NORMAL ABOVE NORMAL

ACTION

EGT DOES NOT RISE WITHIN 20 SECONDS AFTER FUEL CONTROL LEVER IS PLACED TO FUEL ON.

1. Discontinue start, - proceed with unsatisfactory start and / or clearing procedures.
2. Recheck ignition circuit breakers.
3. Select opposite ignition system
4. Attempt restart.
 - A. Continue start if engine indications are normal during restart.
 - B. Discontinue start if EGT does not rise within 20 seconds after placing fuel control lever to on position. Proceed with unsatisfactory start and / or clearing procedures.

NOTE:
Do not select the opposite ignition system or OVRD after placing fuel control lever at ON.

EGT BELOW NORMAL

1. Anticipate hung start.
Crosscheck other engine parameters at idle for normal indications.
2. Continued operation is permissible.

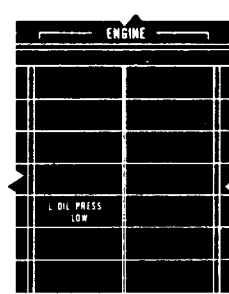
NOTE: At pilots discretion a power check of affected engine can be accomplished prior to takeoff.

EGT ABOVE NORMAL

1. Anticipate possible hot start.
If EGT exceeds limitations shut down engine.
(See LIMITATIONS)

CONDITION

OIL PRESS LOW LIGHT ON AFTER START



ACTION

1. Check oil pressure.
 - A. If above 40 PSI proceed to step 2.
 - B. If below 40 PSI shut down engine and correct malfunction.
2. Advance engine thrust to approx. 75% N₂ RPM.
 - A. If light goes out & engine oil pressure is normal, continue operations.
 - B. If light remains on & engine oil pressure is normal, continue operations, observe oil quantity & oil temp. indications.

CONDITION

START VALVE OPEN LIGHT STAYS ON AFTER START

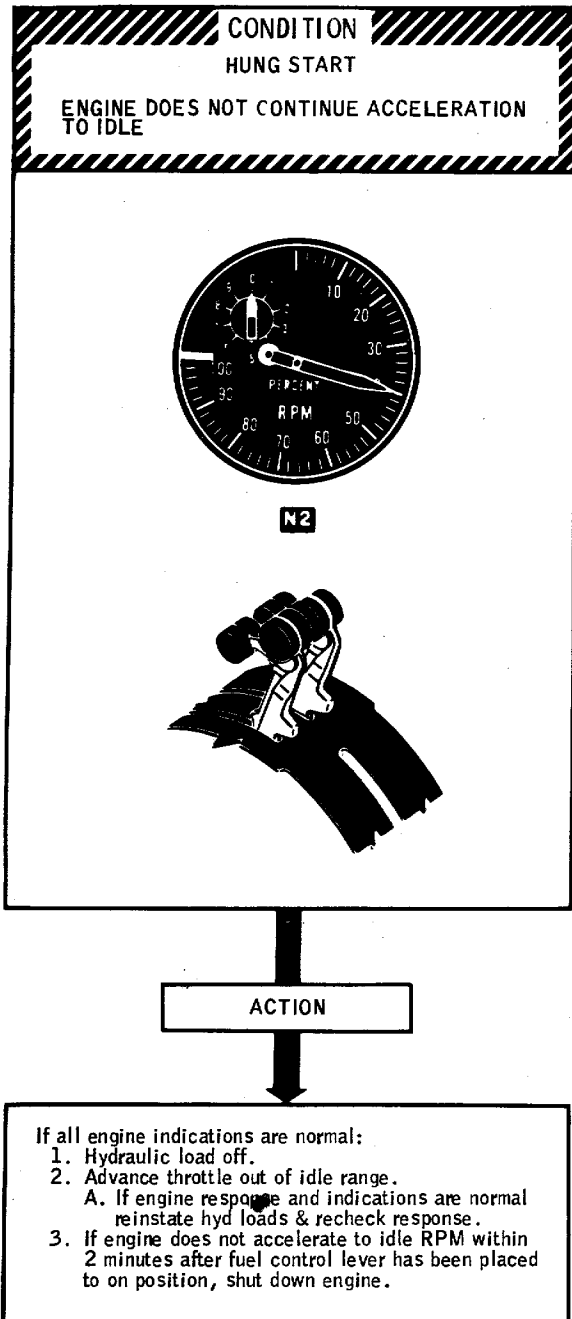
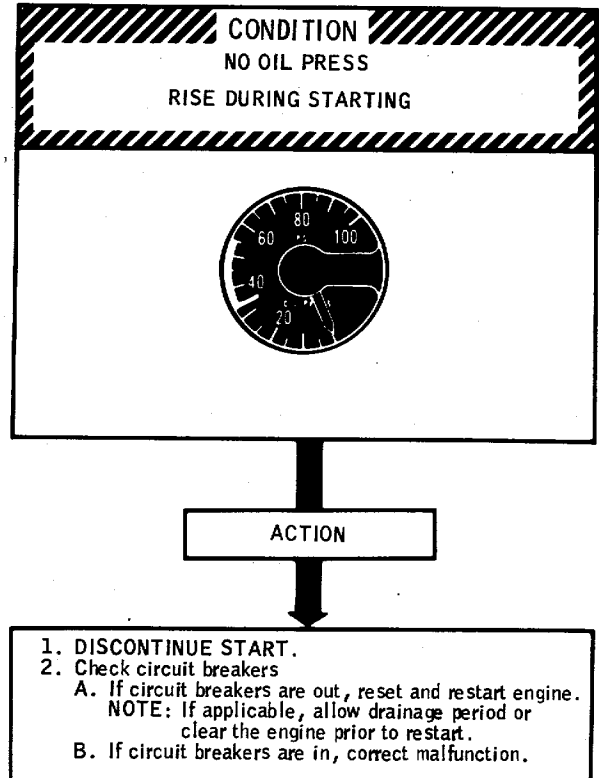


ACTION

1. Close respective engine PNEU X-FEED VALVE.
2. Contact ground crew to ascertain position of starter valve.
3. A. If valve is closed, assume faulty light circuit and continue operation.
B. If valve is not closed, close valve manually.
 - (1) If light goes out and remains out, continue operation.
 - (2) If light goes out and comes on again, indicating that valve does not remain closed, shut down engine.

BB1-935C

ENGINE -- ABNORMAL OPERATION - Starting



ENGINE -- ABNORMAL OPERATION - Starting

CONDITION

EXTERNAL ELECTRICAL POWER AND APU GENERATOR POWER
 NOT AVAILABLE; REQUIRING A BATTERY START.

ACTION

STARTING SEQUENCE

(Also refer to BATTERY START, Section 2, Chapter 5)

Wheels	Chocked
Applicable before start checklist items	Completed
AC BUS X TIE switch	OPEN
BATT switch	ON
EMER PWR switch	ON
PNEU PRESS	Checked
PNEU X-FEED levers	OPEN
START PUMP switch	ON
IGN	SYS A or SYS B

Start right engine

NOTE:

OIL PRESS LOW lights, EGT, and N₁ and N₂ tachometers
 will be operative during the start.

After releasing START switch it can be determined that the
 start valve has closed by observing the pneumatic pressure
 return to its original value.

During the start cycle, until the generator comes on the line,
 the following engine instruments and indicators will be inop-
 erative:

OIL PRESS indicators
 OIL QUANTITY indicators
 OIL TEMP indicators
 PRESS RATIO indicators
 FUEL FLOW meters
 START VALVE OPEN lights
 OIL STRAINER CLOGGING lights

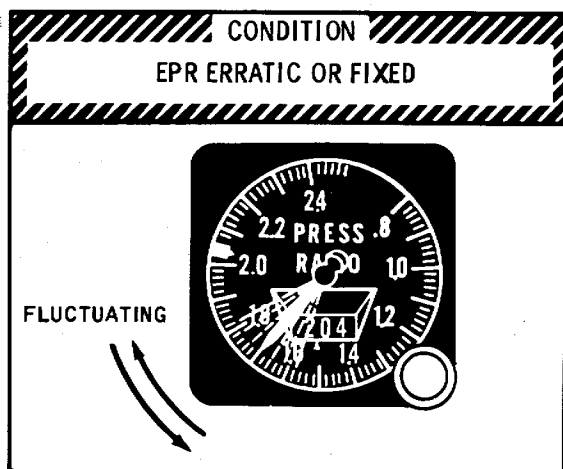
AC BUS X TIE switch AUTO

Start left engine in a normal manner.

EMER PWR switch OFF

BB1-2253A

ENGINE -- ABNORMAL OPERATION



ACTION

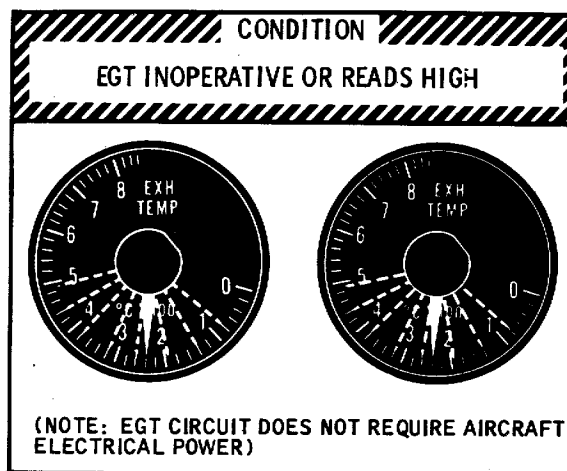
IF ICING CONDITIONS EXIST

1. Turn ignition to SYS A or SYS B position.
2. Turn on engine anti-icing.
3. Check EPR and parameters for normal response.

If response is not normal

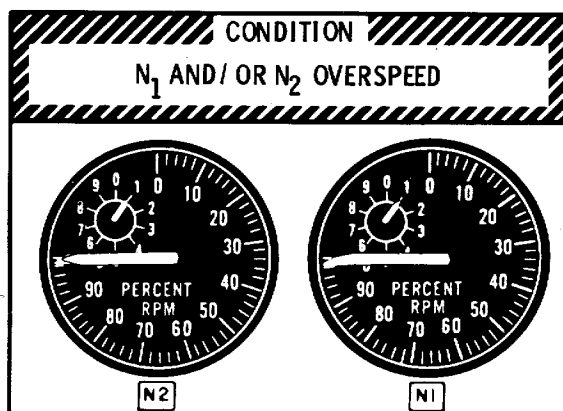
IF ICING CONDITIONS DO NOT EXIST

1. Check EGT, N_1 , N_2 , and fuel flow.
2. If these indications appear normal and respond to throttle changes, assume EPR circuit malfunction. Check circuit breakers. If EPR remains inoperative use N_1 indicators for power setting.



ACTION

1. Reduce thrust.
2. Check EPR, N_1 , N_2 and fuel flow.
 - A. If EGT remains the same and all other indications decrease, assume EGT circuit malfunction.
 - B. If EGT exceeds 580°C and cannot be decreased, shut down engine
 - C. If EGT exceeds 580°C (but not over 600°C) and thrust reduction decreases EGT below 580°C with other indications normal, continued engine operation permissible. Record discrepancy of over limit and time.
 - D. If EGT has exceeded 600°C , a precautionary engine shutdown should be accomplished at pilot's discretion.



ACTION

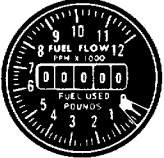
1. Reduce thrust.
 - A. If N_1 has exceeded 100.1% but not over 104.5% and N_2 has exceeded 100% but not over 102.4%, and all engine indicators are normal, continue engine operation and record RPM above maximum limit.
 - B. If N_1 has exceeded 104.5% and/or N_2 has exceeded 102.4%, a precautionary engine shutdown should be accomplished at pilot's discretion. Record RPM overshoot.

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ENGINE -- ABNORMAL OPERATION

CONDITION
 FUEL FLOW INOPERATIVE
 OR READS HIGH



ACTION

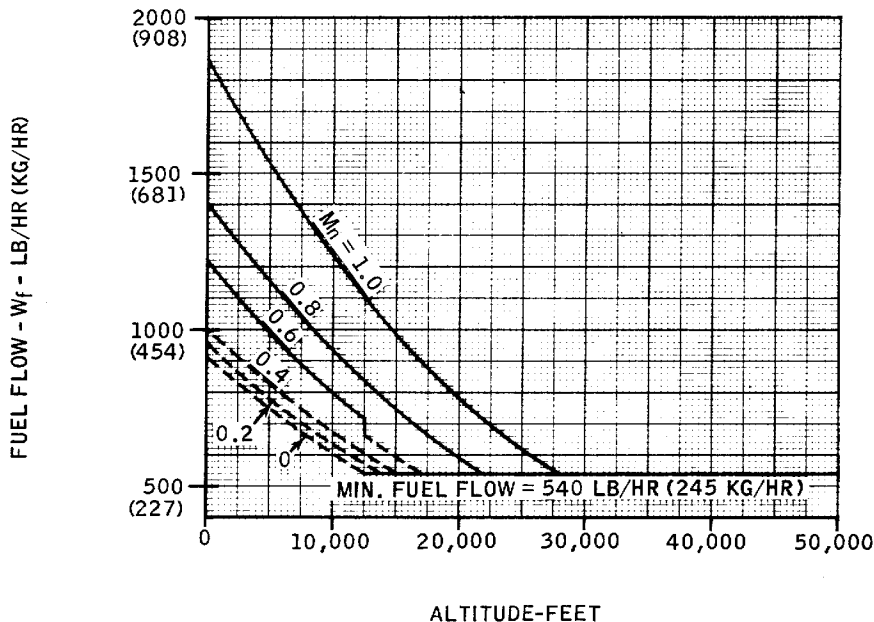
INOPERATIVE FUEL FLOW

If FUEL FLOW fails to respond to throttle changes and other indications are normal, check fuel flow indicator circuit breakers.

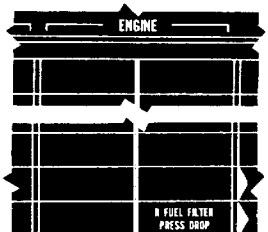
HIGH FUEL FLOW

1. Reduce thrust to idle on affected engine.
2. If FUEL FLOW responds and other indications appear normal but FUEL FLOW is higher than shown on ESTIMATED NET FUEL FLOW AT IDLE THRUST RATING Chart.
 - a. Assume fuel leak in engine section.
 - b. Cross check fuel remaining versus time, to confirm fuel leak. If fuel leak is suspected, shut down engine.
 If fuel remaining confirms normal consumption, continue engine operation and observe fuel usage to maintain even distribution.

ESTIMATED NET FUEL FLOW AT IDLE THRUST RATING JT8D-1, -5, -7, -9, & -11 TURBO FAN ENGINES



CONDITION
 FUEL FILTER PRESS DROP
 LIGHT COMES ON.

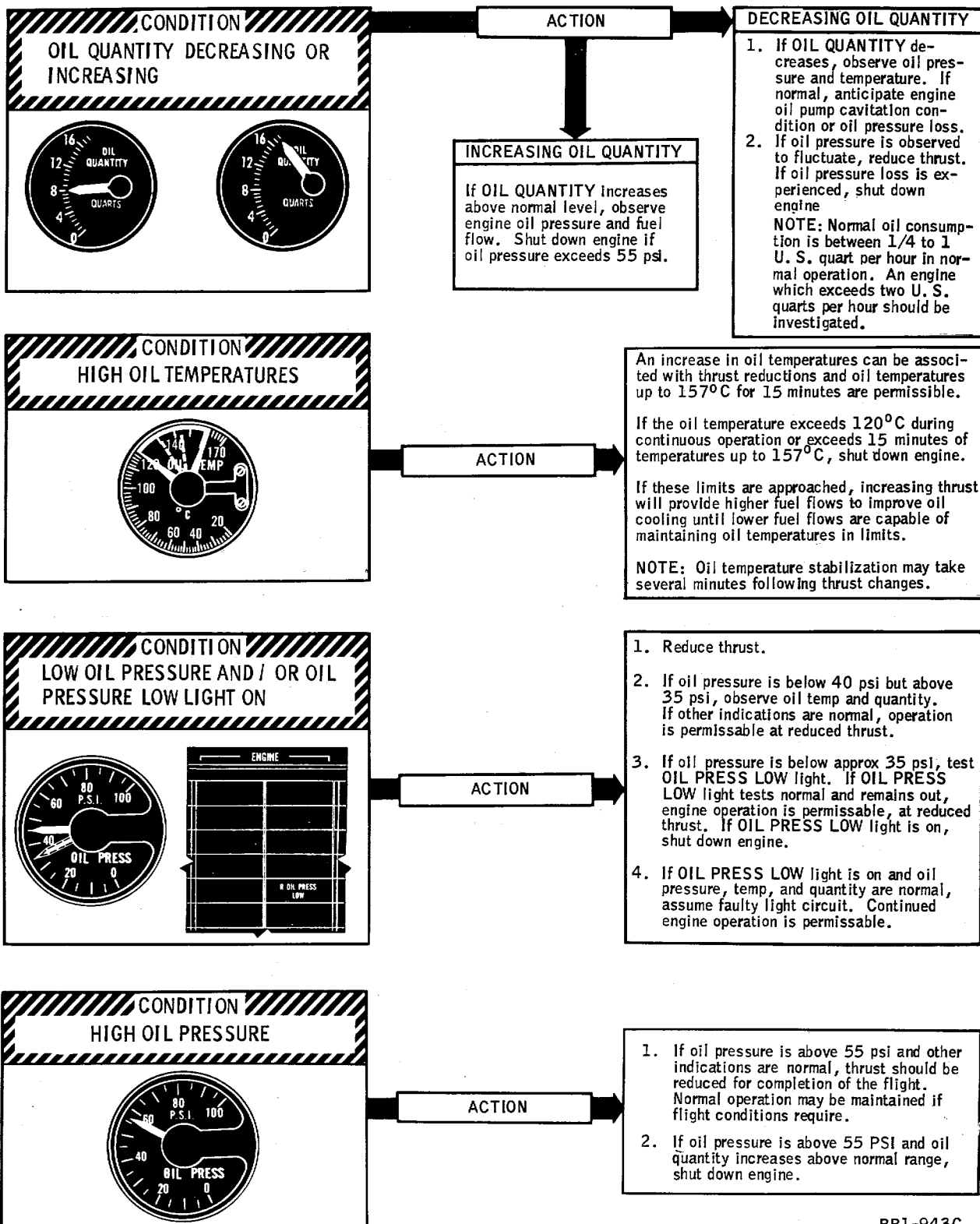


ACTION

1. Turn FUEL HEAT switch ON. Observe that FUEL HEAT ON light comes on.
 NOTE: Fuel heat may be turned on anytime within 10 minutes after the FUEL FILTER PRESS DROP light comes on.
2. Check fuel temperature for rise.
 NOTE: FUEL FILTER PRESS DROP light on with fuel temperature above 15° C. may be due to fuel filter clogging by solid contaminants other than ice. Continued engine operation is permissible if engine oil temperature is maintained within normal limits. FUEL HEAT ON light should go out automatically after one minute.
3. If the FUEL FILTER PRESS DROP light does not go out and the fuel temperature is below 15° C., repeat steps 1 and 2.
 NOTE: Do not exceed oil temperature limitations.

BB1-940B

ENGINE -- ABNORMAL OPERATION



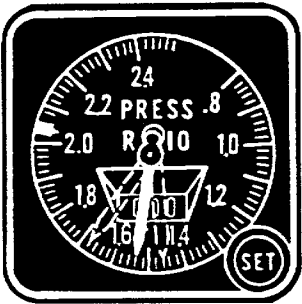
BB1-943C

Diagram illustrating the engine compartment layout. The top section is labeled "ENGINE". Below it, the right side of the compartment is labeled "R OIL STRAINER CLOGGING LIGHT ON".

ACTION

1. Reduce thrust
 - A. If OIL STRAINER CLOGGING light goes out continue flight at reduced thrust setting at or below thrust necessary to keep oil strainer light out.
 - B. If OIL STRAINER CLOGGING light remains on shut down engine.

CONDITION
CONTINUOUS SURGING OR POPPING
IS ENCOUNTERED WITH THE ENGINE
IN FORWARD THRUST.



Fluctuating EPR and/or
audible pops or bangs.

ACTION

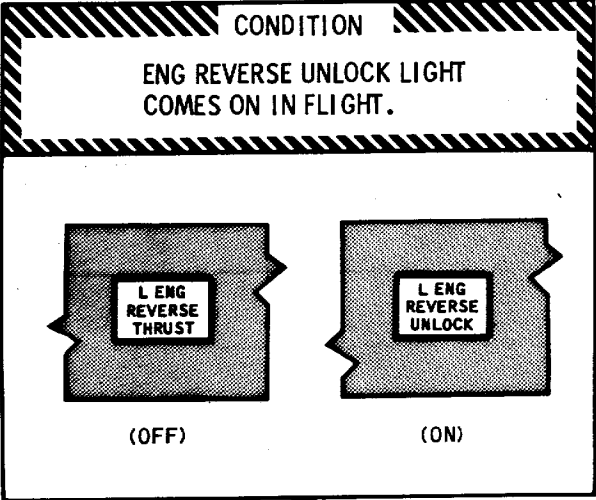
1. Airfoil Ice Protection (on affected side) -----OFF
 2. Air Conditioning Supply (on affected side)-HP BLD OFF
 3. Pneumatic X-FEED Valve (on affected side)--CLOSED
- If surging or popping continues:
4. Throttle (on affected side)----- Reduce thrust
(to idle if required)

IF SURGING OR POPPING PERSISTS
Shut down affected engine.

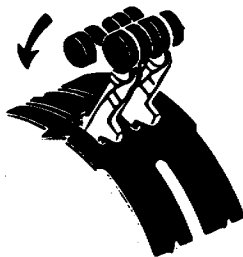
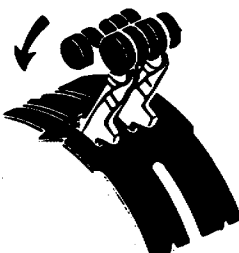
Shut down affected engine.

BB1-948B

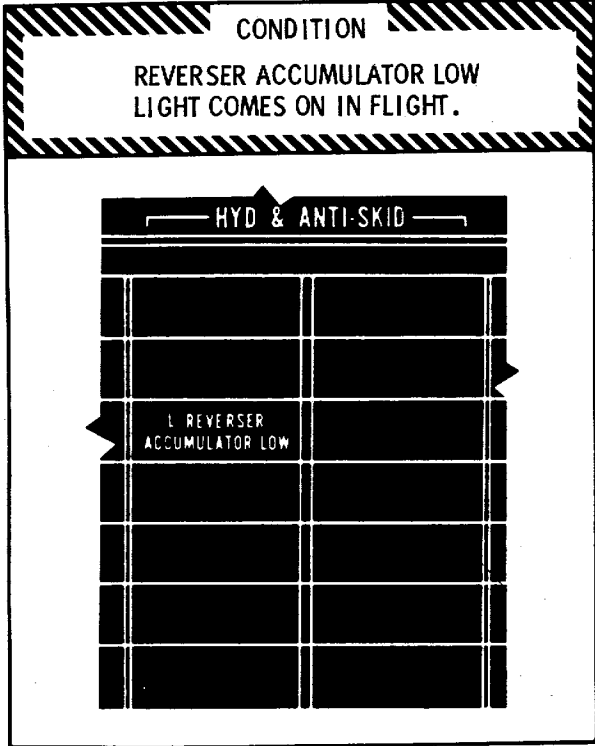
ENGINE -- ABNORMAL OPERATIONS -- Thrust reverser



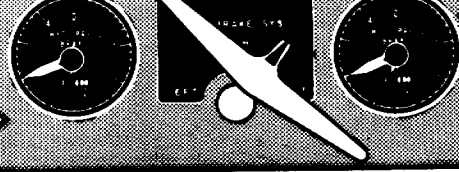
ACTION

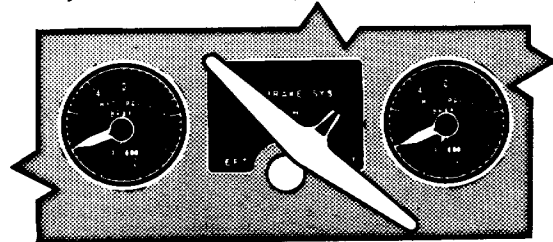
A black and white line drawing of a reverser lever. The lever has a handle with a curved grip and a cylindrical body. An arrow points downwards from the handle, indicating the direction of movement. The lever is shown in a partially extended position.

Check that reverser lever is fully down. If **ENG REVERSE UNLOCK** light remains on continued flight operation is permissible.



ACTION

1. Continued flight operations permissible.
 2. For approach, place the brake selector handle to the unaffected hydraulic supply system.
- 
- The diagram shows a rectangular instrument panel with a jagged, star-like border. It contains two circular gauges on the left and right, and a central rectangular display. The left gauge is labeled 'PRESS. PSI' and has a needle pointing to approximately 10. The right gauge is labeled 'TEMP. °F' and has a needle pointing to approximately 150. The central display shows a silhouette of an aircraft in flight, with the text 'THROTTLE' and 'LVS' visible. Below the aircraft silhouette is a small circular indicator.
3. Use thrust reversers as necessary for deceleration within limits of directional controllability.
- NOTE:**
Affected reverser may not extend and hydraulic supply system may be subject to quantity loss.

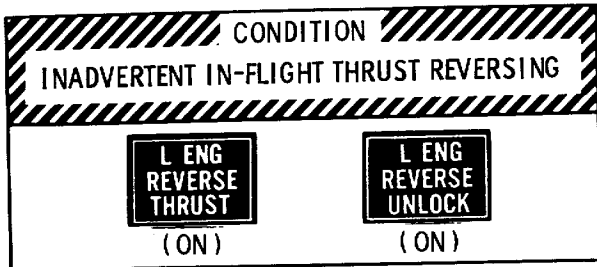


3. Use thrust reversers as necessary for deceleration within limits of directional controllability.

NOTE:
Affected reverser may not extend and hydraulic supply system may be subject to quantity loss.

NOTE:
Affected reverser may not extend and hydraulic supply system may be subject to quantity loss.

ENGINE -- ABNORMAL OPERATION - Thrust reverser

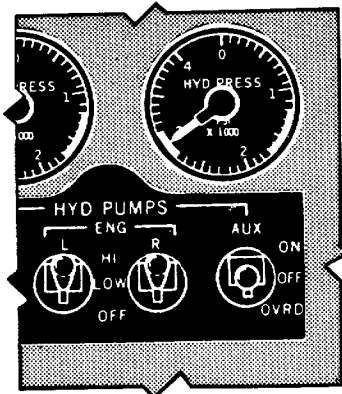


ACTION

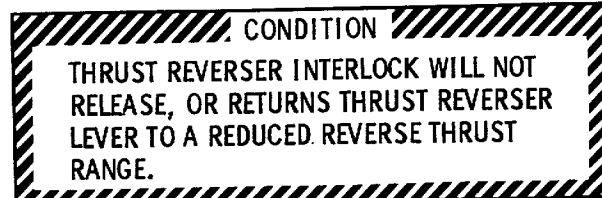


1. Position applicable throttle and thrust reverser lever to the forward idle thrust position.

NOTE: Reversers may not stow above 175 KTS. Applicable throttle should be left in idle position until reverser is stowed.



2. If reversers not stowed, select and maintain 3000 pound hydraulic pump operation.
3. Pull affected reverser accumulator shutoff circuit breaker for not more than 3 seconds to charge applicable accumulator and stowing system.
4. Adjust throttles as necessary to maintain flight.



ACTION

1. Place affected thrust reverser lever at forward idle position.



2. Use unaffected thrust reverser as necessary for deceleration within the limits of directional controllability.

BB1-951

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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 20, SECTION 2, CHAPTER 32, DATED JUN 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-32-10-0 APU -- NORMAL OPERATION - STARTING

ADDED APU INFLIGHT START ENVELOPE CHART.

2-32-15-0 APU -- ABNORMAL OPERATION - AIRSTART USING WINDMILL RPM

REVISED WINDMILL START ENVELOPE PLOT FOR TYPE I OIL (WARM) PROBABLE WINDMILL START.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-32-Eff	66	A11	2-32-Eff	66	A11
2-32-10-0	4	1	2-32-10-0	4	1
2-32-15-0	5	5	2-32-15-0	5	5

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MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 2-32

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft

*2-32-Eff	66	1	Jun 1/70
2-32-Cont	66	1	Sep 1/69
2-32-Cont	66	2	Sep 1/69
2-32-1-0	1	1	Dec 1/69
*2-32-10-0	4	1	Jun 1/70
2-32-10-5	3	1	Sep 1/69
2-32-15-0	5	1	Dec 1/67
2-32-15-0	5	2	Dec 1/67
2-32-15-0	5	3	Dec 1/67
2-32-15-0	5	4	Dec 1/67
*2-32-15-0	5	5	Jun 1/70

*The asterisk indicates pages revised or added by the current revision.

Jun 1/70

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Page 1

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Chapter 32

AUXILIARY POWER UNIT (APU)

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*LIMITATIONS</u>	32-1-0	1	1	A11
<u>*NORMAL OPERATION</u>				
Ground or air start (using starter)	32-10-0	1	4	A11
<u>*NORMAL OPERATION</u>				
Shutdown	32-10-5	1	3	A11
<u>*ABNORMAL OPERATION</u>				
APU will not rotate	32-15-0	1	5	A11
<u>*ABNORMAL OPERATION</u>				
No start or hung start	32-15-0	2	5	A11
<u>*ABNORMAL OPERATION</u>				
No load idle EGT high	32-15-0	3	5	A11
<u>*ABNORMAL OPERATION</u>				
Oil pressure low or oil temperature high	32-15-0	4	5	A11

*Illustration

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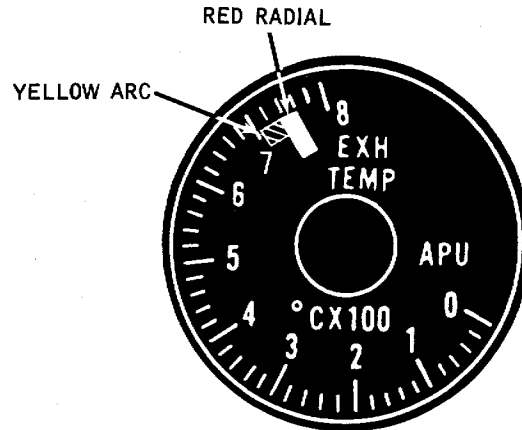
DOUGLAS AIRCRAFT CO.
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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Air start using windmill rpm				
Both generators inoperative	32-15-0	5	5	A11

*Illustration

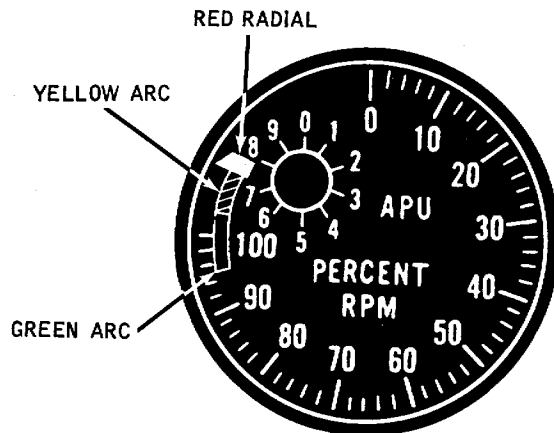
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AUXILIARY POWER UNIT (APU) -- LIMITATIONS



Red radial..... 732° C
 Yellow arc..... 710 to 732° C

NOTE: A temperature of 760° C is allowed for 30 seconds during starting.



Red radial..... 110 percent RPM
 Yellow arc..... 105 to 110 percent RPM
 Green arc..... 95 to 105 percent RPM

APU Pneumatic pressure (zero load) 30 psi to 45 psi.

APU starter motor duty cycle is a maximum of one minute on and a minimum of four minutes off.

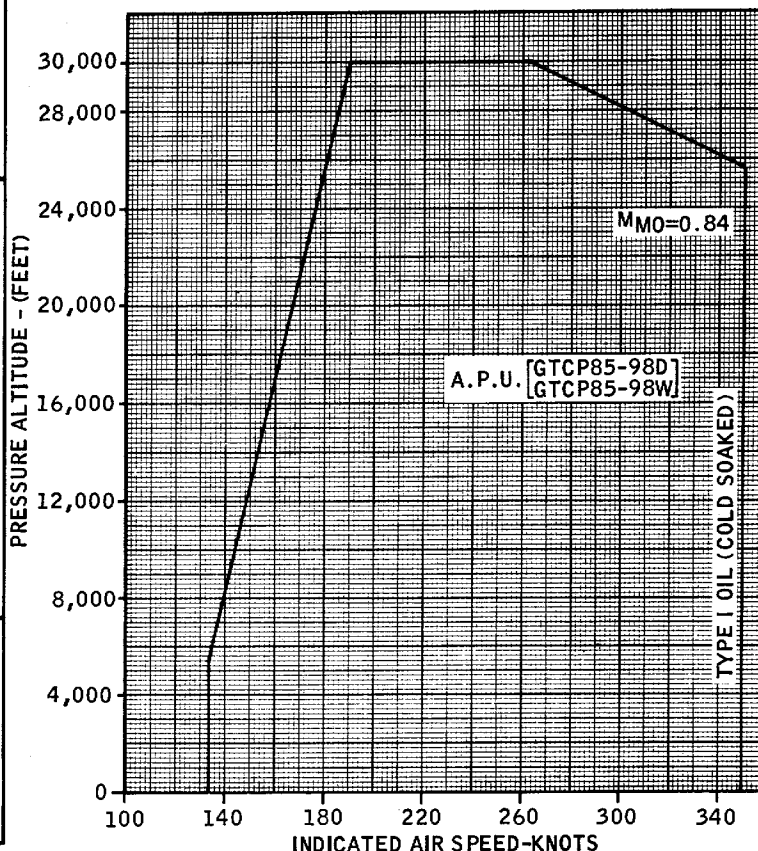
APU bleed AIR switch must be at OFF position for all inflight operations.

APU -- NORMAL OPERATION - Starting

GROUND OR AIRSTART (USING STARTER)

BEFORE START	
1. BATTERY switch ON	
NOTE: Positioning battery switch to ON not required when using DC ground power supply.	
2. FIRE CONT switch NORM	
3. DOORS switch AUTO	
4. Bleed AIR switch OFF	
5. MASTER switch OFF	
6. APU OIL TEMP HIGH light OFF	
7. APU OIL PRESS LOW light OFF	

APU INFLIGHT ELECTRIC START ENVELOPE



GROUND START ONLY
8. ENG panel START PUMP (dc) switch .. ON

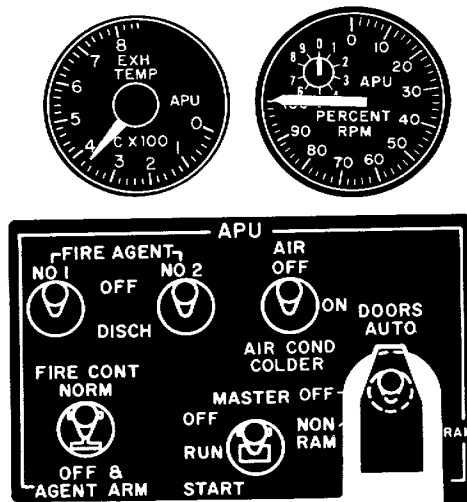
START
1. MASTER switch START, release to RUN upon observing initial rise in rpm.
2. APU OIL PRESS LOW light at approximately 35% rpm OFF
3. Observe APU rpm and exhaust gas temperature limits after EGT rise.

AFTER START (GROUND ONLY)	
1. START PUMP switch (after ac boost pump pressure available) OFF	3. Bleed AIR switch As required
2. PNEU PRESS indicator (if ground pneumatic pressure source is not being used and engines are not running). ZERO psi	4. PNEU PRESS indicator (if applicable) NORMAL
NOTE: Either battery or DC ground power must remain on to sustain APU operation.	

BB1-1509B

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APU -- NORMAL OPERATION - Shutdown



1. APU AIR switch OFF
2. MASTER switch (after EGT has decreased to below 400° C). . . OFF

NOTE: The EGT should be decreased to below 400° C before APU shut down in order to reduce thermal stresses of the turbine. A time period of about 20 seconds is required to decrease the EGT to 400° C after the AIR switch is turned off.

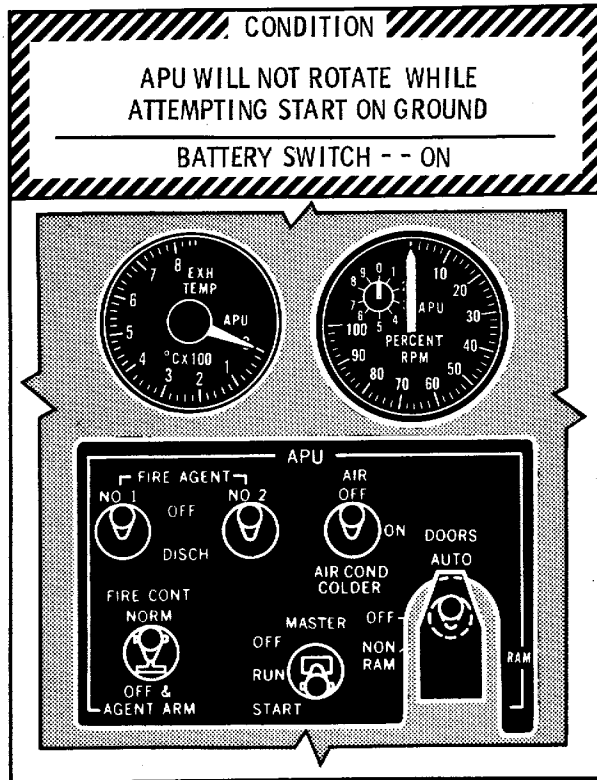
BB1-4265

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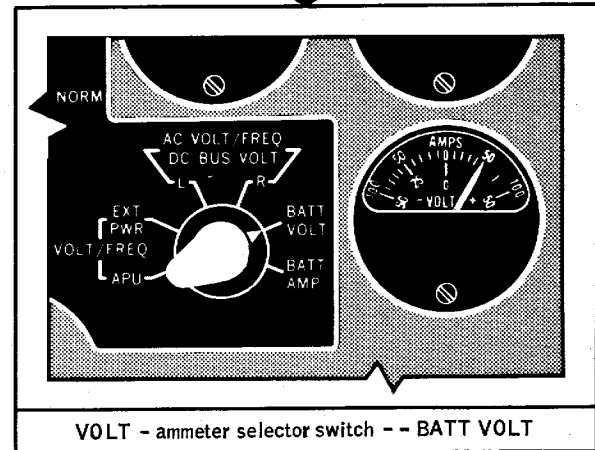
APU -- ABNORMAL OPERATION



* NOTE: Approximate door cycling time:

1. Closed to non-ram open 6 sec.
2. Non-ram open to ram open 6 sec.
3. All closed to ram open 12 sec.
4. Ram open to all closed 12 sec.

ACTION



If voltage is below
22 volts after apply-
ing APU starter motor
load, battery is dis-
charged.

If voltage is above
22 volts, check or
reset APU CONTROL
circuit breaker on
BATTERY BUS on
overhead panel.

If breaker was in,
check or reset APU
DOOR circuit breaker.

Determine that ground
shift mechanism is
in ground mode.

If APU RPM and EGT rise, operate APU using
manual door control.
After APU reaches no-load idle rpm (102%),
Actuate APU AIR SWITCH to ON.

IF PNEUMATIC
PRESSURE IS
INDICATED

APU may be used for
ground operation as
desired.

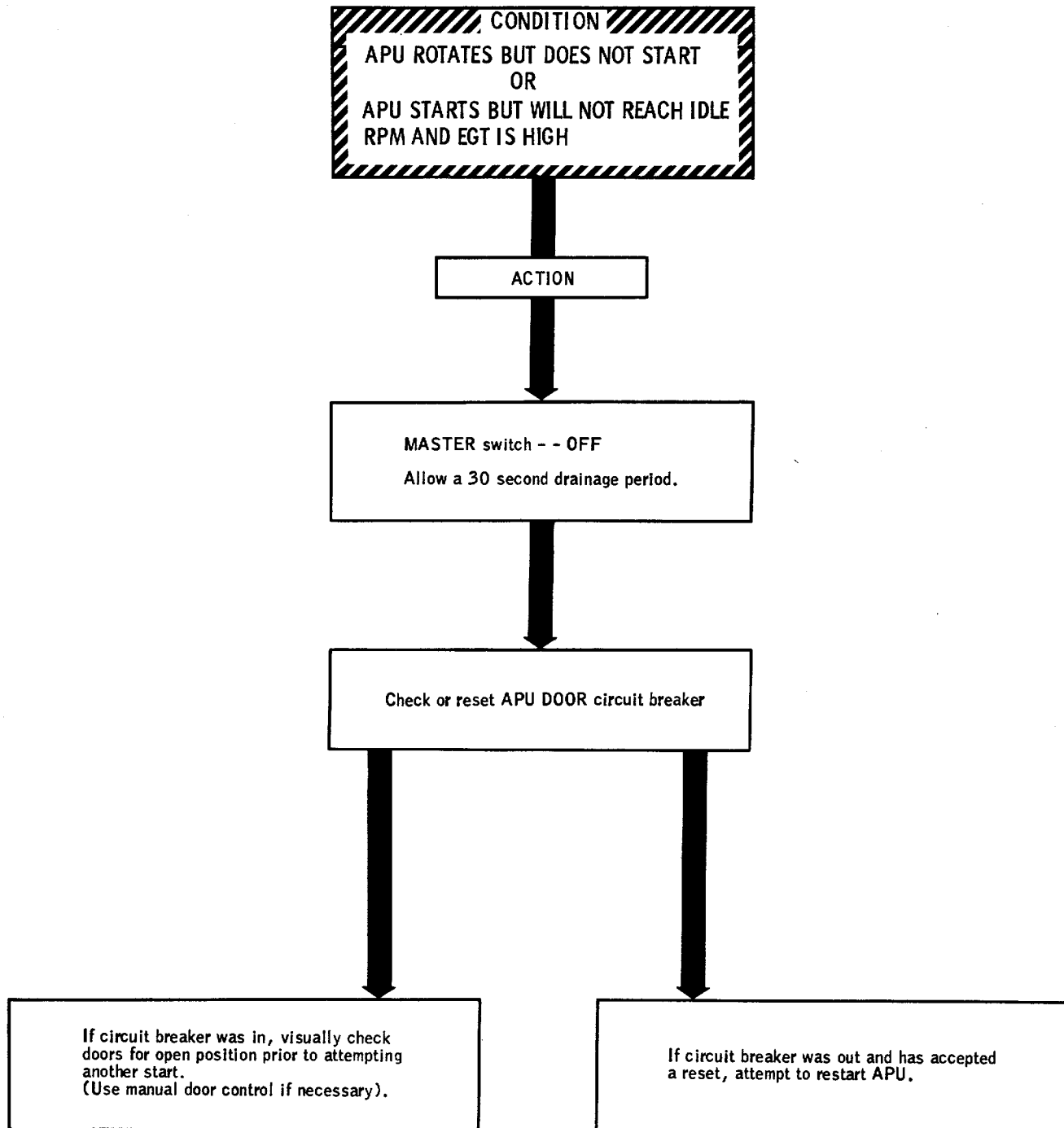
IF PNEUMATIC
PRESSURE IS
NOT INDICATED

Shut down APU and
place DOORS switch
at AUTO.

If breaker was in, operate APU inlet doors
manually as follows: * Hold DOORS switch at
NON RAM for 6 seconds, then OFF. Attempt
another start.

BB1-1510A

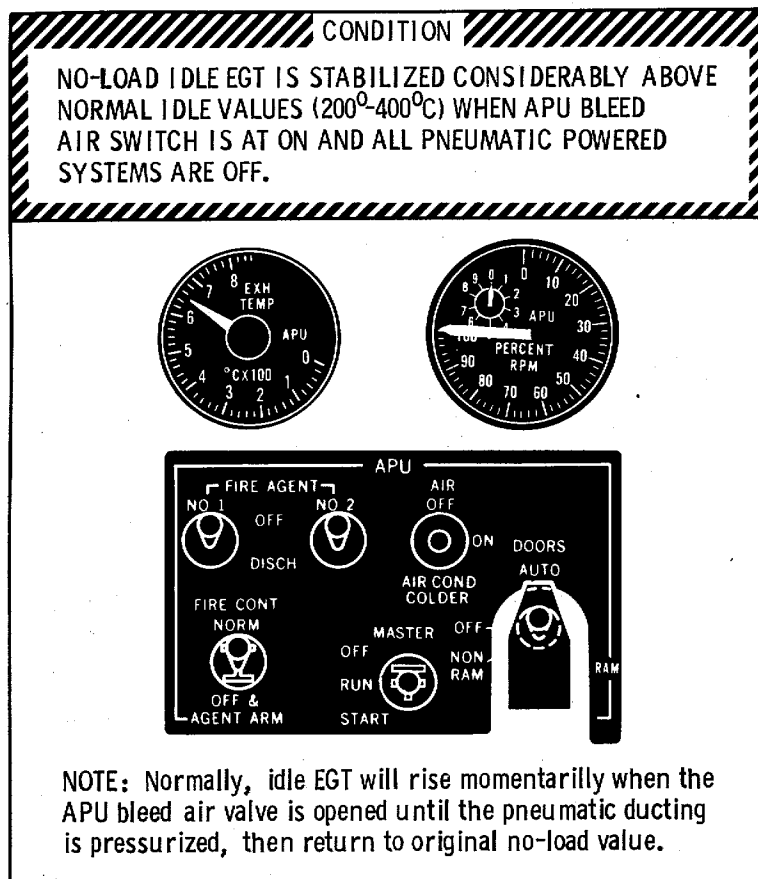
AUXILIARY POWER UNIT (APU) -- ABNORMAL OPERATIONS



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APU -- ABNORMAL OPERATION



ACTION

CHECK TAIL COMPT TEMP HIGH LIGHT

IF ON

APU bleed air switch -- OFF
 NOTE: If APU EGT returns to normal idle value and TAIL COMPT TEMP HIGH light goes off, use APU for generator drive only.

IF OFF

1. Right pneu. crossfeed valve -- CLOSED
2. If APU EGT is still high, left pneu. crossfeed valve -- CLOSED
3. If APU EGT is still high, APU bleed air switch -- OFF
4. Use APU for generator drive only.

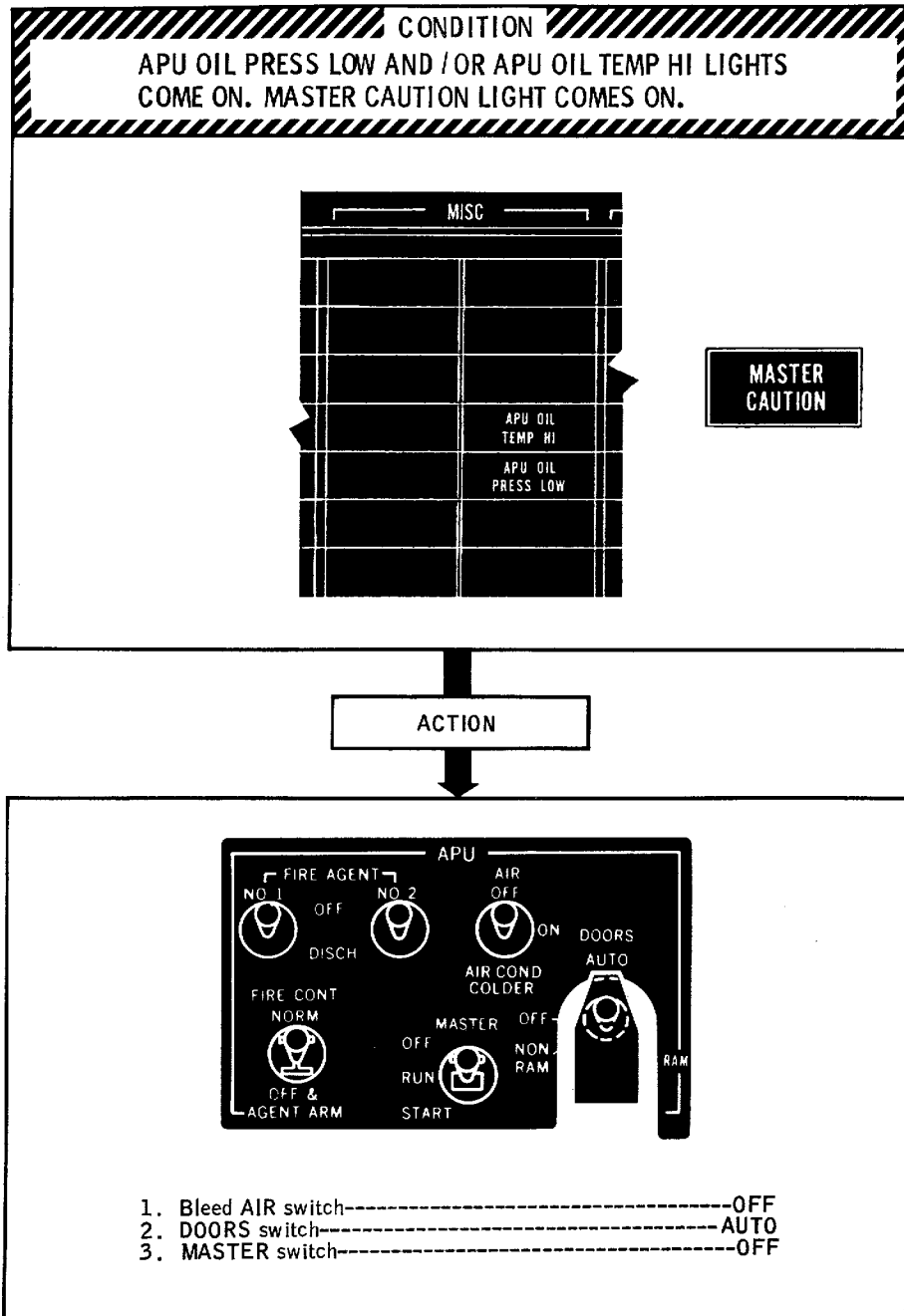
BB1-1511B

Dec 1/67

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APU -- ABNORMAL OPERATION

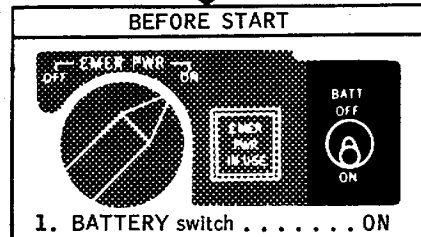
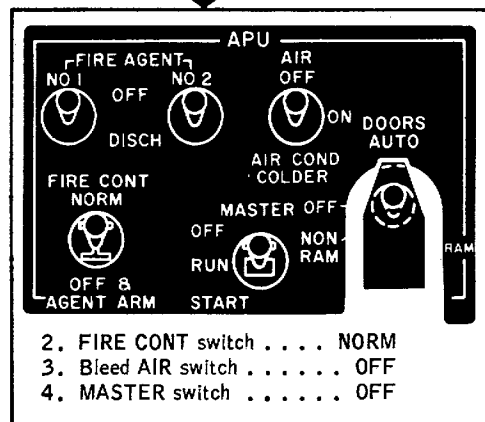
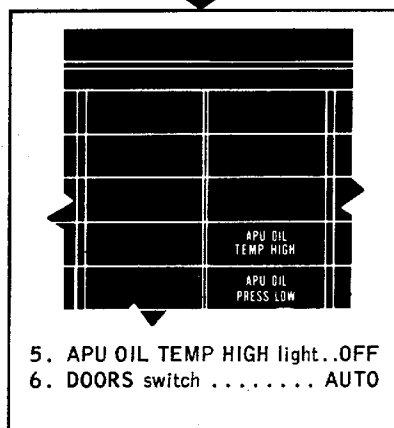
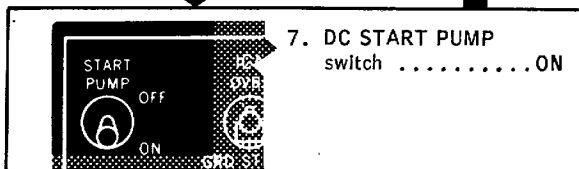
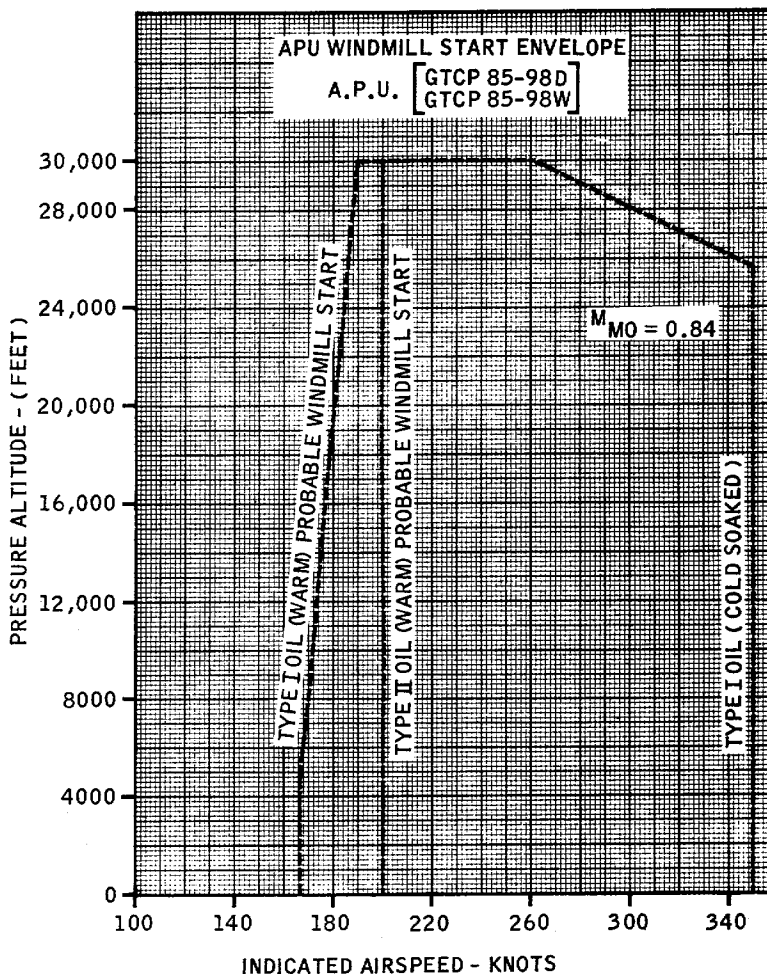


APU -- ABNORMAL OPERATION - Airstart using windmill rpm

CONDITION
 BOTH ENGINE DRIVEN GENERATORS
 INOPERATIVE IN FLIGHT

ACTION

BEFORE START



NOTES:

- Higher air speeds will give a higher probability of a successful start.
- Use the 350 KIAS line (to maximum altitude of 25,000 ft) for Type II oil cold soaked up to 1/2 hour maximum. Windmill start with Type II oil is improbable with cold soak exceeding 1/2 hour.

- MASTER switch .. START, release to RUN on observing RPM rise
- APU OIL PRESS LOW light OFF at approx. 35% rpm
- Observe APU operating limits

AFTER START

NOTE: The BATTERY switch must be left at the ON position to sustain APU operation.

- DC START PUMP switch after AC boost pump pressure available OFF

BB1-3433A

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 20, SECTION 2, CHAPTER 35, DATED JUN 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-35-15-0 REVISED FIRE WARNING & PROTECTION -- ABNORMAL OPERATION PROCEDURE SO AS TO MAKE IT POSSIBLE TO DETERMINE IF FIRE HAS BEEN EXTINGUISHED AFTER AGENT DISCHARGE.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-35-Eff	66	A11	2-35-Eff	66	A11
2-35-15-0	1	1 and 2	2-35-15-0	1	1 and 2

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The following pages are effective for ATL Series 30 Aircraft.

*2-35-Eff	66	1	Jun 1/70
2-35-Cont	66	1	Sep 1/69
2-35-10-0	1	1	Dec 1/66
2-35-15-0	1	1	Dec 1/65
*2-35-15-0	1	2	Jun 1/70

*The asterisk indicates pages revised or added by the current revision.

Jun 1/70

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Chapter 35

FIRE WARNING AND PROTECTION SYSTEMS

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
* <u>NORMAL OPERATION</u> - Fire warning test	35-10-0	1	1	A11
* <u>ABNORMAL OPERATION</u>				
Fire warning test inoperative	35-15-0	1	1	A11
* <u>ABNORMAL OPERATION</u>				
In-flight or on ground the annunciator FIRE DETECTOR LOOP light and respective Loop A or B light comes on and no red warning light comes on	35-15-0	2	1	A11

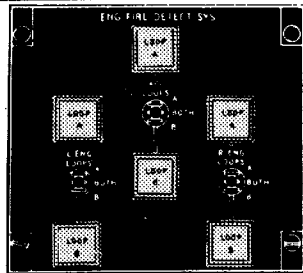
*Illustration

Sep 1/69

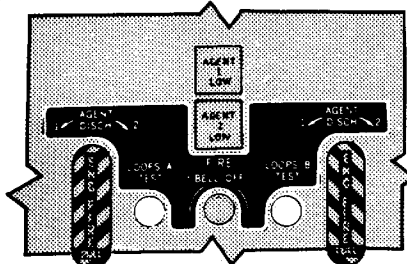
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FIRE WARNING & PROTECTION -- NORMAL OPERATION - Fire warning test



Place all LOOP switches in BOTH position.



Depress both TEST switches simultaneously and hold.

Fire bell should ring.

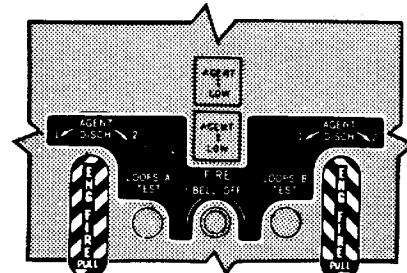


Depress FIRE BELL OFF switch and release.

Fire bell should stop ringing.

Release both TEST switches.

Lights in the ENG FIRE shutoff handles, lights on ENG FIRE DETECT SYS panel, APU FIRE warning and FIRE DETECTOR LOOP lights on annunciator panel, APU FIRE warning light on ground control panel and MASTER WARNING lights should go off.

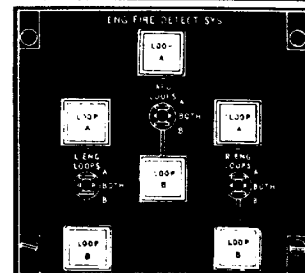


Lights in both ENG FIRE shutoff handles should come on.

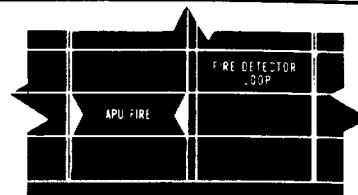
MASTER WARNING

MASTER WARNING

MASTER WARNING lights on glareshield should come on.



All LOOP lights on ENG FIRE DETECT SYS panel should come on.



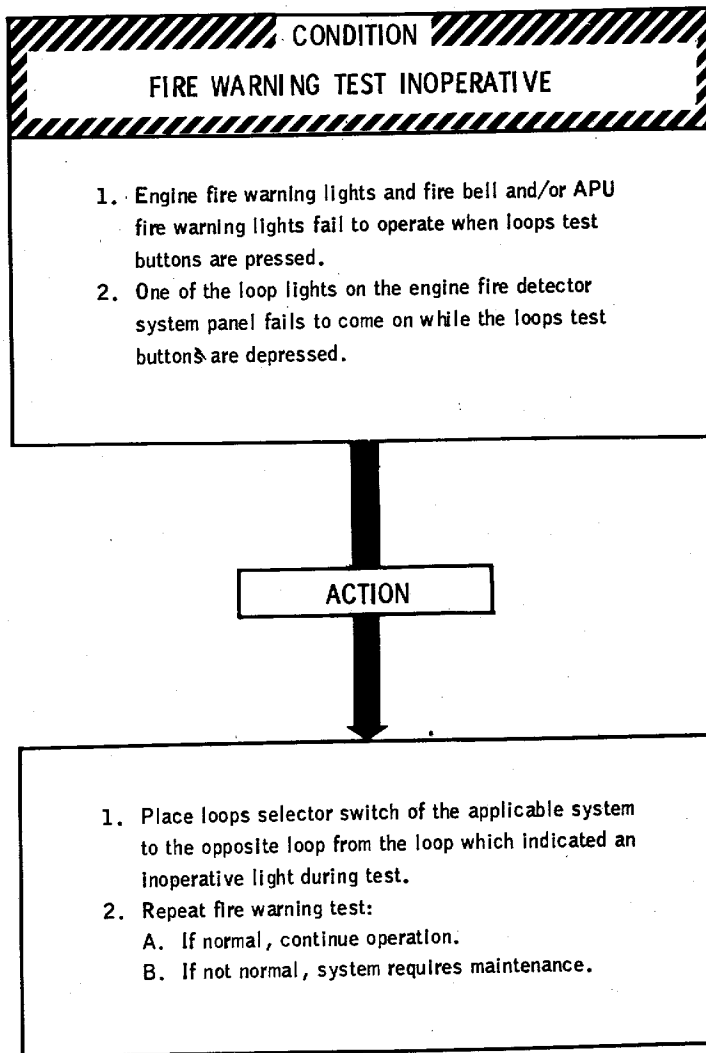
APU FIRE warning and FIRE DETECTOR LOOP lights on annunciator panel should come on.

NOTE:
If fire warning fails to function check applicable circuit breakers.

BB1-156C

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 CODE 1
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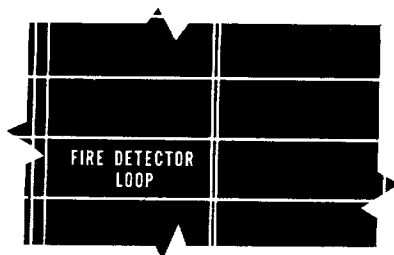
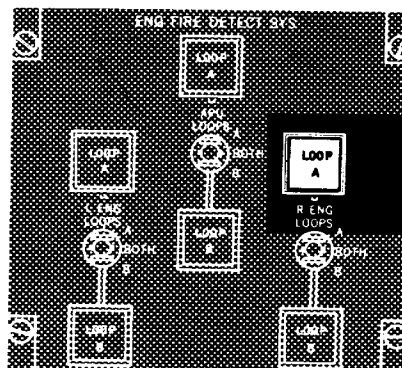
FIRE WARNING & PROTECTION -- ABNORMAL OPERATION



FIRE WARNING & PROTECTION -- ABNORMAL OPERATION

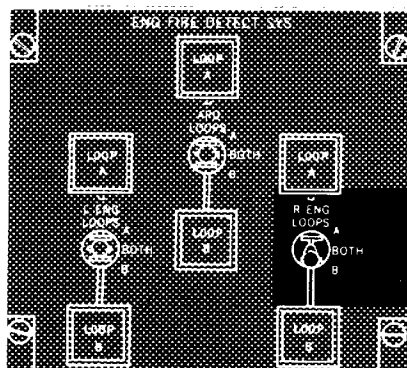
CONDITION

IN-FLIGHT OR ON GROUND THE ANNUNCIATOR FIRE DETECTOR LOOP LIGHT AND RESPECTIVE LOOP A OR B LIGHT COMES ON AND NO RED WARNING LIGHT COMES ON

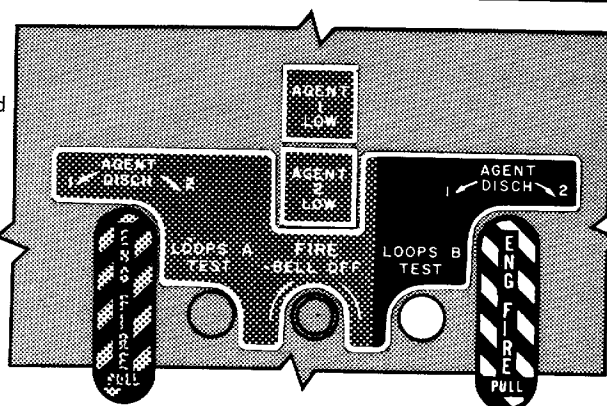


NOTE:
 R ENG LOOP "A" shown illuminated
 (typical procedure for L ENG and APU)

ACTION



1. Place loop light selector switch to opposite loop. Loop light should go out.
2. Push respective loop test switch and check that bell and/or red warning lights come on.



IF LIGHTS COME ON

1. Release test switch. Bell and/or red warning lights should go off.
2. Continue operation with loop selector in remaining (operative) loop position.

IF LIGHTS DO NOT COME ON

1. Release test switch.
2. The applicable fire warning lights failing to come on during test indicates an open circuit in the tested loop. Therefore, the loop light that came on must be assumed to be a fire warning.
3. Return loop selector switch to the operative loop. This will enable the pilot to monitor the effect of the following step.
4. Refer to Emergency Procedures ENGINE FIRE or APU FIRE as indicated.

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2-40-1-0	1	1	Aug 15/65

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Chapter 40

PNEUMATICS

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(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*LIMITATIONS</u>	40-1-0	1	1	A11

*Illustration

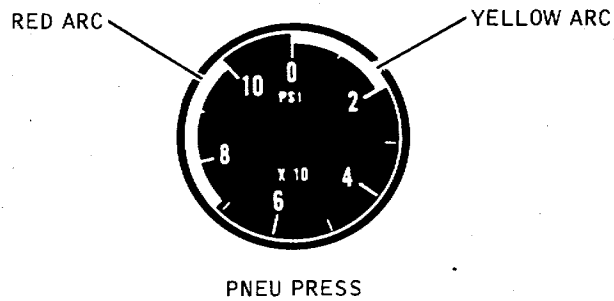
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PNEUMATIC -- LIMITATIONS



Yellow Arc ----- 0-20 PSI
Red Arc ----- 72-100 PSI

Minimum Ice Protection Operating Pressure --- -20 PSI
Maximum Operating Pressure ----- 72 PSI

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2-45-Cont	66	2	Sep 1/69
2-45-Cont	66	3	Sep 1/69
2-45-1-0	3	1	Sep 1/69
2-45-10-0	6	1	Sep 1/69
2-45-10-0	6	2	Mar 1/69
2-45-10-0	6	3	Sep 1/68
2-45-10-0	6	4	Sep 1/69
2-45-15-0	8	1	Mar 1/69
2-45-15-0	8	2	Mar 1/69
2-45-15-0	8	3	Sep 1/68
2-45-15-0	8	4	Sep 1/68
2-45-15-0	8	5	Sep 1/68
2-45-15-0	8	6	Sep 1/68
2-45-15-0	8	7	Mar 1/69

*The asterisk indicates pages revised or added by the current revision.

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Chapter 45

AIR CONDITIONING AND PRESSURIZATION

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*LIMITATIONS</u>	45-1-0	1	3	A11
<u>*NORMAL OPERATION</u>				
Air conditioning on ground with engines running and using APU for supplemental air conditioning	45-10-0	1	6	A11
Ground ventilation with external electrical power	45-10-0	1	6	A11
Air conditioning in flight or on ground with engine bleed air only	45-10-0	1	6	A11
<u>*NORMAL OPERATION</u>				
Pressurization	45-10-0	2	6	A11
<u>*NORMAL OPERATION</u>				
Cabin altitude and differential pressure	45-10-0	3	6	A11
Ground APU air con- ditioning before engine start	45-10-0	4	6	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Supply duct pressure drops rapidly to zero	45-15-0	1	8	A11
AIR COND SUPPLY TEMP HI caution light comes on	45-15-0	1	8	A11
<u>*ABNORMAL OPERATION</u>				
Auto pressurization system inoperative	45-15-0	2	8	A11
RADIO FAN OFF light comes on	45-15-0	2	8	A11
<u>*ABNORMAL OPERATION</u>				
Maintaining normal cabin differential pressure during idle descent with only one HP BLD capability available	45-15-0	3	8	A11
<u>*ABNORMAL OPERATION</u>				
The cabin does not depressurize automatically or by manual control	45-15-0	4	8	A11
<u>*ABNORMAL OPERATION</u>				
Dispatch for flight - unpressurized	45-15-0	5	8	A11
<u>*ABNORMAL OPERATION</u>				
Manual pressurization control - prior to start - after takeoff	45-15-0	6	8	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Manual pressurization controls - during cruise - descent	45-15-0	7	8	A11

*Illustration

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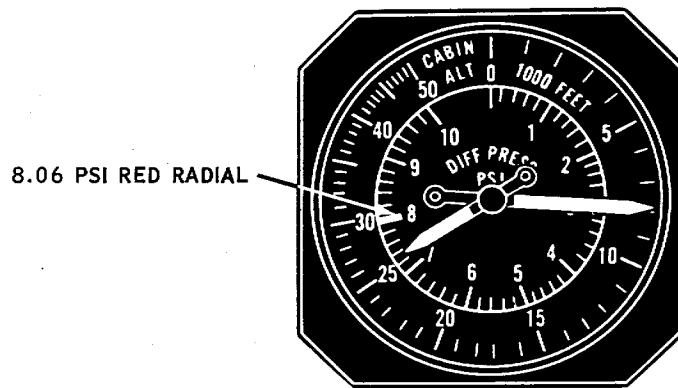
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AIR CONDITIONING & PRESSURIZATION -- LIMITATIONS

TAKEOFF & LAND UNPRESSURIZED

DIFF PRESS Gage

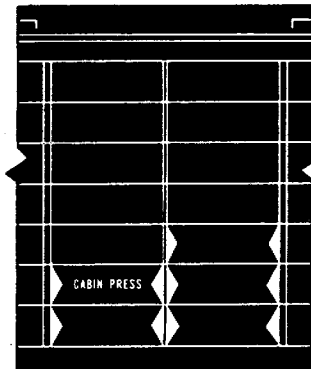


Normal Maximum Differential Pressure ----- $7.46 \pm .3$ psi.

Maximum Relief Valve Differential Pressure ----- 8.06 psi.

Cabin Pressure rate controller -- Min. 50 feet, Max. 1000 feet

ANNUNCIATOR PANEL LIGHT



CABIN PRESS (Red) --- 9,500 (+500-0) feet Cabin altitude

Supply Air Pressure Max. Regulating ----- 27 ± 2 psi

HP Bleed regulating (air conditioning) ----- 18.5 ± 2 psi

BB1-1515C

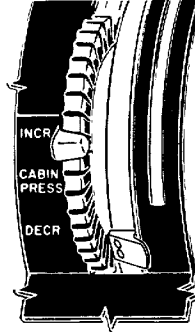
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AIR CONDITIONING -- NORMAL OPERATION

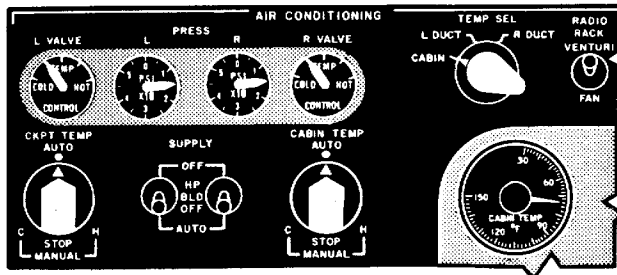
AIR CONDITIONING THE AIRPLANE ON THE GROUND WITH THE ENGINES RUNNING AND USING THE APU FOR SUPPLEMENTAL AIR CONDITIONING.



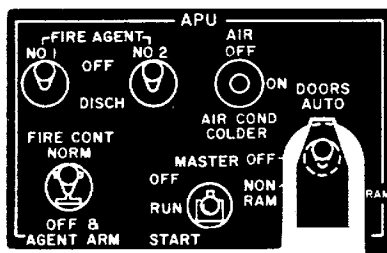
1. Left PNEU X-FEED VALVE OPEN and right PNEU X-FEED VALVE closed.



2. Place cabin pressure controller lever in AUTO position and check indicator at open (DECR) position.



3. Place both air conditioning SUPPLY switches to the AUTO position.

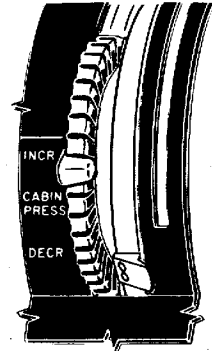


4. Place the APU AIR switch to the ON position.

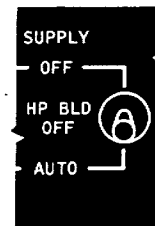
NOTE: Do not select the AIR COND COLDER position. The ON position of the switch provides best combination of air flow and refrigeration.

5. Place CKPT and CABIN TEMP to the AUTO (dot) position.
6. Check air conditioning VALVE positions for desired results.

GROUND VENTILATION (ELECTRICAL EXTERNAL) POWER SUPPLY CONNECTED.



1. Place cabin pressure controller lever in AUTO position and check indicator at open (DECR) position.



2. Place right air conditioning supply switch in AUTO or HP BLD OFF.



3. Place RAM AIR switch to ON position.

AIR CONDITIONING OF AIRPLANE IN FLIGHT OR ON GROUND USING ENGINE BLEED ONLY.

1. Place SUPPLY switch in AUTO position.
2. Select cockpit & cabin temperature controls to AUTO (dot) position.
3. The temperature control valve positions can be checked for proper system operation.
4. Adjust temperature selector as required.

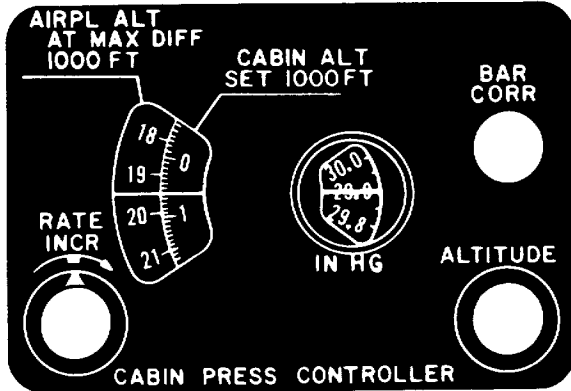
NOTE: To obtain maximum refrigeration during ground operations, gradually advance engine power until supply pressure ceases to rise (Approximately 18 1/2 psi).

BB1-3836B

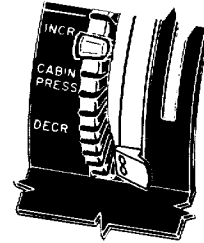
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DC-9
 FLIGHT CREW OPERATING MANUAL

AIR CONDITIONING -- NORMAL OPERATION - Pressurization

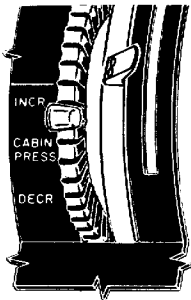
PRIOR TO START



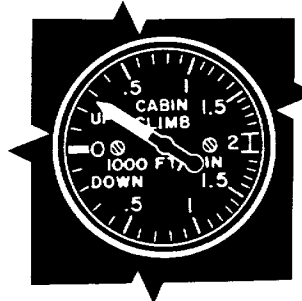
1. Obtain field barometric setting and set cabin pressure controller.
2. Set initial cruise altitude plus 1000 feet on cabin pressure controller. (Not to exceed 8400 feet on cabin scale).
NOTE:
 If setting initial cruise altitude plus 1000 feet results in a cabin altitude less than 1000 feet above field elevation, it is recommended that the cabin pressure controller be set so that cabin altitude indicates takeoff field elevation plus 1000 feet.
3. Compute cabin rate of climb.
NOTE:
 Cabin altitude change in feet (from the controller) divided by airplane time to climb or descend in minutes equals rate of change in feet per minute.
4. Set rate knob at dot position.
5. Check that the cabin pressure controller lever is in automatic and the indicator is at full decrease (aft position.)



AFTER TAKEOFF



1. After takeoff note that the cabin pressure controller wheel and indicator is moving forward to pressurize the airplane.
2. Adjust rate knob until computed rate of change plus 50 feet per minute is obtained. Several seconds may be required between adjustment and rate of change indication.



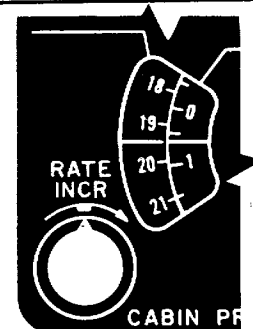
DURING FLIGHT



1. The cabin differential pressure should be periodically checked during all phases of flight.
2. Prior to enroute altitude changes, reset the cabin pressure controller.

NOTE:

For rapid airplane climb or descent adjust rate of change so that desired cabin altitude is obtained prior to or at the same time the airplane reaches planned altitude.



DESCENT

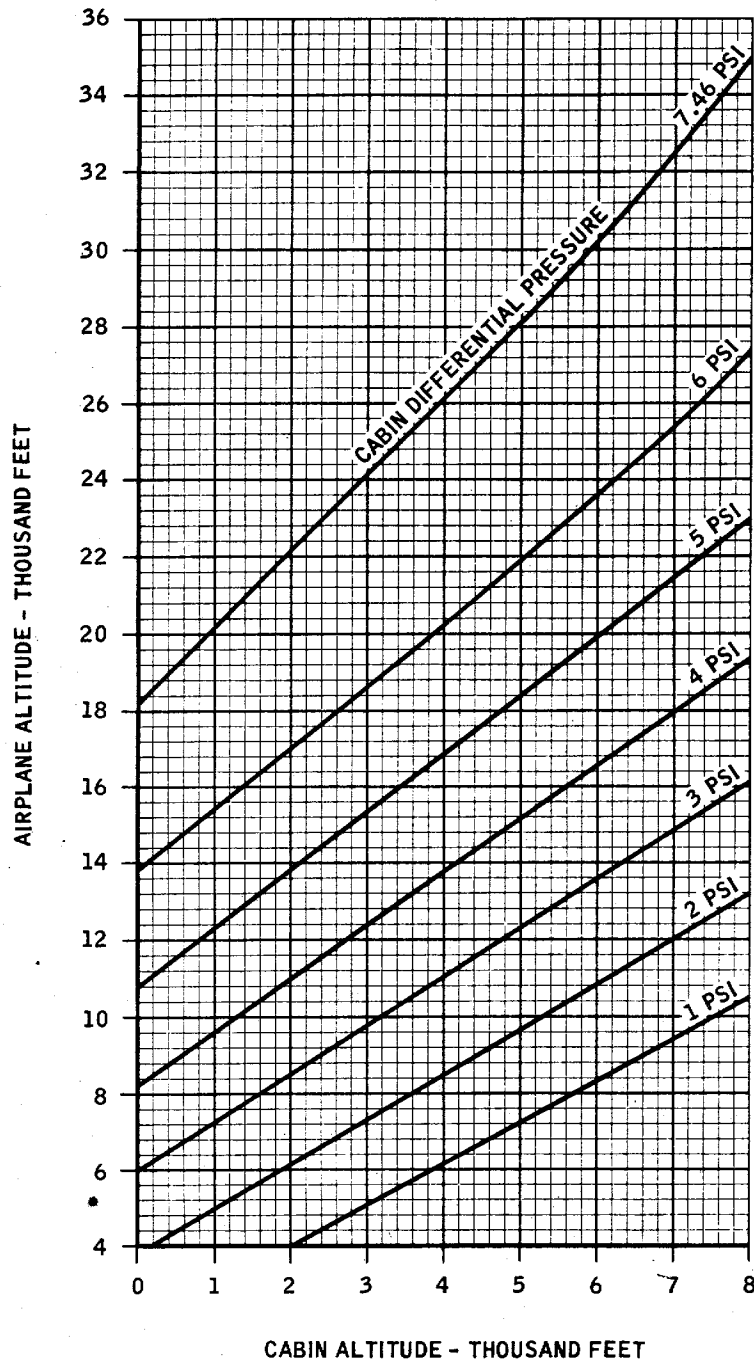
1. Prior to descent compute cabin rate of descent and obtain destination barometric setting.
2. Set cabin rate to minimum
3. Just prior to descent set cabin to field altitude and make barometric corrections on cabin pressure controller.
4. Set rate knob half way between minimum and dot position.
5. When cabin rate is indicated, approximately 30 seconds adjust rate knob to obtain computed rate of descent plus 50 feet per minute.
6. Check cabin differential pressure instrument to determine that the cabin is depressurizing during descent.

BB1-3837A

DOUGLAS AIRCRAFT CO., INC.
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FLIGHT CREW OPERATING MANUAL

AIR CONDITIONING -- NORMAL OPERATION - Pressurization

CABIN ALTITUDE AND DIFFERENTIAL PRESSURE



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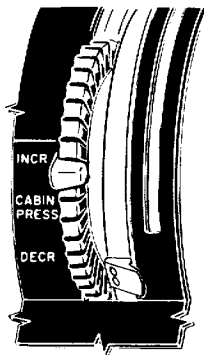
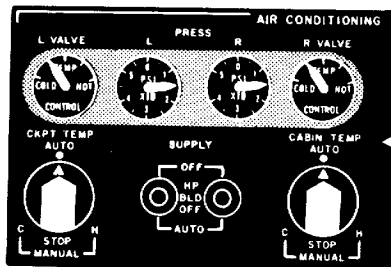
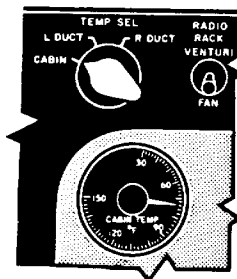
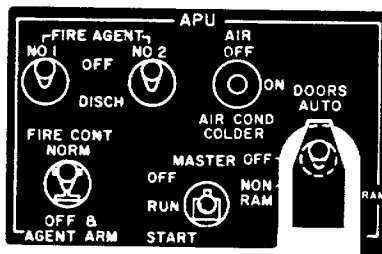
AIR CONDITIONING -- NORMAL OPERATION

GROUND APU AIR CONDITIONING OPERATION—BEFORE ENGINE START

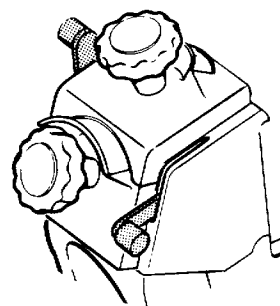
CABIN TEMP
85° F (29° C) OR ABOVE



- Both PNEU X-FEED VALVES OPEN.
- Check cabin pressurization outflow valve open (DECR position).
- Place both SUPPLY switches to AUTO position.
- Place the APU AIR switch to the AIR COND COLDER position.
 NOTE: If the APU will not maintain air conditioning operation with both SUPPLY switches in the AUTO position (APU RPM cycles to below 95%) partially close right PNEU X-Feed to the extent required for stable APU operation.
- Place the CKPT TEMP and CABIN TEMP selectors to the AUTO (dot) position.
- Check air conditioning VALVES at COLD position.
- When CABIN temp reduces to less than 85° F (29° C), place right air conditioning SUPPLY switch to OFF position.
- Change the APU AIR switch to the ON position from the AIR COND COLDER position.
 NOTE: Desirable to increase airflow when on single system operation.
- Close the right PNEU X-FEED VALVE.
 NOTE: Prevents APU air leakage for better operation of left system.



CABIN TEMP
LESS THAN 85° F (29° C)



- Left PNEU X-FEED VALVE OPEN, right PNEU X-FEED VALVE closed.
- Check cabin pressurization outflow valve open (DECR position).
- Place left SUPPLY switch to AUTO position, right SUPPLY switch OFF.
- Place the APU AIR switch to the ON position.
- Place the CKPT TEMP and CABIN TEMP controls to the AUTO (dot) position.
- Check air conditioning VALVE position for desired results.

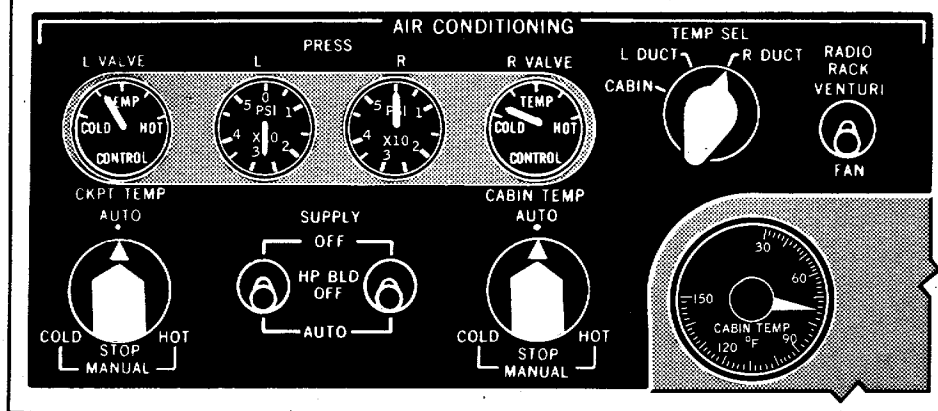
BBI-4298

AIR CONDITIONING -- ABNORMAL OPERATION

CONDITION

DURING OPERATION OF AIR CONDITIONING SYSTEM (OTHER THAN DURING GROUND REVERSING) EITHER SUPPLY DUCT PRESSURE DROPS RAPIDLY TO ZERO.

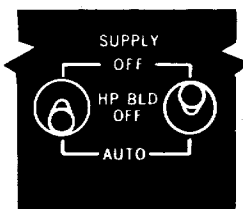
NOTE: This could indicate that one of the protective overheat switches has closed and shut down the system.



ACTION

1. Place applicable SUPPLY switch in OFF position for a short period.
2. Temporarily select a warmer temperature.
3. Place applicable SUPPLY switch to HP BLD OFF position.
4. Check supply pressure and monitor duct temperature.
5. If system has started up, select desired temperature and place respective SUPPLY switch to AUTO.
6. Monitor respective duct temperature and, if necessary, take over manual temperature operation of system.

5. If light remains ON after approximately 1 minute, check duct temperature. If duct temperature is high, place respective SUPPLY switch to OFF.
6. The flight may be continued with system isolated.



CONDITION

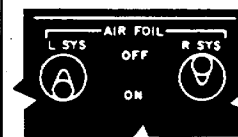
LEFT OR RIGHT AIR COND SUPPLY TEMP HI CAUTION LIGHT COMES ON.

R AIR COND SUPPLY TEMP HI

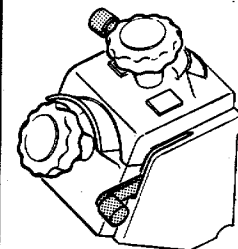
MASTER CAUTION
PUSH TO RESET

ACTION

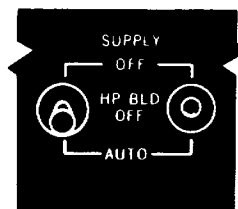
1. Reset MASTER CAUTION light.
2. Respective ICE PROTECTION panel AIR FOIL switch to OFF.



3. Respective PNEU X FEED closed.



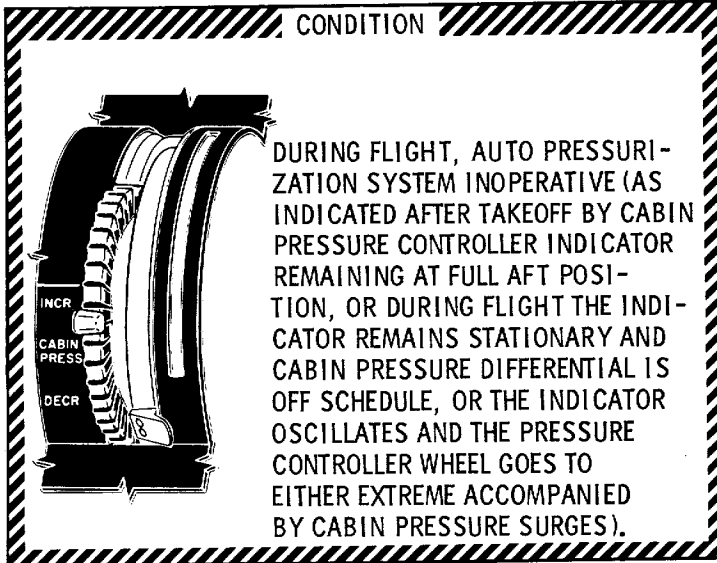
4. Place respective SUPPLY switch to HP BLD OFF position.



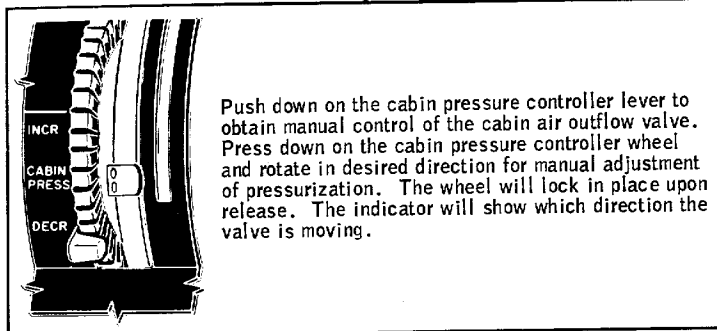
BB1-2954A

AIR CONDITIONING -- ABNORMAL OPERATION

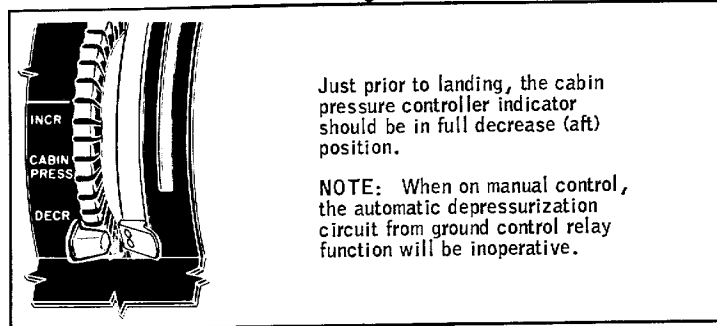
PRESSURIZATION CONDITION



ACTION

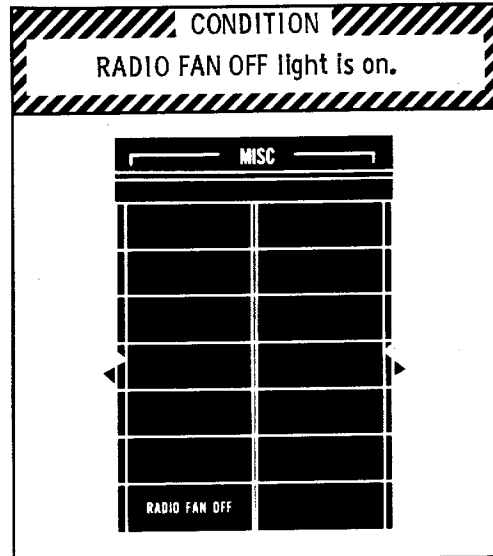


During climb or descent, manual control must be used to vary cabin altitude.

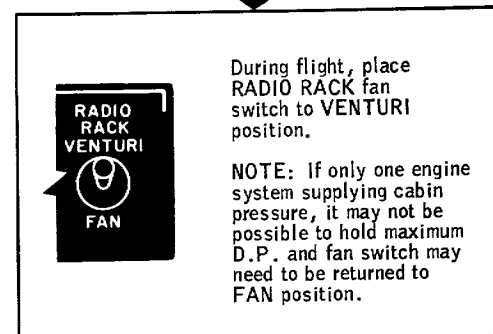
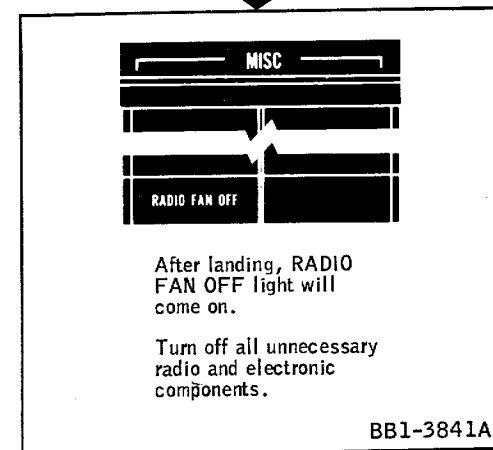


RADIO RACK COOLING FAN

CONDITION RADIO FAN OFF light is on.



ACTION



BB1-3841A

AIR CONDITIONING -- ABNORMAL OPERATION

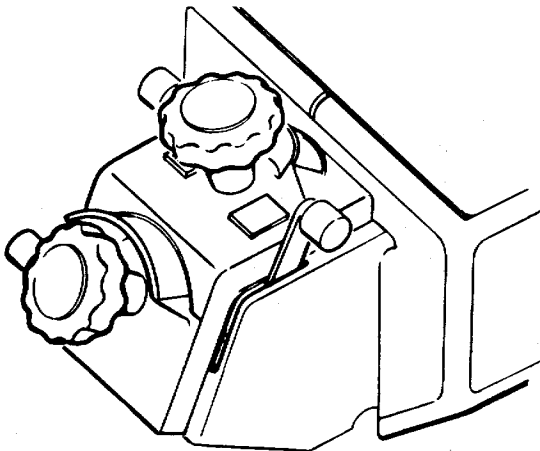
CONDITION

MAINTAINING NORMAL CABIN DIFFERENTIAL
DURING IDLE DESCENT ABOVE 15,000 FEET WITH
ONLY ONE HP BLD CAPABILITY AVAILABLE

ACTION

1. Place RADIO RACK fan switch in FAN position.

IF BOTH AIR SUPPLY SYSTEMS ARE OPERABLE



1. Both PNEU X-FEED VALVES OPEN.

IF ONLY ONE AIR SUPPLY SYSTEM IS OPERABLE

1. Slowly advance throttle on engine supplying high pressure bleed until supply pressure gauge reading ceases to rise (approximately 18 psi).
2. Leave throttle at this position until 15,000 feet altitude is reached, or occasionally adjust throttle as in step 1.
3. Below 15,000 feet idle thrust may be used.

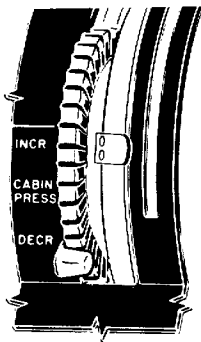
BB1-899

AIR CONDITIONING -- ABNORMAL OPERATION - Pressurization

CONDITION

DURING FLIGHT, CABIN DIFFERENTIAL PRESSURE IS UNCONTROLLABLE EITHER AUTOMATICALLY OR BY MANUAL CONTROL. (AS SHOWN BY A JAMMED CABIN PRESSURE CONTROLLER WHEEL AND INDICATOR).

ACTION



1. Push the cabin pressure controller lever down to the manual position.
2. Pull the circuit breakers, labeled CABIN PRESSURE CONTROL and CABIN PRESSURE MAN/AUTO CONTROL.
3. Attempt to manually operate the cabin pressure controller wheel in the desired direction.

NOTE:

Be prepared to hold the controller wheel firmly if manual control is established. The controller wheel and indicator will move toward the increase differential pressure with varying force depending on cabin D.P. This force is very high when cabin differential pressure is at a maximum.



If the cabin pressure controller wheel and indicator remain in a jammed condition and cannot be moved in either direction:

1. Place RADIO RACK fan switch to FAN position.
2. No smoking sign ON. This will help to reduce cabin air contamination during remainder of flight.
3. Initiate a descent to below 10,000 feet flight altitude. During descent place one air conditioning SUPPLY switch to OFF position. Maintain a comfortable cabin rate of descent by varying throttle position on the side that is supplying air to the operating air conditioning system. Continue descent to below 10,000 feet and turn the operating air conditioning system OFF, after the airplane is level.



NOTE:

Cabin altitude may be below sea level. When cabin altitude rises to 2000 feet above destination altitude, continue descent, approach and landing.

4. When cabin altitude equals airplane altitude place RAM AIR switch to ON. Cabin altitude and airplane altitude will descend at the same rate.
5. After landing, open and lock either one or both clearview windows. Air conditioning may then be resumed for ground comfort.

NOTE:

To prevent any possibility of pressurizing the airplane, do not attempt to close the clearview windows after restarting the air conditioning systems.



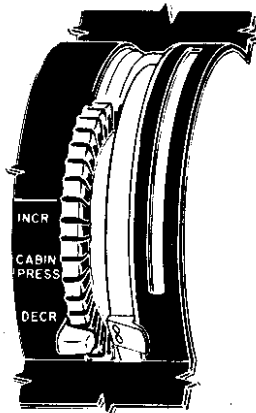
BB1-3842

AIR CONDITIONING -- ABNORMAL OPERATION - Pressurization

CONDITION
DISPATCH FOR FLIGHT - UNPRESSURIZED

ACTION

1. Pull the CABIN PRESSURE CONTROL and CABIN PRESSURE MAN/AUTO CONTROL circuit breakers.



2. Push the cabin pressure controller lever down to the manual position. Move the cabin pressure controller wheel and indicator to manual (DECR) position (aft). Cabin pressure controller wheel should remain in locked position throughout the flight.

3. Use normal air conditioning procedures.

NOTE:

Flight altitude must be limited to 10,000 feet. At altitudes above 9500 feet, expect the CABIN PRESS and MASTER WARNING lights to come on. If either or both air conditioning systems are not serviceable, the ram air system must be operable for flight.

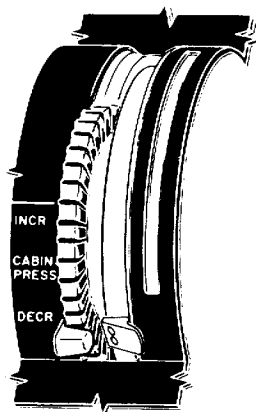
BB1-3838

AIR CONDITIONING -- ABNORMAL OPERATION - Pressurization (sheet 1)

CONDITION MANUAL PRESSURIZATION CONTROL

ACTION

PRIOR TO START



1. Pull the CABIN PRESSURE CONTROL and CABIN PRESSURE MAN/AUTO CONTROL circuit breakers.
2. Check manual operation of the cabin pressure controller wheel and indicator prior to placing the air conditioning supply switches ON, by manually rotating the wheel and indicator to full INCR position and return to DECR.
3. Set initial cruise altitude on CABIN PRESS CONTROLLER scale (AIRPL ALT AT MAX DIFF) and read desired cabin altitude on the opposite scale.

NOTE:

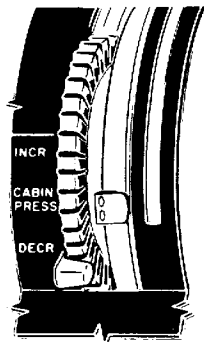
Cabin altitude information can also be obtained from the CABIN ALTITUDE and DIFFERENTIAL PRESSURE chart.

Cabin pressure must be manually controlled to maintain the desired cabin altitude. Lower cabin altitude values at cruise, will result in excessive differential pressures which will activate the relief valves.

Relationship of the manual cabin pressure controller wheel and indicator to the cabin rate-of-climb indicator is the same as the airplane control column to the airplane rate-of-climb (i.e., forward movement inputs a descent and aft movement inputs a climb.)

4. Check that the manual cabin pressure controller wheel and indicator is at full decrease (aft position) and manually locked. The wheel should remain in this position for takeoff.
5. Use normal air conditioning procedures.

AFTER TAKEOFF



1. As soon as practical after rotation move cabin pressure controller wheel and indicator one-third of the quadrant (towards increase) and lock.
2. After clean up, during climb, rotate the cabin pressure controller wheel and position indicator to control the cabin at the desired cabin altitude during airplane cruise. Maintain cabin rate-of-climb at or near 500 feet-per-minute.

NOTE:

Maximum recommended cabin rates of change for passenger comfort are 500 feet-per-minute climb and 300 feet-per-minute descent.

Prior to engine power changes, it is recommended that the cabin pressure controller indicator position be coordinated with throttle movement.

Hold cabin pressure controller wheel firmly when adjusting as it will tend to move toward the full increase position with varying force depending on the cabin D.P.

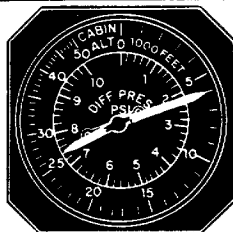
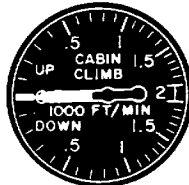
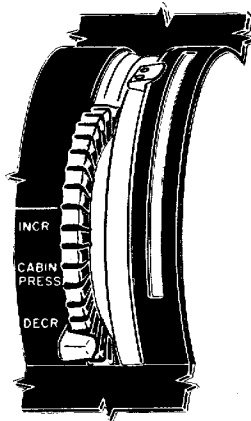
BB1-3839

AIR CONDITIONING -- ABNORMAL OPERATION - Pressurization (sheet 2)

CONDITION MANUAL PRESSURIZATION CONTROL

ACTION

DURING CRUISE

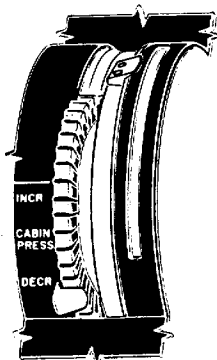
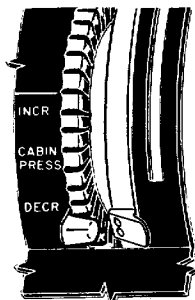


1. At the desired cabin altitude for cruise, manually lock cabin pressure controller wheel in position to maintain a zero rate-of-climb or descent.
2. Prior to enroute altitude changes, manually reset the cabin pressure controller wheel as engine power and altitude changes occur.

NOTE:

For rapid airplane climb or descent, control the cabin rate-of-change to assure that the desired cabin altitude is obtained prior to the airplane reaching the planned altitude.

DESCENT



1. At descent, hold cabin pressure controller wheel firmly and be prepared to control cabin altitude to zero rate. Reduce engine power slowly and move the wheel toward increase (INCR) to compensate for bleed airflow reduction.
2. When engine power is reduced to desired level, adjust the cabin pressure controller wheel to obtain a cabin rate-of-descent of approximately 300 feet-per-minute.
3. Monitor cabin rate-of-descent closely and be prepared to make adjustments during engine power changes.
4. When cabin altitude is equal to 2000 feet above the destination field altitude, maintain the cabin rate at zero until the cabin altitude equals the airplane altitude. Slowly move the cabin pressure controller wheel to full decrease (DECR) and lock. The wheel should remain in this position for the remainder of the flight.

NOTE:

During the approach and landing, the cabin altitude will decrease at the same rate as the airplane altitude.

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DOUGLAS AIRCRAFT CO.
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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 20, SECTION 2, CHAPTER 50, DATED JUN 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-50-10-0 ICE & RAIN PROTECTION -- NORMAL OPERATION - AIRFOIL ICE PROTECTION
PROCEDURE REVISED IN RESPONSE TO REPORTED INCIDENTS OF SEVERE TRIM
CHANGE WHEN FLAPS ARE EXTENDED TO 50° WITH ICE ON HORIZONTAL STABI-
LIZER.

2-50-15-5 ICE & RAIN PROTECTION -- ABNORMAL OPERATION
NEW PROCEDURE PROVIDED IN RESPONSE TO REPORTED INCIDENTS OF SEVERE
TRIM CHANGE WHEN FLAPS ARE EXTENDED TO 50° WITH ICE ON HORIZONTAL
STABILIZER.

TEMPORARY REVISIONS 2-112 AND 2-114 HAVE BEEN INCORPORATED INTO YOUR MANUAL.
PLEASE REMOVE YELLOW PAGES.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-50-Eff	66	A11	2-50-Eff	66	A11
2-50-Cont	66	3	2-50-Cont	66	3
TR #2-114		(Yellow)	None		
2-50-10-0	2	1 and 2	2-50-10-0	2	1 and 2
TR #2-112		(Yellow)	None		
None			2-50-15-5	2	1

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 2-50

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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 FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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*2-50-10-0	2	2	Jun 1/70
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2-50-15-0	6	6	Dec 1/68
2-50-15-0	6	7	Dec 1/68
*2-50-15-5	2	1	Jun 1/70

*The asterisk indicates pages revised or added by the current revision.

Jun 1/70

Printed in U.S.A.

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Chapter 50

ICE AND RAIN PROTECTION SYSTEMS

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(SERIES 30)

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<u>*NORMAL OPERATION</u> Engine anti-ice ground & flight •	50-10-0	1	2	A11
<u>*NORMAL OPERATION</u> Airfoil ice protection	50-10-0	2	2	A11
<u>*NORMAL OPERATION</u> Rain repellent	50-10-0	3	2	A11
<u>*ABNORMAL OPERATION</u> Airfoil ice prot press abnormal light is on during airfoil ice protection	50-15-0	1	6	A11
Airfoil ice prot press abnormal light is on after airfoil ice prot systems are off	50-15-0	1	6	A11
<u>*ABNORMAL OPERATION</u> Left or right ice pro- tection temp hi light is on	50-15-0	2	6	A11
<u>*ABNORMAL OPERATION</u> Ice protect temp low light is on	50-15-0	2	6	A11
<u>*Illustration</u>				

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
<u>*ABNORMAL OPERATION</u>				
Tail deice light goes out immediately after tail button released	50-15-0	3	6	A11
Tail deice on light on continuously	50-15-0	3	6	A11
<u>*ABNORMAL OPERATION</u>				
Either left or right airfoil ice protection switches on but wing anti-ice light is not on	50-15-0	4	6	A11
Ice protect supply press hi light is on	50-15-0	4	6	A11
<u>*ABNORMAL OPERATION</u>				
Pneu press indicator on overhead panel indicates above 72-psi red line	50-15-0	5	6	A11
Windshield heat inoperative as determined by windshield anti-ice circuit breakers being out or ice buildup	50-15-0	5	6	A11
<u>*ABNORMAL OPERATION</u>				
When airfoil ice protection system is turned on, a surge occurs in cabin pressure and the cabin outflow control-indication lever moves toward open if operating in auto mode	50-15-0	6	6	A11
<u>*ABNORMAL OPERATION</u>				
Airfoil ice protection required while both air conditioning systems receiving pneumatic air from one engine	50-15-0	7	6	A11

*Illustration

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Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
*ABNORMAL OPERATION				
TAIL DE-ICE ON light does not come on and WING ANTI-ICE ON light remains on when TAIL button pushed	50-15-5	1	2	A11

***Illustration**

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ICE & RAIN PROTECTION -- LIMITATIONS

THERE ARE NO AIRSPEED LIMITS ON THE CENTER WINDSHIELD AND THE PILOT OR COPILOT'S SIDE WINDSHIELD, ABOVE 10,000 FEET.

THERE ARE NO AIRSPEED LIMITS ON THE CLEARVIEW OR EYEBROW WINDSHIELDS, ABOVE OR BELOW 10,000 FEET.

WINDSHIELD ANTI-ICE INOPERATIVE LIMITS . . . BELOW 10,000 FEET

Center windshield	UNDER 260 KIAS
Pilot or copilot windshield	UNDER 285 KIAS

CRACKED WINDSHIELD OPERATING LIMITS . . . BELOW 10,000 FEET

Center windshield	UNDER 235 KIAS
Pilot or copilot windshield	UNDER 235 KIAS

WARNING: DO NOT OPERATE WINDSHIELD HEAT IF WINDSHIELD CRACKED

NOTE: Pull respective circuit breaker.

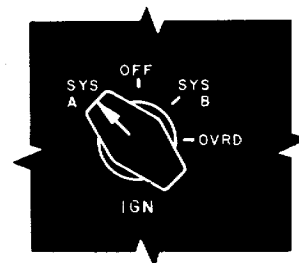


ICE PROTECT SUPPLY PRESS HI 22.5 to 24.0 PSIG

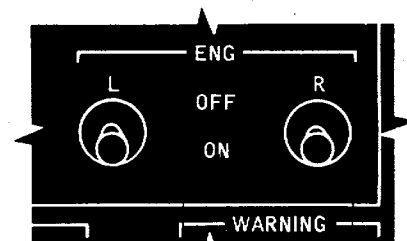
ICE & RAIN PROTECTION -- NORMAL OPERATION - Engine anti-ice - ground & flight

NOTE: Engine anti-ice should be turned on after initial engine start if there is visible moisture and ambient air temperature is below 6°C (42°F) or any time icing conditions exist or are anticipated.

1. Place ignition switch at SYS A or SYS B.



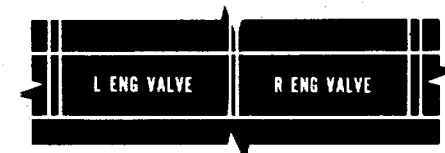
2. **ENGINE ICE** protection switch -- ON
One at a time and wait until the engine is stabilized before turning ON opposite engine.



3. Check that the L & R ENG ANTI-ICE ON lights are on.



4. Check that the L & R ENG VALVE disagreement lights are out.



5. After engine power has been stabilized, the ignition switch may be placed to OFF position. (Duty cycle is 10 minutes on and 10 minutes off).

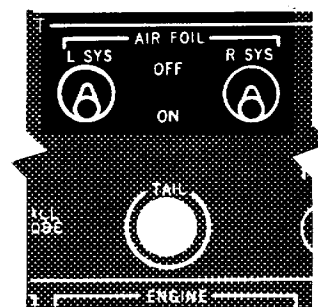
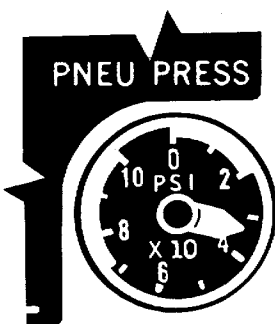
BB1-912C

ICE & RAIN PROTECTION -- NORMAL OPERATION - Airfoil ice protection

NOTE: ANYTIME THAT ICE
 CONDITIONS ARE IMMINENT



1. Both PNEU X FEED valve levers OPEN.
2. AIR FOIL L & R SYS switches to ON position.
3. Check WING ANTI-ICE ON light is on.

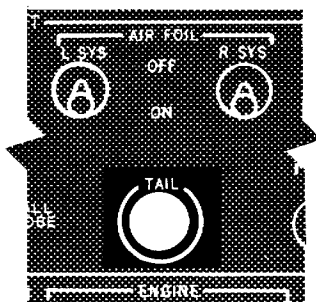


4. When airborne, check for pressure on PNEU PRESS gage to be above amber line. (Not over 72 red).
5. Left and right ICE PROT TEMP LOW and AIRFOIL ICE PROT PRESS ABNORMAL lights should come on but go off within 1 minute.

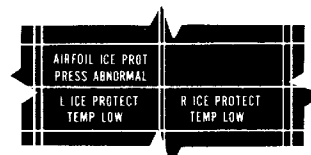
NOTE:

If engines are at low power, it may be necessary to increase engine power.

6. For tail de-ice momentarily push TAIL de-ice button after each icing encounter or at approximate 20 minute intervals in continuing icing conditions. In addition, during landing approach in icing conditions a tail de-ice system cycle should be initiated approximately one minute prior to extension of full flaps (50°). For a normal approach this would be just prior to landing gear extension.



7. Check that WING ANTI-ICE ON light goes off and TAIL DE-ICE ON light comes on.
8. After 2 1/2 minute period check that TAIL DE-ICE ON light goes off and WING ANTI-ICE ON comes on.
9. When icing conditions no longer exist, repeat step 6, then place AIR FOIL switches to OFF and place PNEU X FEED VALVE levers to closed position.



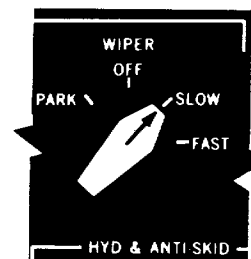
BB1-183D

ICE & RAIN PROTECTION -- NORMAL OPERATION - Rain repellent

NOTE:

Apply repellent in rain with windshield wipers operating and apply to one windshield at a time. Do not apply to dry windshield.

- 1 Place windshield wiper switch at desired speed (slow or fast).



- 2 Momentarily operate L & R repellent push buttons one at a time. A metered amount of fluid will be dispensed. Usually one application per windshield is sufficient.

NOTE:

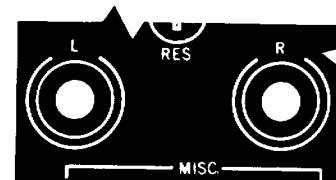
A slight clouding effect may exist until windshield wipers evenly spread the repellent fluid.

NOTE:

When the repellent push buttons are depressed and no fluid is dispensed, momentarily place repellent select switch to reserve.

NOTE:

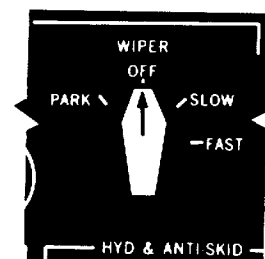
Rain repellent reserve when in use blue light should come on and remain on until maintenance services the system.



3. When conditions permit, place windshield switch to park and off.

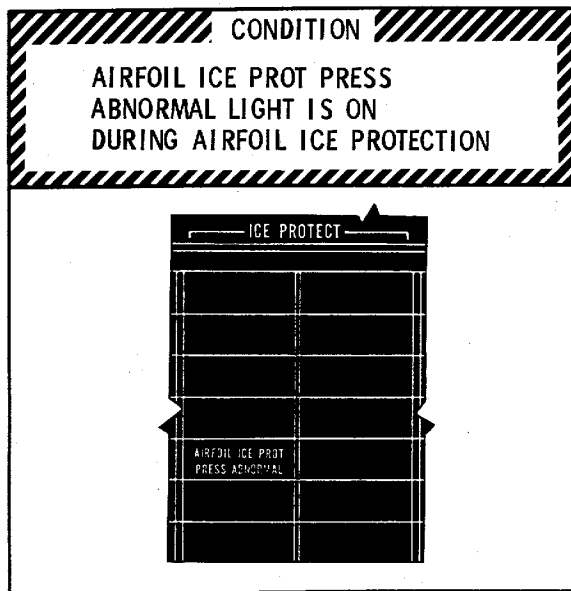
NOTE:

Do not operate windshield on dry glass, or if repellent is inadvertently applied to a dry windshield.

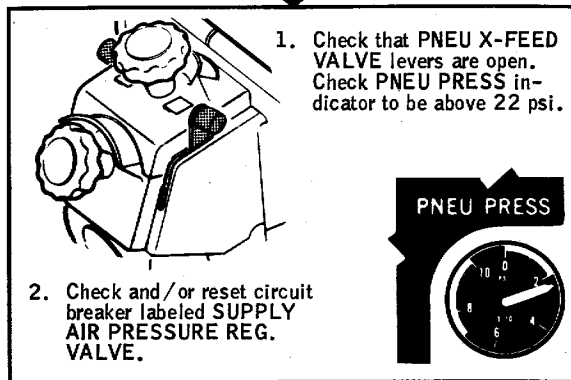


BB1-2079

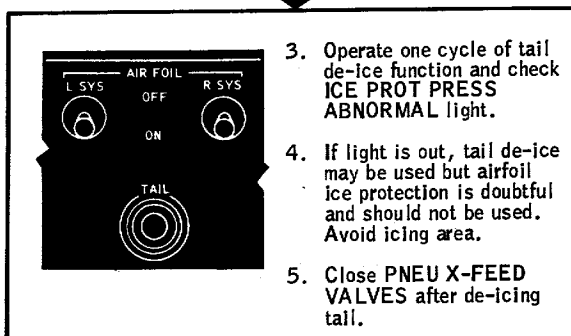
ICE & RAIN PROTECTION -- ABNORMAL OPERATION



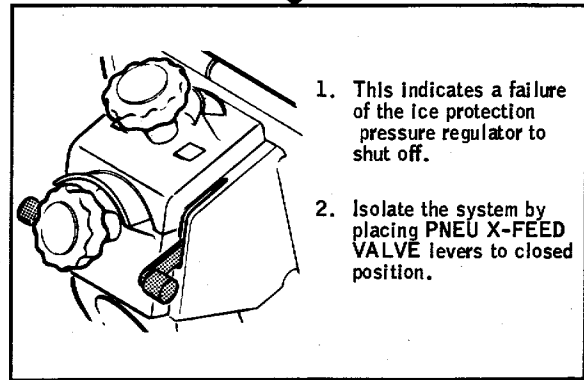
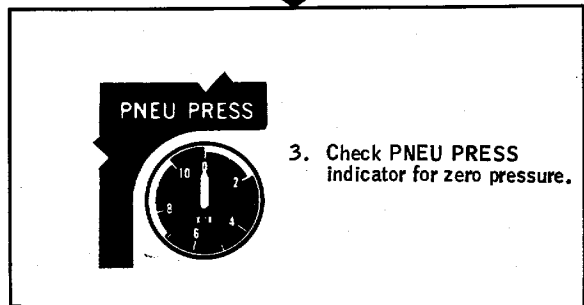
ACTION



IF LIGHT IS STILL ON

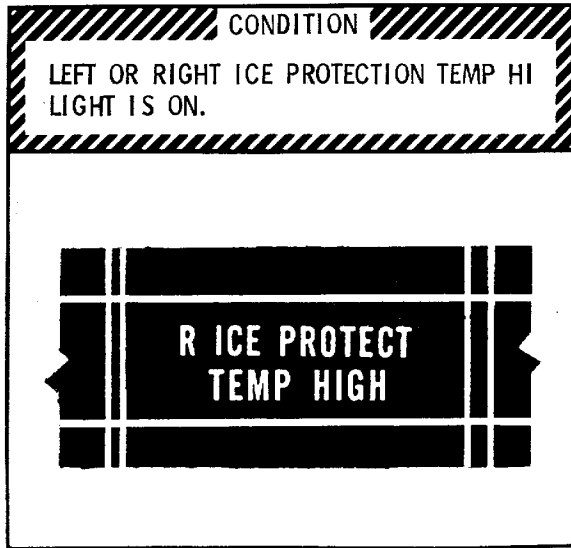


ACTION

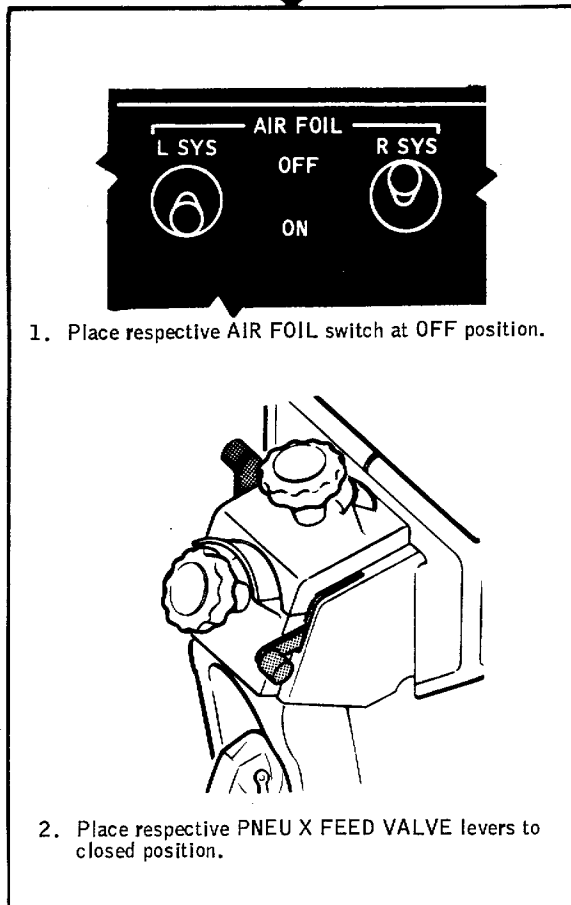
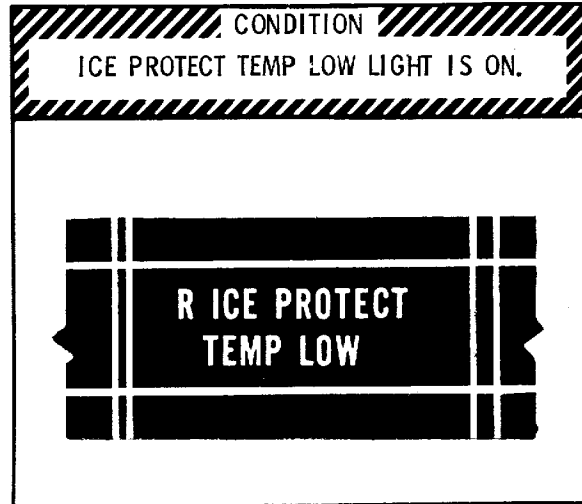


BB1-915

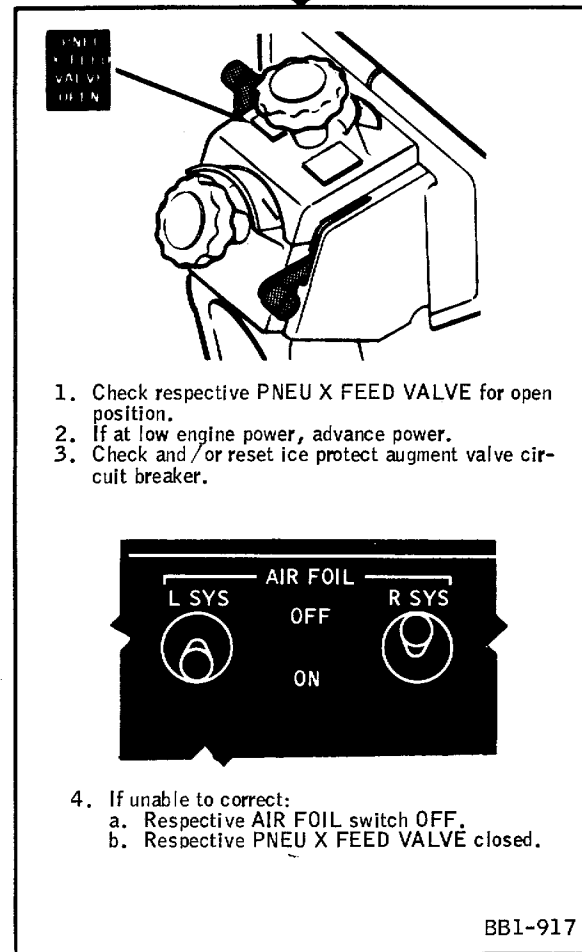
ICE & RAIN PROTECTION -- ABNORMAL OPERATION



ACTION

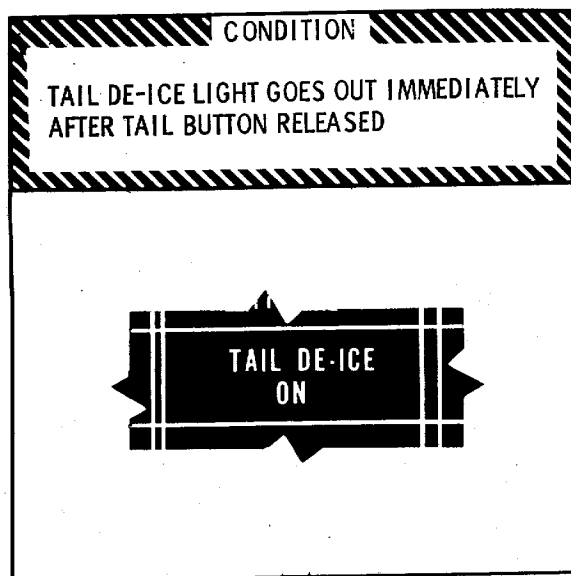


ACTION

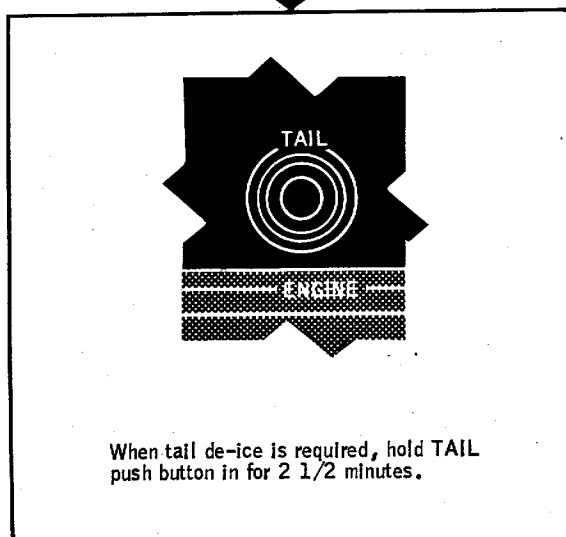
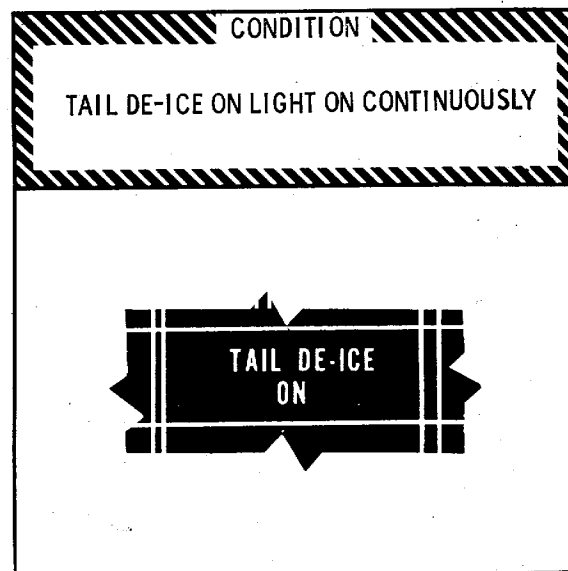


BB1-917

ICE & RAIN PROTECTION -- ABNORMAL OPERATION



ACTION



ACTION

NOTE:

This indicates a stuck timer.

1. Open WING & TAIL VALVES circuit breaker.
2. Check wing visually.

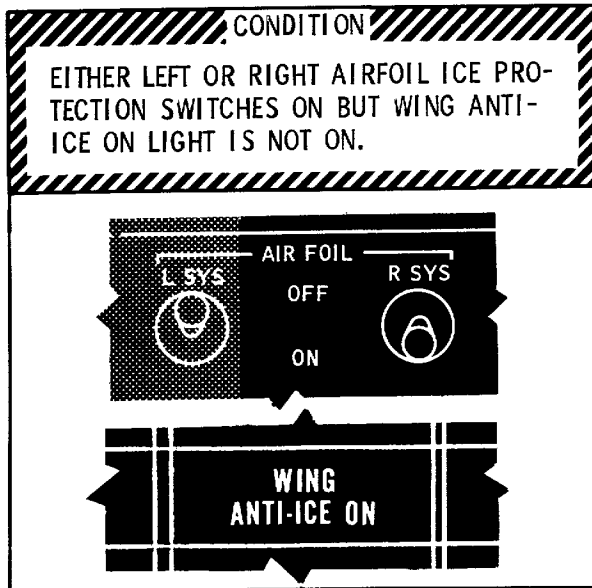
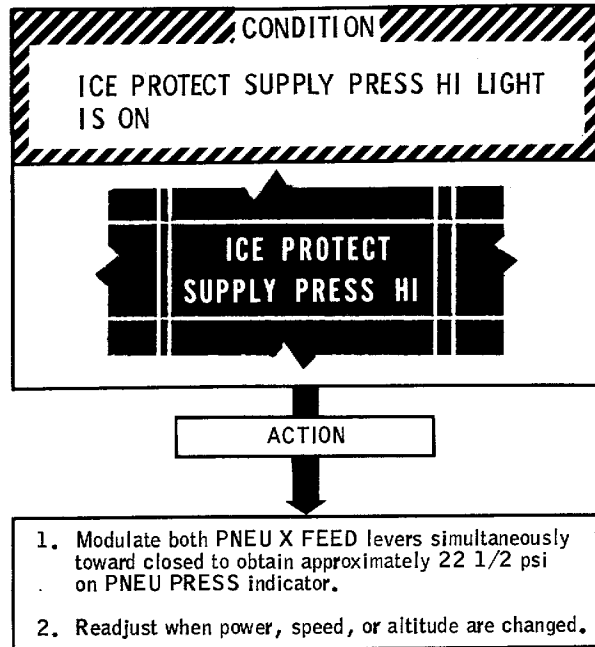
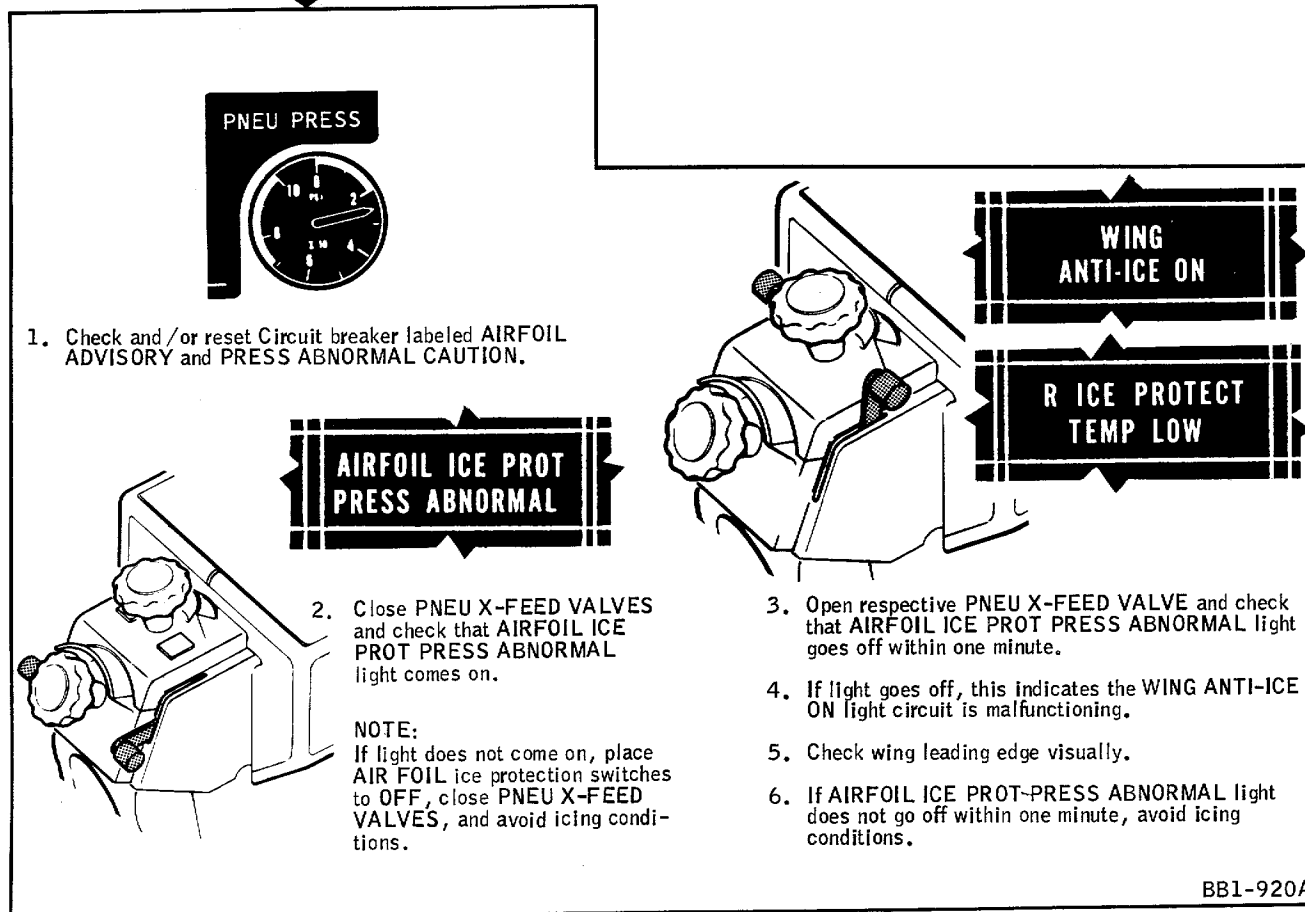
NOTE: The WING ANTI-ICE ON light may not come on. However, the wing valve opens without electrical power and the tail valve closes.

BB1-919A

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Page 3

Dec 1/68

ICE & RAIN PROTECTION -- ABNORMAL OPERATION



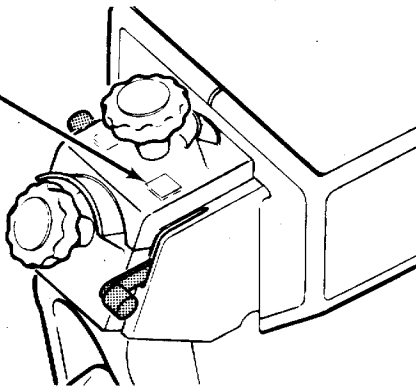
ICE & RAIN PROTECTION -- ABNORMAL OPERATION

CONDITION
HIGH PNEUMATIC PRESSURE
PNEU PRESS INDICATOR ON OVERHEAD PANEL INDICATES ABOVE 72 PSI RED LINE. NOTE: THIS WILL OCCUR ONLY WITH PNEU X-FEED VALVE OPEN;



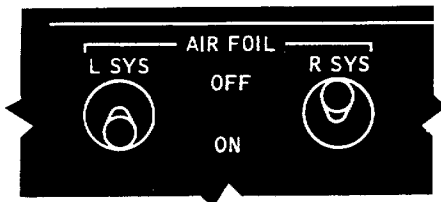
ACTION

PNEU
X-FEED
VALVE
OPEN



Determine which side is malfunctioning by closing one PNEU X FEED valve lever at a time and noting pressure change.

Leave PNEU X FEED valve lever closed for malfunctioning side.



Place AIR FOIL switch of malfunctioning side to OFF.

CONDITION
WINDSHIELD HEAT
WINDSHIELD HEAT INOPERATIVE AS DETERMINED BY WINDSHIELD ANTI-ICE CIRCUIT BREAKERS BEING OUT, OR ICE BUILD UP.

ACTION

Below 10,000 ft. altitude, limit IAS to 260 KIAS if the center windshield affected, or to 285 KIAS if either the captain or first officer's windshield is affected.

Above 10,000 ft. altitude, no restrictions.

BB1-922

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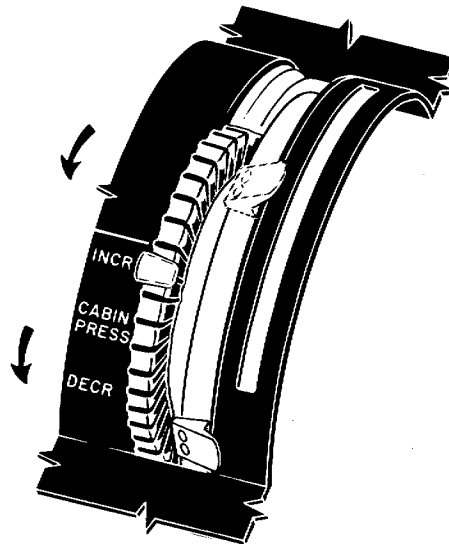
ICE & RAIN PROTECTION -- ABNORMAL OPERATION

CONDITION

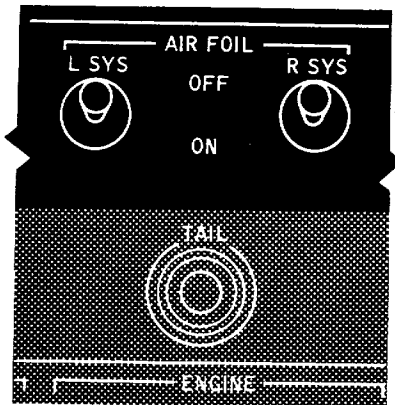
WHEN AIRFOIL ICE PROTECTION SYSTEM IS TURNED ON A SURGE OCCURS IN CABIN PRESSURE AND THE CABIN PRESSURE CONTROLLER WHEEL AND INDICATOR MOVES TOWARD DECREASE (IF OPERATING IN AUTO MODE).



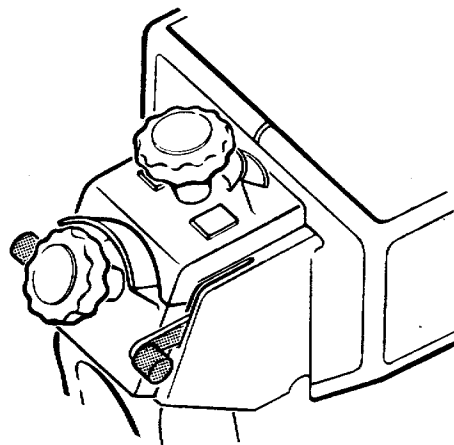
NOTE: This condition would indicate a leak from the wing de-ice duct into the pressurized area.



ACTION



1. Place AIR FOIL L SYS & R SYS switches to OFF.



2. Place both PNEU X-FEED VALVE levers to close.
3. Avoid icing area.

BB1-3869

ICE & RAIN PROTECTION -- ABNORMAL OPERATION

CONDITION

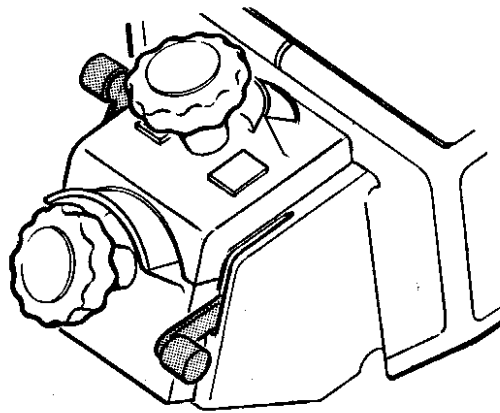
AIRFOIL ICE PROTECTION REQUIRED WHILE BOTH AIR CONDITIONING SYSTEMS RECEIVING PNEUMATIC AIR FROM ONE ENGINE

ACTION

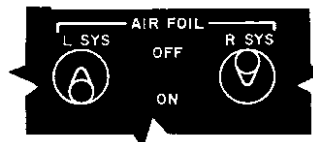
1. Place RADIO RACK switch at FAN position



2. Place pneumatic crossfeed valve lever for engine that is not supplying pneumatic air to closed position.



3. Select airfoil ice protection from the same system (left or right) that is supplying pneumatic pressure.



BB1-866A

ICE & RAIN PROTECTION -- ABNORMAL OPERATION

CONDITION

TAIL DE-ICE ON LIGHT DOES NOT COME ON AND
WING ANTI-ICE ON LIGHT REMAINS ON WHEN
TAIL BUTTON PUSHED.

NOTE: THIS INDICATES THAT TAIL DE-ICE
SYSTEM IS INOPERATIVE.

ACTION

1. Maintain not less than 5 knots above normal minimum maneuvering speeds.
2. Make final approach with flaps 25° and slats extended at a speed of not less than $1.3V_S$ for 25° flaps/slats extended + 5 knots = ($1.3 V_S$ for 50° flaps/slats extended + 15 knots).

NOTE: Do not extend flaps to full (50°) which may result in a decrease in airplane controllability.

BB1-4539

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Jun 1/70

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 25, SECTION 2, CHAPTER 55, DATED SEP 1/71
HIGHLIGHTS:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

2-55-1-0 INST/NAV/COMM -- PITOT/STATIC SYSTEMS - LIMITATIONS, TOLERANCES, & MAXIMUM ALLOWABLE DISCREPANCIES

UNDER TOLERANCES, INSTRUMENT ERROR, ALTIMETER: REVISED SEA LEVEL TOLERANCE TO ± 30 FEET AND 35,000 FEET TOLERANCE TO ± 280 FEET.

UNDER ALLOWABLE DISCREPANCIES, ALTIMETERS: REVISED DISCREPANCIES AS FOLLOWS:

SEA LEVEL.....60 FEET

5,000 FEET.....100 FEET

15,000 FEET.....270 FEET

25,000 FEET.....440 FEET

35,000 FEET.....560 FEET

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
2-55-Eff	66	A11	2-55-Eff	66	A11
2-55-1-0	8	1	2-55-1-0	8	1

Sep 1/71

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2-55-HIGHLIGHTS
CODE 66
Page 1 of 1

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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2-55-Cont	66	1	Sep 1/69
*2-55-1-0	8	1	Sep 1/71
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2-55-10-0	14	2	Dec 1/66
2-55-10-0	14	3	Sep 1/67
2-55-10-0	14	4	Dec 1/66
2-55-10-5	1	1	Dec 1/66
2-55-10-5	1	2	Sep 1/69
2-55-10-5	1	3	Mar 1/67
2-55-15-0	1	1	Sep 1/67

*The asterisk indicates pages revised or added by the current revision.

Sep 1/71

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FLIGHT CREW OPERATING MANUAL

Chapter 55

INST/NAV/COMM

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

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<u>*NORMAL OPERATION</u>				
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Radar test pattern	55-10-5	3	1	A11
<u>*ABNORMAL OPERATION</u>				
Pitot/static systems	55-15-0	1	1	A11

*Illustrations

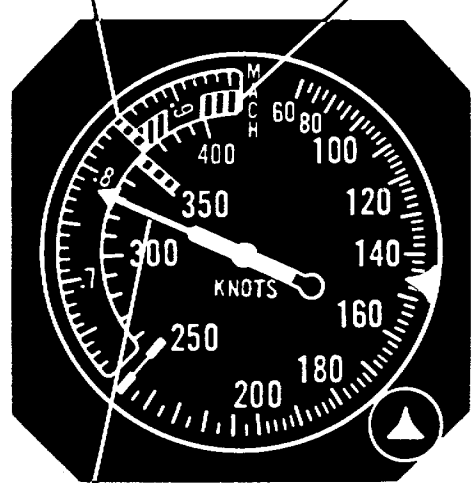
Sep 1/69

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INST/NAV/COMM -- PITOT/STATIC SYSTEMS - Limitations, tolerances, & maximum allowable discrepancies

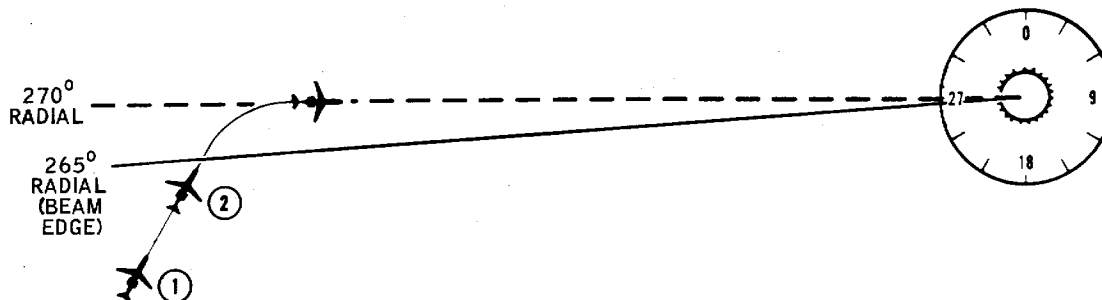
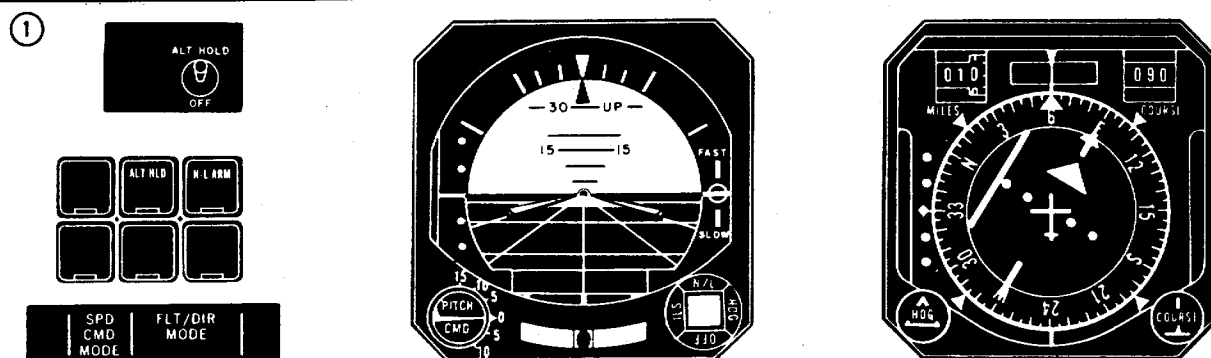
TOLERANCES	
INSTRUMENT ERROR	
ALTIMETER - BAROMETRIC OPERATION	
sea level.	±30 feet
35,000 feet	±280 feet
MACH/AIRSPEED INDICATOR	
high speed	±4 knots
approach speeds	±2.5 knots
POSITION ERROR (static port location)	
Maximum error over a representative range of weights, airspeeds, and flap configurations.	
ALTIMETER	
NORM.	+30 to -20 feet
ALT	+30 to -26 feet
MACH/AIRSPEED INDICATOR	
NORM	+2.5 to -1.0 knots
ALT.	+3 to -0.5 knots

LIMITATIONS	
OVERSPEED WARNING	
The overspeed warning sensor will actuate the aural and visual warning devices when an airspeed of 350(-0, +6) knots, or a Mach number of 0.84(-0, +0.01) is attained	
MACH/AIRSPEED INDICATOR	
MACH-RED AND YELLOW RADIAL AT MACH 0.84	MACH-RED AND YELLOW ARC FROM MACH 0.84 TO MACH 1.0
	
AIRSPEED-RED AND YELLOW RADIAL AT 350 KNOTS	

ALLOWABLE DISCREPANCIES	
ALLOWABLE DISCREPANCIES BETWEEN CAPTAIN'S AND FIRST OFFICER'S INDICATORS	
ALTIMETERS	
sea level.	.60 feet
5,000 feet	100 feet
15,000 feet	270 feet
25,000 feet	440 feet
35,000 feet	560 feet
MACH/AIRSPEED INDICATORS	
high speeds.	8 knots
approach speeds	5 knots
MACH indication.	0.02 Mach
NOTE: This assumes that altimeter checks are made using the same barometric setting for each indicator.	

BB1-1899D

INST/NAV/COMM -- NORMAL OPERATION - Flight director system, VOR capture

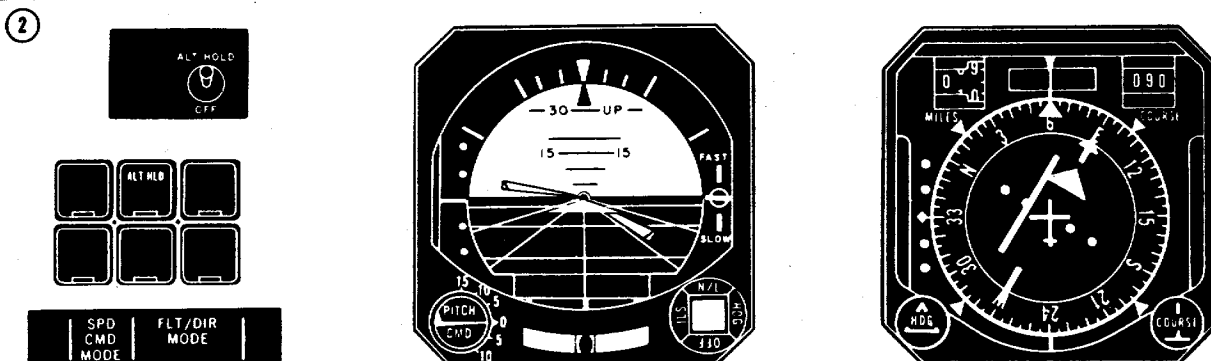


Tune NAV receiver to the VOR station. Rotate the course arrow to coincide with the desired radial. The lateral deviation bar now shows the relative position of the radial when referenced to the miniature aircraft. Set the heading marker to a desired intercept heading, and rotate the mode selector to N/L. The mode annunciator NL ARM light comes on, denoting that steering commands still are referenced to the heading marker and the computer is armed for VOR capture. With ALT Hold switch ON, V-bar pitch commands are referenced existing altitude, and annunciator will display ALT HLD.

*Airspeed, altitude, distance from a station, and prevailing winds combine to influence the amount of overshoot that could be encountered in capturing an omniradial. To optimize capture performance, a convergence angle should be selected that considers the effect of altitude and airspeed on rate of turn, and the fact that the maneuvering area included in 5 degrees of omni deviation is proportional to distance from the station.

As distance from the station increases, the convergence angle also may be increased. Conversely, if capturing at less than 10 miles from the station, a proportionally lesser convergence angle is recommended.

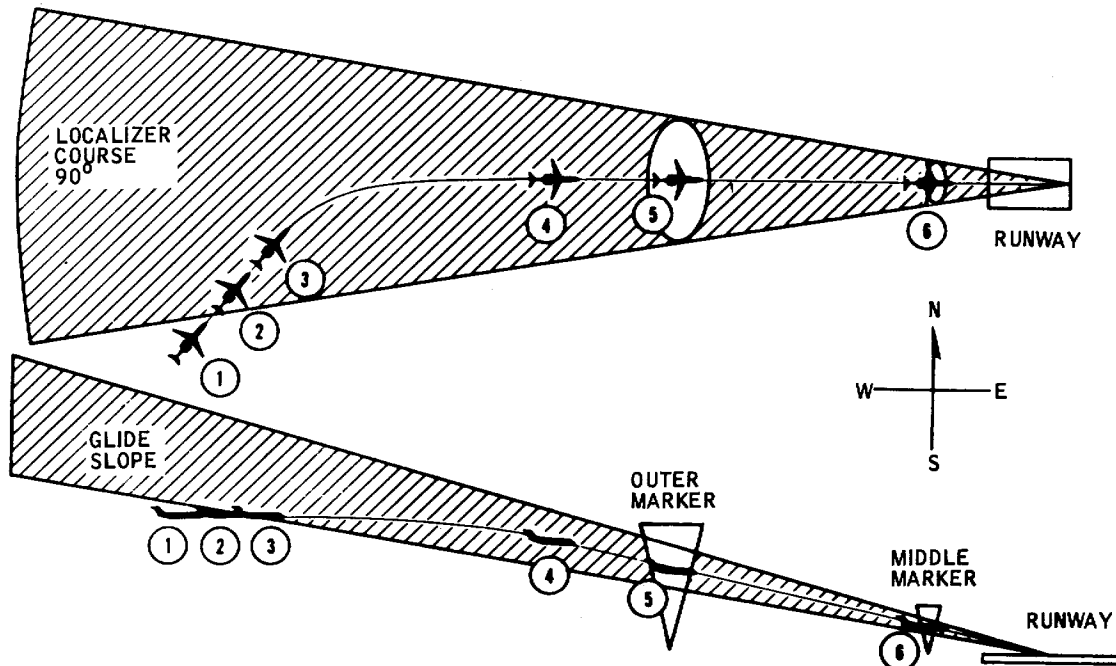
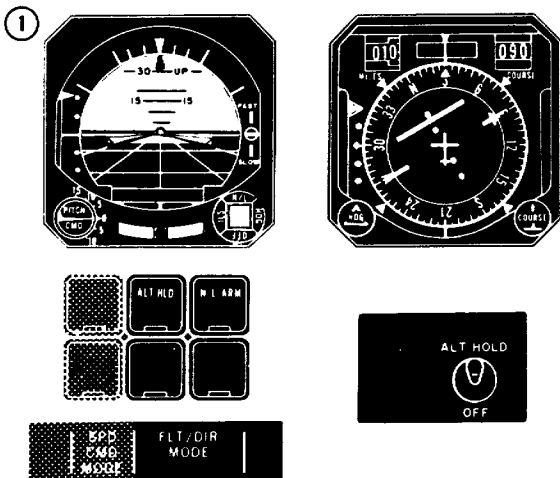
As a guide, use approximately 30 degrees of convergence at 10 miles from the station.



As the aircraft approaches the radial, the lateral deviation bar moves toward center scale. At approximately 5 degrees from the radial (approximately 1 dot), the computer senses "beam edge" and automatically switches to capture operation and the NL ARM light goes off. The system is now in full N/L mode, and V-bar commands direct the aircraft to roll out on and track the radial, compensating automatically for crosswind effect.

BB1-2183A

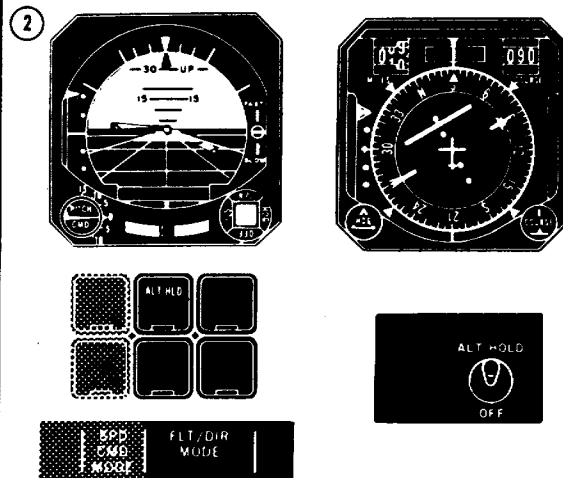
**INST/NAV/COMM - NORMAL OPERATION - Flight director system -
 ILS approach (sheet 1)**



Tune the navigational receiver to the localizer frequency and set the course arrow to the published inbound front course. The mode selector is rotated to N/L, and if the aircraft is more than approximately 2 dots from the localizer center-line, the mode annunciator N-L ARM light will come on. Steering commands are still referenced to the heading marker, which is set to a desired intercept heading.

Assuming that the airplane is at the published minimum approach altitude, engage altitude hold by placing the ALT HOLD switch in the ON position. Annunciator will display ALT HLD. Steering and pitch commands are now displayed by the V-command bar to maintain altitude and capture the localizer course.

NOTE: If altitude hold is not desired, the nose down angle that gives the desired rate of descent is set with the PITCH CMD KNOB.

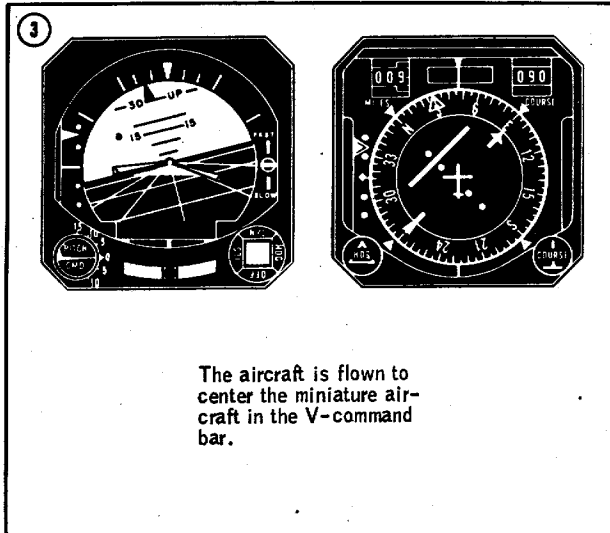
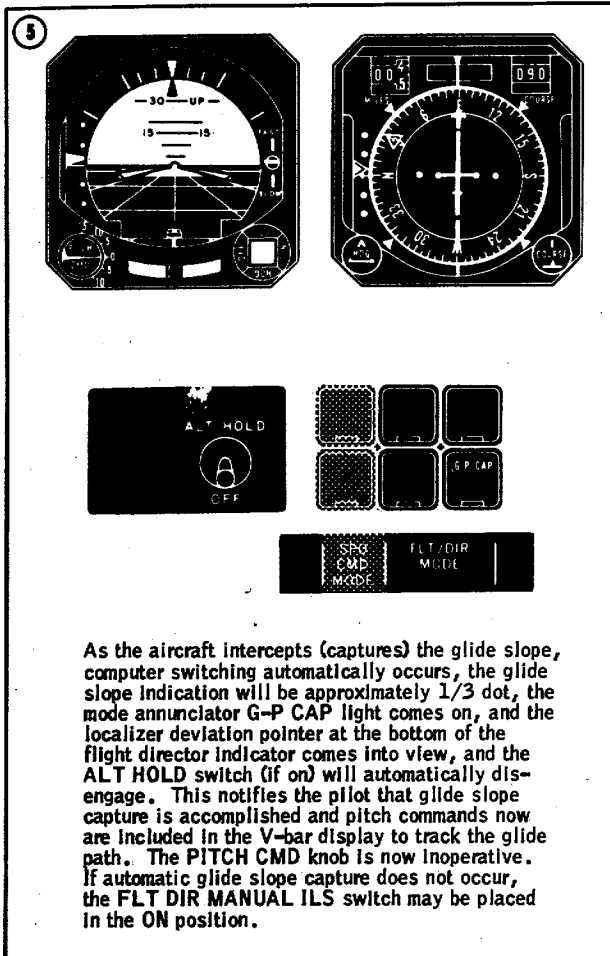
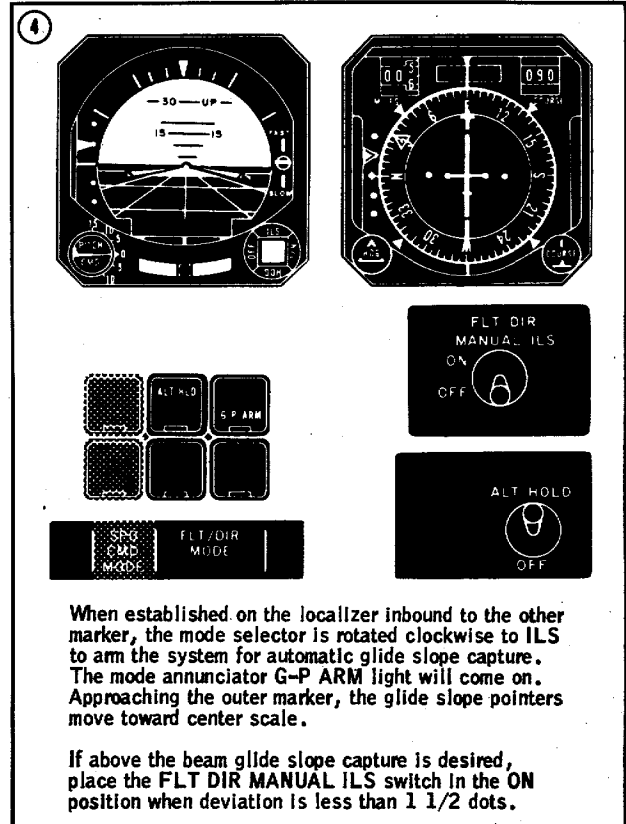
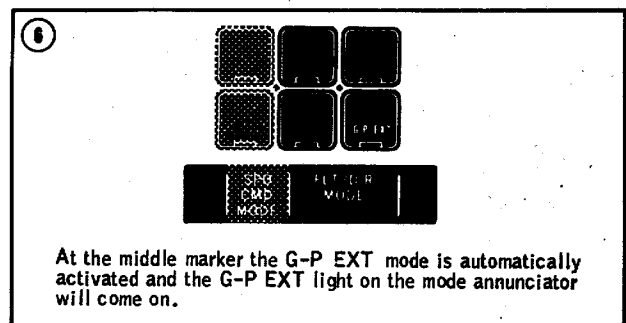


As the "beam edge" (approximately 2 dots) is reached computer switching occurs, the mode annunciator N-L ARM light will go off, and V-bar commands are presented to capture and track the localizer centerline, and maintain existing altitude.

BB1-2184A

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INST/NAV/COMM - NORMAL OPERATION - Flight director system - ILS approach (sheet 2)



The glide slope pointers and localizer deviation pointer are monitored for backup during the approach. The miniature aircraft and course arrow relationship displays any crab angle commanded by automatic crosswind correction.

NOTE:

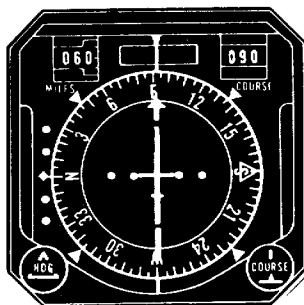
1. Placing the FLT DIR MANUAL ILS switch in the ON position will give immediate glide slope capture.
2. In no case should manual glide slope capture be initiated after passing the outer marker or similar initial approach fix, unless glide slope deviation is approximately zero.

BB1-2185B

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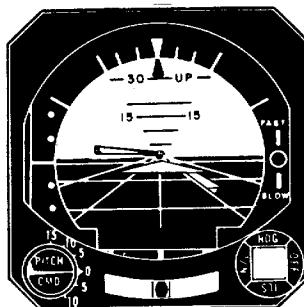
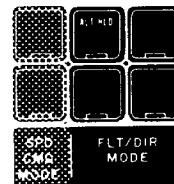
**INST/NAV/COMM -- NORMAL OPERATION - Flight director system -
Heading (HDG) mode**

COURSE INDICATOR



To display heading information on the V-command bar select desired heading on the applicable course indicator.

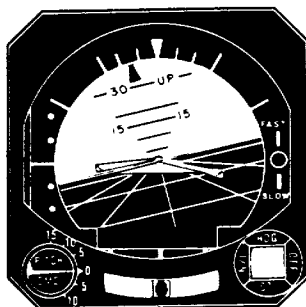
FLIGHT DIRECTOR INDICATOR



Select the HDG mode at the flight director indicator.

When altitude hold is not engaged the PITCH CMD knob controls pitch command signal to the V-command bars. To engage altitude hold, place ALT HOLD switch in the ON position, annunciator will display ALT HLD and V-command bars now display command to maintain altitude existing at time of engagement.

FLIGHT DIRECTOR INDICATOR



Control the aircraft to align the delta-shaped aircraft of the flight director indicator with the V-command bar. Correct heading, as required, with HDG control of the course indicator, and control the aircraft to re-align the delta-shaped aircraft with the V-command bar.

BB1-2186A

INST/NAV/COMM -- NORMAL OPERATION - Radar techniques

NOTE: The following operating techniques are presented to emphasize the overall scope of consideration necessary to efficiently utilize the radar installed in the DC-9.

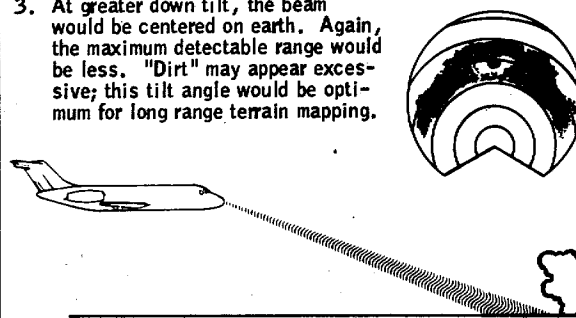
1. Maximum detectable range of storms is obtained by centering (TILT) the radar beam on the "rainfall shaft". A slight amount of "dirt" (isolated strong terrain targets) may be observed.



2. At greater up tilt, the beam would be centered on ice crystals which produce a less intense radar echo (5 times less). The maximum detectable storm range would now be less. The indicator would appear clean; "dirt" eliminated.



3. At greater down tilt, the beam would be centered on earth. Again, the maximum detectable range would be less. "Dirt" may appear excessive; this tilt angle would be optimum for long range terrain mapping.



A RADIO FREQUENCY

PENCIL BEAMS SHOWN
IN TWO DIFFERENT POSITIONS

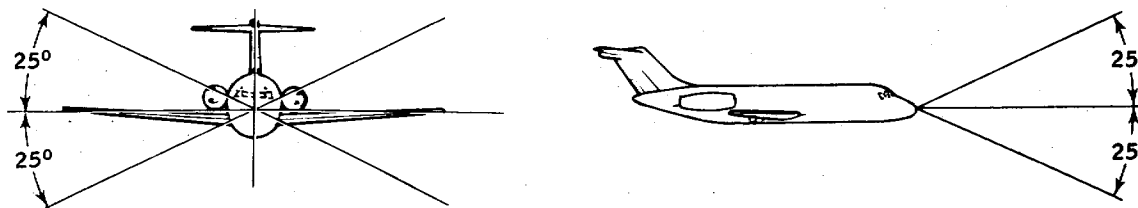
MAP BEAM

PENCIL BEAM
WEATHER OR LONG RANGE TERRAIN TARGETS

MAP BEAM
SHORT RANGE TERRAIN MAPPING

4. The beam configuration is automatically selected by the function switch: Pencil beam for NORM and CTR (contour), and map beam for MAP position.

5. Stabilization limits of the antenna may be exceeded during aircraft maneuvers. These limitations are mechanically fixed at $\pm 25^\circ$ from 0° degrees.



NOTE: It is suggested that during flight training when aircraft attitudes are of a greater than normal value, to prevent undue wear of the antenna tilt motor and antenna stops, that the antenna "STAB" switch be turned to the off position.

6. Should there be any doubt as to the performance of the radar system, position the function switch to the "test" position and observe that the radar indicator displays

a test pattern as described in the "Before Start Expanded Check List".

BB1-1102A

INST/NAV/COMM -- NORMAL OPERATION - Radar weather function operating techniques

The prime consideration in a Weather-Mapping radar is its ability to display weather information in a form which will enable the pilot of an aircraft to recognize and interpret enroute weather conditions and to select a safe route through or around the most dangerous portions of thunderstorms.

NOTES:

- Before attempting the following procedures, the radar should be first adjusted in accordance with the procedures in the Before Start Check List elsewhere in this chapter.
- Do not use test pattern for control setting reference.

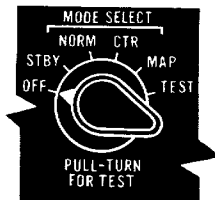
1. Use of Function Switch

NORMAL (NORM) - for initial observation of the weather pattern.

CONTOUR (CTR) - for evaluation of close range weather targets or prior to any penetration attempt.

MAP - Switch to MAP for optimum ground map capability.

NOTE: For storms within the near ranges, the "contour" feature will outline areas of intense rainfall. Where the rainfall density exceeds threshold, a hole is "punched" in that area of display.



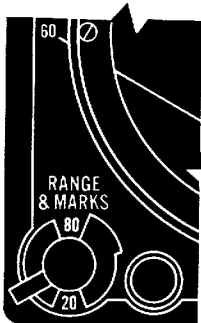
2. Use of Range Switch

180/30 - to display initial detection of maximum range weather.

NOTE: The mere fact that a storm is detected and displayed at advanced range is ample evidence of its intensity.

80/20 - for expanded scale of targets within this range.

30/10 - for maximum scale expansion and resolution of targets within this range.



3. Use of Tilt

Set for desired area of surveillance approximately 2° - 5° down tilt for maximum range weather detection, and optimum ground map when MAP position is selected on function switch.

For normal operation set tilt control so that general ground painting begins at about 75 percent of range in use. This insures that a storm return at a lesser distance will not be overlooked.



4. Use of Gain

Optimum sensitivity is established and maintained by the **AUTO** position. Special effects, however, may be obtained by a reduced setting:

- To improve apparent resolution of select targets.
- Distinguish prominent targets from surrounding terrain.



5. Use of STAB

STAB switch should always be in the **ON** position except for abnormal conditions. In case of vertical gyro failure, radar will still be functional, however, there will be no roll or pitch stabilization of the radar antenna. When the airplane is level in both roll and pitch, normal radar presentation will be available.

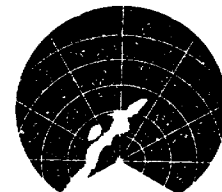
6. Indicator Adjustment Procedure

- Adjust polaroid filter for maximum brightness.
- Vary **TRACE ADJUST** to select desired video brilliance.
- Set **ERASE RATE** control so that the range marks, or targets if available, just disappear as sweep trace begins.
- Display Bloom will be observed if the **TRACE ADJUST** is set too high, **ERASE RATE** set too low, or a combination of the two. If strong video bloom does not erase during the following sweep trace, increase the **ERASE RATE** until bloom disappears. If bloom persists, reduce the **TRACE ADJUST** control until a clearly defined display is obtained.
- Polaroid filter should now be adjusted to suit ambient lighting conditions. Do not use **TRACE ADJUST** to reduce display intensity, target range will suffer.



TYPICAL PRESENTATION OF VARIOUS STORM PATTERNS.

180 mile range
 30 mile range marks
 Normal position

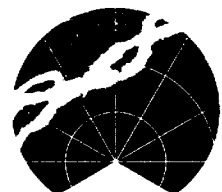


80 mile range
 20 mile range marks
 CTR (Contour) position



Same Storm patterns expanded by the 80 mile range scale. Contour holes clearly indicated

30 mile range
 10 mile range marks

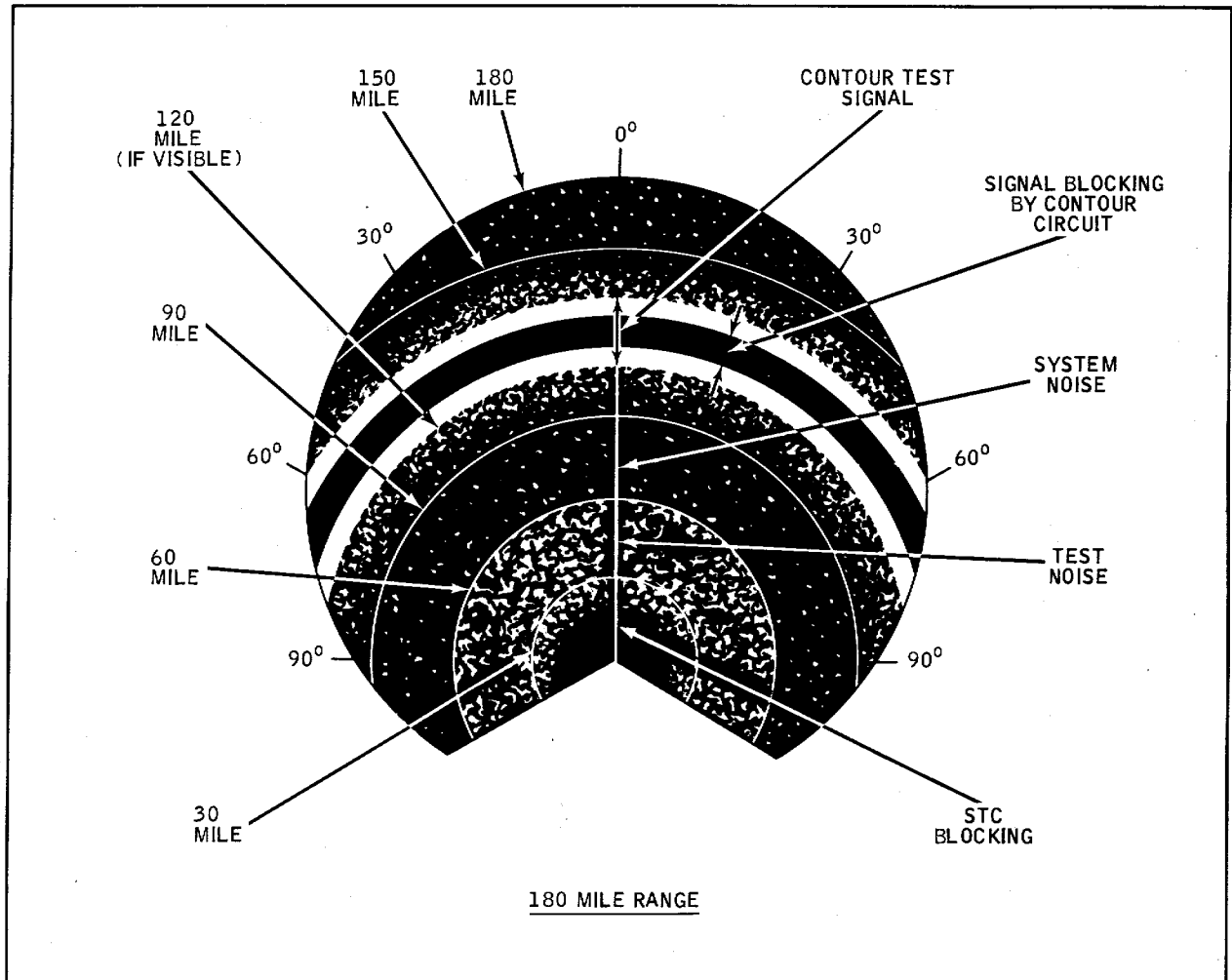


A short time later storm pattern further enlarged by use of the 30 mile range.

BB1-196C

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INST/NAV/COMM -- NORMAL OPERATION - Radar test pattern



NOTE: Do not use test pattern for control setting reference.

- A The six range mark circles indicate an operational range mark generator.
- B The black area near zero range indicates an operational STC (sensitivity-time-control) circuit. The STC circuit reduces the receiver gain to near zero at zero radar range. The receiver gain is then permitted to rise, exponentially, to its normal set level in a time period approximately equal to 30 radar miles. This insures against overwriting and receiver overloading by return signals from large, close-in targets.
- C The range from 30 to 60 miles displays a random noise signal purposely applied to the receiver, and indicates an operational receiver. The applied noise signal is more intense than normal receiver noise and the display of noise is therefore brighter.
- D The range from 60 to approximately 110 miles displays internal random noise with no applied signal. It is what would be seen during normal operation with no targets in the range so displayed.
- E At approximately 110 miles is the start of a display of another signal purposely injected into the receiver. The display of this signal runs out to approximately 135 miles. It is a composite signal with a contoured central area. No cloud could give a signal this extensive or as symmetrical, but the display proves the operation of the contour circuit. The black, center area, between the two white arcs, represents the maximum area of a storm cloud. This area is usually surrounded by the most turbulent area in the storm.

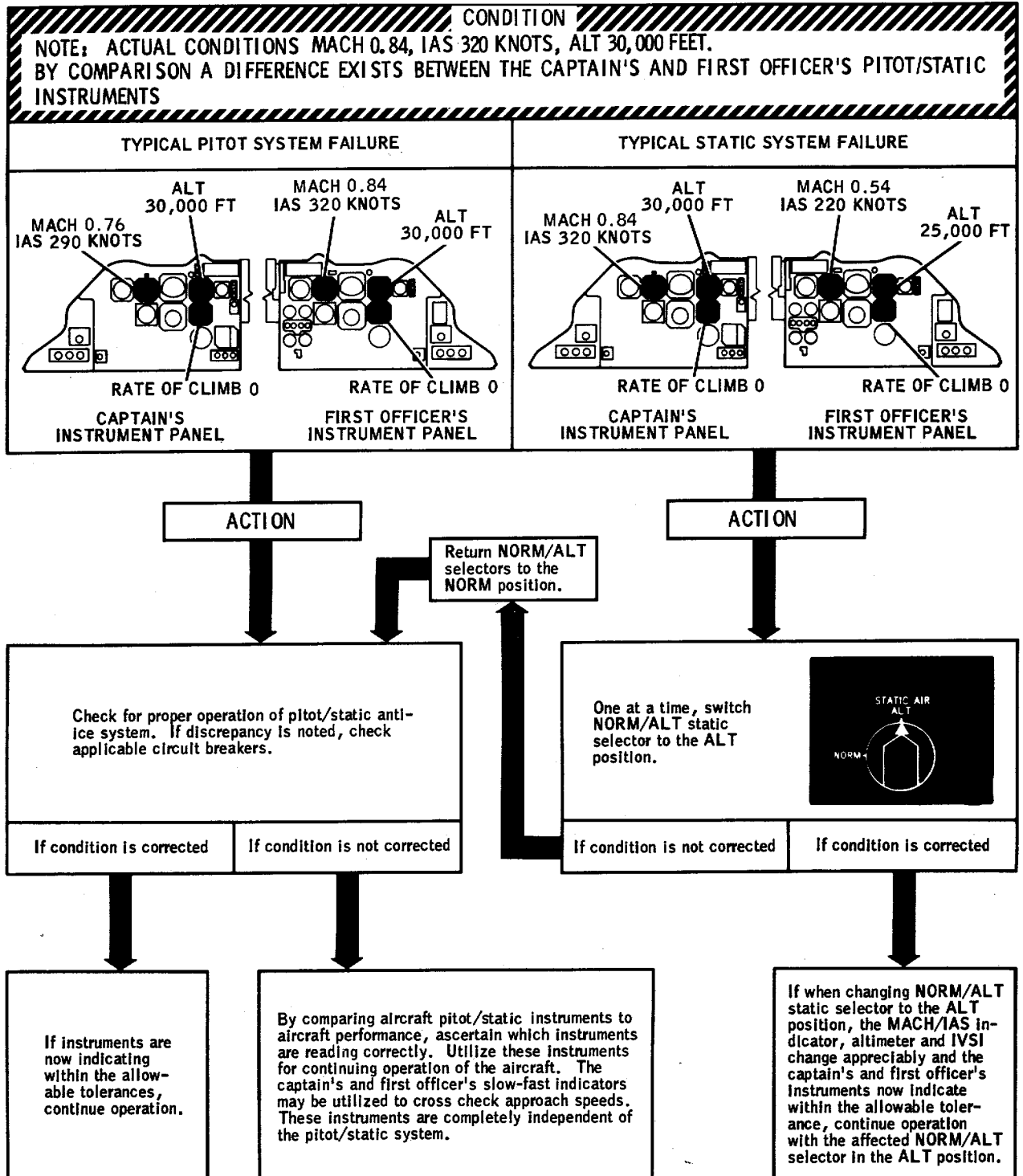
BB1-164A

Mar 1/67

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Section 2
 55-10-5
 CODE 1
 Page 3

INST/NAV/COMM -- ABNORMAL OPERATION - Pitot/static systems



NOTE: Depressurizing the aircraft prior to approach may decrease the error.

BB1-159C

Section 2
 55-15-0
 CODE 1
 Page 1

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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2-60-Cont	66	1	Sep 1/69
2-60-1-0	1	1	Jun 1/66
2-60-10-1	1	1	Dec 1/67
2-60-10-1	1	2	Dec 1/65
2-60-10-2	1	1	Sep 1/67
2-60-10-5	1	1	Dec 1/68
2-60-10-5	1	2	Mar 1/67
2-60-10-10	20	1	Sep 1/67
2-60-10-10	20	2	Sep 1/67
2-60-15-1	1	1	Dec 1/66

*The asterisk indicates pages revised or added by the current revision.

Sep 1/69

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2-60-Effective Pages
CODE 66
Page 1

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Chapter 60

AUTOMATIC FLIGHT CONTROL SYSTEM

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

Title	Chapter Subject Unit	Page	CODE	Airplane Effectivity
*AUTOMATIC PILOT - LIMITATIONS	60-1-0	1	1	A11
*NORMAL OPERATION - Servos engagement and pitch maneuvers	60-10-1	1	1	A11
*NORMAL OPERATION - Pitch hold, IAS hold, and Mach hold	60-10-1	2	1	A11
*NORMAL OPERATION - Turn maneuvers	60-10-2	1	1	A11
*NORMAL OPERATION - Automatic VOR capture	60-10-5	1	1	A11
*NORMAL OPERATION - Automatic ILS approach	60-10-10	1	20	A11
*ABNORMAL OPERATION - Out of trim light stays on	60-15-1	1	1	A11

*Illustration

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Page 1

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AUTOMATIC PILOT -- LIMITATIONS

Do not use pitch axis of the autopilot when the alternate trim for the horizontal stabilizer is inoperative.

Moving the horizontal stabilizer by means of the primary system will cause the autopilot to disengage automatically.

MODE	PARAMETER	VALUE
	PITCH AXIS	
Vertical Speed	Vertical speed limit	+4000 feet per minute -8000
Pitch Hold	Pitch angle limit	±18.5 degrees
	ROLL AXIS	
Turn Knob	Roll angle limit	28 ⁺⁵ / ₋₂ degrees
Heading Select	Roll angle limit	25 ±5 degrees
VOR-ILS Capture Phase	Roll angle limit	25 ±5 degrees
VOR-ILS On-Course Phase	Roll angle limit	10 ±4 degrees

AUTOMATIC PILOT -- NORMAL OPERATION - Servos engagement & pitch maneuvers

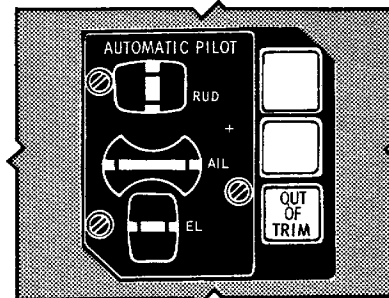
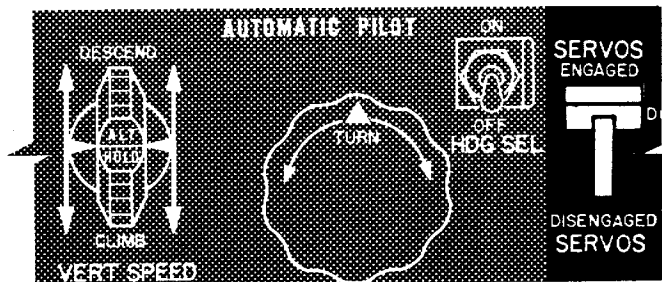
SERVOS ENGAGEMENT

SERVOS ENGAGEMENT

The most desirable procedure to follow when engaging the automatic pilot is to have the airplane in straight and level flight and properly trimmed. However, engagement can be made when the airplane is in a climbing or descending turn. If the climbing or descending turn does not exceed the synchronization roll angle limit (approximately 30 degrees) and pitch angle limit (approximately 18 degrees) the automatic pilot will roll the airplane to a wings level condition and hold the vertical speed existing at the time of engagement. In addition, when the airplane has returned to within 6 degrees of level flight, the automatic pilot will lock on the existing heading.

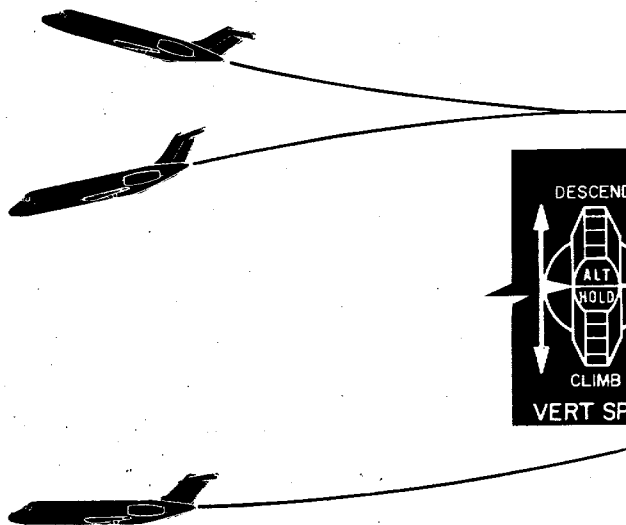
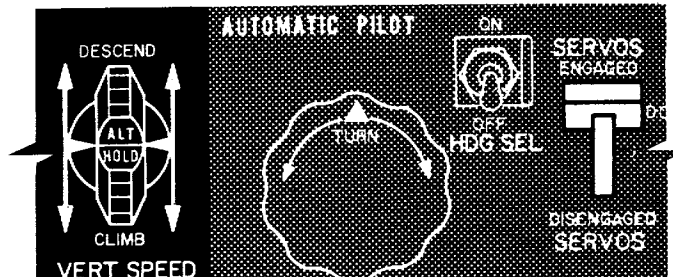
The automatic pilot should not be engaged if the RUD, AIL or EL trim meters show a deflection of more than one needlewidth.

The automatic pilot is engaged by placing the SERVOS engage switch to the SERVOS ENGAGED position.



PITCH MANEUVERS

TO ESTABLISH RATE OF CLIMB OR DESCENT
 Establish the pitch up or pitch down attitude by moving the VERT SPEED wheel towards the CLIMB or DESCEND position as applicable. The rate of climb or descent is proportional to the amount the wheel is moved out of ALT HOLD (detent) position.



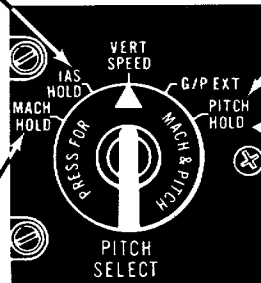
TO LEVEL OFF AND HOLD ALTITUDE
 As the desired altitude is reached move the VERT SPEED wheel to the ALT HOLD (detent) position.

