

Preface

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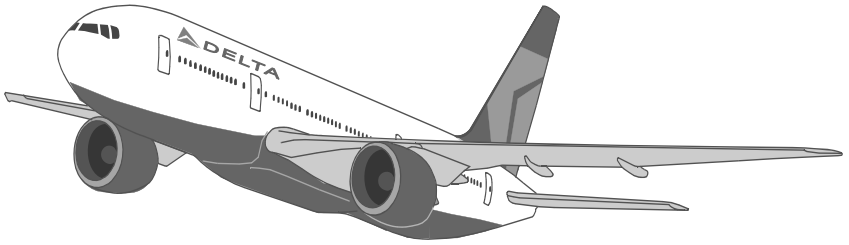
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777-232ER/LR
Operations Manual
Volume 2
Delta Air Lines, Inc.

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October 7, 2016

Preface

Model Identification

Chapter P2

Section 1

General

The aircraft listed in the table below are covered in the operations manual. The numbers are used to distinguish data peculiar to one or more, but not all of the aircraft. Where data applies to all aircraft listed, no reference is made to individual airplane numbers.

Use of the table below permits flight crew correlation of configuration differences by number within an operator's fleet for aircraft covered in this manual. Configuration data reflects the aircraft as delivered configuration and is updated for service bulletin incorporations in conformance with the policy stated in the introduction section of this chapter.

Ship number is supplied by the operator. Registry number is supplied by the national regulatory agency. Serial and tabulation numbers are supplied by Boeing.

The procedures and information contained in this manual also apply to aircraft acquired by Delta Air Lines, Inc. subsequent to the current revision; however, this document may not address all pertinent information for these aircraft. In such instances, specific operating procedures and systems information can be found in appropriate Differences Chapter(s) and/or Fleet Bulletin(s) prior to their incorporation in the next scheduled revision.

Ship Number	Registry Number	Serial Number	Tabulation Number
7001	N860DA	29951	WB446
7002	N861DA	29952	WB447
7003	N862DA	29734	WB448
7004	N863DA	29735	WB449
7005	N864DA	29736	WB450
7006	N865DA	29737	WB451
7007	N866DA	29738	WB452
7008	N867DA	29743	WB453
7101	N701DN	29740	WD066
7102	N702DN	29741	WD067
7103	N703DN	32222	WD068

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7104	N704DK	29739	WD069
7105	N705DN	29742	WD070
7106	N706DN	30440	WD071
7107	N707DN	39091	WD072
7108	N708DN	39254	WD073
7109	N709DN	40559	WD074
7110	N710DN	40560	WD075
And Subsequent			

Preface

Introduction

Chapter P2

Section 2

General

The Boeing Company developed normal and non-normal procedures for the 777 aircraft. Delta Air Lines, Inc. has modified some of the procedures for simplification and standardization, when appropriate, with other Delta Air Lines, Inc. aircraft. Finally, the FAA has approved the procedures presented in the Operations Manual, with the exception of flight crew bulletins.

These procedures are company policy for pilots to follow during ground operations and in flight. Deviations from these policies and procedures should be made only with good cause and based on the safest course of action. If an abnormality occurs that is not covered by these procedures, the Captain must use his best judgement.

Manual Rights

The 777 Operations Manual has been prepared for the exclusive use of Delta Air Lines, Inc., Flight Operations personnel under the direction and authority of Delta and shall, at all times, remain the property of Delta. The holder hereof acknowledges and agrees that this manual contains or may contain trade secrets, copyrighted material and commercial and proprietary information, privileged and confidential, to the interest of Delta, and the holder hereof further agrees that this manual may not be reproduced, distributed or copied, in whole or in part, without the express prior written consent of Delta.

In the event this 777 Operating Manual is sold or distributed to any other party, no warranty or guarantee, expressed or implied, is made as to the accuracy, sufficiency or suitability of the materials contained herein or of any revision, supplement or bulletin hereto. It is understood and agreed to by such other party that it shall release, indemnify, and hold Delta Air Lines, Inc., its officers, employees and agents harmless against any and all claims or actions of whatever nature which may arise or claim to arise from the use hereof.

Corrections to the Manual

Log on to the Delta Flight Operations Portal, <http://deltanet.delta.com> and submit a Publications Change Request (PCR) to correct any errors or discrepancies discovered in this manual, or to submit a suggested change to any Aircraft Operating Manual, Volume 1, Volume 2, Quick Reference Handbook (QRH), Flight Crew Training Manual (FCTM), Normal Checklist, Airway Manual (AM), Flight Operations Manual (FOM), Operating Experience (OE/TOE) Guide, Flight Bulletin (FB), or All Pilot Bulletin (APB).

There is a link to the PCR form at Deltanet > My Division > Pilot Support > Forms and Reports. Once submitted, the PCR is automatically routed to the applicable Fleet Technical Manager and Technical Writer for that manual.

Organization

The operations manual is organized in the following manner.

Volume 1

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.
- Limitations - Covers operational limitations.
- Normal Procedures - Covers all amplified normal operating procedures and are based on a thorough analysis of crew activity required to operate the aircraft, and reflect the latest knowledge and experience available.
- Normal Operational Information - Contains reference material used to support normal procedures.
- Supplementary Procedures is organized by system and covers:
 - any procedure that is non-routine in nature,
 - any first-flight-of-the-day test or other systems test,
 - guidance on lengthy operating procedures, and
 - adverse weather procedures and guidance.
- Differences - Notes differences between aircraft models and variants.

Volume 2

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.
- Contains general aircraft and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

QRH

- Non-normal checklists - Contains checklists used to manage non-normal situations.
- Non-Normal Operational Information - Contains reference material used to support non-normal procedures.
- Non-Normal Checklist Instructions - Contains non-normal checklist instructions and evacuation flow/philosophy.
- Revision Record - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.

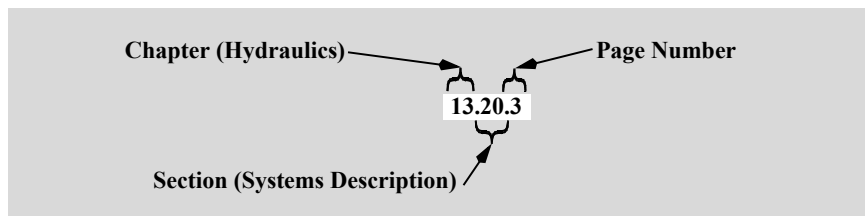
FCTM

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.
- Provides information and recommendations on aircraft operations, maneuvers, techniques, and human factors.

Page Numbering

This manual uses a decimal page numbering system. The page number is divided into three fields; chapter, section, and page. An example of a page number for the hydraulics chapter follows: chapter 13, section 20, page 3.

Example Page Number



Warnings, Cautions, and Notes

The following levels of written advisories are used throughout the manual and are not to be confused with EICAS messages, which are identified in separate text.

Warning - A warning is an instruction about a hazard that if ignored could result in injury, loss of aircraft control, or loss of life. A warning will appear prior to the applicable step or item.

WARNING: Do not pressurize any hydraulic or pneumatic system until clearance is obtained from Maintenance.

Caution - A caution is an instruction concerning a hazard that if ignored could result in damage to equipment. A caution will appear prior to the applicable step or item.

CAUTION: Do not set takeoff thrust until oil temperature is above 50°C.

Note - A note provides amplified information, instruction, or emphasis. A note will appear after the applicable step or item.

Note: The checklist must not be modified in any way.

Aircraft Effectivities

Differences in aircraft configuration are shown by use of aircraft effectivities throughout Volumes 1 and 2, QRH, and the FCTM. The following rules are used to express aircraft effectivities:

- Aircraft effectivities are listed by model and/or ship number. A range of aircraft is defined by a dash, e.g. 9901 - 9910. A comma in the effectivity range indicates a break in the range, e.g. 9901 - 9910, 9912 - 9925; aircraft 9911 is excluded from the range. Aircraft introduced to the fleet following manual publication are effective as subsequent ships, e.g. 9901 & Subsequent.
- Aircraft effectivities are listed in bold text throughout the manual, except in the Limitations chapter. In the Limitations chapter, aircraft effectivities are listed in bold when the effectivity applies to the entire section or subsection. When the effectivity applies only to a step within a section, it is listed in normal text.
- Aircraft effectivities apply only to the paragraph, illustration, operational note, procedural step, etc. and to subordinate items (if any). Refer to the examples below.

Example (with subordinate items):

9951 – 9961	
CTR TK PUMP (affected).....	OFF
Do not open the WING X FEED valve.	
OUTR TK XFR.....	ON

In this example, the effectivity 9951 - 9961 applies to the first procedural step (CTR TK PUMP.....) and the further indented/subordinate step (Do not...). The effectivity does not apply to the next equivalently indented step (OUTR TK XFR.....).

Example (without subordinate items):

Using ship number:

9951 – 9961	
CTR TK PUMP (affected).....	ON
OUTR TK XFR.....	OFF

In this example, the effectivity 9951 - 9961 applies to the first procedural step (CTR TK PUMP.....) only. The effectivity does not apply to the next procedural step (OUTR TK XFR.....).

Using model number:

767-300	
EQUIPMENT COOLING mode selector.....	AUTO

In this example, the 767-300 will have the selector in the AUTO position.

When aircraft effectivities are centered immediately below a checklist title, the entire checklist applies to the listed aircraft. In the following example, the FUEL L + R CTR PUMPS LO PR checklist is applicable to 9951-9961 only:

FUEL L + R CTR PUMPS LO PR
9951-9961

Preface

Abbreviations

Chapter P2

Section 3

General

The following abbreviations may be found throughout the manual. Some abbreviations may also appear in lowercase letters. Abbreviations having very limited use are explained in the chapter where they are used. Since this list is compiled across several fleets, there may be some abbreviations that do not apply to this specific fleet.

A	
ABV	Above
AC	Alternating Current or Aircraft
ACARS	Aircraft Communications Addressing and Reporting System
ACE	Actuator Control Electronics
ACP	Audio Control Panel
ACT	Active
ADC	Air Data Computer
ADF	Automatic Direction Finder
ADI	Attitude Director Indicator
ADIRS	Air Data Inertial Reference System
ADIRU	Air Data Inertial Reference Unit
ADM	Air Data Module
AED	Automated External Defibrillator
AFDC	Autopilot Flight Director Computer

AFDS	Autopilot Flight Director System
AFE	Above Field Elevation
AFM	Airplane Flight Manual (FAA approved)
AFM - DPI	Airplane Flight Manual - Digital Performance Information
AFS	Automatic Flight System (Autopilot or Autothrottle)
A/G	Air/Ground
AGL	Above Ground Level
AH	Alert Height
AHRS	Attitude Heading Reference System
AI	Anti-Ice
AIL	Aileron
ALFA	Safe Stall Margin Speed
ALT	Altitude
ALT ACQ	Altitude Acquire
ALT HOLD	Altitude Hold
ALTN	Alternate
AM	Amplitude Modulation

AIMS	Airplane Information Management System
AMI	Airline Modifiable Information
ANP	Actual Navigational Performance
ANT	Antenna
ANU	Aircraft Nose Up
AOA	Angle of Attack
AOC	Airline Operational Communication Data Link
A/P	Autopilot
APL	Airplane
APP	Approach
APU	Auxiliary Power Unit
ARINC	Aeronautical Radio, Incorporated
ARPT	Airport
ARR	Arrival
ART	Automatic Reserve Thrust
ASA	Autoland Status Annunciator
ASI	Airspeed Indicator
ASR	Airport Surveillance Radar
ASYM	Asymmetry
A/T	Autothrottle
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATIS	Automated Terminal Information Service

ATM	Assumed Temperature Method
ATT	Attitude
AUTO	Automatic
AUTO-THROT	Autothrottle
AUX	Auxiliary
AVAIL	Available
AWABS	Automated Weight and Balance System

B	
BARO	Barometric
BAT	Battery
B/C or B/CRS or BAC or BCS	Back Course
BFO	Beat Frequency Oscillator
BITE	Built-In Test Equipment
BKR	Breaker
BLD	Bleed
BLW	Below
BRG	Bearing
BRT	Bright
BTL	Bottle
BTL DISCH	Bottle Discharge (fire extinguisher)
BTMS	Brake Temperature Monitoring System

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C	
C	Captain or Celsius or Center or Cool
CAA	Civil Aviation Authority
CADC	Central Air Data Computer
CALSEL	Call Select
CANC/RCL	Cancel/Recall
CANPA	Constant Angle Non-Precision Approach
CAP	Capture
CAPT	Captain
CAWS	Central Aural Warning System
CB	Circuit Breaker
CCD	Cursor Control Device
CDS	Common Display System
CDU	Control Display Unit
CFIT	Controlled Flight Into Terrain
CG	Center of Gravity
CHKL	Checklist
CHR	Chronograph
CKD	Checked
CKT	Circuit
CL	Close
CLB	Climb
CLMP	Computer Lockout Manual Power
CLR	Clear

CMD	Command
CO	Company
COMM	Communication
COMP	Comparator
COMPT	Compartment
CON	Continuous
CONFIG	Configuration
CONT	Control
COOL	Cooling
CRS	Course
CRT	Cathode Ray Tube
CRZ	Cruise
CTL	Control
CTR	Center
CWS	Control Wheel Steering

D	
DA	Decision Altitude
DA(H)	Decision Altitude (Height)
DC	Direct Current
DCU	Display Concentrator Unit
D/D	Direct Descent
DDA	Derived Decision Altitude (MDA +50 feet)
DDG	Dispatch Deviations Guide
DEL	Delete
DEP	Departure
DEP ARR	Departure Arrival
DEPR	Depressurize

DES	Descent
DEU	Display Electronic Unit
DFCS	Digital Flight Control System
DFGC	Digital Flight Guidance Computer
DFGS	Digital Flight Guidance System
DH	Decision Height
DIFF	Differential
DIR	Direct
DISC	Disconnect
DISCH	Discharge
DK	Deck
DME	Distance Measuring Equipment
DN	Down
DPC	Display Processing Computer
DSP	Display Select Panel
DSPL	Display
DTG	Distance to Go
DTW	Distance to Waypoint
DU	Display Unit

E	
EADI	Electronic Attitude Director Indicator
ECON	Economy
E/D	End of Descent
E/E	Electrical/Electronic
EEC	Electronic Engine Control

EFI	Electronic Flight Instruments
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature
EHSI	Electronic Horizontal Situation Indicator
EICAS	Engine Indication and Crew Alerting System
EIS	Electronic Instrument System
ELEC	Electrical
ELEV	Elevator
EMER	Emergency
ENG	Engine
ENG OUT	Engine Out
ENT	Entry
EO or E/O	Engine Out
EOAP	Electronic Overhead Annunciation Panel
EPR	Engine Pressure Ratio
EQPT or EQUIP	Equipment
ER	Extended Range
ETOPS	Extended Range Operation with Twin Engine Airplanes
EVAC	Evacuation
EXEC	Execute
EXT	Extend or External

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F	
F	Fahrenheit
FAC	Final Approach Course
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
FAF	Final Approach Fix
FAR	Federal Aviation Regulation
FCB	Flight Crew Bulletin
FCC	Flight Control Computer
FCTL	Flight Control
FCTM	Flight Crew Training Manual
FD, F/D or FLT DIR	Flight Director
FDR	Flight Data Recorder
FDRS	Flight Data Recorder System
FF	Fuel Flow
FFM	Force Fight Monitor
FGCP	Flight Guidance Control Panel
FGS	Flight Guidance System
FILT	Filter
FIR	Flight Information Region
FL CH or FLCH	Flight Level Change
FLT	Flight
FLT CTRL	Flight Control
FLPRN	Flaperon

FMA	Flight Mode Annunciator
FMC	Flight Management Computer
FMS	Flight Management System
F/O or F O	First Officer
FOM	Flight Operations Manual
FPA	Flight Path Angle
FPM	Feet Per Minute
FPV	Flight Path Vector
FREQ	Frequency
F/S	Fast/Slow
FT	Feet
FWD	Forward
FWSOV	Fire Wall Shut Off Valve
FX	Fix

G	
GA	Go-Around
GE	General Electric
GEN	Generator
GLS	GPS Landing System
GMT	Greenwich Mean Time
GND	Ground
GP or G/P	Glide Path
GPS	Global Positioning System
GPWS	Ground Proximity Warning System

GS	Ground Speed
G/S	Glide Slope
GW	Gross Weight

H

HAA	Height Above Airport
HAT	Height Above Touchdown
HDG	Heading or Hydraulic Driven Generator
HDG REF	Heading Reference
HDG SEL	Heading Select
HF	High Frequency
HGS	Head-Up Guidance System (HGS® is a registered trademark of Flight Dynamics)
HI	High
HLD	Hold
HPA	Hectopascals
HPSOV	High Pressure Shut Off Valve
HSI	Horizontal Situation Indicator
HUD	Head-Up Display
HYD	Hydraulic

I	
IAF	Initial Approach Fix
IAN	Instrument Approach Navigation
IAS	Indicated Airspeed
IDENT	Identification

IFE	In-Flight Entertainment System
IFR	Instrument Flight Rules
IGN	Ignition
IGS	Instrument Guidance System
ILS	Instrument Landing System
IM	Inner Marker
IMC	Instrument Meteorological Conditions
IN	Inches
INBD	Inboard
IND	Indicator
IND LTS	Indicator Lights
INOP	Inoperative
INIT	Initialization
INSTR	Instrument
INT or INTPH	Interphone
INTC	Intercept
INTC CRS	Intercept Course
IP	Instructor Pilot
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISDU	Inertial System Display Unit
ISFD	Integrated Standby Flight Display
ISLN	Isolation

J	
JAA	Joint Aviation Authority

K	
K or KTS	Knots
KCAS	Knots Calibrated Airspeed
KGS	Kilograms
KIAS	Knots Indicated Airspeed

L	
L	Left
LAT	Latitude
LBS	Pounds
LD	Load
LDA	Localizer-type Directional Aid
LDG	Landing
LDG ALT	Landing Altitude
LE	Leading Edge
LIM	Limit
LIM SPD	Limit Speed
LKD	Locked
L NAV or LNAV	Lateral Navigation
LOC	Localizer
LOC-BC	Localizer Back Course
LOM	Locator Outer Marker
LON	Longitude
LR	Long Range
LRC	Long Range Cruise

LRU	Line Replaceable Unit
LSK	Line Select Key
LT	Light

LWR CTR	Lower Center
LWR DSPLY or LWR DSPL	Lower Display

M	
M	Mach
MAG	Magnetic
MAHP	Missed Approach Holding Point
MAN	Manual
MAP	Missed Approach Point
MASI	Mach/Airspeed Indicator
MAX	Maximum
MCC	Maintenance Control Center
MCDU	Multi-purpose Control and Display Unit
MCO	Maintenance Carry Over
MCP	Mode Control Panel
MCT	Maximum Continuous Thrust
MDA	Minimum Descent Altitude
MDA(H)	Minimum Descent Altitude (Height)
MDM	Mechanical Dispatch Manual
MEA	Minimum Enroute Altitude

MEL	Minimum Equipment List
MFD	Multifunction Display
MHZ	Megahertz
MIC	Microphone
MIN	Minimum
MKR	Marker
MLS	Microwave Landing System
MM	Middle Marker
MMO	Maximum Mach Operating Speed
MNPS	Minimum Navigation Performance Specification
MOCA	Minimum Obstruction Clearance Altitude
MOD	Modify
MORA	Minimum Off Route Altitude
MSA	Minimum Safe Altitude
MSG	Message
MSGS RCVD	Messages Received
MSL	Mean Sea Level
MTRS	Meters
MUH	Minimum Use Height

N	
N	Normal
NADP	Noise Abatement Departure Procedures
NAR	North American Route
NAV	Navigation

NAV RAD	Navigation Radio
ND	Navigation Display
NGS	Nitrogen Generation System
NLT	No Later Than
NM	Nautical Mile(s)
NNC	Non-Normal Checklists
NNM	Non-Normal Maneuvers
NPS	Navigation Performance Scales
NORM	Normal
N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed (Pratt & Whitney and GE engines) or Intermediate Pressure Rotor Speed (Rolls Royce Engines)
N3	High Pressure Rotor Speed (Rolls Royce Engines)

O	
OAP	Overhead Annunciator Panel (a.k.a. EOAP)
OAT	Outside Air Temperature
OCC	Operations Control Center
ODM	Operational Data Manual
OFST	Offset
OHU	Overhead Unit
OM	Outer Marker
OP	Open

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OUTBD DSPL	Outboard Display
OVHD	Overhead
OVHT	Overheat
OVRD	Override
OVSPD	Overspeed

OXY or O2	Oxygen

P	
PA	Passenger Address
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PASS	Passenger
PBE	Protective Breathing Equipment
PCP	Pilot Call Panel
PDC	Pitch Data Computer or Performance Data Computer or Pre-Departure Clearance
PERF	Performance
PERF INIT	Performance Initialization
PES	Pitch Enhancement System
PF	Pilot Flying
PFAF	Precision Final Approach Fix
PFC	Primary Flight Computer
PFD	Primary Flight Display

PI	Performance Inflight
PIP	Product Improvement Package
PM	Pilot Monitoring
PMC	Power Management Control
PNL	Panel
POS	Position
POS INIT	Position Initialization
POS REF	Position Reference
PPI	Planned Position Indicator
PPOS	Present Position
PRES or PRESS	Pressure
PREV	Previous
PRI	Primary
PROG	Progress
PROX	Proximity
P/RST	Push To Reset
PRV	Pressure Regulating Valve
PSI	Pounds Per Square Inch
PTH	Path
PTT	Push To Talk
PTU	Power Transfer Unit
PWR	Power
PWS	Predictive Windshear System

Q	
Q	Quantity
QFE	Local Station Pressure

QNH	Altimeter Setting
QRH	Quick Reference Handbook
QTY	Quantity

R	
R	Right

RA	Radio Altitude or Resolution Advisory
RAD	Radio
RAT	Ram Air Temperature or Ram Air Turbine
RCL	Request for Clearance
RDMI	Radio Distance Magnetic Indicator
REC	Recorder
RECIR or RECIRC	Recirculation
REF	Reference
RET	Retract
REV	Reverse
RF	Radius-to-Fix (RF) Legs or Refill
RMI	Radio Magnetic Indicator
RNAV or RNV	Area Navigation
RNP	Required Navigational Performance
RPL	Rudder Pressure Limiter
RPM	Revolutions Per Minute
RPR	Rudder Pressure Reducer
RR	Rolls Royce

RSEP	Rudder System Enhancement Program
RST	Reset
RSVR	Reservoir
R/T	Radio Transmit
RTE	Route
RTO	Rejected Takeoff
RTP	Radio Tuning Panel
RUD	Rudder
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minimum

S	
SAARU	Secondary Attitude Air Data Reference Unit
SAT	Static Air Temperature or Satellite
SB	Service Bulletin
S/B	Speedbrake
S/C	Step Climb
SDF	Simplified Directional Facility
SEI	Standby Engine Indicator
SEL	Select
SELCAL	Selective Calling
SENS	Sensitivity
SERV	Service
SG	Symbol Generator
SPD	Speed
SPDBRK	Speedbrake
STA	Station

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STAB	Stabilizer
STAT	Status
STBY	Standby
STD	Standard
SYS	System

T

T or TRU	True
T or TK or TRK	Track (to a Navaid)
TA	Traffic Advisory
TAA	Terminal Arrival Area
TACAN	Tactical Air Navigation
TAC	Thrust Asymmetry Compensation
TAI	Thermal Anti-Ice
TAS	True Airspeed
TAT	Total Air Temperature
T/C	Top of Climb
TCA	Terminal Control Area
TCAS	Traffic Alert and Collision Avoidance System
T/D	Top of Descent
TDZ	Touch Down Zone
TDZE	Touch Down Zone Elevation
TE	Trailing Edge
TEMP	Temperature
TERR	Terrain
TFC	Traffic
TFR	Transfer

THR	Throttle or Thrust
THR HOLD	Throttle Hold
TMC	Thrust Management Computer
TMI	Track Message Identifier
TMSP	Thrust Mode Select Panel
TO or T/O	Takeoff
TOC	Top of Climb
TOD	Top of Descent
TO/GA	Takeoff/Go-Around
TR	Traffic Resolution
TRP	Thrust Rating Panel
TRU	Transformer Rectifier Unit
TURB	Turbine or Turbulence

U	
UNLKD	Unlocked
UNSCHD or UNSCHED	Unscheduled
UPR DSPL	Upper Display
U.S.	United States
USB	Upper Side Band
UTC	Universal Time Coordinated
UTIL	Utility

V	
VA	Design maneuvering speed
VAL	Valve

VANP	Vertical Actual Navigational Performance
VASI	Visual Approach Slope Indicator
VDP	Visual Descent Point
VEF	Speed at Engine Failure
VERT	Vertical
VFR	Visual Flight Rules
VG	Vertical Gyro
VHF	Very High Frequency
VIB	Vibration
VLV	Valve
VMC	Visual Meteorological Conditions
VMCA	Minimum Control Airspeed or Single Engine Minimum Control Airspeed
VMCG	Minimum Control Speed Ground
VMO	Maximum Operating Speed
V NAV or VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VR	Rotation Speed
VREF	Reference Speed
VRNP	Vertical Required Navigation Performance
V/S	Vertical Speed
VSCF	Variable Speed Constant Frequency
VSD	Vertical Situation Display

VSI	Vertical Speed Indicator
VTK	Vertical Track
V1	Takeoff Decision Speed
V1 (MCG)	Minimum V1 for Control on the Ground

V2	Scheduled Takeoff Target Speed

W	
W	Warm
WATRS	Western Atlantic Route System
WDR	Weight Data Record
WGS-84	World Geodetic System of 1984
WHL	Wheel
WPT	Waypoint
WT	Weight
WXR	Weather Radar

X	
X-FEED	Crossfeed
XPDR or XPNDR	Transponder
XTK	Cross Track

Preface

Revision Record

Chapter P2

Section 4

Revision Transmittal Letter

To: All holders of Delta Airlines, Inc. 777 Aircraft Operations Manuals.

Subject: Flight Crew Operations Manual Revision.

This revision reflects the most current information available through the subject revision date. General information below explains the use of revision bars to identify new or revised information.

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
00	October 14, 1998		01	March 19, 1999	
02	March 30, 1999		03	May 31, 1999	
04	December 15, 1999		05	November 17, 2000	
06	February 15, 2008		07	October 24, 2013	
08	February 12, 2015		9	October 07, 2016	

General

Delta Air Lines, Inc. issues operations manual revisions to provide new or revised procedures and information. Revisions also incorporate appropriate information from previously issued Flight Crew Bulletins.

The revision date is the date the revision material is distributed and considered current. EFB revision downloads and/or flight deck distribution should be accomplished as soon as possible, but may take as much as 21 days after the revision date for completion.

Revisions include a Transmittal Letter, Revision Record, Revision Highlights, and a List of Effective Pages. Use the information on the new Revision Record to review the revised operations manual content.

Revision Highlights

Pages containing revised technical and non-technical material have revision bars associated with the changed text or illustration.

Chapter P2 - Preface

Section 2 - Introduction

Corrections to the Manual

P2.2.2 - Updated link information for deltanet.

P2.2.2 - Updated link information to submit a PCR.

Organization

P2.2.3 - Added, human factors to reflect new FCTM chapters.

Chapter P1 - Preface

Section 3 - Abbreviations

P2.3.5 - Added, "FDR - Flight Data Recorder".

P2.3.5 - Added, "FDRS - Flight Data Recorder System".

Chapter P2 - Preface

Section 4 - Revision Record

P2.4.1 - Revised Revision Transmittal Letter information.

P2.4.1 - Revised to match the electronic-only methodology and removed filing instructions information.

Chapter 1 - Airplane General, Emergency Equipment, Doors, Windows

Section 10 - Dimensions

Principal Dimensions

1.10.1-2 - Revised tail height to standardize with Boeing.

Section 20 - Instrument Panels

Flight Deck Panels

1.20.1 - Revised Note to standardize with Boeing.

Section 40 - Systems Description

Portable Protective Breathing Equipment

1.40.10-11 - Added Portable Protective Breathing Equipment section.

Section 46 - Door 1 Upper Crew Rest

Main Control Panel

1.46.6 - Revised text, and removed bullet and reference to push and hold for 2 seconds, to standardize with Boeing.

-
- 1.46.10 - Revised text, and removed bullet and reference to push and hold for 2 seconds, to standardize with Boeing.

Emergency Equipment Location

- 1.46.24 - Added first aid kit to graphic.

Chapter 3 - Anti-Ice, Rain

Section 30 - EICAS Messages

Anti-Ice, Rain System EICAS Messages

- 3.30.1 - Removed, starter from ANTI-ICE LEAK, ENG L, R.

Chapter 4 - Automatic Flight

Section 20 - System Description

AFDS Flight Mode Annunciations

- 4.20.6 - Removed, “The autothrottle will not exceed the operating speed limits or the thrust limits displayed on the EICAS” from SPD and added in Notes.

Autothrottle System

- 4.20.9 - Revised Autothrottle System information to standardize with Boeing.

Manual Flight

- 4.20.9 - Added Manual Flight section to standardize with Boeing.

Automatic Activation

- 4.20.9-10 - Added Automatic Activation section to standardize with Boeing.

Autothrottle Thrust Lever Operation

- 4.20.10 - Added, “Note - When the pitch flight mode annunciation is FLCH SPD, the autothrottle can enter the HOLD mode. This occurs if the pilot overrides thrust levers; or, in a descent, when thrust levers retard to IDLE. When in HOLD mode, thrust lever servos are inhibited and the autothrottle does not control thrust or speed. Thrust levers can be manually advanced.”; to standardize with Boeing.

Chapter 5 - Communications

Section 40 - MFD Communications Functions

Communications Information Messages

- 5.40.16 - Changed, “LOAD” to “LOADED”, to standardize with Boeing.

Manager Menu

5.40.45 - Changed, "SYSTEM INFO" to "SYSTEM INFORMATION" in graphic.

Chapter 7 - Engines, APU

Section 10 - Controls and Indicators

In-Flight Start Envelope

7.10.12 - Changed, "240" to "275" in graphic.

Section 20 - Engine System Description

Introduction

7.20.1 - Updated "110,000 pounds" to "110,760 pounds" to standardize with Boeing.

7.20.1 - Updated "95,000 pounds" to "92,940 pounds" to standardize with Boeing.

Section 30 - APU System Description

APU Start

7.30.2 - Added, "The APUs starter motors duty cycle for the electric starter motor and air turbine starter is 3 start attempts in a 60 minute periods each."; to standardize with Boeing.

Chapter 8 - Fire Protection

Section 10 - Controls and Indicators

APU and Cargo Fire Panel

8.10.4 - Added, "Note - The bulk cargo compartment is included in the AFT cargo fire extinguisher system."; to standardize with Boeing.

Section 20 - System Description

Cargo Compartment Fire Protection

8.20.5 - Added, "Note - The bulk cargo compartment is included in the aft cargo fire detection and extinguishing systems."; to standardize with Boeing.

Chapter 9 - Flight Controls

Section 20 - System Description

Pitch Envelope Protection

9.20.11 - Revised paragraph to clarify system operation, to standardize with Boeing.

Stabilizer Position Indication and Green Band

9.20.14 - Added, “V1” to standardize with Boeing.

Chapter 10 - Flight Instruments, Displays

Section 10 - Controls and Indicators

PFD Failure Flags

10.10.22 - Modified graphic.

EFIS Control CDU Pages

10.10.55 - Changed, “-1001 feet” to “-101 feet”.

Section 20 - System Description

Flight Recorder

10.20.12 - Added Flight Recorder section.

Section 40 - Navigation Displays

ND Symbolology

10.40.17 - Revised remarks to standardize with Boeing.

Chapter 11 - Flight Management, Navigation

Section 20 - Navigation Systems Description

Transponder

11.20.12 - Added, “The transponder responds to Mode S interrogations in all modes except STBY; and when on the ground, it provides airport position.”; to standardize with Boeing.

11.20.12 - Added paragraph describing loss of GPS input and ATC ADS-B reporting, to standardize with Boeing.

Section 31 - Flight Management System Operation

Lateral Navigation (LNAV)

11.31.10 - Added information about fly-by and fly-over waypoints, to standardize with Boeing.

Waypoints

11.31.12 - Grammar correction.

Takeoff and Climb

11.31.19 - Changed, mode to limit, to standardize with Boeing.

11.31.19 - Grammar corrections to standardize with Boeing.

Cruise

11.31.21-22 - Revised Step Climb description to standardize with Boeing.

Missed Approach

11.31.28 - Added information about transition from descent to climb phase, to standardize with Boeing.

Climb (Engine Out above EO Max Alt)

11.31.33 - Revised paragraph to standardize with Boeing.

Cruise (Engine Out Above EO Max Alt)

11.31.33 - Revised paragraph and callout1 to standardize with Boeing.

11.31.34 - Revised callouts 2-4 to standardize with Boeing.

Section 40 - FMC Preflight

Identification Page

11.40.7 - Updated "8YY" to "892" in graphic.

Thrust Limit Page

11.40.38 - Revised TO 1 to "-10%" and TO 2 to "-20%" in graphic.

11.40.41 - Revised, "Push - selects a percentage derate (CLB 1) climb thrust limit." to "Push - selects -10% derate (CLB 1) climb thrust limit."

11.40.41 - Revised, "Push - selects a percentage derate (CLB 2) climb thrust limit." to "Push - selects -20% derate (CLB 2) climb thrust limit."

11.40.41 - Removed, callout for Takeoff Bump (TO B).

Takeoff Reference Page 1/2

11.40.44 - Revised text to standardize with Boeing.

Section 41 - FMC Takeoff and Climb

Engine Out Climb

11.41.13 - Revised paragraph to standardize with Boeing.

EO CLB Page

11.41.13 - Added callout for Page Title.

11.41.14 - Changed callout numbers.

Section 42 - FMC Cruise

Direct To And Intercept Course To

11.42.8 - Added, "Abeam waypoints created from designated position reporting waypoints become positions reporting waypoints."; to standardize with Boeing.

Engine Out Cruise

11.42.19 - Added, “EO CRZ” and “LRC speed may be selected at 6R.”; to standardize with Boeing.

11.42.20-21 - Revised callout 5 to standardize with Boeing.

Calculated Step Climb

11.42.24-25 - Revised callout 2 to standardize with Boeing.

11.42.25 - Revised callout 3 to standardize with Boeing.

11.42.26 - Revised callout 4 to standardize with Boeing.

Fix Information Page

11.42.33-34 - Revised text and separated ER and LR information, to standardize with Boeing.

11.42.35 - Added, "Entering a time displays the predicted along track distance and the time on this line. The predicted airplane position displays on the ND route line as a green circle with the entered ETA."

Section 43 - FMC Descent and Approach

Descent Page

11.43.3 - Revised callout 1 to standardize with Boeing.

Hold Page (First Hold)

11.43.29 - Revised, “Speed or altitude may be entered.” to “Altitude, or speed and altitude may be entered.”; to standardize with Boeing.

11.43.29 - Added, “Note - When descending to a HOLD with VNAV active and the entry altitude is expected to be above the clearance holding altitude, the clearance altitude must be entered in 1R to prevent the airplane from leveling when sequencing the holding fix.”; to standardize with Boeing.

Chapter 15 - Warning Systems

Section 20 - System Description

Engine Indication and Crew Alerting System (EICAS)

15.20.1 - Removed System Alert Level Definitions section to standardize with Boeing.

Alerts Inhibited During Takeoff

15.20.30 - Added, “80 knots airspeed” to Master CAUTION lights, to standardize with Boeing.

15.20.30 - Added, “whichever occurs first” to All EICAS advisory messages. to standardize with Boeing.

15.20.30 - Added, “80 knots airspeed” to New PWS caution alerts, to standardize with Boeing.

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October 7, 2016

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**Airplane General, Emergency
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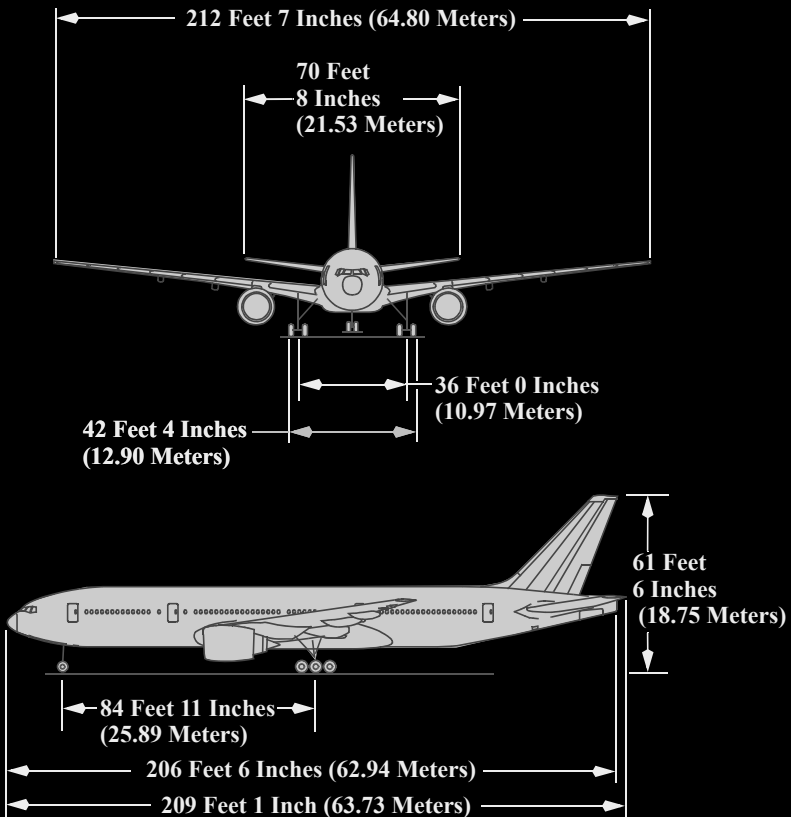
**Airplane General, Emergency
Equipment, Doors, Windows
Dimensions**

Chapter 1

Section 10

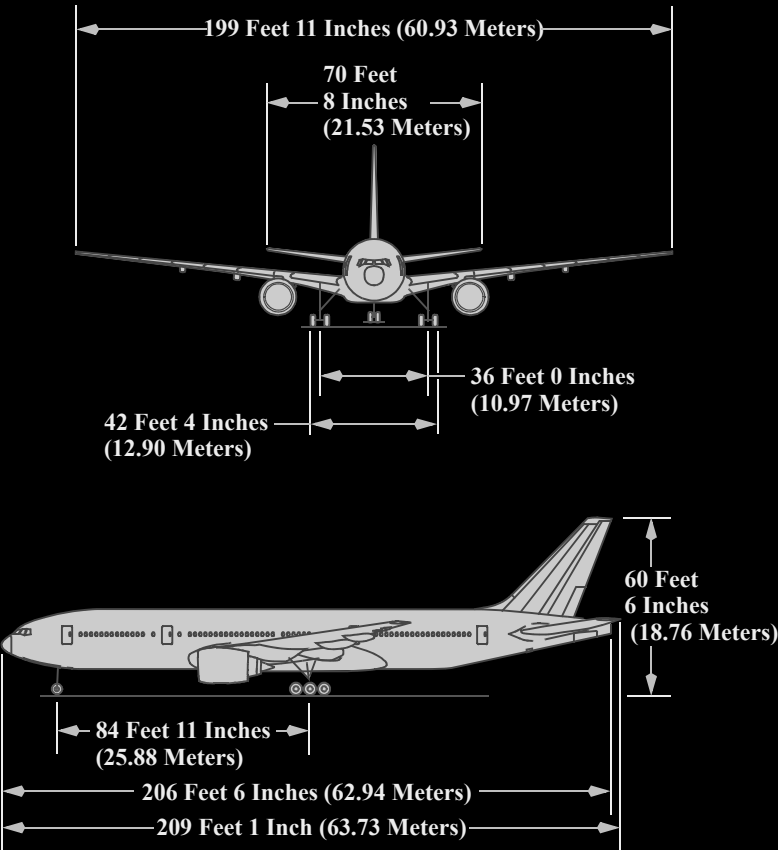
Principal Dimensions

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Principal Dimensions

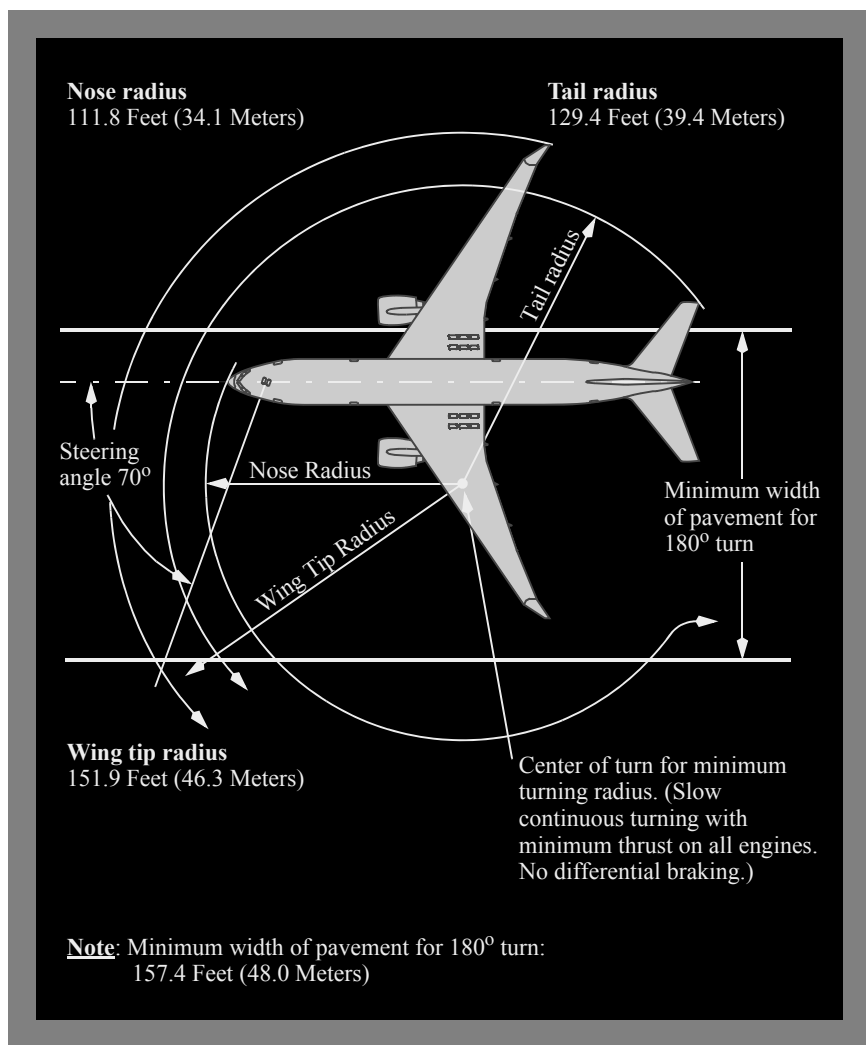
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Turning Radius

7101 - 7110

The wing tip swings the largest while turning and determines the minimum obstruction clearance path. All other portions of the airplane structure remain within this arc.

