WARNING
DO NOT USE THIS MANUAL OR ANY OF THE RELATED MATERIALS IN ANY WAY IN THE OPERATION, USE OR MAINTENANCE OF ANY AIRCRAFT. THESE MATERIALS HAVE BEEN PREPARED AND ARE PROVIDED SOLELY TO GIVE GUIDANCE ON THE LAYOUT AND STRUCTURE OF A TYPICAL AIRCRAFT MANUAL. THESE MATERIALS HAVE NOT BEEN APPROVED BY THE AVIATION ADMINISTRATION FOR USE ON ANY AIRFRAFT AND SHOULD NEVER BE SO USED UNDER ANY CIRCUMSTANCES. FAILURE TO FOLLOW THIS WARNING COULD LEAD TO SERIOUS INJURY OR DEATH.

717

Flight Crew Operations Manual

Volume III – Systems Description

The Boeing Company

Revision Number: 41
Revision Date: April 15, 2017

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Preface — Chapter 0
Chapter Table of Contents — Section TOC

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Preface — Chapter 0
Manual Effectivity — Section 1

General

The airplanes listed in the table below are covered in the Flight Crew Operations Manual (FCOM). The table information is used to distinguish data peculiar to one or more, but not all of the airplanes. Where data applies to all airplanes listed, no reference is made to individual airplanes.

Registry number is supplied by the national regulatory agency. Airplane, serial and tabulation numbers are supplied by Boeing.

Airplane Number	Registry Number	Serial Number	Tabulation Number
0001	TBC01	00001	BC0001

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Revision Transmittal Letter

This revision reflects the most current information available to The Boeing Company through the subject revision date. The following revision highlights explain changes in this revision.

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
Initial	January 15, 1999		1	May 15, 1999	
2	September 15, 1999		3	January 15, 2000	
4	May 15, 2000		5	September 15, 2000	
6	January 15, 2001		7	May 15, 2001	
8	September 15, 2001		9	January 15, 2002	
10	May 15, 2002		11	September 15, 2002	
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16	July 15, 2004		17	January 15, 2005	
18	July 15, 2005		19	January 15, 2006	
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36	October 15, 2014		37	April 15, 2015	
38	October 15, 2015		39	April 15, 2016	

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
40	October 15, 2016		41	April 15, 2017	

General

The Boeing Company issues Flight Crew Operations Manual revisions to provide new or revised procedures and information. Formal revisions also incorporate appropriate information from previously issued Temporary Revisions.

The revision date is the approximate date the manual is mailed to the customer.

Formal revisions include a Transmittal Letter, a new Revision Record, Revision Highlights, and a current List of Effective Pages (LEP).

The Revision Record should be completed by the person incorporating the revision into the manual.

Filing Instructions

Keep applicable Temporary Revisions unless instructed to remove them by the highlights. This manual is revised by pages. To file a revision package, use the LEP to verify the correct content of the manual. On the LEP, pages identified with an asterisk (*) are replacement, new (original) issue or deleted pages. Use the pages provided in the package to add new pages or replace the corresponding pages in the manual. Remove pages that are marked Deleted on the LEP; there are no replacement pages for deleted pages.

Revision Highlights

Throughout the manual, airplane effectivity may be updated to reflect coverage as listed on the Preface - Manual Effectivity page. Registry or tabulation numbers are used as available at the time of printing. Highlights are not supplied.

Highlights and revision bars are provided for technical changes. In some sections, text may be rewritten or reformatted for clarity or other editorial purposes; these changes will have revision bars, but may not have highlights. Pages may also be republished without revision bars due to slight changes to the flow of the document generated by the publishing system.

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Revision Highlights — Section 2

Chapter Air - Air

Section 10 - Description and Operation

Auto Pack Shutdown

Air.10.4...... Revised to reflect the correct operation of the AUTO PACK SHUTDOWN.

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List of Effective Pages — Section 3

Systems Description

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Page	Date
* 0.2.3	April 15, 2017
* 0.2.4	April 15, 2017

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Introduction

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* = Revised, Added, or Deleted

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* = Revised, Added, or Deleted

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Land.50.4	September 15, 2003

* = Revised, Added, or Deleted

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* = Revised, Added, or Deleted

Preface — Chapter 0

Temporary Revision Record — Section 4

TR Number	Date Inserted	TR Number	Date Inserted

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Preface Chapter 0
FCOM Advisory Bulletin Record Section 5

FAB Number	Date Inserted	FAB Number	Date Inserted

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Preface — Chapter 0

Temporary Revision Summary Record — Section 6

NOTE: Remove Temporary Revision(s) cancelled or incorporated.

TEMPORARY REVISION NUMBER	ISSUE DATE	REVISION DATE INCORPORATED
3-1 thru 3-43	Various	Not Applicable, Cancelled or Previously Incorporated

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FCOM Advisory Bulletins

FCOM Advisory Bulletins (FAB) effective for this FCOM have been provided in this chapter as a convenience to operators. FABs will continue to be issued as needed throughout the year.

All FABs have been renumbered, with the number previously associated with the FAB included in the SUBJECT column below. There have been no new technical change to any previously issued FAB.

FAB 717-2-011 is new.

FAB NUMBER	SUBJECT	ISSUE DATE
717-3-001	AIR DATA SENSOR HEATING Service Bulletin 717-30A0003 (Replaces FAB 3-04)	Apr 15/16

FCOM ADVISORY BULLETIN 717-3-001

SUBJECT: AIR DATA SENSOR HEATING – Boeing Service Bulletin 717-30A0003

ISSUE DATE: April 15, 2016

DESCRIPTION AND REASON:

This Advisory Bulletin contains operational information for crews to use after Boeing Service Bulletin 717-30A0003 or production equivalent is installed.

The following Level 1 alerts, found in the sequence of cues providing indications that this problem exists are:

- AOA HEAT L/R FAIL (MISC) – Indicates respective angle of attack probe heater has failed or the AIR DATA HEAT switch is off in flight.
- RAT PROBE FAIL (MISC) – Indicates ram air temperature probe heater has failed or the AIR DATA HEAT switch is off in flight.
- RUD PITOT FAIL (MISC) – Indicates rudder limiter probe heater has failed or the AIR DATA HEAT switch is off in flight. Possible over- or under-restricted rudder.
- STATIC L/R HEAT (STATUS) – Indicates respective static plate heater has failed or the AIR DATA HEAT switch is off inflight.

[END]

Preface — Chapter 0
Introduction — Section 8

The information in the 717 Flight Crew Operations Manual Volume III (Systems Description) is based upon engineering data. For best utilization of the manual the introduction should be read carefully.

The purposes of the Systems Description manual are to:

- Provide detailed aircraft systems information that is controlled and revised.
- Standardize nomenclature.
- Provide a single source reference document for self-teaching.

Basic aeronautical principles have been omitted because the experience of a typical transport category flight crew has been recognized.

The manual is divided into 15 chapters listed alphabetically. Chapters are normally divided into five sections as follows:

- The DESCRIPTION AND OPERATION section is a detailed written description of the system.
- The COMPONENTS section contains illustrations of the major system components.
- The CONTROLS AND DISPLAYS section contains illustrations and descriptions of the system controls, indicators, and applicable LCD displays.
- The ALERTS section contains a table of the applicable alerts that will appear on the LCD.
- The FUNCTIONAL SCHEMATIC section contains integrated functional illustrations and, in some instances, block diagrams of the more complex systems.

Blank pages resulting from the computerized configuration control system are labeled INTENTIONALLY BLANK.

Revisions to the manual will be issued when necessary and are numbered consecutively. Each revision should be inserted immediately. A REVISION RECORD sheet is automatically printed and issued with each periodic revision.

Besides the normal white pages, yellow pages are used to identify the Temporary Revisions (TR). TRs are numbered consecutively and should be inserted immediately upon receipt and entered into the TEMPORARY REVISION RECORD sheet. A TEMPORARY REVISION SUMMARY RECORD sheet is automatically printed and issued with each periodic revision.

FCOM Advisory Bulletins are not considered safety of flight items, but consist of data deemed of enough significance and/or scope that operators are given advance notification of the impending change prior to the next scheduled FCOM revision. FCOM Advisory Bulletins are filed at the front of the appropriate FCOM volume. They are to be retained in the FCOM until operators are notified to remove them.

The style and format of this manual were developed by The Boeing Company after a review of the requirements of a cross section of domestic and international operators. Due to inherent delays in research, compilation, preparation, and printing of technical manuals, this publication may not include the most recent changes to the airplane. Every effort has been made to ensure the currency of the data contained herein. However; all data is subject to change without notice.

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

Comments or inquiries concerning this manual should be addressed to:

Please send all correspondence regarding content or use of this manual, including Service Bulletin status, to the 717 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

ABBREVIATIONS GLOSSARY

A

ABS	Auto Brake System
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACP	Audio Control Panel
ADF	Automatic Direction Finder
ADIRU	Air Data Inertial Reference Unit
ADL	Airborne Data Loader
ADM	Air Data Module
ADS	Automatic Dependent Surveillance
AFS	Auto Flight System
A-ICE	Anti-Ice
AIL	Aileron
ALN	Align
ALT	Altitude; Alternate
ALTN	Alternate
AND	Airplane Nose Down
ANNUN	Annunciator
ANP	Actual Navigation Performance
ANT	Antenna
ANU	Airplane Nose Up
AOC	Aeronautical Operational Communications
AP	Autopilot
APCDU	APU Power Conversion and Distribution Units
APU	Auxiliary Power Unit

AREU	Audio Remote Electronics Unit
ARPT	Airport
ARR	Arrival
A/S	Airspeed
AT or A/T	Autothrottle
ATC	Air Traffic Control
ATR	Automatic Thrust Restoration
ATS	Autothrottle System
ATT	Attitude, Attendant
ATTND	Attendant
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available

B

BARO	Barometric
BATT	Battery
BLS	Bezel Light Sensor
BRT	Bright; Brightness

C

C	Celsius, Center
CAP	Capture
CAPT	Captain
CAWS	Central Aural Warning System
CG	Center of Gravity
CH, CHAN	Channel
CHR	Chronograph
CKPT	Cockpit
CL	Closed
CLB	Climb
CLMP	Clamp

CLR	Clear
CMD	Command
CMP, CMPTR	Computer
COMM	Communication
CONFIG	Configuration
CONSEQ	Consequence
CONT	Control; Continuous
CPA	Closest Point of Approach
C/PDLC	Controller/Pilot Datalink Communications
CRS	Course
CRZ	Cruise
CTR	Center; Crosstie Relay
CVR	Cockpit Voice Recorder

D

DC	Direct Current
D/D	Driftdown
DECR	Decrease
DEG	Degree
DEP	Departure
DES, DESC	Descent
DEST	Destination
DET	Detector; Detection, Detect
DFDAU	Digital Flight Data Acquisition Unit
DFDR	Digital Flight Data Recorder
DH	Decision Height
DIR INTC	Direct Intercept
DISAG	Disagree
DME	Distance Measuring Equipment
DTG	Distance To Go
DTW	Distance To Waypoint
DU	Display Unit

E

EAD	Engine and Alert Display
ECON	Economy
ECP	Electronic Control Panel
ECU	Electronic Control Unit
E/D	End Of Descent
E/E	Electrical/Electronic
EEC	Electronic Engine Control
EGT	Exhaust Gas Temperature
EIS	Electronic Instrument System
ELEC	Electric; Electrical
EMER	Emergency
ENG	Engine
ENG OUT D/D	Engine Out Driftdown
E/O	Engine Out
EPCU	Electrical Power Control Unit
EPR	Engine Pressure Ratio
ET	Elapsed Time
ETA	Estimated Time Of Arrival
ETD	Estimated Time Of Departure
ETE	Estimated Time En Route
EXEC	Execute
EXT	External; Extend

F

F	Fahrenheit
FADEC	Full-authority Digital Electronic Control
FANS	Future Air Navigation System
FCC	Flight Control Computer
FCOM	Flight Crew Operations Manual
FCP	Flight Control Panel

FD	Flight Director
FF	Final Approach Fix
F-F	Fuel Flow
FGS	Flight Guidance System
FL	Flight Level
FLAR	Flare
FLEX TO	Flex Takeoff
FLO	Flow
FLR	Flare
FLT	Flight
FLT DIR	Flight Director
FLT RCDR	Flight Recorder
FMA	Flight Mode Annunciator
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FPA	Flight Path Angle
FPM	Feet/Minute
FQS	Fuel Quantity System
FREQ	Frequency
FT	Feet
FWD	Forward

G

G	Acceleration Of Gravity, Generator
GA, G/A	Go-Around
GEN	Generator
GMT	Greenwich Mean Time
GNSSU	Global Navigation System Sensor Units
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GS	Ground Speed; Ground Service

GS or G/S	Glideslope
GW	Gross Weight

H

HDG	Heading
HF	High Frequency
HI	High
HLD	Hold
HP	High Pressure
HYD	Hydraulic

I

I/O	Input/Output
IAS	Indicated Airspeed
IDENT	Identifier; Identification
IDG	Integrated Drive Generator
ILS	Instrument Landing System
INCR	Increase
IN HG	Inches of Mercury
INIT	Initialization
INOP	Inoperative
INSTR	Instrument
INT	Intercom; Intermittent
INTC	Intercept
INTPH	Interphone
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISOL	Isolation

K

KIAS	Knots Indicated Airspeed

L

L	Left
LAND	Landing
LAT	Lateral; Latitude
LBS	Pounds
LCDU	Liquid-Crystal Display Units
LDG	Landing
LED	Light Emitting Diode
LIM	Limit
LNAV	Lateral Navigation
LND	Land
LO	Low
LOC	Localizer
LONG	Longitude
LP	Low Pressure
LRC	Long Range Cruise
LSK	Line Select Key
LT(S)	Light(s)
LWD	Left Wing Down

M

M	Mach, Meters
MAG	Magnetic
MAINT	Maintenance
MAN	Manual, Maneuvering
MAX	Maximum
MAX ALT	Maximum Engine Out Altitude
MAX CLB	Maximum Climb
MAX DES	Maximum Descent
MAX END	Maximum Endurance
MB	Millibars

MCDU	Multipurpose Control and Display Unit
MCL	Maximum Climb (Engine Rating)
MCT	Maximum Continuous Thrust (Engine Rating)
MECH	Mechanic
MED	Medium
MIC	Microphone
MIN	Minimum; Minute
MISC	Miscellaneous
MKR	Marker
MLG	Main Landing Gear
MLW	Maximum Landing Weight
MMEL	Master Minimum Equipment List
MMO	Maximum Operating Mach
MOM	Momentary
MSG	Message
MSP	Mode Select Panel
MTES	Maintenance Test Enable Switch
MTOGW	Maximum Takeoff Gross Weight
MU	Management Unit

N

N/A	Not Available
NACL	Nacelle
N1	Engine Low Pressure Rotor RPM
N2	Engine High Pressure Rotor RPM
NAV	Navigation
ND	Navigation Display
NDB	Non-Directional Beacon
NL	Nose Left
NLG	Nose Landing Gear
NR	Nose Right
NORM	Normal

O

OFST	Offset
OP	Open
OVHD	Overhead
OVRD	Override
OXY	Oxygen

P

PA	Passenger Address
PBD	Place/ Bearing/ Distance
PBE	Protective Breathing Equipment
PED	Pedestal
PERF PEN	Performance Penalty
PFD	Primary Flight Display
PLAN	Plan Mode
PLI	Pitch Limit Indicator
PMP	Pump
PNEU	Pneumatic
PNL	Panel
POS	Position
PPH	Pounds Per Hour
PRAM	Prerecorded Announcement Machine
PRES, PRESS	Pressure
PROF	Profile
PROG	Progress
PROX	Proximity
PSEU	Proximity Switch Electronics Unit
PSI	Pounds Per Square Inch
PSU	Passenger Service Utilities
PTT	Push To Talk
PTU	Power Transfer Unit

PWR	Power
PWS	Predictive Windshear

Q

QFE	Field Elevation Pressure
QNH	Sea Level Pressure
QTY	Quantity

R

R	Right
RA	Radio Altitude, Resolution Advisory
RAT	Ram Air Temperature
RDR	Rudder
REF	Reference
RET	Retract
RETD	Retard
REV	Reverser
RHM	Rudder Hook Monitor
RLS	Remote Light Sensor
RNAV	Area Navigation
RNP	Required Navigation Performance
RPM	Revolutions Per Minute
RSL	Rudder Stop Limiter
RTE	Route
RTO	Rejected Takeoff
RUD	Rudder
RWD	Right Wing Down
RWY	Runway

S

SAT	Static Air Temperature
SATCOM	Satellite Communication System

SCP	System Control Panel
S/C	Step Climb
S/D	Step Descent
SD	System Display
SDP	System Display Panel
SEL	Select; Selector; Selected
SELCAL	Selective Calling
SENS	Sensitivity
SID	Standard Instrument Departure
SMOK	Smoking
SPD	Speed
SPD BRK	Speed Brake
STAB	Stabilizer; Stabilization
STAR	Standard Terminal Arrival Route
STBY	Standby
STD	Standard
SW	Switch
SYNC	Synchronizer
SYS	System

T

TA	Traffic Advisory
TAKOFF	Takeoff
TAS	True Air Speed
TAT	Total Air Temperature
TBD	To Be Determined
TCAS	Traffic Alert Collision Avoidance System
TD	Traffic Display
TEMP	Temperature
TFR	Transfer
TGT	Turbine Gas Temperature

THNDSTRM	Thunderstorm
THROT	Throttle
TO, T/O	Takeoff
TOC	Top Of Climb
TOD	Top Of Descent
TO FLEX	Takeoff Flexible Derate
TOGA	Takeoff and Go-Around
TOGW	Takeoff Gross Weight
TR	Transformer Rectifier
TRANS	Transition; Transfer
TRFC	Traffic
TRK	Track
TRU	True
TURB	Turbulence

U

U/L	Unlocked
UNBAL	Unbalanced

V

Vapp	Approach Speed
VDC	Volts Direct Current
VERT	Vertical
Vfe	Flap Extend Speed
Vfr	Flap Retract Speed
Vge	Gear Extend Speed
Vgr	Gear Retract Speed
VHF	Very High Frequency
VIA	Versatile Integrated Avionics
VIB	Vibration
VLV	Valve
Vmax	FMC Calculated Max Operating Speed

Vmin	FMC Calculated Min Operating Speed
Vmo	Maximum Operating Speed
VNAV	Vertical Navigation
VOL	Volume
VOR	VHF Omnidirectional Range
Vref	Reference Approach Speed
Vs	Stall Speed
Vse	Slat Extend Speed
Vso	Clean Stall Speed
Vsr	Slat Retract Speed
Vss	Stick-shaker Speed
V/S	Vertical Speed
VSI	Vertical Speed Indicator
V1	Critical Engine Failure Speed; Decision Speed
V2	Takeoff Safety Speed; Climbout Speed
V3	Final Segment Climb Speed

W

WAGS	Windshear Alert Guidance System
WARN	Warning
WINDSHLD	Windshield
WINDSHR, WNDSHR	Windshear
WOW	Weight On Wheel
WPT	Waypoint
W/S	Windshear
WSC	Windshear Computer
WT	Weight
WX, WXR	Weather Radar
WXBRT	Weather Radar Brightness
WX+T	Weather and Turbulence

X

X FEED	Crossfeed
XFER, XFR	Transfer
XPDR	Transponder

Z

ZFW	Zero Fuel Weight
ZFWCG	Zero Fuel Weight Center of Gravity

Intentionally
Blank

General

This chapter describes general airplane information and specific information for the following:

* Cockpit.
* Cabin.
* Passenger forward entrance and service doors.
* Passenger forward entrance stairway (optional).
* Passenger aft emergency exit door.
* Lighting systems.
* Alerting system.

The 717 airplane is powered by two aft-mounted turbofan engines. Minimum crew required is two pilots. Separate seating is provided for a cockpit observer and up to four cabin attendants.

The fuselage consists of nose, center, and tail sections. In addition to the cockpit and the cabin, the fuselage contains main and nose gear wheel wells and various compartments for accessories, electrical/electronics, and forward and aft lower cargo.

The tail consists of a vertical stabilizer, a horizontal stabilizer, two elevators, and a rudder.

The detachable tailcone may be jettisoned on the ground for emergency exit. A door, mounted in the lower forward portion of the tailcone, provides external access to the aft accessory compartment.

Cockpit

The pilot seats are fully adjustable in fore-and-aft, up-and-down directions, and reclines with positive locking in any position. A non-adjustable seat is provided for a flight observer.

To aid each pilot in attaining a precise seat adjustment, an alignment device is provided under the glareshield on each side of the instrument panel. To properly adjust the seat, each pilot must look across the cockpit to the alignment target. When the seat is properly adjusted, the pilot should see a white dot centered in the right eye target locator.

The cockpit contains four different types of windows: a center and two side windshields; a clearview and an aft window on either side; and two upper (eyebrow) windows immediately above the clearview windows. The eyebrow windows are not installed on later production airplanes.

The windshields are electrically heated for anti-icing, anti-fogging and bird impact resistance.

The clearview windows can be opened when the cockpit is not pressurized. They also provide an emergency exit using the escape lines stowed directly above them. These windows are electrically heated for anti-fogging, but not for anti-icing. The eyebrow windows are electrically heated for anti-fogging. The aft windows are not heated.

A fire extinguisher and fire axe are provided in the cockpit.

The vacuum waste status panel has a SYSTEM INOP switchlight. The vacuum waste status panel is located on the attendant panel at the forward attendant station. The light illuminates when the tank is full, the two ultrasonic level sensors fail, or a complete logic control module failure occurs. The SYSTEM INOP switchlight can start a built-in-test.

Reinforced Cockpit Door

Normal Operation

The reinforced cockpit door and remote access system meets requirements for resistance to ballistic penetration and intruder entrance. The remote access system consists of a remote keypad and the FLT DECK DOOR control panel.

The remote keypad, located on the forward flight attendant station, includes entry keys for entering the numeric access code along with red, amber, and green access lights (LED). Operation of the keypad is not intended for routine use in entering the cockpit, but rather is intended to allow entry when it is believed that the pilot(s) is incapacitated. The FLT DECK DOOR control panel, located on the overhead panel, includes a selector and LOCK FAIL and AUTO UNLK indicator lights.

In access mode operation, an aural alert and illumination of the amber AUTO UNLK light indicates the correct access code has been entered on the keypad. Selecting the DENY position on the FLT DECK DOOR selector denies entry and prevents further keypad entry for five minutes. To allow cockpit entry, the selector is pushed and turned to the UNLK position, which unlocks the door while held in that position. The aural alert sounds and the LOCK FAIL light is illuminated.

Emergency Operation

In emergency operation, if the correct access code is entered and the pilot(s) is incapacitated, the door will unlock automatically for five seconds after a programmed time (60 seconds) delay. The aural alert will sound intermittently and the AUTO UNLK light will flash before the door is unlocked.

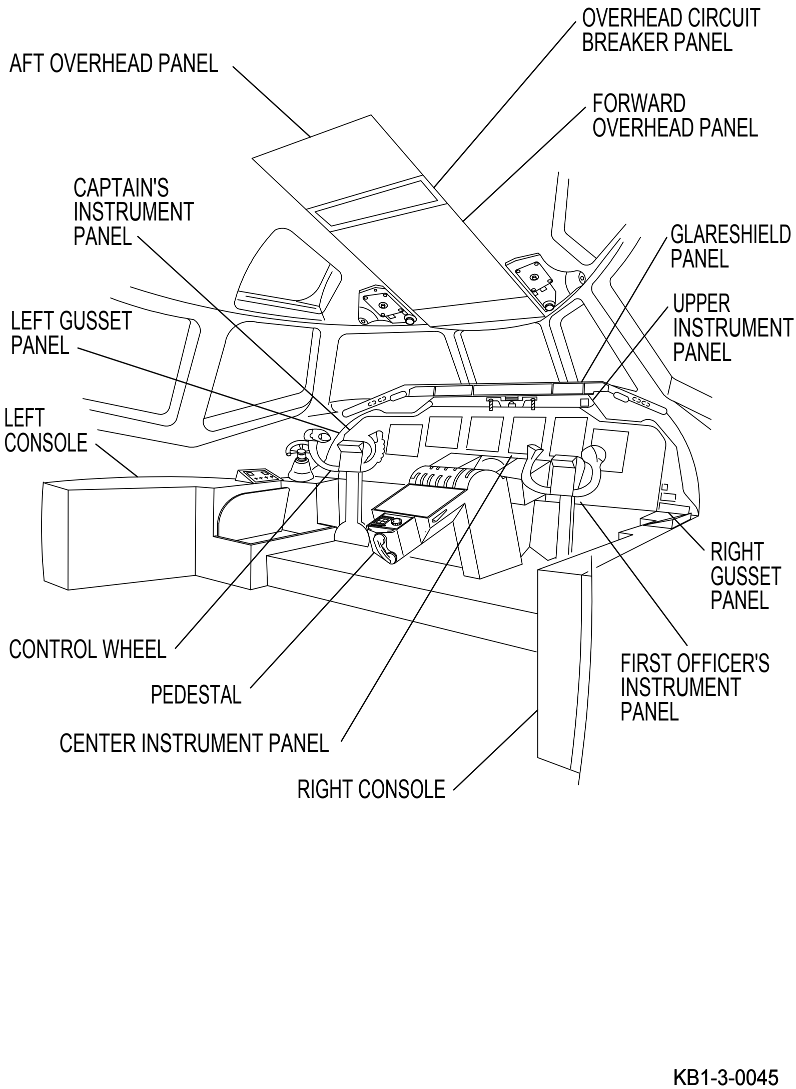
A door latch handle is used to exit the cockpit in normal operation. In the event the door latch handle becomes inoperable, the door may be opened using the pull assembly (D-ring) located at the top of the door (deadbolt must be unlocked). If the door does not unlock using the latch handle or the D-ring, a decompression panel may be used for egress. To exit through one of the decompression panels, lift the latch release tab to the red zone and pull the latch bolt. The decompression panel will then pull forward and away from the door.

A deadbolt, located on the upper edge of the door, is used to secure the cockpit for MEL relief if normal locking system or mechanism fails.

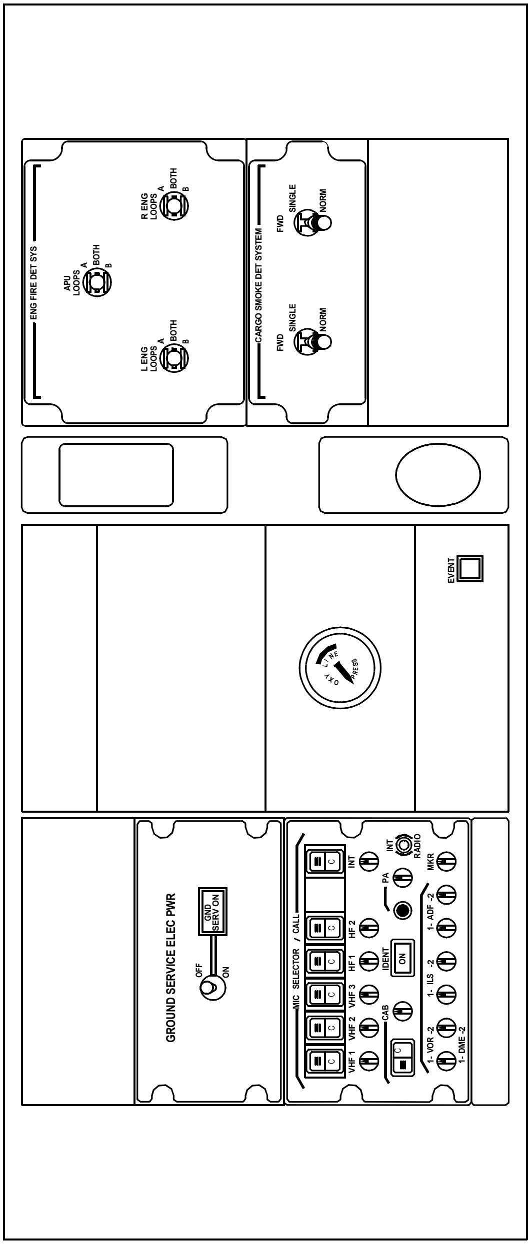
If the right DC Bus is not powered, the aural and visual alerts will not function and the deadbolt should be used to secure the cockpit.

If the left DC Bus is not powered, the keypad will not function. However; the door solenoid will switch over to the right DC Bus and the door will remain locked. Entry can be made manually using operator established procedures.

Cockpit Arrangement



Aft Overhead Panel



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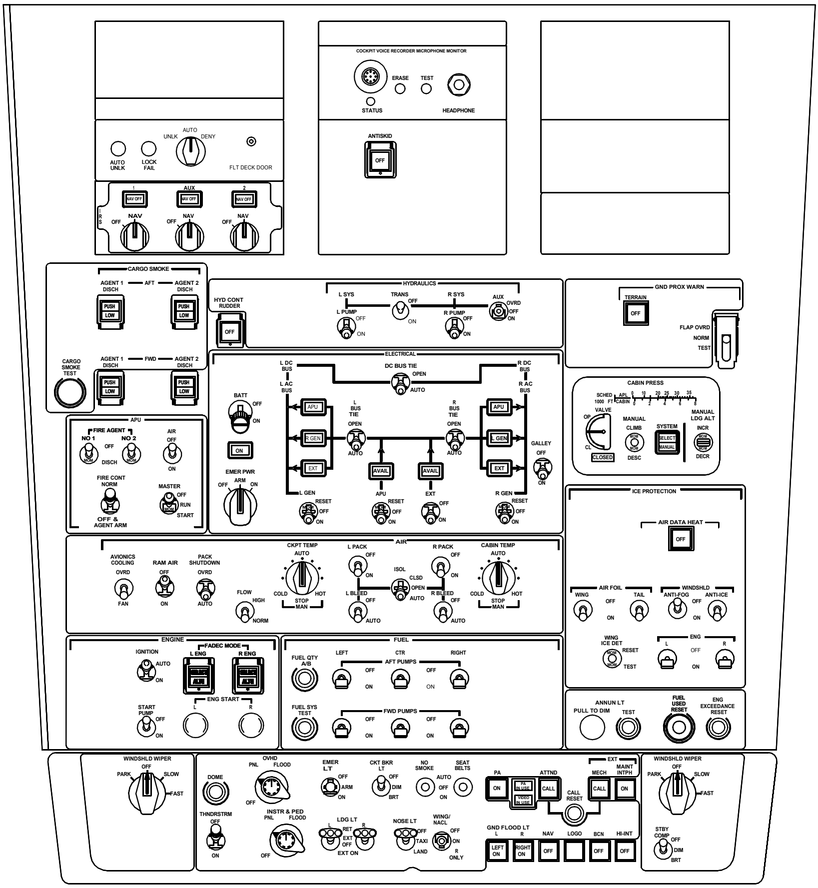
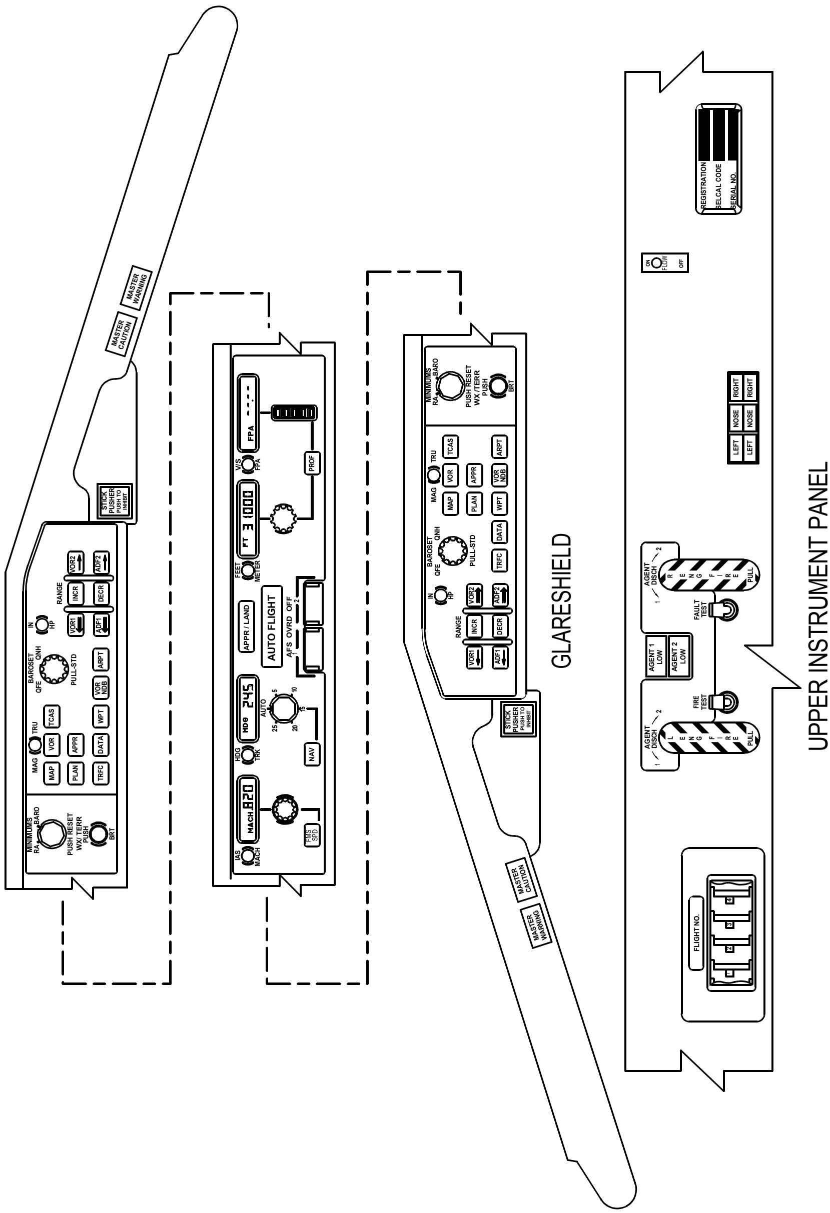
Forward Overhead Panel



Glareshield and Upper Instrument Panel



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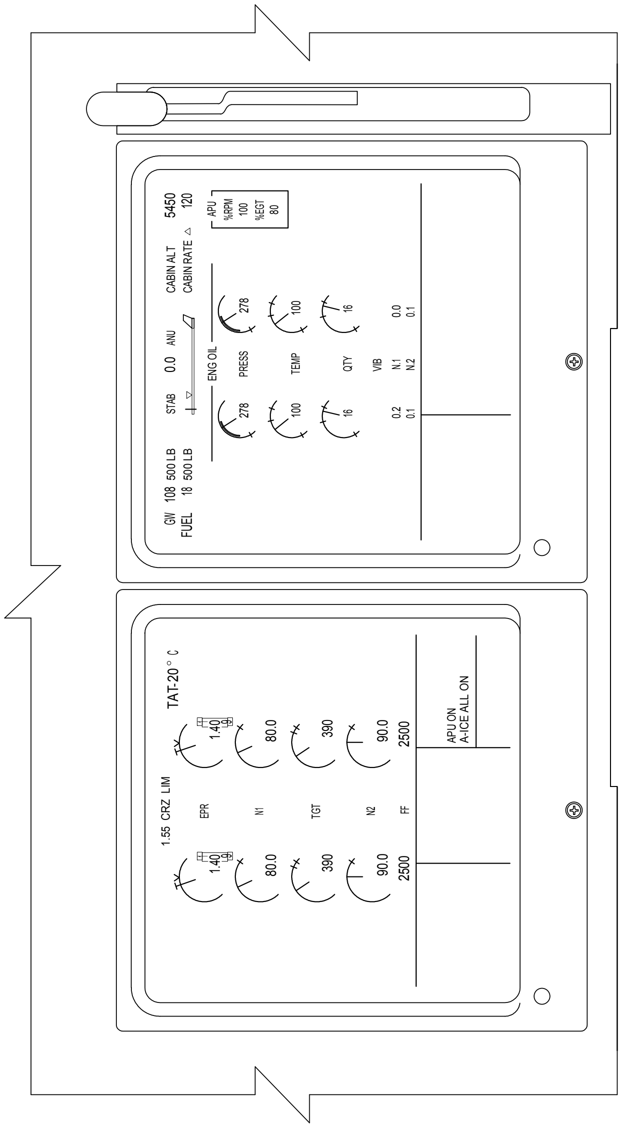
Center Instrument Panel



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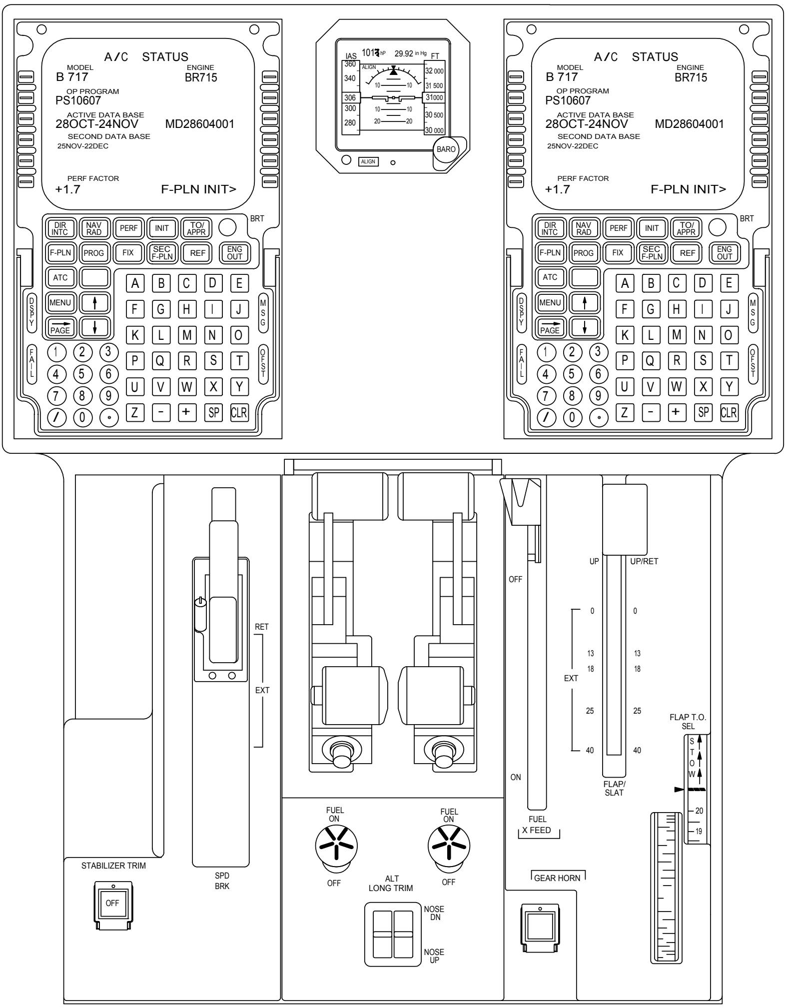
Forward Pedestal



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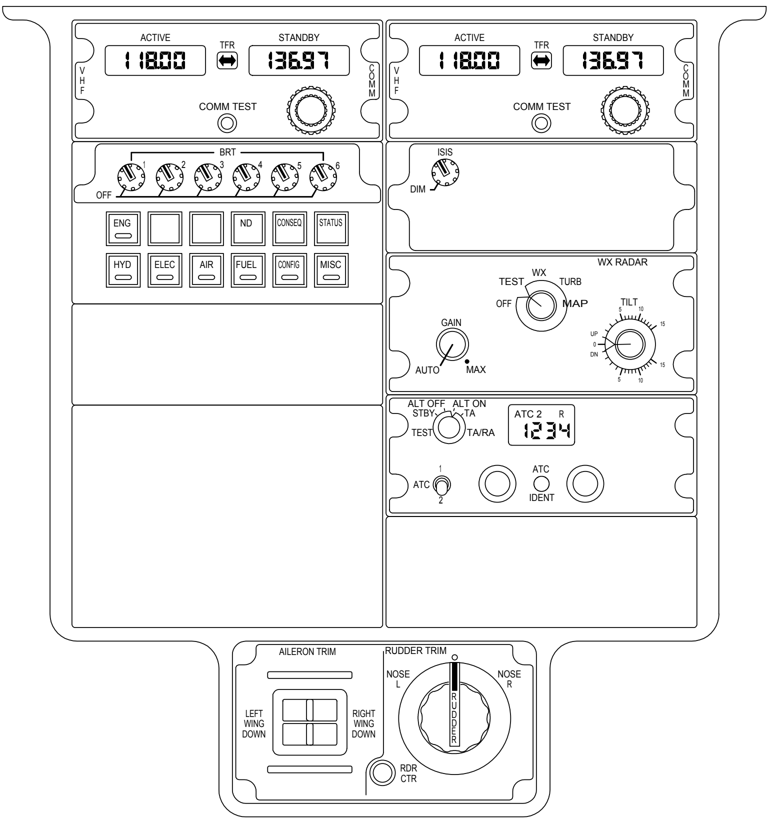
Aft Pedestal



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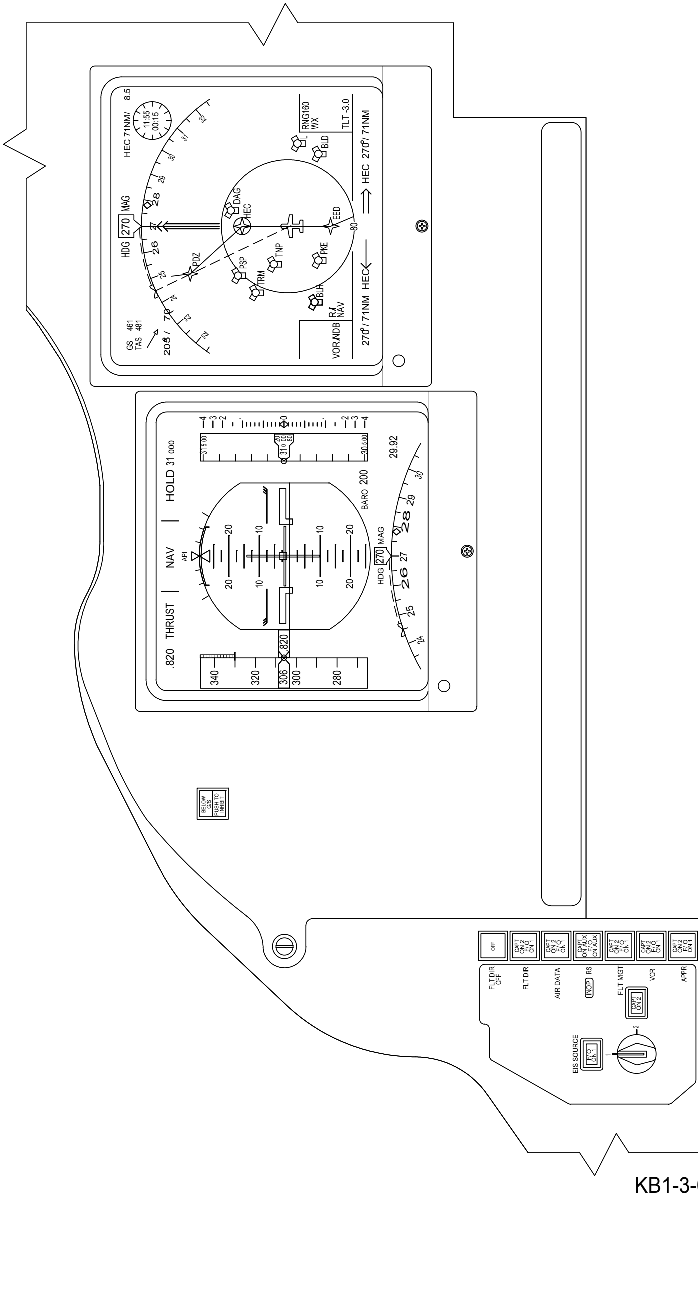
Captain's Instrument Panel



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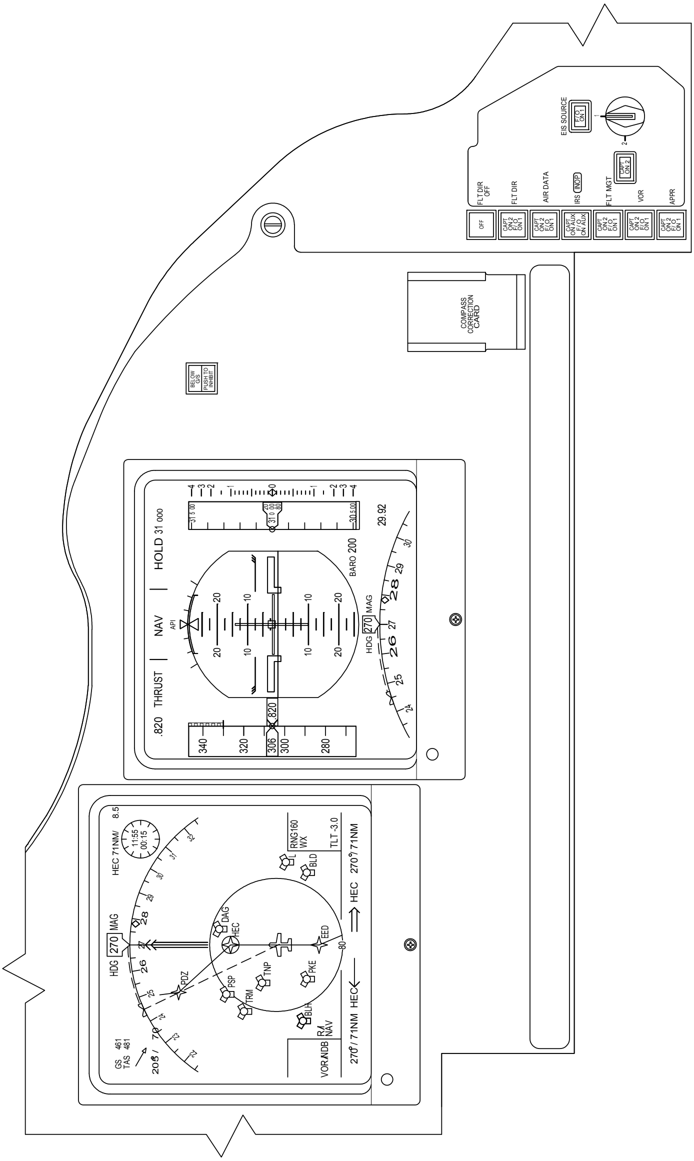
First Officer’s Instrument Panel



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Cabin

Two cabin attendant's stations with control panel and oxygen masks are provided for four cabin attendants. Two cabin attendant's seats are located forward, at the left of the cockpit door, and two are located aft at the aft emergency exit door.

Passenger Service Utilities (PSU), consisting of reading lights, cold air outlets, attendant call buttons, and oxygen compartments, are grouped on panels mounted on the overhead stowage rack lower surface.

All passenger seat backs, except on the outboard seats forward of each overwing exit, are adjustable in the recline position and can be forced to fold down flush with the seat cushions.

All armrests, except the ones mounted next to the overwing exit doors, may be folded up flush with the seat back. The seat bottom cushions can be used as flotation gear.

Three galley units are installed in the cabin. Galleys G1 and G2 are located forward on the right side of the cabin adjacent to the forward service door. Galley G3 is located forward on the left side of the cabin.

Potable Water System

The airplane has a pressurized potable water system. The system supplies water to galley 1 and the lavatories. The airplane pneumatic system pressurizes the water system for distribution. The system can be pressurized for ground maintenance at the water service panel. The water system has a quantity pre-select function with automatic shutoff for servicing.

The potable water system has a 47 gallon (177.9 L) water supply tank with a preset fill capacity of 30 gallons (113.55 L) for usual operation. The tank is in the fuselage right tunnel, aft of the forward cargo door.

The water service panel is on the lower left side of the fuselage, opposite the water supply tank. The service panel has the controls and indications necessary for servicing. During servicing operations, lights on the service panel show valve position and the water level in the water supply tank.

The potable water system has water supply, air supply, fill and drain lines. Rigid lines are stainless steel and flexible lines are braided hoses. Electrical heaters prevent freezing of the water supply lines when the airplane is on the ground.

A two-channel Logic Control Module (LCM) monitors the vacuum waste toilet system. Indicator lights, on the front of the module, show system status. The LCM has built-in-test capability to record failed system components. The LCM stops toilet operation and causes the SYSTEM INOP switchlight to illuminate if any of the following conditions occur:

* A full waste tank assembly
* Two ultrasonic level sensors fail
* A failure of the two channels of the LCM.

Lavatories

A toilet assembly is in each lavatory. The toilet assembly is installed behind a removable shroud. It is a self-contained line replaceable unit with electrical and plumbing connections. The toilet includes the following:

* A toilet bowl
* A Flush Control Unit (FCU)
* A flush valve
* A rinse water valve

The toilet bowl has a rinse ring with three rinse nozzles. The rinse water valve controls the water to the rinse ring. The three rinse nozzles let water go to the upper-inside surface of the toilet bowl to rinse the bowl during the flush cycle.

The FCU is an electronic component that controls the flush sequence of the related toilet assembly. The FCU is on the bottom and side of the toilet assembly. The FCU controls the operation sequence of the flush valve and rinse water valve during the flush cycle. The flush control unit starts the flush cycle by a signal from the flush switch.

The flush valve attaches to the lower part of the toilet assembly. This valve has a disc that turns with control by an electrical motor. The motor operates by open and close signals from the FCU. The motor operates an electromechanical actuator that opens and closes the valve 90 degrees. When the flush valve opens, the toilet contents go out the waste pipe. At the end of the flush cycle, the FCU sends a signal to close the flush valve.

A manual override handle is on the bottom and front of the toilet assembly. The manual override handle lets you close the flush valve manually if the motor does not close the valve electrically.

The rinse water valve is behind the toilet assembly. The rinse water valve is the interface with the potable water system. The FCU supplies signals to operate a solenoid in the rinse water valve. When the solenoid energizes, the rinse valve opens for 0.7 seconds. When the valve is open, 6 to 8 ounces of water flow from the rinse water valve to the rinse ring.

The rinse water valve includes an anti-siphon valve. The anti-siphon valve prevents the flow of liquid back from the toilet bowl into the potable water system.

Logic Control Module

The vacuum waste toilet system components have electrical interfaces for system control and fault detection. The LCM is the central component that controls power for and monitors the vacuum waste toilet bowl system operation. The LCM has two redundant channels (A and B). The LCM also monitors and shows system fault data.

The power for the vacuum waste toilet system is from the AC and DC ground service buses. This lets the system operate when only ground service power is available during ground servicing and cleaning operations.

The LCM gets 28 VDC power for the operation of the two channels. The 28 VDC power for each FCU also goes to the LCM. The LCM controls this power to the FCUs. If the waste tank assembly is full or a critical fault occurs, the LCM stops the power to the FCUs. The LCM gets flush-in-progress signals from the FCUs. These signals make sure the flush sequence completes if the waste tank assembly becomes full or a critical fault occurs during the flush cycle.

The vacuum blower motor operates with 3-phase AC power from the ground service bus. The control power for the vacuum blower comes from the DC ground service bus.

The FCU controls the flush sequence for the related toilet assembly. The FCU controls the operation of the flush and rinse water valve. The FCU sends the flush valve as open or close signal for the DC motor to operate the valve. The flush valve supplies valve position signals back to the FCU. The rinse water valve gets a signal to energize a solenoid and open the valve.

The vacuum blower supplies system differential pressure when the airplane is on the ground or the airplane altitude is less than 16,000 ft (4876.80 m). The vacuum blower gets 3-phase 115 VAC through a blower control relay. The blower control relay energizes with the following conditions:

* Altitude switch senses as altitude less than 16,000 ft (4876.80 m)
* Service panel door switch senses the door is in a closed position
* Thermostats, in the vacuum blower, do not sense a blower motor over temperature.

The blower motor control relay de-energizes and stops the vacuum blower if the airplane is more than 16,000 ft (4876.80 m) or the service door is open. If the thermostats sense a blower motor over temperature, the blower relay de-energizes and the vacuum blower stops. The thermostats set again automatically when the blower cools, the blower relay energizes, and the vacuum blower operates again.

The LCM supplies fault isolation and identification for the vacuum waste toilet system. The LCM monitors the two channels for correct operation. The LCM also gets inputs from:

* Ultrasonic level sensors, for failure or wet (full tank) condition
* Vacuum blower thermostats, for an over temperature condition.

If a condition occurs that causes the system to stop, the LCM sends a signal to the vacuum waste status panel. This signal causes the SYSTEM INOP light to illuminate. The logic control module stops system operation when any of these conditions occur:

* Two ultrasonic level sensors sense a full tank
* Two ultrasonic level sensors fail
* Ultrasonic level sensor fails and one senses a full tank
* Two channels of the LCM fail.

The LCM gets an input when you push the SYSTEM INOP switchlight to start a built-in-test. When the built-in-test is completed, the LCM supplies test status back to the vacuum waste status panel. The SYSTEM INOP switchlight illuminates if the LCM senses a critical fault or a full tank.

Passenger Forward Entrance and Service Doors

The passenger forward entrance door is located on the left side of the fuselage, and the service door is located on the right side. Either door can be opened from either inside or outside of the airplane. A viewing window and evacuation slide are installed on each door.

Aft Emergency Exit Door

The passenger aft emergency exit door provides access to the aft accessory compartment and tailcone emergency exit. The door is mounted on the aft pressure bulkhead and hinged on the right side. A viewing window located in the door handle recess allows inspection of the exit way on the aft side of the door. The aft cabin attendant's seat is attached to the door and automatically folds into a recess in the door when not in use.

Cockpit Lighting

Cockpit dome lights provide area lighting and are controlled by the DOME switch on the overhead panel.

Floodlights illuminate the overhead, glareshield, pedestal, and instrument panels. The light intensity can be adjusted using the INSTR & PED PNL-FLOOD and OVHD PNL-FLOOD knobs on the overhead panel.

A THUNDRSTRM switch overrides the individual lighting controls and illuminates all floodlights to maximum intensity.

In the event of complete loss of normal electrical power, emergency lighting is automatically provided.

Additional cockpit lighting consists of floor lights, map lights, briefcase lights, circuit breaker light, standby compass light, and chart holder lights.

Cabin Lighting

Cabin lighting consists of ceiling and sidewall lights, aisle drop ceiling lights, door and entrance lights, aft passenger stairway lights (optional), and other miscellaneous lights.

The ceiling and sidewall fluorescent lights provide indirect lighting for the ceiling and sidewall respectively. A four-position rotary switch controls illumination levels of sidewall lights. A five-position rotary switch controls illumination levels of ceiling lights and handrail electroluminescent lighting. These switches are located on the forward attendant’s panel.

The ceiling and sidewall fluorescent lights will illuminate full bright automatically if the cabin altitude exceeds 14,150 feet regardless of the cabin attendant’s control panel switch position.

Aisle drop ceiling lights are located in the forward and aft cabin. The fluorescent lights are controlled by switches on the forward cabin attendant's control panels.

Forward passenger entry door incandescent light, located at the entrance area, is controlled by a switch on the forward cabin attendant's control panel.

Forward passenger door stair lights (if forward stairway is installed) are operated automatically by latching or unlatching the stairwell door.

Cabin emergency lights, located in the ceiling, will illuminate automatically if an interruption/loss of normal power occurs.

Passenger Information Signs

Illuminated signs located throughout the cabin provide instructions and/or information for the passengers and cabin attendants.

The NO SMOKING and FASTEN SEAT BELTS signs are controlled by the NO SMOKE and SEAT BELTS switches located on the forward overhead panel. Both signs will illuminate if cabin altitude exceeds 10,000 feet regardless of control switch position.

The RETURN TO CABIN signs in the lavatories will illuminate or extinguish when the FASTEN SEAT BELTS signs are turned ON or OFF.

The words FORWARD LAVATORY and AFT LAVATORIES of the FORWARD LAVATORY OCCUPIED and AFT LAVATORIES OCCUPIED signs are illuminated at all times. The word OCCUPIED illuminates when the forward lavatory or both aft lavatory doors associated with the applicable sign are locked.

Exterior Lighting

Exterior lights consist of wing and nacelle floodlights, forward and aft position and strobe lights, ground floodlights, anti-collision lights, logo light, and landing and taxi lights.

The wing and nacelle floodlights are located in each side of the fuselage to assist in visually checking the engine nacelle and wing leading edge for icing conditions. The lights can be used for ground servicing, fueling, and taxiing.

The wingtip position and strobe lights include forward navigation lights consisting of a red light on the left wingtip and a green light on the right wingtip. A white strobe light is also installed in each wingtip adjacent to the forward position lights. A clear wingtip lens fairing covers each forward position/strobe light. A combination aft white position light and white strobe light is installed in the trailing edge of each wingtip.

The ground floodlights provide lighting for ground service. They also aid side and forward visibility while taxiing.

Anti-collision lights are located on the upper and lower fuselage surfaces.

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 located on the nose gear assembly. The lights will illuminate only when the landing gear control handle is in the down position.

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 light. The system design allows for automatic retraction/extinguishing of the wing landing lights if an engine out condition is detected during flight with the LDG LT switches in EXT OFF or EXT ON position. Normal operation of the landing lights will resume when the LDG LT switches are returned to RET (retract) position. If the LDG LT switches remain in either EXT OFF or EXT ON, the wing landing lights will automatically re-extend/illuminate when the flaps are extended to 25 degrees or greater.

Cargo and Service Compartment Lighting

The cargo and service compartment lights are installed in 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 door. Compartment light extinguishes when the forward or aft cargo door is closed.

The nose gear wheel well and forward accessory compartment lights are controlled by a switch on the external power receptacle panel. The main gear wheel well lights are controlled by switches on the external power receptacle panel in the cabin floor. Electrical/electronics compartment lights are controlled by a switch near the access door.

Tail section area and aft accessory compartment service lights are operated by switch located adjacent to the aft accessory compartment access door.

Alerting System

The alerting system provides aural, visual, and/or tactile indications to warn of potentially unsafe operating conditions or airplane configurations and system malfunctions. Indications are generated by a Central Aural Warning System (CAWS), EIS alerting system, stick shakers, or an Enhanced Ground Proximity Warning System (EGPWS). Refer to Flight Controls for description of stick shakers and Instrumentation and Navigation chapter for EGPWS.

Central Aural Warning System (CAWS)

The aural warnings consist of tones such as horns, chimes, and bells accompanied with voice messages (vocal warnings) for selected warnings. Each voice message is preceded by its associated tone warning.

Warnings - Aural/Visual/Condition

Engine Fire

AURAL WARNINGS - Bell followed by voice "FIRE LEFT ENGINE" or "FIRE RIGHT ENGINE."

VISUAL - L/R ENG FIRE handle(s); MASTER WARNING lights, and associated FUEL switch light.

CONDITION - Fire or overheat in engine nacelle.

APU Fire

AURAL WARNINGS - Horn followed by voice "APU FIRE." Automatically cancelled after 3 cycles.

VISUAL - MASTER WARNING lights and APU FIRE light on external APU ground control panel.

CONDITION - Fire or overheat in APU.

Stall Warning

AURAL WARNINGS - Klaxon followed by voice "STALL."

VISUAL - STALL indications on PFD.

CONDITION - Angle of attack approaching stall condition for flap/slat configuration.

Landing Gear

AURAL WARNINGS - Horn followed by voice "LANDING GEAR."

VISUAL - Red light for any gear not down and locked.

CONDITION - Gear not down and locked and the following:

* Flaps extended in the landing range, or
* Throttles retarded with airspeed less than 210 knots, altitude below 1,200 feet and flaps not in landing range.

Altitude Alert

AURAL WARNINGS - C-chord followed by voice "ALTITUDE."

VISUAL - PFD altitude box turns amber or flashes.

CONDITION - Deviating or approaching selected altitude.

Altitude Alert during Approach

Spoiler/Flaps Extended

AURAL WARNINGS - Horn followed by voice "SPEED BRAKE."

VISUAL - SPD BRK/FLAP alert on EAD.

CONDITION - Flaps and spoilers extended at the same time in flight.

Cabin Altitude

AURAL WARNINGS - Horn followed by voice: "CABIN ALTITUDE."

VISUAL - MASTER WARNING lights and CABIN ALTITUDE alert on EAD.

CONDITION - Cabin altitude is greater than 10,000 feet.

Overspeed

AURAL WARNINGS - Clacker followed by voice: "OVERSPEED" or "SLAT OVERSPEED."

VISUAL - Airspeed tape on PFD amber or red.

CONDITION -

* Overspeed: Vmo or Mmo exceeded (red).
* Slat Overspeed: Over 280 knots with slats extended (amber).

Autopilot

AURAL WARNINGS - Warbler followed by voice: "AUTOPILOT."

VISUAL - Red flashing box on FMA.

CONDITION - Autopilot disconnected.

Horizontal Stabilizer in Motion

AURAL WARNINGS - Horn followed by voice: "STABILIZER MOTION."

VISUAL - N/A.

CONDITION - Horizontal stabilizer in motion for more than 1 second.

Takeoff Warning

AURAL WARNINGS - Horn followed by one of the following voices: "BRAKES," "FLAP," "SLAT," "SPOILER," or "STABILIZER," or "RUDDER TRIM."

VISUAL - Associated red boxed item on EAD Essential Items Checklist.

CONDITION - Airplane on the ground, both throttles advanced and any of the following:

* Brakes: Parking brake on.
* Flap: Flaps not in agreement with takeoff setting entered into FMS.
* Slat: Slats not in takeoff.
* Spoilers: Spoilers not stowed.
* Stabilizer: Stabilizer not in green band.
* Rudder Trim: Rudder trim not centered.

Reactive Windshear Warning

AURAL WARNINGS - Tone followed by voice: "HEADWIND SHEAR" or "TAILWIND SHEAR."

VISUAL - WINDSHEAR message on PFD as follows:

* Amber - Head windshear.
* Red - Tail windshear.

CONDITION - Increasing/decreasing performance windshear encountered.

Predictive Windshear Warning

AURAL WARNINGS -

* Warning Alert - Tone followed by voice: "WINDSHEAR AHEAD, WINDSHEAR AHEAD" during takeoff/go-around; "GO AROUND WINDSHEAR AHEAD" during landing/go-around.
* Caution Alert - Tone followed by voice: "MONITOR RADAR DISPLAY."

VISUAL - Icon on ND and either a red (warning) or amber (caution) "WINDSHEAR AHEAD" on PFD.

CONDITION - Airplane below 1,200 feet AGL and a microburst detected.

Electronic Instrument System (EIS) Alerting

The EIS alerting system displays alerts and applicable consequences on the Display Units (DU).

The EIS alerting system consists of:

* MASTER WARNING and MASTER CAUTION lights.
* Engine and Alert Display (EAD).
* System Display (SD).
* System Display Control Panel (SDCP).

Alerts are categorized into four levels (3, 2, 1, and 0) and have unique display characteristics to allow immediate crew recognition of the alert level. The alerts are sorted by level with the most recent in each level listed first.

Alerts are presented in three columns in the lower 1/3 of the EAD. Each column allows alerts up to 17 characters long, including leading triangles for level 3 alerts. The first two columns may contain 6 alerts, but the third column is limited to only 4 because the two bottom lines are dedicated for reminder messages.

The EAD alerts are logically displayed to minimize the number of alerts requiring action. Additional alerts which occur as a result of the initial failure are displayed on the associated system pages.

Pushing the associated system cue switch on the SDCP, located on the pedestal, displays associated system synoptic page on the SD and resets the illuminated MASTER CAUTION or MASTER WARNING lights.

On any SD page, a PRESS (associated cue switch) AGAIN TO CONTINUE message indicates that alerts or consequences on subsequent SD pages can be accessed by pushing the associated cue switch. The associated cue switch part of the message flashes until all pages have been reviewed. The secondary engine page automatically appears on the SD for alerts associated with the secondary engine page parameters.

Level 3 Alerts - Boxed Red

Level 3 (red) alerts indicate emergency operational conditions that require immediate crew awareness and immediate corrective or compensatory action by the crew. Level 3 alerts are characterized as follows:

* Red MASTER WARNING lights illuminate.
* Boxed red alert on the EAD with a red triangle in the first position.
* Alert is positioned starting at top left corner of the alert list with latest alert at the top of the list.
* Associated cue switch illuminates on the SDCP.
* Alerts remain displayed on EAD until condition no longer exists.
* Cue switch lights are extinguished by pushing the cue switch.
* MASTER WARNING lights are resettable by pushing either the MASTER WARNING light or by pushing associated cue switch.

Level 2 Alerts - Boxed Amber

Level 2 (amber) alerts indicate abnormal operational system conditions that require immediate crew awareness and subsequent corrective or compensatory action by the crew. Level 2 alerts are characterized as follows:

* Amber MASTER CAUTION lights illuminate.
* Boxed amber alert on the EAD.
* Alert is positioned below any level 3 alert in the alert list. The latest level 2 alert is added to the top of the level 2 alerts.
* Associated cue switch illuminates on the SDCP.
* Alerts are acknowledged and possibly reset by pushing associated illuminated cue switch.
* A boxed amber reminder message will appear on the EAD when a level 2 alert has been reset.
* Cue switches are resettable by acknowledging associated alerts.
* MASTER CAUTION lights are resettable by pushing either MASTER CAUTION light or the associated cue switch.

Level 1 Alerts - Amber

Level 1 alerts (amber) may require maintenance prior to takeoff, a logbook entry, a confirmation of desired system configuration, or a flight crew action but not a checklist procedure. Level 1 alerts are characterized as follows:

* Amber MASTER CAUTION lights may illuminate.
* Amber alert appears on the EAD, SD page, or STATUS page.

* Alert is positioned below any level 3 or 2 alerts in the alert list. The latest level 1 alert is added to the top of the level 1 alerts.
* Associated cue switch may illuminate on the SDCP.
* Alerts are acknowledged and possibly reset by pushing associated illuminated cue switch.
* An amber reminder message will appear on the EAD when a level 1 alert has been reset.
* MASTER CAUTION lights are resettable by pushing either the MASTER CAUTION light or the associated cue switch on the SDCP.

Some level 1 alerts appear on the SD synoptic or STATUS page only and will not illuminate the MASTER CAUTION lights. Some level 1 alerts are non-resettable and cannot be removed from EAD.

Level 0 Alerts - Cyan

Level 0 (cyan) alerts are generally operational, or airplane systems status information. Level 0 alerts are characterized as follows:

* A cyan alert on the EAD.
* Alert is positioned above the space for reminder messages. The latest level 0 alert is added to the top of the level 0 alerts.

Consequences

When some level 3, 2, or 1 alerts are displayed, statements called CONSEQUENCES appear (aligned with the associated alert) in the lower third of the associated SD synoptic. The SD consequences are the effects of the failure and/or the required crew action. Required checklist procedures should be integrated with the SD consequences.

Reminder Messages

When level 2 or 1 alerts have been reset by pushing the associated cue switch on the SDCP, the alert is removed from the alert list on the EAD and a reminder message consisting of the associated system name (FUEL, HYD, etc.) is displayed in a dedicated location within the two bottom lines of the right column on the EAD. These reminder messages are amber and boxed for level 2 alerts and amber and unboxed for level 1 alerts. The EAD reminder message will flash when a new alert message appears on the associated SD page.

Inhibits

Takeoff Inhibits - Level 3 alerts and associated MASTER WARNING lights are inhibited from V1 to 400' RA, but no longer than 25 seconds in flight. Level 2 or 1 alerts and associated MASTER CAUTION lights are inhibited at throttle advance or 80 knots or V1- 20 knots. The takeoff inhibits are released at 400' RA (or in flight for 25 seconds), or 1000' barometric altitude above the departure airport (or in flight for 120 seconds). Level 0 alerts are not inhibited.

Takeoff Essential Items Checklist

During taxi, takeoff items are checked sequentially. The EIS provides a dedicated space at the bottom of the center column on the EAD for display of the takeoff essential items checklist. When this checklist is displayed, any alerts are displaced.

The takeoff essential items checklist consists of the following ordered list of conditions and boxed messages.

CONDITION	MESSAGE	COLOR
1. STAB not in green	STAB TRIM	White
2. Rudder Trim not centered	RUDDER TRIM	White
3. Slats not in takeoff	SLAT	White
4. Flaps not in takeoff	FLAP	White
5. Park brake on	BRAKES	White
6. Auto ground spoilers not armed	SPOILERS	White

The checklist is sequentially checked from the top. Only the highest condition not met is displayed. When a condition is met, the EIS continues down the list displaying the next condition not met. When all takeoff conditions have been satisfied, a green takeoff-checklist-complete box is displayed in the essential items checklist area.

With the exception of the auto ground spoilers not armed condition, if any of the other takeoff essential items have not been satisfied, the essential items checklist display (message and box) will turn red, with an aural alert, when the throttles are advanced for takeoff.

If the auto ground spoilers are not armed when the throttles are advanced for takeoff, the “SPOILERS” message will remain white (in a white box), to permit a manual ground spoiler takeoff. The essential items checklist is removed when the airplane becomes airborne.

Landing Essential Items Checklist

During the approach phase, the EIS initiates a check of essential landing items. This checklist is displayed in the same position and manner as the takeoff essential items checklist.

The landing essential items checklist consists of the following ordered list of conditions and messages.

CONDITION	MESSAGE	COLOR
1. Landing gear not down	LANDING GEAR	White
2. Flaps not in landing	FLAP	White
3. Spoilers not armed	SPOILERS	White

The checklist is sequentially checked from the top. Only the highest condition not met is displayed. When a condition is met, the EIS continues down the list displaying the next condition not met. When all landing conditions have been satisfied, a green landing-checklist-complete box is displayed in the essential items checklist area.

The essential items checklist is removed when the airplane is on the ground.

SD Alerts and Consequences Display

Pushing a cue switch on the SDCP causes the associated system page to be displayed on the SD and resets the MASTER WARNING or MASTER CAUTION lights (if illuminated).

The secondary engine page is automatically called up when secondary engine parameter alerts appear or when a secondary engine page parameter changes to amber or red.

Each systems page (except MISC) contains a schematic for that system on the upper 2/3 of the SD. The bottom 1/3 is for alerts related to that system and the alert consequences. Only levels 3, 2, and 1 alerts are shown on the system pages.

Alerts are shown in the left column. The alerts are grouped by level and appear in the same order as they appeared on the EAD.

Consequences are shown in the right column. Consequences are aligned with the associated alerts. Consequences are shown in white and may have a maximum of 34 characters.

If not all alerts or consequences can be displayed within the space available on the first SD page (maximum 5 alerts and 5 consequences), additional pages of alerts and consequences are made available. These pages have the same format as the first page. When there are additional pages, the message PRESS XXXX AGAIN TO CONTINUE will be displayed at the bottom of the page (XXXX = associated cue switch).

SD Consequence Page

The consequence page is displayed on the SD by pushing the CONSEQ switch on the SDCP. The CONSEQ page shows a compilation of all consequences depicted on the individual synoptic pages.

The alerts are grouped by level and appear in the same order as they appear on the EAD. The consequences associated with an alert are displayed adjacent to that alert.

This page and all subsequent pages can display up to 17 alerts and 17 consequences. When additional pages are required, the message PRESS CONSEQ AGAIN TO CONTINUE will appear at the bottom of the page.

SD Status Page

The STATUS page displays a list of all alerts included on the systems pages and is selected by pushing the STATUS switch on the SDCP. The alerts are shown in three columns in the same format as on the EAD. The alerts are grouped per system in the same order as the cue switches on the SDCP and the reminder messages on the EAD (ENG, HYD, ELEC, AIR, FUEL, CONFIG, and MISC).

A separate section for maintenance alerts is after the MISC system alerts. This section is titled MAINT. MAINT alerts appear only on STATUS page one and can only be level 1. MAINT alerts may have impact and should be written up by the flight crew. Within each system group, the alerts are grouped by level and appear in the same order as they appeared on the EAD. Above each group of alerts appears the system label, preceded by a blank line if not at the top of the page. This system label will appear as a place holder even if no alerts are associated with that system. This page and all subsequent pages can display up to 51 alerts. When there are additional pages, the message PRESS STATUS AGAIN TO CONTINUE will appear at the bottom of the page.

SD Miscellaneous Page

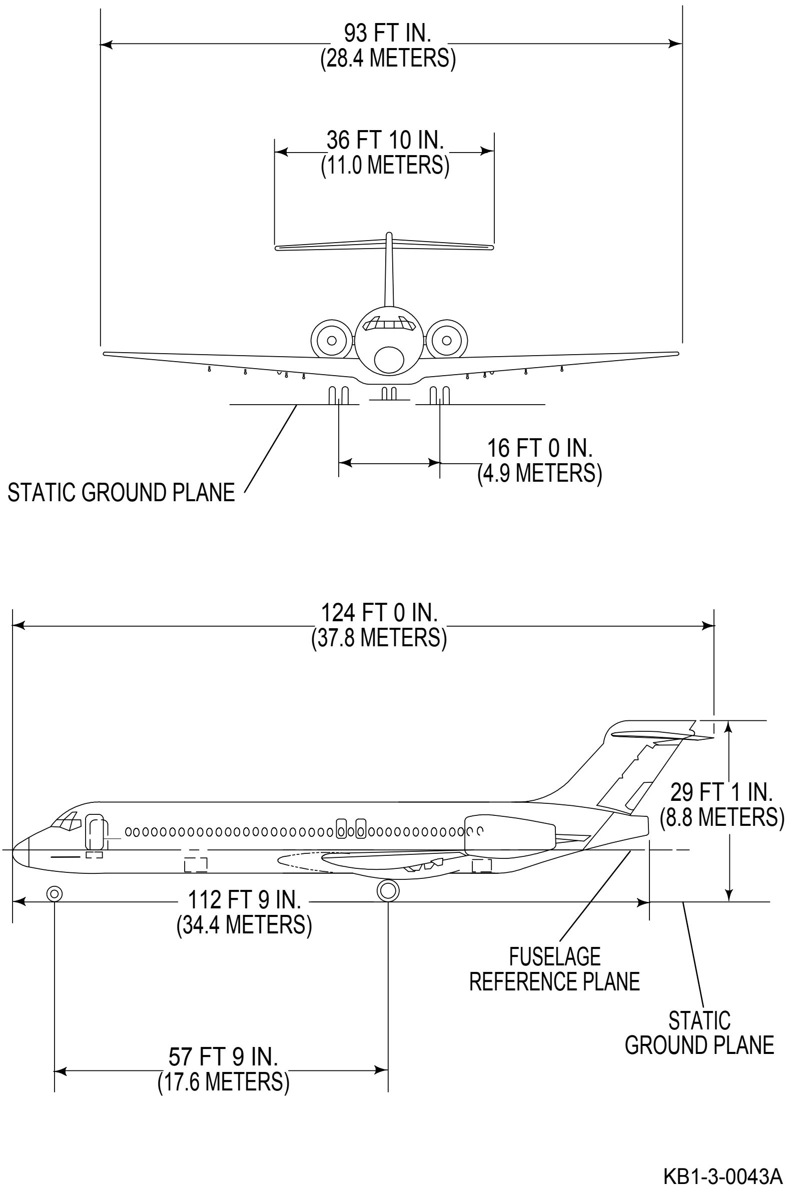
The miscellaneous system page is displayed on the SD by pushing the MISC switch on the SDCP. The miscellaneous system page displays alerts and consequences for various uncategorized systems in text form only.

The consequences are grouped with the alerts in the same manner as the consequences page. The first miscellaneous systems page may have a maximum of 17 alerts and 17 consequences.

