

MD-11

Flight Crew Operations Manual

Volume III Systems Description
KLM - Royal Dutch Airlines

Royal Dutch Airlines
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General

The airplanes listed in the table below are covered in the Flight Crew Operations Manual. The numbers are 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 airplane numbers.

Use of the table below permits flight crew correlation of configuration differences by Serial number within an operator's fleet for airplanes covered in this manual. Configuration data reflects the airplane as delivered configuration and is updated for service bulletin incorporations.

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
557	PH-KCA	48555	1PC801
561	PH-KCB	48556	1PC802
569	PH-KCC	48557	1PC803
573	PH-KCD	48558	1PC804
575	PH-KCE	48559	1PC805
578	PH-KCF	48560	1PC806
585	PH-KCG	48561	1PC807
591	PH-KCH	48562	1PC808
593	PH-KCI	48563	1PC809
612	PH-KCK	48564	1PC810

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Revision Transmittal Letter

This revision reflects the most current information available.

The KLM FCOM version will follow the revision numbers from Boeing's FCOM and started with revision number 51. The following revision highlights explain the changes in this revision.

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
Initial					
51KL	October 02, 2006		52KL 53KL	September 03, 2007	
54KL 55KL 56KL	November 10, 2008		57KL 58KL	November 16, 2009	

General

KLM 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 and Interim Operating Procedures.

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.

Chapter Agen - Aircraft General

Section 10 - Description and Operation

Cockpit Lighting

Agen.10.29 - Editorial change.

Chapter Air - Air

Section 30 - Controls and Displays

AIR Control Panel (Passenger)

Air.30.3 - Editorial change.

Chapter Auto - Automatic Flight

Section 10 - Description and Operation

Guidance

Auto.10.29 - Changed guidance speed during go-around to 1.3 Vs+20.

Chapter Emer - Emergency Equipment

Section 0 - Table of Contents

Emer.00.1/.2 - Updated.

Section 30 - Controls and Displays

Crew Oxygen Control and Indicator

Emer.30.1 - Added single cylinder crew oxygen system for fleet.

Emergency Lighting Controls

Emer.30.7 -Updated..

Emergency Evacuation Warning System

Emer.30.8 -Updated..

Emergency Exits - Cockpit Door

Emer.30.10 - Seperated cockpit emergency exits.

Emergency Exits - Clearview Windows

Emer.30.11 - Added a seperate cockpit window emergency exit description.

Emergency Exits - Cabin Door Interior Controls

Emer.30.13 - Revised cabin door interior controls for fleet.

Chapter Eng - Engines

Section 30 - Controls and Displays

FADEC MODE Panel

Eng.30.2 - Revised text.

Chapter FMS - FMS

Section 0 - Table of Contents

Emer.00.1/.2 - Updated.

Section 30 - Controls and Displays

Descent and Sec Descent Forecast Pages

FMS.30.81/.134 - Corrected page sequence, no editorial changes.

Chapter Fuel - Fuel

Section 40 - Alerts

Red Boxed Alerts (Level 3)

Fuel.40.1 - Revised alert to standardize low fuel quantities.

Amber Alerts (Level 1)

Fuel.40.5 - Revised alert to standardize low fuel quantities.

Chapter Inst - Instrumentation and Navigation

Section 0 - Table of Contents

Inst.TOC.0.1/.2 - Updated.

Section 10 - Description and Operation

Inertial Reference System (IRS)

Inst.10.7 - Added description for IRS aural warning horn.

Chapter Warn- Warning and Alerting

Section 10 - Description and Operation

Takeoff Warning

Warn.10.14 - Added conditions when takeoff warning aural signal will sound.

Mode 5 - Descent Below Glideslope

Warn.10.17 - Changed altitude to 2000 feet.

Preface

Chapter 0

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Chapter 0

Section 4

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Chapter 0

Section 5

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

TEMPORARY REVISION NUMBER	ISSUE DATE	REVISION DATE INCORPORATED
3-001 thru 3-139	Various	Not Applicable, Cancelled or Previously Incorporated

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FAB NUMBER	SUBJECT	ISSUE DATE
3-01 thru 3-03		Cancelled

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Preface
Introduction**Chapter 0**
Section 8

The information in the MD-11 Flight Crew Operations Manual 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 18 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.

Customer airplane configuration determines the data provided in this manual. The Boeing Company keeps a list of each airplane configuration as it is built and modified through the service bulletin process. The FCOM does also reflect customer originated modifications without special contract provisions.

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

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ABBREVIATIONS GLOSSARY**A**

A	Amber
AAIS	Automatic Anti-ice System
ABRKU	Auto Brake Unit
ABS	Auto Brake System
AC	Alternating Current
A/C	Aircraft
ACARS	Aircraft Communications Addressing and Reporting System
ACC	Air Conditioning Controller
ACP	Audio Control Panel
ACS	Air Conditioning System
ADAS	Auxiliary Data Acquisition System
ADC	Air Data Computer
ADF	Automatic Direction Finder
ADG	Air Driven Generator
ADL	Airborne Data Loader
AFM	Airplane Flight Manual
AFQGS	Advanced Fuel Quantity Gaging System
AFS	Auto Flight System
AFSC	Ancillary Fuel System Controller
AGL	Above Ground Level
AGS	Auto Ground Spoiler
AGT	Agent
AIL	Aileron
ALT	Altitude; Alternate
ALTN	Alternate
AMU	Audio Management Unit

AND	Aircraft Nose Down
ANNUN	Annunciator
ANSKD	Anti-Skid System
ANT	Antenna
ANU	Aircraft Nose Up
AOA	Angle of Attack
AOVP	Aft Overhead Panel
AP or A/P	Autopilot
APED	Aft Pedestal
APPR	Approach
APU	Auxiliary Power Unit
ARINC	Aeronautical Radio, Inc.
ARPT	Airport
A/S	Airspeed
ASC	Automatic Systems Control
ASE	Auto Slat Extend
AT or A/T	Autothrottle
ATA	Air Transport Association
ATC	Air Traffic Control
ATS	Autothrottle System
ATT	Attitude
ATT HLD	Attitude Hold
ATTND	Attendant
AUTO	Automatic
AUX	Auxiliary
AVNCS	Avionics
AVSAT	Aviation Satellite

B

B	Blue
BARO	Barometric
BARO SET	Barometric Setting



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BAT	Battery
BCN	Beacon
BIT	Built-In Test
BITE	Built-In Test Equipment
BLST	Ballast
BLWR	Blower
BRG	Bearing
BRK	Brake
BRT	Bright; Brightness
BTM/TPI	Brake Temperature Monitor/Tire Pressure Indicator

C

C	Celsius
CAB	Cabin
CAC	Center Accessory Compartment
CADC	Central Air Data Computer
CAP	Capture
CAPT	Captain
CAS	Calibrated Airspeed
CAWS	Central Aural Warning System
CAWU	Central Aural Warning Unit
CDI	Course Deviation Indicator
CDU	Control Display Unit (MCDU)
CF	Course to a Fixed Waypoint
CFDIU	Centralized Fault Display Interface Unit
CFDS	Centralized Fault Display System
CFDU	Centralized Fault Display Unit
CF(F)	Convertible Freighter, Freighter Configuration
CF(P)	Convertible Freighter, Passenger Configuration
CG	Center of Gravity
CHG	Change
CHRONO	Chronometer

CI	Cost Index
CI	Course to an Intercept
CIPL	Captain's Instrument Panel
CKPT	Cockpit
CL	Close
CLB	Climb
CLR	Clear
CLR ALT	Clearance Altitude
CMD	Command
COMP	Compass
COMPT	Compartment
CONFIG	Configuration
CONSEQ	Consequence
CO RTE	Company Route
CPA	Closest Point of Approach
CPC	Cabin Pressure Controller
CPU	Central Processing Unit
CRC	Cargo Refrigeration Controller
CRS	Course
CRT	Cathode Ray Tube
CRZ	Cruise
CTL	Control
CTR	Center
CWS	Control Wheel Steering

D

DA	Drift Angle
DAMP	Damper
DC	Direct Current
DCAS	Digitally Controlled Audio System
DCU	Data Control Unit
DEC	Declination

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DECR	Decrease
DECEL	Deceleration
DEG	Degree
DENS	Density
DEPL	Deployed
DES	Descent
DEST	Destination
DET	Detector
DEU	Display Electronics Unit
DEV	Deviation
DF	Computed Track to a Fixed Waypoint
DFDAU	Digital Flight Data Acquisition Unit
DFDR	Digital Flight Data Recorder
DH	Decision Height
DIFF	Difference
DIR	Direction; Direct
DIR INTC	Direct Intercept
DIR TO	Direct To
DISAG	Disagree
DISC	Disconnect
DISCH	Discharge
DIST	Distance
DME	Distance Measuring Equipment
DMU	Data Measuring Unit (ADAS)
DN	Down
DP	Differential Pressure
DRV	Drive
DSPY	Display
DTG	Distance To Go
DU	Display Unit

E

E	East
EAD	Engine and Alert Display
ECON	Economy
ECP	Electronic Control Panel
ECU	Engine Control Unit
EEC	Electronic Engine Control
EFOB	Estimated Fuel on Board
EFIS	Electronic Flight Instrument System
EGT	Exhaust Gas Temperature
EIS	Electronic Instrument System
ELEC	Electric; Electrical
ELEV	Elevator
ELF	Elevator Load Feel
ELV	Elevation
EMER	Emergency
ENG	Engine
ENG	Engage
EO	Engine Out
EPCU	Electrical Power Control Unit
EPR	Engine Pressure Ratio
ESC	Environmental System Controller
EST	Estimated
ET	Elapsed Time
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETE	Estimated Time En Route
ETO	Estimated Time Overhead
EVAC	Evacuation
EVM COMP	Engine Vibration Monitor - Compressor
EVM TURB	Engine Vibration Monitor - Turbine
EVMS	Engine Vibration Monitoring System

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EVSC	Engine Vibration Signal Conditioner
EXTN	Extended

F

F	Fahrenheit
F	Freighter
FA	Course from a Fixed Waypoint to an Altitude Termination
FADEC	Full Authority Digital Electronic Control
FAF	Final Approach Fix
FANS	Future Air Navigation System
FC	Course from a Fixed Waypoint to Changeover Point
FCC	Flight Control Computer
FCOM	Flight Crew Operations Manual
FCP	Flight Control Panel
FCU	Fire Control Unit
FD	Fixed Distance
FD or F/D	Flight Director
FDCU	Fire Detection Control Unit
FDU	Fire Detection Unit
FF	Fuel Flow
FFS	Fuel Flow System
FGS	Flight Guidance System
FL	Flight Level; Flap Limiter
FLEX TO	Flex Takeoff
FLP	Flap
FLT	Flight
FLT DIR	Flight Director
FLX	Flex
FM	Course from a Fixed Waypoint with a Manual Termination
FM	Function Module

FMA	Flight Mode Annunciator
FMC	Flight Management Computer
FMS	Flight Management System
FO or F/O	First Officer
FOIP	First Officer's Instrument Panel
FOSC	First Officer's Side Console
FOVP	Forward Overhead Panel
FOB	Fuel on Board
FPA	Flight Path Angle
FPED	Forward Pedestal
F-PLN	Flight Plan
FPLAN	Flight Plan
FPM	Feet per Minute
FPS	Feet per Second
FQ	Fuel Quantity
FQDU	Fuel Quantity Display Unit
FQGS	Fuel Quantity Gauging System
FREQ	Frequency
FSC	Fuel System Controller
FSD	Fast Slew and Day
FSO	Fuel Shutoff
FT	Feet
FWD	Forward

G

G	Acceleration of Gravity
GA or G/A	Go-Around
GCP	Glareshield Control Panel
GCU	Generator Control Unit
GEN	Generator
GLSH	Glareshield
GLY	Galley



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GMT	Greenwich Mean Time
GND	Ground
GPA	Glide Path Angle
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GR	Gear Retract
GS	Ground Speed
G/S	Glideslope
GW	Gross Weight

H

HA	Holding Pattern to an Altitude Termination
HDG	Heading
HF	High Frequency
HF	Holding Pattern to a Fixed Waypoint
HI	High
HI-INT	High Intensity
HLD	Hold
HLD Y	Hold and Year
HM	Holding Pattern with Manual Termination
HMU	Hydromechanical Unit
HORIZ	Horizontal
HP	Hectopascals
HPSOV	High Pressure Fuel Shutoff Valve
HSC	Hydraulic System Controller
HYD	Hydraulic
Hz	Hertz

I

I	Inertial
I/P	Intercept Profile
IAS	Indicated Airspeed

IDENT	Identifier
IDG	Integrated Drive Generator
IDS	Ice Detection System
IF	Initial Fix
IGN	Ignition
IGS	Instrument Guidance System
ILS	Instrument Landing System
INB	Inbound
INBD	Inboard
INCR	Increase
INH	Inhibit
IN/HG	Inches of Mercury
INIT	Initialization
INOP	Inoperative
INS	Inertial Navigation System
INSTR	Instrument
INT	Intercom; Intermittent
INTCP	Intercept
INTKFX	Intercept Fix
INTPH	Interphone
INV	Invalid
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISOL	Isolation

K

KLBS	Thousands of Pounds
KGS	Kilograms
KIAS	Knots Indicated Airspeed
KT	Knot

L

L	Left
LAND	Landing
LAT	Lateral; Latitude
LAT REV	Lateral Revision
LBS	Pounds
LCD	Liquid Crystal Display
LCP	Lighting Control Panel
LDA	Localizer type Directional Aid
LDG	Landing
L/E	Leading Edge
LED	Light Emitting Diode
LIB	Left In Board
LIM	Limit
LL	Latitude/Longitude
LNAV	Lateral Navigation
LNG	Long
LO	Low
LOC	Localizer
LONG	Longitude
LRU	Line Replaceable Unit
LSAS	Longitudinal Stability Augmentation System
LSK	Line Select Key
LT	Light
LTG	Lighting
LVDT	Linear Variable Differential Transformer
LW	Landing Weight
LWD	Left Wing Down
LWR	Lower

M

M	Mach

M	Meters
MAC	Mean Aerodynamic Chord
MAG	Magnetic
MAG DEC	Magnetic Declination
MAG VAR	Magnetic Variation
MAINT	Maintenance
MAN	Manual
MANF	Manifold
MAX	Maximum
MAX CLB	Maximum Climb
MAX DES	Maximum Descent
MAX END	Maximum Endurance
MB	Millibars
MCDU	Multifunction Control Display Unit
MCL	Maximum Climb (Engine Rating)
MCT	Maximum Continuous Thrust (Engine Rating)
MDA	Minimum Descent Altitude
MED	Medium
MEL	Minimum Equipment List
MFCS	Manifold Fail Control System
MFDS	Manifold Failure Detection System
MIC	Microphone
MID	Middle; Midship
MIN	Minimum; Minute
MISC	Miscellaneous
MKR	Marker
MLG	Main Landing Gear
MLS	Microwave Landing System
MLW	Maximum Landing Weight
MMO	Maximum Operating Mach
MO	Month
MOD	Model



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MOM	Momentary
MON	Monitor
MSA	Minimum Safe Altitude
MSC	Miscellaneous System Controller
MSG	Message
MSL	Mean Sea Level
MTOGW	Maximum Takeoff Gross Weight

N

N	North
N/A	Not Available
NAC	Nacelle
N/P	Next Page
N1	Engine Low Pressure Rotor RPM
N2	Engine High Pressure Rotor RPM
NAV	Navigation
NAVAID	Navigation Aid
NAV RAD	Navigation Radio
NBPT	No Break Power Transfer
NCD	No Computed Data
ND	Navigation Display
NDB	Navigation Data Base
NDB	Non Directional Beacon
NLG	Nose Landing Gear
NM	Nautical Miles
NORM	Normal
NRMP	Non Reversible Motor Pump

O

OAT	Outside Air Temperature
OEW	Operators Empty Weight
OFST	Offset

OHP	Overhead Panel
OM	Outer Marker
OPS	Operations
OPT	Optimum; Optional; Option
ORIG	Origin
OUTB	Outbound
OUTBD	Outboard
OVHD	Overhead
OVHT	Overheat
OVRD	Override
OXY	Oxygen

P

P	Passenger
P2	Total Air Pressure (Engine Inlet)
PA	Passenger Address
PAS	Pitch Attitude Sensor
PAX	Passenger
PED	Pedestal
PERF	Performance
PF	Primary Flight Display
PI	Procedure Turn to an Intercept
PLAN	Plan Mode
PLI	Pitch Limit Indicator
PMA	Permanent Magnet Alternator
PNL	Panel
POS	Position
PPOS	Present Position
PRE FLT	Preflight
PRED	Prediction
PRESS	Pressure
PREV	Previous



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PROCT	Procedure Turn
PROF	Vertical Profile
PROG	Progress
PSC	Pneumatic System Controller
PSI	Pounds per Square Inch
PT	Point
PTT	Push To Talk
PVD	Paravisual Director
PWR	Power

Q

QAR	Quick Access Recorder
QFE	Field Elevation Pressure
QNH	Sea Level Pressure
QTY	Quantity

R

R	Right or Red
RA	Radio Altimeter
RA	Radio Altitude
RAD	Radio
RCCB	Remote Control Circuit Breaker
RCVR	Receiver
RCWS	Roll Control Wheel Steering
RDR	Radar
RED	Reduction
REF	Reference
REFUEL	Refueling
REL	Release
REPLNT	Repellent
REQ	Request
RET	Retract

RETR	Retract
REV	Reverser
REV	Revision
RF	Radio Frequency
RIB	Right Inboard
RLS	Remote Light Sensor
RMP	Reversible Motor Pump
RNAV	Area Navigation
RNG	Range
RNP	Required Navigation Performance
ROB	Right Outboard
ROS	Right Observer's Station
RPTG	Reporting
RTA	Required Time of Arrival
RTE	Route
RSV	Reserve
R/T	Receiver/Transmitter
RTN	Return
RTO	Rejected Takeoff
RUD	Rudder
RVR	Runway Visual Range
RWY	Runway

S

S	South
S/C	Step Climb
S/D	Step Descent
SAT	Static Air Temperature
SATCOM	Satellite Communication System
SCHED	Schedule
SD	System Display
SDCP	System Display Control Panel



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SEC	Secondary
SEC PLAN	Secondary Flight Plan
SEL	Select; Selector
SELCAL	Selective Calling
SERV	Service
SID	Standard Instrument Departure
SISP	Source Input Select Panel
SLT	Slat
SMOKE	Smoking
SP	Scratchpad (on MCDU)
SPD	Speed
SSM	Slow Slew and Month
STA	Station
STAB	Stabilizer; Stabilization
STAR	Standard Terminal Arrival Route
STBY	Standby
STD	Standard
SW	Switch
SYS	System

T

T	True
T	Turn
T-P	Turn Point
T/C	Top of Climb
T/D	Top of Descent
T/R	Thrust Reverser
TA	Traffic Advisory
TACAN	Tactical Air Navigation
TAS	True Air Speed
TAT	Total Air Temperature
TBD	To Be Determined

TCAS	Traffic Alert Collision Avoidance System
TCM	Thrust Control Module
TD	Trim Down
TEMP	Temperature
TF	Track to a Fixed Waypoint
TFR	Transfer
TGT	Target
THR	Thrust; Throttle
THNDSTRM	Thunderstorm
TI	Track to an Intercept
TO or 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	Turn Radius
TRANS	Transition; Transfer
TRFC	Traffic
TRK	Track
TRT	Takeoff Rated Thrust
TRU	True
TST	Test
TTG	Time To Go
TURB	Turbulence
TX	Transmitter; Transmit

U

UFOB	Usable Fuel on Board
U/L	Unlock
UPR	Upper
UTC	Universal Time Coordination

V

V	Volt
Va	Maneuvering Speed
VAC	Vacuum
VAC	Volts Alternating Current
Vapp	Approach Speed
VBV	Variable Bleed Valve
Vcl	Operational Climb Speed
VDC	Volts Direct Current
VEL	Velocity
Vfe	Flap Extend Speed
Vfr	Flap Retract Speed
Vge	Gear Extend Speed
Vgr	Gear Retract Speed
VHF	Very High Frequency
Vmax	FMC Calculated Max Operating Speed
Vmin	FMC Calculated Min Operating Speed
Vmo	Maximum Operating Speed
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
Vref	Reference Approach Speed
Vs	Stall Speed
Vse	Slat Extend Speed
Vso	Clean Stall Speed
Vsr	Slat Retract Speed
Vss	Stickshaker Speed
VSV	Variable Stator Vane
V/S	Vertical Speed
V1	Critical Engine Failure Speed; Decision Speed
V2	Takeoff Safety Speed; Climbout Speed
V3	Final Segment Climb Speed

W

W	West
WARN	Warning
WBC	Weight and Balance Computer
WBS	Weight and Balance System
WCU	Waste Control Unit
WINDSHLD	Windshield
WIPE	Wiper
WPT	Waypoint
WX	Weather
WXBRT	Weather Radar Brightness
WX+T	Weather and Turbulence
WXR	Weather Radar

X

XCVR	Transceiver
XFEED	Crossfeed
XFER	Transfer
XMIT	Transmit
XPDR	Transponder

Y

YD or Y/D	Yaw Damper

Z

ZFW	Zero Fuel Weight
ZFWCG	Zero Fuel Weight Center of Gravity



Foreword

The MD-11 Flight Crew Operations Manual provides descriptive information and operational procedures to be used as a guide for operation of the MD-11 aircraft. The data in this manual are based upon engineering information and calculations. Operating instructions were derived from an in-depth study of the tasks which must be performed by the flight crew to properly complete a normal flight. The descriptive text has been prepared by experienced, publications-oriented pilots and technical specialists working in accord with the team that developed the operating instructions.

The MD-11 Flight Crew Operations Manual reflects the aircraft description and operating recommendations approved by The Boeing Company, Long Beach Division. This does not mean that individual airlines may not publish manuals reflecting their own operating philosophies.

The style and format of this manual were developed by The Boeing Company, Long Beach Division 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 aircraft. Every effort has been made to ensure the currency of the data contained herein. However, all data is subject to change without notice.

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Aircraft General Description and Operation

Chapter Agen Section 10

General

The MD-11 is powered by three interchangeable high bypass ratio turbofan engines. It has a fully retractable tricycle landing gear with a load bearing center gear.

The fuselage is of semimonocoque metal construction. All areas are pressurized except nose radome, wheelwells, wing center section, and aft fuselage. The fuselage is divided lengthwise into an upper floor level and a lower floor level.

The cantilevered wing consists of a primary box structure with a leading and trailing edge secondary structure. The primary box contains integral fuel tanks, main landing gear supporting structure, engine pylons, full span leading edge slats, spoilers, trailing edge ailerons, and flaps. The winglets are installed at the wingtips to reduce drag and improve fuel efficiency.

The tail consists of an adjustable horizontal stabilizer with integral fuel tank, right and left two-section elevators, tail-engine pylon, fixed vertical stabilizer, and two-section (four-segment) rudder.

Some parts of the wing and tail are made of lightweight composite materials.

Most MD-11 systems are automated with manual backup operation provided.

Avionics and Controllers

Six Display Units (DU) in the instrument panel show the following:

- DUs 1 and 6 are Primary Flight Displays (PFD).
- DUs 2 and 5 are Navigation Displays (ND).
- DU3 is Engine and Alert Display (EAD).
- DU4 is System Display (SD) (secondary engine data and aircraft system data).

Three (1, 2, and aux) Display Electronic Units (DEU) in the avionics compartment drive the DUs. Normally, DEU1 drives the 3 left side DUs, DEU2 drives the 3 right side DUs, and the aux DEU is a spare. The glareshield control panel consists of a Flight Control Panel (FCP) and two EIS Control Panels (ECP) on both ends of the FCP. The ECPs control data display on the PFDs and NDs. SD data is controlled from the Systems Display Control Panel (SDCP) on the aft pedestal.

The Air Data System (ADS) consists of two Central Air Data Computers (CADC) in the avionics compartment. The CADCs send airspeed, pressure altitude, and total air temperature to various aircraft systems.

The Auto Flight System (AFS) consists of two Flight Control Computers (FCC) in the avionics compartment and an FCP on the glareshield. The pilot makes inputs into the AFS with the FCP.

The Flight Management System (FMS) consists of two Flight Management Computers (FMC) in the avionics compartment and two Multifunction Control Display Units (MCDU) on the forward pedestal. The pilot makes inputs into the FMS with the MCDUs.

The Inertial Reference System (IRS) consists of three Inertial Reference Units in the avionics compartment and an IRS control panel on the forward overhead panel. The pilot makes input into the IRS with the IRS control panel.

The Fuel System Controller (FSC) in the avionics compartment and the FUEL control panel on the overhead panel provide automatic and manual control of the fuel system. The Ancillary Fuel System Controller (AFSC) in the avionics compartment provides backup operation.

The Environmental System Controller (ESC) in the avionics compartment and the AIR control panel on the overhead panel provide automatic and manual control of the three engine air bleeds and air conditioning packs.

The Electrical Power Control Unit (EPCU) in the avionics compartment and the ELEC control panel on the overhead panel provide automatic and manual control of electrical power distribution.

The Hydraulic System Controller (HSC) in the avionics compartment and the HYD control panel on the overhead panel provide automatic and manual control of the three separate hydraulic systems.

The Miscellaneous System Controller (MSC) in the avionics compartment automatically controls:

- Auxiliary Power Unit (APU).
- Pitot, AOA, and TAT heat.
- Engine ignition and start.
- Cargo door test.
- Cargo fire system.
- Emergency light battery test.

The HSC, ESC, and FSC are dual channel controllers in which certain transient faults can be cleared by switching channels. This is accomplished by selecting the associated system to manual mode, and then back to auto. Preflight tests that are in progress will be interrupted by this procedure and must be performed again either automatically or manually.

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The Centralized Fault Display System (CFDS) consists of a Centralized Fault Display Interface Unit (CFDIU) in the avionics compartment and an MCDU on the aft pedestal. Maintenance personnel can access CFDS data by using the MCDU.

Configuration Designators

The following designators may be used in this manual:

- P - MD-11 passenger airplane.

Cockpit

The cockpit of the MD-11 is arranged in the conventional manner. The Captain's seat is on the left and the First Officer's seat is on the right. There is a right observer's seat behind the First Officer's seat. Storage facilities for loose equipment are provided at each station in addition to storage areas in the coatroom.

When the aircraft is ready for normal flight, most of the switches on the overhead panel will be dark (not illuminated). This informs the crew that the panel is in the correct configuration and no abnormalities are present. Under normal conditions, little used switches will illuminate blue as advisory indicators.

Three columns of alerts may be displayed on the lower third of the EAD. The EAD is normally DU-3. Level 3 alerts (warnings) have the highest priority and will not be overwritten. Level 3 alerts are displayed in red within a red box and have leading triangles. The latest level 3 alert appears at the top of the list starting at the top left of the alert area.

Level 2 alerts are displayed as boxed, amber messages below the red alerts and have priority over level 1 and level 0 alerts. Level 1 alerts are displayed as amber messages below level 2 alerts and have priority over level 0 alerts.

Level 1 and 2 alerts may be reset when the appropriate system cue switch on the SDCP is pushed. When an alert is reset, the alert is removed and replaced by an amber reminder message (boxed for level 2 alerts) placed in a dedicated position in the bottom two rows of the right hand column. This reminder message consists of the associated system name as used on the SDCP (e.g. generator faults would be indicated by an ELEC reminder message).

Some level 1 alerts are maintenance alerts that appear on the SD STATUS page only and will not illuminate an SDCP cue switch or the MASTER CAUTION lights.

Level 0 alerts (advisories) have the lowest priority and are displayed as cyan messages starting above the reminder messages at the bottom right side of the alert area. The latest level 0 advisory is added to the top of the level 0 list.

Pushing the corresponding system cue switch will cause a synoptic of the system to appear on the SD. The SD is normally CRT4.

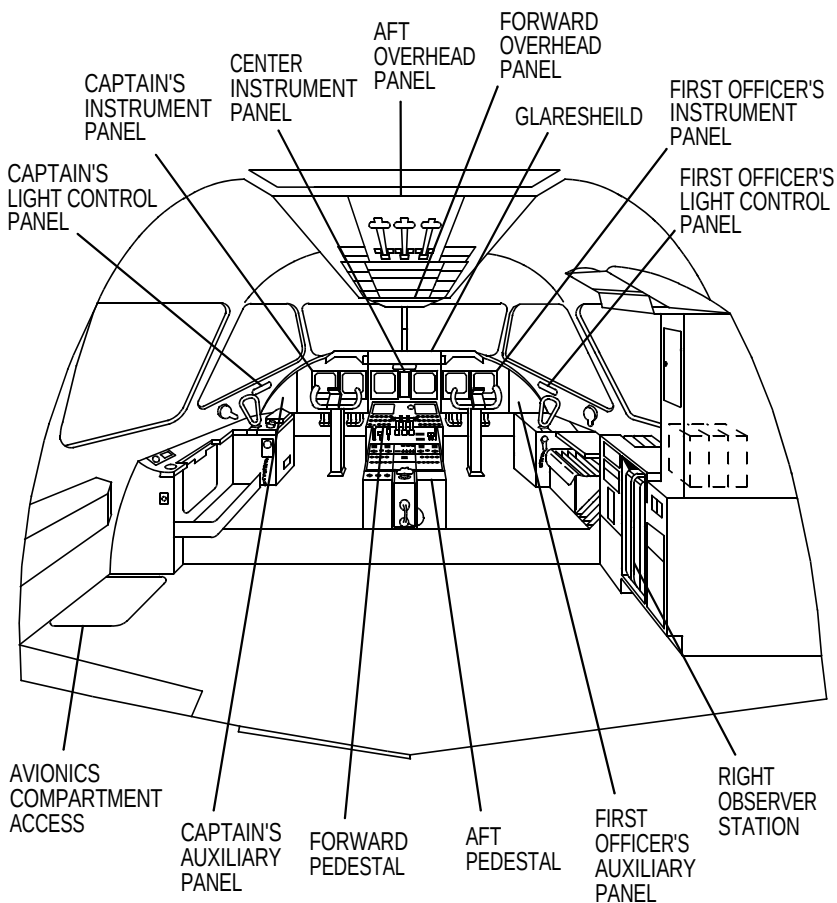
Cockpit Panel Locator

IDENT NO.	SYSTEMS DESCRIPTION CHAPTER
1	Airplane General
2	Air/Pneumatics
3	Auxiliary Power Unit (APU)
4	Automatic Flight
5	Communications
6	Electrical Systems
7	Emergency Equipment
8	Engines
9	Fire Warning and Protection
10	Flight Controls
11	Flight Management System
12	Fuel
13	Hydraulics
14	Ice and Rain Protection
15	Instrumentation and Navigation
16	Landing Gear and Brakes
17	Warning and Alerting
18	Water and Waste

The circled identification numbers on the following pages refer to the chapters where detailed information for each item may be found. The cockpit panel locations are typical and intended for general reference only. Use the corresponding Systems Description chapters noted above for specific arrangements.

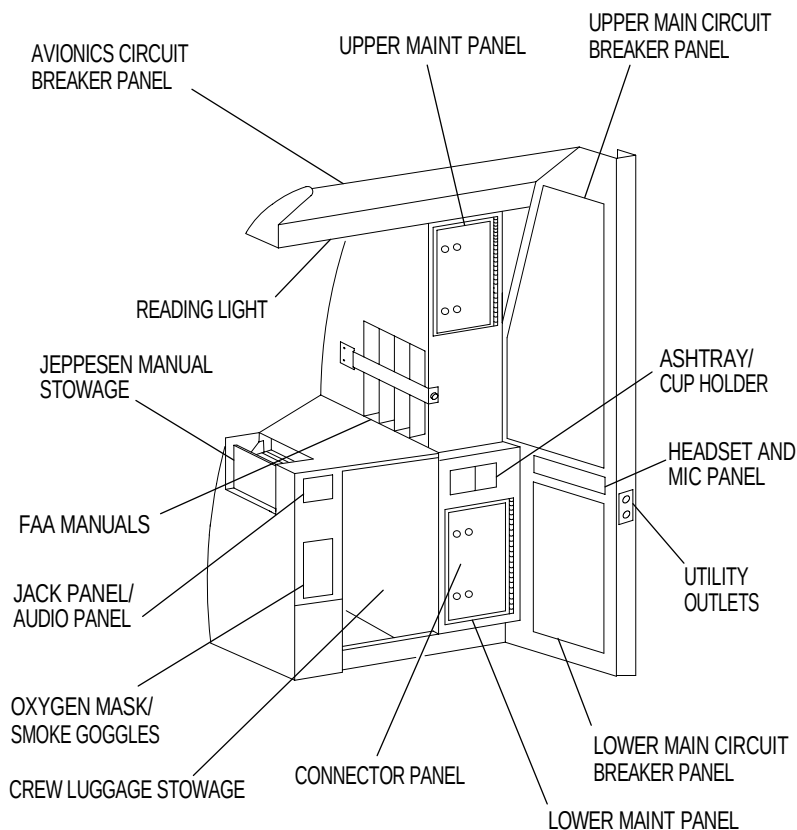
MD-11 Flight Crew Operations Manual

Cockpit Arrangement



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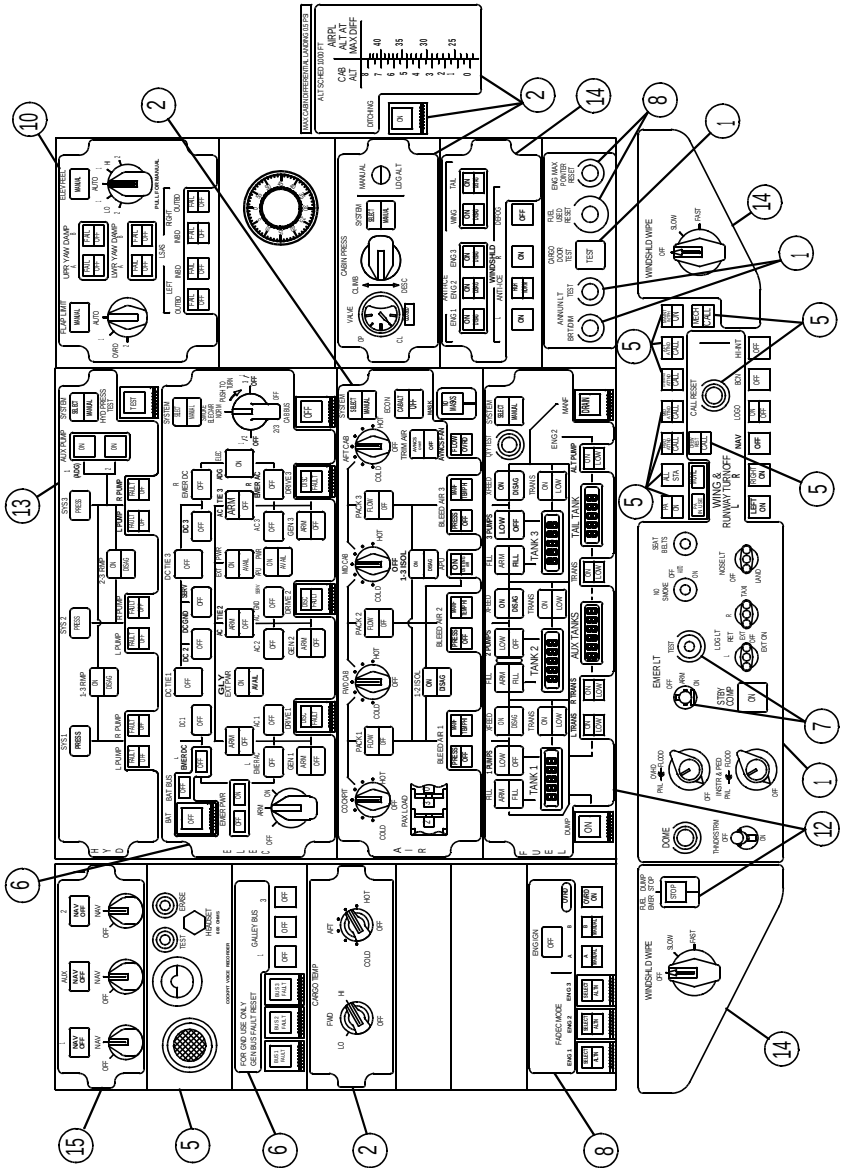
Right Observer's Arrangement



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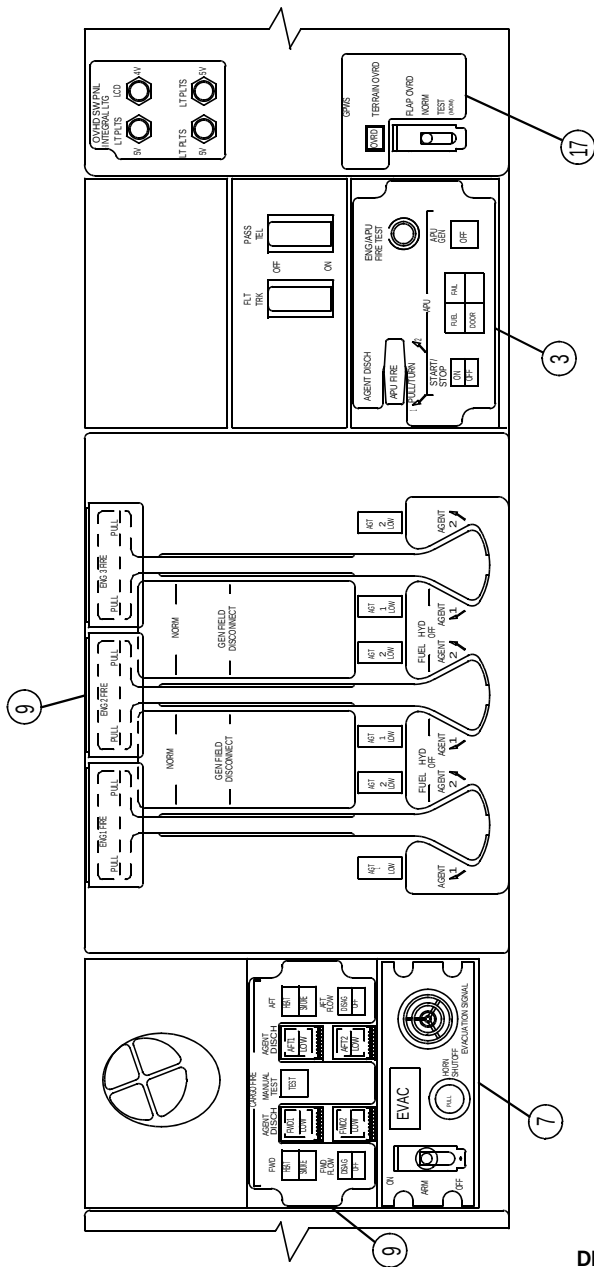
KLM
MD-11 Flight Crew Operations Manual

Forward Overhead Panel



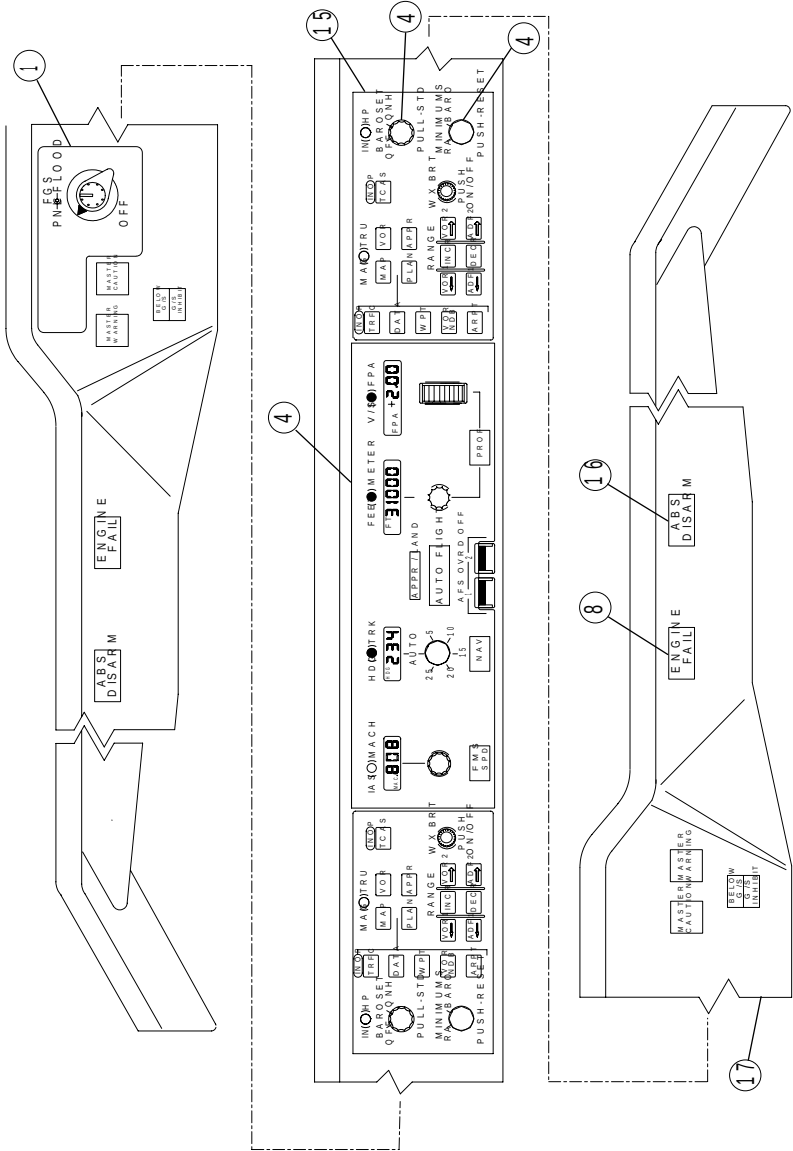
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Aft Overhead Panel



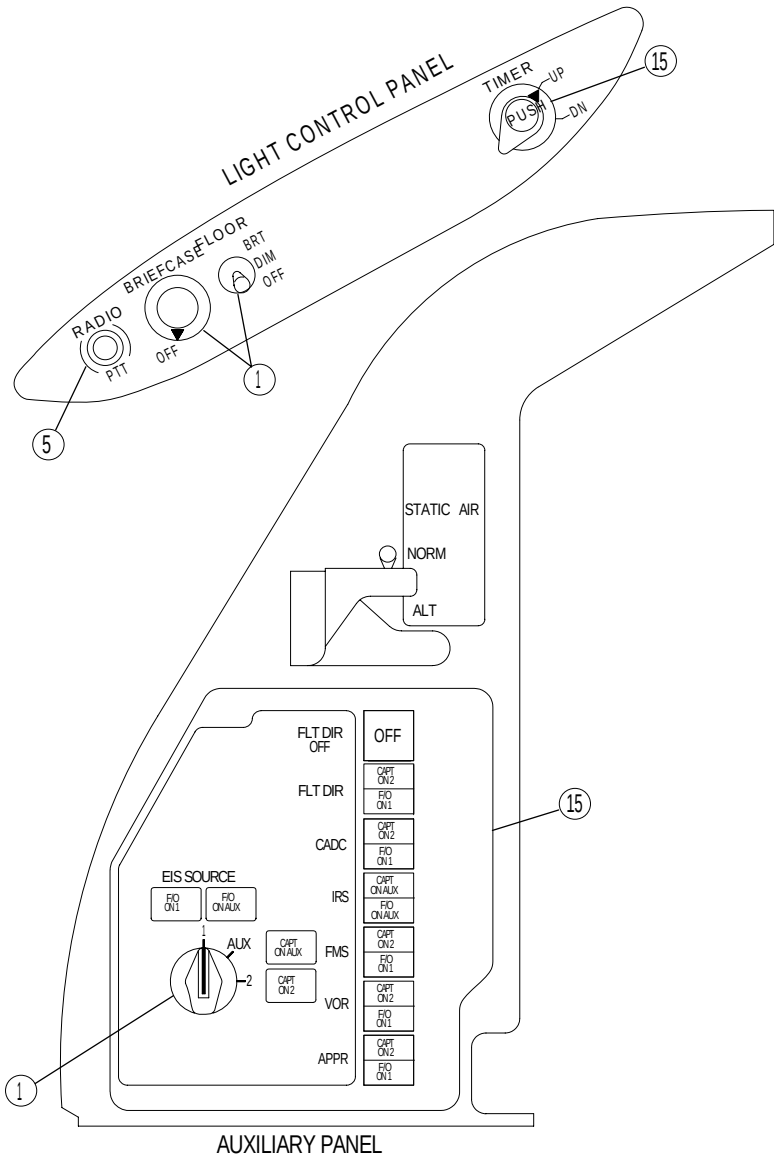
DB1-2-1936

Glareshield [Typical]



DB1-2-1835

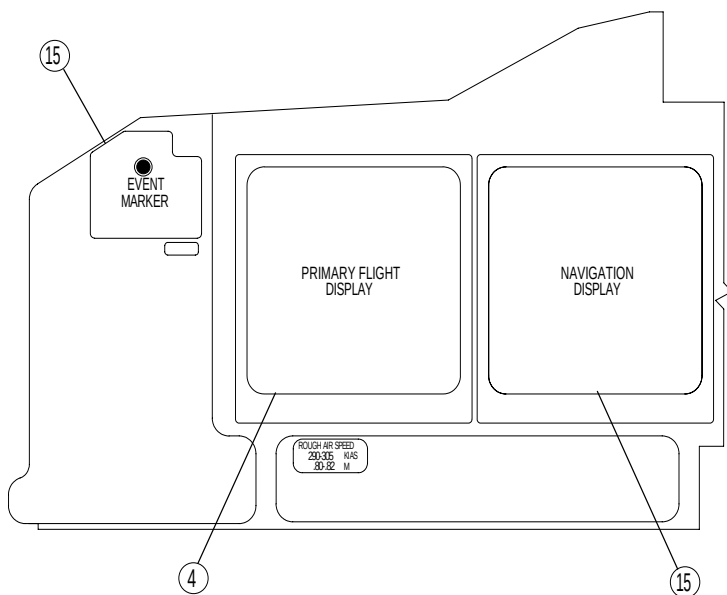
Captain's Auxiliary and Light Control Panels (Typical)



DB1-2-1836

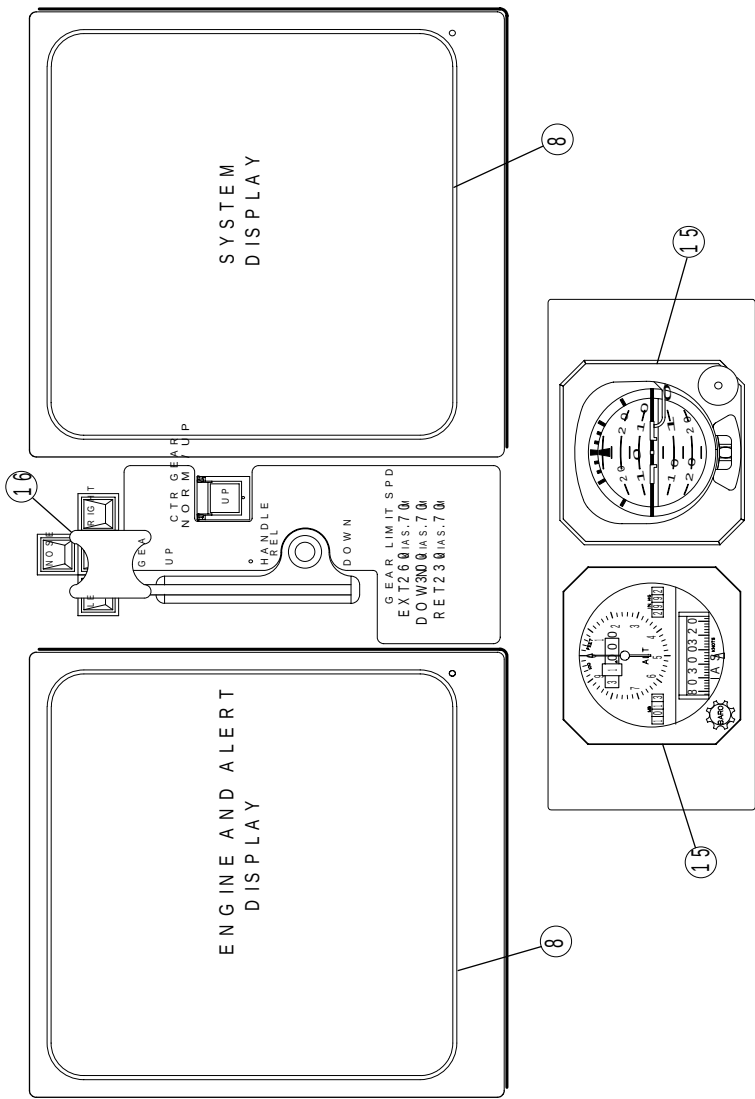
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Captain's Instrument Panel [Typical]



DB1-2-1643A

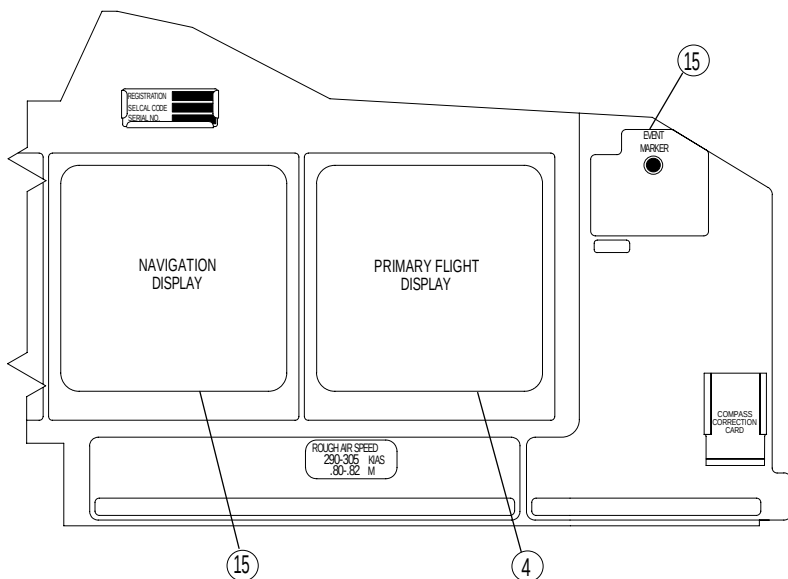
Center Instrument Panel [Typical]



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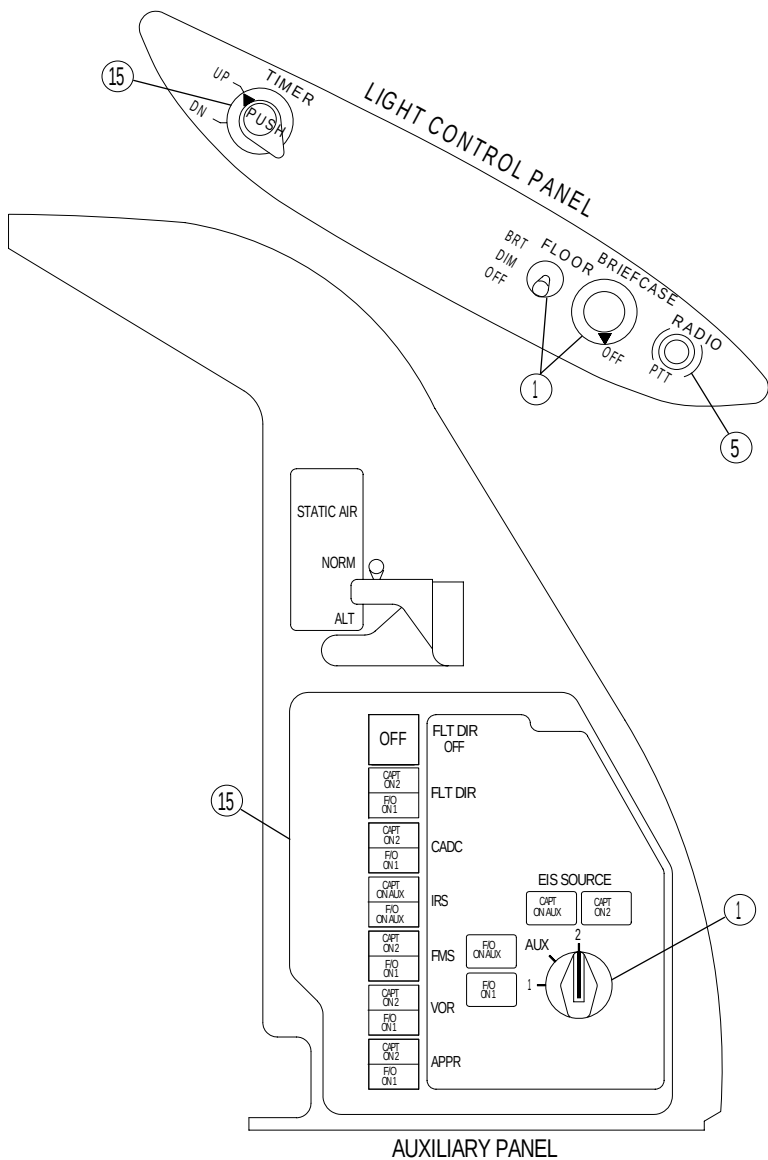
MD-11 Flight Crew Operations Manual

First Officer's Instrument Panel [Typical]



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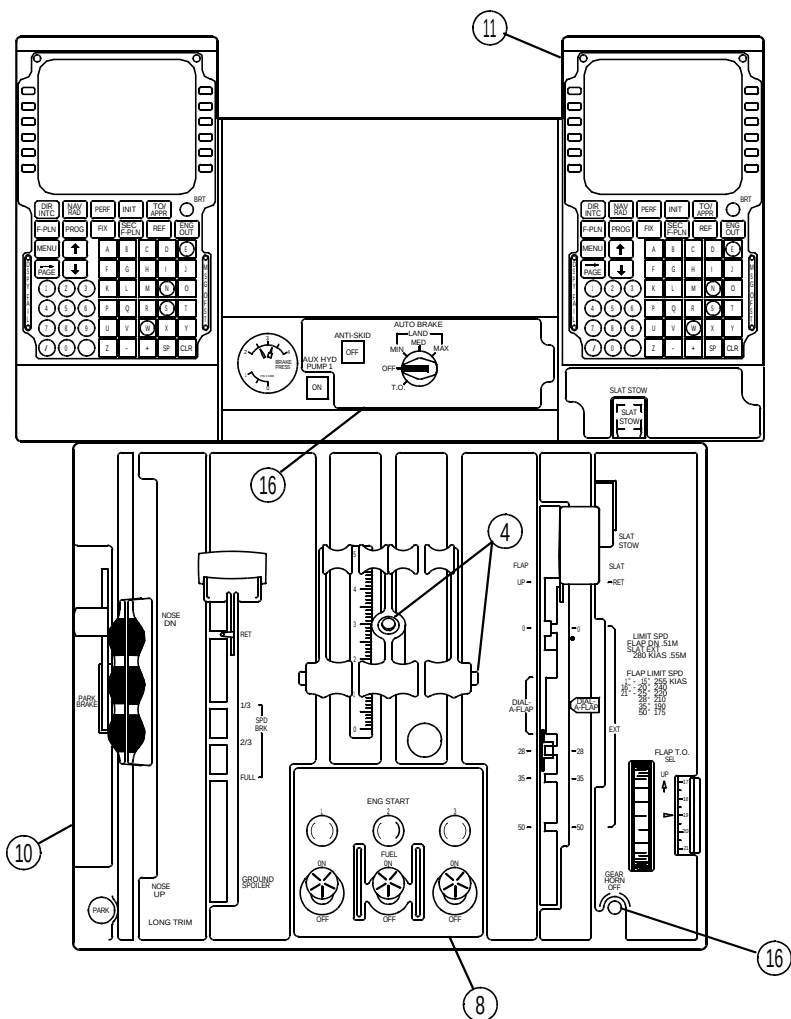
First Officer's Auxiliary and Light Control Panels (Typical)



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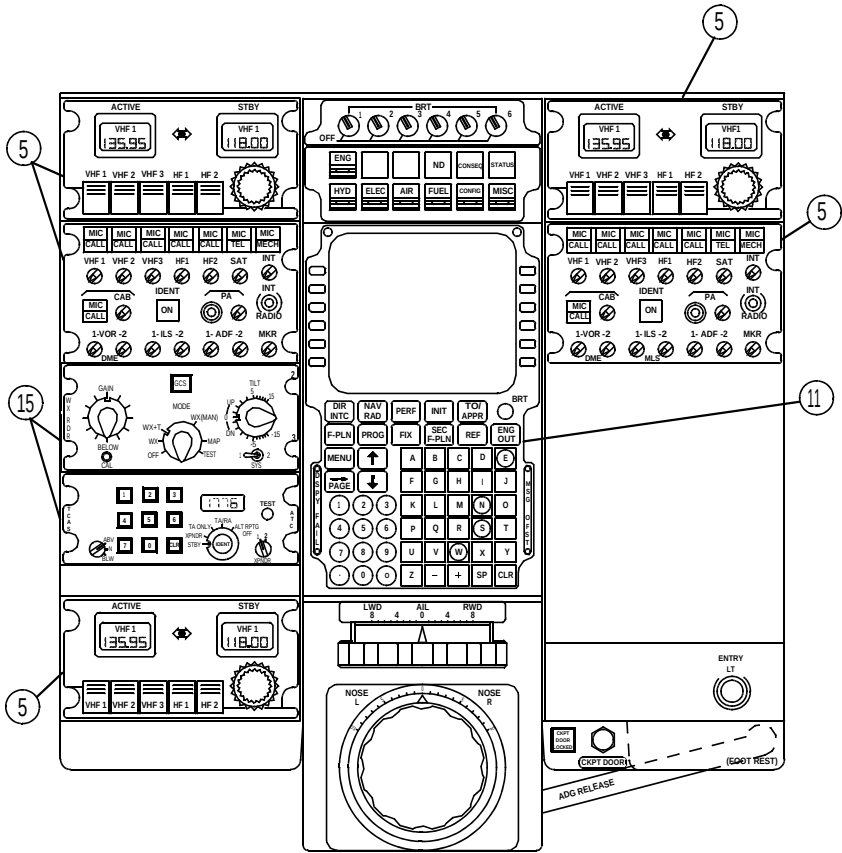
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Forward Pedestal



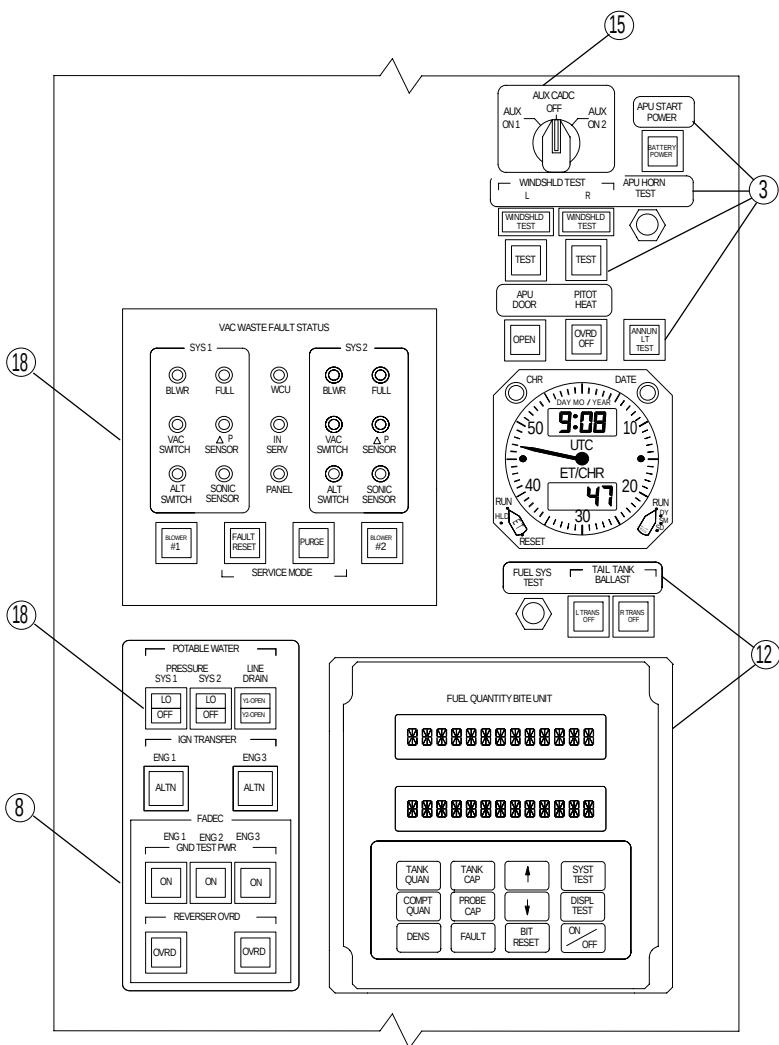
DB1-2-1937

Aft Pedestal



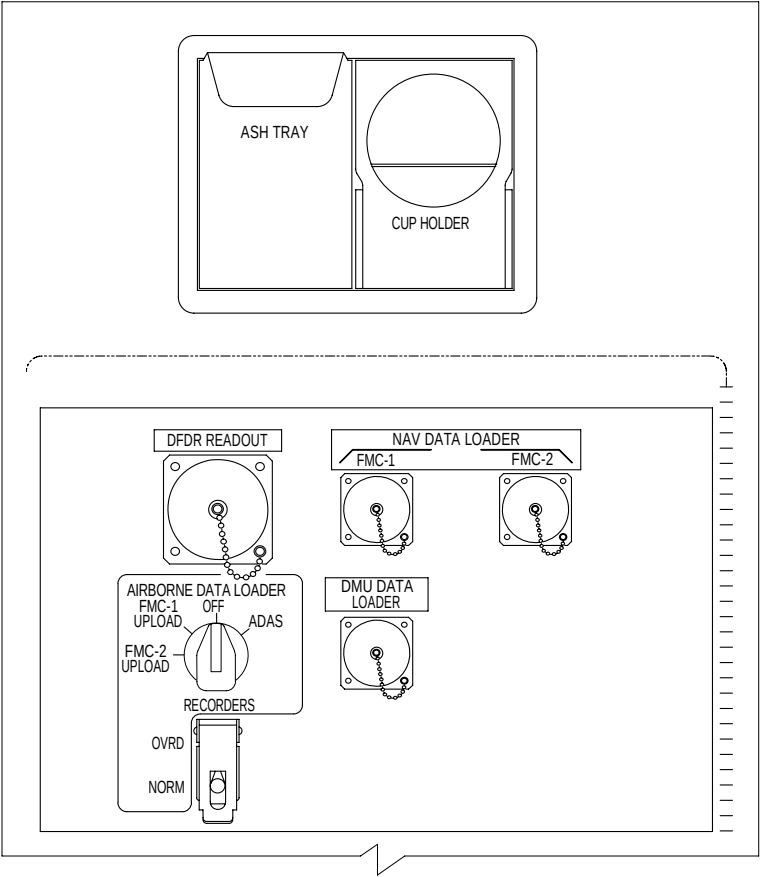
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Right Observer's Station Upper Maintenance Panel [Typical]



DB1-2-1840A

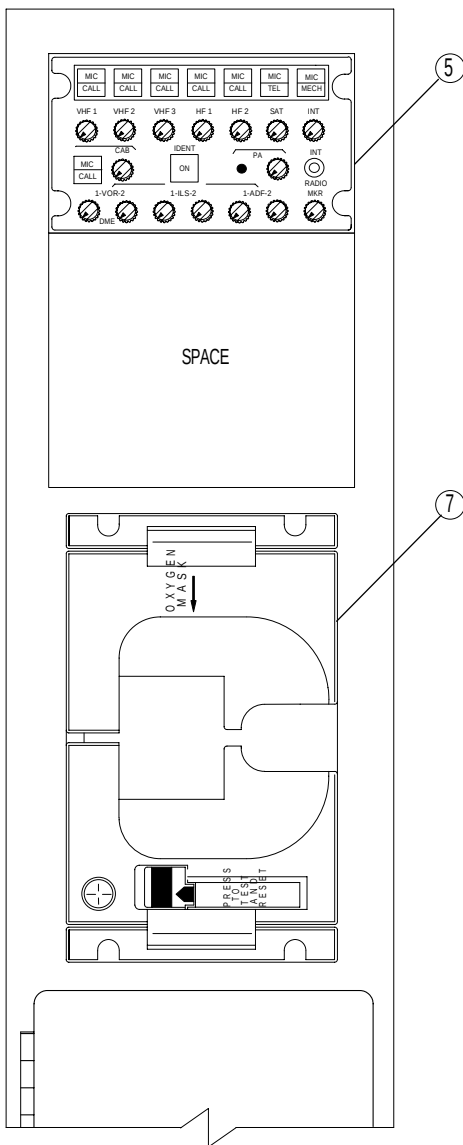
Right Observer’s Station Lower Maintenance Panel [Typical]



DB1-2-1845

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Right Observer's Station Audio Control Panel [Typical]



DB1-2-1846A

Electronic Instrument System

The Electronic Instrument System (EIS) consists of six DUs installed in the instrument panel, two EIS Control Panels (ECP) on the glareshield, one System Display Control Panel (SDCP) on the aft pedestal, one Remote Light Sensor (RLS) on each DU and one on top of the glareshield, and three Display Electronic Units (DEU) in the electronics bay.

The EIS displays will appear on the six DUs (numbered 1 through 6 starting on the far left side). The displays are:

- DU1 and DU6 are the Primary Flight Displays (PFD). The PFDs display attitude, airspeed, barometric altitude, radio altitude, vertical speed, heading, vertical and lateral deviation, limits, and flight modes. Controls for the PFDs are on the glareshield. The PFD and associated controls are described in the Automatic Flight chapter.
- DU2 and DU5 are Navigation Displays (ND). The NDs display aircraft position, waypoints, nav aids, and airports. Controls for the NDs are on the glareshield. The NDs and associated controls are described in the Instrumentation and Navigation chapter.
- 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 Warning and Alerting 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 is described in the associated system chapter. SD alerts and related pages are described in the Warning and Alerting chapter. Each DU presents a full color display with 6.5 inch by 6.5 inch usable area. Automatic and manual brightness controls ensure readability from dark to full sunlit ambient conditions. If the SMOKE switch on the forward overhead panel is pushed, the DUs will go to full bright. Each DU can accept data from any of the three DEUs. Manual brightness controls for the DUs are on the SDCP.

In case of DU failure, the EIS will reconfigure to display all data required for operation of the remaining DUs.

Six controls are provided for on/off and manual brightness control of each DU. Turning the knobs fully counterclockwise through a detent turns off the associated DU. When a DU is turned off with the knobs on the SDCP, the DU will go into a low power condition. This allows the DU to cool and be available for possible later use.

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Turning off a DU automatically causes the system to reconfigure the other DUs so that the minimum data required for flight remains displayed. The DUs are also reconfigure automatically when the aircraft is in an emergency power condition. In an emergency power condition only DU1, DU2, and DU3 are powered.

Seven cue switches on the SDCP allow the flight crew to identify the system that is generating alerts and/or warnings. Pushing a cue switch will cause the associated system synoptic to be displayed on the SD.

When pushed, a CONSEQ switch on the SDCP will cause alert related consequences to be displayed on the SD.

When pushed, the STATUS switch on the SDCP will cause all aircraft system faults to be displayed on the SD.

If five or fewer DUs are operating, pushing the ND switch will cause the existing SD to become an ND. If all six DUs are operating, THIRD NAV DISPLAY NOT AVAILABLE will appear on DU4.

The RLS on top of the Captain's glareshield senses outside light. The RLSs on each DU sense inside light. Inside and outside light levels are compared and DU brightness is adjusted automatically.

Each of the DEUs receives data from aircraft sensors and systems. The DEU then converts this data to graphic commands for display on the DUs. Normally DEU1 provides data for the Captain's DUs (PFD, ND, and EAD). DEU2 provides data for the First Officer's DUs (PFD, ND, and SD). DEU3 is a hot spare.

In case of failure, any DEU can provide data for any DU. DEU selection is accomplished with the EIS SOURCE selectors on the Captain's and F/O's source input select panels. Any of the three DEUs can provide data for all six DUs, but only one independent ND.

Colors

A consistent set of colors is used for all the displays to allow the flight crew to readily recognize and associate various types of data. All information is conveyed with distinctly shaped symbol as well as changes in color.

White is used for scales and associated figures and also denotes manual entry or action. White symbology includes:

- Scales.
- Manually selected values.
- Manually initiated autopilot/autothrottle modes.
- Weather radar turbulence.
- Inactive schematic lines on the SD.

Cyan is used for status indication. Cyan symbology includes:

- Status messages in the alert list.
- Available, but not used, navigation data base items

Green is used to indicate validity. Green symbology includes:

- Track diamond.
- Autopilot/autothrottle land modes.
- Landing gear safe.
- Trend data.
- Weather radar precipitation less than 4 mm/hour.
- Active schematic line on the SD (except electrical).

Magenta signifies electronically generated or derived data. Magenta symbology includes:

- Flight management system (FMS) selected values.
- Flight Director commands.
- Radio navigation data.
- Weather radar precipitation more than 50 mm/hour.
- Weather radar turbulence.
- Localizer and glideslope deviations.

Amber identifies conditions that require immediate crew awareness and possible subsequent corrective action. Amber symbology includes:

- Failures.
- Cautions.
- Abnormal sources.
- GPWS/EGPWS.
- Weather radar precipitation 4 to 12 mm/hour.
- System abnormal conditions.

Red identifies conditions that require immediate crew action or impose consistent limitation on the aircraft. Red symbology includes:

- Warnings.
- Autopilot/autothrottle disconnect and failures.
- VMO/MMO and stickshaker speeds.
- High or low airspeed limits.
- Pitch and roll limits (when exceeded).
- Engine limits and exceedances.
- Landing gear not safe.
- Weather radar precipitation 12 to 50 mm/hour.
- EGPWS.

Gray (half intensity white) is used for scale shading.

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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 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.

Cross-side miscomparisons are generated when the EIS detects significant differences between the displayed data of the Captain's and First Officer's instruments. These comparisons are limited to attitude, airspeed, altitude, radar altitude, ILS and heading.

The detected miscomparisons will be displayed in amber in the upper left-hand corner of the PFD, just outside of the attitude sphere.

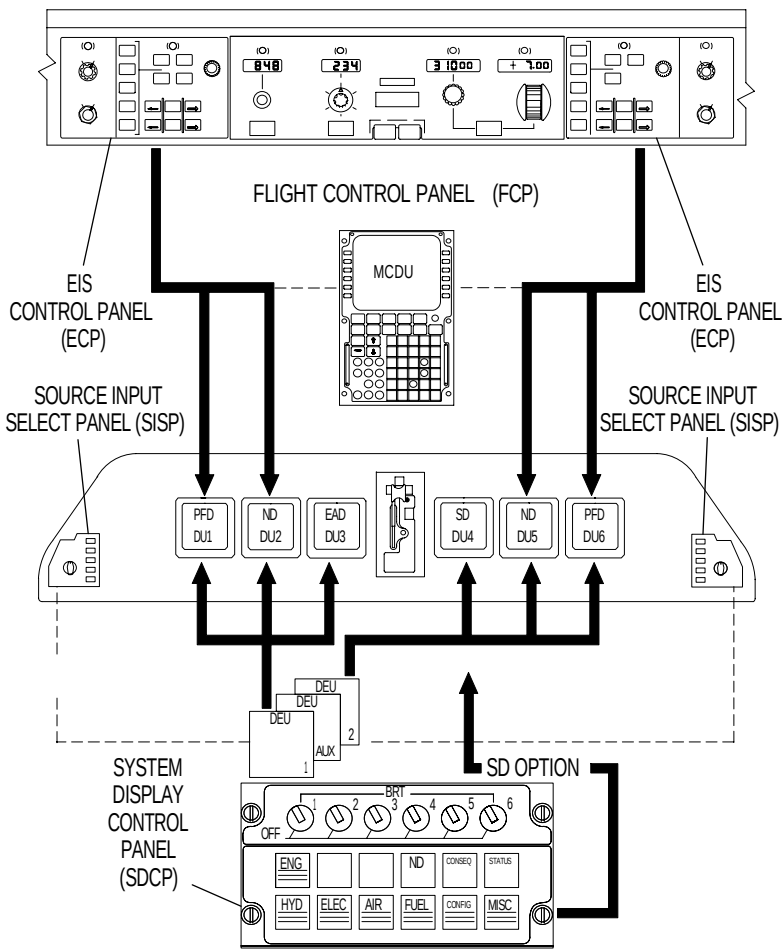
Display Source Annunciation

Normal (on-side) display sources are not annunciated. Abnormal (off-side) sources are annunciated near the associated symbology. These annunciations are white if the Captain and First Officer displays are driven from separate sources and amber if the displays are driven from the same source. Same source annunciation is displayed on both sides.

Data Dropout

In the rare event of EIS data loss, protection schemes ensure that the PFD will display pitch, roll, and altitude. The EAD will display engine thrust settings.

Electronic Instrument System Components



DB1-2-1847

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CRT Quick Reference Table

PFD DU1	ND DU2	EAD DU3	SD DU4	ND DU5	PFD DU6

CRT	POSSIBLE DISPLAY	POSITION ON CRT	CHAPTER DESCRIBED IN	ACCESS
PFD DU1 DU6	Primary Flight Display	Full Screen	AUTOMATIC FLIGHT	Automatic
ND DU2 DU5	Navigation Display	Full Screen	INSTRUMENTATION AND NAVIGATION	Automatic
EAD DU3	Primary Engine Display Alert Presentation	Upper 2/3 Lower 1/3	ENGINES WARNING AND ALERTING	Automatic Automatic
SD DU4	Air Synoptic Configuration Synoptic Configuration Synoptic Electrical Synoptic Fuel Synoptic Hydraulic Synoptic Secondary Engine Display Alert and Consequences Consequence Page Status Page Miscellaneous Page Navigation Display	Upper 2/3 Upper 2/3 Upper 2/3 Upper 2/3 Upper 2/3 Upper 2/3 Upper 2/3 Lower 1/3 Full Screen Full Screen Full Screen Full Screen	AIR LANDING GEAR AND BRAKES FLIGHT CONTROLS ELECTRICAL FUEL HYDRAULICS ENGINES WARNING AND ALERTING WARNING AND ALERTING WARNING AND ALERTING WARNING AND ALERTING INSTRUMENTATION AND NAVIGATION	AIR Cue Switch CONFIG Cue Switch CONFIG Cue Switch ELEC Cue Switch FUEL Cue Switch HYD Cue Switch ENG Cue Switch/ Automatic Automatic CONSEQ Switch STATUS Switch MISC Switch ND Switch

NOTE: Table assumes normal DU configuration

The secondary engine page appears automatically
on the SD if any parameter on it exceeds limits.

DB1-2-1848A

Seats

The cockpit contains seats for a Captain, First Officer, and Observers. All seats, except the aft observer's seat, have electrical and/or manual adjustments. If the electrical control or power of a seat fails, full movement of the seat is possible through manual operation. All seats are equipped with seat belts and dual shoulder harnesses with inertia reels. All seats, except the aft observer's seat, are additionally equipped with a crotch belt. On some seats the headrest can be adjusted vertically as well as tilted to several positions including a fully horizontal (stowed) position.

Seats for the Captain and First Officer are powered by two electric motors. The motors provide vertical and horizontal adjustments. The recline, lumbar support, armrest, and thigh support controls are manually operated. The Captain and First Officer's seat has a recline limit switch which inhibits outboard movement of the seat whenever the backrest is reclined more than one notch from the upright position. The seat indicator incorporates two numerical index scales; one scale representing the vertical position of the seat and the other the horizontal.

Horizontal control switches permit the Captain and First Officer seats to be moved full aft and outboard to facilitate exit.

The right Observer's seat is also powered operated to provide vertical adjustment. The recline, lumbar support, armrest, and swivel controls are manually operated. The swivel control permits adjustment between forward and outboard facing positions. When facing forward, the seat has vertical capability. When facing outboard, the seat does not have vertical capability.

On power-operated seats, turning the power switch to OFF after adjusting the seat for takeoff or landing prevents seat movement (runaway seat) if an electrical short should occur.

The aft Observer's seat is a folding, nonadjustable type bolted directly to the floor structure.

The Pilot Eye Locator consists of optical painted white lines on the instrument panel.

Doors

P - There are eight cabin doors, three lower cargo doors, a cockpit door, and a door for each lavatory.

If any door is open on the ground, a level 1 DOOR OPEN alert appears on the SD. When the first engine is running, the alert then changes to a level 2 alert identifying the specific door.

Cockpit Door

The cockpit door is manually operated by a standard door knob. If electrical power is available, the door locks electricomagnetically by a door selector located on the overhead panel. A totally independent dead bolt lock is installed on the cockpit side, with a key lock on the cabin side. The cockpit door has decompression panels and a viewing port is installed to provide a view of the cabin area. An Emergency Access Panel at the cabin side can provide access to the cockpit. Entering an Emergency Access Code on the 6-button keypad will unlock the cockpit door.

Lavatory Door

Lavatory doors are manually operated from inside the lavatory by a sliding bolt lock. Position of the lock is indicated by VACANT/OCCUPIED sign on the cabin side of door. Each door can be unlocked with a knob behind the hinged LAVATORY sign.

Cabin Door

Passenger aircraft have eight cabin doors, four on each side, for normal passage or emergency escape.

Each cabin door opens by moving slightly inboard and then sliding up into the ceiling. The doors have interior and exterior controls for door operation. The two forward cabin doors are not identical to the other cabin doors. They have different interior controls and operating instructions.

The six remaining (mid, overwing, and aft) doors on passenger aircraft have identical interior controls placarding and operating procedures.

A polarized viewport is installed on the upper portion of all cabin doors. Polarization (clear to dark) can be adjusted by rotating a knob in the center of the port.

Interior controls for normal operation consist of a slide arming lever located on the structure adjacent to door and a door control switch. Escape slides must be disarmed before the switch or switch-lights can be used to open or close door.

Exterior controls, placarding and operating procedures are identical for all cabin doors. Exterior controls are located in a recess in the fuselage forward of door and consists of a door control handle, a door control switch, and an auxiliary handle. The door control handle arms and disarms the escape slide. The door control switch opens and closes the door. An auxiliary handle used in conjunction with a door control handle will close the door by free fall.

A socket drive fitting is installed for opening and closing the left forward cabin door from outside with no electrical power on the aircraft. The socket drive fitting may be operated manually or with a portable air/electric drive motor.

Barrier straps are secured across open doorways as a safety precaution when the ramp or stairway is not installed.

Lower Cargo Doors

The lower cargo doors are installed for access to the forward, center, and aft cargo compartments. Forward and center doors are located on the lower right side of the fuselage. The aft door is located on the lower left side of the fuselage. The cargo doors are electrically operated from a control panel in the exterior fuselage just forward of each door. The cargo doors can be manually operated when electric power is not available.

If a person is locked in the forward, center or aft lower cargo compartment, they can alert the cockpit crew with a cockpit call switch on the inside of each lower cargo door. This switch will cause a CARGO DOOR (FWD, CTR, or AFT) A alert to be displayed in the cockpit.

Lighting

Aircraft lighting systems are installed in the cockpit, exterior, and cabin area. Aircraft lighting is controlled from the cockpit except for certain functions of the cabin area lighting, which are controlled from individual panels in each respective area.

All major lighting subsystems have an emergency standby lighting system that is capable of operating in the event of a power failure. See Emergency Equipment chapter for description of the emergency lights.

Cabin Lighting

Illumination of the cabin and galley is provided by incandescent and fluorescent lighting. These lights are in the ceiling areas, galleys, entrance doors and lavatory.

NO SMOKING and FASTEN SEAT BELTS signs are installed in courier module. RETURN TO CABIN signs are installed in each lavatory. A chime warning sounds when the signs are turned on.

AUTO position of the NO SMOKE switch will cause the NO SMOKING signs to illuminate when the GEAR handle is in DOWN position.

AUTO position of the SEAT BELTS switch will cause FASTEN SEAT BELTS and RETURN TO CABIN signs to illuminate when the FLAP handle is out of UP/RET position or GEAR handle is in DOWN position.

The NO SMOKING and FASTEN SEAT BELT signs will illuminate if the cabin altitude exceeds 10,000 feet with the switches in OFF or AUTO.

Cockpit Lighting

A threshold light in the cockpit doorway illuminates the step between the cockpit and cabin area. It illuminates automatically when cockpit door is open.

Cockpit dome lights provide area lighting. They can be turned on or off with a switch on the forward overhead panel. They also illuminate when the THNDRSTRM switch is on.

Floodlights illuminate the Captain's, First Officer's, and center instrument panels, overhead panel, glareshield, and pedestal. The controls are rotary knobs that vary light intensity with rotation. When the THNDRSTRM switch is on, all floodlights illuminate full bright.

The standby lighting system automatically illuminates the left overhead floodlight if normal electrical power fails to supply dc bus 1.

Panel lights illuminate integrally lighted instruments and lightplates. The controls are rotary knobs that vary light intensity with rotation.

Six individual controls are installed to vary brightness of the six cockpit CRTs. Selected brightness is automatically maintained throughout a wide range of light conditions.

Exterior Lights

Retractable landing lights are located on the forward section of the fuselage. Fixed landing and taxi lights are located on the nose gear support assembly. The nose lights are interlocked with the GEAR handle so they will illuminate only when the GEAR handle is in the DOWN position.

Runway turnoff lights provide additional side and forward lighting during taxiing and runway turnoff.

Navigation lights consist of a red light on the left wing tip, a green light on the right wing tip, and a white light on the trailing edge of each wing tip.

Beacon lights consist of two red flashing lights on the fuselage. One is located on top and the other is on bottom of the fuselage.

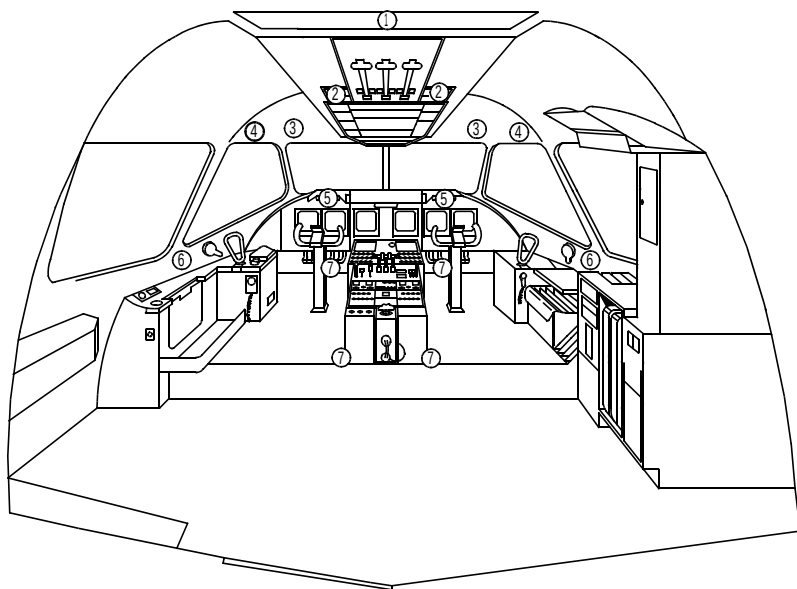
Two cargo loading/unloading floodlights are located on the inside face of the main cargo door. The lights are controlled by a switch located on the main cargo door control panel.

Wing and engine scan lights illuminate engine 1 and 3, wing leading edge, and wing surfaces to aid the flight crew in visually checking for icing.

High intensity supplemental lights consist of forward and aft facing strobe lights on each wing tip.

Logo lights are located in the horizontal stabilizers to illuminate the airline logo on the vertical stabilizer.

Cockpit Lighting Arrangement



LEGEND

- ① COCKPIT DOME LIGHT
- ② PEDESTAL FLOODLIGHTS
- ③ MAP LIGHTS
- ④ OVERHEAD PANEL FLOODLIGHTS
- ⑤ INSTRUMENT PANEL FLOODLIGHTS
- ⑥ BRIEFCASE LIGHTS
- ⑦ FLOOR LIGHTS

DB1-2-1974

Centralized Fault Display System

The Centralized Fault Display System (CFDS) provides maintenance checkout and fault isolation for selected aircraft sub-systems. A Centralized Fault Display Interface Unit (CFDIU) controls the transmission of data between reporting LRUs and the MCDU. The reporting LRUs continuously send data to the CFDIU. The CFDIU then sends this data to the MCDU for display (if selected by maintenance personnel). The CFDIU stores maintenance data for the current flight leg which the MCDU can access. The CFDIU is also a reporting LRU to the CFDS.

The 3 modes of data transmission between the CFDIU and the reporting LRUs are as follows:

- LRUs automatically send faults to the CFDIU.
- Maintenance personnel communicate with an LRU through the MCDU.
- GMT, date, and flight number are sent to the reporting LRUs.

Normally, MCDU-3 on the aft pedestal is used to access CFDS data, however, MCDU-1 and MCDU-2 on the forward pedestal can also be used.

The MCDU has a keypad and display screen which maintenance personnel use to:

- Access LRU maintenance data.
- Start LRU BIT tests.
- Print data on the screen.
- Send data to ACARS for downlink to a ground station.

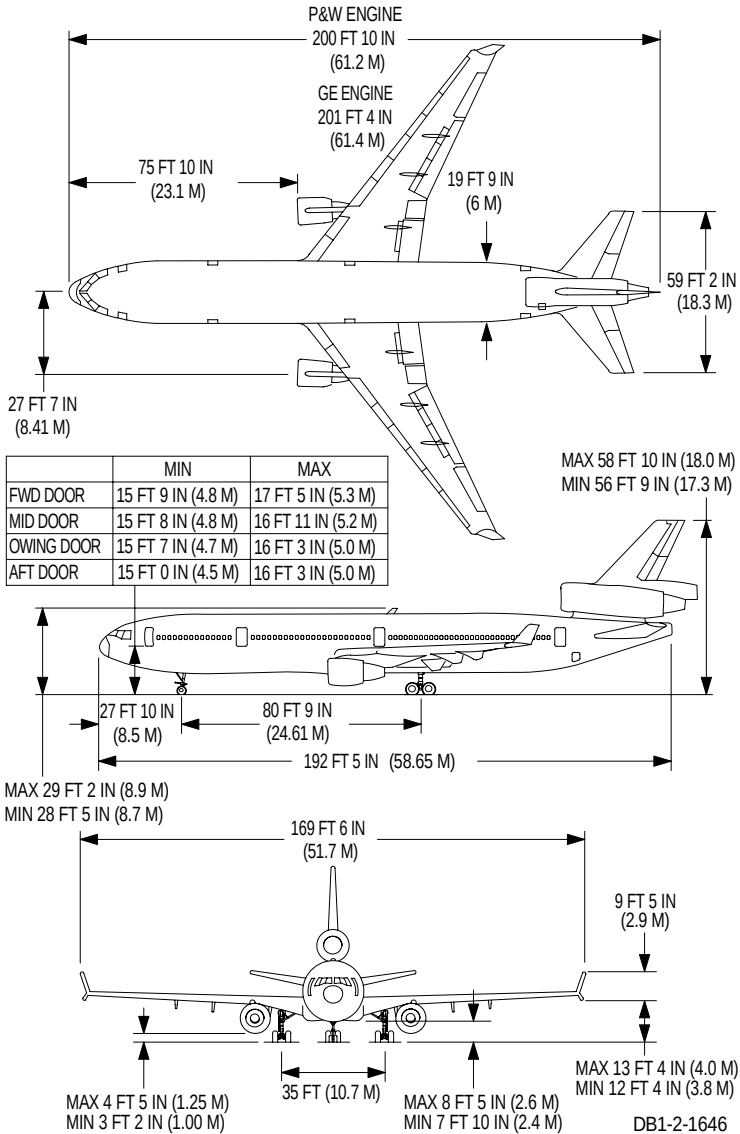
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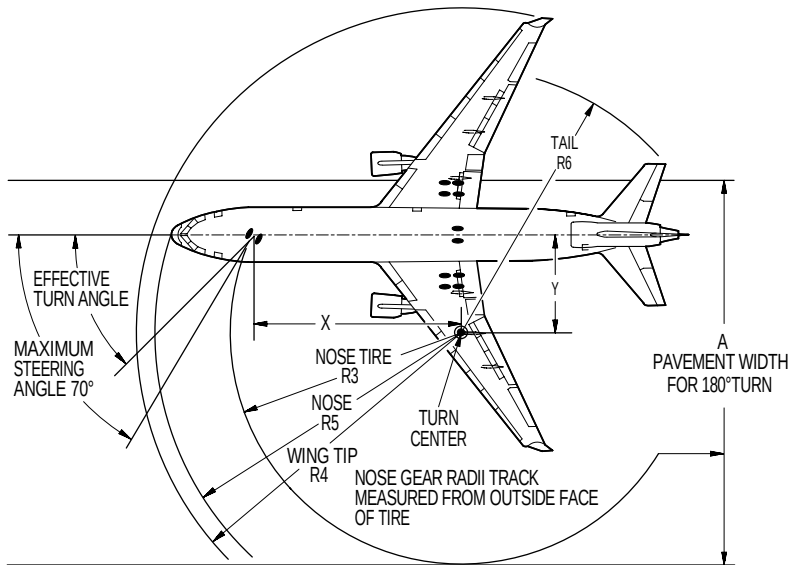
Aircraft General Components

Chapter Agen Section 20

Airplane Dimensions



Turning Radius (Minimum)



NORMAL TURNS

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



MINIMUM RADIUS TO AVOID
EXCESSIVE TIRE WEAR, USE
VARIOUS COMBINATIONS OF :

- STEERING
- ASYMMETRIC THRUST
- LIGHT DIFFERENTIAL BRAKING



MINIMUM RADIUS

- ASYMMETRIC THRUST
- LIGHT DIFFERENTIAL BRAKING
- SLOW CONTINUOUS TURN
- AFT CENTER OF GRAVITY
- MAX GROSS WEIGHT

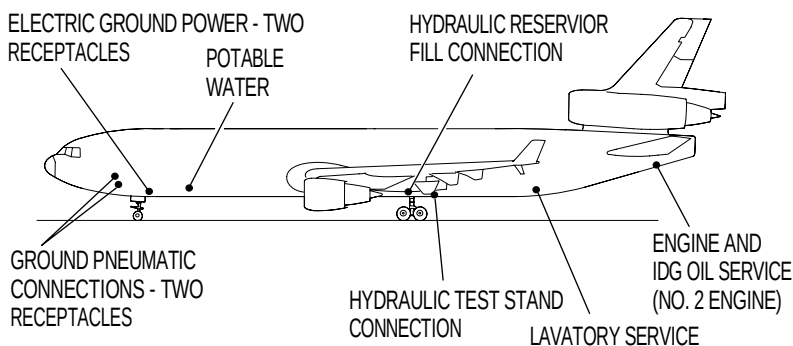
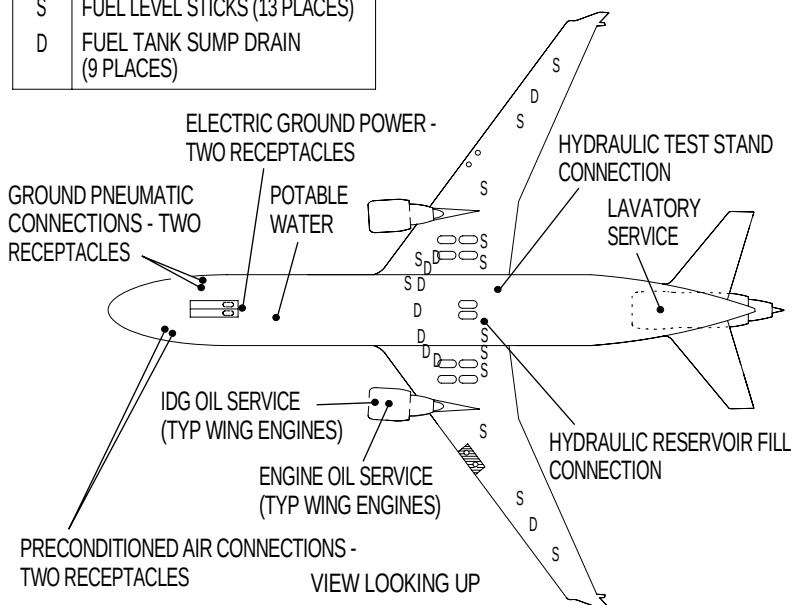
TYPE TURN	EFFECTIVE TURN ANGLE	TIRE SLIP ANGLE	X (Ft/M)	Y (Ft/M)	A (Ft/M)	R3 (Ft/M)	R4 (Ft/M)	R5 (Ft/M)	R6 (Ft/M)
1	60.8°	9.2°	81.2 24.7	45.3 13.8	160.6 49.0	94.7 28.9	136.4 41.6	118.1 36.0	111.9 34.1
2			81.2 24.7	42.1 12.8	155.8 47.5	93.1 28.4	133.4 40.6	116.9 35.6	109.8 33.5
3	72.0°	- 2.0°	81.6 24.9	26.5 8.1	134.6 41.0	87.5 26.7	118.5 36.1	112.6 34.3	100.0 30.5

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Service Connections

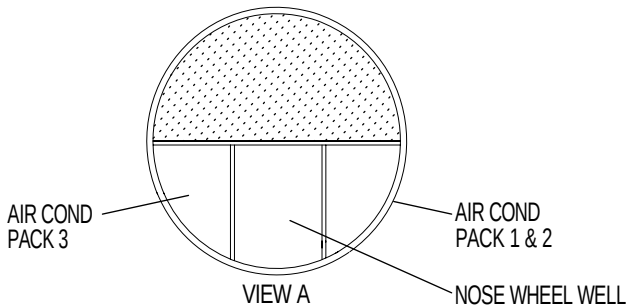
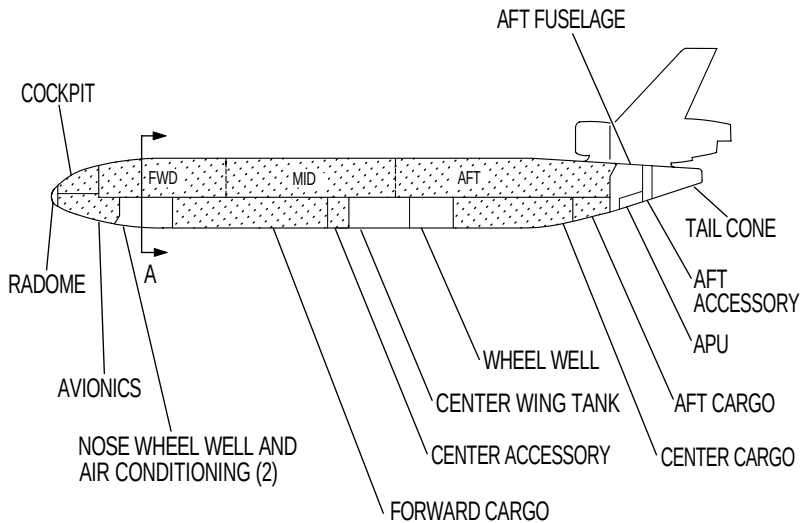
WING SERVICE POINTS	
	REFUELING CONTROL PANEL
○	PRESSURE REFUEL/DEFUEL ADAPTER (4 PLACES)
S	FUEL LEVEL STICKS (13 PLACES)
D	FUEL TANK SUMP DRAIN (9 PLACES)



NOTE: On freighters, the lavatory service connection is forward of the ground pneumatic connections.

DB1-2-1644

Fuselage Compartments

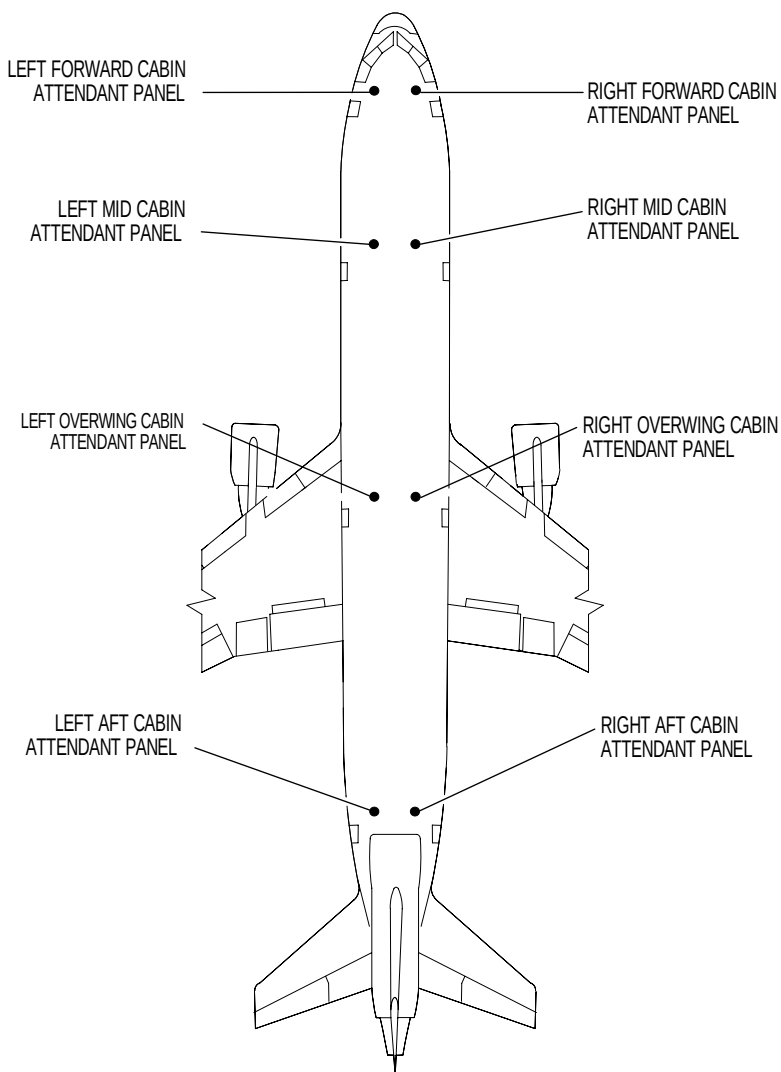


- Not Pressurized
- Pressurized

DB1-2-1882

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Cabin Attendant Panel Locations



NOTE

CABIN ATTENDANT PANELS ARE NOT
INSTALLED ON FREIGHTER AIRCRAFT.

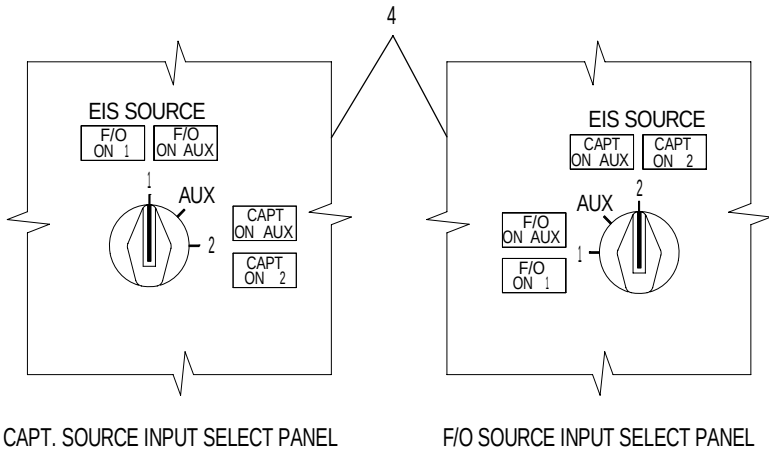
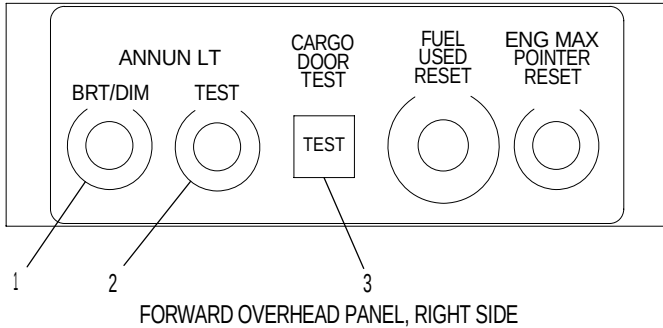
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Aircraft General Controls and Displays

Chapter Agen Section 30

Annunciation, Cargo Door Test and EIS Controls/Lights



1. ANNUN LT BRT/DIM Button

Push to select between bright and dim mode of all annunciator lights and displays. Will not affect MASTER WARNING or MASTER CAUTION lights.

2. ANNUN LT TEST Button

When pushed:

- Overspeed warning sounds.
- Overhead panel - All annunciator lights are on except ENG 1, 2, 3 and the APU FIRE handle lights and the EVAC light
- Glareshield panel - All annunciator lights are on, both MASTER WARNING lights flash, both MASTER CAUTION lights are on, 8s appear in the FCP windows, ENG FAIL, ABS DISARM and BELOW G/S lights are on.
- Instrument panel and SISP panels - All SISP lights are on, all failure and comparison flags and indication on PFD and ND are in view, all failure indications on EAD are in view, red and green GEAR and CTR GEAR P/B UP lights are on.
- Pedestal - All annunciator lights are on, DSPY, FAIL, MSG and OFST on three MCDU are on, 8s appear in frequency windows, VHF and HF CALL lights are on, VHF/HF selector bars, and SDCP key lights are on.
- Failure indications are displayed on all SD pages (ENG, HYD, ELEC, AIR, FUEL, CONFIG, MISC, STATUS and CONSEQ).

NOTES: When button is held pushed for more than 12 seconds, the automatic air system test is initiated.

When button is held pushed for more than 2 minutes, the test is discontinued automatically and the button has to be released and pushed again to reinstate the test.

3. CARGO DOOR TEST Switch

Push and hold to start the MSC cargo door test. Door closed and locked circuits, proximity switches, and unlocked circuits are tested. The test automatically starts when the aircraft is on the ground and the engine start lever is on.

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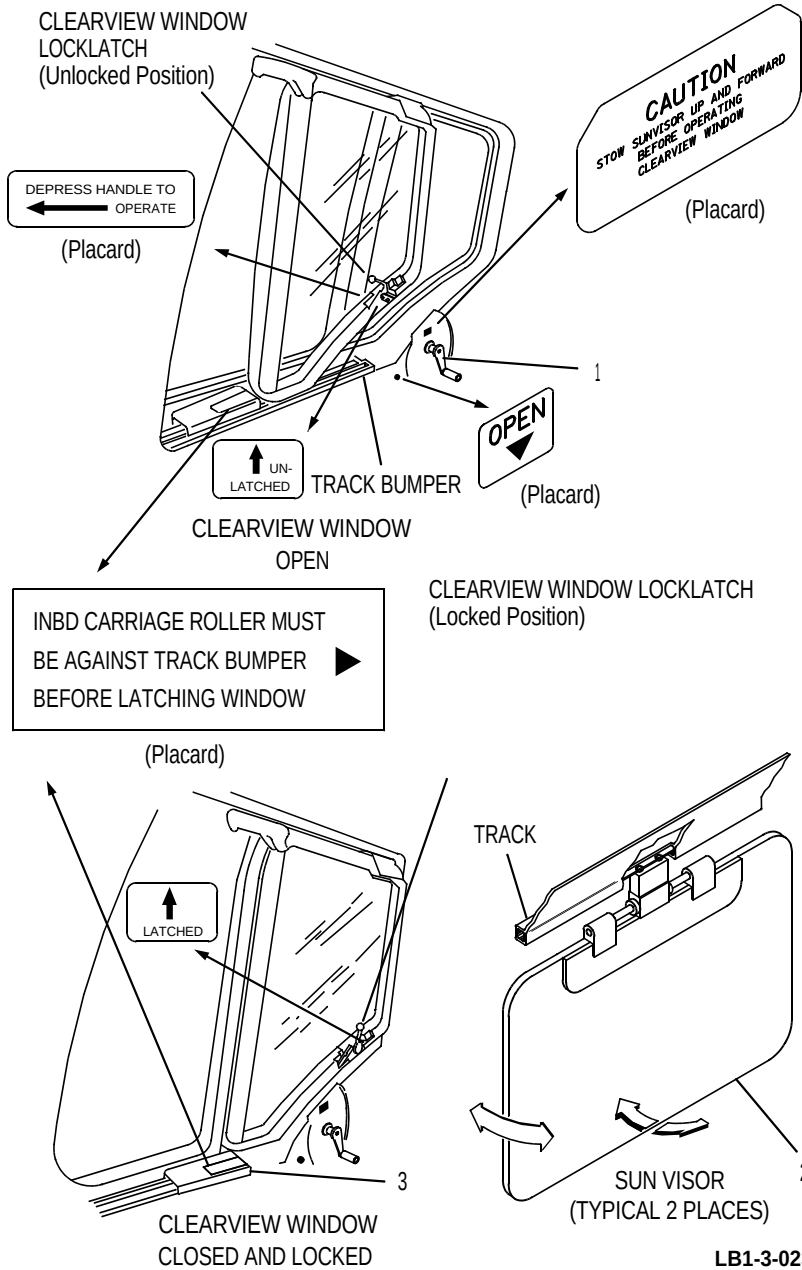
When the test is in progress, this switch illuminates blue and the CARGO DOOR TEST alert is displayed. Light and alert extinguish upon successful completion of test.

4. EIS SOURCE Selector and Annunciator Lights

Normally DEU1 drives the Captain's CRTs (DU1, DU2, and DU3) and DEU2 drives the First Officer's CRTs (DU4, DU5, and DU6). DEU3 is an auxiliary.

Normal selector position is CAPTAIN ON 1 and F/O ON 2. If the selector is out of the normal position, appropriate annunciator light will illuminate amber.

Clearview Window and Sun Visor



1. Clearview Window Crank

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

2. Sun Visor

Visor is moved by grasping the slide block at top of shade and sliding visor to the desired location. On some aircraft, visor is moved by turning and holding locking pin handle down, grasping the bracket at top of shade and sliding visor to the desired location. Releasing locking pin locks visor in place.

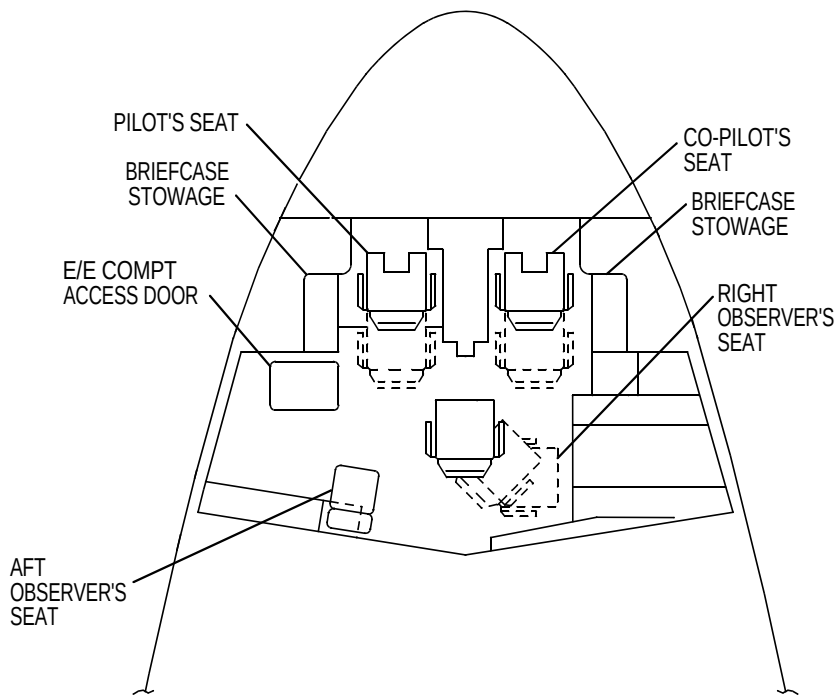
Visor should be moved forward of the forward edge of clearview window and then raised to the stowed position before opening the clearview window. This allows the clearview window to be opened without damaging the visor.

NOTE: Do not move visor by holding lower edge of shade as damage may result due to the leverage applied to the bracket and resultant binding in the track. On some aircraft, the knurled nut or adjustable tension screw immediately above the shade should be tightened only to the degree necessary to hold shade in desired horizontal position.

3. Red Paint

Visible on inboard carriage roller link and end of track when window is closed and in position for latching.

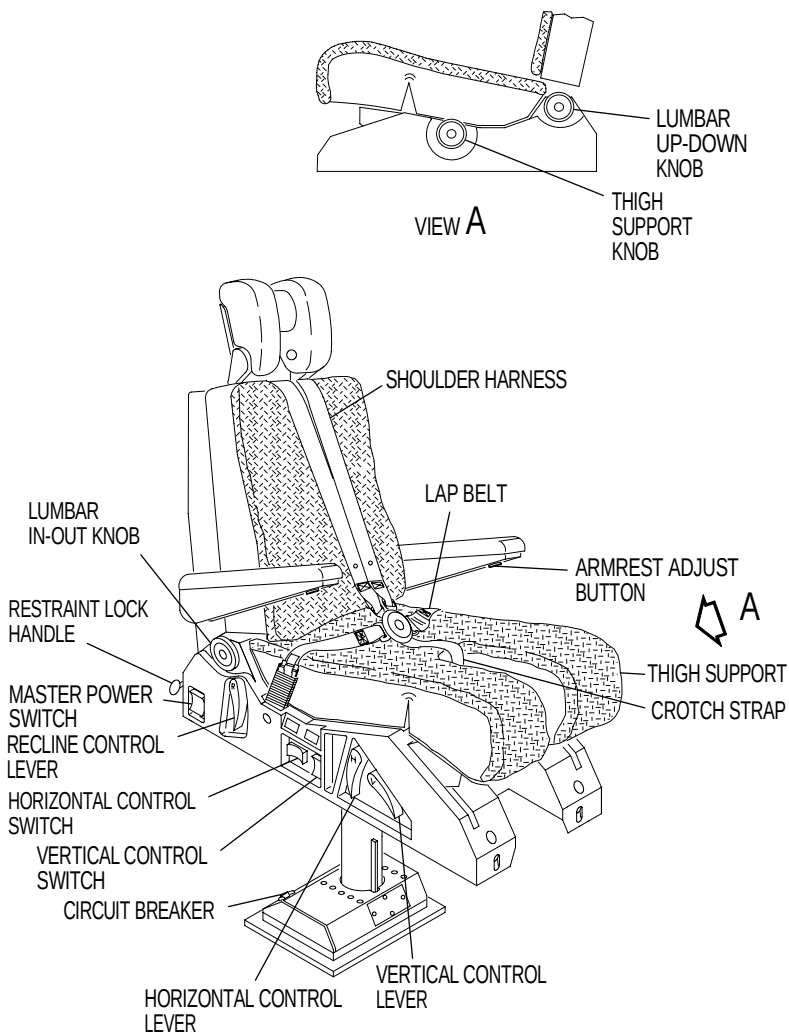
General Arrangement



DB1-2-1965

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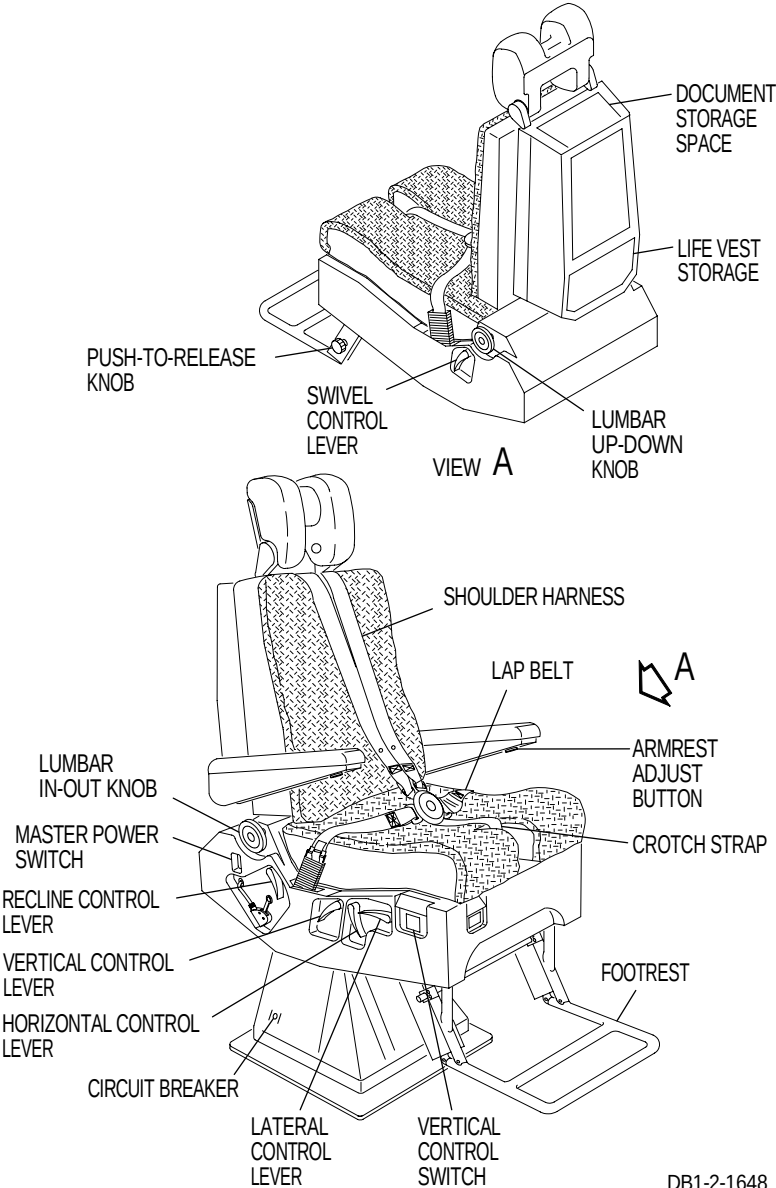
Captain's and First Officer's Seats



NOTE: Captain seat is shown. First Officer seat controls are on the opposite side.

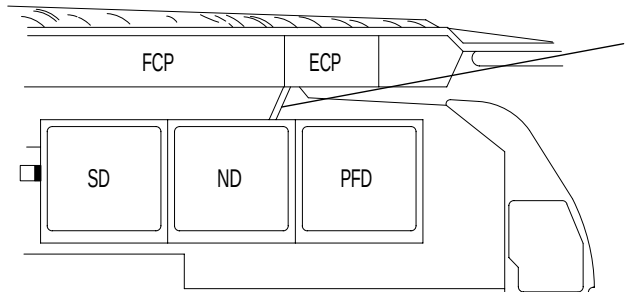
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Observer's Seat



DB1-2-1648

Seats - Eye Locator



CAPTAIN'S VIEW, F/O VIEW SIMILAR

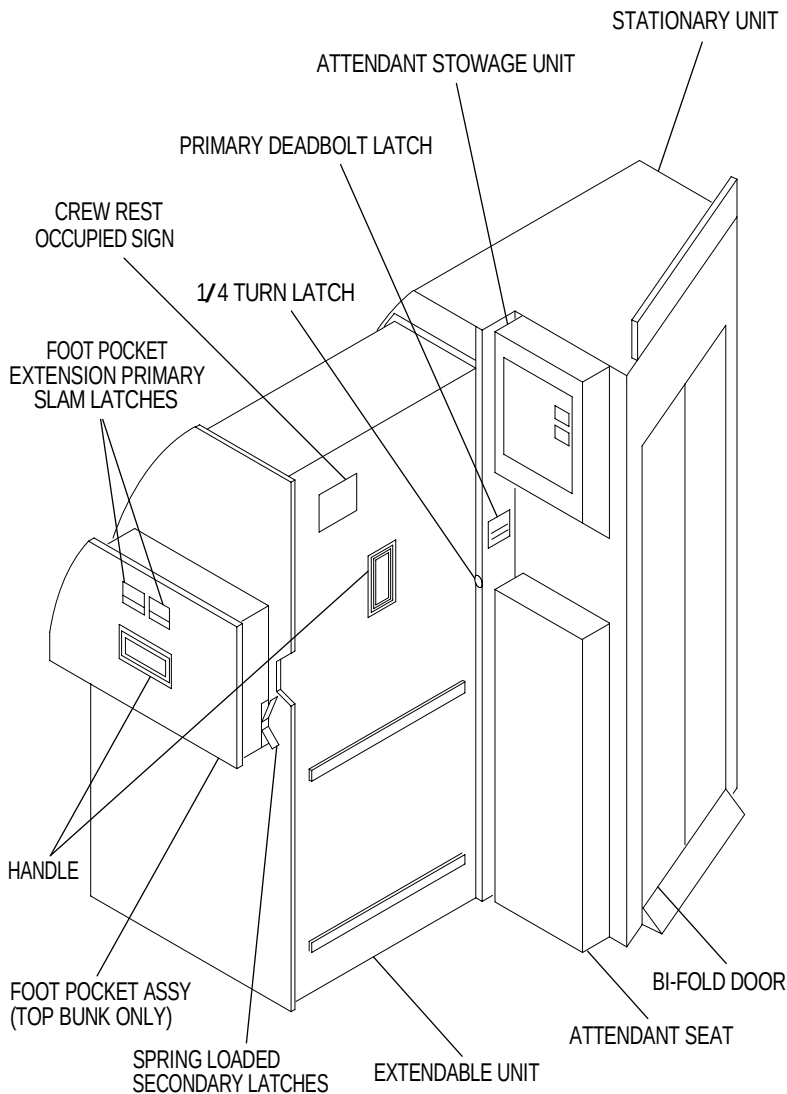
LB1-3-0243

1. Panel Stripes

Adjust respective (Captain or First Officer) seat as follow:

- Adjust seat back for comfort.
- Looking at the white lines on the other pilot's instrument panel, move the seat forward until the lower edge of the space between the FCP and the ECP is between the two white lines.
- Adjust the seat up or down until the line of sight is just over the top of the glareshield.

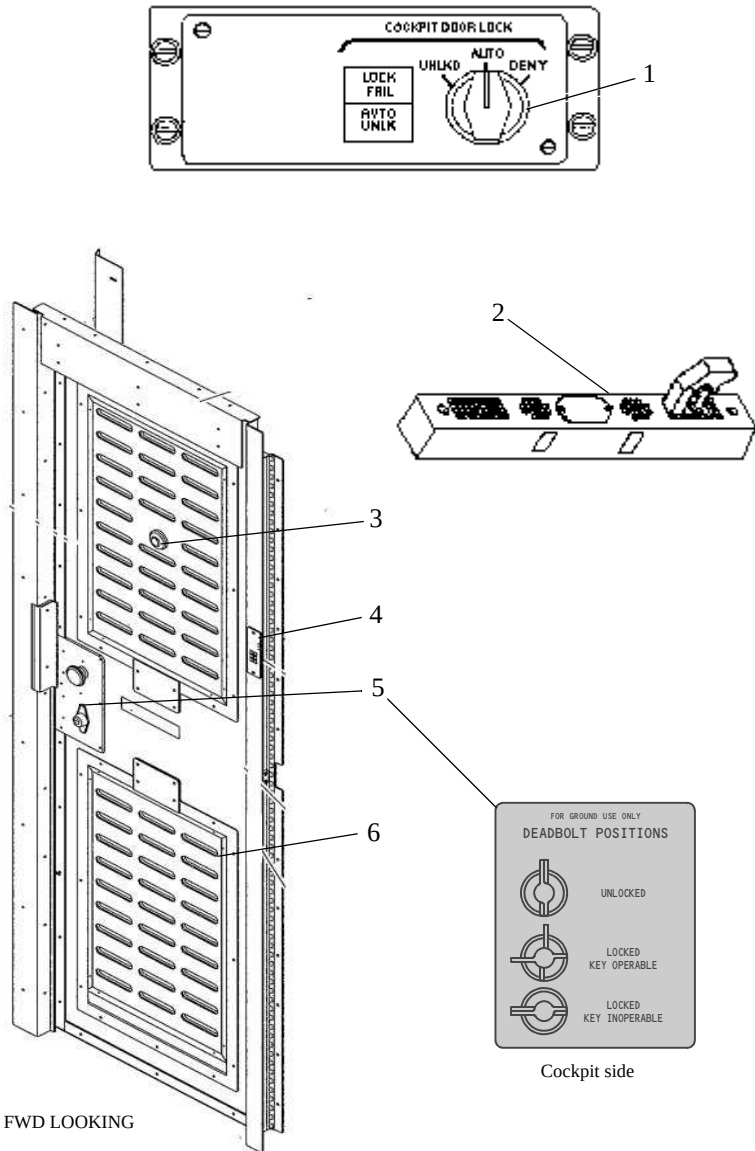
Forward Crew Rest



DB1-2-1876

MD-11 Flight Crew Operations Manual

Enhanced Cockpit Security Door



1. CKPT DOOR LOCK Selector

Two indicator lights and a three position door lock selector are located on the cockpit door lock panel on the lh lower side of the ovhd panel. The lock selector is spring loaded to AUTO, enabling automatic unlocking via the Emergency Access Panel. Holding the lock selector in UNLKD unlocks the cockpit door, and in DENY prevents automatic unlocking from the cabin.

Illumination of the amber LOCK FAIL light indicates the door lock has failed, the door is not fully closed, or the power cutoff switch has been selected off. The amber AUTO UNLK light flashes after keypad entry of the Emergency Access Panel to indicate the door will automatically unlock.

2. Door Control / Chime Module (DCM)

On the lh fwd side of the Upper Maintenance Panel a DCM with a power cutoff switch is mounted. The cutoff switch has a guarded NORM position and an OFF position, controlling electrical power to the door lock. The door unlocks when electrical power (DC Bus 2) is removed. The chime function is activated via the DCM.

3. Viewing port

A viewing port in the door allows observation of the passenger cabin.

4. Emergency Access Panel (EAP)

An Emergency Access Panel is mounted on the rh (fwd looking) doorpost at the cabin side. It consists of a 6-button keypad along with a green, amber and red light. The key pad can be used to enter an Emergency Access Code (EAC). When the correct EAC is entered, the amber keypad light will illuminate and in the cockpit the AUTO UNLK light illuminates and the DCM chime will sound. The cockpit door unlocks after a 60 seconds delay and remains unlocked for 5 sec. The red light will illuminate on the EAP to indicate the door is locked. The green light illuminates to indicate the door is unlocked. If at the keypad the doorbell code is entered (1+ENT) the DCM chime will sound in the cockpit. No automatic unlocking will occur in this case.

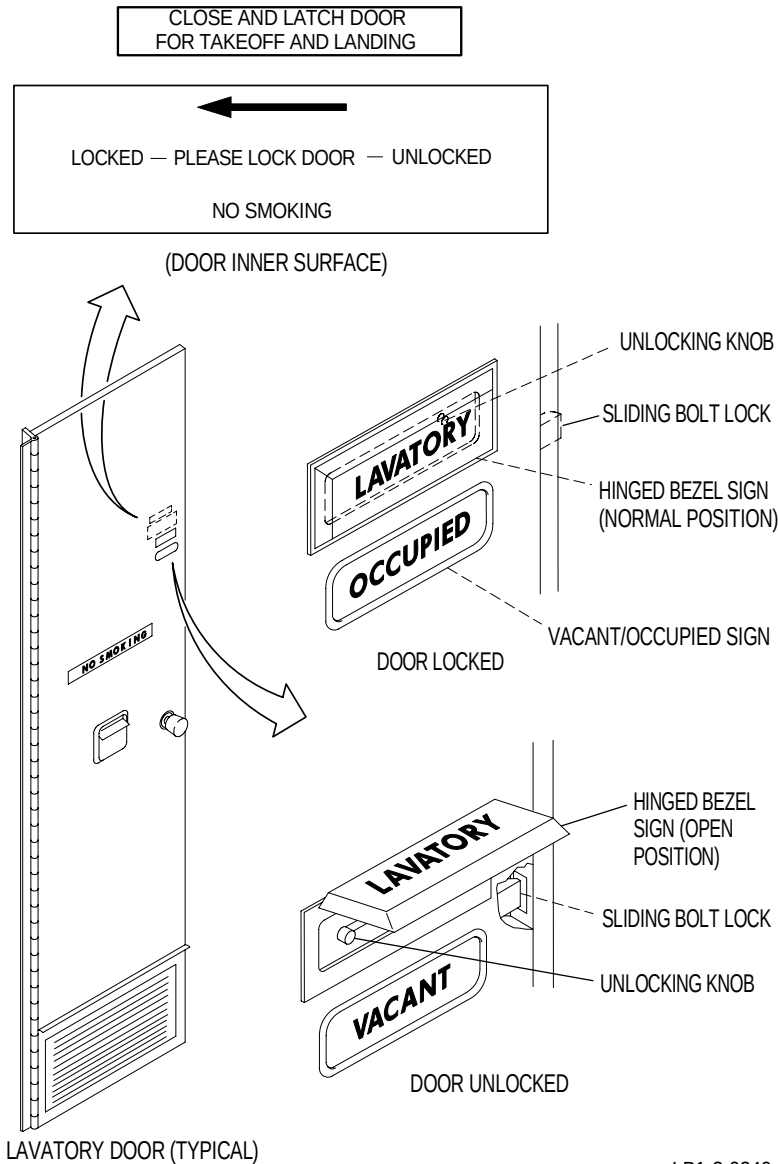
5. Dead bolt position

A totally independent three position deadbolt lock is installed on the cockpit side, with a key lock on the cabin side. Normal position is unlocked, the deadbolt can be single locked to allow access with the cockpit key, or double locked to prevent the key from unlocking the door from the cabin side.

6. Decompression panels

In the event of cabin decompression, two hinged decompression panels open outwards to equalize pressure. Each panel opening has a security grill on the cockpit side. If an emergency evacuation via the cockpit door will be required, release pins on the lower decompression panel can slide inward to release the panel. This allows the panel including the security grill to be pulled inward and removed.

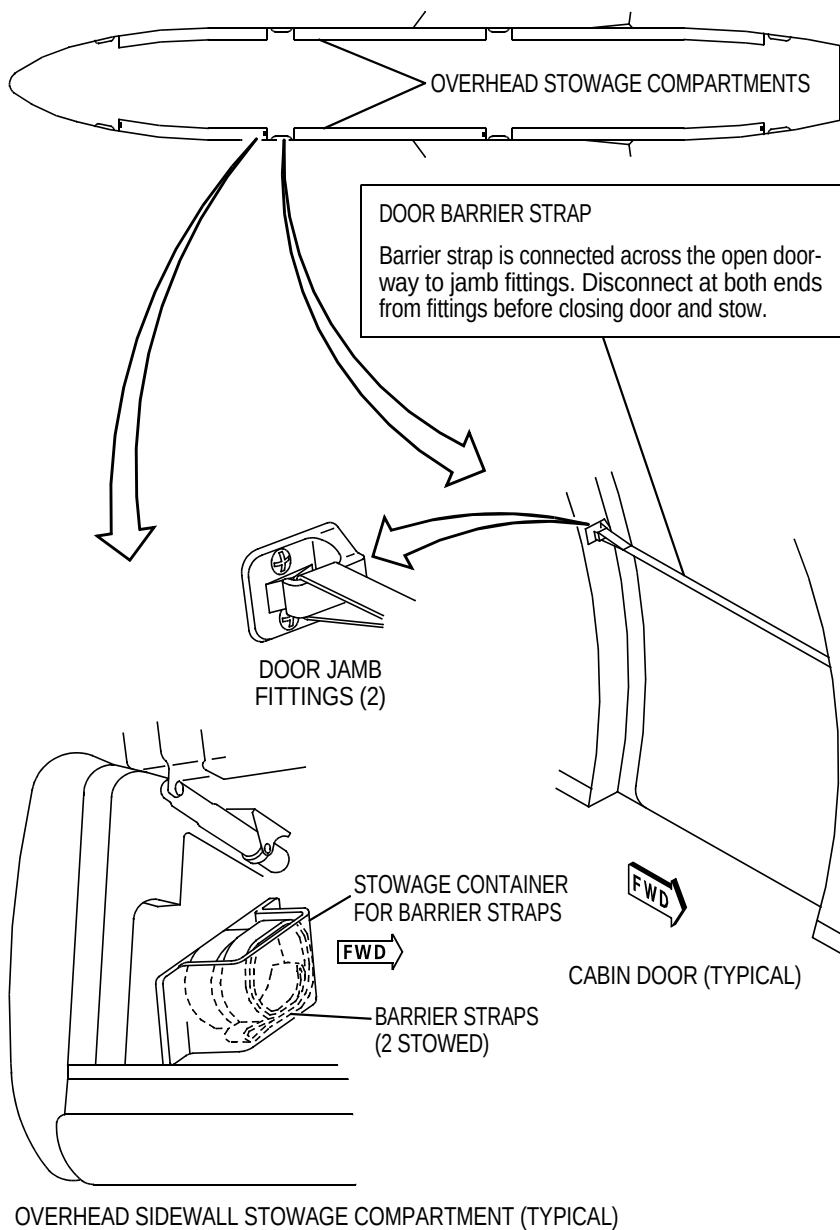
Lavatory Door



LB1-3-0246

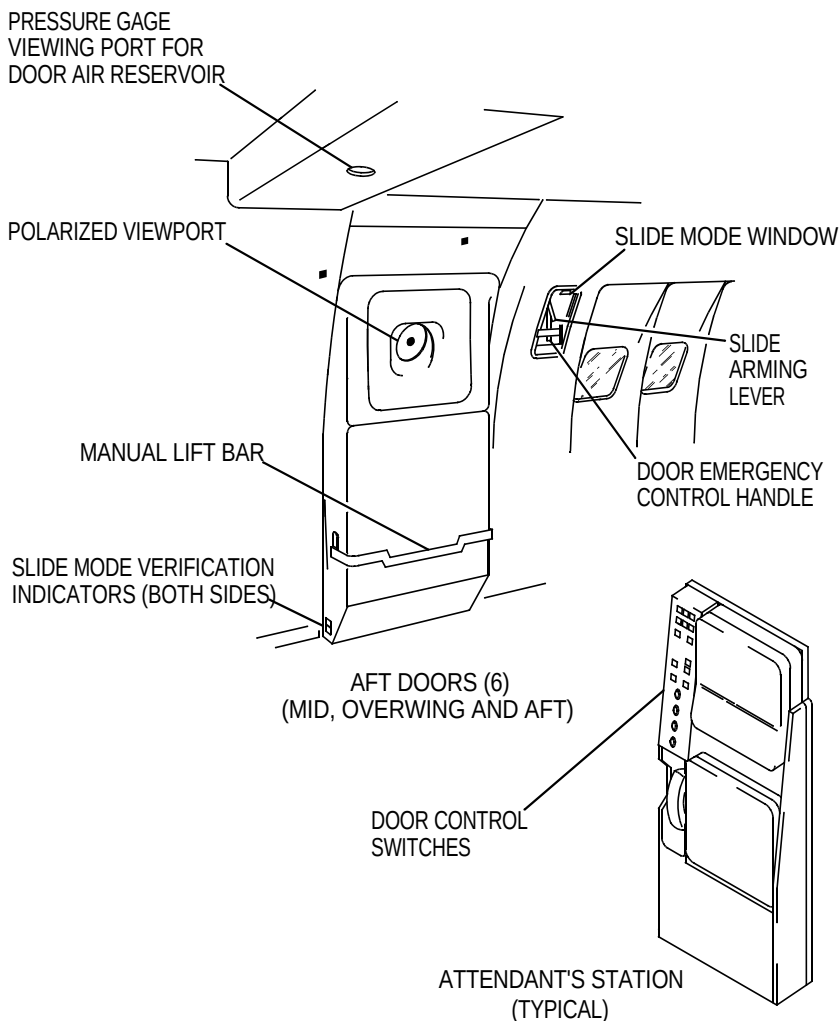
MD-11 Flight Crew Operations Manual

Cabin Door Barrier Straps



DB1-2-1853A

Aft Door Interior Control Locations



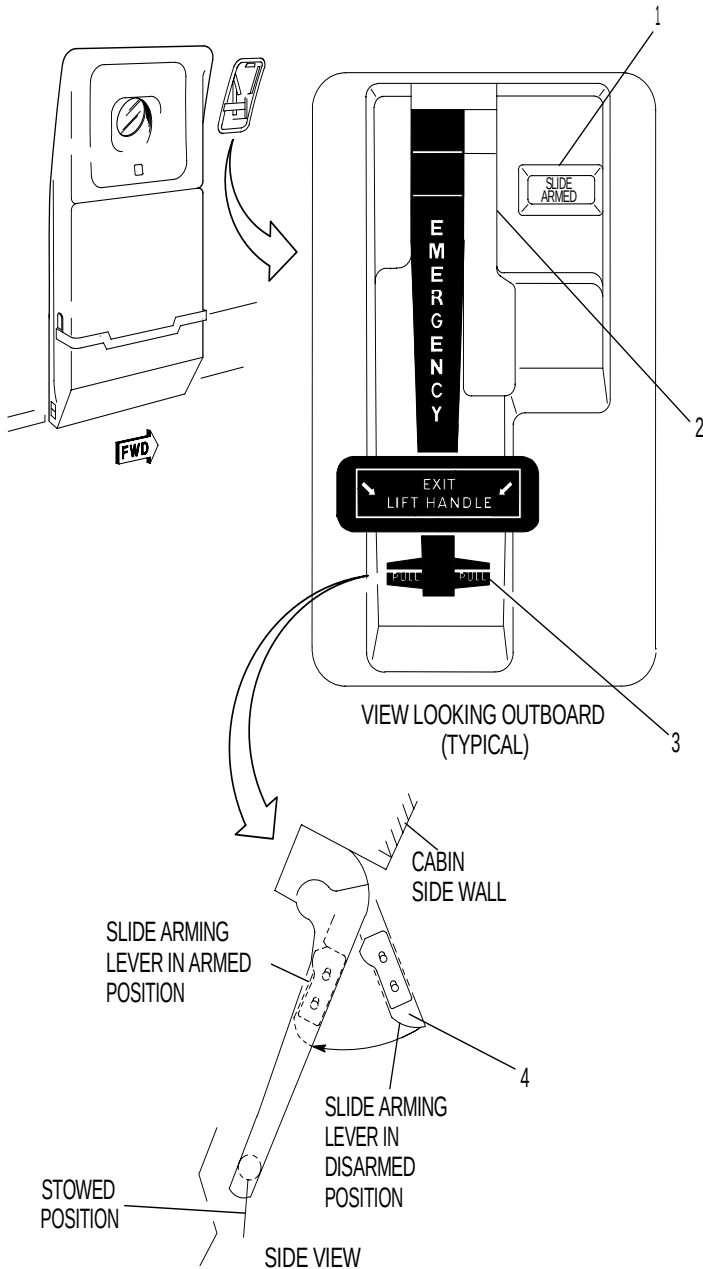
NOTE

The pressure gage viewing port and manual lift bar are described in the Emergency Exits section of the Emergency Equipment chapter.

DB1-2-1966

MD-11 Flight Crew Operations Manual

Mid, Overwing, and Aft Cabin Door Interior Control Locations



DB1-2-1863

1. Slide Mode Indication Window

Indicates whether the escape slide is armed or disarmed.

2. Slide Arming Lever

Arms and disarms the associated escape slide. Lever is normally in the SLIDE ARMED position for emergency operation with slide deployment. When lever is held in emergency interlock override position, door may be opened pneumatically without slide deployment.

3. Door Control Handle (View Looking Outboard)

When slide is armed for emergency operation, or slide arming lever is held in emergency interlock override position, lifting door control handle to emergency EXIT OPEN position will activate the pneumatic power to open the door.

NOTE: Door control handle will return to stowed position when released.

4. Slide Arming Lever (Side View)

Shown in ARMED and DISARMED positions.

MD-11 Flight Crew Operations Manual

Aft Door Interior Control Locations

PRESSURE GAGE
VIEWING PORT FOR
DOOR AIR RESERVOIR

POLARIZED VIEWPORT

MANUAL LIFT BAR

SLIDE MODE VERIFICATION
INDICATORS (BOTH SIDES)

AFT DOORS (6)
(MID, OVERWING AND AFT)

DOOR CONTROL
SWITCHES

ATTENDANT'S STATION
(TYPICAL)

SLIDE MODE WINDOW

SLIDE
ARMING
LEVER

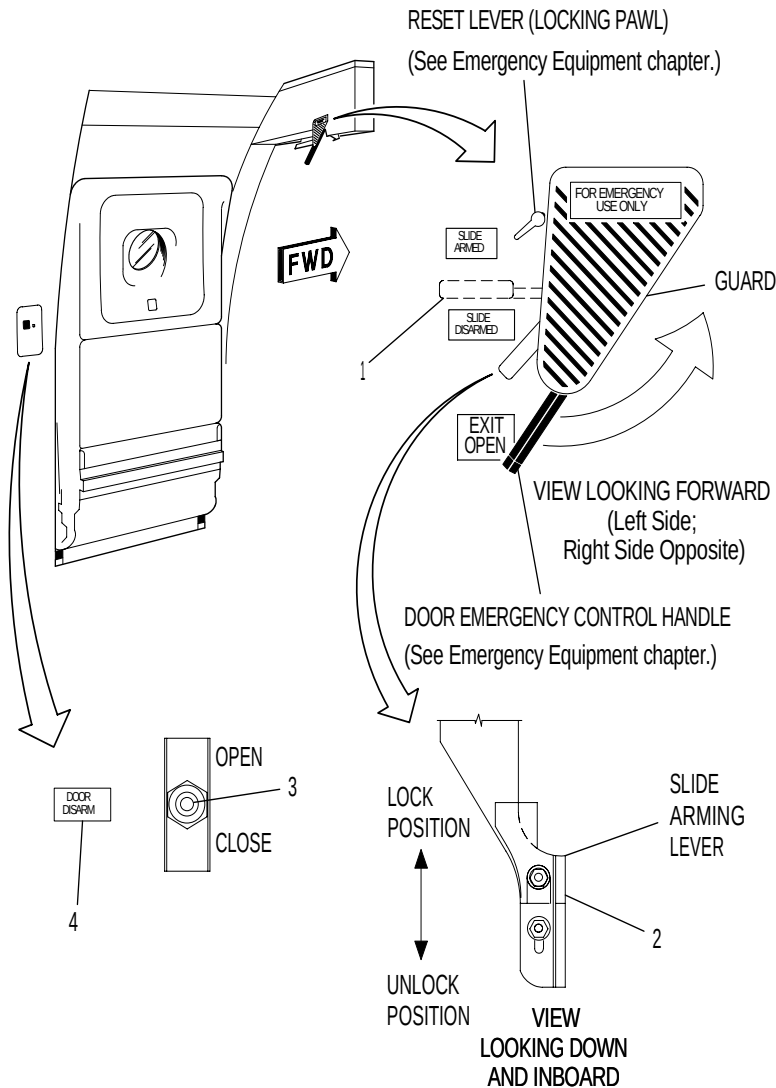
DOOR EMERGENCY
CONTROL HANDLE

NOTE

The pressure gage viewing port and manual lift bar are described in the Emergency Exits section of the Emergency Equipment chapter.

DB1-2-1966

Forward Cabin Door Interior Controls



DB1-2-1852

MD-11 Flight Crew Operations Manual

1. Slide Arming Lever

SLIDE ARMED - When moved to SLIDE ARMED, escape slide is armed and door will be pneumatically powered, ARMED placard will appear in slide mode verification indicator.

SLIDE DISARMED - When moved to SLIDE DISARMED, escape slide is disarmed and electrical power is available to door. ARMED placard will disappear from view in slide mode verification indicator, corresponding CABIN DOOR alert displayed on the EAD, and DOOR DISARM light aft and adjacent to cabin door will illuminate.

NOTE: An interlock mechanism locks slide arming mechanism in disarmed position when door is open.

2. Slide Arming Lever Latch

With slide arming lever in disarmed position. Sliding latch up locks lever in disarmed position. Sliding latch down unlocks lever.

3. Door Control Switch

Not installed.

4. DOOR DISARM Light

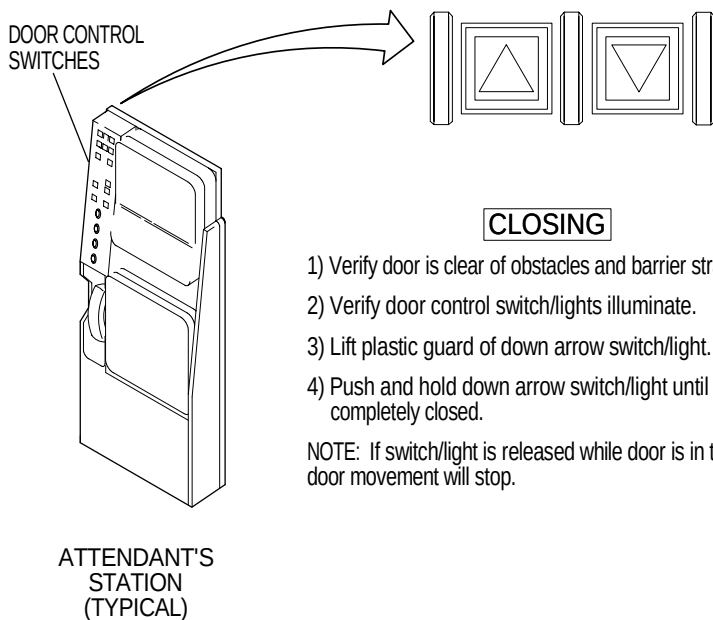
Not installed.

Cabin Door Interior Electrical Operation

OPENING

- 1) Place slide/raft arming lever in the DISARM position.
- 2) Verify door control switch/lights illuminate.
- 3) Lift plastic guard of up arrow switch/light.
- 4) Push and hold up arrow switch/light until door is completely open.

NOTE: If switch/light is released while door is in transit, door movement will stop.



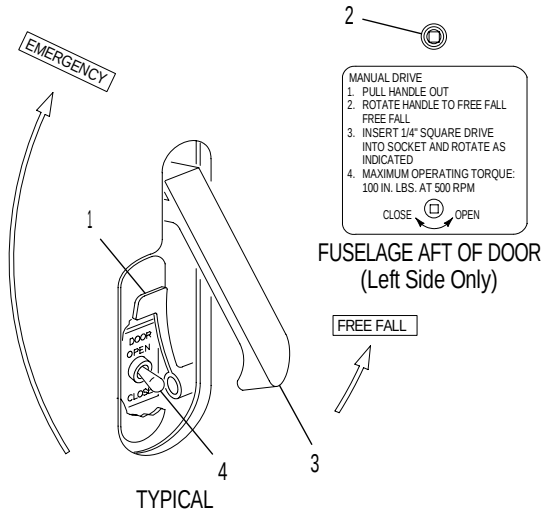
CLOSING

- 1) Verify door is clear of obstacles and barrier strap.
- 2) Verify door control switch/lights illuminate.
- 3) Lift plastic guard of down arrow switch/light.
- 4) Push and hold down arrow switch/light until door is completely closed.

NOTE: If switch/light is released while door is in transit, door movement will stop.

DB1-2-1861

Cabin Door Exterior Controls



LB1-3-0250

1. Auxiliary Handle

Handle is spring-loaded to recessed position and is used to close door by free falling. (normally used by maintenance.)

2. Socket Drive Fitting (Left Forward Door Only)

The socket drive fitting is provided for opening and closing door if electrical power is not available. (normally used by maintenance.)

3. Door Control Handle

Pulling handle out of recess in fuselage disarms escape slide and provides access to door control switch and auxiliary handle.

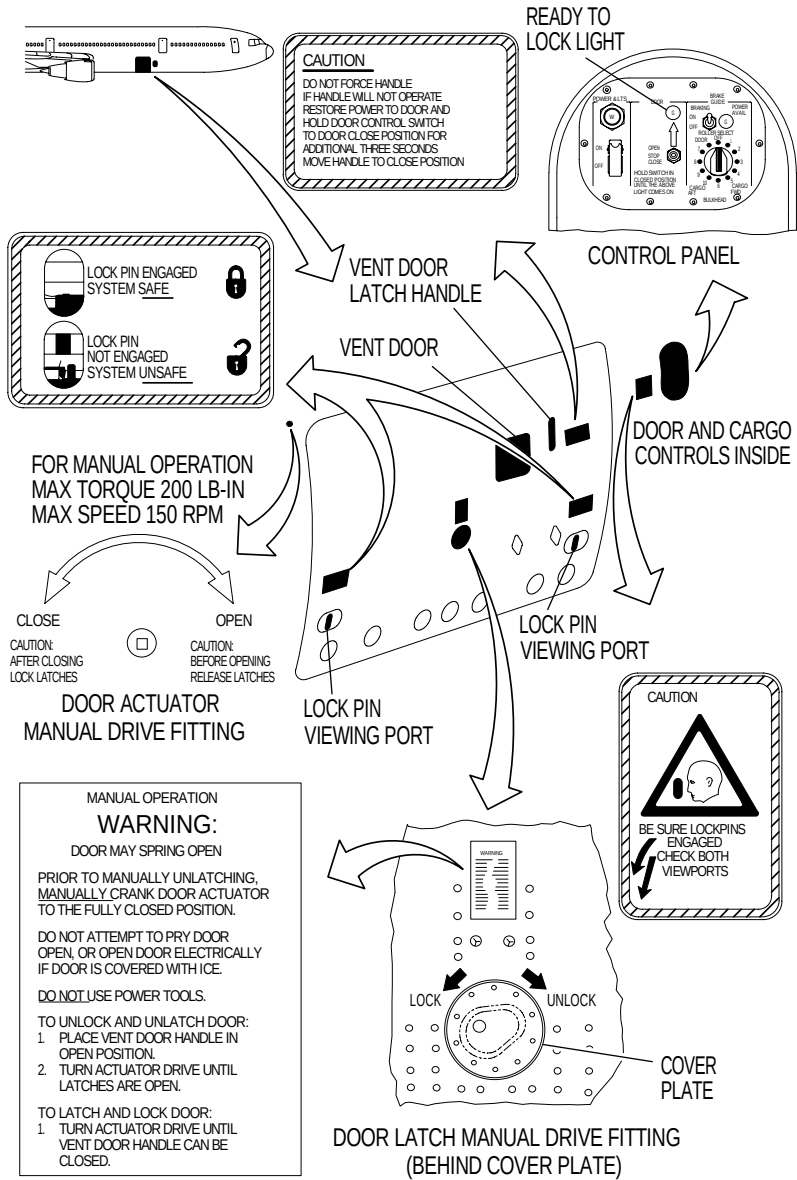
NOTE: For emergency operation of handle, see Emergency Equipment Chapter. An interlock mechanism locks slide arming mechanism in disarmed position when door is open.

4. Door Control Switch

Switch is spring-loaded to center-off and is used to open or close door electrically.

NOTE: If switch is released while door is opening or closing, door movement will stop.

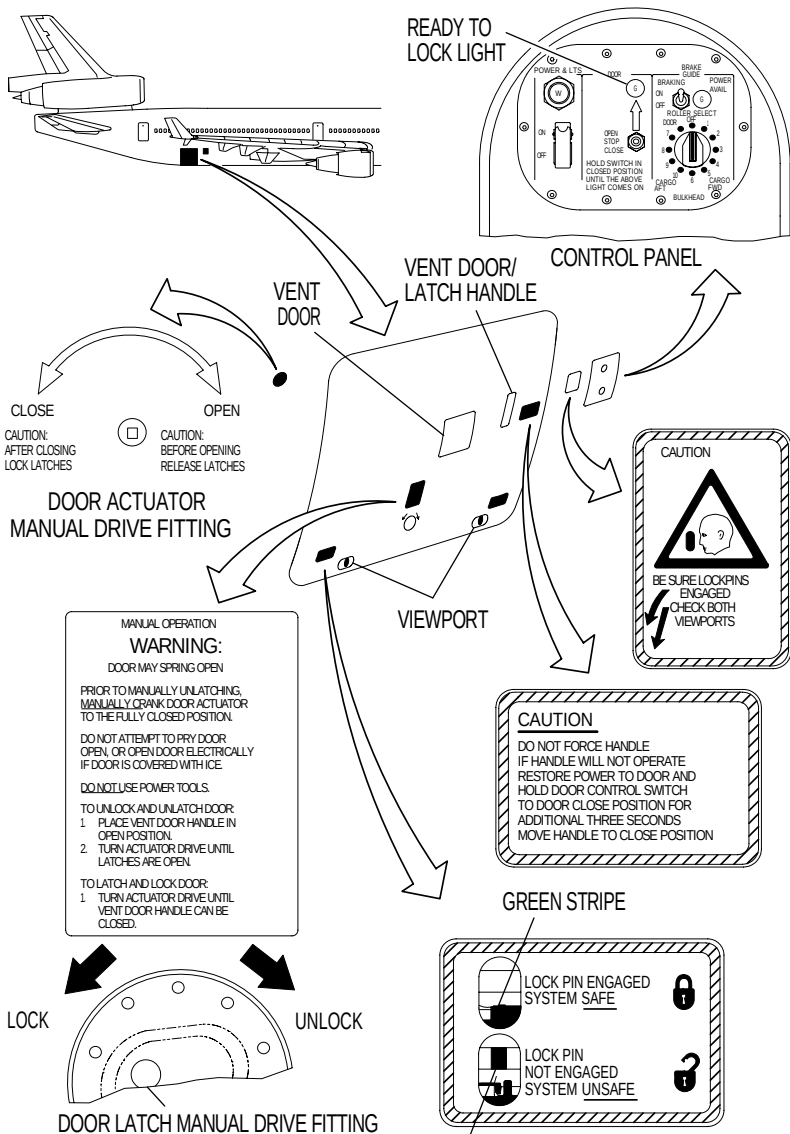
Lower Cargo Doors - Forward



DB1-2-1652

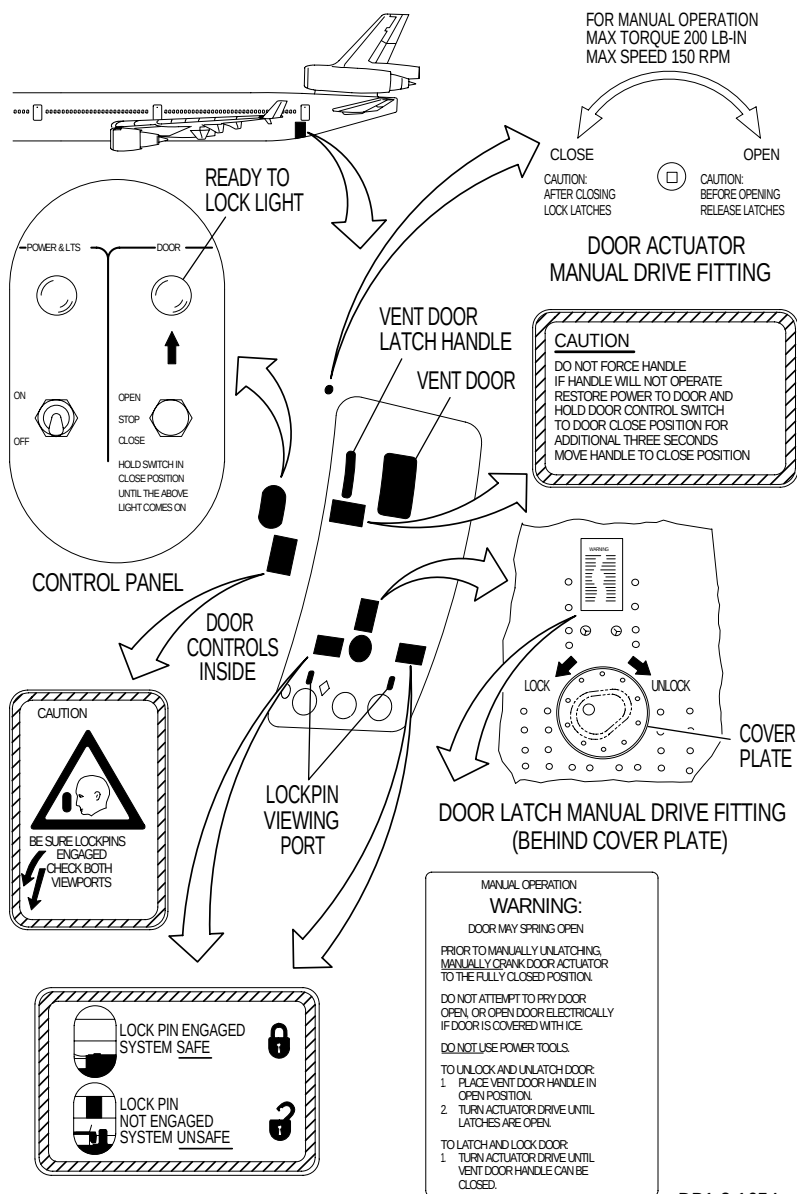
MD-11 Flight Crew Operations Manual

Lower Cargo Doors - Center



DB1-2-1653

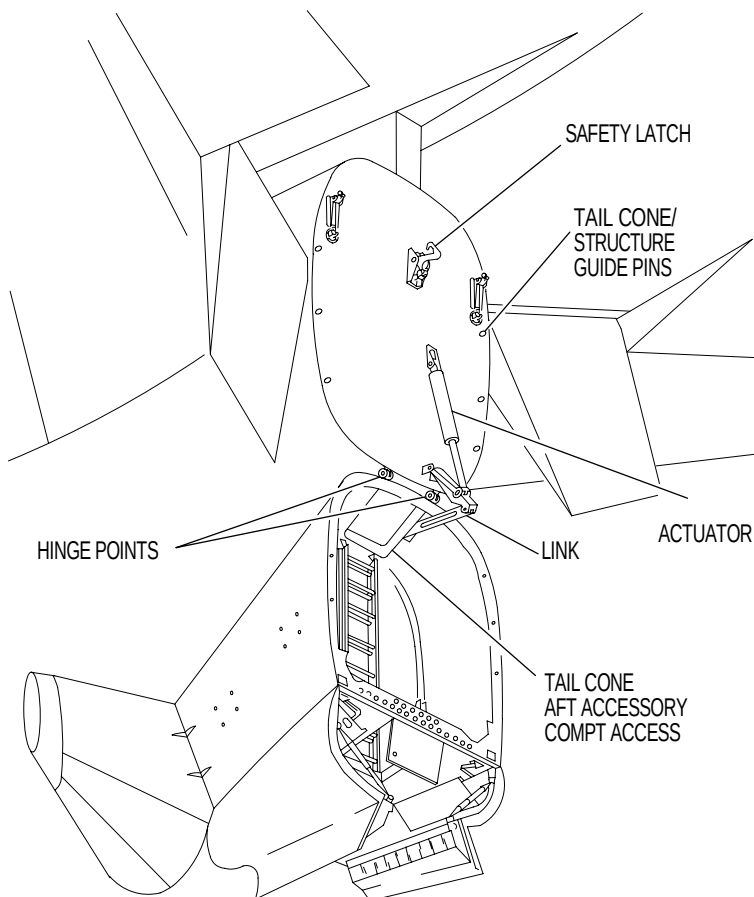
Lower Cargo Doors - Aft



DB1-2-1654

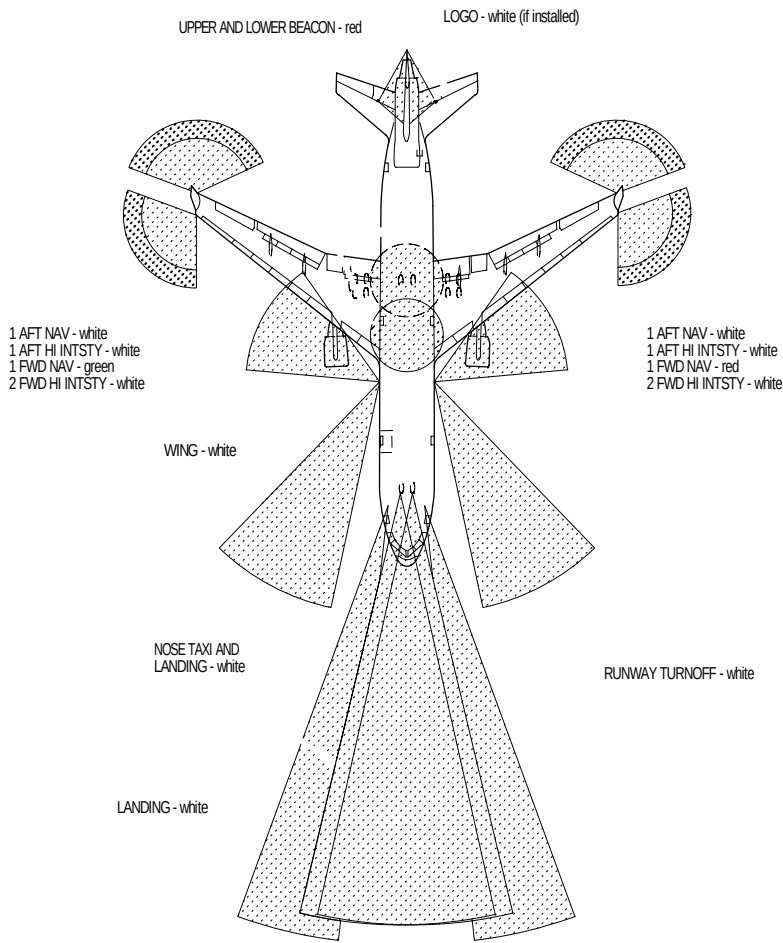
MD-11 Flight Crew Operations Manual

Tail Cone Assembly



DB1-2-1870

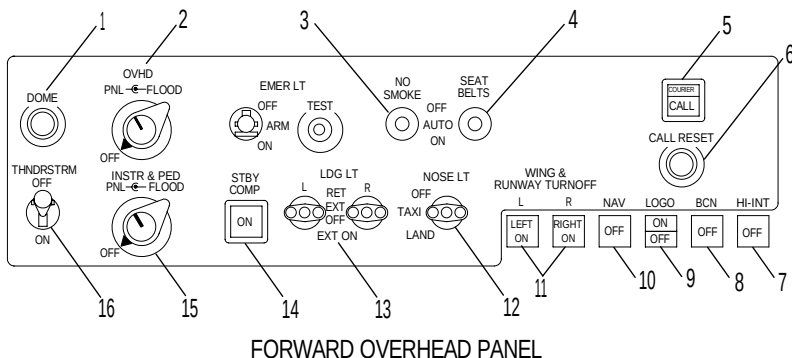
Exterior Lighting Illumination Zones



DB1-2-1900

MD-11 Flight Crew Operations Manual

Lighting - Forward Overhead Controls



LB1-3-0261

1. DOME Switch

Turns dome lights on and off.