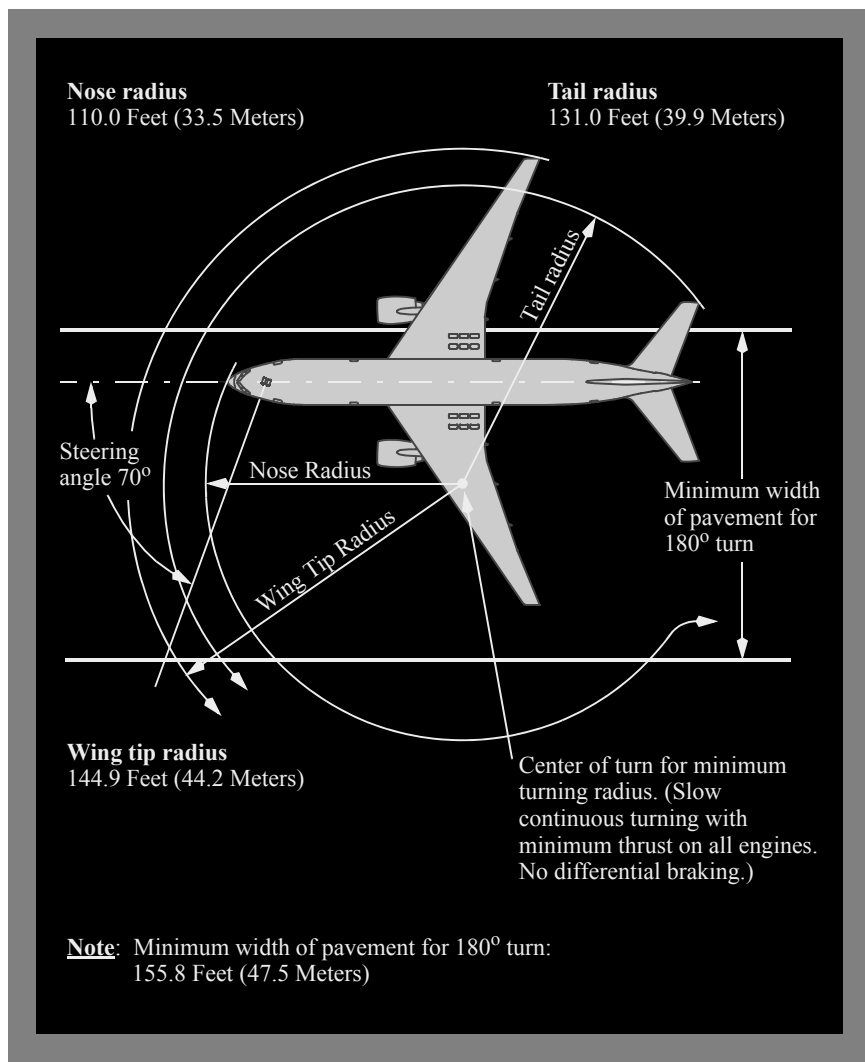


CAUTION: Do not attempt to make a turn away from an obstacle within 15 feet (4.6 m) of the wing tip, or within 55 feet (16.8 m) of the nose.

Turning Radius

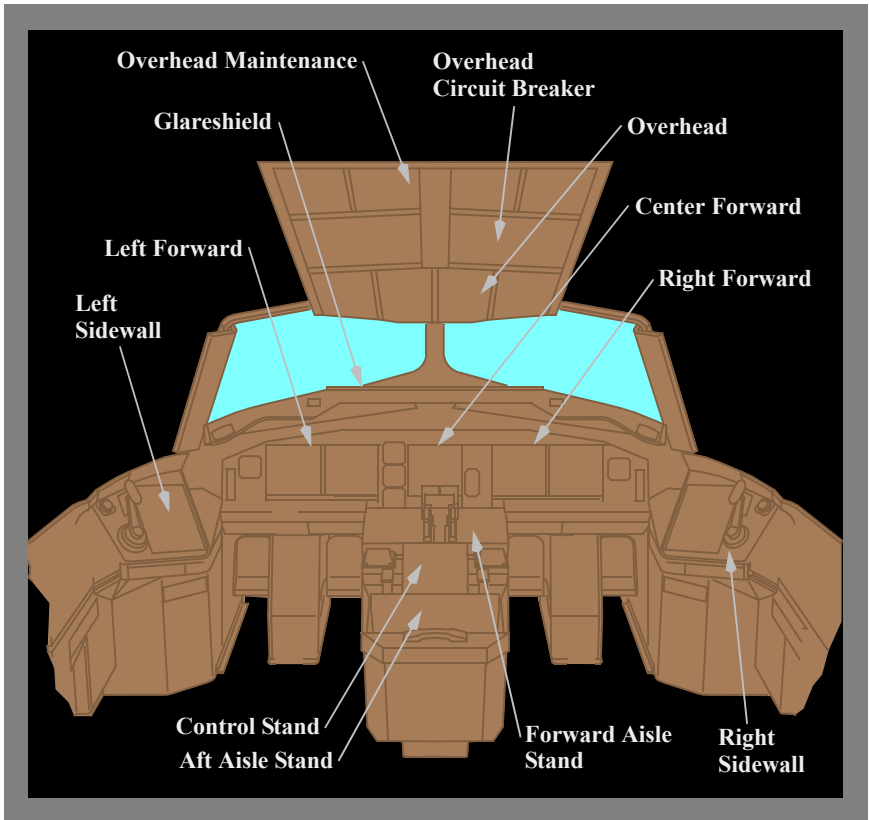
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The wing tip swings the largest while turning and determines the minimum obstruction clearance path. All other portions of the airplane structure remain within this arc.



CAUTION: Do not attempt to make a turn away from an obstacle within 15 feet (4.6 m) of the wing tip, or within 50 feet (15.2 m) of the nose.

Flight Deck Panels



The panels, controls, and indicators shown in this chapter are representative of installed units and may not exactly match the latest configuration. Refer to the appropriate chapter system descriptions for current information.

Note: Do not touch glass displays with bare hands. This can cause damage to the coating.

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Airplane General, Emergency Equipment, Doors, Windows Inst. Panels, Overhead

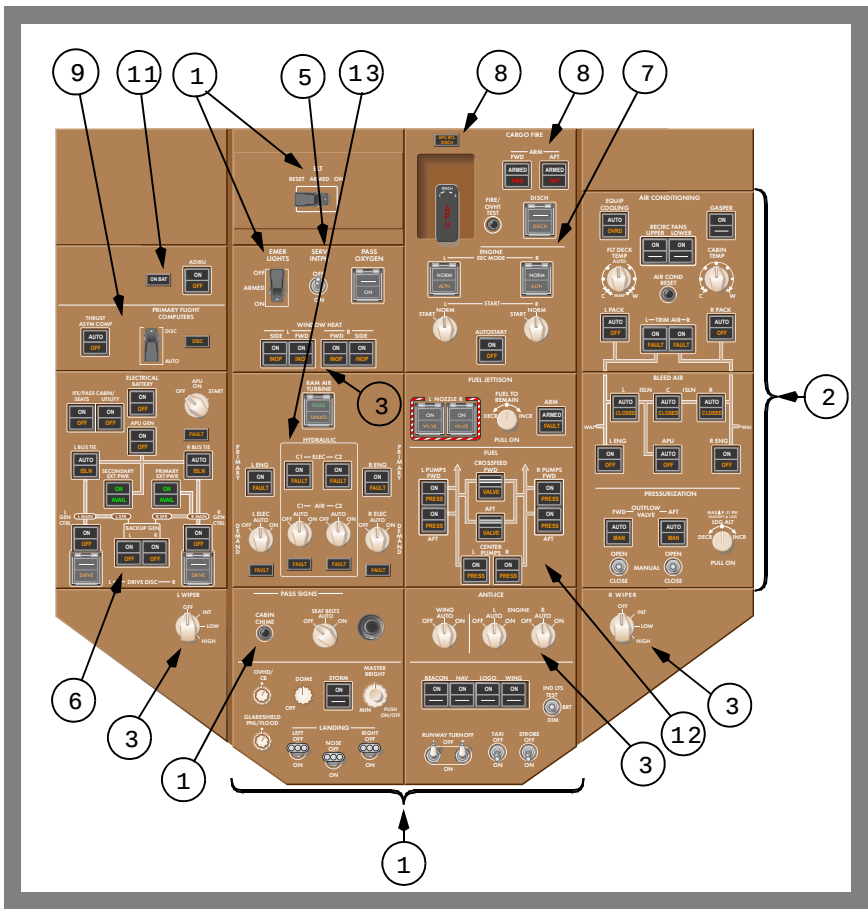
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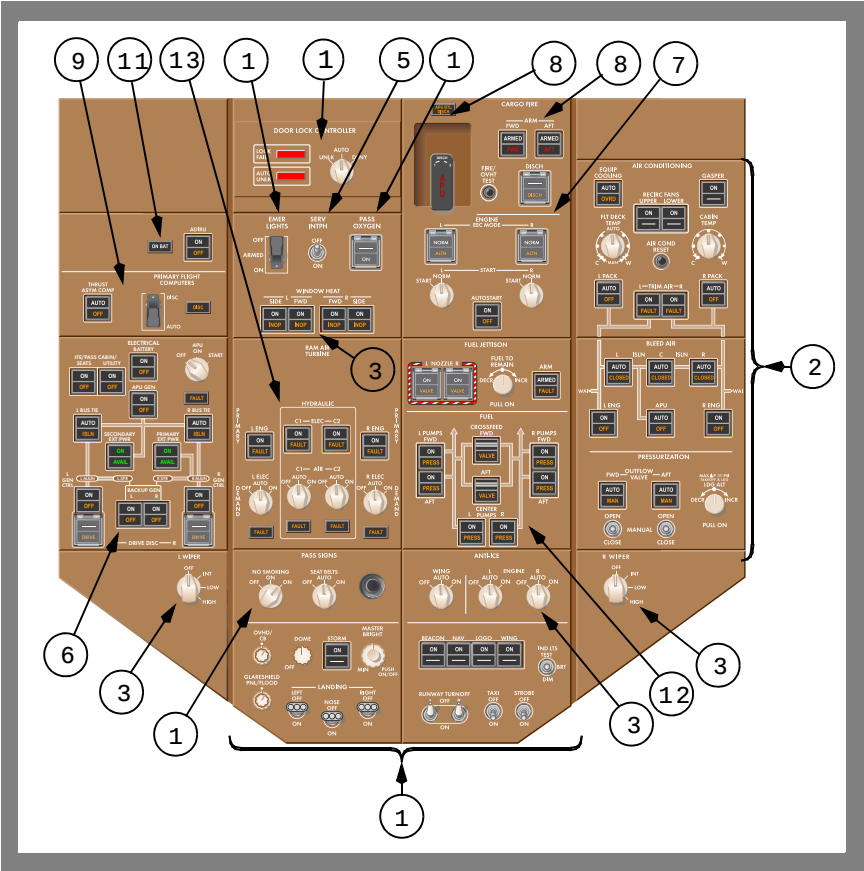
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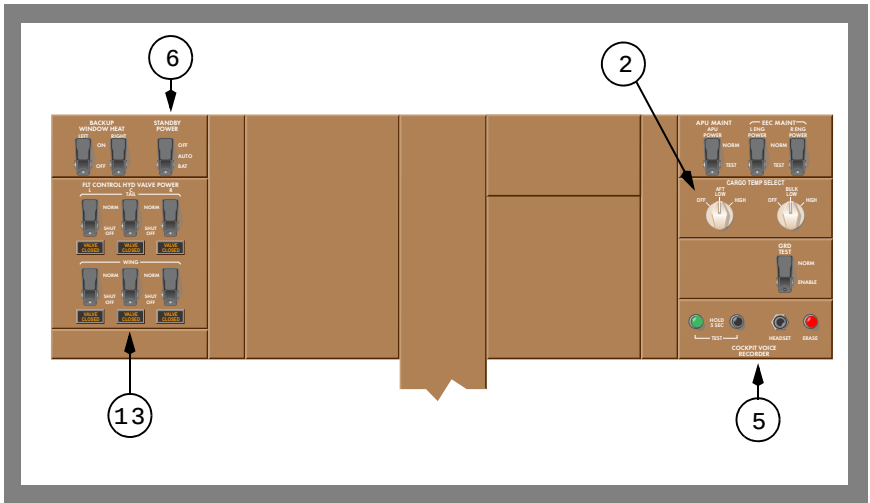
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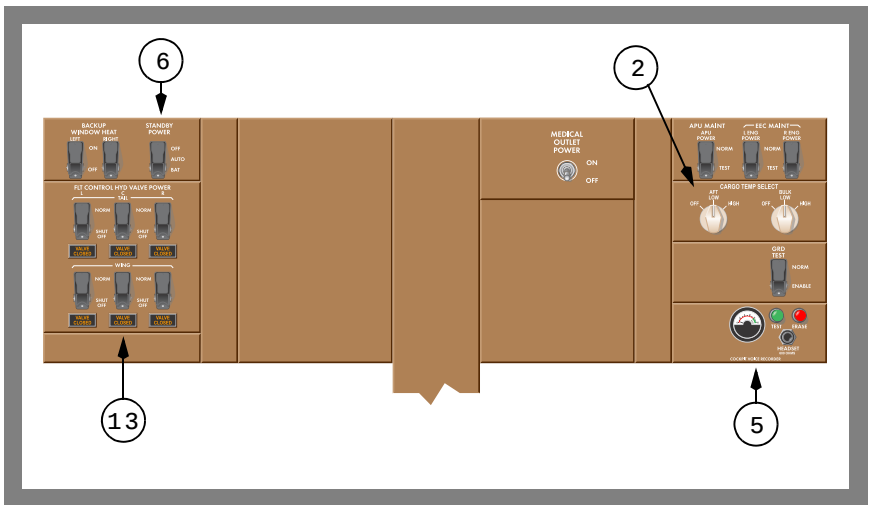
Overhead Maintenance Panel

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Overhead Maintenance Panel

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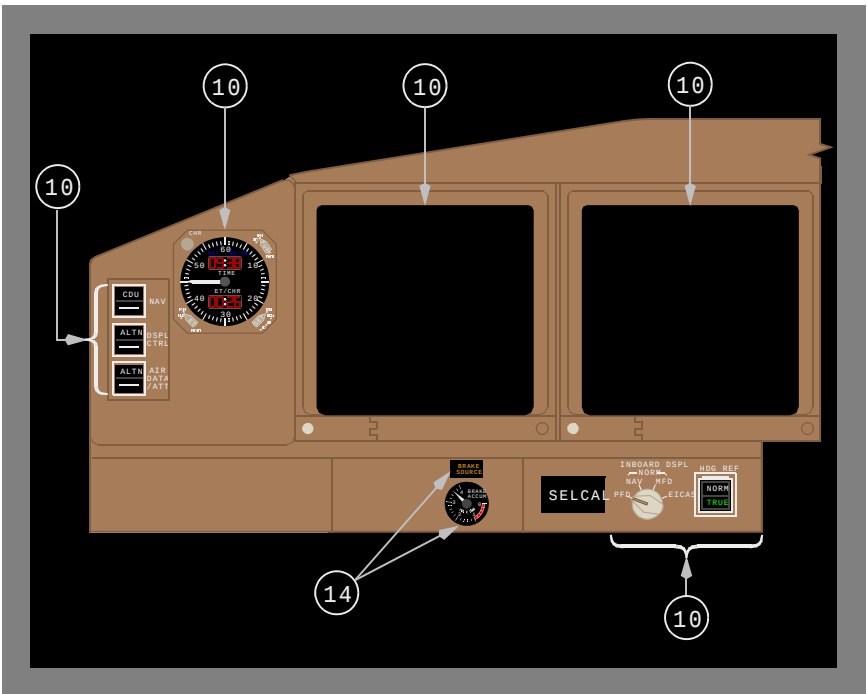
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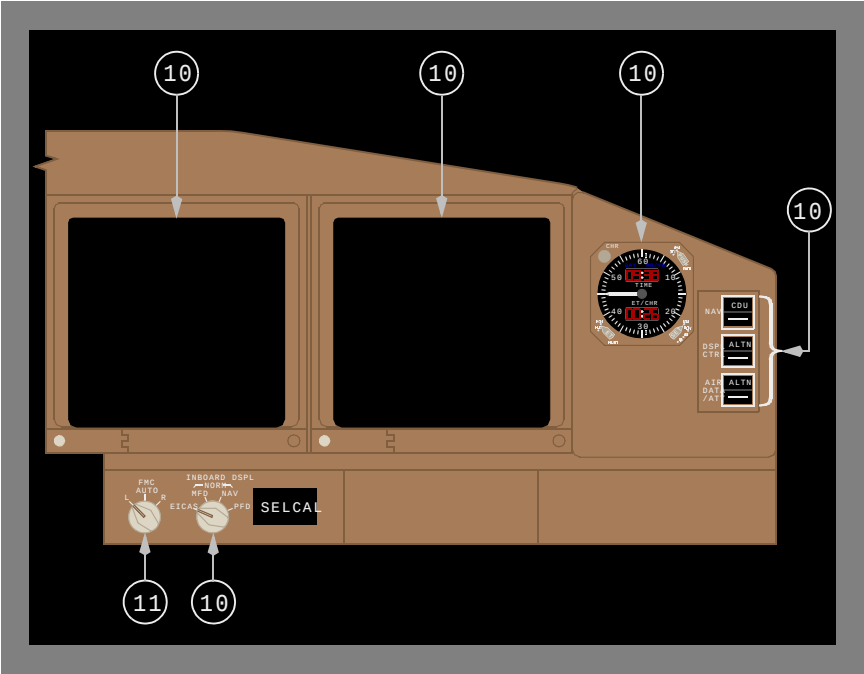
Introduction

Throughout this section, circled numbers refer to chapters where information on the item may be found.

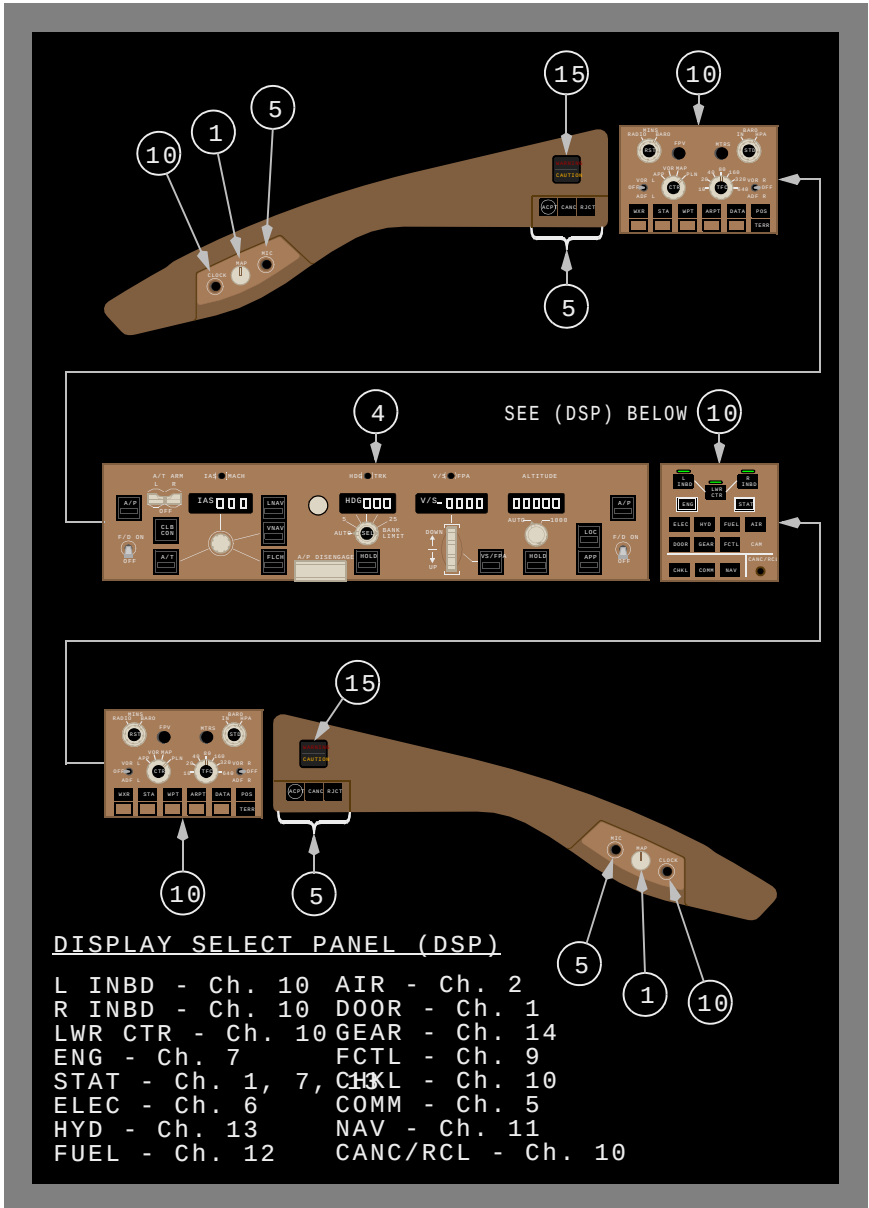
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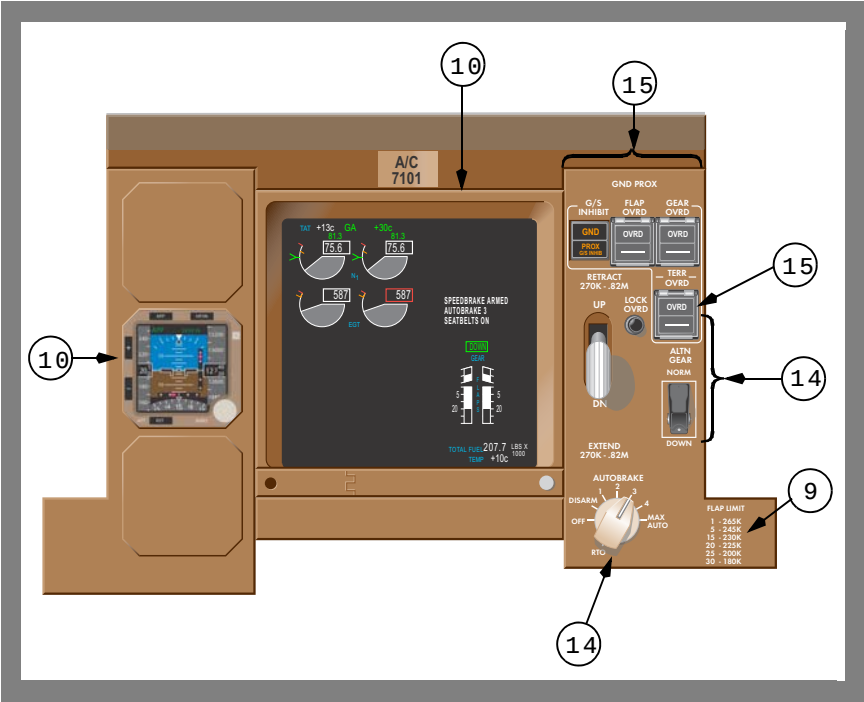
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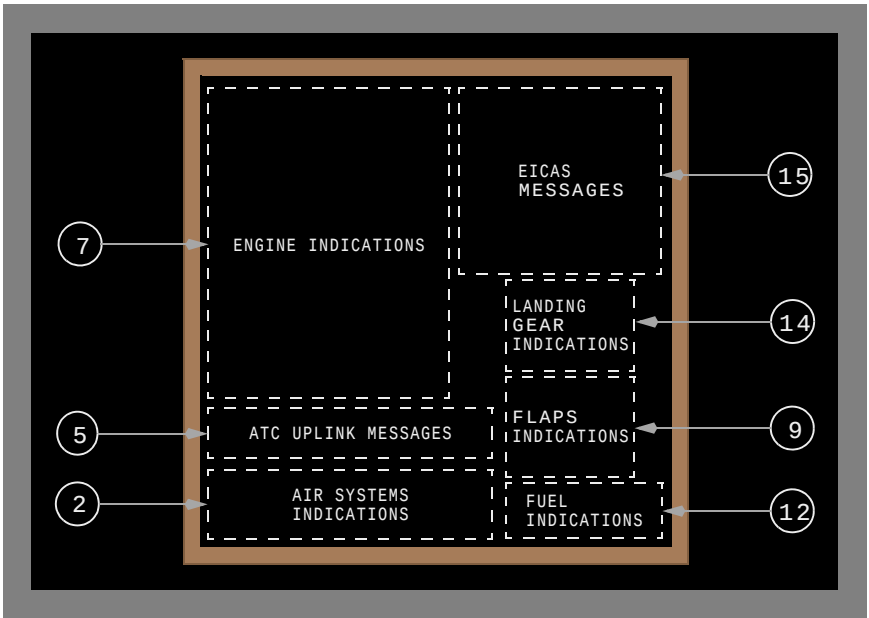
Glareshield Panel



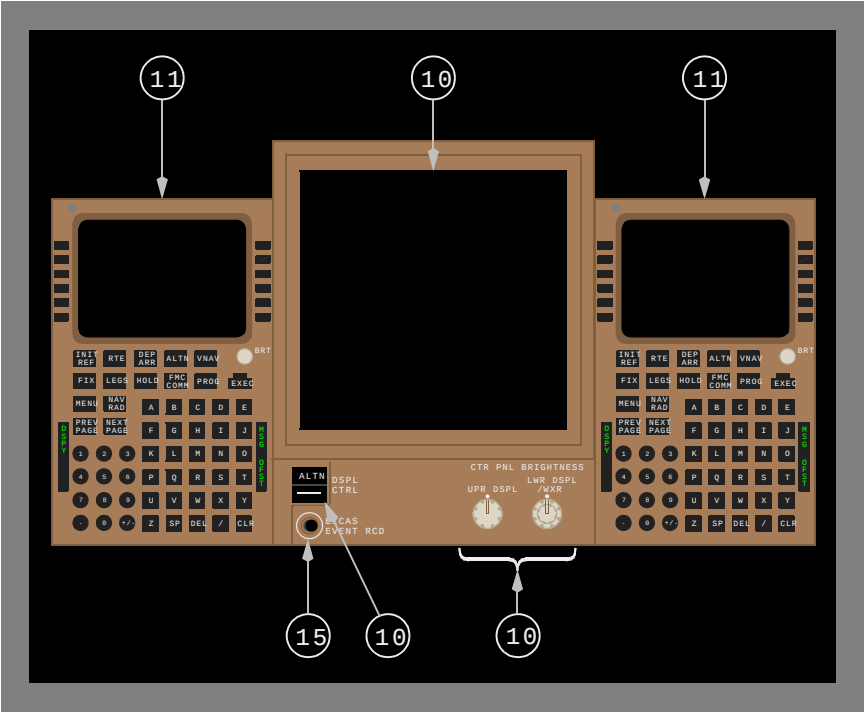
Center Forward Panel



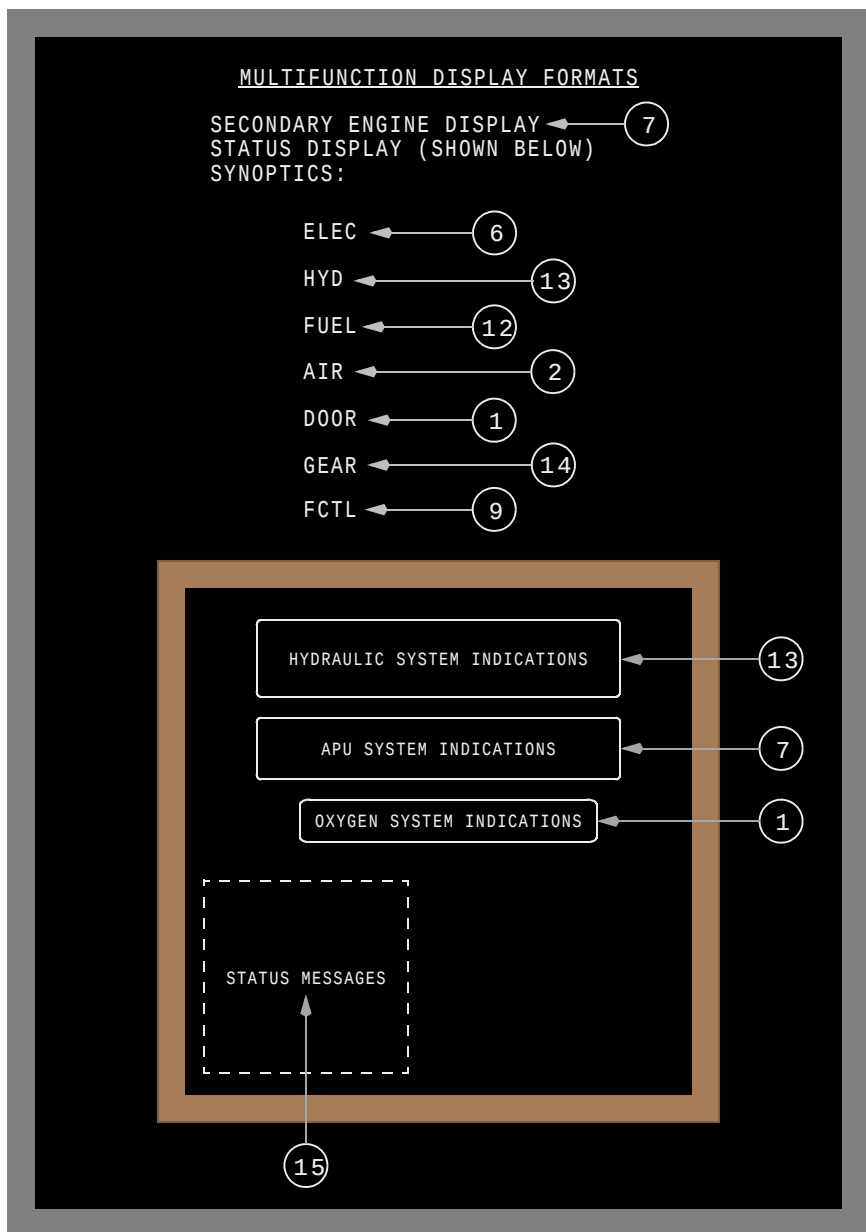
EICAS Display



Forward Aisle Stand



Multifunction Display



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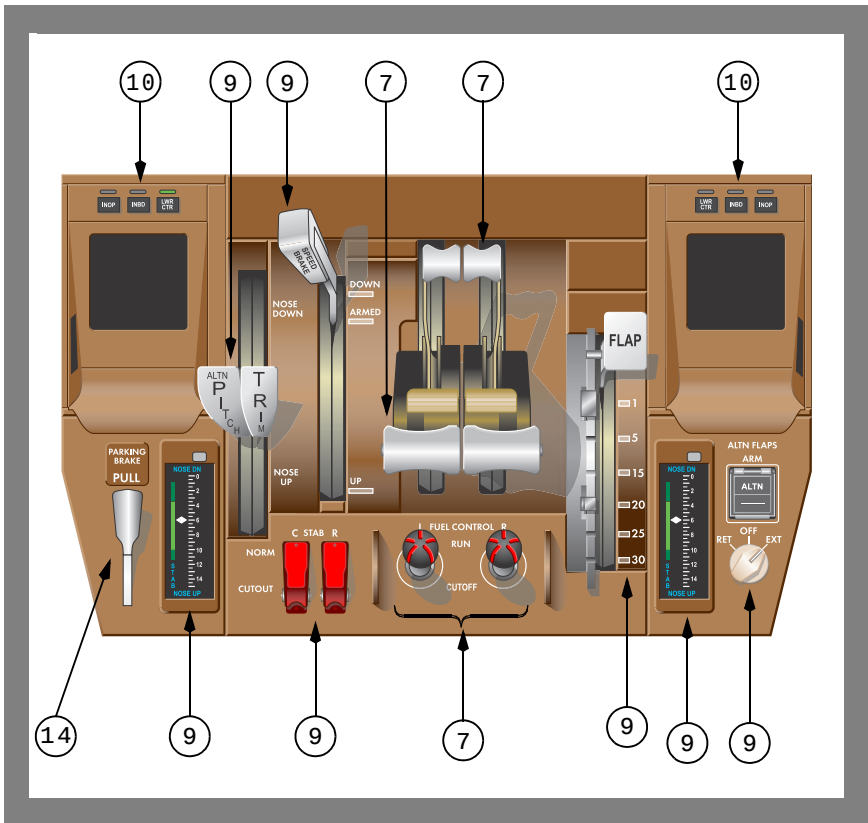
Airplane General, Emergency Equipment, Doors, Windows Inst. Panels, Aft and Side

Chapter 1 Section 23

Introduction

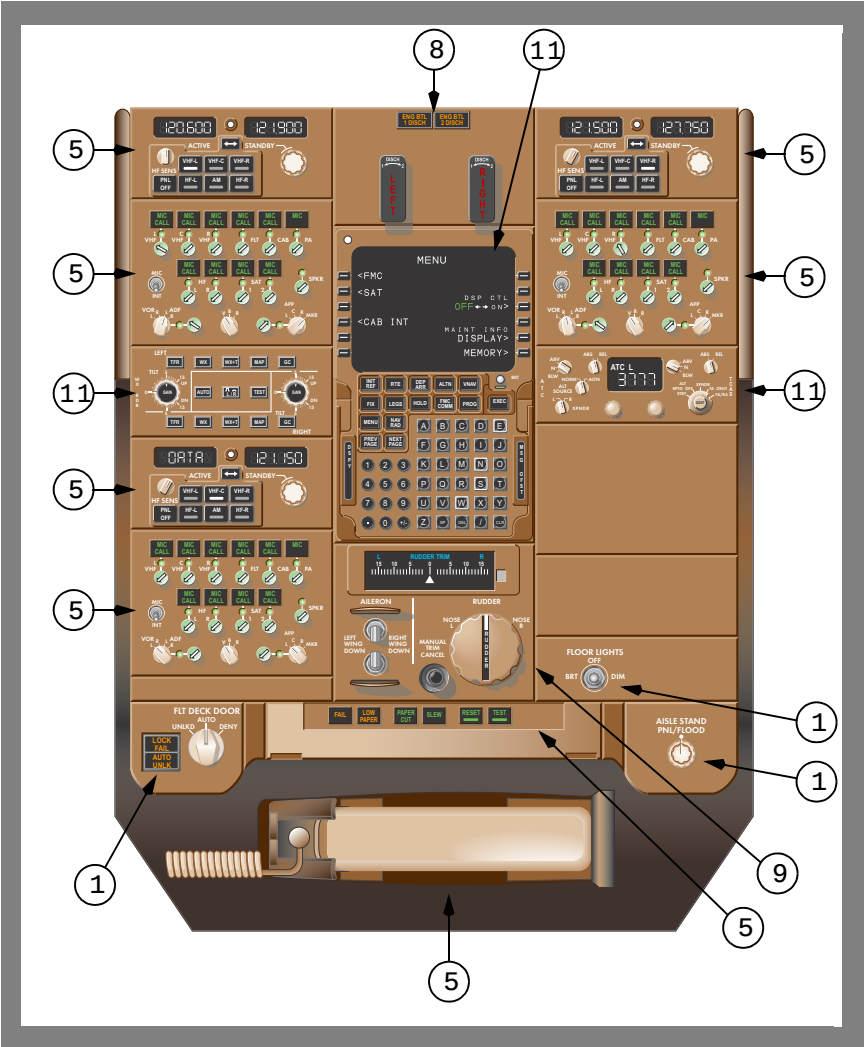
Throughout this section, circled numbers refer to chapters where information on the item may be found.