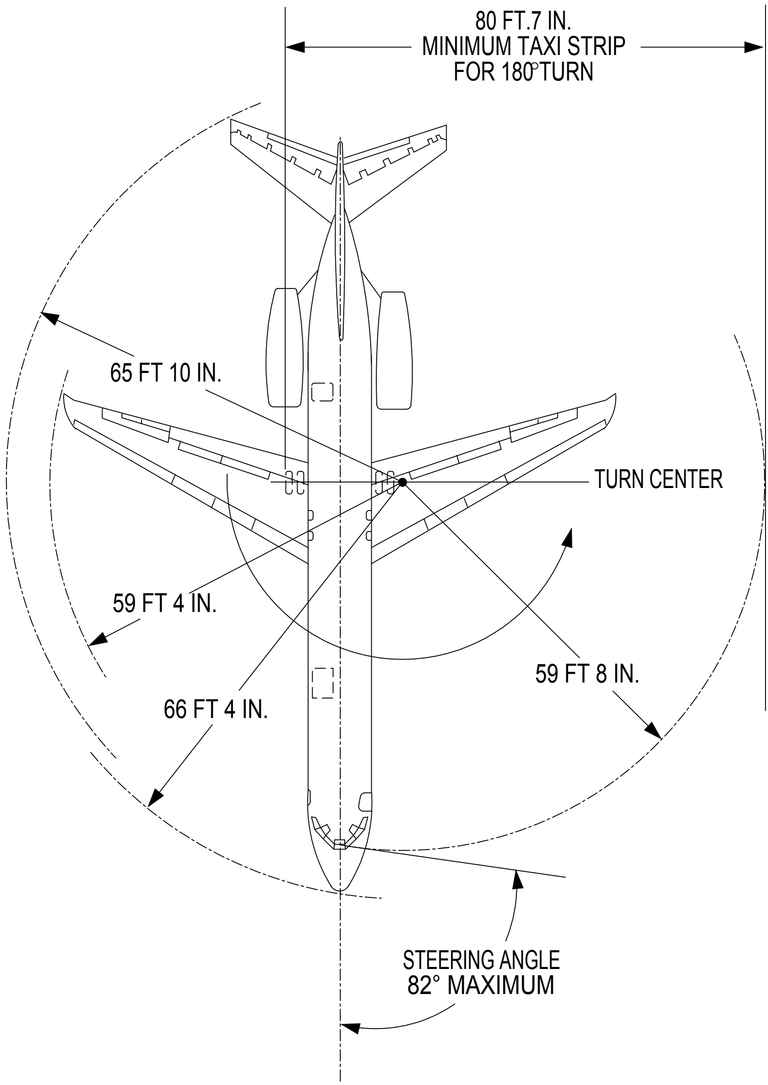
Additional pages may be made available for the display of consequences and may display up to 17 alerts and 17 consequences. When additional pages are required, the message PRESS MISC AGAIN TO CONTINUE will appear at the bottom of the page.

The miscellaneous page is for alerts (levels 3, 2, and 1 only) and consequences (levels 3 and 2).

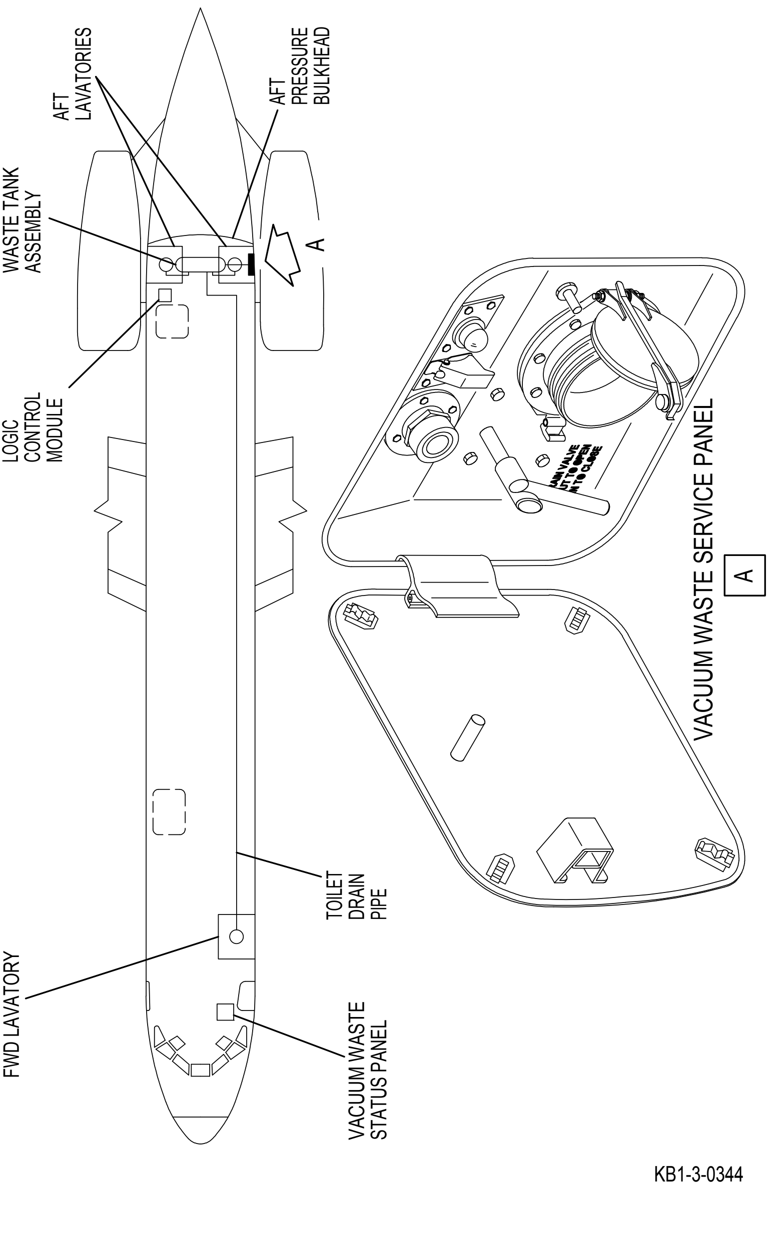
Airplane Dimensions (Typical)



Turning Radius (Typical)



Waste Disposal Service Locations



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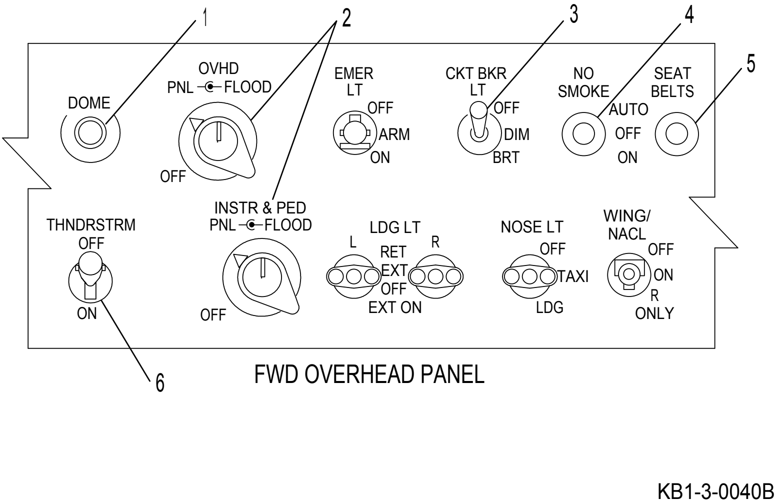
Cockpit Lighting Controls



1. **DOME Switch**

   Push - Illuminates/extinguishes overhead dome lights.

2. **OVHD and INST & PED Rheostats**

   Rotate - Outer rheostats control respective switchplate lights. Inner rheostats control respective floodlights.

3. **CKT BKR LT Switch**

   OFF - Extinguishes circuit breaker panel floodlights.

   DIM/BRT - Sets illuminated circuit breaker panel floodlights to low or full brightness.

4. **NO SMOKE Switch**

   AUTO - NO SMOKING signs illuminate when landing gear is extended. Low chime sounds through PA speakers.

   OFF - Extinguishes NO SMOKING signs. Low chime sounds through PA speakers.

   ON - Illuminate NO SMOKING signs. Low chime sounds through PA speakers.

NOTE: NO SMOKING signs are illuminated at any switch position when there are no ashtrays installed in passenger seats.

5. SEAT BELTS Switch

AUTO - FASTEN SEAT BELT and RETURN TO CABIN signs illuminate when leading edge slats are extended. Low chime sounds through PA speakers.

OFF - Extinguishes FASTEN SEAT BELT and RETURN TO CABIN signs. Low chime sounds through PA speakers.

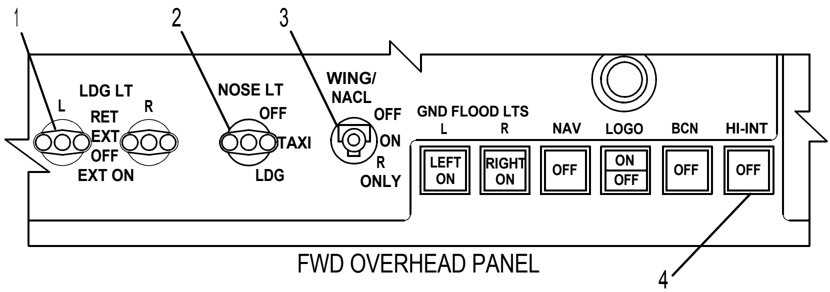
ON - Illuminate FASTEN SEAT BELT and RETURN TO CABIN signs. Low chime sounds through PA speakers.

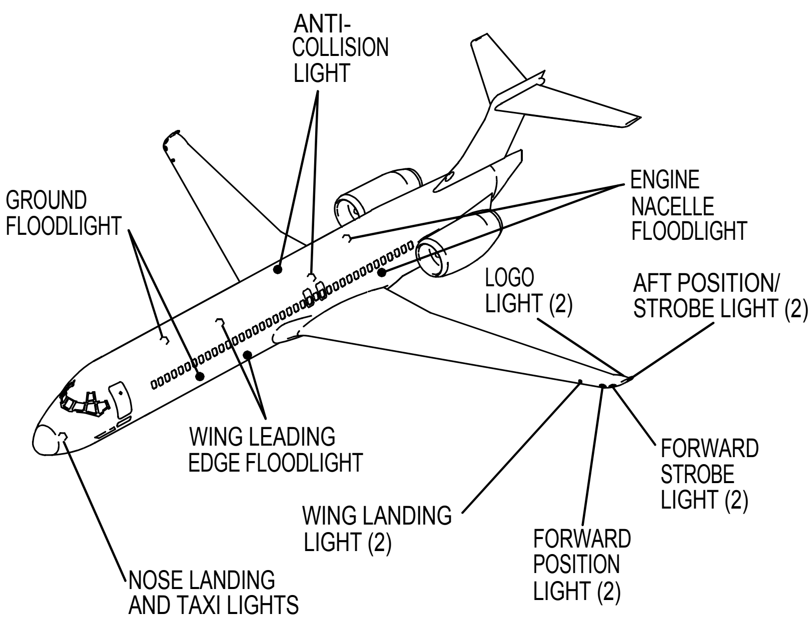
6. THNDRSTRM Switch

OFF - Normal position.

ON - Overrides individual lighting controls to illuminate instrument and control panel floodlights full bright.

Exterior Lighting Controls





KB1-3-0530

1. **LDG LT Switches (L/R)**

   RET - Retracts landing light(s) flush with wing.

   EXT OFF - Extends landing light(s) with lamps off.

   EXT ON - Extends landing light(s) with lamps on.

2. **NOSE LT Switch**

   OFF - Extinguishes nose gear landing taxi light.

   TAXI - Illuminates light for taxi.

   LAND - Illuminates light for landing.

3. **WING NACL Switch**

   OFF - Extinguishes wing leading edge and engine nacelle floodlights.

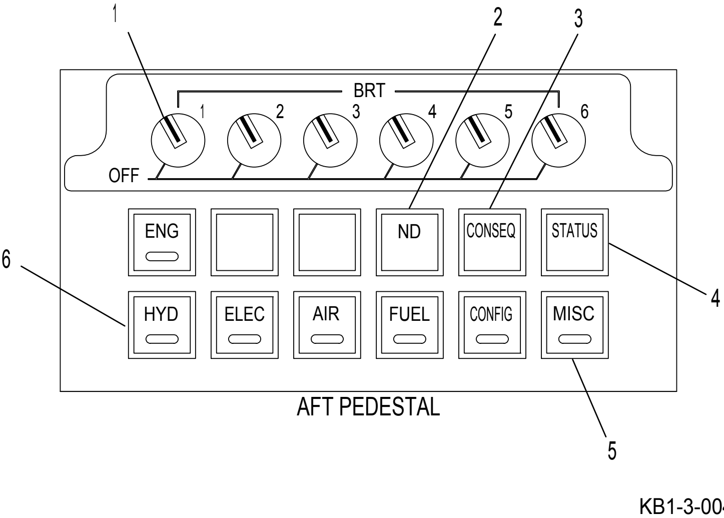
   ON - Illuminates wing leading edge and engine nacelle floodlights.

   R ONLY - Illuminates right wing leading edge and right engine nacelle floodlights.

4. **Switches-Lights (6)**

   Push - Illuminates/extinguishes respective left, right ground floodlights, position (NAV), logo, anti-collision (BCN) or strobe (HI-INT) lights.

EIS System Display Control Panel



1. **BRT Knob**

   Rotate - Controls respective DU brightness. Turning fully counterclockwise through a detent will turn off respective DU.

2. **ND Switch**

   Push - With 1 or more DUs inoperative, causes the existing SD to become an ND. If all DUs are operative, THIRD NAV DISPLAY NOT AVAILABLE will appear on DU 4.

3. **CONSEQ Switch**

   Push - Displays CONSEQUENCE page on SD. Consequences displayed are associated with level 3 and 2 alerts and some level 1 alerts.

4. **STATUS Switch**

   Push - Displays STATUS page on SD.

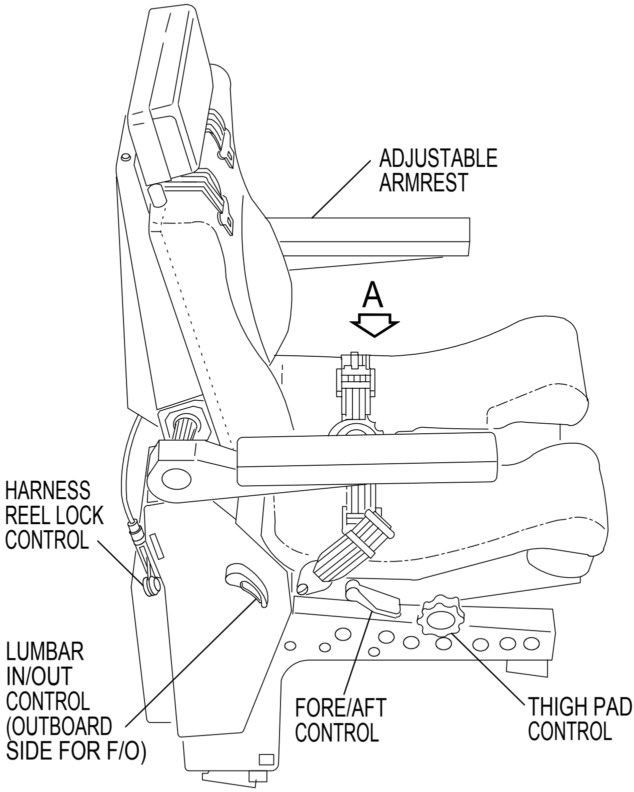
5. **MISC Switch**

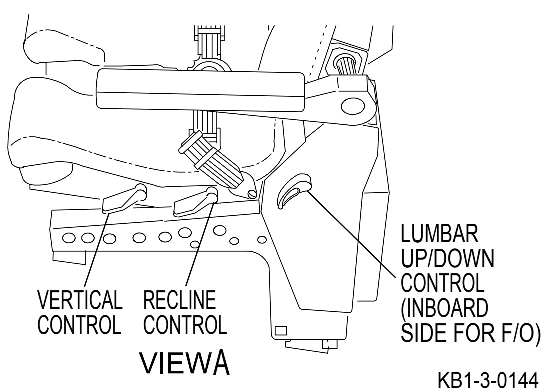
   Push - Displays MISCELLANEOUS page on SD.

6. **System Cue Switch (6)**

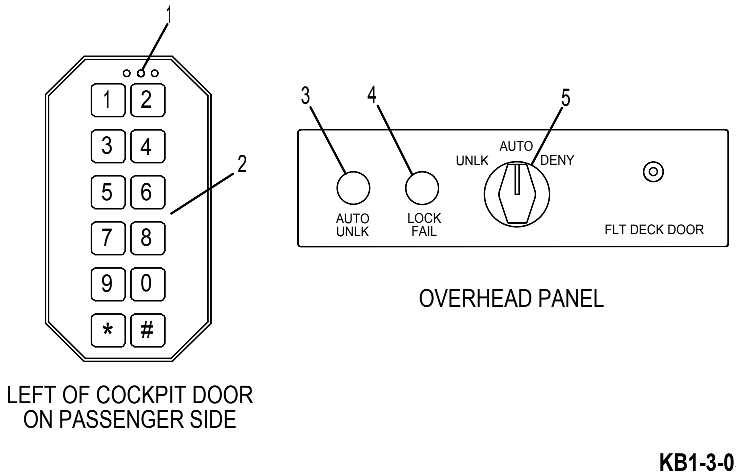
   Appropriate (ENG, HYD, ELEC, AIR, FUEL, or CONFIG) cue switch will illuminate when an alert related to the system appears on the EAD. Pushing cue switch displays applicable synoptic page on SD and resets illuminated MASTER WARNING or MASTER CAUTION lights.

Captain's Seat





Reinforced Cockpit Door Controls/Indicators



1. **Keypad Access Lights**

   Red (Illuminated) - Cockpit door is locked.

   Amber (Illuminated) - Correct access code entered.

   Green (Illuminated) - Cockpit door is unlocked.

2. **Keypad Entry Keys**

   Push - Enters numeric access code.

3. **AUTO UNLK Light - amber**

   Illuminated - Indicates correct access code has been entered, 60-second delay has begun, and automatic cockpit door unlock is pending.

4. **LOCK FAIL Light - red**

   Illuminated - Cockpit door is unlocked.

5. **FLT DECK DOOR Selector**

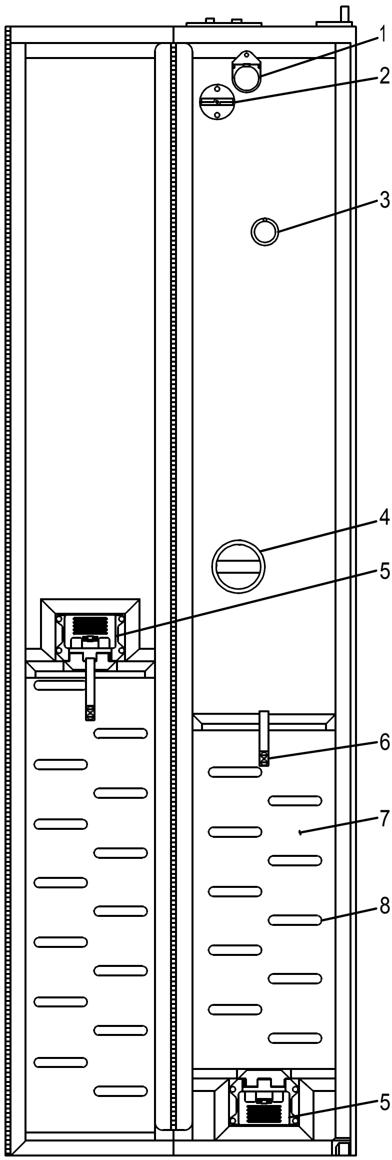
   Spring loaded to AUTO. Selector must be pushed in to rotate from AUTO to UNLK.

   UNLK - Unlocks cockpit door while selector is held in UNLK position.

   AUTO - Locks cockpit door and arms the system for a keypad entry request.

   DENY - Rejects keypad entry request and prevents further access code entry for five minutes.

Reinforced Cockpit Door



VIEW AFT
(FROM COCKPIT)

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1. **D-Ring**

   Used for emergency cockpit egress. Pull if door latch handle is inoperative.

2. **Deadbolt**

   Used for MEL dispatch relief if the normal locking system is inoperative.

3. **View Window**

   Allows to view cabin side from the cockpit.

4. **Door Latch Handle**

   Used for normal cockpit egress.

5. **Decompression Latches**

   Holds decompression panels in place. Releases decompression panels if a cockpit rapid decompression occurs. Each latch has an indicator that indicates green for normal operation of the latch release mechanism. Maintenance should be called if red is indicated.

6. **Vent Shutter Strap**

   Used to prevent smoke from entering the cockpit.

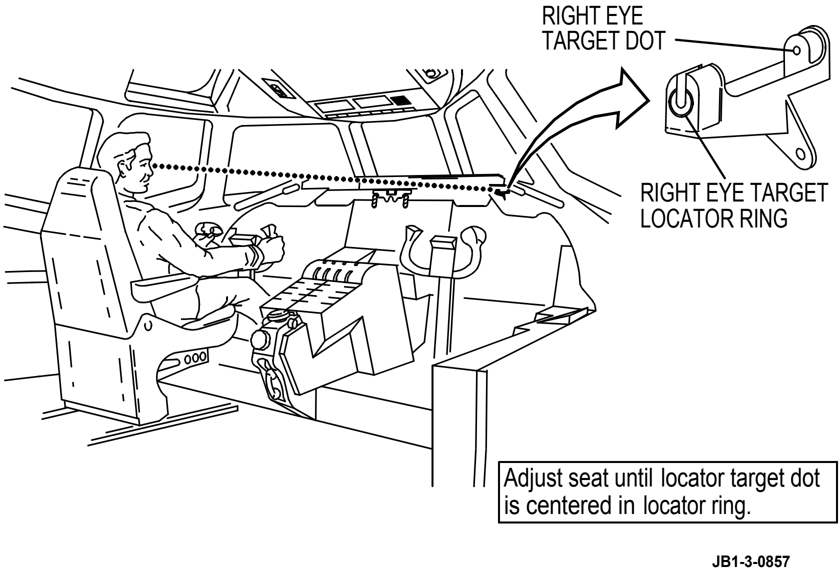
7. **Decompression Panels**

   Equalizes pressure in the event of a cockpit rapid decompression. Provides emergency egress path.

8. **Door Louvers**

   Equalizes pressure in the event of a cabin rapid decompression.

Pilot Eye Locator



NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

TAILCONE UNLOCK (MISC) - Tailcone is not locked.

Amber Alerts (Level 1)

ACCESS COMPT DOOR (MISC) - Accessory compartment door is not closed and locked.

AFT BULKHEAD DOOR (MISC) - Aft exit door is not closed and locked.

CABIN DOOR (MISC) - Forward cabin door is not closed and locked.

CARGO DOOR FWD/AFT (MISC) - Respective cargo door is not closed and locked.

CAWS FAIL (MISC) - Central aural warning function in both VIAs has failed.

DRAIN MAST HEAT (MISC) - Drain mast heater has failed.

DOOR OPEN (MISC) - One or more doors are not closed and locked.

ELEC COMPT DOOR (MISC) - Electrical/electronics compartment door is not closed and locked.

GALLEY DOOR (MISC) - Galley door is not closed and locked.

STAIRWAY DOOR FWD/AFT (MISC) - (Optional) Respective stairway door is not stowed and locked.

Cyan Alerts (Level 0)

NO SMOKING - NO SMOKING signs have been turned on.

SEAT BELTS - FASTEN SEAT BELTS signs have been turned on or SEAT BELTS switch is in AUTO with leading edge slats extended.

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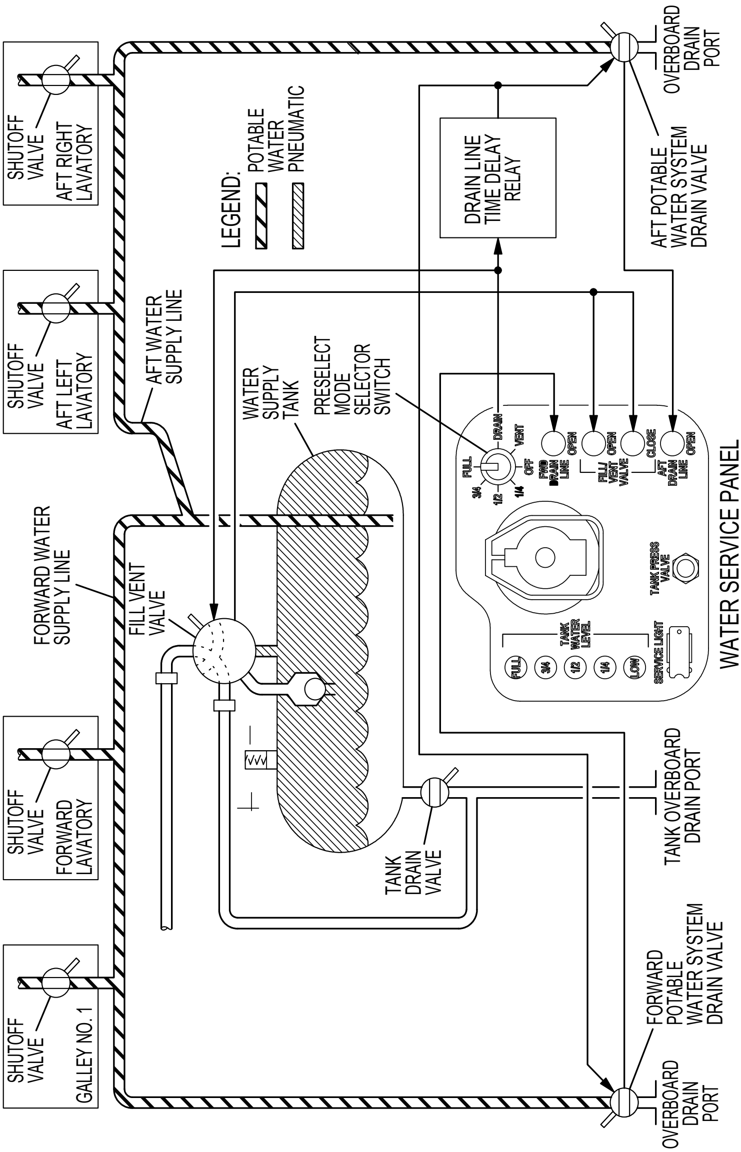
Water Supply Drainage System



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Air — Chapter Air
Table of Contents — Section TOC

General

Air for airplane pressurization, air conditioning, anti-ice, engine start, and potable water system pressurization can be supplied either by the engines, the APU (ground only), or an external source (ground only).

Controls for pressurization, air conditioning, and anti-ice are on the forward overhead panel. Air system flow, temperatures, valve positions, and pressurization status are shown on the Systems Display (SD). Associated alerts are shown on the Engine and Alert Display (EAD).

Air system functions include the airplane pneumatic system, the air conditioning system, and the pressurization system.

The pneumatic system consists of two identical sub-systems, each with the capability of operating independently. Each pneumatic sub-system is normally supplied by its respective engine. During ground operation, however, air from the APU or from a ground pneumatic source may be supplied to the sub-systems through the crossfeed manifold.

There are two independent air conditioning systems. Bleed air entering the air conditioning systems is processed and cooled to provide conditioned air to the cabin and cockpit and for airplane pressurization.

Pneumatic System Component Location

The pneumatic system components are located within the engine nacelles and the tail compartment. The nacelle components consist of low stage check valves, high stage valves, pressure regulator and shutoff valves, pre-coolers and fan air valves.

Components located in the tail compartment include the air conditioning system flow control valves, the pneumatic system isolation valve, the wing and tail ice protection pressure regulator and shutoff valves, and the necessary ducting for APU and ground pneumatic air.

High & Low Stage Valves (Nacelles)

Low fifth stage air is normally sufficient for air conditioning and pressurization. The high stage valve regulates eighth stage air to satisfy pneumatic pressure and temperature requirements when low stage pressure or temperature is insufficient.

Each pneumatic system uses a pre-cooler to reduce the temperature of the air supplied by the engines. Fan discharge air regulates the temperature of the pre-cooler output. After flowing across the pre-cooler, the fan air is exhausted overboard.

Pneumatic System Isolation Valve

The pneumatic system isolation valve, normally closed, isolates the left and right pneumatic sub-systems from each other. On the ground, the isolation valve may be opened to connect both pneumatic systems when using the APU or ground pneumatic air for air conditioning or engine start.

In flight, when only one sub-system is supplying bleed air, the isolation valve automatically opens to supply bleed air for airfoil ice protection. It may also be manually opened to supply pneumatics for both air conditioning systems.

When the isolation valve is open, the AIR ISOL OPEN alert is displayed on the EAD.

Pneumatic System Controller

The pneumatic system controller (PSC) monitors and controls the engine bleed air pressure and temperature requirements for the air conditioning system and the airfoil ice protection system.

Pneumatic manifold pressures are digitally displayed within each pneumatic manifold on the SD synoptic. When manifold pressure is not within the system's normal range, in addition to the pressure display, the temperature of the bleed air entering the manifold is displayed above the engine's outline.

When temperature exceeds operating limits, a failure indication and a BLEED AIR L/R TEMP HI alert is displayed on the EAD.

Pneumatic Overheat Detection System

A pneumatic overheat detection system (PODS) detects overheat conditions in the tail compartment and along the wing and tail ice protection manifolds. System components include dual loop sensors in the tail compartment and single loop sensors along the ice protection manifolds.

The pneumatic overheat detection controller is located in the electrical/electronic (E/E) compartment. When an overheat condition occurs in the tail compartment, the associated TAIL TEMP L/R HI alert is displayed on the EAD.

If a failure is detected in the anti-ice manifolds, PODS automatically closes the respective anti-ice valve and the respective WING A-ICE OFF/TAIL A-ICE OFF alert is displayed.

If PODS fails to shut off the affected manifold, the respective WING MANF FAIL/TAIL MANF FAIL alert is displayed.

A test of PODS is automatically activated when the engine fire protection test is performed. When the PODS test is successful, the PODS TEST PASS alert is displayed on the EAD.

Flow Control Valves

Conditioned air is supplied to the cockpit and cabin from two identical but independent systems. The flow control valves schedule the flow of air into the air conditioning systems. A dual schedule allows the selection of a normal or a high flow rate.

The flow control valves also serve as shutoff valves and may be manually selected closed. The valves close automatically when an air conditioning system malfunction occurs. Automatic shutdown of an air conditioning system occurs if one of the system's over-temperature sensors detects an overheat condition.

In the event of an engine failure below 3000 feet AGL, both air conditioning systems shut down. This enables the remaining engine to operate without the bleed penalty and reduction in thrust associated with an operating air conditioning pack.

The output air temperature of the air conditioning system is adjusted through the temperature control valve. The valve determines how much air coming from the pre-cooler mixes with air from the refrigeration unit.

Refrigeration Units

Each refrigeration unit contains a primary and a secondary heat exchanger, an air cycle machine, an air cycle machine-driven fan and a water separator.

In flight, cooling airflow across the heat exchangers is provided by ram air and by the air cycle machine-driven fans. The fans assist ram air cooling by drawing air across the heat exchangers when ram airflow is insufficient.

Temperature of airflow through the water separator is maintained above freezing by use of a water separator temperature control valve. Refrigerated air from the water separator is mixed with air from the water separator temperature control valve to become conditioned air.

Condensed water from the water separator is sprayed onto the secondary heat exchanger to improve cooling. Conditioned air from both air conditioning systems is routed into a mixing chamber. From the mixing chamber, the greater portion of conditioned air is directed to the cabin. The remaining conditioned air is directed to the cockpit.

Ram Air Ventilation

The ram air system provides ventilation for the cabin and the cockpit when air conditioning is not available. When the ram air valve is open, ambient airflow from the right heat exchanger ram air duct enters the right air conditioning system. Only the right system has a ram air valve.

The RAM AIR switch on the AIR control panel is used to select ram air ventilation ON or OFF. Packs are not required to be running for ram air ventilation.

Air Conditioning And Ventilation

Two air conditioning systems, each associated with an engine, provide conditioned air and pressurization to the cabin and the cockpit. Conditioned air can also be supplied to the cabin and cockpit using a ground pre-conditioned air supply. Ground air supply is connected into and uses the same ducting as the ram air system, however, the ram air valve must be closed for this operation.

The cabin and cockpit are ventilated with cold air and conditioned air (cold air mixed with warm air). This air is normally supplied by the packs associated with each engine. The right air conditioning system ventilates the cabin and the left system ventilates the cockpit. Either system is capable of ventilating both the cabin and the cockpit.

The CKPT/CABIN TEMP selectors on the AIR control panel, in either AUTO or MAN mode, control cockpit/cabin temperatures. When selecting manual temperature control, it is advisable to begin temperature control at the full cold position and adjust as required.

Auto Pack Shutdown

Both packs automatically shut down if either engine fails during takeoff, or if packs are selected off through the FMS. Auto shutdown of the packs due to engine failure is overridden, however, when the PACK SHUTDOWN switch is in OVRD and/or when the airplane is above 3,000’ AGL.

Auto pack shutdowns due to high supply duct temperatures cannot be overridden. The left pack automatically shuts down if supply temperatures to the cockpit become too hot. The right pack automatically shuts down if supply temperatures to the cabin become too hot.

Cabin Pressure Controllers And Outflow Valve

Cabin pressure is maintained by controlling the discharge of cabin air through the outflow valve.

The cabin pressure controllers control outflow valve position during automatic operation. Outflow valve position is displayed on the CABIN PRESS panel outflow VALVE position indicator. The CLOSED light illuminates when the valve is fully closed.

If cabin altitude exceeds the maximum limit, the CABIN ALTITUDE alert is displayed on the EAD, an aural warning is sounded, and the failure indication is displayed on the SD.

Cabin altitude rate is displayed in feet per minute on the SD. Downward moving rates are indicated by a downward pointing arrowhead and upward moving rates are indicated by an upward pointing arrowhead. A CABIN RATE alert is displayed on the EAD when the desired cabin rate is exceeded, and the failure is displayed on the SD.

Cabin altitude and cabin rate information are also displayed on the SD secondary engine page. If either the cabin altitude or the cabin rate limits are exceeded, a failure indication is displayed.

The cabin pressure SYSTEM switch has two operating modes, automatic and manual. When the pressurization system is operating in the automatic mode, the switch is dark. Pushing the switch selects the alternate cabin pressure controller, illuminates the MANUAL light, and selects manual pressurization system control. The CABIN PRES SYS MAN alert is displayed on the EAD.

If both cabin pressure controllers fail, the SELECT light illuminates and the SEL CAB PRES MAN alert is displayed on the EAD.

In manual mode, the flight crew manually adjusts outflow valve position with the two-position (CLIMB/DESC) cabin pressure MANUAL switch. When the switch is moved to CLIMB, the outflow valve moves in the open direction, and cabin altitude increases. When the switch is moved to DESC, the outflow valve moves in the closed direction, and cabin altitude decreases.

The crew controls cabin pressure to the proper level by adjusting the valve position and monitoring cabin altitude rate changes on the secondary engine display.

Airplane Pressurization

Airplane pressurization is controlled by the escape of pressurized air through a cabin air outflow valve. The outflow valve position indicator on the CABIN PRESS control panel indicates valve position in a range from open (OP) to closed (CL). In addition, the outflow valve position is displayed on the AIR page of the SD.

When pressurization control is selected to manual, moving the MANUAL toggle switch to CLIMB or DESC positions the outflow valve to increase or decrease cabin pressure. Moving and holding the MANUAL LDG ALT switch to INCR or DECR increases or decreases the landing altitude selection. This is displayed on the SD.

When cabin altitude exceeds 10,000 feet, a warning sounds in the cockpit, the CABIN ALTITUDE alert is displayed, and a chime sounds in the cabin.

Normal maximum cabin differential pressure is 7.86 psi. At maximum differential pressure the system maintains a sea level cabin pressure up to a flight altitude of 19,000 feet. At flight level 370, the cabin altitude is 8000 feet. Failure of the cabin air outflow valve results in inside pressure exceeding limits. Excessive pressure is relieved by cabin (positive) pressure relief valves. The dual cabin pressure relief valves begin limiting cabin differential pressure at 8.06 psi, and allow a maximum differential pressure of 8.27 psi. Negative pressure relief is provided through the entrance galley door seals and through a negative pressure relief valve in the aft pressure bulkhead.

The cargo compartments are not ventilated. Equalization valves, one for each cargo compartment, equalize main cabin and cargo compartment pressures.

During ground operation, with the air conditioning system selected on, a tail compartment cooling fan provides increased cooling of the tail compartment. Air from the fan exhausts through the right air conditioning exhaust duct.

Airplane pressurization is normally controlled automatically. The automatic system controls outflow valve position through an electrical actuator and clutch mechanism. Two independent pressure controllers, AUTO 1 and AUTO 2, each powered from a separate DC bus, are each capable of automatic pressurization control from takeoff to landing. Normally, one system controls pressurization during all operating conditions.

Automatic cabin pressurization begins when the throttles are advanced for takeoff. During a rejected takeoff, depressurization begins when the throttles are retarded. If the airplane is not in flight mode within 60 seconds after the throttles are advanced, the outflow valves automatically open to depressurize the cabin. During a failure of the active controlling system, automatic transfer to the other controlling system occurs. Cabin pressure is not affected during the system transfer.

Cabin Pressure Relief Valves

Two cabin pressure relief valves, located on the left side of the fuselage just forward of the wing fillet, provide protection from fuselage over-pressurization.

Cabin differential pressure is displayed below cabin altitude on the SD synoptic. When cabin differential pressure exceeds prescribed limits, the CABIN PRES HI alert is displayed on the EAD and a failure indication is displayed on the SD synoptic.

Cabin Pressure Control Panel

The CABIN PRESS control panel provides a means to select the mode of operation, observe the position of the cabin outflow valve, manually change the position of the outflow valve during manual operations, and to manually select landing field elevation.

When landing altitude information is available from the FMS, the landing altitude is displayed on the AIR synoptic.

The two position (INCR/DECR) MANUAL LDG ALT switch is used to manually select the landing field elevation when the data is not available from the FMS. Moving the switch to INCR increases the landing altitude. Moving the switch to DECR decreases the landing altitude. The LDG ALTITUDE MAN alert is displayed.

The CABIN PRESS panel SYSTEM switchlight functions when the pressurization system is operating either in automatic mode or in manual mode. When the pressurization system is operating in the automatic mode, the switchlight is dark. When the switchlight is pushed, the alternate cabin pressure controller is selected and the pressurization system is controlled manually. MANUAL illuminates and the CABIN PRES SYS MAN alert is displayed on the EAD.

If both automatic cabin pressure controllers fail, SELECT illuminates on the SYSTEM switchlight, and the SEL CAB PRES MAN alert is displayed on the EAD.

When in manual mode, the flight crew adjusts the outflow valve position with the CABIN PRESS panel MANUAL switch. The switch has two momentary positions (CLIMB and DESC). Moving the switch to CLIMB moves the outflow valve in the open direction, and cabin altitude increases. Moving the switch to DESC moves the outflow valve in the closed direction, and cabin altitude decreases. The crew controls cabin pressure by adjusting the valve position and monitoring the change in cabin altitude rate on the secondary engine page of the SD.

Radio And Instrument Cooling

The radios are cooled automatically on the ground by two fans (primary and backup) that stay on all the time. During flight, radio cooling is controlled with the AVIONICS COOLING switch. With the switch selected to FAN, the primary fan cools the radios. If the primary fan fails, the backup fan comes on automatically. With the switch selected to OVRD, the fan is off and venturi airflow cools the radios.

The AVIONICS COOLING switch is inoperative on the ground. Both the primary and standby fans are operating and the venturi valve is closed, regardless of AVIONICS COOLING switch position. The forward cargo compartment heater is also inoperative on the ground.

The AVNCS AIR FLO OFF alert is displayed on the ground if the primary fan fails, and in flight if both fans fail with fan cooling selected.

If both fans fail in flight, selection of venturi airflow provides radio rack cooling. Cargo compartment heating is not available when venturi radio rack cooling is in use.

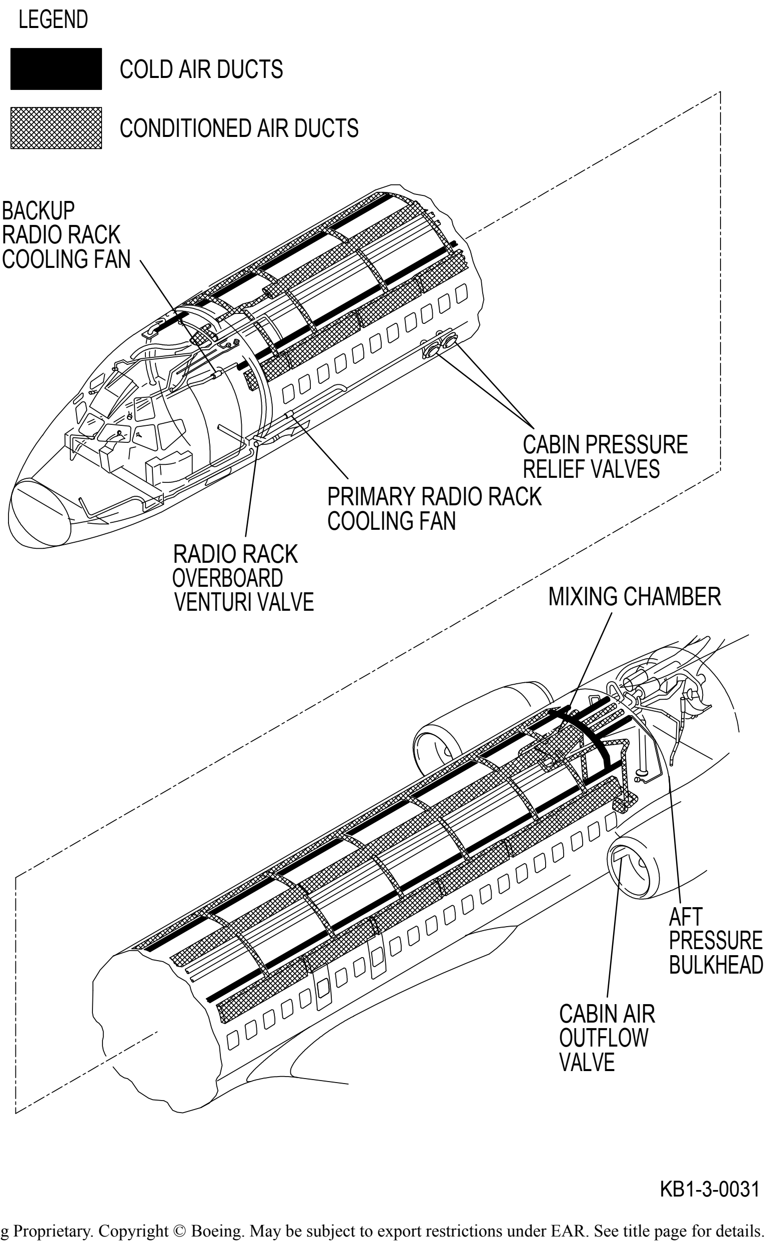
The main instrument panel is cooled automatically by pack airflow when the packs are on. During ground operation, when the packs are off, and in flight, in the event both air conditioning packs fail, the instrument panel is cooled by a fan.

Cargo Compartment Heating

The forward cargo compartment is electrically heated maintaining a temperature range between 60° and 75°F. Live animals must be transported only in the forward cargo compartment, forward of the cargo door.

The aft cargo compartment is heated with cabin exhaust air.

Major Component Location



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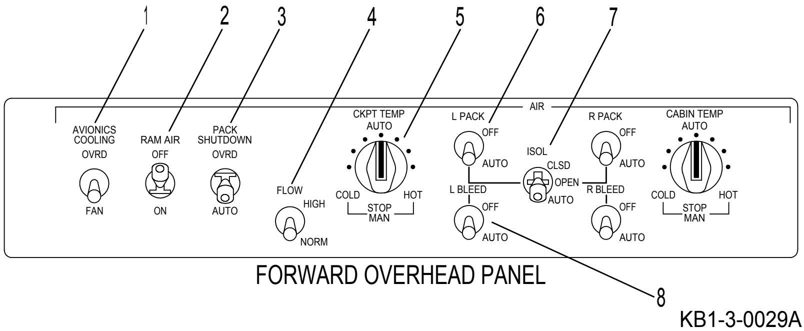
Air Control Panel



1. **AVIONICS COOLING Switch**

   NOTE: Switch operates inflight only.

   OVRD - The venturi valve is commanded open. The radio rack fans are off. Venturi airflow cools the radios.

   FAN - The venturi valve is commanded closed. The fans operate normally.

2. **RAM AIR Switch**

   OFF - Ram air valve is commanded closed.

   ON - Ram air valve is commanded open, allowing ram air to enter the right air conditioning ducts.

3. **PACK SHUTDOWN Switch**

   OVRD - Manually overrides automatic pack shutdown, except when supply temperatures exceed limits.

   AUTO - Allows automatic pack shutdown. (Inhibited above 3,000’ AGL when automatic shutdown is due to engine failure.)

4. **FLOW Switch**

   HIGH - The flow control valve solenoid is de-energized to provide a higher airflow rate.

   NORM - The flow control valve solenoid is energized to provide a lower airflow rate.

5. CKPT/CABIN TEMP Selector

NOTE: When operating in MAN mode, the full cold position should be selected initially. Manual temperature adjustments may be determined and selected thereafter, as desired.

AUTO - The temperature control valve position is automatically adjusted to maintain the selected temperature in the cockpit or cabin. The upper portion of selector rotation, from COLD to HOT, is the automatic range.

MAN - Momentarily rotating and holding the selector toward HOT or COLD moves the temperature control valve towards open or closed, allowing manual control of the output temperature of the air conditioning pack. The valve moves as long as the selector is held toward HOT or COLD.

COLD - Adjusts conditioned air temperature toward cool.

STOP - Spring-loaded position when selector is released. The temperature control valve remains at the last selected position.

HOT - Adjusts conditioned air temperature toward warm.

6. L/R PACK Switch

OFF - The respective flow control valve is commanded closed. Stops conditioned airflow.

AUTO - The respective flow control valve is commanded open. Provides airflow to the air conditioning pack, supplying conditioned air to the cabin and cockpit.

7. ISOL Switch

CLSD - The isolation valve is commanded closed. Isolates left and right pneumatic systems.

OPEN - The isolation valve is commanded open. Allows crossfeed of left and right pneumatic systems.

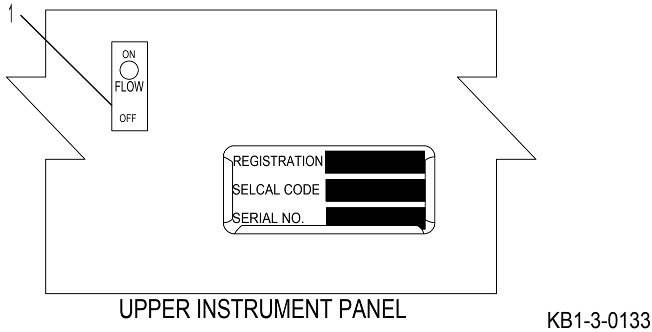
AUTO - The isolation valve position is controlled by the pneumatic system controller. Allows automatic crossfeed of left and right pneumatic systems during one bleed source operation with ice protection selected on.

8. L/R BLEED Switch

OFF - The respective pneumatic system pressure regulator and shutoff valve (PRSOV) is commanded closed.

AUTO - The PRSOVs are controlled by the pneumatic system controller.

Instrument Panel Airflow Indicator



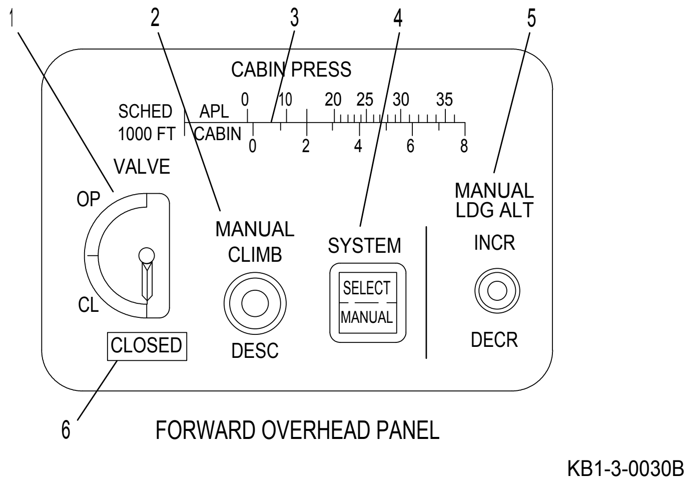
1. FLOW Indicator

ON - On the ground, with air conditioning off, indicates instrument panel cooling fan airflow.

OFF - On the ground, with air conditioning off, indicates the absence of airflow and cooling fan failure.

NOTE: Airflow indications apply only during ground operations, and inflight with both air conditioning packs shut down.

Cabin Pressure Control Panel



1. **Outflow VALVE Position Indicator**

   OP - Valve position towards open indicates decreased cabin pressure.

   CL - Valve position towards closed indicates increased cabin pressure.

2. **MANUAL Switch**

   CLIMB - When the switch is moved towards CLIMB, the outflow valve moves in the open direction, and cabin altitude increases.

   DESC - When the switch is moved towards DESC, the outflow valve moves in the closed direction, and cabin altitude decreases.

3. **CABIN PRESS Schedule**

   APL - Depicts a scale in thousands of feet to represent an airplane altitude.

   CABIN - Depicts a scale in thousands of feet to represent a cabin altitude.

   The normal relationship between airplane altitude (APL) and cabin pressurization (CABIN) is depicted on this scale.

4. **SYSTEM SELECT/MANUAL Switchlight**

   MANUAL - When switchlight is pushed, MANUAL illuminates and the cabin pressurization system operates in manual mode. Also used to alternate control between cabin pressure controllers (auto 1 and auto 2).

   SELECT - Illuminates to indicate failure of both cabin pressure controllers.

SELECT/MANUAL - Extinguished when the pressurization system is operating in automatic mode.

5. MANUAL LDG ALT Switch

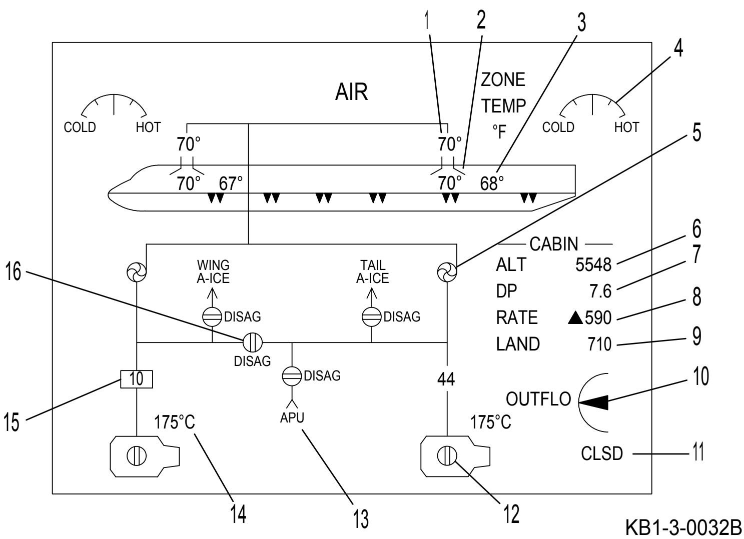
INCR - Increases landing altitude; displayed on the AIR page of the SD.

DECR - Decreases landing altitude; displayed on the AIR page of the SD.

6. Outflow Valve CLOSED Light

Illuminated - Indicated the outflow valve is fully closed.

SD Synoptic – AIR



NOTE: A momentary EXT AIR indication may appear after engine start. The EXT AIR indication is an anomaly.

1. Cockpit/Cabin Supply Duct Temperature

White - Normal.

Amber (boxed) - Temperature exceeds limit.

2. Cockpit/Cabin Actual Temperature

White - Normal. Dashed for manual (cockpit).

3. Cockpit/Cabin Selected Temperature

Cyan - Normal. Dashed for manual.

4. Cockpit/Cabin Temperature Dial

Blank - Auto.

White (dial) - Manual.

5. Air Conditioning Pack

White - Commanded off and there is no air flow.

Green (vaned) - Commanded on and there is normal air flow.

Amber - Commanded off and there is normal air flow.

Amber (vaned) - Commanded on with no air flow.

6. Cabin Altitude

White - Normal.

Red (boxed) - Above 10,000 feet.

7. Differential Pressure

White - Normal.

Amber (boxed) - Above normal limit.

8. Cabin Rate of Climb

White - Within normal limits.

Amber - Exceeds normal limits.

9. Landing Altitude

Magenta - Landing altitude has been generated from the FMCs.

White - Landing altitude has been set with the MANUAL LDG ALT INCR/DECR switch.

Amber - Dashes displayed when no data received from the FMCs and no crew input received.

10. OUTFLO Valve Position

White - Normal.

Blank - No data.

11. Outflow Valve CLSD

Amber - Fully closed.

White - Not fully closed.

12. Bleed Air Valve

White - Commanded off (horizontal lines), or, commanded on (vertical lines).

Green - Commanded on with engine running (vertical lines).

13. APU

Blanked - APU air not available.

White - APU air available, but not selected.

Green - APU air available, and selected.

14. Bleed Air Temperature

White - Normal (°C).

Amber (boxed) - Exceeds upper limit, or, temperature low with wing/tail anti-ice selected on.

15. Manifold Pressure

White - Normal.

Amber (boxed) - Exceeds high and low limits.

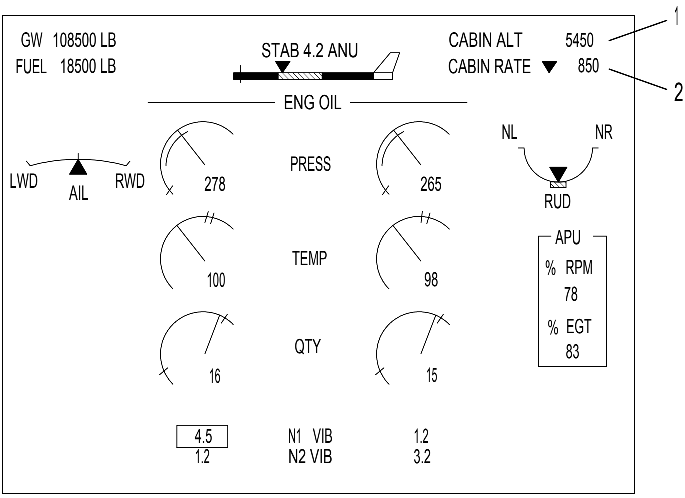
16. Isolation Valve

White - Commanded closed.

Green - Commanded open.

Amber - Valve position disagrees with commanded position.

SD Synoptic – Secondary Engine



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1. CABIN ALT

Cabin altitude in feet.

2. CABIN RATE

Cabin rate of climb in feet per minute.

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

CABIN ALTITUDE (AIR) - Cabin pressure altitude exceeds the maximum limit of 10,000 feet.

TAIL TEMP L/R HI (AIR) - PODS has detected an overheat condition or manifold failure in the tail compartment.

WING/TAIL MANF FAIL (AIR) - PODS has detected an overheat condition in the respective anti-ice manifold and has failed to close the respective ice-protection shutoff valve.

Amber Boxed Alerts (Level 2)

AIR SYS L/R PRES LO (AIR) - Respective system is on with low pressure.

AVNCS AIR FLO OFF (AIR) - On the ground, indicates the primary fan has failed. In flight, indicates both fans have failed with fan cooling (AVIONICS COOLING switch in FAN) selected.

BLD AIR L/R TEMP HI (AIR) - Respective bleed manifold temperature exceeds 535 degrees F (280 degrees C).

BLD AIR L/R TEMP LO (AIR) - Respective bleed air temperature is too low for airfoil protection.

BLEED AIR L/R FAIL (AIR) - Pressure regulator valve failed or PSC channel failed.

CABIN DUCT OVHT (AIR) - Cabin duct temperature exceeds limit. Pack shutdown could occur.

CABIN INFLO LO (AIR) - Cabin pressure is low. Pack airflow is insufficient to maintain pressurization.

CABIN PRES HI (AIR) - Cabin differential pressure exceeds prescribed limits.

CABIN PRESSURIZED (AIR) - The cabin is pressurized while the airplane is on the ground.

CKPT DUCT OVHT (AIR) - Cockpit duct temperature exceeds limit. Pack shutdown could occur.

PACK L/R OVERHEAT (AIR) - Respective air conditioning pack has shut down due to high temperature.

Amber Alerts (Level 1)

AIR ISOL DISAG (AIR) - The pneumatic system isolation valve is not in the commanded position.

AIR SYS FAULT (AIR) - (-909 VIA) Related bleed air system has a failure that prevents satisfactory anti-ice operation.

AIR SYS L/R NOT OFF (AIR) - The respective bleed air system is still pressurized when commanded OFF.

AIR SYS L/R OFF (AIR) - The respective bleed air system is off and the isolation valve is closed.

APU VALVE DISAG (AIR) - The APU valve position disagrees with the APU AIR switch position.

AVNCS COOL OVRD (AIR) - The AVIONICS COOLING switch is in the override (OVRD) position.

BLEED AIR L/R OFF (AIR) - The respective bleed air switch is selected off when bleed air source is available.

CAB PRES MAN FAIL (AIR) - The cabin pressure control panel or manual control of the outflow valve actuator has failed. Manual control is not available.

CAB PRES SYS MAN (AIR) - The cabin pressurization control system is selected to manual.

CABIN RATE (AIR) - Cabin climb or descent rate exceeds desired limits.

CABIN TEMP MANUAL (AIR) - The cabin temperature control knob is selected to manual.

CKPT TEMP MANUAL (AIR) - The cockpit temperature control knob is selected to manual.

CPC 1/2 FAIL (STATUS) - The respective cabin pressure controller has failed.

LDG ALTITUDE MAN (AIR) - When landing field elevation information is not available from the FMS indicates manual input is selected.

PACK L/R FLO DISAG (AIR) - The respective pack pneumatic flow disagrees with the switch position.

PACK L/R OFF (AIR) - The respective pack is commanded off. MASTER CAUTION lights illuminate if both packs are off above 4500 feet AGL.

PACK OVRD (AIR) - The PACK SHUTDOWN switch is in the OVRD position.

PODS A-ICE FAULT (STATUS) - PODS has a fault in the wing or tail ice protection system and cannot detect a manifold failure.

PODS FAIL (AIR) - PODS has failed and is unable to detect manifold failure or overheat in the tail compartment.

PODS FAULT (STATUS) - One loop or controller channel of PODS has failed. Overheat and manifold failure detection are still operative.

PODS TEST FAIL (AIR) - PODS test has failed.

SEL CAB PRES MAN (AIR) - Both cabin pressure controllers have failed and the system only functions when set manually.

SET LDG ALTITUDE (AIR) - Cabin pressurization system landing field elevation data from the FMS is lost and must be set manually.

Cyan Alerts (Level 0)

AIR ISOL OPEN - The pneumatic isolation valve is commanded open.

PACKS ALL OFF - The packs are off for takeoff as selected through the FMS, or the packs are switched off during an engine failure on takeoff.

PACKS HIGH FLOW - HIGH pack flow is selected on the FLOW switch.

PODS TEST PASS - PODS preflight test is successful when the engine fire protection test is performed.

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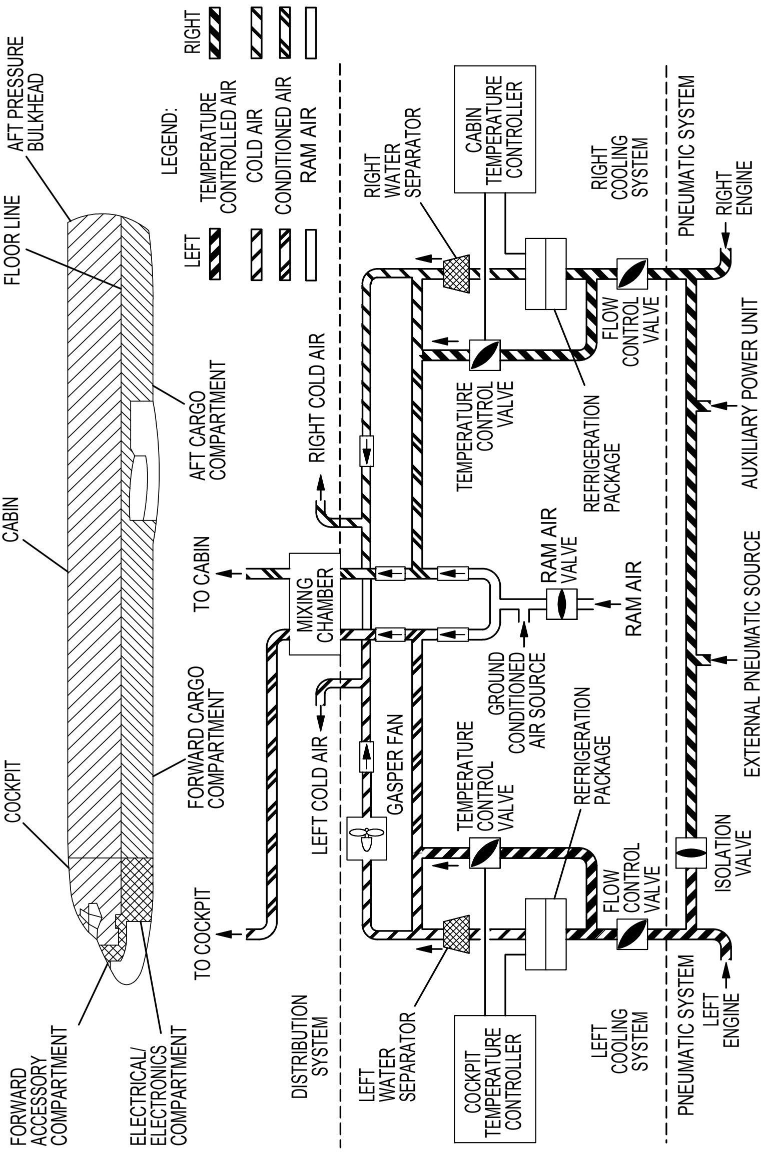
Air Conditioning System



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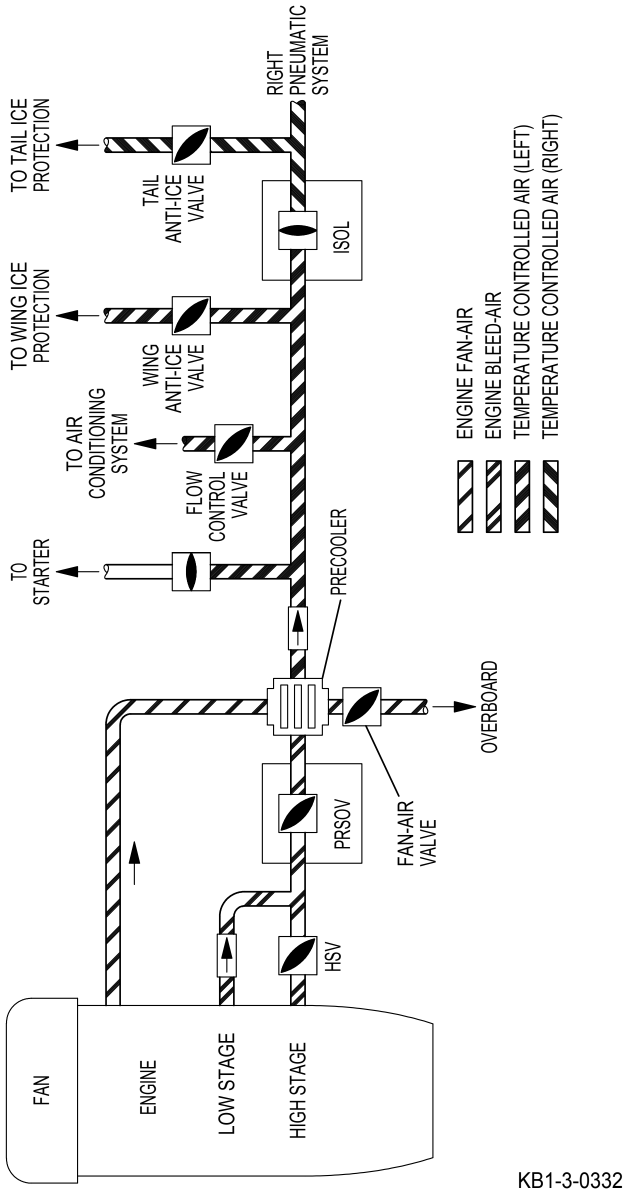
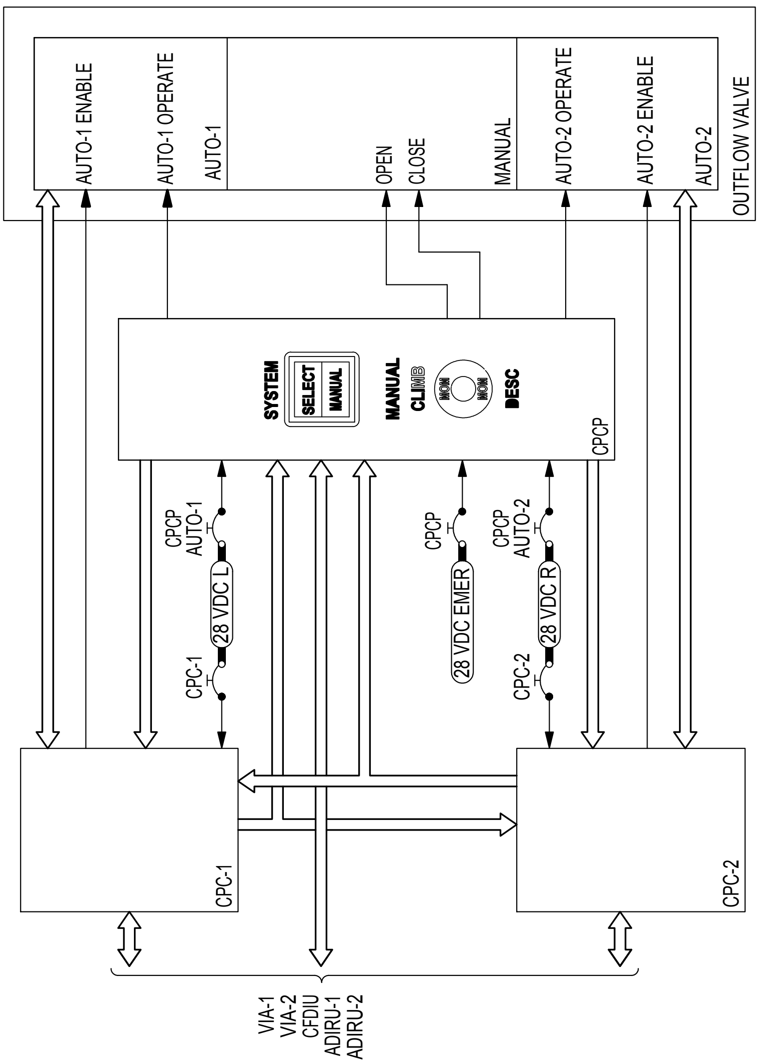
Pneumatic System



Pressurization System



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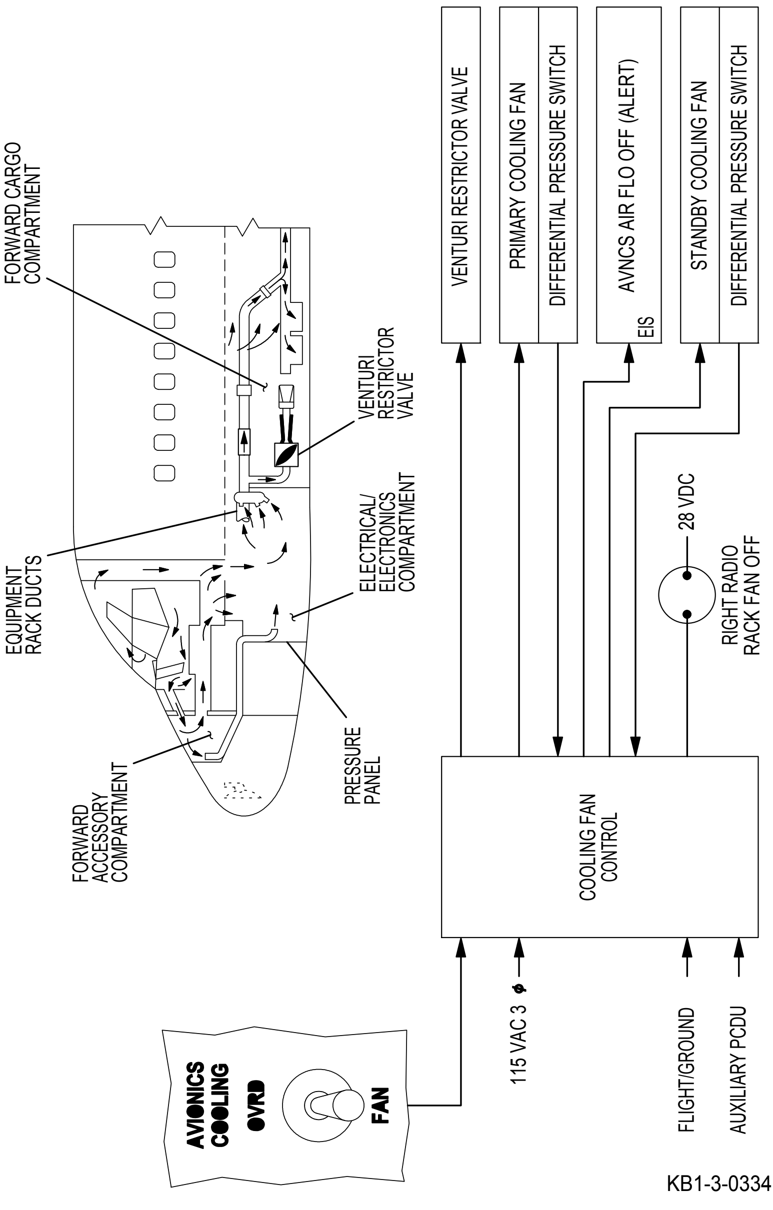
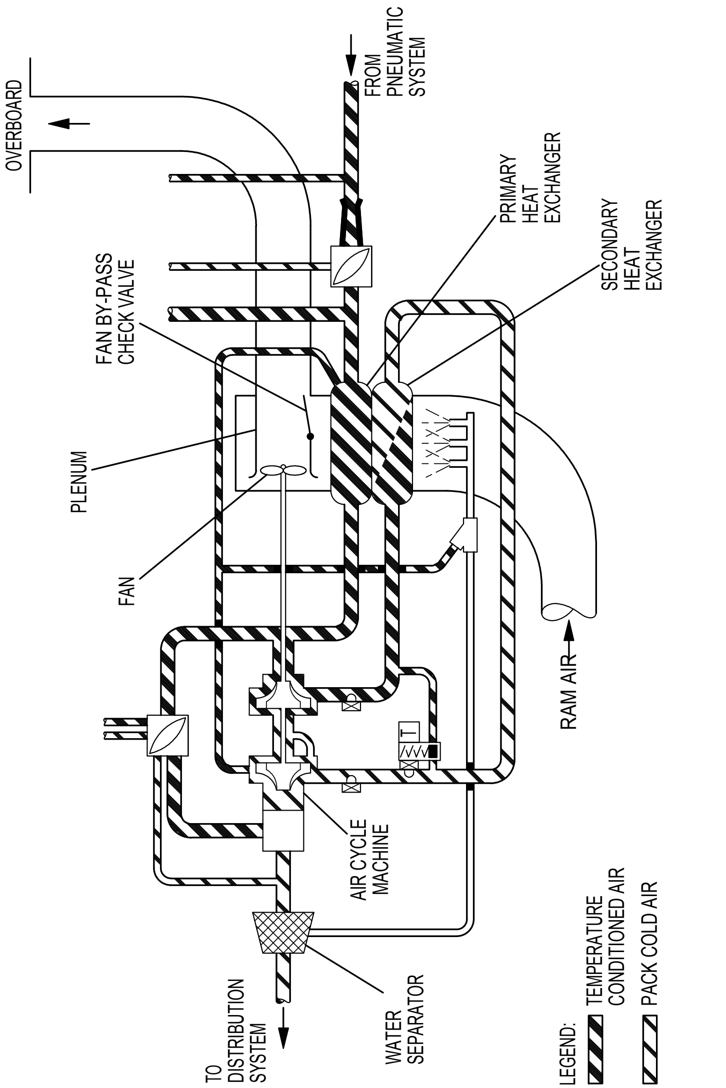
Avionics Compartment Ventilation



Heat Exchanger Cooling Air



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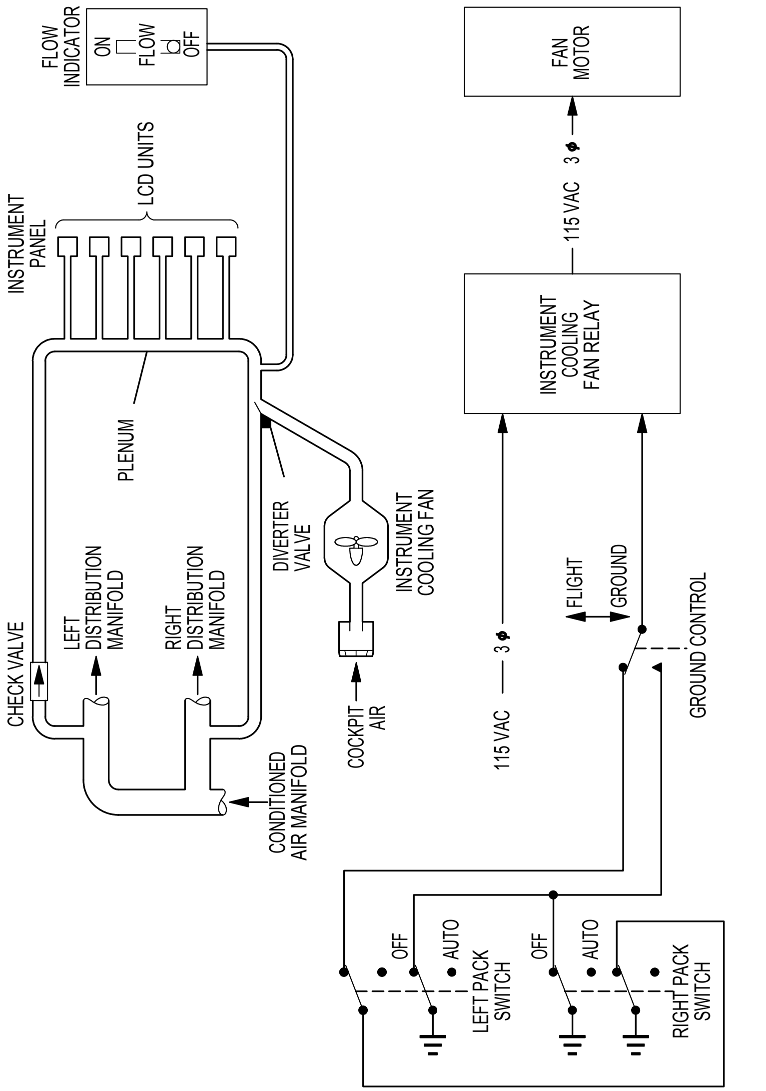
Instrument Panel Ventilation



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Automatic Flight — Chapter Auto
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General

The Automatic Flight System (AFS) consists of 2 Flight Control Computers (FCC), a Flight Control Panel (FCP), a dual autothrottle servo, a stick pusher, a yaw damper actuator, seven position sensors, and three dual autopilot servos. The AFS is a dual, automatic, flight control system, which interfaces with the mechanical control system via dual electric servos. The AFS processes the inputs from airframe sensors, navigational sensors, air data, inertial reference units, and other sources to provide outputs for the control of pitch, roll, yaw, thrust, stall warning, and rudder limiting. The system also sends data to the VIAs where it is processed and used to generate displays and alerts on the LCDUs in the cockpit.

Autoflight controls are on the Flight Control Panel (FCP). Annunciations are displayed on the Primary Flight Display (PFD). Related alerts are displayed on the Engine and Alert Display (EAD).

Automatic Pilot/flight Director (AP/FD)

The FCP provides the means for the flight crew to preselect/select speed, heading, vertical speed/flight path angle, and altitude references to be used by the AFS. Other inputs from configuration sensors, Air Data Computers Inertial Reference Units (ADIRU), and Flight Management Functions (FMF) are processed by the FCCs. The FCCs then send command signals to the ailerons, elevator, rudder, autothrottle, and yaw damper. The yaw damper actuator provides series inputs to the rudder control valve. The aileron, elevator, and rudder servos are activated by a cable control system.

In addition, the FCC provides the computations and outputs required to operate the stick shaker, stick pusher, rudder stop limiter, rudder hook monitor, and automatic ground spoiler.

Pitch Control

Pitch modes are controlled from the FCP and are available as follows:

Vertical Speed - A vertical speed can be captured and maintained with the Pitch wheel.

Altitude Hold - Engages automatically after altitude capture or can be pilot engaged by pushing the altitude select knob.

Level Change - An altitude is preselected with the altitude select knob and the level change is engaged by pulling the altitude select knob.