BB1-970C

**AUTOMATIC PILOT -- NORMAL OPERATION - Pitch hold, IAS hold,
& Mach hold**

IAS HOLD MODE
The IAS (indicated airspeed) hold mode is established by placing the PITCH SELECTOR to the IAS HOLD position. The indicated airspeed existing at the time of engagement is maintained by automatic adjustment of the airplane pitch attitude. IAS HOLD position is inoperative.

PITCH HOLD MODE
The pitch hold mode is established by placing the PITCH SELECTOR to the PITCH HOLD position. This mode provides pitch attitude hold about the airplane attitude existing when the mode is selected.



MACH HOLD MODE
The Mach hold mode is established by placing the PITCH SELECTOR to the MACH HOLD position. The indicated Mach number existing at the time of engagement is maintained by automatic adjustment of the airplane pitch attitude. MACH HOLD position is inoperative.

NOTE:
The IAS HOLD, PITCH HOLD, AND MACH HOLD modes may be engaged anytime the autopilot is not under glide path control. If these modes have been selected and the autopilot then automatically engages the glide path, the PITCH SELECTOR will automatically return to the VERT SPEED position. The pitch selector will also return to the VERT SPEED position if IAS HOLD, PITCH HOLD, or MACH HOLD has been selected and the vertical speed wheel is moved.

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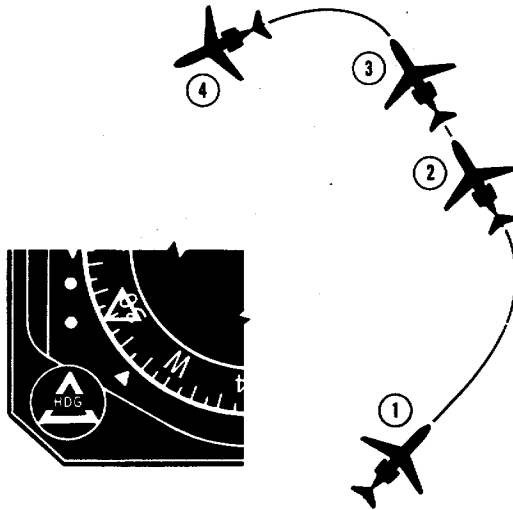
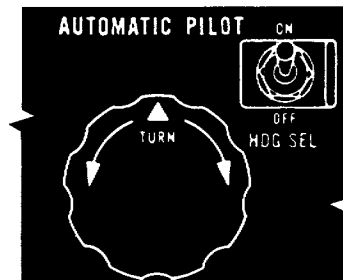
AUTOMATIC PILOT -- NORMAL OPERATION - Turn maneuvers

TO TURN TO PRESELECTED HEADING

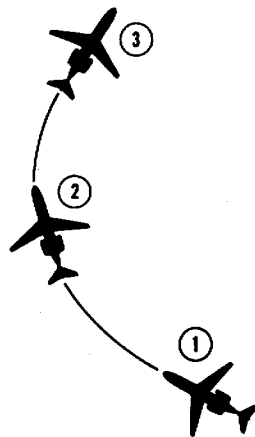
- ① Rotate heading knob on the Captain's course indicator so the heading bug index is aligned with the desired heading on compass card. (300 degrees shown).

Place HDG SEL switch to the ON position.

- ② Airplane will execute a smooth coordinated turn and roll out level on selected heading.
- ③ To change heading at any time with HDG SEL switch on, rotate HDG knob on the pilot's course indicator slowly to select desired new heading.
- ④ Airplane will turn to new heading automatically.



Note: If turn knob is displaced from the detent position when the HDG SEL is on, the HDG SEL switch will automatically return to the OFF position.



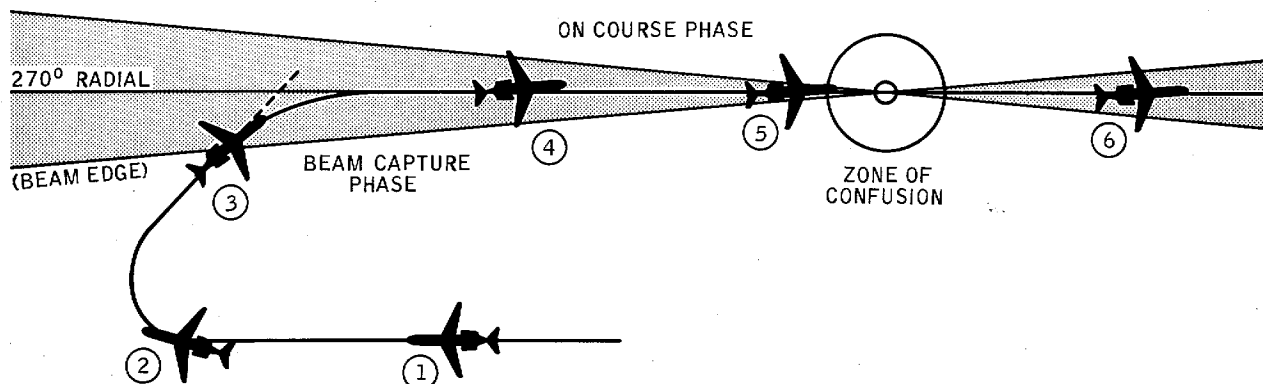
TO TURN MANUALLY

- ① Rotate turn knob out of detent in direction of desired turn. Established bank angle will be proportional to magnitude of knob displacement. Leave turn knob in displaced position until airplane approaches desired heading.
- ② Command rollout by slowly rotating turn knob back toward detent.
- ③ When turn knob is in detent, airplane will roll out level and fly heading that exists when roll angle decreases to approximately 6 degrees.



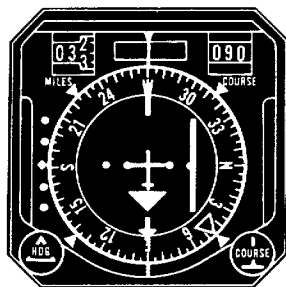
BB1-971A

AUTOMATIC PILOT -- NORMAL OPERATION - Automatic VOR capture **(sheet 1)**



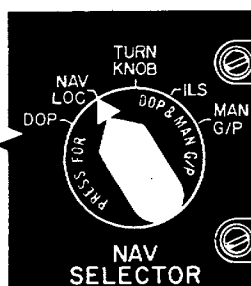
①

Tune the Captain's navigation receiver to the desired VOR frequency.

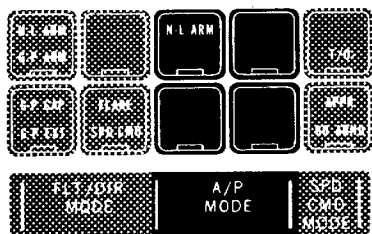


Set the desired course on the Captain's course indicator.

Comparing the miniature aircraft and lateral deviation bar shows the relative position of the radial once it is selected.



Turn the NAV SELECTOR switch to the NAV-LOC position.

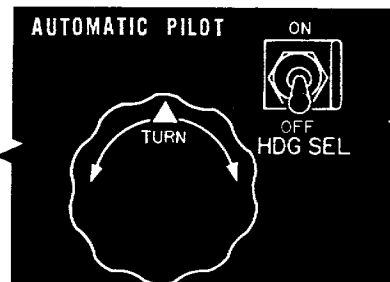


The mode annunciator should indicate that the autopilot is armed for automatic capture.

②

The pilot may continue to fly in the heading select mode or the turn knob mode to approach the selected radial at the desired intercept angle.

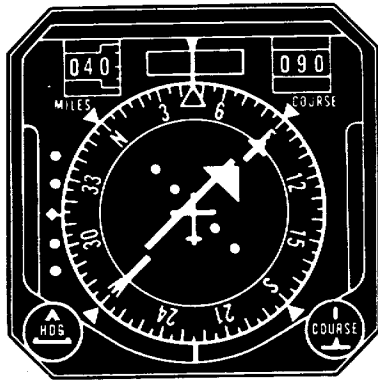
Note: Minimum VOR intercept angles and distances are dependent upon altitude and airspeed (approximately 30° for each 10 miles from station).



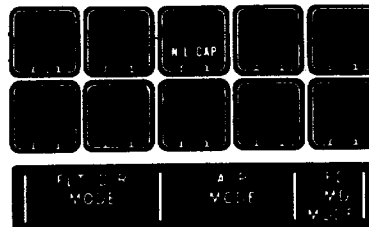
NOTE: The turn knob must be in the detent position for the autopilot to automatically capture the VOR beam.

AUTOMATIC PILOT -- NORMAL OPERATION - Automatic VOR capture (sheet 2)

③



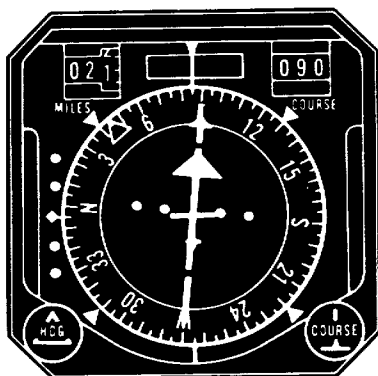
As deviation decreases to approximately 1/3 of a dot, the autopilot will automatically capture and track the selected course.



The mode annunciator should indicate that the VOR beam has been captured.

Note: If the heading select was utilized to establish the intercept angle, the heading select switch will automatically return to the off position.

④



The automatic pilot will automatically compensate for cross winds and continue to fly the VOR beam.

⑤

When the airplane approaches the zone of confusion above the VOR transmitter, the automatic pilot will automatically decouple the beam signal but continue to fly the airplane to a drift corrected radial heading.

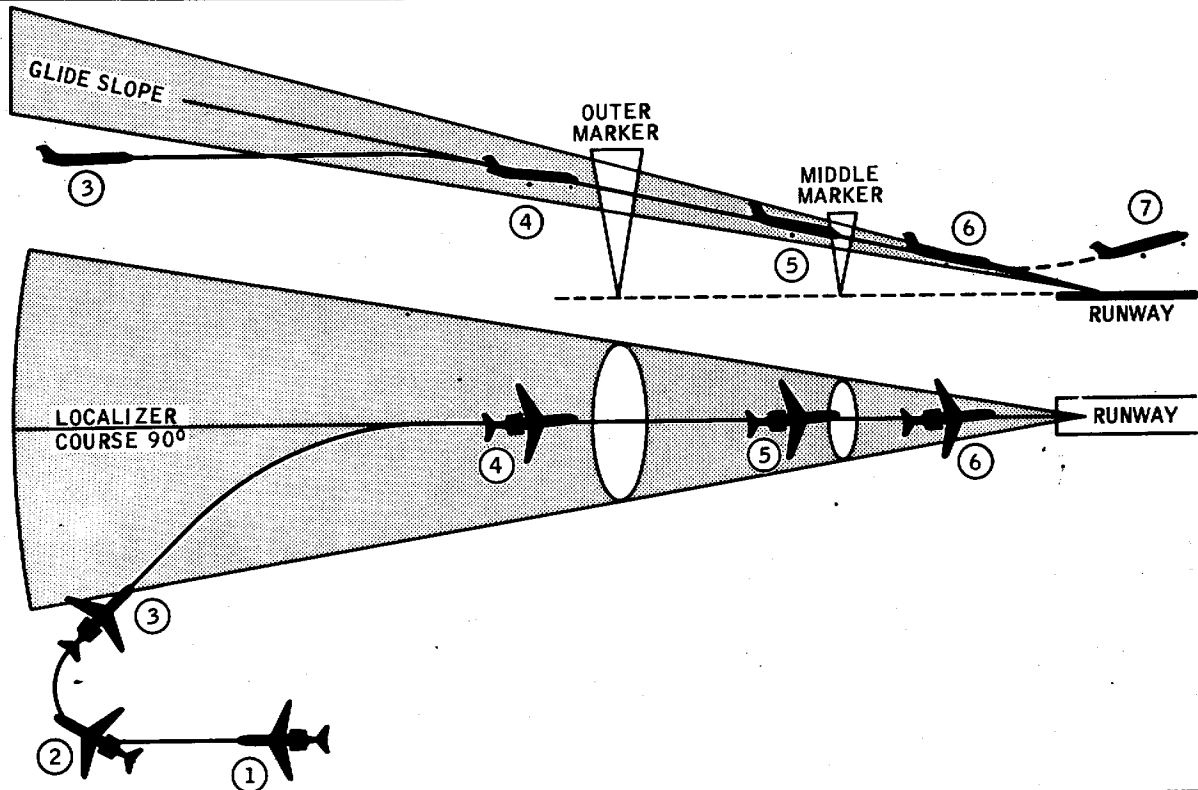
⑥

After passing the VOR station and the beam signal again becomes usable, the autopilot automatically recouples to the beam and continues to fly the outbound radial.

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BB1-973C

AUTOMATIC PILOT -- NORMAL OPERATION - Automatic ILS approach **(sheet 1)**



① Tune the Captain's navigation receiver to the desired localizer frequency.

Set inbound localizer course on the Captain's course indicator.

Turn NAV SELECTOR switch to the ILS position.

The mode annunciator will indicate that the autopilot is armed for an automatic capture.

②

Establish 45 to 60 degree intercept angle (Maximum of 90 degrees) at least 12 to 15 miles from the transmitter.

NOTE: The approach should be planned so glide slope interception occurs between 1000 and 3000 feet altitude above the runway.

The TURN knob or heading select function may be used. Heading select is used, select desired heading on the Captain's course indicator.

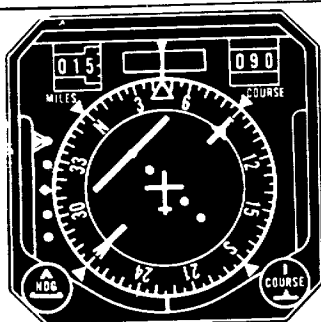
NOTE: The TURN knob must be in the detent position for the autopilot to automatically capture the localizer.

BBI-974C

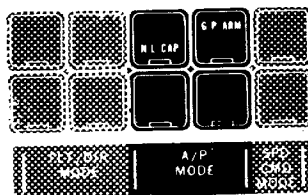
AUTOMATIC PILOT -- NORMAL OPERATION - Automatic ILS approach **(sheet 2)**

3

As the beam edge is reached (approximately 2 dots on the lateral deviation bar), the autopilot will automatically capture and track the localizer beam.



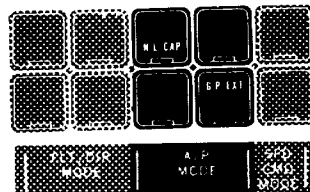
The mode annunciator should indicate that the localizer beam has been captured.



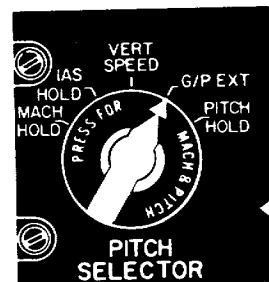
Note:
 If the heading select was utilized to establish the intercept angle, the heading select switch will automatically return to the OFF position.

5

Glide path extension will be initiated by the radio altimeter at approximately 300 feet, or by the marker beacon receiver when the airplane passes over the middle marker. G-P EXT will be displayed on the annunciator to indicate that glide path extension has occurred.



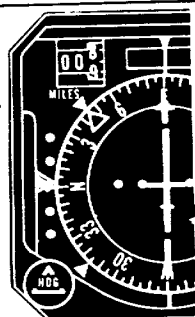
If automatic glide path extension did not occur, rotate the PITCH SELECTOR switch to the G/P EXT position.



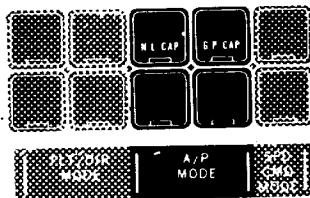
4

Glide path automatically engages when glide slope deviation pointer is approximately 1/3 of a dot or less.

The automatic pilot will automatically capture and track the glide path.



The mode annunciator should indicate that the glide path has been captured.

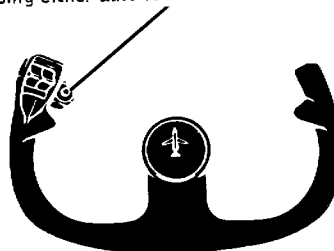


If automatic glide path capture did not occur, push and rotate the NAV SELECTOR switch to the MAN G/P position.



6

Disengage autopilot at automatic approach minimums by pressing either auto release button.



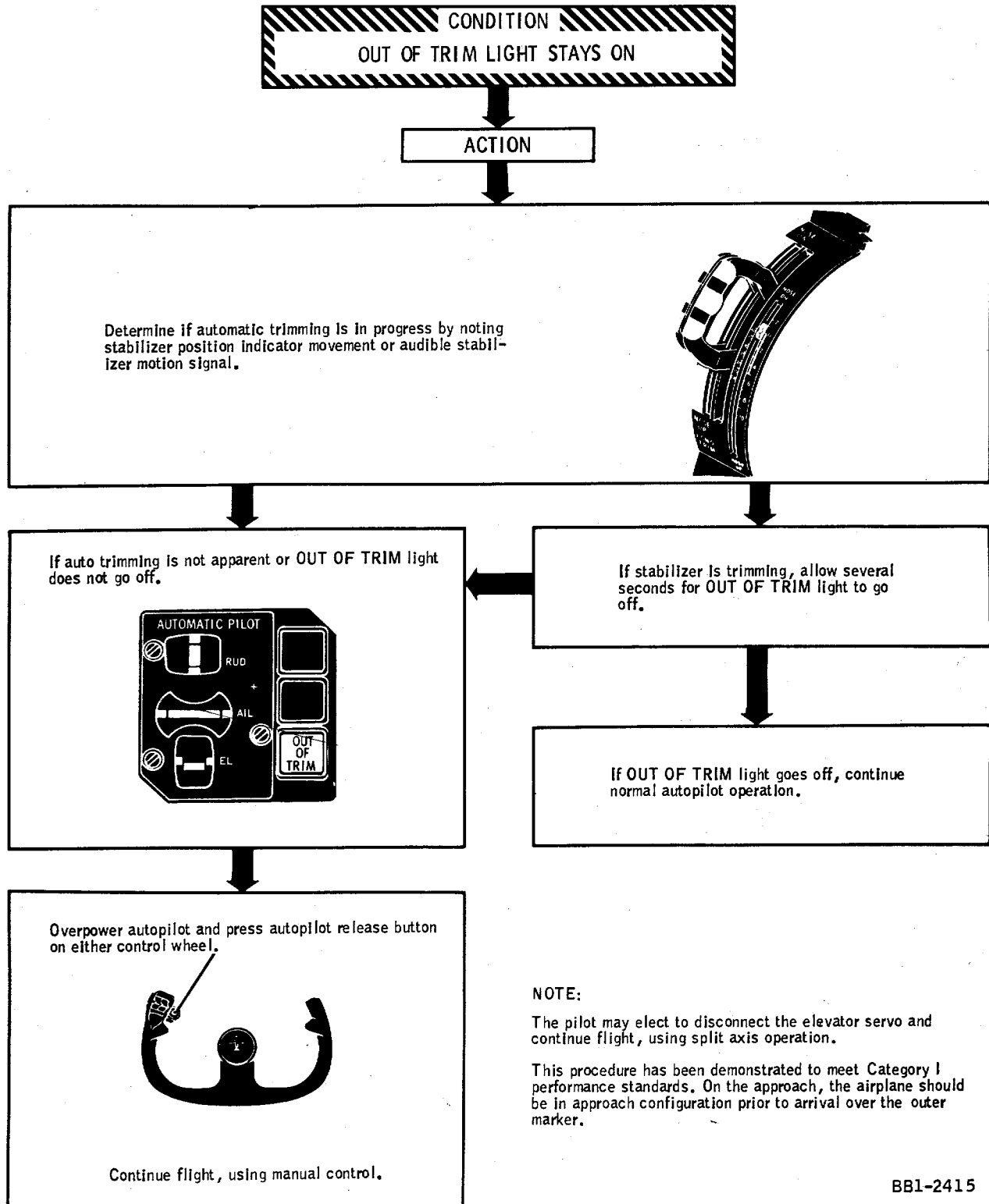
OR

7

On missed approach, disengage autopilot and perform missed approach procedure.

BB1-3169

AFCS -- AUTOMATIC PILOT - ABNORMAL OPERATION



BB1-2415

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SECTION 3
SYSTEM DESCRIPTION

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Section 3

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DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 22, SECTION 3, CHAPTER 1, DATED DEC 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

3-1-35-1 REMOVE CODE 25 AND REPLACE WITH CODE 48. ADDED AC CROSSTIE LOCKOUT AND SPOILER/FLAP EXTENDED LIGHTS TO ANNUNCIATOR PANEL.

3-1-45-1 REVISED PAGE 3 TO REMOVE ESCAPE LINE. LINE NOT APPLICABLE TO ATL AIRPLANES.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
3-1-Eff	66	All	3-1-Eff	66	All
3-1-Cont	66	3 and 4	3-1-Cont	66	3 and 4
3-1-1-3	66	1	3-1-1-3	66	1 and 2
3-1-35-1	25	1 thru 4	3-1-35-1	48	1 thru 4
3-1-45-0	12	1 and 2	3-1-45-0	12	1 and 2
3-1-45-1	59	3 and 4	3-1-45-1	59	3 and 4

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Chapter 1

AIRPLANE GENERAL

GENERAL

INTRODUCTION

This chapter has been prepared to provide the flight crew with general airplane information and specific descriptive information for the following systems, emergency equipment, and passenger facilities:

Lavatories and galleys

Passenger forward entrance door, service door, and stairway

Passenger aft entrance door and stairway

Service interphone and public-address system

Call system

Oxygen systems

Lighting systems

Emergency equipment and exits.

The airplane, powered by two aft-mounted turbofan engines, will operate reliably, efficiently, and economically over route segments of 50 to 1500 miles. The cruise speed is approximately 560 mph at 25,000 feet. Simplicity of design permits efficient operation with a crew of four: a captain, first officer, and two cabin attendants.

Incorporation of an auxiliary power unit (APU) and an integral passenger forward stairway and aft stairway facilitates passenger loading, unloading, and engine starting at airports equipped with minimal ground support equipment.

External service points may be reached without use of ladders or stands, and cargo may be manually loaded from the ground without special equipment, resulting in an approximate turnaround time of 20 to 30 minutes.

FUSELAGE

The fuselage is of all-metal construction consisting of a nose section, a center section, and a tail section. In addition to the flight compartment and the passenger compartment contained in the upper segment, the fuselage contains a nose-gear wheel well, forward accessory compartment, electrical/electronics compartment, forward and aft lower cargo compartment, main-gear wheel well accessory compartment, and an air-conditioning and accessories compartment in the tail section aft of the pressure bulkhead.

All external doors and emergency exits, with the exception of the forward stair well door, are plug-type and pressure sealed. Door operating instructions and emergency markings have either stenciled instructions or instruction plates adjacent to the latches.

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WING GROUP

The wing is all metal, fully cantilevered, sweptback, and mounted through the lower fuselage. The wing incorporates the ailerons, spoilers, trailing edge flaps, leading edge slats, integral fuel tanks, and supporting structure for the main gear.

The slats are a high-lift device located on the leading edge of the wings. The slats are hydraulically actuated to the extend and retract position by pressure from both hydraulic systems. The slat system permits slower takeoff and landing speeds and use of shorter runways.

The aileron and aileron trim tab system provides lateral control and trim of the airplane by aerodynamically operated ailerons. A bus cable system connects the two ailerons; then, as one aileron is moved, aerodynamically or manually, the other aileron moves in the opposite direction. The aileron system provides input to control hydraulically actuated flight spoilers for lateral control assist.

The wing flap system provides mechanical control and hydraulic actuation of the wing flaps, hinged to the trailing edge of each wing. The flaps may be positioned and held from full up to full down to obtain increased drag, to increase the lift of the wing, and to lower the stall speed for landing and takeoff. The wing flap system includes the left and right wing flaps, two hydraulic systems, control cable system, followup cable system, aft movable vane extension cable system, bus cable system, position indicating system, and a takeoff warning system.

The spoiler system consists of hydraulically operated panels on the upper surface of each wing, forward of the

flaps. The spoiler system aids lateral control and also serves as a speedbrake during flight. The panels are also used as ground spoilers after landing.

The vortilon (vortex generating pylon) is installed on the lower surface of each wing and provides airflow control.

TAIL GROUP

The tail group consists of a vertical stabilizer, a horizontal stabilizer, two elevators, and a rudder. The vertical stabilizer is mounted on the aft fuselage, and the horizontal stabilizer is mounted on the top of the vertical stabilizer. The rudder and elevators are mounted on the vertical and horizontal stabilizers, respectively.

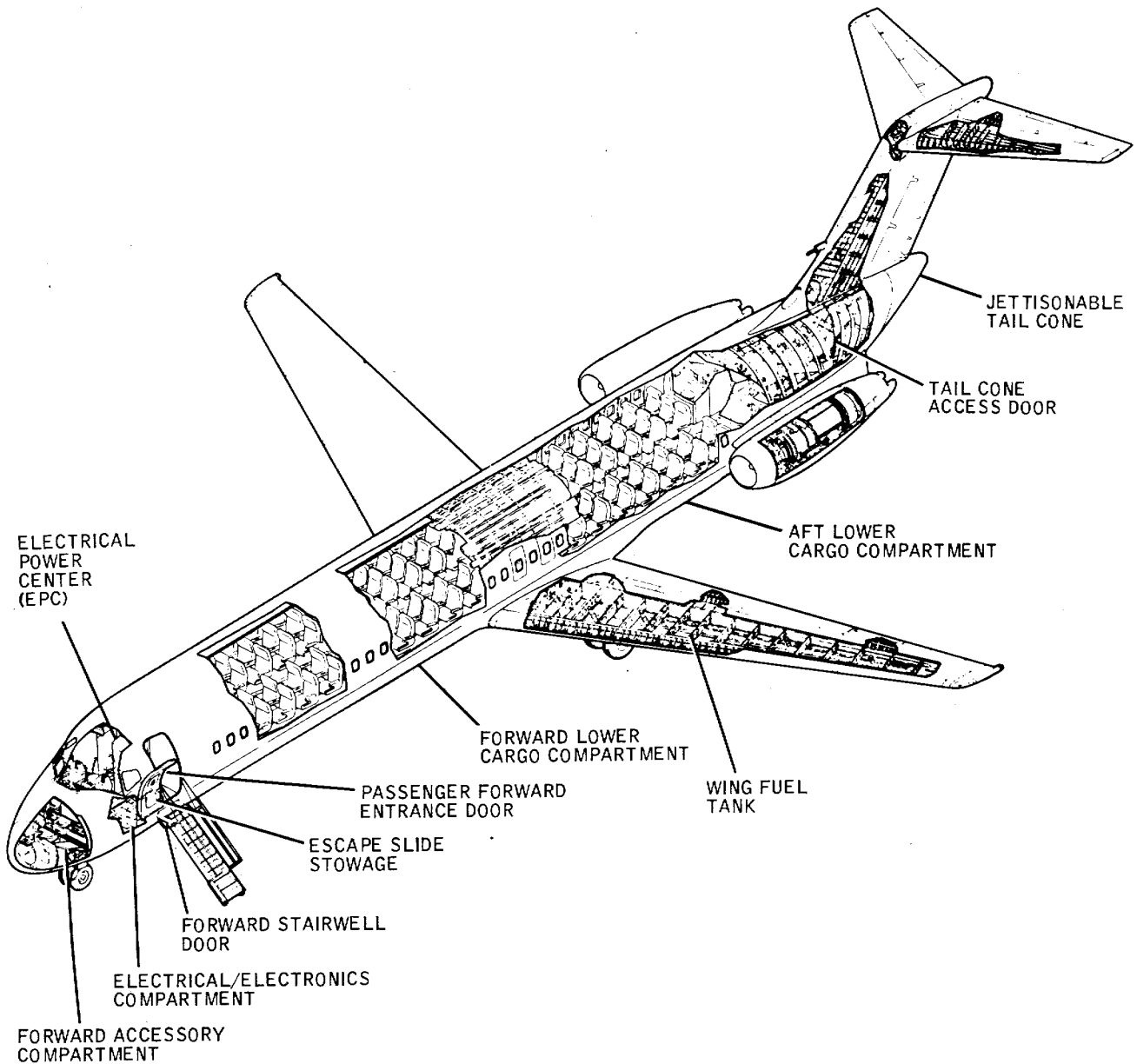
The vertical stabilizer is fully cantilevered and sweptback. A scoop for the air conditioning system is located on the lower leading edge section and is heated as required for anti-icing.

The longitudinal trim control system is an electrically actuated system that controls the movement of the horizontal stabilizer to provide longitudinal trim. The system is controlled electrically from the flight compartment. The longitudinal trim control system consists of a primary system and an alternate system. The leading edge of the horizontal stabilizer is heated as required for deicing.

The elevators are aerodynamically positioned by mechanically controlled tabs, to control the airplane longitudinally during normal flight. In addition, a power boost system (hydraulic augmentation) is provided to position the elevators to the down

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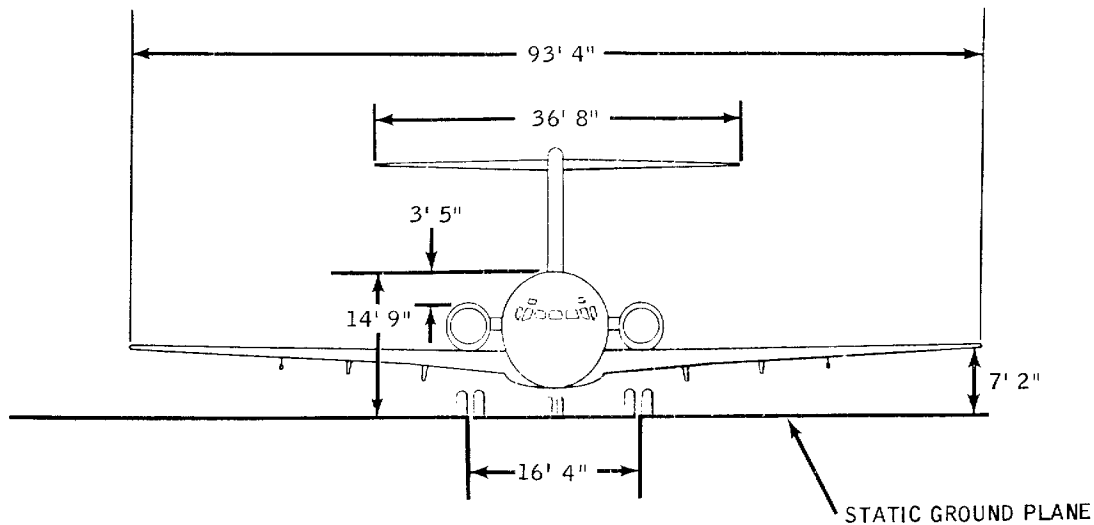
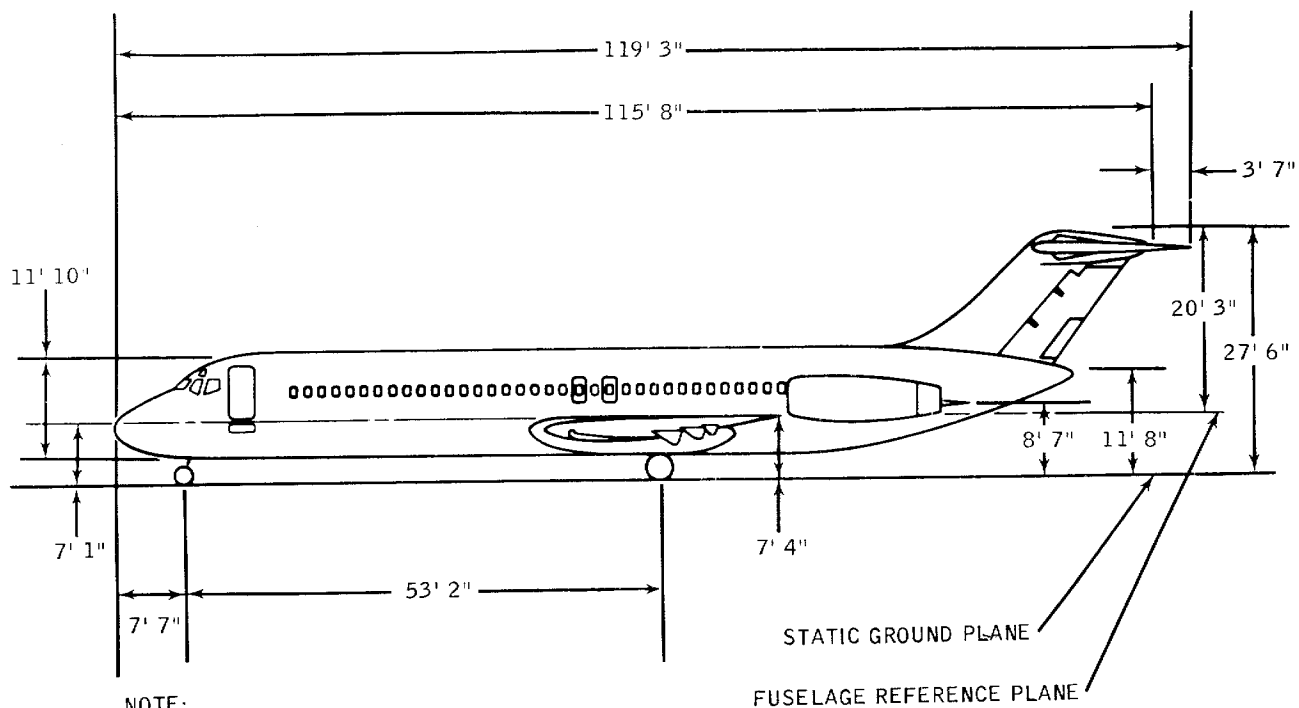
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AIRPLANE GENERAL -- DIMENSIONS



NOTE:
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position only if 10 degrees or more of up-tab is required.

The rudder is operated hydraulically; however, if hydraulic pressure drops below operating pressure, the rudder system will automatically revert to manual operation. Manual operation of the rudder can also be selected by placing the hydraulic power shutoff valve control lever in the off position.

TAIL CONE

The tail cone is attached to the aft end of the fuselage and is jettisonable. The tail cone, when jettisoned, provides an emergency exit accessible from the passenger compartment through the aft passenger entrance door and with the aft stairway ceiling lowered to form a walkway. An access door is provided in the lower forward section, for access to the aft accessory compartment from outside the airplane without jettisoning the tail cone. The tail cone is secured to the fuselage by four spring-loaded latches. The latches are actuated by a cable attached to an arm on each latch, and to release handles (one inside and one outside) on the left side of the aft accessory compartment just forward of the tail cone.

ENGINES

The airplane is powered by two Pratt and Whitney JT8D axial-flow turbofan engines. In addition to powering the airplane, the engines supply pneumatic power for pressurization, air conditioning, anti-icing, and deicing. The engines are protected by a fire detection and fire extinguishing system.

AUXILIARY POWER UNIT (APU)

The APU is a gas turbine engine and compressor that can supply pneumatic

and electrical power for ground operation and electrical power while in flight. The APU is located in the aft accessory compartment and is surrounded by a fireproof enclosure. The unit is protected by a fire extinguishing system, operated either from the flight compartment or the external ground control panel located in the left aft fuselage.

PNEUMATICS

The pneumatic system, controlled from the flight compartment, supplies conditioned air for cabin pressurization, air conditioning, and ice protection. Engine bleed air is used to supply the system. In addition to engine bleed air, an external ground connector is installed to permit connection of a ground pneumatic power source for engine starting. Also, a separate external ground connector is installed to allow connection of a ground source to supply preconditioned air to the airplane during ground operations if required.

ICE AND RAIN PROTECTIONS SYSTEMS

Ice and rain protection is provided for various areas and components of the airplane by the following systems:

Airfoil leading edge anti-icing and deicing system

Engine and engine nose cowl anti-icing system

Windshield and window anti-icing and defogging system

Pitot tube, static ports, and stall warning lift transducer anti-icing system

Windshield wipers

Rain repellent system.

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The anti-icing system prevents an accumulation of ice, and the deicing system removes accumulated ice. The leading edge of the wing is anti-iced, and the horizontal stabilizer is deiced. The ram air scoop, engine, and engine nose cowl are continuously anti-iced when the ice protection switches are on. Hot air from the pneumatic system is used for anti-icing and deicing the wing, horizontal stabilizer, ram air scoop, engine, and engine nose cowl. An electrical anti-icing system is provided for the windshields, a pitot tubes, static ports, and the stall warning lift transducer. Defogging of the windshield and windows is also accomplished electrically.

AIR CONDITIONING AND PRESSURIZATION

Cabin pressurization and conditioned air ventilation of the flight and passenger compartments are provided to maintain crew and passenger comfort. Pressurized, conditioned air is delivered through two independent air-conditioning systems designed for parallel operation but capable of independent operation. Engine bleed air is the primary source of air and energy for the air-conditioning and pressurization system. In addition, ram air may be supplied to the distribution system through the coolant air scoop in the dorsal fin.

The forward and aft lower cargo compartments and cargo floor are maintained above freezing by heating provisions.

Separate, automatic temperature control systems, each with a range of 65° to 80°F, are installed to regulate flight and passenger compartment temperature to the desired settings.

HYDRAULICS

Hydraulic power is provided by two separate, hydraulically closed circuit systems identified as the left system and the right system. The right system provides hydraulic power to the rudder, aft passenger entrance stairway, and the landing gear actuating subsystem; the left system provides hydraulic power to the elevator augmentor subsystem. All other hydraulic subsystems are served by both systems through separate valves and actuators. The primary source of hydraulic power is supplied by two engine-driven pumps and one electrically driven pump.

ELECTRICAL

The airplane is equipped with an ac and dc electrical power system. The systems are divided into two independent systems designated left and right. Two engine-driven ac generators, one on each engine, are normally the primary source of ac power. In the event that engine-driven ac generators fail in flight, or when external power is not available on the ground, auxiliary electrical power may be supplied by an auxiliary power unit driven generator installed in the tail section. The 28-volt dc electrical power is normally supplied by four transformer-rectifiers installed in the forward accessory compartment. These units are supplied 115/200-volt ac power from the airplane generators or from external power source. Battery power is supplied by two 14-volt, nickel-cadmium batteries connected in series.

FUEL SYSTEM

The fuel system has three integral tanks; one in each wing and one in the wing center section. There are six subsystems: fuel storage, fuel

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tank vent, fuel tank fill, engine fuel feed, APU fuel feed, and fuel quantity indicating. The tanks are normally filled through a single-point, pressure-fueling adapter, located approximately midspan of the right wing leading edge. The pressure-fueling control panel is located just inboard of this adapter. A manual defueling valve is located just inboard of the pressure-fueling control panel to permit defueling through the pressure-fueling adapter.

An overwing gravity fueling adapter is located on top of the outboard section of each wing tank.

LANDING GEAR

The airplane has a fully retractable tricycle landing gear. The nose gear assembly is a dual-wheel, steerable assembly with an oleo strut mounted in the forward, lower section of the fuselage. The main gear assembly consists of two oleo struts with a set of dual wheels and brakes attached to each strut. The struts are mounted in the wing root area, aft of the right and left wing rear spar. Each wheel well is completely enclosed by doors when the landing gear is retracted.

INSTRUMENTATION AND NAVIGATION

Instrumentation and navigation equipment is provided to assist the flight

crew in guiding the airplane from one airport to another, and to provide ample information to permit limited visibility flying, approach, and landing. Information provided by the systems includes speed, altitude, attitude, direction, and radio and radar guidance.

Pitot and static pressures are connected to instruments to indicate the airspeed, vertical speed, and altitude of the airplane.

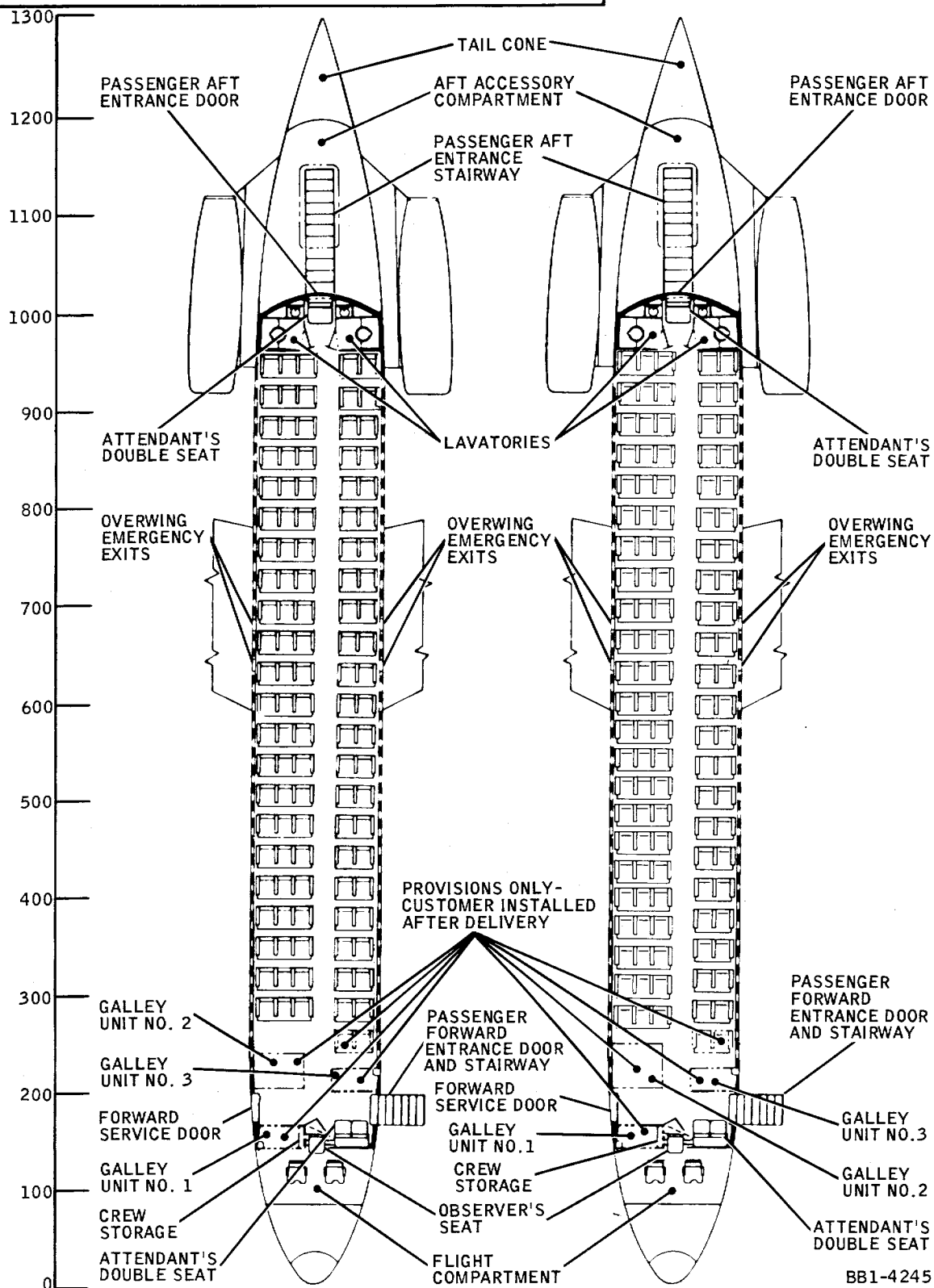
Attitude and direction information uses magnetic, gyroscopic, and inertia forces. These forces are used with gyros, compasses, amplifiers, and servos connected to instruments, to indicate attitude and direction.

Radio guidance depends on the reception of electromagnetic radiation containing navigation information. Radio navigation aids the flight crew in navigating to a selected airport.

Radar guidance requires the transmission of an electromagnetic signal and depends on the reflected signal, or a reinforced, reflected signal. Radar navigation aids the flight crew by providing weather mapping, drift angle, identification, and distance of the airplane from the reinforced signal transmitter.

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AIRPLANE GENERAL -- INTERIOR ARRANGEMENT



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LONG BEACH, CALIF., U. S. A.

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FLIGHT COMPARTMENT

The flight compartment is designed for operation by a two-man flight crew and provides maximum comfort and convenience to enable efficient crew functioning. The two-man capability is made possible by locating all essential controls where they are accessible to either man, and locating all visible indicators and legends where they may be viewed by either man.

The compartment provides flight stations for the captain and first officer. The seats are track mounted and are fully adjustable in fore-and-aft, up-and-down, and reclining planes, with positive locking in any position. In addition, a folding seat is provided for a flight observer. All flight compartment seats are provided with safety belts and shoulder harnesses. The captain's, first officer's, center, and upper instrument panels, overhead panel, left and right consoles, and control pedestal mount the instrument and system control panels. Indicating and control components pertaining to an individual system are usually grouped on the panels, in adjoining positions.

All flight, engine, and miscellaneous instruments have white dial markings on black faces and are readable during daylight without artificial lighting. The airspeed indicators are graduated in knots or Mach number, as applicable. Instrument limitations markings are located on the dials of all instruments requiring such markings.

The flight compartment contains four different types of windows: a center windshield and two side windshields, a clearview window on either side, an aft window on either side, and two upper (eyebrow) windows immediately above the clearview windows.

The center windshield and two side windshields are electrically heated for anti-icing, antifogging, and added bird impact resistance.

The clearview windows are openable to provide forward vision when the flight compartment is not pressurized, and also provide an emergency exit using the escape lines stowed directly above them. These windows are electrically heated for antifogging, but not for anti-icing. The eyebrow windows are electrically heated for antifogging. The two windows located aft of the clearview windows are not electrically heated.

A fire extinguisher containing CO₂ is secured to the bulkhead behind the first officer's station in quick-release-type brackets.

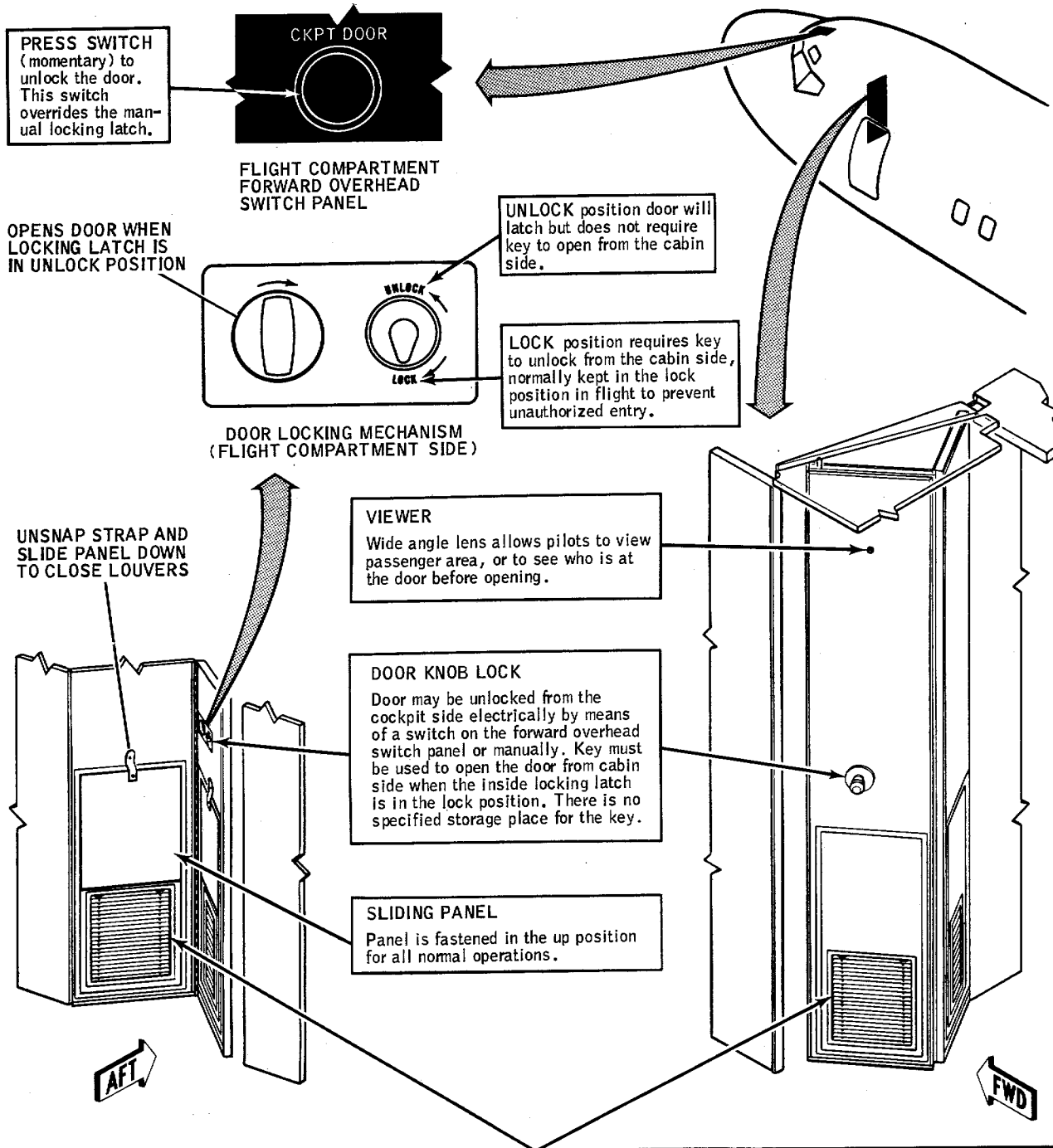
An emergency fire axe is secured to the bulkhead behind the captain's station.

The flight compartment door incorporates an electrical lock operated by a pushbutton switch located on the forward overhead switch panel. In the event of lock malfunction or power loss, the door may be opened from the flight compartment by turning the handle and, from the passenger compartment, by a key. The door automatically locks when closed. A wide-angle viewer in the door provides crew members with a view of the passenger compartment. Louvered panels in the door allow air pressure to balance between flight compartment and passenger compartment in the event of rapid decompression during pressurized conditions. The louvers may be closed during smoke conditions.

A stowage locker for crew baggage and coats is provided as an integral part of the forward galley unit. This stowage is opened toward the flight compartment and is fitted with a luggage retaining webgate.

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AIRPLANE GENERAL -- FLIGHT COMPARTMENT DOOR



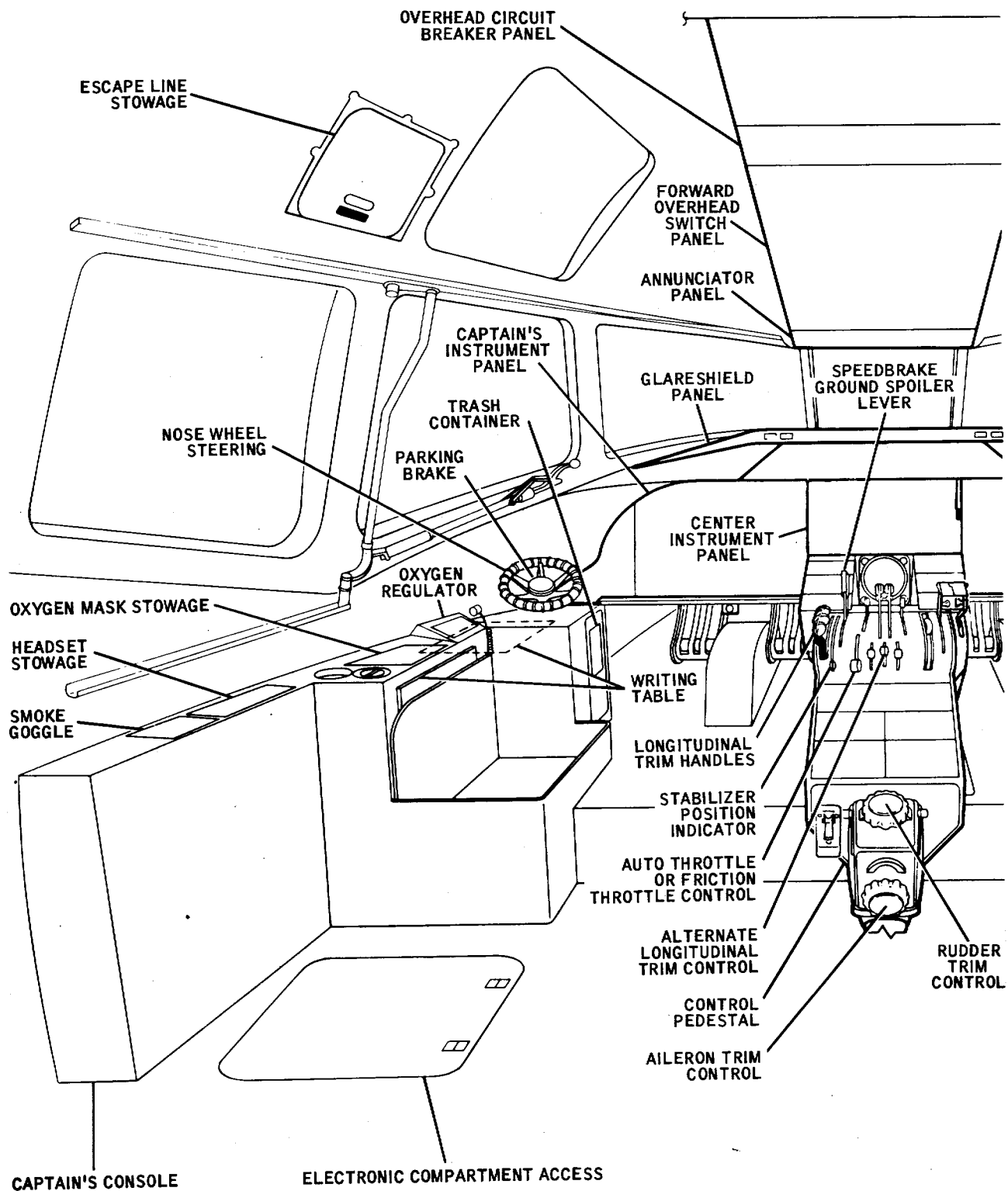
DOOR LOUVERS

Used for equalization of pressure between flight compartment and cabin. Louvers may be closed during smoke conditions by lowering sliding panel on flight compartment side of door. Bottom door panel is designed to blow open towards the flight compartment if rapid decompression occurs in flight compartment.

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AIRPLANE GENERAL -- FLIGHT COMPARTMENT ARRANGEMENT (sheet 1)



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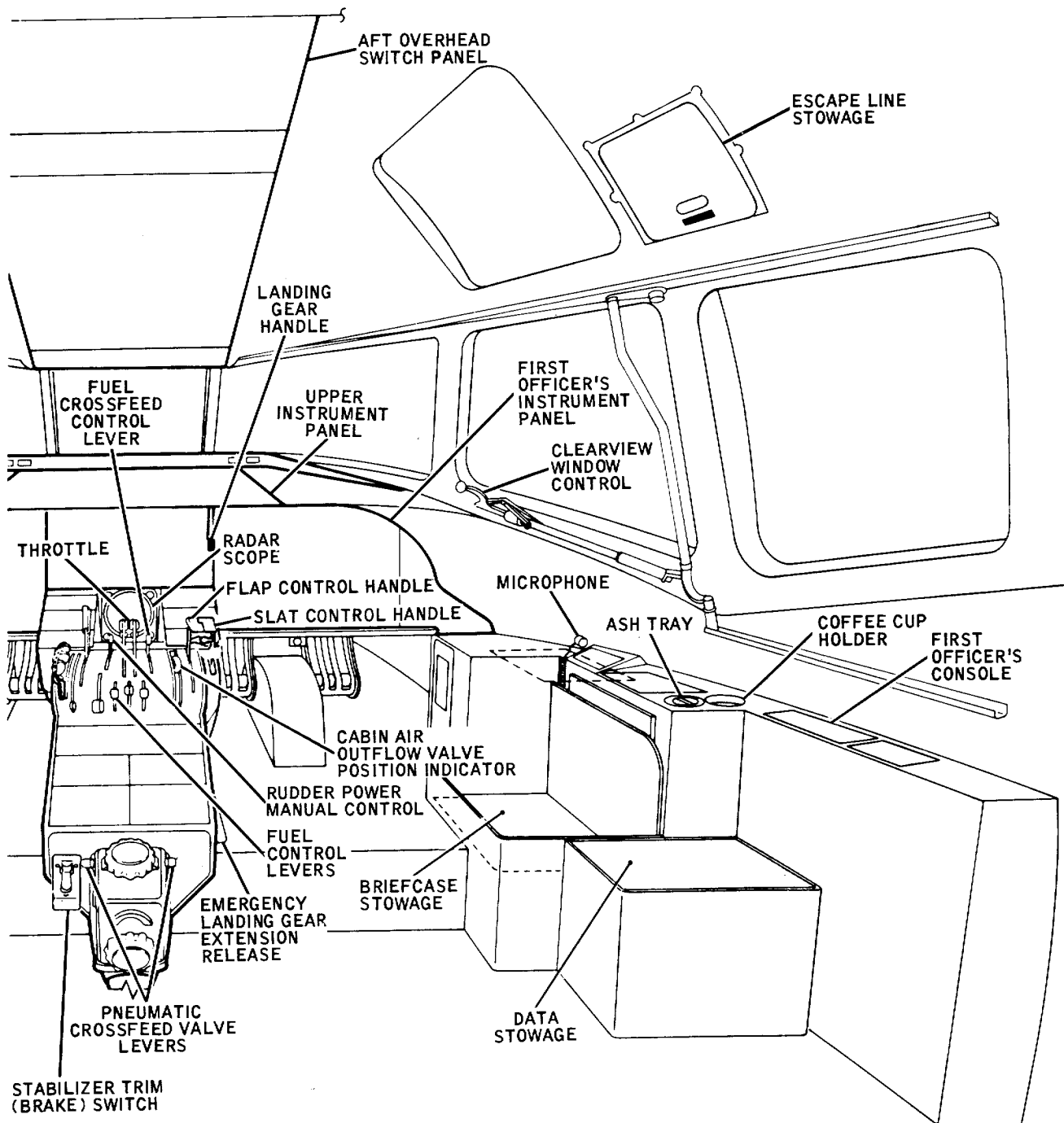
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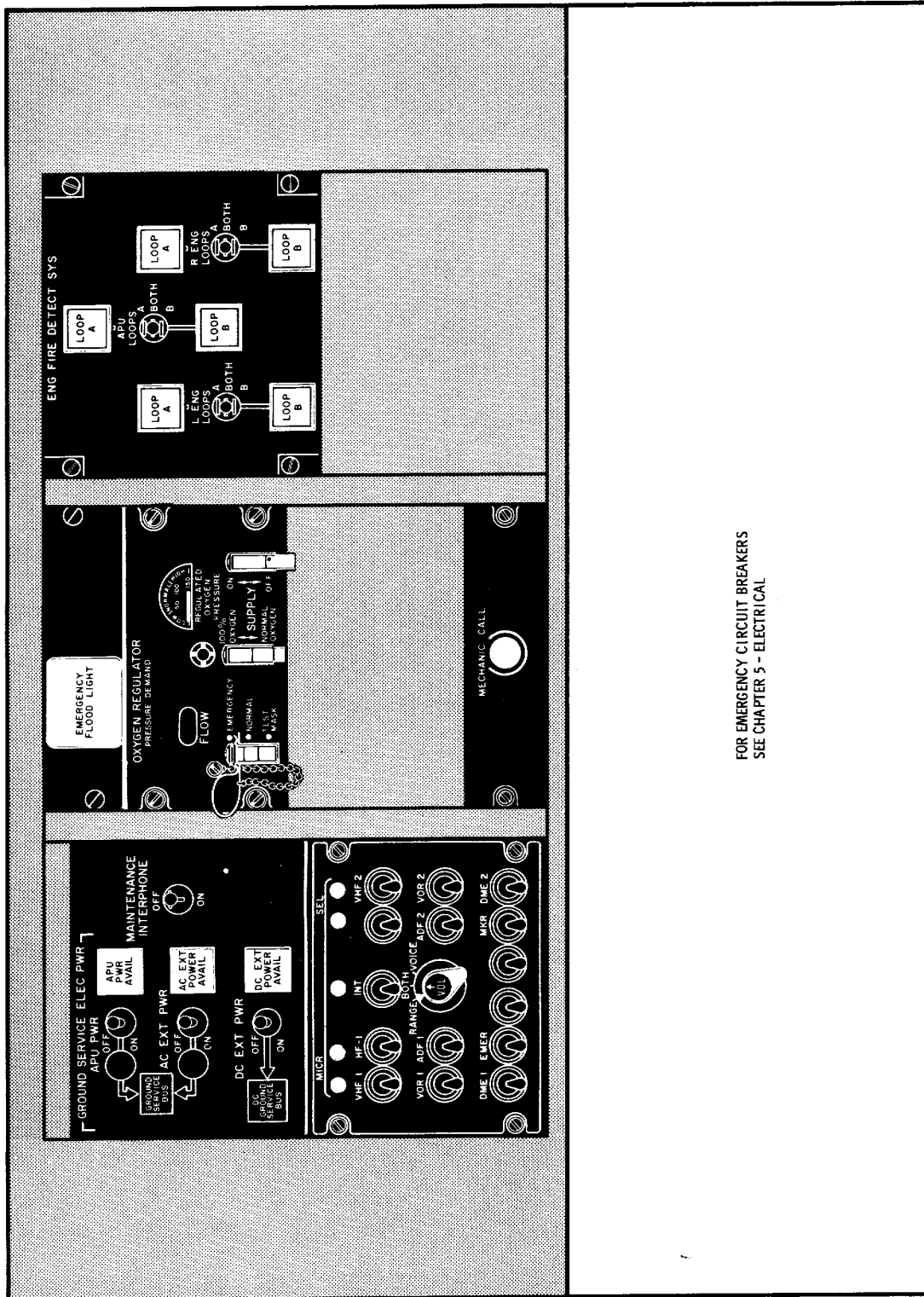
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AIRPLANE GENERAL -- FLIGHT COMPARTMENT ARRANGEMENT (sheet 2)



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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Aft overhead switch panel



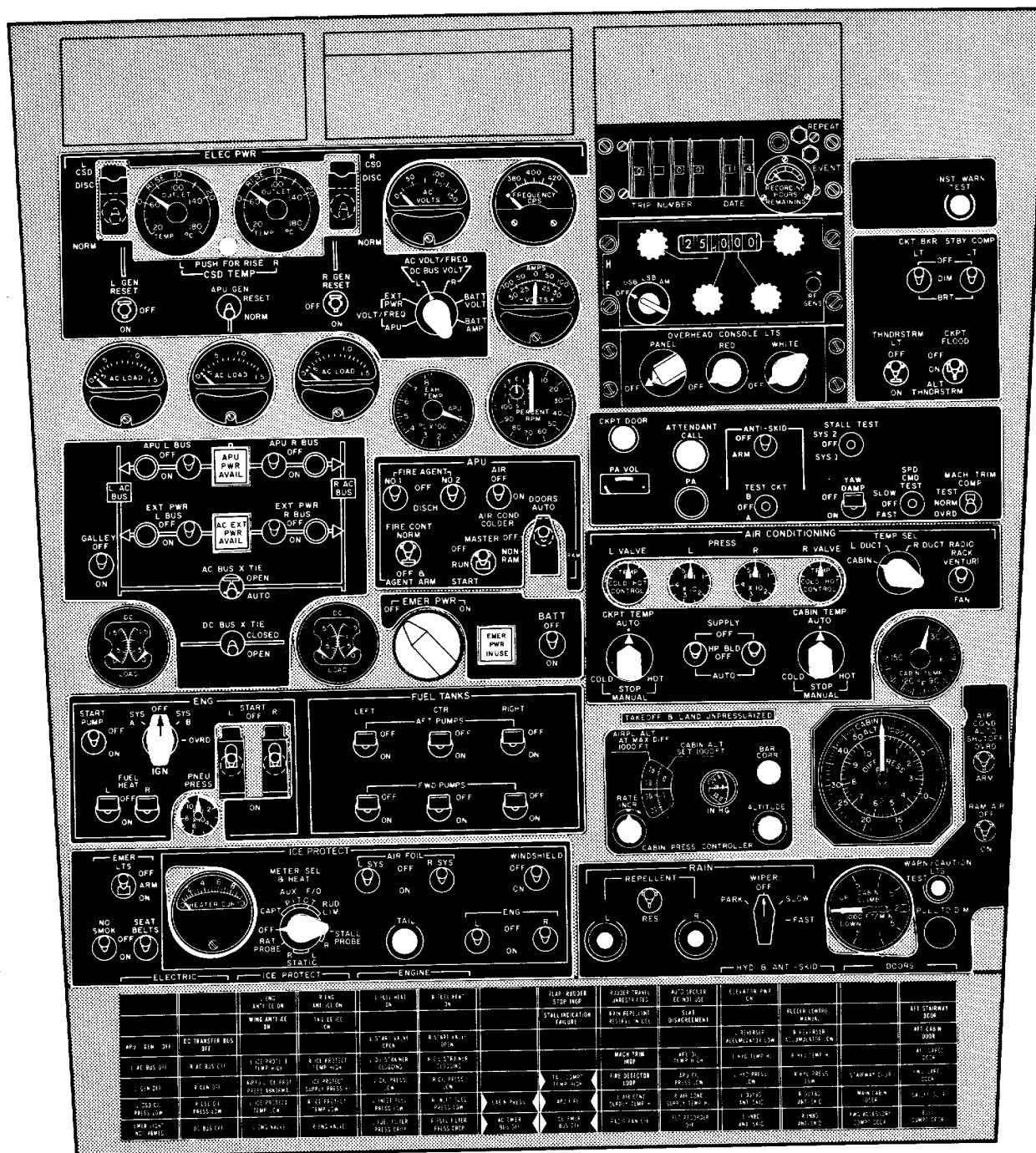
FOR EMERGENCY CIRCUIT BREAKERS
 SEE CHAPTER 5 - ELECTRICAL

BB1-4280

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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Forward overhead switch panel



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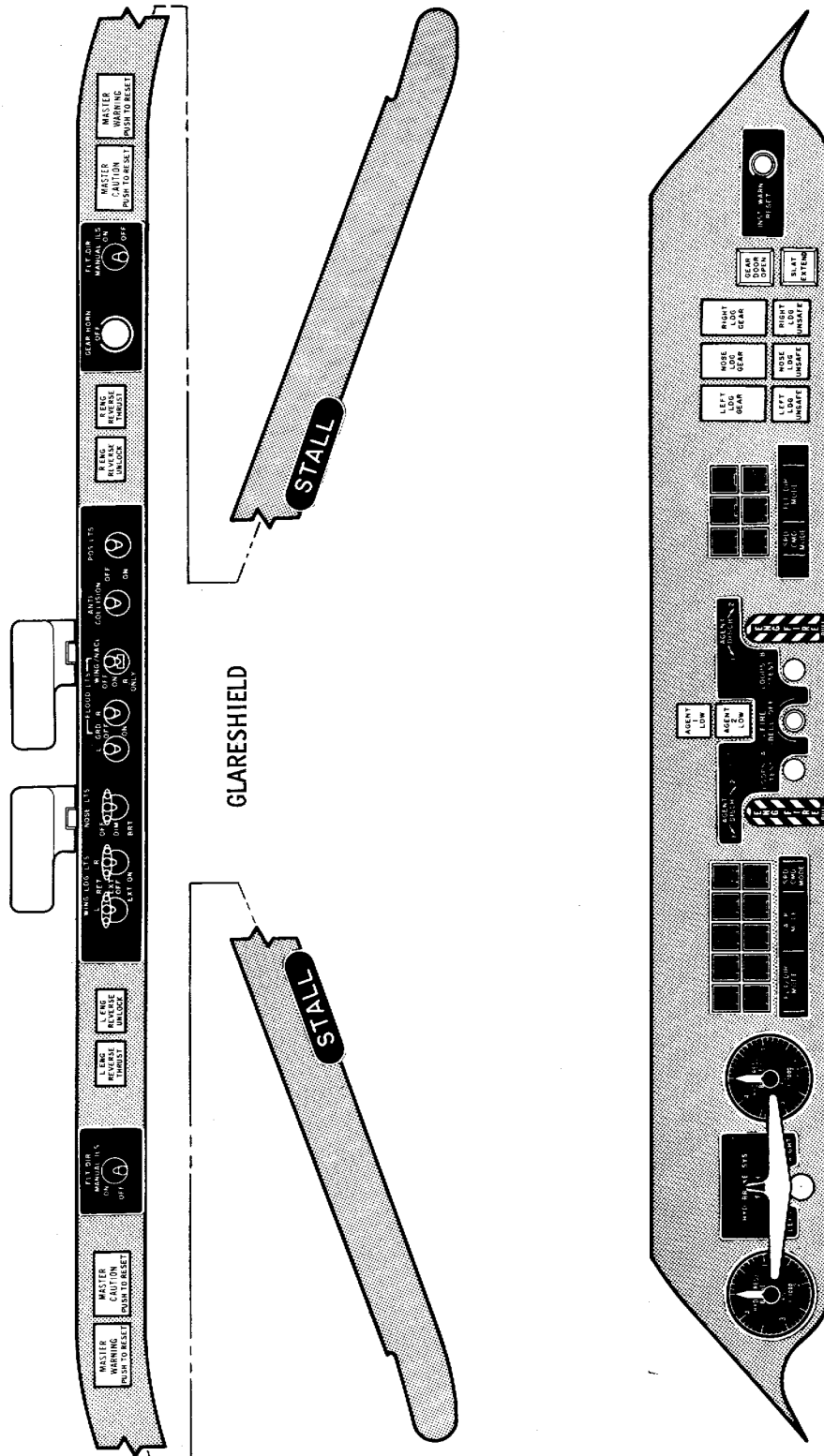
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FORWARD OVERHEAD SWITCH PANEL

The following changes are effective on airplane serial 47457 and subsequent airplanes: An AC CROSSTIE LOCKOUT light has been added to the ELECTRIC portion of the annunciator panel immediately to the left of L ENG ANTI-ICE ON light. Refer to Section 3-5-5-6, ELECTRICAL - WARNING & CAUTION LIGHTS for detail description. A SPOILER/FLAP EXTENDED light has been added to the HYD & ANTI-SKID portion of the annunciator panel directly above the RUDDER CONTROL MANUAL light. Refer to Section 3-20-30-0, FLIGHT CONTROLS - COCKPIT CONTROLS & INDICATORS for detail description. A different type switch (3 position) is used for STALL TEST. Refer to Section 3-20-25-0, FLIGHT CONTROLS for detail description.

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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Glareshield & upper instrument panel



UPPER INSTRUMENT PANEL

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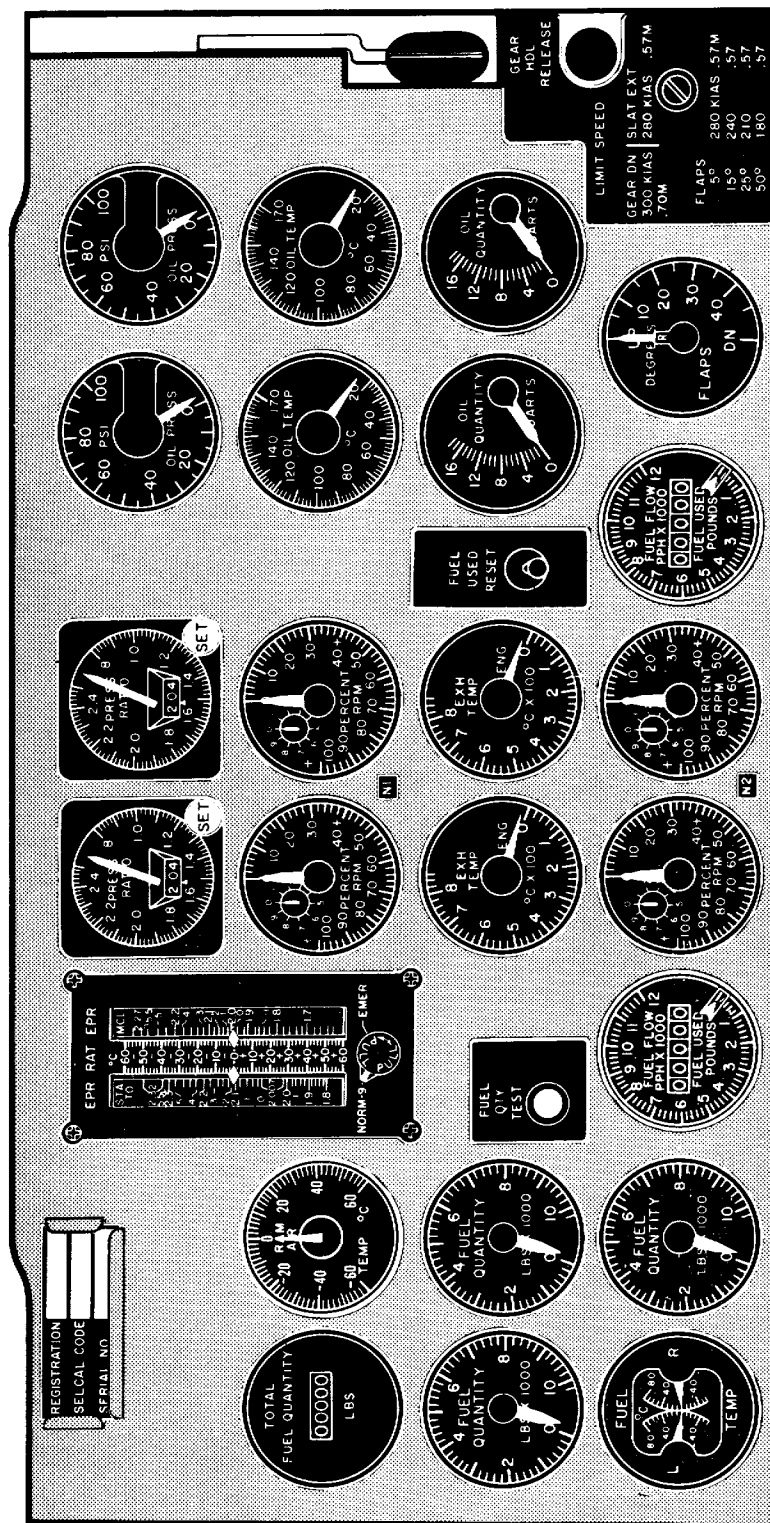
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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Center instrument panel



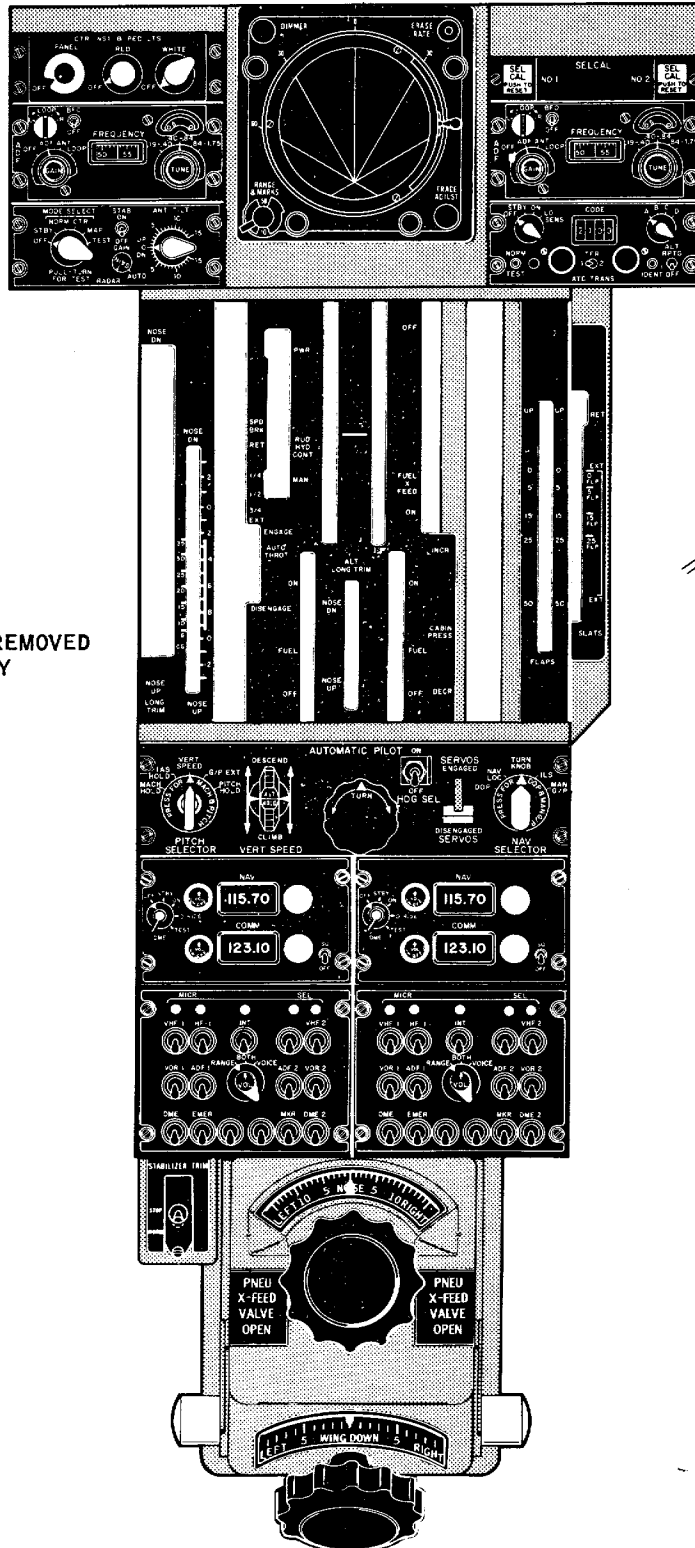
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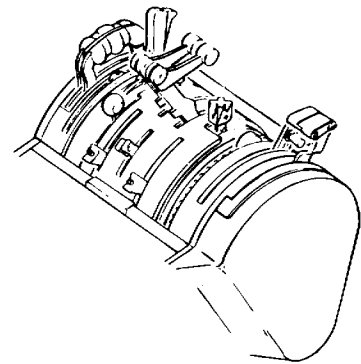
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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Control pedestal



NOTE:
 CONTROLS REMOVED
 FOR CLARITY

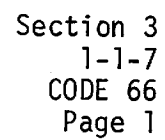


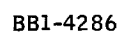
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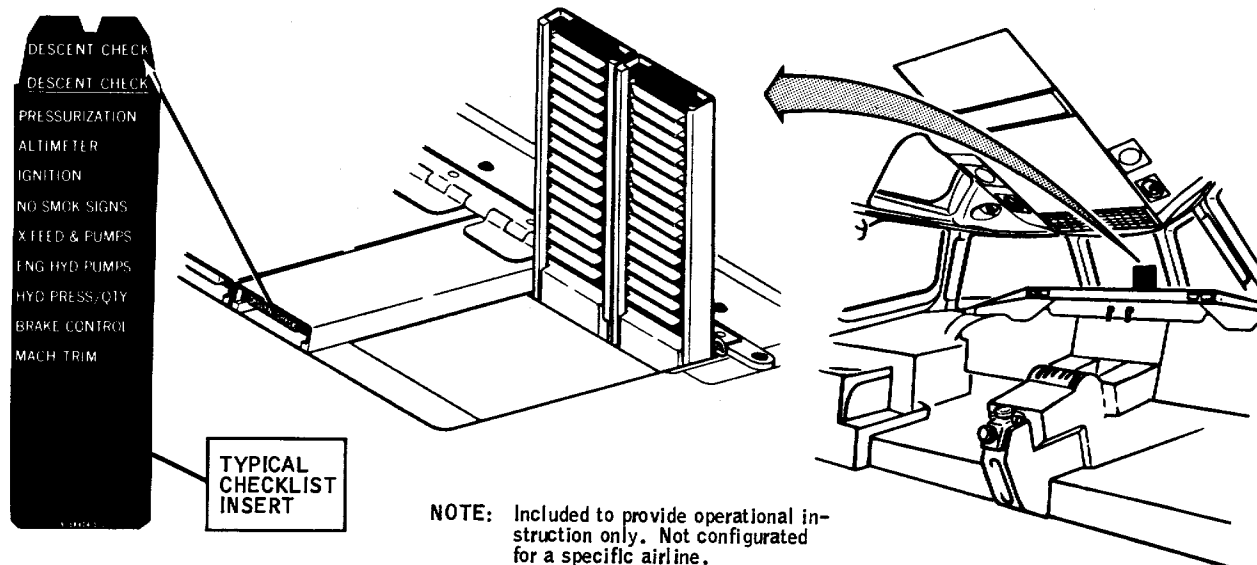
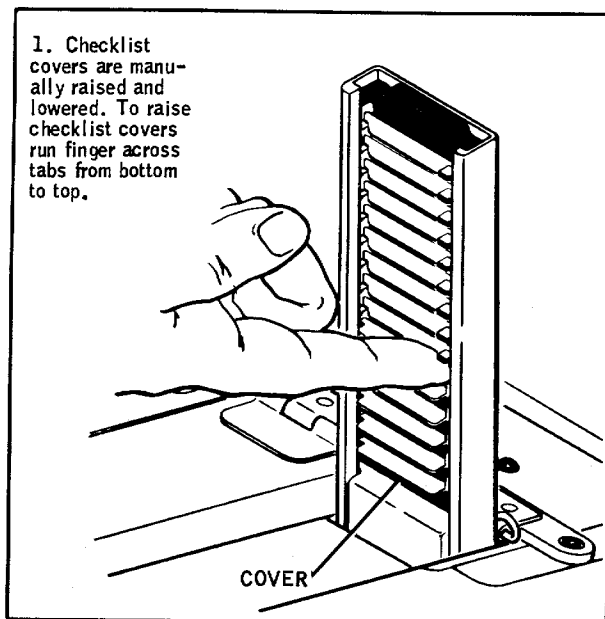
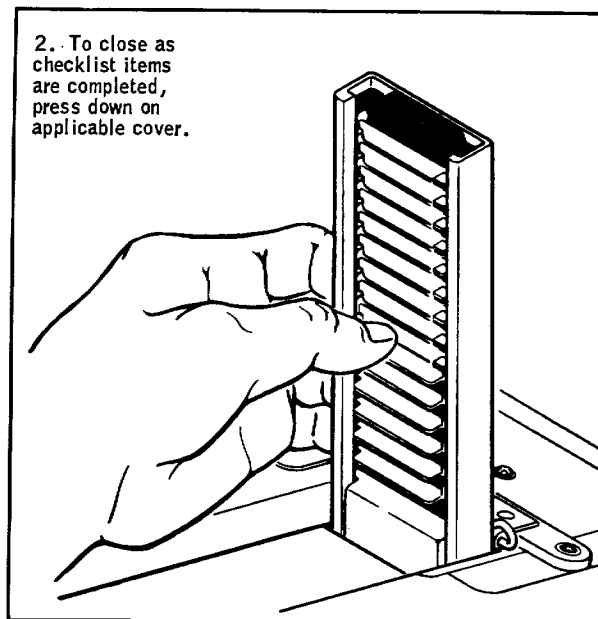
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AIRPLANE GENERAL -- FLIGHT COMPARTMENT - Captain's instrument panel





AIRPLANE GENERAL -- GLARESHIELD CHECKLIST INSTALLATION



3. On and off control of checklist lighting is automatic. Raising a checklist section to the extended position turns on lights for that particular section. Lighting intensity is determined by setting of CTR INST & PED LTS control. Checklist inserts are photo negatives and may be removed and replaced with revised inserts as required.

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PASSENGER COMPARTMENT

GENERAL

The passenger compartment arrangement, interior furnishings, and equipment are designed to provide a high level of comfort and versatility in seating arrangements.

DOOR DIMENSIONS

Approximate door dimensions are as follows:

Passenger forward entrance
door.....34x72 inches
Height to doorsill.....86 inches
Forward service door...27x48 inches
Height to doorsill.....86 inches
Overwing emergency
exit.....20x36 inches
Passenger aft entrance
door.....28x72 inches

CABIN ATTENDANTS' FACILITIES

A cabin attendant's seat is mounted to the partition at the left of the flight compartment door in the entry-way area. An attendant's double seat is installed on the passenger aft entrance door. The cabin attendants' control panels are installed adjacent to each seat, and oxygen mask containers are installed in the ceiling over each seat.

PASSENGER UTILITIES

Passenger utilities, consisting of reading lights, cold air outlets, attendant call buttons, and oxygen masks, are grouped on panels mounted on the overhead stowage rack lower surface.

PASSENGER SEATS

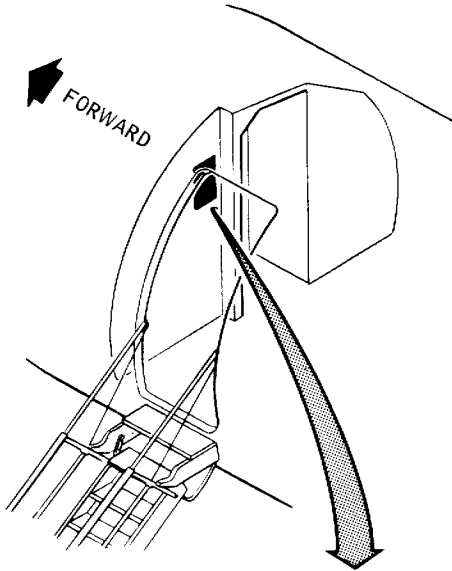
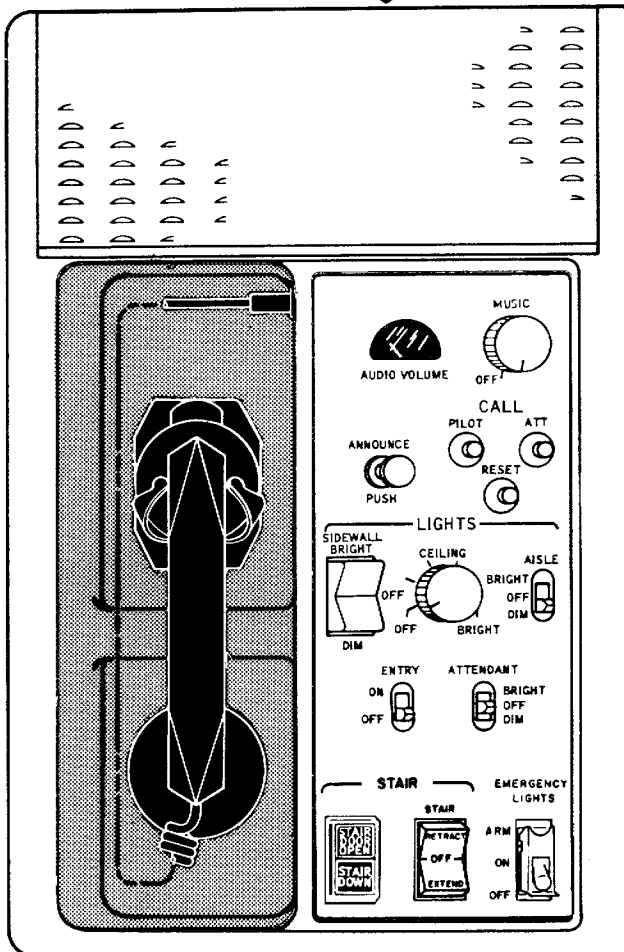
Each seat is equipped with a seat belt, ashtray, folding utility tray, and literature stowage pocket.

Seat backs are adjustable in the recline position by means of a push-button control in the armrest. All armrests, except the one adjacent to the aisle, may be folded up, flush with the seat back, for improved emergency exit. The seat bottom cushions are equipped with hand straps to facilitate use as flotation gear.

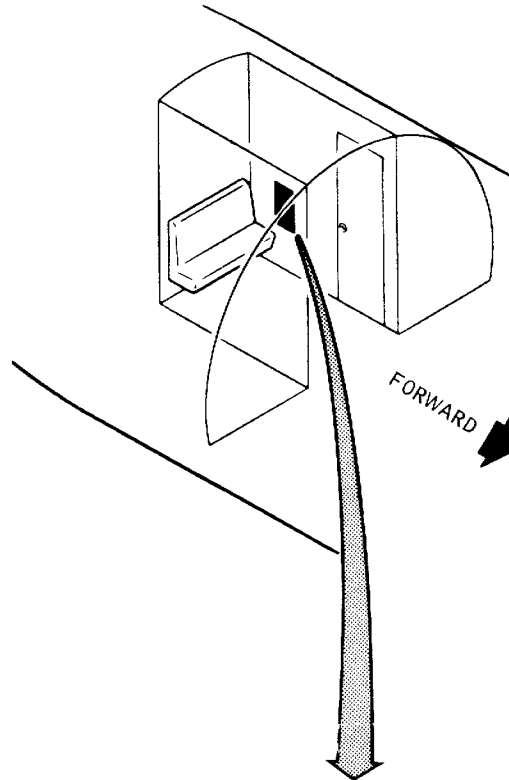
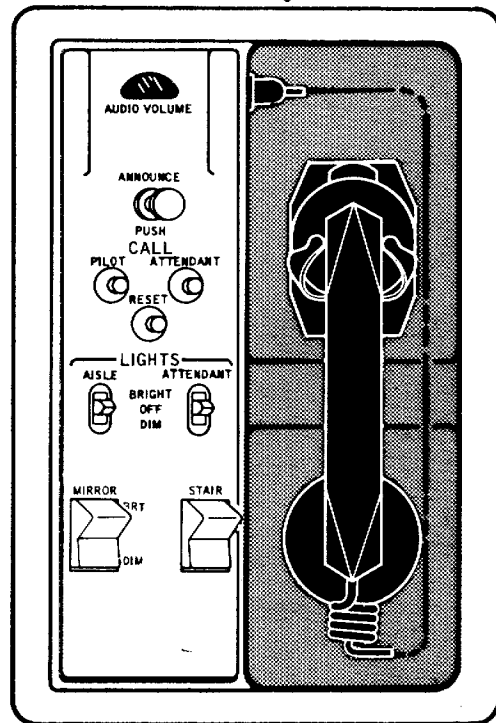
The seats may be returned to the normal upright position by manually exerting approximately 10 pounds of force to the seat back. Twenty-five pounds of force forward on the seat back will override the normal upright position and allow the seat back to fold down flush to the seat cushion.

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AIRPLANE GENERAL -- FORWARD & AFT CABIN ATTENDANTS' PANELS



FORWARD ATTENDANT'S PANEL



AFT ATTENDANT'S PANEL BB1-4075

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GALLEYS

Three galley units are installed in the forward end of the passenger compartment.

Galley unit No. 1 is located forward of the forward service door on the right side of the airplane. It contains a work counter with light, coffee makers, electrical control panel, oven, and refrigerator. A small crew's stowage locker on the inboard side is an integral part of the unit.

Galley unit No. 2 is located aft of the forward service door on the right side of the airplane. It contains an electric oven and control panel, a work counter with lights, and the necessary stowage space for meal carriers and miscellaneous galley equipment.

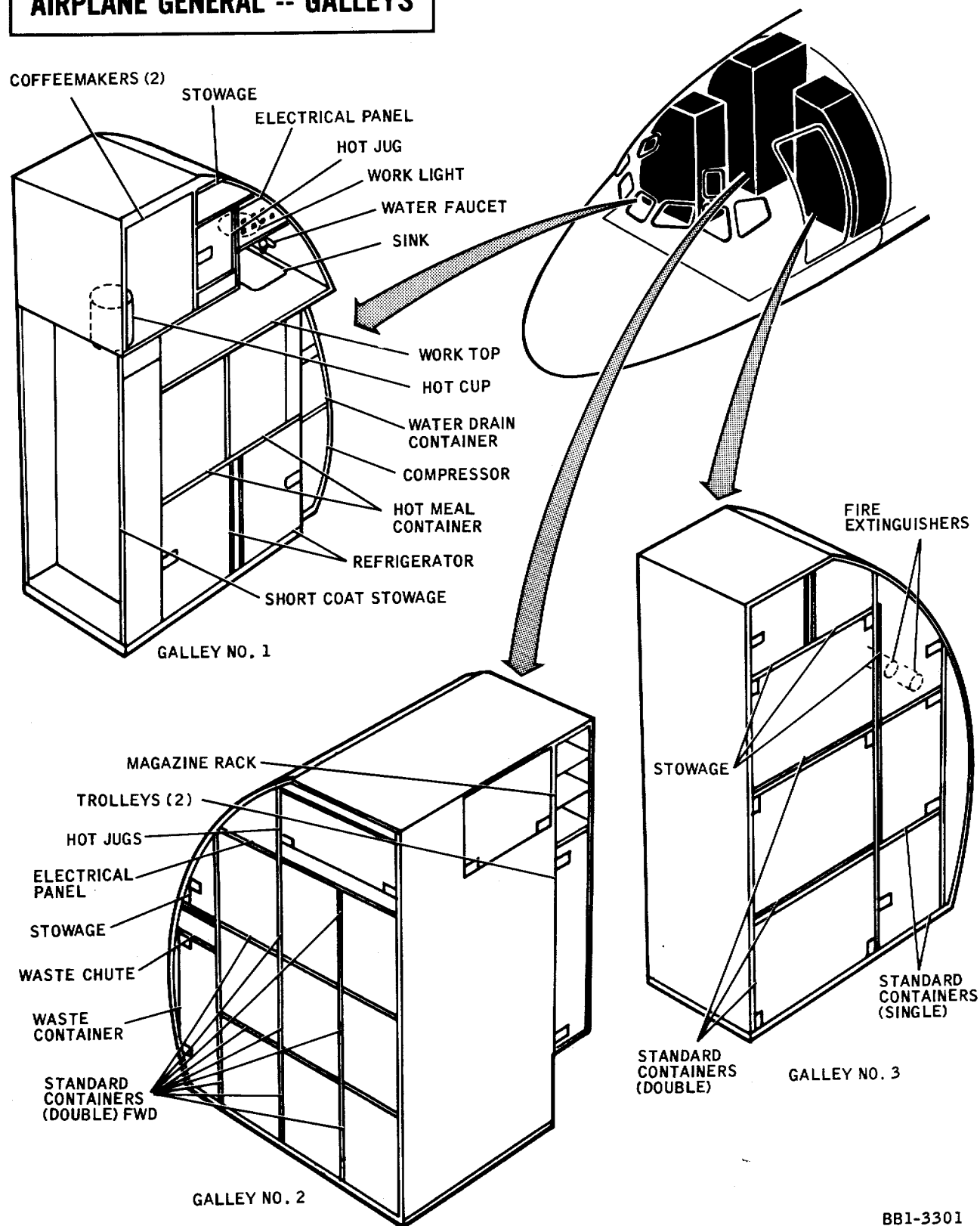
Galley unit No. 3 is located aft of the forward passenger entrance door on the left side of the airplane. It contains stowage for miscellaneous galley equipment.

Waste water from the galleys is drained into a removable container within the galley.

| A 37-gallon pressurized, potable water tank supplies water to the galley. Water level in the tank is indicated by lights in a service panel, located on the forward lower right side of the fuselage surface immediately forward of the wing. (See illustration titled AIRPLANE GENERAL--LAVATORY, for water service panel.) In addition, the service panel contains water fill and overflow fittings to service the system, a water system drain valve, and an automatic heater to prevent freezing during cold weather operation. The air conditioning system must be

operating to provide air flow for pressurizing the water system. Pressure is supplied by engine bleed air, APU, or pneumatic ground cart.

AIRPLANE GENERAL -- GALLEYS



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LAVATORY

The lavatory includes a razor outlet, oxygen masks, lighted RETURN TO CABIN sign actuated from the flight compartment, and passenger call switch. A lavatory OCCUPIED sign, visible from the passenger seats, is located adjacent to the lavatory. The lavatory OCCUPIED sign is also mounted on the lavatory door, actuated from VACANT to OCCUPIED by a placarded locking bar on the inside of the door.

(See AIRPLANE GENERAL -- INTERIOR ARRANGEMENT for lavatory locations.)

A switch, located above the lavatory, is actuated when the door is closed and automatically turns the mirror lights from dim to bright. A switch in the door lock turns on the OCCUPIED sign on the bulkhead outside the occupied lavatory.

NOTE: In an emergency the lavatory door may be unlocked from the outside by inserting a screwdriver or some sharp instrument into a slot on the OCCUPIED sign on the door latch and sliding the sign to the vacant position.

A 37-gallon pressurized, potable water tank is located under the forward cabin floor, in the right hand tunnel, to furnish water to the lavatories. Water level in the tank is indicated by lights in a service panel outside the airplane. The lights are placarded LOW, 1/4, 1/2, 3/4, and FULL, and operate from level-sensing elements located in the water tank.

Also located at the service panel are water fill and overflow fittings, pressurization valve and a water system drain valve handle, which are provided to service the system.

A 2-quart water heater located under the washstand supplies hot water for the washbasin.

A water shutoff valve is located under the water heater to adjust water flow to the washbasin.

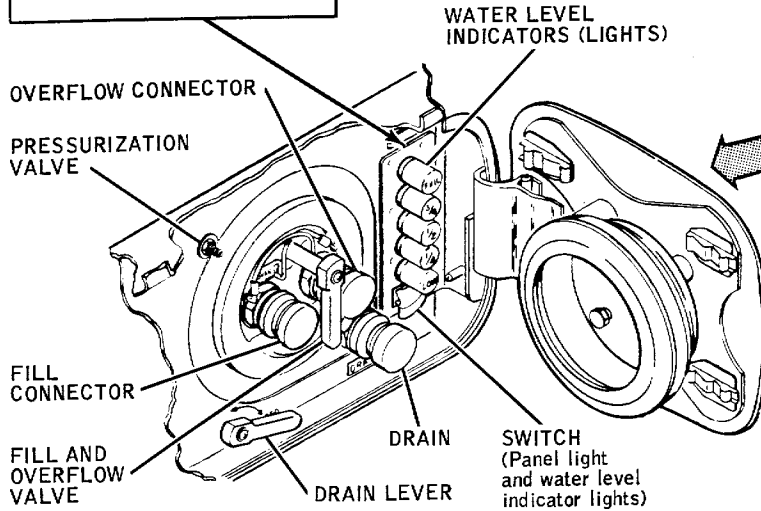
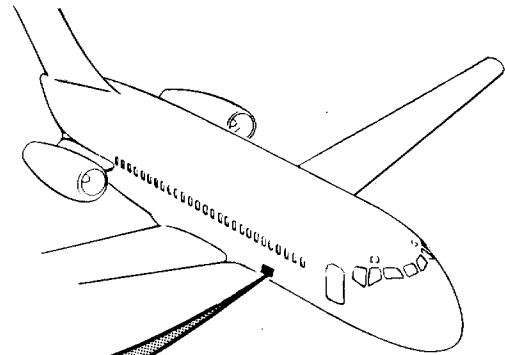
The waste tank, installed for collection of waste and water, is drained through an exterior service panel.

Normally pressure for the water system is supplied by the air conditioning system. The pressurization valve permits pressurizing the system from a ground source, if pressure is required during ground operations when the air conditioning system is not operating. The water system operating pressure is 27 psi.

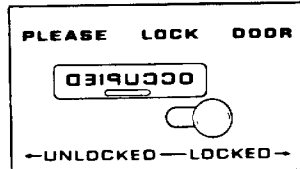
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AIRPLANE GENERAL -- LAVATORIES

WATER SERVICING PANEL
 Service panel is equipped with an automatically controlled heating unit to prevent freezing.



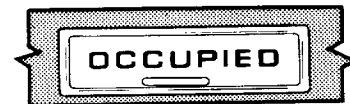
INSIDE VIEW



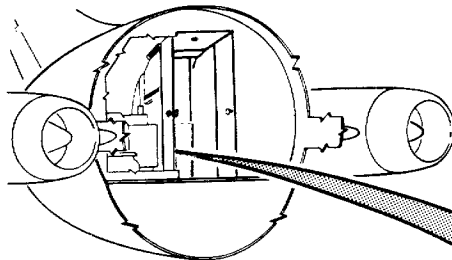
LAVATORY OCCUPIED SIGN

To gain access to lavatory when door is locked from inside, insert a sharp instrument such as a knife or screwdriver in the slot and pry sign up to VACANT. Sign is connected directly to door locking bolt.

OUTSIDE VIEW



Insert instrument here and pry up to unlock lavatory door from outside.



115 VDC RAZOR OUTLET

OXYGEN MASK AND OUTLET CONTAINER

DOOR LOCK

COLD AIR OUTLET

LAVATORY WATER HEATER
 Heats wash basin water to 110° F.

FLUSH BUTTON
 Toilet is flushed by depressing flush button. Entire flushing cycle is automatic.

WATER SHUTOFF VALVE
 Adjusts flow of water to wash basin.

TYPICAL

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CARGO AND ACCESSORY COMPARTMENTS

GENERAL

The cargo and accessory compartments consist of the forward accessory compartment, the electrical/electronics compartment, forward lower cargo compartment, aft lower cargo compartment, main-gear wheel well accessory compartment, and aft accessory compartment.

LOWER CARGO COMPARTMENTS

The two lower cargo compartments are located below the passenger compartment floor in the belly of the airplane. Both compartments are pressurized and heated - the forward compartment is suitable for transporting live animals. The ceilings, sidewalls, and floor are lined with laminated glass fiber panels that are removable in sections to facilitate inspection and repair. Other equipment in the compartments includes cargo tiedown tracks, web barrier nets, and door barriers. Both compartments are equipped with lights, with control switches located immediately inside the door.

FORWARD ACCESSORY AND ELECTRICAL/ELECTRONICS COMPARTMENTS

Two pressurized compartments are located in the forward lower section of the fuselage. The forward accessory compartment, located above floor level in the nose section, houses electronic and electrical equipment. The compartment is accessible through a plug-type door in the ceiling of the nose-gear wheel well.

The electrical/electronics compartment is located between the nose-gear wheel well and the forward lower cargo compartment. The compartment houses the rack mounted electronic components

and is ventilated with exhausted air from the flight compartment. A ground access door for the compartment is located aft of the nose-gear wheel well and an in-flight access door is located in the flight compartment floor behind the captain's station. Both of the forward compartments are equipped with lights. The external doors to the forward accessory and electrical/electronics compartment have door warning lights on the annunciator panel which remain on when the doors are not closed and locked.

MAIN-GEAR WHEEL WELL ACCESSORY COMPARTMENTS

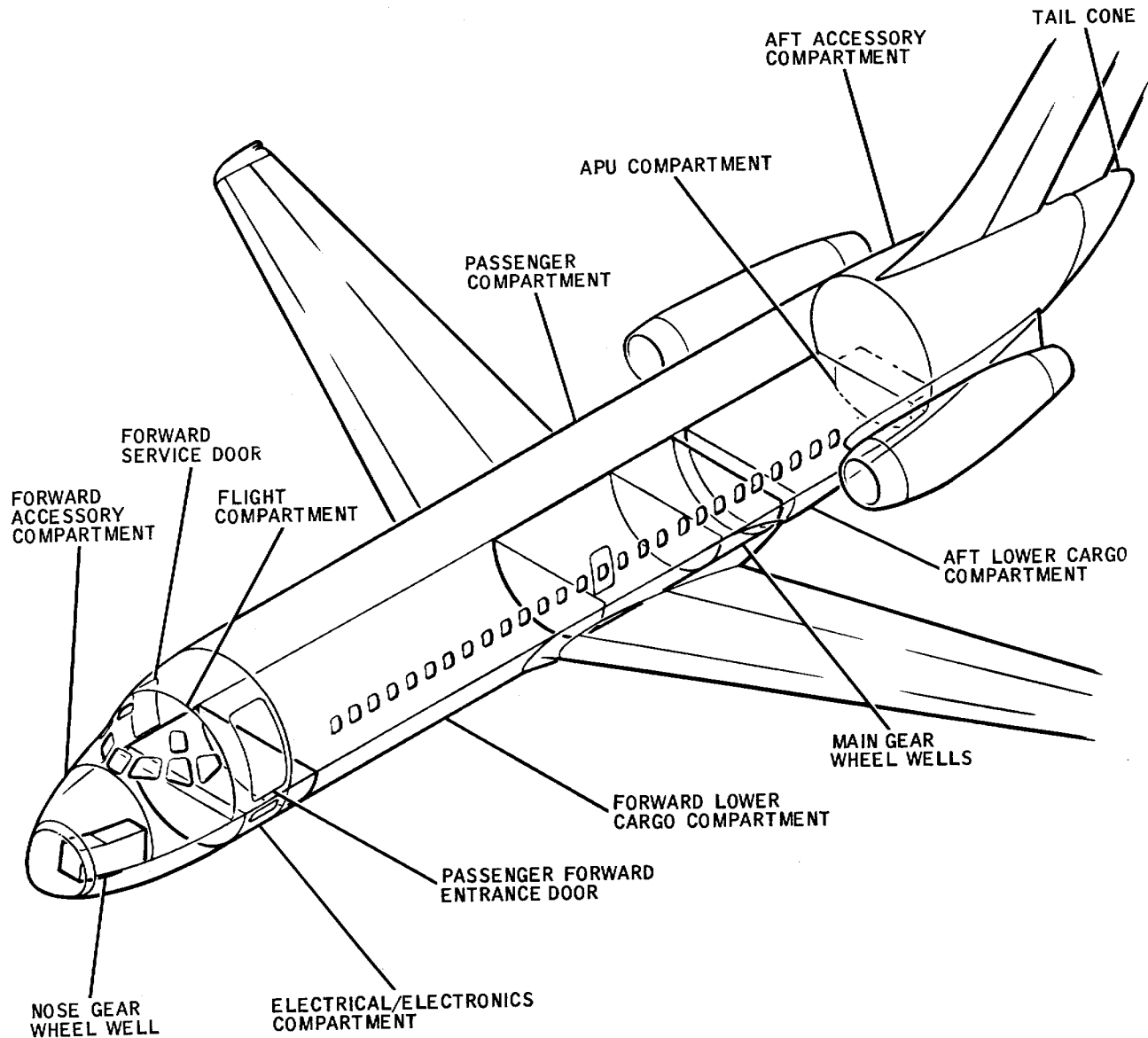
The main-gear wheel wells are located in the lower segment of the fuselage below the wing center section. In addition to housing the wheels when retracted, the wells house such hydraulic system components as reservoirs, filters, accumulators, pressure gages, pumps, and service panels. The inboard wheel-well doors can be opened for access to the hydraulic components while the airplane is on the ground.

AFT ACCESSORY COMPARTMENTS

The aft accessory compartment is located in the tail section of the airplane, aft of the pressure bulkhead. The cabin air-conditioning equipment and engine fire extinguishing equipment are installed in the compartment. Access to the compartment is made through the pressure bulkhead door, through the tail cone access door, or through the opening with the tail cone removed. A walkway is provided in the compartment. The APU compartment is located in the bottom of the aft accessory compartment, immediately aft of the pressure bulkhead. The APU installation is shrouded with a fire-proof cover. Servicing access to the APU is provided on the fuselage exterior. The aft accessory compartment is nonpressurized.

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AIRPLANE GENERAL -- CARGO & ACCESSORY COMPARTMENTS



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PASSENGER FORWARD ENTRANCE DOOR,
SERVICE DOOR, AND STAIRWAY

PASSENGER FORWARD ENTRANCE DOOR AND
SERVICE DOOR

The passenger forward entrance door is installed on the left side of the fuselage, and the forward service door is installed on the right side. Either door can be opened from either inside or outside the airplane. The doors swing outward after the hinge has moved inward, permitting the doors to move edgewise through the doorway. An evacuation slide is installed on each door. Operating instructions for the door and the slide are stenciled on the door and slide container, respectively. Door warning lights on the annunciator panel will remain on when either door is not closed and locked.

PASSENGER FORWARD ENTRANCE AND
SERVICE DOOR OPERATING INSTRUCTIONS

CAUTION: DO NOT OPEN DOOR WITH CABIN
PRESSURIZED.

TO OPEN:

1. Look through the door window for obstructions.
2. Rotate the inner handle clockwise or the outer handle counterclockwise to the open position. (Service door opposite.)
3. Exert a forward and outboard force on the door to disengage the latch.
4. Rotate the door outboard until the hold-open latch engages the fuselage.

TO CLOSE:

1. Ensure that the stairwell door is closed. (Not applicable to service door.)
2. Pull aft on the hold-open latch release handle and rotate the door into the fuselage.
3. Exert a forward and inboard force on the door to engage the latch and rotate the inner handle counterclockwise or outer handle clockwise to the horizontal position. (Service door opposite.)

PASSENGER FORWARD ENTRANCE
STAIRWAY - GENERAL

The passenger forward entrance stairway is located below the entrance door and is electromechanically actuated. The stairway may be controlled from the interior or exterior of the airplane. The stairs are normally operated by dc electrical power from either the airplane normal dc power supply or the batteries. If electrical power is not available, the stairway may be operated manually from outside the airplane. A mechanical interlock, which is part of the stairwell door latching mechanism, prevents the stairwell door from being opened when the passenger door is locked closed and prevents the passenger door from being locked when the stairs are extended. Lights installed on each step come on when the stairwell door is unlatched, and ac power is connected to the stairway circuit. These lights will not come on using the battery mode of operation.

The handrails are made of tubular sections hinged together, permitting the

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rails to retract. The sections of the handrails that extend into the passenger door opening are extended and retracted manually. A release lever on the under side of the handrail (one on each rail) releases the detent mechanism and allows the handrails to be extended and retracted manually. The detents are provided to mechanically lock the handrails in the extended or retracted position.

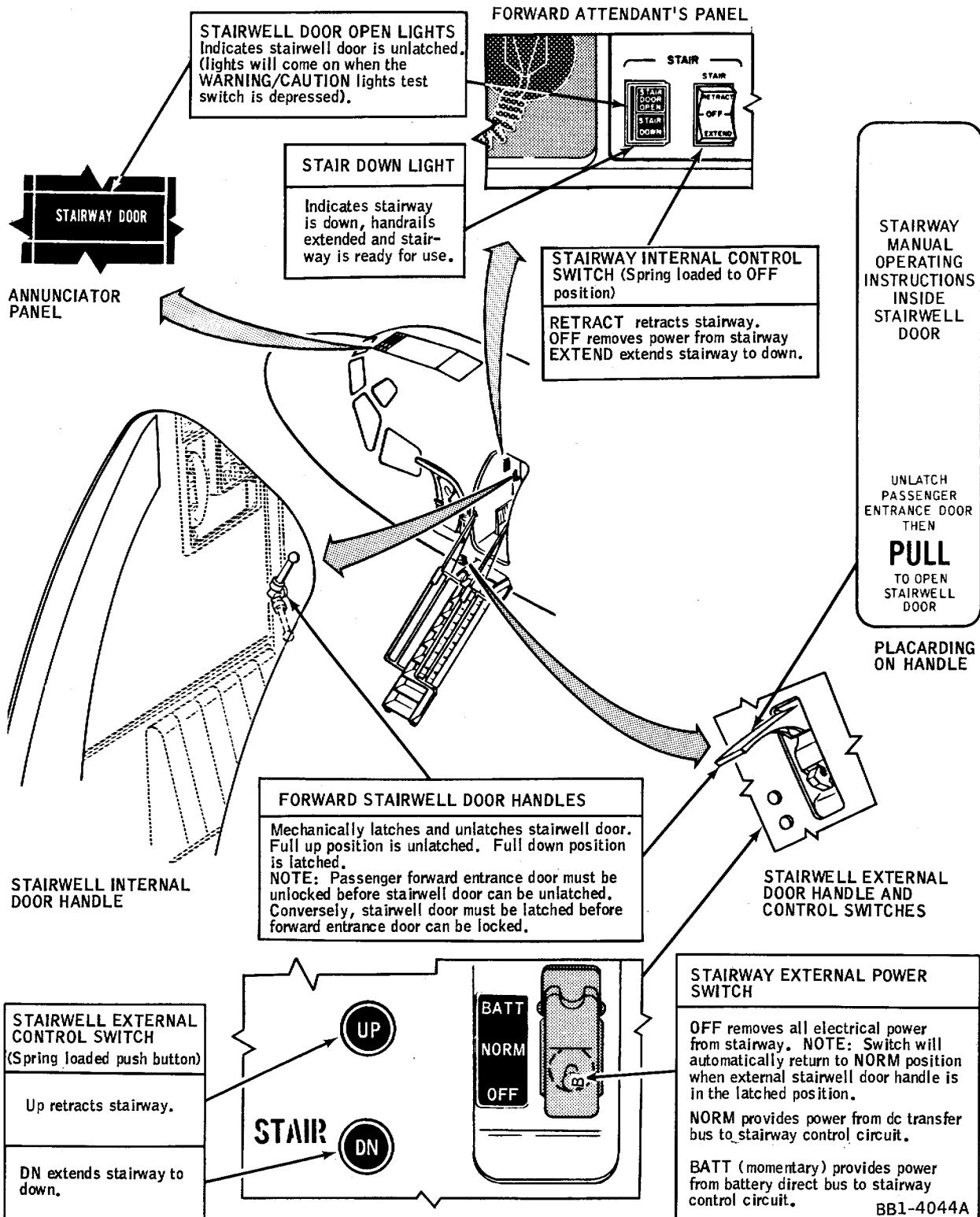
NOTE: Do not pressurize the airplane with forward stairwell door open. Failure to comply may collapse stairwell shroud.

FORWARD STAIRWELL DOOR LATCH INSPECTION VIEWER

An inspection viewer is installed in the left-hand side of the floor beam immediately forward of the stairwell, in the electrical/electronics compartment.

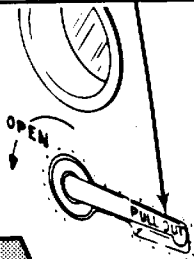
The viewer is used to determine that the stairwell door is latched if the STAIRWAY DOOR light on the annunciator panel and/or the STAIR DOOR OPEN light on the forward attendant's panel inadvertently come on. The viewer installation consists of a small door in the floor beam, and a light switch to turn on the stair lights. Access to the electrical/electronics compartment is gained through the door in the floor of the flight compartment, just aft of the captain's seat or through the external electrical/electronics access door aft of the nose gear well. (See illustration titled FORWARD STAIRWELL DOOR LATCH INSPECTION VIEWER.)

**AIRPLANE GENERAL -- PASSENGER FORWARD ENTRANCE DOOR,
 SERVICE DOOR & STAIRWAY (sheet 1)**



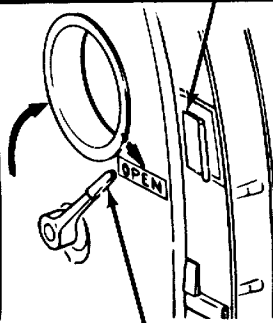
AIRPLANE GENERAL -- PASSENGER FORWARD ENTRANCE DOOR, SERVICE DOOR & STAIRWAY (sheet2)

PASSENGER FORWARD ENTRANCE AND SERVICE DOOR EXTERNAL HANDLES (operation identical).

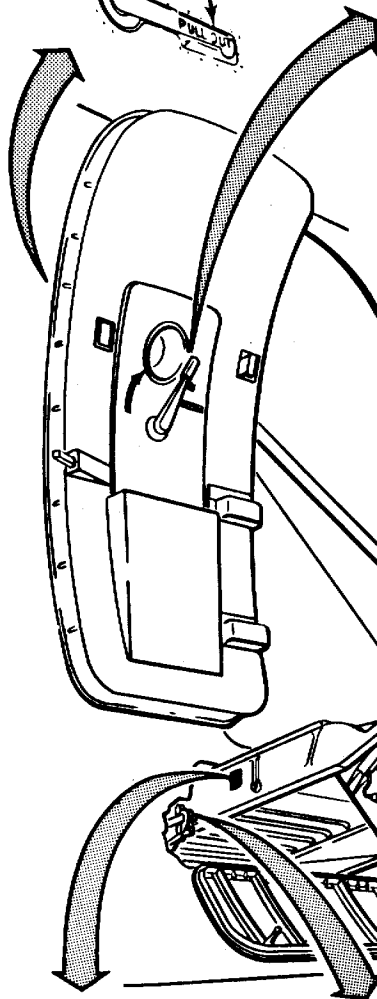


PASSENGER FORWARD ENTRANCE DOOR LATCHED OPEN RELEASE

Unlatches door from the latched open position.



PASSENGER FORWARD ENTRANCE DOOR INTERNAL HANDLE (Passenger door shown, service door identical).



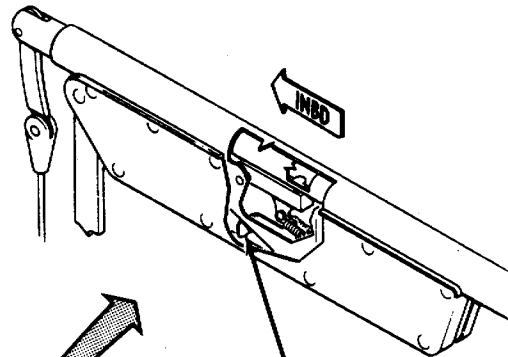
ANNUNCIATOR PANEL DOORS CAUTION LIGHT

MAIN CABIN DOOR light will remain on while forward passenger entrance door remains open.

MAIN CABIN DOOR

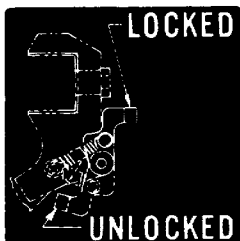
GALLEY DOOR light will remain on while forward service door remains open.

GALLEY DOOR



HANDRAIL MANUAL RELEASE LEVER

Push release lever inboard to manually extend or retract handrail.

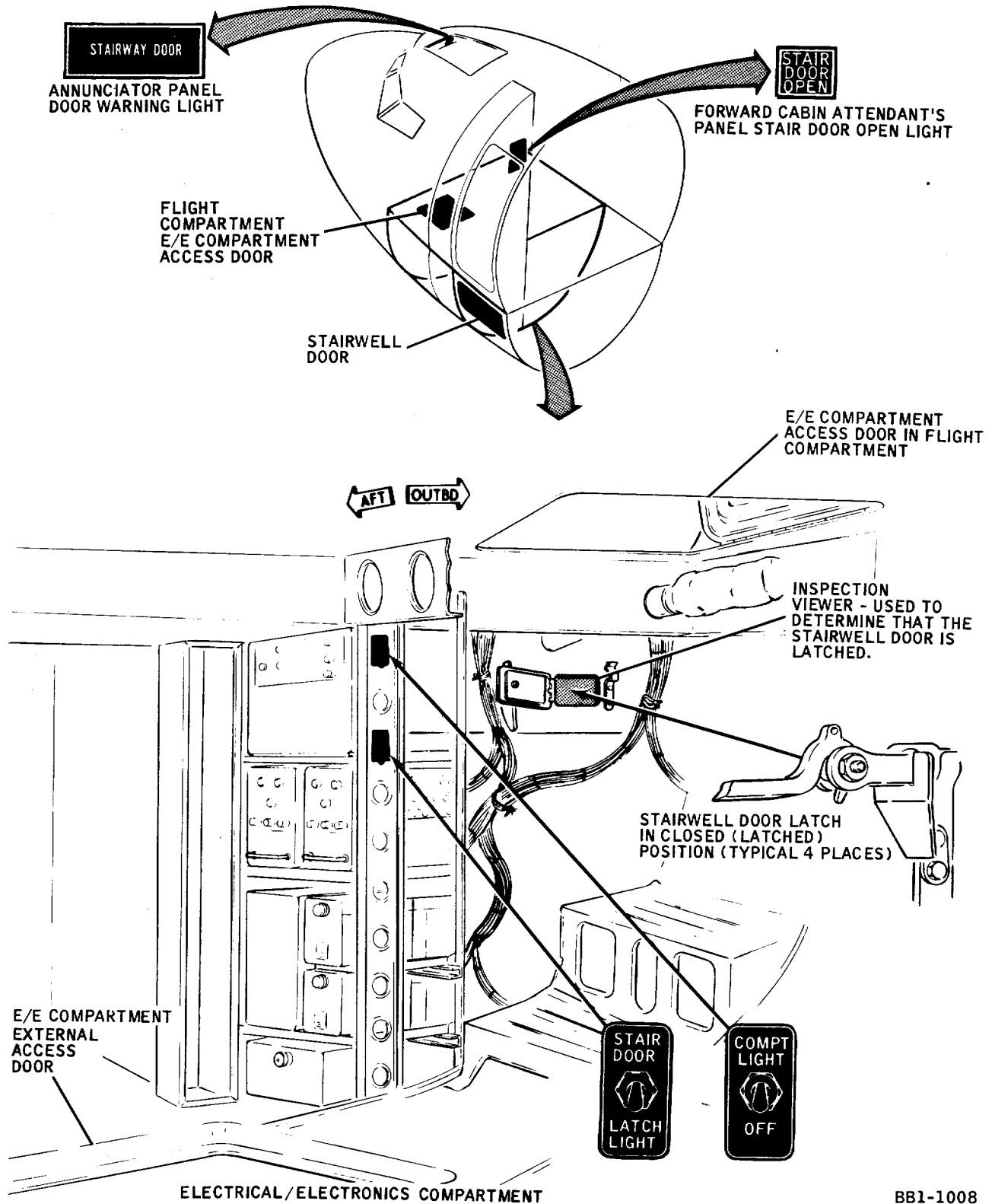


LOCKABLE MECHANICAL DETENT LATCH

Latch must be placed in the lock position when electrical power is removed from the stairway-circuit with the stairs in the extend position to provide a safe passenger loading/unloading condition. This will prevent retraction of the stairway if electrical power is inadvertently applied to the stairway circuit.

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AIRPLANE GENERAL -- FORWARD STAIRWELL DOOR LATCH INSPECTION VIEWER



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PASSENGER AFT ENTRANCE DOOR AND
STAIRWAY

PASSENGER AFT ENTRANCE DOOR

The passenger aft entrance door is mounted on the aft pressure bulkhead and hinged on the right side to swing forward against the lavatory wall. A viewing window is installed in the door handle recess to allow inspection of the stairway area with the door closed. The door provides access to the forward end of the passenger aft stair passageway, where the internal stairway control panel is located. The aft cabin attendant's seat is attached to the door and automatically folds into a recess in the door when not in use. The seat bottom must be folded into the recess when the door is opened. A barrier strap is installed to be placed across the aisle forward of the door for takeoff and landing, to preclude passenger interference when opening the door. A hold open latch is installed on the right side of the aisle to hold door in the open position.

Door warning lights on the flight compartment annunciator panel will remain on when the door is not closed and latched.

PASSENGER AFT ENTRANCE STAIRWAY -
GENERAL

The aft entrance stairway is hydraulically actuated and powered by the right hydraulic system. The stairway may be operated from the interior or the exterior of the airplane. The interior control panel is located on the left side of the stair passageway, immediately aft of the aft entrance door. The panel is recessed into the passageway paneling and, when not in use, is covered with a

spring-latched door. The panel consists of indicating lights, control handle, service light switch and a service interphone receptacle. The control handle has CLOSE and OPEN placarded on the handle, with arrows indicating the respective positions.

The exterior control is located on the aft left fuselage adjacent to the stairway door jamb and is covered by a latched access door. The exterior control station consists of a handle and a stair light switch. The control handle operates in the same manner as the internal control handle.

The stairs may be actuated without hydraulic power by free fall for extension, and by using the hand pump in the main right wheel well for retraction.

The stairway automatically locks in the up position by means of mechanical latches. A stair warning light on the flight compartment annunciator panel remains on when the stairway is unlatched.

In the normal extended position, the stairway does not touch the ground. However, under extreme adverse conditions, such as high winds over the nose or abnormal aft section loadings, the extended stairway will prevent rotation of the aft section of the airplane to the ground. Under these adverse conditions, the operating strut permits the stairs to move toward the closed position until the lower strut retracts to a shock absorbing tube. When this condition occurs, the shock absorbing tube will become visibly distorted. This does not affect the operation of the stairway but the tube should be replaced as soon as possible.

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PASSENGER AFT ENTRANCE STAIRWAY -
CONTROLS AND OPERATION

The switch on the aft attendant's panel controls the stairway lights. The aft entrance door, when open, provides access to the stairway control panel. A door warning light on the annunciator panel remains on while this door is open and unlatched.

The stairway interior control panel is located immediately aft of the aft entrance door on the left side of the passageway. To operate the stairway, the control handle is placed and held in the OPEN position. The STAIR DOOR OPEN light on the stairway control panel and the flight compartment annunciator panel will come on. When the stairs are fully extended and in a safe passenger-loading condition, the STAIR DOWN light on the stairway control panel will come on and the control handle, when released, will return to the neutral (vertical) position.

To retract the stairway, the control handle is placed and held in the CLOSE position. The STAIR DOWN light on the interior stairway control panel will go off. When the stairs are fully retracted and latched, the STAIR DOOR OPEN light on the control panel and on the annunciator panel will go off. The control handle when released, will return to the neutral (vertical) position. When the aft entrance door is closed and latched, the door warning light on the annunciator panel will go off.

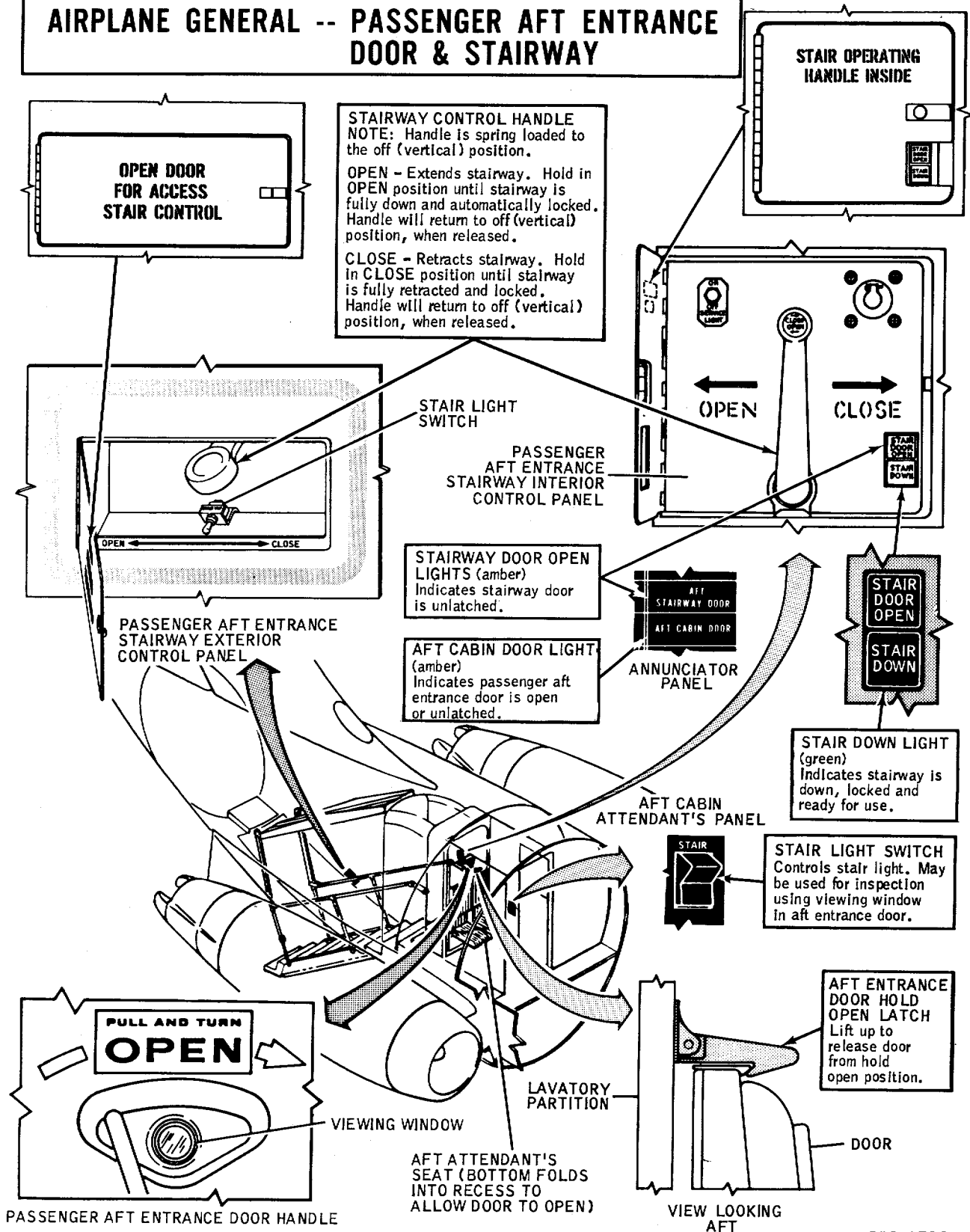
The operation of the stairway from the external control station is identical to that of the interior control panel except that there are no indicator lights at the external control station.

However, the indicator lights on the interior control panel and the annunciator panel function identically to the interior operation when the stairway is operated from the external control station.

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**AIRPLANE GENERAL -- PASSENGER AFT ENTRANCE
 DOOR & STAIRWAY**



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FLIGHT CREW OPERATING MANUAL

SERVICE INTERPHONE, PUBLIC ADDRESS,
AND PASSENGER ENTERTAINMENT

SERVICE INTERPHONE

The service interphone system provides intercommunication between various service and maintenance areas, flight compartment, and cabin attendants. The service interphone and public-address systems are interconnected, and the same telephone-type handsets are used for both systems. One handset is located in the flight compartment and one on each attendant's panel. A switch located in the flight compartment turns off and isolates all interphone stations except the flight compartment, aft right equipment panel (electrical/electronics compartment), forward and aft cabin attendants, and ground power receptacle stations, when in the OFF position. All service interphones are connected when the switch is ON.

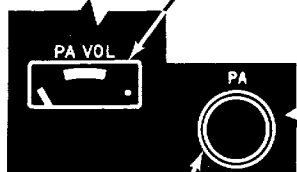
PUBLIC ADDRESS AND PASSENGER
ENTERTAINMENT

The public-address system enables the pilots and cabin attendants to address passengers through speakers located throughout the cabin and lavatory. The system also has provisions for amplifying magnetic tape recordings. A rotary switch is installed on the forward cabin attendant's panel to control tape player volume. The same handsets installed for the service interphone system are used for the public-address system. Announcements from the flight compartment station have priority over those from the cabin stations. The forward attendant's station has priority over the aft attendant's station, and the forward and aft cabin attendants' stations have priority over the tape player (passenger entertainment).

AIRPLANE GENERAL -- PUBLIC ADDRESS, SERVICE INTERPHONE, & PASSENGER ENTERTAINMENT

CABIN P/A VOLUME INDICATOR

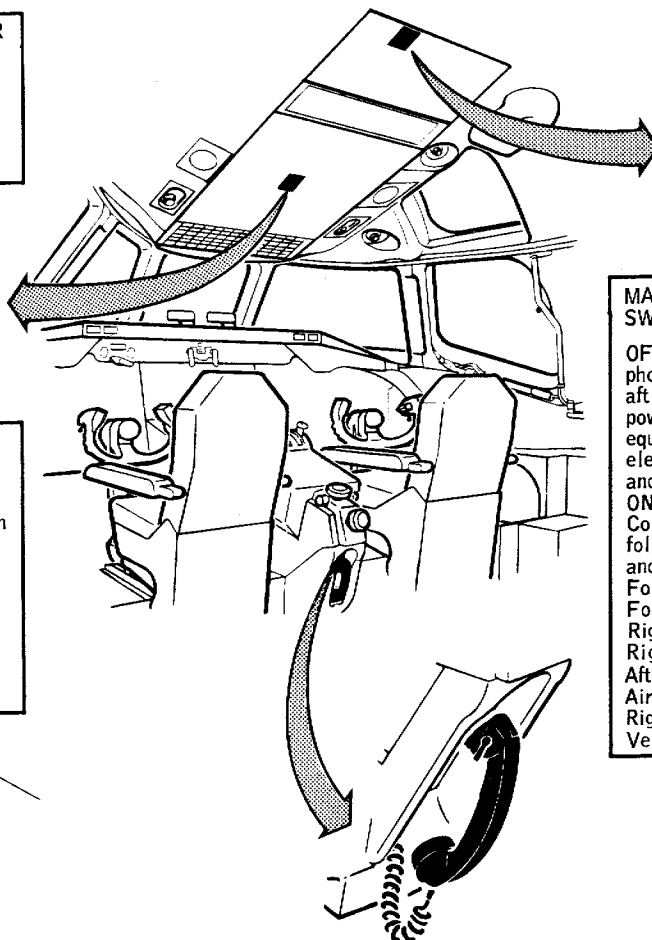
Indicates output level of P/A amplifier. Radial markings on instrument indicates desired level of modulation. (Typical 3 stations.)



P/A SWITCH AND LIGHT

When handset is off hanger and switch is depressed, handset is connected to P/A amplifier. When handset is placed on hanger, button automatically returns to out position, reverting handset to service interphone function.

NOTE: Light will stay on while handset is connected to P/A system.



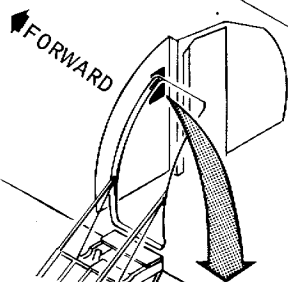
MAINTENANCE INTERPHONE



MAINTENANCE INTERPHONE SWITCH

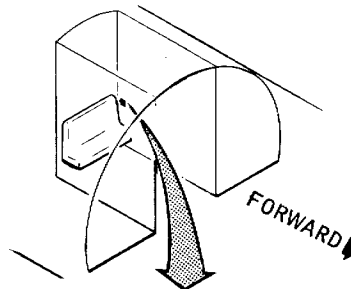
OFF position isolates all interphone jacks except forward and aft attendant panels, ground power receptacle, aft right equipment panel (electrical/electronics compartment), and flight compartment.

ON position Connects interphone jacks in the following locations for maintenance interphone purposes:
 Forward Accessory compartment.
 Forward lower cargo compartment.
 Right wing fueling panel.
 Right and left main gear well.
 Aft lower cargo compartment.
 Air conditioning compartment.
 Right and left fuselage (engine).
 Vertical stabilizer.

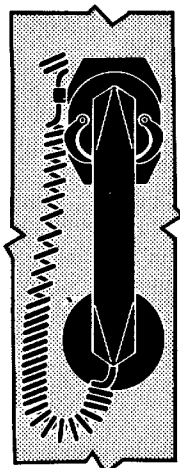


FORWARD ATTENDANTS PANEL

FLIGHT COMPARTMENT HANDSET
 (Typical for attendant's panels)



AFT ATTENDANTS PANEL



HANDSET (Typical each attendant panel)

MUSIC VOLUME CONTROL

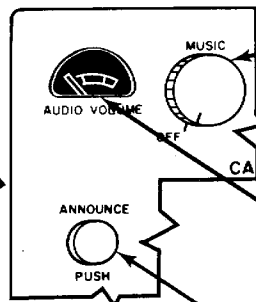
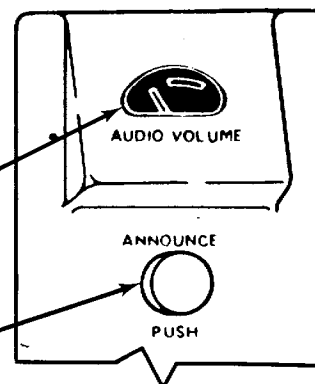
In the ON position, music from the tape player is amplified by the P/A system and distributed throughout the passenger compartment. Audio volume is adjusted by rotating the control.

AUDIO VOLUME INDICATOR

Indicates output level of P/A amplifier. Radial markings indicate desired level of modulation.

ANNOUNCE SWITCH

When handset is off hanger and switch is depressed, handset is connected to P/A amplifier. When handset is placed on hanger, switch automatically returns to out position, reverting handset to service interphone function.



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DOUGLAS AIRCRAFT CO., INC.
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FLIGHT CREW OPERATING MANUAL

CALL SYSTEMS

GENERAL

The call system, consisting of call lights, aural devices, and call switches, is installed at various locations to provide visual-aural communication between flight crew, ground maintenance crew, and passengers.

PILOT TO CABIN ATTENDANT AND MECHANIC CALL SYSTEM

The flight compartment contains a call switch which activates the cabin attendant's master call lights, and a chime that is audible through the public address system. A mechanic's call switch, located at the pilots' station, actuates a horn located in the nose-wheel well.

CABIN ATTENDANT AND MECHANIC TO PILOT CALL SYSTEM

A pilot call switch, installed at the forward and aft cabin attendant's panel and at the ground power receptacle panel, actuates a chime in the flight compartment.

CABIN ATTENDANT TO CABIN ATTENDANT CALL SYSTEM

A cabin attendant call switch is installed on the forward and aft cabin attendants' panels. Actuation of either switch provides momentary operation of the electronic chime, which operates through the passenger address system. In addition, the cabin attendant's master call lights come on.

PASSENGER TO CABIN ATTENDANT CALL SYSTEM

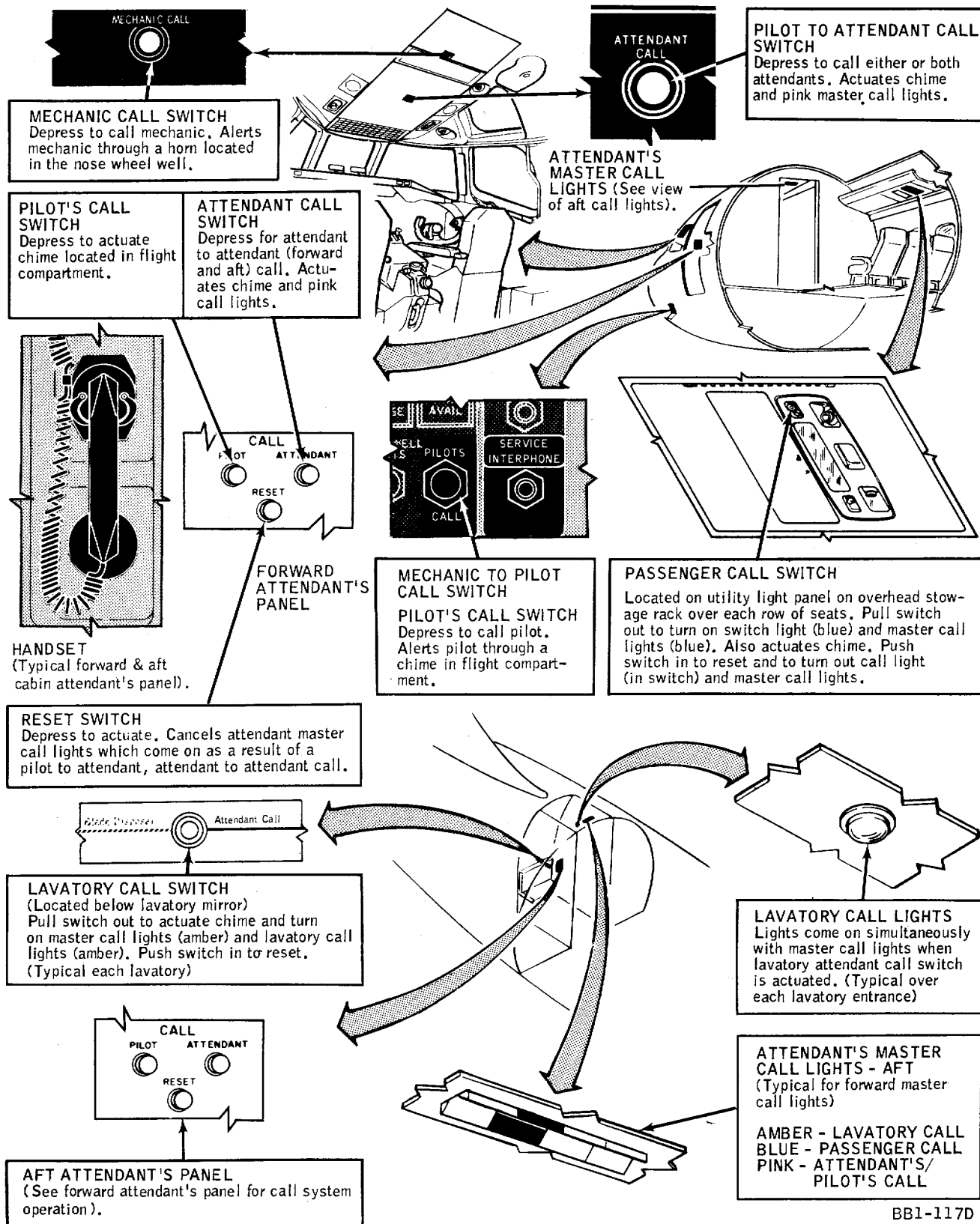
A resettable call switch with an integral light is installed in the bottom of the overhead stowage rack, one call switch for each passenger seat row. Also, a resettable call switch is installed in each lavatory. Actuation of any call switch provides momentary operation of the electronic chime, which operates through the public address system and turns on the cabin attendant's master call lights. The call switch in each lavatory also energizes a call light over each lavatory door. The resetting of any call switch also resets the cabin attendant's master call lights.

CABIN ATTENDANT'S MASTER CALL LIGHTS

Two sets of master call lights are installed in the ceiling over the aisle, one set forward and one aft. The lights protrude from the ceiling and are visible from the cabin attendants' stations. These lights, pilot to attendant and attendant to attendant (pink), passenger to attendant (blue), and lavatory to attendant (amber), are actuated when the applicable call switch is actuated. The master call lights, indicating that a call originated at a passenger seat or a lavatory, are reset at the calling switch. The cabin attendant to cabin attendant and pilot to cabin attendant master call lights are reset at either cabin attendant's panel.

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 FLIGHT CREW OPERATING MANUAL

AIRPLANE GENERAL - - CALL SYSTEMS



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DOUGLAS AIRCRAFT CO., INC.
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FLIGHT CREW OPERATING MANUAL

OXYGEN SYSTEM

GENERAL

Two independent gaseous oxygen systems are installed in the airplane: one in the flight compartment for the crew, and one in the passenger compartment for the passengers and cabin attendants. Both passenger and crew oxygen systems have thermal expansion safety discharge features and use a common discharge indicator. This indicator is mounted in the fuselage skin, below the first officer's side window, and contains a green plastic disc. Absence of this disc requires inspection of both the passenger and crew oxygen cylinders.

The crew oxygen system provides oxygen to the crew members for normal sustained flights in the event of cabin decompression or for protection from the effects of smoke and harmful gases. The system provides more than an adequate supply of oxygen for the crew, ensuring crew proficiency during letdown until a landing can be made.

The masks used with the crew oxygen system are oronasal with an integral microphone. The masks can also be used with the portable oxygen cylinder if necessary.

The passenger oxygen system supplies the oxygen required during descent and recovery, following high-altitude cabin decompression.

The system is designed to open the mask container doors automatically, present the masks, and supply oxygen to all outlets in the event of cabin decompression. If the automatic feature malfunctions, the system may be manually actuated to present the masks.

Portable oxygen is provided for the crew and cabin attendants by individual easy-to-carry oxygen cylinders.

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OXYGEN SYSTEM - FLIGHT COMPARTMENT

Oxygen for the crew system is supplied from a high-pressure cylinder. The cylinder shutoff valve controls oxygen supply to the system.

The cylinder pressure regulator reduces the original pressure of 1850 (+0, -20) psig to approximately 65 psig.

Oxygen flows from the pressure-reducing regulator through lines to individual demand regulators at each flight station. The markings on the pressure gage of each regulator indicate the regulated pressure in the system.

Toggle valves on the demand regulators permit the selection of different methods of supplying oxygen to the masks. The supply toggle on the right side of the regulator panel can be safetied to the ON position if desired. When this toggle is in the OFF position, the regulator will not supply oxygen to the mask. The center toggle is placarded NORMAL OXYGEN and 100% OXYGEN. When this toggle is in the 100% OXYGEN position, only pure oxygen is supplied to the mask; in the NORMAL OXYGEN position, ambient air is mixed with oxygen according to cabin altitude. The emergency toggle on the left side of the regulator panel is placarded EMERGENCY, NORMAL, and TEST MASK. In the TEST MASK position, oxygen is supplied to the mask for test purposes. The toggle is spring loaded from the TEST MASK position to the NORMAL or center position. In the

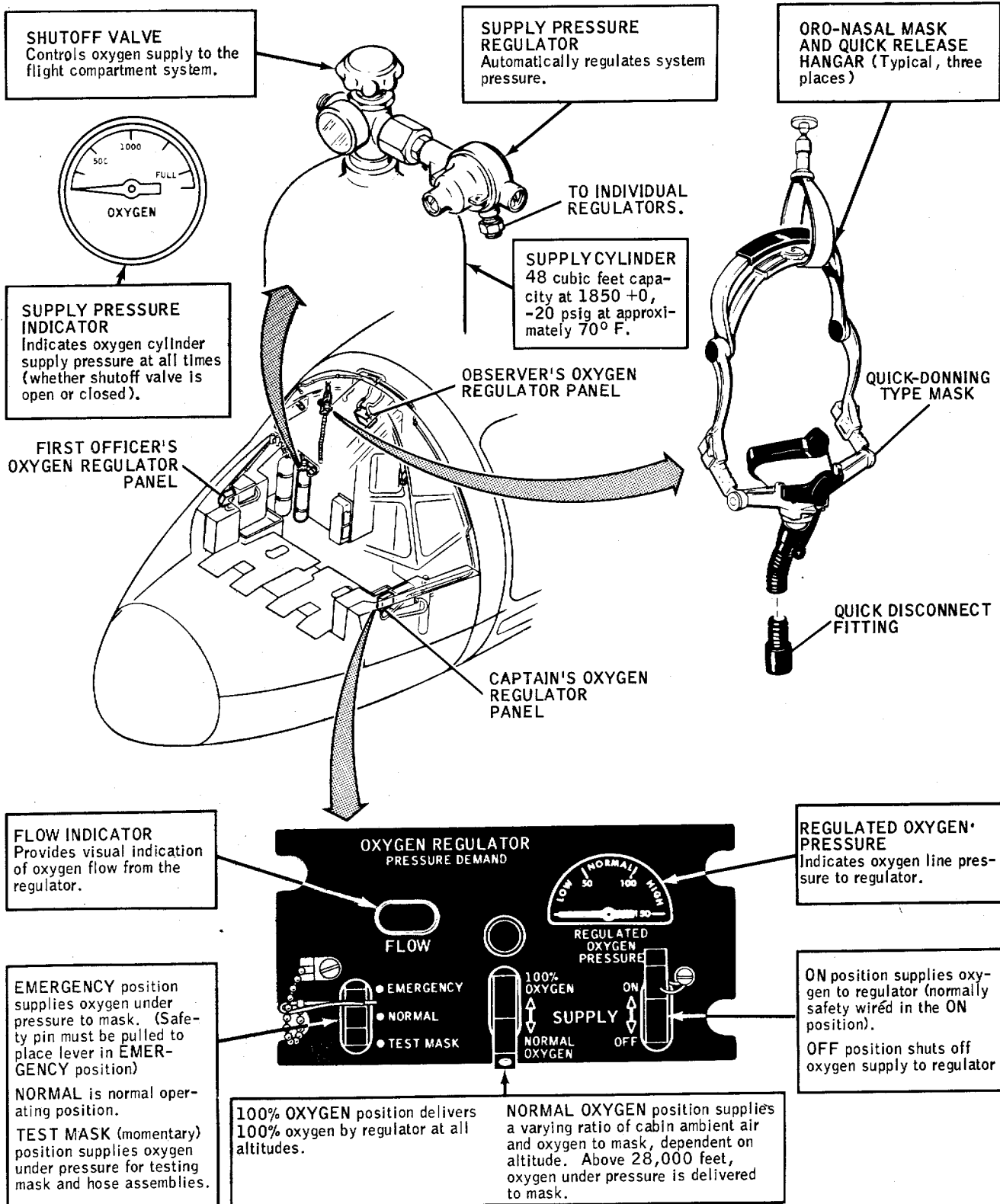
emergency position, positive pressure is sent to the mask.

For normal operation of the system, the supply toggle must be in the ON position, with the center and emergency toggles in the normal position. This supplies oxygen to the mask upon demand. A dilution of oxygen with air is controlled by an aneroid within the regulator. In the event of cabin decompression at altitudes above 28,000 feet, aneroids within the regulator automatically sense the change in cabin pressure and supply pure oxygen at a positive pressure to the masks by closing the air valve and overriding the demand valve. For protective breathing purposes (smoke in the cabin, etc), the center toggle must be in the 100% OXYGEN position. This closes the air valve in the regulator, permitting only pure oxygen to reach the mask.

In the event of regulator failure, the center toggle must be placed in 100% OXYGEN position and the emergency toggle must be in the EMERGENCY position. This feeds only pure oxygen to the masks. The emergency toggle is guarded by a safety pin, which must be removed before the toggle can be placed in the emergency position. The emergency position mechanically overrides the demand diaphragm in the regulator unit. This position is basically a means of supplying positive oxygen pressure to masks if the automatic feature of the regulator fails.

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AIRPLANE GENERAL -- OXYGEN - Flight compartment



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OXYGEN SYSTEM - PASSENGER COMPARTMENT

Oxygen for the passenger system is supplied from a 111 cubic feet high pressure (1850 +0, -20 psig) cylinder located in the flight compartment. The oxygen supply to the system is controlled by a cylinder shutoff valve and an altitude-compensating regulator.

An oxygen mask stowage box is located above each seat row on both sides of the aisle in the overhead stowage rack utility panel, in each lavatory, and at the forward and aft cabin attendant's stations. The stowage box contains oxygen masks and oxygen dispensing valves connected to a manifold. The individual dispensing manifolds incorporate a door-release check valve, emergency valves, and a supplemental valve. A first-aid outlet valve is located on each utility panel forward of the oxygen stowage box door. In the lavatories, the first aid outlet is located inside the stowage box for reasons of sanitation.

If cabin decompression occurs, emergency oxygen is automatically made available to the cabin occupants in the following manner: With the altitude-compensating regulator in either the AUTO or MAN-ON position, the regulator will automatically pressurize the oxygen dispensing manifolds to 75 (+50, -25) psig as the indicated cabin pressure altitude reaches 11,000 to 15,000 feet. This surge of pressure will actuate the door release check valve, unlatch the mask container doors, and make oxygen available to the emergency oxygen valves.

Removal of masks from the container door will automatically pull the emergency valve pins and supply oxygen to the masks. As oxygen is used by the

passengers, the surge pressure will reduce to normal altitude-compensated pressure, controlled by the regulator. Should automatic operation of the regulator fail, the regulator may be manually operated to perform the same operation. To manually actuate the regulator, the auto-manual control lever must be placed to the MAN-ON position, and then the manual mask release knob rotated clockwise to the stop. The knob should be held against the stop for 6 seconds or until the pressure gage on the regulator reads a minimum of 50 psig; then the knob may be released.

After a decompression, and on emergency descent with the regulator auto-manual control lever in the AUTO position, emergency oxygen is available to all masks down to the altitude at which the regulator closes. The regulator closes between 10,000 and 6,000 feet cabin altitude, shutting off oxygen to all passenger outlets. To continue supplemental oxygen flow if desired, or to provide first aid oxygen as required after the regulator closes (indicated by a low pressure reading on the downstream pressure gage), it is necessary to place the auto-manual control lever in the MAN-ON position. The aisle mask in each box is connected to the supplemental valve. Placing this valve in the ON position makes supplemental oxygen available to passengers as desired.

NOTE: If the regulator is placed to the MAN-ON position after automatic mask presentation, but prior to automatic closure of the regulator, oxygen will continue to be available at all outlets until the supply is expended.

First aid oxygen is obtained from quick-disconnect outlets located

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adjacent to the passengers' mask boxes. A special first aid fitting with hose and mask attached may be plugged into the outlet by the cabin attendant. A flow rate of either HI or LO can be selected by rotating the knob which encircles the outlet. The low position provides sufficient oxygen for most usages.

First aid oxygen for clinical purposes can be made available during normal pressurized flight by a crew member placing the regulator auto-manual control lever in the MAN-ON position.

PASSENGER OXYGEN MASKS

The oxygen masks for passengers use are the oronasal type made of plastic-type rubber, pliable enough to form around the nose and mouth area. The mask is basically a facepiece, with valves, rebreathing bag, a length of plastic tubing, a pull cord, and a head strap to secure the mask to the wearer's head. The masks connect to the emergency valves by a plastic tube. Each mask is connected to its emergency valve pull-pin by a cord.

All passenger masks are retained on the utility box doors by a plastic holder and must be manually removed.

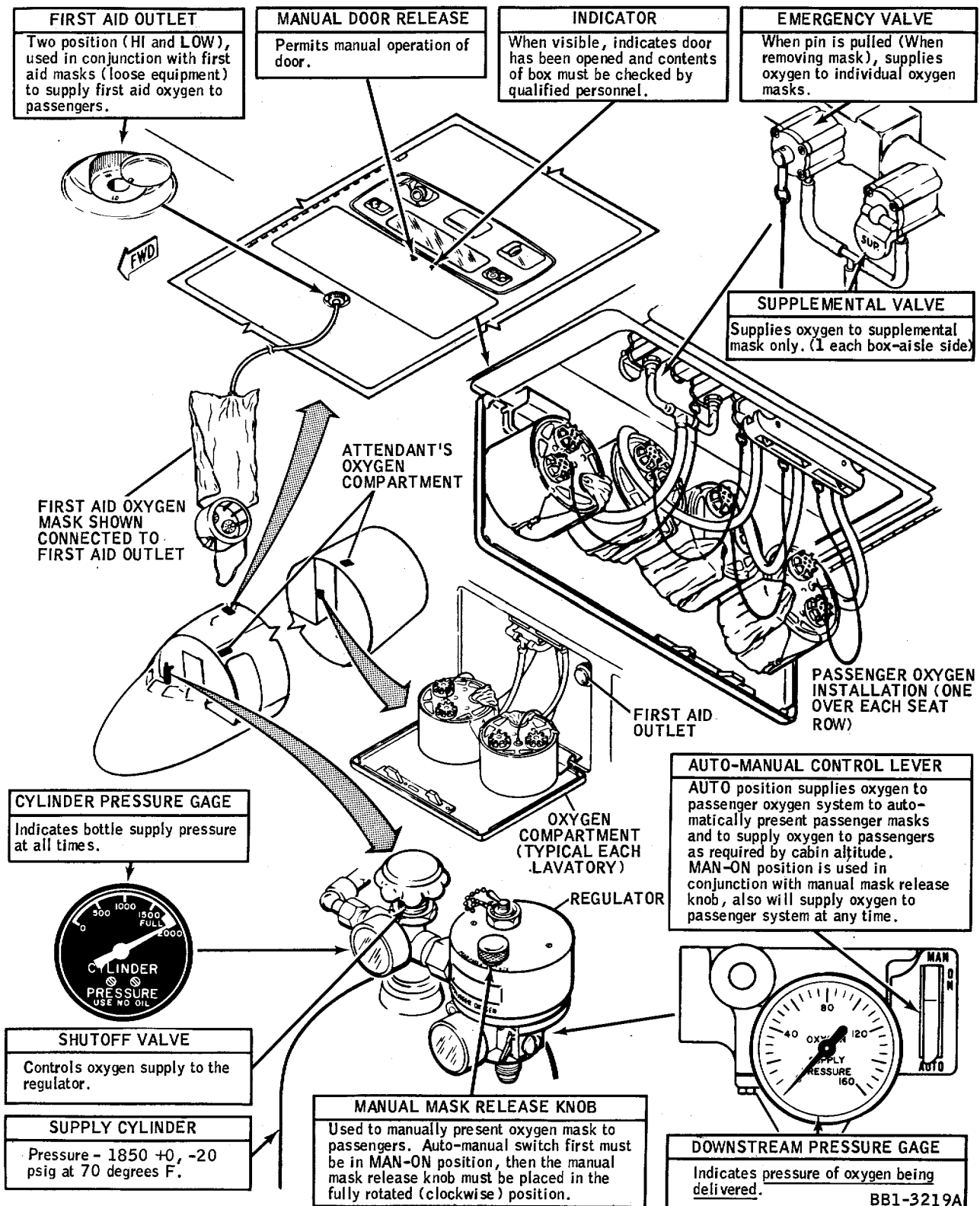
When the emergency valve pin is pulled, oxygen will flow to the masks.

As the wearer inhales, oxygen is withdrawn from the rebreathing bag through the inhalation valve. When the oxygen supply in the bag is depleted, atmospheric air will then be inhaled through the ambient air supply valve, which opens at slightly greater suction pressure than the oxygen inhalation valve.

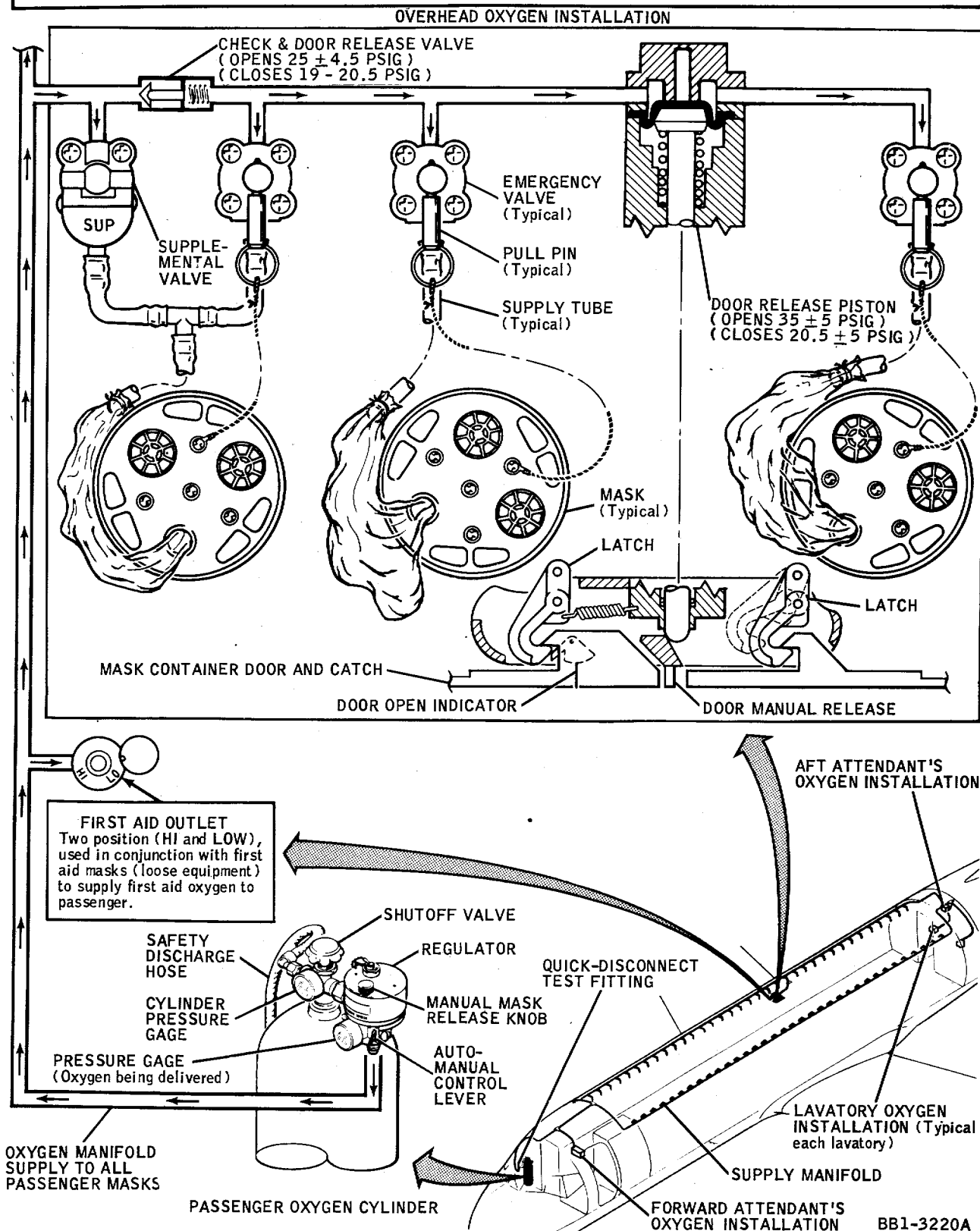
CABIN ATTENDANT'S OXYGEN MASKS

The cabin attendant's oxygen masks are identical in appearance and operation to the passenger oxygen masks. The masks are stored behind a small door in the ceiling over the forward and aft cabin attendant's stations. There are two oxygen masks at each location. The cabin attendant's oxygen mask boxes each contain a door release check valve, oxygen manifold, emergency valves and pull-pins, and a supplemental valve. The cabin attendant's stations do not have first aid outlets. The forward and aft cabin attendant's oxygen masks are stowed so that they can be reached by the attendant's from a seated position when the oxygen mask box doors open.

AIRPLANE GENERAL -- OXYGEN - Passenger compartment



AIRPLANE GENERAL -- OXYGEN - Passenger oxygen system schematic



OXYGEN SYSTEM - PORTABLE - FLIGHT
COMPARTMENT

One portable oxygen cylinder is located in the crew stowage area of No. 1 galley. The cylinder weighs approximately 10 pounds and has a capacity of 11 cubic feet.

The cylinder contains a hand shutoff valve, gage, pressure regulator, demand regulator, pressure relief valve, carrying strap, demand outlet, and a 3-liter-per-minute continuous-flow outlet.

The 3-liter-per-minute continuous-flow outlet supplies 100 percent oxygen for approximately 100 minutes. The demand outlet has an approximate duration of 15 minutes. The crew mask must be connected to the outlet and the shutoff valve opened before oxygen can be supplied. The gage indicates the pressure of the oxygen in the cylinder and the amount of oxygen available for breathing.

AIRPLANE GENERAL -- OXYGEN - Flight compartment portable cylinder



OXYGEN CYLINDER PRESSURE GAGE

CONTINUOUS FLOW OUTLET
 Accomodates continuous flow mask. (Continuous flow 100% oxygen). Flow - 3 liters per minute. Duration - 100 minutes (Full cyl).

OXYGEN CYLINDER PRESSURE GAGE
 Typical all portable cylinders (indicates cylinder pressure at all times)
 Full mark at 1800 +0 -20 psi.

DEMAND OUTLET
 Accomodates typical crew oxygen mask (Demand flow 100% oxygen). Duration - 15 minutes (Full cyl).

CREW OXYGEN CYLINDER (1)
 11 CUBIC FEET

SHUTOFF VALVE

LOW PRESSURE RELIEF VALVE

DEMAND REGULATOR

SLING

NOTE:
 DURATION TIME
 IS APPROXIMATE.

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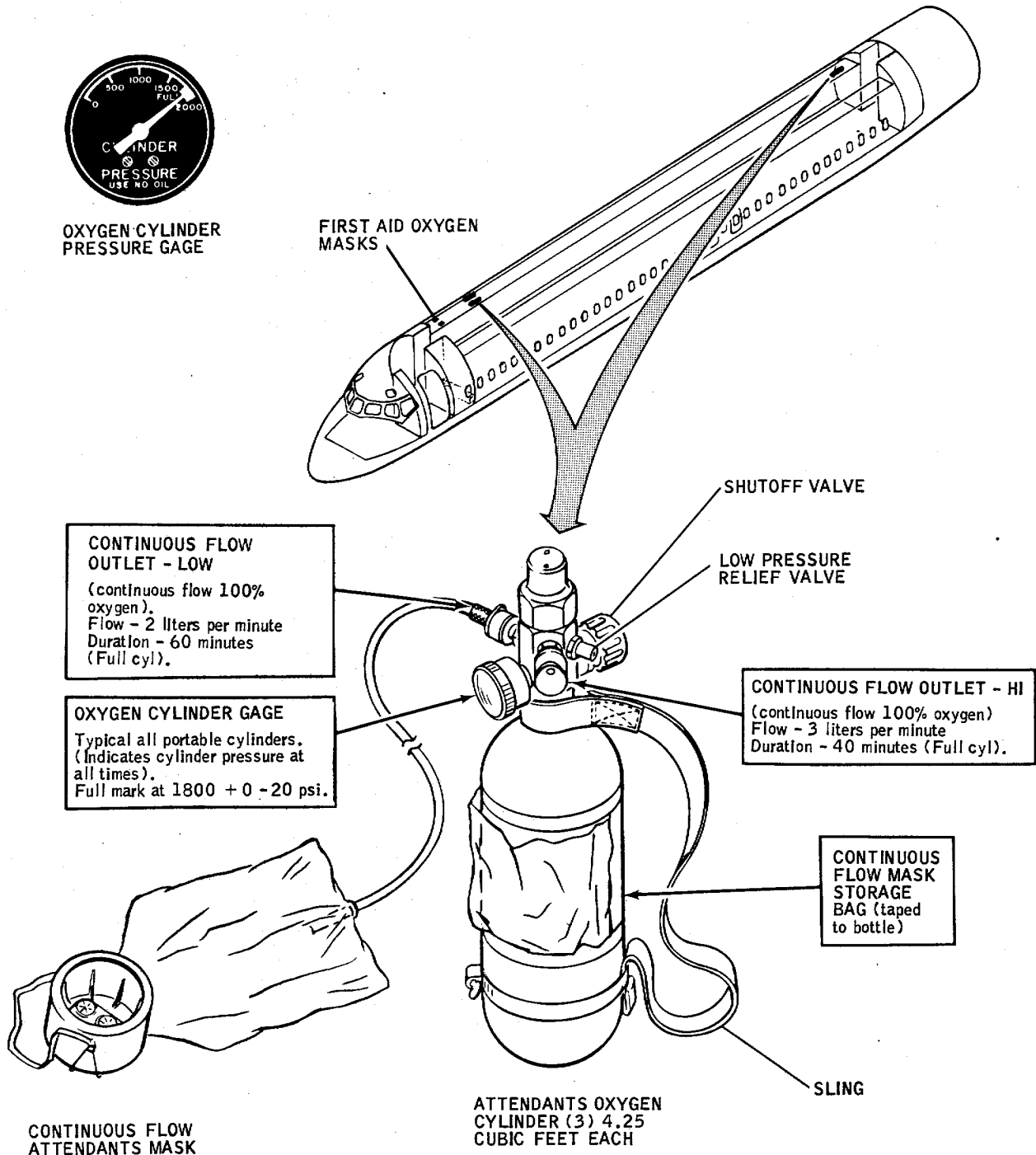
OXYGEN SYSTEM - CABIN ATTENDANTS'
PORTABLE OXYGEN CYLINDERS AND FIRST
AID MASKS

Three portable oxygen cylinders are provided for the cabin attendants. Each cylinder contains a hand shutoff valve, gage, pressure regulator, pressure relief valve, carrying strap, and a 2- and 3-liter-per-minute outlet. Each outlet is coded for a flow and altitude setting. The 2-liter outlet is marked 2.0-20, and the 3-liter outlet is marked 3.0-20. The 2-liter outlet supplies 100 percent oxygen for approximately 60 minutes. The 3-liter outlet supplies 100 percent oxygen for approximately 40 minutes. The mask hose must be connected to the outlet and the shutoff valve opened, to supply oxygen to the mask.

The gage indicates the pressure of the oxygen in the cylinder and the amount of oxygen available for breathing.

The cylinders are stowed with the mask attached and mounted with a quick-detach clamp. See following illustration for location of cylinders and first aid oxygen masks.

AIRPLANE GENERAL -- OXYGEN - Cabin attendant's portable cylinders & first aid masks



NOTE:
 DURATION TIME
 IS APPROXIMATE.

BB1-4262

LIGHTING SYSTEMS

GENERAL

The major lighting systems in the airplane are flight compartment lighting, passenger compartment lighting, cargo and service compartment lighting, exterior lighting, standby lighting, and emergency lighting.

Flight compartment lighting circuits serve the various lights for general flight compartment lighting, crew utility lights, and the master warning and caution system. White primary lighting is provided by incandescent and fluorescent lights.

Passenger compartment lighting provides general lighting of the passenger areas and entrances. Direct and indirect lighting are used. Additional area lighting includes utility and work lights, lighted instruction signs, and a passenger call system.

Lights are installed in the lower cargo compartments and accessory areas to facilitate loading, for area inspection, and for servicing operations.

Exterior light systems provide high intensity lights for landing and taxi, area lighting for ground servicing, flight scanning lights for icing conditions inspection, and navigational and warning lights.

The standby lighting system provides limited lighting throughout the main cabin in the event that the normal electrical power supply system fails. The emergency lighting system provides illumination of the main cabin and overwing exit area to facilitate evacuation of the airplane.

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FLIGHT COMPARTMENT LIGHTING

White primary lighting installations provide general and local lighting of the cockpit area, panels, instruments, and controls. Separate lighting control panels provide individual selection of intensity and the area to be lighted.

Cockpit incandescent white floodlights that are available with normal electrical power on consist of Captain's instrument panel floods, First Officer's instrument panel floods, overhead switch panel floods, center instrument panel floods, and pedestal floods. White, fluorescent floodlights, are provided for the Captain's instrument panel and First Officer's instrument panel. Integral panel and instrument lighting is also provided.

A two-position THUNDERSTORM LIGHT switch is provided which overrides all white floodlight controls. In the ON position, all white floodlights in use will go to full brilliance.

A three-position COCKPIT FLOODLIGHT switch operates two floodlight units in the ceiling to provide general cockpit floodlighting below the level of the thunderstorm lights. In the ON position, the switch turns on one light in each unit. In the ALT THUNDERSTORM position, the switch turns on one additional light in each unit to increase the overall light level.

In the event of complete loss of normal electrical power and with the BATT switch ON, the EMER PWR switch ON, and with the thunderstorm switch OFF, power will be supplied to the Captain's instrument panel floods, First Officer's instrument panel floods, right overhead switch panel flood, left center instrument panel flood, and left pedestal flood from

the DC transfer bus and the emergency DC bus. The individual WHITE incandescent light controls must be manually operated to obtain floodlights. Immediate floodlighting can be obtained if desired, by positioning the thunderstorm switch to ON; and with the battery switch ON and the emergency power switch ON, all incandescent white floodlight controls will be bypassed (except the left center instrument panel floodlight and left pedestal floodlight which must be manually operated) providing cockpit floodlighting of the Captain's instrument panel, First Officer's instrument panel and the right-hand floodlight for the overhead switch panel.

NOTE: Even if the battery switch were to be inadvertently turned OFF, the Captain's and First Officer's white floodlights would still be operative.

Red fill lighting installations provide general lighting for the Captain's instrument panel, First Officer's instrument panel, overhead switch panel, center instrument panel and pedestal.

Additional flight compartment lighting consists of floor lights, map lights, circuit breaker panel light, standby compass light, and chart holder lights. A momentary switch is installed on the First Officer's console which operates lights for nose wheel well inspection.

MASTER WARNING AND CAUTION, AND ANNUNCIATOR PANEL LIGHTING

One set of MASTER WARNING and MASTER CAUTION lights are installed on each glareshield panel, and are connected in parallel with certain warning and

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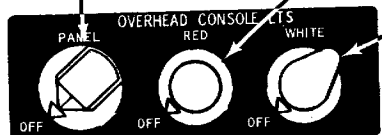
AIRPLANE GENERAL -- LIGHTING - Flight compartment

Rheostat switch operates integral panel lights.

Switch turns on red fill lights to light overhead panel.

3-position switch operates floodlight in ceiling to illuminate circuit breaker panel.

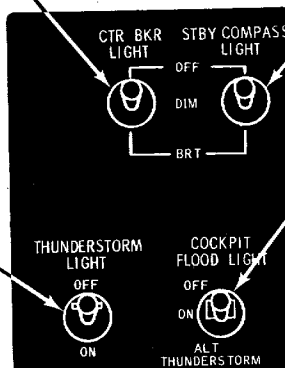
3-position switch operates standby compass light.



OVERHEAD CONSOLE LIGHTS PANEL

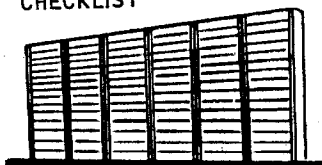
Rheostat switch turns on overhead floodlight for overhead panel.

Overrides all panel white floodlight controls and turns white floodlights to full brilliance.



3-position switch operates floodlights in ceiling for general cockpit floodlighting. In ALT THUNDERSTORM position, general cockpit floodlighting intensity is increased.

CHECKLIST



Lighting turns on automatically when checklist is lifted for viewing. Intensity is controlled at center instrument and pedestal light control panel.

MAP LIGHT

Rheostat switch adjusts brilliance.

BRIEFCASE LIGHT

Rheostat switch adjusts brilliance.

NOSE WHEEL WELL INSPECTION LIGHT SWITCH

Momentary position switch operates lights for nose wheel well inspection.

CHART HOLDER

Rheostat switch located on chart holder to adjust brilliance.

CENTER INSTRUMENT AND PEDESTAL LIGHT PANEL



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

Switch turns on red fill lights for center instrument panel and pedestal.

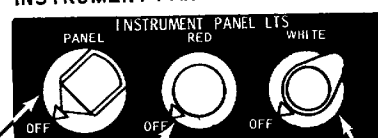
FLOOR LIGHTS SWITCH 3-position switch operates cockpit floor lights.

FLOOR LIGHTS SWITCH



Switch operates integral panel and instrument lights.

INSTRUMENT PANEL LIGHTS PANEL



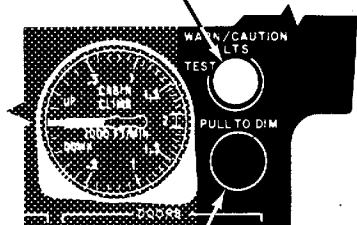
Switch operates red fill lights for instrument panels.

Dual knobs permit separate operation of incandescent and fluorescent lights. BB1-4163

AIRPLANE GENERAL -- ANNUNCIATOR PANEL & MASTER CAUTION & WARNING LIGHTS

WARN/CAUTION LTS

TEST (Momentary) Depress to test integrity of all annunciator panel lights.

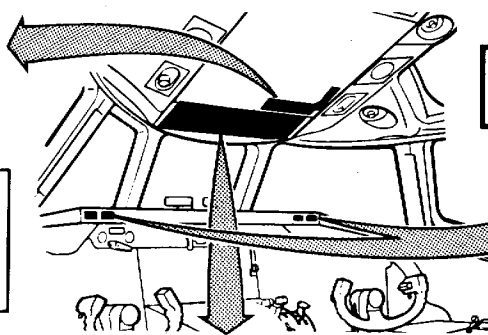


PULL TO DIM

Dims all annunciator lights except DOORS caution lights; and all dimmable warning, caution, and advisory lights on the instrument panel that do not have individual controls.

MASTER WARNING and MASTER CAUTION lights come on in conjunction with certain annunciator panel lights. (See annunciator panel - (★) or (†). Lights cannot be dimmed.

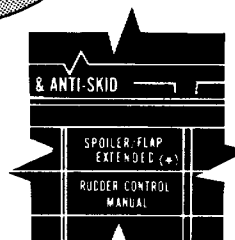
PUSH TO RESET will turn off light and will reset the applicable Master Warning or Master Caution light circuit to indicate illumination of an additional annunciator light. PUSH TO RESET should be initiated immediately after looking at the annunciator panel to see which light or lights caused the MASTER WARNING or MASTER CAUTION to come on.



MASTER
CAUTION
PUSH TO RESET

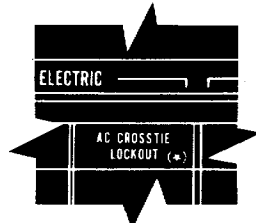
MASTER
WARNING
PUSH TO RESET

ELECTRIC		ICE PROTECTION		ENGINE		
		L ENG ANTI ICE ON (B)	R ENG ANTI ICE ON (B)	L FUEL HEAT ON (B)	R FUEL HEAT ON (B)	FLAP, RUDDER STOP INOP
		WING ANTI-ICE ON (B)	TAIL DE ICE ON (B)			STALL INDICATION FAILURE
APU GEN OFF (★)	DC TRANSFER BUS OFF (★)			L START VALVE OPEN	R START VALVE OPEN	
L AC BUS OFF (★)	R AC BUS OFF (★)	L ICE PROTECT TEMP HIGH (★)	R ICE PROTECT TEMP HIGH (★)	L OIL STRAINER CLOGGING (★)	R OIL STRAINER CLOGGING (★)	
L GEN OFF (★)	R GEN OFF (★)	AIRFOIL ICE PROT PRESS ABNORMAL (★)	ICE PROTECT (★) SUPPLY PRESS HI	L OIL PRESS LOW (★)	R OIL PRESS LOW (★)	TAIL COMPT TEMP HIGH (†)
L CSD OIL PRESS LOW (★)	R CSD OIL PRESS LOW (★)	L ICE PROTECT TEMP LOW (★)	R ICE PROTECT TEMP LOW (★)	L INLET FUEL PRESS LOW (★)	R INLET FUEL PRESS LOW (★)	APU FIRE (†)
EMER LIGHT NOT ARMED	DC BUS OFF (★)	L ENG VALVE	R ENG VALVE	L FUEL FILTER PRESS DROP (★)	R FUEL FILTER PRESS DROP (★)	AC EMER BUS OFF (†)



Effective on air-
planes with
SPOILER/FLAP
EXTENDED light.

ANNUNCIATOR PANEL



Effective on
airplanes with
AC CROSSTIE
LOCKOUT light.

HYD & ANTI-SKID				DOORS	
RUDDER TRAVEL UNRESTRICTED (B)	AUTO SPOILER DO NOT USE	ELEVATOR PWR ON (B)			
RAIN REPELLENT (B) RESERVE IN USE	SLAT DISAGREEMENT		RUDDER CONTROL MANUAL		AFT STAIRWAY DOOR
		L REVERSER ACCUMULATOR LOW	R REVERSER ACCUMULATOR LOW		AFT CABIN DOOR
MACH TRIM INOP	APU OIL TEMP HIGH (★)	L HYD TEMP HI (★)	R HYD TEMP HI (★)		AFT CARGO DOOR
FIRE DETECTOR LOOP	APU OIL PRESS LOW (★)	L HYD PRESS LOW (★)	R HYD PRESS LOW (★)	STAIRWAY DOOR	FWD CARGO DOOR
L AIR COND (★) SUPPLY TEMP HI	R AIR COND (★) SUPPLY TEMP HI	L OUTBD ANTI-SKID	R OUTBD ANTI-SKID	MAIN CABIN DOOR	GALLEY DOOR
RADIO FAN OFF	FLT RECORDER OFF	L INBD ANTI-SKID	R INBD ANTI-SKID	FWD ACCESSORY COMPT DOOR	ELEC COMPT DOOR

(★) Comes on simultaneously with
MASTER CAUTION light.

(†) Comes on simultaneously with
MASTER WARNING light.

NOTE:

All annunciator panel lights not designated either red or blue are amber color.

RED LIGHT (R) -- (Warning) indicates a condition that requires immediate action.

AMBER LIGHT -- (Caution) indicates a condition that requires corrective action.

BLUE LIGHT (B) - (Advisory) indicates a system is ON or in operation.

Annunciator panel Warning and Caution lights will stay on until emergency or malfunction is corrected. Blue lights will stay on until corresponding system is OFF or ceases to operate.

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caution lights on the annunciator panel. The master lights may be turned off (reset) by depressing the light lens. The lights on the annunciator panel will remain on until the indicated malfunction or condition is corrected. A dimming control is provided for all annunciator panel lights except those in the DOORS CAUTION section.

The annunciator panel, located in the overhead panel, contains color-coded indicator lights to advise the flight crew of certain malfunctions or conditions within the airplane systems. Legends on the color-coded light lenses pinpoint the nature and location of the malfunction or condition. Caution (amber) lights indicate conditions requiring attention; warning (red) lights indicate conditions involving safety of the airplane requiring immediate attention; advisory (blue) lights indicate a condition exists which may or may not need correction.

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PASSENGER COMPARTMENT LIGHTING

The passenger compartment lighting system consists of the ceiling lights, sidewall light, aisle drop ceiling lights, door and entrance lights, and aft passenger stairway lights.

The ceiling lights provide direct lighting by means of incandescent lights installed by sections in a trough in the ceiling, on both sides of the air-conditioning duct. A multidimming rotary switch is located on the cabin attendant's panel. The light is diffused by a translucent panel. Emergency lights are also installed in the trough sections.

The sidewall lights provide indirect lighting, by means of a series of incandescent fixtures, to individual sections in the overhead stowage racks. Reflectors installed adjacent to the light fixtures deflect the light pattern to the sidewall area below the racks. A 3-position control switch for the lights is located on the cabin attendant's panel.

Aisle drop ceiling lights are installed in the forward and aft passenger compartment. The incandescent lights are controlled by separate 3-position switches on the cabin attendant's forward and aft control panels. Some of the aisle drop ceiling light assemblies have integral emergency light installations

Door and entrance light installations use combinations of incandescent lights to assure adequate lighting of entrance areas for normal or emergency conditions. The light control switch is located on the forward attendant's panel.

Aft passenger stairway lighting includes spotlights directed on the stairway, floodlights located on the right and left bulkheads above the stairway, and a ceiling light. The lights are controlled by a switch located on the aft attendant's panel.

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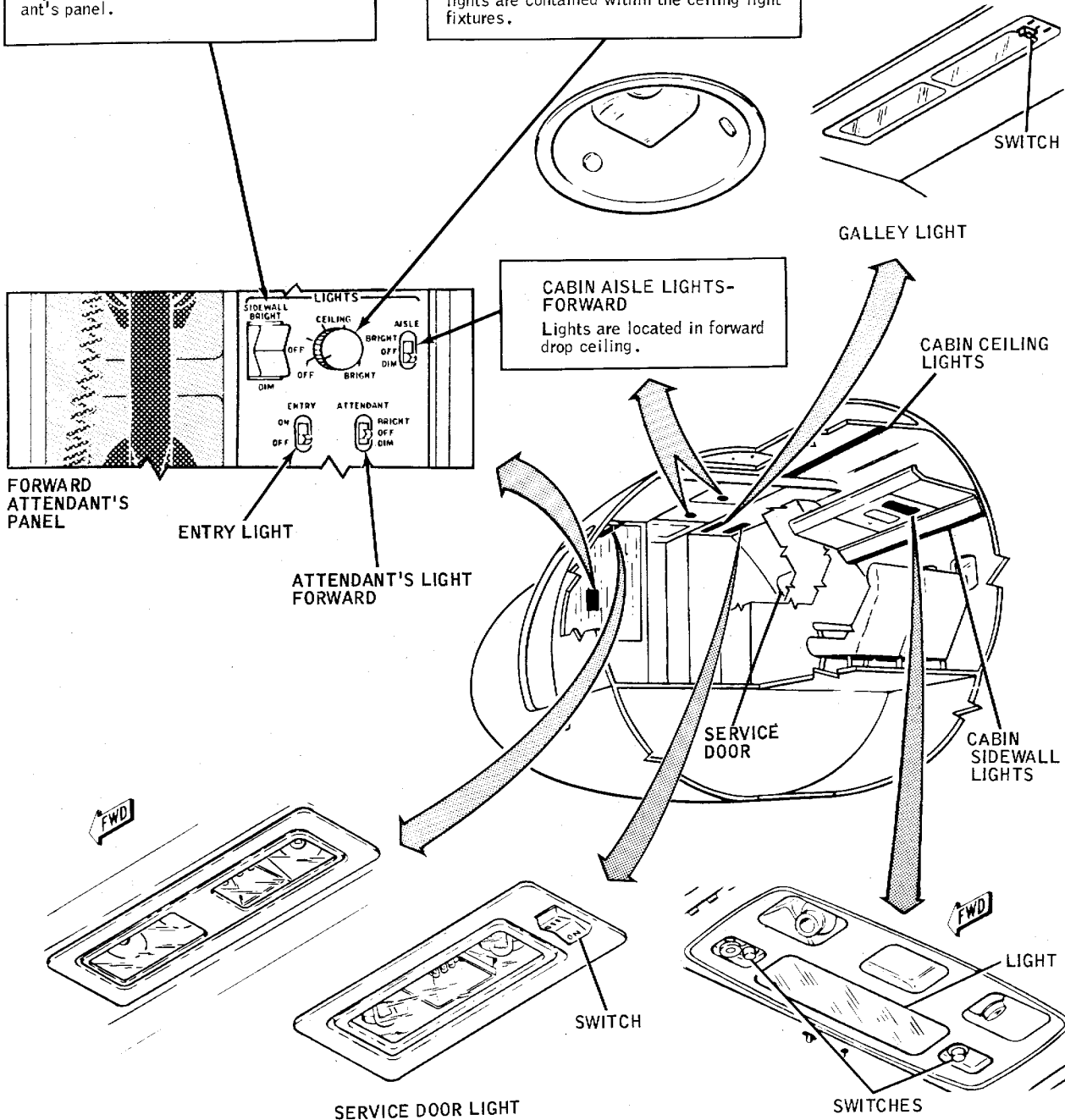
AIRPLANE GENERAL -- LIGHTING - Passenger compartment (sheet 1)

CABIN SIDEWALL LIGHTS

Lights are controlled by 3-position (bright, off, dim) switch, located on forward attendant's panel.