Control Stand

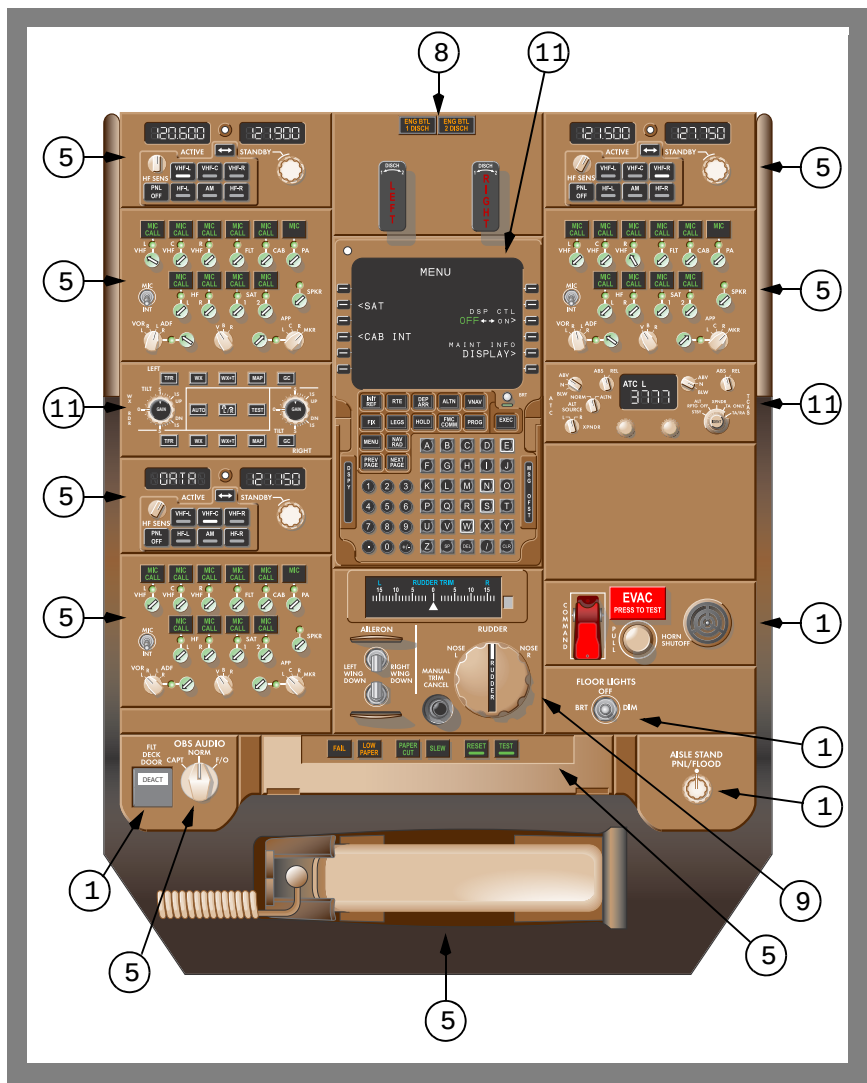


Aft Aisle Stand

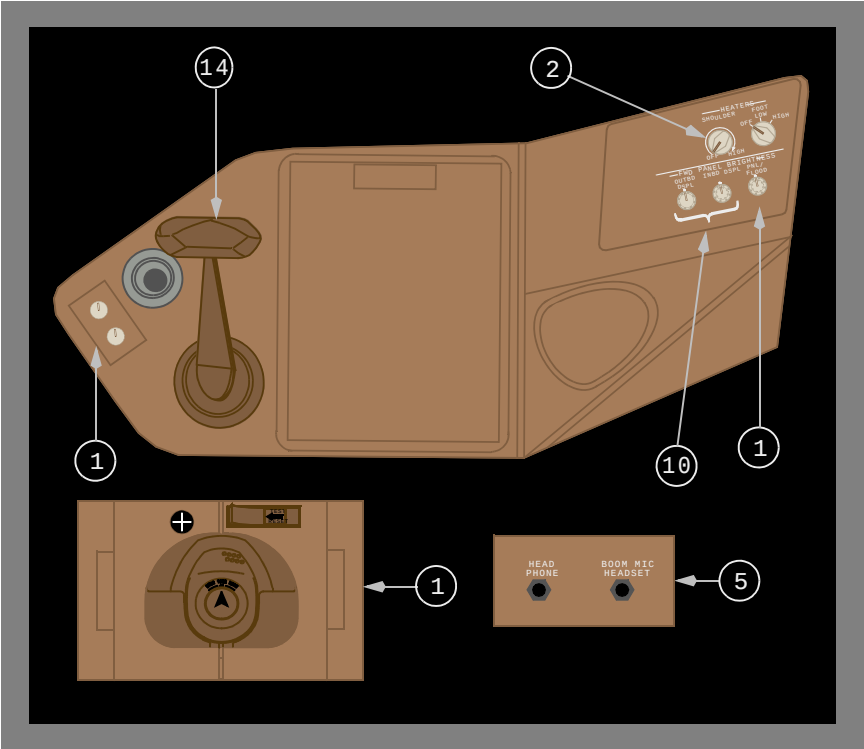
7101 - 7110



7001 – 7008

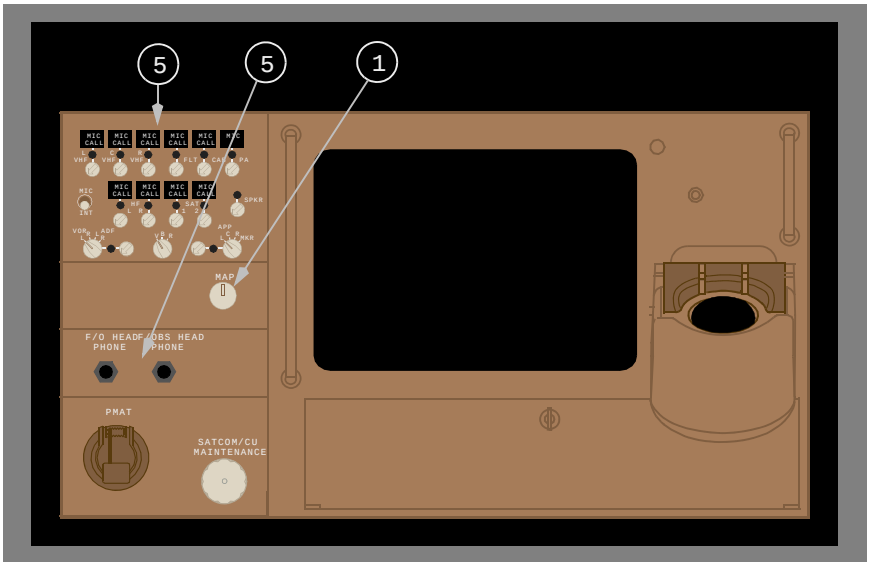


Left and Right Sidewalls



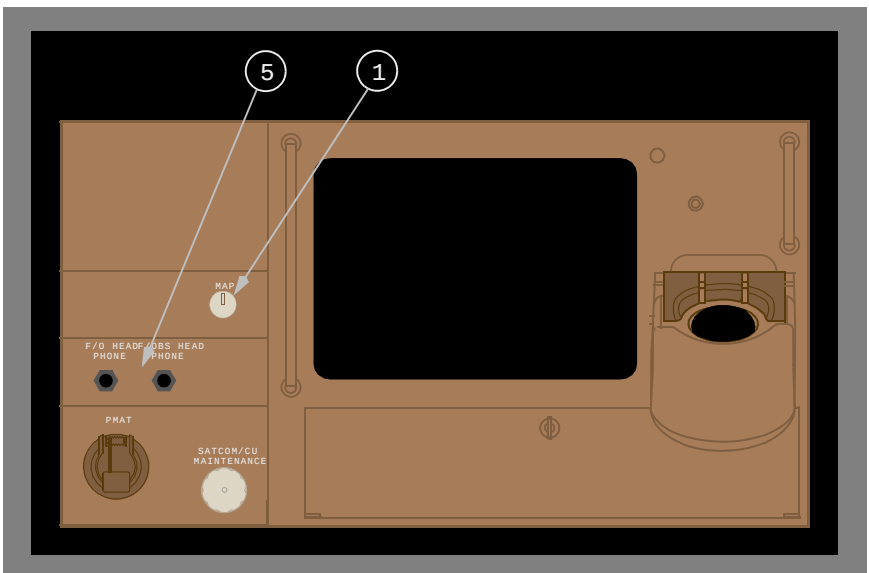
Maintenance Access Terminal Panel

7101 - 7110

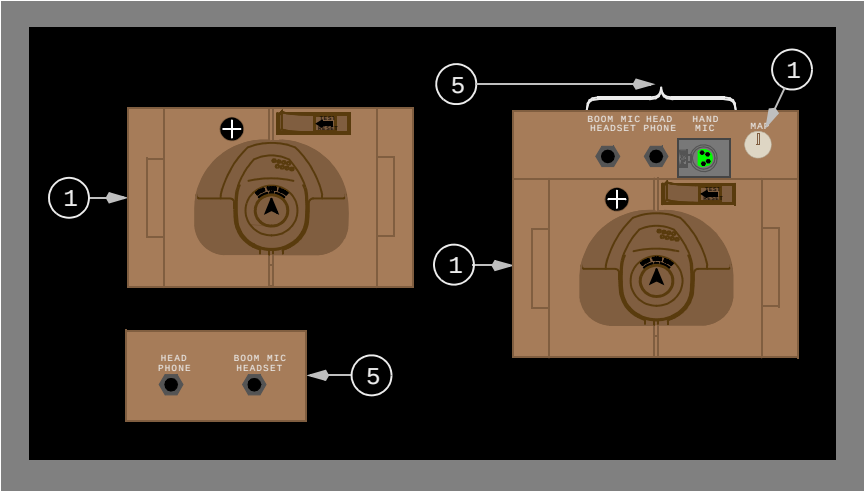


Maintenance Access Terminal Panel

7001 - 7008



First and Second Observer Panels



Airplane General, Emergency Equipment, Doors, Windows Controls and Indicators

Chapter 1

Section 30

Push–Button Switches

The airplane has two types of push–button switches: alternate action and momentary action. Both types direct crew attention to system status and faults.

Note: Maintenance personnel should change switch lights. Changing the light requires changing the entire switch cap.

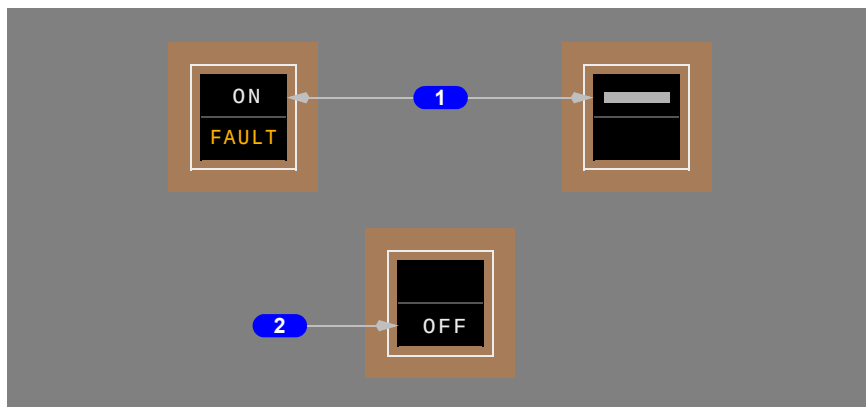
Alternate Action Switches

Alternate action switches have two positions: on and off.

When pushed in and flush with the panel, the switch is on. When the switch is on, a mechanical shutter on the top half of the switch opens to show an illuminated legend, such as "ON", "AUTO", or a flow bar.

When pushed out and extended, the switch is off. When the switch is off, the mechanical shutter closes so the legend is not shown.

Additionally, the bottom half of many switches has a light to indicate system state, such as "PRESS", "FAIL", "INOP", OR "OFF".



1 Switch is ON

ON, AUTO, or flow bar visible.

For some switches, system status (FAULT, MAN, OFF, VALVE) may be shown in the lower half of the switch.

2 Switch is OFF

OFF or a line is visible –

- the top of the switch is blank
- a line indicates no label in this portion of the switch.

Momentary Action Switches

Momentary action switches are spring loaded to the extended position. They are used to activate or deactivate systems or to reset system logic. The switch display indicates system status.



1 Push to Reset

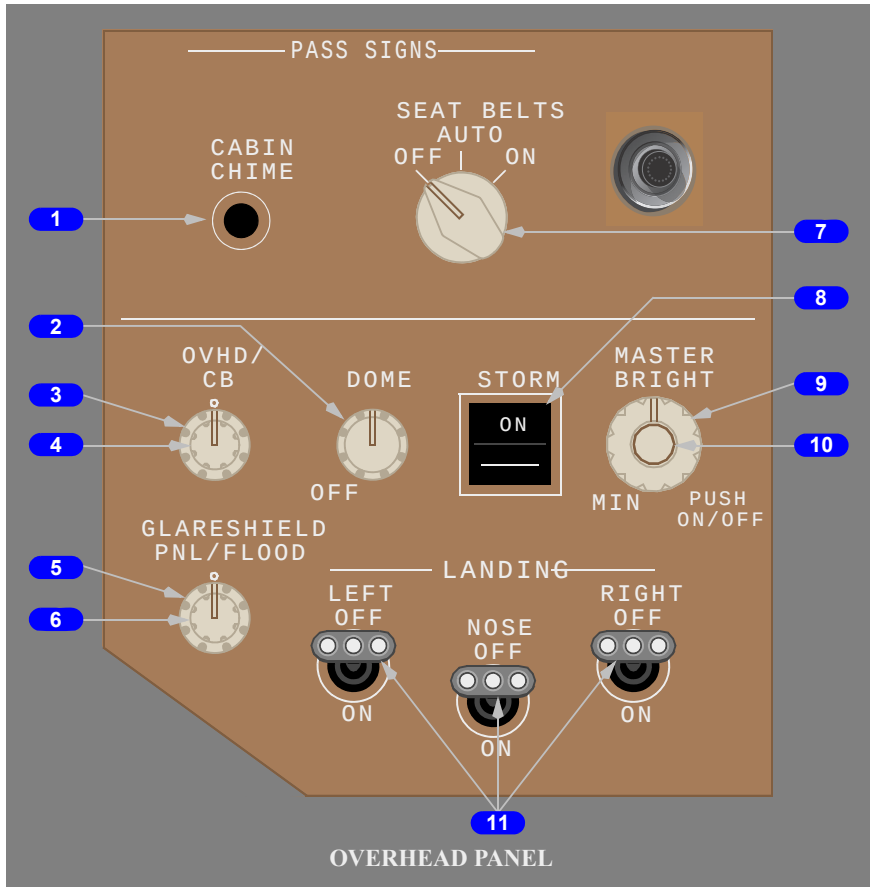
Push – the switch resets the master lights and aural alerts.

2 System Operation

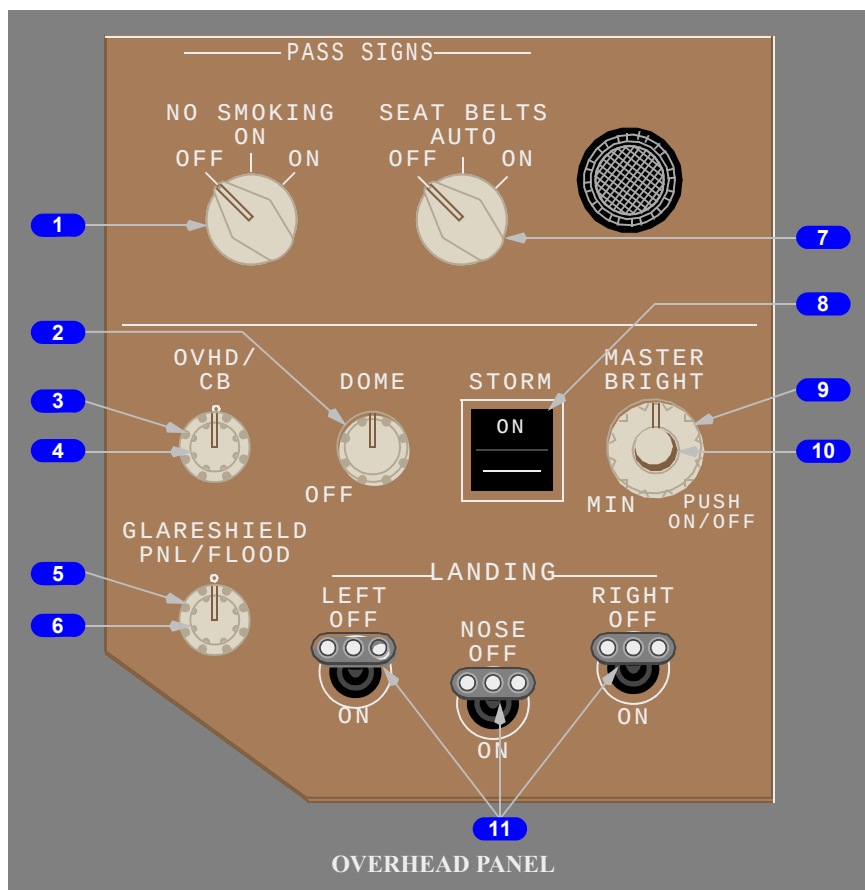
Push – activates or deactivates the system.

Passenger Signs and Lighting

7101 - 7110



7001 – 7008



1 CABIN CHIME Switch

7101 - 7110

Momentary push – Activates the cabin chime with each push.

1 NO SMOKING Selector

7001 – 7008

OFF – the NO SMOKING signs are not illuminated.

ON – the NO SMOKING signs are illuminated.

Note: When cycled between ON and OFF, the cabin chime is activated with each selection.

Note: Any time passenger oxygen is deployed, the NO SMOKING and FASTEN SEAT BELTS signs illuminate automatically, regardless of the selector position.

2 DOME Light Control

Controls overhead dome light brightness.

3 Overhead (OVHD) Panel Light Control (outer)

Rotate – controls overhead panel light brightness.

4 Circuit Breaker (CB) Panel Light Control (inner)

Rotate – controls circuit breaker panel light brightness.

5 GLARESHIELD Panel (PNL) Light Control (outer)

Rotate – controls glareshield panel light and standby compass brightness.

6 GLARESHIELD FLOOD Light Control (inner)

Rotate – controls glareshield flood light brightness.

7 SEAT BELTS Selector

OFF – the FASTEN SEAT BELTS and RETURN TO SEAT signs are not illuminated.

AUTO – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated or extinguished automatically with reference to airplane altitude and system configuration (refer to the Lighting System Description section).

ON – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated.

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Note: Any time passenger oxygen is deployed, the FASTEN SEAT BELTS signs illuminate automatically, regardless of the selector position. The NO SMOKING signs are illuminated full time.

7001 - 7008

Note: Any time passenger oxygen is deployed, the NO SMOKING and FASTEN SEAT BELTS signs illuminate automatically, regardless of the selector position.

8 STORM Light Switch

ON – overrides normal controls and illuminates the following lights at maximum brightness:

- all illuminated indicator lights
- glareshield flood lights
- instrument panel flood lights
- aisle stand flood lights
- dome lights.

9 MASTER BRIGHTNESS Control (outer)

Rotate (when the MASTER BRIGHTNESS switch is pushed on) –:

- controls the brightness of all panel lights and displays (dome lights, flood lights, and circuit breaker panel lights are not controlled by this switch)
- overrides individual brightness control settings
- limits adjustment range of individual brightness controls
- has full adjustment range of all lights when all individual brightness controls are set to the center detent.

10 MASTER BRIGHTNESS Switch

A black ring on the side of the inner switch is visible when the switch is out (OFF).

PUSH ON (in) – the MASTER BRIGHTNESS control is on.

PUSH OFF (out) – the MASTER BRIGHTNESS control is off.

Note: If display brightness cannot be set as desired when master brightness is on, pushing the MASTER BRIGHTNESS switch off may allow setting display brightness to an appropriate level using individual brightness controls.

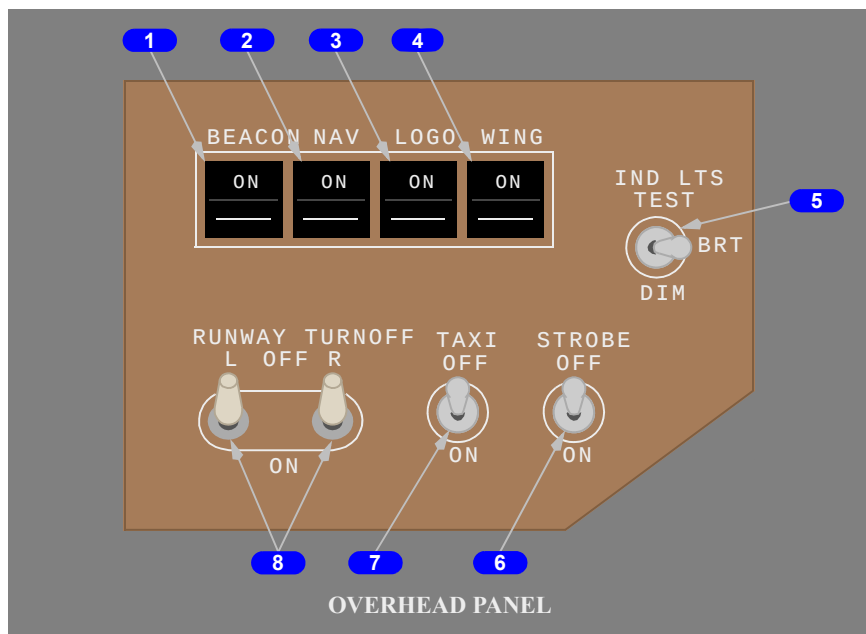
11 LANDING Light Switches

OFF – the landing light is not illuminated.

ON – the landing light is illuminated.

Note: The nose gear landing lights cannot illuminate when the nose landing gear is not down and locked.

Lighting Panel



1 BEACON Light Switch

ON – the red anticollision beacon lights on the top and bottom of the fuselage operate.

2 Navigation (NAV) Light Switch

ON – the red, green, and white navigation position lights are illuminated.

3 LOGO Light Switch

ON – the stabilizer-mounted logo lights illuminate the airline logo on the vertical tail surface.

4 WING Light Switch

ON – the wing leading edge illumination lights are illuminated.

5 Indicator Lights (IND LTS) Switch

TEST (spring-loaded):

- illuminates all annunciator lights to full brightness for 10 seconds to check the bulbs, then dims the lights as long as the switch is held
- causes test patterns to display on the stabilizer position indicators, rudder trim indicator, and radio tuning panel displays.

BRT – sets all illuminated annunciator lights to full brightness.

DIM – sets all illuminated annunciator lights to low brightness.

6 STROBE Light Switch

OFF – the white anticollision strobe lights on the tips of each wing and the tail cone are off.

ON – the strobe lights operate.

7 TAXI Light Switch

OFF – the taxi lights are extinguished.

ON – the taxi lights are illuminated.

Note: The taxi lights do not illuminate when the nose landing gear is not down and locked

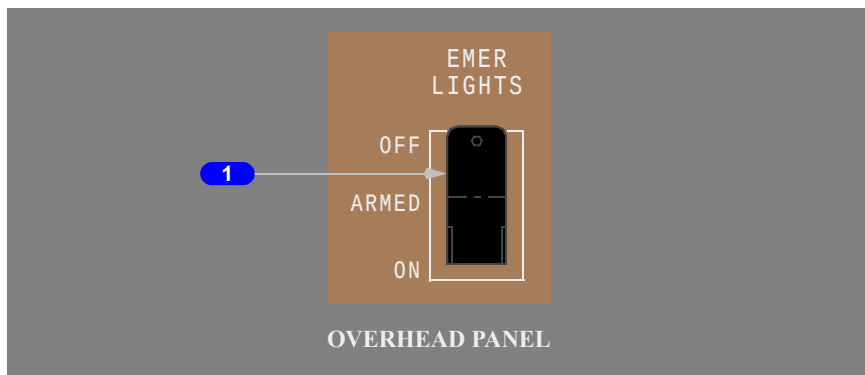
8 RUNWAY TURNOFF Light Switches

OFF – the runway turnoff light is extinguished.

ON – the runway turnoff light is illuminated.

Miscellaneous Lighting Controls

Flight Deck Emergency Lights Switch



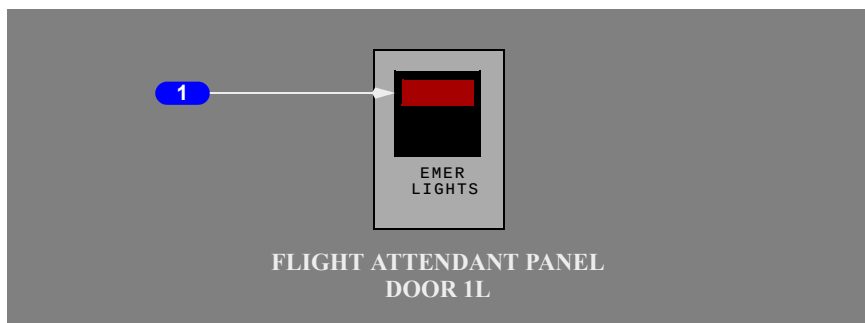
1 Emergency (EMER) LIGHTS Switch

OFF – prevents emergency lights system operation if airplane electrical power fails or is turned off.

ARMED – all emergency lights illuminate automatically if airplane electrical power fails or is turned off.

ON – all emergency lights illuminate.

Passenger Cabin Emergency Lights Switch



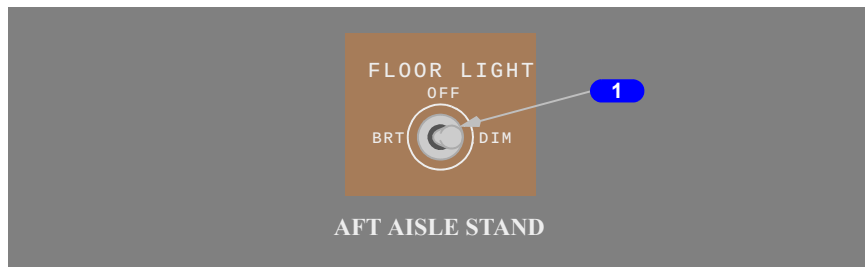
1 Passenger Cabin Emergency (EMER) LIGHTS Switch

Push –

- Illuminated (red):
 - all passenger cabin and exterior emergency lights illuminate

- bypasses the flight deck emergency lights switch
- Extinguished: all passenger cabin and exterior emergency lights extinguish.

Floor Lights Switch



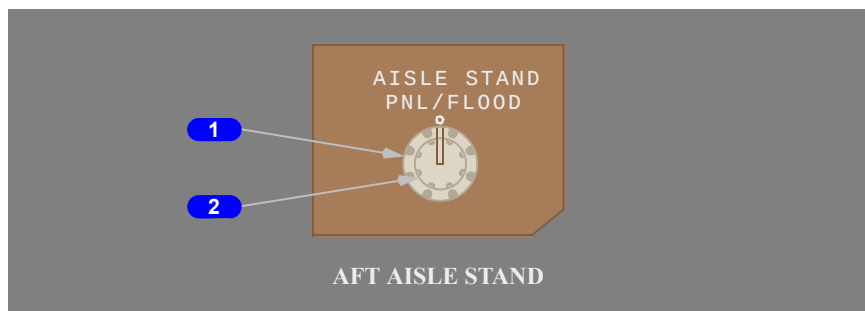
1 FLOOR LIGHTS Switch

OFF – the flight deck floor lights are not illuminated.

BRT – the floor lights are illuminated bright.

DIM – the floor lights are illuminated dim.

Aisle Stand Panel/Flood Light Control



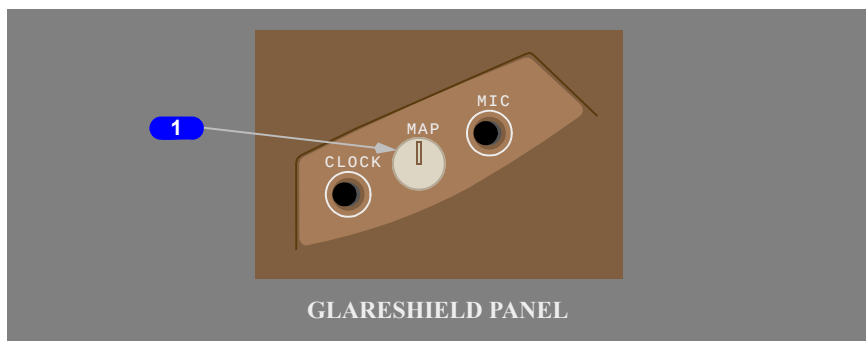
1 AISLE STAND Panel (PNL) Light Control (outer)

Rotate – controls the aisle stand instrument panel light brightness.

2 AISLE STAND FLOOD Light Control (inner)

Rotate – controls the aisle stand flood light brightness.

Map Light Control



1 MAP Light Control

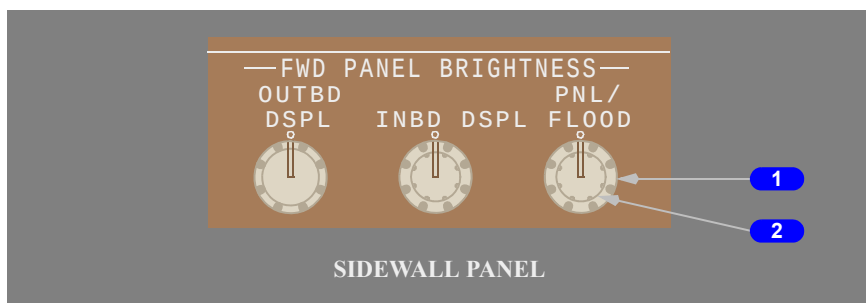
Pull – on.

Push – off.

Rotate – adjusts map light brightness.

Forward Panel Brightness Controls

Note: The display and weather radar brightness controls are described in Chapter 10, Flight Instruments, Displays.



1 FORWARD PANEL Light Control (outer)

Rotate – Controls forward panel lights brightness.

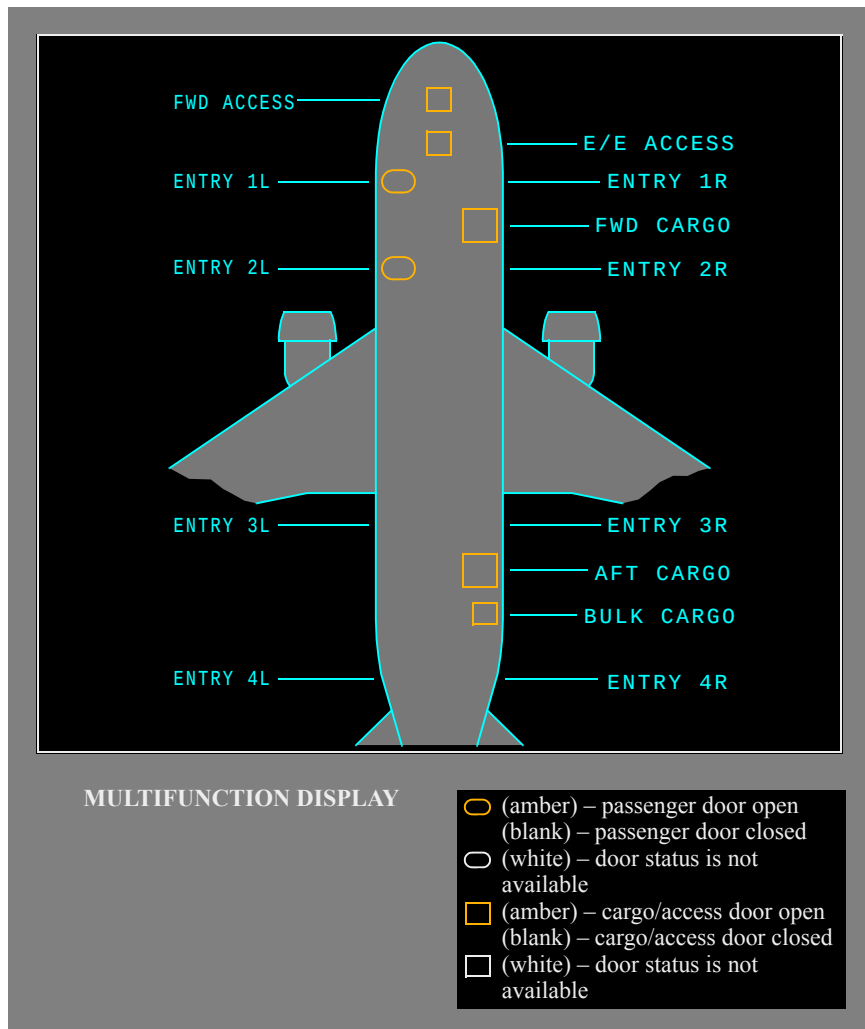
2 FORWARD PANEL FLOOD Light Control (inner)

Rotate – Controls forward panel flood light brightness.

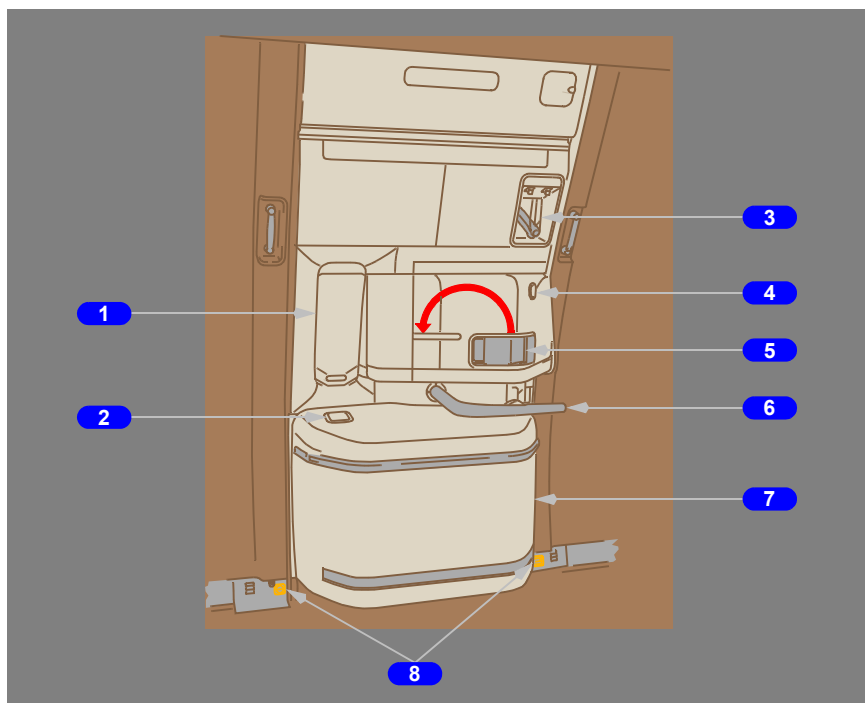
Doors and Windows

Door Synoptic Display

The doors synoptic is displayed by pushing the DOOR synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.



Passenger Entry Door



1 Viewing Window

Allows observation outside the airplane.

2 Slide/Raft Gas Bottle Pressure Gage

Maintenance use only.

3 Door Mode Select Panel

See door mode select panel.

4 Power Assist Reservoir Pressure Gage

If the gage needle is outside the green zone, the system is unusable.

5 Gust Lock Release Lever

Grab and pull inward to close the door.

6 Door Operating Handle

To open the door – rotate in the direction of the arrow.

To close the door – rotate in the opposite direction of the arrow.

7 Slide/Raft

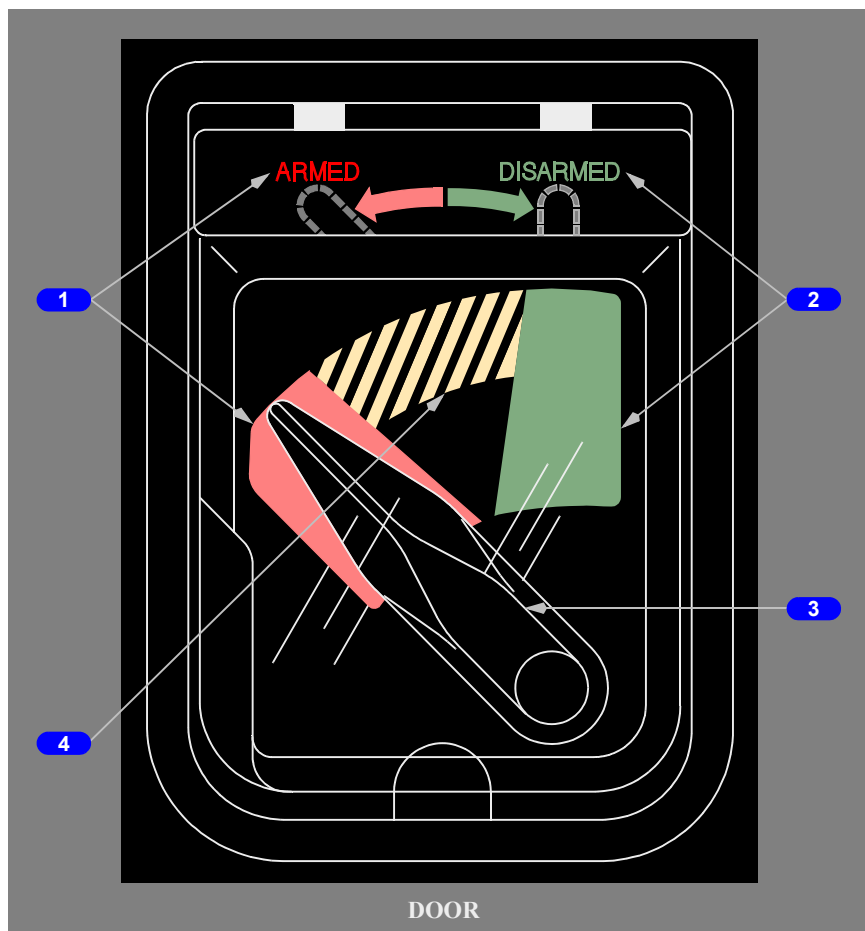
The bustle contains the slide/raft.

8 Girt Bar Indicator Flag Viewing Windows

Yellow in view – door and slide/raft are armed.

Black in view – door and slide/raft are not armed.

Door Mode Select Panel



1 ARMED

Red.

Door is armed if the mode select lever is in the middle of the red band.

When the door operating handle is moved to the OPEN position:

- the door is powered open
- the slide/raft deploys.

Note: If the door is opened from the outside, the mode select lever automatically moves to the DISARMED position.

2 DISARMED

Green.

Door is disarmed if the mode select lever is in the middle of the green band.

Moving the door operating handle to the OPEN position disables:

- power assist for door opening
- automatic slide/raft deployment.

3 Door Mode Select Lever

Used to select the required mode for flight, ARMED, or arrival, DISARMED.

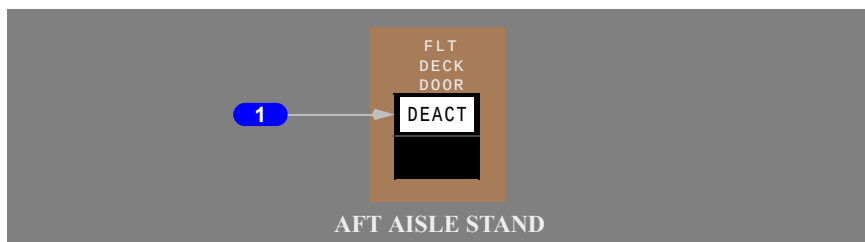
4 Unsafe Band

If the mode select lever is anywhere in the unsafe band, the door may be either armed or disarmed.

CAUTION: To ensure that the door is properly armed or disarmed, the door mode selector must be positioned in the middle of the red or green band.

Flight Deck Door Switch

7001 – 7008

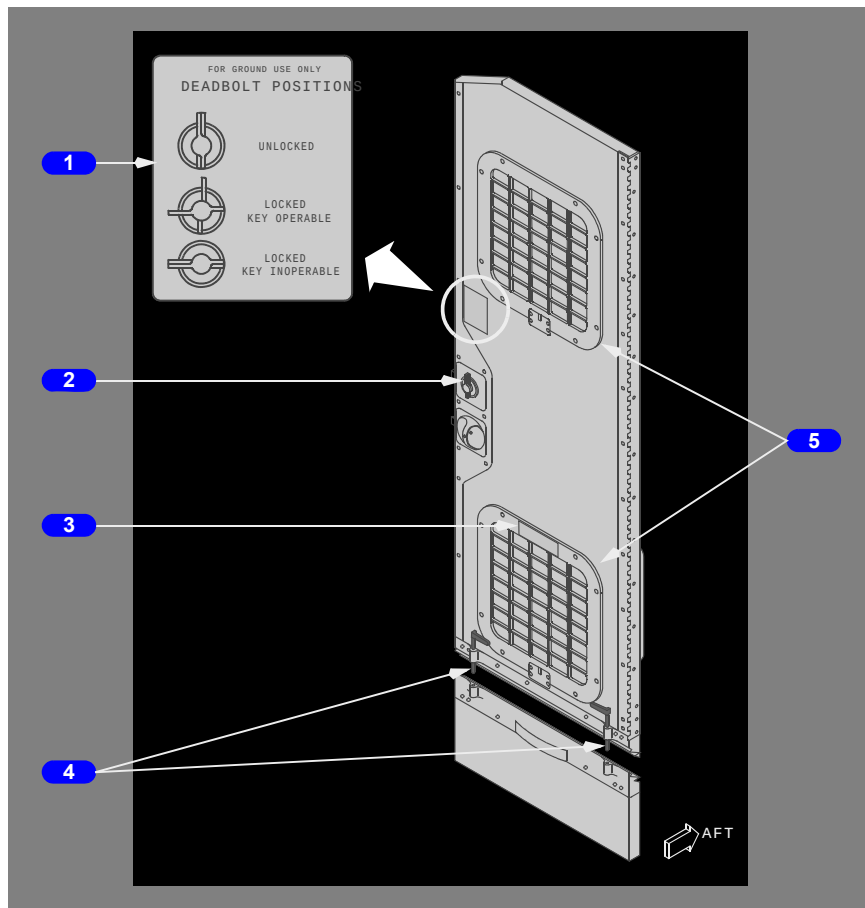


1 Flight Deck Door Switch

Deactivated.

Flight Deck Door

7101 - 7110 [AFM]



1 Deadbolt Positions Placard

2 Deadbolt Levers

3 Emergency Egress Placard

Describes how to separate lower break-away panel from a jammed door to allow door opening and egress

4 Shear Pins

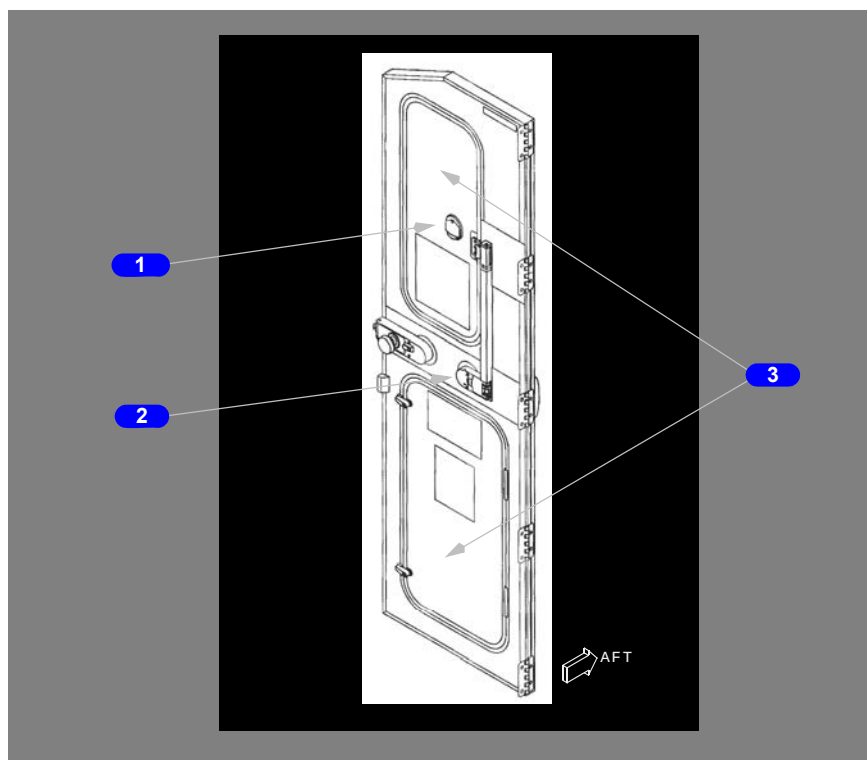
Retract out of lower break-away panel when shear pin levers rotate down.