Airspeed/Mach Hold - Existing airspeed or Mach is held by pushing the IAS/Mach select knob.

Airspeed/Mach Select - An airspeed or Mach is preselected by turning the IAS/Mach select knob. That speed is then captured and maintained by pulling the knob.

Profile - The airplane responds to FMS pitch commands. This mode is engaged by pushing the PROF switch.

FMS Speed -The airplane responds to FMS speed targets. This mode is engaged by pushing the FMS SPD switch.

Flight Path Angle (FPA) - A flight path angle can be captured and maintained with the V/S-FPA pitch wheel.

Automatic Approach/Landing - The airplane captures and tracks an ILS glideslope, flares for landing, and pitches down at runway contact. This mode is engaged by pushing the APPR/LAND switch.

Takeoff - The airplane pitches up to maintain takeoff reference speeds.

Go-around - The airplane pitches up to maintain go-around reference speeds. This mode is engaged by pushing the go-around switches on the aft side of the throttles.

Roll Control

Roll modes are controlled from the FCP and are available as follows:

Heading Hold - The airplane maintains a selected magnetic heading. This mode is engaged by pushing the HDG/TRK selector knob.

Heading Select - The airplane will capture and hold a selected magnetic heading. This mode is engaged by turning the HDG/TRK selector knob to preselect a heading and then pulling the knob.

Lateral Navigation - The airplane captures and maintains an FMS lateral course. This mode is engaged by pushing the NAV button.

Automatic Approach/Landing - The airplane captures and tracks an ILS localizer, aligns with the runway, and rolls out on the airplane centerline. Rudder is used as well as aileron.

Takeoff - The airplane maintains wings level prior to liftoff and then maintains the heading tracked during takeoff roll.

Go-Around - The airplane maintains existing heading. This mode is engaged by pushing the go-around switches on the aft side of the throttles.

Auto Throttle System (ATS)

ATS is engaged by pushing the AUTO FLIGHT switch on the FCP and the following modes are available:

IAS/Mach - The throttles will adjust to capture and maintain a selected IAS/Mach.

Thrust Limit/Target - The throttles will acquire and maintain the thrust limit/target.

Retard - The throttles will cut back for landing at designated radio altitude.

Clamp - During takeoff (at about 80 knots) full manual throttle is available with ATS engaged.

Speed Protection - The ATS will always maintain airplane speed above stall speed and below maximum speed for any configuration. If The ATS is off, it will automatically engage to provide speed protection.

ATS Thrust Limit - The ATS will prevent the engines from exceeding thrust limits.

ATS disconnect switches are on the outboard side of each throttle. ATS annunciations are displayed on the PFD.

Mach Trim

The FCCs provide a Mach trim function that is operative when the AP is not engaged (auto pitch trim not on). When Mach trim is active, the stabilizer will automatically move to compensate for pitch forces caused by Mach number.

If Mach trim becomes inoperative, it will automatically stop driving the stabilizer and an alert will be displayed.

Automatic Pitch Trim

When the autopilot is on, the stabilizer will automatically move as required to provide pitch trim.

Reactive Windshear Alert And Guidance

During takeoff, approach, and go-around, the Windshear Alert and Guidance System (WAGS) provides visual/aural windshear warnings and AP/FD guidance through the windshear. Visual warnings are red for decreasing performance windshear and amber for increasing performance windshear.

On takeoff, when a windshear is detected, WINDSHEAR appears (after flashing) on the PFD and the FMA speed/altitude windows, and three cycles of TAILWIND SHEAR or HEADWIND SHEAR will sound. For decreasing performance windshear the FMA roll window will show HDG XXX. For increasing performance windshear, the FMA roll window will retain takeoff heading. The FD will command a pitch attitude for V2 + 30.

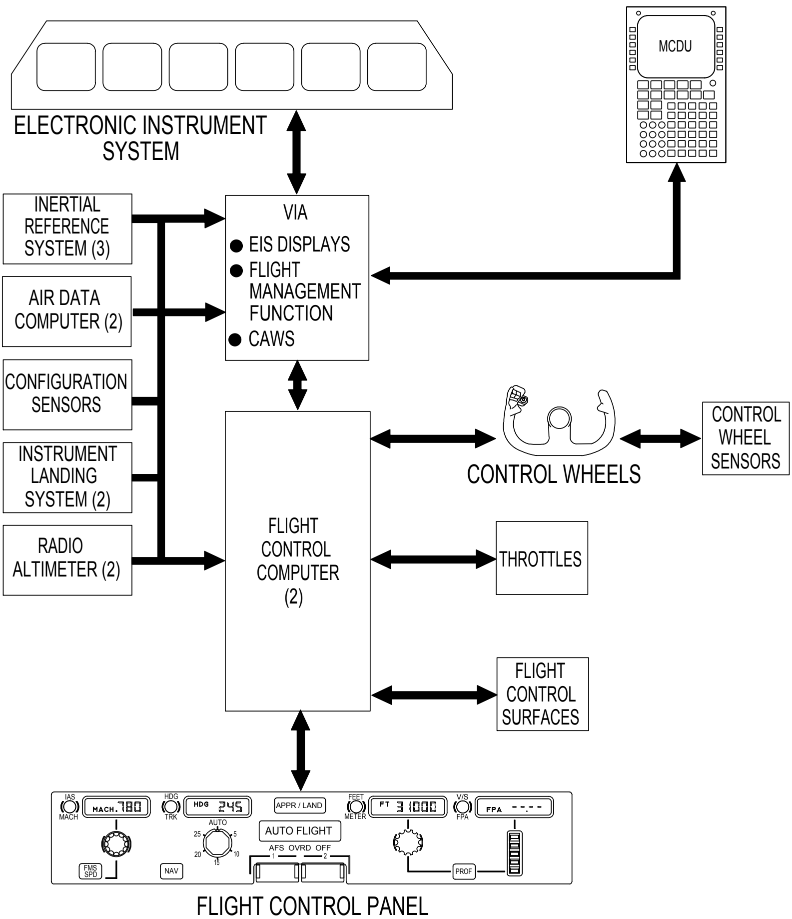
On approach and go-around, the same visual and aural annunciations will activate. The PFD speed bug will go to 1.3Vs+20 and the ATS, if on, will control to this speed. Guidance will not come on during approach unless a go-around is initiated by pushing the GA button or advancing the throttles past the 95% GA thrust limit after windshear is detected. Once the GA is initiated, the ATS, if off, will engage and advance to maximum GA thrust. The FD, if off, will pop up automatically. Guidance will continue until the windshear condition no longer exists.

If windshear is detected after a go-around has been initiated, guidance begins automatically.

For both takeoff and approach/go-around, the Pitch Limit Indicator (PLI) on the PFD shows the difference between airplane AOA and stickshaker AOA. At stickshaker AOA, the cyan PLI turns red. The PLI is for indication only and is not to be used for guidance command.

The GPWS is inhibited during windshear guidance when the FD commands are being followed. The TCAS is also inhibited except for Traffic Advisories (TA) on the ND.

AFS Components



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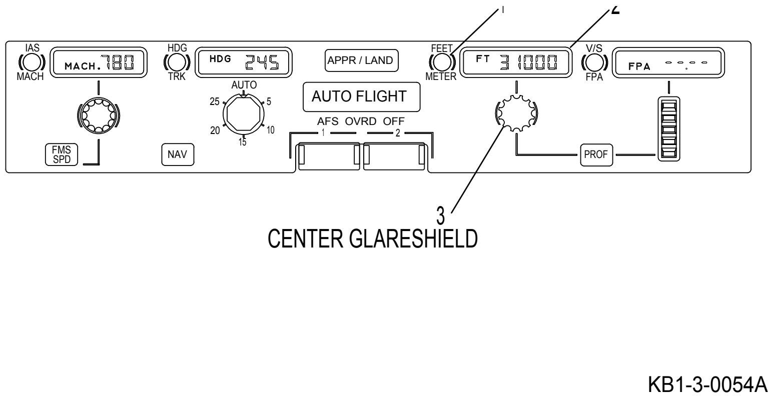
Altitude Control and Display



1. **FEET/METER Changeover Button**

   Push - Selects feet or meters on FCP, FMA, and lower right of PFD.

2. **Altitude Display Window**

   Displays altitude dialed in with the altitude select knob. Window is blank if air data computers fail.

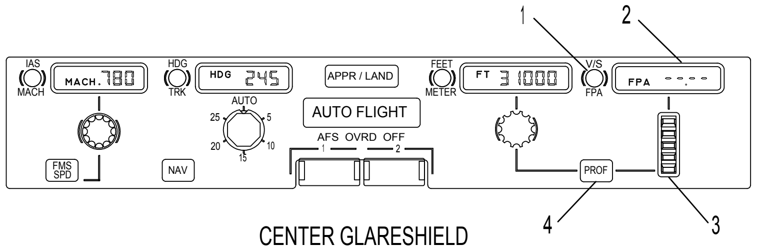
3. **Altitude Select Knob**

   Rotate - Sets preselected altitude in altitude display window. If PROF is engaged, sets FMS clearance ceiling (climb) or floor (descent).

   Pull - Airplane will climb or descend directly to selected altitude. ATS will go to climb thrust or idle descent as required. FCP altitude is displayed on FMA.

   Push - Airplane will hold current altitude. Altitude will display on FCP, FMA, and PFD.

Vertical Control and Display



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1. **V/S-FPA Changeover Button**

   Push - Selects alternately either vertical speed in fpm or FPA in tenths of degrees.

2. **V/S-FPA Display Window**

   Displays vertical speed or FPA selected with the pitch wheel. Display is blank if V/S or FPA are not engaged. When FPA is selected, the value is in degrees and tenths. When V/S is selected, the value is in fpm.

3. **Pitch Wheel**

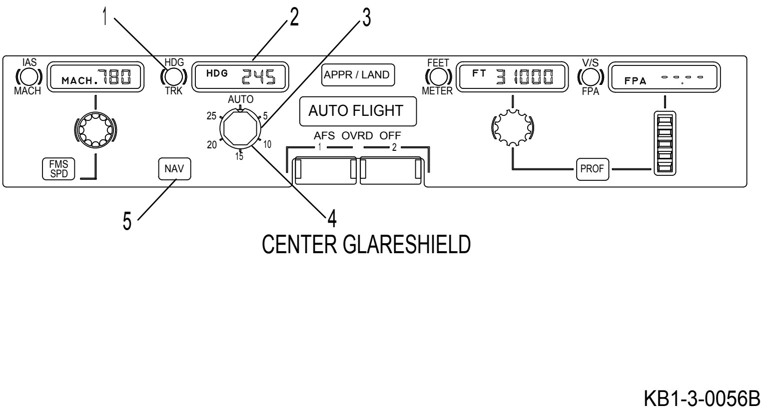
   Rotate - Selects a vertical speed or FPA in the display window. The airplane then maintains that vertical speed or FPA. If the wheel is rotated again, the vertical speed or FPA will change again.

4. **PROF Switch (Deactivated with a cap for FCC -901)**

   For FCC -902 and subs,

   Push - Engages FMS vertical profile guidance.

Heading Control and Display



1. **HDG/TRK Changeover Button**

   Push - Selects alternately either heading or track in the display window and on the ND.

2. **HDG/TRK Display Window**

   Displays HDG or TRK dialed in with the HDG/TRK selector. Window is blank when the AFS is controlling to the FMS flight plan.

3. **HDG/TRK Selector (Inner Knob)**

   Turn - Preselects a heading or track in the display window.

   Pull - The airplane captures and follows the selected track or heading that is in the display window.

   Push - Airplane maintains current heading or track. The window will display this heading or track.

4. **Bank Angle Limit Selector (Outer Knob)**

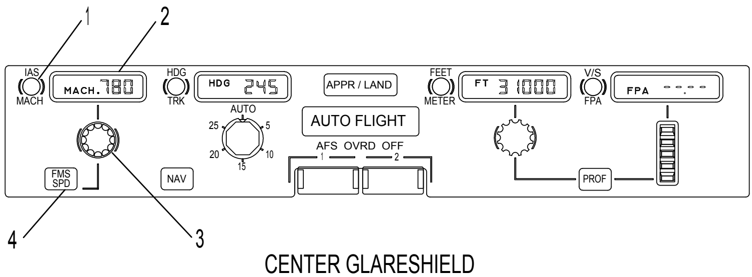
   Rotate - Selects max bank angle in 5 degree increments.

   AUTO - Bank angle limits vary with speed. This selector cannot override FMS bank angle limits. Limits are displayed on the top of the PFD attitude sphere.

5. **NAV Switch**

   Push - Arms the FMS NAV capture mode or resumes FMS lateral control. NAV ARM can be cancelled by selecting HDG/TRK hold, APPR/LAND arm, capturing the localizer, or capturing FMS NAV.

Speed Control and Display



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1. **IAS/MACH Changeover Button**

   Push - Selects alternately either IAS or Mach in the display window.

2. **IAS/MACH Display Window**

   Displays the IAS or Mach dialed in with the IAS/MACH select knob. The window shows dashes when the AFS is controlling to FMS flight plan speed.

3. **IAS/MACH Select Knob**

   Rotate - Preselects IAS or Mach in the display window.

   Pull - The airplane holds speed selected in the window.

   Push - The airplane maintains current speed and the window will display the speed.

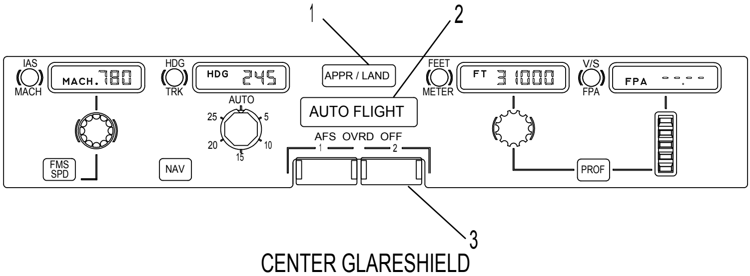
4. **FMS SPD Switch (Deactivated with a Cap for FCC -901)**

   For FCC -902 and subs:

   Push - Selects the armed FMS speed. The display window will show dashes and the FMA speed changes from white to magenta. FMS speed can be edited by preselecting an FCP speed with the IAS/MACH select knob and immediately pushing this switch.

   FMS SPD is disengaged by pushing or pulling the IAS/MACH select knob or by engaging go-around.

APPR/LAND, AUTO FLIGHT and AFS OVRD OFF Switches



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1. **APPR/LAND Switch**

   Push - Arms the APPR and LAND modes. LAND ARMED appears in the FMA roll control window. A tuned ILS is required to arm APPR/LAND.

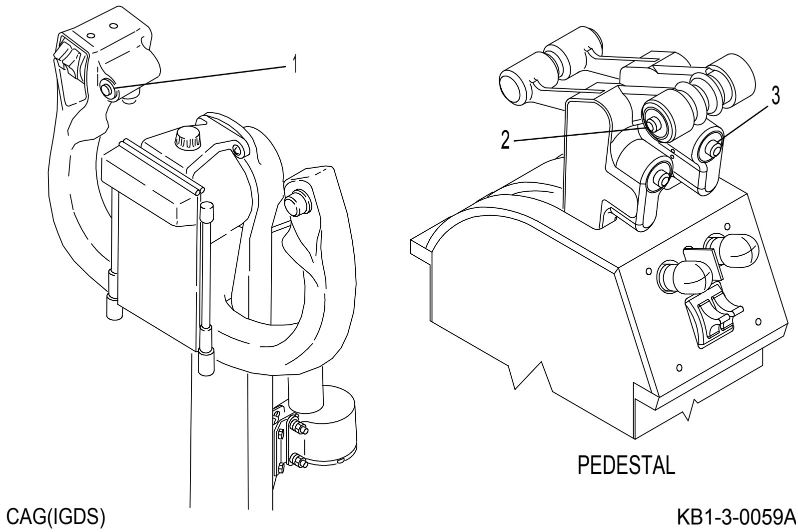
2. **AUTO FLIGHT Switch**

   Push - Engages ATS and one AP in the FD mode that has been selected. If no FD mode has been selected, the AP engages in HDG/TRK HOLD and either altitude hold (if level) or vertical speed hold (if climbing/descending). After AP engagement, each push alternates the AP between AP1 and AP2. This is displayed on the FMA.

3. **AFS OVRD OFF Switches (2)**

   Push down - Allows emergency disconnect of respective autopilot, autothrottle, and yaw damper. In OFF, an amber and gray bar comes into view.

AP and ATS Disconnect Switches and GA Switches



1. AP Disconnect Switches

Push - Disconnects the autopilot system. AP OFF message in red will flash in the PFD.

2. ATS Disconnect Switches

Push - Disconnects the autothrottle system. ATS OFF message in red will flash in the PFD.

Pushing either switch when the ATS warning system is activated, the ATS OFF message stops flashing, changes color to white if re-engagement is possible, or amber if a condition is present which prevents further use of the system.

3. GA Switches (for FCC -901 pushing disconnects the autopilot go-around function)

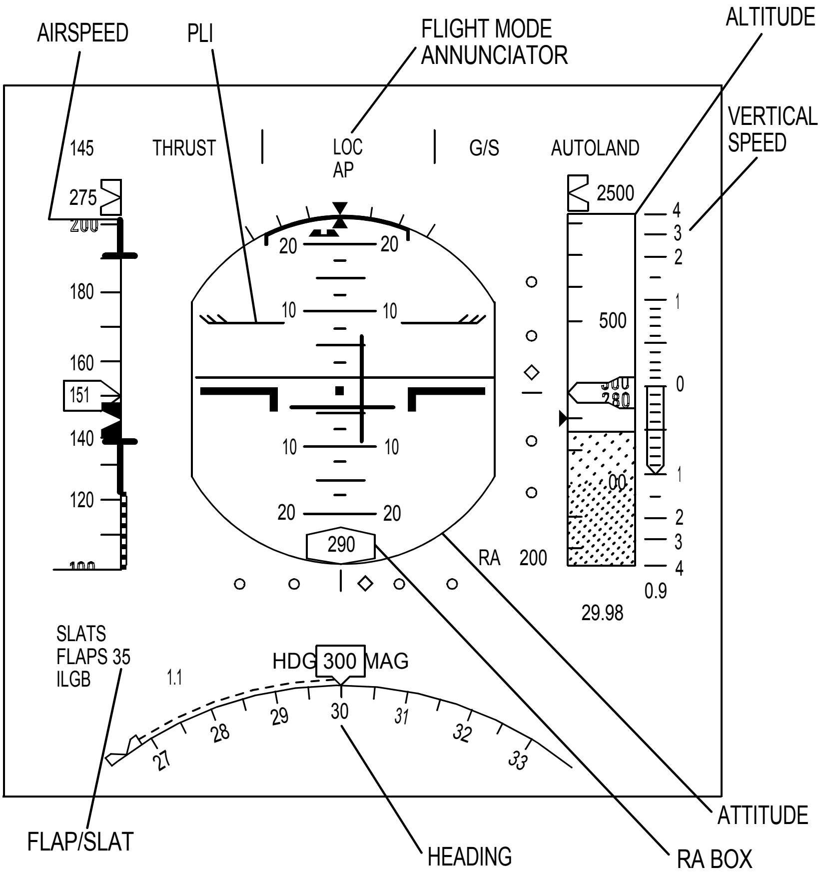
For FCC -902 and subs:

Pushing either switch - Causes the airplane to enter go-around mode as follows:

- FDs pop up to go-around (even if off).
- If AP is on, it will follow FD commands.
- ATS goes to go-around thrust limits.
- Parallel rudder is active and bank is limited to 10 degrees.
- Reference speed, PITCH, and GO-AROUND appear on FMA.

- Windshear pitch guidance comes on if windshear warning is active. WINDSHEAR will appear in the FMA speed and altitude windows.

Primary Flight Display (Typical)



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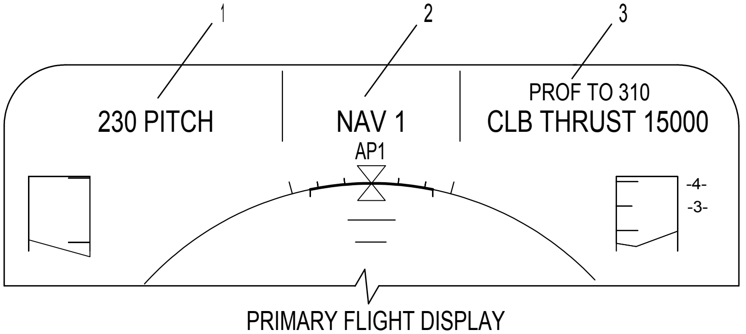
Flight Mode Annunciator



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1. **Speed Control Window**

   Shows FCP or FMS speed and mode. Mode is magenta when the FMS speed is engaged and the airplane is controlling to an FMS or pilot selected speed. The mode is white when an AFS speed mode is engaged and controlling to a pilot selected speed. When THRUST mode is on, ATS should be engaged. If it is not, the white ATS OFF box appears. If ATS is inop, the amber ATS OFF box appears. If a speed has been commanded that cannot be maintained due to vertical speed or FPA, the speed and mode will flash. Flashing continues until the airplane accelerates towards the target speed. If the mode changes due to an auto reversion, the new mode flashes 5 times. If speed protection engages, HI SPEED or LO SPEED PROTECTION will be displayed. Windshear warnings are displayed by a flashing white WINDSHEAR followed by a steady white WINDSHEAR.

2. **Roll Control Window**

   Shows roll mode. Digits are displayed in HDG or TRK mode. Engaged AP (1 or 2) is shown. FMS modes are magenta, pilot and AFS modes are white, and AUTOLAND mode is green. If the mode changes due to an auto reversion, the new mode flashes 5 times. Armed modes are in small characters above the engaged mode.

3. Altitude Control Window

Shows FMS or FCP target altitude and profile mode. FMS altitudes and modes are magenta. Pilot selected altitudes and modes are white. If the mode changes due to an auto reversion, the new mode flashes 5 times. Armed modes are shown above the engaged mode. The GROUND PROX warning is in red and flashes with the engaged mode. The WINDSHEAR mode annunciation has priority over all modes including GPWS.

FMA Control Window Modes

SPEED MODES	ANNUNCIATION	COLOR
FMS Descent	IDLE THRUST	Magenta
Speed-on-Pitch (level change)	PITCH	Magenta/White
Speed-on-Throttle	THRUST	Magenta/White
Throttle Retard	RETARD	White
Windshear	WINDSHEAR	White
Lo Speed Protection	LO SPEED PROTECTION	White
Hi Speed Protection	HI SPEED PROTECTION	White

ROLL MODES	ANNUNCIATION	COLOR
Capture/Track VOR	VOR1 or VOR2	White
Capture/Track LOC	LOC ONLY	White
FMS Nav	NAV1 or NAV2	Magenta
Heading Hold/Select	HEADING	White
Track Hold or Select	TRACK	White
Autoland Rollout	ROLLOUT	Green
Localizer	LOC	Green
Runway Alignment	ALIGN	Green
Takeoff Roll	TAKEOFF	White
Over VOR	VOR1 (or 2) CRS	White
FMS Nav Armed	NAV ARMED	Magenta
LAND Armed	LAND ARMED	White
LOC Armed	LOC ARMED	White
VOR Armed	VOR ARMED	White

ALTITUDE MODES	ANNUNCIATION	COLOR
Takeoff Thrust	T/O THRUST	White/Magenta
Takeoff Clamp	T/O CLAMP	White/Magenta
Climb w/Climb Thrust	CLB THRUST	White/Magenta
Altitude Hold	HOLD	White/Magenta
Climb w/MCT Thrust	MCT THRUST	White/Magenta
Vertical Speed	V/S	White/Magenta
Flight Path Angle	FPA	White
FMS Prof Descent	PROF	Magenta
GA Thrust	GO AROUND	White
Glideslope	G/S	Green
Autoland	AUTOLAND	Green
No Land Mode	APPR ONLY	White
Autoland Flare	FLARE	Green
Autoland Rollout	ROLLOUT	Green
Level Change Desc	IDLE CLAMP	White
FMS Speed-on-Elev	IDLE	Magenta
Next FMS Prof Alt	PROF TO	Magenta
PROF armed	PROF ARMED	Magenta
Prof altitude change	VERT ALERT	Magenta
G/S Capture Arm	LAND ARMED	White
Windshear (GA Thrust)	WINDSHEAR	White
Climb w/GA Thrust	GA THRUST	White/Magenta
Climb w/Cruise Thrust	CRZ THRUST	White/Magenta

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Alerts (Level 1)

A/P NOT AVAIL (MISC) - Autopilot is not available.

AUTOPILOT SINGLE (MISC) - Only 1 autopilot is available.

FCC 1/2 FAIL (CONFIG) - Respective FCC has failed.

FCC 1/2 FAULT (CONFIG) - Respective FCC has a fault.

FD G/A ONLY (MISC) - Autopilot go-around not available.

MANUAL G/A ONLY (MISC) - Autopilot and flight director go around modes are not available.

NO AUTOLAND (MISC) - Autoland mode is not available.

WSHEAR DET FAIL (MISC) - Windshear detection is inoperative.

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Auxiliary Power Unit (APU) — Chapter APU

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General

The Auxiliary Power Unit (APU) provides adequate electrical power to operate all airplane electrical systems simultaneously. It also provides a pneumatic pressure source for the air conditioning systems and engine starting. The electrical system has the higher priority for all operational conditions.

The APU is installed in an unpressurized, fireproof area, aft of the pressure bulkhead. Normal operating controls and fire extinguishing controls are located on the forward overhead panel APU control panel. APU exterior ground controls for fire fighting are located on the lower aft fuselage. (Refer to Fire Protection chapter for complete discussion).

APU RPM, EGT, air output and electrical output are controlled by an Electronic Control Unit (ECU) located in the electrical/electronic compartment.

APU parameters are displayed on the Systems Display (SD) secondary engine page.

APU Start And Shutdown

The APU uses the airplane batteries for starting. The start sequence is fully automatic following the release of the MASTER switch to RUN. Normal starts include a delay period to allow the inlet door to cycle to the fully open position.

With the APU on speed, electrical power is immediately available for distribution. With the APU AIR switch moved to ON, APU bleed air is available, except for the delay following an initial start cycle.

During the start cycle, if specific faults are detected, or the start is not completed within a specific time frame, the APU automatically shuts down to preserve battery power and starter life.

At normal shutdown, the APU continues to run for approximately 17 seconds while the electrical system performs a No Break Power Transfer (NBPT). APU shutdown follows the transfer. This delay is bypassed when the cockpit APU FIRE CONT toggle switch (refer to Fire Protection chapter for complete discussion) is moved to the OFF & AGENT ARM position, or when the exterior ground APU toggle switch is moved to the SHUT OFF position, or when the APU is shut down by the ECU following detection of an APU compartment fire.

APU Fuel Supply

APU fuel is normally supplied from the right main tank. Using crossfeed, fuel can be supplied from any tank.

The DC start pump or any AC-powered operating right main fuel boost pump can be used to supply fuel pressure to the APU. Fuel can also be supplied from the center tank, or the left main tank, provided the fuel X FEED valve is open and AC power is available to the appropriate fuel boost pumps (refer to Fuel chapter for complete discussion).

When center tank pumps are used to supply fuel to the APU, the right main tank fuel boost pumps should also be operating. When center tank fuel value is less than 800 pounds, using center tank pumps can force air into the APU fuel line. Air in the fuel line might cause APU flameout or prevent APU start.

APU Fault Detection

The amber boxed APU FAULT alert is displayed during conditions which could result in APU damage inflight. On the ground when these conditions are present the APU automatically shuts down, the fuel shutoff valve closes, and the amber APU AUTO SHUTDOWN alert is displayed.

Inflight, the ECU automatically shuts down the APU only for an APU overspeed or an APU compartment fire. If an APU FAULT condition occurs inflight, the APU automatically shuts down 10 minutes after landing, unless shut down sooner by the pilot.

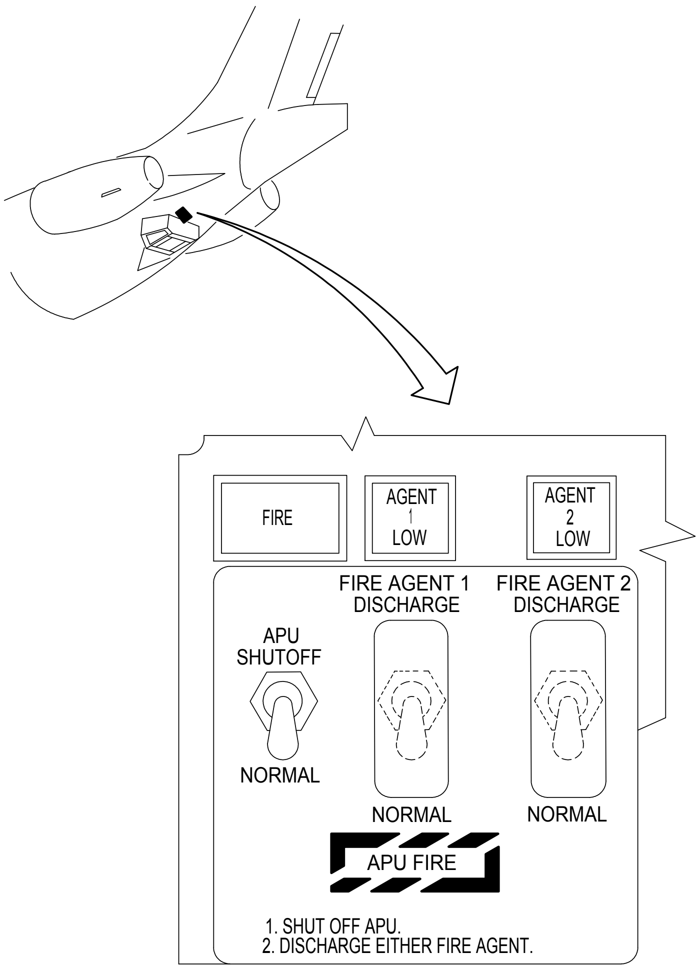
Aft Accessory Compartment Overheat Detection

If the aft accessory compartment overheats, APU bleed air supply shuts off automatically. Automatic bleed air shutoff is inhibited during flight and engine start.

APU Inlet Door System

The APU inlet door is located on the aft upper left surface of the fuselage. It provides intake air for all APU operations. The door has three (3) positions and is set automatically by the ECU.

APU Ground Control Panel



APU GROUND CONTROL PANEL
(For description, refer to Fire Warning and Protection chapter.)

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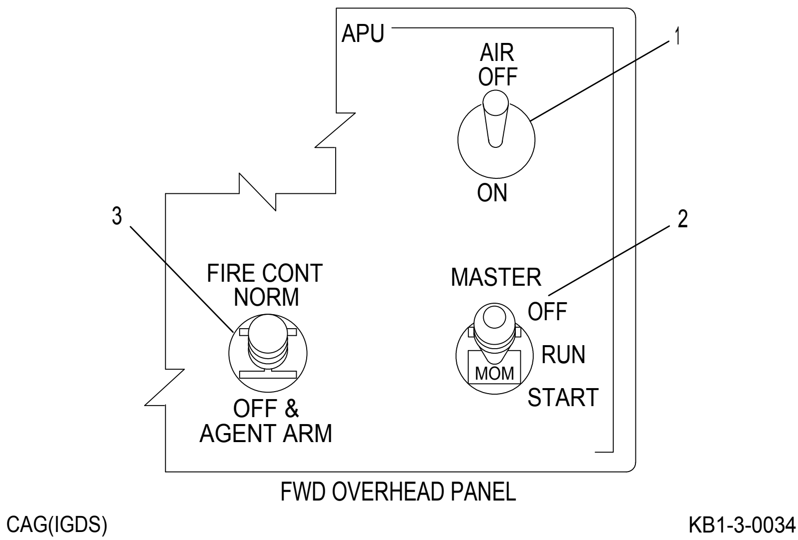
APU Panel



1. **AIR Switch**

   OFF - No APU air is supplied to the pneumatic system.

   ON - APU air is supplied to the pneumatic system. APU bleed air is inhibited until 2 minutes after an APU start is initiated.

2. **MASTER Switch**

   OFF - Shuts down APU and closes inlet door.

   RUN - Allows APU to run and opens inlet door.

   START - (Momentary) Starts APU.

   NOTES: If the APU fails to start or shuts down automatically, the shutdown fault must be cleared before the APU can be restarted. Wait until the APU rolls down to under 7% RPM, then clear the shutdown fault by moving the MASTER switch to OFF, then use normal procedures to restart the APU.

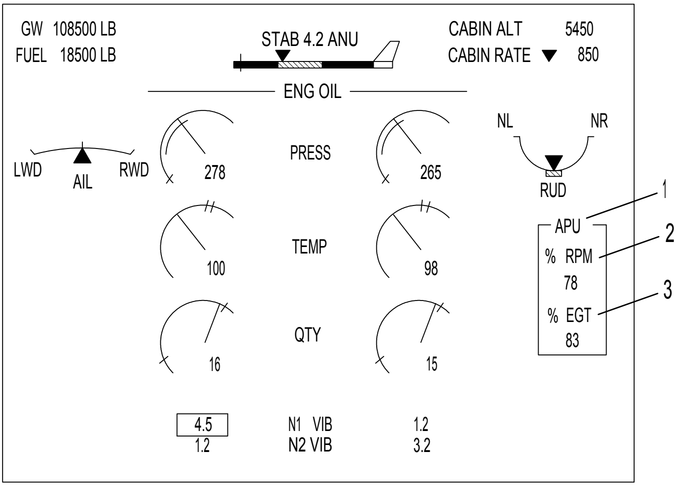
If the APU fails to start, do not attempt another start until after the APU parameters on the Secondary Engine synoptic are no longer displayed. This will provide time for any unburned fuel in the APU combustion chamber to drain out. The APU may emit smoke or flame from the exhaust pipe if it is started with residual unburned fuel remaining in the combustion chamber.

3. FIRE CONT Switch

NORM - Normal operation. Allows APU to run.

OFF & AGENT ARM - Shuts down APU immediately and arms fire extinguishers.

SD Synoptic - Secondary Engine



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1. APU Information Block

APU - Parameters appear when the APU MASTER switch is in RUN. Parameters also appear when the APU MASTER switch is OFF following APU shutdown if the APU inlet door is still open.

2. % RPM Display - white, red

% RPM - APU RPM is displayed as a percentage of rated speed. The white digits become red and boxed when limits are exceeded.

3. % EGT Display - white, red

% EGT - APU EGT is displayed as a percentage of maximum continuous exhaust gas temperature. The white digits become red and boxed when limits are exceeded and return to white when those limits return to normal.

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NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

APU FIRE (ENG) - APU compartment fire detected. APU shuts down.

Amber Boxed Alerts (Level 2)

APU EGT HI (ENG) - APU EGT exceeds 100%.

APU FAULT (ENG) - The APU detects a fault which results in auto shutdown on the ground, but prevents shutdown in flight.

Amber Alerts (Level 1)

APU AUTO SHUTDOWN (ENG) - APU detects a fault and automatically shuts down.

APU DOOR OPEN (ENG) - The APU air inlet door is open with the APU commanded off.

APU VALVE DISAG (AIR) - The APU air shutoff valve position disagrees with the APU AIR switch selection.

Cyan Alerts (Level 0)

APU AIR/ELEC ON - The APU is on and supplying both electrical power and pneumatics.

APU AIR ON - The APU is on and providing pneumatics but not electrical power.

APU ELEC ON - The APU is on and providing electrical power, but not pneumatics.

APU ON - The APU is running without load.

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Communications — Chapter Comm
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General

The communications system incorporates a digitally controlled audio system (DCAS). The flight interphone system, the service interphone system, the audio control panels (ACP), the audio remote electronics unit (AREU), the VHF communication systems, the HF communication system, if installed, SELCAL, PA, the cockpit voice recorder (CVR), and, if installed, the ARINC communications addressing and reporting system (ACARS) function through DCAS.

Flight Interphone System

The flight interphone system provides communications between the flight crew as well as communications at the external power panel.

Microphone connections, headset jacks, and a handheld microphone are located at the Captain's console, the First Officer's console, and on the overhead panel for the Observer. A handset jack is also located on the external power panel.

Two speakers are located in the cockpit for the Captain and First Officer. Operation of the Captain's/First Officer's microphones or the PA mutes the speakers. Operation of the Observer's microphone does not mute the speakers.

Service Interphone System

The service interphone system allows communication between the various service and maintenance locations around the airplane, the cockpit, and the cabin attendant stations. Telephone-type handsets in the cockpit and at the forward and aft attendant panels are used for both the service interphone and the PA system.

Audio Control Panel

Three digitally controlled ACPs are used to control the radios, the PA system, and the audio for cockpit and cabin interphone and navigation receivers. The ACPs for the Captain and First Officer are located on the respective consoles. The ACP for the Observer is on the aft overhead panel.

Pushing a MIC switch on the ACP selects the respective radio. The MIC switch on the outboard horn of either control wheel, the push-to-talk (PTT) switch on either hand microphone, or the INT/RADIO (radio/intercom) PTT switch on each audio control panel may then be used to key the microphone for transmission.

Pushing (to pop out) and rotating the corresponding receiver's volume control knob adjusts volume. Audio signals from two receivers may be simultaneously monitored by pushing the respective ACP volume control knob(s) to pop out and then rotating for desired volume.

Oxygen Mask Microphone and Jacks

The oxygen mask microphone is contained within the oxygen mask. Boom headset, boom microphone, and hand-held microphone jacks are provided. The Captain's and the First Officer's jacks are located in the respective console. The Observer's jacks are located adjacent to the observer's seat.

Boom Microphone/Mask Microphone Switch

A boom microphone/mask microphone switch is located within each oxygen mask stowage box and connects either the boom or the mask microphone.

The boom microphone automatically connects to the communication systems when the mask is stowed (and reset).

The mask microphone automatically connects to the communication systems when the mask is out of its stowage box and is in use.

VHF Communication Systems

Two separate, identical VHF communication systems (VHF-1 and VHF-2) provide communication between the airplane and ground and/or another airplane. Both systems operate separately or simultaneously to provide short-range line-of-sight communications in the 118.000 to 136.975 MHz frequency range, with 25 kHz frequency spacing, and, if installed, 8.33 kHz spacing.

The VHF control panels are on the pedestal. Each VHF panel has a frequency selector, active and standby frequency windows, and a frequency transfer switch.

All VHF communication systems interface with the following avionics systems:

1. SELCAL - The VHF system interfaces with SELCAL to receive selective calling signals.
2. Cockpit Audio System - The VHF system interfaces to the remote electronic unit (REU) for cockpit voice.
3. Central Fault Display System (CFDIU) - The VHF system interfaces with the Centralized Fault Display Interface Unit (CFDIU) for reporting system fault information.
4. ARINC Communication Addressing and Reporting System (ACARS) - The VHF-3 system interfaces with the ACARS communications management unit (CMU), if installed, for uplink and downlink data.

5. Flight Data Recording System - The VHF system interfaces with the versatile integrated avionics (VIA) via a data concentrator unit (DCU) for recording the cockpit communication time.

If installed, a stuck microphone protection feature allows VHF transmission for 35 seconds with the microphone continuously keyed. After 35 seconds of continuous transmission, the transceiver shuts off. Short warning beeps sound every second during the last 5 seconds prior to transceiver shutoff. Releasing and then re-keying the microphone switch reactivates the transmitter and starts a new 35-second transmit time. The transmit time can be re-started any time during a transmission prior to the 35-second shutoff by re-keying the microphone.

Selective Calling (SELCAL) System

The SELCAL system provides visual and aural signals to the crew when the airplane is being called from the ground. The system operates in conjunction with the VHF and HF systems.

When a call is received, the respective MIC switch on the ACP illuminates and a chime from the central aural warning system (CAWS) sounds through the cockpit speakers and the headphones.

SELCAL interfaces with the following avionics:

* VHF communication system.
* HF communication system, if installed.
* Cockpit audio system.
* Audio control panel.
* Central Aural Warning System (CAWS).

PA And Passenger Entertainment System

The PA system enables the pilots and cabin attendants to address passengers from the cockpit or the cabin through speakers located in the cabin, galleys and lavatories. PA announcements from the cockpit have priority over the passenger entertainment system and announcements made from any cabin station.

PA announcements from the cockpit can be made with the service interphone handset, the mask or boom microphones, or the handheld microphones.

When using the service interphone handset on the aft pedestal for PA announcements, the handset must be out of its hanger and the PA switch on the overhead panel must be selected to ON.

PA announcements from the cabin attendant panels are made through the service interphone handsets.

Cockpit Voice Recorder

The CVR, located in the aft tail compartment, continuously records and preserves the last 2 hours of cockpit sounds and communications, and all communications through the Captain's and First Officer's ACP and handsets. Controls for the CVR are on the overhead panel.

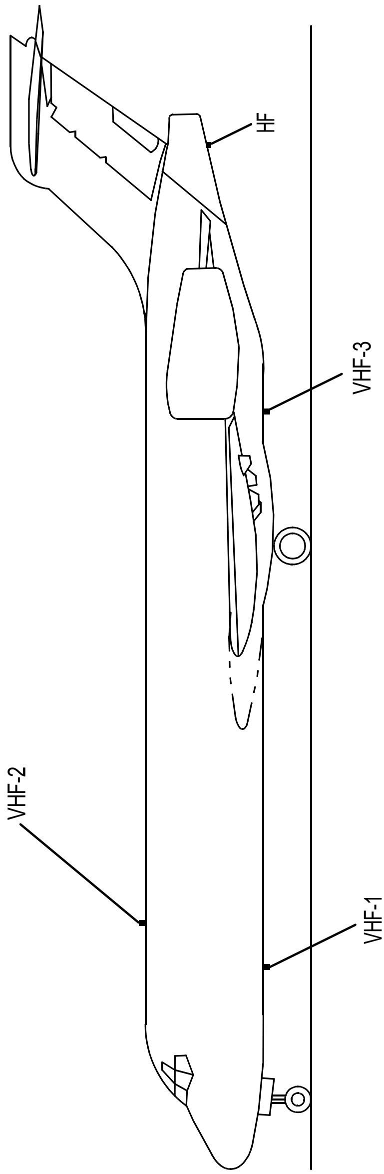
A water-activated underwater locator beacon (ULB), attached to the CVR, provides an acoustic signal to aid in recovery of the submerged CVR.

The CVR operates automatically and continuously whenever power is available to the airplane. No crew action is required.

With the parking brake set, and the airplane ground sensing system automatically set in ground mode, pushing the ERASE pushbutton on the CVR MICROPHONE MONITOR control panel erases the recorder memory.

Communications — Chapter Comm
Components — Section 20

Antenna Locations (Before SB 717-23-0002 Incorporation)



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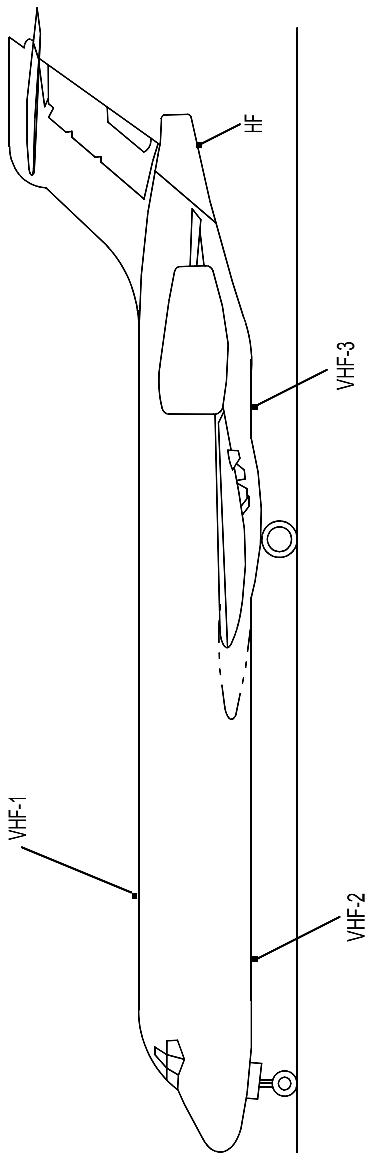
Antenna Locations (After SB 717-23-0002 Incorporation/Production)



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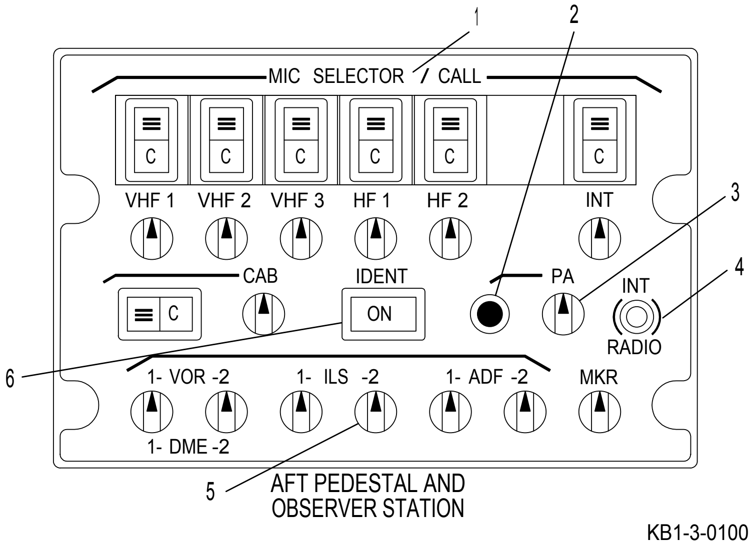
Audio Control Panel



1. **MIC SELECTOR/CALL Switch**

   Push - Selects desired transmitter. Integral (bars) light illuminates to indicate selection. Only one switch can be selected at a time.

   Integral (C) light illuminates in conjunction with chime from CAWS when applicable SELCAL channel is called by a ground station, or for an interphone call (on INT button). Switch and chime may be reset by keying the corresponding radio.

2. **PA Button**

   Push - When the PA button is held, PA transmissions can be made with either the boom or oxygen mask microphone.

3. **PA Volume Control Knob**

   Push - Pops out.

   Rotate - Adjusts the audio volume of the PA audio in the cockpit speakers and headsets.

4. **RADIO/INT Switch**

Keys a radio transmitter or the flight interphone. Momentary in either position. Returns to center (off) when released.

RADIO (Aft) - Keys selected radio transmitter by pushing microphone switch, for mask or boom microphone operation.

INT (Fwd) - Keys flight interphone for mask or boom microphone operation, regardless of MIC selection.

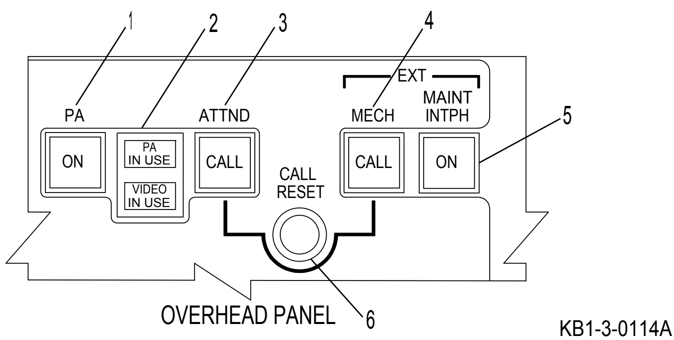
5. **On/Off/Volume Control Knob(s)**

Push - When popped out, selects audio signal to monitor. Push again (to stay in) to discontinue monitoring. Rotates to adjust volume. All receivers can be monitored at the same time.

6. **IDENT Switch - white**

Push - Selects voice and coded identification tones of the NAV1/2 or ADF 1/2 receivers. ON illuminates to indicate selection. Push again for reception without ID tones.

PA, Call And INTPH Switches



1. **PA ON Switchlight - blue**

ON - Push to connect the handset on the aft pedestal to the PA system when the handset is removed from its hanger. ON illuminates.

Extinguished - Replacing the handset disconnects the handset from the PA system, extinguishes the switchlight, and reverts the handset to the service interphone function.

2. **PA IN USE Light - blue**

PA IN USE - Light illuminates when a PA announcement is made from the cockpit microphone(s), the cabin handset(s), or when the Prerecorded Announcement Machine (PRAM)/Video is activated.

3. ATTND CALL Switchlight - blue

CALL - Push switchlight to initiate a cockpit-to-cabin attendant station call. Sounds a chime and illuminates the pink master call light at the cabin attendant stations. Illuminates when a flight attendant calls the cockpit from a cabin attendant station.

4. MECH CALL Switchlight - blue

CALL - Push switchlight to sound the mechanic call horn. Illuminates when ground personnel push the pilot call switch at the ground power panel.

5. MAINT INTPH Switchlight - amber

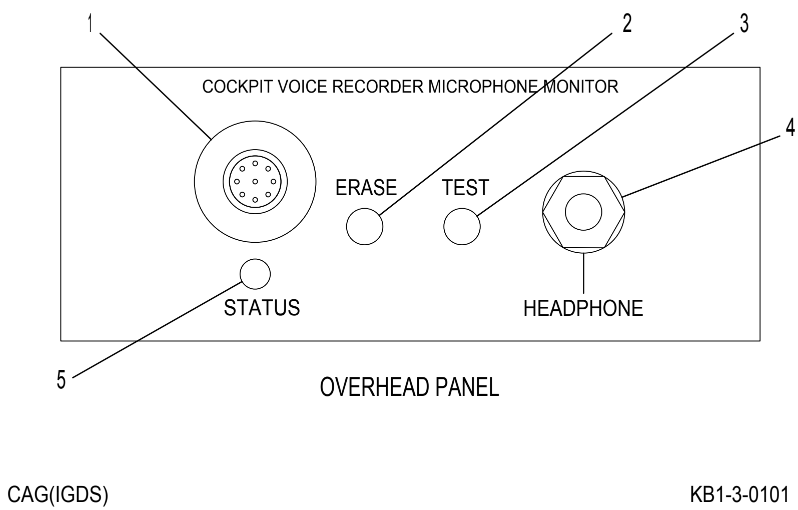
ON - Push switchlight to activate all service interphone jacks located throughout the airplane. ON illuminates.

When pushed again, extinguishes the switchlight and disconnects all stations from the service interphone (except cockpit, electrical/electronics compartment, ground power panel, and attendant stations.)

6. CALL RESET Button

Push - Extinguishes the ATTND CALL and the MECH CALL switchlights.

Cockpit Voice Recorder



1. Cockpit Monitor Microphone

Records all audible sounds in the cockpit.

2. **ERASE Pushbutton**

Push - Erases the recorder memory when the airplane is on the ground and the parking brake is set.

3. **TEST Pushbutton**

Push - Tests the CVR. An aural tone is heard through the monitor headphone and the STATUS light illuminates.

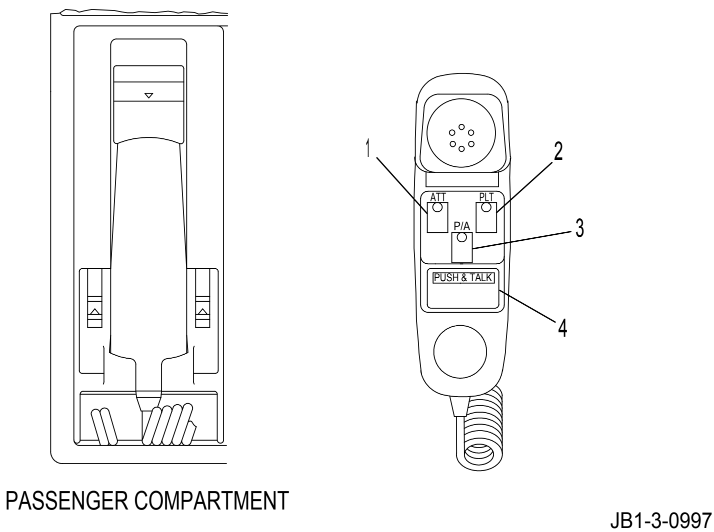
4. **HEADPHONE Jack**

When the headset is plugged into the jack and the TEST pushbutton is pushed, audible tones indicate each function is operating properly.

5. **STATUS Light**

Illuminates to indicate a successful self-test of all input channels. Does not illuminate if a system fault exists.

Flight Attendant Handset



1. **ATT Call Switchlight**

Push - Enables attendant-to-attendant call. Actuates chime and pink call lights in the cabin.

2. **PLT Call Switchlight**

Push - Enables attendant-to-pilot call. Actuates chime and ATTND CALLING light in cockpit.

3. P/A Switchlight

Push - Connects handset to passenger address system.

4. PUSH & TALK Switch

Push and Hold - Allows completion of selected call (ATT, PLT, or P/A).

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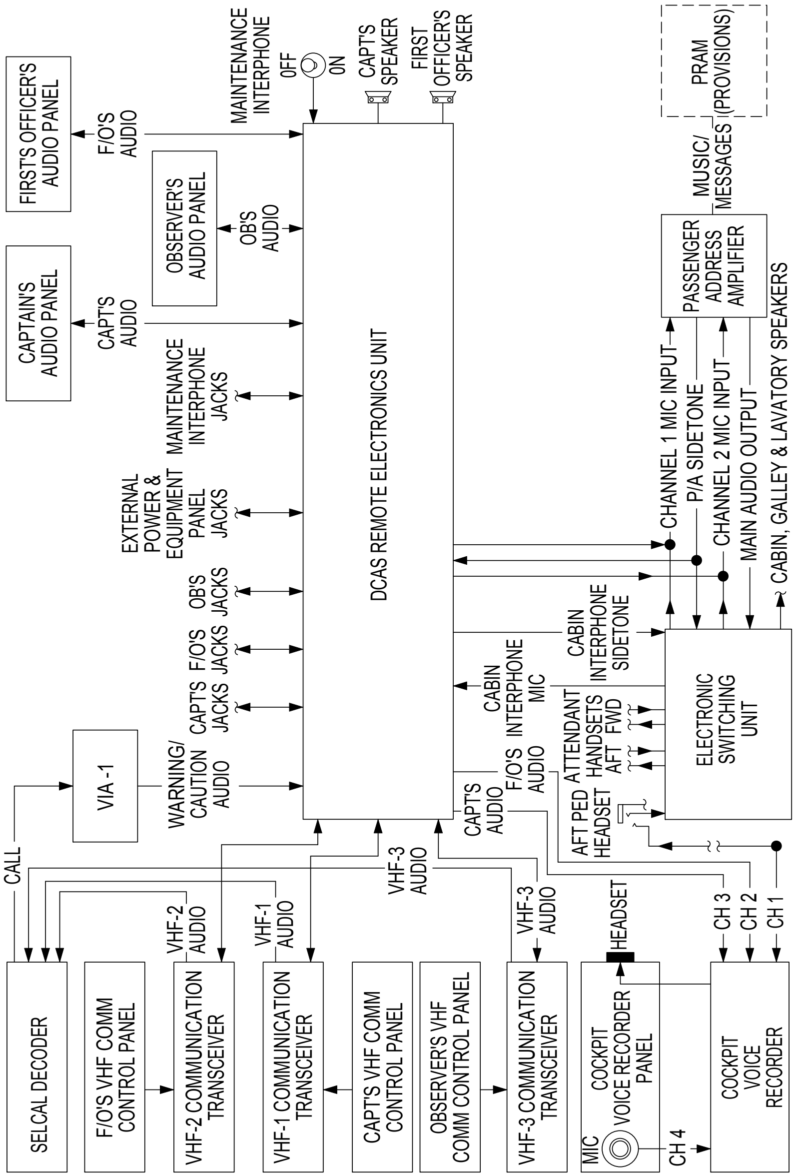
Block Diagram (Typical)



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Electrical — Chapter Elec

Table of Contents — Section TOC

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General

The integrated electrical power system (IEPS) is an automatic system. Flight crew action is not required for normal operating conditions. Power sources for the system are the integrated drive generators (IDGS), the APU generator, external power and the batteries and battery charger.

Most system operation is controlled automatically by the electrical power control unit (EPCU) and the power conversion and distribution units (PCDU) associated with each generator.

The electrical system consists of a 115 volt, 400 hertz, 3 phase AC power system and a 28 volt DC system. The system supplies power to all normal and emergency buses. All systems are protected by individual circuit breakers located throughout the airplane.

For components requiring DC power, each PCDU has an integrated transformer rectifier that converts 115 volts AC to 28 volts DC.

In the event of a total loss of normal AC power, the main airplane batteries will automatically power the emergency buses. This power is adequate to maintain critical flight instrumentation for approximately 60 minutes.

Components

The AC and DC electrical systems are normally powered by the two IDGs. One IDG for each engine. The IDGs consists of a constant speed drive and the AC generator combined in a single housing. Each IDG is rated at 35/40 KVA continuous and is oil cooled.

The function of each IDG is to convert variable speed mechanical power supplied by the engine gearbox to constant voltage, constant frequency AC power.

Another source of AC power is the APU driven generator. It operates at a constant speed and is rated at 40/60 KVA continuous.

The main battery system consists of three nickel cadmium batteries connected in series. This system provides 28 volts DC power to the emergency power system. The batteries have a combined rating to supply emergency power for one hour. The batteries are located in the electrical & electronics (E&E) compartment.

The EPCU is located in the E&E compartment. It provides external power protection, automatic power transfers, emergency power automatic activation and galley power shedding.

There are three PCDUs located in the E&E compartment. A different PCDU controls each generator. The PCDUs receive power from their respective IDG or the APU generator. Power is then distributed to the main generator buses.

Controls & Indicators

The electrical control panel is located on the forward overhead panel. It contains the necessary controls and indicators for operation of the electrical system. The ground service electrical power panel is located on the aft overhead panel. This panel is used when only power to the ground service bus is desired.

When an electrical system malfunction occurs, an alert is displayed on the engine and alert display (EAD). Additional information is displayed on the electrical synoptic page, including power sources, voltage, frequency, generator load, individual relay positions, and primary AC and DC buses.

The external power receptacle is located behind an access panel below the left pilot's window. It is used during ground operations to provide AC power to the airplane.

Electrical Control Panel

The BATT switch has two positions: ON and OFF. When the switch is in the OFF position, the battery is disconnected from the DC transfer bus and the BAT SWITCH OFF alert will be displayed on the EAD.

The BATT switch has a double lock. Lift and rotate the switch to move it to the ON position. Rotate and lift the switch to move it to the OFF position. When the switch is in the ON position, the battery will be connected to the DC transfer bus.

On the synoptic, the battery is represented by a series of vertical lines. This is the display when the battery is commanded off, or the battery is commanded on but not discharging. Battery voltage is displayed next to the battery symbol.

The EMER PWR selector has 3 positions: OFF, ARM and ON. When the selector is in the OFF position, emergency power automatic activation is inhibited and if the emergency power relay was closed, it is commanded open. On the EAD, the EMER PWR SW OFF alert will be displayed.

There are two automatic functions associated with the ARM position.

When the airplane is on the ground and the selector is rotated from OFF to ARM, a test of the emergency power system is performed automatically. During the test, the emergency power ON light is illuminated and the EMER POWER TEST alert is displayed on the EAD. A successful test is indicated when the ON light is extinguished and the alert is no longer displayed.

When the selector is in the ARM position and the BATT switch is in the ON position, the emergency power system will automatically supply battery power to the emergency AC bus and emergency DC bus when a loss of normal power to these buses occurs.

When emergency power has been automatically activated, the emergency power ON light illuminates and the EMER PWR ON alert is displayed on the EAD and on the electrical synoptic.

When emergency power is no longer required, rotating the selector momentarily to OFF and back to ARM will reset the emergency power system.

When manual activation of the emergency power system is desired, the EMER PWR selector must be rotated to the ON position. This allows the battery to supply power to the emergency buses.

When the selector is moved to the ON position, observe the emergency power ON light illuminates and the EMER PWR ON alert is displayed on the EAD. The EMER PWR selector is inoperative when the BATT switch is in the OFF position.

The GALLEY switch has two positions: ON and OFF. When the switch is in the ON position, power is available to all the galleys. When the switch is moved to the OFF position, power is removed from the galleys.

The L/R GEN switches have three positions: RESET, OFF and ON. When the switch is in the momentary RESET position, the respective generator is reset. When the switch is in the ON position, the respective generator automatically supplies power to the respective generator bus.

If either generator switch is moved to the OFF position, the respective generator is disconnected from the generator bus and on the EAD, a steady reminder message will be displayed. On the synoptic, the associated GEN L/R OFF alert will be displayed.

When both generators are commanded on, the integrated drive generators are displayed as a green G symbol. Generator voltage, frequency and percent of load are displayed adjacent to each generator symbol.

The APU generator switch has three positions: RESET, OFF and ON. When the switch is in the momentary RESET position, the APU generator is reset. When the switch is in the ON position, the APU generator supplies power to the AC tie bus and ground service bus.

When the APU generator voltage and frequency are within required limits, and the APU generator switch is in the ON position, the APU light will illuminate.

When APU power is being supplied, the APU ELEC ON alert will be displayed on the EAD.

On the synoptic, the APU is displayed as a chevron. When the APU is supplying power to the entire airplane, APU voltage, frequency and percent of load are displayed adjacent to the APU symbol.

When the APU is operating and the APU switch is moved to the OFF position, the APU light will extinguish and a steady reminder message will be displayed on the EAD and on the synoptic, the GEN APU OFF alert will be displayed.

When the APU is not operating, the APU symbol and flow line are removed from the display.

The EXT power switch has two positions: OFF and ON.

When the switch is in the ON position, external power will be connected to the tie bus and ground service bus by closing the main external power relay, providing all protective circuits are satisfied and external power has priority. The EXT POWER ON alert is displayed on the EAD and on the synoptic, external power is displayed as a chevron. When external power is connected and powering the entire airplane, voltage and frequency of the external power are displayed adjacent to the external power symbol.

When external power is connected and the EXT power switch is moved to the OFF position, the external AVAIL light remains illuminated and the EXT POWER AVAIL alert is displayed on the EAD. When external power is not connected, the external power symbol, flow lines, voltage and frequency are not displayed.

The APU, R/L GEN and EXT power in use lights, when illuminated, indicate which alternate power source is providing electrical power to the affected generator bus.

The L/R BUS TIE switches have two positions: AUTO and OPEN. When in the AUTO position, the IEPS automatically opens and closes the bus tie relays to satisfy power requirements.

On the synoptic, the bus tie relay symbols are displayed in the closed position. The IEPS has automatically closed the relays and the right IDG is now powering the airplane.

When the bus tie switches are moved to the OPEN position, the bus tie relays are commanded open. This prevents the IEPS from automatically closing the bus tie relays under any conditions.

On the synoptic, when the bus tie switches are in the OPEN position the associated BUS TIE L/R OPEN alerts are displayed. The IEPS has configured the electrical system to ensure all essential buses are powered.

The DC BUS TIE switch has two positions: OPEN and AUTO. When the switch is in the AUTO position, the DC bus tie relays are automatically closed or opened to maintain DC power to all DC buses. When the switch is moved to the OPEN position, the DC bus tie relays are commanded open and the left, right and ground service DC buses are isolated from each other.

On the synoptic, all DC tie relay symbols are indicated open and the associated DC TIE SW OPEN alert is displayed. On the EAD, a steady reminder message will be displayed.

Ground Service Electrical Power Panel

The GROUND SERVICE ELEC PWR switch has two positions: OFF and ON. When OFF is selected, the AC ground service bus is powered by the AC tie bus through normal airplane power distribution.

When the switch is moved to the ON position, power is provided to the ground service bus only, and the ON light illuminates.

Power Generation & Distribution

The control, regulation, protection and automatic operation of the electrical power system is performed by the left, right and auxiliary PCDU, and the EPCU.

The PCDUs receive power from their respective IDG or from the APU generator, and distribute the power to the main generator buses and the tie bus.

Each PCDU integrates the following components:

* generator control unit (GCU)
* transformer rectifier (TR)
* generator relay (GR)
* bus tie relay or main external power relay
* DC tie relay
* and various protective circuit breakers.

The EPCU incorporates the no break power transfer function, external power control, DC tie relay control and emergency power automatic activation.

The system control units function together, allowing the generator buses to be powered separately or simultaneously using the APU generator, external power or crosstie operations.

The protection circuits can isolate electrical faults and prevent the connection of unsatisfactory power to the airplane.

AC System

The AC system is divided into a left, right and auxiliary generation and distribution system.

The AC system is a “no break” power transfer system which allows power transfers to occur without power interruption.

The primary source of power for the AC systems are two engine driven IDG systems. Voltage and frequency output from the IDGs are regulated by the left or right generator control unit.

During normal operations, the generator buses remain isolated from each other and receive power from their respective IDG. The right AC system supplies power to the AC tie bus through the right bus tie relay. The AC electrical systems can also be powered from the APU or external power.

External power control and protective functions are provided by the EPCU. Protection for the APU generator is provided by the APU generator control unit. An automatic priority system controls the AC power distribution system. The engine generators have the highest priority for their respective generator bus. The APU generator has second priority for the generator buses.

External power has third priority and the opposite engine generator system has the lowest priority. Power source priority for the tie bus is the APU generator, external power, right and then left AC system.

DC System

The DC system is divided into a left, right and auxiliary DC generation and distribution system.

The primary source of power for the DC system is three transformer rectifiers (TRs), one located in each PCDU. The TRs convert 115 volts AC power to 28 volts DC. The TRs provide power to their respective left, right or ground service DC buses. The main battery system provides 28 volts DC power to the battery direct bus.

When the BATT switch is in the ON position, the battery system also provides power to the DC transfer bus.

A battery charger is included in the electrical system. The charger converts AC power supplied from the ground service AC bus to DC power to keep the main battery fully charged.

During normal operation with the BATT switch in the ON position, the battery will be sharing the DC load with the transformer rectifier connected to the DC transfer bus. When no transformer rectifiers are available, all DC transfer bus loads will be powered by the battery and the battery charger working in the transformer rectifier mode.

No Break Power Transfer (NBPT)

The aircraft incorporates a complete NBPT system. All electrical power source transfers, under normal conditions, will occur without power interruption. This function is accomplished by momentarily paralleling on-coming and off-going power sources on the same bus. NBPT will not be functional if the EPCU is inoperative.

A break power transfer may occur if the EPCU has insufficient time to accomplish power source paralleling prior to the complete loss of a power source. Examples of this would include unexpected loss of APU or IDG power, such as flame-out or uncommanded shutdown. Transfer of aircraft power from APU to an external power source may also cause a break power transfer.

Emergency Power System

The emergency power system provides emergency power to the emergency buses from the main battery system upon loss of normal power to one of these two buses. When activated, the battery will provide power for one hour.

The emergency inverter converts battery DC power to 115 volts AC power and supplies it to the emergency AC bus when emergency power is activated. Activation of the emergency power system is automatic with the EMER PWR selector in the ARM position and the BATT switch in the ON position.

Manual activation of the system requires rotating the EMER PWR selector to the ON position.

When normal power to the emergency buses is lost, the emergency power system is automatically activated the system will provide emergency power to the following buses:

* Battery direct bus
* DC transfer bus
* Emergency AC bus (through emergency inverter)
* Emergency DC bus

The following systems and/or functions ARE available when the emergency power system is activated:

* Captain’s EIS control panel

* Fire detection and protection systems
* Alerting system (EAD and aural) for powered systems
* ADIRU-1
* ISIS
* VIA-1
* FMC-1 (in standby)
* DU-1, DU-2, and DU-3 (Capt. PFD, ND, and EAD - SDs available on DU-3)
* VOR-1 (no DME)
* MMR-1 (provides GPS-1 and ILS-1 (no DME)
* VHF 1
* Captains ACP (F/O can hear and transmit on VHF 1 and interphone)
* Outer marker
* Engine ignition 2
* FADEC and EEC-1 and EEC-2
* Engine fuel start pump
* APU start system
* Manual pressurization control
* Anti-skid.

The following items ARE NOT available when the emergency power system is activated:

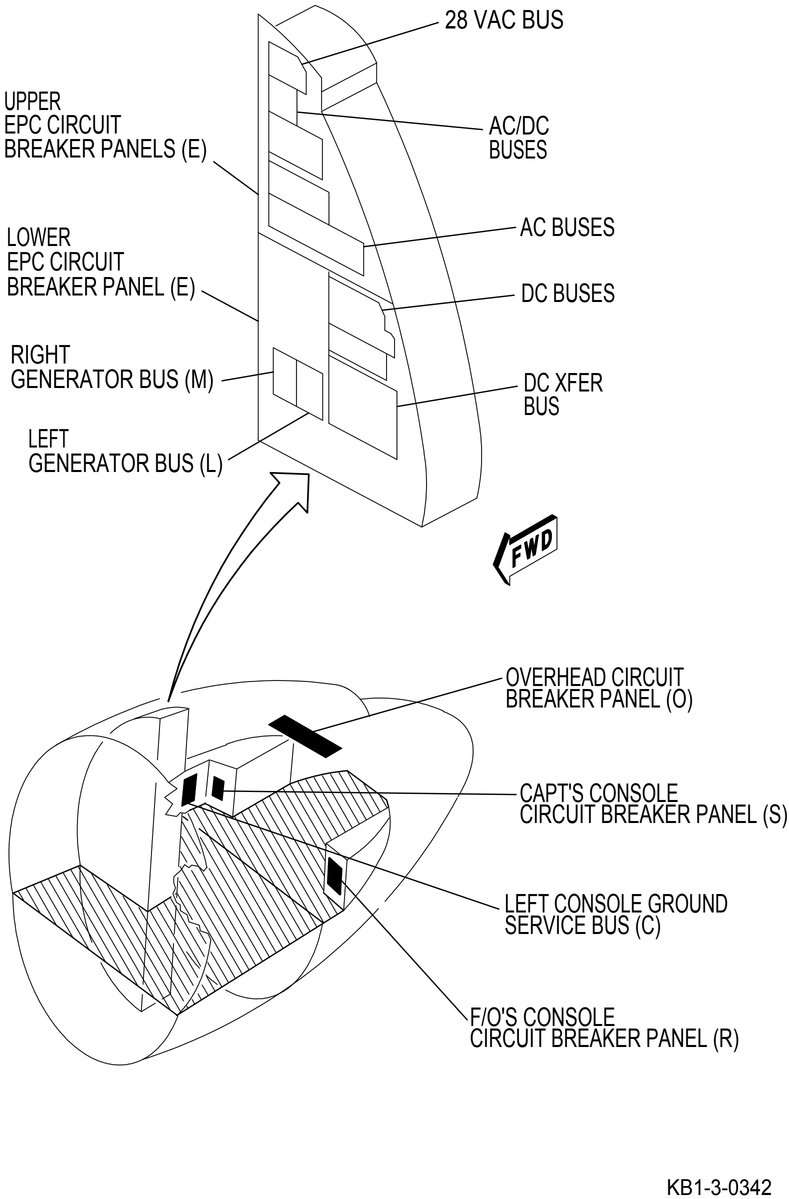
* Fuel pumps
* Stab trim (also no trim indicator)
* Spoilers
* Flight directors
* Autoflight system
* Radio altimeter
* Gear position indicators
* Automatic pressurization control
* Transponder
* FCP and F/O EIS control panel
* Cabin/Cockpit temperature control.

Circuit Breaker Panel Code, Name and Location

CODE	NAME AND LOCATION
B	APU CBP (Sta 115, Left Side)
C	Ground Service Bus CBP (Left Console)
E	Electrical Power Center CBP (Behind Captain’s Seat)
J	E/E Compartment (Sta 115)
L	Left Generator Bus (EPC CBP)
M	Right Generator Bus (EPC CBP)
O	Emergency Circuit Breaker Panel (Overhead)
P	External Power Panel (Sta 101 Left Side)
R	F/O’s Instrument Panel CPB (Right Fwd Console)
S	Captain’s Center Panel and Pedestal CPB (Left Fwd Console)
U	FCC Equip Panel
V	Freeze Protection CPB (Nose Wheel Well)
W	Fwd Cabin Lights CPB (Center Ceiling)
X1	E/E Compartment (Sta 154, Upper)
X2	E/E Compartment (Sta 154, Lower)
Y	Mid Cabin Lights CPB (Right Ceiling)

NOTE: General reference only. Specific circuit breaker locations may vary between airplanes.