2. OVHD PNL FLOOD Rheostats

Outer rheostat regulates intensity of overhead panel switchplate lighting.

Inner rheostat regulates intensity of overhead panel floodlights.

All lights are off when rheostats are turned completely counterclockwise.

Light intensity increases by turning rheostat in a clockwise direction.

3. NO SMOKE Sign Switch

ON - Illuminates NO SMOKING signs and sounds a chime in cabin.

AUTO or OFF - NO SMOKING signs will illuminate and a chime will sound in cabin if a cabin decompression occurs (cabin altitude exceeds 10,000 feet).

AUTO - NO SMOKING sign will illuminate and a chime will sound in cabin when landing gear handle is in DOWN position.

4. SEAT BELTS Sign Switch

ON - Illuminates FASTEN SEAT BELT and RETURN TO CABIN signs and sounds a chime in cabin.

AUTO or OFF - FASTEN SEAT BELT signs will illuminate and a chime will sound in cabin if a cabin decompression occurs (cabin altitude exceeds 10,000 feet). RETURN TO CABIN signs will not illuminate.

AUTO - FASTEN SEAT BELT and RETURN TO CABIN signs will illuminate and a chime will sound in cabin when FLAP handle is out of the UP position and/or landing GEAR handle is in DOWN position.

5. COURIER CALL Switch

Not installed.

6. CALL RESET Button

Pushing the button will turn off the blue CALL light.

7. HI-INT Switch - blue

Turns on supplemental high intensity recognition lights on each wing tip. Each wing tip has three lights (two forward and one aft). Lights flash in sequence with anticollision lights. Illuminates blue when high intensity lights are off.

8. BCN Switch - amber

Turns on beacon lights on top and bottom of aircraft. OFF illuminates amber when anti-collision lights are off.

9. LOGO Switch - blue

Turns on logo light on horizontal stabilizer to illuminate vertical stabilizer.

ON illuminates blue when switch is selected on.

OFF illuminates blue when switch is selected off.

10. NAV Switch - amber

Turns on position lights in each wing tip. The two left forward lights emit red lighting. The two right forward lights emit green lighting. The two aft lights in each wing tip emit white lighting.

OFF illuminates amber when lights are off.

11. WING & RUNWAY TURNOFF Switch - blue

Turns on respective scan lights for the engines and wing surfaces. Turns on the runway turnoff lights for ground operation to supplement available lighting.

LEFT ON illuminates blue when left wing and turnoff lights are selected on.

RIGHT ON illuminates blue when right wing and turnoff lights are selected on.

12. NOSE LT Switch

Turns on nose gear landing lights for taxiing and landing. These lights will only come on if landing gear control handle is in DOWN position.

OFF - Lights are off.

TAXI - Lights are on with less than full intensity for ground operation.

LAND - Lights are on at full intensity for landing.

13. LDG LT Switch (L and R)

Activates respective primary landing lights mounted on the forward fuselage.

RET - Lamp are off and the lights are retracted flush with the fuselage.

EXT OFF - Lights are extended but the lamps are off.

EXT ON - Lights are extended and the lamps are on.

14. STBY COMP Switch - blue

Turns on the standby compass light. ON illuminates blue.

15. INSTR & PED PNL FLOOD Rheostats

Outer rheostat regulates intensity of instrument panel and pedestal switchplate lighting.

Inner rheostat regulates intensity of instrument panel and pedestal floodlights.

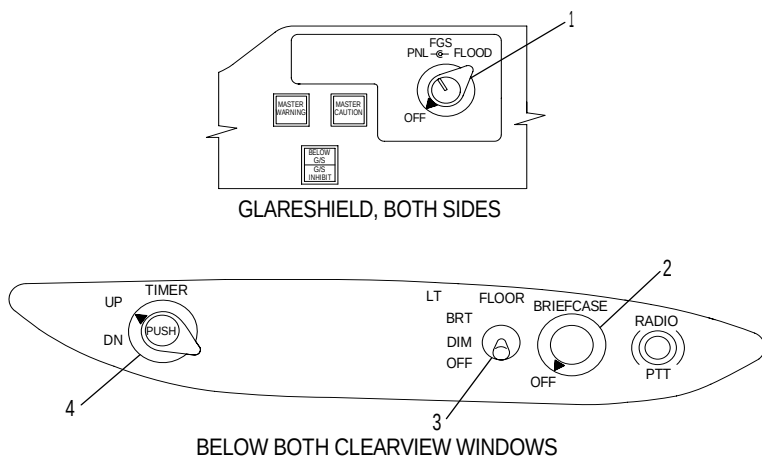
All associated lighting is off when rheostats are turned completely counterclockwise.

16. THNDRSTRM Switch

ON - All instrument and control panel floodlights as well as the dome lights go to full intensity. All individual controls are bypassed.

OFF - Returns lighting control to normal.

Lighting - Light Control Panel



LB1-3-0262

1. FGS PNL and FLOOD Rheostat

Controls backlighting and floodlighting of flight guidance control panel.

Outer rheostat regulates intensity of flight guidance control panel backlighting.

Inner rheostat regulates intensity of flight guidance control panel floodlights.

Both rheostats are off when turned completely counterclockwise. Light intensity increases by turning in a clockwise direction.

2. BRIEFCASE Rheostat

Controls on/off and intensity of briefcase area lighting.

3. LT FLOOR Switch

BRT - Floor lights go to full intensity.

DIM - Floor light intensity is reduced.

OFF - Turns floor lights off.

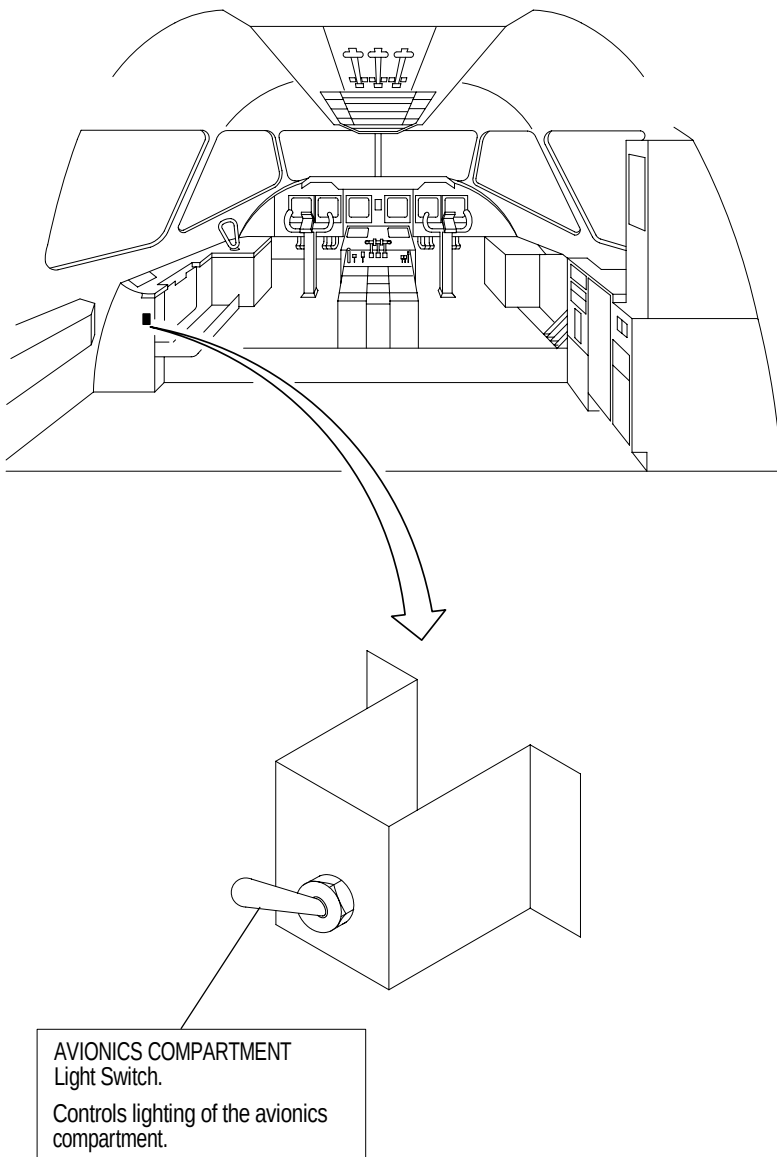
4. TIMER Knob

Push one starts the clock timer on ND. Push two stops the clock timer. Push three resets clock timer to 00:00.

UP - Timer on ND counts up from 0.

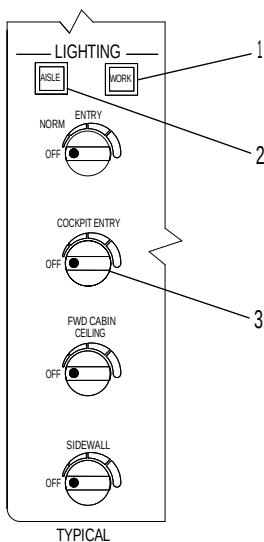
DN - Timer counts down from a preselected time. Preselected time is set on the MCDU Approach page and will also appear on the ND.

Avionics Compartment Light Switch



DB1-2-1901

Flight Attendant Panel



DB1-2-1903

1. WORK Switch

Turns on respective galley work light.

2. AISLE Switch

Enables operation of aisle lights for entire cabin area. Switch available only at forward left cabin attendant panel. Individual brightness control available at respective cabin attendant panel. AISLE illuminates when switch is selected on.

3. OFF/Brightness Control Knob

Controls brightness of respective light. Full counterclockwise turns light off, clockwise rotation increases brightness.

Aircraft General Alerts

Chapter Agen Section 40

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

Amber Boxed Alerts (Level 2)

CARGO DOOR AFT A (MISC) - Aft cargo door is not closed and locked or cockpit call switch is activated.

CARGO DOOR AFT B (MISC) - Aft cargo door not locked.

CARGO DOOR CTR A (MISC) - Center cargo door is not closed and locked or cockpit call switch is activated.

CARGO DOOR CTR B (MISC) - Center cargo door not locked.

CARGO DOOR FWD A (MISC) - Forward cargo door is not closed and locked or cockpit call switch is activated.

CARGO DOOR FWD B (MISC) - Forward cargo door not locked.

MISC ALERTS (MISC) - Both MSC data buses are invalid.

MSC AUTO FAIL (MISC) - Single MSC channel has failed.

TAIL CONE UNLOCK (MISC) - Tail cone is unlocked.

Amber Alerts (Level 1)

AIR COND DOOR (MISC) - One or more air conditioning pack access doors not closed and latched.

AVNCS EXT ACC DR (MISC) - Avionics external access door not closed/locked.

AVNCS NOSE WHL DR (MISC) - Avionics nose wheel door not closed/locked.

CAB DOOR OVWING L (MISC) - Left overwing cabin door is not closed or armed.

CAB DOOR OVWING R (MISC) - Right overwing cabin door is not closed or armed.

CABIN DOOR AFT L (MISC) - Left aft cabin door is not closed or armed.

CABIN DOOR AFT R (MISC) - Right aft cabin door is not closed or armed.

CABIN DOOR FWD L (MISC) - Left forward cabin door is not closed or armed.

CABIN DOOR FWD R (MISC) - Right forward cabin door is not closed or armed.

CABIN DOOR MID L (MISC) - Left mid cabin door is not closed or armed.

CABIN DOOR MID R (MISC) - Right mid cabin door is not closed or armed.

CAC DOOR (MISC) - Center accessory compartment door is not closed and latched.

CREW REST OPEN (MISC) - The expandable crew rest module is not properly stowed and latched. This alert is not displayed when the aircraft is above 17,750 feet.

CRG DOOR TST FAIL (MISC) - Cargo door test has failed.

CRG DR (FWD, AFT, CTR,) DISAG (MISC) - A disagree condition exists between systems A and B of the respective cargo door warning system.

DOOR OPEN (MISC) - One or more aircraft cabin doors are not closed and armed, or one or more cargo or external access doors are not closed and latched.

Cyan Alerts (Level 0)

CABIN DOORS OPEN - All cabin door emergency slides are disarmed.

CARGO DOOR TEST - MSC cargo door test is in progress.

NO SMOKING - The NO SMOKING signs in the cabin are on.

SEAT BELTS - The SEAT BELT signs in the cabin are on.

**Air**
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Air

Description and Operation

Chapter Air

Section 10

General

Three air systems provide the pneumatics required for:

- Engine Start.
- Thrust Reversers
- Air Conditioning.
- Pressurization.
- Anti-ice.
- Avionics Cooling.
- Galley and Lavatory Ventilation (Passenger Configuration).
- Cargo Compartment Heating/Ventilation.
- Potable Water Pressurization (Refer to Water and Waste Chapter).
- Cargo Loading System.

The normal source of pneumatics for each of the three air systems is its associated engine. The three systems normally operate independently, but may be interconnected through two isolation valves, if fewer than three engine bleed air sources are available. The valve(s), ISOL 1-2 and ISOL 1-3, identify the air systems that are interconnected.

When engine air is not available, the following alternate sources may be used:

1. The APU.
2. External air (ground).
3. Any other operating engine.

Each air system manifold is pressurized by engine compressor air.

For GE engines:

- 8th stage air is low stage heated air and is the main source for normal operation.
- 14th stage air is high stage heated air and is used during airfoil anti-ice operation and to compensate for low power settings, such as during idle descent.
- 11th stage air is used for engine anti-ice protection and is routed directly to the engine cowl.

Pneumatics and air conditioning automatically turn off as engine thrust increases for takeoff. Air conditioning remains on, except when airfoil anti-ice is selected prior to takeoff, if the required entry has been made through the Flight Management System (FMS).

Controls for pressurization, air conditioning, and anti-ice are on the 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 Automatic Controllers

The air system automatic controllers work in conjunction with one another. One environmental system controller (ESC) functions as the main controller. The ESC monitors itself and other components, and detects and reports faults to a centralized fault display screen (CFDS).

The ESC reverts to the manual mode for certain system and internal failures. The air system can be controlled manually from the AIR control panel.

The ESC directs the following:

- Two Pneumatic System Controllers (PSC).
- Three Air Conditioning Controllers (ACC).
- Two Cabin Pressure Controllers (CPC).
- One Manifold Failure Controller (MFC).

These eight controllers:

- Manage the pneumatic system.
- Manage the air conditioning system.
- Manage the trim air system.
- Manage the recirculation fan system.
- Manage the equipment cooling fan systems.
- Control cabin pressurization.
- Monitor pneumatic system manifold failures.
- Monitor airfoil anti-ice systems.
- Shut down associated pneumatic system during APU or engine fire.
- Reconfigure air systems for failure of various elements.
- Compensate for inoperative components.

Manifold Failure Detection System

The Manifold Failure Detection System (MFDS) controller detects pneumatic leaks in the following:

- The three pneumatic systems.
- The three air conditioning packs.
- The Center Accessory Compartment (CAC).
- The tail pylon area.
- The horizontal stabilizer anti-ice system.

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The MFDS sends failure signals to the ESC, which then isolates the affected duct from its bleed air system.

Manifold failure indications appear on the AIR synoptic.

Air Conditioning System

The air conditioning system uses engine compressor bleed air from the main engines during flight, and the engines, the APU, or preconditioned air from a ground source during ground operation.

Hot, pressurized air is supplied to the air conditioning packs, where it is cooled and routed to a common manifold. The cooled air is mixed with hot air prior to distribution.

The air conditioning system accomplishes the following:

- Air conditioning packs provide conditioned air in response to a temperature control system.
- An Air Conditioning Controller (ACC) determines cockpit and cabin temperature requirements and provides the appropriate signals.
- The distribution system controls conditioned air flow to the cockpit and cabin
- The compartment ventilation system provides ventilation for the avionics, center accessory and right hand aft tunnel.
- The lower cargo compartment temperature control and ventilation system allows temperature sensitive shipments.

Three identical Air Conditioning Controllers (ACC):

- Interface with the Environmental Control System (ESC), the EIS, and the CFDS.
- Interface with the AIR control panel, the altitude warning system, the oxygen mask deployment system, the APU controller, and the CPCS.
- Send altitude warning and oxygen mask signals.

With ignition A, B, or OVRD selected and the air system in auto, air conditioning is unavailable prior to engine start. It remains unavailable for two minutes if there has not been an engine start.

Individual zone temperature requirements are adjusted by mixing hot trim air from the pneumatic duct with air from the conditioned air manifold.

Avionics and Instrument Ventilation System

The ESC controls the avionics and instrumentation ventilation system. The ESC performs a power-up test of all fans, flow sensors, and annunciation circuitry prior to flight.

One of three cooling fans supplies cooling air to the avionics racks. Normally, one cooling fan operates as primary and a second fan as an automatic backup if the primary fan fails.

Air flow sensors are installed upstream of the main avionics rack, upstream of the two forward Display Electronic Units (DEU), and just upstream of an overboard venturi to detect exhaust flow. These flow sensors detect loss of cooling airflow. The AVNCS AIR FLO OFF alert is displayed on the EAD when both flow sensors detect a no flow condition. The AVNCS EXH OFF alert is displayed when not enough airflow exists in the avionics compartment.

The cooling fans take exhaust air from the cockpit. The exhaust air then flows in two directions. Some of the cooling air flows to the auxiliary and main avionics racks. The rest of the cooling air flows to the CRTs and MCDUs in the cockpit.

Piccolo ducts collect compartment air and air that has passed through the avionics racks. This warm air is routed into an exhaust manifold and dumped overboard through the venturi using cabin differential pressure across the venturi.

When aircraft differential pressure is less than 1.3 psid (ground operation), the venturi remains open while an exhaust fan draws air through the manifold and discharges some of the hot avionics air overboard. The remaining hot avionics air is exhausted into an area under the cabin floor above the nose wheelwell. During normal flight operation, the exhaust fan is off.

When the cabin air inflow is too low for cabin pressurization, the venturi shutoff valve is closed and the exhaust fan is turned on to discharge avionics exhaust air into the left tunnel and reduce the overboard airflow. This avionics override function is done automatically by the ESC, or manually by the flight crew with the AVNCS FAN switch (ESC must be in manual mode) on the AIR control panel.

The AVNCS FAN OVRD alert is displayed when the avionics exhaust fan and venturi shutoff valve are commanded to override. The avionics exhaust fan remains in override until the aircraft cabin air inflow and avionics compartment exhaust airflow are sufficient.

Following takeoff, with 1.3 psid differential pressure and adequate cabin inflow, the ESC automatically turns off the exhaust fan and opens the venturi shutoff valve for normal inflight avionics exhaust flow.

Center Accessory Compartment Ventilation System

The Center Accessory Compartment (CAC) ventilation system is similar to the avionics compartment ventilation system. However, unlike the avionics compartment, there is no exhaust system. The cooling air blows into one side of the CAC avionics rack and exits out the top.

The CAC has two cooling fans. Operation of the fans is similar to those in the avionics compartment. If the last available fan does not produce flow within a specified time after being turned on, a CAC AIR FLO OFF alert is displayed.

Lavatory and Galley Ventilation System

The lavatory and galley ventilation system provides separate ventilation for each area.

Lavatories are individually vented by an exhaust fan system and an individual air system. Exhaust air discharges to the utility tunnels and then overboard through the cabin outflow valve. An individual cooling gasper fan system supplies supplemental air.

After exiting the lavatory, exhaust air passes over a smoke detector sensor for fire detection. The exhaust fans automatically shut off when smoke is detected.

Galleys, if installed, are ventilated by jet pumps powered by bleed air. The forward/center galleys use pneumatic manifold 1 bleed air. The aft galleys use pneumatic manifold 2 bleed air. The jet pumps force the galley air into the left utility tunnel at the cabin air outflow valve. It then vents overboard.

Tunnel Ventilation System

The tunnel ventilation system uses a fan to pull air from the cabin and distribute it to the area under the cabin floor. The fan operates on the ground only.

Forward Cargo Compartment Heating and Ventilation System

The forward cargo compartment is heated, ventilated, and cooled inflight. Pneumatic system 3 bleed air heats the compartment. Temperature sensors maintain the temperature, as selected by the flight crew. Animals may be carried in this compartment.

A flow detector in the ventilation and cooling system signals an insufficient air flow condition to the flight crew. Flow-through ventilation, for animal transport, exits through a sidewall outlet, thus relieving compartment pressure.

The Miscellaneous Systems Controller (MSC) automatically shuts off the ventilation system if a compartment fire is detected. The flight crew manually latches off airflow to the compartment. This prevents dilution of the fire agent, and airflow does not resume when the smoke or fire signal ends. The fire agent remains isolated inside the compartment when check valves close.

Center Cargo Compartment Heating System

The center cargo compartment is heated but not ventilated. Pneumatic system 2 bleed air heats the center compartment.

A thermostat controls temperature between $12.7^{\circ} \pm 2.8^{\circ} \text{ C}$ and $18.3^{\circ} \pm 2.8^{\circ} \text{ C}$.

Aft Cargo Compartment Heating and Ventilation System

The aft cargo compartment is heated, ventilated, and cooled in flight. Pneumatic system 2 bleed air heats the compartment. Temperature sensors maintain the temperature, as selected by the flight crew. Animals may be carried in this compartment.

The air vented into the compartment exhausts through two ceiling outlets, where it is dumped near the cabin air outflow valve.

A flow detector in the flow stream of the exhaust ducting signals the flight crew of insufficient exhaust airflow. Excess fan flow, over the exhaust flow, maintains positive pressure in the compartment.

The Miscellaneous Systems Controller (MSC) automatically shuts off the ventilation system if a compartment fire is detected. The flight crew manually latches off airflow to the compartment. This prevents dilution of the fire agent, and airflow does not resume when the smoke or fire signal ends. The fire agent remains isolated inside the compartment when check valves close.

Pressurization System

The pressurization system controls the aircraft pressurization. Pressurized air supplies the cockpit, cabin, cargo, center accessory and avionics compartments.

Pressurization is controlled by regulating the outflow of conditioned air from the pressurized areas of the fuselage. Pressure relief valves limit the cabin differential pressure to 9.1 psi. The CABIN PRES RELIEF alert is displayed when the relief valves open up at a differential pressure of about 8.9 psi.

The Cabin Pressure Control System (CPCS) provides the following functions:

- Pressurization control during all flight phases.
- Fuselage overpressurization protection.
- Negative pressure relief provided by the door seals.
- Data for monitoring pressure levels and cabin altitude change rate.

Pressurization is normally controlled automatically. A manual back-up mode is provided in case of failure of the automatic mode.

The CPCS allows flight up to 43,200 feet while maintaining a cabin pressure equivalent to an altitude of less than 8,000 feet. The maximum cabin climb rate is 750 fpm and maximum cabin descent rate 350 fpm.

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Comfortable pressure levels are maintained by controlling discharge of cabin air through the outflow valve. The CPCS consists of two digital Cabin Pressure Controllers (CPC), a CABIN PRESS control panel, an outflow valve, and three relief valves.

The CPCS has three modes of control, linked together at a common outflow valve. The three control modes consist of two identical automatic modes and one electric manual mode. Normal pressurization is automatic and requires no crew inputs. The data that the CPC needs for operation can normally be received from other aircraft systems.

The following are the interfaces that the CPC has with other aircraft systems:

- Pressure altitude, computed airspeed, and barometric correction are received from the CADCS.
- Flight data to the CPC, such as time at top of descent, estimated time of arrival, and landing field altitude, are received from the flight management system (FMS). The CPCS is capable of operation without FMS input. The system will revert to internal climb and descent rates. The flight crew needs only to input the landing field altitude in the control panel when this data is not available from the FMS.

The CPC outputs cabin altitude, cabin rate of change, cabin differential pressure, outflow valve position, and system status for display on the air synoptic page. Cabin altitude and cabin rate data are also displayed on the secondary engine page. The outflow valve position is displayed on the CABIN PRESS control panel and the air synoptic page.

The Centralized Fault Display System (CFDS) communicates with both CPCs.

The CPCs also send an analog pressure signal to ACCs 1 and 3. ACC 2 supplies backup cabin altitude and rate data to the Electronic Instrument System (EIS).

All three ACCs trigger the aural warning and an alert when the cabin exceed 10,000 feet. The ACCs signal an additional alert when cabin altitude approaches 15,000 feet. The oxygen masks automatically drop.

In the automatic mode, the cabin altitude schedule is calculated as a function of takeoff elevation, landing field elevation, aircraft altitude, and phase of flight. The cabin altitude will remain at departure field elevation until the aircraft altitude exceeds 5,000 feet above departure field elevation. At that time, the cabin altitude changes according to a predetermined schedule. With the FMS data, the CPC schedule is enhanced by setting cabin rates as a function of planned and predicted flight altitudes.

In the automatic mode, the cabin altitude schedule is calculated by the CPCs as a function of takeoff elevation, landing field elevation, aircraft altitude, and phase of flight.

Cabin altitude remains at departure field elevation until passing through 5,000 feet above departure field elevation.

With FMS data, the CPC schedule is enhanced when cabin rates are set as a function of planned and predicted flight altitudes.

In automatic control, the CPCs:

- Prepressurize to about 100 feet below takeoff field elevation when slats are extended.
- Climb the cabin during aircraft climbout according to takeoff altitude and aircraft altitude.
- Schedule cabin to be at 8.6 psi, or less, higher pressure than ambient during cruise. This limits cabin altitude to 8,000 feet.
- Descend cabin during aircraft descent according to landing elevation and aircraft altitude or, if FMS data is available, the planned flight altitude schedule.

The CPC FAULT alert indicates one of the two CPCs has failed and control has been switched to the backup CPC.

If the second CPC fails, the system switches to manual mode. The SEL CAB PRESS MAN alert is displayed and the CABIN PRESS SYSTEM SELECT light illuminates.

In manual mode, the flight crew can adjust the outflow valve position with a CABIN PRESS rate selector on the CABIN PRESS control panel.

Automatic Operation

Normal Configuration

During normal configuration operation, the ESC pressurizes the 3 pneumatic systems, operates the 3 packs, reconfigures the pneumatic system for engine start, and monitors for the following failures:

- Manifold failures.
- High manifold temperatures.
- Low anti-ice pneumatic supply.
- Avionics and CAC fan failures.
- Cabin pressure failures.
- Trim air failures.
- Pack failures.
- Anti-ice failures.
- Recirculation fan failures (Passenger Configuration).

Phase of Flight Configuration

The ESC senses phase of flight and operates the systems as required. The phases of flight and the associated functions are:

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- Preflight - During normal preflight control actions and engine start operations proper operation of the eight ESC-controlled pneumatic/air conditioning valves is verified. A preflight ESC test verifies trim air shutoff function, and proper operation of the avionics and CAC fans, and the respective flow sensors.
- APU ground operation - The flight crew starts the APU and opens the APU load bleed valve. When in auto mode, the ESC pressurizes all 3 pneumatic systems, thus allowing air conditioning.
- Ground conditioned air operation - Conditioned air flows directly into the distribution ducts downstream of the packs. There are no automatic controller functions.
- Ground engine start with APU pneumatic supply - Selection of engine ignition causes the ESC to:
 1. Turn packs off.
 2. Verify adequate pneumatic pressure for engine start. Display START AIR PRES LO alert, if pneumatic pressure is not adequate.
 3. Close 1-3 ISOL valve and turn on pack 3, after engine 3 start.
 4. Close 1-2 ISOL valve and turn on pack 1, after engine 1 start.
 5. Turn on pack 2 when flight crew closes APU load bleed valve, following engine 2 start.

NOTE: Engine 3 pneumatic supply is inhibited by the PSC when using ground carts until the pressure in all 3 systems has been low for 20 seconds.

- After engine start - Normal air conditioning allowed.
- Takeoff - The three takeoff configurations are:
 1. BLEEDS OFF - (Default) Pneumatics and air conditioning turned off when throttles are advanced for takeoff.
 2. BLEEDS ON PACKS OFF - Airfoil anti-ice manually selected on and packs selected off by flight crew after throttles advanced for takeoff.
 3. PACKS ON - Packs selected on from FMS TAKEOFF page. Airfoil anti-ice manually selected on or off by flight crew.

NOTE: The avionics exhaust fan turns on and the OVRD light illuminates for a packs off takeoff.

- Climb through landing roll - Climb phase begins when thrust is reduced to climb power, after passing through 1,000 feet above airport elevation. At 4,500 feet above airport elevation, if climb thrust is not set, the ESC automatically configures the aircraft for the climb. Pneumatics and air conditioning are restored. Recirculation fan available with ECON selected.

Pneumatic System Management

A Pressure Regulator Valve (PRV) on each engine pneumatic system controls bleed air from that engine. With engines running, only one bleed system may feed a single pneumatic manifold.

The ESC normally keeps all pneumatic systems isolated. However, when one or more systems are tied together, the PSC closes the high stage valve. If the ESC is also in auto, the PRV closes to prevent reverse flow.

With pneumatic supply from the APU or from a ground external source, the ESC opens the isolation valves to allow pressure into all three manifolds.

The PSC enters a Reverse Flow Check (RFC) mode when pneumatics are supplied by a ground cart. All high stage valves are commanded closed until the cart is removed.

The PSC senses cart removal when system pressure in all three manifolds falls below 11 psig for at least 20 seconds. System pressure returns to normal within one minute following cart removal.

Air Conditioning System Management

Each air conditioning pack may be operated by bleed air from its respective engine, from another engine, from the APU, or from external pneumatics. Normally, each engine supplies its respective pack.

The packs cannot use air from the APU if exhaust air from engines 1 or 3 is entering the APU air intake.

When the APU is supplying pneumatics to manifold 2 with engines 1 or 3 running, packs using pneumatics from manifold 2 are commanded off.

Pressurization Control System

The pressurization control system controls cabin altitude throughout the flight, provides gentle pressurization changes enroute, and depressurization during the landing.

Additional ESC Control Functions

The trim air system, the recirculation fan system, and the equipment cooling fans are managed automatically by the ESC.

ESC Automatic Operations - Abnormal

The ESC automatic operations include management of the following abnormal situations:

- **Monitors MFDS** - The ESC reconfigures a failed manifold system to shut off hot air flow. Verifies the failed manifold and restores operative manifolds initially shut down in response to the failure detection. Automatically tests the MFDS before each flight.

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- Monitors airfoil anti-ice - The ESC detects failures of the anti-ice manifolds and shuts off air to the associated main manifold. An alert is sent to the flight crew.
- Airfoil anti-ice valves can only be operated by the flight crew. When a triple manifold failure is detected, however, the airfoil anti-ice valves associated with that manifold automatically close. With the valves closed, a valid manifold decay check is enabled.
- Monitors pneumatic systems for engine/APU fire - Shuts down the associated pneumatic system when an ENG or APU FIRE handle is pulled and the ESC is in auto mode.
- When the fire is associated with the APU pneumatic system, the ESC also closes the APU load control valve.
- Monitors environmental system failures and reconfigures - Reconfigures the affected environmental system for a failed component.
- Monitors inoperative components and compensates - Components that may be inoperative by the Minimum Equipment List (MEL) can be entered into the system via the CFDS. The ESC then configures the system to operate with these components inoperative.
- Monitors itself and other components for proper operation - Continually monitors a large number of system components. The ESC uses alternate means to accomplish the task of a failed component, when able.
- Detects and reports faults - This is done through the CFDS.
- Reverts to manual for certain failure modes - Failures within the controller itself, or of a number of essential air system components, results in reversion to manual mode. The SEL AIR SYS MAN alert is displayed.

EIS Test Display

All AIR synoptic data digits are crossed with amber X's when all of the following conditions are met:

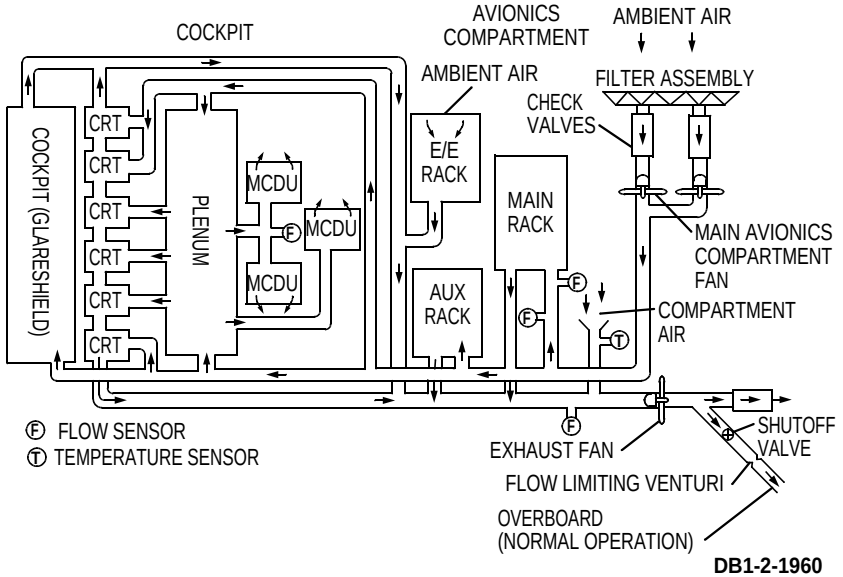
- The aircraft is on the ground and operational.
- The ANNUN LT TEST button on the overhead panel is pushed.
- The AIR synoptic is selected on the SD.

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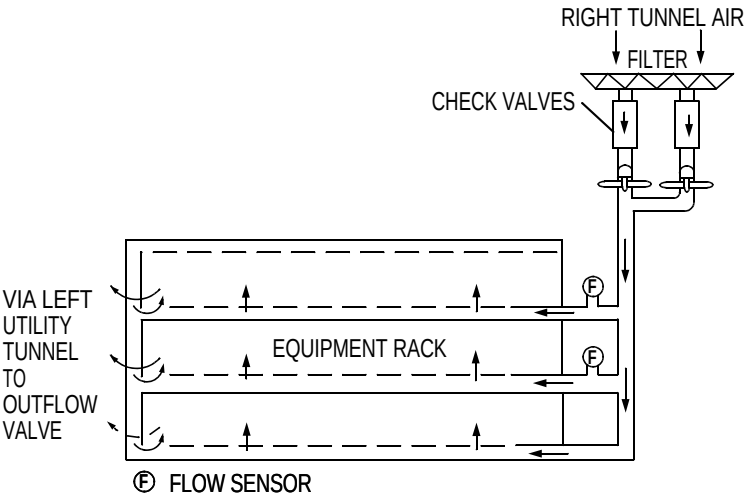
Air Components

Chapter Air Section 20

Avionics and Equipment Cooling Components



Center Accessory Equipment Cooling Components

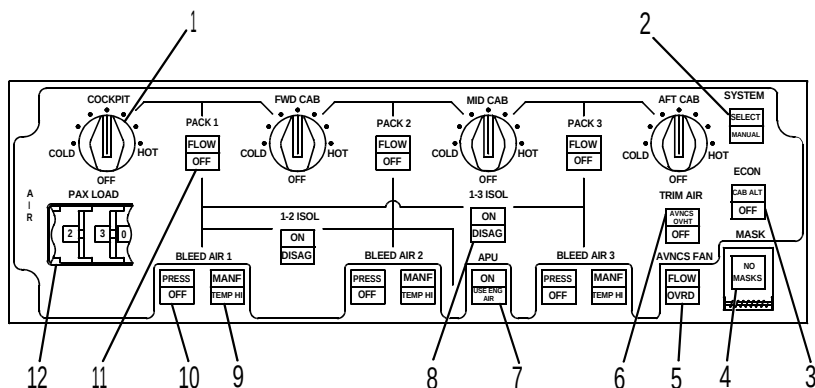


DB1-2-1959

Air Controls and Displays

Chapter Air Section 30

AIR Control Panel (Passenger)



FORWARD OVERHEAD PANEL

DB1-2-1957

1. COCKPIT, FWD/MID/AFT CAB Temperature Selectors

The zone temperature selectors allow selection of temperature within the range of 18° C to 29° C. Center position is 24° C.

OFF - Respective trim air modulating valve is closed (cold) and the ZONE TEMP SEL OFF alert appears.

COLD - All three packs are driven to full cold, causing lower air humidity.

HOT - Trim air is added and condensation is reduced in the outlet area.

2. AIR SYSTEM SELECT Switch - amber

This alternate action switch allows selection between manual and auto modes.

There are 2 alternating auto channels. During auto operation, one of the 2 auto channels is not used. Each time auto is selected, the previous unused auto channel is activated.

SELECT - Illuminates when the air system reverts to manual. The SEL AIR SYS MAN alert is displayed on the EAD, prompting the crew to lock the system in manual by pushing the AIR SYSTEM SELECT switch.

MANUAL - Illuminates when the system is in manual. Also, MANUAL flashes when the system is in auto and a switch on the AIR control panel is pushed that has no effect in auto.

3. ECON Switch - red/amber

The ECON switch is an alternate action switch that starts/stops the economy operation of the packs and recirculation fans. ECON mode may be manually selected on/off when the Environmental Systems Controller (ESC) is operating in auto or in manual.

In ECON mode, the packs operate on low and the recirculating fans are sequenced on. When not in ECON mode, the packs operate normally and the recirculating fans are off.

The Air Conditioning Controllers (ACC) and the ESC automatically turn the ECON mode on and off, as required by flight conditions.

CAB ALT - Illuminates red when cabin altitude is above 10,000 feet.

OFF - Illuminates amber when ECON mode is manually selected off.

4. MASK Switch - red

The NO MASKS switch is a guarded momentary switch that illuminates if cabin altitude exceeds approximately 14,770 feet and the automatic systems have not deployed the oxygen masks.

NO MASKS - Illuminates red when pushed and held for more than 3 seconds. The oxygen mask deploys by using an independent electrical source. The red light in the switch extinguishes.

5. AVNCS FAN Switch - amber

The AVNCS FAN switch is an alternate action switch that starts/stops override operation of the avionics exhaust fan and the venturi shutoff valve when the system is in manual mode. Normal operation provides automatic cooling airflow through the avionics compartment. Override operation closes the venturi shutoff valve and turns on the avionics exhaust fan. The switch has no effect when the system is in auto mode.

FLOW - Illuminates amber when cooling airflow through the avionics is below normal, or cabin inflow is insufficient for pressurization, or cabin altitude is greater than 10,000 feet.

OVRD - Illuminates amber when the avionics fan and the venturi valve are commanded to override.

6. TRIM AIR Switch - amber

The TRIM AIR switch is an alternate action switch that opens/closes the trim air pressure regulator valves when the system is in manual mode. When on, hot air tempers the air conditioning system cold air output. When off, hot air is prevented from entering the trim air manifold. The switch has no effect in auto mode.

AVNCS OVHT - Illuminates amber when an overheat condition is sensed in the avionics compartment. Trim air is latched off.

OFF - Illuminates amber when the trim air pressure regulator valves are commanded off.

7. APU Air Switch - blue/amber

Refer to the APU chapter for switch description.

8. 1-2 ISOL/1-3 ISOL Switch - blue/amber

The 1-2 and 1-3 ISOL switches are alternate action switches that open/close the respective pneumatic isolation valves when the system is in manual mode. The switch has no effect in auto mode.

ON - Illuminates blue when the ISOL valve is commanded on. If the APU is providing the air conditioning, and the air system is in manual mode, ON illuminates.

DISAG - Illuminates amber when the valve position is not in agreement with the commanded position. The light is inhibited for ten seconds when the system is in auto mode. In manual mode, DISAG illuminates when the isolation valves are in transit.

9. BLEED AIR 1/2/3 MANF/TEMP HI Switch (3) - red

The BLEED AIR 1/2/3 MANF/TEMP HI switch is a momentary switch that operates in parallel with and identically to the BLEED AIR PRESS switch. The switch controls the pneumatic pressure regulator valve and provides the respective engine bleed air disconnect capability when in manual mode. The switch has no effect in auto mode.

MANF - Illuminates red when a high temperature is sensed in any compartment through which the respective manifold is routed. A failed or leaking manifold is indicated.

TEMP HI - Illuminates red when engine bleed air temperature is excessively high downstream of the precooler.

10. BLEED AIR 1/2/3 PRESS/OFF Switch (3) - amber

The BLEED AIR 1/2/3 PRESS/OFF switch is a momentary switch that operates in parallel with and identically to the BLEED AIR 1/2/3 MANF/TEMP HI switch. The switch controls the pneumatic pressure regulator valve and provides the respective engine bleed air disconnect capability when in manual mode. The switch has no effect in auto mode.

PRESS - Illuminates amber when the air pressure is less than 11 psi.

OFF - Illuminates amber when bleed air is selected off.

11. PACK 1/2/3 Switch (3) - amber

The PACK switch is a momentary switch controlling the respective pack flow control valve when the system is in manual mode. When on, air conditioning system control of the respective pack is provided. When off, the associated pack flow control valve and ram air door is commanded closed. The switch has no effect when the system is in auto mode.

FLOW - Illuminates amber when the respective pack is commanded on but air flow is insufficient to allow it to operate, or the pack is commanded off and flow is present.

OFF - Illuminates amber when the respective pack is commanded off.

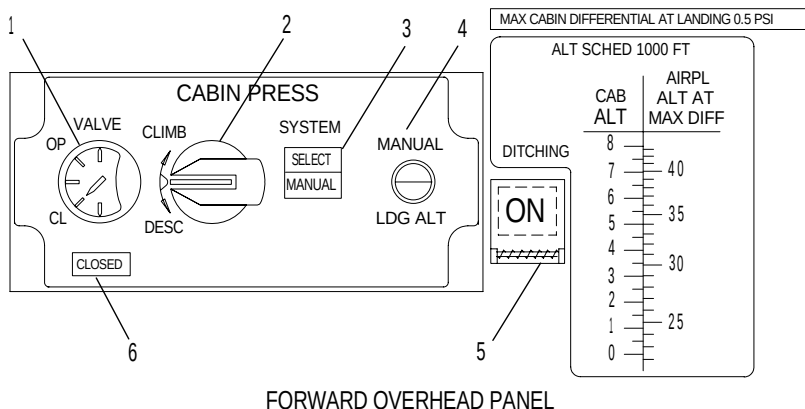
12. PAX LOAD Selector

The number of passengers is entered to the nearest 10 (rounded up) by using the thumbwheels. The range is 100 to 590. The airflow rate through the packs is adjusted for passenger comfort.

In economy mode, the recirculation fans are on and the packs provide a minimum of ten cubic feet per minute of fresh air per passenger. The default of 240 passengers is selected by the ACC when a passenger number less than 240 is selected.

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CABIN PRESS Control Panel



DB1-2-1668

1. Outflow VALVE Indicator

Displays position of outflow valve during manual and automatic operation of cabin pressure control system.

2. CABIN PRESS Manual Rate Selector

This selector is a momentary action, two speed rotary switch that adjusts the position of the outflow valve when the system is in manual. The first detent causes the valve to move slowly. The second detent causes the valve to move faster towards DESC or CLIMB (open or closed). This allows for rapid recovery from failure conditions as well as a fine tuning of cabin altitude rate change.

3. CABIN PRESS SYSTEM SELECT Switch - amber

This is an alternate action switch that allows selection between manual and auto modes.

There are 2 alternating auto channels. During auto operation, one of the auto channels is not used. Each time auto is selected, the previous unused auto channel is activated.

SELECT - Illuminates amber if the system is in manual with the switch in auto.

MANUAL - Illuminates amber if the system is in manual. MANUAL flashes if the system is in auto and a switch on the control panel has been pushed that has no effect in auto.

When the SEL CAB PRES MAN alert is displayed on the EAD, the system has reverted to manual. The system may be locked in manual by pushing this switch.

4. CABIN PRESS MANUAL LDG ALT Knob

This knob is used to enter the landing field altitude if the information is not available from the flight management system (FMS). Landing field altitude is shown on the air system synoptic display. The knob has no effect when the system is in manual.

The data is activated when the knob is rotated at least 120 degrees.

5. DITCHING Switch - amber

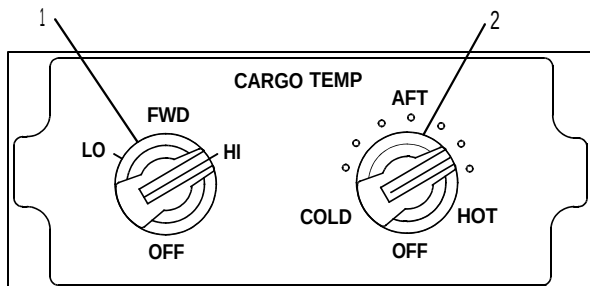
ON - Illuminates amber when pushed, and initiates the following functions:

- Inhibits EGPWS.
- Puts TCAS in TA only mode.
- Maintains existing cabin altitude.
- Shuts off packs at 2,500 feet radio altitude or when cabin differential pressure is less than 0.5 psi.
- Closes venturi shutoff valve.
- Closes ram air door (if open).
- Closes outflow valve.

6. CLOSED Light - amber

Illuminates amber when the outflow valve is fully closed.

CARGO TEMP Control Panel



FORWARD OVERHEAD PANEL

DB1-2-1930

1. FWD CARGO TEMP Selector

Regulates the temperature in the forward cargo compartment.

LO - 4.4° C.

HI - 21.1° C.

OFF - Heating system is off.

2. AFT CARGO TEMP Selector

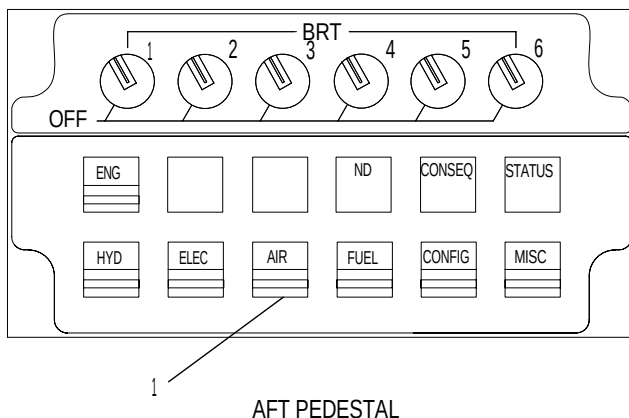
Regulates the temperature in the aft cargo compartment.

COLD - 4.0° C.

HOT - 35° C.

OFF - Heating system is off.

AIR Cue Switch



DB1-2-1670

1. AIR Cue Switch - white

Illuminates white when AIR alert is displayed on the EAD.

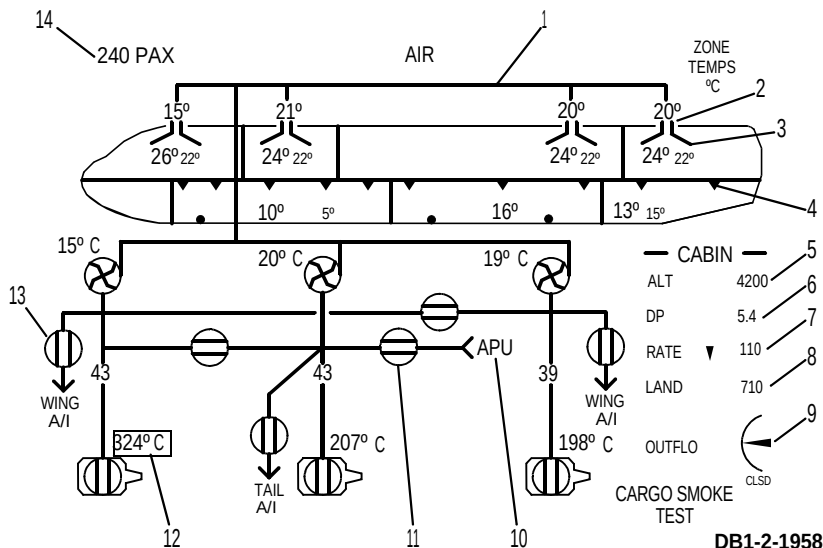
When pushed:

- MASTER CAUTION or MASTER WARNING lights extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- The synoptic and the corresponding consequences appear on SD.

Some Level 1 alerts are for maintenance only, and appear on the SD STATUS page only. These alerts do not illuminate the cue switch or the MASTER CAUTION lights.

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SD Synoptic - Air (Passenger Configuration)



DB1-2-1958

1. Ducts and Flow Lines - white/green/red/amber

Ducts and flow lines are represented as a solid line. Ducts with no flow or unpressurized flow lines are shown as white lines. Ducts and flow lines are green when pressurized, red when there is a manifold failure, and amber if turned off following a manifold failure.

2. Duct Temperatures - white/amber

Duct temperatures are in degrees C. Digits are normally white, and boxed amber when there is a duct overheat. Unavailable data is replaced with an amber X.

3. Zone Temperatures - white/cyan/amber

Zone temperatures are in degrees C. Actual temperatures are shown in large white digits. Set temperature is shown in smaller cyan digits. If temperature selector is off, OFF replaces small digits. Any unavailable temperature is replaced with an amber X. All cargo zones are off with the CARGO TEMP switch in OFF.

4. Smoke and Heat Detectors - amber/white

Detected smoke is shown by a small amber triangle in the appropriate compartment. Detected heat is shown by a small amber circle. During a smoke detector test, CARGO SMOKE TEST is shown in white below the outflow valve readout. Failed smoke and heat detectors are shown as amber rectangles with an F inside.

5. ALT Readout - white/red/amber

Cabin altitude (feet) is shown in the right center of the screen. Digits are normally white, but turn red and are boxed when cabin altitude exceeds 10,000 feet. If no valid cabin altitude is available, the digital readout is replaced by an amber X.

6. DP Readout - white/red/amber

Cabin differential pressure (psi) is shown below ALT readout. Digits are normally white, but turn red and are boxed in red when differential pressure exceeds 9.1 psi. If no valid differential pressure data is available, the digital readout is replaced by an amber X.

7. RATE Readout - white/amber

Cabin altitude rate (feet per minute) is shown below DP readout. Downward rates are indicated by a downward pointing arrowhead. Upward rates have an upward pointing arrowhead. Digits are normally white, but turn amber and are boxed in amber when the rate exceeds plus 1500 feet per minute or minus 750 feet per minute for 15 seconds, or plus 3000 feet per minute or minus 1500 feet per minute for 5 seconds.

8. LAND Readout - magenta/white/amber

Landing altitude is shown below RATE readout. Landing altitude is supplied by the FMS and is shown in magenta, or is shown in white and boxed if set manually through the cabin pressure controller. If no valid landing altitude is available through the FMS, the readout is replaced with amber dashes.

9. OUTFLO Readout - white/amber

Outflow valve position is shown below the LAND readout. This display is normally white, but the letters CLSD turn amber when the valve is fully closed.

10. APU Air Readout - white/green

Readout appears only when APU air is available. Readout is white when APU bleed air load valve is closed and green when APU bleed air load valve is open.

11. Valve Symbol - white/green/amber

Valves always reflect the state commanded by the ESC. They are white when closed, green when open, and amber with DISAG displayed above the valve when not in the commanded position.

12. Engine Bleed Readout - white/amber/red/green

Engine bleed pressure (psi) is shown above the outline of the engine. Digits are normally white but turn amber and are boxed if limits are exceeded. Engine bleed temperature (degrees C) is shown adjacent to the associated engine. Digits are normally white, but turn red and are boxed if high temperature limits are exceeded, or turn amber and are boxed when low temperature limit (ice protection) is exceeded. The pressure regulator valves are shown in the engine outline. The valve is green if the engine is running, the manifold is pressurized, and the valve is commanded open; otherwise, it is white. If no valid engine bleed pressure or temperature data is available, digits are replaced with an amber X.

13. Air Conditioning Pack Readout (3) - green/white/amber/red

The packs always reflect the commanded state. Operating packs are green circles with green vanes. Non-operating packs (no faults) are white circles. If a pack overheats or is turned off due to a pack manifold failure, it is amber. When a manifold fail occurs, it is red. Pack outlet temperatures are programmed in degrees C. Digits are normally white but turn amber and are boxed in amber when the pack overheats. If no valid pack temperature is available, the digits are removed and replaced with a red X.

14. PAX Load Readout - amber

The number of passengers, as entered on the AIR control panel PAX LOAD selector, is shown in the upper left hand corner of the screen. The number is always the next highest multiple of ten (last number is always zero). When the number of passengers is not available, the digits are replaced with amber dashes.

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

Red Boxed Alerts (Level 3)

AIR MANF 1/2/3 FAIL (AIR) - Leak has occurred in respective air system manifold or left wing anti-ice ducting (1)/tail anti-ice ducting (2)/right wing anti-ice ducting (3).

BLD AIR1/2/3 TEMP HI (AIR) - Respective bleed air system exceeds temperature limit.

CABIN ALTITUDE (AIR) - Cabin altitude exceeds 10,000 feet.

CAC MANF FAIL (AIR) - Leak has occurred in pneumatic system ducts in the center accessory compartment.

Amber Boxed Alerts (Level 2)

AIR ALERTS (AIR) - DEUs not receiving valid data from air system controllers. Air system warning and alert faulty.

AIR SYS 1/2/3 PRES LO (AIR) - Respective air system pressure is low.

AIR SYS 1-2 OFF (AIR) - A manifold failure has caused air systems 1 and 2 to shut down and air system is in manual mode.

AVNCS AIR FLO OFF (AIR) - All avionics fans are inoperative and there is no avionics compartment cooling flow.

AVNCS COMPT OVHT (AIR) - Avionics compartment temperature is high.

AVNCS EXH FLO OFF (AIR) - Avionics compartment exhaust flow is low.

BLEED AIR 1/2/3 FAULT (AIR) - Respective system bleed air temperature or pressure is low.

TRIM AIR OFF (AIR) - The air conditioning TRIM AIR has been automatically turned off (a fault exists) or the TRIM AIR switch has been manually selected off.

Amber Alerts (Level 1)

AIR LRU INOP (MAINT) - Maintenance alert. Maintenance action has been taken to declare an air conditioning pack, pneumatic system, or manifold sensor inoperative. The system can be operated in the auto mode and will not use the affected component.

AIR MANF TST FAIL (AIR) - A component of the air manifold failure detection system has failed the automatic test.

AIR SYS 1/2/3 OFF (AIR) - Respective air system bleed is off. Associated isolation valves are off. (System 1 isolation valves are 1-3 and 1-2, system 2 valves are APU load control and 1-2 isolation, system 3 valve is 1-3).

AIR SYS MANUAL (AIR) - Air system is in manual mode.

AIR SYS TEST FAIL (AIR) - A component of the air system has failed the automatic test.

AIR 1-2/1-3 ISOL DISAG (AIR) - The respective pneumatic isolation valve is not in the commanded position.

AVNCS FAN OVRD (AIR) - The avionics exhaust fan, normally off in flight, is operating. The fan turns on automatically when cooling flow goes below normal, or may be manually selected on.

BLEED AIR 1/2/3 OFF (AIR) - Associated engine bleed valve is closed with associated air system pressurized from another source.

BLEEDS NOT OFF (AIR) - Packs off for takeoff is selected (anti-ice off) and the bleeds are not selected off prior to advancing the throttles for takeoff.

CABIN PRES RELIEF (AIR) - Cabin differential pressure has exceeded 8.76 psi and pressure relief valve(s) is open.

CAB PRES SYS MAN (AIR) - Cabin pressurization system is in manual.

CABIN INFLO LO (AIR) - Cabin altitude is climbing, outflow valve is closed and one or more packs are commanded ON. If AIR SYSTEM SELECT switch is in AUTO, the AVNCS FAN switch will revert to OVRD and remain in override until aircraft is on the ground.

CABIN RATE (AIR) - Cabin rate of climb/descent exceeds limits.

CAC AIR FLO OFF (AIR) - All CAC fans are inoperative. There is no CAC cooling.

CAC MANF DECAY CK (AIR) - CAC air manifold air pressure decay check in progress.

CPC FAULT (MAINT) - One of the 2 cabin pressure controllers is inoperative and requires ground maintenance.

CRG FLO AFT/FWD DISAG (AIR) - Associated cargo compartment ventilation does not agree with switch position.

CRG TEMP CTL OFF (AIR) - FWD and/or AFT TEMP selector in OFF.

-
- ECON OFF (AIR)** - The ECON switch has been selected off. The packs command maximum available flow and the cabin recirculation fans will not operate.
- LDG ALTITUDE MAN (AIR)** - The landing field elevation is set by turning the MANUAL LDG ALT knob on the CABIN PRESS control panel. Selecting the cabin pressure controller to manual and back to auto restores automatic operation.
- LWR CARGO TEMP LO (AIR)** - Temperature in one or both lower cargo compartments is below limit.
- OPEN OUTFLOW VALVE (AIR)** - Cabin pressure exceeds allowable limits to open doors while aircraft is on the ground.
- PACK 1/2/3 FLO DISAG (AIR)** - Associated air conditioning pack flow is in disagreement with the commanded position.
- PACK 1/2/3 OFF (AIR)** - Associated air conditioning pack is off, either selected manually by the crew, or automatically by the ESC due to a fault or configuration requirement.
- PACKS NOT OFF (AIR)** - During packs off (bleeds on) takeoff, one or more packs are not off.
- PAX AIR FLO LO (AIR)** - The cabin air inflow from the air conditioning packs is below desired limit based on the number of passengers. This alert is only displayed in flight, and only if all packs are operating.
- SEL AIR SYS MAN (AIR)** - The air system has reverted to manual mode but the AIR SYSTEM SELECT switch is in the auto position.
- SEL (FWD or AFT) TEMP OFF** - temperature in the respective lower cargo compartment exceeds limits. When the associated cargo temperature returns to normal one attempt may be made to restore the system.
- SEL CAB PRES MAN (AIR)** - The automatic cabin pressurization system is inoperative.
- SET LDG ALTITUDE (AIR)** - The cabin pressure controller is not receiving landing field elevation data from the FMS and should be set manually. Automatic operation may be restored by selecting the cabin pressure controller to manual and back to auto.
- SEL PACK 1/2/3 OFF (AIR)** - Respective pack discharge temperature exceeds limits.
- ZONE TEMP SEL OFF (AIR)** - One or more of the cabin zone temperature selectors is selected off.

Cyan Alerts (Level 0)

AIR 1-2/1-3 ISOL ON - Associated pneumatic isolation valve has been commanded on (open).

AIR SYS TEST - Automatic air system preflight test is in progress.

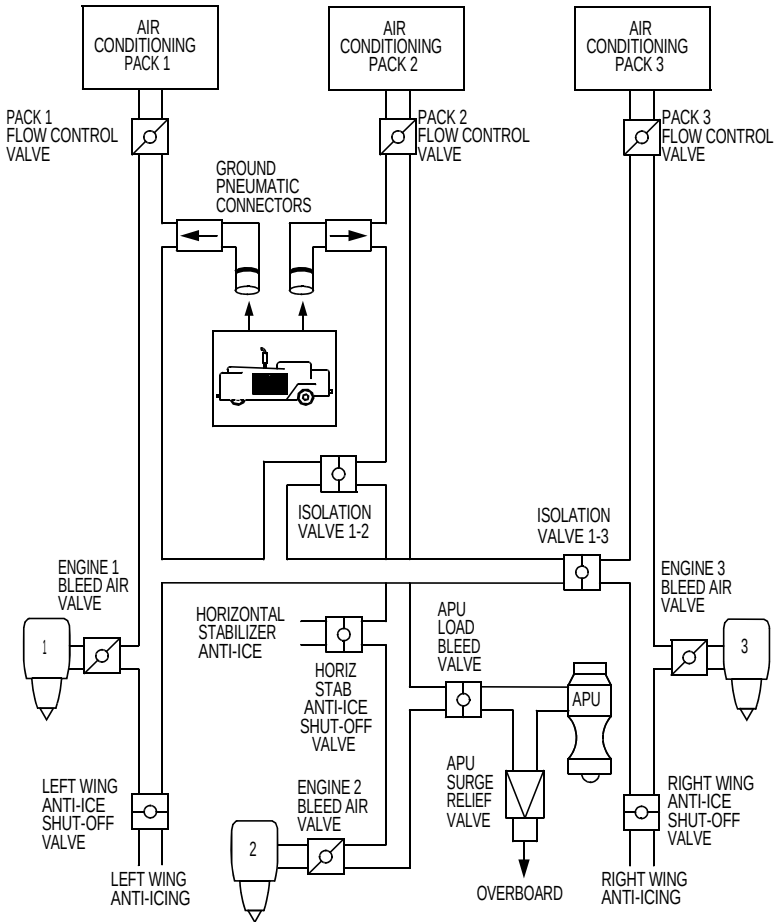
BLEEDS ALL OFF - All three bleeds air supplies are turned off for a bleeds off takeoff.

PACKS ALL OFF - All three air conditioning packs are off for a packs off takeoff.

Air Functional Schematic

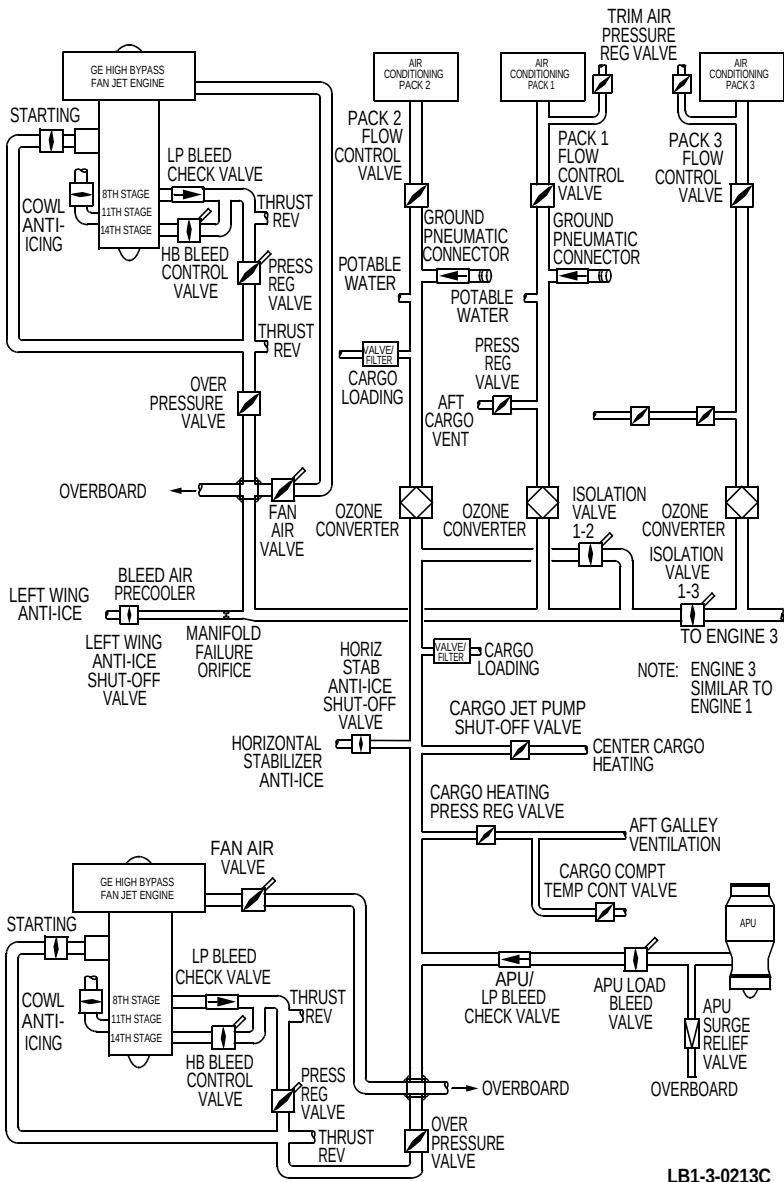
Chapter Air Section 50

Air System Block Diagram



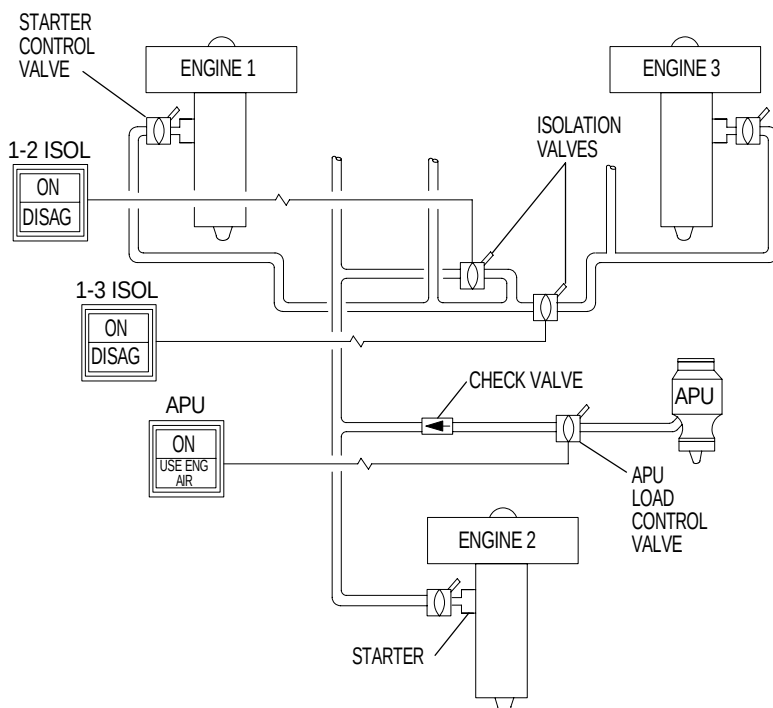
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Pneumatic System Valve Diagram - GE Engine



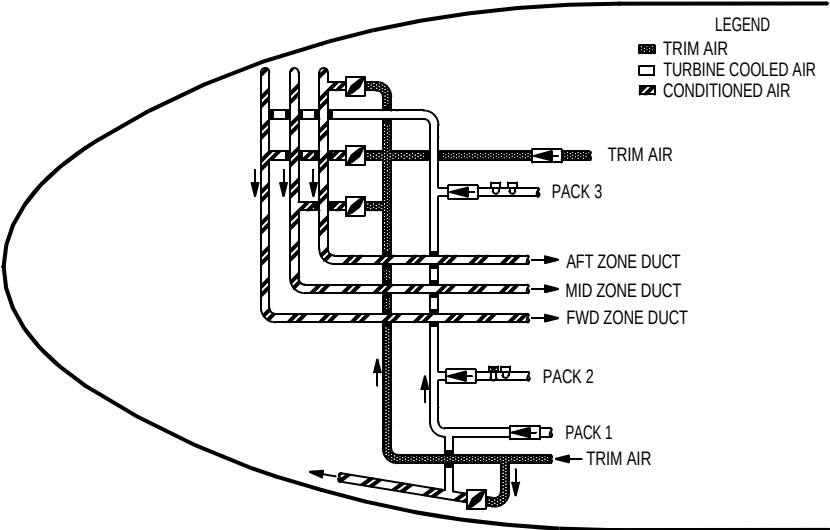
MD-11 Flight Crew Operations Manual

Pneumatic Manifold Isolation Control



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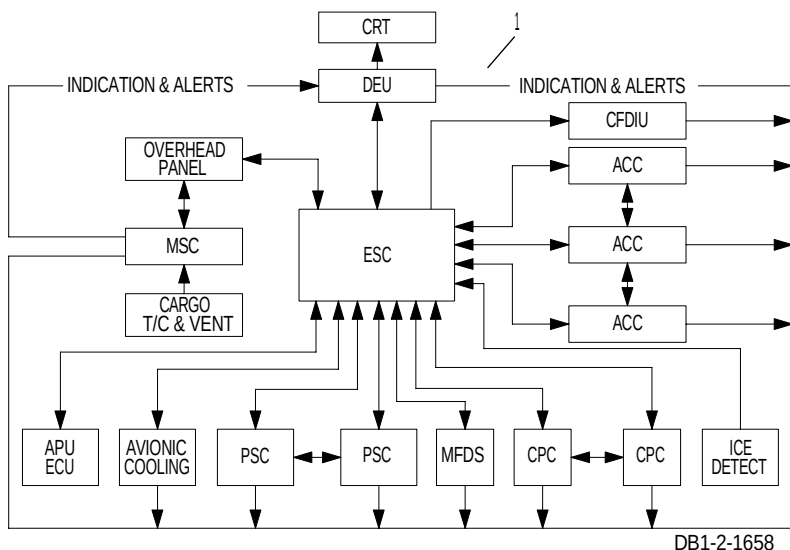
Conditioned-Air Distribution - Passenger



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MD-11 Flight Crew Operations Manual

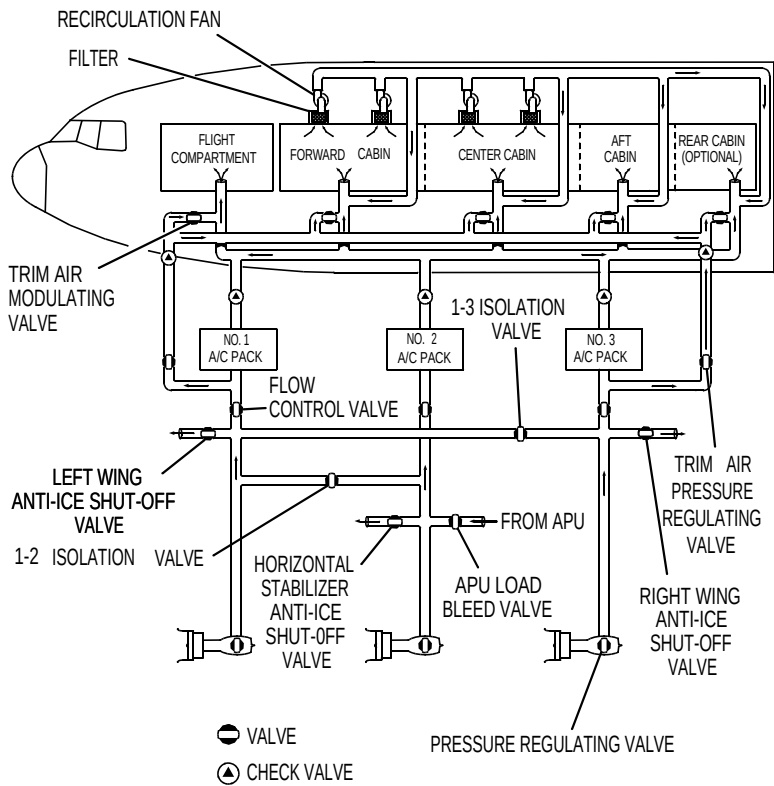
Environmental Control Interface Diagram



1. LEGEND

- ACC - Air Conditioning Controller.
- CFDIU - Centralized Fault Display Interface Unit.
- CPC - Cabin Pressure Controller.
- CRT - Cathode Ray Tube.
- DEU - Display Electronics Unit.
- ECU - Electronic Control Unit.
- ESC - Environmental Systems Controller.
- MFDS - Manifold Failure Detection System.
- MSC - Miscellaneous Systems Controller.
- PSC - Pneumatic System Controller.
- T/C - Temperature Control.

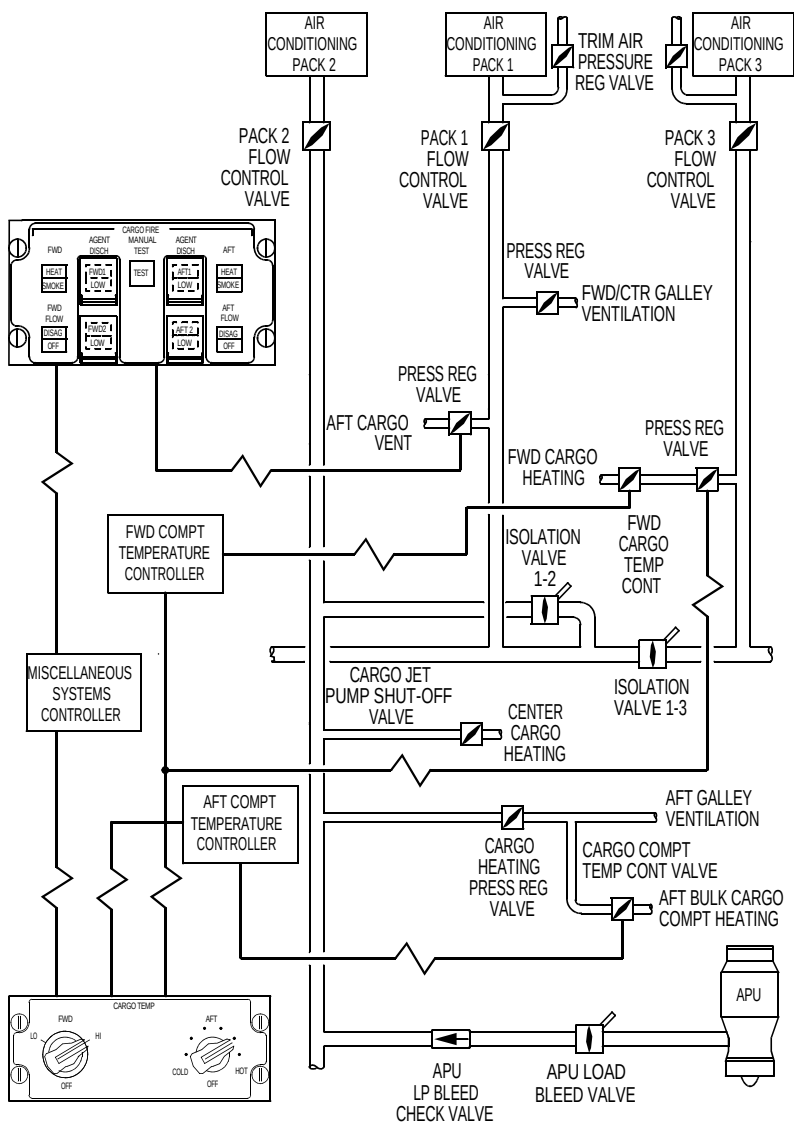
Pneumatic and Air Conditioning Systems - Passenger



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MD-11 Flight Crew Operations Manual

Cargo and Galley Ventilation and Heat - Passenger



DB1-2-1659A

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**Auxiliary Power Unit (APU)****Chapter APU****Table of Contents****Section 0**

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APU**Description and Operation****Chapter APU****Section 10**

General

The Auxiliary Power Unit (APU) provides electrical and pneumatic power for engine start and air conditioning, and supplies ground and in-flight electrical power. Pneumatic and electrical power may be used independently or simultaneously.

The APU is installed in an unpressurized area of the rear pressure bulkhead, beneath engine 2 and the horizontal stabilizer.

APU RPM, EGT, air output and electrical output are controlled by an Electronic Control Unit (ECU).

APU controls are on the overhead panel. The external APU control panel is in the fairing immediately behind the left main gear well. APU parameters are displayed on the Systems Display (SD).

APU Control System

The APU control system consists of the ECU and the Electronic Fuel Control Unit (EFCU). The ECU controls starter operation, fuel scheduling, ignition, and surge bleed airflow and provides a stable, automatic start cycle. The EFCU receives control input from the ECU and controls fuel supply.

The APU requires battery bus power for start and uses fuel from tank 2. The ECU receives primary power from the battery bus.

The APU supplies air to operate the three air conditioning packs, before or after engine start, as required.

APU Door System

The APU installation has an inward-opening door for the intake duct and an outward-opening half door for the exhaust duct. An electric actuator operates the doors.

The inlet and exhaust door actuation system receives electrical power from the battery bus on command from the Miscellaneous Systems Controller (MSC).

If a door starts to close while the APU is operating, the APU shuts down.

APU Start and Shutdown

The APU START/STOP alternate action (pushbutton) switch on the aft overhead panel commands APU start through the MSC, after determining APU running status.

A DC electric starter motor, mounted on the APU gearbox, uses aircraft battery power for APU start. A battery-powered DC pump provides starting fuel flow to the APU from main fuel tank 2. This pump is used for APU start when AC power is not available. When AC power is available, the AC pump in main fuel tank 2 supplies fuel to the APU.

Following APU start, the ECU controls the APU through the EFCU, maintaining a constant APU N2 rpm speed with all varying loads. The ECU also regulates the surge control valve and the load bleed valve to meet demand for pneumatic power.

The EGT reaches set values with combined bleed air and power loads. The ECU commands the low pressure (N1) compressor speed to drop. A variable turbine nozzle actuator adjusts N1 speed by adjusting the position of the vanes, which are located upstream of the N1 turbine.

Following APU shutdown, EGT is monitored continuously until the APU is shut down. The EGT value is displayed on the APU data window of the SD. Should EGT limits set by the ECU be exceeded, N1 speed is slowed to N1/EGT cutback. Shut down is automatic if there is still no control.

The following automatic shutdowns, processed through the ECU, protect the APU against hazardous conditions and potential damage:

- N1 or N2 overspeed.
- Low oil pressure.
- High oil temperature.
- Reverse flow.
- Loss of EGT signal.
- Fire warning.
- Loss of N1 or N2 speed signal.
- High EGT.
- Loss of DC power.
- Slow start.
- No flame during start.
- Inlet door not open.
- Starter motor energized over 1 minute.
- Overcurrent.

APU Pneumatic System

The APU pneumatic system supplies bleed air to the Environmental Control System (ECS) and to the main engine start system.

The components of the APU pneumatic system are:

- APU bleed manifold.
- APU load bleed valve.
- APU surge valve.
- APU flow sensor.
- APU low-pressure bleed check valve.
- aircraft isolation shutoff valves.

The APU pneumatic system shares the ducting and valving associated with the engine 2 bleed air system.

When the APU load bleed valve is opened, low-pressure compressor discharge air flows into the engine 2 bleed line through the air load valve and the low-pressure check valve. This air is directed either to the packs or to the main engine air starters by one or both of the isolation valves.

During APU start, load valve 2 is in the closed position and the surge valve is in the open position.

After start, when no APU air is being routed through the ducting for use by the aircraft systems, air flows overboard through the surge control valve. Operation of the surge control valve is directed by a signal from the flow sensor.

APU Controls and Displays

APU indications are displayed on the SD. Alerts appear on the EAD and SD. The APU control panel is on the aft overhead panel. Additional controls are on the external APU control panel.

The external APU control panel is in the fairing immediately behind the left main gear well. It allows fire extinguishing action by personnel on the ground.

The APU START/STOP switch permits single switch control for manual start/stop and operation under normal ground and flight conditions.

The APU PWR switch on the ELEC control panel also starts the APU, and stops the APU if started with this switch and not supplying bleed air. APU power is automatically supplied to the unpowered generator buses.

With engine integrated Drive Generator (IDG) power from the respective bus, the APU continues to run and to power each main bus during engine shut down.

If the APU is started with the APU START/STOP switch, shut down is not automatic after the load is removed. Manual shutdown with the APU START/STOP switch is required.

The APU cannot be started without battery power. During a battery start, DOOR, FUEL, and FAIL lights, if illuminated indicate malfunctions. During the start sequence, both the AVAIL light on the APU PWR switch and the ON light on the APU START/STOP switch flash.

An APU oil quantity drop is normal during the start sequence.

After APU start, with AC power available, the APU ON alert is displayed on the EAD and N1, EGT, N2, and OIL parameters are displayed on the SD.

The APU door closes when the APU master switch is actuated to STOP. At this time, the APU indication is removed from the SD, and the APU ON alert disappears.

A 90-second time delay provides a cushion against thermal shock to the turbine section. The APU continues to run after it has been commanded OFF if air has been used.

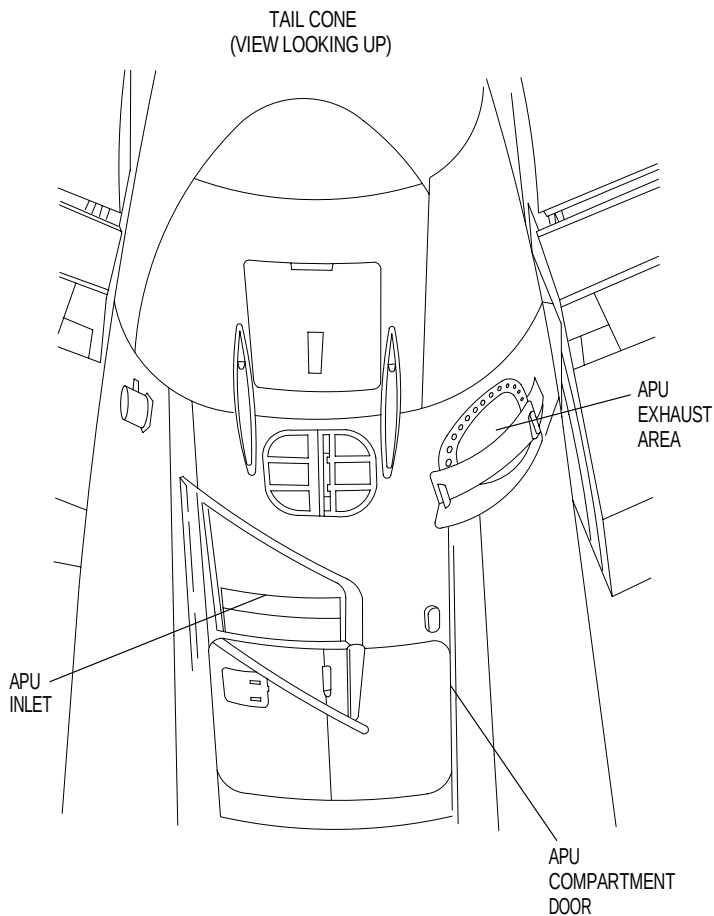
APU shutdown will be inhibited if the APU START/STOP switch is selected to STOP while the APU AIR switch remains selected ON.

The APU symbol is removed from the AIR synoptic when APU air is no longer available.

APU Components

Chapter APU Section 20

APU Tail Cone View and Exhaust Area



CAG(IGDS)

LB1-3-0008

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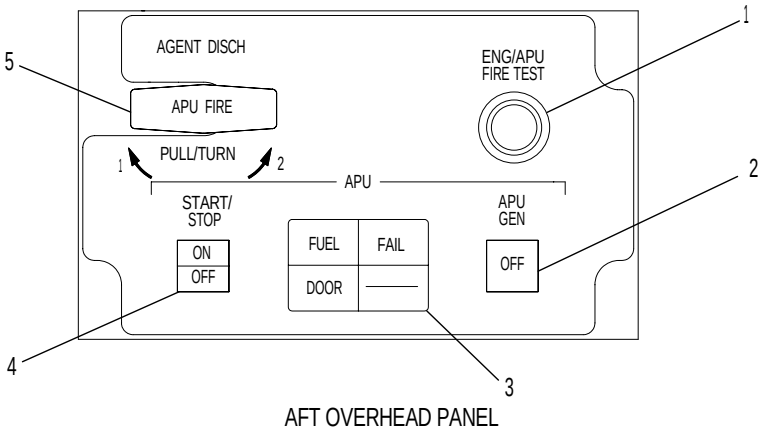
APU

Controls and Displays

Chapter APU

Section 30

APU Control Panel



DB1-2-1625

1. ENG/APU FIRE TEST Button

For description, refer to Fire Protection chapter.

2. APU GEN Switch - amber

When pushed, resets APU generator control unit if electrical system is in manual mode.

OFF - Illuminates amber when generator is on speed and there is a malfunction.

3. APU FUEL/FAIL/DOOR Status Display - amber

FUEL - Illuminates amber when APU fuel pressure is too low.

FAIL - Illuminates amber if the APU fails to start.

DOOR - Illuminates amber if the APU door does not open. DOOR also illuminates during a normal shutdown if the door does not close.

Blank - Illuminates during test only (spare display).

4. APU START/STOP Switch - blue

This switch is an alternate action pushbutton switch that starts and stops the APU manually. With OFF selected, the APU shuts down 90 seconds after the APU bleed air stops.

ON - Flashes blue when the APU is selected to START, and illuminates steady blue when the APU is running on speed. If the APU shuts down automatically due to a fire signal, ON flashes until the APU START/STOP switch is selected to STOP (OFF).

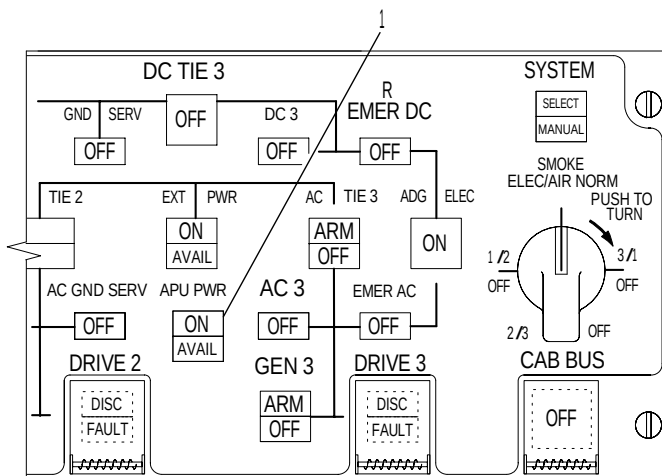
OFF - Illuminates steady when the APU is selected to STOP. Shutdown occurs 90 seconds after the APU is no longer supplying bleed air. OFF remains illuminated until the shutdown cycle is complete.

If the APU is started with this switch, the APU can only be stopped manually with this same switch.

5. AGENT DISCH APU FIRE Handle

For description refer to the Fire Protection chapter.

APU PWR Switch



FORWARD OVERHEAD PANEL

DB1-2-1626

1. APU PWR Switch - green/blue

Push to start the APU.

AVAIL - Flashes green during start until N2 reaches 95 percent, then becomes steady green as the APU generator provides power of correct phase rotation, voltage, and frequency.

If the APU was started from the APU control panel, pushing this switch supplies APU power to the unpowered generator buses if the green AVAIL light is illuminated.

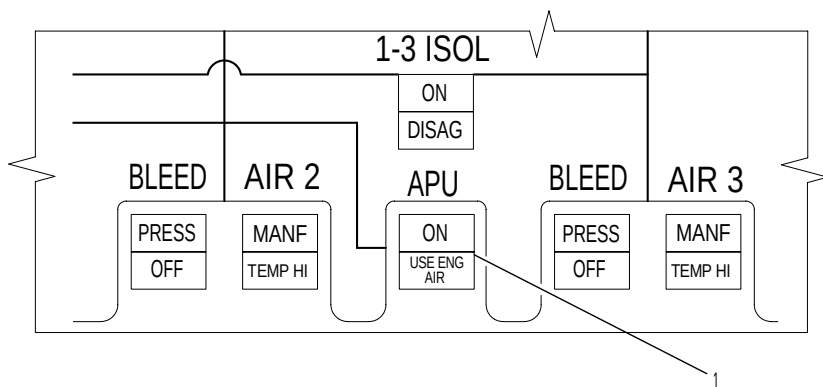
After start, APU power is automatically supplied to unpowered generator buses. When the IDGs are supplying the generator buses, the APU shuts down 90 seconds after APU air is no longer being used.

ON - Illuminates blue when the APU generator is supplying power to any generator bus.

If the APU is on and supplying electrical power, pushing this switch disconnects electrical loads.

If the APU was started from the APU control panel, pushing this switch does not stop the APU.

APU Air Switch



FORWARD OVERHEAD PANEL

DB1-2-1627

1. APU Air Switch - blue/amber

This switch is an alternate action switch that opens and closes the APU load bleed valve.

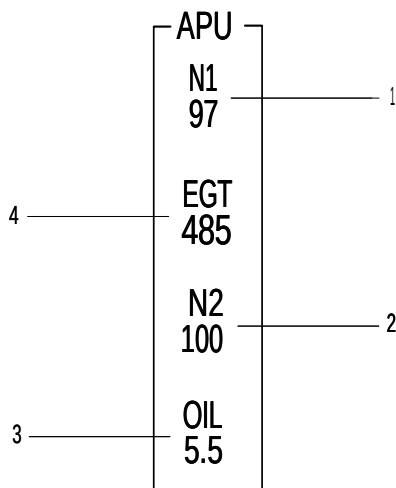
ON - Illuminates blue when the valve is selected open.

USE ENG AIR - Illuminates amber when the APU air switch is on and cabin differential pressure is more than 1.3 psi.

If APU air is desired for engine start, this switch must be pushed prior to pulling the ENG START switch.

NOTE: When the air system is in auto mode, the 1-2 and 1-3 isolation valves are automatically controlled.

APU Data Window



SYSTEM DISPLAY (SD) PANEL

CAG(IGDS)

LB1-3-0019

1. APU N1 Readout - white/red

N1 - White digits turn red and are boxed in red if limits are exceeded (displayed in percent).

2. APU N2 Readout - white/red

N2 - White digits turn red and are boxed in red if limits are exceeded (displayed in percent).

3. APU OIL Readout - white/amber

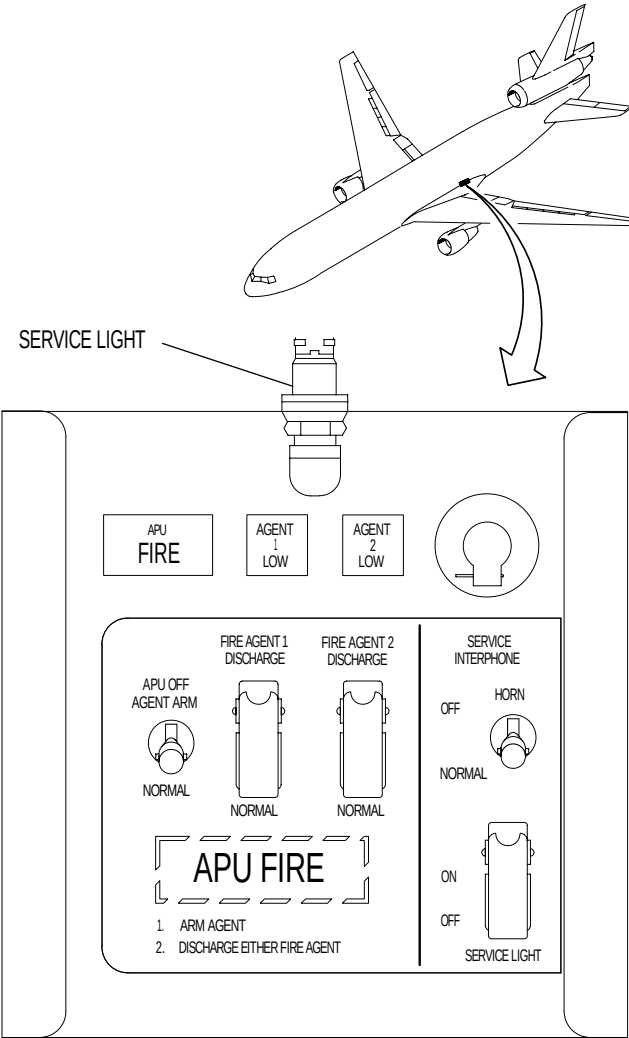
OIL - White digits turn amber and are boxed in amber if oil quantity (quarts) is low.

4. APU EGT Readout - white/red

EGT - White digits turn red and are boxed in red if limits are exceeded (displayed in degrees centigrade).

NOTE: APU data appears on the SD only when the secondary engine display is selected and when APU start cycle is initiated.

External APU Control Panel - 2 Bottle



LOOKING UP, AFT OF LEFT WHEEL WELL

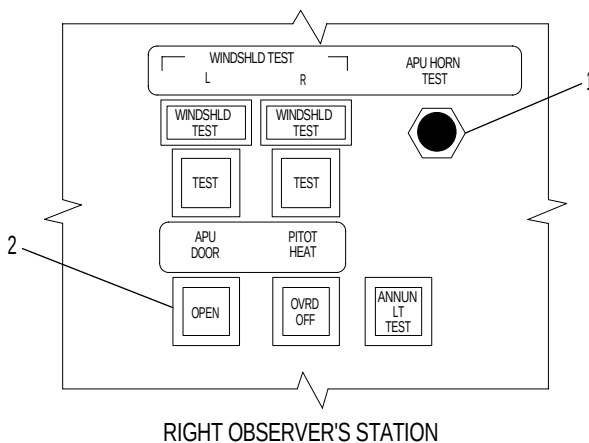
WARNING: Fire warning horn is very loud. Wear ear protection.

NOTE: This panel is described in the Fire Protection chapter.

CAG(IGDS)

LB1-3-0020

APU Maintenance Panel



CAG(IGDS)

LB1-3-0021

1. APU HORN TEST Button

Maintenance use only. Tests APU horn.

2. APU Door Switch - amber

Maintenance use only. When pushed, opens APU door.

OPEN - Switch illuminates amber when APU door is open.

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**APU
Alerts****Chapter APU
Section 40**

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

Red Boxed Alerts (Level 3)

APU FIRE (ENG) - APU fire or air manifold fail conditions in APU compartment.

Amber Boxed Alerts (Level 2)

GEN APU OFF (ELEC) - APU generator is off (manual mode).

Amber Alerts (Level 1)

APU AUTO SHUTDOWN (ENG) - The APU has automatically shut down.

APU DOOR DISAG (ENG) - The APU inlet/exhaust door position is not in the commanded position.

APU FAIL (ENG) - The APU has automatically shut down due to a failure. A restart should not be attempted.

APU FAULT (ENG) - There is a fault in the APU control circuit. APU operation may not be affected.

APU FSO NOT CLSD (FUEL) - The APU fuel shutoff valve did not close following normal or emergency shutdown.

APU FUEL PRES LO (ENG) - APU fuel pressure is low.

APU MAINT DOOR (ENG) - The APU DOOR switch on the upper maintenance panel is in the OPEN position and the APU inlet door is open.

APU STARTER FAULT (MAINT) - An APU starting system fault exists and the APU should not be started. If APU is already running, may continue to operate.

EPGS FAULT (MAINT) - A fault exists in the SMOKE switch circuit, an APU generator fault exists, or a generator (engine or APU) auto reset has been used.

GEN APU OFF (ELEC) - The APU generator has been automatically turned off by the electrical system due to a fault or the APU FIRE handle has been pulled.

SEL APU AIR OFF (AIR) - APU air switch is on and cabin is pressurized.

Cyan Alerts (Level 0)

APU AIR ON - APU bleed air load valve is commanded open and the APU is providing air.

APU AIR/ELEC ON - APU is providing air and electrical power.

APU ON - The APU is running, but not providing air or electrical power.

APU POWER AVAIL - APU electrical power is available, but not powering any buses.

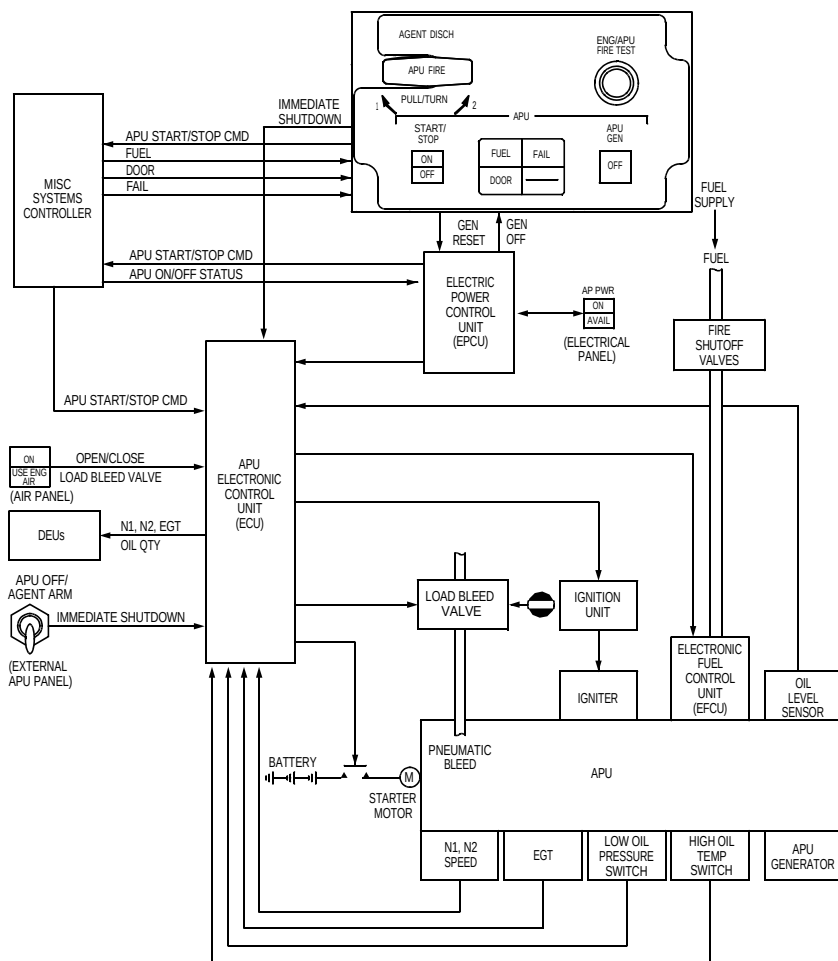
APU POWER ON - APU electrical power is connected to at least one of the three buses.

APU Functional Schematic

Chapter APU

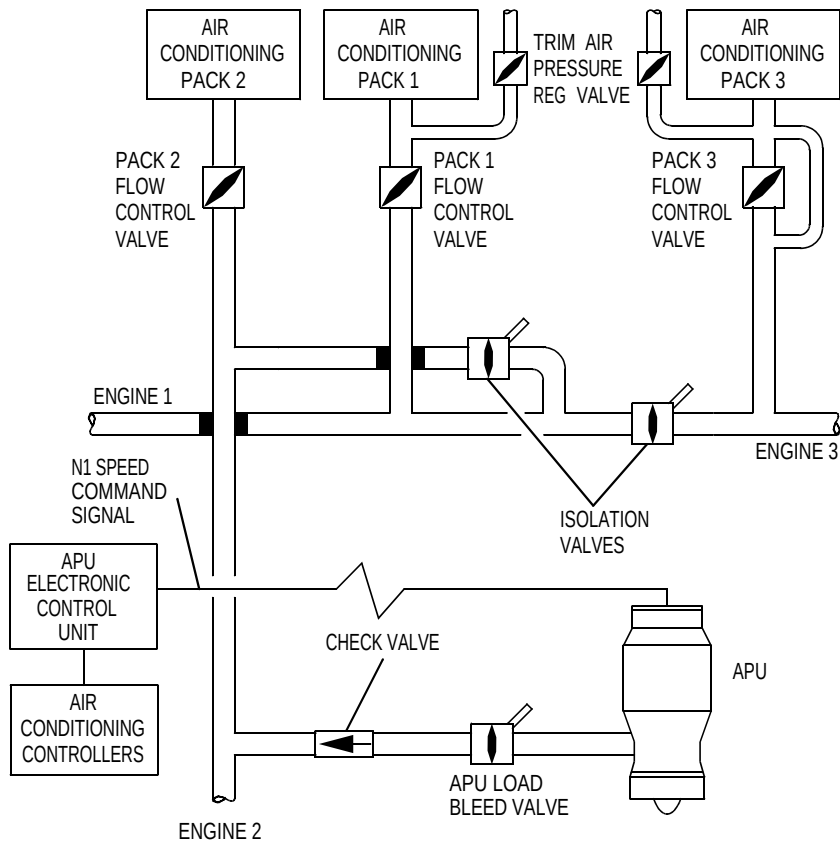
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Components and Subsystems



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Pneumatic Supply



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Automatic Flight

Description and Operation

Chapter Auto

Section 10

Introduction

The purpose of this chapter is to provide an automatic flight system (AFS) general description that can be used to augment the MD-11 computer based training (CBT) program. This chapter must not be used as a procedures guide.

It is recommended that the user become familiar with the FMS chapter in this manual since the AFS system closely interfaces with the FMS.

Complete AFS procedures are described in the MD-11 Flight Crew Operating Manual Operating Procedures.

General

The aircraft is equipped with an Automatic Flight System (AFS) for guidance from takeoff to landing.

The two AFS flight control computers (FCC) receive data from:

- Airframe sensors.
- Air data computers.
- Engine control computers.
- Flight Control Panel (FCP).
- Various other sources.

The FCCs process the data and send:

- Display signals to the EIS CRTs.
- Control signals to the pitch, roll, yaw, and thrust actuators.

The AFS provides the following functions:

- Automatic ILS approach.
- Longitudinal Stability Augmentation System (LSAS).
- Speed envelope limiting (autothrottle and LSAS).
- Dual autopilot (AP), Flight Director (FD) and autothrottle system (ATS)/engine trim control.
- Automatic pitch trim in AP and LSAS.
- Full-time parallel actuation roll Control Wheel Steering (CWS) with roll attitude hold when the AP is not engaged.
- Windshear warning with AP, FD, and ATS compensation.
- Yaw damping/turn coordination.
- Elevator Load Feel (ELF) control.
- Flap limiting (FL).

- Automatic Ground Spoiler (AGS).
- Stall warning with stickshaker and auto slat extend.

For a description of yaw damping, ELF, FL, stall warning, and AGS refer to the Flight Controls chapter.

For a description of altitude alerting refer to the Warning and Alerting chapter.

The AFS consists of the following:

- Flight Control Panel (FCP).
- Two FCCs.
- Duplex ATS system.
- Elevator load feel servos.
- Flap limiter servos.
- Two Control Wheel Steering (CWS) force transducer assemblies.

AFS controls and indicators include the following:

- Flight Control Panel (FCP).
- Two Primary Flight Displays (PFD).
- Two Flight Mode Annunciators (FMA).
- AP disconnect switches.
- AP disengage warnings.
- ATS disconnect switches.
- ATS disengage warnings.
- Go-around (GA) switch.
- Flight director transfer and off switches.
- EIS Control Panels (ECP).

Flight Control Panel (FCP)

The FCP is on the Glareshield Control Panel (GCP). The FCP provides the controls for basic AP/FD mode selection and for crew intervention in FMS SPD, PROF and NAV modes. FCP selector knobs allow select and preselect of reference speeds, altitudes, and headings. These values will appear on the FCP windows and on the PFD.

FCP IAS/MACH, HDG/TRK, and altitude select knobs operate as follows:

- Turn to preselect a value.
- Pull to select a value.
- Push to hold a value.

As an exception, the altitude select knob sets the clearance altitude when FMS PROF mode is coupled.

FCP changeover buttons are used to select the unit of measurement or function shown in the window above each select knob.

Primary Flight Display (PFD)

The PFDs are located on the Captain's and First Officer's instrument panel. The PFDs show aircraft speed, altitude, vertical speed, attitude, heading, and flight modes. The PFD symbology maintains the Basic-T with attitude in the center, airspeed on the left, altitude/vertical speed on the right, and direction of flight on the bottom. In addition, the PFD shows glideslope and localizer deviations, flight modes, bearing info when on emergency power, radio altitude, pitch and roll limits, limit speeds, slip/skid, flight crew or FMS selected speeds, altitudes, heading, failure flags, and warnings.

Normal (on-side) sources are not annunciated. Abnormal (off-side) sources are annunciated near the associated symbology. Refer to the Aircraft General chapter for a complete description of abnormal source annunciation.

Flight Mode Annunciator (FMA)

The FMA annunciations appear across the top of the PFD. The FMA shows what the aircraft is being controlled to, and how the commanded state should be achieved. Each FMA annunciates speed control modes, AP/FD lateral modes, AP/FD vertical modes, and associated control targets.

AP Disconnect Switches

The AP disconnect switches are installed on the outboard horn of the Captain's and First Officer's control wheels. Operation of either switch disconnects the AP.

AP Disengage Warning System

The AP disengage warning system consists of a flashing red AP OFF on the FMA and aural warning tone. After this warning, pushing either AP disconnect switch changes the AP OFF to a steady white FMA (amber if the disconnect was the result of a failure and no AP is available). The AP OFF warning light is reset if the AP is re-engaged. The aural tone is reset when either of the disconnect switches are pushed after at least one cycle of the tone is complete or when the AP is re-engaged.

ATS Disconnect Switches

The ATS disconnect switches are on throttle levers 1 and 3. Operation of either switch disconnects the ATS.

ATS Disengage Warning System

The ATS disengage warning system consists of a flashing red ATS OFF on the FMA. All disconnects, except those due to landing rollout thrust reversal, actuate the warning. Pushing either ATS disconnect switch changes the flashing red ATS OFF to a steady white (or amber if ATS not available). The warning is reset if the ATS is reengaged.

Go-Around (GA) Switch

The GA switch is on the center throttle. Pushing the switch in flight below 2,500 feet AGL with flaps down or slats extended engages the FD go-around mode. If the AP is on, it will follow the FD commands. If a windshear is detected while on approach, pushing this switch engages AP/FD windshear guidance.

FLT DIR and FLT DIR OFF Switches

The FLT DIR and the FLT DIR OFF switches are on the Captain's and First Officer's source input select panels. The FLT DIR switches allow FD1 commands to appear on the First Officer's PFD or FD2 commands to appear on the Captain's PFD. The FLT DIR OFF switches allow the FDs to be selected off.

Automatic Flight System (AFS) Panel

The AFS control panel, on the forward overhead panel, is used for manual inputs to the flap limiter and elevator feel. It is also used to turn on or off yaw damper and LSAS control channels. Refer to the Flight Controls chapter for a description of yaw damper, LSAS, flap limiter, elevator feel, and the AFS control panel.

EIS Control Panels (ECP)

The ECPs are on the GCP, one at each outboard end. These panels control the operation of the Captain's and First Officer's PFD and navigation displays (ND).

Roll Control Wheel Steering (CWS)

The AFS roll CWS provides lateral stability through electronic control of a single inboard aileron when the AP is not engaged.

With no force on the control wheel, the aircraft holds the current roll attitude. Forces on the control wheel command an aircraft roll rate proportional to the applied force, so that when the force is removed from the control wheel, the aircraft holds the new roll attitude.

Attempts to achieve bank angles in excess of 30 degrees require increasing pilot override force on the control wheel proportional to the amount of the bank above 30 degrees. If the pilot releases that override force, the aircraft will immediately roll back to, and hold 30 degrees of bank.

CWS is available when either FCC is operational and at least one yaw damper channel is active.

Pulling down both of the AFS OVRD OFF switches on the FCP disengages the roll CWS (as well as the AP and ATS systems).

Autopilot/Flight Director

Flight Director Engage/Disengage

The FD provides visual commands to fly the aircraft. The flight crew can manually follow the commands or monitor the AP as it follows the commands.

Both FDs are always engaged unless selected off with the respective FLT DIR OFF switch.

On the ground prior to takeoff, the FD takeoff mode engages automatically if either FD is engaged. When the FDs are engaged, FD1 pitch and roll commands are displayed on the Captain's PFD. FD2 pitch and roll commands are shown on the First Officer's PFD.

Turning an FD off removes the command bars from the associated PFD, and resets the mode (unless AP is on).

If an FD is turned off, then back on, the command bars will appear and the FD will acquire the current mode of the AP or other FD.

If both APs and both FDs are off, turning on an FD will cause the FD to command:

- A roll to wings level.
- Heading hold.
- Vertical speed hold if climb/descent is more than 300 fpm or altitude hold if climb/descent is less than 300 fpm.

Autopilot Engagement

Pushing the AUTO FLIGHT switch on the FCP controls the AP channels 1 and 2 as follows:

1. If neither AP channel (1 or 2) is engaged, the armed channel will engage.
2. After first AP engagement, each push transfers the AP channel between AP1 and AP2. The channel that is not engaged will be armed (unless inop).
3. If one of the AP channels is engaged and the other channel is inoperative, no transfer will occur.
4. The engaged AP channel will appear on the PFD below the FMA (AP1 or AP2).

The armed status alternates between the 2 AP channels to ensure equal use as follows:

- After power application with neither AP engaged, the first channel to be powered becomes the armed channel.
- If one AP is engaged and the other is not, the disengaged channel is armed.
- The armed status will alternate each time the AP is disengaged.
- A failed channel will not arm.

Pushing the AUTO FLIGHT switch results in AP operation as follows:

- AP engagement is inhibited on the ground and below 100 feet AGL. An engage attempt will result in an AP disconnect warning.
- AP engagement above 100 feet engages the AP takeoff mode if an FD is in the takeoff mode.
- For AP engagement with both FDs selected off, the AP will roll the aircraft to wings level and hold the wings level heading. The altitude hold mode is also engaged if the rate of climb/descent is below 300fpm; otherwise the vertical speed mode is engaged and the AP holds either the vertical speed or the pitch limit (+25 degrees and -10 degrees).

If the AP is engaged with either or both FDs on, the AP will:

- Engage in the existing FD mode and maneuver the aircraft within the attitude limit to acquire and track the FD mode if the engaged FD mode is heading/track select, level change speed select, pitch TO/GA, FMS NAV, or FMS PROF.
- Engage in the existing FD mode if the engaged mode is altitude capture or glideslope engage. If the pitch command error exceeds limits, the AP will synchronize the AP/FD to the existing vertical speed flight path angle and engage the V/S-FPA mode.
- Engage in the existing FD mode and synchronize the AP/FD reference to existing conditions if the engaged FD mode is V/S-FPA, altitude hold, or level change speed on pitch hold.
- Roll the aircraft toward wings level then engage the AP heading/track hold mode when the bank angle decreases to less than 3 degrees if the engaged FD mode is heading track hold or roll TO/GA. If the AP is engaged when the bank angle is less than 3 degrees, the AP will synchronize the AP/FD reference to the existing heading/track angle and engage the heading/ track hold mode.
- Engage in the localizer mode if the engaged mode is LOC engage and the FD roll attitude command error is less than 3 degrees. If the FD roll attitude command exceeds 3 degrees, the AP will roll the aircraft towards wings level, then engage the AP heading/track hold mode when the bank angle lessens to less than 3 degrees.

Autopilot Disconnects

The primary method of disconnecting the APs is by pushing either pilot's disconnect button on the respective control wheel. AFS OVRD OFF switches are provided on the FCP to disconnect the AP/AT if the normal disconnect switches fail. All AP disconnects, intentional or unintentional, will result in an AP OFF warning.

RCWS and certain other FCC functions are inhibited during an AP disconnect button push.

AP disconnects will also occur as follows:

- Excessive force is applied to the controls.

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- Control wheel trim switches or long trim handles are actuated (except single or dual autoland engaged).
 - During cruise flight when a bank of 60 degrees is exceeded or roll rate exceeds 10 degrees per second or there is excessive acceleration G forces in combination with pitch rates.
 - Associated LSAS failed or off.
 - Altitude below 100 feet AGL when any mode other than autoland or GA is engaged.
 - AFS failures.
 - Any control surface commanded position not in agreement with actual position.
-

Autopilot/Flight Director Operations

General

AP/FD pitch modes are:

- FCP vertical speed/altitude hold (basic pitch mode).
- FCP flight path angle control.
- FCP speed select and hold (flight level change).
- FMS computed speed control.
- FMS vertical flight profile control.

AP/FD roll modes are:

- FCP magnetic heading select/hold (basic roll mode).
- FCP magnetic track select/hold.
- FMS lateral navigation.

AP/FD combined pitch and roll modes are:

- FMS non-precision approach.
- FD and AP ILS approach.
- AP automatic landing.
- Windshear flight path angle and stickshaker guidance.

AP/FD FCP Vertical Speed/Flight Path Angle

The vertical speed mode will engage when V/S is selected on the FCP after one of the following flight crew actions:

- AP engaged and the existing vertical speed is greater than 300 fpm. In this case the V/S-FPA display window on the FCP displays the existing vertical speed and the AP controls to that vertical speed.
- One or both FDs are re-engaged with the AP off and the existing vertical speed is more than 300 fpm.

- The pitch thumbwheel on the FCP is rotated to select the desired vertical speed in the V/S-FPA display window except when the AP is engaged in land mode, dual FD approach mode below 1500 feet, or takeoff/GA mode below 400 feet.
- The V/S-FPA changeover button on the FCP is pushed to V/S from FPA while operating in the flight path angle mode. The vertical speed reference will be the vertical equivalent to the displayed flight path angle at the time of FPA to V/S changeover selection.

Engaging the AP/FD vertical speed mode sets the ATS to control speed. The FMA annunciates V/S in the vertical control window and THRUST in the speed control window.

During an altitude intercept, if the aircraft is in the altitude capture phase of the intercept (FMA annunciates ALT HOLD), manually adjusting the vertical speed wheel (V/S) will cancel the altitude capture. Dashes in the V/S-FPA window will be replaced by the existing V/S, and the V/S may then be adjusted if desired. The capture mode will not re-engage until the V/S wheel has come to rest for two seconds. Repeated adjustments of the wheel at intervals of less than two seconds will defeat the capture function. The target altitude will continue to be displayed, but the autopilot may no longer be able to intercept it.

AP/FD Altitude Control

Altitude control consists of a capture mode and a hold mode. The AFS controls altitude to the FCP altitude display window value automatically whenever the FMS PROF is not engaged.

When the FMS PROF mode is engaged, altitude is controlled by the FMS altitude targets in PROF climb or the FMS steering commands in PROF descent. The final altitude capture is always the FCP selected value.

The capture mode provides a transition phase between any other cruise mode and the FCP-selected, baro-corrected altitude or FMS PROF constraint altitude.

Capture is always armed except when in takeoff or go-around modes below 400-feet RA and in the glideslope engage mode.

Capture will engage automatically when a 0.05-g circular path to the selected altitude is intercepted. The pilot may intervene with V/S control at any time during the altitude capture maneuver, if it is deemed necessary.

If the altitude display window setting on the FCP is changed when the aircraft is within 250 feet of target altitude, a 0.09-g circular path will be commanded when:

- The aircraft is within the 0.05-g path with a high rate of climb or
- The aircraft is past the 0.05-g path with the correct rate of climb.

Changing the altitude display window setting on the FCP while in the altitude capture phase, cancels the capture mode, triggers the mode in control prior to capture, and rearms altitude capture.

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In altitude capture and hold modes, the ATS controls to the FCP-selected speed or FMS computed speed (FMS SPD engaged). The speed control window on the FMA will show THRUST and the altitude control window on the FMA will display HOLD.

The altitude hold mode may be engaged automatically from the altitude capture or vertical speed/flight path angle mode when the AP/FD is initially engaged and the rate is less than 300 fpm and selected altitude error is less than 60 feet.

The altitude hold mode may be engaged manually by pushing the altitude select knob on the FCP. Subsequent knob rotation selects the next increment for the existing flight level. The altitude control and speed control windows on the FMA show the same legends and colors as in altitude capture.

AP/FD Speed Select/Hold (Flight Level Change)

The AP/FD will capture and hold the FMA airspeed/Mach during climb/descent when the climb/descent is commanded by pulling the FCP altitude select knob.

The commanded speed will be the FMS speed if the FMS SPD is engaged.

The commanded speed will be the FCP selected speed if the FMS SPD is not engaged.

The commanded speed may be changed manually with the IAS/MACH select knob on the FCP. Rotating the IAS/MACH select knob preselects a new speed reference. Pulling the IAS/MACH select knob selects the FCP speed. Pushing the IAS/MACH select knob selects the existing speed.

Rotating the IAS/MACH select knob on the FCP or pushing the FMS SPD switch on the FCP changes the commanded speed reference only. AP/FD control modes are not affected. An FMS speed reference failure will change the speed reference to existing aircraft speed, change the FMA reference number color to white and flash the speed mode legends 5 times.

Compatible control of the AP/FD and ATS modes is computed by the AFS when FMS PROF is not engaged.

When the aircraft passes through 26,000 feet in climbout, the speed control will automatically change from IAS to the equivalent Mach if the desired Mach was not preselected.

If the desired Mach number was preselected, the reference will change automatically to Mach at the preselected Mach number. Operation is the same for the Mach-to-IAS changeover in descent.

AP/FD Heading/Track Select/Hold

Heading or track select is engaged by pulling the HDG/TRK select knob on the FCP. If the HDG/TRK display window is blank when the knob is pulled, the current heading or track is selected and the heading select or track select mode engages.

The AP/FD captures the selected heading by turning the aircraft or commanding a bank in the direction the HDG/TRK select knob was turned.

Additional changes may be made while still in the turn. After the aircraft stabilizes on the selected heading or track, control will transition to heading or track hold. The roll control window on the FMA shows HEADING or TRACK and displays the digital heading or track.

Heading or track angle hold is engaged by pushing the HDG/TRK select knob on the FCP. If the aircraft is in a bank at the time of hold selection, the aircraft will roll wings level and the reference heading or track will be the existing value at the time the HDG/TRK knob was pushed. The HDG/TRK display window on the FCP will display the held reference value.

The commanded bank angle limit will be the bank angle selected with the bank angle limit selector (5 to 25 degrees) and the FMS computed bank angle limit. If the bank limit is selected to AUTO, the limit value will be the least of a value varying linearly from 5 degrees at 340 KIAS to 25 degrees at 210 knots KIAS and the 1.3g buffet limit. At 1.3 V stall, the limit is further constrained to a maximum roll angle of 15 degrees. The 1.3g buffet and the 1.3 Vstall speed protection is contingent on FMS availability.

If the bank angle limit selector is set to the AUTO position, the bank angle limit value will vary as follows:

- Between 15 degrees and 25 degrees from zero Mach to Mach 0.17.
- Limited to 25 degrees between Mach 0.17 and Mach 0.55.
- Reduced linearly to 20 degrees at Mach 0.80, 10 degrees at Mach 0.87, and wings level at Mach 0.93.

If the FMS is not available, the AFS provides the Mach bank angle limit schedule. In this case, the Vmin protection is lost. The bank angle limit selector is overridden in the NAV, localizer, or TO/GA modes (computed limits apply).

AP/FD Approach

The AFS provides automatic flying of precision approaches to ILS category I, II, IIIA and IIIB weather minimums and manual guidance (flight director) for flying precision approaches to ILS category I weather minimums. Non-precision approaches may be made either manually or automatically by coupling the FMS NAV and PROF modes or using the AFS track and flight path angle (FPA) modes.

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The approach functions include localizer capture, localizer track, glideslope capture, and glideslope track. The AFS approach and land modes are armed by pushing the APPR/LAND switch on the FCP when the AP or FD is in any lateral or vertical control mode except take-off or go-around and there is a valid ILS frequency.

The localizer may be intercepted at angles up to 90 degrees, but high IAS and/or intercept angles greater than 30-40 degrees may result in overshoot.

After the APPR/LAND switch has been pushed, LAND ARMED is displayed above the FMA roll control window. At localizer capture LOC is annunciated in the FMA roll control window, LAND ARMED transfers to above the FMA altitude control window and the PFD bank angle limit becomes 30 degrees. If the AP is engaged it will automatically capture and track the localizer. If flying FD, the FD will supply commands to manually capture and track the localizer.

When the aircraft is stabilized on the localizer (localizer track), the bank angle limit will reduce to 10 degrees. At 200 feet the bank angle will be further reduced to 5 degrees.

As the aircraft intercepts the glideslope, the glideslope deviation diamond will begin to move. At glideslope capture, G/S is annunciated in the FMA altitude control window under the LAND ARMED annunciation. If flying AP, the aircraft will capture and track the glideslope. If flying FD, the FD will supply commands to manually capture and track the glideslope. During glideslope capture the pitch attitude is limited to +15 and -5 degrees. Glideslope capture is inhibited if course error is more than 80 degrees. Selection of any other pitch or roll mode prior to land engage will cancel the land armed mode.

During ILS approach, the ATS speed reference is the FMS approach speed if FMS speed is engaged. If FMS speed is not engaged, the reference is the IAS/MACH display window setting in the FCP.

VOR approaches may be flown in the NAV and PROF modes by selecting the appropriate VOR database approach and engaging NAV for lateral guidance and PROF for vertical guidance or by following raw data with the use of appropriate FCP controls. VOR approaches may be flown in NAV, TRACK, HEADING or VOR.

NOTE: PROF down to the MDA is not authorized.

FD Only ILS Operation

The LOC and G/S annunciations will be white. When the glideslope is captured, G/S APPROACH ONLY will be annunciated in the FMA altitude control window and LAND ARMED will be removed.

Failures in any FD mode will result in removal of the command bar (for that channel and axis only) on the affected PFD.

For single FCC operation in modes where dual FD operation is required (takeoff, go-around, ILS category II approach), the AFS provides continuous FD command comparison monitoring of the two channels within the FCC. A comparison failure within the FCC will result in the removal of the command bar from both PFDs for the affected axis only. Once removed due to a failure, the FD command bars will not be displayed again until the dual mode is cancelled.

Below 1500 feet RA, dual FD approach mode can only be exited by pushing the go-around button.

Autoland

Autoland adds align, flare, nose lowering, and rollout modes to the normal approach modes (localizer capture, localizer track, glideslope capture, glideslope track).

The SINGLE LAND and NO AUTOLAND alerts indicate the land availability of the aircraft. SINGLE LAND indicates that a CAT II approach may be continued automatically. NO AUTOLAND indicates that there is insufficient equipment redundancy to perform an automatic landing.

Automatic landings have been demonstrated using a reference approach speed of $1.3V_s + 5$ kts. under the following wind conditions:

- Headwinds to 25 kts.
- Tailwinds to 10 kts.
- Crosswinds to 15 kts.

When available, DUAL LAND mode will automatically engage when the aircraft is in approach, tracking both the localizer and glideslope, and has been below 1500 feet RA for ten seconds. If the requirements for DUAL LAND are not met but SINGLE LAND is available, SINGLE LAND will engage between 1500 feet (for ten seconds) and 400 feet RA.

If the equipment redundancy requirements for DUAL LAND and SINGLE LAND are not met, or if a land mode is not engaged prior to 400 feet RA, the AFS will revert to APPROACH ONLY. In the APPROACH ONLY mode, the aircraft will continue to automatically track the localizer and glideslope but the autoland function will not be available. The AP must be disengaged prior to 100 feet and a manual landing performed.

When the aircraft is tracking localizer and glideslope in an FD approach, engaging the AP between ten seconds after descending below 1500 feet (approximately 1360 feet) and prior to five seconds before 400 feet (approximately 460 feet) will also engage DUAL LAND or SINGLE LAND mode depending on equipment redundancy.

The ILS receivers are inhibited from further tuning when the GS or LOC modes are captured.

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When the aircraft is below 1500 feet and is tracking both the localizer and glideslope, the electrical busses will be split to provide complete electrical isolation between AP systems. If the busses do not split, DUAL LAND will not be available.

When a land mode is engaged, all other modes except go-around are inhibited.

Prior to land engagement the aircraft is controlled by a single channel of the engaged AP. The second channel of the engaged AP and both channels of the second AP are on stand-by.

At DUAL LAND engagement the three AP channels on stand-by become operational and their associated control surface actuators are engaged. Also at this time, the upper and lower rudder actuators engage in the parallel mode. The FMA roll and altitude annunciations turn green and LOC, G/S DUAL LAND is displayed. The AP annunciation below the FMA which annunciates AP1 or AP2 in all other modes, switches to AP.

Reversion to SINGLE LAND may occur if:

- The second AP is invalid.
- The autothrottles are invalid or not engaged.
- The electrical busses are not split.
- The sensor redundancy required for DUAL LAND is not achieved.

At SINGLE LAND engagement the FMA roll and altitude annunciations will remain white and LOC, G/S SINGLE LAND is displayed. The AP annunciation below the FMA displays AP1, AP2 or AP. If AP1 or AP2 is displayed, the two channels of the engaged AP are operational in addition to parallel engagement of one rudder. If AP is displayed, both APs are engaged and all surface actuators are controlled as in a DUAL LAND.

A reversion from DUAL LAND to SINGLE LAND is indicated by the FMA altitude control window annunciating G/S SINGLE LAND in white accompanied by the roll control window annunciation turning white. Also, the altitude annunciations flash five times to alert the pilot to the reversion. DUAL LAND reversions are inhibited below 100 feet.

A reversion from SINGLE LAND to APPROACH ONLY is indicated by the FMA altitude control window annunciating G/S APPROACH ONLY and flashing five times.

When descending through 150 feet RA in either SINGLE or DUAL LAND, the FMA roll control window annunciates ALIGN. If a crosswind is present, a side slip runway alignment maneuver is initiated to remove any existing crab angle. The crab angle is removed by the rudder and the up-wind wing is lowered to maintain the localizer center.

At about 50 feet, FLARE mode is initiated. The AP commands an exponential flare path and the throttles retard if engaged. The FMA annunciates FLARE DUAL LAND or FLARE SINGLE LAND in the altitude control window and RETARD in the speed control window.

At touchdown, main wheel spin-up is sensed and ROLLOUT mode is initiated. The auto ground spoilers partially extend (full extension at nose gear compression). The FMA annunciates ROLLOUT in both the roll and altitude control windows. Pitch is reduced from that required for flare to the attitude required for nose wheel touchdown. The localizer centerline is maintained throughout rollout with rudders.

At initiation of reverse thrust, the ATS disengages.

The AP should be disconnected at the completion of ground rollout before attempting to turn off the runway.

An approach terminated by leveling off at the selected MDA without entering a land mode can be accomplished by setting the altitude in the FCP altitude window to the MDA baro altitude displayed on the PFD.

AP/FD Go-Around

Pushing the GA switch on the center throttle during approach conditions (RA less than 2500 ft. and flaps or slats extended) causes the following:

- Aircraft will exit any mode it is in.
- FDs pop up and go to go-around mode even if selected off.
- If AP on, AP will follow FD commands.
- AP/FD rolls wings level if bank more than 3 degrees (current heading held if bank less than 3 degrees).
- Bank angle limited to 10 degrees.
- ATS goes to go-around limits.
- Parallel rudder active (in case of engine failure) or LOC modes are captured.
- Reference speed and PITCH appear on FMA.
- GO-AROUND appears in altitude window.
- Windshear pitch guidance provided if windshear warning active.
WINDSHEAR will appear on the FMA.

AP GA remains engaged after a momentary touchdown if GA is selected before main gear spinup. Selection after spinup disengages the AP. FD GA can be engaged from below 2500 feet RA to 20 seconds after nose gear compression.

FD Takeoff

The FD takeoff mode is automatically established on the ground if:

- On-ground conditions exist for more than 20 seconds and,

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- The FMS V2 speed has been manually confirmed, and
- Either or both FDs are on and working.

The pitch command bar on the PFD is removed until V2 is manually confirmed on the FMS TAKEOFF page.

After touchdown during landing roll, FD takeoff mode is inhibited until the AP and ATS are disengaged. The AUTO FLIGHT switch will not engage the AP below 100 feet if the FD is in takeoff. If autoflight is attempted below 100 feet, the AP OFF red box flashes until the AP disconnect switch is pushed.

Prior to takeoff, the Vspeeds are entered on the MCDU and verified by the pilot for display on the PFD. During takeoff roll through rotation, the FD commands wings level and the FD pitch cues will be about 0 degrees below 80 knots, will rise to about 6 degrees at 80 knots, and then rise to about 15 degrees at rotation speed.

If speed at engine out (EO) is below V2, the target speed will be V2. If speed at EO is between V2 and V2 + 10, the target speed will be that speed. If the speed at time of EO is more than V2 + 10, the target speed will be V2 + 10.

If not already engaged, the FD will engage automatically after liftoff and provide pitch windshear guidance if windshear warning becomes active.

The AP takeoff and parallel rudder modes are engaged above 100 feet by pushing the AUTO FLIGHT switch.

Lateral takeoff control will retain the FD heading reference if the aircraft is on heading and wings level. If the aircraft is not on heading with wings level, a wings level command will be initiated.

Selecting any other roll mode during takeoff will exit the AP roll takeoff and parallel rudder modes without exiting pitch takeoff.

Pitch takeoff exit (if roll axis still in takeoff) sets the roll mode to heading hold at the roll takeoff reference. AP pitch takeoff may be cancelled (above 400 feet) by selecting any other pitch mode. AP pitch takeoff will be cancelled automatically at altitude capture.

Parallel rudder operation is an engaged AP mode in which the FCC controls the rudder to counter asymmetric thrust or to align the aircraft at 150 AGL during autoland. This mode engages automatically when the AP is on during takeoff or go-around, and during DUAL LAND, or SINGLE LAND. During this mode the pilot can feel the rudder motion in the rudder pedals and the bank angle limiter on the PFD indicates 10 degrees or less. This mode stops when another lateral mode is selected (heading select, heading hold, or NAV) during takeoff or go-around, or when the aircraft configuration is changed to clean.

FMS Coupled Operations

General

The FMS lateral navigation (NAV), vertical profile control (PROF), optimum speed control, (FMS SPD), and nonprecision approach (NAV and PROF) functions are coupled to the AP/FD through targets or steering commands.

The FMS also provides AP/FD TO/GA speed references, variable bank angle limit control, Vmin speed protection, and thrust limiting.

Normally, both FCCs will select the FMC on the same side as the FCC in control. Both FDs will control to the same steering command.

If the other FCC is selected by pushing the AUTO FLIGHT switch, both FCCs will select and synchronize to the on-side FMC. The FMA NAV and AP legends (1 or 2) will show the same side selection.

Failure of the selected FMC while the AFS is coupled will result in a reversion to the equivalent FCP mode (AFS basic control mode if no equivalent FCP mode exists). The new FMA mode will flash five times to warn the pilot of the change. The FCCs then select the functional FMC and the desired FMS mode can be reengaged by the pilot on the FCP (NAV, PROF, FMS SPD). When the FCCs are controlling to commands from the on-side FMC, the FCCs do not select the off-side FMC if the FMC cancels a mode. In this case, only the affected FMS mode will be cancelled and the AFS will revert to its basic mode. The FMA mode legend will then flash five times. The pilot must push the AUTO FLIGHT switch to select the other FMC. The pilot must then reengage the desired FMS mode on the FCP.

If only one FMC is functional prior to coupling to the AFS, the FCCs will both select the functional FMC. The FMA NAV and AP legend numbers (1 or 2) will not be the same if the functional FMC is not on the same side as the selected FCC.

If both FMCs are functioning and in different FMS/AFS control modes (FMC independent mode operation) when the pilot pushes the AUTO FLIGHT switch, the FCC will uncouple from the FMS and revert to the basic AFS mode. The FMA mode legend will flash 5 times. The desired FMS control mode must then be reengaged by the pilot.

FMS Speed Control

FMS SPD is selected as the AFS reference speed by pushing the FMS SPD switch. FMS SPD may be engaged independent of PROF engagement. Compatible control of the AP/FD and ATS modes is computed by the AFS when PROF is not engaged. FMS SPD switch engagement is cancelled when an FCP speed is selected.

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Engaging the AP/FD go-around mode cancels the FMS SPD switch and selects current airspeed or FMS VMIN GA reference (whichever is higher).

IAS to MACH and MACH to IAS changeover is computed by the FMS when the FMS SPD mode is engaged.

The FMS speed edit occurs if a speed is preselected and the FMS SPD switch is pushed within ten seconds. The IAS/MACH preselect window on the FCP will be blank.

FMS Vertical Profile Control

FMS vertical profile mode control is engaged by pushing the PROF switch. When the FMS PROF mode is engaged, the AP/FD responds to the requirements of the preplanned vertical profile.

The FCP altitude display window setting is always the absolute ceiling or floor altitude in all AFS modes including FMS PROF except during engine out when the altitude display window may be violated during driftdown.

Compatible control of the AP/FD and ATS modes is computed by the FMS when PROF is engaged.

PROF mode will not engage if any of the following are true:

- Both autopilot and flight director are disengaged.
- In DUAL LAND or SINGLE LAND.
- Below 400 feet radio altitude.

PROF can be armed on the ground. If armed, PROF will engage automatically at 400 ft RA.

PROF mode disengages if any of the following are true:

- The pitch wheel is rotated to engage the V/S-FPA mode.
- The altitude knob is pushed or pulled.
- Go-around or glideslope becomes the active pitch mode.
- Radio altitude becomes less than 100 feet.
- Windshear detection or guidance mode becomes active.
- Autothrottle Speed Protection becomes active.

FMS Lateral Navigation

Pushing the NAV switch on the FCP arms the AFS/FMS NAV mode. NAV ARMED is then displayed on the FMA.

NAV ARMED is reset by:

- Pushing the FCP HDG/TRK select knob to select the existing heading.
- Selecting APPR/LAND.
- Selecting the optional VOR or LOC ONLY modes.

When the FMS NAV capture criteria are satisfied, the roll control window on the FMA changes to NAV1 or NAV2 and the AFS captures and controls to the FMS lateral flight plan in response to steering commands from the selected FMC.

The FMS steering command is limited to an optimum maximum bank angle which also provides a stall speed and initial buffet bank angle limit. The FMS bank limit is used by the FCC to provide bank angle limiting. Bank angle limiting is displayed on the PFD attitude sphere.

If NAV is not engaged, and the NAV switch is pushed (aircraft within NAV capture threshold) the FMS/AFS will momentarily cycle through the NAV ARMED phase to verify the capture criteria. It will then annunciate NAV1 or NAV2 and control to the FMS lateral flight plan.

NAV mode may be armed on ground once all engines are started. NAV can be cancelled on ground by pushing the heading select knob. NAV guidance will be available in FD at 100 feet AGL. If NAV was armed on the ground, NAV guidance will auto engage at 100 feet in FD mode. In air below 400 feet, NAV can be disengaged by pushing the heading select knob or pushing the GA switch. Pushing GA switch reengages parallel rudder if the AP is engaged. The earliest altitude at which AP NAV can be coupled is 400 feet. Below 400 feet, when NAV is armed or engaged, the AP cannot be engaged unless NAV is exited. If the pilot attempts to engage the AP while NAV is armed/engaged, an AP disconnect warning will occur (AP OFF box flashes red and a CAWS warning sounds). To clear the warning, the AP disconnect switch must be pushed or the AP engaged above 400 feet. Below 400 feet, if the AP is engaged, NAV cannot be engaged until above 400 feet. Parallel rudder is only available with AP engaged. If NAV is armed on the ground, parallel rudder is not available unless NAV is cancelled.

Engaging another lateral control mode cancels the NAV mode. The NAV mode may also be disengaged by the FMS.

FMS VOR Approach Mode

VOR control is provided by the FMC to FCC NAV steering command. The mode is requested from the NAV radio page on the MCDU by entering a VOR frequency and the desired VOR radial to the station.

Upon receiving the VOR mode request, the AFS is armed to capture the VOR radial. VOR ARMED is then annunciated on the FMA.

VOR ARMED is reset by:

- Clearing the VOR course entered on the MCDU.
- Pushing the HDG/TRK select knob on the FCP to select the existing heading.
- Selecting APPR/LAND.
- Selecting NAV.
- Selecting the LOC ONLY mode

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When the FMS VOR capture criteria are satisfied, the roll control window on the FMA changes to VOR1 or VOR2 to indicate which VHF NAV receiver is selected by the FMC. The AFS then captures and controls to the VOR radial in response to steering commands from the selected FMC.

Over the VOR station, control is to the selected VOR course only and the FMA will show VOR1 or VOR2 CRS.

The FMS steering command is limited to an optimum maximum bank angle which also provides a stall speed and initial buffet bank angle limit. The FMS bank angle limit is used by the FCC to provide bank angle limiting.

If VOR is not engaged and the VOR is requested (if aircraft within VOR capture threshold), the FMS/AFS will momentarily cycle through the VOR ARMED phase to verify the capture criteria. It will then annunciate VOR1 or VOR2 and control to the selected VOR RADIAL.

The flight crew can select and manually track a VOR radial at any time. The FMS will track a VOR radial only during FMS VOR approach mode. This mode is inhibited as follows:

- On the ground.
- In the land mode.
- In AP roll TO/GA modes below 400 ft.
- Above 18,000 feet. In this case, the FMS tracks FMS-calculated great circle routes between waypoints.

Engaging another lateral control mode cancels the VOR approach mode. The VOR approach mode may also be disengaged by the FMS or may be deselected on the MCDU by clearing the selected course (radial to the station) or selecting another VOR frequency.

FMS ILS Localizer Only

ILS localizer control with disabled glideslope control is provided.

The mode is requested from the NAV radio page on the MCDU by entering the ILS frequency and runway heading and selecting the LOC ONLY prompt.

Upon receiving the LOC ONLY mode request, the AFS is armed to capture the localizer. LOC ARMED is annunciated on the FMA.

LOC ARMED is reset by:

- Pushing the HDG/TRK select knob on the FCP to select the existing heading.
- Selecting APPR/LAND.
- Selecting NAV.
- Selecting the optional VOR mode.

When the FCC localizer capture criteria are satisfied, the roll control window on the FMA changes to LOC ONLY and the AFS captures and controls to the ILS localizer using the same FCC control laws as when APPR/LAND is selected. Align and rollout submodes are not available.

Engaging another lateral control mode cancels the LOC ONLY mode. However, once LOC ONLY has been annunciated in the FMA, de-selecting the LOC ONLY prompt on the MCDU will no longer cancel LOC ONLY. This method can only be used to cancel the LOC ARMED status.

Automatic Pitch Trim

One automatic pitch trim (APT) channel is contained in each FCC. Only one of these channels is operational at a time. In land modes or LSAS, the second channel auto engages if the first channel fails.

The horizontal stabilizer is automatically positioned to off-load any steady state elevator deflections. The trim rate is varied with airspeed to provide best performance for all flight conditions.

APT is available during LSAS operation and in all AP modes except flare.

APT is inhibited if:

- Control column force more than 2 lb.
- Bank angle more than 5 degrees.
- LSAS is in speed protection.

Nose-up trim is delayed for 10 seconds when the AP TO and GA modes are initially engaged.

Autothrottle System (ATS) and Engine Trim

General

The ATS automatically positions the throttles to maintain engine thrust required for the mode selected. The engine thrust trim system will maintain the engines at a common thrust setting to eliminate the need for throttle adjustments. The trim system can operate during manual and ATS operation. It is engaged any time two or more engines are operating above an N1 threshold.

Each FCC contains one ATS control channel that drives a separate section of a dual actuator. This provides two channels of control with fail passive monitoring.

The ATS is designed for full flight envelope operation. It can be engaged on the ground. It can remain engaged until it is automatically disengaged when reverse thrust is applied during landing rollout.

The ATS operates in the following modes:

IAS Hold - Provides control of throttles to maintain the current airspeed.

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IAS Select - Provides control of throttles to acquire and maintain a selected reference speed.

Mach Hold - Provides control of throttles to maintain the current MACH number.

Mach Select - Provides control of throttles to acquire and maintain a selected reference Mach number.

Thrust Limit/Target - Provides control of throttles to acquire and maintain thrust at the thrust limit/target.

Retard - Provides control of throttles to reduce thrust at the appropriate radio altitude for landing.

Clamp - Inhibits ATS control during takeoff at approximately 80 knots without causing disengagement of the ATS. Full manual throttle is available during this mode.

ATS Engage

The ATS is engaged when the AUTO FLIGHT switch on the FCP is pushed. The ATS will also engage when the PROF switch is pushed. Both ATS channels will engage if they are operational.

The ATS engages automatically to provide high speed or low speed protection if the aircraft speed exceeds the Vmax/Vmin limits.

ATS Disengage

The ATS will engage with AFS engagement in most cases. The ATS may be disengaged by any of the following:

- Pushing either throttle 1 or 3 ATS disconnect switches.
- Placing any throttle in reverse thrust.
- System failure (may result in single or dual channel disengagement depending on the fault).
- Pushing down the AFS OVRD OFF switches on the FCP.

Annunciation of ATS disengagement is provided on the FMA. A disengage warning is provided for all cases except when the disengagement is due to reverse thrust operation.

The warning consists of a flashing red ATS OFF display. The display is reset by ATS engagement or by pushing the ATS disconnect switches.

If reset by reengagement, the ATS OFF display disappears. If reset by an ATS disconnect switch the flashing stops and the ATS OFF display changes color to white if ATS reengagement is possible. The display will turn amber if a condition prevents further use of the system.

ATS Clamp Mode

In CLAMP mode the ATS is engaged, but the ATS servos cannot move the throttles. CLAMP mode is enabled in the following conditions:

- Takeoff mode on the ground and two or more engine thrust commands are less than 70 percent of the maximum takeoff setting.
- Takeoff mode is engaged and IAS exceeds 80 knots.
- In flight when command input places the throttles in flight idle and further thrust reduction is required.
- Windshear mode after throttles have reached the maximum rated thrust.

CLAMP mode is annunciated on the FMA.

ATS Unclamp

The ATS will resume normal operation out of the CLAMP mode for the following conditions:

- Takeoff mode on the ground and two or more engine thrust commands exceed about 70 percent of the maximum takeoff setting.
- The aircraft is in flight above 400 feet and the takeoff mode is terminated by selection of any other vertical path control mode by the AP/FD or FMS.
- A command is generated for increased thrust while the ATS is operating in the in-flight idle CLAMP mode.
- Exit of windshear mode.

In a similar manner, the engine trim system resumes normal operation when:

- In-flight termination of the takeoff mode occurs.
- The mid-select engine exceeds the N1 threshold.

ATS Thrust Control

The ATS provides automatic thrust limiting for all thrust and speed control modes. The N1 of each engine is constrained between the maximum limit defined by the FMS and a flight idle limit.

The N1 is also constrained by the engine full authority digital electronic control (FADEC).

The ATS thrust limit control modes are:

- Takeoff.
- Go-around.
- Climb.
- Cruise (alternate climb).
- Windshear.
- Idle.

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The RETARD mode is a form of thrust control. The throttles are driven to the idle stop when the AP goes into FLARE mode or when RA is less than 50 feet, flaps are greater than 31.5 degrees and ATS is engaged. Exit from retard mode is by setting throttles to reverse thrust or initiation of go-around mode.

ATS Speed Control

The ATS speed control is automatically limited by the following speeds:

- $V_{min} + 5$ knots as determined by the FMS and normal flap/slat configurations.
- $V_{min} + 5$ knots as determined by the FMS and abnormal flap/slat configuration.
- $V_{min} + 5$ knots + V_{gust} when flaps exceed 31.5 degrees (landing flaps)
- $V_{mo}/M_{mo} - 5$ knots.
- Flap placard speed - 5 knots.
- Slat placard speed - 5 knots.
- Landing gear placard speed - 5 knots.
- FMS 1.2g buffet speed - 5 knots (standard) or FMS 1.3g buffet speed - 5 knots.

V_{gust} is a wind rate integration term calculated from CAS RATE (wind gust) and can have a value between 0 and 5 knots depending on the gust amplitude. In gusty wind conditions, the minimum ATS target speed will be in a range from $V_{min} + 5$ knots to $V_{min} + 10$ knots, depending on gust amplitude. This V_{gust} term does not affect the speed targets displayed on the PFD.

Pilot selection of the reference speeds is accomplished via the FCP. The FCP provides for preselect of IAS and MACH.

A speed hold function allows the existing speed to be the target speed during steady state flight. It will also allow a smooth capture target speed during aircraft acceleration. Speed control targets are also provided by the FMS profile modes.

The ATS controls to speed targets during approach, altitude hold, vertical speed, flight path angle, and profile modes of the AFS/FMS system.

Flight level change operation transfers the ATS to thrust control. Speed will then be controlled by the pitch attitude. The speed and thrust control are annunciated on the FMA.

The ATS provides for automatic speed reference transitions (IAS/Mach) during climbs and descents as follows:

- If climbing and under IAS control, auto-transition occurs when the existing MACH number equals the preselected Mach number (or 26,000 feet if Mach was not preselected).
- If descending and under control of Mach number, auto-transition occurs when the existing IAS equals the preselected IAS (or 26,000 feet if IAS was not preselected).

If descending at Mmo with wing tip tanks less than 90% full, the auto transition occurs between 30,670 feet and 26,670 feet when computed airspeed exceeds Vmo-10.

Auto-transition is annunciated on the FMA speed window by a change in the control target.

Speed Envelope Limiting

The AFS provides full flight regime speed protection using the following:

- ATS self-engagement.
- ATS speed control.
- LSAS speed limiting and stall protection.
- AP/FD automatic pitch mode transitions.

Automatic Engagement and Speed Control

The ATS (if available but not engaged) will auto-engage and transition to a speed-on-thrust mode when the Vmax or Vmin limit is about to be (or has been) exceeded. The AP/FD (if engaged) reverts to a compatible pitch mode. ATS engagement is annunciated by a flashing white A/T OFF on the PFD and HI SPEED (or LO SPEED) PROTECTION flashing above the FMA speed window as appropriate.

LSAS Speed Limiting and Stall Protection

If the AP is not engaged and the ATS is not available, or unable to maintain a safe speed, LSAS speed limiting will engage automatically to provide overspeed or stall protection. LSAS overspeed limiting is accomplished by changing pitch. The target speed that LSAS chooses in high speed protection is variable between Vmo/Mmo, for throttles at idle, and Vmo/Mmo plus 6 knots for throttles at full power. LSAS will not auto trim in the nose down direction in a high speed encounter.

LSAS does not provide flap, slat or gear overspeed protection.

LSAS stall protection engages at stickshaker warning angle-of-attack (PLI on the PFD turns amber). Stickshaker warning is 75 to 85 percent actual stickshaker angle-of-attack depending on flap setting.

If windshear command guidance is on, LSAS stall protection is delayed until actual stickshaker angle-of-attack.

After the angle-of-attack is reduced below stickshaker warning, LSAS stall protection is discontinued and ATS speed control to FMS Vmin is resumed.

The pilot may counteract the LSAS overspeed or stall protection by pushing on the control column with enough force to defeat the LSAS elevator inputs. This force is approximately 50 pounds. If the pilot releases the control column force rapidly, LSAS will dampen the resulting elevator instability. For further information refer to LSAS description in the Flight Controls chapter.

AP/FD Speed Mode Reversions

Detection of speed limit violations in FMS SPD or PROF modes disengages the FMS and the AFS will resume control (if engaged).

If the FCP level change/speed on pitch mode is engaged, the ATS is off, and a Vmax or FMS Vmin speed limit violation occurs the following will happen:

At 5 knots over or underspeed:

- The AP/FD pitch control mode reverts to V/S FPA at the existing vertical speed/flight path angle.
- ATS engages in speed-on-thrust speed protection with a Vmin or Vmax speed target.
- The FMA flashes THRUST and V/S or FPA five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

At 10 knots over or underspeed:

- The AP/FD pitch mode reverts to pitch speed protection with a Vmin or Vmax speed target.
- The throttles are clamped at their existing positions.
- The FMA flashes PITCH five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

If the level change/speed on pitch mode is engaged, the ATS is on, and a Vmax or FMS Vmin speed limit violation occurs, the following will happen at 5 knots over or underspeed:

- The AP/FD remains in speed on pitch mode but with an increased “g” limit and a Vmin or Vmax speed target.
- ATS speed protection will not engage at any time.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

If the V/S FPA mode is engaged, the ATS is off, and a Vmax or FMS Vmin speed limit violation occurs, the following will happen:

At 5 knots over or underspeed:

- The ATS engages in speed-on-thrust speed protection with a Vmin or Vmax speed target.

- The FMA flashes THRUST and V/S or FPA five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

At 10 knots over or underspeed:

- The AP/FD pitch mode reverts to pitch speed protection with a Vmin or Vmax speed target.
- The throttles are clamped at their existing positions.
- The FMA flashes PITCH five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

If the V/S FPA mode is engaged, the ATS is on, and a Vmax or FMS Vmin speed limit violation occurs, the following will happen at 5 knots over or underspeed:

- The AP/FD will revert to pitch speed protection with a Vmin or Vmax speed target.
- The ATS mode will change to climb thrust or idle clamp to provide compatible mode control. Since the ATS was previously in a speed mode, the throttles will already be at the maximum or minimum position to control speed.
- The FMA flashes PITCH five times before becoming steady.
- The FMA flashes HI SPEED PROTECTION or LO SPEED PROTECTION.

Terminating a speed protection mode requires pilot manual disengagement or selection of another mode.

Speed-On-Pitch AP/FD Speed Protection

ATS speed limiting and ATS speed protection are the primary means used by the FCC to limit speed excursions outside the normal speed envelope. Whenever the altitude FMA window displays HOLD, ATS speed protection is the only speed protection mode that is available. However, whenever the altitude FMA displays a mode other than HOLD, AP/FD Speed-on-Pitch (SOP) speed protection is also available to prevent overspeed or underspeed.

The typical sequencing and scheduling of both ATS and SOP speed protection is as follows:

1. Aircraft begins to violate Vmin or Vmax.
2. Aircraft reverts to Speed-on-Thrust (if engaged in a Speed-on-Pitch mode), and autothrottles engage (if off) no later than Vmin-5 (low speed) or Vmax+5 (high speed). The FMA displays speed protection indications.
3. If the speed violation continues, SOP speed protection comes on no later than Vmin-10 (low Speed) or Vmax+10 (high speed)

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This typical mode sequencing for the two speed protection modes is affected by specific flight conditions and by throttle position. If the throttles are already positioned at an appropriate thrust limit for the speed limit being violated, the FCC will not wait until $V_{min}-10$ (or $V_{max}+10$) to engage SOP speed protection. The following example is provided to clarify this operation.

1. Aircraft is in a $V_{max}-5$ knot descent. Autopilot is on, autothrottles are off, and throttles are at idle.
2. Aircraft begins to exceed V_{max} .
3. Since throttles are already at idle, SOP speed protection comes on not later than $V_{max}+5$. Throttles remain at idle, elevator motion pitches the nose up, and the aircraft decelerates.

Longitudinal Stability Augmentation System (LSAS)

Changes provide enhanced commonality between trijet-model approach/landing handling characteristics and control column force deterrent as the aircraft is rotated to near tail-strike pitch attitudes during takeoff and landing. These changes, referred to as Low Altitude Stability Enhancement (LASE), are as follows:

1. Modified Pitch Rate Damper (PRD) - The existing high-altitude PRD operates throughout the entire flight envelope. The PRD will continue to provide 30% of its high altitude pitch rate damping from 16,500 feet down to field elevations.
2. New Pitch Attitude Protection (PAP) Subfunction - The LSAS control law will implement a pitch attitude limiting function that will be enabled below 100 feet radio altitude. As with all LSAS elevator commands, the PAP will be limited to a total of 5 degrees of elevator authority. The PAP subfunction will be further limited to only command nose-down elevator displacements. If the aircraft approaches a tail strike pitch attitude, the pilot-flying will perceive the effect of PAP as an increase in the control column force required to maintain the pitch attitude. The pitch attitude limit used by PAP will vary linearly from 30 degrees at 40 feet radio altitude down to a minimum of 9.5 degrees at 0 feet radio altitude. The PAP subfunction will be active for both takeoff and landing.
3. New Positive Nose Lowering (PNL) Subfunction - This new subfunction will only be applied during landing phase, and will not affect AUTOLAND operations or Auto Flight System (AFS) autoland performance. The PNL subfunction will apply approximately 3 degrees of nose-down elevator command at main wheel spinup, at the same time that the FCC commands the Auto Ground Spoilers (AGS) to extend. As the spoilers extend beyond 10 degrees, the second phase of PNL will increase the nose-down elevator command to approximately 4 degrees. This subfunction, in combination with the enhanced PRD, will control the elevator to avoid aircraft nose-rise after touchdown, and to assist in de-rotation.

These LSAS changes will not affect the maximum override forces for LSAS, which are dependent upon the position of the Elevator Load Feel (ELF) actuator for any given airspeed. For the takeoff and landing phases, where PAP and PNL are active, the control column forces required to override LSAS are approximately 10 to 15 pounds.

Altitude Alert System

The altitude alert system automatically alerts the flight crew that the aircraft is approaching the preselected altitude or that the aircraft is deviating from a preselected and acquired altitude.

The altitude alert system is always on except when the FD or AP is engaged in the glideslope mode. In this case, the altitude alert system is inhibited.

The altitude alert activates as follows:

1,000 feet from the FCP window altitude - PFD altitude box turns steady amber.

If more than 0.12g required to capture FCP window altitude - Steady amber PFD altitude box and tone. Active only on first approach to the FCP window altitude and is inhibited when aircraft is within 150 feet. If more than 0.12g is required to capture the FCP window altitude and that altitude is more than 1000 feet from the current baro-altitude, the PFD altitude box will be flashing amber. This condition requires an initial vertical speed of more than 5200 fpm and is rare.

Deviation of 150 feet or more from FCP window altitude - Flashing amber PFD altitude box and tone. The flashing amber altitude box will reset when the aircraft returns to the set altitude or a new altitude is selected.

Altitude alerting is not affected by the AFS OVRD switch on the FCP

NOTES: The tone consists of a C-chord.

The altitude alert system is inhibited if the AFS is in glideslope capture mode or flap setting is more than 31.5 degrees (landing).

Windshear Alert and Guidance

General

The windshear alert and guidance system (WAGS) provides detection, alerting, and guidance through windshear.

WAGS is inhibited until nose gear liftoff. On landing WAGS is available from 1500 feet RA to 50 feet RA.

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The WAGS is part of the AFS and gets data from the two central air data computers (CADC), the inertial reference system (IRS), and other AFS components. The CADC and the IRS can sense windshear conditions and will send this data to the WAGS. The WAGS will then provide visual warnings on the PFD and FMA and aural warnings through the CAWS. FD and AP are provided through the AFS.

Indications

A red WINDSHEAR (decreasing performance) or an amber WINDSHEAR (increasing performance) is displayed on the PFD top left corner when the WAGS detects windshear.

The CAWS generates a tone and WINDSHEAR voice warning. Windshear modes are also annunciated on the FMA.

The WAGS provides FD and AP pitch guidance for windshear during takeoff and go-around.

The PLI (on PFD) shows the difference between aircraft AOA and stickshaker AOA. The cyan PLI turns amber as the aircraft approaches stickshaker AOA. At stickshaker AOA the PLI turns red. The PLI is for indication only and is not to be used for guidance command.

The WAGS inhibits the EGPWS when windshear guidance is active and the aircraft is responding properly. If WAGS commands are not being followed, the EGPWS will be enabled.