CABIN CEILING LIGHTS

Lights are controlled by a multidimming rotary switch, located on the fwd attendant's panel. Emergency and evacuation lights are contained within the ceiling light fixtures.



PASSENGER ENTRANCE LIGHT

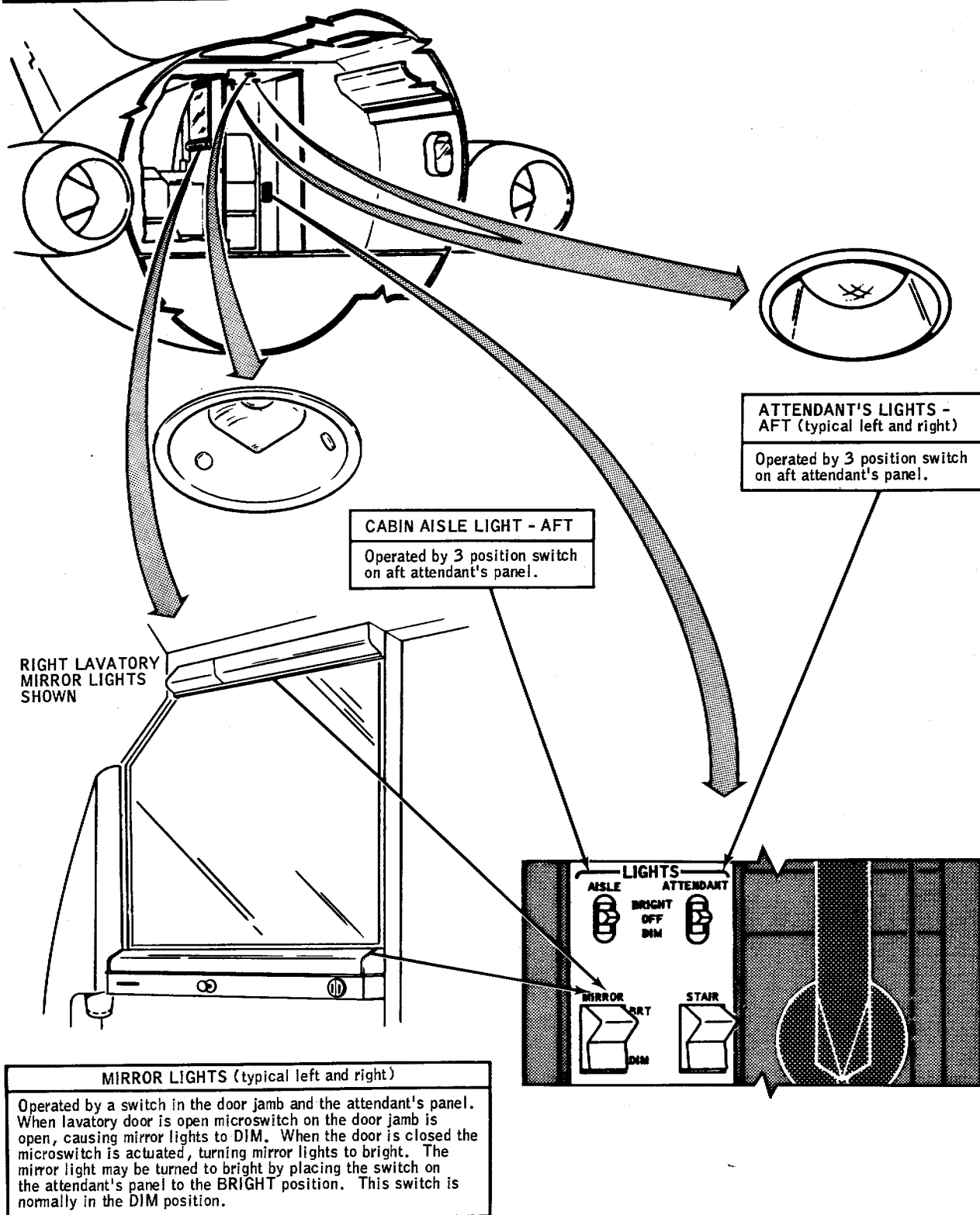
Fwd attendant's light is integral part of entrance light.

PASSENGER READING LIGHT (typical)

Passenger air outlets and attendant call button are also located on each reading light panel.

BB1-4422

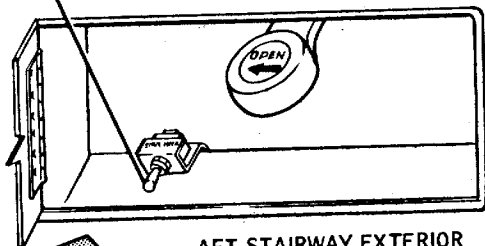
AIRPLANE GENERAL -- LIGHTING - Passenger compartment (sheet 2)



BB1-810A

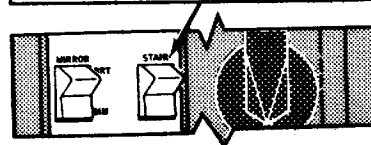
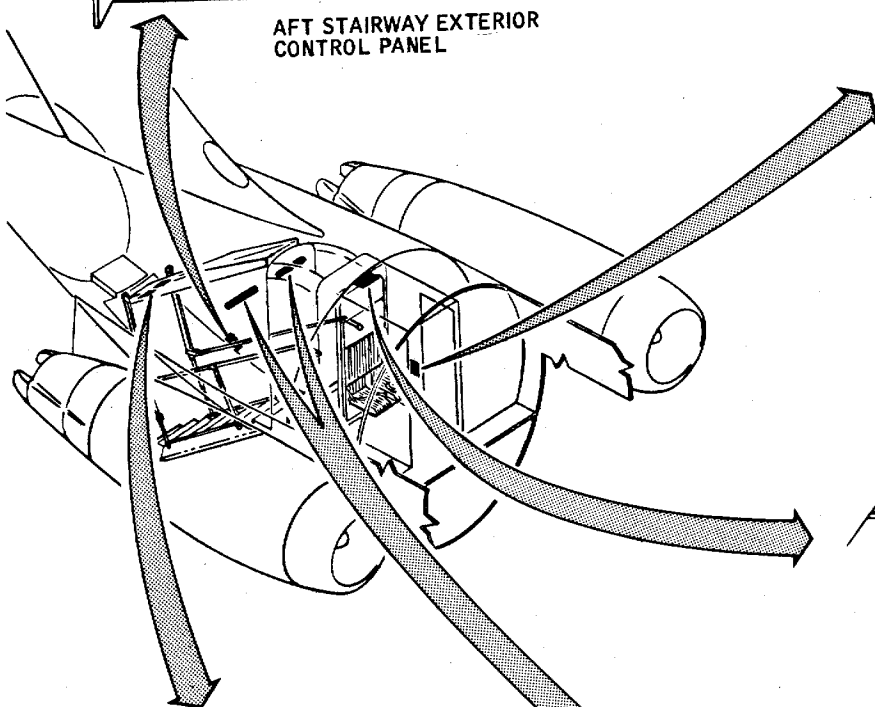
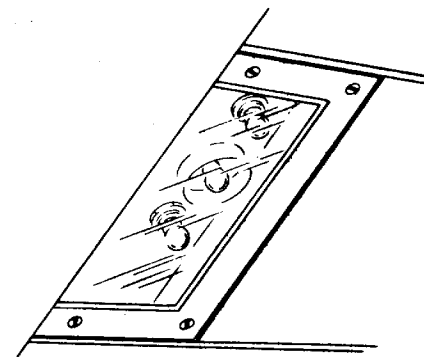
AIRPLANE GENERAL -- LIGHTING - Aft passenger stairway

AFT STAIRWAY EXTERIOR
LIGHT SWITCH

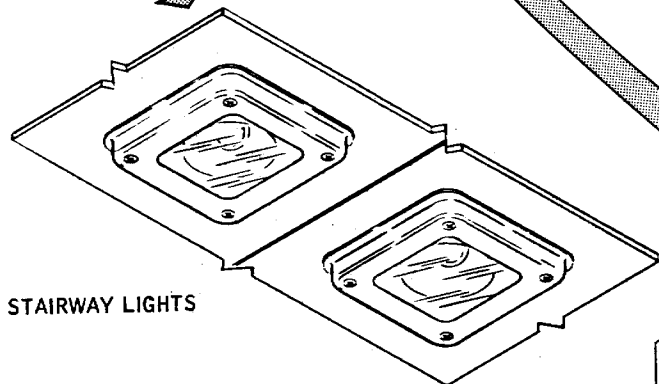


AFT STAIRWAY EXTERIOR
CONTROL PANEL

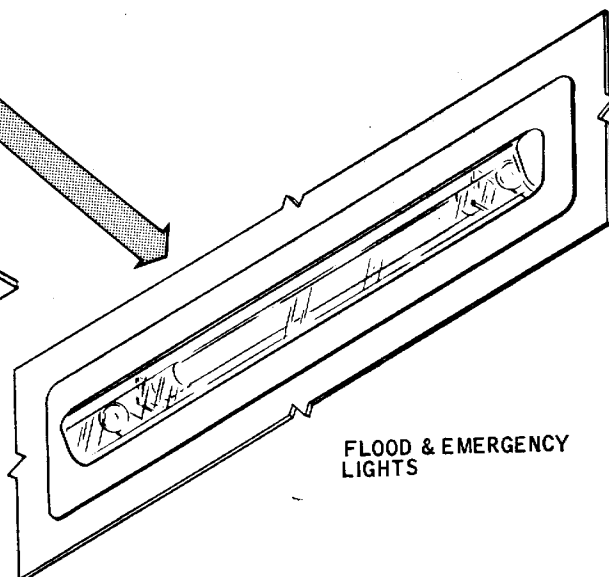
STAIR LIGHT SWITCH
Controls stair lights. May be used for inspection using viewing window in aft entrance door.



PRESSURE DOME
OVERHEAD LIGHT



STAIRWAY LIGHTS



FLOOD & EMERGENCY
LIGHTS

BB1-1037A

PASSENGER INFORMATION SIGNS

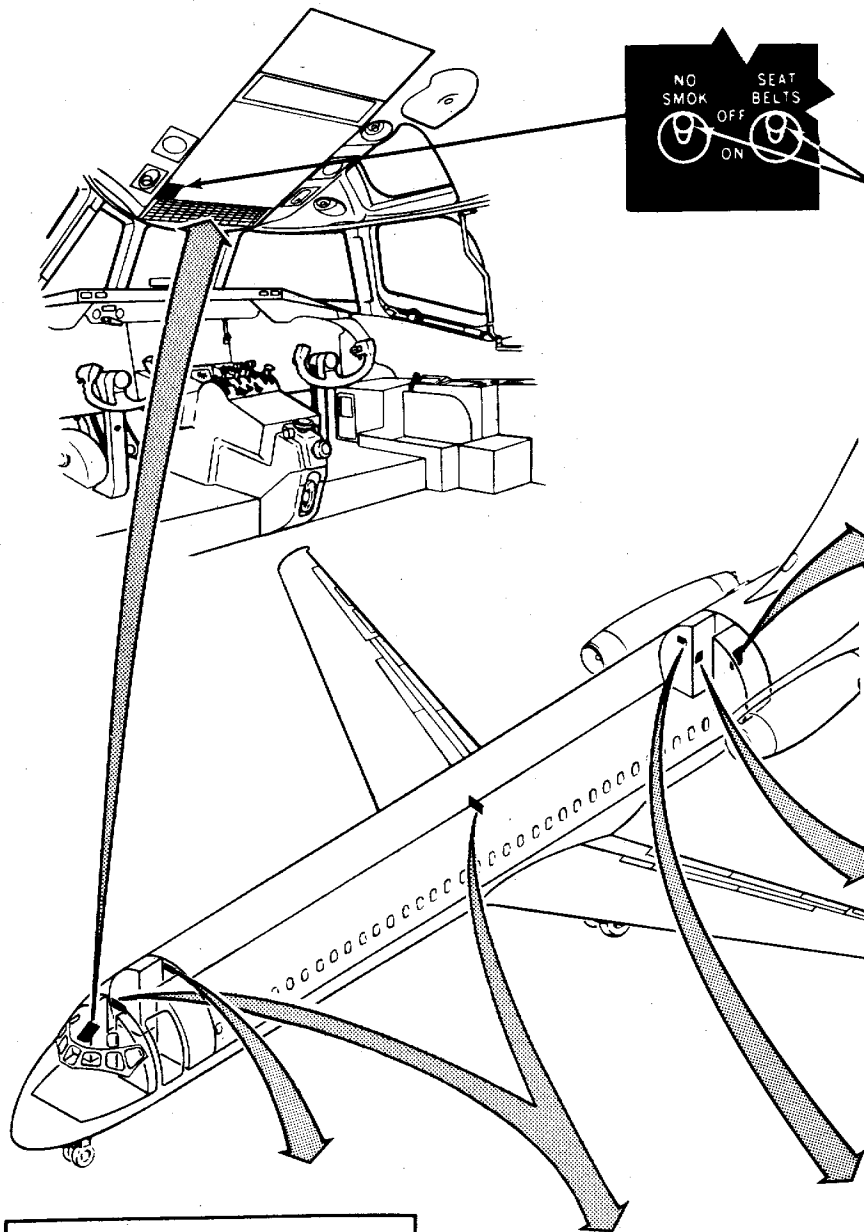
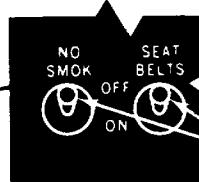
Lighted signs located throughout the passenger compartment provide specific instructions or pertinent information for the passengers.

The NO SMOKING and FASTEN SEAT BELTS signs are controlled by two switches located on the cockpit overhead panel.

The RETURN TO CABIN signs in the lavatories operate on the FASTEN SEAT BELTS circuit, and will come on when the SEAT BELTS switch is placed in the ON position.

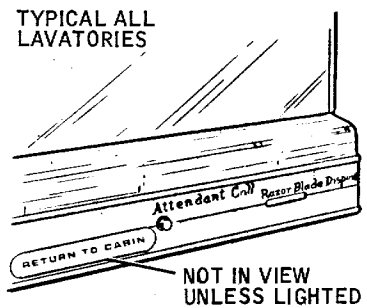
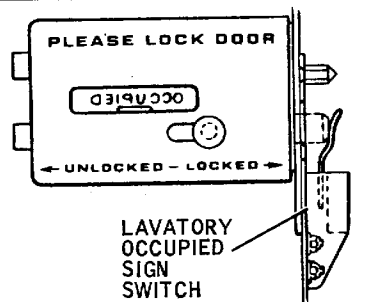
The LAVATORY OCCUPIED signs are turned on by actuation of a switch installed on the lavatory door latching mechanisms.

AIRPLANE GENERAL -- LIGHTING - Passenger information signs

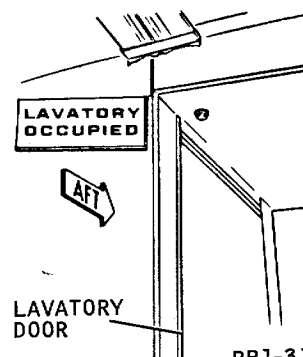


When NO SMOKING and FASTEN SEAT BELTS switches are placed in ON position, the corresponding signs located on the forward ceiling header will light. Also, the RETURN TO CABIN sign is actuated from the FASTEN SEAT BELTS switch.

TYPICAL ALL LAVATORIES



LAVATORY OCCUPIED sign is on when door is locked. Switch on door jamb is actuated by latching mechanism.



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CARGO AND SERVICE COMPARTMENT LIGHTING

The cargo and service compartment lights are installed in the various compartments and accessory areas to facilitate passenger and cargo loading, area inspection, and servicing. Control switches are installed in the compartments adjacent to the access doors. The cargo compartment lights can also be operated by switches at the cargo compartment viewing ports, located in the passenger compartment. The nose well and forward accessory compartment lights are controlled by switches on the external power receptacle panel, or they can be controlled by a switch located in the flight compartment. The main wheel well lights are controlled by switches on the external power receptacle panel and adjacent to the viewing port in the passenger compartment floor. A separate switch installed in the flight compartment controls the light in the electrical/electronics compartment.

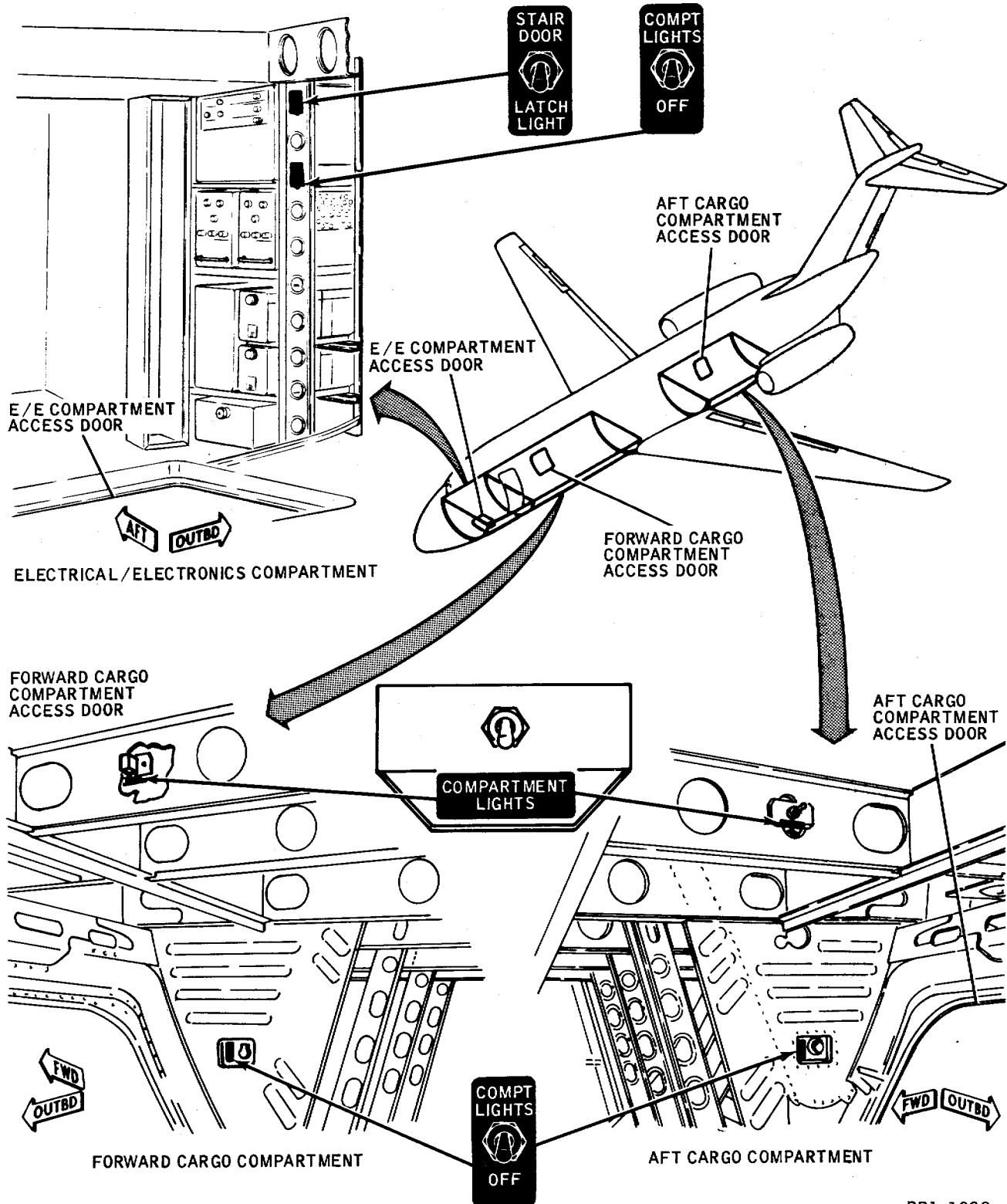
The fuel and water service panel light switches are installed on the respective fuel and water service panels.

Lights located in the tail section area and aft accessory compartment can be operated by either of two switches. Both switches are located just inside the access doors. Both light assemblies incorporate emergency lights (see emergency lighting systems). The forward passenger door stair lights are controlled by a switch that is actuated by the stair well door.

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AIRPLANE GENERAL -- LIGHTING - Cargo & service compartments



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EXTERIOR LIGHTING

The exterior light types and their location arrangement provide, through separate controls, a high-intensity light pattern that can be selectively modified to meet requirements of lighting in adverse weather conditions.

The lights consist of wing and nacelle floodlights, forward and aft position lights, ground floodlights, anti-collision lights, and landing and taxi lights.

The wing and nacelle floodlights are fixed-position assemblies installed in each side of the fuselage to visually check the engine nacelle and wing leading edge for icing conditions. The lights also have sufficient dispersement to facilitate ground fueling and to aid in taxiing. A 3-position OFF/ON/R ONLY switch on the glareshield controls the floodlights.

The forward and aft position lights consist of a red light on the left wingtip, a green light on the right wingtip, and a white light mounted on the trailing edge of the left and right wingtips. The position lights are controlled by a single ON/OFF switch.

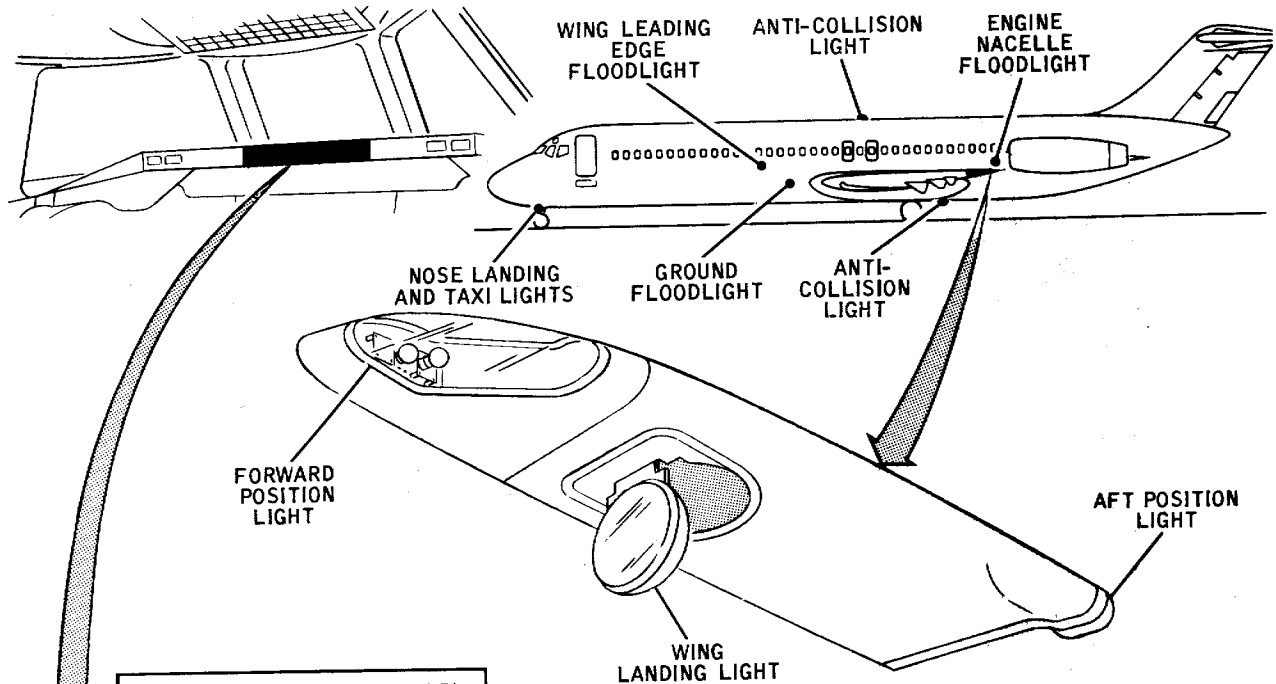
The ground floodlights provide area lighting for ground service and aid side visibility while taxiing. The lights are installed on each side of the fuselage, and are individually controlled by two ON/OFF switches.

Anticollision lights are installed on the upper and lower fuselage surfaces. The lights have a flashing frequency of 85 flashes a minute and are controlled by a single ON/OFF switch.

The landing and taxi lights consist of the nose gear landing and taxi lights and the wing landing lights. Two sealed-beam, fixed-position, combination landing and taxi lights are installed on the nose gear assembly. The circuit is interlocked with the landing gear control relays so that the lights will come on only when the landing gear control handle is in the down position. The nose gear landing and taxi lights are controlled by a single OFF/DIM/BR switch. One sealed-beam retractable landing light is installed on the lower surface of each wingtip. Each light assembly is enclosed in a housing and contains a motor to retract and extend the lights. The light mounting installation provides permanent directional alignment. The wing lights are individually controlled by two RET/EXT OFF/EXT ON switches.

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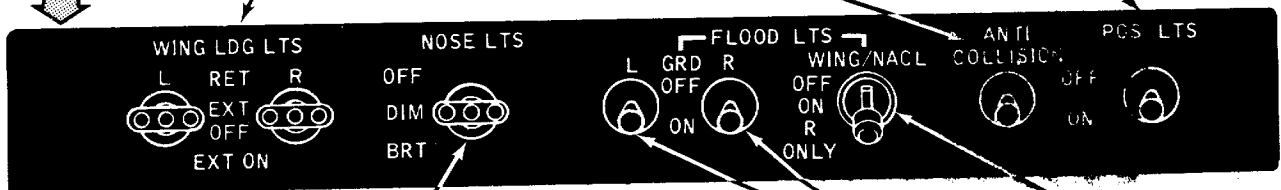
AIRPLANE GENERAL -- LIGHTING - Exterior



WING LANDING LIGHTS (L and R)
 RET - Wing landing lights retracted and off.
 EXT OFF - Wing landing lights fully extended and off.
 EXT ON - Wing landing lights fully extended and on.

ANTI-COLLISION LIGHTS
 2-position switch operates anti-collision lights on top and bottom of fuselage.

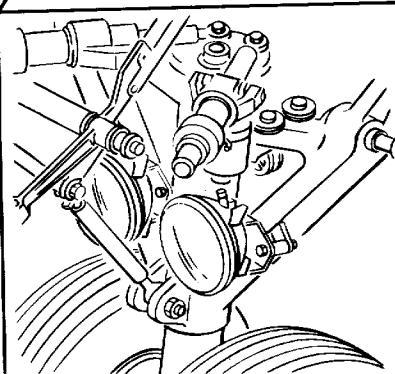
POSITION LIGHTS
 2-position switch operates wing tip lights, green on right and red on left, and a white light on the trailing edge of each wing tip.



NOSE LANDING AND TAXI LIGHTS
 OFF - Nose landing and taxi lights are off.
 DIM - Nose landing and taxi lights are dim.
 BRT - Nose landing and taxi lights are bright.

NOTE

Nose landing and taxi lights automatically turn off when landing gear handle is out of the DOWN detent.



FLOODLIGHTS - GROUND (L and R)

Two 2-position switches operate fixed position floodlights on each side of fuselage, for side and forward taxiing.

FLOODLIGHTS - WING/NACELLE

ON - Both wing leading edge and both engine nacelle floodlights are on.
R-ONLY - Only right wing leading edge and right engine nacelle light comes on.

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STANDBY LIGHTING

The standby lighting system is installed to provide lighting in the main cabin in the event the normal electrical power supply fails. The system is composed of separate bulbs located in the normal lighting fixtures in the ceiling. The standby lights are powered by 28 volt dc power from the airplane batteries through the EMERGENCY DC BUS, and are controlled by the EMER PWR switch on the overhead panel. The lights will provide illumination for a minimum of 45 minutes.

EMERGENCY LIGHTING

The emergency evacuation lighting system is installed to provide illumination of the cabin and overwing exit area to facilitate evacuation of the airplane. The evacuation light system is comprised of separate bulbs at intervals in the ceiling light troughs, over all of the exits, and in the exterior, engine nacelle ice inspection floodlight assemblies. When the overwing exit doors are removed, the overwing exit signs provide exterior illumination of the escape path below the exits on the wings. The engine nacelle floodlights provide illumination of the area to the rear of the wings.

The interior emergency evacuation lighting system is powered by 2.5 volt battery packs. The exterior emergency evacuation system is powered by two, 28 volt battery packs. The emergency evacuation lights are designed to come on automatically whenever a power loss is experienced on the DC EMERGENCY BUS and the control switch is in the ARM position. The lights will also come on for test purposes whenever the EMER LTS switch is held in the momentary ON

position with the DC EMERGENCY BUS energized. To secure the emergency lights system at the end of a flight, the EMER LTS switch must be placed at OFF while the DC EMERGENCY BUS is energized. If the electrical system is turned OFF with the switch in the ARM position, the lights will come ON, and cannot be turned OFF until power is restored to the DC EMERGENCY BUS and the EMER LTS switch is placed at OFF.

NOTE: If the evacuation lights come on inadvertently as a result of removing normal electrical power, and the battery switch is still ON, placing the EMER LTS switch OFF will cause the evacuation lights to go out; however, when the battery switch is subsequently turned OFF, the lights will come back on again. Therefore, either the ON position of the emergency power switch, or normal bus power from the APU or external power must be used to turn OFF the emergency evacuation lights and keep them OFF.

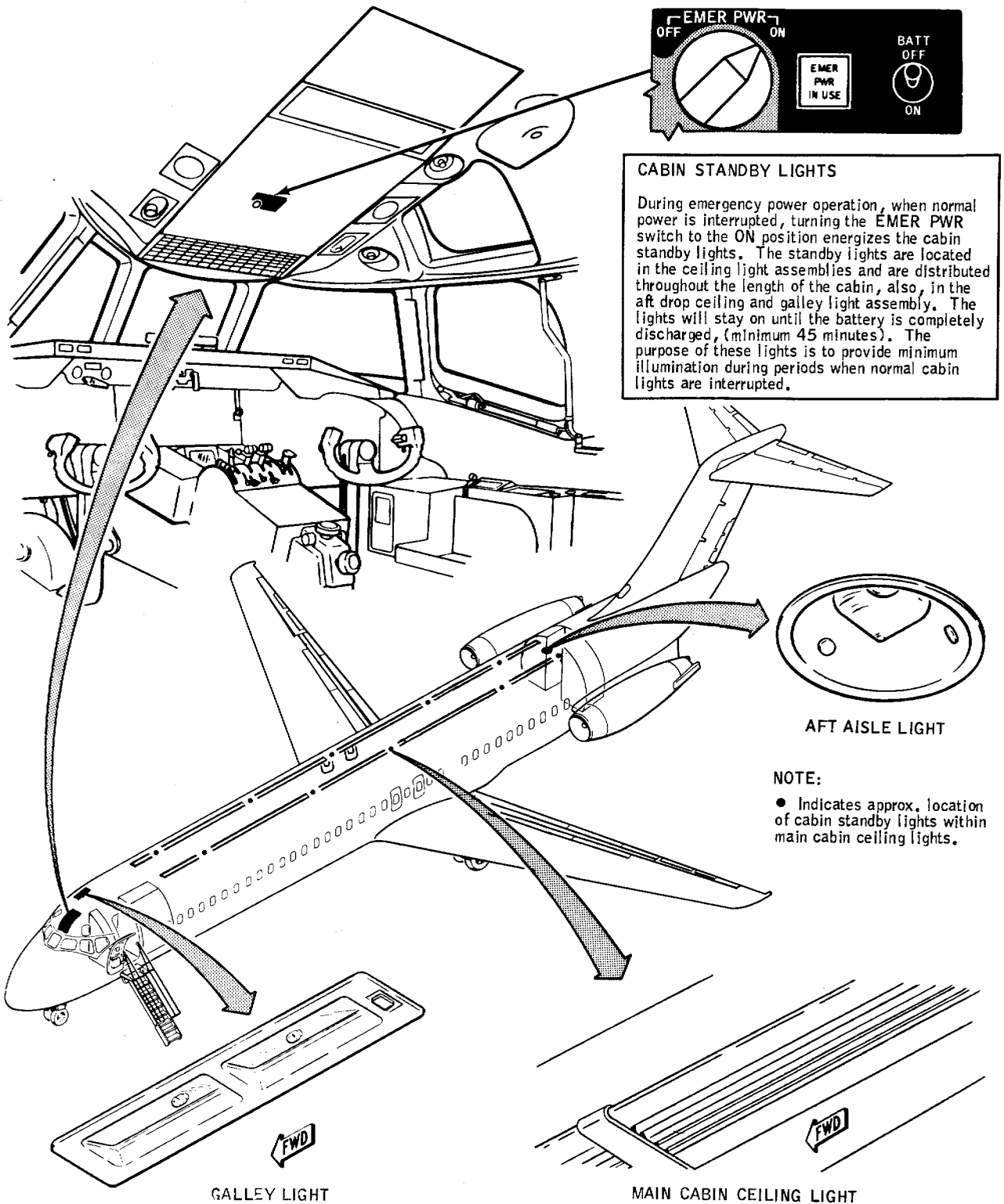
An additional EMERGENCY LIGHTS switch is located on the forward cabin attendant's control panel. This switch has a guarded OFF position, an ON position, and a momentary ARM position. The guard is normally lockwired. Placing this switch momentarily to ARM and then to ON, will turn on the emergency lights regardless of the position of the cockpit EMER LTS switch or the status of the electrical system. Moving the cabin emergency lights switch simply from OFF to ON will not turn the lights ON. Once the lights are ON, they cannot be turned OFF at the cabin attendant's station. To turn OFF the lights (once turned ON at the attendant's panel), both the CABIN EMERGENCY LIGHTS switch and the

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cockpit EMER LTS switch must be OFF while the DC EMERGENCY BUS is energized.

One emergency evacuation light is a portable, self-contained unit. This light is located on the cabin forward bulkhead adjacent to the passenger entrance door. The light operates in the "system," or can be removed and used as a flashlight. When the unit is installed in the airplane emergency lights circuit and the EMER LTS switch is at ARM, a small, amber lamp in the unit glows to indicate that the battery packs are receiving charging current from the DC EMERGENCY BUS. When the EMER LTS switch is at OFF, the battery packs are charged by the DC TRANSFER BUS, if energized; but the small, amber charging lamp in the unit does not glow.

AIRPLANE GENERAL -- LIGHTING - Cabin standby lights



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AIRPLANE GENERAL -- LIGHTING - Emergency evacuation (sheet 1)

OVERHEAD PANEL EMERGENCY EVACUATION LIGHTS SWITCH

NOTE: The following assumes the forward attendant panel EMERGENCY LIGHTS switch is in the guarded OFF position.

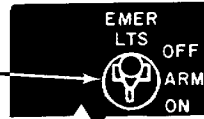
OFF: Annunciator panel light is on, evacuation lights are off; battery packs being charged from DC transfer bus; portable pack 28-volt lamp is off.

ARM: Normal flight position; annunciator panel light is off; evacuation lights are off; battery packs being charged from emergency DC bus; portable pack 28-volt lamp is on. In case of total power failure, evacuation lights come on until battery packs are discharged.

ON: Simulates emergency DC bus power failure; annunciator panel light is on; evacuation lights are on.

CAUTION: Limit test operation to 1 minute to extend bulb life.

OVERHEAD PANEL EMERGENCY LIGHT



EMER LIGHT NOT ARMED
 ANNUNCIATOR PANEL

PASSENGER FORWARD ENTRANCE DOOR LIGHT

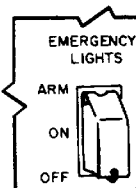
FORWARD SERVICE DOOR LIGHT

1. LIFT TABS AND PUSH BUTTONS TO REMOVE
2. PULL ELEC. PLUG ON BACK TO USE AS PORTABLE FLASHLIGHT

PORTABLE EMERGENCY LIGHT

Light is a portable self contained unit. It operates on the system circuit or can be removed and used as a flashlight. To use as portable flashlight, disconnect electrical plug and place ON/OFF switch, located on unit, to ON. To install portable light into its receptacle, connect electrical plug, lift tabs, push buttons in, and close tabs. When the light is used in the airplane circuit with the emergency light power switch placed in the ARM position, an amber lamp in the unit glows continually to provide visual indications that the battery pack is being charged.

FWD ATTENDANT'S PANEL



FORWARD ATTENDANT'S PANEL EMERGENCY EVACUATION LIGHTS SWITCH

NOTE: Emergency lights controlled from the attendant panel can be operated independently of the position of EMER LTS switch on overhead panel in flight compartment.

OFF: Guarded OFF position (emergency evacuation lights can be normally controlled by switch in flight compartment).

ARM: Momentary ARM position cocks electrical circuit for subsequent use.

ON: With switch in ON position after arming, evacuation lights will come on regardless of the position of the flight compartment's EMER LTS switch. The lights will remain on until the batteries discharge.

CAUTION: Emergency evacuation lights can not be turned off unless EMERGENCY DC BUS is powered.

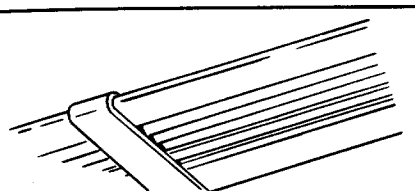
BB1-4077A

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AIRPLANE GENERAL -- LIGHTING - Emergency evacuation (sheet 2)

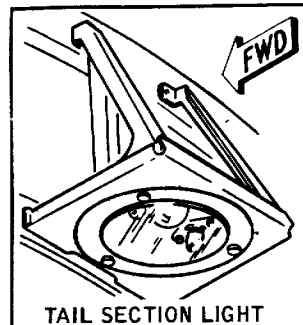
NOTE:

The evacuation light system consists of two lights in the cockpit, lights and lighted exit signs in the passenger compartment, lights in the ventral stairway and tail section, and engine nacelle floodlights. The lights are powered by rechargeable battery packs that supply power for approximately 15 minutes. When the system is armed, the evacuation lights go on if a total power loss occurs, or if power is removed from the EMERGENCY DC BUS. When disarming system, the emergency light switch on the overhead instrument panel and on the forward attendant's panel must be in the OFF position before power is removed from the airplane buses to prevent evacuation lights from coming on.

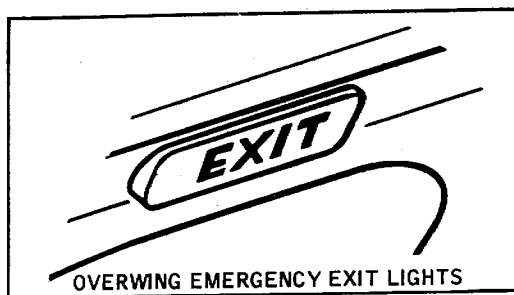


MAIN CABIN CEILING LIGHTS

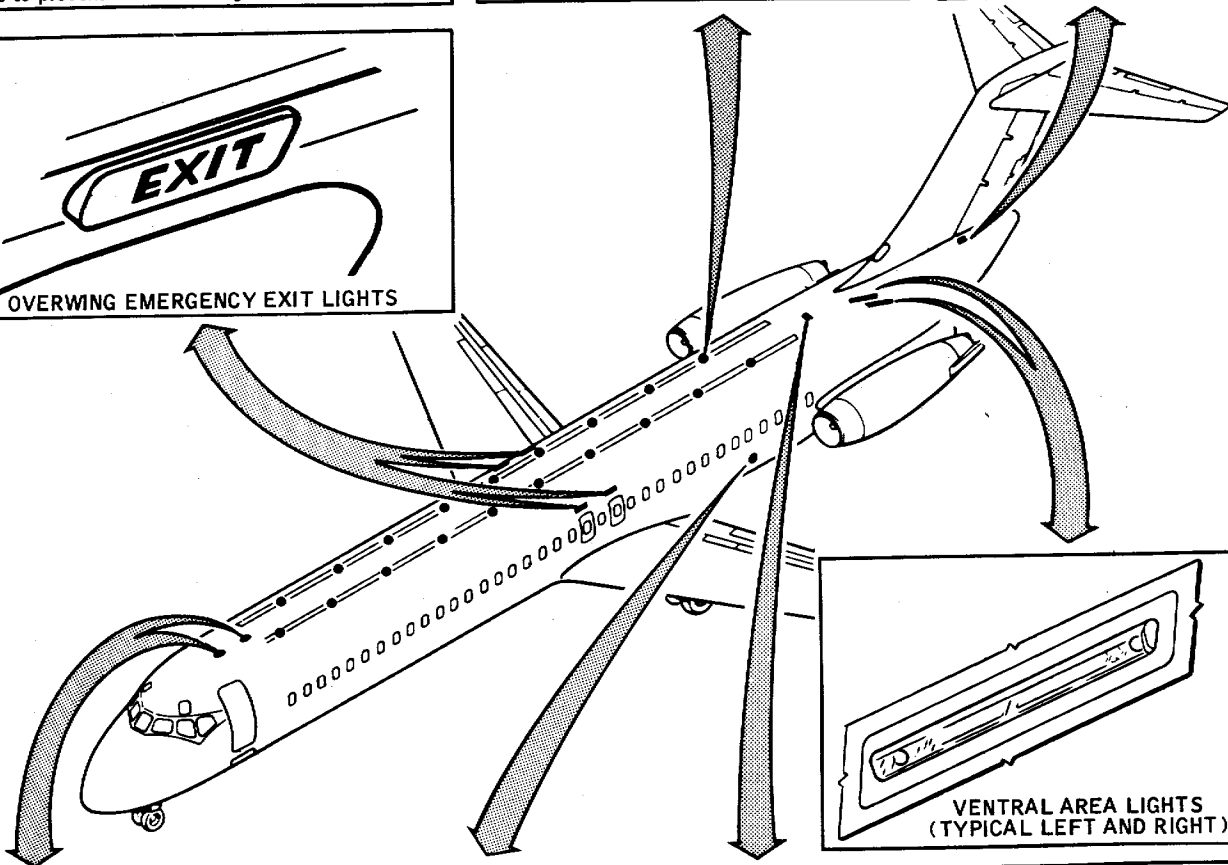
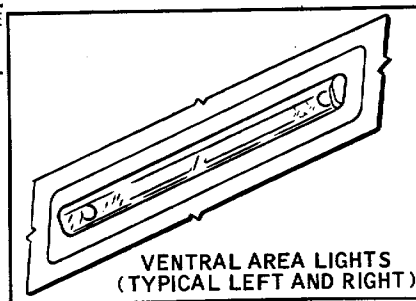
NOTE: ● Indicates approx. location of emergency evacuation lights within main cabin ceiling lights.



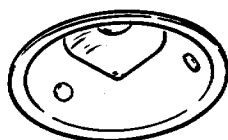
TAIL SECTION LIGHT



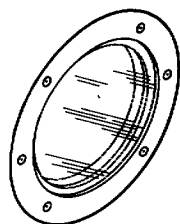
OVERWING EMERGENCY EXIT LIGHTS



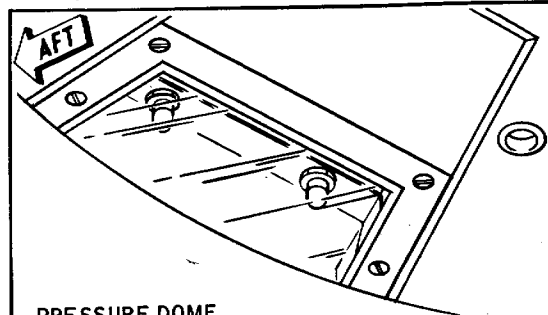
**VENTRAL AREA LIGHTS
(TYPICAL LEFT AND RIGHT)**



**FWD AISLE
LIGHTS**



**ENGINE NACELLE
FLOODLIGHT**



**PRESSURE DOME
EMERGENCY EXIT LIGHT**

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EMERGENCY EQUIPMENT AND EXITS

Emergency equipment includes the escape lines, escape slides, first aid kit, first aid oxygen, portable fire extinguishers, fire axe, life rafts (if installed), and emergency evacuation lights. In addition, the passenger seat cushions have straps installed to facilitate use as flotation gear.

Emergency escape from the airplane can be made through the passenger forward entrance door and escape slide, forward service door and escape slide, overwing emergency exit doors, clearview windows in the flight compartment, aft passenger entrance door and stairway, and, when the aft stairway is inoperative, through the aft section with the stairway ceiling in the down position to form a walkway over the stairs and with the tail cone jettisoned.

FIRST AID KIT

A first aid kit containing the necessary equipment to administer emergency first aid is located in the passenger compartment.

FIRE EXTINGUISHERS

Portable fire extinguishers are installed in the airplane. For location and operation, see illustration titled Emergency Equipment and Exit Locations (Sheet 4).

FIRE AXE

An emergency fire axe is secured to the bulkhead behind the captain's station in a quick-release bracket.

EMERGENCY ESCAPE LINES

One emergency escape line is installed over each clearview window in the

flight compartment and one is installed in the aft accessory compartment. The lines are coiled in a container when stowed. One end of each line is secured to the airplane structure above the container. When used for emergency escape, the free end of the line is extended through the open window in the flight compartment or through the aft accessory compartment after the tail cone has been jettisoned. In addition, one emergency escape line is installed over each overwing emergency exit door. The lines are coiled on reels in a container above each door. The end of the line becomes visible when the door is removed.

CLEARVIEW WINDOW - FLIGHT COMPARTMENT

Two clearview windows are located aft of the windshield side sections and below the upper windows on the right and left sides of the airplane. When the airplane is unpressurized, these windows can be opened. Open the clearview window as follows:

1. Pull handle aft to disengage overcenter lock.
2. Pull handle inboard to move window inboard.
3. Pull handle aft so that window slides aft to an open locked position.

EVACUATION SLIDES

Inflatable, fire-resistant evacuation slides are installed in the passenger forward entrance door, forward service door and at the aft end of the walkway in the tail section. A cover is installed over the stowed slide to protect the slide and hold it in place. (See illustration titled EMERGENCY EQUIPMENT AND EXIT LOCATIONS (Sheet 3).)

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OVERWING EMERGENCY EXITS

Emergency exit doors are located in the over-the-wing area in the passenger compartment. These doors are approximately 22 x 38 inches. The doors are secured at the bottom by rigid bayonets, which fit into the lower section of the doorjamb, and at the top by a mechanical latch, which locks into the upper section of the doorjamb. The doors may be unlatched from either inside or outside of the airplane. A pull of approximately 20 pounds on either handle will release the latch and allow the door to fall inward into the passenger compartment. Removed doors can be jettisoned overboard through the exit opening. The armrests on the passenger seats adjacent to the overwing emergency exit doors may be folded up flush to the back of the seats to provide an obstruction-free escape path.

Vortex generators are located on the leading edge of the flaps (and on the wing of some series 10 airplanes), approximately 4 1/2 feet from the fuselage. The generators on the flaps are visible only when the flaps are extended.

CAUTION: CARE SHOULD BE EXERCISED WHEN USING THIS AREA FOR EMERGENCY EVACUATION TO PRECLUDE INJURY TO PERSONNEL AND DAMAGE TO LIFE RAFTS (IF INSTALLED).

AFT PASSENGER COMPARTMENT EMERGENCY ESCAPE

Provisions are incorporated for aft passenger compartment emergency exit when conditions do not permit use of the passenger aft entrance stairway. The stairway ceiling in the down position forms a walkway to gain access to the tail cone jettison mechanism.

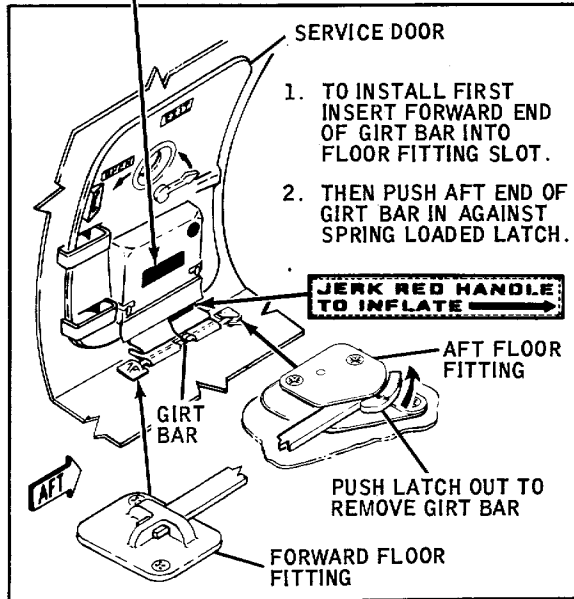
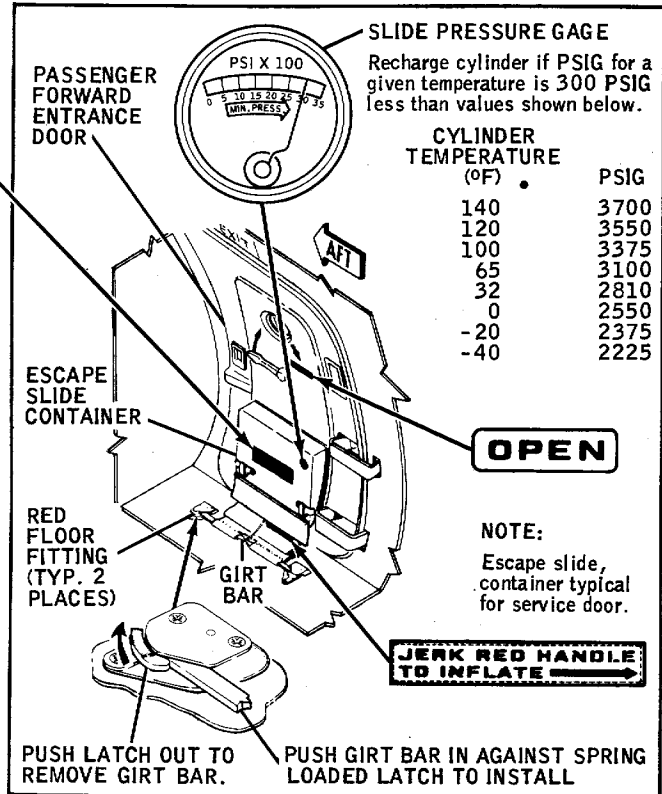
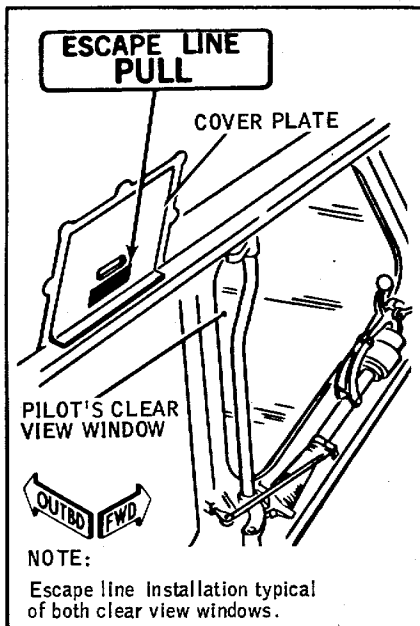
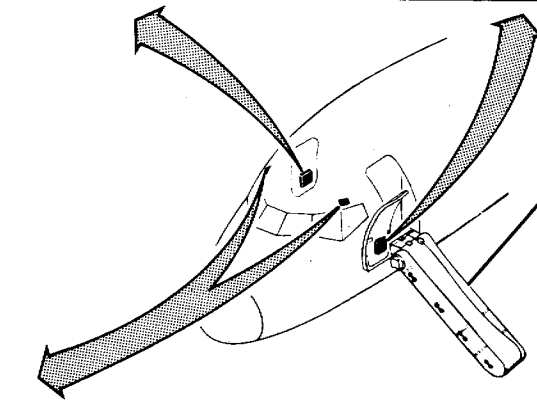
TAIL CONE EMERGENCY EXIT

The tail cone is attached to the aft end of the fuselage and is jettisonable. The tail cone, when jettisoned, provides an emergency exit accessible from the passenger compartment through the passenger aft entrance door, and a walkway formed by the upper surface of the stairway ceiling when lowered. The release handles, one internal and one external, are located on the left side of the airplane, immediately forward of the tail cone. When either of these handles is pulled, the tail cone falls free of the fuselage. An access door, openable from the outside only, is installed in the lower surface of the tail cone.

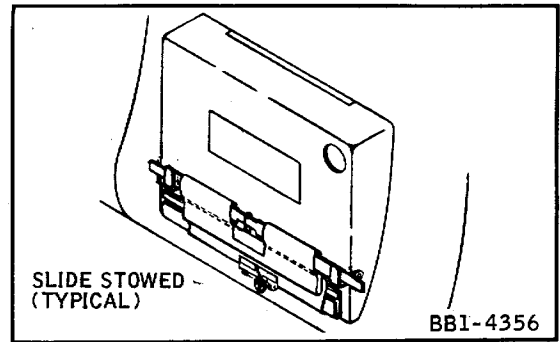
AIRPLANE GENERAL -- EMERGENCY EQUIPMENT & EXIT LOCATIONS (sheet 1)

ESCAPE SLIDE

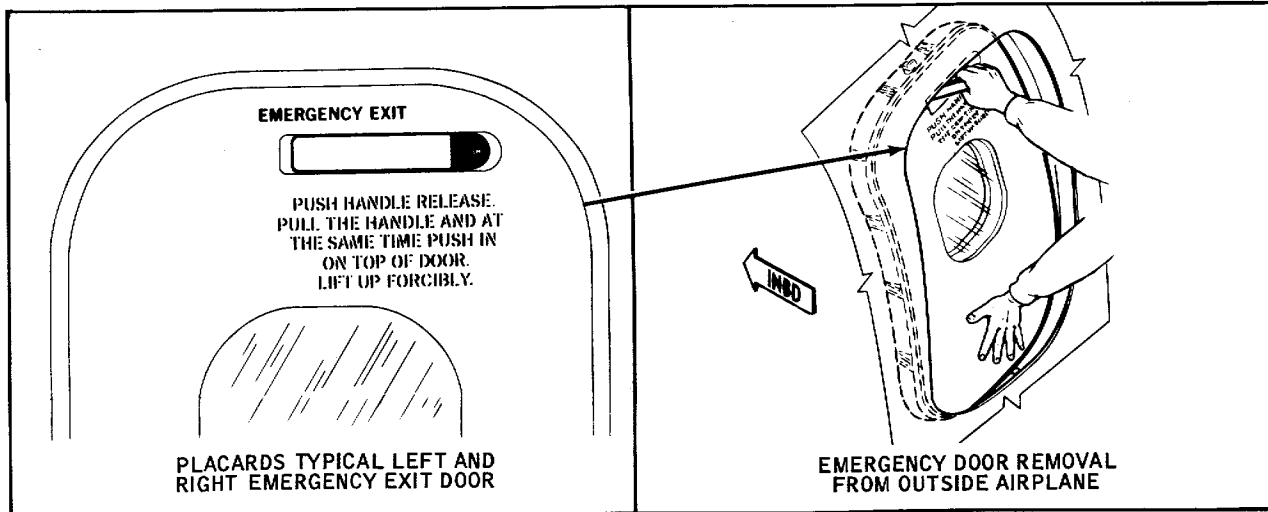
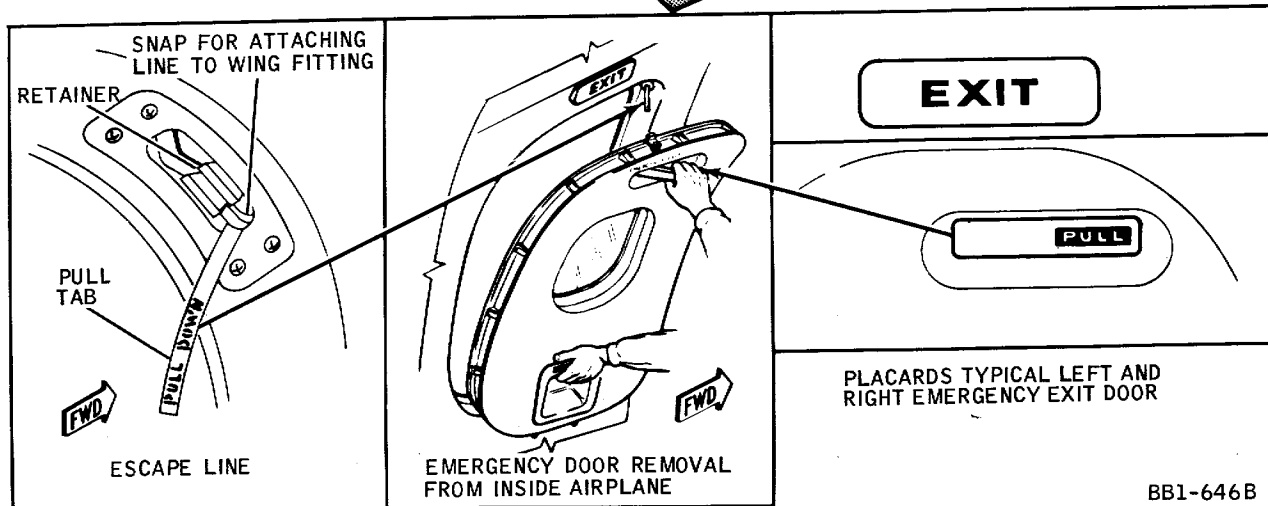
- TO OPERATE
 1. OPEN AIRPLANE ENTRY DOOR
 2. PULL INFLATION HANDLE



CAUTION:
 DO NOT OPEN DOORS FOR NORMAL USE UNTIL SLIDES ARE PROPERLY STOWED.

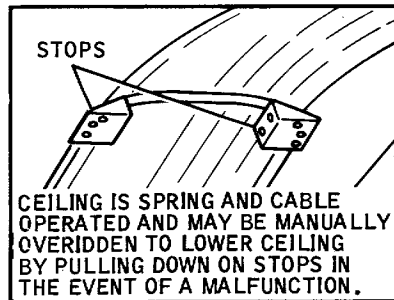
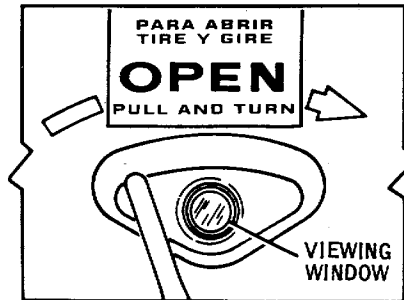


AIRPLANE GENERAL--EMERGENCY EQUIPMENT & EXIT LOCATIONS (sheet 2)

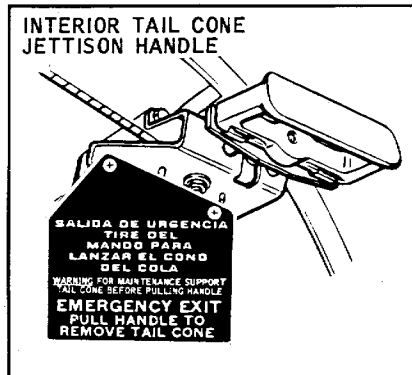
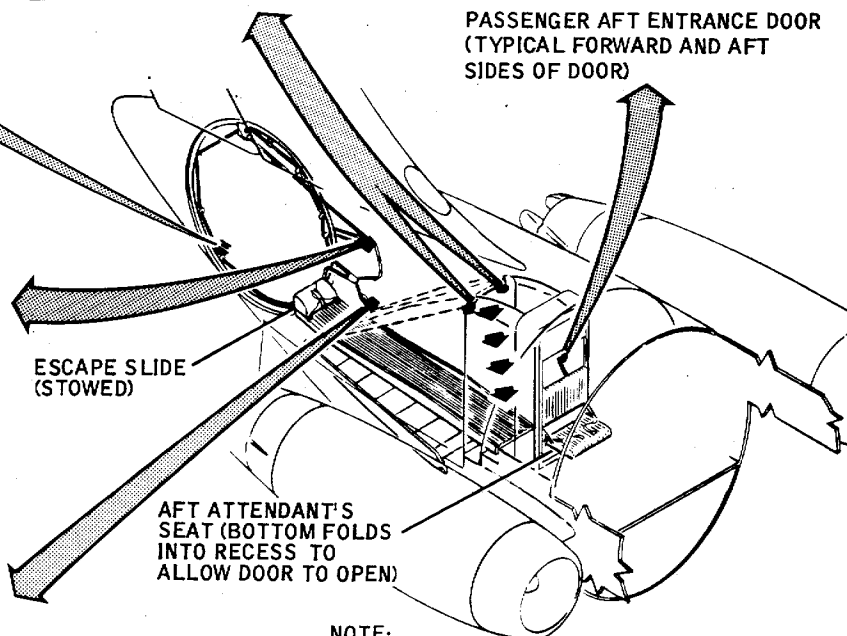
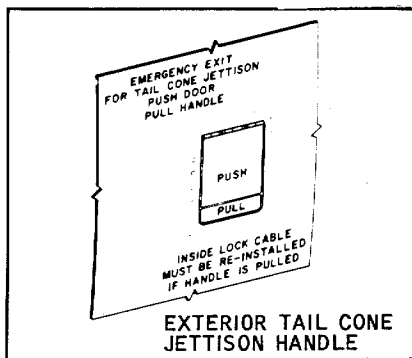


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AIRPLANE GENERAL -- EMERGENCY EQUIPMENT & EXIT LOCATIONS **(sheet 3)**



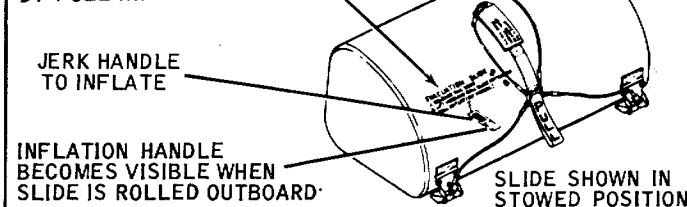
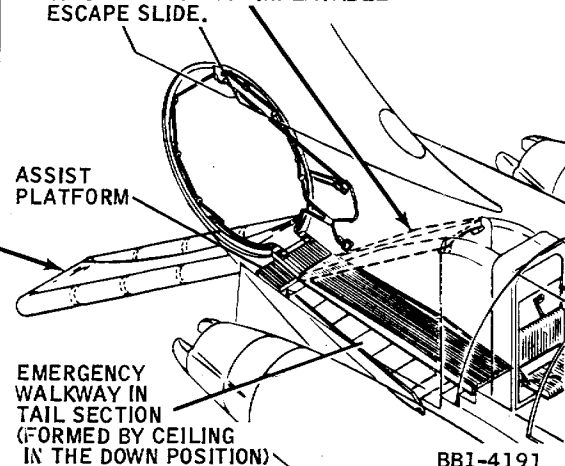
PASSENGER AFT ENTRANCE DOOR
 (TYPICAL FORWARD AND AFT SIDES OF DOOR)



NOTE:
 NORMALLY SLIDE IS AUTOMATICALLY DEPLOYED AND INFLATED WHEN TAIL CONE IS JETTISONED. IF A MALFUNCTION OCCURS MANUALLY OPERATE SLIDE PER INSTRUCTIONS STENCILED ON SLIDE.

NOTE:
 CEILING AUTOMATICALLY RAISES WHEN STAIRS ARE EXTENDED. CEILING AUTOMATICALLY LOWERS WHEN STAIRS RETRACT FORMING A WALKWAY TO THE TAIL CONE JETTISON HANDLE AND INFLATABLE ESCAPE SLIDE.

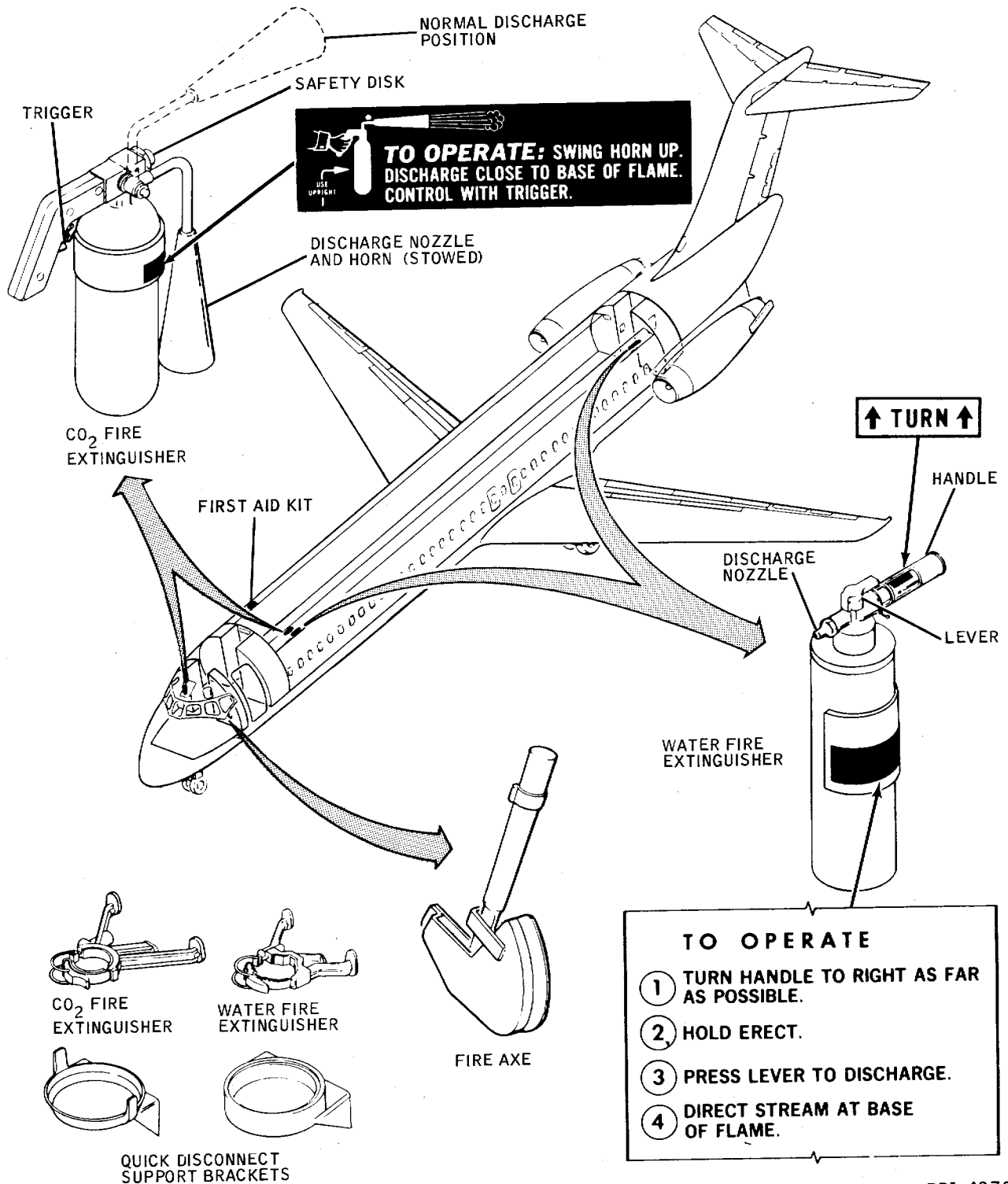
- EVACUATION SLIDE**
1. RELEASE TAIL CONE
 2. LIFT HERE AND ROLL SLIDE OUTBOARD
 3. PULL INFLATION HANDLE



BBI-4191

Section 3
 1-45-1
 CODE 59
 Page 3

AIRPLANE GENERAL -- EMERGENCY EQUIPMENT & EXIT LOCATIONS **[sheet 4]**



BB1-4270

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 23, SECTION 3, CHAPTER 5, DATED MAR 1/71

SUMMARY: ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL ADJACENT TO THE CHANGE.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
3-5-Eff	66	All	3-5-Eff	66	All
3-5-10-1	50	1 and 2	3-5-10-1	50	1 and 2

Mar 1/71

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3-5 Summary
CODE 66
Page 1 of 1

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 3-5

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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3-5-Cont	66	1	Dec 1/70
3-5-Cont	66	2	Dec 1/70
3-5-Cont	66	3	Dec 1/70
3-5-1-0	1	1	Sep 1/66
3-5-1-0	1	2	Aug 15/65
3-5-5-1	7	1	Sep 1/66
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3-5-5-1	7	3	Sep 1/66
3-5-5-1	7	4	Sep 1/69
3-5-5-1	7	5	Jun 1/68
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3-5-5-2	1	2	Dec 1/65
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3-5-10-3	66	1	Jun 1/70
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*The asterisk indicates pages revised or added by the current revision.

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Chapter 5

ELECTRICAL SYSTEMS

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*CIRCUIT BREAKER PANELS - Electrical power center (EPC) locations	5-10-2	1	66	A11
*CIRCUIT BREAKER PANELS - Upper EPC instrument & radio buses	5-10-2	2	66	A11
*CIRCUIT BREAKER PANELS - Upper EPC ac buses	5-10-2	3	66	A11
*CIRCUIT BREAKER PANELS - Lower EPC dc buses	5-10-3	1	66	A11
*CIRCUIT BREAKER PANELS - Lower EPC ground service bus & dc transfer bus	5-10-3	2	66	A11
*CIRCUIT BREAKER PANELS - EPC generator bus	5-10-3	3	66	A11

*Illustration

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*CIRCUIT BREAKER PANELS - Cabin miscellaneous	5-10-6	1	19	A11
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*Illustration

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CHAPTER 5
ELECTRICAL SYSTEMS

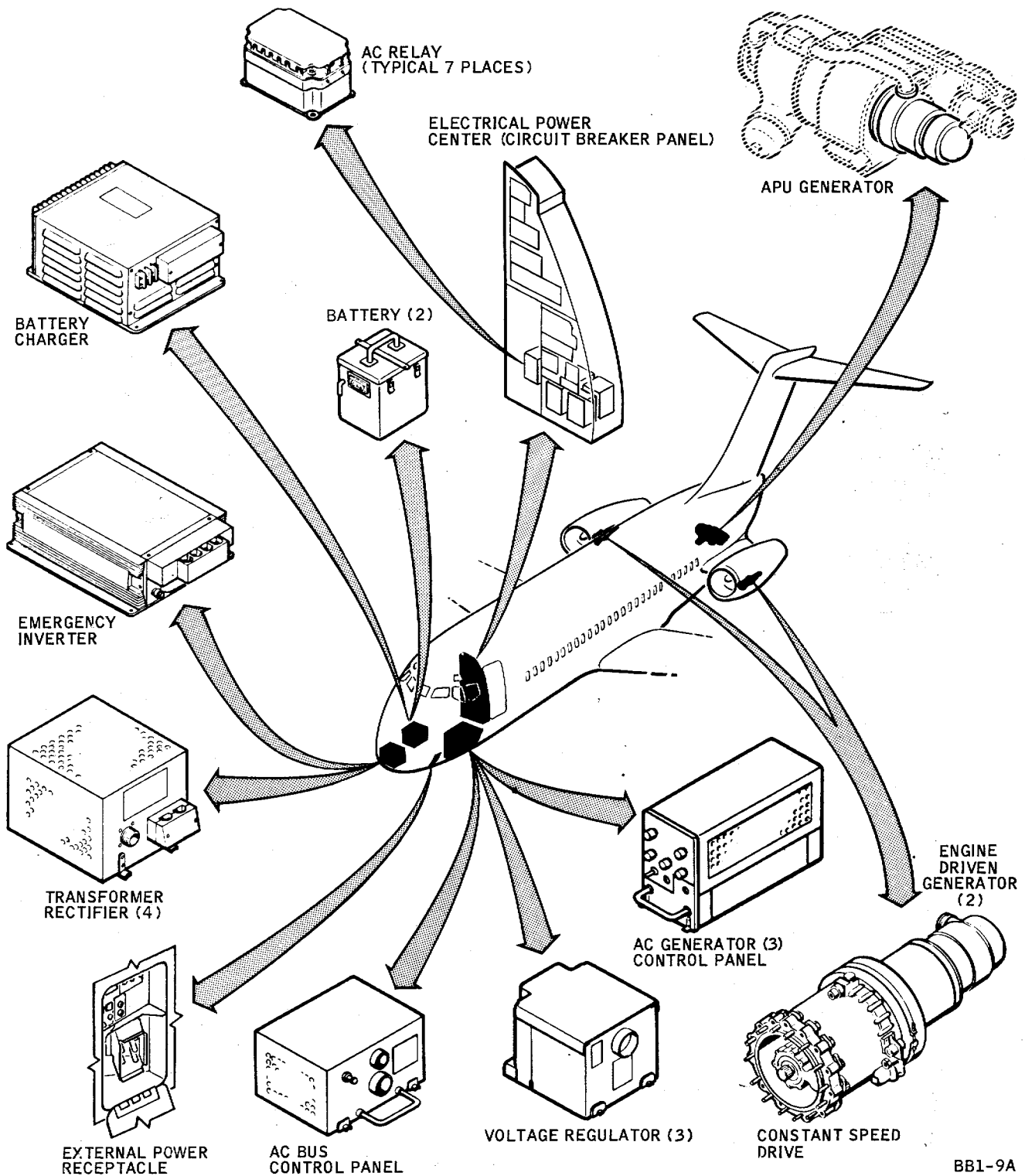
GENERAL

The airplane electrical power system consists of a 115/200-volt, 400-cps, 3-phase ac power generating and power distribution system that furnishes power to the ac, and emergency ac, buses. For control circuits, lighting, and other load devices requiring dc power, 115-volt ac power from the ac power distribution buses is converted to 28-volt dc power by transformer-rectifiers. For instrument power, 115-volt ac power from the ac buses is reduced to 28-volt ac by single-phase transformers. Power for certain portions of the dc system is supplied by two batteries, when the main power distribution system is deenergized. Power for APU starting is supplied by the batteries.

An inverter, powered from the battery bus, supplies single-phase, 115-volt, 400-cps, ac power for emergency use when all other sources of ac power have been lost. The inverter also supplies ac power to the refueling system when normal electrical power is not available.

A battery charger, powered from an ac bus, maintains the batteries in a charged condition.

ELECTRICAL -- MAJOR COMPONENT LOCATION



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AC POWER GENERATING SYSTEM

Ac power is normally supplied by any two of three ac generators, one on each engine, and one on the APU. Each generator is rated at 40-kva maximum continuous output and is capable of supplying more than sufficient power for operation of essential electrical systems, in the event of loss of the other two generators. The APU generator is mounted directly on the APU and is driven at a constant speed. The two engine-driven generators extract power from the engine through a constant-speed drive (CSD), which converts the variable speed output of the engine to a constant speed to maintain a constant-frequency output from the generators. Each CSD has a self-contained lubrication system and an oil temperature indicating system which shows the oil-out temperature and oil temperature rise across the drive. Each CSD is provided with a disconnect switch in the cockpit which will uncouple the CSD from the engine in the event of a malfunction of the generator or the CSD. Once disconnected, the CSD must be engaged manually at the engine after engine shutdown. Fault protection is incorporated in each generator control circuit to remove the generator from its bus and deenergize the generator, in the event of certain circuit malfunctions. The generators may be restored to operation when the malfunction is corrected.

AC POWER DISTRIBUTION SYSTEM

The ac power distribution system is divided into two separate systems operating independently of each other, but with crosstie capabilities. The right and left generators supply

power directly to the respective generator buses for distribution to the respective systems. Power from the APU generator may be routed to both generator buses simultaneously when neither of the engine-driven generators is operating, or directly to the ac ground service bus when only ground service power is required.

The loads, comprising the hydraulic pumps, ground blowers, horizontal stabilizer power, and galley power, are supplied directly from the generator buses. On the left system, the remaining power is routed to the ac bus to furnish power for small ac loads, single-phase ac power, and power for transformer-rectifiers. The right system is identical, with the exception that part of the power is routed through the ground service ac bus. The right ac bus supplies the remaining ac power for that side.

The ac ground service bus provides a means of supplying power to those circuits necessary for ground-servicing operations without having to energize the remainder of the electrical system. Power to the ac ground service bus is supplied directly from the external power receptacle or the APU generator, provided the right generator bus is not energized and, in turn, supplies power to the battery charger and right No. 2 transformer-rectifier. When the right generator bus is energized, the ac ground service bus functions as a part of the ac bus, receiving power directly from the right generator bus. When desired, all ac buses may be energized through the external power receptacle.

There is a priority control of ac power distribution. That is, if the APU generator is supplying power to a bus, and an engine-driven generator is placed on the bus, the APU generator will automatically be taken off

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the bus. If external power is supplying power to a bus, and either the APU or main generator is placed on the bus, external power will automatically be taken off the bus, and the other generator will take the load for that bus.

The shutdown of a generator, for any reason other than a fault on that generator bus, will automatically transfer the load from that generator to the remaining operative generator. Should a generator become inoperative because of a fault on its own bus, or due to differential fault protection action, the ac crosstie relay will lock open, isolating that bus from the rest of the system. The loads connected to the bus will remain deenergized until the fault on the bus is cleared. The loads on the other generator will not be affected.

DC POWER DISTRIBUTION SYSTEM

The function of the dc power distribution system is similar to that of the ac system in that the right and left systems function separately. The dc system has a manual crosstie in the event of failure of either side. In addition to the left and right systems, dc power is supplied from two batteries. In the left dc system, power is supplied by two transformer-rectifiers (TR's), both of which receive power from the left ac bus. In the right system, No. 1 TR is powered from the right ac bus, and No. 2 TR is powered from the ac ground service bus. When the ac ground service bus is receiving power from the generator bus, the two TR's are connected through the dc ground service tie relay and furnish power to the right dc bus. However, when the ac ground service bus is powered from either external power or direct

from the APU, the right No. 1 TR is isolated and only right No. 2 TR supplies power to the dc transfer bus. The dc bus crosstie differs from the ac system in that the relay is not automatic and must be opened or closed from the electrical power control panel. In addition to supplying power to the respective dc buses, the transformer-rectifiers supply power to the ground refueling system, and to the dc transfer bus for engine starting.

If the dc ground service bus is powered, the APU starter and control circuits are automatically supplied electrical power from the dc ground service bus. If the dc ground service bus is not powered, the APU starter and control circuits receive power from their normal buses.

Two 14-volt batteries are connected in series to supply 28-volt dc power to the battery direct bus, regardless of battery switch position. When the battery switch is in the ON position, the battery bus is energized; and the batteries are connected to the dc transfer bus when the right and left dc buses are not energized, except when ground service power is being used. The batteries are being charged when the battery switch is in the ON position and the ground service ac bus is energized, either by the right generator bus or by the ground service ac power panel. When the emergency power switch is in the ON position, the batteries are connected to the dc emergency bus.

EMERGENCY AC AND DC POWER SUPPLY

During normal operation, the emergency ac bus receives single-phase ac power from the left ac bus and the emergency dc bus receives power from the left dc bus. The loss of power to the left

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generator bus will transfer the emergency ac bus to the right ac bus, and the emergency dc bus will be powered from the right dc bus. In the event of complete loss of power, the batteries will provide both ac and dc emergency power when the emergency power switch is placed in the ON position. The dc emergency bus will be powered from the battery direct bus, which will also power the emergency inverter to provide power to essential instruments for approximately 45 minutes.

DC EXTERNAL POWER

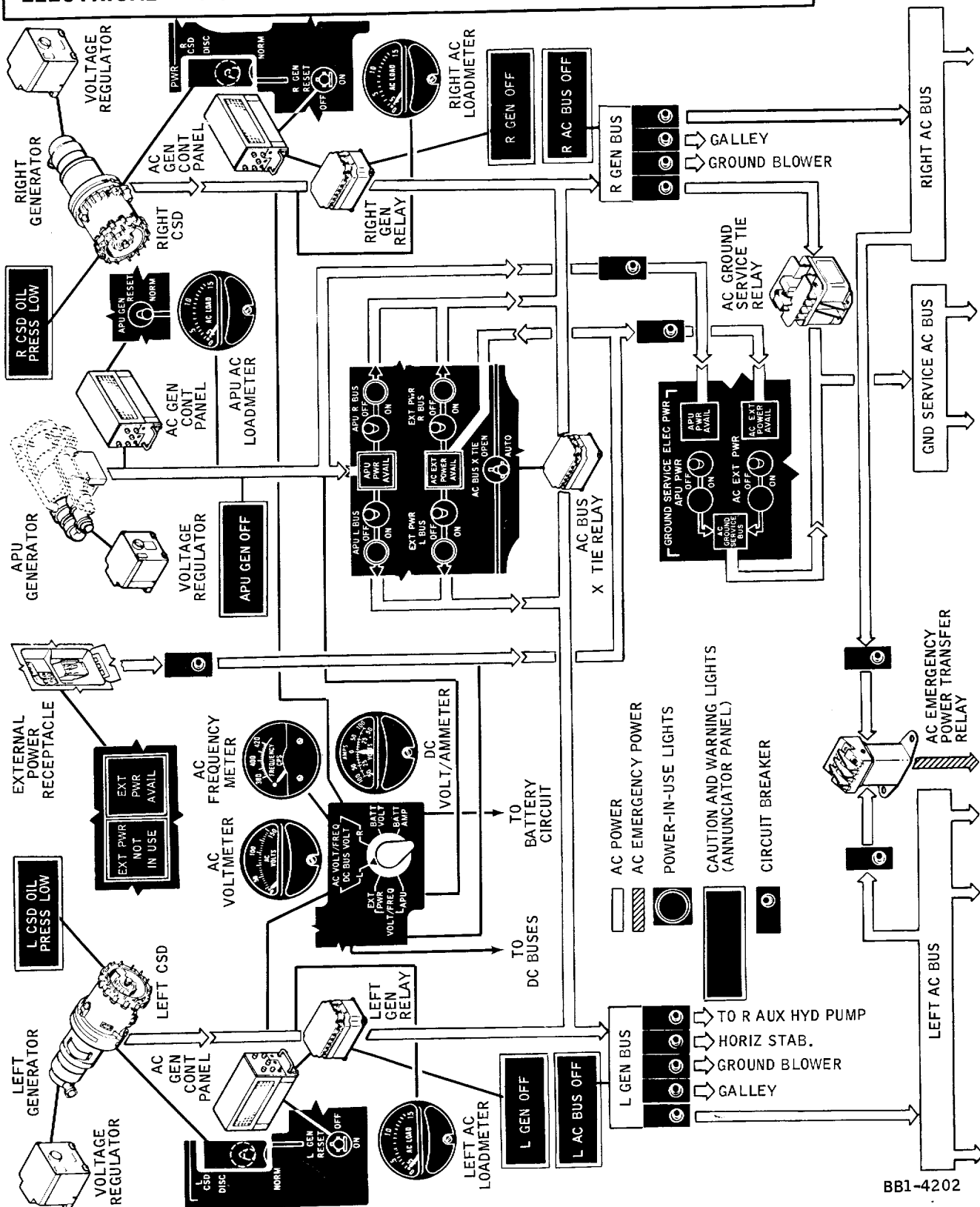
A receptacle for connection of dc external power is located in the E/E compartment. The dc external power feeds the dc ground service bus, dc transfer bus, and APU starter and control circuits. A dc external power switch and a dc external power available light are located on the ground service electrical panel, in the cockpit overhead panel.

If dc external power is removed from the dc ground service bus, the dc external power switch will automatically return to the OFF position.

DC circuit breakers for ship's lighting and ground floodlighting are located in the E/E compartment on a dc external power bus.

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ELECTRICAL -- AC POWER DISTRIBUTION FUNCTIONAL SCHEMATIC



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ELECTRICAL SYSTEM FAULT PROTECTION

A fault protection system is provided for the following fault conditions:

1. Short circuits and grounds
2. Open circuits in generating system
3. Overvoltage and undervoltage
4. Overfrequency and underfrequency
5. Incorrect phase sequence from generators or external power source
6. Open circuits, short circuits, and malfunctions in control equipment.

The fault protection system will automatically take the ideal corrective action. The corrective action will be visually indicated to the flight crew by cockpit instruments or annunciator lights. No immediate flight crew action is required. Evaluation of visual indications will determine what action should be taken.

GENERATOR DIFFERENTIAL

A differential protection relay, used in conjunction with current transformers, compares current at the generator with current at the distribution point. If there is a difference, a fault is in evidence and the differential protection relay will trip the generator control relay, which opens the generator field circuit and trips the generator relay. The generator cannot be reenergized or connected to the bus until the generator control relay is reset by placing the generator control switch momentarily to RESET.

When a generator differential fault occurs, the ac crosstie relay is electrically locked open.

OVERVOLTAGE

An overvoltage relay for each generator protects the system by sensing voltage and tripping the respective generator control relay when an overvoltage occurs.

UNDERVOLTAGE

An undervoltage relay for each generator senses the lowest of the 3-phase voltages on the generator side of the generator relay. When an undervoltage is sensed, timers are energized and a series of corrective actions are automatically programmed. Each step in the series of corrective actions will follow at variable, timed intervals as the fault system seeks to eliminate the undervoltage.

If an undervoltage relay closes when the output frequency of the associated generator is within limits, two timer circuits are energized. The first timer, the ac crosstie relay time delay, sends a trip signal to the ac crosstie relay. If this action causes the undervoltage condition to be corrected, the ac crosstie relay time delay will be locked open and the second timer, the fault selector time delay, will be energized. If the trip signal to the ac crosstie relay does not cause the undervoltage condition to be corrected, the ac crosstie relay cannot close and the second timer sends a trip signal to the associated generator relay. If the signal causes the undervoltage condition to be corrected, the ac crosstie relay will be locked open. If the signal does not cause the undervoltage to be corrected, the ac crosstie relay will close. In both cases, a third timer circuit, the

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undervoltage time delay, is energized. The third timer sends a trip signal to the associated generator control relay, opening the exciter field circuit of the associated generator.

UNDERFREQUENCY

There is one underfrequency relay for each generator. During an engine start when generator frequency reaches approximately 375 cps, the relays complete a circuit for closing the generator relay. When the generator frequency, at engine shutdown, during normal transients, or during faults reduces to approximately 370 cps, the underfrequency will start a timer. If the frequency has not reached 375 cps when the timer times out, at approximately 1 second, the time sends a trip signal to the generator relay.

OVERSPEED

If the constant-speed drive (CSD) attempts to operate at overspeed, the CSD governor setting is automatically reduced by hydraulic means so that the CSD will run at underspeed. Thus, the underfrequency relay will also operate to trip the generator relay for an overspeed condition. If the APU attempts to operate at overspeed, a switch automatically shuts down the APU at approximately 110 percent rpm. The underfrequency relay will also operate to trip the generator relay for an overspeed condition.

DEAD BUS RELAY

There is one dead bus relay for each ac bus, left and right. The main purpose of the relays is to prevent connecting a second power source to a bus already receiving power, and thus avoids paralleling the sources.

AC CROSSTIE LOCKOUT RELAY

The ac crosstie lockout relay and the associated slave relay prevent closing of the crosstie relay into an uncleared fault. There is no manual control provided for the crew to reset or remove the lockout condition. The lockout relays will automatically reset when all electrical power is removed from the buses.

PHASE SEQUENCY RELAYS

There is one phase sequency relay for each engine-driven generator, the APU generator, and the external power source. These relays prevent application of electrical power of incorrect phase sequence to the buses.

ELECTRICAL SYSTEM COMPONENTS

The major electrical system components and their relationship to the system are described in the following text to provide a more thorough understanding of the system operation and to enable flight crews to analyze system malfunctions.

AC GENERATOR

The airplane is equipped with two engine-driven generators and one APU-driven generator. The generators are 3-phase, brushless, permanent magnet type, rated at 120/208 volts ac, 400-cps, with a maximum continuous output of 40 kva.

CONSTANT-SPEED DRIVE (CSD)

Each engine-driven generator is connected to the engine through a transmission mounted on the engine, which controls the output speed of the generator, maintaining speed at a constant 6000 rpm. The transmission is a gear-differential type, with a variable hydraulic pump powering a constant-speed hydraulic motor for rpm control. The governing and control mechanisms adjust the output from the pump to the motor, to compensate for varying engine speed and variations of load on the generator. The resultant constant output speed to the generator maintains the frequency output of the generator at approximately 400 cps for all operating conditions. The CSD can be disconnected from the engine by an electromechanical switch controlled from the electrical power control panel. It is recommended that a CSD should not be disconnected if the N₂ rotor speed is below 25 percent. Once disengaged, the CSD must be mechanically reengaged at the engine after engine shutdown. The CSD oil outlet temperature, oil temperature rise indications, and oil low pressure

lights are provided on the electrical power control panel and the annunciator panel.

VOLTAGE REGULATORS

The voltage output of each generator is controlled by a voltage regulator. The regulators are static-type, adjustable, and are set to maintain voltage output from the generators at approximately 115 volts.

AC GENERATOR CONTROL PANELS

The generator control panels, one for each generator, contain the necessary components for control and protection of each generator system. Overvoltages, under-voltages, underfrequencies, differential current protection, and improper phase sequence are sensed by the control circuits and relays within the control panel, and the generator (or APU) relays trip when any such malfunction occurs. Fault protection circuits are provided with a time delay to prevent tripping of the generator relays during transient conditions, such as a momentary overload. Once a relay is tripped, the generator control switch (or APU generator reset switch) must be placed in the RESET position to place the affected generator back on the corresponding bus.

NOTE: Normally, a generator should be reset only once for a given fault. If a fault trips the generator after reset, the fault should be located and corrected before attempting to place the generator on its bus again.

AC BUS CONTROL PANEL

The ac bus control panel contains the ac crosstie circuits and provides power for for external power relay control.

TRANSFORMER-RECTIFIERS (TR)

Four TR's supply the main source of dc power to the system. The TR's have 50-ampere ratings, with 3-phase, 115/200-volt ac input, and approximately 28-volt dc unregulated output. The two left TR's receive power from the left ac bus and are connected in parallel, both supplying power directly to the left dc bus. The No. 1 right TR receives power from the right ac bus, and the output supplies power directly to the right dc bus. The No. 2 right TR receives power from the ac ground service bus, and the output is connected in parallel to the No. 1 right TR through the ground service tie relay, during normal operation. When APU or external power is being used for ground service only, the No. 2 right TR is used to supply dc power to the dc transfer bus.

BATTERIES

Two 14-volt, nickle-cadmium batteries supply the necessary dc power for operation when no other source of power is available. The batteries are connected in series to produce 28-volt dc for system operation. The batteries supply power for starting the APU or for ground refueling when no external power is available, and power for the emergency inverter and emergency dc bus when all ac power is lost. When ac power is available, the batteries are maintained in a charged condition. When fully charged, the batteries will supply power for emergency operation of essential instruments for a minimum of 45 minutes.

BATTERY CHARGER

The battery charger will be in a charging condition at all times when the ground service bus is powered and the BATT switch is in ON position. The charger mode of operation will depend upon the state of charge and temperature of the batteries. When the batteries are in a fully charged

condition, the charger will be in a pulsing mode. The interval between pulses may vary between approximately 25 seconds to 20 minutes depending on the primary power source (engines, APU, or external power) and the resulting load imposed on the batteries. If the batteries are in a low state of charge, the ammeter will indicate a continuous current of approximately 65 amperes gradually reducing to approximately 40 amperes and then into the pulsing mode as described above.

NOTE: If the batteries are in an extremely low state of charge, the ammeter indication may oscillate between approximately 40 and 65 amperes for a short period of time before a continuous rate of charge is maintained.

BATTERY CHARGER AND DC TRANSFER BUS RELAY (C & TR)

The battery charger and dc transfer bus relay controls the dc power from the battery charger to the battery and from the battery to the dc transfer bus. When the battery switch is in the ON position and the left and right dc buses are not powered, the C & TR connects the batteries to the dc transfer bus, except when ground service power is being used. The C & TR connects the charger to the batteries if the battery switch is in the ON position and the left and right dc buses are powered, if ac power is available to the ground service bus and the emergency power switch is in OFF position. The charger will also charge the batteries if ac ground service power is being used and the battery switch is in the ON position.

EMERGENCY INVERTER

The emergency inverter supplies ac power for operation of essential instruments, in the event of complete

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loss of ac power from the generators. The inverter is a static, solid-state type with a 28-volt dc input, and single-phase, 115-volt, 400-cps output. During normal operation the inverter is inoperative, with the power to the emergency ac bus being supplied from the left and right ac bus. When the emergency power switch is placed in the ON position, the left or right ac bus is disconnected from the emergency ac bus, dc power from the battery direct bus is applied to the input side of the inverter and the inverter output is connected to the emergency ac bus. During ground refueling operations, the emergency inverter also supplies power to the refueling panel when the normal electrical power systems are not energized. The emergency power switch must be in OFF position for this function.

AC EMERGENCY POWER TRANSFER RELAY (AEPTR)

The ac emergency power transfer relay connects the emergency ac bus to either the left or right ac bus, depending on the source of power available. During normal operation, the left ac bus is connected, through the relay, directly to the emergency ac bus. When the left ac bus is not powered, the relay connects the right ac bus to the emergency ac bus. When a complete loss of power occurs, the relay is inactive and power to the emergency bus can be supplied from the emergency inverter.

DC EMERGENCY POWER TRANSFER RELAY (DEPTR)

The dc emergency power transfer relay provides connection between either the right or left dc bus, depending upon the available source of dc power. During normal operation, the left dc bus is connected through the relay directly to the dc transfer bus, and

to the emergency dc bus through the emergency power switch in the OFF position. In the event of loss of power to the left dc bus, the relay connects the right dc bus to the transfer and emergency buses.

AC GROUND SERVICE TIE RELAY (AGSTR)

The ac ground service tie relay connects the ground service bus to the right generator bus when power is applied to the right generator bus. When either external or APU power is being used for ground service only, the relay remains open, isolating the right ac distribution system.

DC GROUND SERVICE TIE RELAY (DGSTR)

The dc ground service tie relay connects both right TR's in parallel to the right dc bus when the right ac bus is powered. When only ac ground service is used, power is supplied to the dc transfer bus from the TR connected to the ac ground service bus.

AC CROSSTIE RELAY (ACTR)

The ac crosstie relay provides a connection between the left and right generator buses. During normal operation the relay is open, isolating the left and right generator buses. The relay will close automatically if power is lost from either generator bus, and will connect both generator buses to a common source, except when external power or the APU generator is being used while the airplane is on the ground. When the ac crosstie relay closes due to the loss of a generator, while the airplane is airborne, the galley power is automatically disconnected to ease the load being carried by the operating generator. On the ground, this action is bypassed due to actuation of the ground control relay. When differential protection or a bus fault occurs, the ac crosstie relay is locked open. When the ac bus

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crosstie switch is in the open position, the relay will be held open to isolate the buses.

DC CROSSTIE RELAY (DCTR)

The dc crosstie relay connects the left and right dc buses when loss of dc power on either side requires crossfeeding of power from the opposite dc bus. The relay, controlled by the dc bus crosstie switch, is open during normal operation. No automatic control function is provided for the relay. The relay is closed by actuating the switch to provide cross-feed of dc power between buses.

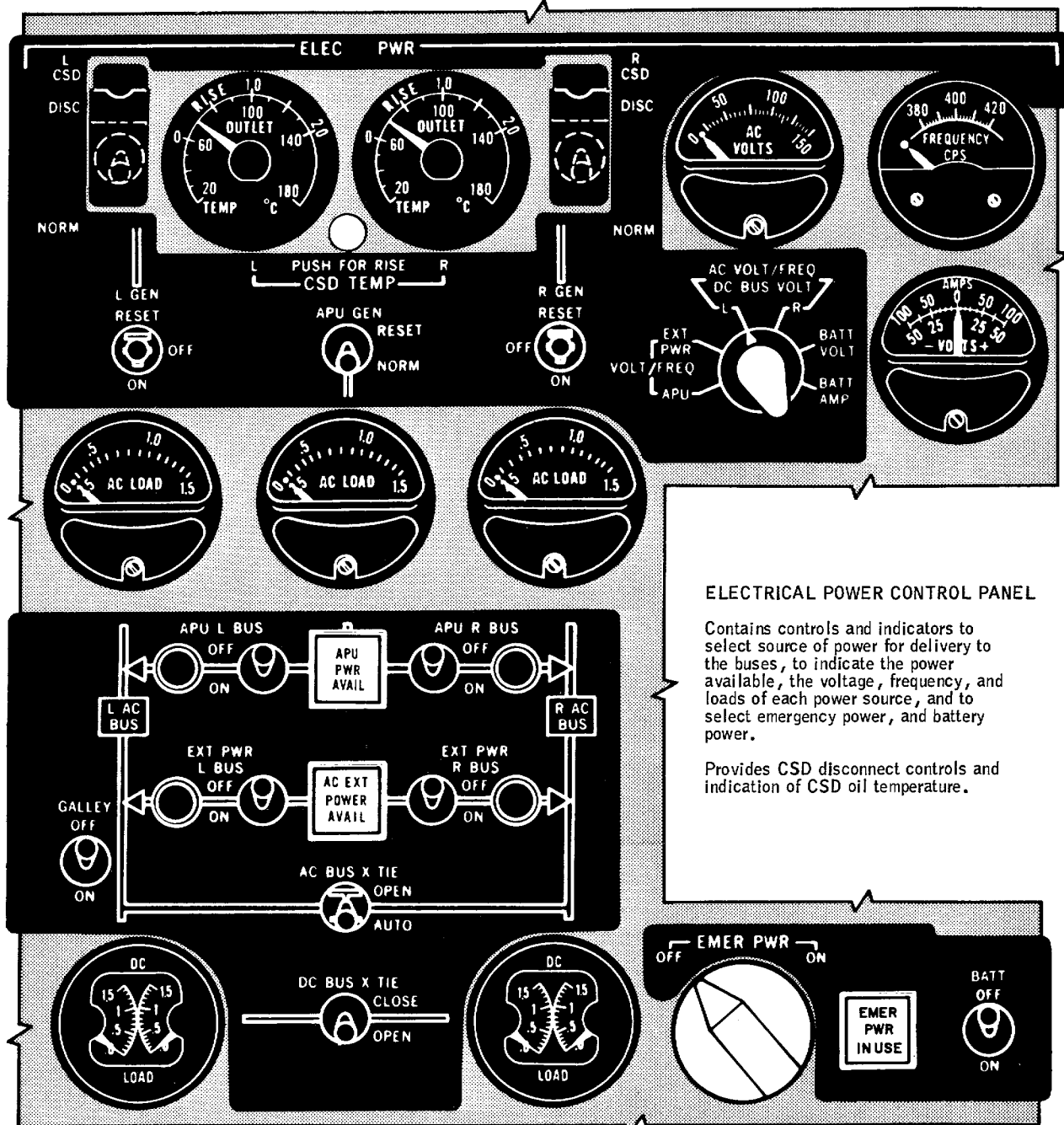
APU STARTER TRANSFER RELAY

Under normal conditions, the APU starter transfer relay routes power for APU starting through the normal buses. If the dc ground service bus is powered, the APU starter transfer relay routes power to the APU starter from the dc ground service bus.

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ELECTRICAL -- COCKPIT CONTROLS & INDICATORS (sheet 1)



ELECTRICAL POWER CONTROL PANEL

Contains controls and indicators to select source of power for delivery to the buses, to indicate the power available, the voltage, frequency, and loads of each power source, and to select emergency power, and battery power.

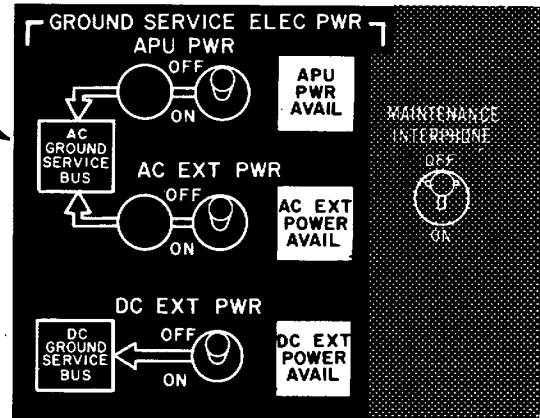
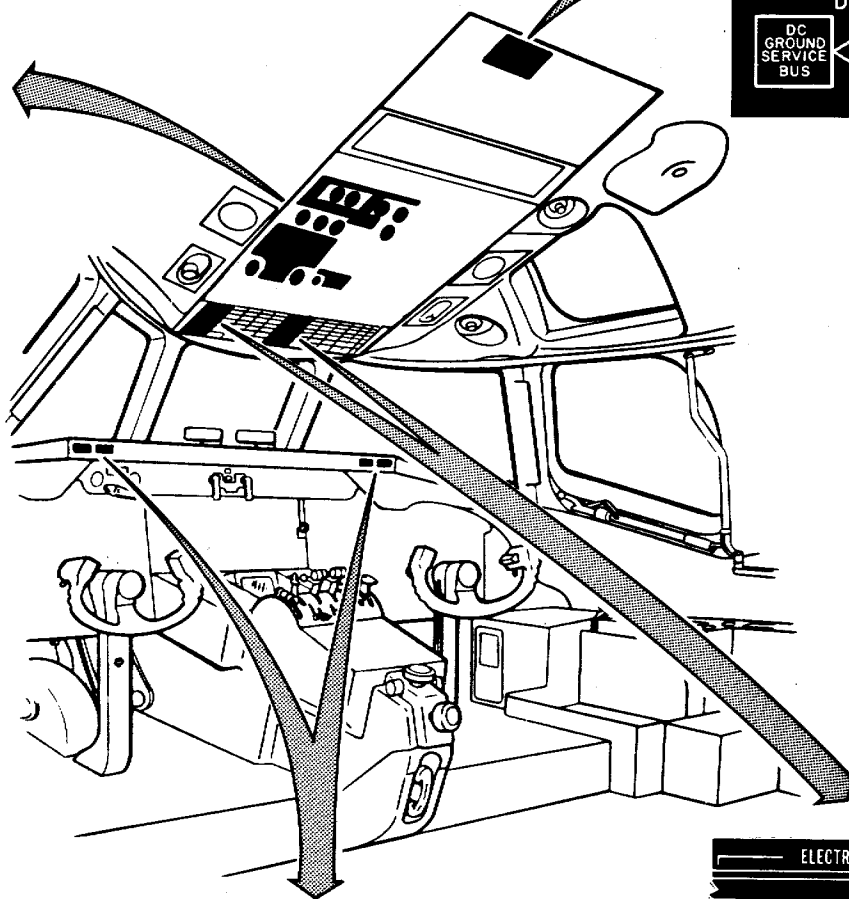
Provides CSD disconnect controls and indication of CSD oil temperature.

BB1-4206

ELECTRICAL -- COCKPIT CONTROLS & INDICATORS (sheet 2)

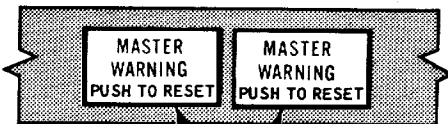
GROUND SERVICE ELECTRICAL POWER CONTROL PANEL

Contains lights to indicate that APU or external power is available, controls to select APU or external power for the ground service bus, and lights to indicate which source of power is being supplied to the bus.



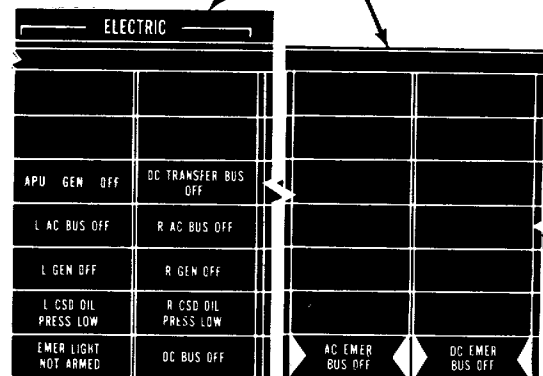
ANNUNCIATOR PANEL

Contains electrical power system warning and caution lights.



MASTER CAUTION AND MASTER WARNING LIGHTS

Provide an indication to both captain and first officer that an electrical malfunction has been indicated on the annunciator panel.



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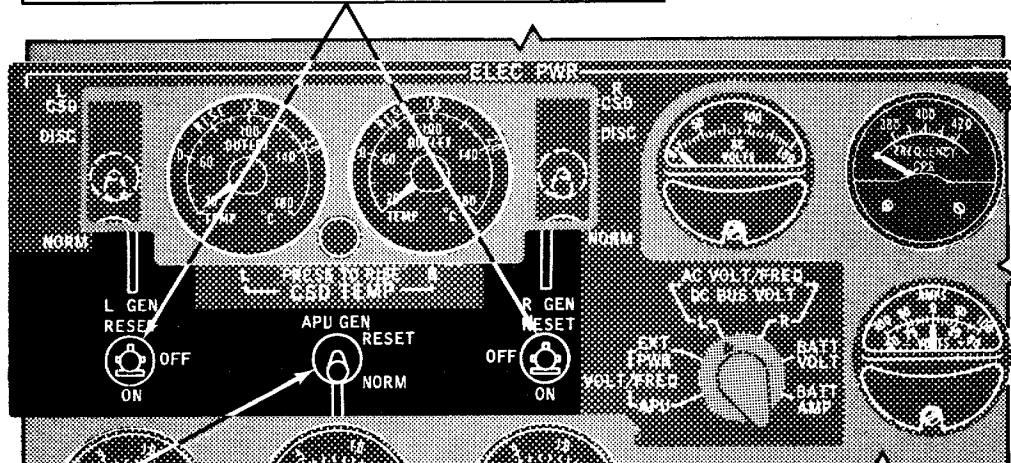
ELECTRICAL -- AC CONTROLS & INDICATING LIGHTS

* GENERATOR CONTROL SWITCHES

RESET (momentary) position -- Resets generator control circuit.

OFF position -- Disconnects the generator from the ac power distribution system.

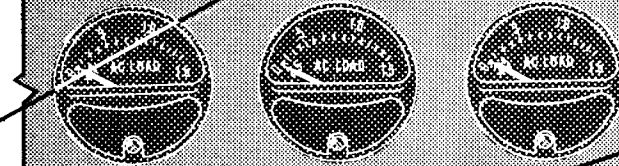
ON position -- Connects the generator to the ac power distribution system providing all protection circuits are satisfied.



* APU GENERATOR RESET SWITCH

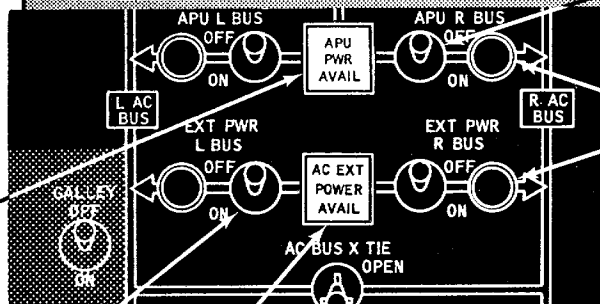
RESET (momentary) position -- Resets generator control circuit.

NORM position -- in this position for normal operation.



* APU BUS SWITCHES (LEFT AND RIGHT)

Select APU power for delivery to the respective bus.



APU POWER AVAILABLE LIGHT (BLUE)

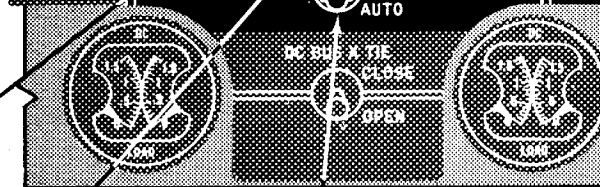
Indicates that APU generator is operating and that power is available.

POWER IN USE INDICATING LIGHT (4) (BLUE)

Indicate that power source selected is connected to the respective bus.

* EXTERNAL POWER BUS SWITCHES (LEFT AND RIGHT)

Select external power for delivery to the selected bus.



AC EXTERNAL POWER AVAILABLE LIGHT (BLUE)

Indicates that ac external power is connected, and power is available.

AC BUS CROSSTIE SWITCH

OPEN position -- Opens the ac crosstie relay if closed, isolating the left and right ac distribution systems. Prevents closing of the relay if open.

AUTO position -- Normally operated in this position. In this position, the ac crosstie relay will operate automatically.

NOTE: Under certain fault conditions, the ac crosstie relay will lock open.

*NOTE: External power will automatically be taken off the bus when either APU or main generator power is connected to the respective bus. APU power will automatically be taken off the bus when main generator power is connected to the bus.

BB1-4208

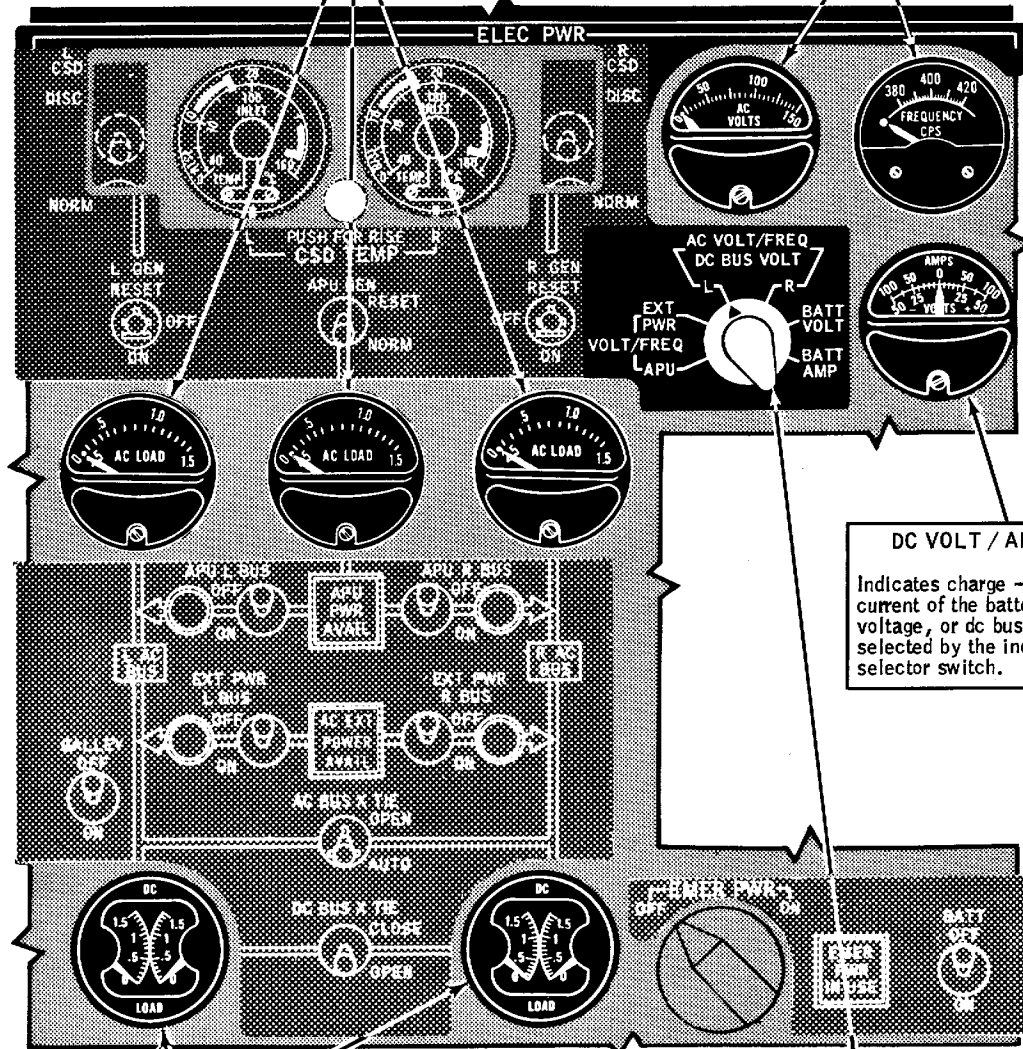
ELECTRICAL -- INDICATORS & INDICATOR SELECTOR SWITCH

AC LOADMETERS

Indicate the load the generator is delivering to the distribution system. Indicate from 0 to 1.5 with 1.0 indicating 100% of generator rated capacity.

AC VOLTMETER AND FREQUENCY METER

Indicate voltage and frequency output of the generators or external power, as selected by the indicator selector switch.



DC VOLT / AMMETER

Indicates charge -- discharge current of the batteries, battery voltage, or dc bus voltage as selected by the indicator selector switch.

DC LOADMETERS

Indicate the load the respective transformer-rectifier is delivering to the distribution system. Loadmeters are dual indicating with separate scales for each of the transformer-rectifiers feeding the respective dc bus. Indicate from 0 to 1.5, with 1.0 indicating 100% of T-R rated capacity.

INDICATOR SELECTOR SWITCH

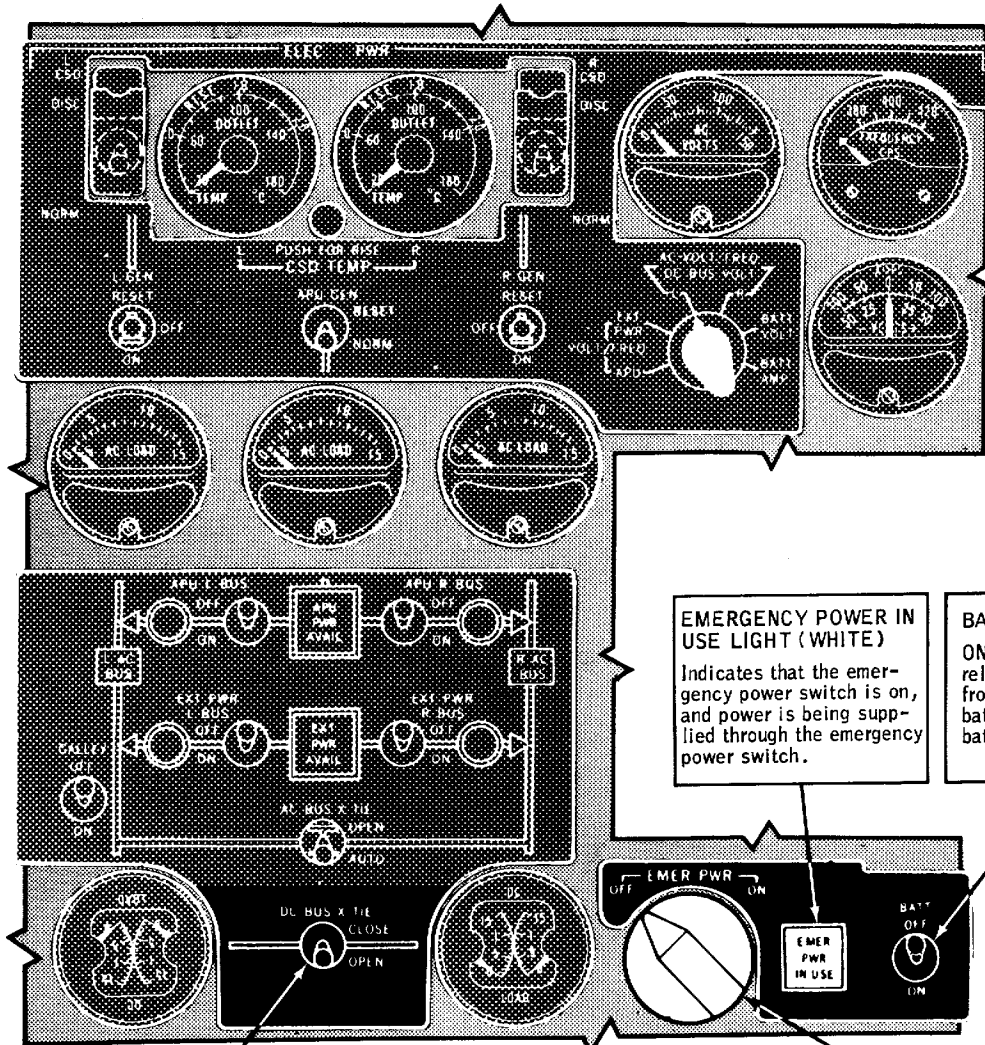
Selects power source to be read on the ac voltmeter and frequency meters and the dc volt/ammeter. When placed in either the L or R positions, ac voltage and frequency and dc bus voltage for the selected sources will be read on the respective meters. All other positions select only the single source indicated on the switch placards.

BB1-4207

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ELECTRICAL -- DC, BATTERY, & EMERGENCY POWER CONTROLS



EMERGENCY POWER IN USE LIGHT (WHITE)
 Indicates that the emergency power switch is on, and power is being supplied through the emergency power switch.

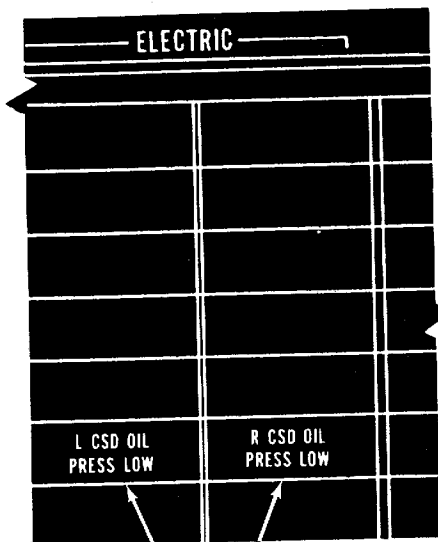
BATTERY SWITCH
 ON -- Actuates battery relay to supply power from the battery to the battery bus through the battery direct bus.

DC BUS CROSSTIE SWITCH
 CLOSE -- Connects the L and R dc buses, allowing any combination of transformer-rectifiers to power both dc buses.
 OPEN -- Isolates the L and R dc bus distribution systems. Dc system normally operated with switch in OPEN position.

EMERGENCY POWER SWITCH
 Selects battery as source of emergency ac and dc power.
 OFF -- Removes battery as source of emergency ac and dc power. If other source of electrical power (external or internal) is available, power to both the ac and dc emergency buses will be supplied through the normal power distribution system.
 ON -- Selects battery as emergency power source. Power to the dc emergency bus is now supplied from the battery direct bus, and single phase ac power is supplied to the emergency bus by the emergency inverter. The inverter is powered from the battery direct bus.

BB1-14B

ELECTRICAL -- CONSTANT SPEED DRIVE (CSD) CONTROLS & INDICATORS



CSD OIL PRESSURE LOW CAUTION LIGHTS (AMBER)

Comes on when oil pressure in the constant speed drive is below operating limits. (MASTER CAUTION lights will also come on.)

CSD DISCONNECT SWITCHES

Guarded momentary contact switch disconnects the constant speed drive from the engine drive pad.

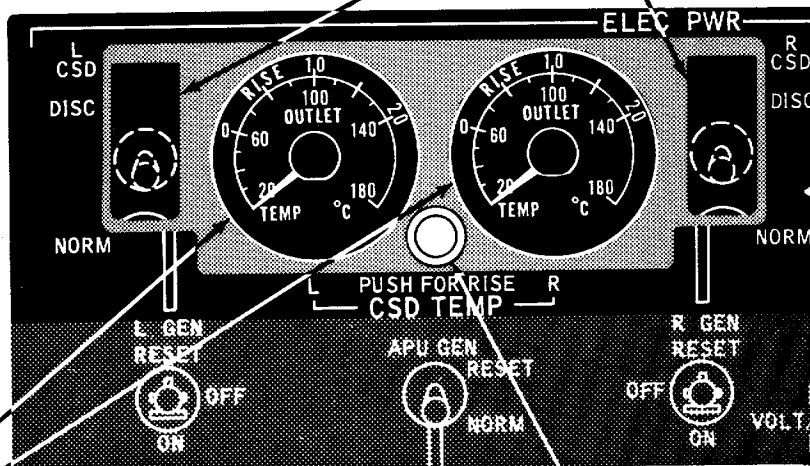
CAUTION - SWITCH ACTION IS IRREVOCABLE. BE CERTAIN THAT CSD DISCONNECT SWITCH ACTUATED IS FOR THE MALFUNCTIONING CSD.

NOTE:

Drive must be reset manually at the drive after being disconnected.

NOTE:

It is recommended that a CSD not be disconnected if the N_2 rotor speed is below 25 percent.



CONSTANT SPEED DRIVE OIL TEMPERATURE INDICATORS

Indicates the CSD oil outlet temperature and, by depressing switch, indicates oil temperature rise across the drives.

CSD OIL TEMPERATURE SELECTOR SWITCH

When momentary switch is depressed, CSD indicators will indicate CSD oil temperature rise across the drives.

BB1-11D

ELECTRICAL -- GROUND SERVICE ELECTRICAL POWER CONTROLS & INDICATORS

NOTE:

Do not turn on switches simultaneously. This action could cause APU and external ground circuits to interlock out.

APU GROUND SERVICE BUS SWITCH

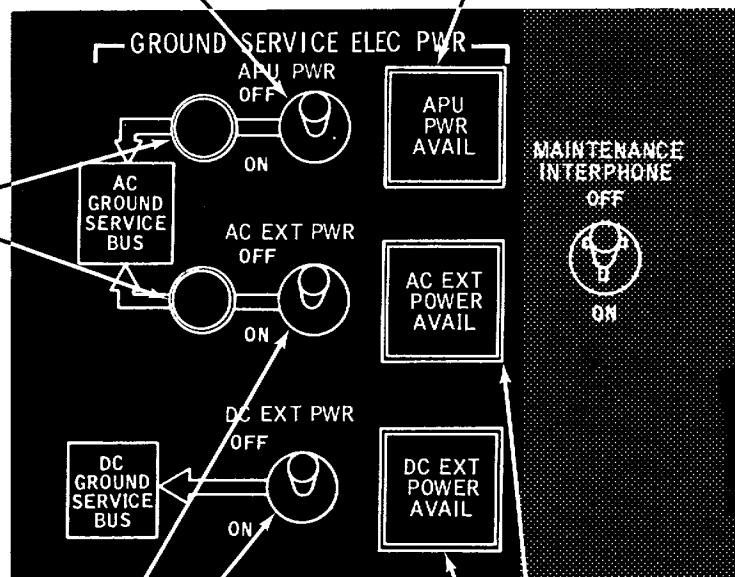
Selects power from the APU ac generator to the ground service bus when power to the bus is desired without energizing the right ac bus.

APU POWER AVAILABLE LIGHT (BLUE)

Indicates that the APU generator is operating and that power is available.

GROUND SERVICE BUS POWER IN USE LIGHTS (BLUE)

Indicate that power source selected is connected to respective bus.



EXTERNAL POWER GROUND SERVICE BUS SWITCHES

Select power from the external power source for delivery to the ground service bus when power to the bus is desired without energizing the right bus or using the APU.

NOTE: If dc external power is removed from the dc ground service bus the DC EXT PWR switch will automatically return to OFF position.

EXTERNAL POWER AVAILABLE

LIGHTS (GREEN)

Indicate that external power is connected and power is available.

BB1-837B

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ELECTRICAL -- WARNING & CAUTION LIGHTS

MASTER WARNING (RED) and MASTER CAUTION (AMBER) LIGHTS

MASTER WARNING lights come on when an electrical annunciator warning light comes on, and MASTER CAUTION lights come on when an electrical annunciator caution light comes on. Lights should be turned off by resetting (push-to-reset) to arm master system for any subsequent malfunction.

LEFT (RIGHT) AC BUS OFF LIGHT (AMBER)

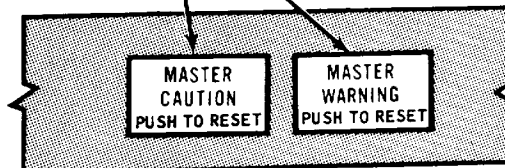
Indicates that bus is not powered. Bus normally powered by respective generator, but can be powered by opposite generator, APU generator (if installed), or external ground power.

DC TRANSFER BUS OFF LIGHT (AMBER)

Indicates that DC TRANSFER BUS is not powered. Bus normally supplied power from LEFT or RIGHT DC BUS, or BATTERY DIRECT BUS, in that order.

DC EMERGENCY BUS OFF LIGHT (RED)

Indicates that EMERGENCY DC BUS is not powered. Bus normally powered from either the LEFT DC BUS or RIGHT DC BUS, in that order. Bus may be powered from the BATTERY DIRECT BUS by placing the EMER PWR switch to the ON position.



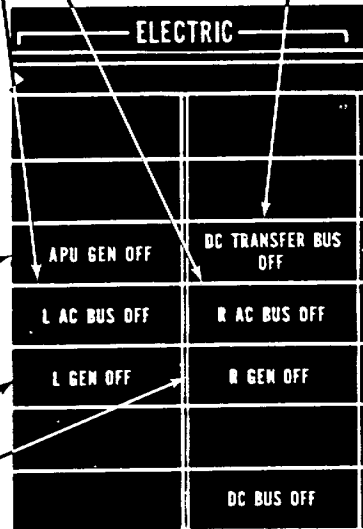
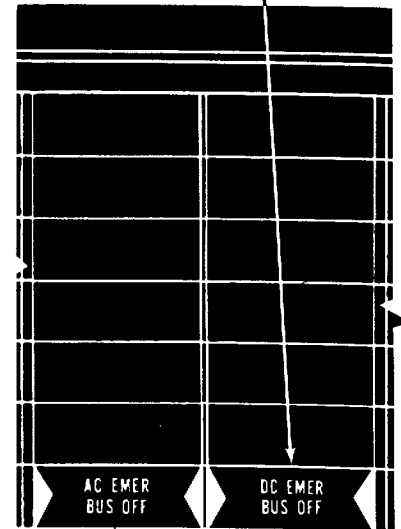
LOCATED ON CAPTAIN'S AND FIRST OFFICER'S GLARESHIELDS

APU GENERATOR OFF LIGHT (AMBER)

Indicates that generator relay is open, disconnecting the generator from its bus.

LEFT (RIGHT) GENERATOR OFF LIGHT (AMBER)

Indicates that generator relay is open, disconnecting the generator from its bus, either by manual operation of generator switch or by fault protection.



LOCATED ON
ANNUNCIATOR PANEL

DC BUS OFF LIGHT (AMBER)

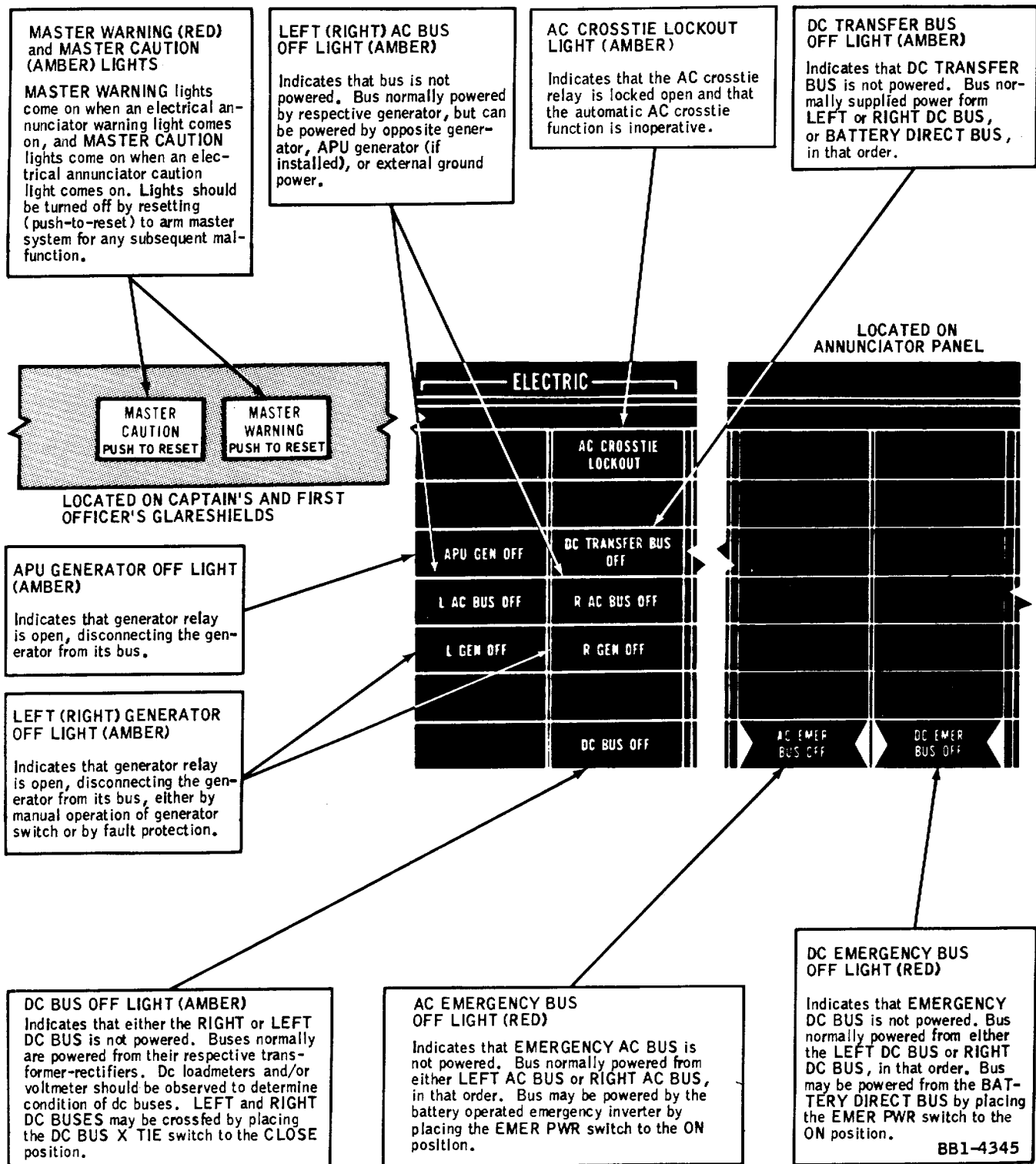
Indicates that either the RIGHT or LEFT DC BUS is not powered. Buses normally are powered from their respective transformer-rectifiers. Dc loadmeters and/or voltmeter should be observed to determine condition of dc buses. LEFT and RIGHT DC BUSES may be crossed by placing the DC BUS X TIE switch to the CLOSE position.

AC EMERGENCY BUS OFF LIGHT (RED)

Indicates that EMERGENCY AC BUS is not powered. Bus normally powered from either LEFT AC BUS or RIGHT AC BUS, in that order. Bus may be powered by the battery operated emergency inverter by placing the EMER PWR switch to the ON position.

BB1-2560

ELECTRICAL -- WARNING & CAUTION LIGHTS



CIRCUIT BREAKER LOCATION

The circuit breakers in the cockpit overhead panel are located on the emergency ac bus, emergency dc bus, battery direct bus, and the battery bus.

NOTE: Effective on airplanes factory serial number 47457 and subsequent, the HANDRAIL ACTUATORS FWD & AFT circuit breakers are removed from the BATT DIRECT BUS and the FWD PASSENGER ENTRANCE STAIR CARRIAGE MOTORS -1 & -2 circuit breakers are relocated adjacent to the CONTROL circuit breaker.

The circuit breakers on the forward side of the electrical power center (EPC) are installed on two panels, upper and lower.

The upper panel contains circuit breakers on the instrument bus, radio bus, and ac bus.

The lower panel contains circuit breakers on the dc bus, ac ground service bus, and dc transfer bus.

NOTE: Effective on airplanes factory serial number 47457 and subsequent; SPOILER FLAP EXTENDED ADVISORY circuit breaker is installed on the DC BUS at location R-34, BATTERY FAN circuit breaker is installed on the GROUND SERVICE BUS at location X-26, PROXIMITY SWITCH CONTROL circuit breaker is installed on the DC BUS at location Z-21, FWD PASSENGER ENTRANCE STAIR HANDRAIL ACTUATORS FWD and AFT circuit breakers are removed from the DC TRANSFER BUS at location Z-36 and Z-37, and the FWD

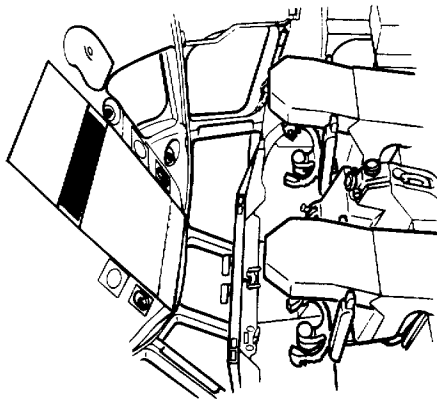
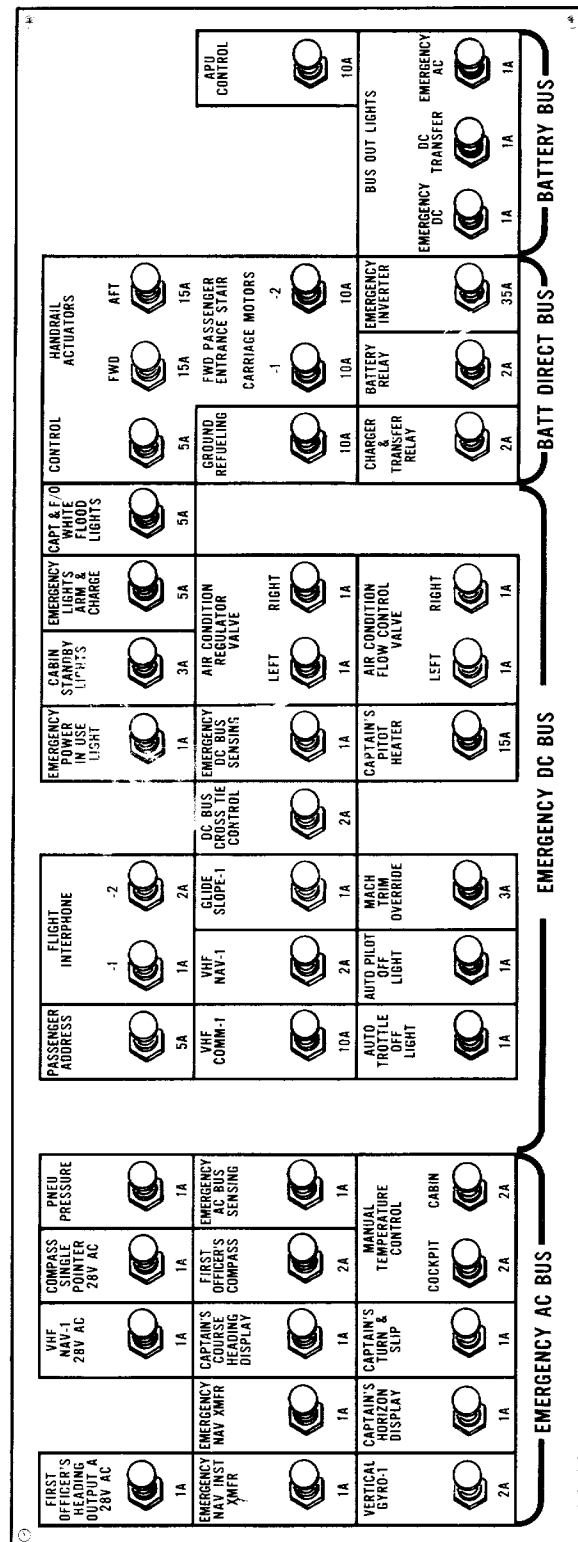
PASSENGER ENTRANCE STAIR CONTROL circuit breaker is relocated from Z-38 to Z-36 on the DC TRANSFER BUS.

Generator bus circuit breakers are located on the generator bus panel, on the forward side of the electrical power center.

Miscellaneous circuit breakers are located on the aft left console, on the inboard side of the EPC, on the external power receptacle panel, the electrical/electronics equipment compartment, in the battery compartment, in the forward cabin overhead, and in sections of the cabin ceiling lights.

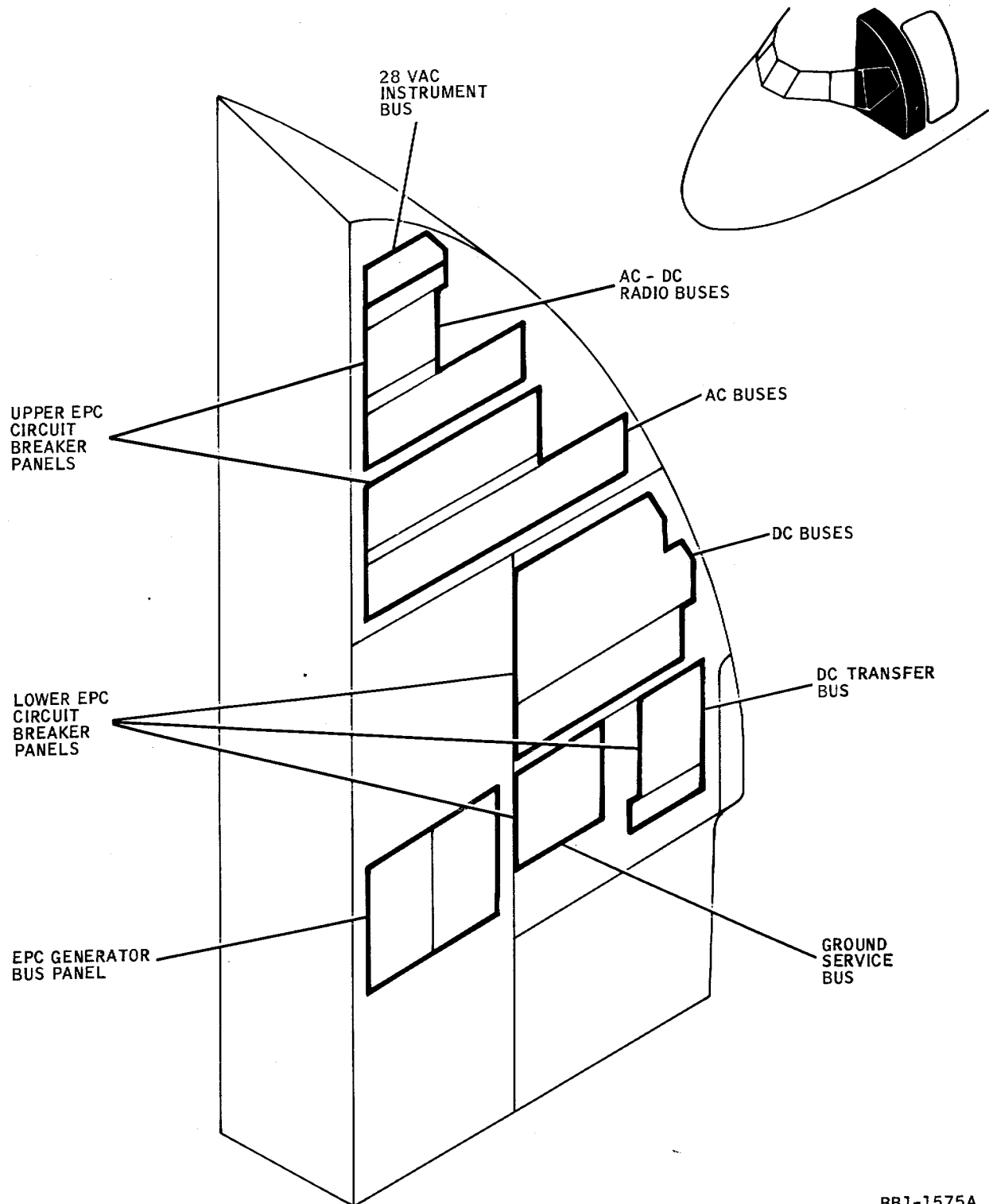
The battery direct bus feed circuit breaker, located near the battery, is actuated by means of a mechanical actuator. The actuator handle and instruction placard are located in the cockpit, on the left side of the pedestal. The battery direct bus feed circuit breaker can be reset only by use of the actuator.

ELECTRICAL -- CIRCUIT BREAKER PANELS - Overhead



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**ELECTRICAL -- CIRCUIT BREAKER PANELS - Electrical power center
(EPC) locations**



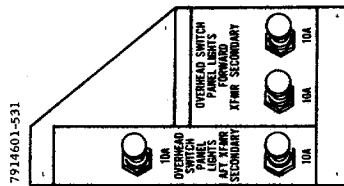
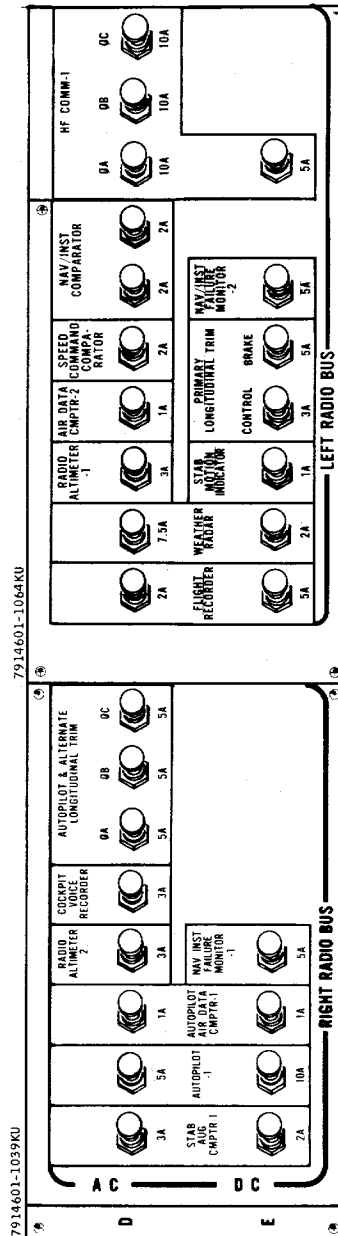
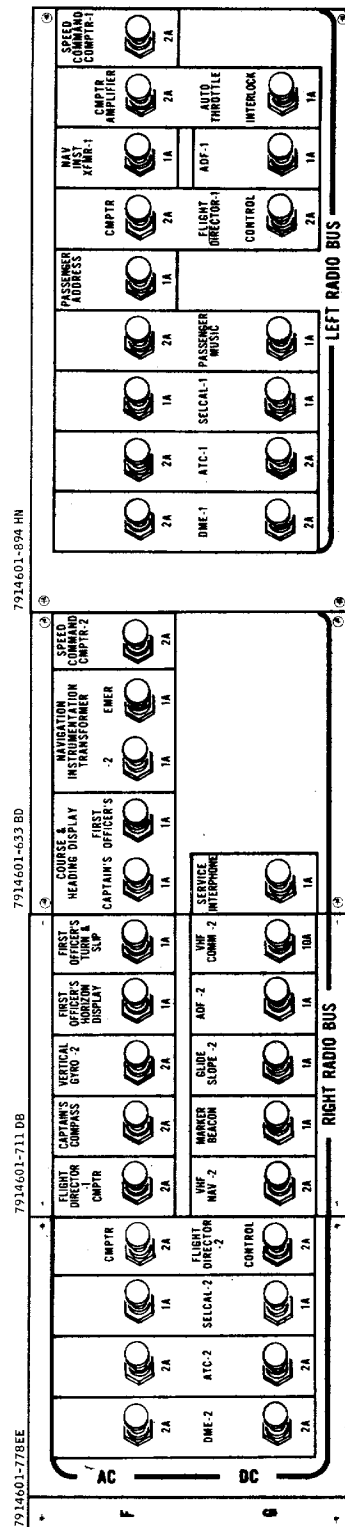
BB1-1575A

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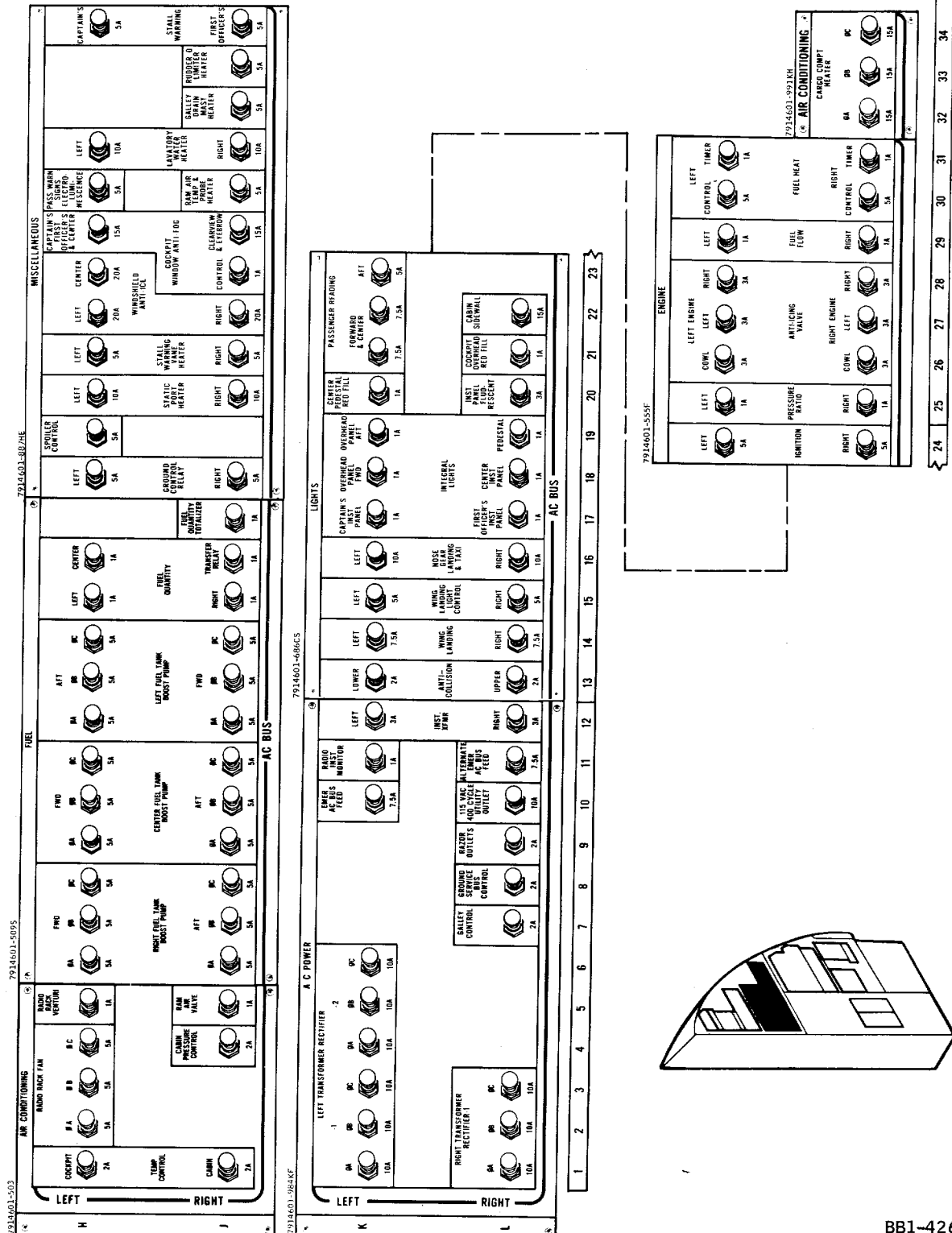
Printed in U.S.A.

**ELECTRICAL -- CIRCUIT BREAKER PANELS - Upper EPC instrument
& radio buses**



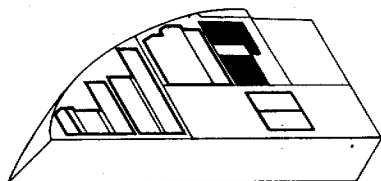
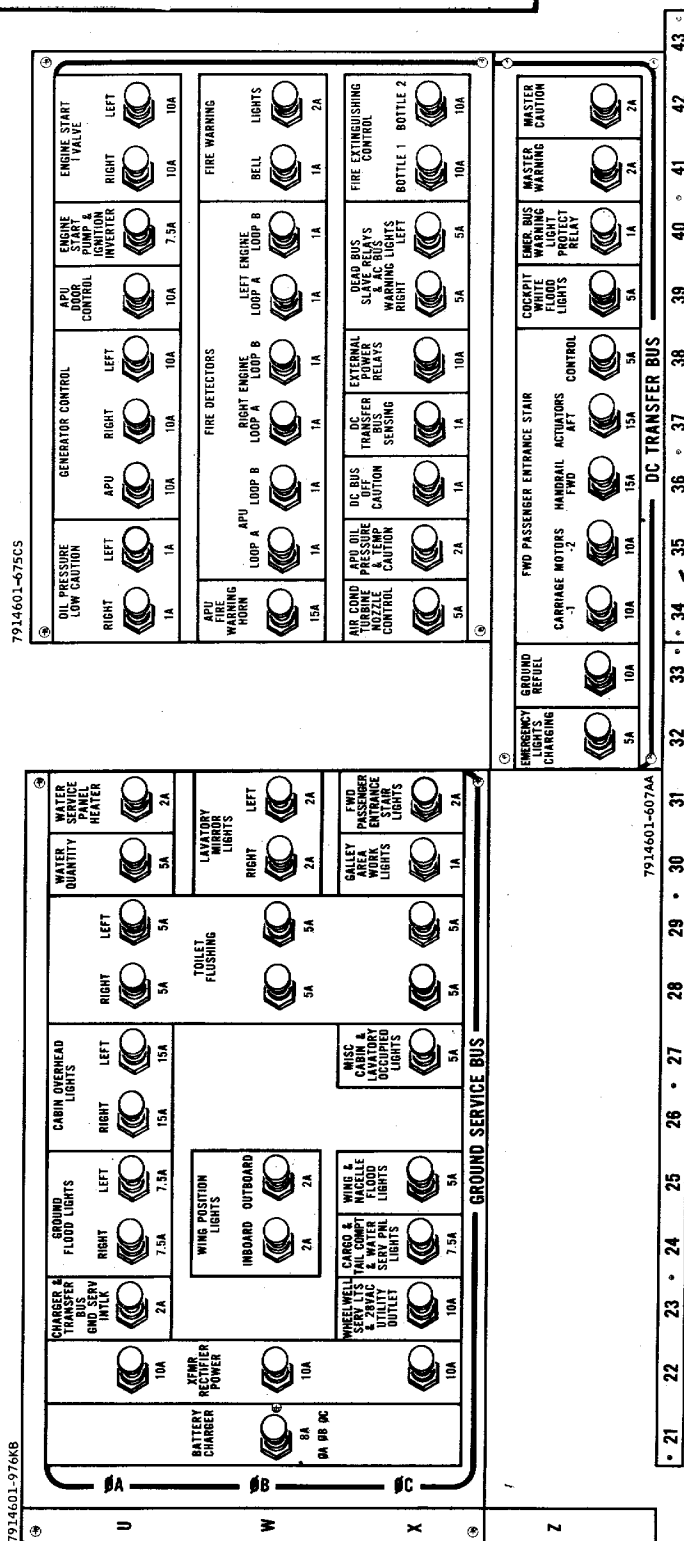
Jun 1/70

ELECTRICAL -- CIRCUIT BREAKER PANELS - Upper EPC ac buses



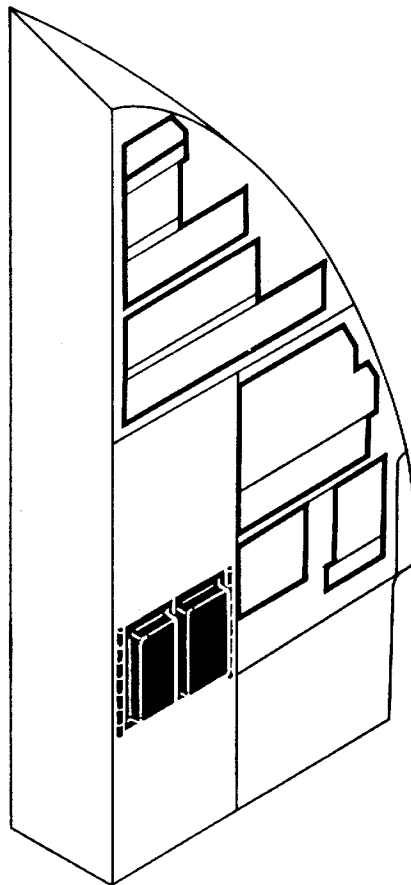
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ELECTRICAL -- CIRCUIT BREAKER PANELS - Lower EPC
 ground service bus & dc transfer bus

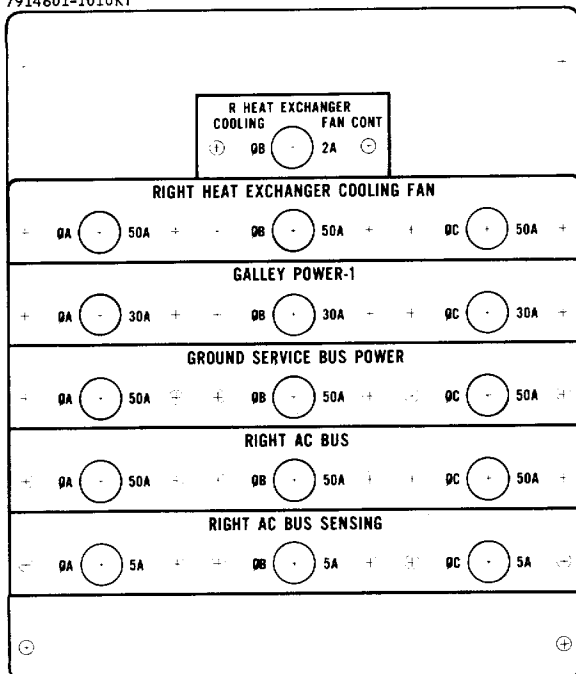


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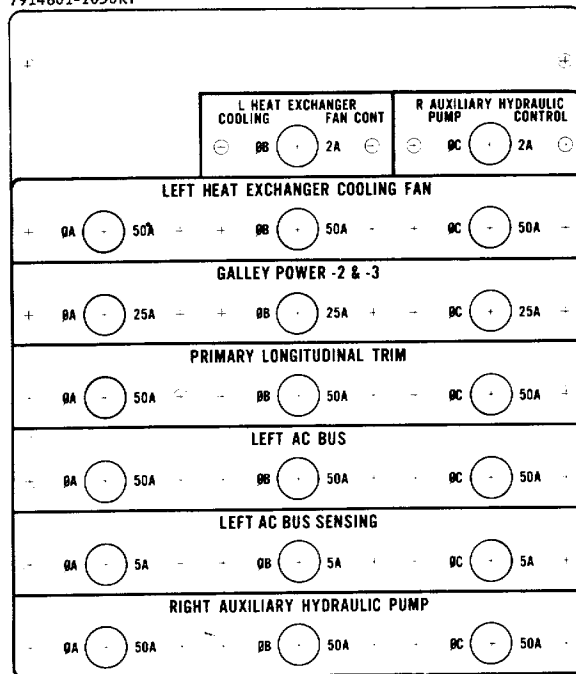
ELECTRICAL -- CIRCUIT BREAKER PANELS - EPC generator bus panel



7914601-1010KT

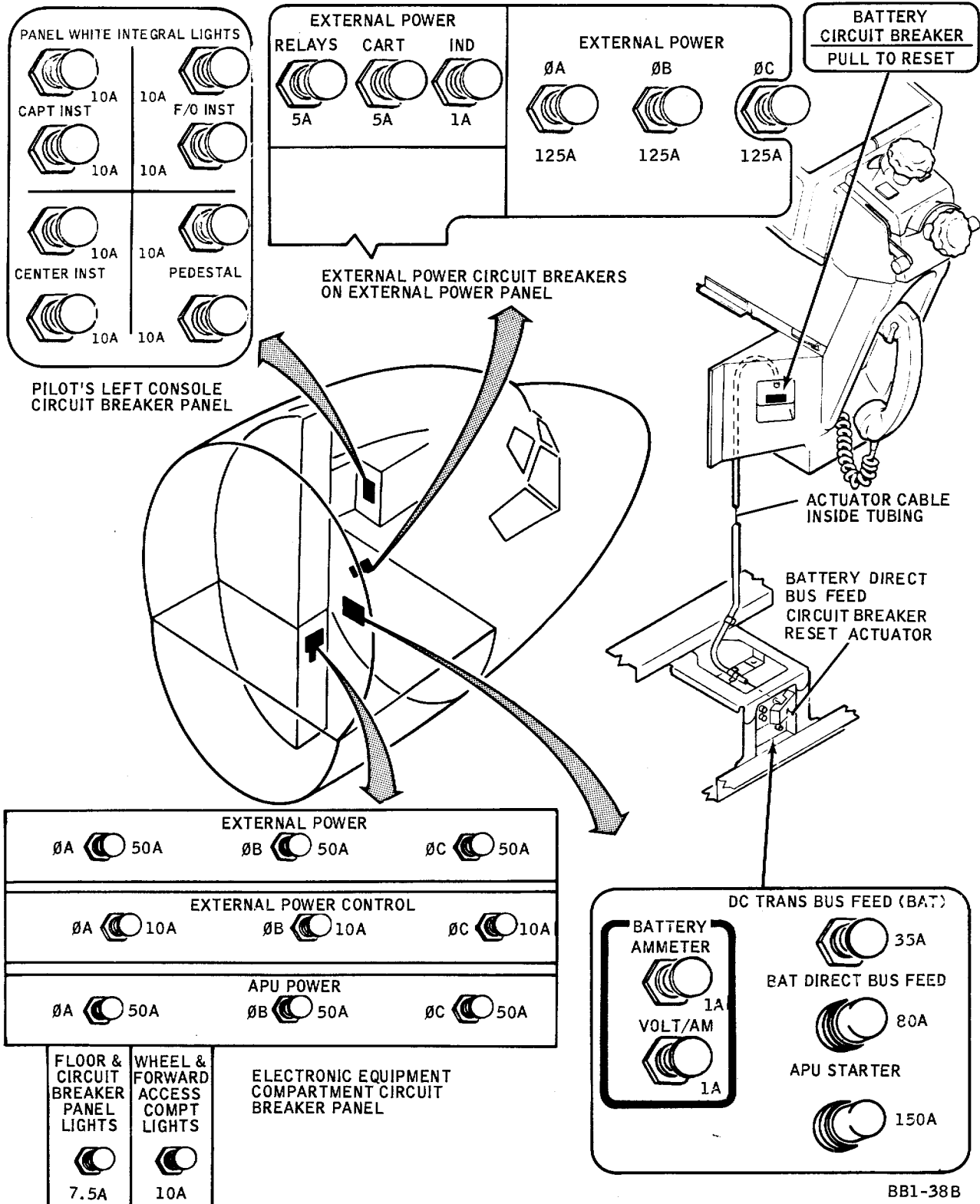


7914601-1030KT



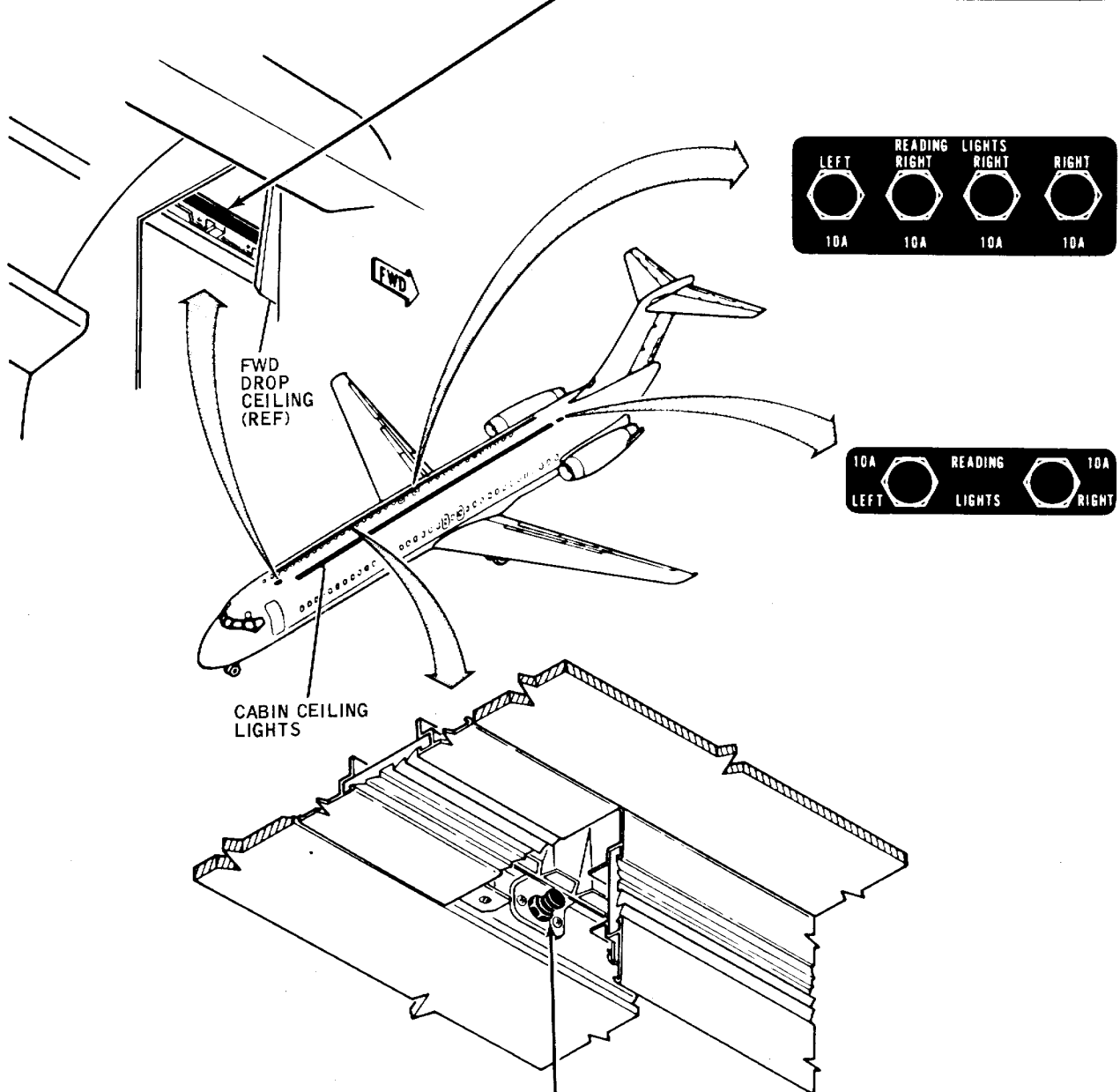
BB1-4271

ELECTRICAL -- CIRCUIT BREAKER PANELS - Miscellaneous



BB1-38B

ELECTRICAL -- CIRCUIT BREAKER PANELS - Cabin miscellaneous

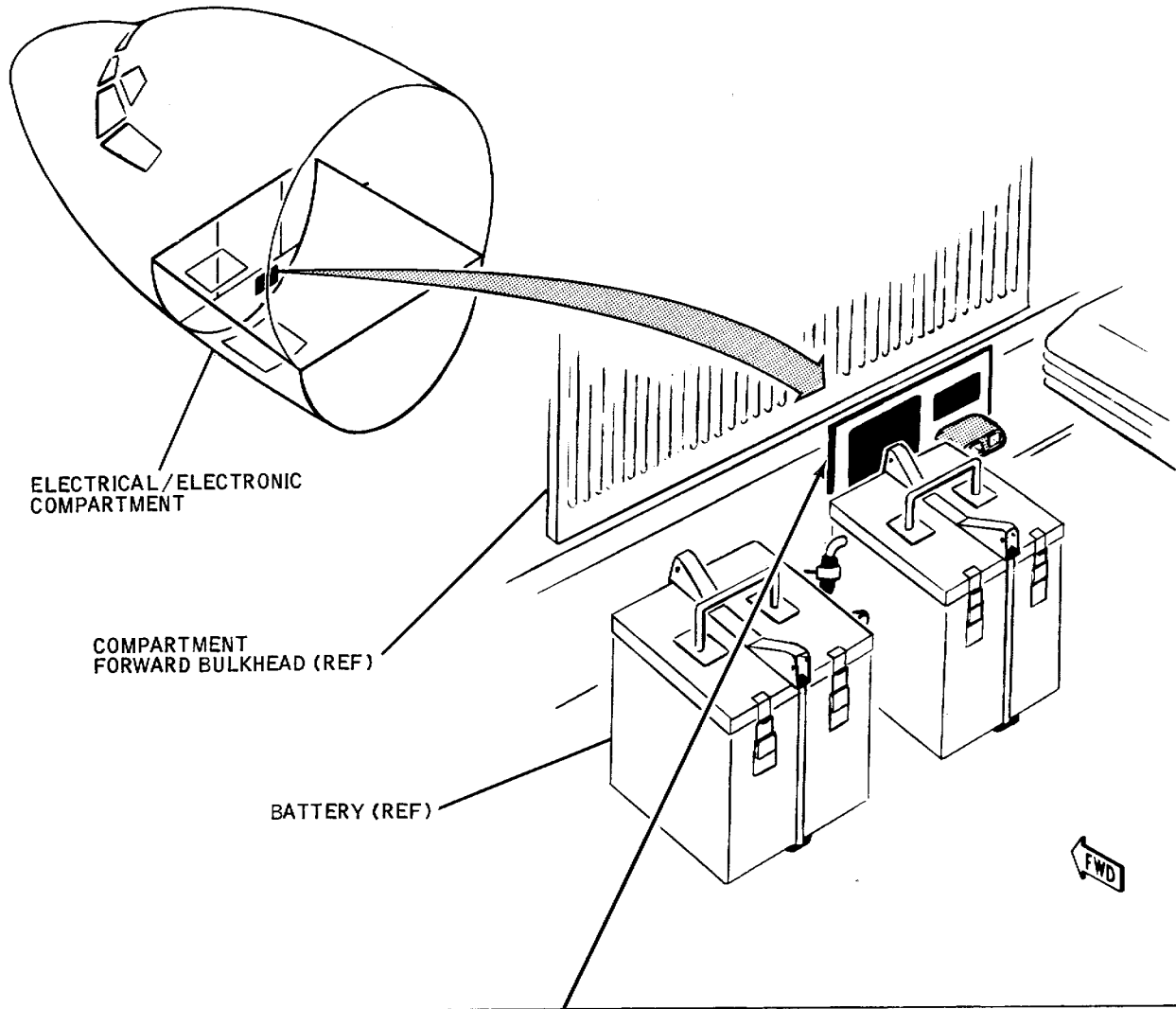
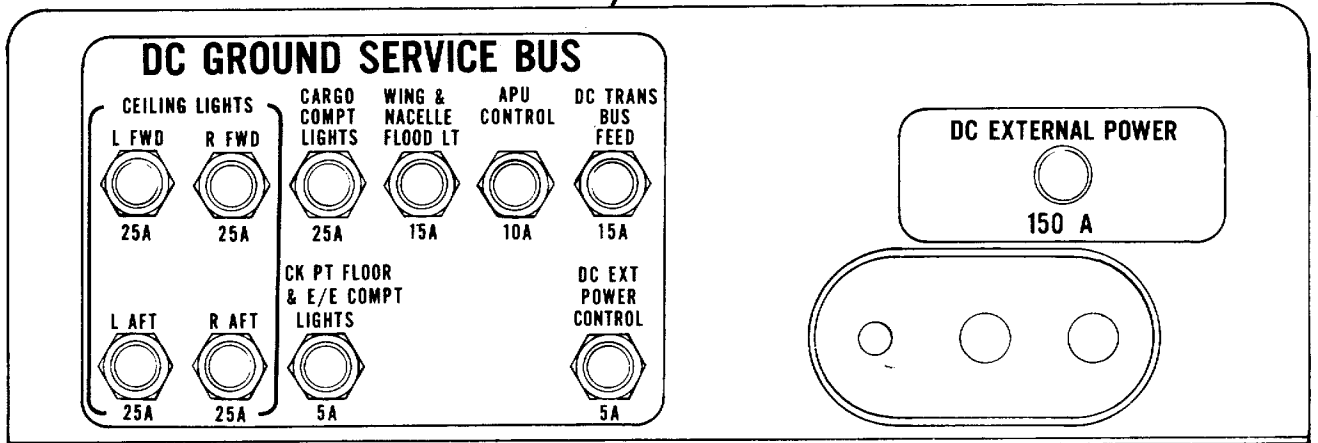


CABIN CEILING LIGHT CIRCUIT BREAKERS (7.5 AMPS)
 (Typical 20 places, right and left)
 STATION 291, 367, 444, 520, 595, 671, 725, 801, 876, & 932

BB1-3909A

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ELECTRICAL -- EXTERNAL DC POWER RECEPTACLE & CIRCUIT BREAKERS



EXTERNAL DC POWER RECEPTACLE AND CIRCUIT BREAKERS

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DOUGLAS AIRCRAFT CO.
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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 19, SECTION 3, CHAPTER 10, DATED MAR 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

3-10-5-1 HYDRAULIC SYSTEM -- MADE CHANGES IN SECTION 3-10-5-1 TO PROPERLY IDENTIFY A RELIEF VALVE IN THE HYDRAULIC SYSTEM.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
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Chapter 10

HYDRAULIC SYSTEM

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Chapter 10

HYDRAULIC SYSTEM

GENERAL

The airplane has two completely independent hydraulic systems, designated left and right. There are no provisions for routing fluid or pressure from one system to the other. In some cases, pressure from each hydraulic system supplies the same service. For example, part of the flap actuating cylinders receive pressure from the left system, and part of the actuating cylinders receive pressure from the right system. Services normally receiving pressure from both hydraulic systems will operate safely but at reduced efficiency when one system is inoperative. Each system has a hydraulic reservoir and an engine-driven hydraulic pump. An alternate hydraulic motor/pump mechanically connects the two systems. In addition, the right system has an electrically powered auxiliary hydraulic pump. All pumps are capable of continuous operation. Required accumulators, filters, valves, and indicators are provided for each system.

Fire-resistant Skydrol hydraulic fluid is used in both systems. Medium- and high-pressure lines are stainless steel. Fluid supply to the engine-driven pump may be stopped by actuation of the fire shutoff handle on the upper instrument panel. Relief valves prevent overpressurization.

The left hydraulic system supplies pressure and pressure distribution for operation of the following:

1. Inboard flight spoilers
2. Left engine thrust reverser
3. Left and right wheelbrakes (when brake system selector handle is set to LEFT or BOTH)
4. Wing flap outboard actuators
5. Nosewheel steering system -- left cylinder
6. Elevator augmentor power
7. Outboard slat cylinders
8. Alternate hydraulic motor/pump.

The right hydraulic system supplies pressure and pressure distribution for operation of the following:

1. Outboard flight spoilers
2. Right engine thrust reverser
3. Rudder power
4. Wing flap inboard actuators
5. Left and right wheelbrakes (when brake system selector handle is set to RIGHT or BOTH)
6. Landing gear
7. Nosewheel steering system -- right cylinder

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8. Inboard slat cylinders
9. Alternate hydraulic motor/pump
10. Rudder throw limiter
11. Ventral stairway

The engine-driven and auxiliary hydraulic pumps supply pressure at approximately 3000 psi. During normal flight, when system demands are low, the engine-driven pumps will be operated at 1500-psi output to extend the system and pump service life. Operation of each engine-driven hydraulic pump is electrically controlled by a 3-position switch located on the first officer's instrument panel. Each switch has high, low, and off positions.

The electrically powered auxiliary hydraulic pump and the alternate hydraulic motor/pump are controlled by switches on the first officer's instrument panel.

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HYDRAULIC SYSTEM COMPONENTS

ENGINE-DRIVEN HYDRAULIC PUMPS

An engine-driven, piston type, variable displacement hydraulic pump is installed on each engine. Each pump is capable of providing continuous hydraulic fluid flow at a rate of 8 gpm and a pressure up to 3000 psi. The left engine pump supplies the left hydraulic system, and the right engine pump supplies the right hydraulic system. Each pump incorporates a solenoid-operated, low-pressure valve for reducing output pressure to approximately 1500 psi for normal flight operation and a solenoid-operated unloading valve with a blocking valve to shut off all pump output when the pump is depressurized. The solenoids are controlled by switches on the first officer's instrument panel.

ELECTRICALLY DRIVEN AUXILIARY HYDRAULIC PUMP

There is one auxiliary pump in the right hydraulic system. The pump is located in the forward area of the right main gear wheel well. The pump can supply the demands of its own hydraulic system and is designed for continuous operation. However, for long life, the auxiliary pump should be shut off when not required. The pump is capable of providing continuous hydraulic fluid flow at a rate of 8 gpm and pressure up to 3000 psi. The motor is 10 horsepower and operates on 115/200 volt, 3-phase, 400-cycle ac power. The pump is powered from the left generator bus, and is controlled by a switch on the first officer's instrument panel. An operable, electrically driven hydraulic pump in the right hydraulic system will provide normal gear retraction if the right engine pump is inoperative.

ALTERNATE HYDRAULIC MOTOR/PUMP
(ALTERNATE GEAR PUMP)

The alternate hydraulic motor/pump utilizes pressure from an operating hydraulic system to drive a pump that will provide pressure in the opposite unpressurized system. The hydraulic motor/pump consists of two axial piston hydraulic units that are hydraulically independent but mechanically connected by a shaft. Pressure to the motor, and from the pump, is controlled by two electrically operated valves that are actuated by an alternate gear pump switch on the first officer's instrument panel. When the solenoid valves are opened, the unit in the pressurized hydraulic system automatically becomes a motor and the unit in the unpressurized hydraulic system becomes a pump.

A sump in the right hydraulic system provides an alternate supply of hydraulic fluid for landing gear and main gear doors actuation in the event that normal right system fluid supply is depleted. The sump is connected in series with the landing gear control valve so that return fluid from the valve during gear extension must enter and fill the sump before it can exit through return lines to the reservoir. The case drain in the right unit of the alternate motor pump is also connected so that case drain fluid returns to the system through the sump. This configuration assures that once filled, the sump will remain full and cannot be depleted by demands of right hydraulic system pumps.

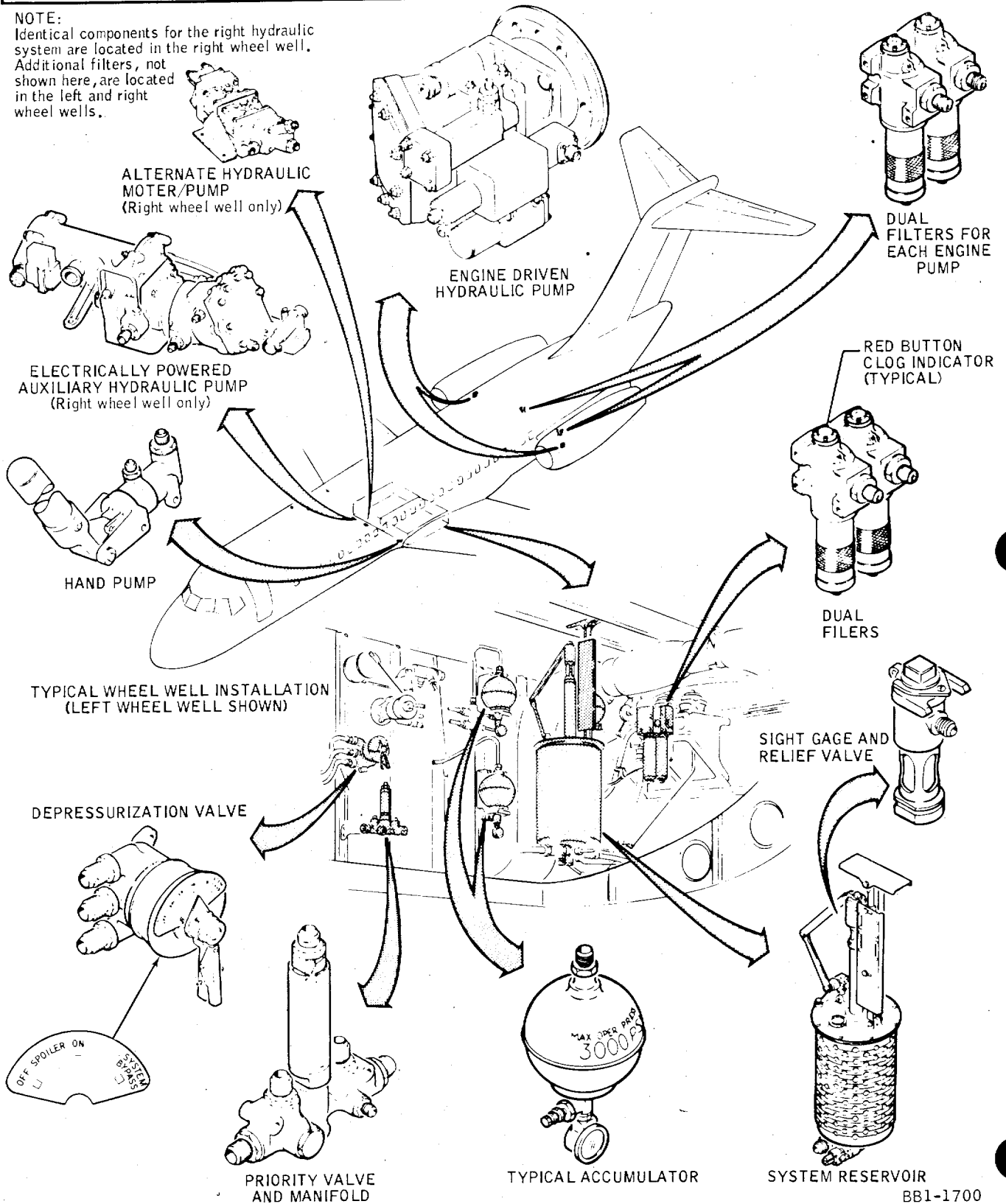
When the left system is unpressurized, the hydraulic motor/pump uses fluid from the hydraulic reservoir and will operate all units of the left system at a slightly reduced rate.

The input pressure from either the left or right hydraulic system is

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HYDRAULIC -- MAJOR COMPONENT LOCATION

NOTE:
 Identical components for the right hydraulic system are located in the right wheel well.
 Additional filters, not shown here, are located in the left and right wheel wells.



HYDRAULIC -- HYDRAULIC RESERVOIR FILL LEVEL PLACARDS

US QTS
12—
11—
10—
9—
8—
7—
6—
5—
4—
3—
2—
1—
0—
US QTS

LEFT SYSTEM FILL LEVELS

FULL
HYDRAULIC PRESSURE ZERO PSI
REFILL

NOTE: FLUID MUST BE VISIBLE IN SIGHT GAUGE BEFORE CHECKING RESERVOIR LEVEL. DEPRESS VALVE ON TOP OF PISTON ROD TO BLEED AIR FROM RESERVOIR.

FULL
HYDRAULIC PRESSURE 3000 PSI
REFILL

FLUID LEVELS ARE FOR 70°F
IF AIRPLANE IS COLD SOAKED: UNDERFILL 1 QT AT +20°F UNDERFILL 2 QTS AT -30°F

FILLING INSTRUCTIONS
(USE ONLY SKYDROL 500 FLUID)

- BEFORE SERVICING, DEPRESS VALVE ON TOP OF PISTON ROD TO BLEED AIR FROM RESERVOIR.
- RELEASE ALL HYDRAULIC PRESSURE IN ACCUMULATORS BY OPERATING THE FOLLOWING:
 - PLACE SPOILER SHUTOFF AND SYSTEM DEPRESSURIZING VALVE IN BY-PASS POSITION.
 - OPERATE BRAKE PEDALS TO DEplete BRAKE SYSTEM PRESSURE.
 - ACTUATE THRUST REVERSER ISOLATION VALVE TO DUMP POSITION.
 - ELEVATOR BY-PASS VALVES.
- CHECK ALL ACCUMULATORS FOR PROPER AIR CHARGE.
- FILL TO FULL LINE AS INDICATED ABOVE.

US QTS
12—
11—
10—
9—
8—
7—
6—
5—
4—
3—
2—
1—
0—
US QTS

RIGHT SYSTEM FILL LEVELS

FULL
HYDRAULIC PRESSURE ZERO PSI
REFILL

FULL
HYDRAULIC PRESSURE 3000 PSI
REFILL

NOTE: FLUID MUST BE VISIBLE IN SIGHT GAUGE BEFORE CHECKING RESERVOIR LEVEL. DEPRESS VALVE ON TOP OF PISTON ROD TO BLEED AIR FROM RESERVOIR.

FLUID LEVELS ARE FOR 70°F
IF AIRPLANE IS COLD SOAKED: UNDERFILL 1 QT AT +20°F UNDERFILL 2 QTS AT -30°F

FILLING INSTRUCTIONS
(USE ONLY SKYDROL 500 FLUID)

- BEFORE SERVICING, DEPRESS VALVE ON TOP OF PISTON ROD TO BLEED AIR FROM RESERVOIR.
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 - PLACE SPOILER SHUTOFF AND SYSTEM DEPRESSURIZING VALVE IN BY-PASS POSITION.
 - OPERATE BRAKE PEDALS TO DEplete BRAKE SYSTEM PRESSURE.
 - ACTUATE THRUST REVERSER ISOLATION VALVE TO DUMP POSITION.
- CHECK ALL ACCUMULATORS FOR PROPER AIR CHARGE.
- FILL TO FULL LINE AS INDICATED ABOVE.

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controlled so that not more than 2 gallons per minute flow will be used to drive the hydraulic motor/pump.

HYDRAULIC SYSTEM RESERVOIR

The left and right hydraulic system reservoirs are located in the inboard aft corner of the left and right main gear wheel wells, respectively. Each reservoir supplies fluid to its own system exclusively. Each reservoir has a fluid capacity of 3 US gallons (2.5 Imperial gallons, 11.35 liters). A manifold on the bottom of the reservoir ports fluid to supply lines for the engine-driven hydraulic pump, the electrically driven auxiliary hydraulic pump, and a ground service hydraulic handpump. Internally the reservoir utilizes system pressure of 3000 or 1500 psi, in a piston and diaphragm assembly, to maintain a pressure head of approximately 30 or 15 psi on the fluid. This pressure head ensures positive transfer of fluid to the pumps. The reservoir is protected against overpressurization by a relief valve set for 47 psi. A temperature pickup in the reservoir will cause the applicable (L or R) hydraulic high-temperature annunciator light to come on when the hydraulic fluid in the reservoir reaches approximately 220°F (105°C). A sight glass located in the top center of the reservoir is used to check excessive air accumulation in the reservoir. If the sight glass does not show some fluid, an accurate indication of fluid level cannot be made and the reservoir should be bled of air. A bleed valve and hose are located on top of the reservoir. An instruction plate, mounted adjacent to the sight glass, and a pointer, attached to the top of the relief and bleed valve, provide fluid level instructions and direct fluid level indications for both system pressurized and unpressurized conditions. A fluid quantity

transmitter, located at each reservoir, transmits fluid quantity information to the applicable hydraulic quantity indicator on the first officer's instrument panel.