Circuit Breaker Panel Locations



Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
C		115 VAC 400 Cycle Utility Outlet
C		115 VAC Utility E/E Compt
X2		AC Tie Bus Volt Sense
E	F-18	ACARS
O	B-18	ACARS Memory Clock
E	F-24	ADF-1
E	F-12	ADF-2
E	E-13	ADIRU Battery
O	B-5	ADIRU-1
O	B-19	ADIRU-1 Backup Power
E	F-1	ADIRU-2
E	F-13	ADIRU-3
C		Aft Cargo, Tail, Serv Pnl & Wheel Well Lights
E	J-21	Aft Center Fuel Tank Boost Pump
E	Z-27	Aft Drain Mast Heater
C		Aft Left Flush Cont
E	H-23	Aft Left Fuel Tank Boost Pump
E	K-19	Aft Overhead Panel Light
C		Aft Right Flush Cont
E	J-19	Aft Right Fuel Tank Boost Pump
E	U-28	Air Cond Auto Off
E	U-32	Air Cond Flow
O	C-16	Air Condition Flow Control Valve Left
O	C-17	Air Condition Flow Control Valve Right
E	M-28	Air Data Heater Ind
E	L-33	Alternate Passenger Oxygen Release
E	N-37	Anti-Collision Lt Cont Indicator
E	R-41	Anti-Skid Ann
E	G-15	Anti-Skid Brake Pressure

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	P-40	Anti-Skid Inboard Power
E	T-38	Anti-Skid Outboard Power
E	Z-34	APCDU DC Power
E	Z-39	APU Control
E	U-39	APU Door Control
E	Z-36	APU Emergency Shutdown Signal
E	X-33	APU Engine Start
E	W-41	APU Fire Warning Horn
X2		APU Gen Feeder Volt Sense
E	Z-35	APU Generator Switch Indication
E	W-31	APU Ready Relay
B		APU Starter
E	D-13	ATC Mode S-1
E	D-1	ATC Mode S-2
E	T-42	Auto Brake Ann
E	P-30	Auto Brake System
E	Z-42	Auto Emer Pwr Transfer Reset
E	L-4	Auto Ground Spoilers Motor
E	L-5	Auto Ground Spoilers Motor
E	L-6	Auto Ground Spoilers Motor
E	E-14	Auto Throttle-1
E	E-4	Auto Throttle-2
E	B-7	Autoflt Sys Ref Voltage-1A
E	A-7	Autoflt Sys Ref Voltage-1B
E	A-8	Autoflt Sys Ref Voltage-2A
E	B-8	Autoflight Sys Ref Voltage-2B
E	M-35	Autoland Light Retract
E	D-11	Autopilot & Alternate Longitudinal Trim
E	D-10	Autopilot & Alternate Longitudinal Trim
E	D-9	Autopilot & Alternate Longitudinal Trim

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	M-36	Autopilot Ldg Lt Retract-1
E	N-36	Autopilot Ldg Lt Retract-2
E	E-19	Autopilot-1
E	E-7	Autopilot-2
E	M-27	Aux Pitot Heater
E	G-26	Aux Fuel Xfer Control A
E	G-13	Aux Fuel Xfer Control B
E	L-20	Bagrack & Handrail Lighting
J		Batt Dir Bus Feed RCCB
O	D-17	Batt Dir Bus Feed
B		Battery Amp
C		Battery Charger
B		Battery Volt/Amp
O	D-11	Battery Xfer Bus Feed
E	T-39	Battery/DC Bus Tie Switch Indic
E	C-2	Cabin Ceiling Lighting Control
E	G-5	Cabin Interphone
W		Cabin Lights Ceiling
W		Cabin Lights Ceiling
W		Cabin Lights Fwd Music
W		Cabin Lights Fwd Music
W		Cabin Lights Handrail
W		Cabin Lights Handrail
W		Cabin Lights Mood Lts
W		Cabin Lights Passenger Reading
W		Cabin Lights Passenger Reading
W		Cabin Lights Passenger Reading
W		Cabin Lights Passenger Reading
W		Cabin Lights Passenger Reading
W		Cabin Lights Passenger Reading

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
W		Cabin Lights Passenger Reading
W		Cabin Lights Sidewall L
W		Cabin Lights Sidewall R
C		Cabin Lower Sidewall Lights Left
C		Cabin Lower Sidewall Lights Right
E	U-21	Cabin Pressure Control-1
E	U-22	Cabin Pressure Cont Pnl Auto-1
E	W-22	Cabin Pressure Cont Pnl Auto-2
O	A-14	Cabin Pressure Control Panel
E	W-21	Cabin Pressure Control-2
O	A-10	Cabin Standby Lights
E	J-1	Cabin Temp Control
C		Cabin Upper Sidewall Lights Left
C		Cabin Upper Sidewall Lights Right
E	P-25	Call System
E	K-14	Captain’s Inst & Pedestal Panel
E	E-20	Captain’s & First Officer’s Sis Panel
O	C-12	Captain’s Pitot Heater
E	P-33	Captain’s Stick Shaker
E	J-11	Cargo Compartment Heater
E	J-12	Cargo Compartment Heater
E	J-13	Cargo Compartment Heater
E	T-29	Cargo Fire Ext Bottle 1
E	T-30	Cargo Fire Ext Bottle 2
E	S-29	Cargo Smoke Det A
E	S-30	Cargo Smoke Det B
E	S-31	Cargo Smoke Test
O	C-1	Category IIIB Loads
E	X-25	Center Windshield Anti-Ice
E	F-3	CFDIU

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	F-6	Cockpit Voice Recorder
E	W-28	Cockpit Dome Lights
E	P-22	Cockpit Door Unlock
E	H-1	Cockpit Temperature Control
E	M-33	Cockpit Thunderstorm Flood Lts Control
E	Z-26	Cockpit Window Anti-Fog Clearview & Eyebrow
E	Z-25	Cockpit Window Anti-Fog Control
E	N-38	DC Tie/DC Xfer Bus Feed
E	X-37	DC Transfer Bus Sensing
J		DC Transfer Bus Feed (Bat) RCCB
O	A-8	DCAS Captain
O	B-7	DCAS Serv/Maint Interphone
E	S-32	DCU Ch A
O	A-15	DCU Ch B
O	A-12	Display Unit-1
E	S-33	Display Unit-2
O	A-17	Display Unit-3
E	E-3	Display Unit-4
E	E-8	Display Unit-5
E	E-15	Display Unit-6
E	N-33	Display Warning Light & Test
E	D-14	DME-1
E	D-2	DME-2
E	R-22	Door Warning
E	M-26	Drain Mast Heater Annunciation
C		Drain Valve Power
E	W-32	EEC-1 Ch A
E	X-32	EEC-1 Ch B
O	B-16	EEC-2 Ch A
O	B-17	EEC-2 Ch B

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
C		Emer AC Bus Feed
O	D-15	Emer DC Bus Feed
O	D-13	Emer Inverter Bus Feed
J		Emer Inverter RCCB
E	Z-31	Emerg Power Load Shed
O	A-3	Emergency AC Bus Sensing
J		Emergency DC Bus Feed RCCB
O	C-7	Emergency DC Bus Sensing
O	A-11	Emergency Lights Arm & Charge
E	Z-37	Emergency Lights Charging
O	A-2	Emergency Nav Instr Xfmr
O	A-9	Emergency Power In Use Lights
E	U-40	Engine Start Pump
E	K-31	Engine Vibration Monitor
E	X-31	EPCU DC Power
E	X-38	Ext Power Light Test
P		External Power
P		External Power
P		External Power
E	X-34	External Power Avail Indication
P		External Power Cart
P		External Power Ind
P		External Power Relays
X2		External Power Volt Sensing
X2		External Power Volt Sensing
X2		External Power Volt Sensing
E	T-34	F/O DCAS
E	N-27	F/O Pitot Heater
E	R-33	F/O Stick Shaker
Y		Fasten Seat Belt

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
W		Fasten Seat Belt
E	S-40	FCC-1 Backup Power
E	G-24	FCC-1A Main Power
E	G-25	FCC-1B Main Power
E	S-41	FCC-2 Backup Power
E	G-10	FCC-2A Main Power
E	G-11	FCC-2B Main Power
E	D-19	FDAMS
E	Z-33	Fill Drain Valve Control
C		Fill/Vent Valve Power
E	W-35	Fire Detectors APU Loop A
E	W-36	Fire Detectors APU Loop B
E	W-39	Fire Detectors Left Engine Loop A
E	W-40	Fire Detectors Left Engine Loop B
E	W-37	Fire Detectors Right Engine Loop A
E	W-38	Fire Detectors Right Engine Loop B
E	X-41	Fire Extinguishing Control Bottle 1
E	X-42	Fire Extinguishing Control Bottle 2
E	U-33	Fire Handle Pulled Signal
E	W-42	Fire Warning Lights
E	R-26	Firex Agent Low Pressure Caution
E	B-12	Flap/Flap Handle Position-1
E	A-12	Flap/Flap Handle Position-2
E	F-21	Flight Recorder
X1		Floor & Circuit Breaker Panel Lights
E	U-31	Flt/Gnd Relay
E	J-17	Fuel Quantity Pwr Xfer Ch A
E	H-17	Fuel Quantity Pwr Xfer Ch B
E	M-31	Fwd Attd Control Switch Illumination
C		Fwd Cargo & Service Panel Lights

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	H-21	Fwd Center Fuel Tank Boost Pump
E	X-27	Fwd Drain Mast Heater
L		Fwd Galley-1 Power
L		Fwd Galley-1 Power
L		Fwd Galley-1 Power
M		Fwd Galley-2 Power
M		Fwd Galley-2 Power
M		Fwd Galley-2 Power
C		Fwd Left Flush Cont
E	J-23	Fwd Left Fuel Tank Boost Pump
O	A-20	Fwd Passenger Entrance Stair Carriage Motors-1
O	A-21	Fwd Passenger Entrance Stair Carriage Motors-2
O	A-19	Fwd Passenger Entrance Stair Control
C		Fwd Passenger Entrance Stair Lights
E	H-19	Fwd Right Fuel Tank Boost Pump
C		Galley Area Work Lights
E	L-3	Galley Control
E	J-27	Gasper Booster Fan
E	C-3	Gasper Booster Fan Control
E	G-12	GCP B Main Power
E	T-41	GCP Backup Power
O	A-13	GCP A Main Power
E	U-36	Generator Control Indicator APU
E	U-38	Generator Control Indicator Left
E	U-37	Generator Control Indicator Right
R		Glareshield Lightplates
R		Glareshield Lightplates LCD
E	F-20	GPWS
E	C-6	Ground Flood Lights Control Left

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	C-5	Ground Flood Lights Control Right
C		Ground Flood Lights Left
C		Ground Flood Lights Right
E	G-20	Ground Proximity Warning Lights
E	Z-38	Ground Refuel
O	B-22	Ground Refueling
X1		Ground Refueling Indicator Input Power
C		Ground Service Bus Sensing Relay
E	M-37	Handrail Lighting Control
E	R-28	Hi-Int Control Indicator
E	B-2	Horiz Stab Position-1
E	A-2	Horiz Stab Position-2
E	R-27	Hyd Power Transfer Unit Control
E	P-37	Inboard Spoilers Actuators
E	Z-41	Inst & Pedestal Panel Flood Lts
E	H-8	Inst Cooling Fan
S		Instrument Panel Lights Capt
S		Instrument Panel Lights Ctr
S		Instrument Panel Lights F/O
E	S-34	IRS Mode Select
O	C-14	Isolation Valve
O	C-15	Isolation Valve Control
O	C-13	Isolation Valve NFC Relay
E	S-36	L Engine Thrust Rvsr Ch A
E	S-37	L Engine Thrust Rvsr Ch B
E	R-40	Lav Smoke Detector
C		Lavatory Mirror Lights Aft Left
C		Lavatory Mirror Lights Aft Right
C		Lavatory Mirror Lights Fwd Left
L		Left AC Bus

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
L		Left AC Bus
L		Left AC Bus
L		Left AC Bus
L		Left AC Bus
L		Left AC Bus
E	X-22	Left Angle of Attack Vane Htr
E	P-21	Left DC Bus Sensing
E	Z-32	Left Engine Fuel Shutoff Solenoid
E	S-27	Left Engine Anti-Ice Caution
E	U-42	Left Engine Fuel Switch
E	S-39	Left Engine Ignitor-1
O	B-8	Left Engine Ignitor-2
E	T-36	Left Engine Lock Prox Sensor Ch A
E	T-37	Left Engine Lock Prox Sensor Ch B
E	K-25	Left Engine P2T2 Prob Heat
E	S-35	Left Engine Start Ch A
E	T-35	Left Engine Start Ch B
E	U-35	Left Engine Start Switch
E	S-38	Left Engine Thrust Reverser
E	U-41	Left FADEC Ch A & Ch B
O	D-1	Left Flap Position 28 VAC
E	U-34	Left Generator Switch Indication
E	K-32	Left Ground Control Relay
E	S-26	Left Hyd Pump Control
E	E-22	Left Hyd Brake Pressure
E	B-5	Left Hyd Oil Quantity
E	E-21	Left Hyd System Pressure
E	K-8	Left Inst Xfmr
E	X-29	Left Lavatory Water Heater Aft
E	X-30	Left Lavatory Water Heater Fwd

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	K-17	Left Logo Lights
E	K-13	Left Nose Gear Landing & Taxi Lt
E	M-21	Left Pneumatic Overheat Detection
E	P-39	Left Proximity Switch Control
E	X-21	Left Static Port Heater
E	S-28	Left Supply Air Flow
E	B-6	Left Temp Control Valve Position
E	X-24	Left Windshield Anti-Ice
E	M-23	Left Windshield Wiper
E	K-11	Left Wing Landing Light
E	K-12	Left Wing Landing Light Control
U		Lights Aft Cargo
U		Lights Aft Service Panel, Wheel Well & Tail Compt
U		Lights Fwd Cargo
U		Lights Fwd Service Panel
C		Logic Cont Module
C		Logo Lights Control Indicator
E	K-10	Lower Anti-Collision
E	X-36	LPCDU DC Power
O	B-3	Manual Temp Control Cabin
O	B-2	Manual Temp Control Cockpit
O	A-5	MCDU-1
E	D-7	MCDU-2
C		Miscellaneous Cabin & Lavatory Occupied Lights Aft
C		Miscellaneous Cabin & Lavatory Occupied Lights Fwd
O	A-1	MMR-1
E	D-8	MMR-2
E	D-18	MMR-3

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	F-23	Multifunction Printer
E	C-4	Nav Control Indicator
W		No Smoking
Y		No Smoking
E	G-7	Observer's DCAS
E	N-35	Observer's Light
E	R-37	Outboard Spoilers Actuators
S		Overhead Panel Lights Aft
S		Overhead Panel Lights Fwd
S		Overhead Panel Lights Fwd
E	Z-40	Overhead Panel Flood Lights
E	S-42	Parking Brake Control
O	A-6	Passenger Address
E	P-32	Passenger Oxygen Control
E	R-32	Passenger Oxygen Control Alternate
E	K-33	Passenger Oxygen Release
E	K-16	Passenger Reading Center
E	K-15	Passenger Reading Fwd
E	W-30	Passenger Warning Signs
E	K-23	Passenger Warning Signs
S		Pedestal Lights
S		Pedestal Lights
E	S-25	Pneumatic System Control Left
E	T-25	Pneumatic System Control Right
E	F-22	Portable Data Loader
C		Position Lights
C		Potable Water Galleys/Lavs Freeze Protect
V		Potable Water Freeze Protection Galleys/Lavs
V		Potable Water Freeze Protection Supply Lines
P		Potable Water Htr

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
P		Potable Water Htr
C		Potable Water Supply Lines Freeze Protect
O	C-5	Pre-Recorded Announce & Boarding Music
E	T-24	Pressure Regulating & Shutoff Valve L
E	S-24	Pressure Regulating & Shutoff Valve R
L		Primary Longitudinal Trim
L		Primary Longitudinal Trim
L		Primary Longitudinal Trim
E	G-23	Primary Longitudinal Trim Brake
E	G-22	Primary Longitudinal Trim Control
E	H-9	Primary Trim Motor Heater
E	C-9	PSC Maint Display
O	B-14	R Engine Lock Prox Sensor Ch A
O	B-13	R Engine Lock Prox Sensor Ch B
O	C-8	R Engine Thrust Rvsr Ch A
O	C-9	R Engine Thrust Rvsr Ch B
E	F-17	Radio Altimeter-1
E	F-2	Radio Altimeter-2
O	B-1	Radio Altimeter-3
E	H-4	Radio Rack Fan
E	H-5	Radio Rack Fan
E	H-6	Radio Rack Fan
E	U-30	Radio Rack Fan Caution
E	H-7	Radio Rack Fan Standby Control
E	H-3	Radio Rack Fan Venturi
E	Z-29	Ram Air Temp & Probe Heater
E	J-3	Ram Air Valve
Y		Reading Lights Left
Y		Reading Lights Left
Y		Reading Lights Left

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
Y		Reading Lights Left
Y		Reading Lights Right
Y		Reading Lights Right
Y		Reading Lights Right
Y		Reading Lights Right
L		Right AC Bus
L		Right AC Bus
L		Right AC Bus
L		Right AC Bus
L		Right AC Bus
L		Right AC Bus
E	Z-28	Right Aft Lavatory Water Heater
E	Z-22	Right AOA Vane Htr
E	H-16	Right Aux Hyd Pump Control
L		Right Auxiliary Hydraulic Pump
E	A-6	Right Control Valve Position
E	R-21	Right DC Bus Sensing
E	T-27	Right Engine Anti-Ice Caution
E	X-40	Right Engine Fuel Switch
E	X-39	Right Engine Ignitor-1
O	B-9	Right Engine Ignitor-2
E	L-25	Right Engine P2T2 Prob Heat
O	B-11	Right Engine Start Ch A
O	B-12	Right Engine Start Ch B
O	B-10	Right Engine Start Switch
O	B-15	Right Engine Thrust Reverser
O	C-6	Right FADEC Ch A & Ch B
O	B-7	Right Fuel Shutoff Solenoid
E	W-34	Right Generator Switch Indication
E	L-32	Right Ground Control Relay

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	T-26	Right Hyd Pump Control
E	E-10	Right Hyd Brake Pressure
E	A-5	Right Hyd Oil Quantity
E	E-9	Right Hyd System Pressure
E	L-8	Right Inst Xfmr
E	L-17	Right Logo Lights
E	L-13	Right Nose Gear Landing & Taxi Lt
E	N-21	Right Pneumatic Overheat Detection
E	R-39	Right Proximity Switch Control
E	Z-21	Right Static Port Heater
E	T-28	Right Supply Air Flow
E	Z-24	Right Windshield Anti-Ice
E	N-23	Right Windshield Wiper
E	L-11	Right Wing Landing Light
E	L-12	Right Wing Landing Light Control
E	X-35	RPCDU DC Power
E	B-11	Rudder Hook Position-1
E	A-11	Rudder Hook Position-2
E	Z-30	Rudder Q Limiter Heater
E	S-22	Rudder Shutoff Valve Coil-1
E	T-22	Rudder Shutoff Valve Coil-2
E	S-21	Rudder Stop Lim-1
E	T-21	Rudder Stop Lim-2
E	T-31	SCP Captain’s Master Caution
E	G-14	Selcal
E	C-1	Sidewall Lighting Control
		Smoke Detector (Aft L Lav) Under Sink
		Smoke Detector (Aft R Lav) Under Sink
		Smoke Detector (Fwd Lav) Under Sink
E	J-14	Smoke Detector Fan

Alphabetical Listing of Circuit Breakers

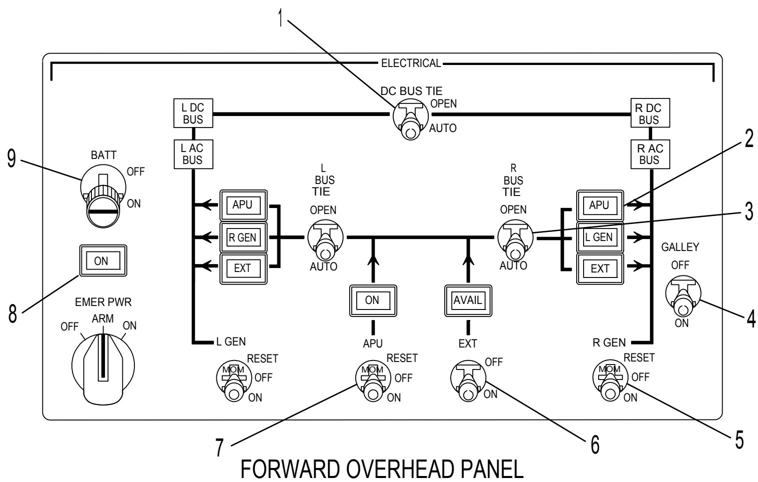
PANEL	LOCATION	CIRCUIT BREAKER NAME
E	P-36	Spoiler Knockdown
E	R-36	Spoiler Lockout
E	P-35	Spoiler Secu Inboard Channel
E	R-35	Spoiler Secu Outboard Channel
E	B-10	Stall Warning Alpha-1
E	A-10	Stall Warning Alpha-2
O	D-3	Standby Compass Lts 28 VAC
E	T-33	Standby Inst
C		Standby R/R Fan
C		Standby R/R Fan
C		Standby R/R Fan
E	R-30	Stick Pusher Control
E	X-23	Stick Pusher Pwr/FCC-1 Data Ldr
E	Z-23	FCC-2 Data Loader
E	K-9	Strobe
E	B-1	Surface Position-1
E	A-1	Surface Position-2
E	N-2	Tail Ice Protection Prsov
E	J-8	Tail Vent Fan
E	J-9	Tail Vent Fan
E	J-10	Tail Vent Fan
E	G-9	Tail Vent Fan Control
E	H-15	TCAS Computer
E	R-29	Trim Control Box
E	G-17	Trim Shutoff Relay
E	L-10	Upper Anti-Collision
C		Vac/Waste Blower Control
E	L-23	Vac/Waste Ovbd Vent Heater
C		Vacuum Blower
O	B-6	VHF Comm-1

Alphabetical Listing of Circuit Breakers

PANEL	LOCATION	CIRCUIT BREAKER NAME
E	G-4	VHF Comm-2
E	G-16	VHF Comm-3
O	A-18	VIA-1 Backup Power
O	A-16	VIA-1 Main Power
O	A-22	VIA-2 Backup Power
E	E-2	VIA-2 Main Power
O	B-4	VOR/Marker Beacon-1
E	F-4	VOR/Marker Beacon-2
E	N-31	Warning Light Dimming
P		Waste Water Heater Cont
C		Water Quantity
E	F-5	Weather Radar Xcvr
X1		Wheel Well & Fwd Access Compt Lights
C		Wheel Well Serv Lts & 28 VAC Utility Outlet
E	X-26	Window Anti-Fog Capt, F/O & Center
C		Wing & Nacelle Flood Lights
E	M-29	Wing Ice Detection
E	M-22	Wing Ice Protection Prsov
E	B-13	YAW Damper
E	G-21	YAW Damper-1
E	G-8	YAW Damper-2

Intentionally
Blank

Electrical Power Control Panel



1. **DC BUS TIE Switch**

   OPEN - (Pull to unlock) Opens all three DC bus tie relays. Used during smoke procedures or testing.

   AUTO - (Pull to unlock) The DC bus tie relays are controlled by the PCDUs and the EPCU as required to make sure all DC buses are powered.

2. **APU, L/R GEN, and EXT Lights**

   Illuminate blue to indicate which power source (APU, generator, or external power) is supplying power to the associated bus.

3. **L/R BUS TIE Switch**

   OPEN - Respective generator cannot power the tie bus. Can also be used to reset a bus tie lockout on the ground.

   AUTO - Generator bus to tie bus connection is controlled automatically, as required.

4. **GALLEY Switch**

   OFF - Galley power is off.

ON - Galley power is on. (In flight, if only one generator is providing power to both generator buses, then system sheds the galleys to conserve electrical power.) Can also be used to reset a galley load shed.

5. **L/R GEN Switch**

RESET - (Momentary) Resets the generator.

OFF - (Pull to unlock) Disconnects the generator from the respective generator bus.

ON - (Pull to unlock) Generator supplies power to the respective generator bus, if generator is operating.

6. **EXT Power Switch and AVAIL light.**

OFF - Disconnects external power from the tie bus.

ON - Connects external power to the tie bus.

AVAIL light illuminates green when external power is connected and within limits.

7. **APU Power Switch and ON Light**

RESET - (Momentary) Resets the APU generator.

OFF - (Pull to unlock) Disconnects the APU generator from the tie bus.

ON - (Pull to unlock) APU generator supplies power to the tie bus if the generator is operating.

ON light illuminates blue when the APU generator is powering the tie bus.

8. **EMER PWR Selector and ON Light**

OFF - Emergency power is off. Resets the automatic emergency power system.

ARM - Emergency power automatically comes on when the EPCU detects a power loss to the emergency AC or DC bus enabling the battery and static inverter to power these buses.

ON - Emergency power is on. The battery supplies power for AC emergency bus (through the static inverter) and DC emergency bus.

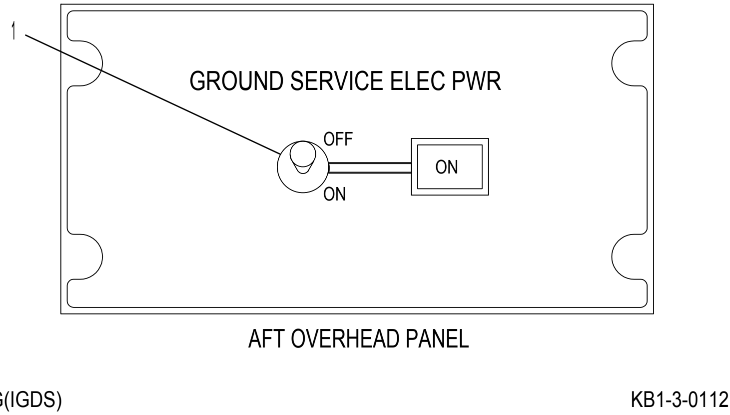
ON light illuminates amber when the emergency power system is on.

9. **BATT Switch**

OFF - (Pull to unlock) Connects to the battery direct bus only. Battery charging is not affected.

ON - (Rotate switch knob counter clockwise and pull to unlock) Connects battery to the DC transfer bus and the battery direct bus.

Ground Service Panel



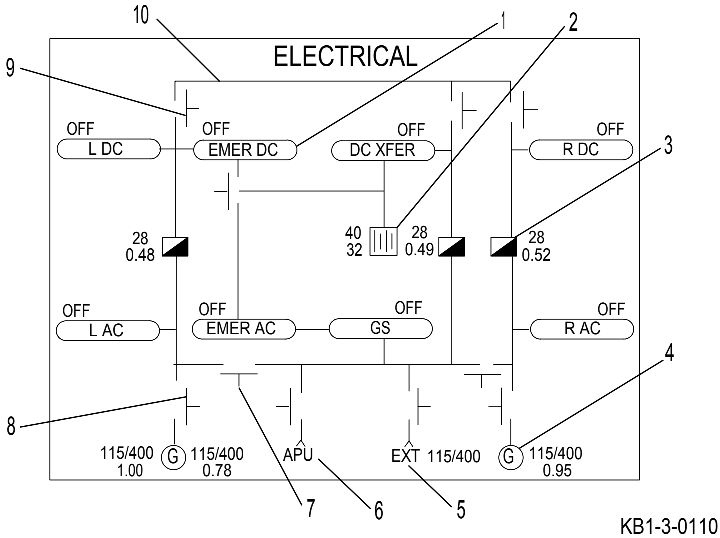
1. GROUND SERVICE ELEC PWR Switch and ON Light

OFF - Neutral position for ground service power.

ON - Connects external power to the AC ground service bus and powers the DC ground service bus. EXT power switch is OFF.

ON light illuminates blue to indicate external power is powering the ground service bus.

SD Synoptic - Electrical



1. **Power Buses**

   Green - Bus has normal power.

   Amber OFF - Bus does not have power.

2. **Battery**

   Green - Battery is discharging normally.

   Amber - Battery voltage is less than normal or battery discharge is abnormal. Voltage digits will be boxed and amber.

   White - There is no load on the battery. Load numerics are white in all conditions.

3. **Transformer Rectifiers**

   White - Normal operation.

   Amber - TR is failed.

4. **Generators**

   Green - Generator is on with voltage and frequency within limits.

   Amber - Generator is off due to relay protective trip. Voltage, frequency, and load current digits are boxed and amber if not within limits.

White - Engine is not operating or generator is turned off. Voltage and frequency digits are white if within limits or engine is not operating. Load current digits are white if within limits.

5. **External Power**

White - External power available. EXT switch in OFF or main external power relay tripped.

Green - External power on and supplying power.

Blank - External power not connected.

6. **APU**

White - APU power available. APU generator off due to APU GEN switch in OFF or APU power relay tripped.

Green - APU on and supplying power.

Amber - APU available. APU generator relay off due to protective trip.

Blank - APU power not available.

7. **Bus Tie Relay**

Green - Relay is closed. Normal condition.

Amber - Relay is opened due to protective trip.

White - Relay is opened. Normal condition.

8. **Power Relays**

Green - Relay is closed. Normal condition.

Amber - Relay is opened, protective trip condition.

White - Relay is opened. Normal condition.

9. **DC Tie Relay**

Green - Relay is closed. Normal condition.

Amber - Relay is opened due to protective trip.

White - Relay is opened. Normal condition.

10. **Schematic Flow Lines**

White - Normal powered condition.

Intentionally
Blank

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

BUS AC EMER OFF (ELEC) - AC emergency bus is off.

BUS DC EMER OFF (ELEC) - DC emergency bus is off.

BUS DC XFER OFF (ELEC) - DC transfer bus has failed.

GEN ALL OFF (ELEC) - Left, Right, and APU generators are off due to faults.

GEN L/R/APU OFF (ELEC) - Respective generator is off due to a fault.

Amber Alerts (Level 1)

BATT CHARGER FAIL (ELEC) - The battery charger is inoperative.

BATT CHARGING (ELEC) - The battery is being charged.

BATT DISCHARGING (ELEC) - The battery is discharging abnormally.

BATT SWITCH OFF (ELEC) - BATT switch is in OFF position.

BUS AC GS OFF (ELEC) - AC ground service bus is off.

BUS AC L/R OFF (ELEC) - Respective bus is off.

BUS DC L/R OFF (ELEC) - Respective DC bus is off.

BUS TIE L/R LOCKOUT (ELEC) - Respective bus tie is locked open due to a fault.

BUS TIE L/R OPEN (ELEC) - Respective BUS TIE switch is in OPEN position.

DC TIE SW OPEN (ELEC) - DC BUS TIE switch is in OPEN position.

ELEC FAULT (ELEC) - Electrical power system has detected an internal fault.

EMER PWR ON (ELEC) - Emergency power is on.

EMER PWR SW OFF (ELEC) - EMER PWR switch is in OFF position.

EMER PWR TST FAIL (ELEC) - The emergency power test has failed.

GEN L/R/APU OFF (ELEC) - Respective generator switch has been selected OFF or ENG/APU FIRE switches have been activated.

TR L/C/R FAIL (ELEC) - A fault exists in the respective TR.

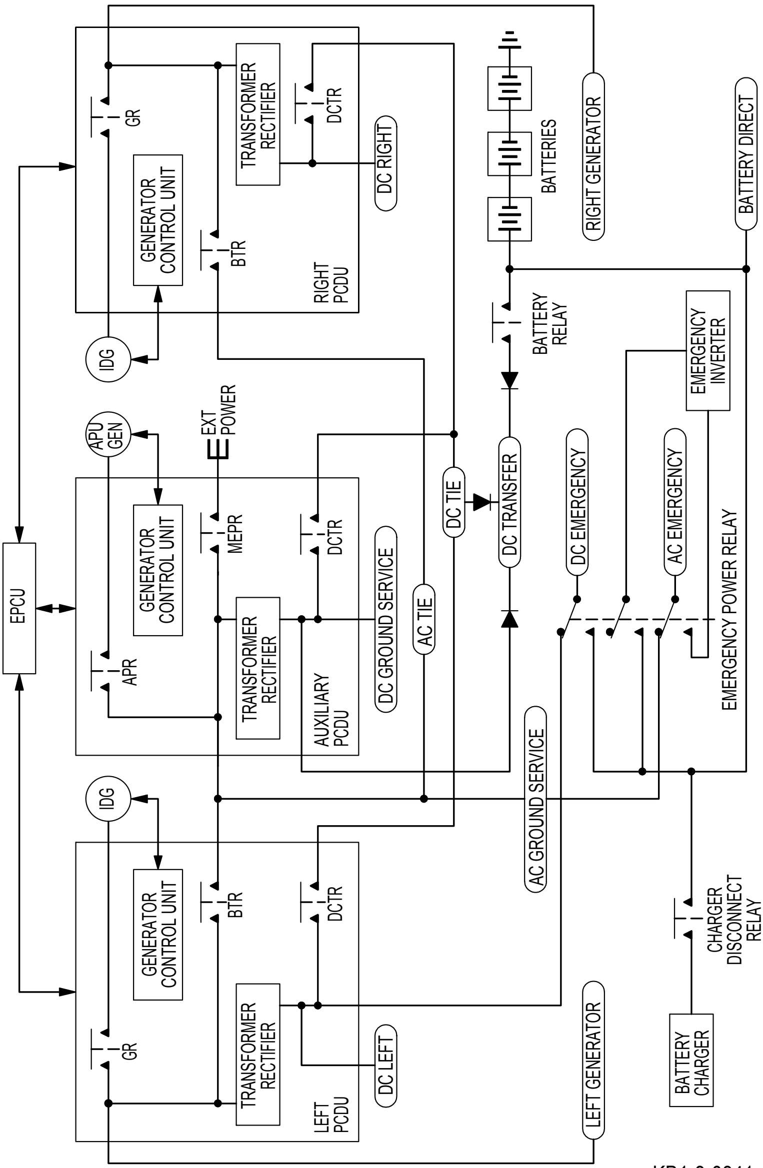
Cyan Alerts (Level 0)

EMER POWER TEST - Emergency power test is in progress.

EXT POWER AVAIL - External power is available.

EXT POWER ON - External power is on.

Electrical System Schematic



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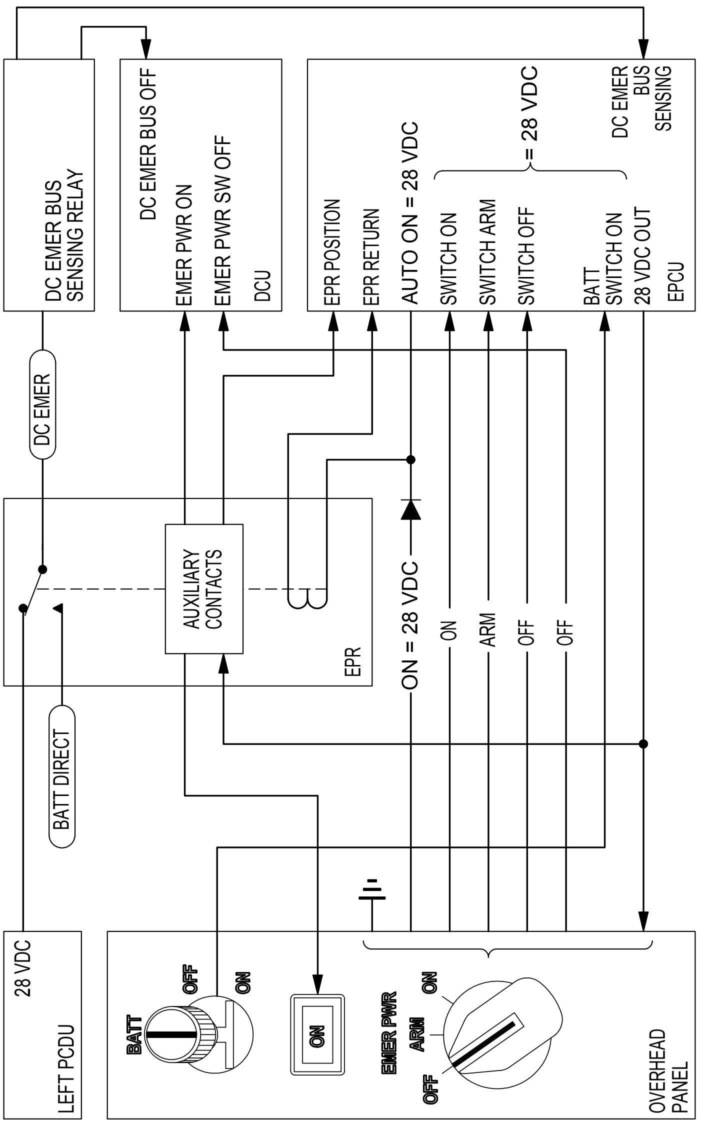
Emergency DC Power



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Emergency Equipment — Chapter Emer
Table of Contents — Section TOC

General

This chapter describes the following: emergency lighting, emergency exits, emergency equipment, and oxygen systems.

Emergency Lighting

Emergency lighting consists of the following:

* Cockpit emergency lights.
* Cabin standby and emergency lights.
* Emergency exit markers/locators/identifiers.
* Cabin floor proximity emergency escape path lights.
* External overwing escape path lights.
* Tailcone escape path lights.

The emergency lights illuminate automatically in the event of an interruption/loss of normal electrical power. The system is powered by rechargeable battery packs that can supply power for approximately 10 minutes. The batteries are continuously kept at a full charge by the normal airplane power.

Emergency lights are controlled by the EMER LT and EMER PWR switches on the overhead panel. An additional EMERGENCY LIGHT switch is located on the forward cabin attendants' panel. This switch overrides the EMER LT switch to turn on the emergency lights.

Cockpit emergency lighting consists of white flood lights to illuminate cockpit instrument and the general cockpit area/door. Cabin lighting consists of emergency standby lights, powered by the Emergency DC Bus, and cabin emergency lights. These lights are located throughout the entire length of the cabin ceiling.

The EXIT markers/identifiers are located at the forward passenger and service doors, overwing emergency exits, and aft emergency exit door. Three EXIT locator signs are located in the cabin ceiling area.

The seat-mounted cabin floor proximity emergency escape path lights located in each seat on both sides of the aisle, illuminate the cabin aisle floor to direct passengers to the emergency exits.

Two external overwing escape path lights, one each located above and aft of the wing, provide illumination to the emergency escape paths on the wings and the ground below the wing trailing edge.

The tailcone escape path lights, located at the top of the tailcone EXIT, provide illumination on the slide and the ground-contacted area.

Emergency Exits

Cockpit

Normally, cabin exits will be utilized by flight crew members. However, two sliding clearview windows, adjacent to the windshields, provide an alternate escape route. Escape lines are provided adjacent to the clearview windows for use by crew members to lower themselves to the ground.

Cabin

There are seven cabin emergency exit doors; a forward entrance door, service door (right forward fuselage), four overwing emergency exit doors, (two each fuselage side), and, when the tailcone is jettisoned, the aft emergency exit door.

Operating instructions for each door are located on the interior and exterior surface of each door. Both forward entrance and service doors have identical handles and similar operating instructions.

The forward entrance and service doors are equipped with a “hold open” latch which secures the doors against the fuselage in the open position.

The forward entrance and service doors are equipped with self-illuminated slides that inflate and deploy automatically when the door is opened with the girt bar installed in airplane floor fittings. A back-up manual inflation handle is provided on each door slide girt should the slide fail to inflate automatically.

NOTE: For normal door operation, the girt bar on the forward entrance and service doors must be removed from the floor fittings and stowed in clips on the slide cover.

When the aft emergency exit door is opened using the emergency exit handle, the tailcone is jettisoned and a slide is automatically deployed and inflated. Back-up interior and exterior tailcone jettison handles and manual slide deployment handle are located behind the aft emergency exit door.

The overwing emergency exit doors have identical handles and emergency operating instructions.

Emergency Equipment

The airplane is equipped with life vests, first-aid kits, hand operated fire extinguishers, and a fire axe. For location and quantity, see Emergency Equipment Location illustration.

Oxygen Systems

Two independent oxygen systems are installed in the airplane: one in the cockpit for the flight crew and one in the cabin for the passengers and cabin attendants.

Portable oxygen cylinders are provided in the cabin. Passenger continuous-flow type masks are attached to the cabin portable oxygen bottles.

Protective Breathing Equipment (PBE) are provided in both cockpit and the cabin. The PBE features a smoke hood with a chemical oxygen generator which provides oxygen for 15 minutes.

Flight Crew Oxygen System

Oxygen for the flight crew system is supplied from a high-pressure gaseous oxygen cylinder located behind the First Officer's seat. The composite cylinder has a pressure gage and an integrated pressure regulator/shutoff valve that supply oxygen to the individual mask-regulator compartment. A valve position indicator is located on the twist on-off handle.

Oxygen line pressure downstream of regulator is indicated by the OXY LINE PRESS gage on the aft overhead panel.

The full-face oxygen mask with pneumatic harness, stowed in the mask-regulator compartment, contains a built-in microphone and a single oxygen regulator control knob. The face seal includes integral purge valve assemblies. These purge valves automatically open when the control knob is in the EMER selection to allow oxygen to enter the face seal purging smoke and fumes. The mask-regulator compartment has an in-place check feature, which allows the oxygen flow and oxygen mask microphone to be functionally tested without removing the mask from its compartment.

Passenger Oxygen System

Oxygen for the cabin, lavatories, and cabin attendants' stations is supplied by self-contained chemical oxygen generator. The generator provides sufficient oxygen for at least 15 minutes of continuous use. The generator with its associated masks and interconnecting hoses are contained in the Passenger Service Unit (PSU).

Passenger masks are located in the cabin as follows:

* Four in each PSU at each triple seat location.
* Three in each PSU at each double seat location.
* Two in each lavatory.
* Two at the forward cabin attendant station.
* Two at the aft cabin attendant station.

All oxygen compartment doors will open automatically if the cabin altitude exceeds approximately 14,150 feet. If cabin altitude exceeds 14,750 feet and the oxygen masks were not deployed, the NO MASKS alert will be displayed on the EAD.

CAUTION: The oxygen generator surface temperature may reach 500°F (260 °C) when generating oxygen. Do not touch or attempt to remove generator, as burn injury can result. If an active generator is inadvertently removed from compartment, it must be placed in metal container such as lavatory or galley sink. Heat will scorch other materials or fabrics.

NOTE: Odor similar to scorched cloth may be created by activation of generators. The odor does not affect the purity of the oxygen and there is no fire hazard.

As a backup to the automatic system, a PASS OXY MASK switch, located on the right side of the bulkhead behind the First Officer's seat, provides manual deployment of the masks. Moving the switch to EJECT opens all oxygen compartment doors. The oxygen masks will free fall from the PSU.

NOTE: Holding switch in EJECT position in excess of 5 seconds may cause damage to the oxygen compartment latches.

If necessary, each individual oxygen compartment door also can be opened manually.

Protective Breathing Equipment

One Protective Breathing Equipment (PBE) is located in the cockpit. The PBE is mounted behind the First Officer.

The PBE consists of a solid-state chemical oxygen generator, a chemical scrubber for carbon dioxide and water vapor, and a lose-fitting hood with supporting head harness and neck seal.

Oxygen generation is actuated by pulling the actuation ring. Low pressure oxygen is produced from chemical decomposition within the generator. This oxygen is fed to the primary flow nozzle of an ejector device and mixes with the hood gases while inducing flow through the scrubber. The scrubber removes CO2, excess moisture and particles, allowing the oxygen to flow back to the hood.

Donning PBE

* Remove unit from storage container.
* Tear off red pull strip and remove unit from plastic wrapper.
* Pull actuation ring in the direction indicated.

* Hold the device by the open end of the hood with the life support pack facing away.
* Bend over and grasp hood opening with thumbs and pull hood over head.
* Raise to standing position and adjust hood and life support pack for most comfortable fit. Check neck seal for secure fit.

Portable Oxygen Cylinders

Portable oxygen cylinders, with continuous flow oxygen masks, are located in the cabin for use by the cabin attendants. Each cylinder contains a hand shutoff valve, relief valve, low and high continuous flow outlets, and carrying strap.

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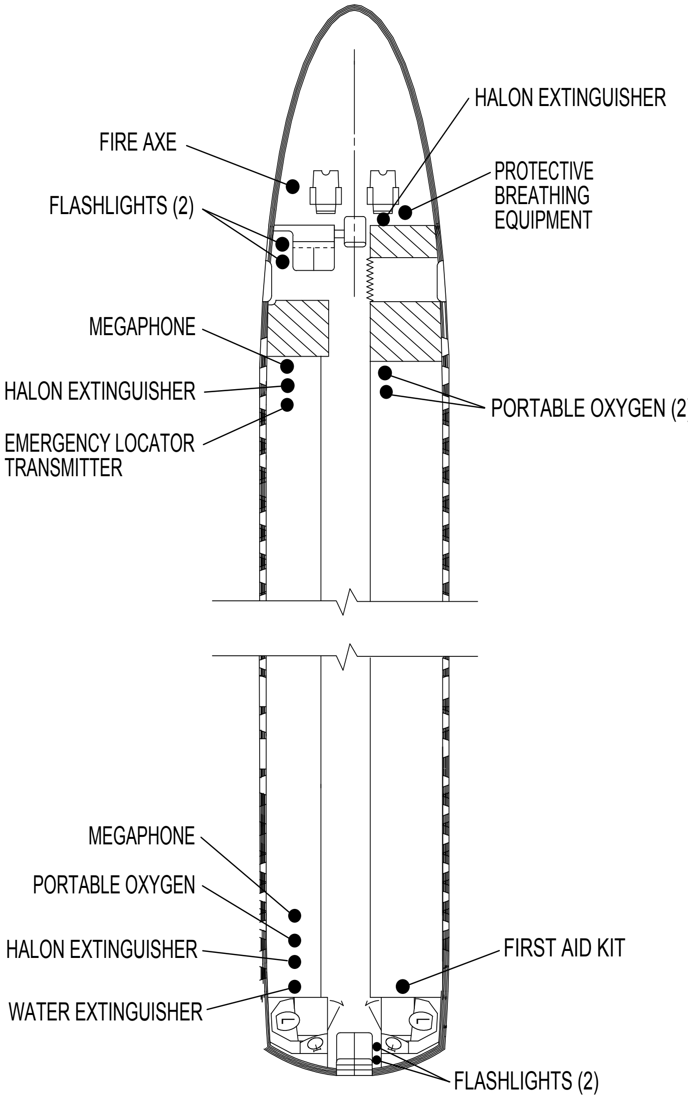
Emergency Equipment Location



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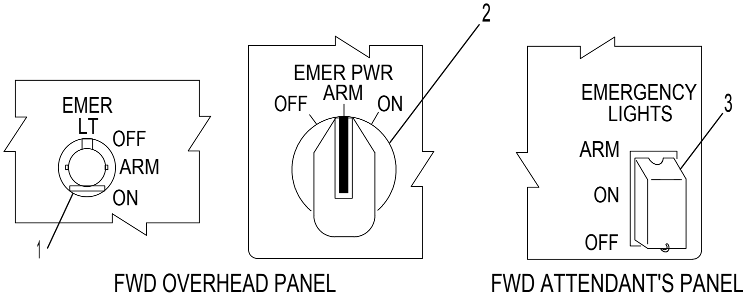
Emergency Lighting Controls



1. **EMER LT Switch**

   OFF - Charges emergency battery packs from DC Transfer Bus. EMER LTS DISARM alert displayed on the EAD.

   ARM - Normal position. Arms emergency battery packs.

   ON - Activates emergency battery packs to illuminate emergency lights.

2. **EMER PWR Selector**

   OFF - Deenergizes emergency power mode.

   ARM - Normal position.

   ON - Airplane battery supplies power to the AC, DC emergency bus and DC transfer bus. Extinguishes all emergency lights except cabin standby lights.

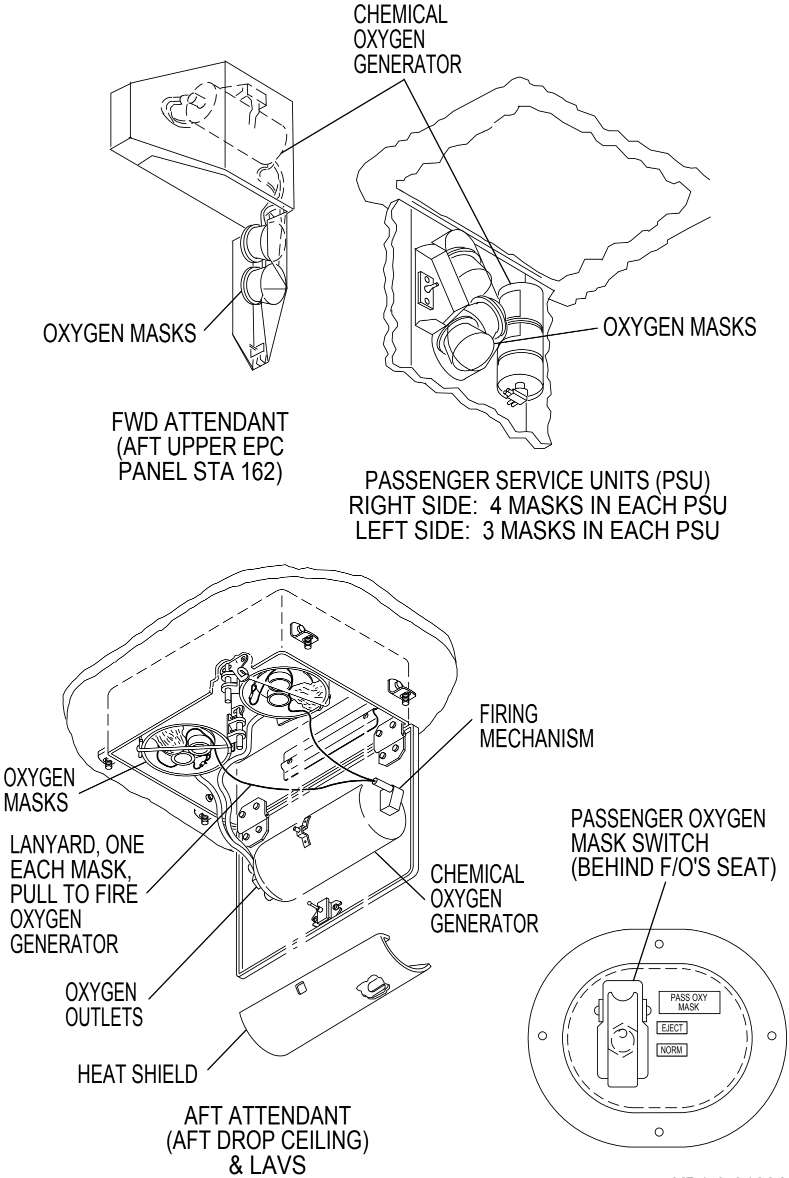
3. **EMERGENCY LIGHTS Switch**

   ARM - Arms emergency lights.

   ON - Overrides the EMER LT switch to illuminate emergency lights. If the EMER LT switch is at OFF, switch must be moved to ARM momentarily prior to ON.

   OFF - (Guarded) Normal position. Emergency lights are controlled by EMER LT switch on the overhead panel.

Oxygen - Cabin



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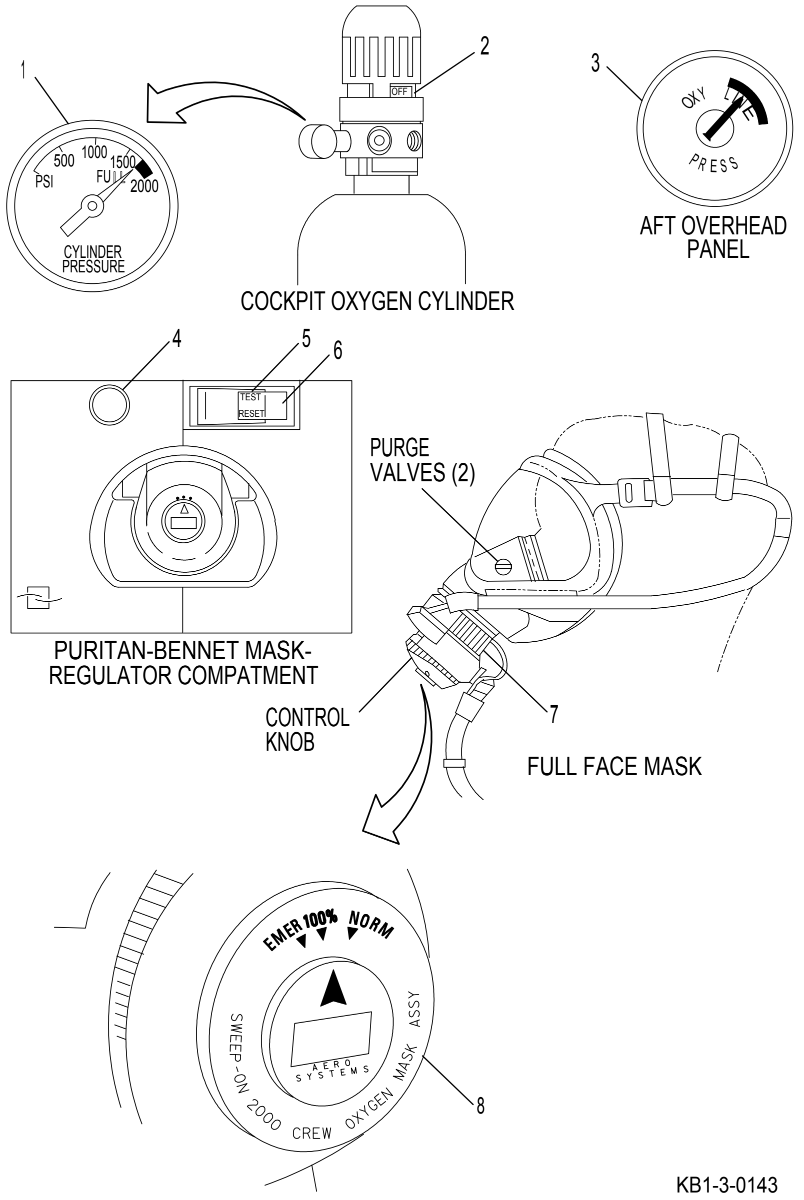
Oxygen - Cockpit



1. **CYLINDER PRESSURE Gage**

   Indicates oxygen cylinder pressure.

2. **Valve Position Indicator**

   Indicates oxygen pressure regulator/shutoff valve is ON or OFF.

3. **OXY LINE PRESS Gage**

   Indicates oxygen line pressure.

4. **Oxygen Flow Indicator**

   Blinks yellow when the TEST/RESET switch is pushed during test or during mask inhalation.

5. **TEST/RESET Switch**

   Push - Produces a short burst of oxygen flow to the mask and automatically switches the boom microphone to mask microphone. When the PTT switch is pushed, oxygen flow can be heard over the cockpit speakers.

   When the mask is removed from the compartment, oxygen flow begins, Oxy On flag comes into view, and the mask microphone is switched from boom to mask.

   After the mask is restowed into the compartment and doors are shut, pushing the switch will stop the flow oxygen to the mask, reset the microphone from mask to boom, and retract Oxy On flag.

6. **Oxy On Flag**

   Indicates oxygen valve is on.

7. **Harness Inflation Switch**

   Push - Inflates mask harness.

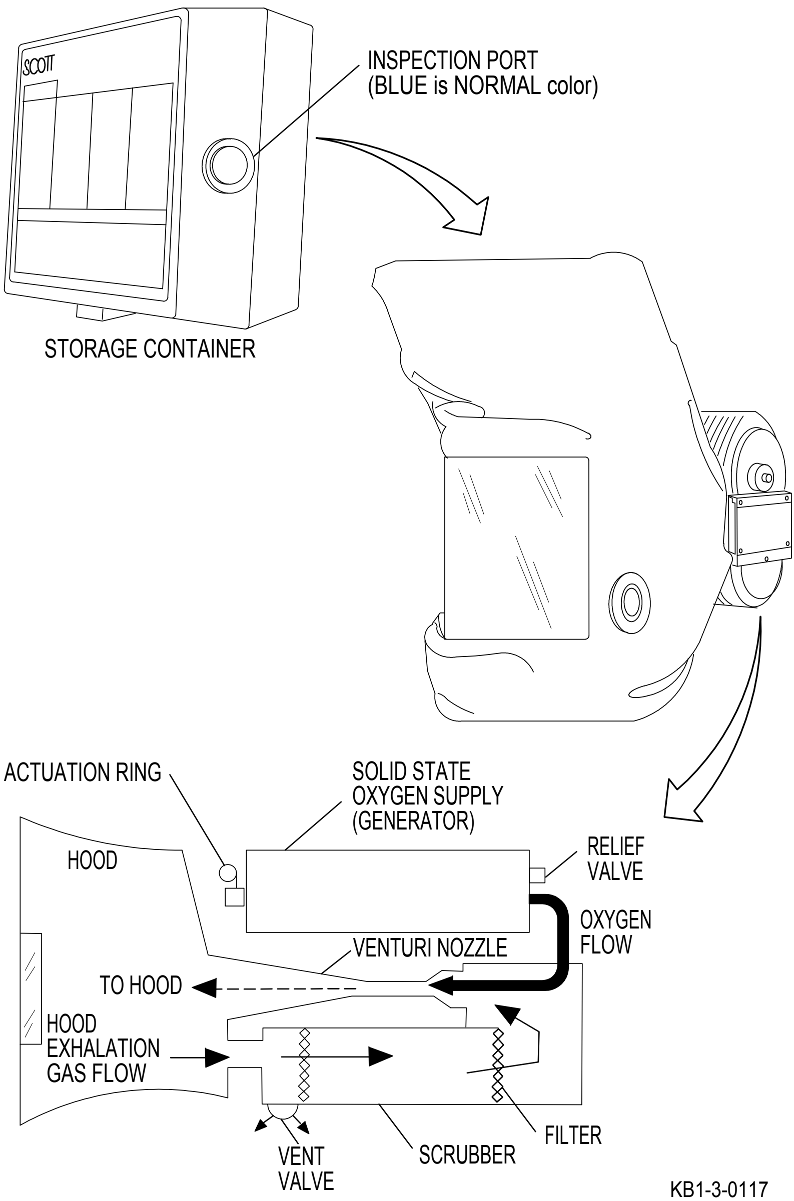
8. **Regulator Control Knob**

   EMER - Supplies 100% oxygen regardless of cabin altitude. In addition, oxygen is supplied at a positive pressure through the purge valves.

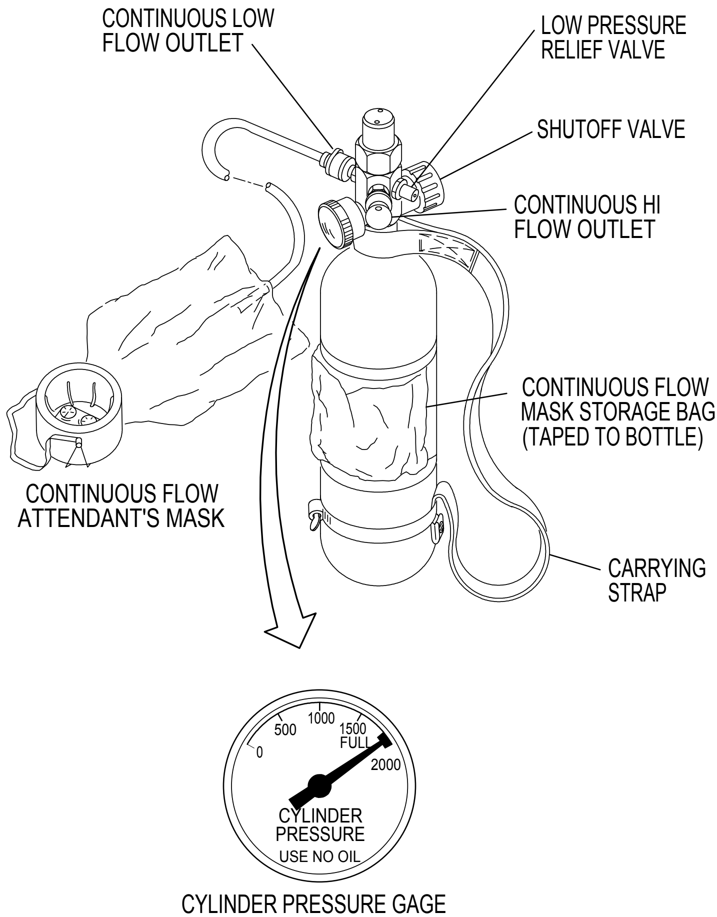
   100% - Supplies 100% oxygen upon inhalation regardless of cabin altitude.

   NORM - Supplies automatic oxygen dilution.

Protective Breathing Equipment



Portable Oxygen Cylinder (Typical)



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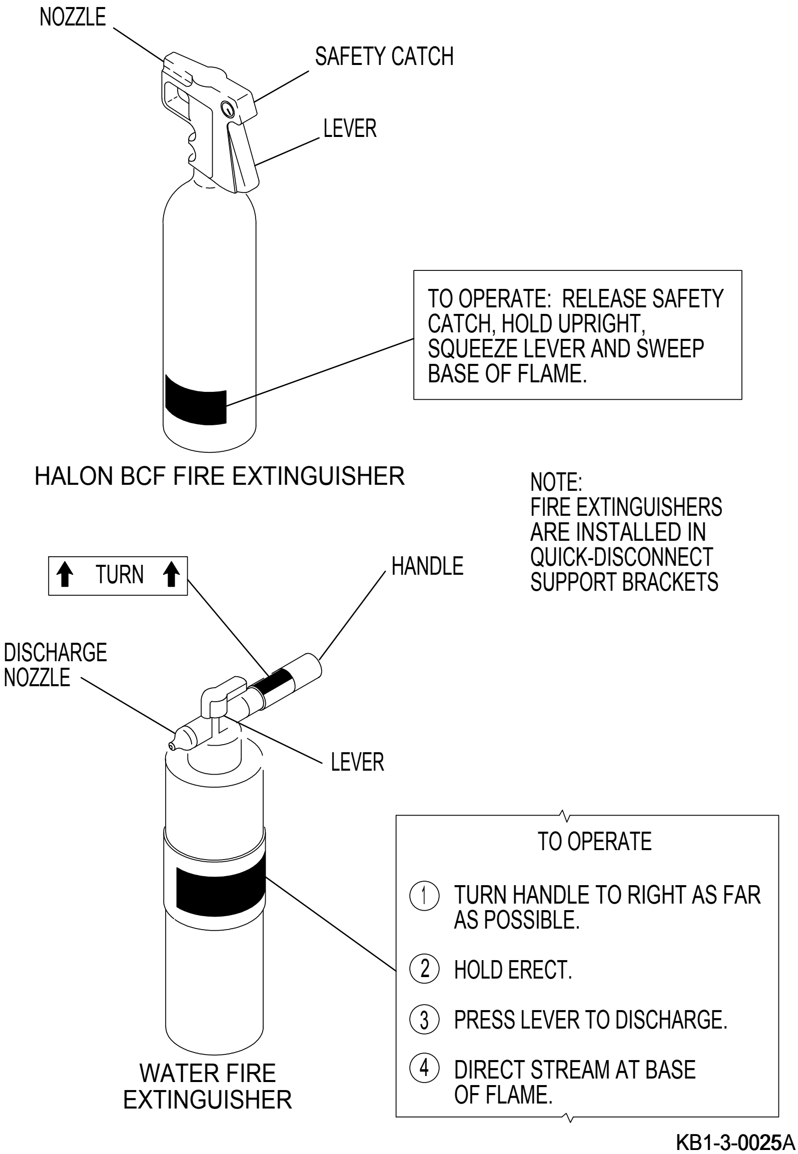
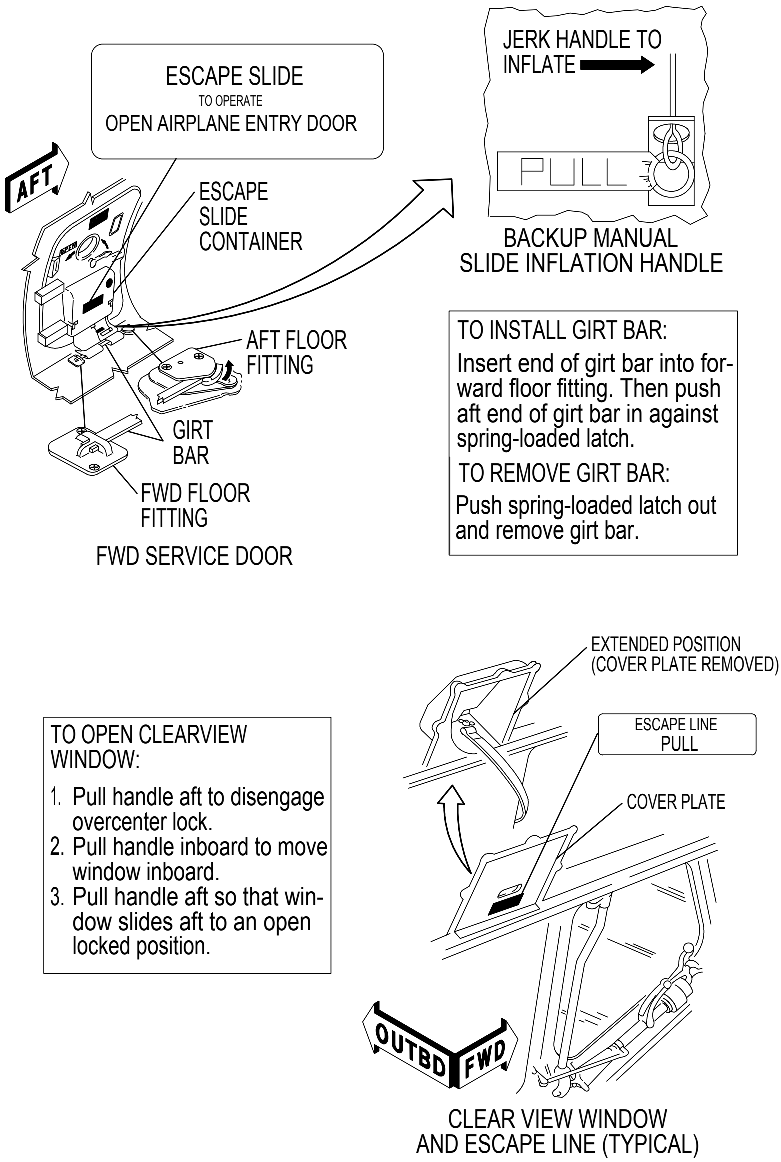
Fire Extinguisher



Emergency Exits - FWD Door and Clearview Window



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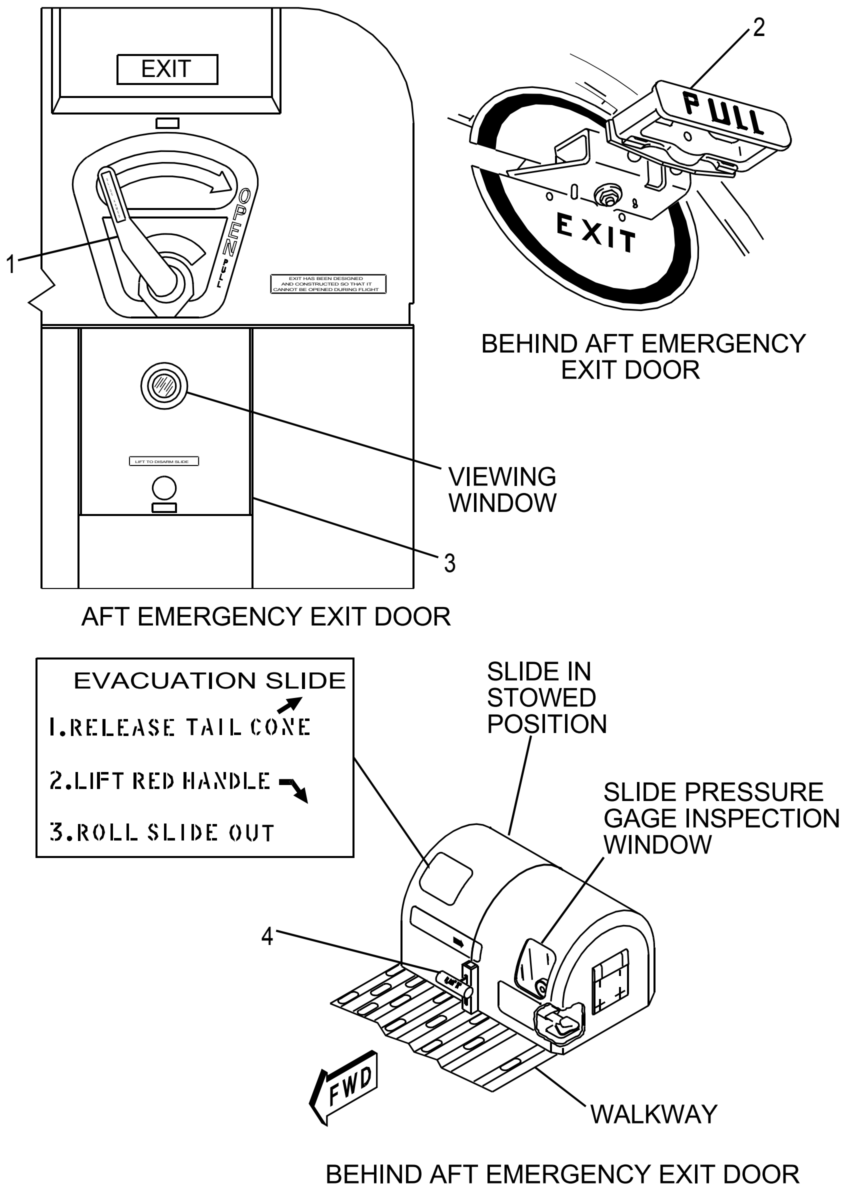
Emergency Exits - Aft Emergency Exit Door and Tailcone Slide



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1. **Emergency Exit Handle (Cover Removed)**

   Rotate Clockwise - Unlatches and opens door. Tailcone is jettisoned and evacuation slide is automatically deployed.

2. **Back-Up Tailcone Interior Jettison Handle**

   PULL - Jettisons tailcone and deploys slide.

3. **Center Head Rest Pad**

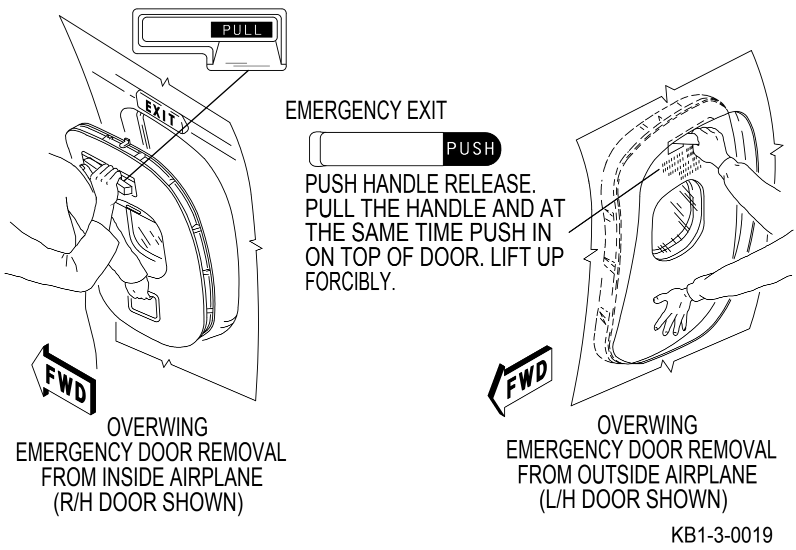
   Lowered - (Shown) Emergency exit handle with cover available.

   Raised - Normal door handle and instructions available.

4. **Slide Manual Deployment Handle**

   LIFT - Releases slide from latches to deploy slide manually.

Emergency Exits - Overwing Emergency Door



NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

NO MASKS (AIR) - Cabin altitude exceeds 14,750 feet and passenger oxygen masks have not automatically deployed.

Amber Alerts (Level 1)

EMER LTS DISARM (MISC) - EMER LT switch is in OFF position.

OVERWING DOOR (MISC) - One or more overwing emergency exit doors is not closed and locked.

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Engines — Chapter Eng
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Engines — Chapter Eng
Description and Operation — Section 10

General

The airplane is powered by two BR715 high-bypass turbo fan engines. Each engine is capable of delivering 18,500 or optional 21,000 pounds of thrust and is equipped with a clamshell type thrust reverser.

The engines use a full authority digital engine control (FADEC) in association with the appropriate airplane sub-systems to control engine functions from start to shutdown. FADEC has three main components: throttle, throttle module and electronic engine control (EEC).

FADEC converts pilot inputs to the throttles into electronic signals that are sent to the EECs. Each EEC has two channels for redundancy. Should one channel fail, the EEC will control and manage all vital engine functions on the remaining channel. The electronic engine controls are the main part of FADEC.

Each EEC optimizes engine operation based on prevailing atmospheric conditions, certain airplane and engine conditions and phase of flight.

The EEC also transmits engine data to the flight control computers (FCCs) and to the versatile integrated avionics (VIAs), which sends it to be displayed on the engine and alert display and the secondary engine display.

Components

The BR715 engine is a high-bypass fan engine. The fan assembly and low pressure compressor are referred to as N1. Air flow produced by the N1 compressor continues to the high pressure compressor referred to as N2. High pressure air enters the combustion section where fuel mixes with air and is ignited. High speed gasses, created by combustion, then enter the turbine section and drive the turbines.

The first and second turbine stages drive the N2 compressor and the other stages drive the N1 compressor.

The accessory gear box is mounted below the engine and is driven by the N2 compressor.

The fan assembly and low pressure compressor section are displayed as N1 on the EAD. The fan produces a large percentage of the engine thrust. The current N1 is displayed as a pointer line moving inside the scale, and by a readout indicating in percent. The red line limit is indicated by a short red line across the scale. If N1 exceeds the red line limit, the pointer and digits become boxed in red and the ENG L/R RPM HI alert is displayed. Also, the N1 red line exceedance is displayed in small digits at the high end of the scale.

EPR is the primary thrust setting parameter and is a ratio of the turbine exhaust stream pressure to the engine inlet pressure. The current EPR is displayed as a pointer line moving inside the scale, and by a rolling digital readout. The T indicates the throttle position and moves along the outside of the scale. The V indicates the computed EPR. When the T fits within the V, the throttles are set to the computed thrust rating.

Behind the low pressure compressor is the high pressure compressor, N2. This compressor operates at a higher speed and is independent of N1. EEC controlled variable stator vanes in the N2 compressor control air flow through the compressor to achieve smooth acceleration and deceleration.

N2 is displayed on the EAD as a pointer line moving inside the scale, and a readout indicating in percent. The N2 red line limit is indicated by a short red line across the scale. If the N2 exceeds the red line limit, the pointer and digits become boxed in red and the ENG L/R RPM HI alert is displayed.

Also, the N2 red line exceedance is displayed in small digits at the high end of the scale.

During a manual start, a FUEL ON line is displayed across the scale to indicate the minimum N2 at which fuel should be turned on.

The diffuser and combustion section contains the combustion chamber, fuel nozzles and igniter plugs.

The high pressure turbine assembly drives the N2 compressor and the accessory drive gear box. The low pressure turbine assembly drives the fan and the N1compressor.

The TGT is displayed as a radial pointer moving inside the scale and a readout indication in degrees Celsius.

The TGT caution range is indicated by an amber line across the scale. If the TGT remains in the caution range for more than 5 minutes, this indication is displayed. The red line limit is indicated by a short red line across the scale. If the TGT reaches the red line, this indication is displayed. The TGT exceedance is displayed in small digits at the high end of the scale and the ENG L/R TGT HI alert is displayed.

During engine operation, a lightning bolt is displayed to indicate when ignition is commanded on.

On the EAD, engine fuel flow is displayed in pounds per hour.

When the ENG EXCEEDANCE RESET button is pushed, any engine exceedance displayed on the EAD will be reset.

The accessory drive gearbox is driven by the N2 compressor. It drives accessories that support engine and airplane systems.

Each engine oil system is self-contained. The system incorporates a tank and de-aerator, pressure pump, pressure filter, combined fuel cooled oil cooler, scavenge pumps and breather.

The pressure pump oil filter contains a bypass valve. If the oil filter becomes clogged, the valve will open, allowing the oil to pass. When the pressure pump oil filter begins to clog and the differential pressure increases to a predetermined value, the ENG L/R OIL FILTER alert is displayed on the EAD.

The engine oil system parameters are displayed as secondary engine data on the systems display. Oil pressure is displayed as a pointer line moving inside the scale, and a readout indicating psi.

The normal oil pressure range is indicated by a green arc. The low pressure limit is indicated by a red line across the scale. If the pressure reaches the red line, the pointer and digits are boxed in amber and the ENG L/R OIL PRES LO alert is displayed on the EAD.

Oil temperature is displayed as a pointer line moving inside the scale, and a readout indication in degrees Celsius. The low temperature precaution range is indicated by a line across the scale.

The high temperature precautionary range is just below the red line. If the oil temperature reaches the high caution range, the pointer and digits are boxed in amber and the ENG L/R OIL TEMP HI alert is displayed on the EAD. The high temperature limit is indicated by a red line across the scale.

If the temperature reaches the red line, the pointer and digits are boxed in amber. Also, the ENG L/R OIL TEMP HI alert remains displayed on the EAD.

Also included on the secondary engine display is the oil quantity. Oil quantity is displayed as a pointer line moving inside a scale, and by a readout indication in quarts.

During start, when the engine reaches idle, the scale is marked with a line to indicate the initial oil quantity. When oil quantity decreases to two quarts, the digits are boxed in amber.

The engine vibration monitoring system, located on the SD synoptic, monitors the N1 and N2 rotor engine vibrations. The readout indicates vibration from 0.0 to 9.9 units. High limit is set at 4.0. When the vibration exceeds the high limit for a predetermined time, the digits turn amber and are boxed in amber and the ENG VIB HI alert is displayed on the EAD. The readout is the highest value of the areas monitored from each engine.

Controls & Indicators

The engine control panel and the ENG EXCEEDANCE RESET button are located on the forward overhead panel.

The engine and alert display (EAD) contains indications for the thrust reversers, engine rating and thrust rating mode, engine pressure ratio (EPR), low pressure compressor (N1), turbine gas temperature (TGT), high pressure compressor (N2) and fuel flow (FF).

The systems display shows additional engine data such as engine vibration, oil pressure, oil temperature and oil quantity.

The thrust limits pages displayed on the MCDUs indicate the thrust selection mode the engine is operating on. Normally engine thrust modes are automatically selected appropriate to the phase of flight. However, if required, the crew can manually select a thrust mode using the line select key adjacent to the thrust mode desired.

The throttles are located on the pedestal.

The FUEL switches are located below the throttles on the center pedestal. During engine start when the switches are moved to the ON position, each EEC is commanded to open its respective fuel on/off valve. When the switches are moved to the OFF position during shutdown, the fuel on/off valves are commanded to close, shutting off fuel flow.

Engine Control Panel

The FADEC MODE switches are located on the overhead panel. The switches are guarded and have two functions. Each provides annunciation and manual selection of the alternate backup mode. When the EEC can no longer calculate a valid EPR, it automatically reverts to the alternate backup mode of thrust control, and the SELECT and ALTN lights illuminate.

On the EAD, the SELECT FADEC ALTN alert will be displayed.

When the EEC defaults to the N1 mode, an X is displayed on the EPR indicator and dashes replace the EPR limit. The autothrottle disconnects and remains disconnected as long as the engine is in the N1 mode.

When the FADEC MODE switch is pushed, the SELECT light extinguishes. The ALTN light will remain illuminated and on the secondary engine display, the ENG L/R FADEC ALTN alert is displayed.

The IGNITION switch, located on the overhead panel, has two positions: AUTO and ON. When the switch is in AUTO, one of the two ignition units for each engine is energized and the auto abort feature will be operational during start.

In flight, both units are energized if the engine flames out or if water in the N2 compressor is detected. The EEC alternates which ignition system is energized from one start to the next.

When the switch is moved to ON, the engine auto start or auto abort functions are disabled. When a FUEL L/R switch is moved to ON, both ignition units for that engine are continuously energized. There is no time limit for the ignition to be on, however, this mode will reduce igniter life if used for prolonged periods. On the EAD, ENG IGN OVRD ON will be displayed.

The ENG START L/R switches, located on the overhead panel, have two positions: in and out. When the switch is pulled out, it is magnetically held out. The switch illuminates and the EEC is commanded to open the engine start valve.

When N2 reaches 41 percent, the start valve closes, the light extinguishes and the ENG START L/R switch pops back in.

Throttle Levers

The throttles have a main lever to set forward thrust and a piggyback lever to command and set reverse thrust. The throttles increase or decrease thrust by electronically commanding the EEC to schedule the required fuel flow.