5 Security Grill

Prevents intrusion into flight deck if decompression panels open due to cabin depressurization.

Flight Deck Door

7001 – 7008 [AFM]



1 Peephole

2 Emergency Escape (placard on the door)

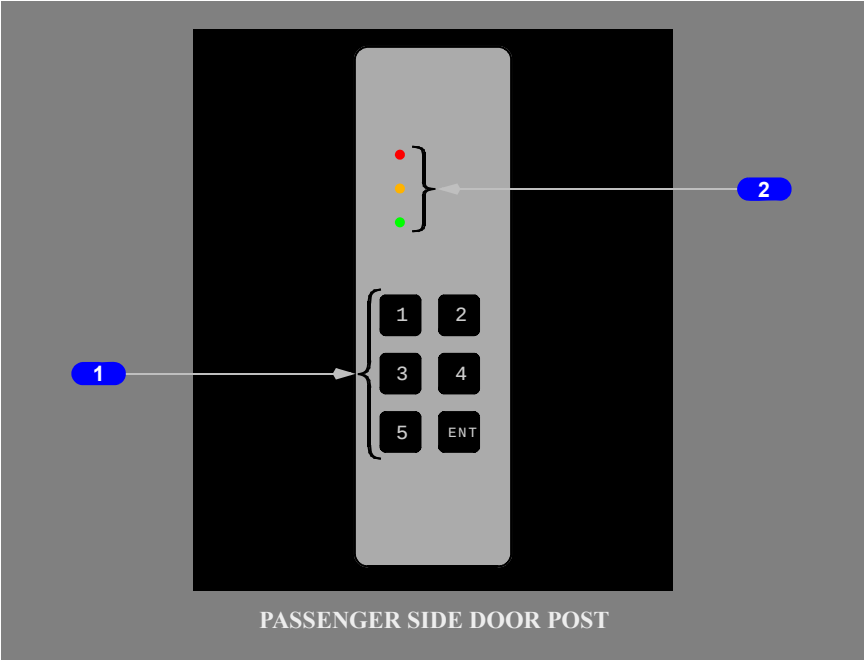
- Open cover and push button on right side of door
- Release lanyard from door
- Push hatch into the cabin

3 Decompression Panels

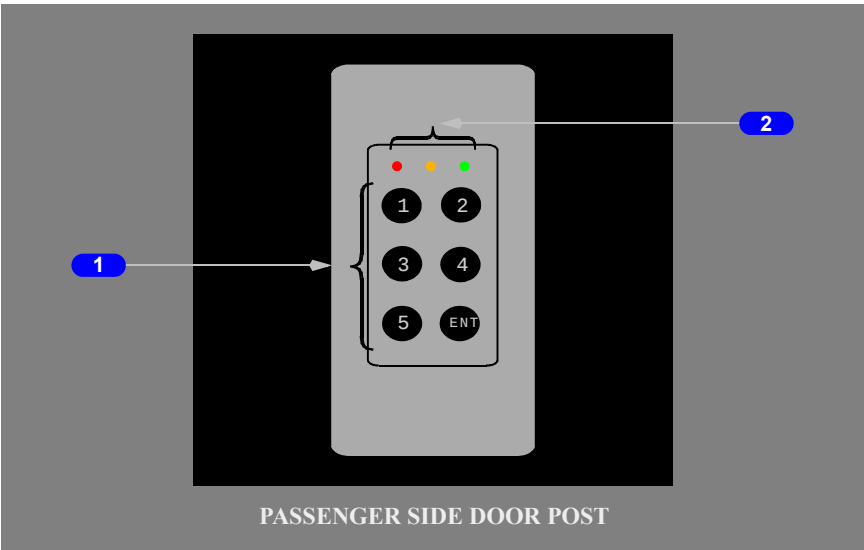
Automatically open during cabin depressurization and provide emergency egress path.

Flight Deck Emergency Access Panel

7101 - 7110 [AFM]



7001 – 7008



1 Keypad

Push - enters 3 to 8 digit emergency access code by pressing numeric then "ENT" keys. Entry of correct emergency access code sounds flight deck chime.

2 Access Lights

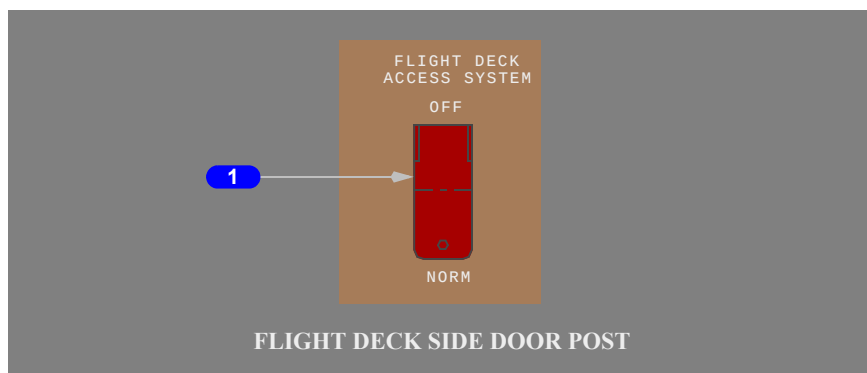
Illuminated (red) - door locked or Flight Deck Access System switch OFF.

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlock switch is activated.

Flight Deck Access System Switch

7101 - 7110



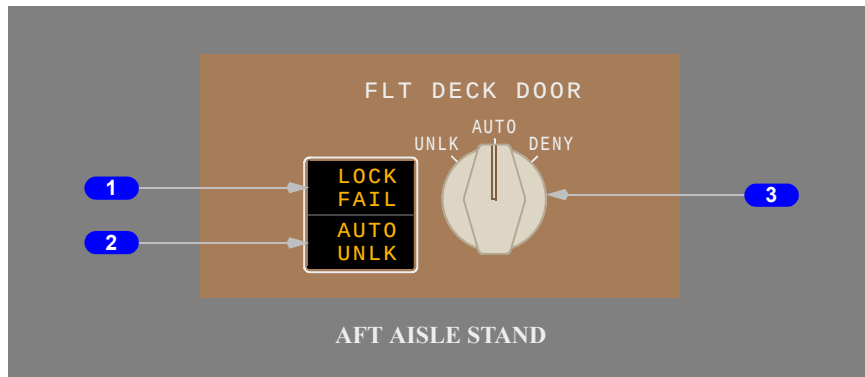
1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

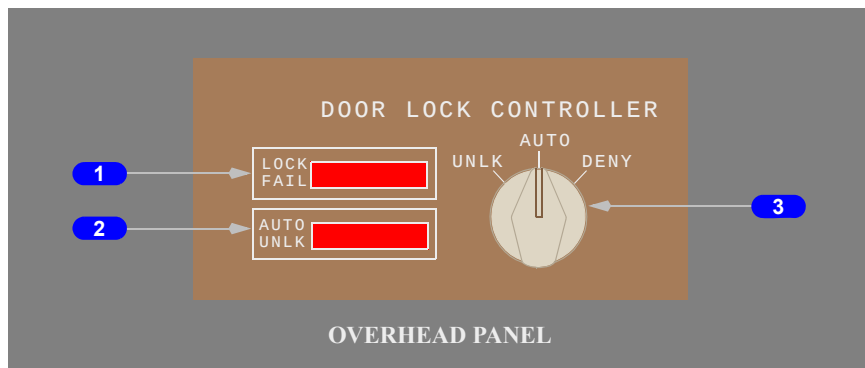
NORM (Normal) - flight deck access system configured for flight.

Flight Deck Door Lock Panel

7101 - 7110



7001 – 7008



1 LOCK FAIL Light

Illuminated (amber) - Flight Deck Door Lock selector in AUTO and door lock has failed or Flight Deck Access System switch in OFF.

2 AUTO Unlock (UNLK) Light

Illuminated (amber) - correct emergency access code entered in keypad. AUTO UNLK light flashes and continuous chime sounds before timer expires and door unlocks.

3 Flight (FLT) Deck Door Lock Selector

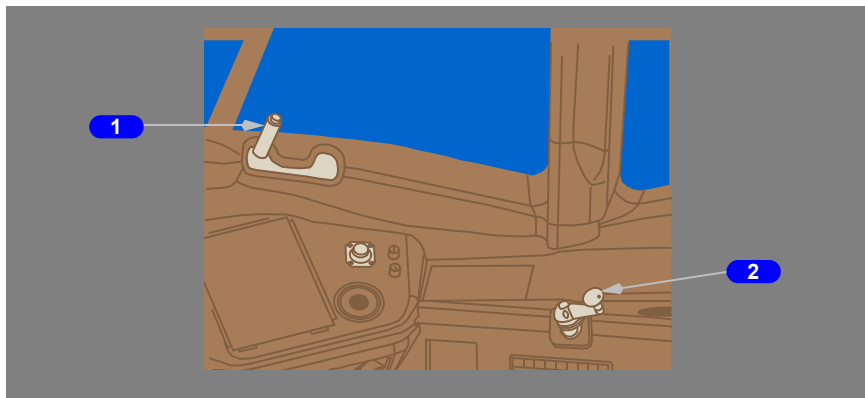
Spring loaded to AUTO. Selector must be pushed in to rotate from AUTO to UNLK. Selector must not be pushed in to rotate from AUTO to DENY.

UNLK - door unlocked while selector in UNLK.

AUTO - door locked. Allows door to unlock after entry of emergency access code and expiration of timer, unless crew takes action.

DENY - rejects keypad entry request and prevents further emergency access code entry for a time period.

Flight Deck Number Two Window



1 Window Lock Lever

Forward – with the window fully closed, locks the window. If the lock lever is properly locked, the orange indicator is not visible below the release button. The EICAS message WINDOW FLT DECK L, R displays if a window is not properly latched.

Aft – unlocks the window so it can be cranked open.

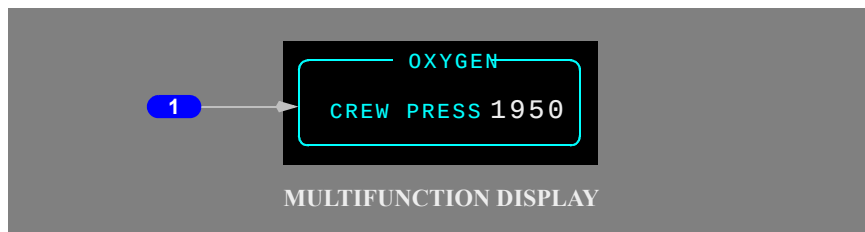
2 Window Crank

Used to position the window open or closed when the window lock lever is unlocked.

To reposition the window crank without moving the window, push and hold the button in the center of the window crank.

Oxygen Systems

Oxygen Indications

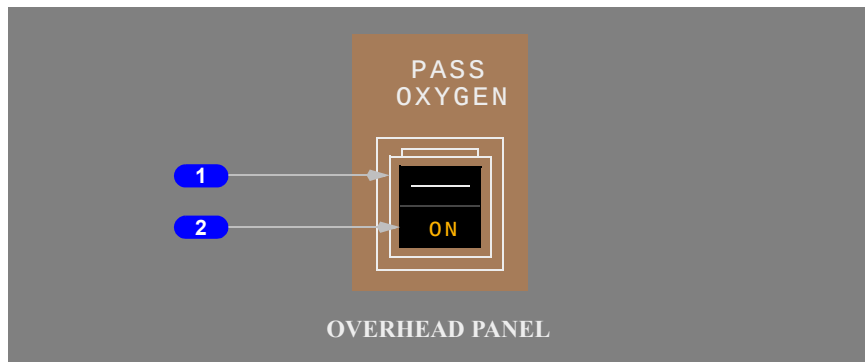


1 Oxygen Pressure Display

Displays crew oxygen cylinder pressure (PSI).

Note: Access is through the display select panel STATUS switch.

Passenger Oxygen Switch



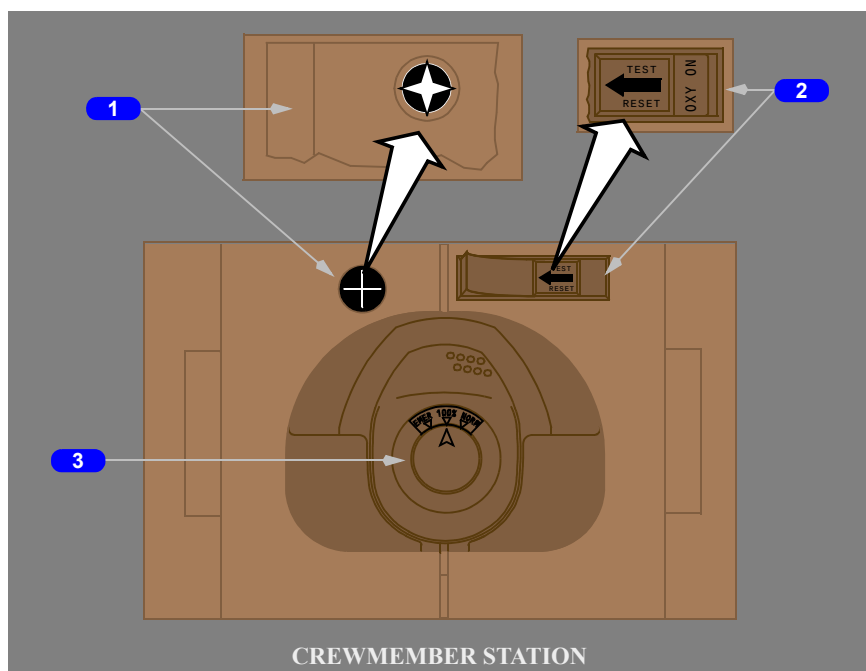
1 Passenger (PASS) OXYGEN Switch

Push – the passenger cabin oxygen masks drop.

2 Passenger Oxygen ON Light

Illuminated (amber) – The passenger oxygen system is operating and the masks have dropped.

Oxygen Mask Panel



1 Oxygen Flow Indicator

Shows a yellow cross when oxygen is flowing.

2 RESET/TEST Switch

Push –

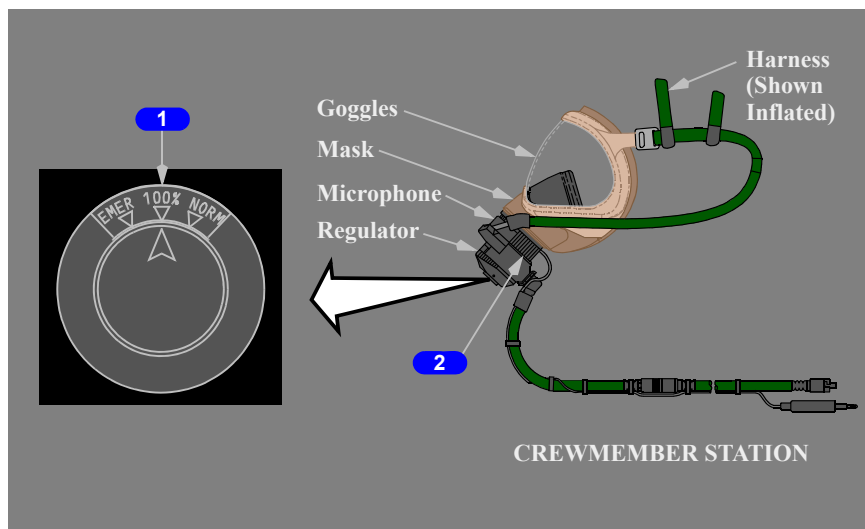
- if mask is stowed, activates oxygen flow momentarily to test regulator
- once activated by opening the right stowage box door, the mask microphone and regulator remain active until the right door is closed and the RESET/TEST switch is depressed

3 Regulator

Grasp Regulator and pull up –

- allows mask removal from stowage box
- activates oxygen and microphone when right stowage box door opens

Oxygen Mask and Regulator



1 Regulator Selector

Rotate –

- EMER - supplies 100% oxygen under positive pressure at all cabin altitudes
- 100% - supplies 100% oxygen on demand
- NORM - supplies air/oxygen mixture on demand (ratio depends on cabin altitude).

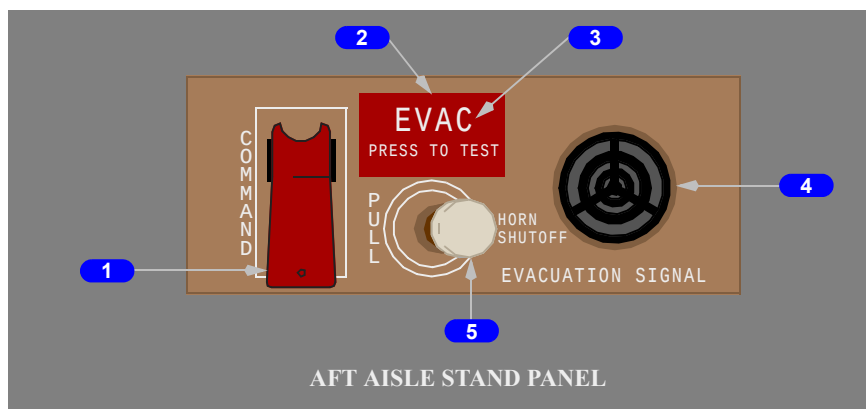
2 Harness Inflation Lever

Squeeze (with right stowage box door open) –

- inflates mask harness
- deflates mask harness when lever is released.

Emergency Evacuation Panel

7001 – 7008



1 Evacuation COMMAND Switch

ON –

- the red EVAC light (flight deck) and amber EVAC lights (flight attendant panels) flash
- an audio horn sounds at each panel.

OFF (guarded position) - the evacuation system is deactivated.

2 Evacuation (EVAC) PRESS TO TEST Switch

Push – tests the EVAC light.

3 Evacuation (EVAC) Light

Illuminated (red) – the command switch is in the ON position.

4 EVACUATION SIGNAL Horn

Sounds an audio signal.

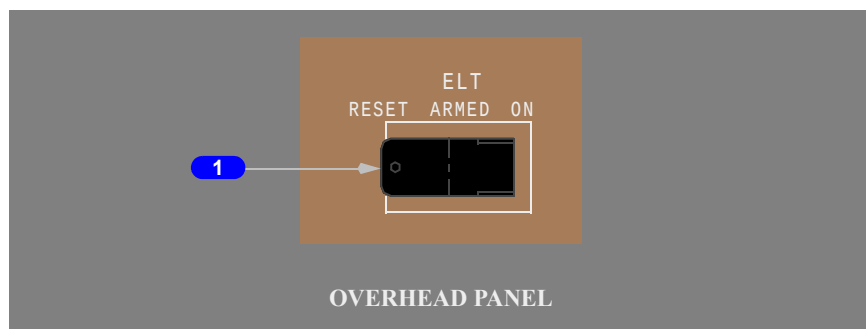
5 Evacuation HORN SHUTOFF Switch

PULL – Silences the flight deck evacuation signal horn.

This system is not currently used by the flight crew.

Fuselage Mounted Emergency Locator Transmitter

7101 - 7110



1 Emergency Locator Transmitter (ELT) Switch

RESET (spring-loaded) – ends transmission of emergency locator signal.

ARMED (guarded position) – transmits emergency locator signal if activated by high deceleration forces.

ON – transmits emergency locator signal.

Airplane General, Emergency Equipment, Doors, Windows Systems Description

Chapter 1

Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- emergency equipment
- doors and windows
- flight deck seats.

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- passenger cabin lighting
- emergency lighting.

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- taxi
- strobe
- beacon
- navigation (position)
- logo
- wing leading edge illumination
- escape slide emergency lights.

Landing Lights

The landing lights consist of the left, right, and nose gear landing lights. The left and right landing lights are located in the left and right wing root. These lights are optimized for flare and ground roll. The two nose gear–located landing lights are optimized for approach.

Runway Turnoff Lights

Runway turnoff lights are installed in the left and right wing roots. The lights illuminate the area in front of the main gear.

Taxi Lights

Taxi lights are installed on the non–steerable portion of the nose strut. They are inoperative when the nose landing gear is not down and locked.

Strobe Lights

The strobe lights are white anticollision strobe lights located on each forward wing tip and on the tail cone.

Beacon Lights

The beacon lights are red anticollision strobe lights located on the top and bottom of the fuselage.

Navigation Lights

The navigation lights are the standard red (left forward wingtip), green (right forward wingtip), and white (aft tip of both wings and tailcone) position lights.

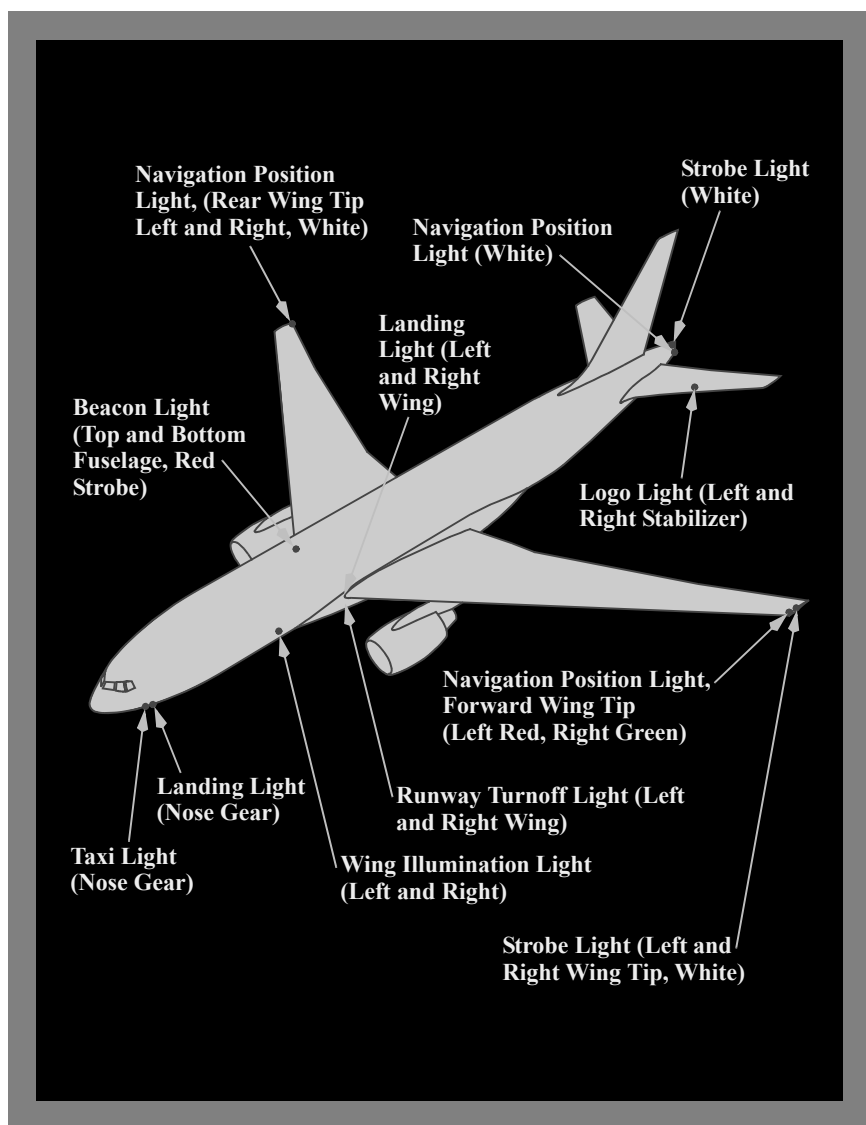
Logo Lights

Logo lights are located on the stabilizer to illuminate the airline logo on the vertical tail surface.

Wing Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

Exterior Lighting Locations



Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting and localized illumination. Flood lights and light plates provide panel illumination. Dome lights provide flight deck area lighting. Map lights and a single utility light provide localized illumination.

Panel and flood lights illuminate the forward panels, glareshield and aisle stand panels. When the storm light switch is on, the left and right forward panel flood lights, glare shield flood lights, dome lights, aisle stand flood light, and all illuminated annunciator lights illuminate at full brightness.

If normal electrical power is lost, standby electrical power is automatically provided to the primary displays. The aisle stand, left and right forward panel and glareshield flood lights, and the dome lights illuminate automatically at a fixed brightness.

Master Brightness Control System

The MASTER BRIGHTNESS control provides the means of controlling panel and display lighting brightness with the use of one control. Maximum and minimum brightness levels are adjusted as ambient lighting changes. The control is turned on when the MASTER BRIGHTNESS switch is pushed on.

Lighting controlled through the master brightness system are:

- PFDs
- MFDs
- EICAS
- CDUs
- clocks
- Integrated Standby Flight Display (IFSD)
- standby compass
- digital displays
- overhead panel
- glareshield panel
- forward panels (left, center, and right)
- aisle stand panels (forward and aft)

The individual lighting controls for the above displays and panels, except the CDUs, have a center detent position identified by a white dot at the mid-range adjustment position.

Individual controls can be used for dimming individual displays and panels. The individual controls have limited adjustment capability when the MASTER BRIGHTNESS switch is on, and should be centered in the detent when first adjusting the MASTER BRIGHTNESS control. They have full range of brightness control when the MASTER BRIGHTNESS switch is off.

Display brightness is automatically adjusted based on ambient lighting when the MASTER BRIGHTNESS switch is on.

Note: If display brightness cannot be set as desired when master brightness is on, pushing the MASTER BRIGHTNESS switch off may allow setting display brightness to an appropriate level using individual brightness controls.

Cabin Lighting

Cabin lighting near the flight deck entry door is automatically dimmed or extinguished when the flight deck door is opened while an engine is operating. This reduces the light level entering the flight deck at night.

Cabin Signs

7101-7110

The FASTEN SEAT BELTS signs are controlled by an overhead panel selector. The FASTEN SEAT BELTS signs illuminate when the FASTEN SEAT BELTS selector is in AUTO and the following conditions are satisfied:

- landing gear not up and locked, or
- flap lever not up, or
- airplane altitude below an airline defined altitude, or
- cabin altitude above 10,000 feet, or
- passenger oxygen on.

The FASTEN SEAT BELTS signs can be controlled manually by positioning the SEAT BELTS selector to ON or OFF. When the SEAT BELTS selector is in the OFF position, and oxygen is ON, the FASTEN SEAT BELTS signs illuminate.

RETURN TO SEAT signs are illuminated with the FASTEN SEAT BELTS signs, except when oxygen is deployed.

When the CABIN CHIME switch is pushed or the FASTEN SEAT BELTS signs illuminate or extinguish, a low tone sounds over the PA system.

The NO SMOKING signs are permanently illuminated by backlight or ambient lighting.

Cabin Signs

7001 - 7008

The cabin signs are controlled by overhead panel selectors. The cabin signs illuminate when the following conditions are satisfied:

FASTEN SEAT BELTS signs (AUTO selected):

- landing gear not up and locked, or
- flap lever not up, or
- airplane altitude below an airline defined altitude, or
- cabin altitude above 10,000 feet, or
- passenger oxygen on.

All cabin signs can be controlled manually by positioning the respective switch to ON or OFF. When the SEAT BELTS and NO SMOKING selectors are in the OFF position, and oxygen is ON, the FASTEN SEAT BELTS and NO SMOKING signs illuminate.

RETURN TO SEAT signs are illuminated with the FASTEN SEAT BELTS signs, except when oxygen is deployed.

When the cabin signs illuminate or extinguish, a low tone sounds over the PA system.

Emergency Lighting

The emergency lighting system is powered by remote batteries. Battery charge is maintained by the airplane electrical system. A fully charged battery provides at least 15 minutes of operation.

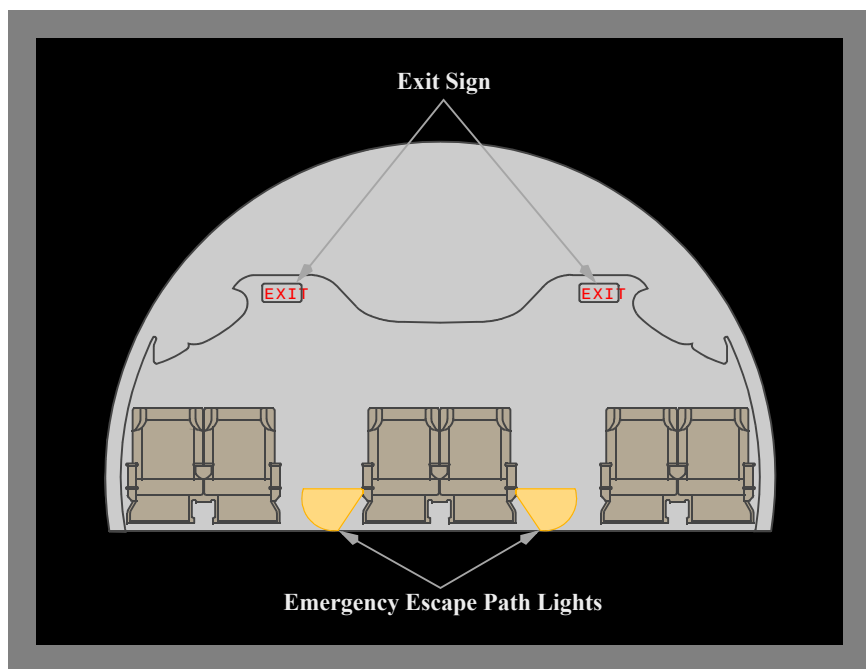
Emergency lighting is controlled by the EMERGENCY LIGHTS switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also be controlled by the EMERGENCY LIGHTS switch on the main flight attendant switch panel.

When the EMERGENCY LIGHTS switch in the flight deck is armed, and the passenger door mode select lever is in the armed position, moving the passenger door handle to the open position will cause the exterior fuselage light and the interior emergency lights at that door to illuminate.

The EICAS advisory message EMER LIGHTS is displayed if:

- the emergency lights switch is not in the ARMED position, or
- the emergency lights switch is in the ARMED position, and the emergency lights are activated by the switch at a flight attendant panel.

Interior Emergency Lighting

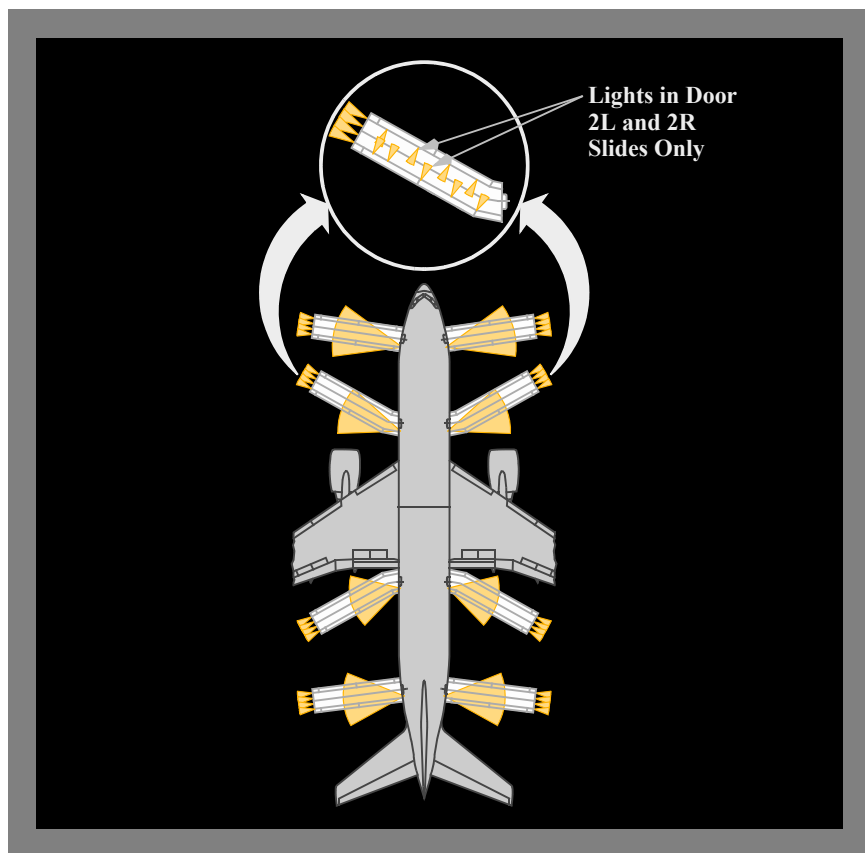


Interior emergency lighting consists of door, aisle, cross-aisle, escape path, exit lights, and luminescent exit signs.

Escape path lighting consists of lights installed in the arm rest of the center passenger seats, and on center galleys, lavatories, closets and partitions spaced at intervals in the aisles and cross-aisles. Escape path lighting illuminates emergency evacuation routes for visual guidance when all sources of lighting more than four feet above the aisle floor are obscured by smoke.

Battery powered exit lights are located at each cabin exit.

Exterior Emergency Lighting



Exterior emergency lighting consists of escape slide lights. The lights are located aft of each door and illuminate the areas at the base of the escape slides. The slides in doors 2L and 2R have lights built into the sliding lanes. When the slide is deployed, the lights turn on automatically to illuminate the slide lanes.

Oxygen Systems

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders are located throughout the airplane for emergency use.

Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning masks and regulators located at each crew station. Oxygen pressure is displayed on the MFD STATUS display.

The EICAS advisory message CREW OXYGEN LOW alerts the flight crew of a low oxygen pressure condition.

Flight crew and observer masks and regulators are installed in oxygen mask panels near each seat. Removing the mask from its stowage box (opening the stowage box right door):

- initiates oxygen flow to the mask regulator
- momentarily displays the yellow oxygen flow indicator
- selects the mask microphone in the removed mask (the boom microphone is deselected).

Squeezing the mask harness inflation lever on the left side of the regulator inflates the mask harness. Releasing the mask harness inflation lever deflates the harness. The mask harness inflation lever is only active when the right door of the stowage box is open, or the door is closed and the OXY ON flag is in view.

The boom microphone can be reselected by closing the right oxygen panel door and pushing and releasing the RESET/TEST switch. This also shuts off oxygen to the mask. The oxygen flow can be restored by opening the right oxygen panel door.

Passenger Oxygen System

The passenger oxygen system is supplied by individual chemical oxygen generators. The oxygen system provides oxygen to:

- passenger seats
- attendant stations
- upper crew rest compartment
- lavatory service units.

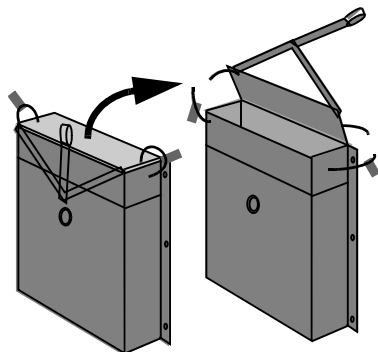
The passenger oxygen masks and chemical oxygen generators are located in passenger service units (PSUs). Oxygen flows from a PSU generator when any mask hanging from that PSU is pulled. Oxygen is available for approximately 12 minutes. The masks automatically drop from the PSUs if cabin altitude exceeds approximately 13,500 feet. The passenger masks can be manually deployed from the flight deck by pushing the overhead panel PASSENGER OXYGEN switch to the ON position.

Portable Protective Breathing Equipment

Protective Breathing Equipment (PBE/Smoke Hood) devices for crew use (for combating fires and/or entering areas of smoke or fume accumulation) may be stowed throughout the airplane; however, they are normally found in the forward and aft sections of the passenger cabin. The device is placed over the head and, when activated, provides approximately 15 to over 20 minutes of oxygen depending upon the device used. Manufacturer's operating instructions are placarded on the container.

The PBE is designed to protect crewmembers from the effects of smoke, heat, carbon dioxide or other harmful gases while combating fires onboard the airplane.

The preflight consists of inspecting the red seals and checking that the PBE is intact. If a seal is broken, refer to the MDM for dispatch procedures.



To Operate the PBE

- Remove the pouch from the compartment.
- Open the pouch by pulling the loose ends apart.
- Remove and unfold the hood.
- Position the hood so the clear side is facing downward, with the neck opening positioned towards you.
- Activate the oxygen flow by pulling apart the two oxygen cylinders sharply. One cylinder discharges rapidly to purge the hood of any contaminated air. In order to receive the full benefit of purging, you must get the hood on quickly (within 15 seconds). The second oxygen cylinder releases slowly, lasting 7-8 minutes. After both cylinders have fully discharged, the hood provides an additional 7-8 minutes of breathable air.
- Insert hands, palms together, into the neck opening and spread hands to enlarge opening.
- Slip hood over your head.

- Verify oxygen flow by illumination of the flashing green light.

Special Considerations

Once the hood is activated and donned, be aware of the following:

- A good neck seal is important; push long hair into the hood.
- You may experience light headedness; this is due to the relatively high oxygen content in the hood.
- A flashing red light will turn on after 15 minutes, indicating the oxygen supply is depleted. Leave the area, if possible, and remove the hood.
- You may feel warm inside the hood from the combined warmth of your body temperature, your exhaled breath and chemical process within the hood.
- Normal interphone and face-to-face communication procedures are recommended. Use the hand held mic with both flight deck speaker volumes high.
- Your ears may pop as the hood is pressurized.

Door 1 Upper Crew Rest Compartments

The upper crew rest compartments oxygen system is a chemical oxygen generator system. The oxygen masks automatically drop from the PSUs if cabin altitude exceeds approximately 13,500 feet.

Door 3 Upper Crew Rest Compartment

7001 – 7008

The door 3 upper crew rest compartment oxygen system is a chemical oxygen generator system. The oxygen masks automatically drop from the PSUs if cabin altitude exceeds approximately 13,500 feet.

Door 4 Upper Crew Rest Compartment

7101 - 7110

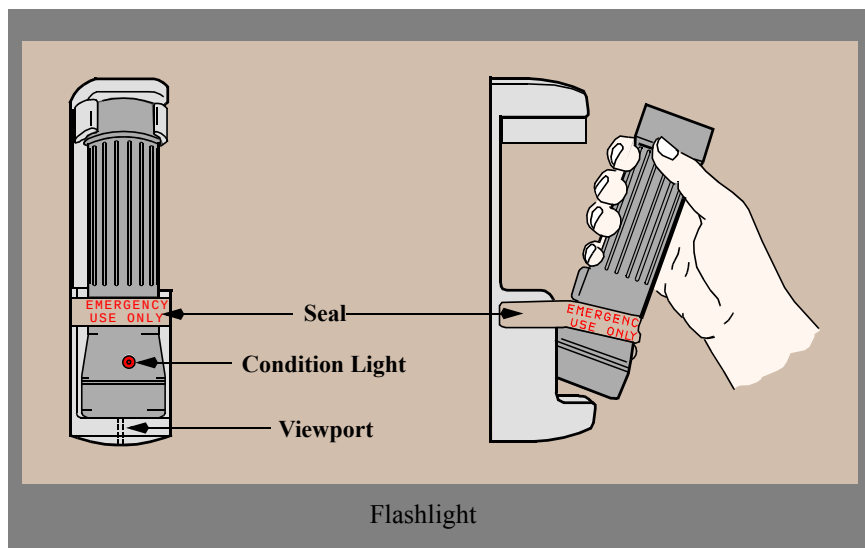
The door 4 upper crew rest compartment oxygen system is a chemical oxygen generator system. The oxygen masks automatically drop from the PSUs if cabin altitude exceeds approximately 13,500 feet.