HYDRAULIC SYSTEM FILTERS

Filters are installed in the engine-driven hydraulic pump pressure and case drain lines, in the electrically driven auxiliary hydraulic pump pressure line, and in the hydraulic system return line. The filters are identical, 15-micron, nonbypassing, line type. Each filter has a red button indicator to indicate an overloaded condition of the filter element. When the filter element becomes overloaded, causing a differential pressure of approximately 120 psi across the filter, the red button will protrude three-sixteenths of an inch from the top of the filter head. The button cannot be reset in a pressurized system until the overloaded condition has been corrected.

The filters for the engine-driven pumps are located in the fuselage aft accessory compartment. Filters for the system return lines and external source pressure lines are located in each main gear wheel well. In the right system, the source line filter also serves as the electrically driven pump pressure line filter.

GROUND SERVICE HYDRAULIC HANDPUMP

Each hydraulic pressure system has a handpump for ground service. One pump is installed in each main gear wheel well. These pumps, though quick-disconnect fittings, are used for normal servicing of system hydraulic fluid. The pumps may be used to build up pressure for ground maintenance.

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SPOILER SHUTOFF AND SYSTEM DEPRESSURIZATION VALVE

There is one depressurization valve in each hydraulic pressure system. The valve is used during maintenance operations to depressurize the system for servicing or to block system pressure to the applicable spoiler cylinders (inboard or outboard) operated by the system. One valve is installed in each main gear wheel well. Each valve has three positions as follows:

1. Spoiler on -- (Detented and safetied). Pressure available to the entire pressure distribution system.
2. Spoiler off -- (Detented). Pressure available to all subsystems, except the spoilers that are supplied by the applicable hydraulic pressure system.
3. System bypass -- System pressure routed through the valve to return line; no pressure available for systems operation.

HYDRAULIC SYSTEM PRIORITY VALVE

A priority valve is installed in the pressure line of the left and right hydraulic pressure systems to give the flight controls priority on pressure available. The valves are designed to prevent hydraulic pump output to pass through the valve unless pressure is 2000 psi or above. The valve will permit free flow in the reverse direction.

Valve Function in Right System

Location of the valve in the right hydraulic pressure system provides pressure priority for the outboard flight spoiler system, the rudder power system, the right engine thrust reverser, inboard slat cylinders, and

ventral stairway. When the right hydraulic system pressure drops below 2000 psi (or system is pressurized by engine-driven hydraulic pump operating at low switch setting), pressure will not be available for operation of wing flap inboard cylinders, landing gear, or right nosewheel steering cylinder. If brake selector handle is set for operation by right hydraulic brake system, hydraulic system pressure must be above 2000 psi to charge brake accumulators and maintain brake system pressure.

Valve Function in Left System

Location of the valve in the left hydraulic pressure system provides pressure priority for the inboard flight spoilers, elevators, outboard slat cylinders, and the left engine thrust reverser. When the left hydraulic system pressure drops below 2000 psi (or system is pressurized by engine-driven hydraulic pump operating at low switch setting), pressure will not be available for operation of wing flap outboard cylinders or left nosewheel steering cylinder. If brake system selector handle is set for operation by left hydraulic brake system, hydraulic system pressure must be above 2000 psi to charge brake accumulators and maintain brake system pressure.

ACCUMULATORS

The accumulators are spherical type. Capacity is 40 cubic inches when charged to 1000 psi; capacity is 48 cubic inches when charged to 675 psi, as for brake and elevator accumulators. An air pressure gage is installed on each accumulator to provide means for checking initial charging pressure.

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PRESSURE REDUCER (1500 PSI) RELIEF
VALVE

A pressure reducer is installed in the pressure line of the left and right hydraulic system that supplies pressure for operation of the lateral control spoilers. The purpose of the pressure reducer is to supply uniform pressure for lateral control spoiler operation when the engine driven hydraulic pumps are operated at HI (3000 psi) or LOW (1500 psi) output. The purpose of the relief valve function is to provide a blowback relief when the spoiler surfaces are exposed to excessive airloads.

L & R HYD PRESS LOW LIGHTS

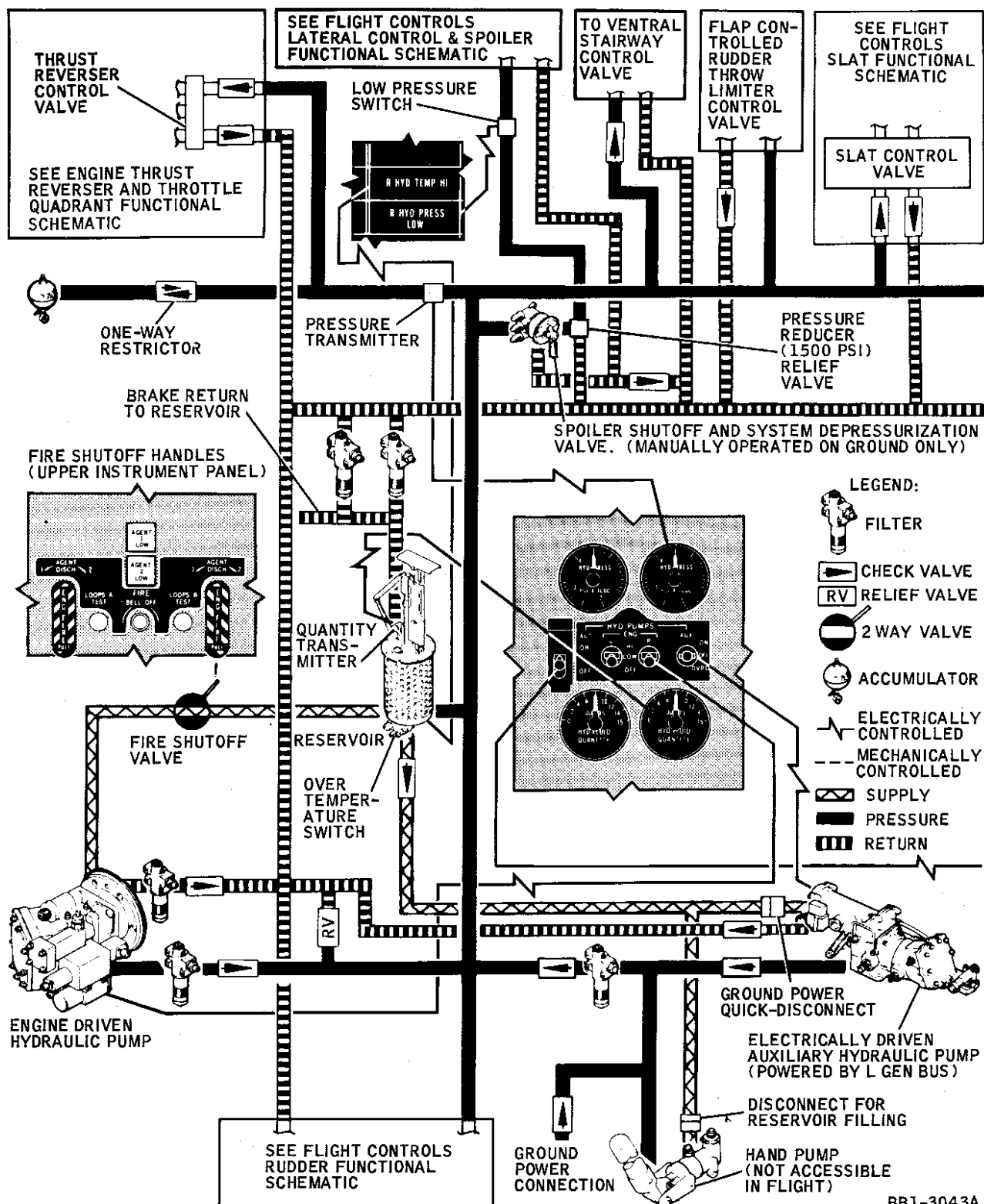
Each light is actuated by a pressure switch located downstream of the pressure reducer (1500 psi) relief valve in the left and right system. The applicable HYD PRESS LOW light and the MASTER CAUTION light will come on when the pressure at the switch drops to approximately 800/1000 psi.

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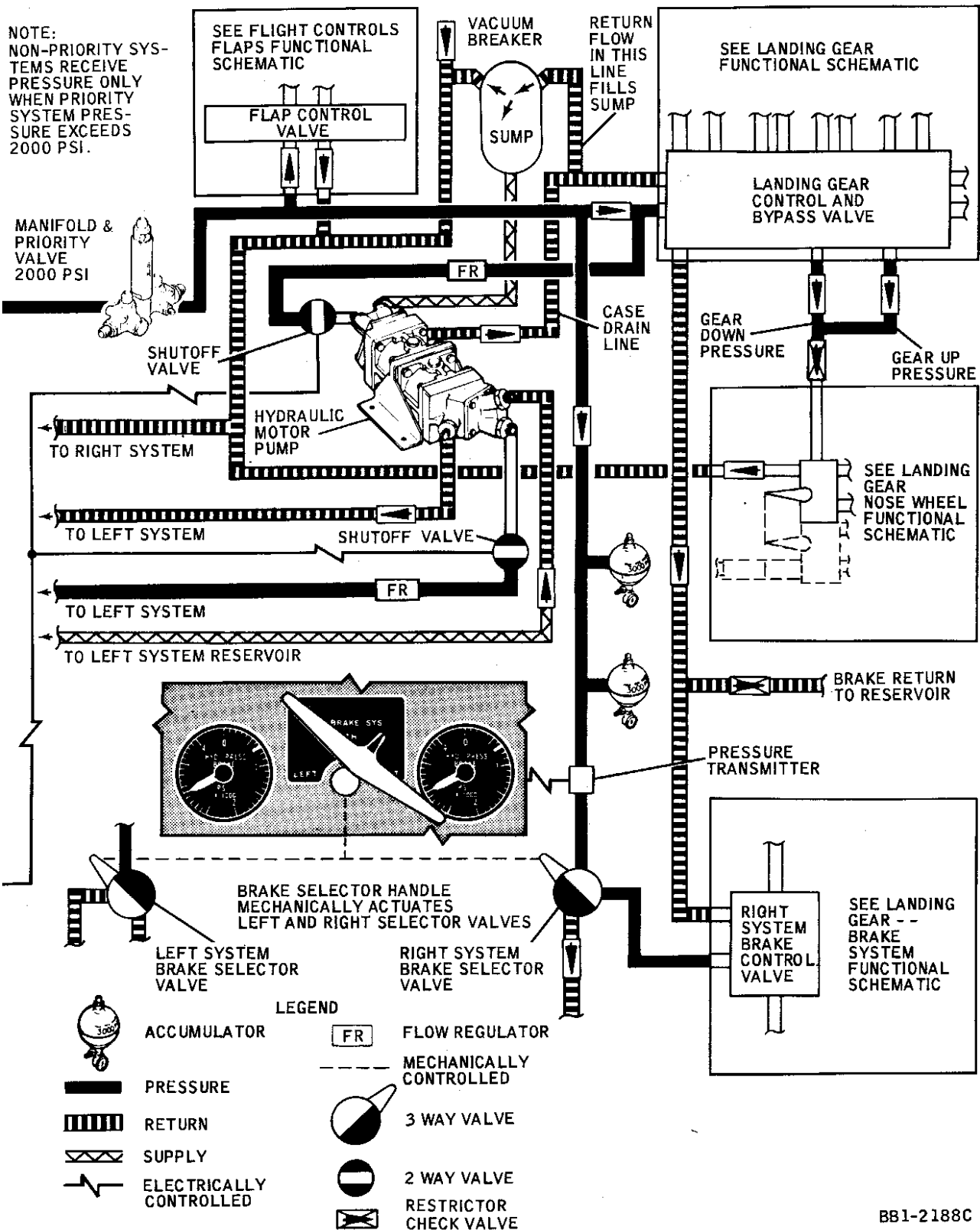
HYDRAULIC -- RIGHT SYSTEM & PRIORITY PRESSURE DISTRIBUTION



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HYDRAULIC -- RIGHT SYSTEM - Nonpriority pressure distribution



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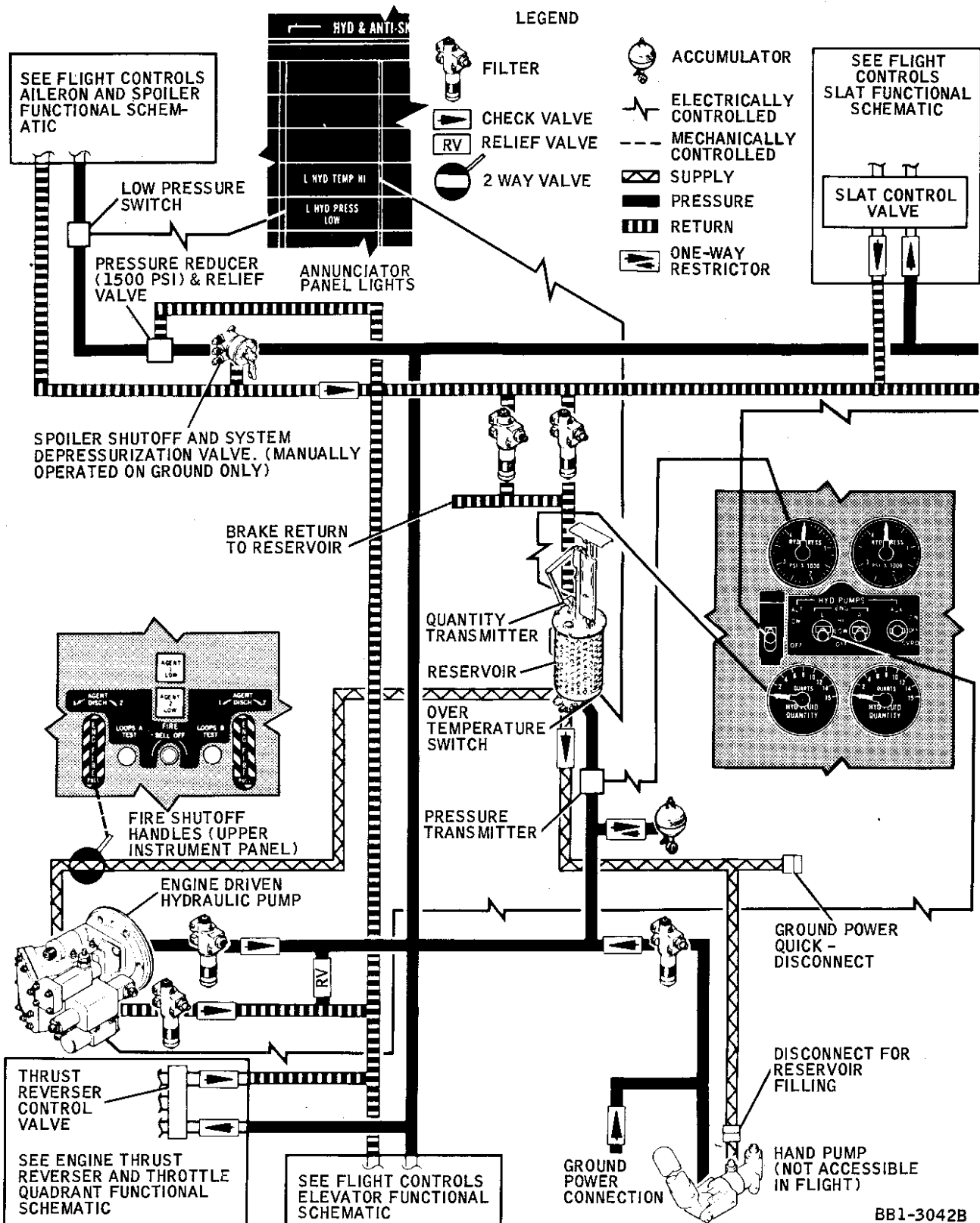
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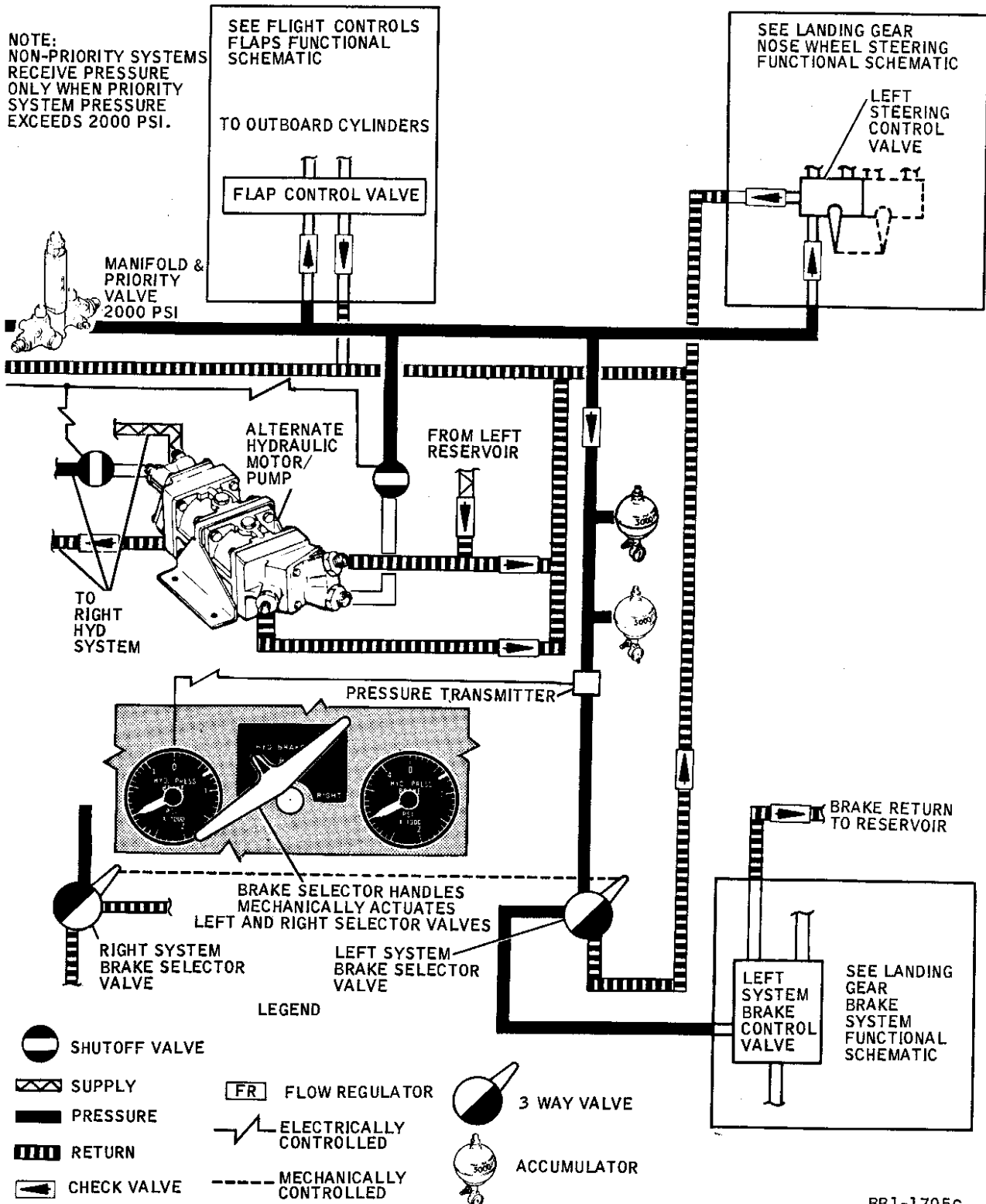
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HYDRAULIC -- LEFT SYSTEM & PRIORITY PRESSURE DISTRIBUTION



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HYDRAULIC -- LEFT SYSTEM - Nonpriority pressure distribution



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HYDRAULIC -- COCKPIT CONTROLS & INDICATORS (sheet 1)

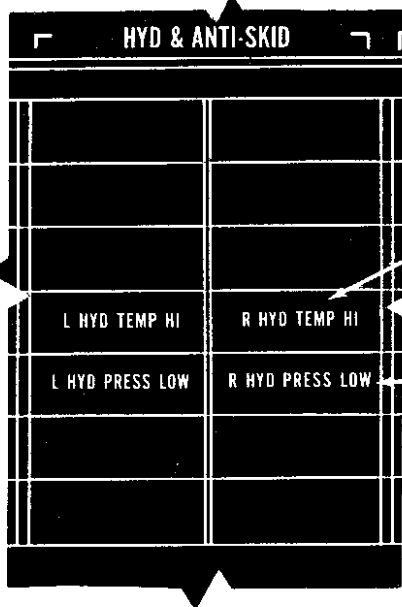
L & R HYD TEMP HI CAUTION LIGHTS

L or R HYD TEMP HI and MASTER CAUTION lights will come on when left or right hydraulic reservoir fluid temperature reaches approximately 105°C (221°F).

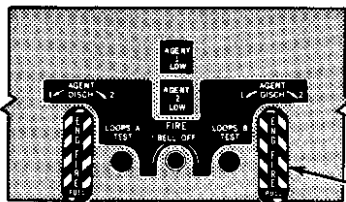
Light is actuated by a temperature switch located in the reservoir.

L & R HYD PRESS LOW CAUTION LIGHTS

L or R HYD PRESS LOW and MASTER CAUTION lights will come on when hydraulic pressure in the line that supplies pressure for lateral control spoiler operation drops to 800/1000 psi. Each HYD PRESS LOW light is actuated by a separate pressure switch, located downstream of the pressure reducer (1500 psi) relief valve, in the respective left or right hydraulic system.



**MASTER
CAUTION
PUSH TO RESET**



FIRE SHUTOFF HANDLES

When the handles are pulled all hydraulic fluid to the engine-driven hydraulic pumps will stop.

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HYDRAULIC -- COCKPIT CONTROLS & INDICATORS (sheet 2)

FIRST OFFICER'S INSTRUMENT PANEL

L & R HYD PRESS INDICATOR

Indicators show pressure existing in hydraulic pressure line. A pressure transmitter located in pressure line, between pumps and reservoir, transmits pressure information to the indicator.

L & R ENG HYD PUMPS SWITCHES

NOTE:

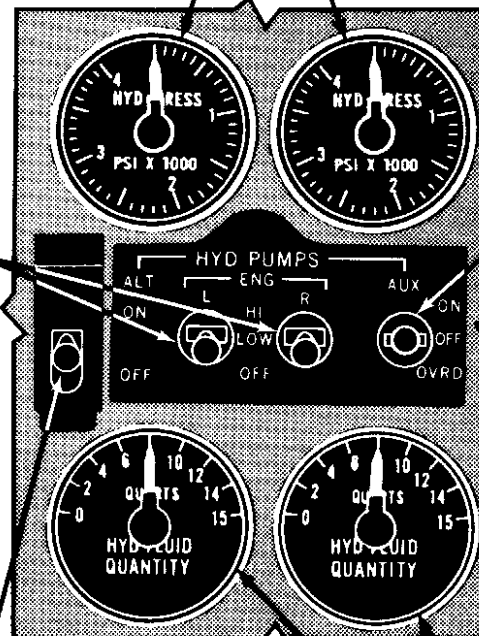
In the event of an electrical failure the engine pumps will operate at full output, regardless of switch position.

L & R switches provide control of engine driven hydraulic pump operation by selection of HIGH, LOW or OFF position.

HIGH - Engine driven hydraulic pump will operate at 3000 psi output.

LOW - Engine driven hydraulic pump will operate at 1500 psi output.

OFF - No pressure output for system operation. Circulation of fluid for pump lubrication only.



AUX HYD PUMP SWITCH

The switch provides control of electrically driven auxiliary hydraulic pump operation by selection of ON, OFF, or OVERRIDE position.

ON - Pump will operate at 3000 psi output.

OFF - Pump inoperative.

OVERRIDE - (Must be held in this position). The auxiliary pump is protected from overheat damage by a thermal protective circuit that disconnects electrical power to the pump when normal operating temperatures are exceeded. The override position bypasses the protective circuit to permit pump operation if no other source of needed pressure is available.

ALT HYD PUMP SWITCH

When placed at ON, opens two valves that allow the left hydraulic motor to drive pump in alternate gear down system. Provides an alternate source of pressure for operating the landing gear or for the right hand hydraulic motor to drive the pump, to pressurize the left hand system.

L & R HYD FLUID QUANTITY INDICATORS

Indicators show quantity of fluid in reservoir. A fluid quantity transmitter located at the reservoir transmits quantity information to the indicator.

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TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 20, SECTION 3, CHAPTER 15, DATED JUN 1/70
SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

3-15-1-0 PROVIDED REVISED TEXT AND ILLUSTRATIONS APPLICABLE TO AIRPLANES BOTH WITH AND WITHOUT LANDING GEAR SPRAY DEFLECTORS.

3-15-10-0 PROVIDED ADDITIONAL TEXT DESCRIBING THE REVERSION OF THE ANTI-SKID TO MANUAL BRAKE CONTROL DURING CONDITION OF A SPEED DIFFERENTIAL BETWEEN PAIRED WHEELS OF 60 KNOTS OR GREATER.

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Chapter 15

LANDING GEAR AND BRAKE SYSTEMS

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Chapter 15

LANDING GEAR AND BRAKE SYSTEMS

LANDING GEAR

GENERAL

The airplane has a conventional tri-cycle landing gear. The nose gear assembly consists of dual wheels mounted on a steerable shock strut. Each main gear assembly consists of dual wheels and brakes mounted on a shock strut. The strut assembly includes an independent hydraulic damper at the joint of the torque links. When retracted, the gear assemblies are fully enclosed by doors. The doors are hydraulically and mechanically actuated during the gear extension and retraction cycles. The gear assemblies are retracted by pressure from the right hydraulic system. The gear assemblies may be extended and locked by pressure from the right hydraulic system, by pressure from an alternate landing gear system, or by free-fall. When free-fall is used, the main gear hydraulically operated doors will not close. Spray deflectors on both the main gear and the nose gear assemblies serve to minimize water and slush injection on takeoff and landing through standing water and/or slush (if installed).

An electrically monitored, visual/audible indicating and warning system provides indication of gear and door positions.

The gear is normally operated by use of the landing gear control handle mounted on the first officer's instrument panel. The gear may be extended (free-fall) by an emergency landing gear extension lever located on the

floor at the right side of the pedestal.

A tail bumper assembly is located on the bottom of the aft fuselage to prevent structural damage during a tail down condition.

MAIN GEAR OPERATION

Each main gear is locked in the extended position by overcenter linkage actuated by a hydraulic bungee cylinder and bungee springs. When retracted, the main gear assemblies will rest on the latched main gear doors. If hydraulic pressure is not available to release the door latches, they may be mechanically released by action of the emergency landing gear extension lever.

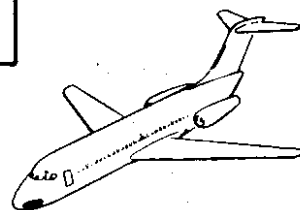
MAIN GEAR DOORS

Each main gear wheel well enclosure consists of a hydraulically operated main gear door and a mechanically operated outboard door. The main gear doors are mechanically latched when closed, and support the main gear during flight. The main gear doors cycle to the closed position after the main gear approaches the fully extended position. The main gear doors may be mechanically released and opened for maintenance operations.

NOSE GEAR OPERATION

The nose gear is locked in both the extended and retracted positions by

LANDING GEAR -- MAJOR COMPONENT LOCATION (sheet 1)



For view through peep hole see GEAR LATCH VISUAL POSITION CHECK.

EMERGENCY NOSE GEAR LATCH PEEP HOLE - REMOVE HOLE PLUG

EMERGENCY LANDING GEAR EXTENSION LEVER

CABLE TO EMERGENCY LANDING GEAR EXTENSION LEVER

BUNGEE CYLINDER

OVERCENTER LINKAGE BUNGEE SPRINGS

NOSE GEAR UPLATCH RELEASE

Operation of the emergency landing gear extension lever forces the arm downward to overcome the overcenter linkage bungee springs and free-fall the gear.

ARM

NOSE GEAR ACTUATING CYLINDER

NOSE GEAR STEERING BY-PASS AND RELIEF VALVE

RIGHT NOSEWHEEL STEERING CYLINDER

(2 way operation, powered by right hydraulic system.)

LEFT NOSEWHEEL STEERING CYLINDER

(2 way operation, powered by left hydraulic system.)

FORWARD NOSE GEAR DOORS

Doors are mechanically operated by linkage connected to nose gear strut. Doors cycle from closed-to-open-to closed during either extension or retraction of the nose gear. Doors are closed when gear is extended.

AFT NOSE GEAR DOORS

Doors are linked to and move with the nose gear strut during extension or retraction. These doors remain open when the gear is extended.

NOSE GEAR SPRAY DEFLECTOR

Deflector minimizes water and/or slush injection during takeoff and landing (if installed).

NOSE GEAR STEERING BYPASS LEVER (Bypass position)

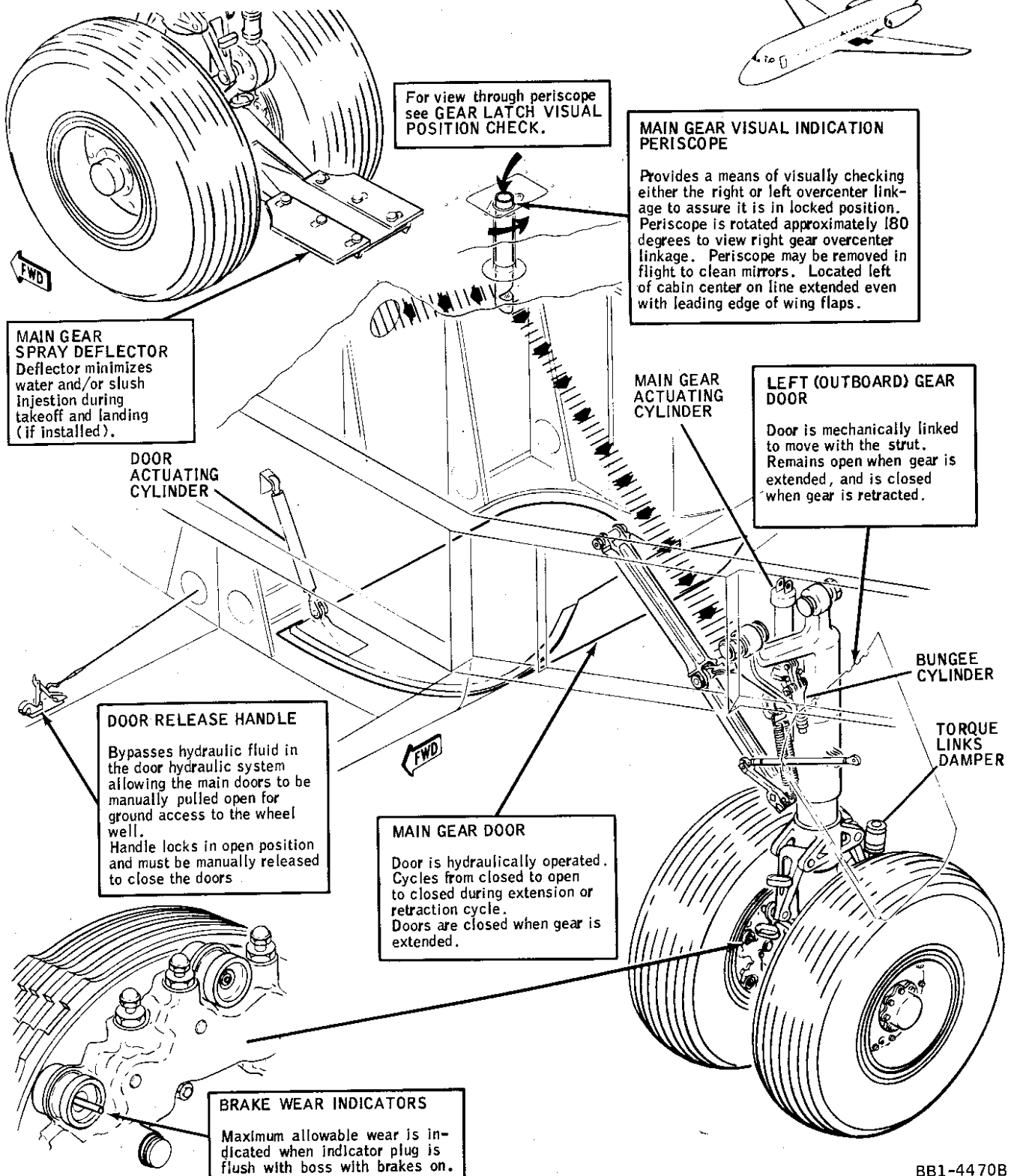
GROUND SHIFT MECHANISM

This handle (2 places) releases a telescoping mechanism allowing the doors to be manually opened for ground maintenance.

If not manually closed, will automatically reengage to close doors during retract cycle.

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LANDING GEAR -- MAJOR COMPONENT LOCATION (sheet 2)



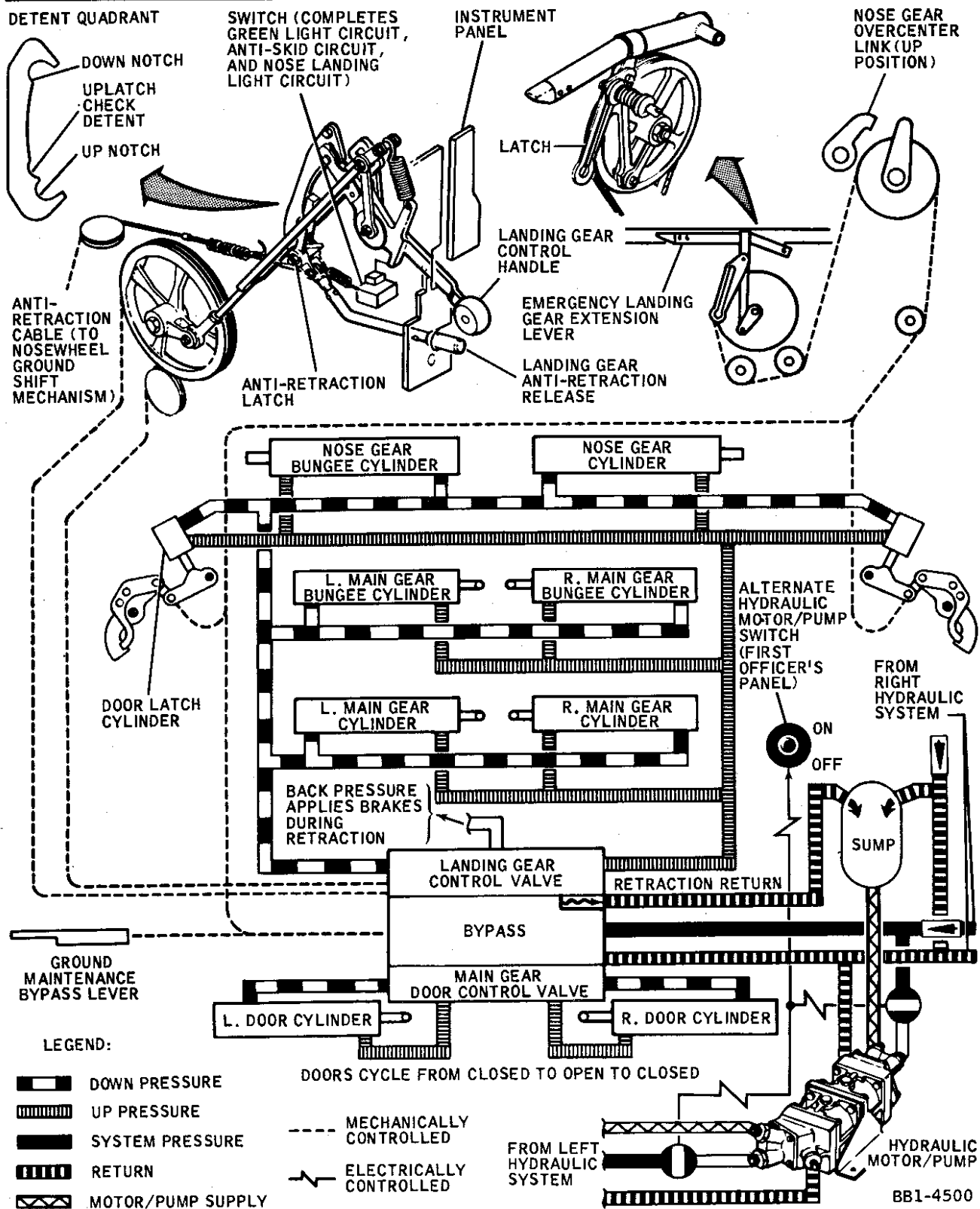
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LANDING GEAR -- FUNCTIONAL SCHEMATIC

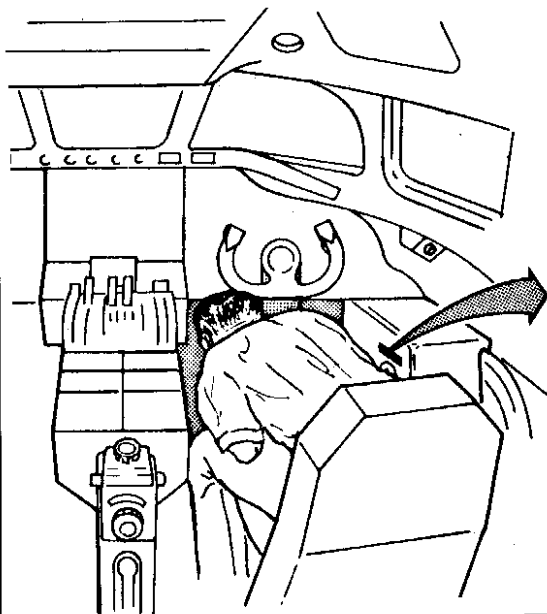
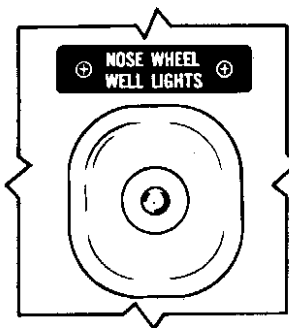


LANDING GEAR -- GEAR LATCH VISUAL POSITION CHECK

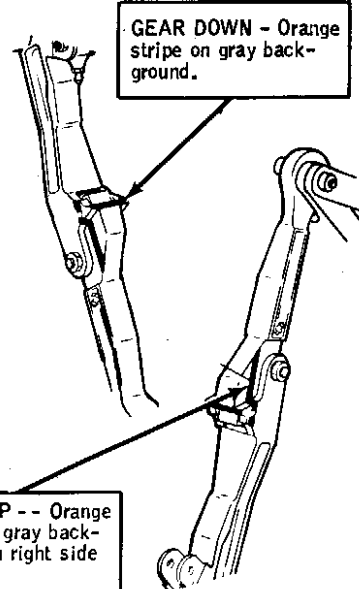
NOSE GEAR

To visually check nose gear overcenter linkage, place seat as far down, and as far back as possible. Remove peep

hole plug and turn nose wheel well light on. For unobstructed view, head should be below control wheel.



NOSE WHEEL WELL LIGHT SWITCH
 Light must be on to view nose gear overcenter link markings.



GEAR DOWN - Orange stripe on gray background.

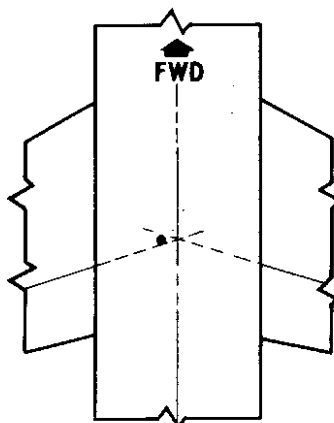
GEAR UP -- Orange stripe on gray background on right side of link.

MAIN GEAR

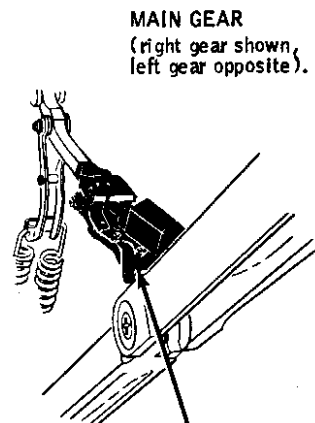
To visually check main gear overcenter linkage, depressurize to below 1 psi differential pressure, raise carpet over periscope, remove cover and dust cap, and turn on wheel well lights (switch located adjacent to periscope). Align periscope with index mark to view desired gear, rotate approximately 180 degrees and align other index mark to view

opposite gear. Periscope may be removed to clean mirrors.

NOTE: Periscope cover may be removed at maximum differential pressure, but causes considerable air noise and has a high air flow.



Periscope located left of center approximately at intersection of line extended from wing flap leading edges.



MAIN GEAR
 (right gear shown, left gear opposite).

GEAR DOWN -- Orange stripe on black background.

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FLIGHT CREW OPERATING MANUAL

overcenter linkage actuated by a hydraulic bungee cylinder and bungee springs. During normal operation, the hydraulic bungee cylinder releases the overcenter linkage to permit gear extension and retraction. If hydraulic pressure is not available, the overcenter links may be released by a manually actuated trip lever and roller connected to the emergency landing gear extension lever.

The nose gear assembly mounts the two hydraulic cylinders of the nosewheel steering system.

NOSE GEAR DOORS

The nose gear wheel well enclosure consists of two forward doors and two aft doors. The doors are mechanically operated by movement of the nose gear during extension and retraction. The forward doors are closed when the gear is extended but may be opened for ground maintenance operations.

GROUND SHIFT MECHANISM

The ground shift mechanism is connected to the torque links and is operated by the compression and extension of the nose shock strut. It provides a mechanical means of establishing a ground mode or a flight mode of operation for various systems. When the nose shock strut is not compressed, the ground shift mechanism disengages the rudder pedal nosewheel steering mechanism (refer to NOSEWHEEL STEERING), centers the nosewheel for retraction, and retracts the landing gear control handle antiretract stop. The ground shift mechanism also actuates two ground control switches that energize or deenergize ground control relays, to establish ground or flight

mode of operation for various systems. See illustration titled LANDING GEAR -- GROUND SHIFT MECHANISM FUNCTIONS.

NOSEWHEEL STEERING SYSTEM

GENERAL

The nosewheel steering system is hydraulically actuated and mechanically controlled by a steering wheel, located on the left side of the flight compartment, or by the rudder pedals. The steering wheel controls 82 degrees of turning angle in either direction.

A pedal steering mechanism permits approximately 14 degrees of steering control in either direction through use of the rudder pedals. This mechanism also contains the locking cams and pushrods that center the nosewheel and lock out all steering during gear retraction.

A followup differential mechanism transfers the cable system action to the steering system hydraulic control valves. The followup mechanism stops are spring loaded to provide load feel to the steering system and prevent oversteering. The ground shift mechanism positions the steering mechanism to actuate either from steering control wheel or rudder pedals when the nose gear strut is compressed, and locks out the steering system when the strut is extended.

The nosewheel steering hydraulic control system consists of two independent control valves and actuating cylinders that are mechanically linked to the steering control cable system and are supplied hydraulic pressure from separate sources. The

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left steering cylinder receives pressure from the left hydraulic power system. The right steering cylinder receives hydraulic pressure from the right hydraulic power system through the landing gear control valve. Nose-wheel steering, with only one hydraulic system in operation, will function normally except for a slight reduction in maximum steering angle.

While the steering system is in the neutral position, the cylinders function as shimmy dampers. During towing maneuvers, hydraulic pressure from the steering control valves is blocked and steering cylinders are bypassed by a manually operated bypass valve.

STEERING WHEEL

The steering wheel, located on the forward end of the pilot's console, is the primary control used to steer the airplane during ground maneuvers. When the indicator mark on the rim of the steering wheel is aligned forward, the steering wheel is in the neutral position and the nosewheels are positioned forward. The parking brake control is located in the center of the steering wheel.

VISUAL/AUDIBLE INDICATING AND WARNING SYSTEM

Three green lights, two bulbs in each, and three red lights, located on the upper instrument panel, provide gear position indication, and an amber light indicates main gear door open. A landing gear warning horn will sound when the throttles are at approximately idle position and the gear is not down, or the gear handle is not in the down notch. The horn may be silenced by a button on the glare-shield under all conditions, including approach, until the flaps are 3 degrees or more below the approach flap

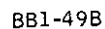
position. Thereafter, placing the gear to down and locked is the only method of silencing the horn.

An amber GEAR DOOR OPEN light will be on when the main gear doors are not in the fully closed position. If the light is off it indicates that the main gear doors are fully closed, and that the ground maintenance door release handle is in the normal (flight) position.

Reference markings on each gear over-center link may be viewed from inside the aircraft to visually verify that the gear has fully extended and locked.

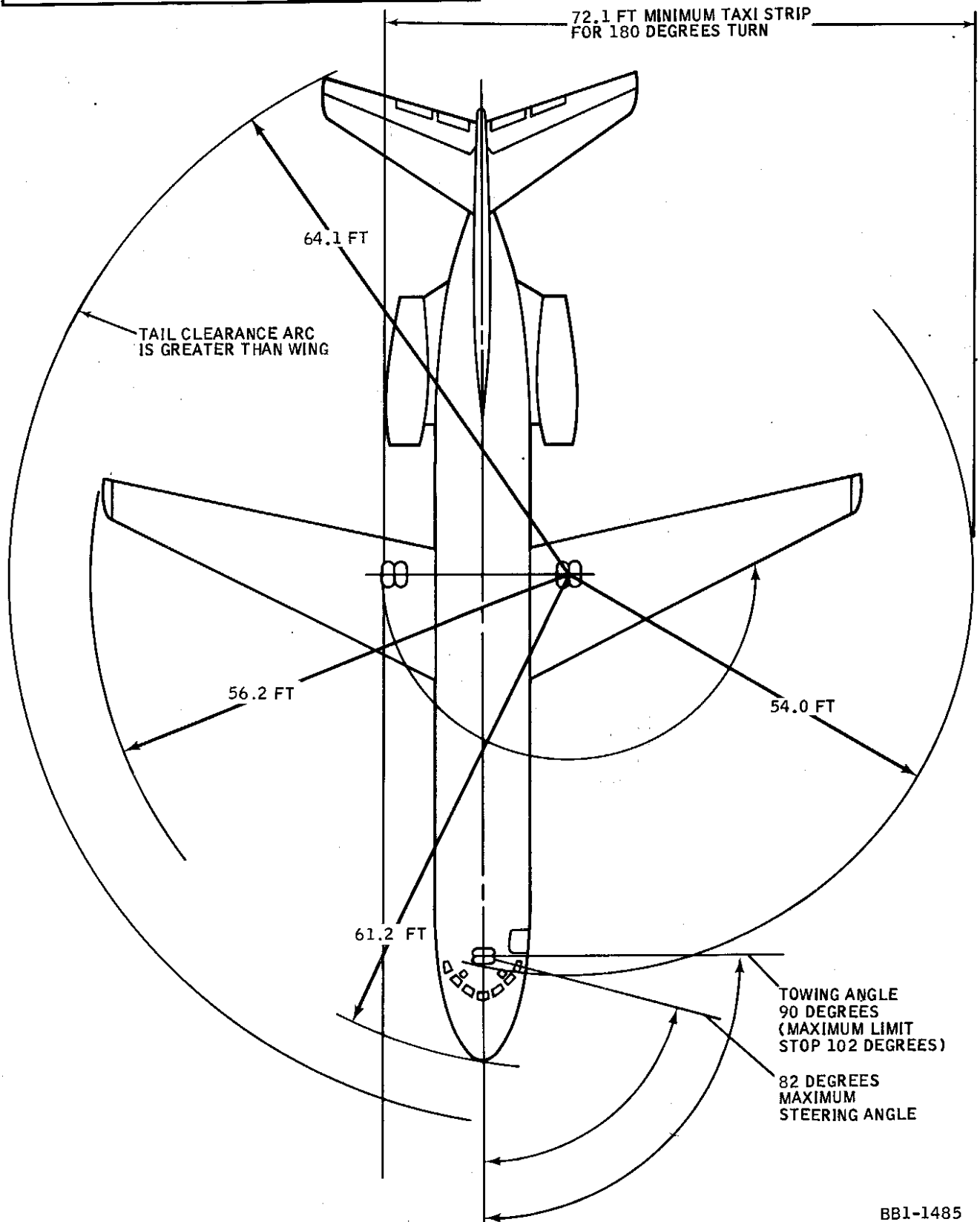
ALTERNATE HYDRAULIC MOTOR/PUMP SYSTEM (For additional details of the system, refer to Section 3, Chapter 10-HYDRAULICS.)

The alternate hydraulic motor/pump system will provide pressure for gear operation, in the event of pressure loss in the right hydraulic system. When the ALT HYD PUMP switch, on the first officers instrument panel, is placed at ON position, pressure in the left hydraulic system will drive the motor/pump unit to provide pressure "specifically" for gear operation. In this mode of operation (left hydraulic system as power source and right hydraulic system with a pressure loss) all other functions of the right hydraulic system are bypassed. A sump in the right hydraulic system provides an alternate supply of hydraulic fluid to the motor/pump unit for landing gear and main gear doors operation in the event that normal right system supply is depleted. The sump is replenished by return fluid from the landing gear control valve during gear extension, and by case drain fluid from the right half of the motor/pump unit. The sump, once filled, will remain filled, and cannot be depleted by demands of the right system pumps.



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LANDING GEAR -- TURNING RADII



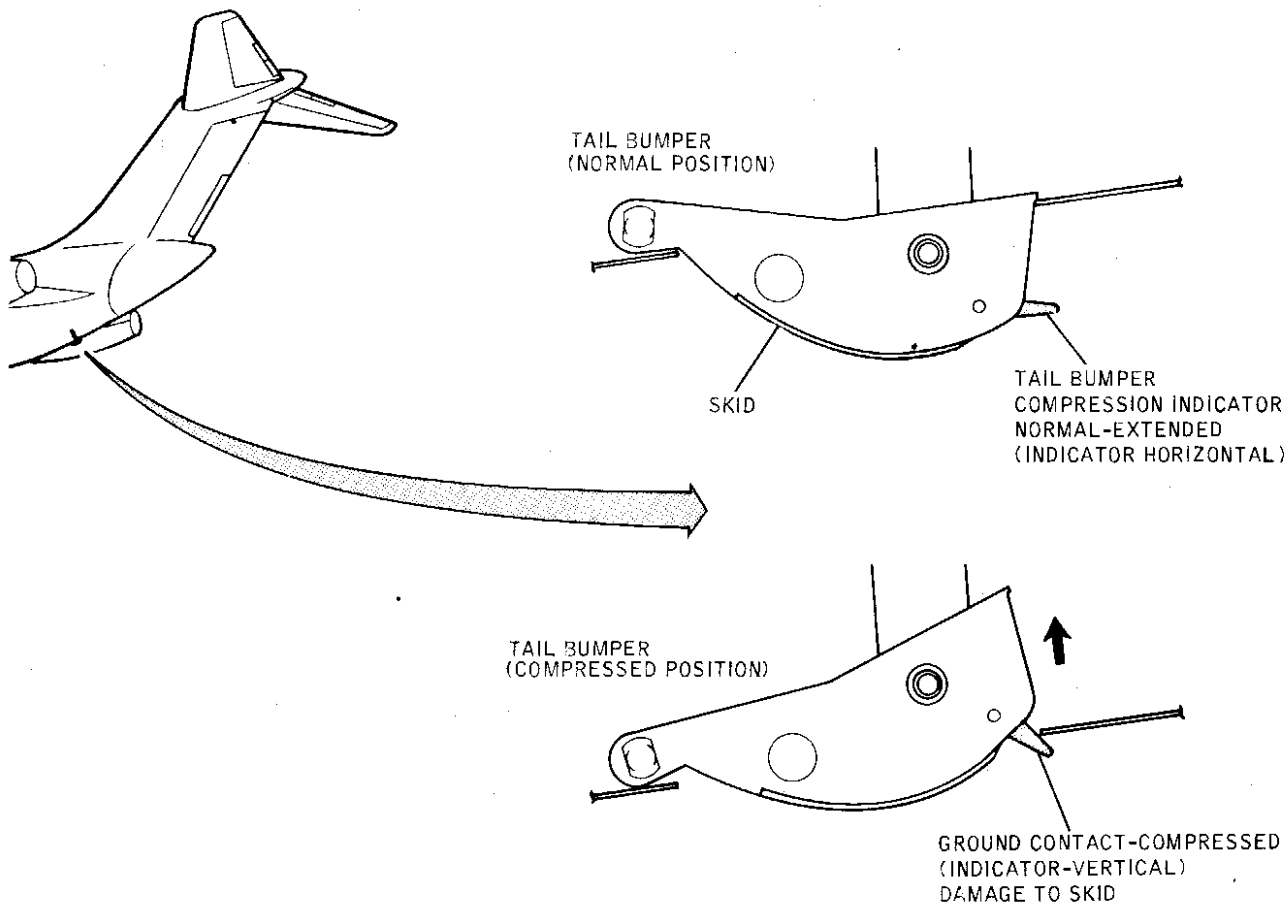
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LANDING GEAR -- TAIL BUMPER & COMPRESSION INDICATOR



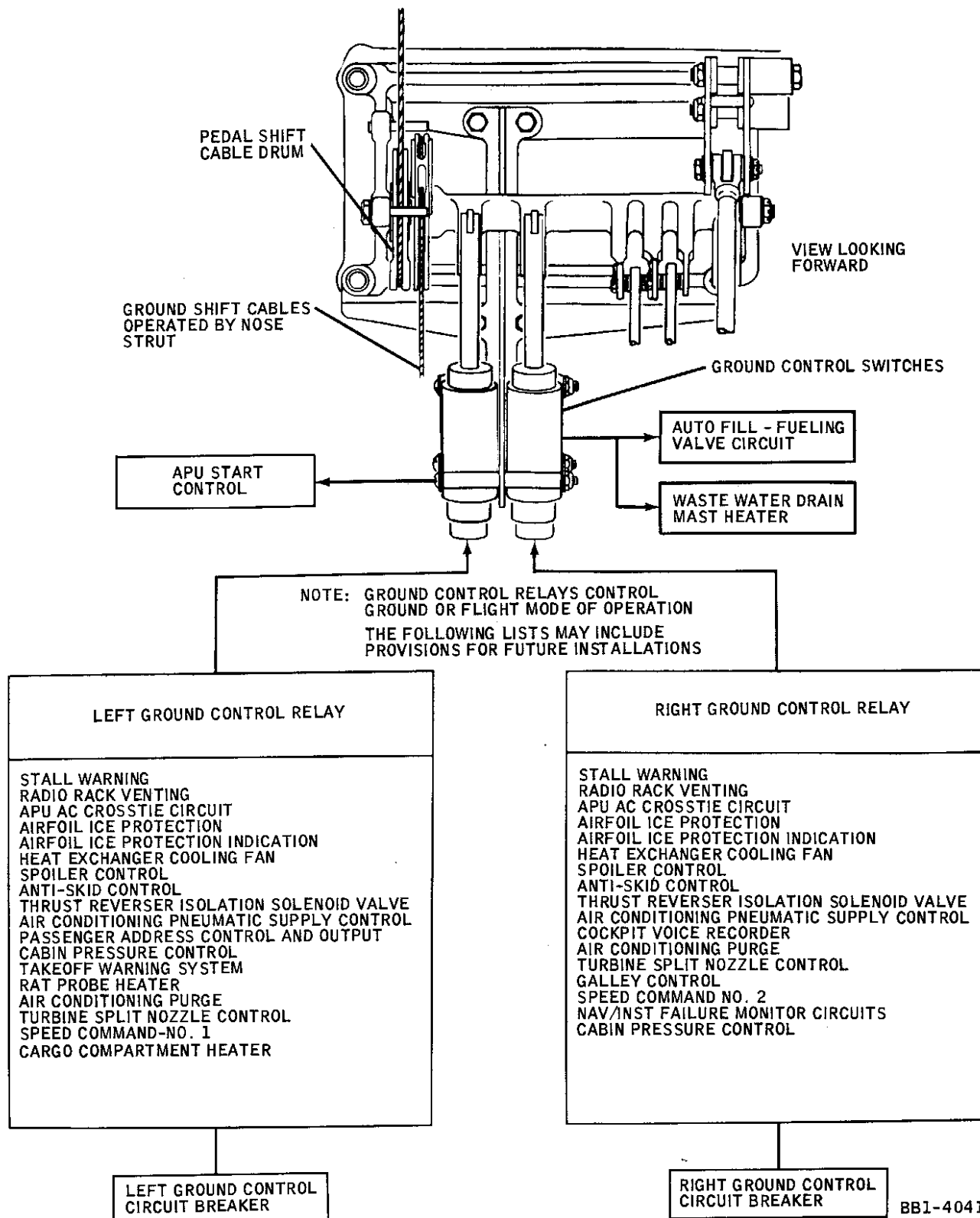
DESCRIPTION: During normal operation the tail of the airplane should not contact the ground surface. If early rotation or other abnormal operation causes the tail to contact the surface, the tail bumper will prevent, or limit, structural damage. The bumper extends beyond the skin and is linked to a shock strut that will absorb impact forces.

TAIL BUMPER COMPRESSION INDICATOR. The tail bumper compression indicator should normally be in the horizontal position. If the tail bumper has contacted the ground and was compressed three inches or more, the indicator will be driven toward the vertical position. In this event a structural inspection is necessary.

NOTE: The indicator can be moved by hand. If the lever is not in the normal horizontal position, and doubt exists as to condition, a visual check for damage of the tail bumper skid should be made.

BB1-3058

LANDING GEAR -- GROUND SHIFT MECHANISM FUNCTIONS



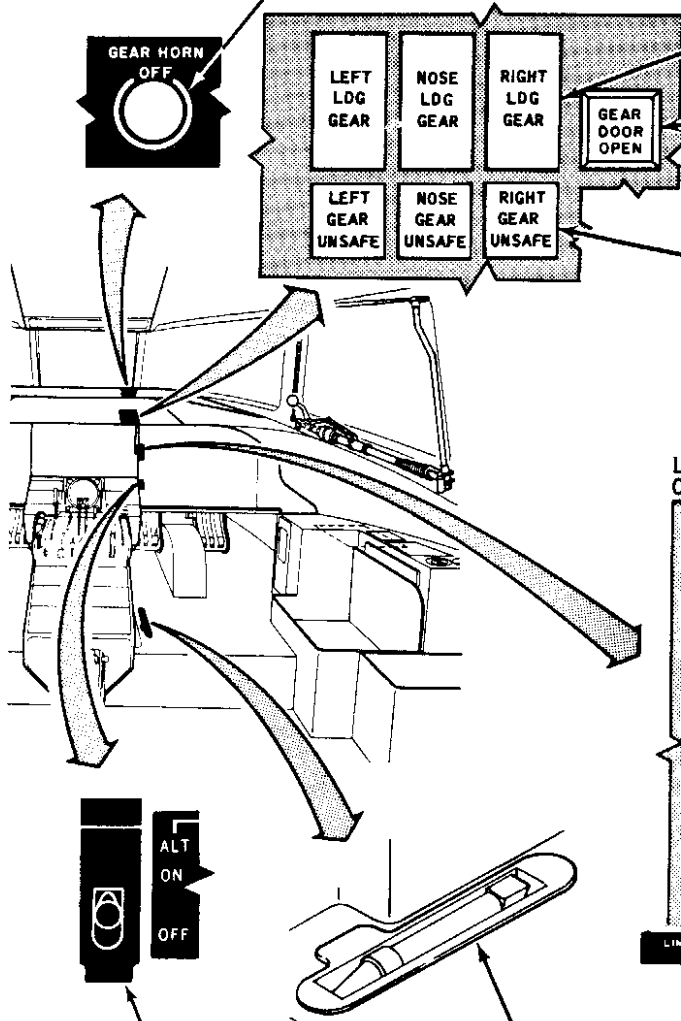
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LANDING GEAR -- COCKPIT CONTROLS & INDICATORS

LANDING GEAR WARNING HORN CUTOFF SWITCH

Pressing the cutoff switch button will silence the landing gear warning horn under all conditions of descent and approach until the flaps are three degrees or more below approach flap position. Thereafter, placing the gear to down and locked is the only method of silencing the horn.

LDG GEAR (GREEN) LIGHTS -- Come on when the landing gear is fully extended and locked and the control lever is in the DOWN notch. Remain off for all other gear conditions. Each light assembly contains two bulbs.



GEAR DOOR OPEN LIGHT (push to test) -- Light on indicates that the main gear doors are not fully closed, or that gear hydraulic valve is in bypass and pressure is not available to fully close doors.

GEAR UNSAFE (RED) LIGHTS (push to test) -- Indicates an unsafe gear condition. Will remain on unless the gear condition (full down and locked or fully retracted) matches the control lever position selected.

UP -- Positions control valves to hydraulically retract the gear. Actuates the gear warning system until gear is fully retracted.

UPLATCH CHECK (neutral position) -- Provides means of checking that the main gear door latches are in locked position and the nose gear is over center. All gear indicating lights should remain off.

DOWN -- Positions control valves to hydraulically unlock, extend, and lock the gear. Actuates the gear warning system until the gear is fully extended and locked. There is a notch at UP and DOWN and a detent at UPLATCH position. The handle must be pulled out of the notch before it can be moved. To prevent inadvertent retraction the handle is blocked in down position until nose gear strut extends and moves the ground shift mechanism.

ALTERNATE HYDRAULIC PUMP SWITCH

ON position opens two solenoid controlled valves allowing left hydraulic system pressure to drive a motor pump in the alternate landing gear system. The alternate system will provide pressure for gear operation when the right hydraulic system is inoperative.

EMERGENCY LANDING GEAR EXTENSION LEVER

Mechanically releases the main gear door latches, nose gear over center locks, and places gear hydraulic system in bypass condition, allowing gear to free-fall and lock in position.

LANDING GEAR HANDLE RELEASE

Provides a means of bypassing the anti-retraction release mechanism and place the landing gear control handle in UP position, in the event of ground shift system malfunction after takeoff.

BB1-3862A

WHEELS AND BRAKES

Each main gear wheel is equipped with a disc type power brake. Each brake is actuated by either of two completely separate sets of cylinders (7 in each set). Each set of cylinders is powered by a separate hydraulic system. Each main gear wheel is equipped with a brake wear indicator that may be visually checked during walkaround inspection. Each main gear wheel has three fuse plugs. The fuse plugs will yield and deflate a tire to prevent dangerous pressure buildup resulting from excessive heat transfer from an overheated brake. The fuse yields from heat and will not prevent overinflation.

There are two completely independent hydraulic brake systems designated left (powered by left hydraulic system) and right (powered by right hydraulic system). Either or both systems may be selected for brake operation by moving the BRAKES selector handle, located on the upper instrument panel, to L HYD SYS, BOTH, or R HYD SYS. Normally both systems are in operation at the same time. Each system has its own hydraulic system selector valve, two brake accumulators, two brake control valves, an antiskid servo valve for each brake, and a separate brake pressure gage.

Mechanical controls common to both brake systems are the brake pedals and linkages and the parking brake mechanism. The cable systems are rigged independently to the right system manual brake control valve in the right wheel well, and the left system manual brake control valve in the left wheel well.

PARKING BRAKE

The parking brake is a mechanical means of holding the wheel brake manual brake control valves in the pressure applied position. The parking brakes are held by accumulator pressure when the hydraulic systems are not operating. The parking brakes are set by depressing the brake pedals, pulling up on the parking brake control knob located in the center of the nosewheel steering control, and releasing the brake pedals. The parking brakes are released by depressing the brake pedals. When the parking brake knob is raised it actuates a switch that will disable the antiskid servo valve pressure return metering function.

ANTISKID SYSTEM

When either pilot depresses the brake pedals, the brake in each main gear wheel (4) is applied by hydraulic pressure from the manual brake control valves. If the antiskid system is not in operation, braking action is mechanically controlled by pilot input at the pedals. Pressure is applied equally to all brakes without regard to variations in individual brake effectiveness, or variations in tire/runway mating surfaces.

The antiskid system provides a means of metering the pressure return at each brake to permit maximum braking efficiency (just before impending skid) while preventing a skid condition of any wheel. The system is electrically controlled and has a touchdown wheel protection circuit that prevents braking action prior to wheel spinup. When the landing gear control handle

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is moved from the DOWN detent, a switch is actuated to deactivate all system functions and lights. A switch, actuated by the parking brake knob, will deactivate the pressure return metering (servo valve) function when the parking brakes are on.

The antiskid system consists of an ANTI-SKID arming switch, a TEST CKT switch, a control box, annunciator panel failure indicating lights (4), wheel speed transducers (4), and dual servo valves (4).

The ANTI-SKID switch has positions OFF and ARM. When the switch is OFF the system is disarmed and braking pressure is manually controlled by pilot application of the brake pedals. Automatic skid protection is not available. The OFF position will trigger the system to recycle (run an automatic self-test) when the switch is returned to ARM. While the switch is OFF, the four antiskid failure lights will remain on to indicate an inoperative system. When the switch is placed at ARM the system is armed and the four antiskid failure indicating lights should go off indicating the system is in operation and that all circuits are functioning normally. If any antiskid light remains on, or comes on later, it indicates that antiskid protection for that wheel is in inoperative and the brake has returned to manual control.

The TEST CKT (test circuit) switch has positions A, OFF, B and is spring loaded to OFF. A and B are identical test circuits and a system test can be accomplished by switching to either position. Before a test can be accomplished, the ANTI-SKID switch must be at ARM to activate the system, and the parking brake must be off or the servo valve return will be blocked and the failure indicating lights cannot be extinguished. After arming, a delay of approximately 5 seconds should be made to allow the system to recycle

(self-test) before placing the switch in test position A or B. A satisfactory test is indicated if all antiskid failure lights come on when the switch is held at either A or B and if all lights remain off when the switch is released.

When the antiskid system is in operation the wheel speed transducers (one for each wheel) transmit wheel speed information to the control box. The control box in turn uses this wheel speed input to control the operation of the servo valves for each wheel. Each servo valve will modulate wheel braking pressure to prevent a skid. The servo valves can only modulate pressure received from the brake control valve as a result of pilot input at the pedals. The servo valves can never permit the application of more braking pressure than called for by pilot input.

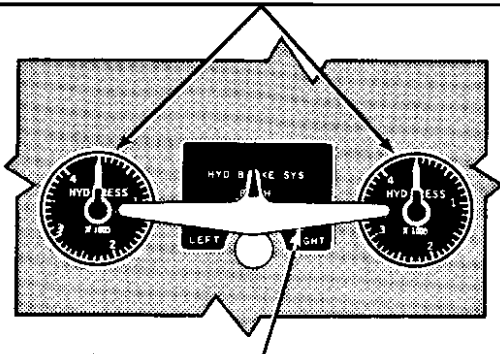
The antiskid system provides locked wheel protection as a back-up to normal skid control action. This function is provided by a transient control loop. If a wheel speed differential of approximately 60 knots exists between a wheel and its paired wheel (DC-9 wheel pairing is 1-4, 2-3), transient control will command a complete pressure release on the affected wheel. Under normal conditions, this will allow the wheel to recover to synchronous speed before pressure is reapplied.

If under adverse or failure conditions, the wheel does not recover and the locked wheel signal (100% pressure release) remains for more than 3 seconds, the monitor logic interprets this as a failure and will revert the affected wheel to manual brake control. When this occurs, the brake pressure that the pilot is metering at that time is immediately applied to that brake. This condition could occur when encountering ice

LANDING GEAR -- BRAKES/NOSEWHEEL STEERING COCKPIT CONTROLS & INDICATORS

L & R BRAKES HYDRAULIC PRESSURE GAGES

Provide indication of pressure available in either hydraulic system for brake application.

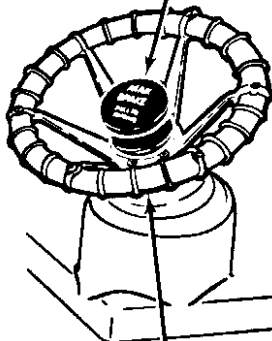


HYDRAULIC BRAKE SYSTEM SELECTOR HANDLE

Provides for selection of either LEFT, BOTH, or RIGHT hydraulic system pressure for brake operation. Handle is detented in LEFT, BOTH, and RIGHT positions.

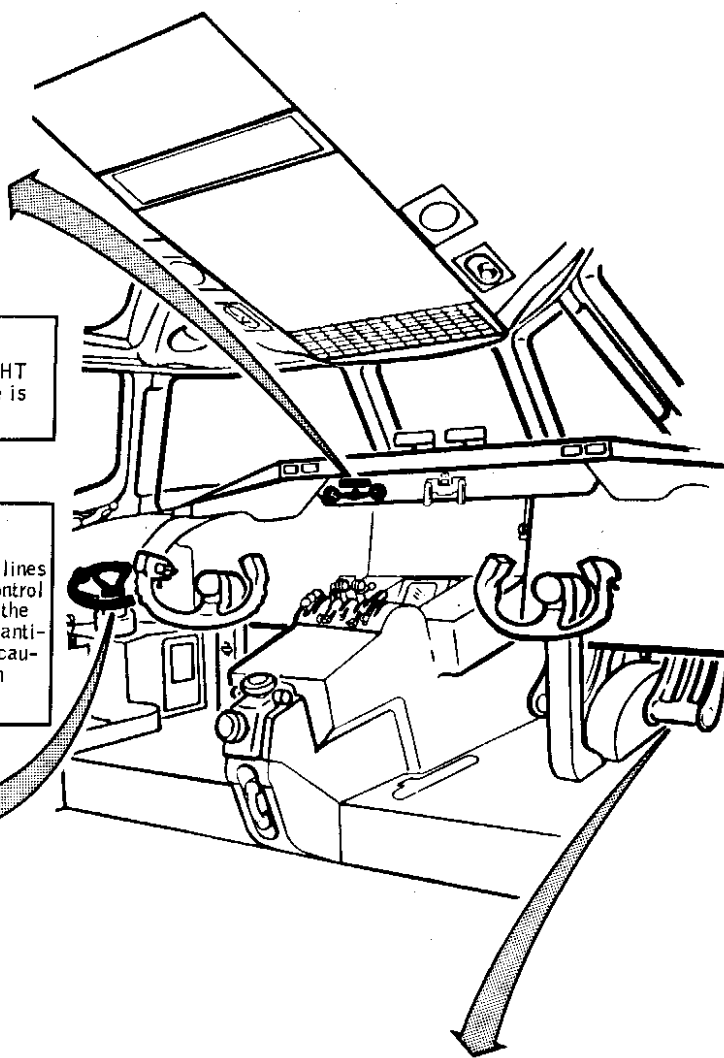
PARKING BRAKE CONTROL

Provides means of locking hydraulic pressure in the brake lines when the brake pedals are depressed, the parking brake control is lifted, and released from parked position by depressing the brake pedals. The parking brake operates a switch in the anti-skid circuitry. When the parking brake is on the anti-skid caution lights will be on. The parking brake must be off when testing anti-skid circuitry.



NOSE WHEEL STEERING WHEEL

Provides control of nosewheel steering thru an arc approximately 82 degrees left or right, during ground operations. Indices on the wheel and structure are aligned when the nose wheel is centered. The parking brake control is located in the center of the wheel.



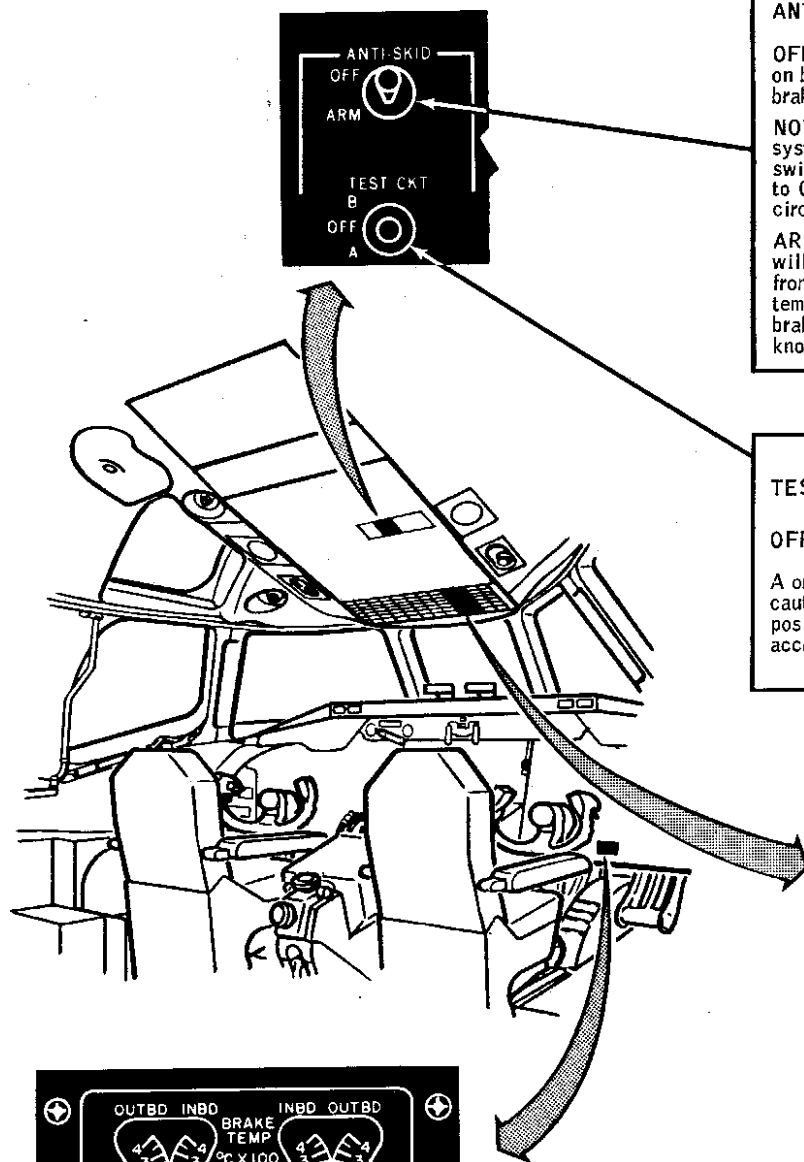
RUDDER/BRAKES PEDALS

NOSEWHEEL STEERING FUNCTION -- Provides control of nosewheel steering thru an arc approximately 17 degrees left or right, during ground operation. If desired, the rudder pedal steering can be blocked or overpowered with the nosewheel steering wheel.

BRAKES FUNCTION -- Depressing top of pedal applies power brake pressure.

BB1-1623A

LANDING GEAR -- BRAKE ANTISKID CONTROLS/INDICATORS



ANTI-SKID SWITCH

OFF -- Antiskid system inoperative. Foot pressure on brake pedal controls hydraulic pressure on the brakes.

NOTE: The OFF position is also used to recycle the system. Should any antiskid light remain on with the switch in ARM position, the switch should be placed to OFF and returned to ARM to recycle the antiskid circuit.

ARM -- After wheel spin up the antiskid system will meter hydraulic pressure to the brakes resulting from pressure on the brake pedals. The antiskid system will monitor wheel speed to provide maximum braking without skidding, down to approximately 20 knots.

TEST CIRCUIT SWITCH

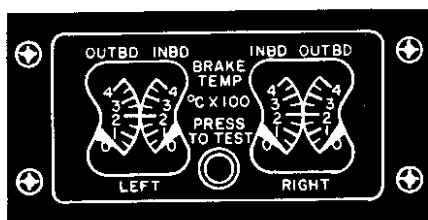
OFF -- Test circuit inoperative.

A or B positions are duplicate test circuits. Antiskid caution light should come on with switch in either position. A satisfactory test on either circuit is acceptable for flight.



ANTISKID CAUTION LIGHTS

Applicable light will come on to indicate malfunction of antiskid protection for a specific wheel. All lights will come on when antiskid TEST CIRCUIT switch is held in A or B position, providing landing gear handle is in the down detent. All lights should go out when switch is released. All lights will remain on while parking brake is in parked position, or if arming switch is OFF.

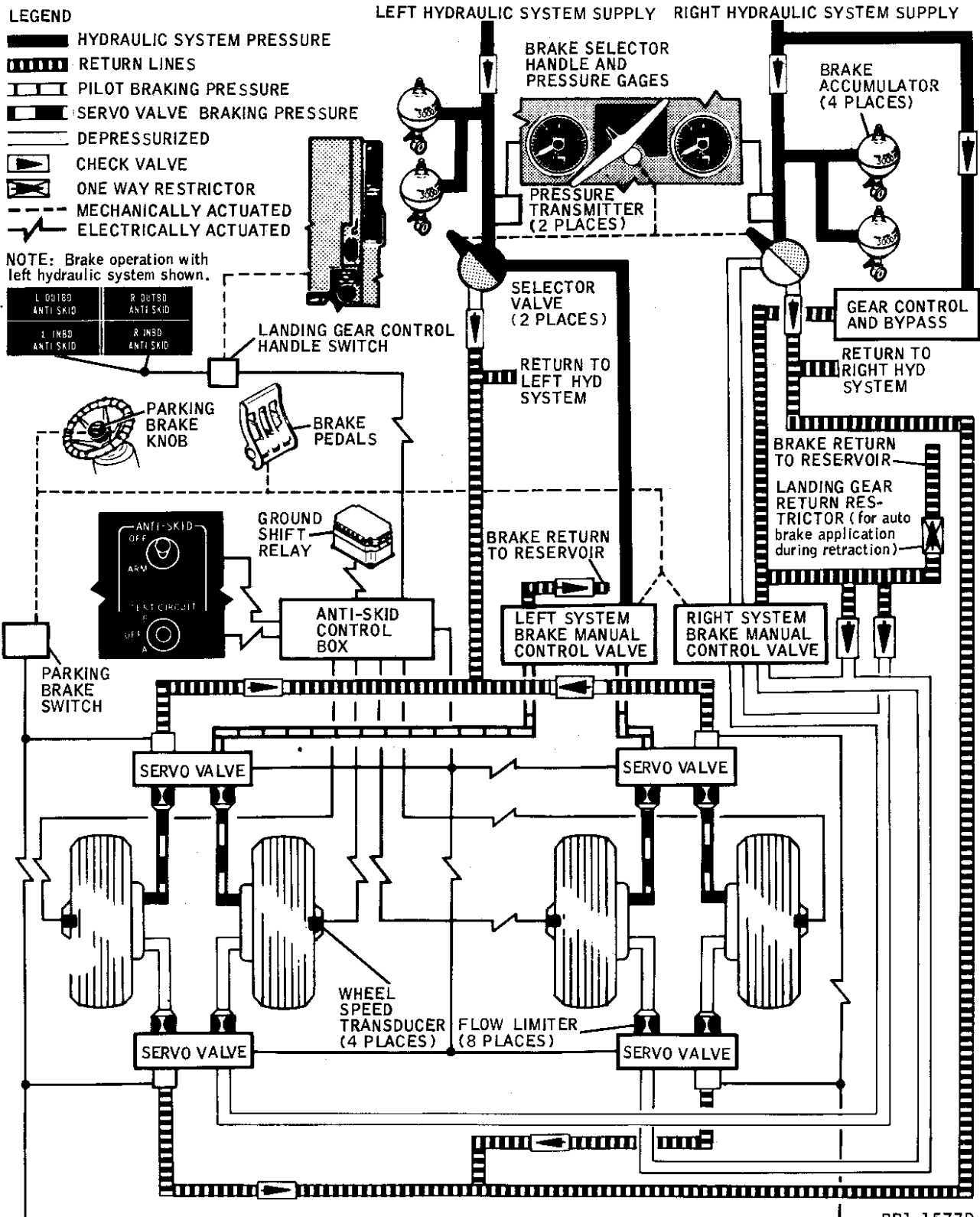


BRAKE TEMP. INDICATOR

Indicates brake temperature in degrees centigrade.

BB1-1148H

LANDING GEAR -- BRAKE SYSTEM FUNCTIONAL SCHEMATIC



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patches or two blown tires on the same main landing gear.

BRAKE TEMPERATURE INDICATORS

The indicators provide a visible indication of the temperature at each brake assembly. The indicator is calibrated in degrees centigrade from 0 to 400. Temperature indications in the range of 205°C to 315°C are considered hot brakes. Indications above 315°C are considered overheated brakes. Overheated brakes can result in deflation of the tire by fuse plugs installed in each wheel, or in danger to ground personnel.

A test switch is provided which, when pressed, causes all four temperature indicators to indicate in the 270°C to 315°C range.

NOTE: At ambient temperature lower than 0°C, the indicated test temperature may be lower than 270°C.

If brakes are hot, pressing the test switch will not cause any indicator to show a temperature lower than shown before the switch was pressed.

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(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 22, SECTION 3, CHAPTER 20, DATED DEC 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

- 3-20-5-0 ADDED CODE 3 (SPLIT EFFECTIVITY) TO PROVIDE COVERAGE ON SHEET 3 OF FUNCTIONAL SCHEMATIC FOR AIRPLANES WITH SPOILER/FLAP EXTENDED ANNUNCIATOR LIGHT.

- 3-20-25-0 ADDED CODE 7 (SPLIT EFFECTIVITY) TO PROVIDE COVERAGE IN THE TEXT FOR AIRPLANES WITH SPOILER/FLAP EXTENDED ANNUNCIATOR LIGHTS AND THE 3-POSITION STALL TEST SWITCH WITH MAINTAINED POSITIONS FOR TEST.

- 3-20-30-0 ADDED CODE 28 (SPLIT EFFECTIVITY) TO PROVIDE COVERAGE FOR AIRPLANES WITH A SPOILER/FLAP EXTENDED ANNUNCIATOR LIGHT AND A 3-POSITION STALL TEST SWITCH WITH MAINTAINED POSITIONS FOR TEST (SHEET 3).

Remove			Insert		
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3-20-Cont	66	1 and 2	3-20-Cont	66	1 and 2
None			3-20-5-0	3	1 thru 4
None			3-20-25-0	7	1 thru 3
None			3-20-30-0	28	1 thru 3

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*3-20-5-0	3	2	Mar 1/70
*3-20-5-0	3	3	Mar 1/70
*3-20-5-0	3	4	Mar 1/70
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3-20-15-0	1	1	Jun 1/69
3-20-15-0	1	2	Mar 1/66
3-20-15-0	1	3	Sep 1/67
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3-20-15-0	1	5	Mar 1/67
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3-20-20-5	1	1	Sep 1/67
3-20-20-5	1	2	Sep 1/67
3-20-25-0	4	1	Dec 1/69
3-20-25-0	4	2	Sep 1/67
*3-20-25-0	7	1	Dec 1/70
*3-20-25-0	7	2	Dec 1/70
*3-20-25-0	7	3	Dec 1/70
3-20-30-0	10	1	Mar 1/67
3-20-30-0	10	2	Mar 1/67
3-20-30-0	10	3	Mar 1/67
*3-20-30-0	28	1	Dec 1/70
*3-20-30-0	28	2	Dec 1/70
*3-20-30-0	28	3	Dec 1/70

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Chapter 20

FLIGHT CONTROLS

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*Illustration

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Chapter 20

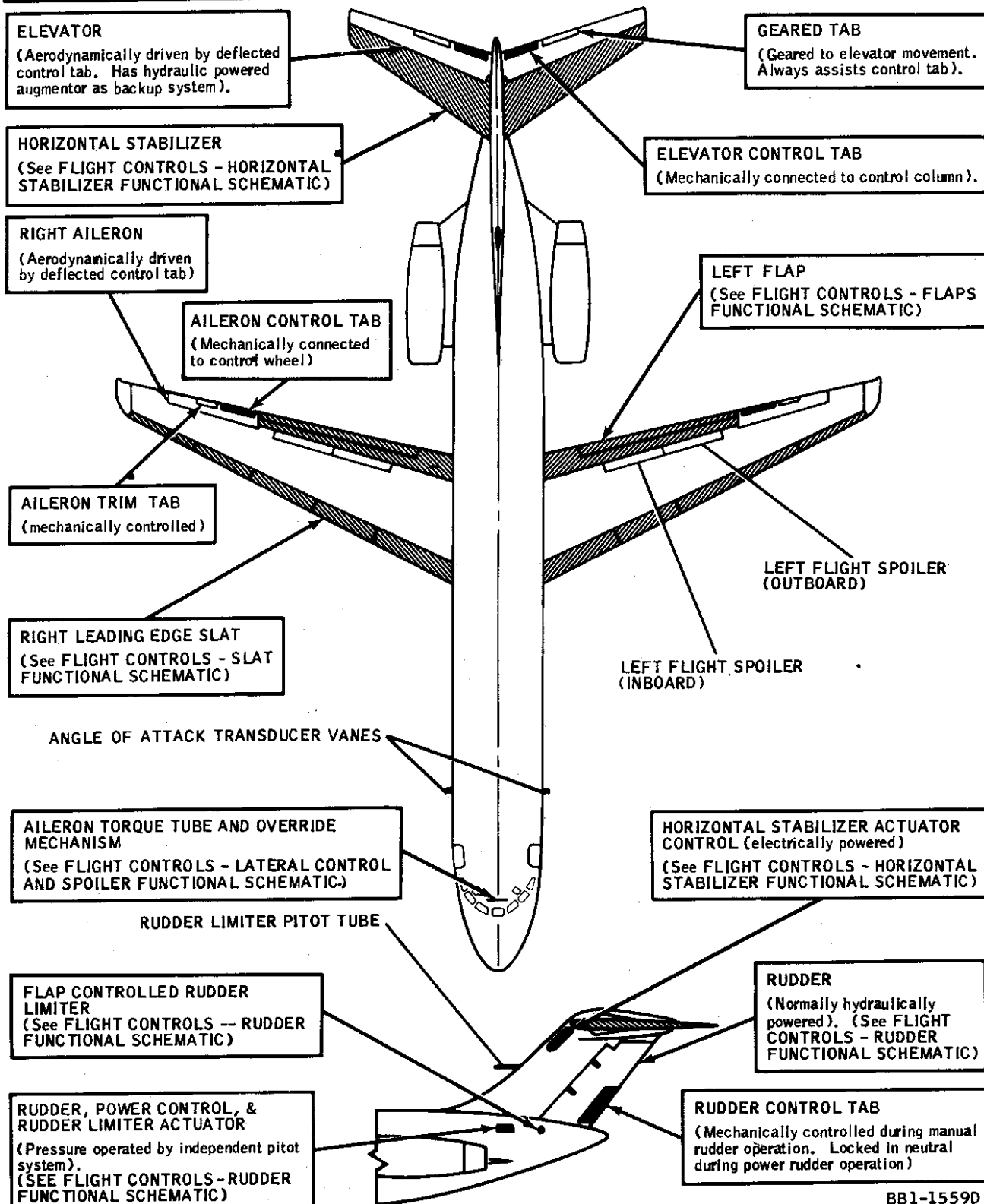
FLIGHT CONTROLS

GENERAL

The DC-9 has conventional aileron, rudder, and elevator control systems. Control surfaces of these systems are protected against ground gust forces by viscous dampers and hydraulic cylinders. The horizontal stabilizer is adjustable for longitudinal trim. Lateral control is aided by hydraulically operated flight spoilers. The flight spoiler surfaces are also operated to serve as speedbrakes. The rudder is normally hydraulically powered with automatic reversion to aerodynamic tab control when hydraulic power is not available. A yaw damper system aids directional stability and a Mach trim system aids longitudinal stability in the high-Mach range. Stall warning and maximum speed warning systems are provided. Conventional slotted flaps are used. Hydraulically actuated slats are installed on the leading edge of each wing. The flight spoilers may be armed to extend automatically at touchdown as an aid for wheel braking. A takeoff warning system is provided. When the throttles are advanced for takeoff and the flaps, slats, spoilers, or stabilizer are not in the correct position, a warning horn will sound intermittently.

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 FLIGHT CREW OPERATING MANUAL

FLIGHT CONTROLS -- MAJOR COMPONENT LOCATION



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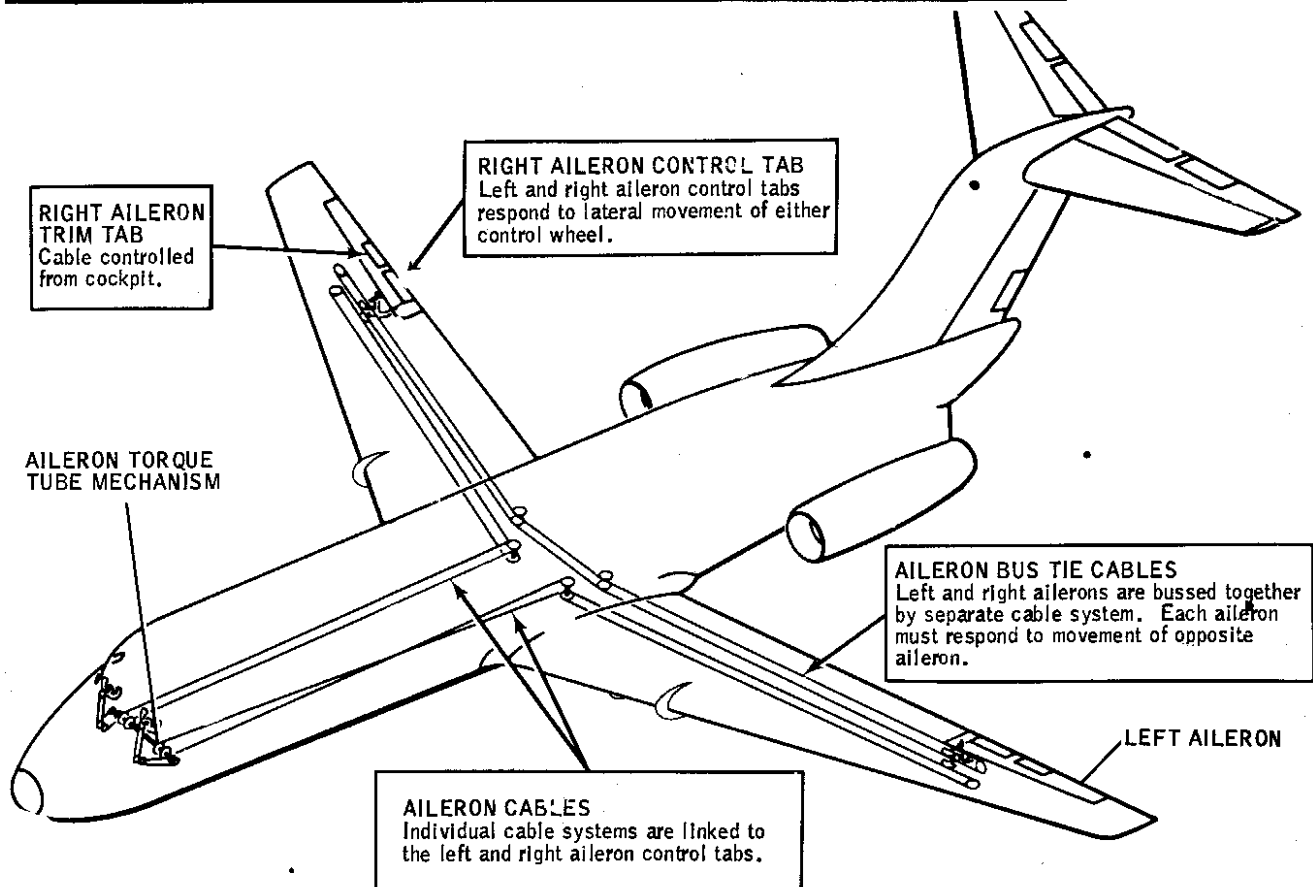
LATERAL CONTROL

Conventional control wheels are cable connected to control tabs on the ailerons. Aerodynamic force on the control tabs move the ailerons. The control wheels are linked together by a torque tube arrangement that drives an independent cable system to each aileron control tab. Should any part of the system become jammed between the torque tube and the control tab, the torque tube mechanism will allow either control wheel to drive the remaining unjammed tab. Left and right ailerons are bused together by cables so that they always move together in the proper direction. Each aileron contains a conventional trim tab connected by cables to a trim knob on the pedestal.

FLIGHT SPOILERS

Aileron lateral control is aided by a flight spoiler system. Aileron control tab cable movement is linked to a mechanical mixer assembly that provides variable actuation of the flight spoiler hydraulic control valve. The flight spoilers consist of two extendible surfaces on each wing. The flight spoiler surfaces start to extend only after approximately 5 degrees control wheel throw. Flight spoilers remain retracted with down aileron. The mixer assembly provides the proper amount of flight spoiler extension in relation to aileron movement. The inner and outer flight spoiler surfaces are powered by separate hydraulic systems, so that with one hydraulic system inoperative, one-half of the flight spoiler system effectiveness is retained.

FLIGHT CONTROLS -- LATERAL CONTROL & SPOILER FUNCTIONAL SCHEMATIC (sheet 1)



AILERON TORQUE TUBE MECHANISM OPERATION

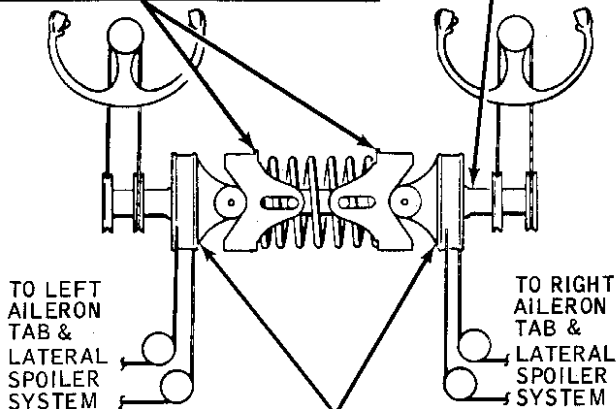
CONDITION SHOWING NORMAL AILERON CONTROL SYSTEM
Aileron torque tube mechanism allows either control wheel to drive opposite aileron tab cable system in the event one aileron tab system should become locked.

CAMS:
Rotate with shaft as result of control wheel movement. Cams can move horizontally against spring pressure.

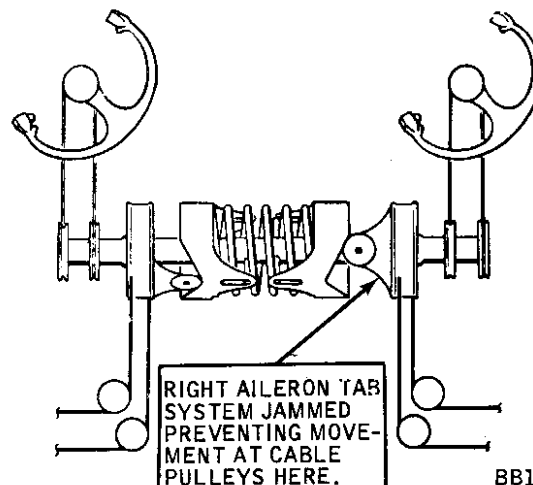
SHAFT:
Control wheels are locked together by shaft.

CONDITION SHOWING RIGHT AILERON CONTROL SYSTEM JAMMED

Rotation of either control wheel will drive shaft and cams. Right cam follower cannot move due to jamming and must ride up on the moving right cam. This forces the cam horizontally and increases spring pressure on the left cam and cam follower. Force required to overcome spring pressure is approximately 60 pounds at wheel rim.



CAM FOLLOWER ASSEMBLIES:
Are free to rotate on shaft but under normal operation the spring loaded cams will drive the cam followers and thus the aileron tab system.



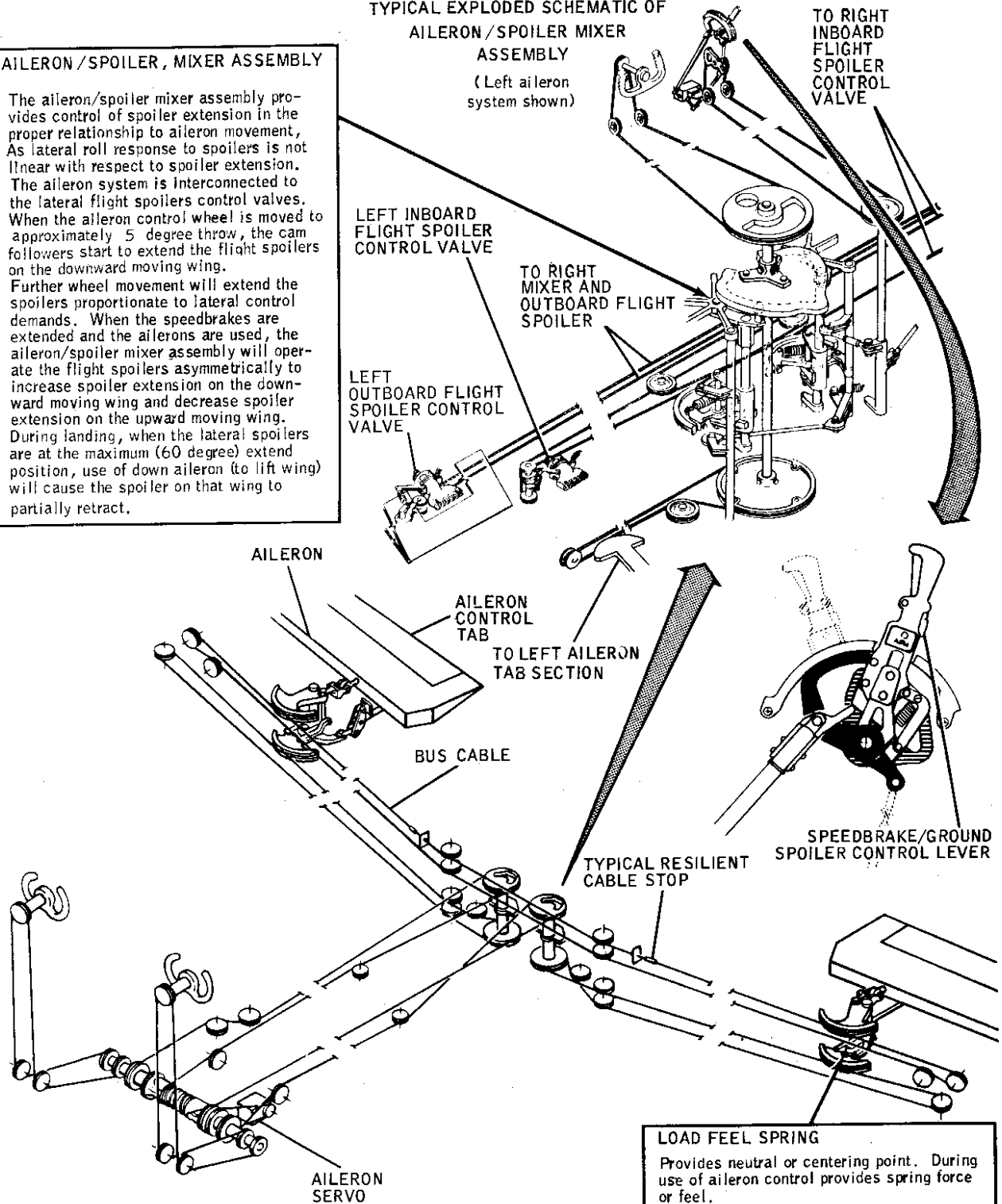
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FLIGHT CONTROLS -- LATERAL CONTROL & SPOILER FUNCTIONAL SCHEMATIC (sheet 2)

AILERON/SPOILER, MIXER ASSEMBLY

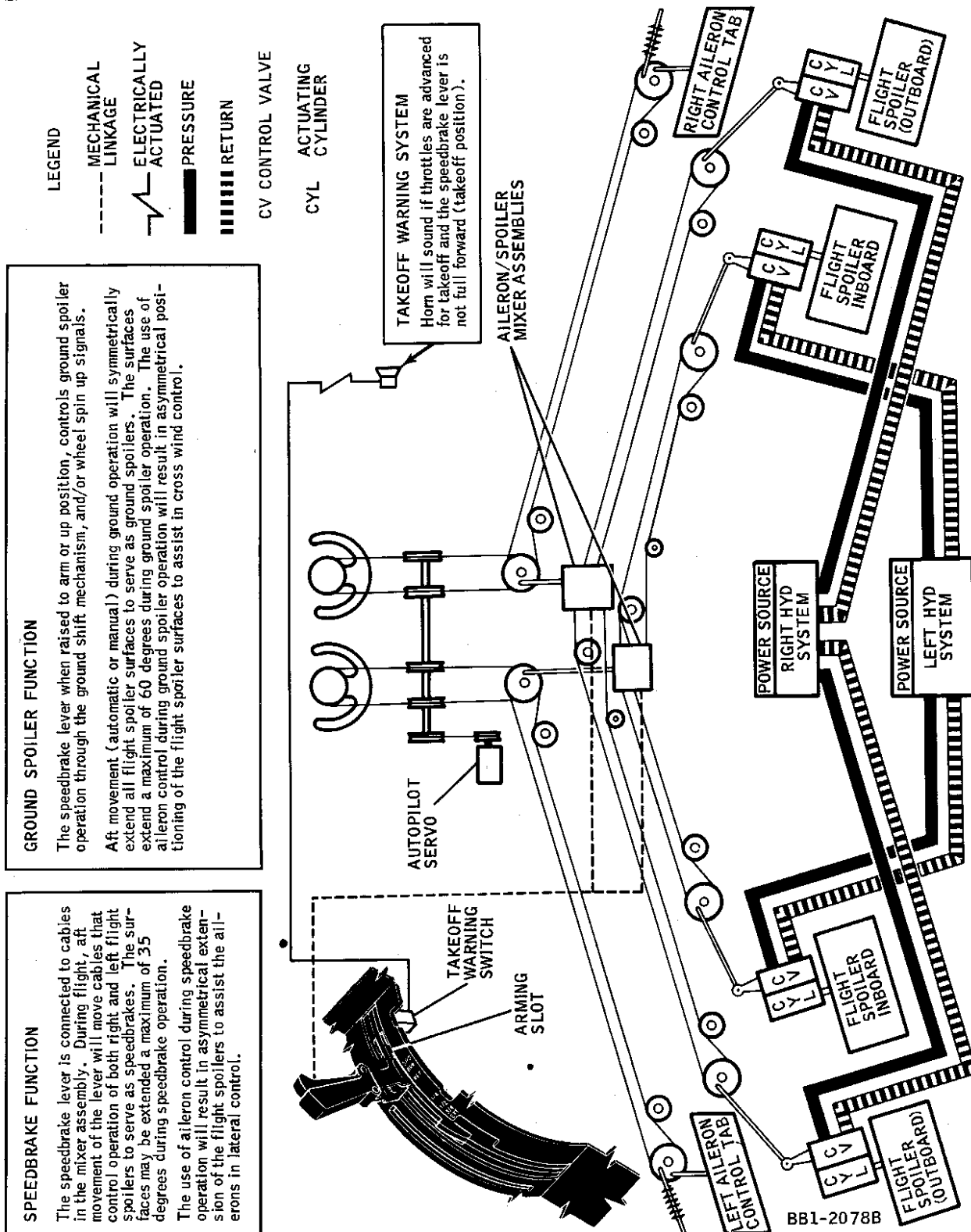
The aileron/spoiler mixer assembly provides control of spoiler extension in the proper relationship to aileron movement. As lateral roll response to spoilers is not linear with respect to spoiler extension. The aileron system is interconnected to the lateral flight spoilers control valves. When the aileron control wheel is moved to approximately 5 degree throw, the cam followers start to extend the flight spoilers on the downward moving wing. Further wheel movement will extend the spoilers proportionate to lateral control demands. When the speedbrakes are extended and the ailerons are used, the aileron/spoiler mixer assembly will operate the flight spoilers asymmetrically to increase spoiler extension on the downward moving wing and decrease spoiler extension on the upward moving wing. During landing, when the lateral spoilers are at the maximum (60 degree) extend position, use of down aileron (to lift wing) will cause the spoiler on that wing to partially retract.

TYPICAL EXPLODED SCHEMATIC OF AILERON/SPOILER MIXER ASSEMBLY (Left aileron system shown)



BB1-487D

**FLIGHT CONTROLS -- LATERAL CONTROL & SPOILER FUNCTIONAL
SCHEMATIC (sheet 3)**



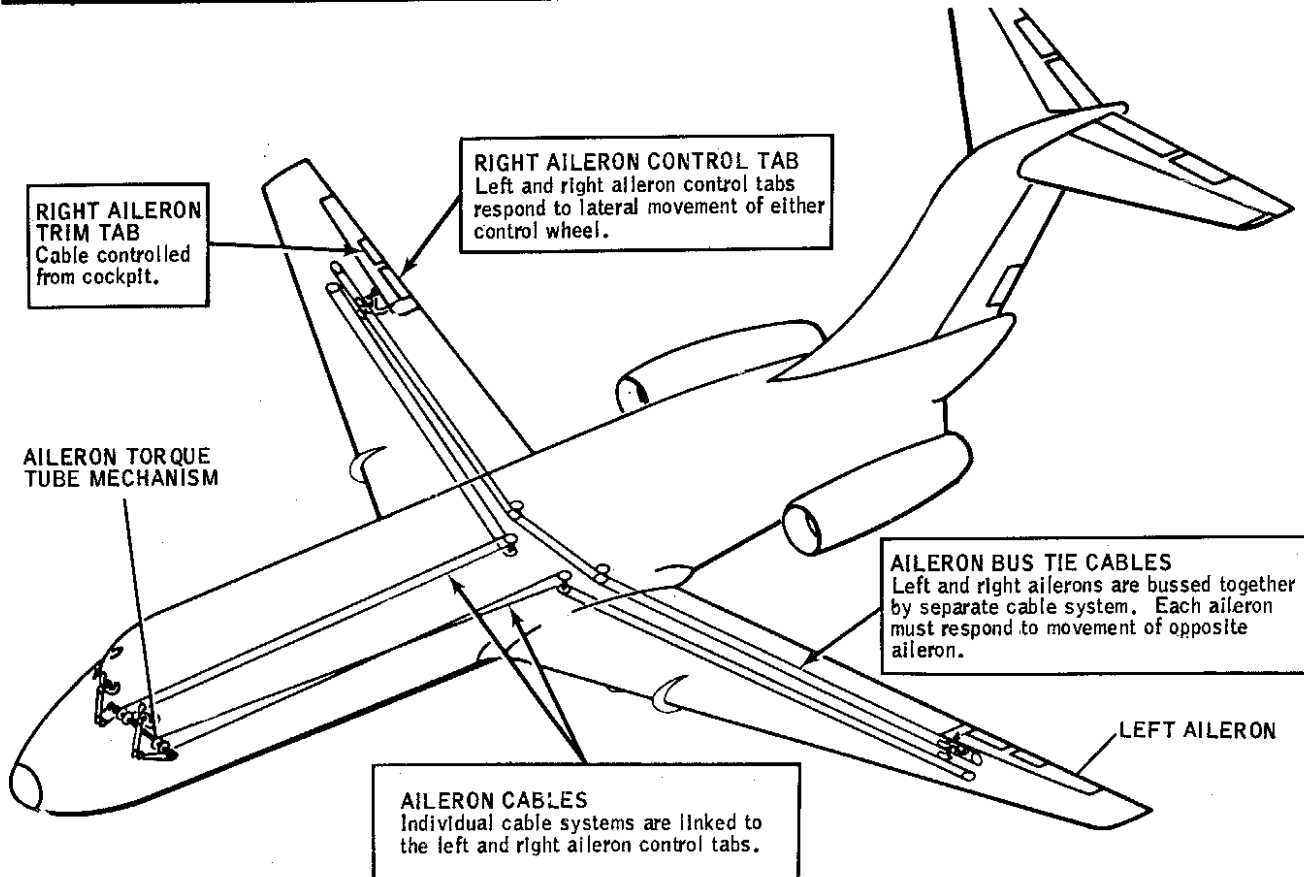
LATERAL CONTROL

Conventional control wheels are cable connected to control tabs on the ailerons. Aerodynamic force on the control tabs move the ailerons. The control wheels are linked together by a torque tube arrangement that drives an independent cable system to each aileron control tab. Should any part of the system become jammed between the torque tube and the control tab, the torque tube mechanism will allow either control wheel to drive the remaining unjammed tab. Left and right ailerons are bused together by cables so that they always move together in the proper direction. Each aileron contains a conventional trim tab connected by cables to a trim knob on the pedestal.

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Aileron lateral control is aided by a flight spoiler system. Aileron control tab cable movement is linked to a mechanical mixer assembly that provides variable actuation of the flight spoiler hydraulic control valve. The flight spoilers consist of two extendible surfaces on each wing. The flight spoiler surfaces start to extend only after approximately 5 degrees control wheel throw. Flight spoilers remain retracted with down aileron. The mixer assembly provides the proper amount of flight spoiler extension in relation to aileron movement. The inner and outer flight spoiler surfaces are powered by separate hydraulic systems, so that with one hydraulic system inoperative, one-half of the flight spoiler system effectiveness is retained.

FLIGHT CONTROLS -- LATERAL CONTROL & SPOILER FUNCTIONAL SCHEMATIC (sheet 1)



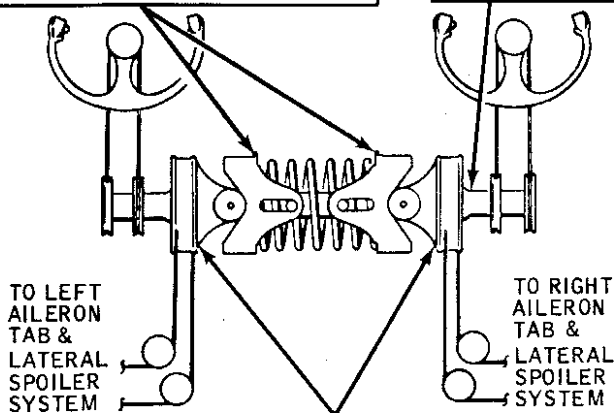
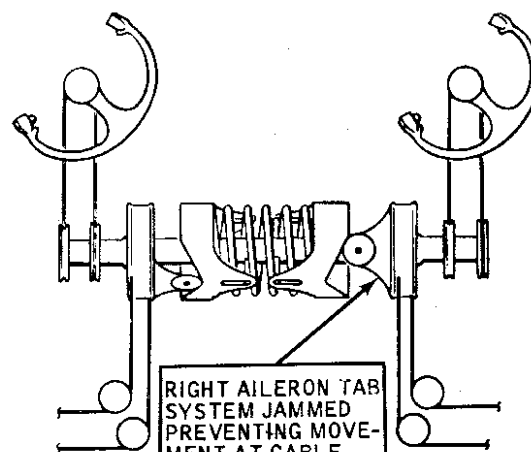
AILERON TORQUE TUBE MECHANISM OPERATION

CONDITION SHOWING NORMAL AILERON CONTROL SYSTEM
 Aileron torque tube mechanism allows either control wheel to drive opposite aileron tab cable system in the event one aileron tab system should become locked.

CONDITION SHOWING RIGHT AILERON CONTROL SYSTEM JAMMED
 Rotation of either control wheel will drive shaft and cams. Right cam follower cannot move due to jamming and must ride up on the moving right cam. This forces the cam horizontally and increases spring pressure on the left cam and cam follower. Force required to overcome spring pressure is approximately 60 pounds at wheel rim.

CAMS:
 Rotate with shaft as result of control wheel movement. Cams can move horizontally against spring pressure.

SHAFT:
 Control wheels are locked together by shaft.



CAM FOLLOWER ASSEMBLIES:
 Are free to rotate on shaft but under normal operation the spring loaded cams will drive the cam followers and thus the aileron tab system.

B81-70B

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SPEEDBRAKE FUNCTION

The speedbrake lever is connected to cables in the mixer assembly. During flight, aft movement of the lever will move cables that control operation of both right and left flight spoilers to serve as speedbrakes. The surfaces may be extended a maximum of 35 degrees during speedbrake operation.

The use of aileron control during speedbrake operation will result in asymmetrical extension of the flight spoilers to assist the ailerons in lateral control.

GROUND SPOILER FUNCTION

The speedbrake lever when raised to arm or up position, controls ground spoiler operation through the ground shift mechanism, and or wheel spin up signals.

Aft movement (automatic or manual) during ground operation will symmetrical extend all flight spoiler surfaces to serve as ground spoilers. The surfaces extend a maximum of 60 degrees during ground spoiler operation. The use of aileron control during ground spoiler operation will result in asymmetrical positioning of the flight spoiler surfaces to assist in cross wind control.

LEGEND

- MECHANICAL LINKAGE
- ELECTRICALLY ACTUATED
- PRESSURE
- RETURN
- CV CONTROL VALVE
- CYL ACTUATING CYLINDER

TAKEOFF WARNING SYSTEM

Horn will sound if throttles are advanced for takeoff and the speedbrake lever is not full forward (takeoff position).

MASTER CAUTION
PUSH TO RESET

SPILER/FLAP EXTENDED

Light on, in-flight, when speedbrakes are extended and flaps are extended beyond the 5 degree position.

RIGHT AILERON CONTROL TAB

LEFT AILERON CONTROL TAB

FLIGHT SPOILER (OUTBOARD)

FLIGHT SPOILER (INBOARD)

POWER SOURCE
LEFT HYD SYSTEM

POWER SOURCE
RIGHT HYD SYSTEM

AILERON/SPOILER MIXER ASSEMBLIES

AUTOPILOT SERVO

ARMING TAKEOFF WARNING SWITCH

BB1-451

BB1-4516

DOUGLAS AIRCRAFT CO., INC.
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DIRECTIONAL RUDDER CONTROL

POWERED RUDDER OPERATION

Directional control is obtained through conventional rudder pedals that control rudder movement. During powered rudder operation, the rudder control tab is locked hydraulically. Rudder pedal movement activates the rudder power control valve that hydraulically actuates the rudder power control unit. The rudder power control unit receives power from the right hydraulic system. Trim is accomplished by turning a conventional trim knob on the pedestal. Movement of the rudder trim knob changes the neutral point of a rudder load feel spring. During power operation, use of the rudder trim knob repositions the neutral point of the rudder power actuator to provide trim. Hydraulic power to the rudder power unit may be shut off by placing the rudder power control handle in manual position. When hydraulic power to the rudder control unit is shut off, or when the pressure drops to approximately 950 psi, the rudder automatically reverts to manual operation, unlocking the rudder control tab. When the rudder reverts to manual, a rudder control manual light on the annunciator panel comes on.

MANUAL RUDDER OPERATION

During manual rudder operation, rudder pedal movement operates a control tab on the rudder. Aerodynamic force on the control tab moves the rudder. Trim is accomplished by turning a conventional trim control on the pedestal. Trim during manual operation changes the center or neutral point of the load feel springs; this in turn holds the rudder control tab in a slightly displaced position relative to the rudder surface.

RUDDER PEDALS

Each set of rudder pedals is individually adjusted by pulling a rudder adjust knob on the instrument panel, adjusting the pedals, and releasing the knob to lock pedals in position. The captain's and first officer's rudder pedal systems are connected by a torque tube under the floor.

RUDDER THROW LIMITERS

Two rudder throw limiters are installed. One "Q" limiter to protect the empennage from overload in the case of inadvertent application of excessive rudder control, and one flap controlled, hydraulically actuated, limiter. The flap controlled limiter restricts rudder throw to ± 17 degrees at low flap settings to prevent excessive sideslip at these flap settings.

"Q" LIMITER

The rudder "Q" limiter is a mechanical device consisting of a bellows, a spring mechanism, and a hook that limits rudder movement. The device operates by ram air pressure from a pitot tube on the leading edge of the vertical stabilizer. The higher the airspeed, the more ram air pressure on the bellows, resulting in proportional restriction of rudder movement. The throw limiter is scheduled to vary the maximum available rudder throw in three stages:

1. ± 22 degrees (unrestricted up to 170 knots)
2. ± 15 degrees (medium speed, 170 to 180 knots)
3. Modulated ± 15 degrees to $\pm 2 \frac{1}{2}$ degrees (high speed, 180 to 350 knots).

The pitot tube may be electrically heated to prevent ice by use of a selector switch on the cockpit ice protection panel.

An annunciator panel rudder travel unrestricted light comes on during "Q" unrestricted rudder throw operation.

FLAP CONTROLLED RUDDER LIMITER

The flap controlled rudder limiter is held in the engaged position by dual mechanical springs at 0, and 5 degrees of flap and is withdrawn by a hydraulic actuator for 15, 25 and 50 degrees of flap. Pressure from the right hydraulic system operates the actuator and is controlled by a valve mechanically connected to the flap followup and control valve mechanism.

Loss of right hydraulic system pressure will result in simultaneous rudder restriction and reversion to manual rudder operation. Manual rudder throws are normally less than 17 degrees. The flap-controlled rudder limiter may be ground checked by comparing rudder pedal travel with the flaps up and down.

An annunciator panel flap/rudder stop inoperative light will come on during flap transit to selected position or if the flap controlled rudder limiter is not in correct position for any given flap setting.

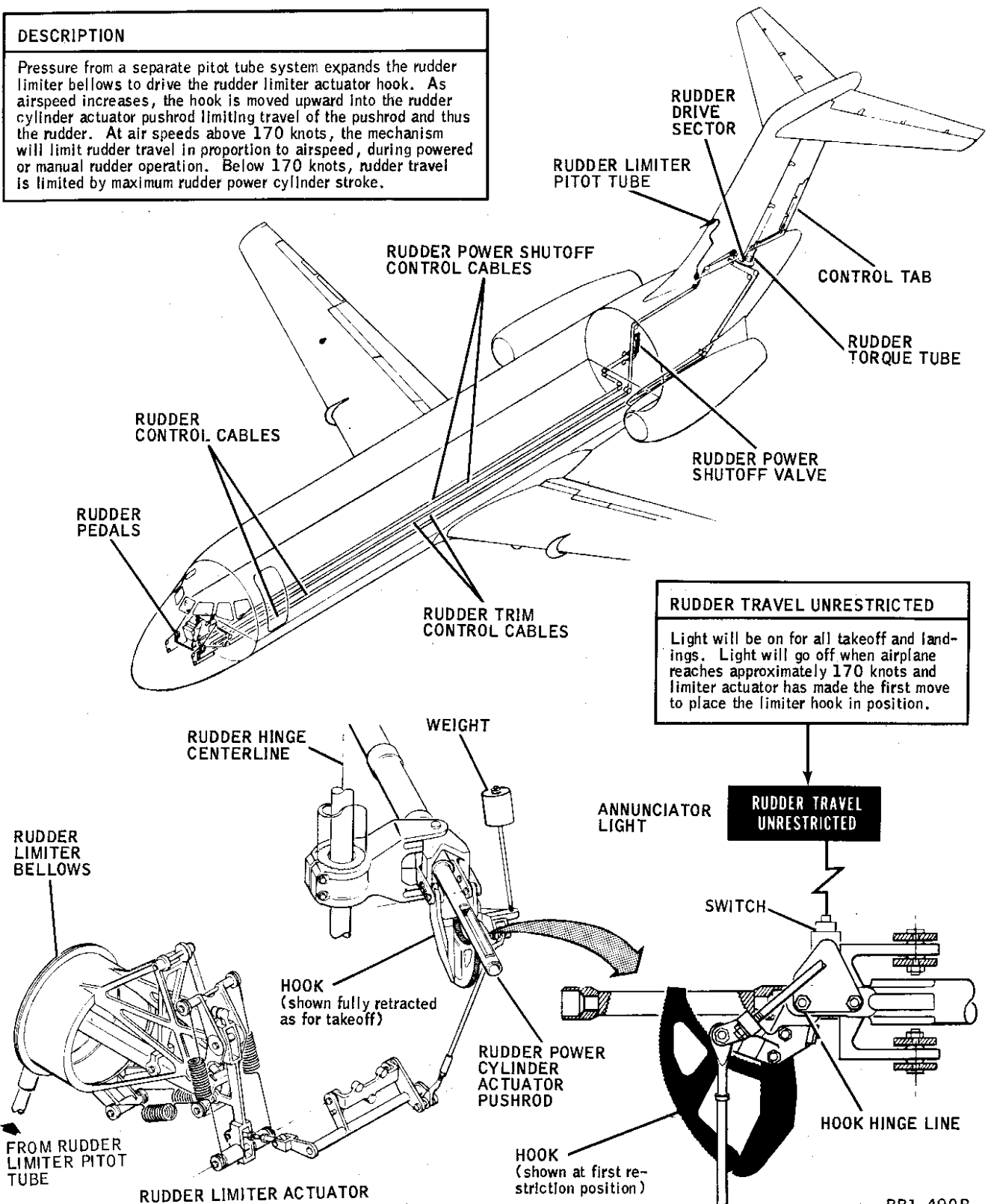
YAW DAMPER

A full-time series yaw damper is installed in the rudder system to improve damping of any lateral directional oscillation. Information from the stability augmentation computer controls a linear actuator that operates the rudder power control actuator, or the rudder control tab when in the manual mode, to provide corrective rudder response without pedal feedback. Yaw damper operation is selected by a switch on the overhead panel.

FLIGHT CONTROLS -- RUDDER FUNCTIONAL SCHEMATIC (sheet 1)

DESCRIPTION

Pressure from a separate pitot tube system expands the rudder limiter bellows to drive the rudder limiter actuator hook. As airspeed increases, the hook is moved upward into the rudder cylinder actuator pushrod limiting travel of the pushrod and thus the rudder. At air speeds above 170 knots, the mechanism will limit rudder travel in proportion to airspeed, during powered or manual rudder operation. Below 170 knots, rudder travel is limited by maximum rudder power cylinder stroke.

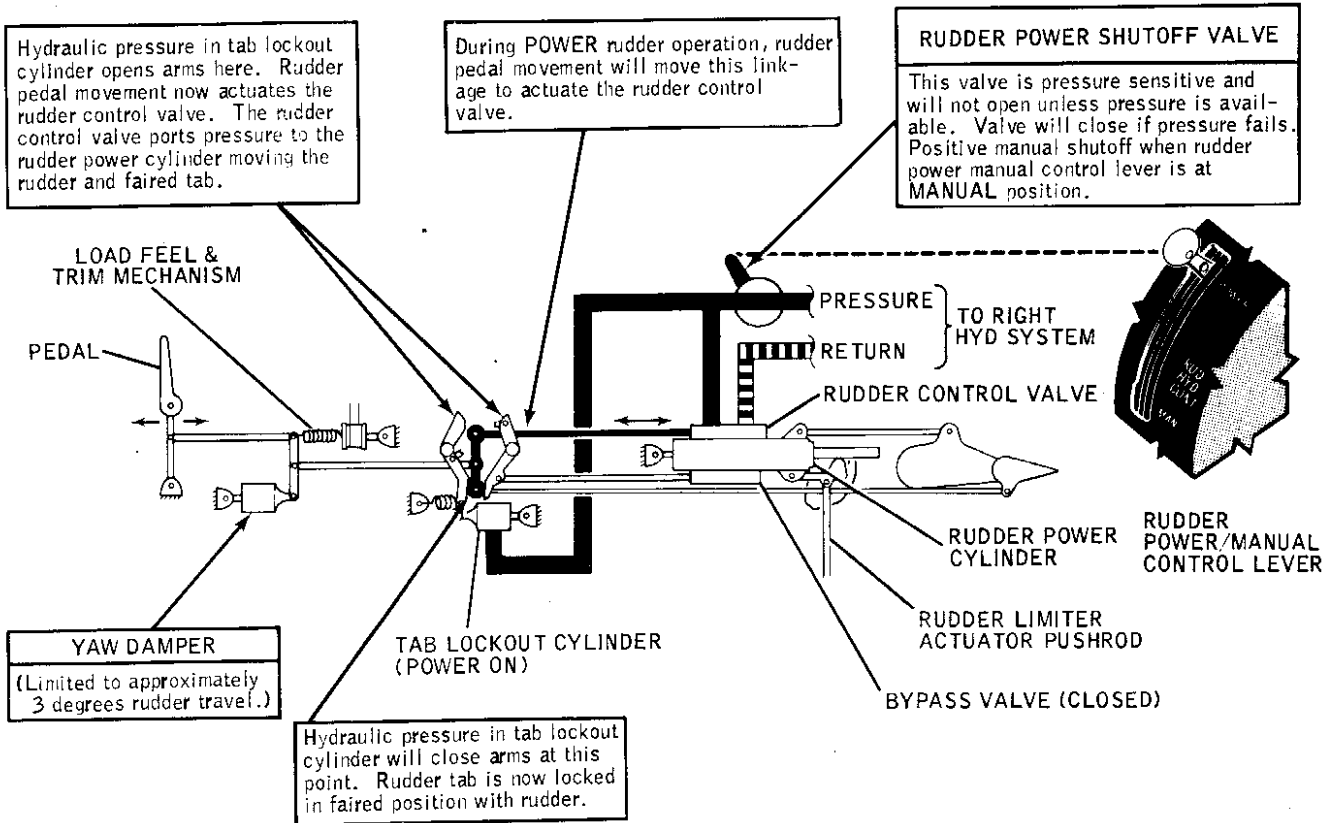


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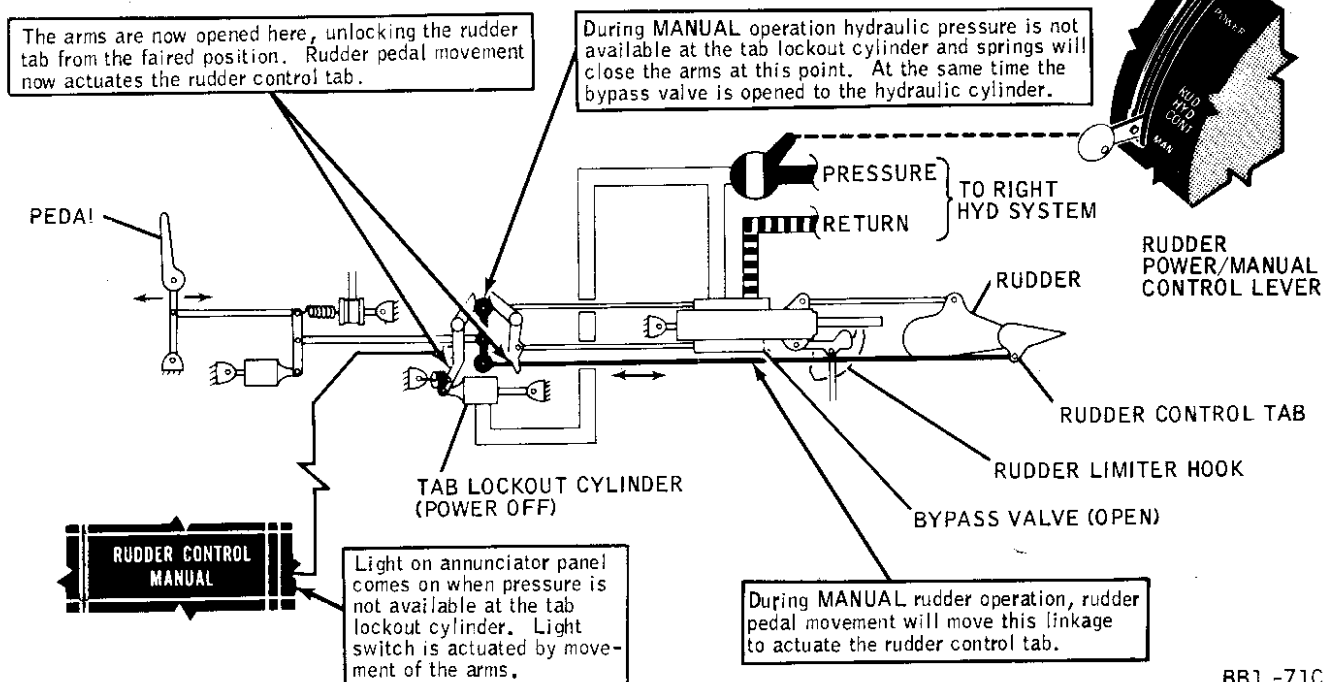
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FLIGHT CONTROLS -- RUDDER FUNCTIONAL SCHEMATIC (sheet 2)

RUDDER -- POWER ON CONFIGURATION



RUDDER -- POWER OFF (MANUAL) CONFIGURATION



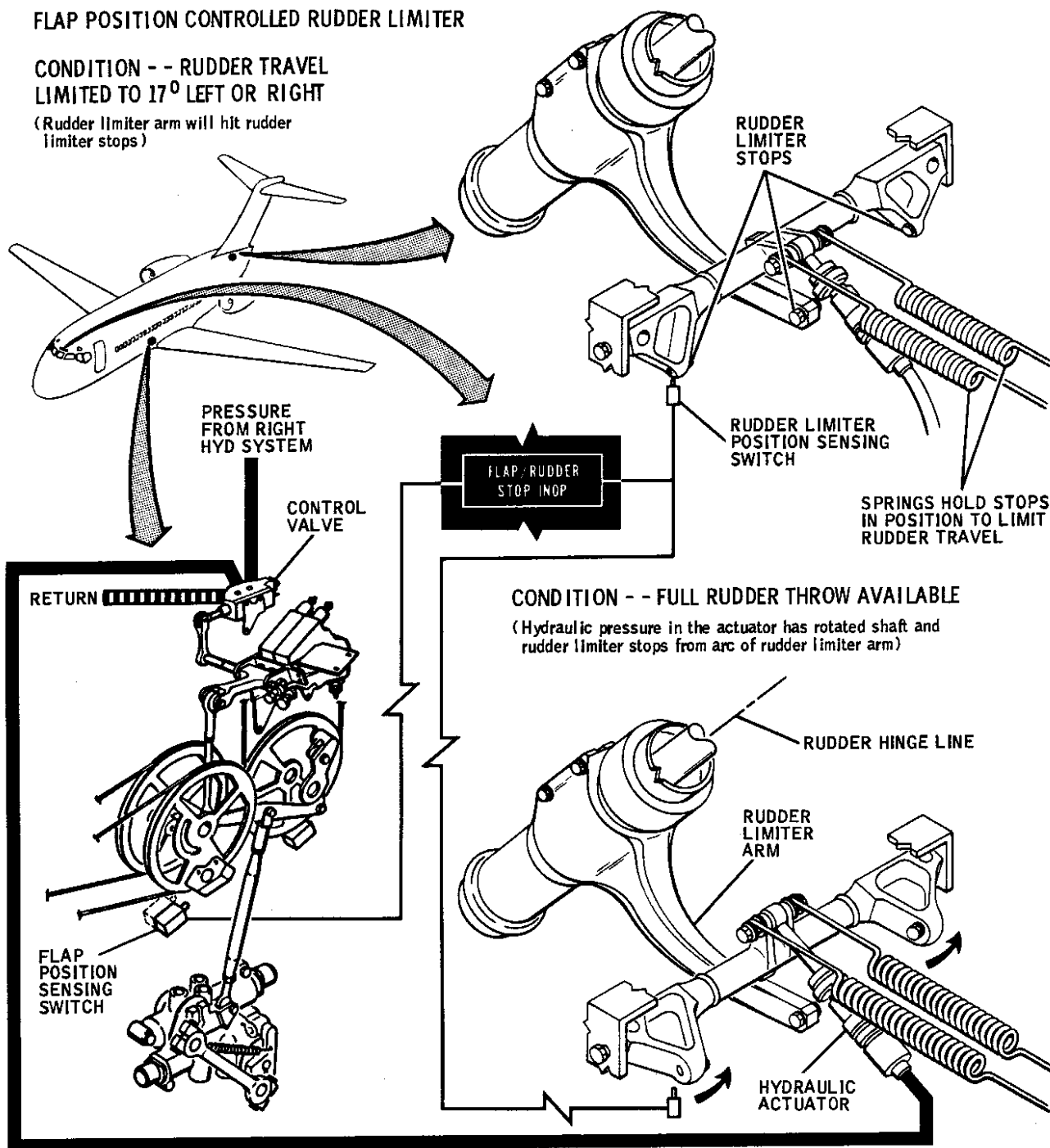
BB1 -71C

FLIGHT CONTROLS -- RUDDER FUNCTIONAL SCHEMATIC (sheet 3)

FLAP POSITION CONTROLLED RUDDER LIMITER

CONDITION -- RUDDER TRAVEL
 LIMITED TO 17° LEFT OR RIGHT

(Rudder limiter arm will hit rudder
 limiter stops)



DESCRIPTION:

Dual springs hold the rudder limiter assembly in position to limit rudder travel when the flaps are at 0, or 5 degree setting. When 15, 25, or 50 degree setting is selected, a valve mechanically connected to the flap control and flap followup system will port pressure to the hydraulic actuator. The actuator will then rotate the limiter assembly to allow full rudder travel. Loss of right

hydraulic system pressure will result in simultaneous rudder restriction and reversion to manual rudder.

FLAP/RUDDER STOP INOP LIGHT. If the limiter fails to respond as required for a given flap setting, either the rudder limiter position sensing switch or the flap position sensing switch will turn on the light.

BB1-2101A

DOUGLAS AIRCRAFT CO., INC.
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LONGITUDINAL CONTROL

ELEVATOR CONTROL SYSTEM

The elevator control system is, for all normal flying, a conventional aerodynamic boost system that operates a single control tab on each elevator. Each control tab is driven by an independent two-way cable system from the corresponding control column in the cockpit. The only interconnection between the two control systems is a bus torque tube between the control columns. Movement of the control column moves the control tab, and aerodynamic force generated by the tab moves the elevator. As each elevator moves, an additional tab, geared to elevator movement, moves to assist the control tab. A hydraulic power augmentor system is provided to assure airplane nosedown capability under extreme, highly unlikely, high angle-of-attack flight conditions.

The hydraulic power augmentor system consists of two control valves in series and an actuator on each elevator surface. The left hydraulic system provides pressure through a pressure reducer; the augmentation system always operates at approximately 975 psi.

An accumulator is provided to store pressure and provide several cycles of airplane down elevator operation in the event of hydraulic system pressure loss.

The control valves are operated by a summing linkage which determines control valve position as a resultant of control input and elevator response. During normal flying, the maximum elevator nosedown tab used is 8 degrees.

If during extreme stall conditions the control tab displacement reaches approximately 10 degrees of airplane

nosedown because the elevator has not responded, the summing linkage will operate the control valves to port pressure to the actuator and thus apply airplane nosedown elevator. From this point on, the elevator will follow the position of the control column.

The actuator cylinders with restrictor check valves and a low-pressure accumulator in the return line are also used as gust dampers.

To provide the flight crew with operating information, an elevator power-on light is provided on the annunciator panel. The light is operated by a pressure switch and will come on when hydraulic pressure is used to drive the elevator.

Aerodynamic load feel forces are supplemented by a load feel spring, and a Mach trim spring, connected to the first officer's control column below the floor. The Mach trim spring is controlled by a Mach trim compensator that provides corrective Mach trim at high Mach number conditions.

The Mach trim system can be selected or overridden by a Mach trim compensator switch on the overhead panel. The switch has three positions: (1) TEST (preflight check) introduces a signal as a means of functionally checking the computer and indicator; (2) NORM, normal flight position; and (3) OVRD, used for preflight test of an independent circuit and for inflight override of malfunctioning system. An indicator on the first officer's control column gives visual indication of Mach trim operation.

HORIZONTAL STABILIZER

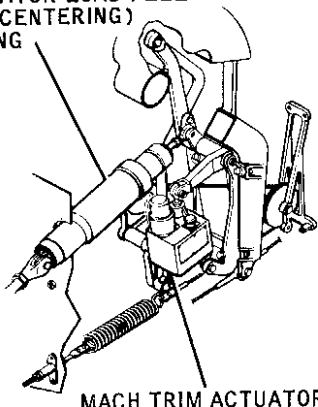
A movable horizontal stabilizer provides longitudinal trim. The stabilizer is moved by a jackscrew driven

FLIGHT CONTROLS -- ELEVATOR FUNCTIONAL SCHEMATIC

ELEVATOR LOAD FEEL (AND CENTERING) SPRING.

Provides centering or neutral point of elevator system. Provides load or feel when elevators controls are moved from neutral position.

ELEVATOR LOAD FEEL (AND CENTERING) SPRING



MACH TRIM ACTUATOR

MACH TRIM ACTUATOR

Provides airplane nose up force on the elevator system to counteract normal pitch down of airplane encountered at high mach. Receives command signals from the air data computer through the stability augmentation computer.

AFCS ELEVATOR SERVO

GEARED TAB (2 PLACES)

CONTROL TAB (2 PLACES)

AUGMENTION ACTUATOR AND DAMPER CYLINDER

ELEVATOR (VISCOUS) DAMPER

SUMMING LINK

SURFACE FOLLOW-UP LINK

HYDRAULIC LINES

PRESSURE SWITCH

OVERRIDE SPRING

HYDRAULIC AUGMENTATION CONTROL VALVE

OVERRIDE SPRING

Allows full throw capability in the event the augmentor control valve should jam.

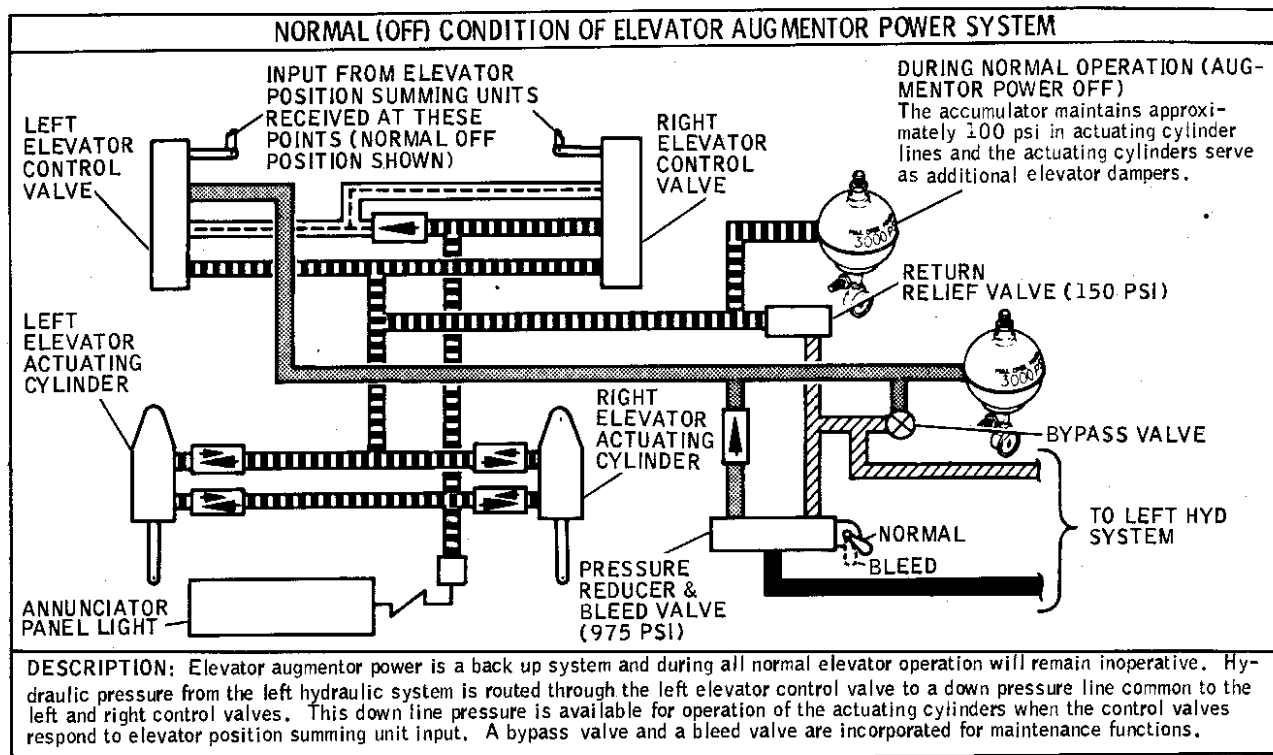
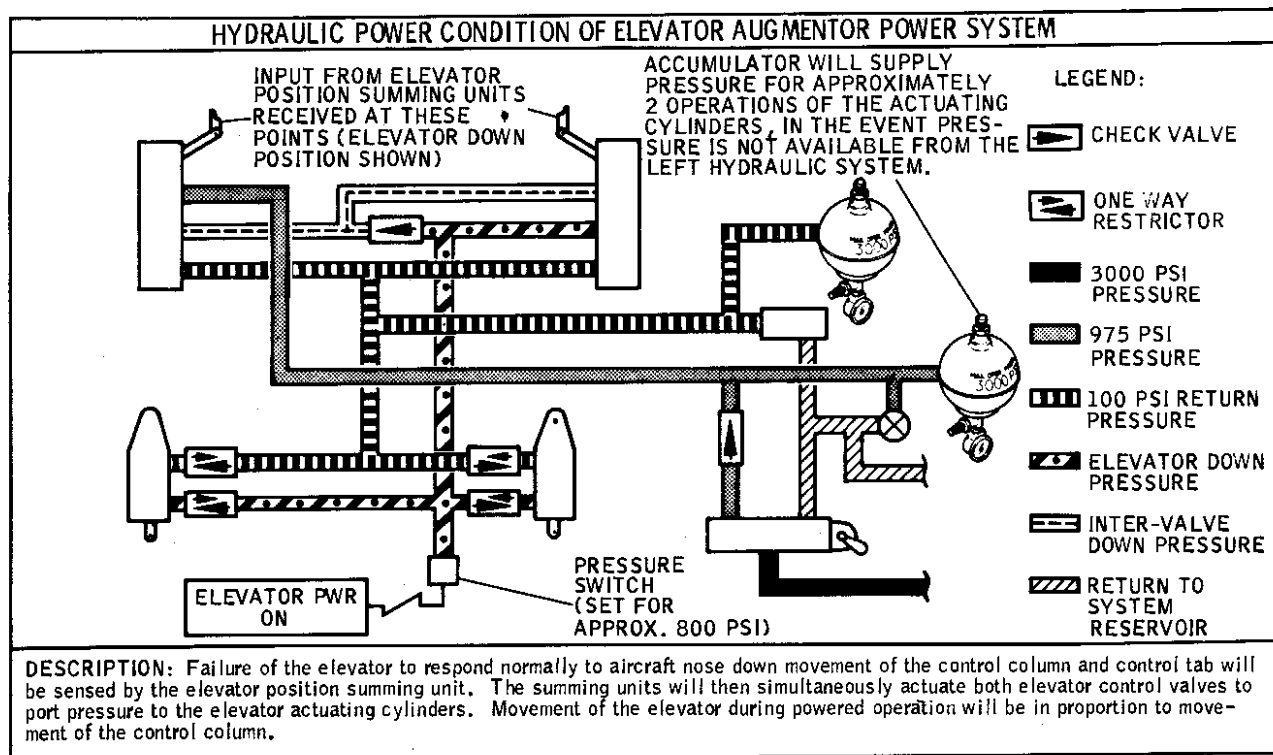
ELEVATOR (VISCOUS) DAMPER

Damper is filled with viscous silicone fluid that will allow normal control surface movement but resists rapid movement.

DESCRIPTION -- The elevator control system has separate control cables to each control tab. The control columns are bussed together by a torque tube located under the cockpit floor. Movement of the control column positions the control tab and resultant aerodynamic forces position the elevator surfaces. Movement of the elevator surfaces out of faired position drives the geared tab in the same direction as the control tab to lower the required pilot force on the control column.

The augmentor power system is provided to give airplane nose down assist if the elevator control tab is displaced more than 10 degrees. Normal required control tab displacement is only 8 degrees. The summing linkage determines the amount of hydraulic assist required, by sensing control tab position and elevator travel and positions the augmentation control valve as required. Hydraulic pressure from the left hydraulic system, reduced to approximately 975 psi powers the augmentation system. An accumulator is provided to store pressure and in the event of hydraulic system failure this accumulator will provide several cycles of nose down power. A light on the annunciator panel indicates when hydraulic power is applied. BB1-201A

FLIGHT CONTROLS -- ELEVATOR AUGMENTOR POWER FUNCTIONAL SCHEMATIC



BB1-1455A

FLIGHT CONTROLS -- HORIZONTAL STABILIZER FUNCTIONAL SCHEMATIC

LONGITUDINAL TRIM HANDLES

These handles are mechanically connected to the contactor and the horizontal stabilizer brake switch by cables. When held together and displaced, they will operate the horizontal stabilizer at the 1/3 deg. per sec. rate. These controls can overpower the electrical signals from the wheel switches or free a jammed contactor or brake switch. If the stabilizer reaches its limit of travel, the stabilizer position cable will mechanically overpower pilot input and open the contactor. The trim indicator pointer, adjacent to the trim handles, is cable connected to the stabilizer and indicates stabilizer position.

ALTERNATE LONGITUDINAL TRIM (SECONDARY) CONTROL

These two controls, when moved simultaneously, will provide longitudinal trim at a rate of 1/10 of a degree per second. Stabilizer movement circuitry for the alternate trim system is independent of the primary trim system.

STABILIZER TRIM (PRIMARY MOTOR BRAKE) SWITCH

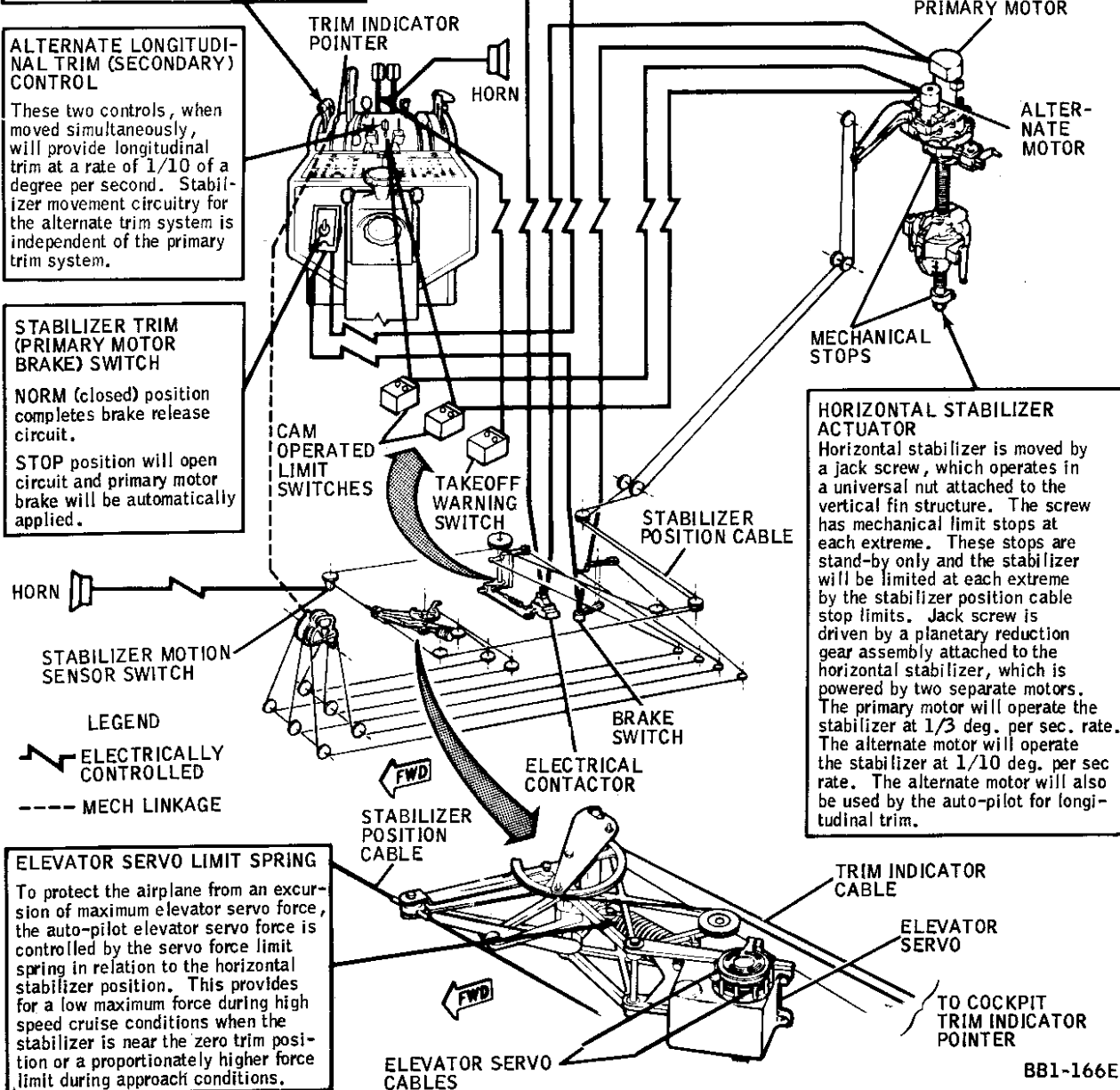
NORM (closed) position completes brake release circuit.
 STOP position will open circuit and primary motor brake will be automatically applied.

STABILIZER WARNING SYSTEMS

When the stabilizer is moving, an audible signal will sound once for approximately each 1/2 degree of travel.
 If the throttles are advanced for takeoff with the stabilizer not in takeoff range, an intermittent takeoff warning signal is sounded.

WHEEL TRIM SWITCHES

These dual trim switches electrically control the horizontal stabilizer contactor and horizontal stabilizer brake switch. They must be operated together to move the stabilizer. If the stabilizer reaches the limit of travel, the stabilizer position cable will open the electrical contactor mechanically and terminate stabilizer movement. When the dual switches in one wheel are being operated, selection of the opposite direction with the switches in the other wheel will cancel stabilizer motion.



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by either a primary or an alternate electric motor. Primary trim control is accomplished by electrical contactors which are controlled by dual switches on each control wheel, or by cable-connected dual handles on the pedestal. Operation by primary control moves the stabilizer one-third degree per second.

Alternate stabilizer operation is provided by two switch levers mounted on the center of the pedestal. Operation by the alternate control moves the stabilizer one-tenth degree per second. The alternate motor is also used by autopilot for trim.

All stabilizer operation is protected by dual switches and dual circuits. One circuit controls an electric brake, and the second circuit controls power to the jackscrew motors.

Regardless of the switch system used, both switches must be moved in the same direction to result in stabilizer movement. When the horizontal stabilizer is being moved by either of the three methods of control or by the autopilot trim, an audible signal is sounded once for approximately each 1/2 degree of stabilizer movement.

STABILIZER POSITION INDICATOR

An indicator adjacent to the primary control shows, in degrees up or down, the position of the horizontal stabilizer in relation to airplane trim. The indicator is cable operated by stabilizer movement. To permit rapid adjustment of the stabilizer position for takeoff, the indicator scale has a green band to indicate correct takeoff stabilizer setting in relation to C.G. The left side of the indicator scale is marked in percent of C.G.

The indicator cable operates a set of limit cams in each motor control system. At each extreme of travel, the

cam will open the contractor mechanically to stop the stabilizer prior to reaching the mechanical safety stops. This indicator cable also controls the tension of the autopilot elevator servo force limiter spring. This provides for a low servo force limit when the horizontal stabilizer is at, or less than, approximately 1 3/4 degrees airplane noseup, as during cruise, and for progressively higher servo authority with increasingly higher airplane noseup stabilizer angle.

STABILIZER TAKEOFF WARNING

A stabilizer takeoff warning switch is cam operated by the stabilizer position indicator cable. The stabilizer takeoff warning provides an intermittent audible warning signal, if the throttles are advanced for takeoff when the stabilizer is not in takeoff range.

STABILIZER TRIM BRAKE SWITCH (Primary motor circuit only)

This two position switch is located on the aft pedestal and is used only to stop a runaway stabilizer condition. When the switch is moved from its normal guarded position to the stop position, the electrical power that holds the primary motor brake release is interrupted and the brake is applied to prevent stabilizer movement. When the switch is returned to the normal position, stabilizer trim may be used.

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FLAPS SYSTEM (See Flaps Functional Schematic.)

The flaps are a double-slotted type and move aft and down. Each flap (right and left) is actuated by two hydraulic cylinders (inboard and outboard). The outboard cylinders are powered by the left hydraulic system, and the inboard cylinders are powered by the right hydraulic system. Normally, the flaps are operated by both hydraulic systems but they will continue to operate, at a reduced rate, with a single hydraulic system.

Flaps positions, through a range of 50 degrees, may be preselected by movement of the flap control handle. The flap control handle has detents at UP, 0-, 5-, 15-, 25-, and 50-degree positions.

Movement of the flap control handle positions a dual control valve (controls pressure from both hydraulic systems) for hydraulic extension or retraction of the flaps. As the flaps move, a followup cable system linked to the flap surfaces will start to close the dual control valves. When the flaps reach the position preselected by the flap control handle, the followup cable system will have fully closed the control valve, stopping further flap movement. Both flaps are connected by a bus tie cable to assure symmetrical movement.

Additional control of the flap movement during retraction is provided by a two-speed restrictor valve system. Flap travel speed is restricted during retraction from 20 to 0 degrees. Retraction from 50 to 20 degrees is at a faster rate.

FLAP POSITION INDICATOR

The indicator contains dual, superimposed pointers and a dial which is graduated in degrees of flap travel. Each flap is linked to a separate flap position transmitter that operates one of the dual pointers. The pointers respond to actual flap movement rather than flap control handle movement and will normally move in unison.

FLAPS WARNING SYSTEM

The flap followup cable system operates a takeoff warning switch and a landing gear warning switch.

If while the airplane is on the ground the throttles are advanced for takeoff and the flaps are at more than a 15-degree setting, the takeoff warning horn will sound.

If while the airplane is on the ground the throttles are advanced for takeoff and the slats fail to extend the takeoff warning horn will sound regardless of flap position.

If the flaps are extended beyond 15 degrees with the landing gear not down and locked, a continuous warning horn is sounded, that cannot be silenced until the gear is down and locked.

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FLIGHT CONTROLS -- FLAPS FUNCTIONAL SCHEMATIC (sheet 1)

FLAP CONTROL HANDLE

During normal operation the flap control and slat control handles are interconnected to prevent independent operation of the slats. For details of flap/slat control handle operation see **FLIGHT CONTROLS - COCKPIT CONTROLS & INDICATORS**.

NOTE: ROTATED 180° FOR CLARITY

FLAP BUS CABLES

Interconnect left and right flaps to provide uniform positioning.

FLAP FOLLOWUP CABLES

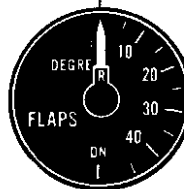
INBOARD FLAP ACTUATING CYLINDER (typical left and right flap)

OUTBOARD FLAP ACTUATING CYLINDER (typical left and right flap)

R FLAP POSITION TRANSMITTER

LINKAGE TO FLAP

FLAP FOLLOWUP CABLES



FLAP POSITION INDICATOR

Dual, superimposed, pointers move in unison as left and right flap surfaces move. Failure of the needles to move in unison indicates a fault in the flap bus system or indicating system.

L FLAP POSITION TRANSMITTER

FLAP POSITION TRANSMITTERS

Control movement of the dual needles on the flap position indicator, provides input to the summing unit for use in the L and R stall warning systems (and speed command installations).

NOTE: Flap position transmitters respond to actual flap movement rather than flap control handle movement.

DESCRIPTION

The flap control handle has detent position at UP, 0, 5, 15, 25, and 50 degrees. Movement of the flap control handle mechanically actuates the flap control valves. The control valves port pressure from the respective left and right hydraulic systems to raise or lower the flaps. The left hydraulic system supplies the outboard cylinders and the right hydraulic system supplies

the inboard cylinders. When the flaps reach the position selected by the flap control handle, a follow-up cable system will place the flap control valve in a neutral position. Transmitters furnish left and right flap position information to the cockpit flap position indicator, the left and right stall warning summing units (and speed command installations).

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FLIGHT CONTROLS -- FLAPS FUNCTIONAL SCHEMATIC (sheet 2)

TAKEOFF WARNING SWITCH

Senses the position of flaps through followup system on the ground. If throttles are advanced for takeoff and the flaps are not in takeoff position, the warning horn will sound.

NOTE: If throttles are advanced for takeoff and the slats are not extended, the horn will sound regardless of flap position.

2 SPEED CONTROL VALVE

Aft movement of the flap control handle will move the beam and control valve linkage downward. Pressure is now ported, from the dual control valve, to the flap actuating cylinders.

As the flap surfaces move the followup cable system starts to move the beam and control valve linkage upward. When the flaps reach the preselected position the followup system will close the control valve.

LEGEND:

Result of flap handle movement

Result of flap follow-up system movement

ELECTRICAL ACTUATION

FROM RIGHT HYDRAULIC SYSTEM

FROM LEFT HYDRAULIC SYSTEM

LANDING GEAR (SECONDARY) WARNING SWITCH

If the landing gear is not down and locked and the flap control handle is moved beyond the 15 degree setting, the landing gear warning horn will sound. Under this condition, the horn cannot be silenced until the gear is down and locked.

FLAP CONTROL VALVE

To assure margin above stall will be maintained, flaps operate at two speeds during retraction. Flap travel speed is restricted during retraction from 20 to 0 degrees. Retraction from 50 to 20 degrees is at a faster rate.

FLAP CONTROL VALVE (supplied by left hydraulic system)

FLAP CONTROL VALVE (supplied by right hydraulic system)

INBOARD FLAP ACTUATING CYLINDER (typical L & R)

OUTBOARD FLAP ACTUATING CYLINDER (typical L & R)

FLAP BUS CABLE

DOUBLE SLOTTED FLAP AREA

TRIPLE SLOTTED FLAP AREA

FWD FLAP VANE

AFT FLAP VANE

SLIDE

GUIDE

INB'D TRACK (SLIDING)

FLAP

BB1-1930A

HINGE

20° DOWN

50° DOWN

ARTICULATED BUTE

Hinged panel provides faired surface when flaps are up. Moves upward to increase airflow and flap efficiency as flaps are lowered. Panel is torsion bar loaded to up and is actuated by a cam as a result of flap movement.

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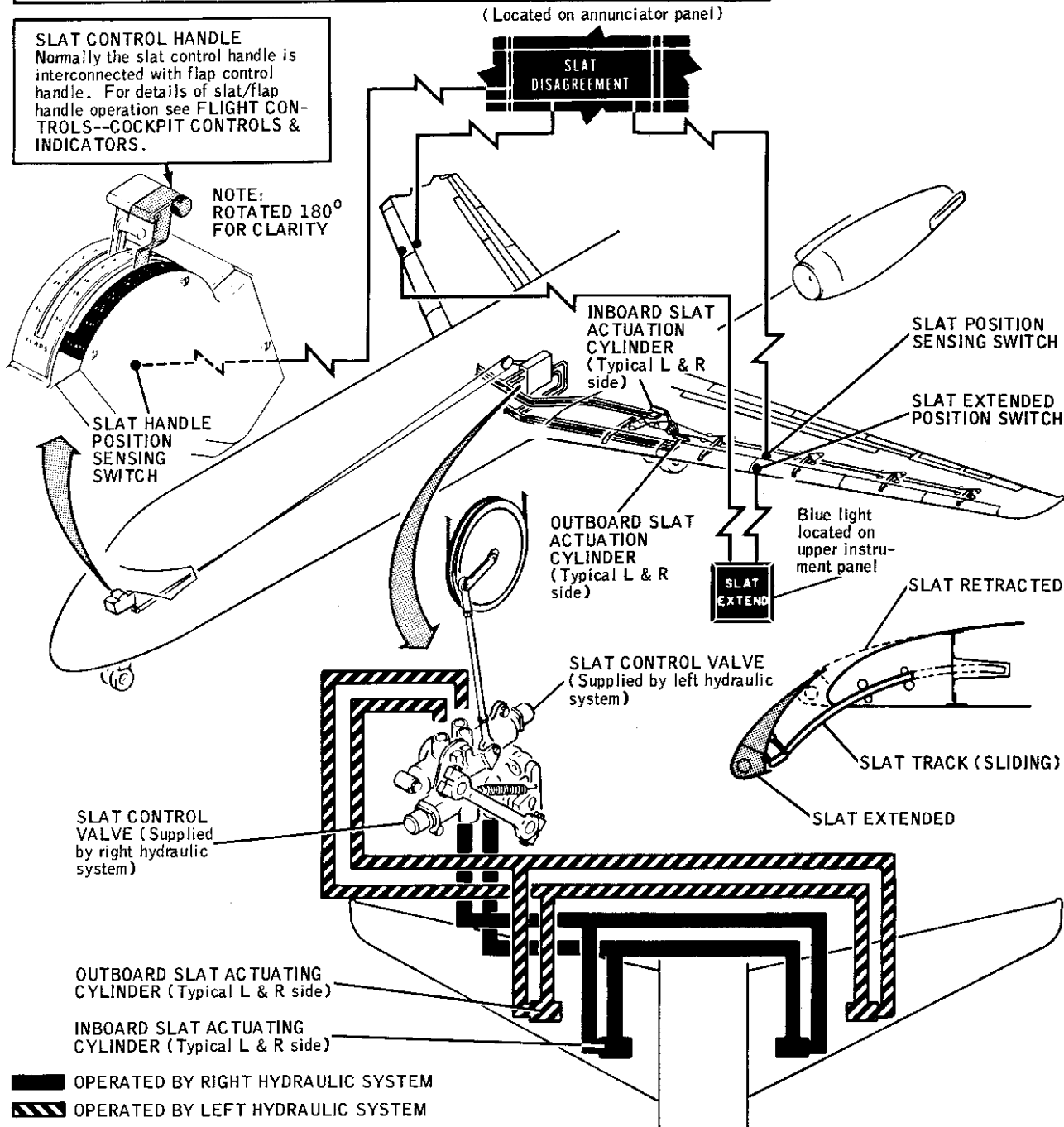
LEADING EDGE SLAT SYSTEM (See Slat Functional Schematic.) For operation of the flap/slat controls see Flight Controls -- Cockpit Controls & Indicators.

The slat system is a high lift device located on the leading edge of the (left and right) wings. Each slat is actuated by two hydraulic cylinders (inboard and outboard). The outboard cylinders are powered by the left hydraulic system and the inboard cylinders are powered by the right hydraulic system. The actuating cylinders extend and retract the slats by a means of a closed cable and track system. Slat response should be fully extended or retracted. When both slats fully extend the SLAT EXTEND light on the upper instrument panel will come on. Failure of the left and right slats to operate symmetrically will be indicated by the annunciator panel SLAT DISAGREEMENT light. The SLAT DISAGREEMENT light will come on during slat transit to position selected by slat handle and will remain on if slat fails to move to selected position. Normally, the slats operate by pressure from both hydraulic systems, but will continue to operate, at a reduced rate, with pressure from a single hydraulic system.

If the throttles are advanced for takeoff and the slats are not extended, the takeoff warning horn will sound.

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FLIGHT CONTROLS -- SLAT FUNCTIONAL SCHEMATIC



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DESCRIPTION: The slats are normally fully extended when the interconnected flap/slat handles are moved from "UP/RET" to "O/EXT" position. For independent operation of the slat handle, see FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS. Initial movement from "UP/RET" will port pressure to the extend side of the actuating cylinders and extend the slats by means of a closed cable and track system. Movement to "O/EXT" will port pressure to the retract side of the actuating cylinders. Slat response for position selected should be fully extended or fully retracted. A slat extended position switch (one in each wing) will turn on the SLAT EXTEND light when both slats reach fully extended position. Additional position sensing switches on each wing, and at the slat control handle, will turn on the SLAT DISAGREEMENT light if left and right slat response is not symmetrical or does not match position selected by slat control handle. SLAT DISAGREEMENT light will stay on during slat movement to position selected by slat control handle.

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SPEEDBRAKES (See Lateral Control and Spoiler Functional Schematic.)

During flight, manually moving the pedestal-mounted speedbrake lever aft will extend all four flight spoiler surfaces to serve as speedbrakes. These surfaces may be symmetrically extended approximately 6 degrees per notch to a maximum of 35 degrees by this method. Use of aileron control during speedbrake operation results in asymmetrical extension of the surfaces to aid in lateral control.

GROUND SPOILERS (See Lateral Control and Spoiler Functional Schematic.)

After landing, all four flight spoiler surfaces may be extended a maximum of 60 degrees to serve as ground spoilers. The system may be armed for automatic operation by pulling up on the speedbrake lever until a red armed placard is exposed and the lever latches in the up position. When the system is armed, the spoilers will automatically extend after wheel spin-up on ground contact or after nosegear oleo actuates ground shift. The spoilers will retract if left throttle is advanced for a go-around and the spoiler handle will be disarmed.

The spoilers may be manually operated by moving the lever up, aft, and up. An auto spoiler do not use light on the annunciator panel, when on, indicates a malfunction in the automatic actuation system. If the automatic actuation system is inoperative a manual ground spoiler secondary latch will hold the speedbrake lever in the 60 degree position to provide maximum ground spoiler operation.

If, while the airplane is on the ground, the throttles are advanced for takeoff and the speedbrake lever is not in the full forward detent, a takeoff warning horn will sound intermittently.

STALL INDICATION SYSTEM (See Stall Indication System Functional Schematic.)

MAXIMUM SPEED WARNING (See Flight Controls -- Cockpit Controls & Indicators.)

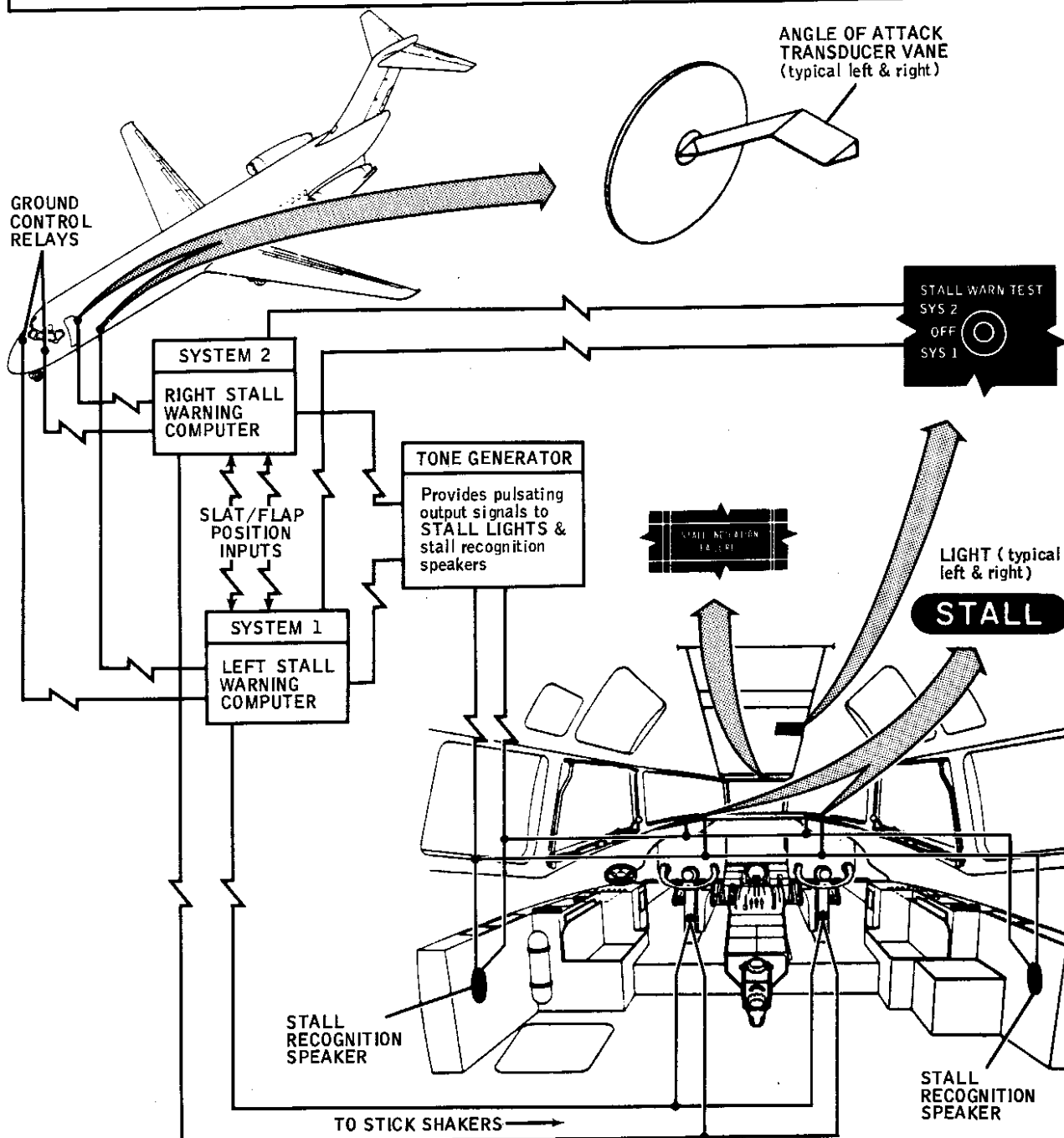
GROUND GUST PROTECTION

Viscous dampers, two on each aileron and two on the rudder, along with the rudder power cylinder and resilient aileron stops, protect the structure and surfaces from ground gusts.

One viscous damper and augmentor power cylinder on each elevator surface protects the elevator from ground gusts.

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FLIGHT CONTROLS -- STALL INDICATION SYSTEM FUNCTIONAL SCHEMATIC



DESCRIPTION -- The stall indication system consists of two independent channels. Each channel has a computer that receives input from an angle of attack vane and slat and flap position transmitters. Either channel will provide pre-stall warning by actuation of both stick shakers at approximately 10% above stall. At stall, either channel will provide stall recognition by means of pulsating input to the glareshield STALL lights and to the stall recognition speakers. Both the pre-stall and stall recognition signals are provided with rate anticipation that will cause the signals to occur sooner when stall is approached at high rates of change. Channel malfunction will be indicated by an annunciator panel STALL INDICATION FAILURE light. When the airplane is on the ground, the ground shift mechanism will disable all normal function of the stall indication system except stall warning test.

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SPEEDBRAKES (See Lateral Control and Spoiler Functional Schematic.)

During flight, manually moving the pedestal-mounted speedbrake lever aft will extend all four flight spoiler surfaces to serve as speedbrakes. These surfaces may be symmetrically extended approximately 6 degrees per notch to a maximum of 35 degrees by this method. Use of aileron control during speedbrake operation results in asymmetrical extension of the surfaces to aid in lateral control.

In flight, a SPOILER/FLAP EXTENDED annunciator light and the MASTER CAUTION lights will come on if the speedbrakes are extended with flaps extended beyond the 5 degree position. Operation of speedbrakes in conjunction with flaps will increase the stall speed. (The system is de-energized when the airplane is in the ground mode.)

GROUND SPOILERS (See Lateral Control and Spoiler Functional Schematic.)

After landing, all four flight spoiler surfaces may be extended a maximum of 60 degrees to serve as ground spoilers. The system may be armed for automatic operation by pulling up on the speed-brake lever until a red armed placard is exposed and the lever latches in the up position. When the system is armed, the spoilers will automatically extend after wheel spin-up on ground contact or after nosegear oleo actuates ground shift. The spoilers will retract and the spoiler handle will be disarmed if left throttle is advanced for a go-around.

The spoilers may be manually operated by moving the lever up, aft, and up. An AUTO SPOILER DO NOT USE light on the annunciator panel, when on, indicates a malfunction in the automatic actuation system. If the automatic actuation system is inoperative a manual ground spoiler secondary latch will hold the speedbrake lever in the 60 degree position to provide maximum ground spoiler operation.

If, while the airplane is on the ground, the throttles are advanced for takeoff and the speedbrake lever is not in the full forward detent, a takeoff warning horn will sound intermittently.

STALL INDICATION SYSTEM

The stall indication system consists of two independent channels. Each channel has a computer that receives input from an angle of attack vane and slat and flap position transmitters. Either channel will provide pre-stall warning by actuation of both stick shakers at approximately 10% above stall. At stall, either channel will provide stall recognition by means of pulsating input to the glareshield STALL lights and to the stall recognition speakers. Both the pre-stall and stall recognition signals are provided with rate anticipation that will cause the signals to occur sooner when stall is approached at high rates of change.

The three-position STALL TEST switch provides the capability of testing each channel individually. SYS 1 position tests the left stall indication system, operates the stick shakers on both control columns, and

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turns on both intermittent STALL lights and both stall recognition speakers. SYS 2 position tests the right stall indication system in the same manner. Channel malfunction will be indicated by an annunciator panel STALL INDICATION FAILURE light. If one of the two systems malfunctions in flight, causing the STALL lights and/or the stall recognition speakers to come on at full intensity, the STALL lights can be dimmed and stall recognition speakers can be muted by placing the STALL TEST switch to either SYS 1 or SYS 2. STALL TEST switch is normally in the OFF position at all times except during stall indication test or isolating malfunctioning system. When the airplane is on the ground, the ground shift mechanism will disable all normal function of the stall indication system except stall indication test.

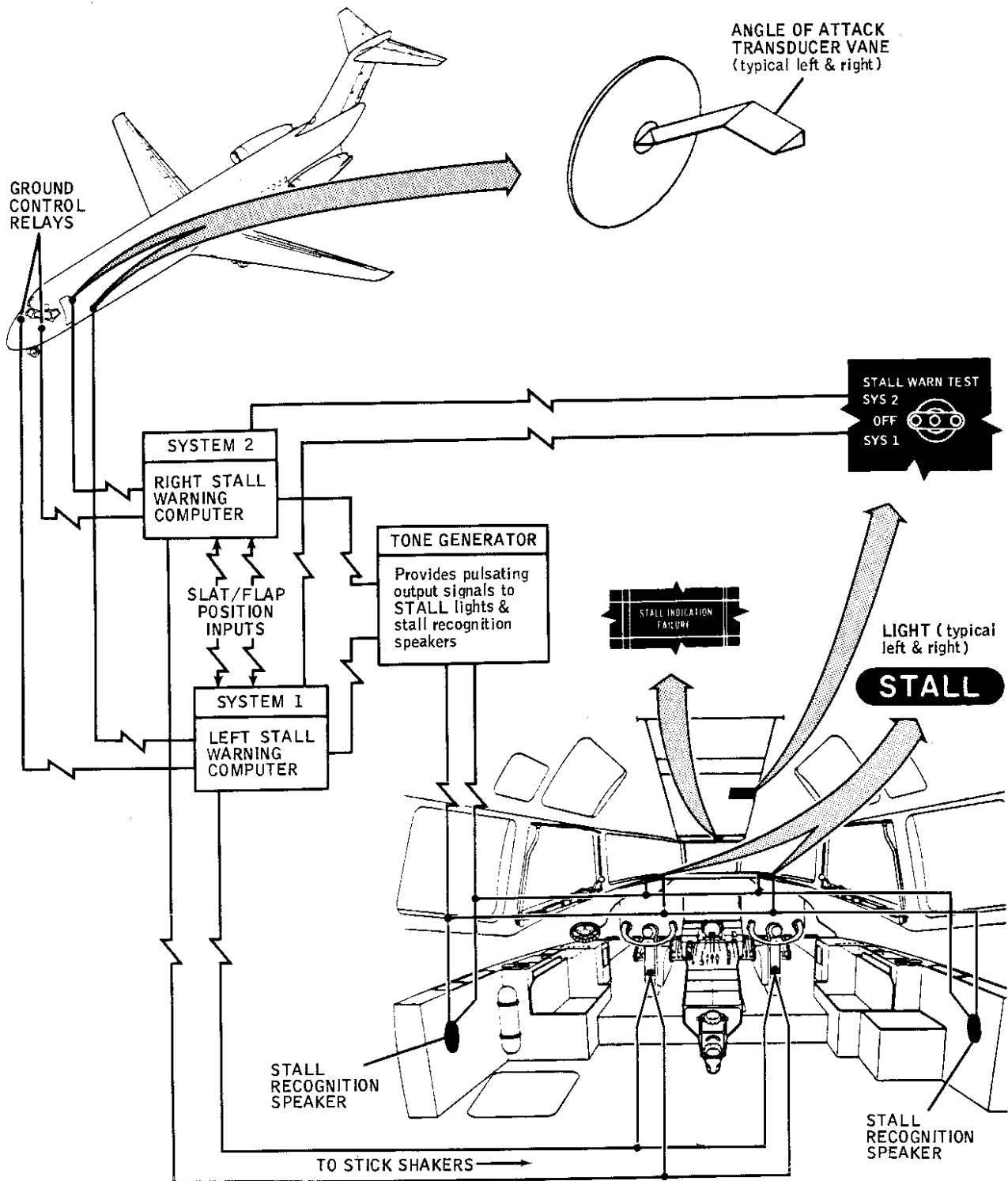
MAXIMUM SPEED WARNING (See Flight Controls -- Cockpit Controls & Indicators.)

GROUND GUST PROTECTION

Viscous dampers, two on each aileron and two on the rudder, along with the rudder power cylinder and resilient aileron stops, protect the structure and surfaces from ground gusts.

One viscous damper and augmentor power cylinder on each elevator surface protects the elevator from ground gusts.

FLIGHT CONTROLS -- STALL INDICATION SYSTEM FUNCTIONAL SCHEMATIC



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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 1)

STABILIZER MOTION WARNING

When the horizontal stabilizer is being moved by any of the three methods of control or the autopilot trim, an audio signal will sound once for approximately each 1/2 degree of stabilizer movement.

LONGITUDINAL TRIM HANDLES

The handles have the same function as the dual trim switches on the control wheels. Both handles must be moved simultaneously to actuate the stabilizer. Trim operation by the trim handles will override action by the dual trim switches on the control wheel.

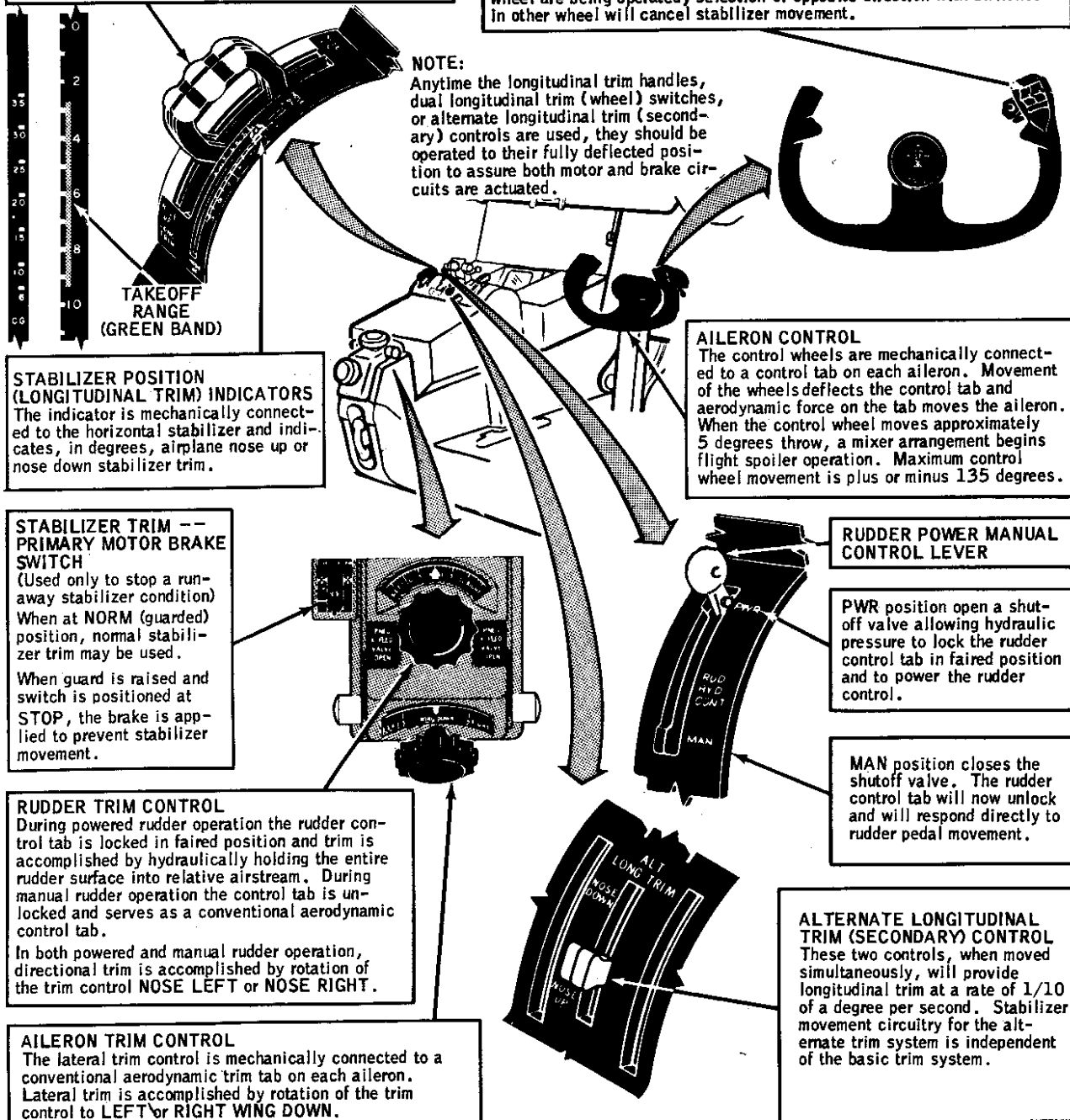
DUAL (LONGITUDINAL) TRIM SWITCHES

(Both switches must be operated simultaneously)

When both trim switches are moved to up or down position, an electrical circuit is completed to power the horizontal stabilizer actuator and thus move the stabilizer. The stabilizer will move at a rate of one third degree per second to provide longitudinal trim. When the dual switches in one wheel are being operated, selection of opposite direction with switches in other wheel will cancel stabilizer movement.

NOTE:

Anytime the longitudinal trim handles, dual longitudinal trim (wheel) switches, or alternate longitudinal trim (secondary) controls are used, they should be operated to their fully deflected position to assure both motor and brake circuits are actuated.



STABILIZER POSITION (LONGITUDINAL TRIM) INDICATORS

The indicator is mechanically connected to the horizontal stabilizer and indicates, in degrees, airplane nose up or nose down stabilizer trim.

STABILIZER TRIM -- PRIMARY MOTOR BRAKE SWITCH

(Used only to stop a run-away stabilizer condition) When at NORM (guarded) position, normal stabilizer trim may be used.

When guard is raised and switch is positioned at STOP, the brake is applied to prevent stabilizer movement.

RUDDER TRIM CONTROL

During powered rudder operation the rudder control tab is locked in faired position and trim is accomplished by hydraulically holding the entire rudder surface into relative airstream. During manual rudder operation the control tab is unlocked and serves as a conventional aerodynamic control tab.

In both powered and manual rudder operation, directional trim is accomplished by rotation of the trim control NOSE LEFT or NOSE RIGHT.

AILERON TRIM CONTROL

The lateral trim control is mechanically connected to a conventional aerodynamic trim tab on each aileron. Lateral trim is accomplished by rotation of the trim control to LEFT or RIGHT WING DOWN.

AILERON CONTROL

The control wheels are mechanically connected to a control tab on each aileron. Movement of the wheels deflects the control tab and aerodynamic force on the tab moves the aileron. When the control wheel moves approximately 5 degrees throw, a mixer arrangement begins flight spoiler operation. Maximum control wheel movement is plus or minus 135 degrees.

RUDDER POWER MANUAL CONTROL LEVER

PWR position open a shutoff valve allowing hydraulic pressure to lock the rudder control tab in faired position and to power the rudder control.

MAN position closes the shutoff valve. The rudder control tab will now unlock and will respond directly to rudder pedal movement.

ALTERNATE LONGITUDINAL TRIM (SECONDARY) CONTROL

These two controls, when moved simultaneously, will provide longitudinal trim at a rate of 1/10 of a degree per second. Stabilizer movement circuitry for the alternate trim system is independent of the basic trim system.