Guidance

When an increasing or decreasing performance windshear is detected, guidance is provided for best flight path angle through the windshear and a positive flight path relative to the ground.

When windshear is detected and guidance is active, the system provides FD and/or AP guidance during takeoff and go-around. The system commands a 1 degree flight path angle until appropriate airspeed is achieved. The system then commands pitch guidance to maintain this speed. For takeoff this speed is V_2+30 . For go-around this speed is $1.3V_s+20$.

Above 450 RA the system allows a zero (or slightly decreasing) flight path. Below 450 RA, if a positive flight path angle is not possible, the system will guide to stickshaker AOA and altitude loss may occur as necessary in order to prevent a stall.

Pop-Up FD and ATS

If the WAGS detects windshear and the FD is off, windshear guidance and maximum power functions are still available. On takeoff, after liftoff, the FD pops up on the PFD and the ATS goes to max available TO thrust.

On approach, FD and ATS are automatic if:

- N1 is more than 95% GA rating or,
- Pilot pushes the GA button or,
- Pilot advances throttles above 95% GA rating.

FD and ATS remain engaged throughout the windshear maneuver even after reversion to TO or GA modes.

Windshear Guidance Reversion

During windshear guidance, selecting another pitch mode will terminate pitch guidance (not a recommended procedure). Guidance can be resumed by pushing the GA button (if below 1500 RA with slats and/or flaps extended).

When windshear no longer exists, all detection annunciations stop.

Windshear pitch and roll guidance will continue until safe conditions exist as follows:

- Altitude is above 1000 feet RA and,
- Rate of climb is at least 750 fpm for 15 seconds and,
- If in TO, speed at least $V_2 + 5$ for 15 seconds.
- If in GA, speed at least $V_{ref} - 5$ for 15 seconds.

Takeoff Roll and Takeoff

The WAGS functions (windshear alerts, warnings, FMA annunciations, and auto thrust increases) are inhibited during takeoff roll until nose gear liftoff.

When windshear is detected the alerts will appear on the PFD and FMA. The precursor tone and associated aural warnings will sound through the CAWS.

When a windshear is detected, the amber or red WINDSHEAR on the PFD will flash three times then remain steady. For decreasing performance windshear the CAWS activates a tone followed by three cycles of WINDSHEAR.

Decreasing performance windshear alerting (red) has priority over increasing performance windshear alerting (amber). When either windshear is detected on takeoff, the ATS remains clamped (except FLEX, DERATE, or ALT TO where the ATS unclamps, sets TO thrust, and reclamps).

The FMA speed, roll, and altitude windows will show changes in the WAGS modes. For a decreasing performance windshear, the system will limit bank to 5 degrees, and will display HDG XXX degrees in the roll window and WINDSHEAR in the speed and altitude windows of the FMA, (after flashing the annunciations five times). For increasing performance windshear, the roll window will retain TO heading while WINDSHEAR is displayed in the speed and altitude windows after flashing five times.

Approach and Go-Around

When windshear is detected, the annunciations will appear on the PFD and FMA. The precursor tone and voice warnings will sound through the CAWS. After flashing 5 times, WINDSHEAR will appear in the FMA and the PFD speed bug will indicate a minimum speed of $1.3V_s + 20$ KTS. The ATS, if engaged, will control to $1.3V_s + 20$ KTS for both increasing and decreasing performance shears. The ATS will not control to a speed below the pilot selected speed.

Guidance is not activated during approach unless the GA button is pushed, or the throttles are advanced manually or automatically above 95% N1 GA thrust limit after windshear is detected.

When guidance is activated, the FMA speed, roll, and altitude windows will show changes in the WAGS mode. For a decreasing performance windshear, the system will: limit bank to 5 degrees and display HDG XXX degrees in the speed and altitude windows of the FMA (after flashing 5 times).

For increasing performance windshear, the roll window will retain the heading. WINDSHEAR will be displayed in the speed and altitude windows after flashing 5 times.

ATS, if disengaged, will engage automatically and advance to maximum available GA thrust. The FD, if off, will pop up automatically. Guidance continues until windshear no longer exists and reversion (safe) conditions exist as noted previously.

If windshear is detected after a GA has been initiated, the aural and visual annunciations will be activated and guidance will begin automatically.

EGPWS and TCAS Inhibits

The EGPWS is inhibited during windshear guidance when FD commands are being followed within + or - 5 degrees. The TCAS is also inhibited during windshear guidance, except for traffic advisory (TA) annunciations on the ND.

Windshear System Modes

The pitch limit indicator (PLI) is in view for all modes. Detection failures are annunciated on the EAD and CFDS.

STANDBY

- Detection - Inactive.
- Guidance - Disabled.
- Autothrottle - No action.
- Thrust limits - No action.

TAKEOFF - Nose oleo extend

- Detection - Active.
- Guidance - Armed. Will engage upon windshear detection.

-
- Autothrottle - If TO derated, unclamp, go to max TO thrust and reclamp.
 - Thrust limits - If TO derated, advance to max rated TO thrust.

ENROUTE - Radio altitude more than 1500 ft.

- Detection - Inactive.
- Guidance - Disabled if windshear encounter not in progress.
- Autothrottle - No action.
- Thrust limits - No action.

APPROACH - Radio altitude less than 1500 ft.

- Detection - Active to 50 ft. radio altitude.
- Guidance - Armed.
- Autothrottle - Speed bias for incr or decr perf windshear.
- Thrust limits - Advance to max GA thrust after windshear detection.

NOTE: WAGS guidance activated by GA activation or thrust more than 95% GA thrust rating while a detection is present.

GO-AROUND - TOGA activation

- Detection - Active.
- Guidance - Armed. Will engage upon windshear detection.
- Autothrottle - Advance to max GA thrust and clamp.
- Thrust limits - Advance to max GA thrust.

NOTE: Change to enroute if RA more than 1500 ft.

TOUCHDOWN - Landing gear touchdown

- Detection - Inactive below 50 ft. RA.
- Guidance - Disabled.
- Autothrottle - No action.
- Thrust limits - No action.

NOTE: When speed below 80 kts, WAGS resets to standby.

Windshear Annunciations and Autothrottle Operation

TAKEOFF ROLL/TAKEOFF

Aural Warning

Incr Perf - None.

Decr Perf - Tone followed by WINDSHEAR voice (3 times).

PFD Upper Left

- Incr Perf - Amber WINDSHEAR.
- Decr Perf - Red WINDSHEAR.

FMA - White WINDSHEAR in speed and altitude control windows.

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Thrust limits - Set to max TO thrust setting.

Autothrottle - If derated TO, unclamp, go to max TO thrust and reclamp.

APPROACH

Aural Warning

Incr Perf - None.

Decr Perf - Tone followed by WINDSHEAR voice (3 times).

PFD Upper Left

- Incr Perf - Amber WINDSHEAR.
- Decr Perf - Red WINDSHEAR.

FMA - White WINDSHEAR in speed control window.

Thrust limits - Set to max GA thrust setting.

Autothrottle - Control to 1.3 VS+20 kts or pilot selected, whichever is greater. No change in pitch or roll modes. No pitch or roll WAGS guidance until G/A activation or thrust exceeds 95% G/A thrust rating while windshear is detected.

GO-AROUND

Aural Warning

Incr Perf - None.

Decr Perf - Tone followed by WINDSHEAR voice (3 times).

PFD Upper Left

- Incr Perf - Amber WINDSHEAR.
- Decr Perf - Red WINDSHEAR.

FMA - White WINDSHEAR in SPEED and ALTITUDE control windows.

Thrust limits - Set to max GA thrust setting.

Autothrottle - Advance to max GA thrust and clamp.

FMA Fault Annunciations

Autopilot or autothrottle faults are annunciated by a box around the affected modes. The box is labeled AP OFF for autopilot disconnects or ATS OFF for autothrottle disconnects. This box is red and flashes until canceled by pushing the autopilot or autothrottle disconnect switch.

When the autopilot or autothrottle is not engaged, the box and label are white if available and amber if not available. For normal autopilot operation, AP1 is shown when FCC1 autopilot is in control, AP2 when FCC2 autopilot is in control, or AP when both autopilots are engaged for DUAL LAND operations.

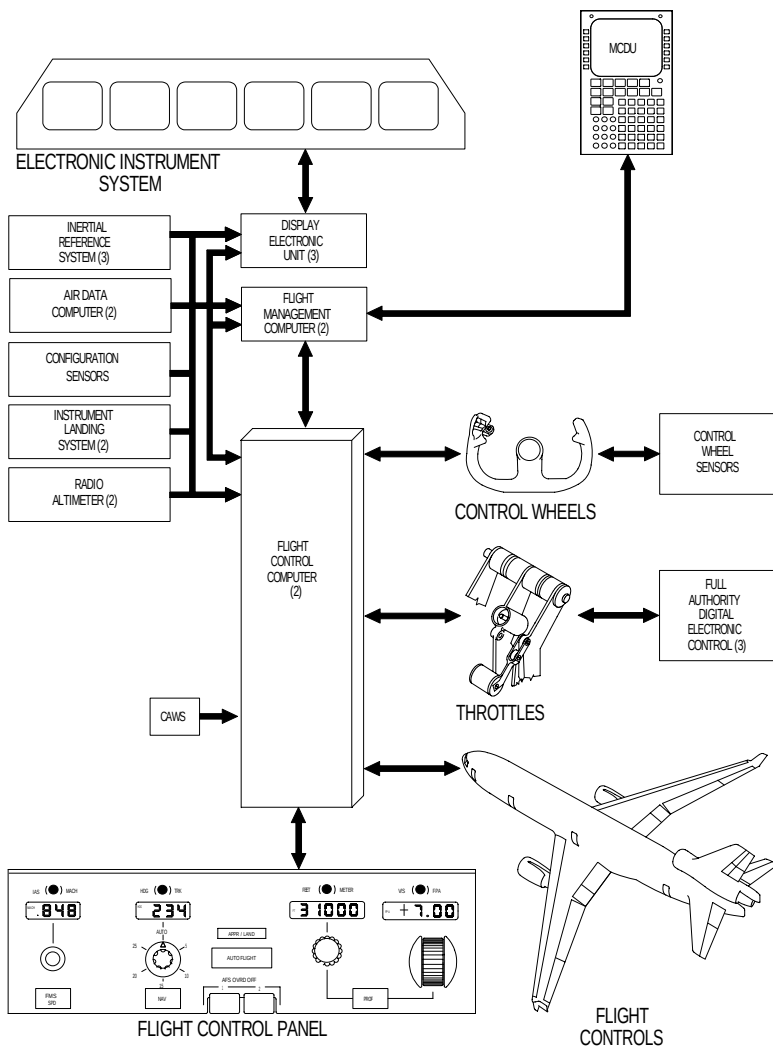
Autothrottle Speed Protection (ASP) is annunciated by a box around the affected modes labeled ATS OFF. This annunciation is white and flashes. In addition, HI SPEED or LO SPEED will flash alternately with PROTECTION as appropriate. The flashing continues until one of the following:

- Selecting a FCP speed within ATS control envelope.
- Disconnecting and/or re-engaging autothrottle within the normal speed envelope.
- Selecting level change, V/S, FMS SPD or FMS PROF within the normal speed envelope.

Chapter Auto

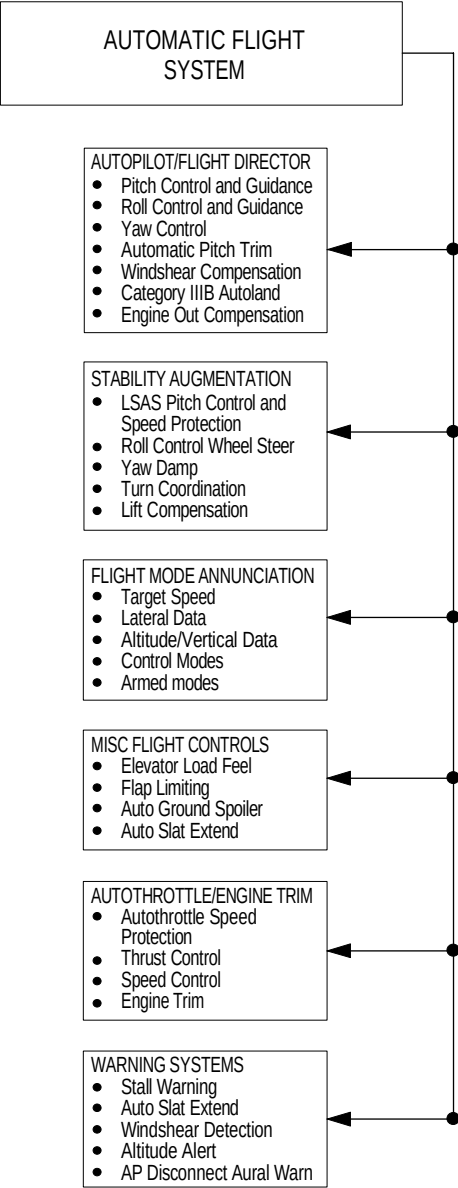
Section 20

Major Components



DB1-2-442D

Automatic Flight System Functions Chart

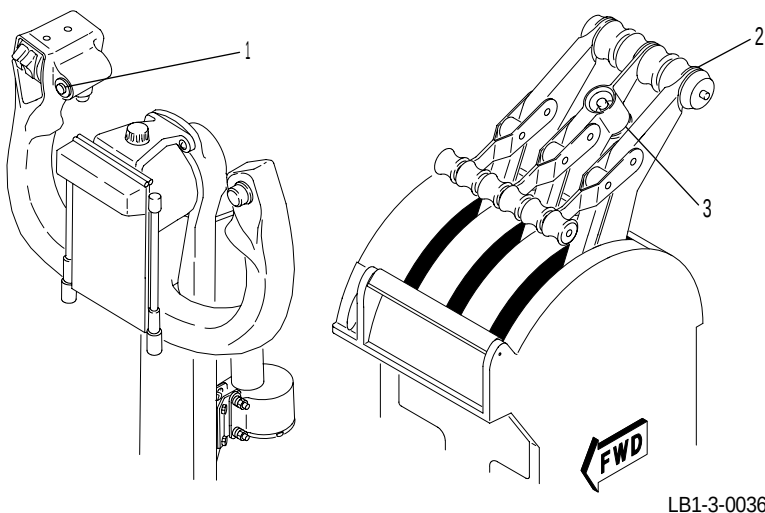


DB1-2-1829

Automatic Flight Controls and Displays

Chapter Auto Section 30

AP, ATS Disconnect and GA Switches



LB1-3-0036

1. AP Disconnect Switches (2)

Pushing either disconnect switch disconnects the autopilot system. This activates the AP disengage warning system, causing an AP OFF light on the PFD to begin flashing red. RCWS is disabled while pushing this switch.

If at any time the AP OFF legend light is flashing red, pushing either of the AP disconnect switches will cause the flashing to stop and the AP OFF display to change color to white or amber if the disconnect was a result of a detected failure and no autopilot is available.

2. ATS Disconnect Switches (2)

Pushing either ATS disconnect switch disconnects the autothrottle system. If at any time the ATS disengage warning system is activated, an ATS OFF light on the PFD will begin flashing red. By pushing either ATS disconnect switch, the flashing will stop and the ATS OFF display 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 Switch

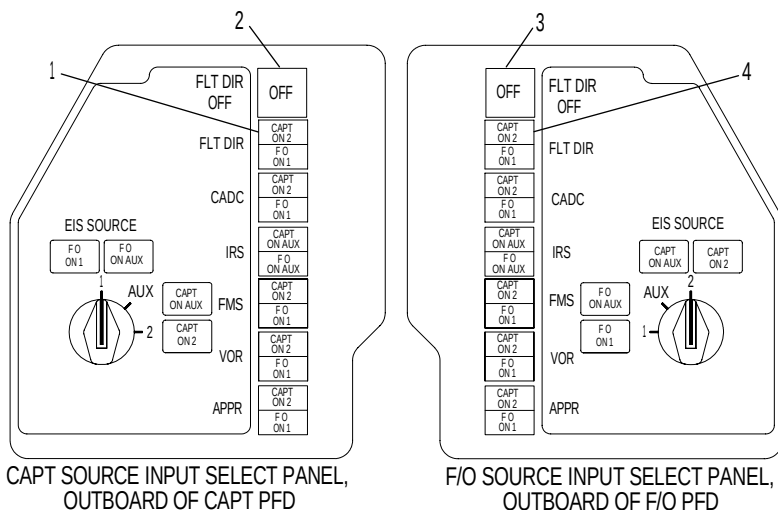
Pushing during approach conditions (RA less than 2500 ft. and flaps or slats down) causes:

- FDs pop up to go-around mode even if selected off.
- If AP on, AP will follow FD commands.
- ATS goes to go-around limits.
- Parallel rudder active (in case of engine failure).
- Bank angle limited to 10 degrees.
- Reference speed and PITCH appear on FMA.
- GO-AROUND appears in altitude window.
- Exits LAND mode (if engaged or armed), localizer capture mode or glideslope capture mode.
- Windshear pitch guidance provided if windshear warning active. WINDSHEAR will appear in FMA speed and altitude windows.

NOTE: If the flap displays on the PFD and the CONFIGURATION page show Xs, FD go-around will not be available due to flap synchro failure.

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Flight Director Switches



LB1-3-0037

1. Captain's FLT DIR Switch - amber

Pushing the switch allows the Captain to direct the FD 2 commands to PFD 1. CAPT ON 2 will illuminate amber. Both PFDs will show FD2 in the upper left corner near the attitude sphere. Pushing the switch again restores normal on-side FD operation.

2. Captain's FLT DIR OFF Switch - amber

With the FD on (OFF not illuminated), pushing the switch selects the Captain's FD to OFF. OFF then illuminates amber and the command bars are removed from the PFD. Pushing the switch when OFF is illuminated engages the FD and extinguishes the light.

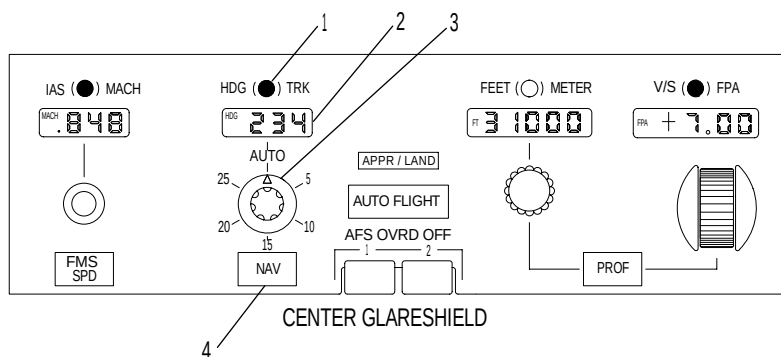
3. First Officer's FLT DIR OFF Switch - amber

With the FD on (OFF not illuminated), pushing the switch selects the First Officer's FD to OFF. OFF then illuminates amber and the command bars are removed from the PFD. Pushing the switch when OFF is illuminated engages the FD and extinguishes the light.

4. First Officer's FLT DIR Switch - amber

Pushing the switch allows the First Officer to direct the FD 1 commands to PFD 2. F/O ON 1 will illuminate amber. Both PFDs will show FD1 in the upper left corner near the attitude sphere. Pushing the switch again restores normal on-side FD operation.

Heading/ Track Controls and Display



LB1-3-0038

1. HDG/TRK Changeover Button

Pushing permits alternate selection of either heading (HDG) or track (TRK) to be displayed in the HDG/TRK display window and on the ND. Operation of this button before HDG/TRK HOLD does not affect the window target number. Operation of the button in the HDG/TRK mode compensates the window target to account for any difference in the magnetic heading and track angle but does not change existing control mode or AP/FD reference until the HDG/TRK selector is pushed or pulled.

2. HDG/TRK Display Window

Shows selected HDG or TRK. Window is blank when the AFS is controlling to the FMS flight plan. At initial powerup the window shows 000 as a preselected value if a valid magnetic heading is not available. If a valid magnetic heading is available at powerup, this is displayed. For powerup while airborne, the current heading is shown as the preselected value.

3. HDG/TRK and Bank Angle Limit Selectors

HDG/TRK Selector (Inner Knob) - Turn to preselect:

- Rapid rotation causes large changes.
- Resolution for slow knob rotation is one degree per detent.

Pull to select:

- Disengages the NAV mode (if engaged).

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- Selects the preselected heading/track and cancels the previous lateral mode. The aircraft follows and captures any selected HDG/TRK while in this mode.
- The display window displays the selected HDG/TRK.
- Once the target HDG/TRK is captured, the system will automatically transition to HDG/TRK HOLD mode and the selector must be rotated, then pulled to select a new heading. During the capture phase, the selected heading/track is changed when the selector is rotated.

Push to hold:

- Disengages the NAV mode (if engaged).
- Causes the aircraft to maintain the present HDG/TRK or, if the aircraft was turning, the heading during the turn plus or minus a small predicted increment to ensure a smooth rollout with no overshoot.
- Cancels VOR, LOC, NAV, and LAND ARMED modes.
- The window displays the capture HDG/TRK.
- Turning the knob in this mode preselects a new HDG/TRK. This requires selection by pulling the knob.

Bank Angle Limit Selector (Outer Knob) -

Allows selection of maximum bank angle in 5-degree increments (5 to 25 degrees). In the AUTO position bank angle limits vary with speed (bank limits decrease as speed increases). This selector cannot override FMS-computed bank angle limits. Bank angle limits are displayed on the top of the PFD attitude sphere.

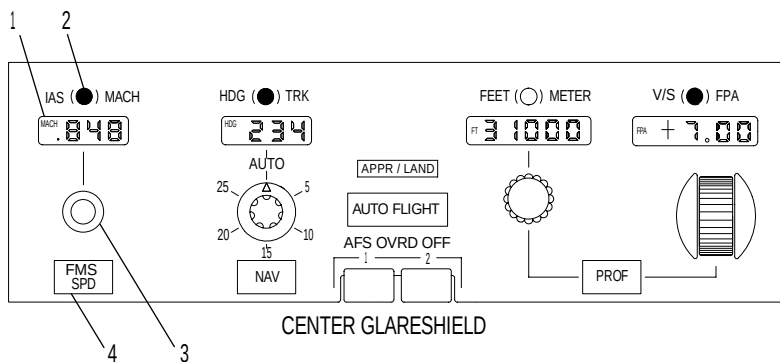
4. NAV Switch

Push to arm the FMS NAV capture mode or resume FMS lateral control if the capture criteria are satisfied.

The NAV armed mode can be cancelled by pushing HDG/TRK hold, selecting APPR/LAND arm, capturing the ILS localizer, or by capturing FMS NAV.

After NAV capture, commands are supplied from the FMS. NAV arming is available on the ground once engines are started. NAV guidance is active at 100 feet AGL in FD mode. AP NAV guidance is not available until 400 feet AGL.

Speed Controls and Display



LB1-3-0039

1. IAS/MACH Display Window

The preselected or selected IAS or MACH number is displayed in this window. The range is from 100 to 499 KIAS and M 0.500 to M 0.900. The left end of the display shows IAS or MACH depending on which function is selected. The window shows dashes when the AFS is controlling to the FMS flight plan speed.

2. IAS/MACH Changeover Button

Pushing the button permits alternate selection of IAS or MACH to be displayed in the window.

3. IAS/MACH Select Knob

Turn to preselect:

- Rapid rotation causes large changes and slow rotation causes slow changes in IAS/MACH display window.
- Each detent is equal to 1 knot or 0.001 Mach.

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If the IAS is displayed, pushing the IAS/MACH changeover button allows display and preselection of the desired cruise Mach. The preselected IAS is retained and displayed when the changeover button is pushed again. At the altitude where the selected IAS corresponds to the preselected Mach, the display and the selected speed reference will automatically change to the Mach mode. The inverse operation (IAS preselection) is available for descent. Changeover to the equivalent Mach or airspeed value occurs automatically at 26,000 feet if no Mach has been preselected.

Pull to select:

- Disengages the FMS speed mode (if engaged).
- The preselected target speed becomes the selected speed.
- The window displays the selected speed.
- The aircraft will follow and capture any selected speed value while in this mode with a pitch or thrust change as appropriate.
- Once the selected speed is captured, the system will automatically revert to the speed hold mode and the IAS/MACH select knob must be rotated, then pulled, to select a new speed. During the capture phase, the selected speed is changed if the knob is rotated.

Push to hold:

- Disengages FMS speed mode (if engaged).
- The aircraft will maintain the present speed plus or minus any small increment if required for a smooth capture.
- The window displays the capture speed.
- Turning the knob in this mode preselects a new speed. The knob must be pulled to select the preselected speed.

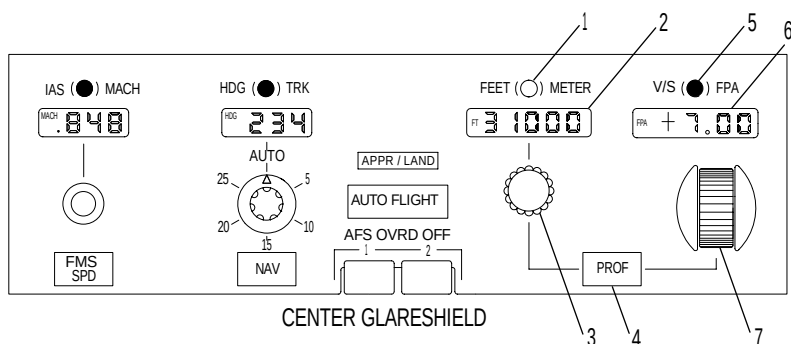
4. FMS SPD Switch

Pushing selects the armed FMS speed, typically an ECON speed, and cancels any selected or preselected speed or Mach number. The IAS/MACH display window shows IAS -- or MACH -- and the FMA speed target and speed control legend changes from white to magenta. Pushing the FMS SPD switch within 10 seconds after preselecting an FCP speed results in editing the FMS-computed speed. The window shows IAS -- (or MACH --) and the PFD FMA speed is the edited FMS speed reference in white (magenta if equal to ECON speed).

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

On takeoff, pushing the PROF switch above 400 feet AGL engages PROF and FMS SPD.

Altitude Controls and Display



LB1-3-0040

1. FEET/METER Changeover Button

The altitude tape on the right side of the PFD is always in feet. Pushing this button allows the pilot to select feet or meters on the FCP, FMA, and lower right corner of the PFD. When meters are selected the values are preceded by an M. When feet are selected the values are preceded by an FT.

2. Altitude Display Window

Displays the selected or preselected altitude for altitude alerting and AP/FD altitude control (except during G/S mode). Range is from 0 to 50,000 feet. Display at initial powerup is 10,000 feet. Window is blank if both air data computer references fail.

3. Altitude Select Knob

Precision altitude selection increments (one detent) for slow knob rotation are:

- 500 feet above 10,000 feet.
- 100 feet below 10,000 feet.
- If BARO is selected on the ECP, a one-foot precision selection capability permits FCP selection of MDA value.
- 50 meters if METER is selected.

Turn to preselect:

- Sets the altitude reference.

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- Window displays the preselected altitude reference.
- Sets FMS clearance ceiling (climb) or floor (descent) when PROF is engaged.

Pull to select:

- Disengages PROF (if engaged) and engages flight level change.
- Disengages vertical speed/FPA or altitude hold modes.
- Flight level change mode sets the ATS to climb thrust or descent idle clamp and AP/FD pitch control to speed. The aircraft climbs or descends directly to selected altitude.
- The aircraft will capture and hold any new altitude selected while in this mode.
- The FCP altitude target becomes the displayed reference on the FMA.

Push to hold:

- Engages altitude capture/hold.
- Disengages PROF (if engaged).
- Disengages VERT SPEED/FPA mode (if engaged).
- Altitude target becomes the current altitude plus or minus a small value required to give a smooth transition to level flight. This target value is displayed in the FCP window, FMA, and on the PFD.

4. PROF Switch

Push to engage the FMS vertical profile guidance if not previously engaged. After PROF engage, commands are supplied from the FMS (based on inserted flight plan). On takeoff, PROF will not engage until 400 feet AGL. On landing PROF can stay engaged until 50 feet. In takeoff mode, this switch will also engage FMS speeds.

5. V/S-FPA Changeover Button

Pushing permits alternate display and control of either vertical speed in fpm or FPA in tenths of degrees. When the V/S-FPA is not engaged, alternate function is not selected until the pitch thumbwheel is rotated. After V/S or FPA is engaged, the displayed value is always the selected value.

6. V/S-FPA Display Window

Displays vertical speed or FPA. 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.

7. Pitch Wheel

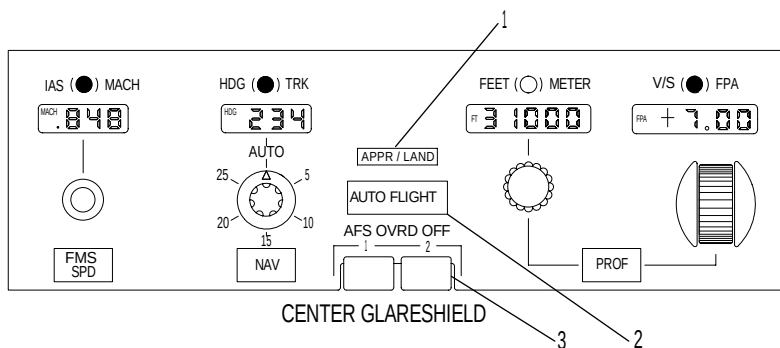
Rapid rotation results in large changes in the display window. Slow rotation results in 100 fpm (or 0.1 degree) changes per detent. A vertical speed bug is positioned on the PFD vertical speed tape corresponding to the selected vertical speed.

Roll to select:

- Disengages PROF, speed on pitch, altitude hold, and glideslope modes if LAND is not annunciated.
- Display window and target initializes to plus or minus 100 fpm (or 0.10 degree FPA) if engaged in altitude hold. Otherwise, initialization is to current vertical speed/FPA. Subsequent wheel changes result in changes in vertical speed/FPA selection.
- Pushing PROF resumes FMS profile operation at the selected vertical speed as an FMS edit.

When the pitch wheel is moved, the AP will cancel the altitude capture mode (if engaged) and will not re-engage in altitude capture until the pitch wheel has come to rest for 2 seconds. The selected altitude will not be captured if the pitch wheel is repeatedly adjusted. In this case, the AP will toggle between vertical speed mode and altitude capture.

APPR/LAND, AUTO FLIGHT, AFS OVRD OFF Switches



LB1-3-0041

1. APPR/LAND Switch

Push to arm 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 to engage both 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 aircraft about level) or vertical speed hold (if aircraft climbing/descending).

After AP engagement, each push alternates the AP between AP1 and AP2. AP mode is always retained. AP1 or AP2 will appear on the FMA (top of PFD).

On ground, pushing engages autothrottles only. Below 100 feet the AP will not engage. If the AP is engaged above 100 feet, it will remain engaged after passing below 100 feet only in LAND or GA modes.

Operating hydraulic systems required for AP and auto pitch trim are as follows:

- AP1 requires HYD system 2 for flight controls and HYD system 3 for auto pitch trim.

- AP2 requires HYD system 1 for flight controls and auto pitch trim.

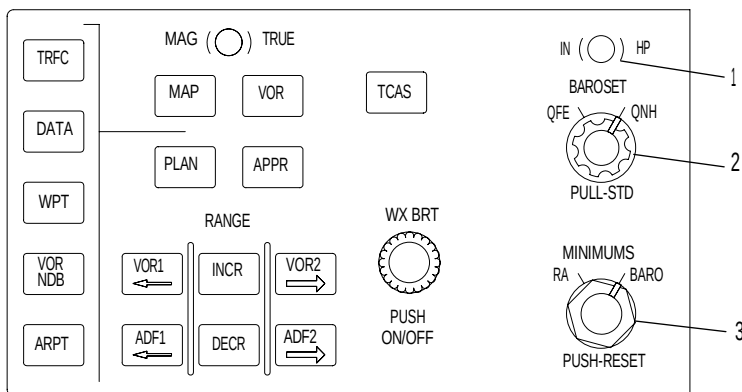
3. AFS OVRD OFF Switches (2)

Push down for emergency disconnect of respective autopilot and autothrottle. In OFF, an amber and gray bar comes into view. Additional FCC functions are affected as follows:

Functions stay on: Altitude alerting, auto ground spoilers, auto pitch trim - LSAS, auto slat extend, elevator load feel, engine trim, flap limiting, FD, LSAS, speed protection - LSAS, stall warning, yaw damp/turn coordination, and windshear guidance.

Functions go off: AP auto pitch trim, Roll control wheel steering, and speed protection - AP & ATS.

EIS Control Panel



GLARESHIELD, LEFT AND RIGHT SIDE

LB1-3-0042

1. IN/HP Changeover Button

BAROSET values may be in either inches mercury or hectopascals. Pushing this button causes the units to toggle from inches mercury to hectopascals or vice versa.

2. BAROSET Control Knob

The BAROSET value is adjusted by turning the inner collar. The outer collar allows the selection of QFE (altitude above station) or QNH (altitude above sea level). Pulling this knob selects the standard BAROSET QNE (29.92 or 1013.2 Hp). BAROSET, QFE and QNH values are displayed on the PFD below the altitude scale.

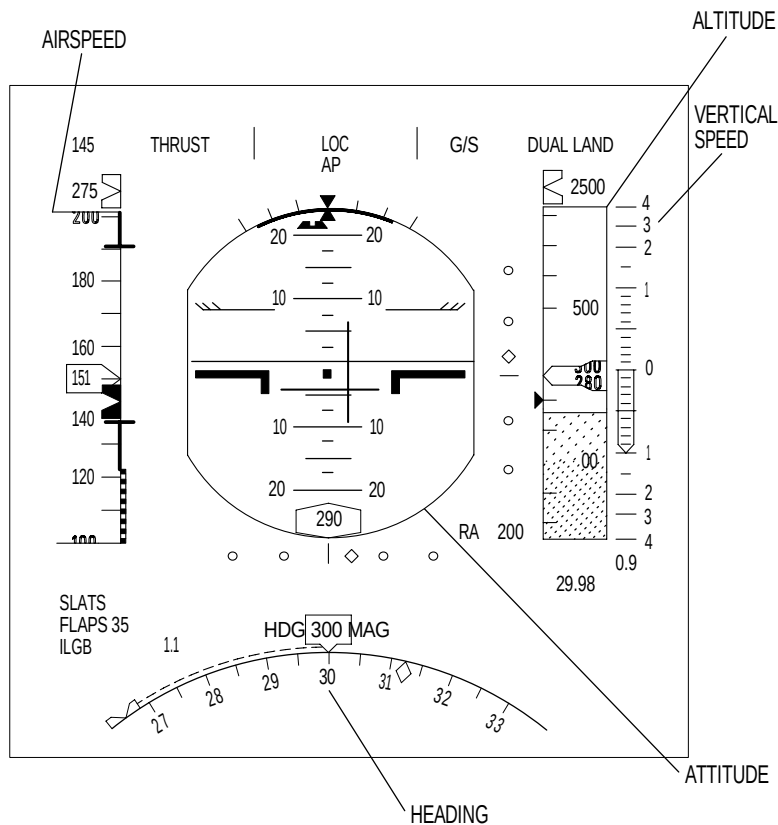
3. MINIMUMS Control Knob

The RA minimums bug is a solid triangle on the left side of the PFD altitude tape. To set the RA bug, turn the inner collar with the knob in RA.

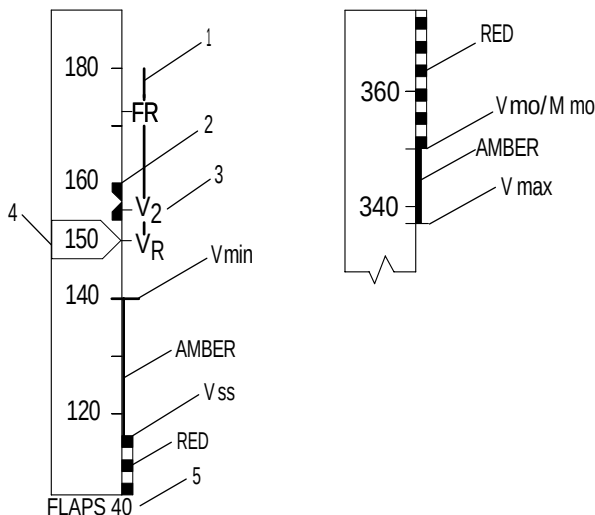
The baro minimums bug is a solid triangle on the right side of the PFD altitude tape. To set the baro bug, turn the inner collar with the knob in BARO. BARO position during initial climb can cause nuisance aural warnings.

Pushing the knob resets the PFD DH alert and silences the aural warning.

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PFD Airspeed Display



LB1-3-0044

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 (bowtie) - Pilot selected AS/Mach.
- White outline (bowtie) - Pilot preselected AS/Mach.
- Solid magenta circle - FMS commanded AS/Mach.
- Outlined magenta circle - FMS speed exists but is not selected.

If selected speed is set lower than V_{min} , the white bug stops at V_{min} and an amber reference bug will be at the selected speed.

If selected speed is set lower than V_{ss} , a red reference bug will be at the selected speed.

If selected speed is set higher than V_{mo}/M_{mo} , the white bug stops at V_{mo}/M_{mo} and a red reference bug will be at the selected speed.

Speed/Mach bugs can park off scale above or below the tape. A digital value will be displayed next to the bug.

Mach is displayed to the right of the airspeed when above 0.47 Mach. When Mach goes below 0.45 it is removed.

If airspeed is no-computed data (less than 53 knots and A/C on ground), the IRS ground speed and TAXI will be shown. This groundspeed display is replaced with an amber NO TAXI if any IRS is in align mode.

3. Speed Bugs

V1, VR, V2, FR, SR, GR, SE, FE, and GE bugs are on outside of the tape. If Vs speeds have not been computed or entered (aircraft on ground), V1, VR, and V2 are attached to dashed boxes.

FR: Flap Retract (FMS calculated) - Displayed only when flaps are extended. Amber when speed is less than flap retract speed. Displayed green when speed is greater than flap retract speed.

SR: Slat Retract (FMS calculated) - Displayed only when slats are extended and flaps are up. Amber when speed is less than slat retract speed. Green when speed is greater than slat retract speed.

GR: Gear Retract (EIS calculated) - Displayed only when landing gear is down. Normally green, turns amber if gear is still extended above 230 knots or .7 Mach.

SE: Slat Extend (EIS calculated) - Displayed only when slats are retracted. Green when speed is less than 280 knots. Amber when speed is greater than 280 knots (.55 Mach).

F15, F28, F35, F50 (EIS calculated): Flap Extend - Displayed symbol depends on flap configuration and speed. Green when speed is less than the applicable flap extend limit speed. Amber when speed is greater than applicable flap extend limit speed. Flap extend limit speeds are:

- F15 - 255 knots.
- F28 - 210 knots.
- F35 - 190 knots.
- F50 - 175 knots.

GE: Gear Extend (EIS calculated) - Displayed whether landing gear is extended or retracted. Green when speed is less than 260 knots (.7 Mach). Amber when speed is greater than 260 knots (.7 Mach).

4. Airspeed

Shown at the center of tape.

- Box and digits red - A/S below Vs or exceeds Vmo/Mmo.
- Box and digits amber - A/S below Vmin or exceeds Vmax.

Vss (from FMC) is the end of a red checker column.

Vmin (from FMC) is a line at the end of an amber column extending from Vss.

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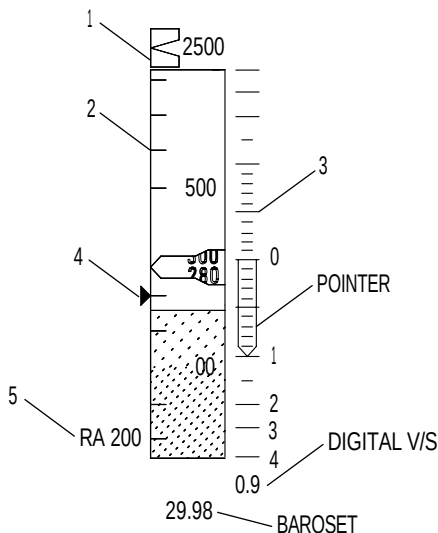
V_{mo}/M_{mo} (from ADC) is a line at the end of a red checker column extending from the high end of the tape.

V_{max} is a line at the end of a narrow amber column extending down from V_{mo}/M_{mo}.

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



LB1-3-0045

1. Altitude Bug

- White outline (bowtie) - Pilot preselected altitude.
- White solid (bowtie) - Pilot 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 FCP set altitude, or the altitude has been preselected and the FMS is engaged.

Selected altitude bug may be parked off each end of altitude scale with digital display next to it.

The pilot selected altitude bug can be used as an MDA bug by dialing it down to the baro DH minimums with the FCP altitude select knob. The bug then meshes with and removes the baro DH triangle on the right. The bug is white above minimums and amber below minimums.

2. Altitude Tape

Tick marks are 100-foot increments. White shading is for QNH display. Green shading is for QFE display. Feet are white and meters are cyan (if selected). Altitude box turns amber and flashes to correspond with CAWS altitude advisory alert.

Baroset is below the scale in white. It can be inches of mercury or hectopascals selectable with the IN/HP changeover button on the ECP.

QFE operation is selected from the ECP. In this case the tape turns green, baroset below the tape change to QFE value, QFE is displayed, and a QNH box appears below the baroset. This box has the QNH baroset value and QNH altitude in feet (or meters if selected).

If meters is selected from the FCP, scale and altitude stay in feet. Metric altitude is in cyan above the feet and is labeled M. If in QFE, the QNH metric is above the QNH altitude.

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. Digital readout limits are 9,900 fpm.

When the aircraft is in V/S mode, the selected V/S is shown by a filled white bug on the scale. When the selected V/S is achieved, the pointer fits in the bug.

4. Minimum Bug

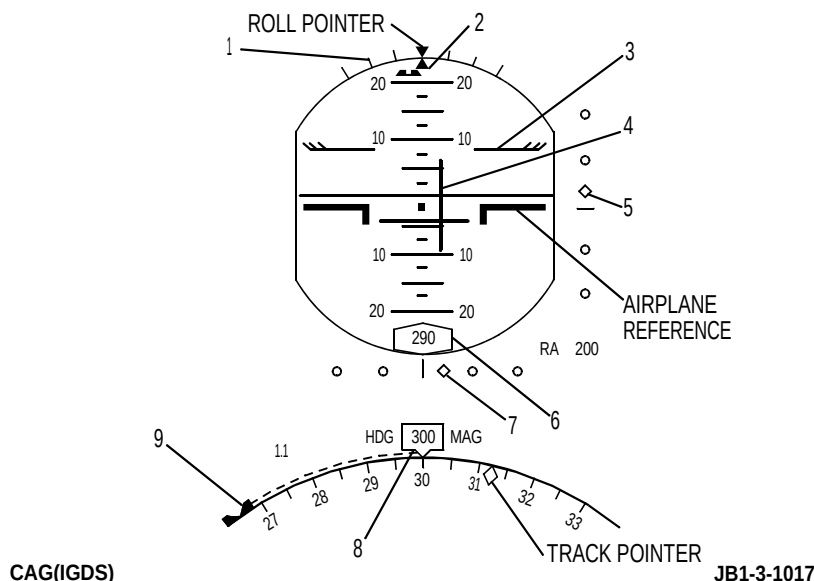
Solid triangle on the left is RA minimum bug. RA is set with the ECP MINIMUMS control knob in the RA position. This bug is white color (above minimum) or amber (below minimum).

A solid triangle on the right side is a BARO DH minimum bug. BARO DH is set with the ECP MINIMUMS control knob in the BARO position. This bug is white above minimums and amber below minimums.

5. Selected Minimum

Value is amber, boxed and flashes for 5 seconds when minimum altitude is reached. It stays amber after flashing. This condition can be reset by pushing the ECP MINIMUMS control knob.

PFD Attitude Display (Typical)



1. Roll Indices

A white triangle at the top shows 0 degrees roll, short ticks show 10 and 20 degrees, long ticks show 30 and 60 degrees, and a triangle shows 45 degrees roll. A white roll pointer (triangle) turns red if the roll angle will produce a stall. 45-degree and 60-degree ticks are not shown for roll angles 30 degrees or less.

Bank angle limits are ticks at the end of an arc. In NAV mode, limits are from the FMS. If not in NAV, limits are the least of either FCP set (pilot) or FMS stall protection limits. The white arc will turn red if the aircraft will stall with a roll greater or equal to bank angle limit of 5 degrees.

2. Slip/Skid Indicator

A trapezoid moves parallel to the horizon line in the direction of rudder required. It will turn amber when it becomes separated from the roll pointer.

3. Pitch Limit Indicator - cyan

Pitch Limit Indicator (PLI) is two cyan lines with feathers. The difference between the line and the aircraft reference is Angle-of-attack (AOA) remaining to stickshaker. The feathers are AOA remaining to stall. Just before stickshaker this display turns amber. At stickshaker it turns red. When slats are retracted the PLI cannot turn amber.

4. Flight Director - magenta

The Flight Director (FD) can be turned off and on with switches outboard of the PFD. The FD comes on automatically for go-around or windshear. Default condition is FDs on. During a TCAS RA, the FD can be removed by pushing the AP disconnect switch once. The FD automatically reappears when clear of traffic conflict.

FCP selected flight path angle is green line with a gap. Two short vertical lines are selected TRK targets. This symbology provides no guidance command.

Flight path vector is a small green circle with wings and tail at the current direction of flight. The vector wings are always level. The flight path vector is shown whenever Flight Path Angle (FPA) is selected from the FCP.

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.

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 0 feet RA while LOC or ALIGN displayed in FMA roll mode window.

8. Heading

Heading is MAG (dim white) but changes to TRU (cyan) at latitudes greater than 73 degrees N or 60 degrees S.

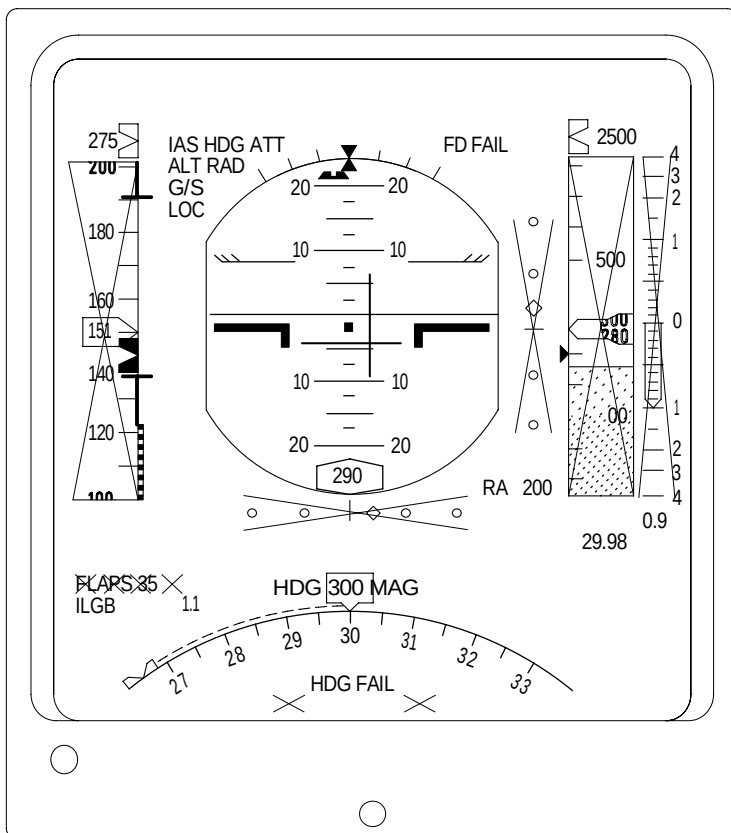
9. Heading Bug

Bug is outline when preselected and filled when selected. If the HDG is off scale, the bug is parked and the HDG is shown digitally at the edge of the screen.

When the aircraft is on emergency power, frequency, bearing, and radial of VOR1 is shown below the HDG scale on the Captain's PFD (DEU1 data only).

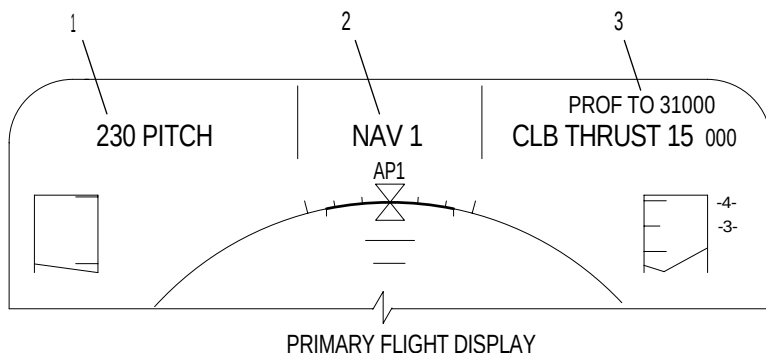
The drift angle (track) pointer is a green diamond.

PFD Test Display (Typical)



LB1-3-0047

Flight Mode Annunciator



LB1-3-0048

1. Speed Control Window

Shows FCP or FMS speed and mode of control. Digits are magenta if equal to the FMS target speed (white otherwise). The mode is in 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 (or an AFS speed reference). When mode shows THRUST and ATS is not engaged, but available, the window is surrounded by a white ATS OFF box. If ATS is not available in THRUST mode, the window is surrounded by an amber ATS OFF box.

If a speed has been commanded that cannot be maintained due to selection of a vertical speed or flight path angle, the speed and mode will flash alternately. This flashing continues until an acceleration in the direction of the speed target is achieved. If the mode changes due to an auto reversion, the new mode flashes 5 times.

If the aircraft is in a speed protection envelope, HI SPEED or LO SPEED will be displayed alternating with PROTECTION above the speed mode.

Windshear warnings are displayed by a flashing white WINDSHEAR (5) followed by a steady white WINDSHEAR.

2. Roll Control Window

Shows what mode is controlling the aircraft roll axis. A digital value is displayed when in HDG or TRK mode. Engaged autopilot (AP1 or AP2) is shown.

Modes are white for pilot-selected AFS, magenta for FMS and green for DUAL LAND.

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 Window

Shows FCP or FMC target altitude and vertical profile mode. Digits are magenta if equal to FMS target (white otherwise). Mode is white for manual, magenta for FMS, and green for DUAL LAND.

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 alternately with the engaged mode (except windshear).

The WINDSHEAR mode annunciation has priority over all modes including GPWS/EGPWS.

FMA Control Window Modes

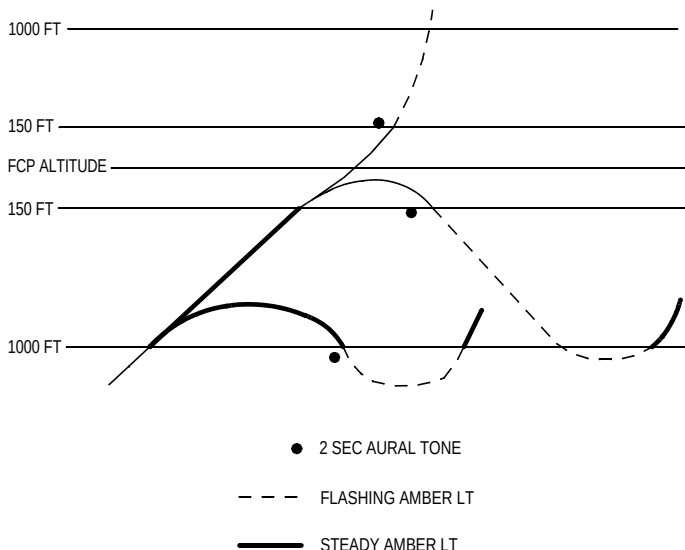
SPEED CONTROL MODES	TYPE	ANNUNCIATION	COLOR
FMS Descent	Engage	IDLE THRUST	Magenta
Speed on Pitch	Engage	PITCH	Magenta/White
Speed on Throttle	Engage	THRUST	Magenta/White
Throttle Retard	Engage	RETARD	White
Windshear FPA Control	Engage	WINDSHEAR	White
Lo Speed Protection	Armed/Engaged	LO SPEED PROTECTION	White
Hi Speed Protection	Armed/Engaged	HI SPEED PROTECTION	White
ROLL CONTROL MODES	TYPE	ANNUNCIATION	COLOR
Capture/Track VOR	Engage	VOR1 or VOR2	White
Capture/Track LOC	Engage	LOC ONLY	White
FMS Nav	Engage	NAV1 or NAV2	Magenta
Heading Hold or Select	Engage	HEADING _____	White
Track Hold or Select	Engage	TRACK _____	White
Landing Rollout	Engage	ROLLOUT	Green/White
Localizer	Engage	LOC	Green/White
Runway Alignment	Engage	ALIGN	Green/White
Takeoff Ground Roll	Engage	TAKEOFF	White
Over VOR	Engage	VOR1 (or 2) CRS	White
FMS Nav Armed	Armed	NAV ARMED	Magenta
Land Armed	Armed	LAND ARMED	White
LOC Armed	Armed	LOC ARMED	White
VOR Armed	Armed	VOR ARMED	White
ALTITUDE CONTROL MODES	TYPE	ANNUNCIATION	COLOR
Takeoff Thrust	Engage	T/O THRUST	White/Magenta
Throttles Clamp	Engage	T/O CLAMP	White/Magenta
Climb w/Climb Thrust	Engage	CLB THRUST	White/Magenta
Altitude Hold	Engage	HOLD	White/Magenta
CLIMB w/MAX Contin Thrust	Engage	MCT THRUST	White/Magenta
Vertical Speed	Engage	V/S	White/Magenta
Flight Path Angle	Engage	FPA	White
FMS Prof Descent	Engage	PROF	Magenta
GA Thrust Mode	Engage	GO AROUND	White
Glideslope	Engage	G/S	White/Green
Dual Autoland	Engage	DUAL LAND	Green
Single Autoland	Engage	SINGLE LAND	White
No Land Mode	Engage	APPR ONLY	White
IIIA/B Autoland Flare	Engage	FLARE	White/Green
IIIA/B Autoland Rollout	Engage	ROLLOUT	White/Green
Level Change Descent	Engage	IDLE CLAMP	White
FMS Speed On Elevators	Engage	IDLE	Magenta
Next FMS Prof Alt	Armed	PROF TO	Magenta
PROF Armed On Ground	Armed	PROF ARMED	Magenta
Alt Chnge in Prof Mode	Armed	VERT ALERT	Magenta
Armed to Capture G/S	Armed	LAND ARMED	White
Windshear (GA Thrust) Mode	Engage	WINDSHEAR	White
CLIMB w/GA Thrust	Engage	GA/THRUST	White/Magenta
CLIMB w/Cruise Thrust	Engage	CLB THRUST	White/Magenta

NOTE: Armed modes appear in smaller letters above the engaged mode.

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MD-11 Flight Crew Operations Manual

Altitude Alert System Chart



The altitude alert activates as follows:

1,000 feet from the FCP window altitude - PFD altitude box turns steady amber.

If more than 0.12g required to capture FCP window altitude - steady amber PFD altitude box and tone. Active only on first approach to the FCP window altitude and is inhibited when aircraft is within 150 feet. If more than 0.12g is required to capture the FCP window altitude and that altitude is more than 1000 feet from the current baro-altitude, the PFD altitude box will be flashing amber. This condition is typically the reason why one may hear two successive altitude tones while approaching an altitude.

Deviation of 150 feet or more from FCP window altitude - flashing amber PFD altitude box and tone. The flashing amber altitude box will reset when the aircraft returns to the set altitude or a new altitude is selected.

NOTES:

- The tone consists of a C-chord.
- The altitude alert system is inhibited if the AFS is in glideslope capture mode or flap setting is more than 31.5 degrees (landing).

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Automatic Flight Alerts

Chapter Auto Section 40

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

Amber Boxed Alerts (Level 2)

FCC (1A, 2A, 1B, 2B) DATA FAULT (CONFIG) - Respective FCC bus not valid.

STAB OUT OF TRIM (CONFIG) - LSAS or autopilot is on and the stabilizer is out of trim.

Amber Alerts (Level 1)

AUTOPILOT SINGLE (MISC) - Only one AP is valid.

FD G/A ONLY (MISC) - AP go-around mode is not available.

MANUAL GA ONLY (MISC) - FD and AP go-around modes not available.

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

ROLL CWS FAIL (MISC) - Roll CWS is inoperative.

SINGLE LAND (MISC) - Autoland availability is reduced from dual land to single land.

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

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**Communications**
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Communications

Description and Operation

Chapter Comm

Section 10

General

The MD-11 communications system consists of the following:

- VHF communications system.
- HF communications system.
- Communication Radio Panels (CRP).
- Audio Control Panels (ACP).
- Flight interphone system.
- Service interphone/call system.
- Passenger address (PA) system.
- Selective Calling System (SELCAL).
- Cockpit Voice Recorder (CVR) system.
- Satellite Communications (SATCOM) system.
- Aircraft Communications Addressing And Reporting System (ACARS).
- Cockpit Entry Video System (CEVS)

Static dischargers on the trailing edges of the wing and tail surfaces dissipate static electricity that could interfere with communications and navigation. The wingtip and winglet dischargers also protect the aft wingtip lenses from lightning strike.

VHF Communications System

The VHF communications system consists of three separate, identical systems, designated VHF1, VHF2 and VHF3.

All of the three systems operate separately or simultaneously. The systems provide short-range line-of-sight communications in the 118.000 to 136.975-MHz frequency range. This allows communications between the airplane and ground and/or other airplanes.

The selection for the VHF communications system is controlled from any of three Communication Radio Panels (CRP).

HF Communications System

The HF communications system consists of two separate, identical systems, designated HF1 and HF2.

The systems provide long range communications between the airplane and ground and/or other airplanes in the 2.000 to 29.9999 MHz in wide range on channels spaced at 1.0 KHz.

The frequency selection for the HF communications system is controlled from the CRP. HF radios must not be operated during airplane refueling operations due to the possibility of arcing.

Communication Radio Panel

Three Communication Radio Panels (CRP) are installed on the aft pedestal to provide tuning of the communications systems.

The interface between CRPs allows tuning of the communications radios from any panel. Pushing one of the five radio select switches on the panel (VHF1, VHF2, VHF3, HF1 or HF2), illuminates the selected switch, and the associated ACTIVE and STBY frequencies are displayed. New frequencies are placed in the STBY memory and transferred to the ACTIVE mode by use of the transfer button.

The three CRPs can be used simultaneously, provided radio selection (VHF1, VHF2, VHF3, HF1, HF2) differs from another CRP. Only one radio may be selected on an individual CRP.

Audio Control Panel

Two Audio Control Panels (ACP) are installed on the aft pedestal and one is installed at the observer station.

The ACPs provide the following functions:

- Communication radio transmit and volume control.
- Navigation radio ident and volume control.
- Flight/service interphone transmit and volume control.
- PA transmit and volume control.

Transmitting can be done using a handheld, boom, or oxygen mask microphone. The handheld microphone cannot be used for the PA system.

Flight Interphone System

The flight interphone is controlled by three ACPs.

Jacks for the boom and handheld microphone are installed at the Captain's, First Officer's, and right Observer's stations. A flight interphone jack is installed at the ground power receptacle, the nose landing gear, and in the avionics compartment. In addition, the oxygen masks in the cockpit each include a microphone which automatically switches from the boom microphone to the mask microphone when the oxygen mask PRESS TO TEST AND RESET lever is pushed, or when the oxygen mask stowage box doors are opened.

Automatic transfer from mask microphone back to boom microphone is initiated by closing the left mask stowage box door and pushing the PRESS TO TEST AND RESET lever.

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Flight interphone transmission may be accomplished by using any of the following:

- The radio Push To Talk (PTT) switch on the outboard horn of either control wheel with INT MIC selected.
- The INT switch on the ACP.
- The PTT switch on each hand microphone with INT MIC selected.
- Radio PTT switches, one each on the Captain and First Officer's lighting control panels with INT MIC selected on the ACP.

The cockpit speakers are muted as follows:

- Keying the Captain's hand, boom, or mask microphone for radio or interphone mutes the Captain's speakers.
- Keying the First Officer's hand, boom, or mask microphone for radio or interphone mutes the First Officer's speakers.
- Keying any microphone or cockpit handset for PA mutes both the Captain's and the First Officer's speakers.
- Keying any microphone or cockpit handset for service interphone does not mute the speakers.
- Keying the Observer's hand, boom, or mask microphone for radio or interphone does not mute the Captain's or First Officer's speakers.

Service Interphone/Call System

The service interphone/call system allows communications between the cockpit and cabin attendant stations and between the cockpit and maintenance service areas.

The service interphone/call panel is installed on the forward overhead panel in the cockpit.

Nine PA/service interphone handsets are installed in the airplane, one in the cockpit on the aft pedestal and one at each cabin attendant station.

The following service interphone operations are possible through the handset:

- The cockpit can call either a selected cabin attendant station, all cabin attendant stations or the maintenance service area.
- Each cabin attendant station can call a selected cabin attendant station or the cockpit.

Maintenance interphone jacks are located at various locations on the airplane. These jacks permit communications between these areas and the cockpit.

The call system consists of call lights, aural signals, and call switches which provide both visual and/or aural signals that do the following:

- Alert the flight crew of a call from the cabin attendant station or ground maintenance.

-
- Alert cabin attendant station or ground maintenance of a call from the flight crew.
 - Alert one cabin attendant station of a call from another cabin attendant station.

Switches (AFT ATTND, FWD ATTND, MID ATTND, OWING ATTND, and ALL) on the forward overhead panel permit calling a selected cabin attendant station pair or all cabin attendant stations simultaneously. Switches at each cabin attendant station permit calling a selected cabin attendant station pair or the cockpit. A button is installed at the external ground power receptacle to permit the mechanic to call the cockpit.

A call from the cockpit to the cabin attendant station pair (L&R) station causes the following:

- Actuation of a chime near the cabin attendant station pair being called.
- Illumination of a reset switch at the station being called.
- Illumination of the pink master call prisms in the cabin ceiling near the cross aisles of the station being called.

A call from the cabin attendant station to the cockpit causes the following:

- Actuation of a call chime in the cockpit.
- Illumination of CALL on the ACP CAB MIC/CALL switch.
- Illumination of a light on the service interphone/call panel identifying the calling station pair.

A call from a cabin attendant to another cabin attendant station pair causes the following:

- Actuation of chime near the cabin attendant station being called.
- Illumination of a reset switch at the cabin attendant station being called.
- Illumination of the pink master call prisms in the cabin ceiling near the cross aisles of the station being called.

A call from the ground power panel to the cockpit causes the following:

- Actuation of a chime in the cockpit.
- Illumination of MECH on the ACP MIC/MECH switch.
- Illumination of CALL on the service interphone/call panel MECH/CALL light.

The call system can be reset from any station or the cockpit by pushing the CALL RESET button. The system resets automatically when the handset is returned to its hanger or a microphone is keyed on the appropriate interphone.

Passenger Address System

The PA system enables the flight crew and cabin attendants to address passengers throughout the cabin and lavatories.

MD-11 Flight Crew Operations Manual

The PA system also allows for the broadcast of music from the passenger entertainment tape reproducer and for the transmission of prerecorded announcements throughout the passenger compartment.

PA announcements from the cockpit may be made with boom microphone or oxygen mask microphone from any audio panel.

The service interphone/PA handsets on the aft pedestal in the cockpit and at the cabin attendant stations are also used to make PA announcements. In the cockpit, the PA switch on the ATTND CALL panel must be pushed to transfer the handset from service interphone to PA.

PA announcements from the cockpit have priority over the passenger entertainment system and any PA announcements from a cabin attendant station.

Priority of the PA system is as follows:

1. Cockpit.
2. Cabin attendants.
3. Pre-recorded announcements.
4. Video system PA.
5. Boarding music.

For PA announcements, the passenger compartment is divided into three zones, forward, mid, and aft.

The Captain, First Officer, and right Observer are able to make PA announcements to all zones from their respective microphone or handset.

Only one PA announcement can be made at a time. To prevent simultaneous accidental announcements, PA IN USE lights are provided at all cabin attendant stations and on the service interphone/call panel. These lights illuminate at any station indicating a handset is off the hook.

PA volume is automatically increased when one or more engines are running.

If the handset is secured by the handset hook, audio to the handset receiver is turned off.

After use, returning the handset to its hanger, or actuating a service interphone call from the cockpit, automatically transfers the PA system to the service interphone system.

Selective Calling (SELCAL) System

Selective Calling (SELCAL) operates in conjunction with the VHF and HF systems to provide visual and aural indications that the airplane is being called by a ground station.

When a ground station calls the airplane, the applicable CALL light on the ACP flashes and the Central Aural Warning System (CAWS) sounds a chime. This chime is inhibited during takeoff or landing.

When the call is acknowledged, the system is automatically reset by pushing the MIC/CALL light on the ACP and keying the radio PTT on the associated control wheel, or ACP.

The radio volume control knobs on the ACP permit volume control of the receivers without affecting SELCAL system operation. In the event the SELCAL system fails, the VHF and the HF communications systems continue to operate normally.

Cockpit Voice Recorder

The solid state Cockpit Voice Recorder (CVR) records the last 120 minutes of:

- Interphone and radio communication from all three cockpit stations via the Audio Management Units.
- All passenger Address System announcements via the PA amplifier.
- All cockpit conversations picked up by the cockpit area microphone.

The recorder runs automatically when aircraft is powered. The Cockpit Voice Recorder panel is located on the overhead panel.

Satellite Communications (SATCOM)

The Satellite Communications (SATCOM) system provides air/ground voice and data communication. The system uses satellites (via SATCOM antenna) and ground stations to relay transmissions to and from the airplane. The Satellite Data Units (SDU) on board the airplane process signals from antennas and interface with the Multifunction Control Display Unit (MCDU), ACARS, Audio Management Unit (AMU), and Cabin Telecommunication Unit (CTU).

Operation of the SATCOM requires the Inertial Reference System (IRS) to be powered-on and aligned. It takes ten minutes for the IRS to become aligned from power on.

Voice communication is available. The flight crew can receive or initiate a call in the cockpit. A single stroke chime accompanied by a flashing TEL light on the ACP indicates an incoming call to the airplane. The flight crew acknowledges the call by pushing the MIC/TEL switch on the ACP. The flight crew initiates a call by entering a phone number on the MCDU prior to pushing the MIC/TEL switch.

Aircraft Communications Addressing and Reporting System (ACARS)

The Aircraft Communications Addressing And Reporting System (ACARS) provides two-way data communications. Aircraft flight operations and maintenance data is collected automatically from systems and sensors, or is entered manually into the ACARS Management Unit (MU) through the MCDU, for downlink. The crew may also enter free text messages, weather report requests, and position reports.

Data that can be uplinked and downlinked includes all of the following:

- Flight plan (Downlinked).
- Load.
- Wind (Downlinked).
- Position report data/requests.
- Weather reports.
- Free text messages.
- Emergency messages.
- Airlines application.

An ACARS Management Unit (MU) is installed in the avionics rack and does the following:

- Receives the ground-to-air messages.
- Controls transmission of the air-to-ground messages.
- Collects data from various airplane systems.
- Converts digital data in receive and transmit modes.

The MU receives data from:

- MCDUs.
- FMCs.
- Digital Flight Data Acquisition Unit (DFDAU) or Data Management Unit (DMU).
- CFDS.
- VHF3 system.
- Door sensors.
- Parking brake.
- Air/ground switch.
- SATCOM.

Ground and satellite networks are responsible for transporting messages between the aircraft and the airline host computer, and are operated by different providers, depending on location.

VHF3 radio or SATCOM communication is available as follows:

- The MU automatically locks in either VHF3 or SATCOM, as appropriate.
- VHF3 or SATCOM can be manually selected through the ACARS screen on the MCDU.

SATCOM communication is possible when the airplane is within range of satellite coverage and SATCOM transmission is enabled.

VHF communication is possible when the airplane is within range of a network ground station and VHF transmission is enabled. Typical VHF range is approximately 200 NM at 30,000 feet.

During VHF communication, the radio transceiver is tuned to a frequency entered on the MCDU or by a ground station uplink frequency command. Voice mode or data mode VHF transmission is selected through the MCDU or the ground station. When in voice mode, the appropriate alert is displayed.

The MU starts contact by transmitting when the flight crew wants to transmit, or when a predefined event occurs. The MU only transmits when the selected channel is available. If the transmission is not received (by the ground station), ACARS attempts to transmit again. After 6 attempts, if the message is not received, the flight crew receives an ACARS NO-COMM alert. The same process occurs for uplink messages.

Cockpit Entry Video System (CEVS)

Cockpit Entry Video System provides means to identify persons requesting entry to the cockpit and to detect suspicious behaviour of persons in the vicinity of the flight deck.

CEVS consists of 4 video cameras, 1 control panel and 1 Video Display Unit (DU).

The system is activated by switching the Power switch to the ON position. Within 5 seconds the image from the selected camera will show on the DU. To select a camera view for display, the View selector must be rotated for any desired position.

The STBY button can be used to switch off the DU backlight (sleep mode). The DU backlight will remain off until any input is generated on the control panel. Using the sleep mode will lengthen the service life of the DU.

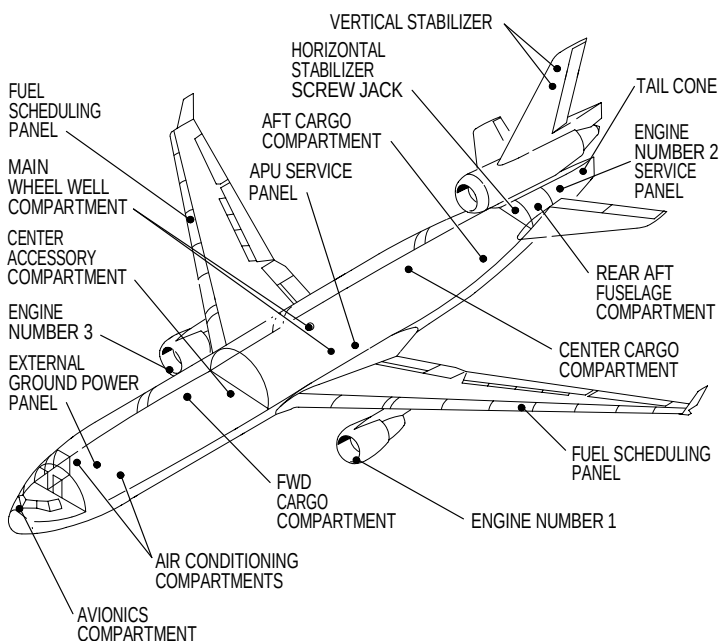
The system will be powered by 28 VDC Bus 2.



Communications Components

Chapter Comm Section 20

Service Interphone Jack Location



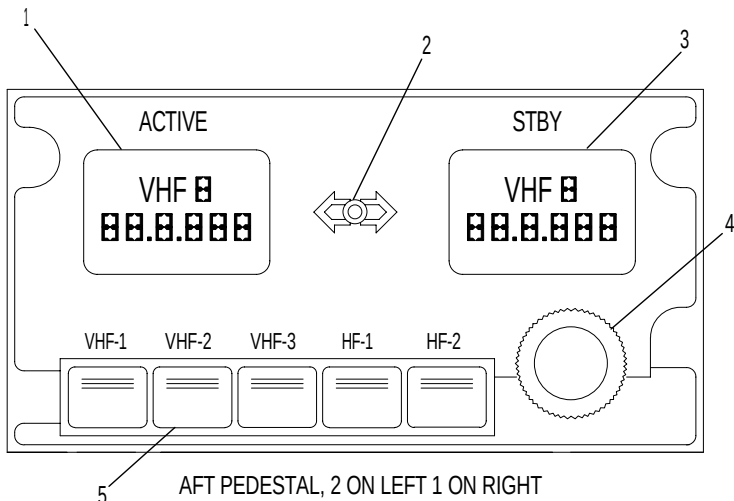
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Communications Controls and Displays

Chapter Comm Section 30

Communication Radio Panel



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1. ACTIVE Window

Displays the active frequency and selected radio. Displays ACARS in one of the windows for VHF-3. Displays FAIL in both windows in case of CRP failure.

2. Transfer Button

Push to transfer the STBY frequency to the ACTIVE window for transmission. STBY frequencies cannot be transmitted until transferred to ACTIVE window.

3. STBY Window

Displays the standby frequency and selected radio.

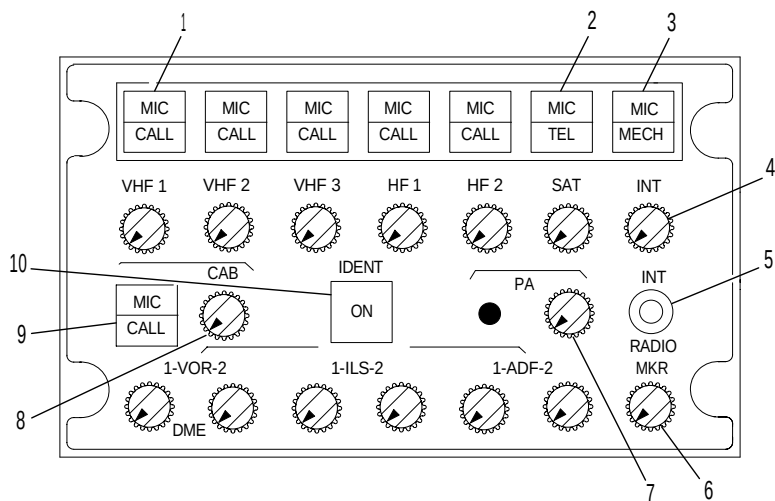
4. Frequency Selector

Turn knobs to select frequency in STBY window only.

5. Radio Selector Switches (5) - white

Push to select respective radio. Switch illuminates white. Selected radio is displayed in the STBY/ACTIVE windows.

Audio Control Panel



AFT PEDESTAL AND OBSERVER'S STATION

DB1-2-1702

1. Navigation Radio MIC/CALL Switches (5) - white

MIC - Illuminates white when a navigation radio system MIC/CALL switch is pushed. Radio transmission is enabled for that system.

CALL - If flashing, a call is being received on the radio system indicated below the flashing light.

2. MIC/TEL Switch - white

MIC - Illuminates white when pushed to transmit via SATCOM.

TEL - Flashes blue and a tone sounds when an incoming/outgoing SATCOM transmission is initiated. With MIC pushed to transmit, air to ground transmission is connected, TEL illuminates steady blue. When transmission is disconnected, TEL extinguishes.

Pushing either RADIO PTT switch enables transmission through either the boom microphone or the oxygen mask microphone.

3. MIC/MECH Switch - white

MIC - Illuminates white when pushed, enabling communication with outside maintenance personnel through the external flight interphone jacks.

Interphone jacks are located at the external ground power receptacle and at the nose landing gear.

MECH - Illuminates white and a tone sounds when maintenance personnel are calling from the external power panel. MECH extinguishes when the flight interphone system is keyed from the cockpit. The hand, boom, or oxygen mask microphones may be used.

4. Communication Receiver Volume Control Knobs (7)

All volume control knobs on the ACP are illuminated and protrude out with a white band at the base when pushed on. The knobs are used to control the volume of the selected radio.

5. INT/RADIO Switch

This switch provides the same function as the PTT switch on the control wheel. When pushed and held to INT, flight interphone transmission is possible even though a non-interphone MIC selector is illuminated. When the switch is held in RADIO and the appropriate radio MIC/CALL switch is pushed, radio transmission is possible with either the boom or oxygen mask microphone. The RADIO position overrides flight interphone actuation with the PTT switch on the control wheel.

6. Navigation Receiver Volume Control Knobs (7)

The knobs control the audio of the NAV systems designated above or below the selected knob. For an operational description of the VOR 1/2, ILS 1/2, ADF 1/2, MKR, and DME systems refer to the Instrumentation and Navigation chapter.

7. PA Button

When the PA button is pushed and held, PA transmission is possible with either the boom or oxygen mask microphone. The PA volume control knob controls the volume of the cockpit speakers and headsets. The hand held microphone cannot be used on PA.

8. CAB Volume Control Knob

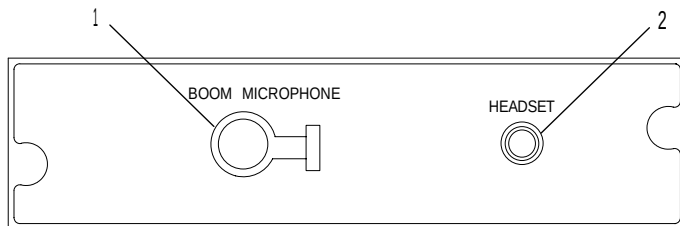
Controls cabin/service interphone volume.

9. CAB MIC/CALL Switch - white

Pushing this switch causes MIC to illuminate white and makes it possible to communicate on the service interphone. Transmission can be made with either the boom or oxygen mask microphone by pushing the hand mic PTT or radio PTT. If CALL illuminates white and a tone sounds, a call is being made from the cabin attendant panel indicated on the service interphone call panels. The volume control knob controls the cabin/service interphone volume at the audio panel.

10. IDENT Switch - white

ON - Illuminates white when pushed. Enables voice and coded identification of DME, VOR, ADF, and ILS navigation receivers.

Cockpit Jack Panel

DB1-2-1703

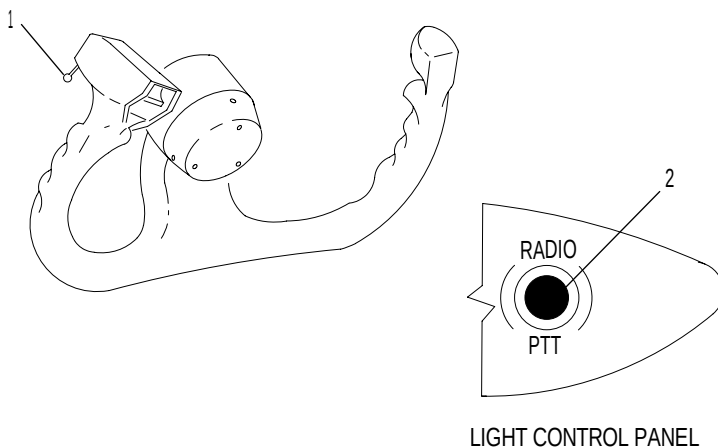
1. BOOM MICROPHONE Jack

Allows connection of boom microphone to the flight interphone system.

2. Spare HEADSET Jack

Allows connection of a spare headset, which is normally used with the handheld microphone at the right observer station.

Control Wheel Microphone and PTT Switches



LB1-3-0015A

1. Control Wheel Microphone Switch

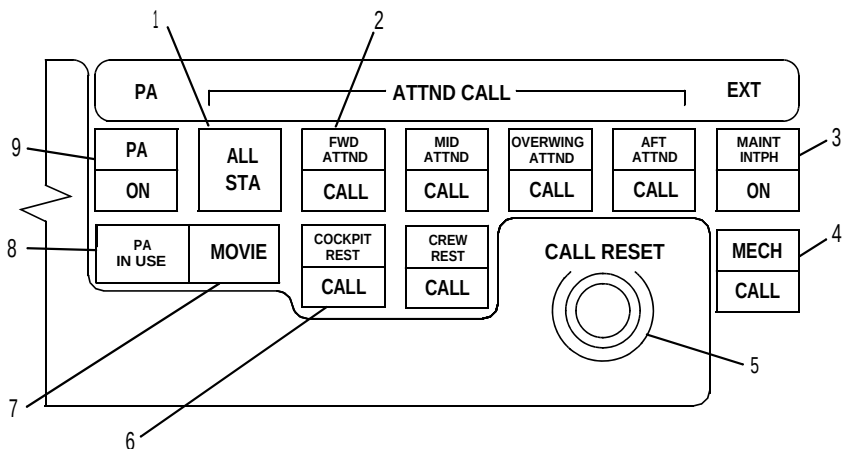
This 3-position switch keys the flight interphone system as follows:

- Forward (Momentary) - Interphone.
- Aft (Momentary) - Radio.
- Center - Off.

2. RADIO PTT Switch (2)

RADIO PTT - Push for radio transmission through the boom or oxygen mask microphone.

Service Interphone Call Panel - Passenger



FORWARD OVERHEAD PANEL, RIGHT SIDE

DB1-2-1947

1. ALL STA Switch - white

Switch illuminates white when the system is powered.

Push to call all cabin attendant stations.

2. CALL Switches - white/blue

CALL - Illuminates blue when a call is made to the cockpit. Station identifier illuminates white when the system is powered.

Push the respective switch to call a station.

3. MAINT INTPH/ON Switch - white/amber

MAINT INTPH - Illuminates white when the system is powered.

ON - Illuminates amber when the switch is pushed to connect the maintenance interphone jacks to the service interphone system.

4. MECH/CALL Switch - white/blue

Pushing the switch momentarily sounds the mechanic call horn.

MECH - Illuminates white when the system is powered.

CALL - Illuminates blue when ground personnel push the PILOT'S CALL button on the ground service panel.

The service interphone system allows communication from the cockpit to any airplane service interphone jack. The aft pedestal handset is used for communication.

Communication with the ground crew through the handheld or boom microphone is made by pushing the audio control panel MIC/MECH switch, and activating either the Captain's or First Officer's control wheel PTT switch or the audio control panel INT switch.

5. CALL RESET Button

CALL RESET - Push to extinguish the CALL light on all attendant switches.

6. Cockpit Crew/Cabin Crew/Call - white/blue

When pushed, activates a continuous horn in the cockpit crew rest and a momentary chime in the cabin crew rest respectively.

CALL illuminates blue when a call has been made from the associated crew rest.

7. MOVIE Light - blue

MOVIE - Illuminates blue when a video movie is in progress.

8. PA IN USE Light - blue

PA IN USE - Illuminates blue when the PA system is in use on the airplane.

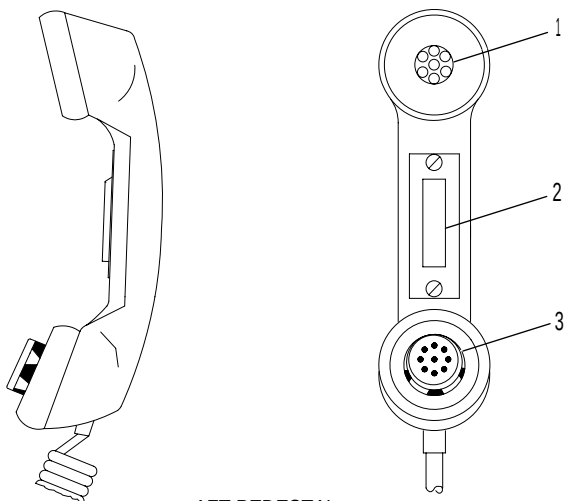
9. PA/ON Switch - white/blue

Pushing the switch allows PA announcements to be made through the aft pedestal handset.

PA - Illuminates white when the system is powered.

ON - Illuminates blue when the switch is pushed and the handset is removed from its hanger.

Service Interphone Handset



CAG(IGDS)

LB1-3-0054

1. Handset Receiver

Returning the handset to the cradle deactivates the PA system and extinguishes the PA ON light.

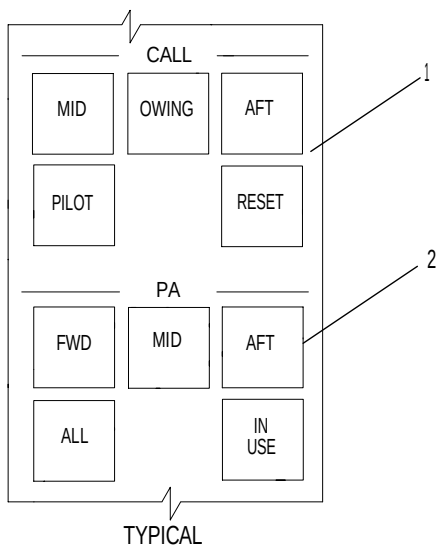
2. Push-To-Talk (PTT) Handset Switch

Pushing the bar-type switch on the handset enables communication through either the PA system or the service interphone system.

3. Handset Microphone

Pushing the PTT handset switch enables PA system or service interphone system communication through the handset microphone.

Cabin Attendant Panel



DB1-2-1705

NOTE: Cabin attendant panel layout differs for various cabin attendant stations.

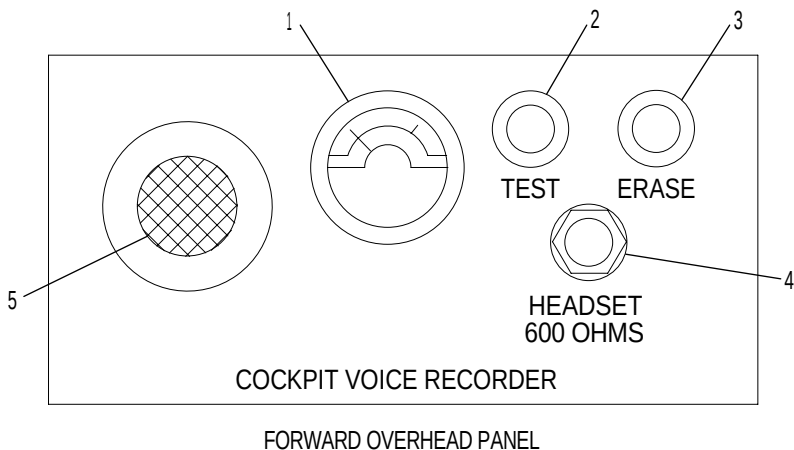
1. CALL Switches - white

- PILOT - Push to call pilot. CALL light illuminates in cockpit and chime sounds.
- MID/OWING/AFT - Push to call selected station. RESET light illuminates at selected station and chime sounds.
- RESET - Push to extinguish master call and reset light.

2. PA Switches/Light - white

- ALL/FWD/MID/AFT - Illuminates white when the system is powered. Push to select a zone for PA call.
- IN USE - Illuminates white when PA system is in use or indicates a handset is off the hook at any station.

Cockpit Voice Recorder Panel



CAG(IGDS)

LB1-3-0055

1. Test Monitor Meter

Indicates the recording level during a test. When the TEST button is pushed, the meter should read in the green band.

2. TEST Button

TEST - Push to initiate a timed test signal, applied at preset intervals, for each channel. The complete test cycle lasts approximately 5 seconds and is accompanied by an aural tone heard through the headset.

3. ERASE Button

ERASE - Push and hold for 2 seconds, when the airplane is on the ground and the parking brake is set, to erase previously recorded cockpit sounds.

4. HEADSET Jack

When the headset is plugged in to this jack and the TEST button is pushed, an aural tone indicates that the system is operational.

5. Cockpit Monitor Microphone

All audible sounds in the cockpit are recorded through the cockpit monitor microphone.

Cockpit Entry Video System (CEVS)



1. Display Unit

The Display Unit (DU) will be located in the area just forward of the throttles and the Autobrake Control Panel, between both FMS MCDUs. The DU will be mounted in a sunken position in a new plate at an angle of 20 degrees (parallel to the MCDUs). The DU consists of a 6.4 inch LCD with a 150-degree viewing angel. On the DU itself are no controls.

2. Control Panel

The CEVS Control Panel will be mounted in the right column of the pedestal. It will be located directly aft the F/O's Audio Control Panel. The panel will be equipped with a Power Switch (POWER), a 4-position camera selector (VIEW) , a Back-light standby button (STBY) and a Display back light selector (DIM).

3. Camera

The CEVS utilises black and white, near infrared video cameras with a 90-degree field of view. The camera assembly is built into a reading light housing. The cameras are adjusted in such a way that as much as possible of the intended area is visible on the DU.

The camera locations are:

- Camera 1, in the ceiling panel directly aft of the cockpit door. This camera faces aft and covers the area aft of door 11 and 21.
- Camera 2, above and aft door 11. This camera faces inboard/forward and covers the area from door 11 to the coatroom.
- Camera 3, above and aft door 21. This camera faces inboard/forward and covers the area from door 21 to the coatroom.
- Camera 4, above the most forward center passenger seat row. This camera faces forward and covers the area aft of the coatroom and the partition behind door 11 and door 21.

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Communications Alerts

Chapter Comm Section 40

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

Cyan Alerts (Level 0)

ACARS MESSAGE - ACARS has received a message.

ACARS NO COMM - ACARS has no available communications link.

VHF-3 VOICE - ACARS is in voice mode.



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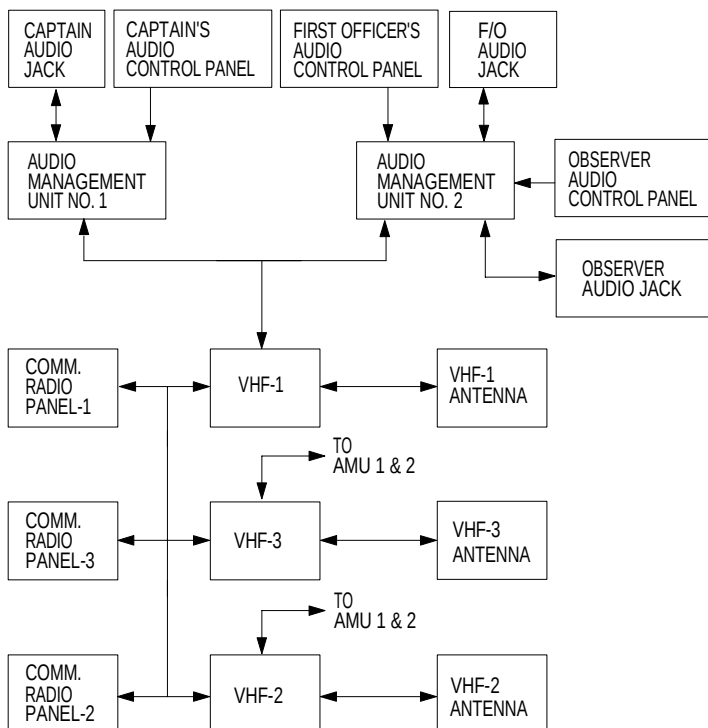
Communications

Functional Schematic

Chapter Comm

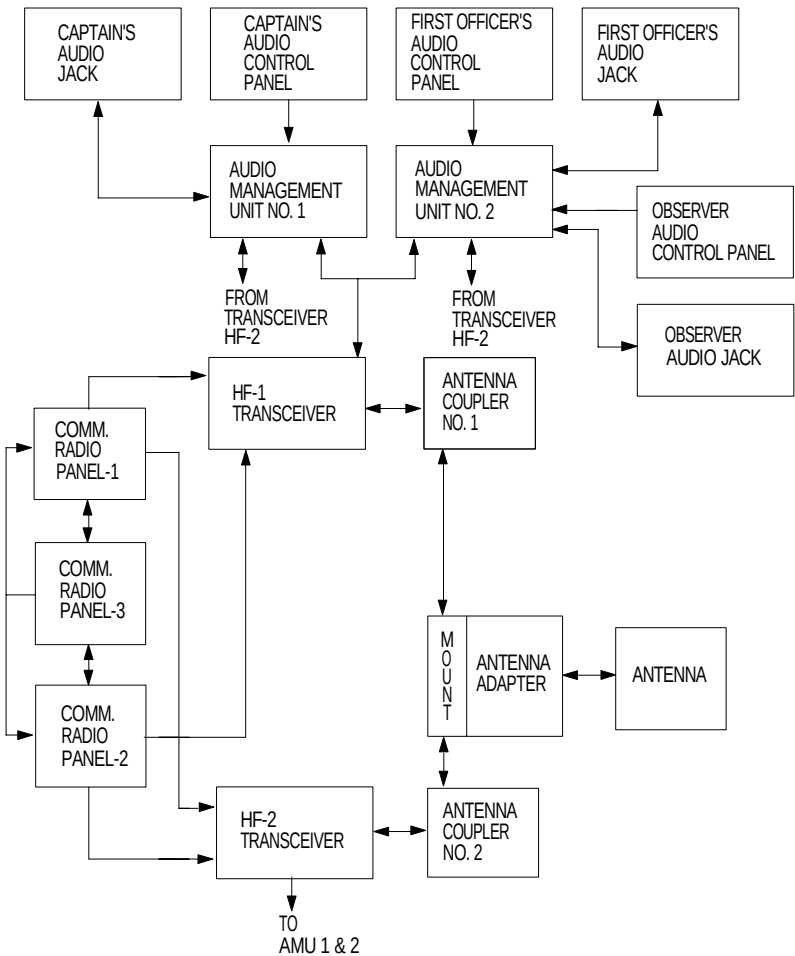
Section 50

VHF System Block Diagram



DB1-2-1712

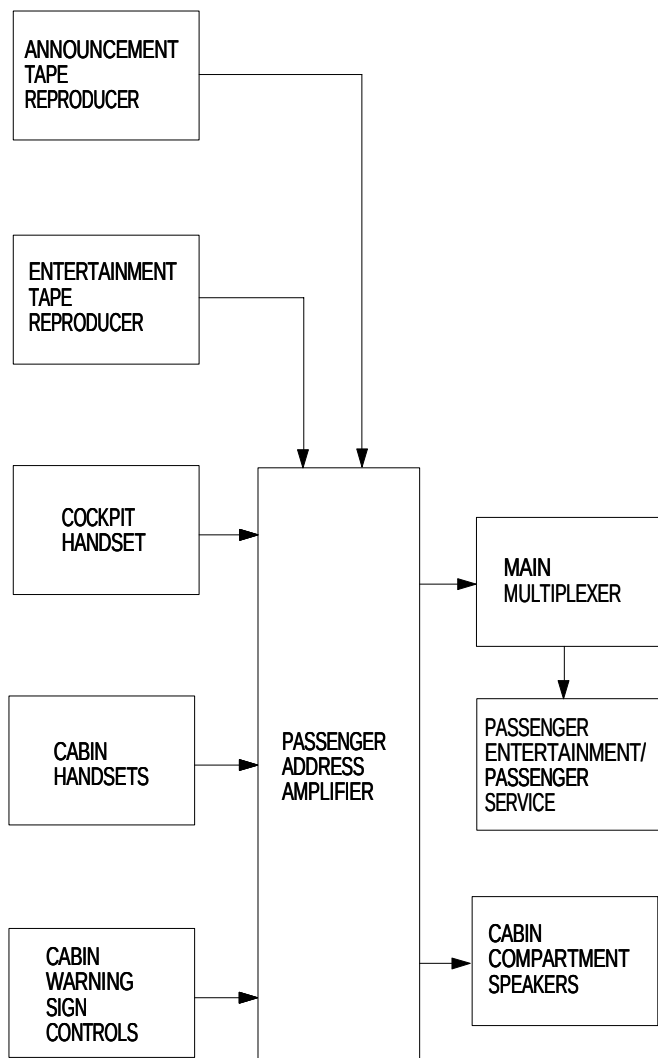
HF System Block Diagram



DB1-2-1713

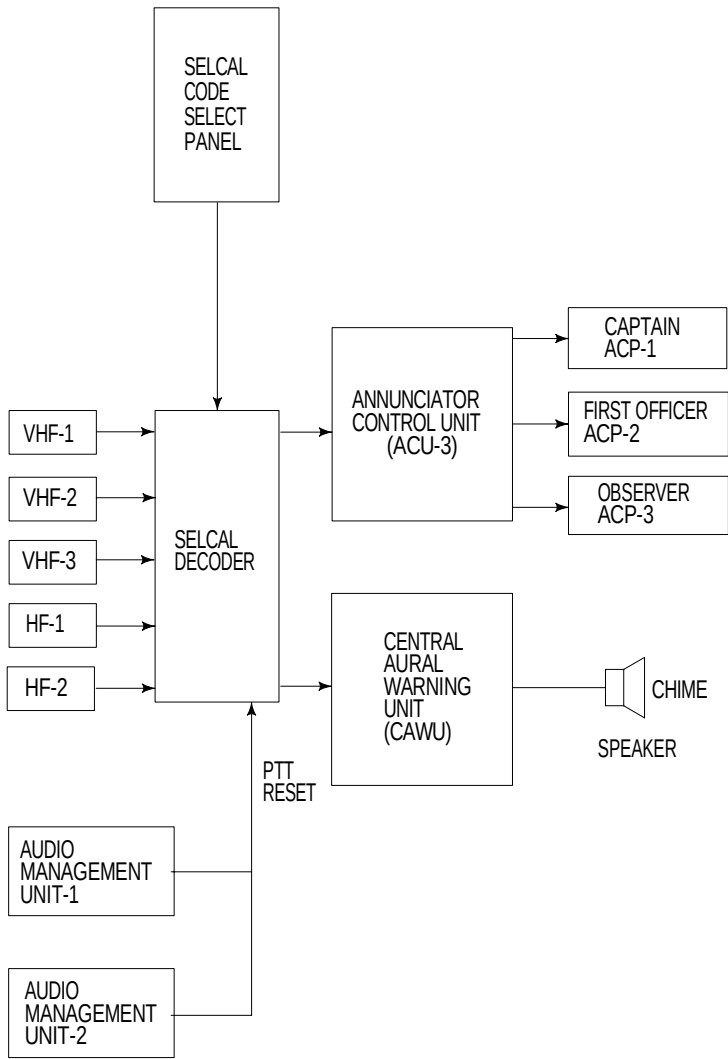
MD-11 Flight Crew Operations Manual

PA System Block Diagram



DB1-2-1714

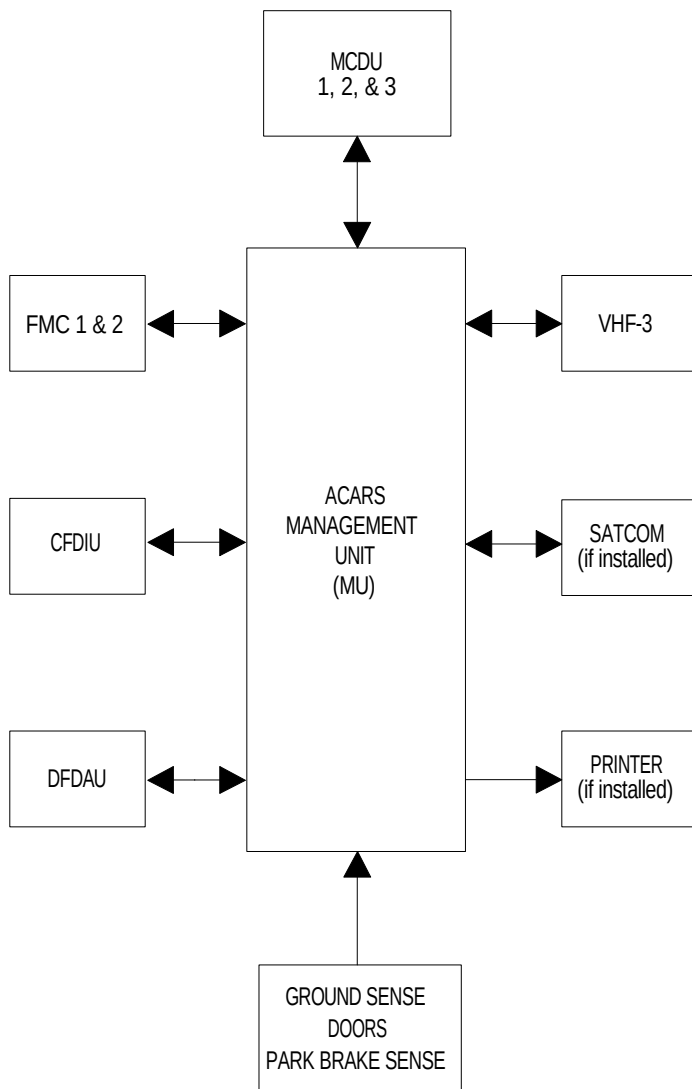
SELCAL System Block Diagram



DB1-2-1715

MD-11 Flight Crew Operations Manual

ACARS Block Diagram



DB1-2-1716

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Electrical Description and Operation

Chapter Elec Section 10

General

The ac and dc electrical systems are normally powered by three engine driven Integrated Drive Generators (IDG). They may also be powered by an Auxiliary Power Unit (APU) generator, or an external source through two external power receptacles (main and galley).

The main external power plug connects external power to the main aircraft buses. The galley external power plug connects external power to the galley buses.

During emergency operation the Captain's and First Officer's flight essential equipment may be powered by a battery and by an Air-Driven Generator (ADG).

Distribution and control is normally done automatically by the Generator Control Units (GCU) and the Electrical Power Control Unit (EPCU). In case of failure of the automatic system the flight crew can control the electrical system manually with controls on the forward overhead panel.

Due to the design of the electrical system, there are no special procedures for operation in the manual mode.

The EPCU transmits system status and alerts to the Engine and Alert Display (EAD) and the System Display (SD).

AC Power

Integrated Drive Generator (IDG)

During ground operations, ac power is supplied by two external power sources, the APU generator, or by one or more of the three engine driven IDGs.

Each IDG is attached to each engine accessory gearbox by means of a Quick Attach/Detach (QAD) adapter.

The IDG consists of a hydromechanical Constant Speed Drive (CSD) and an oil cooled generator mounted side by side in a common housing. The CSD portion of the IDG converts variable input speed from the engine accessory gearbox to a constant output speed. This constant output speed drives the generator portion of the IDG producing a constant 400-Hz frequency output.

The IDG will function paralleled or isolated.

Each IDG is able to supply sufficient power for operation of all essential electrical systems.

APU Generator

The APU generator is installed in the tail section and provides electrical power for ground operations. The APU also serves as a supplemental electrical power source when required in certain flight phases.

The APU generator does not have a CSD. The APU is governed to drive the generator at the correct speed.

External Power

The main external power receptacle is on the ground power panel near the nose of the aircraft. It connects external power onto the ac generator buses through the Bus Tie Relay-External Power (BTR-EP), the External Power Relay (EPR) and associated Bus Tie Relays (BTR). Main external power will not power the galley buses.

Additionally, on passenger aircraft, a galley external power receptacle (on ground power panel) connects external power onto the galley buses through galley transfer relays (GTR) 1, 2, and 3.

AC Distribution

Three independent ac generator buses distribute power to the aircraft ac buses and Transformer Rectifier (TR) units. Each IDG assumes the loads on its respective ac generator bus through its own independent supply network.

Paralleling of the ac generator buses is accomplished automatically through the ac tie bus. This allows assumption of electrical loads by any functioning IDG.

The APU generator can power any of the ac buses through its own independent supply network.

A time limited emergency ac source is available to the left emergency ac bus through the battery/inverter combination. The ADG may be used to power the left and right ac/dc bus, the battery bus and the battery charger.

The ac generator buses and the ac ground service bus supply most of the centrally located and/or high current loads (hydraulic pumps, most fuel pumps, ac buses, and galley power). Power for lower current, non-centrally located loads and essential loads is supplied through the three ac buses, cabin ac buses, ground service buses, and the two ac emergency buses.

Instrument buses supply their respective component loads.

The ac ground service bus distributes power to those components essential to ground servicing operations. The APU generator or main external power can be connected to the ac ground service bus without energizing any of the other ac generator buses. This allows ground servicing of the aircraft without having to energize the whole electrical power distribution system. The ac ground service bus is powered by ac generator bus 2 in flight.

No Break Power Transfer (NBPT) and Parallel Operation

A complete NBPT system is provided on the aircraft. Power transfers between external power, APU generator, and IDG electrical power will normally occur without a power interrupt. If the two power sources cannot be synchronized closely, a break power transfer will occur.

Non-interrupted electrical power is supplied to the aircraft buses by momentarily paralleling alternate electrical power sources before the power transfer occurs. The power source with the highest priority (or selection) momentarily parallels with the lower priority power source before the lower priority power source is disconnected from the bus.

When the electrical power source is available and selected on, the power source priority for the ac generator bus is as follows:

1. Associated IDG.
2. APU generator.
3. The ac tie bus (external power or IDG).

When the electrical power source is available and selected on, the power source priority for the ac tie bus is as follows:

1. External power.
2. Any IDG.

For example, no break power transfer will occur automatically when the IDGs can no longer power the buses after engine shutdown. If both APU and EXT power are available, the APU has the higher priority and will supply electrical power to the buses. On APU shutdown, external power, if available, will take over.

Momentary paralleling between IDG, APU generator, and external power is completely automated through the GCUs and EPCU once the flight crew has selected the respective power source on or off.

Except for dual land operation and external power on the tie bus, the IDGs will normally operate in the parallel mode. Parallel operation of the IDGs is also completely automated through the GCUs and the EPCU.

Generator Control Units (GCU)

The respective GCU (1, 2, 3, and APU) controls the following:

- GR 1, 2, and 3.
- BTR 1, 2, and 3.
- IDG disconnect (crew command).
- DC ties 1 and 3.
- NBPT from APU generator to external power.
- NBPT from APU generator to IDG.
- NBPT from IDG to EXT power across BTR 1, 2, and 3.
- NBPT from external power to IDG.

The respective GCU (1, 2, 3, and APU) regulates the following:

- IDG and APU generator voltage.
- IDG frequency and current limit.
- IDG load control.

Each GCU (1, 2, 3, and APU) protects its respective generator from electrical faults.

The respective GCU (1, 2, 3, and APU) provides automatic operation of:

- IDG reset due to generator protective trips.
- ac generator bus 1, 2, and 3 fault reset.
- Maintaining IDG oil temperature and pressure indication for IDG fault indicating.

Electrical Power Control Unit (EPCU)

The EPCU controls the following:

- EPR.
- BTR-EP.
- Ground Service Relay (GSR) - external power position.
- Auxiliary Power Relay (APR) 1, 2, and 3.
- Load shedding.
- APU N2 speed for APU NBPT operation.
- NBPT from external power to APU generator.
- NBPT from IDG to external power across BTR-EP.
- NBPT from IDG to APU generator.
- DUAL LAND mode electrical system configuration.
- Electrical Power System (EPS) operating mode.
- EPS parameter transmission to EIS.
- EPS fault transmission to the CFDS.
- Frequency reference for GCU 1, 2, and 3.
- Galley Transfer Relay (GTR) 1, 2, and 3.

The EPCU provides protection for the following:

- Main external power phase sequence.
- Main external power over/under voltage.
- Main external power over/under frequency.
- Main external power feeder fault.
- ac tie bus fault.
- If galleys are installed, galley external power voltage, frequency and phase sequence.

The EPCU provides automatic operation of the following:

- APU generator reset for incorrect voltage, frequency or feeder faults.

- Emergency power transfer.
- Smoke procedure.

Protection for ac bus, galley bus, and equipment feeder faults is provided by individual Remote Control Circuit Breakers (RCCB), Circuit Breakers (CB), or fuses.

If galleys are installed, feeder fault and overload protection for the galley buses is also provided by the Galley Load Control Units (GLCU).

DC Power

Transformer Rectifier (TR) Units

Four 75-amp TRs provide dc power to the aircraft dc buses (includes the battery bus). The TRs convert 115-volt ac power into 28-volt dc power. The battery and/or the ADG (through TR 3) may be used as emergency dc power sources.

DC Distribution

Four dc tie RCCBs are normally closed for parallel dc operation. This ensures all dc loads are supplied power during start up, normal operation, shutdown, and abnormal conditions.

An RCCB is used to connect each of the TRs to a common tie bus. This dc bus arrangement allows supplying any single load from any one of the TRs.

If isolated, the four TRs receive ac power from the following ac buses:

- TR 1 receives power from ac generator bus 1.
- TR 2A receives power from ac generator bus 2.
- TR 2B receives power from the flight compartment ac ground service bus.
- TR 3 receives power from the right emergency ac bus.

Emergency Power

The emergency power system consists of one main battery, a battery charger, a manually deployed ADG, and a static inverter.

The main battery is a 28-volt dc battery consisting of two 14-volt dc halves.

The battery charger converts ac input into a controlled dc output to keep the battery fully charged. Battery power is supplied directly to the battery direct bus. The battery can provide power to the left emergency ac and dc buses whenever the left emergency ac or dc bus loses power. The battery direct bus is powered at all times.

A static inverter inverts battery dc power into ac emergency power for the left emergency ac bus.

With the EMER PWR selector in the ARM position and the BAT switch in the ON position (emergency power armed), the left emergency ac and dc buses will automatically transfer to main battery power when either the left emergency ac or dc bus is de-energized (emergency power on).

The ADG is an air cooled, turbine generator that consists of an air turbine unit, brushless generator, and voltage regulator.

With emergency power on and the ADG deployed, the ADG will supply electrical power to:

- The left emergency ac bus and auxiliary hydraulic pump 1 when the ADG ELEC switch is in the OFF position (battery supplies the left emergency dc and battery bus for 90 minutes).
- The left emergency ac bus, left emergency dc bus, right emergency ac bus, right emergency dc bus, battery bus, and the battery charger when the ADG ELEC switch is in the ON position (battery is charged by the battery charger). There is no time limit of the ADG electrical power in this configuration.

This arrangement will allow the battery and ADG to provide emergency electrical power to the Captain's flight essential equipment during an all engines failed situation, or it will allow the ADG to provide non-time limited emergency power to the Captain's and First Officer's flight essential equipment during an all generators failed situation.

During an all engines failed situation, or an all generators failed situation, the battery alone (without the ADG) will supply approximately 15 minutes of emergency electrical power to the Captain's flight essential equipment.

EIS Test Display

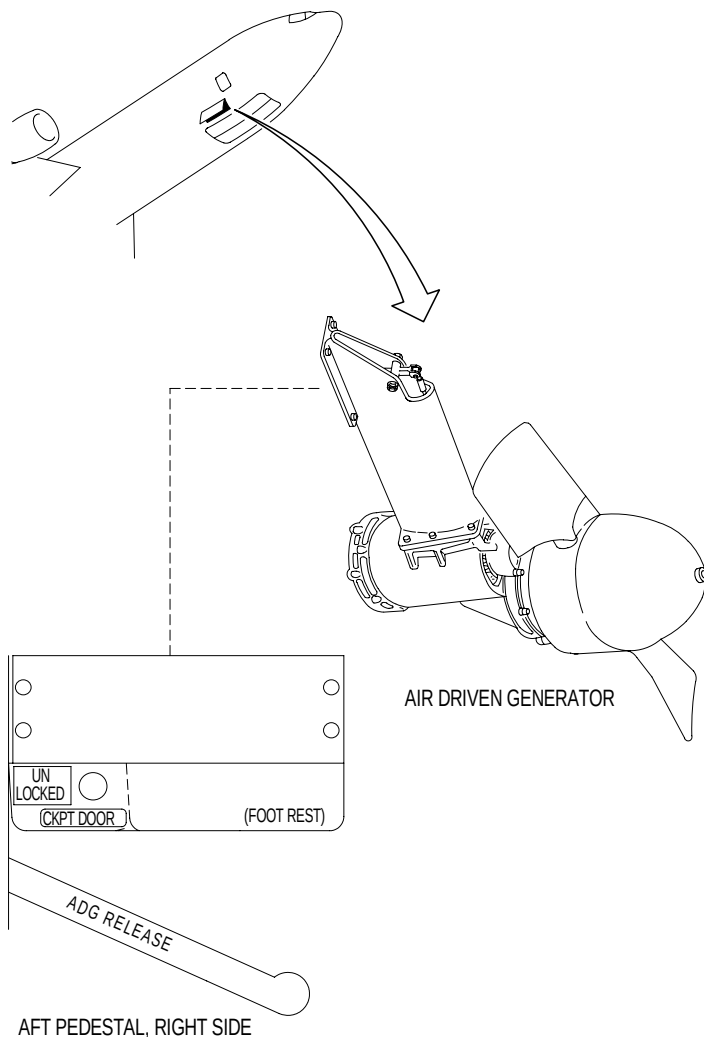
All ELECTRICAL synoptic data digits will be crossed out with amber Xs when all of the conditions are met as follows:

- The aircraft is on the ground.
- The aircraft is operational.
- The ANNUN LT TEST button on the forward overhead panel is pushed.
- The ELECTRICAL synoptic has been selected to appear on the SD.

Electrical Components

Chapter Elec Section 20

Air Driven Generator



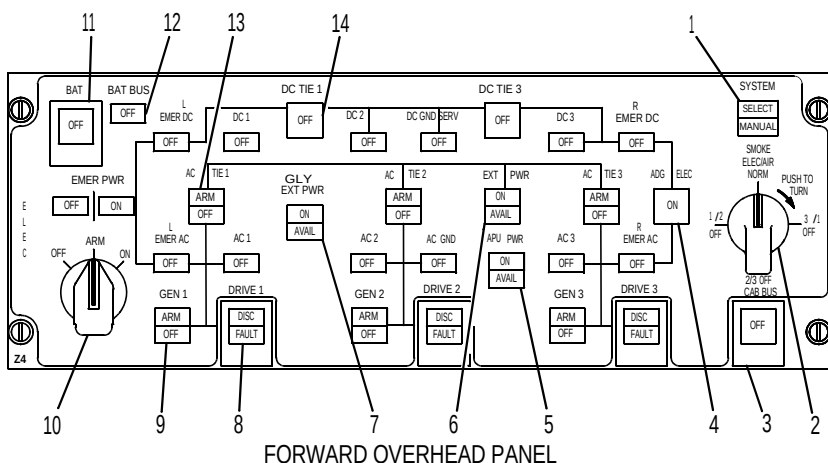
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Electrical Controls and Displays

Chapter Elec Section 30

Electrical Control Panel



DB1-2-1951

1. SYSTEM SELECT/MANUAL Switch - amber

This is an alternate action switch that allows selection between manual and auto modes.

SELECT illuminates amber if the electrical system reverts from auto to manual. In this case, the SEL ELEC SYS MAN alert will be on the EAD and the crew should push this switch to extinguish the SELECT light.

MANUAL illuminates amber if the system is in manual.

MANUAL flashes amber if the system is in auto and a switch on the ELEC control panel has been pushed that has no effect in auto.

2. SMOKE ELEC/AIR Selector

This selector controls the electrical and air smoke isolation functions when the system is in auto or manual mode.

NORM - All gen relays, aux pwr relays, bus tie relays, and dc tie RCCBs are in normal auto or manual mode. Air system operation is normal.

3/1 OFF - Gen relay, aux pwr relay, bus tie relay and dc tie 3 are open. Gen channel 3 is unpowered, ECON mode and galley bus 3 is unpowered. Pack 1 and air supply 1 turn off and EIS CRTs go full bright.

2/3 OFF - Gen relay, aux pwr relay, bus tie relay, and dc tie 3 return to state prior to SMOKE switch operation. When gen channel 3 is again powered, gen channel 2 becomes unpowered. Galley bus 3 is again powered and galley bus 2 is unpowered. Gen relay, aux pwr relay, and bus tie relay 2 are open. Pack 1 and air supply 1 are reinstated. Pack 3 and air supply 3 are turned off.

1/2 OFF - Gen relay, aux pwr relay, bus tie relay 2 return to state prior to SMOKE switch operation. When gen channel 2 is again powered, gen channel 1 becomes unpowered. Galley bus 2 is again powered and galley bus 1 is unpowered. Gen relay, aux pwr relay, bus tie relay, and dc tie 1 are open. Automatic transfer or emer pwr is inhibited. Pack 3 and air supply 3 are reinstated. Pack 2 and air supply 2 are turned off.

NORM - Gen relay, aux pwr relay, bus tie relay, and dc tie 1 return to state prior to SMOKE switch operation. Turns on pack 2 and air supply 2. Returns ECON mode and galley bus 1 to normal operation. EIS CRTs return to auto brightness control.

3. CAB BUS OFF Switch - amber

This switch is a guarded alternate action switch that opens the RCCB bus feeds to the following buses when the system is in auto or manual:

- Cabin AC buses 1 and 3.
- Cabin AC ground service bus.
- Cargo loading bus.

With the CAB BUS OFF light illuminated, power is removed from all cabin buses, including galley buses.

4. ADG ELEC ON Switch - amber

This switch is an alternate action switch that is used after ADG deployment. Operation is the same in auto or manual.

OFF - electrical power is supplied to the aux hydraulic pump. If emergency power is on, power will also be supplied to the left emergency ac bus.

ON - electrical power is supplied to the right and left emergency ac buses, right and left emergency dc buses, battery charger, and battery bus.

5. APU PWR ON/AVAIL Switch - blue/green

The APU PWR switch is a momentary contact switch that starts the APU from the ELEC panel and supplies electrical power to any generator bus. Switch operation is the same in manual or auto mode. Pushing the APU PWR switch starts the APU. If the APU was started by the APU START/STOP switch, it cannot be stopped with this switch.

When this switch is used to start the APU, AVAIL will flash green until APU reaches 95 percent N2. AVAIL will illuminate steadily when APU power is correct. If APU power is not correct, AVAIL light will extinguish.

ON illuminates blue when any APR is closed.

6. EXT PWR ON/AVAIL Switch - blue/green

The EXT PWR switch is a momentary contact switch that supplies external power to the main aircraft buses when the system is in the auto or manual mode.

AVAIL illuminates green when external power is available. Main external power plug must be correctly seated to receptacle and correct signal must be received by the electrical power control unit.

ON illuminates blue when the bus tie relay-external power is closed. If an incorrect signal is received by the electrical power control unit, power receptacle is improperly seated, or switch is pushed while in the ON position, external power is disconnected and ON extinguishes.

7. GLY EXT PWR ON/AVAIL Switch - blue/green

The GLY EXT PWR switch is a momentary contact switch that supplies external power to the galley buses when the system is in the auto or manual mode.

The GLY EXT PWR switch is a momentary contact switch that supplies external power to the galley buses when the system is in the auto or manual mode. This switch is only operative for galley 2.

AVAIL illuminates green when galley external power is available. Galley external power plug must be correctly seated to receptacle and correct signal must be received by electrical power control unit.

ON illuminates blue when galley external power is selected on. If an incorrect signal is received by the electrical power control unit, power receptacle is improperly seated, or switch is pushed while in the ON position, galley external power is disconnected and ON extinguishes.

8. DRIVE 1/2/3 DISC/FAULT Switch - amber

The generator DRIVE switch (guarded) is a momentary contact switch that disconnects the IDG through the generator control unit when the system is in auto and manual mode.

FAULT illuminates amber when a situation requiring an IDG disconnect has occurred.

DISC illuminates amber when an IDG disconnect has taken place. DISC extinguishes when the light illumination logic is reset through the CFDS interface with the EPCU or after the IDG input spline is mechanically reconnected and the engine is run up to about ground idle.

CAUTION: Do not disconnect an IDG with engine speed less than ground idle. Disconnecting an IDG with engine speed less than ground idle will cause damage to the IDG input shaft and seal.

9. GEN 1/2/3 ARM/OFF Switch - blue/amber

The GEN switch is a momentary contact switch that resets the respective generator when the electrical system is in the manual mode. Switch has no effect if system is in auto mode.

OFF illuminates amber when the generator control relay is tripped open.

ARM illuminates blue by pushing the GEN switch from the off position. This initiates a generator control unit to close the generator relay when the generator power is correct. Switch position automatically reverts to OFF when a protective trip of the generator relay occurs in the ARM/reset position. When ARM is illuminated, the generator control relay is closed and the generator relay is open.

The GEN switch is blank when the generator relay is closed.

10. Emer Pwr OFF/ARM/ON Selector and OFF/ON Light - amber

The EMER PWR selector is a three position selector. It operates when the system is in the auto or manual mode as follows:

With the selector in the OFF position the main battery is not allowed to supply power to the left emergency ac and/or dc bus. OFF will illuminate amber.

With the selector in the ARM position the main battery is automatically transferred to the left emergency ac or dc bus when the system conditions are correct. ON will illuminate amber upon transfer. Conditions required for an automatic transfer are:

- BAT switch in ON position.

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- SMOKE ELEC/AIR Selector not in 1/2 OFF position (Generator channel 1 de-energized).
- Left emergency ac or dc bus de-energized.

With the selector in the ON position, the left emergency ac and dc buses are transferred to battery power. ON will then illuminate amber.

If this selector is in ARM when the aircraft electrical power is shutdown, the emergency circuits will remain activated, resulting in depletion of the aircraft batteries.

NOTE: If emergency power automatically transfers ON and then normal power is restored, this selector must be cycled OFF and back to ARM to allow the L emer buses to be powered by the main generator bus. If this is not done, the L emer buses will continue to be powered by the aircraft batteries.

11. BAT OFF Switch - amber

The BAT switch is a guarded, alternate action switch that disconnects the battery from the battery bus and battery charger. This switch is normally on and operates the same when the system is in the auto or manual mode.

When the switch is on, battery charger is allowed to charge the main battery if:

- Battery power is not supplying the left emergency dc bus or (through the static inverter) the left emergency ac bus.
- Inverter powered ground refueling is not taking place.
- Transformer rectifier bus 2A or transformer rectifier bus 2B is energized or the ground service relay is closed into the APU or EXT PWR position.
- Ac power is present at battery charger input.

When the switch is on, battery is connected to the battery bus if:

- Transformer rectifier bus 2A and transformer rectifier bus 2B are not energized.
- Ground service relay is not closed into APU or EXT PWR position.

The switch illuminates amber when pushed into the OFF position. The battery is then disconnected from the battery bus and is not allowed to be charged by the battery charger. Automatic transfer of emergency power to the left emergency ac or dc buses is inhibited.

12. BAT BUS OFF Lights (13) - amber

Illuminates amber when associated ac or dc bus is deenergized. There is one light for each ac or dc bus.

13. AC TIE 1/2/3 ARM/OFF Switch - blue/amber

The AC TIE switch is a momentary switch that controls the respective bus tie relay when the system is in manual mode. Switch has no effect when the system is in auto mode.

OFF illuminates amber when the respective bus tie relay is open and the AC TIE switch is in the OFF position. Related buses are then isolated from the ac tie bus.

ARM illuminates blue when the respective bus tie relay is open and the AC TIE switch is in the ARM position. In ARM, bus tie relay is controlled automatically by the generator control unit.

OFF and ARM extinguished indicates that the respective bus tie relay is closed.

Switch illumination is inhibited during dual land operation.

14. DC TIE 1/3 OFF Switch - amber

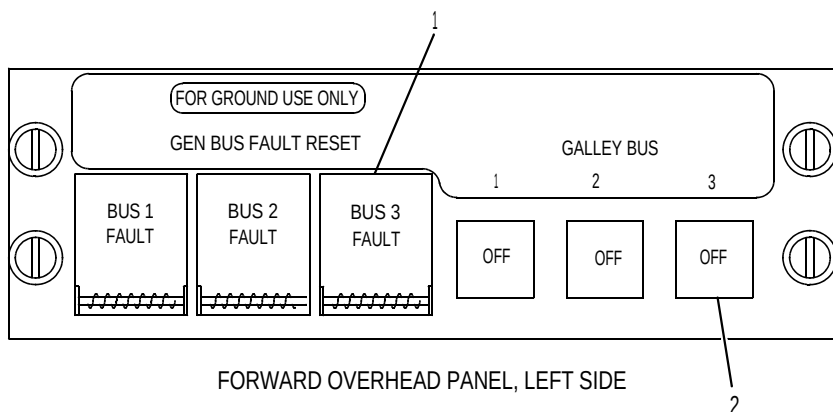
The DC TIE switch is a momentary switch that controls the respective RCCBs when the system is in the manual mode. Switch has no effect when the system is in auto mode.

OFF illuminates amber when the respective RCCBs are open and the generator control unit is inhibited from closing the RCCBs. Pushing switch from the OFF position places it in the ON position and returns control to the generator control unit. Switch position will revert to OFF if the switch is pushed or a protective trip of the RCCBs occurs.

OFF extinguishes when the RCCBs are closed.

Switch illumination is inhibited during dual land operation.

Gen Bus Fault Reset Panel



DB1-2-1953

1. GEN BUS 1/2/3 FAULT RESET Switch - amber

To be used by maintenance personnel only. When pushed, resets the associated BTR or APR. Switch has no effect when the electrical system is in auto mode. Illuminates amber when a generator bus fault trips (and locks out) the associated BTR or APR. Also illuminates when an ac tie bus fault trips (and locks out) all of the BTRs.

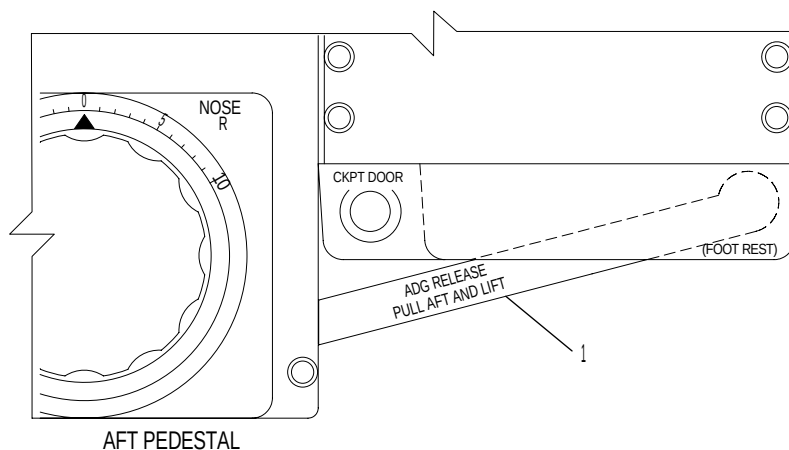
2. GALLEY BUS 1/2/3 OFF Switch - amber

The GALLEY BUS switch is a momentary contact switch that inhibits the galley transfer relays from being closed. .

This switch has no effect when system is in the auto mode. Switch has two positions in the manual mode: OFF and reset/on. Switch position is controlled internally by the electrical power control unit. The reset/on position initiates a galley bus reset and allows galley transfer relays to close.

The switch illuminates amber when galley transfer relays are open or upon receiving a trip signal from the galley load control unit.

ADG Handle



LB1-3-0265

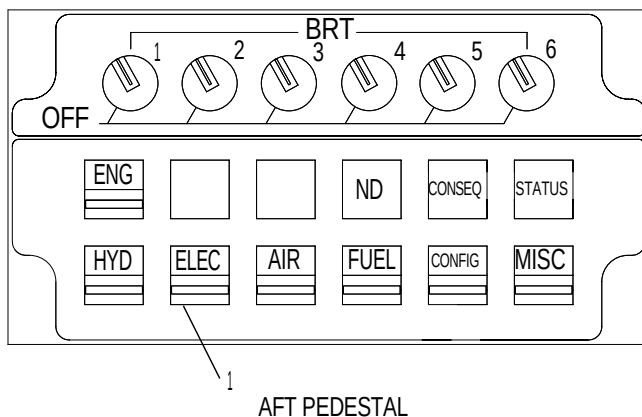
1. ADG Release Handle

This handle deploys (by cable) the ADG. The handle is safety wired in the stowed position. Pulling the handle aft will break the safety wire. A swift upward motion will unlatch and deploy the ADG.

When the ADG is fully out, an overcenter link locks the ADG in the deployed position and locks the handle in the up position.

The handle operates in one direction only, to deploy the ADG. The ADG can only be retracted on the ground by maintenance personnel.

Elec Cue Switch



LB1-3-0266

1. ELEC Cue Switch - white

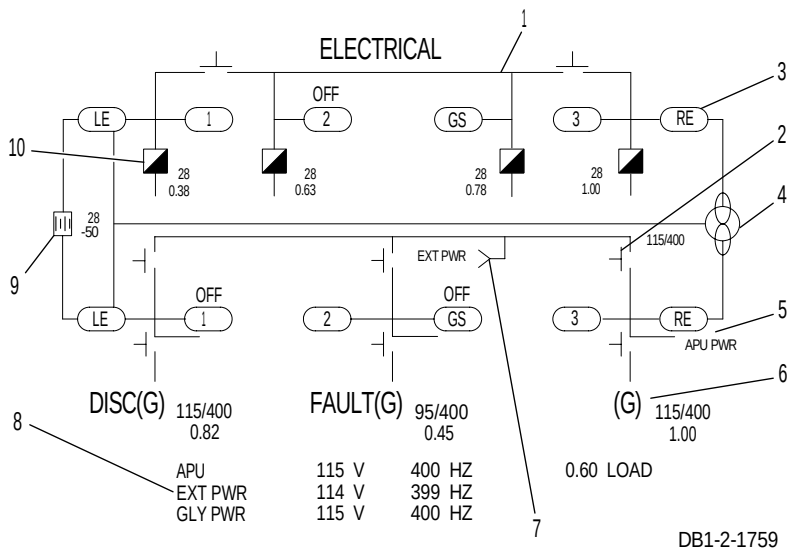
Illuminates white when an ELEC alert is displayed on the EAD.

When pushed:

- MASTER CAUTION or MASTER WARNING lights will extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- Synoptic and consequences come into view on SD.

Some level 1 alerts are maintenance alerts that appear on the SD STATUS page only. These maintenance alerts will not illuminate the cue switch or the MASTER CAUTION lights.

SD Synoptic



1. Schematic Lines

Schematic lines representing power buses are shown as solid white lines at all times.

2. Relays

Relays are shown green when closed and are white when open during normal operation. Relays are amber when open due to a fault.

3. Buses

Buses are shown in green with the bus name inside in white. If off, the buses turn amber and OFF will appear in amber above the bus.

4. Air Driven Generator (ADG)

The ADG and all connecting lines are shown in white. When in use, the ADG symbol is shown in green with its voltage and frequency shown to the left of the ADG symbol in white. If ADG voltage and/or frequency are out of limits, the associated parameter will be boxed and amber. If no valid data is available, the data will be removed.

5. APU Power

APU PWR is shown only when APU power is available. APU PWR will be white with white lines connecting to the three bus lines receiving APU power. When APU power is in use on any bus, the text will turn green. APU voltage, frequency, and load are shown in white digits below the schematic. The APU voltage, frequency, and load parameters will be white during normal operation. The APU voltage and frequency parameters will be boxed and amber when any abnormal APU GEN OFF condition exists. The APU load parameters will be amber and boxed when an APU GEN LOAD HI condition exists. If no valid data is available it will be removed.

6. Generator (3)

The ac generators are shown in green with their voltages, frequencies, and loads in white. The generator will turn amber and associated parameters will turn amber and boxed when a GEN OFF condition exists. The generator load parameters will be amber and boxed when a GEN LOAD HI condition exists. The ac generator symbol is shown in white when engines are off or during engine start-up or shutdown. If a fault requiring disconnect occurs, FAULT is shown at the side of the symbol in amber. When the generator is disconnected, FAULT is replaced by DISC. If no valid data is available, the data will be removed and replaced with an amber X.

7. Main External Power

External power is available when a white EXT PWR is shown and it is connected to the buses receiving external power with white lines. When in use, EXT PWR will turn green. The external power voltage and frequency are shown in white below the APU data. If no valid data is available, the associated data will be removed from the screen. If external power is not available all associated displays are removed.

8. APU and EXT PWR

Associated voltage, frequency, and status are shown in white. If voltage and/or frequency are out of limits, the numbers are boxed and turn amber. If no valid data is available, it will be removed. GLY PWR not applicable on freighters.

9. Battery

The battery symbol is normally white with associated lines in white. The battery becomes green when emergency power is on. Battery voltage with the current load is shown in white next to the battery. The voltage turns amber and boxed, when out of limits. When emergency power is on, the battery load (amps) is shown next to the battery in white. If no valid data is available, the data will be removed and replaced with an amber X.

10. Transformer Rectifiers (TR)

Transformer rectifiers are normally shown in green but become amber when the TR fails. TR voltage and load digits are shown next to the TR symbol in white. If no valid voltage or load data is available, the associated data will be removed from the screen and replaced with an amber X.

**Electrical
Alerts****Chapter Elec
Section 40**

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

Amber Boxed Alerts (Level 2)

BUS L EMER AC OFF (ELEC) - The left emergency ac bus is unpowered.

BUS L EMER DC OFF (ELEC) - The left emergency dc bus is unpowered.

ELEC ALERTS (ELEC) - DEUs are not receiving data from the EPCU.

GEN 1/2/3 OFF (ELEC) - Generator 1/2/3 fault (manual mode). A protective trip has occurred.

GEN ALL OFF (ELEC) - No engine driven generator or APU generator is supplying electrical power. Fuel pressure to engine 2 may not be available. Without fuel tank pump pressure, engine 2 will probably flameout. If the ADG is deployed and ADG ELEC is on, the left aft pump in tank 2 can supply fuel pressure to engine 2. This pump will be powered from the right emergency ac bus. The tail tank alt pump can also be powered when the right emergency ac bus is powered.

GEN BUS 1/2/3 FAULT (ELEC) - The respective generator bus has been de-energized. Fault exists.

GEN DRIVE 1/2/3 FAULT (ELEC) - The respective generator drive oil temperature is high or pressure is low or oil differential temp is out of limits.

GEN LOAD HI (ELEC) - One or more engine driven generators or the APU generator has exceeded load limit.

Amber Alerts (Level 1)

AC TIE 1/2/3 OFF (ELEC) - If the respective AC TIE switch ARM light is illuminated, the relay has opened due to a fault. The system may be in auto or manual. If the respective AC TIE switch OFF light is illuminated, the relay has been commanded open by overhead panel switch action. The system may only be in manual. The OFF light will not illuminate in auto.

AC TIE FAULT (ELEC) - The ac tie bus is inoperative. Relays are locked out.

ADG ELEC SW ON (ELEC) - The ADG ELEC switch on the ELEC control panel has been selected ON.

BAT CHARGER INOP (ELEC) - The battery charger is inoperative.
Inhibited in flight.

BAT CHARGING (ELEC) - The battery is being charged. Normally
displayed for a short time following an APU start.

BAT DISCHARGING (ELEC) - Abnormal battery discharge is indicated.

BAT LOW (ELEC) - Battery voltage is below limit.

BAT SWITCH OFF (ELEC) - The BAT switch has been manually selected
to OFF.

BUS AC 1/2/3 OFF (ELEC) - The respective ac bus is unpowered or the
associated sensing circuit has failed.

BUS AC GND OFF (ELEC) - Ground ac bus is unpowered.

BUS DC 1/2/3 OFF (ELEC) - The respective dc bus is unpowered or the
associated sensing circuit has failed.

BUS DC CABIN OFF (ELEC) - The cabin dc bus is unpowered or the
associated sensing circuit has failed.

BUS DC GND OFF (ELEC) - The ground dc bus is unpowered or the
associated sensing circuit has failed.

BUS R EMER AC OFF (ELEC) - The right emergency ac bus is unpowered
or the associated sensing circuit has failed.

BUS R EMER DC OFF (ELEC) - The right emergency dc bus is unpowered
or the associated sensing circuit has failed.

CABIN BUS SW OFF (ELEC) - The CAB BUS switch has been manually
selected to OFF. This removes power from the cabin buses.

DC TIE 1/3 OFF (ELEC) - When system is in auto, the associated relay has
opened due to a fault. When the system is in manual, the relay has opened
due to a fault or the relay has been commanded open by overhead panel
switch action.

ELEC SYS MANUAL (ELEC) - The electrical system is in manual mode.

EMER PWR ON (ELEC) - Emergency power has been automatically
commanded or manually selected on.

EMER PWR SW OFF (ELEC) - EMER PWR selector has been manually
selected to OFF.

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

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EPGS FAULT (ELEC) - A fault exists in the SMOKE switch circuit, or an APU generator failure exists, or a generator (engine or APU) auto reset has been used.

GALLEY BUS OFF (ELEC) - One or more galley buses are not powered. To select galley bus power, the electrical system must be in manual mode. Does not apply on freighters.

GEN 1/2/3 OFF (ELEC) - The respective generator is off. In auto mode, a protective trip and one auto reset attempt has occurred, or the generator has been commanded on but the generator relay has not closed or the generator is failed. In manual mode, the respective generator has been turned off by the flight crew.

GEN DRIVE DISC (ELEC) - One or more of the generators has been disconnected.

SEL ELEC SYS MAN (ELEC) - GCU or EPCU does not agree with position of select switch or there is a failure in the auto system.

SMOKE SW IN USE (ELEC) - SMOKE switch on the ELEC control panel is out of the NORM position.

TR 1/2A/2B/3 FAIL (ELEC) - The respective transformer rectifier is unpowered.

Cyan Alerts (Level 0)

EXT POWER AVAIL - External electrical power is connected and available for use.

EXT POWER ON - External electrical power is powering the ac tie bus.

GLY EXT POWER ON - External electrical power is connected to the galley buses.

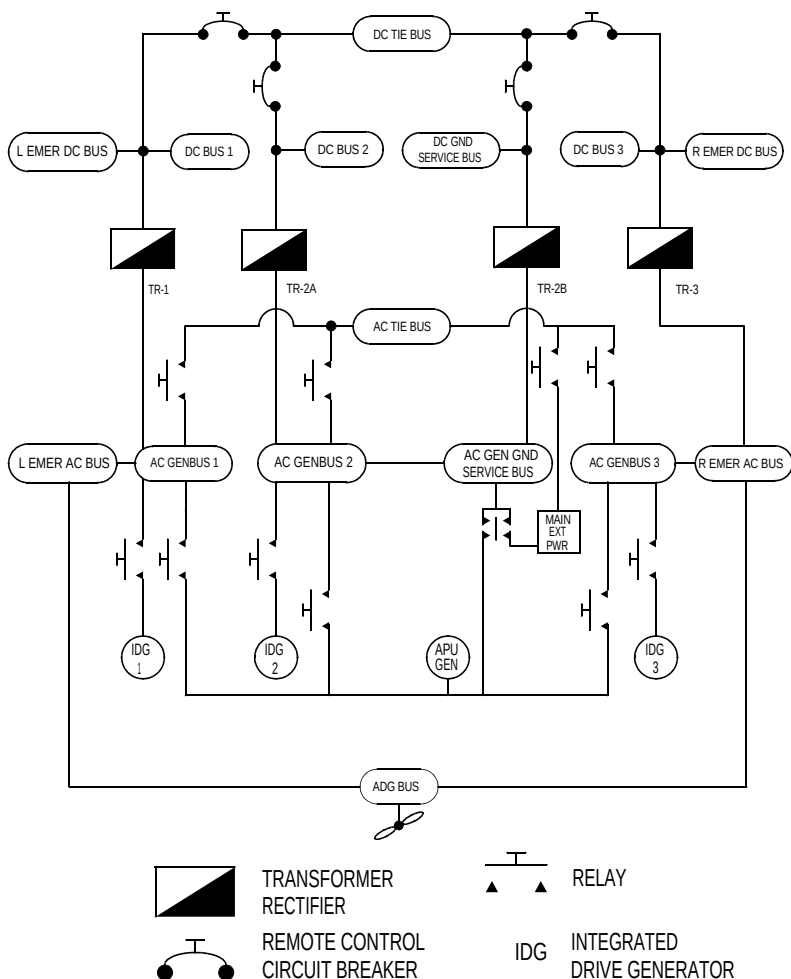
GLY EXT PWR AVAIL - Galley external electrical power is connected and available for use.

Intentionally
Blank

Electrical Functional Schematic

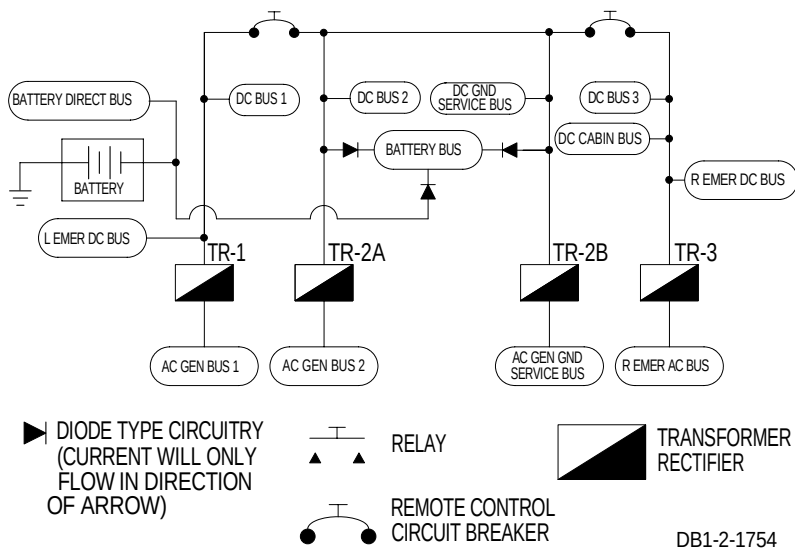
Chapter Elec Section 50

System Diagram

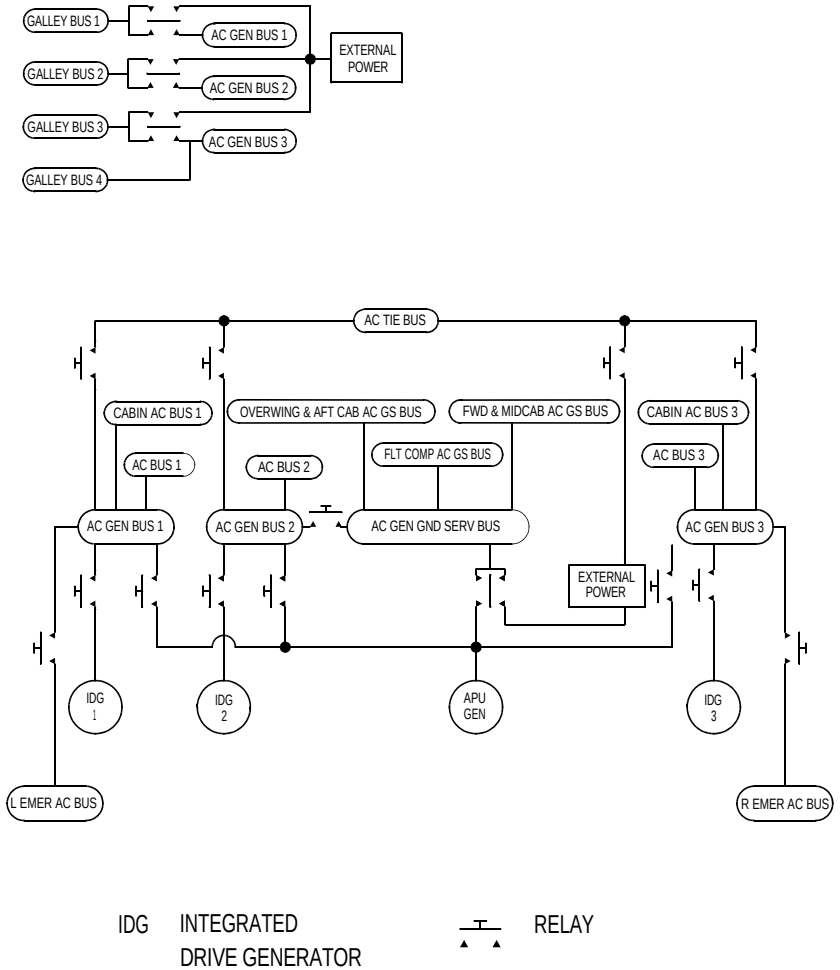


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DC Distribution

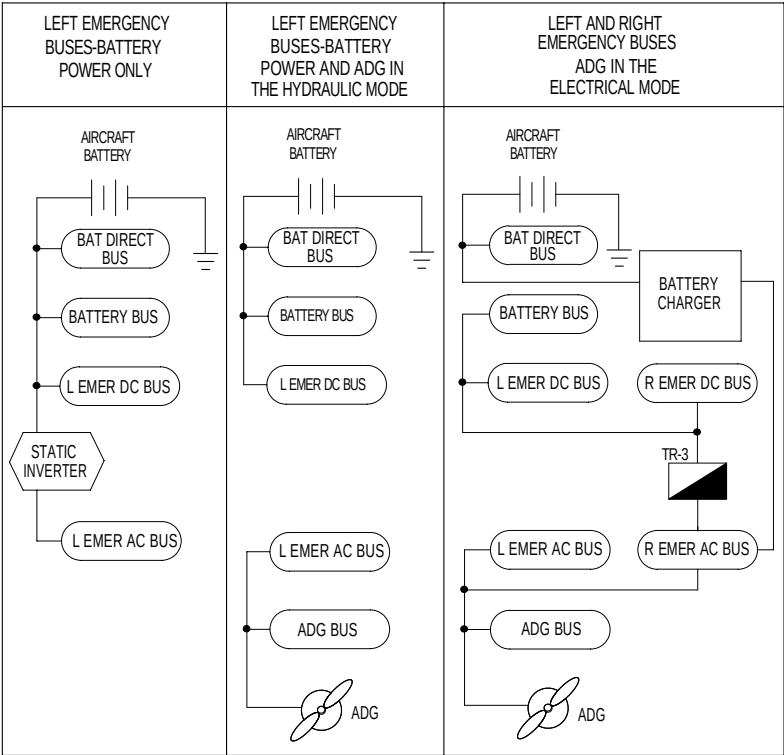


AC Distribution



DB1-2-1952

Emergency Power



ADG - AIR-DRIVEN GENERATOR
TR - TRANSFORMER RECTIFIER

LB1-3-0154

**Emergency Equipment**
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Emergency Equipment Description and Operation

Chapter Emer Section 10

Crew Oxygen

General

The crew oxygen system is supplied by one high pressure cylinders which connect directly to a high pressure regulator. Low pressure distribution lines deliver regulated oxygen to mask mounted regulators. This system supplies oxygen to the Captain, First Officer and up to two observers.

The oxygen supply cylinder has a usable capacity of about 115 cu. ft. and an operating pressure of 1,850 psig at 21° C. The cylinder pressure increases and decreases as the temperature of the oxygen increases and decreases.

The cylinder shutoff valve is threaded into the top of the crew oxygen cylinder.

The shutoff valve incorporates an overboard relief indicator that relieves an overpressured condition. The indicator is a green plastic disk on the lower left side of the aircraft nose. There is also a high pressure gauge for direct reading of the cylinder pressure.

A high pressure regulator mounts directly to the cylinder shutoff valve. This regulator reduces cylinder pressure to a constant system pressure.

The regulator has a relief port that dumps the oxygen overboard if the system overpressured.

There is also a high pressure transducer port on the regulator to measure cylinder pressure. This transducer sends an electrical signal to an indicator in the cockpit near the First Officer oxygen mask. The indicator is lighted so the crew can monitor cylinder pressure in a dark cockpit.

The mask assembly at each flight station consists of:

- Oronasal mask.
- Microphone with a quick disconnect fitting.
- Mask mounted diluter demand regulator.
- Inflatable pneumatic harness.
- Supply hose with a quick disconnect fitting.

The mask is equipped with a vent valve to purge the smoke from the goggles. The regulator can function in normal diluter demand, 100 percent oxygen, or emergency pressure breathing.

The regulator follows an automatic pressure breathing schedule. The regulator incorporates a toggle valve and a rotating selector valve to permit selection of the different modes of operation to supply oxygen to the mask.

The toggle valve on the regulator allows selection of 100 percent oxygen or a normal diluter demand breathing schedule.

The EMERGENCY pressure control knob provides a regulator flow test, and a positive pressure flow to the mask under emergency conditions (high cabin altitudes, smoke in the cabin). This allows only pure oxygen to flow to the mask.

The pneumatic harness is inflated for donning or doffing the mask by manually actuating a lever on the regulator. The harness will deflate upon release of the lever.

Each mask and smoke goggle assembly is stowed in a quick access stowage box at each flight crew station. The oxygen supply lines and microphone connections are at the base of each stowage box. The oxygen stowage box consists of:

- Supply manifold and check valve.
- PRESS TO TEST AND RESET lever.
- Flow indication blinker.
- Oxygen on flag.
- Mask supply hose with a quick disconnect fitting.

The crew oxygen system line pressure is sensed by a transducer located in the supply line leading to the First Officer's oxygen mask stowage box. The line pressure indicator is the same one used to indicate the crew cylinder quantity and is controlled by a switch near the indicator. One switch position will display cylinder quantity and the other position will display line pressure on the indicator.

The overboard relief indicator for both the cylinder shutoff valve and the regulator supply line overpressure are plumbed together to a single line which leads to the green blowout disc.

Passenger Oxygen

The passenger oxygen system provides emergency supplemental oxygen for all cabin occupants in the event of cabin depressurization. Oxygen masks are available:

- In the lavatory(s).
- At the attendant stations.
- At all installed passenger seats.

If the cabin altitude goes above 14,400 feet, a signal will be sent to open the oxygen mask doors. If the doors are not commanded open by 14,770 feet, the NO MASKS switch on the forward overhead panel will illuminate.

The same logic is used by the EIS for the NO MASKS alert on the EAD. The crew will then push the NO MASKS switch for 3 to 5 seconds. This action will deploy the masks through both relays. Pushing the NO MASKS switch will also extinguish the NO MASKS light and the alert.

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Removing and pulling any mask from a single or multiple mask unit will initiate the oxygen generating process. Oxygen will automatically flow through all the masks in that compartment. Oxygen will be supplied for a minimum of 15 minutes of continuous use. Oxygen masks are continuous flow type and the flow rates are low, therefore, reservoir bags may not fully inflate between breathing cycles.

CAUTION: Oxygen generator temperature may reach 260 °C when generating oxygen. Do not touch generator or attempt to replace mask into holder.

When passenger oxygen masks are dropped the video system is shut down.

On passenger aircraft, 10 percent extra masks are installed for attendants-in-aisle and infants-in-arms.

Emergency Lighting

The emergency lighting system will illuminate automatically when primary lighting fails. The emergency lighting system can also be turned on manually from the cockpit or purser work station.

The emergency lighting system consists of:

- Cockpit ceiling lights.
- Cabin ceiling lights.
- Exit sign lights.
- Door handle lights.
- Aisle lights.
- Floor escape path lights.
- Cross aisle flood lights.

Electrical power for the emergency lighting system is supplied by the airplane electrical system or independent emergency lighting batteries installed.

Passenger aircraft have six batteries.

The batteries are self-contained and continuously charged. Batteries are maintained at full charge by individual chargers powered from the right emergency ac bus. When fully charged, the batteries will provide sufficient power to operate the emergency lights for at least 10 minutes.

Power to the emergency lighting system is provided sequentially in the following priority:

- Right emergency ac bus.
- Left emergency dc bus.
- Emergency lighting batteries.

Status of the emergency lighting system will be annunciated by alerts on the EAD and SD.

Emergency Evacuation Warning System

The emergency evacuation warning system provides a means of signaling that an evacuation of the aircraft should begin.

The EVAC control panel in the cockpit consists of the following:

- Flashing EVAC light.
- Horn.
- Evacuation horn shutoff switch.
- A 3-position evacuation signal switch (OFF/ON/ARM) that is guarded from the ON position.

The system components in the cabin consists of the following:

- Guarded EVAC switch on the purser work station.
- Horn on the purser work station and left aft attendant panel.
- Evacuation horn shutoff switch on the purser work station and left aft attendant panel.
- A flashing light on the purser work station and left aft attendant panel.

The warning is actuated with the emergency evacuation signal switch on the cockpit forward overhead panel or with the EVAC switch on the purser work station.

If the cockpit emergency evacuation signal switch is in the OFF position and the EVAC switch at the purser work station is actuated, the flashing EVAC light in the cockpit will illuminate and the Captain's call chime will sound momentarily. This will signal the flight crew to move the cockpit emergency evacuation signal switch to the ON position. The evacuation horn will then sound.

Emergency Exits

Cabin doors are used for emergency exits for both crew and passengers.

All of the normal exits have backup systems to allow their operation during abnormal conditions. For the flight crew, alternate exit routes are through either the cockpit door blowout panel into the forward cabin or through the clearview windows. Escape rope compartments are located in the cockpit above each pilot. A green band will be visible on the tethered end to indicate full extension.

Passenger Aircraft Cabin Doors

There are eight main cabin doors, four on each side of the aircraft. From outside the aircraft the operating handles are identical and all are opened in the same manner in the event of an emergency. From inside the aircraft the six aft doors have identical handles and identical emergency opening procedures. The two forward cabin door handles however, are not identical to the aft six and are operated differently. Power for the emergency opening of all cabin doors is pneumatic. An air reservoir and a pressure indicator are installed at each door. If the emergency door opening procedure is performed from inside the aircraft with emergency pneumatic power, the associated escape slide will deploy automatically. When using emergency pneumatic power to open the doors from the inside, slide deployment can be prevented by holding the slide arming lever in the emergency interlock override position. A manual lift bar is installed on the cabin doors to allow opening of the doors from inside the aircraft when pneumatic power is not available. The manual lift bar can only be used with the door handle in the emergency position. At least two people may be required to open a door by the manual lift method.

Cockpit Door

The cockpit door allows access to the main cabin from the cockpit. In the event the door is jammed, a blowout panel on the lower half can be unhinged or kicked open. This provides an adequate crawl-through opening to the main cabin and the normal evacuation routes.

Clearview Windows

Two sliding clearview windows provide an alternate escape route for the flight crew. The clearview windows are adjacent to the windshields. Escape lines are installed to allow the crew to lower themselves to the ground.

Inadvertent Cabin Door In-flight Pneumatic Discharge

Refer to the illustration for procedures.

NOTE: Inadvertent actuation of a cabin door control handle, to Emergency (pneumatic) Open position, in flight will discharge the corresponding door pneumatic bottle. Discharging the bottle will not open the door in flight unless cabin differential pressure is less than approximately 0.55 psi. Cabin differential pressure above approximately 0.55 psi will keep door closed. With door closed, pneumatic bottle pressure will bleed off within a few seconds, leaving no residual that could force door open even if cabin differential pressure is relieved.

CAUTION: When operating with cabin differential pressure of less than 1psi, crew should caution cabin attendants to ensure that unauthorized personnel remain clear of doors.

Procedures which may result in prolonged periods of operation at low differential pressure are:

- EMERGENCY DESCENT
- SMOKE/FUMES REMOVAL
- OUTFLOW VALVE CONTROL - UNPRESSURIZED FLIGHT
- CABIN SMOKE
- EVACUATION

NOTE: Immediately following inadvertent discharge of a cabin door pneumatic bottle, reset door control handle from emergency (pneumatic) to neutral position. This locks door in closed position until ready for subsequent operation.

Evacuation Slide/Raft

An inflatable evacuation slide/raft (combination escape slide and life raft) is installed in a slide stowage container, mounted on the inside of:

- Every cabin door on passenger aircraft.

Opening the door will automatically inflate and deploy the slide when the arming lever adjacent to the door is in the SLIDE ARMED position. On passenger aircraft, if a door (other than overwing) becomes jammed closed, the slide/raft can be moved to a usable door for deployment and use as a raft.

A manual inflation handle is installed in the slide/raft assembly and becomes visible when the slide is deployed. If the automatic inflation mechanism malfunctions, the manual handle must be pulled to inflate the slide/raft.

The cabin doors are equipped with double-track slide/rafts (optional) so that two persons can exit the aircraft simultaneously.

The overwing slide/rafts are fitted with integral ramps and deploy over the leading edge of the wing, outboard of the engine pylon. When the overwing slide/rafts are deployed and ready for use, slide position indicators will be visible on the upper end of the slide/rafts.

Each slide/raft and ramp is equipped with self-powered, battery operated electric lights as an integral part of the slide/raft and ramp. The lights illuminate the evacuation route from the cargo compartment to the ground or water.

MD-11 Flight Crew Operations Manual

Side handles are provided at the lower portion of the slide so that the first evacuees to exit during a ground evacuation can help hold the slide in position, if necessary. Also attached to each slide/raft is a re-entry/mooring line to be used as an aid to re-enter the aircraft, if necessary, or to moor the slide to the aircraft during evacuation.

Each slide can be released quickly from the aircraft and used as a life raft. A slide disengagement cable with an attached fabric handle is located at the top of the slide. The cable and handle are protected by a fabric flap. The slide/raft may be disengaged by lifting the protective flap and pulling the handle placarded PULL. The slide/raft may be released from the aircraft by unfastening and cutting the re-entry mooring line.