Portable Oxygen Bottles

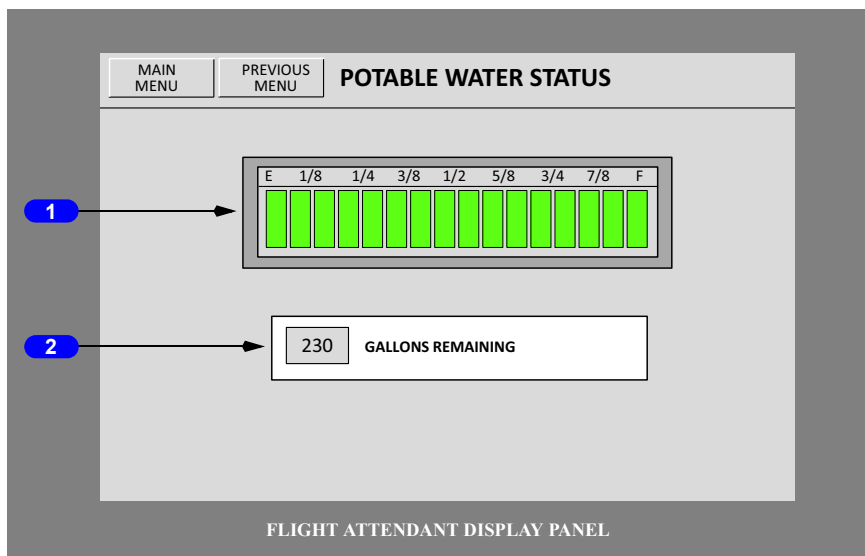
Portable oxygen bottles are stowed in various locations in the passenger cabin. The bottles are fitted with disposable masks and are used for first aid purposes or as walk-around units. All bottles are identical in size and capacity.

Flashlights

Flashlights are stowed on the flight deck, both crew rest areas, and throughout the passenger cabin. These high intensity flashlights illuminate automatically when they are removed from the stowage brackets. A battery indicator light flashes every three to four seconds to indicate adequate power. The light can be extinguished only by replacing the flashlight back into the stowage bracket. The batteries cannot be recharged.



Potable Water Quantity Status



1 Relative Quantity Gauge (Bar Graph)

Displays percentage of gallons remaining (Empty-Full).

2 GALLONS REMAINING

7101 - 7110

Displays total gallons remaining (0-230).

7001 - 7008

Displays total gallons remaining (0-218).

Intentionally
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**Airplane General, Emergency
Equipment, Doors, Windows
Emergency Equipment**

Chapter 1

Section 45

Emergency Equipment

This chapter describes the emergency equipment located throughout the airplane, including:

- emergency locator transmitters (ELTs)
- escape ropes
- fire extinguishers
- portable flight deck emergency equipment location
- portable passenger cabin emergency equipment location

Emergency Evacuation Signal System

7001 – 7008

The emergency evacuation signal system alerts the flight attendants to evacuate the passenger cabin. Evacuation command switches are located on the flight deck and at the flight attendant panels.

This system is not currently used by flight crews.

Emergency Locator Transmitter (ELT)

Portable Emergency Locator Transmitter (ELT)

Passenger Cabin

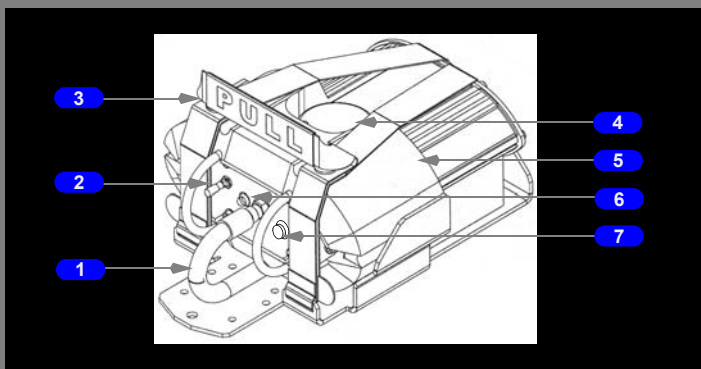
One emergency locator transmitter is installed in the aft cabin near door 4L.

Flight Deck

7001 – 7008

One emergency locator transmitter installed on aft bulkhead.

Portable Emergency Locator Transmitter



1 Whip Antenna

2 ELT Mode Switch (ARMED/OFF/ON)

3 Harness Release

4 Water Sensor/Identification Assembly

5 Float

6 Transmit LED

7 TEST Push Button

Fuselage Mounted Emergency Locator Transmitter (ELT)

7101 - 7110

An emergency locator transmitter (ELT) is mounted to the top center of the fuselage in the passenger cabin area.

The ELT automatically transmits distress signals on 121.5 MHZ, 243 MHZ, and 406 MHZ if a high deceleration is sensed, or if the ELT switch is positioned to ON.

The EICAS alert message ELT ON is displayed if the transmitter is activated. The ELT can be deactivated by placing the ELT switch to RESET momentarily, then ARMED.

Escape Ropes

Escape ropes are attached to the airplane structure above both number two flight deck windows. The ropes are stowed in compartments above the pilot seats.

Miscellaneous Portable Emergency Equipment

Portable equipment is stowed at strategic locations throughout the airplane. Refer to 1.45, Emergency Equipment Locations for specific locations.

Fire Extinguishers

Halon and water fire extinguishers are located throughout the passenger cabin and on the flight deck.

Halon Fire Extinguishers

Halon fire extinguishers contain a liquefied gas agent under pressure.

A safety pin with a pull ring prevents accidental trigger movement. When released, the liquefied gas agent vaporizes and extinguishes the fire. The extinguisher is effective on all types of fires, but is used primarily on electrical, fuel, and grease fires.

WARNING: If a halon fire extinguisher is to be discharged in the flight deck area, all flight crew members must wear oxygen masks and use 100% oxygen with emergency selected.

CAUTION: For electrical fires, remove the power source as soon as possible. Avoid discharging directly on persons due to possibility of suffocating effects. Do not discharge too close to fire as the discharge stream may scatter the fire. As with any fire, keep away from the fuel source. Avoid breathing vapors, fumes and heated smoke as much as possible.

Halon Fire Extinguisher Operation

To use the halon fire extinguisher:

- pull ring pin from lever and handle
- hold extinguisher upright with hand under handle and thumb on top of lever
- from a distance of 6 to 10 feet, direct the nozzle towards the base of the fire source

Note: The extinguisher stream will shoot over 10 foot distance.

- squeeze the lever downward with thumb
- spray at the base of the flame in quick side-to-side -motion.

Water Fire Extinguishers

Water fire extinguishers contain a solution of water mixed with antifreeze. Water fire extinguishers are to be used on fabric or paper fires only. They are not to be used on electrical or grease fires.

WARNING: An antifreeze compound has been added to the water which makes it unfit for drinking.

CAUTION: Do not use on electrical or grease type fires.

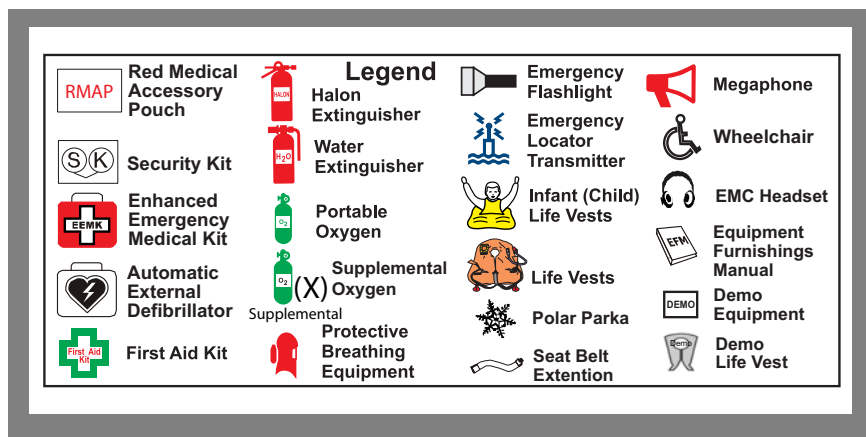
To use the water fire extinguisher:

- remove it from stowage
- turn handle clockwise as far as possible (charges bottle with CO2)
- hold bottle upright
- direct nozzle at base of fire
- press trigger to discharge

Flight Deck Emergency Equipment

Refer to the Emergency Equipment placard in the flight deck for flight deck emergency equipment and location.

Emergency Equipment Symbols



Emergency Equipment Locations

Emergency equipment locations depicted in the following graphic is approximate. For actual locations and quantities, refer to the placards located throughout the cabin.

[illegible]

Emergency Light Switch

- Flight deck
- Fwd FA panel

Exit Seats are shaded

Flashlights

- Under each FA jumpseat
- 3 in crew rest areas

Flotation

- Life vest at each crew and passenger seat
- Inflatable slide/raft at all doors

* Demo life vests in headrests
above all jumpseats, except 2L/2R

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Airplane General, Emergency Equipment, Doors, Windows

Door 1 Upper Crew Rest

Chapter 1

Section 46

Introduction

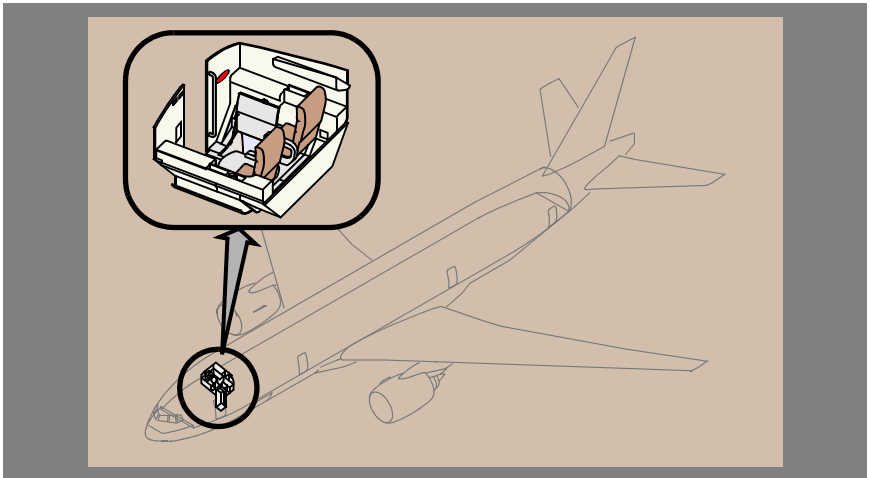
This section describes the crew rest areas, including:

- location and entry enclosure
- control panels
- smoke detection
- decompression
- emergency equipment and location
- evacuation

Door 1 Upper Crew Rest Area [AFM]

A door 1 upper crew rest area is located in the forward part of the airplane near door 1. Access into the area is through an enclosure located in the passenger cabin near door 1L.

The area has its own smoke detection system but no fire extinguishing system.



Occupancy

Door 1 Upper Crew Rest Certified for Occupancy

7101 - 7110

The door 1 upper crew rest is to be occupied by crew members trained in the use of the crew rest evacuation routes, fire fighting procedures and depressurization procedures.

Occupancy of the door 1 upper crew rest area during taxi, take-off and landing is restricted to flight crew members who the pilot-in-command has determined are trained in the emergency procedures for the crew rest compartment are able to rapidly use the evacuation routes.

Note: The door 1 upper crew rest area must be secured for taxi, takeoff, and landing operations. For example, seat backs upright and foot rest stowed.

Note: If the door 1 upper crew rest area is occupied, the entrance door must be latched open during taxi, takeoff, and landing operations. The door may be closed when at altitude and the Fasten Seat Belt signs are extinguished. In preparation for descent, when the Fasten Seat Belt signs are illuminated, the enclosure door must be latched open.

Door 1 Upper Crew Rest Not Certified for Occupancy

7001 – 7008

The door 1 upper crew rest is to be occupied by crew members trained in the use of the crew rest evacuation routes, fire fighting procedures and depressurization procedures.

Note: A placard is installed indicating any door 1 upper crew rest area occupancy restrictions.

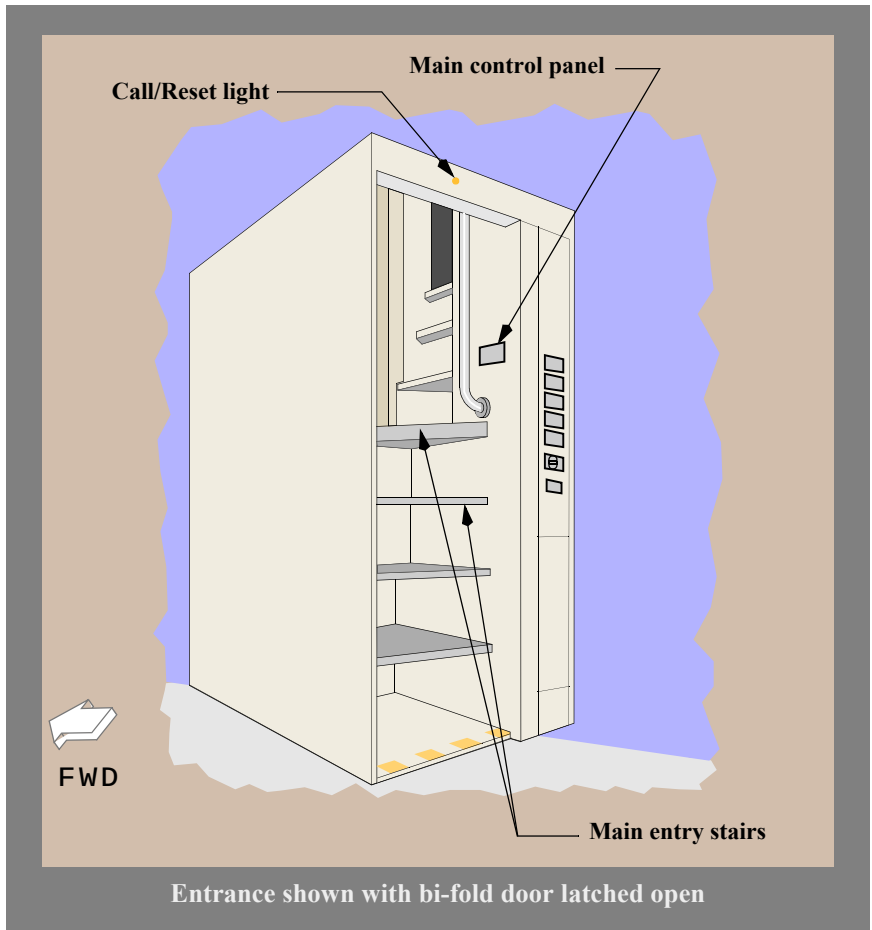
Note: The crew rest area is not to be occupied during taxi, takeoff, or landing operations.

WARNING: The upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

Entrance Enclosure

7101 - 7110

Entry into the door 1 upper crew rest area is through an enclosure located in the passenger cabin near door 1L. The entrance to the crew rest area has a bifold door having the same external appearance as a lavatory, but is placarded for crew use. The entrance enclosure contains a area main control panel.



An amber call/reset light/switch is mounted on the exterior wall above the entrance door. When smoke is detected in the area, the light flashes. The light will illuminate steady when the attendant call button on a passenger control unit (PCU) inside the area has been pushed.

Note: If the door 1 upper crew rest is occupied, the entrance door must be latched open during taxi, takeoff, and landing operations. The door may be closed when at altitude and the Fasten Seat Belt signs are extinguished. In preparation for descent, when the Fasten Seat Belt signs are illuminated, the enclosure door must be latched open.

Conditioned air is used to provide temperature control and ventilation to the door 1 upper crew rest area. When using the area, conditioned air flow must be available. An amber SUPPLY AIRFLOW OFF light on the main control panel in the entrance enclosure illuminates when conditioned air is not available.

Before entering the crew rest area, ensure that conditioned air flow is available. Verify that the SUPPLY AIRFLOW OFF light on the control panel in the entrance enclosure is not illuminated.

Note: If the SUPPLY AIRFLOW OFF light is illuminated with the airplane on the ground, push the AIRFLOW / SMOKE RESET switch to reset the supply air system prior to entering the overhead rest area. Ensure that the enclosure door is latched open.

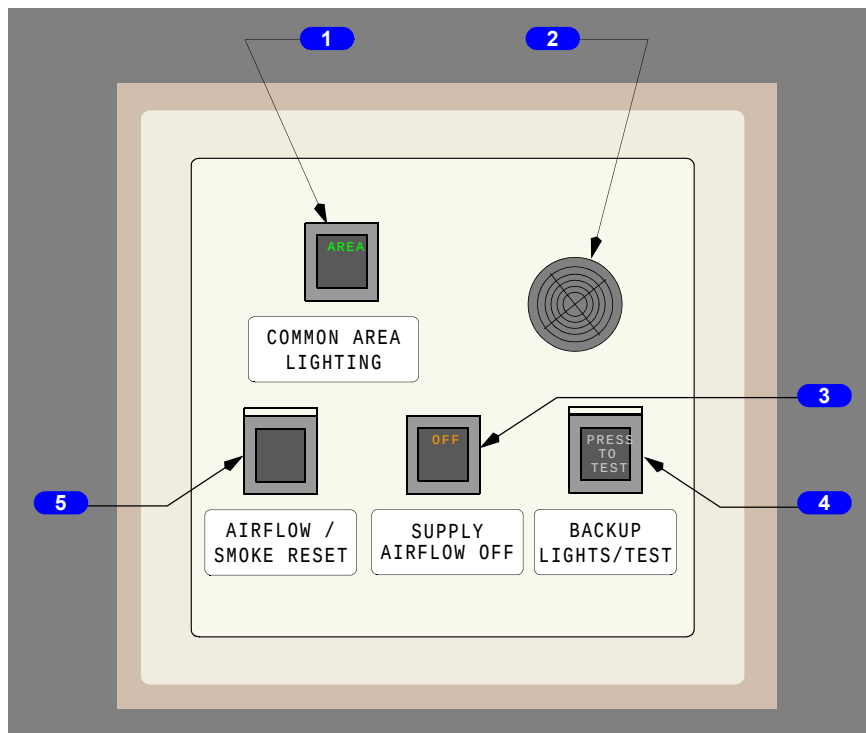
After the FASTEN SEAT BELT signs are turned off, the door 1 upper crew rest door may be closed. Prior to closing the enclosure door, verify that the SUPPLY AIRFLOW OFF light is extinguished.

Note: If the SUPPLY AIRFLOW OFF light is illuminated, push the AIRFLOW / SMOKE RESET switch one (1) time and wait 10 minutes before closing the enclosure door. If the SUPPLY AIRFLOW OFF light remains illuminated, the enclosure door should be latched open to provide proper door 1 upper crew rest area ventilation.

Main Control Panel

7101 - 7110

The door 1 upper crew rest area main control panel is located inside the entrance enclosure.



1 COMMON AREA LIGHTING Switch

Push -

- turns the common seating area lights in the area on (light illuminated)/off (light extinguished).

2 Alert horn

Horn sounds when:

- airplane decompression occurs (continuous)
- smoke is detected in the overhead crew rest area (pulsating)

3 SUPPLY AIRFLOW OFF Light

Illuminated (amber) -

- area airflow exhaust valves are open or during smoke detection mode operations
- the area airflow is off

Note: A HI/LO chime will sound 5 times in the area whenever the air supply shutoff valve is commanded closed.

Note: The SUPPLY AIRFLOW OFF light will be illuminated during the smoke detection mode.

Note: When the SUPPLY AIRFLOW OFF light is illuminated, the overhead crew rest entry door should be latched open when the crew rest area is occupied.

4 BACKUP LIGHTS/TEST Switch

Guarded switch/light.

Push - illuminated (white) -

- the emergency lights in the area turn on for approximately one minute

5 AIRFLOW / SMOKE RESET Switch

Guarded switch.

Push and hold (2 seconds) -

- resets the airflow to the area

Note: If the SUPPLY AIRFLOW OFF light is illuminated, push the AIRFLOW / SMOKE RESET switch one (1) time and wait 10 minutes before closing the enclosure door. If the SUPPLY AIRFLOW OFF light remains illuminated, the enclosure door should be latched open to provide proper door 1 upper crew rest area ventilation.

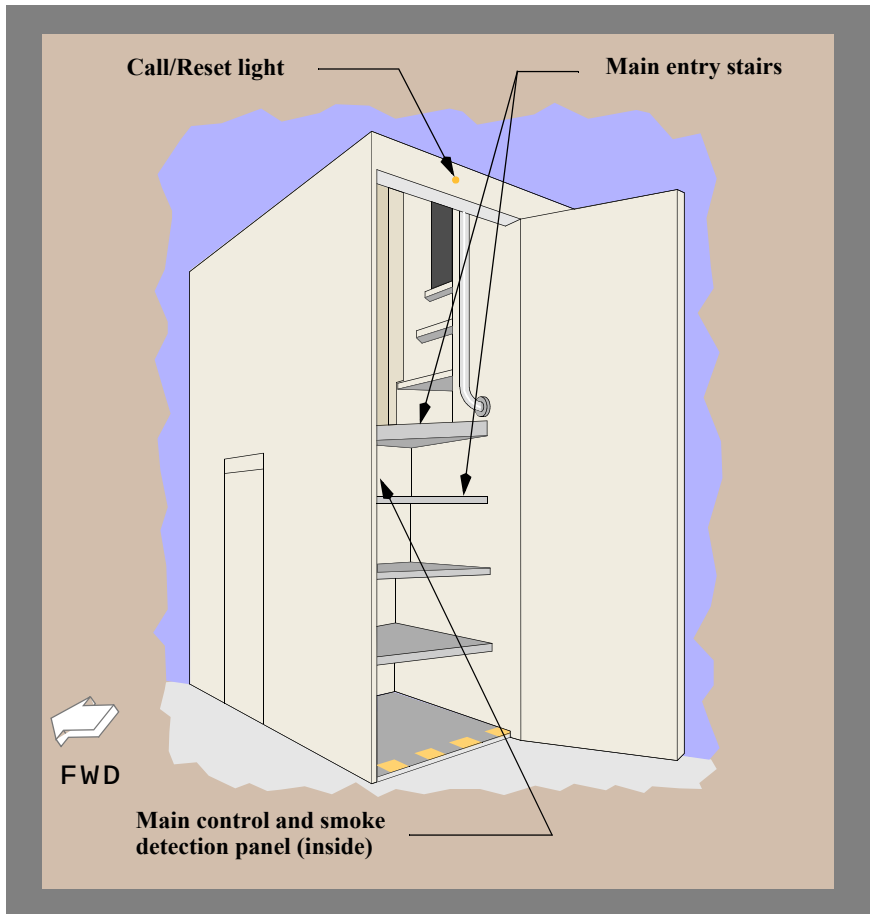
Note: The AIRFLOW / SMOKE RESET switches in both upper crew rest facilities (door 1 and door 4) must be pushed to ensure proper restoration of the aft galley power.

Entrance Enclosure

7001 – 7008

Entry into the door 1 upper crew rest area is through an enclosure located in the passenger cabin near door 1L. The entrance to the crew rest area has the same external appearance as a lavatory, but is placarded for crew use.

The entrance enclosure contains a main control panel and a smoke detector system control panel.



An amber call/reset light/switch is mounted on the exterior wall above the entrance door. When smoke is detected in the area, the light flashes. The light will illuminate steady when the attendant call button on a passenger control unit (PCU) inside the area has been pushed.

Conditioned air is used to provide temperature control and ventilation to the door 1 upper crew rest area. When using the area, conditioned air flow must be available. An amber AIRFLOW OFF light on the main control panel in the entrance enclosure illuminates when conditioned air is not available.

Before entering the crew rest area, ensure that conditioned air flow is available. Verify that the AIRFLOW OFF light on the control panel in the entrance enclosure is not illuminated.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet.

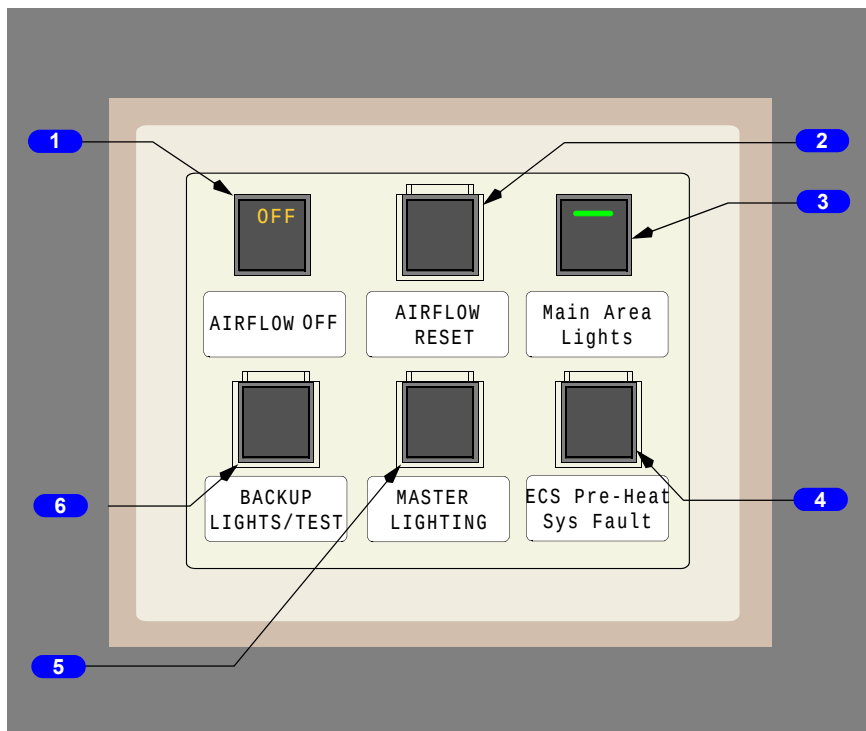
Note: If the airplane is above 25,000 feet and the AIRFLOW OFF light is illuminated, pushing the AIRFLOW RESET switch resets the conditioned air system.

WARNING: If the AIRFLOW OFF light remains illuminated after the AIRFLOW RESET switch has been pushed, the door 1 upper crew rest area should not be occupied.

Main Control Panel

7001 – 7008

The door 1 upper crew rest area main control panels are located inside the entrance enclosure.



1 AIRFLOW OFF Light

Illuminated (amber) -

- the area airflow is off.
- A HI/LO chime will sound 5 times in the area whenever the air supply shutoff valve is commanded closed.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet or during smoke detection mode.

WARNING: The door 1 upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

2 AIRFLOW RESET Switch

Illuminated (red) -

Push and hold (2 seconds) - resets the airflow to the area.

Note: The AIRFLOW RESET switch is inoperative when the airplane is below 25,000 feet.

Note: The AIRFLOW / SMOKE RESET switches in both upper crew rest facilities (door 1 and door 3) must be pushed to ensure proper restoration of the aft galley power.

3 Main Area Lights Switch/Light

Push - illuminated (white) -

- turns the main seating area lights on (light illuminated)/off (light extinguished).

4 ECS Pre-Heat Sys Fault Light

Illuminated (amber) -

ECS pre-heat system failure

Note: The ECS pre-heat system ensures 2 degrees C (35 degrees F) minimum temperature maintained within compartment to prevent ice formation on airflow shutoff valves.

5 MASTER LIGHTING Switch/Light

Push - illuminated (white) -

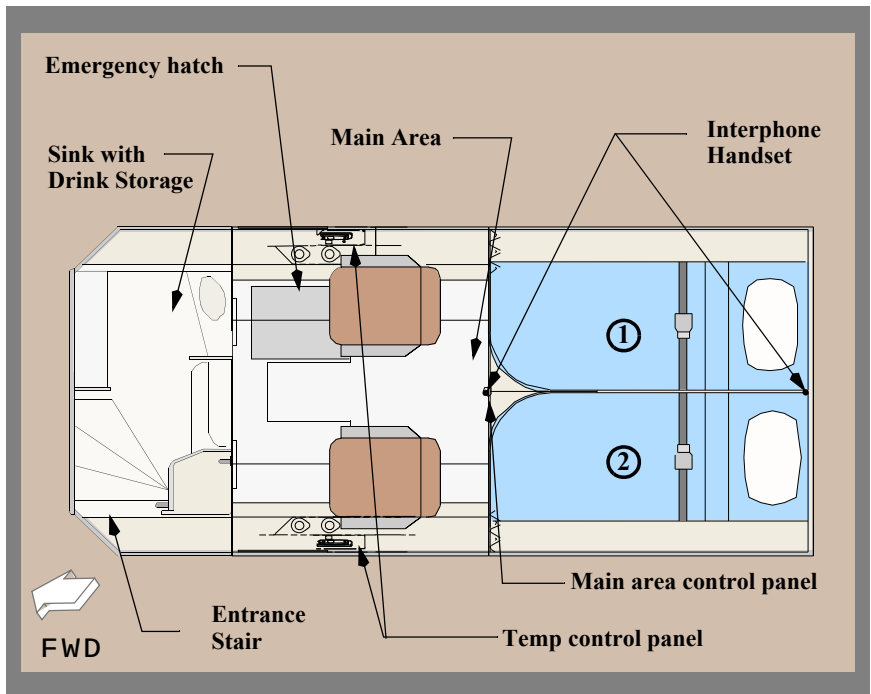
- turns lights in the compartment on (light illuminated)/off (light extinguished).

6 BACKUP LIGHTS/TEST Switch/Light

Push - illuminated (white) -

- the emergency lights in the area turn on for approximately one minute

Crew Rest Layout



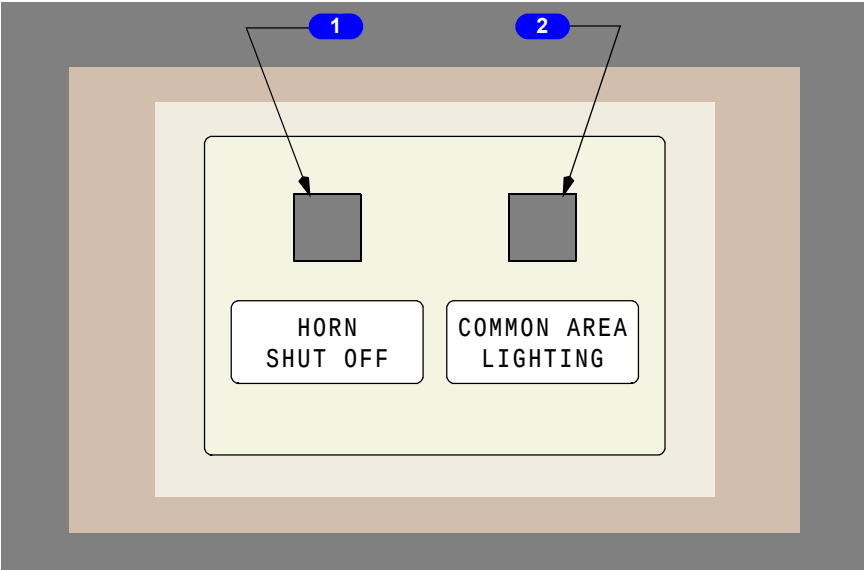
The door 1 upper crew rest area contains the following:

- a sink area
- a main seating area containing:
 - control/warning panels
 - lighting and temperature control panels
 - 2 seats
- bunks (circled numbers 1 through 2)
- interphone handsets (2)
- emergency hatch
- smoke detectors
- emergency equipment

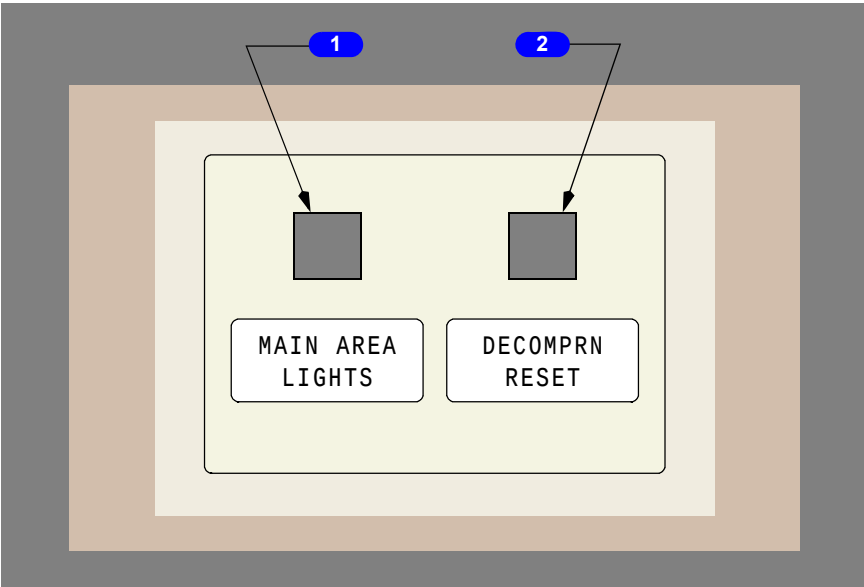
Main Area Control Panels

Area Lights/Decompression Reset Panel

7101 - 7110



7001 – 7008



1 MAIN AREA LIGHTS Light/Switch

Push -

- turns area lights on/off.

2 HORN SHUT OFF Switch

7101 - 7110

Push -

- silences the smoke detector system alarm horns
- silences the decompression alarm horns

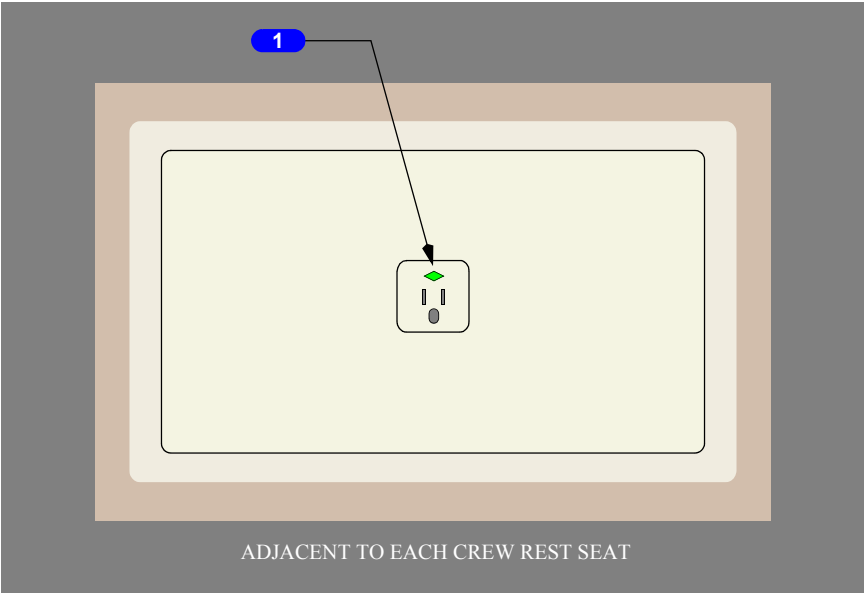
2 Decompression (DECOMPRN) RESET Switch

7001 – 7008

Push -

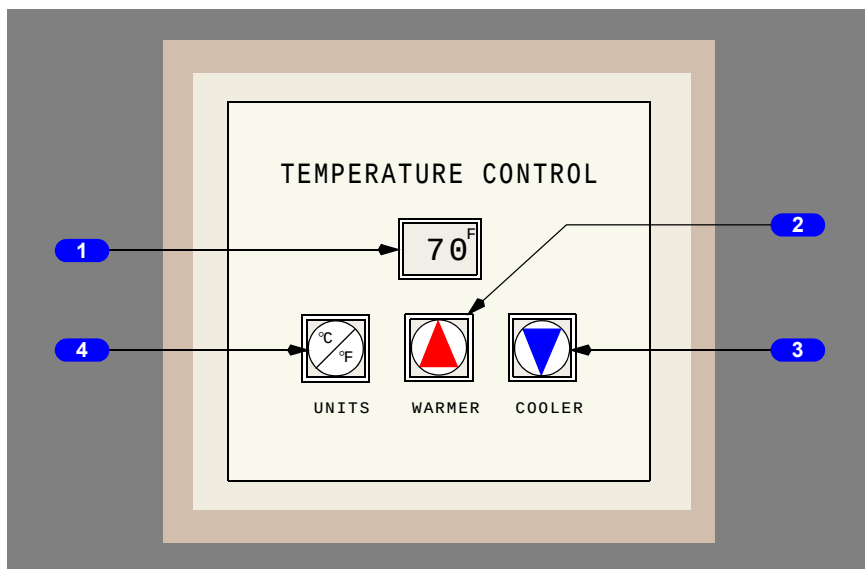
- silences the smoke detector system alarm horns
- silences the decompression alarm horns

PC Power



1 PC Power Connection

Temperature Control Panel



1 Temperature Display

Displays:

- current ambient air temperature in degrees F or C
- flashing, new temperature set point when warmer or cooler arrows are pushed.

2 WARMER Arrow

Push -

- increases temperature in crew rest area

3 COOLER Arrow

Push -

- decreases temperature in crew rest area

4 UNITS Selector

Push -

- toggles between degrees F and degrees C for display and temperature selection.

Crew Rest Temperature Control System

The temperature in the crew rest area is controlled by the temperature controller located in the main area. The temperature can be set between 65 degrees F and 85 degrees F.

Note: If the SUPPLY AIRFLOW light is illuminated on the main control panel, temperature can not be controlled inside the crew rest and the door to enclosure may be opened to provide air from cabin.

System operation

Increase Temperature

To increase the temperature:

- observe the actual temperature
- push and hold the units selector
- use the warmer arrow to increase the target temperature. Each push of the up arrow increases the temperature by 1 degree F

Note: Do not expect an immediate change in the temperature.

Note: Maximum selectable temperature is 85 degrees F.

Decrease Temperature

To decrease the temperature:

- observe the actual temperature
- push and hold the units selector
- use the cooler arrow to decrease the temperature. Each push of the down arrow decreases the temperature by 1 degree F

Note: Do not expect an immediate change in the temperature.

Note: Minimum selectable temperature is 65 degrees F.

Oxygen System

The crew rest oxygen system is a chemical oxygen generator system which provides oxygen for approximately 12 minutes.

The oxygen masks above the bunks and seats will drop automatically in the event of a decompression.

Each mask oxygen valve is held closed by a pin inserted into the valve. Pulling on the mask withdraws the pin, causing the mask oxygen valve to open and oxygen to flow to that mask.

The oxygen masks may be manually released by inserting a hair pin or thin rod into the hole of the oxygen compartment cover.

Note: Cabin depressurization is indicated by a continuous alarm horn sounding in the crew rest area.

Decompression

If a cabin decompression occurs during cruise:

- a decompression (continuous) horn sounds in the crew rest area

The oxygen masks located above the bunks and seats will automatically deploy when the cabin altitude is above 13,500 feet. Oxygen flow is available when the mask or yellow streamer attached to the mask is pulled.

Crew rest occupants should immediately don one of the PSU or bunk service unit oxygen masks, move to an unoccupied position, and fasten the seat/bunk lap belt.

WARNING: It is acceptable to reach over a seat/bunk occupant to obtain an open/unused oxygen mask to prevent oxygen deprivation / light-headedness when moving to an unoccupied position.

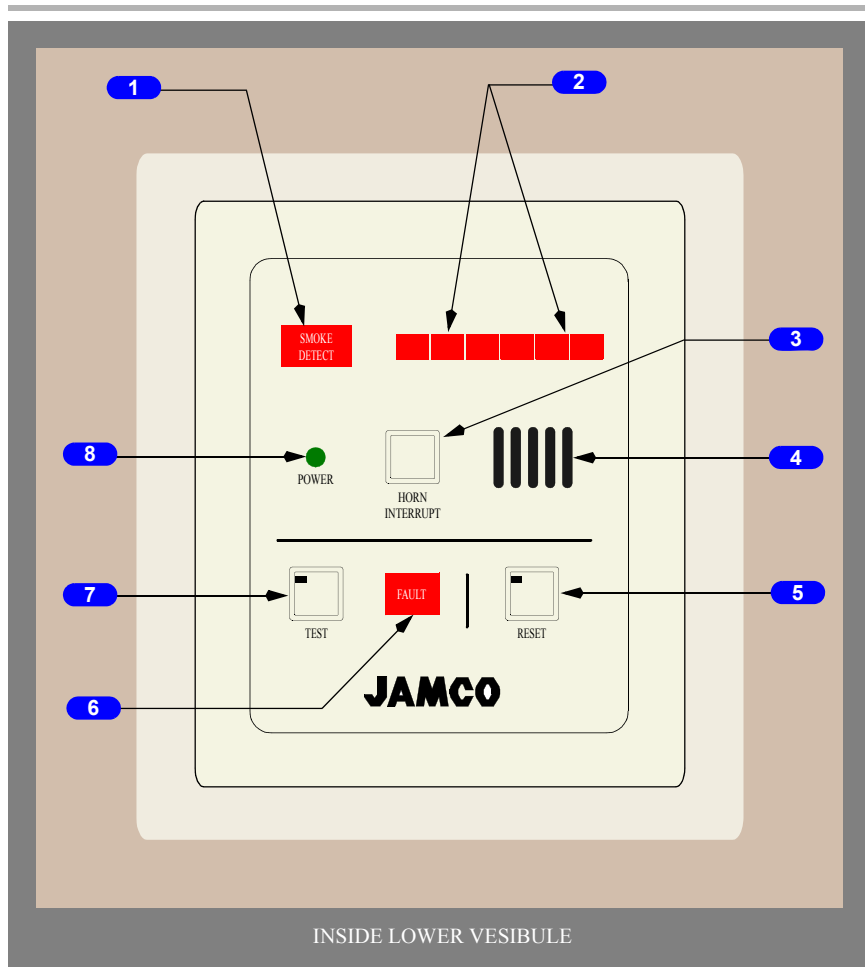
Evacuate the upper crew rest area when directed by the flight crew.