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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 2)

SPEEDBRAKE/GROUND SPOILER CONTROL LEVER

SPEEDBRAKE OPERATION

During flight the lever is manually pulled back to extend the flight spoiler surfaces to 35° which serve as speedbrakes.

GROUND SPOILER OPERATION

ARMED: The lever is pulled up until it latches (and ARM placard exposed). During landing after wheel spin-up or ground shift actuation, the lever will automatically move aft to extend all spoiler surfaces to 60°.

MANUAL: (Do not manually operate lever for ground spoiler extension until the aircraft is on the ground). Pull up and aft to extend all spoiler surfaces, then up to lock.

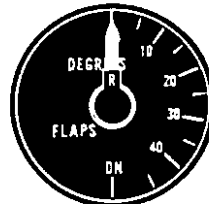
FLAP CONTROL HANDLE

The flap control handle provides for extending or retracting the flaps to a pre-selected position. For flap extension the flap detent release must be raised to move the flap handle from detented positions UP, 0, 5, 15, 25 and 50 degrees. For flap retraction the flap detent release must be raised to move the flap handle from detented positions 50, 25, 15, and 5 degrees. At the 0 degree flap position, a "gate" will stop further forward movement of the flap handle to prevent inadvertent retraction of the normally interconnected slats. To move the interconnected handles past the "gate" and retract the slats, the flap detent release must be depressed and both handles moved forward to the flaps UP/slats RET position.

FLAP RETENT RELEASE

FLAP/SLAT HANDLE INTERLOCK

To prevent inadvertent independent operation of the slat system, the flap and slat control handles are normally locked together by a spring loaded pin. For independent operation of either control handle, a knurled knob on the slat control handle must be rotated counter-clockwise approximately 1/4 turn to release threaded lock. The knob must then be pulled, and held, outward to release the interlock pin.



FLAP POSITION INDICATOR

See FLAPS FUNCTIONAL SCHEMATIC

SLAT EXTEND

Light comes on when slats extend. (Observe slat limit speed.)

SLAT CONTROL HANDLE

The slats are normally extended when the interconnected flap/slat control handles are moved from "UP/RET" to "O/EXT" position. Slats will normally remain extended for all flap setting between 0 degrees and 50 degrees. The slats are normally retracted when the flap detent release is depressed at the 0 flap setting "gate" and the interconnected flap/slat handles are moved forward to the UP/RET position.

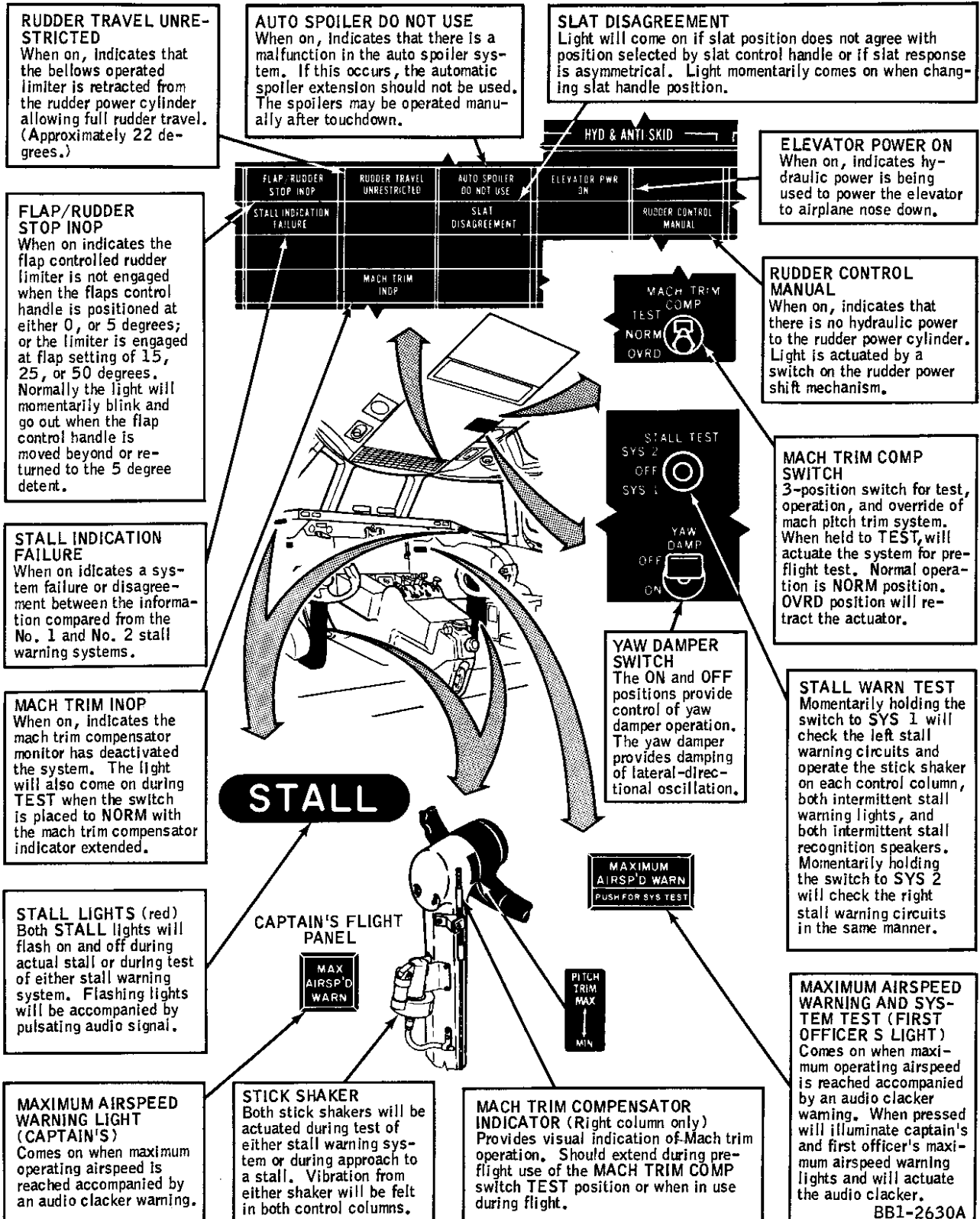
For independent operation of the slats, the slat handle must be disconnected from the flap handle (see FLAP/SLAT HANDLE INTERLOCK). When the handle is moved from RET to EXT position the slats will extend. When the handle is moved from EXT to RET the slats will retract and the handle will be spring loaded to RET position.

RUDDER PEDALS AND PEDAL ADJUSTMENT (TYPICAL)

The rudder pedals are conventional in operation. Pedal adjustment is made by pulling out on the rudder pedal adjustment knob and positioning pedals to desired notch position.

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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 3)



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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 1)

STABILIZER MOTION WARNING

When the horizontal stabilizer is being moved by any of the three methods of control or the autopilot trim, an audio signal will sound once for approximately each 1/2 degree of stabilizer movement.

LONGITUDINAL TRIM HANDLES

The handles have the same function as the dual trim switches on the control wheels. Both handles must be moved simultaneously to actuate the stabilizer. Trim operation by the trim handles will override action by the dual trim switches on the control wheel.

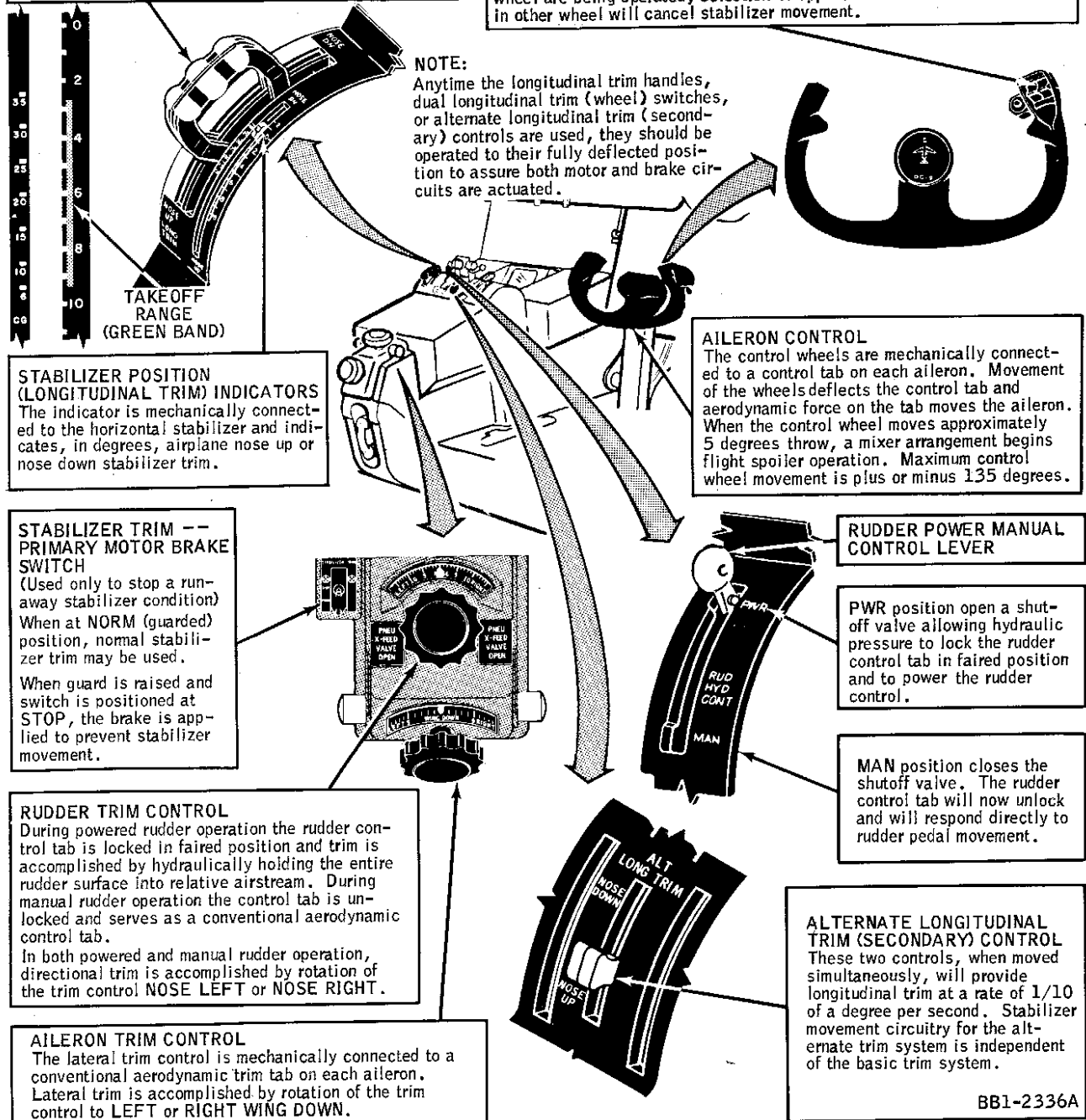
DUAL (LONGITUDINAL) TRIM SWITCHES

(Both switches must be operated simultaneously)

When both trim switches are moved to up or down position, an electrical circuit is completed to power the horizontal stabilizer actuator and thus move the stabilizer. The stabilizer will move at a rate of one third per second to provide longitudinal trim. When the dual switches in one wheel are being operated, selection of opposite direction with switches in other wheel will cancel stabilizer movement.

NOTE:

Anytime the longitudinal trim handles, dual longitudinal trim (wheel) switches, or alternate longitudinal trim (secondary) controls are used, they should be operated to their fully deflected position to assure both motor and brake circuits are actuated.



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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 2)

SPEEDBRAKE/GROUND SPOILER CONTROL LEVER

SPEEDBRAKE OPERATION

During flight the lever is manually pulled back to extend the flight spoiler surfaces to 35° which serve as speedbrakes.

GROUND SPOILER OPERATION

ARMED: The lever is pulled up until it latches (and ARM placard exposed). During landing after wheel spin-up or ground shift actuation, the lever will automatically move aft to extend all spoiler surfaces to 60°.

MANUAL: (Do not manually operate lever for ground spoiler extension until the aircraft is on the ground). Pull up and aft to extend all spoiler surfaces, then up to lock.

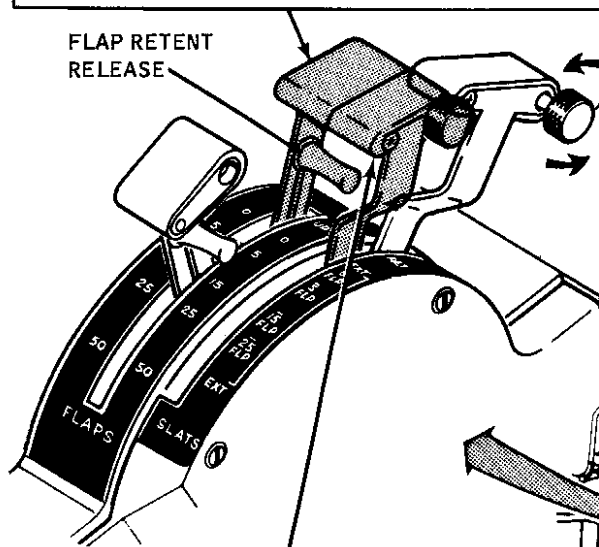
FLAP CONTROL HANDLE

The flap control handle provides for extending or retracting the flaps to a pre-selected position. For flap extension the flap detent release must be raised to move the flap handle from detented positions UP, 0, 5, 15, 25 and 50 degrees. For flap retraction the flap detent release must be raised to move the flap handle from detented positions 50, 25, 15, and 5 degrees. At the 0 degree flap position, a "gate" will stop further forward movement of the flap handle to prevent inadvertent retraction of the normally interconnected slats. To move the interconnected handles past the "gate" and retract the slats, the flap detent release must be depressed and both handles moved forward to the flaps UP/slats RET position.

FLAP/SLAT HANDLE INTERLOCK

To prevent inadvertent independent operation of the slat system, the flap and slat control handles are normally locked together by a spring loaded pin. For independent operation of either control handle, a knurled knob on the slat control handle must be rotated counter-clockwise approximately 1/4 turn to release threaded lock. The knob must then be pulled, and held, outward to release the interlock pin.

FLAP RETENT RELEASE



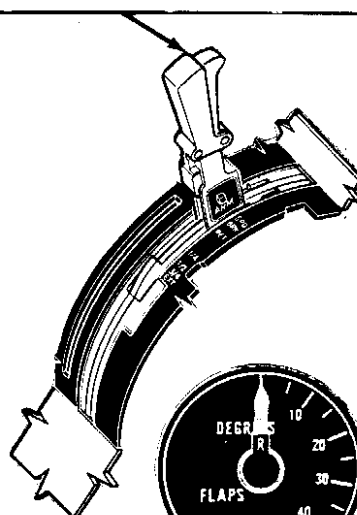
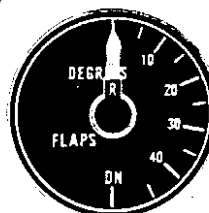
SLAT CONTROL HANDLE

The slats are normally extended when the interconnected flap/slat control handles are moved from "UP/RET" to "O/EXT" position. Slats will normally remain extended for all flap setting between 0 degrees and 50 degrees. The slats are normally retracted when the flap detent release is depressed at the 0 flap setting "gate" and the interconnected flap/slat handles are moved forward to the UP/RET position.

For independent operation of the slats, the slat handle must be disconnected from the flap handle (see FLAP/SLAT HANDLE INTERLOCK). When the handle is moved from RET to EXT position the slats will extend. When the handle is moved from EXT to RET the slats will retract and the handle will be spring loaded to RET position.

RUDDER PEDALS AND PEDAL ADJUSTMENT (TYPICAL)

The rudder pedals are conventional in operation. Pedal adjustment is made by pulling out on the rudder pedal adjustment knob and positioning pedals to desired notch position.

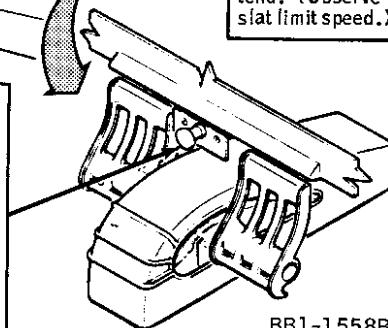


FLAP POSITION INDICATOR

See FLAPS FUNCTIONAL SCHEMATIC

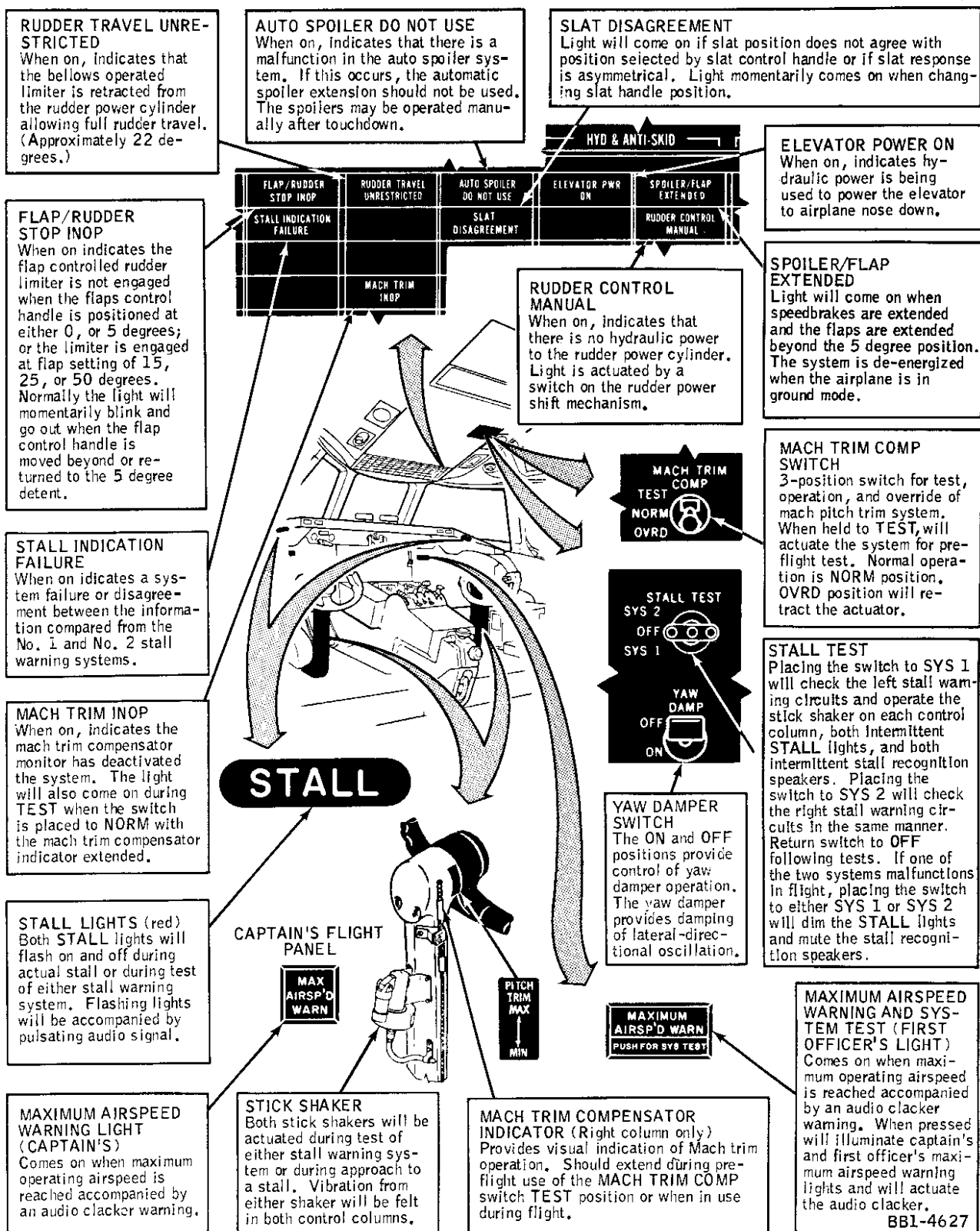


Light comes on when slats extend. (Observe slat limit speed.)



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FLIGHT CONTROLS -- COCKPIT CONTROLS & INDICATORS (sheet 3)



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Chapter 25

FUEL SYSTEM

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Chapter 25

FUEL SYSTEM

GENERAL

The airplane fuel system is designed to provide an uninterrupted fuel flow, under all conditions and attitudes encountered in normal commercial service, with minimum system management. The system is also designed to permit fuel servicing activities to be accomplished from a single point by one man, with no ground support equipment required other than a fuel servicer.

FUEL TANKS

The three integral wing tanks (left main, center, and right main) have a total usable capacity of 3679 US gallons or 24,649 pounds, based on a density of 6.7 pounds per gallon.

A sump drain is located at the lowest inboard point of each wing tank. Two sump drains are installed in the center auxiliary tank. Four magnetic dripless sticks are installed in each main tank and one in the center auxiliary tank. An inclinometer in the nosewheel well provides airplane ground attitude information for fuel gaging calibrations. Sump drains and dripless sticks can be operated with a screwdriver. A drain bottle can also be used for draining sumps.

A gravity-type auxiliary filling provision is incorporated in the top outboard end of each wing. The center wing tank can also be fueled by using the main tank boost pumps to pump fuel

through the defueling line to the center wing tank fill valve. This operation can be accomplished only on the ground during fueling by operating the manual defueling valve and the applicable main tank boost pumps.

The inboard end of each main tank acts as a fuel reservoir, with flapper-type flow baffles to maintain a fuel head around the boost pumps for all normal airplane attitudes and maneuvers.

TANK VENTS

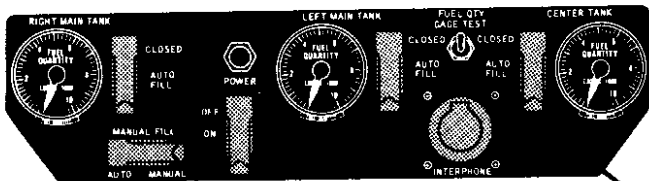
Each main tank is vented through a piping system to a vent box located in the opposite wingtip. An overflow standpipe with a nonicing, drip-free outlet is installed in each vent box.

This vent system arrangement prevents spillage caused by the low wing dihedral in conjunction with taxi sloshing or adverse ground and flight attitudes, without resorting to the use of valves and mechanical devices which would complicate the installation.

Internally each main tank has two vent outlets: an open bellmouth fitting at the outboard end and a float vent valve at the inboard forward end. The bellmouth fitting is always open. The float vent valve is normally closed but opens to vent the tank when the airplane is in a climb attitude. Float drain valves permit fuel in the vent lines to re-enter the tank when fluid level in the line is 1 inch above the fluid level in the tank.

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FUEL -- MAJOR COMPONENT LOCATION

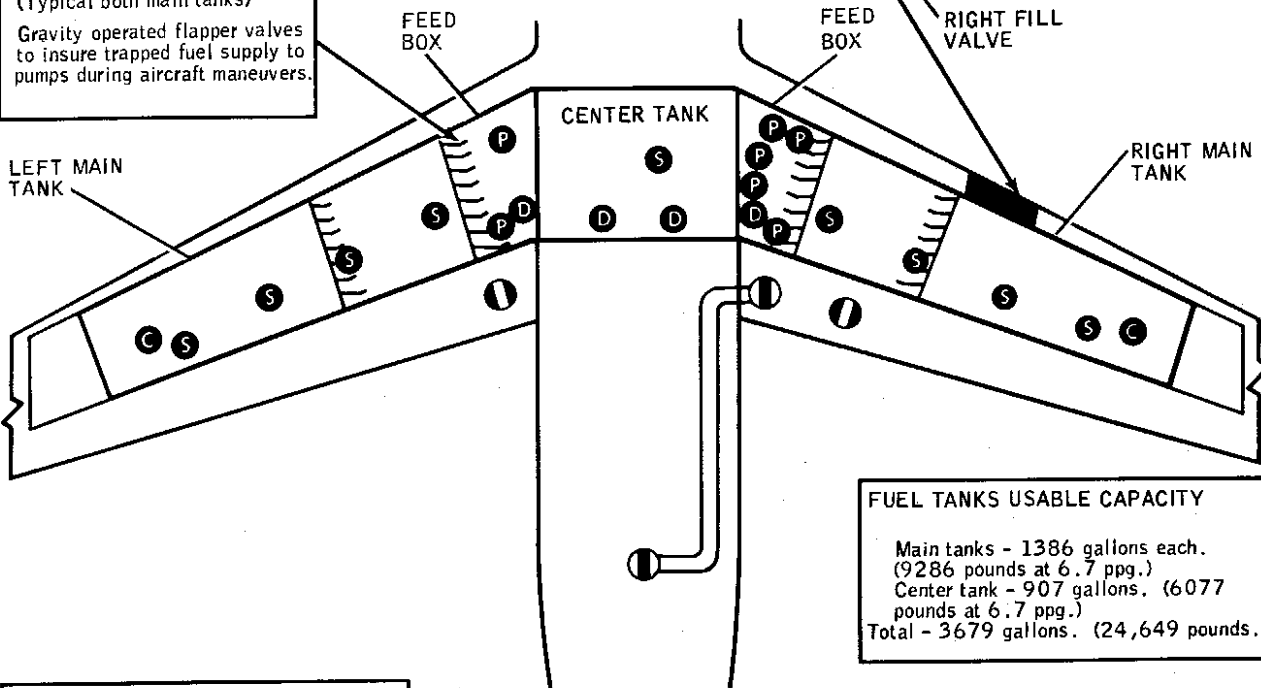


FUEL CONTROL PANEL

Contains all the controls and indicators required for pressure fueling. As a safety precaution the access door is designed so that it cannot be closed until the fuel panel master switch is in a safe flight position.

FLOW BAFFLES (Typical both main tanks)

Gravity operated flapper valves to insure trapped fuel supply to pumps during aircraft maneuvers.



FUELING-DEFUELING STATION

Access to fueling-defueling station is through a hinged door. The entire fueling operation can be accomplished at this point by one man without access to the cockpit. External ground power is not required.

VIEW LOOKING AFT

DEFUELING VALVE

FUELING ADAPTER AND MANIFOLD

LEFT FILL VALVE

CENTER FILL VALVE

RIGHT FILL VALVE

FUEL TANKS USABLE CAPACITY

Main tanks - 1386 gallons each.
 (9286 pounds at 6.7 ppg.)
 Center tank - 907 gallons. (6077 pounds at 6.7 ppg.)
 Total - 3679 gallons. (24,649 pounds.)

I ENGINE FUEL SHUTOFF VALVES

Guillotine type shutoff valves are installed in each main tank to engine supply line. These valves are connected by cables to the fire shutoff handles on the center instrument panel. Each valve incorporates a thermal relief feature.

C FILLER CAPS

Provide provision for gravity fueling the main tanks. The center tank may then be fueled by using the main tank boost pumps to pump fuel through the defueling line to the fill valve.

P FUEL PUMPS

Two boost pumps are provided for each fuel tank. Pumps for the center tank are located in the right wing tank. All ac pumps are identical 115/200V, 400 cycle. Each boost pump is capable of supplying fuel to both engines operating at takeoff power. Pump pressure output is approximately 15 psi. Center tank pumps are arranged in series to double pressure output to approximately 30 psi. Each pump is protected by a thermal switch set to open at 390°F.

I APU FUEL SHUTOFF VALVES

Two fuel shutoff valves are installed in the APU fuel supply line. These valves are electrically controlled. The valve at the rear spar is controlled by the APU master switch. The valve at the APU is controlled by an oil pressure sensing switch on the APU. These valves will automatically close upon signal from the fire detection circuit. The valves are solenoid actuated to open, spring-loaded closed.

D SUMP DRAINS

One (push-to-drain type) sump drain is installed at the low inboard side of each main tank and two are installed in the center tank.

S DRIPLESS STICK

When released and lowered the fuel level at that point may be determined from markings on the stick.

START PUMP

A 28 volt dc engine start pump is installed in the right main tank. The pump is battery-powered and is used for APU or engine starts when ac electrical power is not available. Pump output is 15 psi maximum.

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The center wing auxiliary tank is vented to the left wingtip vent box through a single, open bellmouth fitting in the forward center portion of the tank. The fitting is connected to the crossover vent line for the right main tank which runs to the left wingtip vent box.

The vent lines are sized to flow fuel overboard at maximum fill system pressure with one tank receiving fuel. This provides protection against overpressurization in the unlikely event of simultaneous failure of automatic refueling shutoff and fueling adapter pressure regulator failure or improper ground equipment regulation.

FUEL FEED

Each main tank has two ac boost pumps installed at the inboard end of the tank. Each pump has adequate flow to supply both engines at takeoff power. Two ac boost pumps for the center tank are installed in the right main tank to facilitate access. These pumps are enclosed in a can and are vented and drained back to the center wing tank. A pump prime and can drain line is connected to the center tank fill line. The two center wing pumps are connected in series to provide pressure higher than that of the main tank pumps, ensure usage of the center tank fuel even with main tank boost pumps operating. All ac boost pumps are protected by an internal thermal switch set to open one phase when the pump temperature reaches 390°F. Pumps will continue to operate on two phases at a reduced rate.

A 28-volt dc pump is installed in the right main tank and is used for APU or engine starting when ac electrical

power is not available. The start pump is powered by the airplane batteries and has an output of approximately 15-psi maximum.

The right and left main tank-to-engine feed lines are interconnected by a crossfeed line and a manually operated shutoff valve. Check valves in the center wing pump discharge lines prevent reverse flow when the main tank boost pumps are operating. The two check valves are spring loaded to approximately 1 1/2 psi to prevent the engine-driven pump from pulling air from an empty center wing tank if the main tank boost pumps are off or should fail. A manually actuated guillotine-type fuel tank fire shutoff valve is installed in each engine feed line at the tank rear spar web. The valve incorporates a thermal relief feature set at 40 to 65 psi which relieves back to the tank.

Fuel lines within the pressurized area of the fuselage and all fuel line connectors and valves outside the tanks, are completely enclosed with aluminum shrouds. These shrouds are collectively drained at points aft of the APU inlet, providing safe overboard drainage at all times.

Engine inlet fuel pressure low will be indicated by a light on the annunciator panel.

FUEL TANK QUANTITY INDICATING

A capacitance bridge-type system provides remote fuel quantity indication. There is one master quantity indicator in the cockpit for each fuel tank, and

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a repeater indicator on the fueling-defueling control panel. A fuel quantity totalizer is connected to the master indicators in the cockpit.

The fuel quantity indicating system is calibrated based on a fuel density of 6.7 pounds per gallon with a dielectric constant of 2.13.

FUELING AND DEFUELING

All tank fueling and defueling can be accomplished by one man from a single point pressure fueling station, which is readily accessible through doors utilizing pushbutton-type latches. The fueling control panel and fueling station are located at approximately midspan on the right wing leading edge. The entire fueling operation can be accomplished without the use of external ground power. The fueling control panel contains the panel electrical power switch and indicating light, repeater quantity gages, test switch, fueling valve control switches, and a manual fill override switch. A ground service interphone jack is also installed on the panel.

The tank fueling adapter and manifold is outboard of the fueling panel. The fueling valves are installed on the front spar above the fueling panel. The defueling valve is located along the front spar adjacent to the fueling panel and is accessible through a separate quick-opening access door. The fueling and defueling valves have thermal relief valves set at 40 to 65 psi which relieve into the tank.

There are two tank fill control float switches in each main tank and one in the auxiliary tank. These switches automatically close the shutoff fill valves when a tank becomes full.

The POWER switch on the fueling panel energizes the circuitry between the airplane batteries (or ground power source if connected), quantity instrumentation, quantity test circuit, the tank float switches, and fueling fill valves motors. The fuel quantity gage test circuit puts an unbalance (false indication) on the bridge circuit and drives the indicators toward the empty indication. If the circuit is operating correctly, the indicators will return to the original indication when the test switch is released.

The fueling fill valves are controlled by guarded switches adjacent to each tank quantity indicator. The valves are opened by placing the switch in the AUTO FILL position. The valves are closed automatically by the tank unit float switches. If a fuel level other than full is desired, the valve must be closed by actuating the valve close switch when the desired level is shown on the indicator or dripless sticks.

If at any time a valve fails to close automatically, the manual fill override switch should be placed in the MAN position and the valve closed by manually using the position indicating handle on the valve. Actuation of the manual electrical override switch removes power from the valve actuating motors and the float switch, which allows the airplane to be serviced manually with a float switch stuck. The fueling control panel access door cannot be closed until the master power switch has been placed in a safe flight position.

The airplane can be fueled with no ground or airplane electrical power by manually opening and closing the fill valves and using the dripless sticks for quantity indication.

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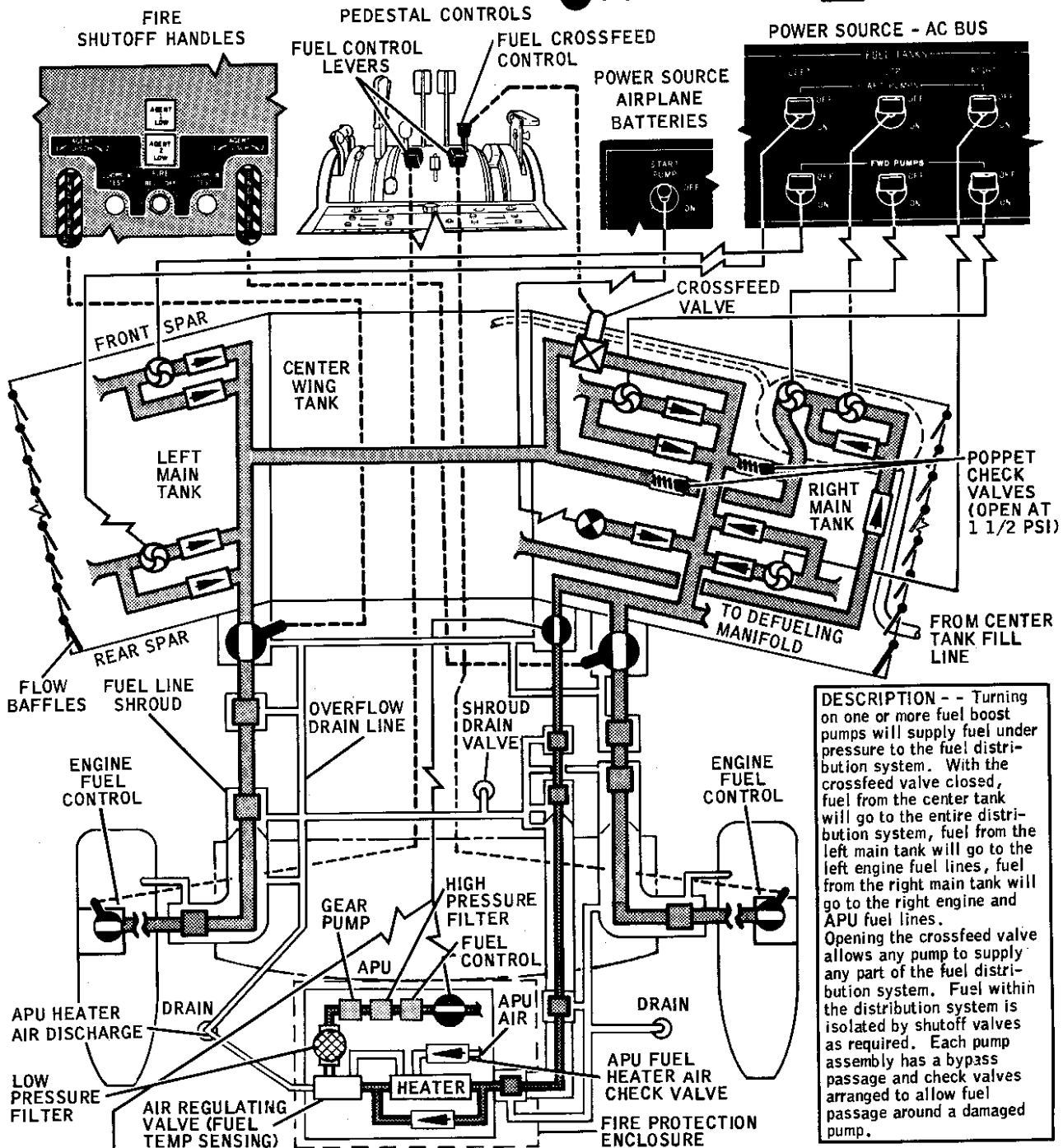
The airplane single-point pressure fueling adapter is a 2 1/2-inch international standard fueling adapter. The airplane fueling adapter incorporates a pressure regulator that controls fuel pressure downstream of the adapter to approximately 50 psi. The fueling manifold connects directly to the adapter.

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FUEL -- FUNCTIONAL SCHEMATIC

LEGEND:

- FUEL BOOST PUMP
- START PUMP
- SHUTOFF VALVE
- ELECTRICALLY ACTUATED
- MECHANICALLY ACTUATED
- CHECK VALVE



DESCRIPTION -- Turning on one or more fuel boost pumps will supply fuel under pressure to the fuel distribution system. With the crossfeed valve closed, fuel from the center tank will go to the entire distribution system, fuel from the left main tank will go to the left engine fuel lines, fuel from the right main tank will go to the right engine and APU fuel lines. Opening the crossfeed valve allows any pump to supply any part of the fuel distribution system. Fuel within the distribution system is isolated by shutoff valves as required. Each pump assembly has a bypass passage and check valves arranged to allow fuel passage around a damaged pump.

APU FUEL SHUTOFF VALVES (electrically controlled, fail-safe closed)

One valve is located at the rear spar and one at the APU. The valves open when the MASTER switch is placed at START or RUN and close at OFF. The valves will automatically close in sequence when the FIRE CONT switch is placed at OFF & AGENT ARM or when there is a warning signal from two loops of the fire detection circuit.

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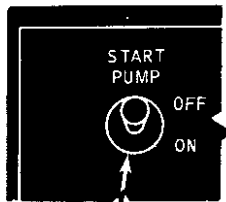
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FUEL -- COCKPIT CONTROLS & INDICATORS (sheet 1)

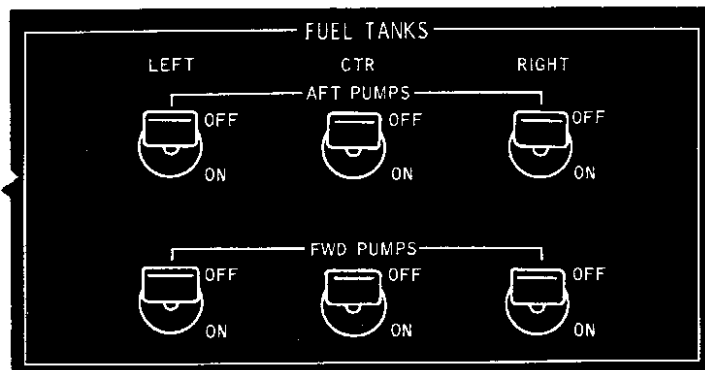
ENGINE PANEL



START PUMP SWITCH

The ON and OFF positions control operation of a 28 volt dc pump installed in the right main fuel tank. When the switch is ON a circuit is completed from the aircraft DC TRANSFER BUS to power the pump. The pump is used for APU or engine starting when ac electrical power is not available. The pump is protected by an internal thermal switch.

FUEL TANKS PANEL

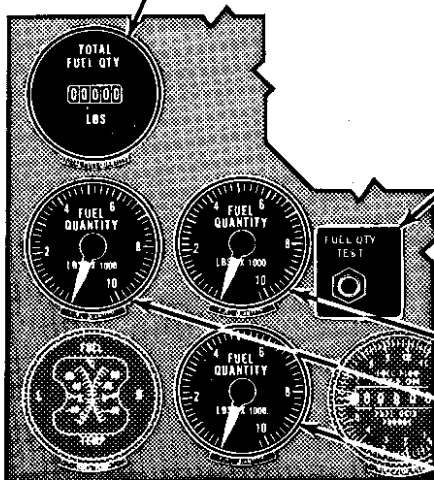


FUEL TANKS SWITCHES

Each switch controls the operation of a fuel boost pump. All fuel boost pumps are identical, ac powered. Each wing tank supply system contains two fuel boost pumps designated as AFT or FWD. When any of the six switches is placed at ON, a circuit is completed to power the applicable fuel boost pump. Each pump is protected by an internal thermal switch.

TOTAL FUEL QUANTITY INDICATORS

The fuel gaging system totalizes the fuel in each tank and provides total fuel quantity input to the indicator. The indicator shows, in pounds, the total fuel remaining.



CENTER INSTRUMENT PANEL

FUEL QUANTITY TEST SWITCH

The FUEL QTY TEST switch introduces a false fuel used input into the fuel totalizer circuit as a means of testing the system. When the switch is pressed, all fuel quantity indicators, and the total fuel quantity indicator, should show decreasing quantity indications. When the switch is released, all indicators should return to their previous quantity indications.

FUEL QUANTITY INDICATORS

RIGHT MAIN
TANK INDICATOR

LEFT MAIN
TANK INDICATOR

CENTER TANK
INDICATOR

A capacitance type bridge circuit and probes in each tank provide input for each FUEL QUANTITY indicator. Each indicator shows, in pounds, the fuel in the applicable tank.

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FUEL -- COCKPIT CONTROLS & INDICATORS (sheet 2)

L & R INLET FUEL PRESS LOW LIGHTS (amber)

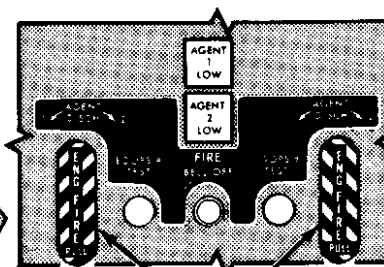
Lights come on when fuel supply pressure at the engine is approximately 5 psi or less.



MASTER CAUTION LIGHT (amber)

Lights come on with the L or R INLET FUEL PRESS LOW lights.

MASTER
CAUTION
PUSH TO RESET

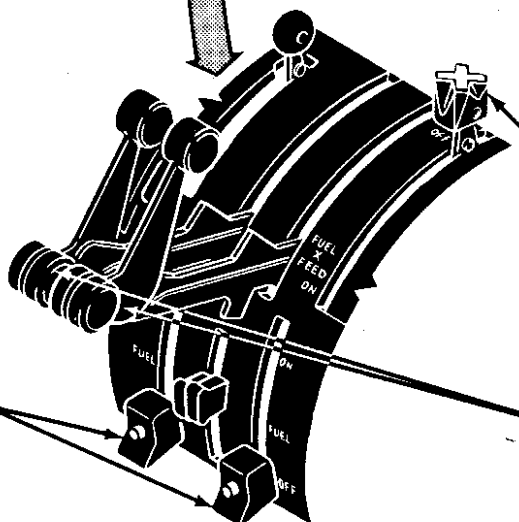


FIRE SHUTOFF HANDLES

Each handle (left or right) is cable connected to the applicable (left or right) engine fuel supply line fire shutoff valve. When a handle is pulled the fuel fire shutoff valve closes, stopping fuel supply to the engine.

FUEL CONTROL LEVERS

The fuel control push rod must be depressed to unlock lever prior to actuation of lever to the ON or OFF position. Each fuel control lever is cable connected to a shutoff valve in the engine fuel control unit. ON position opens the valve to supply fuel to the applicable engine. Movement of each lever also controls engine ignition. As the lever is moved forward from the OFF position it completes the ignition circuit first, then turns on the fuel. As the lever is moved aft from the ON position it shuts off fuel first and then shuts off ignition. (See engine fuel system functional schematic).



FUEL CROSSFEED LEVER

Lever must be pulled out from the pedestal to unlock lever prior to actuation of lever to the ON or OFF position. The fuel crossfeed lever is cable connected to the fuel system crossfeed valve. When the lever is placed at the ON position, the valve opens to route fuel from either main tank to both engines or the APU. Use of the fuel boost system will determine which tanks fuel supply will be used.

THROTTLES

Each throttle is cable connected to its respective engine fuel control unit to regulate engine thrust. For thrust reverser operation see thrust reverser schematic.

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FUEL -- FUELING, DEFUELING, & QUANTITY INDICATION

FILL SYSTEM

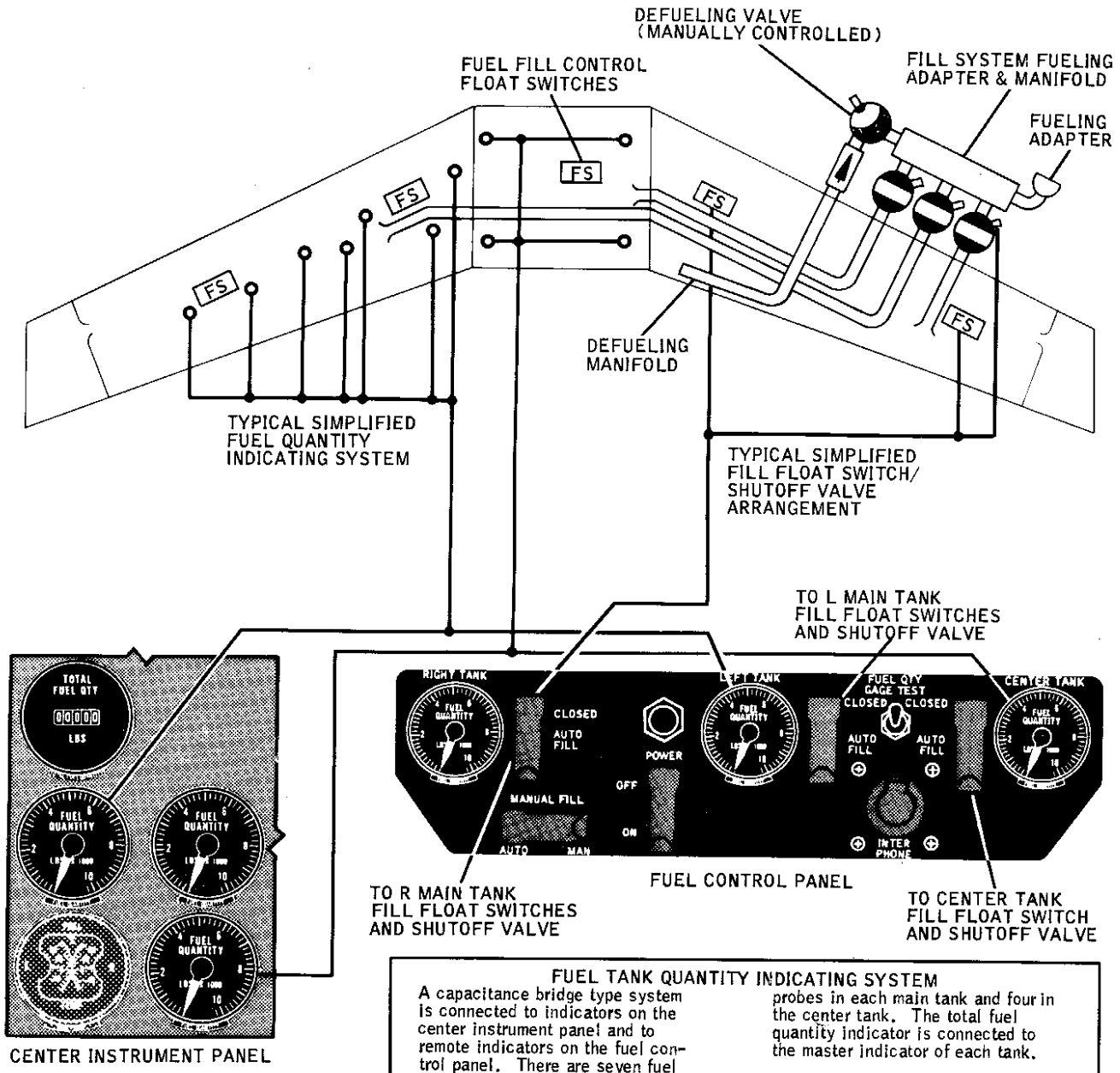
The tank fueling adapter and manifold, the fueling valves, and the defueling valve are located on the front spar. The valves each incorporate a thermal relief valve and relieve into the tank. Capacity filling is controlled by two tank fill-level control float switches in each main tank and one in the center tank. Fill valves have manual levers.

When fueling power is ON, placing a tank switch at AUTO FILL will open the applicable tank shutoff valve for pressure fueling. When the tank becomes full the fuel fill control

float switches will automatically close the shutoff valve. The shutoff valve may be closed at any time by moving the switch from AUTO FILL to CLOSED position.

During ground operations the fuel control panel will be powered by the dc transfer bus or by the battery direct bus when no other electrical power source is available. All switches and quantity gages (except totalizer) will operate on either power source.

After takeoff the ground shift transfer relay removes electrical power from the fuel control panel.



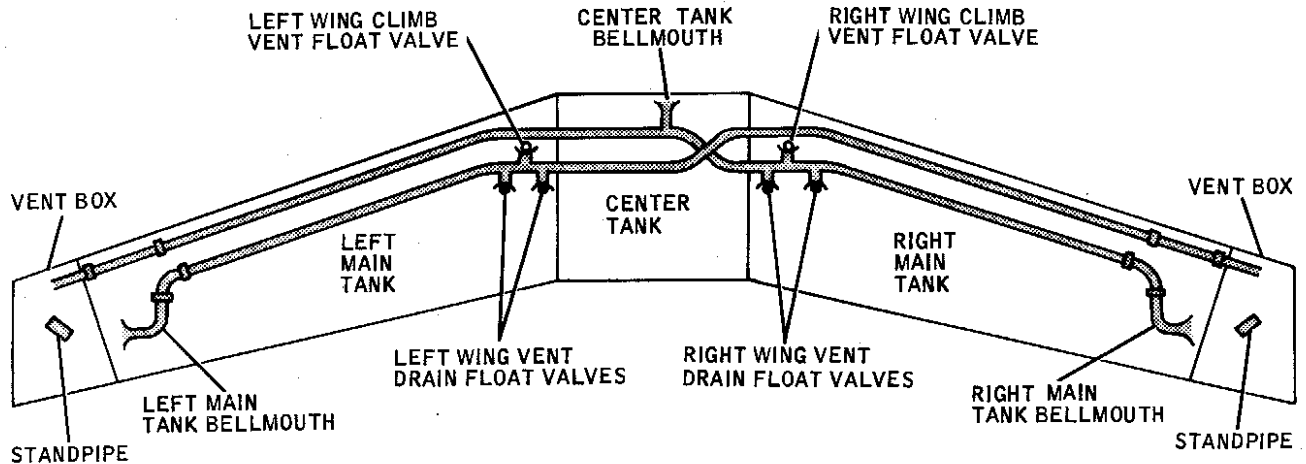
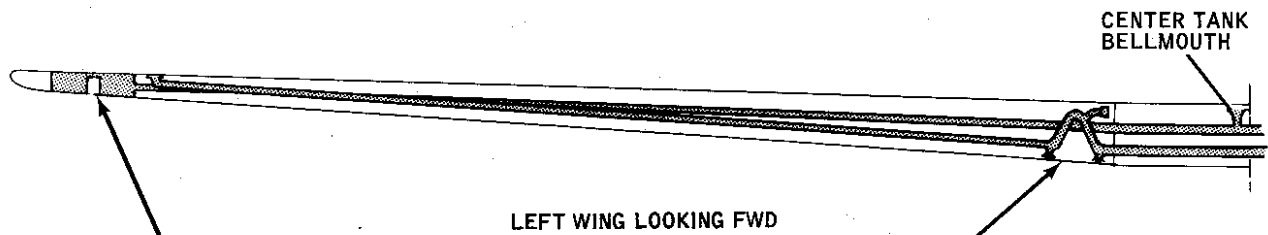
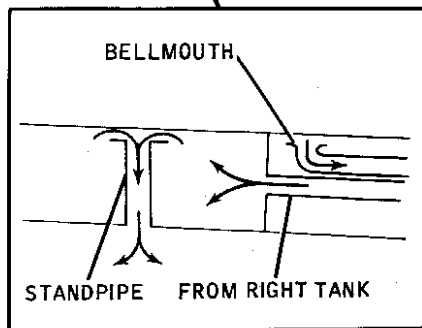
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FUEL -- VENT SYSTEM FUNCTIONAL SCHEMATIC

VENT SYSTEM

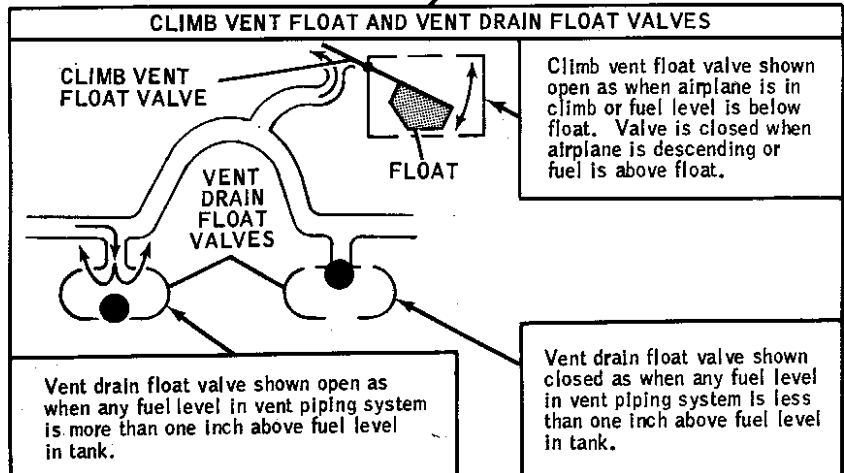
Each main tank is vented through interconnecting piping to a vent box in the opposite wing tip. The center tank opening is connected to the right main tank vent line. The overboard vent openings are located in ice-free areas and designed not to siphon

or spill fuel during any normal airplane operation. The vent system will vent the tanks during pressure fueling operations up to the maximum recommended fueling pressure (50 psig) and flow.



VENT SYSTEM CAPACITIES

Each wing vent box will accommodate approximately 40 gallons of fuel. Each tank-to-vent box piping system will contain an additional 20 gallons.



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RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

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Chapter 30

ENGINE SYSTEMS

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Chapter 30

ENGINE SYSTEMS

GENERAL

The airplane is equipped with two axial-flow, bypass, turbofan, Pratt & Whitney JT8D-9 engines. The JT8D-9 has a static takeoff thrust rating of 14,500 pounds. Each engine is equipped with a thrust reverser.

The engine nacelles are supported from horizontal pylons by vibration-isolating side mount systems. The nose cowls are canted inboard to minimize drag. The nacelles are isolated from the fuselage by a firewall within the pylon and by a secondary fireseal at the pylon fuselage interface. To provide additional protection, the secondary fireseal extends above and below the pylon on the fuselage surface. To achieve necessary nacelle compartmentation, a fireseal is installed aft of the rear engine mount which provides separation of the accessory compartment from the reverser section. The nacelle ventilation system is designed to provide adequate cooling of engine and accessories and to prevent accumulation of combustible mixtures.

The following airplane accessories are mounted on the drive pads of each engine:

40-kva generator mounted to a constant-speed drive (CSD) unit

Hydraulic pump

Tachometer generator (N_1)

Tachometer generator (N_2)

Fuel control and fuel pumps

Pneumatic starter.

ENGINE STARTING

Either engine may be started by using a pneumatic ground cart or by pneumatic supply from the auxiliary power unit. When one engine is operating, the opposite engine may be started by using the pneumatic crossfeed system.

ENGINE OIL SYSTEM (See functional schematic.)

ENGINE FUEL SYSTEM (See functional schematic.)

THRUST REVERSER (See functional schematic.)

The thrust reversers are for ground use only. Static reverse thrust developed is approximately 40 percent of the forward thrust for a given power setting. Reverser actuation time is approximately 2 seconds. The reversers are the hydraulically powered target type. Each reverser consists of two vertically oriented doors (deflectors) which, when stowed, form the aft nacelle fairing. When extended, the doors direct exhaust gases over and under the nacelle. The doors are operated by four-bar linkage driven by hydraulic actuators. The linkage system overcenters to provide positive locking in the stowed position. To prevent accidental extension, a separate mechanical latch bars the reversers from moving out of the stowed position until the thrust reverser lever is moved toward the reverse thrust position.

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DC-9
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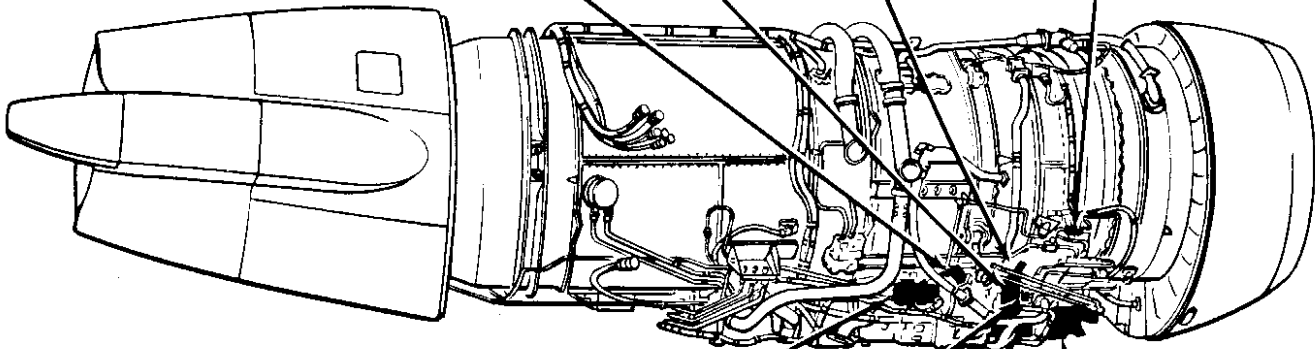
ENGINE -- MAJOR COMPONENT LOCATION (sheet 1)

TACHOMETER GENERATOR (N2)
 Self generating current in proportion to N2 compressor rpm for operation of the N2 PERCENT RPM indicator on the center instrument panel.

FUEL FILTER
 Filter contains internal bypass to open at approximately 9 psi when filter blockage occurs.

FUEL FILTER DIFFERENTIAL PRESSURE SWITCH
 Senses filter blockage due to ice or contamination. Completes circuit to turn on annunciator panel **FILTER PRESS DROP** light when differential pressure reaches approximately 5 psi.

ENGINE LOW FUEL PRESSURE SWITCH
 Senses low fuel pressure supply to 1st stage of engine driven fuel pump. When pressure drops to approximately 5 psi a circuit is completed to turn on the annunciator panel **INLET FUEL PRESS** low light and **MASTER CAUTION** light.



HYDRAULIC PUMP
 See hydraulic system.

FUEL TEMPERATURE BULB
 Senses fuel temperature at point between air fuel heat exchanger and fuel filter. Temperature information is transmitted to the **FUEL TEMP** indicator on the center instrument panel.

FUEL PUMP
 Two stage engine driven type. 1st stage impeller low pressure supply. 2nd stage gear high pressure supply. See engine fuel schematic.

FUEL CONTROL
 Schedules fuel flow as required by throttle position, compressor speed (N2), compressor inlet temperature T_{t2} and internal burner pressure (P_{s4}). See engine fuel schematic.

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ENGINE -- MAJOR COMPONENT LOCATION (sheet 2)

OIL DIFFERENTIAL PRESSURE SWITCH

Senses pressure at both sides of the filter to indicate filter differential pressure. When pressure differential reaches 35 psi the switch closes to turn on the annunciator panel OIL STRAINER CLOGGING light.

OIL LOW PRESSURE WARNING SWITCH

When engine oil pressure drops below 35 psi switch closes to turn on the annunciator panel OIL PRESSURE LOW light.

OIL PRESSURE TRANSMITTER

Provides oil pressure input to the OIL PRESS gage on center instrument panel.

OIL TEMPERATURE BULB

Senses temperature of engine oil after oil passes through fuel-oil cooler. Temperature information is transmitted to the OIL TEMP indicator on the center instrument panel.

FUEL OIL COOLER

See Engine Fuel Schematic.

FUEL FLOW TRANSMITTER

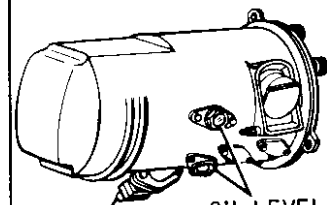
Measures fuel flow to the engine and transmits information to the FUEL FLOW indicator on the center instrument panel.

FUEL AIR HEATER

See Engine Fuel Schematic.

OIL TANK

Gravity filled tank with total capacity of 5.5 gallons (usable 4.0 gallons). A float type transmitter installed through the bottom of tank provides oil quantity information for the oil quantity gage on the center instrument panel. Windows on the tank show full and low levels.

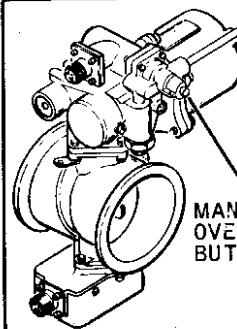


OIL QUANTITY TRANSMITTER

OIL LEVEL SIGHT GAGES

8TH STAGE BLEED MANIFOLD

Provides engine bleed air for engine anti-icing, starting opposite engine, air conditioning and cabin pressurization.



MANUAL OVERRIDE BUTTON

STARTER SHUTOFF VALVE

When open, the valve will regulate pneumatic pressure to maintain a maximum of 38 psi to the starter. The valve is electrically controlled by the cockpit ENGINE START switch and is pneumatically actuated. When the valve opens approximately 5 degrees, a circuit is completed to turn on the annunciator panel START VALVE OPEN light.

HIGH PRESSURE MANIFOLD

Provides high pressure engine bleed air for aircraft air conditioning, pressurization and de-icing systems.

THRUST REVERSER (EXTENDED)

See Thrust Reverser Schematic.

IGNITION EXITER

Provides high energy, high voltage, power to the spark ignitors.

STARTER

Pneumatic powered turbine type. Powers N₂ compressor for accelerating engine to starting speed. Aids engine acceleration after light off until self sustaining speed is reached.

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OVERBOARD BREATHER

Provides internal engine with an atmospheric vent.

OIL FILTER

See Engine Oil Schematic.

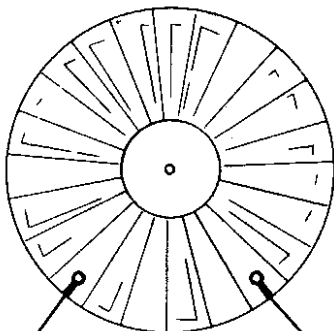
CONSTANT SPEED DRIVE AND AC GEN

Refer to Electrical system.

ENGINE -- FUNCTIONAL SCHEMATIC

ANTISURGE VALVE SENSING CONTROL PROBE (P_{t2})

Provides inlet pressure information to anti-surge valve regulator.



ANTISURGE VALVE SENSING CONTROL PROBE (P_{t2})

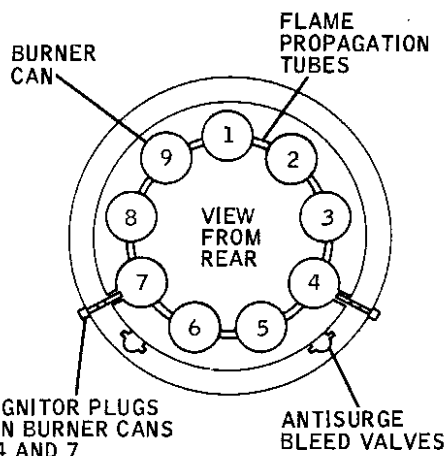
FUEL CONTROL TEMPERATURE SENSING PROBE (T_{t2})

FUEL CONTROL TEMPERATURE SENSING PROBE (T_{t2})

Provides inlet temperature input required for fuel control unit operation.

IGNITOR PLUGS

Ignitor plugs in the number 4 and 7 burner cans provide initial ignition of the fuel air mixture. Once combustion has occurred the flame propagation tubes carry combustion to all burner cans. Combustion will continue until the fuel air mixture is interrupted or a malfunction occurs. Ignition is controlled from the cockpit by the ENGINE IGNITION switch and the pedestal fuel control lever position.



IGNITOR PLUGS IN BURNER CANS 4 AND 7

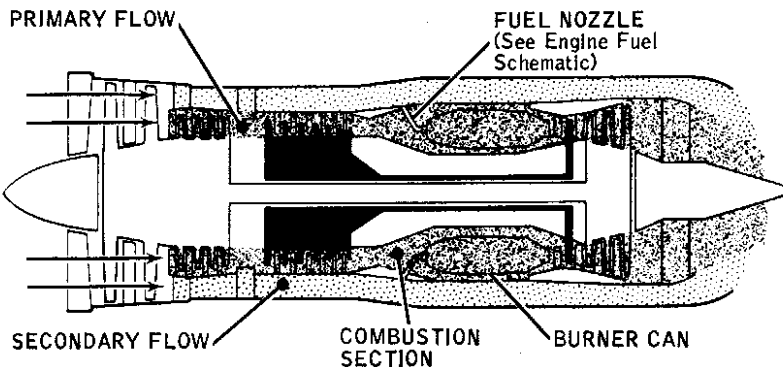
ANTISURGE BLEED VALVES

ANTISURGE VALVE

Controls compressor instability by exhausting rear compressor air into fan duct.

PRIMARY FLOW

As combustion of fuel and air at normal pressure will not produce sufficient energy for efficient operation, air entering the engine is progressively compressed by the front compressor rotors (N_1) and the rear compressor rotors (N_2). At maximum compression the air passes a diffuser which slows velocity and straightens airflow prior to reaching the combustion section. Fuel nozzles at the front of the burner cans spray fuel for rapid mixing with air prior to combustion. Combustion within the burner section adds heat energy to the gases accelerating their mass to provide thrust and to drive the turbines.



SECONDARY FLOW

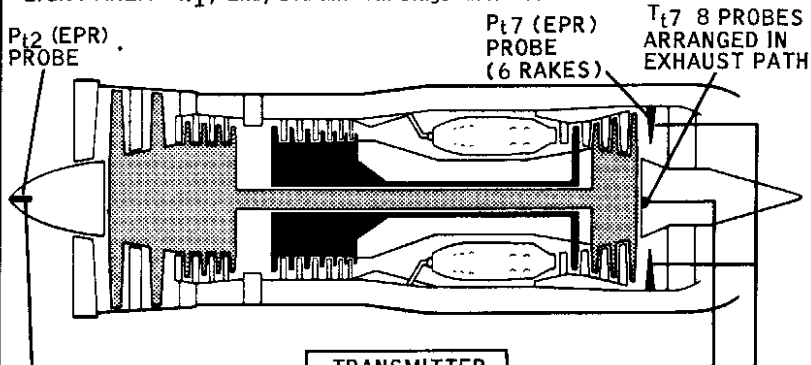
Air in the secondary flow is compressed by the fan blades and is ducted around the engine. This results in movement of greater air mass to increase thrust, aids in cooling the engine and in suppressing exhaust noise.

TURBINE SECTION

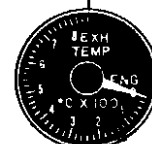
The first stage turbine powers the rear compressor rotor (N_2). The second, third and fourth stage turbines power the fan and the front compressor rotor (N_1).

DARK AREA - N_2 and 1st stage turbine.

LIGHT AREA - N_1 , 2nd, 3rd and 4th stage turbines.



SIMPLIFIED ENGINE PRESSURE RATIO ARRANGEMENT



ENGINE INLET PRESSURE PROBE (P_{t2}) AND ENGINE EXHAUST PRESSURE PROBE (P_{t7})

These probes measure pressure at the engine inlet and at the engine exhaust. The difference in pressure is expressed as engine pressure ratio and is a measure of thrust. Pressure ratio information is transmitted to the PRESS RATIO indicators on the center instrument panel.

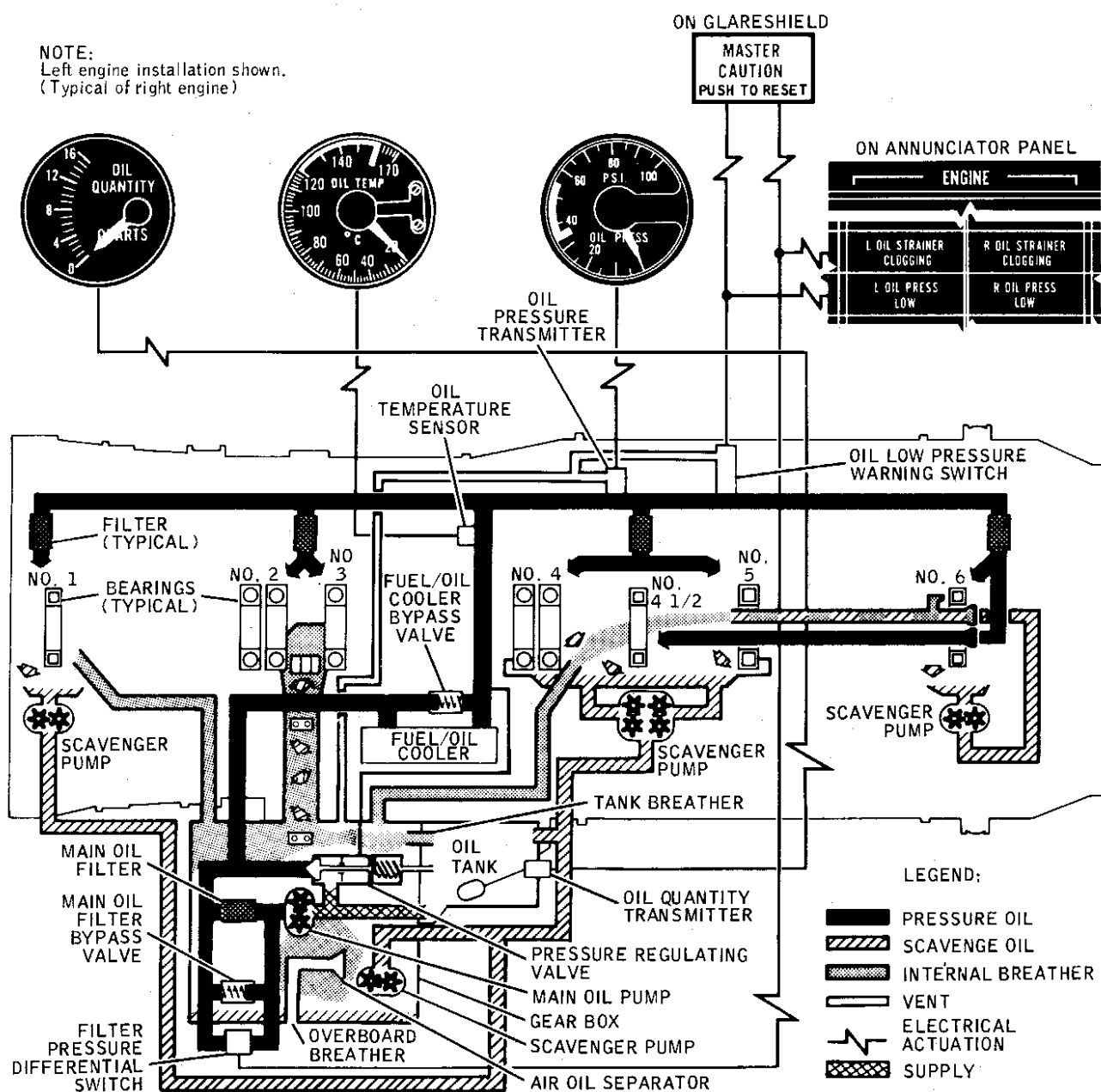
TOTAL TEMPERATURE PROBE #1 (T_{t7})

Energy, created by heat at the probes, operates the EXH TEMP indicator on the center instrument panel. The indicator shows temperature of the jet exhaust. BB1-92B

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ENGINE -- ENGINE OIL SYSTEM FUNCTIONAL SCHEMATIC

NOTE:
 Left engine installation shown.
 (Typical of right engine)



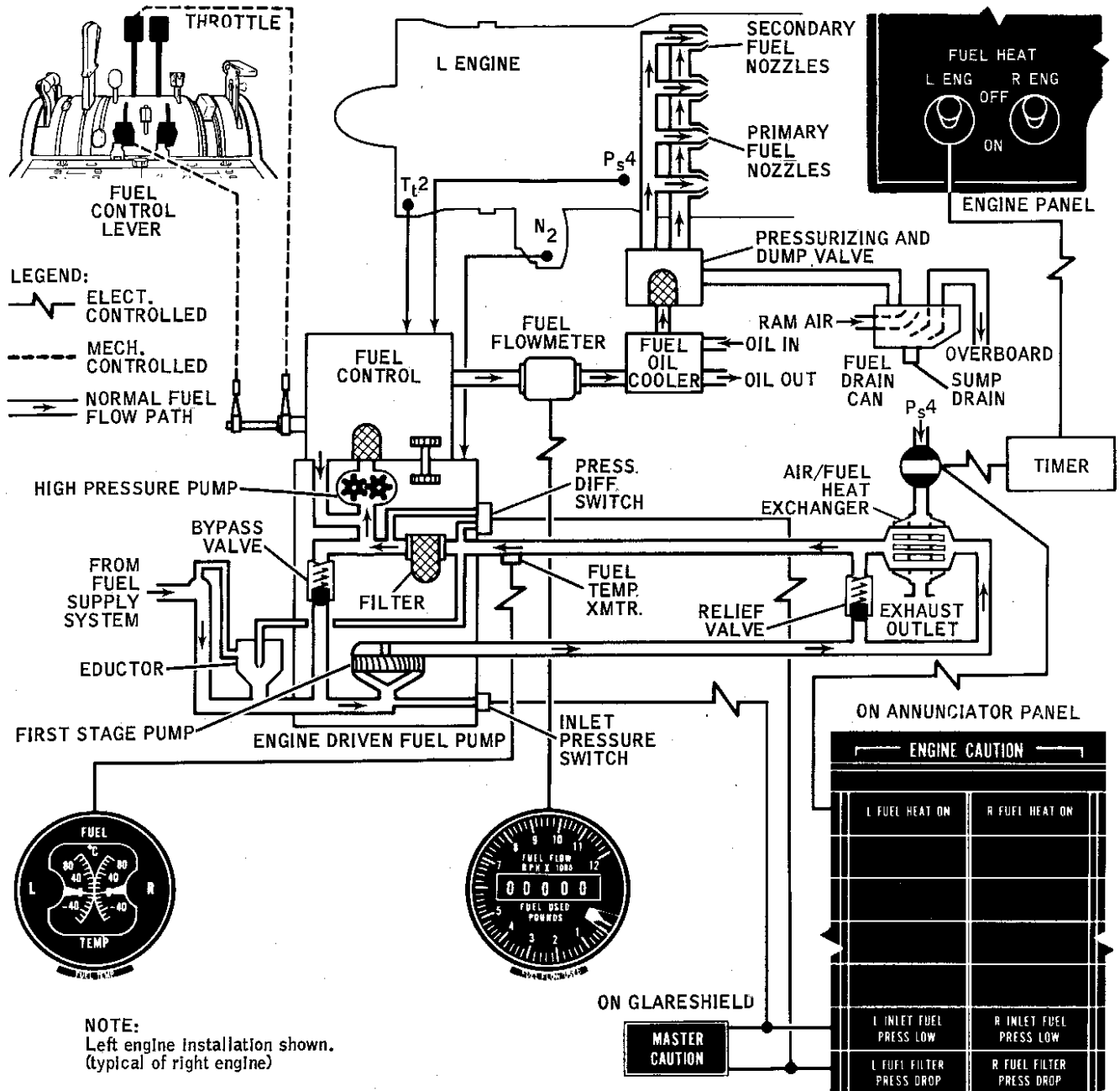
DESCRIPTION

Oil is pumped from the tank by the main oil pump and delivered to the system under pressure. From the main pump the oil passes through the main oil filter. The differential pressure switch senses pressure on both sides of the filter and turns on the annunciator panel OIL STRAINER CLOGGING and MASTER CAUTION lights when the differential pressure is approximately 35 psi. The main oil filter bypass valve will open to bypass oil around a clogged filter. The pressure regulating valve opens to relieve pressure in excess of approximately 45 psi. Oil is passed through the fuel/oil cooler heat exchanger to cool engine oil. Should the fuel/oil cooler passages become blocked the fuel/oil cooler bypass valve will open to bypass oil around

the cooler. The oil temperature sensor provides input for the OIL TEMP Indicator on the center instrument panel. System pressure is transmitted to the OIL PRESS gage on the center instrument panel. The oil pressure low pressure warning switch senses pressure of the oil being delivered to the bearings. If the pressure at this point drops below approximately 35 psi a circuit is completed to turn on the annunciator panel OIL PRESSURE LOW and MASTER CAUTION lights. Oil passes through additional filters before being sprayed on the bearings. Oil from the bearings drains into the collection points and is pumped back to the tank by a series of scavenger pumps.

BB1-735B

ENGINE -- ENGINE FUEL SYSTEM FUNCTIONAL SCHEMATIC



DESCRIPTION

The inlet pressure switch will turn on the INLET FUEL PRESS and MASTER CAUTION lights when the supply pressure drops to approximately 5 psi. Fuel passes through the eductor which eliminates adverse effect of possible fuel vapor. The supply pump delivers fuel to the high pressure pump. Fuel can bypass a damaged supply pump. Should passage through the air/fuel heat exchanger become blocked the relief valve will open to bypass fuel. The shutoff valve for engine bleed air supply to the air/fuel heat exchanger is controlled by the FUEL HEAT switch through a timer. The timer automatically closes the valve after one minute. Valve opening turns on FUEL HEAT ON lights. Fuel heat is used to prevent or remove ice at the filter. The fuel temperature transmitter provides input to the cockpit FUEL TEMP indicator. The differential pressure switch senses clog-

ing (ice) at the filter and will turn on the FUEL FILTER PRESS DROP and MASTER CAUTION lights when filter passage is restricted. The fuel control responds to engine conditions sensed at T_{t2} , N_2 and P_{s4} and will supply fuel for optimum engine operation at a given throttle setting. Fuel flow is blocked at the fuel control until the fuel shutoff lever is moved out of OFF position. The fuel flowmeter measures fuel delivered to the engine for display on cockpit FUEL FLOW indicator. The fuel oil cooler cools engine oil. The primary nozzles spray fuel into burner cans during all engine operation. Secondary nozzles open at higher power settings. The fuel drain can holds fuel drained from engine after shutdown. In flight ram air empties drain can overboard.

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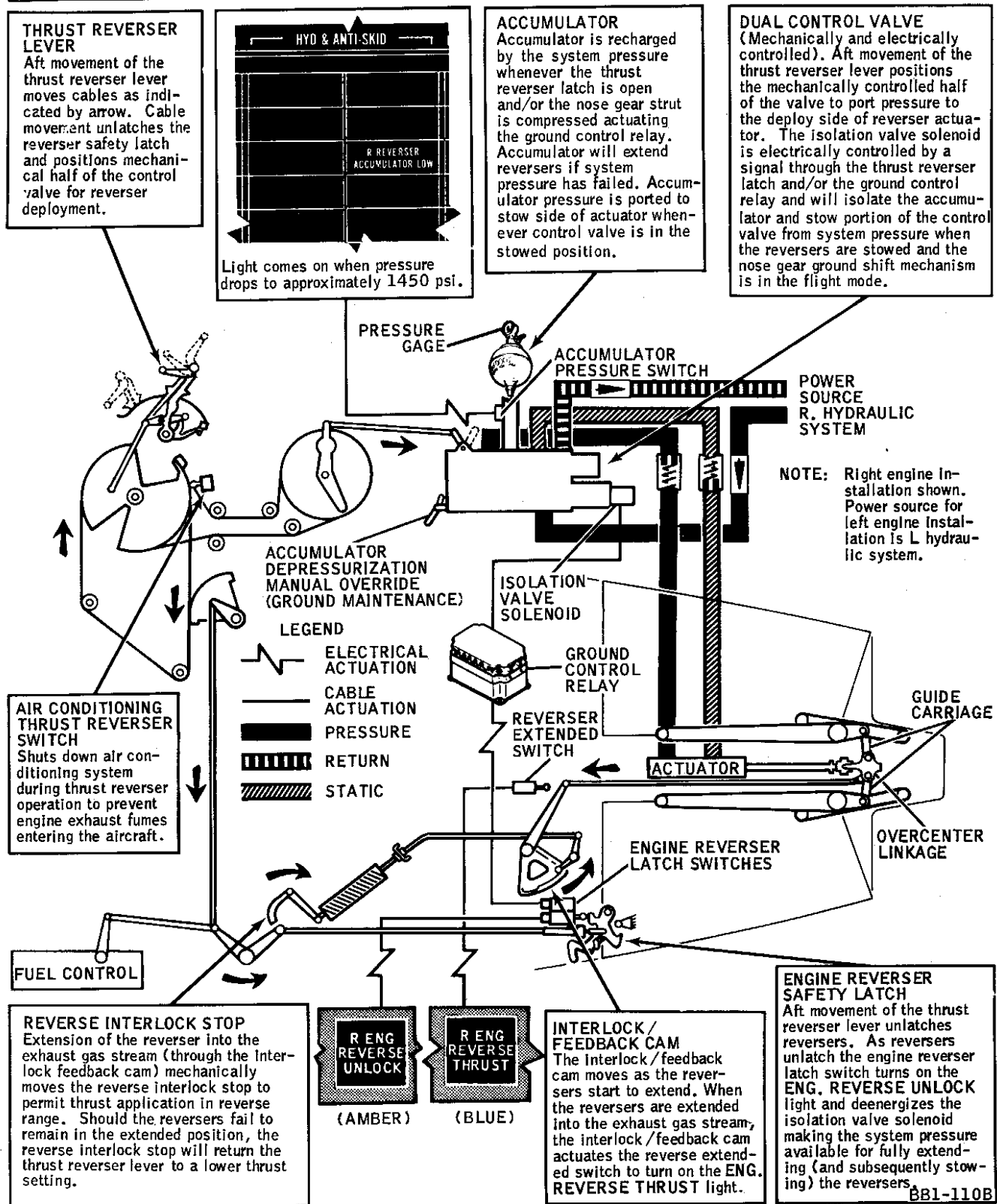
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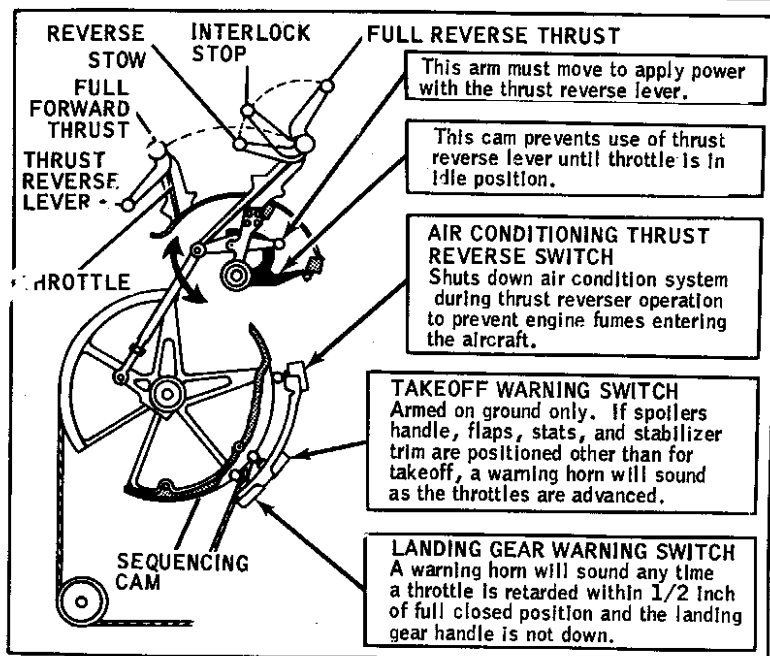
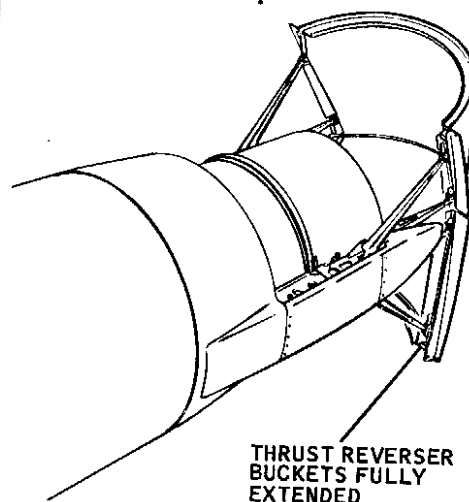
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ENGINE -- THRUST REVERSER & THROTTLE QUADRANT FUNCTIONAL SCHEMATIC (sheet 1)



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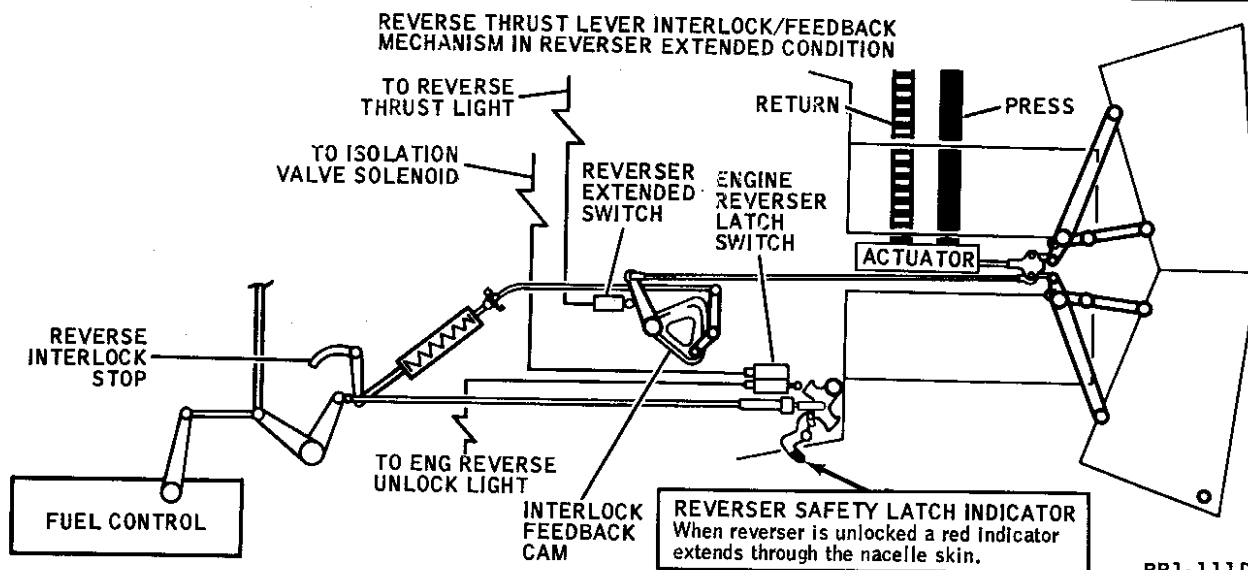
ENGINE -- THRUST REVERSER & THROTTLE QUADRANT FUNCTIONAL SCHEMATIC (sheet 2)



DESCRIPTION

The throttle must be moved to idle position before the thrust reverse lever can be moved aft. Initial aft movement of the thrust reverse lever actuates the cable system to release the engine reverser safety latch and positions the mechanically controlled half of the control valve for reverser extension. (Further aft movement of the thrust reverser lever is prevented by the reverse interlock stop until the reversers are extended into the exhaust gas stream. When the engine reverser safety latch releases, the engine reverser latch switch turns on the ENG REVERSE UNLOCK light and deenergizes the isolation valve solenoid in

the control valve. As pressure in the actuator extends the reversers, linkage moves the interlock/feedback cam and as the reversers extend into the exhaust gas streams the interlock feedback cam, releases the reverse interlock to a position that will allow thrust reverser lever movement to the full reverse thrust position and turns on the ENG REVERSE THRUST light. If for any reason, the reversers come out of the reverse thrust position, the interlock/feedback cam will actuate the reverse interlock stop and return the reverse lever to a lower thrust setting and turn off the ENG REVERSE THRUST light.



BB1-111D

ENGINE -- THRUST REVERSER CONTROL VALVE

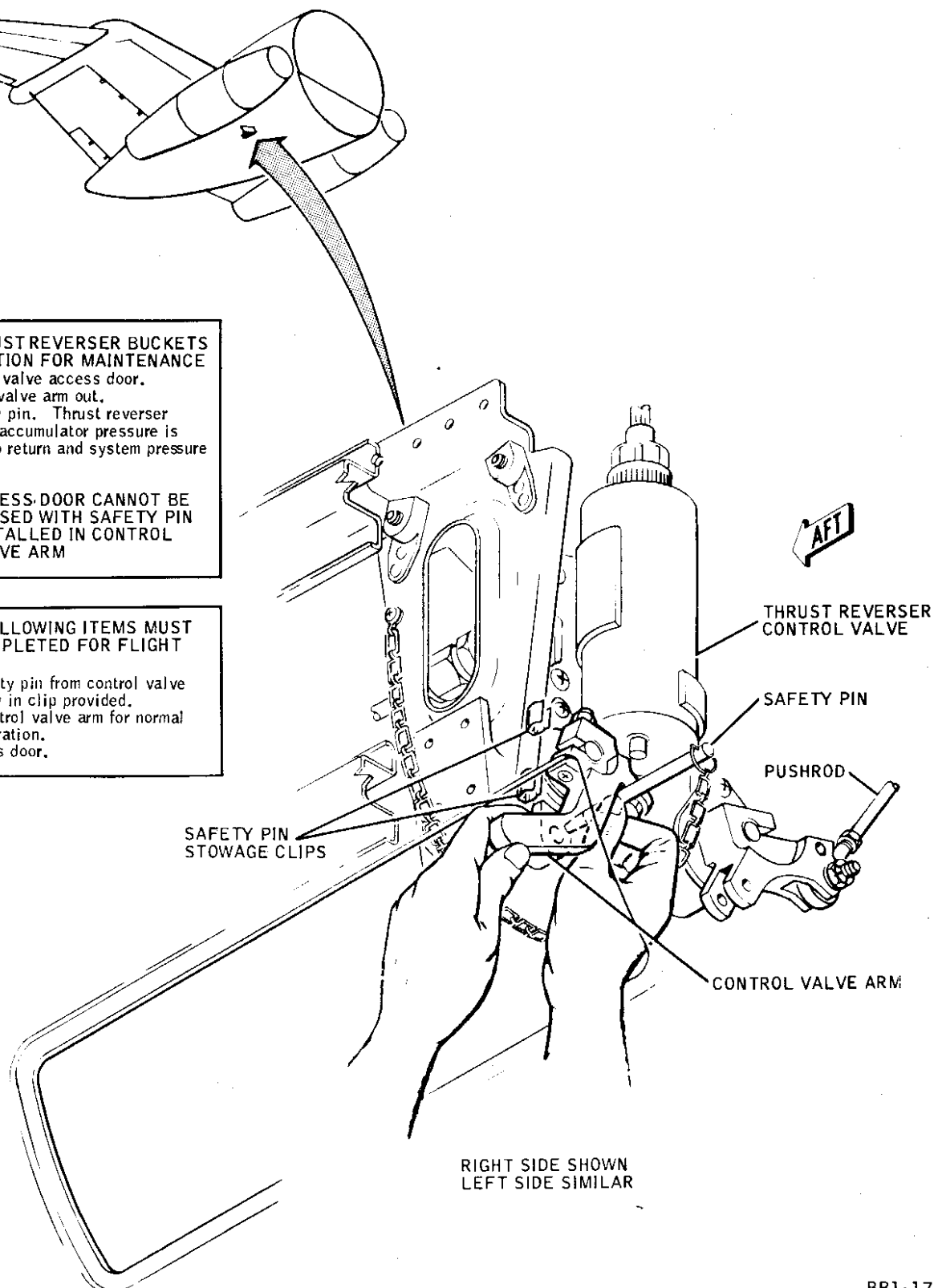
TO PLACE THRUST REVERSER BUCKETS
IN SAFE CONDITION FOR MAINTENANCE

- A. Open control valve access door.
- B. Pull control valve arm out.
- C. Install safety pin. Thrust reverser actuator and accumulator pressure is now ported to return and system pressure is blocked.

NOTE: ACCESS DOOR CANNOT BE
CLOSED WITH SAFETY PIN
INSTALLED IN CONTROL
VALVE ARM

NOTE: THE FOLLOWING ITEMS MUST
BE COMPLETED FOR FLIGHT

1. Remove safety pin from control valve arm and stow in clip provided.
2. Position control valve arm for normal reverser operation.
3. Close access door.



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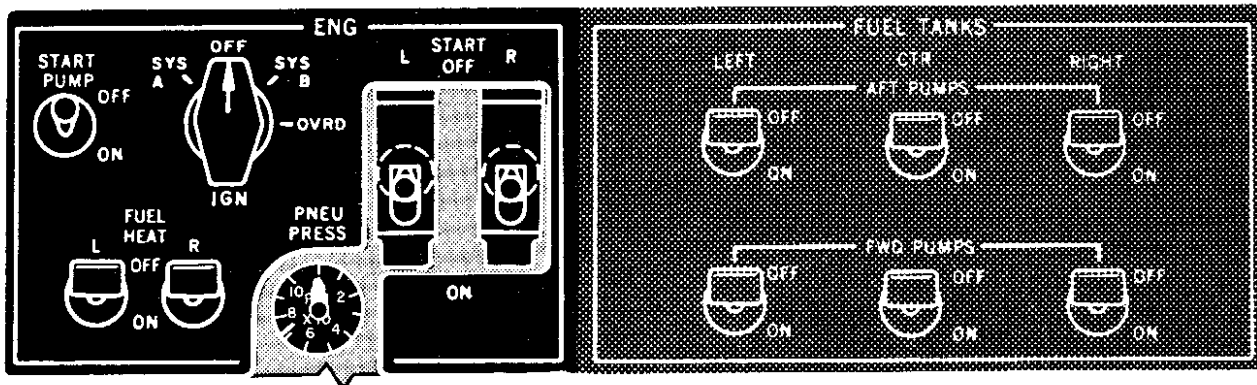
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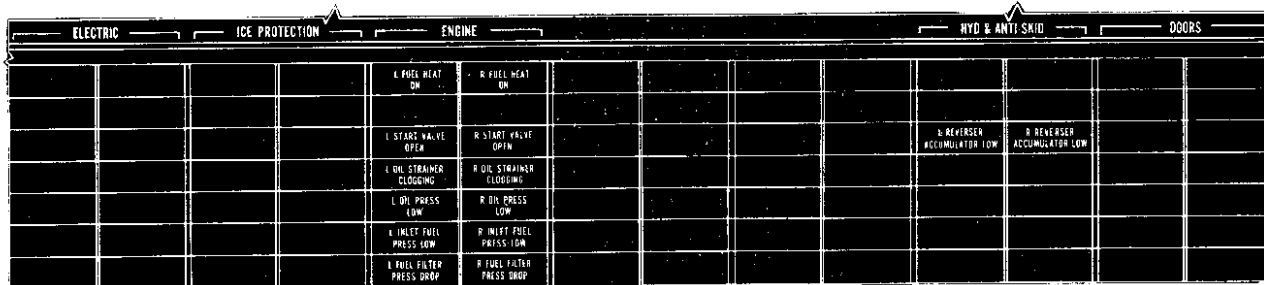
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ENGINE -- COCKPIT CONTROLS & INDICATORS (sheet 2)



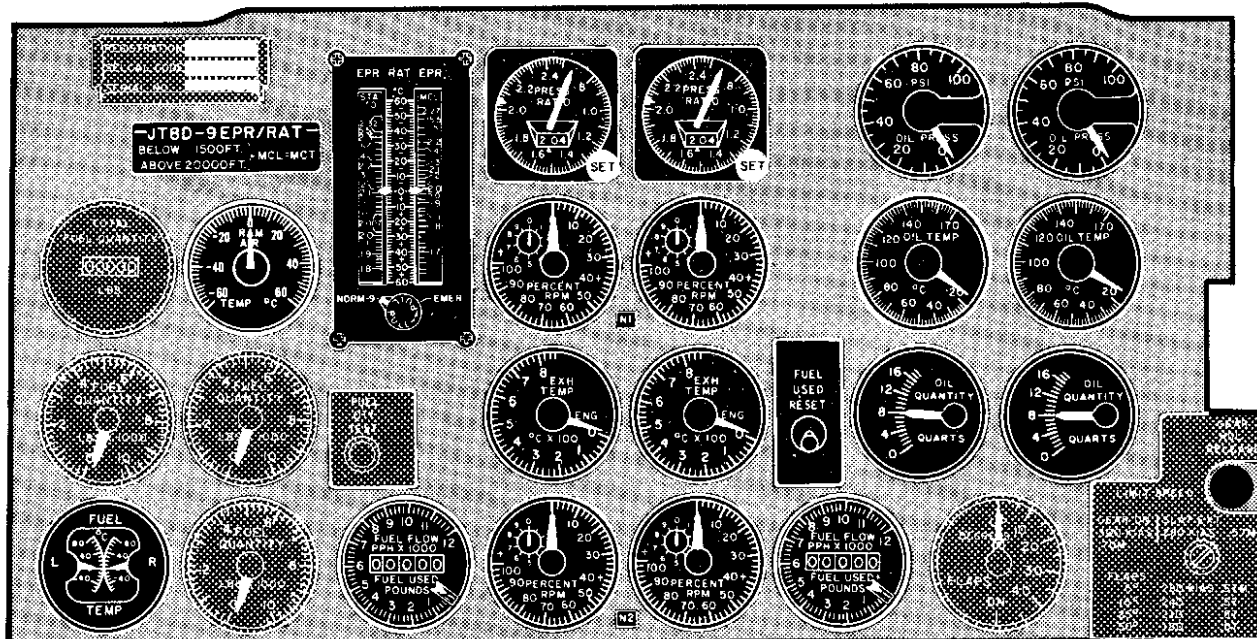
ENGINE PANEL

Contains All Switches Directly Controlling Engine Starting



ANNUNCIATOR PANEL

Contains Engine System Caution Lights



CENTER INSTRUMENT PANEL

BB1-4235

ENGINE -- COCKPIT CONTROLS & INDICATORS (sheet 2)

ENGINE REVERSER LIGHTS
 (See thrust reverser functional schematic)

R ENG
REVERSE
UNLOCK

R ENG
REVERSE
THRUST

RIGHT ENGINE LIGHTS SHOWN
 (TYPICAL)

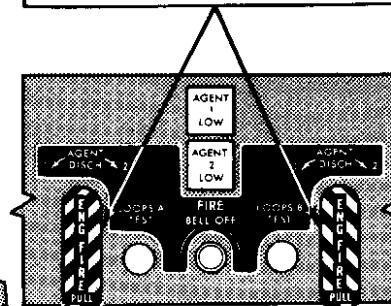
MASTER CAUTION LIGHTS

Provide indication to both the captain and first officer that malfunction has been indicated on the annunciator panel.

MASTER
CAUTION
PUSH TO RESET

FIRE SHUTOFF HANDLES

Pulling applicable engine handle will silence the fire bell, trip the generator control relay, shut off engine fuel and hydraulic pump supply, and close the pneumatic crossfeed valve for the respective engine.



PNEUMATIC CROSSFEED VALVE LEVERS
 (See pneumatic functional schematic)

FUEL CROSSFEED LEVER

Lever must be pulled out from the pedestal to unlock lever prior to actuation of lever to the ON or OFF position. The fuel crossfeed lever is cable connected to the fuel system crossfeed valve. When the lever is placed at the ON position, the valve opens to route fuel from either main tank to both engines or the APU. Use of the fuel boost system will determine which tanks fuel supply will be used.

THROTTLES

Each throttle is cable connected to its respective engine fuel control unit to regulate engine thrust. For thrust reverser operation see thrust reverser schematic.

FUEL CONTROL LEVERS

The fuel control pushrod must be depressed to unlock lever prior to actuation of lever to the ON or OFF position. Each fuel control lever is cable connected to a shutoff valve in the engine fuel control unit. ON position opens the valve to supply fuel to the applicable engine. Movement of each lever also controls engine ignition. As the lever is moved forward from the OFF position it completes the ignition circuit, first, then turns on the fuel. As the lever is moved aft from the ON position it shuts off fuel first and then shuts off ignition. (See engine fuel system functional schematic). BB1-1155A

**AUTOTHROTTLE
ENGAGE LEVER**

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ENGINE -- ENGINE INDICATORS

NOTE: For engine instrument limitation markings, see Section 2 Chapter 30

RAT Vs EPR INDICATOR

See ENGINE -- RAM AIR TEMPERATURE Vs EPR INDICATOR

L & R PRESS RATIO INDICATORS

Pressure measured at engine inlet (P_{t2}) and at the engine exhaust (P_{t7}) is transmitted to the instrument as engine pressure ratio (EPR). The difference in pressure at the inlet and at the exhaust is the measurement of thrust developed by the engine.

L & R OIL PRESSURE INDICATORS

Indicate oil pressure in distribution lines on engine side of main oil filter.

L & R OIL TEMP INDICATORS

Indicate temperature of oil that has passed through the fuel/oil cooler.

L & R N_1 TACHOMETERS

Indicate rpm of N_1 compressor. Small dial is graduated in 1% increments marked from 0-9. Large dial is graduated in 2% increments marked every 10% from 0-100. Tachometer systems are self generating.

JT8D-9 EPR/RAT INSTRUCTION PLATE

See ENGINE -- RAM AIR TEMPERATURE Vs EPR INDICATOR for complete information.

STANDBY RAM AIR TEMPERATURE INDICATOR

Indicates ram air temperature in degrees centigrade measured at the forward fuselage. The dial is graduated in 2°C increments, from -60°C to +60°C.

L & R EXH TEMP INDICATORS

Indicate in degrees centigrade, the temperature of the jet exhaust (T_{t7}). The dial is graduated in 20°C increments from 0°C to 860°C.

FUEL TEMP INDICATOR

Indicates temperature of fuel downstream of the air/fuel heat exchanger.

L & R FUEL FLOW INDICATORS

Measure rate fuel is being delivered to the engine at a point past the engine fuel control. The total fuel used will be displayed on the digital counter.

L & R N_2 TACHOMETERS

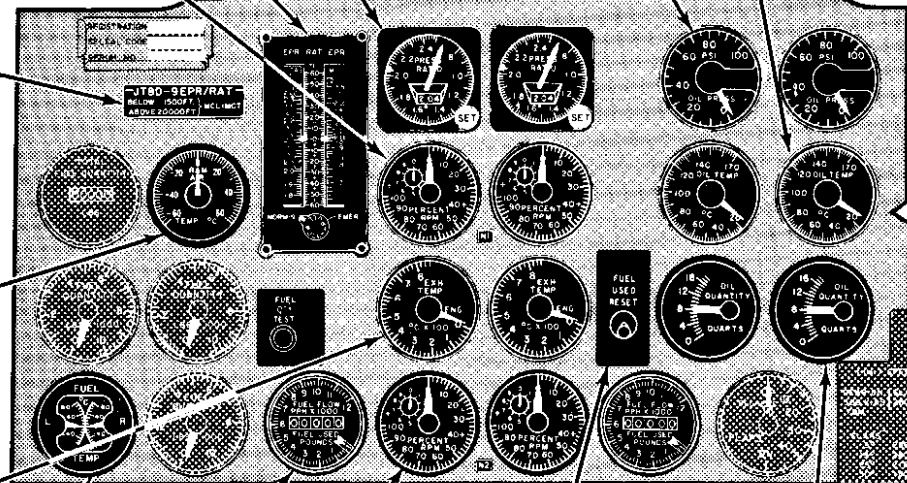
Indicate rpm of N_2 compressor. Small dial is graduated in 1% increments marked from 0-9. Large dial is graduated in 2% increments marked every 10% from 0-100. Tachometer systems are self generating.

FUEL USED RESET

When actuated, resets FUEL USED digital counter (on each FUEL FLOW indicator) to 00000.

L & R OIL QUANTITY INDICATORS

Indicate usable oil in tank.

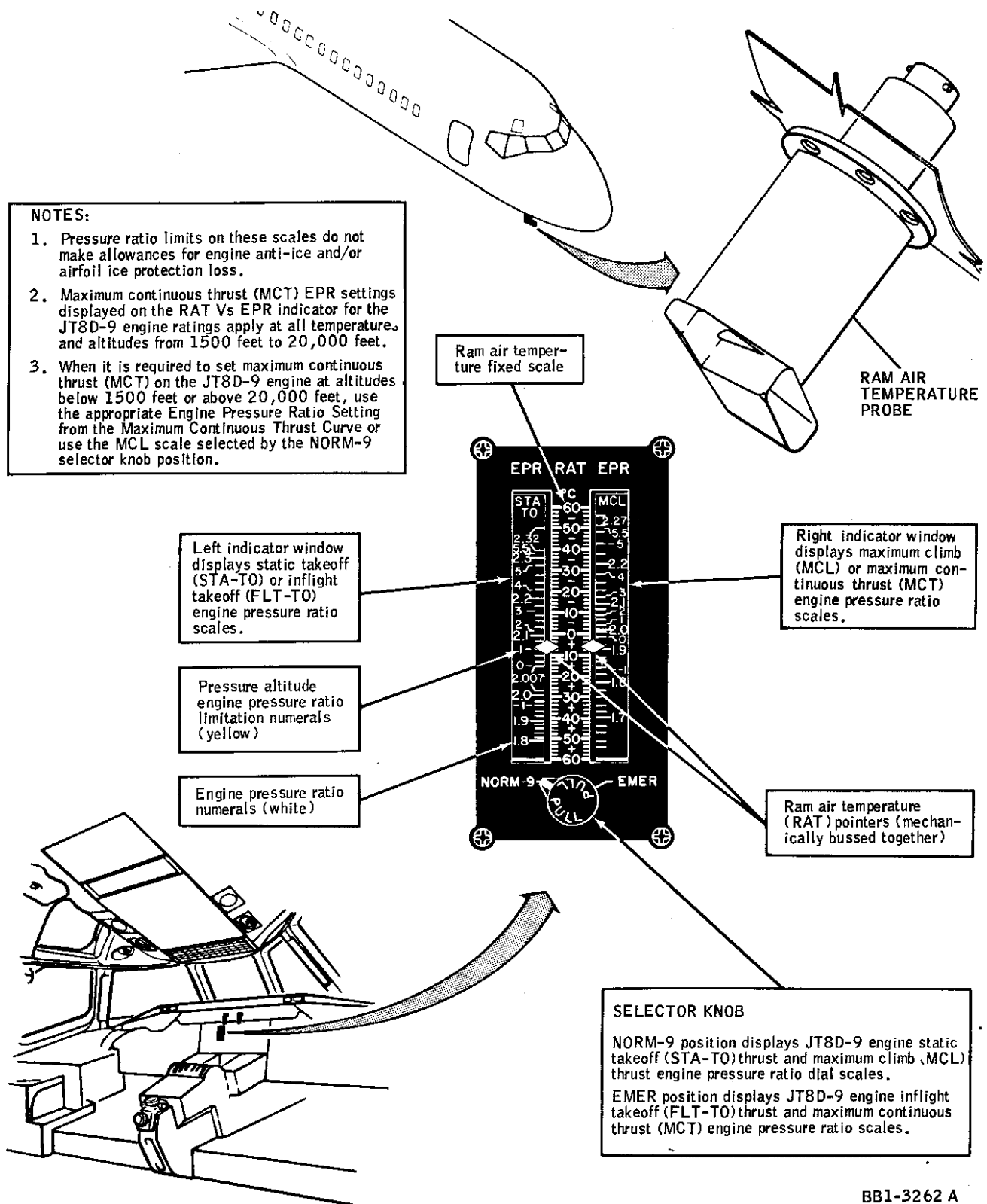


BB1-4236

ENGINE -- RAM AIR TEMPERATURE Vs EPR INDICATOR

NOTES:

1. Pressure ratio limits on these scales do not make allowances for engine anti-ice and/or airfoil ice protection loss.
2. Maximum continuous thrust (MCT) EPR settings displayed on the RAT Vs EPR indicator for the JT8D-9 engine ratings apply at all temperature and altitudes from 1500 feet to 20,000 feet.
3. When it is required to set maximum continuous thrust (MCT) on the JT8D-9 engine at altitudes below 1500 feet or above 20,000 feet, use the appropriate Engine Pressure Ratio Setting from the Maximum Continuous Thrust Curve or use the MCL scale selected by the NORM-9 selector knob position.



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ENGINE -- ENGINE (starting) PANEL

START PUMP SWITCH

Controls a battery powered fuel boost pump. Is used for engine starting when no external or APU electrical power is available. Refer to fuel system.

IGNITION SELECTOR SWITCH

Four position rotary switch:

OFF - System deenergized.

SYS A - Provides 20 joule ac Ignition to exciter A when fuel control lever is at ON.

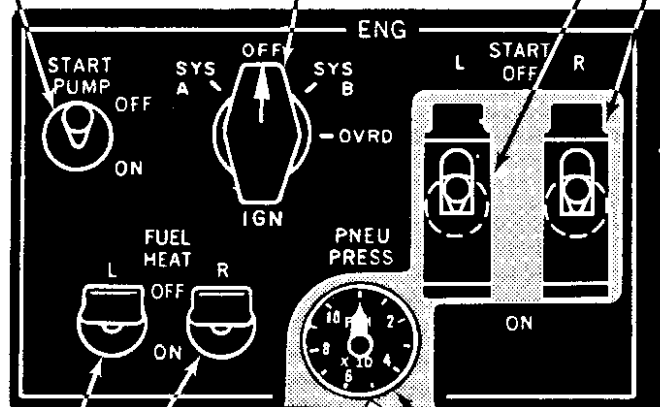
SYS B - Provides 20 joule ac Ignition to exciter B when fuel control lever is at ON.

OVRD - Provides 20 joule ac Ignition to exciters A & B, bypassing the fuel control lever.

Normally powered from the left and right ac buses. Automatically powered by the emergency inverter in event of ac bus or generator failure.

ENG START SWITCHES (Spring loaded to OFF position)

The ON position completes circuit to energize the solenoid controlled, pneumatically actuated, starter valve. When the starter valve butterfly opens 5 degrees a circuit is completed to turn on the annunciator panel START VALVE OPEN light. The valve ports pneumatic pressure to the engine starter turbine.



FUEL HEAT L & R ENG SWITCHES

The ON position of the FUEL HEAT switch is used to prevent or remove ice at the engine fuel filter. Placing the switch momentarily at ON energizes a timer for one minute. The timer electrically opens a pneumatic shutoff valve supplying air to the air/fuel heat exchanger. When the valve opens, a circuit is completed to turn on the annunciator panel FUEL HEAT ON light. After one minute the timer closes the valve and the light goes off.

PNEU PRESS INDICATOR

Indicates, in psi, the pneumatic pressure available for engine starting. The pressure should show a drop as the engine starter valve opens.

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ENGINE -- CAUTION LIGHTS

L & R FUEL HEAT ON Lights (blue)
 Lights come on when the shutoff valve in the engine bleed air supply line to the air/fuel heat exchanger opens.

L & R START VALVE OPEN Lights (amber)
 Lights come on when the engine starter valve butterfly opens 5 degrees or more.

L & R OIL STRAINER CLOGGING Lights (amber)
 Lights come on when the differential pressure across the main engine oil system filter is approximately 35 psi.

L & R OIL PRESS LOW Lights (amber)
 Lights come on when the pressure in the engine oil system is approximately 35 psi or less.

L & R INLET FUEL PRESS LOW Lights (amber)
 Lights come on when fuel supply pressure at the engine is approximately 5 psi or less.

L & R FUEL FILTER PRESS DROP Lights (amber)
 Lights come on when the differential pressure across the main engine fuel system filter is approximately 5 psi.

ENGINE	
L FUEL HEAT ON	R FUEL HEAT ON
L ENG VIB HIGH	R ENG VIB HIGH
L START VALVE OPEN	R START VALVE OPEN
L OIL STRAINER CLOGGING	R OIL STRAINER CLOGGING
L OIL PRESS LOW	R OIL PRESS LOW
L INLET FUEL PRESS LOW	R INLET FUEL PRESS LOW
L FUEL FILTER PRESS DROP	R FUEL FILTER PRESS DROP

ON ANNUNCIATOR PANEL

HYD & ANTI-SKID	
L REVERSER ACCUMULATOR LOW	R REVERSER ACCUMULATOR LOW

ON ANNUNCIATOR PANEL

L & R REVERSER ACCUMULATOR LOW Lights (amber)
 Lights come on when the hydraulic pressure at the reverser accumulator is below approximately 1450 psi.



ON GLARESHIELD

MASTER CAUTION Light
 Light comes on with any of the following lights:
 L or R OIL STRAINER CLOGGING
 L or R OIL PRESS LOW
 L or R INLET FUEL PRESS LOW
 L or R FUEL FILTER PRESS DROP

BB1-104B

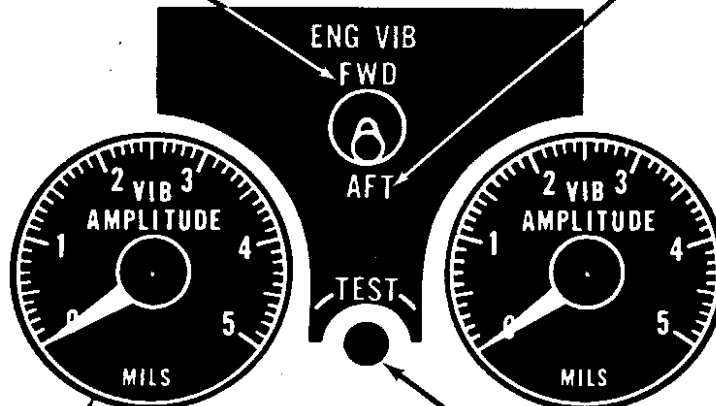
ENGINE -- VIBRATION INDICATORS

ENG VIB SWITCH FWD POSITION

Selects output of vibration pickups located in the engine compressor area for display on the vibration indicator.

ENG VIB SWITCH AFT POSITION

Selects output of vibration pickups located in the engine turbine area for display on the vibration indicator.



VIBRATION INDICATOR (Typical for L & R Engine)

Indicates in MILS the amplitude of engine vibration when selector switch is at FWD or AFT. Will display a preset amplitude reading when TEST switch is pushed-to-test.

TEST SWITCH (Push-to-test)

Sends preset amplitude signal to both indicators when pushed-to-test. Both indicators should read approximately the same positive amplitude during test.

DOUGLAS AIRCRAFT CO.
DC-9
FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG
(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 21, SECTION 3, CHAPTER 32, DATED SEP 1/70

SUMMARY: ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
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3-32-Cont	66	1	Sep 1/69				
*3-32-1-0	9	1	Sep 1/70				
3-32-1-0	9	2	Dec 1/67				
3-32-1-0	9	3	Dec 1/67				
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Chapter 32

AUXILIARY POWER UNIT (APU)

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*MAJOR COMPONENT LOCATION	32-1-0	2	9	A11
*COCKPIT CONTROLS AND INDICATORS (Sheet 1)	32-1-0	4	9	A11
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*Illustration

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Chapter 32

AUXILIARY POWER UNIT (APU)

GENERAL

The APU is a gas turbine engine installed to supply pneumatic requirements for cabin air conditioning and engine starting as well as electrical power for normal airplane systems operation while the airplane is on the ground. The unit is operable in flight to supply an alternate source of electrical power.

The APU is installed in a fixed, fire-proof, sound-attenuated enclosure mounted transversely on the lower centerline of the fuselage, aft of the rear pressure bulkhead. The enclosure bottom is formed by two external access doors and a removable compressor air inlet assembly. The APU support structure consists of three vibration-isolating mounts that attach the unit to the enclosure, which, in turn, is attached to primary airplane structure.

The APU lubrication system consists of a 1-gallon APU-mounted fireproof oil tank and sight gage, an APU-mounted oil cooler, and a cluster containing the pressure and scavenge oil pumps and filter.

Cooling air for the APU compartment and the APU-mounted generator and oil cooler is obtained from the aft fuselage compartment. Cooling air is ducted to an APU-driven cooling fan. A portion of the fan discharge air is ducted through the oil cooler and discharged into the APU compartment. Another portion of the fan discharge air is ducted to the generator. The

remaining air is discharged directly into the APU compartment. Compartment ventilation air is ducted overboard through a hooded exit.

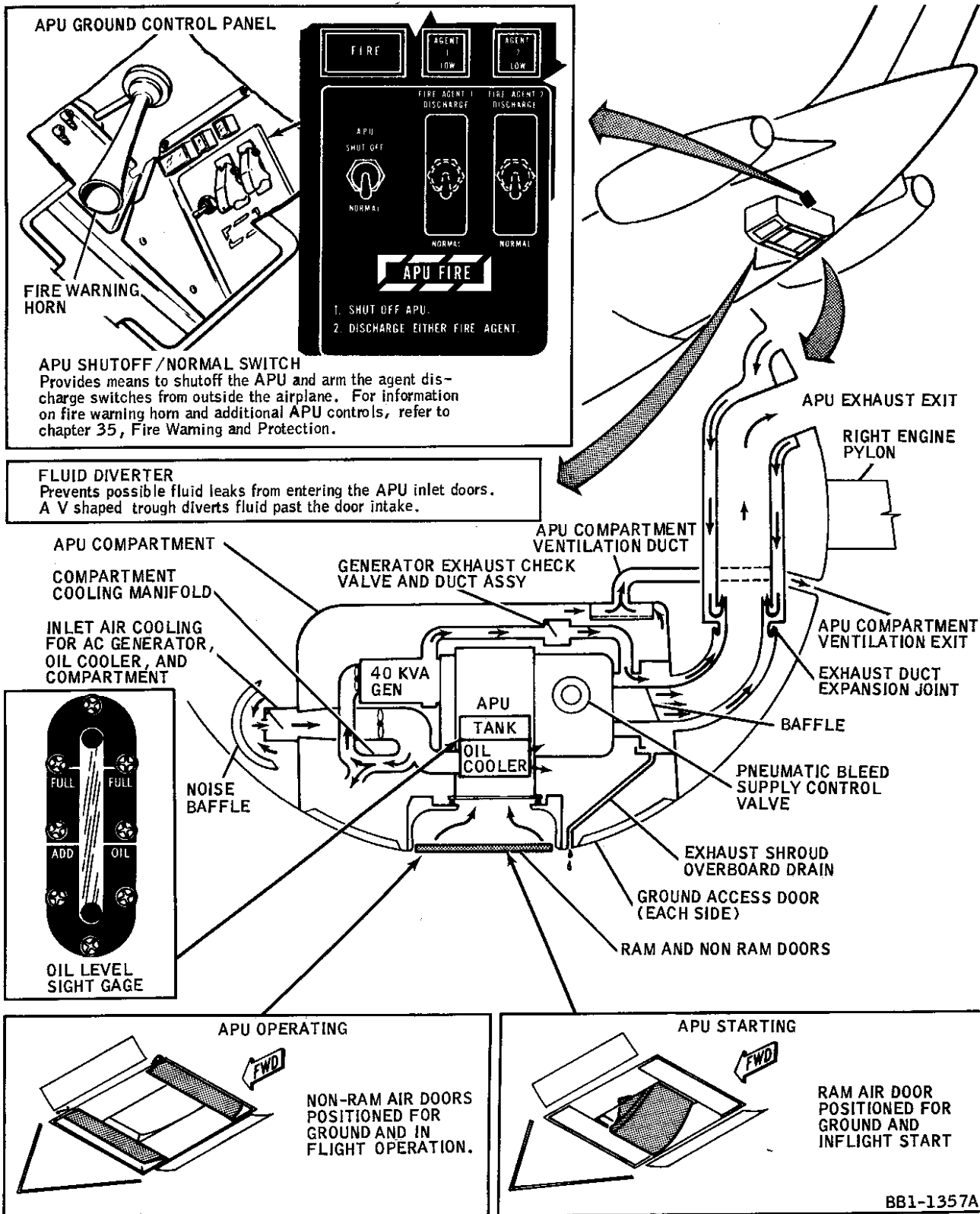
Generator cooling is effected by an integral cooling fan which pumps air in series with the APU-driven cooling fan, assisted by an ejector in the APU primary exhaust duct. APU exhaust and generator cooling air is discharged overboard through a common duct exiting above the right engine pylon.

Fuel is supplied to the APU from the right main tank. The fuel feed line is shrouded and drained where it passes through the pressurized area of the airplane and in the compartment aft of the pressure bulkhead. Two solenoid-operated shutoff valves are installed in the fuel feed line, one at the aft spar of the right main tank, and one on the APU itself. The dc start pump or any operating right main or center tank boost pump will provide adequate inlet fuel pressure to the unit.

A dual, continuous strip fire detector system, having the same characteristics as the main engine detector system, is installed in the APU compartment. When fire is detected, fire warning signals in the cockpit are activated and the APU shuts down automatically. Also, a fire warning light and horn are activated at the ground control panel on the aft fuselage. When the fire control switch is actuated to OFF & AGENT ARM position the APU is also automatically shut down.

A 40-kva power generating system is provided with the APU. Electrical

APU -- MAJOR COMPONENT LOCATION



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power for starting the APU is normally supplied by the airplane's battery. Bleed air for starting the main engines and operating the air conditioning system is obtained from a bleed port on the APU turbine plenum housing. Bleed airflow is controlled by a load control valve with on-off control selected by a switch in the cockpit. A check valve is provided in the pneumatic ducting to prevent reverse airflow from the main engines into the APU.

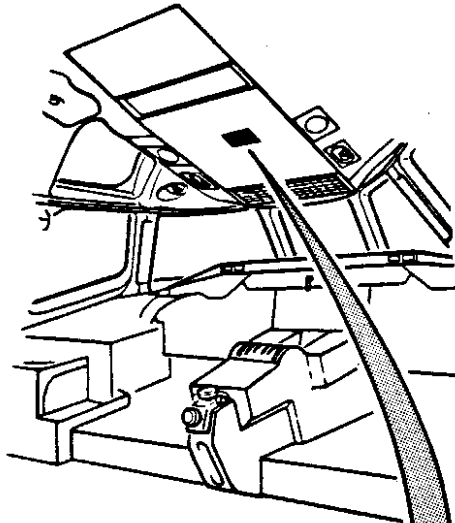
Controls for starting, operation, and fire control are on the APU control panel located on the overhead switch panel. The indicators for APU exhaust gas temperature and rpm are located immediately aft of the APU control panel. The annunciator panel contains caution lights for indicating APU low oil pressure and high oil temperature, and a warning light to indicate APU fire.

A separate door control switch provides for manual or automatic selection of the inlet doors position. The switch is positioned to automatic for all normal start and operating conditions. The non-ram doors are programmed to the open position during normal operation except during the start cycle and acceleration to 95% RPM. The ram air doors open automatically at the beginning of the starting cycle and close when APU RPM reaches 95%. Door sequence provides ram assist for windmill starting with switch in AUTO position. It is not necessary to manually select RAM position for windmill starts. Normally all APU starts will be made using the APU starter and the airplane battery or external dc power. When sufficient battery power to operate the APU starter is not available and when the airplane is operating within the normal windmill start envelope,

the ram air door may be opened to windmill the APU to starting RPM.

APU fuel control is automatic. Pneumatic bleed extraction is regulated by a bleed load control valve controlled by a pneumatic thermostat that regulates fuel flow as required by APU load. The APU generator shaft horsepower requirements have priority over the pneumatic bleed air extraction.

APU -- COCKPIT CONTROLS & INDICATORS (sheet 1)



APU PERCENT RPM INDICATOR

Indicates the rpm of the APU as a percentage of an established normal operating rpm. The periphery of the dial is calibrated to the 100 percent value and has a green arc extending from 95 to 105 percent to indicate normal operation range. The small inner dial is calibrated at 1/10 of the outer dial value.
 Example: at a rpm of 75 percent the outer dial needle would be half way between 70 and 80 and the inner dial needle would be at 5. An integral control in the APU will shut down the APU when the 110 percent point is reached. The APU may be shut down at any rpm by placing the APU MASTER Switch at OFF.
 NOTE: The APU starter will normally cut out at 35 percent rpm. Power from the APU driven generator will not cut in until the rpm reaches 95 percent rpm.

APU EXHAUST TEMPERATURE INDICATOR

Indicates the temperature of the APU exhaust in degrees centigrade.

BLEED AIR SWITCH

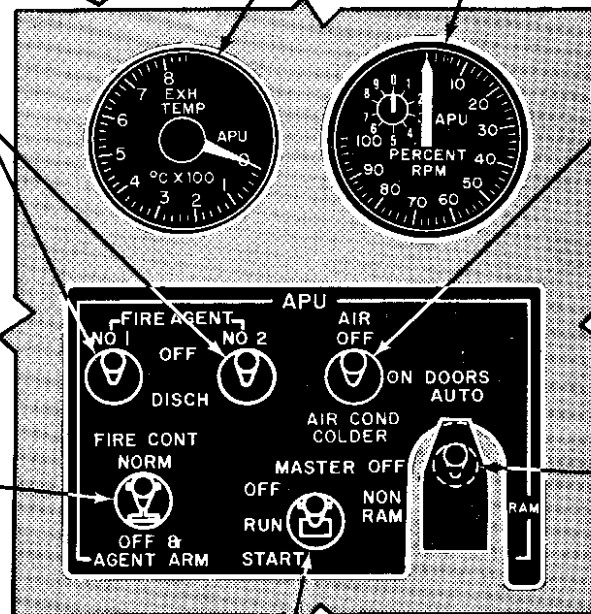
ON position completes electrical circuit to APU bleed control valve providing APU pneumatic bleed air to aircraft pneumatic system after the 95% RPM Switch is armed.
 AIR COND COLDER position selects pneumatic shut off valve closed to provide increased differential pressure across air conditioning cooling turbine. OFF position removes electrical power from APU bleed control and pneumatic shutoff valve circuits.

FIRE AGENT DISCHARGE SWITCHES

OFF position; circuit will not discharge fire agent bottle. DISCH (discharge) position completes circuit to discharge fire agent bottle providing FIRE CONT switch is in APU OFF & AGENT ARM position.

FIRE CONTROL SWITCH (2 position lever lock)

NORM position completes circuit to APU MASTER switch. OFF & AGENT ARM position shuts off both APU fuel supply valves and arms the FIRE AGENT switches for manual release of extinguishing agent.



DOORS SWITCH (4 positions - guarded AUTO)

NON RAM (momentary) position provides manual override to open non-ram doors. AUTO position automatically selects RAM door position for starting and NON-RAM door position for ground and flight operation. RAM (momentary) position provides manual override to open ram doors. OFF position removes power from door control circuit.

NOTE: For limitations see Section 2, Chapter 32

APU MASTER SWITCH

START (momentary) position completes circuit to APU inlet doors open control, arms the 110% rpm overspeed stopping relay, completes circuit to the APU starter which remains closed until 35% rpm switch deenergizes or MASTER switch is manually actuated to OFF position, opens the fuel tank solenoid valve, arms the plus 95% rpm switch, energizes the fire detector amplifier, arms the external APU fire shutoff switch, arms oil pressure sequence switch so that ignition and fuel are provided when APU oil pressure reaches 2 psi or approximately 5% rpm.

RUN position retains all circuits that were initiated in START position with the exception of the initiator portion of the starter circuit. When 95% rpm is reached the plus 95% rpm switch deenergizes ignition and energizes the hour meter and the 95% rpm holding relay which arms the bleed air switch and the pneumatic solenoid valve for shutdown.

OFF position deenergizes circuit to both fuel solenoid valves which then close, deenergizes hour meter, arms the APU inlet doors close control, and isolates the ignition and starter circuits.

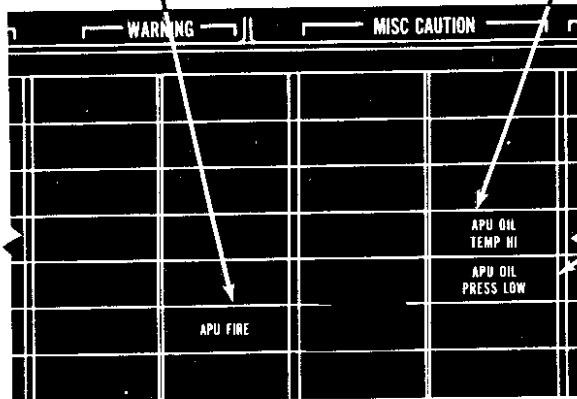
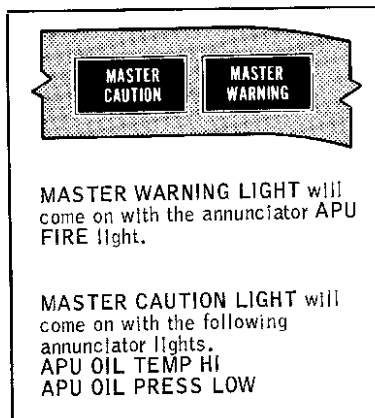
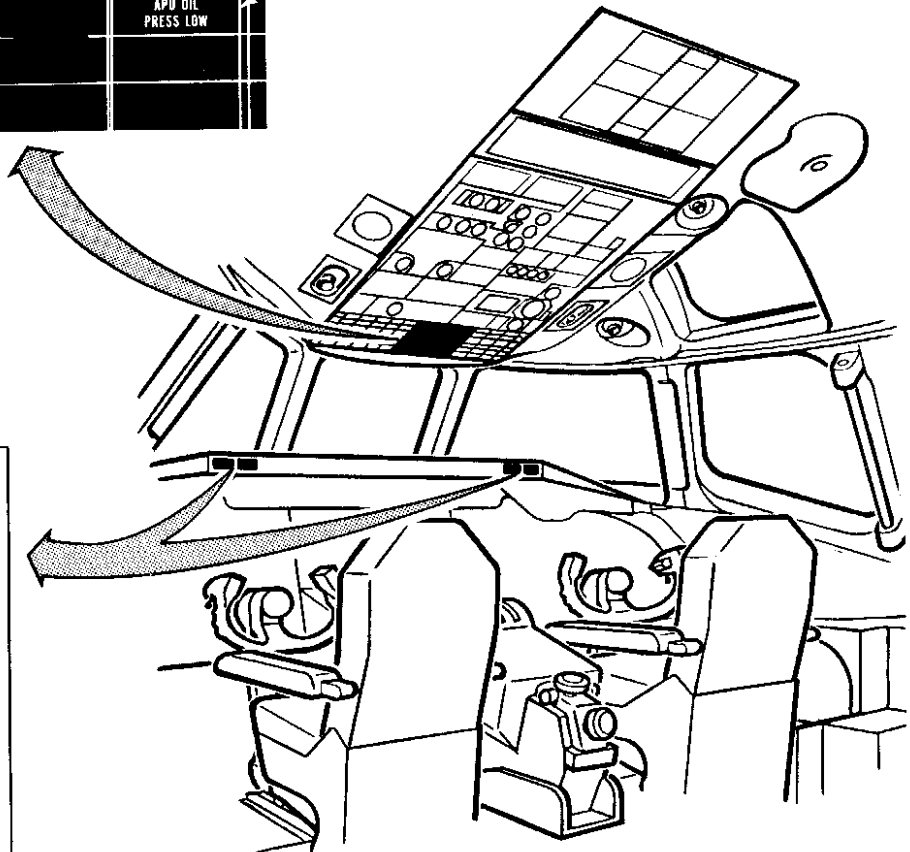
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APU -- COCKPIT CONTROLS & INDICATORS (Sheet 2)

APU FIRE LIGHT (red)
 Will come on from a signal in the fire detection system.
 Refer to chapter 35, Fire Warning and Protection System.

APU OIL TEMP HI LIGHT (amber)
 Actuated by a thermo switch in the APU oil tank when temperature reaches approximately 255° F.

APU OIL PRESS LOW LIGHT (amber)
 Actuated by pressure switch in the APU oil system when the pressure is between 35 and 45 psi. Light should be on when starting APU and should go off during APU start.



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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 18, SECTION 3, CHAPTER 35, DATED DEC 1/69

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

3-35-1-0 REVISED ILLUSTRATION TO CORRECT PLACARDING OF FIRE AGENT DISCHARGE SWITCHES.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
3-35-Eff	66	All	3-35-Eff	66	All
3-35-1-0	1	1 and 2	3-35-1-0	1	1 and 2

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The following pages are effective for ATL Series 30 Aircraft.

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*The asterisk indicates pages revised or added by the current revision.

Dec 1/69

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Chapter 35

FIRE WARNING AND PROTECTION SYSTEM

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<u>FIRE DETECTION</u>	35-1-0	1	1	A11
<u>FIRE WARNING INDICATION</u>	35-1-0	1	1	A11
*MAJOR COMPONENT LOCATION	35-1-0	2	1	A11
<u>ENGINE FIRE DETECTION SYSTEM PANEL</u>	35-1-0	3	1	A11
<u>FIRE PROTECTION</u>	35-1-0	4	1	A11
*COCKPIT CONTROLS & INDICATORS	35-1-0	5	1	A11

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Sep 1/69

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Chapter 35

FIRE WARNING AND PROTECTION SYSTEM

GENERAL

The fire detection system provides the means to detect a fire in the engine nacelle or the auxiliary power unit compartment and immediately alert the crew by aural and/or visual indications. The system consists of fire-detecting components, fire-indicating components, and an electrical circuit. The system is dual, with two separate fire-sensing loops in each fire area and an individual control unit for each area. One fire-sensing loop in an area can be defective and the airplane can still be dispatched or continue in normal flight with adequate fire protection from the remaining operational sensing loop. A fire warning caused by a ground fault in one sensing element loop can be quickly analyzed by a fire test panel located in the flight compartment.

FIRE DETECTION

FIRE DETECTOR UNITS

There are two fire detector units located in each engine nacelle and in the APU compartment. Each unit consists of two sensing elements mounted parallel to each other on a support tube. The sensing elements form a loop which is monitored by a control unit. When the sensing elements are subjected to heat, the resistance value of the element changes. These resistance values are monitored by the control unit. When a preset

resistance is reached by heat imposed on the elements, electrical current is applied to the energizing coils of the fire relays in the control unit. The relays are actuated and close the electrical circuit to the fire warning indicating components.

CONTROL UNITS

The fire detection control unit monitors resistance of the sensing elements and activates the fire warning indication circuit. There are three control units, one for each fire detector area.

FIRE DETECTOR LOOP LIGHT

The annunciator panel light is provided to indicate that one or more engine fire detector system panel lights are on.

FIRE WARNING INDICATION

Fire warning indication is provided by the MASTER WARNING light, fire warning lights for each engine nacelle and the APU compartment, a fire warning bell, and a fire warning horn.

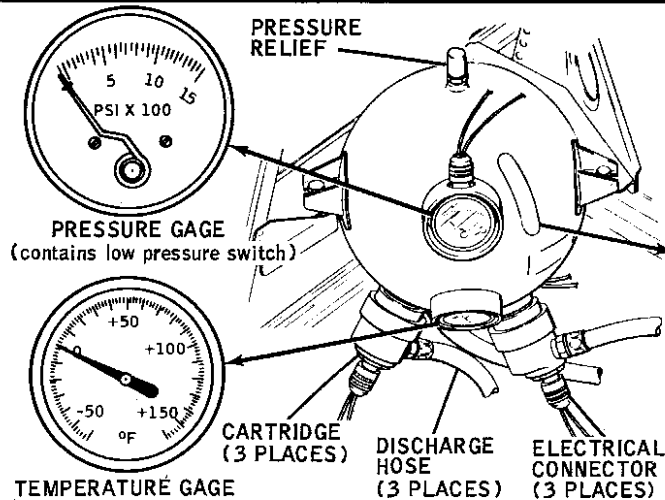
ENGINE NACELLE FIRE INDICATION

The fire warning lights for the engines are located in the fire shutoff handles on the upper instrument panel. The handles are made of a red, translucent material, which is illuminated when the lights come on.

FIRE WARNING & PROTECTION -- MAJOR COMPONENT LOCATION

FIRE EXTINGUISHER CONTAINERS

Each bottle contains a fire extinguishing agent and three discharge heads. One for the left engine area, one for the right engine area, and one for the APU area. When the overhead APU panel FIRE CONT switch is placed at OFF & AGENT ARM and the FIRE AGENT switch is momentarily placed at DISCH, or an ENG FIRE shutoff handle is pulled and turned to AGENT DISCH, an electrical circuit is completed to the electric discharge head and bottle to fire the applicable cartridge. When the cartridge fires, a seal is punctured releasing the agent to the selected area.

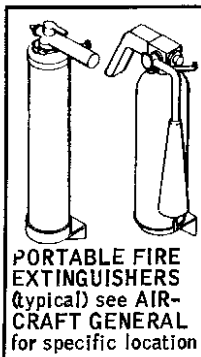
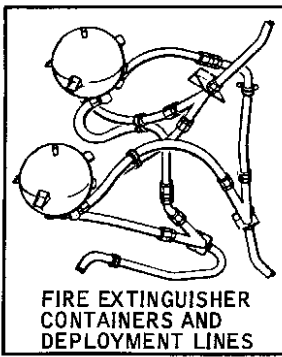
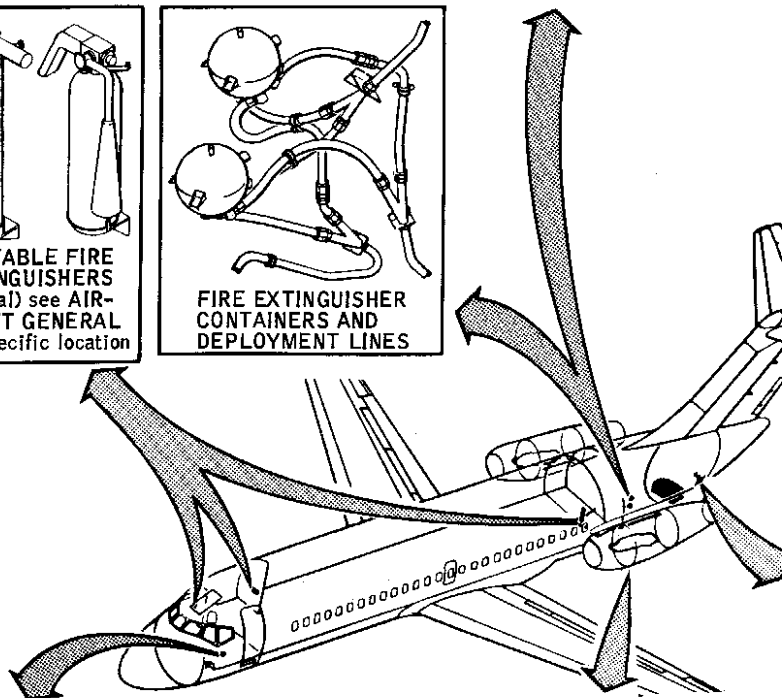
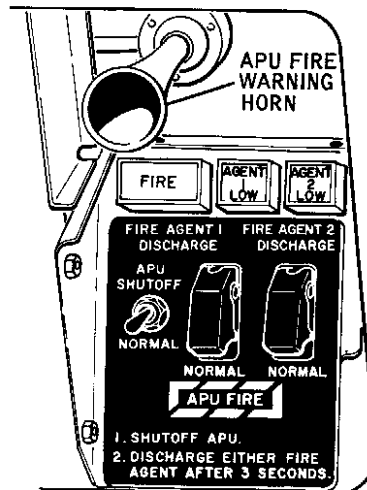


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TEMPERATURE-PRESSURE RELATION TABLE

TEMP. DEGREES F	MIN. ALLOWABLE PRESS.
-40	290
-20	330
0	375
20	430
40	485
60	545
80	600
100	665
120	740
140	840
150	895
160	955

APPLY CORRECTION ON PRESS GAUGE DECAL TO ACTUAL READING BEFORE USING TABLE



APU GROUND CONTROL PANEL

FIRE light comes on with signal from fire detection circuit.

AGENT LOW lights come on when pressure in fire extinguisher containers is less than approximately 275 psi.

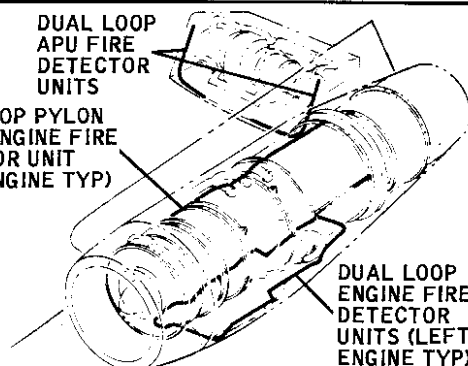
APU SHUTOFF switch provides external means for stopping APU and arming agent discharge switches.

FIRE AGENT DISCHARGE switches provide external means of discharging fire agent into APU area after automatic or manual shutdown.



FIRE WARNING BELL Will sound when a signal is received from the engine fire detection circuit. The bell can be silenced by pressing the FIRE BELL OFF button on the ENGINE FIRE PANEL or pulling the affected engine fire shutoff handle.

DUAL LOOP APU FIRE DETECTOR UNITS
 DUAL LOOP PYLON APRON ENGINE FIRE DETECTOR UNIT (LEFT ENGINE TYP)



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When a fire condition is sensed in an engine area, the respective ENG FIRE shutoff handle illuminates and the firebell rings. The firebell can be silenced by depressing the FIRE BELL OFF switch on the upper instrument panel. The firebell will be silenced automatically when the ENG FIRE shutoff handle is pulled out.

The applicable amber loop lights on the engine fire detection system panel also come on when a fire warning circuit is energized.

APU AREA FIRE INDICATION

Red fire warning lights for the APU compartment are located on the annunciator panel and on the APU ground control panel. The master warning lights on the glareshield also come on with a signal from the APU fire detection circuit. When a fire condition is sensed in the APU compartment, all three lights come on and the fire warning horn sounds. There is no designated control to shut off the warning horn. The horn will stop sounding when the fire indication is cleared.

ENGINE FIRE DETECTOR SYSTEM PANEL

This panel is used in conjunction with the fire test switches to check the fire-sensing loops for proper operational condition.

The panel consists of three switches and six lights with amber caps. The lights and switches are arranged in three groups, with each group consisting of two lights and one switch. Each group represents a fire detector circuit: left engine loops, right engine loops, and APU loops. The switches have three positions and may be lever locked in each position.

The positions are designated as LOOP A, BOTH, and LOOP B. With all fire detector circuits operational, the switches should be placed in the BOTH position. With the switch in this position and both fire test switches depressed, all fire warning lights (except lights on APU ground control panel) and all lights on the engine fire detector system panel should come on and the firebell should ring. When the fire test switches are released, the lights should go off and the firebell should stop ringing. Each loop can be tested separately by placing the loop-select switch in the selected LOOP (A or B) position and depressing the respective loop test switch. The selected area fire warning lights, applicable loop lights, and annunciator panel fire detector loop light should come on. If an engine area is being tested, the firebell will ring.

Normally, both sensing element loops in an area must be grounded or attain the fire condition resistance value before a red fire warning indication is produced. If the annunciator panel FIRE DETECTOR LOOP light comes on (indicating an amber light on the engine fire detector system panel is on) and no red fire warning is presented, the loop should be tested for a ground fault by placing the loop-select switch in the opposite loop position and depressing the loop test switch. The selected loop light and the area red warning light should come on (in engine areas, firebell should ring). The loop light not in selection should go off. This action indicates a ground fault condition in one sensing element loop. The other loop is still operational. If this condition exists, the airplane can be dispatched or continue normal flight. If the selected loop light and red warning indication do not come on, an open circuit in the selector loop is indicated. In this event the loop light which came on

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originally must be considered a fire warning.

TEST SWITCHES

The fire test pushbutton switches are located on the engine fire panel. The left-hand switch is used to test fire detector A loops, and the right-hand switch tests B loops. When the fire test switches are depressed, a ground is formed, simulating a fire condition. This actuates the fire relays in the control units and closes the fire warning indicating circuits.

When the loop-select switches on the engine fire detector system panel are in the BOTH position, both fire test switches must be held depressed to produce a red fire warning indication and cause the firebell to ring. If only one switch is depressed, only the lights on the engine fire detector system panel for the selected loop and the annunciator panel fire detector loop light will come on. To produce a red fire warning indication and cause the firebell to ring when only one switch is depressed, the loop-select switch on the engine fire detector system panel must be placed in the selected loop position.

FIRE PROTECTION

FIRE EXTINGUISHING SYSTEM

The fire extinguishing system consists of a fixed system and portable fire extinguishers. The fixed system consists of two fire extinguishing agent containers, the distribution lines, a control circuit, and agent low indicating lights. The extinguishing agent from a selected container is dispensed to the areas by operating the selected area control. The engine area controls are located on the upper

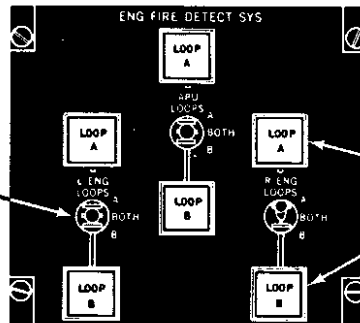
instrument panel. The APU compartment controls are located on the overhead panel in the cockpit and on the APU ground control panel aft of the APU on the left side of the airplane.

Agent-low indicating lights, one for each container, are located on the upper instrument panel in the cockpit and on the APU ground control panel. Below-minimum pressure in a container causes the respective agent-low indicating light to come on.

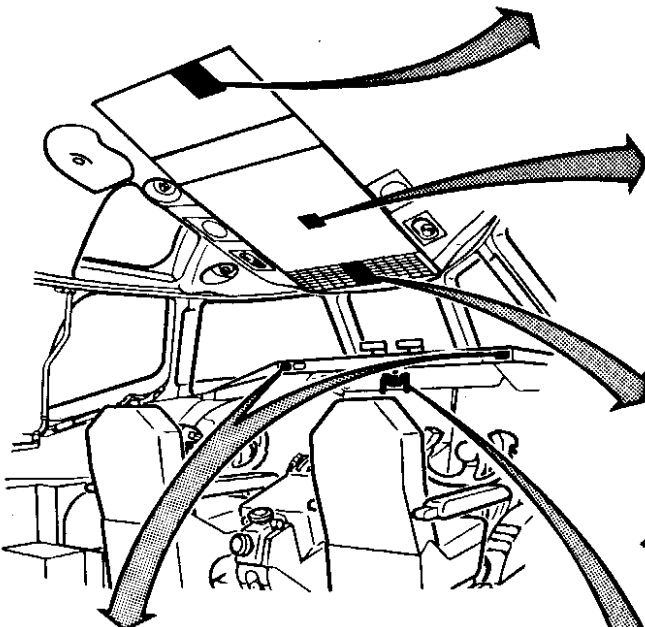
Hand-operated portable fire extinguishers that can be carried to the area of a fire are located in the cockpit and in the passenger compartment. (Refer to AIRPLANE GENERAL.)

FIRE WARNING & PROTECTION -- COCKPIT CONTROLS & INDICATORS

L ENG LOOPS, APU LOOPS and R ENG LOOPS, SWITCHES
 All DC-9 fire detection consists of dual detection loops. These 3 position lever lock switches provide means of connecting the fire warning system to the detection loops designated A, the loops designated B, or to both. The switches are normally left in BOTH position but may be moved to A or B as a means of isolating a malfunctioning detection circuit.



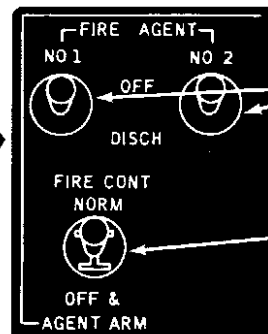
LOOP A & B LIGHTS
 These lights are turned on by a signal from the applicable fire detection system or test circuit. If the LOOPS switch is at A or at B only the applicable LOOP A or B light will come on. If all the LOOPS switches are at BOTH all LOOP lights will come on. A grounded loop will illuminate its respective loop light.



MASTER WARNING

MASTER WARNING LIGHTS
 Turned on by a signal from the APU fire detection circuit. Push cover to clear master warning circuit.

LEFT (AND RIGHT) FIRE SHUTOFF HANDLES
 Each handle provides fire warning indication and protection for the applicable engine. Lights within the handle are turned on by a signal from the engine fire detection circuit or test circuit. Pulling a handle will silence the fire bell, trip the generator control relay, shut off engine fuel and hydraulic pump supply, and close the pneumatic crossfeed valve. Turning the handle counter-clockwise (or clockwise) will discharge fire extinguisher agent from number 1 (or number 2) container.



APU CONTROL PANEL

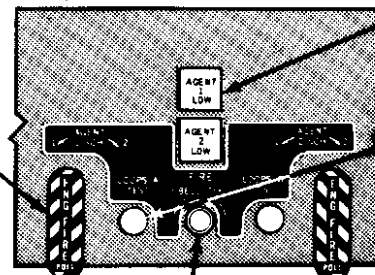
FIRE AGENT SWITCHES
 When actuated to DISCH, fires the applicable fire agent bottle APU head.
FIRE CONTROL SWITCH
 Shuts off APU and completes circuit to fire agent discharge switches when in the OFF & AGENT ARM position. Completes circuit to MASTER switch when in the NORM position.

FIRE DETECT LOOP LIGHT
 Light comes on when any single LOOP light on the ENG FIRE DETECT SYS panel comes on.

APU FIRE LIGHT
 Turned on by a signal from the APU fire detection circuit.



ENGINE FIRE PANEL



AGENT 1 LOW (or AGENT 2 LOW)
 Light will come on when the applicable fire extinguishing agent container is below approximately 275 psi.

LOOPS A (or B) TEST SWITCH
 When a test switch is pressed a false warning signal is introduced into the respective loop and if all the loops selector switches are in the corresponding position, the applicable LOOP, MASTER WARNING, ENG FIRE shutoff handle and APU FIRE lights will come on and the fire bell will ring.

FIRE BELL OFF SWITCH
 Silences the fire warning bell when pressed.

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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Chapter 40

PNEUMATIC SYSTEM

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*PNEUMATIC - FUNCTIONAL SCHEMATIC	40-1-0	2	2	A11
*PNEUMATIC - COCKPIT CONTROLS & INDICATORS	40-1-0	3	2	A11

*Illustration

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DC-9
FLIGHT CREW OPERATING MANUAL

Chapter 40

PNEUMATIC SYSTEM

GENERAL

Pneumatic bleed air is used for engine starting, ice protection, air conditioning, pressurization, and potable water tank pressurization.

Pneumatic bleed air for engine starting is provided by the APU or ground power equipment. Opposite engine bleed air may also be used for starting.

Pneumatic bleed air is supplied by the 8th and/or 13th compressor stages of both engines. Normally the right and left engine bleeds supply the respective air conditioning system requirements. When desired, air conditioning and/or ice protection may be provided using bleed air from either or both engines.

The 8th-stage bleed air is automatically used as much as possible to provide minimum engine power penalty. The 8th-stage check valve prevents reverse flow of high-pressure air, when the duct pressure downstream of the check valve is higher than 8th-stage bleed pressure.

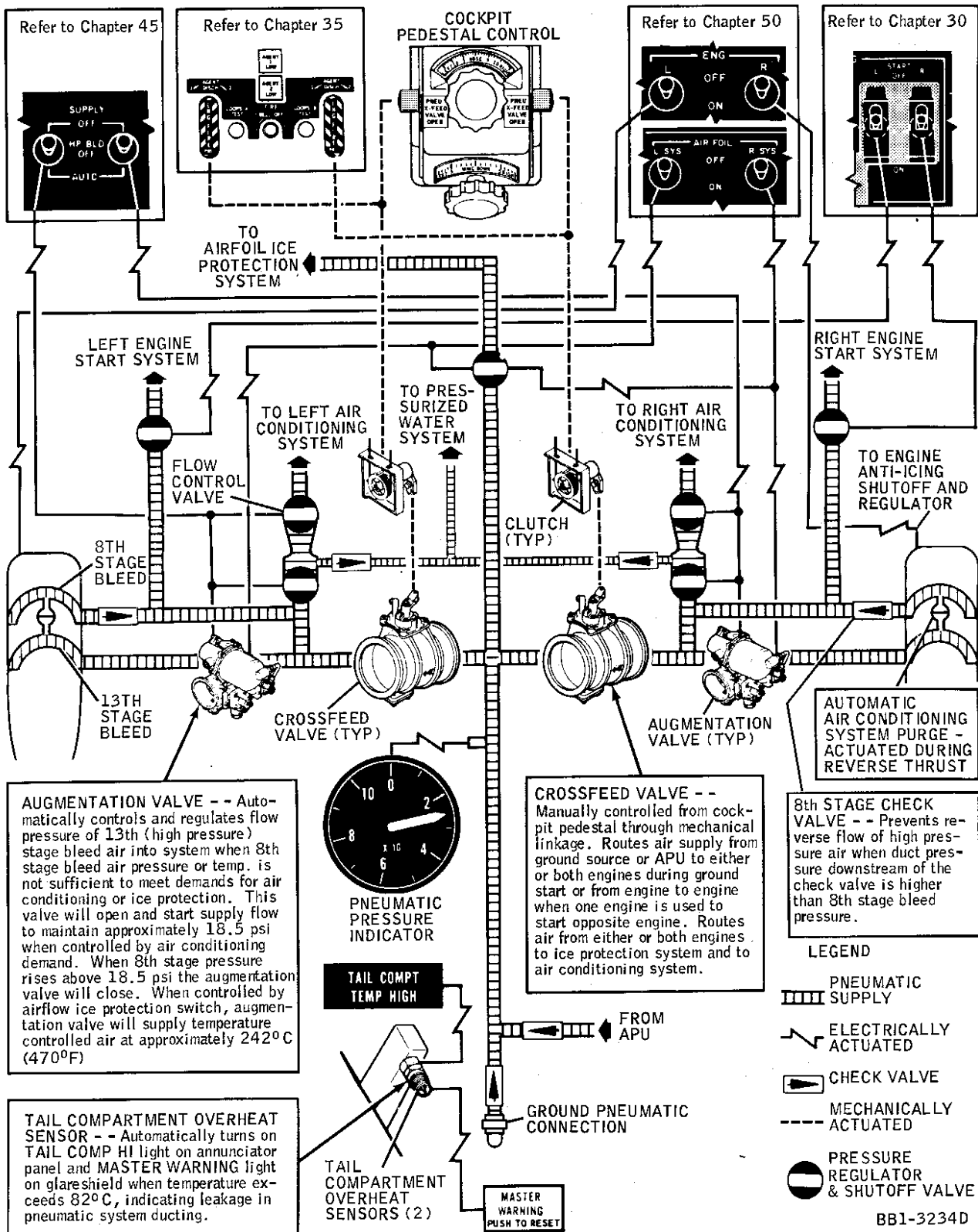
The augmentation valve automatically regulates the flow of 13th-stage bleed air into the system, when the 8th-stage bleed air pressure is not sufficiently high to satisfy flow requirements. During demands for airfoil ice protection, the augmentation valve functions as a temperature control valve controlled by thermostats in the ice protection system.

Manual crossfeed levers on the aft pedestal operate pneumatic crossfeed valves to isolate bleed air from each engine.

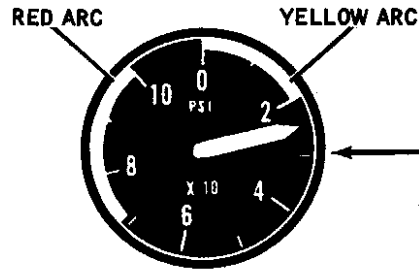
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 FLIGHT CREW OPERATING MANUAL

PNEUMATIC -- FUNCTIONAL SCHEMATIC



PNEUMATIC -- COCKPIT CONTROLS & INDICATORS



PNEU PRESS

PNEUMATIC PRESSURE GAGE
 Reading in excess of 72 psi
 indicates malfunction of pneumatic
 system.
 During anti-ice operation pressure
 will range from 22 to 72 psi



PNEU
 X-FEED
 VALVE
 OPEN

**PNEUMATIC CROSSFEED
 VALVE LEVERS**
 Levers for operation of
 left and right crossfeed
 valves are multisetting
 type and may be set in
 any position from fully
 closed to fully open as
 required.

TAIL COMPT
 TEMP HIGH

TAIL COMP TEMP HI
 Annunciator panel light
 comes on when tail compartment
 temperature exceeds 180° F
 (82°C)
 Light will remain on until tempera-
 ture falls below 180°F (82°C).

**MASTER
 WARNING**
 PUSH TO RESET

MASTER WARNING
 Light comes on simultaneously with annunciator panel
 light, and may be turned off by depressing light lens.

BB1-126B

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

CHAPTER 3-45

RECORD OF REVISIONS

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 FLIGHT CREW OPERATING MANUAL

SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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*The asterisk indicates pages revised or added by the current revision.

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Chapter 45

AIR CONDITIONING

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*MAJOR COMPONENT LOCATION				
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<u>RADIO RACK COOLING AND AIRPLANE AIR EXHAUST</u>	45-1-0	4	26	A11
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*COCKPIT CONTROLS AND INDICATORS (Sheet 1)	45-1-0	10	26	A11
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*Illustration

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DOUGLAS AIRCRAFT CO., INC.
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Chapter 45

AIR CONDITIONING AND PRESSURIZATION

GENERAL

Pneumatic pressure is supplied to two identical refrigeration units to air condition and pressurize the airplane. On the ground, air conditioning may be obtained by connecting an external pneumatic source to the airplane pneumatic ground connector, by extracting bleed air from the auxiliary power unit (APU), or by using engine bleed air. During flight, engine bleed air is used to operate air-conditioning systems and for pressurization. Conditioned air from a ground truck may be connected directly to the airplane distribution system.

PRESSURIZATION

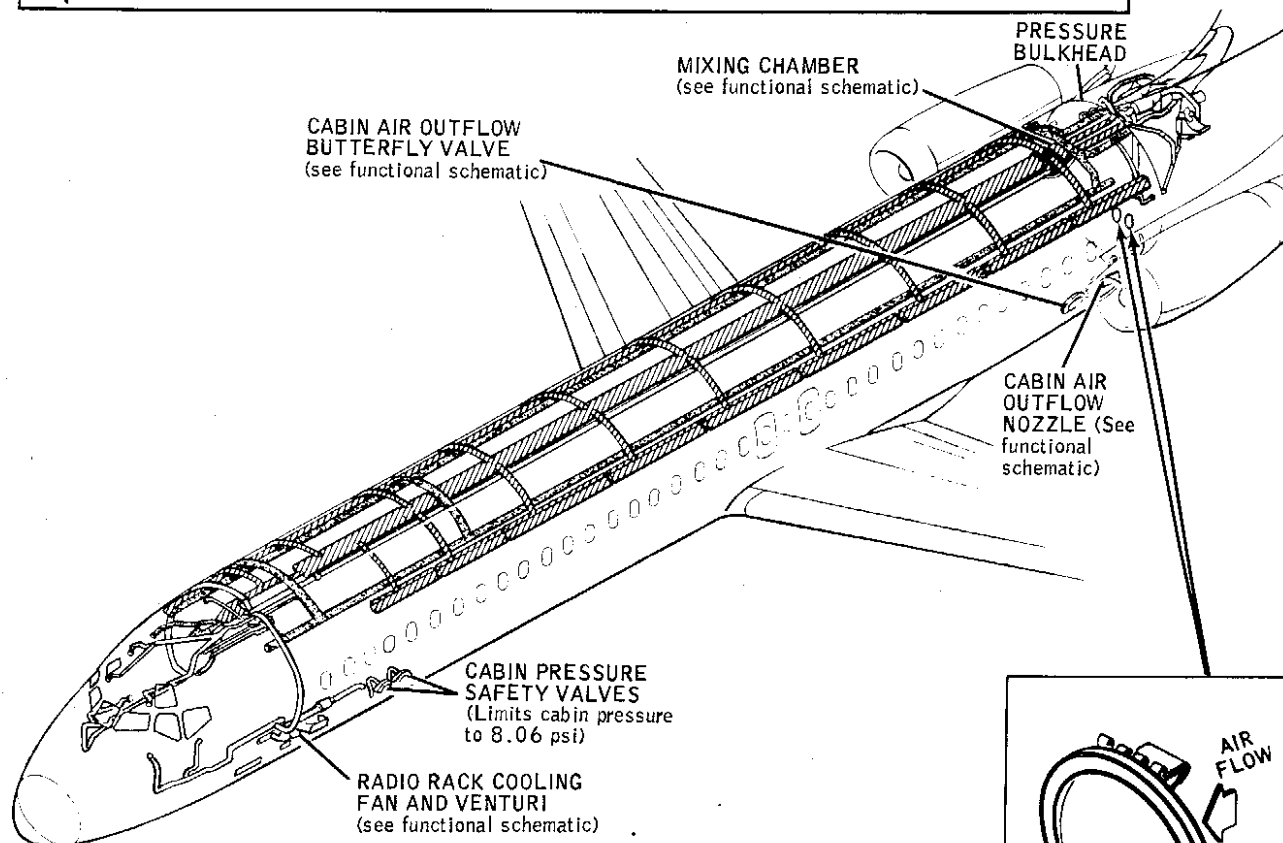
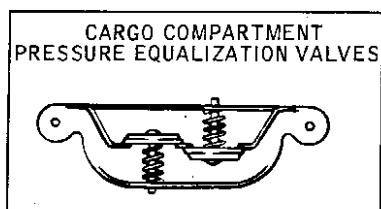
A controlled flow of compressed air from the pneumatic supply passes through the air conditioning systems and ducting to the pressurized areas. Desired pressurization level is maintained by regulating the escape of the compressed air through the cabin air outflow valve. Normally, the cabin air outflow valve is automatically positioned by the cabin pressure control system. For automatic operation of the cabin air outflow valve, place the cabin pressure controller lever in the AUTO (up) position. The cabin pressure controller wheel will rotate as it automatically adjusts to maintain pressurization. An indicator next to the wheel, will move to

indicate the direction that the outflow valve is moving. The cabin air outflow valve may be manually operated to control pressurization by use of the cabin pressure controller wheel. For manual operation, the cabin pressure controller lever is moved to the manual (down) position. The automatic system is deenergized, and the cabin air outflow valve is locked in a fixed position. To change position of the outflow valve, press down on the wheel and rotate in the desired direction necessary to maintain pressurization. The indicator will move at the same time to indicate the direction the outflow valve is moving. The automatic cabin pressure control system will maintain pressure within set parameters to a maximum of approximately 7.46-psi differential pressure. If the airplane lands pressurized, the automatic system will depressurize the airplane by opening the nozzle and butterfly of the cabin air outflow valve in response to a signal from the ground control relay.

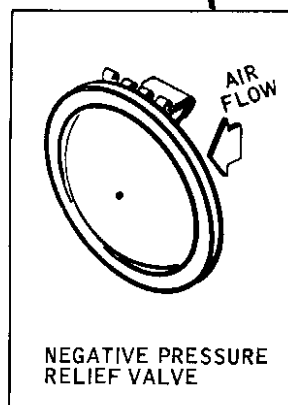
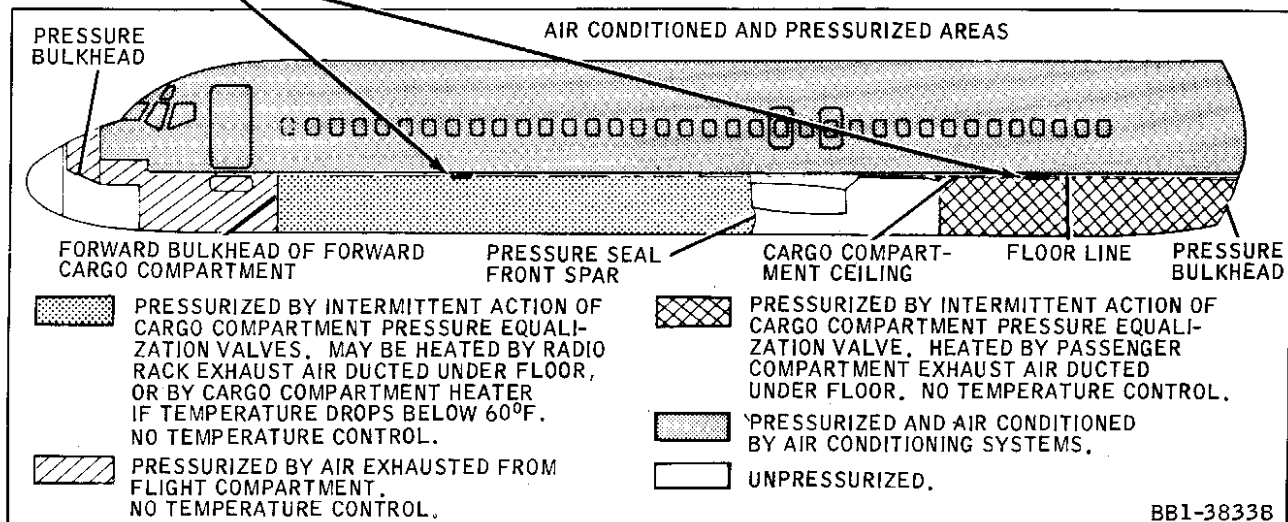
Dual pressure relief valves protect the airplane from maximum pressure input and pressure resulting from a possible wing anti-ice duct rupture. The relief valves are set to limit cabin pressure to approximately 8.06-psi differential. The airplane is protected against negative pressure by the inward movement of the galley service and passenger entrance door seals, and two negative pressure relief valves (swing check type) located on the aft pressure bulkhead.

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AIR CONDITIONING -- MAJOR COMPONENT LOCATION (sheet 1)

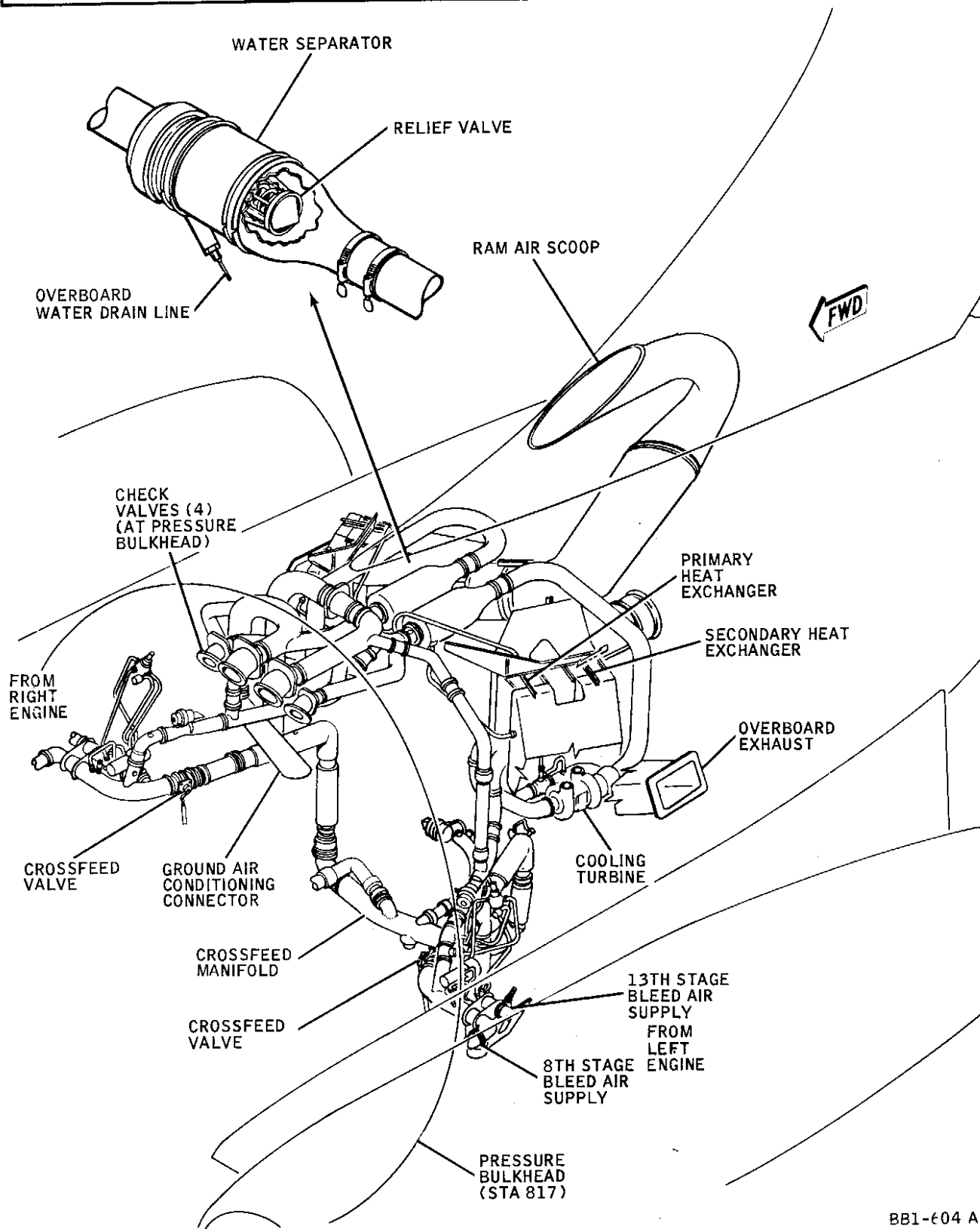


 **COLD AIR DUCTS**
 **CONDITIONED AIR DUCTS**



BBI-38338

AIR CONDITIONING -- MAJOR COMPONENT LOCATION (sheet 2)



DOUGLAS AIRCRAFT CO., INC.
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AIR CONDITIONING

GENERAL

The airplane has two identical air-conditioning systems designed for independent or parallel operation. These systems supply pressurized conditioned air. Normally, the right-hand system operates from right engine bleed air and supplies the passenger compartment requirements. The left-hand system operates from left engine bleed air and supplies the flight compartment requirements. Either system can supply the requirements of both compartments. A baffled mixing chamber diverts 85 percent of the left system's output to the passenger compartment and 15 percent to the flight compartment. Openings in the mixing chamber baffle allow the conditioned air output of a single system to be distributed to both the flight and passenger compartments.

The air-conditioning systems are protected against overheat conditions by thermal switches in the conditioned air ducting, the refrigeration unit compressor discharge duct, and the refrigeration unit turbine inlet duct. An air conditioning flow control valve prevents bleed airflow when heat exchanger cooling is not available. The systems are interlocked with thrust reverser operation and will shut down during reverser operation to prevent engine exhaust entering the airplane.

BASIC SYSTEM HOT AIR AND COLD AIR SUPPLY

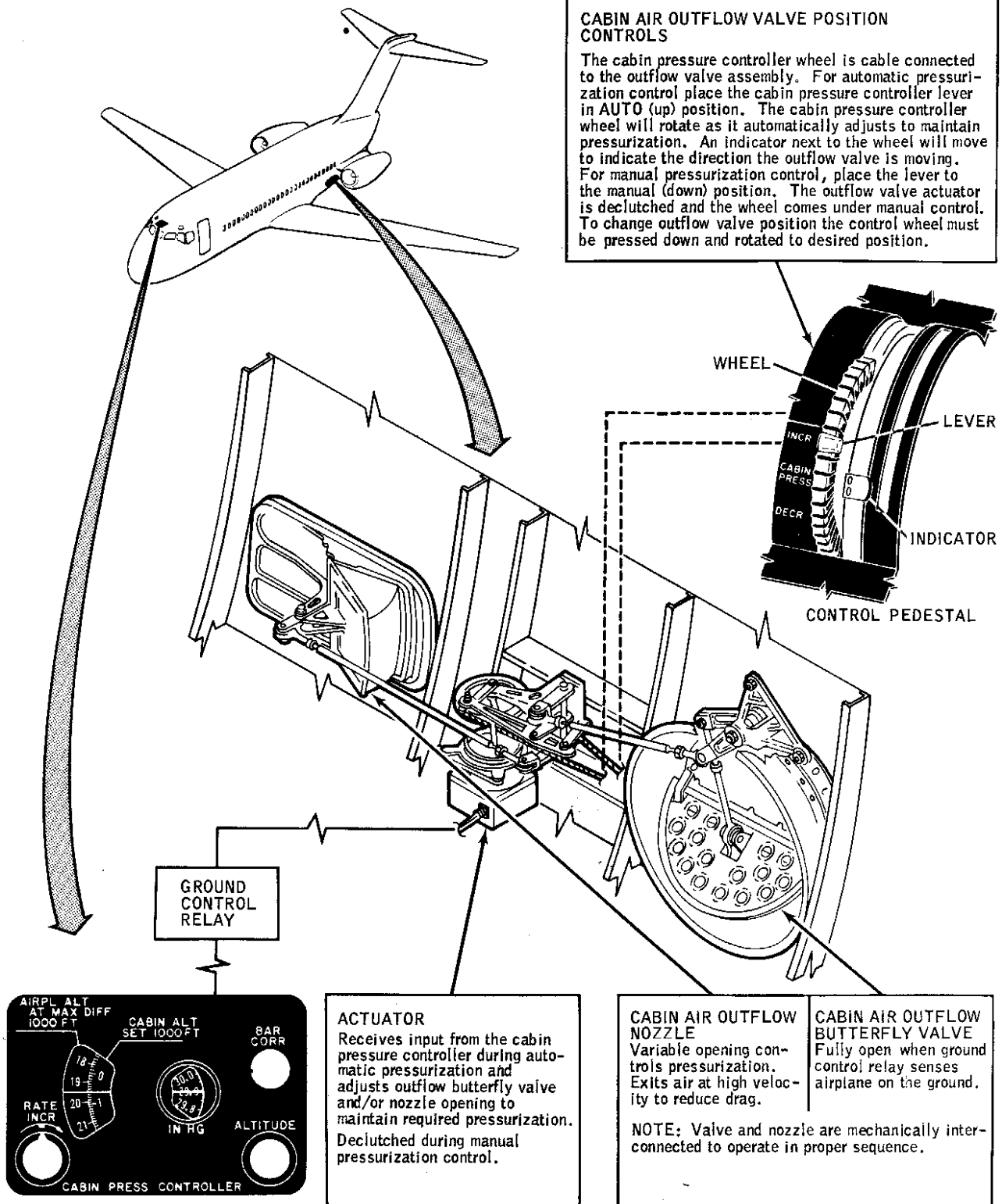
Hot compressed air from the pneumatic supply passes through a pressure regulator set for approximately 27 psi and through an air-conditioning flow control valve at approximately 75 pounds per minute. Part of the air

supply is ducted to temperature control valves and provides the heated air portion of the system. The remaining air supply is ducted through a primary heat exchanger for cooling, through a compressor to a secondary heat exchanger for additional cooling, then to a cooling turbine. Cooling air for the heat exchangers is provided by a fan during ground operation and by ram air during flight. The cooling turbine further decreases system air temperature and provides the cold air portion of the system. From the cooling turbine the cold air passes through a water separator, which removes entrained moisture, and is then available for use through two duct systems. One duct system supplies cold air directly to outlets in the passenger and flight compartments. The second duct system supplies cold air to be mixed with hot air coming from the temperature control valve. Variable opening of the temperature control valve determines the amount of hot air to be mixed with cold air to provide the desired conditioned air temperature. The temperature control valve is normally automatically controlled to respond to temperature requirements selected by the flight crew. The automatic temperature control system is designed to provide individual temperature selection for the flight or passenger compartments through a range of 65° to 80°F (18° to 27°C). The valve may be manually controlled through flight compartment switching.

DISTRIBUTION

Cold air is ducted to individual eyeball-type outlets for each passenger and crewmember seat. Each passenger cold-air outlet may be adjusted for air direction and flow. Conditioned air from the air-conditioning

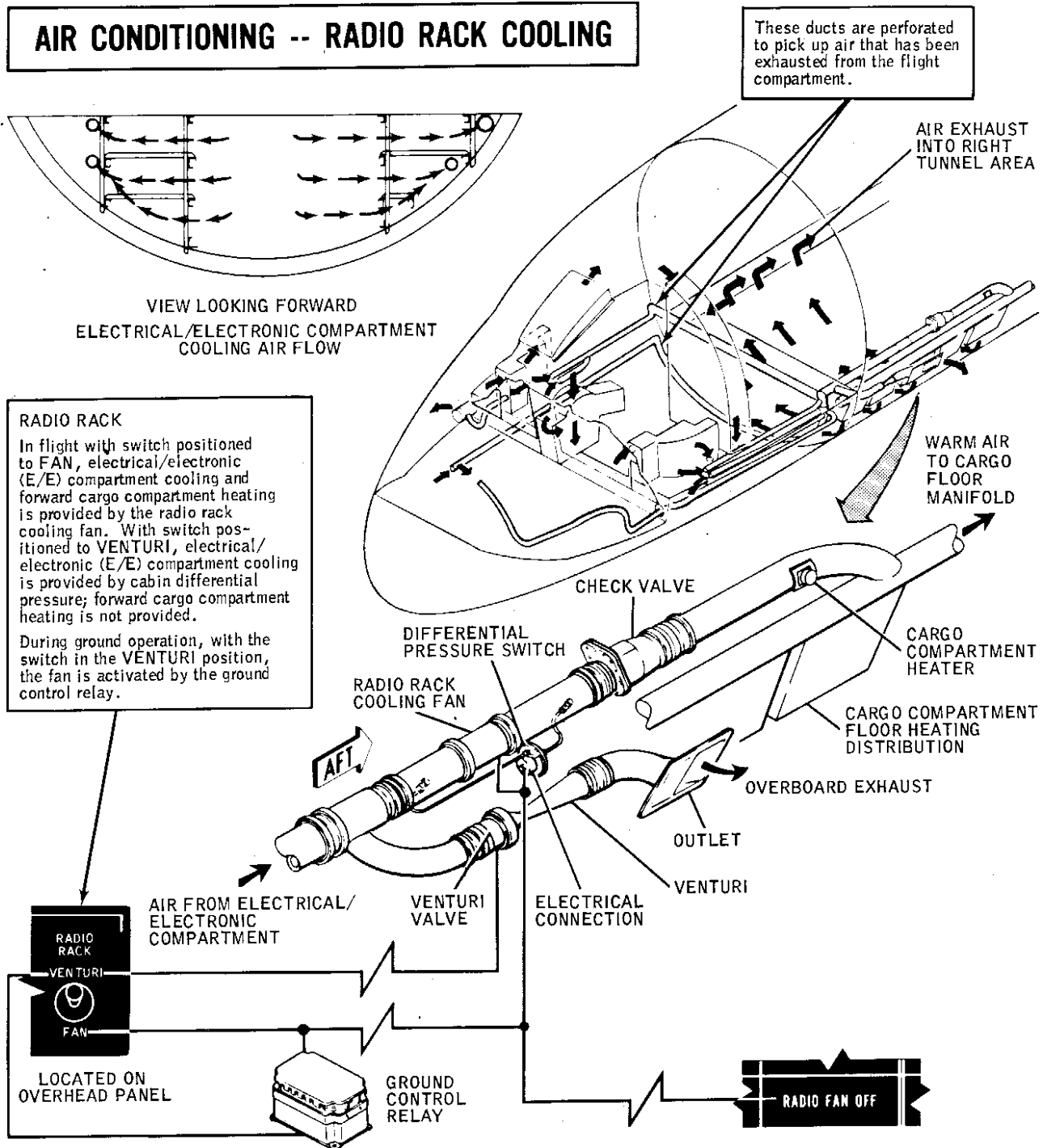
AIR CONDITIONING -- PRESSURIZATION FUNCTIONAL SCHEMATIC



BB1-3835

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 Page 5

AIR CONDITIONING -- RADIO RACK COOLING



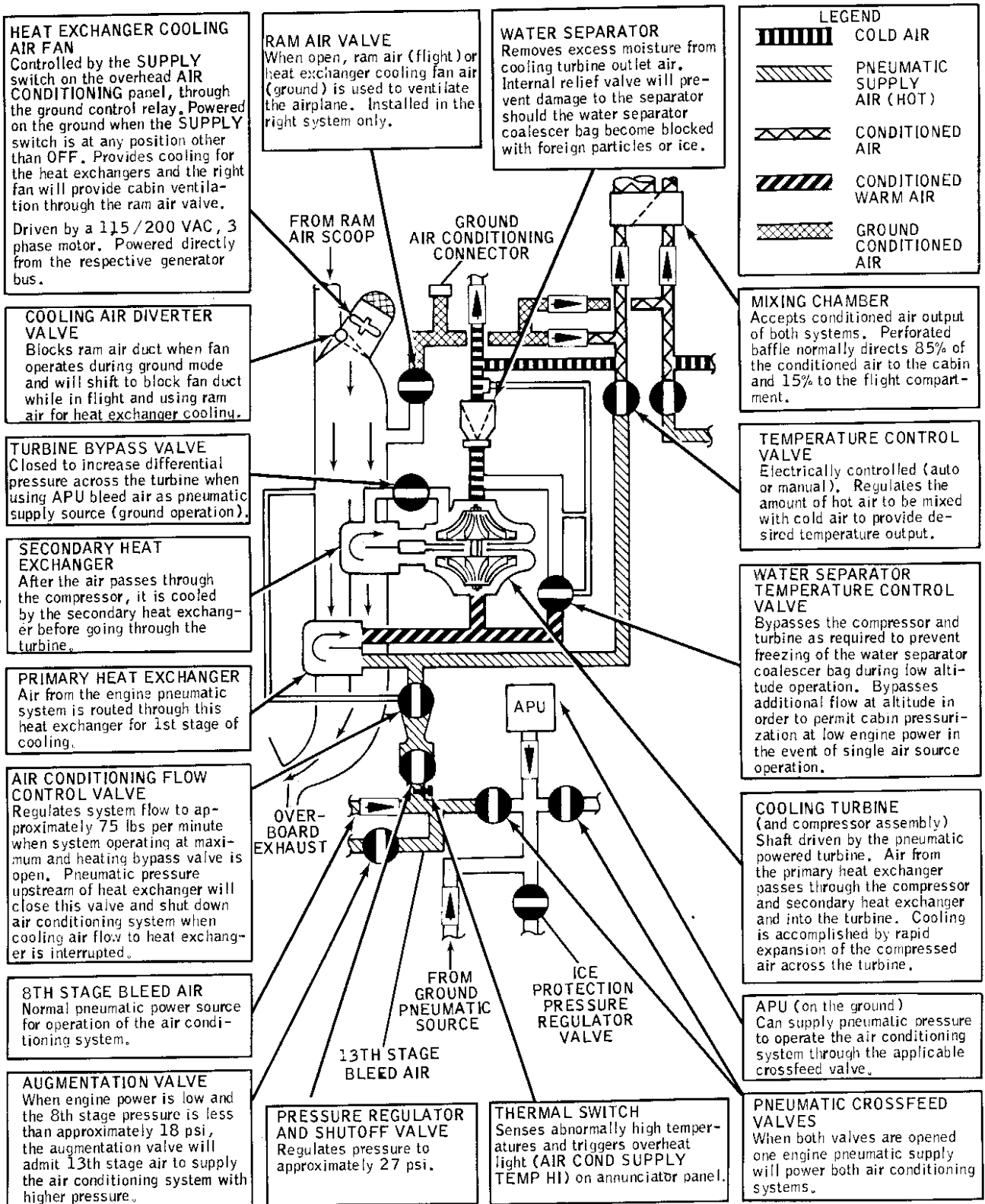
DESCRIPTION

Cockpit ventilation, radio rack cooling, and forward cargo compartment heating are very closely related in that the same air is used in a series flow path to accomplish these functions. This air originates in the cockpit and is removed, through controlled passages to the electrical/electronic compartment. Air leaves the electrical/electronic compartment through holes in the exhaust ducting on the outboard side of the electronic equipment compartment. A pressure difference is provided by the radio rack cooling fan or venturi. When the fan is running a restrictor valve, in the venturi line,

closes to reduce the overboard flow to approximately one half of normal. Fan discharge air is ducted under the cargo compartment floor. In passing under the floor, the warm air from the electronic equipment provides the heat necessary to permit carrying animals in the forward cargo compartment. If the temperature in the forward cargo compartment drops below 60°F, a heater in the cargo compartment duct will come on automatically and supply additional heated air.