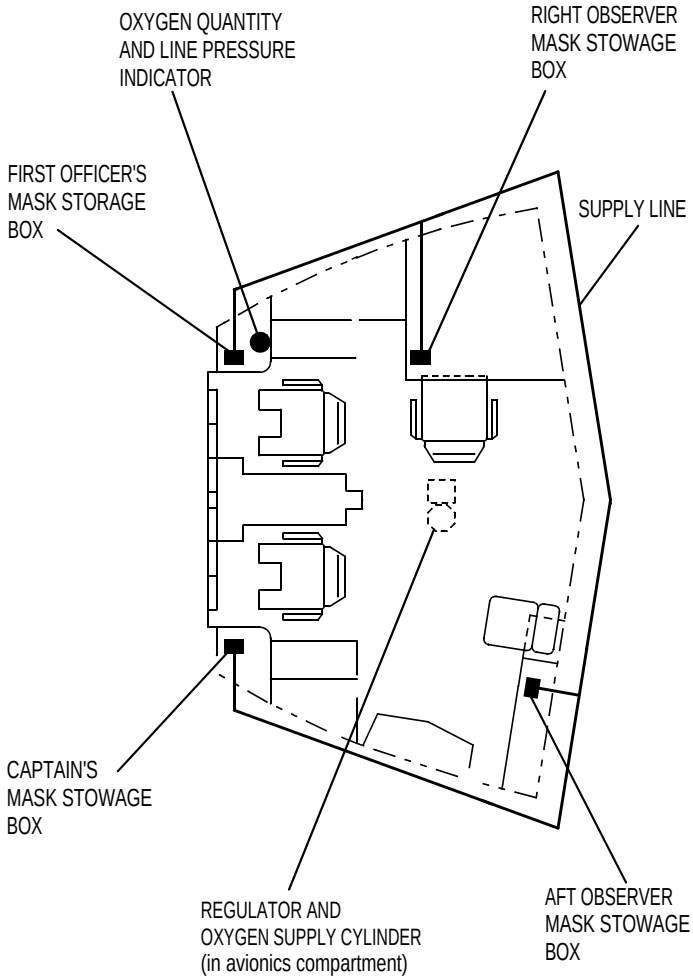
All slide rafts will be usable with the aircraft stopped in any failed landing gear condition.

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Emergency Equipment Components

Chapter Emer Section 20

Crew Oxygen System Component Locations



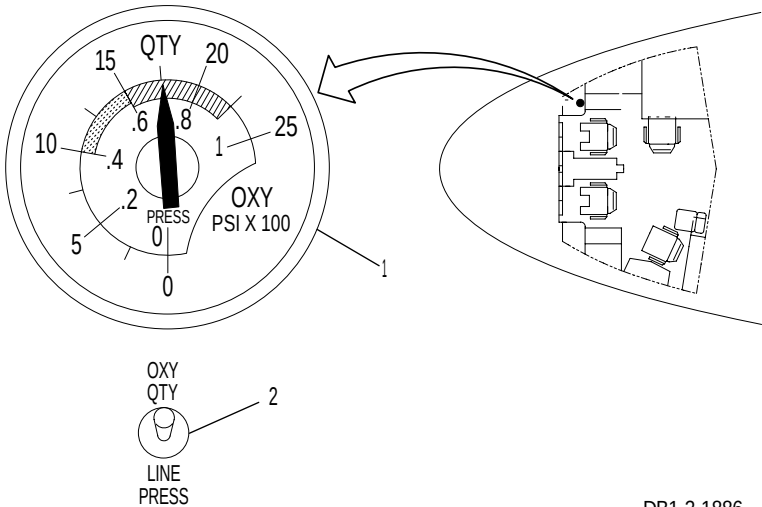
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Emergency Equipment Controls and Displays

Chapter Emer Section 30

Crew Oxygen Control and Indicator



DB1-2-1886

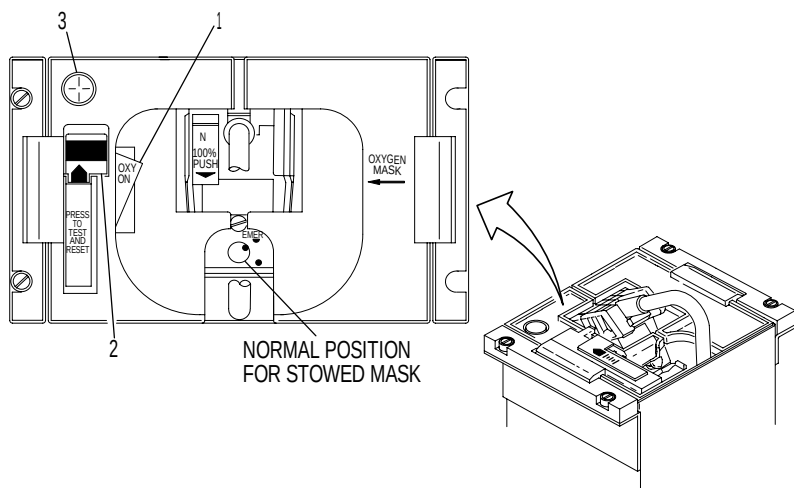
1. OXY/PRESS/QTY Gauge

Oxygen quantity and line pressure are combined into one gauge on the FO's side console. The outer portion of the gauge indicates pressure in the supply cylinder. The inner portion of the gauge indicates regulated oxygen line pressure. The wide portion of the white band indicates the normal line pressure range with no demand on the system. The narrow portion of the white band indicates the line pressure range under maximum flow conditions.

2. OXY SYS QTY/LINE PRESS Switch

This is a two-position switch that is spring loaded to the QTY position. In the OXY QTY position, crew oxygen pressure in the supply cylinder is displayed on the outer scale of the gauge. When held in the LINE PRESS position, crew oxygen line pressure is displayed on the inner scale of the gauge.

Crew Oxygen Mask Stowage Box



LB1-3-0024

1. OXY ON Flag

Flag appears when the mask has been pulled out of the storage box and the left hand door has been closed. To reset the flag and stow the mask, close the left hand and right doors and push the PRESS TO TEST AND RESET lever. This shuts off the flow of oxygen to the mask.

2. PRESS TO TEST AND RESET Lever

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

When the mask is removed from the box, oxygen flow begins, OXY ON flag comes into view, and the mask microphone is switched from boom to mask.

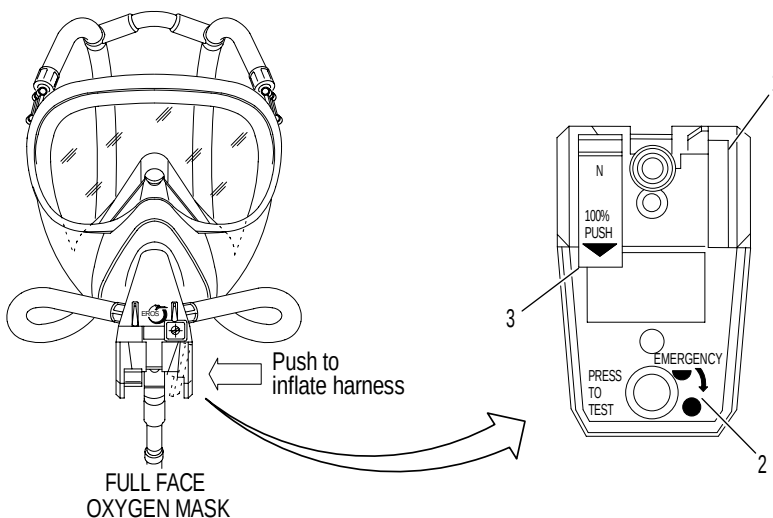
After the mask is restowed into the box and doors are shut, pushing the lever will stop the flow of oxygen to the mask, reset the microphone from mask to boom, and retract the OXY ON flag.

3. Flow Indicator

This indicator is in the upper left corner of the left oxygen mask storage box.

Indicator will blink yellow during positive oxygen flow and will be black when no oxygen is flowing.

Crew Oxygen Mask



LB1-3-0025

1. Mask Release Lever

Squeezing release levers unlocks container doors and inflates mask harness. Right lever is movable. Flow indicator on container door will blink to indicate oxygen flow.

2. EMERGENCY Pressure Control Knob

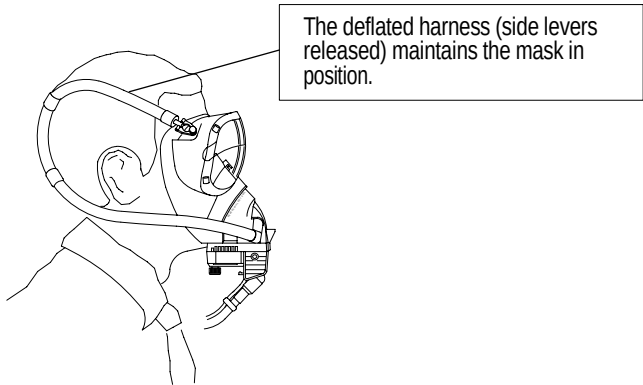
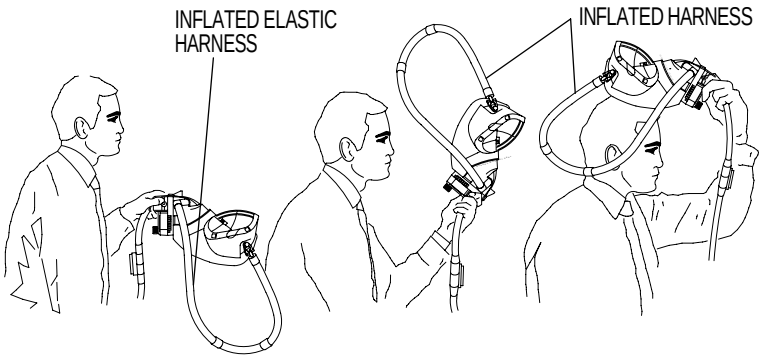
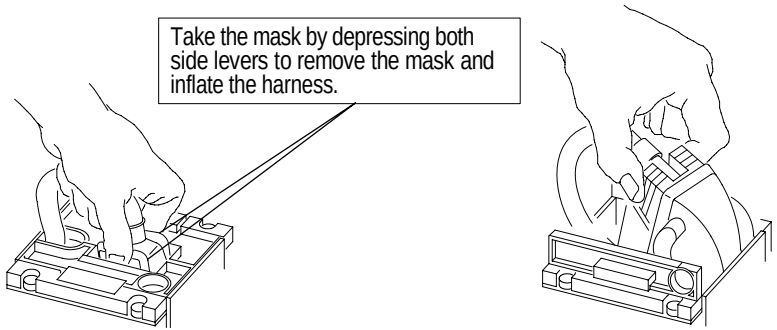
Pushing knob allows flow of 100% oxygen to mask. Rotating knob to EMERGENCY position (clockwise) locks flow valve open to assure a constant flow of oxygen. This is used normally at high cabin altitudes or when the smoke goggles are used.

3. Dilution Control Lever

This lever allows selection of oxygen flow to the mask. In the N (normal) position, the lever is unlocked and pulled out. Diluted oxygen then flows to the mask.

To obtain a flow of pure oxygen the lever must be pushed in and locked.

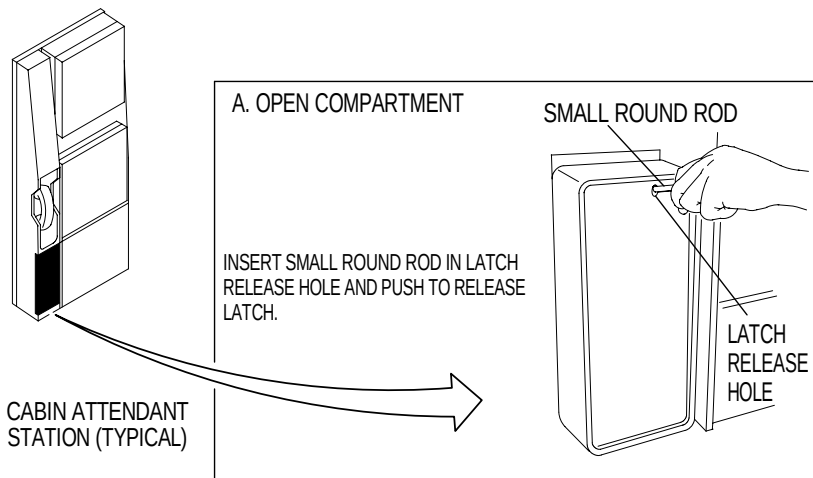
Crew Oxygen Mask Operation



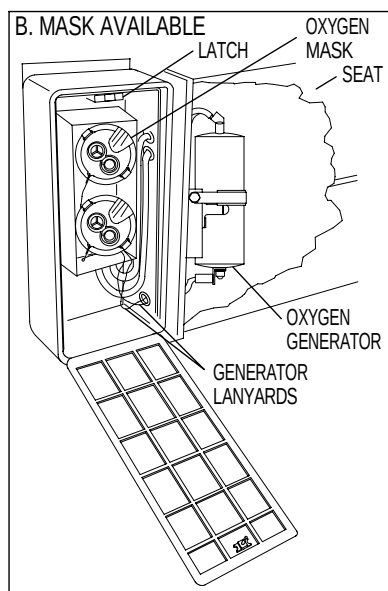
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MD-11 Flight Crew Operations Manual

Cabin Attendant Oxygen

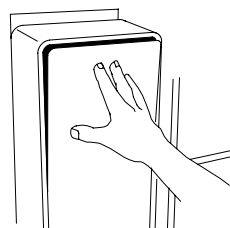


NOTE: Not installed on freighters.



C. RESET LATCH

D. CLOSE DOOR



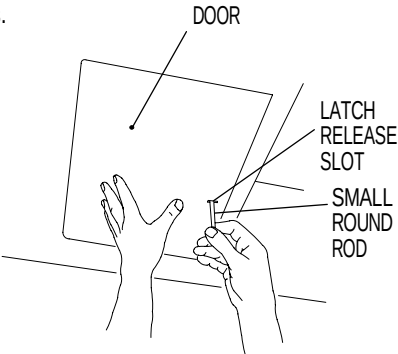
1. ENGAGE DOOR SPRING HINGE AT BOTTOM OF COMPARTMENT.
2. MAKE CERTAIN THERE ARE NOT KINKS IN HOSE AND MASK AND HOSE ARE NOT BETWEEN DOOR AND GENERATOR.
3. PUSH DOOR UNTIL LATCH ENGAGES.

DB1-2-1691

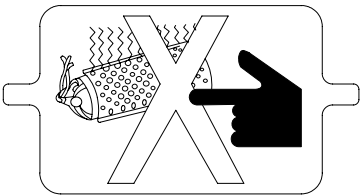
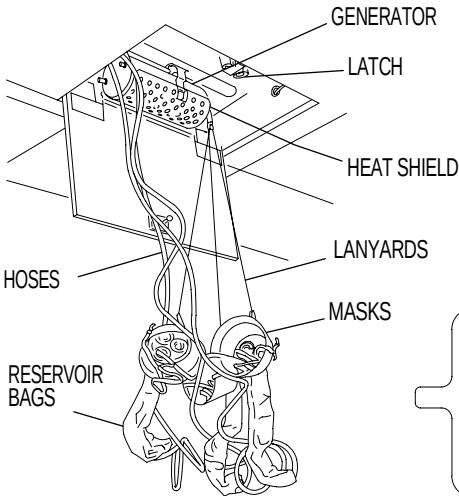
Passenger Oxygen Masks

INSERT SMALL ROUND ROD IN LATCH
RELEASE SLOT TO RELEASE LATCH.

NOTE: Latch installations will vary with different
oxygen compartment installations.

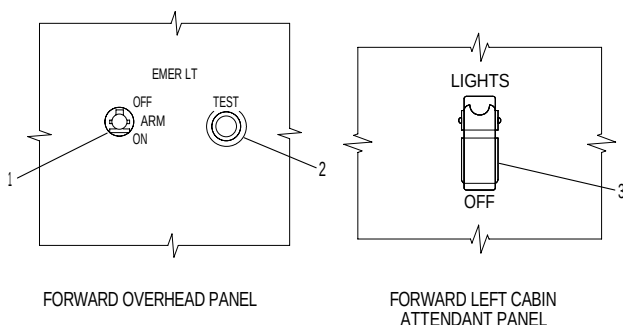


MASKS AVAILABLE
(3-MASK UNIT SHOWN, 1
2, AND 4 UNITS TYPICAL)



TYPICAL ALL
COMPARTMENTS

Emergency Lighting Controls



1. EMER LT Switch

OFF - Normal for ground operations. Emergency lights will not illuminate. Batteries will charge when power is available. EMER LTS DISARM alert will be displayed on EAD.

ARM - Normal for flight. Allows emergency lights to illuminate automatically if normal electrical power is interrupted. Connects batteries to charging system if power is available.

ON - For ground test. Illuminates emergency lights as long as power is available. EMER LTS DISARM alert is displayed on EAD.

2. EMER LT TEST Button

When this button is pushed:

- Emergency lights illuminate.
- Integral batteries are tested under load.
- EMER LTS TEST PASS alert is displayed on EAD when all circuits and batteries are satisfactory.

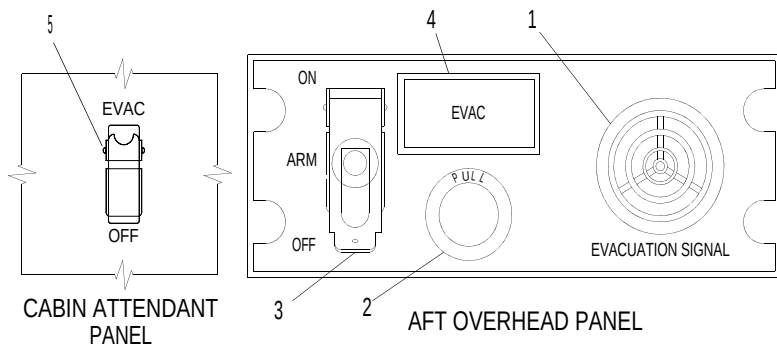
If EMER LTS TST PASS does not appear, batteries with abnormal voltage can be identified on the SD STATUS page MAINT column by pushing the button again.

3. Emergency LIGHTS Switch (Cabin Attendant Panel)

LIGHTS - Overrides cockpit EMER LT switch OFF and ARM positions and turns on all emergency lights.

OFF - All emergency lights are under control of the EMER LT switch in the cockpit. Switch is guarded and lockwired in this position.

Emergency Evacuation Warning System



DB1-2-1694(m)

1. Evacuation Horn

The evacuation horn will sound to signal the system has been actuated from the cockpit or the cabin attendant panel.

2. Evacuation Horn Shutoff Switch

Evacuation warning horn may be silenced by pulling switch out from panel. EVAC lights continue to flash.

3. Evacuation Signal Switch

ON - Actuates evacuation warning horns and EVAC flashing lights at all applicable stations.

ARM - Arms evacuation warning horns and EVAC flashing lights to all applicable stations. Cabin attendant may then initiate an EVAC alarm by actuating the EVAC switch on the cabin attendant panel.

OFF - System cannot be actuated. EVAC light will flash and chime will sound when the cabin attendant EVAC switch is actuated.

4. EVAC Light -red

The EVAC light will flash when the evacuation alarm is on. The alarm can be actuated from the cockpit or the cabin attendant panel.

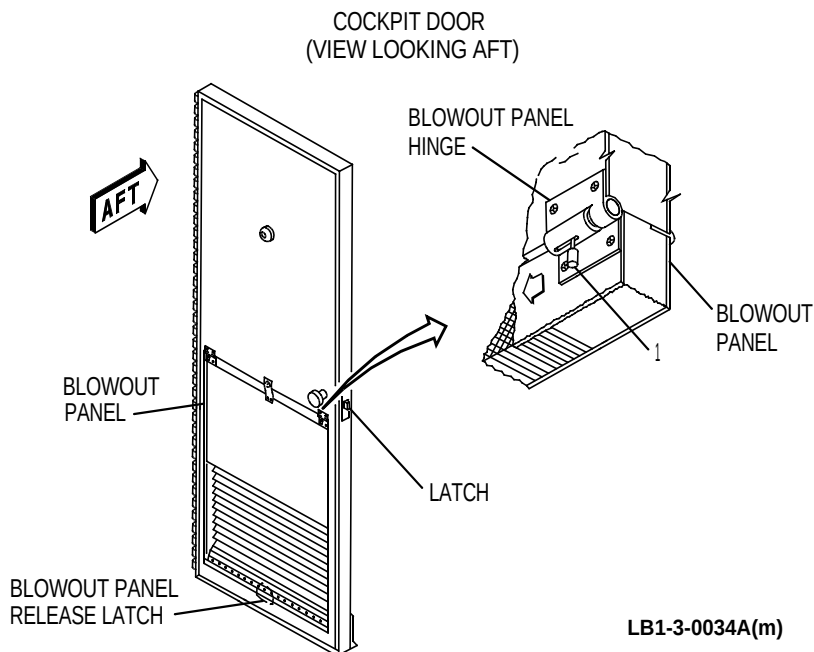
5. EVAC Switch (Cabin Attendant Panel)

Positioning the guarded EVAC switch up will actuate the evacuation warning horn and EVAC flashing lights provided the cockpit evacuation signal switch is armed.

If the cockpit evacuation signal switch is OFF, actuating this switch will cause the cockpit EVAC light to flash and cockpit chime to sound.

|

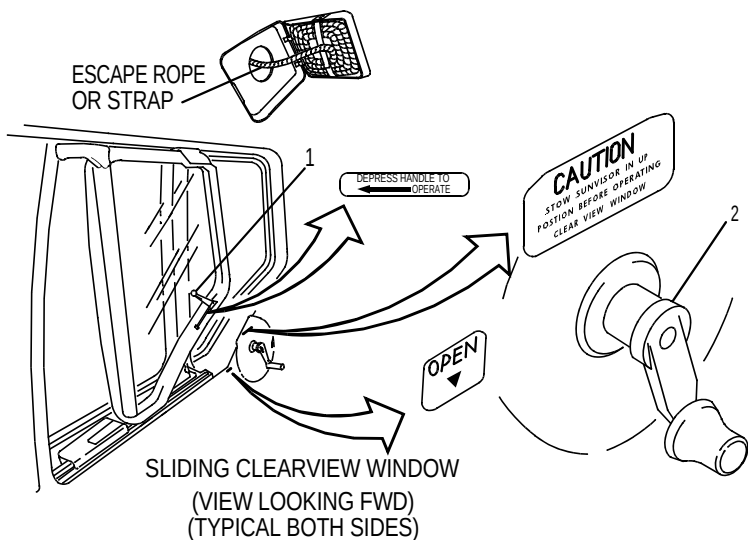
Emergency Exits - Cockpit Door



1. Hinge Release Pin

Slide pin inwards to release lower decompression panel.

Emergency Exits - Clearview Windows



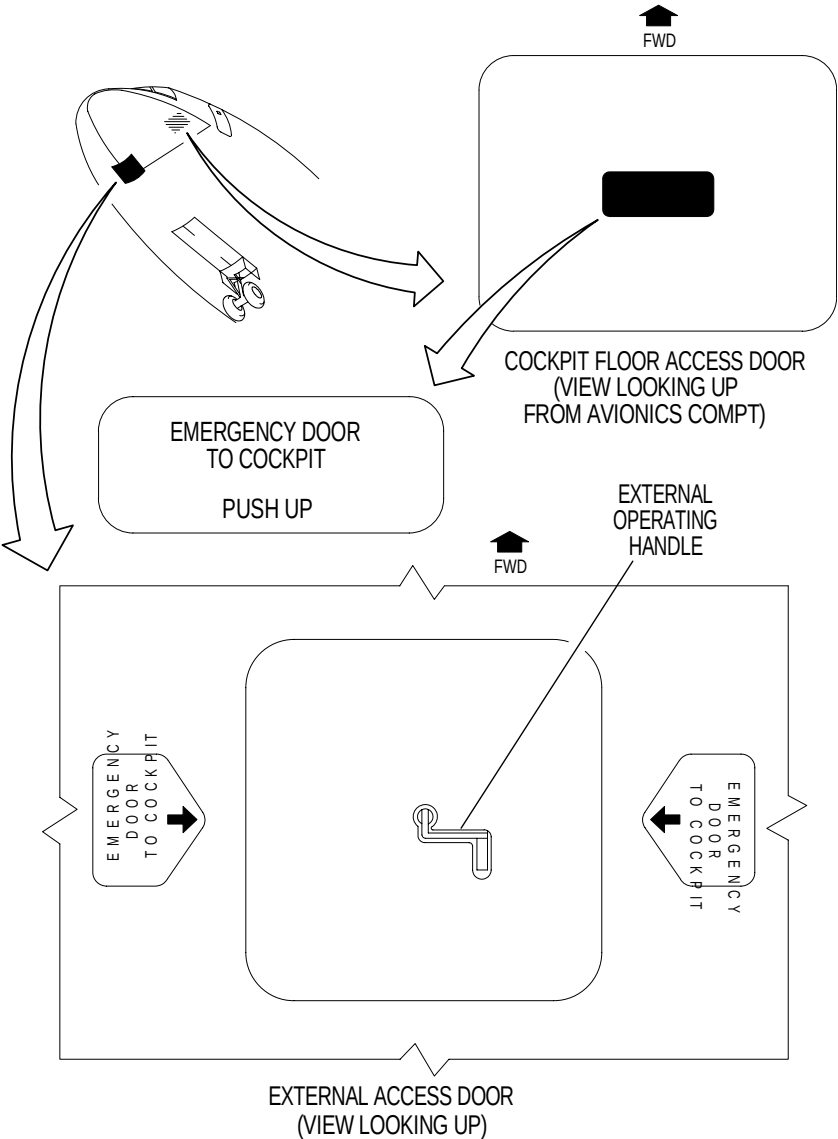
1. Clearview Window Locklatch Handle

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

2. Clearview Window Crank

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

Emergency Exits - Avionics Compartment Door



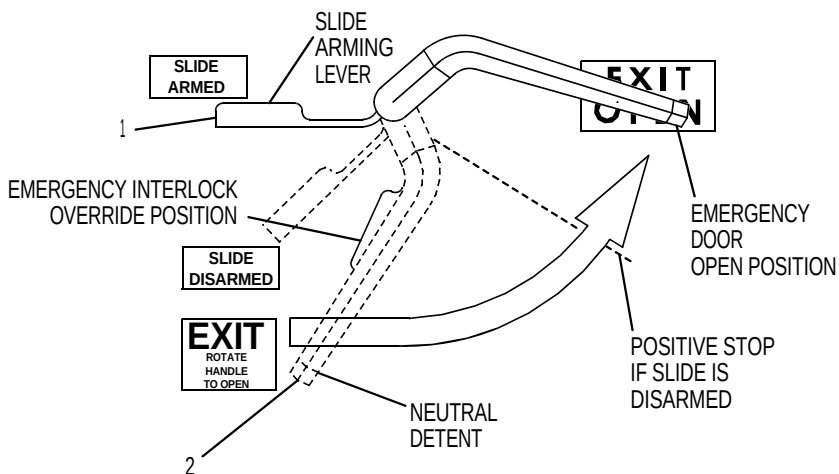
NOTE: Door cannot be opened from the inside.

DB1-2-1695

MD-11 Flight Crew Operations Manual

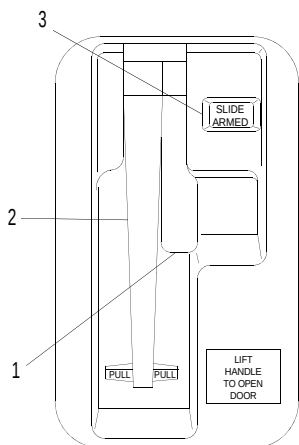
Emergency Exits - Cabin Door Interior Controls

CABIN DOOR INTERIOR CONTROLS (FWD TWO)
(View Looking Forward)

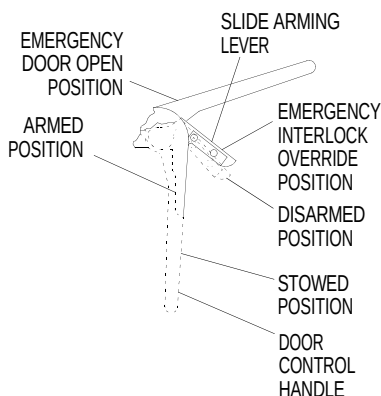


DB1-2-2005

CABIN DOOR INTERIOR CONTROLS (Aft Six)
(View Looking Outboard)



DOOR CONTROLS (Side View)



DB1-2-1696

1. Slide Arming Lever

Arms and disarms the associated escape slide. Lever is normally in the SLIDE ARMED position for emergency operation with slide deployment. When lever is held in emergency interlock override position, door may be opened pneumatically without slide deployment.

2. Door Control Handle

When slide is armed for emergency operation, or slide arming lever is held in emergency interlock override position, rotating door control handle to emergency EXIT OPEN position will activate the pneumatic power to open the door.

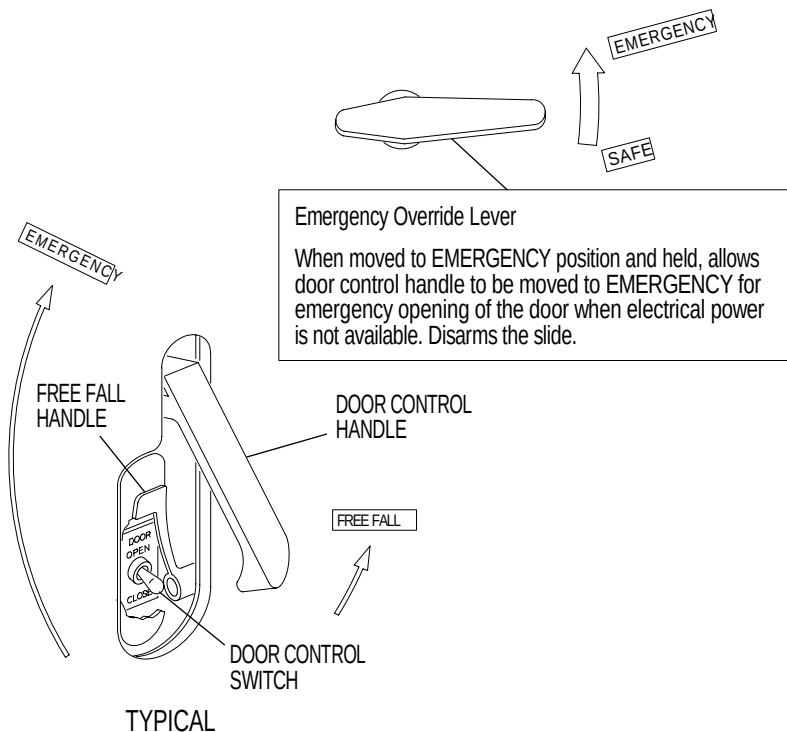
NOTES: Door control handle will stay in the emergency door EXIT OPEN position.

Aft six cabin door control handles will return to stowed position when released.

3. Slide Mode Indication Window

Indicates whether the escape slide is armed or disarmed.

Emergency Exits - Cabin Door Exterior Controls (Sheet 1)



To Open/Close Door (Electrical)

- Pull door control handle out of recess to disarm the escape slide.
- Move door control switch to OPEN or CLOSE.
- Hold door control switch until door reaches desired position.

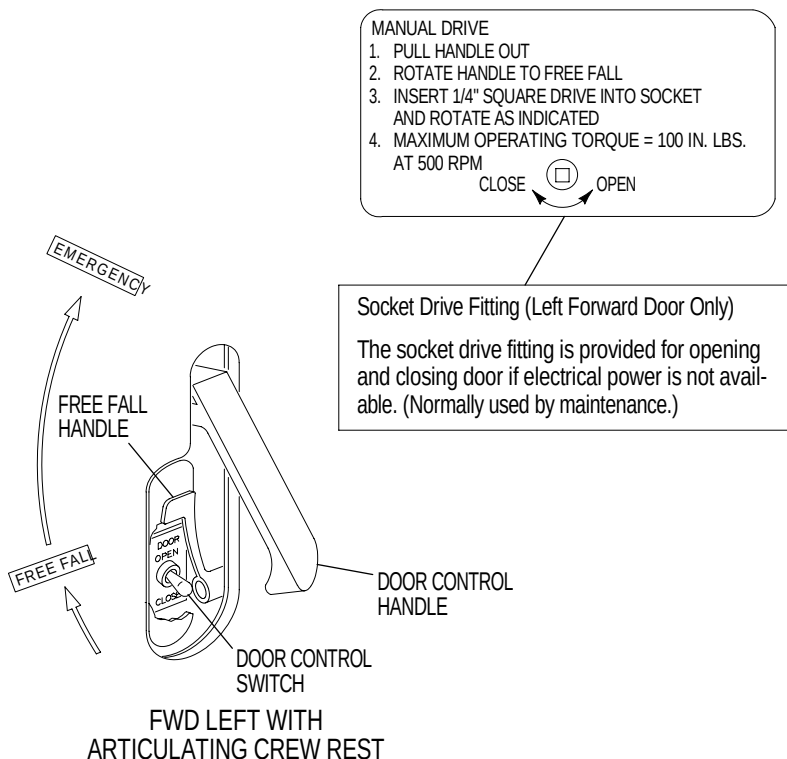
NOTE: Door automatically stops when fully open/fully closed or when switch is released. Stow door control handle when door is closed to arm the escape slide.

To Open Door (Pneumatic)

- Pull door control handle out of recess to disarm the escape slide.
 - Rotate emergency override lever from SAFE to EMERGENCY.
 - Rotate door control handle to EMERGENCY.
- Door will open by pneumatic pressure.

DB1-2-1698

Emergency Exits - Cabin Door Exterior Controls (Sheet 2)



To Close Door (Free Fall)

Free fall door closing is a two person operation, one inside and one outside.

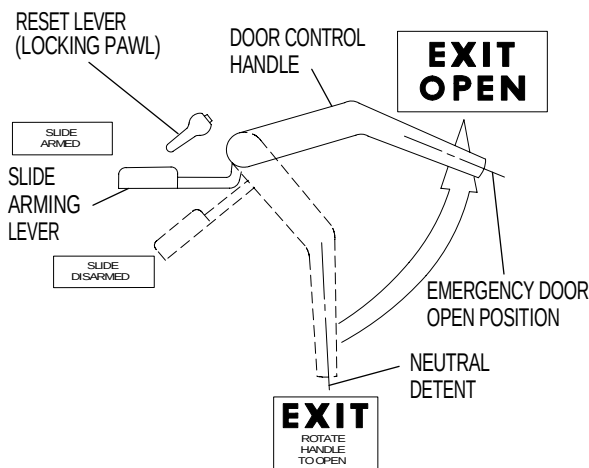
- Person outside pulls door control handle out of recess.
- Rotate handle to FREE FALL position and then pull the free fall lever out of the stowed position.
- Door will slowly lower as assisted by the person inside.
- To fully close door, person inside must continue to pull door down and finally pull door down and out-board.

NOTE: If door had been opened by the emergency or override mode, the door control mechanism must be reset. Refer to reset procedure - interior controls.

DB1-2-1699

MD-11 Flight Crew Operations Manual

Inadvertent Cabin Door In-flight Pneumatic Discharge (Sheet 1)



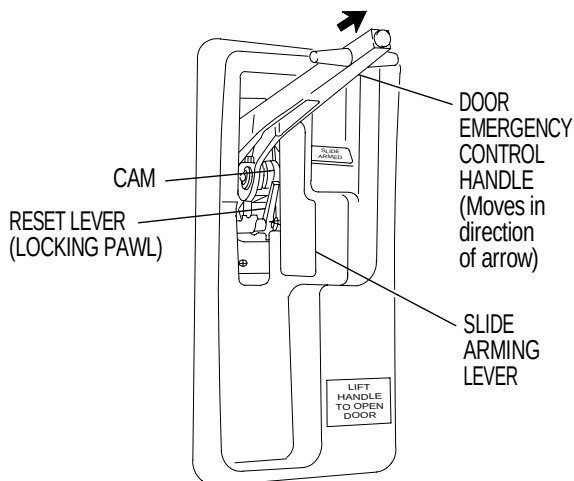
CABIN DOOR INTERIOR CONTROLS (FWD TWO)
(View Looking Forward)

TO RESET DOOR CONTROL HANDLE

1. Hold door control handle in Emergency EXIT OPEN position and rotate reset lever upward.
2. While holding reset lever up, return handle to neutral position.
3. Release reset lever.
4. Make certain slide arming lever is in SLIDE ARMED position.
5. After landing use normal operating procedures to open door.

LB1-3-0031

Inadvertent Cabin Door In-flight Pneumatic Discharge (Sheet 2)



CABIN DOOR INTERIOR CONTROLS
AFT SIX - NOT APPLICABLE ON FREIGHTERS
(View Looking Outboard)

TO RESET DOOR CONTROL HANDLE

NOTE

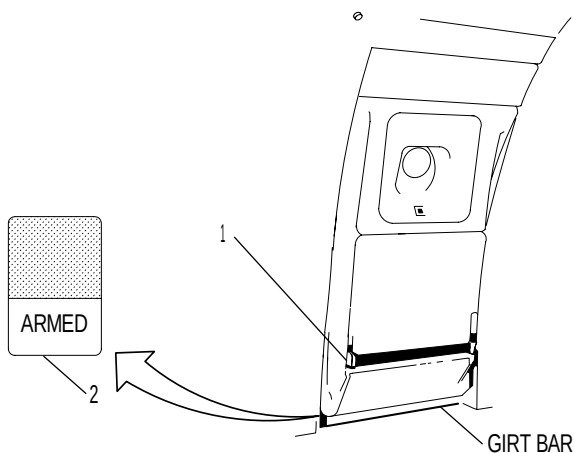
A cam, held in a rotated up position by a reset lever is visible when door control handle is in the Emergency Open position.

1. Hold door control handle in Emergency Open position and press bottom or pull top of reset lever to permit reset lever to clear cam.
2. While holding reset lever clear of cam, squeeze handle trigger and move handle toward neutral position, releasing reset lever when clear of cam.
3. When neutral position is reached, release handle and stow.
4. Make certain slide arming lever is in SLIDE ARMED position.
5. After landing use normal operating procedures to open door.

DB1-2-1697

MD-11 Flight Crew Operations Manual

Emergency Exits Cabin Doors - Manual Controls

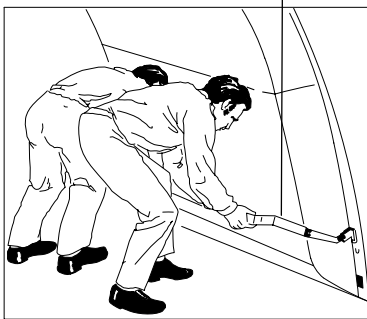


LEFT SIDE SHOWN. RIGHT SIDE OPPOSITE

If door can not be opened using pneumatic power, pull door inboard at approximately 45 degree angle and lift upward.

NOTE

Door controls must be set for emergency operation.



Release manual lift bar and push door upward to full open position.



LB1-3-0032

1. Manual Lift Bar

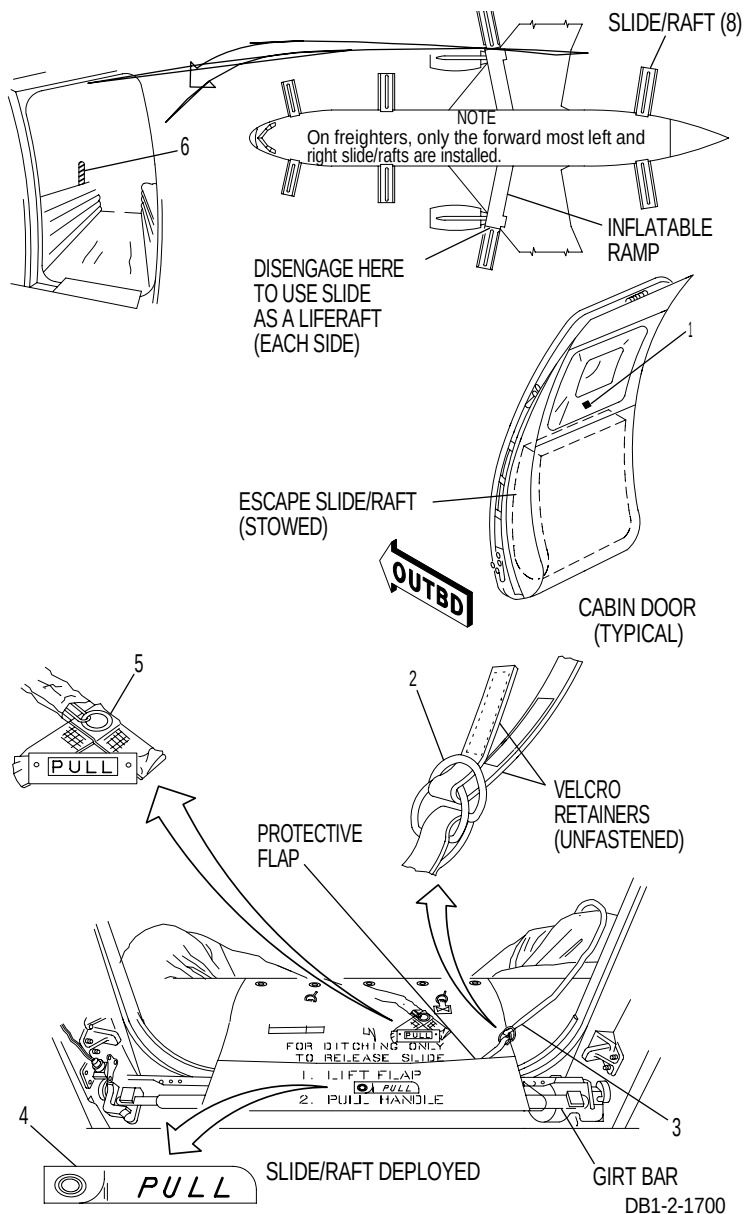
Provides the means for manually lifting door when pneumatic power is not available.

2. Slide Mode Verification Indicator (Two Each Door)

Verifies actual condition of escape slide. An ARMED placard is visible when door is closed and slide is armed.

MD-11 Flight Crew Operations Manual

Evacuation Slide/Raft



1. Slide Inflation Cylinder Low Pressure Switch/light

Not installed.

2. Re-Entry/Mooring Line Fastener

Unfasten/cut line to free slide/raft from aircraft. Line is attached between slide/raft and aircraft at forward, mid, and aft doors. Line is attached between slide/raft and ramp at overwing door.

3. Re-Entry/Mooring Line

Used as an aid for re-entering aircraft. Also used to moor slide/raft during ditching, after slide/raft has been disengaged from girt bar.

4. Slide/Raft Disengage Handle (For Ditching Only)

Visible when slide/raft is deployed and flap lifted. To use slide/raft as a lift raft, pull handle to disengage slide/raft from girt bar. Unfasten/cut re-entry/mooring line to release slide/raft from aircraft. With overwing slide/ramp fully deployed, the slide/raft may be separated from the ramp at the leading edge of the wing by same procedure used to disengage slide/raft from aircraft.

5. Manual Inflation Handle (Typical)

Visible when slide/raft is deployed. If the automatic inflation mechanism malfunctions, the handle may be pulled to inflate slide/raft.

6. Slide/Raft Position Indicator (Overwing Only)

An inflatable pole is visible when slide is properly deployed and ready for use.



Emergency Equipment Alerts

Chapter Emer Section 40

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

Red Boxed Alerts (Level 3)

NO MASKS (AIR) - Oxygen masks have not deployed automatically as required.

Amber Alerts (Level 1)

EMER LT BAT 1/2/3/4/5/6 LO (ELEC) - Maintenance alert. Respective emergency lights battery is low.

EMER LTS DISARM (MISC) - EMER LT switch is not in ARM position. This alert is displayed if the switch is in the OFF or ON position.

Cyan Alerts (Level 0)

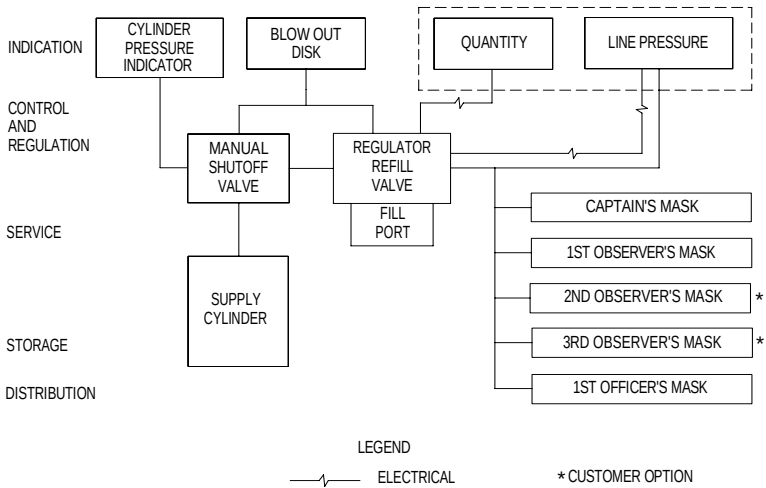
EMER LTS TST PASS - The cockpit and cabin emergency lights test is successful.

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Emergency Equipment Functional Schematic

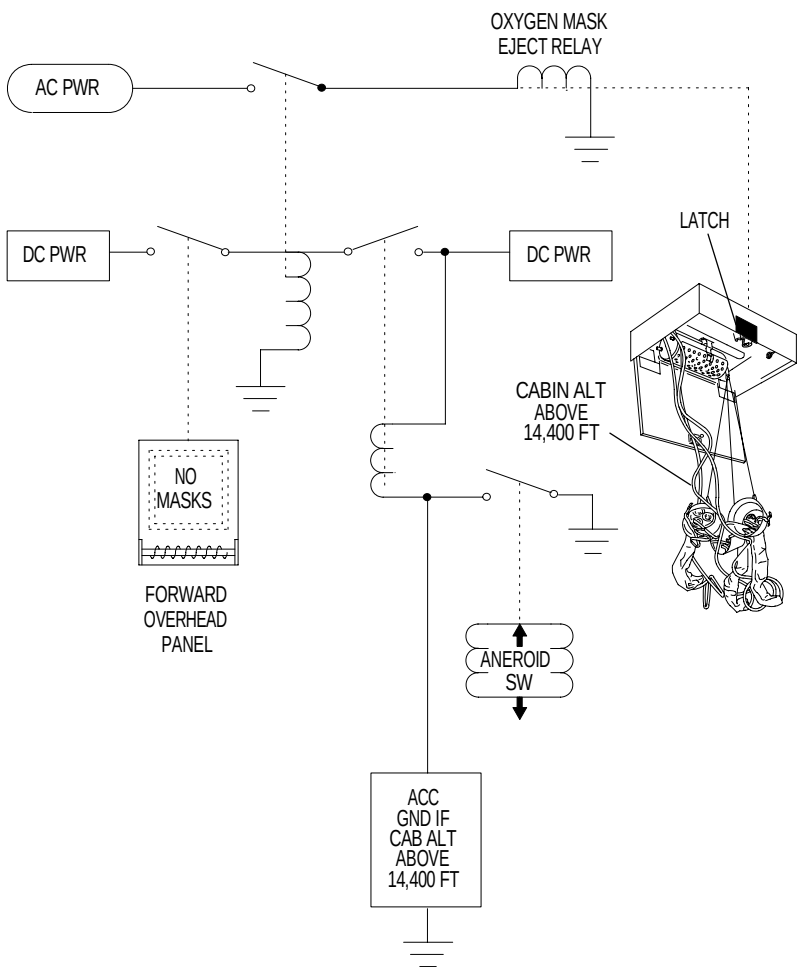
Chapter Emer Section 50

Crew Oxygen - Block Diagram



DB1-2-1884

Passenger Oxygen - Block Diagram



DB1-2-1892

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Engines

Description and Operation

Chapter Eng

Section 10

General

The aircraft is equipped with three GE CF6-80C2 engines.

Each engine has dual rotors, a Low Pressure Compressor (LPC) (N1) incorporating a high bypass ratio turbofan, and a High Pressure Compressor (HPC) (N2).

A multiple stage (low and high pressure) turbine drives the compressors and fan. The fan exhaust cowl contains a fan thrust reverser.

The accessory drive section extracts energy from the core engine rotor to drive accessories and sends core engine speed signals to the Full Authority Digital Electronic Control (FADEC) system. The accessory gearbox is installed in the core engine compartment. Mounted on the gearbox are:

- Starter.
- Electrical N2 sensor.
- Fuel pump.
- Lube and scavenge pump.
- Integrated Drive Generator (IDG).
- Hydraulic pumps.
- Alternator (powers the FADEC computer).

Engine controls are on the forward and aft overhead panel and forward pedestal.

Primary engine indications are shown on the upper 2/3 of the Engine and Alert Display (EAD). The lower 1/3 of the EAD is used for alert presentation.

Secondary engine indications are shown on the System Display (SD) secondary engine page. The secondary engine page is a default page and is presented automatically if any parameter on this page exceeds limits.

Full Authority Digital Electronic Control (FADEC)

FADEC is an engine control system that includes the following functions:

- Engine acceleration to idle speed during start.
- Acceleration and deceleration limiting.
- Automatic control of available thrust.
- Minimum/approach idle speeds during descents.
- Compressor airflow control.
- Selection of alternate modes from cockpit.

-
- Thrust control as a function of throttle position and thrust reverser lever.
 - Protection from exceeding N1, N2, internal pressures, and maximum thrust limits.

FADEC is controlled by an Engine Control Unit (ECU).

Looking aft, the ECU is mounted on the engine fan case at the four o'clock position.

The two channels (A and B) of the ECU are housed in one assembly but are physically separated.

The ECU has dual channel control (A and B). This allows normal engine control and operation with the total failure of one channel. The failure of any sensor results in cross-channel data exchange so that dual-channel capability is retained.

Primary power for each channel is obtained from a dual-output Permanent Magnet Alternator (PMA) driven by the N2 gearbox. The PMA has two independent sets of windings. Each set of windings supplies power to its respective ECU channel. Aircraft 28-volt input power is required for ground starting, testing and ECU back-up power. Back-up power (28 VDC aircraft power) to the ECU is standard and available five minutes after the engine is shutdown.

The ECU is the primary interface between the aircraft and the engines. The ECU operates in response to pilot commanded thrust settings that are transmitted to the ECU by dual electrically isolated position sensors. The position sensors are mechanically linked to each throttle. Each position sensor is dedicated to one channel of the ECU and provides independent analog signals to each ECU channel proportional to the throttle angle.

The ECU interfaces with two Air Data Computers (ADC) through two ARINC 429 data buses. Each ECU channel receives parameters from both ADCs. These parameters include:

- Pressure altitude.
- Total pressure.
- Total air temperature.

FADEC MODE switches on the forward overhead panel allow the flight crew to select the alternate control mode of the ECU. Selection of the alternate mode is required when a primary air data parameter is not available to the ECU. The alternate mode can also be selected by pushing the throttles past the normal forward stop. This provides up to 5% N1 (approximately 10% thrust) increase depending on SAT.

Reverting to the alternate mode will never result in a decrease in thrust, but may result in an increase in thrust and exceedance of limits.

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Reset switches are activated by the engine FUEL switches on the forward pedestal. When the engine FUEL switches are moved to OFF, the ECU will sense fuel shutoff and reset the system.

For engines 1 and 3, the ECU controls a thrust reverser interlock within the Thrust Control Module (TCM) based on reverser position. The interlock prevents the reverse throttle levers from moving past the reverse idle position. The ECU releases the interlock when the reverser is 60 percent deployed and relocks it when the reverser is within 20 percent of being stowed.

The ECU interfaces with the two Flight Control Computers (FCC). Each channel of the ECU interfaces with both FCCs. FCC parameters transmitted to the ECU are:

- N1 trim and autothrottle.
- Bleed configurations.
- GMT.
- DATE.
- Flap/slat position (for idle selection).
- Weight on nosewheel (for reverser 2 operation and idle selection).

The ECU transmits maintenance data to the Central Fault Display Interface Unit (CFDIU). The interface of the ECU with the CFDIU and Multifunction Control Display Unit (MCDU) allows the maintenance crew to access ECU memory for faults detected during a flight.

The ECU will transmit digital data to the aircraft systems. The transmitted data is as follows:

- Engine rating parameter data.
- Parameters used for engine control.
- ECU status and fault data.
- ECU system maintenance.
- Engine condition monitoring parameters.

The engine has two idle modes as follows:

Minimum Idle - Minimum idle is the minimum operating speed of the engine and is intended to minimize thrust, fuel use, noise, and jet blast. Minimum idle is automatically provided in flight during descent when the throttles are positioned to idle.

Approach Idle - Approach idle provides an increased idle rpm which permits rapid response to throttle advancement. All engines will revert to approach idle when any one of the following occurs:

- Any engine cowl anti-ice on.
- Flaps and/or slats are extended
- Any engine or airfoil anti-ice system is on.

Both idle modes are controlled by the ECU.

Thrust Control Module (TCM)

General

The TCM is installed in the forward pedestal and contains all the mechanisms to provide completely electronic signaling (fly-by-wire) between the throttles and the engines. Pilot controls on the TCM include:

- Throttles.
- ENG START switches.
- Engine FUEL switches.

Throttles

Thrust is set by N1.

The three throttles are driven manually by the pilot or automatically by the autothrottle system (ATS). The ATS operation can be overridden by the pilot at any time.

Forward travel of the throttles is limited by an overboost stop. This stop has a detent that allows continued forward movement of the throttles when they are pushed with a strong force. This extra forward travel causes the following:

- ATS disconnects.
- FMS thrust is overridden.
- ECU provides maximum emergency thrust (alternate mode).
- An ENG (1, 2, or 3) FADEC ALTN alert is displayed.

Each throttle has an attached piggyback lever to control reverse thrust.

Miscellaneous

Inside the TCM the following items are installed:

- Three position sensors (resolvers) to electronically transmit throttle position to one of the two ECU channels.
- Engine 1 and 3 thrust reverser interlocks to prevent application of reverse thrust until the reverser is deployed (nosewheel ground sensing is used for engine 2).
- Autothrottle servo to transmit ATS commands to the throttles.

Ignition System

Each engine ignition system consists of two independent ignitors (A and B). The ignitors ignite the fuel/air mixture during starting and provide continuous ignition during takeoff, landing, and when using engine anti-ice. The ignitors use 115-volt, 400 Hz power.

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Only one ignitor is required to start the engine. During a ground start, either ignition (A or B) may be selected with the ENG IGN switches on the forward overhead panel. When either ENG IGN A or B switch has been pushed, moving the respective FUEL switch to ON will turn on the corresponding ignitor.

With A or B selected, continuous ignition is provided automatically during takeoff, landing, and engine anti-ice on (60 seconds only). The selected engine ignitors automatically shut off when flaps/slats are retracted.

The ignition system indicating lights are integral with the ENG IGN switches and the ENG START switches. The Miscellaneous Systems Controller (MSC) provides automatic control of the ignition system.

An ENG IGN OFF light on the forward overhead panel will illuminate if neither system A or B or the OVRD switch is selected. This indicates that no power is being supplied to either ignition system.

Selecting ignition system A or B with the ENG IGN switch will:

- Arm the ENG START switches.
- Arm ignition system A or B.
- Send a signal to the APU for 100 percent N1.
- Configure the air and fuel systems for engine start.

With an ignition system selected, the ENG START switch can then be pulled out. This energizes a coil that holds the switch in that position. The ENG START switch also energizes the start valve to open and supplies 28-volt dc power to the ECU.

The Fuel System Controller (FSC) automatically turns on the aft fuel pumps in fuel tanks 1, 2, or 3 when the respective ENG START switch is pulled or engine FUEL switch is moved to ON.

When the start valve opens, a light in the ENG START switch will illuminate. When the engine FUEL switch is moved to on, the MSC supplies 115-volt ac power to the exciter. A lightning symbol will appear on the EGT display of the EAD and will remain until 45 percent N2.

As the N2 speed accelerates to 45 percent, the MSC causes the ENG START switch to pop in. Then the start valve will close, the light in the ENG START switch will extinguish, and the ignition system will automatically remove power from the ignitors. The MSC controls the start sequence. If the ENG START switch latching function in the MSC fails, the switch must be held out until the engine reaches 45 percent.

The ignition override function can be used for emergency conditions (engine flameout), for simultaneous failure of ignition systems A and B, or when flying in heavy turbulence or precipitation.

Actuation of the ENG IGN OVRD switch will bypass the MSC to simultaneously provide power to both the A and B ignition systems for as long as the override is selected. Selection of the ENG IGN OVRD switch provides power to the ENG START switches to allow starter assisted air starts.

The ignition system has no time limit although excessive use will reduce ignitor service life.

Two IGN TRANSFER switches on the upper maintenance panel allow ignition transfer for engines 1 and 3 as follows:

- Ignitor B power source can be changed from the R emergency ac bus to the L emergency ac bus, or
- Ignitor A power source can be changed from the L emergency ac bus to the R emergency ac bus.

The switches are intended for use on the ground, prior to engine start, if system A ignition is inoperative.

If the engine flames out, the MSC will turn on the respective ignitor for an engine relight attempt. The ignition lightning symbol will be displayed during the auto relight attempt.

Starting System

The starting system consists of an air turbine starter and a starter air valve.

The starter air valve is a butterfly valve that controls the flow of air (supplied by APU, engine crossbleed, or ground power unit) to the engine air turbine starter. It is powered from the battery bus.

The starting system is energized by pulling the ENG START switch on the forward pedestal. Pulling out the ENG START switch will:

- Energize a coil that holds the switch out.
- Energize the engine starter valve open which will illuminate the light in the switch.
- Supply power to the ECU.

Normal engine starts can be done with pneumatic pressure greater than 25 psi. Optimum engine acceleration to idle and lowest EGT peak is obtained with a pressure of 40 psi and above. Conditions may necessitate the use of pressure below 25 psi. Extended time to idle and higher EGT peaks may result. Under these conditions, the start cycle must be closely monitored so that action can be taken to prevent a hung or hot start.

If starter air pressure drops during start, the START AIR PRES LO alert will appear at 25 psi.

When the engine has attained about 45 percent N₂, the starter air valve closes and shuts off air to the starter turbine. As the engine continues to accelerate, a starter clutch automatically disengages the starter.

An amber light in the respective ENG START switch will remain illuminated when the valve is not closed.

Fuel Control System

Fuel flow is controlled by the ECU.

The engine FUEL switch supplies electrical power directly to the Hydromechanical Unit (HMU). The HMU then operates the High Pressure fuel Shutoff Valve (HPSOV).

A red light in the engine FUEL switch will illuminate if an engine fire condition occurs. The light will also illuminate during the ENG/APU FIRE test.

Moving the engine FUEL switch to ON starts ignition and fuel provided the ENG START switch is out and the ENG IGN switch is selected A or B.

The FSC automatically turns on the fuel pumps in tanks 1, 2, or 3 when the respective ENG START switch is pulled to ON.

Moving any FUEL switch to ON initiates a test of the cargo door indicating system sensors. The TEST light on the forward overhead panel will illuminate during the test. If the test is satisfactory, TEST will extinguish. If the test fails, a CRG DOOR TEST FAIL alert will be displayed.

Fuel flows through the following components:

1. Fuel-oil heat exchanger.
2. Fuel filter.
3. Fuel flow meter.
4. IDG fuel-oil heat exchanger.
5. Fuel metering valve.
6. Fuel nozzles (30).

Fuel flowing through the fuel/oil heat exchanger cools the engine oil and heats the fuel.

A pressure differential switch is installed across the main fuel filter and will display an appropriate alert when an impending filter clogging situation exists. If the filter clogs to a predetermined degree, fuel will bypass the filter to maintain flow to the engine.

Emergency Shutdown

In case of an engine fire, the fire detector system actuates the red MASTER WARNING lights and the fire bell, both ENG FIRE handles and FUEL switch will illuminate. Emergency shutdown is accomplished with individual ENG FIRE handles on the aft overhead panel. Pulling the ENG FIRE handles down actuates the generator field disconnect and shuts off electrical, fuel, and hydraulics. The associated air system is depressurized when the air system is operating in the automatic mode.

Fire agent discharge is accomplished by exerting a force forward against the forward stop, while simultaneously twisting the handle in the agent position. The turning action in one direction will activate one discharge switch, opposite motion will activate the other switch.

If the pilot pulls one of the ENG FIRE handles down, a warning (disagreement) light in the related engine FUEL switch is illuminated or remains illuminated in case of engine fire. The light will be extinguished when the engine FUEL switch is placed in the OFF position.

Oil System

Each engine oil system is self-contained. Oil for engine lubrication is supplied from an oil tank. Oil is pumped under pressure to the engine and returns to the tank.

An oil pressure indicating system is installed on each engine to indicate current oil pressure to the flight crew. An oil pressure transmitter senses the differential pressure.

The ENG (1, 2, or 3) OIL FILTER alert indicates a clogged or an impending clogging of the oil filter. The filter bypass valve will open when the oil filter is clogged. All contaminated oil will then bypass the filter and go directly to the engine.

ENG (1, 2, or 3) OIL FILTER alerts are accompanied by the MASTER CAUTION lights and are inhibited when the oil temperature is below 35°C.

An oil quantity sensor is installed in the oil tank. It contains a magnetic float supported by the oil level in the tank. As the oil level changes the float causes switches to close.

All oil indications will be shown on the secondary engine page of the SD. Appropriate alerts will appear on the EAD and the SD.

A conflict between oil pressure displays on the SD and related alerts indicates a sensor failure.

Compressor Control System

The compressor control system controls performance through the range of engine operation. A Variable Bleed Valve (VBV) system controls the amount of air into the high pressure compressor.

At low engine speeds, the low pressure compressor supplies more air to the core than is necessary for operation. This excess air goes into the fan discharge airstream and around the high pressure compressor.

The VBV system valves close when the engine speed is sufficient to use the air. A Variable Stator Vane (VSV) system controls the airflow through the high pressure compressor.

The VSV system changes the direction of this airflow to the best angle for compressor performance. This prevents compressor stalls and improves engine operation during acceleration and deceleration. The ECU controls the operation of the VBV and the VSV systems.

Engine Vibration Monitoring System (EVMS)

The EVMS consists of the following:

- One Engine Vibration Signal Conditioner (EVSC).
- Accelerometers (1 or 2).
- N1 and N2 tachometer signals wired to the EVSC from each engine (6 total).

The EVSC is powered by 115-volt ac/400-Hz electrical power. All EVMS data is displayed on the secondary engine display. When engine vibration exceeds a preset value, the digits will turn amber and will be boxed in amber, and an alert will be displayed.

Compressor (N1) and turbine (N2) vibration signals for all three engines are displayed on the secondary engine page of the SD. The secondary engine page is one of many pages that can appear on the SD. If the secondary engine page is not on the SD it can be selected with the ENG cue switch on the aft pedestal. The secondary engine page will appear automatically if there is an engine vibration alert on the EAD.

The EVSC will perform a self-test on power-up. Missing EVMS data is shown with an amber X on the CRTs.

An engine may experience normal momentary peaks in vibration levels lasting between 5 to 30 seconds during certain throttle transients or engine inlet air entry angles.

The Centralized Fault Display System (CFDS) allows maintenance personnel access to EVMS maintenance data.

Engine Failure Detector System

An N1 difference detector alerts the flight crew of engine N1 loss on any of the three engines during takeoff ground roll by illuminating the ENGINE FAIL lights on the glareshield.

During takeoff between 80 knots and V1 the ENGINE FAIL lights will illuminate when any engine N1 rpm differs by 11 percent or more with any other engine N1 rpm.

Thrust Reversing System

The reverse thrust system is designed for ground use only.

Reverse thrust is accomplished by aft movement of a section of the engine cowl to expose fixed cascades and operate blocker doors that rotate across the fan exhaust stream. Normal fan exhaust flow is then blocked and forced through cascades at a forward angle.

Reversers are most effective at high speeds, however, some slowing force remains at low speeds.

If a failure occurs, aerodynamic forces and mechanical loads on the reverser tend to hold the reverser in the last selected position.

When airborne, engine power will be reduced to idle by the FADEC system whenever throttle position disagrees with its reverser position.

The engine thrust reversers are powered by regulated pneumatic pressure from the respective engine.

The thrust reversers are armed when the FCC software receives input that either the Radio Altitude (RA) is seven feet or wheel spinup is greater than 80 knots. A compressed nose gear strut will also arm the thrust reversers in case of an FCC fault.

Each system is operated by movement of the associated reverser lever. Reverser levers cannot be operated unless the throttle is at the idle stop. To deploy the reverser, the reverser levers must be moved to the reverser interlock position.

The reverser interlock on engines 1 and 3 is a physical stop that prohibits further lever movement until the reverser is safely deployed. When the reverser is 60 percent deployed, the ECU removes the interlock, allowing uninhibited movement of the thrust levers.

Reverser lever 2 does not have a physical interlock. The ECU, however, prohibits thrust increase beyond idle power on engine 2 until the nose wheel ground sensing switch has closed and the reverser is more than 90 percent deployed.

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As the reverser levers are raised to reverse idle, each N1 display on the EAD will show an amber U/L (reverser unlocked). When the reversers are fully deployed and available, a green REV will appear on the N1 displays.

NOTE: The U/L and REV displays are red during flight.

When reducing reverse thrust, the reverser lever will be returned to the reverse idle detent. This position is felt as a slight increase in resistance to lever movement.

The reversers are stowed by movement of the reverser levers through the reverse idle detent to the forward idle stop position.

The EAD displays U/L in each N1 display as each reverser is being stowed. The U/L message will be removed when forward thrust is restored.

Thrust reverser override switches are installed on the cockpit maintenance panel. These switches allow maintenance checks of the reverse thrust range of the throttle resolvers. When pushed, these switches cancel the ECU signals to the wing engine reverser interlocks in the pedestal. This releases the reverser levers so that they can be moved without operating the thrust reversers.

Test Displays

EAD

Engine EAD failure indications are amber Xs over the thrust limit, TAT, and fuel flows, and larger amber Xs over the tapes. These failure indications will appear when all of the following conditions are met:

- The aircraft is on the ground.
- The aircraft is operational.
- The ANNUN LT TEST button on the forward overhead panel is pushed.

SD

SD secondary engine display power failure indications are amber Xs over the digital readouts. In the case of the oil PRESS, TEMP, and QTY the amber Xs are over the tapes. These failure Xs will appear when all of the following conditions are met:

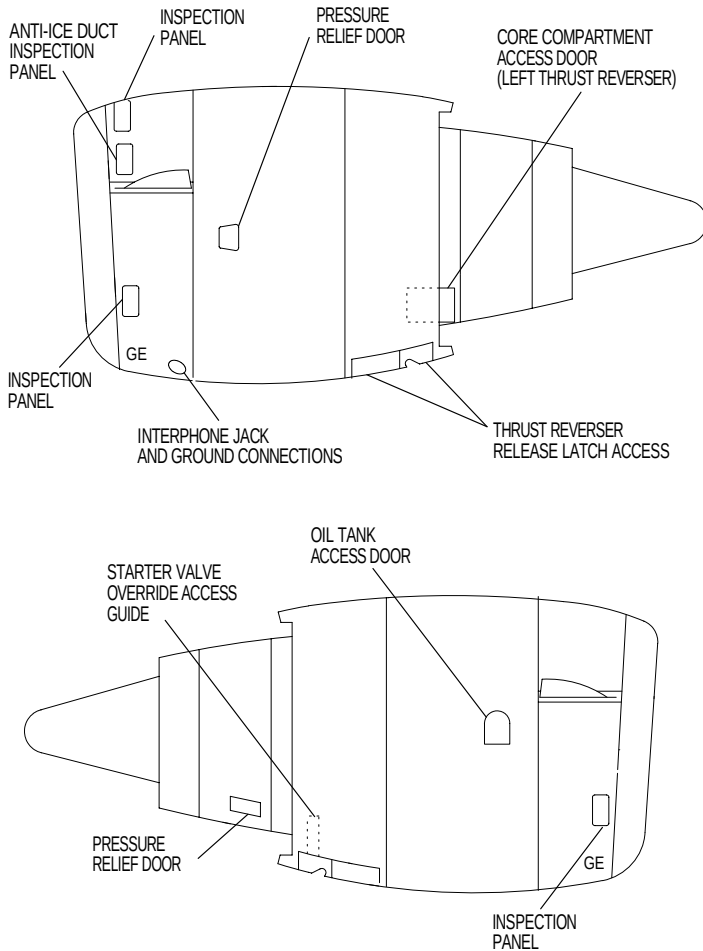
- The aircraft is on the ground.
- The aircraft is operational.
- The ANNUN LT TEST button on the forward overhead panel is pushed.
- Secondary engine display is on the SD.

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Engines Components

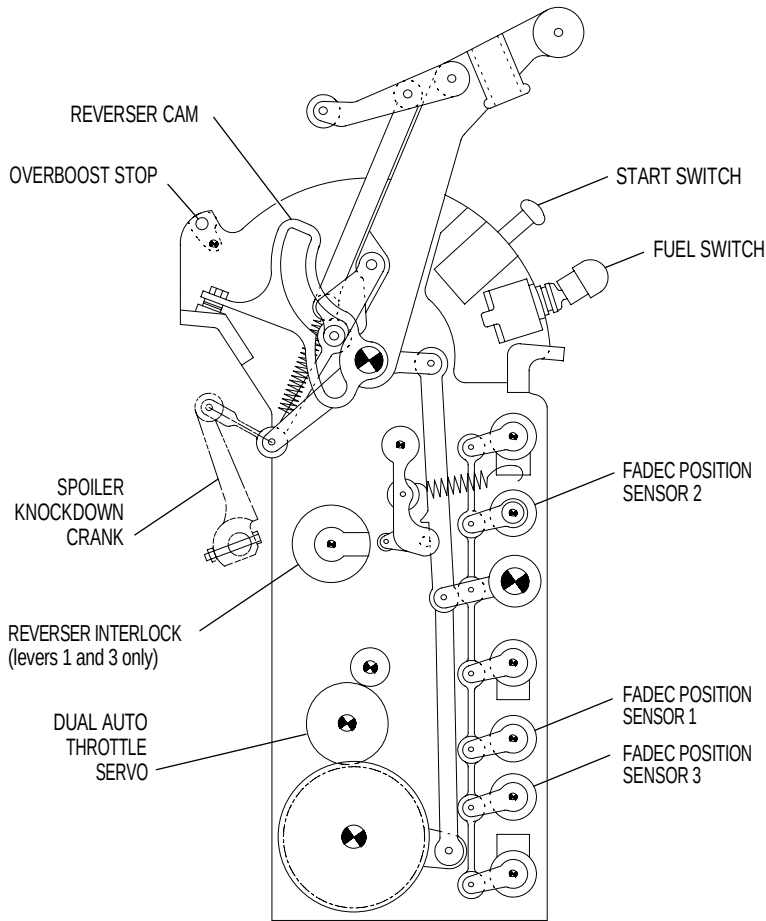
Chapter Eng Section 20

Exterior Details



DB1-2-1717

Thrust Control Module



DB1-2-1720

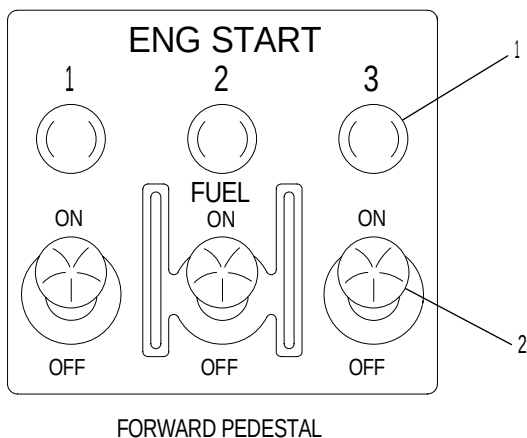
Engines

Controls and Displays

Chapter Eng

Section 30

ENG START Switches and FUEL Switches



DB1-2-1721

1. ENG START Switch (3) - amber

Pulling this switch will:

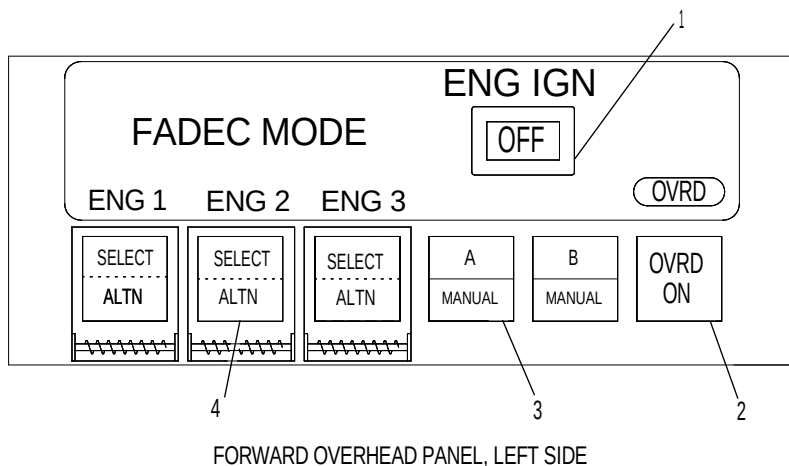
- Energize a coil that holds the switch out.
- Energize the engine starter valve open.
- Illuminate the switch amber.
- Supply power to the FADEC computer.

At about 45-52 percent the ENG START switch will pop in and the light will extinguish indicating that the starter air valve has closed. The MSC controls the start sequence. This switch cannot illuminate until the appropriate electrical bus is powered.

2. FUEL Switch (3) - red

This switch supplies electrical power to a fuel metering device. The fuel metering device then operates the fuel shutoff valve. This switch illuminates red during engine fire and ENG/APU FIRE test. Moving the switch to the ON initiates ignition and fuel if the ENG START switch is out and the ENG IGN switch is selected A or B. The FSC automatically turns on the fuel pumps in tanks 1, 2, or 3 when the respective ENG START switch or FUEL switch is moved to ON.

FADEC MODE Panel



DB1-2-1722

1. ENG IGN OFF Light - amber

Illuminates amber when no ignition system has been selected and no power is being supplied to the ignitors.

2. OVRD ON Switch - amber

Push switch to select ignition override. Direct power to both ignitors on each engine is provided for in-flight use. Normal ignition control is bypassed.

Illuminates amber when ignition override is selected on.

3. ENG IGN Switch (A & B) - white/blue

Selecting ignition with these switches will signal the aircraft system controllers (MSC, ESC, FSC) that the engines are about to be started. The aircraft system controllers will then configure the interfacing aircraft systems for engine start.

Once an ignition selection has been made (A, B, or both A and B), the selection will remain until engine shutdown.

A or B illuminates white when the respective ignition system has been selected with the switch. When A or B is illuminated, the APU N1 will increase to about 100 percent rpm to provide greater pneumatic capability for starting.

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In the normal mode of operation, the auto-ignition feature will provide continuous power to ignition system A or B (whichever has been selected) during takeoff and landing, and for the first 60 seconds after one of the engine cowl anti-ice systems has been commanded on.

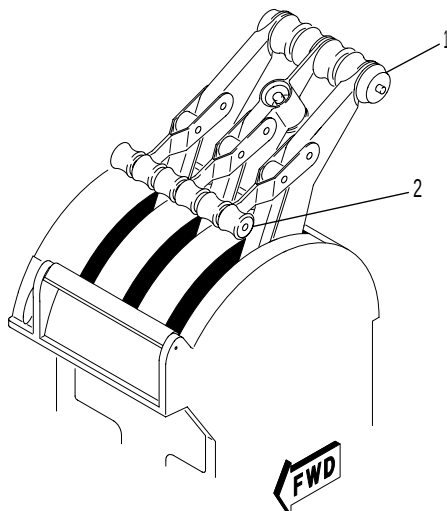
MANUAL illuminates blue to indicate that power is being supplied continuously to the selected ignition. This occurs when the ignition has reverted to the manual mode (auto-ignition failure). In this case the ignition system will remain powered until the pilot turns it off by pushing ENG IGN switch.

4. FADEC MODE ENG 1/2/3 Switch (3) - amber

SELECT ALTN illuminates amber when the respective FADEC cannot operate in the primary mode. The crew can then push this switch to select the backup alternate mode. When the alternate mode is selected, ALTN will remain illuminated.

If the overboost stop on the throttle quadrant has been exceeded, the associated FADEC system will switch to the alternate mode and SELECT/ALT lights will illuminate.

Throttles and Reverser Levers



DB1-2-1723A

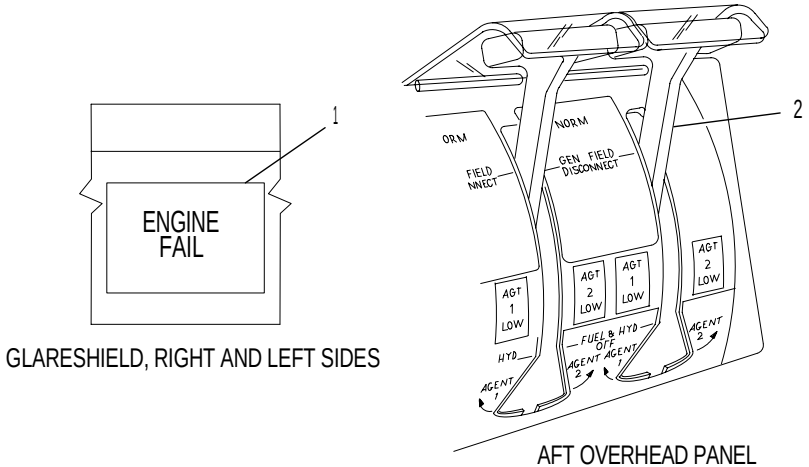
1. Throttles (3)

Each throttle is mechanically linked to 2 electrically isolated position sensors. Sensors send signals to the FADEC. FADEC then schedules fuel flow as required.

2. Reverser Levers (3)

The throttle levers must be at the forward idle stop before the reverser can be moved. Movement upward of the reverser lever commands the reverser to deploy. Continued upward movement commands engine reverse power increase.

ENGINE FAIL Lights and ENG FIRE Handles



LB1-3-0290

1. ENGINE FAIL Light (2) - red

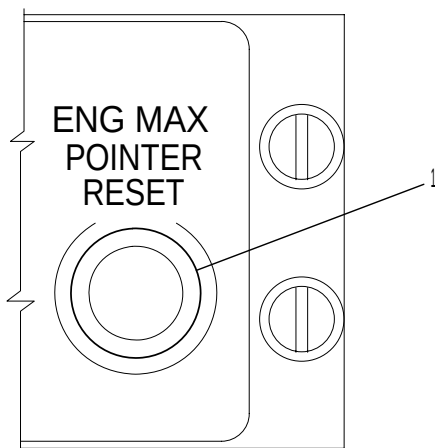
This light illuminates red if the aircraft is in takeoff between 80KTS and V1 and any engine N1 differs by 11% or more with any other engine. The MASTER WARNING or MASTER CAUTION lights will not illuminate.

2. ENG FIRE Handle (3) - red

Pulling the ENG FIRE handle full down will shutoff fuel and hydraulic supply to the associated engine, deenergize associated generator field, and turn off fire bell. The associated FUEL switch on the forward pedestal will be illuminated red if it is ON.

Twisting the ENG FIRE handle while pulling may result in premature firing of extinguishing agent.

ENG MAX POINTER RESET Button



FORWARD OVERHEAD PANEL RIGHT SIDE

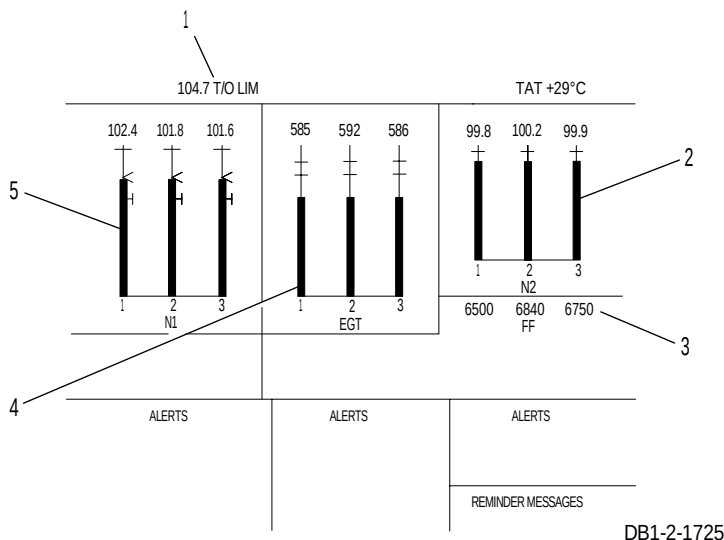
LB1-3-0291

1. **ENG MAX POINTER RESET Button**

When pushed, resets exceedance, if any, on the N1, N2, and EGT displays.

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EAD Primary Engine Display (GE Tapes)



1. Thrust Rating and TAT

FMS N1 limit and modes are magenta. Manually set modes are white. Available modes are: CLB (climb), CRZ (cruise), GA (go-around), MCT (max contin thrust), TO (takeoff), and TO FLEX (takeoff flex). In TO FLEX, the assumed temp is also shown. TO 1, TO 2 (10%, 20% derated takeoff thrust) are displayed if selected. Total air temperature is in the upper right corner in white.

2. N2

Columns are white, but turn red if N2 exceeds the redline limit. During start, a cyan line appears to indicate the N2 at which fuel should be turned on. Maximum redline exceedance, if any, is shown in amber at the top. This exceedance can be reset with the ENG MAX POINTER RESET button on the forward overhead panel.

3. Fuel Flow

Fuel flow is in white digits. Unit of measurement is kilograms per hour. When the engine fuel valve is closed, a cyan FUEL OFF appears above the digits.

4. EGT

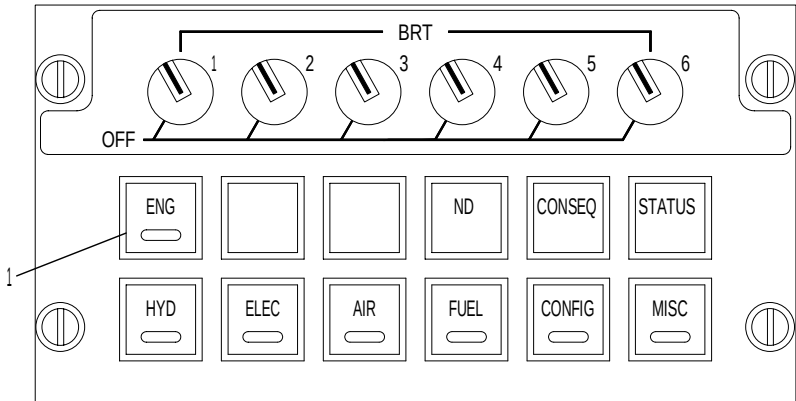
Columns are white but turn amber if EGT exceeds the amber line or red if EGT exceeds redline limit. During starting there is an additional red line limit for start. A cyan lightning symbol appears (overwrites digits) when ignition for that engine is on. Maximum redline exceedance, if any, is shown in amber at the top. This exceedance can be reset with the ENG MAX POINTER RESET button on the forward overhead panel.

5. N1

Throttle position is a white T riding on the side of each column. Computed N1 is a magenta V on the side of each column. When the throttle is set to a computed thrust, the T will fit in the V. The thrust reverser display is on top (overwrites digits). It is blank for reverser stowed, amber U/L for in transit, and green REV for reverser fully deployed. Maximum redline exceedance, if any, is shown in amber at the top. This exceedance can be reset with the ENG MAX POINTER RESET button on the forward overhead panel.

NOTE: If one of the two ECU channels is inoperative, N1 will not be displayed until the FUEL switch is moved to on.

ENG Cue Switch



AFT PEDESTAL

LB1-3-0293

1. ENG Cue Switch - white

Illuminates white when an ENG alert is displayed on the EAD.

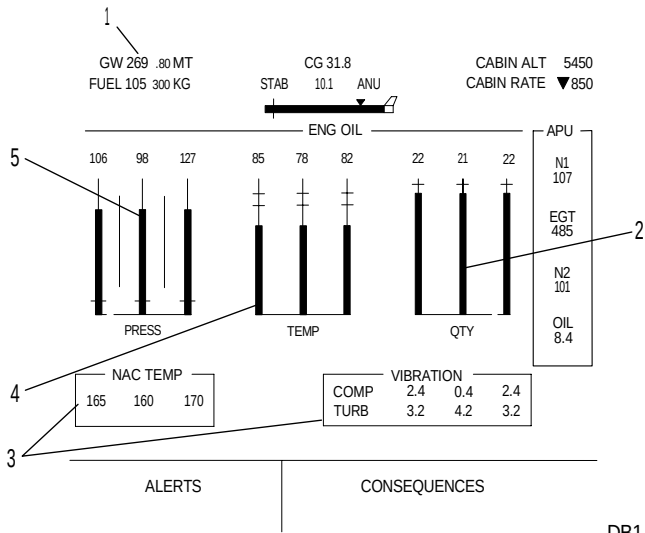
When pushed:

- MASTER WARNING or MASTER CAUTION lights will extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- Secondary engine display comes into view on the SD.

The secondary engine page is a default page and is presented automatically if any parameter on it exceeds limits.

Some level 1 alerts are maintenance alerts that appear on the STATUS page only. These maintenance alerts will not illuminate the cue switch or the MASTER CAUTION lights.

SD Secondary Engine Display (Tapes)



DB1-2-1730

1. Gross Weight and Fuel

Gross weight and fuel are in white. Invalid data is marked with an amber X. Unit of measurement is metric tons and kilograms.

2. OIL QTY Display

When the engine reaches minimum idle (on ground), a cyan line appears showing initial oil quantity for oil consumption reference. The display turns amber and digits are boxed in amber when oil quantity is below 4 quarts. If associated DEU power supply fails, an amber X appears.

3. NAC TEMP and VIBRATION Readouts

Nacelle temperature is shown with white digits. Compressor and turbine vibration levels are white but turn amber and boxed in amber if they exceed limits. If data is not available, an amber X will appear.

4. OIL TEMP Display

The display will turn amber and digits will be boxed in amber if oil temperature exceeds the high amber line or below the low amber line.

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The display will turn red and digits will be boxed in red if red line is exceeded or temperature remains in the high amber range longer than 15 minutes for GE.

5. OIL PRESS Display

A green column shows the valid operating range. The display turns amber if pressure moves out of the green band. The display will turn red when the pressure moves below the redline limit. During engine starts under extreme cold conditions, oil pressure may reach maximum indication due to low oil viscosity.

Normal ranges are 10 to 120 psi for GE.

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Engines
Alerts**Chapter Eng**
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NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

ENGINE 1/2/3 FIRE (ENG) - Respective engine fire or overheat condition.

Amber Boxed Alerts (Level 2)

ENG 1/2/3 EGT HI (ENG) - Engine 1/2/3 EGT over redline limit.

ENG 1/2/3 OIL FILTER (ENG) - Engine 1/2/3 oil may be bypassing the oil filter.

ENG 1/2/3 OIL PRES LO (ENG) - Engine 1/2/3 oil pressure is low.

ENG 1/2/3 OIL TEMP HI (ENG) - Engine 1/2/3 oil temperature is high.

ENG 1/2/3 RPM HI (ENG) - Engine 1/2/3 (N1 or N2) rpm is high.

ENG 1/2/3 RPM LO (ENG) - Engine 1/2/3 N2 is below idle.

SELECT FADEC ALTN (ENG) - One or more engines are operating in ALTN mode, a degraded automatic mode.

Amber Alerts (Level 1)

ENG 1/2/3 FADEC ALTN (ENG) - Engine 1/2/3 FADEC MODE switch is in the ALTN position, or the throttle has been pushed through the overboost stop. The FADEC is operating in a degraded mode and care should be taken to avoid exceeding thrust limits.

ENG 1/2/3 FADEC FAULT (ENG) - FADEC 1/2/3 has detected an internal fault or loss of redundancy. Engine operation is not affected.

ENG 1/2/3 FADEC MAINT (ENG) - FADEC 1/2/3 has detected an engine fault or combination of faults that could affect engine operation.

ENG 1/3 FSO CLOSED (FUEL) - Engine 1/3 fuel shutoff valve is closed (fuel off) with the engine fire handle in the normal (up) position.

ENG 1/3 FSO NOT CLSD (FUEL) - The respective engine fuel shutoff valve is not closed with the engine fire handle in the FUEL & HYD OFF (down) position.

ENG 1/2/3 FUEL FILTER (ENG) - The respective engine fuel filter is clogged and engine fuel may be bypassing the filter. In flight, monitor engine operation.

ENGINE 1/2/3 VIB HI (ENG) - Engine 1/2/3 vibration 4.0 units or greater.

ENGINE IGN MANUAL (ENG) - Automatic control of the engine ignition system is inoperative.

ENG IGN NOT ARMED (ENG) - Engine ignition is not armed.

FADEC 1/2/3 B/U PWR (ENG) - Engine 1/2/3 FADEC on backup power.

FADEC GND PWR ON (ENG) - One or more of the FADEC GND PWR switches, on the upper maintenance panel, is ON. The switches should be selected OFF prior to engine start.

REV 1/2/3 FAULT (ENG) - The respective thrust reverser pressure indication system has failed.

REV 1/2/3 PRESS FAULT (ENG) - Either the respective thrust reverser system is pressurized or the pressure switch has failed to the closed position.

START AIR PRES LO (AIR) - Insufficient air pressure for engine start.

Cyan Alerts (Level 0)

ENG IGN OVRD ON - The engine ignition override function has been selected.

ENGINE IGN ON - Automatic control of the engine ignition system is inoperative and ignition is on.

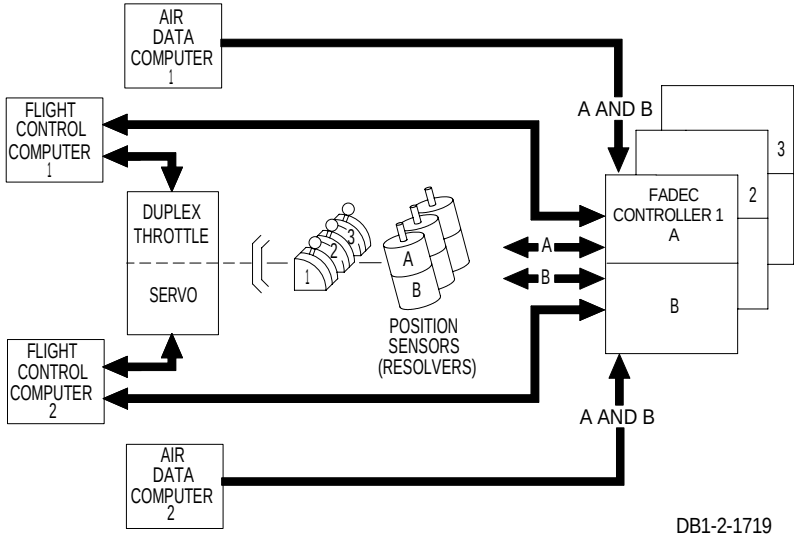
Engines

Functional Schematic

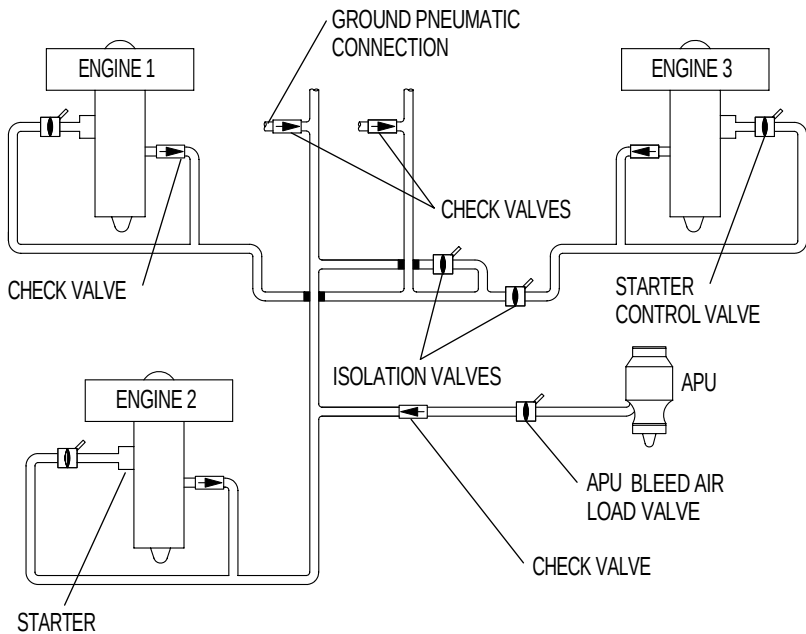
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Section 50

Electronic Thrust Control



Start System



LB1-3-0156

Fire Protection

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Fire Protection

Description and Operation

Chapter Fire

Section 10

General

The fire protection system is a dual function system. The two functions are detection and extinguishing.

The detection system detects fires in the engine nacelles, APU compartment, and cargo compartments. It also detects smoke in the cargo compartments. The extinguishing system will extinguish fires in any of these fire zones.

The detection system includes the following:

- Dual sensing elements in the engine nacelles and APU compartments.
- Separate heat and smoke detectors in the cargo compartment.
- Single smoke detector in each lavatory.
- Fire Detection Control Units (FDCU) (Engine 1, 2, 3, and APU).
- Control switches and lights on the aft overhead panel.
- EAD alerts, AIR synoptic smoke/heat symbology, engine fire bells and aural warning.

The extinguishing system includes pressurized agent storage bottles installed near the fire zone they protect. With the exception of the lavatory, discharge of the extinguishing agent is accomplished with controls located in the cockpit. Agent can be discharged to the APU by ground personnel from the external APU control panel behind the left main gear well.

The cargo area is divided into two class C compartments, forward and center/aft. The center/aft compartment is considered a single compartment for fire protection purposes.

Fire protection system alerts are displayed on the EAD. MASTER WARNING lights on the glareshield illuminate when a fire detection system is activated.

Engine and APU Fire Detection

The system includes dual sensing elements, control units and circuits, MASTER WARNING lights, control switches, aural fire warning accompanied by alerts on the EAD for the engines, and an external alarm horn for the APU.

An FDCU for each engine and the APU contains dual channels in a single unit. Each channel operates from a single sensing element or loop. The loops are mounted in close proximity on the same support structure along the routing. The outputs of the channels are integrated so that fire signals from both operative loops must be received to result in a fire alarm.

If one of the loops is inoperative, a fire signal from the remaining operative loop can provide a valid signal. The outputs are also integrated through a logic circuit to differentiate between a fault signal and a fire signal.

Engine and APU fire detection and extinguishing is available during battery starts.

Main Engine Sensing Elements

The sensing elements consist of a stainless steel tube filled with pressurized helium gas. The tube also contains a hydrogen impregnated gas core.

One end of the tube is sealed and the other end has an assembly containing the pressure switches (alarm and integrity).

During overheat conditions, an increase in temperature from normal to a specified average will cause thermal expansion of the helium gas with an increase in pressure until an electrical contact is made to trigger the alarm system.

During a fire condition, hydrogen gas is released from the core material when a section of the sensing element is heated to a preset temperature. This release of hydrogen will activate the alarm switch.

The expansion of gases in the sensing element is reversible. The sensing element will detect the extinguishing of a fire as well as the presence of a fire.

A single break in the element casing or wiring will cause a loop FAULT alert and will not cause false fire alarms.

The main engine fire detector sensing elements are located in the engine core compartment.

The sensing elements detect the following types of fire or overheat conditions:

- Fires caused by flammable fluids leaking on hot surfaces or ignited by electrical sparks.
- Fire/overheat caused by burn through of the combustor case.
- Ruptured bleed ducts (during certain operating conditions only).

APU Sensing Elements

The APU is installed in the aft fuselage. The dual fire detector sensing elements for the APU are routed along the sides of the compartment wall. There are two loops, each loop is divided into three segments.

The system is designed to detect flammable fluid fires and hazardous overheat conditions from ruptured pneumatic ducts.

Besides the APU duct, this compartment also contains the pneumatic duct from engine 2 (aft). Thus, an APU FIRE warning could also mean that pneumatic duct 2 has ruptured. The APU sensing elements are activated by a uniform temperature of about 218 °C.

Since the bleed air temperature from engine 2 can vary over a wide range depending on engine operating conditions, and since the fire detection alarm temperature is above the nominal bleed air temperature expected, a ruptured duct will be detected only if it is hazardous.

Fire Detection Control Unit (FDCU)

One FDCU for each main engine and the APU is located in the avionics compartment directly below the cockpit. The four FDCUs are identical, however, the external circuitry for the engines is different than for the APU.

The FDCU contains circuits that will:

- Detect signals from the sensing elements.
- Differentiate between a fire signal and a fault.
- Receive inputs from the LOOPS A/B and LOOPS A/B TEST switches.
- Energize the MASTER WARNING lights, LOOP A/B lights, alerts, and aural fire warning or APU horn.

The FDCU incorporates two loop circuits (loop A and loop B) which provide continuous monitoring of the detectors. These loop circuits provide warning signals to the flight crew in the event of any fire/overheat alarms, or loop faults.

In addition to the loop circuits, the FDCU has a microprocessor and ARINC 429 transceiver circuit.

The microprocessor monitors detectors wiring, and FDCU integrity. It is capable of isolating a fault to the Line Replaceable Unit (LRU) level.

The FDCU has Built-in-test Equipment (BITE) and interfaces with the centralized fault display system (CFDS) via the ARINC 429 bus.

The FDCU continuously receives and analyzes both fire detection loops signals and is capable of detecting one or more failures in the fire detection loops.

In the event of a failure, the FDCU will:

- Store the failure in a memory.
- Isolate the failure to an LRU.
- Provide alerts regarding the system status including failures.
- Enable single loop fire detection capability on the remaining good loop when a single loop fails.

When a fire condition is sensed, the FDCU will generate two fire outputs. Fire output 1 is powered by the loop A power source, and fire output 2 is powered by the loop B power source.

The two fire outputs eliminate the possibility of a single point failure preventing an alarm during a fire condition.

In addition to the two fire outputs, a third output is also provided for cockpit aural warning. The fire outputs will be activated in response to any one of the following conditions:

- (Fire loop A) and (Fire loop B).
- (Fire loop A) and (Fault loop B).
- (Fault loop A) and (Fire loop B).
- (Fault loop A) and (Fault loop B) - AND both faults occurring within 5 seconds of each other.

If any of the following conditions exist, the FDCU will generate a FAIL output signal for the affected loop:

- Loss of power for that loop.
- Fault in a detector for that loop.
- A failure within that loop's fire detection circuit.
- Detection of fire by single loop for greater than 15 seconds while the other loop is indicating normal (no fire and no fault).

The FDCU has a built-in test circuit capable of testing both the loop A and loop B detection circuits and sensing loops. The circuit provides the following functions:

- During FIRE TEST (pilot initiated), both FDCU loop detection circuits are tested and the fire warnings activate.
- During the maintenance test the FDCU performs an internal test of itself, the detection loops, and the critical wiring. The maintenance test automatically occurs when the system powers up and the aircraft is on the ground.

The fire bell has the following characteristics:

- Sounds when a fire condition (engine) is detected.
- Sounds during pilot initiated fire test.
- Will stop sounding when the fire output clears.
- Is inhibited during maintenance test.

The FDCU contains two redundant control channels (loop A and loop B) in a single enclosure, with each channel operated by one of the sensing element loops. Alerts are activated as follows:

MD-11 Flight Crew Operations Manual

LOOP A	LOOP B	ALERT
Fire	Fire	ENGINE (1,2,3, or APU) FIRE
Fire	Normal	FIRE DET (1,2,3, or APU) FAULT
Normal	Fire	FIRE DET (1,2,3, or APU) FAULT
Fire	Fault	ENGINE (1,2,3, or APU) FIRE
Fault	Fire	ENGINE (1,2,3, or APU) FIRE
Fault	Fault	ENGINE (1,2,3, or APU) FIRE (if both loops were good before control unit detected dual fault within 5 seconds.
Fault	Fault	FIRE DET (1,2,3, or APU) FAIL (if control unit detects dual fault occurred outside 5 seconds.

Fire Indications

A main engine fire or overheat condition is indicated by:

- Illumination of MASTER WARNING lights.
- Sounding of fire bell.
- Illumination of ENG FIRE handle.
- Illumination of engine FUEL switch.
- Alert on the EAD.

The red MASTER WARNING light, located on both the Captain's and First Officer's glareshield, is actuated by the relays of the FDCU. This light is a push-to-reset light used to turn the aural warning and MASTER WARNING light off after a fire warning. This enables the system to indicate another warning if necessary.

A red light in the ENG FIRE handle and the associated alert on the EAD will indicate which ENG FIRE handle to pull for fire extinguishing. A red light in the engine FUEL switch indicates which engine FUEL switch to turn off. With the ENG FIRE handle pulled and the engine FUEL switch on or off, the FUEL switch remains illuminated if the fire warning still exists.

With the ENG FIRE handle pulled and the fire warning terminated, the engine FUEL switch will remain illuminated until the FUEL switch is moved to the OFF position.

An APU fire or overheat condition is indicated by:

- Illumination of MASTER WARNING lights.
- EAD alert.
- Aural warning in cockpit.
- Illumination of APU FIRE light on the external APU control panel.
- Illumination of APU FIRE handle on the APU control panel.
- Sounding of horn near the external APU control panel.

The APU FIRE handle and the alert on the EAD will continue to stay on as long as the warning exists

The APU will automatically shut down when a fire is detected and the APU FIRE light on the external panel will flash.

The ENG/APU FIRE TEST button on the APU control panel sends a voltage input simulating a fire signal for loops A and B. This tests FDCU circuitry for the output drives for the fire bell, FIRE handle, MASTER WARNING and FUEL switch lights, aural warning, and level 3 ENG/APU FIRE alert. This does not test loops A and B.

The FDCU continuously monitors the loops. If the FDCU detects both engine or APU loops on a single element are faulty, the alert FIRE DET (1, 2, 3, APU) FAIL will be displayed. If only one of the two engine or APU loops (A or B) on a single element is detected faulty, the alert FIRE DET (1, 2, 3, APU) FAULT will be displayed.

The FIRE DET (1, 2, 3, APU) FAULT alert is common for a single loop fault (A or B) for any of the engine elements or APU. It indicates that the fire detection system for engines and APU is operative even though one loop is inoperative.

Engine and APU Fire Extinguishing

The engine/APU fire extinguishing system is a chemical (Halon 1301) high rate discharge system used to extinguish fires in the engine and APU compartments. The system is powered by the battery direct bus.

Each extinguishing system consists of two stainless steel agent bottles, discharge heads, discharge cartridges with electrical connectors, agent distribution system, cockpit controls and displays, and warning lights.

In case of bottle overpressure, a disk will rupture and agent will flow to the respective zone.

Agent discharge is not automatic.

Two bottles located in the rear fuselage provide agent for the aft engine (engine 2) and APU fire zones. Each bottle has two outlets, allowing discharge to the selected fire zone, with provision for the second bottle to discharge to the same fire zone, if necessary.

When both engine 2 fire agents have been discharged to the APU, none remains for engine 2.

Two identical bottles are located in each wing inboard of the pylon near the front spar. They provide agent for each of the pylon mounted engine fire zones.

Each bottle has two outlets, one of which is capped. The uncapped outlets are connected together to allow discharge to the same fire zone.

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The ENG FIRE handles allow the crew to discharge fire agent to an engine from one of two bottles installed for each engine. Moving the handle to the first position turns off the generator field. The second position shuts off fuel, hydraulics and pneumatic supply. The handle can then be rotated clockwise to discharge bottle 1 and counterclockwise for bottle 2. When a fire is extinguished, the handle light will extinguish, however, the engine FUEL switch will remain illuminated if FUEL switch is still on.

The APU FIRE handle allows the crew to discharge fire agent to the APU. Pulling the handle turns off the APU if not already off. The handle can then be rotated clockwise to activate bottle 1 and counterclockwise for bottle 2. Switches on the external APU control panel allow discharge from the wheel well area. Normally, the APU will shutdown automatically if a fire is detected. With the aircraft on the ground a horn will sound. This horn will stop when the fire signal is no longer received.

Lower Cargo Fire Detection

The aircraft has class C forward and center/aft lower cargo compartments which require detection and fire extinguishing provisions. A fabric cargo net separates the center and aft cargo compartments.

The center and aft compartments are considered a single class C cargo compartment.

The lower cargo fire detection system consists of photoelectric smoke detectors, overheat detector, smoke detector annunciation, heat detector annunciation, FWD and AFT flow DISAG/OFF lights, and CRT displays.

The aircraft has five smoke detectors installed in the forward cargo compartment and five in the center/aft cargo compartment area.

In addition, one overheat detector is installed in the ventilation exit duct of the ventilated forward cargo compartment area and two overheat detectors are installed in the exhaust ducts of the ventilated center/aft cargo compartment area. Any one of the smoke or overheat detectors will activate the warning system.

Both the forward and aft cargo compartments are ventilated. Ventilation of these areas is controlled by the FLOW switches on the CARGO FIRE control panel. In the event of heat or smoke, the HEAT or SMOKE lights on the CARGO FIRE control panel illuminate and an alert will be displayed.

When smoke or heat is detected in the cargo compartment, heating and ventilation of that compartment will automatically shut off and the respective cargo flow DISAG light on the CARGO FIRE control panel will illuminate. The auto shutoff of heating and ventilation continues as long as the smoke signal exists. Once the smoke stops, the MSC will return the cargo heating and ventilation to normal operation. Pushing the DISAG/OFF switch will illuminate the OFF light, and prevent automatic restoration of the heating and ventilation without pilot intervention. Turning FWD/AFT CARGO HEAT selector to OFF prevents automatic restoration of heating without pilot intervention.

The cargo fire detection and extinguishing system is automatically tested when the first of 3 IRUs is turned on. It is manually tested with the CARGO FIRE MANUAL TEST switch on the CARGO FIRE control panel.

Any failure in the system will cause a CRG FIRE TST FAIL alert to be displayed.

If the alert MSC AUTO FAIL appears on the status page of the SD, a manual cargo fire test must be performed.

The air synoptic on the SD informs the flight crew of specific failures in the systems. For a description of the air synoptic refer to the Air chapter.

Lower Cargo Fire Extinguishing

The cargo fire extinguishing system is a chemical (Halon 1301) discharge system used to extinguish fires in the lower class C cargo compartments.

Each extinguishing system consists of two different sized, stainless steel, agent bottles, discharge head(s), discharge cartridge(s) with electrical connector(s), low pressure switch agent distribution system, cockpit controls and warning lights.

The normal discharge time prior to the LOW light illumination on the CARGO FIRE control panel is about 28 seconds for bottle 1 and about 15 seconds for bottle 2.

Agent discharge is not automatic. The primary discharge is initiated manually by the flight crew upon fire indication. The second bottle is discharged by the flight crew into the lower cargo compartment after 90 minutes.

Agent from the fire extinguishing bottles is discharged into the appropriate cargo compartment (fwd or aft) when the corresponding AGENT DISCH switch on the CARGO FIRE control panel is pushed.

When heat and/or smoke is detected in a forward or aft cargo compartment the appropriate AGENT 1 light on the CARGO FIRE control panel will flash to indicate the proper agent to discharge. The DISCH CARGO AGENT alert will be displayed on the EAD. The AGENT 2 light will flash immediately if AGENT 1 LOW light was illuminated due to a low pressure condition.

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Approximately 90 minutes after the agent 1 bottle has been discharged, DISCH AGENT 2 light will flash to indicate that agent 2 bottle should be discharged.

The agent 2 fire extinguishing bottle is considerably smaller than the agent 1 fire extinguishing bottle.

If smoke or heat is detected in the forward or aft compartments, ventilation airflow to the compartments automatically shuts off. This isolates that compartment prior to agent discharge.

Lavatory Fire Detection

Three smoke detection panels are installed at galley G1: Two detection panels for the FWD and AFT lavatories. One detection panel for cockpit and lower deck crew rest. When smoke is sensed, the following will happen:

- A red warning light flashes above the respective lavatory or crew rest door.
- An intermittent high pitch tone sounds every five seconds as long as the smoke detectors are activated.
- A red indicator light on the smoke detection panel flashes.
- A horn in the smoke detection panel sounds.
- In case of a crew rest smoke condition a level 2 CREW REST SMOKE alert is displayed.

When smoke is detected, the lavatory fan will be automatically shut off. The fan can be reset with a LAVATORY FAN RESET P/BV below the smoke detection panel.

Lavatory Fire Extinguishing

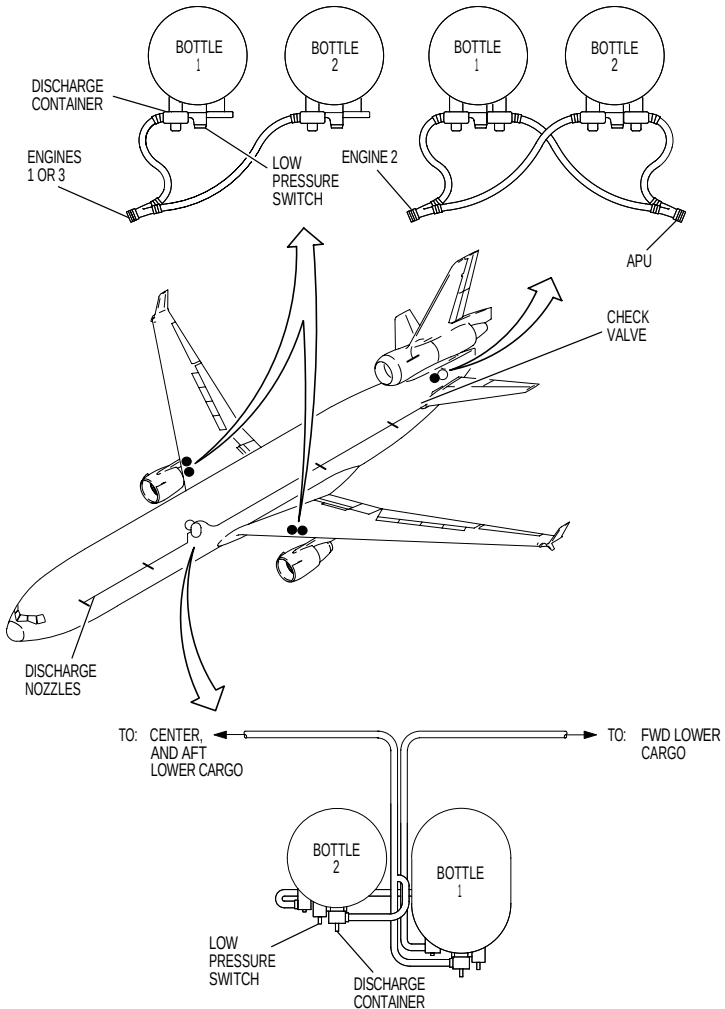
A disposable fire extinguisher is installed adjacent to the trash container in each lavatory. The system is automatic and self-contained. When the temperature at the extinguisher discharge tube tips is between 76.6 °C and 80.5 °C the tube tips melt allowing the extinguishing agent to be discharged into the container.

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Fire Protection Components

Chapter Fire Section 20

Fire Protection - Extinguisher Locations



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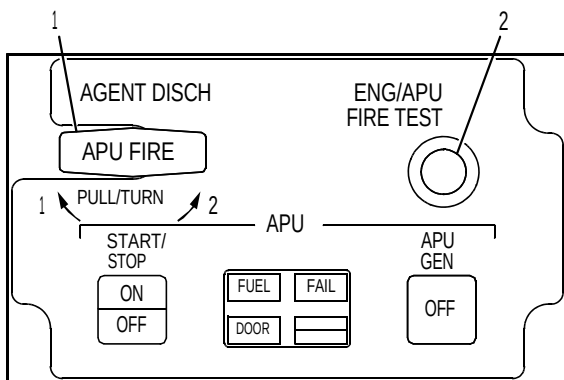
Fire Protection

Controls and Displays

Chapter Fire

Section 30

APU Controls/Indicators



AFT OVERHEAD PANEL, RIGHT SIDE

DB1-2-1945

1. APU FIRE Handle

Illuminates red when the APU fire warning circuit is activated. At the same time, the following actions will take place automatically:

- MASTER WARNING lights illuminate red.
- Alert appears on EAD.
- APU FIRE illuminates red on the external APU control handle.
- Fire horn sounds near the external APU control panel.
- APU shuts down.
- Aural warning will sound.

When the handle is pulled:

- APU goes to emergency shutdown.
- Fire extinguishing agent is armed.
- APU generator field is deenergized.
- APU fuel valve closes.
- APU load bleed valve closes.

After handle has been pulled, rotating handle clockwise will discharge bottle 1 agent. Counterclockwise rotation will discharge bottle 2 agent.

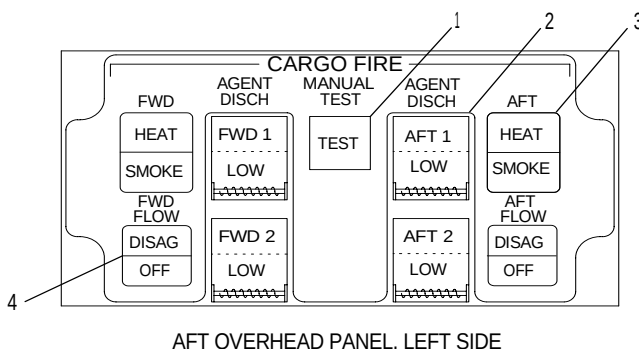
2. ENG/APU FIRE TEST Button

When pushed:

- ENGINE FIRE handles, APU fire handle, and engine FUEL switches illuminate.
- Both MASTER WARNING lights flash, fire bell, and aural tone sound.
- ENG 1, 2, 3, and APU FIRE alerts are displayed.
- ENGINE FIRE voice warning (optional) sounds.

MASTER WARNING lights, fire bell, and FIRE alerts will not activate unless aircraft power or emergency power is available.

Cargo Fire Panel



DB1-2-1685

1. MANUAL TEST Switch - blue

Push to test lower cargo smoke and heat detectors and agent discharge squibs. MASTER WARNING, HEAT/SMOKE, FLOW DISAG, AGENT DISCH LOW, and MANUAL TEST lights illuminate. Aural tone sounds. Related alerts appear on the EAD and SD AIR synoptic.

2. AGENT DISCH Switch (4) - amber

FWD1 or AFT1 flashes amber when heat and/or smoke is detected in the associated cargo compartment to alert the crew to discharge fire extinguishing bottle 1.

FWD2 or AFT2 flashes amber to alert the crew to discharge bottle 2 when:

- heat and/or smoke is detected in the associated cargo compartment and fire extinguishing bottle 1 pressure is low.
- 90 minutes have passed after bottle 1 has been discharged.

LOW illuminates amber when associated fire extinguishing bottle pressure is low.

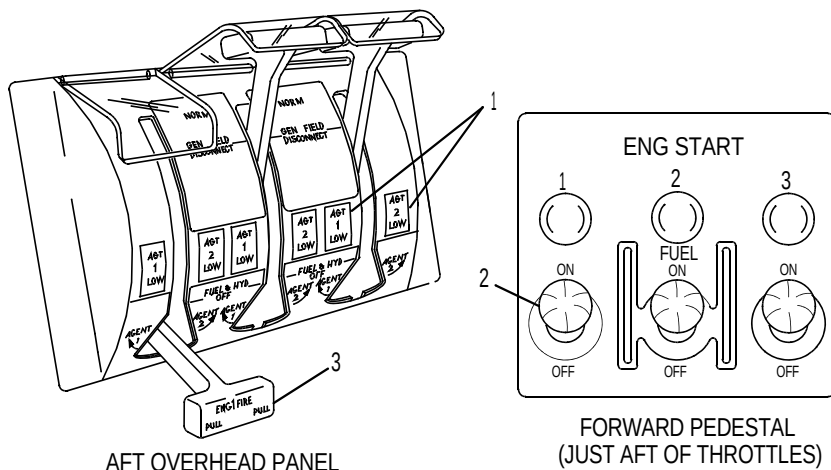
3. HEAT/SMOKE Light (2) - red

SMOKE or HEAT illuminates red when smoke or heat is detected in the respective lower cargo compartment. Ventilator airflow to respective compartment shuts off. MASTER WARNING lights, EAD alert, and aural tone come on.

4. Cargo FLOW Switch (2) - amber

Flow (ventilation fan) to the lower cargo area shuts off automatically if smoke or heat is detected. DISAG then illuminates amber (flow does not agree with switch position). OFF illuminates amber if flow is commanded off with this switch. Auto control is prevented when OFF is illuminated.

Fire Protection Controls/Indicators



DB1-2-1686A

1. AGT LOW Light (2) - amber

Illuminates amber when fire extinguishing agent in respective bottle has been discharged. Engine 2 (and APU) AGENT LOW lights 1 and 2 are powered by the battery bus.

2. FUEL Switch (3) - red

Illuminates red when respective ENG FIRE handle illuminates. Indicates which FUEL switch to shut off. With ENG FIRE handle pulled and FUEL switch on or off, the switch will remain illuminated if the fire warning still exists. With the ENG FIRE handle pulled and fire warning terminated, this switch will remain illuminated until it is moved to OFF.

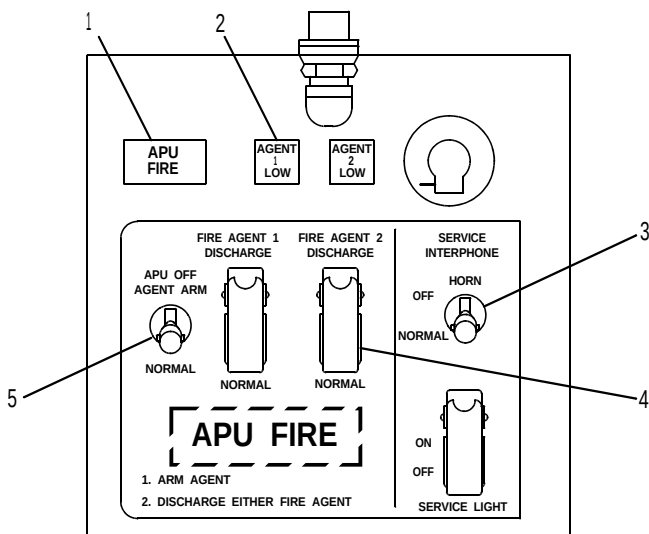
3. ENG FIRE Handle (3) - red

Illuminates red when an overheat or fire has been detected in respective engine nacelle. At the same time, the following actions will take place automatically:

- MASTER WARNING lights illuminate.
- Alert appears on EAD.
- FUEL switch illuminates red.
- Fire bell sounds.

GEN FIELD DISCONNECT position shuts down the generator and stops the alarm (if not already stopped by pushing MASTER WARNING light). FUEL & HYD OFF position shuts off fuel, hydraulics and pneumatics and allows handle rotation. Pulling forward and rotating handle discharges agent into the engine nacelle. Respective engine FUEL switch on pedestal will illuminate red if it is ON and the ENG FIRE handle is actuated.

External APU Control Panel



AG(IGDS)

LB1-3-0056

1. APU FIRE Light - red

Illuminates red when APU fire detection system is energized or during test. If illuminated due to detected fire, automatic APU shutdown will occur.

For APU fire detection to be armed, battery bus must be powered for all APU operations.

2. AGENT LOW Light (2) - amber

Illuminates amber when fire extinguishing agent in respective bottle has been discharged.

3. HORN Switch

The OFF position will silence the horn. When the switch is in the NORMAL position, the horn circuitry is armed.

WARNING: *The horn is very loud. Wear ear protection.*

4. FIRE AGENT DISCHARGE Switch (2)

The DISCHARGE position will discharge the respective fire agent bottle to the APU compartment if the APU OFF AGENT ARM switch is in the APU OFF AGENT ARM position.

5. APU OFF AGENT ARM Switch

The APU OFF AGENT ARM position will shut down the APU, arm the fire extinguishing system, and deenergized the APU generator field.

When the switch is in the NORMAL position, the fire extinguishing system is not armed.

Fire Protection Alerts

Chapter Fire Section 40

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

Red Boxed Alerts (Level 3)

APU FIRE (ENG) - APU fire or air manifold fail conditions in APU compartment.

CRG FIRE LWR AFT (AIR) - Heat and/or smoke detected in lower aft cargo compartment.

CRG FIRE LWR FWD (AIR) - Heat and/or smoke detected in lower forward cargo compartment.

ENGINE 1/2/3 FIRE (ENG) - Respective engine fire or overheat condition.

Amber Boxed Alerts (Level 2)

CREW REST SMOKE (AIR) - Smoke is detected in the cockpit crew rest.

Amber Alerts (Level 1)

CARGO FIRE AGT LO (AIR) - Pressure in one or more cargo fire agent bottles is low.

CARGO FLO AFT OFF (AIR) - The CARGO FIRE AFT FLOW switch has been manually selected OFF.

CARGO FLO FWD OFF (AIR) - The CARGO FIRE FWD FLOW switch has been manually selected OFF.

CRG FIRE TST FAIL (AIR) - The cargo fire test has failed. The manual test is required.

CRG FLO AFT DISAG (AIR) - The aft cargo compartment ventilation flow is in disagreement with the commanded position of the switch on the CARGO FIRE panel.

CRG FLO FWD DISAG (AIR) - The forward cargo compartment ventilation flow is in disagreement with the commanded position of the switch on the CARGO FIRE panel.

DISCH CARGO AGENT (AIR) - Approximately 90 minutes have elapsed since the first CRG FIRE AGENT was discharged. The flashing CRG FIRE AGENT DISCH switch should be pushed. If CRG FIRE LWR_ alert was not displayed, discharging the extinguishing agent may cause the CRG FIRE LWR_ alert to display for a few seconds.

ENG FIRE AGENT LO (ENG) - One or more of the engine fire agent bottles has low pressure. Observing the overhead panel AGT LOW lights will indicate the affected bottle.

FIRE DET 1/2/3 FAIL (ENG) - Both loops of the respective engine fire detector system have failed. Fire detection is inoperative, even though the ENG/APU fire test is successful.

FIRE DET APU FAIL (ENG) - Both loops of the APU fire detector system have failed. Fire detection is inoperative, even though the ENG/APU fire test is successful.

FIRE DET APU FAULT (MAINT) - One of the two fire detector loops on the APU is inoperative. Fire detection capability is not affected.

FIRE DET 1/2/3 FAULT (MAINT) - One of the two fire detector loops on an engine is inoperative. Fire detection capability is not affected.

Cyan Alerts (Level 0)

CARGO FIRE TEST - Cargo fire test in progress.

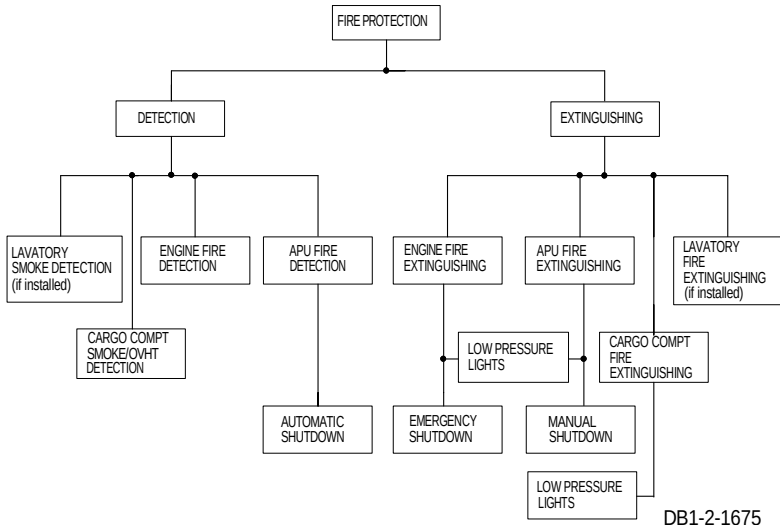
Fire Protection

Functional Schematic

Chapter Fire

Section 50

Fire Protection Block Diagram



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**Flight Controls**
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Flight Controls

Description and Operation

Chapter Flt

Section 10

General

All primary and secondary flight controls are hydraulically powered, each by at least two, and in some cases, by all three airplane hydraulic systems.

Primary flight controls consist of the ailerons (inboard and outboard), the elevators (inboard and outboard), and the upper and lower two-segmented (forward and aft) rudders.

Secondary flight controls consist of the trailing edge flaps (inboard and outboard), leading edge slats (inboard and outboard), combination speed brakes/spoilers, and an adjustable horizontal stabilizer.

Flight control positions are displayed on the System Display (SD) by selecting the configuration page with the CONFIG cue switch. In addition to the SD, flap and slat positions are also shown on the Primary Flight Display (PFD). Alerts will appear on the Engine And Alert Display (EAD) and SD.

Lateral Control System

The lateral control system consists of inboard and outboard ailerons, augmented on the downward moving wing by spoilers operating in proportion to control wheel displacement and/or spoiler input.

The lateral control system is a full power system. Pilot control wheel motion is transmitted to hydraulic actuators by a closed cable system. No aerodynamic feedback is provided to the pilot for load feel. Load feel is mechanically provided.

The left-hand inboard aileron and the outboard ailerons of both wings are powered by hydraulic systems 2 and 3. The right-hand inboard aileron is powered by hydraulic systems 1 and 3.

When the flaps, slats, and landing gear are retracted, a lockout mechanism keeps the outboard ailerons faired (neutral) to avoid wing twist. In this case lateral control is provided by the inboard ailerons and the lateral function of the spoilers. As the airplane slows down, the outboard ailerons unlock with flaps extended to 15 degrees, or with slats extended, or with landing gear down and locked.

Longitudinal Control System

The longitudinal control system consists of inboard and outboard elevators. Each surface is powered by two of the three hydraulic systems. The elevator segments respond to commands from the flight crew, the Longitudinal Stability Augmentation System (LSAS), and the autopilot.

An inboard section of each inboard elevator can be detached mechanically from the remainder of the elevator segments to rotate the tailcone under the airplane during engine 2 removal. Two manually operated pins for each section lock the segments in the normal position for flight.

A tandem hydraulic actuator, powered by two independent hydraulic systems, combines in pairs to provide full flight envelope hinge movement in the event any single hydraulic system failure occurs. Sufficient power capability to maintain flight is available with the loss of any two systems.

The actuator valves (surface position) are controlled mechanically by movement of the control columns in the cockpit. The two cockpit control columns are mounted on a common torque tube.

Elevator Load Feel System

The Elevator Load Feel (ELF) system is a self-monitored, dual channel system. A spring-type, variable load-feel mechanism provides a simulated feel of elevator aerodynamic loads. The ELF mechanism acts as a centering device to return the control columns to neutral when released from an off-neutral position. ELF functions are performed by the Flight Control Computers (FCCs). In the event of failure, a brake is applied to the ELF actuator in the failed channel. The remaining channel of the dual channel system maintains uninterrupted EFL system control.

With the ELEV FEEL selector in the AUTO position, the ELF system regulates the control column force per degree of column rotation as a function of airspeed.

The ELF actuator may be operated in the manual mode by pulling the ELEV FEEL selector out and holding the selector in either HI or LO until the desired ELF speed appears on the configuration page of the SD. The ELEV FEEL MANUAL amber light illuminates.

The SEL ELEV FEEL MAN level 2 alert will be displayed to indicate failure of the dual channels of the ELF system. The ELEV FEEL MANUAL level 1 alert will be displayed to indicate manual selection of the ELEV FEEL selector. In the case of ELF dual channel failure, the SEL ELEV FEEL MAN level 2 alert will be replaced by the ELEV FEEL MANUAL level 1 alert upon ELEV FEEL selection to manual.

Directional Control System

The directional (yaw) control system consists of an upper and lower rudder, each having a forward and an aft segment. The aft segment of each rudder is hinged to the forward segment and is mechanically biased in such a manner that it deflects in the same direction as the forward segment. The upper rudder is powered by hydraulic system 1 and the lower rudder is powered by hydraulic system 2. The full power rudder control system of the MD-11 requires an artificial load feel since no aerodynamic surface loading is fed back to the pedals.

The rudder mechanical control system is operated with pedals in the cockpit. Each pair of pedals is independently adjustable for pilot comfort. The rudder pedal motion is transferred to the rudder actuators by a closed cable system. The rudder pedals also provide input to the nose wheel steering system for directional control on the ground.

Non-Reversible Motor Pumps (NRMP), installed in the hydraulic systems, automatically provide a standby source of hydraulic power to the upper rudder, stabilizer trim, and lower rudder. A compensator with a low fluid level switch automatically shuts off hydraulic flow to the motor side of the NRMP if a compensator low fluid level is detected.

Alerts warn the flight crew when one or both of the NRMPs are inoperative. With both NRMPs inoperative, rudder standby power is unavailable.

A rudder trim system is installed. Dual yaw damper systems for each rudder provide turn coordination and damping of dutch roll. The system operates the rudder hydraulic control valves.

The yaw damper moves the rudder pedals when the autopilot is engaged in takeoff, go-around, and both SINGLE and DUAL LAND modes. Turn coordination is always on except during engine-out land mode, engine-out takeoff mode, engine-out go-around mode, align mode, and rollout mode.

Each Flight Control Computer (FCC) contains two redundant yaw damper control channels enabling each FCC to be self-monitored and providing four redundant channels of control. Either FCC provides dual yaw damper function.

Appropriate alerts and overhead panel annunciations warn the flight crew of yaw damp failures. If a failure is isolated to a single channel, the associated FAIL light illuminates and an alert is displayed. If the failure cannot be isolated to a single channel, the FCC fails both channels on the corresponding surface. In this case, the other FCC maintains dual control. Whenever a channel is selected off, an appropriate amber alert is displayed. If all channels are selected off, the YAW DAMP ALL OFF alert is displayed. If all channels have failed the YAW DAMP ALL FAIL alert is displayed.

Spoiler System

Five spoiler panels are provided on the upper surface of each wing to assist aileron lateral control, reduce speed during flight, and spoil lift for increased brake efficiency. Each spoiler panel is individually powered by one of the three hydraulic systems. All hydraulic systems are required for full spoiler operation.

When used to assist lateral control, the system extends all five spoiler panels on one wing, to a maximum of about 60 degrees from faired, while maintaining the opposite wing panels retracted. When used as speed brakes for slowdown and emergency descent, the system symmetrically extends all panels simultaneously on both wings, to a maximum of about 30 degrees from faired. With flaps retracted during flight, the spoilers can be manually deployed to a maximum of 30 degrees.

When both functions are used at the same time, the panel extension for speed brake function is a maximum 60 degrees on one wing. On the other wing, lateral control panel extension is subtracted from the speed brake panel extension to retract those panels. Flight spoilers, when used as speed brakes or when deployed as ground spoilers retain lateral control differential motion capability.

Spoiler system lateral control assist is active in all modes, extending all spoilers on the downward moving wing in proportion to control wheel movement. All five flight spoilers on each wing are used for lateral control over the flight speed range. The spoiler handle does not move.

An inoperative cable system servo or spoiler actuator can be overridden by pilot force to maintain control over the remaining active portions of the system. Spoiler up-float, in the event of a hydraulic failure, is prevented by a hold-down check valve in the spoiler actuator valve manifold.

Spoiler/speed brake extension and retraction is controlled by the position of the SPOILER handle. The SPOILER handle consists of a T-handle with a latch. Detents in the pedestal allow latching at the RET, 1/3, 2/3, and FULL positions. At the FULL position, a positive (lower) gate prevents further spoiler deployment. This gate, at full speed brake (half ground spoiler) deflection protects against exceeding allowable wing stress levels during flight. The latch is disengaged by squeezing the T-handle or by lifting the handle upward into the ARM position.

The pilot cannot manually deploy symmetrical spoilers with flaps extended 5 degrees or more, except with the autospoiler in transit or the nose gear strut compressed. The maximum available manual spoilers under these conditions is 60 degrees.

With speed brakes deployed and flaps extended, the RETRACT SPD BRK alert is displayed. With flaps or speed brakes retracted, the alert is not displayed.

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On the ground, with nose gear strut compressed, pulling the SPOILER handle up and aft to the GROUND SPOILER position extends all ten spoilers to maximum deflection. When in the full aft position, pulling the handle up locks it in that position.

Spoiler extension is accomplished automatically by an Auto Ground Spoiler (AGS) actuator. This provides an increase in drag and a rapid transfer of weight to wheels during landing or Rejected Takeoff (RTO). The FCCs control power to the AGS actuator.

An electrical control system provides operation logic in the automatic mode. Additional logic is provided by arming the SPOILER handle. An ARM flag, integral to the handle on each side, is exposed when the handle is placed in the ARM position.

Disarming the SPOILER handle may be initiated at any position during AGS actuation by pushing the T-handle down. The SPOILER handle then moves fully forward to the spoiler retracted (RET) position, drops down to disarmed position, and automatically latches.

After landing, all ten spoiler panels may be extended to maximum deflection by automatic operation of the SPOILER handle. In order for this to occur, the SPOILER handle must be armed and the flaps 31 degrees or more. After main wheel spinup, spoilers extend between the 2/3 and FULL speed brake position. After nose gear touchdown spoilers move to the GROUND SPOILER position or in case no nose wheel spinup is detected, ground spoilers extend after nose gear touchdown with any two throttles moved into reverse thrust. Maximum ground spoilers are then deployed.

If an RTO is necessary, ground spoilers automatically extend as a function of indicated airspeed when:

- Groundspeed is less than 80 knots, with auto spoilers armed, and any two of the three throttles is moved to reverse thrust.
- Groundspeed is greater than 80 knots, with auto spoilers armed, and any two of the three throttles is moved to idle.

The USE MANUAL SPOILERS alert or DISARM SPOILERS alert, if the spoiler handle is armed, warns the flight crew that the handle is armed and the AGS system has failed. In this case, manual ground spoiler deployment is required. AGS is not affected by the (automatic flight system) AFS OVRD OFF switches on the auto flight control panel. After spoiler extension, advancing throttle 2 automatically moves the SPOILER handle to full forward, retracting the spoilers. If the number 2 engine throttle is not at idle at main gear wheel-spinup it is possible that the AGS will initiate deployment and will then immediately retract the spoilers. If this occurs, ground spoilers must be manually extended.

The SPOILER handle must be armed for automatic deployment of ground spoilers for either landing mode or rejected takeoff mode. Moving the SPOILER handle from the RET position enables the Autobrake System (ABS). The USE MANUAL SPOILERS alert warns the flight crew of auto spoiler malfunctions.

A spoiler bias system extends the spoilers as necessary so that the spoiler panels will not touch the flap/vane surfaces. When the aircraft is on the ground the spoilers may be up a small amount (gap) depending upon slat/flap position, aileron trim knob position, and spoiler cable system temperature.

Flap System

The trailing edge flap system consists of inboard and outboard flap segments on each wing. Each segment is powered by two of the three hydraulic systems. The inboard flap control valve is connected to the cockpit flap handle. The inboard flaps are interconnected by a cable bus system to ensure symmetrical motion. The flap system is mechanically controlled by the FLAP/SLAT handle on the forward pedestal. Each flap is driven by two independently powered hydraulic actuators. The outboard actuator on each flap is driven by hydraulic system 1 and the inboard actuator by hydraulic system 2.

An automatic Flap Limiting system (FL) is installed. There is no automatic flap limiting up to an airspeed of 175 knots. Beyond that airspeed, when the flaps are extended between 22 and 50 degrees, the system provides automatic retraction to the minimum position of 22 degrees flaps. A manual override is available in the event of a malfunction.

The SEL FLAP LIM OVRD level 2 alert will be displayed to indicate that both flap limiting channels have failed and manual override is required. The FLAP LIMIT OVRD level 1 alert will be displayed to indicate manual selection of the FLAP LIMIT selector to OVRD 1 or 2. In the case when both flap limiting channels have failed, the SEL FLAP LIM OVRD level 2 alert will be replaced by the FLAP LIMIT OVRD level 1 alert upon manual selection of the FLAP LIMIT selector to OVRD 1 or 2.

The flap indicating system includes the following:

- Position transmitters in the left and right outboard flap follow-up systems that send signals to the FCCs. These signals cause flap position to be displayed on the SD. The left outboard transmitter provides a takeoff warning when the flaps are extended 29 degrees or more (not takeoff). Also installed is a switch that provides the landing gear warning when the flaps are extended 31.5 degrees or more.

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- Position transmitters in the left and right inboard flap drive systems provide position control signals that will display on the SD a 4 degree inboard flap angle disagreement. The signals are also used by the autothrottle and flight recorder systems.
- A FLAP/SLAT handle transmitter under the pedestal compares commanded handle position with the outboard flap position transmitters. If the signals disagree by 4 degrees or more, an indication appears on the SD. The flight crew must lift the FLAP/SLAT handle and then position the handle in one of the takeoff detents.

Flaps may not extend into the landing range when operating on emergency power only.

Flaps position may be selected using the dial-a-flap system, a moveable detent for flaps settings. The detent is selected by rotating the dial-a-flap thumbwheel until the required detent flap setting appears in the FLAP T.O. SEL window. Fifteen non-linear divisions are displayed in the window. These divisions represent detent settings between 10 degrees and 25 degrees of flap deflection. Rotation of the thumbwheel drives the indicator and positions the detent. A moveable detent for takeoff allows setting the flaps at the position which would provide best takeoff performance for a given set of field conditions

To set takeoff flaps and slats, the flight crew rotates the thumbwheel until the proper takeoff flap setting is displayed in the FLAP T.O. SEL window. The flight crew then lifts the FLAP/SLAT handle out of the 0 degree detent and pulls aft until the handle latches in the detent.

To retract takeoff flaps and slats, the flight crew grasps the FLAP/SLAT handle and lifts up while moving the handle forward. When the 0 degree detent is reached, the handle is pushed down and forward until the handle reaches the retract position.

To extend landing flaps and slats when in the UP/retract detent, the flight crew lifts the FLAP/SLAT handle up and aft past the go-around gate to either the 35 degree or 50 degree landing detent.

To retract landing flaps and slats, the flight crew lifts the FLAP/SLAT handle out of the detent and moves it forward, pushing down and then up to pass the go-around gate. When the 0 degree detent is reached, the flight crew pushes down and forward to the retract position. For electric slats (see next page) the handle has to be lifted over a gate and pushed forward to the UP/RET detent for slat retraction.

The flaps can be operated without the slats. With the FLAP/SLAT handle in the UP/retract position, the flight crew pushes forward on the SLAT STOW lever while lifting the FLAP/SLAT handle up and aft to the desired flap position. To reengage slats, flight crew returns the handle to the UP/retract position.

Electrically Controlled Slat System

An electrically controlled slat system replaces the cable controlled system. With this system FLAP/SLAT handle operation is simplified as follows:

- Operating forces are less.
- Operation is single path, up-and-aft to extend; up-and-forward to retract.
- There is no go-around type gate at the 0/EXT detent.
- The blue dot maintenance detent is plugged.

The 28-volt right emergency DC bus and the 28-volt DC bus 2 power the system.

The electrical slat control modification consists of:

- Adding switches in the cockpit flap/slat module for slat command, handle position, and speed/Mach inhibit override.
- Adding two electrically operated hydraulic valves in the CAC, one for the inboard slats and one for the outboard slats.
- Adding wiring between the switches and valves.
- Deleting slat cable control linkage from the flap/slat module.
- Deleting the slat stow lever and linkage.
- Deleting the FLAP/SLAT handle latch and gate cover.

At extension, both inboard and outboard slats begin to extend simultaneously. At retraction, both inboard and outboard slats begin to retract simultaneously. The inboard slats retract at a slower rate and are approximately half retracted when the outboard slats are fully retracted.

An added feature to the system is a slat extension inhibit system. The inhibit system prevents slat extension at speed of 280 knots/.55 Mach or greater. This system uses a signal from any one of the three DEUs. At flap settings of 10° or more, the system is deactivated. The autoslat system is not affected by this system.

A SLAT STOW switch, located on the forward pedestal, deactivates slat extension and illuminates amber when activated. The flaps operate normally as selected with slats deactivated.

Lateral Trim System

Lateral trim, driving aileron and spoiler actuators through a cable system, is accomplished with the aileron trim knob on the center pedestal.

When the trim knob is moved, the neutral point of the ailerons is repositioned. If more than 5 degrees of aileron trim is commanded, the lateral control spoilers begin to deflect upward, as required, to provide additional trim. Spoiler trim motion is limited to 6 degrees.

Aileron trim is indicated on the aileron trim indicator, the surface position indicator, and by physical displacement of the control wheel.

Directional Trim System

Directional trim is accomplished with the rudder trim knob on the center pedestal. The rudder trim knob repositions the neutral point of the rudders. Rudder trim motion is limited to 13 degrees in both directions.

Rudder trim is indicated on the rudder trim indicator, on the surface position indicator, and by physical displacement of the rudder pedals.

Longitudinal Trim System

Longitudinal trim is provided by a two-speed, hydraulically powered adjustable stabilizer. The stabilizer is actuated by two hydraulic motors powered independently by hydraulic systems 1 and 3. Hydraulic system 2 provides backup hydraulic power to the stabilizer through the 2-1 NRMP.

The stabilizer operates automatically at two different trim rates as a function of airspeed and/or altitude to provide optimum performance. To accomplish smooth and appropriate longitudinal trim operation for all flight conditions, the two trim rates are provided for each mode of operation. The rate change occurs at 250 knots airspeed or at 33,000 feet, and is also dependent upon which stabilizer control input is in use.

A compensator with a low fluid level switch automatically shuts off hydraulic flow from hydraulic system 2 to the 2-1 NRMP if fluid level is low in the compensator.

Four modes of operation are available as follows:

1. Autotrim [Longitudinal Stability Augmentation System (LSAS)]. When LSAS is engaged in pitch attitude hold (force on column less than 2 pounds), the automatic pitch trim moves the horizontal stabilizer to trim out steady state elevator commands. The FCC operates one trim motor in this mode. Rate (high or low) is based on altitude and airspeed.
2. Autotrim, using the autopilot. When the autopilot is engaged, the autotrim function controls the stabilizer based on average elevator position offsets. When the AFS OVRD switch on the FCP is pushed down, AP automatic pitch trim turns off.
3. Manual trim, using switches. Full-time actuation of both trim motors is available to the pilot through use of the manual trim switches on both control wheels. These switches move the stabilizer in the commanded direction and disengage the autopilot from any engaged mode (except DUAL or SINGLE LAND).

-
4. Manual trim, using the LONG TRIM handles. Override of the electrical trim systems is accomplished with a pair of LONG TRIM suitcase style handles on the Captain's side of the forward pedestal. The LONG TRIM handles remain stationary when the control wheel switches operate trim. Use of these handles disconnects the autopilot from any engaged mode (except DUAL or SINGLE LAND).
-

Longitudinal Stability Augmentation System (LSAS)

The Longitudinal Stability Augmentation System (LSAS) enhances longitudinal stability and provides:

- Pitch attitude hold.
- Pitch attitude limiting.
- Pitch rate damping.
- Pitch attitude protection.
- Positive nose lowering.
- Speed limiting.
- Stall protection.

Each FCC contains two LSAS control channels. This provides four redundant channels of control. LSAS operates through series control of the elevators (no movement of control column), and is inhibited when autopilot is engaged.

With less than 2 pounds of force applied on the control column, LSAS holds pitch attitude by deflecting the elevators up to $\pm 5^\circ$. LSAS provides automatic horizontal stabilizer trim to off load steady-state elevator displacement, restoring a full 5° of elevator authority. Whenever there is more than 2 pounds of force on the control column, pitch attitude hold function is inhibited and the aircraft rotates in proportion to the applied force. When force is then removed from the column, the aircraft holds the new pitch attitude. Pitch attitude hold is inhibited at bank angles exceeding 30° or below 100 feet RA.

Pitch Attitude Limiting (PAL) ensures that LSAS will only hold a pitch attitude between 30° ANU and 10° AND.

Pitch Rate Damping (PRD) increases the apparent static stability to reduce the chance of overcontrol in pitch, especially at high altitudes. It is active throughout the flight envelope, below 16,500 feet at 30% of the maximum damping (FCC-908) increasing linearly to 100% above 20,000 feet.

Pitch Attitude Protection (PAP)(FCC-908) reduces the chance of a tail strike during take-off and landing by adding nose down elevator if the aircraft is at serious risk of tail contact with the ground. PAP is a direct function of pitch attitude, radio altitude and pitch rate and is enabled below 100 feet RA. The pitch attitude limit will vary linearly from 30° at 40 feet RA to 9.5° at 0 feet RA.

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Positive Nose Lowering (PNL)(FCC-908) will apply 3° of nose-down elevator command when the FCC commands the Auto Ground Spoilers to extend at main wheel spinup. As the spoilers extend beyond 10°, PNL will increase the nose-down elevator command to 4°. The command fades out when FD mode cycles back to T/O, or if throttles are advanced for G/A.

During take-off and landing flight phases, when PAP or PNL is active, approximately 10-15 pounds of force on the control column is required to override LSAS.

Upon detecting a fault, both channels of one FCC shut down. After selecting both failed channels off, the remaining FCC is armed to revert to single LSAS channel operation should one of the two remaining LSAS channels fail. The remaining LSAS channels will increase deflection 2-fold (4-fold deflection occurs automatically in case of reversion to single elevator LSAS operation).

NOTES:

- *With LSAS LEFT (RIGHT) INBD off or failed, AP1 (AP2) is not available.*
- *With LSAS LEFT (RIGHT) OUTBD off or failed, AP2 (AP1) Takeoff, Go-Around, Windshear, and Land modes are not available in the associated AP. Only SINGLE LAND will be available.*
- *Only Two Channel LSAS is available if an automatic horizontal stabilizer trim system has failed and only Single Channel LSAS is available if both automatic trim systems have failed.*

Refer to autoflight chapter for speed limiting and stall protection information.

Stall Warning System

The dual stall warning system provides indications of an impending stall.

Stall warning indications can be divided into two categories, alpha-based (angle-of-attack) and speed-based. The two categories will not match unless the airplane is in steady state, level, 1g, non-maneuvering flight.

During ground powerup, each FCC automatically tests the angle-of-attack sensor and the stickshaker. Afterwards, other tests are continuously done to verify that valid angle-of-attack data is being used for stall warning computations.

Stall warning is not affected by the AFS OVRD switch on the FCP.

Alpha-based indications are more accurate than speed-based indications during maneuvering flight. They are generated by the FCC and are the function of alpha, alpha rate, flap position, slat position, and Mach number.

In a slowdown maneuver, prior to stickshaker, alpha-based indications are as follows:

- The PLI on the PFD meshes with the airplane symbol and turns amber.
- PFD airspeed digits turn amber and are boxed in amber.
- LSAS stall protection (nose down elevator) engages if windshear command guidance is off. If windshear command guidance is on, LSAS stall protection engages later (red PLI).

At stickshaker condition:

- PLI feathers mesh with the horizon bar and turns red.
- PFD bank angle limits turn red.
- PFD airspeed digits turn red and are boxed in red.
- Stickshaker actuates (all configurations, to Mach 0.90).
- Outboard slats (autoslats) extend and remain extended for 5 seconds after the condition has been corrected. This applies if in clean configuration with Mach at or below 0.55.
- LSAS stall protection engages if windshear command guidance is on. If windshear command guidance is off, LSAS stall protection should have engaged earlier (amber PLI).

Speed-based indications are accurate only during level maneuvering (bank angle compensated only). They are generated by the FMC.

In a steady slowdown, speed-based indications apply. When the airplane slows to V_{min} :

- The airspeed pointer hits the top of the amber column on the PFD airspeed tape.
- The airspeed digits turn amber and are boxed in amber.

As the airplane slows more and reaches V_{ss} :

- The airspeed pointer hits the top of the red column on the PFD airspeed tape.
- The airspeed digits turn red and are boxed in red.

If the airplane has not climbed through the ACCEL altitude (FMS TAKEOFF page and G/A page) and flaps and slats are extended, the V_{min} marker on the airspeed display is a function of 1.2 V_s . If flaps are extended with slats retracted, the V_{min} marker is a function of 1.25 V_s . V_{min} returns to 1.3 V_{stall} after the airplane has climbed through ACCEL altitude.

Takeoff Deflected Ailerons System

A system for takeoff deflected ailerons deflects the inboard and the outboard ailerons for takeoff and allows an additional takeoff flap setting of 28°.

With this system, for takeoff only, the neutral position of the ailerons is as follows:

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- 15° trailing edge down on the outboard ailerons.
- 11.5° trailing edge down on the inboard ailerons.

During all phases of flight except takeoff, the neutral (baseline) position of the ailerons is as follows:

- 4° droop trailing edge down on the outboard ailerons.
- 0° (faired) on the inboard ailerons.

With the autopilot engaged, the control wheel moves slightly in roll and returns to neutral when the flap/slat handle is moved to takeoff flap setting, and again when the flap/slat handle is moved from the takeoff flap setting to 0/EXT.

Nose gear strut compression activation of the AILERON DEFLECTION OVRD switch enables the takeoff command for aileron deflection. Once enabled, placing the FLAP/SLAT handle in the takeoff flap range signals the actuator for deflection. Placing the FLAP/SLAT handle in a setting other than the takeoff flap range removes aileron deflection. Repositioning the handle back into the takeoff flap range while the airplane is still on the ground restores the deflected aileron.

MD-11 DEF AIL is displayed on the FMS A/C STATUS page when the airplane is configured for deflected ailerons takeoff.

The AIL DEFLECT DISAG alert is displayed if the ailerons are not in proper position based on selected flap position, phase of flight, and actual aileron position.

During takeoff, the aileron symbols on the SD synoptic CONFIGURATION page droop to show the 15° trailing edge down (outboard ailerons) and 11.5° trailing edge down (inboard ailerons). The baseline 4° droop (non-takeoff flight phases) is not indicated on the SD.

Following takeoff (nose gear strut not compressed) aileron deflection remains until normal wing cleanup when the FLAP/SLAT handle is positioned out of the takeoff flap range. The ailerons return to baseline configuration (4° droop on outboard ailerons and 0° inboard). The deflected aileron position is not enabled again until nosewheel strut compression occurs and the FLAP/SLAT handle is again placed in the takeoff flap range. Landings occur in the baseline aileron configuration.

Following takeoff, and with the nose gear strut not compressed, the ailerons will remain deflected until the FLAP/SLAT handle is positioned out of the takeoff flap range. The ailerons should then return to the normal configuration (4° droop on outboard ailerons and 0° inboard). On a normal takeoff, with the AILERON DEFLECTION OVRD switch remaining in the normal position, regardless of the FLAP/ SLAT handle position, the ailerons will not be able to deflect again until after landing (nose-wheel strut compression), and the FLAP/SLAT handle is again placed in the takeoff flap range.

If the AILERON DEFLECTION OVRD switch is placed in the OVRD position following takeoff, the ailerons will be deflected again if the FLAP/SLAT handle is at anytime, placed in the takeoff flap range (6.5 to 30 degrees). This function is intended to provide the flight crew with the capability of cycling the aileron deflection system should an AIL DEFLECT DISAG alert be displayed following flap/slat retraction during normal wing cleanup.

Flight crews should be aware that if the AILERON DEFLECTION OVRD switch is left in the OVRD position, the ailerons will deflect whenever the FLAP/SLAT handle is placed in the takeoff range. However, should this occur, the ailerons will return to their undeflected condition when landing flaps (> 31.5 degrees) are selected.

The aileron lockout system is not affected by the deflected aileron system. Outboard ailerons continue to be locked out with slats and flaps not extended and main landing gear retracted. Extension of flaps, slats, or gear unlocks the outboard ailerons.

Spoiler operation is not affected by the deflected aileron system. Spoiler movement on roll command occurs at the same wheel position. When the ailerons are deflected, the aileron position to spoiler position is offset by the amount of aileron deflection commanded.

Aileron trim is not affected by the deflected aileron system. Use of the aileron trim wheel repositions the aileron surfaces whether or not the ailerons are deflected. Deflected ailerons are repositioned from the deflected position. When ailerons are not deflected, trimming repositions the ailerons from the baseline configuration.

When control wheel deflection is more than 45°, control wheel force is approximately double.

Test Displays

EIS Test Display

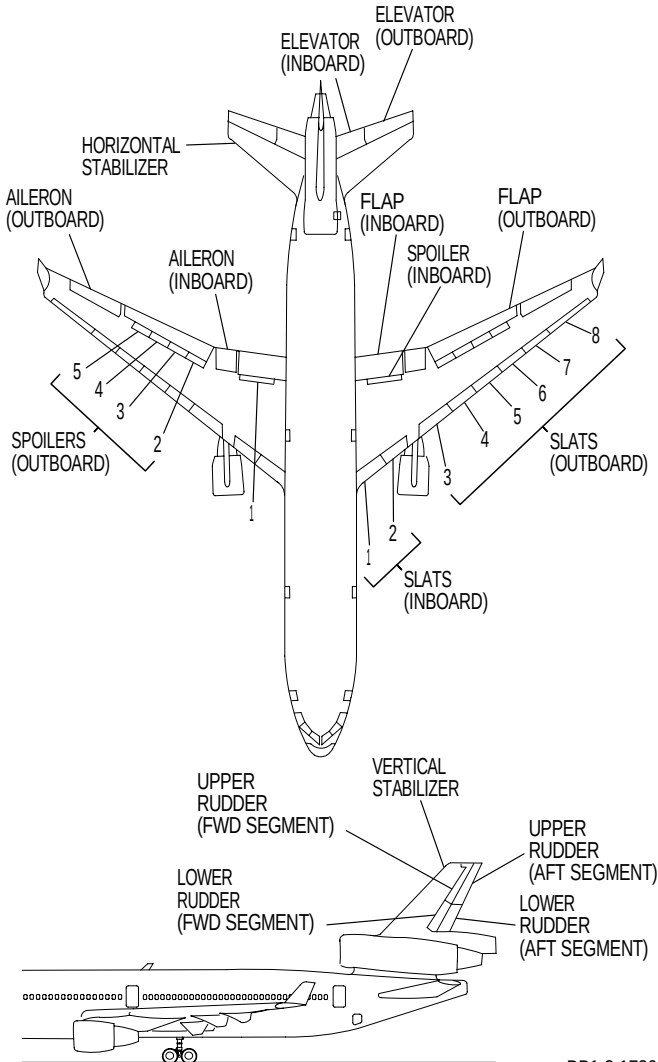
On the ground, pushing the ANNUN LT TEST switch (forward overhead panel) causes the configuration page SD synoptic and all data failure indications to be displayed.

SD configuration display failure indications are amber X's over the rudders, elevators, ailerons, spoilers, and flaps. The four gear indicators will each be half green and half red.

Flight Controls Components

Chapter Flt Section 20

Control Surfaces Location



DB1-2-1736

Intentionally
Blank

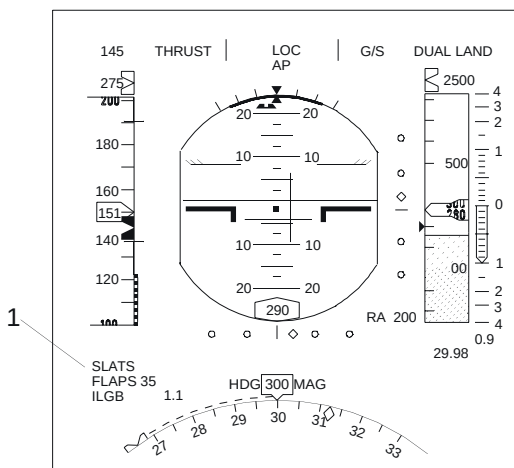
Flight Controls

Controls and Displays

Chapter Flt

Section 30

EIS Primary Flight Display



INSTRUMENT PANEL

LB1-3-0311

1. FLAP/SLAT Configuration

Flap/slat configuration affecting mach/airspeed limits is shown below the airspeed tape.

Invalid flap positions are flagged with an amber "X".

Slat messages are amber boxed when in disagreement with the commanded state and flaps are extended.

FLAPS 35 - Flaps down 35°.

FLAPS 35 (with down arrow) - Flaps set at 35° and extending.

FLAPS 10 (with up arrow) - Flaps set at 10° and retracting.

FLAPS (amber) - Inboard flaps are split.

FLAPS 25/35 - Outboard flaps are split.

SLATS (with down arrow) - Slats in transit (down).