Maximum thrust is commanded when the throttles are advanced to the max forward throttle gate. This gate is part of the throttle mechanism located under the pedestal. Movement of the throttles beyond the gate detent commands the EEC to the alternate/N1 mode of thrust control. EPR will continue to be displayed, however, thrust management or throttle response will be based on N1 not EPR.

Engine Starting

General (Automatic and Manual Starts)

The engines may be started by using a pneumatic supply from the APU, an external air source or from an operating engine using the pneumatic crossfeed system. The AIR page should be checked to confirm the pneumatic source and ensure the pressure is greater than 25 psi. Pneumatic manifold pressure may be checked by selecting one air conditioning PACK to AUTO, observing the air pressure as displayed on the AIR synoptic page, and then returning the PACK switch to OFF. The “START AIR PRES LO” alert will be displayed if air pressure below 25 psi is sensed for more than 15 seconds after the ENG START switch has been pulled. Start attempts with low air pressure may lead to a maximum TGT exceedance and/or a hung start.

Throttles should be at idle for all engine starts to prevent undesired acceleration to thrust levels higher than idle.

An engine start is initiated when the respective ENG START L/R switch is pulled out. This action energizes the start switch holding coil and signals the EEC to command the start air valve (SAV) open. The EEC commands start valve closed and deenergizes the start switch holding coil as the engine accelerates through 39% N2. EEC inhibits starter operation if N2 is above the starter reengagement speed of 39% N2.

Rotor bow occurs when the engine rotor and case distort due to the higher metal temperatures at the top of the engine. This occurs between 20 minutes and 5 hours after shutdown. Vibration may be higher than normal after start due to this distortion. Motoring the engine for 30 seconds prior to fuel ON will reduce the distortion. The EEC accomplishes this procedure automatically during auto starts.

Tailwinds can cause the engine fan rotor to windmill backwards (clockwise). During start, it may take some time for the pumping action of the engine core flow to stop this rotation and start the fan turning in the correct direction (counter-clockwise). If fuel is turned ON too early in a tailwind, the reversed flow in the fan duct can re-ingest burning exhaust gases and damage the engine. Thus, the start procedures require a positive indication of fan rotation before turning fuel ON when starting with a significant tailwind. Auto-start logic in the EEC software will automatically motor the engine for all starts to provide this assurance.

Pre-Start (Automatic and Manual Starts)

If the throttle is not at idle, the engine will accelerate to the thrust selected by the throttle. This is not recommended. Always ensure that the throttle is at idle during starting. The EEC is to be de-powered at least once a day. If this is not the case it is recommended to cycle the FUEL switch ON and OFF before an engine start in order to enable EEC internal checks are to be performed. If oil temperature is not above the minimum limit, do not start engine. If the available starter air pressure is below 32 PSIG a start attempt may lead to a maximum TGT exceedance and/or a hung start. Do not attempt to start the engine with a starter air pressure greater than 43 PSIG or less than 32 PSIG. To check manifold pressure turn a PACK switch to AUTO, check pressure, and then turn PACK switch to OFF.

Auto Start

An auto start is selected whenever the engine IGNITION switch is in the AUTO position, the ENG START switch is pulled and the FUEL switch is placed to ON. During an auto start the EEC controls the start air valve, fuel shutoff valve, fuel metering and ignition. The ignitors will be energized and the fuel valve will normally open after 30 seconds of motoring unless TGT protection is active, in which case the fuel will be delayed until the TGT is less than 150°C.

Engine start is automatically aborted if any of the following are detected:

* Hung Start.

* Starter cutout speed not reached within the period of the starter duty timer (180 sec.).
* Hot Start, TGT exceeds 700°C or the rate of TGT increase would lead to a TGT exceedance.
* Fuel on condition not being satisfied.
* Loss of a valid N2 input.
* Certain failures of both channels of the EEC.

Should an auto abort occur, the EAD message “ENG L/R START ABORT will be displayed. This message may be cancelled by selecting the FUEL switch OFF.

The EEC will motor the engine (hold SAV OPEN) after an auto aborted start if SAV is still open at time of abort. Motoring will continue until the pilot selects the ENG START switch off or motoring time exceeds starter duty time limits. EEC will not reopen SAV to motor if auto abort occurs after SAV cut out.

The EEC does not monitor oil pressure or N1 during start.

In flight the EEC will not auto abort an engine start.

Refer to FCOM Vol. II, Normal Procedures, for AUTOMATIC ENGINE START procedures.

Manual Start

A manual start is initiated by placing the IGNITION switch to the ON position. During manual starts the crew is responsible for monitoring engine parameters for start exceedance. In the event of a starting anomaly or exceedance the start must be manually aborted by turning the FUEL switch OFF. The EEC will automatically abort a start on loss of N2 signal or on non-dispatchable failures of the EEC associated with both channels of the EEC being unable to control the engine.

During manual starts on the ground, motor the engine for a minimum of 30 seconds at 19% N2 or greater prior to placing the FUEL switch to ON. This provides starting protection for both bowed rotor and typical tailwinds.

If there is residual TGT in excess of 150°C, the crew should wait until residual TGT is 150°C or less before placing the FUEL switch to ON.

Both engine igniters are continuously energized (as indicated by the cyan lightning bolt symbol on the TGT display) whenever the engine IGNITION switch is in the ON position, the engine FUEL switch is ON and engine is at idle power or below.

During manual starts, the EEC will release the ENG START switch and close the start air valve when the engine reaches 39% N2. At stabilized idle, the IGNITION switch should be returned to AUTO to prolong igniter life.

All inflight engine starts are manual starts.

Refer to FCOM Vol. II, Supplemental Procedures, for the MANUAL ENGINE START procedure.

Engine Warm-up

No minimum warm up time is required following an engine shutdown of two hours or less. In order to reduce adverse thermal stresses, it is recommended that engines started after a shutdown period of greater than two hours are warmed up at thrust settings normally used for taxi operation for at least 3 minutes. It is not, however, necessary to delay the takeoff unless the vibration levels are higher than normal or the oil temperature is below the lower limit for accelerating to take-off power. If vibration levels are higher than normal the warm-up period should be extended until the vibration levels have returned to normal.

Ignition System

Each engine's ignition system consists of two ignition units, two igniter leads and two surface discharge semiconductor igniters. The ignition system is controlled by the EEC. Each channel of the EEC has the capability of energizing either or both ignition units. The EEC energizes a single ignition unit during auto start and both ignition units for all other modes. The FCC will also command continuous ignition for 60 seconds after either ENG anti-ice switch has been selected ON.

During auto starts the EEC automatically alternates use of ignitors in the following sequence and then repeats: (Note that the EEC also alternates control channels each start.)

Start 1) EEC Channel-A/Ign-A

Start 2) EEC Channel-B/Ign-A

Start 3) EEC Channel-A/Ign-B

Start 4) EEC Channel-B/Ign-B

Ignition system ON is indicated by the appearance of the cyan lightning bolt symbol on the TGT display.

When the IGNITION switch is selected to ON the EEC will command both ignition systems on as long as the engine is near idle power. When the engine power exceeds idle the EEC will inhibit ignition unless it requires ignition by the auto-relight logic.

The EEC provides for automatic activation of the ignition system (Auto-Relight) if the following conditions are detected and until the conditions no longer exist:

* Combustor instability.
* Significant water/ice ingestion (water is detected at HP compressor).
* Flameout.

Immediately upon detection of a flameout, the EEC energizes both igniters and schedules fuel flow until the engine relights. Following relight, the EEC will accelerate the engine immediately to the currently commanded power setting. The ignitors are kept energized after detection of engine relight (the engine reaches idle) for 20 seconds.

The auto-relight function is armed when start is completed. Auto-relight is disabled upon engine shutdown or at N2 speeds of 15% or less.

Ignition switch is used to select between EEC commanded ignition (AUTO)(single for ground starting, dual for flameout protection) and (ON) dual continuous ignitor operation, and to arm either the manual or automatic ground start mode. In flight, manual start mode and dual ignition are provided during starting regardless of ignition switch position.

Additional information on the ignition system is also contained in the Engine Control Panel description.

Thrust Reversers

When the reverser levers are in the full down position, the EEC is commanded to forward idle.

When the reverser levers are moved to the reverse idle detent, the EECs will unlock and deploy the reversers, provided the EECs are not detecting any failure in the reverser systems.

When the reversers are out of the stowed position, the reverser unlock indication (U/L) are displayed inside the EPR arcs on the EAD. When the reversers are approximately 90% deployed, the reverse thrust indication (REV) are displayed in green inside the EPR arcs.

When the reverser levers are moved to the maximum thrust reverse position, the EEC is commanded to maximum reverse thrust. Emergency reverse thrust is available by pulling the reverser levers through a mechanical gate. When selected, reverser thrust above maximum is commanded by the EEC and the emergency reverser thrust exceedance reminder is displayed as a REV in amber at the end of the EPR arc on the EAD. The green REV displayed inside the EPR arcs are not affected by the emergency reverse thrust. Emergency reverse thrust can damage an engine and requires maintenance inspection to be performed on the engine.

Built-in safety features prevent uncommanded deployment of thrust reversers in flight. However; should this occur, the EEC will automatically reduce thrust on the affected engine to idle. On the EAD, REV will be displayed in red inside the EPR arcs. In addition to the EPR indication, the REV L/R DEPLOYED alert will be displayed.

The reversers will only deploy when the respective engine is running. However, when landing with an engine shut down, the reverser on the inoperative engine is permitted for 30 seconds to deploy after nose wheel strut compression. In-flight, the thrust reversers are inhibited by nose and main gear strut compression switches. A switch in the aft fuselage provides override capability to permit reverser operation during maintenance while the engine is not running.

Thrust Mode System

The thrust limits page displayed on the MCDU allows the crew to manually set a thrust limit mode for a specific phase of flight. Thrust limits are calculated by the EEC based on outside pressure and temperature, engine bleed configuration, and phase of flight.

EPR thrust limit data generated by the EECs are sent to the VIAs for display on the EAD.

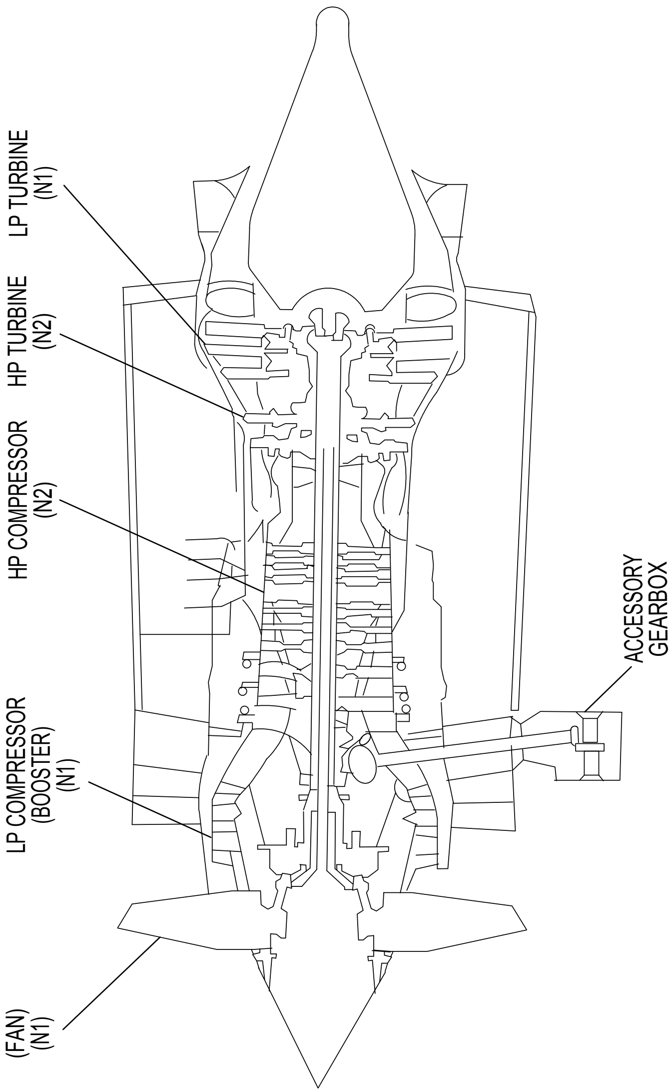
The EAD displays the current thrust limit mode, engine pressure ratio limit, throttle position T symbol and actual engine pressure ratios.

There is a backup mode used to set forward thrust if the EEC cannot set thrust using EPR. This mode uses engine N1 speed for thrust management.

Synchronizer System

The engine synchronizer system matches EPR or fan speeds to reduce crew workload and reduce noise. The EEC automatically controls the system. During takeoff the system synchronizes left EPR to the right EPR. During climb, cruise and descent, the system synchronizes fan speeds.

Engine Components



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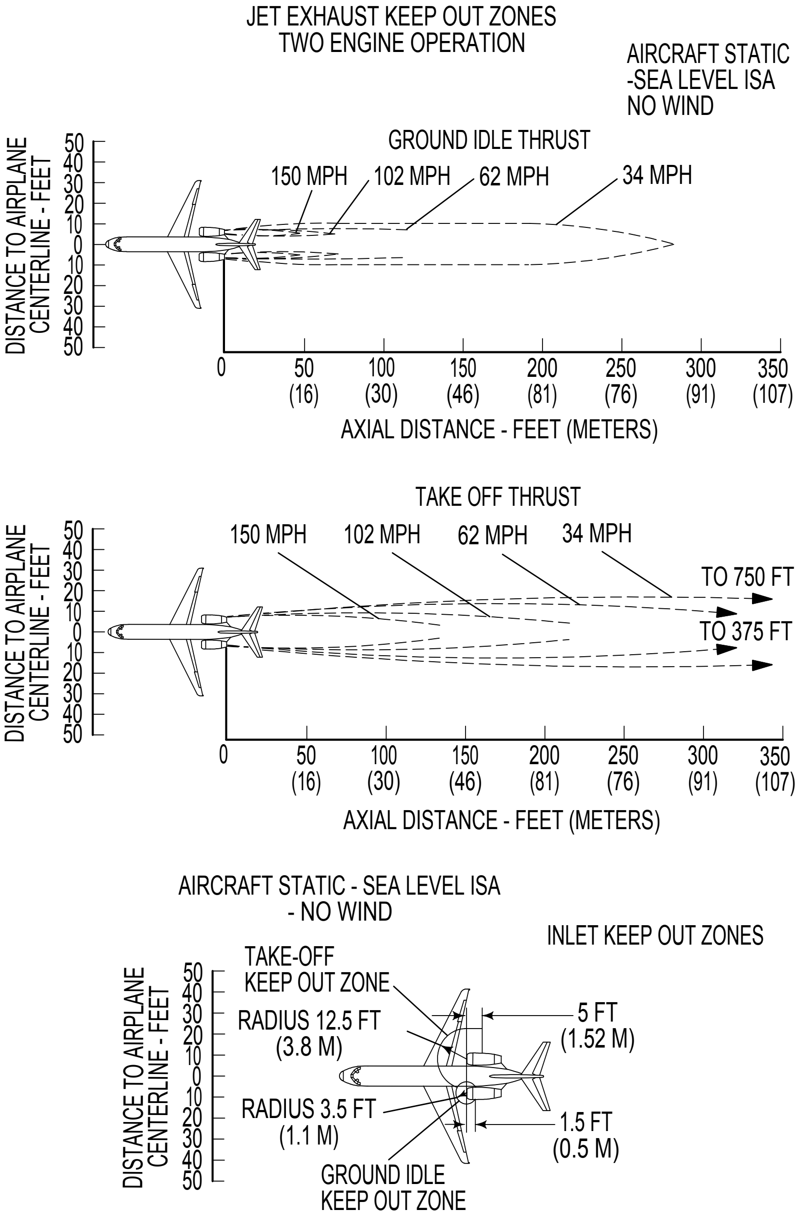
Jet Exhaust And Inlet Keep Out Zones



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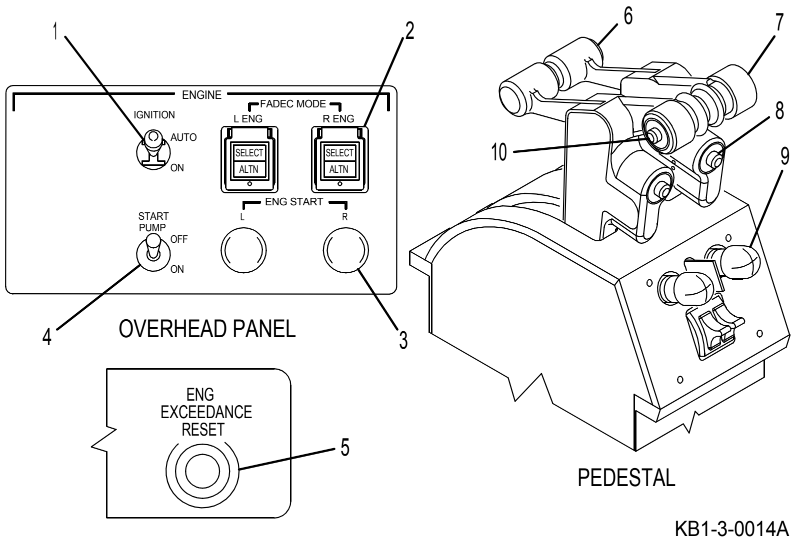
Engine Controls



1. **IGNITION Switch**

   AUTO - Selects an automatic start sequence.

   ON - Selects a manual ground start sequence and provides continuous power to the igniters.

   In flight, AUTO or ON positions both provide power to both igniters during starting.

2. **FADEC MODE Switches (L/R)**

   Push - Alternate backup mode comes on. Initially switch illuminates amber to indicate that the respective FADEC cannot measure or control EPR. Crew can then push this switch to select the alternate backup mode. SELECT extinguishes and ALTN remains illuminated.

3. **ENG START Switch (L/R)**

   Pull - Engine begins cranking. Switch illuminates amber.

4. **START PUMP Switch**

   ON - Turns start pump on with 28 volt DC power.

OFF - Turns start pump off.

5. ENG EXCEEDANCE RESET Switch

When depressed, resets exceedance, if any, on the EPR, N1, TGT, and N2 primary engine synoptic displays.

6. Thrust Reverser Levers (L/R)

Pull aft - Thrust reversers deploy.

The throttle lever must be at the idle stop to lift the reverse levers into the reverse range. There are no other mechanical interlocks. Reverse thrust has a detent at reverse idle.

There is about a 20 pound per throttle lever load increase at maximum reverse power. If the lever is pulled aft through this 20 pound load increase, the EEC will select emergency reverse power.

7. Throttles (L/R)

Each throttle transmits an electronic throttle position signal to the respective EEC. The EEC then controls engine thrust.

Takeoff thrust in normal (EPR) control mode is marked by a 30 pound throttle lever load increase. This 30 pound load will apply to either throttle lever individually or to both levers if the levers are pushed forward beyond the Takeoff position.

If a throttle lever is pushed forward beyond the takeoff gate, the respective engine EEC will switch to the alternate control mode. In the alternate mode the EEC will not automatically control to EPR limits.

8. Take-Off/Go-Around Switch

These switches are described in the Automatic Flight chapter.

9. FUEL Switches (L/R)

ON - Fuel valve opens and fuel flows to the engine.

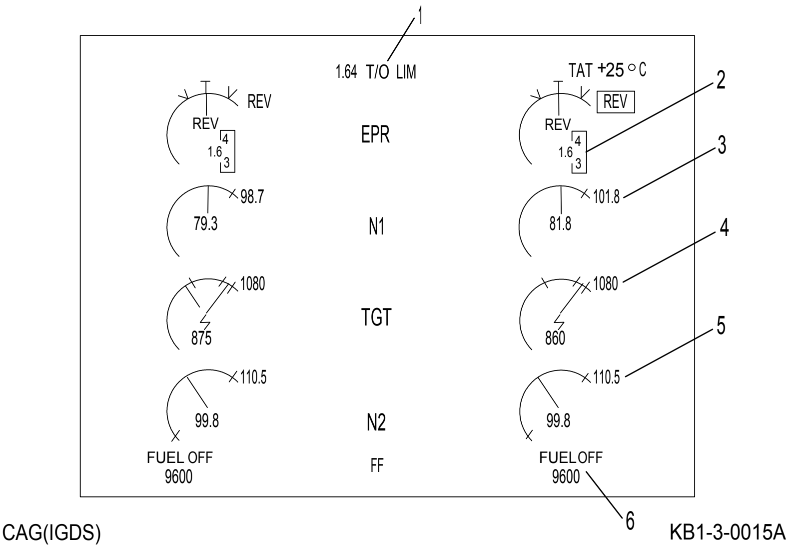
OFF - Fuel valve closes.

In ON position, this switch will illuminate red if a fire is detected or the engine fire handle is pulled. Switch remains illuminated until it is placed in OFF.

10. Autothrottle Engage/Disengage Switch

These switches are described in the Automatic Flight chapter.

EAD - Primary Engine Display



1. **Thrust Rating and TAT**

   FMS limits and modes are magenta. Manually set modes are white. TAT is in degrees C.

2. **EPR**

   Throttle position is a white T riding on the EPR arc. The computed EPR thrust rating is a magenta V riding on the scale. When the throttle is set to the computed thrust rating, the T fits in the V.

   The thrust reverser (REV) is displayed in green in the EPR arc for on ground operation. If emergency reverse thrust is selected, the emergency reverse thrust exceedance reminder will be displayed as an amber REV at the end of EPR arc. This exceedance can be reset with the ENG EXCEEDANCE RESET button on the overhead panel. A red REV will be displayed in the EPR arc if there is an uncommanded thrust reverser deployment in flight.

3. **N1**

   Display is white, but pointer and digits turn red (digits boxed in red) if N1 exceeds the redline limit. Maximum redline exceedance is shown in amber at the high end of the scale. This exceedance can be reset with the ENG EXCEEDANCE RESET button on the overhead panel.

4. TGT

The display is white but the pointer and digits turn amber (digits boxed) if TGT exceeds the amber line for more than 5 minutes. The pointer and digits turn red (digits boxed) if TGT exceeds the redline. A cyan lightning bolt appears over the digits when ignition for that engine is on. An engine start temperature limit is displayed on the arc when the airplane is on the ground and the ENG START switch is on. The start limit is removed when the engine is at idle speed. Maximum redline exceedance, if any, is shown in amber at the high end of the scale. This exceedance can be reset with the ENG EXCEEDANCE RESET switch on the overhead panel.

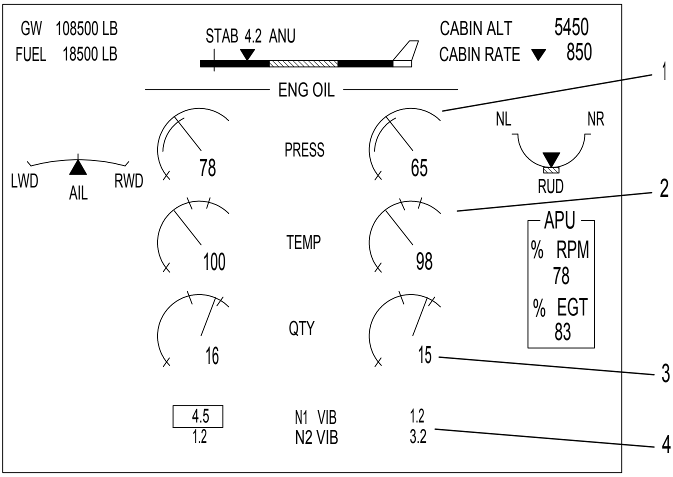
5. N2

The display is white, but the pointer and digits turn red (digits boxed in red) if N2 exceeds the redline limit. During manual start when the IGNITION switch is ON, a cyan line appears to indicate the minimum N2 at which fuel should be turned on. Maximum redline exceedance will be shown in amber at the high end of the scale and can be reset with the ENG EXCEEDANCE RESET switch on the overhead panel.

6. Fuel Flow

Fuel flow is in white digits. When the engine fuel valve is closed, a cyan FUEL OFF appears in place of the digits.

SD Synoptic - Secondary Engine



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1. **Oil Pressure**

   A green arc shows the valid range. The digits are normally white. If the pointer moves above the green arc or below the amber trigger point, the digits and the pointer turn amber and the digits are boxed in amber. The pointer, digits, and box will turn red when the pointer moves below the redline.

2. **Oil Temperature**

   The white digits and pointer turn amber (digits boxed in amber) if the temperature falls below the low amber line limit. The digits and pointer turn red (digits boxed in red) if the high redline is exceeded or below the low red trigger limit.

3. **Oil Quantity**

   When the engine reaches minimum idle each scale has a cyan line showing initial quantity for consumption reference. The pointer and digits turn amber (digits boxed in amber) if quantity falls below the low oil quantity amberline.

4. **Engine Vibration**

   Digits are shown in white but will turn amber and will be boxed in amber if vibration level exceeds limit.

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NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

ENG L/R BRG OVHT (ENG) - Overheat detected in the aft bearing compartment.

ENG L/R COMP STALL (ENG) - (-909 VIA) Respective engine compressor stall.

ENG L/R OIL PRES LO (ENG) - Respective engine oil pressure is low.

ENG L/R OIL TEMP HI (ENG) - Respective engine oil temperature exceeds red line limit.

ENG L/R RPM HI (ENG) - Respective N1 or N2 has exceeded the red line limit.

ENG L/R RPM LO (ENG) - N2 speed has dropped below idle (less than 55%).

ENG L/R TGT HI (ENG) - Respective engine TGT exceeds red line limit or exceeds amber line limit after 5 minutes.

SELECT FADEC ALTN (ENG) - An engine has reverted to N1 mode.

START VLV L/R OPEN (ENG) - Respective start valve is open when engine is above starter cutout speed (41%).

Amber Alerts (Level 1)

ENG L/R FADEC ALTN (ENG) - Respective FADEC N1 mode has been selected.

ENG L/R FUEL FILTER (ENG) - Respective engine has high differential pressure across fuel filter indicating impending fuel filter clog.

ENG L/R OIL FILTER (ENG) - Respective engine has high differential pressure across oil filter. Oil temperature must be greater than 30°C.

ENG L/R START ABORT (ENG) - Ground only. During engine start, an abnormal condition is detected in the respective engine and autostart sequence is aborted.

ENG L/R SURGE (ENG) - Respective engine compressor surge. With -909 VIA installed, this alert is replaced with new level 2 alert ENG L/R COMP STALL.

ENG L/R SYS FAIL (ENG) - Respective engine has a class 1 fault. No dispatch until fault is fixed.

ENG L/R SYS FAULT (STATUS) - Respective FADEC has detected an internal fault or loss of redundancy.

ENGINE VIB HI (ENG) - Engine vibration level exceeds acceptable limit.

REV L/R DEPLOYED (ENG) - Thrust reverser doors are uncommanded deployed.

REV L/R FAULT (ENG) - Respective thrust reverser fault.

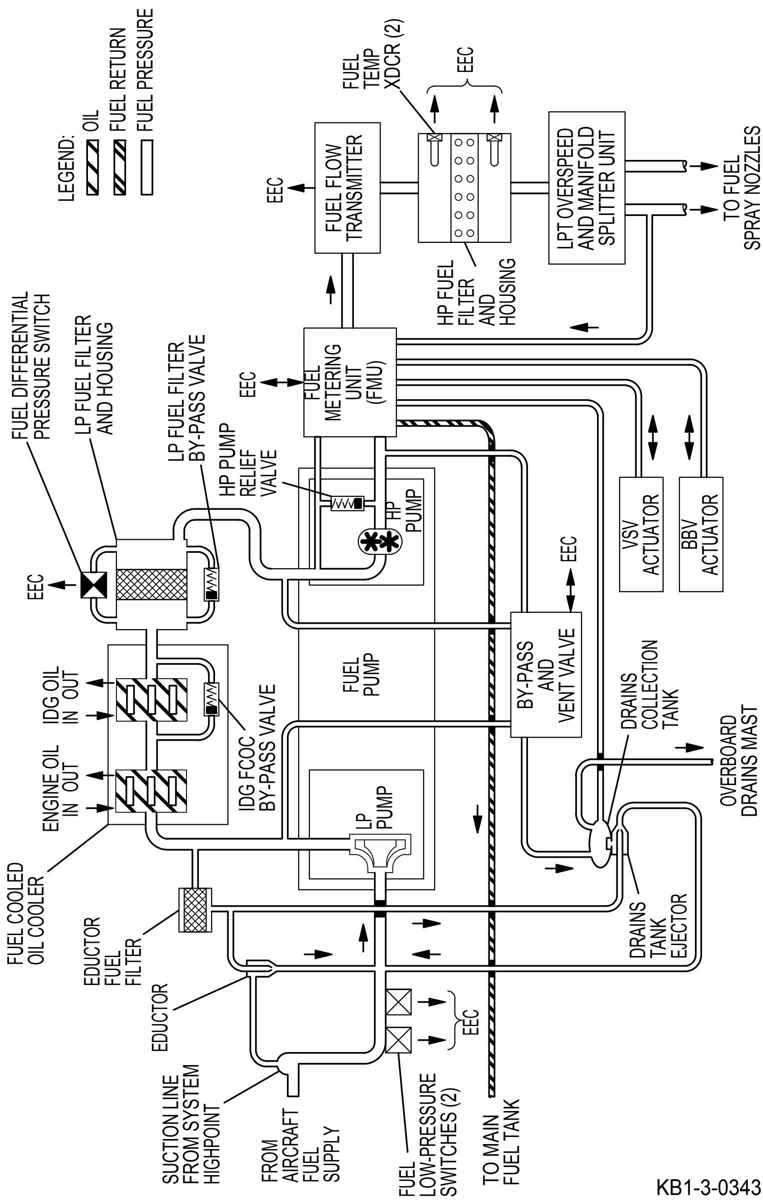
START AIR PRES LO (AIR) - Pressure in the manifold is insufficient for engine start.

Cyan Alerts (Level 0)

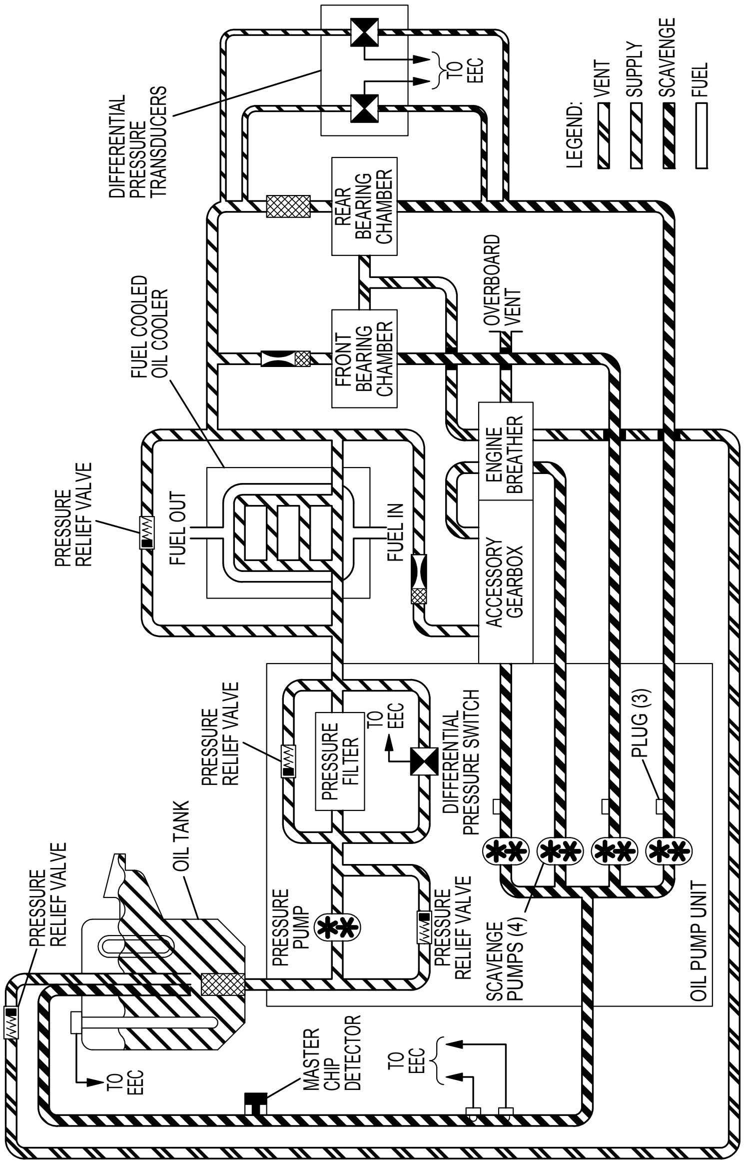
ENG IGN OVRD ON - Engine ignition switch is in ON position.

ENGINE COOL - Engine has cooled sufficiently after landing to be shut down.

Engine Fuel System



Engine Oil System



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Fire Warning & Protection — Chapter Fire

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Fire Warning & Protection — Chapter Fire
Description and Operation — Section 10

General

The fire detection and extinguishing system provides fire warnings and fire extinguishing in the engine nacelles and the Auxiliary Power Unit (APU) compartment, and smoke detection and extinguishing for lavatory and lower cargo compartment.

Fire Detection System

The fire detection system consists of two independent, heat sensitive, detector loops (A and B) located in each engine and the APU. Each loop provides both fire and overheat detection.

In normal operation, with the LOOPS switch at BOTH, false fire warnings are minimized because both loops must be subjected simultaneously to fire or overheat conditions before they will activate the fire warnings. When a fire is detected in one loop but the other loop has not yet detected a fire (STBY condition), the system will indicate a fault by displaying the FIRE DET (APU/L/R) FAIL and the corresponding FIRE __FAULT alert, which will be associated with the loop detecting the overheat condition. If the standby loop subsequently detects an overheat, the fire warning will be activated.

If one loop is confirmed defective (i.e., short circuit or loss of power has been detected), the airplane can still be dispatched, using the single operational loop by moving the applicable LOOPS switch to the operational loop position. In this case, if a fire is detected in this loop, the fire warnings will be activated.

If both loops have a short circuit or lose power, the respective FIRE DET L/R FAIL and FIRE DET APU FAIL alerts will be displayed on the System Display (SD) secondary engine synoptic page.

LOOP A	LOOP B	INDICATION
Fire	Fire	Fire Warning
Fire	Short or loss of power	Fire Warning & FIRE L/R/APU B FAULT
Short or loss of power	Fire	Fire Warning & FIRE L/R/APU A FAULT
Fire	Normal – no fire detection	FIRE DET L/R/APU FAIL & FIRE L/R/APU A FAULT
Normal – no fire detection	Fire	FIRE DET L/R/APU FAIL & FIRE L/R/APU B FAULT
Short or loss of power	Normal – no fire detection	FIRE L/R/APU A FAULT
Normal – no fire detection	Short or loss of power	FIRE L/R/APU B FAULT
Short or loss of power	Short or loss of power	FIRE DET L/R/APU FAIL & FIRE L/R/APU A FAULT & FIRE L/R/APU B FAULT

Each lavatory is equipped with a smoke detector. When smoke in a lavatory is detected, aural and visual warnings will be generated. These warnings will remain until smoke in the lavatory has dissipated.

Engines

If both loops are detecting an engine fire, the warnings are:

* L/R ENG FIRE handle light(s) illuminated.
* FUEL switch light(s) illuminated.
* Aural/vocal warnings sound.
* ENGINE L/R FIRE alert(s) displayed on the EAD.
* MASTER WARNING lights illuminated.

Pulling the associated ENG FIRE handle to fully extended position causes the following:

* Closes fuel and hydraulic shutoff valves.
* Trips engine generator off and silences aural/vocal warnings if the MASTER WARNING light has not been pushed.

The aural/vocal warnings can also be silenced by pushing the MASTER WARNING light. The ENG FIRE handle light(s) will remain illuminated until the fire is extinguished.

APU

If both loops are detecting an APU fire, the warnings are:

* APU automatically shuts down.
* APU FIRE alert displayed on the EAD.
* MASTER WARNING lights illuminated.
* FIRE light on the external APU ground control panel illuminated.
* Aural/vocal warnings and exterior fire warning horn sound.

The aural/vocal warnings shut off automatically after three cycles. Exterior fire warning horn will remain audible until the fire is extinguished.

Lavatories

When smoke is detected, the warnings are:

* MASTER CAUTION lights illuminate.
* Alert appears on EAD.
* Light illuminates red on the ceiling adjacent to the lavatory.
* Flight attendant master CALL lights illuminate red.
* HI-LO chime sounds on PA.

Fire Extinguishing System

The engine and APU fire extinguishing system consists of two fire extinguisher agent containers and AGENT LOW lights.

Each container has separate discharge heads and distribution lines to each engine and APU. The ENG FIRE handles and the APU FIRE AGENT switches, located on the overhead panel, and FIRE AGENT DISCHARGE switches on the APU ground control panel arm and discharge the selected fire extinguishing agent.

The AGENT LOW lights, located on the upper instrument panel and APU ground control panel, illuminate when pressure in container is below minimum, indicating that fire extinguishing agent has been discharged. In addition, FIRE AGENT LO alert will be displayed on the SD secondary engine synoptic page.

The lavatory fire extinguishing system consists of a heat-activated Halon extinguisher located inside the trash container. The system is automatic and self-contained. When the temperature at the extinguisher discharge tube tips is between 170 and 177°F, the fusible tips melt, allowing the extinguishing agent to be discharged into the trash container.

Portable fire extinguishers are provided at strategic locations in the cabin and cockpit. Refer to Emergency Equipment chapter for specific locations.

Cargo Compartment Smoke Detection and Fire Suppression Systems

The cargo compartment smoke detection and fire suppression systems consist of photoelectric smoke detectors, fire extinguishing agent containers, and cockpit controls and displays.

The smoke detection system consists of photoelectric smoke detectors mounted in a recessed pan in the ceiling of the cargo compartment. Two detectors are mounted per pan. Four pairs of detectors are located in the forward cargo compartment and two pairs are in the aft compartment. The system is designed as a dual detection system, but can revert to a single detection system, in either or both cargo compartments, by selection of the appropriate NORM or SINGLE position of the FWD/AFT switches on the CARGO SMOKE DET SYS panel. In NORM position, any two detectors (not necessarily in a single pan) will activate the alarm. In SINGLE position, any one detector will activate the alarm.

The fire suppression system uses chemical discharge to extinguish fires in the cargo compartment. The system consists of two Halon fire extinguishing agent containers connected to both forward and aft cargo compartments. The discharge nozzles are located at each smoke detector pan. The system can suppress a fire and maintain an atmosphere that will prevent reignition of a fire for a period of about 80 minutes.

When smoke or fire is detected in the cargo compartment, the following will occur:

* MASTER WARNING lights will flash and MASTER CAUTION lights will illuminate.
* CARGO SMOKE voice warning will be heard from the Central Aural Warning System (CAWS).
* Appropriate CARGO SMOKE FWD (or AFT) level 3 alert will be displayed on the EAD and on the SD AIR page along with the consequence message LAND AT NEAREST SUITABLE AIRPORT. In addition, the level 1 alert DISCH CARGO AGENT will also be displayed on the EAD and the SD AIR page.
* AIR synoptic page with the smoke detectors in alarm (red triangles) will be displayed on the SD.
* PUSH light on FWD (or AFT) CARGO SMOKE AGENT 1 DISCH switchlight will illuminate flashing (amber). When the appropriate switchlight is pushed to discharge the fire-extinguishing agent from the first bottle, the PUSH light will go steady. In addition, the DISCH CARGO AGENT alert disappears on the EAD and SD AIR page.

* After approximately 1 minute after the first bottle has been discharged, the PUSH light on FWD (or AFT) CARGO SMOKE AGENT 1 DISCH switchlight will extinguish when the LOW light illuminates and the level 1 alert CARGO AGENT 1 LO will be displayed on the SD AIR page.

Six (6) minutes after the first bottle has been discharged, the following will occur:

* Level 1 alert DISCH CARGO AGENT will again be displayed on the EAD and SD AIR page.
* MASTER CAUTION lights will illuminate and can be extinguished by pushing the illuminated AIR cue light on the SCP.
* PUSH light on FWD (or AFT) CARGO SMOKE AGENT 2 DISCH switchlight will illuminate flashing (amber). When the appropriate switchlight is pushed to discharge the fire-extinguishing agent from the second bottle, the PUSH light will go steady. In addition, the DISCH CARGO AGENT alert disappears on the EAD and SD AIR page.
* LOW lights on FWD and AFT CARGO SMOKE AGENT 2 DISCH switchlights and level 1 alert CARGO AGENT 2 LO will illuminate after the second bottle has been depleted after about 2 hours.

Pushing and holding the CARGO SMOKE TEST button on the overhead panel tests system. The following will occur during the test:

* CARGO SMOKE FWD and CARGO SMOKE AFT alerts will be displayed on the EAD.
* The detector symbols (either red triangles or boxed amber F) of AIR synoptic page will be displayed on the SD.
* PUSH lights on all CARGO SMOKE AGENT 1 and 2 DISCH switchlights will illuminate (amber).
* CARGO SMOKE voice warning will be heard.

During the system test in normal mode (FWD or AFT switch at NORM on the CARGO SMOKE DET SYS panel), if any detector is failed, the appropriate CRG SMK FWD (or AFT) FAIL alert will be displayed. The flight crew then should place applicable FWD/AFT switch in the SINGLE position to redo the test. The CRG SMK FWD SGL and/or CRG SMK AFT SGL will be displayed on the SD Status Page whenever the system is in the SINGLE mode.

The CRG SMK TEST PASS level 0 alert on the EAD indicates successful system test.

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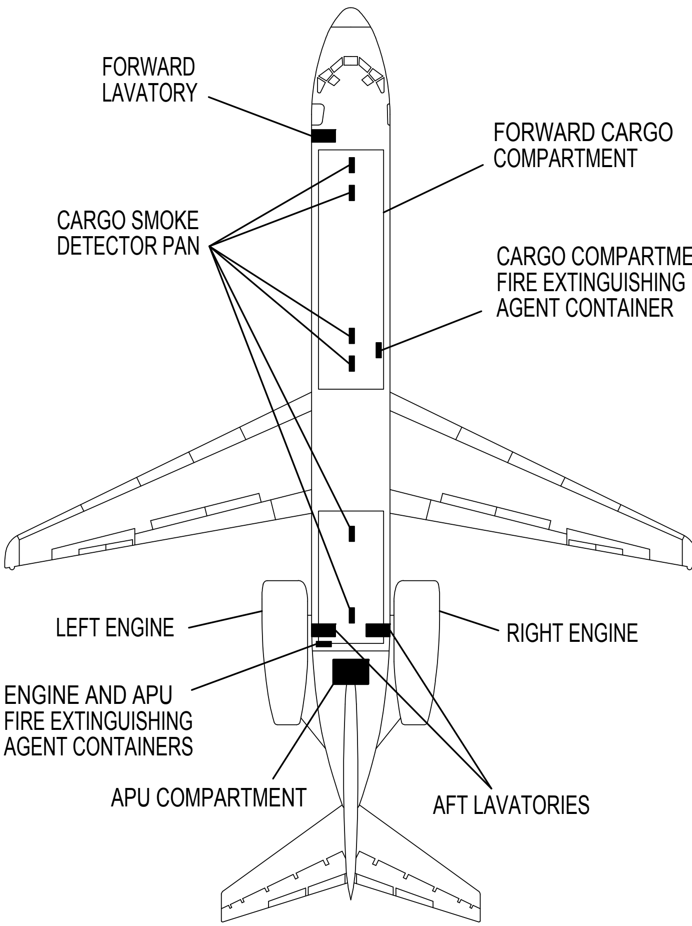
Fire Extinguishing System



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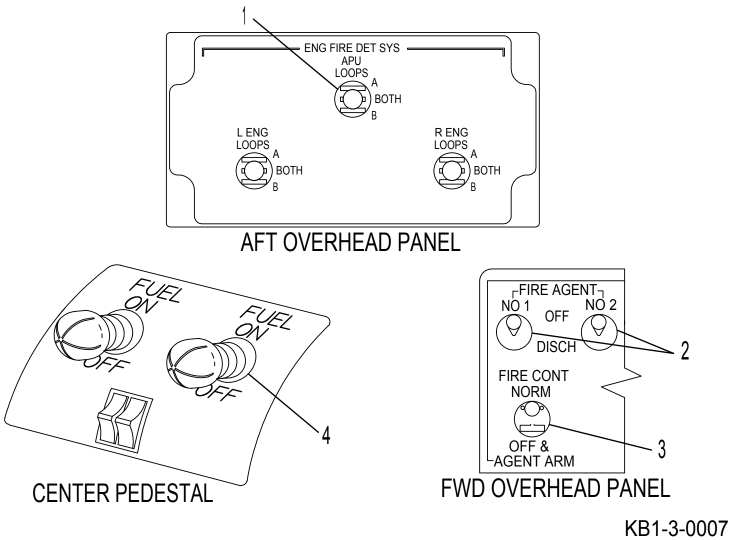
Fire Controls and Indicators



1. **LOOPS Switch (L ENG/R ENG/APU)**

   A/B - Connects engine or APU fire warning system to respective fire detector loop.

   BOTH - Normal position.

2. **APU FIRE AGENT Switch (NO 1/NO 2)**

   OFF - Normal position.

   DISCH - Discharges selected fire extinguishing agent into the APU compartment after the fire extinguishers are armed.

3. **APU FIRE CONT Switch**

   NORM - Normal position.

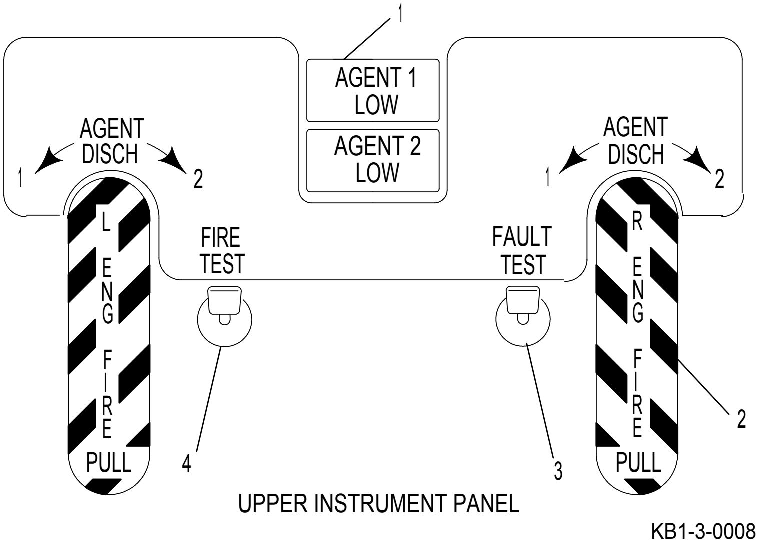
   OFF & AGENT ARM - Immediately shuts down APU and arms the fire extinguishers.

4. **FUEL Switch**

   Illuminated - Associated engine fire is detected or the system fire test is in progress.

   OFF - Extinguishes light.

Engine Fire Extinguishing Controls and Indicators



1. **AGENT LOW Light (1/2)**

   Illuminated - Respective fire extinguishing agent has been discharged (pressure below minimum).

2. **ENG FIRE Handle (L/R)**

   Light Illuminated - Associated engine fire is detected or the system fire test is in progress.

   Pull - (Fully extended position) Shuts off associated engine fuel and hydraulic shutoff valves, trips engine generator off, and silences aural/vocal warnings if the MASTER WARNING light has not been pushed.

   Rotate - (After pulling) Discharges respective fire extinguishing agent into the engine.

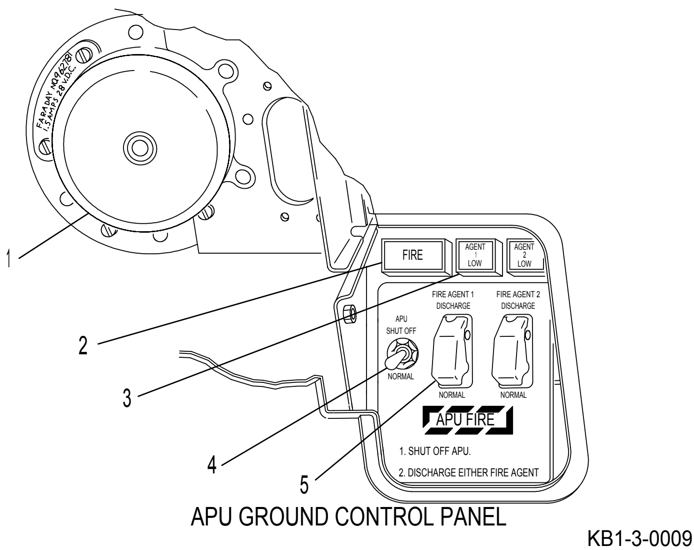
3. **FAULT TEST Switch (Maintenance Test)**

   Tests both A and B loops and components for faults.

4. **FIRE TEST Switch**

   Tests both A and B loops. A successful test is indicated by all fire warnings displayed on the EAD.

APU Fire Extinguishing Controls and Indicators



1. **APU Fire Warning Horn**

   Sounds when APU compartment fire is detected.

2. **APU FIRE Light**

   Illuminated - APU compartment fire is detected.

3. **AGENT LOW Light (1/2)**

   Illuminated - Respective fire extinguishing agent has been discharged.

4. **APU SHUT OFF Switch**

   NORMAL - Normal position.

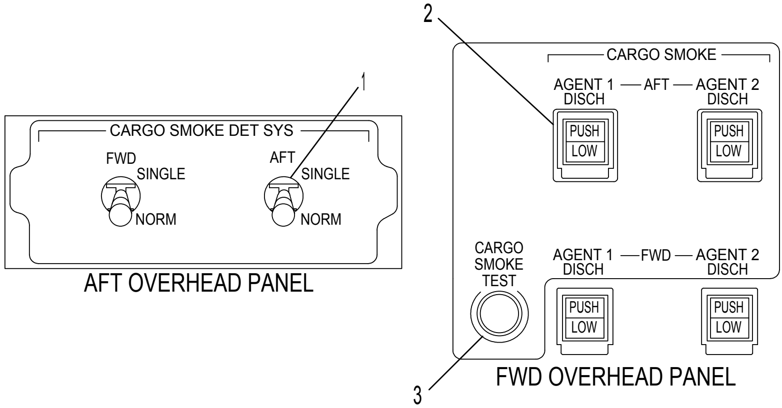
   SHUT OFF - Shuts down APU and arms fire extinguishers.

5. **FIRE AGENT DISCHARGE Switch (1/2)**

   NORMAL - (Guarded) Normal position.

   DISCHARGE - Discharges respective fire extinguishing agent into the APU compartment.

Cargo Smoke Detection and Fire Suppression Controls



1. **CARGO SMOKE FWD/AFT Switch (2)**

   SINGLE - Selects single smoke detection system.

   NORM - Selects normal dual smoke detection system.

2. **AFT/FWD CARGO SMOKE AGENT 1/2 DISCH Switchlight (4)**

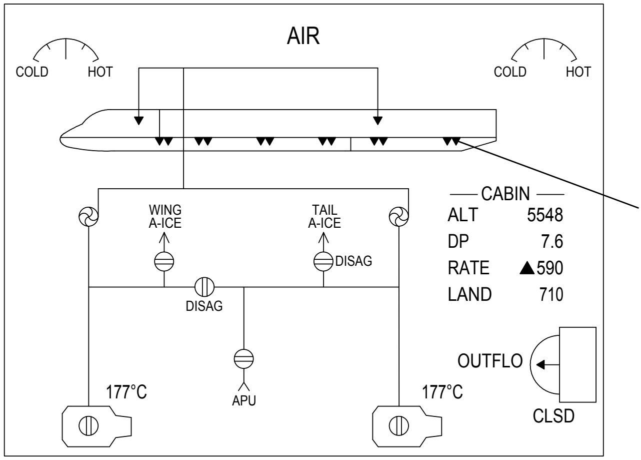
   PUSH light illuminates flashing (amber) to indicate smoke/fire detected in the cargo compartment. Pushing switchlight discharges the fire-extinguishing agent and changes light from flashing to steady. PUSH light will extinguish when the LOW light illuminates.

   LOW light illuminates (amber) after the fire-extinguishing agent has been discharged. PUSH light extinguishes.

3. **CARGO SMOKE TEST Button**

   Push and Hold - Tests system. Alerts are displayed on EAD, smoke detector status are displayed on SD AIR synoptic page, all PUSH lights illuminate, and CARGO SMOKE voice warning sound.

SD Synoptic - Air



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1. **Cargo Smoke Detector**

   No Triangle - Normal.

   Amber Boxed F - Failed detector.

   Red Triangle - Smoke detected.

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NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

APU FIRE (ENG) - APU compartment fire is detected.

CARGO SMOKE FWD/AFT (AIR) - Smoke has been detected in forward/aft cargo compartment.

ENGINE L/R FIRE (ENG) - Engine fire detection system has detected a fire.

Amber Alerts (Level 1)

CARGO AGENT 1/2 LO (AIR) - Respective cargo compartment fire-extinguishing agent has been discharged.

CRG SMK FWD/AFT FAIL (AIR) - Respective forward/aft cargo compartment smoke detector test has failed.

CRG SMK FWD/AFT SGL (AIR) - Respective cargo compartment smoke detection system is operating in single mode.

DISCH CARGO AGENT (AIR) - Indicates AGENT 1 (or 2) DISCH PUSH switchlight is flashing and fire-extinguishing agent should be discharged. Alert will extinguish when flashing switchlight is pushed.

FIRE AGENT 1/2 LO (ENG) - Respective engine fire-extinguishing agent has been discharged.

FIRE APU A/B FAULT (STATUS) - Respective APU detector loop has detected a fault.

FIRE DET APU FAIL (ENG) - Both APU detector loops are inoperative or a fire/overheat is detected in one of two active loops.

FIRE DET L/R FAIL (ENG) - Both detector loops are inoperative in the respective engine or a fire/overheat is detected in one of two active loops.

FIRE L/R A/B FAULT (STATUS) - Respective engine detector loop has detected a fault.

LAVATORY SMOKE (AIR) - Smoke has been detected in a lavatory.

Cyan Alerts (Level 0)

CRG SMK TEST PASS - Smoke detection system test is passed.

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Flight Controls — Chapter Flt
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Flight Controls — Chapter Flt
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General

The flight control system has two primary functions:

* Directional control in the yaw axis,
* Attitude control in the lateral (roll) axis, and in the longitudinal (pitch) axis.

The flight control system incorporates mechanical, cable-controlled systems to accomplish directional, lateral, and longitudinal control. Electronic control is used for spoilers, longitudinal trim, directional trim, and lateral trim. No single control system failure will result in loss of airplane control.

System controls and indicators are on the overhead panel and the pedestal. System alerts are displayed on the Engine and Alert Display (EAD). Control surface positions are displayed on the System Display (SD) CONFIGURATION synoptic.

Component Location

The primary flight controls consist of ailerons on each wing, elevators on the horizontal stabilizer, and rudder on the vertical stabilizer.

The secondary flight controls include leading edge slats, spoilers and speed brakes, trailing edge flaps, and horizontal stabilizer.

Cockpit Controls & Indicators

A flap/slat limit speed placard is located on each side of the instrument panel.

The interconnected control wheels and columns are located adjacent to the pedestal. Each control wheel provides lateral or roll control and each control column provides longitudinal or pitch control.

The control wheel primary trim switches are located on the outboard side of both control wheels. They provide longitudinal or horizontal stabilizer trim.

The rudder pedals are located forward of the control wheel column. They provide directional or yaw control. Each set of pedals is individually adjustable.

Additional controls, located on the center pedestal, are the following:

1. SPD BRK lever,
2. ALT LONG TRIM switches,
3. FLAP/SLAT control handle,
4. FLAP T.O. SEL thumbwheel control and position indicator window,
5. STABILIZER TRIM switch.

The RUDDER TRIM controls and the AILERON TRIM controls are located on the aft pedestal. Flight control information is displayed on the CONFIGURATION synoptic display. The display portrays the airplane as viewed from the rear.

Rudder

The rudder assembly consists of the rudder and the rudder control tab.

There are two modes of rudder operation, powered and manual. Normally, the rudder is powered hydraulically by the right hydraulic system.

If manual mode is selected or if right hydraulic pressure is too low, the rudder control tab unlocks. In manual mode, the rudder pedals move the control tab on the rudder, and aerodynamic forces on the control tab move the rudder.

The HYD CONT RUDDER switch allows selection of manual rudder operation. When the switch is pushed, OFF illuminates, hydraulic power to the rudder is shut off, and the rudder reverts to manual operation. The RUDDER PWR OFF alert is displayed on the EAD.

The rudder is trimmed with the RUDDER TRIM knob by rotating and holding the knob momentarily to NOSE L or NOSE R. When the RDR CTR button is pushed, rudder trim is automatically centered to zero. Rudder trim information is displayed on the CONFIGURATION synoptic.

The rudder pedals are adjusted by pulling out on the individual rudder pedal adjustment knobs and positioning the pedals as desired.

A primary rudder limiter protects the empennage from excessive loads by progressively restricting rudder travel as airspeed increases. It is a mechanical system operated by ram air pressure from a pitot tube on the leading edge of the vertical stabilizer.

A second rudder restricting system provides backup rudder limiting to protect the empennage from overload, in the event the primary rudder limiter system fails. The system has two positions, restricted and unrestricted. The actuators of the system are controlled by the flight control computer (FCC), as a function of airspeed. When the airplane reaches a predetermined speed, the limiter engages and restricts rudder movement if the primary rudder throw limiter fails to properly limit rudder movement.

The limiter system uses two actuators. Each actuator is powered by its respective hydraulic system. If one hydraulic system fails, one actuator is capable of maintaining normal limiter operation. If both hydraulic systems fail, the return springs automatically disengage the backup limiter.

Rudder movement is displayed on the synoptic as a box in proportion to the amount of rudder deflection.

Ailerons

The ailerons are aerodynamically positioned by control tabs connected to the control wheels. An aileron bus cable assembly synchronizes aileron movement. The control wheels are spring-loaded to neutral.

The control wheels are linked together by a torque tube and an override mechanism. In the event that one control tab cable system or control wheel becomes jammed, roll control is still possible with the other tab by overriding the jammed component. The bus cable system positions both ailerons correctly.

The ailerons are positioned by aerodynamic forces on the control tabs. For greater roll control, with more than 5 degrees of control wheel input, the flight spoilers extend a proportionate amount on the downward moving wing.

The ailerons are trimmed by a trim tab outboard of the control tab on each aileron. The AILERON TRIM switches, located on the pedestal, operate the trim tabs for LEFT WING DOWN/RIGHT WING DOWN control. Aileron trim information is displayed on the CONFIGURATION synoptic.

Elevators

The elevators are aerodynamically positioned by control tabs, which are mechanically connected to the control columns. A variable load feel mechanism simulates aerodynamic forces and returns the control columns to an artificial center position when the columns are released.

An override mechanism is installed on the torque tube connecting the two control columns. It is designed to allow each column to operate independently, in the pitch axis, should either side jam. A substantial amount of force, about 130 pounds (59 kilograms), must be applied to the operable, or free column, for the mechanical disconnect to occur. A single audible “bang” sound may be heard from the base of the Captain’s control column, below the cockpit floor, as the mechanical disconnect occurs. Once the columns are disconnected, they will remain disconnected until maintenance re-connects them.

The elevator control system is also connected with a clapper (spring mechanism) located at the control sectors between the elevators. When the control columns are disconnected and no jam is present in the elevator control system, the clapper will cause both columns and both elevators to move together. Should a jam be present in either elevator control path, the clapper will also allow one elevator to move independently from the other if one side of the system is jammed.

The elevators, when deflected, are displayed as a box on the synoptic, in proportion to the amount of deflection.

Each elevator has two tabs, a control tab and a geared tab. The control column operates the control tabs, which then aerodynamically position the elevators. As each elevator moves, the geared tabs are deflected, providing aerodynamic assistance in moving the elevators.

A standby cable loop system automatically activates to provide elevator control in the event that the right elevator cables are severed due to an uncontained engine failure.

An index cable for the standby system runs adjacent to the right side primary elevator cable. If an uncontained engine failure severs the index cable, the lack of tension on the index cable causes the standby cable loop system to engage.

The standby cable loop system provides elevator control using a different pathway to the elevator control tabs. Reduced pitch response and increased column forces may be expected due to the increased friction and freeplay of the system.

The elevator has two hydraulic boost cylinders that augment elevator control during a deep stall recovery, providing additional nose down capability. The actuators are powered by the left hydraulic system with an accumulator backup in the event system pressure is lost.

When the elevator augmentation system is activated by pushing the control columns full forward, the elevators move to full deflection, trailing edge down. This is displayed on the CONFIGURATION synoptic.

Spoilers

The spoilers have three functions:

1. Roll augmentation,
2. Inflight speed brakes,
3. Decrease lift and increase drag during a rejected takeoff, or during the landing roll.

The spoilers are controlled by the spoiler electronic control unit (SECU) and are hydraulically powered. The left hydraulic system operates the inboard spoiler panels. The right hydraulic system operates the outboard spoiler panels.

The SPD BRK lever, used to control the spoilers, has three positions: RET, armed, and EXT.

The spoilers supplement roll control, in conjunction with the ailerons, when the control wheel is moved approximately 5 degrees beyond the neutral position.

Spoiler position is displayed on the synoptic. When the spoilers are stowed, the spoiler panels are blanked. When the spoilers are partially deployed, a white outline displays the position between stowed and fully deployed. When the spoilers are fully deployed, the panels are green.

The spoilers may be used as speed brakes to increase the rate of descent or to decrease speed by positioning the SPD BRK lever. All four spoilers extend symmetrically. By squeezing the lever and moving it aft, the vernier feature of the lever allows the spoilers to be extended in any setting between fully retracted and fully extended.

When speed brake and roll augmentation are used simultaneously, the spoiler panels deflect in the same direction as the ailerons. When the speed brakes are fully extended, the spoiler panels on the upward moving wing retract in proportion to the amount of control wheel rotation, thus augmenting roll control.

Pulling the SPD BRK lever fully up to the armed detent arms the spoilers. Pushing down on the SPD BRK lever retracts the lever. The red band and ARM placard are visible on both sides of the lever when the spoiler is armed. When armed, the spoilers operate automatically to increase braking during landing, and during a rejected takeoff, by reducing lift and increasing drag. Selecting reverse thrust deploys the spoilers for a rejected takeoff. When landing, main wheel spin-up or a ground shift signal from the nose gear deploys the spoilers.

If a ground spoiler system malfunction occurs with the spoilers armed, the DISARM SPOILERS alert is displayed on the EAD. If the throttles are advanced to high thrust while the speed brakes are extended, the spoilers automatically retract.

Flaps/Slats

Both the flaps and the slats are hydraulically powered. Flaps and slats augment the lift of the wing during slow speed flight, as during the takeoff, approach or landing phases of flight.

A go-around gate is installed at the 18 degree setting. The handle must be released into the detent and then raised again to move the handle forward.

The FLAP/SLAT handle can be moved from 0 degrees to the UP/RET detent to retract flaps and slats by lifting the handle up and moving it forward.

The FLAP T.O. SEL thumbwheel is used to select a detent position when a flap setting other than 13 or 18 degrees is needed. The FLAP T.O. SEL position indicator window displays the position of this movable detent.

Each flap is operated by an inboard and an outboard hydraulic actuator. The outboard actuators are powered by the left hydraulic system and the inboard actuators are powered by the right hydraulic system.

The leading edge slats are high-lift devices. Five individual slat sections on each wing operate as a single unit. The slats are positioned by cables connected to hydraulically powered drums.

The slat drum assemblies each have two hydraulic actuators, one powered by the left hydraulic system and one powered by the right hydraulic system. Either hydraulic system can operate the slats.

The slats are controlled with the FLAP/SLAT handle. There are two slat positions, UP/RET and EXT.

An alert is displayed on the EAD if there is a discrepancy between the left and right wing slats position or between slats position and the FLAP/SLAT control handle setting.

On the CONFIGURATION page of the SD synoptic, flaps position is displayed under each wing in fixed size boxes with an individual digital readout of flaps setting. When flaps are retracted, the boxes are not displayed.

Slats position is displayed on the CONFIGURATION page of the SD synoptic beneath the airplane symbol.

The flap/slat position indication is also displayed on the primary flight display (PFD). When the flaps are in transit, the selected FLAP/SLAT handle position is displayed. The displayed flap position is followed by an up or down arrow indicating the direction of flap movement during transit. The arrow is not displayed when the flaps reach the commanded position.

When the slats are selected and in transit, the message SLATS is followed by an up or down arrow indicating direction of slat movement during transit. The message and the accompanying arrow are not displayed when the slats reach the commanded position.

Horizontal Stabilizer Trim

Horizontal stabilizer trim is controlled by either the primary trim switches, the alternate trim switches, or by the autopilot. The primary trim switches are on the control wheel. The alternate trim switches (ALT LONG TRIM) are on the pedestal.

Two switches, moved simultaneously, operate stabilizer trim. One switch operates the trim motor and the other releases the brake.

When both primary trim switches on either control wheel are moved simultaneously, the primary trim brake is released and the primary trim motor drives the stabilizer in the commanded direction.

A warning horn, inhibited on the ground, sounds to alert the crew any time the stabilizer moves more than one degree, and continues to sound once for each approximately one degree of stabilizer movement. The “stabilizer motion” voice warning also sounds. Separate movement of either switch does not produce stabilizer movement.

When both ALT LONG TRIM switches on the pedestal are moved simultaneously, the alternate trim motor moves the stabilizer in the commanded direction at a rate slower than the primary trim motor. When in the spring-loaded OFF position, no power is applied. When moved to the NOSE DN or NOSE UP position, nose down or nose up control pressure is reduced. Separate movement of either switch does not produce stabilizer movement.

The autopilot trims the airplane using the alternate trim system.

The STABILIZER TRIM switch is a guarded switch and has two positions: OFF and normal. When the switch is pushed, the OFF light illuminates and electrical power to the brake is removed. This sets the brake and prevents the primary trim motor from moving the stabilizer. When the switch is in the normal position and the OFF light is extinguished, the primary stabilizer trim is enabled.

Stabilizer position is displayed at the top of the SD synoptic secondary engine page as follows:

1. Horizontal bar displays the stabilizer range,
2. Position bug displays stabilizer relative position,
3. Digital readout displays the exact stabilizer position,
4. ANU for airplane nose up, and AND for airplane nose down, indicates the respective condition,
5. Zero line indicates the division between ANU and AND.

The stabilizer position indicator is also displayed at the top of the CONFIGURATION page of the SD synoptic, above the airplane symbol.

Takeoff Warnings

Takeoff warnings are activated if takeoff is attempted with improper control positions or configurations.

Once activated, aural and vocal warnings sound until the improper condition no longer exists.

Stall Warnings

Stall warnings alert the pilots of an approach-to-stall condition. Stick shakers activate. Following stick shaker activation, flashing red STALL annunciations appear on the Captain’s and First Officer’s PFD, an aural warning (klaxon) sounds, and a vocal warning (“stall”) is activated.

The stall warnings are generated by angle-of-attack, horizontal stabilizer position, and flap/slat position inputs to the Flight Control Computers (FCCs).

A caution alert is displayed on the EAD to indicate a system failure.

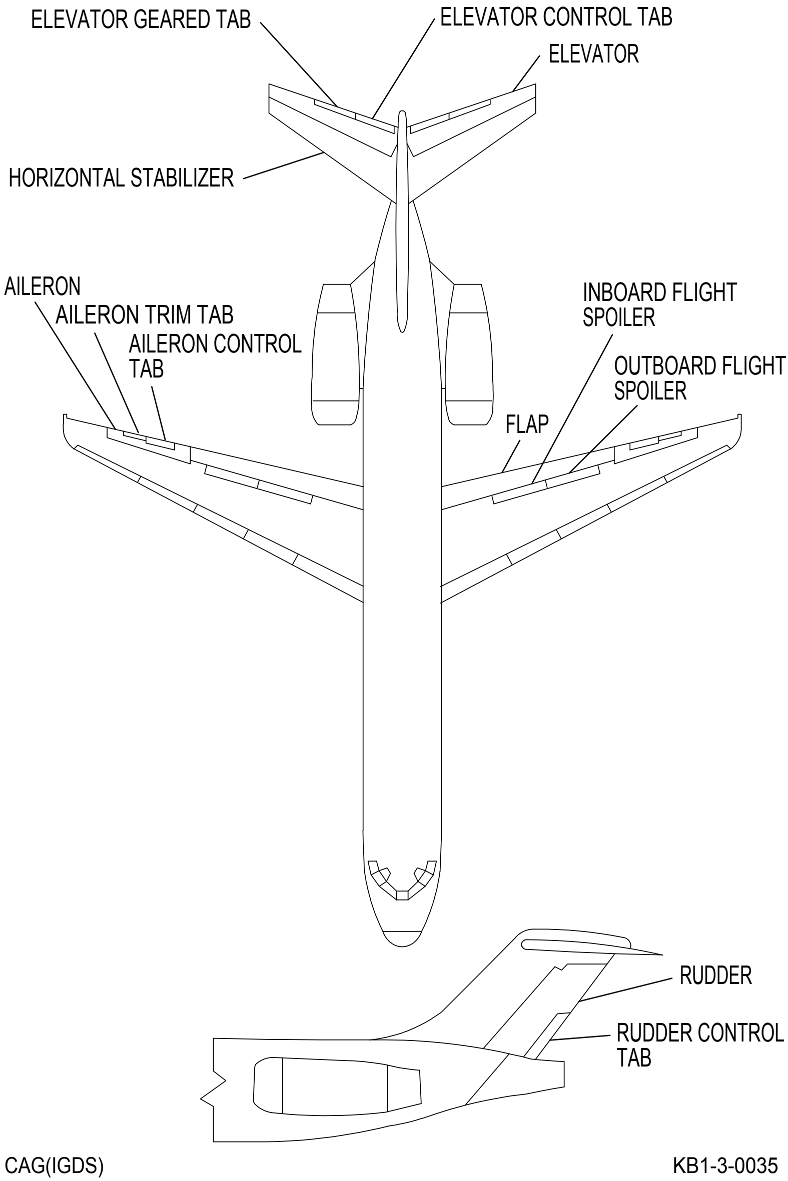
Stick Pusher

During detection of an imminent stall condition, the glareshield STICK PUSHER PUSH TO INHIBIT switchlights illuminate and the autopilot, if in use, disconnects. Abrupt forward movement of both control columns occurs, followed by stick shaker deactivation.

Forward pressure on the control columns continues until either the angle-of-attack is reduced below stick shaker onset, the gravity force is sufficiently reduced, or a STICK PUSHER PUSH TO INHIBIT switchlight is pushed. The flight crew has the ability to override the stick pusher system by pushing either switchlight.

The stick pusher system is inhibited any time a decreasing performance windshear is detected by either windshear computer.

Major Component Location



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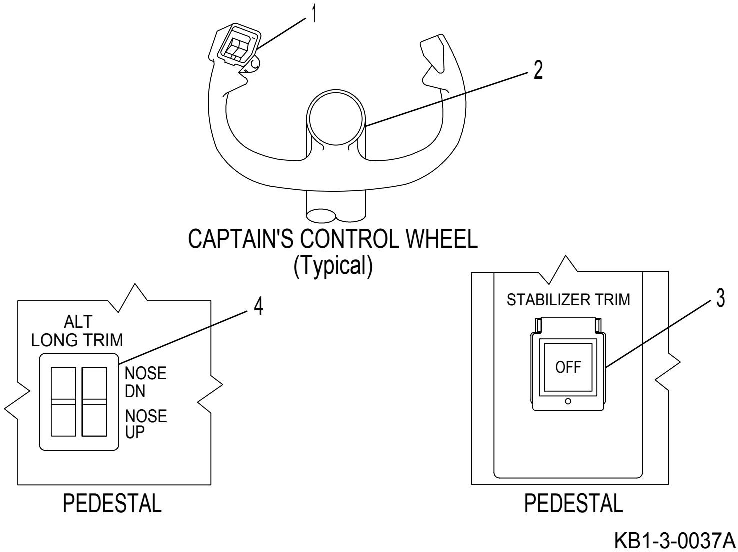
Control Column/Horizontal Stabilizer Trim Switches



1. **Control Column Elevator Primary Trim Switches**

   Move - (Forward simultaneously) Reduces nose down control pressure.

   Move - (Aft simultaneously) Reduces nose up control pressure.

2. **Control Column**

   Move - (Forward) Positions elevator control tab to decrease airplane pitch attitude.

   Move - (Aft) Positions elevator control tab to increase airplane pitch attitude.

3. **STABILIZER TRIM Brake Switch - amber**

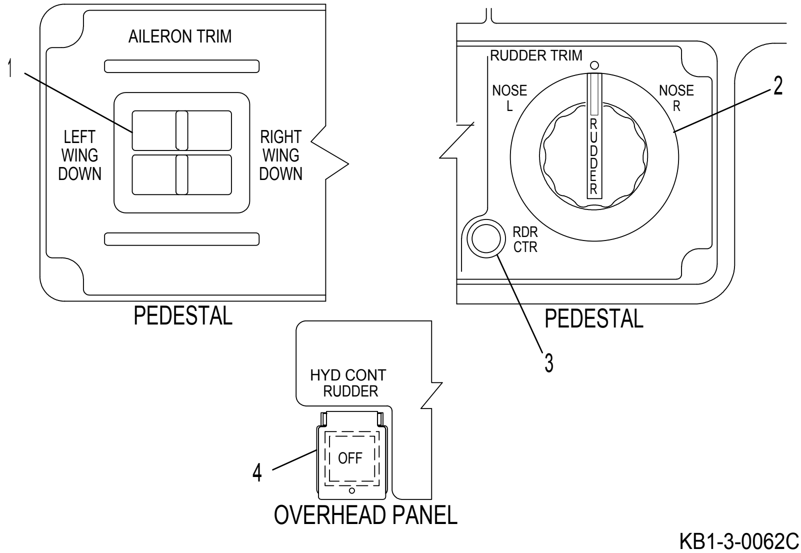
   Push - Stops horizontal stabilizer movement. OFF illuminates.

4. **ALT LONG TRIM Switches**

   NOSE DN - Move simultaneously to reduce nose down control pressure.

   NOSE UP - Move simultaneously to reduce nose up control pressure.

Aileron And Rudder Trim, Rudder Switches



1. **AILERON TRIM Switches**

   NOTE: Both switches should be moved simultaneously and in the same direction.

   LEFT WING DOWN - Slide to reduce left aileron pressure.

   RIGHT WING DOWN - Slide to reduce right aileron pressure.

2. **RUDDER TRIM Knob**

   NOSE L - Rotate to reduce left rudder pressure.

   NOSE R - Rotate to reduce right rudder pressure.

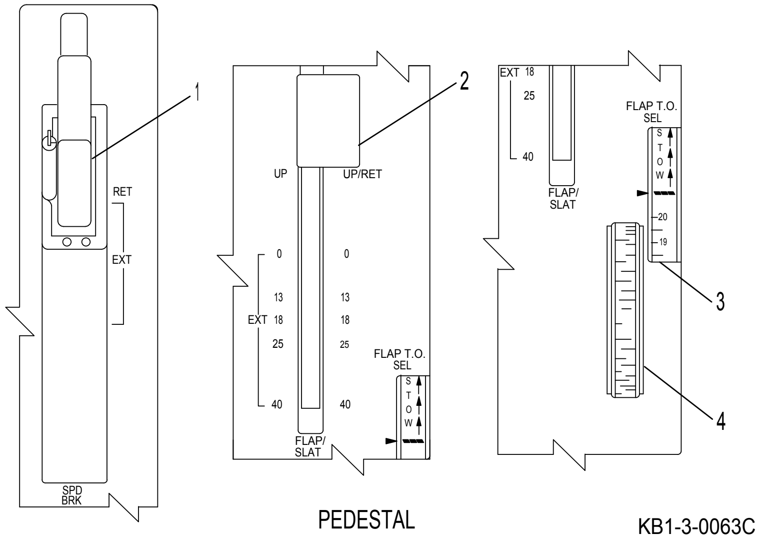
3. **RDR CTR Switch**

   Push - Automatically resets rudder trim to zero.

4. **HYD CONT RUDDER Switch - amber**

   Push - Selects manual rudder control. OFF illuminates.

Speed Brake Lever, Flap/Slat Controls



1. **SPD BRK Lever**

   RET - Retracts speed brakes.