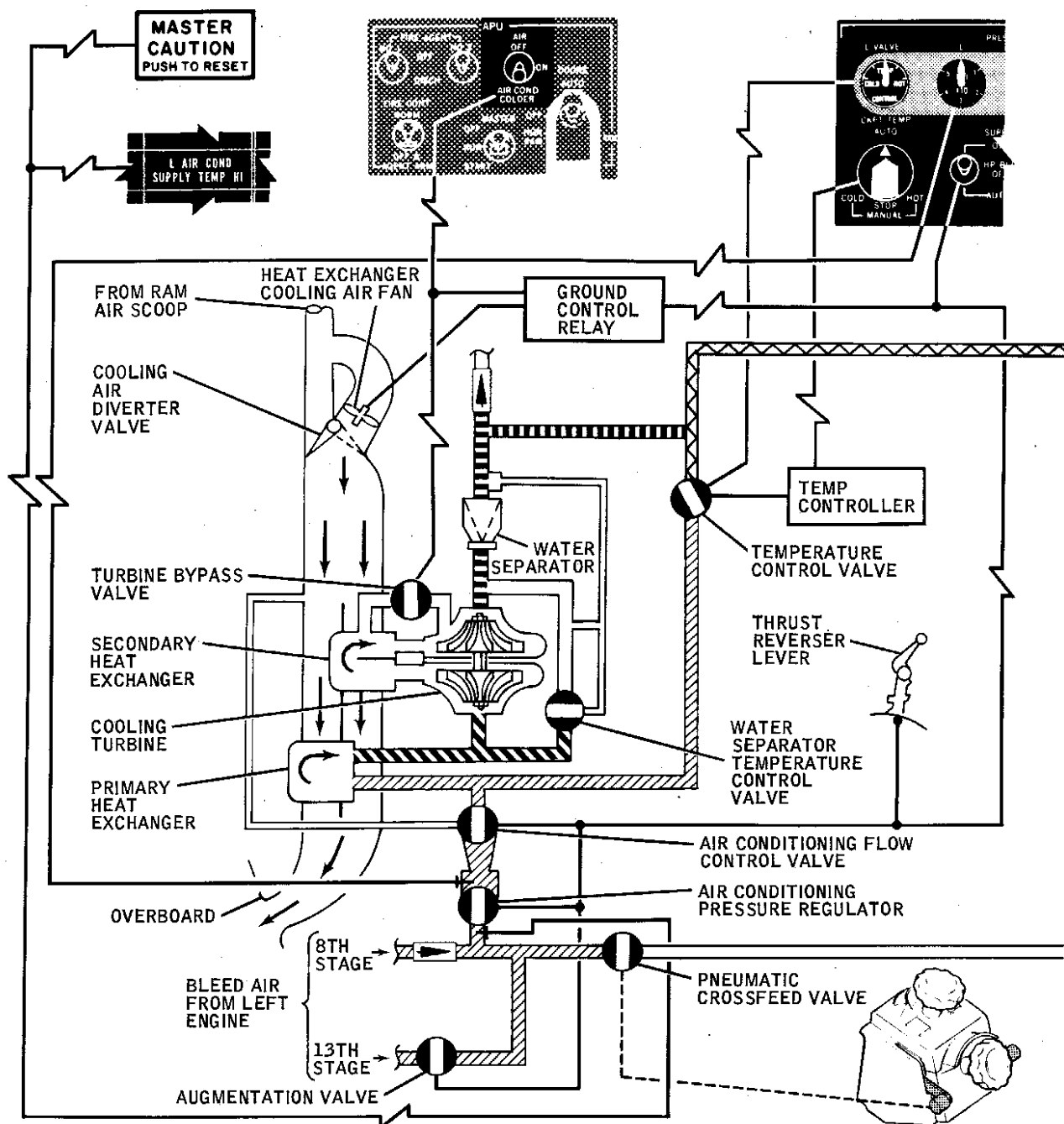
BB1-3788

AIR CONDITIONING -- FUNCTIONAL SCHEMATIC (Sheet 1)



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AIR CONDITIONING -- FUNCTIONAL SCHEMATIC (sheet 2)



DESCRIPTION

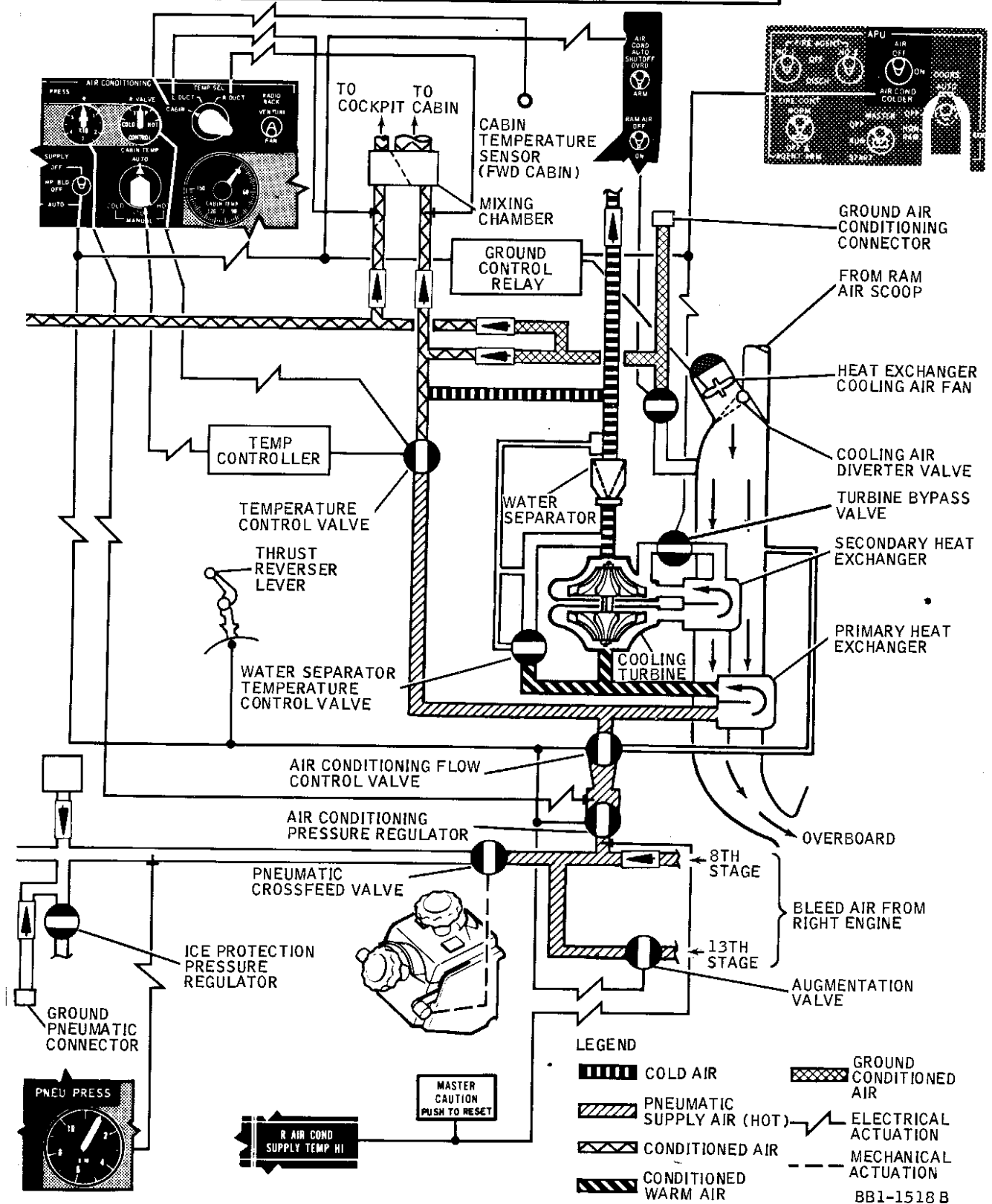
Pneumatics supply air (hot) to the air conditioning system is controlled by the respective supply switches. With the supply switches positioned to HP BLD OFF pneumatics supply air is provided by the 8th stage bleed. With the supply switches in AUTO position the augmentation valve admits 13th stage bleed air to provide additional supply pressure when engine power is low and 8th stage bleed pressure is less than approximately 18 psi.

Pneumatics supply air passes through the pressure regulator, the flow control valve, the primary heat exchanger, the compressor, the secondary heat exchanger, the turbine, and then through the water separator to the mixing chamber.

The temperature control system (auto or manual) positions the temperature control valve to blend supply air (hot) with conditioned air as required for passenger comfort.

BB1-3975

AIR CONDITIONING -- FUNCTIONAL SCHEMATIC (Sheet 3)



AIR CONDITIONING -- COCKPIT CONTROLS & INDICATORS (sheet 1)

CABIN PRESS LIGHT (red)
 Comes on when the pressurization system fails to maintain cabin pressure equivalent to a pressure altitude of 10,000 feet or less.

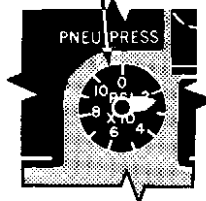
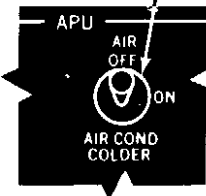
L & R AIR COND SUPPLY TEMP HI LIGHTS (amber)
 Comes on when the left or right air conditioning pneumatic supply temperature exceeds approximately 600°F. Actuated by a thermoswitch located upstream of the air conditioning pressure regulator valve. Indicates a malfunction of the pneumatic system augmentation valve.

PNEU PRESS INDICATOR
 Indicates the pneumatic pressure available for systems operation. Senses pressure in the crossfeed manifold between the crossfeed valves.

BLEED AIR SWITCH
 ON supplies APU bleed air to airplane pneumatic system after 95% rpm MASTER bleed air switch is armed.

AIR COND COLDER
 Closes turbine bypass valves to increase differential pressure across the turbine when using APU bleed air as pneumatic supply source.

(Ground Operation)
 OFF removes power to the APU bleed control and pneumatic shut-off circuits.



RADIO FAN OFF (amber) light comes on in flight when radio rack switch is positioned to FAN and fan is inoperative. On the ground with switch positioned to VENTURI, the fan is turned on by the ground control relay and light will come on if fan is inoperative.

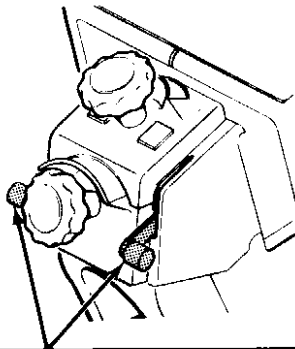
RADIO FAN OFF light is activated by a differential pressure switch connected across the fan and (when on the ground) by the ground control relay.

MASTER WARNING
 PUSH TO RESET

MASTER CAUTION
 PUSH TO RESET

MASTER WARNING LIGHT
 Comes on with the annunciator panel CABIN PRESS light when cabin pressure exceeds approximately 10,000 feet altitude.

MASTER CAUTION LIGHT
 Will come on with either of the annunciator panel L or R AIR COND SUPPLY TEMP HI LIGHTS.

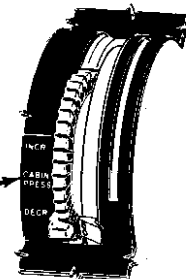


PNEU X-FEED VALVE OPEN LEVERS

Provide means to operate both air conditioning systems from one engine pneumatic supply when both crossfeed valves are opened or to isolate pneumatic supply sources and provide parallel systems operation. Used for routing and if necessary manually controlling air foil ice protection air. Also used to route APU or external pneumatic air.

CABIN AIR OUTFLOW VALVE POSITION CONTROLS

The cabin pressure controller wheel is cable connected to the outflow valve assembly. The indicator shows the direction the outflow valve is moving. For manual operation place the cabin pressure controller lever to the manual (down) position. The outflow valve actuator is declutched and the wheel locked into position. To change outflow valve position the controller wheel must be pressed down and rotated to desired position.



BB1-3834A

AIR CONDITIONING -- COCKPIT CONTROLS & INDICATORS (sheet 2)

L & R TEMPERATURE CONTROL VALVE POSITION INDICATOR (VALVE)

Indicates the actual position of the air conditioning system temperature control valve. Pointer at COLD indicates valve closed and blocking hot air supply. Pointer at HOT indicates valve fully opened to allow maximum hot air supply.

L & R SUPPLY AIR PRESSURE INDICATORS (PRESS)

Indicate the pneumatic supply pressure available for operation of each air conditioning system. Pressure is measured at a point downstream of the air conditioning pressure regulator valve.

TEMPERATURE INDICATOR SELECTOR (TEMP SEL)

Provides means to select CABIN, L DUCT or R DUCT temperature for display on the adjacent CABIN TEMP indicator. Temperature sensors are located in the cabin and in the left, and right conditioned air ducts at the inlet to the mixing chamber.

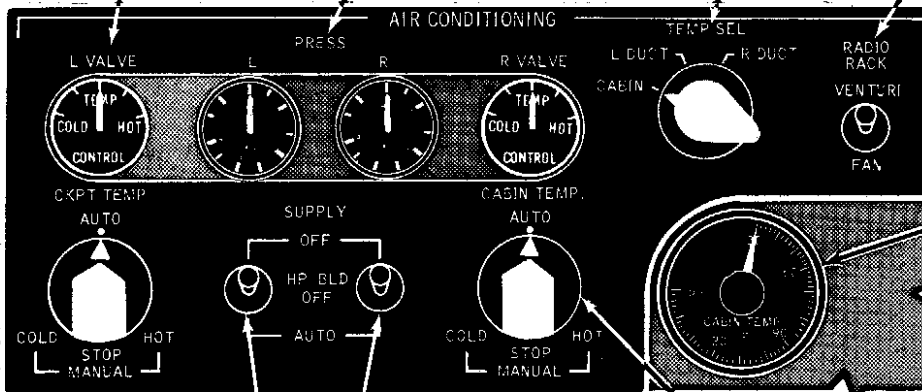
RADIO RACK switch

Controls the radio rack cooling fan operation and the venturi valve position.

FAN position turns on the radio rack fan and closes the venturi valve. In this mode cargo compartment heating is provided.

VENTURI position opens the venturi valve and turns off the fan. In flight radio rack cooling air flow is provided by differential pressure. Cargo compartment heating is not provided.

On the ground with the switch in the VENTURI position, the radio rack fan is turned on by the ground control relay.



CABIN/(DUCT) TEMPERATURE INDICATOR (CABIN TEMP.)

The indicator will show temperature at the location selected by TEMP SEL switch.

L & R SUPPLY SWITCHES

Each switch arms the respective augmentation valve controls the position of the air conditioning pressure regulator valve, the air conditioning flow control valve, and through the ground control relay controls the heat exchanger cooling air fan. OFF position closes air conditioning pressure regulator valve, the air conditioning flow control valve, closes the augmentation valve and (on the ground) shuts off the heat exchanger cooling air fan. HP BLD OFF position maintains augmentation valve at closed position, and all other functions as in auto. AUTO position opens air conditioning flow control valve, the pressure regulator valve, arms the augmentation valve, and on the ground, starts the heat exchanger cooling fan.

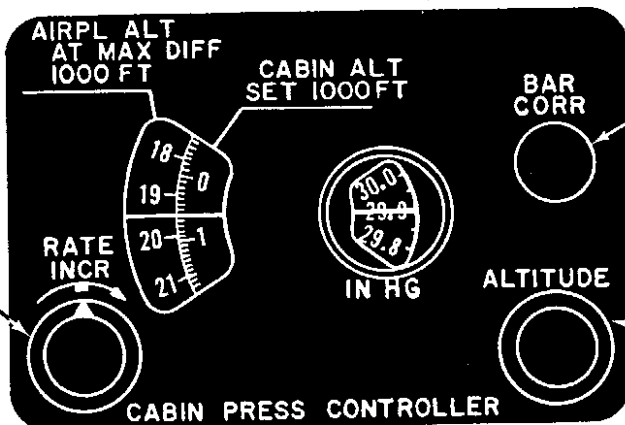
CABIN/FLIGHT COMPARTMENT TEMPERATURE SELECTORS (CKPT) TEMP/CABIN TEMP)

Each control provides automatic or manual control of temperature in the applicable compartment. The AUTO WARMER (automatic temperature control) range extends from a detent at the 8 o'clock position to a detent at the 4 o'clock position. When the control knob is moved beyond the detent positions, toward the MANUAL range, it becomes spring loaded to the STOP position. Movement from the STOP position toward HOT or COLD will move the air conditioning temperature control valve. Releasing the knob to STOP will stop movement of the valve. Valve position is shown by position indicators directly above the temperature controls.

BB1-1340

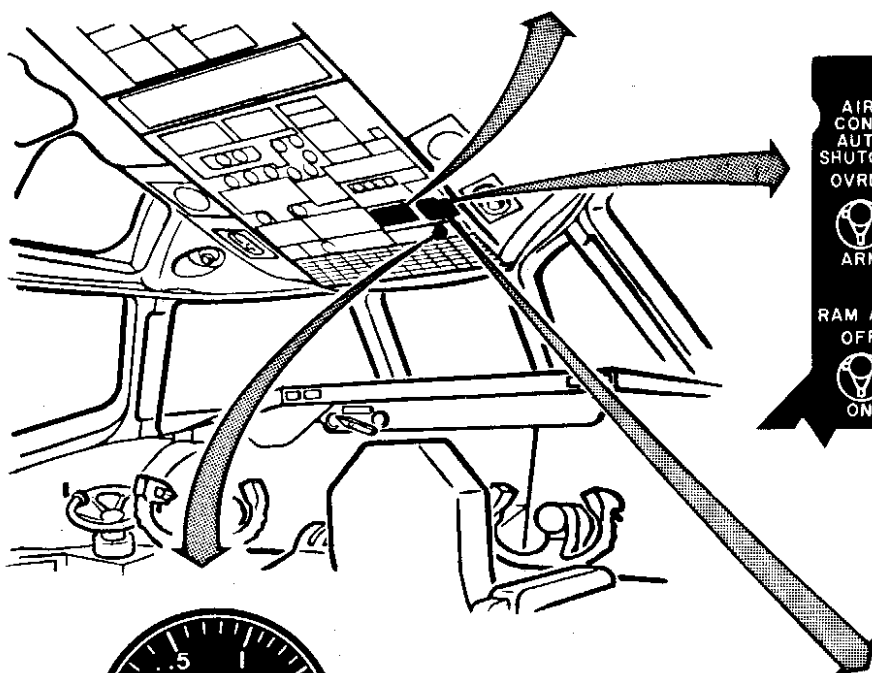
AIR CONDITIONING -- COCKPIT CONTROLS & INDICATORS (sheet 3)

RATE INCR CONTROL
 When set at index mark will maintain a cabin rate of climb of approximately 250 fpm.



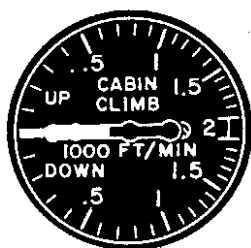
BAR CORR CONTROL
 Position is used to set correct airport barometric pressure reading in the IN HG window prior to takeoff or landing.

ALTITUDE CONTROL
 Prior to takeoff -- Used to set the expected cruise altitude reading in the AIRPL ALT AT MAX DIFF 1000 FT window. Prior to landing -- Used to set the altitude of the destination airport in the CABIN ALT SET 1000 FT window to assure that cabin altitude will equal airport altitude upon landing.



AIR COND AUTO SHUTOFF Switch
 When positioned to ARM deactivates air conditioning systems in the event of single engine failure during takeoff. Positioned to OVRD returns systems to normal.

RAM AIR
 The ON and OFF positions open and close the ram air valve in the air conditioning system. ON position opens the valve and allows ram air to enter the conditioned air ducts of both air conditioning systems at a point prior to the mixing chamber.



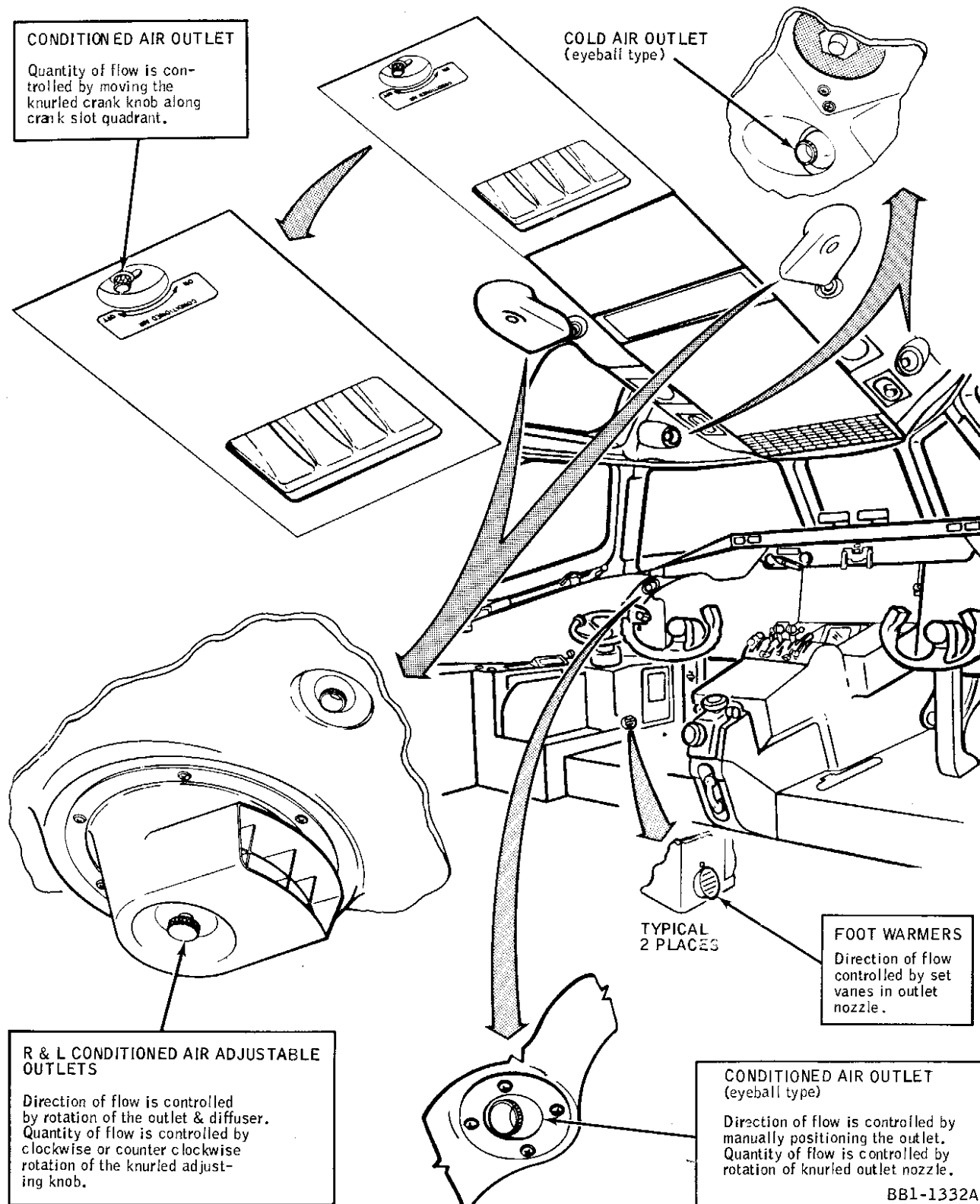
CABIN RATE OF CLIMB INDICATOR (CABIN CLIMB)
 The CABIN CLIMB indicator is a standard rate of climb instrument. It is vented to cabin pressure to indicate the rate of climb of the cabin rather than that of the aircraft. It is used to monitor the rate of change in cabin pressurization during automatic or manual pressurization control.

CABIN DIFFERENTIAL PRESSURE AND ALTITUDE INDICATOR (CABIN ALT & DIFF PRESS PSI)
 The indicator is an altimeter & pressure gauge with separate vents to atmospheric and cabin pressure. The outer CABIN ALT dial will indicate the existing cabin altitude in thousands and hundreds of feet. The inner DIFF PRESS dial will show the difference in pressure between the cabin and the outside of the aircraft in psi. The inner dial provides a means of monitoring fuselage pressurization during automatic or manual control of pressurization. The DIFF PRESS dial has a red radial at 8 PSI to indicate the operating limit.



BB1-153E

AIR CONDITIONING -- COCKPIT CONTROLS & INDICATORS (sheet 4)



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system passes through a mixing chamber and sound suppressor for distribution to the passenger and flight compartment. Conditioned air for the cabin is discharged from continuous outlets below the overhead stowage rack and from an overhead diffuser in the passenger entryway. Conditioned air for the flight compartment is discharged through two foot warmers, two adjustable nozzles adjacent to forward instrument panel, and three adjustable overhead diffusers.

RADIO RACK COOLING AND AIRPLANE AIR EXHAUST

The radio rack (electrical/electronics compartment) cooling and forward lower cargo compartment heating is provided by conditioned air from the flight and passenger compartments. Flight compartment air is ducted through the electrical/electronics installation. This air along with cabin air ducted through the electrical accessory compartment heats the double floor of the lower forward cargo compartment when the radio rack fan switch is positioned to FAN. When positioned to VENTURI cargo compartment heating is not provided and the air is discharged overboard through the venturi.

On the ground and in flight, the radio rack fan will ensure electrical/electronics compartment cooling. Air discharges from the cabin through a continuous outlet at the bottom of the cabin side panels into tunnels on either side of the cargo compartments. In the area of the aft lower cargo compartment, the right tunnel air is ducted under the cargo compartment floor to the left tunnel to provide cargo compartment heating. From the left tunnel, air passes to the outflow valve and is discharged overboard. Air from the passenger compartment

also discharges through small venturi-type outlets in the areas of the galley and lavatories for ventilation.

APU GROUND COOLING

The APU can be used to supply air conditioning to the flight and passenger compartments while the airplane is on the ground. There is ample bleed air pressure from the APU through the pneumatic system to provide air conditioning for the airplane. The bleed AIR switch in the ON position, supplies electrical power to the APU bleed control valve, thereby providing APU pneumatic bleed air to the airplane pneumatic system. The 95% rpm MASTER bleed air switch must be armed. The AIR COND COLDER position provides increased differential bleed air pressure across the air conditioning cooling turbine for additional air conditioning. The OFF position discontinues electrical power to the APU bleed air control valve and the pneumatic shutoff valve circuits.

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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 19, SECTION 3, CHAPTER 50, DATED MAR 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

3-50-1-0 REVISED TO SHOW ELECTRICAL CONNECTION BETWEEN ICE PROTECT SUPPLY PRESS HI ANNUNCIATOR LIGHT AND THE MASTER CAUTION SYSTEM.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
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3-50-1-0	6	3	3-50-1-0	6	3

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MODEL DC-9

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CHAPTER 3-50

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Chapter 50

ICE AND RAIN PROTECTION SYSTEMS

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Chapter 50

ICE AND RAIN PROTECTION SYSTEMS

GENERAL

The airplane ice protection systems employ hot air and electrical resistance heating for anti-icing, and defogging functions. Rain removal is accomplished by chemical repellent and mechanical wipers.

Heated air for thermal anti-icing of wing slat leading edge and ram air-scoop, and for de-icing the horizontal stabilizer leading edge, is supplied by the engine 8th-stage bleed air, supplemented as necessary by the 13th-stage (high-pressure) bleed air. Separate systems control anti-icing of the engine compressor guide vanes and bullet and of the engine nose cowl. A crossfeed duct system permits airfoil heat to be supplied from either or both engines.

Electrical resistance coatings provide heat for anti-icing and antifogging on the pilots' three windshields, and for antifogging the clearview and eyebrow windows. The windshield electrical resistance coatings which provide heat for anti-ice also provide the heating required for bird impact resistance.

Electrical resistance elements are used for anti-icing the pitot tubes, static port areas, angle of attack vanes, and ram air temperature probe.

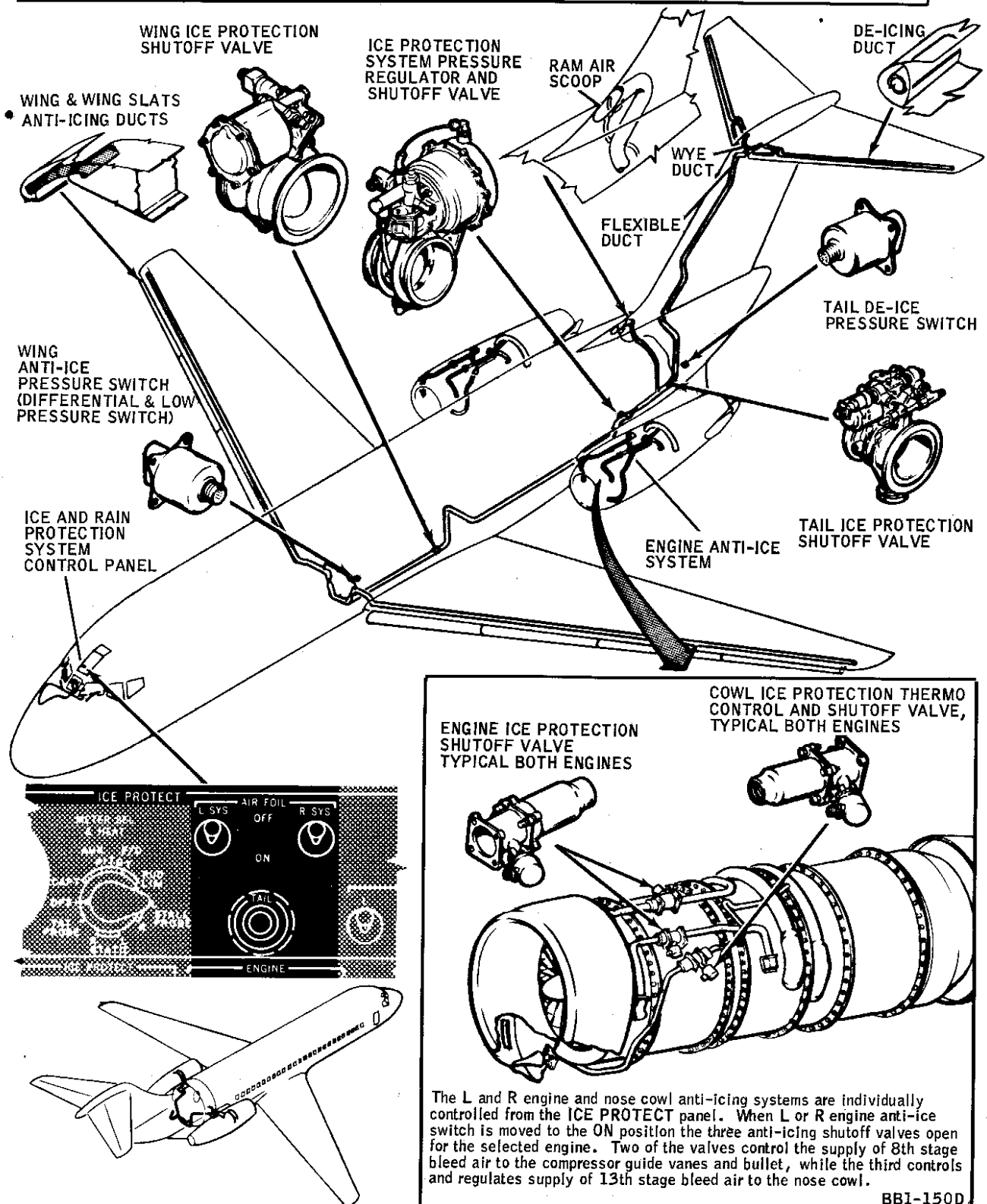
AIRFOIL AND ENGINE ICE PROTECTION

The airfoil ice protection system provides anti-icing heat to the wing leading edge and to the air-conditioning ram air scoop inlet in

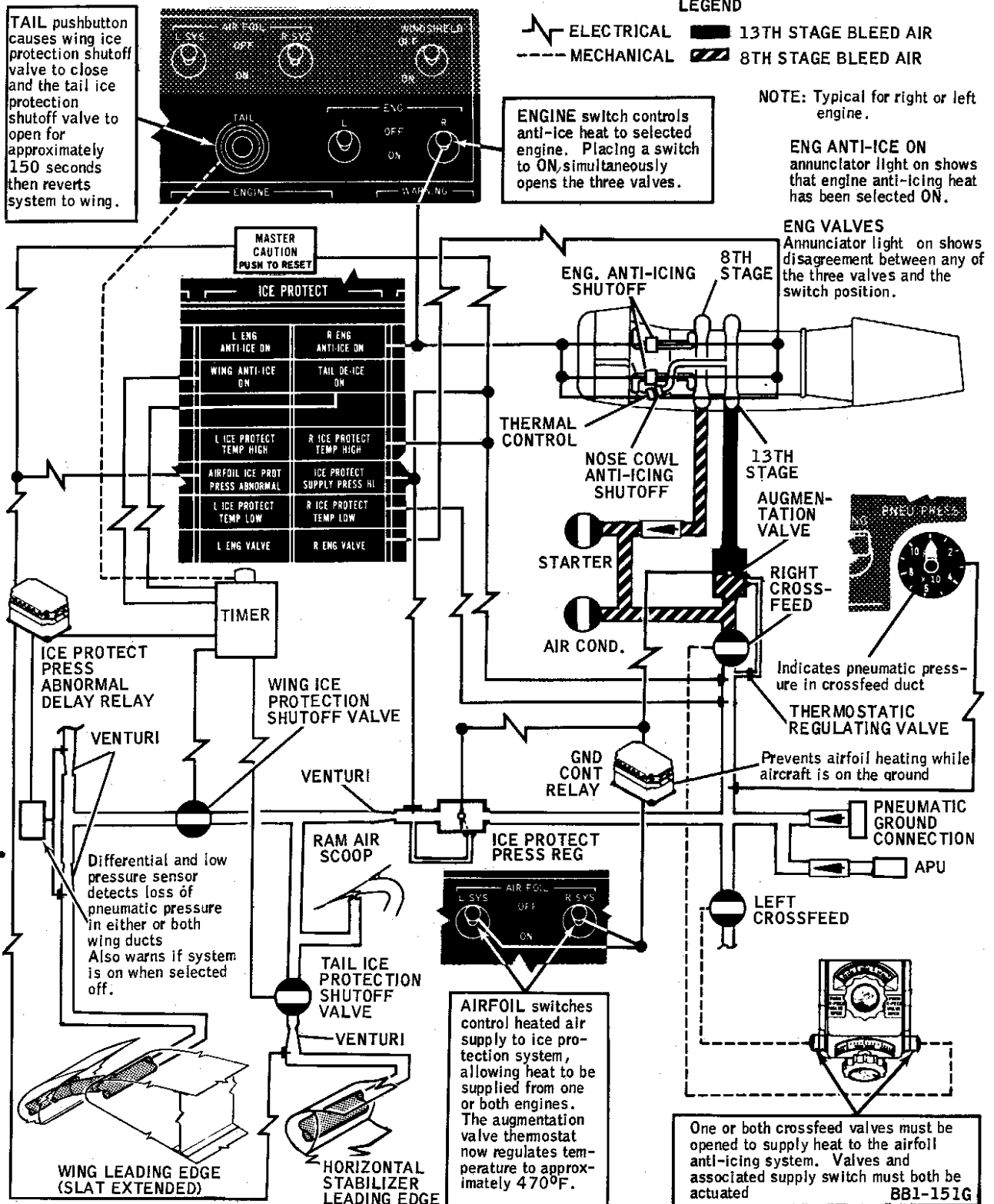
flight when one or both of the airfoil switches and associated cross-feed valves are actuated. De-icing is available to the horizontal stabilizer leading edge when selected by operating the tail pushbutton on the ice protection panel, thereby diverting the flow of heated air from the wing ducts to the stabilizer. At the end of the timed de-icing period, flow reverts to the wing slat ducts again. Wing slat anti-icing is accomplished through a duct in the leading edge of each wing that is connected to a duct in the leading edge of each slat. These two ducts are connected by a single duct that incorporates a slip joint and telescopic section to maintain pneumatic flow with the slats extended or retracted. When the slats are extended anti-icing of the wing slat leading edge is maintained by hot air exhausted from small openings in the aft surface of the slat. Interlock of the airfoil ice protection control valves through the ground control relay prevents flow of heated air to these surfaces until the airplane becomes airborne.

Engine anti-ice protection is provided by independent systems, controlled by individual switches located on the ice protection panel. Each system (right and left) provides ice protection for the respective engine nose cowl, inlet bullet, and inlet guide vanes.

ICE & RAIN PROTECTION -- MAJOR COMPONENT LOCATION - Airfoil & engine ice protection system



ICE & RAIN PROTECTION -- AIRFOIL & ENGINE ANTI-ICING SYSTEM -- Functional schematic

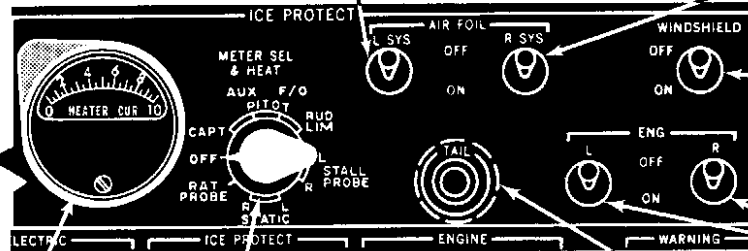


ICE & RAIN PROTECTION -- COCKPIT CONTROLS & INDICATORS (sheet 1)

AIRFOIL SWITCH

L SYS ON OFF switch actuates the ice protection pressure regulator valve, allowing engine 8th stage bleed air to flow into the wing anti-icing system. It also activates the left augmentation valve, allowing it to open as necessary to raise duct temperatures to the 232-254°C (450-490°F) range.

R SYS ON OFF switch function is the same as for L SYS except that it activates the R augmentation valve. Switches may be ON singly or together.



HEATER CUR ammeter
 Monitors current flow in heater circuit selected by meter sel and heat switch.

METER SEL & HEAT SWITCH
 When switch is moved from the OFF position all heater circuits are energized. Switch provides DC power to the integral pitot heating elements, and AC power to the RAT probe, static port, stall probes, and rudder Q limiter pitot heating elements. During ground operation ram air temperature probe heating is not provided.

TAIL pushbutton switch
 closes wing ice protection shutoff valves and opens tail ice protection shutoff valve for timed period of approximately 2 1/2 minutes then returns heat to wings.

WINDSHIELD ON-OFF switch
 controls anti-icing and anti-fogging heat to flight compartment windshields, and anti-fogging heat to the clear view and upper windows.

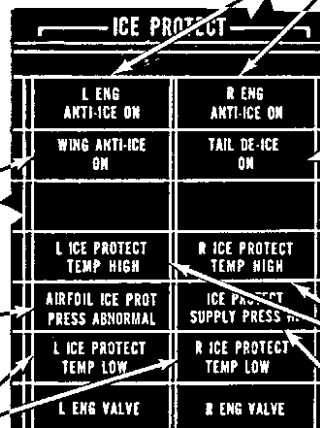
ENGINE L or R (ON-OFF) SWITCH
 When placed to ON opens the respective engine anti-icing shutoff and regulator valves, admitting 8th stage bleed air to the compressor guide vanes and bullet. The ENG switches also open the nose cowl anti-icing shutoff valve, admitting 13th stage bleed air to the engine nose cowl. ENG ANTI-ICE ON light comes on when switch is at ON. ENG VALVE light will come on if there is a position disagreement between the three anti-ice valves and the switch positions.

LEFT (RIGHT) ENG. ANTI-ICE ON light
 indicates L & R engine anti-ice switches are on. Switch actuates 3 valves; 2 for engine inlet area & 1 for nose cowl.

WING ANTI-ICE ON light
 indicates anti-icing heat has been selected for the wing leading edge.

AIRFOIL ICE PROT PRESS ABNORMAL light
 indicates low or unbalanced pressure in wing or low pressure in the horizontal stabilizer leading edges.

LEFT (RIGHT) ICE PROTECT TEMP LOW light
 indicates temperature 199°C (390°F) or below in the pneumatic crossfeed duct. This indicates that temperature is too low due to low engine power or a malfunction in the respective temperature control system.



TAIL DE-ICE ON light
 indicates de-icing heat has been selected for the leading edge of horizontal stabilizer. This timer-controlled valve opens for approximately 2 1/2 minutes when TAIL de-ice button on the ICE PROT panel is depressed. Switch action also closes the wing anti-ice valve during this period.

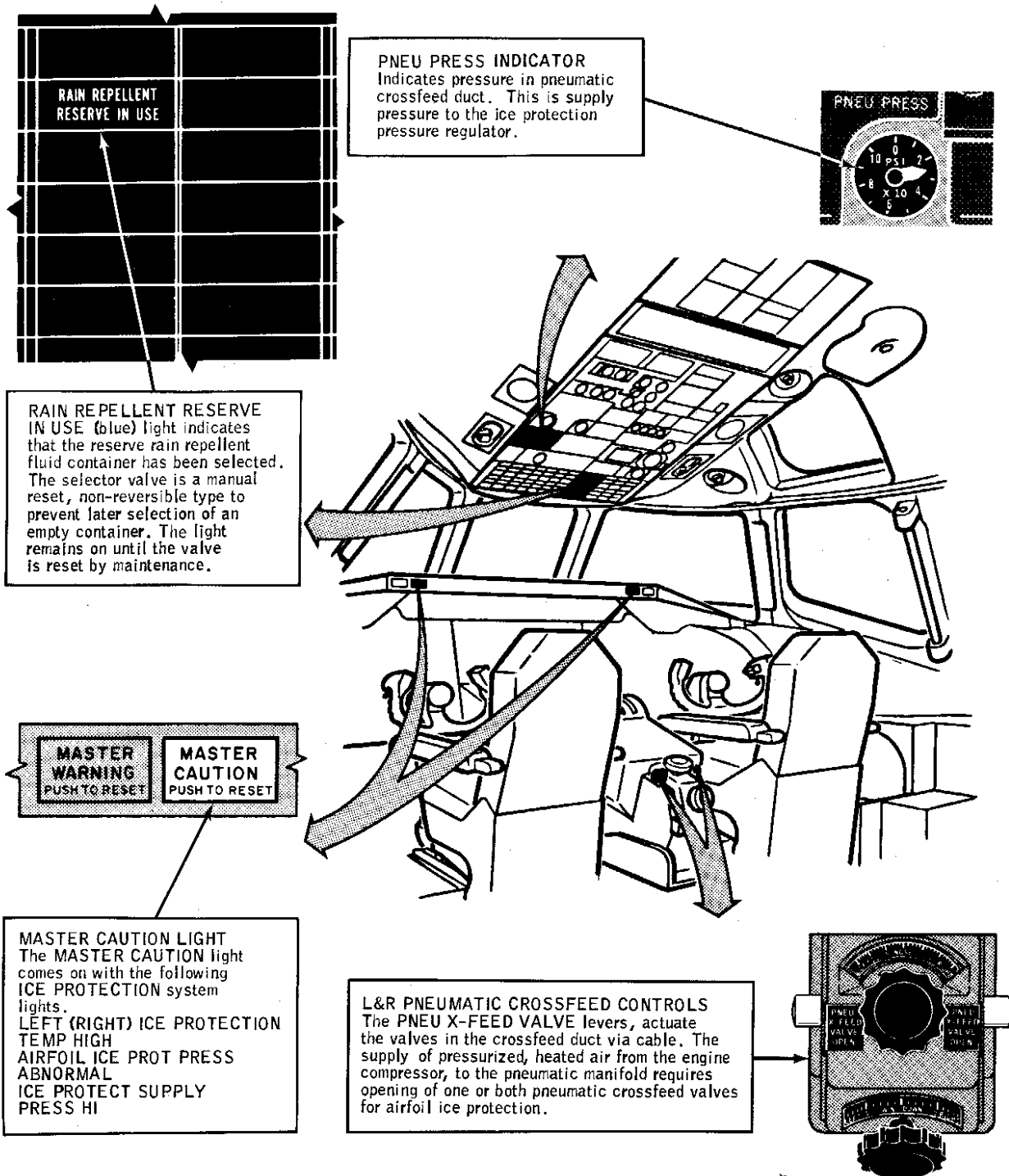
LEFT (RIGHT) ICE PROTECT TEMP HIGH light
 indicates air delivered to the crossfeed duct is above approximately 265°C (510°F) indicating malfunction of the respective temperature control system.

LEFT (RIGHT) ENG VALVE light
 indicates disagreement between any of the three anti-ice valves and the switch positions.

ICE PROTECT SUPPLY PRESS HI light
 indicates excessive duct pressure from malfunction of the ice protection pressure regulating valve.

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ICE & RAIN PROTECTION -- COCKPIT CONTROLS & INDICATORS (sheet 2)

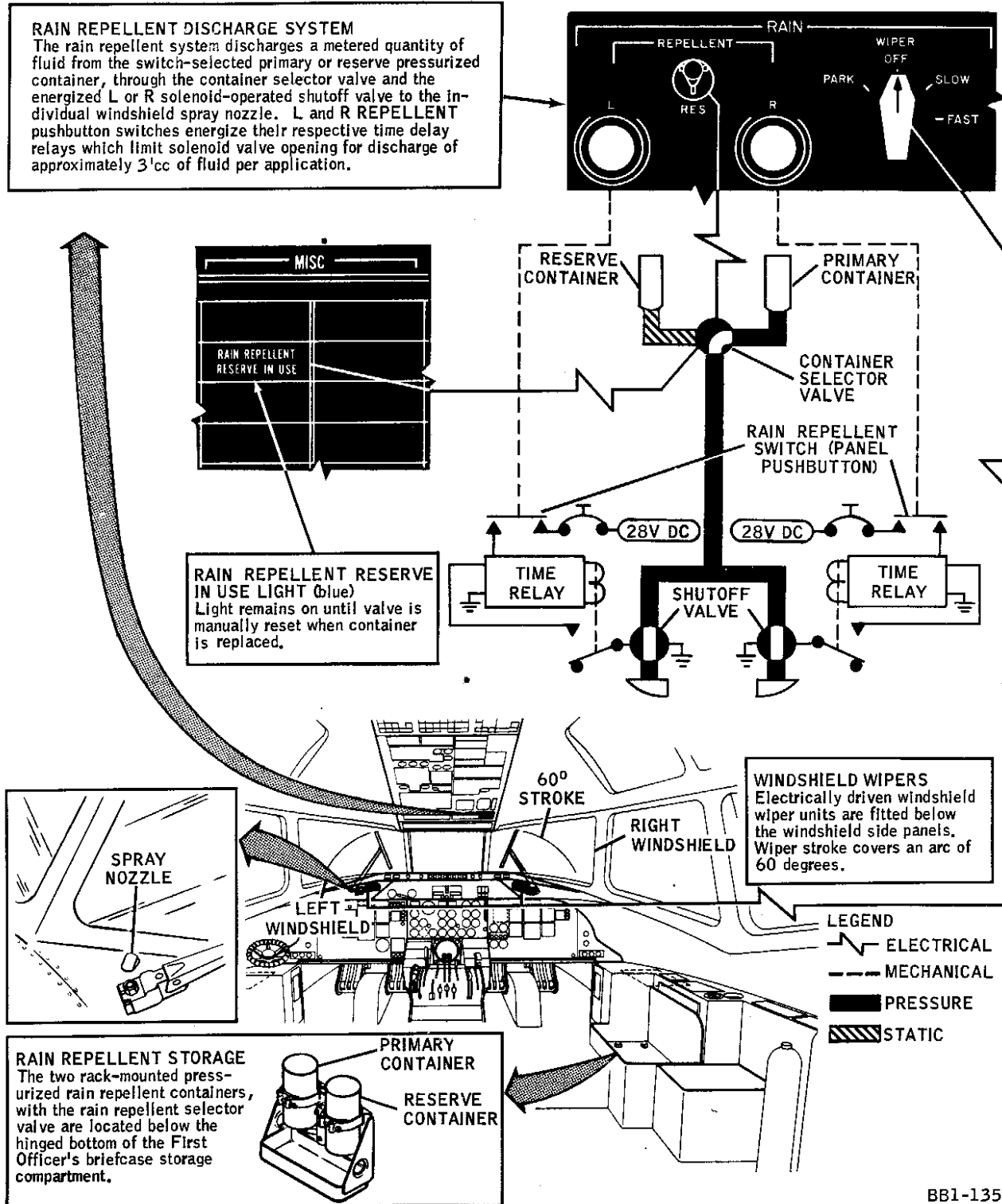


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ICE & RAIN PROTECTION -- WINDSHIELD ANTI-ICE & FOG FUNCTIONAL SCHEMATIC (sheet 1)

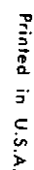
RAIN REPELLENT DISCHARGE SYSTEM

The rain repellent system discharges a metered quantity of fluid from the switch-selected primary or reserve pressurized container, through the container selector valve and the energized L or R solenoid-operated shutoff valve to the individual windshield spray nozzle. L and R REPELLENT pushbutton switches energize their respective time delay relays which limit solenoid valve opening for discharge of approximately 3'cc of fluid per application.

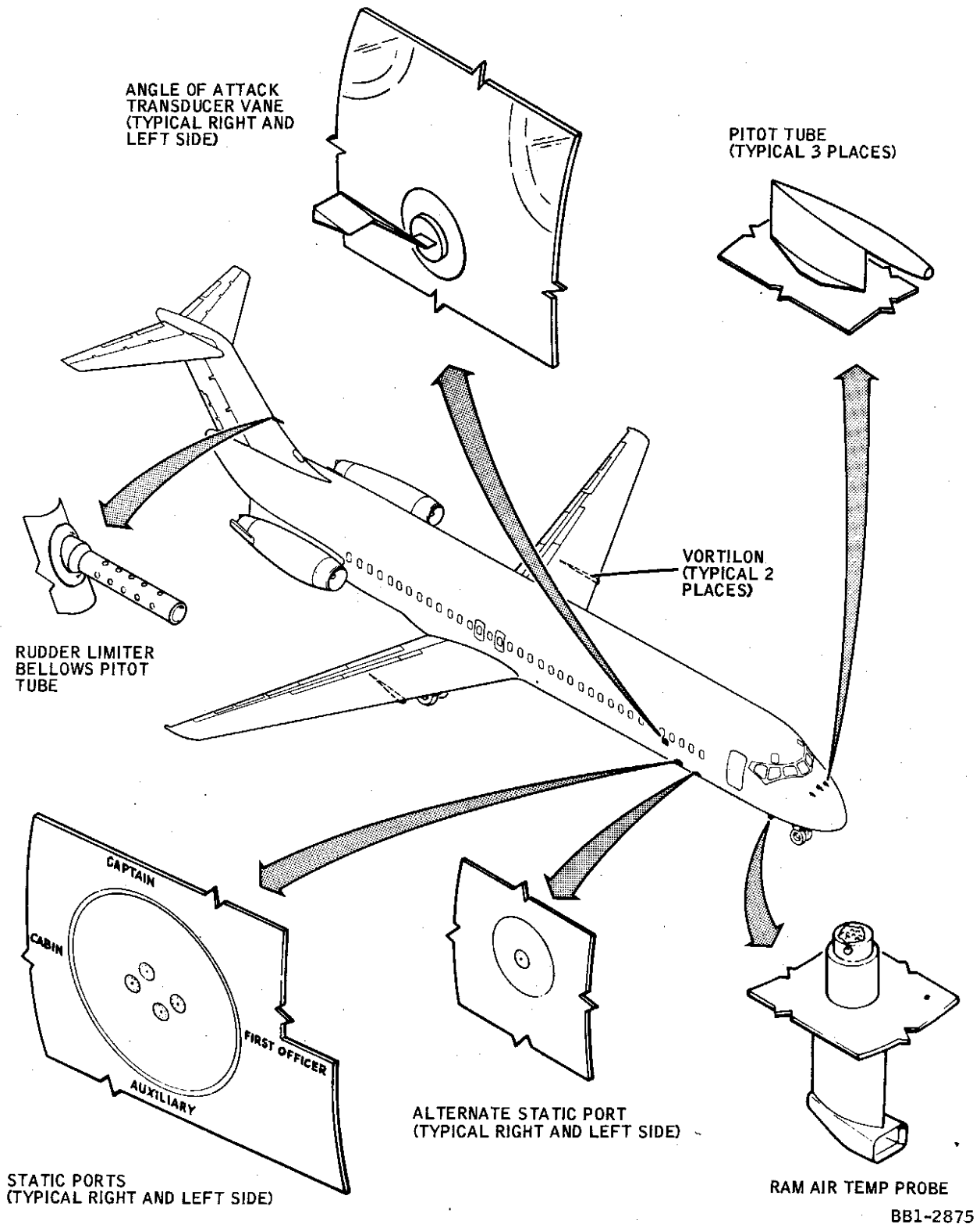


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**ICE & RAIN PROTECTION -- WINDSHIELD ANTI-ICE RAIN & FOG
FUNCTIONAL SCHEMATIC (sheet 2)**



**ICE & RAIN PROTECTION -- PITOT, STATIC, STALL WARNING & RAM AIR
TEMP ANTI-ICING MAJOR COMPONENT LOCATION**



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(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 20, SECTION 3, CHAPTER 55, DATED JUN 1/70

SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

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Chapter 55

INSTRUMENTATION, NAVIGATION, AND COMMUNICATION SYSTEMS

GENERAL

Miscellaneous instrumentation, navigation, and communications equipment and systems are covered in this chapter. Detailed descriptive information is provided for instruments and components associated with navigation of the airplane, radio aids to navigation and navigational systems and components, and for communications systems and components, in each of the individual sections of the chapter.

INSTRUMENTATION

The coverage of airplane instrumentation in this chapter supplements information provided in other chapters and includes descriptive information on the following systems and related components:

1. Pitot static system instruments and related components
2. Gyrosyn compass system
3. Flight director system and related components
4. Speed command system
5. Automatic throttle system
6. Flight recorder system
7. Standby magnetic compass, turn-and-slip indicator, and clock.

PITOT/STATIC SYSTEMS

The pitot/static systems provide indications of airplane airspeed, Mach number, altitude, rate of climb and descent, and overspeed warning. The pitot/static instruments consist of a group of pressure-actuated instruments operated from the airplane pitot and static pressure systems.

STATIC SELECTOR VALVES

The static selector valve knob is located outboard of each pilot's instrument panel. The selector valves are placarded NORM and ALT. Placing either the captain's or first officer's control knob in the ALT position provides the corresponding static system with an alternate static pressure source.

MACH/AIRSPEED INDICATORS

Two Mach/airspeed indicators are used on the airplane, one each on the captain's and first officer's instrument panels. Each indicator is a differential-pressure measuring instrument that continuously senses total and static pressures from the pitot and static systems and presents the results simultaneously as Mach number information and indicated airspeed. Mach is indicated by the airspeed pointer on a moving scale that covers the range of 0.4 to 1.0 Mach. Airspeed is indicated by the moving pointer on a fixed scale covering the range of 60 to 400 knots. Maximum allowable airspeed is indicated by a barber pole at 350 knots on the airspeed scale. Mach limitation is indicated by a barber pole on the Mach scale at 0.84.

BAROMETRIC ALTIMETER INDICATORS

Two barometric altimeter indicators are used on the airplane, one each on the captain's and first officer's instrument panels. Each indicator is an absolute-pressure-measuring instrument that continuously senses static air pressure from the airplane static pressure system and translates the data into pressure altitude units.

The indicator has a range of -1000 to 50,000 feet, indicated by a drum and pointer. A digital counter on the indicator, calibrated in inches of mercury, is used to indicate barometric pressure setting. The barometric pressure is manually set by using the knob on the front of the indicator. A vibrator, attached to the back of each barometric altimeter, eliminates effects of internal mechanical friction.

INSTANTANEOUS VERTICAL SPEED INDICATORS (IVSI)

Two inertial-lead vertical speed indicators are used on the airplane, one located on the captain's instrument panel, and the other on the first officer's instrument panel. Each indicator operates from the airplane static pressure system and provides instantaneous display of airplane vertical speed in the range of 0 to 6000 feet per minute, up or down. Pneumatic accelerometers within the indicator eliminate lag by providing instantaneous response without overshoot. The instantaneous vertical speed indicator should not be used during entry and recovery from steeply banked turns.

OVERSPEED WARNING

One overspeed warning sensor is used to provide warning when indicated

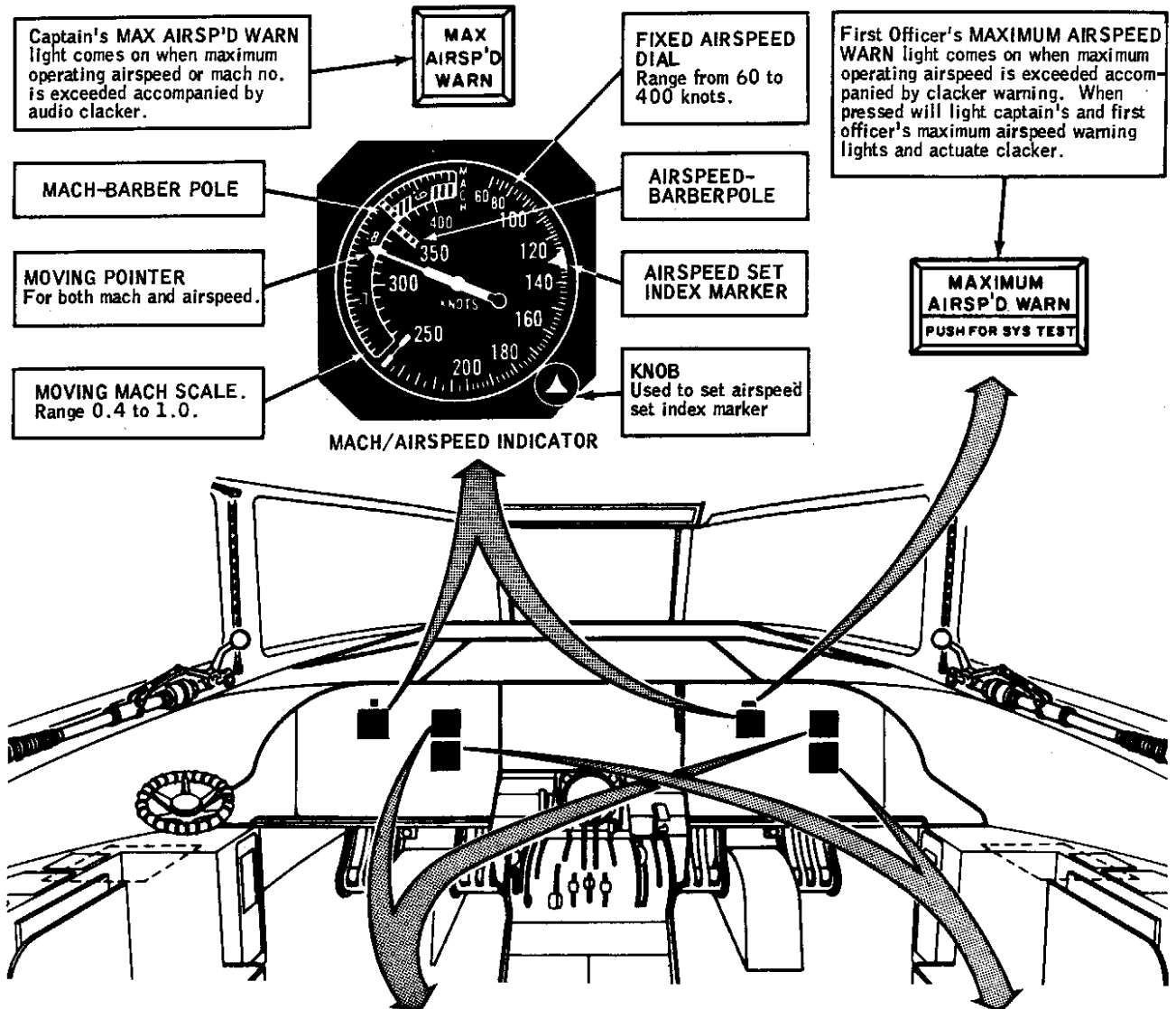
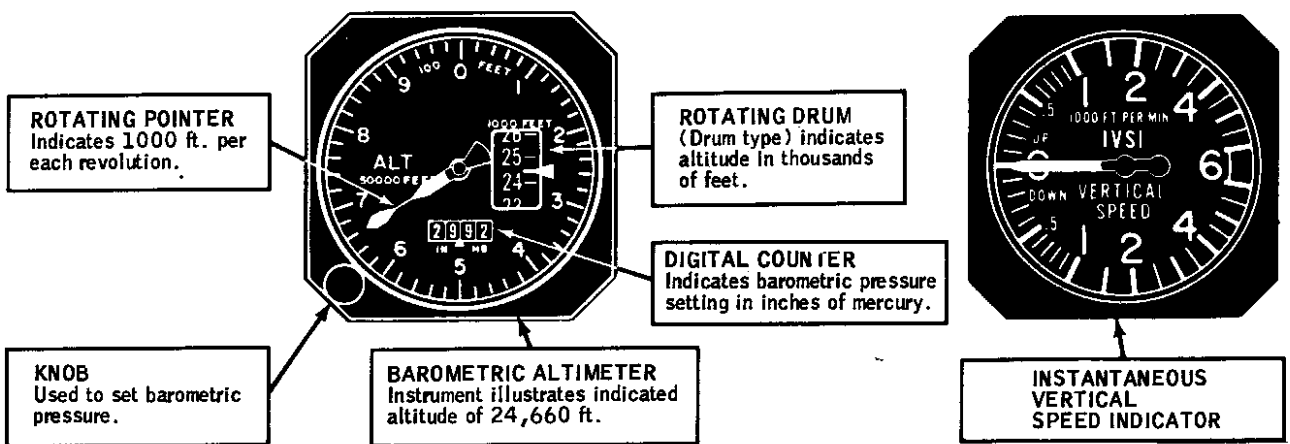
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airspeed exceeds 350 knots (for altitudes from sea level to 25,850 feet) and when the Mach number exceeds 0.84 (for altitudes above 25,850 feet). The differential-pressure-operated sensor provides a signal to light the maximum airspeed warning lights on the captain's and first officer's instrument panels and to actuate an aural warning clacker located in the left console. The first officer's warning light includes a system press-to-test feature that turns on the captain's and first officer's warning lights and actuates the clacker.

AIR DATA COMPUTER

The air data computer is installed in the electrical/electronics compartment. The computer supplies altitude information to the autopilot and flight directors for altitude hold, vertical speed information to the autopilot, and "q" switching for the autopilot gains. Mach information is also supplied to the Mach trim compensator.

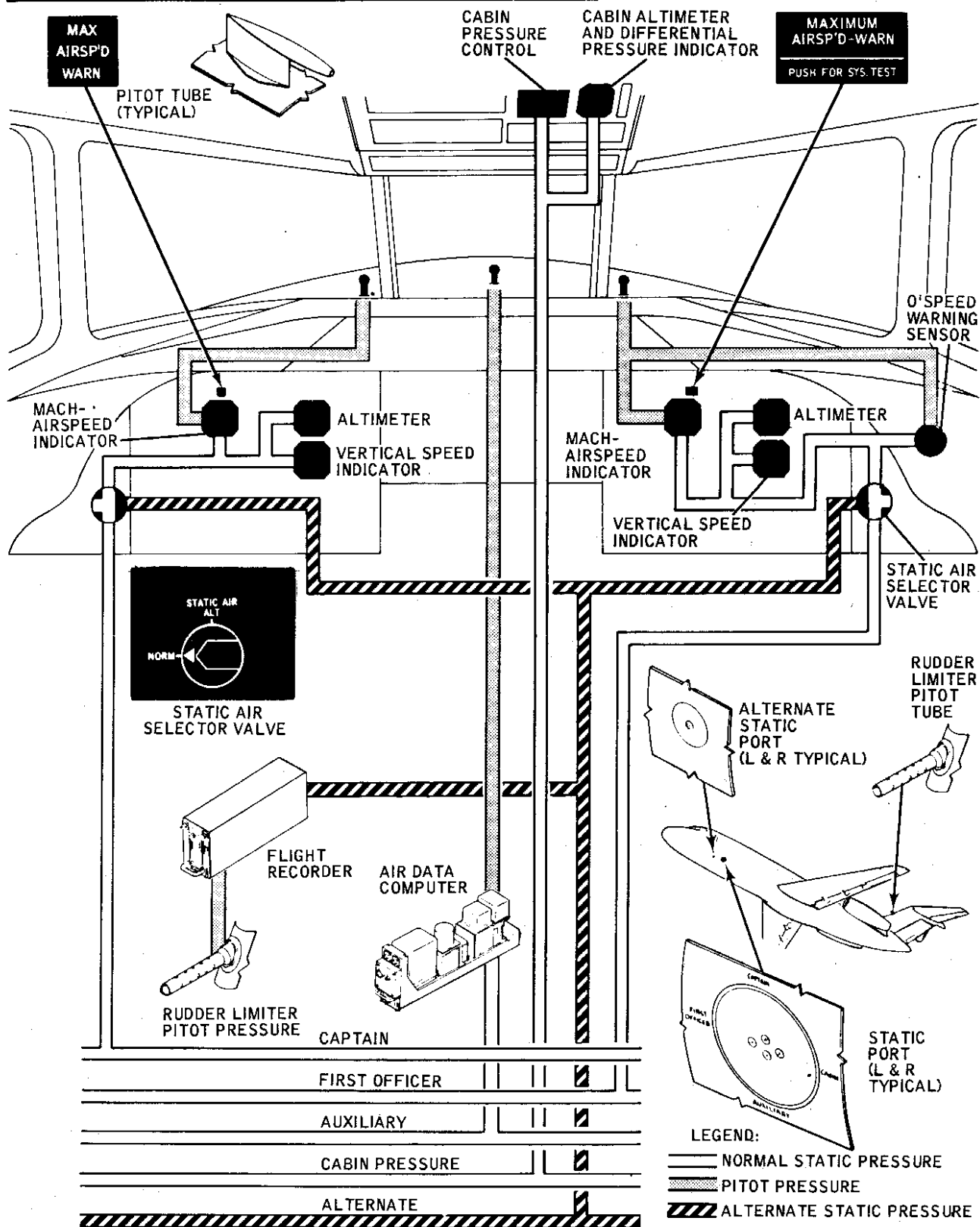
INST/NAV/COMM -- PITOT STATIC SYSTEM INSTRUMENTS



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INST/NAV/COMM -- PITOT STATIC SYSTEM



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GYROSYN COMPASS SYSTEMS

Two independent, slaved gyrosyn compass systems are installed in the airplane. Flux valves in the wings sense direction of the earth's magnetic field and transmit a magnetic heading signal, which is compared to the compass card. If an error exists between the sensed magnetic heading and the compass card indication, the error signal is amplified, and it then precesses the directional gyro. The gyro heading signal then positions the compass card until the indicator is in agreement with the sensed magnetic heading signal. A synchronizing knob on the compass indicator is used to manually synchronize the system. Slaving error of the system is indicated by an annunciator on the compass indicator.

Heading signals from the captain's compass indicator supply heading information to the following systems or units:

1. VOR/LOC receiver No. 2
2. First officer's course indicator.

Heading signals from the first officer's compass indicator supply heading information to the following systems or units:

1. VOR/LOC receiver No. 1
2. Captain's course indicator
3. Flight recorder.

NOTE: The automatic pilot receives heading select information from the captain's course indicator which receives heading information from the first officer's (No. 2) compass system.

Warning flags on the captain's or first officer's compass indicator appear when any of the following malfunctions occur:

1. Electrical power failure to the compass system
2. Directional gyro not leveling
3. Directional gyro speed incorrect
4. Excessive heading error signal
5. Gimbal error of the directional gyro exceeds 45 degrees.

Operation of the captain's and first officer's compass systems are continuously monitored by the instrument failure warning system. The functions monitored are automatically selected, and depend upon the flight mode (take-off, cruise, approach, or go-around). Significant functions of the captain's and first officer's systems are monitored and compared for each flight mode. Instrument failure warning indications related to the compass systems are covered in the description of the instrument failure warning system, 55-15-0.

INST/NAV/COMM -- GYROSYN COMPASS SYSTEM - Controls & indicators

ANNUNCIATOR

When error exists in compass card reading annunciator pointer is off center, resulting in a + indication or an • indication. These indications correspond to the direction synchronizing (sync) knob is to be turned to correct error in heading display. Pointer centered between the + and • symbols, indicates correct heading display.

NO. 1 ADF/VOR POINTER

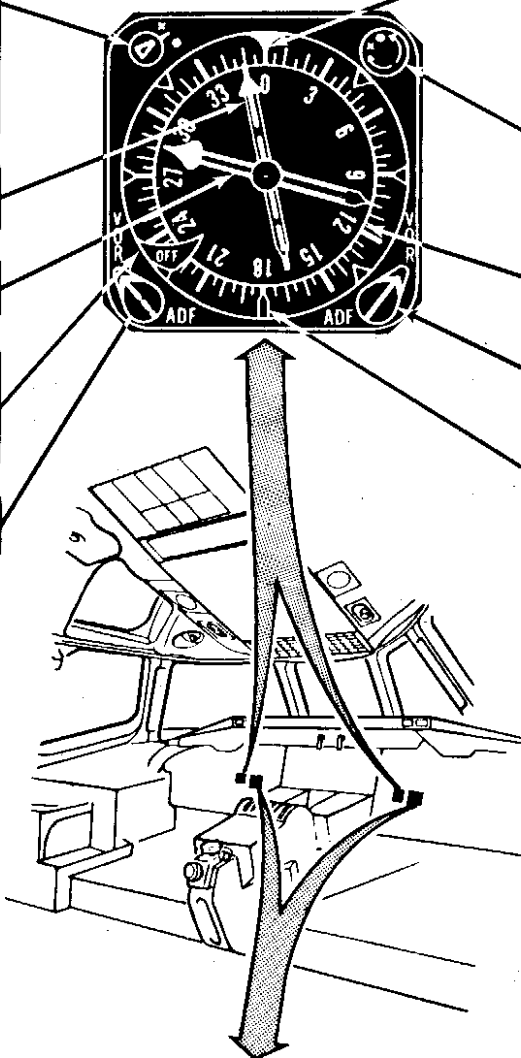
NO. 2 ADF/VOR POINTER

WARNING FLAG

When in view, indicates all compass card information displayed on indicator is unusable.

NO. 1 ADF/VOR SELECTOR KNOB.

COMPASS INDICATORS



LUBBER LINE

Rotating heading card is read against lubber line. Shows actual compass heading of airplane when system is properly synchronized.

SYNCHRONIZING (SYNC) KNOB

To use, push and turn in direction indicated by annunciator. When pointer indicates + turn knob clockwise. When pointer indicates •, turn knob counterclockwise.

ROTATING HEADING CARD

NO. 2 ADF/VOR SELECTOR KNOB

RECIPROCAL HEADING MARKER
Shows reciprocal compass heading

COURSE INDICATORS

WARNING FLAG

When in view, indicates all compass card information displayed on indicator is unusable.



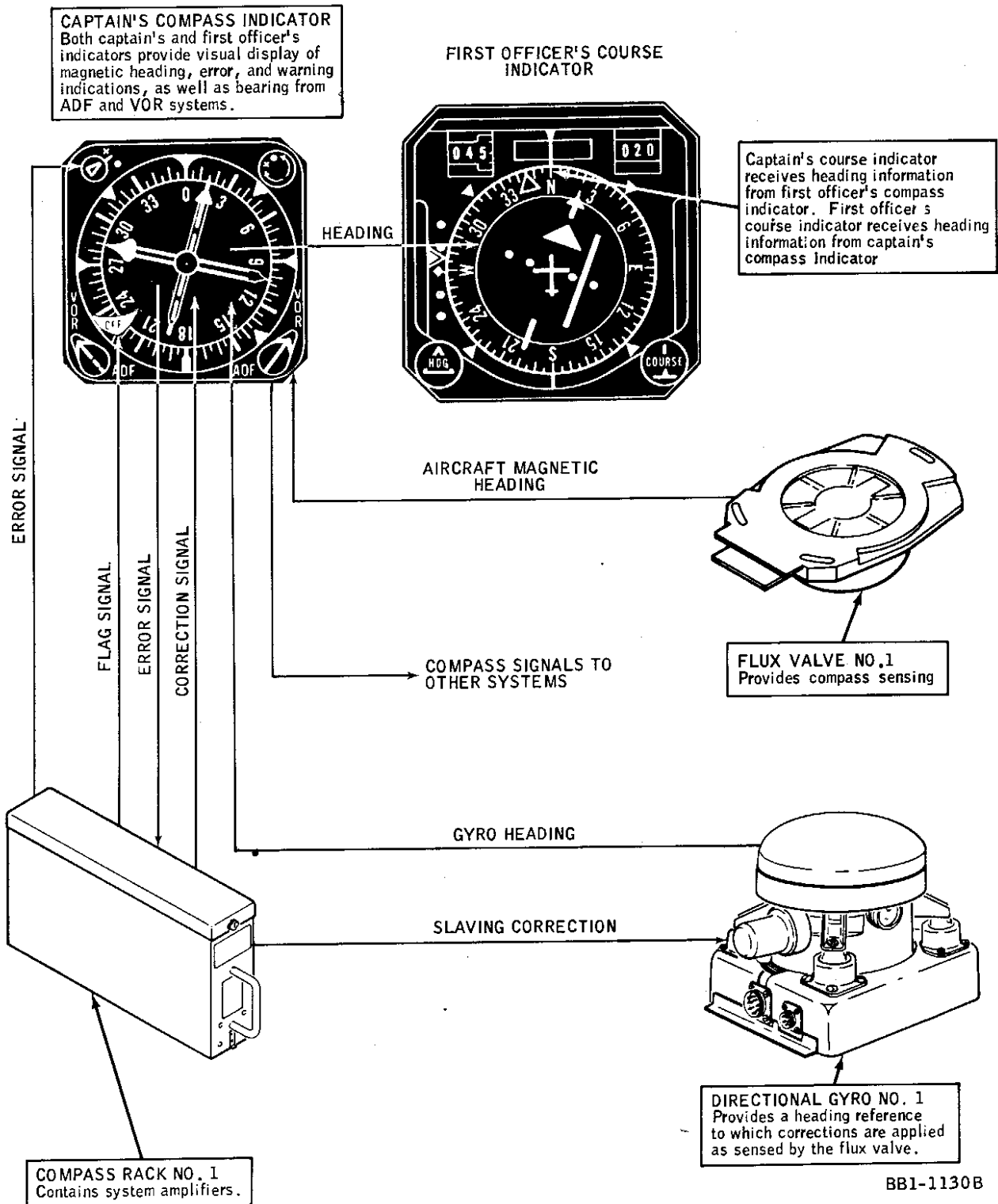
HEADING CARD

Repeats compass heading indicated by the rotating heading card of the compass indicator.

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BB1-462C

INST/NAV/COMM -- GYROSYN COMPASS SYSTEM -
Functional schematic



BB1-1130B

FLIGHT DIRECTOR SYSTEM

GENERAL

The flight director system provides visual displays to assist the flight crew in navigation and control of the airplane. A flight director indicator and course indicator are provided for each pilot. The captain's and first officer's flight director instruments function, essentially, as two separate systems. In addition to the flight director and course indicators, a speed command (SC) light and switch, captain's and first officer's manual ILS switches, and captain's and first officer's mode annunciators are included. Flight director modes of operation are: OFF, HDG (Heading), N/L (navigation/localizer), ILS (instrument landing system) automatic and manual capture operation, and SC (speed command). The OFF, HDG, N/L, or ILS modes are selected at the flight director indicator; manual ILS operation is selected with the FLT; DIR MANUAL ILS switches; and the SC mode may be selected with the SC light and switch, or by throttle palm switches (refer to Speed Command System, 55-5-25). The flight director section of the captain's and first officer's mode annunciators display existing flight conditions; N-L ARM, G-P ARM, G-P CAP, or G-P EXT for the N/L or ILS modes of operation, ALT HLD for altitude hold, or SP COMD for the speed command mode.

NOTE: The speed command system is covered as a separate system (refer to 55-5-25). The captain's and first officer's annunciators also display the existing speed reference mode, in the speed command section of the annunciators, for T-0 (takeoff), APPR (approach) or GO-ARND (go-around). During

all operating modes of the flight director, operation of the SLOW-FAST indication on the flight director provides continuous indications of deviation from the computed speed reference.

The flight director system consists of two essentially separate flight director systems, one for the captain and one for the first officer. Significant functions are monitored or compared for various flight conditions (takeoff, cruise, approach, and go-around).

Compared functions are as follows:

1. Attitude (HORIZON), flight director indicators
2. Compass (HDG), course indicators
3. Localizer signal (LOC), VHF NAV receivers
4. Glide slope signal (GP), glide slope receivers
5. Speed command (SPD COMD), speed command computers
6. Radio altimeters (RAD ALT), radio altimeter systems.

Monitored functions are as follows:

1. Vertical gyro and attitude displays
2. Compass system and related displays
3. VHF NAV receivers
4. Glide slope receivers
5. Speed command computer
6. Flight director computers
7. Flight director command servo loops
8. Radio Altimeters

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System failures of either flight director are monitored by the instrument failure warning system. Failure of a monitored function will result in a warning flag at the associated instrument. A red-arrow indication on the instrument failure warning annunciator may also appear, depending upon the existing flight mode.

When a significant discrepancy exists between compared functions, the comparator unit of the instrument failure warning system senses the discrepancy and provides an amber warning indication in the center of the instrument failure warning annunciator. Whenever a warning flag is present, the flag will override the comparator, and no comparator light will appear.

FLIGHT DIRECTOR INDICATOR

Basically the flight director indicator provides attitude information as the relationship between a fixed airplane symbol at the center of the indicator and a movable-horizon background. Computed pitch and roll command information is also displayed by a V-command bar. The mode selector knob controls the inputs to the V-command bar, and a PITCH CMD knob permits selection of pitch attitude references in the HDG and N/L modes and in the ILS mode before glide slope capture. Command information for capturing and maintaining the pre-selected, desired flight path is displayed by the relative position of the V-command bar and the fixed airplane symbol. The airplane is maneuvered to fly the airplane symbol to the V-command bar. The HDG mode of operation normally precedes either N/L or ILS modes.

With the FLT/DIR MANUAL ILS switch in the OFF position, the airplane approaches the edge of the beam on the selected heading. At the beam edge,

the flight director provides a V-bar command for an asymptotic capture (gradual capture) of the selected radial or localizer. If N/L or ILS modes are used for beam intercept without first selecting or switching through HDG position of the mode selector switch, the flight director will immediately display a roll command for beam capture outside the beam edge. In N/L or ILS mode, when tuned to a localizer frequency, placing the FLT DIR MANUAL ILS switch in the ON position will force immediate capture of localizer course and glide slope. The flight director V-command bar will display roll commands to intercept and fly localizer course and pitch commands to fly glide slope. The flight director indicators also display glide slope and localizer deviations.

NOTE: During HDG mode, steering commands to capture the desired heading are displayed by the V-command bar. During N/L and ILS modes, steering commands to capture and track the selected course are displayed by the V-command bar.

The ALTITUDE HOLD switch may be engaged when operating in HDG, N/L, or ILS mode prior to glide slope capture. When in the ON position, the V-command bars will indicate pitch attitude necessary to maintain the altitude established at time of engagement. When tuned to a localizer frequency, the ALT HLD switch will automatically return to OFF position when glide slope is automatically or manually captured.

COURSE INDICATOR

The course indicators provide displays of selected navigational aids and associated information, with respect to airplane position. The relative

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position and course of a beam is displayed by a movable segment (lateral deviation bar) of the course arrow; after capture, the relative distance from the centerline is indicated by the displacement of this segment. Directional indications are displayed with respect to magnetic heading of the airplane, as indicated by the lubber line on the compass card (azimuth ring). The HDG control is set for the desired course.

The COURSE control is set for the desired VOR radial or localizer magnetic course. The position of the course arrow, with respect to four dots (two on each side of the course arrow), provides a relative indication of lateral deviation from the course. Space between the two outer dots represents approximate beam width during both ILS and N/L modes of operation. Glide slope vertical deviation indications are also displayed on the course indicator.

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 FLIGHT CREW OPERATING MANUAL

INST/NAV/COMM -- FLIGHT DIRECTOR SYSTEM - Component locations

MODE
ANNUNCIATOR

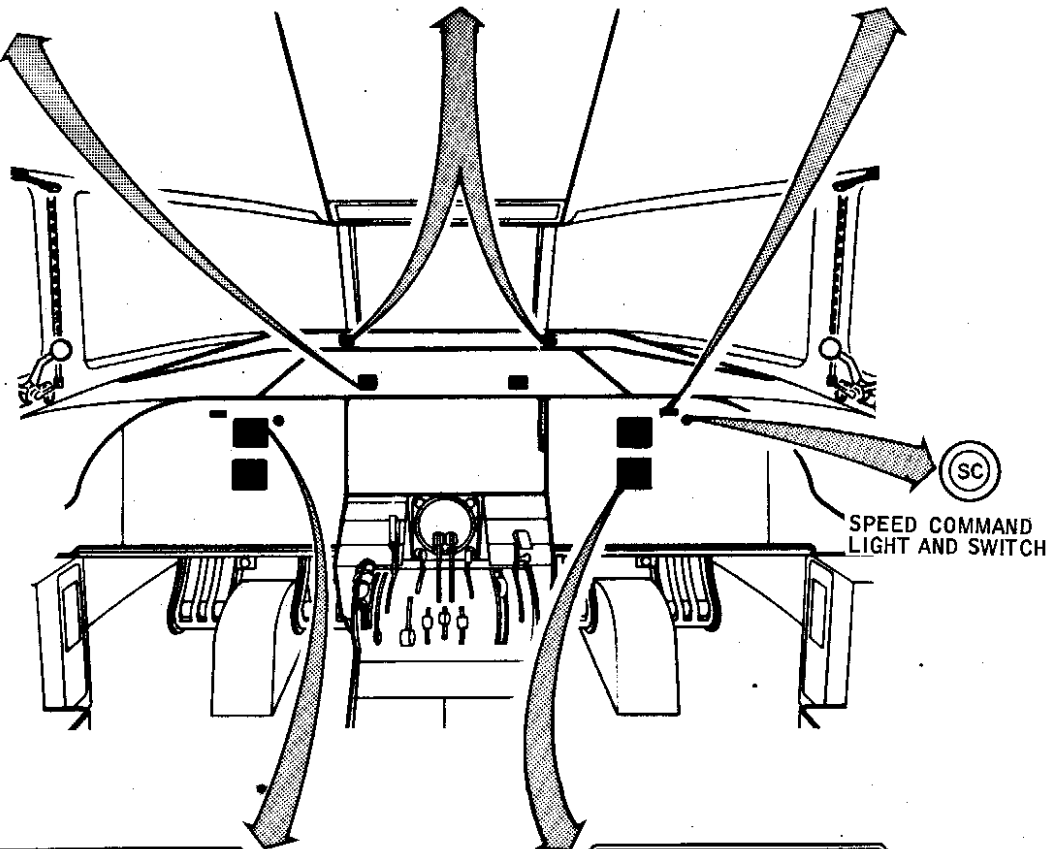


FLT DIR
MODE

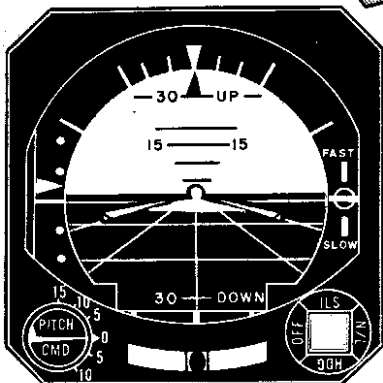
FLIGHT DIRECTOR
MANUAL ILS SWITCH



ALTITUDE HOLD
SWITCH



SPEED COMMAND
LIGHT AND SWITCH



FLIGHT DIRECTOR INDICATOR



COURSE INDICATOR

NOTE:
Controls and indicators identical
on captain's and first officer's
panels except as noted.

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INST/NAV/COMM --FLIGHT DIRECTOR SYSTEM - Warning flags

FLIGHT DIRECTOR INDICATOR

GS flag monitors glide slope receiver and reliability of radio signal input. When flag is in view glide slope indications are not usable.

SPEED command flag monitors reliability of the speed command indication. When flag is in view, speed command indications are not usable.

GYRO flag monitors power or signal failure of the vertical gyro and malfunction of the primary attitude display servo system. When flag is in view attitude information is not usable.

COMPUTER flag monitors active input signals to computer for selected modes of operation. When flag is in view, command information for selected mode is not usable. When the mode selector is at OFF, the flag is not visible.

Localizer shutter monitors LOC reception for unreliable localizer signal. Shutter is retracted after glide slope capture during ILS mode of operation.

COURSE INDICATOR

Shutter indicates distance information not usable.

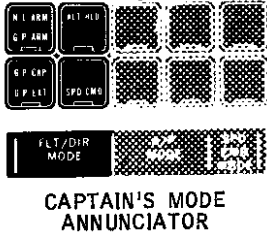
COMPASS flag indicates compass card information is not usable.

GS flag monitors glide slope receiver and reliability of radio signal input. When flag is in view glide slope indications are not usable.

VOR LOC flag monitors VOR/localizer receiver for unreliable VOR or LOC radio signal. When flag is in view during VOR reception, VOR commands are not usable. When flag is in view during LOC reception, LOC commands are not usable.

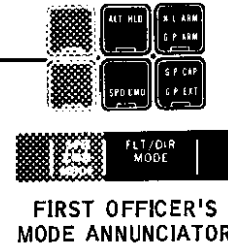
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INST/NAV/COMM -- FLIGHT DIRECTOR SYSTEM - Controls & indicators (sheet 1)



- N-L ARM** -- Light is on when Flight Director mode selector is in NAV-LOC or ILS position, and Flight Director is armed for automatic capture of VOR or localizer beam, but beam has not been intercepted.
- G-P ARM** -- Light is on when Flight Director mode selector is in ILS position and aircraft has not intercepted glide slope, but has captured localizer.
- G-P CAP** -- Light is on when Flight Director mode selector is in ILS position and aircraft has captured glide slope.
- G-P EXT** -- Light is on when Flight Director mode selector is in ILS position and glidepath extension has been automatically initiated by a middle Marker Beacon signal.
- ALT HLD** -- Light is on when altitude hold switch is engaged.
- SPD CMD** -- Light is on when Speed Command (SC) mode selector switch is actuated or when a remote signal is received from the associated speed command system.

NOTE: Initiating speed command mode disables all mode indications except SP CMD.



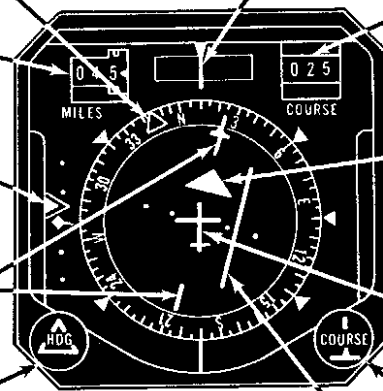
SPEED COMMAND LIGHT AND SWITCH



Speed command mode may be selected by pressing SC light and switch, while mode selector knob is in ILS, N/L or HDG position. The speed command light comes on when the SC mode is in effect. (The SC GO-ARND mode may also be initiated by throttle palm switches.
NOTE: The speed command mode is cancelled when mode selector knob is momentarily rotated.

Lubber line indicates gyro-stabilized magnetic heading of airplane on compass card.

- Heading marker is rotated by HDG knob and sets selected heading on azimuth ring.
- Digital readout of DME slant-range distance in nautical miles.
- Glide slope scale and pointer are only in view when tuned to and receiving a glide slope signal. Displays airplane vertical deviation from glide slope center - line.
- Course arrow is rotated with COURSE control knob to the VOR radial or localizer magnetic course to be flown.
- HDG (heading) control is used to set heading marker to desired heading.



- Digital repeat of VOR radial or localizer course selected with course control knob.
- TO-FROM pointer indicates direction of selected course when flying toward the station. After flying over station, pointer indication shifts 180 degrees, and appears on the opposite side of the aircraft symbol.
- Stationary miniature aircraft symbol represents aircraft position, with respect to movable portions of the indicator display.
- COURSE control is used to set in desired VOR radial or localizer magnetic course.
- Lateral deviation bar represents a segment of selected VOR radial or localizer course. Bar displays position of the selected radio course, with respect to the aircraft position (represented by the miniature airplane symbol).

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**INST/NAV/COMM -- FLIGHT DIRECTOR SYSTEM - Controls
 & indicators (sheet 2)**



ALTITUDE HOLD SWITCH

When in the ON position, and operating in HDG, N/L, or ILS modes prior to glide slope capture, the V-command bar will indicate pitch attitude necessary to maintain altitude established at time of engagement.

Switch will return to the OFF position when automatic or manual glide slope capture occurs.



**FLIGHT DIRECTOR MANUAL
 ILS SWITCH**

When in the ON position, capture of localizer course and glide slope occurs immediately. The V-bar displays roll command to intercept and track the localizer course, and pitch command to fly the glide slope. Switch will return to the OFF position when mode selector is placed in any position from N/L or ILS.

BANK INDICATOR AND HORIZON BAR

Airplane bank angle is displayed by an indicator read against a fixed scale at the top of the instrument case. Bank angle scale markings are at 10, 20, 30, and 60 degrees. Roll attitude is shown by horizon bar rotation relative to the airplane symbol. The horizon bar also moves vertically to display pitch attitude.

**FLIGHT DIRECTOR
 INDICATOR**

Stationary miniature delta-shaped aircraft symbol. Peak of symbol indicates actual airplane pitch attitude on the pitch scale.

Glide slope scale and pointer displays vertical position relative to the glide slope. The airplane is on glide slope when the pointer is aligned with the center mark.

V-command bar. Indicates computed pitch and roll commands, required to capture and track selected headings, radio course, or glide slope. The V-command bar is aligned with the delta shaped aircraft symbol when pitch and roll commands are satisfied. Pitch commands are indicated by vertical displacement of the V-command bar, with respect to the delta-shaped aircraft symbol.

Roll commands are indicated by tilt of the V-command bar, with respect to the delta shaped aircraft symbol.

The bar is driven from view when loss of signal occurs, or sensing circuits fail that are associated with the selected mode of operation.

PITCH CMD (pitch command) in HDG, N/L, and ILS, (prior to glide slope capture), the pitch command knob may be used to set a fixed climb or descent pitch angle. This pitch reference is then displayed by the V-command bar as pitch command. Adjustment is in excess of plus 15 through minus 10 degrees.

ATTITUDE TAPE

Speed command deviation pointer indicates deviation from optimum speed for existing flight mode (takeoff, approach, or go-around).

SLIP INDICATOR

Position of mode selector knob selects OFF, ILS, N/L, and HDG modes (determines functions used for computing command - see mode selector functions chart.)

Horizontal deviation scale and pointer indicate lateral deviation from localizer course. Shutter disappears and indication is displayed after G/P capture. Expanded scale movement has approximately 2-to-1 relations with the lateral deviation bar of the course indicator. Outside reference marks of the scale (below pointer) are equivalent to the first deflection dot, as indicated on the course indicator.

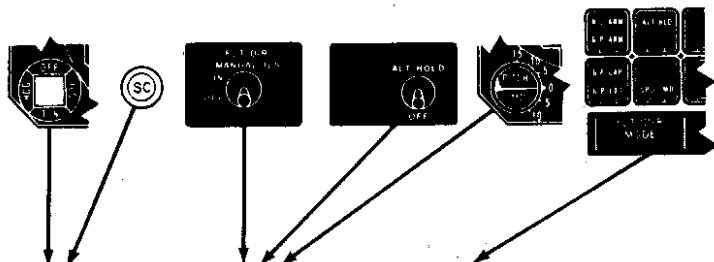
PITCH SCALE OF ATTITUDE TAPE

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INST/NAV/COMM -- FLIGHT DIRECTOR SYSTEM - Mode selector functions

NOTES:

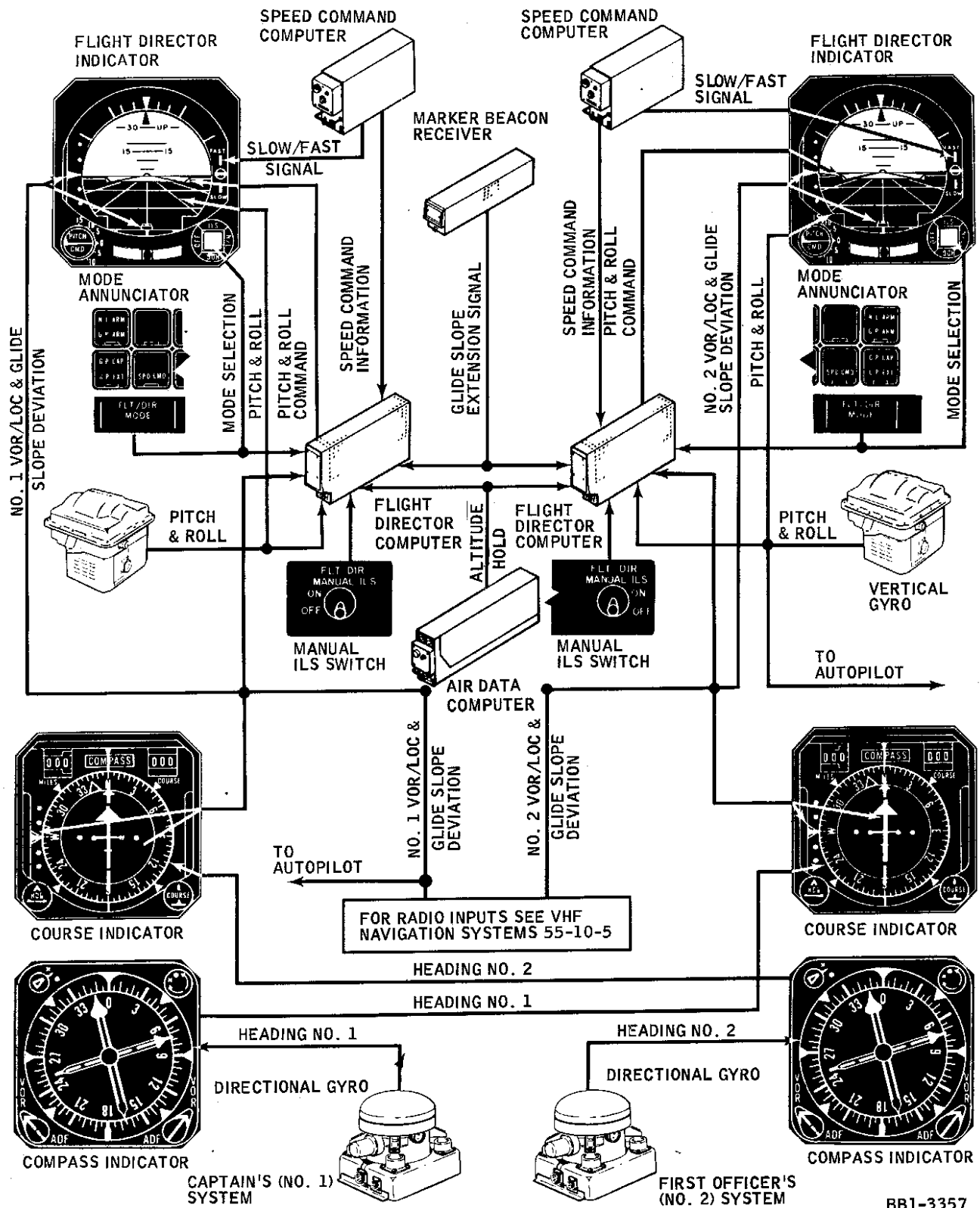
1. When N/L mode is selected without going through or from HDG mode, a fixed angle intercept (45 degrees) will be commanded and no annunciation will occur. At course capture command displays are as shown in N/L mode. When ILS mode is selected without going through or from HDG mode, a fixed angle intercept (45 degrees) will be commanded and no annunciation will occur. At localizer capture command displays are as shown below in ILS mode and G-P ARM will be annunciated.
2. Glide slope extension will be initiated by the middle marker.
3. VOR, localizer, and glide slope capture points for the various operating modes and conditions are shown in NORMAL OPERATIONS, Section 2, 55-10-0.



MODE	SUBMODE OR CONDITION		FLT DIR MODE ANNUNCIATION	FLIGHT DIRECTOR V-BAR COMMAND DISPLAY		FLIGHT DIRECTOR HORIZONTAL DEVIATION INDICATOR	FLIGHT DIRECTOR AND COURSE INDICATOR GS DEVIATION POINTER	COURSE INDICATOR LATERAL DEVIATION BAR
				PITCH	ROLL			
OFF	NONE		NONE	OUT OF VIEW				
SC	SC mode selected by pressing SC light and switch. Mode selector knob must be in HDG, N/L, or ILS position. SC mode may also be initiated by throttle palm switches.		SPD-CMD and SC LIGHT	Pitch attitude to maintain reference speed	Wings level			
HDG	PITCH COMMAND (selected with PITCH CMD knob on flight dir. ind.)		NONE	Selected pitch attitude	Selected heading (selected with course indicator HDG control)			
	ALTITUDE HOLD (ALT HOLD switch ON)		ALT HOLD	Pitch attitude to maintain altitude				
N/L NOTE 1	Switch to N/L from HDG prior to VOR or localizer capture. Radio tuned to VOR or localizer frequency.	PITCH COMMAND	N/L ARM	Selected pitch attitude	Selected heading until VOR or localizer capture	Out of view	Out of view unless radio is tuned to localizer frequency -- then glide slope deviation	Displays VOR or localizer deviation
		ALTITUDE HOLD	N-L ARM ALT HLD	Pitch attitude to maintain altitude				
	After VOR or localizer capture. Radio tuned to VOR or localizer frequency.	PITCH COMMAND	NONE	Selected pitch attitude	At capture, command to turn to VOR or localizer course, then commands to maintain VOR or localizer course			
		ALTITUDE HOLD	ALT HLD	Pitch attitude to maintain altitude				
ILS NOTE 1	After localizer capture and prior to glide slope capture. Radio tuned to localizer frequency.	PITCH COMMAND	G-P ARM	Selected pitch attitude	Commands to maintain selected localizer course	Displays localizer deviation	Displays glide slope deviation	
		ALTITUDE HOLD	G-P ARM ALT HLD	Pitch attitude to maintain altitude				
	After glide slope capture (ALT HOLD switch automatically goes to OFF position at glide slope capture).	NONE (PITCH CMD knob function inoperative after GS capture)	G-P CAP	Pitch attitude to fly glide slope	Same as above			
		GS EXTENSION (Actuated by middle marker)	G-P EXT	Same as above				
N/L or ILS	MANUAL CAPTURE AND FIXED ANGLE INTERCEPT -- FLIGHT DIRECTOR MANUAL ILS switch ON and radio tuned to localizer frequency. (ALT HOLD switch automatically goes to OFF position).		G-P CAP (immediate) then G-P EXT (when glide slope extension is reached)	Same as above (PITCH CMD knob function inoperative)	Immediate command for fixed angle intercept (45 degrees) and when course edge is reached command for turn to fly course.			BB1-2216D

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INST/NAV/COMM -- FLIGHT DIRECTOR SYSTEM - Functional schematic



SPEED COMMAND SYSTEM

The speed command system is an automatic computing system that senses various conditions related to speed control and provides speed-deviation indications, with respect to the computed reference speed. The system is designed for use only during low speed maneuvers such as takeoff, approach, and go-around. The system provides SLOW-FAST indications at the captain's and first officer's flight director indicators. The captain's and/or first officer's flight director indicator(s) also display V-command bar pitch commands when the speed command mode of the corresponding flight director is initiated. A test circuit, controlled by the SPD COMM TEST switch, is included in the system. SLOW or FAST positions of this switch produce corresponding indications at the flight director indicators.

The speed command system aids the pilot in rapidly acquiring and maintaining the computed reference speed for T/O (takeoff), APPR (approach), or GO ARND (go-around). The speed command system is especially useful for situations such as go-around, when the aircraft angle of attack, attitude, airspeed, and thrust are all rapidly changing. To minimize altitude loss and maintain a safe margin above stalling speed, the pilot must precisely control attitude and airspeed and predict aircraft response. The speed command system senses the angle of attack, pitch and pitch rate, flap position, slat position, forward acceleration, and provides SLOW-FAST and V-command bar pitch commands. The reference speed is automatically increased for large nose-down attitudes and for turbulent air conditions in APPR modes at 25 to 50 degrees flap.

The speed command system slow-fast output is displayed simultaneously on the captain's and first officer's throttle director (slow-fast indicator) display of their respective flight director indicators. For a very slowly changing condition (such as stabilized on glide slope), a SLOW indication means that the aircraft speed is below the computed approach reference speed and that additional power is required. For a rapidly changing or dynamic condition (such as initiation of go-around), a SLOW indication can also mean that, after the aircraft responds to the present amount of control and rate of control movement, the aircraft will be below the computed go-around reference speed.

Throttle director displays of SLOW-FAST indications are present on the slow-fast indicator at all times. When airspeed is increased above the computed reference speed for a given gross weight and flap position, the SLOW-FAST pointer will display a FAST indication. When the pointer deflects toward SLOW, the airspeed is slower than the computed reference speed. During phases of flight such as enroute, when airspeed is generally faster than those for low speed maneuvers (above approximately 240 knots), the indicator pointer will display FAST indications and is not used for computed reference speed. The SLOW-FAST pointer will be biased out of view in the event of failure of the speed command system in any flight mode.

Either the captain or first officer may select the speed command mode for his flight director by depressing the SC light and switch when the flight director mode selector is in any position other than OFF. The V-command bar of the corresponding flight director indicator is then driven by the

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 FLIGHT CREW OPERATING MANUAL

speed command system, to provide a pitch command. The speed command mode of both flight directors is automatically selected when either throttle palm switch is depressed, as in a go-around maneuver.

The speed command system automatically computes the mode reference speed for the prevailing mode. The mode is determined by sensing nosewheel oleo position, flight director mode, and throttle position. The speed command

modes T/O (takeoff), GO ARND (go-around), and APPR (approach) are annunciated on the related SPD CMD MODE annunciator. The throttle director signal is used during the APPR mode to drive the autothrottle system when the autothrottle is engaged.

The speed reference mode depends upon conditions associated with the airplane, throttle position, and flight director mode, as listed in the following table.

SPEED COMMAND MODES AND CONDITIONS

Airplane	With throttles	Speed reference mode will be	Flight director
On the ground longer than 3 seconds	In any position	T/O (takeoff)	Pilots can select speed command flight director mode by pressing SC light and switch. <u>NOTE:</u> Mode selector must not be at OFF position.
During lift-off, after takeoff, or in climb conditions	In takeoff thrust position	T/O (takeoff)	
In flight	Less than takeoff thrust position.	APPR (approach)	Not in speed command mode
		GO ARND (go around)	In speed command mode

NOTE: Throttle switches maintain T/O mode after liftoff until the first time throttles are retarded, thereafter, the throttles have no effect on speed command switching while the airplane is still in the air.

Speed command mode of the flight director system is selected either by pressing the SC light and switch, or by depressing the throttle palm switches. When selected by the SC light and switch, only the associated flight director system is affected. When selected by depressing either or both of the palm switches, both flight directors will be switched to the speed command mode, providing the mode selectors are not in the OFF position.

INST/NAV/COMM -- SPEED COMMAND SYSTEM - Controls & indicators

SPEED COMMAND TEST SWITCH

Simulates a slow-fast signal for test of system.

For test, place speed command system in T/O mode by placing the flight director mode selector to any position other than OFF, flaps at zero degrees, and pressing the SC light and switch. SLOW-FAST pointer should be on the SLOW side of center and V-command bars should indicate slight nose down command.

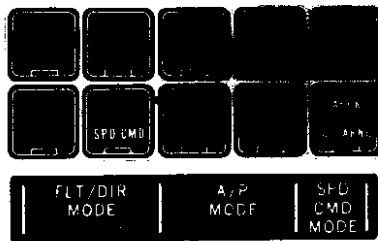
Place test switch in either SLOW or FAST position. Pointer will deflect toward respective end of scale. V-command bars will indicate pitch command of approximately 2 degrees, nose down for SLOW indication, or nose up for FAST indication.

SPEED COMMAND LIGHT AND SWITCH (Identical for captain and first officer)

Push to select flight director speed command mode with mode selector in any position other than OFF.

Switch is released by momentarily placing mode selector to another position.

Dimmable light indicates that speed command mode has been selected for respective flight director. Light will come on when speed command is selected with the throttle palm switches.



MODE ANNUNCIATOR (typical)

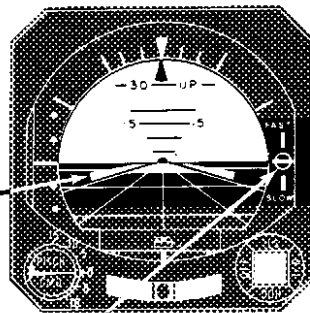
Indicates speed reference mode of operation of speed command system:
 T/O (takeoff)
 APPR (approach)
 GO ARND (Go-around)

SPD CMD Indicates flight director is in speed command mode

NOTE: One mode will always be displayed on annunciator.

V-COMMAND BARS

When flight director is in speed command mode the V-command bar will display pitch command to maintain the correct pitch attitude to fly the computed reference speed. The roll axis of the V-command bar displays a roll command to maintain wings level attitude.



SLOW - FAST INDICATOR

(Identical for Captain's and First Officer's panel) when SLOW - FAST pointer shows FAST, airplane is flying faster than reference speed.

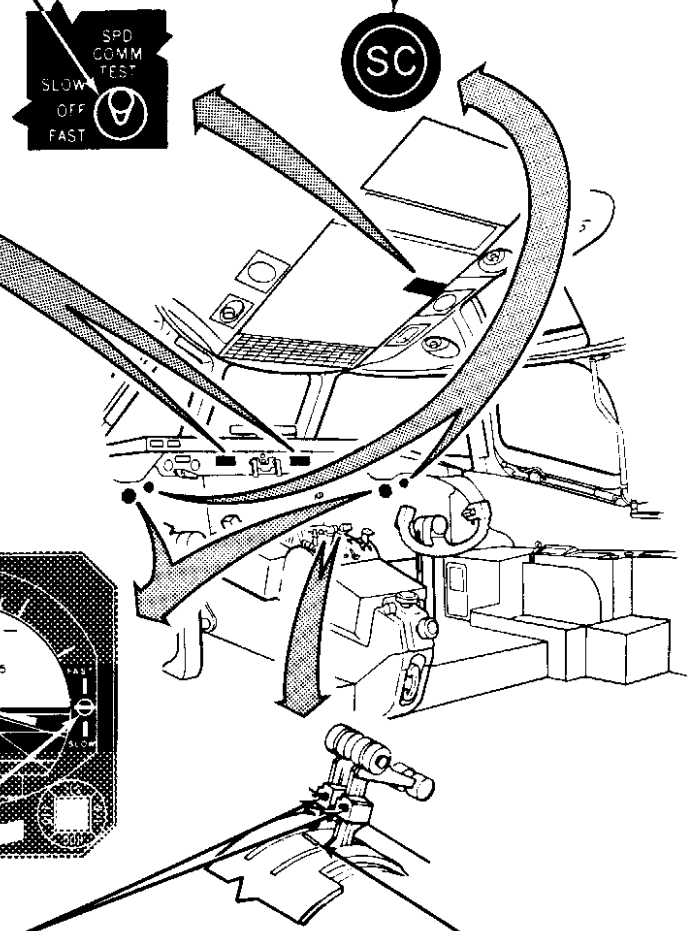
SPEED flag covers the SLOW-FAST indicator when speed command information is unusable.

THROTTLE PALM SWITCHES

Initiates go-around speed command mode. When either switch is depressed, both flight director systems will go to speed command operation providing the mode selector is in any position other than OFF.

TAKEOFF MODE HOLD SWITCH INDICATING LINE

White line indicates actuation point of takeoff mode hold switches. Speed command systems will remain in T/O mode until both throttles are retarded (aft edge behind white line).



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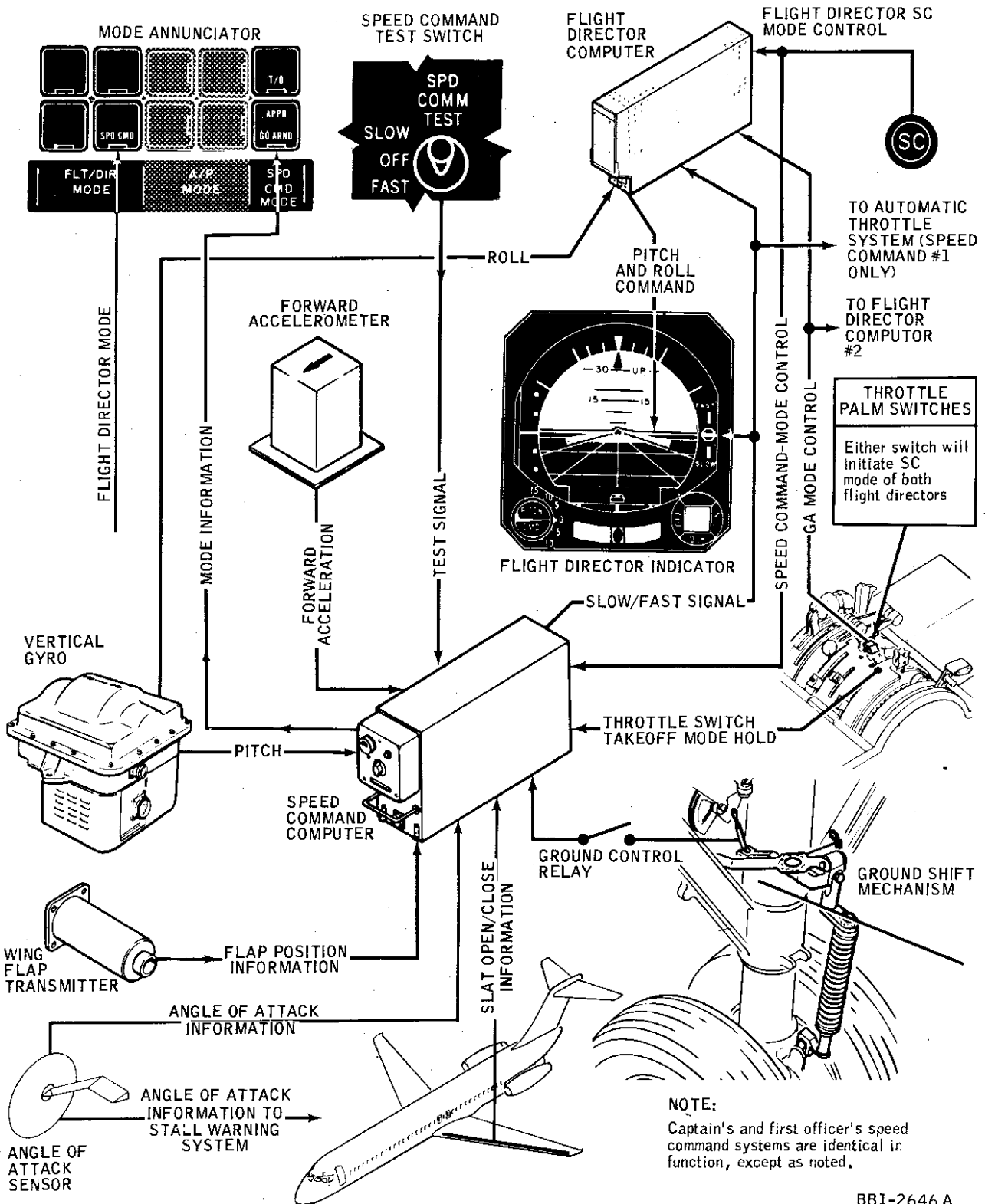
Section 3

55-5-25

CODE 14

Page 3

INST/NAV/COMM -- SPEED COMMAND SYSTEM - Functional schematic



BB1-2646 A

AUTOMATIC THROTTLE CONTROL SYSTEM

The automatic throttle control system is used to provide automatic speed control for the airplane during approaches in adverse weather conditions and to ease the workload in flying the airplane during approach maneuvers. The system utilizes the output of the captain's speed command computer as a reference. The automatic throttle computer/amplifier contains the electronic circuitry required to process this reference signal and generate the electrical outputs for the throttle servo drive. In addition, the computer/amplifier provides any minor loop stabilization required, the necessary automatic throttle control interlocks, warning circuitry, and throttle logic circuitry.

The throttle servo drive is an electromechanical rotary servo, coupled to the throttle linkage through an irreversible gearbox, chain drive, and clutch mechanisms. The clutch mechanisms, one for each throttle lever, are mounted in the control pedestal. These mechanisms allow the pilot to individually position each throttle lever with minimum pilot override forces without disengaging the automatic throttle control system.

Control and interlock circuitry provides pilot management of the automatic throttle control system and automatic disengagement in the event of a system malfunction. If the speed command system is not in the approach mode, an interlock prevents the pilot from moving the engage lever. When the speed command system is in the approach mode, the pilot activates the automatic throttle control by moving the engage lever to the engage position. The engage lever, which operates a positive action switch, is

then solenoid held in the engaged position and the throttles are automatically controlled to maintain a reference airspeed.

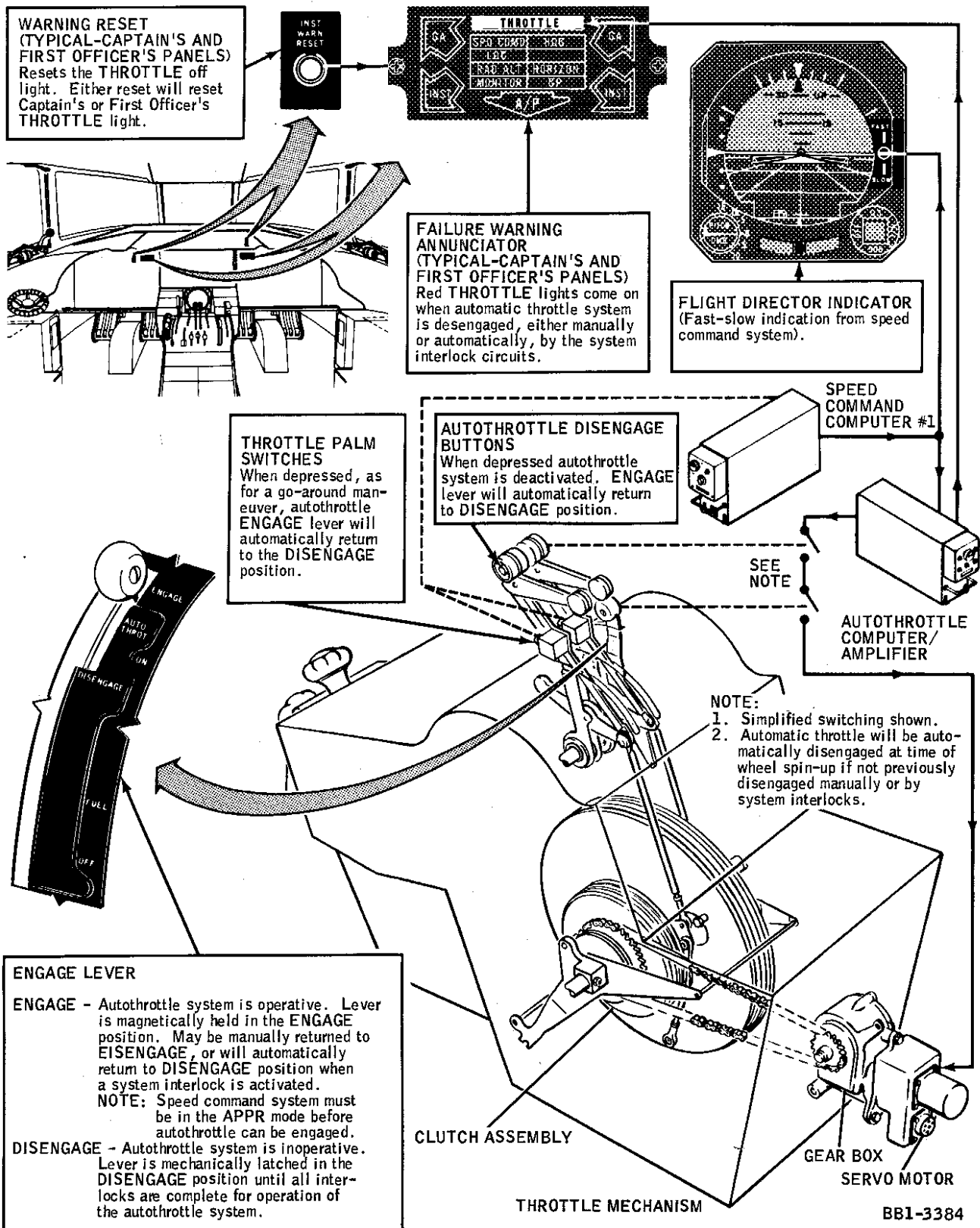
The automatic throttle control system is automatically disengaged when any one of the following conditions occurs:

1. The monitor in the computer/amplifier detects a malfunction.
2. The approach mode in the speed command computer is disengaged.
3. Autothrottle disengage button on either throttle is depressed.
4. Either palm switch on throttle levers is depressed.
5. Movement of throttle engage lever to off position.
6. At wheel spin-up after touch down if not previously disengaged by system interlocks noted above.

Red throttle warning lights will come on at any time the autothrottle engage lever moves to the off position, manually or automatically. The lights can be turned off by depressing either instrument warning reset button. The lights will also go off when the automatic throttle is re-engaged.

Low-authority limit switches prevent the throttle servo drive from driving either throttle into the extremely low rpm region of engine operation. The limit switches do not disengage the automatic throttle control system.

INST/NAV/COMM -- AUTOMATIC THROTTLE SYSTEM



FLIGHT RECORDER SYSTEM

The flight recorder system is an airborne recorder that provides a record of pressure altitude, indicated airspeed, heading, and vertical acceleration with respect to time. The records are oscillographic engravings on a metal tape. In addition to the four types of recorded flight data, trip and date information is also recorded. The system consists of a flight recorder unit, a trip and date encoder unit, an acceleration sensor, and a power-failure caution light, together with pitot pressure and pitot static pressure sources.

Heading information is supplied to the recorder from an output synchro in the first officer's compass indicator. Pitot pressure is supplied to the system from the rudder limiter pitot system. Static pressure is supplied from the alternate static system.

No ON/OFF switches are provided. The recorder is energized whenever the left radio bus is powered.

All data is recorded on a metal tape. The recording tape moves uniformly at the rate of 6 inches per hour. The tape provides 400 hours recording for each side of the tape. The recording tape is fireproof, and waterproof, and is able to withstand unusual shock and vibration. If unusual stress conditions are encountered in flight, the recorded information may be used to facilitate ground inspection procedures.

The accelerometer is mounted in the right main gear well near the airplane center of gravity. The sensor is a sealed component which delivers an electrical signal that is proportional to the forces along its vertical axis,

and is calibrated to provide proportional signals for forces within the range of -3G's to +6G's.

The FLT RECORDER OFF caution light, located on the annunciator panel, will indicate a system power failure, broken recording tape (foil), or an exhausted recording magazine. The FLT RECORDER OFF light will also come on when the tape is not winding properly.

DOUGLAS AIRCRAFT CO.
DC-9
 FLIGHT CREW OPERATING MANUAL

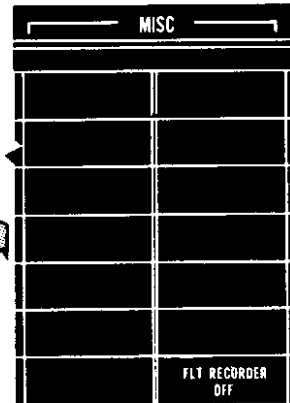
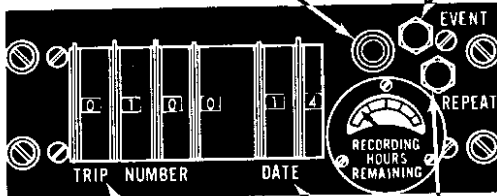
INST/NAV/COMM -- FLIGHT RECORDER SYSTEM

Light indicates 15-minute encoding cycle is in process. Recording cycle is simultaneously in process with encoding cycle. Recording cycle will start automatically when power is applied to recorder. After completion of cycle, a momentary interruption of power will automatically repeat the encoding cycle.

EVENT control is depressed for unusual event. A scribe mark is made on the recording strip, for identification of data associated with the event.

NOTE: Depressing EVENT control, when encoding cycle is in process (light on), will interfere with trip and date information.

ANNUNCIATOR PANEL



Rotate to set
TRIP NUMBER

Rotate to set
DATE

REPEAT control is depressed momentarily to repeat the encoding cycle, and record the TRIP NUMBER and DATE as determined by control settings.

FLT RECORDER OFF

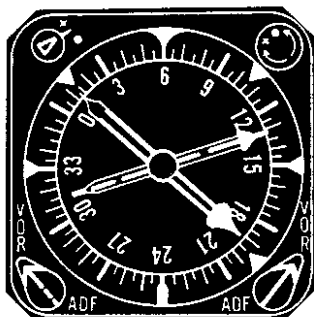
When light is on, indicates recorder deenergized or that tape is broken, exhausted, or not winding properly.

RUDDER LIMITER
PITOT TUBE

ALTERNATE
STATIC PORT
(L & R typical)

ALTERNATE
STATIC PRESSURE
RUDDER LIMITER
PITOT PRESSURE

ACCELERATION
SENSOR

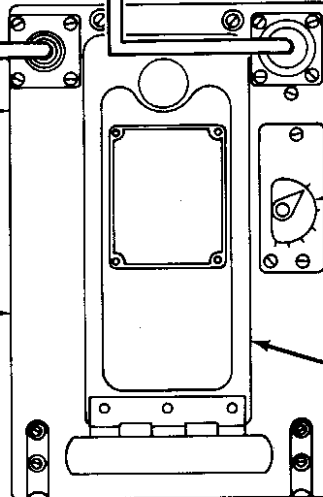


FIRST OFFICER'S
COMPASS INDICATOR

HEADING

HOURS REMAINING
(on tape)

Access for removal and replacement of magazine. Magazine contains a metallic recording tape, is accessible when the access panel is opened, and is released by raising a lever.



FLIGHT RECORDER

BB1-2789 B

STANDBY MAGNETIC COMPASS, TURN & SLIP
INDICATOR, AND CLOCK

STANDBY MAGNETIC COMPASS

The standby magnetic compass is installed to provide a magnetic heading reference in relation to magnetic north. The compass is installed in the ceiling, aft of the first officer's seat, and is viewed through mirrors mounted at the compass and on the glareshield. The captain's and first officer's viewing mirrors are mounted on hinged brackets, to permit them to be folded down against the glareshield when desired. The compass is lighted by an interior light and an external light, both controlled by a switch located on the overhead panel.

TURN & SLIP INDICATOR

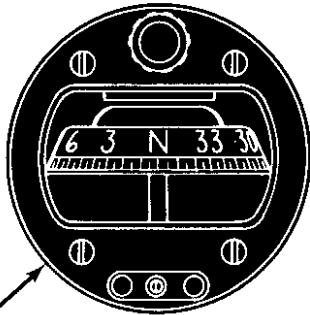
Two electrically operated turn-and-slip indicators are installed, one each on the captain's and first officer's instrument panel. The indicators are calibrated for a 4-minute turn and are equipped with a warning flag that appears when power to the instrument is lost.

CLOCK

Two 8-day, stem-wound clocks are installed, one each on the captain's and first officer's instrument panel.

INST/NAV/COMM -- STANDBY MAGNETIC COMPASS, TURN & SLIP INDICATOR, & CLOCK

STANDBY MAGNETIC COMPASS



Indicates heading of airplane in relation to magnetic north.

COMPASS CORRECTION CARD

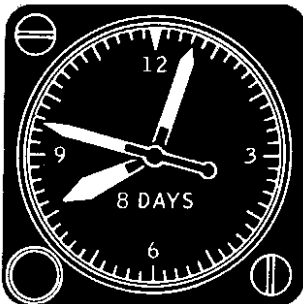
COMPASS _____
DATE _____

FOR	STEER	FOR	STEER
N		S	
30		210	
60		240	
E		W	
120		300	
150		330	

AIRPLANE TYPE _____
AIRPLANE NO. _____
COMPASS SER. _____
SWUNG BY _____

2336938

CLOCK



WINDING KNOB

Eight day clocks are mounted in the Captain's and First Officer's instrument panels. The clocks are stem wound and have sweep second hands.

STANDBY COMPASS

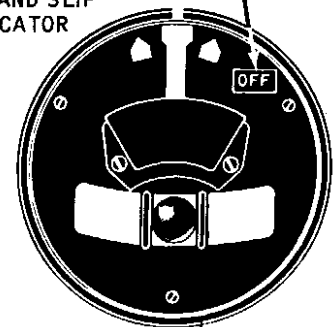
REFLECTED LINE OF SIGHT FOR PILOTS

CONCAVE MIRROR

GLARESHIELD

MIRRORS

TURN AND SLIP INDICATOR



OFF flag appears when indicator power is disabled or when power circuit is defective.

The turn and slip indicator is electrically operated, and is calibrated for 4-minute turns.

BB1-468

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

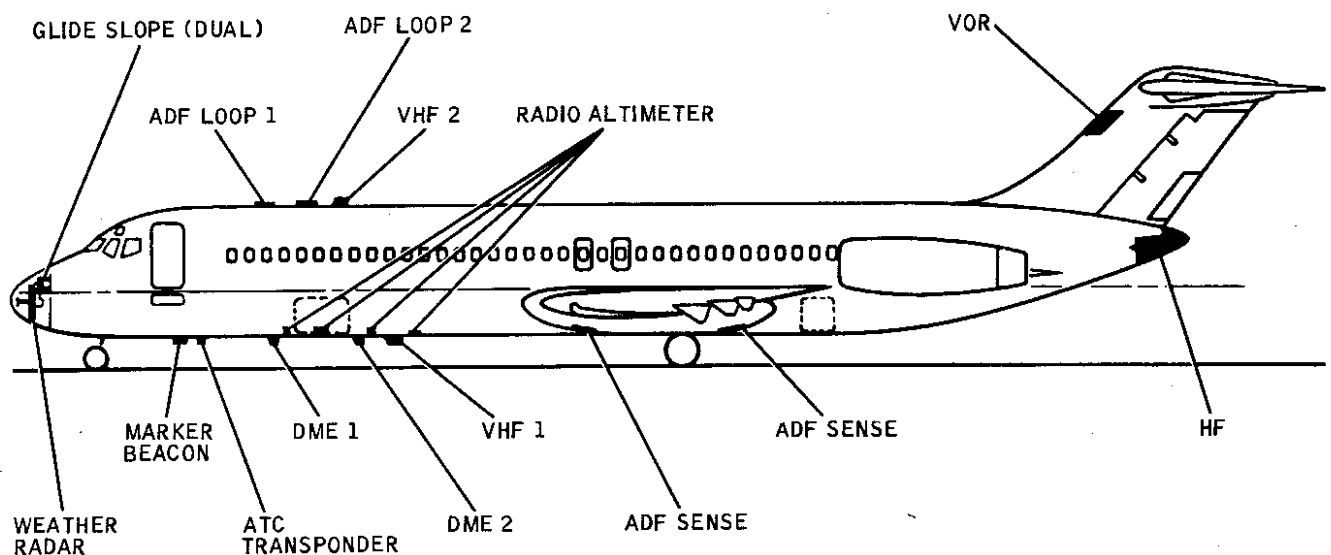
NAVIGATION SYSTEMS

Radio aids to navigation and navigation systems installed on the airplane include the following:

1. VHF navigation system
2. Glide slope system
3. Distance measuring equipment (DME)
4. ADF system
5. Marker beacon system
6. ATC transponder system
7. Weather radar system
8. Radio altimeter system.

The antenna location diagram shows locations of antennas for both navigation and communications systems.

INST/NAV/COMM -- ANTENNA LOCATIONS



VHF NAVIGATION SYSTEMS

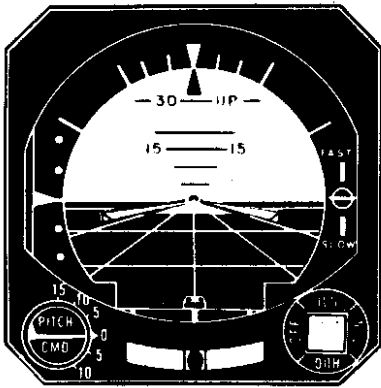
Two very-high-frequency navigation systems are included, one for the captain and another for the first officer. Each system includes a VHF navigation receiver and a VHF NAV/COMM control panel, with associated antennas. System indications are provided by the flight director indicator, course indicator, and compass indicators. Directional indications are displayed by pointers of the compass indicators. VOR/LOC warning flags, to-from arrow, vor localizer shutter, and V-bar commands are displayed by the flight director indicators.

The VHF NAV/COMM control panels provide controls to energize the system, select the operating frequency, and adjust the audio volume. The audio outputs (VOR-1 and VOR-2, or both) can be selected at any audio control panel location.

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DC-9
 FLIGHT CREW OPERATING MANUAL

INST/NAV/COMM -- VHF NAVIGATION SYSTEM - Component location

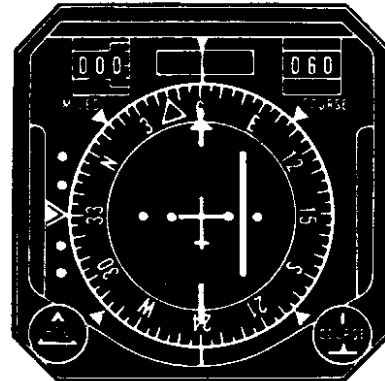
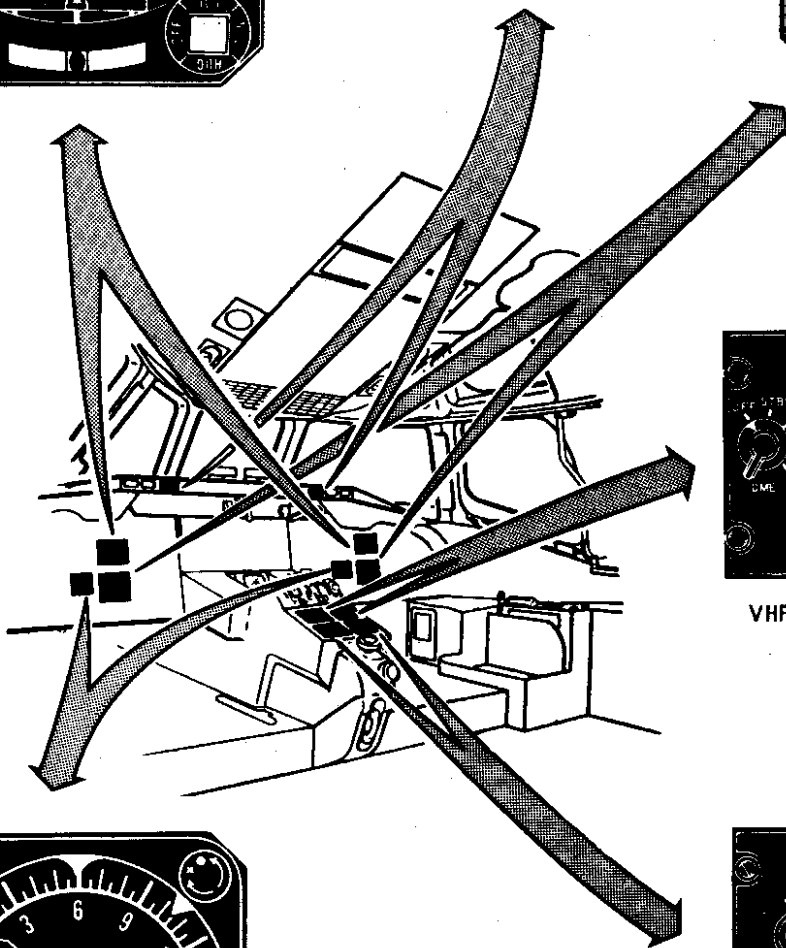
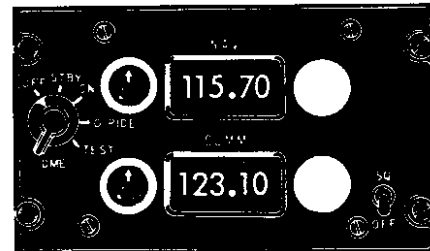
FLIGHT DIRECTOR INDICATOR



FLT DIR MANUAL
ILS SWITCH

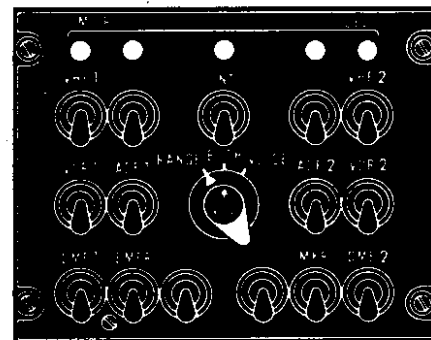
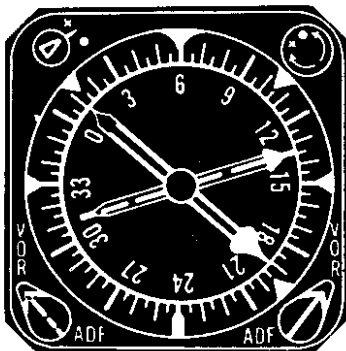


COURSE INDICATOR



VHF NAV / COMM CONTROL PANEL

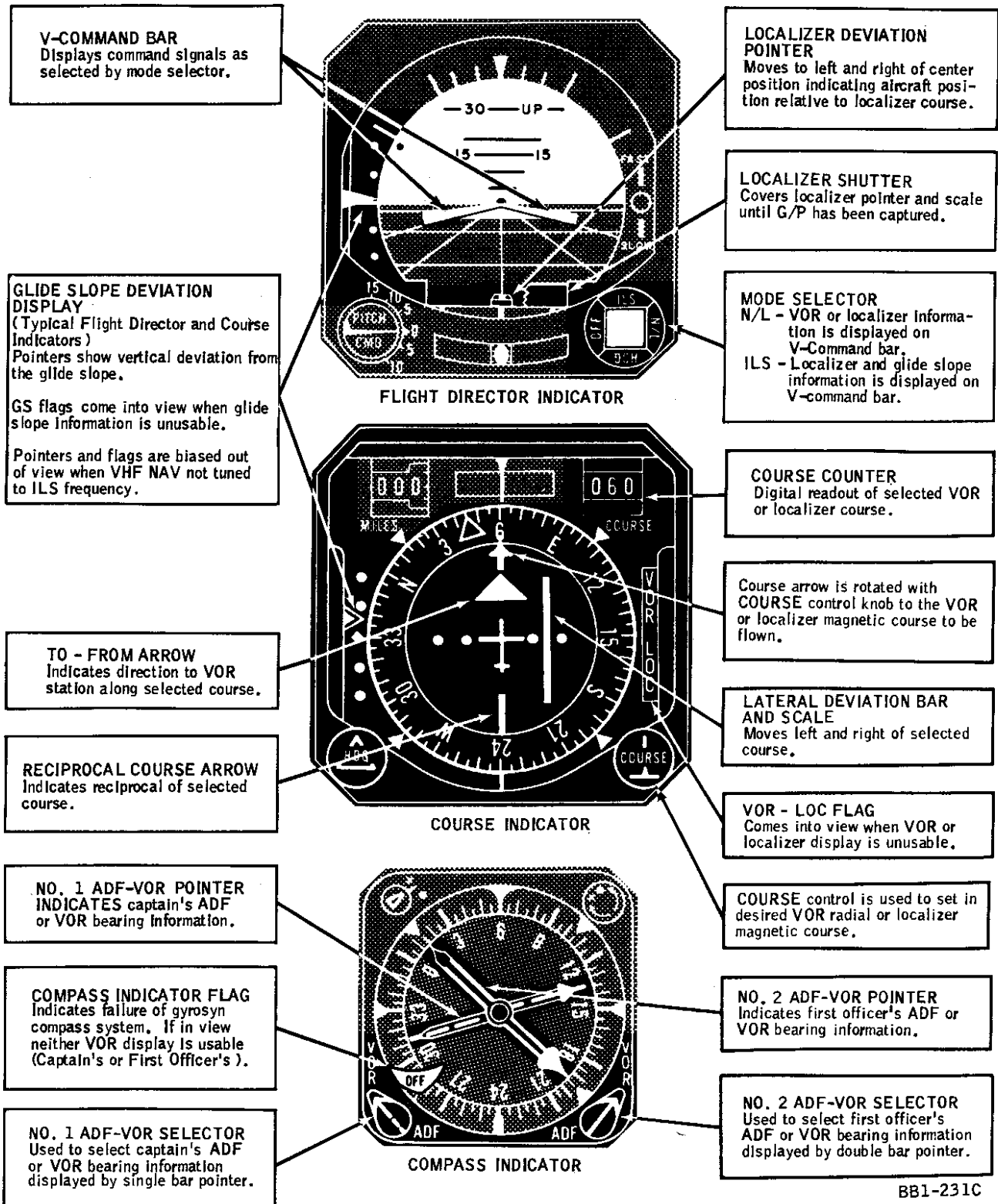
AUDIO CONTROL PANEL



COMPASS INDICATOR

BB1-230C

INST/NAV/COMM -- VHF NAVIGATION SYSTEMS - Cockpit indicators



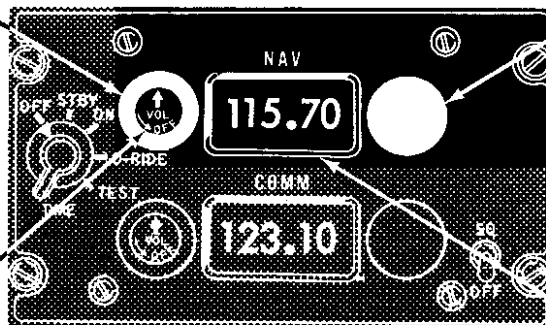
BB1-231C

DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

INST/NAV/COMM -- VHF NAVIGATION SYSTEMS - Cockpit controls

FREQUENCY SELECTOR KNOB
 Used to select second and third or tens and units digits of VOR or localizer frequency.

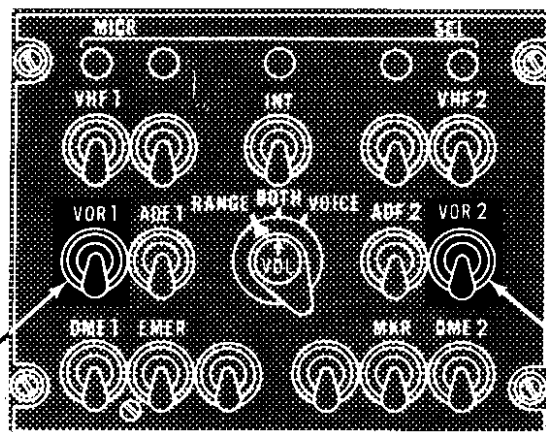
FREQUENCY SELECTOR KNOB
 Used to select fourth and fifth or tenths and hundredths digits of VOR or localizer frequency.



VHF NAV/COMM CONTROL PANEL

VOLUME CONTROL/ON-OFF SWITCH
 Controls VOR/Localizer Audio volume to the captain's and first officer's interphone system.

FREQUENCY WINDOW
 Displays selected VOR or localizer frequency.



AUDIO CONTROL PANEL

VOR 1 AUDIO SELECTOR SWITCH
 In up position selects audio output of VOR-1 receiver.

VOR 2 AUDIO SELECTOR SWITCH
 In up position selects audio output of VOR-2 receiver.

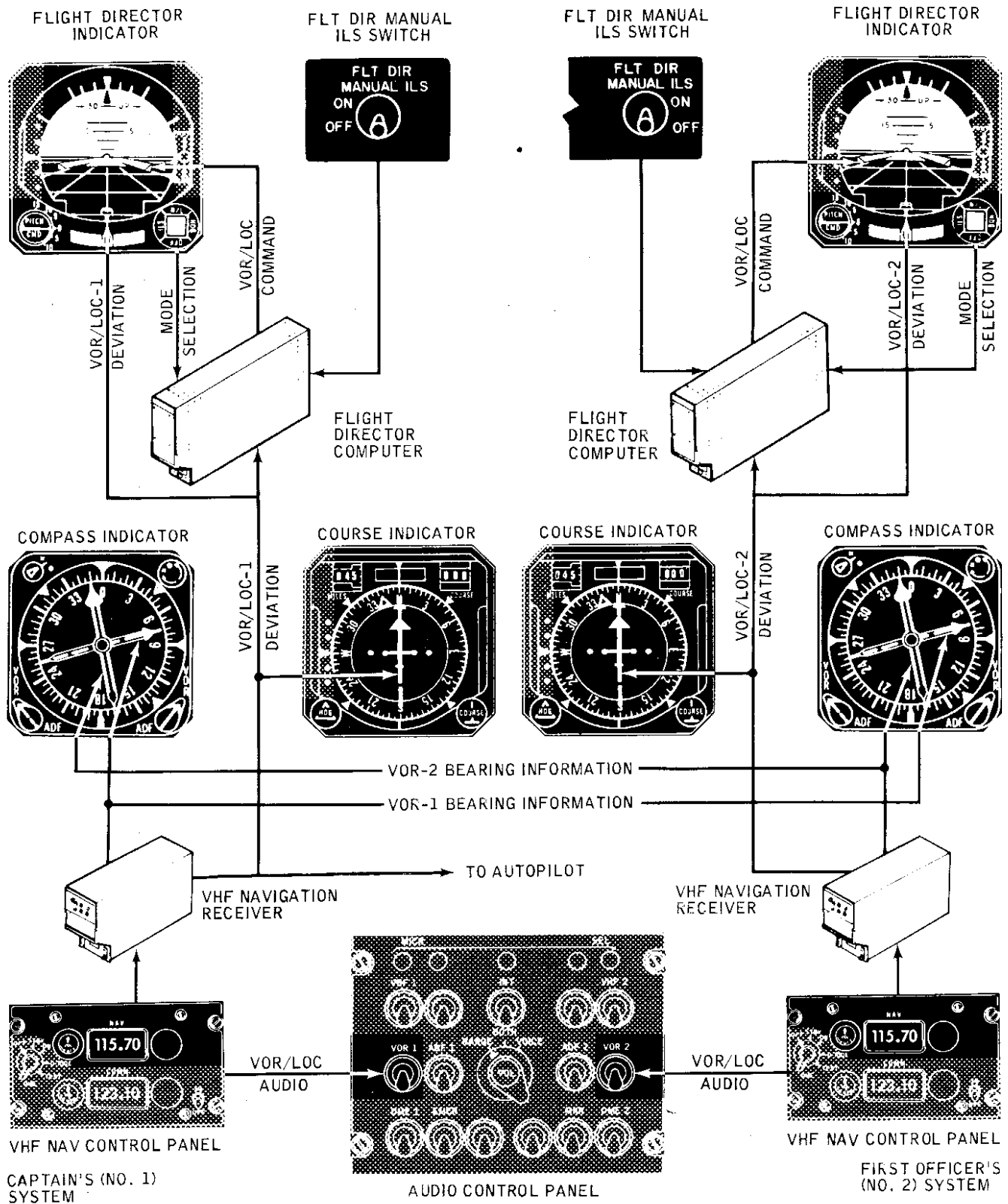
FLIGHT DIRECTOR MANUAL ILS SWITCH
 When in the ON position, flight director receives roll command to intercept the localizer course, and pitch command to manually fly the glide slope. Switch will return to the OFF position when mode selector is placed in any position other than ILS.

FLT DIR MANUAL ILS SWITCH



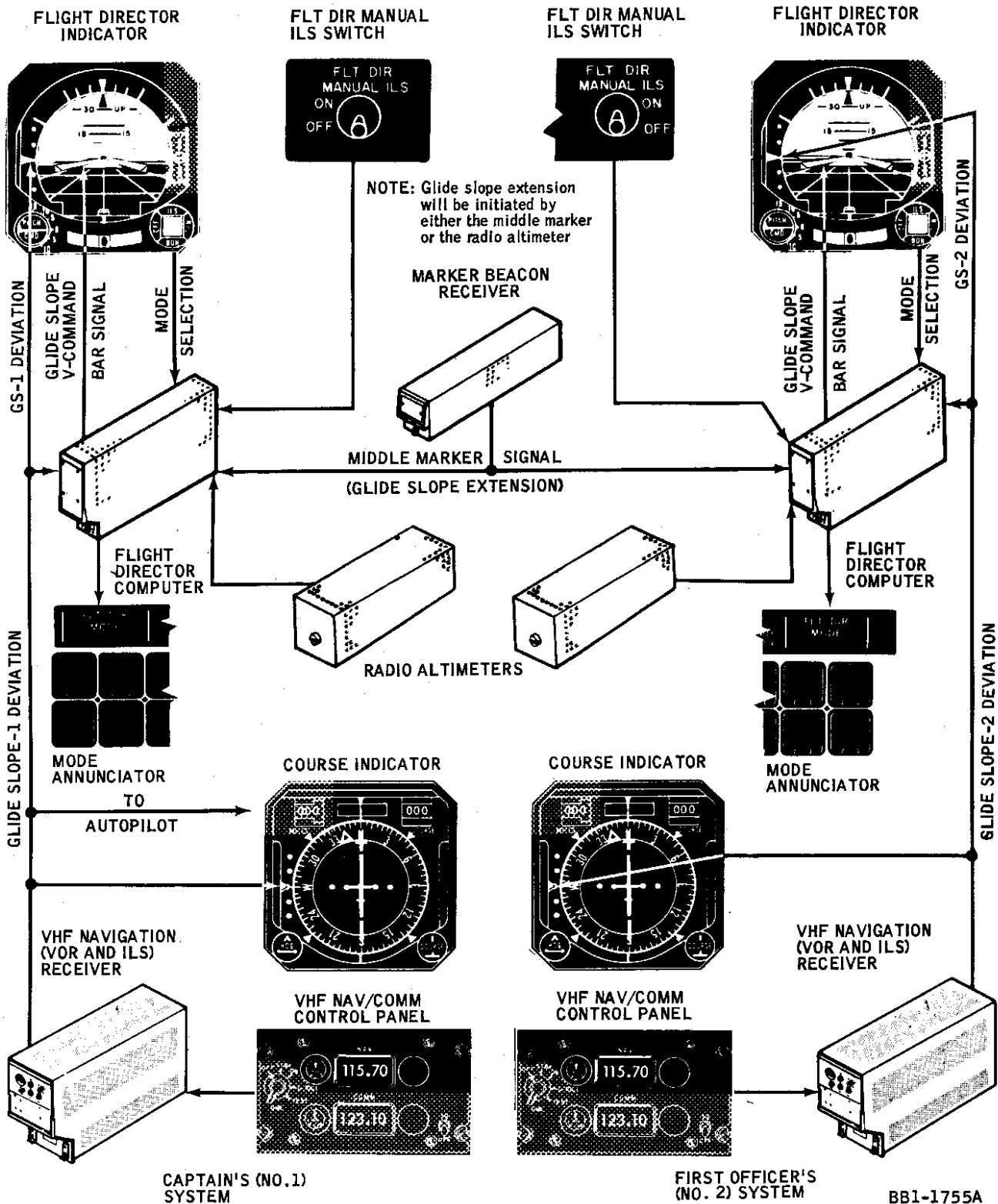
BB1-228C

INST/NAV/COMM -- VHF NAVIGATION SYSTEMS - VOR/LOC functional schematic



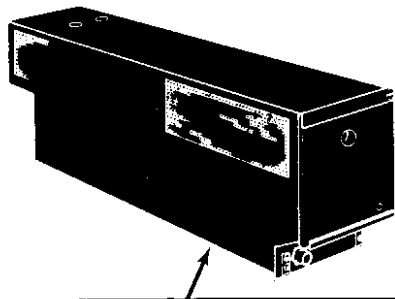
DOUGLAS AIRCRAFT CO., INC.
DC-9
 FLIGHT CREW OPERATING MANUAL

INST/NAV/COMM -- VHF NAVIGATION SYSTEMS - Glide slope functional schematic



INST/NAV/COMM -- DISTANCE MEASURING EQUIPMENT (DME)

The two DME systems utilize a portion of the captain's and first officer's course indicators and VHF NAV/COMM control panels. A distance indicator is located on each Course Indicator and a DME function switch is located on each VHF NAV/COMM control panel. Each system can track a VORTAC station up to a maximum of 200 miles or DME at an ILS station up to a maximum of 50 miles. With DME function switch at ORIDE position each system will track a DME signal at an ILS station up to a maximum of 200 miles.

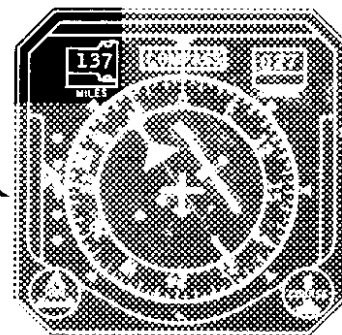


DME TRANSMITTER-RECEIVER UNIT

The Transmitter-Receiver (T/R) unit randomly transmits pulse pairs (interrogations) of L-band radio energy to the DME ground station and measures reply time from the station. The reply time is converted to nautical miles and displayed on the distance indicator. T/R unit is located in electrical/electronics compartment.

DISTANCE INDICATOR

Indicates distance in nautical miles between DME ground station and airplane. This distance is the slant (line of sight) distance to the station. A flag covers the distance indicator when distance information is not usable.



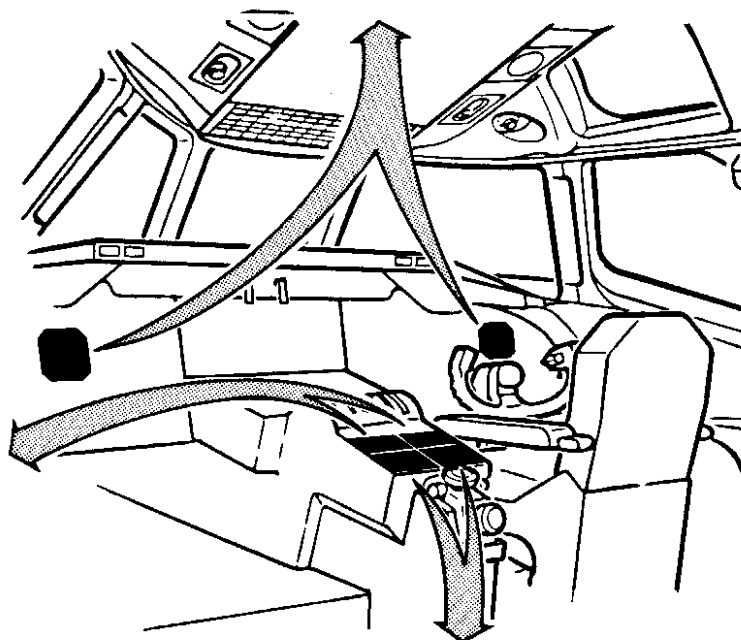
VHF NAVIGATION FREQUENCY SELECTOR.
 When a VHF NAV/LOC frequency is selected; the DME channel, if available, is automatically selected.



VHF NAV/COMM CONTROL PANEL

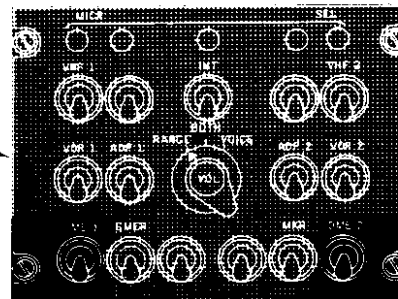
DME FUNCTION SWITCH

- STBY** - Position applies power but equipment is not searching for station.
- ON** - Equipment is in full operation. DME at an ILS station is not overridden. (Maximum range for ILS-DME operation is 50 miles.)
- ORIDE** - Position places equipment in full operation. DME at an ILS station is over-ridden. (Maximum range is 200 miles.)
- TEST** - Position causes distance indicator to rotate backwards to slightly below zero and then align at zero.



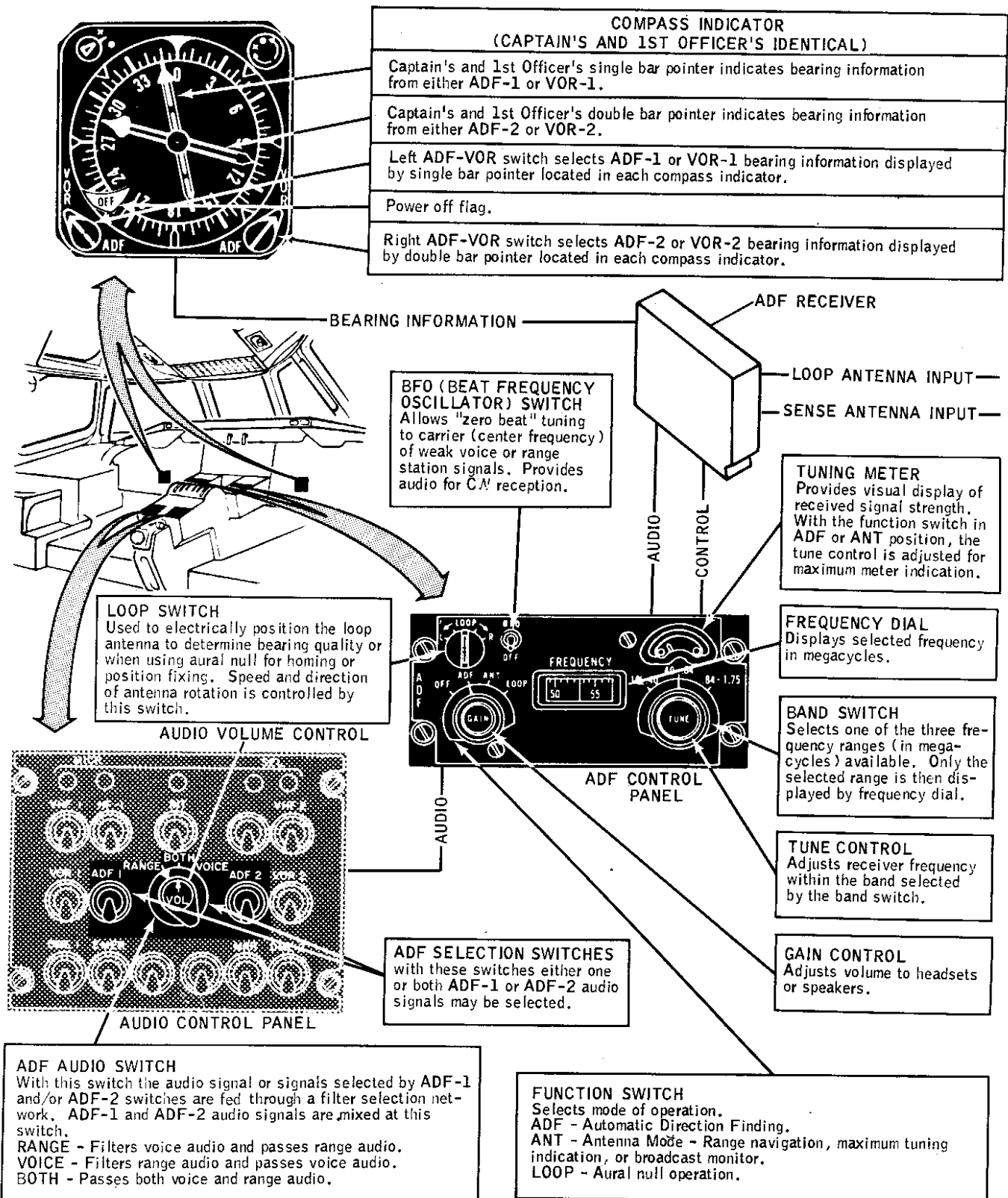
AUDIO CONTROL PANEL

Switches on audio control panels permit monitoring DME ground station identification signals.



BB1-187A

INST/NAV/COMM -- ADF SYSTEM



BB1-2127

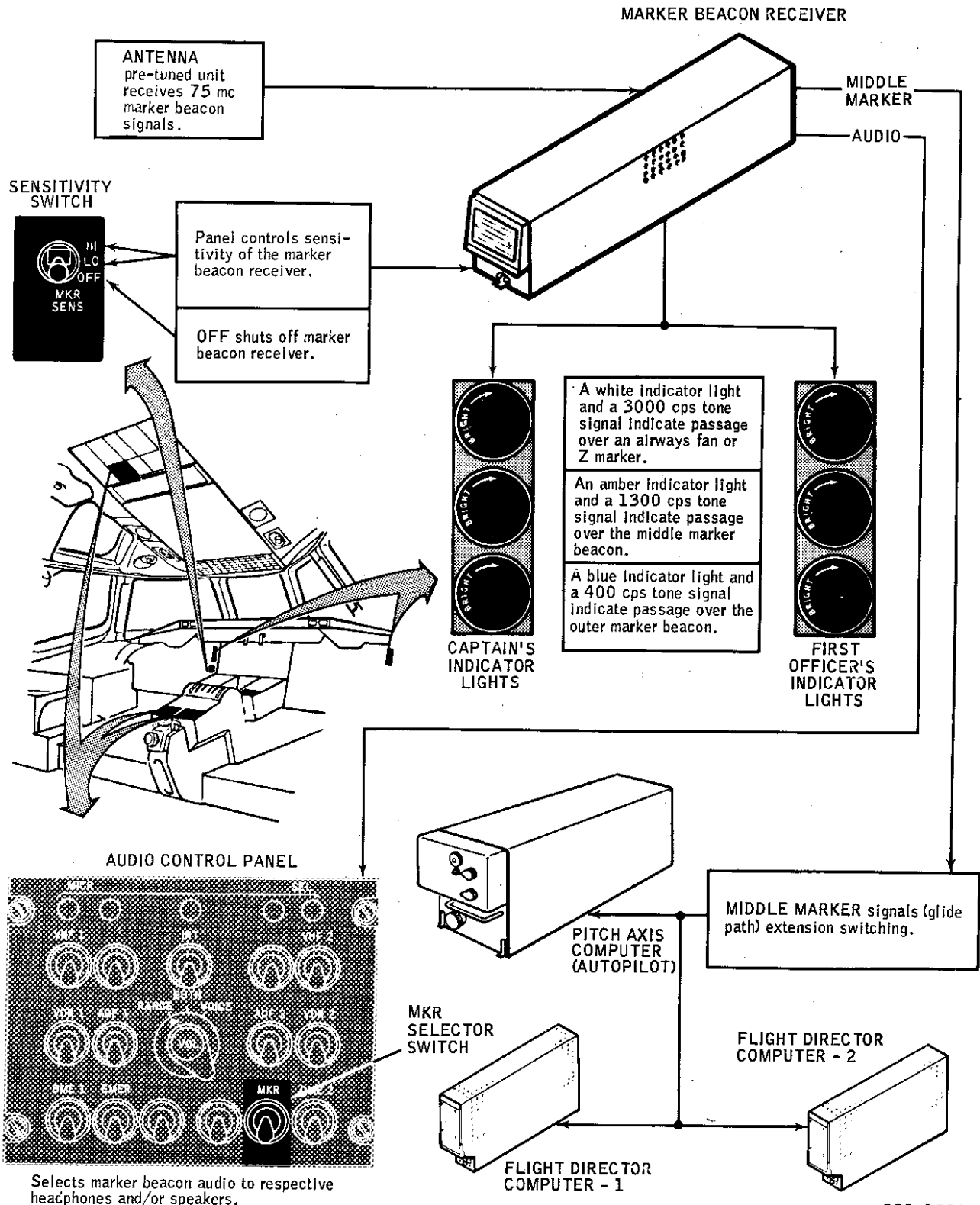
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DC-9
FLIGHT CREW OPERATING MANUAL

MARKER BEACON SYSTEM

The marker beacon system provides visual indications and aural signals for the pilots, and control signals for the automatic flight control and flight director systems when the airplane is flying under radio beam control. The receiver is pre-tuned to 75 mc, to receive signals from any marker beacon transmitter.

The aural signals are monitored through the flight interphone system, and the visual indications are lights (white, amber, and blue) on the pilot's instrument panels. Each light is dimmable, and has a push-to-test feature.

INST/NAV/COMM -- MARKER BEACON SYSTEM



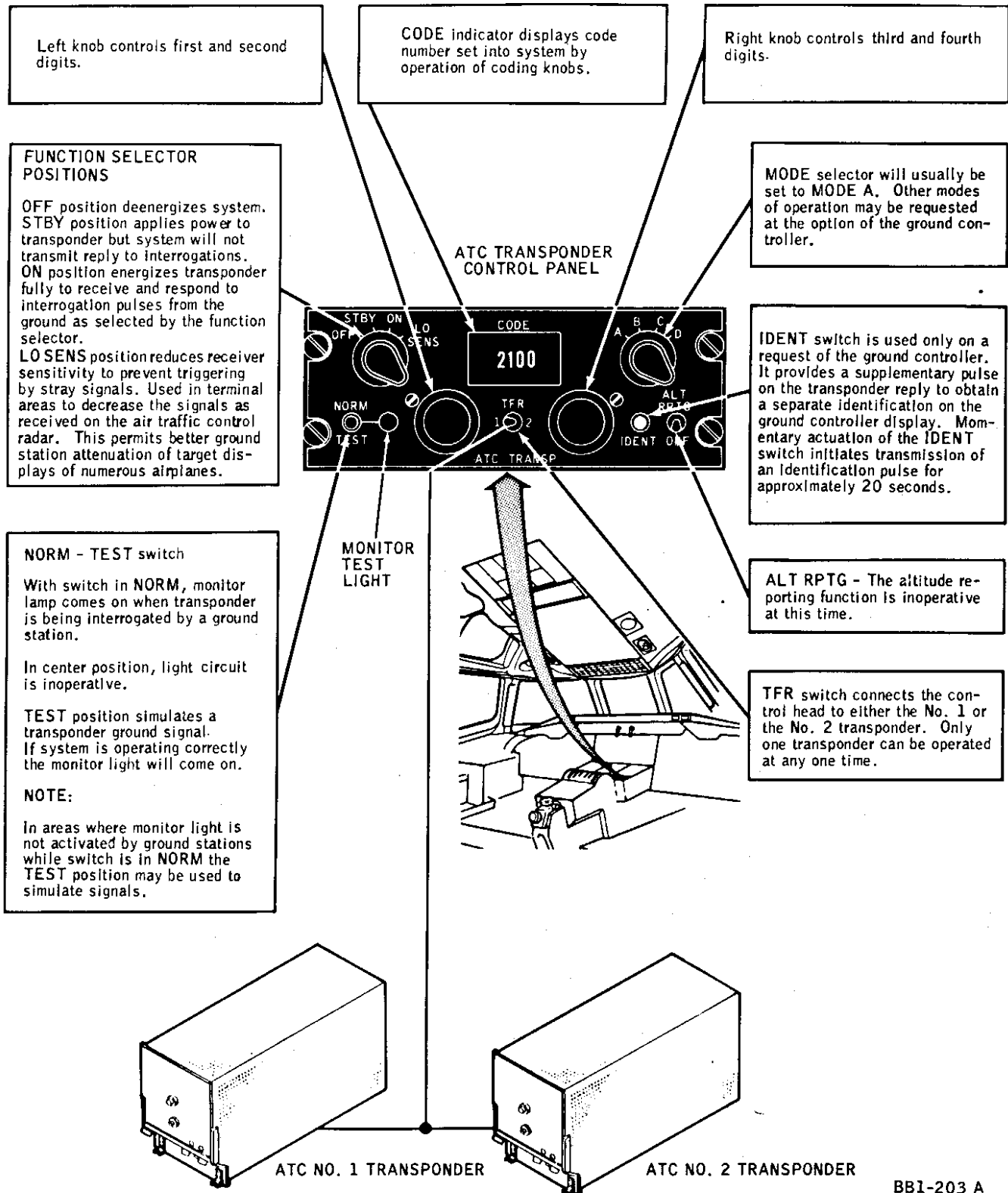
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ATC TRANSPONDER SYSTEM

The ATC transponder system facilitates air traffic control procedures by providing positive airplane identification on the ground radar scope. The transponder is the reply portion of the ATC radar beacon system. It receives interrogations from a ground station and transmits a coded reply signal which is displayed on the ground controller radar scope.

A control panel on the forward end of the center pedestal is accessible to both captain and first officer. The panel contains the necessary controls to turn the system on or off, select the desired transponder No. 1 or No. 2, test the system, select sensitivity, select the operating mode and the desired coded replay, and to manually transmit coded reply to the ground interrogating station.

INST/NAV/COMM -- ATC TRANSPONDER SYSTEM



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BB1-203 A

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WEATHER RADAR SYSTEM

The weather radar system affords the flight crew a bright, visible display of weather and ground targets, readable under all normal ambient lighting conditions without use of a viewing hood. The system comprises a 30-inch dish antenna, with its drive and stabilization mechanisms mounted in the nose radome; a receiver-transmitter unit, mounted in the forward accessory compartment; a control panel and the indicator, mounted in the forward end of the pilot's center pedestal.

The indicator display is an off-centered, plan-position type, with selective ranges of 30, 80, and 180 nautical miles. The antenna is gyro-stabilized in the pitch and roll axes by signals from the No. 1 vertical gyro, to maintain a stable indicator display. Antenna tilt angle, with respect to the fuselage reference plane, is controllable from 15 degrees up to 15 degrees down.

In the normal and contour modes, target illumination coverage angle of

the pencil beam is approximately 3.6 degrees maximum. In the map mode, beam coverage angle varies with altitude and range.

Azimuth lines on the indicator screen at the zero (aircraft heading), and at 30 and 60 degrees to either side, supply target relative heading reference. Range marks electronically projected on the indicator screen permit range distance measurement. Ranges and range marks are calibrated in nautical miles. Selection of the 180-mile range simultaneously presents six range marks on the indicator in the form of concentric arcs drawn at 30-mile intervals. In the 80-mile position, four marks indicate 20-mile intervals, in the 30-mile position, three marks indicate 10-mile intervals.

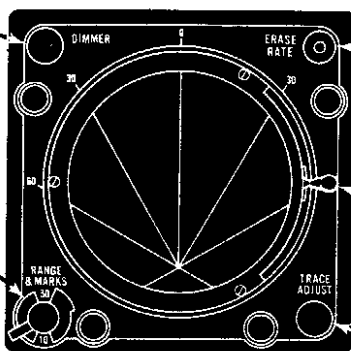
Built-in circuitry provides a ready means for test of radar system function. By placing the mode selector switch in test position and the RANGE & MARKS CONTROL TO 180 NM position, test pattern is displayed to indicate correct system functioning.

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DC-9
 FLIGHT CREW OPERATING MANUAL

INST/NAV/COMM -- WEATHER RADAR SYSTEM COCKPIT CONTROLS & INDICATORS

DIMMER control regulates panel lamp brightness.

RANGE & MARKS switch selects the desired range (30, 80 or 180 NM) and associated range marks (10, 20, or 30 nautical miles apart, respectively).



WEATHER RADAR INDICATOR

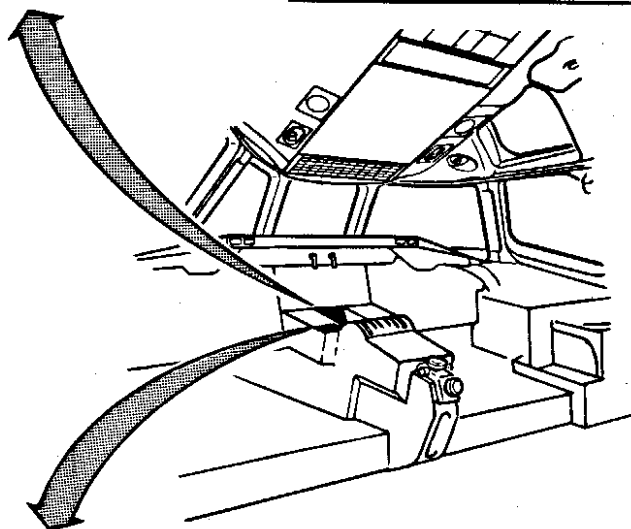
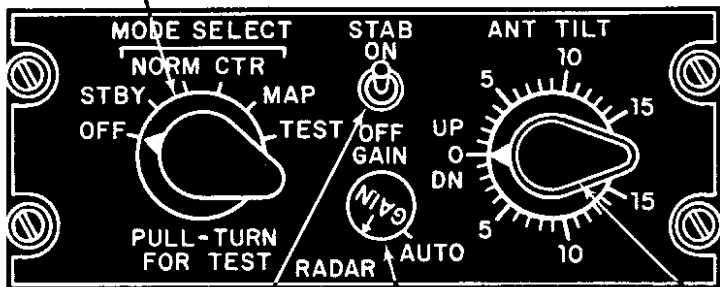
ERASE RATE knob controls retention time of illuminated targets on indicator screen.

VARIABLE BRIGHTNESS control adjusts polaroid filter from neutral to red for optimum viewing under ambient lighting conditions.

TRACE ADJUST controls sweep trace brilliance and cutoff level.

MODE SELECTOR

OFF position deenergizes system.
 STBY position places the system in warmup mode. (Approximately 3 minutes required).
 NORM position is used for normal scanning.
 CTR (CONTOUR) position energizes iso-echo circuitry - enables identification of storm cells within clouds or heavy rainfall areas.
 MAP position is used for ground mapping and terrain avoidance.
 TEST position is used for test of the radar system.



WEATHER RADAR CONTROL PANEL

STAB switch ON engages gyro stabilization of antenna to compensate for aircraft pitch and roll ± 25 degrees. STAB switch OFF maintains antenna alignment to aircraft.

GAIN control adjusts the receiver gain to increase or decrease the level of received targets on the indicator. In AUTO position, gain is a value preset by maintenance.

ANT TILT controls tilt angle of antenna in relation to heading centerline of the aircraft through range from 15 degrees above fuselage reference plane to 15 degrees below.

BB1-165C

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DC-9
FLIGHT CREW OPERATING MANUAL

RADIO ALTIMETER SYSTEMS

Two separate radio altimeter systems are provided to obtain precise altitude information above the ground at the minimum decision altitude (MDA). This information is essential to the pilot in his decision to land or initiate a go-around maneuver. The altitude outputs of the radio altimeters are connected to the indicators located on the pilot's and first officer's instrument panels.

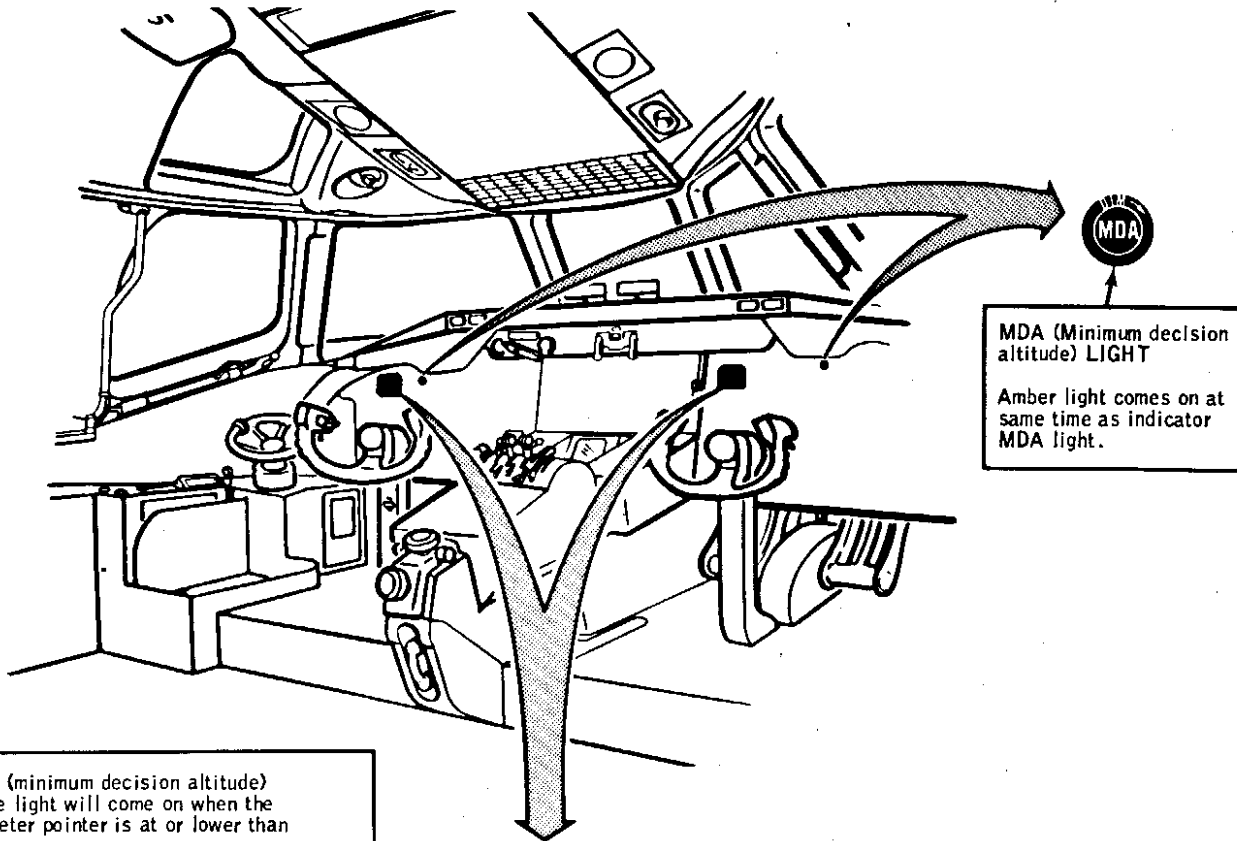
Each system consists of a transmitter-receiver unit, transmitting and receiving antennas, and indicators. The two systems will function separately or simultaneously.

Radio energy from the transmitter is directed to the earth's surface through the transmitting antenna. The receiving antenna receives the radio energy reflected from the ground. This received signal has undergone a change proportional to the airplane height above the ground, which is displayed on the radio altimeter.

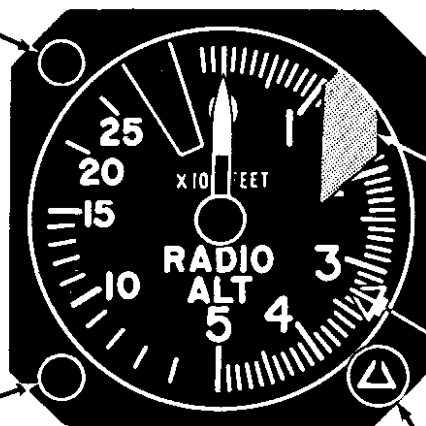
The radio altimeter is not operational above 2500 feet. For this reason, a test feature on the indicator provides an in-flight check at any altitude.

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INST/NAV/COMM -- RADIO ALTIMETER SYSTEMS



MDA (minimum decision altitude)
 White light will come on when the altimeter pointer is at or lower than the cursor.



WARNING FLAG-- Flag will appear when the TEST switch is pressed, and in the event of failure in the altimeter system, loss of power, or excessive altitude error signal, at altitudes below 2,500 feet. Above 2,500 feet, flag is retracted from view unless a power failure occurs. Pointer will be biased from view when flag appears, except when warning is result of power failure.

MINIMUM DECISION ALTITUDE CURSOR

MINIMUM DECISION ALTITUDE (MDA) SET KNOB
 Rotate to set cursor to desired altitude.

TEST BUTTON -- Push-to-test, provides in-flight test of the radio altimeter system. When test button is actuated the pointer will be at the 100 foot altitude position and the warning flag will show.

RADIO ALTIMETER INDICATOR

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INSTRUMENT FAILURE WARNING SYSTEM

The instrument failure warning system includes two navigation instrument failure warning annunciators, one each, on the captain's and first officer's instrument panels. The annunciator display assists the pilots in early recognition and evaluation of instrument system failures detected by the navigation instrument failure monitor or instrument system differences detected by the instrument or speed command comparator. Indications displayed are always identical on both the captain's and first officer's annunciators.

The instrument failure warning system operates continuously, but is designed for optimum warning during the approach. Switching of priority logic circuits occurs automatically under various flight conditions to determine signal input to the system during take-off, cruise, approach, and go-around.

Malfunctions detected by the instrument failure monitor are displayed on each failure warning annunciator by two GA (go-around) warning light arrows, two INST (instrument) warning light arrows, and one A/P (autopilot) warning light. The GA and INST arrows indicate which system has failed. The arrows on the left indicate failures in the captain's instruments and the arrows on the right indicate failures in the first officer's instruments. INST arrows indicate whether the failure will affect instrument flight and GA arrows indicate whether the condition detected will affect operation during go-around. Certain failures also cause the flight director V-command bars to be biased from view. The A/P light provides indications for the autopilot systems. Failure annunciators displayed by arrows are sensed by the failure monitor from the associated instrument warning flag circuits and will be

accompanied by flag indications at the instruments.

The autothrottle is not a monitored system. The THROTTLE light comes on if the autothrottle engage lever returns to the OFF position for any reason.

Systems and functions monitored by the instrument failure monitor are as follows:

1. Vertical gyro and attitude display.
2. Compass systems and related displays.
3. VHF NAV and glide slope receivers.
4. Speed command computers.
5. Flight director computers.
6. Flight director command servo loops.
7. Autopilot.
8. Radio Altimeters.

The center of the failure warning annunciator displays amber legends when the instrument or speed command comparator circuits sense a difference between the signal output of the captain's and first officer's systems. Functions monitored by the comparator and the associated light legends are as follows:

1. Attitude, flight director indicators -- HORIZON.
2. Compass, course indicators -- HDG.
3. Localizer signal, VHF NAV receivers -- LOC.
4. Glide slope signal, glide slope receivers -- GP.
5. Speed command computers -- SPD COMD.

DOUGLAS AIRCRAFT CO., INC.
DC-9
FLIGHT CREW OPERATING MANUAL

6. Radio altimeter systems --
RAD ALT.
7. Comparator failure --
MONITOR.

The INST WARN TEST switch is provided to test the annunciator lights. When pressed, the lights will come on, and lights go off when the switch is released. The INST WARN RESET switches are provided to turn off the annunciator lights and arm the system for subsequent malfunctions. When pressed, all lights with the exception of the A/P red warning light will go off. The red A/P warning light is reset by depressing the autopilot release button on the control wheel.

INST/NAV/COMM -- INSTRUMENT FAILURE WARNING SYSTEM - Controls & indicators

THROTTLE (Red Light)

Comes on if the autothrottle engage lever is manually placed in the OFF position or if an autothrottle interlock circuit automatically returns the engage lever to the OFF position. Light can be turned off by depressing either instrument warning reset switch.

RESET SWITCH (Typical)



INSTRUMENT WARNING RESET

Resets all annunciator lights, except the autopilot light when on red, and rearms system for another discrepancy display. (Auto Pilot - red - is reset by the Auto Pilot release button on either control wheel.)

NOTE: Previously reset warnings, if still valid, will reappear in the event of subsequent indications.

GA (Go-Around) Arrows (Typical 2 places)

Red - Indicates that an instrument equipment failure has occurred and indicated instruments are not to be used in a go-around maneuver.

Green - Indicates that an instrument or equipment in the parallel system to that reporting the failure is still operating satisfactorily and may be used in a go-around maneuver.

COMPARATOR LIGHTS

The center of the instrument failure warning annunciator displays a series of amber legends. When a difference between two identical systems is detected by failure monitoring (instrument warning flag circuits), a signal is sent to the appropriate legend and the light comes on. The comparator provides a time delay of 1 to 2 seconds from the time of error detection to the time the legend light comes on.

INSTRUMENT FAILURE WARNING ANNUNCIATOR



INST (Instrument) ARROWS (Typical 2 places)

Red - Indicates that an instrument or equipment failure has occurred and the arrow points to the affected instrument panel.

Green - Indicates that an instrument or equipment failure has occurred but the instrument panel indicated by the arrow direction is not affected.

NOTE: Red arrows identify the panel on which the failure has occurred; flag warnings on instruments identify the particular instrument or equipment failure.

INST WARN TEST



INSTRUMENT WARNING TEST SWITCH (ON OVERHEAD PANEL)

When pressed, INST and GA arrows (both red and green) lights, green A/P lights, and comparator lights should come on. Lights will go off when switch is released.

AUTO PILOT (Red or Green Arrow)

Red - If automatic pilot has been disengaged by any other means than by the AUTO PILOT RELEASE button on one of the pilot's control wheels, the AUTO PILOT arrow comes on red. It is turned off by pressing a pilot's control wheel release button.

Green - If a failure, as indicated by the instrument failure warning arrows, does not affect auto pilot operation the AUTO PILOT arrow comes on green.

NOTE: The automatic pilot must be engaged for the green light to come on.

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**INST/NAV/COMM -- INSTRUMENT FAILURE WARNING SYSTEM -
Annunciator indications (sheet 1)**

SPEED COMMAND MODE (exists when flight director is in SC mode)

ANNUNCIATIONS SHOWN ARE INDICATED SIMULTANEOUSLY ON BOTH CAPTAIN'S AND FIRST OFFICER'S ANNUNCIATORS										
COMPARATOR LIGHTS	FAILURES		FAILURE WARNING LIGHTS						V-COMMAND BAR BIAS (NOTE 3)	
			INST ARROWS		GA ARROWS		A/P ARROW	THROTTLE		
Indicate difference between No. 1 and No. 2 system which does not involve a failure.	• No. 1 indicates failure in captain's system, No. 2 indicates failure in first officer's system.		CAPT.	F/O	CAPT.	F/O			CAPT.	F/O
HORIZON	VERTICAL GYRO	No. 1	RED	GREEN	RED	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	RED	RED			X
HORIZON	ATTITUDE DISPLAY	No. 1	RED	GREEN	RED	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	RED	GREEN			X
HDG	COMPASS SYSTEM	No. 1								
		No. 2								
HDG	COURSE INDICATOR HEADING	No. 1								
		No. 2								
	FLIGHT DIRECTOR COMPUTER	No. 1	RED	GREEN	RED	GREEN	GREEN			
		No. 2	GREEN	RED	GREEN	RED	GREEN			
	FLIGHT DIRECTOR COMMAND	No. 1	RED	GREEN	RED	GREEN	GREEN			
		No. 2	GREEN	RED	GREEN	RED	GREEN			
SPD COMD	SPEED COMMAND COMPUTER	No. 1	RED	GREEN	RED	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	RED	GREEN			X
	AUTO PILOT						RED			

NOTES:

1. When failure is indicated by GA or INST arrows, warning indications will appear on associated instruments.
2. MONITOR light comes on to indicate failure of comparator.
3. X indicates V-command bar biased out of view.