Note: Prior to evacuating the upper crew rest area, push the HORN SHUT OFF switch (LR) or DECOMPRN RESET (ER) (located in the crew rest common area). This will silence the decompression alarm horns in the overhead crew rest area.

Smoke Detection Panel

7001 – 7008

The Smoke Detection Panel is located inside the lower vestibule. There are 6 smoke detectors installed throughout the Door 1 Upper Crew Rest Area.



1 Alarm Indicator Light

Illuminated (red) - smoke is detected by one of the detectors in the area.

2 Smoke Detector Location Indicator Light

Illuminated (red) -

- location of smoke detector in alarm
- smoke detector with fault condition when TEST switch pushed.

3 HORN INTERRUPT Switch

Push - silences the smoke detector system alarm horns.

4 Smoke detector horn

Sounds if smoke is detected in the area.

5 Smoke Detector System RESET Switch

Push - resets area smoke detector system.

6 FAULT Indicator

Illuminated (red) during smoke detector system test if system has fault detected.

7 Smoke Detector System TEST Switch

Push - tests the area smoke detectors controlled by that panel.

Note: Smoke Detector Location Indicator Light will illuminate within 15 seconds.

8 Smoke Detector POWER Light

Illuminated (green) - power is supplied to the area smoke detectors.

Crew Rest Smoke Detection System Operation

7101 - 7110

Two smoke detectors are installed in the crew rest area common area. Additionally, there is one smoke detector in each bunk area and one in the closet.

If smoke is detected in the door 1 upper crew rest area:

On the flight deck:

- the master caution light illuminates
- an aural caution alarm sounds
- a SMOKE REST UPR DR 1 Engine Indication and Crew Alerting System (EICAS) caution message is displayed

In the crew rest area:

- the pulsing smoke detection system alarm horns sound in the overhead area
- the crew rest area air supply valves are closed and the area smoke evacuation valves are opened

At the entrance main control panel:

- supply AIRFLOW OFF light illuminates
- an alarm horn will sound

At the entrance smoke detection panel:

- the SMOKE DETECTED light illuminates red
- the appropriate smoke detector zone light illuminates red
- an alarm horn will sound

In the passenger cabin:

- the amber light above the entrance enclosure door flashes
- a SMOKE DETECTED DR1 UPR REST message appears on the cabin management system control panels
 - a continuous HI chime sounds:
 - at door 1L
 - in the door 1 cross aisle area
 - in the forward galley
 - at door 1R
 - at door 2L
 - at door 2R
 - in the crew rest area
- the cabin master call lights flash

Continue to monitor the area until the smoke detector red alarm indicator light extinguishes.

Once the smoke clears, the red alarm indicator light extinguishes, the smoke detector is sensitive to smoke again.

Note: When the smoke detector has been activated, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor (the small screen cutout on the side of the cube extending from the unit) may clear lingering smoke.

Crew Rest Smoke Detection System Operation

7001 – 7008

Two smoke detectors are installed in the crew rest area common area. Additionally, there is one smoke detector in each bunk area and one in the closet.

If smoke is detected in the door 1 upper crew rest area:

On the flight deck:

- the master caution light illuminates
- an aural caution alarm sounds
- a SMOKE REST UPR DR 1 Engine Indication and Crew Alerting System (EICAS) caution message is displayed

In the crew rest area:

- the smoke detection system alarm horns sound
- the smoke detector alarm indicator light will illuminate
- all area lights will illuminate

At the entrance main control panel:

- AIRFLOW OFF light illuminates
- an alarm horn will sound

At the entrance smoke detection panel:

- the SMOKE DETECTED light illuminates red
- the appropriate smoke detector zone light illuminates red
- an alarm horn will sound

In the passenger cabin:

- the amber light above the entrance enclosure door flashes
- a SMOKE DETECTED CR UPR DR 1 message appears on the cabin management system control panels
 - a continuous HI chime sounds:
 - at door 1L
 - in the door 1 cross aisle area
 - in the forward galley
 - at door 1R
 - at door 2L
 - at door 2R
 - in the crew rest area
 - the cabin master call lights flash

Continue to monitor the area until the smoke detector red alarm indicator light extinguishes.

Once the smoke clears, the red alarm indicator light extinguishes, the smoke detector is sensitive to smoke again.

Note: When the smoke detector has been activated, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor (the small screen cutout on the side of the cube extending from the unit) may clear lingering smoke.

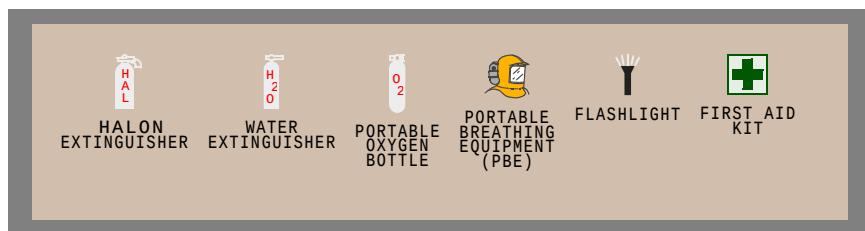
Emergency Equipment

Door 1 Upper Crew Rest Emergency Equipment

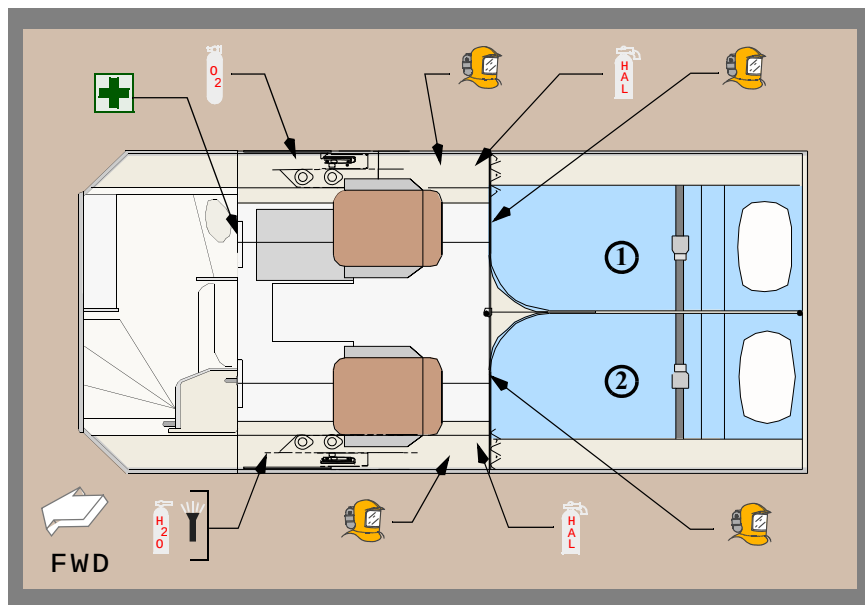
The door 1 upper crew rest area emergency equipment includes:

- halon fire extinguishers (2)
- water fire extinguisher
- portable oxygen bottles (2)
- protective breathing equipment (PBE) (4)
- first aid kit
- flashlight

Emergency Equipment Symbols



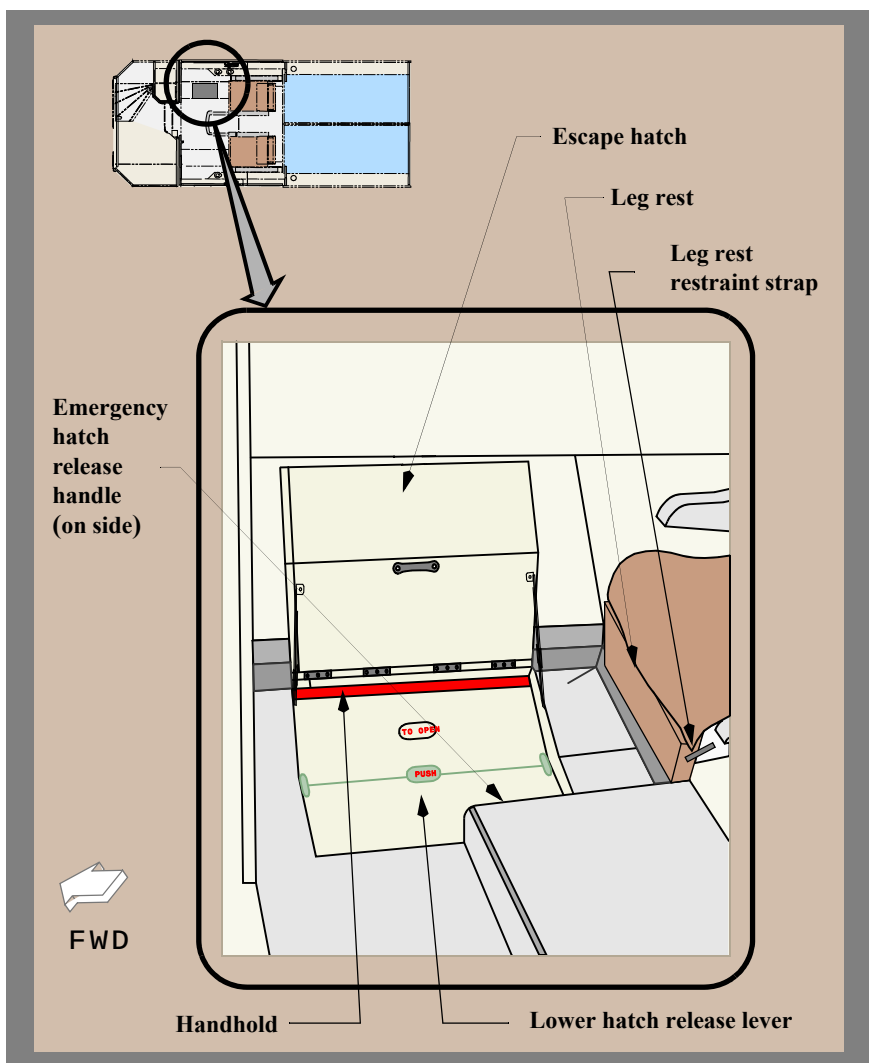
Emergency Equipment Location



Evacuation from the Crew Rest Area using the Door 1 Upper Crew Rest Emergency Hatch

The primary evacuation route is down the entrance stairway through entrance enclosure.

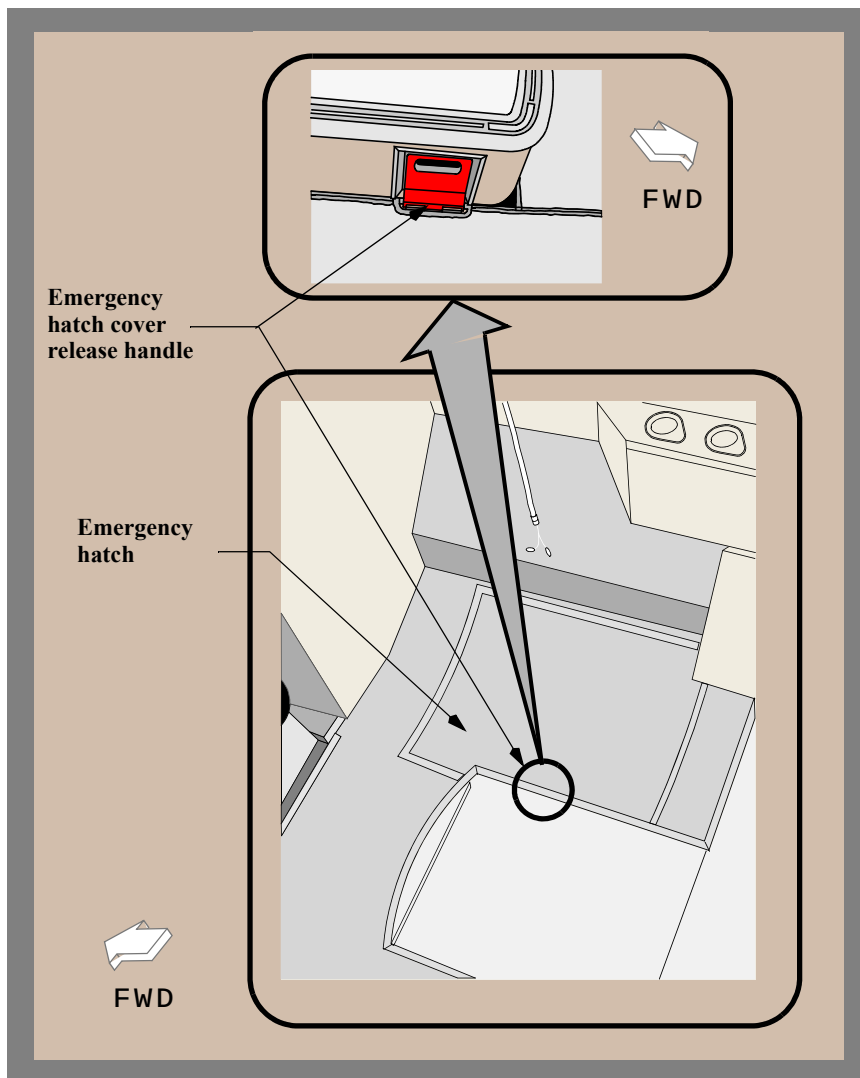
If the main entrance is unusable, evacuation is possible through the emergency hatch located on the right side of the area.



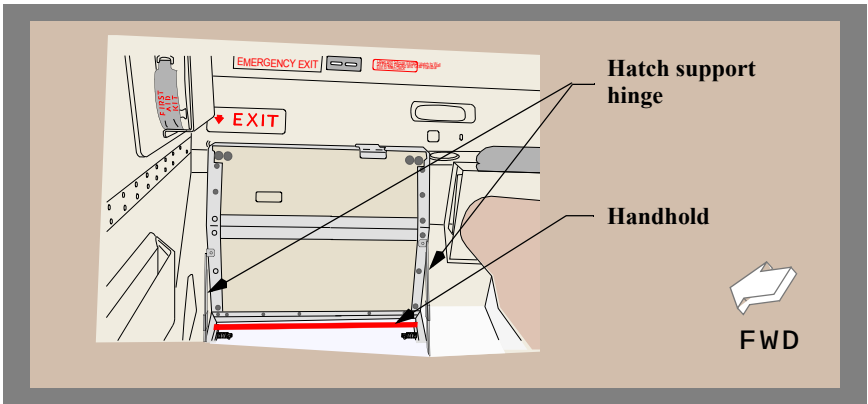
For egress:

- retract right seat leg rest (if required)

Note: Secure the seat leg rest using the seat leg rest restraint straps.



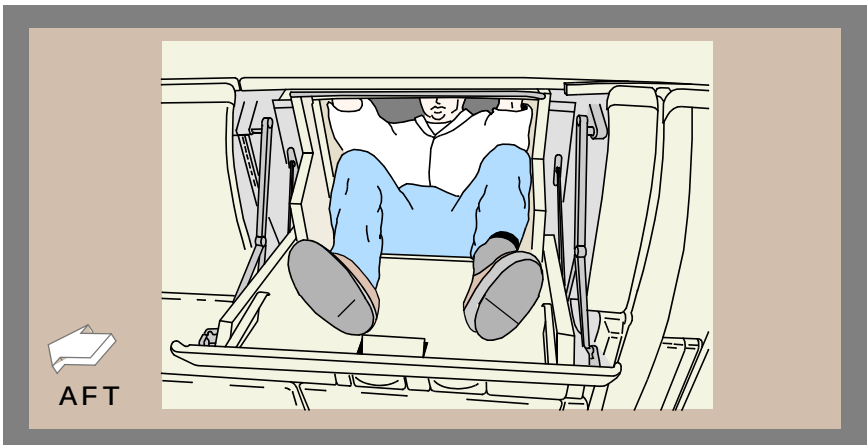
- unlatch upper hatch using the emergency hatch cover release handle



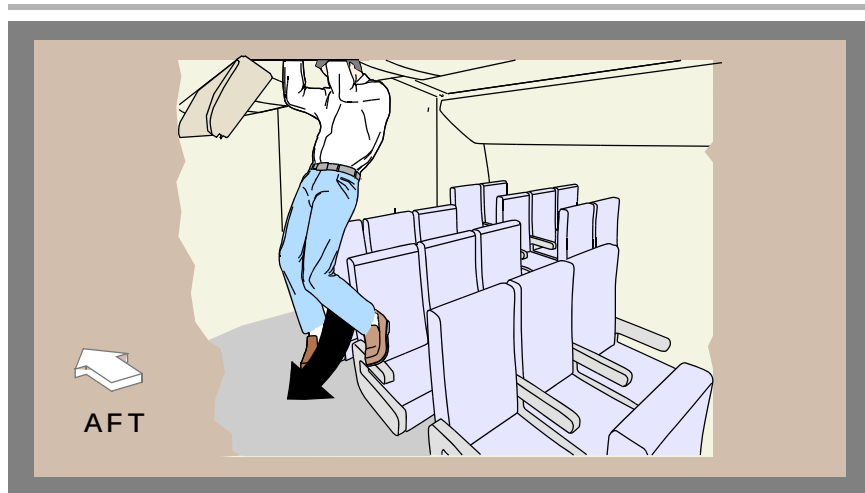
- raise upper hatch cover to fully open position to lock the hatch support hinge in place

WARNING: Failure to ensure the hatch cover is locked in position may allow the hatch to unexpectedly close causing injury.

- unlatch lower hatch
 - push the lower hatch release lever
- command passengers in immediate area to move clear of evacuation area



- sit on floor facing outboard and lower legs into hatch opening
- reach out and grab the outboard handhold
 - keep elbows close to sides



- swing down to main deck

CAUTION: During exit to the main deck, stepping on the seat back may cause the seat back to fold forward. If this occurs, the crew member may lose balance and hand grip, resulting in personal injury.

- close the lower hatch when evacuation is complete

WARNING: If the emergency hatch was used for crew evacuation, the lower hatch must be closed to help prevent the spread of smoke or fire.

Airplane General, Emergency Equipment, Doors, Windows

Door 4 Upper Crew Rest

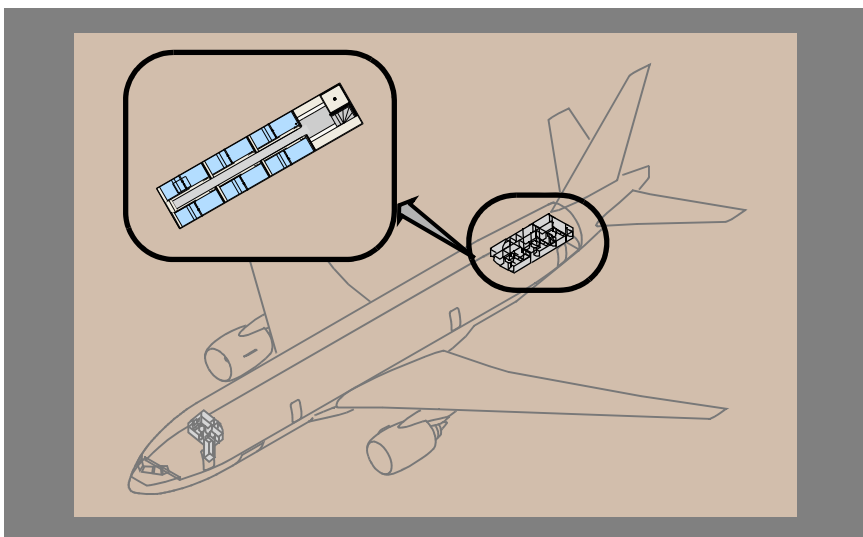
Chapter 1

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Door 4 Upper Crew Rest [AFM]

The area has its own smoke detection system but no fire extinguishing system.



Occupancy

The door 4 upper crew rest is to be occupied by crew members trained in the use of the crew rest evacuation routes, fire fighting procedures and depressurization procedures.

Note: A placard is installed indicating any door 4 upper crew rest area occupancy restrictions.

Note: The crew rest area is not to be occupied during taxi, takeoff, or landing operations.

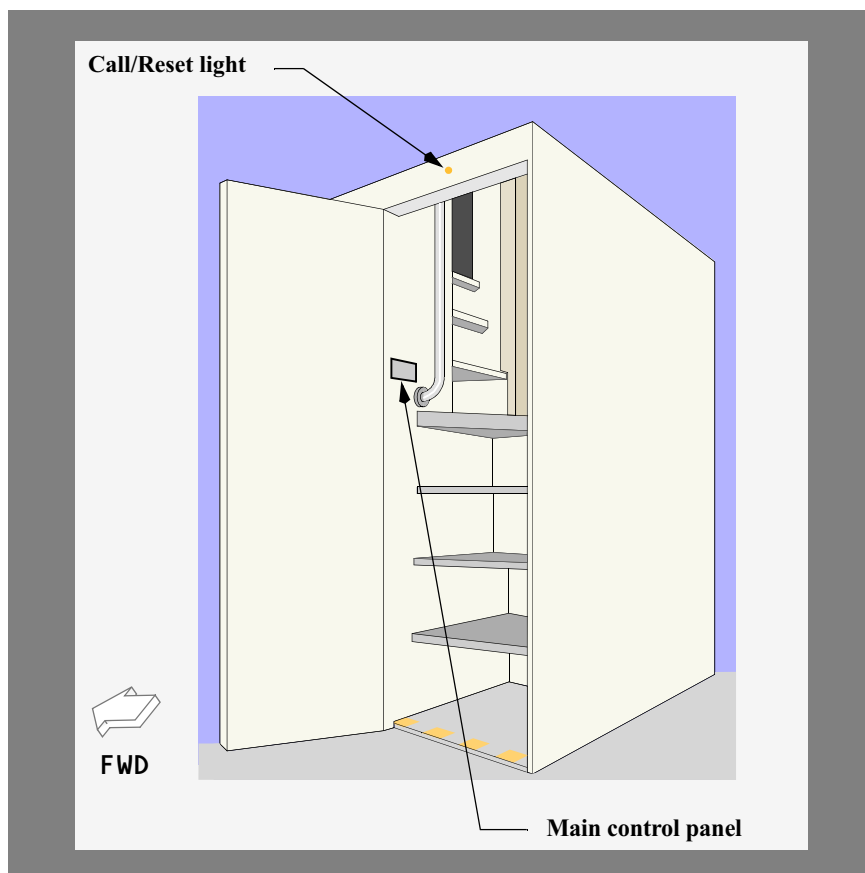
WARNING: The upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

Entrance Enclosure

Entry into the crew rest area is through an enclosure located in the passenger cabin across from door 4L. The entrance to the crew rest area has the same external appearance as a lavatory, but is placarded for crew use only.

The door should remain closed and locked at all times.

The entrance enclosure contains the main control panel.



An amber call/reset light/switch is mounted on the exterior wall above the entrance door. When smoke is detected in the area, the light flashes. The light will illuminate steady when the attendant call button on a passenger control unit (PCU) inside the area has been pushed.

Conditioned air is used to provide temperature control and ventilation to the door 4 upper crew rest area. When using the area, conditioned air flow must be available. An amber AIRFLOW OFF light on the main control panel in the entrance enclosure illuminates when conditioned air is not available.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet.

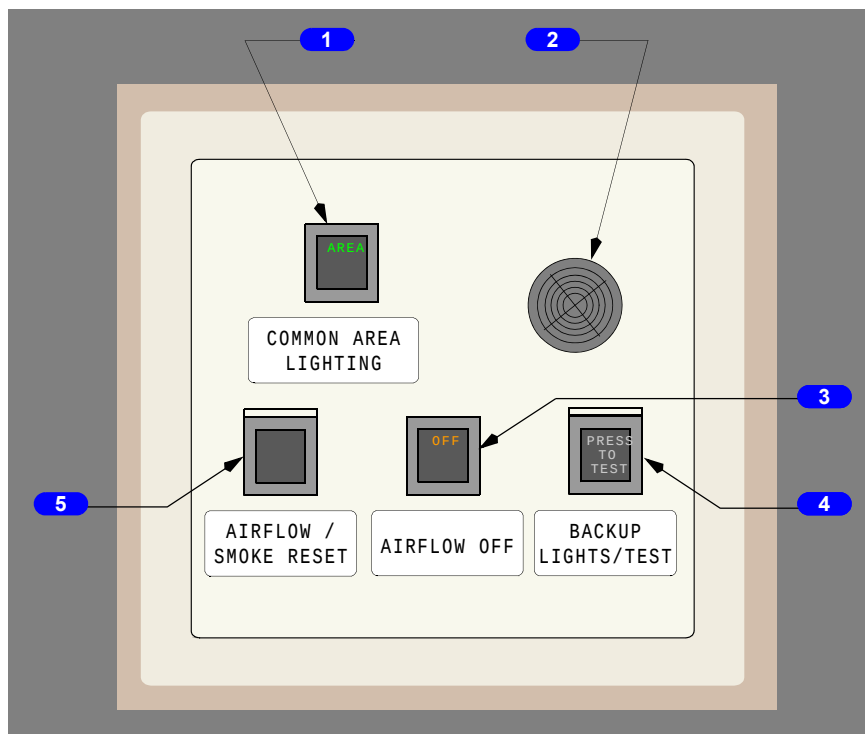
Note: If the airplane is above 25,000 feet and the AIRFLOW OFF light is illuminated, pushing the AIRFLOW / SMOKE RESET switch resets the conditioned air system.

WARNING: If the AIRFLOW OFF light remains illuminated after the AIRFLOW / SMOKE RESET switch has been pushed, the door 4 upper crew rest area should not be occupied.

Entrance Enclosure Control Panel

The door 4 upper crew rest area main control panel is located inside the entrance enclosure.

Main Control Panel



1 COMMON AREA LIGHTING Switch/Light

Push -

- turns the common seating area lights in the area on (light illuminated)/off (light extinguished)

2 Alert horn

Horn sounds when:

- airplane decompression occurs (continuous)
- smoke is detected in the overhead crew rest area (pulsating)

3 AIRFLOW OFF Light

Illuminated (amber) -

- area airflow exhaust valves are open or during smoke detection mode operations
- the area airflow is off

Note: A HI/LO chime will sound 5 times in the area whenever the air supply shutoff valve is commanded closed.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet or during smoke detection mode.

WARNING: The upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

4 BACKUP LIGHTS/TEST Switch/Light

Guarded switch/light.

Push - illuminated (white) -

- turns the emergency lights in the area on (light illuminated)/off (light extinguished)

Push and hold (2 seconds)

- the emergency lights in the area turn on for approximately one minute

5 AIRFLOW / SMOKE RESET Switch

Guarded switch.

Push and hold (2 seconds) -

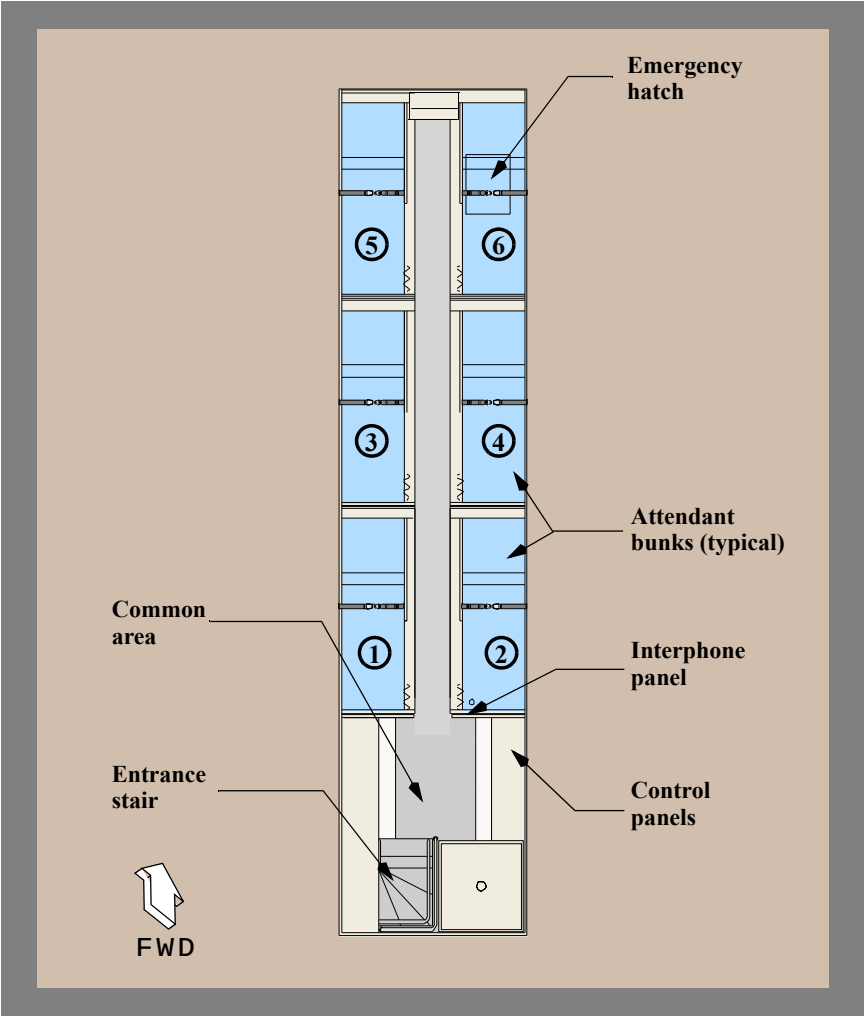
- resets the airflow to the area

Note: The AIRFLOW / SMOKE RESET switch is inoperative when:

- crew rest area smoke detectors are not in alarm
 - the airplane is on the ground and the left pack is off
 - the airplane is at or above 25,000 feet
- resets aft galley electrical power

Note: Both crew rest AIRFLOW / SMOKE RESET switches must be pushed to ensure proper restoration of the aft galley power.

Crew Rest Layout



The area contains the following:

- a common area containing:
 - control/warning panels
 - lighting and temperature control panels
 - interphone handsets (2)
- 6 bunks
- emergency hatch
- smoke detectors
- emergency equipment

Crew Rest Smoke Detection System Operation

Two smoke detector is installed in the crew rest area common area. Additionally, there is one smoke detector in each bunk area.

Note: Smoke detection is annunciated by a pulsing alarm horn sounding in the crew rest area and the entrance enclosure.

If smoke is detected in the door 4 upper crew rest area:

- on the flight deck:
 - the master caution light illuminates
 - an aural caution alarm sounds
 - a SMOKE REST UPR DR 4 Engine Indication and Crew Alerting System (EICAS) caution message is displayed
- in the crew rest area:
 - all area lights will illuminate
 - the pulsing smoke detection system alarm horns sound in the overhead area
 - the smoke detector alarm indicator light will illuminate
 - the crew rest area air supply valves are closed and the area smoke evacuation valves are opened
- at the crew rest area detector in alarm:
 - the integral smoke detector alarm horn sounds
 - the smoke detector alarm indicator light will illuminate
- at the entrance main control panel:
 - an alarm horn will sound
 - the AIRFLOW OFF light illuminates
- in the passenger cabin:
 - the amber reset light above the entrance enclosure door flashes
 - a SMOKE DETECTED DR4 UPR REST message appears on the cabin management system control panels
 - a continuous HI chime sounds:
 - at door 1L
 - in the door 1 cross aisle area
 - in the forward galley
 - at door 1R
 - at door 2L
 - the door 2 cross-aisle
 - at door 2R
 - at door 3R
 - in the crew rest area
 - the cabin master call lights flash

Continue to monitor the area until the smoke detector red alarm indicator light extinguishes.

Once the smoke clears, the red alarm indicator light extinguishes, the smoke detector is sensitive to smoke again.

Note: When the smoke detector has been activated, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor (the small screen cutout on the side of the cube extending from the unit) may clear lingering smoke.

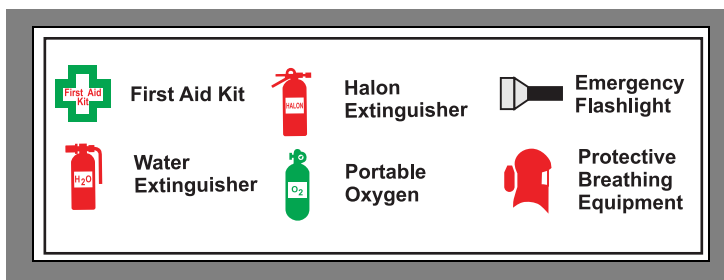
Emergency Equipment

Door 4 Upper Crew Rest Emergency Equipment

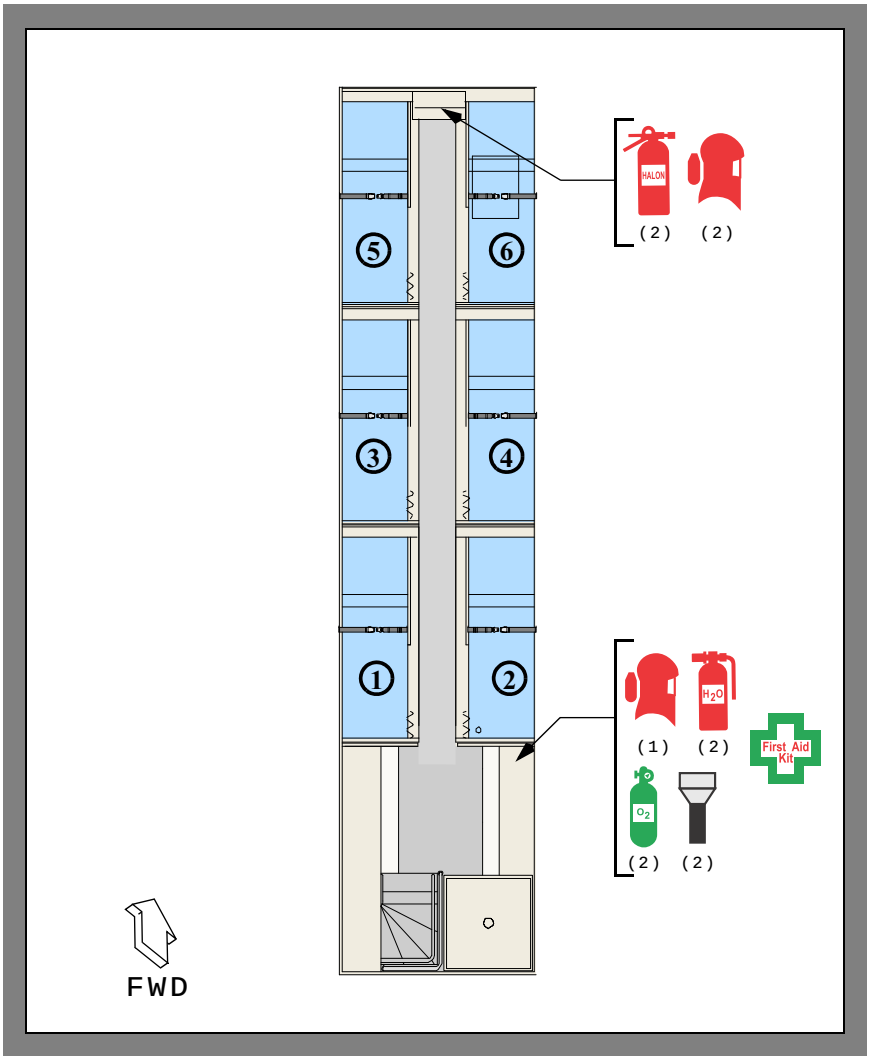
Door 4 upper crew rest emergency equipment includes:

- halon fire extinguishers (3)
- portable breathing equipment (PBE) (3)
- flashlight (1)
- crash axe (1)

Emergency Equipment Symbols



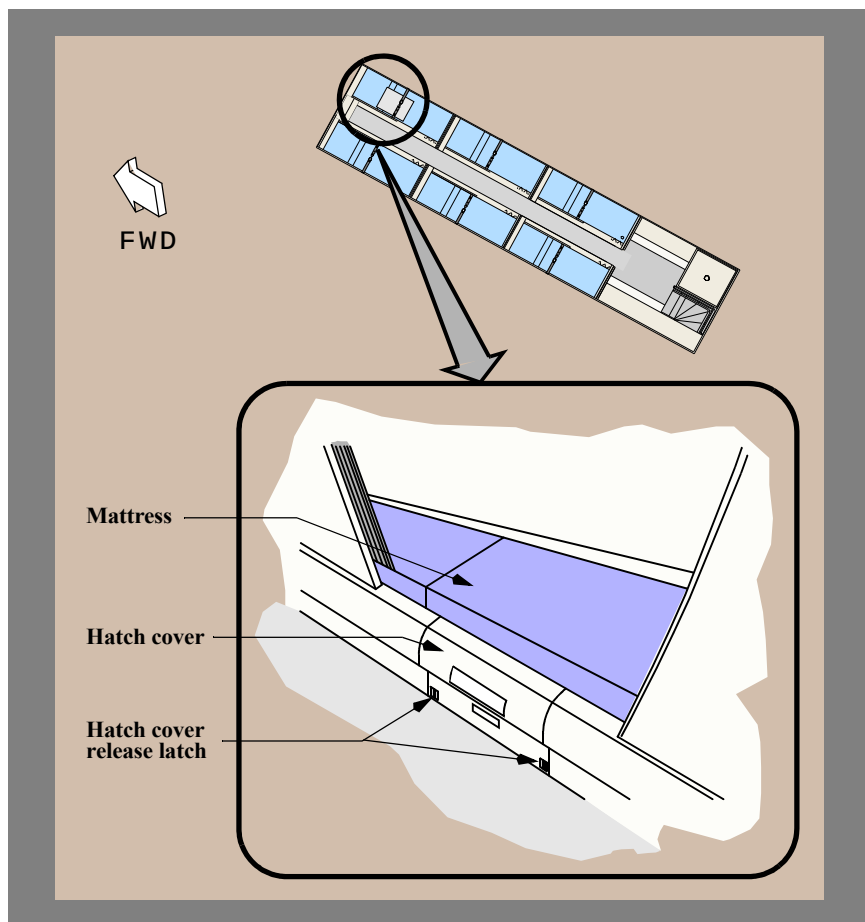
Emergency Equipment Location



Evacuation from the Crew Rest Area using the Door Upper 4 Crew Rest Emergency Hatch

The primary evacuation route is through the entrance enclosure.

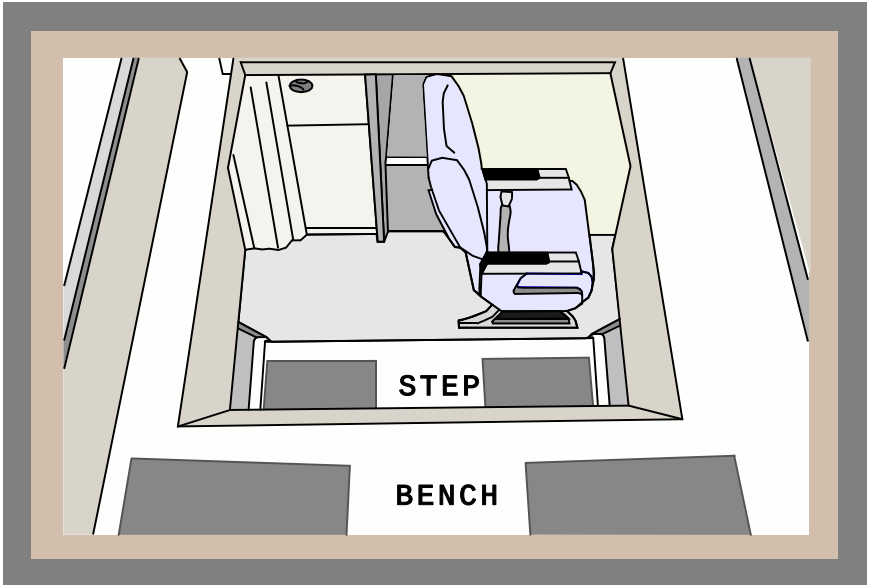
If the main entrance is unusable, evacuation is possible through the emergency hatch located between bunks 1 and 2.