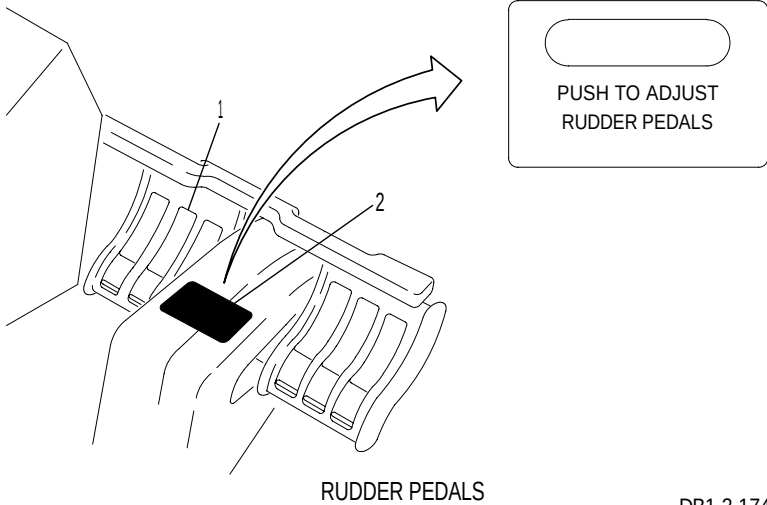
SLATS (with up arrow) - Slats in transit (up).

SLATS ASE – Slats are in auto extension.

SLATS - FLAP/SLAT handle in 0°/EXT and slats are extended.

NO SLATS - SLAT STOW switch or lever is activated and FLAP/SLAT handle is more than 3°.

Rudder Pedals



DB1-2-1740

1. Rudder Pedals

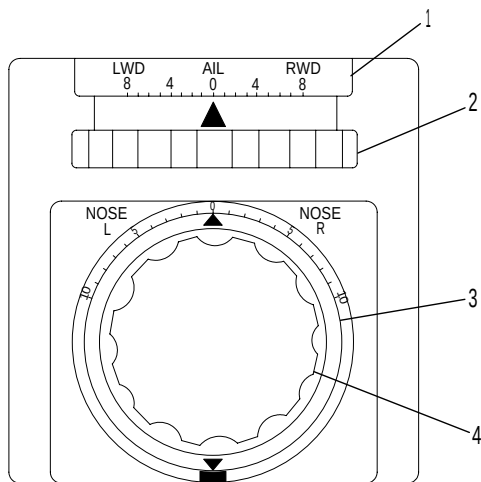
Rudder pedals are used to control upper and lower rudder deflection during flight, and nosewheel steering on the ground.

2. Adjust Tab

Each set of rudder pedals is independently adjustable for pilot comfort.

Pressing the adjust tab unlocks the pedals, which are spring loaded aft. Pedals may be locked in the selected position by releasing the adjust tab. Feet must be on the pedals when actuating the adjust tab.

Aileron and Rudder Trim



AFT PEDESTAL

DB1-2-1741

1. AIL Trim Indicator

LWD - Indicates left wing down as shown in units on scale.

RWD - Indicates right wing down as shown in units on scale.

2. Aileron Trim Knob

When rotated, repositions the aileron load feel and override mechanism, which repositions the ailerons and the control wheels to effect lateral trim.

If more than 5 units of aileron trim is selected, spoilers are activated. Full aileron trim extends spoilers 6°.

3. Rudder Trim Indicator

The pointer indicates the direction of rudder displacement from neutral.

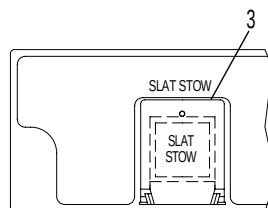
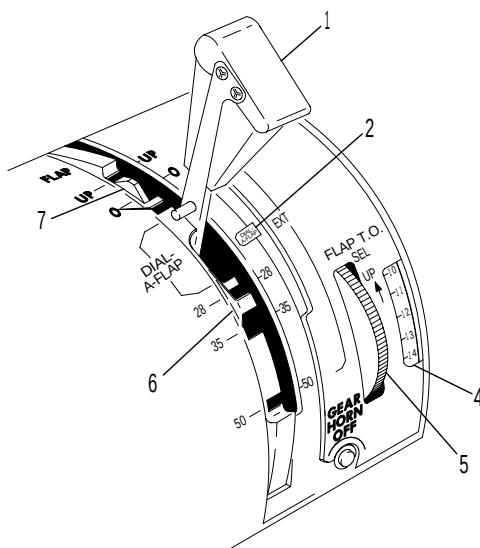
NOSE L - Indicates nose left trim as shown in units on scale.

NOSE R - Indicates nose right trim as shown in units on scale.

4. Rudder Trim Knob

When turned, provides manual adjustment to the lower and the upper rudder trim and load feel mechanism, which repositions the lower and the upper rudders.

FLAP/SLAT Handle - Electrically Controlled Slats



FORWARD PEDESTAL,
RIGHT SIDE

DB1-2-1743

1. FLAP/SLAT Handle

Lifting FLAP/SLAT handle up and pulling aft to latch in preselected takeoff DIAL-A-FLAP detent, 28° go-around gate, or 35°/50° landing flap detent, extends the flaps and the slats.

Rotating the FLAP T.O. SEL thumbwheel until the proper takeoff flap setting appears in the FLAP T.O. SEL indicator sets the takeoff DIAL-A-FLAP detent.

The 28° go-around detent has a gate/stop to prevent inadvertent extension/retraction of the flaps. The handle can be maneuvered past the gate/stop.

Lifting the handle up and aft past the go-around gate to either the 35° or the 50° landing detent extends landing flaps.

Lifting the handle out of the detent and moving it forward past the go-around gate retracts landing flaps.

Positioning the handle at the 0°/EXT detent (flaps retracted/slats extended) retracts the flaps without retracting the slats. Maneuvering the handle from the 0°/EXT detent gate to positively engage it in the FLAP UP/SLAT RET detent retracts the slats.

WARNING: *To prevent unintentional slat extension:*

- *When retracting slats, be sure FLAP/SLAT handle is firmly engaged in the FLAP UP/SLAT RET detent.*
- *After flap/slat retraction, do not push, pull, or otherwise manipulate the FLAP/SLAT handle unless extension is desired.*

2. DIAL-A-FLAP Detent Indicator

Indicates position of DIAL-A-FLAP detent. The detent position varies with the DIAL-A-FLAP setting.

3. SLAT STOW Switch - amber

SLAT STOW - With the FLAP/SLAT handle in retract position, pushing the SLAT STOW switch deactivates the slat extend function. Switch illuminates amber. With the FLAP/SLAT handle positioned greater than 3°, NO SLATS is displayed on the PFD.

The SLAT STOW alert is displayed on the SD CONFIGURATION page. A SLAT DISAG alert is displayed when operating the SLAT STOW switch with slats extended.

NOTE: Pushing the SLAT STOW switch with slats stowed and flaps extended extends the slats.

4. FLAP T.O. SEL Indicator

Indicates the preselected DIAL-A-FLAP takeoff flap setting.

5. FLAP T.O. SEL Thumbwheel

When rotated, sets the DIAL-A-FLAP takeoff flap setting for any flap setting between 10° and 25°.

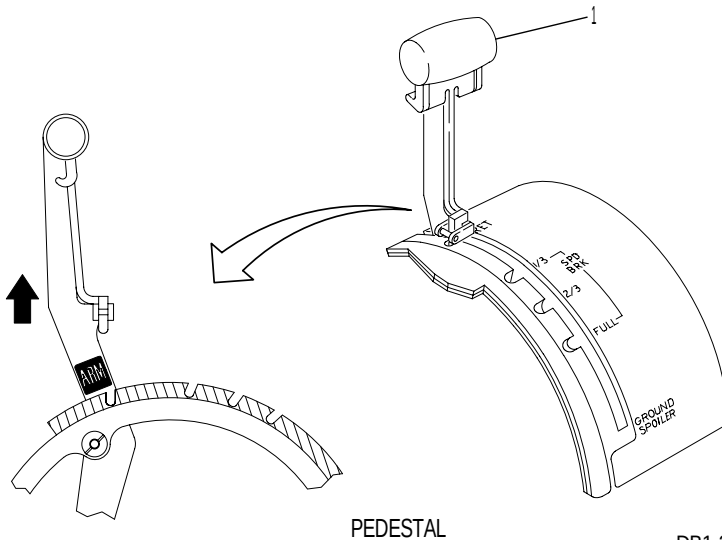
6. Go-Around Gate

Prevents retraction of the flaps to less than 28° until lifting pressure is released (the handle drops into the 28° detent) and then reapplied (the handle passes through the gate).

7. 0° EXT Detent Gate

Prevents retraction of the slats with the flap handle at 0°.

Spoilers



DB1-2-1745

1. SPOILER Handle

The spoiler handle is used to either select automatic operating modes or to control the manual modes of the spoiler system.

When arming for automatic spoiler operation, the spoiler handle, which is spring-loaded to RET, must be at RET before it can be pulled up to armed. When armed (up), a red placard labeled ARM in white letters, is visible on both sides of the handle.

When auto spoilers are armed, automatic operation is as follows:

- During a rejected takeoff, ground spoilers automatically extend when groundspeed is less than 80 knots, and any two of the three throttles move into reverse thrust. With groundspeed greater than 80 knots, moving any two throttles to idle deploys ground spoilers.
- During landing, with flaps 30° or greater and after main wheel spinup, the spoiler handle moves to approximately the two-thirds position. At nose gear touchdown, the handle moves to full ground spoiler position and the ground spoilers fully extend.
- After ground spoiler extension, advancing throttle 2 automatically moves the SPOILER handle to full forward, retracting the spoilers. If the number 2 engine throttle is not at idle at main gear spin-up it is possible that the AGS will initiate deployment and will then immediately retract the spoilers. If this occurs, ground spoilers must be manually extended.

Manual spoiler operation is as follows:

- In flight, the handle controls the speed brake mode when the "T" handle release is squeezed and pulled aft to the 1/3, 2/3, or FULL position. The handle stops at FULL.

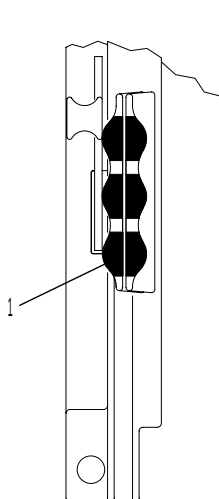
1/3 - all 5 spoilers on both wings extend 10°.

2/3 - all 5 spoilers on both wings extend 20°.

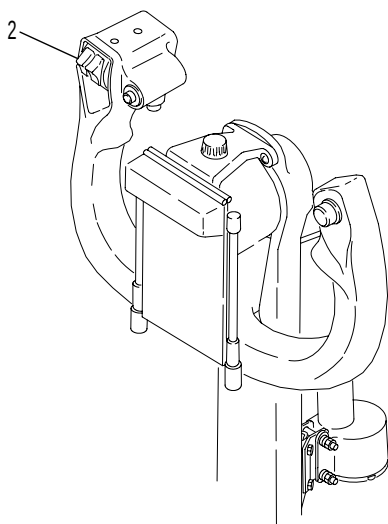
FULL - all 5 spoilers on both wings extend 30°.

- On the ground, the handle controls the ground spoiler mode when pulled up and aft to the GROUND SPOILER position. Pulling the handle up again locks it aft.
- The handle will not move to the GROUND SPOILER position until the nose gear strut is compressed during landing.

Horizontal Stabilizer Trim



FORWARD PEDESTAL, LEFT SIDE



CONTROL WHEEL

DB1-2-1739

1. LONG TRIM Handles

The handles provide direct mechanical control of the horizontal stabilizer control valves. The trim handles have the same function as the electric control wheel trim switches, except that they have override authority over LSAS or autopilot inputs except in DUAL or SINGLE LAND mode.

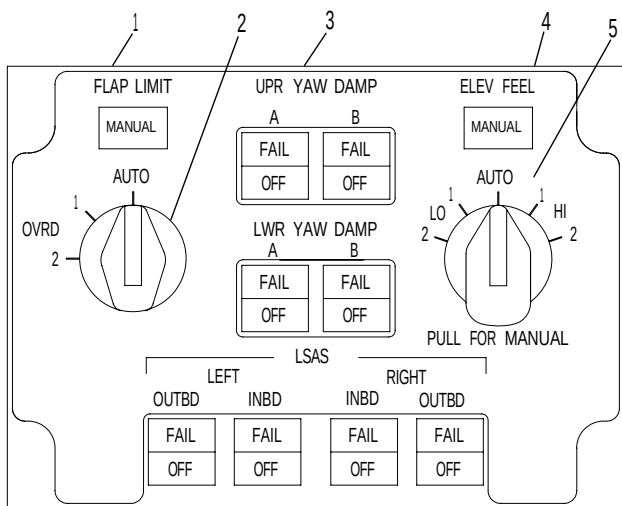
Moving the handles together provides control of the horizontal stabilizer. Stabilizer movement rate is determined by airspeed and altitude. Both handles must be operated together to move the horizontal stabilizer.

2. Control Wheel Trim Switches (Capt & F/O)

Stabilizer motion is electrically controlled by dual trim switches on each control wheel. Actuation of the switches engages both horizontal stabilizer trim motors. Both switches on the respective control wheel must be operated simultaneously and in the same direction. Stabilizer motion rate is determined by airspeed and altitude.

Operation of these switches will disengage AP except in DUAL or SINGLE LAND mode and interrupt LSAS operation.

Flap Limit, Yaw Damp, Elevator Feel and LSAS



FORWARD OVERHEAD PANEL, RIGHT SIDE

DB1-2-1744

1. FLAP LIMIT MANUAL Light - amber

MANUAL - Illuminates amber when both flap limiter channels fail, or when the FLAP LIMIT selector is in OVRD 1 or 2.

2. FLAP LIMIT Selector

The FLAP LIMIT selector is used to manually override the auto mode of the flap limiter.

AUTO - The flap limiter automatically retracts the flaps if the airspeed exceeds limits for flap settings between 22 and 50 degrees.

OVRD 1 or 2 - Automatic flap limiting is bypassed.

3. YAW DAMP and LSAS Switches - amber

OFF - When a YAW DAMP or LSAS switch is pushed, the respective control channel shuts off and OFF illuminates amber. With OFF illuminated, pushing a YAW DAMP or LSAS switch engages the respective control channel, if not failed.

FAIL - The respective FAIL light automatically illuminates amber during a failure of a yaw damper or LSAS control channel, and the failed control channel shuts off.

4. ELEV FEEL MANUAL Light - amber

MANUAL - The ELEV FEEL MANUAL light illuminates amber when both Elevator Load Feel control (ELF) channels fail, or when the ELEV FEEL selector is pulled to MANUAL.

5. ELEV FEEL Selector

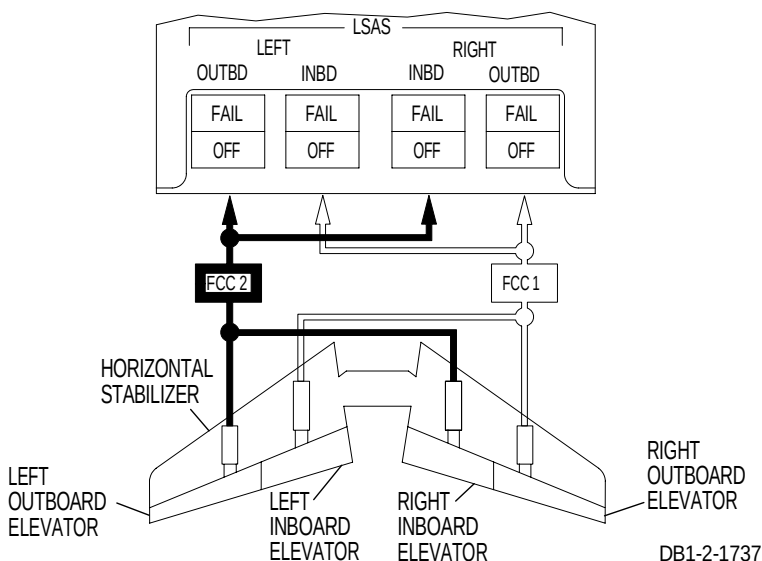
The ELEV FEEL selector allows manual slewing of the ELF when airspeed is between 120 and 300 knots.

With the selector in AUTO, the ELF is varied automatically to correspond with the airspeed.

HI - The MANUAL HI position allows slewing of the ELF to a higher airspeed. The airspeed is displayed on the configuration page of the SD.

LO - The MANUAL LO position allows slewing of the ELF to a lower airspeed. The airspeed is displayed on the configuration page of the SD.

LSAS Channels

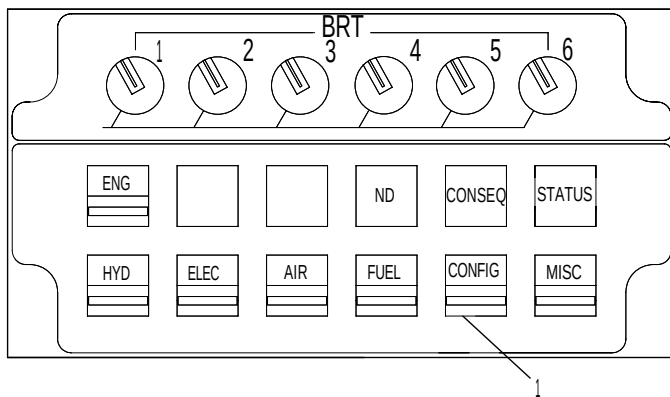


LSAS Channels

LEFT OUTBD/RIGHT INBD - Flight Control Computer 2 (FCC2) controls the left outboard and the right inboard hydraulic actuators at the elevator segments through two of four discreet LSAS channels.

RIGHT OUTBD/LEFT INBD - Flight Control Computer 1 (FCC1) controls the right outboard and the left inboard hydraulic actuators at the elevator segments through two of four discreet LSAS channels.

CONFIG Cue Switch



AFT PEDESTAL

DB1-2-1750

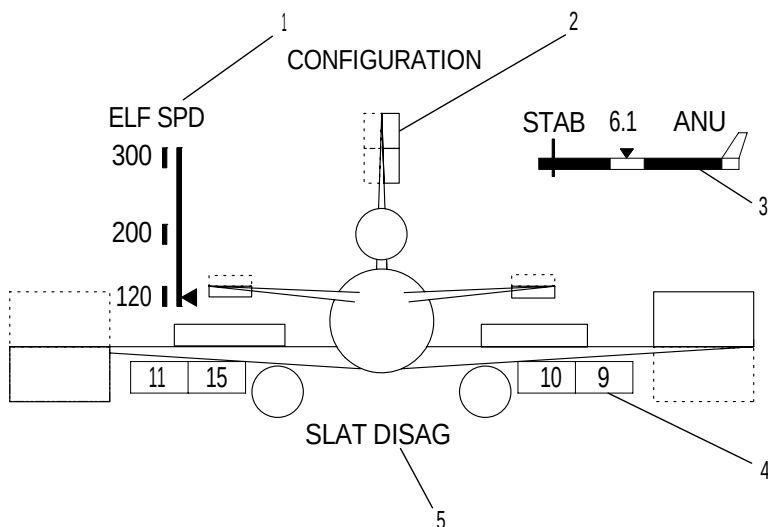
1. CONFIG Cue Switch - white

CONFIG - Illuminates white when CONFIG alert is displayed on EAD.

When pushed:

- MASTER CAUTION or MASTER WARNING lights extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- Flight control synoptic and consequences appear on SD.

SD Synoptic - CONFIGURATION



DB1-2-1746

1. Elevator Load Feel Speed

ELF SPD - The speed is displayed when ELF is in MANUAL by an arrow (reference speed bug) pointing to the current ELF reference speed.

With ELF in MANUAL and reference speed not available, the ELF arrow (reference speed bug) is not displayed.

2. Rudder, Elevator, Spoiler, Aileron Position - grey, white, green or amber

Faired - A grey outline appears.

Deflected - A white box appears at the respective location. The box size is proportional to the amount of deflection.

Fully Deflected - A solid green box appears at the respective location.

Position Not Available - An amber "X" appears in the respective control surface box.

During takeoff, the aileron symbols deflect to show the 15° trailing edge down of the outboard ailerons and the 11.5° trailing edge down of the inboard ailerons. (Applies only to airplanes with A1 takeoff deflected aileron package installed).

A 30 second delay after flaps are lowered to takeoff range may occur before green aileron boxes are displayed at full deflection.

3. Stabilizer Position - green, amber

Stabilizer position is depicted inside the schematic fuselage.

On the ground, stabilizer position is green when within the computed takeoff band.

If stabilizer trim is more than 2 units different than computed trim setting on the T/O page, the takeoff warning sounds when takeoff power is applied.

Trim limits are shown when the stabilizer has reached maximum travel. The upper limit is depicted above the stabilizer position by a downward pointing amber triangle. The lower limit is depicted by an upward pointing amber triangle.

4. Flap Position - grey with white or amber

Flaps are shown under the wing as a fixed-size grey box with white digital readout of the flap position.

Retracted - Boxes are removed.

Position Not Available - An amber "X" appears in the respective left or right (inboard and outboard) flap position box.

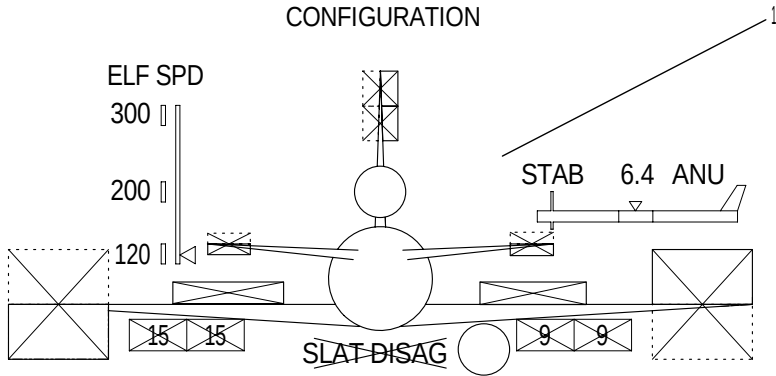
5. Slat Position - white, amber

Slat position is displayed below the schematic fuselage. There is no annunciation when the slats are retracted.

SLAT EXT - The slat position annunciation appears in white.

SLAT DISAG - The slat position annunciation appears in amber.

SD Synoptic - EIS Test



DB1-2-1747

1. EIS Test Display - amber, red

On the ground, pushing the ANNUN LT TEST switch (forward overhead panel) causes the configuration page SD synoptic and all data failure indications to be displayed.

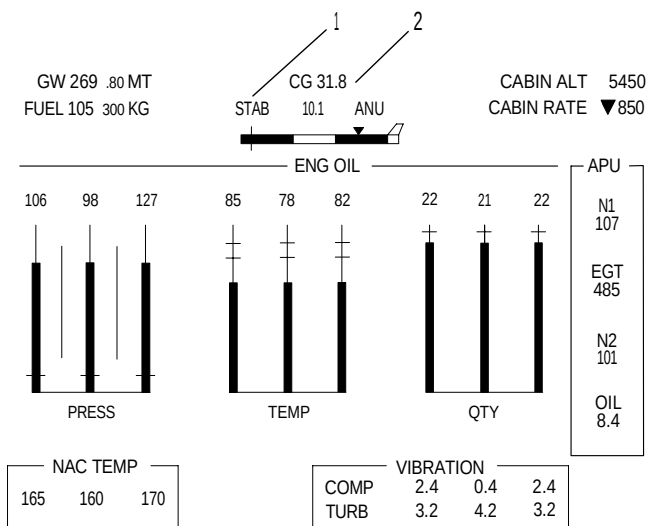
SD configuration display failure indications are amber X's over the rudders, elevators, ailerons, spoilers, and flaps. The four gear indicators will each be half green and half red.

These indications appear when all of the following conditions are met:

- The airplane is on the ground.
- The airplane is operational.
- The ANNUN LT TEST button on the forward overhead panel is pushed.
- The CONFIGURATION page is displayed on the SD.

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SD Synoptic - Secondary Engine - Tapes



DB1-2-1749

1. STAB - green, white

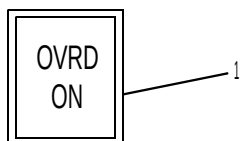
A horizontal bar represents the stabilizer range. A green band, removed in flight, displays the stabilizer takeoff range. The STAB position is displayed in white digits and with a bug.

2. CG - white, boxed amber

Center of gravity (CG) is expressed in white digits, in percent MAC. The display flashes when the forward or aft CG limit is reached. The white digits become boxed amber when the CG is out of limits.

AILERON DEFLECT OVRD Switch

AILERON DEFLECT
OVRD



OVERHEAD PANEL

DB1-2-1972

1. AILERON DEFLECT OVRD Switch

Normal - (OVRD not illuminated) Ailerons will be commanded to deflect only when the aircraft is on the ground (nose wheel strut compressed) and the FLAP/SLAT handle is placed in the takeoff range (6.5 to 31.5 degrees).

Push - OVRD ON illuminates amber. The ailerons will be commanded to deflect whenever the FLAP/SLAT handle is placed in the takeoff range. Allows flight crew to cycle the aileron deflection actuators in flight if ailerons do not all retract at flap retraction.

Flight Controls

Alerts

Chapter Flt

Section 40

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

Amber Boxed Alerts (Level 2)

AIL DEFLECT DISAG (CONFIG) - Aileron(s) not in proper position based on selected flap position and phase of flight.

FLAP DISAG (CONFIG) - More than 4 degrees position difference between flap handle and outboard flap, or more than 4 degrees position difference between L and R inboard flaps, or more than 4 degrees position difference between L and R outboard flaps exists.

LSAS ALL FAIL (CONFIG) - All LSAS channels failed.

SEL ELEV FEEL MAN (CONFIG) - Both elevator load feel transmitters inoperative.

SEL FLAP LIM OVRD (CONFIG) - Both flap limiter channels have failed. Crew must select OVRD 1 or 2.

SLAT DISAG (CONFIG) - Slats asymmetric or not in selected position.

STAB OUT OF TRIM (CONFIG) - LSAS or autopilot is on and the stabilizer is out of trim.

USE MAN SPOILERS (CONFIG) - The automatic ground spoiler function should not be used. Increased landing distance may be required.

YAW DAMP ALL FAIL (CONFIG) - All yaw damper channels have failed or are off.

Amber Alerts (Level 1)

AIL DEFLECT INOP (CONFIG) - Aileron deflection is inoperative.

AUTO SLAT FAIL (CONFIG) - Auto slat system is inoperative

AUTO TRIM FAIL (CONFIG) - Auto pitch trim is inoperative. Manual trim is operative.

DISARM SPOILERS (CONFIG) - Auto spoilers are inoperative. Inadvertent ground spoiler deployment may occur.

ELEV FEEL MANUAL (CONFIG) - ELEV FEEL selector is out of the AUTO in position.

FLAP LIMIT DISAG (CONFIG) - OVRD is selected with the FLAP LIMIT selector, and actuator did not attain the override position within 20 seconds.

FLAP LIMIT OVRD (CONFIG) - FLAP LIMIT selector is out of AUTO position.

LSAS ALL OFF (CONFIG) - All LSAS switches off.

LSAS L/R INBD OFF (CONFIG) - Left/right inboard LSAS switch OFF.

LSAS L/R OUTBD OFF (CONFIG) - Left/right outboard LSAS switch OFF.

RETRACT SPD BRK (CONFIG) - Speed brakes and flaps are extended in flight.

RUD STBY LWR OFF (HYD) - The 3-2 non-reversible motor pump is inoperative. Standby hydraulic power to the lower rudder is not available.

RUD STBY UPR OFF (HYD) - The 2-1 non-reversible motor pump is inoperative. Standby hydraulic power to the upper rudder and stabilizer trim motor is not available.

RUDDER BOTH INOP (HYD) - No primary or non-reversible motor pump power to the upper or lower rudder actuator.

RUDDER LWR INOP (HYD) - No primary or non-reversible motor pump power to the lower rudder.

RUDDER UPR INOP (HYD) - No primary or non-reversible motor pump power to the upper rudder.

SEL ELEV FEEL LO (CONFIG) - Airspeed less than 200 knots and ELF speed indicator more than 200 knots with ELF selected to MANUAL position.

SEL LSAS (LIB, LOB, RIB, ROB) OFF (CONFIG) - An LSAS channel has failed.

SEL YAW (UPR A, UPR B, LWR A, LWR B) OFF (CONFIG) - A yaw damper channel has failed.

SLAT STOW (CONFIG) - SLAT STOW switch is activated.

SLATS INHIBITED (CONFIG) - Slat mach inhibit relay is preventing slats from extending.

STALL WARN FAIL (MISC) - Stall warning is inoperative.

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YAW DAMP ALL OFF (CONFIG) - All YAW DAMP switches are in OFF.
No autoland modes available.

YAW DMP LWR A/B OFF (CONFIG) - The respective YAW DAMP switch
is OFF.

YAW DMP UPR A/B OFF (CONFIG) - The respective YAW DAMP switch
is OFF.

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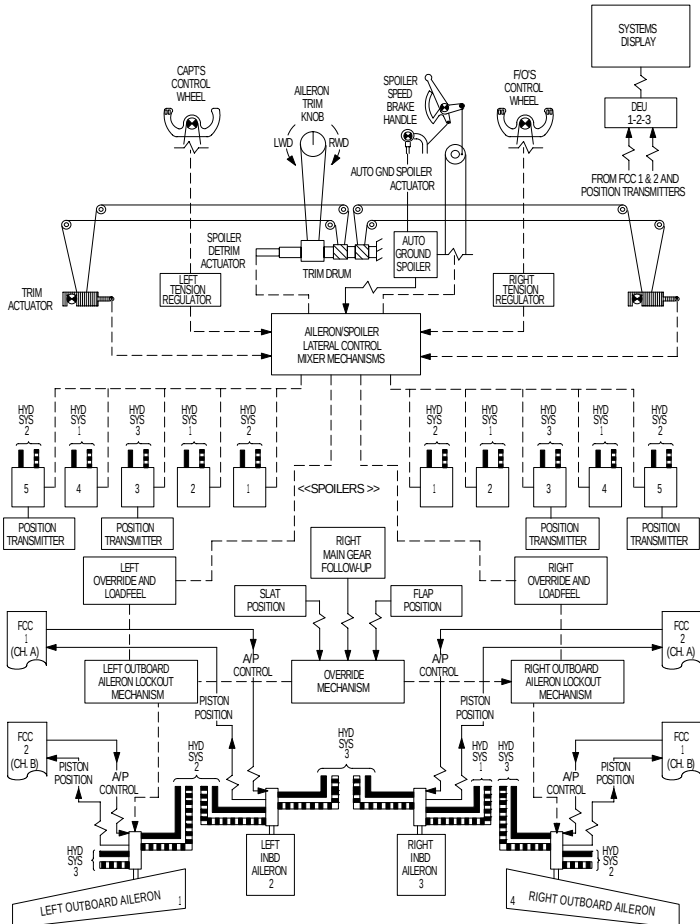
Flight Controls

Functional Schematic

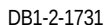
Chapter Flt

Section 50

Lateral Control System

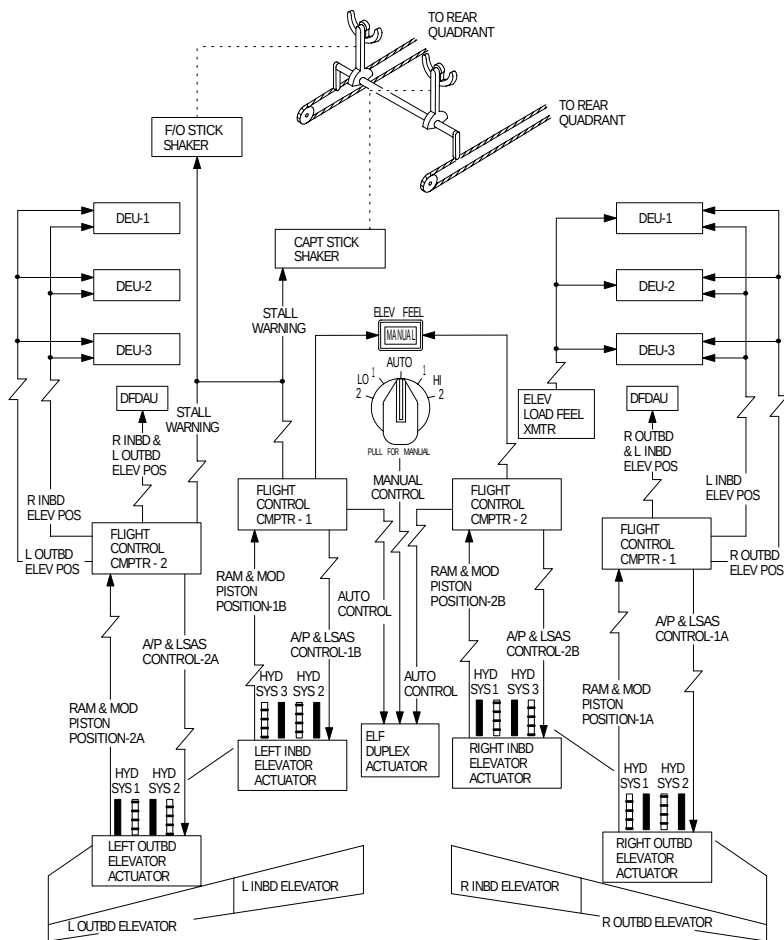


DB1-2-1734



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Longitudinal Control System

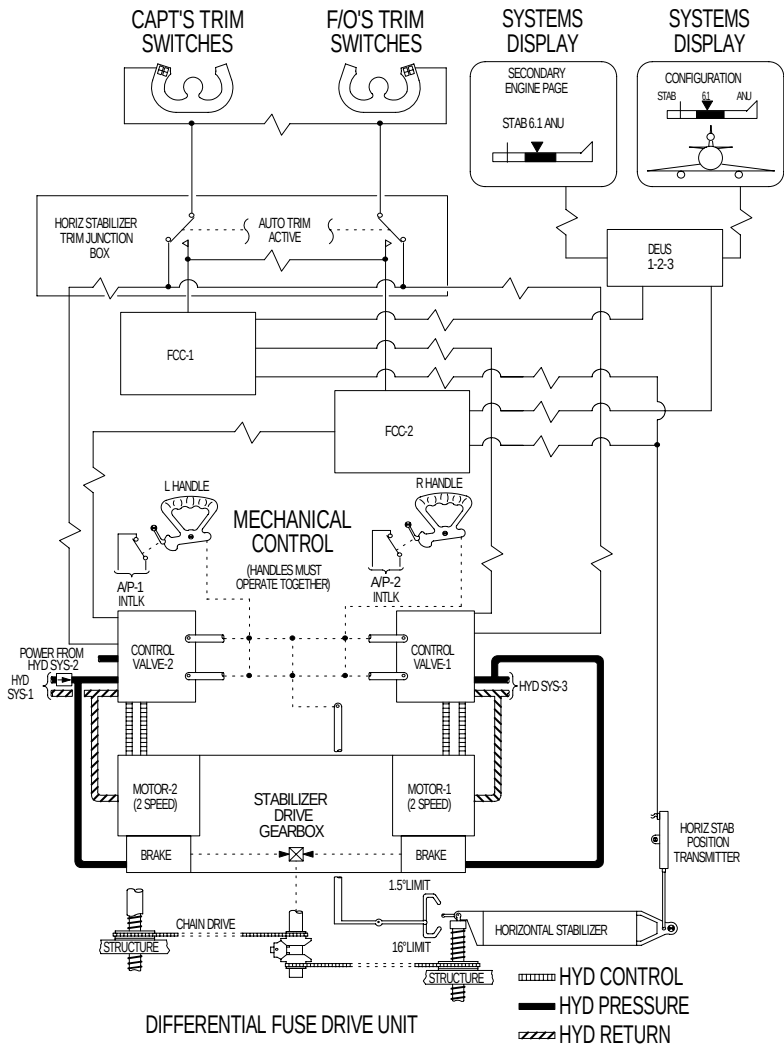


DB1-2-1733

Horizontal Stabilizer System

Trim switches operate as follows:

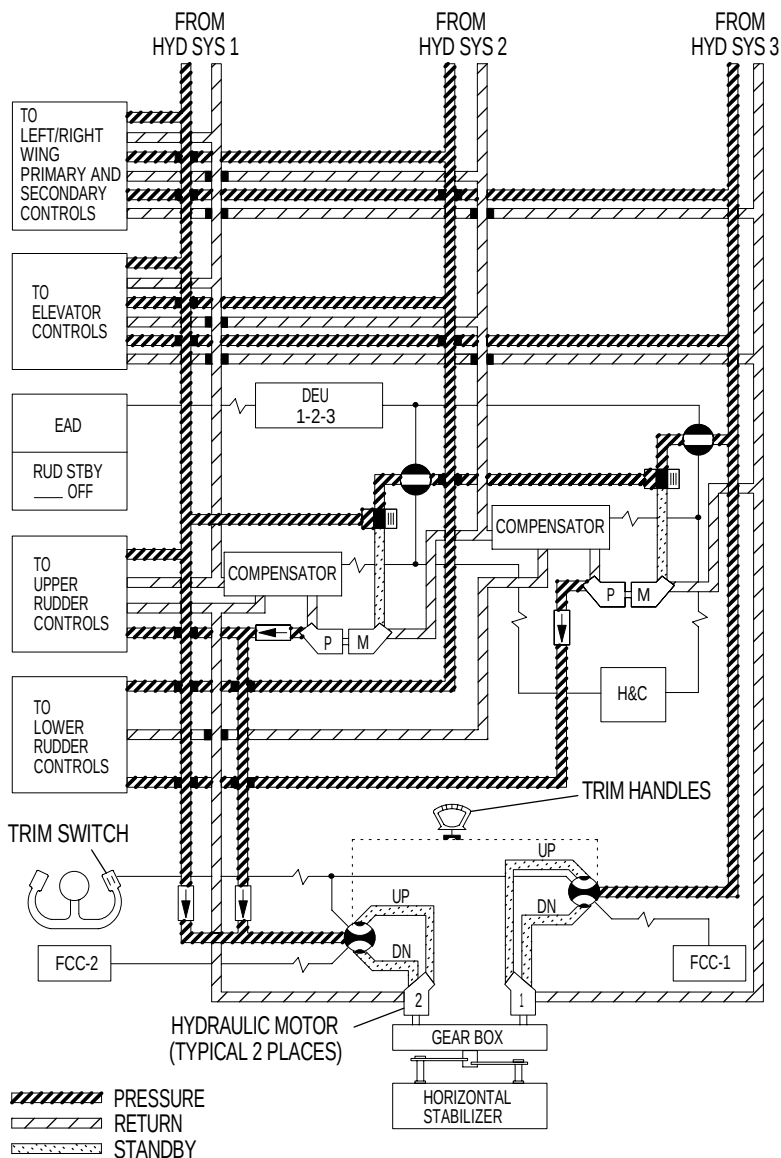
- If auto trim active, no stabilizer control.
- If in AP cruise, the AP disconnects.
- If in AUTOLAND, there is no effect.



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Hydraulic Flight Controls



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FMS

Description and Operation

Chapter FMS

Section 10

General

The FMS is used by pilots for flight planning, navigation, performance management, aircraft guidance, and flight progress monitoring.

The FMS consists of Flight Management Computer (FMC) 1 and 2 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 FMCs generate a flight profile from the origin to the destination airport. The FMCs then guide the aircraft along that profile by providing roll, pitch, speed, and thrust commands to the FCCs.

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 aircraft flight profile conforms to clearance requirements.

Flight Phases

Page FMS.20.1 shows a typical FMS profile from the preflight phase at the origin airport to the rollout phase at the destination airport. In addition to the vertical profile (PROF) and speed mode (SPD), the FMS will supply lateral navigation (NAV) guidance to follow waypoints along the predefined route.

The predefined route may be divided into a number of FMS flight phases that include PREFLIGHT, TAKEOFF, CLIMB, CRUISE, DESCENT, and APPROACH.

For the PREFLIGHT phase, the FMC is initialized and the flight plan either recalled from the navigation database by company route designator, or strung (entered waypoint by waypoint) from the origin to the destination airport.

In PREFLIGHT the following items are accomplished:

-
- Review of aircraft configuration and FMC database effective dates.
 - Entry/selection of origin destination, cruise altitudes, flight no., and cost index.
 - Entry of weight and fuel data.
 - IRS alignment.
 - Flight plan, runway SID and transition entry and waypoint revision to include speed, altitude, and time constraints.
 - Entry of takeoff Vs speeds.
 - Selection of economy or pilot selected flight phase speed.
 - Confirming auto tuning of navigation radios for departure.

The TAKEOFF phase extends up to the acceleration altitude. NAV mode may be armed on the ground once all engines are started. NAV will be engaged at 100 feet in FD mode. AP/NAV cannot be coupled until 400 feet. Thrust reduction will be automatic at the thrust reduction altitude only if FMS PROF is engaged.

PROF can be armed on the ground. If armed, PROF will engage automatically at 400 feet RA.

The CLIMB phase extends from the acceleration altitude to the top of climb (T/C) for the first cruise flight level entered on the F-PLN INIT page.

The SPD/PROF climb mode will provide guidance for accelerating the aircraft when above the terminal area speed restriction altitude. The mode will observe speed/altitude constraints that have been stored in the FMC database or inserted by the pilot. The FMC will provide speed and altitude targets to the AFS during climb if FMS SPD and PROF are pushed.

The CRUISE phase extends from the T/C point to the Top of Descent (T/D). Cruise could include step climbs as well as enroute descents. The FMC will calculate the optimum step climb point. A step climb requires setting a new altitude target on the FCP with the altitude changes being initiated automatically. Enroute descents are initiated by level change or vertical speed mode, and then reinserting a new CRZ FL into the MCDU.

The DESCENT and APPROACH phases start from the T/D or by the pilot initiating a descent via V/S or level change mode. The FMC will calculate the appropriate point for the start of descent and will initiate the descent automatically if the FCP altitude has been lowered and the aircraft is in PROF and SPD mode. NAV and PROF guidance during an approach are terminated when the ILS localizer and glideslope are intercepted. If a missed approach becomes necessary, NAV and PROF modes may again be engaged in order to automatically fly the Missed Approach Procedure (MAP). After landing and engine shutdown, the FMC goes through a flight-complete phase, clearing the active flight plan in preparation for re initializing. In addition, some of the data entry fields reinstalled to default data.

Operation

General

FMC 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 FMCs also provide AP/FD takeoff (TO) 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.

FMC 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 FMC 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 modes are DUAL, INDEPENDENT, and STANDBY. INDEPENDENT and STANDBY modes are covered in the FMS DEGRADED OPERATION in this chapter.

DUAL mode is the normal operating mode of the FMS. When operating in DUAL mode, there is cross talk between the FMCs to ensure the following:

- MCDU entries made on one side are entered simultaneously into the other FMC. The respective MCDUs can display different pages, however, if the same page is displayed on each MCDU, the display is similar, but the predicted values may not be the same.
- Initiation of leg sequencing occurs simultaneously in both FMCs.
- Independent calculations of aircraft position.
- Independent calculations of A/C gross weight
- Independent calculations of active thrust limit.

After DUAL mode is established, both FCCs select the FMC on the same side as the FCC in control. This FMC will then become the master. This selection process ensures that both Flight Directors (FD) will be controlled with the same steering commands.

NOTE: Recalculation of data by the FMS may cause momentary irregularities in displayed data.

Functions

Navigation

Position and velocity data from the GNS and the Inertial Reference Units (IRU) are combined with range and bearing data from VOR/DME stations to form an accurate and stable estimate of the aircraft position and groundspeed. The primary mode of operation is to combine range from two DME stations, and position and groundspeed data from a weighted average of the 2 GNSs and the three IRUs. If two available nav aids do not form an angle between 30 degrees and 150 degrees, range and bearing from a single VOR/DME may be used with the GNS and IRU data. As the aircraft progresses along the route, the FMC uses current estimate of the aircraft position and the stored nav aids in the database to tune the VOR/DME receivers to the stations that will yield the most accurate estimate of position.

The database contains data on the class and figure of merit of the available nav aids. The class of a nav aid is defined as VOR, DME, VOR/DME, VORTAC or LOC. The figure of merit (reception quality) is based primarily on usable range of the station relative to the aircraft.

Each FMC independently computes the FMC position as a weighted average of all three IRUs and GNSs. Below 78 degrees latitude, if any latitude or longitude data from one IRU differs from the previous average by 36 NM or more, that IRU will not be used in the averaging process until the output of that IRU is within 36 NM of the previous average. More complex but similar calculations occur above 78 degrees latitude. The defective IRU will also be eliminated if north/south or east/west velocities differ more than 20 KTS. When only two valid IRUs are available, each FMC will use one valid IRU for its independent calculation of the aircraft position.

Performance

The FMS performance modes optimize the aircraft's vertical profile. Those performance or speed modes include economy (ECON), POLICY, EDIT, MAX climb (CLB), MAX endurance (END), and MAX descent (DES). Speed targets associated with these modes are:

ECON - The ECON climb, cruise, and descent phase speed/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 FL, GW, temperature, and current or predicted winds.

POLICY - Same as the ECON speed mode, except with a crew-selected (CAS) (intended to suit a specific airline descent policy).

EDIT - Pilot entered CAS/MACH for CLB, cruise (CRZ), and DES phases of flight subject to flight envelope limits.

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MAX CLB - The MAX CLB speed is a table look-up speed for best angle of climb.

MAX END - The MAX END and best holding speed targets are calculated for obtaining the least drag for maximum time aloft.

MAX DES - The MAX DES speed is based on operation at maximum flight speeds.

The performance functions include the computation of optimal speeds, estimates of fuel consumption, and gross weight, predictions of time, fuel, and distances, at all flight plan waypoints. It also covers the computations of reference parameters, such as optimum altitude, maximum altitude, approach speed, database search/retrieval and FMC calculation of the operational speed envelope.

Flight path predictions are computed by the FMC 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 incorporating Aircraft (A/C) performance and Ground Speed (GS).

Descent path synthesis predicts the descent path by assuming flight idle thrust above the descent speed limit altitude and a small adjustment above idle below this altitude. The synthesis starts at the destination to compute the point where slats/flaps are expected to be extended and then intersect the cruise altitude creating a T/D 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 S/C to a pilot defined altitude that will result in minimum trip cost. The step-to altitude is preselected by the pilot on the FCP. The system will then begin climb at the programmed S/C point.

Approach speed targets are computed as a function of calculated gross weight and slat/flap settings. The final approach speed (VAPP) contains a + 5 knot bias above $1.3 \times \text{VSO}$ or VREF. This bias can be increased by pilot input for wind conditions.

The FMS fuel/weight/CG calculation is a prerequisite for all performance computations.

After engine start, the fuel/weight calculation is updated on the basis of fuel tank readings and a time integration of the fuel flows to each engine.

The route of flight is displayed on the Electronic Instrument System (EIS) map display, and when the descent phase is active, a vertical deviation indicator is displayed to show aircraft deviation from the computed flight path. Additionally, appropriate PROF flight mode annunciation is displayed on the FMA (top of PFD) to indicate whether the aircraft is tracking the descent vertical path.

Guidance

The FMS guidance function provides commands for controlling aircraft roll, pitch, speed and engine thrust. Fully automatic, performance-optimized guidance along flight paths in two or three dimensions is available. This is accomplished using SPD/NAV/PROF modes of the FMS coupled via the FCP. SPD, NAV and PROF may be used separately or together. NAV provides lateral guidance and speed/thrust control.

Lateral Guidance - This is provided by a primary flight plan with automatic route leg sequencing. The NAV guidance function compares the aircraft actual position with the desired flight path and generates steering commands to the autopilot and flight director. This causes the aircraft to fly along the desired path. Direct guidance from the aircraft present position to any waypoint is also available.

Vertical Guidance - This encompasses the takeoff, climb, cruise, descent, and approach phases of the flight plan. The flight planning capability of the FMS includes means to enter published departure, arrival, and approach segments and individual waypoints that include speed/altitude and time constraints. These constraints, as well as the entered cruise altitude and cost index define the vertical profile for which FMS provides guidance.

In the climb portion of the profile, the Autoflight System (AFS) will control thrust from FMC thrust limits and speed targets via the FCCs. The aircraft will climb at climb limit thrust to each altitude constraint, fly level until past the constraining waypoint using an appropriate speed target, and then resume the climb at CLIMB LIMIT thrust. Automatic level-off will also occur as a function of the altitude setting on the FCP.

The climb speed schedule is a function of 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 will maintain the selected performance mode speed until the descent phase is reached.

The descent path generator calculates a vertical path that meets waypoint altitude/speed constraints. This calculation also considers the selected DES performance mode. The path construction to the first altitude constraint assumes idle thrust and a calculated descent gradient which will maintain the mode speed schedule or the limit speed under the predicted wind conditions. PROF guidance controls aircraft pitch in a manner similar to the tracking of an ILS beam. While flying the descent path, PROF pitch commands to the FCC hold the path while the pilot uses speed brakes to maintain speed if a significant, unanticipated acceleration occurs. The FMS mode in descent on the FMS path will be a speed-on-throttle mode. Slight throttle activity may occur in an FMS descent to maintain the SPD target.

The route of flight is displayed on the ND, and when the descent phase is active, a vertical deviation indicator is displayed to show aircraft deviation from the computed flight path.

Software and Database

The FMC software includes the principal FMC operational program, navigation database, and performance data for the MD-11 aircraft.

The operational program provides the following FMS functions:

Navigation - Radio autotuning, position, velocity, and wind data determination.

Performance - Trajectory determination, definition of guidance and control targets, flight path predictions.

Guidance - Error determination, lateral steering and control command generation.

EIS - Computation of map and situation data for display.

MCDU - Processing of keystrokes, and flight plan construction.

I/O - Processing of received and transmitted data.

BIT - System monitoring, self-testing and record keeping.

Operating system - Executive control of the operational program, memory management, and stored routines.

The purpose of the performance database is to reduce the need for the pilot to refer to a performance manual during flight and to provide the FMC with data required to transmit pitch and thrust commands to the FCC. The performance database is also used by the FMC to provide detailed predictions along the entire aircraft trajectory. The data stored in the database includes accurate aircraft drag and engine model data, optimal speed data, maximum altitudes, and maximum and minimum speeds.

The FMC navigation database includes most of the information the pilot would normally determine by referring to navigation charts. This information can be displayed on the MCDU or EIS map. The geographic area covered includes all areas where the aircraft is normally flown. The database is tailored to specific airline customers. The stored data includes the location of VHF navigation aids, airports, runways, airways, holding patterns, geographical reference points, and other airline-selected information such as SIDs, STARs, approaches, and company routes. Up to 40 additional waypoints can be entered into temporary database by the pilot.

The FMC contains two sets of navigation data updated by maintenance action 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 FMC and should be ready for pilot activation during preflight.

Multifunction Control and Display Unit (MCDU)

The MCDU is the interface unit between the pilot and the FMC. It provides the means for manually inserting system control parameters and selecting modes of operation. In addition, it provides FMC readout capability as well as verification of data entered into memory. Flight plan and advisory data are continuously available for display on the MCDU.

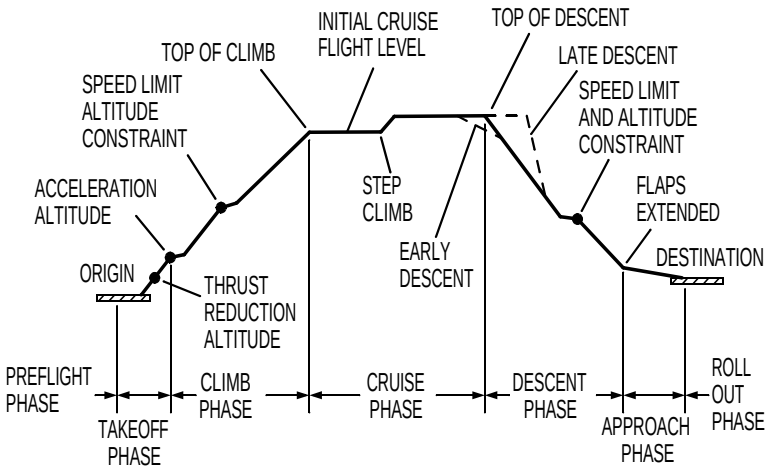
The MCDU keyboard assembly provides a full alphanumeric keyboard combined with mode, function, data entry, slew function keys, and advisory annunciators. In addition, the keyboard assembly contains two integral automatic light sensors and a manual knob to control display brightness.

Refer to the Controls and Indicators section in this chapter for a description of the MCDU. The FMS pages shown throughout this chapter are examples only. Actual pages may differ depending upon actual aircraft situations, engine type, and selected options.

FMS Components

Chapter FMS Section 20

FMS Profile



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FMS Interfaces

Components Receiving Data from the FMS

FCC (2) receive:

- Horizontal command.
- Roll limits.
- Gross weight.
- Airspeed target.
- Altitude target.
- Vmax and Vmin.
- Flap and slat retract speeds.
- EPR or N1.

FSC and FQDCU receive:

- Zero fuel weight.
- Zero fuel weight CG.
- Dump to gross weight.
- Total refuel quantity.
- Ballast fuel quantity.
- Fuel freeze point.
- Ballast cancel.

BTM/TPI receives:

- Ground speed.
- Flight number.
- Date.
- Time.

ACARS (if activated) receives:

- Downlink data and/or,
- ETA.
- Date.
- Flight number.
- Flight phase.
- Origin airport.
- Destination airport.

CPCS receives:

- Destination altitude.
- Time at top-of-descent.
- ETA.

DFDAU receives:

- Flight recorder parameters.

CFDS receives:

- Flight number.
- Date.
- Time.
- Baro corrected altitude.
- CAS.
- Maintenance data.

IRU (3) receive:

- Initial latitude.
- Initial longitude.

EIS receives:

- ND data.
- Deviations.

ADL (if installed) receives:

- DLDR data.

MCDUs receive:

- Display data.

GPWS (if connected) receives:

- Present position.

ADAS (if connected) receives:

- Flight recorder data.

GNS (2) (if activated):

- True airspeed.
- Pressure altitude.

Components Sending Data from the FMS

WBS (2) (if installed) send:

- Gross weight.
- CG.
- ZFWCG.

EIS send:

- Throttle resolver angle.
- Fuel flow.

ACARS (if connected) send:

- Uplink data.

FCC (2) send:

- Average flap position.
- Edit CAS and Mach.
- Selected airspeed and Mach.
- Selected altitude.
- Selected vertical speed.
- Actual N1 or EPR.
- Operating mode signals.

ESC sends:

- Engine bleed data.

CHRONO sends:

- GMT and date.

IRU (3) send:

- Inertial altitude.
- Position.
- Mag and true heading.
- North/South & East/West veloc.
- Flight path angle and accel.
- Roll and pitch angle.
- Yaw rate.
- Ground speed.
- Inertial vertical speed and accel.

ADL sends:

- Nav data base.

MCDU sends:

- Button push data.

CFDC sends:

- Commands.

VOR and DME (2) send:

- Frequencies.
- Bearings.
- DME distance.

CADC (2) send:

- Altitude.
- Mach and Airspeed.
- Ram airspeed.
- Temperature.

FQDCU sends:

- Fuel quantity.
- Center of gravity.

ILS (2) send:

- Frequencies.
- Loc deviations.

FCP sends:

- Preselected altitude.
- Mode request.

GNS (2) (if installed) send:

- PPOS latitude and longitude.
- Ground speed.
- Time, date.
- Sensor status.

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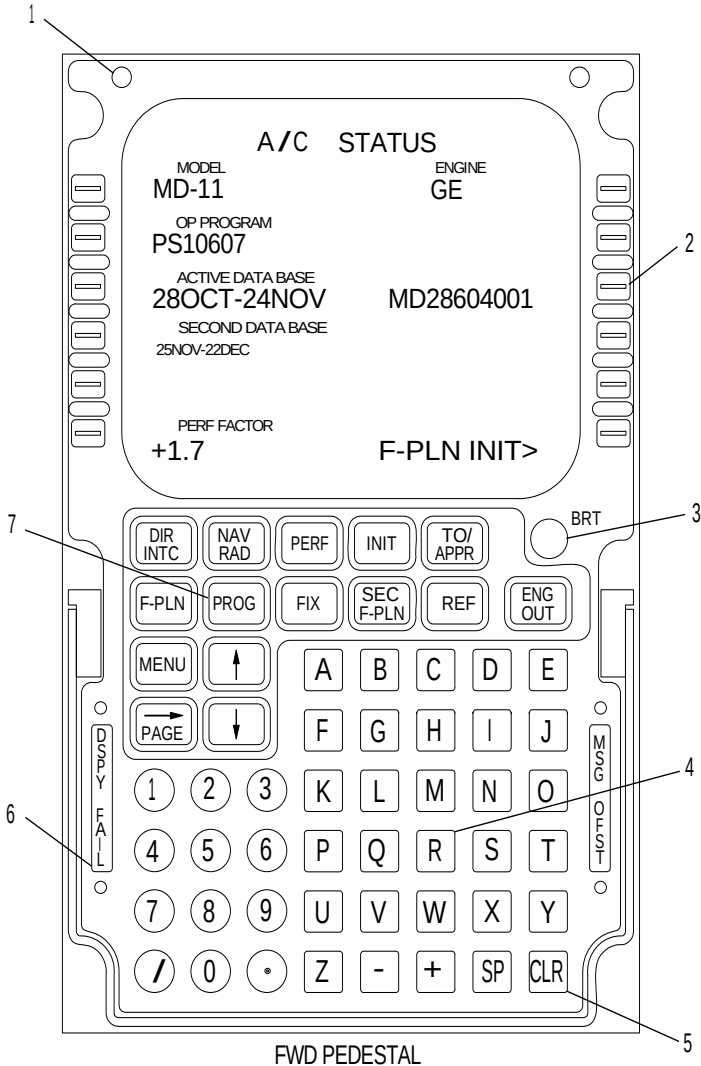
FMS

Controls and Displays

Chapter FMS

Section 30

MCDU



1. Light Sensor

Senses ambient light and automatically adjusts reference brightness level.

2. Line Select Key (LSK)

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

Misc keys are described below

- 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, ILS, and MLS.

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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 FOM, TO, NEXT, DESTINATION, and ALTERNATE waypoints. Actual and estimated times of arrival, altitudes, predicted fuels, and wind/temp data are available for review.

FIX - Selects FIX INFO page. Provides radial entry from a waypoint or navaid reference not on the active route (creates intercept points on the active route). Predictions are displayed for distance-to-go as well as estimated arrival time and altitude at the intercept point on the flight plan route.

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 including A/C STATUS, SENSOR STATUS, WAYPOINT, DEFINED WAYPOINT, POS REF, CLOSEST AIRPORT, and NAVAID.

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. The MENU page also provides for selection of standby operation.

PAGE - Selects additional pages of a set when another page is required to complete the display of data. This function is indicated by a horizontal arrow on the right side of the title line. The PAGE function is closed loop (wrap around from last page to first).

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.



MCDU Page Formats

PAGE TITLE

VERTICAL SLEW PROMPT

LABEL LINE

DATA LINE

SCRATCH PAD LINE

1L

2L

3L

4L

5L

6L

F-PLN INIT

1/3 →

CO ROUTE

ALTN ROUTE

LAT ↑ALIGN POS

N4158.8

FLT NO

AAL 1234

CRZ LEVELS

290/330/370/410/[]/[]

TEMP / WIND OPT / MAXFL

-45 / 120/280/328

FROM TO

KORD/LSZH

ALTN

EDDM

LONG

W08754.3

POS REF>

ci

100

1R

2R

3R

4R

5R

6R

NEXT PAGE PROMPT

LARGE FONT PILOT ENTRY

SMALL FONT

PAGE TITLE

AIRWAY

ASTERISK

1L

2L

3L

4L

5L

6L

AIRWAYS FROM YYZ

VIA

J586

VIA

J500

VIA

[]

*INSERT

TO

YJN

TO

YSC

RETURN TO

LAT REV>

WAYPOINT

PAGE PROMPT

FLYING FROM THE WAYPOINT

PSEUDO WAYPOINT

1L

2L

3L

4L

5L

6L

ACT F-PLN

FROM

ETE

SPD

ALT

KORD

0000

---/

670

ELX

13

355/

FL 199

UNBAR

17

.82/

FL259

(T/C)

19

// /

FL290

SVM

24

// /

FL290

YXU

36

// /

↑ ↓

0 →

1R

2R

3R

4R

5R

6R

PAGE NUMBER

NEXT PAGE PROMPT

CRZ FL

VERTICAL SLEW PROMPT

MCDU Data Labels

Page Title (Large font) - Identifies selected page and type of data displayed below the title.

Scratchpad Line (bottom line of display) - Displays FMS-generated messages and keyboard entries. When a message is received, the MSG annunciator on the right side of the MCDU illuminates. The EIS also displays MCDU MSGs on the ND.

Large font entry - Represents database of pilot entries that define the operation of the FMS.

Small font entry - Represents predicted, default, or FMC-calculated values. When adjacent to LSK, the data can be changed by pilot entry. If changed by the pilot, the font changes to large.

Label line (small font) - identifies the data displayed directly under the label line.

Data Line - Contains box prompts, dashes, brackets, computer generated data (small font), or pilot entered data (large font).

Box Prompts (empty boxes) - Usually indicate that data entry is required for minimum FMS operation. This data entry is performed through the use of the scratchpad and the corresponding LSK. Entry into a box prompt line is displayed in large font. Dashes in a data field indicate that data entry into that field is not allowed or that data is being calculated by the FMC. Bracket prompts indicate optional entry is possible in the applicable field.

Next Page Prompt (arrow pointing right) - Indicates that additional data is available for the page selected.

Vertical slew prompts (up or down arrows) - Indicate that the latitude or longitude value below the prompts can be increased or decreased. The slew prompt can also appear to the extreme right of the scratchpad line. This indicates that the lines of the display can be scrolled to move up or down one line at a time.

Page Number (small font) - Indicates the page number of a data set and the number of pages in the set. Example: 2/7 indicates page 2 of 7 pages.

Waypoint (large font) - Waypoint is on the selected route.

Airway (large font) - Identifies the published airway between two waypoints.

Asterisk (*) - Appears adjacent to an LSK if the actuation of the key will affect the active situation.

Page Prompts (< or >) - pushing the associated LSK accesses another MCDU page but no function is performed. A triangle beside a waypoint identifier on the F-PLN page indicates that the aircraft must overfly the waypoint. A left or right arrow beside a waypoint identifier shows the required turn direction at that waypoint.

Pseudo Waypoint - Computer generated point inserted into the flight plan to indicate a vertical (PROF) event. Pseudo waypoints are T/C (Top of Climb), S/C (Step Climb), T/D (Top of Descent), and I/P (Intercept Profile/descent only).

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MCDU Page Symbol Summary

	BOX PROMPTS	DATA ENTRY REQUIRED FOR MINIMUM FMS OPERATION.
	DASHES IN DATA FIELD	DATA ENTRY NOT ALLOWED OR DATA IS BEING COMPUTED FOR DISPLAY BY FMC.
	BRACKET PROMPTS	OPTIONAL DATA ENTRY POSSIBLE.
	VERTICAL SLEW PROMPTS	SCROLL PAGE UP/DOWN OR INCREMENT LARGER/SMALLER LATITUDE LONGITUDE VALUES.
 	VERTICAL SLEW KEYS	PUSH TO SCROLL DATA LINES UP OR DOWN.
	TRIANGLE	MUST OVERFLY WAYPOINT.
	NEXT PAGE PROMPT	RIGHT TITLE LINE. ANOTHER PAGE AVAILABLE.
	FUNCTION KEY	PUSH TO SCROLL NEXT PAGE.
	ARROW WITH WAYPOINT	TURN DIRECTION AT WAYPOINT.
	ASTERISK	ACTUATION OF LSK THAT HAS AN ASTERISK DISPLAYED, AFFECTS THE ACTIVE SITUATION.
	PSEUDO WAYPOINT	COMPUTER GENERATED PERFORMANCE (VERTICAL) EVENT (I.E., TOP OF DESCENT, ETC.)
	PAGE PROMPT	PUSHING ASSOCIATED LSK ACCESSES ANOTHER MCDU PAGE.

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MCDU Data Entry

Data must be entered into the Scratchpad (SP) from left to right with the alphanumeric keys. Usually, the display field or data field acts as an example format that when followed will result in successful data entry. After SP entry and confirmation of correct data, an LSK push will transfer data from the SP to the data field.

The two FMCs of the dual system communicate with each other over a private Intersystem Bus (ISB). Each FMC receives button pushes directly from the same side MCDU and button pushes from the off-side MCDU. The master FMC sequences button pushes in the order received, and transmits button push messages via the ISB to the other FMC. Thus, both FMCs process the same data simultaneously and will not start a new button push process until both have confirmed completion of the last button push. In case of simultaneous button pushes on the MCDU, the master FMC assumes that its own MCDU's button push came first. This allows both pilots to operate simultaneously on the same or different MCDU pages and to enter data on different pages or on different lines of the same page, however, only one flight plan modification at a time will be processed. Data entry notes are as follows:

Lateral Flight Path Revision (LAT REV) - Accomplished on the F-PLN page by pushing the appropriate left LSK with the SP empty.

Vertical Flight Path Revision (VERT REV) - Accomplished on F-PLN page using right LSKs.

Altitude/Flight Level Entry - Altitude related fields may be entered as either altitude or flight level. Data will be taken as flight level if 2 or 3 digits are entered without FL or if data are entered with prefix FL. Data will be taken as altitude if 4 or 5 digits are entered (500 feet must be entered as 0500).

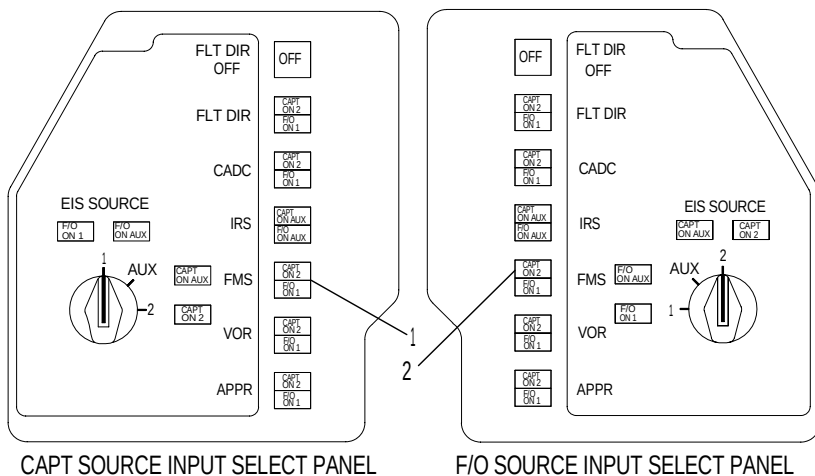
Runway Waypoint Entry - A runway may be used as a waypoint and must be typed as KORD27L where KORD is an ICAO airport, 27 is the runway, and the last space is blank or L, R, or C. The waypoint will be named RW and inserted into the MCDU data line. Example: RW27L.

RETURN TO > 6R - When pushed, usually returns the pilot to the previous or annotated page.

BUTTON PUSH IGNORED - This MCDU message is displayed if an LSK is pushed during or just after a predicted profile point data appears.

NOTE: Access to MCDU pages may take up to 10 seconds or more when the FMC is performing other computations.

FMS Transfer Switches



LB1-3-0060

1. Captain FMS Transfer Switch - amber

Captain FMC onside operation is FMC1 communicating with the Captain MCDU. Pushing this switch causes an offside condition (FMC2 communicating with the Captain MCDU). CAPT ON 2 will illuminate amber on both the Captain and F/O switches. Pushing again restores onside operation.

2. First Officer FMS Transfer Switch - amber

F/O FMC onside operation is FMC2 communicating with the F/O MCDU. Pushing this switch causes an offside condition (FMC 1 communicating with the F/O MCDU). F/O ON 1 will illuminate amber on both the Captain and F/O switches. Pushing again restores onside operation.

Preflight and Flight Planning Pages

A/C STATUS Page

A/C STATUS		
1L	MODEL MD-11 DEF AIL	1R
2L	ENGINE AS APPLICABLE	2R
3L	OP PROGRAM PS10607	3R
4L	ACTIVE DATA BASE 28OCT-24DEC	4R
5L	SECOND DATA BASE 25DEC-22JAN	5R
6L	PERF FACTOR +1.7	6R
	MD19603001 CONFIRM* F-PLN INIT>	

DB1-2-1986

The top of the A/C STATUS page shows the flight crew the FMS parameters. The model, engine type, and operating systems program numbers are displayed for reference in 1L, 1R, and 2L. If a performance database is not available to support the engine configuration, NO FMS SPD/PROF appears in 1L.

The effective database is changed by pushing 4L. A prompt will then appear in 4R for confirmation. When confirmed, the effectivity periods change positions on the page. Changing the navigation database effectivity is only possible during preflight.

The performance factor in 6L allows entry of known percentage performance deviation of the airframe engine combination from nominal. A positive performance factor increases predicted fuel flow by the entered percentage.

The prompt in 6R provides access to the F-PLN INIT page, the first of three initialization pages for entry of flight, performance, and fuel-related data.

NOTES: LSKs are labeled for reference only. On the aircraft they are not labeled.

The FMS pages shown throughout this chapter are examples only. Actual pages may differ depending upon actual aircraft situations, engine type, and selected options.

All data on the A/C STATUS page should be reviewed for applicability and date.

F-PLN INIT Page

F-PLN INIT 1/3 →

1L	CO ROUTE	FROM/	TO	1R
2L	ALTN ROUTE		ALTN	2R
3L	LAT		LONG	3R
4L	FLT NO .		POS REF>	4R
5L	CRZ LEVELS			5R
6L	TEMP / WIND	OPT / MAXFL	CI	6R

LB1-3-0062

This page may be accessed with the INIT key, or in preflight from the A/C STATUS page with the prompt in 6R. It allows the flight crew to initialize the primary origin/destination (or company route), alternate destination (or company route), cruise altitudes, wind and temperature, align the IRUs, and provides access to the WEIGHT INIT page with the PAGE key.

Boxes are initially displayed in 1L and 1R. A company route may be entered in 1L causing the FROM/TO field to be filled in automatically. Alternatively, a FROM/TO may be entered causing the route selection page to be displayed for optional selection of a company route.

F-PLN INIT

1/3→

CO ROUTE
JFKATL24L
ALTN ROUTE
[][][][][][][][][][][][][][][][]

LAT $\updownarrow$ ALIGN POS
N4038.0
FLT NO
[][][][][][][][][][][][][][][][]

CRZ LEVELS
[][][][][][][][][][][][][][][][]

TEMP / WIND OPT / MAXFL CI
-40° / HD 038 [][][][][][][][][][][][][][][][]

FROM/TO
KJFK/KATL
ALTN
[][][][][][][][][][][][][][][][]

LONG
W07346.4

INITIALIZE IRS*
[][][][][][][][][][][][][][][][]

1L

2L

3L

4L

5L

6L

1R

2R

3R

4R

5R

6R

LB1-3-0063

INIT pages may also be accessed during preflight through the *REF* key, *A/C STATUS* prompt, and *F-PLN INIT* prompt.

Latitude and longitude of the origin are obtained from the nav database and displayed in 3L and 3R or may be entered while dashes are displayed (to allow for IRS alignment prior to flight plan entry). The scroll prompt arrows are displayed by LAT initially but can be moved over to LONG by pushing 3R with the Scratchpad (SP) empty. Pushing 3L again moves the scroll prompt arrows back to LAT. The scroll arrows increment LAT or LONG magnitude in 0.1-minute steps. LAT and LONG may also be edited through the SP. The latitude and longitude fields will be blanked when the aircraft is airborne.

During the align mode, while the POS REF prompt is displayed, a new latitude and/or longitude may be entered with the SP or scroll arrows. The change will cause the INITIALIZE IRS prompt to be redisplayed. Selecting the prompt will transmit the new position to the IRUs and redisplay the IRS STATUS prompt. Alternatively, the INITIALIZE IRS prompt may be cleared, redisplaying the last transmitted position and the POS REF prompt.

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The first cruise flight level at 5L is mandatory data once the primary destination is entered and is taken from the nav database for the company route or may be flight crew-entered. Five additional cruise levels are optional and may be flight crew-entered. Multiple flight level entries must be separated by slashes.

NOTES: If preceding slashes are not used, the previously entered values will be cleared if the entered new value is higher than the aircraft altitude. Lower CRZ LEVELS require FMS transition to DES before a lower flight level can be entered.

Entering a CRZ LEVEL below the thrust reduction altitude will prevent FMC computation of F-PLN predictions.

Both the temperature and average cruise wind component may be entered at 6L. The default value for the cruise altitude temperature is standard day conditions.

NOTE: The TEMP/WIND entry is not compulsory but does help the FMS compute better predictions.

F-PLN INIT Page

1L

2L

3L

4L

5L

6L

F-PLN INIT

1/3→

CO ROUTE

JFKATL24L

ALTN ROUTE

Ø

LAT ↕

N4038.0

FLT NO

5612

CRZ LEVELS

310/350/

TEMP / WIND

-40°/HD 038

FROM/TO

KJFK/KATL

ALTN

NONE

ALIGN POS

W07346.4

LONG

POS REF>

[]/[]/[]/[]/[]

OPT / MAXFL

351/398

CI

50

1R

2R

3R

4R

5R

6R

LB1-3-0064

The average cruise wind component may be entered as either a tailwind or a headwind. A tailwind is entered by entering a leading slash (/) and a +, followed by the desired value, into the SP and then pushing 6L. Alternatively, the flight crew may enter the leading slash (/) followed by the alpha character(s) T, TL, or TAIL, followed by the value. The entered value will be displayed in 6L preceded by TL. A headwind is entered by the same methods except the + is replaced by a - and the T is replaced by an H, HD, or HEAD. The entered value in this case would be preceded by HD. The default windspeed is 0 knots, headwind, but a correct value will help the FMS compute better predictions on fuel consumption for the flight.

Optimum and maximum flight levels are displayed in line 6 for flight crew information only.

The cost index in 6R reflects time cost relative to fuel cost, and can range from 0 to 999. This field will remain dashed and not allow any entries until an active primary destination is entered or engines are started. Once the destination is entered, the cost index is either taken from the nav database for the company route, or is flight crew-entered. It is recommended that this not be entered until the flight plan is strung.

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WEIGHT INIT Page

WEIGHT INIT				2/3→
1L	TAXI 0.2	UFOB 144.8	BLOCK [][]	1R
2L	TRIP TIME --.-/---		TOGW [][]	2R
3L	RTE RSV/% --.-/5.0	BLST 0.0	IN ZFW [][]	3R
4L	ALTN --.-		LW [][]	4R
5L	FINAL/TIME --.-/0030		TOCG [][]	5R
6L	EXTRA/TIME --.-/---		ZFWCG [][]	6R

Initial Page Entry

LB1-3-0065

Accessed from F-PLN INIT with the PAGE key, this page allows the pilot to initialize weight and fuel parameters. Access to the FUEL INIT page is gained with the PAGE key. This page provides advisory warnings when entries exceed limits.

The fields in 1R, 2R, 5R, and 6R (BLOCK, TOGW, TOCG, and ZFWCG) appear as boxes (mandatory entry). The BLOCK field allows trial entries for fuel planning purposes.

NOTE: Before engine start, none of the calculations of weight data (ZFW = TOGW + TAXI - BLOCK) account for ballast fuel. Therefore, pilot entries of weight data must already account for ballast fuel. Upon edit of ballast fuel, the pilot is responsible for correcting the weight data.

BLOCK, TOGW, or ZFW will be calculated based on which two of these three parameters are entered by the pilot. The calculated value shall be displayed in small font and pilot entered values are displayed in large font. If the pilot entry made for BLOCK, TOGW or ZFW is cleared, then both the cleared value and the computed value (small font) shall revert to boxes. The amount of ballast fuel included in the ZFW is taken from the FUEL INIT page and displayed to the left of the ZFW. Before engine start, the TOGW and TOCG on this page are equivalent to the TOGW, and TOCG on the TAKEOFF page. Changing the value on the WEIGHT INIT page will alter the value on the TAKEOFF page as well.

The UFOB item in 1R is the actual usable fuel on board not including ballast fuel, if any.

The Landing Weight (LW) is computed after the EFOB at destination prediction is made and the ZFW is computed.

NOTE: When calculated value is not available, dashes are shown.

Other data on the WEIGHT INIT page is optional. 1L, taxi fuel weight, defaults to database value or may be entered by the flight crew. 3L is route reserve fuel and its percentage of trip fuel. Either factor may be entered, but not both simultaneously. 4L, fuel weight to the alternate, may be entered if there is no alternate destination, otherwise it is computed and no entry is allowed. 5L is fuel and time allowance for holding at the alternate. Entry and display are as defined for 3L above.

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WEIGHT INIT Page

WEIGHT INIT			2/3 →
1L TAXI	UFOB	BLOCK	1R
0.2	144.8	144.8	
2L TRIP/TIME		TOGW	2R
55.0/0147		449.8	
3L RTE RSV/%	BLST	IN ZFW	3R
1.2 /5.0	20.2	305.2	
4L ALTN		LW	4R
0.0		394.8	
5L FINAL/TIME		TOCG	5R
7.0 /0030		39.3	
6L EXTRA/TIME		ZFWCG	6R
3.5 /0015		32.0	

Entries Prior To Engine Start

LB1-3-0066

The trip fuel and time to the primary destination, in 2L, are computed, and cannot be edited by the flight crew. If TRIP fuel is greater than BLOCK fuel, then INSUFFICIENT FUEL will be displayed in the scratchpad of the MCDU.

The data in 6L, extra fuel and hold time at the alternate, are computed considering available block fuel and all consumption and reserve values. If negative values are calculated for this field, it indicates the flight may be into reserve or holding fuel. This field is also editable by the flight crew.

To make entries into the editable fields, without WBS, the flight crew enters the desired value into the SP and then pushes the desired LSK.

If an entry for TOGW exceeds the maximum value (stored in the nav database and pre programmed) a message is displayed in the SP indicating the maximum value and the entry is rejected. If an acceptable entry is made, but that entry causes a calculation in another field (ZFW, LW) to exceed its maximum value, the entry is accepted, the calculation is displayed, and a message is displayed stating the maximum nav database value for the calculated field.

WEIGHT INIT Page

WEIGHT INIT		2/3 →
1L TAXI 0.2	UFOB 144.8	/FF+FQ 1R
2L TRIP/TIME 55.0/0147		TOGW 449.8 2R
3L RTE RSV/% 1.2 /5.0	BLST 20.2	IN ZFW 305.2 3R
4L ALTN 0.0		LW 394.8 4R
5L FINAL/TIME 7.0 /0030		TOCG 39.3 5R
6L EXTRA/TIME 3.5 /0015		ZFWCG 32.0 6R

After Engine Start

LB1-3-0067

At engine start the TAXI field in 1L disappears, the BLOCK and TOGW fields change, and ZFW will be displayed in large font whether or not it was pilot entered or calculated. Large font boxes will be displayed in data line 3R if ZFW was never entered or calculated prior to engine start. CHECK ZFW is displayed in the MCDU SP if the absolute value of UFOB minus BLOCK is > 500 KG.

The BLOCK field changes to show the sensors used for UFOB calculation (FF+FQ) in the data line and the label line is blank. FF represents the fuel flow sensor and FQ represents the fuel quantity sensor. The flight crew may deselect either sensor used for calculating UFOB, or may re initialize UFOB by entering a new value (thereby deselecting the fuel quantity sensor). After deselecting either sensor, the flight crew may re-select it by clearing the 1R field. Should UFOB be invalid, the INITIALIZE WEIGHTS message will also be displayed in the scratchpad.

The TOGW field changes to GW and displays dashes, a calculated value, or an accepted flight crew entry.

If an entry is made into the ZFW, GW, or UFOB field, the pilot entry will be displayed in large font and the computed value will be displayed in small font.

The TOCG field is displayed until airborne, at which time the field disappears. Entries into the TOCG field on the WEIGHT INIT page will cause the display on the TAKEOFF pages to change as well.

NOTE: If the UFOB is invalid (dashed) and GW is invalid (dashed), the pilot must first enter UFOB before entering GW. When UFOB is pilot updated, the fuel quantity (FQ) is removed from the UFOB computation and only fuel flow (FF) is used to update UFOB.

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FUEL INIT Page

FUEL INIT		3/3 →
REFUEL QTY	DUMP TO GW	
[.]	430.0	
BLST FUEL	DUMP TIME	
95.0	0428	
BLST TANK	FUEL TYPE	
2	JET A	
	FREEZE TEMP	
	-40°	
FUEL DIPSTICK>		

LB1-3-0070

Accessed from WEIGHT INIT with the PAGE key, this page allows the flight crew to initialize fuel-related parameters. Pushing the PAGE key returns display to the F-PLN INIT page.

Refuel quantity may be entered in 1L for the total fuel the flight crew wants on board after fueling.

2L through 4L are for ballast fuel entries. A BLST FUEL entry in 2L identifies a certain quantity of fuel onboard as ballast fuel (nonusable fuel). The BLST TANK field in 3L allows the flight crew to identify the tank that contains the ballast fuel. This field will not be displayed until an entry has been made in the BLST FUEL field, at which time boxes will be displayed. If BLST fuel is entered or edited after engine start, then CHECK ZFW will be displayed in the scratchpad of the MCDU.

After a flight, if ballast fuel had been in the system, the FMC will retain ballast fuel quantity and ballast tank identifier on the FUEL INIT page. CHECK BALLAST FUEL will appear in the SP.

If a BLST FUEL or BLST TANK entry is made that has BLST FUEL greater than the limit of the BLST TANK, TANK LIMIT EXCEEDED is displayed and the entry is rejected. If a BLST FUEL entry is greater than the largest tank limit, ENTRY OUT OF RANGE is displayed and the entry is rejected.

FUEL INIT Page

1L

2L

3L

4L

5L

6L

FUEL INIT

3/3 →

REFUEL QTY
[.]

BLST FUEL
62.0

BLST TANK
☐

DUMP TO GW
430.0

DUMP TIME
04

FUEL TYPE
JET A

FREEZE TEMP
-40°

FUEL DIPSTICK>

TANK LIMIT EXCEEDED

1R

2R

3R

4R

5R

6R

LB1-3-0071

DUMP TO GW in 1R is a gross weight that the aircraft will dump to if the fuel DUMP switch is pushed. This field defaults to maximum landing weight, but allows entry from 109 kgs up to the takeoff gross weight.

The DUMP TIME in 2R is a calculated value based on a 2300 kg/min dump rate from current gross weight to the DUMP TO GW value displayed in 1R. The resulting calculation is rounded to the nearest minute and displayed in small font. When the current gross weight falls below the DUMP TO GW value, this field displays zero. Prior to engine start the dump time is calculated using the takeoff gross weight entry as the starting weight for the dump.

FUEL TYPE in 3R defaults to JET A, but may be changed by the flight crew. The freeze temperature of this fuel is displayed in 4R. The freeze temperature defaults to the maximum specified limit for the fuel type entered in 3R, but may be changed by flight crew entry. This causes the fuel type in 3R to become dashed. The freeze temperature is used for freeze logic and fuel recirculation. The FUEL DIPSTICK in 5R provides access to FUEL DIPSTICK pages.

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Route Selection Page

KJFK/KATL 1/3→

1L	JFKATL24L			1R
	IF CYN J37 GVE			
2L	J22 PSK J53 SPA			2R
3L	J14 BUMPY 01R ANVAL			3R
4L				4R
5L				5R
6L	*INSERT		RETURN TO F-PLN INIT>	6R

LB1-3-0072

This page allows review of defined routes from the entered origin to the entered destination, and insertion of one if desired.

Accessed from either F-PLN INIT or SEC F-PLN INIT page due to entry of a FROM/TO or ALTN, the route selection page displays the route number in 1L and the route elements in 2 through 5. If there are no defined routes, NONE is displayed in 1L. In this sample there are three company routes, one per page, as indicated by the 1/3 in the title line. The PAGE key allows display of the additional defined routes.

Pushing 6L *INSERT (without asterisk if accessed from SEC F-PLN INIT page) enters the route in the appropriate flight plan (primary or secondary depending on how this page was accessed) and changes the display back to the previous page. Pushing 6R changes the display back to the previous page without entering the route.

If the company route contains a procedure that is not allowed, the page will display blanks where the procedure would be displayed and the SP will display the error message INVALID CO RTE PROC. Upon insertion into the flight plan of a company route with a non allowable procedure, the SP will again display the INVALID CO RTE PROC message and the flight plan will string a discontinuity in place of the non allowable procedure. If there are any transitions associated with the non allowable procedure, blanks will be displayed for the transition also.

ACT F-PLN Page 1/2

ACT F-PLN					1 / 2→
FROM	ETE	SPD	ALT		
1L RW22R H222°	0000	133/	10		1R
2L 410 CYN5	0001	183/	410		2R
3L CYN J37	03	220/	5000		3R
4L ENO J37	11	200/	15000		4R
5L MOSSI J37	19	.74/	FL250		5R
6L MARBY	21	.78/	FL275		6R

LB1-3-0073

The ACT F-PLN pages consist of pages 1 and 2. Pages display both lateral and vertical elements of the flight plan in a time sequence. The entire flight plan may be viewed by use of the scroll keys. These pages are accessed following initialization by pushing the F-PLN key.

The ACT F-PLN page 1 displays left to right waypoints, waypoint data, time (ETE or ETO), and speed/altitude. Prior to takeoff the predicted times are ETE, after takeoff they are ETO. If the aircraft clock fails, CLOCK INVALID is displayed. Pseudo waypoints are presented for reference only.

Speed and altitude constraints may be changed or entered directly on the ACT F-PLN page 1 by entering the change data in the SP and entering it with the right LSKs. These constraints may be deleted with the CLR key and the right LSKs.

Existing waypoints may be deleted by the CLR key with the left LSKs. A new waypoint may be entered from the SP with the respective left LSK. The new waypoint may be in the form of a waypoint identifier, or a latitude/longitude, or a place/bearing/distance. The new waypoint will cause the previous waypoint and the remaining flight plan to be pushed down.

ACT F-PLN pages provide access to the LAT REV pages (left LSK) and VERT REV pages (right LSK). The SP must be empty to allow this access.

NOTES: Insertion of the runway configures the ND MAP display with a runway symbol and course. Previously entered SLOPE/WIND data on TAKEOFF page will be deleted.

All FMS data should be verified against confirmed data (i.e. computer flight plans, SIDs, approach charts, etc.).

Do not enter more than 100 waypoints in the FMS.

ACT F-PLN Page 1/2

ACT F-PLN				1/2→
1L	HOLD R	RESUME	HOLD*	1R
2L	C185• MARBY	ETO SPD 1503 .78/	ALT FL250	2R
3L	BUM35	07 280/	FL190	3R
4L	BUMPY	09 210/+	6500	4R
5L	ANVAL ILS27L	09 210/	4000	5R
6L	DEPOT	10 * /	2800	6R

LB1-3-0074

When the DECEL mode, or the holding pattern related commands, EXIT AT FIX or RESUME HOLD, become allowable, a prompt to activate the mode appears in 1R of both F-PLN pages, overwriting the data otherwise displayed. Pushing F-PLN LSK 1R initiates the command or the mode.

The DECEL mode prompt appears when the aircraft crosses the descent path at the FCP altitude. When the prompt is selected the ACT F-PLN page returns to normal and the speed target is reduced.

Once the DECEL mode has been selected, either dialing the clearance altitude down or selecting any other speed mode will cancel the DECEL mode.

LB1-3-0075

NOTE: Refer to the MD-11 Flight Crew Operating Manual Operating Procedures for a description of VFR approach procedures.

ACT F-PLN Page 2/2

ACT F-PLN 2/2 →				
	FROM	DIST	°C	WIND
1L	RW22R		12	HEAD/24
	H222°	2		
2L	410		5	' / '
	CYN5	5/229°		
3L	CYN		-2	' / '
	J37	81		
4L	ENO		-13	Ø35°40
	J37	72		
5L	MOSSI		-24	HEAD/24
	J37	15		
6L	MARBY		-25	' / '

LB1-3-0076A

The ACT F-PLN page 2/2 displays great circle distance to the next waypoint, the flight plan outbound course for the next leg, and temperature and wind information for the same waypoints displayed on page 1. Pushing the PAGE key with the ACT F-PLN page 1 displayed accesses the ACT F-PLN page 2/2.

Waypoints, nav aids, or flight plan events are displayed on the left side (1L through 6L). The FROM waypoint is displayed in 1L.

The distance between the flight plan waypoints is displayed in the center field between the lines for the corresponding waypoints. The departure runway surface temperature is displayed in the center of line 1. This temperature defaults to ISA temperature. Actual temperature can be entered on the CLIMB FORECAST page LSK 5R. After it is changed, it is displayed in large font on the page. If the magnetic course between two waypoints is different than the previous leg, the course is displayed next to the distance in the center field.

Temperature and winds for the waypoints are displayed on the same line as the waypoint identifier (or event name) on the right side (1C/R through 6C/R). The temperature defaults to ISA temperature unless there is a value entered on the F-PLN INIT page. Then it is a calculated value for that altitude. Winds default to HD/000 unless there is a value entered on the F-PLN INIT page.

The temperature and winds for climb are from the CLIMB FORECAST page. If parameters do not change on successive legs of the flight plan, ditto marks (“”) are displayed.

Pilot-entered Waypoint Formats

This page and the next show examples of flight plan data that will be displayed in the waypoint field in the left column of the ACT F-PLN pages. This data is for lateral defining legs, pseudo-waypoints, and flight plan markers.

MCDU	COMMENT
WPT TTTT SSS/HHHHH	WPT is the termination of a direct leg (track to a Fix, Direct-To a Fix, or Initial Fix).
AWY WPT	WPT is a waypoint on a procedure names "airway".
N34W117	Waypoint pilot-defined as Lat/Long = n34 xx.x'/w117 yy.y'
ABWPT	Waypoint abeam of WPT, entered via the DIR to page.
PBS HH	Waypoint pilot-defined as place/bearing/distance, #nn of 40.
WPTDDD OR DDWPT	Along-track Waypoint pilot-defined from flight plan fix named WPT, DDD=distance before or after WPT.
HOLD R C234 ° WPT	Right-turn holding pattern to a manual termination; inbound course 234°, holding fix is WPT. Created automatically or manually. If created automatically as PPOS HOLD the waypoint name will be T-P.
PROC T WPT	Manually entered procedure turn ending at a fixed waypoint.
T-P	Becomes "FROM" waypoint when a present position hold is executed and may also be the termination. Also "FROM" for a Direct to. PPOS Becomes "FROM" waypoint when the aircraft is flown into a discontinuity.
PPOS	Becomes "FROM" waypoint when the aircraft is flown into a discontinuity.

Database Entered Waypoint Formats

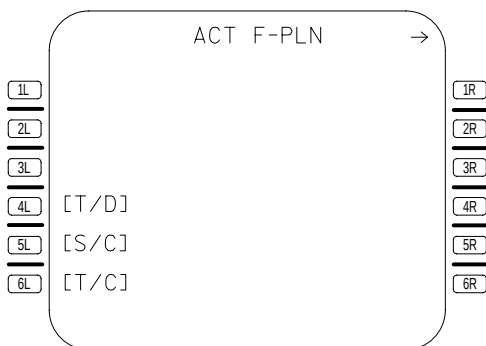
MCDU	COMMENT
C123° WPT	WPT is the termination of a "Course 123° to a FIX" leg.
C072° HHHHH CONDITIONAL C072° WPT TTTT SSS/HHHHH	Conditional altitude termination. FMS predicts termination will occur at the altitude fix.
DD NAV WPT	Leg along a DME arc of radius DD with center at navaid "NAV" and terminating at WPT>
FANNN	Final approach waypoint automatically entered into flight plan when VFR approach is inserted. NNN = destination runway number.

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Database Entered Waypoint Formats (Continued)

HOLD L WPT	Left-turn holding pattern to a fixed named WPT - automatically inserted as part of procedure.
HOLD L HHHHH	Left-turn holding pattern to altitude HHHHH - automatically inserted as part of procedure.
PROC T INTCPT	Database defined procedure turn starting at prior waypoint and intercepting course to next waypoint.
H345° HHHHH TTTT SSS/HHHHH	Heading leg, 345°, terminating at altitude HHHHH.
H321° WPTRRR	Heading leg, 321°, terminating at intercept with radial RRR from waypoint WPT.
H210° NAV/DD	Heading leg, 210°, terminating at intercept with DME distance DD from navaid NAV.
H012° INTCPT	Heading leg, 012°, terminating at intercept of next leg.
H003° MANUAL	Heading leg, 003°, to a manual termination.
C345° HHHHH	Course leg, 345°, terminating at altitude HHHHH; part of procedure.
C321° WPTRRR	Course leg, 321°, terminating at intercept with radial RRR from waypoint WPT.
C210° NAV/DD	Course leg, 210°, terminating at intercept with DME distance DD from navaid NAV.
C012° INTCPT	Heading leg, 012°, terminating at intercept of next leg.
WPTXXX° HHHHH	Course XXX°, from waypoint, WPT, to altitude HHHHH.
WPTXXX° MANUAL	Course XXX°, from waypoint, WPT, to manual termination.

Pseudo Waypoints



LB1-3-0077

All pseudo waypoints are enclosed in brackets as shown by the illustration above. They are not displayed on field 1L as the FROM waypoint.

The pseudo waypoints are computer-generated and are in brackets. They are placed in the flight plan for pilot reference and cannot be displayed as a FROM waypoint.

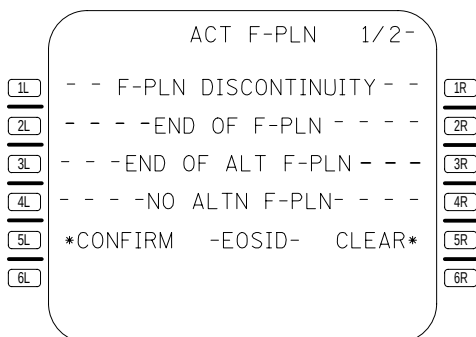
[T/D] is Top of Descent. FMC calculates where the A/C should start its descent.

[S/C] is Step Climb Point. Computed by the FMC. Pilot has inserted multiple flight cruise levels.

[T/C] is Top of Climb. FMC calculates where the A/C will reach the cruise altitude or step altitude if in a step climb.

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Flight Plan Markers



LB1-3-0078

Flight plan markers are special entries which mark certain things which must be made obvious to the flight crew.

Applies to active or secondary flight plan.

Performance Mode Pages

The PERF (Performance) pages present the flight crew with FMS speed mode data, along with time and distance predictions for planned altitude transitions for the climb, cruise, and descent phases of flight. The two types of PERF pages are active and preselect.

Active Pages - display the active FMS speed mode used for guidance and provide predictions to determine the proper speed targets for the current phase of flight. The title line of the active PERF page will display the active FMS speed mode and current phase of flight. Available active performance modes are:

- In climb, available FMS speed modes are ECON, MAX, CLB, and EDIT.
- In cruise, available FMS speed modes are ECON, MAX END, and EDIT.
- In descent, available FMS speed modes are ECON (POLICY), MAX DES, and EDIT.

Available FMS speed modes and their associated speeds are displayed for review or activation, with the speed of the currently active mode displayed in large font. Speeds of the non active FMS speed modes are displayed in small font with an asterisk prompt for activation.

In addition to activating FMS speed via the PERF page, the flight crew may affect the FMS speed mode via the FCP as follows:

- Pushing the FMS SPD switch within 10 seconds of preselecting an FCP speed activates the EDIT speed mode.

- Pushing the FMS SPD switch any other time activates the ECON speed mode.
- Pushing or pulling the FCP speed knob resets the FMS speed mode to ECON.

Preselect Pages - preview and define speed profiles to be used in the cruise and descent phases of flight. This page is accessed by pushing the PAGE mode key from the active performance page. Available preselect performance modes are:

- In cruise, available FMS speed modes are ECON and EDIT.
- In descent, available FMS speed modes are ECON (POLICY) and EDIT.

If the CLB page is the active performance page then two preselect performance pages are available (PRESELECT CRZ and PRESELECT DES). If the CRZ page is the active performance page, then only the PRESELECT DES page is available.

Available FMS speed modes and their associated speeds are displayed for review or preselection. The speed of the preselected mode is displayed in large font. Speeds of other FMS speed modes are displayed in small font with an asterisk prompt for preselection.

The following pages provide some examples of specific performance mode pages related to the individual phases of flight.

Active CLB Page

EDIT CLB		1/3 →
1L	ECON	PRED TO
2L	280/.780	FL 250
3L	MAX CLB	DIST
4L	210	0029
5L	EDIT	22
6L	260/Mmo	0030
	TRANS	CLIMB
	OPT/MAXFL	26
	18000	FORECAST>
	341/398	THRUST
		LIMITS>

LB1-3-0079

The CLB page is the active PERF page when the aircraft is in climb (below the first CRZ FL).

The FMS speed modes are as follows:

- ECON is the most economical CAS/Mach for time and fuel trade-off, based on the cost index entry (not editable).
- MAX CLB is the CAS that provides the maximum angle-of-climb (not editable).
- EDIT is a flight crew-selected CAS and/or Mach. A CAS entry without a specified Mach causes MMO to be the associated Mach. A Mach entry without a specified CAS causes VMO to be the associated CAS.

The flight crew may activate any of these speed modes by pushing the LSK adjacent to the speed displayed for that mode. If no mode is activated, the last engaged mode will become active on engagement. ECON will be the default only on power up on ground.

The CLB page provides time and distance predictions for achieving the selected (PRED TO) altitude of 1R. If a flight crew entry is made in the PRED TO field, it is displayed in large font. Otherwise, the FCP altitude is displayed in small font.

The time and distance predictions are displayed in large font for the active speed mode. If ECON or EDIT speed mode is active, time and distance predictions for MAX CLB mode are also displayed, but in small font.

If an altitude conflict exists between the FMS target altitude and the FCP selected altitude such that the aircraft is between the two, ??? is displayed on the left side of the title line.

The transition altitude of the origin (from the nav database) is displayed at lower left and is not editable. If a value is not available from the nav database, then 18000 ft. is displayed. The computed optimum and maximum altitudes are displayed at bottom center and are not editable. Access the CLIMB FORECAST and THRUST LIMITS pages with LSKs 5R and 6R. Access the PRESELECT CRZ page with the NEXT PAGE key.

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Active CRZ Page

RTA		ECON CRZ		1/2→	
		S/C TO FL 350			
		0019/139 NM			
1L	ECON				1R
2L	.78 0				2R
3L	MAX END				3R
4L	*.68				4R
5L	EDIT				5R
6L	[]				6R
		OPT/MAXFL		THRUST	
		341/398		LIMITS>	

LB1-3-0080

The CRZ page is the active PERF page when the aircraft is in cruise, including any step climbs.

The FMS speed modes are as follows:

- ECON is the most economical cruise Mach for time and fuel trade-off, based on the cost index entry (not editable).
- MAX END is the CAS which provides the maximum endurance (time aloft), and also provides the minimum drag (not editable).
- EDIT is a flight crew-selected CAS or Mach. Prior to a selection, brackets are displayed.

If a speed mode is preselected on the PRESELECT CRZ page, that mode is automatically activated when the CRZ page becomes the active PERF page. If no mode is preselected, then the previous active mode remains active by default (or if that mode is not available in cruise, ECON is activated). Thereafter, the flight crew may activate any of these speed modes by selecting the LSK adjacent to the speed displayed for that mode.

Selecting an edit speed in CRZ will not automatically carry the cruise speed edit into descent.

The CRZ page provides time and distance predictions to the next step climb point in 1R in large font (not editable). If the aircraft passes that point before the FCP altitude is raised for the step, the time and distance is replaced by STEP NOW. If the next step climb point is within 200 nm of the top of descent, the label for this field is replaced with TO T/D, and the time and distance to the predicted top of descent is displayed in 1R.

If a time constraint is inserted at a flight plan waypoint, TIME is displayed on the left side of the title line to indicate that the ECON speed is adjusted accordingly.

If an altitude conflict exists between the FMS target altitude and the FCP selected altitude (aircraft is between the two), ??? is displayed on the left side of the title line to indicate the conflict.

The computed optimum and maximum altitudes are displayed at bottom center and are not editable. Access to the THRUST LIMITS page is with LSK 6R. Access the PRESELECT DES page with the NEXT PAGE key.

The FMS has the capability to constrain the aircraft to an altitude at a waypoint in cruise. The format is /SFLXXX which is entered on the right side of the ACT F-PLN page adjacent to the desired constraining waypoint with a flight level of XXX. The flight level must be equal to one of the flight levels on the F-PLN INIT page. This capability applies primarily in step climb between flight levels defined in the FMS. Once the aircraft sequences the waypoint which has the constraining altitude and sequences the step climb point for that altitude, a vertical alert will be provided and the aircraft will begin to climb provided the FCP altitude has been raised to the new cruise flight level.

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Active DES Page

???		ECON DES	
1L	PATH ERROR	0 HI 0 LONG	PRED TO 15000
2L	ECON	UTC 2130	DIST 25
3L	MAX DES	2129	22
4L	EDIT	[]	
5L	TRANS		DESCENT FORECAST>
6L	18000		THRUST LIMITS>
1R			
2R			
3R			
4R			
5R			
6R			

LB1-3-0081

The DES page is the active PERF page when the aircraft is in descent or approach (including driftdown).

The FMS speed modes are as follows:

- ECON - Most economical Mach/CAS for time and fuel trade-off, based on the cost index entry (not editable).
- POLICY - Same as ECON mode, except with a flight crew-selected CAS (intended to suit airline descent policy).
- MAX DES - CAS which provides the maximum rate of descent (not editable).
- EDIT - Flight crew-selected Mach and/or CAS. A Mach entry without a specified CAS causes VMO to be the associated CAS. A CAS entry without a specified Mach causes MMO to be the associated Mach. Prior to any selection, brackets are displayed.

ECON mode is available for activation except as follows: If POLICY mode was previously enabled in preflight with the DES PRESELECT page, then POLICY mode is available (instead of ECON) for activation. If POLICY mode is removed (with the CLR key and 2L), then ECON becomes available again.

The speed mode that is preselected on the PRESELECT DES page is automatically activated when the DES page becomes the active PERF page. Thereafter, the flight crew may activate any available speed mode by selecting the LSK adjacent to the speed displayed on that mode.

The DES page provides time and distance predictions for achieving the selected (PRED TO) altitude of line 1R. If a flight crew entry is made in the PRED TO field, it is displayed there in large font. Otherwise, the FCP altitude is displayed in small font.

The time and distance predictions are displayed in large font for the active speed mode. If ECON or EDIT speed mode is active, time and distance predictions for MAX DES mode are also displayed, but in small font.

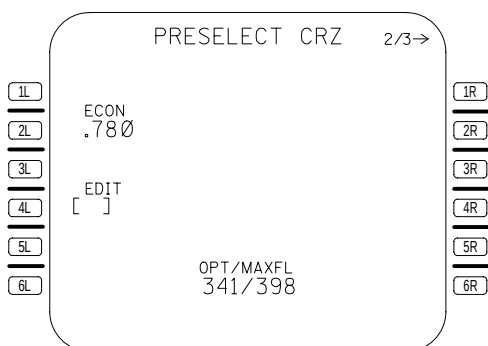
If an altitude conflict exists between the FMS target altitude and the FCP selected altitude (aircraft is between the two), ??? is displayed on the left side of the title line to indicate the conflict.

Aircraft deviation from the FMS descent path is displayed in 1L for flight crew reference. The vertical deviation (in feet) is displayed first followed by the horizontal deviation (in NM). The values indicate the position of the aircraft with respect to the FMS path (+-1000 feet full scale).

The transition altitude of the destination (from the nav database) is displayed at lower left and is not editable. If a value is not available from the nav database, then 18000 ft. is displayed. The optimum and maximum altitudes are displayed at bottom center and are not editable. Access the DESCENT FORECAST and THRUST LIMITS pages with LSK 5R and 6R.

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PRESELECT CRZ Page



LB1-3-0082

The PRESELECT CRZ page is accessed from the active CLB page with the NEXT PAGE key.

The FMS speed modes are as follow:

- ECON - Most economical cruise Mach for time and fuel trade-off, based on the cost index entry (not editable).
- EDIT - Flight crew-selected CAS or Mach. Prior to a selection, brackets are displayed.

The flight crew may preselect either ECON or EDIT speed modes by pushing the LSK adjacent to the speed. If the flight crew has no preference for preselect, then ECON mode is shown as preselected by default, and the ECON speed is used for cruise predictions. If the flight crew preselects a mode, then that mode is used both for cruise predictions and for initializing the speed mode of the active CRZ page, causing that speed mode to be activated when the cruise portion of the flight begins.

The optimum and maximum altitudes are displayed at bottom center and are not editable. Access the PRESELECT DES page with the NEXT PAGE key.

PRESELECT DES Page

PRESELECT DES 2/2 →			
1L	POLICY	1R	
2L	•.780/280	2R	
3L		3R	
4L	EDIT	4R	
	M MO /320		
5L		5R	
	TRANS	DESCENT	
6L	18000	FORECAST >	6R

LB1-3-0083

The PRESELECT DES page is accessed from either the PRESELECT CRZ page or the active CRZ page with the NEXT PAGE key.

- ECON - Most economical Mach/CAS for time and fuel trade-off, based on the cost index entry (not editable).
- POLICY - Same as ECON mode, except with a flight crew-selected CAS (intended to suit an airline descent policy).
- EDIT - Flight crew-selected Mach and/or CAS. A Mach entry without a specified CAS causes VMO to be the associated CAS. A CAS entry without a specified Mach causes MMO to be the associated Mach. Prior to any selection, brackets are displayed. If EDIT is preselected for descent via the CRZ page, then the associated cruise Mach is displayed with VMO as the CAS.

The flight crew can choose to replace the display of ECON speed mode with POLICY mode for descent by entering the desired CAS in 2L of the PRESELECT DES page while the aircraft is on the ground. The flight crew may choose to return the display to ECON mode at any time with the CLR key. In either case, the speed mode displayed at takeoff for a given flight leg (ECON or POLICY) is displayed in preflight for the next flight leg.

The flight crew may preselect a speed mode by pushing the LSK adjacent to the corresponding speed. If the flight crew has no preference for preselection, then ECON mode (or POLICY, if applicable) is shown as preselected by default. The preselected mode is used both for descent predictions and for initializing the speed mode of the active DES page, causing that speed mode to be activated when the descent portion of the flight begins.

The transition altitude is displayed at lower left and is not editable. Access the DESCENT FORECAST page with LSK 5R. Access the active PERF page with the NEXT PAGE key.

Flight Plan Modification Pages

Flight plan modifications may be performed by making changes on the preflight and flight planning and performance pages. This entails working through special pages, the lateral revision (LAT REV) and vertical revision (VERT REV) pages, and subordinate pages which provide special capabilities. Some of the operations presented here as flight plan modifications can also be part of the initial flight planning process. They are carried out through use of the LAT REV and VERT REV pages.

Other means of modifying the flight plan exist, including provisions for performing a direct to (a waypoint or intercept course) maneuver, inserting and then activating a secondary flight plan, or by making direct entries on the F-PLN pages.

Flight planning and the flight plan modification are supported by provisions for storing and using flight crew-defined waypoints.

LAT REV Page

LAT REV FROM KJFK N4038.0/W07346.4		
1L	<SID	STAR>
2L	<AIRWAYS	HOLD>
3L		PROCEDURE
4L	NEXT WPT	TURN>
5L	* []	NEW CO RTE
6L	OFFSET	[]*
	* []	NEW DEST
	ENABLE ALTN	[]*
	* TO KJAX	RETURN TO
		ACT F-PLN>

LB1-3-0084

This page allows the flight crew to revise the definition of the lateral flight plan. It will be displayed automatically when a left LSK is pushed on either of the ACT F-PLN pages or either of the SEC F-PLN pages. The waypoint next to the pushed LSK forms the title of the LAT REV page and the prompts displayed provide a menu of all revisions allowed at that waypoint.

Lines 1L SID, 2L AIRWAYS, 1R STAR, 2R HOLD, and 3R PROCEDURE TURN provide access to the stipulated menu pages. The SID prompt is accessible only during pre-takeoff operation, and only when the left LSK for the origin airport or runway is selected on the F-PLN page. In this case the STAR and PROCEDURE TURN prompts do not appear. When any other left LSK on the F-PLN page is selected, the SID prompt does not appear but all other applicable prompts do.

Line 4L allows entry of the next waypoint after the accessing waypoint. The next waypoint may be entered through the SP as an identifier of the database waypoint, navaid, airport, runway, or as a latitude/longitude/place/ bearing/distance. In the latter two cases, the FMS automatically assigns an identifier as one of up to 40 flight crew-defined waypoints.

Line 4R allows entry of a new company route from the waypoint named in the page title. Line 5R allows entry of a new destination.

When this page is accessed with the FROM waypoint of the flight plan and the current leg is a great circle path to a fixed waypoint, 5L allows entry of a lateral offset. Otherwise, 5L is blank.

Line 6L allows the flight plan to the alternate destination to be enabled. This only affects the portion of the active flight plan. Selection will not change the secondary flight plan.

The entry fields in 4L, 5L, 6L, 4R, and 5R will appear with an asterisk when the entry data affects the active flight plan. No asterisk will appear on lateral revisions to the secondary flight plan following the revise point.



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Line 6R allows return to the previous page without revision. Revisions made by 4L, 5L, 6L, and 5R also cause return to the previous page.

SID Page

SID FROM KJFK

SIDS	RWYS
1L BELLE6	04L
2L CYN5	04R
3L LINND3	13L
4L OKWD2	13R
5L PLUME9	22L
6L *INSERT	RETURN TO LAT REV> ↑

Initial SID Page

LB1-3-0085

The SID page lists and allows selection of SIDs and runways from the origin airport as well as selection of a departure transition. It also displays the automatically-selected engine out SID for the selected runway.

If enroute transitions are available, they will be listed below the selected SID. After transition selection, remaining transitions are listed following the remaining SIDs.

There is only one EOSID per runway in the database and this is automatically selected by the FMS.

The selected combination may be inserted in the flight plan by pushing LSK 6L (*INSERT for the active primary flight plan, or INSERT for the alternate or secondary flight plans). The display will then return to the accessing F-PLN page. The accessing LAT REV page may be recalled by pushing the RETURN TO LSK (6R) on the SID page (canceling any selections).

AIRWAYS Page

AIRWAYS FROM SPA			
1L	VIA JF3	TO XJ85	1R
2L	VIA J85	TO AMG	2R
3L	VIA []	TO []	3R
4L			4R
5L			5R
6L	* INSERT	RETURN TO LAT REV>	6R

LB1-3-0086

The AIRWAYS page, accessed from the LAT REV page, allows entry of the desired airway in 1L under VIA and the desired termination on the airway under TO. After the initial VIA entry, VIA and TO appear in 2L and 1R soliciting the next stage of airway routing. The flight crew may then choose between entry of a TO waypoint in 1R, or entry of the next intersecting airway in 2L. For the latter entry the intersection of the two airways is computed. If the airways intersect at a database waypoint, then the identifier of this waypoint is automatically inserted in 1R. Otherwise, an identifier composed of X followed by the second airway's identifier is inserted to represent the calculated intersection. Subsequent airway segments cannot be entered until completion of the intercept computation.

The INSERT prompt is displayed in 6L after entering an exit fix for the last entered VIA. Selection of this prompt inserts the airway in the flight plan and returns to the originating ACT F-PLN or SEC F-PLN page. The asterisk will only be displayed when this page has been accessed from the ACT F-PLN page. Pushing LSK 6R allows return to the appropriate LAT REV page without insertion of the airway routing.

STAR and APPR TRANS Pages

STAR TO KATL			
1L	STARS		APPRS
	MACEY	<SEL>	ILS27L
2L	TRANS		
	NONE		REMAINING
3L			APPRS
	REMAINING		ILS09L
4L	STARS		ILS09R
	LGC6		ILS26
5L	RMG5		RETURN TO
6L	* INSERT		LAT REV>
			↑

LB1-3-0087

The STAR page, accessed from the LAT REV page, is similar to the SID page. Arrivals and profile descents are listed under the STARS column. Runway approaches to the entered destination airport are listed under the APPRS column. Any approach procedure in the navigation database that is not certified for use by the aircraft will not be displayed on the STAR page and will not be available for use by the flight crew. After an arrival is selected, enroute transitions to the selected STAR are displayed for selection.

If an approach transition is automatically selected, the display is returned to the originating F-PLN page after *INSERT is selected.

If an approach transition cannot be automatically selected, (or this feature not installed), the approach transition page is displayed to allow flight crew selection by pushing an LSK. The display is returned to the originating F-PLN page after selecting an approach transition or by selecting the RETURN TO prompt in 6R.

*NOTE: The * is displayed to the left of the INSERT prompt for the ACT F-PLN, but is not displayed with the SEC F-PLN.*

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STAR and APPR TRANS Pages

STAR TO KATL			
1L	STD STAR MACEY <SEL>	APPRS VOR27L	1R
2L	TRANS NONE	MIN PROF □□□□FT	2R
3L	ADDL STARS LGC6	ADDL APPRS ILS27L	3R
4L	RMG5 CUSTOM	ILS27R CUSTOM	4R
5L	<STARS	APPRS>	5R
6L		RETURN TO LAT REV ↑	6R

LB1-3-0088

Non-precision approaches (IGS, LDA, LOC, NDB, RNAV, VOR) are available for selection from the NAV database. Non-precision approaches will not be strung into the flight plan unless a MIN PROF altitude has been entered by the pilot. Once a non-precision approach has been selected via the STAR page, boxes will be displayed at line 2R indicating mandatory entry of a MIN PROF altitude. The INSERT prompt will not be displayed until the pilot has entered a MIN PROF altitude. Once the MIN PROF altitude has been inserted, it may be edited via the STAR page. Once edited, the MIN PROF altitude will be displayed in small font with an asterisk. Selecting LSK 2R will edit the MIN PROF altitude and revert the STAR page to the F-PLAN page. Editing the MIN PROF altitude will not cause a restringing of the selected STAR/APPR or descent path reconstruction.

NOTE: In FMS PROF mode, the aircraft will not descend below the pilot entered MIN PROF altitude. Upon transition into altitude hold at the MIN PROF altitude, PROF mode will automatically disengage.

HOLD Page

HOLD AT REMIR			
1L	INB CRS 200°	TIME/DIST 1.5/--.-	1R
2L	TURN L	REVERT TO STANDARD	2R
3L	TRIP 1.4	LIMIT UTC/FUEL ---/---	3R
4L	RTE RSV/% 1.1/05.0	ALTN/FUEL EDDM/5.4	4R
5L	FINAL TIME 8.1/0030	CLR ALTN RETURN TO	5R
6L	*INSERT	LAT REV>	6R

LB1-3-0089A

The holding function is used to insert a holding pattern with a pilot-controlled termination into the flight plan or to modify an existing holding pattern. The holding pattern may be inserted at any waypoint or the FROM waypoint for holding at present position. A revision at an existing holding fix is permitted. Any inserted change becomes effective upon the crossing of the holding fix. Changes are activated immediately if made on the active leg prior to entry of the holding pattern. The HOLD page is accessed by pushing LSK 2R on the LAT REV page.

Titles can be as follows:

HOLD AT (waypoint or PPOS). Previously modified holding pattern or pilot defined holding already defined for the waypoint. PPOS is a special case FROM waypoint holding page.

DATABASE HOLD AT (waypoint). Enroute holding pattern defines from the nav database.

STANDARD HOLD AT (waypoint). Holding pattern parameters were defaulted by the FMS.

The default speed for a holding pattern inserted into flight plan is max endurance, subject to applicable ICAO or FAA speed limitations. This speed may be changed via F-PLN page.

WARNING: The flight crew has the final responsibility to ensure that the aircraft stays within limits of the holding airspace.

Line 1L INB CRS. Holding pattern course defaults to: 1. Database or pilot-defined holding pattern inbound course. 2. Inbound course from flight plan. 3. Current track (when page accessed) for PPOS or discontinuity holding.

Line 3L TRIP. FMC calculated trip fuel from the holding fix to destination.

Line 4L RTE RSV/%. Route reserve fuel from the holding fix to the destination.

Line 5L FINAL/TIME. Fuel and time allowance for holding at the alternate.

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Line 6L INSERT. Inserts hold into the flight plan.

Line 1R TIME/DIST. Time (minutes) and leg distance of the holding pattern. Default time is 1.0 minute at or below 14,000 ft. and 1.5 minutes above 14,000 ft. The altitude used to determine this is the predicted altitude at the revise point when HOLD page was accessed. For a PPOS HOLD, the aircraft altitude at the time the FROM point was accessed is used. Either time or distance may be entered as the leg defining parameter but not both.

NOTE: The time of a holding pattern with a default time of 1.5 minutes will not be automatically modified to 1.0 minute when the aircraft descends to an altitude at or below 14,000 feet. The time may be modified on data line 1R of the holding page.

Line 2R REVERT TO STANDARD. Return to default hold parameters in existence before alteration by the crew. REVERT TO DATABASE is displayed when the hold parameters from the NAV database are modified and inserted by the crew. Selecting 2R causes previously displayed data to return.

Line 3R LIMIT UTC/FUEL. Calculated values in large font are shown and pilot entry is not allowed. Dashes displayed if value not available.

LIMIT UTC - Predicted value at which FOB is equal to LIMIT FUEL. LIMIT FUEL - Fuel necessary to complete the flight plan with no changes to fuel reserves. $\text{LIMIT FUEL} = \text{TRIP} + \text{RTE RSV} + \text{ALTN} + \text{FINAL}$.

The entry in 3R is not displayed until the holding pattern is inserted in the F-PLN. Then it is displayed on both the F-PLN and the HOLD page. Pushing 6L *INSERT inserts the holding pattern into the flight plan.

Line 4R ALTN/FUEL. Alternate airport and the fuel to fly from the destination airport to the alternate airport. If there is no alternate, NONE is displayed but a fuel entry may be entered.

Line 5R CLR ALTN. Displayed if an ALTN destination exists and the revise point is in the primary portion of the F-PLN. Pushing 5R when the prompt is displayed deletes the alternate destination and route legs setting ALTN fuel to zero.

FMS maximum holding airspeed is ICAO limited as follows:

- Up to 14,000 - 230 KIAS
- 14,000 to 20,000 - 240 KIAS
- 20,000 to 34,000 - 265 KIAS
- Above 34,000 - .83 Mach.

During an HM or HF hold, when localizer or VOR mode is captured, an automatic *EXIT AT FIX button push will occur.

PROC TURN Page

PROC TURN ATBUMPY		
1L	OUTB CRS	1R
2L	295°	2R
3L	INB DIST	3R
4L	2.0	4R
5L	INB CRS	5R
6L	160°	6R
	* INSERT	RETURN TO LAT REV>

LB1-3-0090

This page allows the flight crew to insert or modify a procedure turn at the revise waypoint.

Upon entry of the data, the computer checks to see if the procedure turn entries are acceptable. If they are, the *INSERT prompt appears in 6L (without the * for alternate and secondary flight plans). If the turn is inserted, the aircraft will turn to the OUTB CRS from the revise point (BUMPY), fly out a distance equal to INB DIST, make the turn rolling out on the INB CRS and re-cross the revise point. The return prompt is in line 6R to enable return to the LAT REV page without insertion of the procedure turn.

During an active procedure turn, entry of data is not allowed.

database procedure turns will be displayed on the ACT F-PLN page.

VERT REV Page 1/2

VERT REV AT SPA 1/2		EFOB = 130.8 EXTRA=2.8	
1L	SPD	RTA	1R
2L	* []	PROGRESS>	2R
3L	AT OR ABOVE		3R
4L	* []		4R
5L	AT ALT		5R
6L	* []		6R
	AT OR BELOW	CLB SPD LIM	
	* []	275/10000	
		RETURN TO	
		ACT F-PLN>	

LB1-3-0091

This page will be displayed when a right LSK is pushed on the ACT F-PLN page 1 or SEC F-PLN page 1. The waypoint from the accessing page will form the title.

The Estimated Fuel On Board (EFOB) at this waypoint and the extra fuel remaining (EXTRA) at the destination are displayed below the page title.

This page allows the flight crew to modify the elements of the flight plan that affect the vertical profile. Elements that can be modified are speed, altitude or time constraints.

If a constraint exists at the selected waypoint, it is displayed in the appropriate field. Asterisks will be placed next to the field that can be edited only when the entries affect the active flight plan. An asterisk will only be displayed when this page is accessed from the ACT F-PLN page 1. This constraint may be deleted from the flight plan by use of the CLR key.

Line 2L SPD allows entry of a speed constraint.

Line 3L AT OR ABOVE allows entry of an altitude constraint at or above an altitude or Flight Level (FL).

Line 4L AT ALT allows entry of an altitude constraint at a specific altitude or Flight Level (FL).

Line 5L AT OR BELOW allows entry of an altitude constraint at or below an altitude or Flight Level (FL).

Line 2R Allows access to the RTA page.

Line 5R SPD LIM allows entry of an altitude speed limit at the revise waypoint. This may be a CLB or DES SPD depending on phase of flight. This value will default to VCL/10000 indicating VCL at or below 10000 feet.

Line 6R RETURN TO allows return to the originating ACT F-PLN or SEC F-PLN page.

NOTE: If the selected waypoint is sequenced, a CLEAR SPD prompt is displayed adjacent to line 2L if the waypoint has a speed constraint.

VERT REV Page 1/2

1L

2L

3L

4L

5L

6L

VERT REV AT SPA

EF0B=130.8 EXTRA=2.8

1/2

ALT: AT OR ABOVE

12500

* CLB

DES *

1R

2R

3R

4R

5R

6R

LB1-3-0092

After a constraint is entered in the respective field, the FMC requests verification of phase of flight.

Line 6L and 6R *CLB or *DES allows selection of phase of flight.

The VERT REV page 2 allows the crew to enter wind and temperature information for prediction purposes.

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Direct To/Intercept Page

ACT F-PLN				
1L	DIR TO		INTC FIX/CRS	1R
	* MARBY		MARBY/135°*	
2L	WITH			2R
	* ABEAM POINTS			
3L	J37			3R
	MOSSI	1218	.78/FL358	
4L	J37			4R
	MARBY	58	° / °	
5L	J37			5R
	GVE	1334	° / °	
6L	J37			6R
	SANNY	1488	° / °	
↑↓				

LB1-3-0093

The direct to/intercept page is similar in display to the ACT F-PLN page 1 and allows initiation of a direct flight leg to a selected waypoint or intercept fix. This page is accessed by pushing the DIR INTC key.

This page is initially displayed with brackets in 1L and 1R, prompting entry of a direct to (DIR TO) fixed waypoint or intercept fix/inbound course (INTC FIX/CRS), respectively.

If the SP is empty, a waypoint entered in line 1 can be selected from the active flight plan by an adjacent left LSK, or may be manually entered by the flight crew by means of the SP.

When a left LSK is pushed adjacent to a flight plan fixed waypoint with the SP empty, the waypoint is displayed in 1L preceded by an asterisk and in 1R followed by its inbound course (from the flight plan) and an asterisk. Selection of a pseudo-waypoint, F-PLN marker or nonfixed waypoint is not allowed.

An SP entry must be previously defined by an identifier, either in the database (navaid, waypoint, airport, or runway), or in the flight plan as a flight crew-defined waypoint. Waypoints entered as PBD or lat/long will result in a corresponding pilot-defined waypoint being created.

Upon entry, the CRS prompt in 1R remains displayed as brackets, and the trailing asterisk is not displayed until the flight crew defines the inbound course to the entered fix. Course entries are only permitted in 1R. The course entry may be separate or combined with the entered fix. When the entry is complete, a trailing asterisk is displayed. If the aircraft's existing heading intersects the chosen course ahead of the chosen fix, heading hold is maintained to the intercept. Otherwise, the flight plan is unchanged and the SP message NOT ON INTC HEADING is displayed.

If the waypoint is displayed in 1L, either by LSK selection or direct entry, the prompt *WITH ABEAM POINTS is displayed in 2L.

The asterisks displayed in lines 1 and 2 indicate to the flight crew that the following choices are available by pushing the indicated LSK:

- 1L initiates an immediate direct-to maneuver to the entered waypoint.
- 2L performs the same maneuver with automatic insertion of up to 20 abeam points along the new path. To initiate a direct-to-maneuver with abeam points, push LSK 2L and observe insertion of abeam points along the new path.
- 1R enables the aircraft to capture the specified course to the fix.

The DIR TO (1L) or the INTC FIX/CRS (1R) may or may not be an existing flight plan waypoint. If it is not in the flight plan, a discontinuity will be created just after the waypoint on the F-PLN page. The discontinuity is cleared by the CLR key. If the waypoint is an existing flight plan waypoint then the intervening waypoints are automatically cleared without discontinuity.

When any of the above functions are initiated, the display returns to ACT F-PLN, page 1. Vertical scrolling does not displace line 1 or line 2 when *WITH ABEAM POINTS is displayed. The direct-to/intercept page is exited without execution by use of the other mode keys.

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SEC F-PLN Page

SEC F-PLN INIT 1/2→		
1L	CO ROUTE FROM/TO JFKATL24L KJFK/KATL	1R
2L	ALTN ROUTE ALTN [] []	2R
3L	COPY ACTIVE SEC F-PLN>	3R
4L	CLEAR SEC ACTIVATE SEC	4R
5L	CRZ LEVELS []/[]/[]/[]/[]/[]/[]/[]	5R
6L	TEMP WIND OPT/MAXFL CI -40%HO 038 351/398 []	6R

LB1-3-0094

The FMS provides a secondary flight plan which can be entirely different from the active flight plan or can be a modified version of the active flight plan. The secondary flight plan is for use in preplanning or evaluating changes to the active plan. The SEC F-PLN INIT page is accessed by the SEC F-PLN key.

The existing active flight plan may be copied for evaluation of modifications by pushing LSK 3L (COPY ACTIVE). This causes the display to change to the SEC F-PLN page 1. If it is necessary to completely clear the secondary flight plan, pushing 4L (CLEAR SEC) leaves the SEC F-PLN INIT page displayed.

When NAV is engaged, the prompt ACTIVATE SEC* in 4R is not displayed unless the first leg of the secondary flight plan is the same as the current active flight plan leg. If that is the case and 4R is pushed, the secondary flight plan immediately becomes the active flight plan and the display changes to F-PLN INIT page 1. The aircraft will now be on the same active lateral leg (no lateral maneuver will occur).

If NAV is not engaged, ACTIVATE SEC* is always displayed in 4R. Upon activation of the secondary flight plan the previously active flight plan becomes the new secondary.

If the flight crew had previously entered in 5L of the SEC F-PLN INIT page a flight level lower than the current aircraft altitude, that lower flight level is not transferred to the now-active flight plan. If the previously-entered flight level is higher than the aircraft, it will become the new active cruise altitude, but no climb maneuver will occur until the flight crew has raised the clearance altitude and initiated the climb by raising the FCP altitude.

A secondary flight plan independent of the active flight plan may be built by entering a company route (CO ROUTE) in 1L or FROM/TO identifiers in 1R.

The cruise altitude temperature, in degrees centigrade, and average cruise wind component may both be entered by typing TEMP/WIND in the SP and pushing LSK 6L. The default for the cruise altitude temperature is standard day conditions. The average cruise wind component may be entered with either a + or T before the component indicating a tailwind, or a - or H to the left of the component indicating a headwind. The default wind speed is zero knots. Optimum (OPT) and maximum flight levels (MAXFL) from the active flight plan are displayed in 6 for flight crew information only.

The Cost Index (CI) in 6R reflects time cost relative to fuel cost and can range from 0 to 999. The cost index is either taken from the database for the company route or is flight crew-entered.

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SEC PROGRESS Page

SEC PROGRESS		2/2 →	
1L	RTE RSV/% 1.2 / 5.0	1R	
2L	FINAL/TIME 78 / 0030	2R	DESCENT FORECAST>
3L	EXTRA/TIME 3.5 / 0015	3R	
4L		4R	
5L	DEST KATL	5R	ETA 2359
6L	ALTN KBOS	6R	DTG 720
			EFOB 14.7
			8.9

LB1-3-0095

The secondary progress (SEC PROGRESS) page displays fuel and time information. This page is accessed from the SEC F-PLN INIT page, by pushing the PAGE key.

Route reserve fuel and its percentage of trip fuel (RTE RSV/%) are displayed in 1L. Either factor can be entered, but not both simultaneously. Fuel and time allowance for holding at the alternate are located at 2L and follow the same entry rules as RTE/RSV.

The data in 3L, extra fuel and hold time at the alternate (EXTRA/TIME), are computed considering available block fuel and all consumption and reserve values. This field cannot be edited by the flight crew.

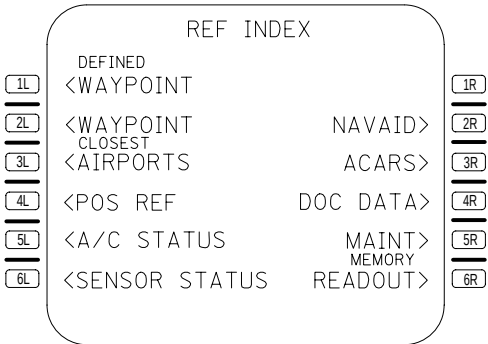
Access to the secondary descent forecast page is provided in 2R (DESCENT).

Lines 5 and 6 show the Estimated Time of Arrival (ETA), Distance To Go (DTG), and Estimated Fuel On Board (EFOB) at the secondary destination and Alternate (ALTN) secondary destination, respectively. If an enroute waypoint for an alternate is desired, enter an alternate in the SP and push LSK 6L. The information displayed will be the same type as that of the secondary destination.

The SEC F-PLN pages serve the same purpose as the ACT F-PLN pages except that they relate to the secondary flight plan. Their format and data are identical with two exceptions. The title ACT is replaced with SEC and predictions are displayed on the SEC F-PLN only if the secondary flight plan was created by copying the primary flight plan. The predicted time, speed, altitude, and distance fields are dashed.

The SEC F-PLN provides the pilot with the capability to develop an altered F-PLN that incorporates a new approach and landing runway at the destination. It can be used for runway changes, alternate routes, and changes in destination. Refer to the MD-11 Flight Crew Operating Manual Operating Procedures.

REF INDEX Page (with ARINC 724 ACARS)



LB1-3-0096

The reference index (REF INDEX) page provides access to special pages which build or modify a flight plan frequently requiring reference to existing waypoints and nav aids, or definition of new ones. The REF INDEX page illustrated above provides access to status and maintenance pages, discussed in a later section of this chapter.

The maintenance page, accessed by LSK 5R, is only available during preflight or after the completion of a flight plan.

WAYPOINT Page

WAYPOINT		
1L	IDENT RW25L	1R
2L	LAT/LONG N3356.0/W11825.9	2R
3L		3R
4L	ELEV 1530	4R
5L	LENGTH 11096	5R
6L	CRS 249°	6R
	CATEGORY 1	

LB1-3-0097

The WAYPOINT page displays waypoint data. This page is accessed from the REF INDEX page by pushing LSK 2L on that page.

This page is initially blank except for the title, the IDENT and boxes in 1L which indicate that the flight crew must type in the waypoint identifier.

The illustration above shows a format for a runway waypoint. If the selected runway contains an ILS approach, ILS category of either 0, 1, 2, or 3 will be displayed in 4R and runway data will be displayed in 4L, 5L, and 6L. For other waypoint types such as those from airway charts or other flight crew-defined waypoints, the runway data in 4L, 5L and 6L will be blank.

Exit from the WAYPOINT page is by use of the mode keys.

DEFINED WAYPOINT Page

1L

2L

3L

4L

5L

6L

DEFINED WAYPOINT 8/40

IDENT
P8008
LAT/LONG
N4532.6/W12645.3
PLACE/BRG/DIST
MOSSI/030.0°/21.0

NEW
WAYPOINT>
DELETE ALL

1R

2R

3R

4R

5R

6R

NEXT>

PREV>

LB1-3-0098

This page displays or allows deletion of waypoints defined by the flight crew. The illustration shows a waypoint defined as a place/bearing/distance. In this example, this is the 8th of the allowable 40 flight crew-definable waypoints as indicated by the 8/40 at the right end of the title line. The other defined waypoints are displayed by use of the 1R NEXT and 2R PREV prompts. Definition of a new waypoint may be done on the ACT F-PLN page 1 or SEC F-PLN page 1 or on the NEW WAYPOINT page accessed by 4R. Line 5R deletes all defined waypoints, but waypoints may be deleted singly by use of the CLR key line selected to 1L. Deletion is not allowed if the waypoint is constrained in either the active or secondary flight plan.

If the waypoint had been defined as a latitude/longitude waypoint the place/bearing/distance data in 3L would be blank. If it had been defined as a runway, the elevation, length, and course information would be displayed in lines 4L, 5L, and 6L as on the WAYPOINT page.

All defined waypoints are deleted upon flight completion unless they are stored in the secondary flight plan.

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NEW WAYPOINT Page

NEW WAYPOINT		
1L	IDENT □□□□□□	1R
2L	LAT/LONG □□□□.□/□□□□□□.□	2R
3L	PLACE/BRG/DIST □□□□□□/□□□.□°/□□□.□	3R
4L		4R
5L		5R
6L		6R

LB1-3-0099

The NEW WAYPOINT page allows definition of waypoints as latitude/longitude points, place/ bearing/distance points or as runways. When the page first appears, it is blank except for the labels and boxes, prompting the flight crew's choice of definition types. This page is accessed from the DEFINED WAYPOINT page by pushing LSK 4R of that page.

The flight crew may enter a new waypoint by typing the identifier (IDENT) in 1L and pushing LSK 1L. If the identifier is already in the database, a subsequent call-up of the waypoint will result in the display of the DUPLICATE NAMES page. The DUPLICATE NAMES page allows selection of a specific waypoint, runway or navaid when more than one with same identifier exists in the database.

After entering the identifier in 1L, the flight crew may enter either a latitude/longitude by typing LAT/LONG in the SP and pushing LSK 2L or a place/bearing/distance by typing in the place/bearing/distance in the SP and pushing LSK 3L. If a latitude/longitude is entered in 2L (LAT/LONG) then 3L (PLACE/BRG/DIST) is blanked. If a place/bearing/distance is entered in 3L, then the latitude and longitude are computed and displayed in 2L.

If a runway entry is desired, type the runway in the SP and push LSK 1L. In this case either 2L or 3L data must also be entered and the position is assumed to be the threshold.

The prompts ELEV, LENGTH and CRS will appear in 4L, 5L and 6L and the data must be filled in before ENTER is displayed in 6R, allowing the new waypoint to be entered in the database.

If there are already 40 defined waypoints, the first one in the defined waypoints list that is not in the flight plan is deleted and the newly defined one entered. If there are none that are not in the flight plan, then entry of the new one is not allowed.

NAVAID Page

NAVAID		1/4
IDENT	TYS	STATION DEC 01W
LAT/LONG	N3554.3/W08353.7	NEXT>
FREQ	116.40	PREV>
ELEV	1050	DESELECT []
CLASS	VORDME	
FIG OF MERIT	2 (130NM)	

LB1-3-0100A

Upon initial access the NAVAID page displays information on navaids then being tuned by the FMS. Data on the navaids being tuned are presented on separate NAVAID pages as follows:

Page 1 - Navaid for bearing pointer display.

Pages 2 and 3 - Navaids for radio position computation.

Page 4 - ILSDME/MLSDME for display.

If a navaid for bearing pointer display is also being used for positioning, then the navaid for ILSDME/MLSDME display, if present, will move up to page 3.

The NAVAID page can also display information on any navaid in the database upon definition of that navaid by the flight crew.

The illustration is an example of a NAVAID page as first accessed from the REF INDEX page. It shows the data displayed for a VORDME: Identifier, latitude/longitude, elevation, class, figure of merit, and magnetic declination. The illustration also indicates that there are four navaids being tuned by the FMS (1/4 in title line). Information on the others may be obtained by use of the NEXT and PREV prompts.

If the navaid had been a DME, the declination field would have been blank. If it had been a non collocated VORDME, the CLASS would have been VORDME NON-COLLOCATED.

If no navaids were being tuned when the page was accessed, the data fields would have been blank except for boxes in 1L.

If the flight crew enters a navaid identifier in 1L, the same types of information will be displayed but only one page of data will be available. NEXT and PREV will not appear and no numbers (1/4) will be in the title line.

For reference, the maximum allowable navaid distances for tuning are shown in 6L. For the four figures of merit the distances are: 0, 40 NM; 1, 70 NM; 2, 130 NM; 3, 250 NM.

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Line 4R allows a way to stop a navaid from being autotuned for position update or display during the current flight. Manual tuning capability will not be affected.

The flight crew may restore the navaid by use of the CLR key. It is also cleared by completion of the flight or by activation of the other database on the A/C STATUS page.

The mode keys are used to exit the NAVAID page.

DUPLICATE NAMES Page

1L

2L

3L

4L

5L

6L

DUPLICATE NAMES

LAT/LONG

FREQ

*ENO

N39/W075

111.40

*ENO

N40/W064

111.80

*ENO

N50/W070

116.60

RETURN TO

LAT REV>

1R

2R

3R

4R

5R

6R

LB1-3-0101

This page allows the flight crew to select a specific waypoint, airport runway or navaid when more than one with the same identifier exists in the database. The page comes up automatically when a non-unique identifier is entered on any one of the following pages: Any flight plan page, LAT REV page, FIX page, PROGRESS page, NAVAID page, NAV RADIO page, WAYPOINT page or direct to/intercept page. It is also displayed whenever duplicate names cannot be resolved automatically in ACARS route data.

The illustration above shows a page of duplicate navaid names. If the ambiguous identifier had been a waypoint of any type, the page would look the same except there would be no FREQ (frequencies) label. The asterisks are not displayed if the duplicate names are not associated with the active flight plan.

Pushing LSK 6R returns to the page which called up the DUPLICATE NAMES page with no selection having been made. Pushing any one of the LSKs beside a defining waypoint or navaid selects that one and returns the display to the calling page.

NOTE: Detailed data may be displayed about a specific waypoint by entry of its entire identifier in the IDENT box.

Flight Reference Information Pages

TAKEOFF Page

TAKEOFF KORD RW32L

1L 2L 3L 4L 5L 6L FLEX TOCG/TOGW THRUST * [] 25.3/585.0 LIMITS> PACKS N1 SLOPE/WIND OFF 108.7 [] [] [] [] [] [] FLAP STAB OAT [] [] [] [] [] [] V1 VFR CLB THRUST --- --- 2150 VR VSR/V3 ACCEL --- 235 3650 V2 VCL EO ACCEL --- 275 1450	1R 2R 3R 4R 5R 6R	

LB1-3-0102

This page is accessed by pushing the TO/APPR mode key prior to or during takeoff. It displays pilot-entered and calculated takeoff data. Once this page is exited it will no longer be accessible after the takeoff phase.

Line 1L allows the flight crew to enter an assumed temperature for a FLEX TO thrust rating. FLEX entries on this page will also be entered on the THRUST LIMITS page, and vice versa. Range is from TAT to 70 degrees C. TAT from the ADC will be displayed to the right of FLEX values. TAT is not pilot alterable. To regain full thrust the assumed FLEX temperature may be cleared.

Line 2L displays the expected packs setting which may be toggled from OFF (small font) to ON (large font) by pushing LSK 2L. The PACKS OFF or ON signal controls automatic pack operation during takeoff. To the right of the PACKS field, the N1/EPR computed thrust rating will be displayed (small font) and cannot be changed.

Line 3L allows the flight crew to enter the flap setting. Range is from 10 degrees to 25 degrees. For aircraft equipped with takeoff deflected ailerons there is also a 28 degrees flap setting. To the right of FLAP values, the stabilizer (STAB) position is displayed in small font and cannot be altered. If, after inserting a FLEX temperature for a reduced thrust takeoff, full power takeoff is desired, pushing the GA button will reset all takeoff data and thrust settings to full power. Changing the active runway in the MCDU will accomplish the same actions. Either of these actions will require reconfirming takeoff data in the FMS.

TOCG/TOGW - These values are the same numbers as on the WEIGHT INIT page. After engine start, the TOGW on the WEIGHT INIT page changes to GW. As fuel is used, both pages reflect the change.

Line 4L V1, line 5L VR, and line 6L V2 are computed for pilot reference and display on the PFD. Before any values are computed, the fields are displayed as dashes allowing pilot entry and clearing. Once these values are computed, they are displayed in small font with asterisks, prompting the pilot to confirm them by pushing the associated LSK. CHECK/CONFIRM VSPDS is displayed in the SP until the pilot either confirms/enters all three Vspds or clears the message. Each Vspeed is displayed in large font once it is confirmed. Until the throttles are set for takeoff, the pilot may make an entry overwriting a confirmed or computed value. If this entry is then cleared, the computed value is redisplayed in small font with an asterisk and the CHECK/CONFIRM VSPDS message in the SP. Vspeeds are not computed by the FMS if ALT T/O or any of the GE derate T/O thrust limits are used.

Confirmed Vspeeds are compared to the computed values and if a +/- 2 knot tolerance is exceeded, the computed value is displayed in small font with asterisks and the message CHECK/CONFIRM VSPDS in the SP. If at any time the computed values are disabled, the CHECK/CONFIRM VSPDS message is displayed in the SP. This message is also displayed when the FMS goes into LAT ONLY mode.

The flap and slat retract speeds/final segment climb speed (V3) and operational climb speed (VCL) displayed in small font to the right of fields 4L, 5L, and 6L are computed and not pilot-alterable. Whenever V1, VR, and V2 are all confirmed, the flap retract (VFR), speed is displayed. VSR/V3, the slat retract speed, is equal to V3 and is computed and displayed based on aircraft gross weight. If FMS is in LAT ONLY mode, VFR is not calculated by the FMS and is displayed as dashes.

Line 1R provides a prompt to access the THRUST LIMITS page.

Line 2R runway SLOPE/WIND are required for FMS Vspeed calculation. Entries for either of these two fields must be preceded with a + or a - (even for zeros). A + in the slope field represents an uphill slope and a - represents a downhill slope. Up and downhill slopes may also be entered in the SP preceded by U or D, respectively. A - in the wind field represents a tailwind and a + represents a headwind. Head and tailwinds may also be entered in the SP preceded by H or T, respectively. Omission of the prefixes with the slope and/or wind will be assumed to be an uphill slope and/or a headwind component, respectively.

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OAT - Outside air temperature is boxed indicating a mandatory entry for V-speed computations. Entries may be preceded by a + or - for temperature, otherwise + will be the default. Entries may be made in either degrees Centigrade or Fahrenheit. C for Centigrade or F for Fahrenheit must follow the temperature entered. After the temperature is entered, pushing 3R with no data in the SP will cause the OAT entry to be converted between Centigrade and Fahrenheit values.

NOTE: Temperature for the FMS OAT must not be taken from the TAT display on the EAD. Another source such as ATIS, ATC, weather dispatch, etc., must be used.

Line 4R CLB THRUST, Line 5R ACCEL and Line 6R EO ACCEL are computed by FMS and may be altered by the pilot during preflight. If the computed values are not available, the pilot is allowed to enter values into the dashed fields.

NOTES: With the FCP altitude set lower than the ACCEL or CLB THRUST altitude, the FMS values will be edited to the FCP altitude during altitude capture. Provided all engines are operational, climb speed (VCL), limited by constraints and placard speeds, will become the FMS speed target and climb thrust (CLB THRUST) will become the engine thrust setting when the aircraft levels off at the FCP altitude (ALT HOLD).

If the aircraft has not climbed through the ACCEL altitude and flaps and slats are extended, the Vmin marker on the airspeed display will be a function of 1.2 Vs.

The takeoff speeds (V1, VR, V2) computed by the FMS are based on Balanced Takeoff Performance as computed in the Airplane Flight Manual (AFM)

APPROACH Page

APPROACH KATL RW27L

1L 2L 3L 4L 5L 6L	CLEAN MIN 191 SLAT EXT MIN 176 FLAP 28° MIN 150 35/LAND VAPP 140 • 50/LAND	LW 309.9 LENGTH 9000 ELEV 1050 TIMER MMSS [] VREF 135 GO AROUND>	1R 2R 3R 4R 5R 6R

LB1-3-0104

The APPROACH page is accessed by pushing the TO/APPR key after takeoff or by line selecting 6R APPROACH> on the GO AROUND page. It is not available if there is no destination in the flight plan. This page displays landing and go-around data. The illustration shows a typical APPROACH page.

Lines 1L, 2L, and 3L display the minimum maneuvering speeds for clean, slats extended, and flaps extended configurations. These speeds will not be editable by the flight crew and will be displayed in large font. If FMS is in LAT ONLY mode, the minimum maneuvering speeds for slats extended and flaps 28 degrees are displayed as dashes.

Lines 4L and 6L indicate available slat/flap settings for landing. The selected configuration is displayed in large font without an asterisk in 4L. The setting in 6L (small font with an asterisk) may be selected by pushing 6L with the SP empty. This selection will cause the setting in 6L to be transferred into 4L (large font without an asterisk) and the setting in 4L to be transferred into 6L (small font with an asterisk).

Line 5L VAPP and VREF displays computed final approach speed and the reference speed. VAPP is computed as VREF plus 5 knots, but may be altered by the flight crew. VREF is computed as 1.3 times the stall speed for the selected landing configuration and may not be altered by the flight crew.

NOTE: For approach speed target information, refer to MD-11 Flight Crew Operating Manual, Operating Procedures.

The computed landing weight is displayed in 1R in small font and is not editable by the flight crew.

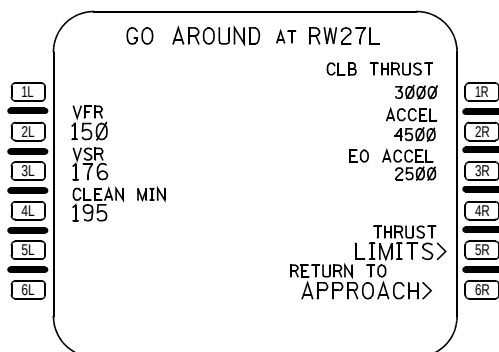
Lines 2R and 3R display runway length in meters and elevation in feet. Both of these fields are displayed in large font and neither are flight crew editable.

A timer value in minutes and seconds entered in 4R is used to initialize the EIS countdown timer. Entries may be cleared by the flight crew. The timer may be set to a max of 59 minutes and 59 seconds.

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Line 6R gives access to the GO AROUND page but is only available while in cruise, descent, or approach. Otherwise, exit from the APPROACH page is by the mode keys.

GO AROUND Page



LB1-3-0105A

The GO AROUND page is accessed from 6R on the APPROACH page, or is displayed automatically if the G/A button on the center throttle is pushed. This page allows the crew to review or modify thrust reduction or acceleration altitudes.

Line 2L VFR displays flap retract speed.

Line 3L VSR displays slat retract speed.

Line 4L CLEAN MIN displays predicted landing weight Vmin for flaps and slats retracted.

Line 1R CLB THRUST displays climb thrust altitude or allows alteration by the flight crew. The default value is 1500 feet AGL. Minimum allowable is 1000 feet AGL.

Line 2R ACCEL displays origin elevation where acceleration above $V_2 + 10$ knots can begin. Flight crew may alter this value. This value must be greater than CLB THRUST altitude. The default value is 3000 feet AGL. Minimum allowable is 1000 feet AGL.

Line 3R EO ACCEL allows flight crew alteration of origin elevation where engine out acceleration is initiated. The default value is 1500 feet AGL.

THRUST LIMITS page may be accessed from line 5R.

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APPROACH page may be accessed from line 6R.

NOTES: With the FCP altitude set lower than the ACCEL or CLB THRUST altitude, the FMS values will be edited to the FCP altitude during altitude capture. Provided all engines are operational, climb speed (VCL), limited by constraints and placard speeds, will become the FMS speed target and climb thrust (CLB THRUST) will become the engine thrust setting when the aircraft levels off at the FCP altitude (ALT HOLD).

If the aircraft has not climbed through the ACCEL altitude and flaps and slats are extended the Vmin marker on the airspeed display will be a function of 1.2 Vstall. If the slats are retracted prior to reaching the ACCEL altitude, the Vmin marker will be a function of 1.25 Vstall. Once the ACCEL altitude has been achieved, the Vmin marker will be a function of 1.3 Vstall.

THRUST LIMITS PAGE

Access to the THRUST LIMITS page is available from the TAKEOFF page, active PERF page, and the GO AROUND page.

The THRUST LIMITS page allows selection of maximum as well as preselected derated thrust limits. The THRUST LIMITS function allows for two THRUST LIMIT modes: AUTO and MANUAL. In AUTO mode, the FMC performs all automatic thrust limit transitions based on the aircraft state in the vertical flight plan. In MANUAL mode, the flight crew causes thrust limit transitions by manual selection on the THRUST LIMITS page and the only automatic transitions performed by the FMCs are aircraft safety related.

AUTO is the default selection mode at power up or in preflight. MANUAL mode is activated by selecting any thrust limit displayed in large font.

NOTE: The thrusts selected on this page merely set thrust limits; they do not control the thrust required.

Through the course of a flight one thrust limit is always ACTIVE while all others are either AVAILABLE FOR ACTIVATION, ARMED, or AVAILABLE FOR ARMING. The ACTIVE thrust limit is sent to the FCC for throttle control. This is the limit displayed on the left side of the page in large font, preceded by a right arrow.

NOTE: The pilot can change the ACTIVE thrust limit any time prior to takeoff by pushing the line select key (LSK) corresponding to an AVAILABLE FOR ACTIVATION takeoff thrust limit (one with an asterisk).

AVAILABLE FOR ACTIVATION thrust limits are displayed in small font with an asterisk. Pilot selection results in this thrust limit immediately becoming the new, ACTIVE thrust limit.

ARMED thrust limits are displayed in large font without an asterisk (MCT, CLB, CRZ, G/A) and are programmed to automatically become the ACTIVE thrust limit as flight conditions (aircraft state or phase of flight) require. A pilot manually selecting any ARMED thrust limit changes the functioning THRUST LIMIT mode to MANUAL and the selected thrust limit immediately becomes the ACTIVE thrust limit.

AVAILABLE FOR ARMING thrust limits are displayed in small font without an asterisk (CLB1, CLB2). Pilot selection results in this thrust limit immediately becoming the new, ARMED thrust limit. Selecting this thrust limit does not change the functioning THRUST LIMIT mode but immediately becomes the corresponding ARMED thrust limit.

An item on the THRUST LIMITS page which is pin selectable but is independent of the aircraft engine type is:

- a. Dual Derate: This option provides two fixed-percentage derates each for takeoff and climb. When enabled, two takeoff and two climb fixed-percentage derates are available for selection. The derate percentage values are fixed, and cannot be altered by the pilot.

AUTO THRUST LIMITS Page

AUTO THRUST LIMITS					
		N1	TAT	FLEX	
1L	→ T/O	108.1	20°	[]*	1R
	10% DERATE		20%	DERATE	
2L	* T/O1	106.1		T/O2*	2R
				SELECT	
3L	MCT	103.2		ALT*	3R
				OVERRIDE	
4L	CLB	102.8		[]*	4R
	10% DERATE		20%	DERATE	
5L	CLB1	101.5		CLB2	5R
			RETURN TO		
6L	CRZ	100.1	PERF	MODE>	6R

LB1-3-1925

AUTO THRUST LIMITS Page During Preflight/Takeoff

The THRUST LIMITS page, during preflight or takeoff, is shown above in AUTO mode with the Dual Derate option enabled.

LSK 1L - T/O Thrust. Displays the available or ACTIVE/selected maximum takeoff thrust limit (T/O, ALT T/O, or OVRD T/O) with corresponding N1 limit. Selection will result in the making the thrust limit the ACTIVE thrust limit and being displayed in large font.

Line 1C - TAT (Total Air Temperature) - TAT is displayed in small font.

LSK 1R - Flexible Derated Takeoff Thrust (FLEX). Entry field for the pilot-enterable temperature for computing a flexible derated takeoff thrust limit. Entering a flex temperature and pressing LSK 1R activates the Flex Derate Takeoff thrust limit, as indicated by “FLX DERATE T/O” and the ACTIVE thrust limit arrow in 2L. A FLEX temperature can be cleared and a flex temperature thrust limit can be cancelled by pressing the CLR key, then pressing LSK 1R anytime prior to throttle advance. Clearing a FLEX temperature entry or thrust limit causes the FMS to revert to the maximum takeoff thrust limit (T/O).

LSK 2L - Derated Takeoff Thrust 1, T/O1 (Optional). If the Single Derate option is enabled, then this field will, by default, display the first Fixed-Percentage Derate, T/O1. Additionally, this field will display the ACTIVE takeoff thrust limit, indicated by an arrow, when a takeoff thrust limit other than T/O is selected (T/O1, FLX DERATE) for use. If the Dual Derate option is enabled, the second fixed-percentage derate thrust, T/O2, will be displayed here, if it is selected to be the active takeoff thrust limit. If either ALT T/O, FLX DERATE, or OVRD T/O is selected, then T/O1 and T/O2 are not displayed.

LSK 2R - Derated Takeoff Thrust 2, T/O2(Optional). If the Dual Derate option is enabled, then this field will by default, display the second Fixed-Percentage Derate takeoff thrust limit T/O2. Additionally, this field will display T/O1 when T/O2 is selected to be the active takeoff thrust limit. If either ALT T/O, FLX DERATE, or OVRD T/O is selected, then T/O1 and T/O2 are not displayed. If the Dual Derate option is not enabled, then this field is blank.

LSK 3L - Maximum Continuous Thrust (MCT). Always displays the Maximum Continuous Thrust (MCT) limit.

LSK 3R - Alternate Thrust Rating, ALT (Optional). If the ALT Takeoff option is enabled, then this field will display the inactive, alternate takeoff thrust limit (ALT), a 3% derated takeoff thrust limit. Pressing LSK 3R displays “ALT T/O” in 1L as the ACTIVE thrust limit, indicated by an arrow, and places “T/O” in 3R. This field is blank if the ALT Takeoff option is not enabled or the FMS has transitioned out of the takeoff flight phase.

LSK 4L - Maximum, Climb Thrust (CLB). Always displays the Maximum Climb Thrust (CLB) limit.

LSK 4R - Takeoff Thrust Override, OVERRIDE (Optional). If the Takeoff Override option is enabled, then this field will display “OVERRIDE []” in 4R, where the pilot can enter the override thrust limit value into the blank field between the brackets. If an override thrust limit is entered, then 1L displays “OVRD T/O” as the ACTIVE thrust limit, indicated by an arrow, with the entered thrust limit to the right. This field is blank when OVRD T/O is the ACTIVE takeoff thrust limit or the Takeoff Override option is not enabled. An OVRD T/O entry can be cleared with the CLR key or by selecting any other available takeoff thrust limit.

LSK 5L - Derated Climb Thrust 1, CLB1 (Optional). If the Single Derate option is enabled, then this field will display the ARMED or ACTIVE/selected fixed-percentage climb thrust limit, CLB1(by default). If the Dual Derate option is enabled, then this field will display the active fixed-percentage derated climb thrust, CLB1 (by default) or CLB2.

LSK 5R - Derated Climb thrust 2, CLB2 (Optional). If the Dual Derate option enabled, then this field will display the unarmed or inactive fixed-percentage derate climb thrust limit, CLB2 (by default) or CLB1 (if CLB2 is the ARMED or ACTIVE thrust limit). If the Dual Derate option is not enabled, then this field will be blank.

LSK 6L - Maximum Cruise Thrust (CRZ). Always displays the Maximum Cruise Thrust (CRZ) limit.

LSK 6R - RETURN Prompt. Selection of this prompt returns to the previous FMS page from where the THRUST LIMITS page was accessed (TAKEOFF, PERF, or GO-AROUND).

Takeoff Derates

A pilot has as an option, to choose from two different kinds of derated takeoff thrust limits, a flex temperature and a fixed-percentage.