   EXT - Extends speed brakes in flight (with 0 degrees flaps), or after landing.

   (Armed) - Extends ground spoilers at touchdown.

2. **FLAP/SLAT Control Handle**

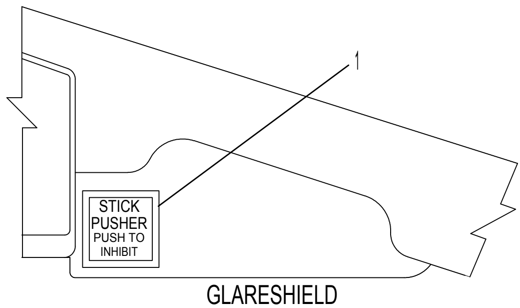
   UP/RET - Retracts flaps and slats.

3. **FLAP T.O. SEL Position Indicator Window**

4. **FLAP T.O. SEL Thumbwheel**

   Rotate - Sets an adjustable detent which works in conjunction with the FLAP/SLAT control handle in setting flap position for optimum takeoff or landing performance.

Stick Pusher Inhibit Switchlight

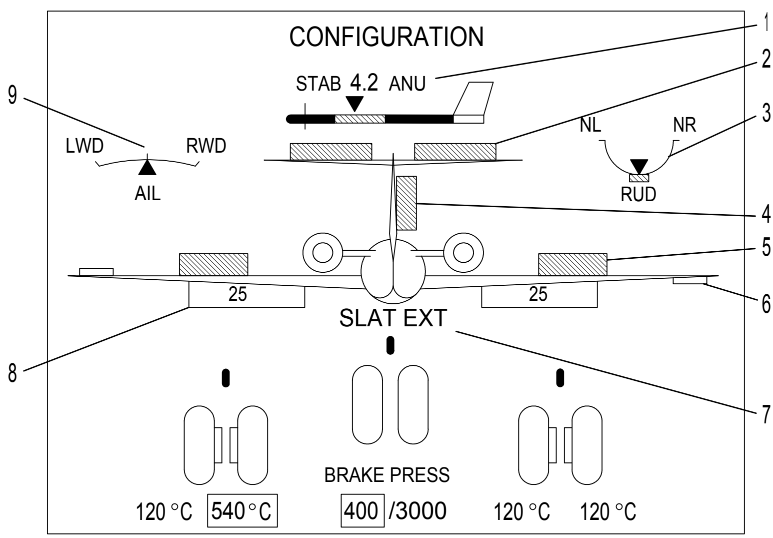


1. **STICK PUSHER PUSH TO INHIBIT Switchlight- amber**

   The switchlight illuminates while the stick pusher system is active.

   Push - Disengages automatic stick pusher system.

SD Synoptic - CONFIGURATION



1. **Stabilizer Position**

   White - Stabilizer improperly set.

   Green - Stabilizer properly set.

2. Elevator Position

Blank - Neutral.

White Outline - Between neutral and fully deflected.

Green - Fully deflected.

3. Rudder Trim

NL - Nose left trim added.

NR - Nose right trim added.

4. Rudder Position

Blank - Neutral.

White Outline - Between neutral and fully deflected.

Green - Fully deflected.

5. Spoilers

Blank - Stowed.

White Outline - Between stowed and fully deployed.

Green - Fully deployed.

6. Ailerons Position

Blank - Neutral.

White Outline - Between neutral and fully deflected.

Green - Fully deflected.

7. Slats

White - Proper position.

Amber - Improper position.

8. Flaps Position

Blank - Retracted.

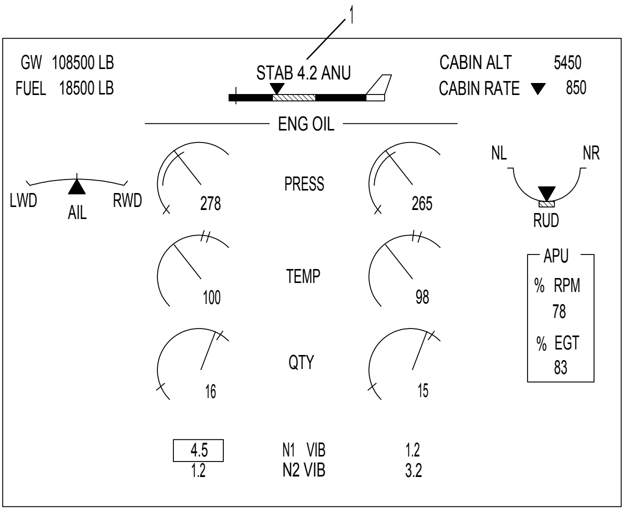
White Outline - Deployed. Flap degree numerical depiction.

9. Aileron Trim

LWD - Left wing down trim added.

RWD - Right wing down trim added.

SD Synoptic - Secondary Engine



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1. Horizontal Stabilizer Position Indication

* Stabilizer Range - Horizontal bar.
* Stabilizer Relative Position - Position bug.
* Stabilizer Exact Position - Digital readout.
* Stabilizer Condition - ANU (airplane nose up) or AND (airplane nose down).
* ANU/AND Division Line - Zero line.

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

ELEVATOR SPLIT (CONFIG) - A split between left and right elevator panels exists, possibly indicating a jammed condition.

FLAP DISAG (CONFIG) - Left and right flap positions disagree with each other or with commanded position.

RUDDER LIM FAIL (CONFIG) - Both primary and secondary rudder limiters failed to unrestricted position.

SLAT DISAG (CONFIG) - Left and right slat positions disagree with each other or with commanded position.

Amber Alerts (Level 1)

AGS FAIL - The Auto Ground Spoiler (AGS) system detects a failure which may cause the AGS to not deploy.

AIL TRIM FAIL (STATUS) - The aileron trim system has failed.

AUTO TRIM FAIL (CONFIG) - The FCC is unable to trim the stabilizer.

COLUMN DISC (CONFIG) - The control columns are disconnected from each other.

DISARM SPOILERS (CONFIG) - The Auto Ground Spoiler (AGS) system has detected a failure which may cause the AGS to not deploy.

PSEU FAIL (CONFIG) - The proximity sensor system has failed, resulting in loss of gear, door, and slat position information.

PSEU FAULT (STATUS) - The proximity sensor system has logged an internal fault, or detected a failure of a redundant sensor.

RUDDER LIM FAULT (CONFIG) - Either the primary or secondary rudder limiter system has failed to the rudder unrestricted position.

RUDDER PWR OFF (CONFIG) - The rudder is in manual mode either due to hydraulic failure, or pilot selection.

RUDDER RESTRICTED (CONFIG) - The rudder is restricted more than it should be for the flight condition.

SECU FAULT (STATUS) - A spoiler system fault is detected by the Spoiler Electronic Control Unit (SECU).

SPEEDBRAKE DISAG (CONFIG) - The speed brakes are extended with throttles set at high power.

SPEEDBRAKE/FLAP (CONFIG) - The speed brakes are extended with the flaps in the landing range.

SPOILER FAULT (CONFIG) - The spoiler system detects a fault.

SPOILER INBD/OTBD FAIL (CONFIG) - The respective spoiler system has shut down in response to a detected failure or SECU channel failure.

STAB OUT OF TRIM (CONFIG) - The stabilizer is not responding to autopilot trim commands.

STAB TRIM OFF (CONFIG) - The STABILIZER TRIM shutoff switch is selected to OFF.

STALL WARN FAIL (MISC) - The stall warning system has failed.

STALL WARN FAULT (STATUS) - The stall warning system has lost two channels of stall warning and/or one channel of stick pusher.

STICK PUSHER FAIL (STATUS) - The stick pusher system has failed, or is one failure away from an uncommanded push.

YAW DAMP FAIL (CONFIG) - The yaw damper function has been shut off by the FCC.

Cyan Alerts (Level 0)

SPEEDBRAKE - The speed brakes are extended.

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Description and Operation — Section 10

General

The fuel system consists of fuel tanks, fuel pumps, cockpit fuel controls, quantity indicating, and alerts. Fuel system controls are located on the overhead panel and on the pedestal. Fuel alerts are displayed on the Engine and Alert Display (EAD). Tank quantities and component status are displayed in the fuel synoptic page of Systems Display (SD).

Fuel Tanks

Fuel is stored in three integral wing tanks; a left main, center, and right main. Each fuel tank has an integral reservoir at the outboard end. Flapper valves installed in these reservoirs ensure that a head of fuel is retained at all times to keep boost pumps inlet submerged at all normal flight attitudes and during all normal maneuvers. The left and right tanks each have a capacity of 1,383 U.S. gallons. The center tank has a capacity of 907 U.S. gallons.

A continuous scavenging system prevents water from accumulating in the low points of the tanks. The system operates continuously when a boost pump is operating in the respective tank. The system consists of jet pumps, check valves and scavenge rakes.

Tank Capacity Chart

TANK	GALLONS	POUNDS @6.7 LBS/GAL	LITERS	KILOGRAMS
Left Wing Tank	1,383	9,266	5,235	4,188
Center Wing Tank	907	6,077	3,433	2,746
Right Wing Tank	1,383	9,266	5,235	4,188
TOTALS	3,673	24,609	13,902	11,122

Venting

The fuel vent system permits equalization of pressure between tanks during all fuel conditions. The system also prevents siphoning and spilling of fuel during normal flight and ground maneuvers. Left and right main tanks are vented to the center tank, which in turn is then vented to the wing tip vent boxes. This venting arrangement permits overflow from the main tanks to drain into the center tank during fuel return to tank operation with the main tanks full.

Fuel Return To Tank

Excess warmed fuel cycling through the engine fuel system is returned to the inboard cooled corner of each main tank. This warms the fuel in the tank, which retards wing ice formation due to cooled fuel. Fuel return to tank flow is inhibited by the EEC for many reasons, such as takeoff, landing, main tank fuel low or high fuel temperature.

Refueling/Defueling

A single point refueling station is located at the right wing leading edge. Fill valves located next to the fuel load selector display panel can be operated manually or automatically through the fill pre-select. Access to the cockpit is not required to refuel and refueling can be accomplished using battery power only. If single point refueling equipment is not available, refueling can be accomplished through overwing fill fittings on the top outboard of each wing.

The aircraft can be defueled through a defueling shutoff valve using pressure from the boost pumps.

Fuel can be transferred between tanks by opening the defueling shutoff valve and the associated fill valves along with the three fill valves (one for each tank). The fill valves can be operated manually with a switch or automatically through the fuel fill pre-select.

Engine And APU Fuel Supply

Each main tank has two AC boost pumps. The main tank boost pumps are arranged in parallel. The center tank pumps are arranged in series. Normally, fuel from the left main tank feeds the left engine and fuel from the right main tank feeds the right engine. However, if the center tank contains fuel, its higher pressure output will allow the center to feed both engines. A FUEL X-FEED lever on the pedestal controls a valve which permits use of fuel from either main fuel tank to both or a single operating engine. Cross-feeding is enabled when the valve is opened and the boost pumps on the receiving side are turned off.

Fuel to the APU is normally supplied from the right main tank. However, if the center tank contains fuel and its pumps are on, the center will supply the APU. A DC start pump located in the right main tank provides fuel pressure when starting the APU or engines when AC power is not available.

NOTE: Fuel usage for ground operation of the APU is 350 lbs. (159kg)/hr.

The fuel supply to the engine will shutoff when the respective FIRE handle in the cockpit is pulled.

Fuel Quantity Indicating

Tank quantities, total quantity, and gross weight are displayed on the fuel synoptic page of the SD. The gross weight is displayed when the zero fuel weight is entered into the MCDU.

A fuel load selector display panel, in the leading edge of the right wing, also displays fuel quantity and load selection.

In the event of a Fuel Quantity Gauging System (FQGS) failure, fuel quantity may be determined while on the ground using magnetic dripless sticks installed at the bottom of each tank.

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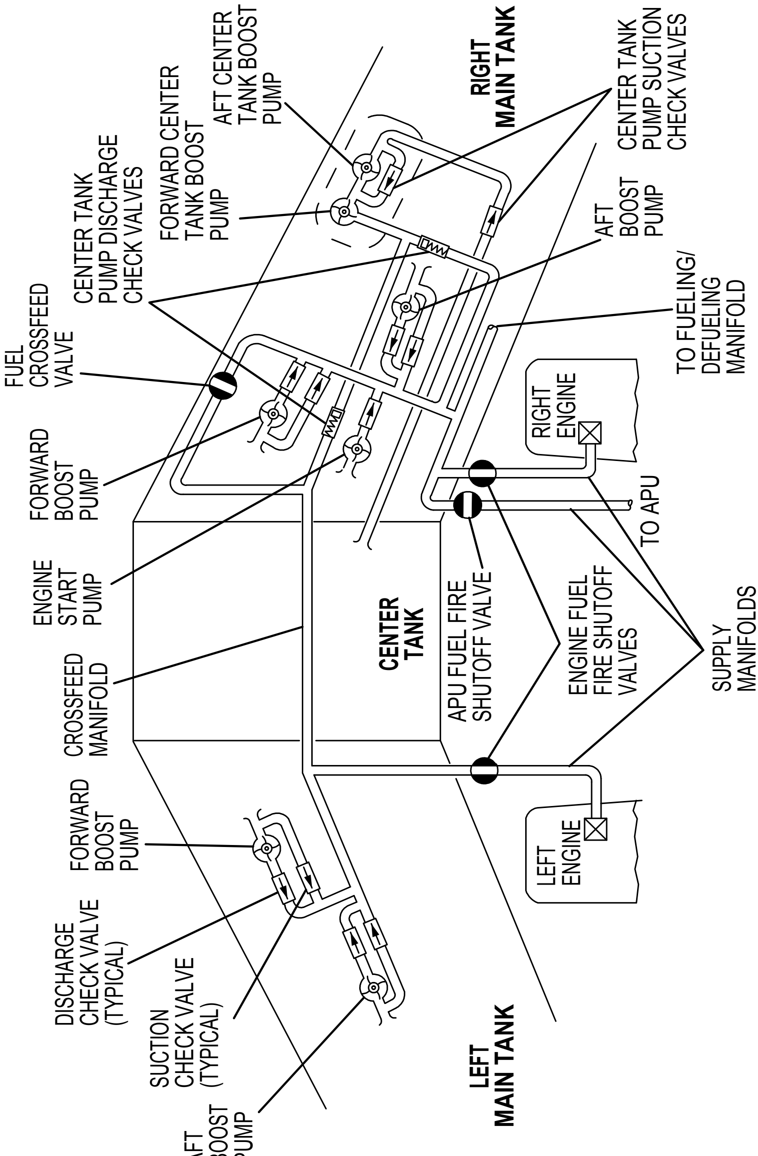
Pump and Valve Components



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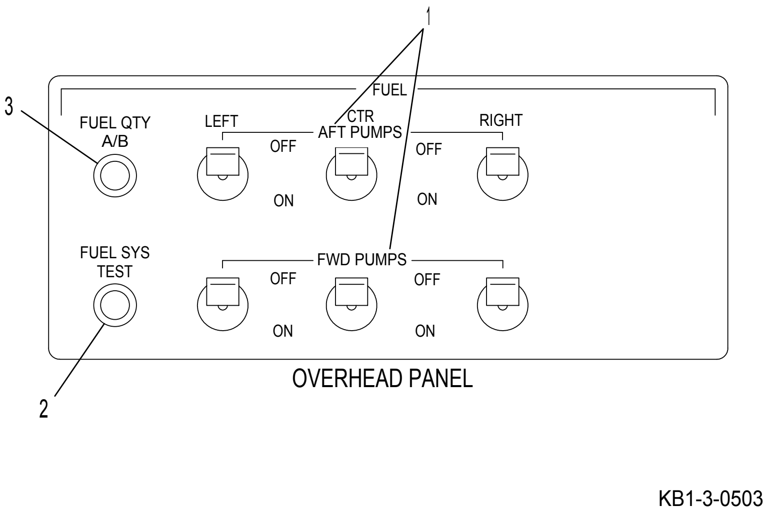
Fuel Control Panel



1. **AFT/FWD PUMPS Switches (LEFT/CTR/RIGHT)**

   ON - Turns respective tank boost pump on.

   OFF - Turns respective tank boost pump off.

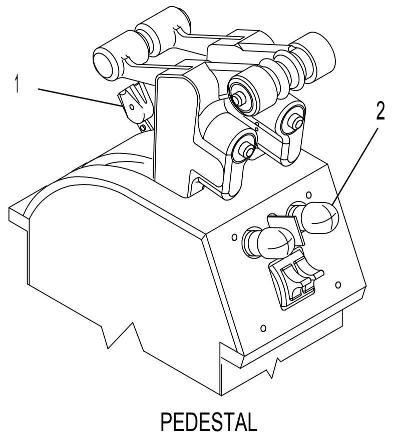
2. **FUEL SYS TEST Button**

   Push - When pushed and held for 2 seconds, starts a fuel system test display on the SD fuel page. System will remain in test for 45 seconds.

3. **FUEL QTY A/B Button**

   Push - Selects the alternate channel of the fuel quantity gaging system.

Fuel X-feed Lever And Fuel Switch



1. FUEL X-FEED Lever

OFF - Closes fuel crossfeed valve. Left main tank feeds left engine and right main tank feeds right engine.

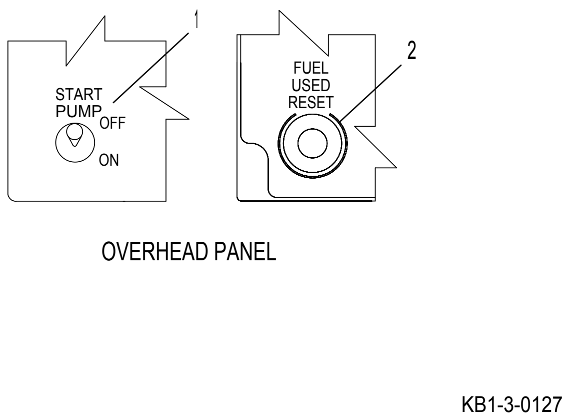
ON - Opens fuel crossfeed valve. Either or both main tanks can feed both engines or APU.

2. FUEL Switch

OFF - Shuts off fuel to respective engine, then turns off ignition.

ON - Commands EEC to energize ignition and open FMU high pressure shutoff valve when start requirements are satisfied.

Start Pump Switch And Fuel Used Reset Button



1. **START PUMP Switch**

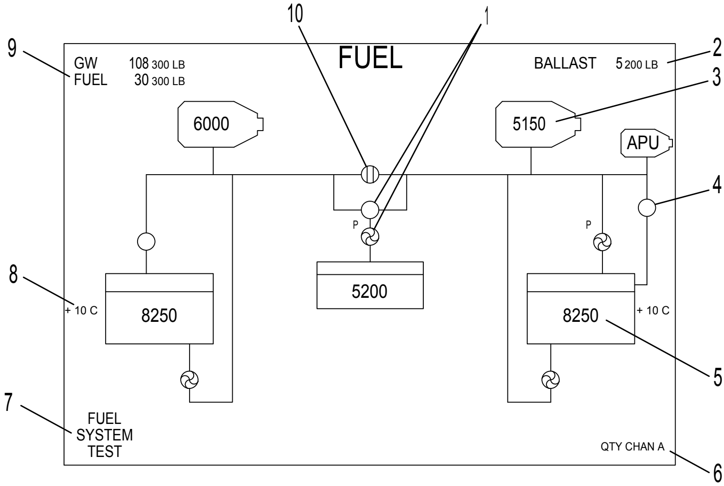
   ON - Turns start pump on.

   OFF - Turns start pump off.

2. **FUEL USED RESET Button**

   Push - Resets fuel used digits on the fuel synoptic.

SD Synoptic - Fuel



KB1-3-0028A

1. **Fuel Pumps**

   White - Pumps are commanded off.

   Green - Pump is in on and is operating normally.

   Amber - Pump is commanded on but has low pressure. P appears.

2. **Ballast Fuel**

   Blank - Ballast fuel entered in MCDU is 0.

   Cyan - MCDU entered value is more than 0.

   Amber - FMS ballast fuel has changed after takeoff.

3. **Fuel Used**

   White - Fuel used per engine. Can be reset to 0 by pushing the FUEL USED RESET button on the overhead panel.

4. **Fuel Start Pump**

   Blank - Pump is off.

   Green - Pump is commanded on.

5. **Fuel Quantity**

   White - Total fuel quantity per tank. Includes ballast fuel.

6. **Fuel Quantity Channel Indicator**

   Indicates the currently active fuel quantity channel.

7. **Fuel System Test**

   Indicates that a fuel system test is in progress. Fuel quantity displays will show test value and ENG L/R FUEL PRESS alerts will be displayed if engine fuel pressure is low.

8. **Fuel Temperature**

   White - Fuel temperature in degrees C.

9. **Total Fuel Weight**

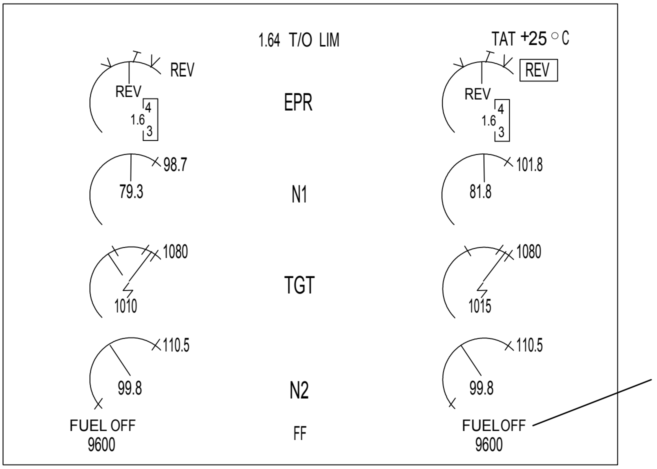
   White - Total usable fuel (total weight minus ballast fuel weight). Measurement is displayed in pounds.

10. **Fuel Crossfeed Valve**

    White - Fuel crossfeed is off (valve closed).

    Green - Fuel crossfeed is on (valve open).

EAD - Primary Engine Display



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1. **Fuel Flow**

   Fuel flow is in white digits. When the engine fuel valve is closed, a cyan FUEL OFF appears above the digits.

   NOTE: Once the center tank is depleted and center tank fuel pumps are turned off, up to 200 pounds per hour of fuel may migrate under normal conditions.

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

BALST FUEL DISAG (FUEL) - Verify correct quantity of ballast fuel is loaded or revise FMS ballast fuel entry, if required.

CTR FWD/AFT PUMP LO (FUEL) - A center tank fuel pump is not producing pressure. System must be reconfigured to ensure center fuel can be used.

FUEL OFF SCHEDULE (FUEL) - Either the left or the right main tanks have low fuel while the center tank has usable fuel.

FUEL QTY FAULT (FUEL) - Loss of fuel gauging in one or more fuel tanks.

FUEL QTY SYS FAIL (FUEL) - Complete loss of fuel gauging on one channel.

Amber Alerts (Level 1)

CTR FWD/AFT PUMP OFF - Respective pump is off with usable fuel in center tank.

ENG L/R FUEL PRES (FUEL) - Respective engine has low fuel pressure.

FUEL LEVEL LO (FUEL) - Indicates center quantity is less than 1000 pounds and either the left or right main tank(s) fuel quantity is below 2000 pounds for 2 minutes.

FUEL RTT L/R INOP (STATUS) - Fuel return-to-tank (RTT) has failed. Fuel suction feed performance is degraded.

LAT FUEL UNBAL (FUEL) - Fuel quantities in the left and right main tanks differ by more than 1400 pounds.

SEL CTR PUMPS OFF (FUEL) - Center tank has low fuel and either center pump has low pressure or, center tank quantity is slightly greater than the ballast quantity with either pump on.

SEL CTR PUMPS ON (FUEL) - Center pumps are off with usable fuel in center tank.

TANK L/R PUMPS LO (FUEL) - Respective tank pump(s) have low pressure.

TANK L/R PUMPS OFF (FUEL) - Both forward and aft main tank pumps are commanded off with FUEL switch on.

TNK L/R FWD/AFT PMP LO (FUEL) - Respective pump pressure is low.

TNK L/R FWD/AFT PMP OFF - Respective pump is commanded off with associated FUEL switch in ON.

Cyan Alerts (Level 0)

ENG START PUMP ON - Fuel start pump is commanded on.

FUEL SYS TEST - Fuel system is in test mode.

FUEL XFEED ON - Fuel crossfeed open.

Hydraulics — Chapter Hyd

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Hydraulics — Chapter Hyd
Description and Operation — Section 10

General

The purpose of the hydraulic system is to provide hydraulic power to the flight control surfaces, landing gear, nosewheel steering and brakes. System controls are on the overhead panel.

The hydraulic system is divided into two separate systems, left and right. The left hydraulic system supplies pressure to the left and right inboard spoilers, the left engine thrust reverser and the elevator augmentation system. The right hydraulic system supplies pressure to the left and right outboard spoilers, the rudder, the right thrust reverser and the landing gear.

Both hydraulic systems supply pressure to the slats, flaps, rudder stop limiter, nosewheel steering, brakes and anti-skid.

On some airplanes, installation of two spoiler system bypass valves in lieu of the specified spoiler shutoff valves eliminates the spoiler bypass handle seen during the Exterior Inspection Walkaround. The “Spoiler bypass handle ON” item (reference Operating Procedures volume, Normal Procedures tab) is eliminated from these airplanes.

During flight hydraulic pressure is normally supplied by two engine-driven hydraulic pumps.

The auxiliary pump, an electric motor-driven pump, has two functions: as a backup to the right engine-driven pump, and to pressurize the hydraulic systems on the ground when the engines are not running.

The transfer pump enables a pressurized system to mechanically transfer power to an unpressurized system when both systems reservoir quantities are normal.

System alerts are displayed on the Engine and Alert Display (EAD). Fluid pressures, quantities, and temperatures are displayed on the Systems Display (SD).

Components, Controls & Indicators

The hydraulic system contains the following components:

1. Hydraulic control panel,
2. Hydraulic reservoirs,
3. Engine-driven hydraulic pumps,
4. Auxiliary pump,
5. Transfer pump.

Cockpit Controls & Indicators

The hydraulic control panel is located on the forward overhead panel and hydraulic system information is displayed on the hydraulic synoptic page.

The switches for the left and right engine-driven pumps, the auxiliary pump and the transfer pump are located on the hydraulic control panel. The lines on the panel represent a simplified schematic of the hydraulic system.

Hydraulic Reservoirs

The hydraulic reservoirs are located in each main gear wheel well. The reservoirs store fluid for their respective hydraulic system.

The reservoirs are displayed as rectangular boxes on the synoptic. Reservoir quantity is displayed by shading in each rectangle and numerical readouts below each rectangle. Each reservoir has a fixed quantity reference line. The reference line appears after engine start when each engine reaches idle.

When reservoir quantity decreases to a predetermined level, the HYD L/R QTY LO alert is displayed on the EAD and is indicated on the synoptic.

When hydraulic fluid temperature is above normal, the HYD L/R TEMP HI alert is displayed on the EAD and is indicated on the synoptic.

Engine-Driven Hydraulic Pumps

The left and right hydraulic systems are pressurized by a hydraulic pump mounted on each engine. Pump operation is controlled by the L/R PUMP switches on the hydraulics control panel. The pump switches have two positions: ON and OFF.

When the engines are running and the pump switches are ON, the pumps supply pressure to their respective hydraulic system, regulated to 3000 psi. When electrical power is removed from an engine-driven pump, the pump defaults to on. When the switch is moved to the OFF position, the pump is electrically commanded to zero pressure output.

When pump output pressure drops below a predetermined value the letter P is displayed next to the respective pump symbol on the synoptic. Hydraulic system pressure readouts are digitally displayed on the synoptic. If system pressure is not within a predetermined value, the HYD L/R PRES LO alert is displayed on the EAD.

Fluid supply to the hydraulic system is stopped when the respective ENG FIRE handle is pulled.

Auxiliary Pump

The electrically driven auxiliary pump, located in the right wheel well, is a crew selectable backup for the right hydraulic system. The pump is powered by the left generator bus.

If the right engine-driven pump fails, or the right engine fails, the auxiliary pump may be used to supply pressure to operate all right system components, including the landing gear.

The AUX pump switch has two positions, ON and OFF. When the switch is ON, the auxiliary pump is commanded on. When the switch is OFF, the auxiliary pump is commanded off.

The auxiliary pump has built-in thermal protection. The pump automatically shuts down if it overheats.

Transfer Pump

The transfer pump is located in the left wheel well. When selected ON by the crew, the pump mechanically transfers pressure from an operating pressure source to an unpressurized system through the use of an interconnected hydraulic motor and pump. This operation can be reversed to provide hydraulic pressure in either direction.

The TRANS pump switch has two positions, ON and OFF. The switch controls the power transfer unit shutoff valve assembly. When the switch is ON, the transfer pump shutoff valve is commanded open, enabling operation of the transfer pump. When the switch is OFF, the transfer pump shutoff valve is commanded closed and the transfer pump is inoperative.

If the shutoff valves do not move to the commanded position, the valve symbol on the synoptic displays the commanded position, and the disagree symbol remains displayed. In addition, the HYD TRANS DISAG alert is displayed on the EAD.

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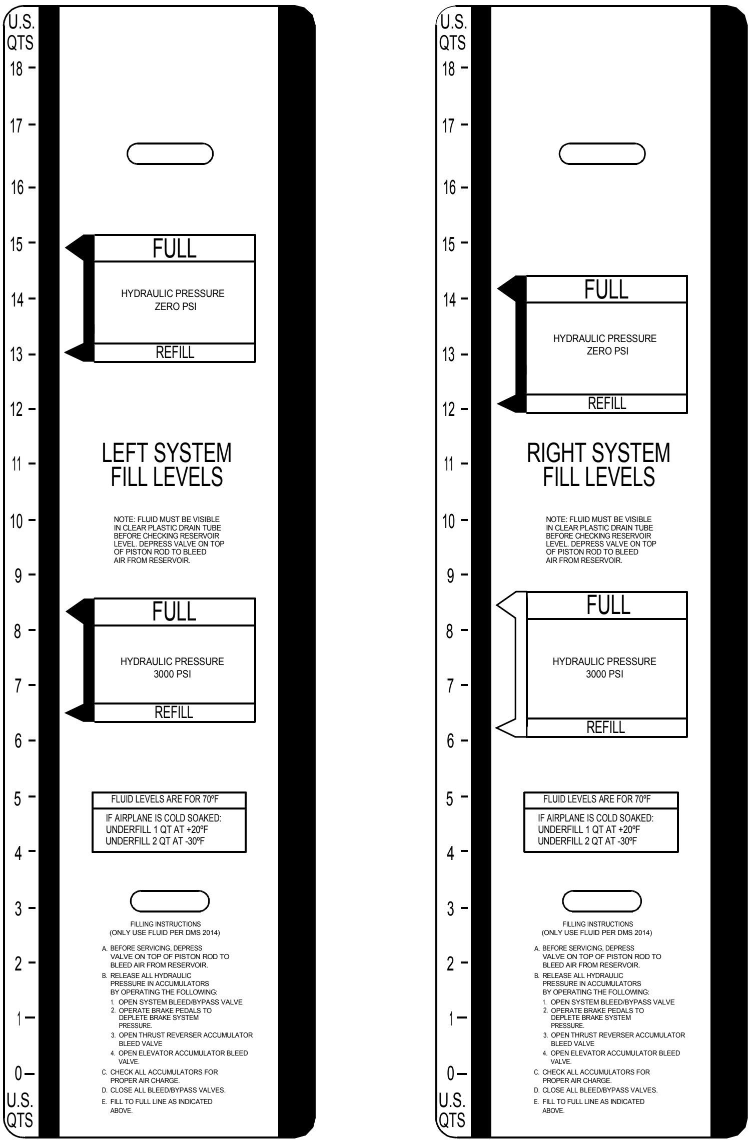
Reservoir Fill Level Placards



LEFT/RIGHT MAIN GEAR WHEEL WELLS (TYPICAL)

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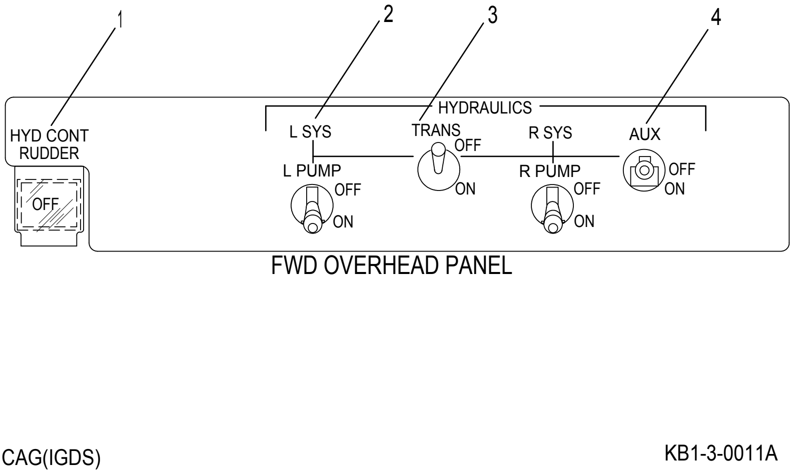
Hydraulics Control Panel



1. **HYD CONT RUDDER Switch - amber**

   Push - Disconnects hydraulic power from rudder. OFF illuminates.

2. **L/R SYS/PUMP Switches**

   OFF - Removes hydraulic pressure from respective system. Fluid circulates for pump lubrication and cooling.

   ON - Pressurizes respective hydraulic system.

3. **TRANS Pump Switch**

   OFF - Closes valve on each side of Power Transfer Unit (PTU) to disconnect left and right systems.

   ON - Opens valve on each side of PTU to connect left and right systems.

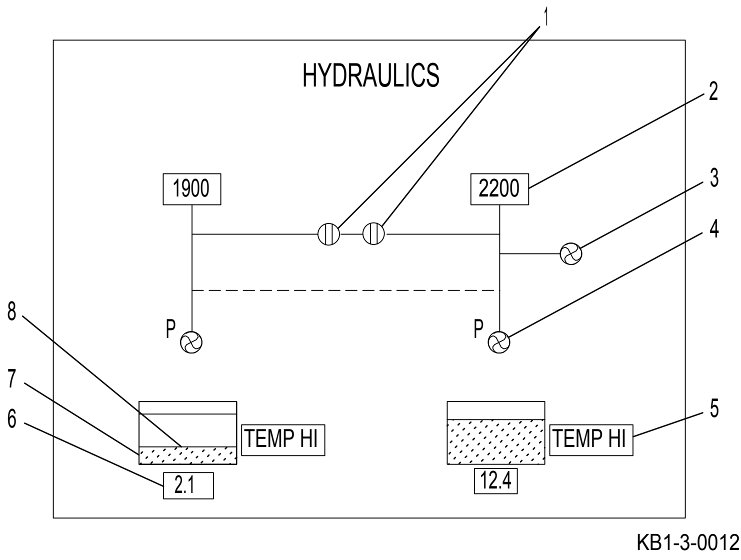
   Automatically allows the system with low pressure to be pressurized by the system with normal pressure in the event one system becomes low when the switch is selected ON.

4. **AUX Pump Switch**

   OFF - Turns off electric auxiliary pump.

   ON - Turns on electric auxiliary pump.

SD Synoptic - Hydraulics



1. **Hydraulic Power Transfer Unit (PTU) - white, green**

   White - Commanded OFF. Vertical parallel lines appear.

   Green - Commanded ON. Horizontal parallel lines appear.

2. **Hydraulic Pressure - white, amber**

   White - Pressure within limits.

   Amber - (Value boxed) Pressure exceeds high or low limits.

3. **Auxiliary Hydraulic Pump - white, green, amber**

   White - Commanded OFF. Pump symbol is open.

   Green - Commanded ON with adequate pressure. Pump symbol is vaned.

   Amber - Commanded ON with low pressure. Pump symbol is vaned with letter P displayed.

4. **L/R Engine Hydraulic Pumps - white, green, amber**

   White - Commanded OFF. Pump symbol is open.

   Green - Commanded ON with adequate pressure. Pump symbol is vaned.

   Amber - Commanded ON with low pressure. Pump symbol is vaned with letter P displayed.

5. **Hydraulic Fluid TEMP HI Display - amber**

   Amber - (Boxed) Fluid temperature exceeds high limit.

6. **Hydraulic Fluid Quantity - white, amber**

   White - Fluid level within limits.

   Amber - (Values boxed) Fluid levels below limits.

7. **Hydraulic Fluid Reservoir - white, gray, amber**

   White - Fluid level within limits. Reservoir outlined.

   Gray - Fluid level within limits. Fluid shaded.

   Amber - Fluid level exceeds low limits. Reservoir outlined/shaded.

8. **Pre-Flight Hydraulic Fluid Level - cyan**

   Cyan - Normal.

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Hydraulics — Chapter Hyd
Alerts — Section 40

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

HYD L&R FAIL (HYD) - Both left and right hydraulic systems have failed.

HYD L/R PRES LO (HYD) - Respective hydraulic system pressure is low.

HYD L/R QTY LO (HYD) - Respective hydraulic reservoir fluid quantity is too low.

HYD L/R TEMP HI (HYD) - Respective hydraulic system fluid temperature is too high.

Amber Alerts (Level 1)

HYD AUX PUMP FAIL (HYD) - The auxiliary hydraulic pump is commanded on, but is not producing pressure.

HYD AUX PUMP OFF (HYD) - The auxiliary hydraulic pump is not on with the slats extended and at least one engine on.

HYD L/R OFF (HYD) - Engine-driven pumps, hydraulic Power Transfer Unit (PTU), and auxiliary pump (right system) are all commanded off.

HYD PUMP L/R FAIL (HYD) - Respective hydraulic pump is commanded on but not producing pressure.

HYD PUMP L/R OFF (HYD) - The respective hydraulic pump is commanded off.

HYD TRANS DISAG (HYD) - Hydraulic PTU commanded position disagrees with actual position.

HYD TRANS OFF (HYD) - The hydraulic transfer pump is not on with slats extended and at least one engine running.

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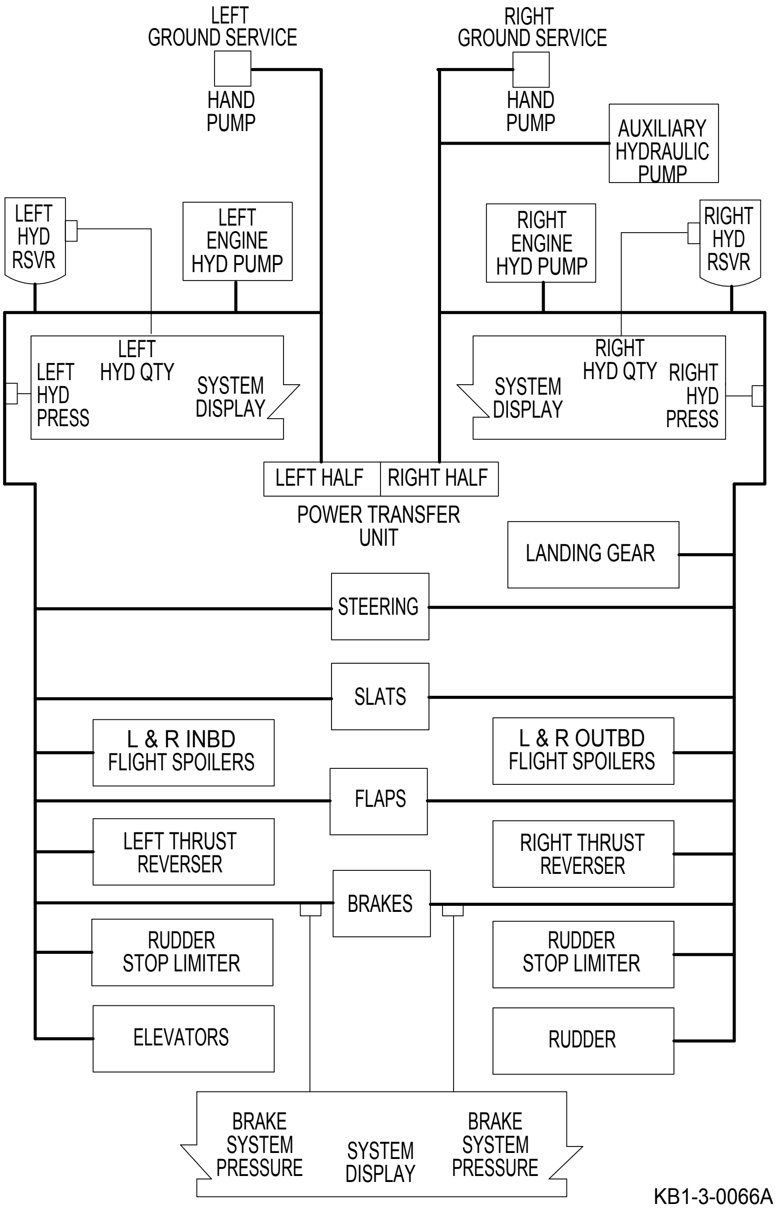
Block Diagram



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Ice & Rain Protection — Chapter Ice

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Ice & Rain Protection — Chapter Ice
Description and Operation — Section 10

General

The ice and rain protection system consists of the following:

* Wing, tail, and engine cowl anti-ice.
* Air data system and windshield anti-ice.
* Windshield wipers and anti-fog.
* On-ground, upper wing surface ice detection system.

The wing slats and the horizontal stabilizer leading edge are anti-iced with engine bleed air. A cross-ship duct system permits heat to be supplied from either or both engines.

The engine nose cowls are anti-iced by separate bleed air systems.

The three pilot windshields are electrically anti-iced and anti-fogged. The clearview and overhead windows are also anti-fogged.

The wing ice detection system functions only on the ground.

Wing Anti-ice

The wing anti-ice system provides in flight anti-icing of the leading edge slats. With the WING AIR FOIL switch selected ON, engine bleed air flows through ducts in the wing leading edge to anti-ice the slats. The WING A-ICE ON alert is displayed.

With the WING AIR FOIL and TAIL AIR FOIL switches selected ON, the AIRFOIL A-ICE ON alert is displayed. With the WING AIR FOIL, TAIL AIR FOIL and L/R ENG anti-ice switches selected ON, the A-ICE ALL ON alert is displayed.

Tail Anti-ice

The tail anti-ice system provides in flight anti-icing of the horizontal stabilizer leading edge. With the TAIL AIR FOIL switch selected ON, engine bleed air flows through ducts to the horizontal stabilizer leading edge to anti-ice the tail. The TAIL A-ICE ON alert is displayed.

Engine Anti-ice

The engine anti-ice systems provide in flight and on ground anti-ice heat to their respective engine nose cowl. The engine anti-ice systems are independent of the airfoil anti-ice system.

Engine anti-ice is controlled with the L and R ENG anti-ice switches. With both switches selected ON, hot air flows to both engine nose cowls. The ENG A-ICE ON alert is displayed. If only one switch is selected ON, the respective ENG (L/R) A-ICE ON alert is displayed.

On-Ground Wing Upper Surface Ice Detection

An on-ground wing upper surface ice detection system alerts the pilots prior to takeoff to the presence of wing upper surface ice.

On the ground, when ice is detected on either or both wing upper surfaces, the alert WING ICE DETECTED is displayed. The alert is inhibited during takeoff, landing, and in flight.

The system is tested by moving the WING ICE DET RESET/TEST switch to TEST. The system runs a self-test. Following a successful test, all wing ice detection alerts are displayed.

The system is reset by moving the WING ICE DET RESET/TEST switch to RESET. The WING ICE L/R FAIL alert indicates a failed test, and the system is not reset.

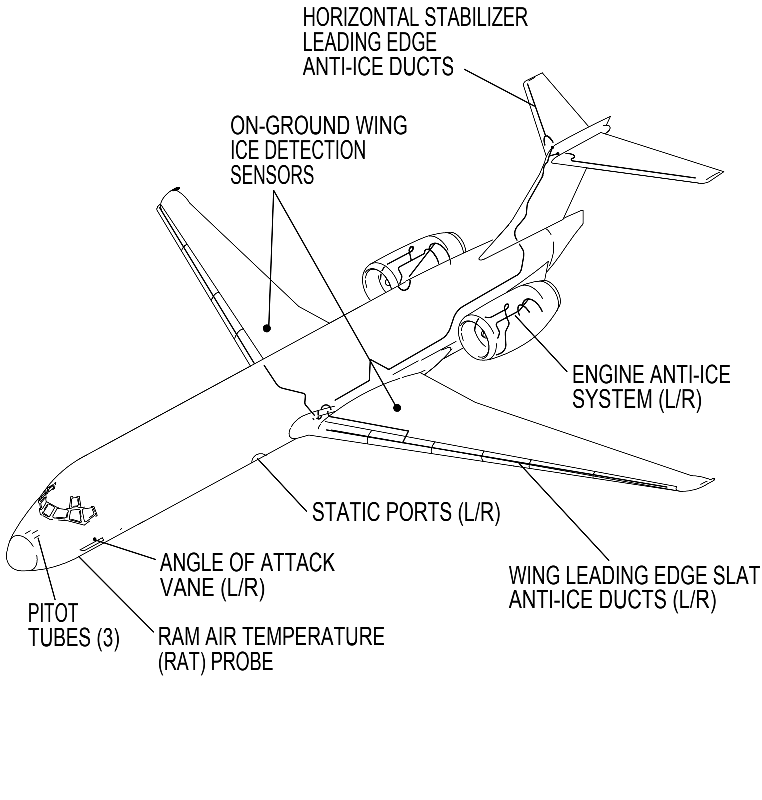
Windshield Anti-Ice And Anti-Fog

The three pilot windshields are electrically anti-iced and anti-fogged. The clearview and overhead windows are anti-fogged. The WINDSHLD ANTI-ICE and ANTI-FOG switches separately control the systems.

Windshield Wipers

Windshield wipers are used for rain removal. Two independent WINDSHLD WIPER switches, one for each pilot windshield, control wiper operation.

Major Component Location



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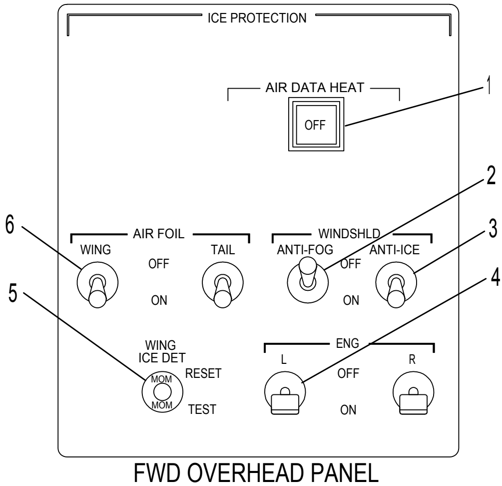
Ice Protection Control Panel



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1. **AIR DATA HEAT Pushbutton - amber**

   OFF - Illuminates when all air data system heaters are off.

   Dark when all heater circuits for pitots, rudder limiter, stall probes, static ports, and RAT probes are energized. On the ground, heat to RAT probe is inhibited.

2. **WINDSHLD ANTI-FOG Switch**

   OFF - Turns off windshield, clearview, and overhead window anti-fog.

   ON - Turns on windshield, clearview, and overhead window anti-fog.

3. **WINDSHLD ANTI-ICE Switch**

   OFF - Turns off windshield anti-ice.

   ON - Turns on windshield anti-ice.

4. **ENG L/R Anti-Ice Switches**

   OFF - Turns off respective engine anti-ice heat.

   ON - Turns on respective engine anti-ice heat.

5. **WING ICE DET Switch**

RESET - Resets system and removes WING ICE DETECTED alert from the EAD. The system will not reset if ice remains on the sensors.

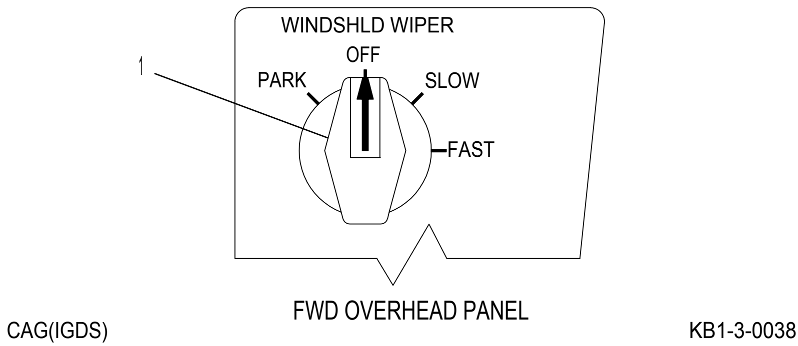
TEST - Tests the wing ice detection system.

6. **AIR FOIL WING/TAIL Anti-Ice Switches**

OFF - Turns off airfoil (WING)/horizontal stabilizer (TAIL) anti-ice.

ON - Turns on airfoil (WING)/horizontal stabilizer (TAIL) anti-ice.

Windshld Wiper Selector



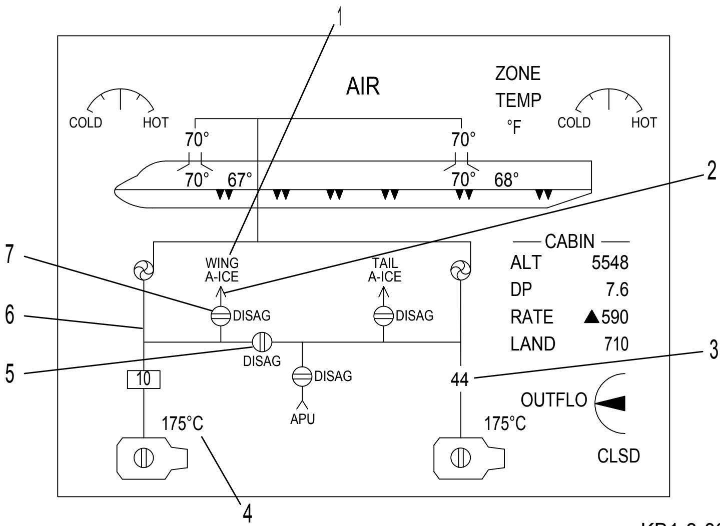
1. **WINDSHLD WIPER Selector**

PARK - Positions wiper to parked position.

OFF - Turns off wiper.

SLOW/FAST - Selects applicable operating speed.

SD Synoptic - AIR



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1. **Wing/Tail Anti-Ice - white, red**

   Blank - Off.

   White - Commanded on. Commanded off with system pressurized.

   Red - Manifold failed.

2. **Wing Anti-Ice/Tail Anti-Ice Bleed Air - white, green, amber**

   Blank - Anti-ice off.

   White - On the ground, anti-ice is commanded on. Also, anti-ice is commanded off with the system pressurized.

   Green - Anti-ice commanded on inflight.

   Amber - Anti-ice bleed air temperature out of limits.

3. **Engine Bleed Air Pressure - white, amber**

   White - Normal.

   Amber - Exceeds limits.

4. **Engine Bleed Air Temperature - white, amber**

   White - Normal.

   Amber - Anti-ice bleed air temperature out of limits.

5. Isolation Valve - white, green, amber

White - Commanded closed.

Green - Commanded open.

Amber - Valve position disagrees with commanded position.

6. Engine Bleed Air Manifold Temperatures - white, green, red

White - No anti-ice.

Green - Anti-ice available.

Red - Burst duct in tail compartment.

7. Wing/Tail Anti-Ice Valves - white, green, amber, red

Blank - Closed.

White - On with no pressure. Alternate system is pressurized and the letter A appears.

Green - On.

Amber - Commanded position disagrees with actual position when inflight. The word DISAG appears.

Red - Manifold failed.

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

TAIL TEMP L/R HI (AIR) - PODS has detected an overheat condition or manifold failure in the tail compartment.

WING/TAIL MANF FAIL (AIR) - PODS has detected an overheat condition in the respective anti-ice manifold and has failed to close the respective ice-protection shutoff valve.

Amber Boxed Alerts (Level 2)

BLEED AIR L/R FAIL (AIR) - Pressure regulator valve failed or PSC channel failed.

BLD AIR L/R TEMP HI (AIR) - Respective bleed manifold temperature exceeds 535 degrees F (280 degrees C).

BLD AIR L/R TEMP LO (AIR) - Bleed air temperature is too low for airfoil protection.

TAIL A-ICE DISAG (AIR) - The tail anti-ice valve position disagrees with the commanded position.

TAIL A-ICE OFF (AIR) - The tail anti-ice system is shut down by PODS due to an overheat or a manifold failure.

WING A-ICE DISAG (AIR) - The wing anti-ice valve position disagrees with the commanded position.

WING A-ICE OFF (AIR) - The wing anti-ice system is shut down by PODS due to an overheat or a manifold failure.

WSHLD HEAT FAIL (MISC) - The windshield heater has overtemped.

Amber Alerts (Level 1)

AIR DATA HEAT OFF (MISC) - The AIR DATA HEAT pushbutton is selected OFF (the air data probe heater switch is off) and illuminated amber.

AOA HEAT L/R FAIL (MISC) - Respective angle-of-attack probe heater has failed with the AIR DATA HEAT pushbutton selected on.

DRAIN MAST HEAT (MISC) - Drain mast heater has failed.

ENG L/R A-ICE DISAG (AIR) - The respective anti-ice valve position disagrees with commanded position.

PITOT AUX/CAPT/FO FAIL (MISC) - The respective probe heater has failed.

PODS A-ICE FAULT (STATUS) - PODS has a fault in the wing or tail ice protection system and cannot detect a manifold failure.

RAT PROBE FAIL (MISC) - The ram air probe heater has failed with the AIR DATA HEAT pushbutton selected on in flight.

RUD PITOT FAIL (MISC) - The rudder limiter pitot tube heater has failed with the AIR DATA HEAT pushbutton selected on.

STATIC L/R HEAT (STATUS) - The respective static plate heater has failed with the AIR DATA HEAT pushbutton selected on.

WING ICE DETECTED (AIR) (Ground only) - Either wing ice detector has detected upper surface wing ice.

WING ICE L/R FAIL (AIR) (Ground only) - Respective upper surface wing ice detection system is inoperative.

WSHLD A-ICE OFF (MISC) - Windshield anti-ice is selected off.

Cyan Alerts (Level 0)

AIRFOIL A-ICE ON - Both wing and tail anti-ice are selected on, and engine anti-ice is off.

A-ICE ALL ON - All engine and airfoil ice protection is selected on.

ENG A-ICE ON - Both ENG ANTI-ICE switches are on, and air foil anti-ice is off.

ENG L/R A-ICE ON - Respective system engine anti-ice switch is on, and air foil anti-ice switches are off.

PODS TEST PASS - PODS preflight test is successful when the engine fire protection test is performed.

TAIL A-ICE ON - Tail anti-ice is selected on and wing and engine anti-ice are off; or wing and tail anti-ice are selected on and the system is in alternating mode.

WING A-ICE ON - Wing anti-ice is selected on and tail and engine anti-ice are off; or wing and tail anti-ice are selected on and the system is in alternating mode.

WING ICE DET PASS - The upper wing surface ice detection system test is successful.

WSHLD ANTI-FOG ON - The WINDSHLD ANTI-FOG switch is selected ON. Anti-fog heat to the windshields, the clearview and the overhead windows is on.

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General

This chapter describes the following systems: electronic instrument, air data, VOR/MB, ADF, ILS, radio altimeter, flight data recording, global positioning, weather radar, enhanced ground proximity warning, traffic alert and collision avoidance, and flight management.

Electronic Instrument System

The Electronic Instrument System (EIS) consists of six flat panel Liquid- Crystal Display Units (LCDU) on the instrument panel, two EIS Control Panels (ECP), and one System Display Control Panel (SDCP). The system also includes one Bezel Light Sensor (BLS) on each DU, one Remote Light Sensor (RLS) on top of the glareshield, and two Versatile Integrated Avionics (VIA) units in the Electrical/ Electronics (E/E) compartment.

The EIS displays appear on the six DUs (numbered 1 thru 6 starting on the far left side). The displays are:

* DU1 and DU6 are the Primary Flight Displays (PFD).
* DU2 and DU5 are Navigation Displays (ND).
* DU3 is the Engine and Alert Display (EAD). The primary engine display appears on the upper 2/3 of the EAD. Alerts appear on the lower 1/3 of the EAD. The primary engine display is described in the Engines chapter. Alert display is described in the Airplane General chapter.
* DU4 is the System Display (SD). The SD displays either secondary engine data, systems synoptic, status pages, miscellaneous pages, or consequences pages. Selection is made by pushing the associated cue switch on the SDCP. The SD synoptic are described in the associated system chapter. SD alerts and related pages are described in the Airplane General chapter.

The RLS on top of the Captain's glareshield senses outside light. The BLSs on each DU sense inside light. Inside and outside light levels are compared and DU brightness is adjusted automatically.

System Display Control Panel

The System Display Control Panel (SDCP), located on the pedestal, consists of BRT knobs, system cue switches, and ND, CONSEQ, STATUS, and MISC switches.

Rotating the BRT knob adjusts brightness of each DU. Turning fully counterclockwise through a detent turns off the associated DU and reconfigures the other DUs to display minimum required data. The DUs are also reconfigured automatically when the airplane is in an emergency power condition in which only DU1, DU2 and DU3 are powered.

With incorporation of VIA-904 software, turning all six BRT knobs fully counterclockwise through detents turns on all DUs to full brightness.

In case of DU failure, the EIS will reconfigure to display all data required for operation of the remaining DUs.

The system cue switches illuminate to identify the associated system that is generating alerts and/or warnings. Pushing a cue switch displays the associated system synoptic on the SD.

Pushing the CONSEQ, STATUS or MISC switch respectively displays alert related consequences, airplane system faults, or the miscellaneous page on the SD.

If five or fewer DUs are operating, pushing the ND switch will cause the existing SD to become an ND.

EIS Control Panel

The EIS Control Panel (ECP) consists of switches for selecting MAP, PLAN, TCAS, VOR or APPROACH display. TCAS display with advisories, FMS waypoints and waypoint constraints, non-tuned or active VOR/NDB stations, weather radar range and brightness, baroset values, radio altitude minimums and MAG/TRUE heading can be selected with the appropriate switches.

Versatile Integrated Avionics Units

Two VIAs provide the following functions: data display, flight management computing, central aural warning, master warning and caution light activation, and flight data acquisition. The display function converts data received from airplane systems to graphic display on the DUs. Normally VIA-1 provides data for the DUs 1 - 3 (PFD, ND, and EAD). VIA-2 provides data for the DUs 4 - 6 (SD, ND and PFD).

In case of failure, either VIA unit will automatically provide data for all DUs.

Colors

A consistent set of colors is used to display data on the DUs as follows:

* Red - warning, flight envelope and system limits.
* Amber - cautions and abnormal sources.
* Brown - earth.
* White - scales and associated figures.

* Green - engaged modes.
* Blue - sky.
* Cyan - advisory or status.
* Magenta - ILS deviation pointer and flight bars.

Color for system synoptic symbols are as follows:

* Red - warning state requiring immediate crew awareness and/ or action.
* Amber - abnormal state requiring crew awareness.
* White - inactive or commanded off and nomenclature.
* Green - active or commanded on.
* Cyan - general (static) information.

Color for system synoptic lines are as follows:

* Red - manifold failure.
* Amber - high temperature condition.
* White - primary flow lines with no flow.
* Green - primary flow lines with proper flow.

Failure Annunciations

Invalid data and cross-side miscompared data are the two types of failure annunciations. Invalid data is removed from the screen. Miscompared data is displayed with a miscompared flag.

When invalid data is removed from the screen, it may be replaced by a flag (some non-essential data is removed from the screen only). These flags consist of an X covering the area of removed data.

The Xs may be of two colors: Red Xs signify a loss of data requiring immediate crew awareness and action to restore the loss of data. Amber Xs signify a loss of data requiring immediate crew awareness but action to restore the data may be momentarily deferred.

NOTE: On very rare occasions, a parameter may "X" out and then return. In this case, the data is as valid as it was prior to the "X" being displayed and the pilots should comply with any related alerts as they would normally.

Cross-side miscomparisons are generated when the EIS detects significant differences between the displayed data of the Captain's and First Officer's DUs. These comparisons are limited to attitude, airspeed, altitude, radio altitude, ILS and heading.

The detected miscomparisons are displayed in amber in the upper left-hand corner of the PFD, just outside of the attitude sphere. This annunciation blinks for five seconds, then remains as long as the miscompared condition exists.

Data Dropout

In the event of EIS data loss, the PFD will display pitch, roll, and altitude. The EAD will display engine thrust settings.

Primary Flight Display (PFD)

The PFD displays the following:

* Conventional attitude indication.
* Flight director bars (pitch and roll).
* Lateral (localizer) deviation.
* Vertical (glideslope) deviation.
* Marker beacon.
* Radio altitude.
* Airspeed/Mach/taxi speed.
* Limit speed.
* Pitch limit/ bank angle limit indication.
* Vertical speed/ TCAS.
* Slip (lateral acceleration).
* Flight mode annunciation (FMA).
* Windshear and predictive windshear.
* Airplane configuration.
* Heading/track.
* STALL annunciation.
* Altitude/ baroset/ selected altitude.
* Marker beacon.

The PFD symbology maintains the basic T configuration with attitude in the center, airspeed on the left, altitude and vertical speed on the right, and direction of flight on the bottom.

With Boeing Service Bulletins 717-22-0001 (-902 FCC) and 717-31-0002 (-903 VIA) incorporated or production equivalents, the PFD airspeed display provides a visual cue of the approach to the stick shaker speed; i.e., to stall. Stick shaker speed (Vss) is presented as the top end of the lower red checker column, and is based on measured angle-of-attack. This red checker column will move up on the PFD display as airspeed is reduced, thereby visibly displaying the reduction in the margin between the current airspeed and the stall speed. Because it is based on measured angle-of-attack the red column is dynamic and fluctuates as function of load factor, "g's", and pitch attitude. Its rate of movement has been tuned to not be a nuisance during turbulence, yet to be an accurate depiction of the margin between the current speed and stick shaker speed, including during maneuvers involving elevated load factor. To account for Mach effects at higher altitudes both the stick shaker and the lower red zipper are designed to follow the aerodynamic buffet onset boundary of the airplane, particularly above Mach 0.5 where the rate of change of the angle-of-attack for stick shaker/red zipper changes rapidly with Mach number. Thus, the lower red zipper gives an accurate indication of margin to stall for all Mach numbers.

Navigation Display (ND)

The ND displays the following:

* Heading/ track.
* Selected heading, course.
* Drift angle.
* Vertical deviation.
* Windspeed and direction.
* DME distance.
* Distance to waypoint (DTW)/ estimate time of arrival (ETA).
* Active waypoint.
* MAP and Plan modes.
* GMT.
* VOR/ADF bearing and distance.
* VOR/LOC deviations.
* ADF bearing.
* To/From information.
* Ground speed.
* True airspeed.
* TCAS information.

* Weather radar.
* Course deviation or navigation map.
* Windshear/ predictive windshear.

Bearing pointer and weather radar displays are available in MAP, VOR and APPROACH modes only.

DU Configuration (Sheet 1)

FORMAT DISPLAYED					
DU1	DU2	DU3	DU4	DU5	DU6
L-PFD	L-ND	EAD	SD	R-ND	R-PFD
L-PFD	L-ND	EAD	R-SND	R-PFD	
L-PFD	L-ND	EAD	R-SND		R-PFD
L-PFD	L-ND	EAD		R-SND	R-PFD
L-PFD	L-ND		EAD	R-SND	R-PFD
L-PFD		L-ND	EAD	R-SND	R-PFD
	L-PFD	L-ND	EAD	R-SND	R-PFD
L-PFD	L-SND	EAD	R-PFD		
L-PFD	L-SND	EAD		R-PFD	
L-PFD	L-SND		EAD	R-PRD	
L-PFD		EAD	R-SND	R-PFD	
	L-PFD	EAD	R-SND	R-PFD	
L-PFD	L-SND	EAD			R-PFD
L-PFD	L-SND		EAD		R-PFD
L-PFD		EAD	R-SND		R-PFD
	L-PFD	EAD	R-SND		R-PFD
L-PFD	EAD			R-SND	R-PFD
L-PFD		EAD		R-SND	R-PFD
	L-PFD	EAD		R-SND	R-PFD
L-PFD			EAD	R-SND	R-PFD
	L-PFD		EAD	R-SND	R-PFD
		L-PFD	EAD	R-SND	R-PFD
L-PFD	L-SND	EAD			
L-PFD	L-SND		EAD		
L-PFD		L-SND	EAD		
	L-PFD	L-SND	EAD		
L-PFD	L-SND			EAD	
L-PFD		L-SND		EAD	
	L-PFD	L-SND		EAD	
EAD			R-SND	R-PFD	
	EAD		R-SND	R-PFD	
		EAD	R-SND	R-PFD	

L/R - Left/Right SND - Navigation/System Display Blank - Off

DU Configuration (Sheet 2)

FORMAT DISPLAYED					
DU1	DU2	DU3	DU4	DU5	DU6
L-PFD	L-SND				EAD
L-PFD		L-SND			EAD
	L-PFD	L-SND			EAD
EAD			R-SND		R-PFD
	EAD		R-SND		R-PFD
		EAD	R-SND		R-PFD
EAD				R-SND	R-PFD
	EAD			R-SND	R-PFD
		EAD		R-SND	R-PFD
			EAD	R-SND	R-PFD
L-PFD	EAD				
L-PFD		EAD			
	L-PFD	EAD			
L-PFD			EAD		
	L-PFD		EAD		
		L-PFD	EAD		
L-PFD				EAD	
	L-PFD			EAD	
		EAD		R-PFD	
			EAD	R-PFD	
L-PFD					EAD
	EAD				R-PFD
		EAD			R-PFD
			EAD		R-PFD
				EAD	R-PFD
					R-PFD
				R-PFD	
			R-PFD		
		L-PFD			
	L-PFD				
L-PFD					

L/R - Left/Right   SND - Navigation/System Display   Blank - Off

Air Data System

Three pitot tubes are located on the nose of the airplane, one each for the Captain's, First Officer's and auxiliary pitot system. A rudder pitot tube, located on the leading edge of the vertical stabilizer, provides pitot pressure to operate the rudder throw limiter. Two static plates, located on each side of the airplane, and two alternate ports provide static pressure.

During normal operation, the Captain's pitot and static air data goes to Air Data Inertial Reference Unit (ADIRU)-1, and the First Officer’s pitot and static air data goes to ADIRU-2. Alternate static and auxiliary pitot air data goes to the Integrated Standby Instrument System (ISIS).

Static pressure is sensed by an Air Data Module (ADM), one for each static and pitot system, and electrically transmitted to the related ADIRU unit or ISIS unit. Each unit then calculates and supplies Static Source Error Correction (SSEC) to the measured static pressure. The corrected static pressure value is used to calculate the displayed values for altitude, airspeed and Mach.

Inertial Reference System

The inertial reference function of the ADIRU provides air data and inertial reference information to the PFD and ND. The ADIRU is controlled by a single IRS control panel located on the overhead panel. An independent back-up battery will provide power to ADIRU-2 for a minimum of 30 minutes if the normal power is lost. ADIRU-1 is powered by the airplane battery.

VHF Omnidirectional Range/Marker Beacon (VOR/MB)

Two VOR receivers are normally tuned automatically by the VIA flight management computing function, but can be tuned manually. The identifiers of VORs currently providing update data to the VIA are displayed on the FMS POS REF 2/3 page. The ND automatically displays the identifier/ frequency of the tuned VORs. Manual VOR tuning is accomplished on the FMS NAV RADIO page.

VOR bearings and course deviation are displayed on the ND map display. VOR frequency and selected course are displayed in the lower left hand corner.

Outer, middle and inner marker beacons are displayed by symbols on the PFD. An aural tone sounds simultaneously with a symbol. Volume for the marker beacon is controlled on the audio control panel.

Distance Measuring Equipment (DME)

Two DME systems are normally tuned automatically by the VIA flight management computing function, but can be tuned manually. The identifiers of DMEs currently providing update data to the VIA are displayed on the POS REF 2/3 page. DME distance is displayed on the ND map display.

MultiMode Receiver (MMR) Systems

Two MMR systems (MMR-1 and MMR-2) provide ILS and Global Positioning System (GPS) functions.

The MMR ILS function provides localizer and glideslope guidance information to the flight control and display systems. The GPS function receives and processes satellite RF signals from the NAVSTAR GPS satellite constellation to provide position, velocity and time data to the VIA.

ILS frequency are normally tuned automatically by the VIA flight management computing function, but can be tuned manually using the MCDUs. ILS autotuning requires that an ILS approach be part of the active route and the airplane is less than 50 NM from the top of descent or less than 150 NM from the landing runway threshold. On initial takeoff, ILS autotuning is inhibited for 10 minutes to prevent clutter on the PFD. ILS selected course is displayed on the ND. Tuned ILS frequency is displayed on the PFD and ND in the approach mode.

Radio Altimeter System

The radio altimeter system provides terrain clearance (altitude) data during approach, landing, or climb out. The altitude range of the system is from 2,500 feet to touchdown. The system consists of two radio altimeter receiver/transmitters and antennas.

Altitude indications are displayed on the PFDs. The decision height minimum can be set with the MINIMUMS control knob on the ECP.

Flight Data Recording System

The flight data recording system records data from airplane subsystems, sensors, and multifunction control and display unit (MCDU) inputs. The data are recorded on a crash-survivable flight data recorder which stores the last 25 hours of flight operation. The system consists of VIA digital flight data acquisition function, a triaxial accelerometer, flight data recorder, and a control panel on the overhead panel.

The recorder is automatically turned on when the airplane parking brake is released and either the FUEL switch is on.

An EVENT switch on the overhead panel can be pushed to mark an event on the recorder memory.

Global Positioning System (GPS)

A dual GPS (GPS-1 and -2) system consists of MMR receivers, GPS antennas, and sensor system. The MMR receives satellite positioning signals to provide airplane position to the VIA.

Weather Radar System

The weather radar system with forward-looking predictive windshear detection function consists of a receiver/ transmitter, control panel, and antennas.

The radar detects and displays areas of severe weather and ground mapping on the ND. Different levels of precipitation are displayed with appropriate colors as green, yellow, red, and magenta.

Both the Captain and First Officer may choose their own range for displaying weather information.

Predictive Windshear Detection

The Predictive Windshear (PWS) detection function detects microburst windshear hazard to provide visual and aural alerts during takeoff and landing. PWS alerts consist of an ICON of red and black bands with yellow boundaries showing location of any detected windshear on the NDs, appropriate messages on the PFDs, and aural alert through cockpit speakers/headsets.

PWS detection function is automatically activated in flight, regardless of radar mode selection (including OFF), when the airplane is below 2,300 feet radio altitude. Cockpit alerts are generated when the airplane is below 1,200 feet AGL and a microburst is detected. The azimuth coverage for PWS display is limited to +/-40 degrees of the airplane heading and detection range is limited to 5 NM ahead of the airplane.

Three levels of alerts for windshear conditions are warning, caution, and advisory.

Warning Alert

PWS warning alerts are generated for windshear event detected within +/- 0.25 NM from the longitudinal axis of the airplane and within +/- 25 degrees of the airplane heading. Maximum range for warning alert is 1.5 NM ahead of the airplane during landing and 3 NM in takeoff.

During takeoff, warning alerts are inhibited from 100 knots airspeed until reaching 50 feet AGL. Alerts are inhibited below 50 feet AGL during landing.

The ICON, overlaid on the selected radar mode information, is displayed on ND and a red WINDSHEAR AHEAD message is displayed in the top left corner of the PFD. Aural alerts WINDSHEAR AHEAD, WINDSHEAR AHEAD are generated during takeoff and GO AROUND WINDSHEAR AHEAD during landing/go-around.

Caution Alert

PWS caution alerts are generated for windshear events detected outside the warning alert region but within +/- 25 degrees of the airplane heading. Maximum rage for caution alert is 3 NM ahead of the airplane. Inhibiting conditions for caution alerts are the same as for the warning alerts.

In addition to the ICON displayed on ND, an amber WINDSHEAR AHEAD message is displayed in the top left corner of the PFD, and an aural alert MONITOR RADAR DISPLAY is generated.

Advisory Alert

PWS advisory alerts are generated for windshear events detected outside the warning and caution alert regions but within +/- 25 degrees of the airplane heading. Maximum range for advisory alert is 5 NM ahead of the airplane. Only the windshear ICON is displayed on the ND.

Aural Alert

The aural alerts are prioritized in the following order among the airplane systems:

1. Windshear (Reactive).
2. Predictive windshear.
3. GPWS.
4. TCAS.

PWS ALERT LEVEL	VISUAL ALERT		AURAL ALERT	
	ND	PFD	TAKEOFF	APPROACH
ADVISORY	ICON	NONE	NONE	
CAUTION	ICON	AMBER "WINDSHEAR AHEAD" MESSAGE	"MONITOR RADAR DISPLAY"	
WARNING	ICON	RED "WINDSHEAR AHEAD" MESSAGE	"WINDSHEAR AHEAD, WINDSHEAR AHEAD"	"GO AROUND WINDSHEAR AHEAD, GO AROUND WINDSHEAR AHEAD"

Enhanced Ground Proximity Warning System (EGPWS)

The EGPWS interfaces with the radio altimeters, ADIRUs, VIAs, ILS, and landing gear lever position to determine dangerous proximity to the terrain between 2,450 and 10 feet.

In addition to basic ground proximity warning and airport envelope modulation, the enhanced features include terrain clearance floor, terrain awareness, terrain alerting and display, peaks and obstacles.

A BELOW G/S warning light, located on the Captain's and First Officer's instrument panel, terrain display on ND, PFD warning messages, and voice warnings will annunciate to indicate adverse conditions.

The system provides visual and aural warnings for the following conditions:

Mode 1 - Excessive Descent Rate

Mode 1 provides warning for excessive descent profiles with respect to altitude AGL during cruise and approach AGL. Two different warning boundaries are possible:

* Outer Boundary - Penetration will activate the amber GROUND PROX message on the PFD and generate voice warning SINKRATE.
* Inner Boundary - Penetration will activate the red GROUND PROX on the PFD and generate the voice warning PULL UP (WHOOP WHOOP PULL UP - option).

Mode 2 - Excessive Terrain Closure Rate

Mode 2 provides warning based on RA and how rapidly that RA is decreasing. Mode 2 has two areas of applications as follows:

* Mode 2A - This mode is applied when the landing flaps are not down and the airplane is not on the glide slope. When the boundary is penetrated, the amber GROUND PROX message is displayed on the PFD and voice warning TERRAIN TERRAIN is generated. If the airplane continues to penetrate the envelope, the voice warning PULL UP (WHOOP WHOOP PUL UP - option) will be generated. The upper boundary of the alert envelope varies as the airspeed increases from 220 kts to 310 kts.
* Mode 2B - Enables for three conditions: landing flaps are set for landing, the airplane is on the glide slope during an ILS approach, or the airplane is in the first 60 seconds after takeoff. When the airplane penetrates the alert envelope with either gear or flaps not in landing configuration, the amber GROUND PROX message is displayed on the PFD and voice warning TERRAIN TERRAIN is generated. If the airplane continues to penetrate the envelope, the voice warning PULL UP (WHOOP WHOOP PULL UP - option) will be generated. If the airplane penetrates the alert envelope with both gear and flaps in landing configuration, the voice warning TERRAIN is repeated until the envelope is exited.

Mode 3 - Altitude loss after takeoff

Provides a warning for significant altitude loss after takeoff or go-around from below 245 feet AGL with gear up and flaps are not in the landing configuration. Penetration of the boundary will result in the amber GROUND PROX message displayed on the PFD and voice warning DON’T SINK, DON’T SINK.

Mode 4 - Unsafe Terrain Clearance

Mode 4 exists in three forms:

* Mode 4A - Insufficient Terrain Clearance, Gear Up. Active during cruise and approach with the landing gear not in landing configuration. Upper boundary is at 500-feet RA. If the airplane penetrates this boundary with the gear up, the voice warning will be TOO LOW GEAR and the amber GROUND PROX message will be displayed on the PFD. Above 190 knots, the upper boundary increases linearly with airspeed to a maximum of 1,000 feet RA at 250 knots or more. Penetration of this boundary generates a repetitive TOO LOW TERRAIN voice warning.
* Mode 4B - Insufficient Terrain Clearance, Flaps Up. When the landing gear is lowered, mode 4B is active. Upper boundary has decreased to 245 feet RA. If the airplane penetrates this boundary at an airspeed below 159 kts and flaps are not in landing configuration, the voice warning will be TOO LOW FLAPS and the amber GROUND PROX message will be displayed on the PFD. Above 159 knots, the boundary increases linearly (same as mode 4A) and the voice warning is TOO LOW TERRAIN.
* Mode 4C - Insufficient Terrain Clearance at Takeoff. Provides a warning based on minimum RA clearance during takeoff. A value equal to 75 percent of the current RA is stored in a filter. If the altitude decreases below the stored value, a TOO LOW TERRAIN voice warning will be generated and the amber GROUND PROX message will be displayed on the PFD.