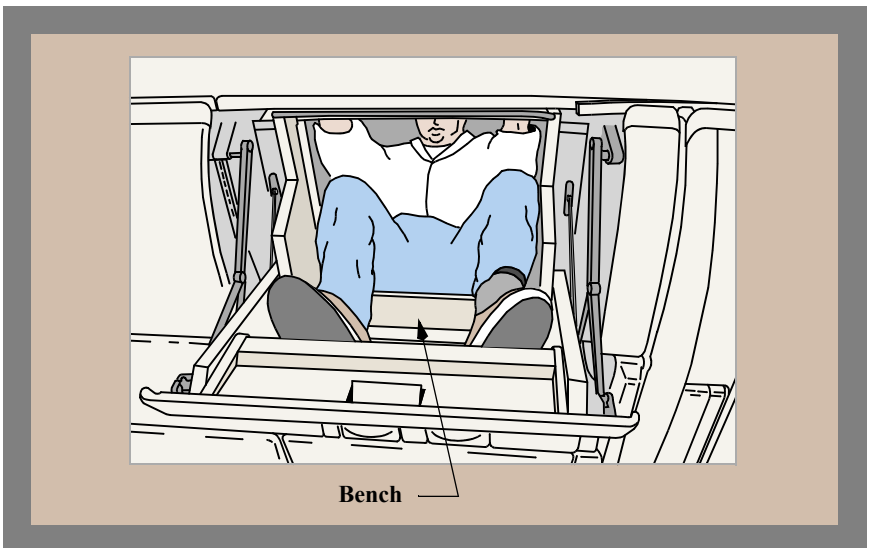
For egress:

- lift and remove the mattress pad
 - Note: Stow the mattress pad where it can not obstruct emergency hatch.
- unlatch bunk escape hatch cover
 - raise hatch cover

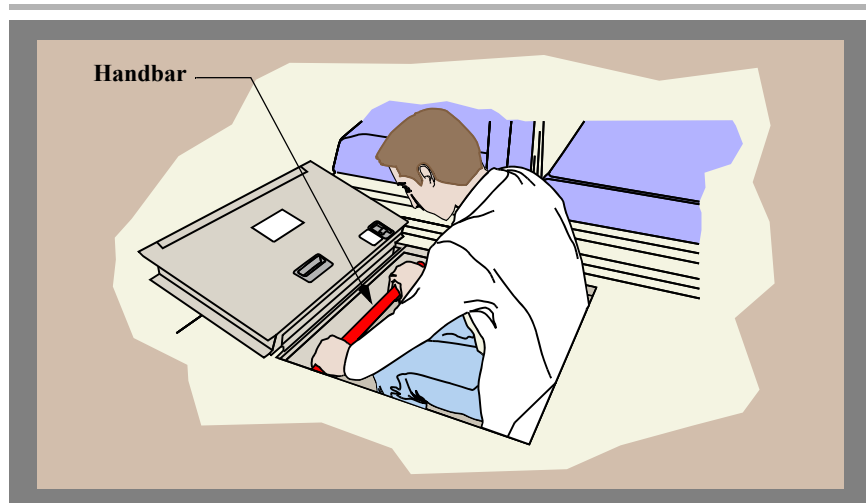
- unlatch lower hatch
- command passengers in immediate area to move clear of evacuation area



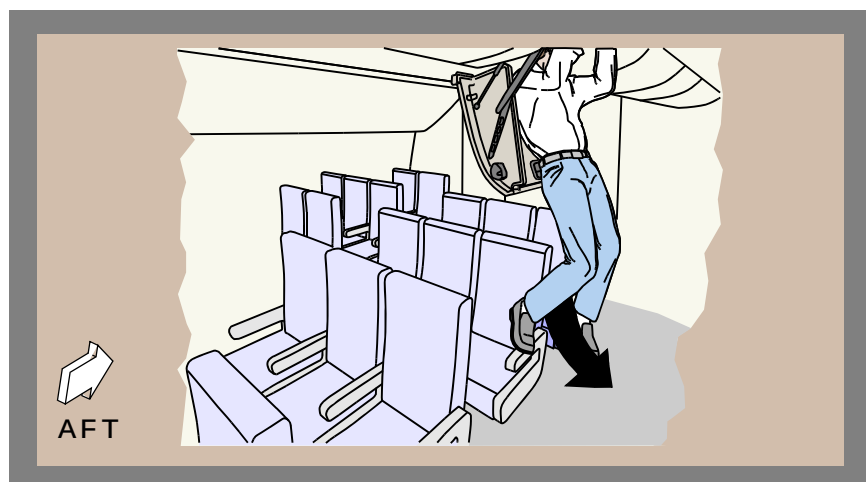
- sit on bunk facing placard
- lower legs into hatch opening



- sit on bench



- reach out and grab the handbar
- keep elbows close to sides



CAUTION: During exit to the main deck, stepping on the seat back may cause the seat back to fold forward. If this occurs, the crew member may lose balance and hand grip, resulting in personal injury.

- close the lower hatch when evacuation is complete

WARNING: If the emergency hatch was used for crew evacuation, the lower hatch must be closed to help prevent the spread of smoke or fire.

Airplane General, Emergency Equipment, Doors, Windows

Door 3 Upper Crew Rest

Chapter 1

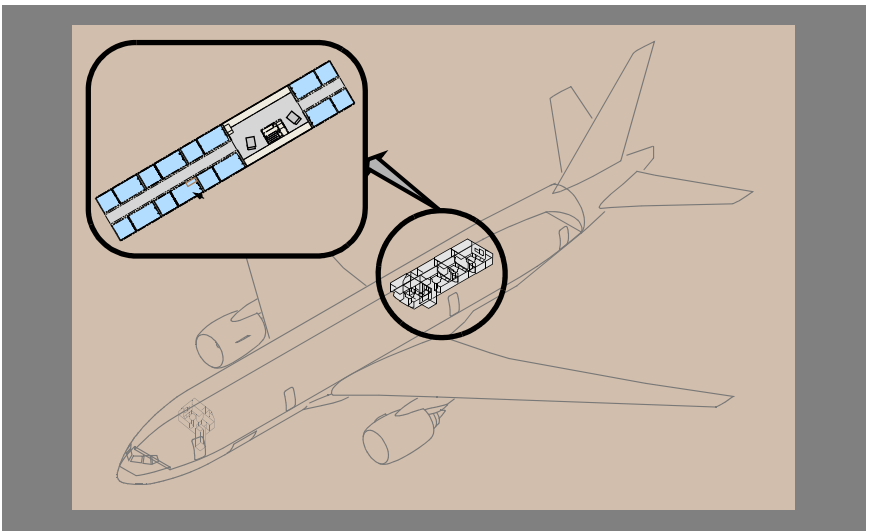
Section 48

7001 – 7008

Door 3 Upper Crew Rest [AFM]

A door 3 upper crew rest area is located in the aft part of the airplane in the overhead between doors 3 and 4. The crew rest area contains a common area with one seat and six sleeping areas.

The area has its own smoke detection system but no fire extinguishing system.



Occupancy

The door 3 upper crew rest is to be occupied by crew members trained in the use of the crew rest evacuation routes, fire fighting procedures and depressurization procedures.

Note: A placard is installed indicating any door 3 upper crew rest area occupancy restrictions.

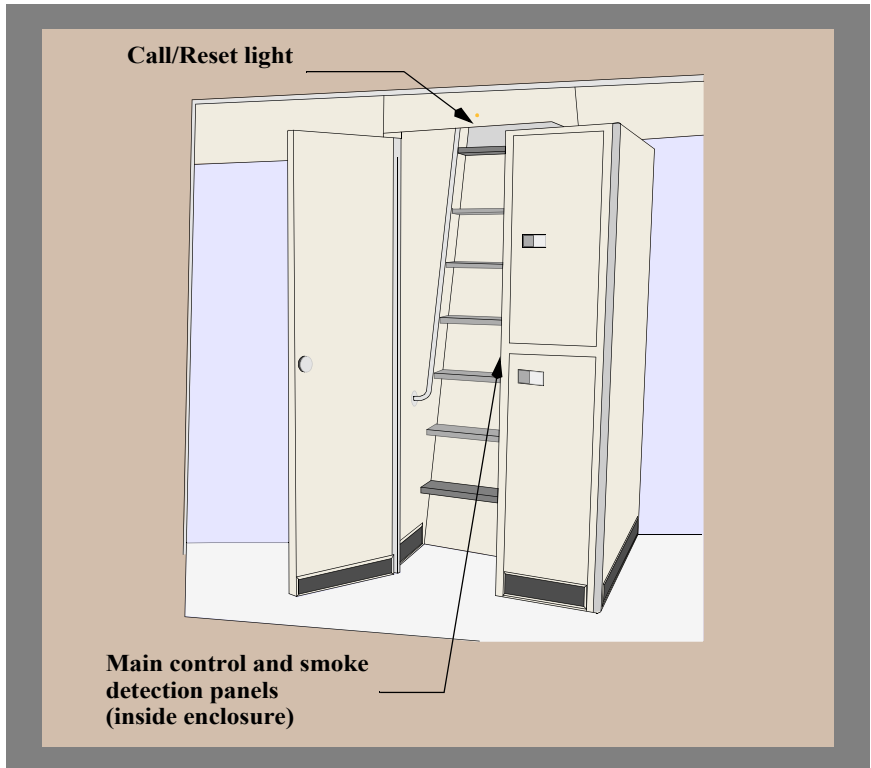
Note: The crew rest area is not to be occupied during taxi, takeoff, or landing operations.

WARNING: The upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

Entrance Enclosure

Entry into the crew rest area is through an enclosure located in the passenger cabin across from door 3R. The entrance to the crew rest area has the same external appearance as a lavatory, but is placarded for crew use only.

The door should remain closed and locked at all times.



An amber call/reset light/switch is mounted on the exterior wall above the entrance door. When smoke is detected in the area, the light flashes. The light will illuminate steady when the attendant call button on a passenger control unit (PCU) inside the area has been pushed.

Conditioned air is used to provide temperature control and ventilation to the door 3 upper crew rest area. When using the area, conditioned air flow must be available. An amber AIRFLOW OFF light on the main control panel in the entrance enclosure illuminates when conditioned air is not available.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet.

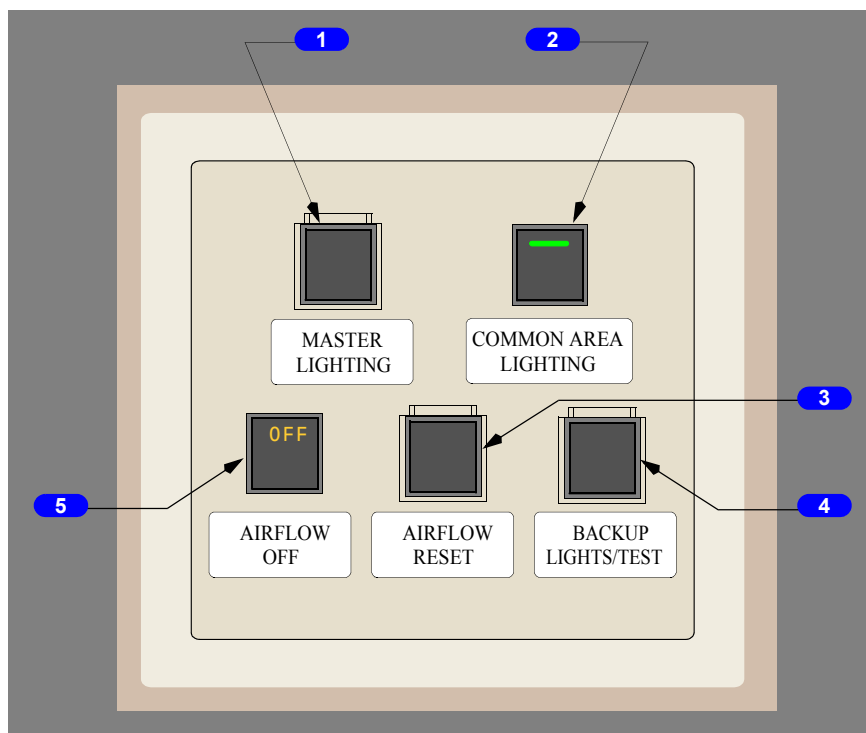
Note: If the airplane is above 25,000 feet and the AIRFLOW OFF light is illuminated, pushing the AIRFLOW / SMOKE RESET switch resets the conditioned air system.

WARNING: If the AIRFLOW OFF light remains illuminated after the AIRFLOW / SMOKE RESET switch has been pushed, the door 3 upper crew rest area should not be occupied.

Entrance Enclosure Control Panel

The door 3 upper crew rest area master panels are located inside the entrance enclosure.

Main Control Panel



1 MASTER LIGHTING Switch/Light

Push -

- turns the main lights in the area on (light illuminated)/off (light extinguished)

2 COMMON Area Lighting (LTG) Switch/Light

Push -

- turns the common seating area lights in the area on (light illuminated)/off (light extinguished)

3 AIRFLOW RESET Switch

Push and hold (2 seconds) -

- resets the airflow to the area

Note: The AIRFLOW RESET switch is inoperative when the airplane is below 25,000 feet.

4 BACKUP LIGHTS/TEST Switch/Light

Push - illuminated (white) -

- turns the emergency lights in the area on (light illuminated)/off (light extinguished)

Push and hold -

- tests the emergency lights in the area.

5 AIRFLOW OFF Light

Illuminated (amber) -

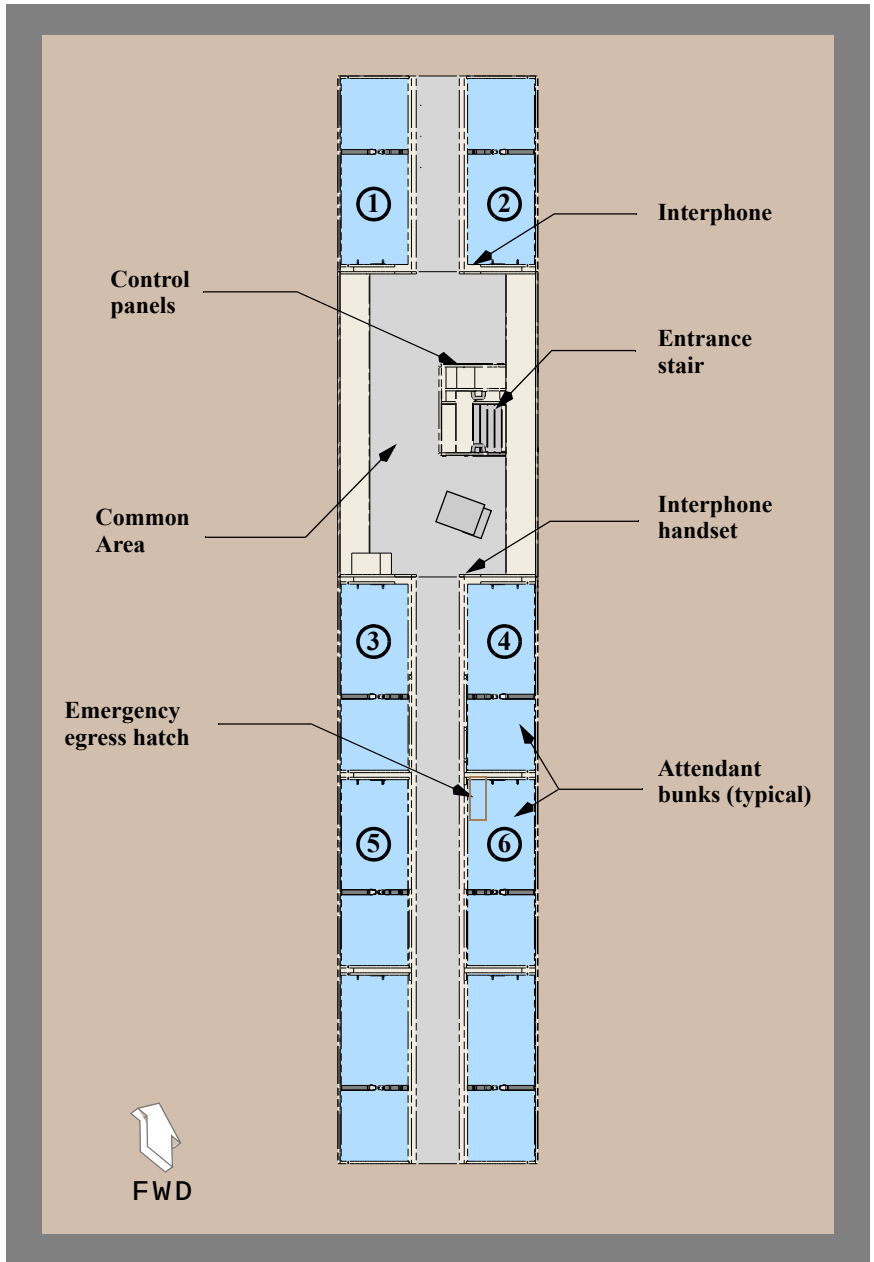
- area airflow exhaust valves are open or during smoke detection mode operations
- the area airflow is off

Note: A HI/LO chime will sound 5 times in the area whenever the air supply shutoff valve is commanded closed.

Note: The AIRFLOW OFF light will be illuminated when the airplane is below 25,000 feet or during smoke detection mode.

WARNING: The upper crew rest area should not be occupied when the amber AIRFLOW OFF light is illuminated.

Crew Rest Layout



The door 3 upper crew rest area contains the following:

- a common area containing:
 - control/warning panels
 - lighting and temperature control panels
 - interphone handset
 - 1 seat
- 6 bunks
- emergency hatch
- main control panel and 3 smoke detection panels
- smoke detectors
- emergency equipment

Crew Rest Smoke Detection System Operation

Two smoke detectors are installed in the crew rest area common area. Additionally, there is one smoke detector in each bunk area, each closet, and two in the hall.

Note: Smoke detection is annunciated by a pulsing alarm horn sounding in the crew rest area and the entrance enclosure.

If smoke is detected in the door 3 upper crew rest area:

- on the flight deck:
 - the master caution lights illuminate
 - an aural caution alarm sounds
 - a SMOKE REST UPR DR 3 EICAS caution message is displayed
- in the crew rest area:
 - the smoke detection system alarm horns sound
 - the respective smoke detector alarm indicator light illuminates
 - all area lights will illuminate
 - the crew rest area air supply valves are closed and the area smoke evacuation valves are opened
- at the entrance main control panel:
 - the AIRFLOW OFF light illuminates
 - an alarm horn sounds
 - the SMOKE DETECTED light illuminates red
 - the appropriate smoke detector zone light illuminates red
- in the passenger cabin:
 - the amber reset light above the entrance enclosure door flashes
 - a continuous high chime sounds in the passenger cabin
 - a SMOKE DETECTED CR UPR DR 3 message appears on the cabin management system control panels
 - a continuous HI chime sounds
 - the cabin master call lights flash

Continue to monitor the area until the smoke detector red alarm indicator light extinguishes.

Once the smoke clears, the red alarm indicator light extinguishes, the smoke detector is sensitive to smoke again.

Note: When the smoke detector has been activated, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor (the small screen cutout on the side of the cube extending from the unit) may clear lingering smoke.

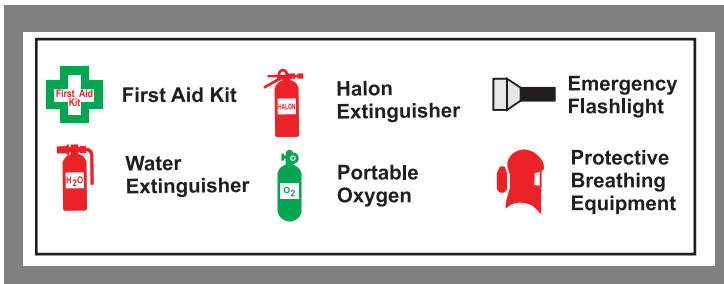
Emergency Equipment

Door 3 Upper Crew Rest Emergency Equipment

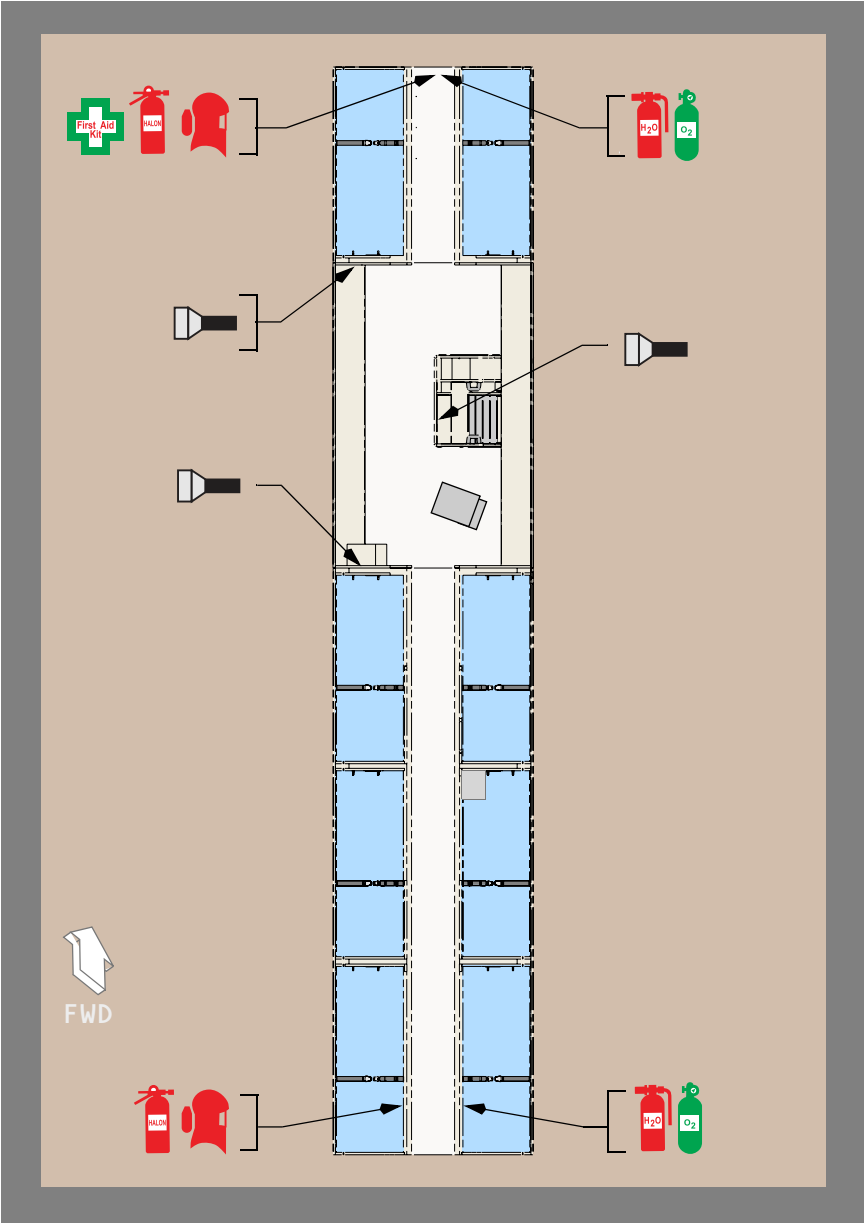
Door 3 upper crew rest emergency equipment includes:

- halon fire extinguishers (2)
- water fire extinguisher (2)
- portable oxygen bottle (1)
- portable breathing equipment (PBE) (2)
- flashlights (3)
- first aid kit (1)

Emergency Equipment Symbols



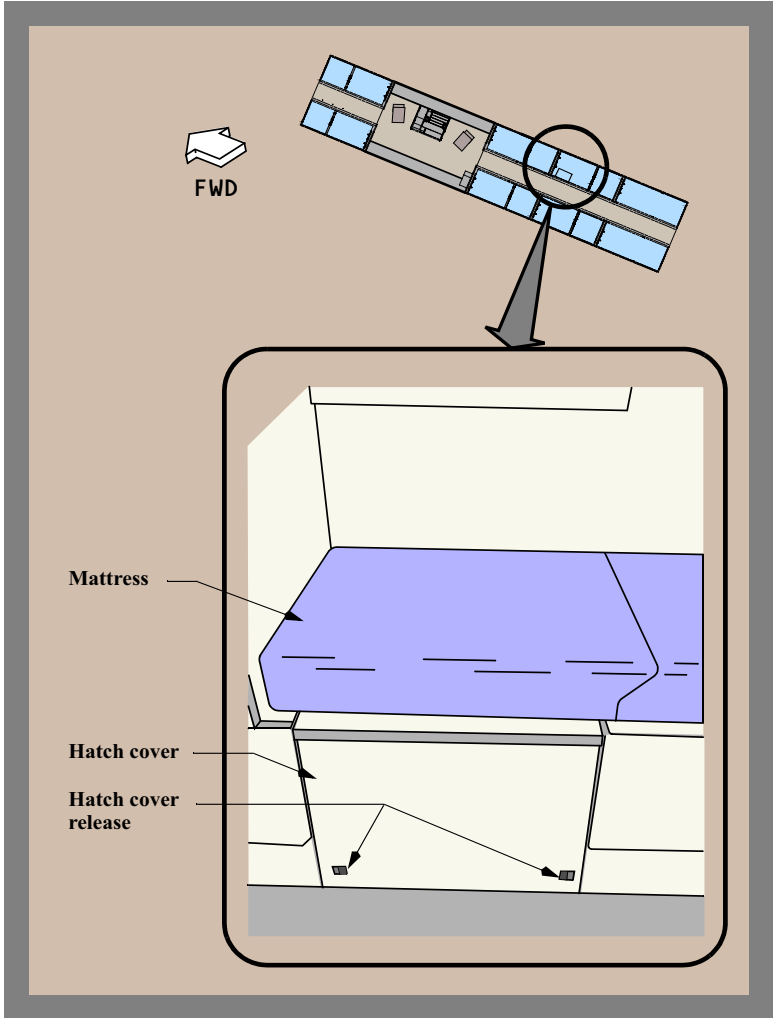
Emergency Equipment Location



Evacuation from the Crew Rest Area using the Door Upper 3 Crew Rest Emergency Hatch

The primary evacuation route is through the entrance enclosure.

If the main entrance is unusable, evacuation is possible through the emergency hatch located under bunk 6.

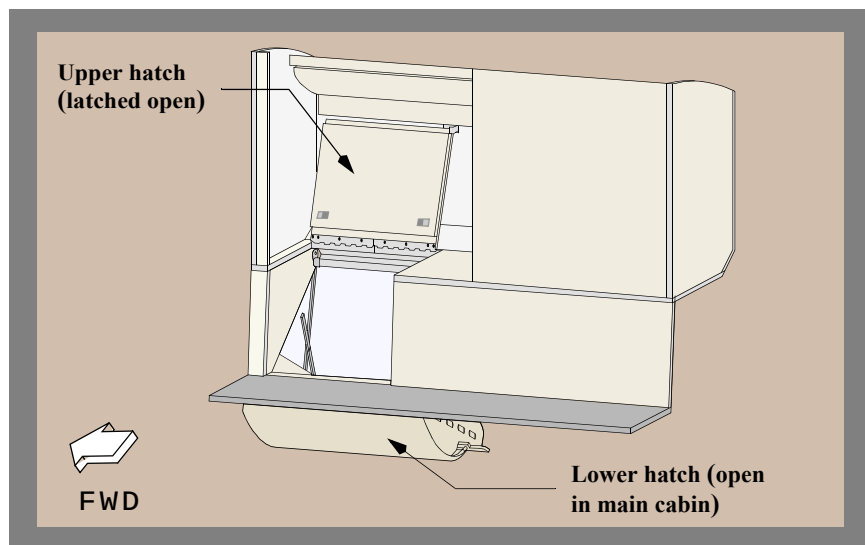


For egress:

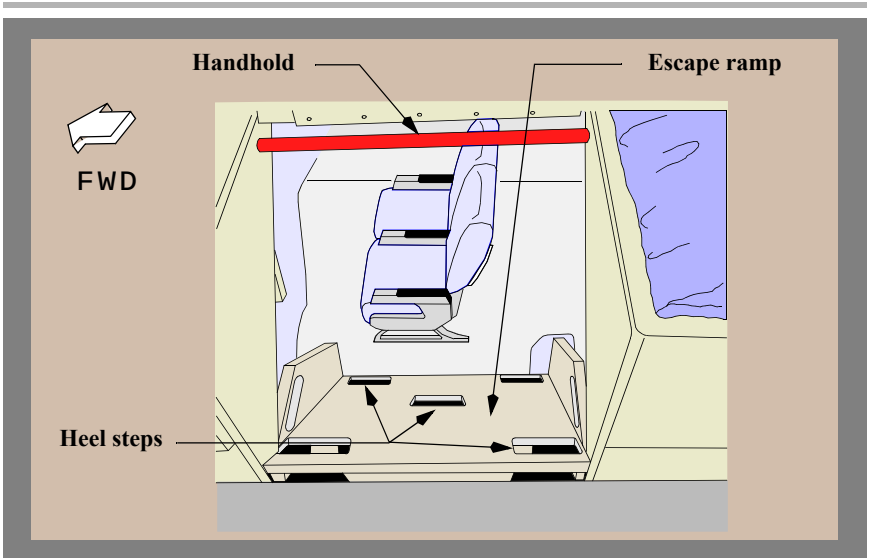
- lift and remove the mattress pad

Note: Stow the mattress pad where it can not obstruct emergency hatch.

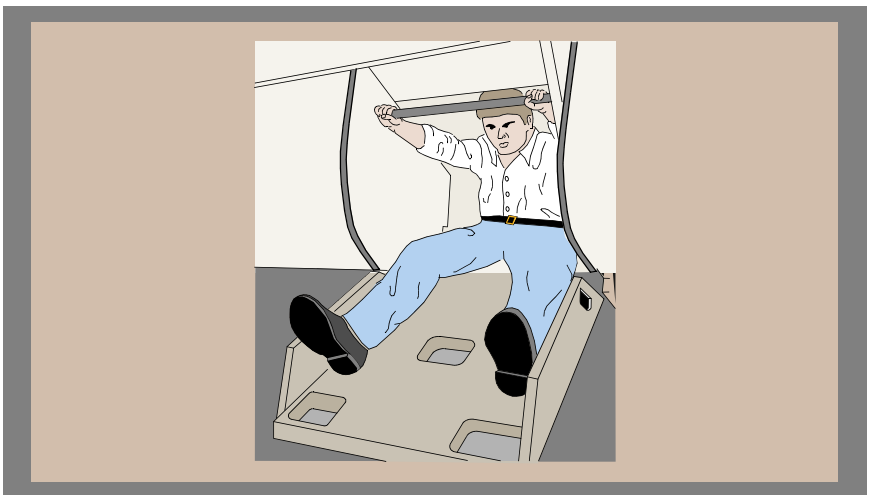
- unlatch and raise upper bunk escape hatch cover



- unlatch lower hatch
- command passengers in immediate area to move clear of evacuation area



- sit on floor facing outboard and lower legs into hatch opening



- reach out and grab the outboard handhold
 - keep elbows close to sides
- swing down to main deck
- close the lower hatch when evacuation is complete

CAUTION: During exit to the main deck, stepping on the seat back may cause the seat back to fold forward. If this occurs, the crew member may lose balance and hand grip, resulting in personal injury.

- close the lower hatch when evacuation is complete

WARNING: If the emergency hatch was used for crew evacuation, the lower hatch must be closed to help prevent the spread of smoke or fire.

Airplane General, Emergency Equipment, Doors, Windows Systems Description

Chapter 1

Section 50

Introduction

This section describes miscellaneous airplane systems, including:

- doors and windows
- flight deck seats

Doors and Windows

The airplane has eight passenger entry doors, one flight deck door (the flight deck/passenger cabin entry), and three cargo doors. It also has two center electrical and electronic (E/E) equipment access doors, one forward and one main.

CAUTION: Do not operate the entry or cargo doors with winds at the door of more than 40 knots. Do not keep doors open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.

The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

An EICAS message is displayed when a passenger door, cargo door, access door, or flight deck window is not closed, latched, and locked.

Flight Deck Door

The flight deck door meets requirements for resistance to ballistic penetration and intruder entrance. The door opens into the flight deck. When closed, the door locks when electrical power is available and unlocks when electrical power is removed. A viewing lens in the door allows observation of the passenger cabin. The door can be manually opened from the flight deck by turning the door handle.

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The door incorporates a deadbolt with a key lock. Rotating both concentric deadbolt levers to the locked (horizontal) position prevents the passenger cabin key from unlocking the door. Rotating only the forward deadbolt lever to locked allows the key to unlock the door.

7001 - 7008

A mechanical latch pin is stored in a hole on the door catch sidepost on the flight deck side of the door. The pin is attached to the side post with a lanyard.

All

The flight deck access system consists of an emergency access panel, a chime module, a door lock selector, two indicator lights, and an access system switch (LR). The emergency access panel includes a six button keypad for entering the numeric emergency access code along with red, amber, and green lights. The red light illuminates to indicate the door is locked. When the correct emergency access code is entered, the amber light illuminates. The green light illuminates to indicate the door is unlocked.

Two indicator lights and a three position rotary door lock selector are located on the aft aisle stand (LR) or the overhead panel (ER). Illumination of the amber LOCK FAIL light indicates the door lock has failed or the access system switch is in the OFF position.

A keypad is located on the cabin side of the flight deck. The emergency access code may be entered on the keypad to gain access to the flight deck in case of pilot incapacitation or the door is inadvertently locked during ground operations.

Annunciation of a flight deck chime and illumination of the amber AUTO UNLK light indicates the correct emergency access code has been entered and the door is programmed to unlock after a time delay. Selecting the DENY position on the door lock selector denies entry and prevents further keypad entry for several minutes. To allow entry, the selector is turned to the UNLKD position which unlocks the door while held in that position. If the emergency access code is entered and the pilot takes no action, the door unlocks after expiration of the time delay. Before the door unlocks, the chime sounds continuously and the AUTO UNLK light flashes.

The door latch system incorporates a pressure rate-sensor that unlocks the door in the event of flight deck depressurization. Two hinged decompression panels open to equalize pressure in the event of cabin depressurization. Each panel opening has a security grill on the flight deck side.

Features are included to prevent a jammed door due to structural deformation. A lower break-away panel is attached to the main door section by interlocking extrusions and two shear pins. If sufficient upward force occurs, the pins will shear and the break-away panel will separate from the door. If the pins fail to shear, they can be retracted manually to aid in egress. An angled door jamb aids in forcing the door open into the flight deck in case of surrounding bulkhead deformation.

Mechanical Latch Pin

7001 – 7008

The pin is designed to accomplish the following:

- On the ground:
 - prevents inadvertent locking of flight deck door once the door has been opened.
- Inflight (if electrical locking system inoperative):
 - prevents flight deck door being opened from the cabin side

Note: A placard is located below the pin stowage hole. This placard refers to normal operations in which the electrical access is operating normally. Any time the electrical access system is not working, the pin must be used to secure the door in flight.

To lock the door, ensure the door is in the fully closed position. Remove the latch pin from its stowage hole and insert it into the hole on the flight deck side of the door latch mechanism.

The mechanical latch pin will reach to the back surface of the rotatable catch and interfere with the movement (rotation) of the catch so it will be kept locked manually. The pin is designed to allow the door to be opened from inside the flight deck even though the door cannot be opened from outside the flight deck.

Flight Deck Number Two Windows

The flight deck number two windows can be opened on the ground or in flight. The flight deck number two windows can be used for emergency evacuation. The associated window lock lever locks or unlocks the window. With the window unlocked, rotating the window crank opens the window. To open the window:

- rotate the window lock lever aft to the open position
- crank the window to the full open position (the WINDOW NOT CLOSED placard is visible).

When closing the window, the window lock lever must be in the unlocked position. As the window approaches the full closed position, the force required on the crank increases. To close the window:

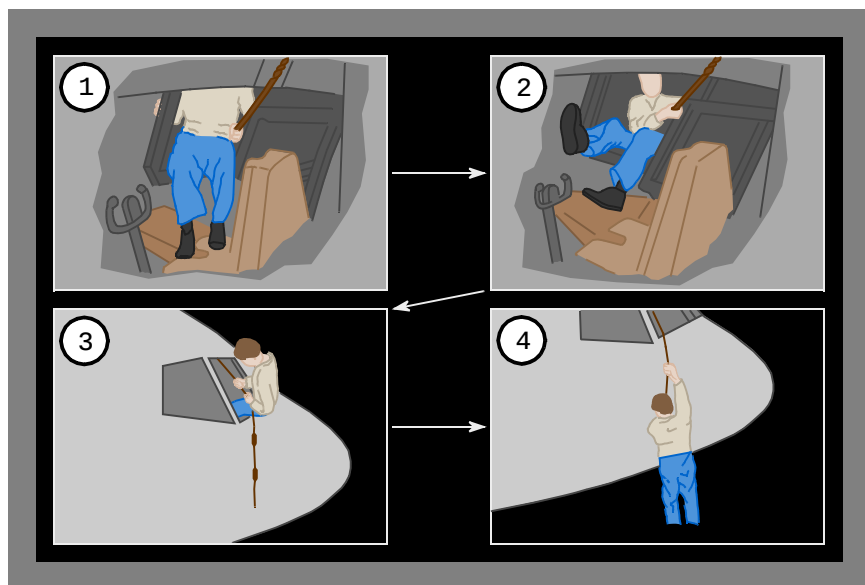
- crank the window to the full closed position (the WINDOW NOT CLOSED placard is not visible)
- rotate the window lock lever forward to the locked position.

The windows can be opened or closed in flight with minor flight deck consequences if the airplane is unpressurized. The force required to move the crank increases with airspeed. With the window open, voice, interphone, and radio audio may not be heard due to high noise levels. Prior communications arrangements with the controlling agency should be established before opening the window. The design provides an area of relatively calm air over the open window. Forward visibility can be maintained by looking out of the open window.

Escape ropes are attached to the airplane structure above both number two flight deck windows. The ropes are stowed in compartments above the pilot seats.

The EICAS advisory message WINDOW FLT DECK (L or R) or WINDOWS (both windows) is displayed if the window(s) are not closed and latched.

Flight Deck Window Emergency Egress



If the flight deck number two windows must be used for emergency egress, use the following procedure:

- open the window
- remove the bag containing the rope (above and aft of window)
- pull on rope to ensure it is securely attached
- throw the bag out the window (bag falls off)
- check the first rope handhold is green and is located in the window opening
- sit on the window sill with upper body outside
- exit in accordance with the above illustration.

CAUTION: Ensure the rope is securely fastened to the airplane.

Passenger Entry Doors

The passenger entry doors are used to enter and exit the airplane, and also serve as emergency exits. There are no other passenger cabin exits. The eight passenger entry doors are paired along the airplane fuselage. The doors are identified 1 through 4 left, and 1 through 4 right. The passenger entry doors can be opened or closed manually from inside or outside of the airplane.

The entry doors are translating, plug-type doors. During opening, the door first moves inward and upward, then translates outward and forward. Each door is held in the open position by a gust lock. The gust lock drops into a latch as the door nears its forward limit of travel. A window in each door allows observation outside of the airplane.

Each door has a vent panel connected to the door handle. The vent is designed to prevent pressurization to an unsafe level if the door is not fully closed, latched, and locked. Forward rotation of the door handle past the latched position closes the vent. Initial aft door handle rotation opens the vent to equalize cabin and ambient pressure. At low differential pressure, the door handle can be rotated to allow the door to open fully. At high differential pressure, the vent can be partially opened; however, a mechanical interlock prevents door opening until the differential pressure is reduced. At very high differential pressure, the vent cannot be opened.

Passenger Entry Door Flight Lock

Each door handle is automatically locked when airspeed is greater than 80 knots. The flight lock allows limited door handle rotation sufficient to partially open the door vent, but prevents door opening. If electrical power is removed or fails, the flight lock is spring-loaded to the unlocked position.

Entry Door Slide/Raft

Emergency evacuation slide/raft and emergency power assist systems are contained in each entry door. Each emergency power assist system has enough power to pneumatically open the door unassisted, even if the airplane is not level because of any landing gear collapse condition. A slide/raft cover in the lower face of the door contains the slide/raft.