Flex Temperature Derates - A FLEX temperature can be entered on the TAKEOFF page or in 1R on the THRUST LIMITS page. If a FLEX temperature has been entered, the computed FLX DERATE thrust limit is displayed in 2L. If either of the Single or Dual Fixed-Percentage Derate(s) option are enabled, then those takeoff derates are removed from the display when a FLEX temperature has been entered. The FLX DERATE thrust limit can be deactivated before takeoff by clearing the FLEX temperature entry in 1R using the CLR key, or by selecting an available takeoff thrust. During a flexible derate takeoff, full takeoff thrust can be restored by pushing the TO/GA button on the throttle levers.

Fixed-Percentage Derates - If enabled, one or two fixed percentage derates are displayed in line 2 (2L and 2R, as applicable). The ARMED or ACTIVE derated thrust limit is always displayed on the left side of the display, 2L. For example, if T/O2 in 2R is selected to be the ACTIVE thrust limit, then T/O2 is moved to 2L, displayed in large font, and T/O1 is displayed in 2R as available to be activated.

Whenever a fixed percentage takeoff derate is selected as the ACTIVE thrust limit, the associated climb derate is automatically ARMED (CLB1 with T/O1, or CLB2 with T/O2). The pilot has the option of cross-arming climb and takeoff derates (CLB2 with T/O1, or CLB1 with T/O2) by simply selecting the desired AVAILABLE FOR ARMING climb derate at LSK 5R after the derated takeoff thrust has been selected.

Maximum Continuous Thrust

MCT automatically becomes active in the event of low-speed protection or engine failure. When the low speed condition or engine out condition has been cleared, the thrust limit automatically transitions from MCT to CLB or CRZ, as appropriate for the current flight phase.

Climb Derates

If enabled, one or two fixed-percentage climb thrust derates are displayed in line 5 (5L and 5R, as applicable). The climb derate is armed when the associated fixed-percentage takeoff derate is selected (CLB1 with T/O1 and CLB2 with T/O2). The pilot has the option of cross-arming climb and takeoff derates (CLB2 with T/O1, or CLB1 with T/O2) by simply selecting the desired derated climb thrust limit after the derated takeoff thrust limit has been selected.

The climb thrust limit (4L) and climb derates (5L and 5R) operated the same as the maximum and derated takeoff thrust limits. At the thrust reduction altitude, the following occurs:

- The FMS transitions to CLIMB thrust limit.

- The derated takeoff thrust limits in 2L and 2R are removed.
- Line 1 displays the go-around thrust limit.
- The climb thrust limit is the ACTIVE thrust limit and the other climb thrust limits are AVAILABLE FOR ACTIVATION.

AUTO THRUST LIMITS Page

AUTO THRUST LIMITS			
ALT	N1	TAT	
1L → T/O	101.6	20°	1R
2L			2R
3L MCT	99.1	SELECT T/O *	3R
4L CLB	98.1	VERRIDE [] *	4R
5L 10% CLB1	97.1	20% DERATE	5R
6L CRZ	95.5	RETURN TO PERF MODE>	6R

LB1-3-0146

Alternate Takeoff Thrust Limit

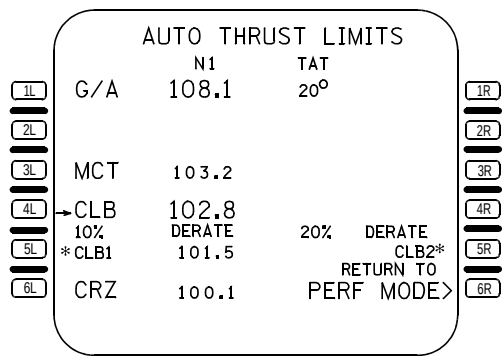
When the derated Alternate Takeoff (ALT T/O) Thrust option is enabled, the pilot may switch between the ALT T/O thrust limit and the T/O thrust limit at anytime prior to takeoff by selecting LSK 3R. If ALT T/O is the ACTIVE thrust limit and a windshear condition occurs, the “Maximum Takeoff (T/O)” thrust limit automatically becomes ACTIVE.

Manual Override Thrust Limit

A pilot can manually enter and activate a takeoff thrust limit prior to 70% thrust being reached by entering an N1 into 4R (OVERRIDE). When an OVRD T/O thrust limit is activated all other available takeoff thrust limits are no longer displayed on the page. The OVRD T/O thrust limit can be deactivated by clearing (CLR) the OVRD T/O thrust limit in 1L or selecting any non-takeoff thrust limit. Additionally, the OVRD T/O thrust limit may be deactivated by inserting an ACARS uplinked FLEX temperature. Deactivating the OVRD T/O entry causes T/O to become activated and all other available takeoff thrust limits are displayed. If the ACTIVE thrust limit is the OVRD T/O, an automatic deselection will not occur due to detection of a windshear situation.

CRZ and MCT thrust limits are always ARMED during the preflight/takeoff portions of flight. CRZ, the ARMED climb and MCT thrust limits are allowed to be activated on the ground for engine runup purposes. Safeguards are provided to prevent these thrust limits from remaining as ACTIVE during takeoff.

AUTO THRUST LIMITS Page



LB1-3-1927A

AUTO THRUST LIMITS Page During Climb

When the thrust reduction altitude is reached, the THRUST LIMITS page will automatically transision from takeoff to climb, and the ARMED climb thrust limit becomes the ACTIVE thrust limit, being displayed on the left side of the page and indicated by the ACTIVE thrust limit arrow. At the same time, all takeoff thrust limits are removed and Line 1 displays the ARMED go-around thrust limit, “G/A.”

AUTO THRUST LIMITS Page

AUTO THRUST LIMITS					
1L	G/A	N1 108.1	TAT 20°		1R
2L					2R
3L	MCT	103.2			3R
4L	CLB	102.8			4R
5L	10% DERATE		20% DERATE		5R
6L	CLB1	101.5		CLB2	6R
	→CRZ	100.1		RETURN TO PERF MODE>	

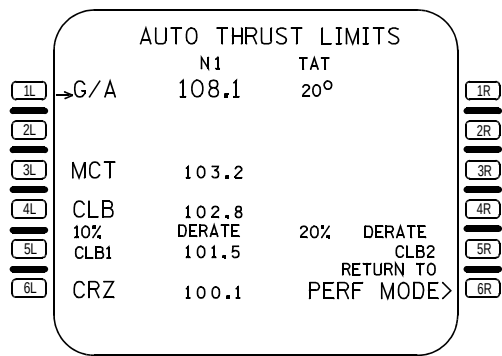
LB1-3-1928A

AUTO THRUST LIMITS Page During Cruise and Descent

During the cruise or descent phase of flight, the accessed THRUST LIMITS page displays the CRZ thrust limit as the ACTIVE thrust limit indicated by the arrow.

Once the slats/flaps are deployed during descent, CLB becomes the ACTIVE thrust limit as indicated by the arrow.

AUTO THRUST LIMITS Page



LB1-3-1929A

AUTO THRUST LIMITS Page During Go Around

In go-around, the THRUST LIMITS page displays G/A as the ACTIVE thrust limit. All other thrust limits remain as ARMED or AVAILABLE FOR ARMING.

MANUAL THRUST LIMITS Page

MANUAL THRUST LIMITS					
	N1	TAT	N1	FLEX	
1L → T/O	108.1	20°	[] *		1R
10% DERATE		20%	DERATE		
2L * T/O1	106.1		T/O2 *		2R
			SELECT		
3L MCT	103.2		ALT *		3R
			SELECT		
4L CLB	102.8		AUTO *		4R
10% DERATE		20%	DERATE		
5L CLB1	101.5		CLB2		5R
			RETURN TO		
6L CRZ	100.1		PERF MODE >		6R

LB1-3-1930

MANUAL THRUST LIMITS Page

The title of the THRUST LIMITS page changes to MANUAL THRUST LIMITS any time the pilot selects an ARMED or the ACTIVE thrust limits. All of the displayed thrust limits are available to be activated and are displayed in large font. The ACTIVE thrust limit has an arrow in front of it with the corresponding thrust limit displayed in large font. Line 4R displays the SELECT AUTO* prompt. Pushing LSK 4R returns the thrust limit MODE to AUTO.

In MANUAL MODE, only crew action can change the ACTIVE thrust limit, except in the event of an engine out, windshear or low speed protection. Automatic thrust limit transitions will occur under these conditions..

Windshear, Low-Speed Protection, and Engine-Out Conditions

Aircraft reactions to detected windshear events are dependent on the phase of flight and the system which detected the windshear phenomenon. A windshear event detected by the reactive windshear system will activate the maximum available (non-derated) takeoff or go-around thrust limit, as applicable. However, windshear conditions detected by the predictive windshear system (PWS) simply provides visual and aural cockpit warnings, but DOES NOT activate the maximum available thrust limit.

An engine-out confirmation in portions of flight other than takeoff or go-around, automatically activates the MCT thrust limit. Additionally, the low-speed protection function, when activated, will also activate the next higher thrust limit above the current thrust limit (CRZ-->CLB-->MCT) as necessary to recover airspeed.

NOTE: Windshear or Low-Speed Protection commands full, available thrust regardless of thrust mode selections made by the flight crew.

PROGRESS Page

PROGRESS 5612					
1L	FROM	ATG	ALT		1R
	CYN	2145	5000		
2L	TO	ETG			2R
	N3912/W07523	2152	FL350		
3L	NEXT				3R
	MOSSI	2201	FL370		
4L	TEMP	WIND	UFOB		4R
	-21°	270° / 75	28.8		
5L	DEST	ETA	DTG	EFOB	5R
	KATL	2359	720	14.7	
6L	ALTN		DIST		6R
	KBOS	0038	880	8.9	

LB1-3-0106

The PROGRESS page displays the following data:

- The last flight plan waypoint (FROM) with the actual time (ATG) of crossing and altitude (ALT).
- The currently active (TO) waypoint with a predicted time (ETG) to waypoint and altitude.
- The NEXT waypoint.

This page is accessed by pushing the PROG key.

Line 4 shows current Wind (WIND) and Temperature (TEMP) and Usable Fuel On Board (UFOB), and line 5 shows Estimated Time of Arrival (ETA), flight plan Distance To Go (DTG), and Estimated Usable Fuel (EFOB) at the primary destination (DEST). Line 6 displays similar data for the Alternate (ALTN) destination.

An existing flight plan waypoint can be entered in 6L to enable flight crew monitoring for re clearance (no effect on existing flight plan). The same prediction data will be displayed for this new waypoint as is displayed for the destination.

The title line of the PROGRESS page shows the flight number if it was entered on the F-PLN INIT.

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DESCENT and SEC DESCENT FORECAST Pages

DESCENT FORECAST		
1L	ALT / WIND	ANTI-ICE OFF
2L	FL290/090°/105	2R
3L	FL210/078°/69	3R
4L	[]/[]°/[]	4R
5L	KJFK/037°/45	5R
6L		6R

LB1-3-0107

The DESCENT FORECAST page is accessed by LSK 5R on the DESCENT perf mode page and enables the flight crew to enter the descent wind and temperature, for the active flight plan. The SEC DESCENT FORECAST page is accessed by LSK 2R on the SEC PROGRESS page and allows the flight crew to enter the same type of data for the secondary flight plan.

A maximum of three different altitude/wind combinations may be entered in lines 2L, 3L and 4L. The FMS will automatically arrange them in descending order from top to bottom. Entries of altitude only, or altitude and wind are acceptable and displayed in large font. The wind bearing and magnitude may only be entered without the altitude when the altitude already exists. Each altitude entry may be entered as flight levels or as pressure altitudes.

Line 5L automatically displays the destination in large font, only allowing the winds to be entered.

Pushing 1R selects anti-ice for descent path computation. Turning the anti-ice on does not automatically select the FMS anti-ice computation.

The temperature at the destination can be entered in 5R. This field is displayed in large font and may be cleared back to brackets.

NOTES: Altitudes should be entered as a FL above the transition level.

If the destination is changed to other than the destination airport, all previous wind entries on this page are deleted.

The Insert prompt is displayed in 6L whenever an altitude/wind entry or edit is performed. An asterisk precedes the inset prompt for the active DESCENT FORECAST page, but not for the SEC DESCENT FORECAST page.

A return to PERF Mode and SEC PROGRESS page prompts are provided on the active and secondary DESCENT FORECAST pages, respectively, and both the DESCENT FORECAST and SEC DESCENT FORECAST pages may be exited by mode key selection.

FIX INFO Page

1L

2L

3L

4L

5L

6L

FIX INFO1/2 →

FIX

YEE

RAD /DIST

246°/ 241

DNTKFX

[]°/---

ETO

DTG

ALT

[]°/---

[]°/---

ABEAM

164°/ 51

2202

242

FL290

1R

2R

3R

4R

5R

6R

LB1-3-0108

The FIX key provides access to two FIX INFO pages that provide the pilot with the bearing and distance from a specified fix and the capability to obtain predicted down path crossing times, distances, and altitudes from a defined radial off the reference fix. The specified fix may be a waypoint, a waypoint/course intercept point on the ACT F-PLN, or an abeam point. Fix identifiers must be defined in either the database or as a pilot defined waypoint. Waypoints entered as PBD or lat/long will result in a corresponding pilot defined waypoint being created. The operation of each page is identical. Pushing the FIX key results in a screen with FIX INFO as the title and 7 empty boxes in 1L (not shown). Choosing a fix and entering it into 1L with the SP results in the FIX INFO page shown here.

Line 1L FIX, RAD/DIST. FIX of interest entered into the FIX data field 1L. RADial and DISTance from that point to the aircraft.

Line 3L DNTKFX, ETO, DTG, ALT. Course from that fix may be entered in 3L, 4L, and/or 5L. Predictions are calculated for the radial distance or down track distance (DNTKFX) from the fix to over the F-PLN intercept point, the Estimated Time Over (ETO) to the intercept point, the Distance To Go (DTG) to the intercept point, and the predicted altitude (ALT) over the intercept point. Course entries which do not intercept the active F-PLN or that intercept with a leg transition or any leg not terminating at a fix are displayed in large font followed by NO INTERCEPT on the same line. Lines 3L, 4L, and 5L can be cleared by the CLR key.

Line 6L ABEAM. The abeam course to the flight plan track with the same data as in 3L above. If there is not an abeam course to the flight plan, then the abeam field is dashed with the NO INTERCEPT message.

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CLOSEST AIRPORTS Page

CLOSEST AIRPORTS		
	BRG /DIST	
1L KNEL	035° /13	1R
2L KWRI	334° /15	2R
3L KACY	206° /25	3R
4L KTTN	335° /32	4R
5L []	---° /----	5R
6L		6R

LB1-3-0109

The airports are displayed in lines 1 through 4, in approximate order of distance from the aircraft, along with the bearing/distance from the aircraft. Only those airports within a 4000 nautical mile radius of the aircraft are shown. If there are no airports within this limit, the message NONE WITHIN 4000 NM will be displayed across the center of the page.

Airport identifiers may be entered by the flight crew in 5L. Entries into this field are not restricted by the 4000 NM limit.

Similar to the NONE WITHIN 4000 NM display, CHECK A/C POSITION will be displayed across the center of the page when the aircraft's position is considered to be invalid.

CLIMB and SEC CLIMB FORECAST Pages

1L

2L

3L

4L

5L

6L

CLIMB FORECAST

ALT/ WIND

FL290/ []°/[]

FL250/190 °/065

FL210/210 °/030

KJFK /220 °/010

*INSERT

TEMP

[] °

RETURN TO

PERF MODE>

1R

2R

3R

4R

5R

6R

LB1-3-0110

The CLIMB FORECAST page is accessed by LSK 6R on the CLIMB PERF mode page and enables the flight crew to enter the climb wind and temperature for the active flight plan. The SEC CLIMB FORECAST page is accessed by LSK 1R on the SEC PROGRESS page and enables the flight crew to enter the same type of data for the secondary flight plan. The SEC CLIMB FORECAST page differs from the CLIMB FORECAST page in that SEC is added to the title and the asterisk (*) is deleted preceding the INSERT prompt.

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CLIMB and SEC CLIMB FORECAST Pages

SEC CLIMB FORECAST		
1L	ALT / WIND	1R
2L	FL260/140°/035	2R
3L	[] []°/[]	3R
4L	[]/[]°/[]	4R
5L	KJFK/ []°/[]	5R
6L	INSERT	6R
TEMP []° RETURN TO SEC PROGRESS>		

LB1-3-0111

A maximum of three different altitude/wind combinations may be entered in lines 2L, 3L, and 4L. The FMS automatically arranges the entries in descending order. Entries of altitude only, or altitude and wind are acceptable and displayed in large font. The wind bearing and wind magnitude may only be entered without the altitude when the altitude already exists. Each altitude entry may be entered as either flight levels (FL200) or as pressure altitudes (20000). Wind entries may be changed by any of the following format examples: /102/69, 102/69, or 102/069.

The altitude/wind field in 5L automatically displays the origin in large font, only allowing the winds to be entered.

The temperature at the origin can be entered in 5R. This field is displayed in large font and may be cleared back to brackets.

After an entry/edit is made, the insert prompt is displayed in 6L with the asterisk (*) on the CLIMB FORECAST page and without the asterisk (*) on the SEC CLIMB FORECAST page.

The CLIMB FORECAST page provides a RETURN TO PERF MODE page prompt in 6R. The SEC CLIMB FORECAST page provides a RETURN TO SEC PROGRESS page prompt in 6R. Both the CLIMB FORECAST and SEC FORECAST pages may be exited by pushing a mode key.

VERT REV Page 2/2

VERT REV AT MOSSI 2 / 2 →		
	ALT / TEMP	
	[]/[]°	
1L	ALT/ WIND	1R
2L	FL300/ 090° /110	2R
3L	FL200/ 218° /080	3R
4L	FL150/ 198° /044	4R
5L	*[]/[]°/[]	5R
6L	*INSERT	6R
	RETURN TO	
	ACT F-PLN>	

LB1-3-0112

The VERT REV page 2 allows the crew to enter wind and temperature information for prediction purposes. This page is accessible from the VERT REV page 1 via the PAGE key, by right LSKs corresponding to cruise waypoints on the ACT F-PLN page 2, or from another VERT REV page 2 via the PREV or NEXT prompt.

The title at the top of the page is the respective waypoint of the flight plan the VERT REV page 2 corresponds to.

A maximum of four different altitude/wind combinations may be entered in lines 2L, 3L, 4L, and 5L. The FMS automatically arranges the entries by altitude in descending order from the top to the bottom of the page. Entered altitudes at any waypoint are carried over to all waypoints, but the winds for each altitude may be unique to each waypoint. Entries of altitude only, or altitude and wind are acceptable and are displayed in large font. Altitude entries may be entered as either flight levels (FL200 or 200) or as pressure altitudes (20000). The wind bearing and wind speed may be entered without the altitude when the altitude already exists. In such a case, wind bearing and speed may be entered either with or without a leading slash. Selecting one of the altitude/wind LSKs with CLR in the SP clears the entire entry, and upon insertion will clear all waypoint altitude/wind entries for that altitude.

If the crew has entered and inserted wind data at a given altitude for at least one waypoint, then all waypoints for which no entries have been made at that altitude will have wind data automatically computed for them. This computation is accomplished by using the inserted values to all other waypoints. These wind values are displayed in small font.

VERT REV Page 2/2

VERT REV AT MOSSI 2 / 2 →		
	ALT / TEMP	
1L	FL250/-20°	1R
2L	ALT / WIND	2R
	FL200/090/050	
3L	[] [] °/[]	3R
		PREV>
4L	[]/[] °/[]	4R
		NEXT>
5L	[]/[] °/[]	5R
6L	INSERT	6R
	RETURN TO	
	SEC F-PLN>	

LB1-3-0113

The ALT/TEMP field in 1R allows the pilot to enter a specific altitude with a known temperature (in degrees C). Both the altitude and temperature are required for entry, but edits may be made to either field once they are both entered.

If TRIP WIND has been entered on the F-PLN INIT page and there are no entries in 2L, 3L, 4L, and 5L, then TRIP WIND is displayed in field 2R.

VERT REV page 1 is a flight plan modification page and can be accessed from VERT REV page 2 by use of the PAGE key.

Winds are always referenced to true north. Unless pilot entered, origin winds default to HD/000 kts and destination winds default to 0 kts.

The INSERT prompt is displayed in 6L whenever an altitude/wind entry or edit is performed. The data entered or edited on this page has no effect on the system until the INSERT prompt is pushed. If the page is exited without pushing INSERT, then the entered or edited data is not retained.

The PREV> prompt is displayed in 3R. Selecting LSK 3R will slew back to the previous waypoint. Should the VERT REV page 2 correspond to the active waypoint the PREV> prompt will not be displayed.

The NEXT> prompt is displayed in 4R. Selecting LSK 4R will slew to the next waypoint with the exception of the destination. Should a next waypoint be the destination the NEXT> prompt will not be displayed.

The RETURN TO ACT F-PLN page prompt is displayed in 6R.

The SEC VERT REV page 2 functions the same for the secondary flight plan as the VERT REV page 2 does for the primary flight plan, except there is no asterisk by the INSERT prompt.

NAV RADIO Page

NAV RADIO

1L

2L

3L

4L

5L

6L

SLI/CRS
115.70/234*

* VOR ARM
ADF1/FREQ
EMT/359.0
ILAX/CRS
113.6 /049*

* LOC ONLY

PRESELECT

1R

2R

3R

4R

5R

6R

115.70/CRS
SLI/234*

VOR ARM *
ADF2/FREQ
[]/[]

[]/[]

LB1-3-0114

The NAV RADIO page provides tuning status display and tuning control capability for the VOR, ADF, ILS, and MLS receivers. It also provides for selection of the VOR and LOC modes.

The ident, frequency, and course of VOR1 and VOR2 selected for display are shown in 1L and 1R, respectively. The VOR ident (or frequency) is always followed by /CRS in the label line. The course may not be entered until a VOR ident (or frequency) has been defined, but an ident (or frequency) may be entered without a course. If an ident is entered, the frequency corresponding to that ident is displayed in the label line in small font. The data line displays the ident and course value (if any) in large font. If an entered ident is not found in the database, the message NOT IN DATA BASE is displayed in the SP. If more than one ident exists for the entered ident, the DUPLICATE NAMES page is displayed and the flight crew will select the desired ident.

NOTE: Once a radio has been manually tuned, it will not auto tune again until that radio frequency is cleared.

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NAV RADIO Page

NAV RADIO			
1L	SLI/CRS 115.70/234*	115.78/CRS SLI/234*	1R
2L	* VOR ARM	VOR ARM *	2R
3L	EMT 359.0	EMT 359.0	3R
4L	ILS/CRS []/[]*	525 IPLT	4R
5L		GPA/CRS 3.0/020*	5R
6L	IOSS/030	PRESELECT []/[]	6R

LB1-3-0115

When a frequency is entered into either of the VOR fields, the label line displays the ident in small font and the data line displays the entered frequency and course in large font. If, upon an entered frequency, there is no available ident in the database, the label remains VOR#/CRS with the frequency and course in large font on the data line. If more than one ident exists for the entered frequency, the ident closest to the aircraft is chosen from the database. If the VOR is autotuned, the ident is displayed on the label line in small font and the frequency is displayed on the data line, also in small font.

A small font VOR ARM prompt with an asterisk is provided upon entry of a VOR ident (or frequency) and course. The prompt appears in 2 on the same side of the MCDU page as the entered VOR information. If the VOR information is entered on both sides of the MCDU, then the prompt appears on both sides of the MCDU. Pushing the VOR ARM prompt prepares the FMC for VOR mode and replaces the VOR ARM prompt with a VOR ARMED display (large font). Once the VOR mode conditions for the armed VOR ident are satisfied, VOR TRACK (large font) replaces the VOR ARMED display. Any of the VOR prompts or displays may be cleared.

FMS VOR approach mode is not available above 18,000 feet. FMS VOR approach mode is explained in the Automatic Flight chapter. FMS VOR approach procedures are described in the MD-11 Flight Crew Operating Manual Operating Procedures.

NAV RADIO Page

NAV RADIO			
1L	VOR1/CRS []/[] *	VOR2/CRS []/[] *	1R
2L			2R
3L	ADF1/FREQ []/[]	ADF2/FREQ []/[]	3R
4L	ILS/CRS []/[] *		4R
5L		PRESELECT	5R
6L	[]/[]	[]/[]	6R

LB1-3-0116

The ident or frequency for ADF1 and ADF2 are flight crew-enterable in 3L and 3R, respectively. Either the ident, or the frequency may be entered, but not both. If the frequency is entered the ident is extracted from the NAV database and displayed in the label line. If the ident is entered the frequency is extracted from the NAV database. If both the ident and the frequency are entered, they must match an ident/frequency pair in the NAV database and displayed in the label line. If an ident is entered and it does not exist in the NAV database, the message NOT IN DATA BASE is displayed in the SP.

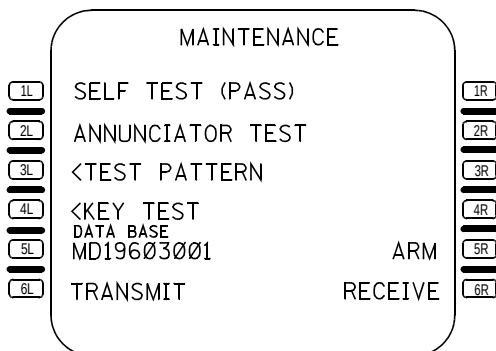
The ILS ident (or frequency) and course are flight crew-enterable in 4L. If the ident is entered, the frequency is displayed in small font on the label line and the ident is displayed in large font on the data line. If the frequency is entered, the ident is displayed in small font on the label line and the frequency is displayed in large font on the data line. In either case, the MLS field clears to brackets (if not already). The course field represents the runway heading derived from the runway database (displayed in small font), but may be entered by the flight crew (displayed in large font). If the ILS is autotuned, the ident is displayed on the label line in small font and the frequency and course (if available) is displayed on the data line in small font.

Once an ILS course is entered or derived from the runway database, the LOC ONLY prompt is displayed in small font in 5L with a leading asterisk. If LSK 5L is pushed, LOC ONLY is displayed in large font without the asterisk.

FMS LOC ONLY approach mode is explained in the Automatic Flight chapter. FMS LOC ONLY approach procedures are described in the MD-11- Flight Crew Operating Manual Operating Procedures.

System Monitoring Pages

MAINTENANCE Page


LB1-3-0117

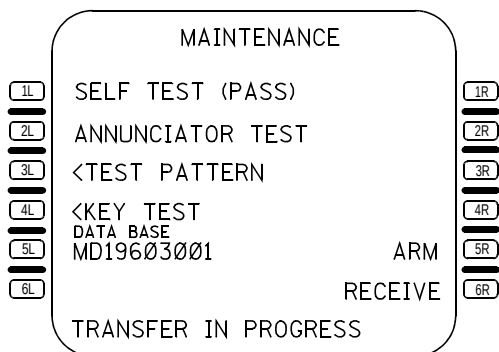
The MAINTENANCE page allows FMS test functions to be performed. This page is only available during preflight or after completion of a flight plan, and cannot be displayed in the takeoff, climb, cruise descent or approach phases of flight. This page is accessed by pushing the REF mode key, then when REF INDEX is displayed, by pushing LSK 5R.

After the MAINTENANCE page is displayed, the following tests may be accomplished as detailed below:

- **SELF TEST.** Push LSK 1L. If it passes the test, (PASS) is displayed beside the LEFT-TEST legend. If it fails the test, the MENU page is displayed and the FMC prompt does not appear.
- **ANNUNCIATOR TEST.** Push LSK 2L. This illuminates all three annunciators on the MCDU (DSPY, MSG, and OFST) located on the sides of the MCDU. The annunciators are extinguished in approximately 10 seconds.
- **TEST PATTERN.** Push LSK 3L. This brings up a special page which displays all MCDU characters and symbols, and includes a RETURN prompt for returning to the MAINTENANCE page.
- **KEY TEST.** Push LSK 4L. This brings up a succession of pages containing specific key push instructions. Passing each test sequences to the next key test until the down arrow, whose correct operation returns back to the MAINTENANCE page.

The identifier for the currently loaded navigation data base is displayed in large font in location 5L, and is not editable.

MAINTENANCE Page



LB1-3-0118

A navigation data base crossload may be armed by entering ARM into the brackets of 5R. Once ARM is displayed, the user may select either the transmit designation or the receive designation, thus arming the FMC to transmit or receive a data base. If the user arms the FMC to transmit the crossload, the receive designation is cleared. Alternatively, if the user arms the FMC to receive the crossload the transmit designation is cleared.

Prior to selection of the transmit or receive designations, or following the transmit designation, the ARM display may be cleared back to brackets with the CLR key.

To enable the crossload function, the transmitting FMC must be armed before the receiving FMC is armed. Once the receiving FMC is armed, the crossload begins and TRANSFER IN PROGRESS is displayed in the SP. Once completed, TRANSFER COMPLETE is displayed in the SP, the transmit and receive designations are displayed, and 5R once again displays brackets. While the crossload is in progress the MCDU is nonfunctional. If for any reason the crossload is interrupted, the transmitting MCDU displays TRANSFER ABORTED in the SP. The receiving MCDU becomes inoperative and displays NAV DATABASE LOAD INCOMPLETE in the center of a blank page. A portable data base loader is then required to complete the load.

If the FMC is armed to receive a crossload before the transmitting FMC is armed, the crossload function is not performed, and TRANSFER ABORTED is displayed in the SP.

Exit from the MAINTENANCE page is by mode key, or automatically.

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POS REF Page

POS REF		1/3 →
1L	FMC LAT/LONG (G/I) N4038.1/W07346.0	1R
2L	IRS (MIX) H4038.0/ 07345.8	2R
3L		3R
4L	RNP/ACTUAL 2.00/0.05NM	4R
5L		5R
6L		6R

GNS NAV
INHIBIT*
RETURN TO
PERF MODE>

LB1-3-0119

This page is accessed from the F-PLN INIT or REF INDEX page. It provides IRS average comparative position data, FMC position and the RNP and ANP values and allows manual updating of the FMC position.

The current FMC-calculated position is displayed in line 1. Pushing LSK 1L with the SP empty freezes the LAT/LONG display (but not the position filters); pushing it again unfreezes the display. An entry may be made into 1L (with a waypoint, navaid, PBD or lat/long entry) at any time. Upon entry the field will be considered frozen and the UPDATE* prompt will be displayed in 1R. Pushing the update prompt will re-initialize the position filters and cause the updated filter values to be displayed (unfrozen). Clearing the UPDATE* prompt displays again the current FMC-calculated position (unfrozen) in 1L.

The POS REF page is exited by use of a mode key or the return prompt in 6R. The return prompt in 6R will return the page to either the F-PLN INIT page or the REF INDEX page, whichever page the IRS STATUS page was accessed from.

CHECK POSITION will appear on the ND when either of the following MCDU scratch pad messages appear.

- FMC POSITION MISMATCH appears. The pilot should go to the POS REF page 1/3 and compare FMC position on both FMCs. The message appears when the two FMC positions differ by more than 5 NM or double the RNP distance in nautical miles (NM). The message goes away if the positions are less than 3 NM or double the RNP distance in nautical miles (NM), respectively. After comparing, use the FMC considered to be the most accurate. The above is generally a result of poor radio DME position computation.
- VERIFY AIRCRAFT POSITION appears if a single FMC radio position varies from the IRS's. Usually it shows on only one MCDU. Check the IRS status page on that MCDU. If the condition persists it is advisable to use the other FMC as primary for navigation. It is possible to have this message on both MCDUs if a single IRS has drifted more than 12 NM. Comparison of both IRS status pages should confirm this. Again, use the FMC considered to be the most accurate.

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IRS POS or IRS/GNS POS Pages

IRS/GNS POS
2/3 →

IRU 1 NAV

IRU 2 NAV

IRU 3 ALIGN

GNS 1 ACQUIRE

GNS 2 NAV

N4038.1/W07346.0

N4038.0/W07345.8

-----/-----

N4038.1/W07346.8

000°/00

000°/00

2 MIN

3 SV

5 SV

REF
INDEX >

1L

2L

3L

4L

5L

6L

1R

2R

3R

4R

5R

6R

LB1-3-0120A

Lines 1 through 3 indicate the position of the three IRUs being used to calculate the FMC position, along with relative bearing and distance (from the FMC-calculated position to each IRU position) once the IRU is aligned. The label lines in lines 1 through 3 display the status (NAV or ALIGN) of the respective IRU. The time remaining before alignment is also displayed when the IRU is in the ALIGN mode. The data lines will display the lat/long position of each IRU when in the NAV mode and dashes when in the ALIGN mode.

Lines 4 and 5 indicate the position of the two GNSSUs being used to calculate the FMC position, along with the relative bearing and distance (from the FMC-calculated position to each GNSSU position) once the GNSSU is in the NAV mode. The label lines in 4 and 5 display the status (NAV or ACQUIRE) of the respective GNSSU. The satellite vehicles (SV) tracked are displayed at all times for the GNSSUs.

IRS STATUS Page

IRS STATUS			3/3 →
	DRIFT RATE	GS	
1L IRU1	Ø	Ø	1R
2L IRU2	Ø	Ø	2R
3L IRU3	Ø	Ø	3R
4L			4R
STATUS CODE			
5L IRU1	ØØ		5R
IRU2	ØØ		
IRU3	ØØ	RETURN TO	
		F-PLN INIT>	6R

LB1-3-0121

Residual ground speed and drift rates are displayed for each IRU in lines 1 through 3 for post-flight inspection. The status code for each IRU is displayed in the lower left-hand corner. The status code will be set to equal 00 when codes 01 through 10 are not applicable.

DOCUMENTARY DATA Page

DOCUMENTARY DATA		
1L	TIME (CLOCK)	1R
2L	1008.7	2R
3L	DAY/MONTH (CLOCK)	3R
4L	15/02	4R
5L	DOC DATA	5R
6L	542607	6R

LB1-3-0122

The DOCUMENTARY DATA page is used to transmit an octal code via the ARINC bus to the Digital Flight Data Acquisition Unit (DFDAU) and Digital Flight Data Recorder (DFDR).

NOTE: Requires compatible DFDAU and DFDR.

The FMC will use the time/date from the GNS and not the aircraft clock and (CLOCK) is replaced by (GNS). If the GNS is disabled then the FMC will revert to the aircraft clock time/date and the display reverts back to (CLOCK).

ACARS Page

ACARS		
1L	ROUTE REQ	CO RTE KSANKPHX01
2L	T/O DATA REQ	RWY 22R>
3L	POS REPORT SEND	F-PLN/FL SEC/290
4L	WIND PLAN REQ	STATUS
5L	WIND CHG REQ	READY
6L		

LB1-3-0123

The ACARS page enables the flight crew to manage FMS-related data transfers over the ACARS VHF air-ground communications link, if ACARS is installed. The flight crew may initiate requests for data (via downlink), review requested or unrequested data (via uplink), and insert reviewed route and takeoff data into the FMS.

The FMS ACARS pages consist of the ACARS menu page, where requests are initiated; the ACARS ROUTE page, where route data is reviewed before inserting, and up to four ACARS T/O pages, where takeoff data is reviewed before inserting.

The ACARS menu page provides for flight crew-initiation of four types of requests and a position report, and displays the current status of the FMS-ACARS interface.

The format of the ACARS page is as follows:

- Line 1L Route Request.
- Line 2L T/O Data Request.
- Line 3L Position Report.
- Line 4L Wind Plan Request.
- Line 5L Wind Change Request.

Line 6R displays status of FMS-ACARS interface. If the indication is BUSY, the flight crew should not make further requests until the indication returns to READY.

Line 1R CO RTE is where a 10 character company route is specified (entered) by the flight crew.

Line 1L ROUTE REQ is pushed to initiate the route request (downlink), after the company route is entered into line 1R.

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Following receipt of the requested data, the label line for 1R changes from CO RTE to REVIEW and a page select prompt appears next to line 1R. If unrequested route data is received, the unrequested company route identifier is displayed next to line 1R. Whether requested or not, the route data may be reviewed on the ACARS ROUTE page via line 1R.

NOTE: ACARS ROUTE DATA is displayed in the scratchpad when uplinked ACARS route data is received.

Line 2R RWY, on the ACARS MENU page, is where the intended departure runway is entered.

Line 2L T/O DATA REQ, is pushed to initiate the T/O data request (downlink), after the intended runway is entered by the flight crew.

Upon receipt of the takeoff data, the label line for 2R changes from RWY to REVIEW, and a page select prompt appears next to line 2R. Pushing 2R then selects the ACARS TAKEOFF PAGE. If unrequested takeoff data is received, the first runway identifier is displayed on line 2R by default. Up to four runways, either requested or unrequested for the takeoff data, can be received by the FMS until the throttles are set for takeoff thrust.

NOTE: ACARS TAKEOFF DATA is displayed in the scratchpad when uplinked ACARS takeoff data is received.

Line 3L POS REPORT SEND, initiates the transmission of current LAT/LONG position, time, altitude, temperature, wind (bearing and speed), and up to 22 characters of free text from the scratchpad.

NOTE: Unsolicited uplinks may be requested at any time. Downlinks may be manual or automatic if an uplink is received. When a position report is downlinked, SEND will be displayed next to POS REPORT.

Line 4L WIND PLAN REQ, allows the flight crew to obtain a printout of wind data at a single flight level for waypoints ahead. When received, the requested wind plan data is directed to the cockpit printer and is not displayed or used by the FMS.

Line 5L WIND CHG REQ, allows the flight crew to update wind data for FMS flight plan predictions. When received either requested or unrequested, the wind change data is inserted into the specified FMS flight plan at the appropriate waypoints.

Descent wind information, as an option, may be included in the wind change data. Descent wind information is inserted into the DES FORECAST page of the FMS, for the specified flight plan.

Line 4R F-PLN/FL specifies the flight plan (active or secondary) and the flight level to be used in the WIND CHG REQ or the WIND PLAN REQ.

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ACARS ROUTE Page

ACARS ROUTE				
1L	KSANKPHX01		1056	1R
2L	IF KSA	BRDR3	JLT	2R
	DIR D031J	J11	SRP	
3L	J92 BABIT	DIR	ALFA	3R
	DIR TOTEC	TOTC4	FOWLE	
4L	VOR08 RW08			4R
5L				5R
6L	INSERT		RETURN TO ACARS>	6R

LB1-3-0124

Line 1L displays the company route identifier. Line 1R displays the flight number. Below lines 1L and 1R, the most recently received route data (read from left to right) is shown. A longer route will generate additional pages.

Line 6L displays DUPLICATE NAMES when several waypoints, nav aids or airport runways have the same identifier in the ACARS flight plan and cannot be resolved automatically. When all duplicate names have been resolved, the DUPLICATE NAMES prompt is replaced by INSERT.

Line 6L INSERT, inserts the ACARS route and any optional performance data into the secondary flight plan and inserts the flight number into the F-PLN INIT page. If performance factor is present in the ACARS data, it is also inserted in the secondary flight plans. After inserting, the page display returns to ACARS MENU. Access to the ACARS ROUTE page is not allowed following insertion, until new route data is received.

If the uplinked data contains a non-precision approach, an MDA entry is required in 5R before the insert prompt is displayed in 6L. The MDA can only be edited before the insert prompt is pushed. After the route is inserted the MDA will not be displayed on the ROUTE REVIEW page. Editing the MDA can be accomplished on a secondary STAR page after the route has been inserted.

Line 6R RETURN TO ACARS, is used to return to the ACARS MENU page without inserting the data. The route data remains available for later review until replaced by newly received route data.

NOTES: The DUPLICATE NAMES page lists all the waypoints with duplicate names and each lat/long. Pushing an LSK next to the waypoint enters the waypoint and returns to the ACARS ROUTE review page.

To insert route data into the active flight plan, the ACTIVATE SECONDARY prompt must be selected on the secondary flight plan INIT page.

ACARS T/O Page

ACARS T/O RW22R 1/4→

1L 2L 3L 4L 5L 6L FLEX 43° FLAPS 20.0 V1 168 VR 174 V2 182 *INSERT	TAXI	BLOCK 144.8 TOGW 572.0 ZFW 427.2 TOCG 20.0 ZFWCG 22.0 RETURN TO ACARS> 1R 2R 3R 4R 5R 6R

LB1-3-0125

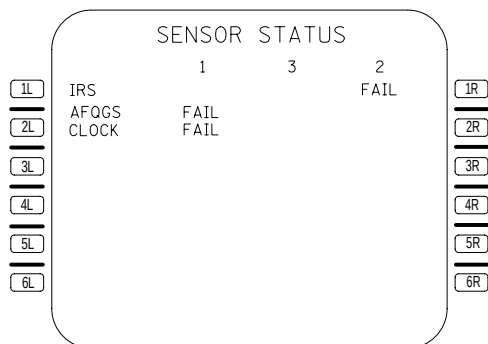
Each ACARS T/O page displays ACARS (uplinked) takeoff data in large font. ACARS takeoff data may not be edited while displayed on the ACARS T/O page, except that FLEX temperature can be cleared. FLEX temperature and FLEX Vspds are optional uplinked (ACARS) takeoff data. Therefore, if this optional data is present in the uplinked message, then it will be displayed first. Clearing the displayed FLEX temperature in LSK 1L will also clear the FLEX Vspds and allow Max Vspds to be displayed for pilot review. After engine start, BLOCK and TAXI fields are removed. Takeoff data for up to four runways may be reviewed on separate pages via the PAGE key. Data fields corresponding to parameters which are not included in an uplink will be dashed.

The FMS Vspeeds will not appear on the FMS T/O page until inserted on the ACARS T/O page. Also, once inserted with the *INSERT prompt, the ACARS Vspeeds will not be invalidated or checked for a change in conditions automatically.

Line 6L *INSERT is displayed when the runway in the page title is the same as the runway in the active flight plan. The flight crew may then insert the ACARS data into the FMS. After inserting, the page display returns to the ACARS menu page. If the runway in the page title is not the same as in the active flight plan, *INSERT is not displayed and ACARS RWY NOT IN F-PLN is displayed in SP. Line 6R RETURN TO ACARS, is used to return to ACARS menu page without inserting data.

NOTE: Dashed fields indicate values for which the FMS has no data.

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SENSOR STATUS Page


LB1-3-0126

The SENSOR STATUS page displays information on the present status of the sensors which provide data to the FMC. Only failed sensors are displayed on this page. This page is accessed by pushing LSK 6L on the REF INDEX page.

Up to 11 lines may be used to display failed sensors. The failures are appropriately displayed under these columns:

- 1 = left side of the aircraft.
- 2 = right side of the aircraft.
- 3 = center of the aircraft.

Where only one sensor is fitted to the aircraft, failures are indicated in column 1.

When operating mode is independent, the RESET FMC prompt is displayed in 6R. Pushing LSK 6R initiates a resync operation.

NOTE: AFQGS FAIL will appear while the fuel quantity system is being tested.

FUEL DIPSTICK Page

FUEL DIPSTICK

	DENSITY	TOTAL FQ KG	TOTAL FQ	
1L	[]		---	1R
	STK/INCH	TNK1	STK/INCH	
2L	[]/[]	--,-	7/[]	2R
	STK/INCH	TNK3	STK/INCH	
3L	[]/[]	--,-	7/[]	3R
	STK/INCH	AUX	STK/INCH	
4L	8/[]	--,-	9/[]	4R
	STK/INCH	TNK2		
5L	[]/[]	--,-		5R
	STK/INCH	TAIL		
6L	[]/[]	--,-		6R

LB1-3-0127

Accessed from the FUEL INIT page, if installed, this page provides the flight crew with an alternate means of viewing the total fuel quantity of the aircraft as well as the fuel quantity of each separate tank. This page may be exited by pushing a mode key.

Line 1L DENSITY, displays brackets until a manual entry is made. The entries into this field are displayed in large font and may be cleared by the flight crew. The units for this field are determined according to the entered value and are displayed in small font to the right of the entry.

Line 2L STK/INCH entry, requires also the STK/INCH entry in 2R for determining the fuel quantity in tank 1. The acceptable stick entries for 2L are 4, 5 and 6. Line 2R stick entry is defaulted to 7, since an inch entry for stick 7 is necessary in determining the fuel quantity in tank 1. Each stick and inch measurement is displayed in large font and may be entered as pair, stick/inch, or individually (stick or /inch). The tank 1 fuel quantity calculation is displayed in small font. Clearing either or both of the STK/INCH fields causes the tank 1 field to go dashed and STK/INCH field(s) to display brackets with the STK field in 2R remaining at 7.

Line 3L, line 3R STK/INCH entries for tank 3 and the tank 3 field work the same as the tank 1 field and STK/INCH entries for tank 1.

NOTES: The IRUs must be aligned before data can be entered onto this page.

Data entry is not allowed when engines are started (NOT ALLOWED appears in SP).

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FUEL DIPSTICK Page

FUEL DIPSTICK					
	DENSITY		TOTAL FQ		
1L	6.720 LB/US GAL		236.0	1R	
	STK/INCH	TNK1	STK/INCH		
2L	5/11.4	34.0	7/10.1	2R	
	STK/INCH	TNK3	STK/INCH		
3L	6/8.2	47.0	7/11.4	3R	
	STK/INCH	AUX	STK/INCH		
4L	8/70.3	42.9	9/16.1	4R	
	STK/INCH	TNK2	FAUX1/IN		
5L	2/20.6	19.2	12/	5R	
	STK/INCH	TAIL	FAUX2/IN		
6L	11/12.0	92.9	13/	6R	

LB1-3-0128

Line 4L, line 4R STK/INCH entries for AUX tank and the AUX field work the same as for tanks 1 and 3 above, except that default stick is location 8. The AUX field value will be the total of all AUX tanks entered.

Line 5L tank 2, line 6L tail tank, only require one STK/INCH entry each. The acceptable stick entries for tank 2 are 1, 2 and 3. The acceptable stick entries for the tail tank are 10 and 11.

Line 1R TOTAL FQ, displays the total fuel quantity of all fuel tank calculations.

The ATTITUDE OUT OF RANGE message will be displayed in the SP if attitude of the aircraft is outside the range of 0-2 degrees pitch or +/- 1 degree roll.

Line 4R, STK/INCH. Default stick location is 9. The inch reading is from location 9 of the AUX tank.

Lines 5R and 6R are blank.

Degraded Performance

Dual and Independent Operation

The FMS is operable when electrical power is applied to the aircraft. Power-up tests are performed after any reset (restart of processing) due to either a long term or short term power transient, or due to hardware or software problems.

Pilot-entered data is retained during power transients through battery powered memory. However, if an FMC detects the same software problem four times within five minutes, and the FMS flight phase is not descent or approach, then all pilot-entered data will be automatically cleared during a long term reset. This automatic reset is generated to prevent the FMC from latching fail. A latch failure is a complete halt of processing, recoverable only by cycling the circuit breaker.

The FMS supports DUAL, INDEPENDENT, and STANDBY operation modes. One MCDU must be available to operate any FMS mode. Dual mode is the normal mode of the FMS. In DUAL mode the two FMCs communicate with each other (crosstalk) and is operable in any FMS transfer switch configuration selected on the source input select panel (SISP). When CAPT ON 2 or F/O ON 1 is selected, the Captain or F/O MCDU will display the MENU page. If FMC2 or FMC1 is available, the <FMC-2 or <FMC-1 prompt is shown in line 1L of the MENU page for pilot selection.

DUAL mode operation involves both FMCs operating together with one acting as master and the other as spare. Following a long term power transient, the first FMC up is designated the master and begins crosstalk communication with the spare by comparing databases, operational programs, and aircraft configuration data (aero model, engine type) as displayed on the A/C STATUS page. If this data is identical, the master FMC will begin memory synchronization (including pilot-entered data) of the spare. Upon completion of memory synchronization, DUAL mode will be established.

If a single FMC generates an automatic reset in DUAL mode operation, then it will be resynchronized by the master FMC. However, if both FMCs generate an automatic reset at the same time, then the pilot must reenter data (GW, ZFWCG, F-PLN, radio tuning). The MCDU STANDBY flight plan and radio tuning will also be cleared. The pilot will be prompted to reenter data by SP messages displayed on the MCDU.

An FMC change could cause the FMS to operate in INDEPENDENT mode (no crosstalk) if the data in each installed FMC is not the same. Any discrepancy on the A/C STATUS page generates the MCDU message A/C STATUS MISMATCH.

After DUAL mode is established, both FCCs will select only one FMC to be the FMC on the same side as the FCC in control. This FMC will then become the master. This selection process ensures that both Flight Directors (FD) will be controlled with the same steering commands.

If the onside FCC fails, all FMS modes will disengage on the onside FMS. If the offside FCC fails, there should be no effect. All FMS modes should be available. To correct the loss of FMS modes the pilot should push the AUTOFLIGHT button on the FCP and then reselect FMS modes.

In DUAL mode operation, aircraft present position, gross weight, and active thrust limit is computed independently by each FMC. Individually computed data is compared and any significant errors are annunciated with an MCDU message as follows:

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- FMC POSITION MISMATCH - Present position differs by more than 5 NM or double the RNP distance in NMs. Automatically canceled when difference is less than 3 NM or double the RNP distance in NMs respectively.
- GROSS WEIGHT MISMATCH - Gross weight differs by more than 6,818 kgs. Automatically canceled when difference is less than 2,272 kgs.
- THRUST LIMITS MISMATCH - Active thrust differs by more than 1% N1. Automatically canceled when the difference is less.

NOTE: In some dynamic conditions, vertical and lateral computations may temporarily disagree and may be evident on the ND. In this case, the flight director and autoflight system will use the respective FMC and autopilot for tracking.

While synchronization of data is in progress, the MCDU message PLEASE WAIT is displayed. The same message is displayed for a power interrupt longer than 4 seconds. In this case, the FMC in question will become the spare and resync itself to the master while establishing DUAL mode operation. While the PLEASE WAIT message is displayed, MCDU key inputs from either MCDU will not be accepted for processing. The message is automatically cleared when re-synchronization is attained.

When crosstalk or re-synchronization is attempted and fails, each FMC will revert to a completely INDEPENDENT mode of operation without crosstalk. The message INDEPENDENT OPERATION is displayed in the MCDU scratchpad until it is cleared or the FMS reestablishes DUAL mode. If an FMC generates an automatic reset in INDEPENDENT operation, then the pilot can reenter data (GW, ZFWCG, F-PLN, radio tuning) or select the offside FMC via the FMS transfer switch on the source input select panel. The pilot can attempt to reestablish DUAL mode by selecting the RESET FMC prompt on the SENSOR STATUS page. If the problem which is causing the FMS to operate independently no longer exists, then the FMS will reestablish DUAL mode operation. However, before selecting a RESET FMC prompt, the pilot must decide which FMC F-PLN to maintain in case they are different. The pilot should select the RESET FMC prompt for the FMC which is to be resynchronized.

NOTE: In the INDEPENDENT mode each FMC may evolve its own flight plan. In this case position errors could be encountered, and will be seen on the EIS ND.

Single Flight Management Computer

The FMS BITE consists of a combination of internal software and hardware monitors within the FMC and MCDU. The BITE can detect and isolate at least 95% of all failures in the FMS. When an error or failure is detected, the FMS will attempt to correct the situation with hardware/software resets. During single FMC operation, if the FMC detects the same software error four times within five minutes, and the FMS flight phase is not descent or approach, then all pilot entered data will be automatically cleared during a long term reset. The pilot must reenter data (GW, ZFWCG, F-PLN, radio tuning). The pilot will be prompted to reenter data by SP messages on the MCDU. This automatic reset is generated to prevent the FMC from latching fail. During descent or approach, if the software error cannot be corrected the FMC will latch fail (completely stop processing) and the MENU page will display without an FMC prompt.

If the master FMC latch fails, it is detected by itself and the slave FMC. The slave FMC will then function as the master FMC as selected by the FCCs.

When an FMC latch fails, the affected pilot may select the other FMC with the SISP FMS transfer switches. During single FMC operation, both NDs will display proper information as long as the same modes (NAV, VOR, APPR, or PLN) and ranges are selected on both ECPs. Both MCDUs will function normally to make inputs to the functional FMC.

If an MCDU failure is detected, the MCDU display is blanked and the FAIL light on the MCDU (lower left) illuminates.

NO FMS SPD/PROF Message

When the NO FMS SPD/PROF message is displayed on the A/C STATUS page, the FMS is operating in a limited mode of operation. All functions involving active performance and vertical guidance will be inoperative (FMS speed, vertical profile, fuel computation, F-PLAN predictions). If one FMC initiates a NO FMS SPD/PROF message, the other FMC will revert to the same limited condition.

This condition can be identified by the following indications: NO FMS SPD/PROF message on the A/C STATUS page, ATS OFF remains amber after engine start, takeoff green band removed from the stabilizer position display and, thrust limit values will become dashed.

This condition is caused by lack of valid performance data loaded in the FMC.

Degraded Navigation

General

Due to inherent drift rates in the IRUs or noisy radio inputs, there are times when the IRS position and the FMC computed radio position are different. This condition may indicate faulty IRUs or radio inputs to FMC position computation. When the radio position is different from the IRS position by more than 12 NM, the following will occur automatically:

- If possible, different radios are selected and tuned and the new radio position is compared to the IRS. If the difference is less than 12 NM no further corrective action will occur.
- If the position difference remains 12 NM or more, the MCDU message VERIFY A/C POSITION is displayed.

The pilot must now resolve the discrepancy between the two positions. If it is not possible to select different nav aids and resolve the discrepancy, the position update mode changes from radio/inertial to inertial. The VERIFY A/C POSITION MCDU message is automatically cleared if the difference between IRS and mean radio position falls below 8 NM. The pilot may also clear the message.

IRS Degraded

Inertial position is normally computed in the FMC at a 5-per-second rate by combining three independent IRU positions. Each IRU position is normally compared to the previous position and after passing the comparison test is combined into the new inertial position using a weighted average. For the comparison test, errors more than 36 NM result in a failed test. If any IRU fails the comparison test or is operated in other than NORMAL mode, each FMC will revert to and use a single IRU for position inputs. The IRU failure and usage combinations are as follows:

- If IRU1 fails, FMC1 uses IRU3 and FMC2 uses IRU2.
- If IRU2 fails, FMC1 uses IRU1 and FMC2 uses IRU3.
- If IRU3 fails, FMC1 uses IRU1 and FMC2 uses IRU2.

Inertial groundspeed is also computed in the FMC by a simple average after a comparison test. If the comparison test is failed or any IRU is operated in other than normal mode, the FMC receives a single groundspeed input per the previous table.

NOTE: The SENSOR FAIL MCDU message is displayed for this degraded operation. IRS failures can be found on the SENSOR STATUS PAGE.

When two IRU platforms are operated in other than normal modes the FMCs both use the remaining IRS or position and groundspeed inputs. In the enroute flight phase the message IRS ONLY NAVIGATION is displayed when the position update mode has been inertial only for 10 minutes. The message automatically clears when a radio update is obtained. When in transition to descent or approach, the message is immediately displayed when the FMC goes IRS ONLY NAVIGATION. The loss of all IRU inputs to the FMC will result in RADIO ONLY NAVIGATION being displayed on the MCDU if it can be calculated. This message is automatically cleared when the FMC transitions out of RADIO ONLY mode.

Radio Degraded

Radio navigation is accomplished by either DME/DME or DME/bearing calculations of aircraft position. Position errors of up to .35 NM for DME/DME and a calculated error based once-per-second confidence check is accomplished on new radio data to verify radio position data. Radio deviation outside the allowable range declares the radio position invalid and reverts navigation to inertial, or in its absence, to no navigation. The message IRS ONLY NAVIGATION will be displayed on the MCDU. No navigation is declared two minutes after a radio and inertial position calculation cannot be made. During the two minutes before no navigation is declared, the FMC position on the IRS STATUS page does not change. If no navigation is declared or a radio position is recalculated, an FMC position update is required before FMC position can be established.

CAUTION: No navigation entry into this condition indicates a complete failure to engage in any navigation mode.

While airborne, the aircraft position is considered valid for the first two minutes, and during this time, a resumption of radio data and/or the return of IRU data would cause the engagement of a navigation mode consistent with sensor availability. After two minutes the aircraft position is considered invalid and at least one valid IRU position is required to terminate the no navigation condition. In the no navigation condition, the FMC position on the IRS STATUS page becomes dashed and MCDU scratchpad message A/C POSITION INVALID is displayed.

Standby MCDU Operation

If at any time the crew does not believe its FMC is working, the MCDU can be used for STANDBY operation. When the FMC fails to provide valid page data to the MCDU within 3 seconds of a request, the MCDU will deactivate that FMC and display the MENU page. During the time between failure of an FMC and subsequent recovery of the FMC (or pilot select of standby), the MCDU operates in an INTERIM navigation mode. In this mode the MCDU supplies the last known valid radio frequencies received from the FMC. Guidance data to the FCC is not provided. In the full-up standby mode, the MCDU provides navigation, radio frequencies, and lateral guidance.

During STANDBY navigation, the MCDU provides aircraft position and groundspeed. The STANDBY aircraft position consists of the aircraft lateral position updated by using the present position inputs from the IRU. If INERTIAL ONLY position update is not active, then the aircraft lateral position is not computed. STANDBY groundspeed is the groundspeed input from the IRU.

Radio frequencies that were tuned by the FMC prior to failure will remain tuned until the pilot enters new frequencies into the STANDBY NAV RADIO page. If the MCDU also fails, it will latch a request for the onside radio equipment to receive tuning frequencies from the offside FMC until the onside MCDU becomes operational again.

In STANDBY operation the following data is available to other aircraft systems:

- Aircraft present position.
- Current groundspeed.
- Navaid frequencies (VOR, ADF, ILS) and course (VOR).
- ILS runway heading.
- Distance to active waypoint.
- Time to go (to active waypoint).
- Active waypoint identifiers.
- MAP displays.

MCDU lateral guidance provides horizontal control of the aircraft to the defined lateral flight path. Roll rate and roll magnitude are limited appropriately for aircraft speed. Lateral guidance performs the following tasks:

- Lateral path construction.
- Current path leg sequencing.
- Steering commands to AFS (horizontal only).
- Crosstrack deviation (display by EIS).

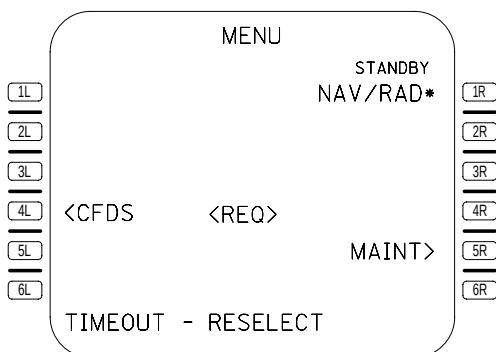
The MCDU pages used for STANDBY operation are as follows:

- STANDBY F-PLAN page displays each leg of the active route, provides position data for each waypoint, computed course, and distance data for connecting legs.

- STANDBY PROGRESS page displays dynamic data for the current flight.
- STANDBY NAV RADIO page provides tuning status and display and control for the onside VOR, ADF, and ILS.

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MENU Page



LB1-3-0129

The MENU page allows access to subsystems that use the MCDU for display. Pushing the MENU key will call up the MENU page. Pushing the LSK next to the subsystem name causes the subsystem menu or top level page to be displayed and activates the subsystem. Upon returning to the MENU page, ACT is displayed next to the active subsystem. If a non-active system makes a request to send a message to the MCDU, the prompt REQ will be displayed as in 4L for CFDS.

If the NAV RAD* prompt is displayed, MCDU STANDBY operation is available at any time. Pushing 1R activates MCDU STANDBY operation and causes the display to change to the STANDBY NAV/RAD page. During normal flight, the MCDU is continually updating the STANDBY NAV/RAD page to reflect the onside FMC radio tuning. Thus, on entering the STANDBY mode, the MCDU is already initialized with the current tuning data. If STANDBY NAV/RAD is selected after the onside FMC has completed an automatic reset, then the pilot must retune the radios. MCDU3 will display F-PLN* in lieu of NAV/RAD* and will display the STANDBY F-PLN page upon selection. If the MENU page is accessed during STANDBY operation, the NAV/RAD* prompt is replaced by an ACTIVE prompt in 1R. The pilot may return to the active subsystem by pushing the LSK adjacent to the active subsystem, or by pushing 6R. When returning to the FMC1 or FMC2, the MCDU display last shown before going to the MENU page reappears. If both FMCs are inoperative and FMC1 and FMC2 become operable, the A/C STATUS page is accessed when returning to normal FMS operation. MCDU3 will provide an EXIT* prompt in line 2R which can be used to deactivate the STANDBY mode on MCDU3. TIMEOUT-RESELECT appears when the MCDU cannot talk with the FMC and is cleared only by the CLR key (or MCDU begins talking with the FMC). If an FMC long term software reset (TIMEOUT) occurs, the onside ND MAP/PLAN modes show MAP FAIL/NO PLAN MODE. The onside MCDU shows the MENU page, TIMEOUT-RESELECT in the SP, and no FMC prompt. The FMCs will try to resynch and the good FMC will display PLEASE WAIT in the SP. Resynch should take no more than 40 seconds. To access VOR, ILS, or ADF, during this time, the pilot must select the STANDBY/NAV RAD* prompt in the MENU page (disables thrust limits and GW data).

STANDBY F-PLN Page

STANDBY F-PLN					
1L	FROM				1R
	T-P				
2L	C287°	236NM			2R
	REMIR	N4757.5	E00638.1		
3L	C170°	19NM			3R
	D099Q	N4739.0	E00642.7		
4L	C099°	48NM			4R
	GOLKE	N4732.0	E00753.4		
5L	C067°	9NM			5R
	EKRON	N4735.6	E00805.8		
6L	C094°	12NM			6R
	CF 14	N4734.9	E00824.1		
↑ ↓					

LB1-3-0130

Pushing the F-PLN key with STANDBY active displays the STANDBY F-PLN page. This page displays each leg of the active route, provides position data for each waypoint and computed true course and distance for the connecting legs. The pilot can make waypoint entries using the left LSKs only. A valid waypoint entry should consist of an identifier followed by a lat/long or a lat/long only. The NAV database is not available. A lat/long entry will be assigned a name such as N51W050. Vertical scrolling is available to review and modify the F-PLN.

During normal flight, the MCDU is continually updating the STANDBY F-PLN to reflect the FMC flight plan. Thus, on entering the STANDBY mode of operation, the MCDU is already initialized with the current F-PLN. Up to 118 waypoints can be stored in the MCDU.

Basic F-PLN functions such as sequencing, waypoint entry/deletion, DISCONTINUITY insertion, DIR TO function, and PPOS/T-P generation are operable.

NOTES: The STANDBY F-PLN should be reviewed, as only waypoints, tracks and distances are maintained in the MCDU. Discontinuities may appear where flight plan data has been lost.

If the STANDBY F-PLN is selected after the onside FMC has completed an automatic reset then the STANDBY F-PLN will be cleared.

STANDBY PROGRESS Page

STANDBY PROGRESS					
1L	FROM	ALT			1R
	T-P	---			
2L	TO	TTG	DTG		2R
	REMIR	0031	228		
3L	NEXT				3R
	D099Q	0033	246		
4L	DEST				4R
	CF 14	0043	316		
5L	PRESENT POSITION		GS		5R
	N4841.3/E01221.5		445 KT		
6L					6R

LB1-3-0131

The STANDBY PROGRESS page is accessed by the PROG key and displays dynamic data for the current flight. Line 1 displays the FROM waypoint identifier and altitude if available. Lines 2 thru 4 display the TO, NEXT, and DESTINATION waypoints along with the distance to go and the time to go to each waypoint. The computed aircraft present position is displayed in 5L, with the current groundspeed displayed in 5R.

NOTE: Entries are not allowed on this page.

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STANDBY NAV RADIO Page

1L	STANDBY NAV RADIO		1R
2L	ERD/CRS		2R
	113.60/ []°		
3L	ADF1		3R
	[]		
4L	ILS / CRS		4R
	[]/[]		
5L			5R
6L		PRESELECT	6R
	[]/[]	[]/[]	

LB1-3-0132

The STANDBY NAV RADIO page allows tuning status display and control capability for the onside VOR, ADF, and ILS. The left MCDU in STANDBY mode of operation will control only the radios as shown.

The pilot can tune the radios manually by entering the frequency (not ident) normally. The ILS runway heading is output to systems that use the data if entered. The capability to preselect navaid frequencies for later use is provided in line 6.

Engine Out Operation

Unconfirmed EO PERF Page

ECON CLB		1/3
1L	ECON	PRED TO
2L	349/.83	FL330
3L	MAX CLB	DIST
4L	* 218	70
5L	EDIT	
6L	[]	
	UTC	
	0034	
	0035 - - - -	
		CLIMB
		FORECAST>
	CONFIRM ENG OUT	CLEAR

LB1-3-0133

The FMS ENGINE OUT mode predicts 1-Engine Out (EO) performance. If the FCC detects an EO or the pilot pushes the ENG OUT key, a *CONFIRM ENG OUT CLEAR* prompt appears for pilot selection. The actual EO or ENG OUT key push is shown on the above modified PERF page. Pushing LSK 6R clears the FMC/FMC EO request. Confirming the EO request (LSK 6L) activates the computations that provide EO maximum altitude and new MAX CLB, MAX END and ECON speed targets. The climb/descent paths and fuel consumption predictions are recomputed and displayed.

If an EO occurs during a standard instrument departure for which an EOSID is provided in the database, the flight plan page will automatically appear with *CONFIRM EOSID CLEAR*. Confirming the EOSID activates the EOSID flight plan. If the database does not have an EOSID or the aircraft has flown past the diversion point, the modified PERF page is displayed. The original SID and flight plan will be flown as EO speeds/altitudes.

The T/O EO speed target is the speed obtained at the time of EO detection (between V2 and V2 + 10) until the EO ACCEL altitude. At the EO ACCEL altitude, the aircraft levels and accelerates to V3 and continues to climb at V3 until reaching the all engine ACCEL altitude. The speed target will then become either the next constraint speed or 250 KTS (whichever occurs first). T/O or G/A thrust limit is maintained for EO operation until the following three conditions are met: V3 or above is obtained, aircraft attains a clean configuration, altitude is above the all engine ACCEL altitude.

After the conditions are met, thrust limit changes to MCT.

If the FCP altitude is set below the all engine ACCEL altitude, the ACCEL altitude will be automatically edited when the FCC transitions to altitude capture. Upon capture the FMS speed target will become VCL. Thrust cutback will not occur until the FCC enters altitude hold and the configuration is clean.

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Confirmed EO PERF Page

ENG OUT CLB 1/3 →		
1L	D/D 246	PRED TO FL330
2L	ECON 296/.78	DIST
3L	MAX CLB * 258	---
4L	EDIT []	---
5L	TRANS 5000	CLIMB FORECAST>
6L	OPT/MAXFL ---/290	THRUST LIMITS>
CRZ FL ABOVE MAX FL		

LB1-3-0134

Confirming the EO condition results in the MCDU display shown above. CRZ FL ABOVE MAX FL in the SP shows that the three engine CRZ FL was FL 330. After confirming the EO condition, the PERF page displays the MAX ENG OUT altitude. Maximum altitude is that altitude maintained with two engines operating at MCT with a 100 fpm climb available. Pilot confirmed EO request results in selecting the MCT limit for the remaining two engines as shown on next page. The selection is thrust limit and not EO required thrust.

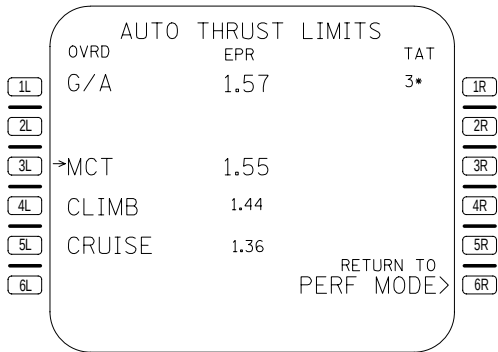
NOTES: For all 2 engine accelerations, climbs, and driftdowns above the 2 eng max altitude (except max descent), operation is at MCT and 2 engine speeds selected from 2 engine flight test data.

The select AUTO prompt will not be available on the THRUST LIMITS page until the EO has been cleared. The thrust limits will remain in MCT until AUTO is selected on the THRUST LIMITS page.

The EO mode cancels time constraints and the DECEL mode.

To reselect a 3 engine state, the pilot must again push the ENG OUT key to display the CONFIRM ENG OUT CLEAR prompts. Selecting CLEAR will cause the ENG OUT function to deactivate (performance predictions revert to 3 engine).

EO AUTO THRUST LIMITS Page



LB1-3-0135

The EO mode cancels time constraints and the DECEL mode. To reselect a three engine state, the pilot must again push the ENG OUT key with the CONFIRM ENG OUT CLEAR prompt. Selecting CLEAR will cause the ENG OUT function to deactivate and performance prediction to revert to the three engine state.

NOTE: For all two engine accelerations, climbs and descents above two engine maximum altitude (except max descent), operation is accomplished at maximum continuous thrust and two engine speeds selected from two engine flight test data.

The thrust limits will revert to AUTO MCT upon engine out detection. The thrust limits will automatically revert from MCT to another thrust mode when the engine out condition no longer exists.

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Engine Out Driftdown

D/D		ENG OUT DES		PRED TO	
1L	D/D 250				FL310
2L	ECON .770/260	UTC 2300			DIST 148
3L	MAX DES *355		2242	4	
4L					
5L					
6L	TRANS 18000				
				DESCENT FORECAST>	
				THRUST LIMITS>	

LB1-3-0136

When the aircraft is flying above the max EO altitude and an EO occurs, the condition must be manually confirmed. When the FCP altitude is lowered and the aircraft has slowed to the driftdown (DD) speed, the aircraft enters a DD.

If an EO occurs in climb above the 2 engine maximum altitude, the aircraft will continue to climb with a speed target of DD and MCT power. When the aircraft can no longer climb at the DD speed a level off will occur. The aircraft will remain in level flight until the DD speed is reached and the FCP altitude is lowered. At this time a DD to the FCP altitude will occur.

When an EO in cruise occurs and pilot has confirmed the engine out, the current speed target will remain the active target. The thrust limit will transition to MCT, however, the engaged mode will remain in altitude hold/speed. When the speed target can no longer be maintained in altitude hold/speed, the mode will transition to alt hold/max thrust and the speed target will become the DD speed. The aircraft will remain in level flight until the DD speed is reached and the FCP altitude is dialed down.

When the FCP altitude is lowered, the FMC transitions to DD EO descent (D/D ENG OUT DES page on the MCDU). The cruise flight level is cleared on the INIT page and the aircraft will descend to the FCP altitude. DD speed is displayed adjacent to 1L on the D/D ENG OUT DES page as well as the speed targets on the PFD speed tape and FMA. When the aircraft V/S is greater than -100 fpm for 60 seconds, the FMS enters a V/S mode and will descend at -100 fpm. The pilot can edit this via the FCP and then reengage PROF mode.

If the FCP clearance altitude is below the 2 eng max altitude, the aircraft will continue the descent to that altitude. To transition from descent to cruise, it will be necessary to enter a cruise flight level on the INIT page. Once the cruise flight level is entered, the FMC calculates a new EO econ cruise speed. Thrust limits remain in manual MCT. Once below the 2 engine max altitude the V/S will increase to -750 fpm. The FMS speed target will remain at the DD speed until one of the following occurs:

- Aircraft achieves cruise level operation.
- Aircraft captures the descent path.
- Pilot performs any speed edit.

If an EO is detected above the 2 engine max altitude while the aircraft is already in descent, the thrust limit will again go to MCT, but the aircraft will be flown with idle-thrust down to the FCP altitude. The aircraft will maintain the current speed target which was active at EO engagement. This yields a 3 engine speed/profile and does not result in any undue pitch changes. When the aircraft reaches the 2 engine maximum altitude, it will then start flying with reference to the 2 engine descent path, or a 2 engine cruise depending upon pilot selected cruise flight level entered on the INIT page.

WARNING: If current speed is less than DD speed, the FMS will enter a DD mode but the aircraft will not descend until the FCP altitude knob is dialed down. DD mode is a speed on pitch mode with throttles at MCT. The aircraft will fly level in FMS PROF and speed until the FCP altitude window is lowered regardless of speed. The aircraft will not depart the clearance altitude with FMS modes engaged. If the FCP altitude is not dialed down and speed decays to VMIN, FMS PROF and SPD will drop out. If speed decays to VMIN -10, AFS speed protection will engage and the aircraft will depart the clearance altitude in order to maintain VMIN.

NOTE: EO confirmation does not clear previously selected edit or max speeds.

Supplemental Data

Polar Navigation

Polar Navigation Polar regions are north of 73 degrees north latitude or south of 60.5 degrees south latitude. In these polar regions the following occurs:

- IRU enters a true heading mode.
- PFD displays TRU in cyan.
- ND MAP displays TRU in white.

Flying south through 72.5 degrees north latitude, or flying north through 59.5 degrees south latitude, causes the IRU heading to display normally. In this region radio navigation may not be available and the FMS will enter the IRS ONLY NAVIGATION mode.

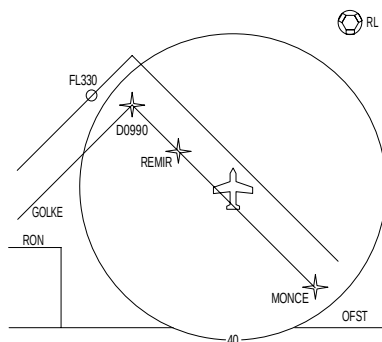
Above 85 degrees north or south latitude, the FMS transitions to a calculated FMS true track mode. In this case, a magenta FMS TRACK will replace HDG on the ND.



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The FMS enters a wings level mode during polar transitions (2 NMs before the pole, up to 10 NMs after the pole).

Parallel Offset NAV



LB1-3-0137

The parallel offset function enables the aircraft to fly parallel to the original flight plan, laterally offset by a pilot entered distance. This F-PLN alteration can be done by performing a LAT REV at the FROM waypoint and entering the offset distance measured in NMs into the OFFSET brackets of line 5L of the LAT REV page. Refer to FCOM Operating Procedures for detailed procedures.

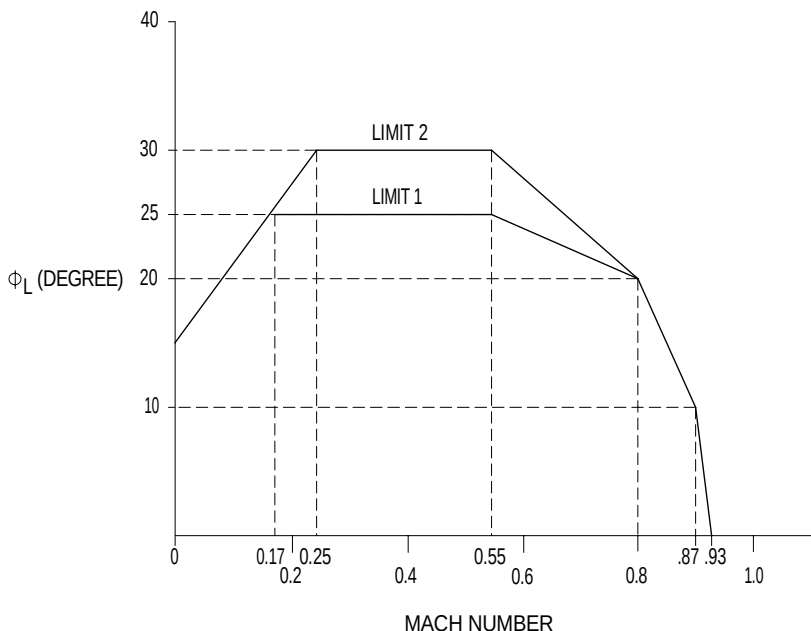
The parallel offset entry accepted by the FMC becomes active immediately after the offset distance is entered and the aircraft turns to intercept the parallel course using up to a 45 degree intercept.

If the FMC cannot accept the offset, an ENTRY OUT OF RANGE message will be displayed. The parallel offset is cancelled when the active leg is changed to a lateral revision, clearing the offset data, or the next leg is not applicable for an offset. In the latter case, the FMC automatically initiates cancellation of the offset and displays CANCELLING OFFSET in the SP. Cancellation will occur when the along track distance to go referenced to the original path is 1.3 NM more than the calculated return path distance. Return to the F-PLN is accomplished again with up to a 45 degree intercept. Entry to a holding pattern is one example where the offset is automatically cancelled.

NOTE: The offset feature is not available during Polar Transition (above 85 degrees latitude).

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FMS Bank Angle Limits



The AFS and FMS compute the bank angle limits that are shown on the PFD. The active bank limit will vary with selected modes and aircraft conditions.

AFS FCP BANK LIMIT SELECTOR

- 5-25 DEGREES SELECT - Bank limit is the minimum of the FCP-selected bank limit (5-25 degrees), the 1.2g to buffet limit, or the 1.2g to stickshaker limit.
- AUTO SELECT - Bank limit is the minimum of limit 1 (chart), the 1.2g to buffet limit, or the 1.2g to stickshaker limit. If FMS is not available, the AFS will use limit 1 (chart).
- LOC MODE - limit is the minimum of limit 1 (chart), the 1.2g to buffet limit, or the 1.2g to stickshaker limit. The FCP bank limit selector is overridden.

FMS NAV MODE

- Bank limit is the minimum of the chart, the 1.2g to buffet bank limit, or the 1.2g to stickshaker limit.

NOTES:

- Limit 2 is used by the FMS on curved-path transitions and for the turns associated with holding patterns and procedure turns.
- Limit 1 is used by the FMS when not controlling to curved path transitions. Limit 1 is also used by the AFS with the FCP bank limit selector set to AUTO.
- The characteristics of the buffet and stickshaker bank limits are such that when flying at V_{min} , the bank limit will close to 5 degrees. As speed increases away from V_{min} , the bank limit rapidly increases to 25-30 degrees.

DB1-2-1842A

MCDU Message List

Two types of messages may be displayed in the scratchpad (SP) of the MCDU. Type I messages are less important than type II messages. Except for PLEASE WAIT, any message can be cleared by pushing the CLR key on the MCDU. The CLR key on one MCDU will not clear messages on the other MCDU.

Type I messages are displayed immediately when received and will overwrite any entry in the SP. The original entry will reappear when the message is cleared. Type I messages are not stored and are cleared automatically by the next key push.

The existence of a type II message will illuminate the MSG annunciator on the MCDU and display the legend CDU MSG on the ND. The message will not appear in the SP if the SP is occupied. The message is stored and will appear whenever the SP is empty and remain until the message is cleared. A total of five messages can be stored at any one time. The stack must be cleared one at a time. Pilot entry into the SP will overwrite the type II message, however, the message will reappear when the pilot entry is removed. Most type II messages are cleared automatically when they no longer apply.

ABEAM POINTS INCOMPLETE - A direct-to with abeam points is entered and

- There is not room in the defined waypoints list for all of the abeam points or,
- The available guidance leg storage is not enough to accommodate all the legs required for the abeam points.

A/C POSITION INVALID - Position changes from valid to invalid while the HOLD or DIRECT TO page is displayed.

A/C STATUS MISMATCH - The FMC requesting re synchronization detects that its program, navigation database, or program pin configuration is different than that of the offside FMC.

ACARS PERF DATA - Appears upon receipt of the first piece of performance data in an ACARS FPR (flight planning) or LIF (takeoff data) uplink.

ACARS ROUTE DATA - Appears upon receipt of an ACARS FPR (flight planning) uplink.

ACARS RWY NOT IN F-PLN - The runway displayed on the ACARS TAKEOFF REVIEW page disagrees with the origin runway in the active primary flight plan.

ACARS TAKEOFF DATA - Appears following the receipt of an ACARS LIF (takeoff data) uplink.

ACARS WIND DATA - Appears upon receipt of an ACARS PWD (wind) uplink.

- **ALIGN IRS** - Appears if all of the following are true:
- At least one IRS sensor is operating and in align mode.
- The F-PLN INIT page is not being displayed.

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- The IRS latitude and longitude have been updated.
- The flight phase is preflight.

ALT ERROR AT XXXXXX - Altitude constraint cannot be met. XXXXXX is constrained waypoint name.

ALTN F-PLN CLEARED - When an attempt is made to add a guidance leg to the primary or alternate flight plans, but no memory is available, then the secondary flight plans are sacrificed for space. When an attempt is made to add a guidance leg to the primary flight plan, but no memory is available and the secondary flight plans have already been sacrificed, then the alternate flight plan is sacrificed and this message is displayed.

ATTITUDE OUT OF RANGE - Attitude of the aircraft is outside of 0 to +2 degrees pitch or plus/minus 1 degree roll when an entry is attempted on the FUEL DIPSTICK page.

BLOCK OUT OF RANGE - A crew entry has caused the calculated BLOCK fuel weight to become less than minimum acceptable BLOCK or greater than maximum acceptable BLOCK.

BUSY-WAIT FOR READY - A downlink has been attempted while the ACARS MU-FMS interface was busy.

BUTTON PUSH IGNORED - MCDU LSK push attempted during or just after predicted profile point data appears on the F-PLN page.

CANCELLING OFFSET - When the aircraft is flying an offset and the next leg is incompatible for an offset, the aircraft will leave the offset and capture the active leg just before sequencing. At this time the offset is canceled and the message appears.

CHECK ALT CSTR - XXXXXX - Conflicting constraint is entered. XXXXXX is waypoint name. Appears if one of the following conditions is met:

- An at-or-below climb constraint follows an at-or-above climb constraint and the altitude of the at-or-below constraint is less than that of the at-or-above.
- An at-or-above descent constraint follows an at-or-below descent constraint and the altitude of the at-or-above constraint is greater than that of the at-or-below.
- A cruise constraint follows a cruise constraint with greater altitude.

CHECK ALTITUDES - An altitude conflict exists as follows:

- In climb, if FCP clearance altitude is set below the aircraft.
- In cruise, if FCP clearance altitude is set below aircraft during a step climb.
- In descent, if FCP clearance altitude is set above the aircraft.

CHECK BALLAST FUEL - There is a valid ballast fuel and a transition to preflight phase occurs.

CHECK/CONFIRM VSPDS - Appears for any of the following:

A pilot entered or pilot confirmed value of V1, V2 or VR is manually cleared.

- ALT T/O is selected as the thrust limit and V1, V2 or VR have been pilot confirmed.
- Calculated values for V1, V2 or VR change from invalid to valid.
- Values for V1, V2, and VR can no longer be calculated because input necessary for calculation has become invalid.
- A new runway is entered into the active primary flight plan and V1, V2 or VR are pilot confirmed or pilot entered.
- Calculated value for V1, V2 or VR is found to be more than 2 knots different than the pilot confirmed value for V1, V2, or VR.
- FMS transitions into the LAT ONLY state and V1, V2 or VR is not pilot entered.

CHECK DATA BASE CYCLE - Appears if the following conditions are met:

- A new ORIG/DEST pair or CO RTE is entered in the active or secondary flight plan.
- The date displayed on the DOC DATA page is valid and does not fall within the nav database cycle dates.
- The cockpit chrono is valid and does not fall within the nav database cycle dates.

CHECK WEIGHTS - Appears at engine start when:

- Pilot entered TOCG differs more than 2 percent from WBS TOCG or,
- Pilot entered TOGW differs more than 2 percent from WBS TOGW.

CHECK ZFW - At engine start, if BLOCK and UFOB differ by more than 500 kgs. After engine start, if BALLAST is entered or edited.

CLB ALT CSTRS DELETED - Descent is entered before all of the climb altitude constraints have been sequenced. All altitude constraints are associated with a lateral leg and are sequenced when that leg is sequenced.

CRZ ALT CSTRS DELETED - Descent is entered before all of the cruise altitude constraints have been sequenced. All altitude constraints are associated with a lateral leg and are sequenced when that leg is sequenced.

CRZ FL ABOVE MAX FL - The cruise flight level for the active primary flight plan has changed and is above the computed maximum flight level.

CRZ FL(S) REMOVED - Appears if one of the following conditions is met:

- A new cruise altitude is entered above a step altitude causing the step to the lower altitude to be removed.
- A transition to descent or approach occurs, with multiple Cruise flight Levels entered for the active primary flight plan.

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- An engine out is confirmed, with multiple cruise flight levels entered for the active primary flight plan.
- The secondary flight plan is activated with multiple cruise flight levels entered for the active primary flight plan.

DATABASE ACCESS ERROR - An error occurred while the FMS was accessing the nav database, or there is an error in the data read from the nav database.

DEFAULT STATE ASSUMED - All pilot entered data is cleared after a long term power-up. This can occur following NAV database loading or an FMC automatic reset.

DISCONTINUITY AHEAD - Appears 30 seconds before entering a discontinuity.

ENTRY OUT OF RANGE - An LSK input is not within the correct range.

FMC BATTERY LOW - Mass memory batteries are low and require maintenance.

FMC POSITION MISMATCH - Position differs by more than 5 NM (or double the RNP distance in NM) between FMCs. Automatically clears when FMC positions are within 3 NMs of each other.

F-PLN FULL - Appears if changes to a flight plan are requested but the memory capacity for the flight plans is exceeded.

F-PLN WPT/NAV RETAINED - Appears when deletion of a pilot defined waypoint is attempted while the defined waypoint is in use as follows:

- Contained in a flight plan.
- Displayed on the AIRWAYS page.
- Part of the ACARS flight plan uplink.

FORMAT ERROR - Format of the LSK input data is not correct.

GPS ONLY NAVIGATION - Navigation position is being determined by GPS data only. This message causes the CDU MSG to annunciate on the ND.

GROSS WEIGHT MISMATCH - Gross weight differs by 15,000 pounds (6,000 kilograms) between FMCs.

GW OUT OF RANGE - Appears if, due to a TOGW, FOB, or ZFW entry, the GW becomes less than the minimum GW or more than the maximum GW.

ILS UNTUNEABLE - When within 20 miles of the destination, invalid data is continually received from a tuned ILS.

INDEPENDENT OPERATION - Dual FMC operation not possible.

INITIALIZE COST INDEX - Engines are started without a valid cost index or an FMC automatic reset has occurred.

INITIALIZE CRZ FL - Engines are started without a valid CRZ LEVEL or an FMC automatic reset has occurred.

INITIALIZE WEIGHTS - Calculation of FOB is impossible because of a failed fuel quantity sensor or an FMC automatic reset has occurred.

INITIALIZE ZFWCG - Engines are started and no valid ZFWCG entry is available or an FMC automatic reset has occurred.

INSUFFICIENT FUEL - Predicted fuel burn to the primary destination is greater than the current usable FOB.

INVALID ACARS DATA - This message is issued if invalid data is received in an ACARS uplink.

INVALID CO RTE PROC - Invalid approach types are present in a company route. The FMS will automatically clear the invalid approach segment.

IRS ONLY NAVIGATION - Inertial data only. No radio or GNS position updating. Issued 2 minutes after a transition to IRS only navigation. If in terminal area, appears 1 minute after the transition to IRS only navigation. The message will then be issued every 10 minutes while in IRS only mode.

Inertial data only. No radio or GNS position updating. The IRS ONLY message will not periodically reappear when in the IRS ONLY navigation mode. It will only reappear once the aircraft sequences into the descent mode if IRS only navigation is still active. If the RNP option is selected, the IRS ONLY message will not be displayed.

LIST OF FORTY IN USE - An attempt is made to create a defined waypoint and the capacity of that list has been reached. The FMS will attempt to delete any unused defined waypoints to make room for the new waypoint before the message appears.

MAX LW NNN.N Calculated destination Landing Weight exceeds the limit. NNN.N is max value for Landing Weight.

MAX TOGW NNN.N - Appears if any of the following conditions are met:

- A GW is entered, while not airborne, which exceeds limits.
- A TOGW is entered which exceeds limits.
- An FOB or ZFW entry is made, while not airborne, which causes either the GW or TOGW to exceed limits.

MAX ZFW NNN.N - Appears if any of the following causes the ZFW to exceed limit:

- TOGW entry.
- Taxi fuel entry.
- Block fuel entry.
- Ballast fuel entry.

- GW entry.
- ZFW entry.

MULTIPLE ENGINEOUT - More than one engine inoperative.

NEW CRZ ALT - FLNNN - A change is made to the active primary cruise altitude which was not pilot initiated. For example, entry of an altitude constraint that is higher than the cruise flight level causes the cruise flight level to be raised to the altitude constraint value.

NO DESTINATION - Appears for the following:

- An attempt is made to access the **APPROACH** page with no destination in the active primary flight plan.
- An entry of a descent constraint is attempted without a destination in the affected flight plan.

NO FMS SPD/PROF - No Perf database exists for the programmed engine or airframe or the engine detected by the FCC does not match programmed engine specified to the FMC at engine start.

NOT ALLOWED - A key input is not allowed or is not functional.

NOT IN DATA BASE - An **IDENT** entry is attempted that is not in the nav database and/or the pilot defined waypoint list.

NOT ON INTC HEADING - Present track will not intercept the selected course for the **DIR/INTCP** function.

PLEASE WAIT - FMCs are re synchronizing to the dual state.

RADIO ONLY NAVIGATION - Appears on transition to Radio Only navigation mode (no inertial navigation).

REF NAVAID DESELECTED - A procedure specified navaid is deselected while the aircraft is in the terminal area.

REF NAVAID UNTUNEABLE - A procedure specified navaid has been blackballed by the FMS and is not used in position calculation.

RTA ERROR AT XXXXXXXX - RTA constraint will be missed by more than 30 seconds.

SEC F-PLN CLEARED - When an attempt is made to add a guidance leg to the Active Primary or Active Alternate flight plans, but there is no memory available, then the Secondary flight plans are sacrificed for space and this message is issued.

SEC RTA REMOVED - RTA constraint in active (secondary) flight plan is automatically deleted as an indirect result of aircraft or crew action.

SENSOR FAIL - Sensor transitions to fail on **SENSOR STATUS** page.

SENSOR IS INVALID - Sensor is declared invalid for FMC use.

SPD ERROR AT XXXXXXXX - It is predicted that a speed constraint cannot be met. XXXXXXXX is the constrained waypoint name.

SPD LIM EXCEEDED - The aircraft is unable to slow to descent speed limit by descent speed limit altitude.

STAB TRIM MISMATCH - The FMS stabilizer trims differ by more than 0.1% between FMSs. This message causes the CDU MSG to annunciate on the ND.

STEP DOWN INVALID - Appears when entry of a cruise FL lower than the previous cruise FL is attempted on the INIT page.

TANK LIMIT EXCEEDED - The ballast fuel quantity entry exceeds the limit for the specified tank.

THRUST LIMIT MISMATCH - Thrust limits differ by 0.02 EPR (or 1% for GE engines) or more between FMCs. Any of the percent derate values established for takeoff percent derate #1, takeoff percent derate #2, climb percent derate #1, or climb percent derate #2 differ between FMCUs.

TIME CSTR REMOVED - There is a valid time constraint and any one of the following conditions is met:

- Aircraft becomes airborne.
- The clock becomes invalid.
- A transition out of descent occurs.
- The aircraft becomes active in a manual leg.
- An engine out is confirmed.

TIMEOUT - RESELECT - Issued by the MCDU. The MCDU has lost communications with the previously active subsystem.

TOGW OUT OF RANGE - Appears if, due to an FOB or ZFW entry, the TOGW becomes less than the minimum or more than the maximum, the aircraft is not airborne, and the GW is not out of range.

TRANSFER ABORTED - Unsuccessful completion of a nav database crossload.

TRANSFER COMPLETED - Successful completion of a nav database crossload.

TRANSFER IN PROGRESS - Appears in SP of the FMC which is transmitting a Nav database to the other FMC.

TUNE AAA - FFF.FF - The manually tuned navaid is not the procedure specified navaid.

UNABLE TO UPDATE F-PLN - FMS tried to process a flight plan change but a processing error occurred or the data from the nav database was not available or had an error.

VERIFY A/C POSITION - GNS or radio position differs from inertial position by 12 NM or more or a position entry on the POS REF page is greater than 33 miles from the currently displayed position.

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VERIFY RNP ENTRY RNP - entry is greater than default RNP from NDB.

VMIN MISMATCH - The VMIN speeds differ by more than 5 knots between FMSs. This message causes the CDU MSG to annunciate on the ND.

ZFW OUT OF RANGE - Calculated ZFW is less than minimum or greater than maximum due to any of the following:

- Block fuel entry.
- Taxi fuel entry.
- TOGW entry.
- GW entry.

Intentionally
Blank



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

Amber Alerts (Level 1)

UNABLE RNP (MISC) - Required navigation performance is not being met during that phase of flight.

Cyan Alerts (Level 0)

CDU1/2 MENU REQUEST - A message is displayed on the MENU page of respective MCDU1 or MCDU2.

Intentionally
Blank

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Fuel

Description and Operation

Chapter Fuel

Section 10

General

The MD-11 fuel system is designed for the use of commercial turbine fuels. Always refer to the MD-11 Flight Crew Operating Manual Operating Procedures, Limitations section or the FAA approved Airplane Flight Manual (AFM) for possible fuel type limitations.

A Fuel System Controller (FSC) is installed on the aircraft. It is a control device which contains two microprocessors and a control relay system. A second control device, the Ancillary Fuel System Controller (AFSC), is installed for additional control. The FSC and the AFSC together provide complete control of fuel system functions.

FSC and AFSC control of the fuel system components is arranged so that in case of failure of either the FSC or AFSC, the remaining device can control the fuel system.

The FSC is capable of either automatic or manual operation. The crew may choose to operate the system in manual mode, or in certain failure conditions, the system may automatically revert to manual mode.

In manual mode the crew controls all fuel system functions (engine feed, fuel transfer and crossfeed) with controls on the FUEL control panel.

Fuel system indications are displayed on the Engine and Alert Display (EAD), the System Display (SD) and FUEL control panel.

Fuel System Controller (FSC)

FSC automatic functions include the following functions:

- Supplies fuel to the engines and APU.
- Checks and maintains the fuel schedule.
- Maintains a fuel efficient CG by transferring fuel to and from the tail tank.
- Monitors fuel temperature and starts cold fuel recirculation to prevent fuel from freezing.
- Recognizes when ballast fuel is being carried and keeps it in its proper tank.
- Backs up manual/mechanical commands for fuel dump.
- Takes appropriate corrective action for early transfer or no transfer of tip tank fuel.
- Equalizes tank quantities during low fuel flight.
- Maintains wing fuel quantity balance.

- Corrects for tank overfill.
- Reconfigures the fuel system for failure of various elements.
- Reconfigures for a dump valve failed open.
- Employs special management procedures to compensate for various components being inoperative at the beginning of flight.
- Monitors itself and other fuel system components for proper operation and detects and reports faults to the Centralized Fault Display System (CFDS).
- Reverts to manual for certain failure modes.

Fuel Tank Arrangement

Three main fuel tanks are installed in the wings. These main tanks are tank 1, 2, and 3. The numbers correspond to the engine which the tank feeds. Additional fuel is contained in a center wing auxiliary tank consisting of upper and lower sections and a tail tank located in the horizontal stabilizer.

All of the tanks are integral except for the lower auxiliary which contains a bladder cell.

Tanks 1 and 3 in the left and right wings respectively are identical. Each has an outboard compartment and a main compartment. The main compartment is further divided by a check valve bulkhead which allows inboard fuel flow to the boost pump reservoir but prevents outboard fuel flow that could occur under some flight conditions such as a steep climb or uncoordinated maneuvers.

Tank 2 supplies fuel to the APU and the aft engine. It is a split tank with half of the volume in the left wing and half in the right wing. Gravity flow and vent lines connect the two tank sections. This tank has a greater fuel capacity than tank 1 or 3.

Manifold drain/outboard fill valves are located at the outboard ends of the fill/crossfeed manifold in tanks 1 and 3. These valves serve the dual function of controlling manifold venting for drainage and providing an alternate fill path for tanks 1 and 3. A manifold drain float valve is located at the low point of the fill/crossfeed manifold. This valve allows drainage of the manifold into tank 2 when the fuel level in tank 2 is below 815 kilograms. In auto mode, the FSC commands the manifold drain/outboard fill valves open at the appropriate time allowing fuel drainage. In manual mode, a crew member operates the MANF DRAIN switch which opens the same valves. The MANF DRAIN switch is a guarded switch.

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The center wing auxiliary tanks consist of an upper tank and a lower tank. The upper tank has upper (overwing) and wing box compartments which are interconnected for gravity flow. The lower tank fuel is transferred to the wing box by two transfer pumps through a fill valve. This fill valve controls the transfer flow to maintain a specified fuel level band in the wing box tank. The fill valve also prevents overfilling.

Fuel from the upper tank is transferred to the main tanks through the fill/crossfeed manifold by two transfer pumps. The fuel quantity for the upper and lower tanks is shown on one quantity readout as the total for the auxiliary tank.

There is one sump drain valve in each outboard compartment and four spar mounted drain valves for the main tanks. One drain valve is located in each tank 1 and 3 main compartment and two are located in tank 2, one on each side of the fuselage. Two sump drain valves are located in the center wing upper auxiliary tank. The lower auxiliary tank has a sump drain in the bottom of the tank.

The tail tank is located in the horizontal stabilizer and is divided into three compartments by the operating bulkheads. These structural members contain the stabilizer pivots (aft) and are connected to the jack screws which control stabilizer pitch attitude (forward). The operating bulkheads also serve as check valve bulkheads allowing fuel flow into the center (constant) section but inhibiting flow into the outboard compartments.

The tail tank functions as part of the aircraft Center Of Gravity (CG) management system. Fuel is transferred to and from the tail tank as necessary maintain a fuel efficient CG. Fuel is transferred from the tail tank by two transfer pumps.

In case of transfer pump failure, tail tank fuel quantity may be reduced by feeding the tail engine directly from a dedicated alternate pump. During operation in auto mode, the forward boost pump in tank 2 remains on during this procedure to provide uninterrupted fuel flow to the aft engine when tail tank fuel is depleted.

All tail tank pumps and valves are mounted on the front spar of the constant section. The tail tank has four front spar mounted sump drain valves. Two drain the center section and one drains each of the two outboard sections.

Tank Capacity Chart

TANK	LITERS	KILOGRAMS
Tank 1 (Left Wing)	22,873	18,365
Tank 2 (Center)	36,177	29,048
Tank 3 (Right Wing)	22,873	18,365
Aux Tank Upper Compartment	49,205	39,510
Aux Tank Lower Compartment	6,215	4,990
Horizontal Stabilizer Tank	7,411	5,950
Manifolds & Engines	344	277
TOTALS	146,142	117,345

NOTE: After engine start, actual fuel on board (FOB) is used for gross weight calculations. The flight management system (FMS) display changes to show, along with FOB, the sensors used for FOB calculation. The pilot may select or clear the sensor(s) to be used for calculating FOB, or may re-initialize FOB by entering a new value.

NOTE: These approximate usable fuel capacities assume a density of 0.803 kilograms per liter.

Engine Feed System

The engine feed system is controlled and monitored by the FSC. Each engine is normally supplied fuel by an independent system from the respective main tank. Engines are fed by tank boost pumps through fire shutoff valves to the engine pump inlets. The wing engine fire shutoff valves are electric. The tail engine has two fire shutoff valves, both mechanical. The boost pumps are driven by ac motors.

Tank 1 and tank 3, which feed the wing mounted engines, have three pumps each. These three pumps are:

- One forward mounted boost pump.
- One aft mounted boost pump.
- One aft mounted transfer pump.

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The transfer pump supplies fuel directly to the crossfeed manifold. One of the boost pumps is mounted to the rear spar next to the transfer pump to minimize the unusable fuel during nose up or level flight attitudes. The other boost pump is mounted to the bottom wing skin in the forward part of the tank to minimize unusable fuel during nose down flight attitudes.

The aft engine is fed by tank 2 which contains four fuel pumps. These four pumps are:

- Two aft mounted boost pumps.
- One forward mounted boost pump.
- One forward mounted transfer pump.

The boost pumps feed directly to the aft engine.

A dc powered APU start pump is also located on the right side of tank 2.

In each tank, the pumps are all powered from different electrical buses. In case of electrical failure, the left aft boost pump in tank 2 can be run from the Air Driven Generator (ADG).

The aft feed pump(s) in each tank (one each in tank 1 and 3 and two in tank 2) and the two upper aux transfer pumps have a jet pump installed in the inlet. Each boost pump is capable of supplying fuel at the takeoff fuel flow rate to two engines.

Each tank mounted pump is provided with a pressure sensor which provides information to the FSC.

In auto mode the FSC uses this input combined with fuel quantity information to decide if a tank is empty or a pump is inoperative. If the quantity is above the preset limit when a low pressure situation is sensed, the FSC turns the pump off and logs a fault in the CFDS. The appropriate PUMP OFF alert will be displayed. The forward pumps and tank 2 transfer pump will not be turned off if pump pressure is low due to a high pitch angle with a low fuel level. In manual mode, a pumps LOW light on the FUEL control panel is illuminated if all boost pumps that have been commanded on in a tank have low discharge pressure.

Suction feed is accomplished for the wing engines only through the aft pump inlet. The engine feed pump suction line contains a bypass with a check valve. This allows the inlet to be used for suction feed.

Electrically operated crossfeed valves provide crossfeed capability from any tank to any engine or to any other wing tank. In auto mode, the FSC controls crossfeed and will compensate for failed components.

In either mode of operation, lights on the FUEL control panel illuminate to indicate valve disagreement with switch position. A short time delay is provided in the annunciation logic to allow for normal valve transition. The valve has a manual override for ground use.

Electrically controlled fire shutoff valves are mounted on the front spar for the wing mounted engines. There are two cable controlled fire shutoff valves for the aft engine, one on the rear spar and one in the aft fuselage. The two shutoff valves for the aft engine are operated from the same fire extinguishing handle in the cockpit.

The APU fuel system consists of a dc start pump and two solenoid operated fire shutoff valves. The system is controlled from the APU control panel. The start pump, controlled by the Miscellaneous System Controller (MSC), is used to supply fuel to the APU for start and ground operation.

When the APU START/STOP switch or the APU PWR ON switch is pushed, the MSC opens both valves. One solenoid valve is located at the rear spar and one is located in the aft fuselage near the inlet to the APU. The solenoid valves are normally closed and require electrical power to open them. A pressure sensor at the APU inlet provides the MSC with APU inlet fuel pressure information.

When the fuel system is in auto mode, the FSC will recognize when the APU is operating and will turn on a tank 2 boost pump. After a 90 second time delay, when the tank 2 boost pump is operating and providing adequate fuel pressure, the FSC will interrupt start pump operation. Fuel then continues to be supplied to the APU through the aft engine feed line.

With the FSC in manual mode, APU start pump operation will not be interrupted, even if tank 2 boost pumps are operated. Fuel feed to the APU, whether from a tank 2 boost pump or the dc start pump, is continued for 90 seconds after a shutdown has been commanded. This prevents possible damage to the APU.

Fuel Transfer and Crossfeed

For fuel transfer from the center wing auxiliary tank (assuming fuel in both upper and lower tanks) the FSC commands both the left and right center aux tank transfer pumps on and energizes the three main tank (tanks 1, 2, and 3) fill valve solenoids.

With the left and right transfer pumps commanded on, the upper and lower pumps are energized along with the upper fill valve solenoid. When the fill valve solenoids are energized, flow through the valve is controlled by the mechanical fill pilot valves. These valves contain floats which sense the level of fuel present in the tank. The three main tank and upper aux tank fill valves cycle open and closed automatically to maintain the tanks full.

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If the indicated quantity in the lower aux tank is below 458 kilograms and the pump discharge pressure is low, the FSC starts a time-out procedure. Once either lower aux pump registers continuous low pressure for 4 minutes or the lower aux tank quantity decreases below 229 kilograms for 10 minutes, the tank is timed out as empty. The left and right lower pumps are then shut down and the upper aux tank fill valve solenoid is de-energized. Further fuel transfers will rely only on the upper pumps.

The FSC will reinitiate lower aux tank transfer if the fuel quantity should increase to above 227 kilograms.

Transfers continue from the upper aux tank to all main tanks until the aux tanks quantity indicator shows less than 816 kilograms. If the indicated quantity in the upper aux tank is less than 816 kilograms and pump discharge pressure is low, the FSC starts time-out procedures. Once either upper aux pump registers continuous low pressure for 2 minutes or the upper aux tank quantity decreases below 272 kilograms for 4 minutes, the tank is timed out as empty. The upper pumps are then shut down and the tank 2 fill valve solenoid is de-energized.

The FSC will reinitiate upper aux transfer if the fuel quantity should increase to above 318 kilograms or after the aircraft is refueled. In auto mode, the FSC can independently control any pump in the system. In manual mode however, when either the aux tank left or right transfer pumps are selected, both upper and lower pumps are commanded on or off. In manual mode, after 4 minutes of continuous low pressure, the lower pumps are automatically turned off by timed relays

When upper aux transfer is complete, fuel transfer from tank 2 is initiated by the FSC which commands the tank 2 transfer pump on. The fuel quantity gaging system (using a float switch as a backup) signals the FSC when the fuel level in tank 2 drops below 18,144 kilograms. The FSC then commands the tank 1 and tank 3 fill valves closed and the tank 2 transfer pump off.

There are three situations where crossfeed is required to maintain proper system operation as follows:

- If a main tank transfer pump fails and fuel must be transferred from that tank, the crossfeed valve is opened and fuel is transferred using the boost pumps.
- If certain boost pump failures occur, the crossfeed valve is opened and the associated engine is fed by the transfer pump.
- Fuel scheduling or balance requirements cause fuel to be moved from tank to tank through the fill system. In the event of a failed closed fill valve, the crossfeed valve associated with that fill valve is opened and the engine is fed by the transfer pump from the heavy tank.

Gravity and Jet Pump Transfer System

To relieve bending stresses caused by the generation of lift by the wings, the tank 1 and 3 outboard compartments are maintained full until the inboard fuel level decreases to about 2,268 kilograms.

There are two transfer systems controlled by fuel level in the inboard compartment. These systems will allow fuel to transfer from the outboard compartment to the inboard compartment maintaining the inboard compartment fuel quantity at about 2,268 kilograms. The total amount of wing tank fuel will be about 4,990 kilograms when the transfer begins.

One fuel transfer system utilizes a transfer valve and transfer float valve. The other transfer system, a jet pump system, transfers fuel accumulations in the aft portion of tank 1 and 3 on both sides of the vent box. The jet pump system is the primary system at aircraft attitudes in excess of six degrees nose-up.

The two compartments of tanks 1 and 3 contain float switches which provide the FSC with fuel schedule information. One float switch is located high in the outboard tank and two float switches are located low in the main tank. The FSC compares the condition of the three float switches in each tank with fuel quantity information, checking for possible failures.

If outboard compartment leakage has occurred and the fuel schedule condition is identified with tank total quantity above 5,216 kilograms, the FSC will refill the outboard compartment by opening the fill valve and using either the transfer pump or the boost pumps through a crossfeed valve. The manifold drain/outboard fill solenoid valve can also be used to fill the outboard compartment if the FSC senses that the fill valve is failed closed. If fuel schedule condition is identified with total tank quantity below 3,850 kilograms, the FSC assumes a failure in fuel transfer from outboard to inboard compartment and an alert will be displayed to warn the crew that the tank fuel quantity is low and that a tip fuel trapped condition exists. In this condition, approximately 2,495 kilograms of fuel will not be available to engines.

Continuous Scavenge System

A continuous scavenge system is installed to prevent water accumulations within the tanks. This is accomplished by pumping fuel/water from the low points to the fuel pump inlets. The system consists of jet pumps, pressure actuated shut-off valves, check valves and scavenge rakes.

Jet pumps are used to scavenge the fuel tank low points where the tank bottom is too flat for gravity draining. The primary flow of these pumps is obtained from the boost pump manifolds in each tank. The outlets of the jet pumps are located so that the discharge is directed toward an aft pump inlet. The jet pumps are in operation whenever the pumps are working.

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For tanks 1 and 3 there are two scavenge jet pumps, one pumping the low points of the outboard compartment and the other pumping the low points of the main compartment. Since the outboard compartment must be maintained full during most of the flight, a small bleed flow tapped off of the engine fuel supply is directed to this compartment through the transfer valve control line. The bleed flow to the compartment is greater than the scavenge flow from the compartment to ensure that the outboard compartment remains full.

Check valves in the primary flow line of the jet pumps prevent air entry in the engine supply line during suction feed operation (boost pumps off). A pressure operated valve in the outboard compartment secondary flow (scavenge flow) line is opened by boost pump pressure and is used to prevent drainage from the outboard compartment to the main compartment when the boost pumps are not operating.

Two scavenge jet pumps are installed in tank 2. One is located in the left compartment and one in the right. Both are located low in the tank and discharge scavenged fluids at the inlets of the spar mounted boost pumps.

The upper aux tank contains two identical scavenge systems, one for the left side and one for the right side. Each system has two jet pumps which receive motive flow from the respective fuel transfer pump and return the scavenge fluid to the inlet of the same pump. The lower aux tank contains a bladder cell and does not have a scavenge system.

The tail tank contains two identical scavenge systems, one for the left side and one for the right side. Each system has four jet pumps which receive motive flow from the respective fuel transfer pump and return the scavenge fluid to the inlet of the same pump. There are two scavenge rakes on each side of the operating bulkhead.

Fuel Quantity Gaging System (FQGS)

The FQGS consists of:

- Probes in the fuel tanks.
- An Standard Electronic Module (SEM).
- A Data Control Unit (DCU) in the cockpit.
- Refueling panel on the right wing.

The probes in the fuel tanks send quantity data to the electronic module. The electronic module processes this quantity data and sends it to the data control unit and the refueling panel.

The data control unit sends the fuel quantity data to aircraft components that use the data. These components include:

- FSC.
- FUEL control panel in the cockpit.
- MCDU through the FMC.

- CRTs for display.
- Air data computers.

The refueling panel sends preselect fuel quantities to the electronic module during refueling.

The FQGS self-tests before each flight and after refueling.

Refueling and Defueling

The aircraft is refueled through four pressure refueling adapters (fuel entry valves), two on each wing. Each tank can be selectively pressure fueled to any desired quantity through any or all four fill adapters. There are no gravity fillers.

The horizontal stabilizer must be at 3 degrees Aircraft Nose Up (ANU) to completely refuel the tail tank. For convenience, on the right side of the aft fuselage there is a line on the fuselage and on the stabilizer that will line up when the stabilizer is at 3 degrees ANU. The left side of the aft fuselage has markings that indicate the neutral position (0 degrees ANU) that are not for refueling.

The right wing control panel provides refueling control without the necessity of personnel in the cockpit. Power (dc) is supplied to this control panel through the control panel access door switch and the ARM switch on the panel. Both switches must be closed for the right wing control panel to be energized. The access door switch is closed when the door is open and the toggle switch is closed by the refueling operator.

Energizing the fueling system by actuation of the refuel switch at the wing control panel energizes a relay that assures that the crossfeed valves are energized closed. If a crossfeed valve switch in the cockpit is in the open position, a crossfeed DISAG light on the FUEL control panel will be illuminated until the refueling system is de-energized and the valve returns to the open position.

The refueling/fueling operation will be automatically stopped prior to the overfill level being reached.

The tail tank float switch has an additional function. When tripped, it will cause fuel flow into the tank to stop. The float switch is located low enough in the vent box so that if the fill valve fails, the isolation valve will close before a fuel spill occurs.

While refueling is in progress the FSC stops all functions except for APU support, engine support, and a limited number of system checks that are not related to fueling. The REFUELING alert will be displayed.

Fuel Dump System

Fuel dumping uses all main tank and upper aux tank pumps to pump the fuel overboard through exits on each wing located at the trailing edge between the outboard aileron and the outboard flap. The dump flow is controlled by two electrically operated shutoff valves, and the low level shutoff float switches in the three main tanks. The dump valves are dc motor operated valves. They are energized by a dedicated dump control network which is activated by a guarded DUMP switch. An alert will be displayed to indicate that the fuel dump system has been activated.

The fuel dump operation is initiated by pushing the guarded DUMP switch on the FUEL control panel. The dedicated dump control network then commands all transfer and boost pumps on, all crossfeed valves open, and the dump valves open in a controlled sequence. The sequence will not overload the electrical system or adversely affect engine feed capability.

The FSC monitors the state of the fuel dump valves. Left or right dump valve disagree alerts are displayed on the SD if one or both of the dump valves are not in the commanded position.

The dump valves are on separate electrical buses. If the FSC is in auto mode, backup commands will be sent to the crossfeed valves and the pumps to ensure that they are properly activated in the event of a malfunction of the dump control network. The FSC performs fault checking of the fuel dump system by monitoring the sequencing of the pumps and valves. Any faults in the operation of the system are isolated and recorded. The FSC has no control over the operation of the dump valves. This feature ensures that fuel can not be inadvertently dumped due to a malfunction of the FSC.

At any time during the fuel dumping operation a crew member can stop the flow of fuel overboard by pushing the DUMP switch again. This action causes the dump valves to close, all crossfeed valves to close, and the transfer pumps to be commanded off. If fuel dumping is started a second time during a single flight, dump continues to low level dump cutoff or until the DUMP switch is pushed again. If a malfunction of the DUMP switch occurs, the fuel dump sequence can be overridden by pushing the FUEL DUMP EMER STOP switch.

When dumping fuel from the aux tanks, both upper and lower pumps turn on. After the lower aux fuel has been pumped to the upper aux tank, then tail tank fuel is pumped to the upper aux tank and dumping continues using the upper pumps.

The aircraft can carry dedicated ballast fuel in either tank 2 or the upper aux tank. Tail ballast fuel will remain on board and will not be moved during fuel dump. Ballast fuel in the upper aux tank will also remain on board, but may be relocated (to tank 2) in the dump process. Total fuel quantity remaining on board following dump will be the low level dump cutoff quantity plus any dedicated ballast.

When dump is discontinued (the dump valves are commanded closed) the FSC will discontinue its dump follow-up procedure in a controlled manner so as not to interfere with the shutdown sequence of the dump system.

The FSC will exit the dump state when any of the following conditions are met:

- 12 seconds have passed since the dump valves were commanded closed.
- A reset interrupt occurs.
- The FUEL DUMP EMER STOP switch is pushed.

The FSC must support engine operation before, during, and after fuel dump. If the FSC is in auto mode when the dump state is exited, it will immediately resume fuel system control. If the FSC is in manual mode at the end of dump, the fuel system will be configured to the last state commanded from the FUEL control panel.

The CG may move slightly out of range (usually forward) during fuel dump. If the FSC is in auto mode, after the completion of the dump process, the fuel remaining on board will be rescheduled. If the FSC is in manual mode, the flight crew must reschedule fuel manually.

During fuel dump operation, the CG OUT OF LIMITS alert may be displayed.

Shroud and Drain System

The shroud and drain system consists of component, fuel line and coupling shrouds, and their respective drains. The drains terminate at two push-to-drain valves and are vented to an overboard drain mast on the lower aft fuselage. At the rear spar of the outer wing, all electrical feed-thrus are shrouded and drained together with the components and electrical feed-thrus of center wing rear spar. The push-to-drain valve for this part of the system is located forward of the center wheel well.

Fuel Vent System - Wing

The wing fuel tank vent system is an open system which allows airflow from the tank during fueling, airflow into the tanks during fuel usage, fuel dumping, aircraft climb and descent, or flow overboard during a fueling overfill condition (failed open fill valve).

The system prevents tank pressures from exceeding structural limits. The vent outlet is in the bottom wing surface. It is non-icing and drip-free. It is remote from the wing tip and wing edges to avoid those areas which are most subject to lightning strike or streamering.

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Tank 1 and 3 inboard and outboard sections are separated by a vent box. The vent box is a sealed compartment that forms a trap between the vent manifold and the standpipe overboard outlets. A small quantity of fuel can enter the static and climb vent lines during various maneuvers, but the vent box size (about 379-530 liters) traps this fuel and prevents spillage overboard. Fuel can also enter the vent box during refuel or transfer overfill conditions. Fuel drains from the vent box back into the tank through the drain valves.

The two compartments of tanks 1 and 3 are interconnected by a vent line which also serves as the fill line for the inboard compartment. This line has an open vent, a float type climb vent valve, and a check valve to prevent back flow. The left and right compartment vent spaces of tank 2 are connected with a simple vent line through the center wing tanks.

A cross vent system is installed. The vent spaces in the left wing are connected to the vent box in the right wing and vice versa. The open vent in tank 1 and the tank 2 open vent are joined and routed to the right wing vent box. Similarly, the vent spaces of tank 3 and the center aux tanks are connected and routed to the left wing vent box. Alternate vent inlets in each tank are used to vent the tanks when fuel covers the open outlet during aircraft maneuvers. These alternate inlets are fitted with float valves to prevent fuel flow when they are submerged. Drain valves connected to the vent lines permit the fuel that may slosh into the vent lines to re-enter the tank whenever the fluid level in the line is approximately 1 inch or more above the fluid level in the tank.

A flame arrestor is installed in the vent box stand pipe to eliminate flame propagation through the vent system as the result of an external fire source. There are pressure relief and vacuum relief valves in the stand pipe which bypass the flame arrestor to vent the tank if the flame arrestor becomes iced or otherwise blocked.

The tank 2 fill rate is higher than that of tanks 1 and 3. This creates the potential for greater vent back pressure in tank 2 during fill. A relief valve located in tank 2 interconnects the two vent systems. This relief valve opens when the combined tank 1 and tank 2 vent system pressure exceeds the combined tank 3 and center aux tank vent pressure by more than 0.4 psi.

Fuel Vent System - Tail

The tail fuel tank vent system is an open system similar to the wing fuel tank vent system.

The tail fuel tank vent system is completely isolated from the wing fuel tank vent system.

The vent outlet is located in the bottom of the left side of the stabilizer surface without projections. The outlet is remote from the stabilizer tip and leading and trailing edges.

Cross venting is also used in the tail tank vent system to prevent overboard fuel spillage during aircraft maneuvers. The left side open vent is routed through the constant section to connect with the right side open vent at a high location in the tank. The right side open vent then is routed back through the constant section to the vent box.

A climb vent is located forward in the constant section to provide venting when both open vents may be covered during takeoff or climb. This vent has a float valve to prevent fuel from entering the vent system during normal flight attitudes.

Drain valves are installed at low points in the cross vent lines so that fuel which enters the vent lines during maneuvers returns to the tank. Since the possibility of fuel entering the vent box exists, a return line from the vent box to the tank has been provided. A flapper check valve prevents fuel from entering the vent box through the return line.

A flame arrestor system similar to the wing fuel tank vent system is installed in the vent box outlet valve.

Automatic Operation

Engine and APU Fuel Feed

The FSC supplies fuel to the engine and APU as follows:

- When the aircraft is parked fuel transfer is permitted.
- When APU start is selected, the FSC will check the status of boost pumps in tank 2. If one or more pumps is operating it interrupts the APU start pump. The APU starts and operates using fuel pressure from the operating pump. If no pumps are operating, the APU will turn on its own start pump. When the APU has started and ac power is available, the FSC will turn on a tank 2 pump; 90 seconds later it will turn off the APU start pump.
- During engine start, tanks 1, 2, and 3 aft pumps are turned on as each respective ENG START switch is turned on.
- During taxi, tanks 1, 2, and 3 aft pumps are on. Fuel transfer is permitted. Tail fuel management is inhibited.
- During takeoff, tanks 1, 2, and 3 forward and aft pumps are on. Aux manifold fuel transfer and tail fuel management are inhibited.
- During climb tanks 1, 2, and 3 aft pumps are on. Fuel transfer and tail fuel management are permitted.
- During cruise tanks 1, 2, and 3 aft pumps are on. Fuel transfer and tail fuel management are permitted.

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- During descent, from 26,750 feet till 17,750 feet, if any fuel remains in the tail tank, tail fuel is transferred forward.
- During approach, tanks 1, 2, and 3 forward and aft pumps are on. Aux manifold fuel transfer is inhibited.
- After landing, tanks 1, 2, and 3 forward pumps are turned off one minute after landing, unless the fuel level is less than 5,216 kilograms in a tank.
- After engine shutdown, all main tank pumps are turned off unless the APU is operating, in which case the tank 2 left aft pump will remain on.

Fuel Scheduling

The FSC checks and maintains the fuel schedule. Fuel management is required to satisfy aircraft structural load requirements. If fuel is not properly distributed, it will be rescheduled to the correct tanks. Depending on the total fuel quantity and distribution when transfer is permitted, the fuel transfer will continue from that point. The sequence of fuel management is as follows:

- If tail fuel management is not in use, tail tank to upper auxiliary tank, maintaining the upper auxiliary tank full.
- Lower auxiliary tank to upper auxiliary tank, maintaining the upper auxiliary tank full.
- Simultaneously with the preceding two functions, upper auxiliary tank to tanks 1, 2, and 3, maintaining them full.
- Tank 2 to tanks 1 and 3, maintaining them full.
- When tank 2 quantity equals that in 1 or 3, discontinue transfer from tank 2, allowing tanks 1, 2, and 3 to burn down to equal fuel quantities.
- When tanks 1 and 3 tip fuel equals the fuel in the inboard section of the tank, the tip fuel is mechanically transferred to the inboard section, keeping it at a constant level of about 2,268 kilograms until the tip fuel is depleted (FSC monitors but does not perform this action).
- In case of reversion to the manual mode, fuel schedule is still maintained through float switches.

Tail Fuel Management

The FSC manages the tail fuel. Tail fuel management begins when the climb phase of flight begins. The primary purpose of tail fuel management is to improve aircraft cruise performance by maintaining an aft center of gravity (CG). Tail fuel is managed as follows:

- The CG is controlled to a preselected aft limit. This function is allowed only if the total fuel quantity exceeds 27,216 kilograms at termination of refueling. Once the total fuel quantity is below 23,134 kilograms, no further fuel will be transferred aft for CG control. If engine 2 is shut down, tail fuel is limited to a maximum of 2,268 kilograms. If the CG moves aft of the aft control limit, the fuel system controller will revert to the manual mode and the SEL FUEL SYS MAN alert is displayed.

-
- CG control maintains a constant moment margin forward of the aft CG limit. The CG control margin tolerance is 0 percent aft and 1.0 percent forward of the selected control point.
 - When CG demand requires aft fuel transfer, fuel will be transferred from the lower or upper auxiliary tanks, or main tanks to the tail tank. When the tail tank transfers fuel forward, it goes to the upper auxiliary tank. Once the main tank quantities decrease to 5,216 kilograms each tank (fuel dump cutoff level), tail fuel will be transferred to the main tanks to keep them at that level until tail fuel is exhausted.
 - If fuel remains in the tail tank during descent below 26,750 feet, it will be transferred forward.
 - The FSC will transfer and replace fuel from the tail tank to purge water. Every 30 minutes fuel is transferred forward for two and one-half minutes. When the forward transfer is complete, CG control is again in effect. When the fuel temperature drops to 2°C this function is terminated.
 - Flow through or pressurization of the tail tank manifold during takeoff and landing is terminated.
 - Tail fuel is limited to a maximum of 2,268 kilograms when any of the following conditions occur: tail tank engine 2 alternate pump inoperative, auxiliary fill/isolation valve inoperative closed, or engine 2 shutdown.
 - Tail fuel management will be terminated by a number of abnormal conditions. When this occurs, tail fuel will be moved forward and distributed to conform to normal fuel scheduling. These abnormal conditions are:
 1. Upper aux fill valve fails.
 2. Any two of the tail tank pumps fails.
 3. Aux fill isolation valve fails and either upper aux tank pump fails.
 4. Either upper tank aux tank pumps fails.
 5. Any two of tail tank pumps (left, right, alternate) fails and aux fill/isolation valve fails.
 6. Invalid or loss of all temperature data.
 7. Loss of air data.
 8. Loss of all fuel quantity data.
 9. Loss of tail tank quantity data.
 10. Loss or aircraft CG data.
 11. Loss of gross weight data.
 12. Tail tank overfill detected.
 13. Tail tank fuel temp. within 3°C freezing point.
 14. Slat position; gear position; vertical speed or altitude data invalid.
 15. Loss of LSAS.

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- Tail fuel management can be reset by selecting manual mode, then reselecting auto mode. If the conditions that caused termination of tail fuel management no longer exist, management will resume.
- Cold fuel is recirculated (see following).

Cold Fuel Recirculation

Fuel temperature is maintained above freezing. Phase one involves tanks 1 and 3 and applies when fuel quantity in each main tank is greater than 6,214 kilograms. When the fuel temperature sensed in the tank 3 tip falls to within 6°C of the fuel freeze point, tanks 1 and 3 transfer pumps will be turned on and their fill valves will open. An alert, COLD FUEL RECIRC will be displayed. The transfer will continue until fuel temperature rises 5°C, or for 15 minutes. Should the tail and/or wing fuel temperature drop within 3°C of the freeze value, an alert FUEL TEMP LO will be displayed. Phase two involves the tail tank. When the temperature sensed in the tail tank falls to within 8°C of the fuel freeze point, the fuel within the tail tank is recirculated in order to raise the temperature. If the fuel temperature drops to within 5°C of the fuel freeze point, about one third of the tail fuel is transferred forward. It is then replaced with warmer fuel from another tank. If the fuel temperature drops to within 3°C of the fuel freeze point, tail fuel management is terminated.

Fuel Manifold Draining

When the fuel quantity in tank 2 drops to less than about 816 kilograms, the manifold drain float valve in tank 2 will open to drain the fuel manifold into tank 2. The manifold drain float valve is not dependent on system operation, auto or manual. If the fuel system is in auto the FSC will open the manifold drain/outboard fill valves in tanks 1 and 3 when the fuel quantity in tank 2 is less than 680 kilograms. This will allow air into the fuel manifold. If the fuel system is in manual the manifold drain/outboard fill valves will open when the MANF DRAIN switch is pushed. The FUEL MANF DRAIN alert will be displayed in auto or manual when the manifold drain/outboard fill valves are open.

Preflight Checks

The FSC will perform preflight checks. The preflight test can be initiated by maintenance. The preflight tests consist of both standard and conditional tests. The following functions are performed:

- The standard test will:
 1. Record fuel float faults from refueling.
 2. Verify manifold pressure sensor operation.
 3. Verify fuel dump valves closed.
 4. Verify all main tank pumps are operational and supplying at least 15 psi fuel pressure.
 5. Verify crossfeed valve operation.

6. Verify fill valve operation.
7. Verify fuel temperature probe operation.
 - The conditional test will:
 1. If more than 681 kilograms of fuel is in the lower auxiliary tank, verifies lower auxiliary tank pump operation. In addition, if the auxiliary tank is not full, verifies lower aux fill valve operation.
 2. If total usable fuel is more than 27,216 kilograms, verifies ability to fill and empty upper auxiliary and tail tanks. If upper auxiliary tank is not full, verifies ability to transfer tail fuel into and out of upper auxiliary tank.

Ballast Fuel Control

The FSC will recognize when ballast fuel is being carried and will keep it in its proper tank. Ballast fuel may be carried in tank 2, the upper auxiliary tank, or the tail tank. Only one tank can be assigned for ballast fuel. Tank 2 is allowed to have only up to 11,340 kilograms of ballast fuel. All or part of the fuel in the upper auxiliary tank may be ballast. The tail tank cannot contain both ballast and usable fuel. The fuel must be either all ballast or all usable fuel. The flight crew enters the amount and location of ballast fuel in the FMS, and the FSC then manages it appropriately. In the case of the tail tank, two switches on the aft maintenance panel must also be positioned.

Fuel Dump System Backup

The FSC will back up the manual/mechanical system for fuel dump. The FSC does not have control of the fuel dump valves. The fuel dump valves are always controlled by the flight crew. When the first main tank fuel quantity reaches the undumpable level of about 5,443 kilograms, the transfer pump in that tank will be shut off and all crossfeed valves will close.

When fuel dump terminates by the flight crew selecting the FUEL DUMP switch off, the following functions are mechanically performed and backed up by the FSC:

- Crossfeed valves close.
- Transfer pumps turn off.
- Tank pumps are correctly reconfigured for the amount of fuel remaining.
- Fuel is rescheduled as required.

Early Transfer and No Transfer of Tip Tank Fuel

The FSC will correct for early transfer or no transfer of tip tank fuel. In the case of early transfer the FSC will turn on the transfer pump in affected tank and open the tank fill valve. In the case of no transfer, normal lateral fuel imbalance requirements are stopped. The FSC will alternate between the other two main tanks using their transfer pumps and opening the fill valve of the affected tank until the usable fuel is distributed equally. An alert, TNK 1/3 TIP TRAPPED, will be displayed.

Equalization of Tank Quantities

The FSC will equalize tank quantities during low fuel flight. When tank 2 is below 18,824 kilograms, the FSC will correct fuel quantity imbalance between any two main tanks that exceeds 1,089 kilograms.

The FSC will maintain wing fuel quantity balance between tanks 1 and 3. Imbalance correction between tanks 1 and 3 stops when wing tip fuel quantity is less than 227 kilograms or tank 2 quantity is less than 1,814 kilograms.

Fuel Tank Overfill Correction

The FSC will correct for tank overfill. For the main and auxiliary tanks, the FSC stops transfer and depressurizes the manifold, then determines which tank is overfilled and controls the quantity of that tank 907 to 1,361 kilograms below full. All three main tanks are controlled at 907 to 1,361 kilograms below full for the remainder of the flight.

Tail tank overfill correction occurs as follows: After the FSC detects the overfill float has gone up, fuel will be transferred out until the total quantity is below 5,443 kilograms or until the overfill condition stops. The tail tank will then be limited to a maximum of 5,443 kilograms. If the tail tank overfills twice on the same flight, fuel will be transferred out of the tail tank until the total tail tank quantity is below 4,536 kilograms. If the tail tank overfills a third time on the same flight, tail fuel management will be terminated and the tail tank will be emptied.

Compensation for Inoperative Components

The FSCs will reconfigure the fuel system for failure of various elements. The FSC can compensate for a number of fuel system component failures by use of alternate pumps and flow paths.

The FSC will turn off all transfer pumps and close the crossfeed valves if a dump valve fails open.

The FSC will employ special management procedures to compensate for various components being inoperative at the beginning of a flight.

The FSC will monitor itself and other components for correct operation. A large number of system components are continually monitored. If any fail to operate properly, the FSC can, in many cases, use alternate means to accomplish the desired action.

The FSC will detect and report faults to the CFDS.

Manual Reversion

The FSC will revert to manual for certain failure modes. The FSC is unable to accommodate certain component failure modes and conditions. When these occur, the FSC will revert to the manual mode and the flight crew will be notified with an alert.

The FSC establishes the following fuel system configuration when it reverts to manual mode:

- Tank 1, 2, and 3 pumps on.
- Fill valves remain in previous state.
- Crossfeed valves commanded closed.
- Tank 1 and 3 transfer pumps off.
- Tank 2 transfer pump remains in previous state.
- Aux tank L and R trans pumps on.
- Tail tank trans pump on.
- Tail tank alt pump off.

EIS Test Display

All FUEL synoptic data digits will be crossed out with amber Xs when all of the conditions are met as follows:

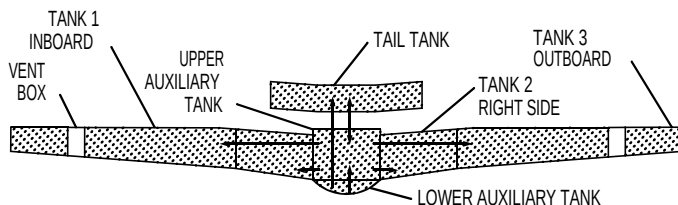
- The aircraft is on the ground.
- The aircraft is operational.
- The ANNUN LT TEST button on the forward overhead panel is pushed.
- The FUEL synoptic has been selected to appear on the SD.

Fuel Components

Chapter Fuel Section 20

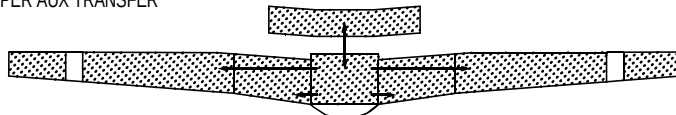
Automatic Fuel Scheduling

LOWER AUX TRANSFER



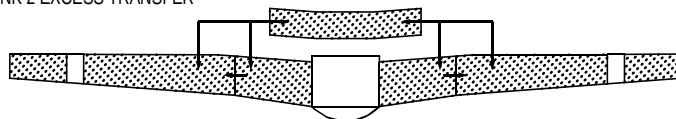
Typical fuel transfer and burn schedule with the fuel system performing tail fuel management, starting with full tanks after T/O. Fuel is transferred from the aux tanks to keep the main tanks full as fuel is burned by the engines.

UPPER AUX TRANSFER



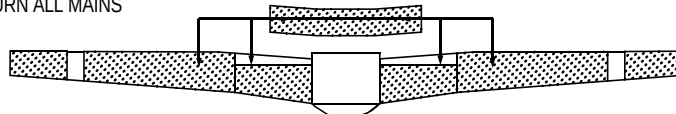
With tail fuel management, the CG is controlled automatically to a preselected aft limit, by allowing fuel to be transferred from any tank to or from the tail tank. The lower aux tank is the first tank to empty. Upper aux tank fuel transfers to main tanks until empty.

TANK 2 EXCESS TRANSFER



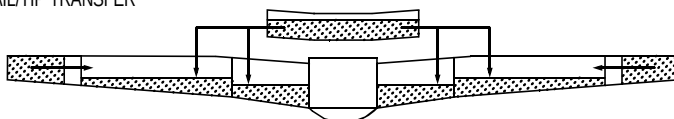
Tank 2 fuel is transferred into tanks 1 & 3 until tanks are equal.

BURN ALL MAINS



Tail tank fuel will transfer forward during descent when descending below 26,750 feet or when any main tank quantity decreases below 5,216 kgs. When tanks 1 or 3 decrease to below 5,216 kgs the associated tip tank will transfer inboard.

TAIL/TIP TRANSFER



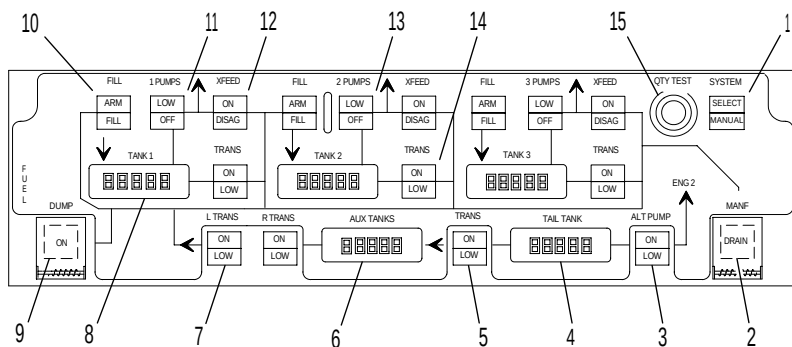
DB1-2-1939

Intentionally
Blank

Fuel Controls and Displays

Chapter Fuel Section 30

FUEL Control Panel



FORWARD OVERHEAD PANEL

DB1-2-1683

1. SYSTEM SELECT/MANUAL Switch - amber

This is an alternate action switch that allows selection between manual and auto modes.

There are 2 alternating auto channels. During auto operation, one of the 2 auto channels is not used. Each time auto is selected, the previous unused auto channel is activated.

SELECT illuminates amber if the fuel system reverts from auto to manual. In this case, the SEL FUEL SYS MAN alert will be on the EAD and the crew should push the FUEL SYSTEM SELECT switch to lock the system in manual.

MANUAL illuminates amber if the system is in manual.

MANUAL flashes amber if the system is in auto and a switch on the FUEL control panel has been pushed that has no effect in auto.

If fuel system is in AUTO, selecting MANUAL configures the fuel system as follows:

- Tank 1, 2, and 3 pumps on.
- Fill valves remain in previous state.

- Crossfeed valves commanded closed.
- Tank 1 and 3 transfer pumps off.
- Tank 2 transfer pump remains in previous state.
- Aux tank L and R transfer pumps on.
- Tail tank transfer pumps on.
- Tail tank alt pump off.

2. MANF DRAIN Switch - amber

The MANF DRAIN switch is a momentary switch that controls the main tank 1 and 3 manifold drain/outboard fill valves. In the manual mode the switch operates both valves together for manual drain function. The switch has no effect in the auto mode. In the auto mode the valves are controlled individually by the fuel system controller as alternate fill valves or together for manifold drain function.

Illuminates amber in manual mode when valves are commanded open and illuminates in auto mode only when the valves are used to drain the manifold. The FUEL MANIFOLD DRAIN alert is displayed when DRAIN is illuminated. DRAIN will extinguish when the FSC commands the outboard fill valves closed.

The switch is guarded and safetied.

3. TAIL TANK ALT PUMP Switch - blue/amber

The TAIL TANK ALT PUMP switch is a momentary switch that turns the tail tank alternate pump on and off when the fuel system is in the manual mode. The switch has no effect in the auto mode.

ON illuminates blue when the tail tank pump is commanded on.

In manual mode, LOW illuminates amber when the tail tank pump is commanded on and has low pressure.

This pump is powered by the right emergency ac bus and supplies engine 2 exclusively.

4. TAIL TANK Quantity Readout

Total fuel quantity in tail tank.

5. TRANS ON/LOW Switch (Tail Tank) - blue/amber

The tail tank TRANS switch is a momentary switch that turns the tail tank transfer pumps on and off when the fuel system is in the manual mode. When on, the upper aux tank fill valve opens to transfer fuel into the upper aux tank. The switch has no effect when the system is in the auto mode.

ON illuminates blue when the transfer pump has been commanded on.

In manual mode, LOW illuminates amber when the pump is commanded on and has low pressure.

6. AUX TANKS Quantity Readout

Total fuel quantity in upper and lower aux tanks.

7. L/R TRANS ON/LOW Switch (Upper and lower aux tanks) - blue/amber

The aux tank TRANS switches are momentary switches that turn the upper and lower pumps on and off when the fuel system is in the manual mode. The switch has no effect in the auto mode. L TRANS controls both upper and lower LH auxiliary transfer pumps. R TRANS controls both upper and lower RH auxiliary transfer pumps.

ON illuminates blue when the respective transfer pump has been commanded on.

LOW illuminates amber when the upper aux tank pump is commanded on and has low pressure continuously for several minutes.

8. TANK 1/2/3 Quantity Readouts

Total fuel quantity in respective main tank.

9. DUMP ON Switch - amber

The DUMP switch is an alternate action switch that starts and stops the fuel dump sequence. When on:

- Switch illuminates amber.
- Fill valves and fill isolation valves close (except upper aux tank).
- Upper aux fill valve will open.
- Tank pumps turn on (except tail tank alternate pump).
- Transfer pumps turn on.
- Crossfeed valves open.
- Left and right dump valves open.

Fuel dump is independent of the auto/manual mode of the FSC. Dump valves are not controlled by the FSC. Pumps are staggered on to avoid excessive electrical power transient loads. Fuel dump rate is initially about 2,631 kilograms per minute. As tank fuel levels drop and pumps shut off, the dump rate decreases. An average for the entire fuel dump is about 2,268 kilograms per minute.

Maintaining a high nose-up attitude during dump may cause main tank dump low level shutoff at a higher than normal fuel level.

The FUEL DUMP LEVEL alert notifies the flight crew that the dump system did not automatically shut off at the low level cutoff and manual stop dump is required.

This switch is guarded, safetied, and amber stripes will be visible on the side of the switch when not activated.

10. ARM/FILL Valve Switch (Tanks 1, 2, and 3) - blue

The FILL valve switch is a momentary switch that opens and closes the respective tank fill valves when the system is in the manual mode. Pushing the switch arms the fill valve for as long as the switch is held. Tank 2 fill valve will remain armed following switch release if any upper aux tank pump is on. Tank 1 and 3 fill valves will remain armed following switch release if tank 2 contains more than 18,144 kilograms of fuel. When the fill valve is armed, pushing the switch causes the fill valve to disarm.

ARM illuminates blue when the respective fill valve is armed.

FILL illuminates blue when the respective fill valve is open. In the auto mode, the light is inhibited.

11. 1/3 PUMPS LOW/OFF Switch (Tanks 1 and 3) - amber

The tank 1/3 PUMPS switch is a momentary switch that turns the respective tank forward and aft pumps on and off when the fuel system is in the manual mode.

LOW illuminates amber when all pumps that are commanded on have low pressure.

In manual mode, OFF illuminates amber when neither pump is commanded on. In auto mode, OFF illuminates amber when pumps are off due to suction feed.

12. XFEED ON/DISAG Switch (3) - blue/amber

The XFEED switch opens and closes the respective crossfeed valves when the fuel system is in the manual mode.

ON illuminates blue when the respective crossfeed valve is commanded open.

DISAG illuminates amber when the actual valve position differs from the commanded position. In the auto mode, the light is inhibited for 4 seconds to prevent illumination during valve transition.

13. 2 PUMPS LOW/OFF Switch (Tank 2) - amber

The tank 2 PUMPS switch is a momentary switch that turns the forward, left aft, and right aft tank 2 pumps on and off when the system is in the manual mode.

LOW illuminates amber when all pumps are commanded on and have low pressure.

OFF illuminates amber when none of the three pumps is commanded on.

14. TRANS ON/LOW Switch (Tanks 1, 2, and 3) - blue/amber

The main tank TRANS switch is a momentary switch that turns the respective tank transfer pumps on and off when the fuel system is in the manual mode.

ON illuminates blue when the respective transfer pump has been commanded on.

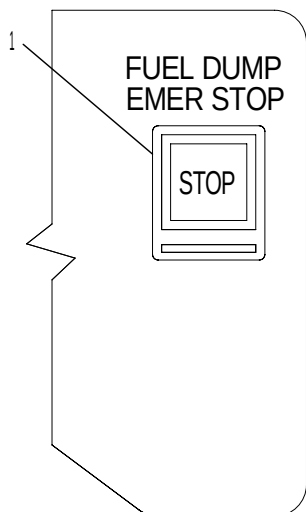
LOW illuminates amber when the respective pump is commanded on and has low pressure.

15. QTY TEST Button

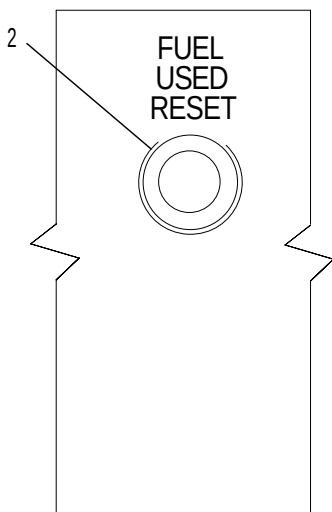
The QTY TEST button is a momentary button that initiates a test of both channels of the Fuel Quantity Gaging System (FQGS). When the button is released, the FQGS returns to normal using the alternate channel.

The FQGS is automatically tested when ac electrical power is applied to the aircraft.

FUEL DUMP EMER STOP Switch and FUEL USED RESET Switch



FORWARD OVERHEAD PANEL,
LEFT SIDE



FORWARD OVERHEAD PANEL,
RIGHT SIDE

LB1-3-0215

1. FUEL DUMP EMER STOP Switch - amber

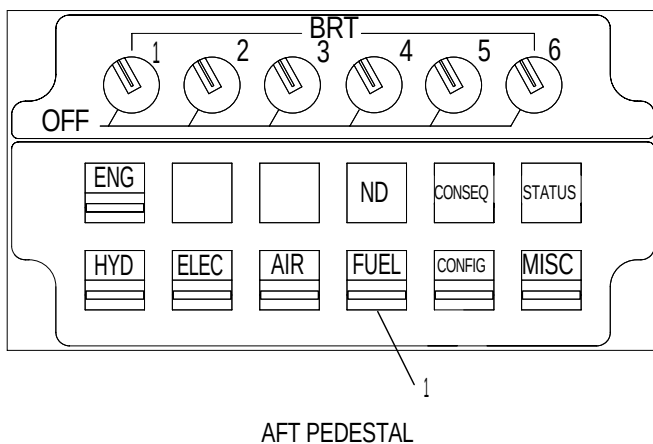
Alternate action switch that electrically overrides the fuel DUMP switch by reversing the signal and stopping the fuel dump sequence. Illuminates amber if dump valves have been commanded closed.

The fuel dump sequence can be restarted by pushing the FUEL DUMP EMER STOP switch a second time.

2. FUEL USED RESET Button

Push switch to reset fuel used indications to zero on the corresponding synoptic display.

FUEL Cue Switch



LB1-3-0216

1. FUEL Cue Switch - white

Illuminates white when a FUEL alert is displayed on EAD.

When pushed:

- MASTER WARNING or MASTER CAUTION lights will extinguish.
- Reminder message will replace the alert, except for Level 3 alerts.
- FUEL synoptic comes into view on the SD.

Some level 1 alerts are maintenance alerts that appear on the SD STATUS page only. These maintenance alerts will not illuminate the cue switch or the MASTER CAUTION lights.

CG 31.8
GW 269.80 MT

FUEL 65 908 KG
BALLAST 4082KG
AUX TANK

11700

APU

TAIL

11700

11700

9572

TIP 4000

16216

9639

TIP 4000

10°C

9300

5216

-27°C

ENG 2

DUMP

FUEL SYSTEM TEST

1

2

3

4

5

6

7

8

9

10

11

October 02, 2006

4. Valves

Closed valves are shown as white circles with lines perpendicular to the fuel line. Open valves are shown as green circles with lines parallel to the fuel line. If a transfer valve does not go to commanded position within 5 seconds, DISAG appears over the valve. The valve will be displayed in the commanded position. There is no fuel dump valve symbology on the FUEL synoptic unless the DUMP switch is on or either dump valve is in disagree.

5. Fill Valve

Fill valves are shown as spigots. These spigots and associated lines are green when open, white when armed, and not shown when off.

6. Fuel Pump

Pumps are shown as white circles when off. When on, pumps are shown as green circles with vanes. If pressure is low, the pump is displayed in amber with a small P shown adjacent to the amber pump.

7. Main Tank Quantity Readouts (3)

The fuel quantity in each main tank is indicated by the level of white shading. Total fuel quantity is also displayed digitally within each tank symbol. Unit of measurement is kilograms. If fuel is transferred from tip of tank 1 or 3 too early, TIP LOW will appear adjacent to the appropriate tank. If fuel is trapped in the tank, TIP XXX will appear in amber adjacent to the tank, where XXX is the quantity trapped.

8. Tail Tank Quantity Readout

The total fuel quantity in the tail tank is indicated by the level of gray shading. Total fuel quantity is also displayed digitally within the tank symbol. Unit of measurement is kilograms.

9. Fuel Temperature Readout

Fuel temperature is displayed for the tail tank and right wing tank. Digits are normally white but become amber and boxed in amber when the fuel temperature drops below the limit temperature.

10. Aux Tanks Quantity Readout

The upper and lower aux tank quantities are indicated by the level of gray shading. The total quantity of both upper and lower aux tanks is shown digitally in the upper aux tank symbol. Unit of measurement is kilograms.

11. Center of Gravity Readout

Center of gravity is displayed digitally in top left corner. Digits are normally white but are boxed and turn amber if the CG goes out of limits. If no valid CG data is available the digits are replaced by an amber X.

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

Red Boxed Alerts (Level 3)

TNK 1/2/3 FUEL QTY LO (FUEL) - Indicates approximately 4536 kgs of fuel in each tank 1 and 3, and approximately 1724 kgs in tank 2 during fuel dump.

Amber Boxed Alerts (Level 2)

BALST FUEL DISAG (FUEL) - Amount of fuel in the ballast tank is not compatible with the FMS ballast fuel value or FSC does not acknowledge receipt of ballast fuel data from the FMS.

CG OUT OF LIMIT (FUEL) - Aircraft CG out of aft limit.

DUMP VLV L/R DISAG (FUEL) - Left or right fuel dump valve is in disagreement with commanded position.

FSC AUTO FAIL (FUEL) - FSC cannot control the fuel system in auto mode and has not reverted to manual.

FUEL DUMP LEVEL (FUEL) - The fuel dump function did not shut off at the programmed level.

FUEL OFF SCHEDULE (FUEL) - Fuel in the tanks is not according to schedule.

FUEL QTY ALERTS (FUEL) - Data transmission is affected. There is a possible total failure of fuel alerting or a particular bus structure is inoperative.

FUEL QTY FAULT (FUEL) - Fault in one or more tank quantity indicating systems or total quantity has not changed in the past 12 minutes.

FUEL QTY/USED CHK (FUEL) - FSC senses a discrepancy between calculated and indicated fuel on board. There may be a fuel leak.

FUEL SYS ALERTS (FUEL) - Display electronic units not receiving valid data from fuel system controllers. Fuel system warning and alerting is faulty.

LAT FUEL UNBAL (FUEL) - The fuel quantities in tanks 1 and 3 differ more than the allowed tolerance of 1,800 kilograms.

TAIL FUEL QTY LO (FUEL) - During operation with alternate tail pump on, tail fuel quantity is becoming low.

TAIL PUMPS LO (FUEL) - Fuel pressure is low on the tail tank pumps that are commanded on (one or both).

TANK 1/3 PUMPS LO (FUEL) - Output pressure of both tank 1 or 3 pumps is low. Manual mode.

TANK 2 PUMPS LO (FUEL) - Output pressure of the three tank 2 pumps is low. Manual mode.

TNK 1 AFT PMP LO (FUEL) - The fuel pressure output of the aft fuel pump in tank 1 is low. The pump should be considered inoperative.

TNK 1/2/3 FWD PMP LO (FUEL) - The fuel pressure output of the forward fuel pump in tank 1, 2, or 3 is low and the pump is commanded on. Manual mode. Inhibited at high pitch angles with low fuel levels.

TNK 1/3 TIP FUEL LO (FUEL) - The tank 1 or 3 tip quantity is low. Manual mode.

TNK 1/2/3 XFER PMP LO (FUEL) - The fuel pressure output of the transfer pump in tank 1, 2, or 3 is low and the pump is commanded on. Manual mode.

TNK 2L AFT PMP LO (FUEL) - The fuel pressure output of the left aft fuel pump in tank 2 is low and the pump is commanded on. Manual mode.

TNK 2R AFT PMP LO (FUEL) - The fuel pressure output of the right aft fuel pump in tank 2 is low and the pump is commanded on. Manual mode.

TNK 3 AFT PMP LO (FUEL) - The fuel pressure output of the aft fuel pump in tank 3 is low and the pump is commanded on. Manual mode.

TNK TAIL OVERFILL (FUEL) - Horizontal stabilizer fuel vent box contains fuel.

TNK WING OVERFILL (FUEL) - One or both wing fuel vent boxes contain fuel.

Amber Alerts (Level 1)

AFSC FAULT (FUEL) - There is an internal fault detected by the AFSC. System operation may be affected.

APU FSO NOT CLSD (FUEL) - The APU fuel shutoff valve did not close following normal or emergency shutdown.

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AUX LWR L/R PMP OFF (FUEL) - With the fuel system in the auto mode, the FSC has detected low pressure in the respective pump and turned the pump off. The rate of fuel transfer from the lower aux tank will be slower.

AUX LWR L/R PMP LO (FUEL) - With the fuel system in manual mode, the respective fuel pump outlet pressure is low and the pump should be considered inoperative. The rate of fuel transfer from the lower aux tank will be slower.

AUX LWR PUMPS LO (FUEL) - Fuel pressure output is low on the lower auxiliary tank pump(s) that are commanded on (one or both).

AUX UPR L/R PUMP OFF (FUEL) - With the fuel system in the auto mode, the FSC has detected low pressure in the respective pump and turned the pump off. The rate of fuel transfer from the upper aux tank will be slower.

AUX UPR L/R PUMP LO (FUEL) - With the fuel system in manual mode, the respective fuel pump outlet pressure is low and the pump should be considered inoperative. The rate of fuel transfer from the upper aux tank will be slower.

AUX UPR PUMPS LO (FUEL) - Fuel pressure output of the upper auxiliary tank pumps that are commanded on is low.

BALST SW/FMS XCHK (FUEL) - The tail tank ballast switches on the maintenance panel are not in agreement with the declared ballast in the FMS.

CG DISAG (FUEL) - Disagreement between the aircraft CG displayed on the SD and the CG entered in the FMS. Confirm fuel load and entered data.

COLD FUEL RECIRC (FUEL) - The FSC is automatically circulating fuel in tanks 1 and 3 or the tail tank to increase the fuel temperature. If the fuel temperature continues to drop to within 3°C of the freeze point, the FUEL TEMP LO alert will be displayed.

ENG 1/3 SUCT FEED (FUEL) - Engine 1 or 3 on suction feed only. Appears only with the FSC in auto, when all boost pumps and crossfeeds for that engine are off.

FMS DUMP DISABLED (FUEL) - Fuel dump not stopped at FMS dump-to-gross-weight.

FSC CONFIG (FUEL) - FSC and DEU not in agreement on fuel system configuration.

FSC FAULT (MAINT) - The FSC has detected an internal fault. The fuel system will continue to run in auto mode.

FSC MODE FAULT (FUEL) - Operating mode or mode selection (auto/manual) disagree between processors.

FUEL CONTAMINATED (FUEL) - Two or more fuel filters are clogged, fuel may be contaminated.

FUEL DUMP ON (FUEL) - DUMP switch is in the ON position.

FUEL LRU INOP (MAINT) - Maintenance has deactivated a fuel system component. The FSC will compensate in the auto mode.

FUEL MANF DRAIN (FUEL) - Fuel manifold drain has been commanded, either automatically by FSC, or manually by the crew pushing the MANF DRAIN switch.

FUEL QTY 2 DISAG (FUEL) - There is a discrepancy in the tank 2 fuel quantity indication. This alert appears if the fuel quantity measurement disagrees with the position of the 4,536 kilogram float in the tank.

NOTE: If the aircraft has a right wing down ground attitude, this alert may appear with a normally functioning float switch and fuel quantity system at quantities below 7,258 kilograms in Tank 2.

FUEL QTY TST FAIL (FUEL) - The fuel quantity test has failed.

FUEL SYS MANUAL (FUEL) - Fuel system is in the manual mode.

FUEL SYS TST FAIL (FUEL) - Automatic fuel system preflight test has failed.

FUEL TEMP FAIL (FUEL) - The wing or tail fuel tank temperature sensor is inoperative.

FUEL TEMP LO (FUEL) - The tail and/or wing fuel is within 3°C of the fuel freeze value (or colder).

FUEL VALVE FAULT (FUEL) - Either the tail fill isolation valve, the aux fill isolation valve, or the left or right outboard fill/manifold drain valve is inoperative. The FSC may be operated in the auto mode, however, tail fuel management may be affected.

FUEL XFEED1/2/3 DISAG (FUEL) - Tank 1, 2, or 3 fuel crossfeed valve is failed open or closed.

SEL FUEL SYS MAN (FUEL) - The fuel system has reverted to manual mode but the FUEL SYSTEM SELECT switch is in the auto position.