Mode 5 - Descent Below Glide Slope

Provides two levels of warning when the airplane descent is below the glide slope on an ILS approach.

* Mode 5 Soft Alert - Occurs when the airplane is more than 1.3 dots below the glide slope. This soft alert envelope has a typical upper limit of 1,000 feet. The GLIDESLOPE voice warning is generated and the BELOW G/S light is illuminated.
* Mode 5 Hard Alert - Occurs when the airplane is below 300 feet RA with greater than 2 dots below the glide slope. The warnings are the same as the soft alert.

The warning can be cancelled by pushing the BELOW G/S switch at any time below 1,000 feet RA. The warning is reset by climbing above 1,000 feet or descending below 30 feet.

Mode 6 - Altitude Callouts/ Excessive Bank Angle Warning

Mode 6 provides optional callouts for descent through predefined radio altitudes between 2,500 and 10 feet AGL and excessive roll or bank angle warning.

Bank angle warning provides over banking protection during approach, climbout, and cruise. Additionally, the warning protects against wing strikes during landing.

The bank angle warning limits are determined by two factors as follows:

* The basic bank angle limits that vary linearly from 6 degrees at 0 feet (and below) RA to 40 degrees at 150 feet RA and above and
* The roll rate adjustment of 1.5 degrees added for every 1 degree roll rate (limited to +/- 6 degrees).

When bank angle exceeds the warning limits, voice warning BANK ANGLE are generated twice, and then suppressed unless the roll angle increases by an additional 20%.

If RA data is invalid, the bank angle warning limit will be 40 degrees.

Airport Envelope Modulation

The airport envelope modulation feature provides improved alert/warning protection at some key locations throughout the world while improving margins against nuisance warnings at others. Near certain airports, modes 4 and 5 are expanded to provide warnings consistent with normal approaches. Near other airports, modes 1, 2, and 4, are desensitized to prevent nuisance warnings that result from unusual terrain or approach procedures.

Enhanced Operation
Terrain Clearance Floor

The Terrain Clearance Floor (TCF) alert function adds an additional element of protection to the basic GPWS by creating an increasing terrain clearance envelope around the airport runway. TCF alerts are based on current airplane location, destination runway center point position and radio altitude. When the TCF envelope is penetrated:

* TOO LOW TERRAIN voice warning is generated twice.
* Amber GROUND PROX message is displayed on PFD.
* Additional TOO LOW TERRAIN voice warning will be generated for every additional loss of radio altitude of approximately 20%.

TCF is active during takeoff, cruise, and final approach. The TCF alerts add to the existing Mode 4 protection by providing alerts based on insufficient terrain clearance including landing configuration.

Terrain Awareness

The terrain awareness features add a terrain "look ahead" capability of the GPWS. The features include terrain alerting and standard terrain display.

Terrain alerting function continuously computes terrain clearance envelopes ahead of the airplane. This data is then compared with terrain elevation data stored in the terrain database. If there is any conflict between the boundaries of these envelopes, the terrain alerts are issued.

Terrain display is the basic presentation on the ND upon system power up. The system displays a color-coded terrain map in MAP, VOR and APPR modes. The displays can be replaced at any time with weather radar information by pushing the WX BRT switch on the EIS control panel (ECP).

Terrain will be automatically displayed on the ND if the pop-up option is enabled and neither Captain nor F/O has terrain selected.

Terrain conditions are displayed and annunciated as follows:

* Terrain caution - Displayed in solid amber on ND, amber flashing GROUND PROX on PFD, and voice warning CAUTION TERRAIN, CAUTION TERRAIN (TERRAIN AHEAD, TERRAIN AHEAD - option).
* Terrain warning - Displayed in solid red on ND, red flashing GROUND PROX on PFD, and voice warning TERRAIN, TERRAIN, PULL UP (TERRAIN AHEAD, PULL UP or WHOOP WHOOP PULL UP - options).
* Terrain that is close, but is not of warning or caution condition, is in green, amber, or red dot patterns.

The following messages are displayed on the ND as applicable:

* TERRAIN (white) with selected range - Weather radar is deselected with the WX BRT switch on the ECP.
* TERRAIN TEST (white) - Pilot-initiated preflight GPWS test.
* TERRAIN RANGE DISAGREE (amber) - Display ranges on the NDs are not the same.

Peaks Display Mode

The optional peaks mode terrain display allows terrain below the airplane to be viewed on the terrain display during the cruise portion of flight. At altitudes safely above all terrain for the display range chosen, the terrain is displayed independent of airplane altitude emphasizing the highest and lowest elevations to provide increased situation awareness.

The peaks mode display adds a new solid green level to the standard terrain display to indicate the highest, non-threatening terrain and two elevation numbers indicating the highest and lowest terrain currently being displayed. The elevation numbers indicate terrain in hundreds of feet above sea level (MSL). These numbers are shown in the same color as the highest or the lowest terrain color pattern shown on the display, respectively. A single elevation number is displayed when the display is all black or blue as a result of flying over water or relatively flat terrain.

Aural caution and warning alerts are displayed/annunciated the same as standard terrain awareness. Pilot selection between standard terrain display and Peaks display mode is not available.

Obstacles Display Mode

The optional obstacles feature provides audio and visual alerts when the EGPWS identifies a conflict with a man-made object that is higher than 99 feet and contained within the EGPWS terrain database.

An obstacle caution alert displays the offending obstacle as an amber area and the voice warning CAUTION OBSTACLE, CAUTION OBSTACLE (OBSTACLE AHEAD, OBSTACLE AHEAD - option) is generated. A warning alert will change the color of the obstacle to red and the voice warning OBSTACLE OBSTACLE, PULL UP (OBSTACLE OBSTACLE, WHOOP WHOOP PULL UP or OBSTACLE AHEAD, PULL UP - options) will be generated.

Traffic Alert and Collision Avoidance System (TCAS)

The TCAS is an airborne system that interrogates ATC transponders in nearby airplanes to identify and display potential collision threats. Visual and aural warnings are provided when a penetration of the TCAS protected airspace is predicted

Threat airplanes are displayed with data tags on the ND with different symbols and color codes to indicate threat level of each airplane. The data tag shows relative altitude and climb/descent in excess of 500 fpm of the intruders. TCAS cannot detect traffic unless the traffic has an operating transponder turned on. TCAS controls are on the transponder control panel and the EIS mode select panel.

A Resolution Advisory (RA) appears on the PFD and ND when a threat airplane is about 25 seconds from the Closest Point Of Approach (CPA). There are two types of RAs. Corrective RAs recommend changing vertical speed with a green fly-to zone on the PFD vertical speed display. Preventive RAs recommend not changing vertical speed with red forbidden zones on the PFD vertical speed display. On the ND, the RAs are red squares.

Voice warnings associated with RAs for basic version and change 7 (if installed) are as follows:

BASIC ANNUNCIATION	CHANGE 7 ANNUNCIATION
Traffic, Traffic	Traffic, Traffic
Climb, Climb, Climb	Climb, Climb
Descend, Descend, Descend	Descend, Descend
Climb, Crossing Climb. Climb, Crossing Climb	Climb, Crossing Climb. Climb, Crossing Climb
Descend, Crossing Descend. Descend, Crossing Descend	Descend, Crossing Descend. Descend, Crossing Descend

BASIC ANNUNCIATION	CHANGE 7 ANNUNCIATION
Reduce Climb, Reduce Climb	Adjust Vertical Speed, Adjust
Reduce Descent, Reduce Descent	Adjust Vertical Speed, Adjust
Climb, Climb Now. Climb, Climb Now	Climb, Climb Now. Climb, Climb Now
Descend, Descend Now. Descend, Descend Now	Descend, Descend Now. Descend, Descend Now
Increase Climb, Increase Climb	Increase Climb, Increase Climb
Increase Descent, Increase Descent	Increase Descent, Increase Descent
Monitor Vertical Speed, Monitor Vertical Speed (Initial Preventive RAs)	Monitor Vertical Speed, Monitor Vertical Speed
Monitor Vertical Speed, Monitor Vertical Speed (Non-crossing, maintain rate RAs)	Maintain Vertical Speed, Maintain
Monitor Vertical Speed, Monitor Vertical Speed (Altitude crossing, maintain rate RAs)	Maintain Vertical Speed, Crossing Maintain
Monitor Vertical Speed (Corrective VSL)	Adjust Vertical Speed, Adjust
Monitor Vertical Speed (Preventive VSL)	Monitor Vertical Speed
Clear of Conflict	Clear of Conflict

Traffic Advisories (TA) are amber circles on the ND representing airplanes that are 40 seconds from the CPA. There is no requirement to change or monitor vertical speed but visual acquisition of the threat airplane is required. The voice warning associated with TAs is TRAFFIC, TRAFFIC.

Proximate traffic are cyan diamonds on the ND that represent airplanes that are not threat traffic but are within 6 NM and 1200 feet vertically.

Other traffic are outline cyan diamonds on the ND representing nonthreat traffic that are outside the range of TA, RA, or proximate traffic.

Off scale RAs and TAs are shown by one half of the symbol at the edge of the display area. Data tags and vertical trend arrows are shown.

A two-mile range ring with an asterisk (*) at each of the twelve clock positions will appear when TCAS mode is selected on the ECP and the range goes to 10 NM.

TCAS Display Modes

Pushing the TRFC switch on the ECP displays proximate or other TCAS targets either full time or part time.

Full-Time Mode (TRFC selected). Pushing the TRFC switch displays proximate and other traffic regardless of the occurrence of a TA or RA. In this case, TRFC will appear in the lower left box on the ND.

Part-Time Mode (TRFC not selected). TAs and RAs cause TCAS targets to automatically appear on all ND modes except PLAN mode. During a TA or RA, any proximate or other traffic will also be displayed.

TCAS mode - This ND mode is selected by pushing the TCAS switch on ECP. The ND will:

* Declutter (remove FMS course line, radar returns, bearing pointers, and waypoint symbols).
* Go to a 10-mile range.
* Display a 5-mile range ring and a 2-mile range ring (made of asterisks).

TCAS mode range can be changed by using the INCR/DECR switches on the ECP.

The 10-mile range is automatically selected only when selecting the TCAS display from MAP, PLAN, VOR or APPROACH. If the NAV display is already in TCAS mode at another range, pushing the TCAS switch again does not automatically select the ND back to the 10-mile range.

TCAS Operating Modes

TA/RA mode - This mode is selected from the transponder control panel. In this mode, TAs and RAs are generated on the basis of the calculated time for a threat airplane to reach the CPA. The CPA will vary with altitude. An RA is generated when an intruder is either 20, 25, or 30 seconds from the CPA, depending on altitude. A TA is generated at 35, 40, or 45 seconds from the CPA.

TA mode - In this mode TCAS generates only TAs, proximate, and other traffic. RAs are not generated. When in this mode, a white TA ONLY message appears in the lower left of the ND and changes to flashing amber when a TA occurs. This mode can be selected from the transponder control panel or occurs automatically when:

* In flight below 1000 feet AGL (+/-100 feet).
* On ground and transponder control panel is set to TA or TA/RA.
* Whenever there is a GPWS warning or windshear guidance.

Operating Constraints

TCAS operating constraints are as follows:

* Descend RAs are inhibited below 1,200 feet AGL in takeoff and 1,000 feet AGL in approach.
* Increase descent RAs are inhibited below 1,450 feet AGL.

* Climb RAs are inhibited above 37,000 feet MSL.
* RAs are inhibited below 1,100 feet in takeoff and 900 feet in approach.
* There are no TCAS voice warnings below 1,000 feet (+/- 100 feet) for basic version and 500 feet (+/-100 feet) for Change 7 version.
* There are no TCAS voice warnings or RAs during windshear guidance.
* There are no TCAS voice warnings or RAs during GPWS warnings.
* RAs are based on pilots starting the maneuver within 5 seconds (for a corrective RA).

Integrated Standby Instrument System (ISIS)

The ISIS provides displays of altitude, airspeed (IAS and optional Mach number), attitude, and baro setting (in inches of mercury and optional hectopascals) on a LCD located in the forward pedestal. The system is electrically-operated and interfaced with the auxiliary pitot and alternate static port through two Air Data Modules (ADM).

System warm-up (approximately 1 minute) is initiated and the SELF TEST IN PROGRESS message is displayed on the LCD when the electrical power is on. An ALIGN message is displayed on the lower part of the attitude display when attitude alignment is in progress. If attitude failure occurs, a red ATT FAIL message will appear on the upper part of the attitude display. If altitude, airspeed or baroset display failure occurs, respective data will be removed and replaced by a red diagonal cross. All data will be removed and a big red diagonal cross will appear to indicate total system failure.

Pushing the ANNUN LT TEST button on the overhead panel displays ALIGN, ATT FAIL messages, and all red diagonal crosses overlay the displays. The system will be powered by the airplane battery if the electrical power is lost.

Standby Magnetic Compass

The standby magnetic compass provides a heading reference in relation to magnetic north. The Captain's and First Officer's viewing mirrors, mounted on the glareshield, permit viewing the standby compass.

Flight Management System (FMS)

The FMS is used by pilots for flight planning, navigation, performance management, airplane guidance, and flight progress monitoring.

The FMS consists of Flight Management Function (FMF) 1 and 2 (provided by the VIAs) and two MCDUs installed in left and right sides of the forward pedestal.

The pilot uses the Flight Control Panel (FCP) to select flight modes and the Multifunction Control Display Unit (MCDU) to enter flight plans and other flight data. Flight progress is monitored through the MCDU and the EIS.

After data entry, the FMFs generate a flight profile from the origin to the destination airport. The FMFs then guide the airplane along that plan by providing roll, pitch, speed, and thrust commands to the FCCs. See FMS Guide of Vol. II for detailed information.

CAUTION: All data entered into the FMS is advisory only and must be confirmed to be accurate and current by comparison to published and approved flight navigation charts and approach plates.

The flight crew is responsible for assuring accuracy of the strung FMS flight plan. All entries and edits to the FMS flight plan must be confirmed to be in compliance with ATC clearances, both laterally and vertically. If FMS NAV or FMS PROF guidance does not appear to be complying with the desired flight profile, the crew must intervene and assure that the airplane flight profile conforms to clearance requirements.

Operation

FMS operations include lateral navigation (NAV), vertical profile control (PROF), and optimum speed control (SPD) functions coupled to the AP/FD through targets or steering commands. The FMS also provides AP/FD takeoff (T/O) and go-around (GA) references, variable bank angle limit control in AUTO position, Vmin bank angle limiting, ILS LOC ONLY mode, VOR mode (option), and Vmin speed and thrust limiting data.

FMS generated data, command entries and performance data are displayed on the MCDU pages. Each flight mode has its own page or pages. Other functions of the FMS are identification, initialization, position reference, radio tuning, navigation reference, performance thrust limiting, takeoff, approach, go-around, maintenance, sensor data, route data, route legs, route progress, and standby operation.

Dual Mode

The FMS operates in DUAL, INDEPENDENT, and STANDBY modes. INDEPENDENT and STANDBY modes are covered in the FMS Guide, Vol. II.

DUAL mode is the normal operating mode of the FMS. When operating in DUAL mode, there is cross talk between the VIAs to ensure the following:

* MCDU entries made on one side are entered simultaneously into the other VIA. The respective MCDU can display different pages, however, if the same page is displayed on each MCDU, the displays is similar, but the predicted values may be slightly different.
* Leg sequencing is initiated simultaneously in both VIAs.
* Airplane position is calculated independently.

In the DUAL mode of operation, each FCC is coupled to the on-side FMC. The FMC in use is the master. This selection process ensures that both flight directors are controlled with the same steering commands.

NOTE: Recalculation of data by the FMS may cause momentary irregularities in displayed data.

During normal operation, advisory messages may be displayed on one, or both, MCDU's. Both MCDU's should be monitored during flight.

Navigation Function

The airplane position and groundspeed (GS) are derived from the position and velocity information from the GNS.

If GNS is inhibited, the position and velocity information from the IRUs is combined with range and bearing information from VOR/DME stations to calculate the airplane position and groundspeed. In this case, the FMS combines range from two DME stations, and position and groundspeed information from a weighted average of the three IRUs. If two available navaids do not form an angle between 30 degrees and 150 degrees, range and bearing from a single VOR/DME are used with the IRU data. As the airplane progresses along the route, the FMS uses present airplane position and the stored navaids in the database to tune the VOR/DME receivers to the stations that yield the most accurate position estimate.

The database contains information on the class and figure of merit of the available navaids. The class of a navaid is defined as VOR, DME, VOR/DME, VORTAC, or LOC. The figure of merit (or reception quality) is primarily based on usable range of the station relative to the airplane.

The exact airplane position at power-up is determined by the system and displayed as the start coordinates. Navigation reverts to IRS with VOR/DME radio update only when the GNS is not available or has been inhibited.

Performance Function

The FMS performance or speed modes optimize the airplane vertical profile. These modes are as follows:

* ECON (Economy) - The ECON CLIMB, CRUISE, and DESCENT phase airspeed/Mach targets are calculated to obtain the minimum operating cost per mile traveled enroute based on the entered cost index. Some factors considered in these calculations include cruise flight level, gross weight, temperature, and current or predicted winds.
* POLICY - The POLICY mode is the same as the ECON speed mode, except with a crew-selected calibrated airspeed (CAS). This is done to satisfy a specific airline descent policy.
* EDIT - The pilot enters CAS/Mach for CLIMB, CRUISE, and DESCENT phases of flight, subject to flight envelope limits.
* MAX CLB - The MAX CLIMB speed is a table look-up speed for best angle of climb.
* MAX END (Endurance) - The MAX END and best holding speed targets are calculated for obtaining the least drag for maximum time aloft.
* MAX DES (Descent) - The MAX DES speed is based on operation at maximum flight speeds.

The performance mode computes optimum speeds, estimates fuel consumption and gross weight, predicts time, fuel, and distances at all flight plan waypoints, computes reference parameters such as optimum altitude, maximum altitude, and approach speed, searches and retrieves database information, and calculates the operational speed envelope.

Flight path predictions are computed by the FMS using an origin-to-destination trajectory that is based on gross weight, cost index, predicted cruise winds, speed/altitude/time constraints at specific waypoints, and specified modes for climb, cruise, descent, and approach. Allowances are made for takeoff and acceleration requirements between the legs of the vertical profile. The predictions are updated periodically as the flight progresses to incorporate airplane performance and groundspeed.

Descent path synthesis predicts the descent path by assuming flight idle thrust above the descent speed limit altitude and slightly above idle below this altitude. The synthesis starts at the destination and computes the point where slats/flaps are expected to be extended. It then intersects the cruise altitude creating a top-of-descent point. This results in a predicted path that takes into account speed targets, waypoint altitude constraints, and the impact of wind forecasts.

The optimum Step Climb (S/C) computes the best point along the route to initiate a step climb to a pilot-defined altitude that results in minimum trip cost. The “step to” altitude is preselected by the pilot on the FCP. The system then begins the climb at the programmed step climb point.

Approach speed targets are computed based on calculated gross weight and deceleration segments between configuration changes to arrive at the final approach speed 1000 ft. above the destination airport. The final approach speed (VAPP) includes a 5 knot bias above 1.23 x VSO or VREF. VAPP can be altered by the pilot for landing conditions.

The FMS fuel/weight/Center of Gravity (CG) calculation is a prerequisite for all performance computations.

After engine start, the fuel/weight calculation is updated based on fuel tank readings and a time integration of the fuel flow to each engine (/FF+FQ).

The route of flight is displayed on the EIS Navigation Display (ND) map display, and when the descent phase is active, a vertical deviation indicator is displayed to show airplane deviation from the computed flight path. The appropriate PROF Flight Mode Annunciator (FMA) is displayed on the EIS Primary Flight Display (PFD) to indicate that the airplane is tracking the descent path.

Guidance Function

The FMS supplies guidance commands for controlling airplane roll, pitch, speed, and engine thrust. Fully automatic flight path guidance that optimizes airplane performance is available in two or three dimensions. The NAV mode is for lateral guidance, and the PROF and FMS SPD modes are for vertical guidance and speed/thrust control. These modes are selected on the FCP and can be engaged separately or together.

Lateral Guidance – Lateral guidance is derived from a primary flight plan with automatic route leg sequencing. The FMS compares the airplane present position with the desired flight path and generates steering commands to the autopilot and flight director. The autopilot directs the airplane to fly along the desired path. Direct navigation from the airplane present position to any waypoint is also available.

Vertical Guidance – Vertical guidance includes the TAKEOFF, CLIMB, CRUISE, DESCENT, and APPROACH phases of the flight plan. Published departure, arrival, and approach segments, and individual waypoints that include speed and altitude constraints can be entered into the FMS for flight planning. These constraints, as well as the entered cruise altitude and cost index, define the FMS vertical profile.

In the climb part of the vertical profile, the AFS controls thrust based on FMS thrust limits and speed targets that are sent through the FCCs. The airplane climbs at climb limit thrust to a given altitude constraint. It then flies level at an appropriate speed target until past the constraining waypoint, and resumes the climb at climb limit thrust. Automatic level--off occurs at the altitude selected on the FCP.

The climb speed schedule is based on the speed limit and speed constraints at lateral waypoints. If not restricted by either of these conditions, the selected performance mode speed is used. After reaching the cruise altitude, the SPD mode maintains the selected performance mode speed until the descent phase is reached.

For the descent part of the vertical profile, the FMS calculates a vertical path that satisfies waypoint altitude and speed constraints. This calculation also considers the selected descent performance mode. The path to the first altitude constraint is constructed assuming idle thrust and a calculated descent gradient that maintains the mode speed schedule or the limit speed (considering the predicted wind conditions). PROF guidance controls airplane pitch similar to tracking an ILS beam. While flying the descent path, PROF pitch commands the FCC to hold the path while the pilot uses speed brakes to maintain speed if a significant, unanticipated acceleration occurs. The throttles are automatically advanced if speed falls below the target speed by 10 knots.

Software and Database

The FMS software includes the principal FMS operating program, performance database, Airline Modification Information (AMI) database, Operational Program Configuration (OPC) database, and navigation database for the 717 airplane.

The operating program executes the following FMS functions:

* Navigation – Determines radio autotuning, position, velocity, and wind data.
* Performance – Determines trajectory, defines guidance and control targets, and predicts flight path.
* Guidance – Determines flight path deviation, and generates lateral steering and control commands.
* EIS – Computes map and situation data for display.
* MCDU – Processes keystrokes and constructs flight plans.
* I/O – Processes received and transmitted data.
* BITE (Built-In Test Equipment) – Monitors the system, performs self-testing, and keeps records.
* Operating System – Controls the operating program, memory management, and stored routines.

The performance database in the FMS reduces the need for the pilot to refer to a performance manual during flight and gives the FMS the data required to compute pitch and thrust commands for the FCC. The performance database is also used by the FMS to compute detailed predictions along the entire airplane trajectory. The data stored in the database includes accurate airplane drag and engine model data, optimum speed data, maximum altitudes, and maximum and minimum speeds.

The Airline Modifiable Information (AMI) database contains default data for certain parameters that can be modified by the operator. This data includes taxi fuel, route reserve information, final time, and datalink options (lookup tables).

The Operational Program Configuration (OPC) database contains data that is read by the FMS to establish the operating configuration. This data includes GNS enable, 702 AOC datalink enable, 1.3g buffet limit enable, RNP message set, maximum takeoff gross weight, maximum landing weight, etc.

The navigation database in the FMS includes most of the information the pilot would normally get from navigation charts. This information can be displayed on the MCDU or EIS map. The geographic area covered includes all areas where the airplane is normally flown. The database is tailored to specific airline customers and can contain over 65,000 navigation points and airway route structure data. The stored data includes the location of VHF navaids, airports, runways, geographical reference points, and other airline-selected information such as SIDs, STARs, approaches, and company routes. Up to 40 additional waypoints can be entered by the pilot into a temporary database.

The FMS contains two sets of navigation data updated by maintenance procedures about every month to correspond to the normal revision cycle for navigation charts. When the navigation chart revision date arrives, the new data should have been loaded into the FMS and should be ready for the pilot to activate during preflight.

Multifunction Control and Display Unit

FMS generated data, command entries, and performance data are displayed on the MCDU on individual full-screen pages. Each flight mode will have its own individual page or pages, as will other functions of the FMS such as: identification, initialization/reference, position initialization, position reference, navigation reference data, takeoff, approach, maintenance, data (sensor status), holding pattern, route data, route legs, and route progress.

Two different character sizes are used on the display pages. The larger is used for data that has been entered by the pilot or retrieved from the data base, such as speed/altitude constraints at identified waypoints. The smaller is used for data identification and also to display predicted or calculated data such as course/distance between waypoints. The top line on the MCDU is the title line, displaying flight mode, submode and the number of pages of that mode with an indication of which page is currently displayed. The bottom of the screen is the scratchpad area where messages are displayed and information is entered for selection into the appropriate data field.

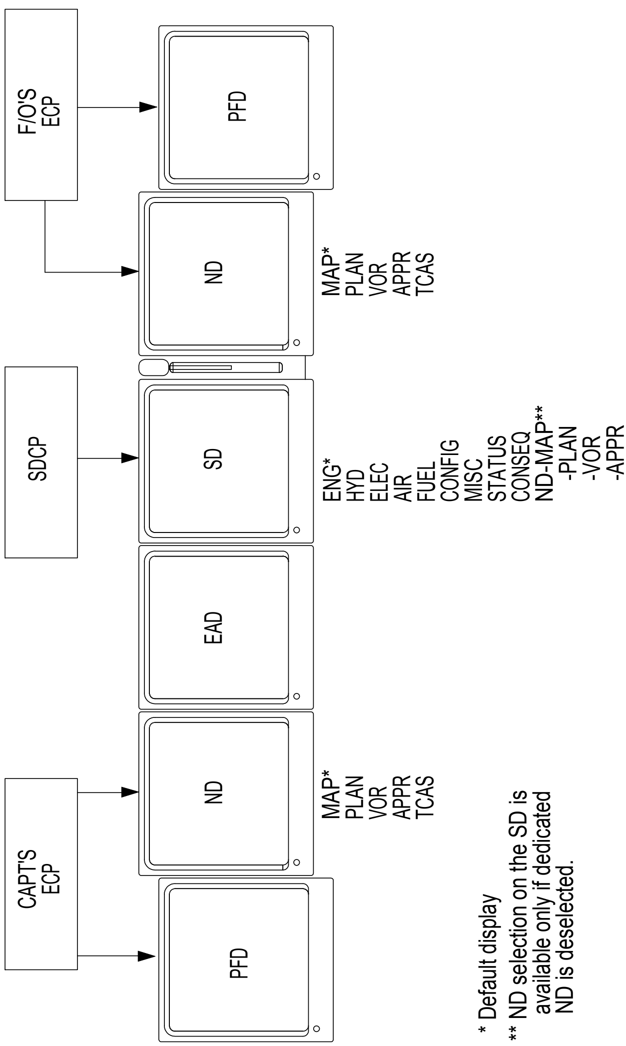
Each page is made up of 6 data entry lines (excluding the title line and scratch pad line), left and right, creating 12 data fields. There are 24 characters per line. The screen is framed by 12 line select keys (LSK). These LSKs are used to enter information into the adjacent data field, select the FMS function or submode, or to select different pages whose title appears in the corresponding data field. The pilot uses the keyboard to type entries into the MCDU scratchpad. The data is then transferred into the appropriate data field using the LSK adjacent to that field.

Data entered by the pilot into the MCDU is checked for reasonableness and validity. Rejected data and attempts to enter data into a non-accessible field will generate an INVALID ENTRY message in the scratchpad. Data necessary for system operation will be displayed as box prompts in the appropriate field, and optional data fields will be displayed as dashes.

Pushing an LSK when the scratchpad contains data causes its adjacent data field to accept the data. If the adjacent data field contains a prompt, pushing the LSK will carry out the prompted action. Data necessary for the flight or for flight calculations may not be deleted in flight. However, some data may be updated when the system is in operation. If data necessary for system operation are omitted during preflight, a message will appear indicating which data needs to be added. Individual data fields may be cleared by pushing the CLR key, then pushing the appropriate LSK for the data field. The CLR key will delete any entry or message in the scratchpad.

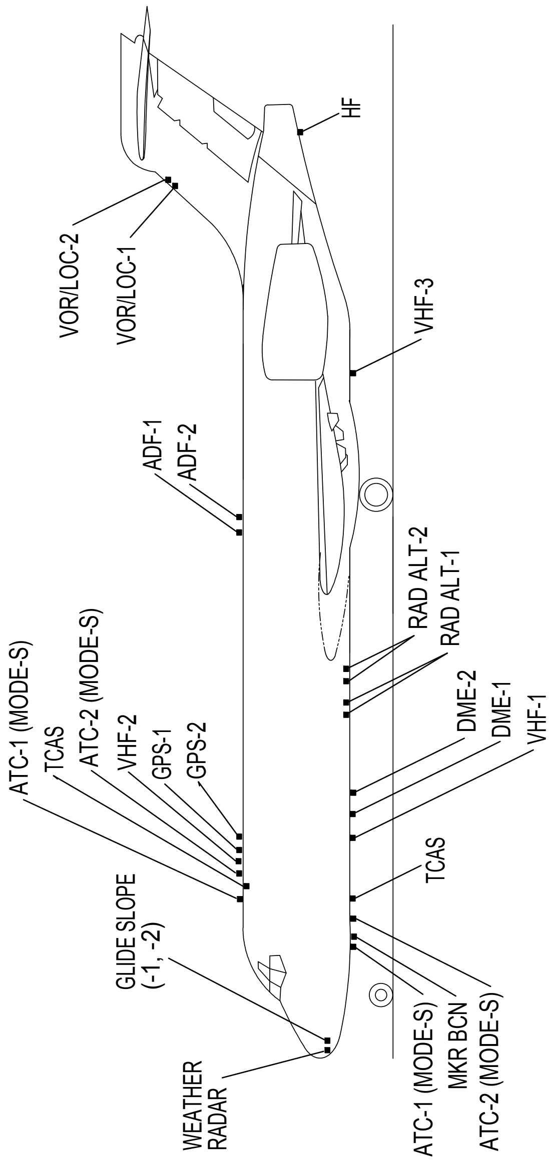
The MCDU is also used to display messages. Messages are either alerting or advisory, depending upon the severity of the set condition. The alerting messages cause the CDU MSG annunciation displayed on the ND.

EIS Components & Displays



KB1-3-0105A

Antenna Locations



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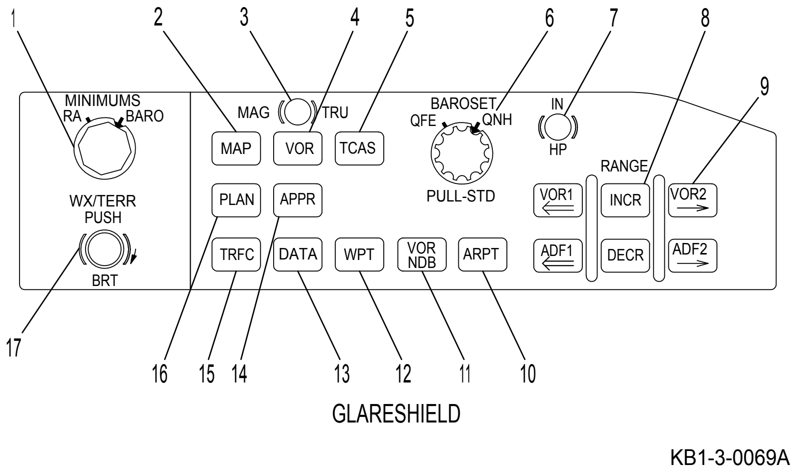
EIS Control Panel



1. **MINIMUMS Knob**

   RA - Sets RA bug on PFD altitude tape by rotating the inner collar.

   BARO - Sets BARO bug on PFD altitude tape by rotating the inner collar.

   Push - Resets PFD DH alert and silences the aural warning.

2. **MAP Switch**

   Push - Selects MAP display on ND. Non-flight plan waypoints, airports, navaids, weather radar data and bearing pointers are displayed.

3. **MAG/TRUE Button**

   Push - Selects MAG or TRUE reference for heading/track indicator on the ND MAP display.

4. **VOR Switch**

   Push - Selects VOR display on ND.

5. **TCAS Switch**

   Push - Selects dedicated TCAS display on ND with 10 NM autorange and 2 NM range ring.

6. BAROSET Knob

QFE/QNH - Selects altitude above station (QFE) or altitude above sea level (QNH) by rotating inner collar. Value is displayed on PFD.

Pull - Selects standard baroset (29.92 or 1013.2 Hp). Value is displayed on PFD.

With Alert Service Bulletin 717-34A0002 incorporated or production equivalent, the ISIS BARO set knob is now independent from the Captain's BAROSET knob on the ECP. Any barometric inputs to the ISIS will require the use of the ISIS BARO set knob.

7. IN/HP Button

Push - Changes BAROSET value in inches of mercury or hectopascals.

8. INCR/DECR Switch

Push - Controls MAP range from 10 to 640 NM on ND.

9. VOR/ADF Switches

Push - Controls bearing pointer display on ND.

10. ARPT Switch

Push - Selects non-flight plan airports normally not displayed on ND.

11. VOR/NDB Switch

Push - Selects display of non-tuned VORs, DMEs, VOR/DMEs, or non-directional beacons on ND. Tuned stations are not deselectable thru this switch.

12. WPT Switch

Push - Selects display of non-flight plan waypoints on ND.

13. DATA Switch

Push - Selects display of waypoint data on ND. Waypoint data consists of an identifier, crosstrack deviation, and waypoint constraint data.

14. APPR Switch

Push - Selects APPROACH mode display on ND.

15. TRFC Switch

Push - Selects full time TCAS display on ND.

16. PLAN Switch

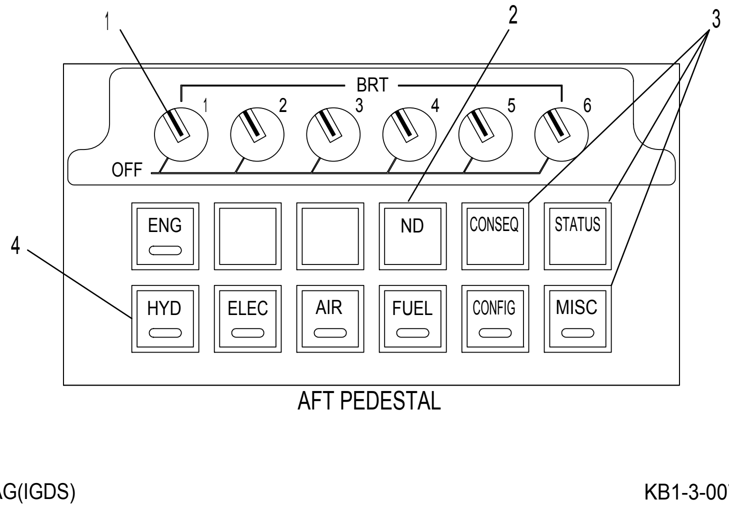
Push - Selects PLAN mode display on ND.

17. WX/TERR Switch

Rotate - Adjusts weather radar display brightness.

Push - Turns on/off weather radar display. EGPWS terrain is displayed when weather radar is not selected.

EIS System Display Control Panel



1. BRT Knob

Rotate - Adjusts respective DU brightness. Turning fully counterclockwise through a detent turns off respective DU.

With VIA-904 software incorporated, if all BRT knobs are turned off, all six DUs default to full brightness.

2. ND Switch

Push - With 1 or more DUs inoperative, causes the existing SD to become an ND.

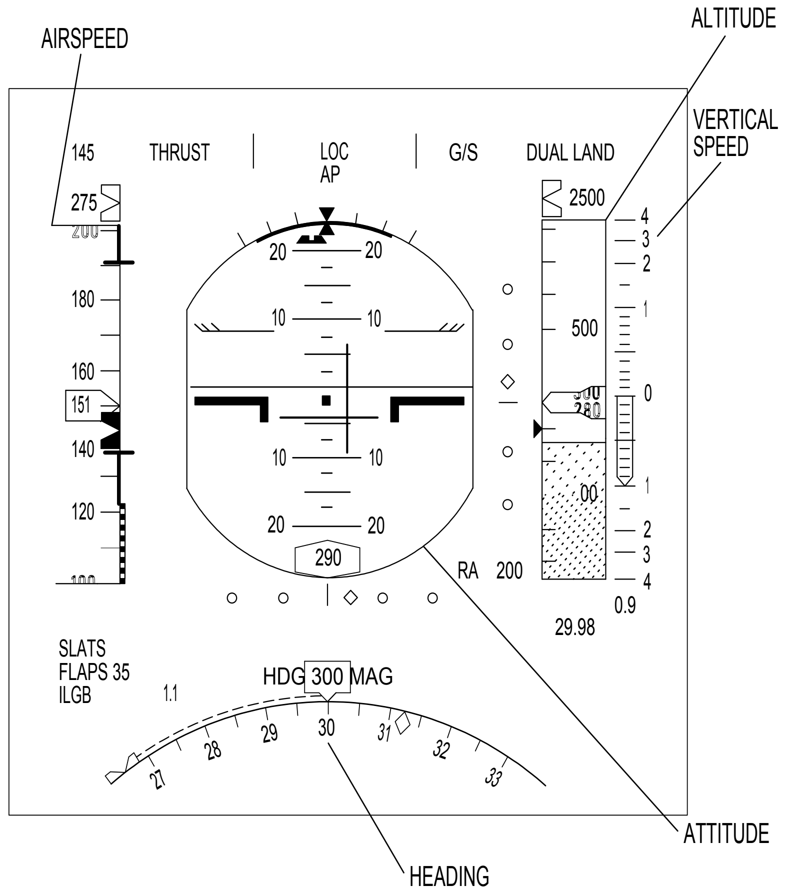
3. CONSEQ/STATUS/MISC Switch

Push - Displays respective CONSEQUENCE, STATUS, or MISCELLANEOUS page on SD.

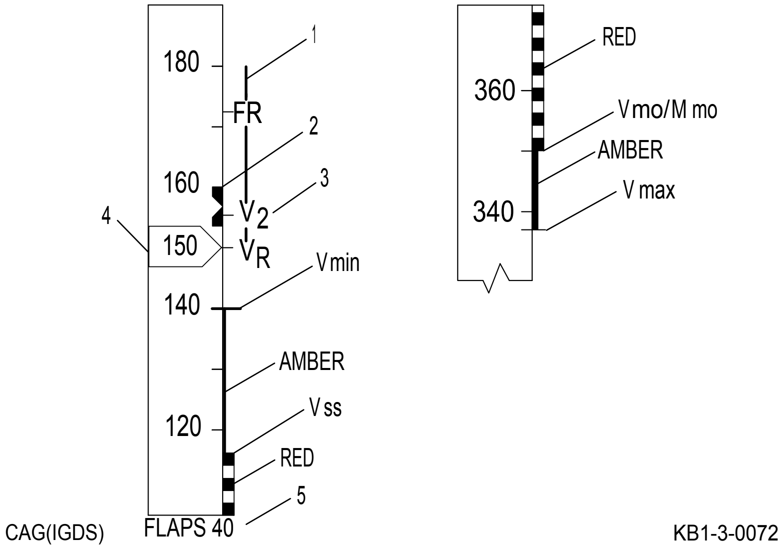
4. System Cue Switch (6)

Push - Displays applicable system (ENGINE, HYDRAULIC, ELECTRIC, AIR, FUEL or CONFIGURATION) synoptic page on SD.

EIS Primary Flight Display



PFD Airspeed Display



1. **Airspeed Trend**

   Displayed as a green column. The end of the column is the airspeed to be achieved in 10 seconds.

2. **Airspeed Bug**

   - White solid - Selected airspeed.
   - White outline - Preselected airspeed.
   - Solid magenta circle - FMS commanded airspeed.
   - Outlined magenta circle - FMS speed not selected.

   If selected speed is set lower than Vmin, the white bug stops at Vmin and an amber reference bug will be at the selected speed.

   If selected speed is set lower than Vss, a red reference bug will be at the selected speed.

   If selected speed is set higher than Vmo/Mmo, the white bug stops at Vmo/Mmo and a red reference bug will be at the selected speed.

   Speed/Mach bugs can park off scale above or below the tape and a digital value will be displayed next to the bug.

   Mach is displayed to the right of the airspeed when above 0.50 Mach.

   If airspeed is no-computed data, ground speed and TAXI will be shown.

3. Speed Bugs

V1, VR, V2, FR, GR, SE, FE, and GE bugs are on outside of the tape. If Vspeeds have not been computed, V1, VR, and V2 are attached to dashed boxes.

4. Airspeed

Shown at the center of tape.

- Box and digits red - A/S below Vss or exceeds Vmo/Mmo.
- Box and digits amber - A/S below Vmin or exceeds Vmax.

Vss is the end of a red checker column.

Vmin is a line at the end of an amber column extending from Vss.

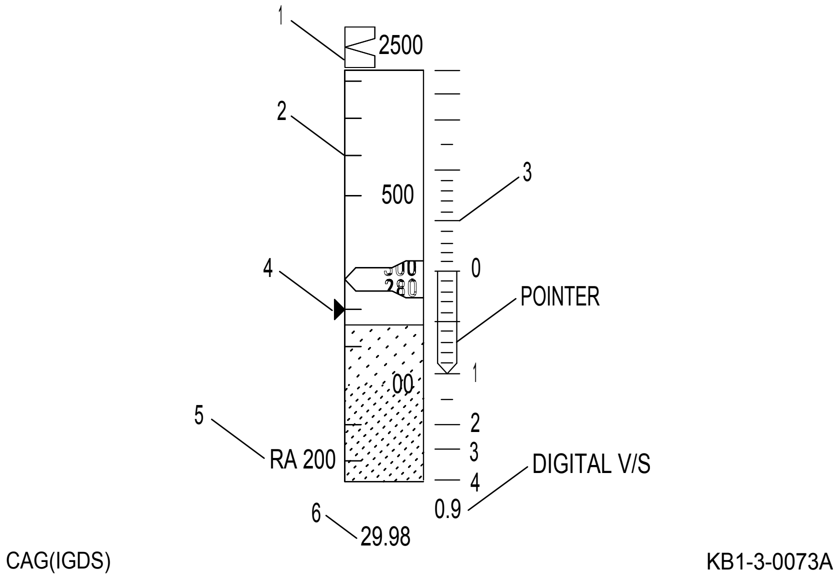
Vmo/Mmo is a line at the end of a red checker column extending from the high end of the tape.

Vmax is a line at the end of a narrow amber column extending down from Vmo/Mmo.

5. Flap/Slat

Invalid flap positions are flagged with an amber X. Slat messages turn amber and are boxed when they are in disagreement with extended flaps.

PFD Altitude/ Vertical Speed Display



1. **Altitude Bug**
   - White outline - Preselected altitude.
   - White solid - Selected altitude.
   - Magenta circle - FMS constraint altitude. Circle is filled when FMS engaged. It is outlined if the crew has intervened in an FMS profile, FMS altitude is beyond FGCP set altitude, or FMS is engaged the preselected altitude.

   Selected altitude bug may be parked off each end of altitude scale with digital display next to it.

2. **Altitude Tape**

   Tick marks are 100-foot increments. White shading is for QNH display. Green shading is for QFE display. Feet are white. Altitude tape turns amber and flashes to correspond with CAWS altitude advisory alert.

   If QFE operation is selected, baroset will change to QFE value and a box with QNH baroset value and altitude in feet will appear below the baroset.

3. Vertical Speed

Current vertical speed (V/S) is shown by a wide outline pointer. Range is +/- 4,000 fpm, with tick marks every 100 feet below 1,000 feet. Pointer appears when V/S is more than 100 fpm and remains until below 50 fpm.

If V/S is more than 100 fpm, current V/S is shown digitally above scale for positive V/S, or below scale for negative V/S.

Pointer fits in the selected V/S bug when the selected V/S is achieved.

4. Minimum Bug

Solid triangle with white color (above minimum) or amber (below minimum). RA minimum bug is on the left side of the tape. BARO DH minimum bug is on the right side.

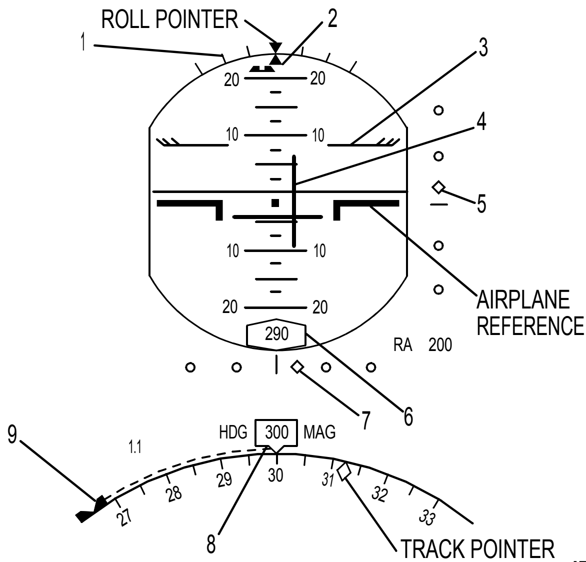
5. Selected Minimum

Value is amber, boxed and flashes for 5 seconds when minimum altitude is reached.

6. Baroset

Set with the BAROSET knob on the ECP. Last valid baro setting is latched if communication anomaly occurred between the ECP and the VIA. Should the communication be re-established, the setting will be boxed and flash indicating that the setting can now be changed from the latched value.

PFD Attitude Display



CAG(IGDS) JB1-3-1017

1. **Roll Indice**

   Short ticks show 10 and 20 degrees, long ticks show 30 and 60 degrees, and a triangle shows 45 degrees roll.

2. **Slip/Skid Indicator**

   Moves parallel to the horizon line in the direction of rudder required. Turns amber when separating from roll pointer.

3. **Pitch Limit Indicator - cyan**

   Indicates difference between airplane angle-of-attack (AOA) and stickshaker AOA. Turns red at stickshaker.

4. **Flight Director - magenta**

   Displayed automatically for go-around or windshear. Default condition is FD on.

5. **Glideslope Pointer and Scale**

   Glideslope deviation scale is in view after the ILS is tuned. The magenta glideslope pointer is in view when valid glideslope data is received to indicate glideslope position relative to the airplane. Pointer changes to amber and flashes if the glideslope deviation exceeds 1 dot between 500 and 100 feet RA while G/S displayed in FMA vertical mode window.

6. **Radio Altitude**

Displayed below 2,500 feet AGL. Box and digits are normally white but turn amber for altitudes below the minimum altitude set on the ECP.

- At about 430 feet AGL, the RA box starts to move up so that the top of the box reaches the center of the attitude indicator at 0 feet RA.
- An optional magenta T rising runway symbol begins rising at 200 feet AGL and moves laterally with the localizer. The symbol will flash for excessive localizer deviations (.27 dots). An E symbol on top of the RA box provides localizer deviation alignment.

7. **Localizer Pointer and Scale**

Localizer deviation scale is in view after the ILS is tuned. The magenta localizer pointer is in view when valid localizer data is received to indicate localizer position relative to the airplane. Pointer changes to amber and flashes if the localizer deviation exceeds 1/4 dot between 300 and 50 feet RA while LOC displayed in FMA roll mode window.

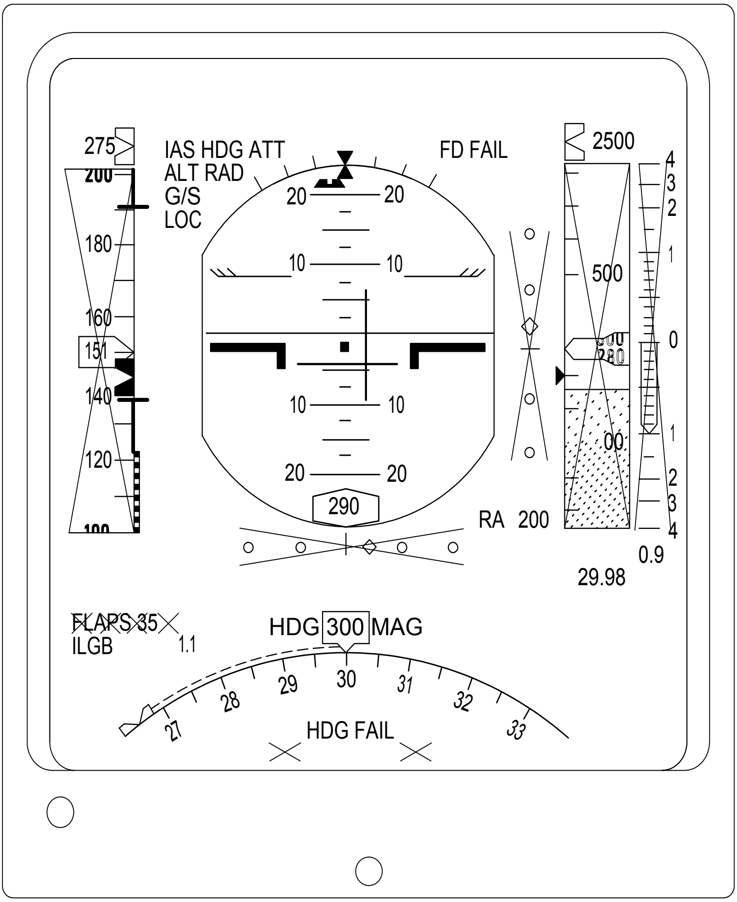
8. **Heading**

Heading is MAG (dim white) but changes to TRU (cyan) at latitudes greater than 72 degrees.

9. **Heading Bug**

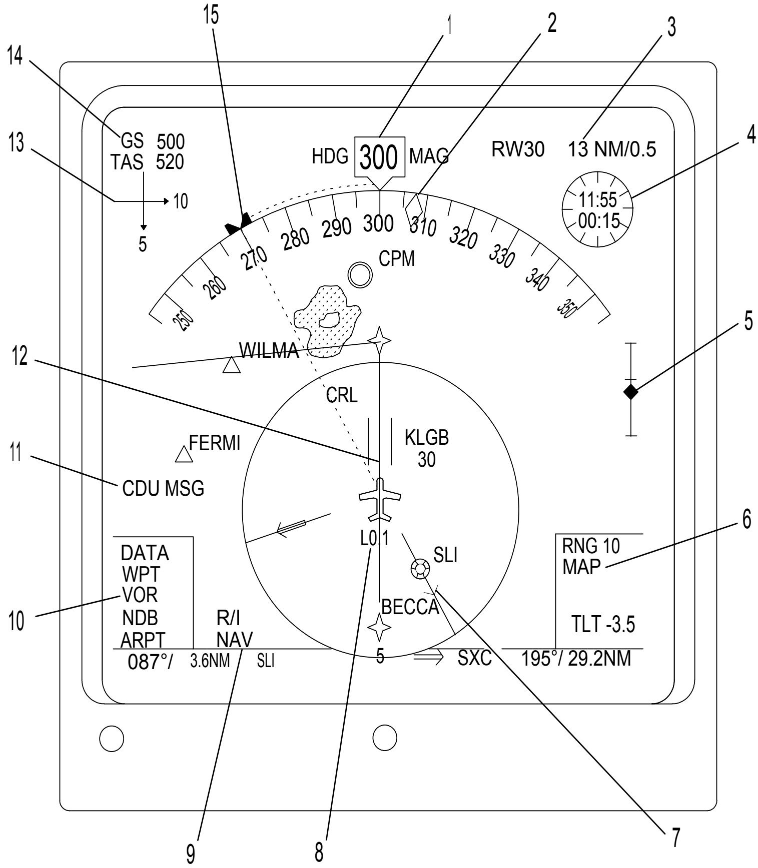
Bug is outline when preselected and filled when selected.

PFD Test Display



CAG(IGDS) KB1-3-0078

Navigation Display- Map Mode (Typical)



The MAP mode is selected by pushing the MAP switch on the ECP. The MAP mode has the following characteristics:

- The map is referenced to the airplane position and heading (or track).
- It allows display of non-flight plan waypoints, airports, navaids, weather radar data, and bearing pointers.

KB1-3-0075

1. Heading/Track

Displays HDG/TRK as the display orientation, current heading/track, MAG or TRU as the reference, and points to the heading on the compass rose.

2. Track Pointer - green

Points to track in heading mode. Pointer is removed in track mode.

3. Distance/Time-To-Go - magenta

Distance and time to the active FMS waypoint.

4. Clock

Displays current time (UTC) on top and elapsed flight time on the bottom. Elapsed time starts at lift-off and stops at touchdown. Elapsed time resets to zero when the FMS is initialized for the next flight.

5. FMS Vertical Deviation - magenta

Displays vertical deviation from selected VNAV path during decent only. Full scale deviation is 1,000 feet. For deviations more than 1,000 feet, half the pointer is visible in direction of the deviation.

6. Weather Radar Message

Status messages:

- RNG - Range displayed in NM.
- MAP - Ground mapping mode.
- STBY - No scanning, transmitter off.
- WX - Weather radar detection on.
- WXR OFF - Weather radar detection off.
- WX/T - Weather/Turbulence detection on.
- SCH - Search/Precipitation detection.
- TURB - Turbulence detection on.
- TEST - Test mode on.
- GCS/ID - Ground clutter suppression on.
- VAR - Variable gain.
- ATT - Attitude (stabilization) inputs are invalid.
- STAB - Stabilization not selected.
- TLT - Tilt angle displayed in degrees.

Test messages appear above the status messages during Test mode:

- R/T - Receiver/transmitter problem.
- ANT - Antenna not scanning.
- CNTL - Control panel problem.
- COOL - High receiver/transmitter problem.
- CAL - Automatic calibration not available. Low transmitter power.

- ATT - Attitude (stabilization) inputs are invalid.

Messages appear in the center of ND:

- WRX ON - Flashes white. Radar on and airplane on ground.
- WXR FAIL - Flashes amber. Radar failure.
- WXR RANGE DISAGREE - ND range is 640 NM. Radar range capability is 320 NM.

7. Bearing Pointer

Indicates bearing to the tuned station. Pointer 1 (cyan single arrow) always for left radios and pointer 2 (green double arrow) for right radios. Bearing pointer data is at the bottom of ND.

8. Crosstrack Deviation

Displayed when the DATA switch on ECP is pushed.

9. Navigation Mode

Messages displayed:

- R NAV - Radio navigation only.
- IRS NAV - Inertial navigation only.
- R/I NAV - Radio and inertial navigation.
- NO NAV - No navigation mode is active.
- G/I - GNS/Inertial navigation.
- GNS NAV - GNS navigation.
- Any invalid mode is flagged with an amber X.

10. Active MAP Mode

Additional map data is controlled with DATA, WPT, VOR, NDB, and ARPT mode switches on the ECP.

11. CDU Message

A message is displaying on the MCDU.

12. Flight Plan Course

Flight plans are shown according to selected range and are displayed from the last waypoint passed through all succeeding waypoints:

- Active - A series of magenta lines and arcs.
- Secondary - Cyan dotted lines.
- Provisional - (Alternate Destination). Magenta dotted lines and arcs.
- Offset - Long magenta dashed lines and arcs.
- Temporary - Short magenta dashed lines and arcs.

13. Wind

Cross track and along track are labeled with wind speed. For the vector display option, a white vector points wind direction with direction and speed in digits below.

Wind is displayed when wind speed is more than 5 knots. Display is removed when wind speed is less than 3 knots.

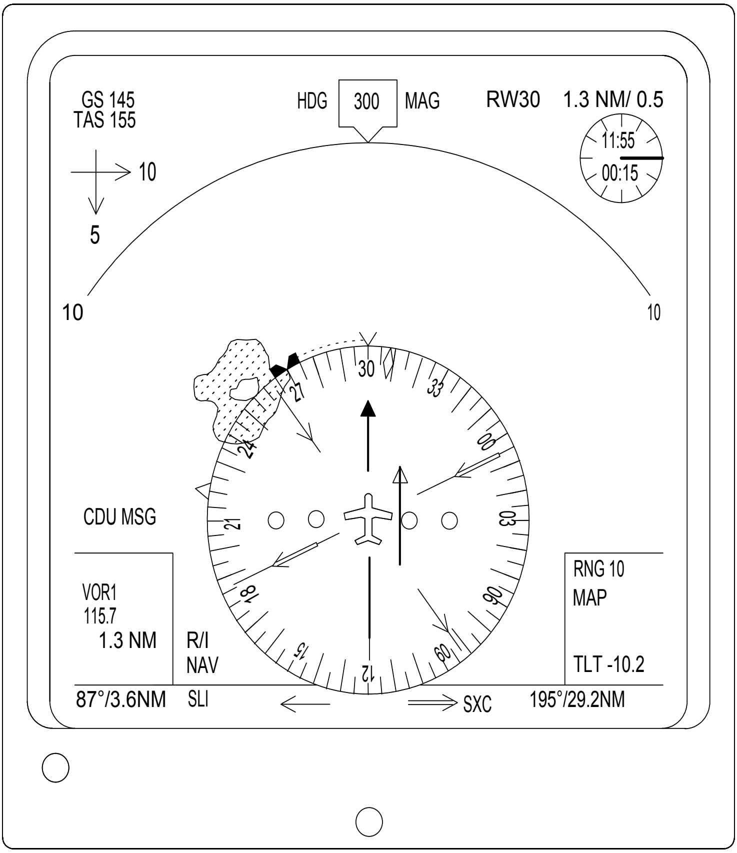
14. Speed

Indicates airplane ground speed and true airspeed.

15. Selected Heading/Track Bug

Selected heading/track is filled white bug. A white dotted arc is turn direction. A white dotted line extends from airplane symbol to the bug. The line is removed when a selected heading has been captured or the airplane is in FMS NAV with no preselected heading or track. Preselected bug is the same except that it is outlined only.

Navigation Display - VOR/APPR Mode (Typical)



The VOR mode is selected by pushing the VOR switch on the ECP.
The VOR mode has the following characteristics:

- Weather radar data may be displayed
- A compass rose is centered around the reference airplane and represents half the selected weather radar range. Current airplane heading is at the top.
- Selected heading is shown with a solid white bug on the compass. Preselected heading is shown with an outline bug on the compass.
- The CDI is a magenta arrow and bar showing deviation from selected VOR course. Four circles make up the CDI scale.
- To/from is shown by an arrow on the end of the CDI bar.
- CDI source and DME distance is shown in the lower left.

The APPR mode is selected by pushing the APPR switch on the ECP.

- The APPR mode is identical to the VOR mode except the source for the CDI data is ILS and the to/from arrow on the CDI bar is not shown.

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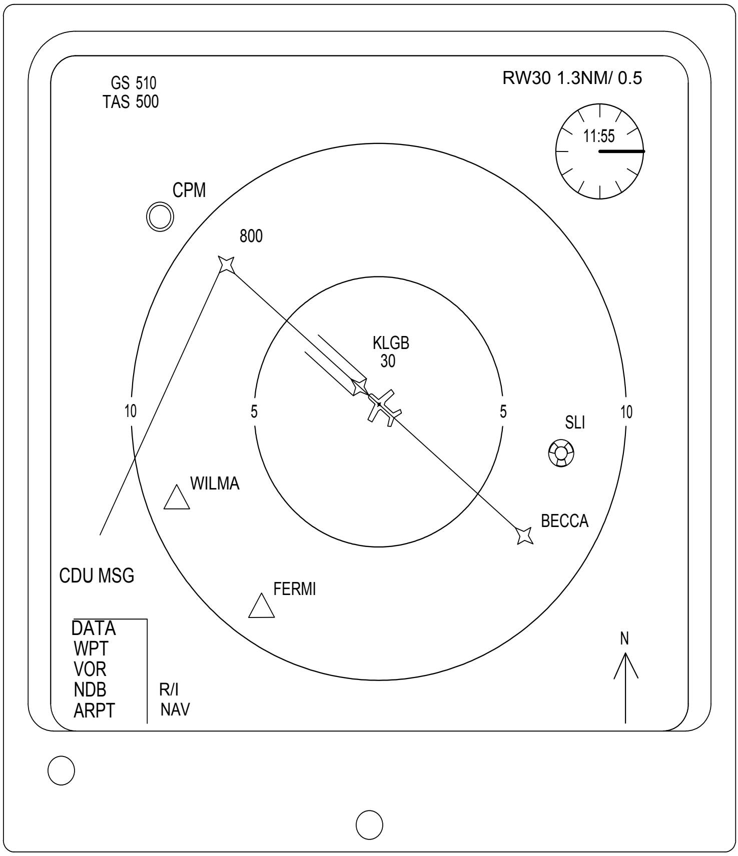
Navigation Display - Plan Mode (Typical)

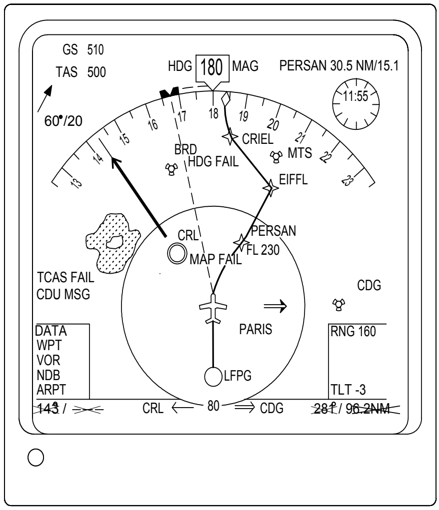


The PLAN mode is selected by pushing the PLAN switch on the ECP.
The PLAN mode has the following characteristics:

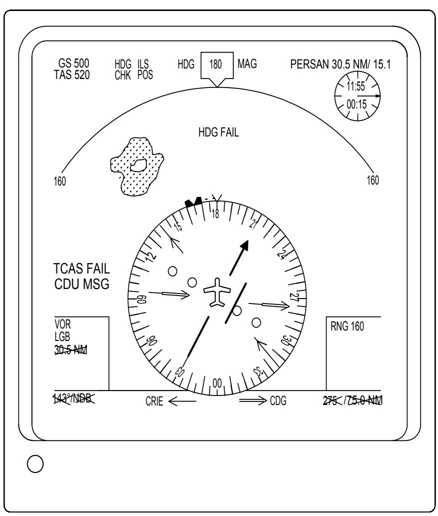
- It displays a north up flight plan.
- All map data may be displayed.
- Two range rings are centered in the display. The center of the rings corresponds with the reference waypoint selected through the MCDU. The half range ring is half the selected range.
- A north pointer is displayed in the lower right hand corner except when in the polar region (more than 85°) where the pole symbol is displayed.
- The airplane symbol is relative to true north when the present position is in the flight plan segment and range. When in the polar region (more than 85°), the airplane is relative to FMS true track.

KB1-3-0076

ND Test Displays (Typical)



MAP MODE



VOR/APPR MODE

All display failure indications will be displayed on the ND when the airplane is on the ground and the ANNUN LT TEST switch on the forward overhead panel is pushed.

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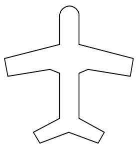
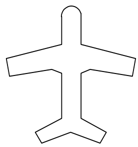
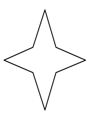
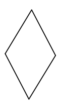
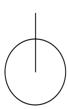
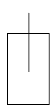
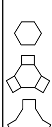
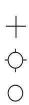
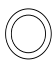
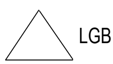
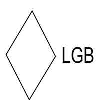
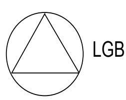
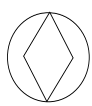
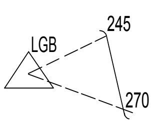
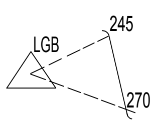
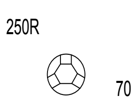
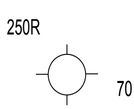
ND Flight Plan Symbology (Sheet 1)

U.S. SELECTED	EUROPEAN SELECTED	EXPLANATION
		Airplane Symbol The airplane symbol is visible in all modes. In the PLAN mode the symbol will be displayed only if the present position of the airplane is within the flight plan segment and range. Symbol will point to true north, except in polar ranges above the 85° latitude when symbol will be referenced relative computed FMS track. In the MAP mode symbol will be oriented relative to airplane heading.
 PERSAN 12:00 FL230	 PERSAN 12:00 FL230	Waypoint and Waypoint Data The active (next) waypoint and its identifier are displayed in magenta; all other flight plan waypoints are displayed in white. Waypoint data consists of any constraint data from the FMS at the waypoint. Waypoint data is displayed in the same color (magenta or white) as the associated waypoint. Display of waypoint data is selected/deselected by pushing the DATA switch on the ECP.
		Airports Destination and departure airports are white and are displayed with runway lines (when available), or as parallel lines indicating runway orientation (scale 40 nautical miles or less). Display of Non-Origin/Destination airports (displayed as cyan circles) may be selected or deselected with the ARPT mode switch on the ECP.
 VOR VORTAC DME/TACAN	 VOR VORTAC DME/TACAN	VOR Non-tuned VOR, DME, or VOR/DME stations are displayed in cyan and can be selected or deselected by pushing the VOR switch on the MSP. Tuned stations (through MCDU) are displayed in white and are not deselectable through the ECP.

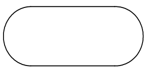
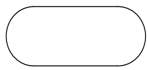
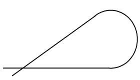
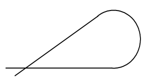
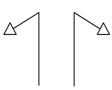
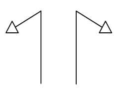
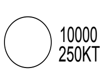
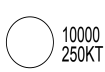
KB1-3-0080

ND Flight Plan Symbology (Sheet 2)

U.S. SELECTED	EUROPEAN SELECTED	EXPLANATION
		NDB Non-tuned or Non-Directional Beacons (NDB) are displayed in cyan and are selected/de-selected by pushing the NDB switch on the ECP. Tuned stations are displayed in cyan within a magenta circle and are not deselect-able through the ECP.
		Ground Reference Points Ground reference points (non-flight waypoints) are displayed in cyan, and can be selected or deselected by pushing the WPT switch on the ECP.
		Selected Reference Points Up to two ground reference points or navaids may be selected through the MCDU. The appropriate symbol will be displayed in white circle. Points will be displayed even if sym-bology of the same class has been deselected through the ECP.
		Selected Reference Points Radials Up to four (three selectable plus a beam) radials from selected reference points may be displayed as a white dashed line labeled with its bearing from the navaid. The display and selection of these radials is through the FMS MCDU.
		Tuned Navaids Tuned navaids are displayed in magenta within a circle (indicating FMS selection).

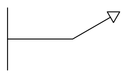
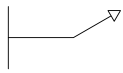
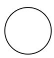
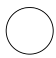
KB1-3-0081

ND Flight Plan Symbology (Sheet 3)

U.S. SELECTED	EUROPEAN SELECTED	EXPLANATION
		Holding Pattern Holding patterns are displayed using a race-track shaped symbol. For smaller ranges (80 n mi or less), the racetrack symbol is replaced with arcs and lines representing the actual flight path along the holding pattern. Holding patterns are generated by the FMS via the HOLD page. The pilot may select a holding pattern at present position (PPOS) or at a defined waypoint.
		Procedure Turns Procedure turns are displayed as a standard tear drop pattern. For smaller ranges (40 n mi or less) the procedure turn is replaced with arcs and lines representing the actual flight path in the procedure turn. Procedure turns are generated by the FMS through the PROC TURN page.
		Turn Direction Turn direction symbols are displayed in amber to indicate which direction to make a course change when it is not obvious such as a leg sequence discontinuity or a large course change.
		Speed Limit/Constraint (Climb or Descent) Altitude, speed limit, and a circle symbol represent the lateral path point the FMS predicts the climb or descent speed limit will be reached. Data is displayed in magenta. A speed limit may be entered or altered via the LEGS page on the MCDU. An altitude speed limit is defaulted into the flight plan as 250 knots at or below 10000 feet. Altitude speed limits may be altered or cleared.

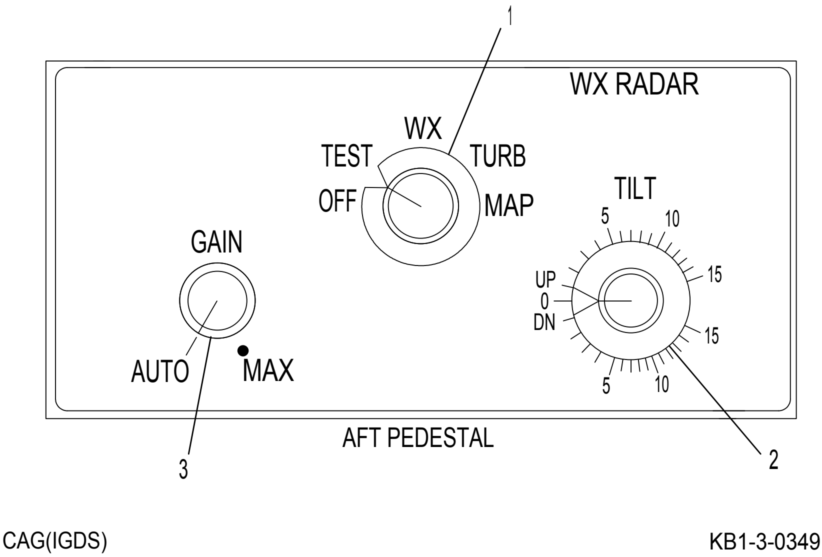
KB1-3-0082

ND Flight Plan Symbology (Sheet 4)

U.S. SELECTED	EUROPEAN SELECTED	EXPLANATION
		Step Climb The symbol is displayed in magenta and represents the lateral path point where the FMS predicts a step climb will begin.
 FL320	 FL320	Top of Climb Flight level and a circle symbol represent the lateral path point along the flight path plan the FMS predicts the airplane will level off at the requested cruise level.

CAG(IGDS) KB1-3-0115

Weather Radar Control Panel



1. **Mode Selector**

   OFF - Turns radar off. PWS function is automatically enabled in flight below 2,300 feet RA.

   TEST - Tests system. If an LRU fault exists, test message on ND will identify failed component. In addition, PWS alerts are provided as follows:

   - PFD - Flashing amber and red WINDSHEAR AHEAD messages.
   - Aural Alert - MONITOR RADAR DISPLAY, GO AROUND WINDSHEAR AHEAD, and WINDSHEAR AHEAD, WINDSHEAR AHEAD.

   WX - Displays areas of precipitation.

   TURB - Overlays turbulence on WX mode in magenta when turbulence exists.

   MAP - Displays local terrain feature.

2. **Antenna TILT Selector**

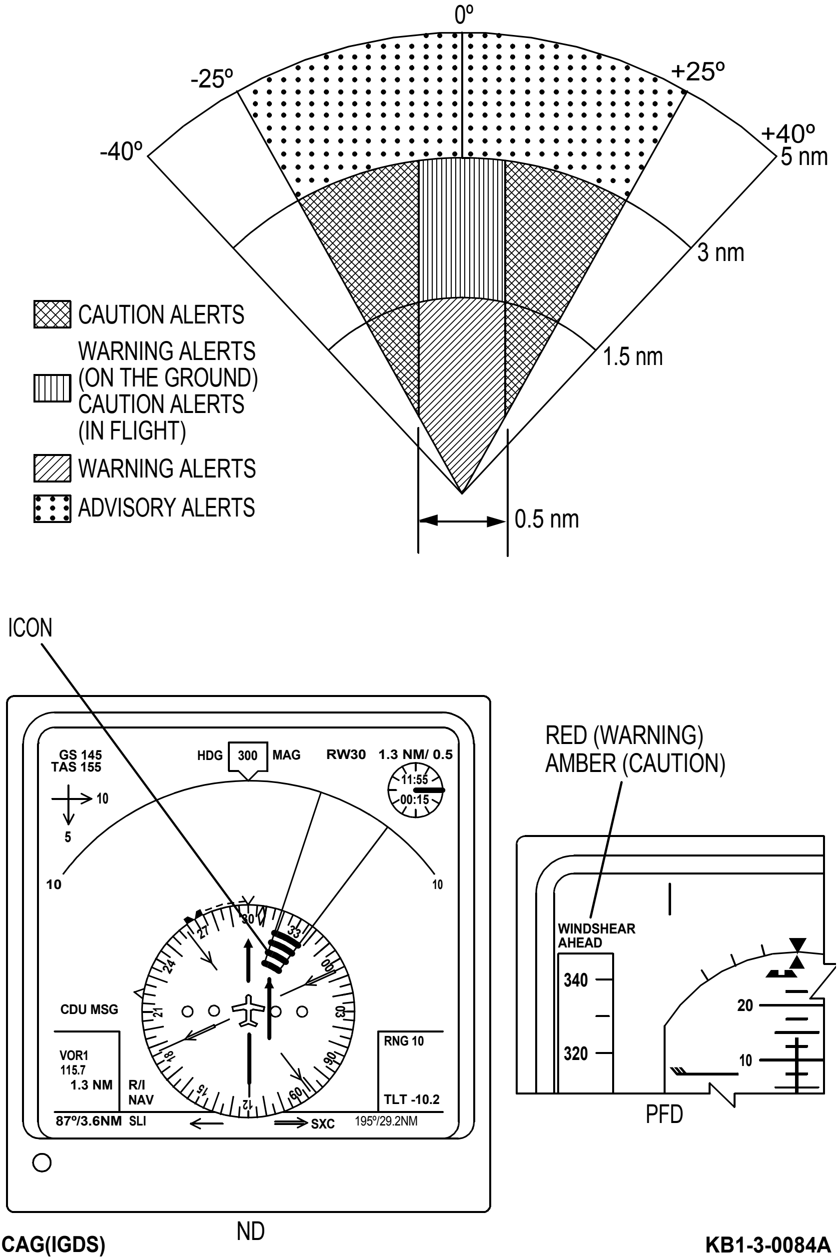
   Rotate - Tilts antenna up to +/- 15 degrees of the fuselage reference plane.

3. **GAIN Selector**

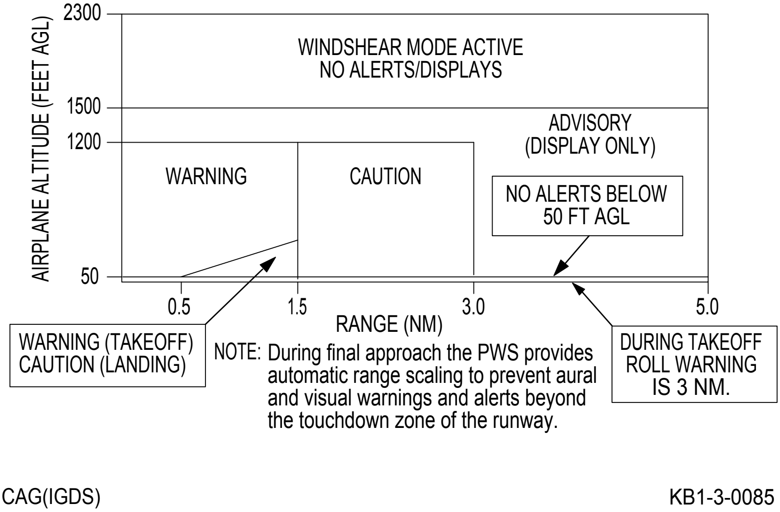
   MAX - Maximum receiver sensitivity.

   AUTO - Automatically controls receiver sensitivity.