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**INST/NAV/COMM -- INSTRUMENT FAILURE WARNING SYSTEM -
 Annunciator indications (sheet 2)**

CRUISE MODE (exists at all times when not in approach or
 speed command mode)

ANNUNCIATIONS SHOWN ARE INDICATED SIMULTANEOUSLY ON BOTH CAPTAIN'S AND FIRST OFFICER'S ANNUNCIATORS								
COMPARATOR LIGHTS	FAILURES		FAILURE WARNING LIGHTS					
Indicate difference between No. 1 and No. 2 system which does not involve a failure.	No. 1 indicates failure in captain's system, No. 2 indicates failure in first officer's system.		INST ARROWS		GA ARROWS		A/P ARROW	THROTTLE
			CAPT.	F/O	CAPT.	F/O		
HORIZON	VERTICAL GYRO	No. 1	RED	GREEN	RED	GREEN	GREEN	
		No. 2	GREEN	RED	GREEN	RED	RED	
HORIZON	ATTITUDE DISPLAY	No. 1	RED	GREEN	RED	GREEN	GREEN	
		No. 2	GREEN	RED	GREEN	RED	GREEN	
HDG	COMPASS SYSTEM	No. 1	RED	GREEN	GREEN	GREEN	GREEN	
		No. 2	GREEN	RED	GREEN	GREEN	RED	
HDG	COURSE INDICATOR HEADING	No. 1	RED	GREEN	GREEN	GREEN	GREEN	
		No. 2	GREEN	RED	GREEN	GREEN	GREEN	
	AUTO PILOT						RED	

NOTES:

1. When failure is indicated by GA or INST arrows, warning indications will appear on associated instruments.
2. MONITOR light comes on to indicate failure of comparator.

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**INST/NAV/COMM -- INSTRUMENT FAILURE WARNING SYSTEM -
 Annunciator indications (sheet 3)**

APPROACH MODE (exists when the flight directors or
 autopilot have captured glide slope)

ANNUNCIATIONS SHOWN ARE INDICATED SIMULTANEOUSLY ON BOTH CAPTAIN'S AND FIRST OFFICER'S ANNUNCIATORS										
COMPARATOR LIGHTS	FAILURES		FAILURE WARNING LIGHTS						V-COMMAND BAR BIAS	
Indicate difference between No. 1 and No. 2 system which does not involve a failure.	No. 1 indicates failure in captain's system, No. 2 indicates failure in first officer's system.		INST ARROWS		GA ARROWS		A/P ARROW	THROTTLE	(Note 3)	
			CAPT.	F/O	CAPT.	F/O			CAPT.	F/O
HORIZON	VERTICAL GYRO	No. 1	RED	GREEN	RED	GREEN	GREEN	RED	X	
		No. 2	GREEN	RED	GREEN	RED	RED			X
HORIZON	ATTITUDE DISPLAY	No. 1	RED	GREEN	RED	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	RED	GREEN			X
HDG	COMPASS SYSTEM	No. 1	RED	GREEN	GREEN	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	GREEN	RED			X
HDG	COURSE INDICATOR HEADING	No. 1	RED	GREEN	GREEN	GREEN	GREEN		X	
		No. 2	GREEN	RED	GREEN	GREEN	GREEN			X
	FLIGHT DIRECTOR COMPUTER	No. 1	RED	GREEN	RED	GREEN	GREEN			
		No. 2	GREEN	RED	GREEN	RED	GREEN			
	FLIGHT DIRECTOR COMMAND	No. 1	RED	GREEN	RED	GREEN	GREEN			
		No. 2	GREEN	RED	GREEN	RED	GREEN			
LOC	VHF NAV RECEIVER	No. 1	RED	GREEN	GREEN	GREEN			X	
		No. 2	GREEN	RED	GREEN	GREEN	GREEN			X
GP	GS RECEIVER	No. 1	RED	GREEN	GREEN	GREEN			X	
		No. 2	GREEN	RED	GREEN	GREEN	GREEN			X
RAD ALT	RADIO ALTIMETER	No. 1	RED	GREEN	GREEN	GREEN	GREEN			
		No. 2	GREEN	RED	GREEN	GREEN	GREEN			
SPD COMD	SPEED COMMAND COMPUTER	No. 1	GREEN	GREEN	RED	GREEN	GREEN	RED		
		No. 2	GREEN	GREEN	GREEN	RED	GREEN			
	AUTO PILOT						RED			
	AUTO THROTTLE							RED		

NOTES:

1. When failure is indicated by GA or INST arrows, warning indications will appear on associated instruments.
2. MONITOR light comes on to indicate failure of comparator.
3. X indicates V-command bar biased out of view.

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COMMUNICATIONS SYSTEMS

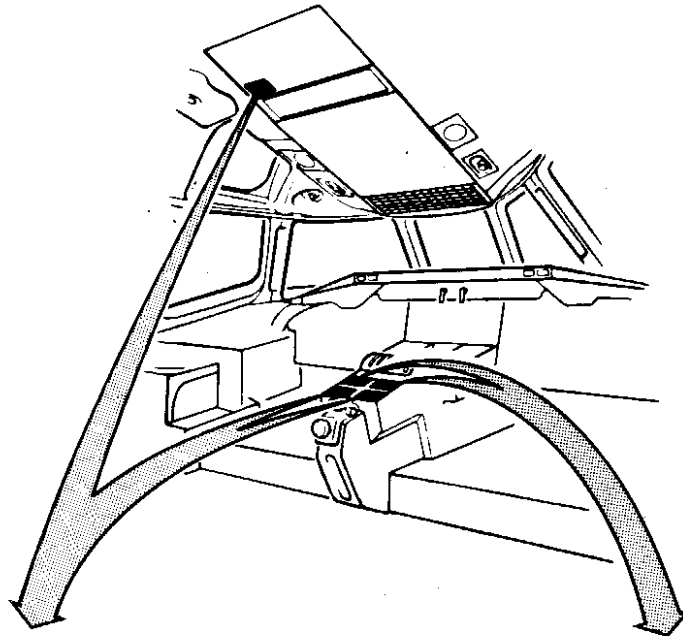
The VHF communications system is installed to provide air-to-ground and air-to-air communications. The interphone system allows communication between crew positions within the airplane, monitoring of the communications transceivers and navigational receivers, and selection of transmission with the communications transceivers.

The selective calling system provides a visual and aural indication that the airplane is being called by a ground facility, thus relieving the crew of the necessity for constant monitoring of a communications channel.

VHF COMMUNICATION SYSTEMS

The VHF system is two separate, identical systems designated VHF-1 and VHF-2. The systems can be operated separately or simultaneously. The system is used to provide communication between the airplane and ground and/or another airplane, and operates in the range of 118.00 to 135.95 megacycles. The transmitting and receiving frequency selection is controlled from the VHF NAV/COMM control panels. The audio control panels are used to control selection of receiver audio, and microphone selection of the transmitter section for operation. The microphone switch buttons located on the outboard horns of the control wheels, and the buttons located on the microphone, can be used to place the selected transmitter section in operation. Selection of the desired VHF system is made by pressing the applicable MICR SEL pushbutton and placing the corresponding reception toggle switch in the on position, thus connecting the microphone and the headset of the flight interphone system to the desired VHF system transmitter section. Depressing the microphone push-to-talk button actuates the transmitter section and connects the output of the transmitter section to the system antenna.

INST/NAV/COMM -- VHF COMMUNICATION SYSTEMS



AUDIO CONTROL PANEL	
MICROPHONE SELECT BUTTONS Push to connect microphones to the applicable VHF system.	
VHF SELECTION SWITCHES VHF-1, VHF-2 or both (systems) may be selected.	

VHF NAV/COMM CONTROL PANEL	
VOL-OFF Turns applicable VHF system on and off, and controls volume.	SQUELCH SWITCH In SC position, squelches background noise while awaiting the frequency selected signal.
FREQUENCY SELECTION KNOB Controls second and third digits on frequency indicator (first digit remains stationary).	FREQUENCY SELECTION KNOB Controls two digits to right of decimal point on frequency indicator.

VHF COMMUNICATIONS SYSTEM	
The VHF system is two separate, identical systems designated VHF-1 and VHF-2 and can be operated separately or simultaneously. The system is used to provide communication between the airplane and ground and/or another airplane and operates in the range of 118.00 to 135.95 megacycles. The transmitting and receiving frequency selection is controlled from the VHF NAV/COMM control panels.	Selection of the desired VHF system and the applicable microphones are controlled from the audio control panel. Power is supplied to the VHF system when power is applied to the airplane, circuit breakers are closed, and the appropriate power on-off switches are in the on position.

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HF COMMUNICATION SYSTEM

The HF communication system provides communication between the airplane and ground and/or another airplane in the frequency range between 2.0 and 30.0 megacycles. The transmitting and frequency selection is controlled from the HF control panel located on the overhead panel. The control panel contains frequency selector controls, a mode selector for selecting USB (upper sideband), LSB (lower sideband) or AM (amplitude modulation) modes of operation, and an RF SENS control for adjusting the audio output of the receiver. During tuning operations, the receiver will be muted, and a 1000-cps tone signal will be heard until the tuning cycle is completed.

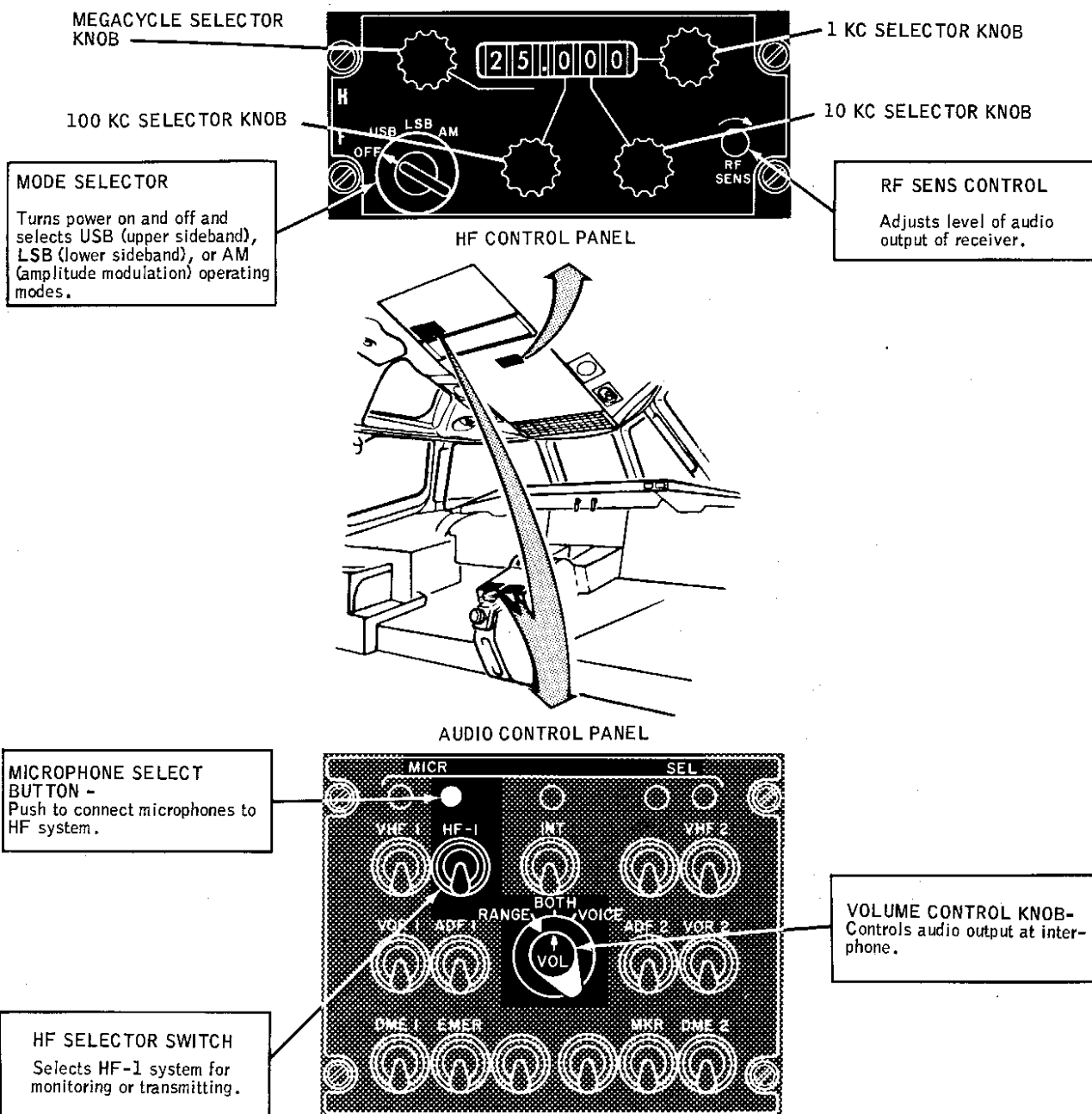
NOTE: When the desired operating frequency is already set up when the operating mode is selected from the off position, rotate the 10-kilocycle select knob one digit off frequency to allow the system to retune to the desired frequency.

The audio control panels are used to control selection of receiver audio and microphone selection of the transmitter section for operation. The microphone switches in the outboard horns of the control wheels, or the button on the hand microphones can be used to place the transmitter in operation. Selection of the HF system is made by pressing the HF microphone selector button and placing the HF toggle switch in the on position, which connects the microphone and headset of the flight interphone system to the HF transmitter section. Depressing the microphone push-to-talk button on either the control wheel or

hand microphone actuates the transmitter section and connects the output of the transmitter to the system antenna.

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INST/NAV/COMM -- HF COMMUNICATION SYSTEM



HF COMMUNICATION SYSTEM

The HF communication system provides air-to-air and air-to-ground communication in the frequency range of 2.0 to 30.0 megacycles. The transmitting and receiving frequency selection is controlled from the HF control panel. When selecting a new frequency a delay of up to 18 seconds will be required before transmitting, to electrically tune the transmitter and antenna to the new frequency. A 1000-CPS tone signal is heard while the tuning control is cycling. When tone signal stops, tuning cycle is completed and set is ready for operation.

Selection of the HF system and applicable microphones is controlled from the audio control panel. Power is supplied to the HF system when power is applied to the airplane, circuit breakers are closed, and power on-off switch is in the ON position.

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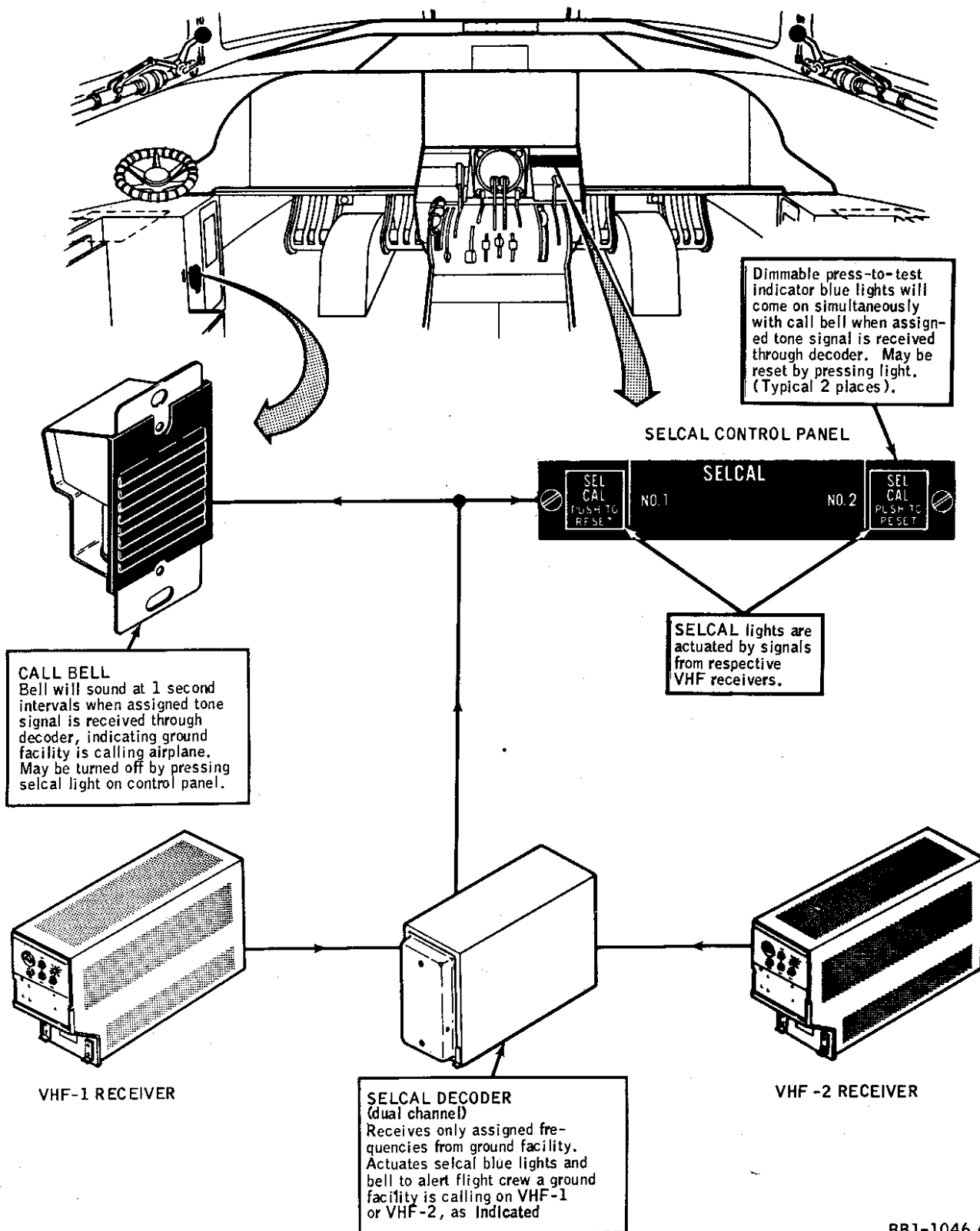
SELECTIVE CALLING SYSTEM

The selective calling (SELCAL) system provides flight crew with visual and aural indications that a ground facility is calling the airplane on VHF. The system relieves flight crews from having to continuously monitor a secondary radio channel. The system enables ground facilities equipped with SELCAL tone transmitting equipment to call individual airplanes selectively. The airplane system consists of a decoder with dual channels, one for each VHF receiver, a selective control panel with blue indicator lights, and a call bell.

Each airplane is assigned a tone code. The tone code can be received by any airplane monitoring the VHF transmitting frequency. However, only the decoder in the airplane with the assigned frequency of the tone being transmitted will actuate to sound the call bell and turn on the indicator light on the SELCAL control panel. When the SELCAL light is pressed, the light goes off, the bell stops ringing, and the decoder is reset to accept the next call.

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INST/NAV/COMM -- SELCAL SYSTEM



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FLIGHT INTERPHONE SYSTEM

The flight interphone system provides for communications between positions (stations) within the airplane, selection and monitoring of the audio outputs of the communications transceivers and navigation receivers, and for selection and transmission with the communications transceivers.

Audio selection function is provided and permits the operator to select and monitor the audio output of one or more of the communications transceivers and navigation receivers. Microphone selection function enables the operator to select and control the desired communications transceiver. There are two means provided for each crewmember to key transmission: the hand microphone keying switch, and another keying switch located on the outboard horn of each control wheel. The latter keying control is used when the oxygen masks are being worn.

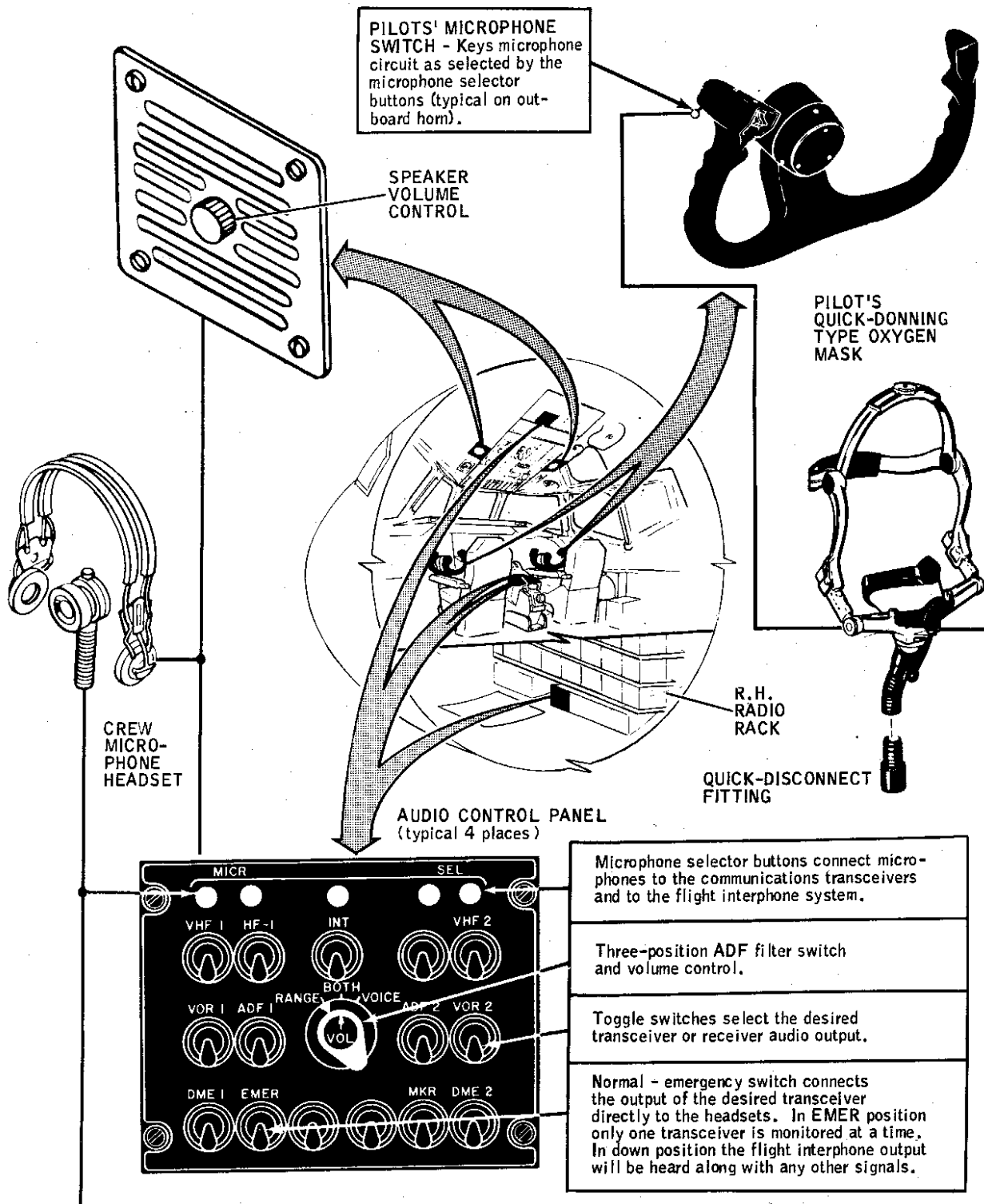
Audio control panels are included for the captain and first officer, and are also located at the observer's station and the electrical/electronics compartment. Each panel includes an integral amplifier. If an amplifier should fail, a normal-emergency panel switch can be placed to EMER, connecting the output of a selected receiver directly to the headset or speaker. In this instance, only one receiver can be monitored at a time.

A hand microphone jack and a headset jack are installed at the captain's and first officer's station, and at the observer's station. A hand microphone and headset jacks are located in the electrical/electronics compartment, for use by maintenance personnel. In addition, a headset jack is located on the external electrical

power receptacle panel. Two speaker assemblies are installed overhead in the flight compartment to monitor audio signals selected by the captain and first officer, respectively. The speaker amplifiers are muted to prevent feedback when the microphones are operated.

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INST/NAV/COMM -- FLIGHT INTERPHONE SYSTEM



**NOTE: OBSERVER'S
 OXYGEN MASK MICROPHONE
 KEYED BY SWITCH
 MOUNTED ON MASK HOSE**

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CHAPTER 3-60

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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The following pages are effective for ATL Series 30 Aircraft.

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*The asterisk indicates pages revised or added by the current revision.

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Chapter 60

AUTOMATIC FLIGHT CONTROL SYSTEM

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*Illustration

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Chapter 60

AUTOMATIC FLIGHT CONTROL SYSTEM

GENERAL

The Sperry SP-50 automatic flight control system (AFCS) is a gyroscopically controlled electromechanical system which maintains the airplane on any desired heading or in coordinated turn maneuvers in a normal, stabilized attitude. The system consists of two basic subsystems that function independently or as parts of an integrated system. The subsystems are the stability augmentation, which incorporates yaw damper and Mach trim compensator, and the automatic pilot, which incorporates roll axis and pitch axis controls.

Engagement of the autopilot with the AUTOMATIC PILOT controller SERVOS switch will automatically engage the yaw damper, together with the autopilot roll and pitch axes, to provide fully automatic control of the airplane.

STABILITY AUGMENTATION SYSTEM

MACH TRIM COMPENSATOR

The Mach trim compensator (MTC) mode is established when stability augmentation computer and air data computer power is applied to the system and the MACH TRIM COMP switch is in normal position. Pitot and static pressures, applied through the air data computer portion of the AFCS, control MTC actuator output in relation to Mach number

to compensate for the nosedown pitching moments generated during operation at high Mach numbers.

YAW DAMPER SYSTEM

The yaw damper is in standby mode when power is applied to the stability augmentation system. The yaw damper function is activated at any time the automatic pilot is engaged, regardless of whether the YAW DAMP switch is ON or OFF. With automatic pilot disengaged, the yaw damper is activated by placing the YAW DAMP switch in the ON position. Rudder movements generated by the yaw damper action are not transmitted to the rudder pedals, due to the action of an irreversible linear actuator installed in series with the basic rudder control system.

AUTOMATIC PILOT SUBSYSTEM

The automatic pilot controls the airplane in vertical speed attitude and heading to reduce workload on the flight crew and to provide improved flight comfort and stability. The automatic pilot consists of a roll channel and a pitch channel. These channels, acting together with the yaw damper, control the airplane in the yaw, pitch, and roll maneuvering axes. Each of the three axes actuates the appropriate surface to control the airplane according to the control mode selected by the pilot.

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The automatic pilot stabilizes the airplane in pitch and roll axes and steers it to headings set in manually by the pilot or fed in from the compass system or from navigational radio beams. Pitch attitude may be automatically controlled to maintain a precise barometric altitude, a fixed pitch angle, or a fixed vertical speed.

The AFCS receives and utilizes signals and commands from several sources. The roll axis receives heading displacement signals from the directional gyro, roll displacement signals from the vertical gyro, navigation information from the VOR/localizer receiver, and heading select and course error information from the integrated flight instrument system.

The AFCS pitch axis receives basic pitch displacement information from the vertical gyro, glide slope information from the glide slope receiver, and altitude information from the air data computer.

AUTOMATIC PILOT CONTROLLER

The VERT SPEED wheel is the primary pitch control and will maintain the airplane vertical speed existing when the autopilot is engaged. With the wheel in detent (ALT HOLD), the automatic pilot will hold the airplane to the barometric altitude existing upon engagement. Movement of the wheel from detent when the airplane is under any other vertical path control mode will return control to the VERT SPEED mode.

The PITCH SELECTOR knob permits selection of the specific pitch axis control mode desired.

The G/P EXT position on the selector switch enables manual selection of the glide path extension mode. This mode modifies the glide path gains, to provide necessary performance for low

approaches. Glide path extension is normally initiated by the radio altimeter at approximately 300 feet or by the marker beacon receiver when the airplane passes over the middle marker. The G/P EXT position permits manual initiation of glide path extension mode in the event that the radio altimeter or marker beacon is inoperative, or when glide slope extension is desired before automatic switching occurs.

Selection of the PITCH HOLD mode will command the airplane to maintain the pitch attitude existing upon engagement with respect to the associated vertical gyro.

The TURN knob establishes the basic directional command mode, having priority over all other directional command modes. Rotation of the TURN knob will command a coordinated turn. The airplane will turn in the direction of knob rotation and maintain a bank angle proportional to the degree of knob rotation. When the TURN knob is returned to detent position, the automatic pilot will maintain the heading existing at the time the bank angle decreases to approximately 6 degrees.

The HDG SEL switch establishes the heading select mode, and the AFCS will maneuver the airplane along a path defined by the selected heading on the integrated flight instrument system. In this mode, the airplane will be turned through the smallest angle between the present heading and the selected heading, which will be maintained until a new heading is commanded or the mode is disengaged. Headings may be preselected before engagement of heading select, or selected after engagement. The HDG SEL switch, adjacent to the TURN knob, engages the heading select mode when actuated and when the TURN knob is in detent. Heading select may be used during the armed phase of a directional radio beam capture.

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However, it will yield control to the radio mode at the beam edge, and it may not be engaged during lateral radio beam control.

The automatic pilot SERVOS ENGAGED/DISENGAGED switch, located on the automatic pilot controller, will permit engagement and disengagement of the aileron and elevator axes when the automatic pilot and associated circuit breakers are closed. If the yaw axis is not engaged at the time the aileron and elevator axes are engaged, it will be engaged by the SERVOS ENGAGED switch.

Disengagement of the automatic pilot by any abnormal procedure or condition will cause the A/P arrow (Red) to come on in the failure warning annunciator. Included are disengagement by movement of the controller SERVOS switch to DISENGAGED or any interruption of the power supply. The A/P arrow may be turned off by depressing either the captain's or first officer's control wheel release buttons. Independent disengagement of the three servo channels is available by use of the AFCS SERVOS switches on the captain's instrument panel. For normal operation, these switches remain in the AIL, ELEV, and RUD positions.

The NAV SELECTOR switch provides selection of radio control modes. When the switch is placed in the NAV/LOC position, the AFCS will automatically capture and maneuver the airplane along paths defined by the localizer and VOR systems. Sensors which monitor and radio beam displacement automatically switch the AFCS to the capture mode at the appropriate time in NAV/LOC or ILS. VOR radial heading, corrected for crosswinds, is provided during VOR station passage. The system uses combinations of beam rate, beam

displacement, and beam heading. The NAV/LOC mode may be selected with the TURN knob in or out of detent, and with the HDG SEL mode engaged or disengaged. However, automatic beam capture will not start until the TURN knob is returned to detent.

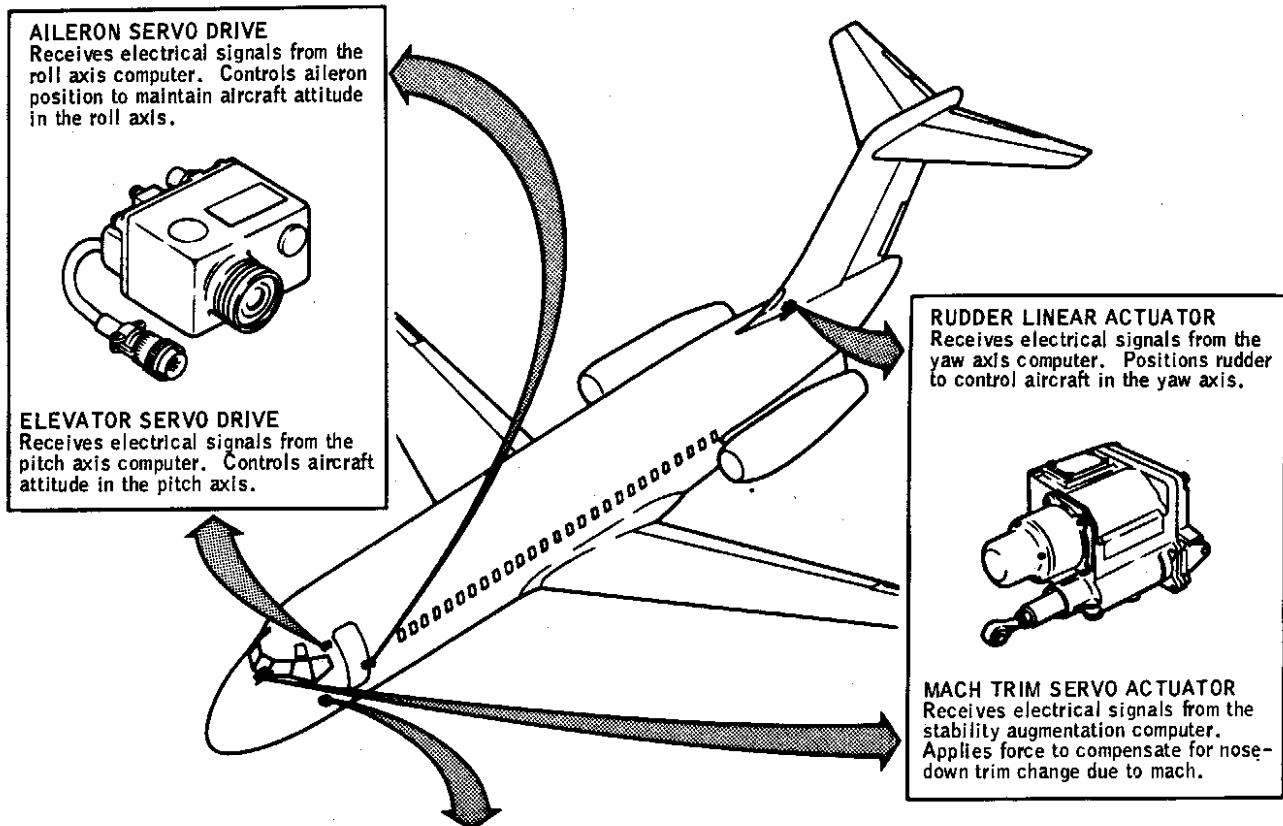
The ILS position of the NAV SELECTOR switch arms the ILS control mode with the TURN knob in or out of detent and with HDG SEL engaged or disengaged.

The MAN G/P position of the NAV SELECTOR switch enables the pilot to manually bypass the beam capture sequence, and force beam capture, establishing a fixed angle intercept of the glide path.

MODE ANNUNCIATION

The AFCS mode annunciator continuously indicates the mode of operation when the AFCS is operating in a radio beam function. The annunciated modes are N-L ARM, N-L CAP, G-P ARM, G-P CAP, and G-P EXT. Dual bulbs are installed in the annunciator positions to prevent a single bulb failure from leaving the pilot without indication during the critical portion of approach.

AFCS -- MAJOR COMPONENT LOCATION

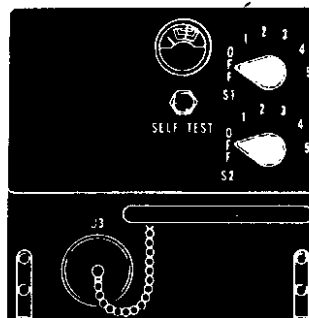


AUTOMATIC FLIGHT CONTROL SYSTEM COMPUTER INSTALLATION

STABILITY AUGMENTATION COMPUTER

Yaw damper computer section receives signals from yaw rate gyro. Controls yaw rate by energizing rudder linear actuator.

Mach trim compensator components in stability augmentation computer and air data computer racks compute Mach number from pitot/static pressure. Provide programmed force to compensate for nose-down trim change.

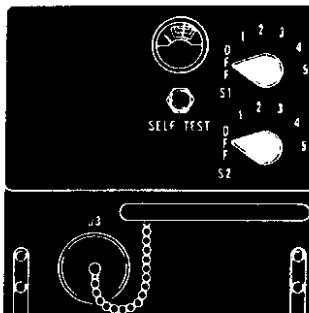


ROLL AXIS COMPUTER

Receives heading signals from the automatic pilot controller, directional gyro, course indicator, and VHF NAV receiver, and roll signals from the vertical gyro and the roll rate gyro. Amplifies and transmits roll signals to the aileron servo drive to maintain aircraft roll attitude.

AIR DATA COMPUTER

Supplies: "Q"-switching of Auto-pilot gains, Mach signals for the MTC, altitude error signals to the Autopilot, and vertical speed error signals to the Autopilot.



PITCH AXIS COMPUTER

Receives pitch signals from the vertical gyro, automatic pilot controller, air data computer, pitch rate gyro, and VHF NAV receiver. Computes pitch corrections, amplifies and transmits pitch signals to elevator servo drive and horizontal stabilizer drive motor.

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AFCS -- COCKPIT CONTROLS & INDICATORS (sheet 1)

Autopilot armed for automatic capture of VOR or LOCALIZER beams.

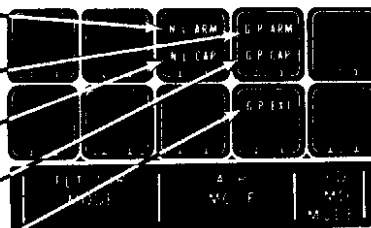
Autopilot armed for automatic capture of GLIDE PATH beam.

Autopilot has captured VOR or LOCALIZER beam.

Autopilot has captured GLIDE PATH beam.

Autopilot is in GLIDE PATH EXTENSION mode.

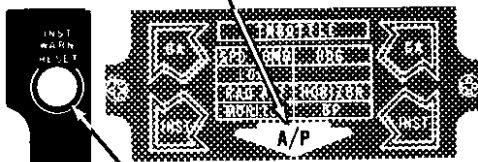
CONTROL MODE ANNUNCIATOR



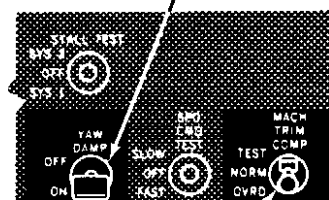
YAW DAMP SWITCH

Placing the YAW DAMP switch ON energizes the rudder axis linear servo to control the aircraft in the yaw axis, effectively damping yaw tendency in either manually or automatically controlled flight. Yaw damper will be activated automatically, regardless of switch position, when automatic pilot is engaged. With switch OFF, yaw damper will be deactivated when automatic pilot is disengaged, either by means of the SERVOS ENGAGE/DISENGAGE switch or the autopilot release button. A/P SERVOS RUD switch must be on for yaw damper function to operate in manually controlled flight.

A/P arrow shows red when any abnormal condition causes autopilot disengagement. A/P arrow shows green to indicate satisfactory condition when abnormal condition depicted above does not affect autopilot function.



RESET is used to return warning system green A/P arrow to the armed condition after abnormal condition is corrected. Reset from red A/P arrow requires use of pilots wheel autopilot release switch.



MACH TRIM COMP SWITCH

MACH TRIM COMP TEST SWITCH (momentary)

Switch position actuates the MACH TRIM system to the extended position.

TEST - Momentary position tests integrity of system. Switch must be held in TEST position for at least 5 seconds to allow time-delay circuits to actuate.

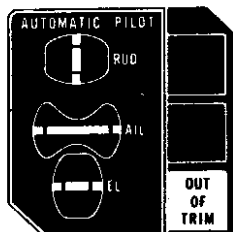
NORM - Mach trim compensation system automatically scheduled as a function of aircraft Mach number.

OVRD - Utilizes Emergency dc bus power to retract Mach pitch trim compensator.



A/P SERVOS SWITCHES

Provide separate disengagement of the aileron and rudder servo drives and rudder actuator when respective switch is placed in the OFF position. All three axes will be disengaged simultaneously when the automatic pilot controller SERVOS ENGAGE/DISENGAGE switch is placed in the DISENGAGED position or the autopilot release button on either control wheel is depressed.



OUT OF TRIM (Amber)
Annunciator light indicates failure of the horizontal stabilizer to trim out sustained elevator deflection.

AUTOPILOT RELEASE SWITCH

Disengages servos in aileron and elevator axis without deactivating yaw axis if YAW DAMP switch is ON. When YAW DAMP switch is OFF, all three axes will disengage. Does not cause annunciator A/P arrow to come ON.

AUTOPILOT INDICATOR

The autopilot trim indices, one each for the elevator, aileron, and rudder, (placarded EL, AIL and RUD) indicate trim condition, i.e. the amount of force applied by the servos to maintain the existing attitude.

BB1-2356B

AFCS -- COCKPIT CONTROLS & INDICATORS (sheet 2)

AUTOPILOT CONTROLLER

Contains switches and controls for automatic pilot engagement, selection of operational modes, and insertion of manual commands.

TURN KNOB

Primary control mode of the AFCS; permits manually initiated changes in airplane heading. An Interlock system automatically disengages any other lateral control mode when the TURN knob is displaced from detent (center position). Moving the knob out of the detent after VOR or localizer capture will cause the NAV SELECTOR switch to return to the TURN KNOB position.

VERT SPEED CONTROL WHEEL

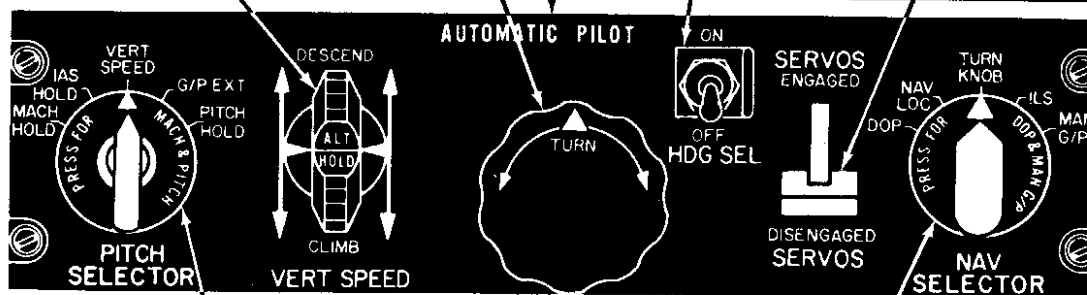
Permits insertion of vertical speed commands into the automatic pilot. ALT HOLD (center position) maintains existing altitude. Approximate vertical speed rates are labeled on the wheel.

HDG SEL ON-OFF SWITCH

Locks airplane directional control to the gyro compass heading as selected when TURN knob is in detent position. Switch will return to the OFF position when TURN knob is moved from the detent (center position).

SERVOS ENGAGED-DISENGAGED SWITCH

Provides simultaneous engagement and disengagement of aileron and elevator servo drives, and rudder actuator. A/P SERVOS switches must be ON for servos to be engaged. Yaw damper function will be activated when switch is positioned to ENGAGE, even though YAW DAMP switch is OFF. When positioned to DISENGAGE, yaw damper will be deactivated unless YAW DAMP switch is ON. PITCH SELECTOR and NAV SELECTOR switches will return to VERT SPEED and TURN KNOB positions when switch is placed in DISENGAGED position.



PITCH SELECTOR SWITCH

Selects desired operating mode in pitch axis. MACH HOLD - Provisions only, position is inoperative.

IAS HOLD - Provisions only, position is inoperative.

VERT SPEED - Permits vertical speed commands to be inserted into automatic pilot system with VERT SPEED wheel or glide slope deviation signal. Position will be automatically selected when VERT SPEED wheel is moved out of detent (ALT HOLD), or when glide slope is intercepted.

G/P EXT provides manual selection of glide path extension mode.

PITCH HOLD maintains aircraft pitch attitude existing at time of engagement.

NAV SELECTOR SWITCH

Permits selection of radio modes for control of the airplane.

DOP provisions only, position is inoperative.

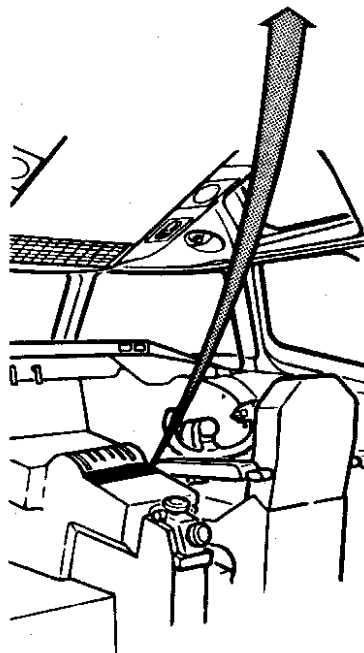
NAV LOC position provides automatic capture and maneuver along localizer and VOR paths. Mode may be selected with turn knob in or out of detent position, with or without HDG SEL engaged. Automatic capture will start when TURN knob is returned to detent.

TURN KNOB position permits manual changes in airplane heading by means of the TURN knob. Switch will return to the TURN KNOB position when the TURN knob is moved out of the detent after VOR or localizer capture, or when the VERT SPEED wheel is moved out of the detent (ALT HOLD position) after glide slope capture.

ILS position arms the system for automatic capture of the instrument landing system beams. Mode selection may be made with TURN knob in or out of detent and with or without HDG SEL engaged.

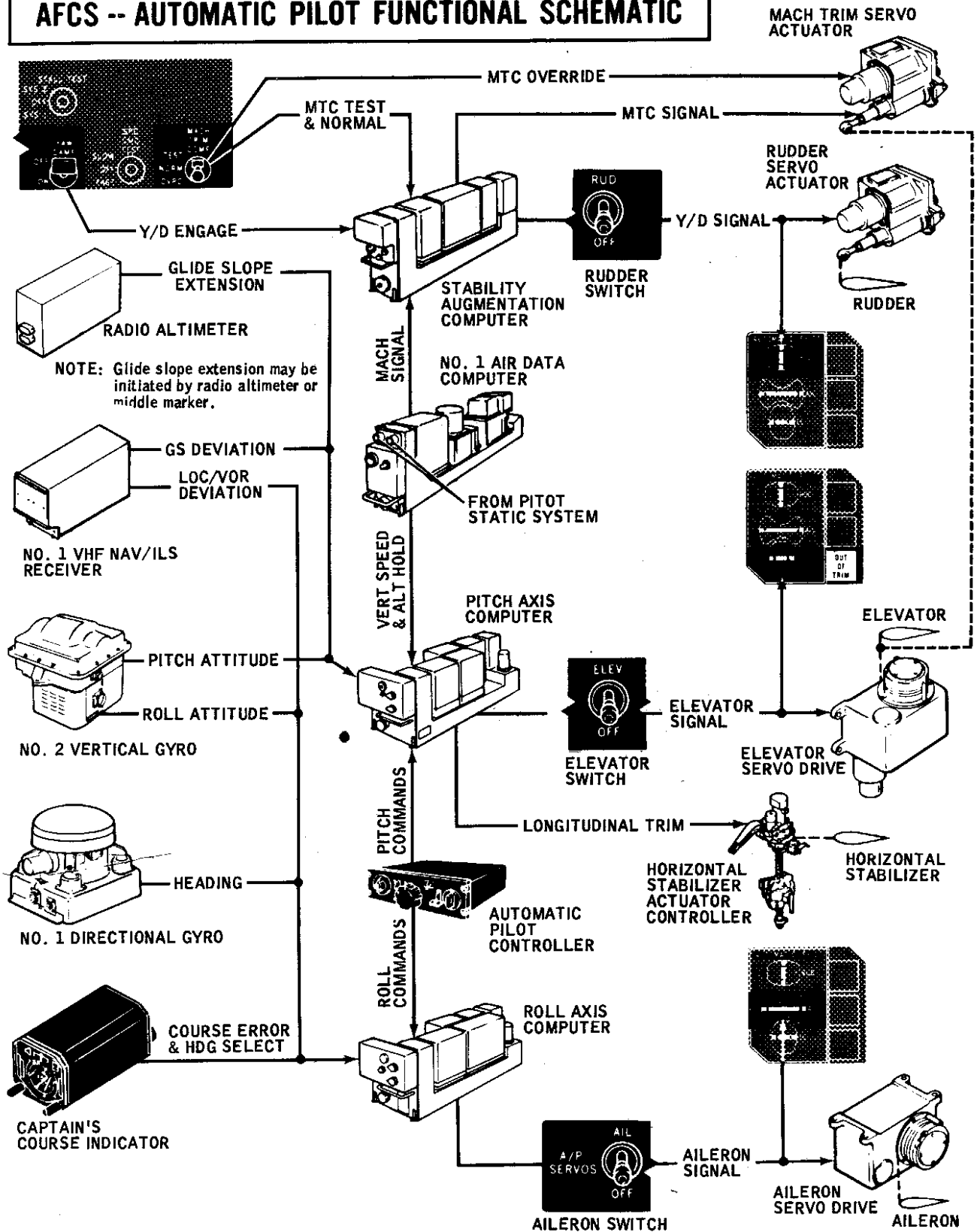
MAN G/P position same as ILS mode except pilot initiates glide path capture by selecting MAN G/P position.

BB1-148D



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AFCS -- AUTOMATIC PILOT FUNCTIONAL SCHEMATIC



BB1-3182

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SECTION 4
EMERGENCY PROCEDURES

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

SECTION 4

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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4-Cont	66	1	Sep 1/69
4-Emer	26	1	Sep 1/69
4-Emer	26	2	Sep 1/69
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*The asterisk indicates pages revised or added by the current revision.

Sep 1/69

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Section 4

EMERGENCY PROCEDURES

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(SERIES 30)

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*Illustration

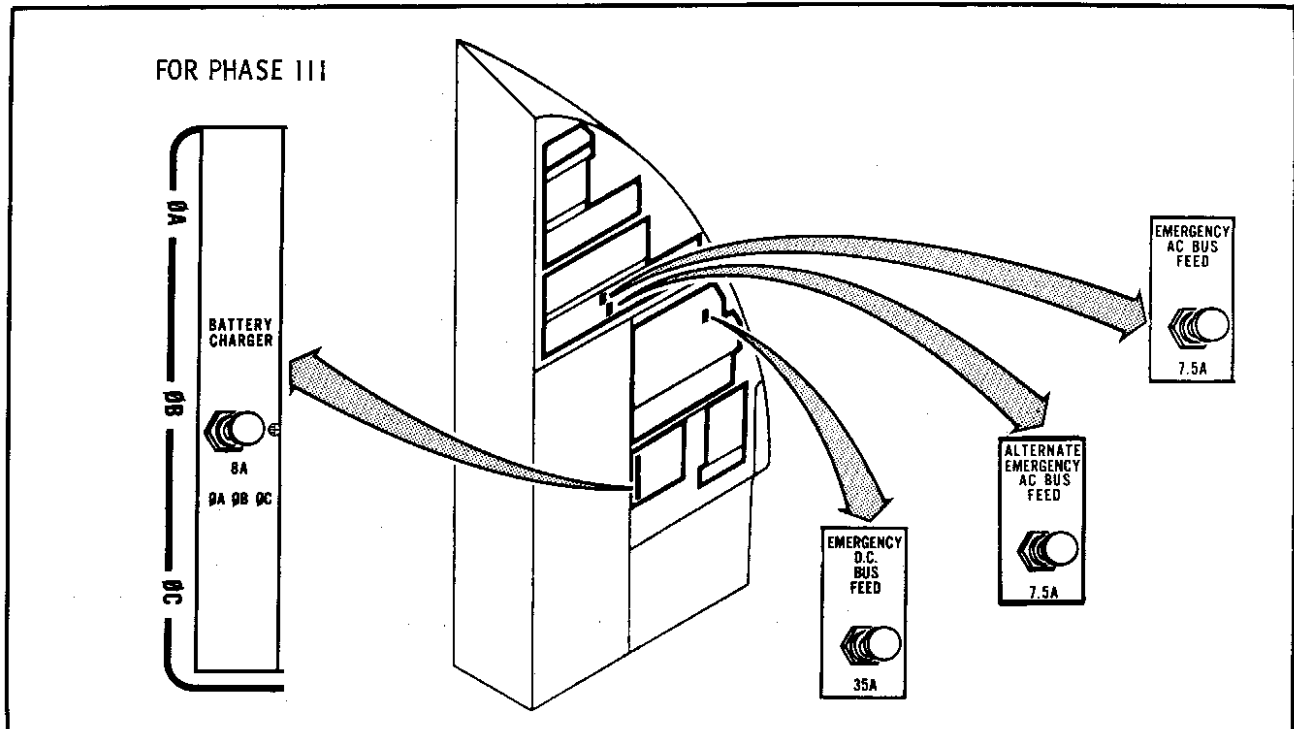
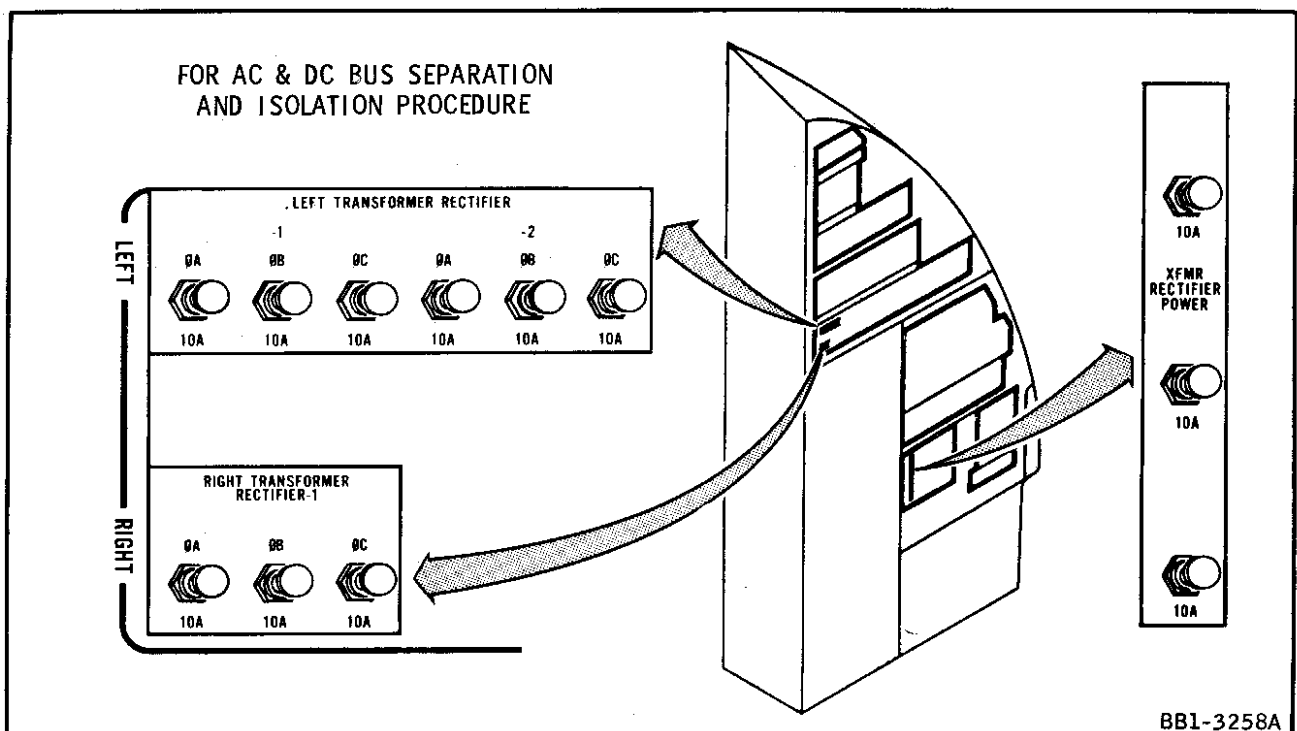
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EMERGENCY PROCEDURES -- ELECTRICAL SMOKE OF UNKNOWN ORIGIN
 (sheet 1)

EPC PANEL CIRCUIT BREAKERS LOCATIONS



EMERGENCY PROCEDURES -- ELECTRICAL SMOKE OF UNKNOWN ORIGIN **(sheet 2)**

CONDITION **ELECTRICAL SMOKE OF UNKNOWN ORIGIN**

ACTION

PHASE I & II

RADIO RACK SWITCH - - - - - VENTURI

The radio fan off light will remain off. This action will shut down the radio rack fan and open the radio rack venturi valve. These components are powered by the left ac bus; therefore, when the left ac bus is deenergized at a later point in this procedure and the fan stops running, the venturi valve will be open to provide the most effective path for smoke removal and E/E compartment cooling.

CABIN PRESSURE CONTROLLER LEVER. MANUAL POSITION

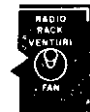
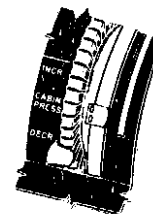
Placing the lever in the manual (down) position will maintain the existing degree of pressurization, as the cabin outflow valve motor and clutch will be disabled electrically when the right ac and dc buses are deenergized in a following step in this procedure.

AC CROSSTIE SWITCH - - - - - OPEN

The ac crosstie switch must be placed at OPEN to isolate the left and right electrical systems when their respective generator switches are placed at OFF. If this were not done, the systems would crosstie automatically when either generator is turned off, making smoke isolation impossible.

RIGHT GENERATOR CONTROL SWITCH (OR R APU BUS SWITCH IF POWER SOURCE) - - - - - OFF

This action deenergizes the right-hand ac and dc busses. The alternate stabilizer trim system will be inoperative. The first officer's instruments and radios will be deenergized. The autopilot and/or yaw damper will automatically disengage. If operating with only the aft boost pumps selected in each main tank, the right-hand engine will be operating on suction feed and the inlet fuel pressure low light will not illuminate. If operating with the forward boost pumps selected, the left engine will be operating on suction feed, and the inlet fuel pressure low light will come on. If fuel boost pressure is desired, turn on the remaining boost pumps in each main tank. If center tank fuel is being used to feed the engines, it will discontinue feeding the engine on the side that has the operative main tank boost pump.



IF SMOKE CONTINUES

IF SMOKE DISAPPEARS

Proceed to AC & DC bus separation and isolation procedure (sheet 4)

RIGHT GENERATOR CONTROL SWITCH (OR R APU BUS SWITCH IF POWER SOURCE). ON

This step will restore right ac and dc electrical system power. If desired, the cabin pressure controller lever may be returned to AUTO position for automatic operation at this time.

NOTE: Wait until the first officer's instruments are operational before proceeding to the next step. The first officer's instrument flags should be out of view and his radios operational before continuing with the following steps, because the captain's radios and/or instruments will be off at various points in the procedure.

LEFT GENERATOR CONTROL SWITCH (OR L APU BUS SWITCH IF POWER SOURCE) - - - - - OFF

This action deenergizes the left-hand ac and dc busses. The primary stabilizer trim system will be inoperative. If operating with only the aft boost pumps selected in each main tank, the left engine will be operating on suction feed and the inlet fuel pressure low light will not illuminate. If operating with the forward boost pumps selected, the right engine will be operating on suction feed, and the inlet fuel pressure low light will come on. If fuel boost pressure is desired, turn on the remaining boost pumps in each main tank. If center tank fuel is being used to feed the engines, it will discontinue feeding the engine on the side that has the operative main tank boost pump.



IF SMOKE CONTINUES - PROCEED TO PHASE I AND II ON SHEET 3

IF SMOKE DISAPPEARS

Proceed to AC & DC bus separation and isolation procedure (sheet 4)

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EMERGENCY PROCEDURES -- ELECTRICAL SMOKE OF UNKNOWN ORIGIN
(sheet 3)

PHASE I AND II CONTINUED

LEFT GENERATOR CONTROL SWITCH (OR L APU BUS SWITCH IF POWER SOURCE) ----- ON

This step will restore left-hand ac and dc electrical system power. If desired, the radio rack switch may be returned to the FAN position at this time.

AC CROSSTIE SWITCH ----- AUTO

Placing the ac crosstie switch at AUTO will arm the crosstie system for operation if a generator failure occurs at any time during the remainder of the flight.



IF SMOKE CONTINUES PROCEED TO PHASE III

PHASE III

BATTERY CHARGER CIRCUIT BREAKER ----- OPEN (PULL)

Pulling the breaker for the battery charger will disable the charger to determine if it is the source of smoke. The battery is not being charged following this action. If smoke continues, the battery charger circuit breaker may be reset if desired.

EMER AC BUS FEED & ALTERNATE EMER AC BUS FEED CIRCUIT BREAKERS ----- OPEN (PULL)

This action will deenergize the ac emergency bus. The captain's flight instruments and navigation radio, and manual temperature controls will be inoperative.

EMERGENCY DC BUS FEED CIRCUIT BREAKER ----- OPEN (PULL)

This action will deenergize the dc emergency bus. The captain's navigation and communication radios, turn-and-slip indicator, and pitot heater will be inoperative. Flight interphone and passenger address systems will be inoperative. It will not be possible to shut down the air conditioning systems, if required. The Mach trim override and dc crosstie control circuits will be inoperative. The captain's and first officer's white, instrument panel floodlights will be deenergized; however, normal cockpit lighting is still available. The emergency evacuation lights will come on.

NOTE: If it is desired to keep the emergency light circuit from being activated to prevent compromising the required operating time available in case of a subsequent emergency, it is necessary to place the cabin emergency lights switch at OFF prior to pulling the dc emergency bus circuit breaker.

IF SMOKE CONTINUES

IF SMOKE DISAPPEARS

Proceed to isolation checklist
(sheet 4)

EMER AC BUS FEED & ALTERNATE EMER AC BUS FEED CIRCUIT BREAKERS ----- CLOSED (PUSH)

This step will restore power to the ac emergency bus.

EMERGENCY DC BUS FEED CIRCUIT BREAKER ----- CLOSED (PUSH)

This step will restore power to the dc emergency bus. If the cabin emergency lights switch was placed at OFF, it should be returned to the ARM position at this time.

NOTE: Wait until the captain's instruments are operational before proceeding to the next step.

BATTERY SWITCH ----- OFF (APU if operating will be shut down)

This step, in addition to removing electrical power from the APU control circuits, will disable the dc transfer bus off and ac and dc emergency bus off lights.

IF SMOKE CONTINUES

IF SMOKE DISAPPEARS

Proceed to isolation checklist
(sheet 4)

BATTERY DIRECT BUS CIRCUIT BREAKERS
(Located on overhead emergency circuit breaker panel) ----- OPEN (PULL)

Following this step, it should be noted that if the battery bus relay and/or the charger and transfer relay circuit breakers remain pulled that battery charging capability is disabled, and also that the dc transfer bus will be deenergized if it is subsequently necessary to revert to emergency power operation. If the emergency inverter circuit breaker remains pulled, there will be no flight instruments or navigational radio available if subsequent emergency power operation is required.

NOTE: The dc transfer bus is not isolated during this procedure. If an electrical component connected to this bus is suspected as the source of smoke, individual circuit breakers may be pulled at the discretion of the captain.

BB1-3185B

EMERGENCY PROCEDURES -- ELECTRICAL SMOKE OF UNKNOWN ORIGIN
[sheet 4]

ISOLATION CHECKLIST

Open (pull) all circuit breakers on the affected bus.
Reinstate electrical power to the affected bus. (Applicable bus feed or transformer-rectifier circuit breakers.)
Close (push) each circuit breaker on the affected bus individually, pausing between each operation to check for smoke.
If smoke is detected after any one, or group of circuit breakers are closed (pushed), leave the particular breaker(s) open (pulled) and reinstate remaining circuit breakers and normal electrical power distribution.
Note electrical services which will not be available during the remainder of the flight.

AC & DC BUS SEPARATION AND ISOLATION PROCEDURE

IF SMOKE DISAPPEARED WHEN EITHER GENERATOR SWITCH WAS TURNED OFF:

A. RIGHT GENERATOR:

1. Transformer-Rectifier circuit breakers
(Right-hand AC and Ground Service Buses)-----OPEN (PULL)
2. Right Generator Control Switch-----ON

IF SMOKE REAPPEARS:
(trouble is on R "AC" bus)

IF SMOKE DOES NOT REAPPEAR:
(trouble is on R "DC" bus)

3. Right Generator Control Switch-----OFF
4. DC Bus Crossie Switch-----CLOSE

B. LEFT GENERATOR:

1. Transformer-Rectifier circuit breakers
(Left-hand AC Bus)-----OPEN (PULL)
2. Left Generator Control Switch-----ON

IF SMOKE REAPPEARS:
(trouble is on L "AC" bus)

IF SMOKE DOES NOT REAPPEAR:
(trouble is on L "DC" bus)

3. Left Generator Control Switch-----OFF
4. DC Bus Crossie Switch-----CLOSE

BB1-3186A

EMERGENCY PROCEDURES -- RAPID DECOMPRESSION/EMERGENCY DESCENT

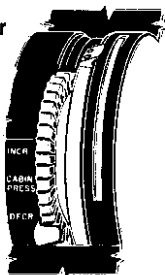
CONDITION

RAPID LOSS OF CABIN PRESSURE

ACTION

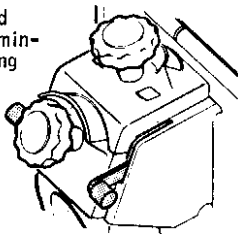
PHASE I AND II

1. Place the cabin pressure controller lever in manual (down) position. Depress and rotate the cabin pressure controller wheel forward. Release the wheel when the indicator is at full forward (INCR) position.



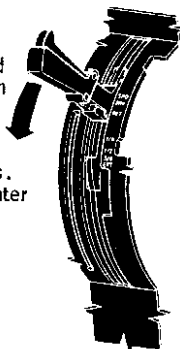
2. Crew oxygen masks -- ON.

3. Close pneumatic crossfeed levers. This action will minimize the amount of ducting that is pressurized.



4. Autopilot -- OFF. Disengage by pressing release button on either control wheel.

5. Extend speedbrakes. It is necessary to offset the "pitchdown" tendency as the speedbrakes are fully extended by compensating control column pressure until retrimmed.
6. Retard throttles to IDLE. Evaluate descent requirements. Begin emergency descent. Enter descent by pushing smoothly straight over (not to exceed approximately 100°) or initiate 30° bank and start descent. While accelerating roll wings level. Speed profile .80M/320-350 KIAS.



NOTE:

The speed profile is based on loss of pressurization with no loss in structural integrity and assumes smooth air conditions. Known failures that affect structural integrity and/or turbulence might dictate other speed profiles and entry maneuvers.

PHASE III

1. Check passenger oxygen masks deployed and illumination of No Smoking and Seat Belt sign.

MASTER WARNING

2. Reset Master Warning Light.

3. Place Radio Rack switch in FAN position.

RADIO RACK VENTURI
FAN

4. 2000 feet above desired level off altitude gradually reduce rate of descent. (In configuration described the rate of descent is approximately 8000 feet per minute.)

5. After level off and at desired airspeed, minimum of 220 knots, retract the speedbrakes.

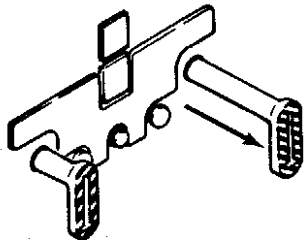
BB1-3277

EMERGENCY PROCEDURES -- ENGINE FIRE OR SEVERE ENGINE DAMAGE OR ENGINE SEPARATION



ACTION PHASE I AND II

Pull the applicable fire shutoff handle out fully to the stop. (Fire bell will cut off automatically.)



IF FIRE WARNING PERSISTS *

Rotate the fire shutoff handle to either the AGENT DISCH 1 or AGENT DISCH 2 position. (Applicable AGENT LOW light should come on).



IF FIRE WARNING PERSISTS *

IF FIRE WARNING LIGHT GOES OUT

Discharge remaining bottle of agent

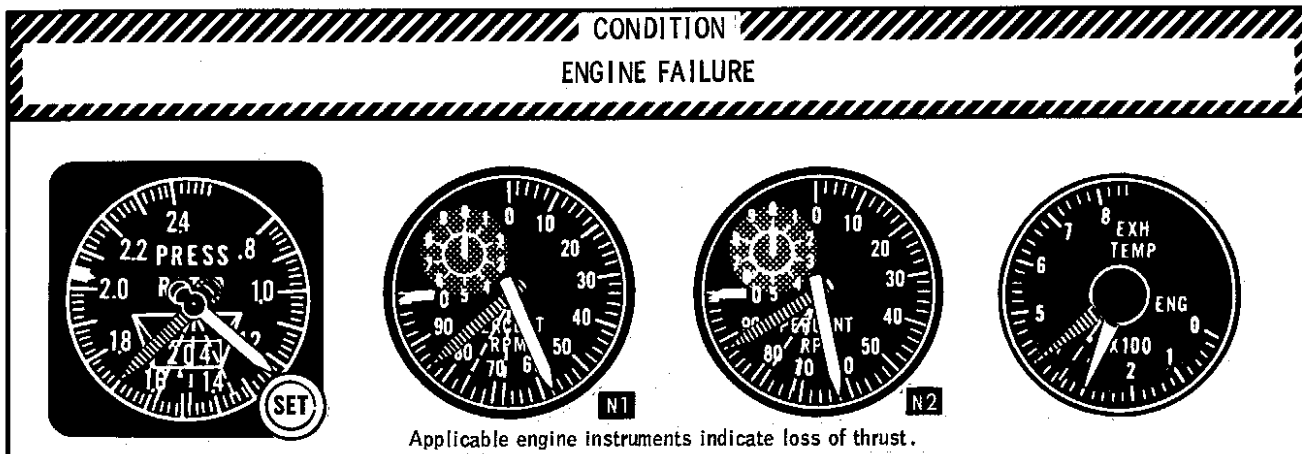
IF FIRE WARNING LIGHT GOES OUT

PHASE III

Throttle	IDLE/FAILED ENGINE
Fuel shutoff lever	OFF/FAILED ENGINE
Pneumatic crossfeed lever	CLOSED/FAILED ENGINE
(The applicable pneumatic crossfeed lever will normally close automatically when the fire shutoff handle is pulled, but should be checked to verify that it has closed. Do not move the lever to OPEN as this action will cause the fire shutoff handle to retract.)	
Engine hydraulic pump control switch	OFF/FAILED ENGINE
Aux. or Alt. hydraulic pump control switch	AS REQUIRED
(If necessary to pressurize the hydraulic system on the side of the failed engine the alternate pump may be used to pressurize the left side, or the auxiliary pump to pressurize the right side.)	
Fuel tank pumps and crossfeed lever	AS REQUIRED
(If center tank fuel remains, it should be consumed first. Subsequent use of main tanks fuel should be predicated on maintaining lateral balance within limits. Refer to Section II, Chapter 25.)	
Generator control switch	OFF/FAILED ENGINE
Electrical loads	CHECKED
(Verify that AC crosstie relay has tied both electrical systems to the operating generator by observing AC loadmeters. If generator load is high, it may be reduced rapidly by placing the galley power switch at OFF.)	

BB1-2089A

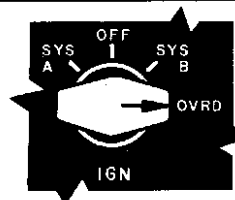
EMERGENCY PROCEDURES -- ENGINE FAILURE



ACTION PHASE I AND II

Ignition..... **VERRIDE**

(Provides high energy ignition to both
 igniters in both engines simultaneously)



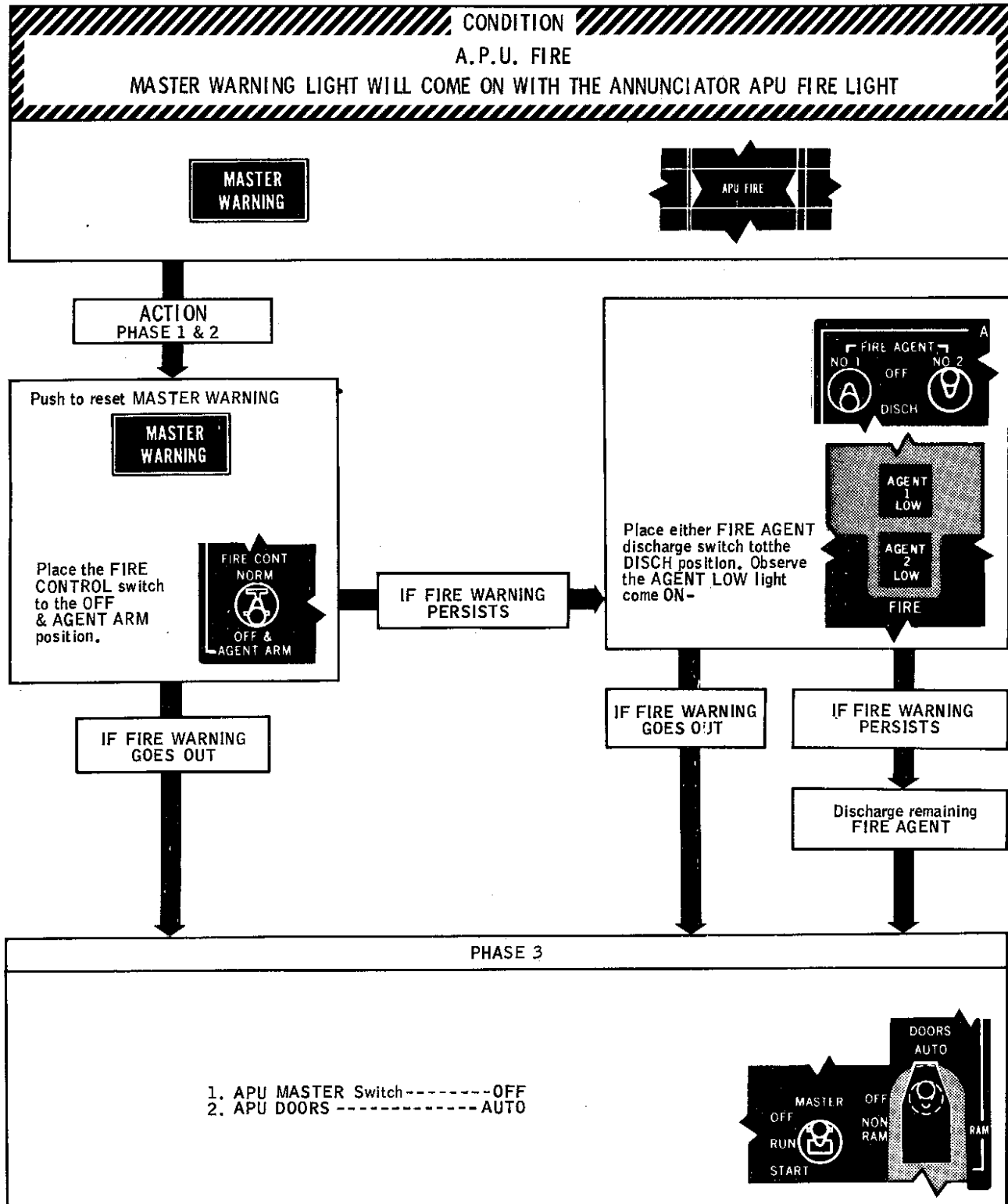
IF NO RELIGHT IS ACHIEVED

PHASE III

Throttle **IDLE/FAILED ENGINE**
 Fuel shutoff lever **OFF/FAILED ENGINE**
 Pneumatic crossfeed lever **CLOSED/FAILED ENGINE**
 Engine hydraulic pump control switch **OFF/FAILED ENGINE**
 Aux. or Alt. hydraulic pump control switch **AS REQUIRED**
 (If necessary to pressurize the hydraulic system on the side of the
 failed engine the alternate pump may be used to pressurize the left
 side, or the auxiliary pump to pressurize the right side.)
 Ignition **AS REQUIRED**
 (Ignition may be placed at SYS A OR SYS B OR OFF depending
 upon ambient conditions.)
 Fuel tank pumps and crossfeed lever **AS REQUIRED**
 (If center tank fuel remains, it should be consumed first. Subsequent
 use of main tanks fuel should be predicated on maintaining lateral
 balance within limits. Refer to Section 2, Chapter 25.)
 Generator control switch. **OFF/FAILED ENGINE**
 Electrical loads **CHECKED**
 (Verify that AC crosstie has tied both electrical systems to the
 operating generator by observing AC loadmeters. If generator
 load is high, it may be reduced rapidly by placing the galley
 power switch at OFF.)

BB1-2085

EMERGENCY PROCEDURES -- APU FIRE



BB1-1928

EMERGENCY PROCEDURES -- TAIL COMPARTMENT TEMPERATURE HIGH

CONDITION
TAIL COMPARTMENT TEMPERATURE HIGH LIGHT ON

NOTE: When time permits reset MASTER WARNING

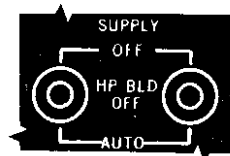
TAIL COMPT
TEMP HIGH

MASTER
WARNING
PUSH TO RESET

ACTION

PHASE I AND II

1. Place pneumatic crossfeed valves closed. Isolate each system at the crossover duct to prevent flow of air into the ice protection manifold.
2. Place left and right airfoil switches OFF. Ice protection is not usable with the crossfeed valves closed, so both systems should be turned OFF. This also eliminates an open signal to the augmentation valve. The same as the next step.
3. Place air conditioning supply switches to HP BLD OFF. Extreme temperatures could aggravate the condition. Closing both augmentation valves will prevent 13th stage high pressure bleed airflow allowing only 8th stage bleed air into the system for cabin pressurization.



NOTE:

Avoid icing conditions if possible. If icing is encountered with airfoil switches OFF in excess of two minutes, increase all maneuvering, approach, and flare speeds approximately five knots. (This would give added margin in the event of some ice buildup on wing.) If the light remains on (after two minutes) accomplish the next phase in the order listed.

PHASE III

1. Place RADIO RACK switch to FAN. During the next series of steps while operating on a single air conditioning system, closing the restrictor valve will limit the flow of air through the radio rack discharge venturi to maintain cabin pressurization.
2. Place right engine throttle to IDLE. Low power setting will result in minimum flow of cool engine bleed air to the suspected leak source.
3. Place right air conditioning switch OFF. If a rupture exists in the right ducting, with the air conditioning system shut down the light should go out.



NOTE:

If the light goes out, restore power on right engine for approximately two minutes and if the light is still out, place the left air conditioning system supply switch to AUTO. Continue operations with right bleeds off and isolated. If light remains on (after two minutes), restore thrust to the right engine and place the right air conditioning supply switch to AUTO. Repeat the previous steps using the same procedure with the left engine and air conditioning system.

NOTE:

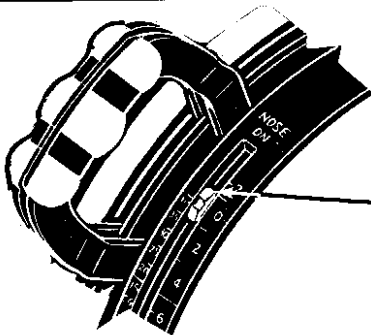
Isolating each system as in the above procedure will determine where the malfunction exists. If the procedures are successful in isolating the condition, the light should go out. There may be a possibility of reinstating air foil ice protection. For example: If the right engine or system was determined to contain the malfunction the left engine and left crossfeed valve could be used for air foil ice protection. If the proper procedures are completed without success and the light remains on, it must be assumed that a faulty light circuit or some other possible pneumatic malfunctions exist. A faulty light circuit would preclude any detection of a future emergency. In either case, continue operations as in PHASE I AND II and land as soon as practicable.

BB1-1995A

EMERGENCY PROCEDURES -- RUNAWAY STABILIZER

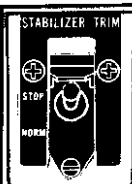
CONDITIONS HORIZONTAL STABILIZER TRIM RUNAWAY

INDICATIONS



1. Stabilizer in motion warning horn sounding without pilot input to trim controls.
2. Steady movement of the stabilizer trim indicator either forward or aft without pilot input to trim controls.
3. Increasing forward or aft pressure is required on the control column to maintain desired airplane attitude.

ACTION



Immediately actuate the stabilizer trim (red guarded) switch, located on the left side of the center pedestal, to the STOP position.

NOTE:

This switch interrupts power to the primary motor brake release and applies the brake. It does not interrupt electrical power to the primary trim motor and does not affect the alternate trim brake or motor. If the runaway was caused by the primary system, movement of the stabilizer will stop because the motor is not capable of overcoming the brake.

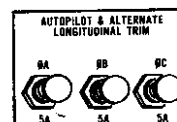
IF THE STABILIZER CONTINUES TO RUNAWAY

1. Restore power to the primary system (red guarded switch to NORM).
2. Utilize horizontal stabilizer primary trim control and return the trim indicator to its original position. (Use the thumb-switches on the control column or the longitudinal trim control handles).

NOTE:

If trim runaway occurs when autopilot is engaged, the malfunction may be caused by the autopilot trim coupler.

3. Pull the three circuit breakers labeled AUTOPILOT AND ALTERNATE LONGITUDINAL TRIM located on the EPC circuit breaker panel.

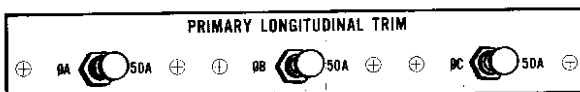


4. Continue flight using the primary trim system.

BB1-3175 A

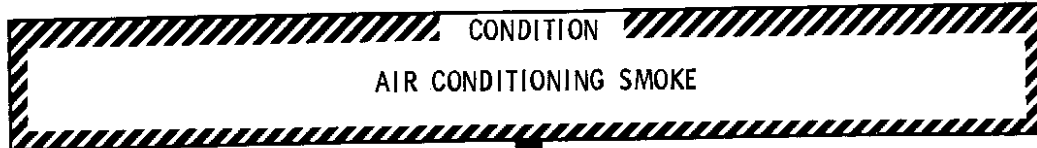
IF CONDITION CORRECTED

1. Pull the three circuit breakers, on the EPC circuit breaker panel, labeled PRIMARY LONGITUDINAL TRIM. This will prevent the trim motor from overheating.



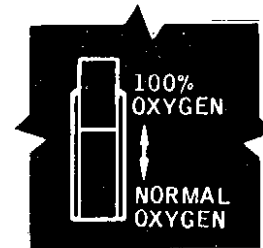
2. Continue flight using the alternate system for controlling of horizontal stabilizer trim. Allow for slower trim rate.

EMERGENCY PROCEDURES -- AIR CONDITIONING SMOKE



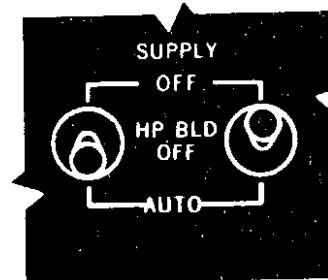
PHASE I AND II

1. Place crew oxygen regulators at 100%. To insure against inhalation of toxic fumes associated with smoke, only pure oxygen is dispensed in the 100% position.
2. Place left air conditioning supply off.



IF SMOKE
CONTINUES

1. Place left air conditioning supply switch to auto.
2. Place right air conditioning supply off.



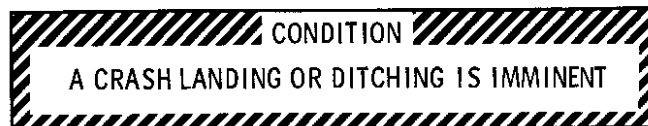
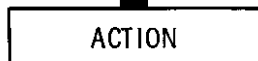
NOTE:

Isolation of each air conditioning system will determine the source of smoke. Place the affected system supply switch to off and continue the flight.

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EMERGENCY PROCEDURES -- CRASH LANDING OR DITCHING (sheet 1)



NOTE:

If time and circumstances permit, direct the crew to take appropriate crash landing or ditching action, and initiate transmission of emergency messages on the applicable communication frequency and ATC transponder.

If cabin is occupied, turn on the NO SMOKING and FASTEN SEAT BELT signs.

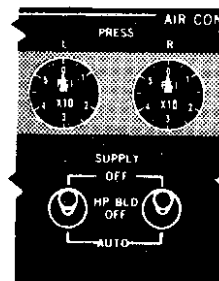
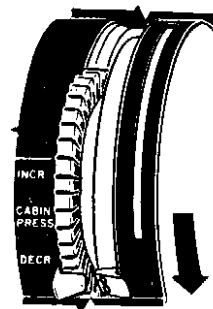
SYSTEM CONFIGURATION

AIR CONDITIONING SUPPLY SWITCHES OFF

This action eliminates the source of pressurized air to permit subsequent depressurization and insure that all doors and exits can be readily opened. Placing the air conditioning supply switches off one at a time will reduce the severity of the pressure surge experienced by the passengers.

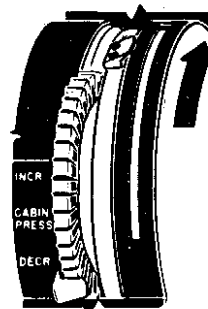
When the air conditioning input is shut off, the cabin will ascend at approximately 4000 feet per minute initially (if at full differential pressure), until the pressure controller drives the outflow valve closed. When the cabin outflow valve is fully closed, the rate of ascent will be approximately 1000 feet per minute (depending upon aircraft configuration) due to the internal pressure bleeding off through the galley and lavatory vents, the radio rack venturi, and various drain holes and structural leaks.

If time and the operational situation permit, the cabin pressure controller could be used to schedule a cabin rate of descent commensurate with the situation, so that the cabin is depressurized prior to turning off the air conditioning supply switches.



DEPRESSURIZE BY MANUAL PRESSURIZATION CONTROL

This step is used to manually depressurize the airplane if the preceding step has not resulted in full depressurization. Manually move the pressurization control in the DECR direction to obtain the desired rate, commensurate with the situation, until fully depressurized. Manual pressurization control forces will be high unless the airspeed is relatively low.



WHEN DEPRESSURIZED: FULL FORWARD AND
 MANUAL PRESSURIZATION CONTROL MANUALLY LOCKED

This step manually closes the pressurization high speed outflow nozzle and the cabin outflow butterfly valve in order to present a smoother fuselage surface during ditching, and to close these openings to reduce the rate of water entry into the fuselage after ditching. The outflow valve and nozzle will be submerged following ditching.

RADIO RACK SWITCH FAN

In the event that the radio rack switch was in the Venturi position, this step would close the valve leaving a much smaller opening for the entry of water following ditching.



BB1-4010

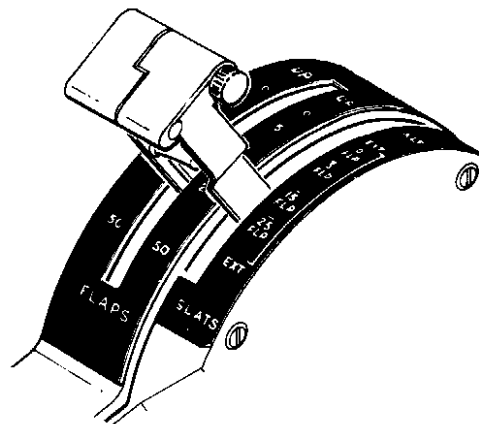
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EMERGENCY PROCEDURES -- CRASH LANDING OR DITCHING (sheet 2)

AIRCRAFT CONFIGURATION

FLAPS/SLATS..... 25°

Extending the flaps and slats as indicated will provide the best lift/drag ratio under both ditching and crash landing situations for both the two-engine and single-engine cases. The approach body angles will be slightly higher than the standard approach utilizing 50° of flap. During crash landing or ditching, impact forces may carry away the flaps. The flap hinges and attaching fittings are designed to fail without damaging the integral main fuel tanks.

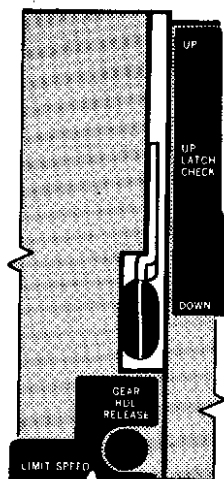


LANDING GEAR:

CRASH LANDING..... DOWN

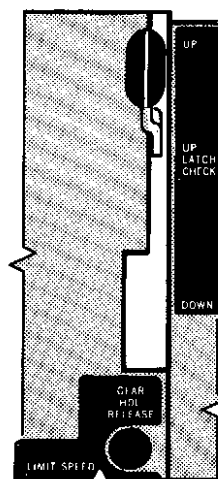
The landing gear should be extended as it will absorb a great deal, if not all, of the impact forces.

In rough terrain, the gear may be carried away, but is designed to shear away from the airplane without damage to the integral main fuel tanks.



DITCHING..... UP

The landing gear should be retracted to present a smooth, unobstructed fuselage surface for minimum drag upon contacting the water. With the gear extended, the protruding gear and open wheelwells would cause violent deceleration and the possibility of nosing under.



PRIOR TO TOUCHDOWN

EMER LTS..... ON

This action will assure that the "Battery Pack" powered emergency lights come on to assist in evacuating the airplane. It may also serve as a signal to the cabin attendants to prepare the passengers for impact if prearranged in training.

NOTE:

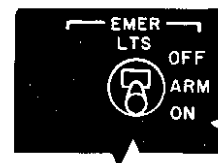
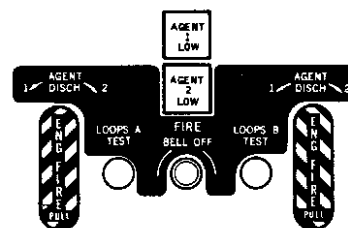
Flotation studies of the DC-9 indicate that the airplane will assume a slight taildown attitude after ditching. Floor angle should not exceed 5 degrees nose up in any center-of-gravity configuration. At high gross weights such as immediately after takeoff, the wings will be awash. At lower gross weights, the upper wing surface will be clear of the water.

If time permits, and prior to leaving the cockpit, pull both fire shutoff handles.

This action will shut off fuel and hydraulic oil at the engines. If the situation indicates a need, the fire handles can be rotated to discharge the extinguishing agent into the engine nacelles.

NOTE:

The battery switch must be on to discharge the fire extinguishing agent in this configuration as there is no generator or transformer-rectifier power available.



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EMERGENCY PROCEDURES -- COCKPIT SMOKE REMOVAL - UNPRESSURIZED

CONDITION
COCKPIT SMOKE REMOVAL IS REQUIRED DURING UNPRESSURIZED FLIGHT

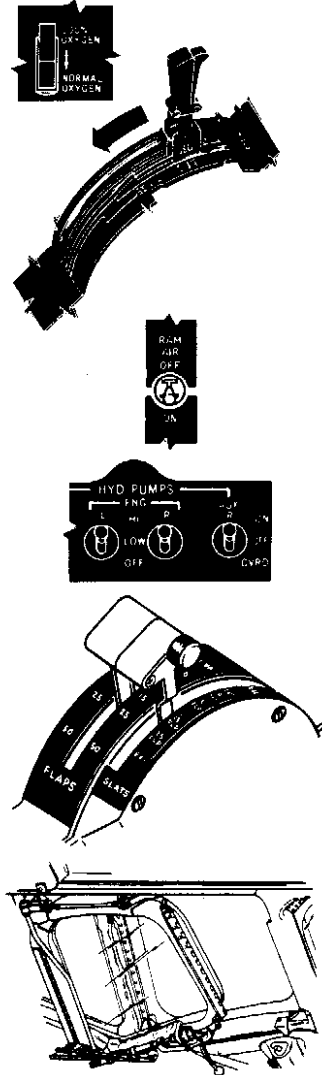
ACTION

PHASE I AND II

1. Crew Oxygen Masks . . ON/100%.
To insure against inhalation of toxic fumes associated with smoke. Only pure oxygen is dispensed in the 100% position.
2. Retard Throttles to IDLE
3. Extend Speedbrakes.
It is necessary to offset the normal "pitchdown" tendency when extending the speedbrakes by compensating control column pressure until retrimmed.
4. Ram Air Switch . . ON
To provide a flow of ambient air for ventilation and to aid in smoke removal.
5. Retract Speedbrakes.
(Minimum of 200 KIAS). Do not use speedbrakes in conjunction with flaps
6. Engine Hydraulic Pumps or Aux Hydraulic Pump . . HIGH or ON.
3,000 psi output must be available for flap operation.
7. Flaps/Slats . . Flaps 150/Slats Extended.
Reduce airspeed and adjust throttles to maintain 165 KIAS. This flap setting will provide sufficient margin above stall while operating at reduced airspeed.
8. Open Either Cockpit (clearview) Window Approximately 1/2 to 2/3
This will allow proper air circulation for smoke removal.

NOTE:

The cockpit (clearview) windows should not be opened at speeds above 165 KIAS due to the resulting high noise level making radio communication difficult or impossible.



PHASE III

1. Ram Air Switch . . AS REQUIRED.
After smoke removal, the switch may be left in the ON position for ventilation purposes.
2. FLAPS/SLATS . . AS REQUIRED
If a landing is intended, the flaps and slats may be positioned to the proper setting for the Initial approach.

NOTE:

The above procedure is intended only for smoke removal unpessurized. Emergency procedures for ELECTRICAL SMOKE OF UNKNOWN ORIGIN or AIR CONDITIONING SMOKE must be used in conjunction with this procedure.

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SECTION 5
PERFORMANCE AND FLIGHT PLANNING
FOR
DC-9 SERIES 30 AIRPLANES

DOUGLAS AIRCRAFT Co., Inc.

MODEL DC-9

FLIGHT CREW OPS MANUAL

SECTION 5

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

The transmittal sheet provided with each revision, or in lieu of a revision, identifies the revision number and date. Enter this information below, after the revision has been inserted.

Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By	Rev. No.	Rev. Date	Inserted By

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Section 5

PERFORMANCE

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5-Eff	66	1	Sep 1/69				
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Sep 1/69

Printed in U.S.A.

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CODE 66
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DOUGLAS AIRCRAFT CO., INC.
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INTRODUCTION AND GLOSSARY

INTRODUCTION

Extensive experience in designing and building commercial and military jet aircraft has enabled the Douglas Aircraft Company to achieve its goals set for the DC-9. Short- and medium-range jet operations can now be offered commercially by airlines at minimum operating costs. By nature, short-range operations require frequent takeoffs and landings, often in areas of limited field lengths and navigational aids. This demands an aircraft with

good low-speed flight characteristics, as well as efficiency at high altitudes and at high subsonic speeds.

This Section of the Flight Crew Operating Manual presents design concepts, flight characteristics, recommended techniques and procedures, and airplane performance. The material is primarily based on flight test data. Estimated data is identified as such or is marked "preliminary." In the event of conflict between this manual and the FAA Approved Airplane Flight Manual, the FAA Manual shall govern.

GLOSSARY OF TERMS

V_1	Decision speed
V_R	Rotation speed
V_2	Takeoff safety speed
V_A	Design maneuvering speed
V_B	Design speed for maximum gust intensity in knots
V_D	Design diving speed in knots
M_D	Design diving speed in Mach number
$V_{L/D}$	Airspeed for maximum ratio of lift to drag. The minimum speed, stability of speed, of an airplane for cruise conditions is related to percentages above $V_{L/D}$.
V_{LO}	Liftoff speed
V_{MC}	(Air-ground) Minimum control speed with one engine becoming inoperative

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V _{MO} /M _{MO}	Maximum operating limit speed
V _{MU}	Minimum unstick speed
V _S	Stalling speed, or the minimum steady flight speed at which the airplane is controllable
P _{t2}	Compressor inlet total pressure, HG absolute
P _{t7}	Turbine discharge total pressure, HG absolute
$\frac{P_{t7}}{P_{t2}}$ =	Engine pressure ratio
Mach number	A number expressing the ratio of the speed of a moving body to the speed of sound in air. $\text{Mach number} = \frac{\text{True Airspeed}}{\text{Speed of sound at flight temperature}}$
Transonic speed	A speed at which an aircraft moves relative to the undisturbed air when the airflow over one or more points is subsonic and at the same time at one or more points it is sonic or supersonic.
Local velocity	The velocity of air at some specific point on a moving body, as distinguished from the velocity of the moving body.
Flow separation	Airflow Separation occurs when the Boundary Layer Airflow no Longer Adheres to the Airfoil Surface thus forming a Turbulent Wake and Reversed Flow Aft of the Separation Point.
Compressibility	The compressing together of the molecules of air by an object moving faster than the molecules can move out of the way; the result of compressibility is to increase the density of the air in the immediate vicinity of the object.
Drag Rise	The rapid increase of parasite drag encountered by an airplane as it approaches the speed of sound.
Shock Wave	A line across which a flow of air, relative to a body passing through the air, changes in pressure, velocity, density, temperature, and energy within an infinitesimal period of time.
Maximum gross weight	The maximum weight authorized by the flight manual for an aircraft and its contents.

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Empty Weight	Weight of the aircraft, including only fixed furnishings, items of equipment, and residual fuel and oil
Zero fuel weight	The maximum weight authorized for an airplane with no disposable fuel and oil
Operating weight	The empty weight of the airplane in addition to oil, crew, baggage, passenger equipment, and emergency equipment
MAC	Mean aerodynamic chord
RAT	Ram air temperature
MCT	Maximum continuous thrust, used for single engine operation
MCL	Maximum climb thrust
Ultimate load factor	150% of limit load
Δ	Symbol delta, in this manual, means a change
Angle of incidence	The angle between the chord line of the airfoil and the longitudinal axis of the aircraft
Angle of attack	The acute angle between a reference line in a body and the line of the relative airflow direction

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Chapter 1

AERODYNAMICS AND FLIGHT CHARACTERISTICS

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(SERIES 30)

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*Airfoil with Slats Extended (Figure 2)	1-0-0	2	30	A11
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*Illustration

Chapter 1

AERODYNAMICS AND FLIGHT CHARACTERISTICS

GENERAL AERODYNAMIC BEHAVIOR

1. Theory of Lift. What is lift and how is it produced? Lift is a force created by the difference in air pressures acting on the upper and lower surfaces of the wing.

Each part of the wing serves to assist in the creation of an airflow that will produce lift. (See Figure 1.) The leading edge of a wing is rounded, the upper surface is curved, and the trailing edge is sharp. The round leading edge of the wing splits the approaching air stream and forces part of it to flow over the wing and some of it to flow under the wing. The air at some point on the leading edge stops completely and forms a stagnation point and a high-pressure area. Below the wing, the air stream creates a high-pressure area. The air flowing over the wing, however, follows the contour of the wing, which is a longer path of travel and causes an increase in speed and a decrease in pressure. As the speed of the airplane increases, the speed of the air flowing over the wing surface increases and will, at some airplane speed, exceed the speed of sound.

The greatest pressure difference occurs near the leading edge of the wing and, since it is the pressure

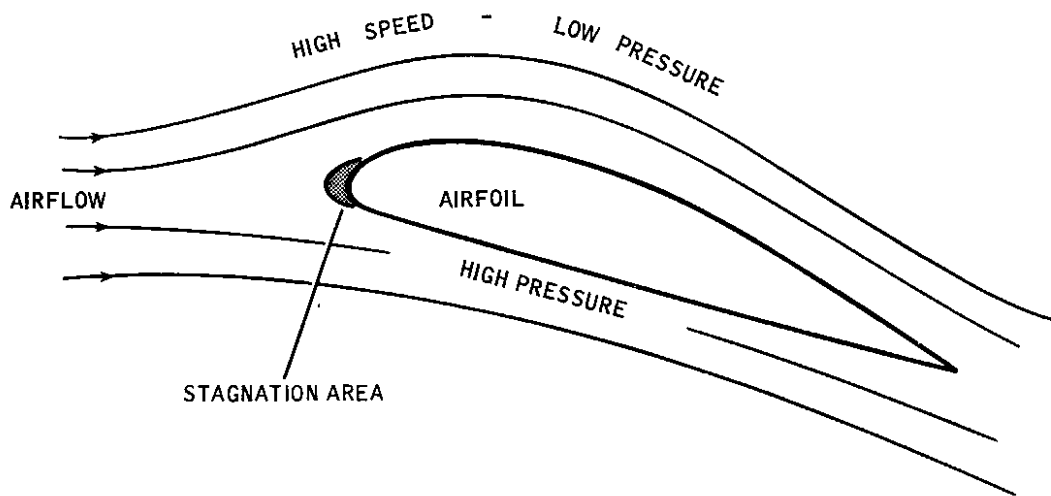
differential that produces lift, the greatest portion of the wing's lift is produced toward the leading edge. The rear part of the wing produces very little lift. The sharp trailing edge serves primarily to prevent the airstream on the bottom of the wing from curving around to the upper surface and creating a second high-pressure stagnation point on the upper surface that would oppose lift.

The difference in pressure between the upper and the lower surface of the wing creates an increasing amount of lift as the angle of attack is increased. This is because at high angles of attack the air flowing over the wing has farther to travel and, therefore, travels faster. Also, at high angles of attack the slower air along the lower surface of the wing produces an increased high-pressure area.

Finally, however, the pressure differential between the leading edge and the trailing edge of the wing at high angles of attack becomes excessive and the wing air flow separates or stalls.

The DC-9 Series 30 is the first Douglas commercial airplane to incorporate leading edge slats. These powerful high lift devices unload the wing leading edge so that the pressure

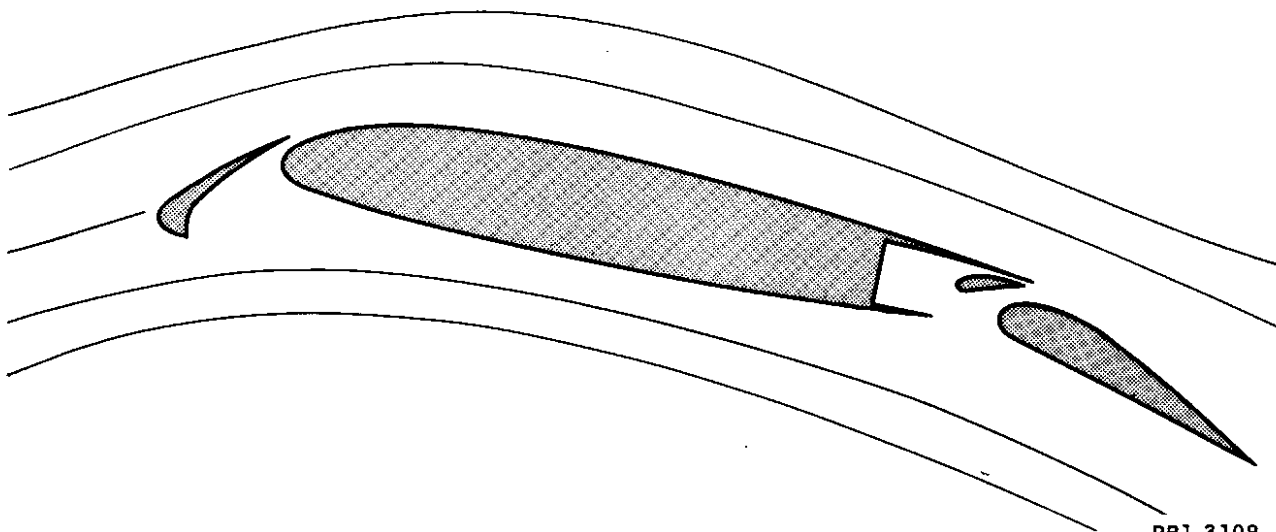
AIRFOIL CHARACTERISTICS



BB1-209A

Figure 1. Airfoil Characteristics

AIRFOIL WITH SLATS EXTENDED



BB1-3108

differential between leading edge and trailing edge is reduced, and the airplane can reach much higher angles of attack (and, therefore, higher lift and lower airspeeds) before the wing stalls. See Figure 2.

2. Temperature Effects on Speed of Sound. The speed of sound varies only with temperature. As the air gets colder, the speed of sound decreases. At sea level standard conditions - that is, at a temperature of +15°C - the speed of sound is approximately 662 knots TAS. At 35,000 feet and a temperature of -54°C, the sonic speed is reduced to 576 knots TAS.

3. Mach Number and Associated Phenomena. The speed of the airplane and the speed of the airflow around the airplane with relation to the speed of sound for any given outside temperature is referred to as Mach number. When an airplane of the DC-9 speed range is traveling at Mach numbers below approximately 0.75, which is below the speed of sound, the airflow around the airplane is generally also below the speed of sound and is called subsonic flow. When an airplane is traveling between approximately Mach 0.75 and Mach 1.2, the airflow is part subsonic, and is called transonic flow. For airplane speeds above approximately Mach 1.2, the airflow is entirely above the speed of sound and is called supersonic flow.

The DC-9 flies at subsonic Mach numbers at which the airflow around some portions of the airplane exceeds the speed of sound. At these Mach numbers, it encounters a change in flight

characteristics due to a phenomenon called compressibility.

As an airplane moves through the air, it continuously creates small pressure disturbances in the airstream as it collides with the air particles in its path. These disturbances are transmitted outward from the point of origin in the form of a pressure wave which travels at the speed of sound.

When the airplane travels at low subsonic speeds, the pressure wave moves ahead of it and causes the air particles to change direction and to conform to the shape of the airplane before it reaches them. As the speed of the airplane increases, the wing comes closer and closer to the air particles before they start to change directions. When the wing speed reaches the speed of sound, the wing is immediately behind the pressure wave and the air particles have no time in which to move out of the way. Consequently, the air particles temporarily pile up in front of the wing, and the density of the air increases and causes drag.

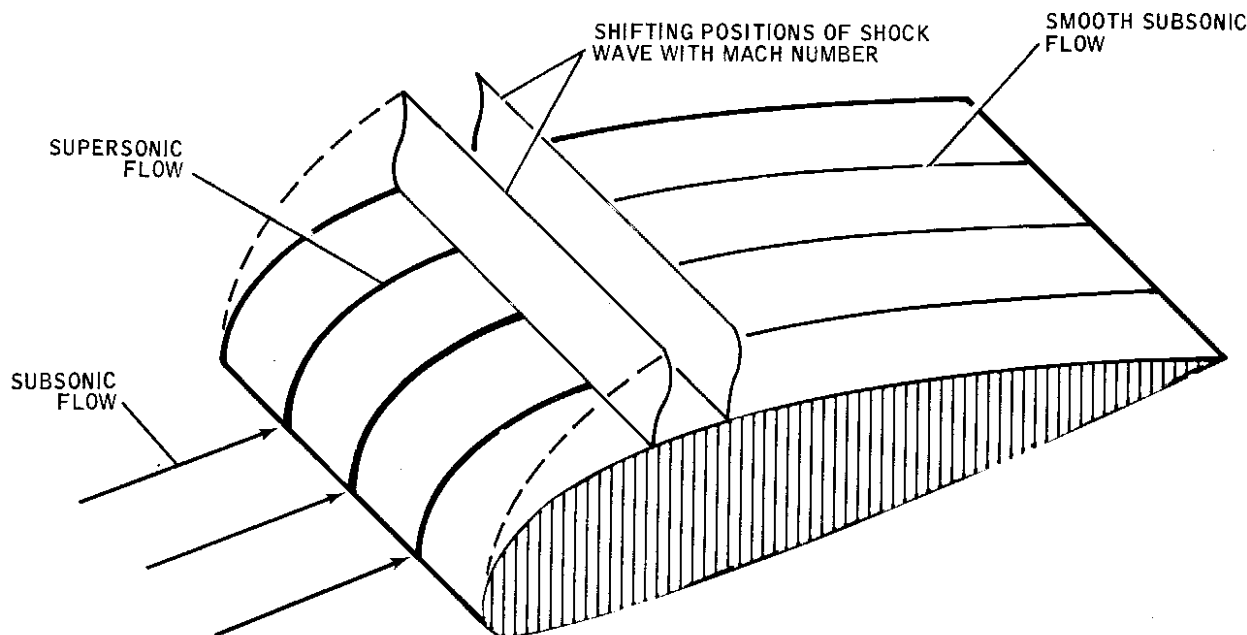
4. Shock Waves. When wing speed is increased beyond the speed of sound, the pressure and the density of the air just in front of it increase correspondingly. This compressed region of air extends some distance out ahead of the wing, the distance depending on the dimensions of the wing, its speed, and the temperature of the air. Thus, we have a situation in which at one point in an air stream the air particles are completely undisturbed, and then in the next instant are compelled to undergo drastic changes in

temperature, velocity, pressure, and density. Because of the sudden nature of these changes, the boundary line between the undisturbed air and the compressed region is called a shock wave.

At transonic speeds, shock waves similar to those that occur ahead of the wing at flight Mach numbers above 1.0 can occur over the wing surface as the wing reaches its critical Mach number; that is, the Mach number at which the local flow over some point on the airfoil is equal to the speed of sound. During transonic flight, air flowing over the leading edge of the wing increases in velocity and passes the speed of sound. As illustrated in Figure 3, this air increases in speed for a short distance and then passes through a normal shock wave.

A normal shock wave is practically perpendicular to the direction of the airflow. As the airflow passes through the shock wave, it decreases from supersonic to subsonic speed. It should be noted that air transitioning from subsonic to supersonic speed is always smooth and is not accompanied by rapid changes in pressure, temperature, and density across the shock wave that is formed. As the airplane Mach number varies, the shock wave on the wing moves back and forth over the top of the wing, and varies in size depending on the amount of air that is traveling at supersonic speed. Small, weak shock waves are formed on the airfoil of the DC-9 at a Mach number of 0.75. The energy loss of the air passing through the shock wave is small, and, therefore, the increase in drag associated with

FORMATION OF SHOCK WAVES AT SUBSONIC SPEEDS



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the shock wave is small. As the shock wave is increased in size, there is a great increase in drag, since the wing is required to pull with it a larger amount of relatively high-pressure air in the subsonic region behind the wave. The sharp increase in drag is called "drag rise" and occurs at approximately 0.81 Mach number. When a Mach number of 0.84 is reached, the shock waves are quite large and strong. They also move rapidly fore and aft on the wing, which causes oscillating pressure of such a magnitude that buffet will be felt in the airplane. The initial buffet is gentle but of a higher frequency than that associated with low-altitude stall buffet, and increases in intensity as the shock wave increases in size with increasing Mach number. Buffet can and does occur at lower Mach numbers when the angle of attack of the wing is increased. This causes the air flowing over the wing to travel faster and hence to reach the speed of sound at a lower airplane Mach number. Buffet onset boundary, as affected by bank angle (load factor), is illustrated in Figure 4.

These transonic airflow characteristics are common to all aircraft operating in the speed range of the DC-9. It is beyond the scope of this text to go into the detailed theory and explanation of all of these characteristics; however, a general comprehension of these phenomena should be understood by all DC-9 pilots.

WING DESIGN

1. General. The basic requirements of a wing for a high subsonic speed transport are high lift, good stall characteristics, freedom from flutter, and a thick airfoil section required for fuel storage. In addition to these qualities, the wing of the jet transport must be designed to reach a high Mach number before encountering compressibility drag rise, and must have good stability and control characteristics over a wide range of speeds.

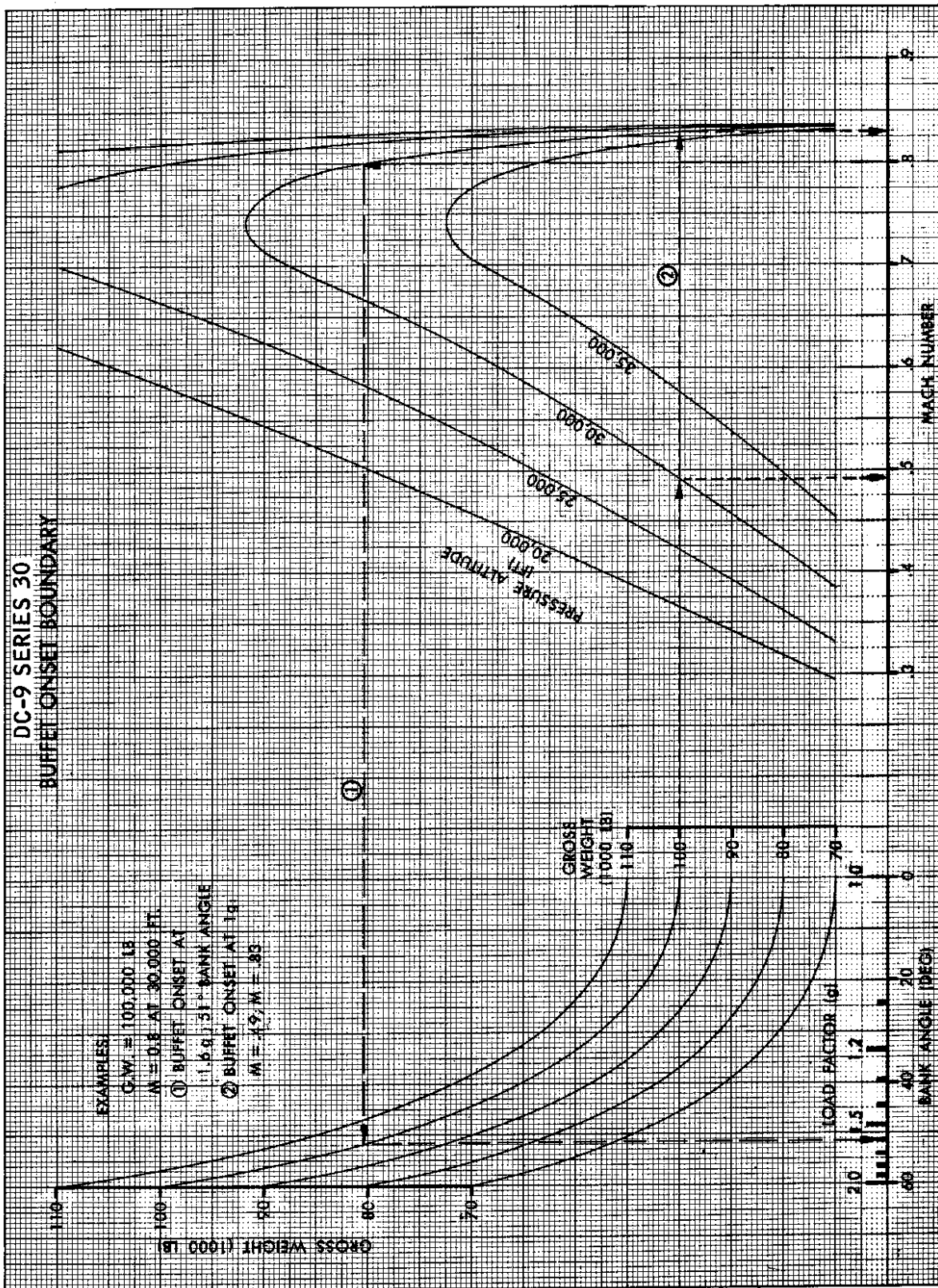
While many wing design features must be varied to meet the needs of a jet transport, the most fundamental of these variations are those made in the wing thickness, sweepback, and airfoil shape.

2. Design Objectives. Two areas, of all the wing characteristics considered, stand out in importance when applied to the short-range transport. They are:

- a. High Mach number characteristics and drag divergence Mach number.
- b. Takeoff and landing performance and low-speed flying qualities.

In general, designs which benefit the first category tend to affect the second adversely, and vice versa. For instance, reducing wing thickness and increasing sweep benefit high Mach

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Figure 4. Buffet Onset Boundary

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number performance. However, reducing the thickness also tends to reduce maximum lift coefficients and raise the stall speeds. Increased wing sweep leads to deterioration of low-speed handling qualities and dynamic stability characteristics.

In the design of a short-range jet transport, the low speed characteristics are of much greater importance than they are for a long-range transport, where the design requirements are speed and range capability. A short-range transport such as the DC-9, spends a very limited time in cruise, and thus benefits very little from an increase in cruise Mach number. For example, increasing the cruise Mach number from 0.80 to 0.83 would result in less than two minutes savings in block time on a 500 nautical mile flight.

Thus the emphasis in a short-range jet transport is on low speed performance. The short range airplane will be subject to much more frequent takeoff and landings, often in areas with shorter runways, and fewer radio/navigation facilities than at major airports. Therefore the DC-9 Series 30 utilizes full span leading edge slats to achieve the best possible low speed performance without compromising the design cruise Mach number.

3. Design Features. Early in the DC-8 development program it was discovered that modified NACA series airfoils possessed better high Mach number drag characteristics than the more commonly used high-speed airfoils. Intensive investigation into the reasons for the superiority of these airfoils led to the development

of the special airfoils originally used on the DC-8 jet transport and to the modified airfoils developed for the DC-9 Series 10. Since the DC-9 Series 30 airfoils are relieved of the requirement for high maximum lift capability, due to the incorporation of the leading edge slats, further refinement of the airfoil nose shape to improve high speed characteristics, was permitted. The airfoils used in the wing of the Series 30 are shown in Figure 5.

The major improvements achieved with these airfoils result in the desired drag divergence Mach number of 0.80, with only 24.5 degrees of wing sweep and an average thickness of 11 percent chord. An unusual feature of the DC-9 wing is the "vortilon", so-called because it acts as a vortex-generating pylon, similar to the pylons on an airplane with wing-mounted engines. This underwing device does not affect the aerodynamic characteristics of the airplane at normal angles of attack, nor does it alter the maximum lift capability. However, as the angle of attack approaches that for stall, the "vortilon" interferes with the spanwise flow and creates a vortex which goes over the top of the wing. This vortex cleans up the boundary layer flowing from the inner to the outer part of the wing and reduces its detrimental effect on the outer panel maximum lift capability. Thus outer panel stall is delayed and an inboard stall assured. An inboard stall is important on any wing to minimize rolling and to retain good lateral control at the stall. On a swept wing, an inboard stall is mandatory to prevent pitchup.

DC-9 SERIES 20 & 30 -- WING AIRFOIL SECTIONS

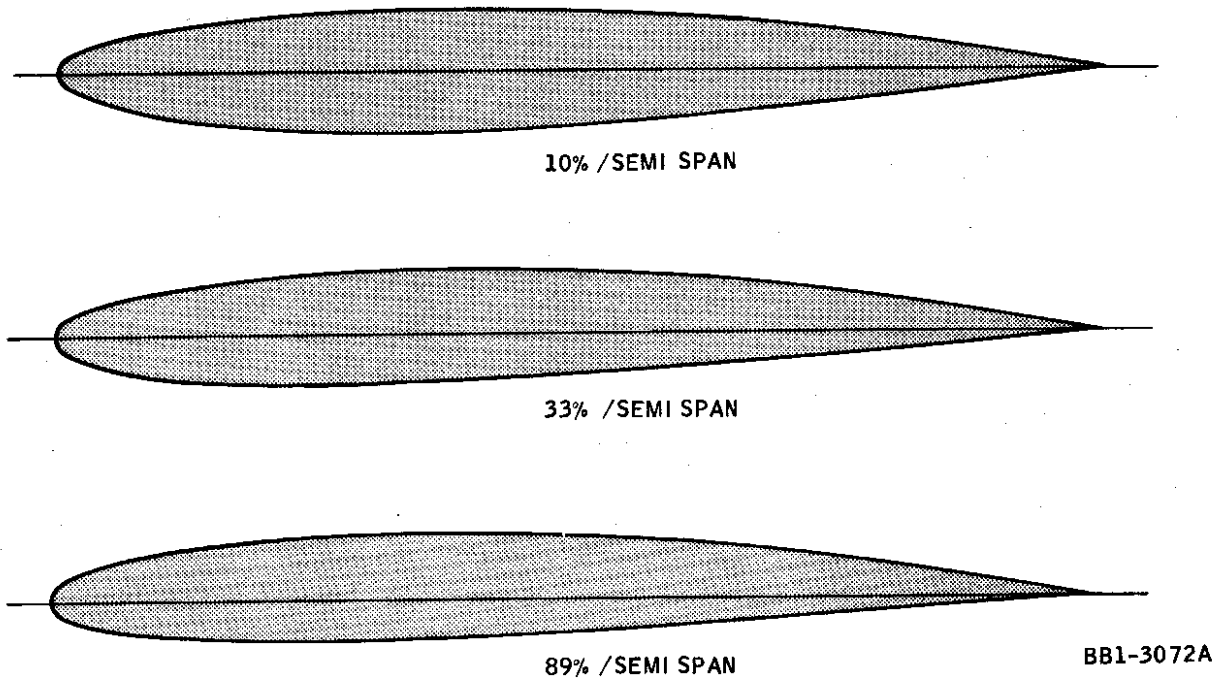
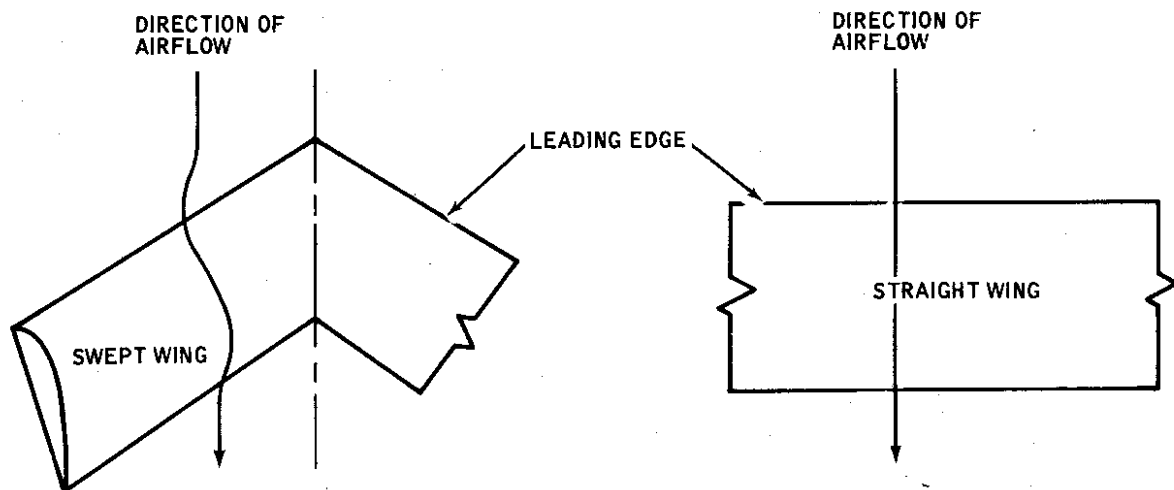


Figure 5. Wing Airfoil Sections

FLOW LINES OVER WING



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On a straight-wing airplane, the airflow strikes the leading edge of the wing at, or near, a 90-degree angle and exercises the full impact of its airspeed to produce pressure and lift. (See Figure 6.)

A wing having sweepback is struck by this same airflow at an angle smaller than 90 degrees. Sweepback theory is based on the idea that it is only the component of airflow perpendicular to the leading edge that affects pressure distribution and attendant effects.

In Figure 7, the free-stream speed (V_F) has been resolved into its components V_S and V_L . The spanwise flow (V_S) has no effect on the lift nor on the drag forces of the airfoil; only V_L , which is perpendicular to the leading edge, produces pressure distribution around the wing in the usual manner. For this reason, V_F can be increased to a supersonic value; but so long as V_L remains subsonic, no shock waves will form on the wing.

Although sweepback can be used successfully to obtain a high critical Mach number and a delay in drag, there is a limit to the amount of sweepback that can be used successfully. This limit is imposed by the unfavorable low-speed stability and control characteristics which arise as the sweepback angle increases.

Airflow over a swept wing is such that its lines of constant pressure do not continue undisturbed to the wing root. Instead, the flow is modified and the chordwise pressure distribution near the root differs from that outboard of the disturbed area. This is

because the lift forces of the wing root tend to move farther aft of the leading edge as the angle of attack increases, whereas, in the rest of the wing, the forces move toward the leading edge. The distorted pressure distribution that results is undesirable regarding stall characteristics. As a consequence the ordinary swept wing tends to stall first near the tip and, as it stalls, destroys lateral control and creates an unstable pitchup.

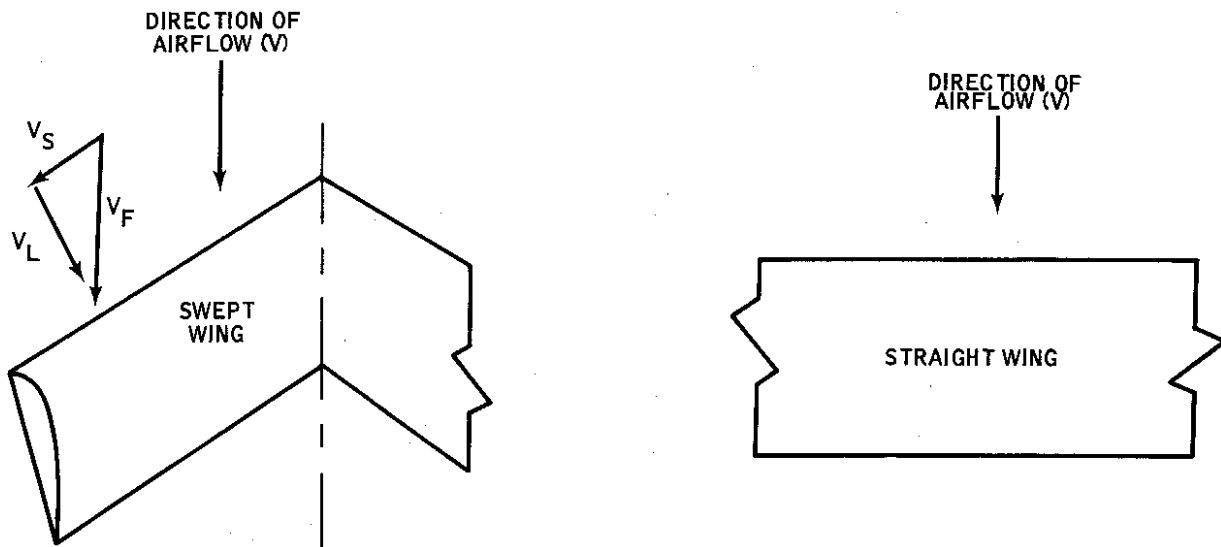
The airfoil section of the DC-9 wing root has a negative camber and resembles an inverted conventional airfoil. Its nose is sharper than the outboard wing leading edge, and is set to give a higher angle of incidence to obtain a higher angle of attack. This design refines and gives a more normal pressure distribution over the wing root, and delays the drag rise in this area.

The inboard and outboard airfoil sections are conventional in overall appearance, and are characterized by a rather blunt nose and a relatively flat section in the region of the crestline.

4. Dutch Roll. Another unfavorable characteristic of a highly swept wing is that of dutch roll. This is the name given to the oscillating, rolling, and yawing motions of an airplane that follow a disturbance about the longitudinal and vertical axes. The disturbance which initiates a dutch roll may be a gust upset or a displacement of the rudder or aileron.

A simple flight demonstration of a dutch roll may be made by releasing

USE OF SWEEPBACK



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Figure 7. Use of Sweepback

the controls of the airplane while it is in a steady sideslip. The resulting maneuver can be best described as a skid followed by a roll, with continued yawing and rolling from side to side in a corkscrew fashion. If the airplane yaws to the right, the right wing will slow down and the left wing will speed up. This added speed will create more lift on the left side of the plane and the left wing will rise. Since an increase in drag will accompany an increase in lift, the plane will then tend to yaw to the left. The right wing will rise

because of the increase in lift, and the cycle will be repeated at a decreasing amplitude (on the DC-9) until the plane comes to a static condition.

The characteristics of dutch roll, that is, the relationship between the period of the oscillation, the ratio of the rolling to yawing in the oscillation, and the damping of the oscillation, are strongly affected by the airplane's directional stability, effective dihedral due to sweepback, and inertia.

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EMPENNAGE

Specific horizontal and vertical tail airfoils have been designed for the DC-9. Root and tip airfoils only are used in defining the tail surfaces, since there is no stalling problem involved. As is the case with the wing, the airfoils are designed to alleviate the three-dimensional root and tip effects which occur on swept surfaces.

The horizontal tail is located at the top of the vertical tail. This arrangement has many aerodynamic and practical advantages, some of which are:

- Reduced downwash at the tail

- Increased horizontal tail length

- Increased vertical tail effectiveness due to the end plate effect of the horizontal tail

- Negligible effects from engine jet exhaust

- Reduced interference drag

Careful selection of airfoil section, thickness, and sweep ensures that the tail "force-break" Mach number (Mach number beyond which lift effectiveness falls off) is above the designed dive speed for both the horizontal and vertical tails.

NACELLES

The nacelles have been designed to enclose the JT8D engine with a shape

that will allow the highest installed performance (thrust minus drag) possible at all flight conditions. The nacelle nose cowling is nonsymmetrical, to keep the drag to a minimum at the high Mach number cruising conditions.

The nonsymmetry is required to maintain an extremely flat nacelle line adjacent to the fuselage, such that the nacelle supersonic increments, when added to those from the pylon and fuselage, do not lead to supercritical velocities with resultant shock wave losses.

The nacelle axis and pylon have been set at 3 degrees angle of attack relative to the fuselage to align them with the local flow conditions prevalent at cruising conditions. This is necessary to eliminate the interference and high induced drag that they would otherwise be subjected to. The nozzle is then canted upward relative to the engine axis, thus eliminating the pitching effects due to thrust.

The inlet design, characterized by moderately thick internal lips, provides inlet performance better than that obtained with the engine manufacturer's calibration bell mouth at all essential flight conditions. This has been demonstrated by model tests of this configuration and by full-scale testing.

Other advantages of fuselage engine mounting are: clean wing with higher efficiency - a minimum of 3500 pounds higher second-segment limit weight; single, noninterrupted flap; higher lift potential with lower drag at

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high lift; lower cruise drag level; better conditions in reverse thrust and lower cabin noise; freedom from trim changes with thrust changes; better dynamic stability because of greater tail length; better crosswind landing capability and freedom from minimum-control speed limitations. The design places fuselage closer to the ground, thus facilitating ground handling activities and enabling faster turnarounds.

PYLONS

Symmetrical airfoil sections are used for the pylons which attach the nacelles to the fuselage. In order to minimize the interference between the fuselage and the pylons, the trailing edge of the pylon is swept so that the chord of the inboard airfoil is greater than the chord of the outboard airfoil. In this way, it is possible to achieve a reduction in the trailing edge angle of the pylon, in the region of the thick boundary layer, and adverse pressure gradient on the fuselage without sacrificing the pylon structural depth and simplicity of construction.

FUSELAGE

The drag divergence Mach number is in excess of 0.90 and provides a fuselage drag divergence Mach number above that of the wing. The low fuselage design provides ease of ground servicing, access to service panels and fueling. Ground effect on the DC-9 is quite

strong, as illustrated by the fact that approximately 59 percent of drag is lost just prior to runway contact.

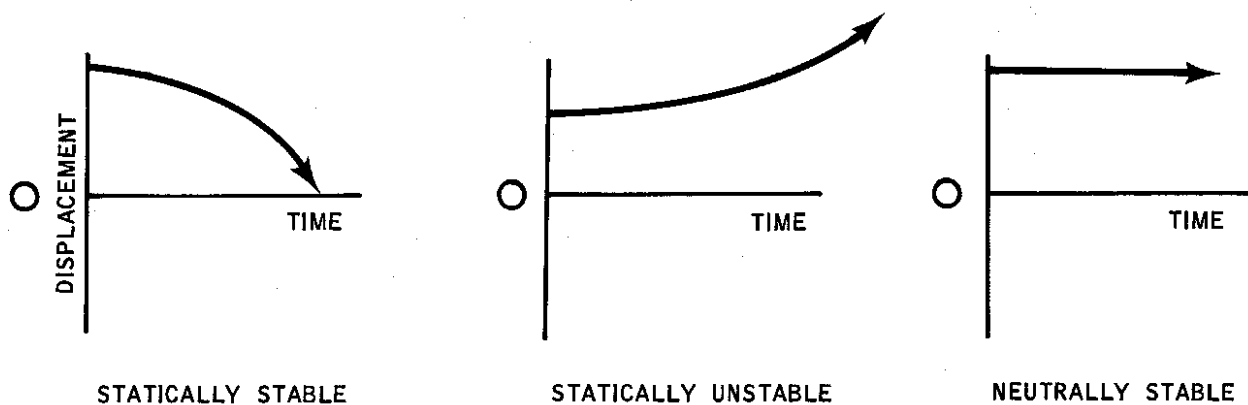
STABILITY

1. Static Stability. The handling qualities of an airplane are a function of its stability. An airplane, when in equilibrium (or trimmed), will remain so until disturbed by some outside force. Positive static stability is defined as the tendency of the airplane to return to equilibrium following a displacement from that condition. If the airplane were to continue away from its original state of equilibrium after displacement, it would be statically unstable. If the aircraft were to reach equilibrium in a new position, it would be termed neutrally stable. These conditions of stability are shown in Figure 8.

2. Dynamic Stability. Dynamic stability is defined as a timed study of the movements of the aircraft after a displacement from equilibrium. Before the aircraft can display any dynamic stability tendencies, it must first possess positive static stability. The dynamic stability characteristics of an aircraft that has positive static stability can be either stable, unstable, or neutrally stable, and are illustrated in Figure 9.

The DC-9 possesses static and dynamic stability about all axes throughout the entire speed range.

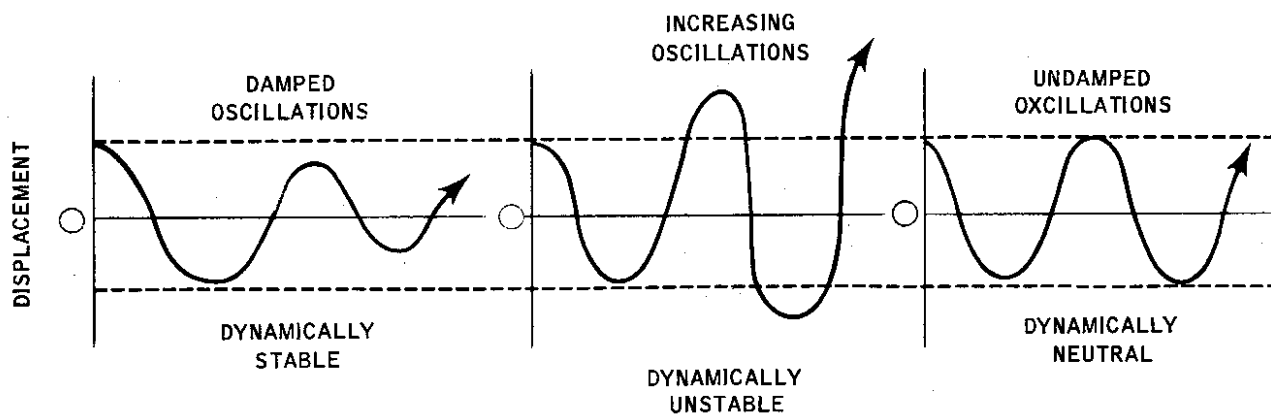
STATIC STABILITY



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Figure 8. Static Stability

DYNAMIC STABILITY



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Figure 9. Dynamic Stability

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3. Transonic Tuck-under. In order to obtain longitudinal stability in the transonic speed range, a Mach trim compensator is installed. This device is necessitated by the trim change associated with the transonic tuck, to provide speed stability whereby an increasing control column push force is required with increasing speed, and an increasing pull force is required to decrease speed from a given trim point.

As the airplane increases speed, the air pressure distribution over the wing changes shape. Angle of attack airfoil design, and many other factors will also affect the pressure pattern; but, with all other conditions held constant, as speed increases, the center of pressure moves aft. Figure 10 shows the pressure distribution at low and high Mach number, resulting in a downward pitching moment as the center of pressure moves aft.

If the center of pressure were the only factor affecting airplane pitch, the airplane would always tend to pitch down as speed increased or pitch up as speed decreased. However, a number of other effects directly related to speed, primarily the pitching moments generated by the horizontal tail, provide an offsetting pitching moment which keeps the nose up as speed increases.

4. Mach Trim Compensator. In the high transonic speed range, compressibility effects directly related to the airplane's Mach number reduce the noseup pitching moment as speed increases and causes the nosedown pitching tendency, commonly referred

to as tuck-under. On the DC-9, this begins at Mach 0.80, which is faster than the normal high-speed cruise Mach number. However, if this condition goes uncorrected, the airplane continues to nose over gradually and pick up even more speed. To ensure that a control column push force is required to increase speed from a trimmed condition, near the transonic tuck Mach number, a trim compensator is installed. This device operates on a Mach schedule and pulls the control column back as the Mach number increases, causing the pilot to exert an increasing push force on the column. If he does not, the airplane returns to the trimmed position.

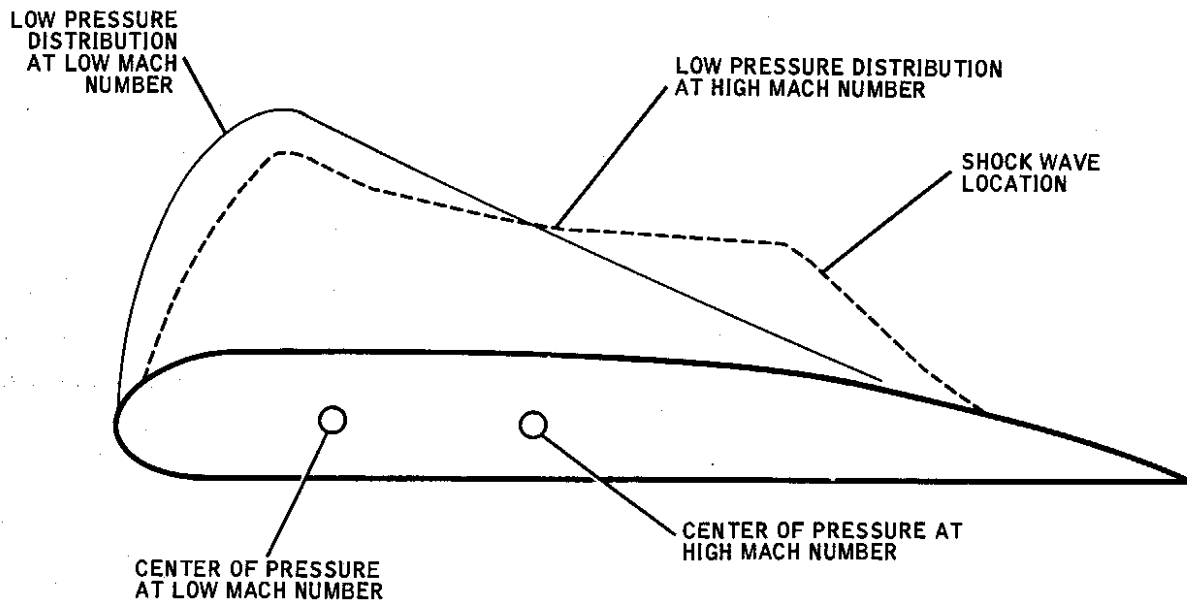
As the control column moves back, due to the Mach trim compensator, an indicator rod simultaneously extends which is correlated to the M.T.C. actuator. The column force varies linearly up to a maximum of 7 1/2 pounds at full extension at a Mach of 0.85, as illustrated on Figure 11.

LATERAL, DIRECTIONAL AND LONGITUDINAL
FLIGHT CHARACTERISTICS

Design Objectives

1. Rolling performance at low speeds with flaps up and down.
2. Rolling performance at the design dive speeds.
3. The ability to maintain roll control in steady sideslip and during crosswind landings to full rudder deflection.

PRESSURE DISTRIBUTION AT DIFFERENT MACH NUMBERS

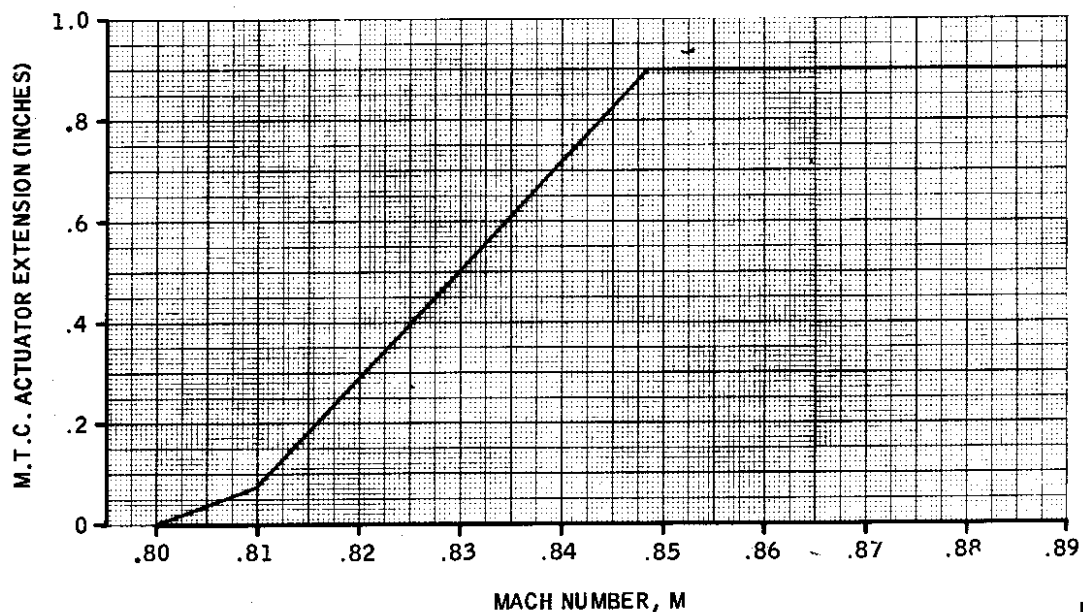


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Figure 10. Pressure Distribution at Different Mach Numbers

MODEL DC-9 MACH TRIM COMPENSATOR ACTUATOR EXTENSION VS MACH NUMBER

REF: DC9-C3.105



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Figure 11. Mach Trim Compensator Chart

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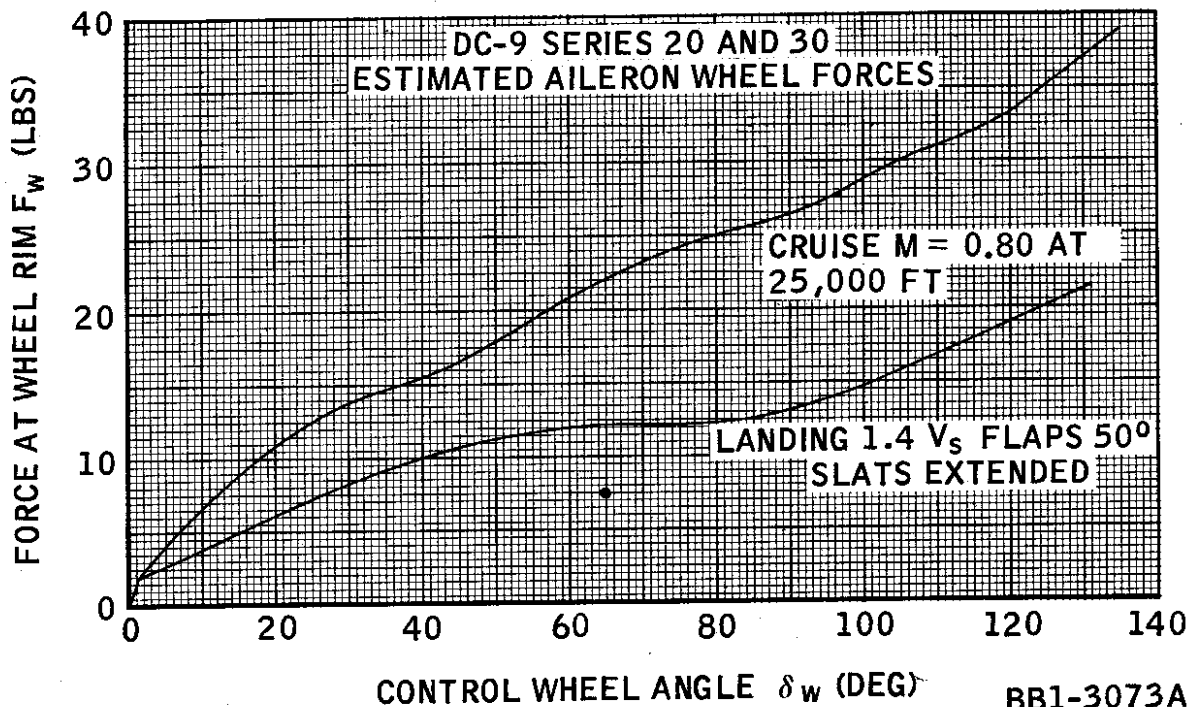
LATERAL CONTROL SYSTEM

The lateral control system is a combination aileron-spoiler system. The single aileron on each wing is aerodynamically balanced and aerodynamically boosted by a control tab. The ailerons are augmented by the actuation of two lateral control spoilers on each wing. Trim capability is provided by an aileron trim tab, actuated by cables from the cockpit trim knob. Aileron wheel forces are derived from aerodynamic tab hinge moments and from load fuel springs. As can be seen in Figure 12, the aileron wheel forces in cruise at 25,000 feet are about 17 pounds at 45 degrees wheel throw, only 6 pounds more than during landings. Maximum roll rates under all flight

conditions are always greater than 15 degrees per second. Even without lateral control spoilers, roll rate capability never diminishes below approximately 5 degrees per second.

DIRECTIONAL CONTROL SYSTEM

Rudder Power System. The rudder of the DC-9 is aerodynamically balanced and is driven primarily by an irreversibly hydraulic power control system. Rudder pedal forces are supplied to the pilot by a simple spring-type artificial feel unit. The power system makes possible a low force of approximately 80 pounds at full rudder deflection. Structural protection is provided by two rudder throw limiter



systems; a flap controlled rudder limiter for low airspeeds and a "Q" limiter for high airspeeds. The flap controlled rudder throw limiter restricts the maximum rudder deflection to 17 degrees for flap angles of 0 and 5 degrees. For flap angles greater than 5 degrees the maximum available rudder deflection is 22 degrees except as limited by action of the "Q" limiter. The rudder throw "Q" limiter is actuated by dynamic pressure to limit the maximum rudder deflection as a function of airspeed so that starting at approximately 175 knots the rudder deflection available decreases gradually to 2.5 degrees at 280 knots. The rudder limits allow for sufficient directional control in the engine inoperative condition and during crosswind landings.

Manual Rudder System. In the event of a hydraulic malfunction, the rudder automatically reverts to aerodynamic tab control. During manual rudder operation, with loss of right hydraulic system pressure, the maximum attainable rudder deflection is 17 degrees because the flap controlled rudder limiter reverts to its lower limit restriction. This restriction in rudder throw penalizes the crosswind landing capability of the DC-9 by approximately 17 percent. However, the DC-9 has demonstrated a crosswind landing capability to handle a 90 degree crosswind component of 38 knots at 1.3 V_S at maximum landing weight with a manual rudder and 50 percent lateral control spoilers.

LONGITUDINAL CONTROL SYSTEM

The longitudinal control system consists of a conventional aerodynamically balanced elevator, aerodynamically boosted by a control tab. Two tabs provide the forces necessary to drive the elevator, an inboard control tab, and an outboard geared tab.

Motion of the geared tab approximates that of the control tab under most conditions. Longitudinal trim is provided by the adjustable horizontal stabilizer.

Pilot forces are derived from aerodynamic hinge moments and from a two-rate control column centering spring. This spring has a steep force gradient through neutral for good centering and a lower gradient away from neutral. Column force approximates 40 pounds per G.

A Mach trim compensator is provided in the longitudinal control system. This device provides a trim force and repositions the centering spring as a function of Mach number in the trim change, or "tuck" region. It assures a stable force variation with speed throughout the flight envelope.

Supplemental longitudinal control is provided by the elevator power augmentor for deep stall recovery only. It gives the pilot the ability to move the elevator to the full down position when the airplane is at an unusually high angle of attack and the control

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tab has lost effectiveness. The augmentor system has no effect on the control tab system in all normal control regimes.

Small amounts of Longitudinal trimming will usually be necessary to fly with zero column force when the airplane configuration changes.

LONGITUDINAL TRIMMING

The horizontal stabilizer is adjustable to provide longitudinal trim throughout the entire center of gravity range and speed envelope. The movable stabilizer makes longitudinal trimming different from that accomplished with the elevator trim tab on earlier commercial transports.

To trim longitudinally with an elevator trim tab as found on aircraft such as a DC-7C, the control column is displaced a given amount which, in turn, moves an aerodynamic tab and the elevator. With the control column held essentially in this position, the column force is reduced to zero with the trim tab, to maintain a given airplane attitude without significantly moving the control column.

With the adjustable horizontal stabilizer, the technique is different. As the stabilizer is moved, the elevator forces must be relaxed and reapplied to maintain the same airplane attitude. This is necessary because the angle of attack of the horizontal stabilizer changes during the trimming process. Particular attention must be given to proper technique, since stabilizer trim forces are approximately 2 1/2 times greater than elevator movement through the same angular deflection.

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MODEL DC-9

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CHAPTER 5-5

RECORD OF REVISIONS

ALL REVISIONS MUST BE INSERTED AND LOGGED IN NUMERICAL ORDER.

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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The following pages are effective for ATL Series 30 Aircraft.

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Chapter 5

STRUCTURAL DESIGN LIMITS

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*Illustration

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Chapter 5

STRUCTURAL DESIGN LIMITS

DESIGN GUST INTENSITIES AND ROUGH AIR SPEED

1. General. When an airplane wing encounters an air gust, the additional load it receives is caused by the abrupt increase in angle of attack. The following pertains to the gust intensities for which the airplane is designed.

2. Design Gust Intensities. Gust intensities are difficult to measure directly. Because of this, the acceleration produced by the gust is measured in flight and then the gust intensity is calculated by a method of back-figuring.

It may be noted that the design gust intensities shown in Figure 1 are appreciably higher than the gust intensities previously associated with other aircraft. Formerly, only the wing loading was used to determine the intensity of a gust and the airplane's reaction to it. Now, however, not only the wing loading but also the airplane geometry, the density of the air, and the mass of the air are taken into account. The use of the new system does not mean that the older aircraft are obsolete or that jet transports are designed to withstand gusts of greater intensities; it merely means that the old method used

to calculate gust loads was inadequate when applied to jet transports.

In selecting the gust intensities to be used for design, a certain standard of gust frequency is used. As an example, for level flight or climb, the airplane is designed for the gust intensity that can be expected once in one million miles of flying. That is, once in approximately one million miles of flight at altitudes up to 20,000 feet, the gust intensity will be 50 feet per second; at higher altitudes, assuming the same frequency of gust, the intensity will be less.

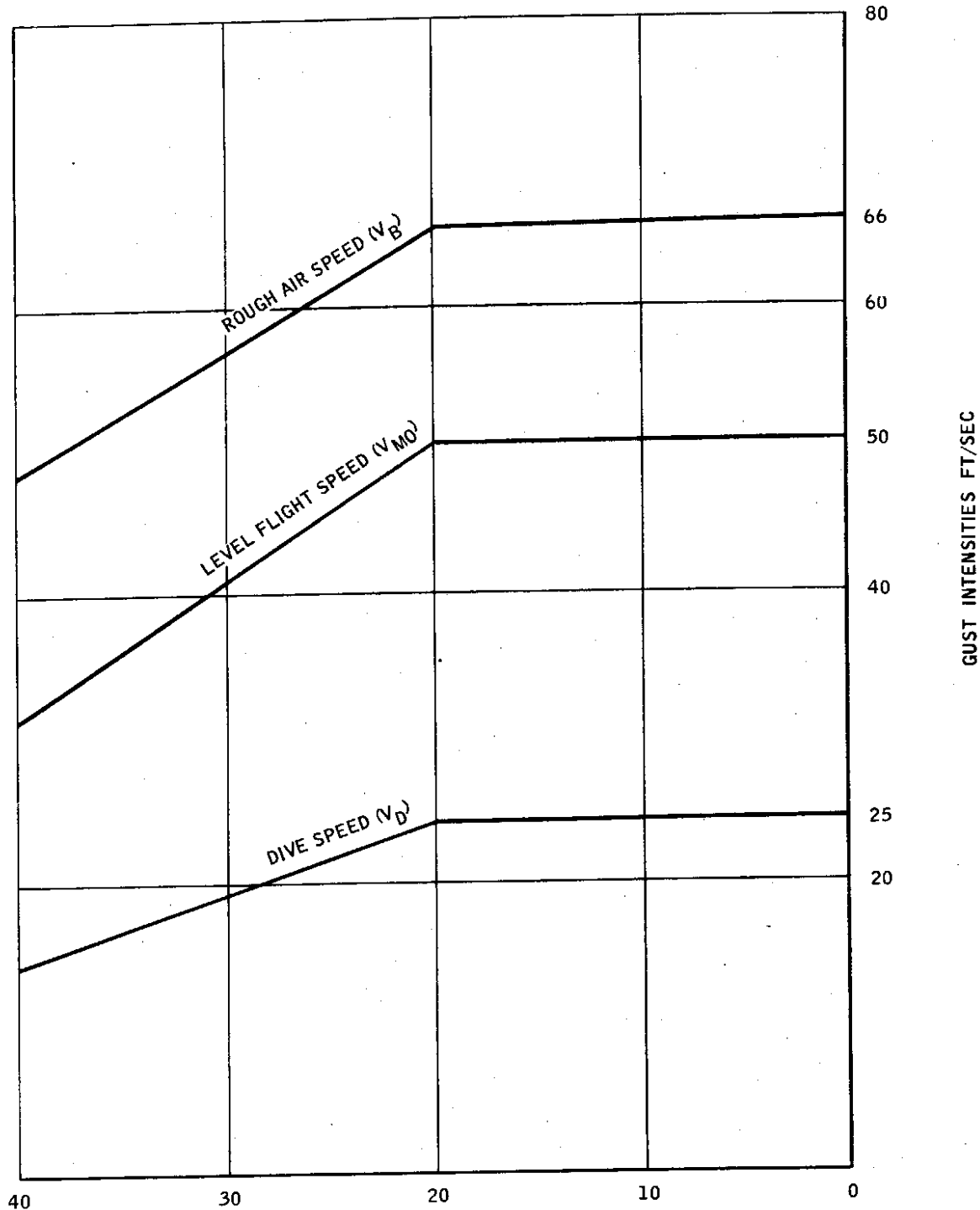
The possibility is very unlikely that an aircraft will encounter an extreme gust during its relatively short periods at the design dive speed, V_D . This flight condition needs a less stringent gust requirement than that needed for level flight. For dive, the gust intensity used is 25 feet per second up to 20,000 feet of altitude.

For the rough-air condition, V_B , a design gust intensity of 66 feet per second is used up to altitudes of 20,000 feet. The variation of the design gust intensities with altitude is shown in Figure 1.

3. Rough-Air Speed. An airplane is not designed for the roughest gust condition that can occur, because this

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DESIGN GUST INTENSITIES



STANDARD ALTITUDE - 1000 FT

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condition is not specifically known. However, the values to which the DC-9 has been designed to meet structural requirements, such as the 66 feet per second, are truly rough. There is little chance that this gust intensity will be encountered except, perhaps, in the most severe thunderstorms.

Under circumstances where it is necessary to reduce the airspeed in turbulent air, decrease the airspeed either by reducing thrust or by using the speed brakes and allowing the airplane to slow down without pulling the nose up. Pulling the nose up abruptly will combine the acceleration due to the pullup with acceleration due to the encountered or anticipated turbulence.

SEVERE TURBULENCE PENETRATION

Knowledge of adequate maneuvering margins, maximum practical altitude in lieu of maximum operating altitude, good weather briefing, and common sense are all criteria for this type of operation. If severe turbulence is encountered, use following procedures:

1. Speed - Use applicable V_B Speed. For all Series 30 airplanes use 285 KIAS/0.79 Mach. Do not chase speed.
2. Yaw damper (If operating) - ON.
3. Autopilot ----- optional. If used altitude hold must be off. Pitch hold should be used.

4. Fly attitude, use attitude indicator as prime reference, do not use sudden large control inputs.

5. Avoid, if possible, use of stabilizer trim for controlling pitch attitude.

6. Attitude - sacrifice altitude to maintain attitude. Do not chase altitude.

7. Thrust - ignition on, change thrust only in case of extreme air-speed variation.

ROUGH-AIR SPEED V_B

The rough-air speed is 285 KIAS/0.79 Mach for all altitudes and weights.

WING STRENGTH AND FUEL LOADING

General. An airplane must withstand not only the speeds and accelerations encountered in normal operation, but must also meet additional requirements related to maneuvering, rough air, and situations that may develop inadvertently. Aircraft structure is designed to meet maximum maneuver or gust load factors, whichever is the more critical. In addition, it must withstand landing loads resulting from ground contact at specified gross weights and rates of descent.

The DC-9 provides structural integrity throughout the speed and thrust range necessary for economical airline

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operation, and its load factor envelope provides sufficient strength margin for any flight condition that may arise.

Wing Loads. The wing loads are affected by the wing fuel load distribution, the sequence of fuel usage, wing air loads, wing weight, and the weight of the fuselage and its contents. These loads are shown in Figure 2. With any airplane in level flight, the total up-load on the wings equals the total airplane gross weight (neglecting the horizontal tail load). The fuselage, fuel, and wing weights are downward loads.

Since the upward loads on the wing are greater than those downward, in order to lift the fuselage, upward load and bending moments are produced at the wing roots.

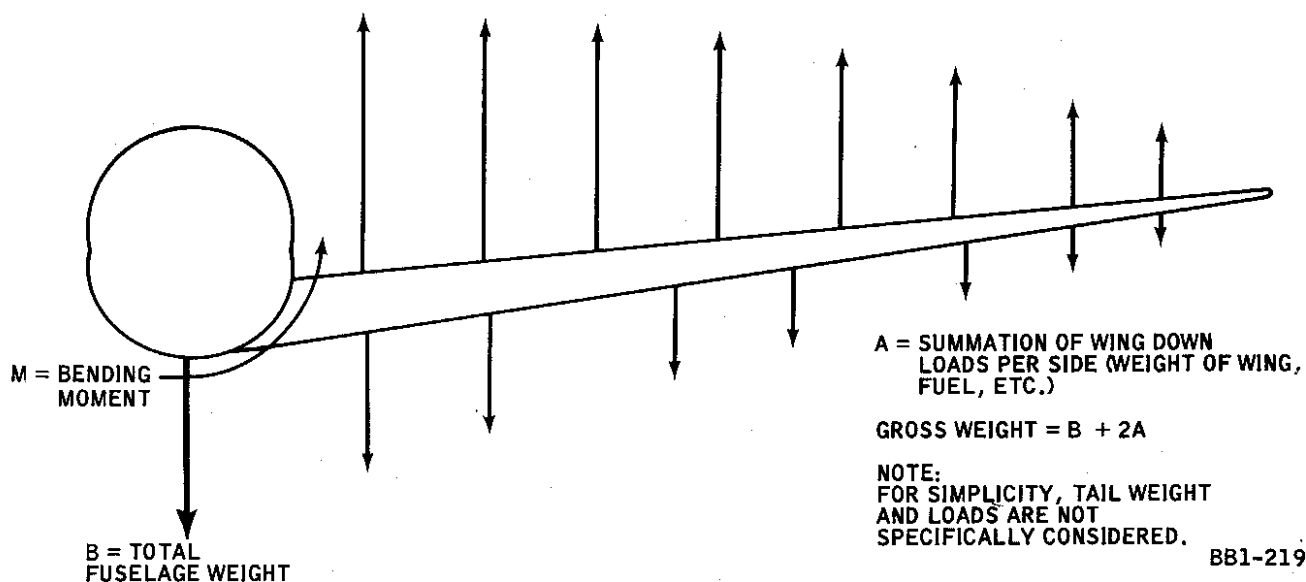
LOAD FACTORS AND V-G DIAGRAM

General. When an airplane is in a static condition, the only loads imposed upon its structural components are the result of weight. In steady, level flight, the structure is acted upon not only by weight but also by local air pressures, thrust, lift, and drag. An additional load is imposed when an airplane is subjected to an acceleration, whether caused by rough air or a maneuver by the pilot.

Load Factors. When a condition of acceleration induces an additional load, the ratio of such a load to the static load due only to weight is the load factor. Therefore, it is logical for a load factor to be specified in terms of G, the static pull of gravity

IN-FLIGHT WING AND FUSELAGE LOADS

SUMMATION OF WING
UP LOADS PER SIDE = GROSS WEIGHT/2



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on a body due to its own weight. Yield strength is used as the basis for determining the limit load factor, which designates the maximum load an airplane can withstand without undergoing permanent deformation. The load required for ultimate failure is 50 percent greater than the limit load.

The limit gust load factor is determined by the gust velocity, airspeed, altitude, and gross weight. The relationship between these variables for the design level flight condition, V_{MO} , is shown in Figure 3. It should be noted that the minimum value of the load factor scale is 2.5 G, the limit maneuver load factor.

Maneuver Load Factor Diagrams. The capacity of an airplane from a structural design standpoint is depicted by V-G diagrams. By plotting positive and negative accelerations versus airspeed, an envelope is formed within which the airplane is designed. V-G diagrams vary with gross weight, C.G., and altitude. Two examples of the maneuver load factor diagrams are given in Figures 4 and 4a.

As shown there, the DC-9 is designed for a maximum positive maneuver acceleration of 2.5 and a negative value of -1 at all weights up to and including the maximum for takeoff. Each diagram is bounded on the left by the stall region, and vertical lines are drawn on the right at V_{MO} and V_D speeds.

Fuel, Passenger, and Cargo Loading Effects on C.G. The C.G. range at maximum takeoff gross weight will vary from approximately 10% to 20% for

model 32 airplanes. The fore and aft limits expand linearly and vary from approximately 5.9% to 34.7% at light weights. The tanks are of a size and located such that the burning of fuel has relatively small effect on C.G. on a three tank airplane. From full tanks (including center tank full) the C.G. will move aft 1% MAC arriving at this maximum displacement when the center wing tank becomes empty. On a four tank airplane, center and forward auxiliary tanks full, the C.G. will move aft 4-1/2% of MAC arriving at this maximum displacement when the center wing tank becomes empty. As the wing tank fuel is used, the C.G. will then move forward until half tanks (2%MAC) and then back again as the remaining fuel is burned. The lateral imbalance limit in flight is 1500 pounds. Normally there are no restrictions relating to passenger loading. However, the loading of the cargo compartments must be scheduled to establish and retain the C.G. within limits.

STRUCTURAL DESIGN SPEEDS AND MAXIMUM OPERATING SPEEDS

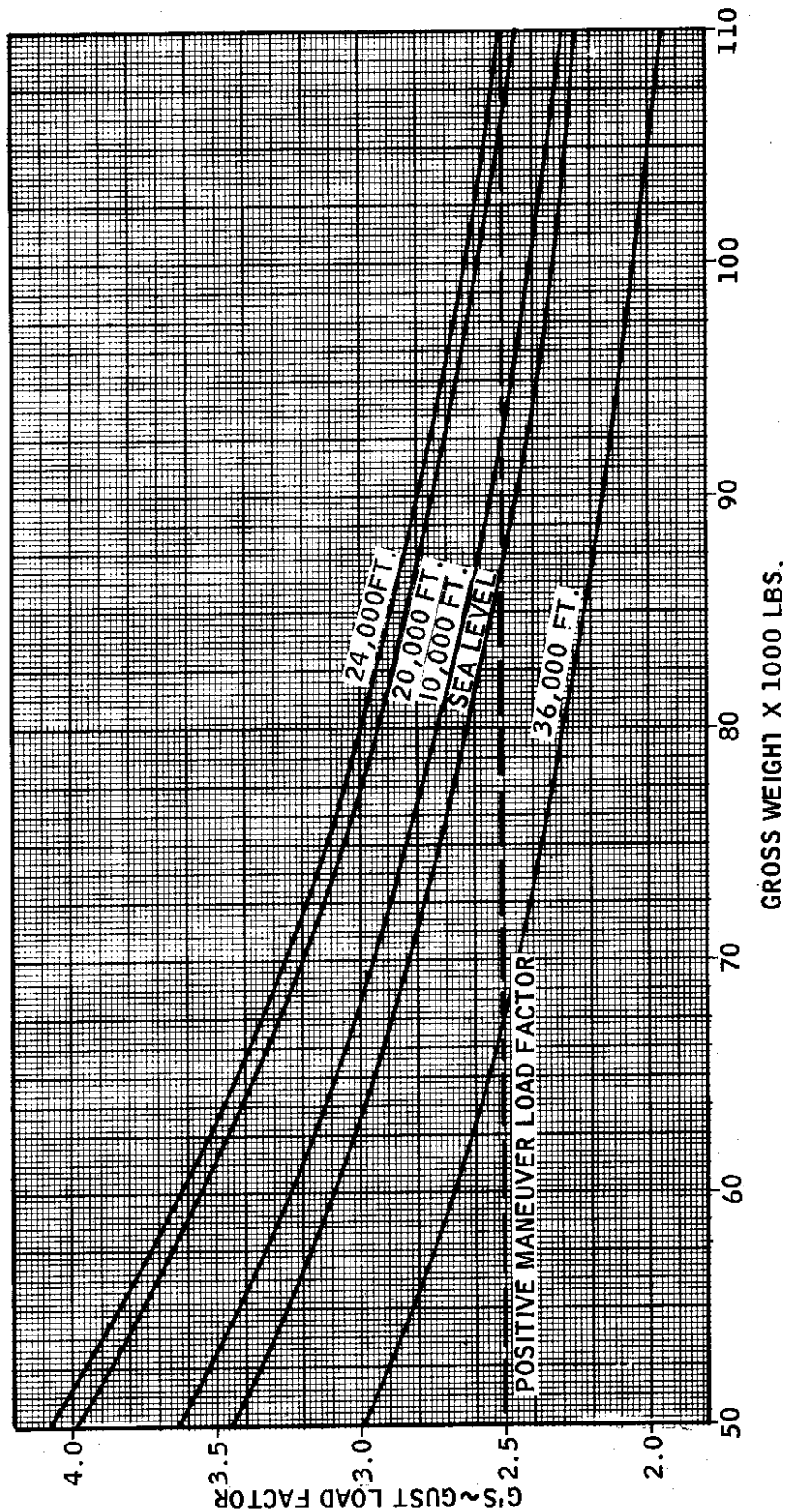
General. The speeds used in the structural design are in accordance with the requirements of CAR.4b. These following speeds are shown in Figure 5. (Figure 5 to be added when available.)

V_{MO}/M_{MO} - design climb and level -
flight high speed

V_D/M_D - design dive speed

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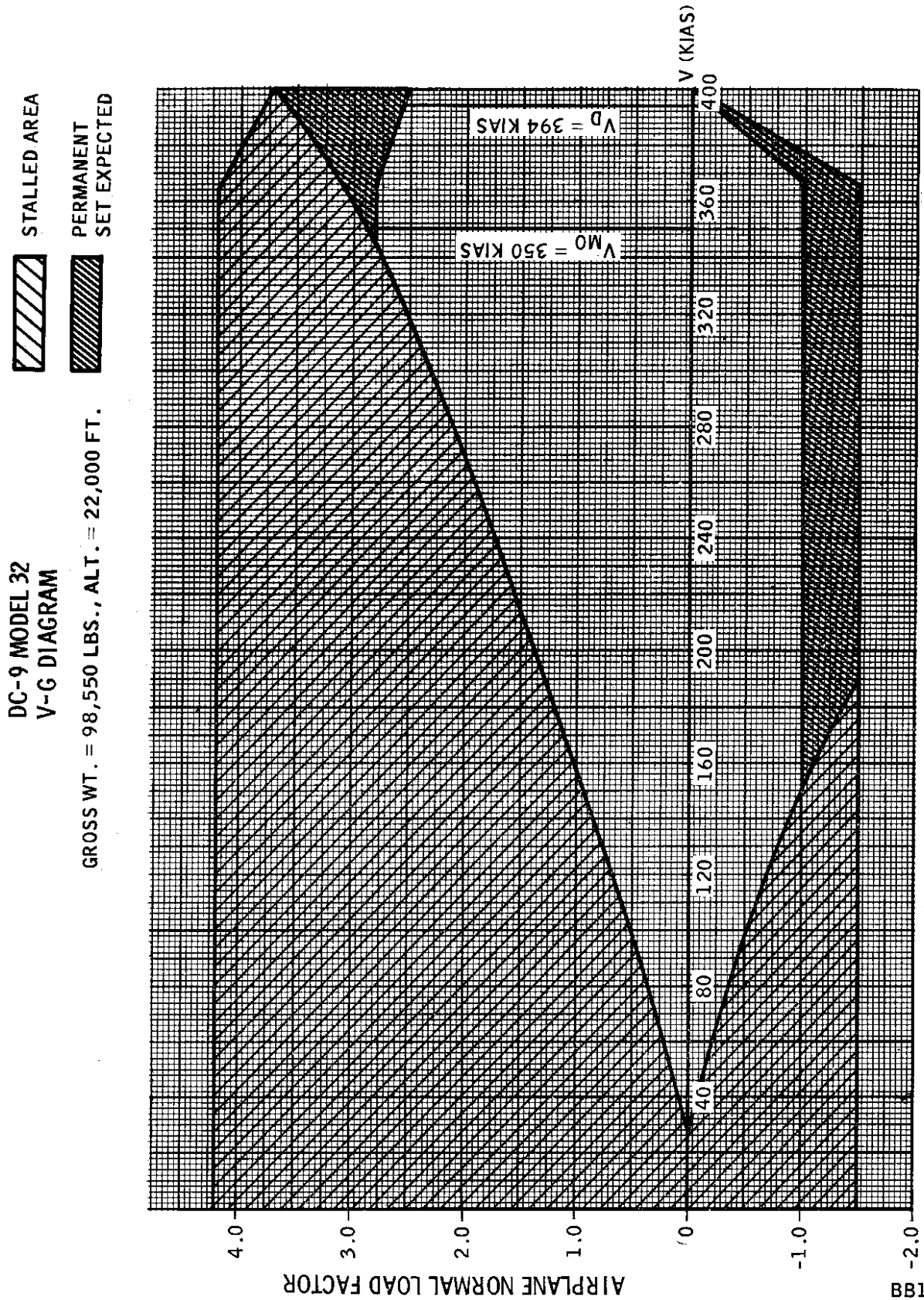
DC-9 MODEL 32
 GUST LOAD FACTORS AT V_{MO}
 SYMMETRICAL FLIGHT



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Figure 3. Positive Gust Load Factor at V_{MO}

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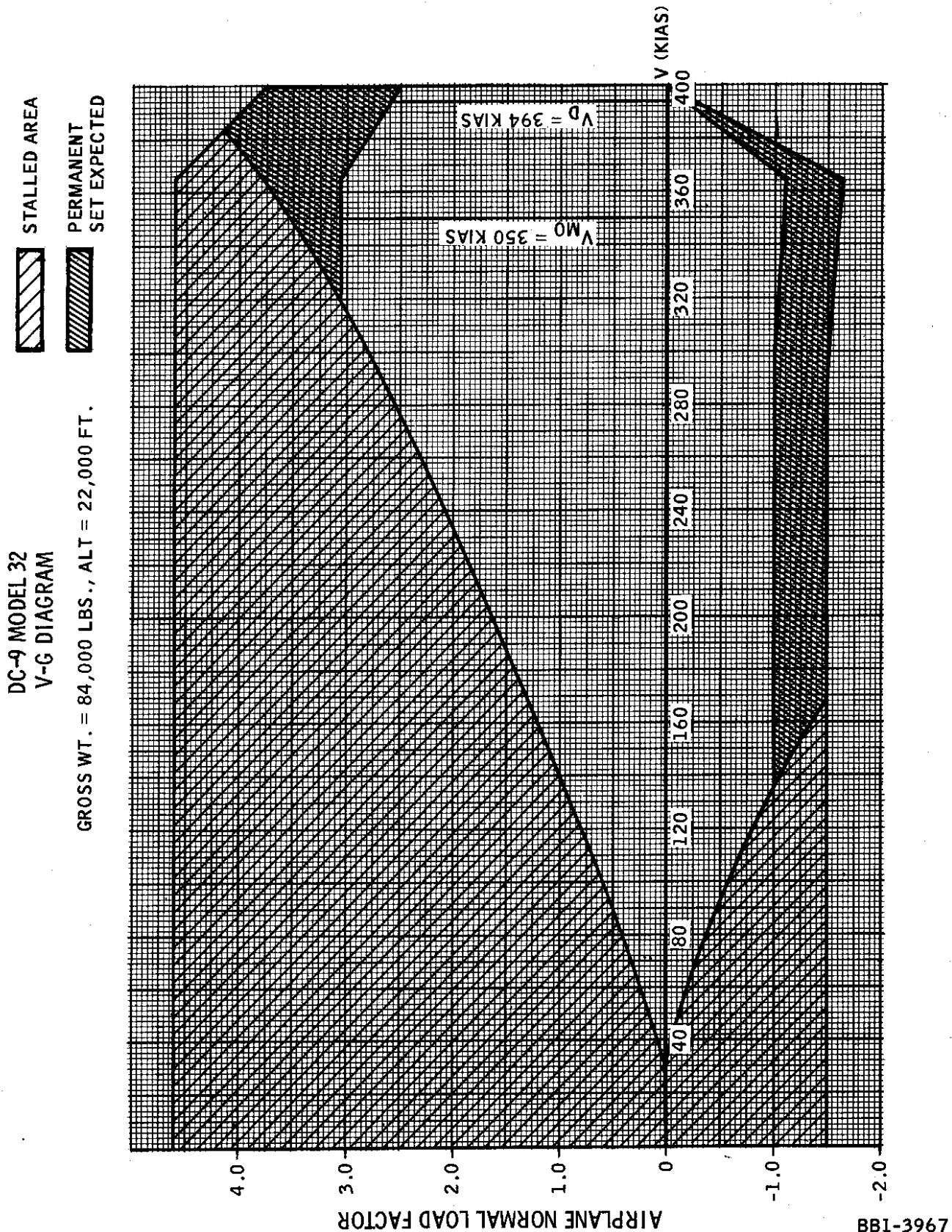
Figure 4. V-G Diagram - Heavy Airplane

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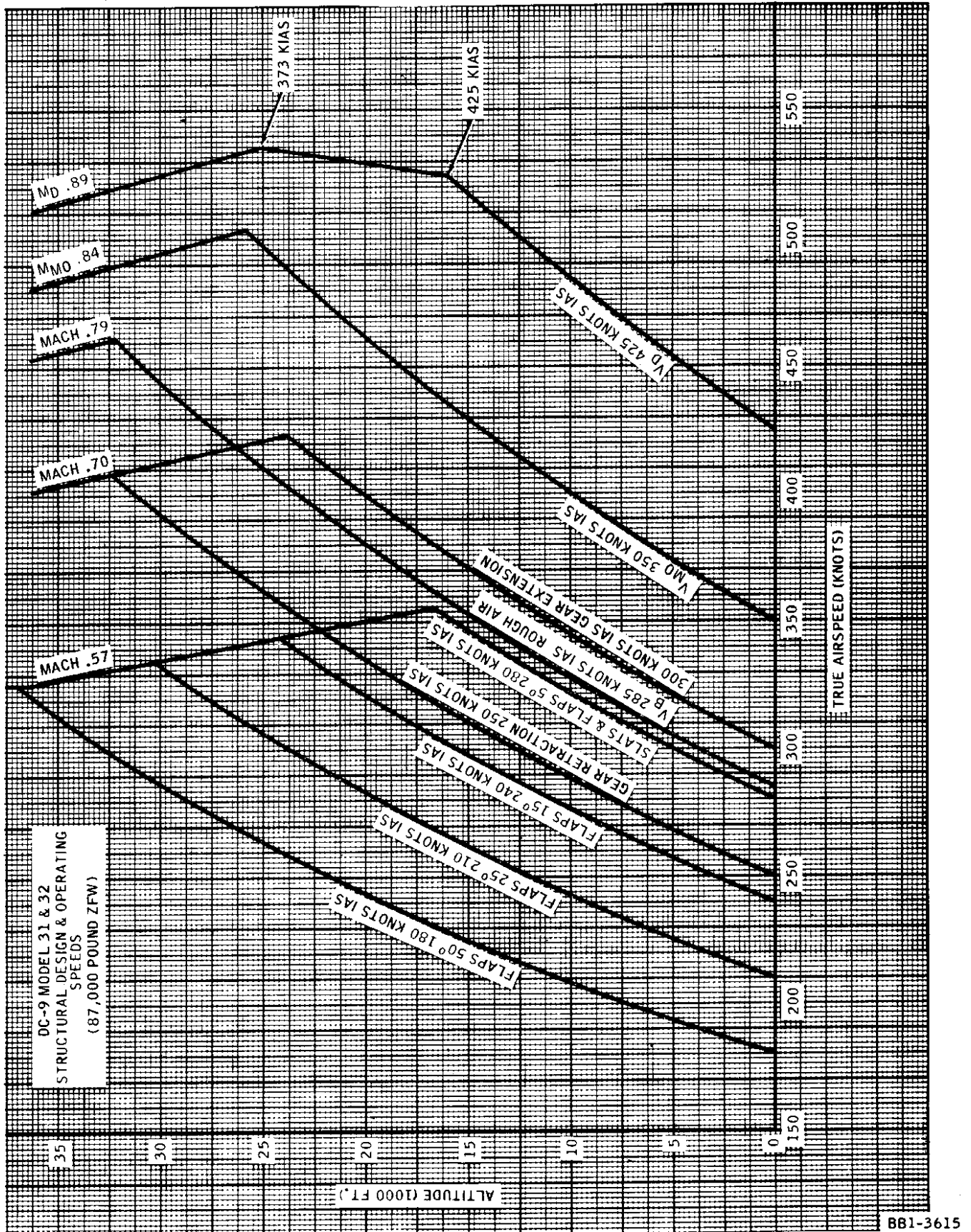
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Figure 5. Structural Design and
 Maximum Operating Speeds

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V_B - design rough air gust speed

Design landing gear extension speed

Establishment of Speeds. V_{MO}/M_{MO} speeds. The maximum operating limit speed is that speed which shall not be exceeded in climb, cruise, or descent. The selection of this design level flight speed permits unrestricted use of maximum cruise thrust capabilities of the engines at all altitudes above approximately 20,000 feet. The relationship between the operating capabilities and the structural placards are shown in Figure 5. It is apparent that, at the lower altitudes, the airplane has power to fly at airspeeds higher than placard values V_{MO} . The V_{MO} speed selected provides a speed margin above recommended climb and descent speeds.

V_D/M_D Speeds. The design dive speed is the maximum speed in which it is highly improbable that this speed will ever be inadvertently exceeded in operations. The selection of these speeds was based on an initial stabilized flight at V_{MO}/M_{MO} , the airplane then being upset, flown for 20 seconds along a flight path of 7-1/2 degrees below the initial path, and pulled up at a load factor of 1.5.

V_B Speeds. The design rough air gust speed was chosen to satisfy four conditions:

1. Provide passenger comfort in rough air

2. Reasonable time to slow down from climb, descent, or cruise speed
3. Avoid stalling of aircraft due to rough air gust intensities
4. Ability to stay out of buffet at the high gross weights and altitudes

The Barber Pole and V_{MO}/M_{MO} Speed. The relationship between the airplane's indicated airspeed and V_{MO}/M_{MO} speed is made constantly available to the pilot by the barber poles on the Mach/airspeed indicator. The maximum allowable Mach and airspeed are both indicated by a red and yellow striped barber pole (movable pointer) which will indicate a limit of Mach 0.84 or V_{MO} , whichever is the limiting factor for the existing conditions. The pilot need only be sure that the Mach/airspeed indicator hand does not go beyond the barber pole to stay at or below V_{MO}/M_{MO} .

Overspeed Warning. Overspeed warning is provided by audio and light signals which are actuated at V_{MO} according to the conditions shown in Figure 5. To ensure early warning, and thus make a major portion of the speed margin between the limit and demonstrated airplane speeds available for pilot reaction and recovery maneuvers, this overspeed warning occurs whenever the speed exceeds the maximum operating limit speed. In addition to the overspeed warning system, there is another warning in the form of airplane buffet which starts at approximately 0.84 Mach number in 1G flight.

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Speed Brakes. There is no restriction on the use of speed brakes; however, due to aerodynamic loads, full extension may not occur above 350 KIAS or Mach 0.84.

CONTROL SURFACE LIMITS

General. The speed at which full deflection or maximum use of the primary flight controls can be obtained is called the design maneuvering speed (V_A). The V_A speed is 235 knots at sea level, increasing linearly to 274 knots at 28,000 feet. Above 28,000 feet, it linearly reduces to 256 knots at 35,000 feet.

Rudder. Full deflection of the rudder should be limited to a speed not in excess of the design maneuvering speeds (V_A). The greatest (powered rudder) deflections are provided in the low-speed regime below 170 knots, for increased directional control. However, as speeds increase, the aerodynamic effect causes a diminishing requirement for larger rudder deflections. To provide structural strength sufficient to allow for larger rudder angles in the higher speed regime would then impose an unnecessary weight penalty on the airplane. For this reason the "Q" rudder limiter has been designed to restrict rudder travel as follows:

- ±22 degrees from 0 to 170 knots
- ±17 degrees from 170 to 175 knots
and modulated to 2.5 degrees at 280 knots
- 2.5 degrees above 280 knots

This schedule of restriction provides ample rudder effectiveness throughout the high speed range while preventing excessive load exposure to the vertical fin area.

Reverting to manual rudder operation will pose no structural problem as the "Q" limiter bellows will maintain the same restriction schedule. However, below 170 knots the maximum available deflection is 17.0 degrees.

Elevator. Deflection of the elevator is limited by a load factor of +2.5 G and -1 G with the flaps retracted. With the flaps extended the limits are +2.0 G and -0 G.

Aileron. The airplane is designed for maximum wheel throw at all speeds up to V_D/M_D .

LANDING LOAD FACTOR

General. Normally, the airplane should not be landed at gross weights in excess of the maximum permissible landing weight. For emergency purposes, the airplane is designed to be landed at maximum takeoff gross weight. In designing for a maximum takeoff gross weight landing, a rate of descent of 6 feet per second (360 fpm) is used. In designing for a landing at the maximum landing weight, a rate of descent of 10 feet per second (600 fpm) is used.

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MISCELLANEOUS STRUCTURAL SPEED
LIMITATIONS

Flap/Slat Speed Limitations. The maximum structural design speeds for various flap and slat extended positions are shown in Table 1.

The airplane is designed to withstand a limit load factor of 2G's in the flap extended configuration.

Landing Gear Limitations. The maximum indicated airspeed at which the landing gear may be extended is 300 knots up to 26,400 feet. Above

this altitude, a Mach number limit of 0.70 applies. These limits cannot be exceeded after the landing gear is down. Maximum landing gear retract speed is 250 KIAS. This is not a structural limit but a case of hydraulic power versus aerodynamic loads.

Landing Light Structural Limitations. The wing landing lights can be operated at all speeds up to V_{MO}/M_{MO} . If the wing landing lights are extended at speeds faster than approximately 200 knots they will cause some noticeable airplane buffet. For wing landing light and nosewheel light duty cycle, refer to Section 2, Chapter 1 - Limitations

Table 1

Position	Maximum Speed	
Slats-extended	280 KIAS	Mach 0.57
Flaps-5 degrees	280 KIAS	Mach 0.57
Flaps-15 degrees	240 KIAS	Mach 0.57
Flaps-25 degrees	210 KIAS	Mach 0.57
Flaps-50 degrees	180 KIAS	Mach 0.57

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LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL
CONCERNING: REVISION 20, SECTION 5, CHAPTER 10, DATED JUN 1/70
SUMMARY:

ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

5-10-0-0 FIGURE 6. ENGINE FAILURE AFTER PASSING V_1
ROTATION AT V_R REFERENCED TO MAINTAIN V_2 SPEED IN LIEU OF 15-16° NOSEUP.

5-10-0-0 FIGURE 8. RAPID DECOMPRESION EMERGENCY DESCENT
TEXT IN REFERENCE TO PRESSURIZATION CONTROLS REVISED SO THAT IT APPLIES TO ORIGINAL AS WELL AS MODIFIED PRESSURIZATION CONTROLS.

Remove			Insert		
Subject	Code	Page	Subject	Code	Page
5-10-Eff	66	All	5-10-Eff	66	All
5-10-0-0	31	5 and 6	5-10-0-0	31	5 and 6
5-10-0-0	31	13 and 14	5-10-0-0	31	13 and 14
5-10-0-0	31	17 and 18	5-10-0-0	31	17 and 18

Rev. No.	Rev. Date	Inserted By

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The following pages are effective for ATL Series 30 Aircraft.