MD-11 Flight Crew Operations Manual

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- TAIL ALT PUMP LO (FUEL)** - The tail tank ALT PUMP pressure is low. Additional pumps should be turned on to prevent a possible engine 2 flameout.
- TAIL ALT PUMP OFF (FUEL)** - With the fuel system in the auto mode, the FSC has detected low pressure from the tail tank ALT PUMP and turned the pump off. If there is fuel in the tail tank, it may be trapped.
- TAIL FUEL FWD (FUEL)** - Control of aircraft CG by tail fuel management has been terminated. The FSC will transfer all fuel out of the tail tank. Recovery of tail fuel management may be possible by selecting the FSC to manual and back to auto.
- TAIL L/R PUMP LO (FUEL)** - The respective fuel pump outlet pressure is low. The rate of fuel transfer from the tail tank will be slower.
- TAIL L/R PUMP OFF (FUEL)** - With the fuel system in the auto mode, the FSC has detected a fault in the respective tail tank transfer pump and turned the pump off.
- TANK 1/2/3 PUMPS LO (FUEL)** - All the boost pumps in the associated tank have low pressure.
- TANK 1/2/3 PUMPS OFF (FUEL)** - All the tank pumps in the associated tank have been selected off.
- TNK 1/3 AFT PMP LO (FUEL)** - The respective fuel pump pressure is low.
- TNK 1/3 AFT PMP OFF (FUEL)** - With the fuel system in the auto mode, the FSC has detected a fault in the respective fuel tank pump and has turned the pump off.
- TNK1/2/3 FUEL QTY LO (FUEL)** - Indicates approximately 1724 kgs of fuel in tank 1, 2, or 3.
- TNK 1/2/3 FWD PMP LO (FUEL)** - The respective fuel pump pressure is low.
- TNK 1/2/3 FWD PMP OFF (FUEL)** - With the fuel system in the auto mode, the FSC has detected a fault in the respective fuel tank pump and has turned the pump off.
- TNK 1/3 TIP FUEL LO (FUEL)** - Tank 1 or 3 tip compartment is not full when there is more than 2,700 kilograms of fuel in the inboard compartment. This alert (level 1) appears in the auto mode only and the FSC will take corrective action once the engines are started.

TNK 1/3 TIP TRAPPED (FUEL) - Fuel in tank 1 or 3 tip is trapped and unusable. Fuel in the tip tank is not transferring to the inboard compartment.

TNK 1/2/3 XFER PMP LO (FUEL) - The respective tank transfer pump pressure is low.

TNK 2L/2R AFT PMP LO (FUEL) - The respective fuel pump pressure is low.

TNK1/2/3 XFER PMP OFF (FUEL) - With the fuel system in the auto mode, the FSC has detected a fault in the respective transfer pump and has turned the pump off.

TNK 2L/2R AFT PMP OFF (FUEL) - With the fuel system in the auto mode, the FSC has detected a fault in the respective fuel tank pump and has turned the pump off.

Cyan Alerts (Level 0)

FUEL SYS TEST - The automatic fuel system preflight test is in progress.

FUEL XFEED 1/2/3 ON - Fuel system 1, 2, or 3 XFEED switch is on.

REFUELING - The refueling panel is armed. Aircraft should not be dispatched in the refueling mode.

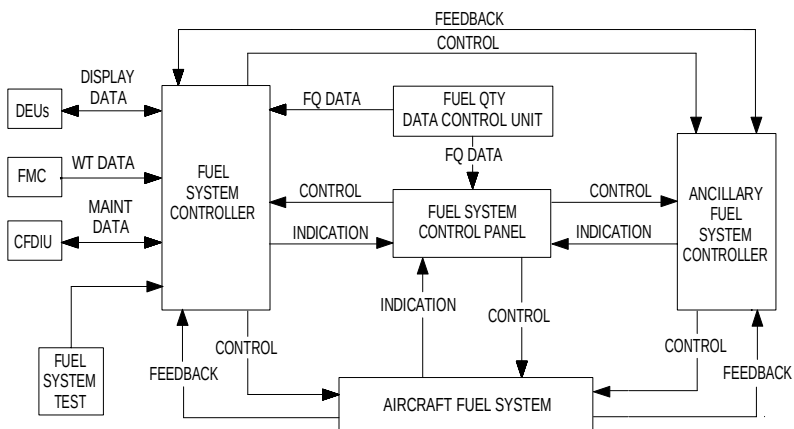
Fuel

Functional Schematic

Chapter Fuel

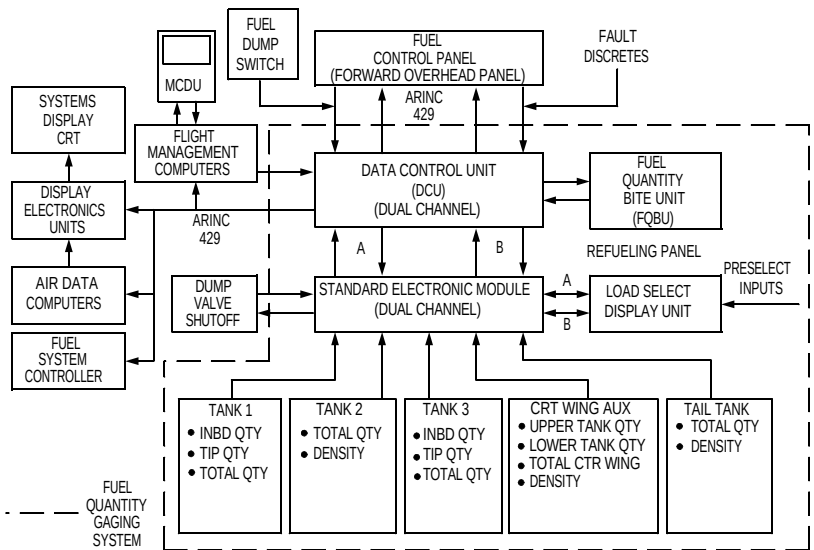
Section 50

Control Interface



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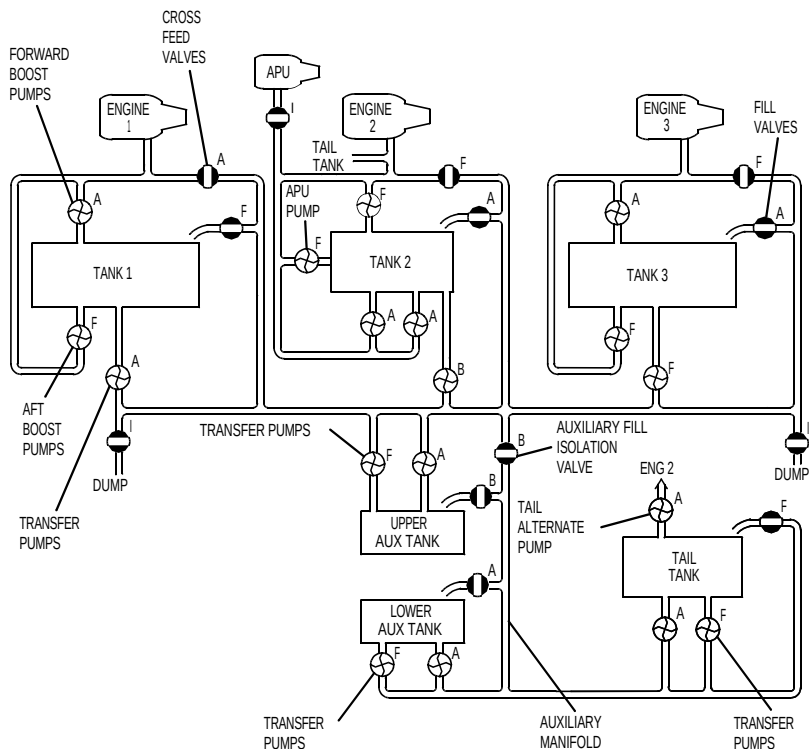
FQGS Interface



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MD-11 Flight Crew Operations Manual

Pump and Valve Schematic



VALVE



PUMP

F - Controlled by fuel system controller (FSC)

A - Controlled by ancillary fuel system controller (AFSC)

B - Controlled by both FSC and AFSC

I - Independent control

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Hydraulics

Description and Operation

Chapter Hyd

Section 10

General

Three hydraulic systems provide power to operate nose gear steering, landing gear, wheel brakes, and flight controls.

Hydraulic pressure for each system is provided by two engine-driven pumps. Three separate, parallel hydraulic systems operate continuously at 3000 psi. Each system includes an identical 12-gallon capacity hydraulic reservoir. Each reservoir can be filled from a pressurized ground service unit or from an unpressurized container by use of a hand pump near the fill panel.

Two electrically-driven auxiliary pumps provide an additional source of pressure to hydraulic system 3. If the Air-driven Generator (ADG) is deployed, it powers auxiliary pump 1.

Two hydraulic Reversible Motor Pumps (RMP) provide an alternate source of hydraulic pressure. One RMP is installed between systems 1 and 3, and the other is installed between systems 2 and 3.

Two Non-reversible Motor Pumps (NRMP) provide an alternate source of hydraulic pressure to the rudders and stabilizer trim.

Three bladder-type accumulators in each brake system provide a backup source of hydraulic pressure, and partial antiskid capability if the hydraulic system malfunctions. Pressure gauges are installed on each accumulator.

A BRAKE PRESS indicator, on the cockpit brake control panel, allows verification of brake pressure for aircraft towing.

Heat generated in the engine-driven pumps carries through the case drain lines to the reservoirs and back through the suction lines to the engine-driven pumps. This serves as the main heat radiating system. The entire pressure and return network is a secondary heat radiating system.

Switches on the HYD control panel control hydraulic components and annunciators. Hydraulic system indications are displayed on the System Display (SD) when the hydraulic synoptic is selected with the HYD cue switch. Hydraulic alerts are displayed on the Engine And Alert Display (EAD) and SD.

Hydraulic System Controller

The Hydraulic System Controller (HSC) has two modes, auto or manual. Only one mode is in control at any time.

If an active HSC channel fails, control is automatically transferred to an alternate HSC channel. Should the second HSC channel fail, the system automatically reverts to the manual mode, and the crew manually operates the hydraulic system for the remainder of the flight.

In the auto mode the HSC performs the following functions:

- Controls the hydraulic system components which supply and route hydraulic pressure.
- Monitors the phase of flight and configures components accordingly.
- Conducts a preflight pressure test of the auxiliary hydraulic pumps and RMPs when initiated by the flight crew.
- Conducts a test of engine-driven hydraulic pumps after engine start.
- Reconfigures the hydraulic systems for various component, system, and aircraft failures.
- Monitors itself and hydraulic components for proper operation and reports faults to the Centralized Fault Display System (CFDS) and EIS.
- Reverts to manual mode if the auto mode is inoperative or if any combination of hydraulic system, and/or aircraft abnormal operation requires more than four engine-driven hydraulic pumps to be commanded off.

Reservoirs and Accumulators

Identical pressurized reservoirs are provided for each system. Mounted on each reservoir is a fluid quantity transmitter, low level switch, fluid temperature sensor, and a pressure relief valve. The 12-gallon reservoir is normally serviced to about 6 gallons. Each hydraulic system has a bladder-type accumulator to store pressurized fluid. After engine shutdown, reservoir pressure is maintained for about 8 hours.

Engine-Driven Pumps

Left and right engine-driven hydraulic pumps are mounted on the accessory drive for each engine. The left pump normally powers its respective system. The right pump is armed to operate if the left pump pressure drops below a predetermined value. The left pump low pressure switch electrically commands the right pump on. When the left pump pressure rises above a predetermined value, the right pump is electrically armed after 20 seconds. The HSC monitors the right pump and commands the right pump on or armed if it does not automatically respond to the electrical commands given by the left pump pressure switch.

The pump FAULT light on the HYD control panel illuminates if pump pressure is low and the pump is on, or if pump case drain temperature is high.

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In manual, the pilot commands the left pump on or off, and the right pump armed or off. In auto, the HSC commands the left pump on or off, and the right pump armed, on, or off.

Engine-driven pumps are interchangeable.

Electric Auxiliary Pumps

Two electrically-driven auxiliary pumps, installed in system 3, are used to pressurize system 3 on the ground or in flight. These pumps also pressurize system 1 via the 1-3 RMP, and system 2 via the 2-3 RMP.

In an emergency, auxiliary pump 1 is automatically controlled and powered by a deployed ADG. The ADG remains in the hydraulic mode unless the ADG/ELEC switch on the ELEC control panel is pushed.

The flight crew controls the auxiliary pumps with the HSC in auto or manual mode.

When either auxiliary pump is commanded on, the recirculation fans are automatically commanded off. When the auxiliary pumps are commanded off, the recirculating fans are automatically commanded back on.

Reversible Motor Pumps

Two Reversible Motor Pumps (RMP) allow transfer of pressure from an operating hydraulic system to a non-operating hydraulic system. Pressure is transferred in either direction. No fluid transfer takes place. The transfer of energy is mechanical. RMPs are installed between systems 1-3, and between 2-3. The RMPs pressurize a system to 3,000 psi in about 3 seconds when driven by a fully pressurized system. A pressure differential between the connected systems causes pumping direction reversal. If there is no flow demand, the delivery from the pump stops.

The RMPs are commanded off when:

- The reservoir fluid quantity on either side of the RMP is less than 1 gallon.
- The ADG is deployed and ADG/ELEC switch on the ELEC control panel is not illuminated.

Both RMPs are commanded on at automatic slat extend and when any engine N2 rpm is less than 45 percent during taxi or takeoff/land flight phases.

In the manual mode the RMPs are manually commanded on or off. In the auto mode the RMPs are commanded on or off by the HSC.

Rudder Standby Power/Non-Reversible Motor Pumps

Two Non-reversible Motor Pumps (NRMP) provide an alternate source of hydraulic power to the rudder and horizontal stabilizer when the primary hydraulic system cannot provide power. Hydraulic system 2 powers the upper rudder and horizontal stabilizer via the 2-1 NRMP when hydraulic system 1 cannot provide power. Hydraulic system 3 powers the lower rudder via the 3-2 NRMP when hydraulic system 2 cannot provide power.

A compensator is installed for each NRMP. Low NRMP compensator fluid level automatically disarms the affected pump.

NRMPs operate when the primary system pressure falls below 2,000 psi $\pm$ 200 psi. The NRMPs stop operating when the primary system pressure rises above 2,000 psi $\pm$ 400 psi.

The NRMPs are always armed in flight. The HSC disarms the NRMPs only during ground maintenance via input through the Multifunction Control Display Unit (MCDU).

Hydraulic System Enhancement

A check valve and motor-operated shutoff valve in hydraulic system 3 enhances system integrity if there is an uncontained failure of engine 2. The installation uses reservoir level sensing to detect leakage, and automatically shuts off system 3 elevators and 3-2 NRMP when the fluid in the reservoir reaches a predetermined level. This action retains enough fluid in hydraulic system 3 for pitch and roll control through use of horizontal stabilizer trim and lateral controls powered by system 3. The HYD 3 ELEV OFF alert is displayed when the shutoff valve closes.

Flight Control Bypass Valve

A hydraulic system 3 flight control bypass valve isolates its associated flight control actuators from pressure when the rest of the system is pressurized. This valve is controlled by the HSC only during ground maintenance via input through the MCDU.

Automatic Operation

The HSC automatically controls the hydraulic system. The HSC calculates aircraft flight phases and configures hydraulic components as necessary.

Normal Configuration

Normal configuration is as follows:

- Engine-driven left pumps on.
- Engine-driven right pumps armed.

- Reversible motor pumps (RMP) off.
- Auxiliary pumps off.
- NRMP rudder standby power armed.
- Flight control bypass valve open.

Normally, only the left engine-driven pump in each system operates. The right pump is controlled by an armed circuit external to the HSC, which turns on the right pump if the left pump pressure falls below 2,400 psi. The HSC also monitors this function and turns on the right pump if the external circuitry fails to do so.

Hydraulic Preflight Pressure Test

The hydraulic preflight pressure test, the first of two preflight tests required to test the hydraulic system, is performed only before engine start, and uses system 3 auxiliary pumps and both RMPs. The following conditions must be satisfied in order to start or continue the test:

- Aircraft is on the ground and all engine FUEL switches are off.
- Hydraulic fluid quantity in each system reservoir is more than a predetermined value, and the quantity transmitters are operative.
- Flight control bypass valve is in the normal position (open).
- System pressure sensors are operative.
- System pressure is less than 1,000 psi when the test is started.
- Auxiliary pumps are off when the test is started.
- Auxiliary pumps are not operated manually by anyone in the cockpit during the test.
- AC ground service bus is energized.

The pressure test can be initiated only by the flight crew. This is necessary to assure proper safety clearance before pressurizing hydraulically powered components. When the HYD PRESS TEST switch is pushed, a series of commands, sent by the HSC, accomplishes the following:

- Performs internal HSC checks for about the first 45 seconds.
- Verifies each auxiliary pump independently produces at least 2,400 psi.
- Verifies RMP 1-3 is able to produce at least 2,400 psi in system 1 and that the associated shutoff valves operate correctly.
- Verifies RMP 2-3 is able to produce at least 2,400 psi in system 2 and that the associated shutoff valves operate correctly.
- Verifies hydraulic fluid quantity in each system reservoir is at least 3.8 gallons (14.38 liters) with the system pressurized.
- Verifies engine pump pressure low switches function correctly while the pumps are depressurized.

Hydraulic Preflight Engine-Driven Pump Test

The hydraulic preflight engine-driven pump test, the second of two preflight tests required to test the hydraulic system, is performed when the ignition is on for engine start.

The following conditions must be satisfied in order to start or continue the test:

- Aircraft is on the ground and the associated engine FUEL switch is on.
- Hydraulic fluid quantity in each system reservoir is more than 2.5 gallons (9.46 liters).
- System pressure sensors are operative.
- Auxiliary pumps remain off.

NOTE: If the auxiliary pump(s) are on when engine 3 is started, the HSC turns them off in preparation for system 3 pump test.

When an ENG IGN switch is on, each left engine-driven pump is off and each right pump is armed. After each engine is started and at idle rpm, a test of the engine-driven pumps is automatically conducted.

The pumps are tested to ensure the following:

- The HSC can control the engine-driven pumps.
- The right engine-driven pump produces at least 2,800 psi.
- The right engine-driven pump ARM circuits are operating correctly.

Preflight Fail Alerts Test

If either preflight hydraulic system test fails, a HYD PRES TST FAIL or HYD PUMP TST FAIL alert appears on the EAD. The HSC clears the alert when manual mode is selected. Selecting manual clears the alert only, and does not fix the cause.

Parked Configuration

When the aircraft is on the ground and all engine FUEL switches are OFF, the HSC places the hydraulic system in the normal configuration.

Taxi Configuration

During taxi, the HSC:

- Does not turn the engine-driven pumps off.
- Places the hydraulic system in the normal configuration after each engine-driven pump test is completed. Taxi is defined as aircraft on the ground, any engine FUEL switch ON, and computed airspeed less than or equal to 80 knots.

Takeoff/Land Configuration

Takeoff configuration is aircraft on the ground, speed more than 80 KTS, and any engine FUEL switch on.

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Land configuration is aircraft in the air, altitude equal to or less than 17,750 feet, and slats, flaps, or landing gear extended.

During takeoff/land configurations, the HSC accomplishes the following:

- Allows the engine-driven pumps to remain on.
- Turns off the RMPs when the reservoir fluid quantity is less than 4 quarts, or when certain multiple faults exist.

Cruise Configuration

When in cruise flight, the HSC configures the hydraulic system in the normal configuration. Cruise flight is defined as gear, flaps, and slats retracted, or baro-corrected altitude more than 17,750 feet.

Abnormal Operations

The hydraulic system can be placed into abnormal operations by aircraft failures/faults external to the hydraulic systems, or by component failures within the systems.

The aircraft failures are as follows:

- Engine fire - When an ENG FIRE handle is pulled, a mechanical valve shuts off hydraulic fluid to both engine-driven pumps. The HSC turns off both pumps except during the take-off and landing phase and the taxi phase when this condition is sensed.
- Engine N2 rpm less than 45 percent - Both RMPs are turned on in the taxi or takeoff/land phases of flight.
- Inflight engine start - When the engine FUEL switch is off, and the engine N2 rpm is less than 45 percent, the HSC turns off both engine-driven pumps to enhance engine rotation during starting.
- Electrical power during cruise condition - All left engine-driven pumps are controlled by one electrical circuit and all right pumps by another circuit. Loss of power causes all pumps on a circuit to go on. When the HSC recognizes a failure of one of these circuits, it turns off the opposite pumps. However, if one of the pumps on the failed circuit has low pressure, the HSC turns on the other pump in that system.

The HSC takes corrective action to perform the following functions in response to system faults:

- The HSC pressurizes all three hydraulic systems if the aircraft is in the taxi or takeoff/land phase of flight.
- The HSC pressurizes two systems if the aircraft is in the cruise phase of flight.
- Restores system pressure if the original pressure source fails and there is adequate fluid in the affected system(s).
- Depressurizes a system with high temperature if the aircraft is not in taxi or takeoff/land phase of flight.

-
- Depressurizes a system when its reservoir quantity drops to 2.5 gallons (9.46 liters) if the aircraft is not in taxi or takeoff/land phase of flight.
 - Turns off a source of excessive pressure and substitutes one of correct pressure if the aircraft is in the cruise phase of flight.

When the aircraft enters the land phase, these systems are repressurized, if the reservoir fluid level is greater than 1.0 gallon (3.78 liters).

Fault Priorities

A system of priorities is established for execution of abnormal/emergency procedures by the HSC. For conditions with equal priority, the first condition detected has priority.

The procedure for the highest priority condition is executed when it is detected. Any procedure for a lower priority condition that may be in progress at that time is aborted.

Once the procedure for a higher priority condition is completed, normal monitoring resumes and a lower priority procedure is restarted if still applicable.

The priority sequence is as follows:

1. Loss of fluid (reservoir fluid <2.5 gallons).
2. Engine fire.
3. Inflight engine start.
4. Engine N2 rpm less than 45 percent.
5. System pressure low or high.
6. System temperature or engine-driven pump case drain temperature high.
7. Engine-driven pump pressure low.
8. Engine-driven pump electrical power loss.

Reversion To Manual Mode

The HSC reverts to the manual mode if:

- Manual is selected.
- Both HSC channels fail.
- Tripple hydraulic failure occurs.
- Dual hydraulic failure occurs and at the same time an EDP fails in the remaining system.
- More than four EDPs are required to be commanded off because of detected failures.

EIS Test Display

All hydraulic synoptic data digits are crossed with amber X's when all of the following conditions are met:

- The aircraft is on the ground and operational.

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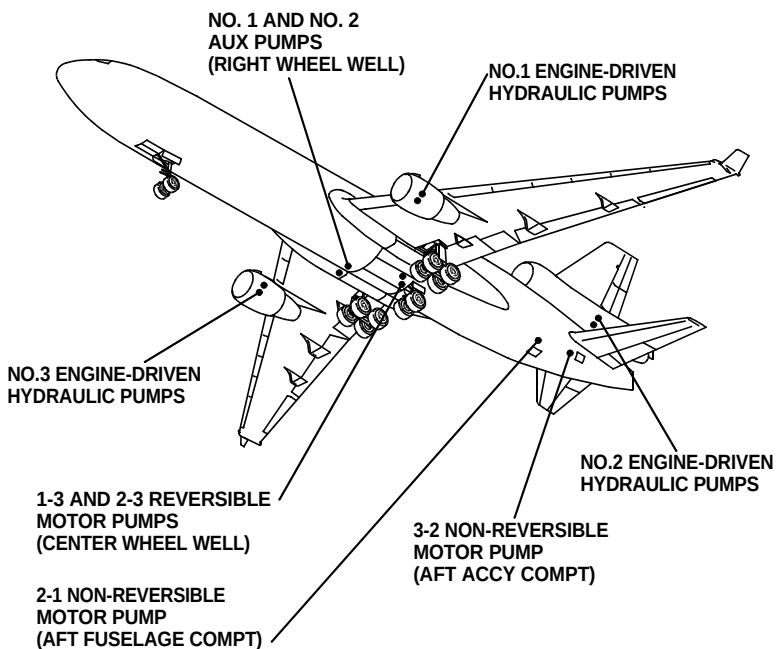
- The ANNUN LT TEST button on the overhead panel is pushed.
- The HYDRAULIC synoptic is selected on the SD.

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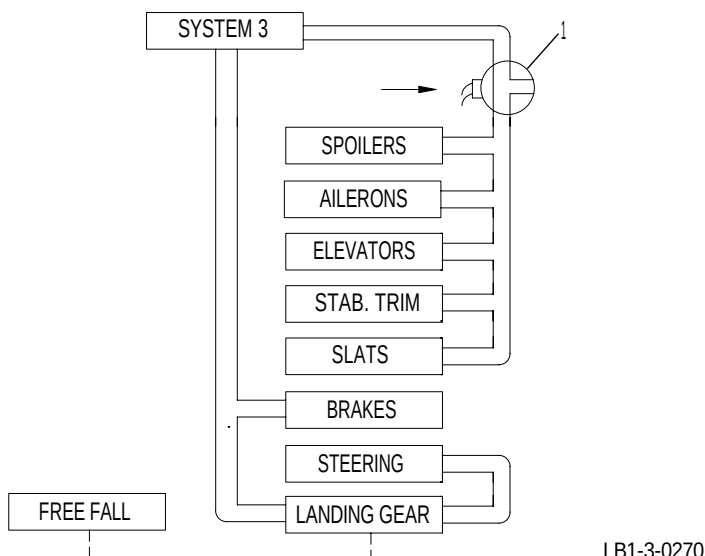
Hydraulics Components

Chapter Hyd Section 20

Pump Locations



Flight Control Bypass Valve



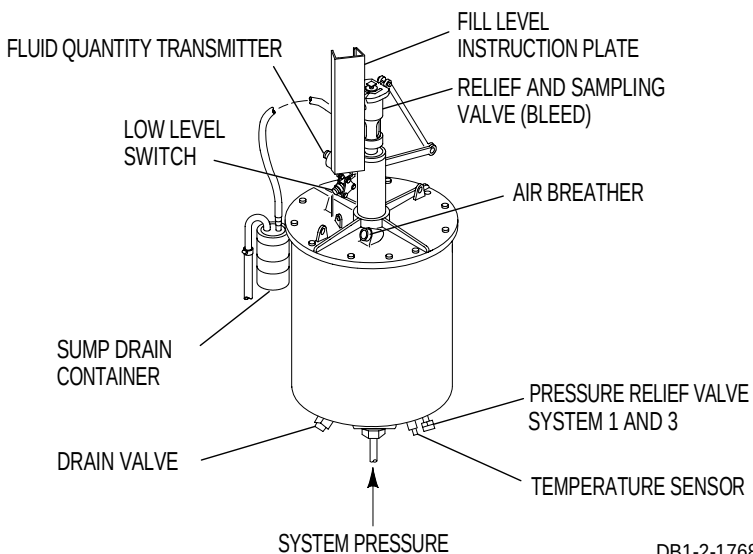
1. Flight Control Bypass Valve

Amber alert HYD SYS 3 ISOL is displayed on the EAD when:

- Flight control bypass valve is not in the normal open position.
- Maintenance closes the valve via the Multifunction Control Display Unit (MCDU) for maintenance reasons.
- Circuit breaker is open.

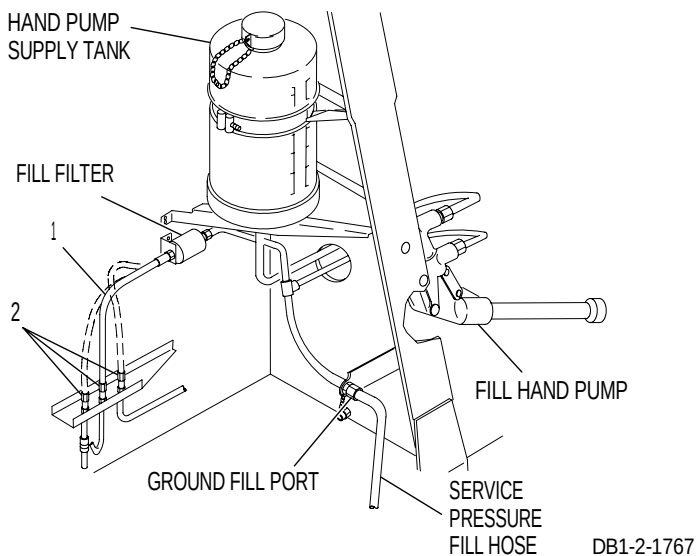
NOTE: The airplane cannot be dispatched. Maintenance action is required. This valve can only be closed on the ground.

Hydraulic Reservoir Components



DB1-2-1768

Reservoir Servicing



1. Fill Hose

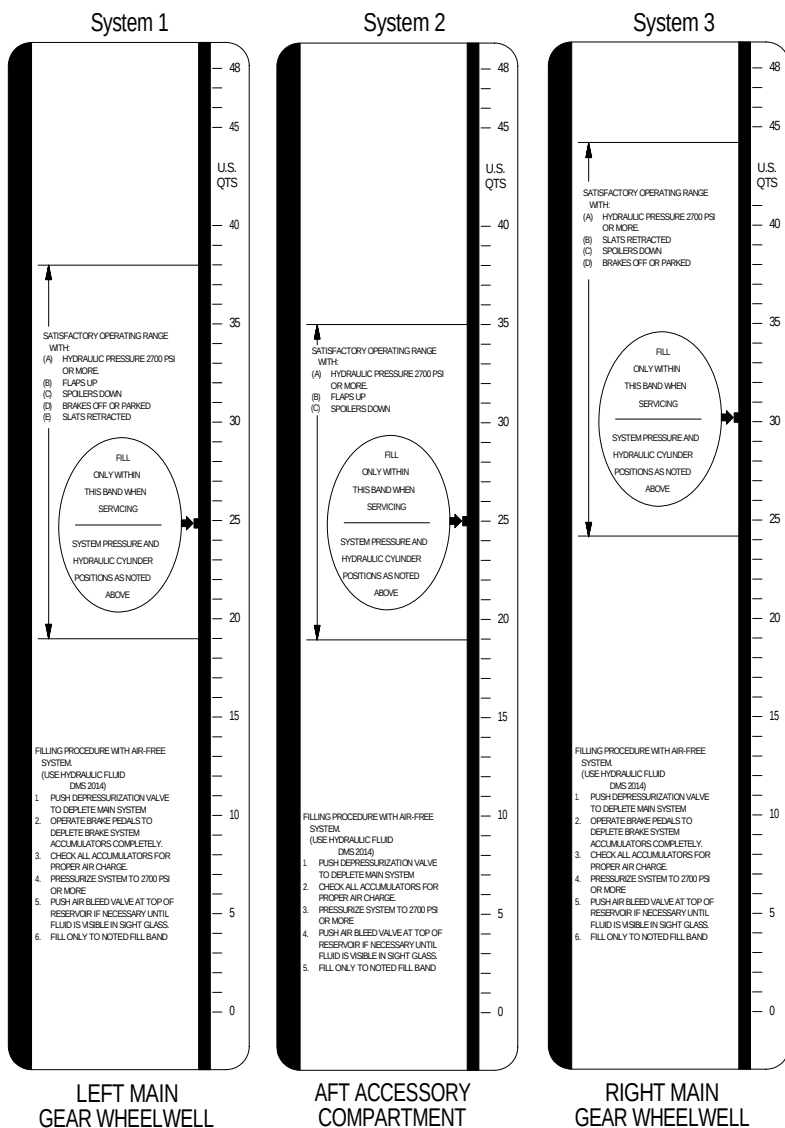
This hose connects to the system requiring service.

2. System 1/System 2/System 3

All three hydraulic system reservoirs are serviced from the left main landing gear wheel well by use of the fill hand pump or by the ground fill port.

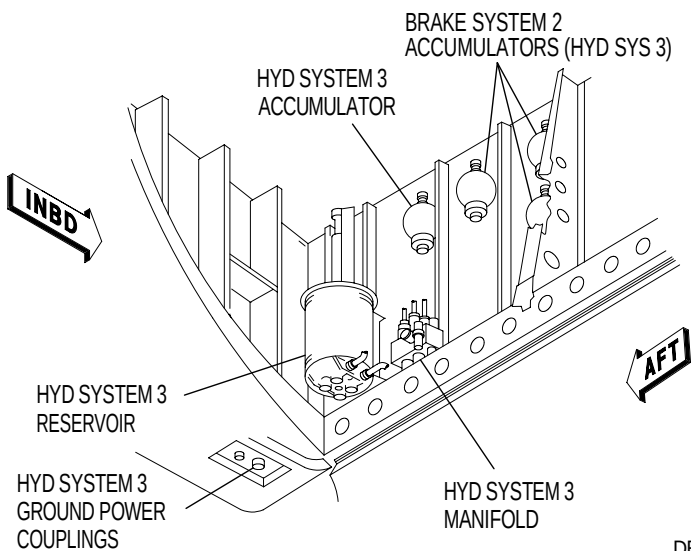
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Reservoir Placards



LB1-3-0269

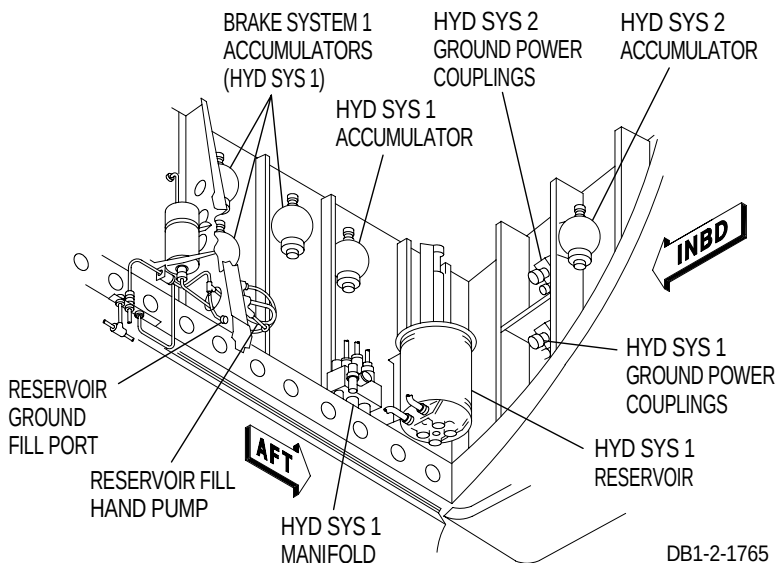
Right Wheel Well Components



DB1-2-1766

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Left Wheel Well Components



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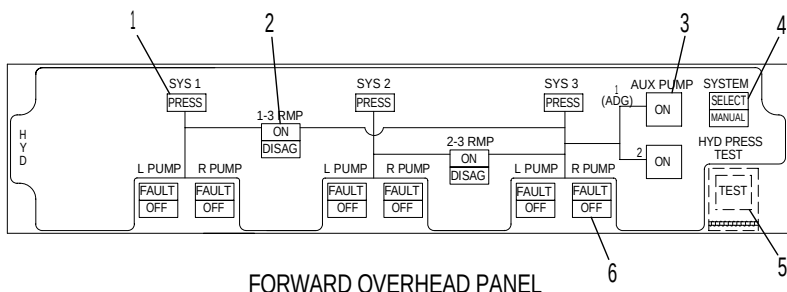
Hydraulics

Controls and Displays

Chapter Hyd

Section 30

Hydraulic Control Panel



DB1-2-1761

1. SYS1/2/3 PRESS Light - amber

PRESS - Illuminates amber when system pressure is less than 2400 psi or more than 3500 psi. Extinguishes when system pressure is within limits.

2. 1-3/2-3 RMP Switch - blue/amber

This switch is a momentary switch that controls the RMP shutoff valves when the system is in manual mode. The switch has no effect in the auto mode.

ON - Illuminates blue when the pump is commanded on (valves commanded open).

The RMPs are commanded on and provide hydraulic system pressure when:

- Any engine N2 falls below 45 percent during taxi or takeoff and landing phases of flight.
- The engine-driven pumps are not able to maintain necessary system pressure during taxi, takeoff and landing phases of flight.
- The pump receives an auto slat extend signal.

DISAG - Illuminates amber when one of the valves does not open and the RMP is commanded on. DISAG also illuminates if the RMP is commanded off and the internal pump pressure is more than 600 psi, but is inhibited for 8 seconds when the Hydraulic System Controller (HSC) is in auto.

ON and DISAG extinguish when the pump is commanded off. This pump is commanded off when:

- It is not required for the phase of flight.
- The associated hydraulic reservoir has less than 1.0 gallon of fluid (all phases of flight).
- The Air Driven Generator (ADG) is released and the ADG switch is in the hydraulic position.

3. Electric AUX PUMP 1 (ADG)/2 Switch - blue

The electric AUX PUMP switch is a momentary switch that commands the electric auxiliary hydraulic pump on and off when the system is in manual or auto mode. The aux pumps are under automatic control only during the manually activated preflight hydraulic pressure test.

ON - Illuminates blue when the AUX PUMP is commanded ON. When on, the applicable pump supplies pressure to hydraulic system 3.

When either pump is commanded ON, the recirculation fans are automatically commanded off. When the pumps are commanded off, the recirculation fans are automatically commanded on.

AUX PUMP 1 is powered by the ADG when the ADG is deployed in the hydraulic mode.

4. HYD SYSTEM SELECT/MANUAL Switch - amber

This is an alternate action switch that allows selection between manual and auto modes.

There are 2 alternating auto channels. During auto operation, one of the 2 auto channels is not used. Each time auto is selected, the previous unused auto channel is activated.

SELECT - Illuminates amber when the system reverts to manual with auto selected. The SEL HYD SYS MAN alert is displayed on the EAD. Pushing the HYD SYSTEM SELECT/MANUAL switch locks the system in manual.

MANUAL - Illuminates amber when the system is in manual.

MANUAL - Flashes amber when auto is selected and a switch on the HYD control panel has been pushed that has no effect in auto.

5. HYD PRESS TEST Switch - blue

The HYD PRESS TEST switch is a guarded momentary switch that initiates the hydraulic pressure test in the HSC. The switch has no effect when the system is in manual.

TEST - Illuminates blue when testing is in progress.

The switch, when pushed, tests the electric aux pumps and RMPs. If the test is stopped before completion, the RMPs and aux pumps turn off. If the electric AUX PUMP switches are pushed during the test, the test stops.

6. SYS 1/2/3 L/R PUMP Switches - amber

These system (SYS 1/2/3) switches command the left (L) engine-driven hydraulic pump on or off, and the right (R) engine-driven pump armed or off, when the respective system is in manual mode. The respective switches have no effect when the system is in auto.

The right pump is armed when the L PUMP switch is commanded on. If the left pump pressure is less than 2400 psi, the right pump is commanded on.

FAULT - Illuminates amber on the respective system PUMP switch when pump pressure is less than 2400 psi and the pump is on, or the pump case drain temperature is more than 100°C.

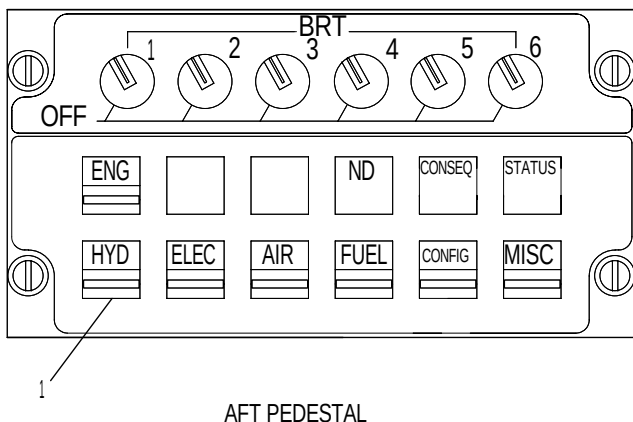
Both **FAULT** and **OFF** on the L PUMP switch are extinguished when the left pump is pressurizing its respective hydraulic system (SYS 1/2/3).

Both **FAULT** and **OFF** on the R PUMP switch are extinguished when the right pump is armed or is pressurizing its respective hydraulic system (SYS 1/2/3).

The pumps are commanded off when:

- Pump pressure is low.
- Pump case drain temperature is high.
- Fluid quantity is low.
- System temperature is high.
- System pressure is low.
- System pressure is high.
- The engine is started.
- The engine FIRE handle is pulled.

HYD Cue Switch



LB1-3-0272

1. HYD CUE Switch - white

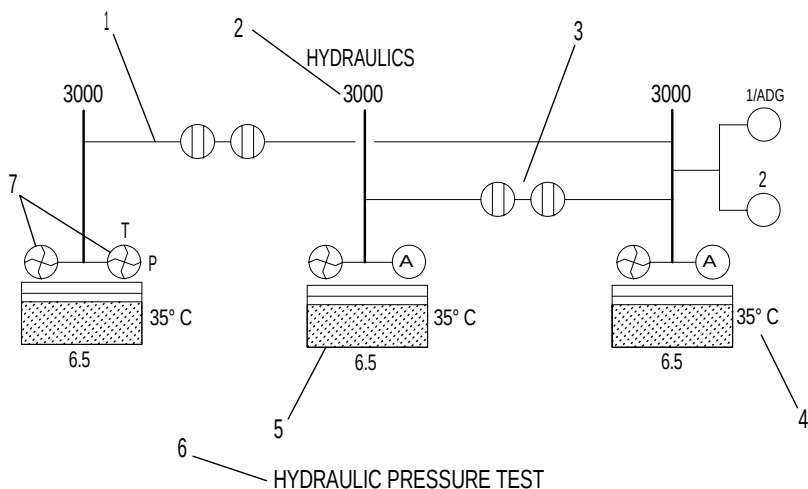
HYD - Illuminates white when a HYD alert is displayed on the EAD.

When pushed:

- MASTER CAUTION or MASTER WARNING lights extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- Synoptic and consequences are displayed on the SD.

Some Level 1 alerts are maintenance alerts that appear on the SD STATUS page only. The HYD cue switch and the MASTER CAUTION lights do not illuminate for these maintenance alerts.

SD Synoptic



LB1-3-0273A

1. Schematic Lines - green/white

Schematic lines representing hydraulic systems and pressure transfer lines are green when pressurized and white when unpressurized.

2. System Pressure Readout (3) - white/amber

Hydraulic system pressure (psi) is shown digitally at the head of each system. White digits turn amber and are boxed when the pressure is out of limits (high or low). When no valid pressure data is available, the digits are replaced by an amber "X".

3. Reversible Motor Pumps (2) - white/green/amber

RMPs are displayed as double valve symbols. When closed, the valves are white with valve lines perpendicular to the schematic line. When open, these valves are green and the valve lines are parallel to the schematic line. If the valves do not go to the commanded position within 8 seconds, the commanded valve position is displayed in amber with DISAG in amber above the valves.

4. Reservoir Temperature Readout (3) - white/amber

Reservoir temperature in degrees C is shown in white digits to the right of each reservoir. If the temperature exceeds 100 degrees C, the digits are displayed in amber and are boxed. The digits are replaced by an amber "X" when no valid temperature is available.

5. System Reservoir (3) - grey/white/cyan/amber

Hydraulic fluid quantity is shown as a grey shaded area, proportional to reservoir quantity. Quantity in gallons is displayed in white digits below each reservoir.

During minimum idle speed each tank is marked with a cyan line to represent the preflight quantity. This line is used as a reference to monitor for fluid leakage.

If the quantity drops below 2.5 gallons, the shaded area, the reservoir outline, and the quantity digits are displayed in amber. The digits are boxed.

If no valid quantity data is available, the digital quantity display and grey shading are removed, and the digital quantity is replaced by an amber "X".

6. HYDRAULIC PRESSURE TEST Display

This text appears during the hydraulic pressure test.

7. Engine and Auxiliary Pumps - white/green/amber

Engine pumps are shown as white circles when the pump is off or armed (containing the letter "A" when armed). When commanded on, the pumps are green circles with vanes.

Low pump pressure is shown as an amber pump symbol with the letter "P" displayed next to it.

High case drain temperature is shown as an amber pump symbol with the letter "T" above it.

Auxiliary pumps are shown as white circles when commanded off, and green circles with vanes when the pump is on.



Hydraulics Alerts

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

Red Boxed Alerts (Level 3)

HYD 1 & 2/1 & 3/2 & 3 FAIL (HYD) - Fluid quantity in respective systems (1 and 2/1 and 3/2 and 3) is less than 1 gallon or the system press and all pump press (L, R & RMP) are low and slats/flaps extended.

Amber Boxed Alerts (Level 2)

HSC AUTO FAIL (HYD) - HSC cannot control the hydraulic system in auto mode and has not reverted to manual.

HYD 1/2/3 FAIL (HYD) - Fluid quantity in respective system is less than 1 gallon or the system press and all pump press (L, R & RMP) are low and slats/flaps extended.

HYD 1/2/3 PRES HI (HYD) - Respective system pressure is more than 3500 psi.

HYD 1/2/3 PRES LO (HYD) - Respective system pressure is less than 2400 psi. Manual mode.

HYD 1/2/3 QTY LO (HYD) - Respective system fluid less than 2.5 gallons (manual mode only).

HYD 1/2/3 TEMP HI (HYD) - Respective system has exceeded 100 degrees C (manual mode).

HYD ALERTS (HYD) - Data interface between the HSC and the DEUs is not valid. Hydraulic alerts, synoptic and master warning are affected, however, quantity, pressure, and temperature alerting should be valid.

Amber Alerts (Level 1)

HYD 1/2 OFF (HYD) - Respective system engine driven pumps 1/2 and the respective reversible motor pumps 1-3/2-3 are off.

HYD 1/2/3 PRES LO (HYD) - Respective system pressure is less than 2400 psi. Auto mode.

HYD 1/2/3 QTY LO (HYD) - Respective hydraulic system fluid quantity is low. This alert is displayed if there is less than 4.75 gallons (system 1 and 2) or 6 gallons (system 3) on the ground prior to engine start, or less than 2.5 gallons after engine start.

- HYD 1/2/3 TEMP HI (HYD) - The temperature in the respective hydraulic system reservoir has exceeded 100 degrees C (212 degrees F).
- HYD 1-3/2-3 RMP DISAG (HYD) - 1-3/2-3 reversible motor pump not in commanded position.
- HYD 3 ELEV OFF (HYD) - The elevator shutoff valve in hydraulic system 3 is closed. Hydraulic system 3 is not powering the elevators.
- HYD 3 OFF (HYD) - System 3 engine driven pumps, both reversible motor pumps, and both auxiliary (electric) pumps are off.
- HYD LRU INOP (MAINT) - Maintenance has taken action to declare a hydraulic system component inoperative. The auto controller will reconfigure around the inoperative component in the auto mode.
- HYD PRES TST FAIL (HYD) - The flight crew initiated hydraulic pressure test has failed. A second test may be performed. If alert is displayed again, call maintenance.
- HYD PUMP 1L/1R/2L/2R/3L/3R <2800 (HYD) - Respective pump pressure is less than 2800 psi during engine pump preflight test. This test is accomplished by the HSC during each engine start. This alert will be displayed in conjunction with a HYD PUMP TST FAIL alert.
- HYD PUMP 1L/1R/2L/2R/3L/3R FAULT (HYD) - The respective engine-driven hydraulic pump pressure or temperature is out of limits. The HSC will turn off the affected pump when the aircraft is in cruise.
- HYD PUMP 1L/1R/2L/2R/3L/3R OFF (HYD) - The respective engine-driven hydraulic pump is off.
- HYD PUMP TST FAIL (HYD) - The engine-driven hydraulic pump preflight pressure test has failed.
- HYD SYS 3 ISOL (HYD) - The flight control bypass valve is closed. Hydraulic system 3 pressure is not available to the flight controls.
- HYD SYS MANUAL (HYD) - The HSC is in the manual mode.
- RUD STBY LWR OFF (HYD) - The 3-2 non-reversible motor pump is inoperative. Standby hydraulic power to the lower rudder is not available.
- RUD STBY UPR OFF (HYD) - The 2-1 non-reversible motor pump is inoperative. Standby hydraulic power to the upper rudder and stabilizer trim motor is not available.
- RUDDER BOTH INOP (HYD) - No primary or non-reversible motor pump power to the upper or lower rudder actuator.

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RUDDER LWR INOP (HYD) - No primary or non-reversible motor pump power to the lower rudder.

RUDDER UPR INOP (HYD) - No primary or non-reversible motor pump power to the upper rudder.

SEL HYD PMP 1L/1R OFF (HYD) - Respective engine 1 left pump/right pump pressure is less than 2400 psi or pump case drain temperature is more than 100 degrees C (212 degrees F) (manual mode).

SEL HYD PMP 2L/2R OFF (HYD) - Respective engine 2 left pump/right pump pressure is less than 2400 psi or pump case drain temperature is more than 100 degrees C (212 degrees F) (manual mode).

SEL HYD PMP 3L/3R OFF (HYD) - Respective engine 3 left pump/right pump pressure is less than 2400 psi or pump case drain temperature is more than 100 degrees C (212 degrees F) (manual mode).

SEL HYD SYS MAN (HYD) - The hydraulic system has reverted to manual mode but the HYD SYSTEM SELECT switch is in the auto position.

Cyan Alerts (Level 0)

HYD 1-3/2-3 RMP ON - Respective reversible motor pump 1-3/2-3 is on.

HYD AUX PUMP ON - One or both of the hydraulic system aux pumps are on.

HYD PRES TEST - The automatic hydraulic pressure test is in progress.

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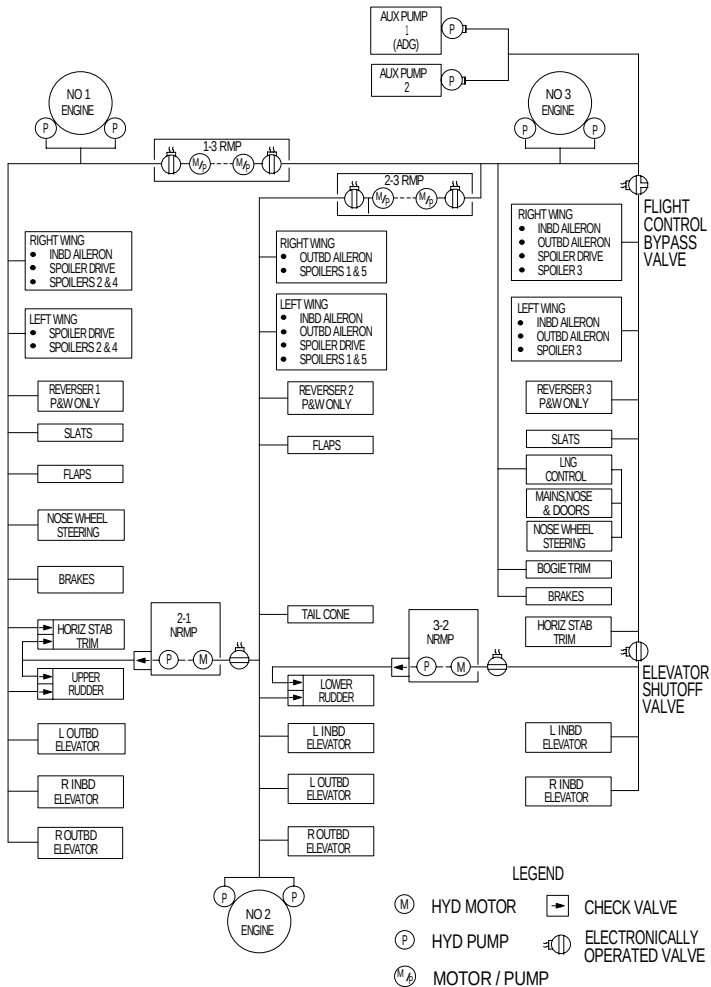
Hydraulics

Functional Schematics

Chapter Hyd

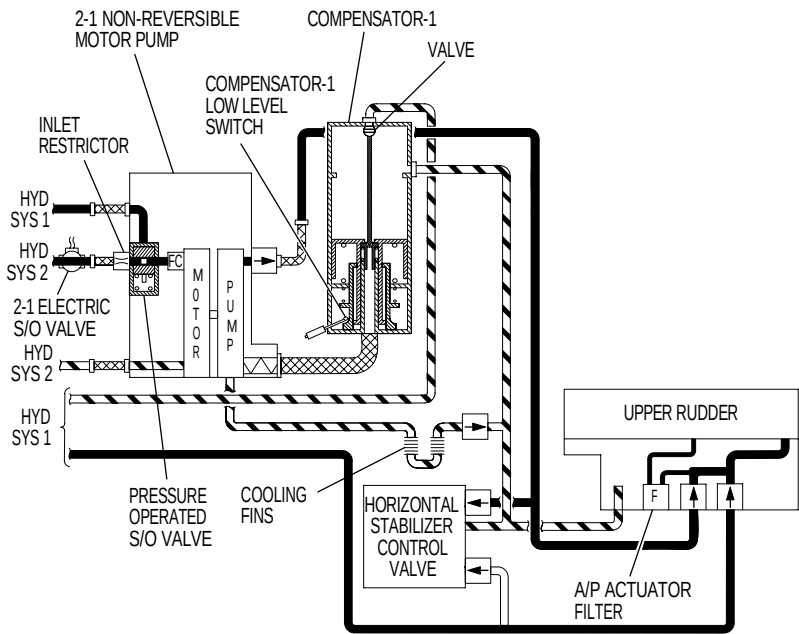
Section 50

Systems Block Diagram



DB1-2-1760

Upper Rudder Diagram



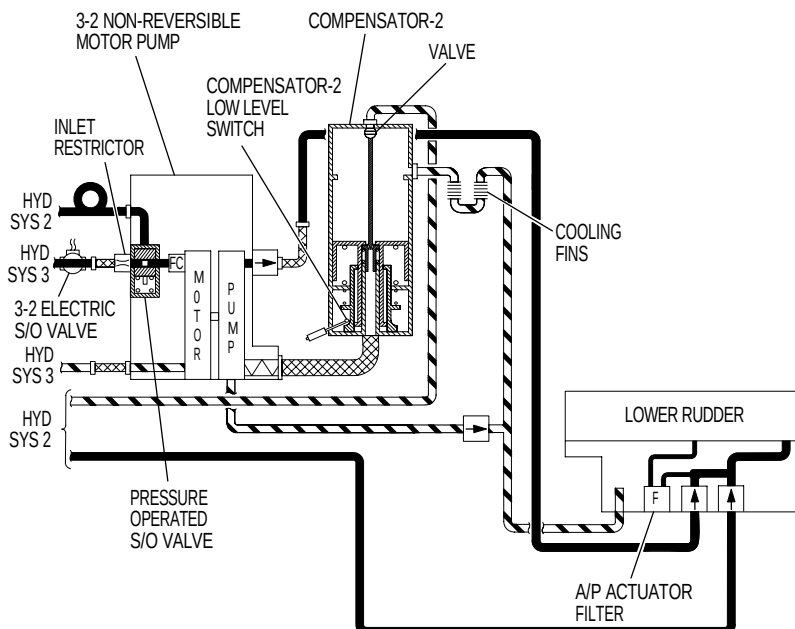
LEGEND:

- HOSE
- 3000 LB PRESSURE
- CONTROL
- RETURN
- SUCTION

DB1-2-1764

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Lower Rudder Diagram



LEGEND:

HOSE	
3000 LB PRESSURE	
CONTROL	
RETURN	
SUCTION	

DB1-2-1763

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Ice and Rain Protection

Description and Operation

Chapter Ice

Section 10

General

Ice and rain protection consists of:

- Airfoil (wing and tail) anti-ice systems.
- Engine cowl anti-ice system.
- Air data heater system (pitot, static, TAT).
- Windshield/window anti-ice and defog systems.
- Windshield wiper system.
- Ice detection system.
- Miscellaneous heating systems.

The ice detection system will primarily be used in the automatic mode.

The Environmental Systems Controller (ESC) monitors engine cowl anti-ice system operation.

The Pneumatic Systems Controller (PSC) monitors wing and horizontal stabilizer anti-ice system operation.

The Miscellaneous Systems Controller (MSC) automatically controls and monitors pitot tube, static port, and AOA heater operation.

Ice and rain protection controls are located on the forward overhead panel. Alerts are displayed on the Engine and Alert Display (EAD) and System Display (SD) to provide system status information to the crew.

The AIR cue switch illuminates when alerts related to wing, tail, engine anti-ice, and ice detection system (if installed) are displayed.

The MISC cue switch illuminates when alerts related to air data heaters, windshield heat, or defog are displayed.

Airfoil Anti-Ice System

The airfoil anti-ice systems consist of the wing anti-ice system and the tail (horizontal stabilizer) anti-ice system. Pushing the WING and TAIL ANTI-ICE switches ON prior to takeoff arms the airfoil anti-ice systems to function automatically when left and/or right ground sense mechanisms sense flight.

The two PSCs provide the following functions:

- Controls pneumatic system temperature and pressure requirements for ice protection.
- Monitors horizontal stabilizer anti-ice valve position.
- Monitors system ducts for leaks.

Wing Anti-Ice System

The wing anti-ice system provides ice protection for the outboard wing slats. Ice protection is not provided for the inboard slats.

Each wing has 8 leading-edge slats. The outermost slats (4 through 8) are anti-iced with hot engine bleed air. The bleed air source is either low stage air, high stage air, or low stage air augmented with high stage air, depending on the engine power setting.

The bleed air, drawn from the main pneumatic manifold, flows through a stainless steel duct to the piccolo duct. The piccolo duct, installed in the slats, controls the anti-ice airflow rate. The anti-ice air is discharged from the piccolo duct and through double skin passages. After leaving the double skin passages, the air is discharged overboard at the slat lower trailing edge.

Pushing the WING ANTI-ICE switch to ON before takeoff arms the airfoil anti-ice system to automatically function when the left and/or right ground sense mechanism senses flight. The system automatically turns off when the aircraft lands. An alert warns the flight crew if the system fails to shut off when on the ground. The slats may be damaged if the anti-ice system is on longer than 15 seconds while on the ground.

During a Center Accessory Compartment (CAC) manifold fail condition, wing anti-ice is turned off automatically in order to facilitate the automatic manifold decay check.

The wing anti-ice valves are armed on the ground or open during flight if selected on. The two wing anti-ice shutoff valves are normally opened and closed with the WING ANTI-ICE switch on the ANTI-ICE/WINDSHIELD control panel. The valves open only in flight, when pneumatic pressure is available. Pushing the WING ANTI-ICE switch opens the wing anti-ice valve. ON illuminates. DISAG illuminates when the open limit switch is tripped and the switch is off, or the closed limit switch is tripped and the switch is ON. A WNG A-ICE (L or R) DISAG alert is displayed.

On the ground, the WNG A-ICE DISAG alert is displayed and the DISAG light illuminates when an anti-ice valve is open, regardless of the switch position.

If wing anti-ice valve power fails, the valves fail in the closed position.

Tail Anti-Ice System

The tail (horizontal stabilizer) anti-ice system functions in the same manner as the wing anti-ice system.

Hot engine bleed air from pneumatic system 2 manifold is routed over the horizontal stabilizer box, diverging to right and left leading edges. Piccolo tubes, positioned along the leading edges, supply the hot engine bleed air.

Pushing the TAIL ANTI-ICE switch opens the horizontal stabilizer anti-ice valve. ON illuminates on the TAIL ANTI-ICE switch when the horizontal stabilizer is commanded open. DISAG illuminates on the TAIL ANTI-ICE switch when the switch is OFF and flow is sensed, or when the switch is ON and flow is not sensed. The TAIL A-ICE DISAG alert is displayed

On the ground, the TAIL A-ICE DISAG alert is displayed and the DISAG light illuminates when an anti-ice valve is open, regardless of the switch position.

The ESC depressurizes pneumatic system 2 after 27 seconds if the anti-ice valve disagree condition continues to exist, and anti-ice air flow exceeds normal flow tolerances after duct pressurization and if a CAC manifold failure occurs. A tail manifold fail signal is transmitted to the PSC, which sends a signal to the ESC for annunciation and shutdown of pneumatic system 2.

The tail anti-ice shutoff valve fails closed if valve power fails.

Engine Cowl Anti-Ice System

The engine cowl anti-ice system uses hot engine bleed air (11th stage for GE engines) incorporating a swirl system for cowl ice protection. Hot bleed air is ducted to the nose lip, where it is discharged by a nozzle, producing a swirling flow into the circumferential chamber (D-duct).

For engine 2 cowl anti-ice system, hot bleed air is ducted from the engine and discharged into the D-duct. The hot air then enters into a double skin passage through openings located in the inner skin. The anti-ice air is exhausted from the double skin passage into the aft compartment and vented overboard.

Engine cowl anti-ice valves are open when the flight crew selects the respective anti-ice system on. The engine cowl anti-ice valves are opened by pushing the appropriate ENG 1/2/3 ANTI-ICE switch. The anti-ice valve ON light illuminates on the switch when the valve is commanded open.

DISAG illuminates on the respective ENG 1/2/3 ANTI-ICE switch when the valve position (open or closed) does not agree with the commanded position. Momentary illumination of the DISAG light occurs while the valve is in transit.

The ESC inhibits an engine anti-ice DISAG annunciation while the FUEL switch is selected OFF. The DISAG annunciation is also inhibited for up to 45 seconds after the FUEL switch is selected ON (GE engines).

With the engine 2 anti-ice switch selected ON, if a leak is detected adjacent to anti-ice ducting for engine 2, causing the valve to automatically close (KCE & on), the alert ENG 2 A-ICE OFF is displayed.

With the engine 2 anti-ice on or commanded OFF and not verified off, if a leak exists in the anti-ice ducting for engine 2, the alert ENG 2 A-ICE DUCT (KCA - KCD) is displayed.

If electrical power to the valve fails, the valve fails open.

Air Data Heater System

The air data sensor heater system consists of integral heating elements within the pitot tubes, AOA sensors, and the TAT probe. Heaters are also mounted to the static pressure ports.

A Miscellaneous Systems Controller (MSC) automatically controls, monitors operation of the air data heater system and provides alerts to the flight crew.

The pitot tubes are installed on the underside of the fuselage. Each pitot tube is electrically anti-iced with two self-regulating heaters. Each pitot tube heater contains two elements which may be powered individually or in series. When on the ground, the elements operate in series to prolong their life

The TAT probe and AOA sensors each contain a single heating element. On the ground, the TAT probe heater is not powered and the AOA heaters operate from 28-volt ac. In the air, the AOA heaters operate from 115-volt ac.

All static pressure port heaters contain dual heater elements.

The MSC turns on all air data heat (except TAT) when any engine FUEL switch is moved to ON. The MSC turns these heating systems (except TAT) off when all three engine FUEL switches are moved to OFF.

The MSC allows the TAT heat to be on only when the ground sense mechanism senses flight. However, maintenance personnel can override the MSC, as necessary, with switches on the maintenance panel.

Windshield/Window Anti-Ice and Defog Systems

The clearview windows and aft windows are equipped with a defog system only. The windshields are equipped with both defog and anti-ice systems.

All cockpit windshields/windows can withstand full airplane pressurization with one glass pane cracked.

The windshield anti-ice system (which may also be used for backup windshield defogging) consists of separate, independent, electrically-heated left and right windshields, selector switches, temperature controllers and temperature sensors.

A controller and sensor maintains the windshield at the correct temperature. The controller automatically provides ramp warm-up (gradually increasing) power to the windshield for three to four minutes during initial turn-on to minimize thermal shock. The controller automatically removes power from the windshield if an overheat condition occurs.

Windshield anti-ice can be selected on at NORM anti-ice heat or HIGH anti-ice heat without thermal shock to the windshield.

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Appropriate alerts are displayed for windshield heat on and for failure conditions.

The windshields are constructed of a glass-vinyl-glass-vinyl-glass, layered configuration. A thin anti-ice heating film (stannous oxide) is on the inboard surface of the outer glass pane, next to the vinyl layer. Heating is accomplished by electrical potential across the resistive oxide film.

Defogging is accomplished by applying power to a similar conductive film on the outboard surface of the inner glass pane. The defogging system consists of elements and sensors in each windshield, clearview, and aft window and a controller for each window. A single DEFOG switch controls defogging. DEFOG should be on for all flight conditions.

Two switches (L/R WINDSHLD ANTI-ICE) on the lower maintenance panel allow maintenance personnel to switch between primary and spare (L and R) anti-ice heat sensors on each windshield. Six switches on the lower maintenance panel (L/R WINDSHLD, L/R CLEARVIEW, and L/R AFT WINDOW) allow maintenance personnel to switch between primary and spare (L and R) defogging heat sensors on each window.

Windshield Wiper System

A separate wiper system is installed for left and right windshields. Each wiper system is independently controlled by a WINDSHLD WIPE selector on the forward overhead panel. The wipers may be selected to OFF/SLOW/FAST.

With wipers selected to OFF, the wiper and arm assembly move to the vertical, parked position.

Operation of the windshield wipers on a dry surface is not recommended.

Ice Detection System

General

The ice detection system determines when the wing, tail, and engine ice protection systems should be turned on or off.

The ice detection system is a dual detector system (left and right). Each detector system has an independent failure monitoring system. For the ice detection system to be considered the primary indicator of an aircraft-in-ice condition, both left and right ice detector systems must be operative.

Both left and right systems consist of a sensor in each wing engine cowl and a controller in the leading edge of the wing near the engine pylon area.

Both left and right ice detector controllers interface with the ESC. The system operates using 115-volt ac power.

The secondary method of detecting ice buildup on the aircraft is the monitoring of Outside Air Temperature (OAT) and humidity combined with visual inspection of the aircraft windshield wipers and window frames during flight. This method is used when both left and right ice detector systems are inoperative.

If one of the two systems fails, the flight crew must act based on the following:

- A single operative ice detector may be used for advisor information only.
- Monitoring of OAT and humidity.
- Visual inspection of windshield wipers and window frames.

If both left and right ice detector systems fail, the flight crew must rely entirely on the following:

- Monitoring of OAT and humidity.
- Visual inspection of windshield wipers and window frames.

In icing conditions, ice builds up on the sensing probe. The resonant frequency of the probe then decreases due to the added mass of the ice. When this frequency shift is sensed by the controller, an ICE alert is displayed if any airfoil or engine anti-ice switch is not on. Simultaneously, the probe starts to deice itself in preparation for the next ice detection cycle.

Heaters in the probe are powered for about ten seconds to melt the ice buildup. If during the next cycle, no ice is detected, a NO ICE DETECTED alert is displayed if the anti-ice system is commanded on.

An ICE DET SINGLE alert will warn the crew that one of the 2 systems has failed. An ICE DETECTOR FAIL alert will warn the crew that both ice detection systems have failed.

Ice detector system faults are stored in the ESC fault review.

System Operation

When electrical power is on, the ice detection system is operative. Powerup of the aircraft electrical system will automatically initiate a system powerup test. This test checks the system interface signals, the heater, and the software memory. If no faults are detected during the powerup test, the ice detection system begins normal operation for the detection of ice. If a fault is detected during the test, the ICE DET SINGLE or ICE DETECTOR FAIL alert will be displayed and the ESC will store the fault in fault review.

The ice detection system is operational on the ground. The system alerts are inhibited from display during takeoff and landing.

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During normal operation, if an ice signal is transmitted from either the left or right ice detector controllers, the ICE alert will be displayed if any airfoil or engine anti-ice switch has not been turned on. As each ice protection system is selected on, a corresponding alert will be displayed showing status of the respective ANTI-ICE switch (this is in addition to switch illumination). When all the ice protection systems have been selected on, the individual alerts are replaced by a single alert, A-ICE ALL ON.

As the ice protection systems are operating, the sensor probe continuously cycles through the test for the detection of ice. If during the next cycle no ice is detected, a NO ICE DETECTED alert appears after the 60 second ICE signal timer has elapsed. This informs the flight crew that the ice protection systems may be selected off. This alert will stay on until all of the ice protection systems have been selected off.

If a single ice detection system fails, the ICE DET SINGLE alert is displayed. This tells the flight crew that the ice detection system is now an advisory system only and observation of windshields and window frames is also required to detect icing conditions. At the same time the fault is detected, the ICE and NO ICE alerts from the fault controller are inhibited.

If both ice detector systems fail, the ICE DETECTOR FAIL alert informs the flight crew that observation of windshields and window frames is required to detect icing conditions. When this alert is displayed the ICE and NO ICE alerts are inhibited.

If the ESC loses both digital data buses that transmit the ICE, NO ICE, and FAIL signals to the Display Electronic Units (DEU), an AIR ALERTS alert is displayed. In this case, the ice detection system cannot be used to determine if the aircraft is in icing conditions.

Miscellaneous Heating Systems

The forward, center, and aft lower cargo door latch actuators, as well as the forward and center lower cargo door sill drains, are electrically heated by a system powered through the 115-volt ac ground service bus.

The potable water system supply lines, drain lines, drains, and fill/drain valves are electrically heated. The system is powered through the 115-volt ac ground service bus. The potable water system vent/overflow and aft drain heaters are powered through the ground service bus by 28 volts dc.

Automatic Anti-Ice Protection System

The ice protection system automatically commands the wing, tail, and engine cowl anti-ice valves open when either of the two ice detection systems detect ice. The automatic ice protection system consists of the following:

- Environmental System Controller (ESC).
- Ice detection system in conjunction with ANTI-ICE control panel.
- ANTI-ICE SYSTEM MANUAL switch on the overhead panel.

The automatic ice protection system provides the following:

- Indication.
- Fault detection monitoring.
- Test capability.
- Reconfiguration capability.
- Anti-ice system manual control.

The automatic ice protection system has a dedicated ANTI-ICE SYSTEM MANUAL switch on the overhead panel. This switch allows the flight crew to place the ice protection system in manual mode with the AIR control panel in auto mode.

The ice protection system operates in the auto mode when the AIR control panel is placed in auto.

The ice protection system reverts to manual mode for the following:

- The AIR control panel is selected or reverts to manual.
- Both ice detection systems are failed more than 60 seconds.

When the ice protection system reverts to manual, the system leaves the valves in their last commanded position. While in manual, the ESC does not command the anti-ice system valves.

When auto is selected, the ESC evaluates ice detection system status, and reconfigures the anti-ice valves.

The ESC does not use a failed ice detection system ICE signal to control wing, tail, or engine cowl anti-ice system valves.

Wing/Tail and Engine Cowl Anti-Ice Control System

The wing and tail anti-ice valves are armed on the ground or open in flight, and the engine cowl anti-ice valves are open for the following:

- When in auto and ice is detected.
- When in manual and the flight crew selects the respective anti-ice system on.

The ESC turns off the wing, tail, and associated engine cowl anti-ice system when the system is in auto and all three engines are not running.

Wing/Tail and Engine Cowl Anti-Ice System Failure

During automatic operation of the anti-ice system in icing conditions, the ICE DETECTED alert is displayed. When the ESC detects a condition which prevents an anti-ice valve from opening, ICE DETECTOR FAIL alert is displayed.

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The ICE DETECTED alert is cleared when the ice detection system no longer detects icing conditions.

Airfoil Anti-Ice Valve Disagree

In flight, when operating in auto anti-ice in icing conditions and the ERSC detects a wing anti-ice valve failed closed for 25 seconds, the wing anti-ice system is commanded off and ICE DETECTED is displayed. On the ground, the ESC depressurizes the associated pneumatic system any time a valve is detected as failed open.

Wing or Tail Anti-Ice Manifold Failure

The ESC turns the associated anti-ice system off during a wing or tail anti-ice failure if the system is active. The associated pneumatic system is turned off if the failure continues, or, for a non active system.

ESC - CAC Manifold Failure Test Procedure

The ESC commands wing and tail anti-ice valves closed during a CAC manifold failure test procedure.

If the air system is in manual, the ESC cannot close the wing and tail anti-ice valves automatically. The valves have to be closed manually by the crew.

ESC - 1-2 Manifold Failure Test Procedure

For the duration of the test, during a 1-2 manifold failure test, the ESC commands the wing anti-ice system off when pneumatic system 1 is depressurized. The tail anti-ice system is commanded off when pneumatic system 2 is depressurized.

ESC - Single Manifold Failures

The wing anti-ice system is commanded off when the ESC senses a pneumatic system 1 or 3 manifold failure, or a left/right wing manifold failure.

The tail anti-ice system is commanded off when the ESC senses a pneumatic system 2 manifold failure, or a tail manifold failure.

ENG FIRE Handle Operation

With the ice protection system in automatic mode, pulling an ENG FIRE or APU FIRE handle results in the associated engine being shut down. The respective engine cowl anti-ice system is unavailable when an engine is shut down.

The ESC turns off associated systems as follows:

- Engine 1 or 3 - wing anti-ice system.
- Engine 2 - tail anti-ice system.
- APU - tail anti-ice system.

SMOKE ELEC/AIR Selector Operation

Moving the SMOKE ELEC/AIR selector on the ELEC control panel from NORM turns off wing anti-ice. Returning the selector to NORM turns wing anti-ice back on.

Tail anti-ice is not available when 3/1 OFF or 1/2 OFF are selected.

Tail anti-ice operates normally when 2/3 OFF is selected.

DITCHING Switch

The ESC commands the associated wing and tail anti-ice systems off as pneumatic systems are shut down following selection of DITCHING ON.

Bleed Air Temperature High Operation

The ESC reverts the ice protection system and the air system to manual when a single bleed air source is feeding 2 or 3 pneumatic manifolds and a high temperature condition exists in an airfoil (wing or tail) anti-ice system bleed air source.

DEU Alerting

The A-ICE SYS MANUAL alert is displayed when the automatic anti-ice system is in manual.

The ICE DETECTED alert is displayed when, in automatic mode, any anti-ice system is not commanded on while ice condition is detected.

When the automatic anti-ice system opens a wing, tail, or engine cowl anti-ice valve, the following alerts appear:

- AIRFOIL A-ICE ON indicates wing and/or tail anti-ice valves are open.
- ENG 1/2/3 A-ICE ON indicates respective engine cowl anti-ice valve is open.
- ENGINE A-ICE ON indicates all three engine cowl anti-ice valves are open.
- A-ICE ALL ON indicates wing, tail, and engine cowl anti-ice valves are open.

Annunciator Controls

The ANTI-ICE SYSTEM MANUAL switch illuminates when the ice protection system is in manual mode. If in automatic mode, this switch blinks when a momentary switch on the ANTI-ICE control panel is pushed.

Status of the respective anti-ice valves is indicated on the ANTI-ICE control panel. WING and TAIL ANTI-ICE switches illuminate ON when commanded open/armed. ENG 1/2/3 ANTI-ICE switches illuminate ON when the associated engine cowl anti-ice valves are commanded open.

The PSCs provide wing and tail anti-ice disagree indication.

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The ESC inhibits an anti-ice disagree annunciation when the FUEL switch is OFF, and up to 45 seconds after the FUEL switch is turned ON.

During automatic mode operation of the ice protection system, the ENG ANTI-ICE DISAG lights illuminate when commanded position disagrees with actual position for more than 15 seconds.

Automatic Anti-Ice System Panel Interface

The automatic ANTI-ICE system control panel ENG, WING, and TAIL ANTI-ICE switches are momentary action.

The ANTI-ICE SYSTEM MANUAL switch is a momentary switch with a single MANUAL light.

Ice Detection System Preflight Test

The ice detection system is tested when the ANNUN LT TEST button is pushed until the AIR SYS TEST alert is displayed. This feature is functional on airplanes equipped with automatic anti-ice protection.

If the ESC senses one ice detection system as failed, the ICE DET SINGLE alert is displayed. The ESC does not use that system as input to control the automatic anti-ice protection system.

If the ESC senses both ice detection systems as failed, the ICE DETECTOR FAIL alert is displayed. The automatic anti-ice protection system reverts to manual mode.

If the alert ICE DET SINGLE or ICE DETECTOR FAIL was displayed due to a failure of the ice detection preflight test, the alerts are cleared under the following conditions:

- The preflight test is rerun and the ice detection systems pass the preflight tests.
- Maintenance has cleared the problem from the ESC faults screen on the CFDS.

A preflight failure of the ice detection system does not cause the AIR SYS TEST FAIL alert to be displayed.

The ice detection system preflight failures are remembered through the AIR control panel auto/manual/auto switch activations.

If the ANNUN LT TEST button is held for more than 1 minute, the alert ICE DETECTOR FAIL is displayed and remains displayed until 10 seconds after the button is released. This does not indicate an ice detection system failure.

Engine 2 Anti-Ice Duct Overheat Detection

This system is effective on KCE & on.

Engine 2 supplies hot bleed air to the engine inlet through a double shrouded anti-ice duct which runs through the tail. This duct is continuously monitored for an overheat condition due to a burst or a leak by a Continuous Fire Detection unit (CFD) and its three associated sensing elements.

The outer shroud of the anti-icing duct is thinner than that of previous airplanes.

NOTE: The CFD does not detect fire, only overheat.

The system consists of the CFD, sensing elements, and the cowl anti-ice valve. Annunciation of system status is provided by the Environmental System Controller (ESC), anti-ice control panel, and Electronic Instrument System (EIS).

The CFD is in the center accessory compartment and operates on 28-volt DC power. There are two overheat sensors below the engine 2 anti-ice duct and one above the duct.

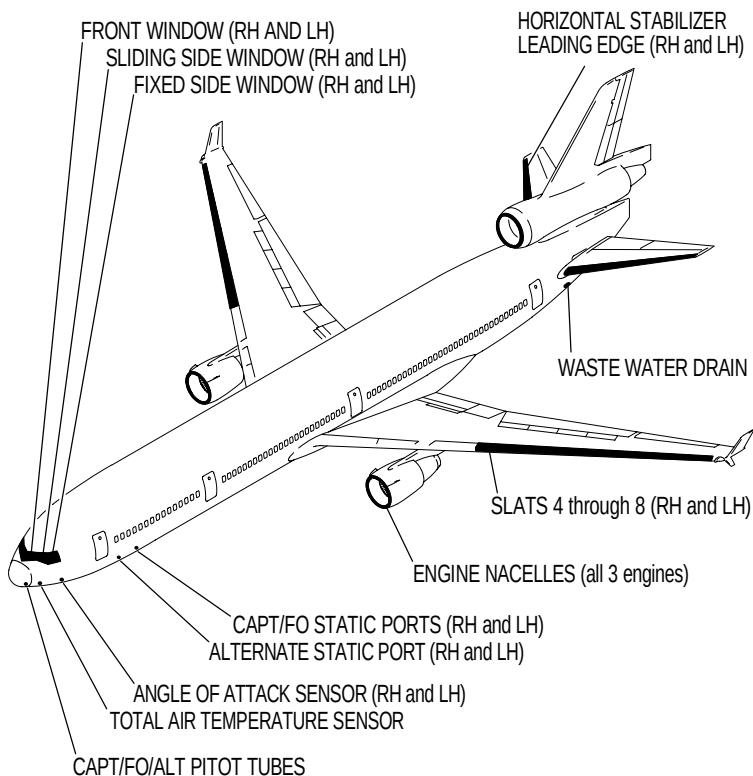
When an overheat is sensed (about 154°C) the CFD closes the engine 2 cowl anti-ice valve when commanded on. DISAG illuminates on the ENG 2 ANTI-ICE switch (valve closed and commanded on). If the valve remains open during the overheat, due to a failure, the ENG 2 A-ICE DUCT alert is displayed.

A preflight test of the system is initiated when the ANNUN LT TEST button is pushed until the AIR SYS TEST alert appears. The ENG DUCT TST FAIL alert is displayed if the overheat detection system detects a preflight test failure.

Ice and Rain Protection Components

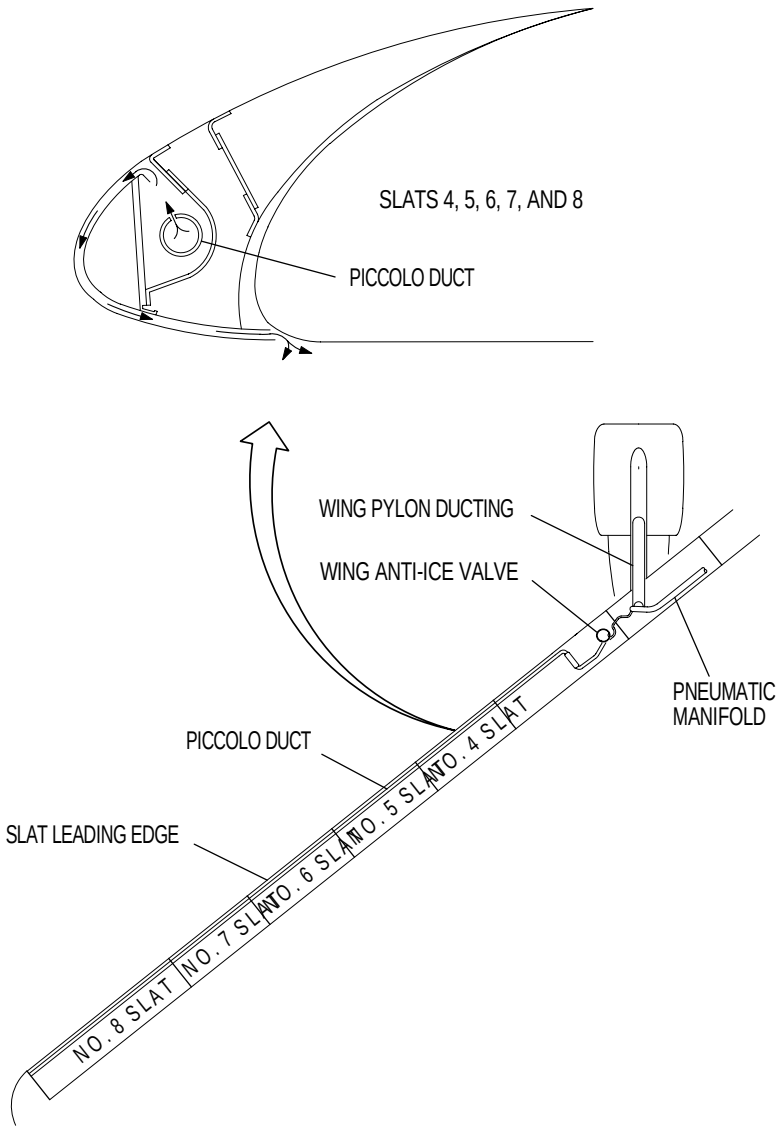
Chapter Ice Section 20

Ice and Rain Protected Zone Locations



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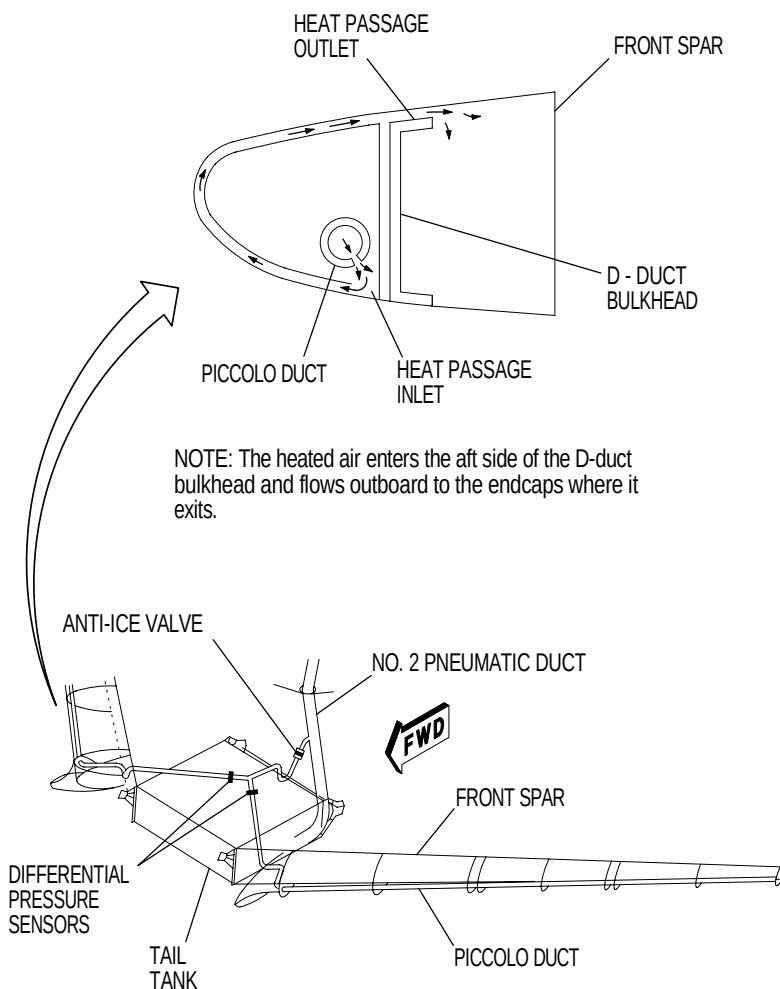
Wing Anti-Ice



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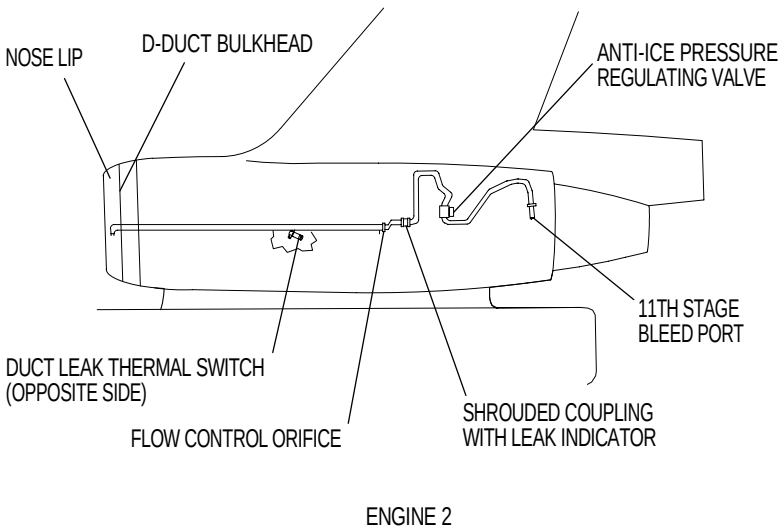
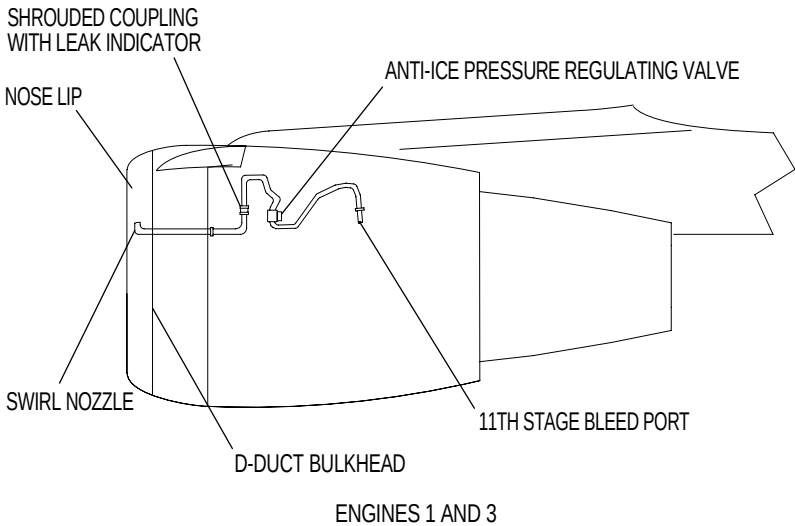
MD-11 Flight Crew Operations Manual

Tail Anti-Ice



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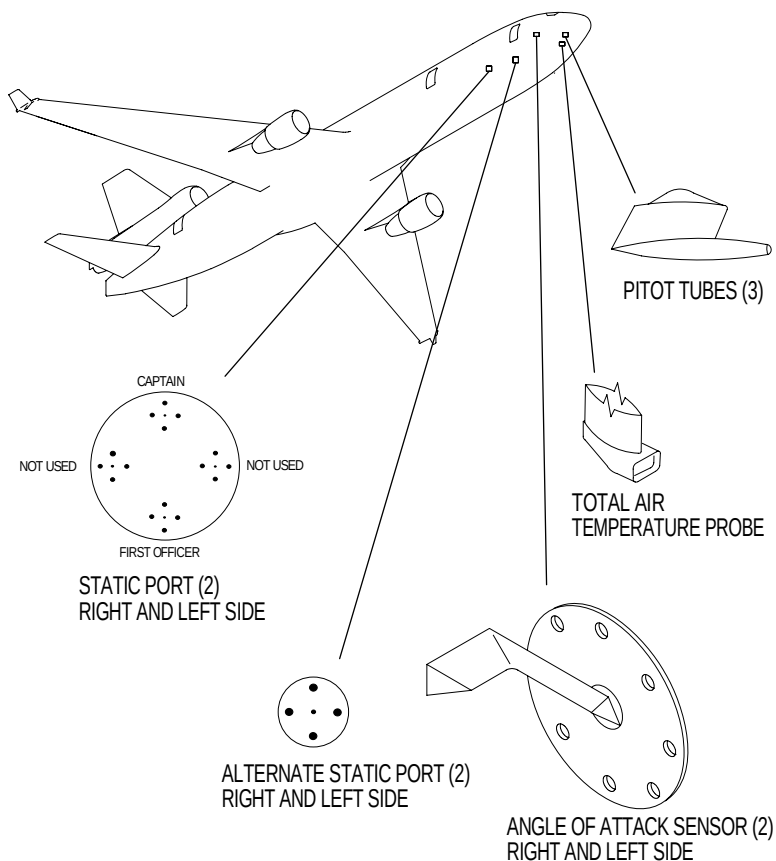
GE Engine Anti-Ice



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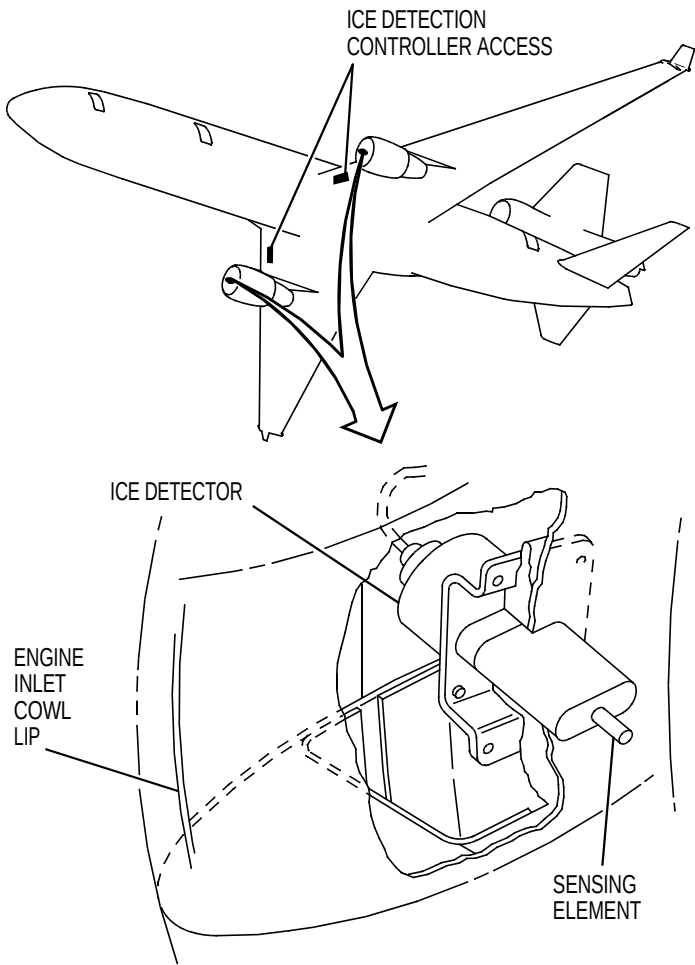
MD-11 Flight Crew Operations Manual

Probe and Sensor Locations



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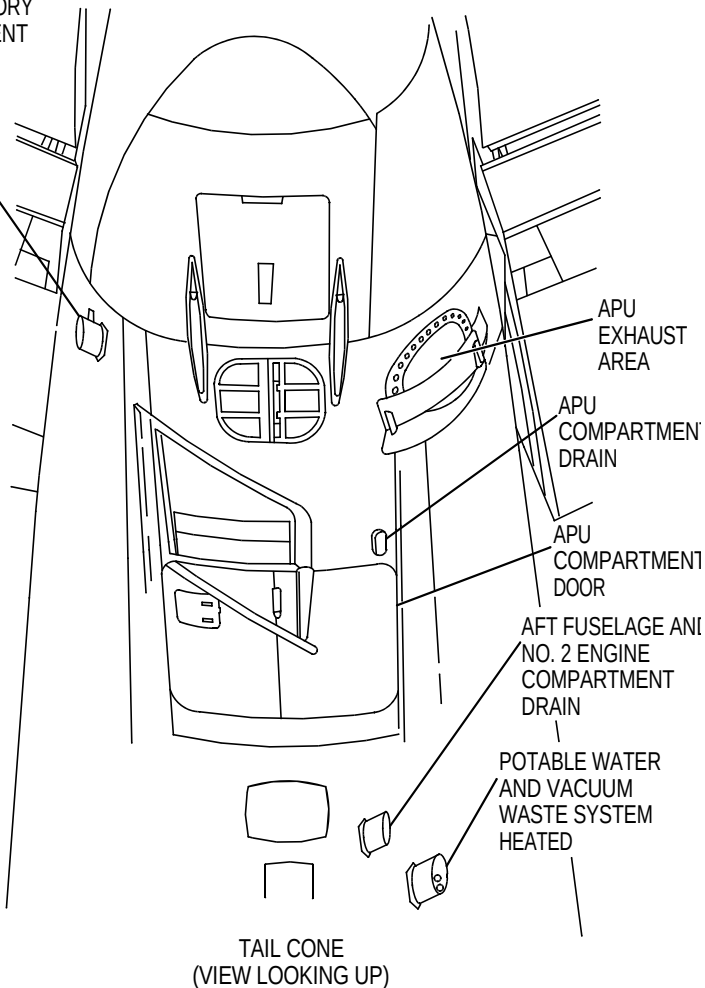
Engine Cowl Ice Detection System



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Water Line and Waste Drain Locations

NO. 2 ENGINE AND
AFT ACCESSORY
COMPARTMENT
DRAIN



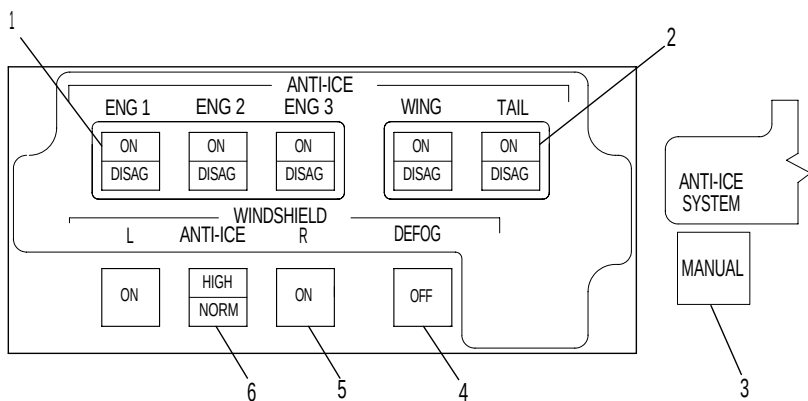
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Ice and Rain Protection Controls and Displays

Chapter Ice Section 30

Anti-Ice/Windshield Control Panel



FORWARD OVERHEAD PANEL, RIGHT SIDE

DB1-2-1775

1. ENG ANTI-ICE Switch (3) - blue/amber

The ENG ANTI-ICE switches are alternate action switches that open and close the respective cowl anti-ice shutoff valves.

ON illuminates blue when engine anti-ice is on.

DISAG illuminates amber when the anti-ice shutoff valve is in transit and remains illuminated if the valve position disagrees with the switch position.

2. WING and TAIL ANTI-ICE Switches - blue/amber

The WING and TAIL ANTI-ICE switches are alternate action switches that open and close the wing and tail anti-ice shutoff valves.

ON illuminates blue when the respective switch is on.

Inflight, DISAG illuminates amber when the anti-ice shutoff valves are in transit, and when valve position disagrees with the commanded anti-ice flow.

On the ground, DISAG illuminates amber when the valve is open, regardless of switch position.

The associated pneumatic system turns off when the respective anti-ice manifold fails.

On the ground, pushing the WING or TAIL ANTI-ICE switch. The following occurs:

- Ground sensing is bypassed.
- The respective (WING or TAIL) anti-ice valve opens.
- Disagree (DISAG) appears above the respective (WING or TAIL) anti-ice valve on the AIR synoptic to indicate proper system function.
- The respective (WING or TAIL) anti-ice valve closes.

3. ANTI-ICE SYSTEM MANUAL Switch - amber

This momentary type switch allows selection of automatic or manual control of the wing, tail, and engine cowl anti-ice systems.

MANUAL illuminates amber if the anti-ice system reverts from auto to manual, or if the system is selected to manual. A-ICE SYS MANUAL is displayed on the EAD.

NOTE: With installation of the automatic anti-ice system, the ENG, WING, and TAIL ANTI-ICE switches are momentary type in lieu of alternate action type.

4. WINDSHIELD DEFOG Switch - amber

The WINDSHIELD DEFOG switch, an alternate action switch, turns defog power to the windshield on and off. WINDSHIELD DEFOG OFF illuminates amber when windshield defog is commanded off.

With electrical power applied to the airplane, the defog controllers are energized. Windshield defog automatically turns on and the WINDSHIELD DEFOG OFF light extinguishes. The inner panes of the windshields and window are heated.

5. (L/R) WINDSHIELD ANTI-ICE Switches - blue

The WINDSHIELD ANTI-ICE switch, an alternate action switch, turns power to the windshield anti-ice controller on and off. The switch illuminates blue when anti-ice is on normal or high (NORM or HIGH).

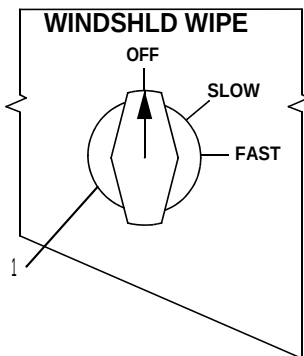
6. WINDSHIELD ANTI-ICE HIGH/NORM Switch - blue

The WINDSHIELD ANTI-ICE HIGH/NORM switch, an alternate action switch, provides high or normal anti-ice heat to the windshield. HIGH illuminates blue when the WINDSHIELD ANTI-ICE switch is on and high heat is selected. NORM illuminates blue when the WINDSHIELD ANTI-ICE switch is on and normal heat is selected.

HIGH position may be used to remove ice if NORM is inadequate.

Use of windshield heat prevents window fogging during a descent into high humidity conditions.

Windshield Wiper Selector



FORWARD OVERHEAD PANEL, LEFT AND RIGHT SIDES

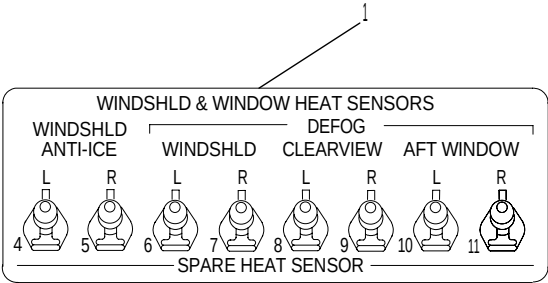
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1. WINDSHLD WIPE Selector - (Captain and First Officer)

Each wiper has an OFF, SLOW, FAST speed. When selected OFF, the wiper and arm assembly move to the vertical parked position.

Operation on a dry surface is not recommended.

Windshield & Window Heat Sensors Control Panel



MAINTENANCE PANEL

DB1-2-1777

1. **WINDSHLD & WINDOW HEAT SENSORS Switches - blue**

Maintenance use only. Selects alternate heat sensor for respective ANTI-ICE or DEFOG system.

Ice and Rain Protection Alerts

Chapter Ice Section 40

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

Red Boxed Alerts (Level 3)

ENG 2 A-ICE DUCT (AIR) - (Effective for KCE & on) Leak in the engine 2 anti-ice duct. Engine 2 anti-ice valve is still open.

Amber Boxed Alerts (Level 2)

TAIL A-ICE DISAG (AIR) - Flow/no flow not in agreement with switch position.

WNG A-ICE L/R DISAG (AIR) - Flow/no flow not in agreement with respective switch position.

Amber Alerts (Level 1)

A-ICE SENSOR FAIL (AIR) - Anti-ice system monitor failure exists.

A-ICE SYS MANUAL (AIR) - Auto anti-ice system, if installed, reverts to manual during fault condition, or, is selected to manual by flight crew.

AIR DATA HTR ON (MAINT) - An air data probe heater is on when it should be off.

AOA HEAT L/R FAIL (MISC) - Left/right angle-of-attack probe heater has failed.

ENG 1/2/3 A-ICE DISAG (AIR) - Respective engine (1/2/3) anti-ice valve in disagreement with commanded position.

ENG 2 A-ICE DUCT (AIR) - (Effective for KCA - KCE) Leak in the engine 2 anti-ice duct. A secondary shroud allows continued use of ice protection.

ENG 2 A-ICE OFF (AIR) - (Effective for KCE & on) A leak is detected adjacent to engine 2 anti-ice duct, engine anti-ice valve is automatically closed, and engine 2 anti-ice switch is commanded on.

ENG DUCT TST FAIL (AIR) - (Effective for KCE & on) Engine 2 anti-ice duct test has failed.

ICE DET SINGLE (AIR) - One channel of the dual ice protection system, if installed, is inoperative. The ice detection system is no longer primary for ice detection.

ICE DETECTED (AIR) - Icing conditions exist with an airfoil or engine anti-ice system not on. On airplanes with auto anti-ice system installed, and auto or manual anti-ice selected, ice is detected and one of the ice protection systems is not commanded on.

ICE DETECTOR FAIL (AIR) - Both channels of the dual ice detection system, if installed are inoperative. Auto anti-ice, if installed, is inoperative.

NO ICE DETECTED (AIR) - Ice detection system, if installed, indicates icing conditions do not exist and one of the ice protection systems is commanded on. May turn anti-ice systems off.

PITOT HEAT AUX (MISC) - Auxiliary pitot heater is inoperative.

PITOT HEAT CAPT/FO (MISC) - Respective pitot heat is inoperative.

PITOT HEAT OFF (MISC) - The PITOT HEAT switch on the upper maintenance panel is in the OVRD OFF position.

TAT PROBE HEAT (MISC) - TAT probe heater is inoperative.

WSHLD DEFOG OFF (MISC) - WINDSHIELD DEFOG switch is in OFF.

WSHLD HEAT L/R FAIL (MISC) - Left/right windshield heater is inoperative.

Cyan Alerts (Level 0)

A-ICE ALL ON - All engine and airfoil ANTI-ICE systems have been commanded on.

AIRFOIL A-ICE ON - Wing and/or tail anti-ice has been commanded on.

ENG 1/2/3 A-ICE ON - Respective engine (1/2/3) ANTI-ICE switch is commanded on.

ENGINE A-ICE ON - All 3 ENG ANTI-ICE switches are ON.

WSHLD HEAT HI - L and/or R windshield heat is on and in the HIGH mode.

WSHLD HEAT ON - L and/or R windshield heat is on and in the NORM mode.

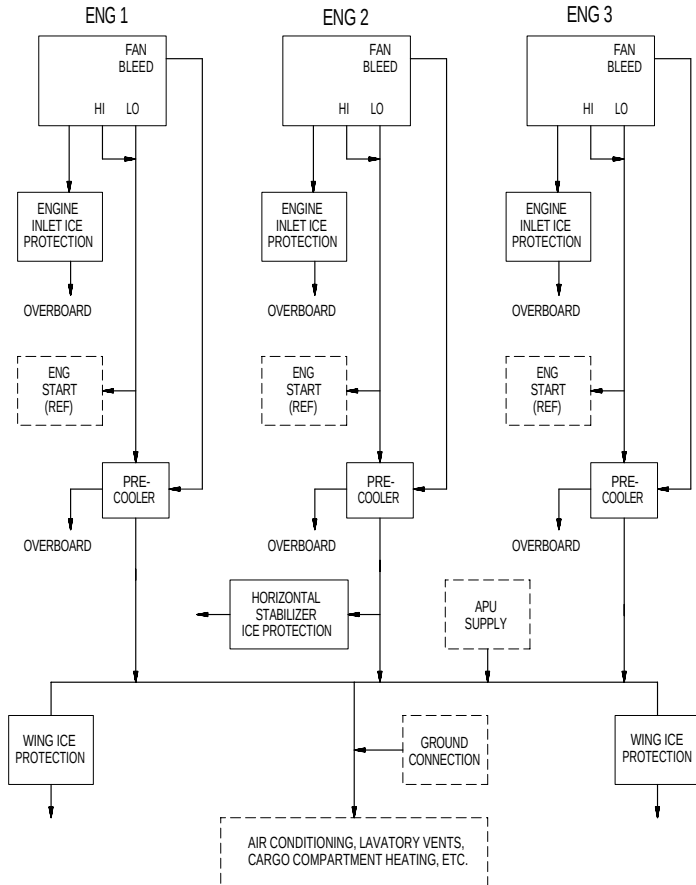
Ice and Rain Protection

Functional Schematic

Chapter Ice

Section 50

Pneumatic Diagram



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Instrumentation and Navigation

Description and Operation

Chapter Inst

Section 10

General

The instrumentation and navigation systems include both ground dependent and independent systems. The systems provide displays and annunciations for aircraft attitude, airspeed, altitude, vertical speed, heading, direction, course, and time.

EIS Control Panel (ECP)

An ECP is installed on both outboard ends of the glareshield. The ECPs control the operation of the Captain's and First Officer's ND and PFD.

For a description of the ECP controls relating to the PFD refer to the Automatic Flight chapter.

Multifunction Control Display Unit (MCDU)

Two MCDUs are installed in the forward pedestal. These are the primary interfaces for the Flight Management System (FMS). A third MCDU is installed in the aft pedestal for interface with the centralized fault display and ACARS systems.

Each MCDU continuously stores current flight plan waypoints. The MCDUs are coupled to the Inertial Reference System (IRS). This provides navigation flight planning and lateral guidance to all waypoints previously stored in the FMS flight plan (or added to the flight plan in the standby mode) in case of dual flight management computer (FMC) failure.

The MCDUs also provide flight plan data for the Navigation Display (ND) and standby tuning for the navigation radios.

The VOR, ADF, and ILS equipment are automatically tuned from the FMS in accordance with the selected SID, STAR, or enroute navigational aid requirements. The FMS also tunes the scanning DME to the associated VOR and ILS station and scans three other DME frequencies to obtain position updating data.

Manual tuning of the VOR/DME, ADF, or ILS is available through the MCDU.

If either the Captain's or First Officer's MCDU fails, operation is normal through the remaining MCDU. If a single FMC fails, normal operation continues through the remaining FMC. If both FMCs fail, each radio may be manually tuned by entering the required frequencies in the associated MCDU.

For a complete description of the MCDU refer to the FMS chapter.

Primary Flight Display (PFD)

The PFD (one for each pilot) will display aircraft:

- Airspeed.
- Altitude.
- Vertical speed.
- Attitude.
- Heading.

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.

In addition to the basic T, the PFD will also show:

- Glide slope and localizer deviation.
- Marker beacon annunciation.
- Flight modes.
- Radio altitude.
- Pitch and roll limits.
- Limit speeds.
- Slip and skid indication.
- Pilot or FMS selected speeds, altitudes, and headings.

In addition, the PFD displays computed pitch and roll attitude commands in TCAS mode.

For a complete description of the PFD, refer to the Automatic Flight chapter.

Navigation Display (ND)

The ND (one for each pilot) will display:

- Aircraft position.
- Heading.
- FMS flightplan data.
- Bearing pointers.
- Waypoints.
- Navaids.
- Airports.
- Weather.
- Groundspeed.
- True airspeed.
- Wind speed/direction.
- Distance/time to waypoint.
- Chronograph.

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Four ND modes (MAP, PLAN, VOR, and APPR) can be selected from the ECPs.

Bearing pointer and weather radar displays are available in MAP, VOR, and APPR modes only.

Selected sources are not annunciated for the normal on-side sources (Captain on 1 First Officer on 2). When alternate sources have been selected the source is annunciated in the upper right of the display.

The selected IRS heading/track source is not annunciated if the source is the normal on-side source for that display. If a different source is selected, it will be annunciated in white to the left of the digital heading/track display area. When the Captain's and First Officer's IRS source are the same, they are annunciated in amber on both NDs.

When an alternate FMS source has been selected (Captain on 2 or First Officer on 1) and the ND is in MAP or PLAN modes, the source is annunciated in amber below the distance to go display in the top right corner of the display.

When an alternate Course Deviation Indicator (CDI) source (VOR, ILS) has been selected (Captain on 2 or First Officer on 1) and the ND is in VOR or APPR modes, the source is annunciated in amber below the distance to go display in the top right corner of the display.

If data is marked as no computed data by its source, all symbology dependent on that data will be removed from the ND. No failure flags will appear.

VHF Omnidirectional Range/Marker Beacon (VOR/MB)

The VOR/MB radio system is an aircraft navigation aid in the frequency range of 108 to 118 MHz (VOR) and 75 MHz (MB).

Two VOR/MB receivers are installed but marker beacon signals are received and processed by VOR/MB receiver 1 only.

The VOR airborne equipment receives and presents this information in such a way that the relative bearing with respect to the ground transmitter can be determined. Any bearing with respect to the ground station can be selected and flown.

The VOR unit supplies bearing data to interface with the ND and the FMS.

The marker beacons provide enroute flight reference points and landing guidance. Marker beacon annunciations are displayed above the minimums (DH or BARO) display on the PFD. Passing over an outer marker generates a sequence of two aural dashes and a flashing blue light. The middle marker generates an aural dot dash sequence and a flashing amber light. The inner marker generates an aural string of dots and a flashing white light.

Distance Measuring Equipment (DME)

The DME radio system functions as an aircraft navigation aid in the frequency range of 960 to 1,215 MHz. Two DME interrogators are installed.

The DME transmits coded interrogation signals (pulsed pairs) to the ground station. The ground station receives the interrogation signal and returns a coded reply signal (pulse pair) for each interrogation. One antenna is used for both transmission and reception.

The DME measures the slant range distance between the aircraft and ground stations. The DME can provide multiple station distance data to the FMS for high accuracy position fixing.

The DME can use up to five ground stations at once. The DME provides for 200 channels. Distance is sent to the NDs.

The DME is tuned automatically by the FMS. In case of FMC failure, the MCDUs may be used to provide backup inertial navigation, flight planning, coupled lateral guidance, and MAP display capability. To support these functions, each MCDU can generate its own limited page displays.

Automatic Direction Finding (ADF)

The ADF radio functions as an aircraft navigation aid in the frequency range of 190 to 1,750 KHz.

The ADF receiver provides relative bearing information for display on the NDs. Relative bearing is sensed and computed electronically. The single pointer represents ADF1 and the double pointer represents ADF2.

The ADF selects signals from a sense antenna (omnidirectional) and two directional loop antennas. Audio volume and tone filter controls are on the audio control panels.

Instrument Landing System (ILS)

The ILS components consist of:

- Two ILS receivers installed in the main avionics rack.
- Two glide slope (G/S) antennas installed in the radome.
- Two G/S antennas installed in the nose landing gear (NLG).
- Two VOR/LOC antennas installed on the tail.

The ILS receiver provides localizer and G/S course information to the AFS and GPWS.

ILS frequencies are from 108.10 to 111.95 MHz.

The localizer and G/S deviation data are shown on the PFDs and NDs.

The NLG G/S antennas are automatically selected when the nose gear is down. Both G/S antennas must be in the NLG configuration for dual land operation. Single land configuration is allowed for a single NLG G/S antenna configuration.

Multi-Mode Receiver (MMR)

The MMR system provide ILS and Global Navigation Satellite System (GNSS) functions and replace the existing stand-alone ILS and GNSS receivers installed.

The MMR ILS function detects the differences in the 90 Hz and 150 Hz modulated signals from the ground station to provide glide slope and localizer deviation signals to the Autoflight system and to the EIS for display on the PFD and ND.

The GNSS function of the MMR receives and processes the satellite RF signals from the NAVSTAR GPS satellite constellation to provide data to different aircraft systems.

The system components includes two MMR (ILS/GPS) receivers (located in the main avionics rack), two GPS active antennas and utilizes the existing localizer and glide slope antennas.

The system interfaces with the following: FCC, EIS, FMS, IRS, EGPWS, AMU, Data Management Unit (DMU), DFDAU, and Centralized Fault Display System (CFDS).

Primary frequency tuning for the MMR is supplied by the on-side MCDU. If a failure is detected, tuning will be received from the off-side FMC.

Global Navigation Satellite System (GNSS)

The GNS system consists of two GPS receiver units, either a Global Navigation Satellite Sensor Unit (GNSSU) or a Multi-Mode Receiver (MMR). GNS 1 and GNS 2 are independent, each simultaneously tract signals from up to 12 GPS satellites and process these signals to provide a three-dimensional position, velocity and precise time estimate to the FMS, EIS and EGPWS. GNS system operation is automatic and requires no pilot interaction.

The Flight Management Computer (FMC) IRS/GNS POS page 2/3 displays GNS position data. GNS 1 and GNS 2 latitude/longitude position and bearing/distance relative to FMC position are displayed in lines 4 and 5 respectively. Each GNS label line indicates current status (i.e. ACQUIRE, NAV) and to the right the current number of tracked satellite vehicles (SV).

GNS failure status is provided on the FMC SENSOR STATUS page. If a GNS fails, the SENSOR STATUS page will display FAIL for the appropriate unit (e.g. GNS 1 FAIL), the CDU MSG will be displayed on the ND and the SENSOR FAIL message will be displayed on the MCDU scratchpad.

G/x (x is other position updating systems, e.g. I, R, DD) is displayed on both ND (navigation mode field) and FMC POS REF page 1/3 (line 1, label field) when GNS is being used as an FMC position update source. GNS position updating to the FMC can be manually inhibited by selecting the GNS NAV INHIBIT* prompt displayed on the POS REF page 1/3. Selecting GNS NAV INHIBIT* inhibits all FMC position updates based upon GPS. Re-enabling GNS position updating to the FMC is accomplished by selecting the GNS NAV ENABLE* prompt. GNS time and date is utilized by the FMS regardless of GNS inhibit state. Manually inhibiting GNS position updating to the FMC does not affect the GNS output to using systems. No other controls are provided.

NAV Radio Tuning

Navigation radio stations are stored in the Nav Data Base (NDB). VOR/DME and ILS radios are normally tuned and updated automatically by the on-side FMC. On-side means that the Captain's radios are tuned by FMC-1, and the First Officer's radios are tuned by FMC-2. Any radio can be manually tuned from either MCDU.

ADF stations are tuned in the following order of priority:

1. Pilot manually tunes a station.
2. FMC tunes a station required for current leg.
3. FMC tunes a station required for an upcoming F-PLN waypoint.
4. FMC tunes a station required for a preceding F-PLN waypoint.

ADF stations are never used for radio position computations.

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 altitude indications are displayed on the PFDs. The decision height minimum can be set by turning the inner knob of the MINIMUMS control knob on the ECPs.

The radio altimeter uses an FM radio wave to measure the distance between the aircraft and the terrain. The radio altimeter uses two microprocessors, one for altitude calculation and one for monitoring.

Three radio altimeter transceivers are located in the center accessory compartment. The transmitter and receiver antennas are installed on the bottom of the fuselage.

Weather Radar System

The dual weather radar system with 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.

Inertial Reference System (IRS)

The IRS continuously computes:

- Latitude and longitude.
- Track.
- Attitude.
- Heading (magnetic and true).
- Vertical speed.
- Ground speed.

The IRS interfaces with several aircraft systems including the FMS and the Automatic Flight System (AFS).

The IRS is powered by 115-volt ac power. About 15 minutes of backup DC power is available from a dedicated battery.

EAD alerts provide the flight crew with IRS status information. IRS faults are stored in the Centralized Fault Display System (CFDS) for review by maintenance personnel.

The IRS control panel provides mode selecting and annunciation for the three IRUs. Each IRU (1, 2, and AUX) has a mode selector and a NAV OFF light. When the selector is set to NAV, the respective IRU powers-up and enters the align mode for about 10 minutes. During this time NO TAXI will appear on the PFD airspeed tape. The pilot can enter position into the MCDU during this time.

After 10 minutes in the align mode, the IRU automatically enters the nav mode. During nav mode, navigation and steering are done by the FMC. No pilot inputs to the IRUs are accepted during operation in the nav mode. In-flight realignment of the IRS is not possible.

The Inertial Aural Warning Logic Unit provides an aural warning horn if the aircraft is on the ground with the mode selector set to NAV, and cooling air is not being supplied to the IRU's, electrical power is removed from the aircraft, or the battery switch on the electrical control panel has been left on.

Aircraft Clock

An electronic clock/chronograph/elapsed timer is controlled and located on the maintenance panel. The clock provides the Universal Time Coordinated (UTC) and date reference for the FMC and DEUs.

The ND provides UTC, elapsed flight time, and an individual count up/down counter. The elapsed flight time starts when the aircraft transitions from ground-to-air and stops 30 seconds after the air-to-ground transition. The elapsed flight time is held as long as aircraft electrical power is available. The elapsed flight time is reset when V2 is computed on the FMS TAKEOFF page for the next flight. The elapsed time display is the default display.

The count up/down counter is started, stopped, and reset from the controls on the lighting control panel. The count down timer value is entered on the FMS APPROACH page. A tone will sound when counter passes through zero. The counter display will override the elapsed counter display.

Air Data System

The air data system consists of pitot and static air lines, one Total Air Temperature (TAT) sensor, two AOA sensors, two CADCs, and one standby altimeter/airspeed indicator.

Baro data is received from the glareshield control panel. Wing tip fuel quantity data is received from the Fuel Quantity Gauging System (FQGS) for VMO computation.

Three pitot tubes (Captain's, First Officer's and auxiliary) sense aircraft pitot (impact) pressure and send it to the two CADCs and the standby altimeter/airspeed indicator.

The four static ports sense the static (outside air) pressure and send it to the two CADCs, standby altimeter/airspeed indicator and the avionics fan control pressure switch.

The TAT sensor (one for both CADCs) sends total air temperature to the CADCs.

The AOA sensors send angle-of-attack data to the CADCs.

Wing tip fuel quantity from the FQGS is used to compute VMO/MMO. VMO/MMO will decrease linearly as wing tip fuel quantity decreases. Wing tip fuel quantity does not affect VMO/MMO when tip quantity is below 60% full.

The CADCs compute and output airspeed, Mach number, altitude, maximum airspeed, vertical speed, TAT, static air temperature, AOA, True Airspeed (TAS), and pressures (pitot, impact, and static).

Static source (position) errors and AOA effects are corrected in each CADC. TAT is corrected for anti-ice heater effect.

Pitot/Static System

The Captain's pitot tube is connected to CADC1 and the First Officer's pitot tube is connected to CADC2. The auxiliary pitot tube is connected to the standby altimeter/airspeed indicator.

Four static ports are installed on each side of the aircraft. A port from each side is provided for the Captain's static pressure system and the First Officer's static pressure system. The other ports are spares.

Each pilot port is cross connected to minimize errors caused by aircraft yaw. The Captain's ports are connected through the Captain's STATIC AIR selector to CADC1. The First Officer's ports are connected through the First Officer's STATIC AIR selector to CADC2.

The alternate static system has two flush ports symmetrically located on each side of the aircraft at some distance from the static plates. The ports are cross connected to minimize errors and are connected to the standby altitude/airspeed indicator and both STATIC AIR selectors.

The STATIC AIR selectors allow the pilots to switch the source of static pressure for their respective CADCs from their normal ports to the alternate port.

Air Data Parameters

The following parameters are output by the CADCs:

- Standard altitude.
- Captain's baro-corrected altitude.
- First Officer's baro-corrected altitude.
- Computed airspeed.
- Mach number.
- Altitude rate.
- Maximum operating speed.
- True airspeed.
- Total air temperature.
- Static air temperature.
- Overspeed signal.
- Total pressure.
- Static pressure.
- Impact pressure.
- Indicated angle-of-attack.

The following aircraft systems use the CADC outputs:

- Flight control system.
- Flight Management System (FMS).
- Electronic Instrument System (EIS).

- IRUs
 - FADEC
 - ATC transponders.
 - CAWS.
 - GPWS.
 - Cabin Pressure Controllers (CPC).
-

Standby Altimeter/Airspeed Indicator

A standby altimeter/airspeed indicator is installed on the standby instrument panel below the GEAR lever. The standby altimeter is an aneroid instrument and functions without electrical power. The standby airspeed indicator is a pitot/static instrument connected to the auxiliary pitot system and operates without electrical power.

Altitude data is presented by means of a pointer reading against a circular dial and height counters. Ground pressure is shown by two counters, one in millibars and one in inches of mercury. They are visible through cutouts in the main dial.

A knob in the lower left hand corner of the case provides the means of setting the ground pressure counter. It will simultaneously apply a correction to the altitude counter pointer.

Airspeed data is presented by means of a graduated drum reading against a fixed datum and visible through a cutout in the lower part of the main dial.

The instrument is integrally illuminated.

Standby Attitude Indicator

A standby attitude indicator is installed on the standby instrument panel below the GEAR lever. It is a self-contained, electrically-operated gyroscope that turns around a vertical axis. It operates on DC power from the battery bus. An OFF flag comes into view when there is a power failure.

Standby Compass

A direct reading standby magnetic compass is installed in the cockpit. It is magnetically compensated to read within plus or minus 10 degrees error on all aircraft headings.

ATC Transponder

The system consists of two mode S transponders in the main radio rack, four antennas installed on the top and bottom fuselage, and a single control panel on the aft pedestal.

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The transponders respond to Air Traffic Control Radar Beacon System (ATCRBS) mode A, C, and S interrogations.

Aircraft with mode S transponders have the capability of air-to-air data exchange with other aircraft with mode S transponders.

The mode S transponders can be upgraded with enhanced functionality to provide additional information in the interrogation replies to ATC ground stations. A primary added feature is the capability to transmit flight ID as part of the interrogation reply. Flight ID, entered into the FMS by the flight crew, is automatically transferred from the FMS to the mode S transponder. In addition to the flight ID, the enhanced transponders provide aircraft status and intent information, such as current heading, altitude, airspeed, selected altitude, autopilot mode, etc. obtained from other aircraft systems.

Auxiliary Data Acquisition System (ADAS)

The ADAS allows additional monitoring of engine systems, aircraft systems, or crew performance. The system consists of a Data Management Unit (DMU) and a Quick Access Recorder (QAR). Both are installed in the avionics compartment. Flight crew interface with ADAS is accomplished with the MCDU. EVENT MARKER switches on the Captain's and First Officer's instrument panels are used to mark an event on the QAR.

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 control 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 TCAS Change 7 are as follows:

CHANGE 7 ANNUNCIATION
Traffic, Traffic
Climb, Climb
Descend, Descend
Climb, Crossing Climb. Climb, Crossing Climb
Descend, Crossing Descend. Descend, Crossing Descend
Adjust Vertical Speed, Adjust
Adjust Vertical Speed, Adjust
Climb, Climb Now. Climb, Climb Now
Descend, Descend Now. Descend, Descend Now
Increase Climb, Increase Climb
Increase Descent, Increase Descent
Monitor Vertical Speed, Monitor Vertical Speed
Maintain Vertical Speed, Maintain
Maintain Vertical Speed, Crossing Maintain
Adjust Vertical Speed, Adjust
Monitor Vertical Speed
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. All TCAS voice warnings are inhibited below 500 feet AGL (+/-100 feet), and during windshear guidance or GPWS warning.

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 non threat 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.

Autopilot Disconnect Switch - Pushing the AP disconnect switch during an RA will always remove the FD bars from view. This occurs with the AP on or off. The TCAS CLEAR OF CONFLICT voice message will automatically return the FD bars into view.

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 44,000 feet MSL.
 - RAs are inhibited below 1,100 feet in takeoff and 900 feet in approach.
 - There are no TCAS voice warnings below 500 feet (+/-100 feet).
 - 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).
-

Failure Flags And Warnings

Failure Annunciation

There are two major types of failure annunciation, invalid data and cross-side miscompared data. 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 most likely valid and the pilot should comply with any related alerts.

Primary Flight Display

Comparison Monitor Annunciation

Captain and First Officer PFD data is cross compared by the DEUs. If the difference between the parameters exceeds a predetermined value, a miscompare annunciation is shown in amber below the speed control window (upper left PFD). A NO COMPARE message indicates comparisons are not being done due to a crosstalk bus failure.

The following miscompare annunciations can be displayed on the PFD:

- ATT - for IRS pitch roll.
- ALT - for CADC failure.

- RAD - for radio altitude.
- HDG - for IRS heading.
- LOC - for localizer.
- IAS - for CADC airspeed.
- G/S - for glideslope.

Inertial Reference System (IRS) Failures

If IRS pitch or roll fails, the attitude sphere pitch scale is removed, the sphere turns cyan, and a red ATT FAIL appears in the top center of the sphere. If IRS heading data fails, the heading value and scale are removed (lower PFD) and a red HDG FAIL appears.

Flight Director Failure

If the flight director fails, FD mode annunciations and command bars are removed and a red FD FAIL is shown below the roll control window (upper right PFD).

Loss of ILS Data

Loss of ILS data will be annunciated on the PFD as follows:

- NO LOC (cyan) - on the lateral deviation scale when the localizer is initially tuned. NO LOC is removed after a deviation is continuously valid for 10 seconds.
- NO LOC (amber) - on the lateral deviation scale when the localizer is initially received.
- NO G/S (cyan) - on the vertical deviation scale when the glideslope is initially tuned. NO G/S is removed after a deviation is continuously valid for 10 seconds.
- NO G/S (amber) - on the vertical deviation scale when the glideslope is lost after is initially received.
- X (red) - on either scale indicates failure of the associated receiver.

Radio Altimeter Failure

If the radio altimeter system fails, the RA shading on the attitude sphere is removed and the radio altitude sphere is removed and the radio altitude is replaced with an amber X within the white radio altitude box.

Airspeed/Mach (CADC) Failures

For invalid airspeed data, the precision airspeed, scale, and any bugs are removed and a red X is drawn through the tape. Invalid Mach data is indicated by a replacement of the precision Mach value with amber dashes and removal of all Mach bugs.

Altitude/Vertical Speed (CADC) Failures

For invalid altitude data, the precision altitude, scale markings, and any associated bugs are removed and a red X is drawn through the tape. For invalid vertical speed a red X is drawn through the vertical tape.

No Computed Data (NCD) Indications

No computed data means that a source is valid but the data is not in the valid range.

NCD Airspeed or Altitude - The precision tape digits and bugs will be removed. The tape shading and scale marks remain.

NCD ILS Vertical or Lateral deviation - The localizer or glideslope pointer will be removed but the scale will be displayed if the receiver is tuned.

If a difference exists cross-side (one side NCD, the other getting good data), the NCD indication will be accompanied by a miscompare annunciation on the PFDs.

Navigation Display

Comparison Monitor Annunciation

Captain and First Officer heading and position data are cross compared in the DEUs. FMS position is also compared with averaged IRS position. If the difference between the parameters exceeds a predetermined value, a miscompare message annunciation is displayed on the NDs.

The following miscompare messages can be displayed on the ND:

- HDG - IRS Heading miscompare.
- LOC - ILS Localizer miscompare.
- CHK POS - IRS/FMS position miscompare.

Inertial Reference System Failures

Failure of IRS heading information is shown by removing the displayed digital heading value, compass scale, map data (if any), VOR bearings (ADF bearings remain), wind vectors and selected or preselected heading or track bugs, and displaying in red the label HDG FAIL at the top center of the ND compass arc or rose.

FMC Map Data Failure (Map Mode)

Loss of map data allows crew selection of the associated MCDU for flight plan data. When an MCDU is used for flight plan data, MAP STDBY is annunciated in white on the ND in the MAP mode annunciation area (lower left corner). Loss of FMC and MCDU map data results in the removal of all flight plan data and the display of MAP FAIL in amber above the aircraft symbol.

FMC Map Data Failure (Plan Mode)

Loss of map data results in the loss of PLAN Mode. Selection of PLAN mode results in the display of NO PLAN MODE in amber in the center of the display.

Bearing Pointer Data Failure

Failure of bearing pointer data results in the removal of the associated bearing pointer and replacement of the digital value at the bottom of the display with an amber X.

DME Failure

Failure of DME data will cause the associated digital value at the bottom of the display to be replaced by an amber X. The DME data associated with the CDI distance is removed and flagged with an amber X.

CDI Source Failure

Failure of the CDI source results in removal of the course deviation indicator (pointer and scale), with the display of an annunciation (VOR, ILS) FAIL in red within the compass rose.

CDI Source Annunciation

When an alternate CDI source (VOR, ILS) has been selected (Capt. on 2 or F/O on 1) and the ND is in VOR or APPR modes, the source is annunciated in amber in the top right corner of the ND.

Possible CDI source annunciations on the ND are as follows:

- ILS1 on F/O ND.
- ILS2 on Capt. ND.
- VOR1 on F/O ND.
- VOR2 on Capt. ND.

No Computed Data Indications

When data is marked as No Computed Data (NCD) by its source, all symbology dependent on that data will be removed from the display. No failure flags will be displayed for NCD data.

IRS Source Annunciation

The selected heading/track source is not annunciated if the current source is the normal on-side source for the display. If the auxiliary source is selected, it is annunciated in white to the left of the heading/track display area. When the Captain and First Officer source is the same, the annunciation is amber on both NDs.

Possible IRS source annunciations on the ND are as follows:

- IRS AUX (white) - on either F/O or Captain ND.
- IRS AUX (amber) - on both F/O and Captain NDs.

FMS Source Annunciation

When an alternate FMS source has been selected (Capt. on 2 or F/O on 1), and the ND is in MAP or PLAN mode, the source is annunciated in amber in the top right corner of the ND.

Possible FMS source annunciations on the ND are as follows:

- FMS1 on F/O ND.
- FMS2 on Capt. ND.

Weather Radar Failure

When both Receiver/Transmitters (R/T) are failed, WXR FAIL is shown in amber (MAP, VOR, or APPR modes only). If an R/T is not failed, but the R/T range does not agree with the pilot selected ECP map range, WXR RANGE DISAGREE is shown in amber.

FMS Range Disagree

If the FMS map range disagrees with the pilot selected ECP map range, FMS RANGE DISAGREE is shown in amber (MAP and PLAN modes only).

Map Full

If the crew selects a range for which there are a greater number of map symbols to be displayed than can be displayed, DECLUTTER or REDUCE RANGE is shown in amber (MAP and PLAN modes only).

Source Test Indications

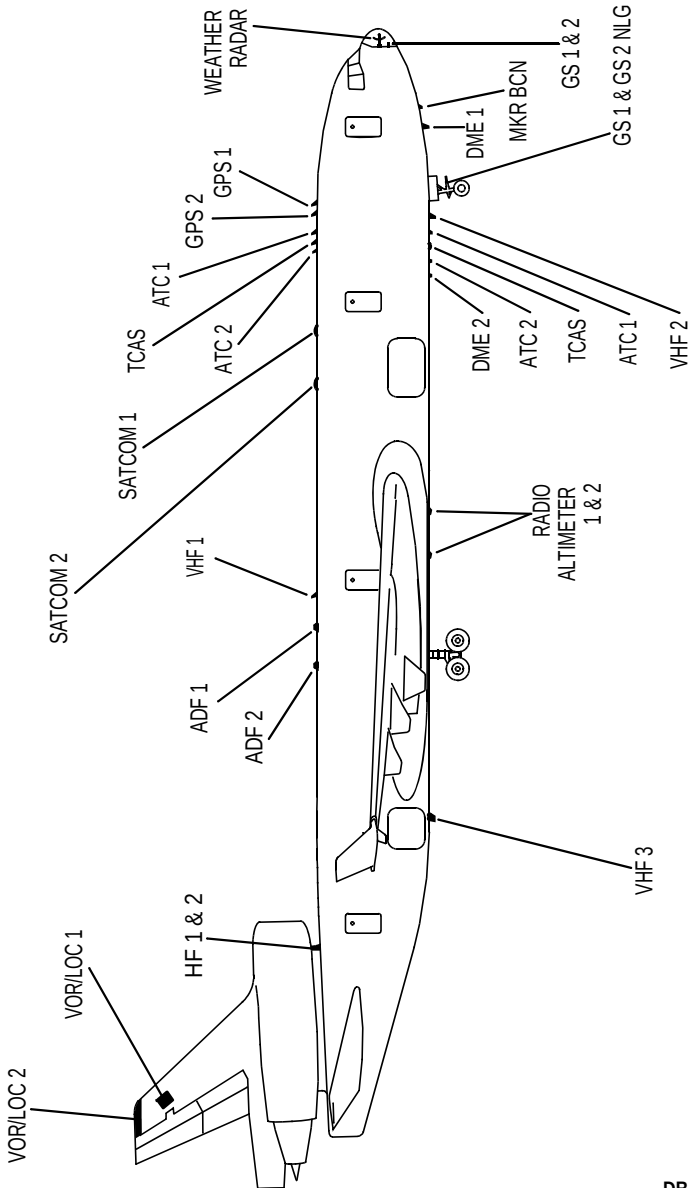
Source test mode data is displayed as follows:

- If the aircraft is on the ground the associated symbology will be displayed but flagged as not valid.
- If the aircraft is not on the ground, the data is considered not valid and the symbology will be removed and flagged.

Instrumentation and Navigation Components

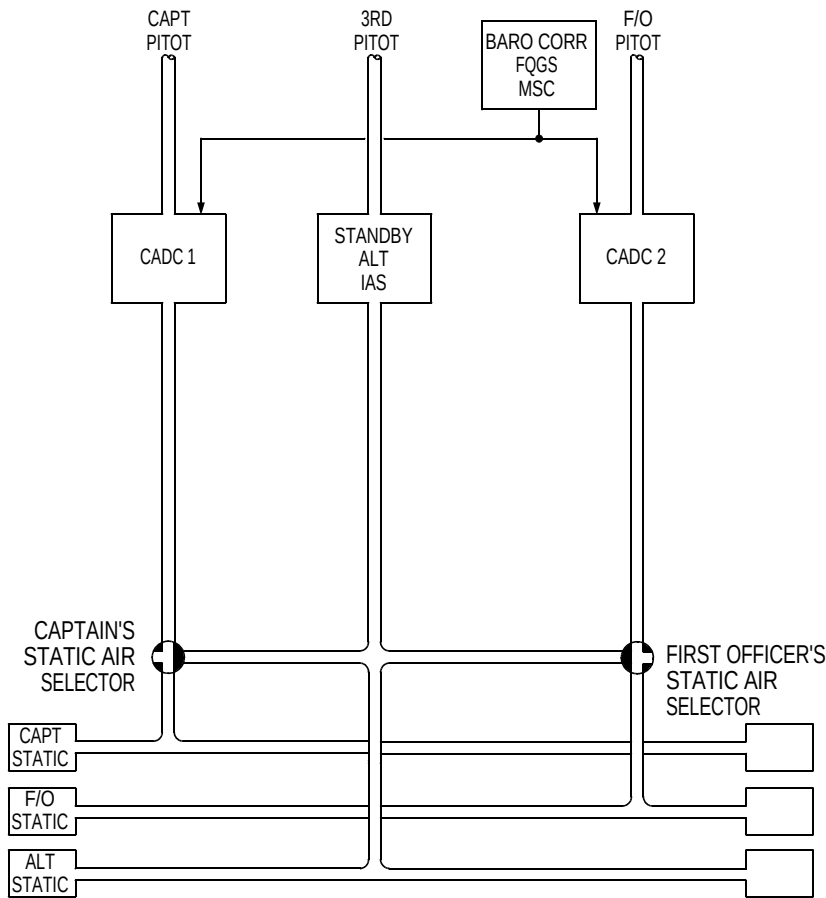
Chapter Inst Section 20

Antenna Locations



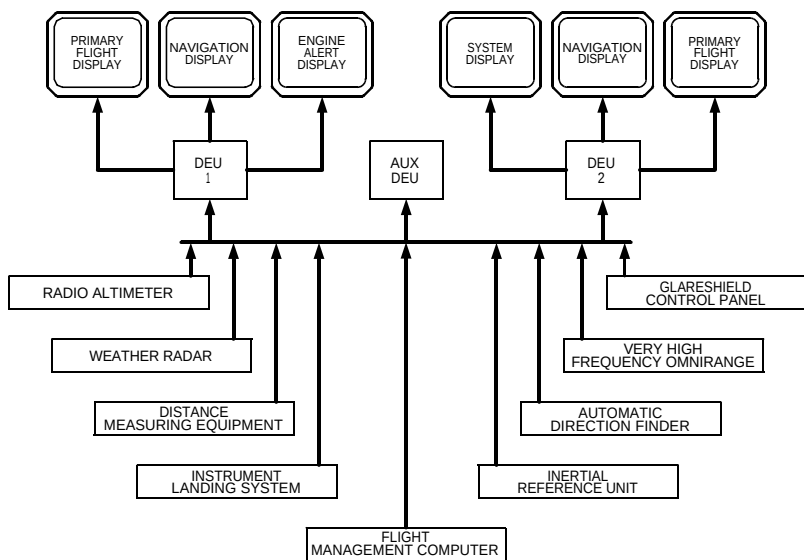
DB1-2-1617B

Pitot/Static System



DB1-2-1956

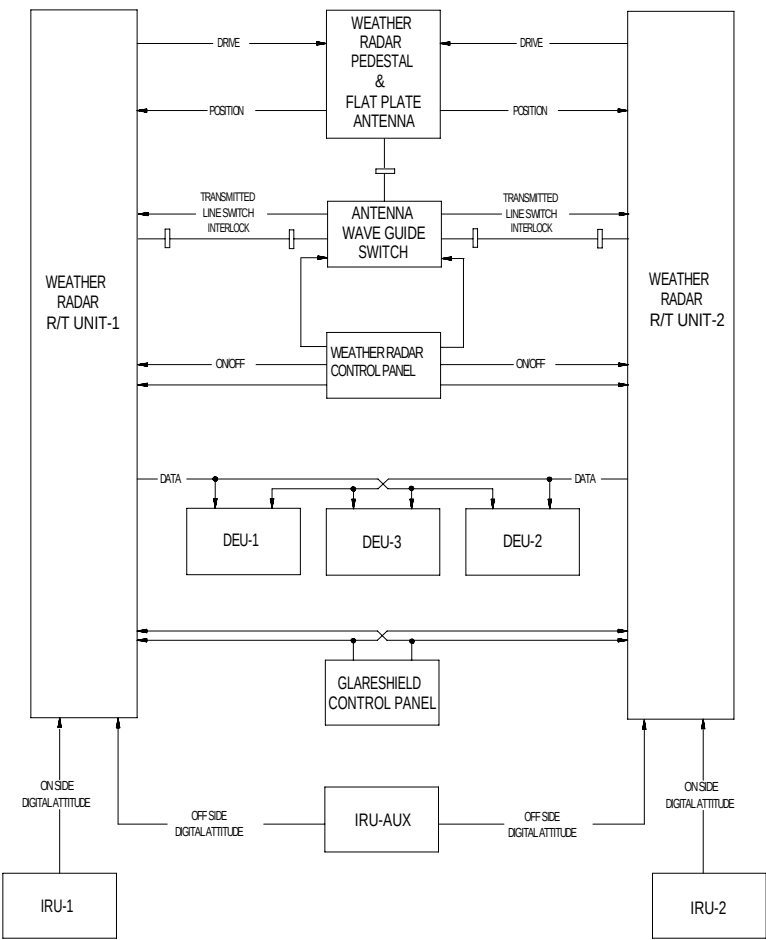
MD-11 Flight Crew Operations Manual

Navigation System


DB1-2-1825A



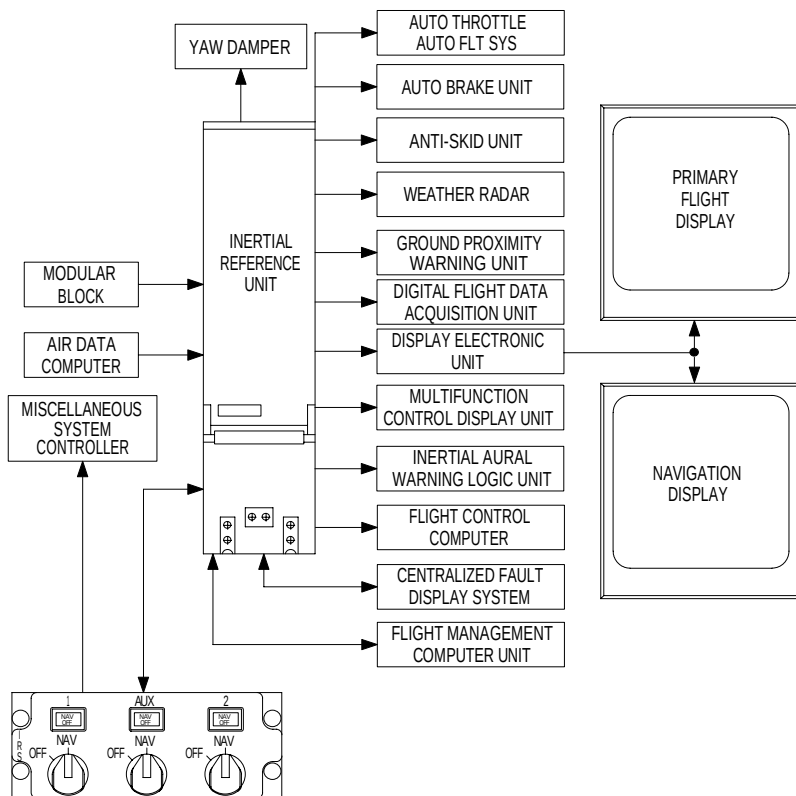
Weather Radar System



DB1-2-1826

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IRS System



DB1-2-1827

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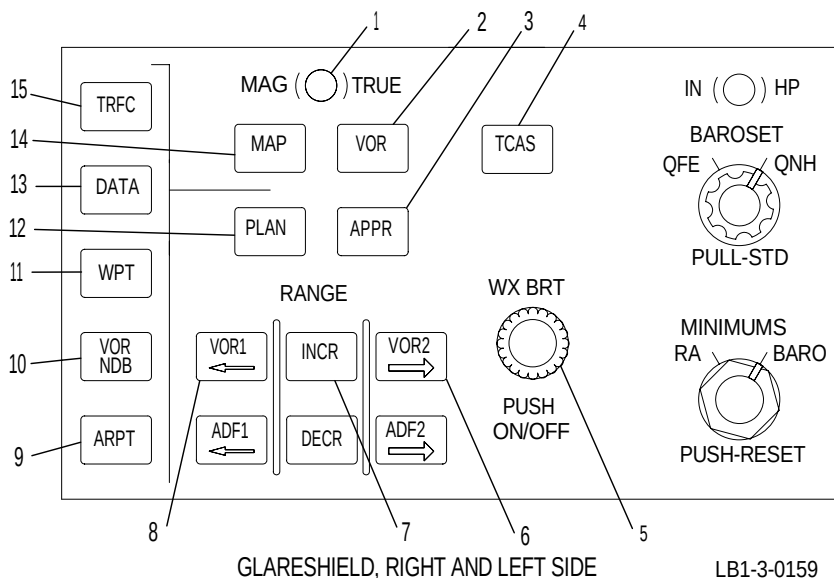
Instrumentation and Navigation

Controls and Displays

Chapter Inst

Section 30

EIS Control Panel



LB1-3-0159

1. MAG/TRUE Changeover Button

Controls the reference for the heading/track indicator on the ND. If MAG is selected the reference will be magnetic north. If TRUE is selected the reference will be true north.

2. VOR Mode Switch

Push to select VOR mode on the ND. VOR mode allows the display of full compass rose and a course deviation indicator. VOR display is compatible with MAP and APPR mode display. Weather data may be displayed in the VOR mode.

3. APPR Mode Switch

Push to select APPR mode on the ND. APPR mode is identical to the VOR mode except that the CDI data source is an ILS receiver. No TO/FROM display is shown in the APPR mode.

4. TCAS Mode Switch

Push to select TCAS display on the ND with 2 nm range ring and auto range to 10 nm.

5. WX BRT Knob

Pushing this knob alternates between weather radar and terrain awareness display on ND. Brightness of display is adjusted by turning this knob clockwise or counter clockwise direction.

6. VOR/ ADF Switch

Controls the bearing pointer display on the ND. Pushing selects or deselects the corresponding source.

7. Range INCR/ DECR Switch

Controls the function of the map range on the ND. Push INCR to increase the map range from 10/20/40/80/160/320, up to a maximum of 640 nautical miles. Push DECR to decrease map range to a minimum of 10 nautical miles. Map range is displayed on the ND.

8. VOR/ADF Switch

Controls the bearing pointer display on the ND. Pushing selects or deselects the corresponding source.

9. ARPT Switch

Push to select display of non-flight plan airports normally not displayed on the ND. Runways displayed have at least 5,000 feet of available stopping distance. Origin and destination airports are normally displayed on the ND.

10. VOR/NDB Switch

Push to select display (cyan) of non-tuned VORs, DMEs, VOR/DMEs, or non directional beacons (NDBs) on the ND. Tuned stations are displayed in white and are not deselectable through this switch.

11. WPT Switch

Push to select display (cyan) of non-flight plan waypoints on the ND.

12. PLAN Switch

Push to select PLAN mode on the ND. PLAN mode displays the north-up flight plan with a reference aircraft moving along it. All map data may be displayed in the PLAN mode.

13. DATA Switch

Push to select display of waypoint data on the ND. Waypoint data consists of an identifier, crosstrack deviation, and waypoint constraint data.

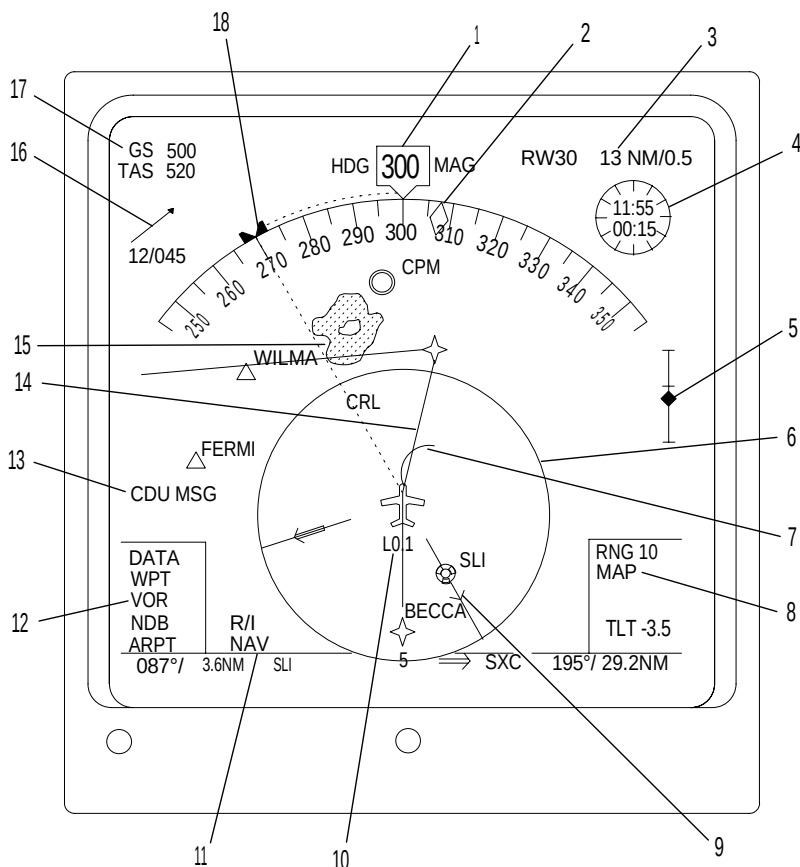
14. MAP Switch

Push to select MAP mode on the ND. MAP mode allows the display of non-flight plan waypoint, airports, nav aids, weather radar data, and bearing pointers.

15. TRFC Switch

Push to select full-time TCAS traffic display on the ND in MAP, VOR, APPR and TCAS modes. If a full-time display is not selected with this switch, traffic display is inhibited until TA or RA occurs.

Navigation Display - Map Mode



The MAP mode is selected by pushing the MAP mode switch on the ECP. The MAP mode has the following characteristics:

- The map is referenced to the aircraft position and heading (or track).
- It allows display of non-flight plan waypoints, airports, navaids, weather radar data, and bearing pointers.

LB1-3-0160

1. Heading/Track Display

Heading or track can be selected with the HDG/TRK button on the FCP. Reference (magnetic or true) can be selected with the MAG/TRU switch on each pilot's ECP. Default is magnetic except at latitudes more than 73 degrees when the default is true. When in the polar region (more than 85 degrees) map orientation is FMS true track.

Selected heading or track is a filled white bug. A white dotted arc is turn direction. A white dotted line goes from the aircraft to the bug and is removed when a selected heading has been captured or the aircraft is in FMS NAV with no preselected heading or track. Preselected bugs are the same as selected except that they are outline only.

2. Drift Angle Pointer

Drift angle is a green diamond that points to track when in heading mode and is removed when in track mode.

3. Distance/Time To Go

Distance (NM) and time (MIN) to the active FMS waypoint is displayed in magenta.

4. Clock/Chronograph Display

Current time (UTC) is on top and elapsed time/timer is on bottom. The bottom display defaults to elapsed flight time in cyan, unless timer is in operation. Timer is displayed in white and is controlled by the TIMER knob on the light control panel. Elapsed flight time is started at ground-to-air transition and stops 30 seconds after air-to-ground transition. Elapsed flight time is held until reset when a new V2 speed is entered on the FMS takeoff page.

5. FMS Vertical Deviation

FMS vertical deviation is indicated by a magenta diamond, moving against a scale on the right side of the map display. Full scale deviations is 1,000 ft. For deviations more than 1,000 ft., half the pointer is visible in the direction of deviation.

6. Half Range Ring

The half range ring is a white circle 2.0 inches in radius centered on the nose of the reference aircraft. The bottom of the circle displays half of the full range selected through the ECP.

7. Curved Trend Vector

The curved trend vector consists of three green arcs starting at the nose of the reference aircraft. The end points of these segments correspond to the predicted position of the aircraft in 30, 60, and 90 seconds at the current groundspeed and rate of turn. The 30 second arc is shown for all ranges. The 60 second arc is shown for ranges equal to or more than 20 miles. The 90 second arc is shown for ranges equal to or greater than 40 miles. These arcs are filtered to reduce activity due to gusts.

8. Weather Radar Annunciator Display

Weather radar data consisting of range, tilt angle, and fault or warning messages are displayed in this area. Maximum range of weather radar display is 320 NM. Tilt angle is controlled from the weather radar control panel located on the pedestal. When weather radar display is disabled, WX OFF is displayed in this area.

9. Bearing Pointers

Bearing pointers are controlled from the ECP. Each pointer may show VOR or ADF data or may be turned off. Pointer 1 (cyan single arrow) always shows data from the left radios and pointer 2 (green double arrow) always shows data from the right radios. Bearing pointer data is at the bottom of the ND. Outboard of the ident or frequency is the bearing and distance to the station. Pointer 1 data is in cyan and pointer 2 data is in green.

10. Crosstrack Deviation

Crosstrack deviation is activated when the DATA switch on the ECP is pushed. Indicates L or R crosstrack deviation in NM. Normally displayed in white. L-R is displayed in amber if crosstrack deviation is invalid.

11. Navigation Modes

Navigation modes are displayed as follows:

- R NAV indicates radio navigation only.
- IRS NAV indicates inertial navigation only.
- R/I NAV indicates radio and inertial navigation.
- NO NAV indicates no navigation mode is active.
- G/I NAV indicates GPS and inertial navigation.
- GNS NAV indicates GPS navigation only.
- Any invalid mode is flagged with an amber X.

12. Active Map Modes

Additional map data is controlled with the DATA, WPT, VOR, NDB, and ARP modes switches on the ECP. Active modes are shown in the lower left of the ND. Modes are displayed as follows:

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- TRFC indicates full time traffic display is on.
- The DATA mode displays FMS constraint data (time and/or altitude) next to the waypoints.
- The WPT mode displays ground reference points (non-flight waypoints).
- The VOR/NDB mode displays non-tuned VORs/DMEs and NDBs.
- The ARPT mode displays non-origin/destination airports.

13. Messages

During descents ADD DRAG or RMV DRAG (magenta) will flash five times and remain steady when applicable. CDU MSG will be displayed (white) when there is a message on the MCDU.

14. Flight Plan Course

Flight plans are shown according to selected range and are displayed from the last waypoint passed through all succeeding waypoints. Flight plans are displayed as follows:

- Active (First Choice) - A series of magenta lines and arcs.
- Secondary (Second Choice) - Cyan dotted lines.
- Provisional (Has Alternate Destination) - Magenta dotted lines and arcs.
- Offset (Parallel to Active Flight Plan) - Long magenta dashed lines and arcs.
- Temporary - Short magenta dashed lines and arcs.

15. Weather Radar Display

Display can be selected or deselected and brightness adjusted with WX BRT knob on the ECP. Maximum range of weather radar display is 320 nautical miles.

16. Wind

Wind is shown with a vector display. A white vector points along the direction of the wind with direction and speed in digits below. Wind is not displayed until wind speed is more than 5 knots and is removed when wind speed falls to less than 3 knots.

17. Speed

Aircraft ground speed and true airspeed are in white.

18. Selected Heading/Track Display

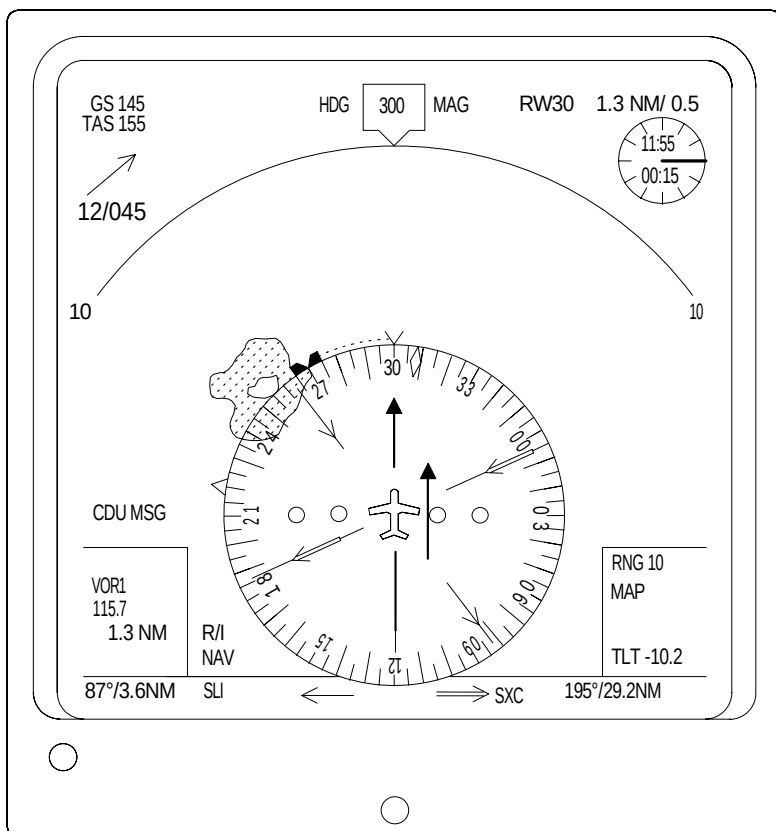
Selected heading or track is displayed as a solid white bowtie shaped bug. This bug is connected to the heading/track index with a dotted white arc indicating direction of turn, and with a dotted line to the nose of the reference aircraft. This line is removed when the aircraft has captured a selected heading, or is in the FMS NAV mode with no preselected heading or track.

For selected headings or tracks that are off scale (more than 55 degrees from the index) the bug is parked and the selected heading or track is digitally displayed at the edge of the screen corresponding to the direction of the turn. If this heading/track is removed far enough the display will appear on the opposite side of the screen and the parked bug will disappear.

Preselected heading/track bugs are displayed only as an outline.

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Navigation Display - VOR/APPR Mode



The VOR mode is selected by pushing the VOR mode switch on the ECP.