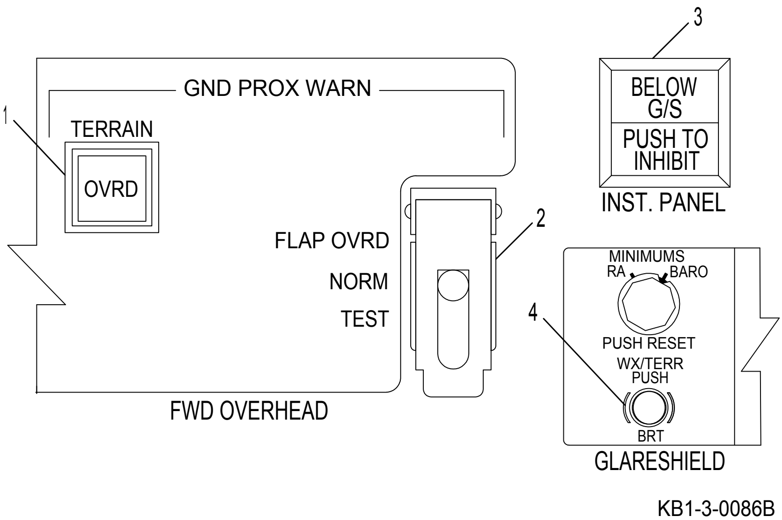
PWS Alerts


0º
-25º
+25º
-40º
+40º
5 nm
3 nm
1.5 nm
0.5 nm
CAUTION ALERTS
WARNING ALERTS (ON THE GROUND) CAUTION ALERTS (IN FLIGHT)
WARNING ALERTS
ADVISORY ALERTS
ICON
RED (WARNING)
AMBER (CAUTION)
GS 145
TAS 155
HDG 300 MAG
RW30 1.3 NM/ 0.5
11:55
00:15
CDU MSG
VOR1
115.7
1.3 NM
R/I
NAV
87º/3.6NM SLI
SXC
195º/29.2NM
RNG 10
TLT -10.2
WINDSHEAR
AHEAD
340
320
20
10
ND
PFD
CAG(IGDS)
KB1-3-0084A

PWS Alert Envelope



EGPWS Controls



1. **TERRAIN Switch**

   Push - Illuminates blue OVRD legend and disables the enhanced functions. Basic EGPWS modes are not affected. Enhanced functions can also be disabled automatically by the EGPWS.

2. **GND PROX WARN Switch**

   FLAP OVRD - Inhibits warning when landing is made with less than normal landing flap configuration.

   NORM - Normal position.

   TEST - (Momentary) Tests system integrity.

3. **BELOW G/S Switch - amber**

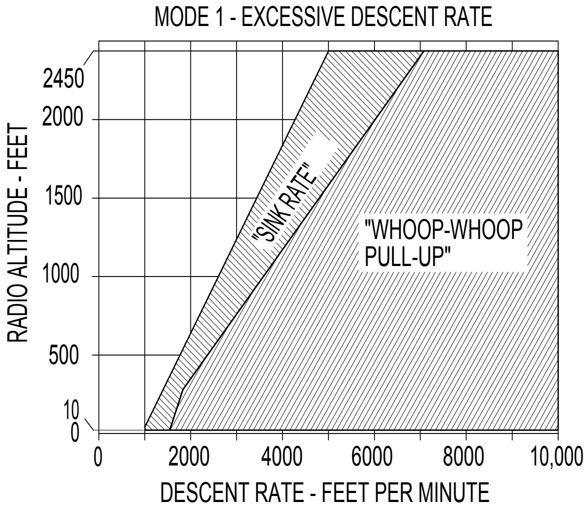
   Indicates excessive deviation below glide slope. Light is accompanied by voice warning GLIDE SLOPE.

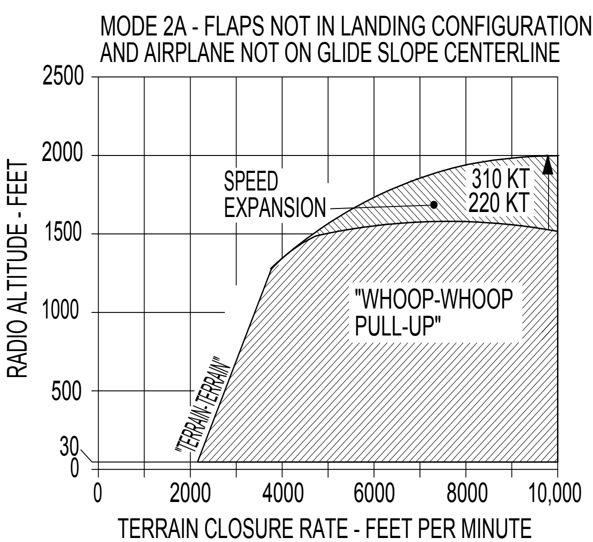
   Pushing switch when the airplane is below 1,000 feet RA inhibits or cancels warning.

4. **WX/TERR Switch**

   Push - Selects weather radar display on ND (MAP, VOR and APPR modes). Push again to deselect weather radar. Terrain is displayed when weather radar is not selected.

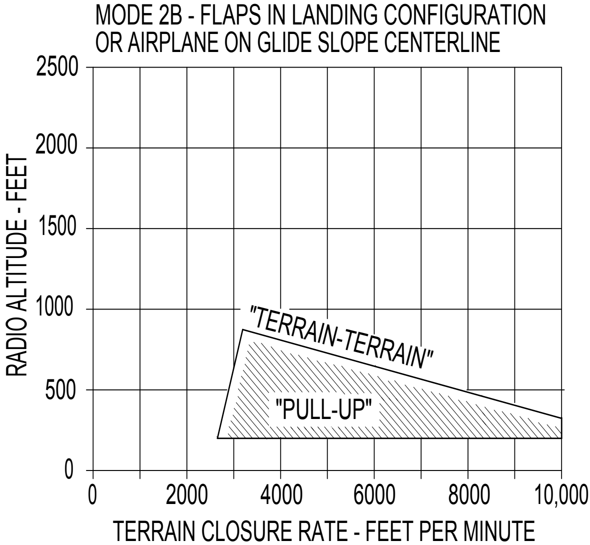
EGPWS Envelope (Sheet 1)

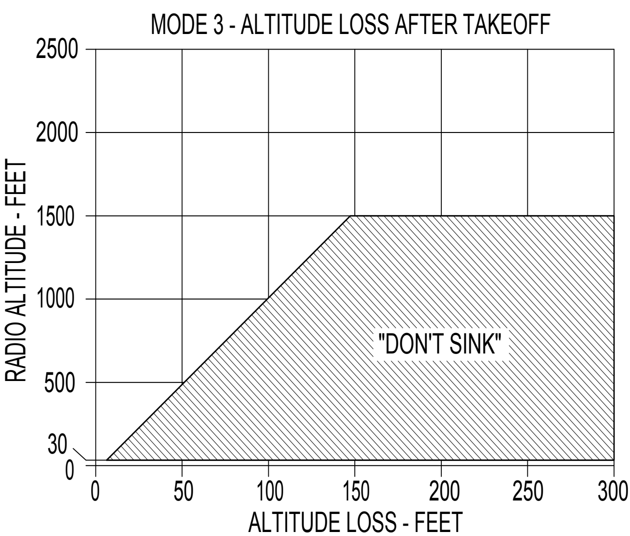




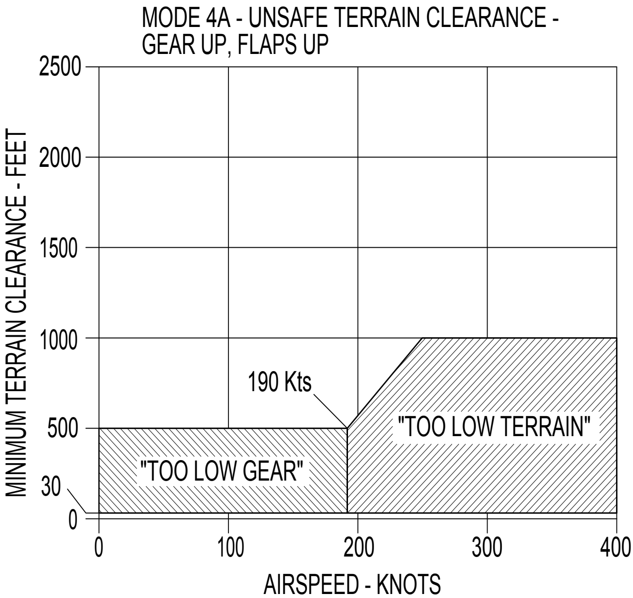
CAG(IGDS) KB1-3-0087

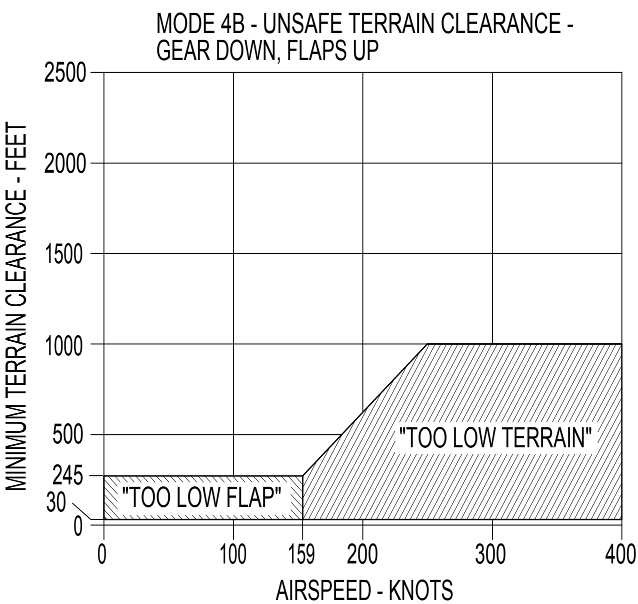
EGPWS Envelope (Sheet 2)





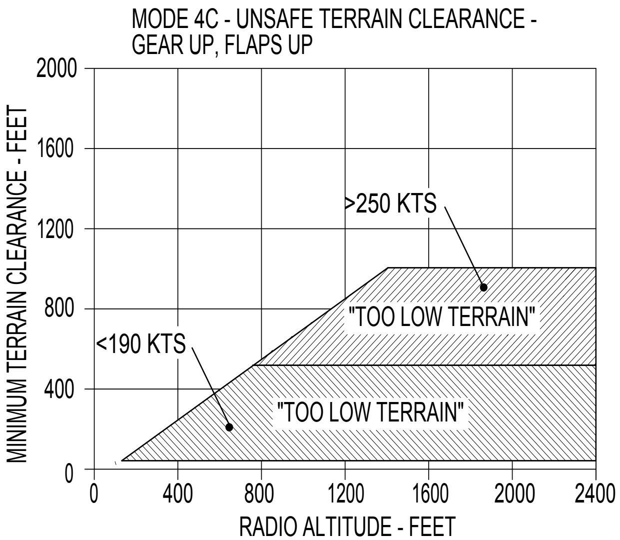
EGPWS Envelope (Sheet 3)

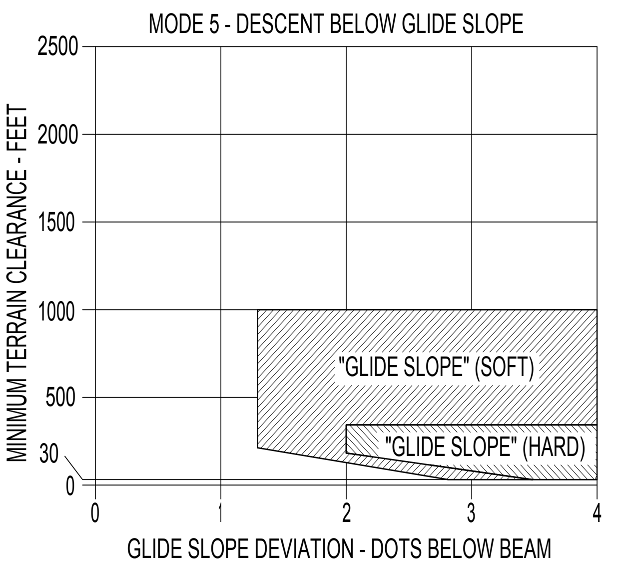




CAG(IGDS) KB1-3-0089

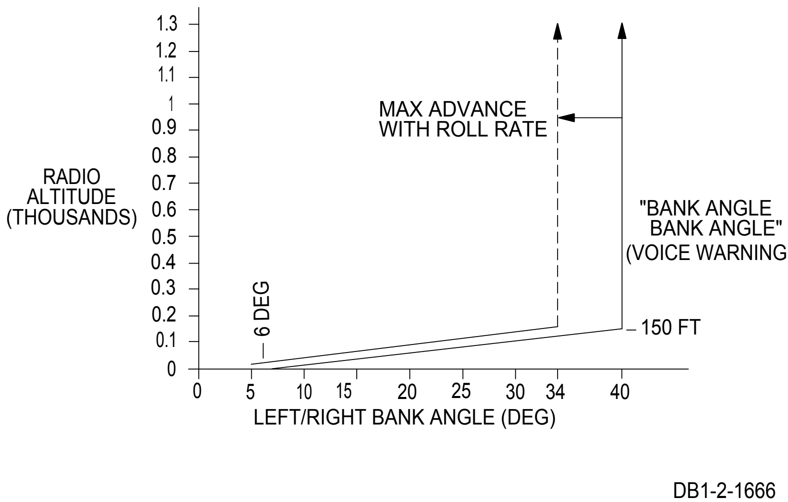
EGPWS Envelope (Sheet 4)



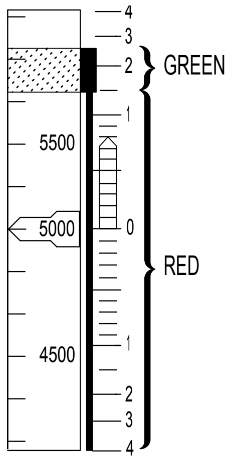


KB1-3-0090A

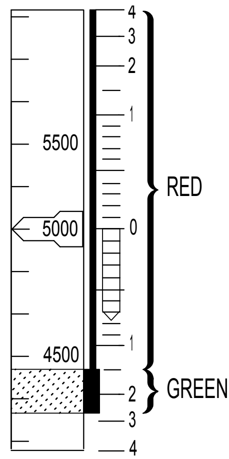
EGPWS - Bank Angle Warning Limits



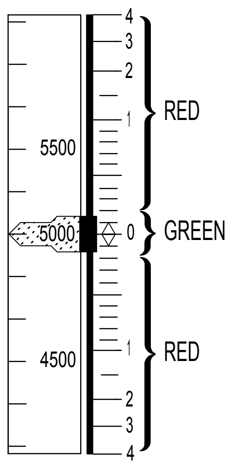
TCAS Resolution Advisories on PFD



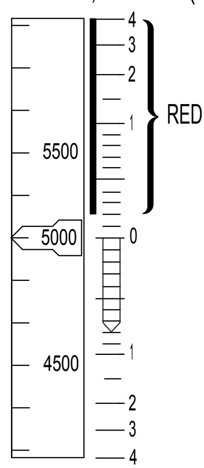
Corrective RA
Up Advisory
Climb >1500 fpm
Voice warning:
climb, climb, climb (basic).
climb, climb (change 7)



Corrective RA
Down Advisory
Descend >1500 fpm
Voice warning:
descend, descend, descend (basic).
descend, descend (change 7).



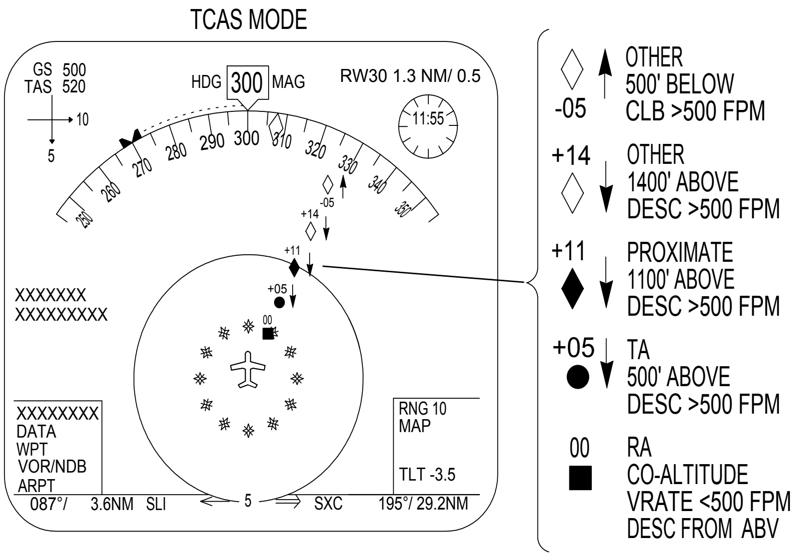
Preventive RA
Don't Climb
Don't Descend
Voice warning: monitor vertical speed, monitor vertical speed (basic & change 7).
No action required.

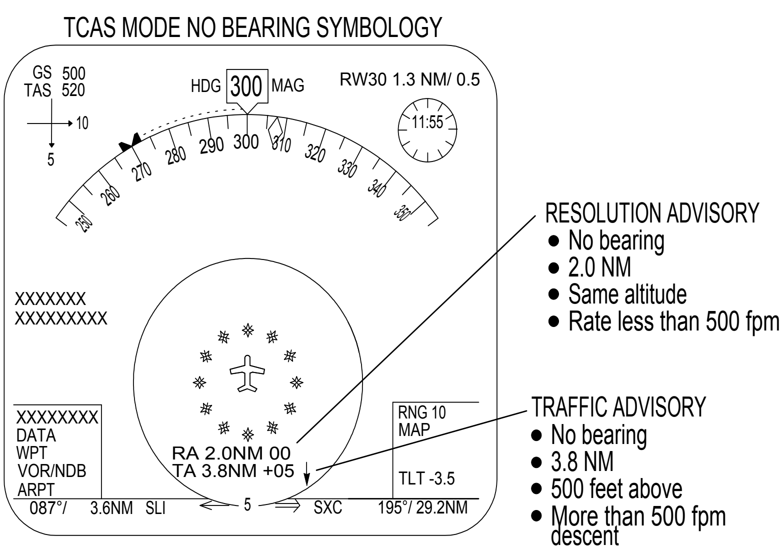


Preventive RA
Don't Climb
Voice warning: monitor vertical speed, monitor vertical speed (basic & change 7).
No action required.

KB1-3-0092A

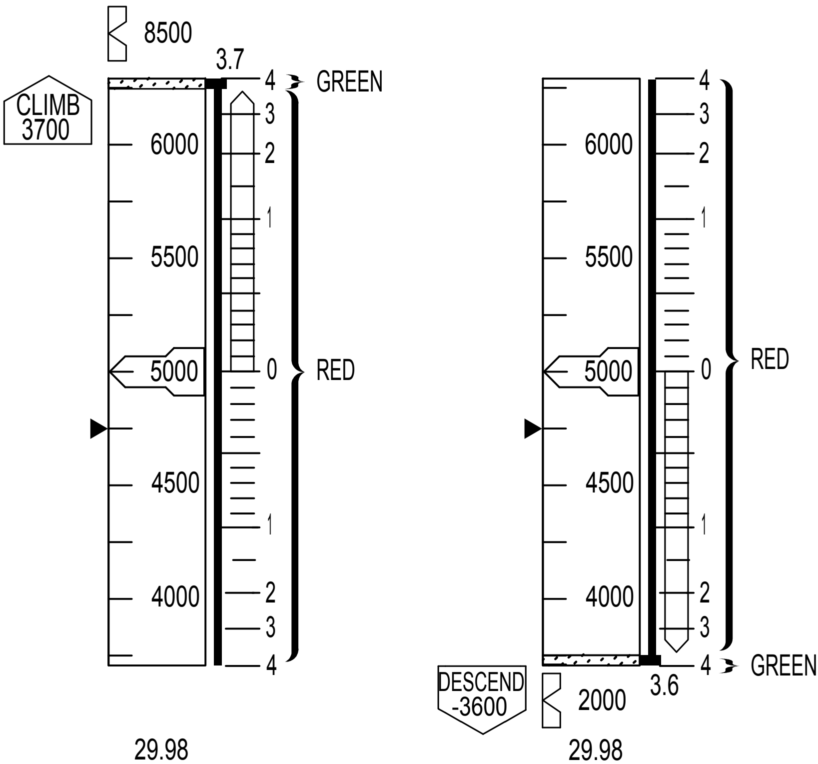
TCAS - ND Displays (Typical)





KB1-3-0093

TCAS - Off Scale RA on PFD



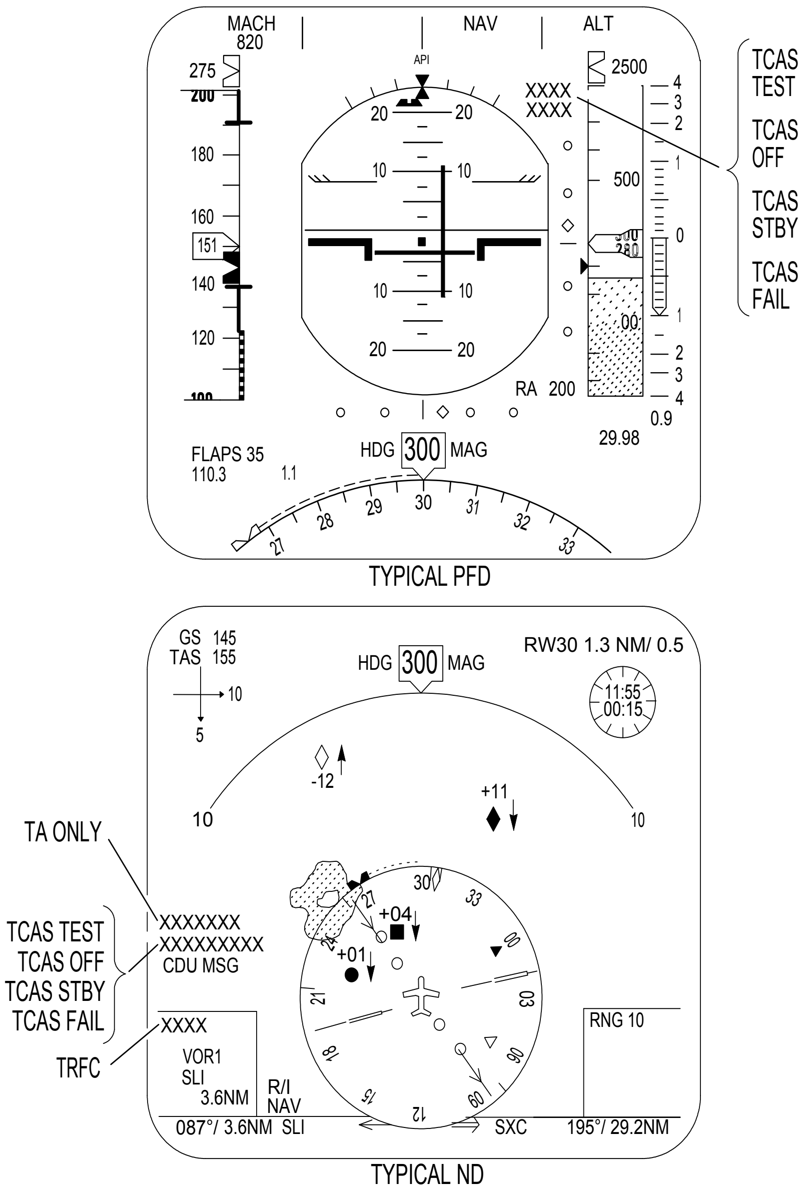
- Corrective RA
- Up advisory
- Climb 3700 fpm
- Voice warning:
- monitor vertical speed, monitor vertical speed (basic)
- maintain vertical speed, maintain (change 7).

- Corrective RA
- Down advisory
- Descend 3600 fpm
- Voice warning:
- monitor vertical speed, monitor vertical speed (basic)
- maintain vertical speed, maintain (change 7).

The limits of the PFD vertical speed tape are 4000 fpm climb and 4000 fpm descent. If an RA is more than 3000 fpm up/down, an appropriate climb or descend doghouse box appears. The required V/S appears in the box with the word CLIMB or DESCEND. The box and text are initially green, however, if desired V/S is not met the two lines forming the tip of the arrow are red and turn green when the required V/S is achieved.

KB1-3-0094B

TCAS Displays on PFD and ND



CAG(IGDS)

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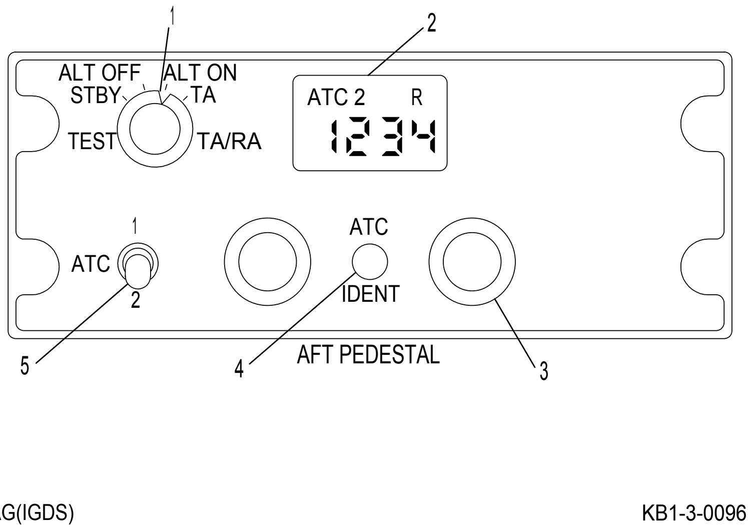
ATC Transponder



1. **TCAS/Transponder Function Selector**

   TEST - Initiates system self-test.

   STBY - Places system in standby.

   ALT OFF - Activates transponder without altitude reporting. TCAS is in standby.

   ALT ON - Activates transponder altitude reporting. TCAS is in standby.

   TA - Selects TCAS traffic advisory mode.

   TA/RA - Selects TCAS traffic and resolution advisory modes.

2. **Code Display Window**

   Displays code selected, active transponder and transponder function.

3. **Code Selector Knob (2)**

   Rotate - Selects transponder code.

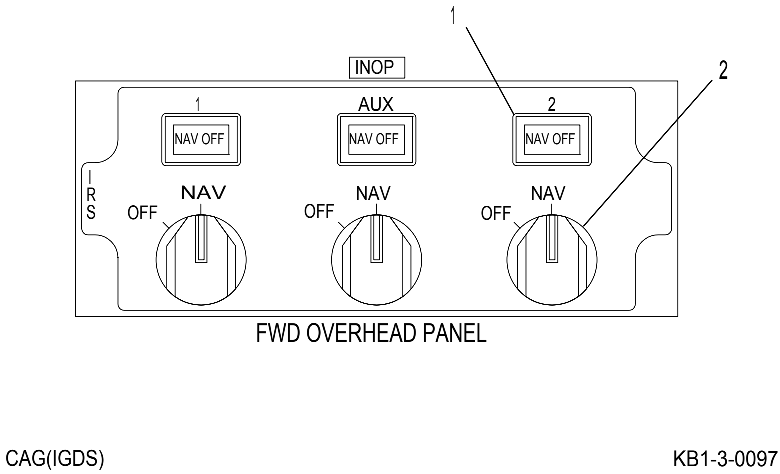
4. **IDENT Pushbutton**

   Push - Initiates pulse for identification (20 seconds).

5. **ATC Switch**

   1/2 - Selects respective transponder.

IRS Control Panel



1. **NAV OFF Light - amber**

   Illuminates when:

   - ADIRU is off.
   - ADIRU is in align mode.
   - Primary ADIRU failure.

   Flashes if:

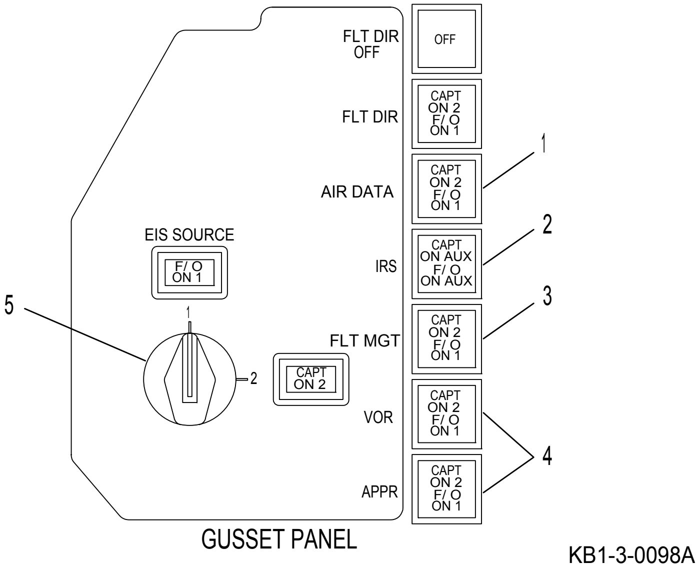
   - During alignment, ADIRU does not receive present position initialization within 5 to 10 minutes of turn on.
   - Present position entry fails the comparison test with either the stored or calculated present position.

2. **Mode Selector**

   OFF - Turns ADIRU off.

   NAV - Normal position. After initial powerup, the align mode starts automatically. Align mode takes about 10 minutes if present position initialization has been done. A 3-minute fast realignment is done by cycling the selector from NAV to OFF to NAV within 5 seconds. Realignment is initialized with the existing attitude and heading.

Source Input Select Panel (Captain's)



1. **AIR DATA Switch**

   Push - Selects off-side ADIRU source for DUs. Switch illuminates amber. Pushing again restores normal, on-side ADIRU sources.

2. **IRS Switch**

   Push - Selects off-side IRS. Switch illuminates amber. IRS 2 or IRS AUX message is displayed on the PFD. Pushing again restores normal, on-side IRS.

3. **FLT MGT Switch**

   Push - Selects off-side FMS source for DUs. Switch illuminates amber. Pushing again restores normal, on-side FMS sources.

4. **VOR/APPR Switch**

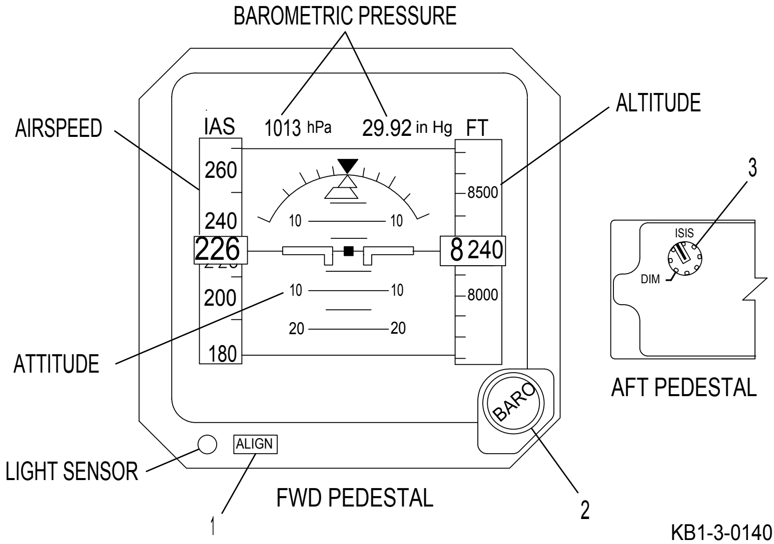
   Push - Selects off-side radio system. Switch illuminates amber. Pushing again restores normal, on-side radio sources.

5. **EIS SOURCE Selector**

   1 - Normal position for Captain's side.

   2 - Captain uses VIA-2 output for EIS. CAPT ON 2 light illuminates amber. If First Officer's selection is 1, F/O ON 1 light will illuminate amber.

Integrated Standby Instrument System



1. **ALIGN Button**

   Push - Resets attitude display. Airplane should be in level flight.

2. **BARO Set Knob**

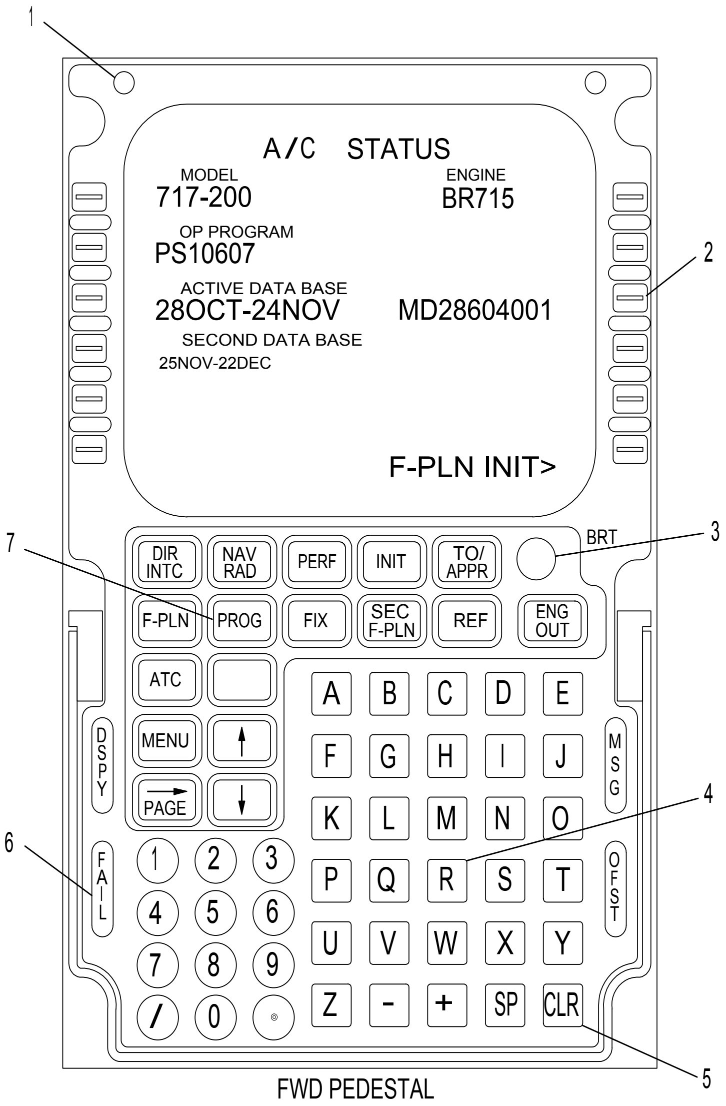
   Sets barometric pressure display in inches of mercury and hectopascals (option).

   With Alert Service Bulletin 717-34A0002 incorporated or production equivalent, the ISIS BARO set knob is now independent from the Captain's BAROSET knob on the ECP. Any barometric inputs to the ISIS will require the use of the ISIS BARO set knob.

3. **ISIS Knob**

   Rotate - Adjusts ISIS LCD brightness. The LCD will illuminate full bright automatically during electrical failure.

FMS - MCDU



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1. Light Sensor

Senses ambient light and automatically adjusts reference brightness level.

2. Line Select Key

Push - Provides for the entry, selection, or deletion of information on an adjacent line.

- Entry - Moves information to a selected line from scratchpad.
- Selection - Selects a page, procedure, or performance mode as required. Moves information to scratchpad from selected line when the scratchpad is blank.
- Deletes information from the selected line when DELETE is displayed in the scratchpad.

3. BRT Knob

Rotate - Manually adjusts brightness of CRT display.

4. Alpha/Numeric Keys

Push - Enters selected character into the scratchpad.

5. Miscellaneous Keys

- CLR Key - Push to clear data in the scratchpad.
- / Key - Used as a data separator.
- SP Key - Not used.

6. Message Light

MSG - Illuminates when the FMS generates a message displayed in the scratchpad.

OFST - Illuminates when the airplane is flying a parallel offset of the active flight plan.

DSPY - Illuminates when the current display is not related to the active flight plan leg or current performance mode.

FAIL - Illuminates when the MCDU has stopped operating properly. The screen will be blank.

7. Function Keys

DIR INTC - Selects page for flying direct to, or intercepting a course to an off-route waypoint while on active leg.

NAV RAD - Selects NAV RADIO page for tuning VOR, ADF, and ILS.

PERF - Selects PERF page for performance modes.

INIT - Selects F-PLN INIT page for initialization.

TO/APPR - Selects TAKEOFF page when on the ground or APPR page in flight.

F-PLN - Provides access to the flight plan by leg description of the active flight plan route.

PROG - Selects PROGRESS page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates.

FIX - Selects FIX INFO page for creating reference point on the ND map.

SEC F-PLN - Selects SEC F-PLN INIT page for planning or evaluating changes to the active flight plan.

REF - Selects REF INDEX page where several reference pages can be accessed.

ENG OUT - Provides manual access to the F-PLN or PERF page for review of engine-out performance. Automatic access is provided when the FCC detects an engine-out condition.

MENU - Selects MENU page to choose subsystems.

PAGE - Selects additional pages of a set when another page is required to complete the display of data.

ATC - Provides access to uplinked ATC messages if the FANS option is selected.

Up/Down Arrow - Provides up and down scrolling of flight plan, SID, STAR, and runway data that cannot be displayed on a single page. Can also be used to increment the latitude and longitude of the initial position data on the F-PLN INIT page.

NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

AIR DATA 1/2/ FAIL (MISC) - Respective air data system has failed.

IRS 1/2/AUX FAIL (MISC) - Respective inertial navigation portion of the ADIRU has failed.

Amber Alerts (Level 1)

ADIRU 1/2/AUX FAULT (STATUS) - Respective inertial navigation portion of the ADIRU may have degraded navigation performance or there is a failure of the baroset input bus from either VIA.

ATC XPDR 1/2 FAIL (MISC) - Respective ATC transponder has failed.

DCU CHANNEL FAIL (MISC) - One data concentrator unit (DCU) channel has failed.

DCU FAIL (MISC) - Data concentrator unit has failed.

DCU FAULT (MISC) - Data concentrator unit has an internal fault that may result in loss of data redundancy.

DME 1/2 FAIL (STATUS) - Respective DME receiver has failed.

EIS SINGLE SOURCE (MISC) - A single VIA channel is driving all six displays. Captain’s and First Officer’s PFDs display the same data (not independent).

FLT REC FAIL (STATUS) - Digital flight data recorder or flight data acquisition unit has failed. Flight recorder is inoperative.

FMS DUAL FAIL (MISC) - Flight management function in both VIA has failed.

FMS 1/2 FAIL (MISC) - Respective flight management function of the VIA has failed.

GPS 1/2 FAIL (STATUS) - GPS function of the respective MMR has failed.

GPWS FAIL (MISC) - GPWS has failed.

GPWS FAULT (MISC) - GPWS has detected a fault.

GPWS TERR OFF (MISC) - EGPWS terrain mode is selected off.

ILS 1/2/3 FAIL (STATUS) - Respective ILS function of MMR has failed.

IRS BATT LO (MISC) - IRS-2 or IRS Aux battery voltage is below 21 volts.

IRS OFF (MISC) - One or more IRUs have been selected OFF in flight.

IRS 1/2/AUX NO ALIGN (MISC) - Respective IRS has failed to complete an alignment.

IRS 2 ON BATT (MISC) - IRS-2 is powered by IRS battery. IRS-2 operation beyond 20 minutes cannot be relied on.

PRED WSHEAR FAIL (MISC) - Predictive windshear function is not available.

PRED WSHEAR FAULT (MISC) - EGPWS has detected a fault in the predictive windshear mode.

TERRAIN FAIL (MISC) - Terrain mode has failed in the EGPWS.

TERRAIN NOT AVAIL (MISC) - Terrain mode is not available in the EGPWS.

UNABLE RNP (MISC) - FMS required navigational performance not within limits for particular phase of flight.

VIA CONFIG DISAG (MISC) - VIA-1 and VIA-2 configurations do not agree.

VIA FAIL (MISC) - VIA computers have detected a failure in the display system.

VIA FAULT (STATUS) - VIA has a limited dispatch condition or the engine comparison monitor has failed.

VOR 1/2 FAIL (STATUS) - Respective VOR receiver has failed.

Cyan Alerts (Level 0)

CDU 1/2 MENU REQ - Respective MCDU is selected to a function other than flight management.

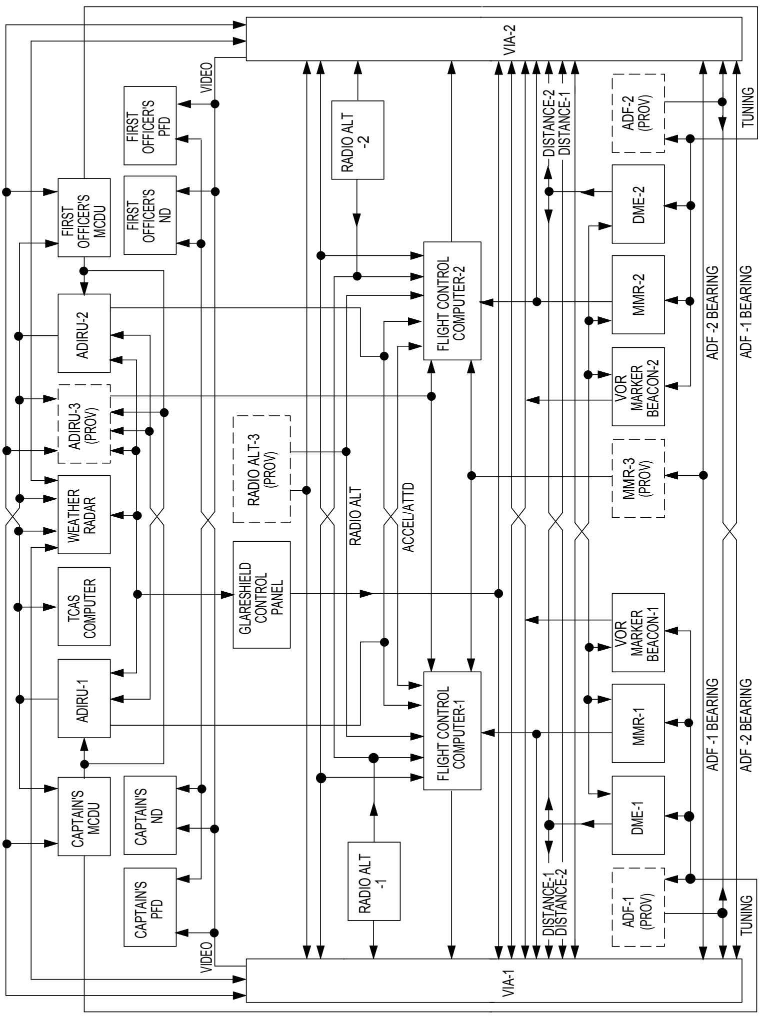
GPWS FLAP OVRD - GND PROX WARN switch is in FLAP OVRD position.

IRS IN ALIGN - One or more IRUs are in alignment mode.

PRED WSHEAR OFF - Predictive windshear function of weather radar is off.

TERRAIN OVRD - EGPWS terrain mode is off.

Navigation System



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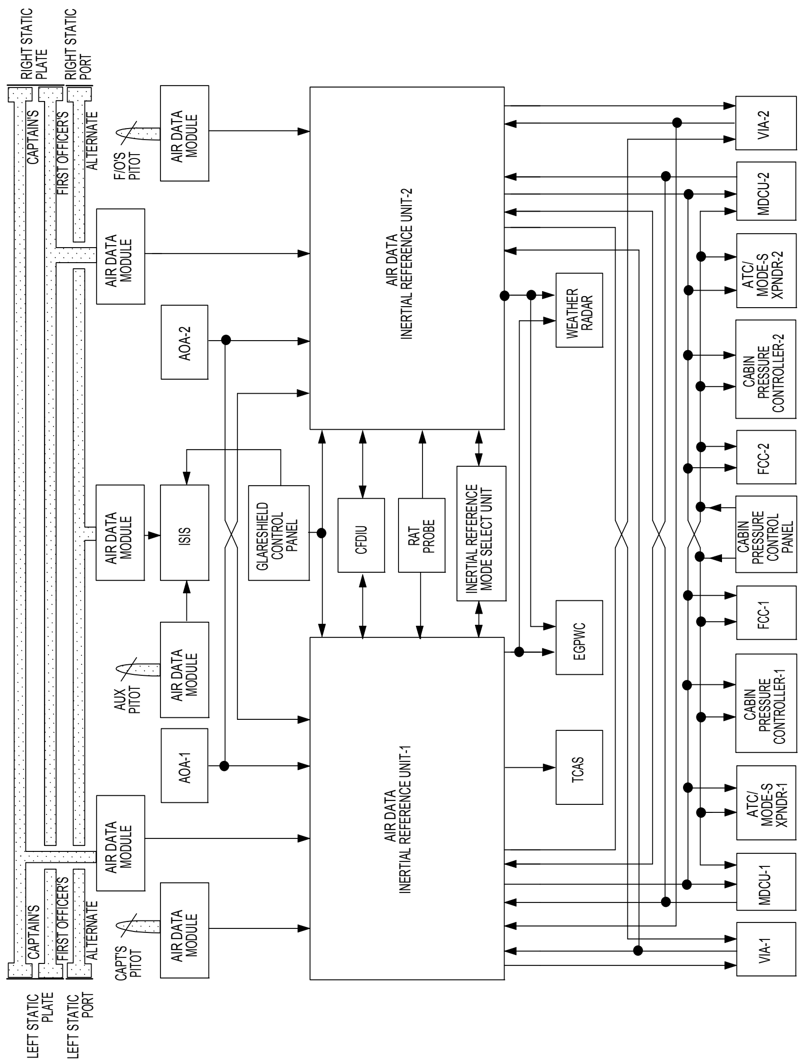
Air Data System



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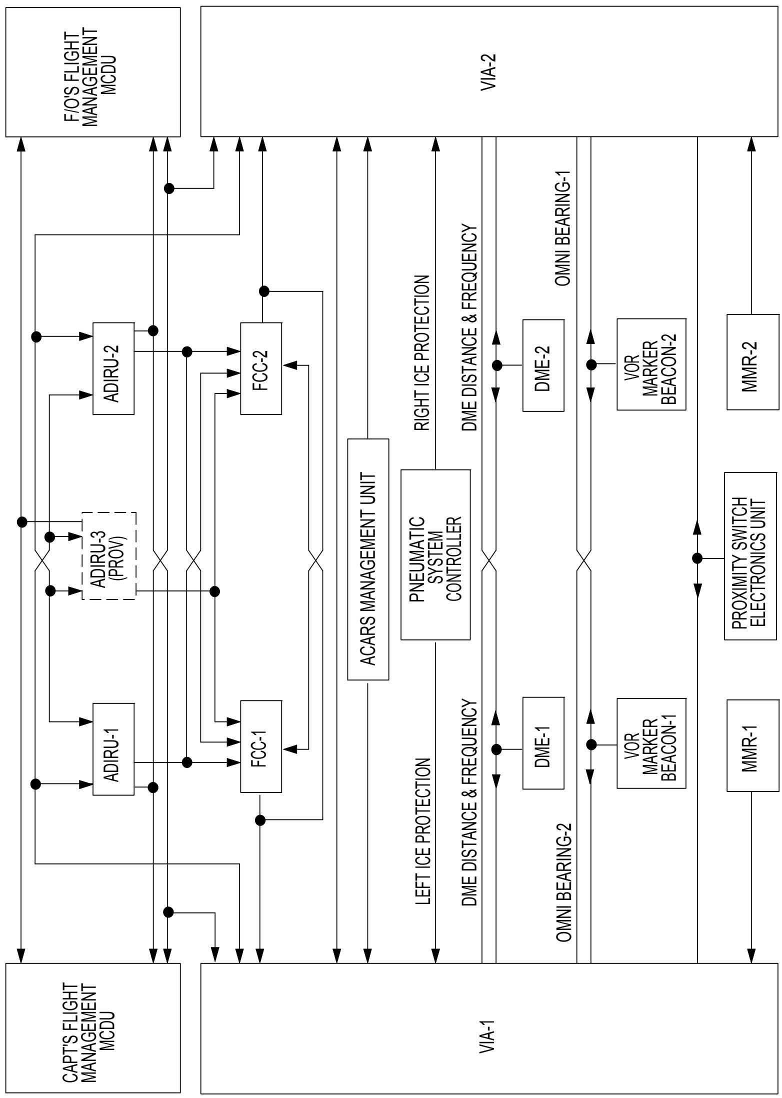
FMS



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Landing Gear & Brakes — Chapter Land
Table of Contents — Section TOC

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General

The airplane has a tricycle landing gear configuration consisting of a nose gear and two main gear assemblies. Pressure for extension and retraction of the landing gear is provided by the right hydraulic system.

Each main gear wheel is equipped with hydraulic disc brakes. Both hydraulic systems supply pressure for the brakes.

Controls & Indicators

The gear position lights, located above and to the left of the gear handle on the center instrument panel, indicate a safe or unsafe gear position.

A warning horn and voice warning are also part of the gear position indicating system. When the GEAR HORN button, located on the forward pedestal, is pushed, the landing gear warning horn is silenced, unless landing flaps have been selected.

The landing gear handle is located on the center instrument panel. Adjacent to the gear handle is the gear handle release switch.

Nose gear steering is controlled either by the nose gear steering wheel located on the left console or by the rudder pedals.

The ANTISKID switch is located on the forward overhead panel.

The PARK BRAKE knob is located in the center of the nose gear steering wheel.

The toe portion of the rudder pedals is used to apply brake pressure.

The crew is notified of advisories, faults or malfunctions in the landing gear, anti-skid or brake system by the warning and alerting system. Landing gear data is displayed on the CONFIGURATION page of the systems display. The lower portion of the display is a diagram of the tires and brakes. The two left main gear wheels are shown on the left side of the display and the two right main gear wheels are shown on the right. The two nose gear wheels are located at top center. Secondary landing gear position indicators are displayed as small oval symbols. These symbols indicate a safe or unsafe condition.

Landing gear positions are indicated by the gear position lights and the landing gear position indicators on the CONFIGURATION synoptic. A set of three green gear light indications on either the gear position lights on the instrument panel or the gear position indicators on the CONFIGURATION synoptic constitute a gear down and locked confirmation.

Gear Handle

Landing gear retraction and extension is controlled by the landing gear handle. The gear is retracted by pulling the handle out against spring tension moving it to the full UP position and then releasing it.

The gear is extended by pulling out on the handle moving it to the full DOWN position and releasing it.

Emergency Gear Extension Lever

The emergency gear extension lever is located in the floor on the right side of the pedestal and is used to extend the gear if the normal method fails. When the lever is raised and latched, the landing gear will free fall to the down and locked position.

Nose Gear Steering

On the ground, steering is controlled by the nose gear steering wheel located on the left side console and by the rudder pedals. Maximum steering deflection is available when using the nose gear steering wheel and a limited amount of nose gear steering is available through either set of rudder pedals.

Nose gear steering is powered by both hydraulic systems. If one hydraulic system fails steering is restricted, both in direction and rate of turn to the side opposite the failed system.

During gear retraction, the steering mechanism is deactivated and the nose gear is automatically centered.

Nose gear steering is also affected by use of the emergency gear extension lever. When the lever is raised, the right hydraulic system is isolated from the landing gear. As a consequence, nose gear steering is restricted to the left, even when both hydraulic systems are operating.

Gear Warning

Landing gear position lights (LEFT, NOSE, RIGHT) and the Systems Display (SD) CONFIGURATION synoptic illuminate green to indicate that the landing gear and landing gear handle are in the down-and-locked position. The light(s) will illuminate red when the gear is not locked in the position that corresponds to the position of the gear handle.

The GEAR DOOR OPEN alert will be displayed any time either one or both main gear doors are not closed.

The takeoff warning horn and vocal warning will sound when both throttles are advanced for takeoff when the parking brakes are set.

The landing gear warning horn and vocal warning will sound in the following conditions:

* Landing gear is not down and locked with flaps extended in the landing range.

Landing gear is not down and locked, throttles retarded, airspeed is less than 210 KIAS, and altitude is below 1200 feet. The aural/vocal warning for this condition can be silenced by pressing the GEAR HORN button on the pedestal.

Brakes & Anti-Skid

Each main gear wheel is equipped with disc-type brakes operated by two independent hydraulic brake systems. Both hydraulic brake systems power each brake assembly. The systems are synchronized to simultaneously apply the brakes. Each is equipped with an accumulator of sufficient capacity to provide brake pressure to stop the airplane, should both hydraulic systems fail.

The main gear wheels are equipped with fuse plugs. If the brakes overheat the plugs will melt, causing the tires to safely deflate. The temperature of each brake is displayed on the CONFIGURATION synoptic. When brake temperatures exceeds specific limitations, the digits are boxed in amber.

The brake pressure indication displays left and right brake system hydraulic pressure.

The parking brake is set by pushing the brake pedals, lifting the PARK BRAKE knob and releasing the brake pedals. When the parking brakes are set, the PARK BRAKE ON alert is displayed on the EAD.

When ready for takeoff, and the parking brakes have not been released, a boxed BRAKES message is displayed. When the parking brakes are not released and the throttles are advanced, the PARK BRAKE ON alert is displayed. In addition, the takeoff warning horn and aural warning will sound.

Each brake system incorporates an anti-skid feature. The purpose of the anti-skid system is to allow maximum wheel braking without skidding the tires.

In addition, the anti-skid system provides touchdown protection in flight, which prevents brake application until after wheel spinup. At low taxi speeds, the anti-skid system is automatically disabled to allow manual braking.

The ANTISKID switch is located on the forward overhead. When the switch is pushed, the OFF light illuminates, indicating the anti-skid system is off and the ANTISKID OFF alert is displayed on the EAD. The anti-skid system is tested automatically whenever power is applied. When a malfunction occurs, an associated anti-skid alert is displayed.

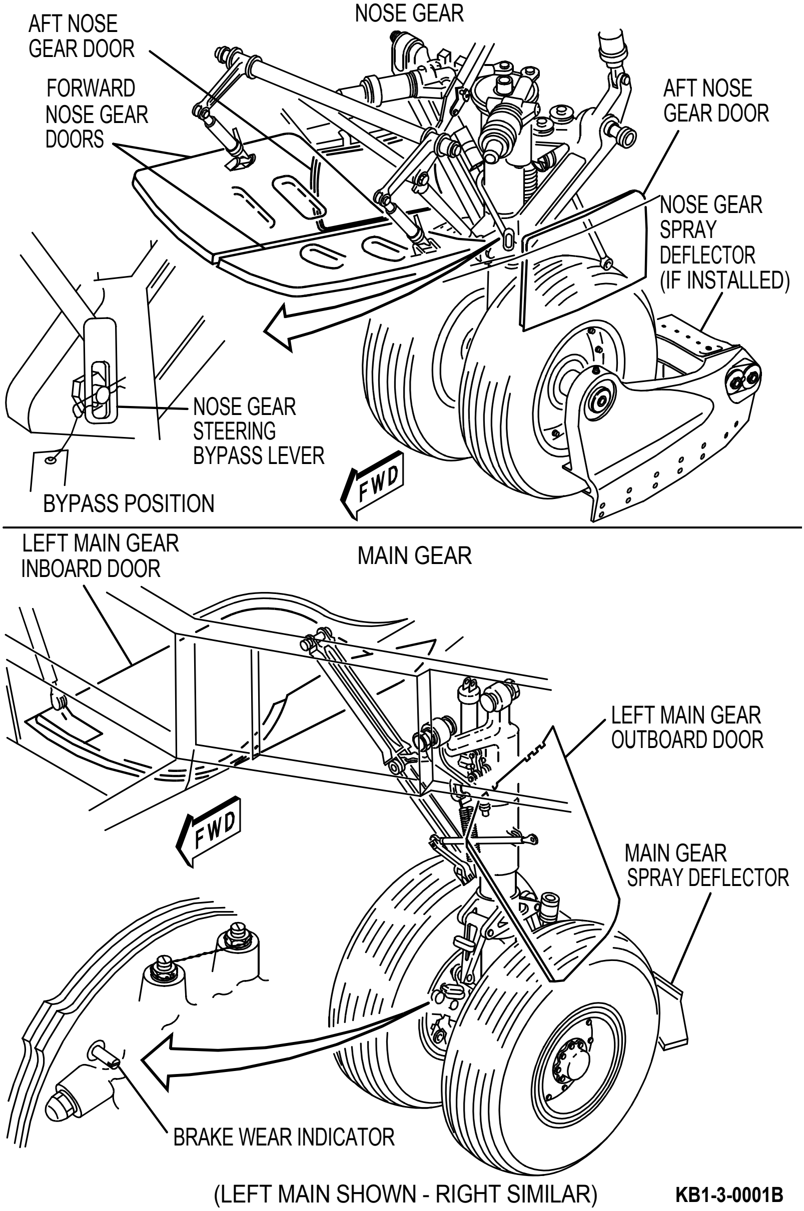
Ground Shift Sensing

The ground shift sensing system signals various airplane systems as to whether the airplane is on the ground or in flight. The ground shift sensing mechanism is located on the nose gear. The linkage connects the ground shift relays to the nose gear strut position. When the strut extends, airplane systems are shifted into the flight mode by the left and right ground control relays.

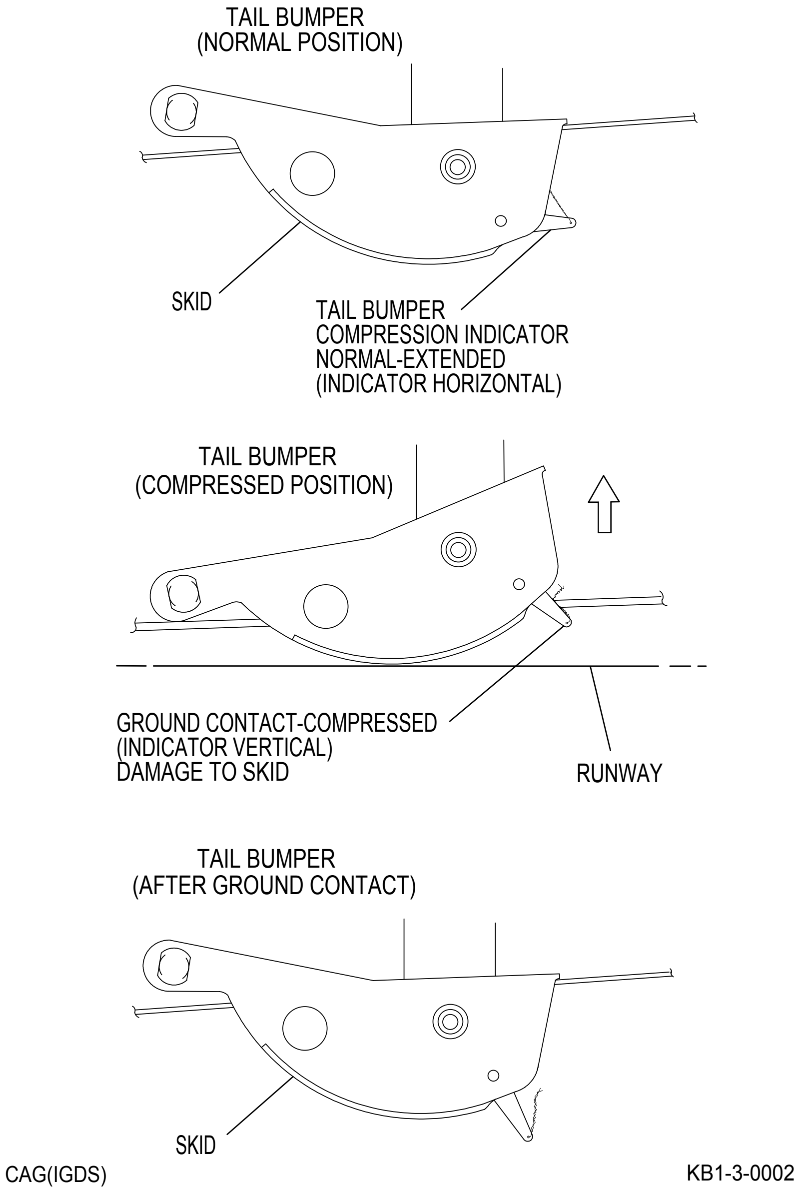
After landing with nose strut compression, the ground control relays are shifted to the ground mode. In addition, a ground control interlock switch is located above the nose gear to prevent a false ground mode signal as the gear extends.

The landing gear handle anti-retraction release mechanism is also connected to the ground shift sensing mechanism. When the airplane is on the ground, the handle is locked in the DOWN position. When the nose strut is extended, the anti-retract mechanism is released allowing gear handle movement to the UP position. If the anti-retract mechanism fails to release, the gear handle can be raised by pulling out the handle, then pushing the GEAR HANDLE RELEASE button and then moving the handle to the UP position.

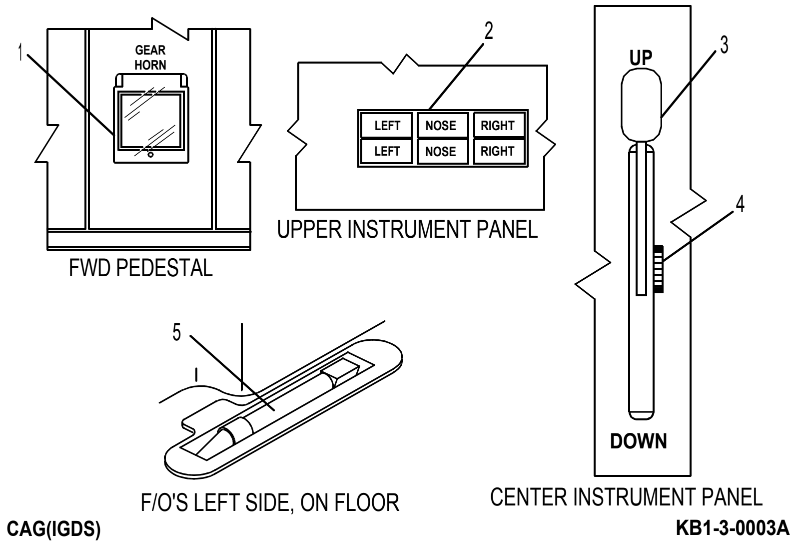
Major Component Locations



Tail Bumper And Compression Indicator



Gear Handle/Indicators



1. **GEAR HORN Button**

   Push - Silences landing gear warning horn and vocal warning except when gear is not down and flaps are extended for landing; gear must be down and locked to silence the warning.

2. **Gear Lights (LEFT, NOSE, RIGHT)**

   Green - Landing gear is down and locked.

   Red - Respective landing gear is not locked in position that corresponds to the position of gear handle.

3. **Gear Handle**

   UP - Retracts landing gear.

   DOWN - Extends landing gear.

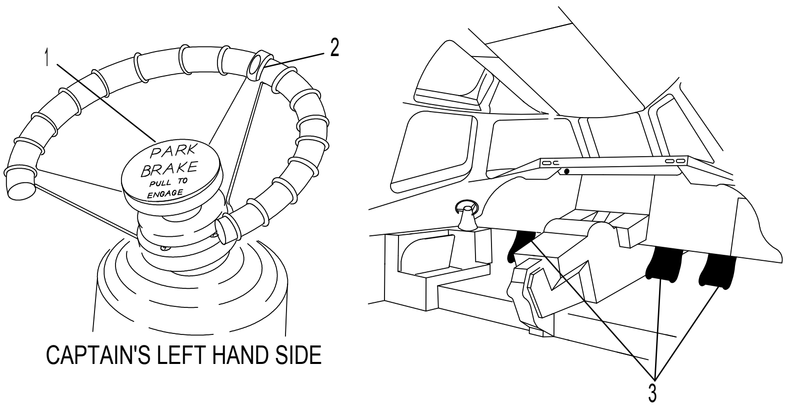
4. **Gear Handle Release Switch**

   Push and Hold - Allows to raise gear handle in the event of ground shift system malfunction after takeoff.

5. Emergency Gear Extension Lever

Pull - Allows landing gear to free-fall to down and locked position.

Brakes/Nosewheel Steering



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1. PARK BRAKE Knob

Pull - Sets parking brake when both brake pedals are simultaneously depressed.

2. Nose Gear Steering Wheel

Rotate - Overrides rudder pedal steering to turn nose wheel up to 82 degrees in either direction.

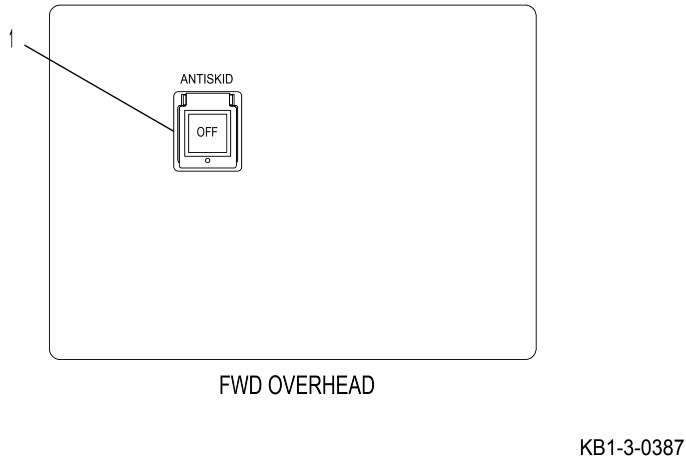
Relative position of the nosewheel is indicated by the index on the wheel.

3. Rudder/Brake Pedals

Push Full Pedal - Controls nosewheel steering up to 17 degrees in either direction.

Push Top of Pedal - Actuates wheel brakes.

Antiskid Panel

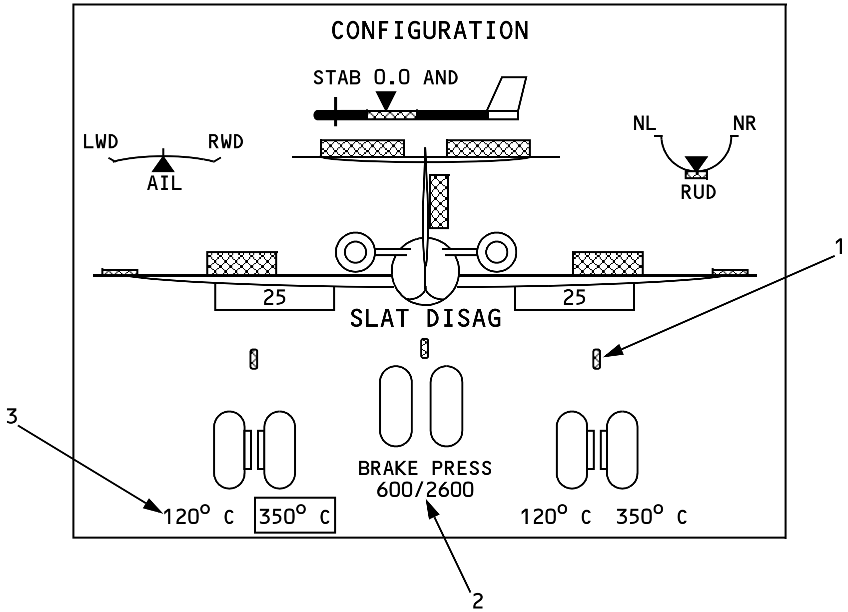


1. ANTISKID Switch

ON - Activates antiskid system.

OFF - Deactivates antiskid system.

SD Synoptic - Configuration



1. **Secondary Gear Indicators**

   White - Landing gear is up and locked.

   Green - Landing gear is down and locked.

   Red - Indicates one of the following:

   - Landing gear is not down and locked and gear handle is down
   - Landing gear is in transit or not in agreement with gear handle
   - Any unsafe gear condition exists.

   Green and Red - Disagreement in position indicators or ANNUN LT TEST Switch has been depressed.

2. **Brake Pressure**

   White - Normal range

   Amber - Falls below low pressure limit. Value is boxed.

3. **Brake Temperature**

   Indicates a relative value of wheel brake temperature:

   White - Normal range

   Amber - Exceeds temperature limits. Value is boxed.

NOTE: After landing, brake temperature differential up to 60°C on the same gear is considered normal.

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NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Amber Boxed Alerts (Level 2)

ANTISKID L/R FAIL (CONFIG) - Respective antiskid system is inoperative.

BRAKE OVERHEAT (CONFIG) - Brake temperature exceeds 260°C. Resets when temperature falls below 230°C.

GEAR DOOR OPEN (CONFIG) - One of the main landing gear doors is open.

Amber Alerts (Level 1)

ANTISKID FAULT (STATUS) - (Ground only) Antiskid system has detected a fault. Antiskid is still fully functional.

ANTISKID OFF (CONFIG) - ANTISKID switch is OFF.

BRAKE PRES LO (CONFIG) - One or both brake accumulator pressures are low.

PSEU FAIL (CONFIG) - The proximity sensor system has failed, resulting in loss of gear, door, and slat position information.

PSEU FAULT (STATUS) - The proximity sensor system has logged an internal fault or detected a failure of a redundant sensor.

Cyan Alerts (Level 0)

PARK BRAKE ON - (Ground only) Parking brakes are set. If parking brakes are not set, indicates an antiskid malfunction.

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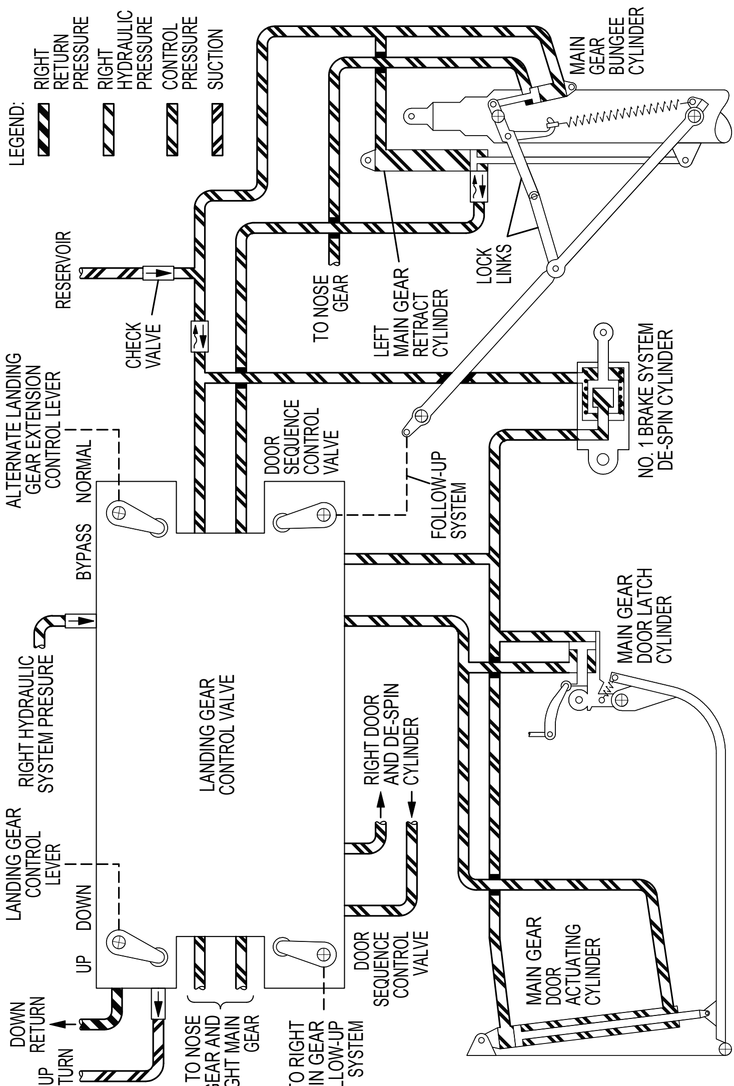
Main Landing Gear Actuation



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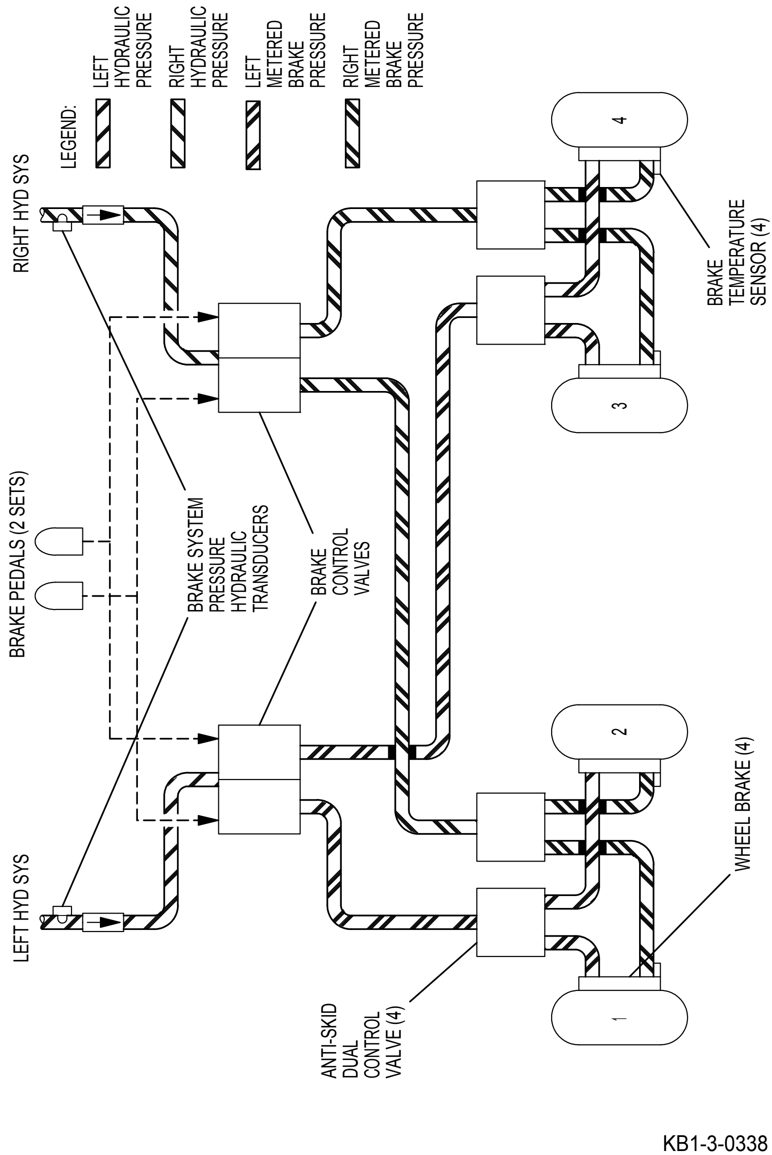
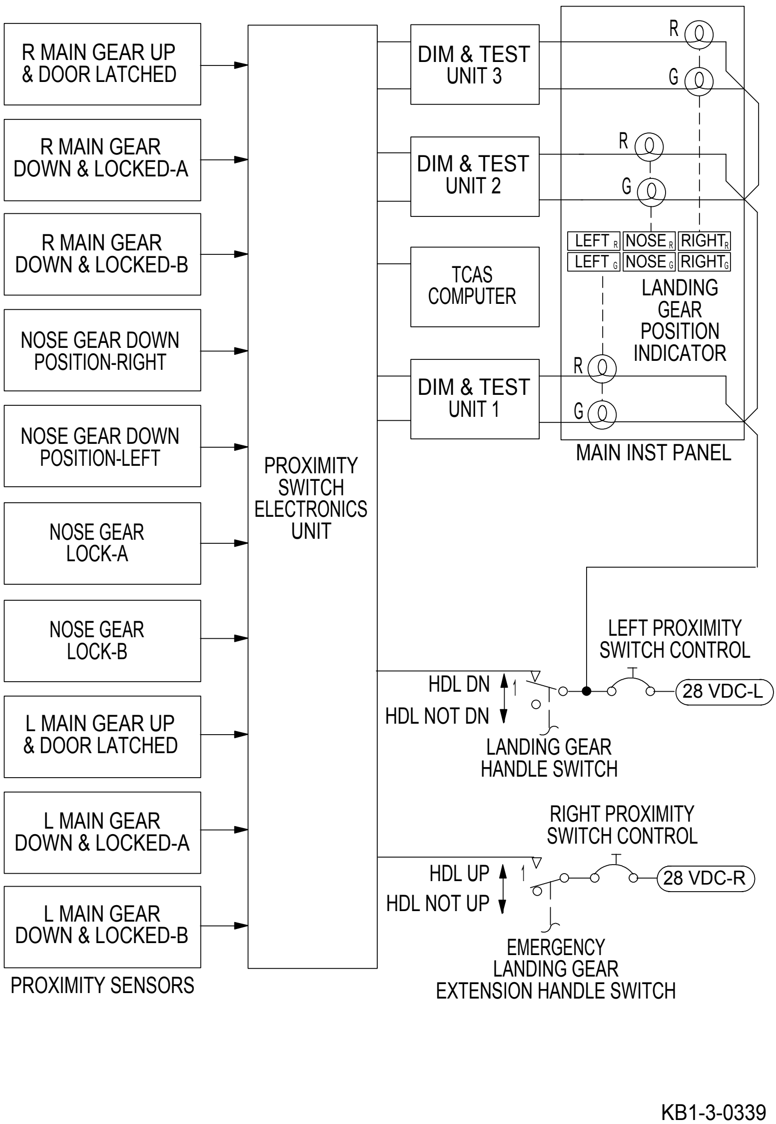
Brake System



Gear Position Indicating System



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