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Chapter 10

PERFORMANCE AND OPERATING TECHNIQUES

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Chapter 10

PERFORMANCE AND OPERATING TECHNIQUES

TAKEOFF PERFORMANCE

Minimum Takeoff Field Length

Requirement. The minimum takeoff length required varies with gross weight, temperature, altitude, wind, and runway slope. The required runway length is the longer of the following distances. (See Figure 1.)

1. Two-Engine Takeoff Runway Length. One hundred fifteen percent of the distance from brake release to a point where a 35-foot height above the surface is reached, with both engines operating normally.

2. Accelerate Stop Distance. The distance required to accelerate to the decision speed (V_1) with both engines operating normally, experience the loss of one engine at V_1 , retard the operating engine, extend the ground spoilers, and bring the airplane to a full stop.

3. Takeoff Distance with an Engine Failure. This is the distance required to accelerate to V_1 with both engines operating normally, experience the loss of an engine, continue to accelerate on the remaining engine to V_R at which time rotation is commenced to reach a height of 35 feet above the runway at V_2 .

The takeoff field length required is dependent, among other things, upon the V_1 , V_R , and V_2 speeds. The basis and relationship of these speeds is covered in more detail later in this chapter.

In addition to takeoff runway lengths as described above, the takeoff field length required may include the use of a "clearway" or "stopway."

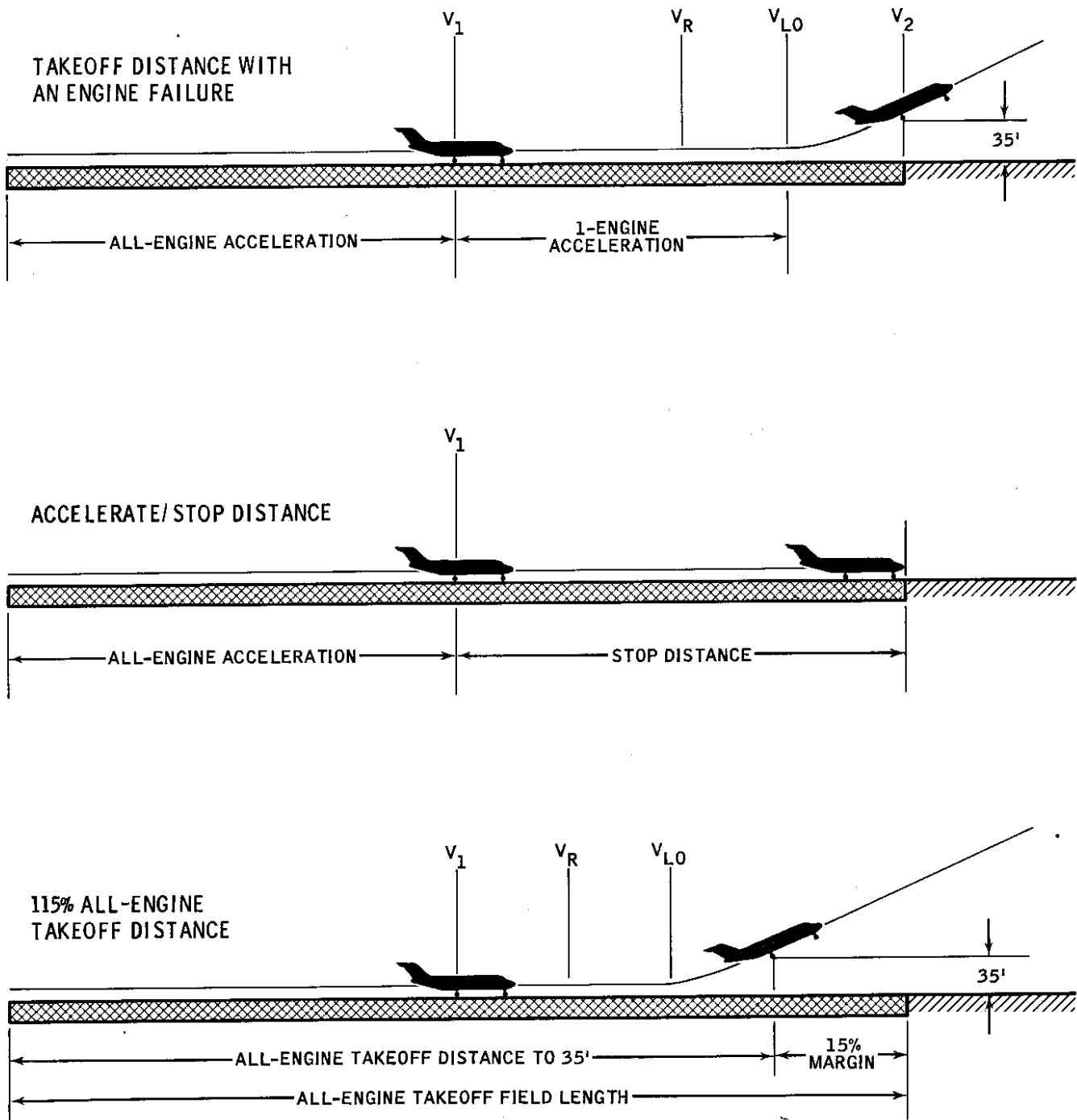
Operations at high gross weights commensurate with the increased performance capabilities of jet aircraft are enhanced by the incorporation of clearways and stopways. (See Figure 2.)

1. A "stopway" is an extension beyond the runway end which may be used to decelerate an airplane in case of an aborted takeoff. It cannot be less in width than the runway and must be constructed so that its surface is adequate to support the airplane without inducing structural damage. It is not intended for normal use.

2. A "clearway" is an area beyond the runway which is cleared of obstructions so that it provides an additional obstacle free space for climbout. It is under control of the airport. Where a clearway exists, it is considered to start at the end of the runway irrespective of whether a stopway is incorporated or not. It must be at least 500 feet wide with an upslope of not more than 1.25 percent. There can be no protrusions into the sterile area except the threshold lights, and then only if they are not more than 26 inches in height and are to the side of the runway line.

Minimum Control Speed - Air. The DC-9 minimum control speed during takeoff and in flight is sufficiently low to have negligible effect on takeoff

MINIMUM REQUIRED TAKEOFF RUNWAY LENGTH WITHOUT THE USE OF A STOPWAY OR CLEARWAY



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MINIMUM REQUIRED TAKEOFF RUNWAY LENGTH UTILIZING CLEARWAY AND/OR STOPWAY

NOTE: The two-engine takeoff distance times 1.15 must not be greater than the runway if there is only stopway. With two engines operating, the maximum usable clearway is 1.15 times half the distance from liftoff to 35 feet.

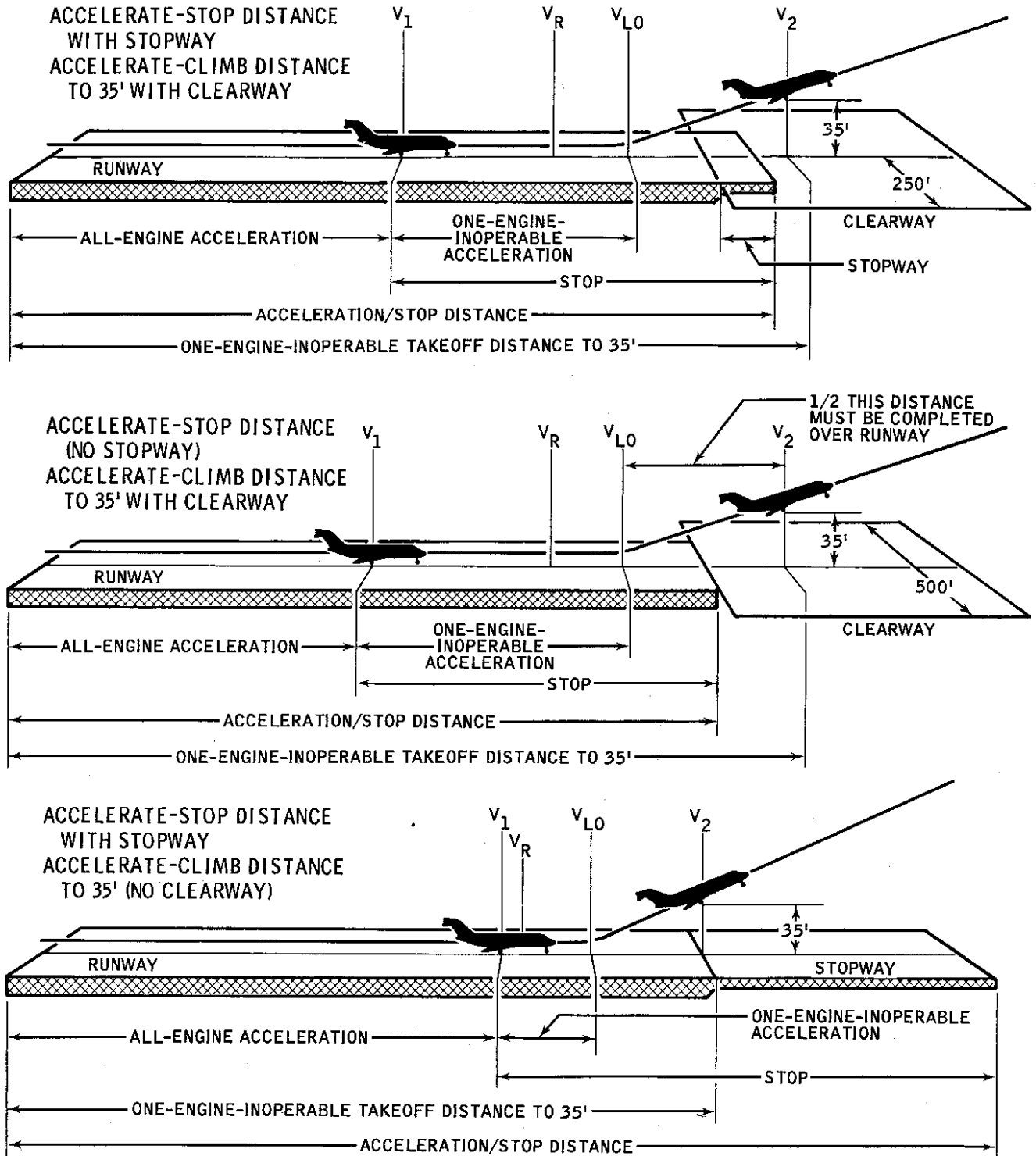


Figure 2. Minimum Required Runway Length Utilizing Clearway and/or Stopway

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directional control. The aft-mounted engines located on the fuselage eliminate this problem; therefore, it does not appear in the DC-9 takeoff performance data.

Takeoff Decision Speed (V_1). V_1 is the decision speed. At this point the pilot must decide whether to continue the takeoff or to abort.

The speeds given in the FAA Approved Airplane Flight Manual have been selected so that (1) if engine failure is recognized at or above the V_1 speed, the takeoff may be continued on one engine; or (2) a stop may be initiated at, or prior to, V_1 and completed within the distance specified in the FAA requirement for takeoff field length. The stopping distance is based on retarding the throttles to idle at the time of recognizing a requirement to abort, maximum braking on a dry runway, antiskid operative (unless otherwise noted), and with full spoiler extension initiated after the throttles are moved to idle. The effect of reverse thrust is not included in the computation.

Minimum Unstick Speed (V_{MU}). The minimum unstick speed is the minimum speed that the aircraft can be made to lift off the ground, without demonstrating hazardous characteristics, and continue the takeoff. The V_{MU} speed airplane is limited by tail clearance. This speed is established with all engines operating and with one engine inoperative.

Rotation Speed (V_R). Rotation speed is that speed at which the pilot begins to rotate the airplane to the liftoff attitude. The rate of rotation can vary, but it should normally take approximately 2.5 seconds.

Rotation at the maximum practical rate will result in a minimum liftoff speed (V_{LO}). Rotation at the normal

rate will result in attaining the V_2 speed at, or below, 35 feet with one engine inoperative or exceeding the V_2 speed at 35 feet with both engines operating. The criteria used in establishing the rotation speed are as follows:

1. A speed which cannot be less than 5 percent above the minimum control speed in the air (V_{MC-air}). (Not a DC-9 consideration.)
2. A speed which permits the attainment of V_2 prior to reaching 35 feet.
3. A speed which will result in at least the minimum required liftoff speed.
4. A speed which will not result in increasing the takeoff distance if rotation is commenced 5 knots lower than the established V_R during one-engine-inoperative acceleration or 10 knots lower than the established V_R during all engine acceleration.

Liftoff Speed (V_{LO}). The liftoff speed is the speed at which the airplane becomes airborne. If the airplane is rotated at maximum rate, the minimum liftoff speed must be at least 5 percent above the one-engine-inoperative minimum unstick speed ($V_{MU-one-engine-inoperative}$) and 10 percent above the all engine minimum unstick speed ($V_{MU-all-engines}$).

Takeoff Safety Speed (V_2). The takeoff safety speed is the speed at 35 feet, or a speed which is at least 20 percent above the stall speed, whichever is greater. It cannot, however, be less than 10 percent above the minimum control speed in the air ($V_{MC air}$). The correct V_2 is a result of proper rotation and liftoff procedures and it allows the airplane to maintain a specified gradient in the climbout flight path.

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Considerations in Performance Chart Construction. To obtain the basic flight test data for the published performance, flight procedures were used that could be adopted by airline pilots and enable them to obtain similar performance. Some of the factors which were used in the tests and construction of the charts are as follows:

1. Time delays were considered for the average reaction time which can be expected in airline operations.
2. Reverse thrust was not used to establish the ground-stopping distances.
3. Full altitude and temperature effects on performance were taken into account where applicable.
4. Performance charts were constructed using only 50 percent of reported headwinds and 150 percent of reported tailwinds measured at a height of 50 feet.
5. Performance is predicated on a smooth, dry, hard-surface runway.

Miscellaneous Performance Information. Percentages above the stall speed as referenced in this manual are based upon calibrated airspeed (some charts will show IAS, thus assuming zero installation and instrument error). At low speeds, sea level and standard condition CAS and EAS are the same.

Takeoff performance data is computed considering engine failure at the most critical time (V_1). Failure either before or after V_1 provides a further margin of safety if proper procedures and techniques are employed for stopping or continuing.

Engine Thrust. The engines are approved for continuous operation at

takeoff thrust for 5 minutes. The takeoff flight path data (with one engine inoperative) is based on the full 5 minutes of takeoff thrust. If the takeoff thrust rating is reduced due to the use of airplane deicing or engine anti-icing, a reduction from the normal airplane performance must be taken into account.

TAKEOFF FLIGHT PATH PERFORMANCE

General. The takeoff flight path is considered to begin when the airplane reaches a height of 35 feet above the surface and continues to a point where 1500 feet above the surface is reached, or to the point where the enroute climb speed of $1.38 V_S$ is reached, whichever point is higher. Figure 3 shows the performance requirements and the profile for the various takeoff flight path configurations. The DC-9 must meet the required climb gradient performance with one engine inoperative at all approved operating gross weights, temperatures, and altitude conditions. (The FAA climb segment gradients required for two-engine turbine-powered airplanes are: (1) for the first segment, a positive rate of climb; (2) for the second segment, a climb gradient of not less than 2.4 percent; (3) for the transition segment, a climb gradient of not less than 1.2 percent.)

Gradient Requirement. The gradient method of calculating climb performance during the various flight path segments is basically a percentage of the horizontal distance traveled with zero wind. For example, if a 2.4 percent climb gradient is required, for every 1000 feet that the airplane travels horizontally it must climb 24 feet. Figure 4 shows climb gradient versus IAS for both engines operating normally and for one engine

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inoperative with various configurations established.

Takeoff Obstacle Clearance. Capability to meet the three takeoff climb segments is required assuming an engine failure at V_1 . In that condition, FAA regulations require that the airplane weight allow a net takeoff flight path that clears all obstacles either by a height of at least 35 feet vertically, or by at least 200 feet horizontally within the airport boundaries and by at least 300 feet horizontally after passing the boundaries. All obstacles must be cleared by specified amount until airplane reaches final segment climb speed or 1500 feet above the airport elevation, whichever is greater.

The airplane cannot be banked before reaching 50 feet, and thereafter the maximum bank angle is 15 degrees. The obstacle clearance requirement is an expanding type which requires that the net flight path must clear all obstacles by 35 feet. The net path is determined by reducing the zero wind gradients by 0.8 percent and then correcting for wind. With zero wind, this gives an expanding clearance equal to 0.8 percent of the distance from the end of the required takeoff field length. Figure 3 shows this as net flight path, which is 0.8 percent below actual flight path to any given point.

Since local obstacle clearance is dependent upon the height of the obstacles and distance from the end of the runway, each airline must make its own flight path profile analysis for the airports from which it operates. To obtain the clearance required for one-engine-out operation, the takeoff flight path must be flown at V_2 . With both engines operating, the climbout gradient at a pitch attitude of 15 to 16 degrees is approximately five times

greater than the one-engine-out gradient flown at V_2 . This climb capability assures obstacle clearance with both engines operating, provided the thrust available for climb is not used excessively for acceleration, thereby inadvertently failing to achieve the flight path that provides obstacle clearance. The maximum pitch attitude during climbout should not exceed 16 degrees.

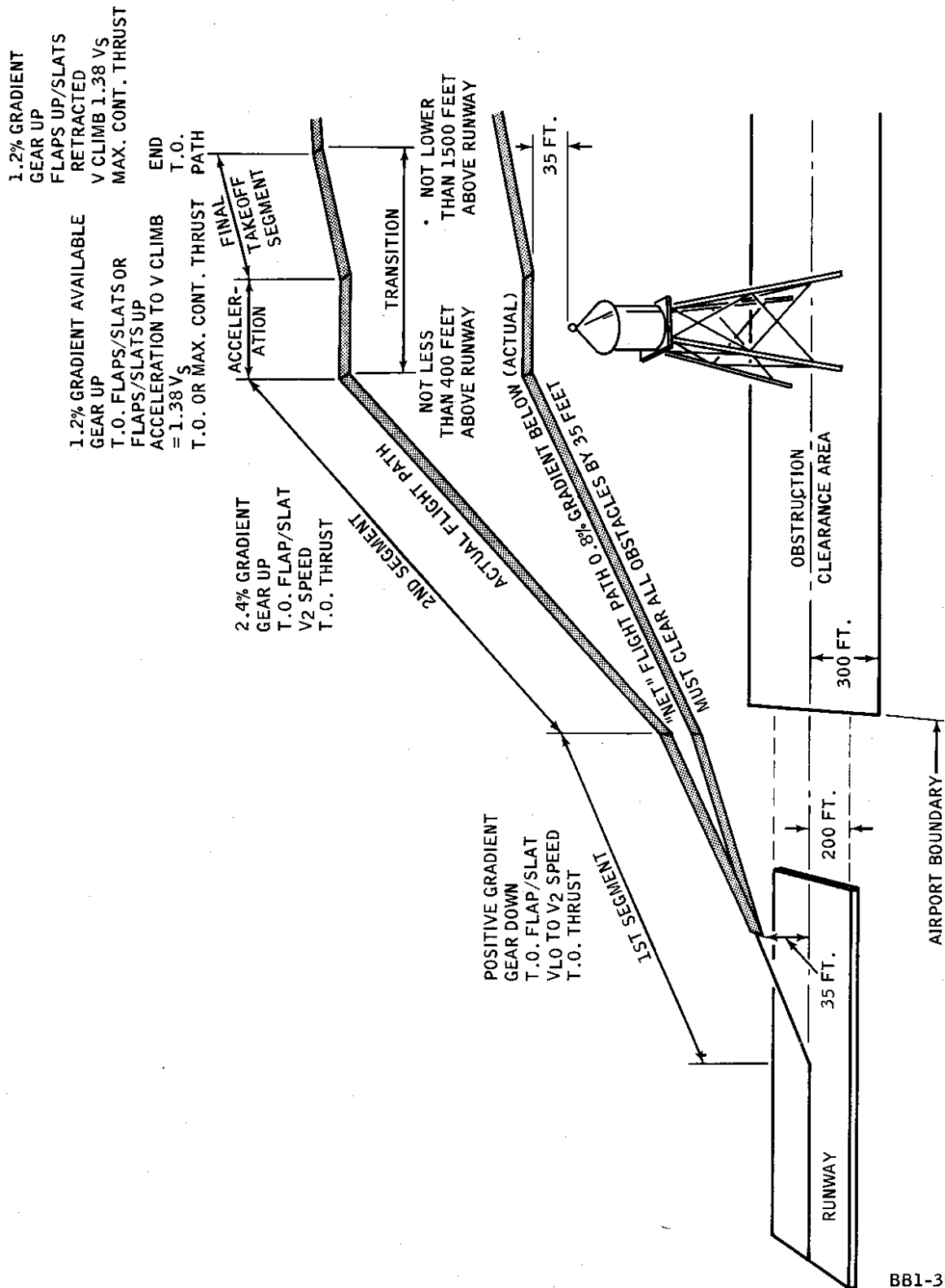
Takeoff Climb - First Segment. This is the climb segment just after lift off and continued until the landing gear is retracted. The speed will vary from V_{L0} to V_2 at 35 feet. The allowable gradient shall be positive at all points. The DC-9 is never limited in this segment.

Takeoff Climb - Second Segment. This segment starts at the time the landing gear is fully retracted and continues until the airplane reaches an altitude of at least 400 feet above the runway. It is flown at V_2 speed and must have a gradient of at least 2.4 percent.

Takeoff Climb - Transition Segment. The takeoff flight path profile will vary during the transition segment depending upon obstacle location and height. If obstacle clearance requirements warrant, the climb to 1500 feet could be made in the second segment configuration. As shown in Figure 3, the transition segment may start at 400 feet.

As the flaps retract followed by the slats and the airplane accelerates, the IAS should never be less than 120 percent of the stall speed. The available gradient must be at least 1.2 percent with the flaps at the takeoff setting or retracted, and with the thrust at takeoff or maximum continuous. When the airplane reaches the final takeoff flight path point at 1500 feet, it must have a climb

DC-9 SERIES 30 -- TAKEOFF FLIGHT PATH PROFILE

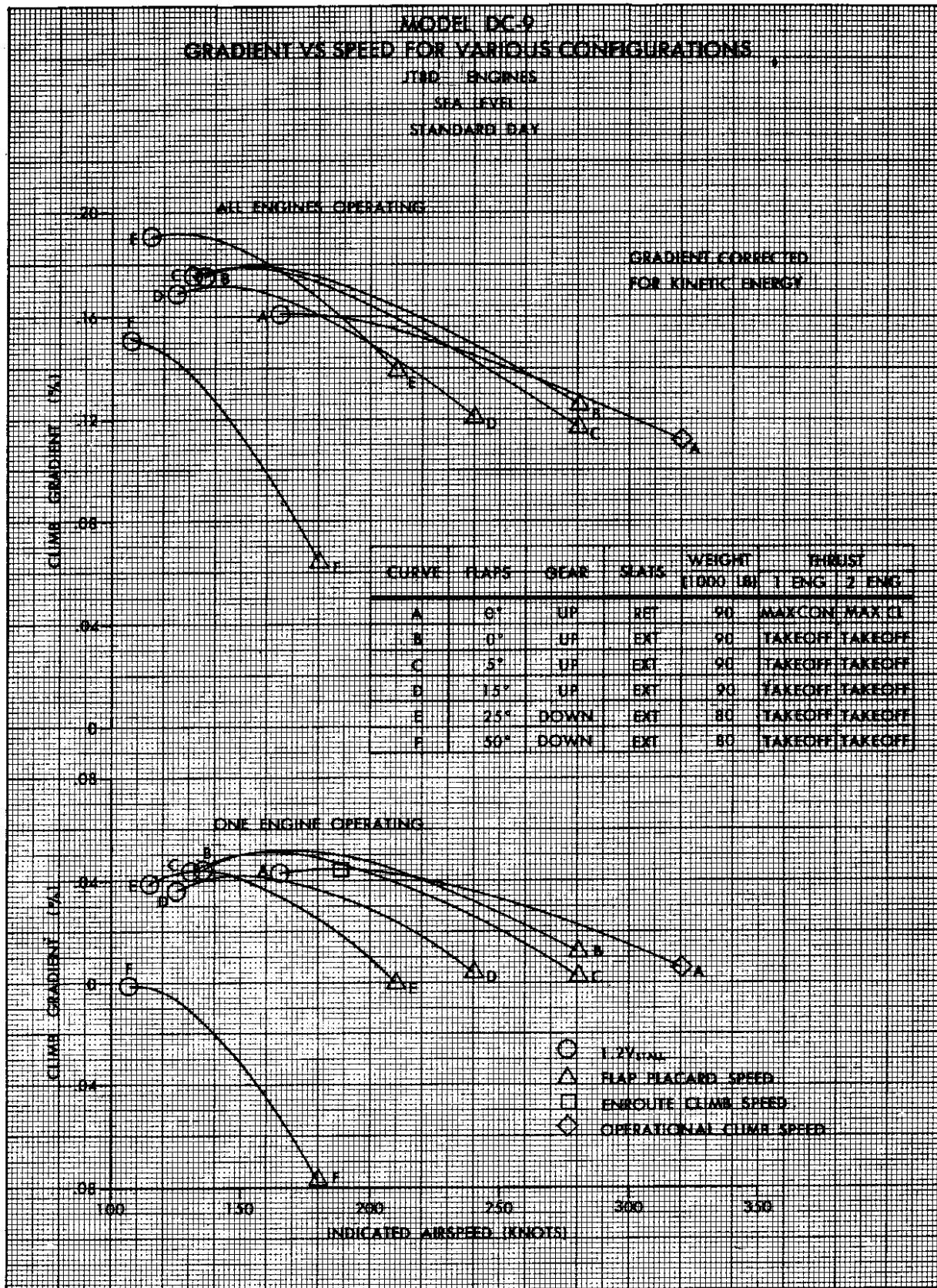


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Figure 3. Takeoff Flight Path Profile

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gradient of 1.2 percent while using maximum continuous thrust, with the gear up, slats retracted, and a speed of at least 38 percent above the stall speed.

Normal Two Engine Takeoff. (See Figure 5.) If the takeoff weight has been limited by obstacles in the takeoff flight path, climbing out at a pitch angle of 16 degrees, after an all engine takeoff, will assure obstacle clearance as long as takeoff flaps, slats, and power are maintained. Distance obstacles must be considered in transitioning to enroute climb speeds configuration and thrust settings.

TAKEOFF PROCEDURES & TECHNIQUES

Normal Takeoff with Both Engines Operating. (See Figure 5.) The entire length of the runway should always be available for use, especially if the precalculated takeoff performance shows the airplane to be runway length or obstacle limited. After taxiing into takeoff position at the end of the runway, the airplane is aligned with the runway centerline. The pilot should advance the throttles to approximately 70 or 80 percent N_2 and allow both engines to stabilize. The throttles can then be advanced to takeoff EPR. The engine instruments should be checked for proper operation. On a rolling takeoff, the T/O thrust is set prior to reaching 60 knots. No further EPR adjustment should be necessary until the desired climb speed is reached unless the engine operating limits are exceeded. If the pilot desires, he may set takeoff thrust prior to brake release. If this procedure is used, brake release should be accomplished smoothly for passenger considerations. At the same time, care must be taken to avoid dragging brakes at light operating weights.

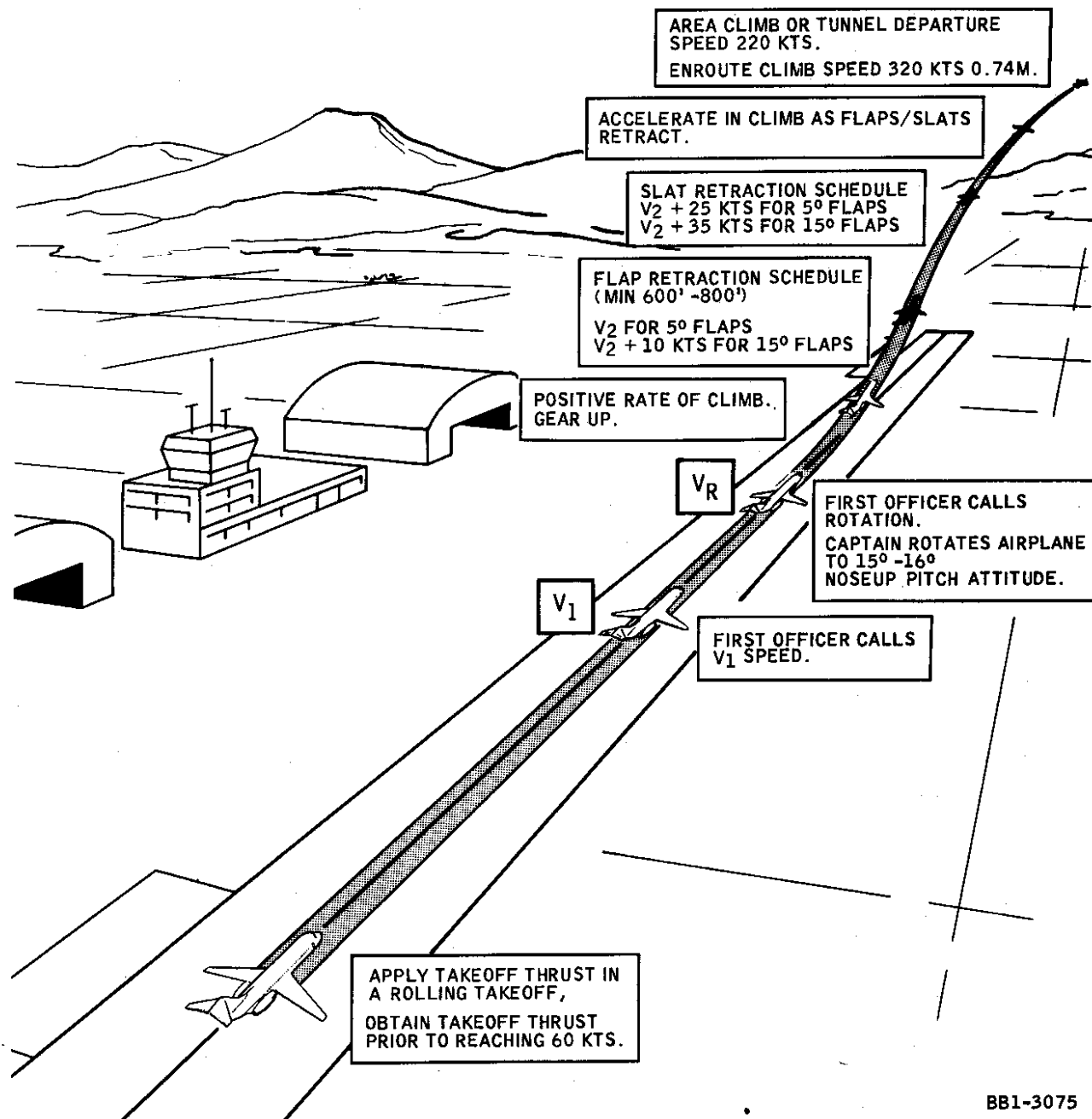
A slight push force on the control column may be required to keep the nosewheel rolling firmly on the runway. Rudder pedal steering is available, and the pilot need not use the nose gear steering wheel to maintain directional control and runway alignment.

The left hand should be on the control wheel and the right hand should be on the throttles until reaching V_1 . The airplane will stay level under normal conditions; however, the pilot must be alert to use lateral control if necessary. The duties of the co-pilot during the takeoff should be to monitor the instruments and to observe the general airplane condition and performance. The co-pilot should call out the V_1 and V_R speeds.

After passing V_1 speed on the takeoff roll it is not necessary for the pilot to keep his right hand on the throttles. Both hands can be placed on the control wheel. At V_R approximately 15 to 20 pounds of pull force will be required to start the rotation to liftoff attitude. Liftoff attitude varies with flap settings. The pitch attitude, therefore, varies from approximately 7 to 9 degrees. Proper rotation technique consists of a smooth rotation to liftoff attitude requiring 2 to 3 seconds. The rotation should be continued until reaching a pitch attitude of 15 to 16 degrees requiring another 2 to 3 seconds. Proper techniques will result in a smooth rotation with clean liftoff. At 35 feet above the surface, the speed will always be above V_2 when climbing out at a pitch attitude of 15 to 16 degrees, the airspeed will stabilize substantially above V_2 dependent upon gross weight, temperature, and altitude. Assumption of correct rotation attitude is necessary to achieve planned performance. If the nose is not rotated high enough, the ground roll will be increased.

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DC-9 SERIES 30 -- NORMAL TAKEOFF



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Figure 5. Normal Takeoff

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Conversely, a pitch attitude in excess of 15-16 degrees should not be established in consideration of passenger comfort. Landing gear retraction is initiated upon establishing a definite rate of climb.

Prior to takeoff, the stabilizer trim is set according to C.G. position (% MAC). This provides zero control force at a speed of 1.35 V_S . Because of this, a diminishing back pressure will be experienced from rotation until attaining the initial trim speed. The climb attitude (maximum 16 degrees) should be held and the airplane allowed to accelerate to flap and slat retract speeds. Ground effect and gear drag reduction results in rapid acceleration to the desired speed during this phase of the takeoff flight path.

Obstacle Clearance. Technique and procedure for obstacle clearance differs only in that the second segment climb configuration must be maintained until obstacle clearance is achieved. Again, distant obstacles must be considered in transitioning to enroute climb speeds, configuration and thrust settings.

Aborted Takeoff. The takeoff may be safely aborted up to V_1 speed. The recommended procedure is as follows:

1. Throttles - Retard to idle.
2. Spoilers - Fully extend manually. (Pull spoiler handle up, aft, and up.)
3. Brakes - Use maximum if required or as desired if abort is early in takeoff roll.
4. Reverse Thrust - Apply reverse thrust as required within limits of directional control and runway conditions. Up to takeoff EPR is permissible if conditions warrant.

If an engine fails rapidly, as during a flameout, a slight yawing of the airplane occurs. Directional control can be maintained with rudder pedal steering. The yawing and banking tendencies of the airplane due to using asymmetrical reverse thrust is almost insignificant, and the pilot should have no trouble maintaining directional control with the rudder pedal steering and lateral control with the ailerons. It is desirable to apply forward pressure on the control column to provide maximum nosewheel steering effectiveness.

Full spoiler deployment and reverse thrust will impose an increased weight on the tires and make available a high degree of braking efficiency. This increase will be attended by excessive heat in the brakes, tires, and wheels. An adequate cooling period must be provided before attempting another takeoff.

Crosswind Takeoff. The crosswind takeoff characteristics of the DC-9 are typical of most sweptwing transports, and the technique required for this kind of takeoff is not much different than that used during the normal takeoff. The upwind wing will have a tendency to rise soon after brake release and aileron deflection must be applied in the direction of the crosswind to maintain wings level. This deflection will not materially affect the takeoff performance. Directional control is maintained as during a normal takeoff by use of rudder pedal steering, with the rudder becoming aerodynamically effective at approximately 50 knots. As the speed increases, the aileron deflection requirement will decrease but it will never diminish to zero throughout the ground roll. The primary objective is to KEEP THE WINGS LEVEL.

Takeoff On An Icy Runway. If icing conditions exist or are anticipated

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during the use of the takeoff power, the engine anti-ice should be turned on prior to takeoff-power application. The actual takeoff technique may vary from the normal takeoff in that the pilot might elect to override the rudder pedal nosewheel steering by holding the steering wheel in the center position. This is especially true under crosswind conditions.

Engine Failure After V_1 . If engine failure occurs after the decision speed has been reached, the takeoff must be continued. The airplane will yaw toward the failed engine. One-third to one-half rudder pedal deflection will provide directional control. As the speed increases, less deflection will be required.

Rotation at V_R should be done in the same manner as during a normal all-engine takeoff. (See Figure 6.)

One-Engine-Inoperative Takeoff. At liftoff, due to the asymmetric thrust condition, the rudder and aileron displacement must be employed with discretion to avoid unnecessary rolling and yawing motions. Additional rudder pedal deflection will be required to maintain heading at liftoff in the event of the loss of an engine. During climbout, the aileron and rudder force requirements to offset the asymmetric thrust condition are very light and need not be trimmed out immediately.

The gear retraction should be initiated when a definite rate of climb has been established. Acceleration with one-engine-inoperative is such that obtaining V_2 prior to 35 feet is not difficult with the proper liftoff attitude. Pitch attitude to maintain V_2 will require 15-16 degrees; however, airspeed is the primary consideration.

Takeoff thrust should be used until

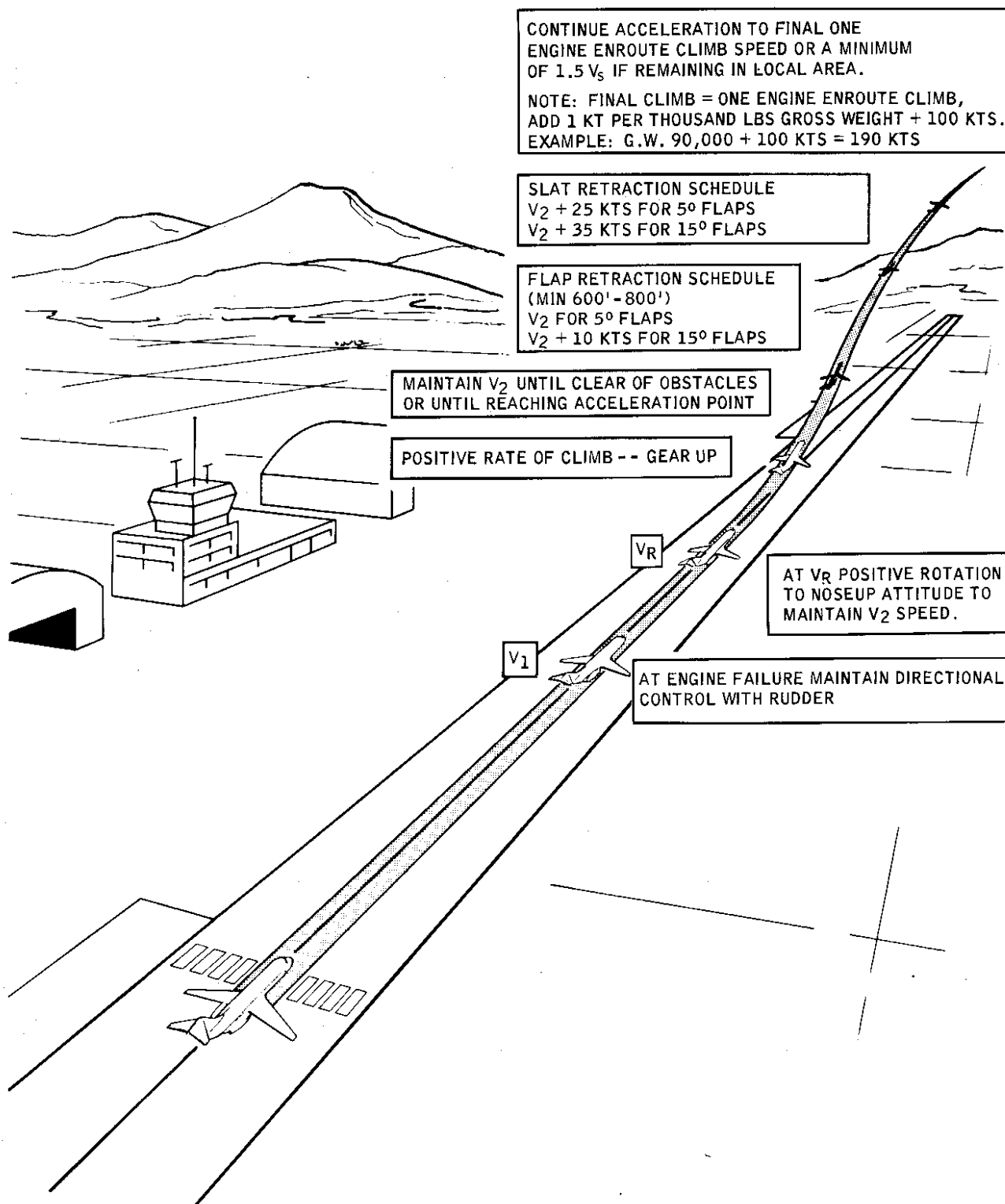
reaching the final segment climb speed or until reaching the takeoff-power time limitation of 5 minutes. Maintain takeoff speed and takeoff flap and slats until obstacle clearance is assured. If the obstacle is relatively far out it may be desirable to initiate flap and slat retraction as soon as possible following the normal clean up schedule.

Takeoff and Landing in Dry Snow, Slush, or Standing Water. Past airline operations have revealed that the effect of standing water, slush and snow on takeoff and landing performance must be considered. Ground roll is extended, and also a possibility of damage due to flying slush exists. The condition of the runway should be determined as near departure time as possible. A representative measurement can be determined by checking at a number of places along the length of the runway. Particular attention should be given to the high speed section of the takeoff roll.

1. Takeoffs in Standing Water, Slush, or Wet Snow. Estimated two-engine takeoff field length in slush or water up to 1/2-inch in depth may be obtained by use of Figure 7. The dashed line should be used for standing water and the solid line for slush or wet snow. An engine failure has not been considered. Takeoffs should not be attempted when standing water, slush, or wet snow greater than 1/2-inch in depth covers an appreciable part of the runway.

2. Takeoffs in Dry Snow. Dry snow in this context is defined as snow that cannot be readily formed into a snow ball. For depths of less than 4 inches, no correction is required. In 4 to 6 inches read Figure 7 for 1/2-inch of slush. Takeoffs should not be attempted in depths greater than 6 inches.

DC-9 SERIES 30 -- ENGINE FAILURE AFTER PASSING V_1



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Figure 6. Engine Failure After Passing V_1

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MODEL DC-9 SERIES 10, 20, 30, AND 40
 ESTIMATED TWO ENGINE TAKEOFF FIELD LENGTH IN SLUSH OR WATER*
 *ENGINE FAILURE HAS NOT BEEN CONSIDERED
 TWO ENGINE TAKEOFF FIELD LENGTH INCLUDES 15% FAA FACTOR

SAMPLE PROBLEM

TEMPERATURE = -10°C TO 10°C
 ALTITUDE = 0 TO 8000 FT.
 SLOPE = -.02 TO .017
 SLUSH DENSITY = 1.585 SL/FT³
 WATER DENSITY = 1.940 SL/FT³

-10 KNOT TAILWIND 1/2 INCH OF WATER ON RUNWAY
 AVAILABLE FIELD LENGTH=8300 FT.
 EQUIVALENT FIELD LENGTH=6400 FT.
 ENTER APPROPRIATE CHART IN FAA MANUAL AT 6400 FT. TO
 DETERMINE MAXIMUM TAKEOFF WEIGHT.

THESE DISTANCES ARE FOR
 DOUGLAS RECOMMENDED
 TIRE PRESSURES. HIGHER
 PRESSURES REQUIRE
 GREATER FIELD LENGTHS.

—— SLUSH
 --- WATER

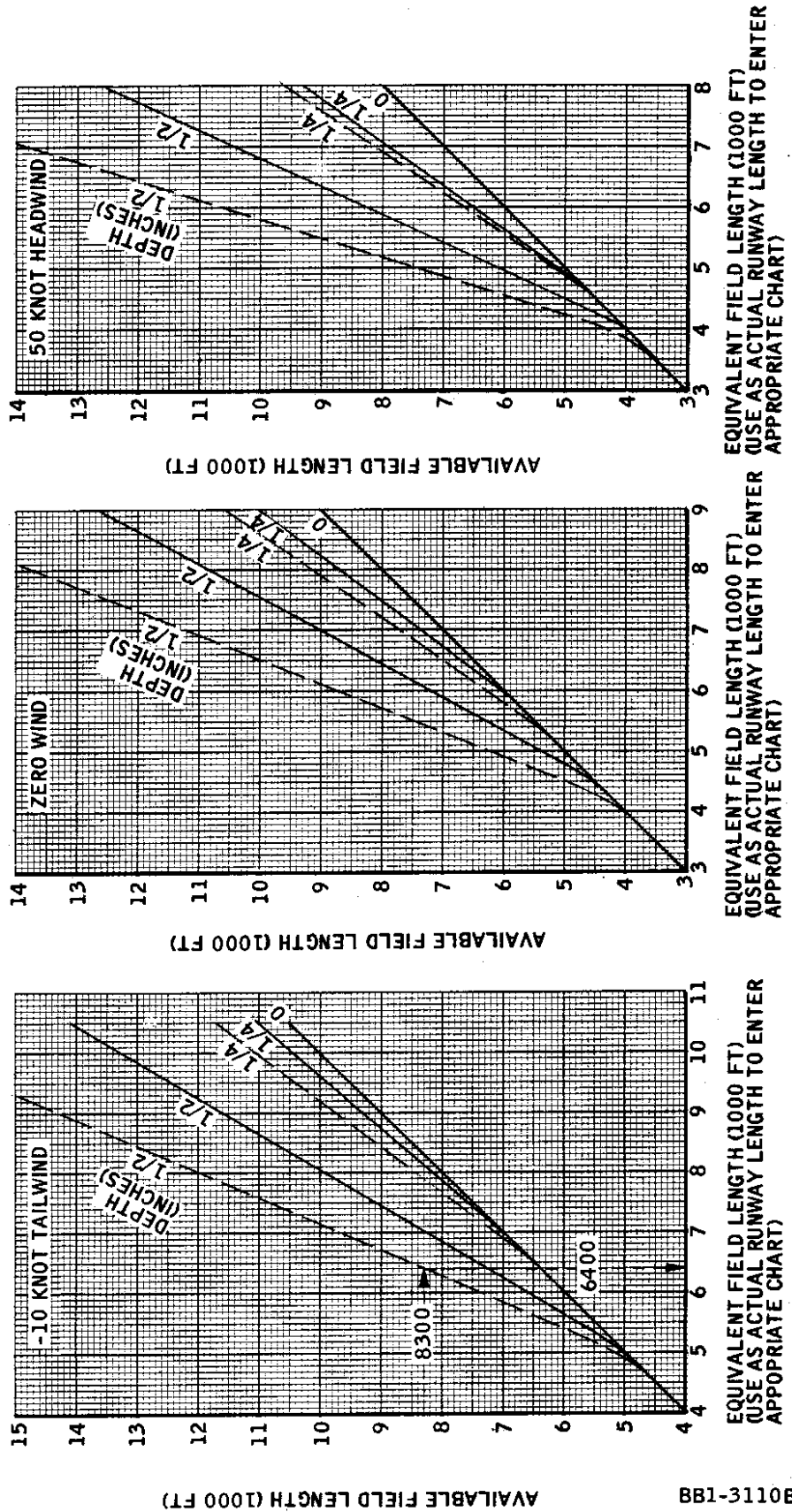


Figure 7. Takeoff in Standing Water, Slush, or Wet Snow

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3. Landings. Landings may be made in wet snow, slush, or standing water up to a maximum depth of 1 inch.

ENROUTE CLIMB PERFORMANCE

Two-Engine Operational Climb. The two-engine climb speed is 320 knots IAS for all temperatures. Above an altitude of approximately 25,850 the airplane should be climbed at a constant Mach number of 0.74 to cruising altitude. As altitude increases a constant Mach indication will result in a decreasing IAS. The enroute climb speed schedule provides the highest practical true airspeed. If rough air is encountered, the climb should be made at V_B speed (285 knots/0.79 Mach).

One-Engine Inoperative Enroute Climb. Final segment and one engine enroute climb speeds are the same. This speed represents 1.38 V_S zero degree flap/slat retracted configuration and equals approximately 100 knots plus 1 knot for each 1000 pounds gross weight. This speed provides the best combination of climb gradient and highest limiting gross weights at all temperatures and altitudes.

ENROUTE CLIMB TECHNIQUE

Subsequent to obstacle clearance, a positive rate of climb should be maintained while accelerating as soon as possible to the enroute climb speed of 320 KIAS (100 KIAS plus 1 knot for each 1000 pounds of gross weight with one engine inoperative).

Acceleration on only one engine may require a level attitude. The airplane should be trimmed about all axes and the enroute climb speed adhered to

as closely as possible. Small changes in pitch attitude will result in rapid speed changes while using climb thrust. If the airplane is leveled off for any reason throughout the climb, the thrust should be monitored so as not to exceed V_{MO} or M_{MO} . To resume climb, the applicable climb thrust setting should be restored when the enroute climb speed is reestablished. As long as the temperature lapse rate remains normal with altitude increase, the climb thrust setting will remain reasonably stable at a constant throttle position. The thrust schedule should be checked at each 5000 feet to ensure the correct setting.

Maneuvering should be held to a minimum. Bank angles of over 30 degrees may cause passenger discomfort due to the load factor.

During level-off at cruising altitude, the climb thrust should be held until reaching cruise speed, thereby attaining the fastest acceleration to the desired speed. As the Mach number increases, the RAT will also increase. It is essential that cruise thrust is set after attaining cruise speed to ensure accurate thrust settings.

CRUISE CHARACTERISTICS

General. The operation of the DC-9 in a cruise configuration is somewhat unique when compared to previous jet services provided by commercial airlines. The very term "jet service" in the past has been synonymous with long range. The purpose of the DC-9 is to offer the passenger the obvious benefits of jet flight for short and medium trips as well. Its versatility enables profitable commercial operations ranging from 50 to 1500 miles. On the shorter trips a cruise regime

is virtually nonexistent. The profile could, and will in some cases, consist of takeoff, climb, descent, and landing. However, in this chapter, performance of the DC-9 in cruise configuration at operating altitudes will be discussed.

Basically, two cruise procedures are available. They are (1) high speed cruise 350 IAS or 0.80 constant Mach number, and (2) long range cruise varying Mach number in relation to gross weight and altitude. Each of the two procedures has advantages either in block time or fuel used. Individual airlines will, of course, determine the procedure most suited to their routes and operations.

Fuel Flow, Miles Per Pound, and Range Constant. The fuel flow of turbojet engines cannot be easily generalized. Fuel flow is a function of temperature, EPR, altitude, and Mach number. The nautical miles per pound of fuel, however, is a function of weight, altitude, and speed, and is essentially independent of temperature. The speed of sound increases with an increase in temperature. The specific fuel consumption (SFC) for given values of thrust, altitude, and Mach number increases with temperature at approximately the same rate as the speed of sound. Therefore, the miles per pound of fuel is independent of temperature and the range constant equals the miles per pound of fuel times the weight. The greater the range constant, the more efficient the cruise procedure.

Adherence to optimum altitudes is essential to achieve the ultimate in high speed and efficiency. A compromise must be made at lower than optimum altitude by reducing speed for the sake of economy or sacrificing fuel in favor of faster block times.

CRUISE CONTROL PROCEDURES

It is anticipated that the DC-9 will normally fly at high speed cruise, since this provides the minimum direct operating cost based on ATA standards. When utilizing high speed cruise, the optimum altitude is 30,000 feet for all ranges greater than 265 nautical miles.

If cruise is made at an altitude less than optimum, the penalty will be increased fuel consumption. Higher altitudes may be desired for exceptionally long flights or in consideration of wind. From an Air Traffic Control practical standpoint altitude selection for short distances may be determined by multiplying the distance times 100. For example:

$$150 \text{ Miles} \times 100 = 15,000' \text{ Altitude}$$

As the name implies, long range cruise is used when fuel economy becomes the prime consideration. The long range speed is defined as the greater of the two speeds at which 1 percent in range is sacrificed (99 percent of maximum nautical miles/pound of fuel), and will vary with the gross weight and flight altitude.

An error in establishing the thrust setting EPR or Mach number can result in a large speed or power discrepancy and could possibly yield an unstable flight condition. After determining the airplane's gross weight, the pilot should refer to the appropriate performance chart for the desired speed schedule and EPR required.

HOLDING PROCEDURES AND TECHNIQUES

Holding is normally done in the clean configuration (zero degree flaps/slats

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retracted) at an airspeed of 1.53 Vs. This may be easily computed by taking 120 knots and adding 1 knot for each 1000 pounds gross weight. The holding speeds are a compromise considering speed stability, safe margin above stall, and fuel economy. The pilot must exercise good judgment in the determination of holding speed and configuration to be used. If conservation of fuel is critical, holding should be done in the clean configuration (less drag, less thrust) and at the highest practical altitude. If pattern size or lower holding speed is the primary concern then the slats should be extended and the airspeed reduced by 25 knots.

DESCENT

A proper descent procedure requires planning to arrive at desired maneuvering speed and configuration before the final instrument approach fix or down wind in the case of a VFR approach. This is accomplished by estimating the time to the final fix, usually the outer marker, and establishing a rate of descent that will assure the proper altitude before reaching the fix. During the descent the rate is adjusted as necessary. 0.80 Mach/320 KIAS is considered the normal high speed descent, a long range descent is accomplished at 250 KIAS. If a high speed descent is made the FAA requirement for slowing to 250 KIAS at below 10,000 feet must be considered. The descent should be planned without anticipating the use of speed brakes. They would be used when excessive altitude or airspeed must be lost.

In estimating the distance covered in a descent, as a general rule, it can be assumed that from high altitudes, say 20,000 feet and over, an average of 7 to 8 miles per minute will be

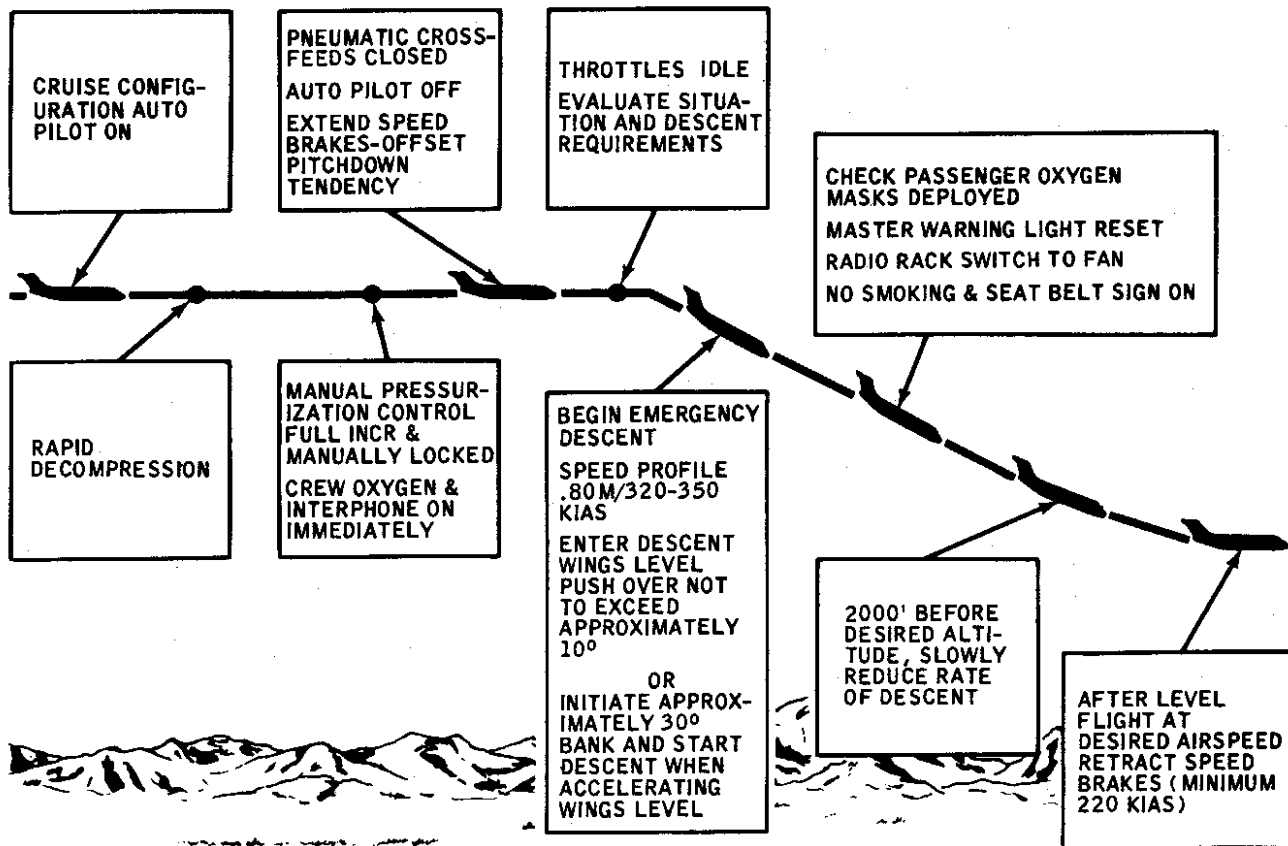
covered during a high speed descent as compared to 5 or 6 miles when descending at a long range descent speed of 250 knots. From lower altitudes, 20,000 and below, a general rule can be used of starting a high speed descent at a distance of 4 miles for every 1000 feet of altitude. For example, if cruising at 15,000 feet, an optimum descent would be started at 60 miles. This would mean the airplane should be descended at about 2000 feet per minute at high speed initially, slowing to 250 below 10,000 feet.

RAPID DECOMPRESSION EMERGENCY DESCENT

For the recommended procedure in the event of rapid decompression see Figure 8. Prompt and positive reaction is essential to an emergency of this type; however, the few times that it has occurred in airline operation proved that "hurried" response is not necessary and can in some instances create confusion. If rapid loss of pressure is experienced the following sequence of action is recommended:

1. Pressurization control to full INCR and manually locked.
2. Crew on oxygen and interphone immediately.
3. Pneumatic crossfeeds closed.
4. Autopilot - OFF.
5. Extend speedbrakes.
6. Throttles to idle. Evaluate descent requirements.
7. Nose straight over smoothly. Maximum pitchdown attitude of 10 degrees. Target speed 0.80 M/350 KIAS.

RAPID DECOMPRESSION EMERGENCY DESCENT



NOTE:

The speed profile is based upon loss of pressurization with no loss in structural integrity and assumes smooth air conditions. Known failures that affect structural integrity and/or turbulence might dictate other speed profiles and entry maneuvers.

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8. Check passenger oxygen masks deployed, No Smoking and Seat Belt sign on. Reset Master Warning and place Radio Rack switch at FAN position.

9. 2000 feet above desired altitude gradually reduce rate of descent.

10. When at desired altitude and speed, retract speed brakes.

LANDING APPROACH TECHNIQUE

Both Engines Operating. Proper entry into the landing pattern is the key to attaining the correct speeds throughout the approach since acceleration and deceleration are closely correlated with drag and thrust. Maneuvering speed and thrust setting should be stabilized early in the approach. The approach pattern for the DC-9 will normally be a little larger than for a propeller-driven airplane of comparable size. If the landing pattern is to be a circling approach, the approach configuration should be established upon entry to the base leg. The descent is commenced as the increased flap and gear drag slows the airplane to approach speed. A glide path angle of 2 1/2 to 3 degrees will eliminate the necessity of large thrust changes. Airspeed trends will indicate thrust requirements to maintain desired speed schedule at a steady glide path angle. Proper reaction to the trend will limit corrections to small attitude and thrust changes. The point for lowering full flaps can vary but, normally, it will coincide with the passage of the outer marker and the start of final descent. As the wing flaps extend to the landing position, the nose of the airplane must be lowered slightly to maintain a constant glide path profile. Some

increase in thrust may be required to enable arrival at the runway threshold at flare speed due to the high drag with full flaps. Applied control forces can be reduced or eliminated by proper use of the horizontal stabilizer trim control.

It is recommended that 2/3 of the gust or crosswind factor be added to the computed threshold speed (not to exceed 15 knots IAS).

Summary of landing approach sequence:

1. Enter pattern with flaps at zero/slats extended at flare speed plus 45 knots.

2. Maneuvering configuration, flaps 15 degrees/slats extended at flare speed plus 25 knots. Retrim stabilizer as flaps extend and pitch changes. Full flaps should be applied far enough out on the approach to minimize trim changes in the slot prior to touchdown.

3. Stabilize altitude, airspeed.

4. Plan entry and approach to allow sufficient time to properly align the downwind, base, and final approach legs.

5. Follow a linear descent path with speed decaying to flare speed plus 5 knots and retrimming for near zero control forces. Slow speed bleedoff to flare speed at the approach end of the runway.

6. Begin reducing power as the aircraft enters ground effect and the speed reaches the threshold value (check wings level).

7. As the aircraft crosses the end of the runway, flare slightly with slow power reduction as the nose of

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the aircraft is rotated through level flight to landing attitude.

One Engine Inoperative. The technique and procedure for a single engine approach differs only in that (1) more power is required to maintain the desired schedule and glide slope, and (2) 25-degree flap extension is used.

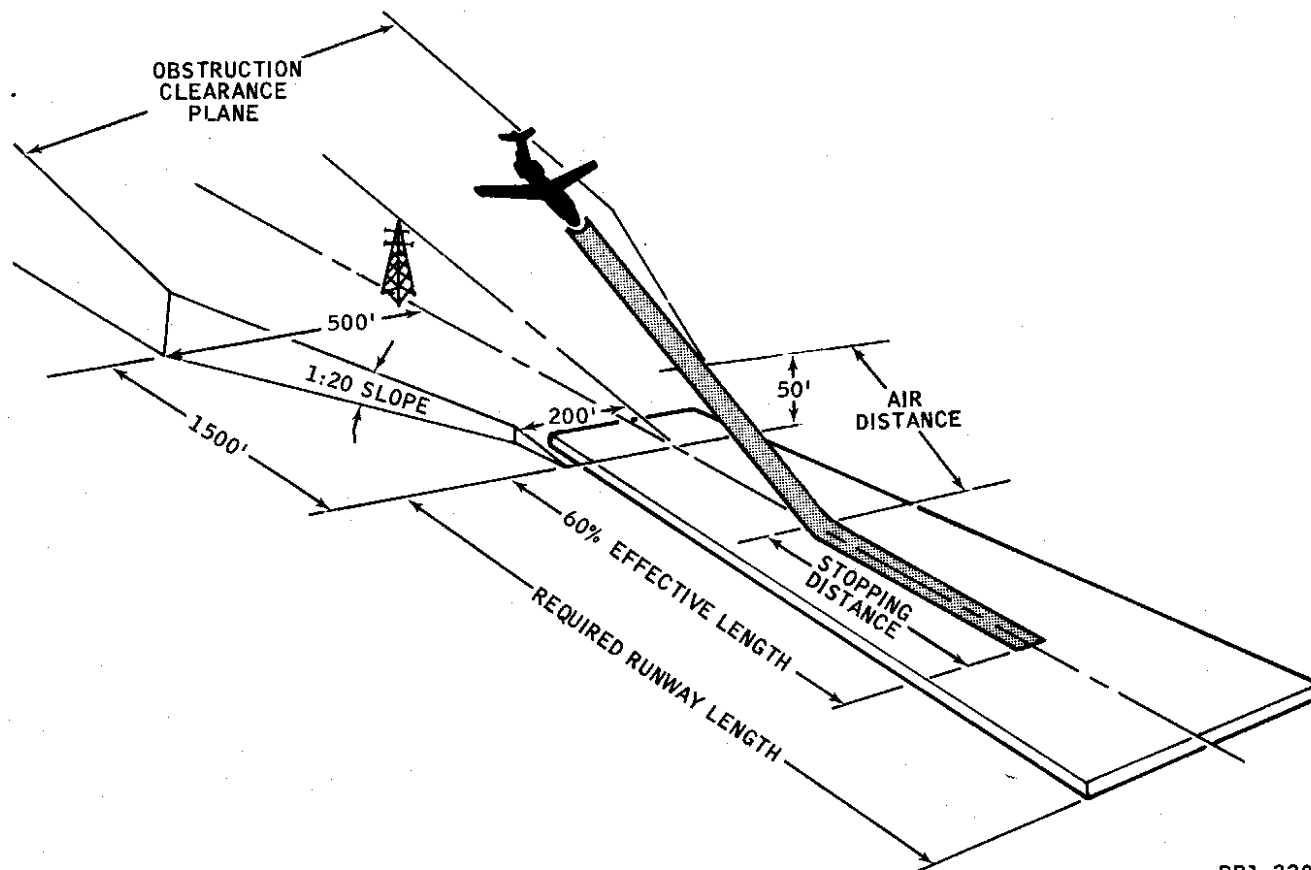
LANDING PERFORMANCE

General. FAA regulations specify certain requirements that must be considered when determining the runway length required at destination and alternate airports for all transport aircraft. The runway length must be

such that a full stop landing can be made at the intended destination or alternate airport within 60 percent of the effective length of the runway from a point 50 feet above the intersection of the obstruction clearance plane and the runway. "Obstruction Clearance Plane" means a plane sloping upward from the runway at a slope of 1:20 to the horizontal, and tangent to or clearing all obstructions within a specified area surrounding the runway, as shown in Figure 9.

Landing Distance. The runway length requirement for landing at the destination or alternate airport is based on full spoiler extension, brakes, and with the flaps down throughout the landing roll. Reverse thrust is

REQUIRED RUNWAY LIMITATION AT INTENDED DESTINATION



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Figure 9. Required Runway Limitation at Intended Destination

not considered. A speed of 30 percent above the stall speed at a 50-foot height is used in determining the actual landing distance. Figure 10 shows the increase in landing distance from a 50-foot height when the flare speed is increased above 1.3 V_S .

JAMMED STABILIZER APPROACH AND LANDING

If the horizontal stabilizer becomes "jammed," the ability to change its angle of incidence is lost and special care must be taken, particularly at lower speeds. The pitch change effectiveness of the stabilizer is about 2 1/2 times that of the elevator. Because of this, it is of paramount importance to avoid high rates of descent, especially on the final approach. Improper techniques could result in the loss of elevator control if large changes in pitch were required at low airspeeds. Control of descent and pitch attitude without stabilizer trim must be provided by coordinated use of thrust and elevator. To compensate in part for this loss of trim capability airspeed should be added to the computed normal threshold speed, thereby enabling more elevator effectiveness. See Figure 11 for the proper airspeed to be added.

MISSED APPROACH PERFORMANCE

General. The required climb performance from a missed approach is termed the Approach Climb and the Landing Climb. The airplane is not performance limited in the landing climb configuration up to the maximum structural landing weight at normal operating temperatures and altitudes. It

is limited at heavier weight and at high field elevations.

Approach Climb Performance. The approach climb gradient is based on one-engine-inoperative with approach flaps (15 degrees), landing gear retracted, and takeoff thrust at all normal landing weights. The climb gradient must be at least 2.1 percent, and the speed cannot be more than 50 percent above the stall speed.

Landing Climb Performance. The landing climb gradient is based on both engines operating at the thrust available 8 seconds after throttle application (takeoff thrust). The configuration of the airplane is full flaps (50 degrees) and landing gear extended. The speed must not be more than 30 percent above the stall speed and the climb gradient must be at least 3.2 percent.

Two-Engine and One-Engine-Inoperative Missed Approach Performance, and Technique. The missed approach procedure for both conditions is the same. The minimum control speed on the one-engine-inoperative condition does not affect the procedure of a missed approach. If a missed approach becomes necessary, apply takeoff thrust, rotate to a pitch attitude of 15 or 16 degrees, and retract flaps to 15 degrees. After a positive rate of climb is established, retract the landing gear and climb at 1.3 V_S flaps full down +10 knots until obstacles are cleared. If the missed approach speed results in a pitch attitude in excess of 16 degrees, the 16 degree pitch attitude should be maintained. With less than 1000 pounds of fuel in any main tank, open the fuel crossfeed valve and do not exceed 10 degree climb attitude during initial climb to 1000 feet terrain clearance altitude. If it is necessary to climb

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 FLIGHT CREW OPERATING MANUAL

MODEL DC-9
 INCREASE IN LANDING DISTANCE
 WITH SPEED INCREASE ABOVE $1.30 V_S$ AT 50 FT. HEIGHT

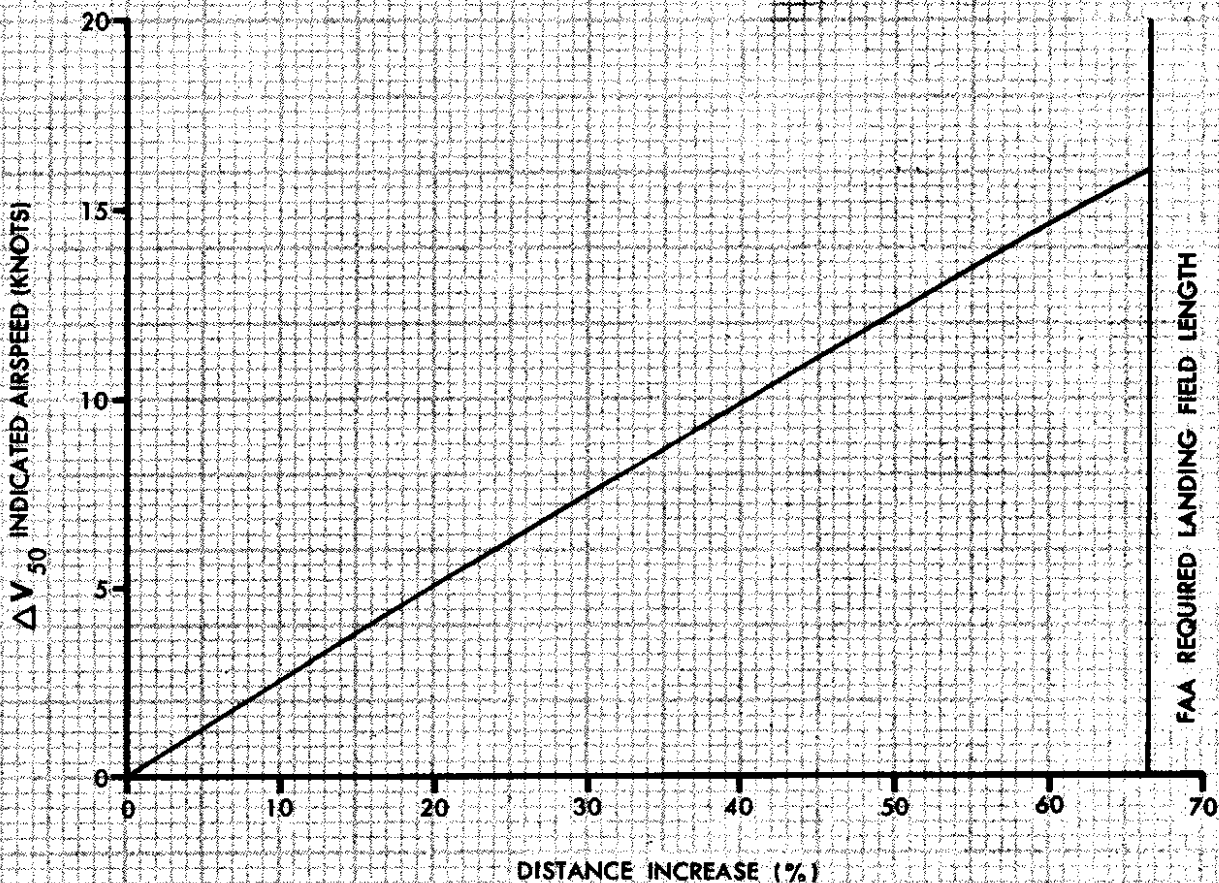
SEA LEVEL
 STANDARD DAY

BASED ON NORMAL AUTOMATIC SPOILER OPERATION

FLAPS FULL DOWN

NOTE:

TOUCHDOWN SPEED = $1.26 V_S$



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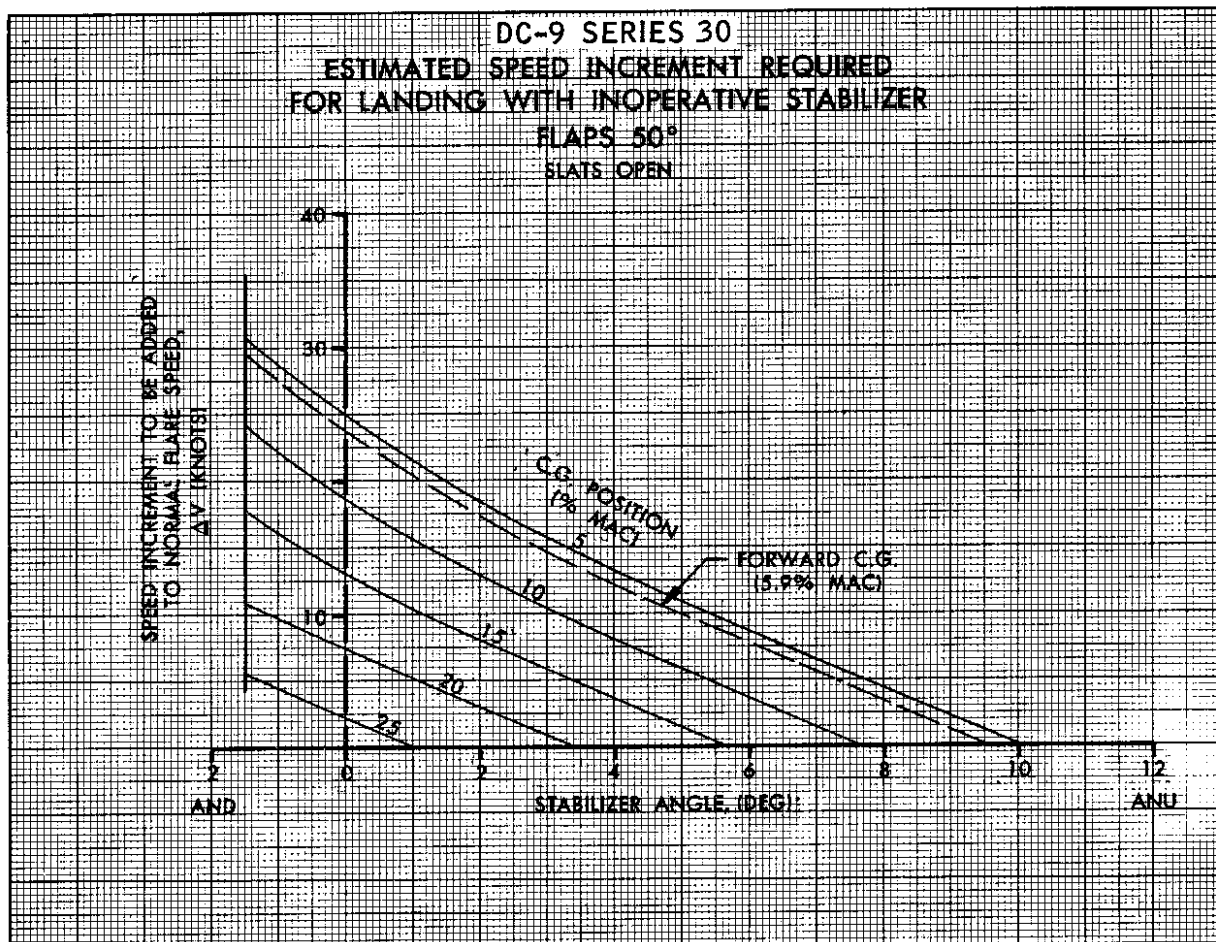
INOPERATIVE STABILIZER LANDING

If the stabilizer becomes inoperative add the following speed increments to the landing flap flare speed:

- A. 5 knots if stabilizer becomes inoperative during normal approach.
- B. 20 knots if stabilizer becomes inoperative during normal climb, cruise or descent.

Avoid high sink rates during the flare to landing.

NOTE: If the C.G. is known and time and conditions permit, the speed increment for the flare speed may be determined from the curve below.



BB1-3081

Figure 11. Estimated Speed Increment Required for Landing with Inoperative Stabilizer

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beyond 1000 feet with low fuel, the climb angle and thrust should be as low as possible.

LANDING PROCEDURES AND TECHNIQUES

Required runway length is provided by a chart similar to Figure 12. Improper technique could adversely affect the stopping distance. Normally, the intended point of touchdown should be approximately 1000 feet beyond the approach end of the runway. This technique will assure against undershooting and at the same time will leave ample distance for stopping. (See Figure 13 for normal VFR landing, Figure 14 for ILS approach and landing, and Figure 15 one-engine approach and landing.) If the airspeed is inadvertently high and a go-around is not made, it is desirable to still touch down as near the 1000-foot point as possible. Deceleration on the runway is about three times more effective than floating just off the surface. Height of the airplane over the end of the runway also has a significant effect on total landing distance. A height of 100 feet instead of 50 feet over the runway end will increase the total landing distance by approximately 900 feet, assuming a normal 3-degree glide path. The total landing distance is also dependent upon the glide path angle. As the glide slope is flattened, the total landing distance will increase. A combination of excessive height over the runway end and a flat approach deprives the use of a considerable portion of the runway. Proper pilot technique and a glide slope angle of approximately 3 degrees (ILS slope usually 2 1/2 to 3 degrees) will contribute materially to consistently good approaches. In the DC-9, as in any high performance aircraft, a decision to go-around should be made early. The continuance of a poor approach could lead to

serious adverse consequences, for obvious reasons. Another factor that greatly affects landing roll is the coefficient of friction between the tires and the runway surface. This depends on the variables of tire and tread design, runway surface material, the condition of the runway (dry or wet), tire pressure, gross weight, and, of course, braking equipment and technique employed. Stopping distance computations for the DC-9 are made without considering the effects of reverse thrust. However, normal procedures for stopping employ its use and a very significant reduction in landing roll is achieved.

The sequence of normal procedures for stopping after touchdown is:

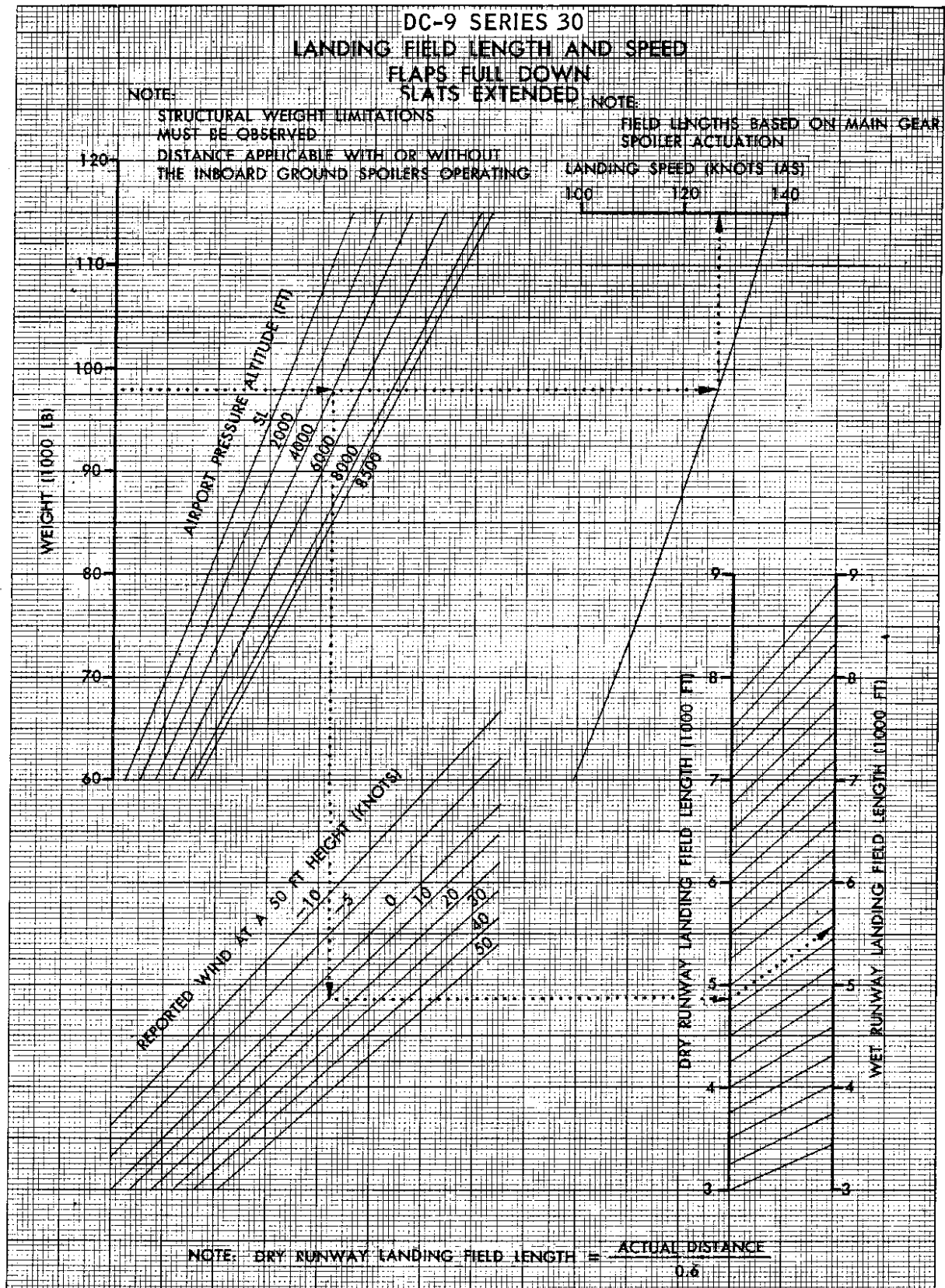
1. Throttles to idle.
2. Apply reverse thrust, normally to 1.6 EPR.
3. Use brakes as required. Come out of reverse thrust slowly when no longer required and in any case below 1.2 EPR at speeds lower than 60 knots.

During reverse thrust operation, should difficulty be experienced in maintaining directional control, reduce thrust as required.

The importance of timing during the use of all means for stopping the airplane cannot be overemphasized. As soon as it is definitely known that the main wheels are rolling on the runway, use elevators to bring the nosewheels onto the runway smoothly and hold them there; in other words, fly the nosewheel onto the ground. Apply wheel brakes. Reverse thrust may be initiated any time after main gear contact. The spoiler lever should be checked for proper extension.

As noted earlier, raising spoilers reduces wing lift and increases drag

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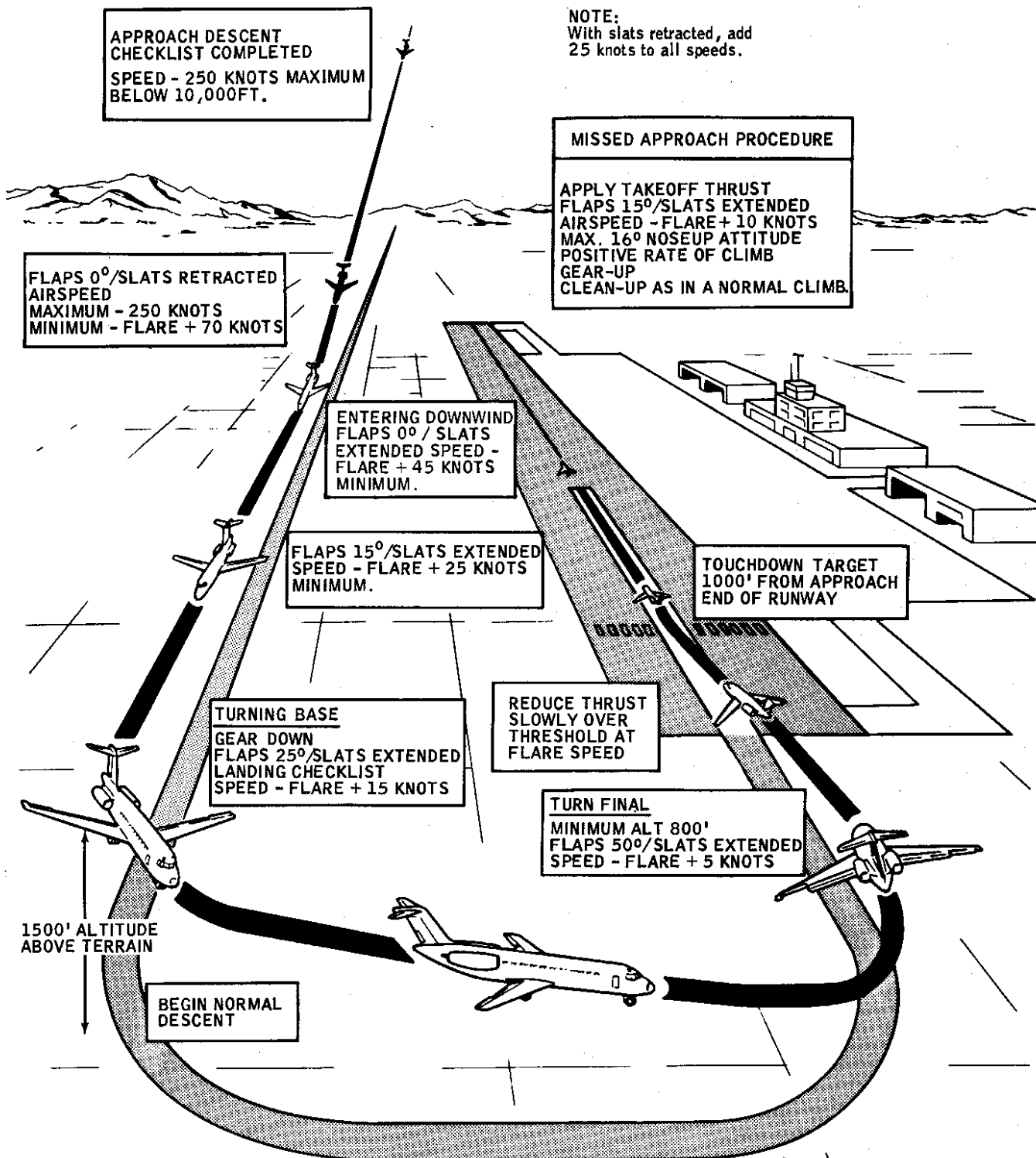


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Figure 12. Landing Field Length and Speed,
 Flaps 50 Degrees/Slats Extended

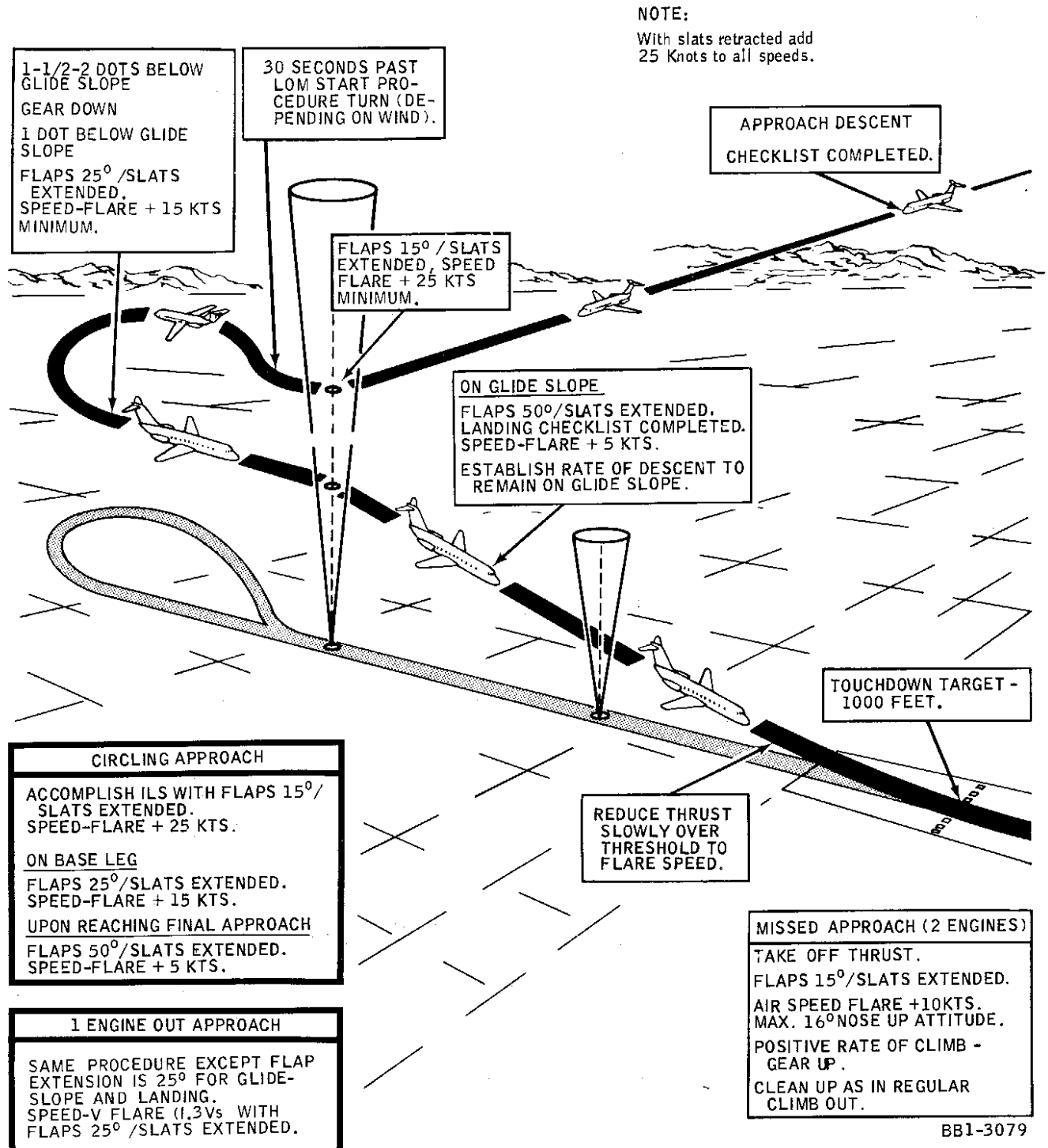
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NORMAL VFR LANDING



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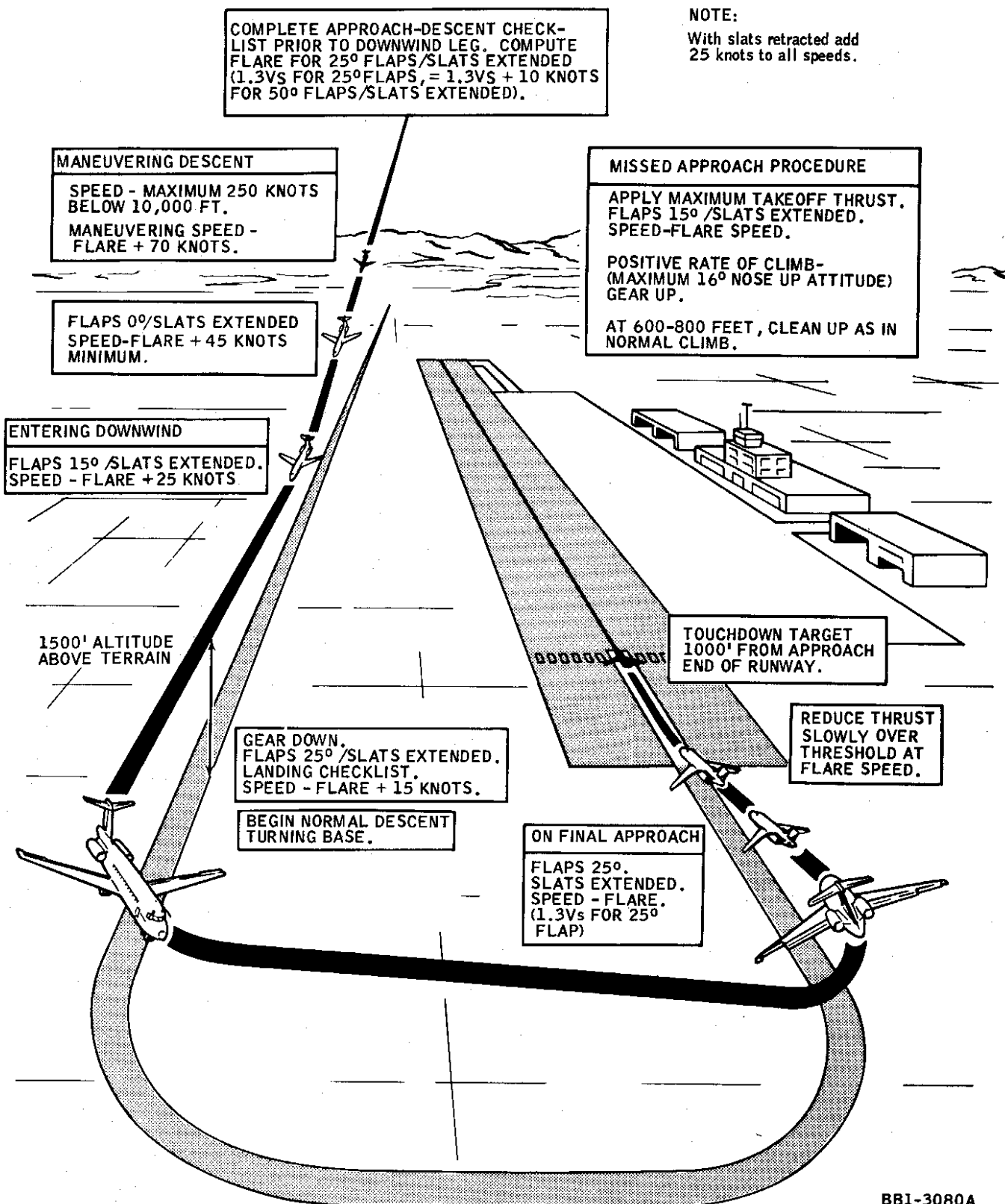
DC-9 SERIES 30 -- ILS APPROACH & LANDING



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Figure 14. ILS Approach and Landing

ONE ENGINE APPROACH & LANDING



and braking effectiveness. Bringing the nose gear down to the runway also reduces wing lift and increases the effectiveness of the brakes. Throughout the landing roll, keep enough forward pressure on the control column to hold the nosewheel on the runway noticeably improves directional stability, particularly in crosswinds.

Zero Flap Landings. A wider than normal approach pattern should be flown if a landing must be made without the use of flaps and slats. (See Figure 16.) An increased radius of turn will be necessary because of the higher airspeeds in consideration of the greater V_s . This condition could be further aggravated if the flap loss was due to dual hydraulic failure. If such a remote double failure occurred, the loss of lateral spoilers would also be experienced with the resulting decrease in rolling rate capability. In the event this double hydraulic failure occurred with the slats extended, they would remain extended.

The turn to base leg should be delayed to ensure a long, straight, final approach. One hundred and fifty percent of V_s is recommended for maneuvering speed. The landing gear should be extended before the approach is started for speed stabilization. A reduction in speed to $1.25 V_s$ ($1.35 V_s$ if the configuration is zero degrees flaps with the slats extended, see Figure 17) should be made at about 600 feet above the ground. The low drag resulting from the zero flap configuration will require a rather high body angle and a flatter than normal approach. Deceleration will be slow. Conversely acceleration will be rapid either by an increase in thrust or lowering the nose. As the aircraft enters ground effect, a noticeable increase in control

effectiveness is apparent, especially in the longitudinal axis. The airplane is already in a landing attitude and should be flown onto the runway. An attempt to make a smooth landing by "holding off" should not be attempted. Such a tactic in the low drag configuration would result in a long float, waste of runway, and the possibility of contacting the runway tail first. This technique would be especially undesirable if the trouble was complete loss of hydraulic pressure, as ground spoilers would not be available for stopping. Upon touchdown it is advisable to apply a forward force on the control column to destroy lift and increase braking effectiveness. Prior to landing without flaps, special consideration must be given to (1) runway available and surface conditions, (2) weather, (3) landing gross weight, and (4) missed approach capability. In addition, it is imperative that the pilot be fully aware of the total effect brought about by the complete loss of hydraulic pressure, if that was the source of the emergency.

LANDING IN GUSTY/CROSSWIND CONDITIONS

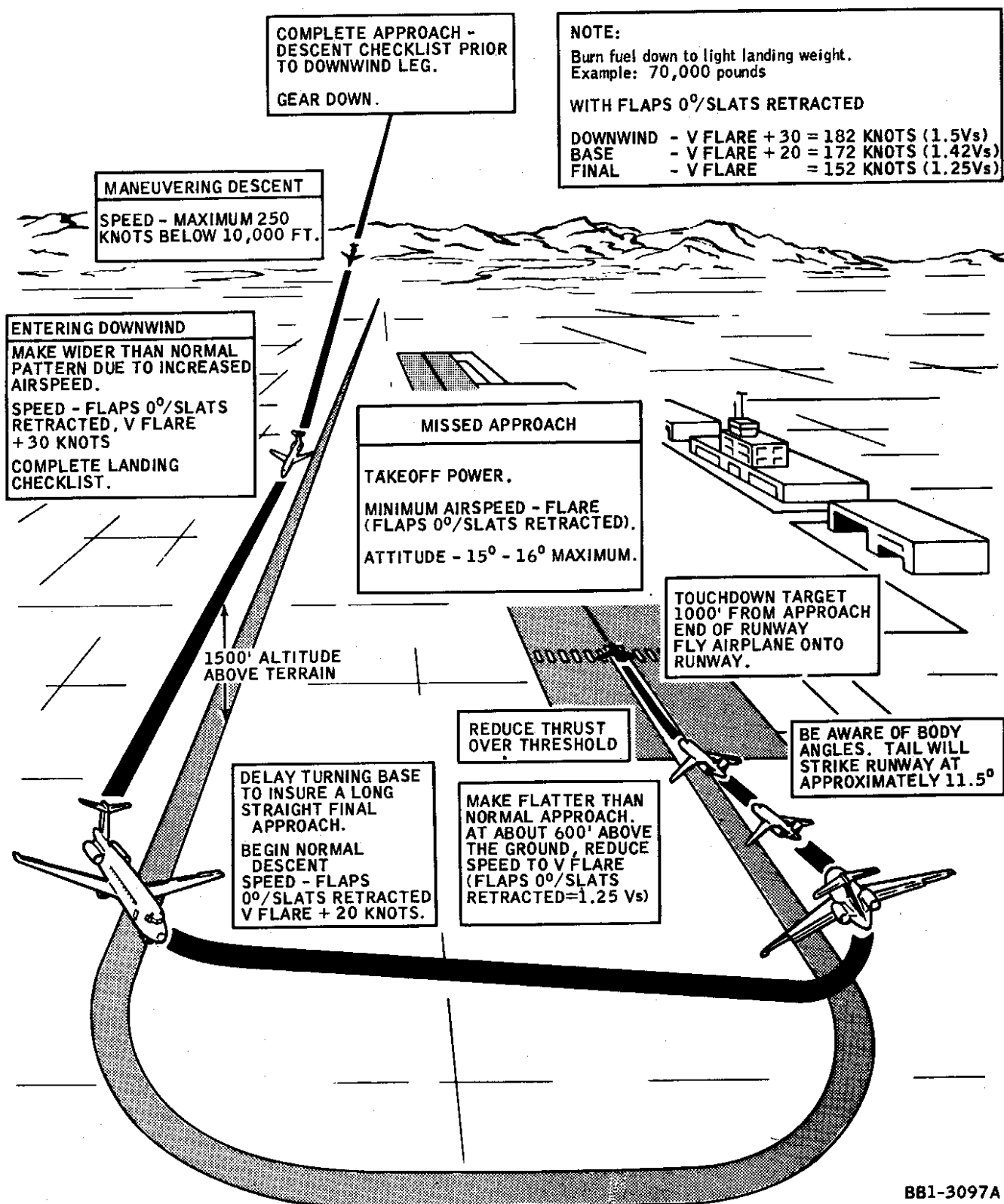
If landing in gusty or crosswind conditions, increase final approach speed by $2/3$ of the reported gust and/or $1/2$ of the effective crosswind, not to exceed 15 knots total.

LANDING RULES OF THUMB

1% INCREASE IN AIRSPEED - 2% INCREASE IN STOPPING DISTANCE

1% CHANGE IN GROSS WEIGHT - 1% CHANGE IN STOPPED DISTANCE

NO FLAPS/SLATS RETRACTED APPROACH & LANDING



BB1-3097A

Figure 16. Approach and Landing -- No
 Flap/Slats Retracted

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**NO FLAPS/SLATS EXTENDED
 APPROACH & LANDING**

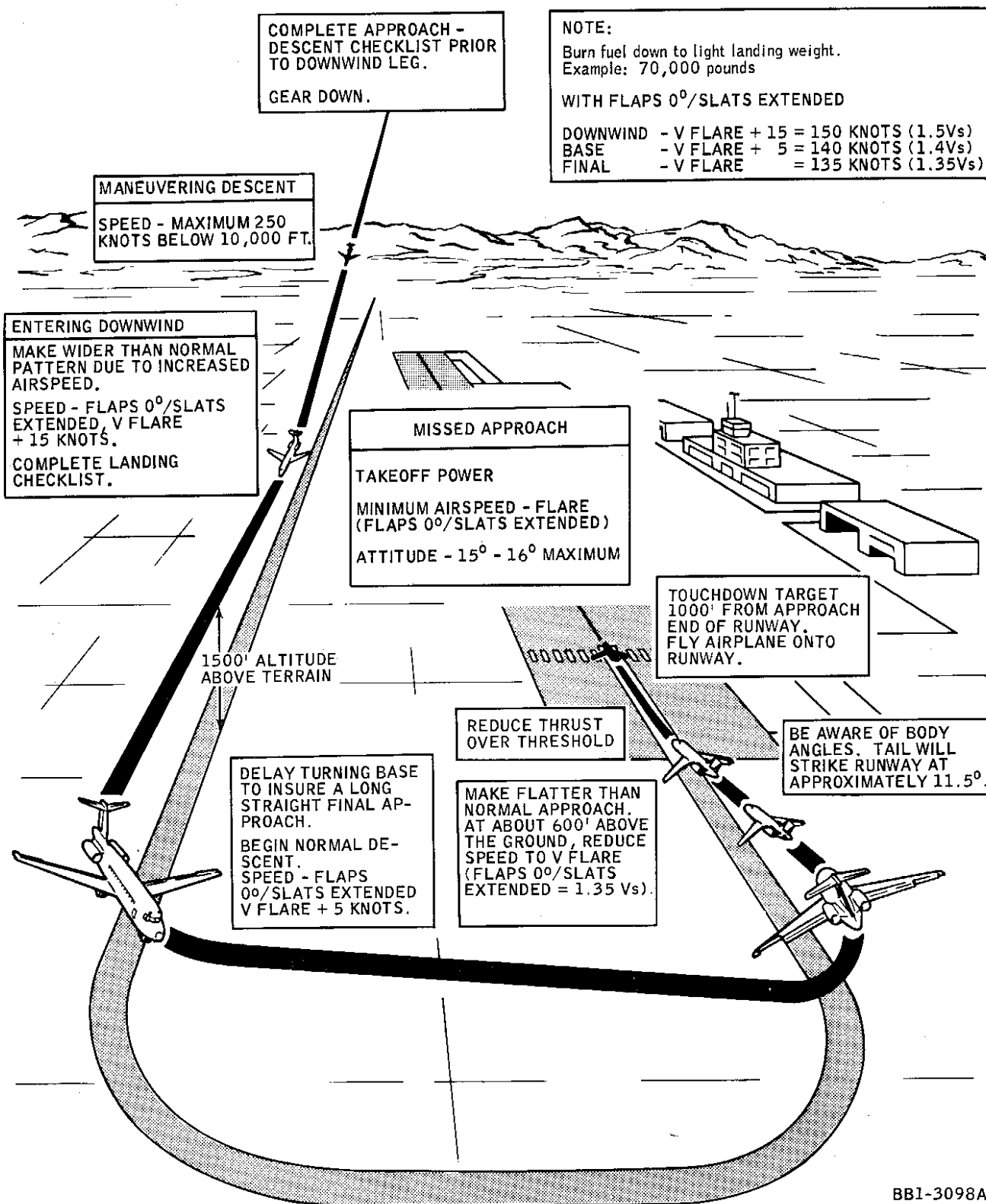


Figure 17. Approach and Landing -- No
 Flap/Slats Extended

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1000 FOOT CHANGE IN FIELD ELEVATION -
4% CHANGE IN STOPPING DISTANCE

15°F CHANGE IN TEMPERATURE - 4% CHANGE
IN STOPPING DISTANCE

10 KNOT CHANGE IN WIND - APPROXIMATELY
15% CHANGE IN STOPPING DISTANCE

NO SPOILER - INCREASE STOPPING DIS-
TANCE BY 25%

MCT REVERSE THRUST DECREASES STOPPING
DISTANCE BY 10% TO 20% ON A SLICK
RUNWAY.

DC-9 ANTISKID SYSTEM

The DC-9 antiskid braking system modulates the brake pressures under all runway surface conditions. It is a self-adapting system that automatically modulates brake pressure through electronic devices which sense and determine wheel speed rate of change rather than actual wheel speed. The self-modulating system continuously controls brake pressure to the maximum that the aircraft tires and runway will tolerate.

The DC-9 antiskid system offers individual wheel control which affords the maximum degree of braking power on wet or icy runways. This configuration is considered optimum, as each wheel is regulated to its needs alone and is not influenced by different runway surface conditions. When using the antiskid system the pilot should hold the steady brake pedal pressure desired for the particular stopping distance. It is not necessary, or desired, to "pump the brakes." If the pilot does not want full brake pressure, the system will adapt to whatever metered pressure he chooses. The system provides the most efficient

utilization of the amount of pressure applied, including full brake application.

MANUAL BRAKING TECHNIQUE

When landing with the antiskid inoperative, the antiskid switch should be OFF and brake pedals should be applied using normal braking techniques - holding a steady brake pedal force that provides a moderate deceleration. This is approximately 60 percent of that obtained with maximum antiskid braking and is achieved with less than one half of full pedal application. Too much brake pedal pressure will cause the tires to skid.

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FLIGHT CREW OPERATING MANUAL

LUFTVERKEHRSUNTERNEHMEN ATLANTIS AG

(SERIES 30)

TO: ALL HOLDERS OF DC-9 FLIGHT CREW OPERATING MANUAL

CONCERNING: REVISION 20, SECTION 5, CHAPTER 15, DATED JUN 1/70

SUMMARY: ADDITIONS, DELETIONS, OR CHANGES ON TEXT PAGES ARE INDICATED BY A VERTICAL LINE ADJACENT TO THE CHANGE.

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Subject	Code	Page	Subject	Code	Page
5-15-Eff	66	All	5-15-Eff	66	All
5-15-0-0	31	3 and 4	5-15-0-0	31	3 and 4

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SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE	SECTION CHAPTER SUBJECT UNIT	CODE	PAGE	DATE
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5-15-Cont	66	2	Sep 1/69
5-15-Cont	66	3	Sep 1/69
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Chapter 15

FLIGHT PLANNING

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<u>LANDING FIELD LENGTH AND SPEED</u>	15-0-0	19	31	A11
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<u>APPROACH CLIMB AND LANDING CLIMB</u>	15-0-0	19	31	A11
*Approach and Climb Limiting Weights (Figure 15)	15-0-0	24	31	A11

*Illustrations

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FLIGHT PLANNING

GENERAL

Regular, recurring flights over the same route are simply and adequately accommodated by a precomputed flight plan. It is made considering stable factors, typical conditions and average weather for the appropriate season and locations involved. Significant variations in temperature, weather and other variables are easiest applied using tabulated information whenever such data lends itself to tabulation.

Some airlines now employ the use of machine computers. The current weather conditions and other pertinent variables are fed into the computer and the modified flight plan and performance capability for the existing conditions is presented within a very few minutes. The same information can be obtained by the use of charts and graphs in lieu of the sophisticated machine or tabulated information. This section will deal with the use of such charts when planning a typical DC-9 flight. For simplicity the

DC-9 SERIES 30 -- FUEL WEIGHT WORKSHEET

OPERATING WEIGHT		<u>58,500</u>
PAYLOAD		<u>23,500</u>
ZERO FUEL WEIGHT		<u>82,000</u>
REQUIRED RESERVE FUEL	<u>6,350</u>	
CONTINGENCY FUEL	<u>1,100</u>	
TOTAL RESERVE FUEL		<u>7,450</u>
DESTINATION LANDING WEIGHT		<u>89,450</u>
TRIP FUEL (FLIGHT LEVEL 290)	<u>8,850</u>	<u>8,850</u>
TOTAL FUEL TO LOAD	<u>16,300</u>	
RAMP GROSS WEIGHT		<u>98,300</u>
TAKEOFF GROSS WEIGHT (RAMP MINUS 300#)		<u>98,000</u>

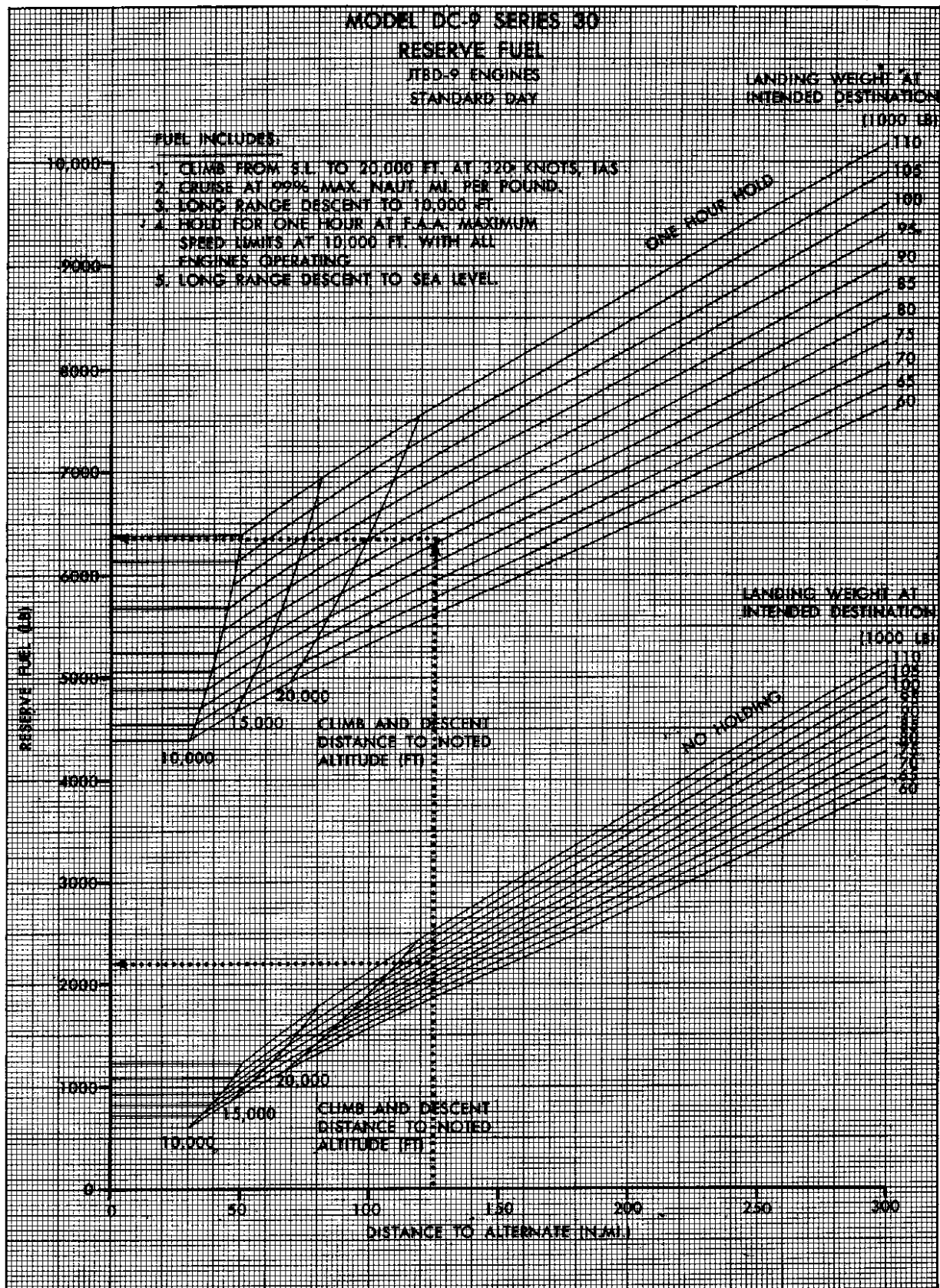
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Figure 1. Fuel/Weight Worksheet

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presentation is condensed and rather superficial. For more detailed information concerning specific performance consult the Douglas Aircraft publications titled, DC-9 DOUGLAS JET TRANSPORT - FLIGHT PLANNING & CRUISE CONTROL MANUAL.

For the purpose of example, assume an operating weight of 58,500 pounds and a payload of 23,500 pounds. This results in a zero fuel weight of 82,000 pounds. After obtaining this information it could be entered onto a fuel/weight work sheet such as shown in Figure 1.

GROSS WEIGHT AND RESERVE FUEL DETERMINATION

Weather, payload, and other variables changing near takeoff time will affect flight plan computations. The "LANDING WEIGHT" is relatively stable once the payload is determined and affords an optimum starting point for total fuel, gross weight, and takeoff performance considerations. The landing weight is obtained by totaling the operating weight, payload, and the required fuel reserves.

None of these factors will normally change enroute to destination. After determining the zero fuel weight (operating weight plus payload), the required fuel reserve can be obtained from the "RESERVE FUEL CHART" (see Figure 2). This chart establishes the fuel required to climb from the destination airport to 20,000 feet, proceed to the alternate at LRC, descent to 10,000 feet, hold at that altitude for one hour, and then to descend and land. (Note the conservative factors of both airports at sea level and holding time in excess of FAA minimum). Example: Enter the

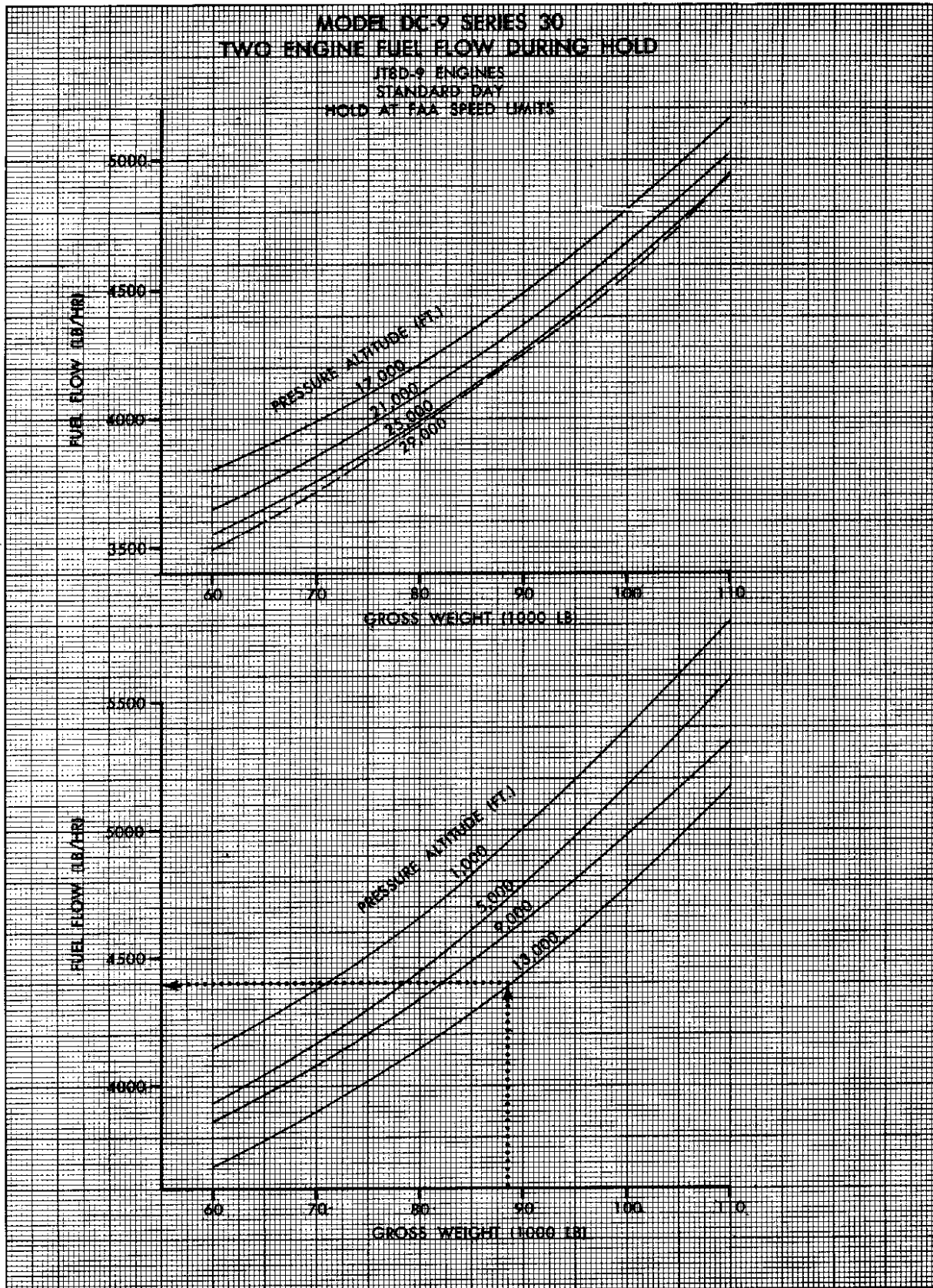
reserve fuel chart at the distance to the alternate airport (in this case 125 NM). Project straight up to the landing weight at intended destination (82,000 lbs.) and then follow left to read the reserve fuel required (6350 lbs.). This can now be entered on the fuel worksheet.

FUEL REQUIRED TO REACH ALTERNATE AIRPORT

Figure 2 reveals the fuel required to proceed from intended destination with no holding. It considers a climb from sea level to 20,000 feet (lower for shorter distances). Cruise at 99 percent maximum NM/lb of fuel and a long range descent to sea level. Example: Distance to alternate 125 NM, weight at missed approach 88,350 pounds. Fuel required, 2200 pounds.

At times, due to adverse weather or some other reason, it may be desirable to increase the normal fuel reserves by loading contingency fuel. Figure 3 gives an approximation of the added fuel weight and time in relation to gross weight and altitude. Example: To compute contingency fuel required to hold at 13,000 feet for 15 minutes, enter the chart at the gross weight of 88,350 pounds (the weight at departure for an alternate to ensure the required reserves). Follow straight up to the holding altitude (13,000 feet). Project left to the reference line, and read the fuel flow in pounds per hour (4400 lb/hr). For contingency fuel, 15 minutes at this rate equals 1100 pounds. This provides a total reserve fuel supply of 7450 pounds. If a landing is made upon arrival at destination, none of this fuel will be used leaving a maximum landing weight (in this example 89,450 pounds) with which to work. This amount can

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be entered onto the fuel/weight worksheet.

OPTIMUM ALTITUDE

To determine the optimum altitude for airline operations, many factors must be considered in addition to the altitude which will yield the best engine performance and fuel economy. Optimum altitude is based on the minimum direct operating cost, referenced herein as "MIN. D.O.C." (see Figure 4). The DC-9 zero wind optimum altitude is 30,000 feet for flights in excess of 265 NM.

For this example assume that the destination is at 500 NM, and therefore the optimum no-wind altitude is 30,000 feet.

TRIP FUEL

Figure 5 reveals the fuel required from departure to destination. Example: Enter the chart at the range in NM (500). Follow up to the appropriate effective wind line (zero wind for this example). (Note on the chart the relatively small effect of wind when traveling at .8 Mach for distances less than 500 NM. As the range increases, the advantages or disadvantages experienced are magnified due to the element of time and is represented by the diverging lines as the distance increases.) From that point move left to intercept the appropriate altitude line. (Reference is final cruise altitude.) Assume an assigned altitude of flight level 290. From there move up to the landing weight (89,450 lbs.) and then left to the reference line for fuel burned (8,850 lbs.). This quantity includes

the fuel for start and taxi (300 lbs.), acceleration, climb, cruise, descent, maneuvering (850 lbs.), approach, and landing. There are numerous charts for each of these phases of the flight and it is possible to obtain a higher degree of accuracy by using them for each of the trip segments. However, the simple "FLIGHT PLANNING" chart will not normally be in error by more than 50 pounds over a range of 500 NM. (Temperature accountability is not necessary as the effect is negligible.) Adding the fuel column gives the total fuel to load (16,300 pounds). This results in a total gross weight of 98,300 pounds (zero fuel weight plus total fuel). Approximately 300 pounds of fuel will be burned for start and taxi. This gives a takeoff gross weight for performance computations of 98,000 pounds.

Now that the takeoff weight has been determined, it is possible to compute takeoff and other performance data.

RUNWAY LENGTH REQUIRED FOR TAKEOFF

Figure 6 is based on a balanced field length (takeoff distance to 35 feet after an engine failure at V_1 equal to the accelerate stop distance).

Assume the following conditions for takeoff:

Temperature.....65°F (18°C)

Pressure altitude.....3000 feet

Wind.....+20 knots (headwind)

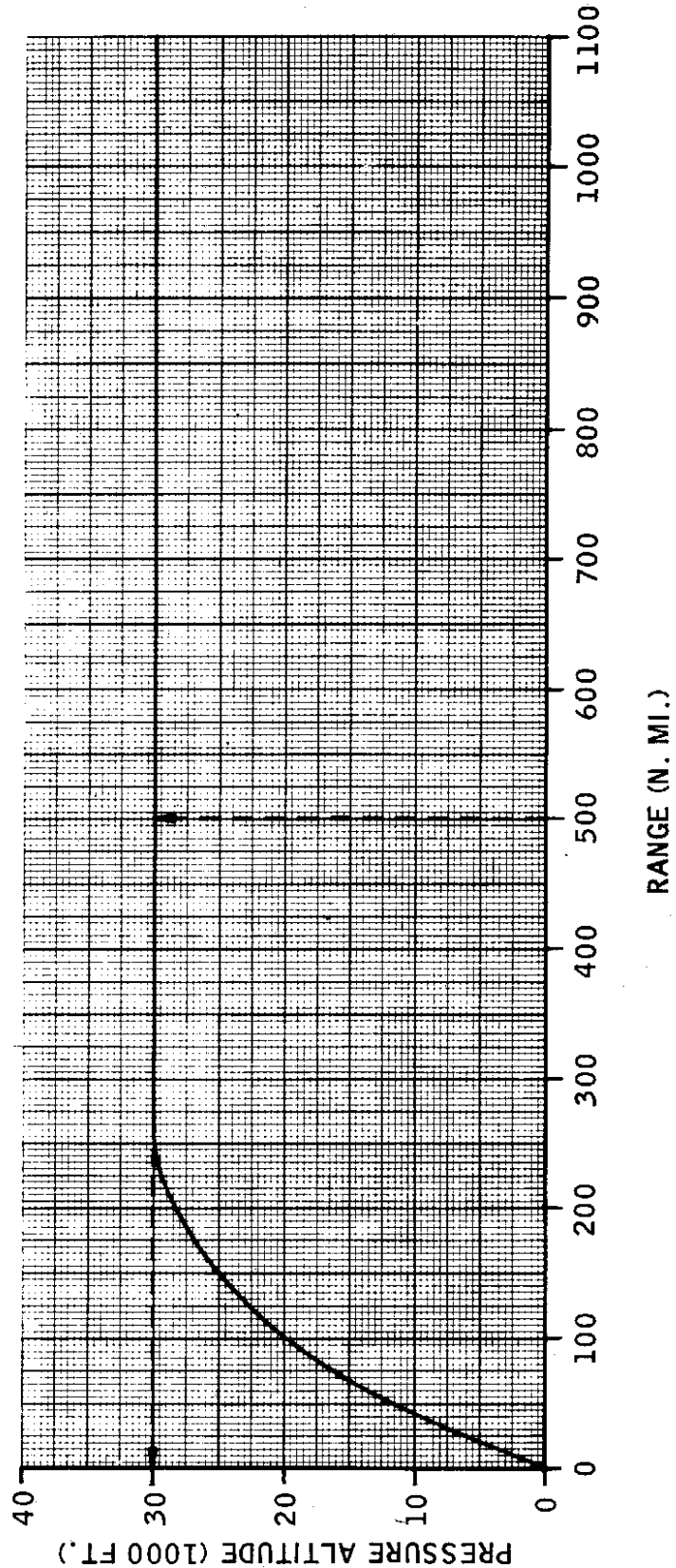
Runway Slope..1.0% (.010)(downhill)

Determine the runway length required at the takeoff gross weight of 98,000 pounds. (Reference example in

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MODEL DC-9 SERIES 30
 OPTIMUM ALTITUDE* VS RANGE

* OPTIMUM ALTITUDE BASED ON
 MINIMUM DIRECT OPERATING COST (D.O.C.)

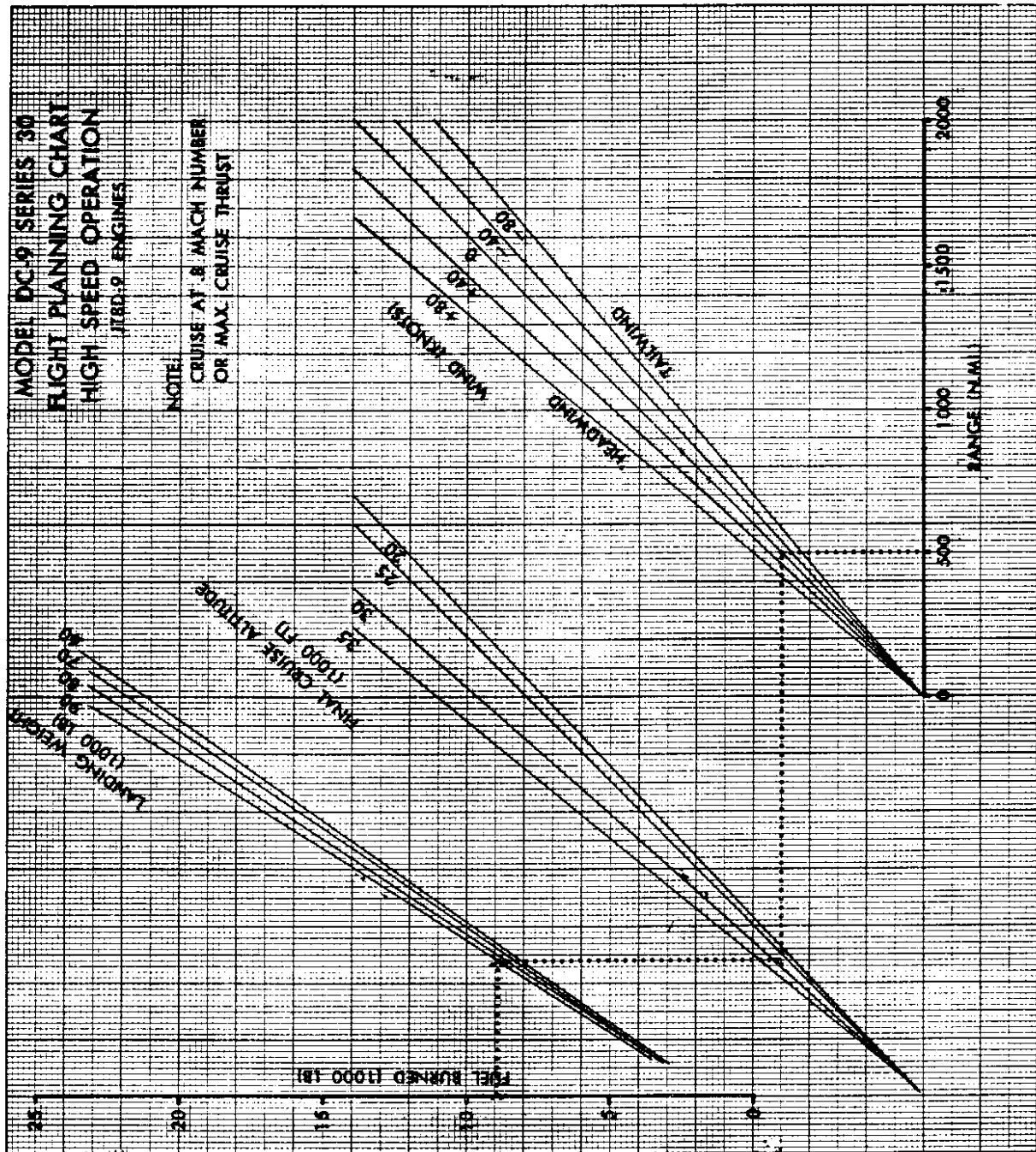


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Figure 4. DC-9 Optimum Altitude V_S Range

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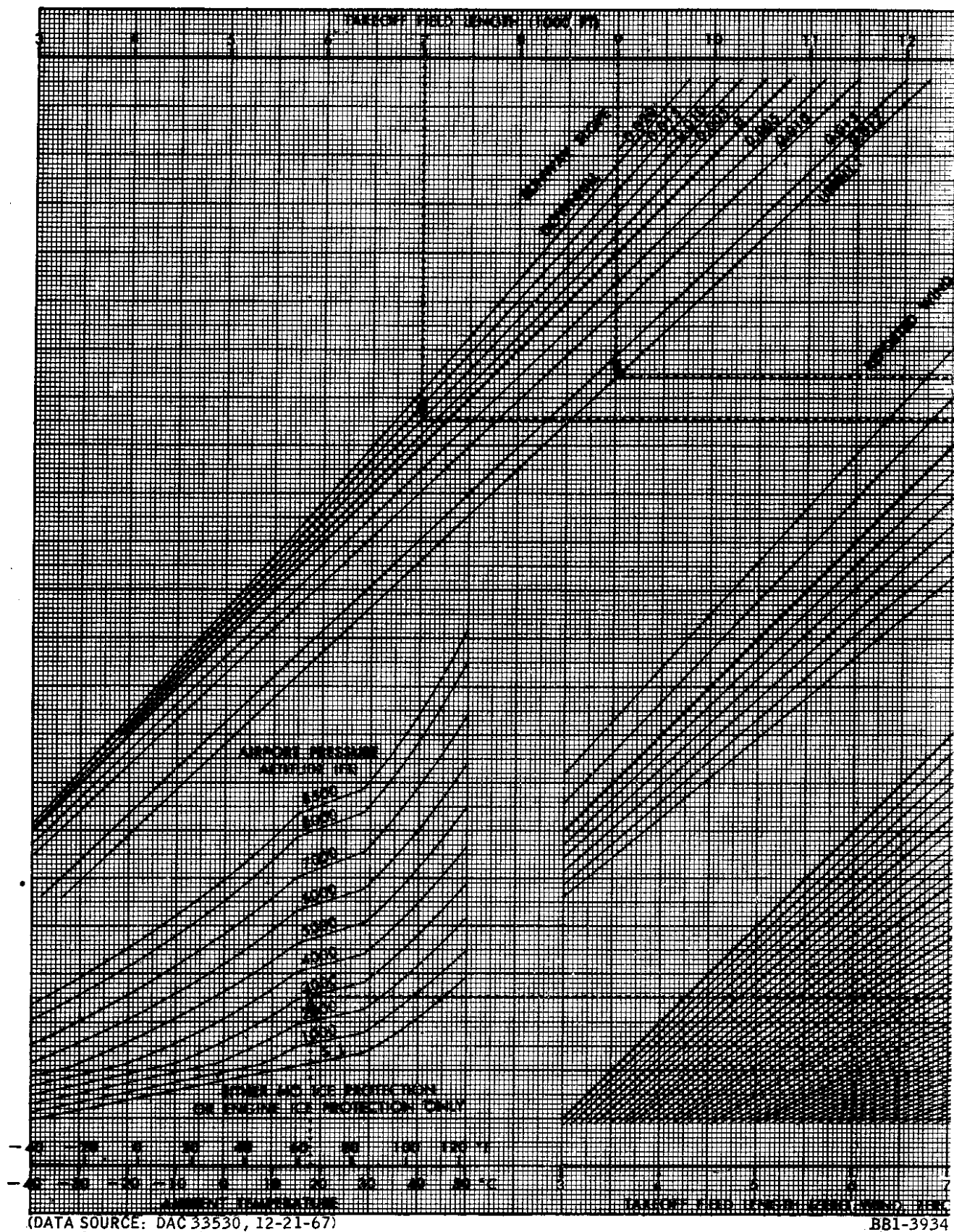
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Figure 5. Flight Planning Chart

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Figure 6. Takeoff Performance (Takeoff field length) (Sheet 1)

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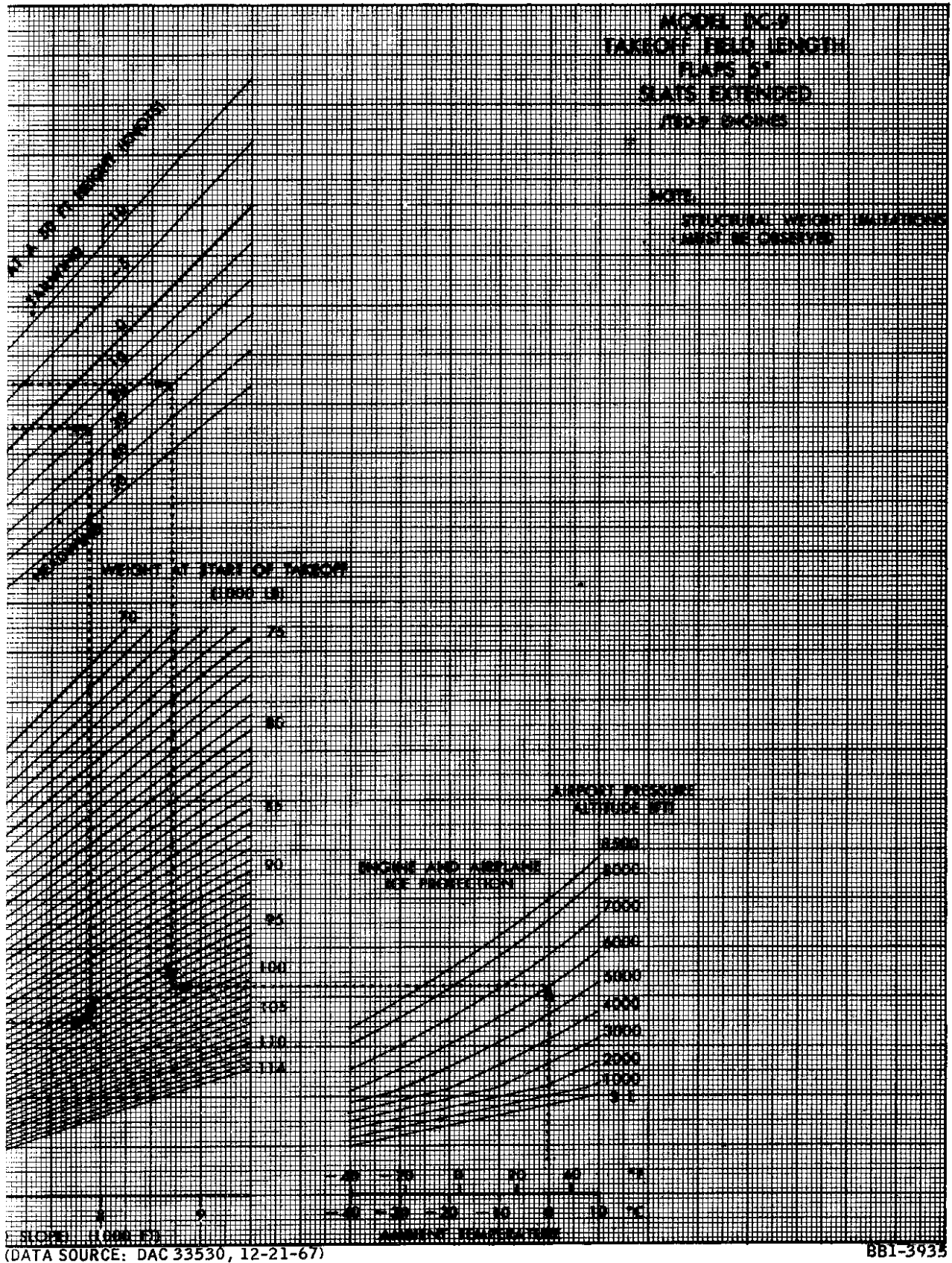
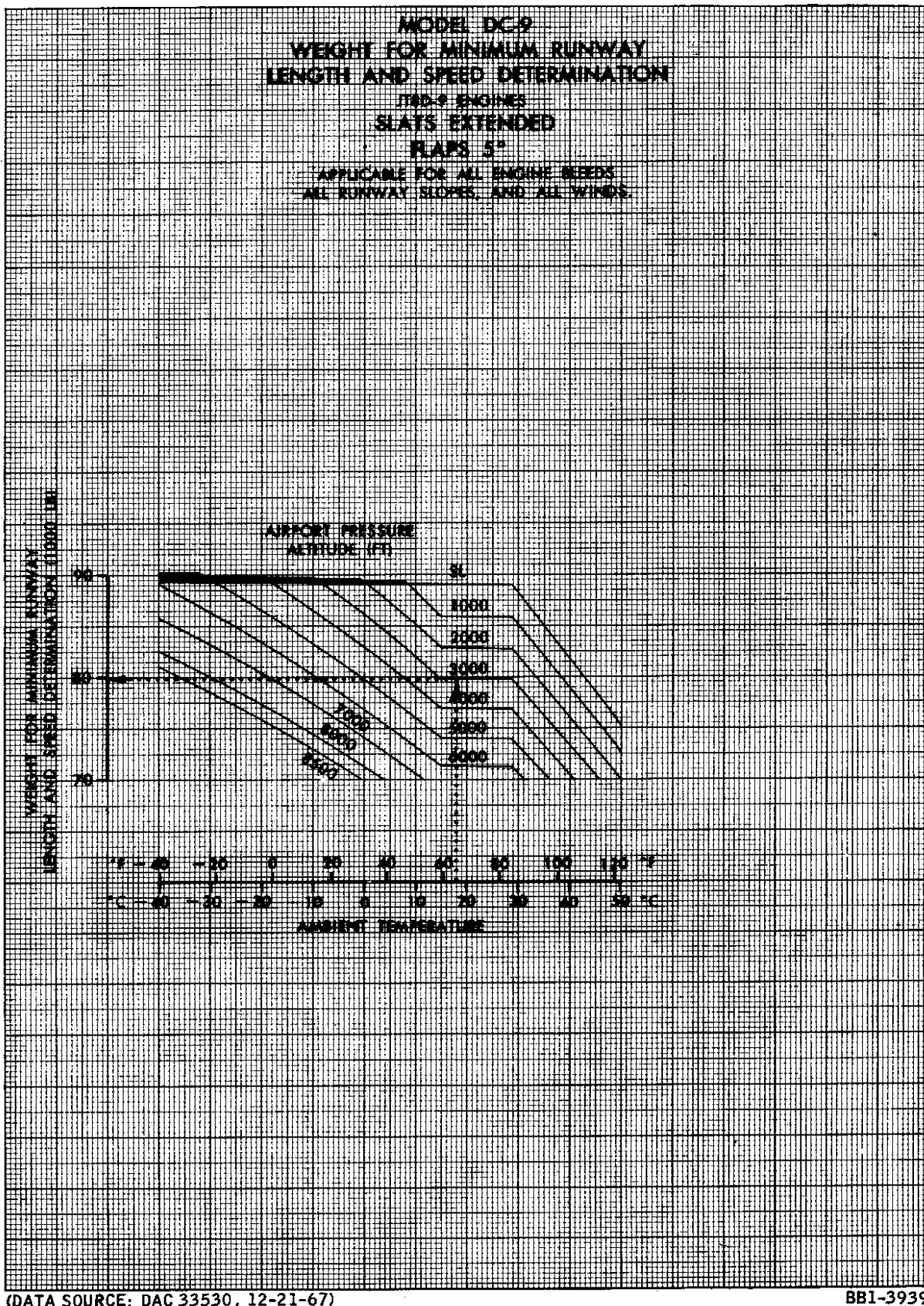


Figure 6. Takeoff Performance (Takeoff field length) (Sheet 2)

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Figure 6.) This chart is constructed considering the FAA requirement of using not more than 50 percent of any headwind, nor less than 150 percent of any tailwind. (Observe the difference in the spread between headwind lines and tailwind lines for the same numerical values.) The runway required in this example is 7000 feet.

WEIGHT FOR MINIMUM RUNWAY LENGTH
AND SPEED DETERMINATION

This chart (Figure 6) depicts the computed weight to be used for determining runway length and takeoff speeds (V_1 , V_R & V_2) when the actual airplane gross weight is less than the computed weight. It is based on a maximum pitch attitude of 15.6 degrees and performance values have been adjusted accordingly. This chart must be referred to any time the takeoff gross weight is below 91,000 lbs. for 5 degree flaps and 79,000 lbs. for 15 degree flaps. When the actual airplane gross weight is less than the computed weight for a given temperature and pressure altitude, then the computed weight is the determining factor. If the actual weight is more than the computed weight, then the actual weight is the deciding factor. Using the same conditions for temperature and pressure altitude, the weight derived is 80,000 lbs. In this case the actual airplane gross weight of 98,000 lbs. is used for computing the takeoff distance and speeds.

STABILIZER TRIM

Stabilizer trim is set for approximate zero control force at 1.35 V_S with the gear up and flaps set for takeoff. Figure 7 provides the

stabilizer setting for all takeoff flap settings. Example: C.G. = 17.5% MAC. Interpolation between 16% and 20% C.G. on chart results in an ANU (airplane nose up) stabilizer trim setting of 6.5.

TAKEOFF SPEEDS

From brake release, progressing along the takeoff path there are three initial reference speeds to observe: V_1 , V_R , and V_2 .

Figure 8 is for -9 power and 5 degree flaps, slats extended.

The top block shows the basic speeds at various weights for a standard day at sea level. For weights between the tabulated values interpolate to determine the basic speed. Example: Interpolation between the values for 95,000 pounds and 100,000 pounds gives basic speeds for 98,000 pounds of 138 for V_1 , 141 for V_R , and 148 for V_2 .

Corrections to the basic speeds for temperature, pressure altitude, slope, wind, and ice protection are made by using the graph in the center of the chart and applying the tabulated data as instructed at the bottom.

Notice that the variations that effect the value of V_1 and V_R , are opposite in their effect to the value of V_2 . Example: Using the same conditions for temperature and pressure altitude, a correction of +1 knot is added to the values of V_1 and V_R , while a correction of -1 knot is subtracted from the value of V_2 .

V_2 , assuming the loss of an engine, is in relation to V_{MU} (minimum unstick speed). When correcting for temperature and pressure altitude, the V_2 speed is reduced because of the

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reduced acceleration between V_{LO} (lift off speed) and V_2 . V_1 and V_R are related in varying degrees to acceleration and deceleration on the runway and are affected by variations in these factors.

The asterisk item states that if V_1 exceeds V_R , set V_1 equal to V_R . This condition could exist, for example, if takeoff were to be made with a large headwind component and significant uphill slope. V_1 is a decision speed to abort the takeoff or to continue. It is not acceptable to make a decision to abort after rotation. Reducing the decision speed to equal V_R provides the pilot with a single, logical reference speed to either stop or go. The arbitrary reduction of V_1 to equal V_R unbalances the

field length in that a lower V_1 increases the takeoff distance and decreases the accelerate stop distance. This change is easily accommodated in the construction of the FAA Required Field Length chart, and it is not necessary to make further adjustments to obtain the minimum runway required. Information at the bottom of the chart includes the flap and slat retraction speeds for the configured flap takeoff setting (in this case 5 degree flaps). Slat retraction is V_2 . Slat retraction speed is always 25 knots above the flap retraction speed. If the takeoff is configured for a 15 degrees flap setting, the flap retraction speed is $V_2 + 10$ knots IAS and the slat retraction speed is $V_2 + 35$ knots IAS. Final segment climb speed is $1.38 V_S$.

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ALL FLAP ANGLES									
% C.G.	6%	8%	12%	16%	20%	24%	28%	32%	(35) 34.7%
Stabilizer Setting	9.5ANU	9	8	7	6	5	4	3	2.5

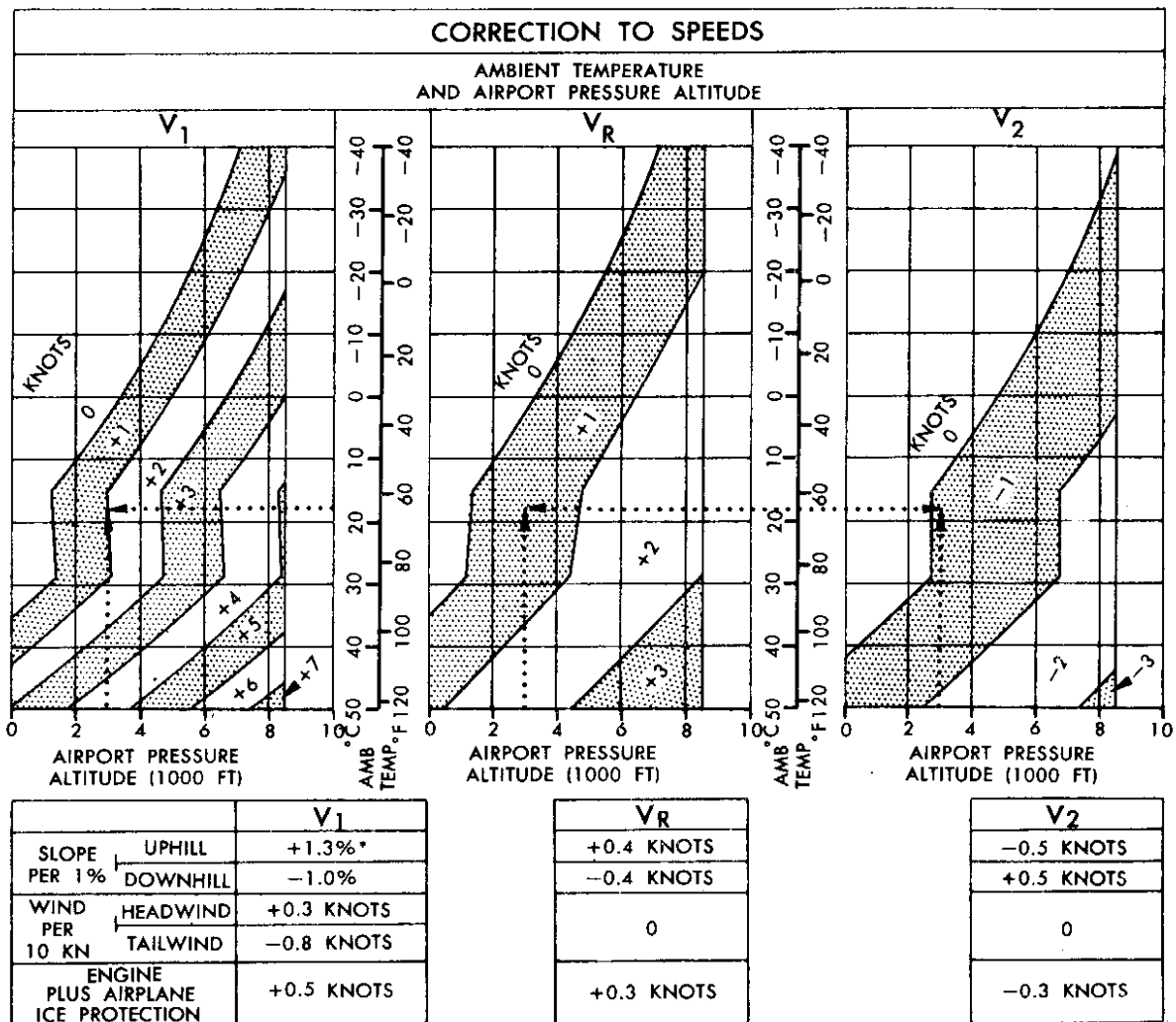
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MODEL DC-9
 TAKEOFF AND TRANSITION SPEEDS
 JT8D-9 ENGINES

NOTE: MINIMUM SPEEDS MUST BE CHECKED AT WEIGHTS BELOW 91,000 POUNDS

TAKEOFF SPEEDS — FLAPS 5° — SLATS EXTENDED										
EITHER NO ICE PROTECTION OR ENGINE ICE PROTECTION ONLY										
TAKEOFF WEIGHT (1000 LB)	70	75	80	85	90	95	100	105	110	115
V ₁ (KNOTS, IAS)	111.0	116.0	121.0	125.5	130.0	134.5	139.0	143.0	147.0	151.0
V _R (KNOTS, IAS)	117.0	121.5	126.0	130.5	134.5	138.5	142.5	146.5	150.0	153.5
V ₂ (KNOTS, IAS)	127.5	131.5	135.5	139.5	143.0	146.5	150.0	153.5	156.5	159.5



*IF V₁ EXCEEDS V_R, SET V₁ EQUAL TO V_R

FLAP RETRACTION SPEED = V₂

SLAT RETRACTION SPEED = FLAP RETRACTION SPEED + 25 KNOTS, IAS = V₂ + 25 KNOTS, IAS

FINAL SEGMENT CLIMB SPEED = 1.38 V_s = APPROX. 100 KNOTS, IAS, + 1 KNOT, IAS, PER 1000 LB OF WEIGHT

(DATA SOURCE: DAC 33530, 12-21-67)

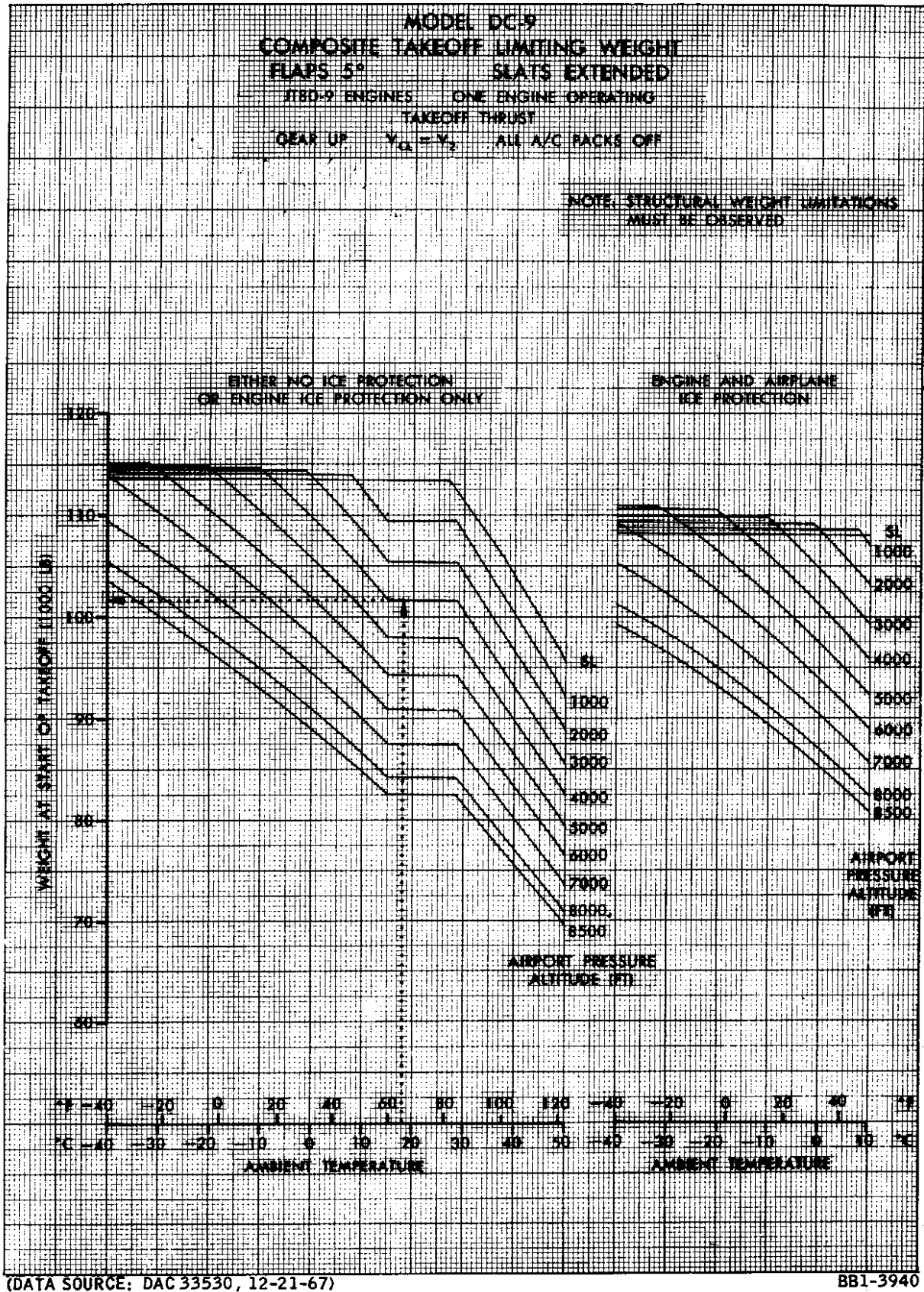
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Figure 8. Takeoff and Transition Speeds

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An easy method of calculation is approximately 100 knots IAS + 1 knot per each 1000 pounds gross weight.

COMPOSITE TAKEOFF OR SECOND SEGMENT
LIMITING WEIGHT

Figure 9 indicates the limiting weight for meeting the required climb gradient capability for the applicable takeoff flap setting. Observe that for the example of temperature and pressure altitude (5 degree flaps, slats extend) the limiting weight is approximately 101,000 lbs. Five degree flaps offers a better gradient capability than a 15 degrees configuration but requires a longer runway.

GRADIENT CAPABILITY

Regulations require a 2.4% gradient capability during the second segment climb. A 1.2% gradient capability must be available while transitioning to the final segment climb and until the airplane is in the clean configuration.

Figure 10 shows the actual gradient capability in relation to temperature pressure altitude and gross weight. Example: the actual gradient capability is 2.8% at the takeoff gross weight of 98,000 pounds, temperature 65°, and pressure altitude of 3000 feet.

OBSTACLE CLEARANCE

Regulations require jet transport aircraft to have a gradient capability that enables the net flight path to clear all obstacles within the bounds of the takeoff flight path by at least

35 feet. For a typical example and detailed explanation of obstacle clearance computations, see the DC-9 FAA Approved Airplane Flight Manual.

CLIMB

Normal climb will be high speed climb, 320/.74M (crossover altitude is approximately 23,500 feet in a standard atmosphere). The desired power setting for climb can be read directly from the RAT/EPR gage. If LRC procedures are to be used at altitude, the climb should be made at 290/.72M. The best rate of climb is approximated by 285 KIAS and is also the recommended airspeed for flight in rough air conditions. (Single engine climb speed and max gradient for all gross weights and altitudes is 1.38 Vs or gross weight plus 100 knots IAS.)

CRUISE

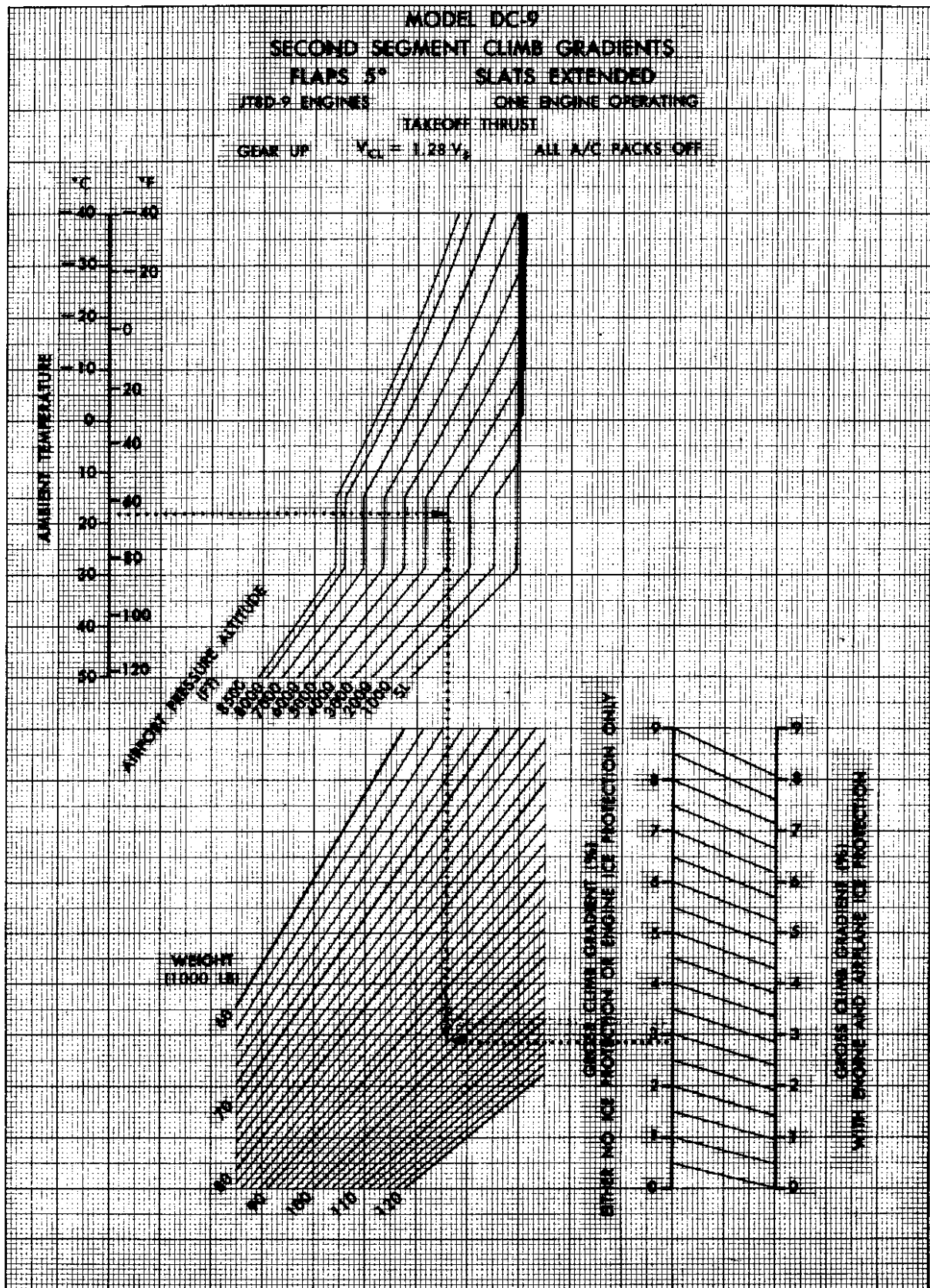
Upon level off at altitude, allow acceleration at climb power until reaching a Mach number .005 to .01 greater than desired before setting power. The throttles should then be reduced to the desired EPR for cruise at .80 Mach. If LRC power is to be used, refer to DC-9 EPR Vs MACH (two engines) Chart (see Figure 11). Note: Example is for a 95,000 pound airplane at 27,000 feet.

DRIFT DOWN WITH LOSS OF AN ENGINE

Assume that trouble requires shut down of an engine while at cruising altitude.

Set MCT power on the good engine (read power setting from RAT/EPR gage). Hold

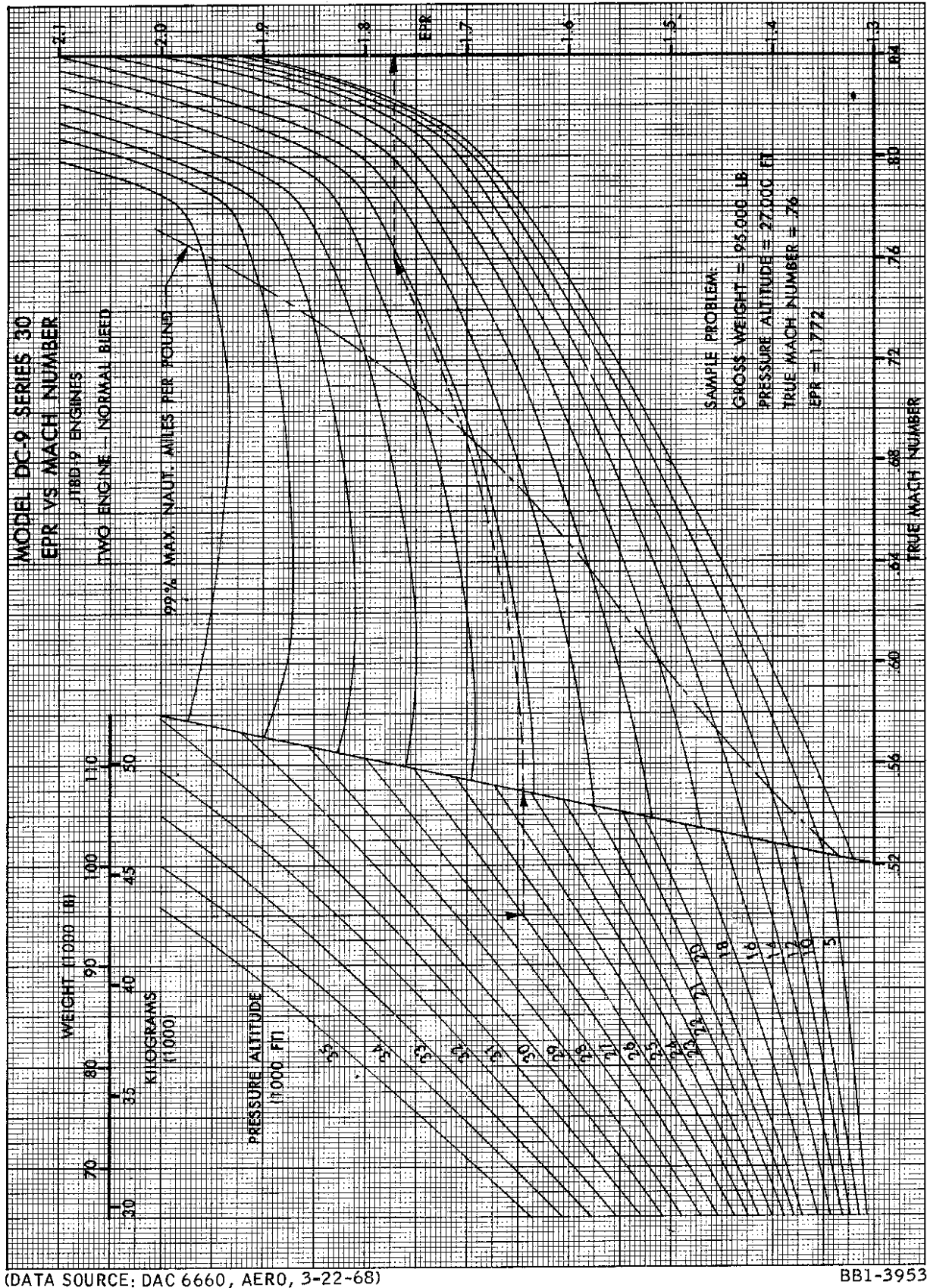
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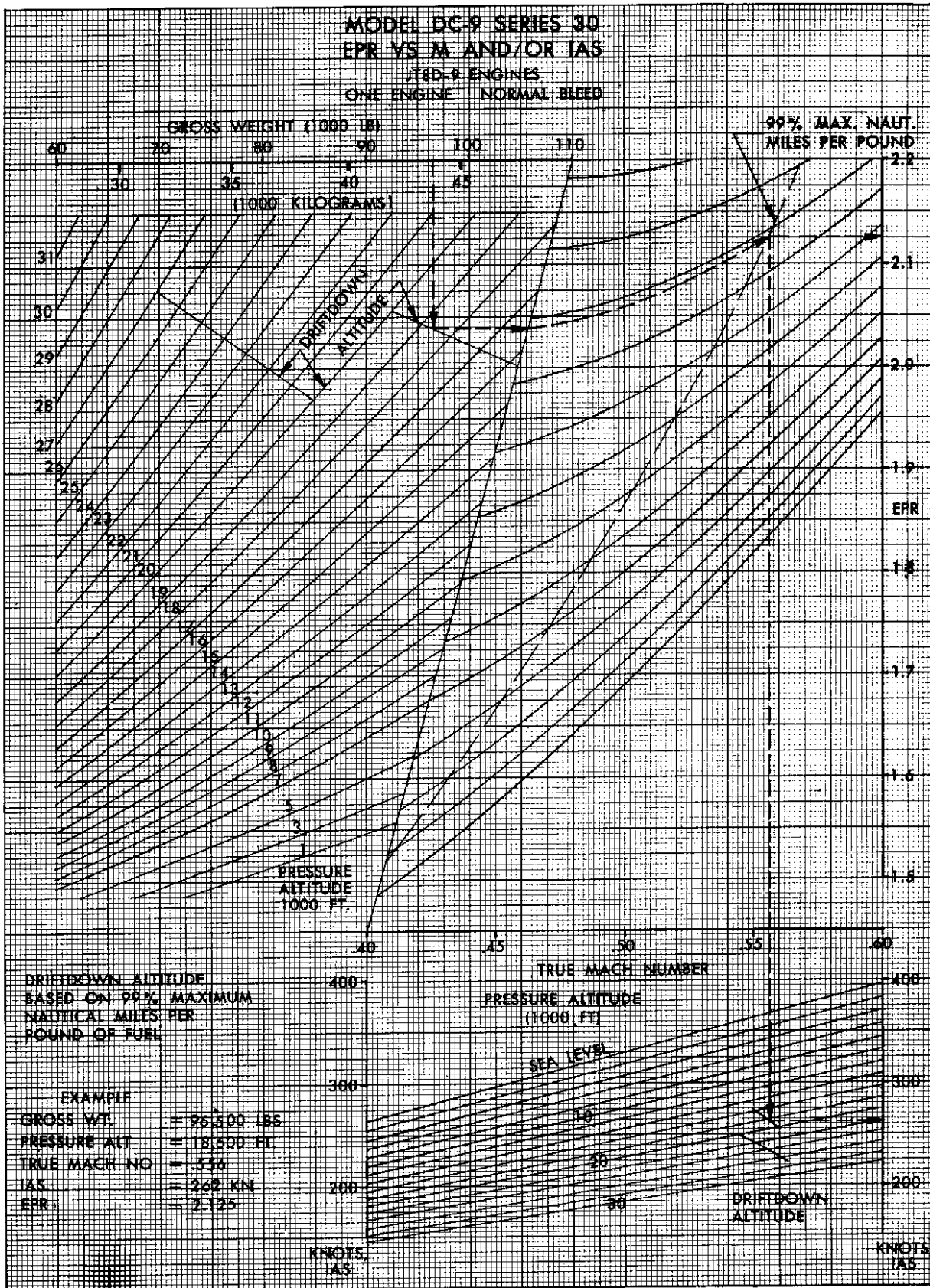
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Figure 11. EPR Vs Mach (Two engines)

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altitude and let the airspeed bleed down to 250 KIAS. Start drift down with descent speed schedule of 250K and power at MCT. Continue descent until reaching driftdown altitude. Under the conditions of this example, the distance covered in driftdown would be about 100 miles. Figure 12 provides the appropriate altitude for level off, as well as the power setting and IAS for LRC. The following example is for a gross weight of 96,500 pounds:

Drift-down altitude.... 18,600 feet
EPR..... 2.125
Mach..... .556
IAS..... 262 KIAS

As weight diminishes due to the burning of fuel, it may be desirable to recompute for the new reduced weight if appreciable time is involved to reach the airport selected for landing.

DESCENT

High speed descent is considered the normal procedure and is most desirable when conditions permit its use. The descent speed schedule is .8 Mach/320 KIAS and with a cabin altitude rate of descent not to exceed 300 ft/Min. LRC descent is made at 250 KIAS. Figure 13 provides distance out to start descent for either high speed or LRC. Example shows that descent should be started at 116 NM from destination if at 29,000 feet and high speed technique is to be used (assume G.W. 91,000 pounds). If LRC descent, start at 97 NM. The cabin descent restriction (higher altitudes) and the speed schedules (lower altitudes) account for the mileage differences in the two procedures.

LANDING FIELD LENGTH AND SPEED

Reference Figure 14. This chart is made considering the FAA requirement of using not more than 50 percent of any headwind, nor less than 150 percent of any tailwind. The landing field length required also considers that only 60 percent of the effective runway length may be used for landing computations at the destination or alternate airports. Note the example in the chart using a landing gross weight of 98,000 pounds, pressure altitude of 4000 feet, and a 10 knot headwind component. This combination requires a landing field length of 4850 feet for a dry runway. The right hand scale of the chart depicts the landing field length for wet runway conditions. In the upper right hand corner read V_{REF} (V_{FLARE}) for this weight (127 Kts).

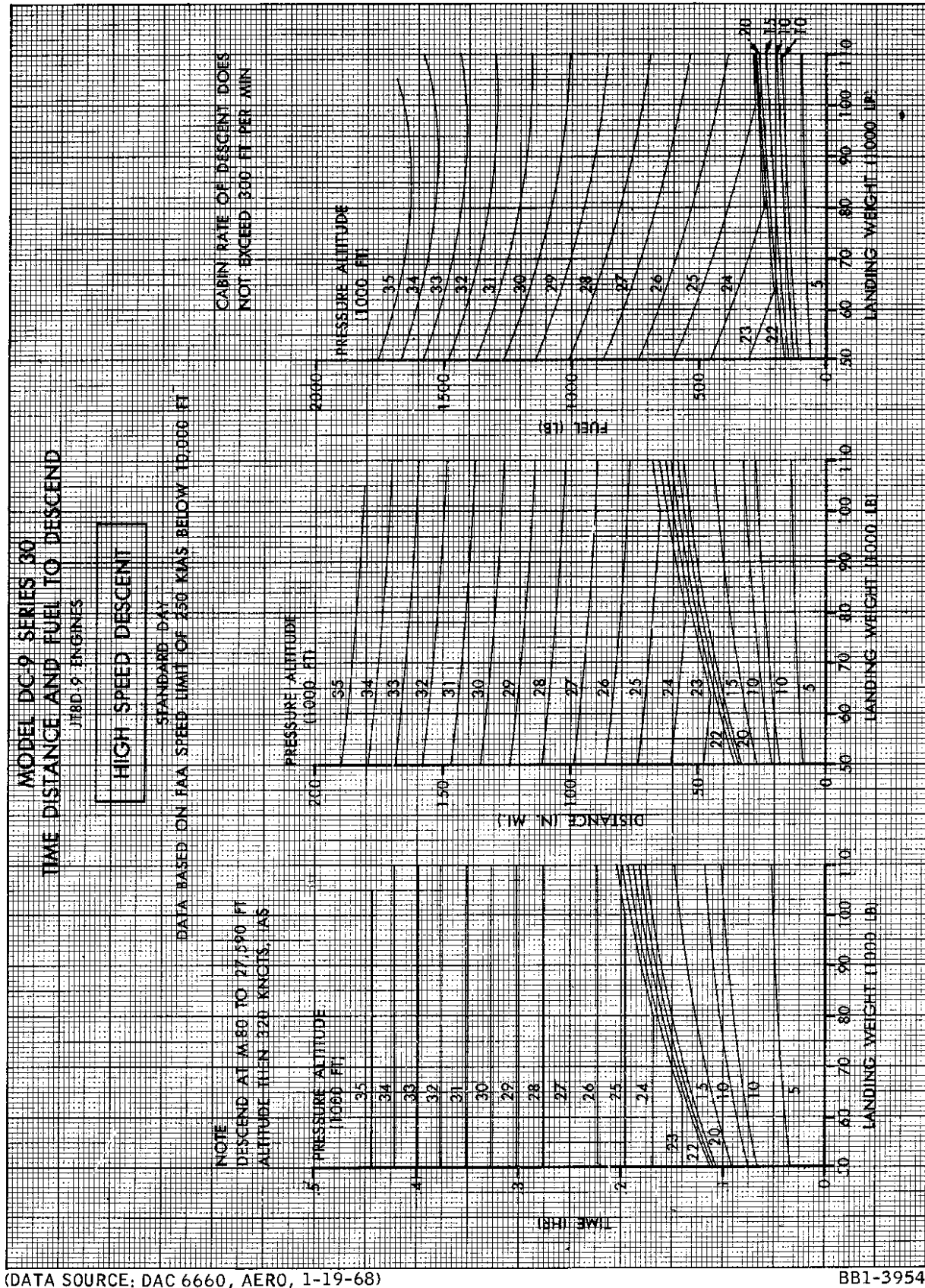
APPROACH CLIMB AND LANDING CLIMB

The airplane is limited in the Landing Climb and Approach Climb configuration only at high weights, and temperatures, and pressure altitudes. Of the two, the approach climb is always the more limiting, and, therefore, is the only one presented here. For information regarding Landing Climb, refer to the FAA Flight Manual. The example on Figure 15 shows that at 46°F, and 3000 feet pressure altitude, the limiting weight in the approach Climb configuration is approximately 104,000 pounds.

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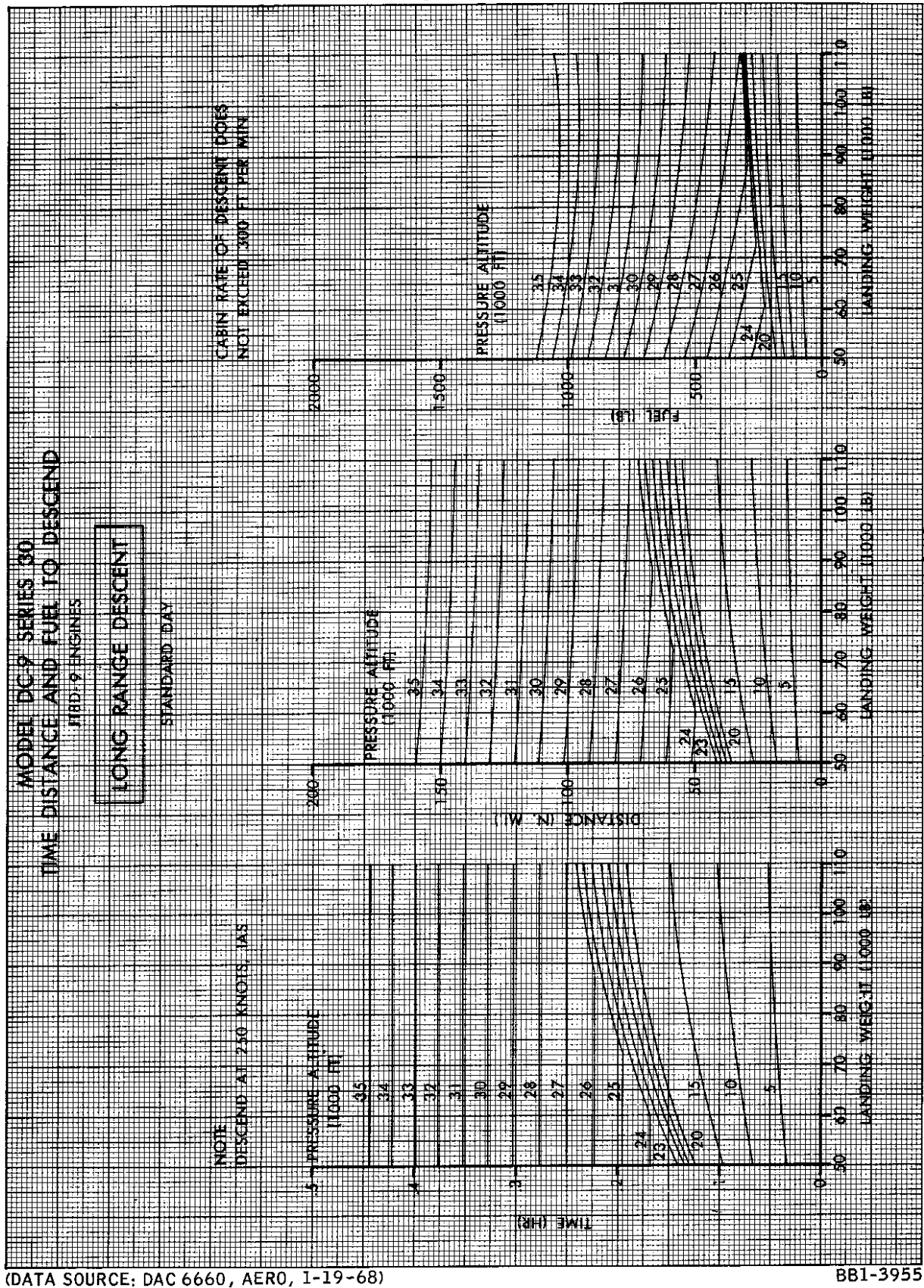


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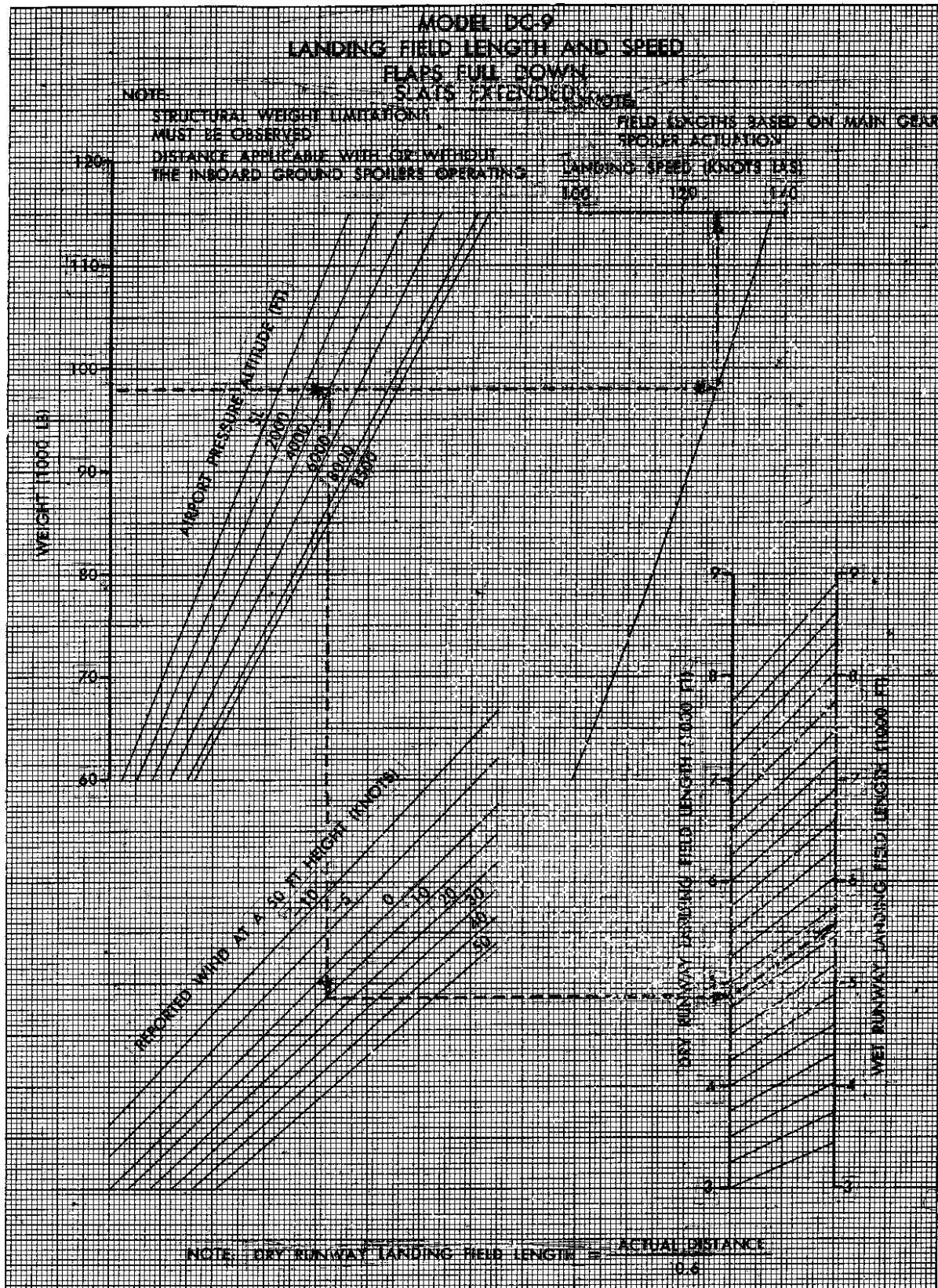
Figure 13. Time, Distance, and
 Fuel to Descend (Sheet 1)

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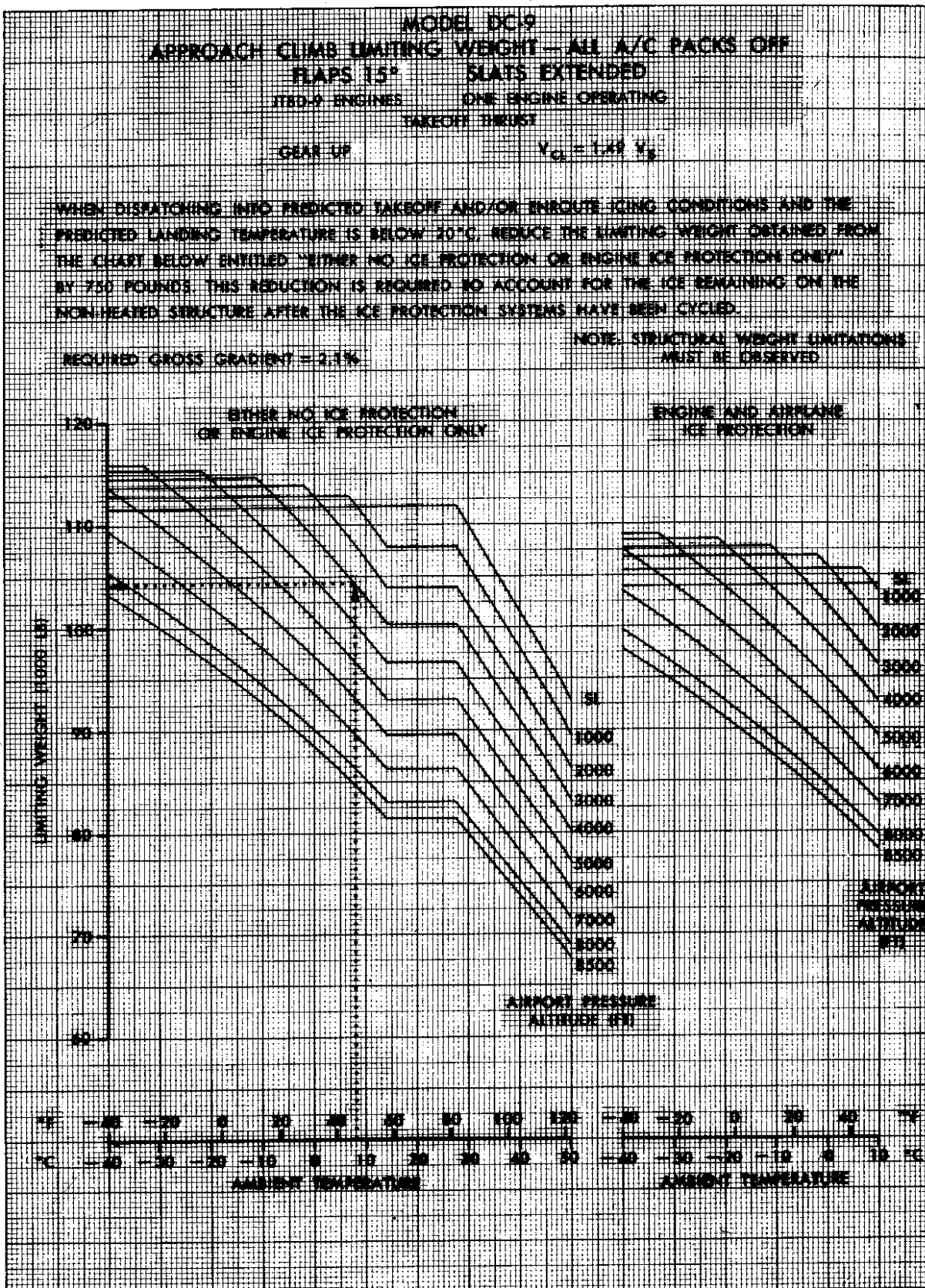


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