The VOR mode has the following characteristics:

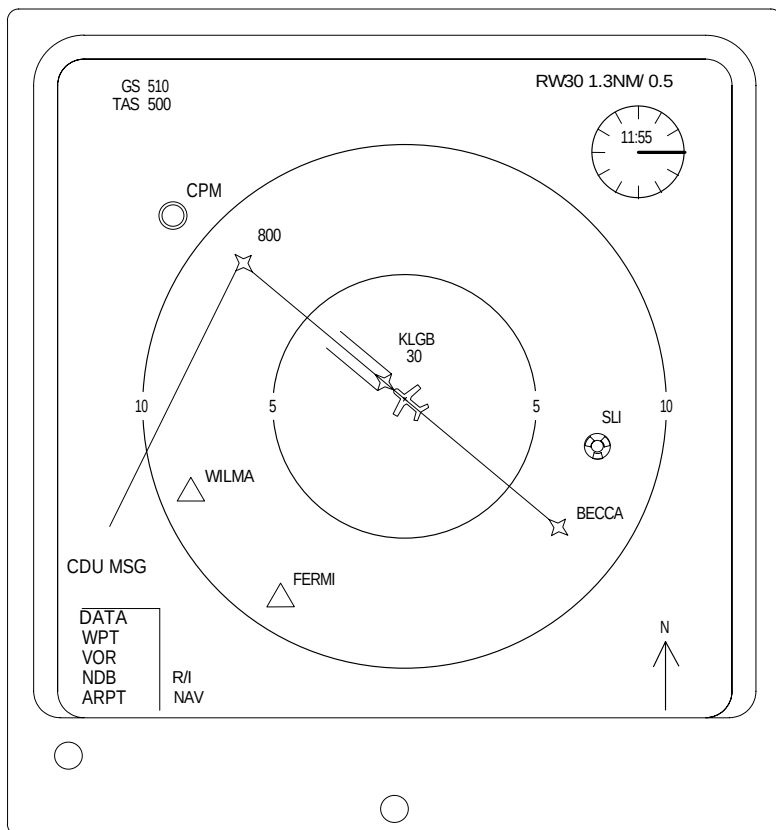
- Weather radar data may be displayed
- A compass rose is centered around the reference aircraft and represents half the selected weather radar range. Current aircraft heading is at the top.
- Selected heading is shown with a solid white bug on the compass. Preselected heading is shown with an outline 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 mode 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



The PLAN mode is selected by pushing the PLAN mode switch on the ECP.

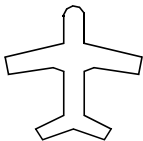
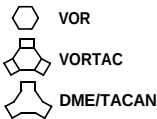
The PLAN mode has the following characteristics:

- 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 aircraft 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 aircraft is relative to FMS true track.

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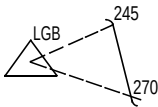
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ND Flight Plan Symbolology (Sheet 1)

U.S. SELECTED	EXPLANATION
	Airplane Symbol The aircraft 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 aircraft heading.
	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 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.

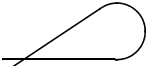
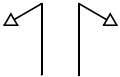
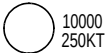
LB1-3-0321

ND Flight Plan Symbolology (Sheet 2)

U.S. SELECTED	EXPLANATION
	NDB Non-tuned or Non-Directional Beacons (NDB) are displayed in cyan and are selected/deselected by pushing the NDB switch on the ECP. Tuned stations are displayed in cyan within a magenta circle and are not deselectable 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 nav aids may be selected through the MCDU. The appropriate symbol will be displayed in white circle. Points will be displayed even if symbology 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 nav aid. The display and selection of these radials is through the FMS MCDU.
250R 	Tuned Nav aids Tuned nav aids are displayed in magenta within a circle (indicating FMS selection).

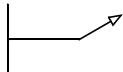
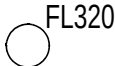
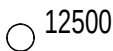
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ND Flight Plan Symbolology (Sheet 3)

U.S. 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.

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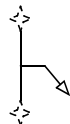
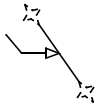
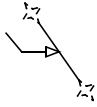
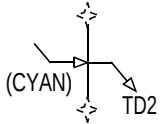
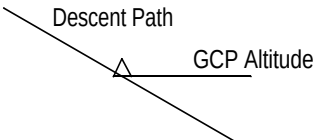
ND Flight Plan Symbolology (Sheet 4)

U.S. 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.
	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.
	Intercept From Below FMS predicted lateral path point where the aircraft will rejoin the FMS descent profile when below path. Data is displayed in magenta.
	Intercept From Above FMS predicted lateral path point where the aircraft will rejoin the FMS descent profile when above path. Data is displayed in magenta. With speed brake extended, data is displayed in white.
	Altitude Intercept Lateral path point where the FMS predicts that the aircraft next reaches the corresponding altitude entered into the MDCU
	Pole Display When the FMC determined north or south latitude of the aircraft is within ND range selection distance from the pole, the north or south pole is displayed on the ND as a filled cyan circle with the label POLE.

LB1-3-0318

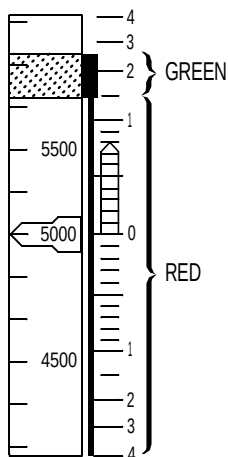
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ND Flight Plan Symbolology (Sheet 5)

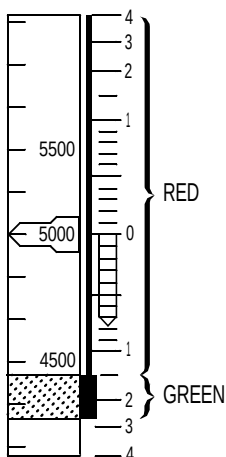
U.S. SELECTED	EXPLANATION
	Top of Descent 1 (TD1) Lateral point where the FMS predicts the aircraft will begin descent from current altitude. Data is displayed in magenta.
	Top of Descent 2 (TD2) Computed point where an altitude below the aircraft, set in the FCP, is at the altitude of descent path for that lateral position on the track.
	Level During Descent Computed point where the FCP altitude is at the descent path altitude for that lateral position on the track. Data is displayed in cyan.
	Level During Descent-Missed Constraint Computed point where the FCP altitude is at the descent path altitude for that lateral position on the track, and the remaining predicted profile has a missed constraint.
	Level During Descent To FCP on Path ALT Computed point where the FCP altitude is at the descent path altitude for that lateral position on the track, and the remaining predicted profile has a missed constraint. Data is displayed in cyan and white.
	

LB1-3-0317

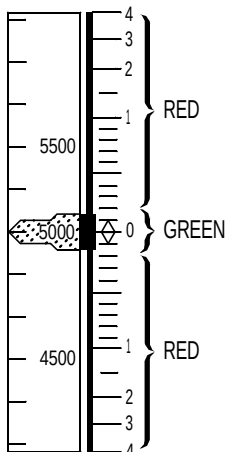
TCAS Resolution Advisories on PFD



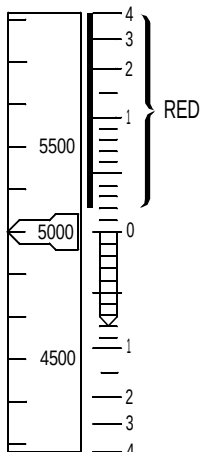
Corrective RA
Up Advisory
Climb >1500 fpm
Voice warning:
climb, climb (change 7)



Corrective RA
Down Advisory
Descend >1500 fpm
Voice warning:
descend, descend (change 7).



Preventive RA
Don't Climb
Don't Descend
Voice warning: monitor vertical
speed, monitor vertical speed
(change 7).
No action required.

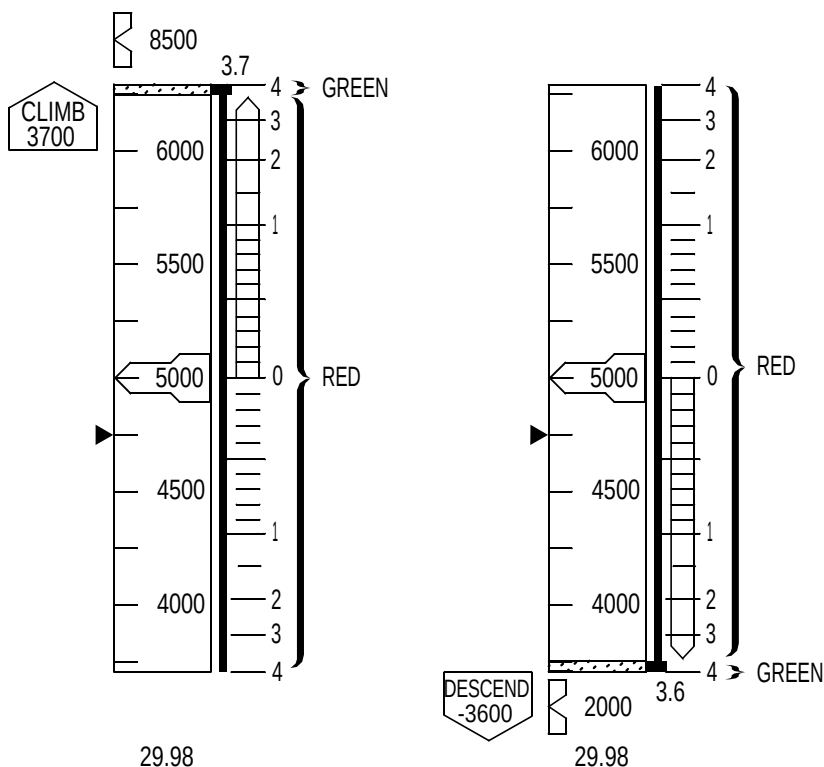


Preventive RA
Don't Climb
Voice warning: monitor vertical
speed, monitor vertical speed
(change 7).
No action required.

LB1-3-0323

MD-11 Flight Crew Operations Manual

TCAS - Off Scale RA on PFD

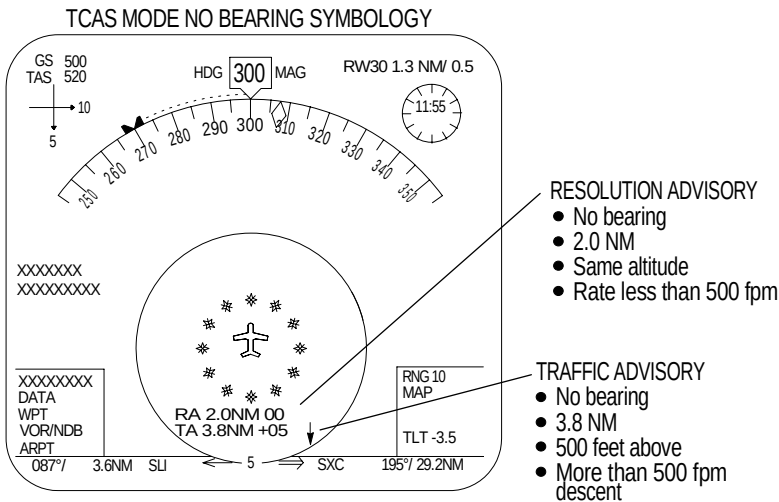
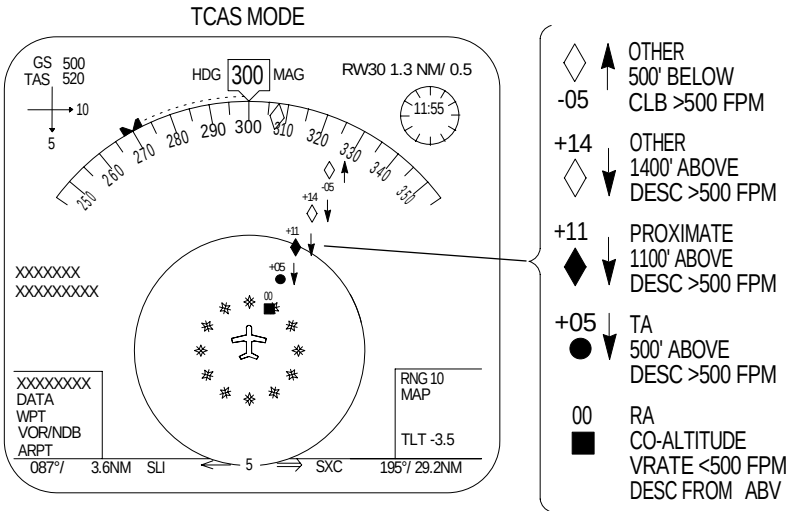


- Corrective RA
- Up advisory
- Climb 3700 fpm
- Voice warning: maintain vertical speed, maintain (change 7)

- Corrective RA
- Down advisory
- Descend 3600 fpm
- Voice warning: 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.

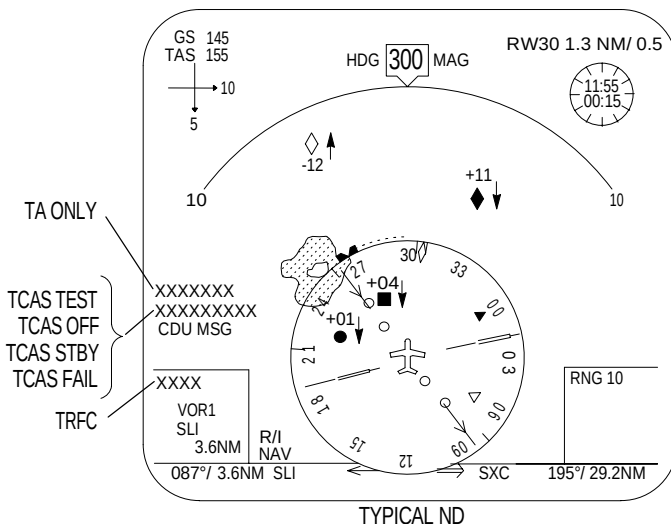
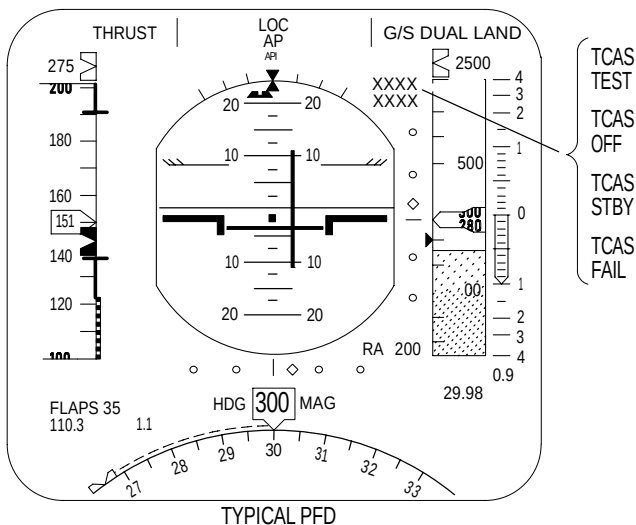
TCAS Displays on ND



DB1-2-1621

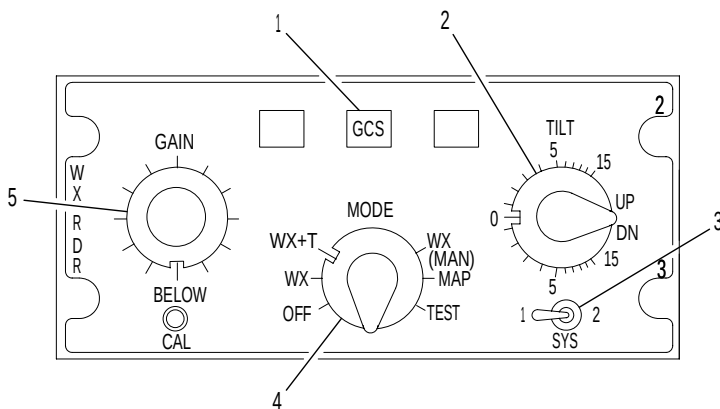
MD-11 Flight Crew Operations Manual

TCAS Displays on PFD and ND



DB1-2-1623

Weather Radar Control Panel (Collins 622-5130-120)



AFT PEDESTAL, LEFT SIDE

DB1-2-1813

1. GCS Switch

Push and Hold - Enables ground clutter suppression when in WX modes.

2. TILT Control

Controls antenna tilt.

3. SYS Switch

1/2 - Selects system 1 or 2.

4. MODE Selector

OFF - Removes power from system.

WX - Selects precipitation detection mode.

WX + T - Selects precipitation and turbulence detection mode.

MAP - Selects ground map mode.

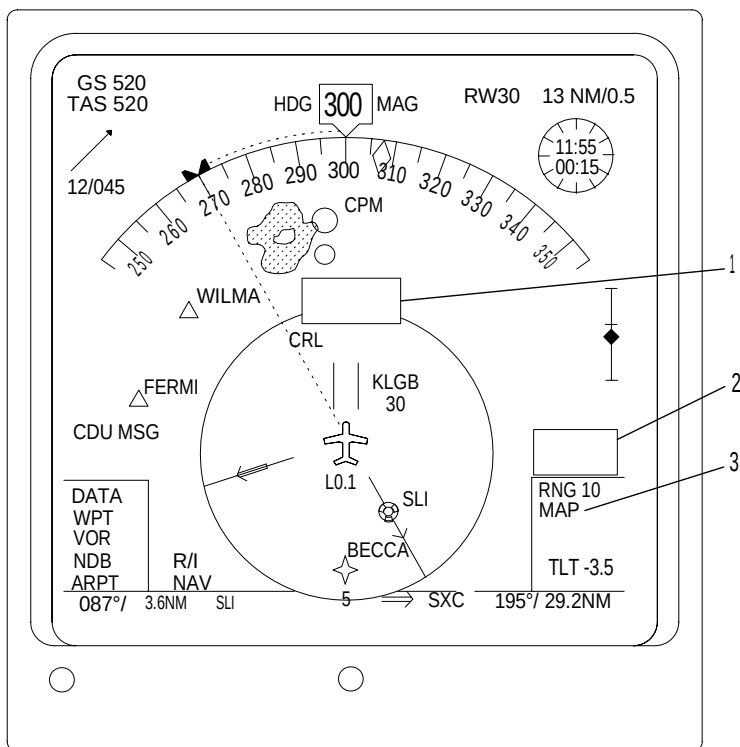
TEST - Activates test mode.

5. GAIN Knob

Controls gain in WX (MAN) and MAP modes. BELOW CAL light illuminates if gain is set below calibrated level.

MD-11 Flight Crew Operations Manual

Weather Radar Display



LB1-3-0177

1. WXR Annunciations

WXR ON - Flashes white if R/T is on and aircraft is on the ground.

WXR FAIL - Amber if R/T has failed.

WXR RANGE DISAGREE - Amber if WXR range differs from range selected.

2. Fault Messages

Messages are stacked vertically on top of each other when the WXR is in TEST mode and the aircraft is on the ground.

R/T - Receiver/Transmitter problem.

ANT - Antenna has stopped scanning.

CNTL - Control panel problem.

ATT - Stabilization input to the R/T are invalid.

CAL - Automatic calibration not available. Transmitter output power is low.

STAB - Antenna elevation drive has exceeded limits and is driving into mechanical stops.

3. Status Messages

RNG - Range displayed in nautical miles.

MAP - Map mode. Ground mapping on.

STBY - No scanning, transmitter off.

WX - Weather radar detection on.

WXR OFF - Weather radar detection off.

WX/T - Weather/Turbulence detection on.

TURB - Turbulence detection on.

TEST - Test mode on.

REAC - WXR Rain Echo Attenuation Compensation Technique (REACT) circuitry is enabled.

GCS/ID - Ground clutter suppression on.

VAR - Variable gain. GAIN knob not in CAL position.

TLT - Tilt angle displayed in degrees.

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Standby Compass

COMPASS CORRECTION CARD

COMPASS _____

DATE _____

FOR	STEER	FOR	STEER
N		S	
30		210	
60		240	
E		W	
120		300	
150		330	

AIRPLANE TYPE _____

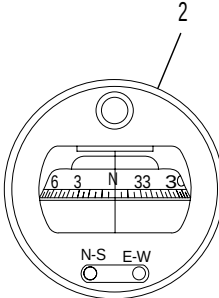
AIRPLANE NO. _____

COMPASS SER. _____

SWUNG BY _____

2336938

FIRST OFFICER'S INSTRUMENT PANEL



WINDSHIELD

LB1-3-0180

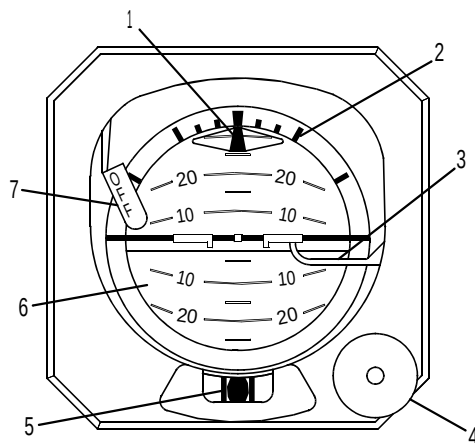
1. Standby Compass Correction Card

Provides standby compass correction data as set during calibration and compass check.

2. Standby Compass

Indicates heading of aircraft in relationship to magnetic north.

Standby Attitude Indicator (Typical)



LB1-3-0314

1. Roll Pointer

Triangular mark indicates center of roll index and center of horizon spheroid. Pointer on spheroid moves in relationship to pointer on roll index indicating amount of roll.

2. Roll Index

Indexed scale indicates amount of roll left or right. Triangular mark indicates center (zero degrees roll), short tick marks indicate 10 and 20 degrees increments followed by large tick marks indicating 30, 45, and 60 degrees of roll.

3. Miniature Airplane

Miniature airplane is fixed to the instrument frame.

4. Caging Knob

Provides a means to bypass the normal electrical erection process of the indicator and orients the internal gyro within 1.0 degrees of an apparent vertical axis. Pulling the knob out will erect the gyro in pitch and roll.

5. Slip Indicator

Slip and skid is indicated by ball in fluid.

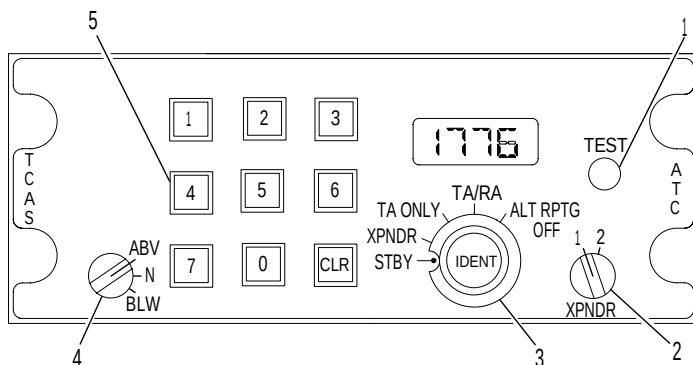
6. Horizon Spheroid

A plastic sphere with a horizon line engraved in the center to indicate the transition between a climb and a dive condition. The sphere is marked to indicate pitch attitude with a long horizontal line every 10 degrees and a short line indicating 5 degree increments.

7. OFF Flag

Flag will be displayed whenever there is an interruption to power or indicator is caged.

ATC Transponder



AFT PEDESTAL, LEFT SIDE

DB1-2-1820

1. TEST Button

Push - Activates system test.

2. XPNDR Selector

1/2 - Selects transponder 1 or 2.

3. Mode Selector

STBY - Applies power to the transponder but inhibits response to ground interrogation.

XPNDR - Allows response to ground interrogation.

TA ONLY - Selects TCAS Traffic Advisory mode only.

TA/RA - Selects Traffic/Resolution Advisory mode.

ALT RPTG OFF - Turns altitude reporting off.

4. ABV/BLW Selector

ABV - Selects display of traffic that is above (up to 9,900 feet) and below down to 2,700 feet.

N - Selects display of traffic within +/- 2,700 feet of own altitude.



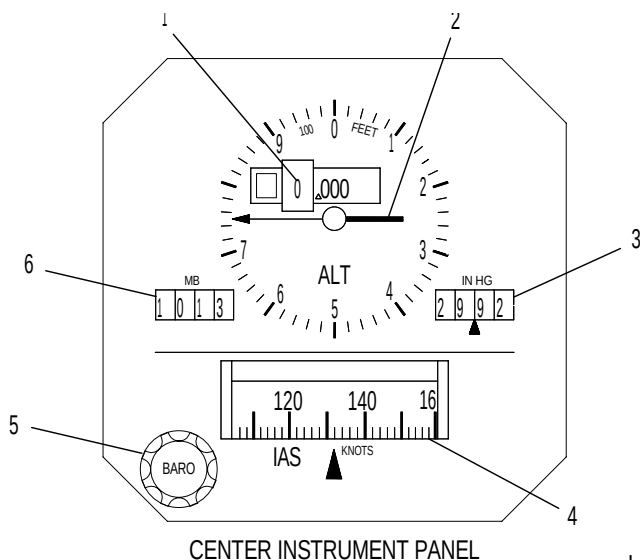
MD-11 Flight Crew Operations Manual

BLW - Selects display of traffic that is below (down to 9,900 feet) and above up to 2,700 feet.

5. **Keys**

Allows code selection. CLR key clears the selection.

Standby Altimeter/Airspeed Indicator



LB1-3-0182

1. ALT Readout

Displays altitude from -1,000 to 50,000 feet in 1,000 foot increments. The zero position in the left hand ten-thousands is indicated by a green square when below 10,000 feet and a red square when below sea level.

2. 100 Foot Pointer

Indicates altitude against a graduated circular dial, numbered every 100 feet. Pointer makes one complete circle every 1,000 feet.

3. IN HG Barometric Pressure Display

Indicates pressure, set through the BARO set knob, in inches of mercury.

4. IAS Indicator

Triangular shaped lubber line indicates non-corrected indicated airspeed.

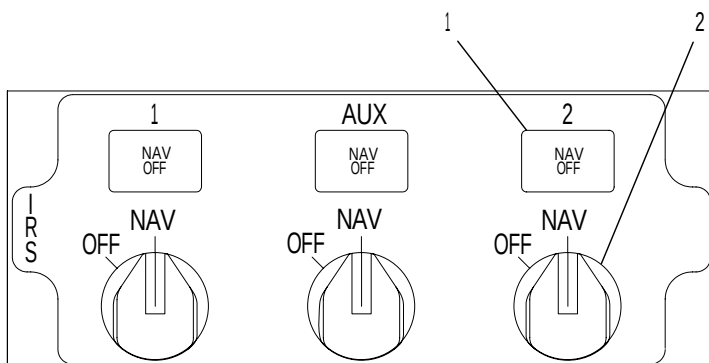
5. BARO Set Knob

Sets barometric pressure.

6. MB Barometric Pressure Display

Indicates pressure, set through the BARO set knob, in millibars.

IRS Control Panel



FORWARD OVERHEAD PANEL, LEFT SIDE

LB1-3-0184

1. NAV OFF Light (3) - amber

Illuminates amber if:

- System is off.
- System is in align submode.
- A primary IRU failure (attitude, heading, angular rate, or acceleration) has been detected by the built-in-test functions.

Flashes amber if:

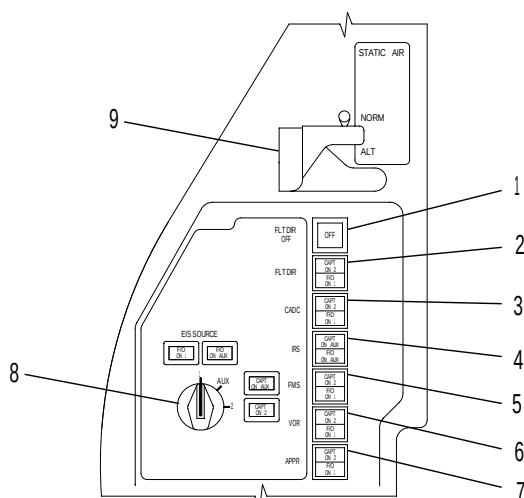
- During alignment the IRS does not receive present position initialization within 10 minutes of turn on.
- Present position entry fails the comparison test with either the stored present position or calculated position. The comparison test must be about 1 degree latitude and/or 1 degree longitude.
- Excessive aircraft motion is sensed during align submode.

2. Mode Selector (3)

OFF - Turns off power to system.

NAV - Normal position. The cargo fire test is performed automatically when the first IRU is turned on after landing.

Source Input Select Panel



CAPTAIN'S AUXILIARY PANEL
(First Officer's opposite)

LB1-3-0185B

1. FLT DIR OFF Switch - amber

Illuminates amber when flight director is selected off. Pushing switch while illuminated will reengage the flight director. See Automatic Flight chapter for a complete description.

2. FLT DIR Switch - amber

Allows selection of flight director source displayed on PFD.

3. CADC Switch - amber

Allows selection of respective CADC output to the Captain's or First Officer's DUs. Under normal operation, the Captain's DUs use CADC 1 as a source, and the F/O's DUs use CADC 2 as source. No light will illuminate if conditions are normal. CAPT ON 2 or F/O ON 1 will illuminate amber to indicate respective condition. Pushing switch while illuminated will return DUs source to normal CADC output.

4. IRS Switch - amber

Allows selection between normal operation of the IRS or using the auxiliary IRU as a display source. Under normal conditions, the Captain's DUs use IRU-1 and the F/O's DUs use IRU-2 as a display source. CAPT ON AUX or F/O ON AUX will illuminate amber to indicate respective condition. Pushing switch while illuminated will return system to normal operation.

5. FMS Switch - amber

Allows selection between normal in line operation of the FMS or a transfer to a secondary FMS. Captain may select F/O's FMS (FMS-2) or F/O may select Captain's FMS (FMS-1), but Captain and F/O may not select each others FMS simultaneously.

6. VOR Switch - amber

Allows selection of VOR display source to be transferred from an alternate source. Normally the Captain's VOR display is controlled by the left radio systems, and the F/O's VOR display is controlled from the right radio systems. CAPT ON 2 or F/O ON 1 will illuminate amber to indicate respective condition. Pushing switch while illuminated will return VOR source to normal.

7. APPR Switch - amber

Allows selection of approach data (ILS or MLS) to be transferred from an alternate source. Normally the Captain's APPR display is controlled by the left radio systems, and the F/O's APPR display controlled by the right radio systems. CAPT ON 2 or F/O ON 1 will illuminate amber to indicate respective condition. Pushing switch while illuminated will return APPR source to normal.

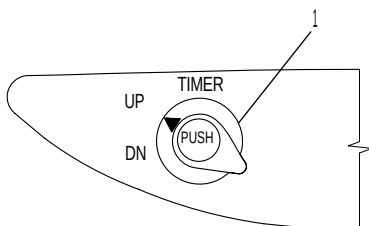
8. EIS SOURCE Selector and Annunciator Lights

Normally DEU 1 drives the Captain's DUs (DU1, DU2, and DU3) and DEU 2 drives the F/O DUs (DU4, DU5, and DU6). Normal selector position is Captain on 1 and F/O on 2. If the selector is out of the normal position, the appropriate annunciator light will illuminate amber.

9. STATIC AIR Selector

When Captain's and F/O's selector is in NORM, CADC 1 receives static pressure from Captain's static system and CADC 2 receives static pressure from F/O's static system. When Captain's or F/O selector is in ALT, respective CADC receives static pressure from alternate system.

ND Clock Timer Selector



BELOW BOTH CLEARVIEW WINDOWS

LB1-3-0186A

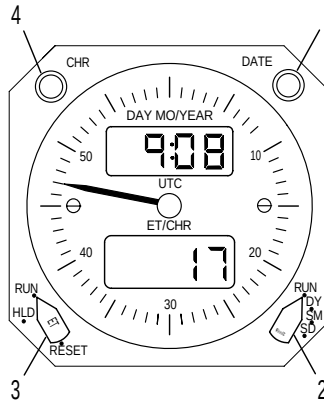
1. ND Clock TIMER Selector

Push one starts clock timer on ND. Push two stops clock timer. Push three resets clock timer to 00:00.

UP - Timer counts up from 0.

DN - Timer counts down from a preselected time. Preselected time is set on the MCDU APPROACH page and also will appear on ND.

Electronic Chronometer



RIGHT OBSERVER STATION

DB1-2-1859

1. DATE Button

Push to display date in window. Push again to display UTC time. If chronograph is counting, elapsed time will be displayed in lower window for 2 seconds upon returning to UTC time.

2. UTC Selector

Sets date or UTC time in upper window. Function is dependent on display of date or time in the window.

RUN - Starts time.

HLDY - Hold time/Set year.

SSM - Slow slew minutes/Set month.

FSD - Fast slew hours/Set day.

3. ET Selector

RUN - Starts elapsed time in lower window.

HLD - Records elapsed time.

RESET - Resets elapsed time to 0.

4. CHR Button

Push one starts chronometer time. Push two holds the time. Push three resets chronometer to 0 (sweep second hand returns to 0). Chronometer display overrides elapsed time display.

Instrumentation & Navigation**Chapter Inst****Alerts****Section 40**

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

Amber Boxed Alerts (Level 2)

IRU AUX FAIL (MISC) - Auxiliary IRU failed. May also appear during transponder and TCAS test.

IRU 1/2 FAIL (MISC) - Respective IRU failed.

Amber Alerts (Level 1)

ATC XPDR 1/2 FAIL (MISC) - Respective transponder failed.

CAWS FAULT (MISC) - Some functions of the CAWS may be inoperative.

DFDAU FAULT (MAINT) - Maintenance alert. Some or all DFDR parameters are not being recorded.

DFDR OFF (MISC) - DFDR is not operating. On the ground, the DFDR requires engines operating and parking brakes released to operate.

IRU BAT LO (MISC) - One or more of the IRU backup batteries is not fully charged.

IRU OFF (MISC) - One or more IRU mode selectors is in OFF during flight.

IRU 1/2/AUX NAV FAIL (MISC) - Respective IRU navigation function failed. Attitude data remains usable.

IRU 1/2/AUX NO ALIGN (MISC) - Respective IRU did not align. Pilot should confirm position coordinates are entered.

IRU 1/2/AUX ON BAT (MISC) - Respective IRU is operating on backup battery power. The battery will provide about 15 minutes of power.

UNABLE RNP (MISC) - Required navigation performance is not being met during that phase of flight.

Cyan Alerts (Level 0)

IRU IN ALIGN - One or more IRU in alignment mode. Aircraft should not be moved during alignment.

Intentionally
Blank

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Landing Gear and Brakes

Description and Operation

Chapter Land

Section 10

General

The aircraft has a tricycle landing gear consisting of four-wheel trucks on each main gear, dual wheels on the nose gear, and a dual wheel center gear. Maximum tire speed is 204 KTS.

All landing gear as well as the main gear wheelwell doors are hydraulically actuated. The main and nose gear can be extended without extending the center gear. A free fall capability is designed into the system for use in case of hydraulic failure.

An electrically monitored, visual/aural indicating and warning system provides gear status indications during the various flight phases.

Dual, hydraulic powered, multi-disk wheel brakes with anti-skid control systems are installed on the main and center gear.

Hydraulic accumulators provide reserve brake pressure in case of normal hydraulic pressure loss.

Tire pressure and brake temperature are monitored continuously and displayed on the CONFIGURATION page of the System Display (SD).

Alerts on the Engine and Alert Display (EAD) and SD will warn the flight crew of anti-skid, brake, and tire malfunctions.

Gear Retraction and Extension

The landing gear and main doors are retracted and extended by hydraulic system 3. If system 3 has a pressure loss, but fluid is available, hydraulic power to retract the gear can be supplied if either the (1-3) or (2-3) Reversible Motor Pumps (RMP) are operating.

HYD SYS 3 hydraulic quantity indication will show a slight increase when the gear is retracted.

If no hydraulic pressure is available due to loss of fluid or complete system failure, or if the GEAR handle is jammed in the up position, the main and nose gear can be mechanically unlatched by an alternate gear extension lever in the floor at the right side of the pedestal. The center gear can be unlatched by a center gear alternate extension handle on the cockpit floor. All landing gear will then free fall and mechanically latch in the down position. The main landing gear is normally held in the up position by hydraulic pressure. In case of pressure loss, the main gear will rest on the main wheelwell doors. The nose gear and center gear are held up by overcenter linkage.

Trim cylinders maintain the truck beams perpendicular to the main gear struts. A trim cylinder interlock mechanism prevents moving the GEAR handle up in the event of hydraulic failure in the trim system.

Nose Gear Steering

Nose gear steering is powered by hydraulic systems 1 and 3. The nose gear steering wheel and rudder pedals provide steering control. The nose gear steering wheel has override authority over the rudder pedal steering.

Maximum steering angle using the nose gear steering wheel is 70 degrees either side of center. Full rudder pedal travel provides steering to a maximum of 10 degrees either side of neutral.

If hydraulic system 1 or 3 fails completely, nosewheel steering is limited to 25 degrees in the direction of the inoperative system. Rudder pedal steering is not affected noticeably by loss of one hydraulic system.

Rudder pedal steering is rendered inoperative by the mechanical ground sensing mechanism during nose gear strut extension at takeoff.

Nose gear steering using the nose gear steering wheel while the gear is retracted is not possible as the steering bypass valve is mechanically placed in a bypass mode upon nose gear retraction. This prevents inadvertent steering and possible jamming of the nose wheels in the nose wheelwell.

Ground Sensing System

A mechanically operated ground sensing mechanism is installed. It is operated by extension and compression of the nose gear strut.

The system does the following:

- Mechanically disables rudder pedal nose gear steering.
- Releases the GEAR handle anti-retract lock.
- Activates flight or ground mode for various systems.

When the ground sensing mechanism does not shift to flight mode, the following systems are affected:

- Takeoff warning system will remain active.
- Pressurization will not function in automatic.
- Airborne engine thrust reverse possible.
- Stall warning, stickshakers, and auto slats will not function.
- Pitot and angle-of-attack heat stays low.
- Airfoil anti-ice inoperative.
- Spoilers have unrestricted operation.
- Autoflight system limited to TO function.

Gear Indicating and Warning

The landing gear position indicating system consists of lights, aural warning, mechanical indicating, and indications shown on the SD.

Two separate systems provide gear position and warning indications. Indication and warning lights for one system are installed adjacent to GEAR handle. Inputs from the second system are shown on the SD. Either system can be connected to the display adjacent to GEAR handle. This is done by reversing the output signal connectors in the avionics compartment.

Both indication displays will show a separate green indication for each landing gear when gear is down and locked. It will also show a separate red indication for each gear when a gear is not in a position that corresponds with the GEAR handle.

With the GEAR handle in the DOWN position, both indication systems will display an unsafe condition if the down-lock links are not over center.

With the GEAR handle in UP position, both indication systems will display an unsafe condition if either main gear door is not closed and latched or the nose and centerline gear are not in the retracted position with lock links over center.

The gear warning horn will sound when any throttle is retarded to idle with the landing gear up, the airspeed below 210 knots, and radio altitude 1200 feet or less. The warning horn can be silenced with the GEAR HORN OFF button on the forward pedestal.

The primary system is responsible for the gear warning horn. The secondary system is responsible for green box indication on the secondary display. The nose gear primary system is responsible for the TOO LOW GEAR aural warning.

The gear warning horn will also sound any time any gear is not down and locked and the flaps are extended 31.5 degrees or more. In this case, the horn cannot be silenced with the GEAR HORN OFF button.

When the CTR GEAR NORM/UP switch is in UP and the center gear is up and locked, the CTR gear light will remain off during any subsequent gear warning. The center gear position will not input to the aural warning.

With the CTR GEAR NORM/UP switch in UP and the center gear in the down and locked position, the green and red indicator lights will illuminate based on the agreement/disagreement status with the GEAR handle position.

Both indication systems function in the normal manner when the alternate control system is used for gear extension.

If the electrical gear indicator fails, the main landing gear can be verified down and locked by viewing a protruding button on the top surface of each wing. Main gear up/doors closed can be verified by looking through a viewing window in the cabin floor. Nose gear up or down and locked can be verified by checking the alignment of marks painted on the nose gear assembly. This check is done through two viewing tubes located in the floor of the forward main cabin.

Center gear down locks do not have a visual check. The uplock can be checked with the center gear alternate extension handle.

An interlock prevents nuisance aural warnings during normal low thrust descents.

Brake System

There are two independent brake systems for each of the eight main wheels and two center wheels. Each brake system uses a separate hydraulic system.

Brake system 1 is powered by hydraulic system 1. Brake system 2 is powered by hydraulic system 3.

Both systems actuate brakes on all main and center gear wheels independently. One brake system can provide braking for all landing conditions. Electric aux hydraulic pump 1 can provide reserve pressure to hydraulic system 3 to power the brakes. The pump switch is located on the AUTO BRAKE control panel and the HYD control panel.

The hydraulic pressure available for each brake system is displayed on the AUTO BRAKE control panel.

Brakes are available when the brake system pressure is above the red band on the respective BRAKE PRESS indicator.

Three accumulators in each brake system will supply reserve braking pressure in case of hydraulic system failure. Fully charged accumulators allow about 10 manual brake applications and will permit anti-skid operation.

Excessive brake temperature will melt a wheel fuse-plug, releasing tire pressure at that wheel to protect against wheel failure.

Parking brakes are set by applying full braking pressure with the toe-operated rudder pedal brakes, positioning the PARK BRAKE handle full aft, and then releasing the rudder pedals. This traps braking pressure in the system.

Adequate parking brake pressure is available if the brake system BRAKE PRESS indicators indicate pressure in the green band or higher.

With the parking brake set for several hours, hydraulic system pressure bleed off can occur. Normal hydraulic pressure to the brakes is backed up by three accumulators in each brake system. As long as the BRAKE PRESS indicators show pressure, there will be hydraulic pressure at the brakes.

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When the brake system is in park, an amber PARK brake light on the forward pedestal and a PARK BRAKE ON alert will illuminate.

The parking brakes can be released by fully depressing and then releasing the toe pedals. Depressurization of the hydraulic system(s) will not effect parking brake capability. Subsequent pressurizing of the hydraulic system(s) will automatically reset full parking brake capability regardless of initial parking brake pressure. During re-pressurization of the parking brake, the PARK BRAKE handle does not need to be operated or reset.

If throttles 1 and 2 are advanced for takeoff, the ground mechanism is in ground mode, and parking brake is on, a tone will sound.

Anti-Skid System

The anti-skid system is an automatic, pressure modulating system controlled by an anti-skid control box, with individual wheel speed transducers, and anti-skid control valves for each main and center wheel brake. The system prevents tire skid by reducing individual brake pressure (manual or automatic braking) as required. Touchdown protection prevents inadvertent brake application on landing. Automatic brake release of a locked wheel is provided down to speeds of 25 knots.

When the gear is in the up position, power to the anti-skid system is removed.

A continuous anti-skid self test is performed whenever power is supplied to the anti-skid control unit. A more extensive powerup test is performed whenever the gear extends down or the ANTI-SKID switch is cycled from off to on.

A failure in the anti-skid system which may affect anti-skid function will cause an ANTI-SKID L FAIL, ANTI-SKID R FAIL, or ANTI-SKID FAIL alert to be displayed. Fault/status data is sent to the Centralized Fault Display System (CFDS).

If a wheel brake or anti-skid channel is inoperative, the aircraft can be dispatched using the Minimum Equipment List (MEL) procedure and the CFDS. In this case the alert WHEEL BRAKE INOP will appear as a reminder to the flight crew.

The anti-skid system can be manually disarmed with the ANTI-SKID switch on the forward pedestal (switch will illuminate OFF).

Center gear brakes are off when brake control valve output pressure is below about 1,500 psi.

During taxi (below 50 knots), center gear brakes are off and the remaining eight main gear brakes are symmetrically alternated after each brake application

Automatic Brake System (ABS)

The ABS automatically applies the brakes during landing and rejected takeoff. The system consists of an AUTO BRAKE control panel on the forward pedestal, an amber ABS DISARM light on each side of the glareshield, two Integrated Brake Control Valves (IBCV), and an autobrake control unit.

Hydraulic systems 1 and 3 are required for normal auto brakes.

In the landing mode, the ABS operates from both brake system 1 (hyd sys 1) and brake system 2 (hyd sys 3) and provides selection of one of three modes: MIN, MED, or MAX. ABS is available in HIGH deceleration rates. With the AUTO BRAKE selector in the MIN and MED position, the system compares actual aircraft deceleration data obtained from the Inertial Reference Units (IRU) with the selector position. The system then maintains a constant level of deceleration.

In the MAX position, maximum pressure from brake system 1 and 2 is applied to the brakes by both of the IBCVs. The maximum individual brake pressure is reduced only by anti-skid operation. Maximum deceleration is achieved.

The ABS landing mode is armed after the gear is down prior to landing by selecting the deceleration level desired. Arming of the ABS requires:

- ABS operative (no system failure).
- Deceleration level selected prior to landing.
- Anti-skid armed and operational.
- IRU1 and IRU2 operational.
- Flaps more than 28 degrees.

The ABS landing mode is activated when the spoilers are deployed automatically or manually with throttles retarded to the idle position and brake pedals released. Automatic braking is delayed after spoiler deployment for about 1 second in MAX position and 3 seconds in MIN and MED positions. This allows for a normal nosewheel touchdown.

Pilot takeover can be initiated at any time and ABS will disarm if:

- Brake pedal is depressed beyond about 40 percent travel (ABS DISARM lights illuminate).
- Throttle 1 or 3 is advanced beyond 5 degrees (ABS DISARM lights illuminate).
- AUTO BRAKE selector is placed in OFF position (ABS DISARM lights do not illuminate).

The ABS will also disarm and ABS DISARM lights will illuminate if flaps are less than or equal to 28 degrees when spoilers are deployed.

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After the ABS initiates braking, normal landing mode braking will continue regardless of flap setting. Stowing the ground spoilers will release the brake pressure without disarming the ABS landing mode. ABS DISARM lights will remain off and automatic braking will again be available if spoilers are deployed.

The ABS takeoff mode is armed by selecting T.O. with the AUTO BRAKE selector. It is desirable that auto ground spoilers be armed and flaps must be in the takeoff range.

In the Rejected Takeoff (RTO) mode above 100 knots the ABS provides maximum brake pressure from both brake system 1 (hyd sys 1) and brake system 2 (hyd sys 3). Maximum individual brake pressure is reduced only by anti-skid operation. Maximum deceleration is achieved.

RTO initiation must occur at speeds greater than 100 knots for maximum dual system braking. If RTO is initiated below 100 knots, the ABS reverts to landing mode operation and MIN braking is applied. The ABS takeoff mode is activated during a rejected takeoff when automatic or manual ground spoilers are deployed. If spoilers fail to deploy automatically, manual deployment will activate the ABS.

Once automatic brakes are applied for an RTO, pilot takeover can be initiated by either advancing throttles 1 or 3 beyond 5 degrees of travel or by depressing the brake pedals beyond 90 percent of travel for MAX RTO and 40 percent of travel for MIN RTO. Automatic disarming will cause the ABS DISARM lights on the glareshield to illuminate.

An ABS malfunction will cause the system to automatically disarm. The ABS DISARM lights will illuminate and the AUTO BRAKE FAIL alert will be displayed.

To rearm the ABS system after it has automatically disarmed, the AUTO BRAKE selector must be moved to the OFF position and then back to a deceleration setting. If the fault has cleared, the system will rearm. In flight, when the GEAR handle is up, power to the ABS is removed.

ABS faults are stored in the CFDS.

ABS Deceleration Rates

The CFDS can display the ABS configuration (HIGH). Approved Flight Manual (AFM) stopping performance with ABS is available and data used should match the CFDS display.

ABS HIGH DECELERATION RATES

MODE	DECEL RATE	REMARKS
MIN	6.5 ft per sec ²	Normal braking for most day to day operations. Comfortable ride for passengers.
MED	9.0 ft per sec ²	This braking should be used on short runways, contaminated runways, or any time greater than normal braking is required.
MAX	N/A	This braking allows maximum antiskid braking for the shortest stopping distance.

Brake Temperature Monitoring/Tire Pressure Indicating (BTM/TPI)

General

The BTM/TPI system consists of a BTM/TPI computer in the Center Accessory Compartment (CAC) and pressure and temperature sensors on the landing gear. The system monitors tire pressures and individual brake temperatures. These temperatures and pressures are displayed on the SD when the CONFIGURATION page is selected with the CONFIG cue switch.

Abnormal tire pressures and temperatures are annunciated by EIS alerts.

A blanked out portion of the CONFIGURATION page tire/brake display indicates a component failure in the system. The display of an individual tire or brake will be blank if data for that tire or brake is not available.

The BTM/TPI computer interfaces with both Flight Management Computers (FMC) and all 3 display electronic units (DEU). BTM/TPI faults are stored in the CFDS.

Tire Pressures

Normal tire pressures are as follows:

- Main gear - 210 psi.
- Center gear - 176 psi.
- Nose gear - 180 psi.

If a tire pressure is below normal (11 percent below on ground, 21 percent below in flight/landing), the level 1 alert TIRE PRES LO is displayed.

On any axle, if one tire pressure is too far below the other tire (15 percent below on ground, 26 percent below in flight/landing) the level 1 alert TIRE DIFF PRES is displayed.

If the pressure in any tire drops below 50 psi, the level 2 alert TIRE FAIL is displayed. The TIRE FAIL voice warning is inhibited during takeoff (80 kts - 400 ft) and landing (100 ft - 80 kts).

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An overpressure fuse will release if any main or center gear tire pressure exceeds 375 psi. On the nose gear, the fuse will release if tire pressure exceeds 330 psi.

Brake Temperatures

If any brake temperature exceeds 550°C, the BRAKE OVERHEAT alert is displayed. The alert goes off when the overheated brake(s) cool to 450°C. Each wheel has a thermal fuse plug that may release if the temperature exceeds 550°C.

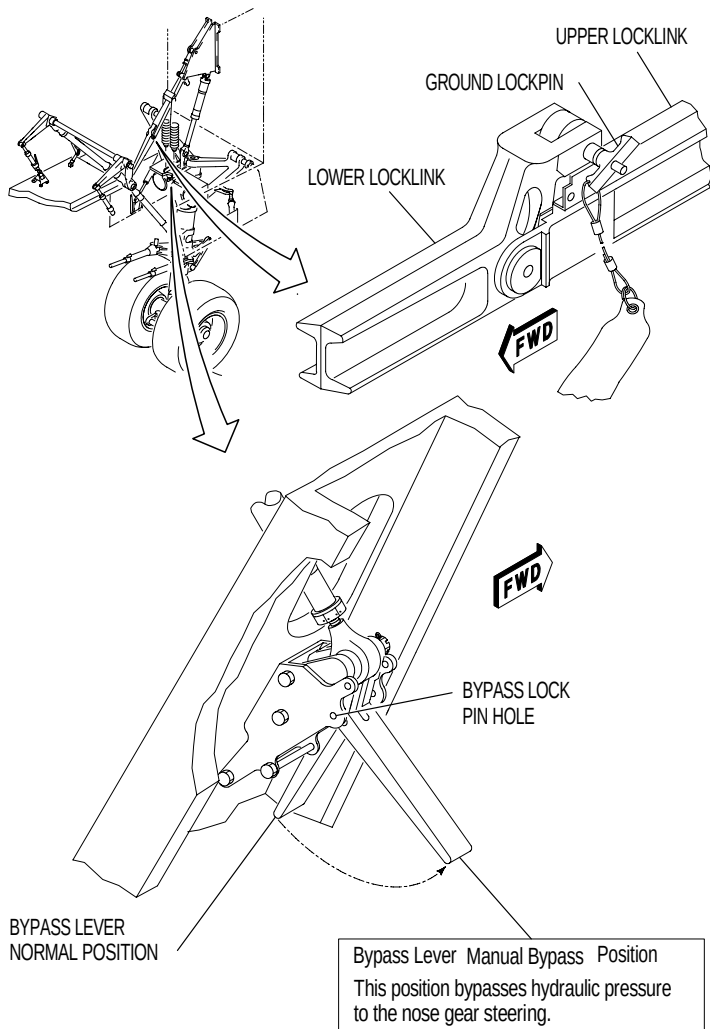
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Landing Gear and Brakes Components

Chapter Land Section 20

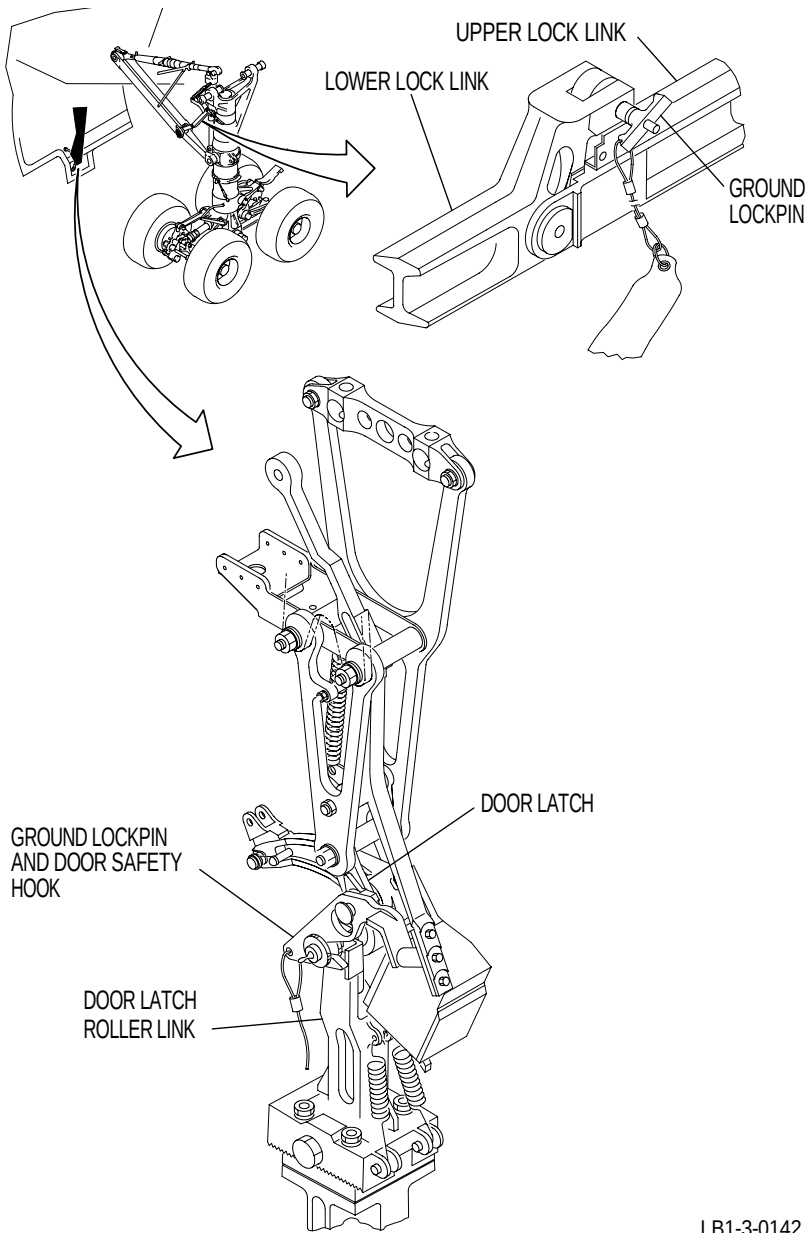
Nose Gear Ground Lockpin and Steering Bypass Lever



CAG(IGDS)

LB1-3-0141

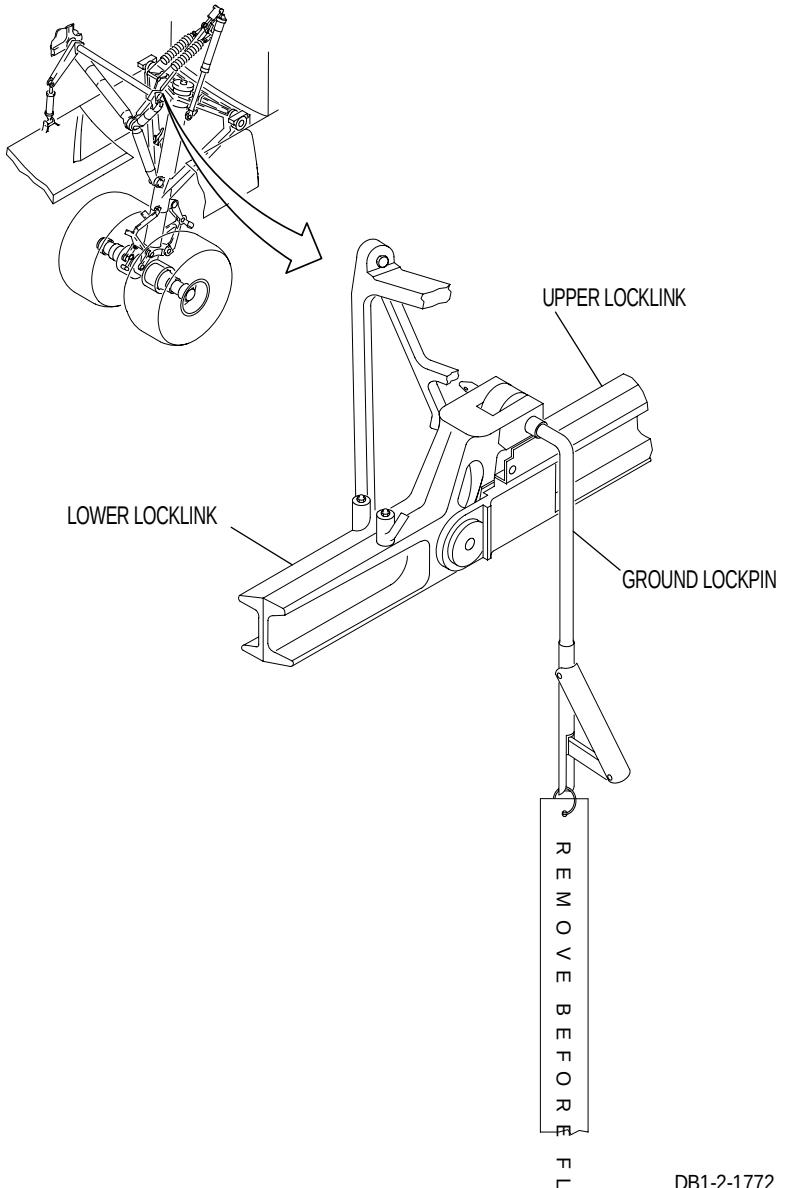
Main Gear Ground Lockpin and Door Safety Hook



LB1-3-0142

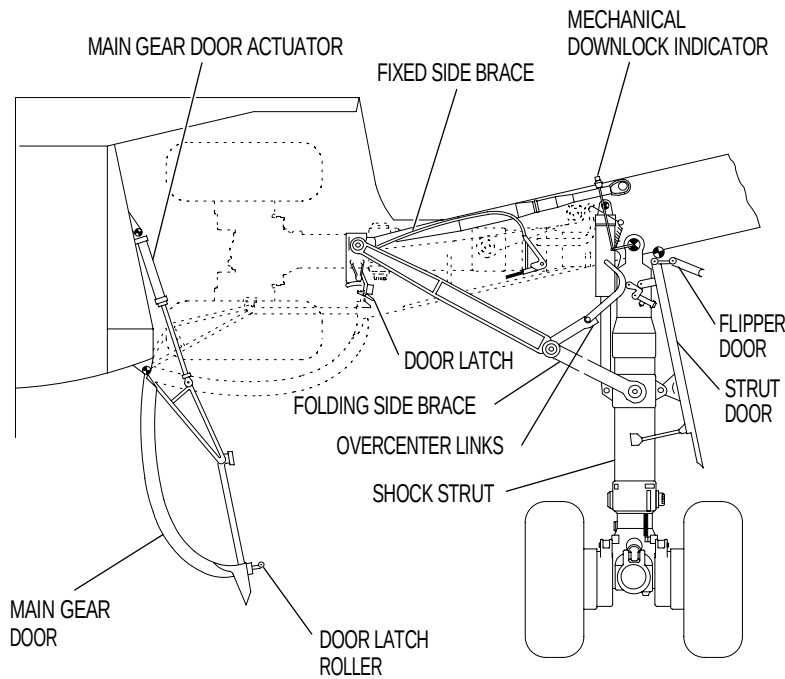
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Center Gear Ground Lockpin



DB1-2-1772

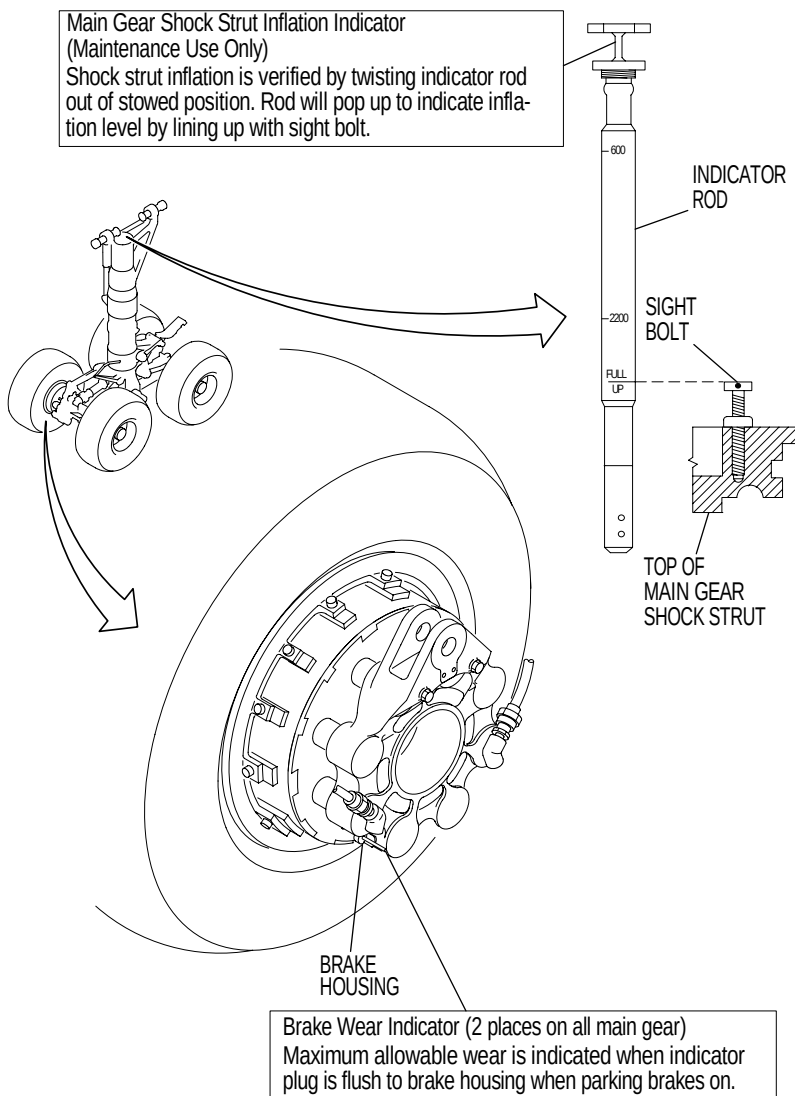
Main Gear and Doors



LB1-3-0144

MD-11 Flight Crew Operations Manual

Brake Wear and Shock Strut Inflation Indicators



MLG WHEEL IS SHOWN
THE CLG WHEEL IS THE SAME

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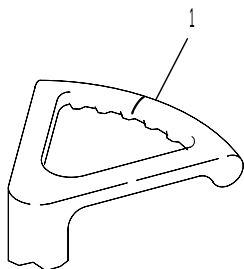
Landing Gear and Brakes

Controls and Displays

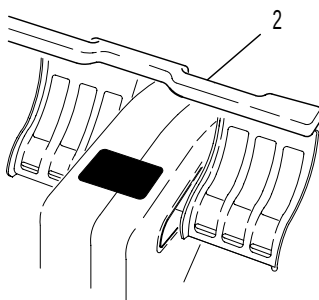
Chapter Land

Section 30

Nose Gear Steering



CAPTAIN'S CONSOLE



CAPTAIN AND F/O STATION

LB1-3-0161

1. Nose Gear Steering Wheel

Provides nosewheel steering up to 70 degrees left and right of the neutral position and overrides the rudder pedal steering. Full rudder pedal movement results in up to 10 degrees steering either side of the neutral position when the ground shift mechanism is in the ground mode.

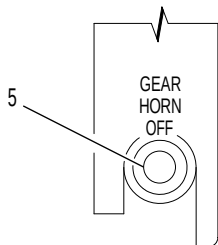
NOTE: A second nose wheel steering wheel can be installed on the First Officer's console.

2. Rudder Pedals (2 pair)

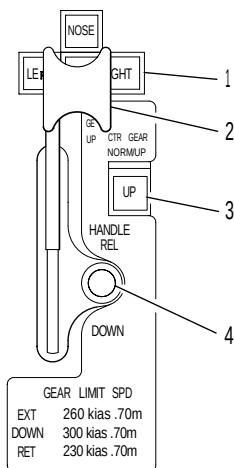
Rudder pedals are used to control the nosewheel steering when the airplane is on the ground. Maximum nosewheel deflection when using rudder pedals is 10 degrees.

Rudder pedals are used to control upper and lower rudder deflection during flight.

Landing Gear Control Panel



FORWARD PEDESTAL



CENTER INSTRUMENT PANEL

DB1-2-1769

1. GEAR Lights - green/red

Green illuminates when:

- GEAR handle is down and landing gear is down and locked.
- GEAR handle is up and landing gear is down and locked via the alternate gear extension lever.

Red illuminates when:

- 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.

All lights are extinguished when the GEAR handle is up and the landing gear is up and locked.

Red and green illuminate when the respective main gear door maintenance safety hook is installed.

An unsafe condition on one of the two gear indicating systems does not require a mandatory visual inspection. Any green indication indicates a safe gear.

NOTE: Improved gear lights that are red on top and green on bottom. They are easier to read in direct sunlight.

2. GEAR Handle

Mechanically positions landing gear hydraulic control valve for retraction or extension of landing gear. To move handle from UP or DOWN it must be pulled aft. An interlock prevents moving GEAR handle to UP if hydraulic pressure to landing gear trim system fails. A force of 160 pounds may be applied to GEAR handle without causing damage to system.

Failure of the landing gear trim system prevents moving the GEAR handle to UP.

3. CTR GEAR NORM/UP Isolation Switch - blue

Permits main gear to be extended without extending center gear.

UP prevents center gear from extending when main gear is extended. Center gear warning circuits are inhibited.

If switch is not illuminated, center gear will extend and retract when main gear extends and retracts by means of gear handle. If switch is illuminated, the center gear remains retracted regardless of GEAR handle position.

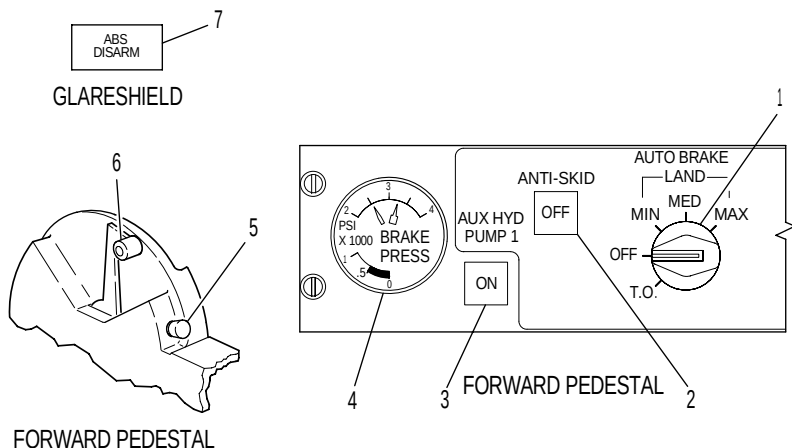
4. HANDLE REL Button

Releases anti-retraction mechanism and permits gear handle to be placed in UP in event of ground sensing release mechanism malfunction.

5. GEAR HORN OFF Button

When pushed, will silence gear warning horn when flaps are not in landing range and landing gear is up.

Brake Controls



DB1-2-1770

1. AUTO BRAKE Selector

OFF - ABS is not armed but manual braking is available.

T.O. - Provides maximum braking from brake system 1 and 2 when spoilers deploy during RTO with ABS armed above 100 knots. Below 100 knots, MIN braking is provided.

MIN, MED, MAX - Selected braking level engages when spoilers are deployed automatically or manually during landing with ABS armed.

If any AFS land mode is selected with aircraft on ground, the ABS disarms and the ABS DISARM light illuminates.

2. ANTI-SKID OFF Switch

Push to select anti-skid off. Illuminates amber when anti-skid is selected off.

3. AUX HYD PUMP 1 Switch - blue

Turns on electric aux pump 1 to pressurize hydraulic system 3 if pressure is lost. Hydraulic system 3 powers brake system 2. Pump can also be turned on from the HYD control panel.

4. BRAKE SYS HYD PRESS Gage (1 and 2)

Pointer 1 shows hydraulic pressure in brake system 1. Pressure shown is highest of hydraulic system 1 or brake system 1 accumulator. Pointer 2 shows hydraulic pressure in brake system 2. Pressure shown is highest of hydraulic system 3 or brake system 2 accumulator.

5. PARK Light - amber

Illuminates amber when PARK BRAKE handle is set to park position. Will extinguish when parking brake is released.

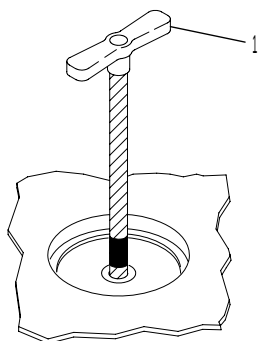
6. PARK BRAKE Handle

Brakes are fully applied for parking by positioning the handle aft. Pressure from brake system 1 and 2 is maintained with trapped fluid.

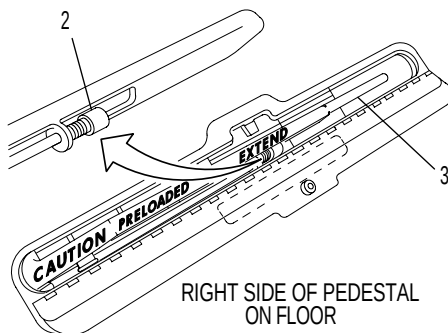
7. ABS DISARM Light (2) - amber

Illuminates amber when ABS is disarmed by malfunction or flight crew. Pilot can disarm ABS during rejected takeoff by depressing brake pedal 90 percent full travel. Pilot can disarm ABS during landing by depressing brake pedal 40 percent full travel.

Alternate Gear Extension



FORWARD OF MAIN CIRCUIT
BREAKER PANELS ON FLOOR



RIGHT SIDE OF PEDESTAL
ON FLOOR

LB1-3-0164A

1. Center Gear Alternate Extension Handle

Pulling handle up will mechanically unlatch center gear and allow it to free fall and lock in the down position. Before this can occur, the alternate gear extension lever must be raised to position the landing gear control valve to a bypass position.

To determine the position of the center gear, gently pull the center gear alternate extension handle until a pronounced increase in resistance is felt (a force of 10-15 pounds may extend the gear if a loss of hydraulic system 3 pressure has occurred). As long as the red band on the cable is not visible or the bottom of the red band is at or below the floor level, the gear is up and locked. If the bottom of the red band is above the floor level, the center gear is unlocked.

2. Lever Release Pushrod Knob

To unlock alternate gear extension lever and return to stowed position, lift the lever to relieve tension on link in detent, then press down on pushrod knob on outboard side of lever and allow lever to return to stowed position.

3. Alternate Gear Extension Lever

Lifting lever will:

- Mechanically release all uplatches except center gear.

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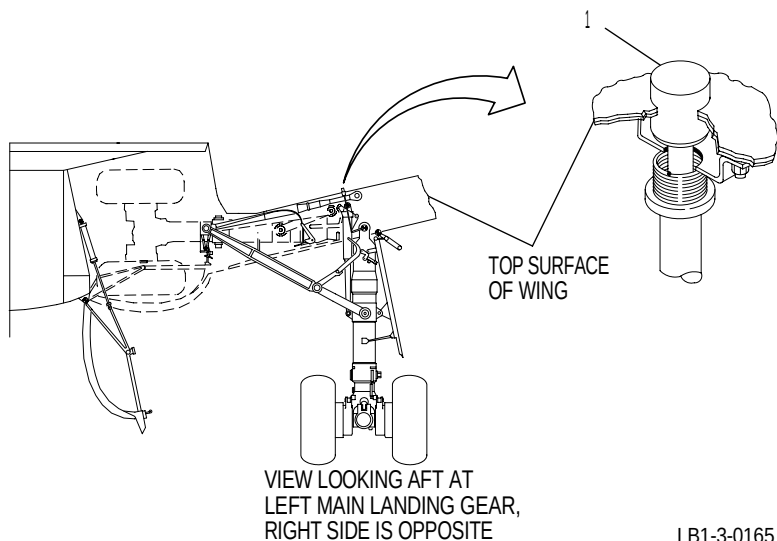
- Mechanically position landing gear control valve to bypass and shut off hydraulic system 3 pressure to nose gear steering.
- Limit nose gear steering to 25 degrees to right (pressure from hydraulic system 1) when using nose gear steering wheel.

Stowing lever if hydraulic system 3 is operative will:

- Retract gear if gear handle is in GEAR UP position.
- Return nose gear steering to normal (hydraulic system 3 restored).

A force of 160 pounds may be applied to the alternate gear extension lever without causing damage to the system.

Main Gear Visual Downlock Indicator

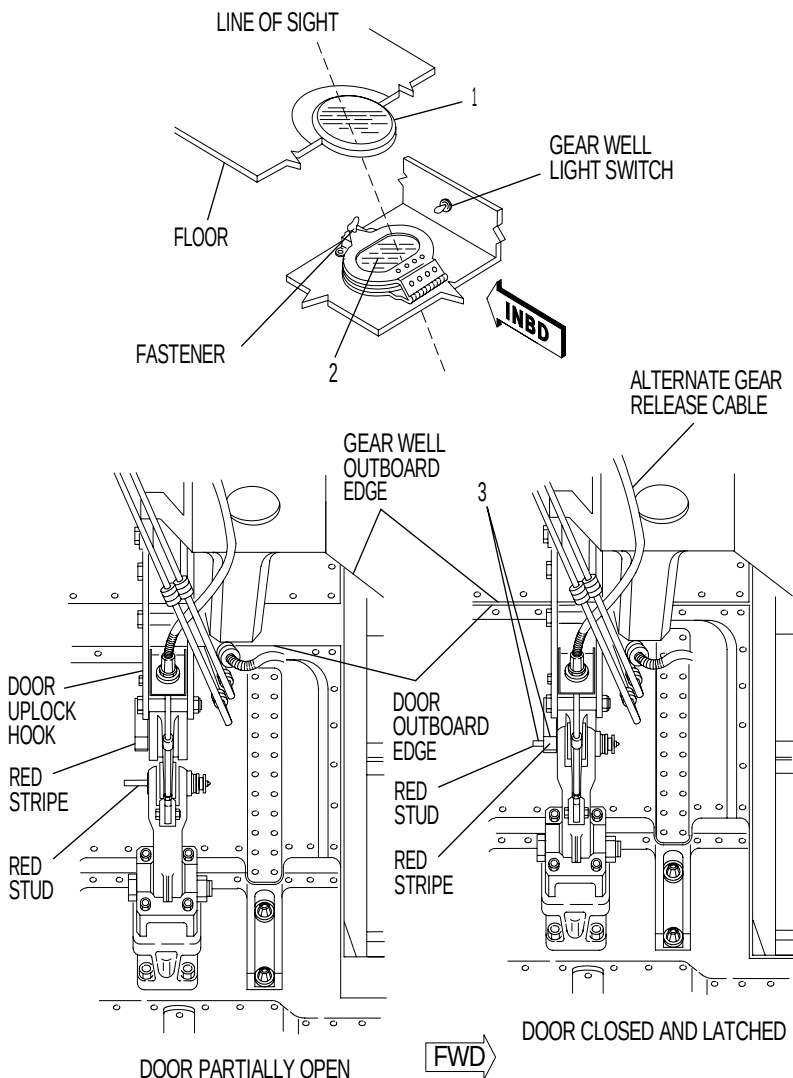


1. Visual Downlock Indicator (2)

Indicator button is yellow and black on top and is visible on the top surface of each wing. It is raised when the gear is in down and locked position. Crew member may view the indicator by looking out of overwing cabin door window.

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Main Gear Door Uplock Indicators



LEFT SHOWN, RIGHT OPPOSITE.

LB1-3-0166A

1. Access Door

Door is located in line with left and right overwing doors.

2. Viewing Window

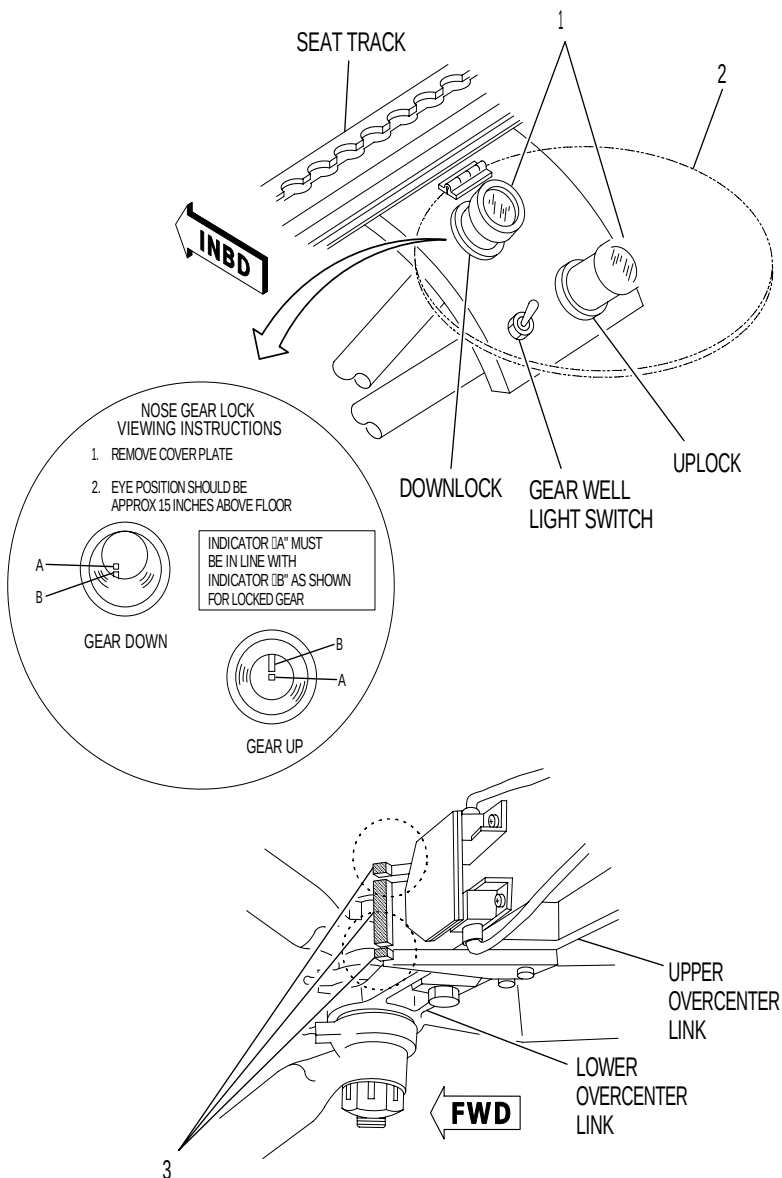
Clear window below access door provides line of sight view of main gear door uplock indicators.

3. Visual Main Gear Door Uplock Indicators

Red stud and stripe must be aligned to indicate door closed and latched. Indicators are not usable when covered by cargo pallet 8.

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Nose Gear Visual Uplock and Downlock Indicator



LB1-3-0167

1. Viewing Tubes (2)

Tubes with removable transparent viewing caps are visible below access door.

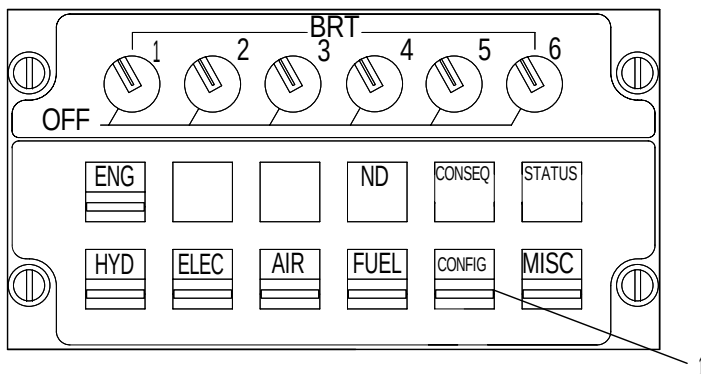
2. Access Door

Door is located in line with forward edge of the fifth window aft of forward cabin doors and left of center seat tracks. Roll back carpet and lift door for access to viewing tubes.

3. Visual Uplock and Downlock Indicator

Red surfaces must be aligned for gear DOWN/LOCKED and UPLOCKED positions. Indicator is not usable when covered by cargo pallets.

Config Cue Switch



AFT PEDESTAL

LB1-3-0168

1. CONFIG Cue Switch - white

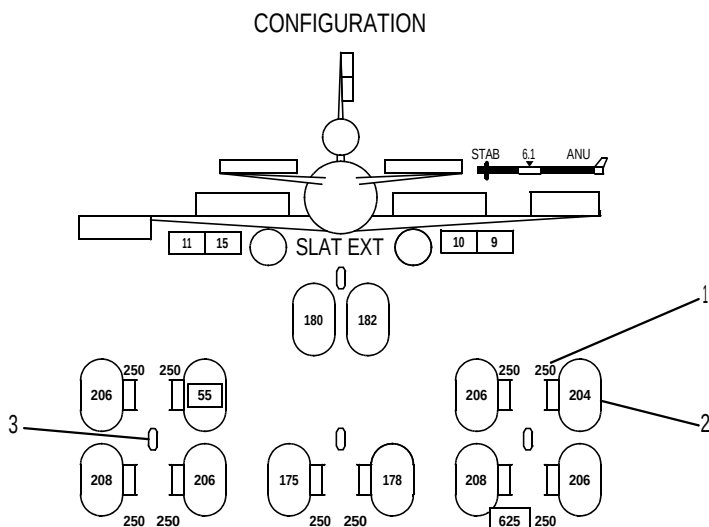
Illuminates white when CONFIG alert is displayed on EAD.

When pushed:

- MASTER WARNING or MASTER CAUTION lights will extinguish.
- A reminder message replaces the EAD alert, except for Level 3 alert.
- Configuration synoptic comes into view on the SD.

Some Level 1 alerts are maintenance alerts that appear on the SD STATUS page only. These maintenance alerts will not illuminate the cue switch or the MASTER CAUTION lights.

SD Synoptic - Configuration



NOTE: View is from tail looking forward.

DB1-2-1771A

1. Brake Temperature Readout (Typical)

Brake temperature is shown digitally (°C) adjacent to the brake outline at the side of the respective wheel. The white digits turn amber and are boxed in amber when brake temperature is out of limits. If brake temperature is not available, no data is shown. Temperatures above 936°C cannot be measured. The display will go blank for the affected brake(s). As the temperature falls back below 936°C, the temperature(s) will appear again if sensors are not damaged.

2. Tire Pressure Readout (Typical)

Actual tire pressure is shown digitally (psi) within gray outline of tire. The white digits turn amber and are boxed in amber if tire pressure is low or substantially different from adjacent tire. If tire pressure data is not available, no data is shown.

3. Secondary Gear Lights (Typical)

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.

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Green and Red - Indicates the respective main gear door maintenance safety hook is installed.

All lights are extinguished when the gear handle is up and the landing gear is up and locked.

An unsafe indication on one of the two gear indicating systems does not require a mandatory visual inspection.

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Landing Gear and Brakes Alerts

Chapter Land Section 40

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

Amber Boxed Alerts (Level 2)

ANTI-SKID FAIL (CONFIG) - Anti-skid system is inoperative.

ANTI-SKID L/R FAIL (CONFIG) - Left/right anti-skid is inoperative.

AUTO BRAKE FAIL (CONFIG) - Auto brake system is inoperative.

BRAKE OVERHEAT (CONFIG) - Brake temperature exceeds limits.

TIRE FAIL (CONFIG) - Pressure in one or more tire(s) drops below 50 psi.

Amber Alerts (Level 1)

ANTI-SKID FAULT (MAINT) - Maintenance alert. Anti-skid has a fault.
Anti-skid will function normally.

ANTI-SKID OFF (CONFIG) - ANTI-SKID switch selected OFF.

AUTO BRAKE OFF (CONFIG) - AUTO BRAKE selector is in OFF and the
GEAR handle is down.

BRAKE DIFF TEMP (CONFIG) - There is a significant difference in the
brake temperatures.

TIRE DIFF PRES (CONFIG) - Any tire pressure is too low compared with
its axle mate.

TIRE PRES LO (CONFIG) - Any tire pressure low.

Cyan Alerts (Level 0)

AUTO BRAKE MAX - AUTO BRAKE selector set to maximum braking.

AUTO BRAKE MED - AUTO BRAKE selector set to medium braking.

AUTO BRAKE MIN - AUTO BRAKE selector set to minimum braking.

AUTO BRAKE T.O. - Auto brake system selected to takeoff.

PARK BRAKE ON - PARK BRAKE lever is set and the parking brake is
engaged.

WHEEL BRAKE INOP - A wheel brake has been rendered inoperative by
maintenance. Aircraft performance must be adjusted accordingly.

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Landing Gear and Brakes

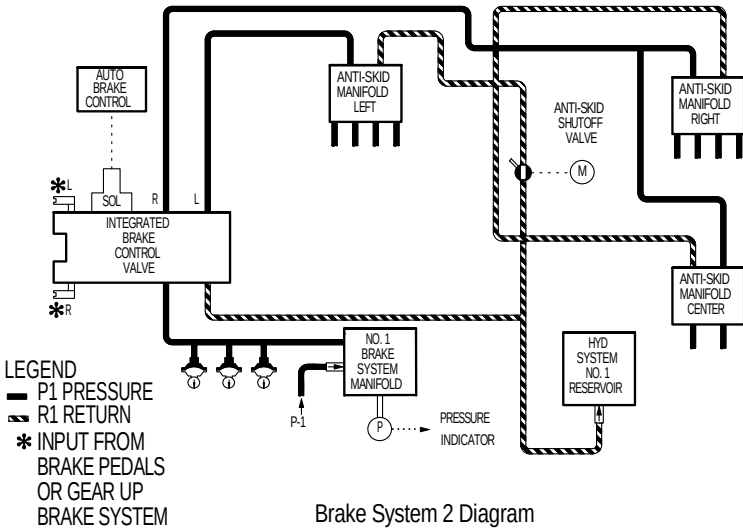
Functional Schematic

Chapter Land

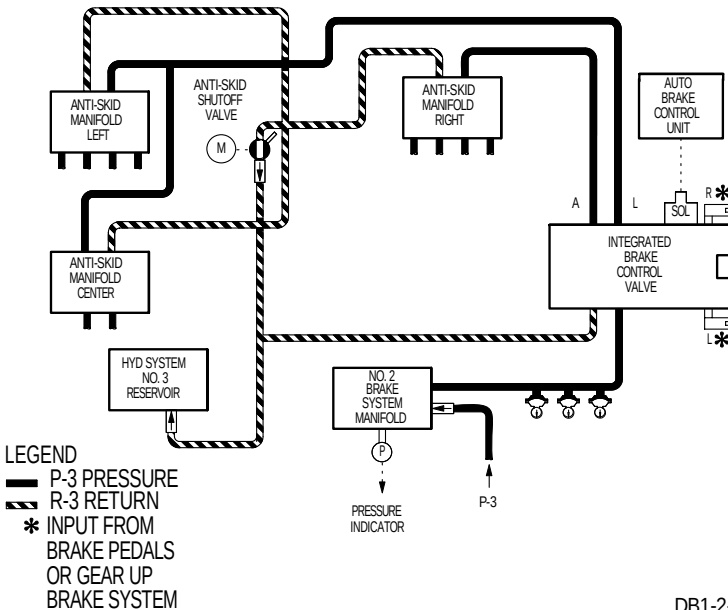
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Brake System Diagrams

Brake System 1 Diagram



Brake System 2 Diagram



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Warning and Alerting

Description and Operation

Chapter Warn

Section 10

General

Warning and alerting consists of Electronic Instrument System (EIS), Central Aural Warning System (CAWS), and Ground Proximity Warning System (GPWS).

Electronic Instrument System (EIS) Alerting

The EIS alerting system displays alerts on the CRTs in the cockpit.

The system also displays the consequences, if any, of the alerts. The EIS alerting system consists of:

- MASTER WARNING and MASTER CAUTION lights (MW/MC).
- The Engine and Alert Display (EAD).
- The System Display (SD).
- The System Display Control Panel (SDCP).

Alerts are categorized into four levels (3, 2, 1, and 0). Alert levels have unique display characteristics to allow immediate crew recognition of the alert level.

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 filtered. Only the root cause alert will be displayed. Additional alerts which occur as a result of the initial failure are inhibited.

Pushing the associated system cue switch on the SDCP will cause the associated system synoptic page to be displayed on the SD and also resets the MASTER CAUTION or MASTER WARNING lights if they are illuminated and no other lights are illuminated.

On any SD page a PRESS (associated cue switch) AGAIN TO CONTINUE message tells the pilot 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 (see Engines chapter).

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:

- Tritone for most level 3 alerts.
- 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 on the EAD.
- Associated cue switch will illuminate white on the SDCP.
- Level 3 alerts are acknowledged but not reset by pushing the associated cue switch.
- Cue switches are resettable by acknowledging associated alerts.
- 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.
- Will be positioned below any level 3 alert in alert list on the EAD.
- Associated cue switch will illuminate white on the SDCP.
- Alert is acknowledged and possibly reset by pushing associated illuminated cue switch on the SDCP.
- 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, or confirmation of desired system configuration. A list of level 1 alerts and the required pilot action can be found in the MD-11 FCOM Operating Procedures. Level 1 alerts are characterized as follows:

- Amber MASTER CAUTION lights illuminate.
- Amber alert appears on the EAD.
- Alert will be positioned below any level 3 or 2 alerts in the alert list on the EAD.
- Associated cue switch will illuminate white on the SDCP.
- Alert is acknowledged and possibly reset by pushing associated illuminated cue switch on the SDCP.

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- 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 SD CP.

Some level 1 alerts are maintenance alerts that appear on the SD status page only and will not illuminate an SD CP cue switch or the MASTER CAUTION lights.

Level 0 Alerts - Cyan

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

- A cyan alert on the EAD.
- Alert will be positioned above the space for reminder messages at the bottom right of the EAD.

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. If the affected system is operating in automatic mode, the crew could safely complete the flight by referring only to the SD consequences. For maximum system recovery, however, 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 SD CP, 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 shown 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. In some cases the EAD reminder message will flash (serving as a pseudo MASTER CAUTION light).

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-air. 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-air for 25 seconds), or 1000' barometric altitude above the departure airport (or in-air for 120 seconds). Level 0 alerts are not inhibited.

Takeoff inhibit exceptions are as follows:

- The level 3 ENGINE FIRE alerts are not inhibited during takeoff, but the associated MASTER WARNING lights are inhibited at V1.

- The level 3 NO MASKS and CABIN ALTITUDE alerts are uninhibited from throttle advance to 400’ RA.
- The level 2 TIRE FAIL alert is not inhibited. The associated MASTER CAUTION lights are inhibited from V1-20 until 400’ RA.
- The level 1 FUEL DUMP ON alert is not inhibited.

Landing Inhibits - Level 3 alerts and associated MASTER WARNING lights are not inhibited during landing. Level 2 or 1 alerts and associated MASTER CAUTION lights are inhibited from 1000' barometric altitude above field elevation to 80 knots ground speed (but no longer than 120 seconds), or from 100' RA to 80 knots ground speed (but no longer than 25 seconds). Level 0 alerts are not inhibited. The level 1 FUEL DUMP ON alert is 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 white boxed messages.

CONDITION	MESSAGE
STAB not in green	STAB TRIM
Flaps not in takeoff	FLAPS
Slats not in takeoff	SLATS
Park brake on	BRAKES
Spoilers not armed	SPOILERS

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.

Before takeoff, if takeoff flap setting does not match flap value on the FMS TAKEOFF page:

- The green takeoff-checklist-complete box will not appear and,
- The flap takeoff warnings will activate if throttles are advanced for takeoff.

With the exception of the spoilers, takeoff essential items that have not been satisfied will cause the checklist display (message and box) to turn red when the aircraft begins the takeoff roll. The essential items checklist is removed when airspeed exceeds 80 knots.

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 white messages.

CONDITION	MESSAGE
Landing gear not down	LANDING GEAR
Flaps not in landing	FLAPS
Spoilers not armed	SPOILERS

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.

If the landing essential items checklist box displays LANDING GEAR in white with the gear handle down, observe the primary gear lights. If the primary gear lights indicate safe, landing gear is down and locked.

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

EAD Alert Display

▶ ALERT LEVEL 3		
ALERT LEVEL 2		ALERT LEVEL 0
		ENG HYD ELEC AIR
ALERT LEVEL 1		FUEL CONFIG MISC

LOWER 1/3 OF EAD

LB1-3-0187

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 six messages, but the third column is limited to only four messages because the two bottom lines are dedicated for reminder messages. Alerts are presented in the following order:

- Level 3 alerts are displayed in red, boxed in red, and have leading triangles. They are presented at the top of the leftmost column on the EAD. There is no priority within level 3 alert messages. The latest is added to the top of the list.
- Level 2 alerts are shown in amber and boxed in amber. They are presented below any level 3 alerts. There is no priority within level 2 alerts. The latest is added to the top of the group of level 2 alerts.
- Level 1 alerts are displayed in amber and are presented below any level 3 or level 2 alerts. There is no priority within level 1 alerts. The latest is added to the top of the group of level 1 alerts.
- Level 0 alerts are displayed in cyan and are presented above the dedicated reminder message area (fifth line of the right column). There is no priority within level 0 alerts. The latest is added to the top of the group of level 0 alerts.

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When level 1 or 2 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 shown in a dedicated location within the two bottom lines of the right column on the EAD. These reminder messages are amber and are boxed for level 2 alert messages and amber and unboxed for level 1 alerts.

Where one failure may create multiple consequential alerts only the highest order alert is displayed on the EAD. The other alerts are inhibited.

SD Alerts and Consequences Display

ALERT LEVEL 2	CONSEQUENCE MESSAGE _____
ALERT LEVEL 1	CONSEQUENCE MESSAGE _____
	CONSEQUENCE MESSAGE _____
	CONSEQUENCE MESSAGE _____

LOWER 1/3 OF SD

LB1-3-0188

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) provided no other alert conditions exist that would illuminate the MASTER WARNING or MASTER CAUTION lights.

The secondary engine page is automatically called up when secondary engine parameter alerts appear or when a secondary engine page parameter changes from amber to red (except APU data and cabin rate).

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 generating alerts (alignment available on the CONSEQUENCE page). 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 lines), additional pages are made available. These pages have the same format as the first page and thus also show the system synoptic.

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When there are additional pages, the message PRESS ENG (or HYD, ELEC, AIR, FUEL, CONFIG) AGAIN TO CONTINUE will be displayed flashing at the bottom of the page. In the RH bottom corner of the page, the current page number and total number of pages are displayed in brackets, e.g. (1/3). When on the last page, pushing the cue P/B will display page 1 again. The message will be displayed steady when all pages have been selected.



SD Consequence Page

CONSEQUENCE	
ALERT LEVEL 3	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
ALERT LEVEL 2	MESSAGE _____
	MESSAGE _____
	MESSAGE _____

LB1-3-0189

The consequence page is selected to appear 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 21 alerts and 21 consequences. When additional pages are required, the message PRESS CONSEQ AGAIN TO CONTINUE will appear at the top of the page.

SD Status Page

STATUS		
ENG		
ALERT LEVEL 2		
HYD		
ELEC		
AIR		
ALERT LEVEL 2		
ALERT LEVEL 1		
ALERT LEVEL 1		
FUEL		
CONFIG		
MISC		
ALERT LEVEL 2		
ALERT LEVEL 1		
MAINT		

LB1-3-0190

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. 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 if there are additional pages.



SD Miscellaneous Page

MISCELLANEOUS (1/2)	
	CONSEQUENCES
▶ ALERT LEVEL 3	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
ALERT LEVEL 2	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
	MESSAGE _____
ALERT LEVEL 2	MESSAGE _____
	MESSAGE _____
	MESSAGE _____

PRESS MISC AGAIN TO CONTINUE

LB1-3-0191

The miscellaneous system page is selected to appear 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).

Central Aural Warning System (CAWS)

The CAWS function provides aural warnings of an unsafe condition or situation. The CAWS consists of a controller installed in the avionics rack. The controller receives and process signals from selected sources for activation of the appropriate aural warnings. The CAWS operates on 28-volt dc power.

An additional interface links the controller to the Display Electronic Units (DEU) that send data to the Display Units (DU) in the cockpit. A CAWS FAULT alert will be displayed when a fault is detected in the CAWS.

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The audio signals generated in the CAWS controller feed into the Digitally Controlled Audio System (DCAS) audio management units 1 and 2. These units then send the signal to the appropriate speakers and headphones.

The aural warnings are tones such as horns, chimes and bells accompanied with voice warnings from selected warnings and alerts. The voice warning and its associated tone warning is cycled, a one-second tone followed by a one-second voice warning for the duration of the warning period.

The CAWS can automatically sequence each aural warning when two or more warnings occur at the same time. The latest warning will interrupt the warning in progress. Sequential operation will continue with the latest warning included in the sequence.

Some warnings are inhibited during certain phases of flight.

Landing Gear Warning

The CAWS will provide an aural warning tone for an unsafe landing configuration. An unsafe configuration is defined by either of the following conditions:

1. Any gears not down and locked and flaps in landing configuration.
2. Any gears not down and locked, any throttle(s) retarded to idle, airspeed less than 210 knots, flaps not in landing configuration (less than 31.5 degrees) and RA at 1,200 feet or below.

For condition 1 above, if the wing flaps exceed 31.5 degrees, the only way that the aural warning can be silenced is by extension of the landing gear to the down and locked position.

The aural warning for condition 2 can be silenced manually with the GEAR HORN OFF button on the forward pedestal if the flap angle does not exceed 31 degrees. The landing gear warning function will activate whenever the throttles are retarded to idle.

There is a delay of 16 seconds in the gear horn actuation when the gear is in transit (being raised) and flaps are in landing range. This allows time for the flaps to retract without sounding the horn during a missed approach.

Engine Fire Warning

The CAWS will provide an aural warning tone when a fire is detected by the engine fire detection system. Refer to the Fire Protection chapter for a description of the engine fire detection system.

Altitude Advisory Warning

The CAWS will sound an aural warning tone and turn the PFD precision altitude amber to caution the flight crew if the aircraft approaches a preselected altitude or deviates from the preselected altitude. The altitude advisory operates independently from the engagement of the flight director or autopilot. The altitude advisory function receives input from both Flight Control Computers (FCC). This dual advisory circuit will annunciate the first advisory signal received.

Takeoff Warning

A takeoff warning aural signal (intermittent horn identical to cabin altitude warning) will warn the flight crew of an unsafe takeoff configuration. The warning will sound when either throttle 1 or 2 is advanced for takeoff with the ground shift mechanism in the ground mode and any one of the following conditions exist:

1. Stabilizer settings not in green band
2. Slats not extended
3. Flaps not in agreement with setting on FMS TAKE OFF page (plus or minus 3 degrees)
4. Parking brake set.

Cabin Low Pressure Warning

The CAWS will provide an aural warning tone for detected cabin low pressure. The warning will automatically actuate when the cabin altitude exceeds 10,000 feet. The warning will cycle three times and reset when the altitude switch resets.

Overspeed Warnings

The CAWS will provide an aural warning tone when an overspeed condition is detected by either Central Air Data Computer (CADC). The CAWS will also provide an aural warning whenever the aircraft exceeds the maximum speed with the slats extended. The clacker will sound when airspeed exceeds 280 knots and the slats are extended.

Autopilot Disconnect Warning

The CAWS will provide an aural warning tone when a disconnect signal is received from either FCC.

Horizontal Stabilizer Motion Warning

During flight, a horn will sound to alert the flight crew that the horizontal stabilizer is in motion. The warnings sound after each continuous movement of more than 2 degrees stabilizer travel at a rate greater than 0.08 degrees per second for manual trim and after continuous movement of more than 2 degrees stabilizer when in the automatic pitch trim mode.

SELCAL

The CAWS will provide an aural signal (single chime) when the SELCAL decoder receives call information from the VHF and/or the HF COMM receivers. This signal is provided by the SELCAL decoder (ground active).

Cockpit Timer Aural Tone

An aural tone will sound when the cockpit timer has counted down to zero.

Tire Failure Warning

The CAWS unit will sound an aural warning (voice only) when a tire failure is detected. A voice warning TIRE FAILURE will sound three times.

Windshear Warning

The CAWS will sound an aural warning (tone and voice) if a windshear signal is received from FCC 1 or 2.

Radio Altitude Voice Warnings

The CAWS will monitor the two radio altimeters and will sound airline selected voice warnings when either altimeter sends the signal.

Ground Proximity Warning System (GPWS)

The GPWS provides visual and aural warnings associated with the following flight conditions:

Mode 1 - Excessive Descent Rate

Mode 1 provides a warning for excessive descent profiles with respect to altitude AGL during cruise and approach AGL. Two different warning boundaries are possible:

- Mode 1 outer boundary - Penetration will activate the amber GROUND PROX message on the PFD and produce the voice warning SINKRATE.
- Mode 1 inner boundary - Penetration will activate the red GROUND PROX message on the PFD and produce the voice warning PULL UP.

Mode 2 - Excessive Terrain Closure Rate

Mode 2 provides a warning based on RA and how rapidly that RA is decreasing. Mode 2 has two areas of application as follows:

- Mode 2A - This mode is applied when the landing flaps are not down and the aircraft is not on the glideslope. Upon penetration, the amber GROUND PROX message is activated and a voice warning TERRAIN - TERRAIN sounds. If the condition persists, the voice warning PULL UP will be announced. 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, aircraft is on the glideslope during an ILS approach, or the aircraft is in the first 60 seconds after takeoff. When the aircraft penetrates the alert envelope with either gear or flaps not in landing configuration, the amber GROUND PROX message is activated on the PFD and the voice warning TERRAIN TERRAIN is generated. If the condition persists, the voice warning PULL UP will be generated. If the aircraft 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 after a 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 activated on the PFD and a voice warning 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 aircraft penetrates this boundary with the landing gear still up and at an airspeed less than 190 kts, the voice warning will be TOO LOW GEAR and the amber GROUND PROX message will appear on the PFD. Above 190 knots the upper boundary increases linearly with airspeed to a maximum of 1,000 feet RA altitude at 250 knots or more. Penetrating this boundary produces a repetitive TOO LOW TERRAIN voice warning.



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- 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 aircraft penetrates this boundary at an airspeed below 159 kts and flaps not in landing configuration, the voice warning will be TOO LOW FLAPS and the amber GROUND PROX message will appear on the PFD. Above 159 kts the boundary increases linearly (same as mode 4A) and the voice warning is TOO LOW TERRAIN.
- Mode 4C (with EGPWS installed) - 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 RA begins to decrease, the maximum attained value is stored. 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 Glideslope

Mode 5 provides two levels of warning when aircraft descent is below the glideslope on an ILS approach.

- Mode 5 soft alert - Alert occurs when the aircraft is more than 1.3 dots below the glideslope. This alert is called soft because the volume level of the alert is less than the volume of other warnings. This soft alert envelope has a typical upper limit of 1,000 feet. Voice warning GLIDESLOPE is generated and the BELOW G/S switch is illuminated.
- Mode 5 hard alert - Alert occurs when the aircraft is below 300 feet RA with more than 2 dots below the glideslope. It is called a hard alert because the volume level is raised to that of the other warnings. Provides the same warnings as the soft alert.

Mode 5 warning can be cancelled by the flight crew by pushing the BELOW G/S switch on the glareshield at any time below 2,000 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 or engine 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).

If RA data is invalid, the bank angle warning limit will be 40 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%.

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 Ground Proximity Warning System (EGPWS)

The EGPWS combines basic GPWS functions with the enhanced features including terrain clearance floor, terrain awareness, and optional peaks and obstacles. The enhanced features are independent of, and have no affect upon, the other modes of the GPWS.

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 aircraft location, destination runway center point position and radio altitude.

A Runway Field Clearance Floor (RFCF) alert function is available. RFCF alerts are based on current aircraft location, destination runway center point position and height (MSL, not AGL) above destination runway.

When the TCF or RFCF 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 altitude (AGL or MSL) 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.

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Terrain alerting function continuously computes terrain clearance envelopes ahead of the aircraft. 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 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 warning - Displayed in solid red on ND, red flashing GROUND PROX on PFD, and voice warning TERRAIN, TERRAIN, PULL UP.
- 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 EGPWS test.
- TERRAIN RANGE DISAGREE (amber) - Display ranges on the NDs are not the same.

Selected Warnings

2,500 feet voice.

1,000 feet voice.

500 feet voice.

400 feet voice.

300 feet voice.

200 feet voice.

100 feet voice.

10/20/30/40/50 voice warning - standard.

Altitude warning inhibit with landing flaps.

Altitude warning inhibit during FMS confirmed non precision approach.

TIRE FAIL voice inhibit during takeoff and landing.

Standard Annunciations Table

Altitude Alert

AURAL - C-chord.

- Logic - approaching or deviating selected altitude.
- Inhibit - takeoff (80 KTS and 400' RA) and landing (100' RA to 80 KTS)

VISUAL - amber box flashes on PFD altitude scale.

- Logic - approaching or deviating selected altitude.
- Inhibit - none.

REMARKS - options: 1. no light at acquisition. 2. tone at acquisition. 3. inhibit with flaps in landing. 4. inhibit with FMS approach.

Autopilot Disconnect

AURAL - warbler.

- Logic - AP disconnect in all flight regimes (signal from FCC).
- Inhibit - none.

VISUAL - red flashing AP OFF on PFD.

- Logic - AP disconnect full flight regime (signal from FCC).
- Inhibit - none.

REMARKS - none.

Horizontal Stabilizer in Motion

AURAL - horn.

- Logic - horizontal stabilizer in continuous motion (2 degrees or more).
- Inhibit - Aircraft on ground.

VISUAL - display on secondary engine page and configuration synoptic.

- Logic - current status of stabilizer.
- Inhibit - none.

REMARKS - none.

SELCAL

AURAL - chime.

- Logic - call on preselected channel.
- Inhibit - takeoff (80 KTS to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - call light on ACP illuminates indicating applicable radio.

- Logic - none.
- Inhibit - none.

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REMARKS - visual on audio control panel indicating applicable radio (not inhibited).

Tire Failure

AURAL - TIRE FAILURE voice.

- Logic - one or more tire failed (signal from BTM/TPI).
- Inhibit - takeoff (80 KTS to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - MASTER CAUTION and TIRE FAIL alert (amber and boxed on EAD).

- Logic - one or more tire failed (signal from BTM/TPI).
- Inhibit - MASTER CAUTION: takeoff (V1-20 to 400" RA) and landing (100' RA to 80KTS). TIRE FAIL: takeoff (V1 to 400') and landing (1,000' RA to 80 KTS). Alert not inhibited.

REMARKS - Visual alert is not reissued for new tire failure, the aural will be. Customer may select aural warning to be inhibited during takeoff and landing.

Minimums

AURAL - MINIMUMS voice.

- Logic - signal from DEUs when a/c descends thru the set minimum value.
- Inhibit - none.

VISUAL - white minimums bug turns amber on PFD.

- Logic -a/c descends thru the set minimum value.
- Inhibit - none.

REMARKS - none.

Approaching Minimums

AURAL - APPROACH MINIMUMS voice.*

- Logic - signal from DEUs when a/c descends thru the set minimum + 100'.
- Inhibit - none.

VISUAL - none

REMARKS - none.

Cabin Altitude

AURAL - tone.

- Logic - cabin altitude more than 10,000' (signal from cabin pressure switch).
- Inhibit - takeoff (80 KTS to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - MASTER WARNING lights and red CABIN ALTITUDE alert.

-
- Logic - cabin altitude more than 10,000' (signal from CPCs thru ESC).
 - Inhibit - takeoff (V1 to 400' RA).

REMARKS - visual indications of CAB ALT are in red on overhead panel.

Landing Gear Not Down in Approach

AURAL - tone.

- Logic - gear not down and locked and flaps in land mode, throttles retarded, airspeed less than 210 KTS, 1,200' RA or below and flaps not in land mode.
- Inhibit - takeoff (80 KTS to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - white LANDING GEAR on EAD.

- Logic - any landing gear not down and locked in approach.
- Inhibit - none.

REMARKS - visual indication for landing gear is in red/green above gear handle with independent back-up on configuration page.

Landing Gear Not Down in Landing

AURAL - tone and TOO LOW GEAR (GPWS) voice.

- Logic - airspeed less than 159 KTS and a/c below 245', and airspeed less than 190 KTS and a/c below 500'.
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - flashing red GROUND PROX on PFD.

- Logic - gear not down and locked and airspeed less than 159 KTS and a/c below 145', and airspeed less than 190 KTS and a/c below 500'.
- Inhibit - windshear condition or DITCH switch enabled.

REMARKS - none.

Engine(s) Fire

AURAL - continuous bell.

- Logic - engine fire detected.
- Inhibit - takeoff (V1 to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - MASTER WARNING lights and red ENG (1, 2, Or 3) FIRE alert.

- Logic - engine fire detected.
- Inhibit - MASTER WARNING lights inhibited on takeoff (V1 to 400' RA).

REMARKS - visual indication on engine FIRE handles and on FUEL switches.

Decreasing Performance Windshear

AURAL - tone and WINDSHEAR voice.

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- Logic - tail windshear condition determined by FCC.
- Inhibit - above 1,500' RA.

VISUAL - red WINDSHEAR on PFD.

- Logic - tail windshear condition determined by FCC.
- Inhibit - above 1,500' RA.

REMARKS - Refer to windshear description, AUTOMATIC FLIGHT chapter.

Increasing Performance Windshear

AURAL - tone and WINDSHEAR voice.

- Logic - head windshear condition determined by FCC.
- Inhibit - above 1,500' RA.

VISUAL - amber WINDSHEAR on PFD.

- Logic - head windshear condition determined by FCC.
- Inhibit - above 1,500' RA.

REMARKS - Refer to windshear description, AUTOMATIC FLIGHT chapter.

Overspeed

AURAL - clacker.

- Logic - airspeed above V_{mo}/V_{mo} plus 4 KTS or above 280 KTS with slats extended.
- Inhibit - takeoff (80 KTS to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red and white bar on airspeed tape on PFD.

- Logic - airspeed above V_{mo}/V_{mo} plus 4 KTS.
- Inhibit - none.

REMARKS - none.

Takeoff Configuration Slats Warning

AURAL - tone.

- Logic - slats not in takeoff range, a/c on ground and throttle 1 or 2 advanced for takeoff.
- Inhibit - takeoff (V₁ to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red SLAT message on EAD.

- Logic - takeoff roll and slats not in takeoff range.
- Inhibit - a/c airborne.

REMARKS - visual is white during taxi and turns red when flight phase changes to takeoff roll.

Takeoff Configuration Flaps Warning

AURAL - tone.

- Logic - flaps not in takeoff range, a/c on ground and throttle 1 or 2 advanced for takeoff.
- Inhibit - takeoff (V1 to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red FLAPS message on EAD.

- Logic - takeoff roll and flaps not in takeoff range.
- Inhibit - a/c airborne.

REMARKS - visual is white during taxi and turns red when flight phase changes to takeoff roll.

Takeoff Configuration Stabilizer Warning

AURAL - tone.

- Logic - stabilizer not set for takeoff, a/c on ground and throttle 1 or 2 advanced for takeoff.
- Inhibit - takeoff (V1 to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red STAB TRIM message on EAD.

- Logic - takeoff roll and stabilizer not set for takeoff.
- Inhibit - a/c airborne.

REMARKS - visual is white during taxi and turns red when flight phase changes to takeoff roll.

Takeoff Configuration Brakes Warning

AURAL - tone.

- Logic - parking brake is set, a/c on ground and throttle 1 or 2 advanced for takeoff.
- Inhibit - takeoff (V1 to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red BRAKES message on EAD.

- Logic - takeoff roll and parking brake is set.
- Inhibit - a/c airborne.

REMARKS - visual is white during taxi and turns red when flight phase changes to takeoff roll.

Takeoff Configuration Spoiler Warning

AURAL - tone.

- Logic - spoiler not down, a/c on ground and throttle 1 or 2 advanced for takeoff.
- Inhibit - takeoff (V1 to 400' RA) and landing (100' RA to 80 KTS).

VISUAL - red SPOILER message on EAD.

- Logic - takeoff roll and ground spoilers disarmed in approach for takeoff.
- Inhibit - none.

REMARKS - none.

Radio Altitude Call-outs

AURAL - 2,500, 1,000, 500, 400, 300, 200, 100 voice* and 50-40-30-20-10 voice*.

- Logic - voice annunciation when a/c descends thru respective altitude.
- Inhibit - none.

VISUAL - radio altimeter window displayed on PFD.

- Logic - radio height of 2,500' and below.
- Inhibit - none.

REMARKS - 2,500, 1,000, 500, 400, 300, 200, and 100 voices are individually selectable. 50-40-30-20-10 voice is standard with option to delete it.

Cockpit Timer

AURAL - tone.

- Logic - countdown timer expired.
- Inhibit - none.

VISUAL - white clock face on PFD.

- Logic - cockpit timer activated.
- Inhibit - none.

REMARKS - none.

Ground Proximity Mode 1

AURAL - SINKRATE voice (outer boundary) or PULL UP voice (inner boundary).

- Logic - excessive descent rate (inner or outer boundary).
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - GROUND PROX flashing red on PFD.

- Logic - excessive closure rate to terrain (logic from GPWS).
- Inhibit - windshear condition or DITCH switch enabled.

REMARKS - none.

Ground Proximity Mode 2

AURAL - SINKRATE voice (outer boundary) or PULL UP voice (inner boundary)

- Logic - excessive closure rate to terrain.
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - GROUND PROX flashing red on PFD.

- Logic - excessive closure rate to terrain (logic from GPWS).
- Inhibit - windshear condition or DITCH switch enabled.

REMARKS - if condition persists after two messages, voice changes to WHOOP WHOOP PULL UP.

Ground Proximity Mode 3

AURAL - DON'T SINK voice.

- Logic - altitude loss after takeoff.
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - GROUND PROX flashing red on PFD.

- Logic - altitude loss after takeoff (logic from GPWS).
- Inhibit - windshear condition or DITCH switch enabled.

REMARKS - none.

Ground Proximity Mode 4

AURAL - TOO LOW TERRAIN twice or TOO LOW FLAPS or TOO LOW GEAR

- Logic - unsafe terrain clearance or gear/flaps not in landing configuration.
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - GROUND PROX flashing red on PFD.

- Logic - unsafe terrain clearance (logic from GPWS) or gear/flaps not in landing configuration.
- Inhibit - windshear condition or DITCH switch enabled.

REMARKS - none.

Ground Proximity Mode 5

AURAL - GLIDESLOPE voice.

- Logic - descent below glideslope.
- Inhibit - windshear condition or DITCH switch enabled.

VISUAL - none.

- Logic - none.
- Inhibit - none.

REMARKS - amber BELOW G/S switches on glareshield illuminate. Warning may be cancelled by pushing the BELOW G/S switch below 1,000'.

Level 3 Alerts

AURAL - level 3 tritone.

- Logic - any level 3 alert.
- Inhibit - takeoff (V1 to 400' RA) - 25 sec. override.

VISUAL - MASTER WARNING lights and red boxed alert on EAD.

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- Logic - any level 3 alert.
- Inhibit - takeoff (V1 to 400' RA) - 25 sec. override.

REMARKS - none.

Level 2 Alerts

AURAL - none (except for TIRE FAIL alert).

- Logic - n/a.
- Inhibit - n/a.

VISUAL - MASTER CAUTION lights and amber boxed alert on EAD.

- Logic - any level 2 alert.
- Inhibit - takeoff (V1-20 to 400' RA) and landing (100' RA to 80 KTS) - 25 sec. override.

REMARKS - none.

Level 1 Alerts

AURAL - none.

- Logic - n/a.
- Inhibit - n/a.

VISUAL - MASTER CAUTION lights and amber alert (not boxed) on EAD.

- Logic - any level 1 alert.
- Inhibit - takeoff (V1-20 to 400' RA) and landing (100' RA to 80 KTS) - 25 sec. override.

REMARKS - none.

Level 0 Alerts

AURAL - none.

- Logic - n/a.
- Inhibit - n/a.

VISUAL - cyan alert on EAD.

- Logic - any level 0 alert.
- Inhibit - none.

REMARKS - none.

IRS Alert

AURAL - Horn.

- Logic - a/c on ground, one or more IRS selectors in NAV, no cooling airflow.
- Inhibit - n/a.

VISUAL - none.

- Logic - n/a.
- Inhibit - n/a.

REMARKS - none.

Buses Not Powered Alert

AURAL - Horn.

- Logic - a/c on ground, BATTERY switch on, a/c buses not powered.
- Inhibit - n/a.

VISUAL - none.

- Logic - n/a.
- Inhibit - n/a.

REMARKS - KCK.

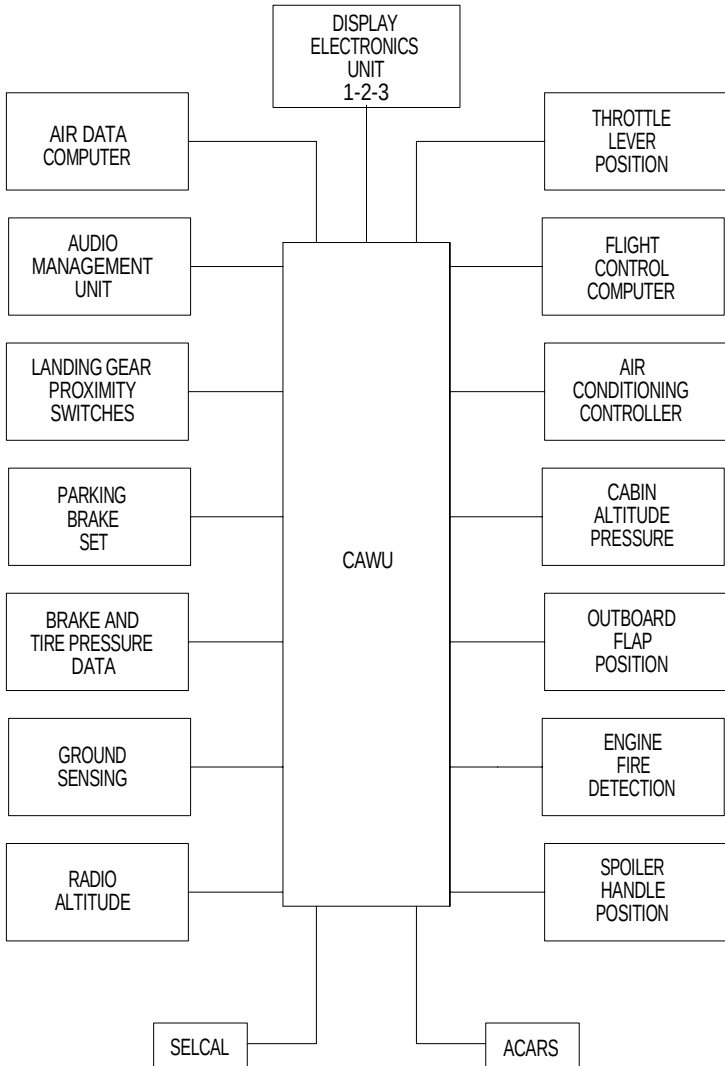




Warning and Alerting Components

Chapter Warn Section 20

Central Aural Warning System



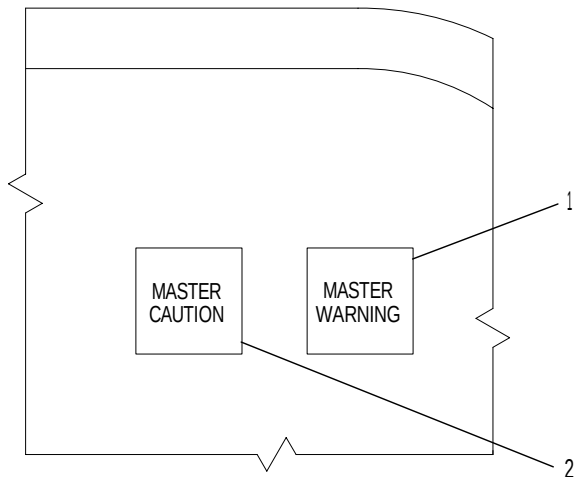
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Warning and Alerting Controls and Displays

Chapter Warn Section 30

Master Warning and Master Caution Lights



GLARESHIELD, LEFT AND RIGHT SIDE

LB1-3-0192

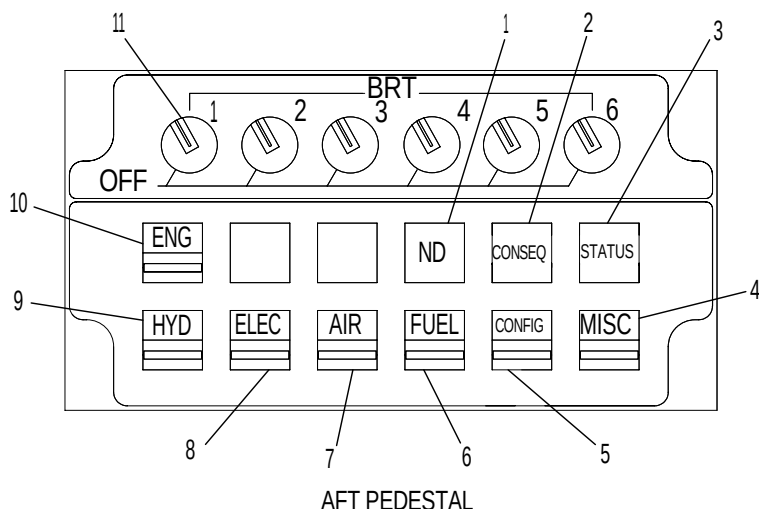
1. MASTER WARNING Lights (2) - red

Both lights will illuminate red when a level 3 alert has appeared on the EAD. Pushing either light will extinguish both MASTER WARNING lights and reset the system for subsequent alerts. The MASTER WARNING lights can also be extinguished and reset by pushing the associated system cue switch on the SDCP when it is illuminated.

2. MASTER CAUTION Lights (2) - amber

Both lights will illuminate amber when a level 1 or 2 alert has appeared on the EAD. Pushing either light will extinguish both MASTER CAUTION lights and reset the system for subsequent alerts. The MASTER CAUTION lights can also be extinguished and reset by pushing the associated system cue switch on the SDCP when it is illuminated.

System Display Control Panel



LB1-3-0193

1. ND Switch - white

Pushing this switch with 1 or more DUs inoperative causes the existing SD to become an ND. If all DUs are operative, THIRD NAV DISPLAY NOT AVAILABLE message will appear on DU4.

2. CONSEQ Switch - white

When pushed, the COSEQUENCES page will appear on the SD. The CONSEQUENCES page displays consequences associated with level 2 and level 3 alerts. 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. When additional consequences pages are required, PRESS CONSEQ AGAIN TO CONTINUE message will appear at the bottom of the page.

3. STATUS Switch - white

When pushed, the STATUS page will appear on the SD. The STATUS page displays a list of all alerts included on the systems pages. The alerts are shown in three columns in the same format as on the EAD. A separate section for maintenance alerts is after the MISC system alerts. This section is titled MAINT. MAINT alerts appear on STATUS page 1 and can only be level 1. The STATUS pages can display up to 51 alerts. When additional STATUS pages are required, PRESS STATUS AGAIN TO CONTINUE message will appear at the bottom of the page.

4. MISC Cue Switch - white

When pushed, the MISCELLANEOUS page will appear on the SD. The MISCELLANEOUS page displays alerts (level 3, 2, and 1 only) and consequences. The consequences are not grouped with the alerts in the same manner as the systems page. The MISCELLANEOUS page has maximum of 17 alerts and 17 consequences. When additional pages are required, PRESS MISC AGAIN TO CONTINUE message will appear at the bottom of the page.

5. CONFIG Cue Switch - white

Illuminates when an alert related to the flight controls or landing gear appears on the EAD. Pushing the CONFIG cue switch causes the flight controls synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING provided no other alert condition exist that would illuminate the MASTER CAUTION or the MASTER WARNING lights.

6. FUEL Cue Switch - white

Illuminates when an alert related to the fuel system appears on the EAD. Pushing the FUEL cue switch causes the fuel synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING lights provided no other alert condition exist that would illuminate the MASTER CAUTION or MASTER WARNING lights.

7. AIR Cue Switch - white

Illuminates when an alert related to the air system appears on the EAD. Pushing the AIR cue switch causes the air synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING lights provided no other alert condition exist that would illuminate the MASTER CAUTION or MASTER WARNING lights.

8. ELEC Cue Switch - white

Illuminates when an alert related to the electrical system appears on the EAD. Pushing the ELEC cue switch causes the electrical synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING lights provided no other alert condition exist that would illuminate the MASTER CAUTION or MASTER WARNING lights.

9. HYD Cue Switch - white

Illuminates when an alert related to the hydraulic system appears on the EAD. Pushing the HYD cue switch causes the hydraulic synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING lights provided no other alert condition exist that would illuminate the MASTER CAUTION or MASTER WARNING lights

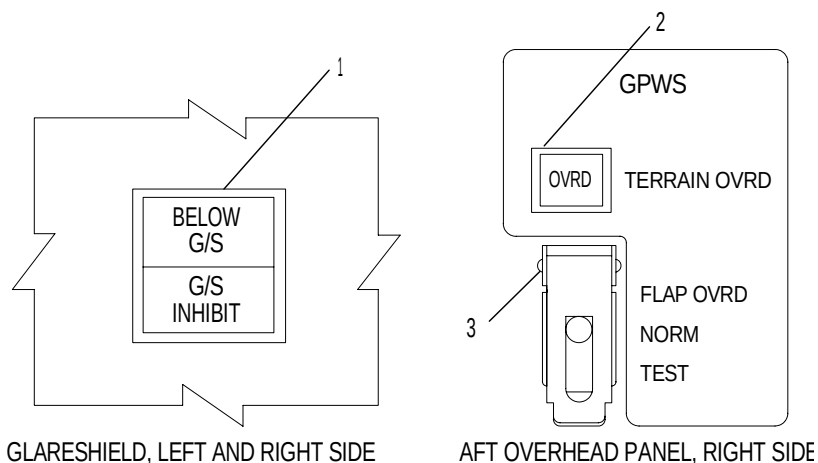
10. ENG Cue Switch - white

Illuminates when an alert related to the engines or APU appears on the EAD. Pushing the ENG cue switch causes the secondary engine page synoptic page to be displayed on the SD and resets the MASTER CAUTION or MASTER WARNING lights provided no other alert condition exist that would illuminate the MASTER CAUTION or MASTER WARNING lights. The secondary engine page is automatically called up on the SD for alerts associated with secondary engine page parameters.

11. BRT Knobs (6)

Each knob controls the respective DU brightness. Turning the knob fully counterclockwise through a detent will turn off the respective DU. When a DU is turned off with this knob, the DU will go to low power condition. This will allow the DU to cool and be available for later use.

GPWS/EGPWS Controls/Indicators



LB1-3-0194

1. BELOW G/S Switch - Amber

Illuminates to indicate corrective action required due to excessive deviation from glideslope. Light is accompanied by GLIDESLOPE voice warning. G/S INHIBIT will illuminate when the switch is pushed and the warnings are inhibited.

2. TERRAIN OVRD Switch

Push to illuminate the blue OVRD legend and disable the enhanced features during takeoff, approach or landing with any of the following:

- Airport has no approved instrument approach procedure.
- Longest runway is less than 3,500 feet.
- Airport is included in the current list of airports with insufficient data for correct EGPWS operation.

Basic GPWS modes are not affected. Enhanced features can also be disabled automatically by the EGPWS computer.

3. GPWS Switch

FLAP OVRD - GPWS is prevented from actuating during a landing with flaps not in landing configuration.

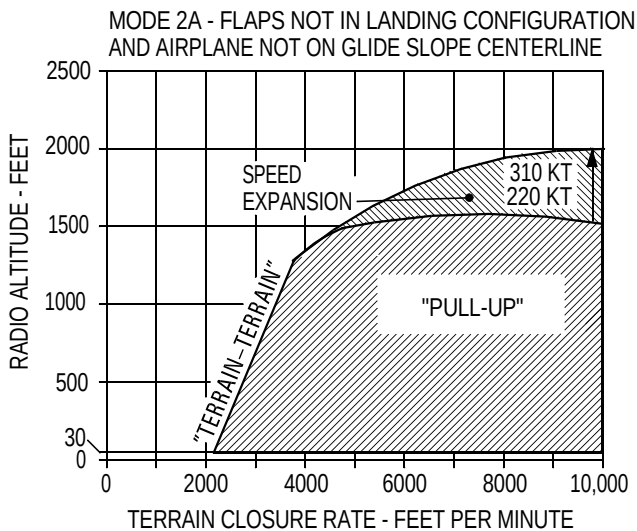
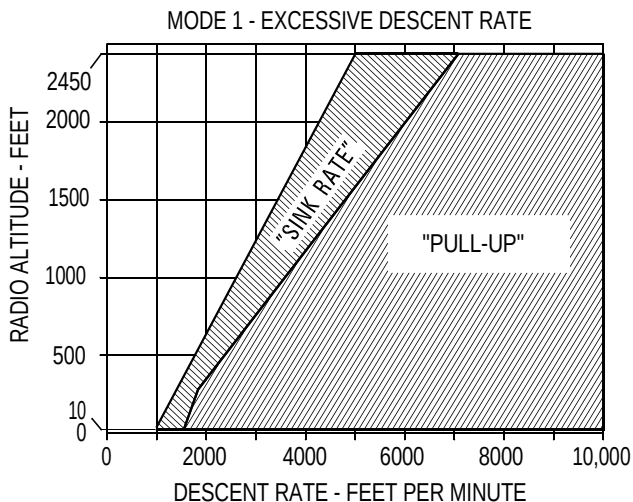
NORM - GPWS annunciates dangerous situations and remains silent during normal flight conditions.

TEST - EGPWS executes a self test. Hold the switch at TEST for approx. 5 seconds. The following sequence of events will occur:

- GPWS FAULT alert is displayed on the SD MISC page.
- TERRAIN FAIL alert is displayed on the SD MISC page.
- BELOW G/S lights illuminate on glareshield.
- GLIDESLOPE voice warning will sound.
- PULL UP voice warning will sound.
- TERRAIN TERRAIN voice warning will sound.
- PULL UP voice warning will sound.
- SINK RATE voice warning will sound.
- PULL UP voice warning will sound.
- TERRAIN voice warning will sound.
- PULL UP voice warning will sound.
- DON'T SINK DON'T SINK voice warning will sound.
- TOO LOW TERRAIN voice warning will sound.
- TOO LOW GEAR voice warning will sound.
- TOO LOW FLAPS voice warning will sound.
- TOO LOW TERRAIN voice warning will sound.
- GLIDESLOPE voice warning will sound.
- BANK ANGLE BANK ANGLE voice warning will sound.
- TOO LOW TERRAIN voice warning will sound.
- CAUTION TERRAIN CAUTION TERRAIN voice warning will sound.
- TERRAIN TERRAIN voice warning will sound.
- PULL UP voice warning will sound.
- GPWS FAULT alert extinguishes on the SD MISC page.
- TERRAIN FAIL alert extinguishes on the SD MISC page.

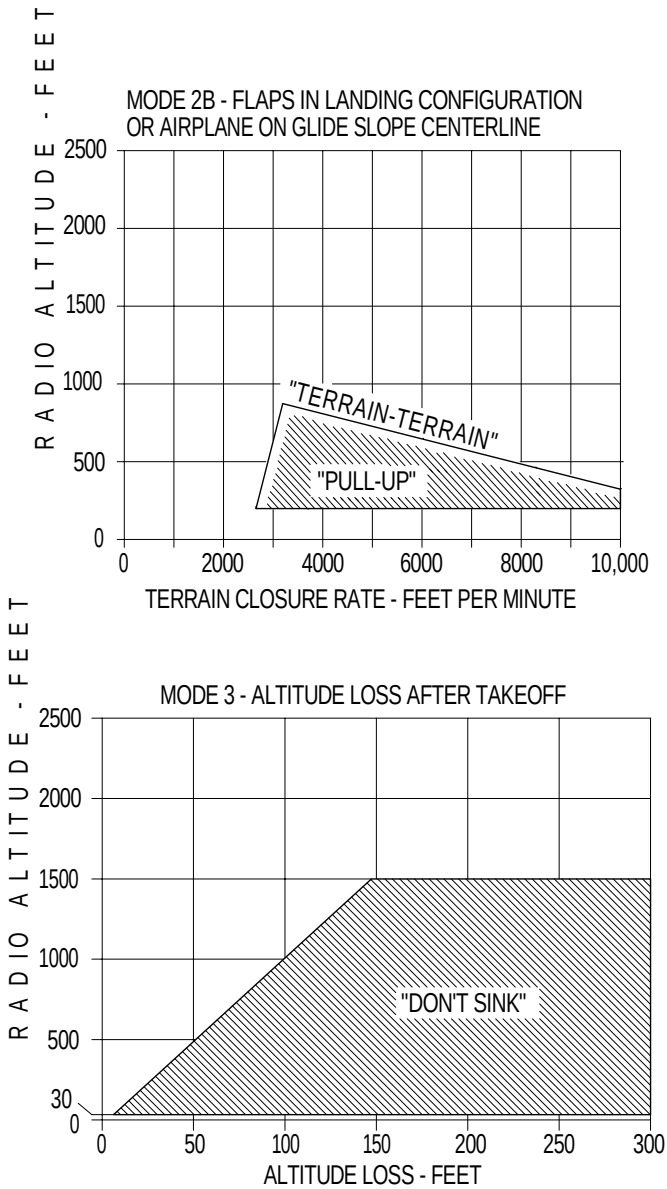
MD-11 Flight Crew Operations Manual

GPWS/EGPWS Envelope (Sheet 1)



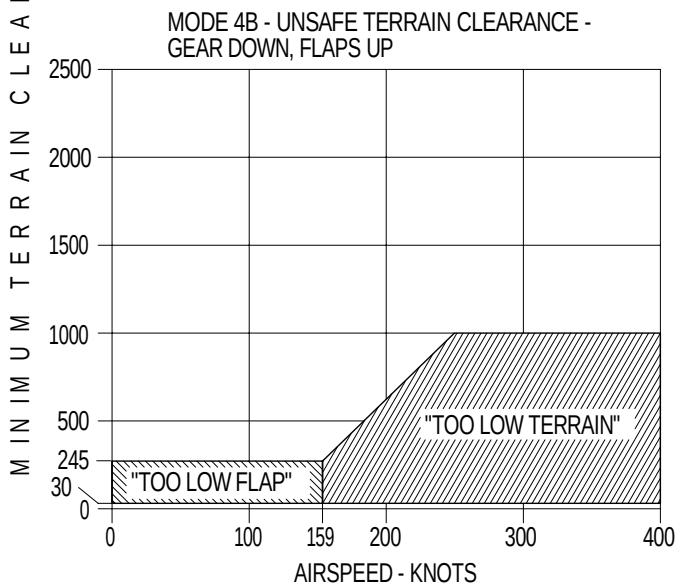
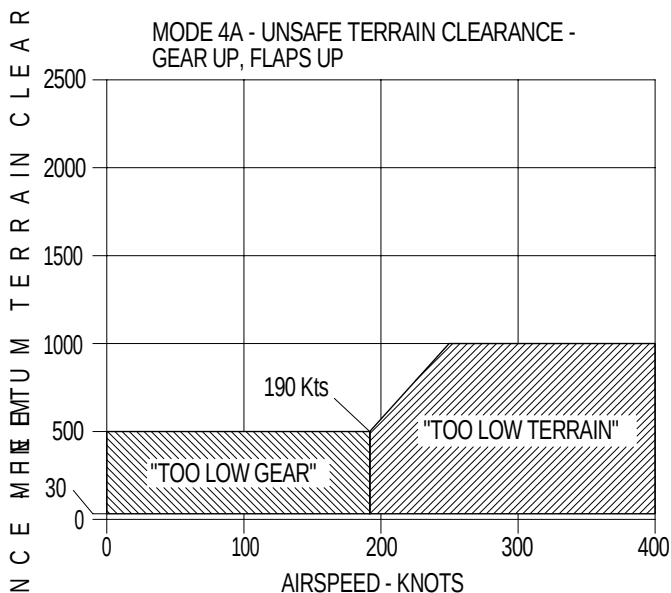
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GPWS/EGPWS Envelope (Sheet 2)



MD-11 Flight Crew Operations Manual

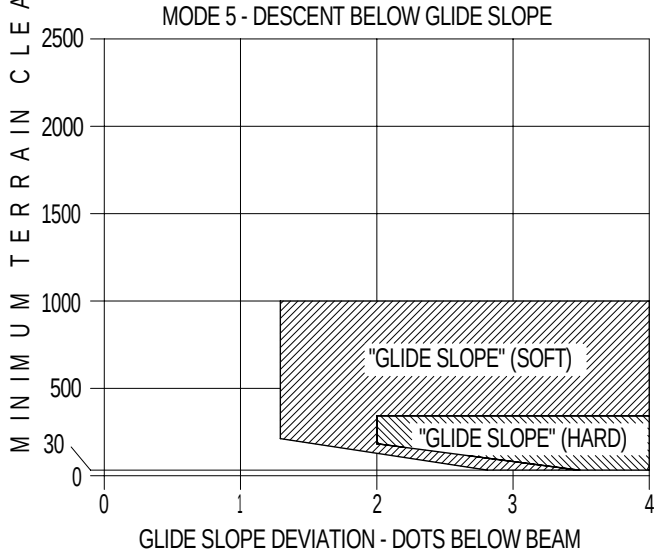
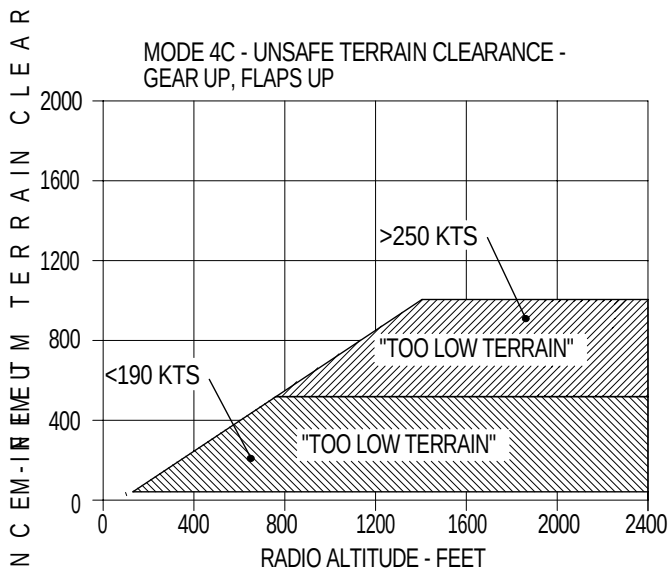
GPWS/EGPWS Envelope (Sheet 3)



CAG(IGDS)

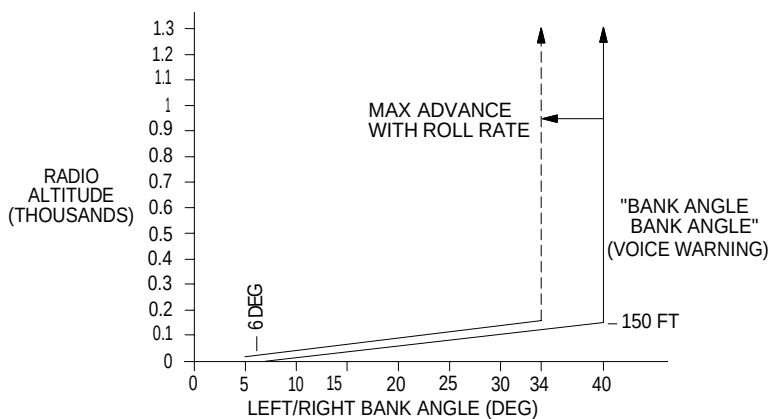
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GPWS/EGPWS Envelope (Sheet 4)

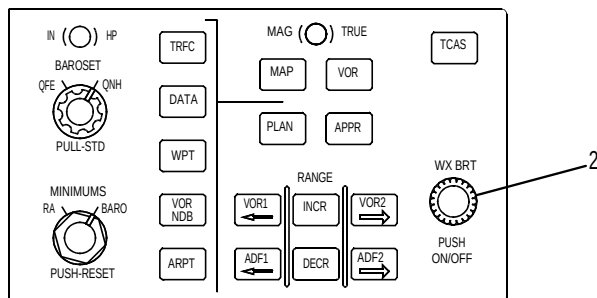
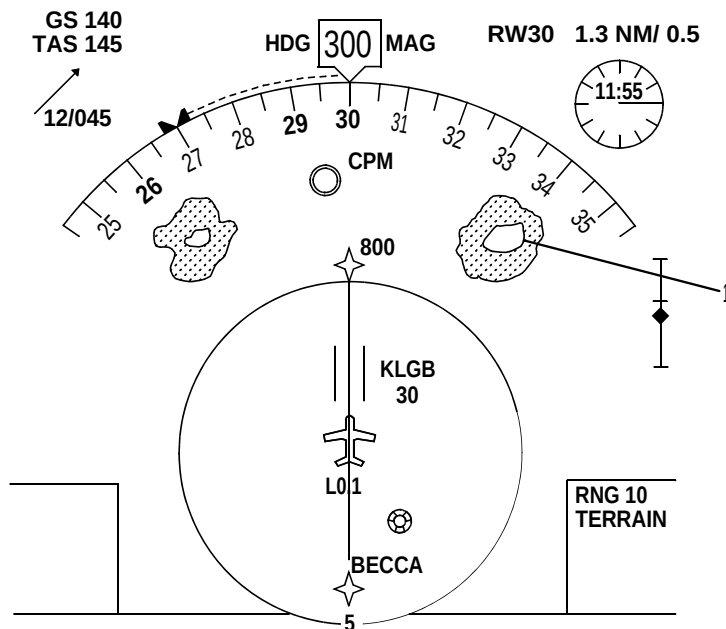


MD-11 Flight Crew Operations Manual

GPWS/EGPWS - Bank Angle Warning Limits



DB1-2-1666



GLARESHIELD, LEFT & RIGHT SIDE

DB1-2-1710A

1. Terrain Display

Warning status terrain is displayed in solid red. Caution status terrain is displayed in solid amber. Terrain that is close but is not of warning or caution status is in green, amber or red dots.

2. WX BRT Knob

Push to select weather radar on ND (MAP, VOR and APPR modes only). Push again to deselect weather radar. Terrain is displayed when weather is not selected.

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Warning and Alerting Alerts

Chapter Warn Section 40

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

Amber Alerts (Level 1)

GPWS FAIL (MISC) - GPWS has failed. This alert normally appears during the GPWS test or if the DITCHING switch is selected. It also indicates the ground proximity and terrain awareness functions have failed.

GPWS FAULT (MISC) - One or more of the GPWS modes (except terrain) is inoperative.

TERRAIN FAIL (MISC) - Terrain awareness function has failed, ground proximity is still operative.

TERRAIN NOT AVAILABLE (MISC) - Terrain awareness function is disabled automatically due to an inadequate navigation sensor position.

Cyan Alerts (Level 0)

GPWS FLAP OVRD - GPWS switch is in FLAP OVRD position. This will prevent ground proximity warnings when flaps are less than landing flap on approach.

TERRAIN OVRD - Terrain awareness override is selected by the pilot.

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Water and Waste
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TO BE ADDED WHEN AVAILABLE	Wat.40.1

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Water and Waste

Description and Operation

Chapter Wat

Section 10

Potable Water System

Passenger

Two systems (4 tanks) supply pressurized and fresh water for the galleys, coffee makers, drinking fountains, lavatory washstand, and toilet flush.

The tanks are installed below the cabin floor in the left and right-hand tunnel of the forward cargo compartment. Hoses allow flexible lavatory and galley configurations.

When the engines or APU are operating, bleed air from pneumatic systems 1 and 2 automatically pressurizes (40-45 psi) the system. If the engine or APU air pressure drops below about 38 psi, a compressor automatically starts to maintain normal system pressure (if electric power is available).

On the ground, when electric power and air are not available, the system can be pressurized at the exterior service panel located on the lower fuselage near the nose.

Waste System

Passenger

A vacuum waste system uses a pressure differential to move water and waste from the toilets or sinks to the two waste tanks installed behind the aft cargo compartment.

On the ground, differential pressure is supplied by blowers. Above about 16,000 feet the blowers are deactivated since the cabin-to-ambient differential pressure is sufficient.

The system is controlled by a dual channel Waste Control Unit (WCU). If one channel fails, control transfers to the other channel.

The toilets are controlled by a Flush Control Unit (FCU). The FCU interfaces with the WCU to control the toilet flush valve and rinse unit.

In the forward and mid lavatories and galleys, waste water from the water fountain and sinks drains into the vacuum waste system. In the aft lavatories and galleys, water from the water fountains and sinks drains overboard through a drain mast.

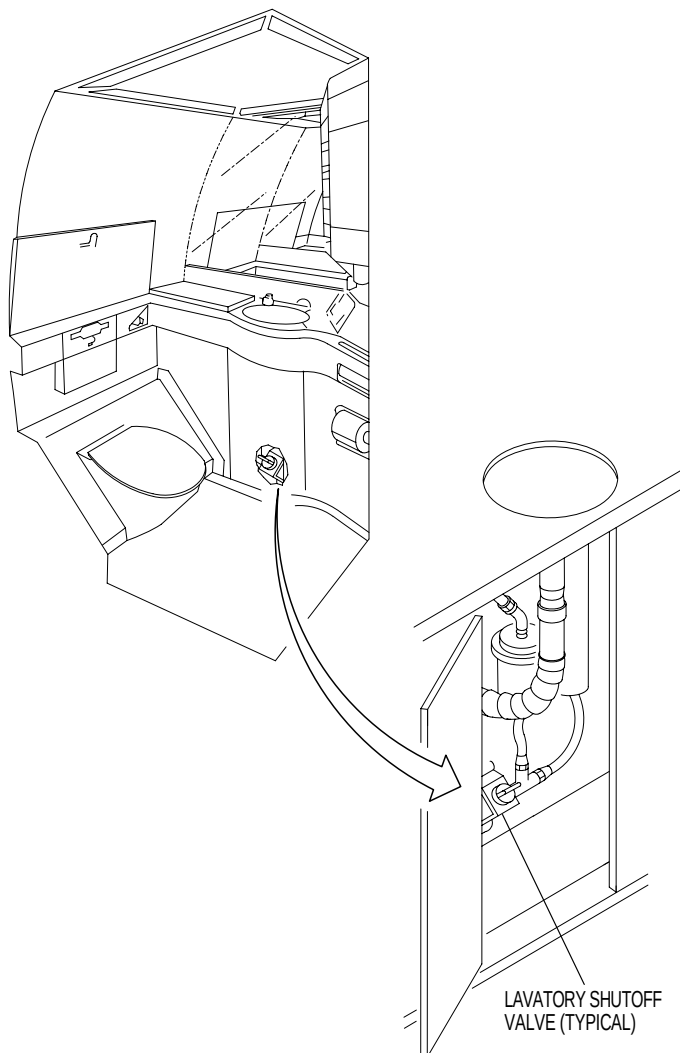
The exterior service panel is located on the lower fuselage near the tail.

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Water and Waste Components

Chapter Wat Section 20

Lavatory Shutoff Valve



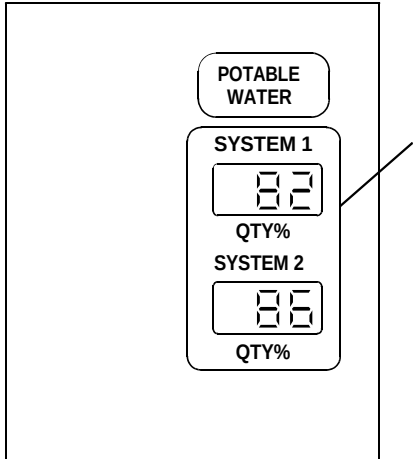
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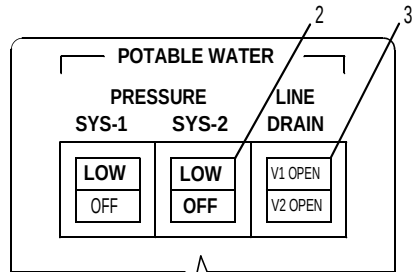
Water and Waste Controls and Displays

Chapter Wat Section 30

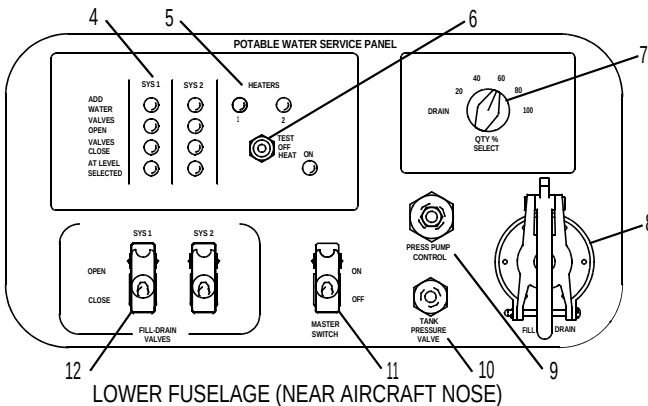
Potable Water System (Typical)



MAIN FLIGHT ATTENDANT PANEL or PURSER STATION



RIGHT OBSERVER'S STATION



LOWER FUSELAGE (NEAR AIRCRAFT NOSE)

DB1-2-1950

1. POTABLE WATER Quantity Indicator

Indicates how much water in the potable water tank. 100% is full.

2. PRESSURE Switch (2) - amber

Used by maintenance to depressurize the systems. LOW illuminates amber when pressure in system tanks is low. OFF illuminates amber when respective system is depressurized. This switch can be used to depressurize and isolate an individual system.

3. LINE DRAIN Switch - amber

Used by maintenance to open valve and drain respective system lines. FWD water drains into tanks. AFT water drains overboard. Respective OPEN light illuminates amber when drain valve is open.

4. SYS 1/2 Status Lights - green and amber

ADD WATER illuminates amber when the water supply is below the selected quantity.

VALVES OPEN illuminates amber when the fill/drain and overflow/vent valves are open.

VALVES CLOSED illuminates green when the fill/drain and overflow/vent valves are closed.

AT LEVEL SELECTED illuminates green when the tank is filled to the selected level.

5. HEATERS 1/2 Light - green

Illuminates green during test when heater is operating properly.

6. TEST Switch and HEAT ON Light

TEST - Verifies status of heater circuits.

OFF - Turns heaters off.

HEAT - Turns heaters on.

HEAT ON light illuminates amber when the heaters are on and the water temperature falls below 50 degrees F.

7. QTY SELECT Switch

Selects quantity to which the tanks are to be filled. DRAIN position allows tank draining.

8. FILL/DRAIN Cap and Fitting

Tanks are filled and drained through this fitting. Protecting the fitting is a lever lock cap.

9. PRESS PUMP CONTROL Switch

Turns off the air compressors when the service panel door is open.

10. TANK PRESSURE Valve

Used to pressurize the system from a ground air source.

11. MASTER Switch

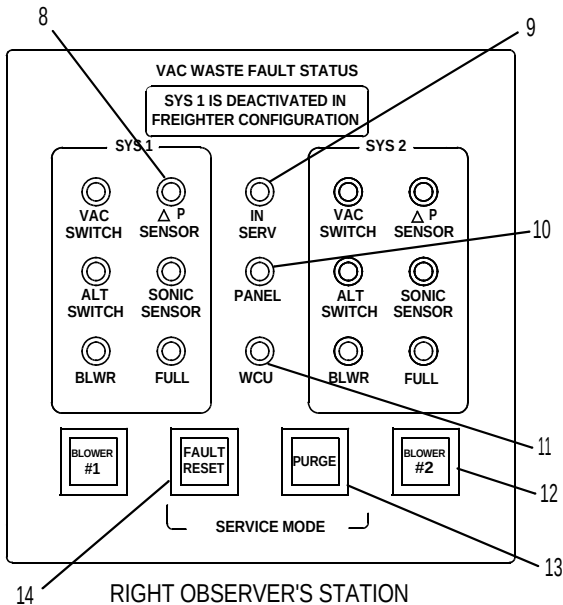
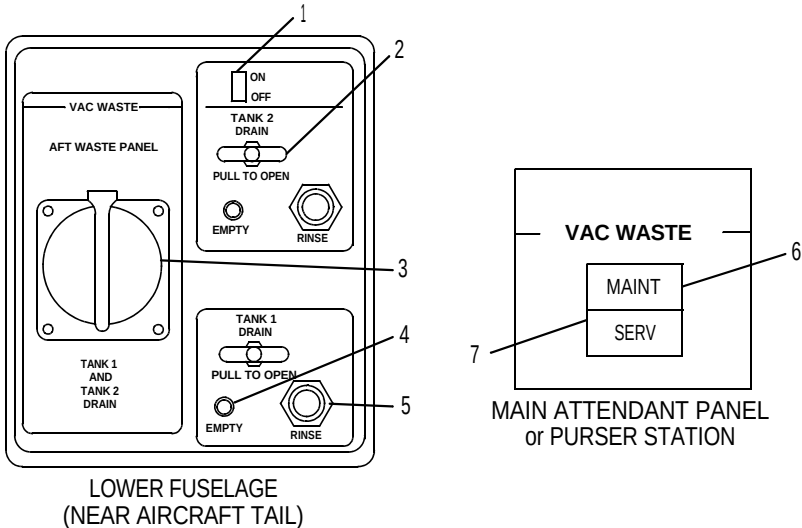
OFF - Turns off both systems.

ON - Turns systems to standby.

12. FILL/DRAIN VALVE Switches

Positions fill/drain, overflow/vent, and isolation valves to service one or both systems.

Vacuum Waste System



DB1-2-1949

1. Service Panel Switch

Push to turn power on/off to the service panel lights and EMPTY light.

2. DRAIN Handle (2)

Pull to open the tank drain.

3. Drain Manifold and Cap

The waste system is drained through this manifold. A double-door drain cap protects the manifold.

4. EMPTY Light (2) - amber

Illuminates amber when waste tank is empty.

5. RINSE Fitting (2)

Rinse equipment is connected to the tank through the fitting.

6. MAINT Light - amber

Illuminates amber when maintenance is necessary on the waste system.

7. SERV Light - amber

Illuminates amber when waste tank is 60% full and needs servicing.

8. STATUS Lights - amber

Illuminates to indicate status as follows:

VAC SWITCH - Vacuum switches disagree.

ALT SWITCH - Altitude switches disagree.

BLWR - Blower is over temperature.

P SENSOR - Differential pressure level sensor failed.

SONIC SENSOR - Waste level sensor failed.

FULL - Waste tank is full.

9. IN SERV Light - amber

Illuminates amber when system is being serviced.

10. PANEL Light - amber

Illuminates amber when there is a fault with this STATUS panel.

11. WCU Light - amber

Illuminates amber to indicate a WCU fault.

12. BLOWER Switch (2) - green

Push to turn on the blower. Illuminates green to indicate blower is on (ground flushing).

13. PURGE Switch - green

Push to start purge cycle. Illuminates green to indicate purge cycle is on.

14. FAULT RESET Switch - green

Push to extinguish lights if faults have been corrected. Illuminates green when pushed.



**Water and Waste
Alerts**

**Chapter Wat
Section 40**

TO BE ADDED WHEN AVAILABLE

Intentionally
Blank