Emergency Exit Operation

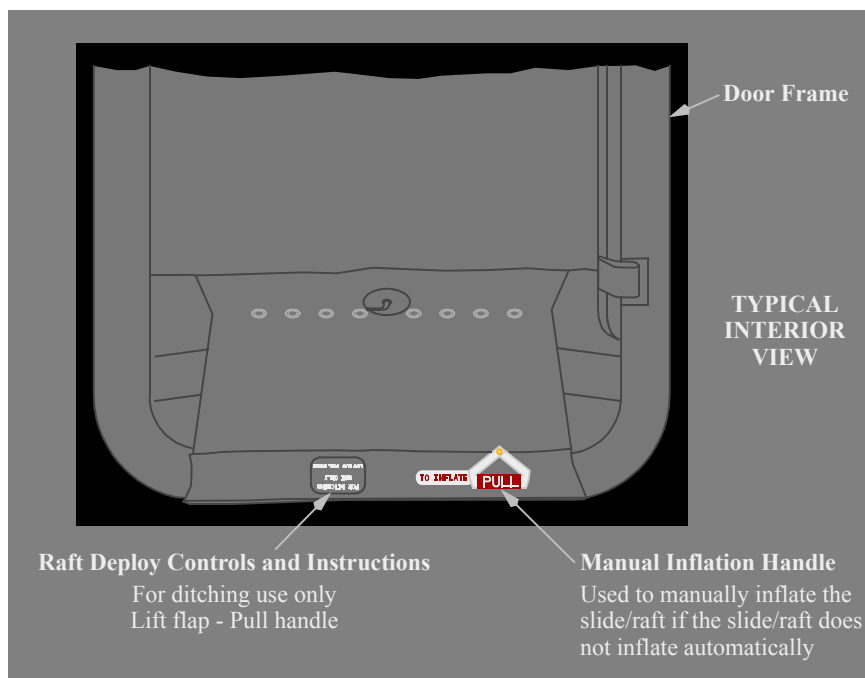
Placing the mode select lever in the ARMED position:

- arms the emergency power assist system
- engages the girt bar on entry doors
- arms the escape slide/rafts

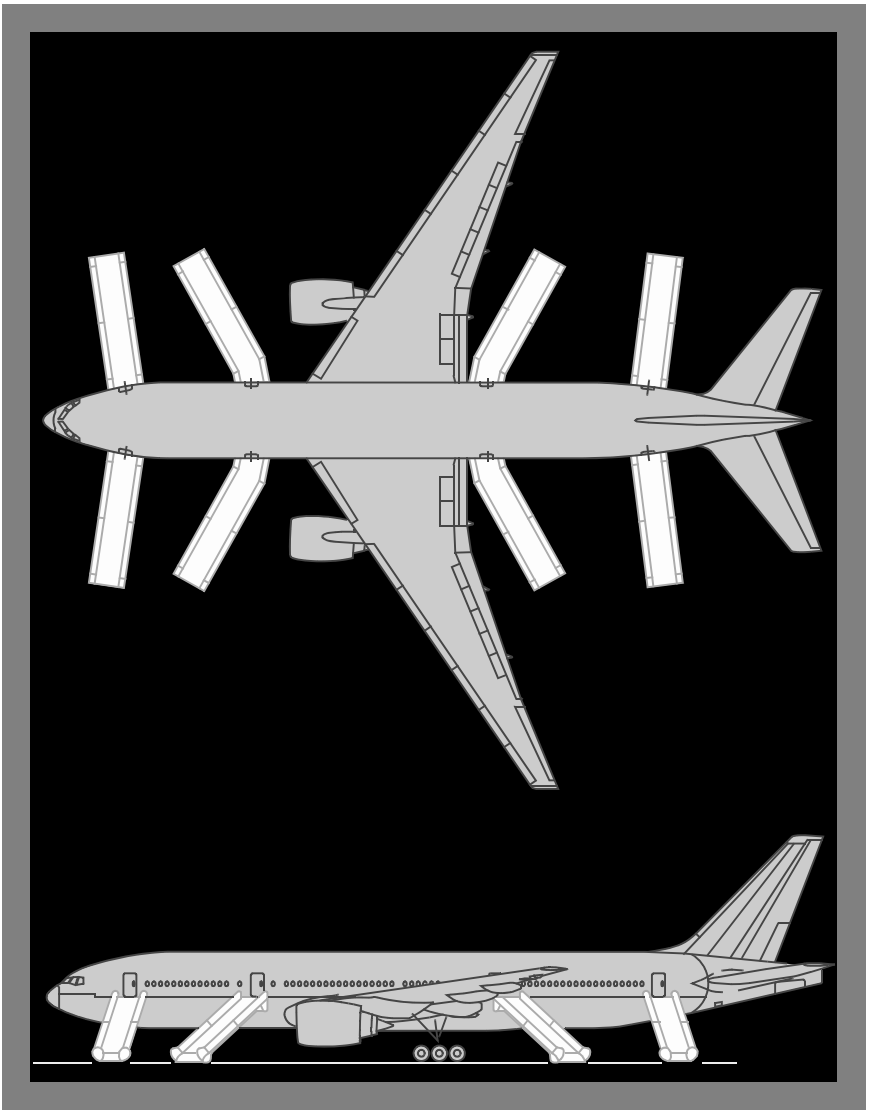
Once armed, moving the interior door handle to the open position operates the emergency power assist system actuator. The pneumatic actuator drives the door open, and the slide automatically deploys and inflates.

The emergency power assist system and the slide/raft are automatically disarmed when the door is opened from the outside. If the mode select lever is in the ARMED position and the door is opened using the exterior door handle, the mode select lever automatically moves to DISARMED and the door opens without slide/raft deployment.

Slide/Raft Deployed



Evacuation Slide/Rafts



Cargo Doors

There are three lower cargo doors located on the right side of the airplane; one forward, one aft, and one bulk. The cargo doors all open upward. The forward and aft cargo doors open outward and the bulk cargo door opens inward.

Both forward and aft cargo doors are normally operated electrically from an exterior or interior fuselage-mounted control panel located with each door. A control panel light indicates cargo door latching. Forward and aft cargo door locking is accomplished manually. If necessary, the forward and aft cargo doors may be operated manually.

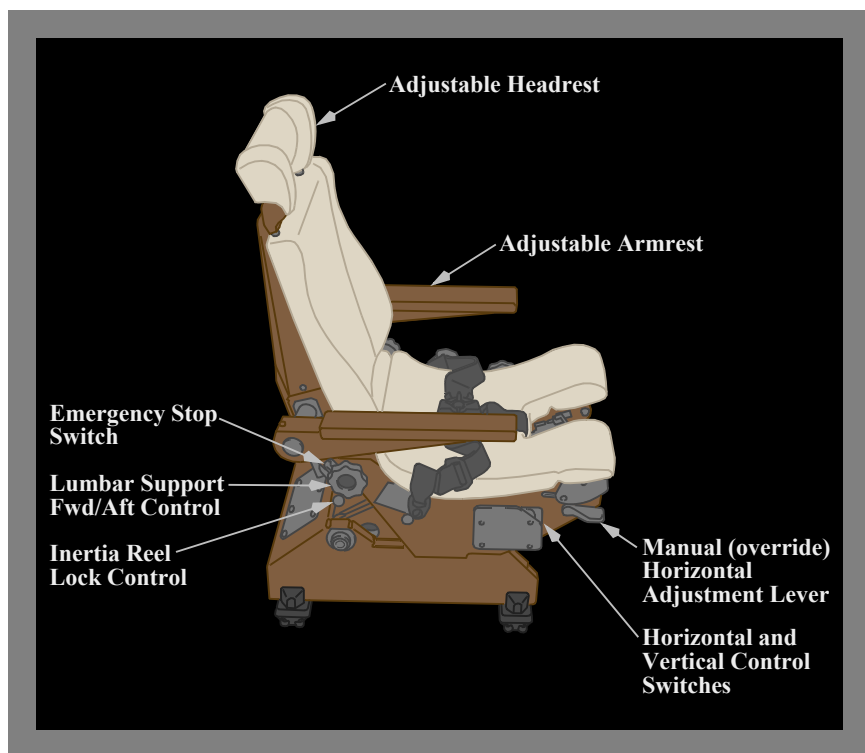
The bulk cargo door is manually opened and closed, and is counterbalanced for ease of operation.

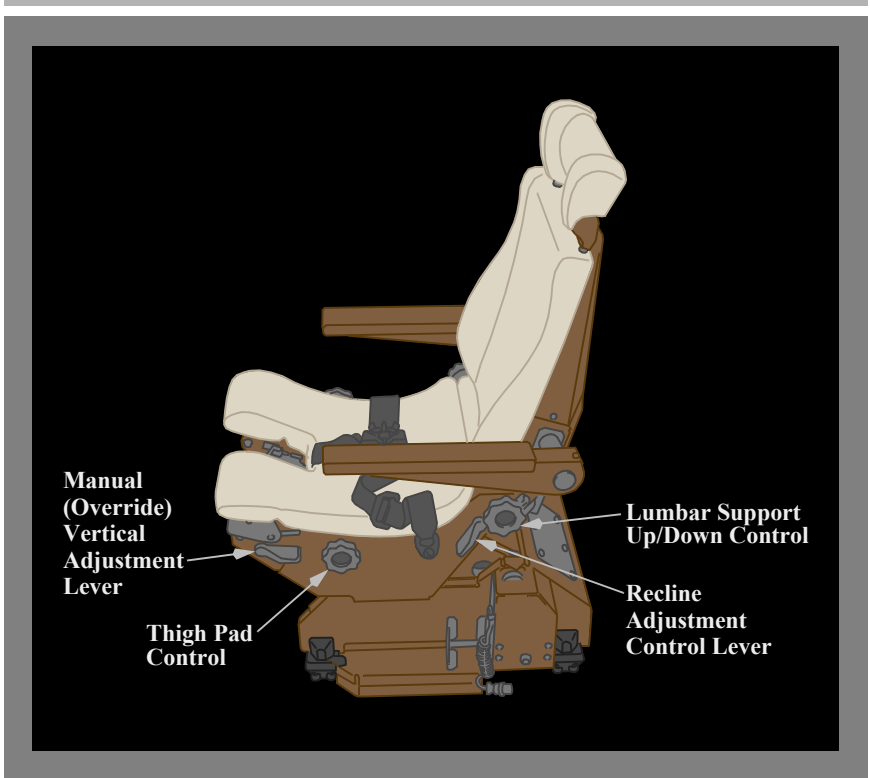
Flight Deck Seats

The flight deck has three seat types:

- pilot seats (captain and first officer)
- first observer seat
- second observer seat.

Pilot Seats





The pilot seats:

- recline
- adjust vertically
- adjust forward and aft
- adjust for thigh support
- adjust for the lumbar region of the back.

The seats also have:

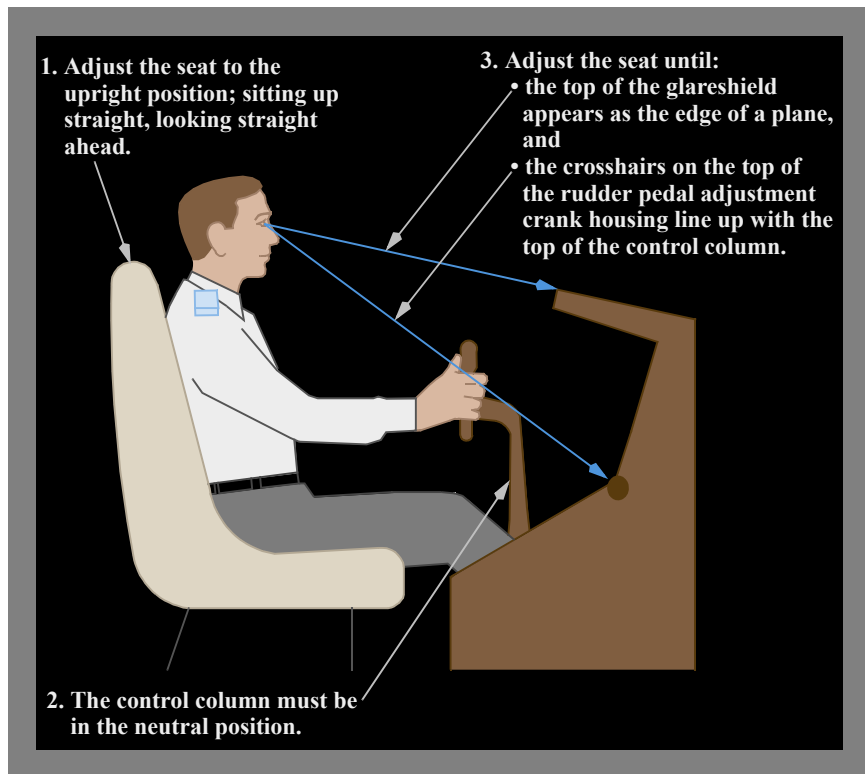
- adjustable armrests
- crotch straps
- inertial-reel shoulder harnesses with manual locks
- lap belts
- adjustable headrests.

The seats move outboard during the last two inches of aft travel. Electric and manual controls provide forward, aft, and vertical adjustment. Manual levers provide other adjustments.

Lumbar and thigh pad support can be adjusted using the adjustment hand wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access. The headrest angle can be adjusted by moving the cushion to the right and turning it.

Adjust the seat to obtain the optimum eye position as shown on the following illustration.

Pilot Seat Adjustment



Observer Seats

The first observer seat is pedestal-mounted. It adjusts manually in the vertical, forward and aft directions. The seat has:

- a folding arm rest on the left side
- lap belt
- adjustable headrest.
- crotch strap
- inertial-reel shoulder harness with manual locks

The second observer seat is not adjustable. The seat has:

- folding arm rests
- lap belt
- adjustable headrest.
- crotch strap
- shoulder harness with manual locks

Intentionally
Blank

Airplane General, Emergency Equipment, Doors, Windows EICAS Messages

Chapter 1

Section 60

Airplane General, Emergency Equipment, Doors, Windows EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
CREW OXYGEN LOW	Advisory		Crew oxygen pressure is low.
DOOR AFT CARGO	Caution	Beeper	Cargo door is not closed and latched and locked.
DOOR BULK CARGO	Advisory		Bulk cargo door is not closed and latched and locked.
DOOR E/E, FWD ACCESS	Advisory		Access door is not closed and latched and locked.
DOOR ENTRY 1-4L, R	Advisory		Entry door is not closed and latched and locked.
DOOR FWD CARGO	Caution	Beeper	Cargo door is not closed and latched and locked.
DOORS	Advisory		Two or more doors are not closed and latched and locked.

7101 - 7110

ELT ON	Advisory		Emergency locator transmitter is on.

EMER LIGHTS	Advisory		Emergency lighting system has been manually activated or emergency lights switch is OFF.
PASS OXYGEN ON	Advisory		Passenger oxygen system is activated.
WINDOW FLT DECK L, R	Advisory		Side window is not closed and latched.
WINDOWS	Advisory		Left and right side windows are not closed and latched.

EICAS Memo Messages

Message	Level	Aural	Message Logic

7001 - 7008

NO SMOKING ON	Memo		NO SMOKING switch is in the on position.
PASS SIGNS ON	Memo		The NO SMOKING and SEAT BELTS switches are in the on position.

SEATBELTS ON	Memo		The SEAT BELTS switch is in the on position.

Air Systems

Chapter 2

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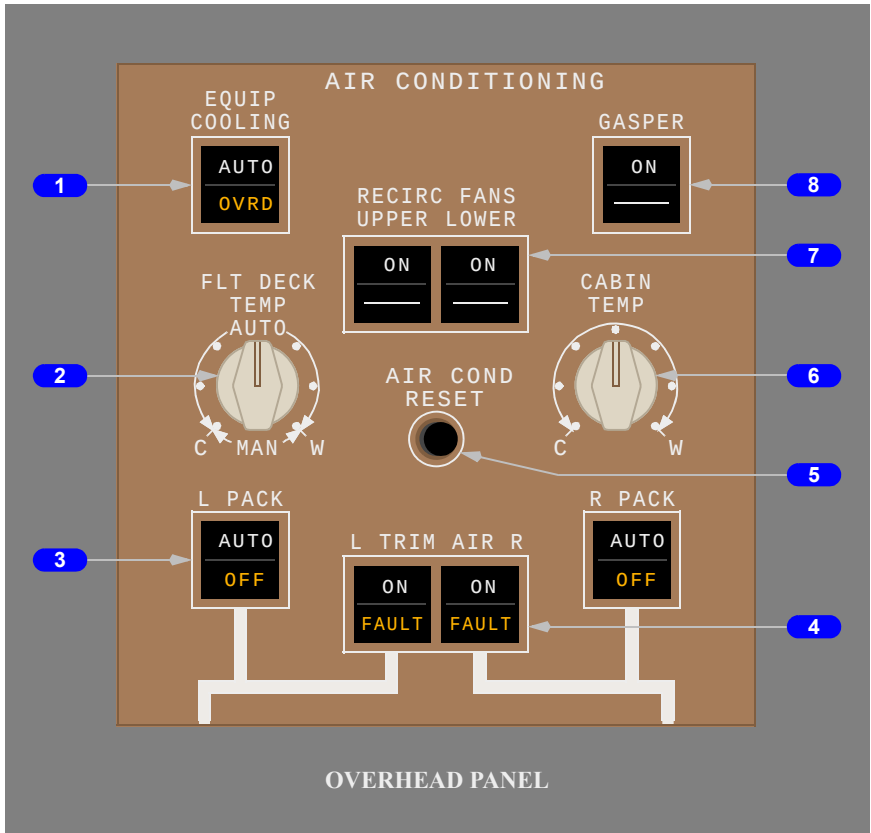
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Air Systems Controls and Indicators

Chapter 2 Section 10

Air Conditioning System

Air Conditioning Panel



1 Equipment Cooling (EQUIP COOLING) Switch

AUTO – equipment cooling mode is controlled automatically.

Off (AUTO not visible) –

- both equipment cooling supply fans are not operating
- the override valve is open
- the forward cargo heat valve is closed
- the OVRD light is illuminated

OVRD (override) illuminated (amber) – equipment cooling override valve is open.

2 Flight Deck Temperature (FLT DECK TEMP) Control

AUTO –

- provides automatic temperature control for the flight deck
- turning the control toward C or W sets the desired temperature between 65 degrees F and 85 degrees F. Mid position (12 o'clock) sets approximately 75 degrees F.

MAN (manual) –

- provides manual control of the flight deck trim air modulating valve
- turning the control from the MAN position to the C detent drives the flight deck trim air modulating valve toward closed to provide cooler air
- turning the control from the MAN position to the W detent drives the flight deck trim air modulating valve toward open to provide warmer air.

3 PACK Switches

AUTO – the pack is automatically controlled.

OFF (AUTO not visible) – the pack flow control valves are commanded closed.

OFF illuminated (amber) – the pack flow control valves are commanded closed:

- automatically during engine start
- automatically due to a pack or compressor outlet high temperature, both flow control valves failed closed, no pneumatic air, or
- OFF is manually selected.

4 TRIM AIR Switches

ON – the trim air valve is commanded open.

Off (ON not visible) –

- the trim air valve is commanded closed, and
- FAULT illuminates.

FAULT illuminated (amber) –

- the trim air valve is failed closed
- the trim air valve is commanded closed because of a zone supply duct overheat, or
- the TRIM AIR switch is selected off.

5 Air Conditioning Reset (AIR COND RESET) Switch

Push –

- resets any closed pack flow control valves or trim air valves held closed due to overheat, control failure, or valve failure
- attempts to reset a failed recirculation fan
- resets fault protection.

6 Cabin Temperature (CABIN TEMP) Control

Provides automatic passenger cabin temperature control.

Turning the control toward C or W sets the passenger cabin master reference temperature between 65 degrees F and 85 degrees F.

7 Recirculation Fans (RECIRC FANS) Switches

ON – provides automatic operation of the associated recirculation fans.

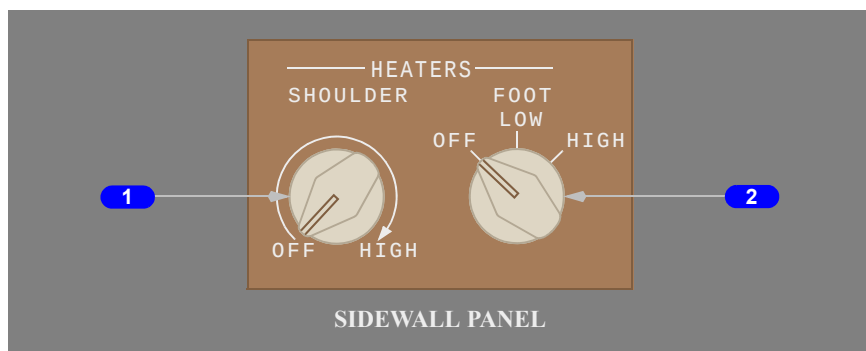
Off (ON not visible) – the selected recirculation fans do not operate.

8 GASPER Switch

ON – the gasper fan operates.

Off (ON not visible) – the gasper fan does not operate.

Shoulder and Foot Heaters



1 SHOULDER HEATER Control

OFF – the electric heater is not operating (no heat added to the conditioned air flowing at shoulder level).

Turn – the electric heater adds heat to the conditioned air flowing in at shoulder level at variable temperature settings up to HIGH.

2 FOOT HEATER Selector

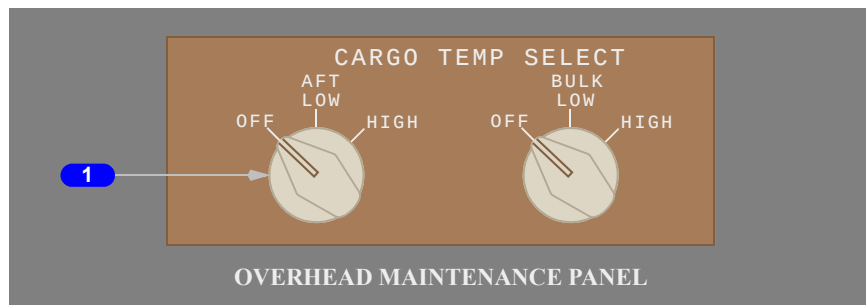
OFF – the under-floor electric heater is not operating.

LOW – the under-floor electric heater operates on low setting.

HIGH – the under-floor electric heater operates on high setting.

Cargo Temperature Control

Aft and Bulk Cargo Temperature Control



1 CARGO TEMPERATURE Selectors

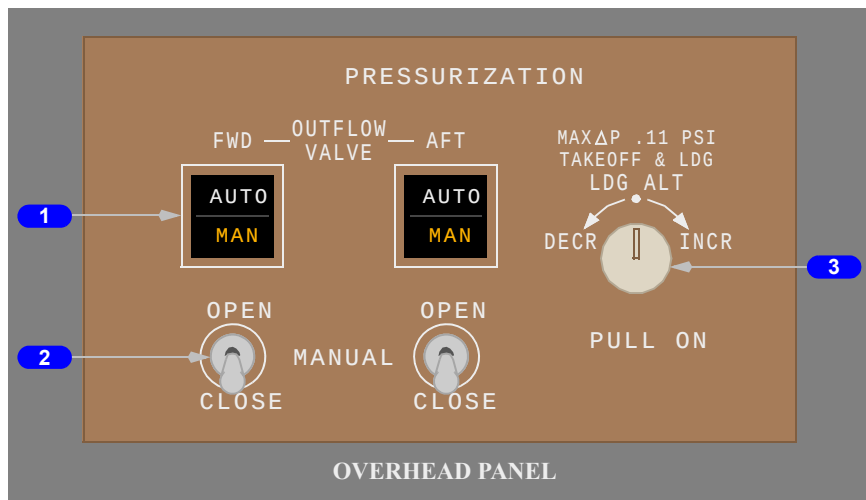
OFF – shuts off bleed air to the compartment.

LOW – the compartment temperature is maintained between 40 and 50 degrees F.

HIGH – the compartment temperature is maintained between 65 and 75 degrees F. For the bulk compartment only, the bulk compartment ventilation fan operates continuously.

Pressurization System

Pressurization Panel



1 OUTFLOW VALVE Switches

AUTO – outflow valve controlled automatically.

MAN (manual) illuminated (amber) –

- outflow valve is controlled manually
- bypasses automatic outflow valve control and cabin altitude limiter
- AUTO extinguished

2 OUTFLOW VALVE MANUAL Switches

OPEN – moves the outflow valve toward open.

CLOSE – moves the outflow valve toward closed.

3 Landing Altitude (LDG ALT) Selector

Pull ON, then rotate –

- sets landing altitude manually
- landing altitude followed by MAN displayed on EICAS
- landing altitude changes in 100 foot increments at first detent, 500 foot increments at second detent

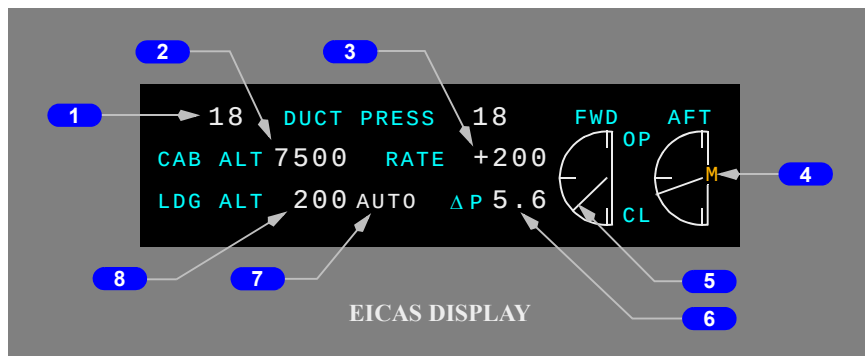
Push –

- landing altitude set automatically from FMS – Refer to Chapter 11, Flight Management Navigation – Approach
- landing altitude followed by AUTO displayed on primary EICAS

Duct Pressure and Pressurization System Indications

Pressurization system indications are displayed automatically when:

- landing altitude MAN
- either OUTFLOW VALVE switch in MAN
- cabin altitude is above normal range (amber)
- cabin differential pressure is above normal range (amber)
- cabin differential pressure is excessive (red)
- duct pressure is below normal range (amber) with the respective engine running
- AIR synoptic selected on any MFD
- the following EICAS messages are displayed:
 - CABIN ALTITUDE
 - CABIN ALTITUDE AUTO
 - LANDING ALTITUDE
 - OUTFLOW VALVE AFT
 - OUTFLOW VALVE FWD.



1 Duct Pressures

White – normal range.

Amber – below normal range.

2 Cabin Altitude

White – normal range.

Amber – above normal range.

Red – excessive cabin altitude.

3 Cabin Altitude Rate

+ (plus) – rate of climb.

– (minus) – rate of descent.

4 Outflow Valve Control Source

M (manual) (amber) – manual control.

Blank – automatic control.

5 Outflow Valves Position

OP – open.

CL – closed.

6 Cabin Differential Pressure

White – normal range.

Amber – above normal range.

Red – excessive cabin differential pressure.

7 Landing Altitude Selection

AUTO (white) – altitude set automatically from FMC.

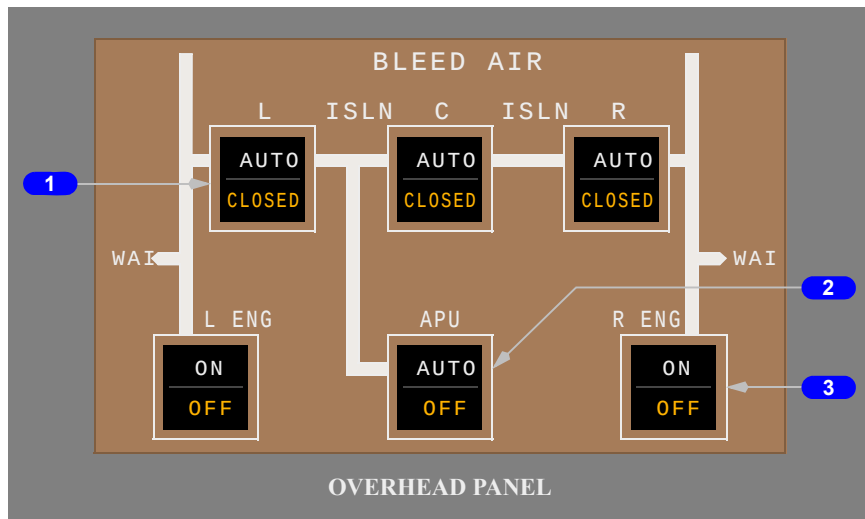
MAN (amber) – altitude set by LANDING ALTITUDE selector.

8 Landing Altitude

Landing altitude supplied by the FMC or manually selected using the LANDING ALTITUDE selector.

Blank – display is blank without valid FMC landing altitude.

Bleed Air System



1 Bleed Isolation (ISLN) Switches

AUTO – the bleed isolation valve is automatically controlled.

Off (AUTO not visible) – manually commands the respective bleed isolation valve to close.

CLOSED illuminated (amber) –

- the isolation valve is closed due to a duct leak or bleed loss
- the valve is closed because the switch is selected to off, or
- the valve fails closed.

2 APU Bleed Switch

AUTO – the APU bleed air valve is automatically controlled.

OFF (AUTO not visible) – the valve is commanded closed.

OFF illuminated (amber) – the APU bleed air valve is closed:

- automatically due to a duct leak
- because the switch is selected OFF
- due to the valve failing closed
- because the APU fire switch is pulled out.

3 Engine (ENG) Bleed Switches

ON – the engine bleed valves open when engine bleed air is available.

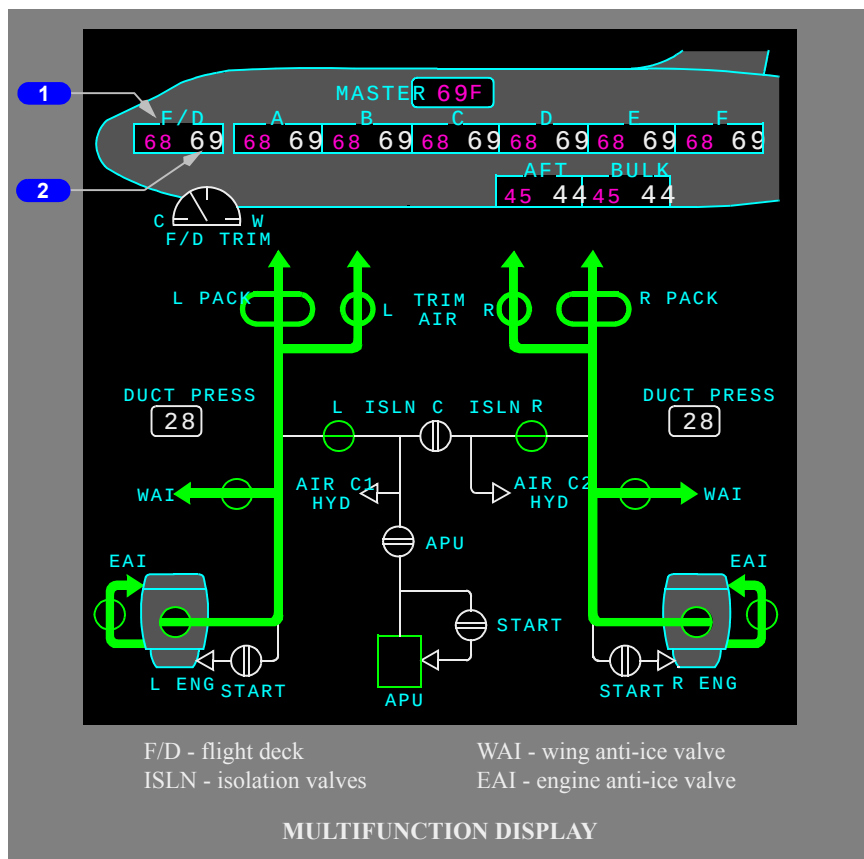
OFF (ON not visible) – valve is manually commanded closed.

OFF illuminated (amber) – the engine bleed valves are closed:

- automatically due to a protective bleed shut down or duct leak
- because the switch is selected OFF
- because the engine is not running, or
- because the engine fire switch is pulled out.

Air Synoptic Display

The air systems synoptic is displayed by pushing the AIR synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.



1 Selected Temperatures (magenta)

Selected by the FLT DECK TEMP and the CABIN TEMP controls.

2 Actual Temperatures (white)

Actual temperature sensed on the flight deck or the passenger zone.

Air Systems

Chapter 2

Air Conditioning System Description

Section 20

Introduction

The air conditioning system supplies conditioned bleed air and recirculated cabin air at a controlled temperature throughout the airplane.

The system supplies conditioned air to the flight deck shoulder heaters.

The system supplies ventilation for the passenger cabin:

- lavatories
- galleys
- individual passenger seat gaspers
- overhead crew rest compartments

Pack control, zone temperature control, cabin air recirculation, fault detection, and overheat protection are all automatic. Backup system control modes operate automatically in the event of system failures.

The airplane is divided into seven temperature zones: the flight deck and six passenger cabin zones.

Air Conditioning Packs

Two identical air conditioning packs cool bleed air from the engines, APU, or high pressure air from a ground source. Bleed air is precooled before entering the pack. The packs are controlled by two identical pack controllers. If a controller fails, pack control switches automatically to the other controller.

Pack output is increased automatically during high pack demand periods or to compensate for a failed pack or recirculation fan. Each pack may operate at reduced flow during high bleed air demand periods, such as during gear retraction, and during certain phases of flight to reduce fuel consumption.

Pack Ground Operation

Both air conditioning packs are normally selected to AUTO for ground operations. Fuel consumption is about the same for single pack and two pack operation, and single pack operation causes higher flight line noise levels.

A ground source of conditioned air may be used to supply conditioned air directly to the cabin distribution system, eliminating the need for pack operation.

Pack Non–Normal Operation

Pack control, fault detection, and overheat protection are all automatic. If an overheat or other significant pack fault is detected, the pack shuts down automatically. An attempt to restore pack operation may be made by pressing the AIR COND RESET switch.

Standby Cooling Mode

For certain internal malfunctions, pack control automatically uses standby cooling mode as a backup to normal mode. In standby cooling mode, the EICAS advisory message PACK MODE (L, R) is displayed, and STBY COOLING is displayed in amber on the AIR synoptic.

If one pack is in standby cooling and the other pack is operating normally, the pack in standby cooling mode shuts down at lower altitudes and higher outside air temperatures when ambient conditions do not permit standby cooling. The pack restarts automatically when altitude and outside air temperatures are suitable for standby cooling.

If both packs are in standby cooling mode, or if one pack is inoperative and the other pack is in standby cooling mode, the packs or pack operates continuously to maintain cabin pressurization, regardless of altitude or outside air temperature.

In standby cooling mode, pack cooling capacity may be less than in normal mode and may result in warm flight deck or cabin temperatures at lower altitudes.

Air Distribution

The flight deck receives 100% fresh conditioned air from the left pack. The flight deck is maintained at a slightly higher pressure than the passenger cabin to prevent smoke and objectionable odors from entering the flight deck.

Recirculation fans assist the packs to maintain a constant ventilation rate through the cabin. The fans draw cabin air through filters, then reintroduce the air into the conditioned air distribution system.

Air exhausted from the passenger cabin flows into the upper recirculation system or to the lower deck, where it is either exhausted overboard through outflow valves or drawn into the lower recirculation system. Air from the recirculation fans is mixed with pack air before entering the distribution ducts.

When one or both RECIR FANS switches are OFF, the packs operate at full flow, the cabin air exchange rate is increased, and fuel consumption increases 0.7% for each fan switch OFF.

Temperature Control

Zone temperatures are controlled by the cabin air conditioning and temperature control system (CACTCS). Hot trim air from the bleed air system is added through trim air valves in the conditioned air supply ducts. The CACTCS modulates the zone trim air valves to achieve the target temperature of the conditioned air in each zone.

Trim air from the left engine bleed is added to conditioned air ducts for the flight deck, three passenger cabin zones, and the aft cargo compartment. Trim air from the right engine is added to the conditioned air ducts for the three passenger cabin zones and the E & E compartment.

The cabin temperature controllers regulate the temperature by controlling the addition of hot trim air to the zone supply ducts through the trim air valves to achieve the target temperature of each temperature zone.

The CABIN TEMP selector sets a master reference temperature between 65 and 85 degrees F. The master reference temperature is increased or decreased automatically or manually to set target temperatures for each temperature zone.

The target temperatures of each passenger cabin temperature zone may be further modified plus or minus 10 degrees F, within the range of 65 and 85 degrees F, using the cabin management system.

The temperature zone requiring the coolest temperature controls the pack outlet temperature.

If the flight deck or cabin temperature selector setting is unavailable to the pack temperature controller, the pack outlet temperature is regulated to achieve either the last temperature set or an average cabin temperature of 75 degrees F.

Temperature Control With Loss of Trim Air

If the left or right trim air system is off, the CACTCS attempts to maintain all zones at the average target temperature. Flight deck temperature will be maintained between 65 and 85 degrees F.

The flight deck may become uncomfortably warm or cool. Setting the CABIN TEMP selector to a cooler or warmer master temperature may achieve a cooler or warmer flight deck temperature.

Operation With Complete Loss of Zone Temperature Control

If CACTCS control of cabin temperature zones fails, or all engine and APU electrical power fails, the air supply and cabin pressurization controllers control the pack flow control valves. Pack flow rate is modulated to achieve a pack outlet temperature between 40 and 110 degrees F. All flight deck ECS controls are disabled except the PACK switches.

Shoulder and Foot Heaters

Flight crew shoulder heat is provided by electric elements in the side window air diffusers. The foot heaters have electric heating elements only, with no airflow. Both are available in flight only.

Gasper System

The gasper system fan supplies conditioned air from the aft cabin distribution duct to the passenger service unit air gasper outlets above each passenger seat.

Cargo Temperature Control System

Cargo Heat System

The aft and bulk cargo compartments have independent bleed air heating systems. An insulated curtain separates the two compartments.

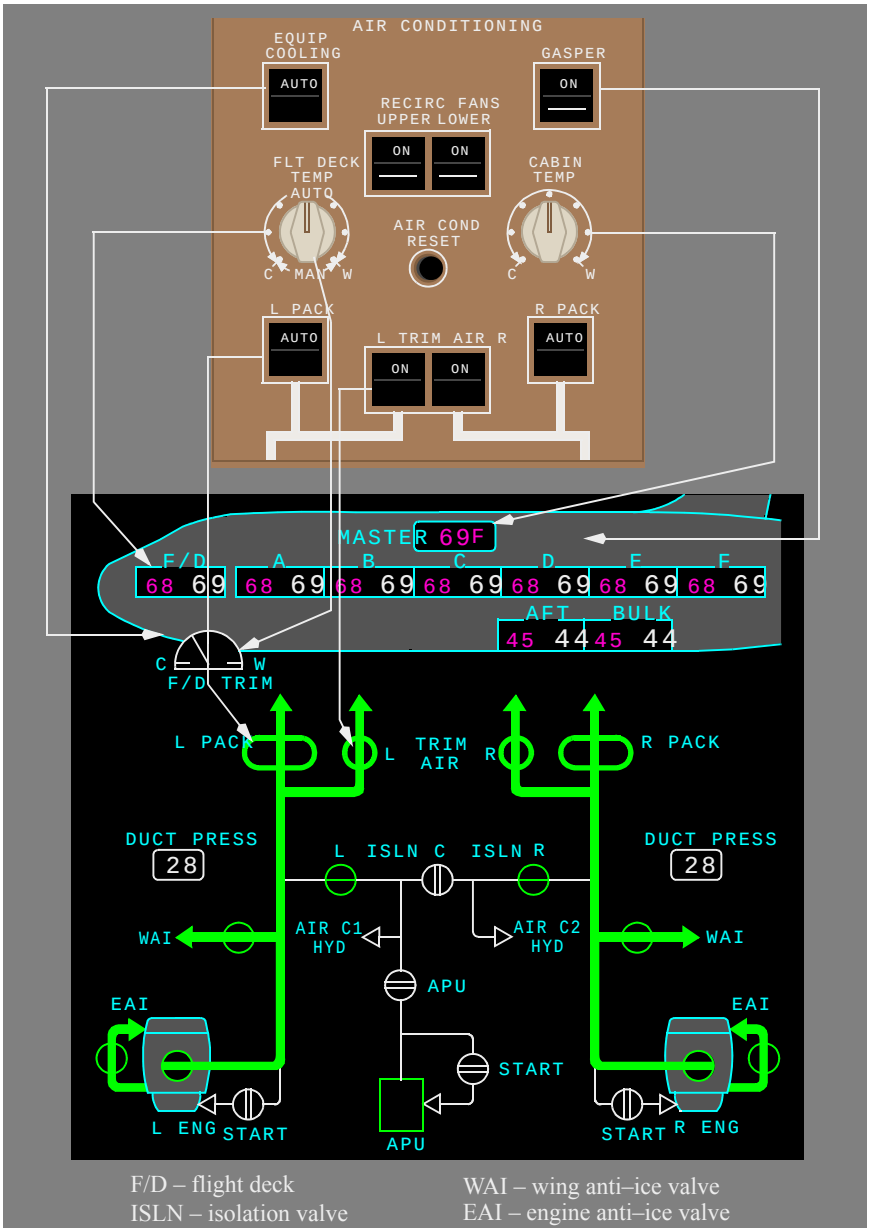
With the CARGO TEMP selector set to LOW or HIGH, the respective cargo heat shutoff valve opens and the temperature control valve opens and closes to maintain the temperature in the compartment. The lavatory/galley vent fans draw air across temperature sensors in each compartment. If both vent fans fail, cargo heat is not provided.

With the CARGO TEMP selector set to LOW and TAT less than 45 degrees F, the respective temperature control valve opens. The compartment temperature is maintained between 40 and 50 degrees F. With the CARGO TEMP selector set to HIGH and TAT less than 70 degrees F, the respective temperature control valve opens. The compartment temperature is maintained between 65 and 75 degrees F.

Selecting the HIGH setting on the BULK CARGO TEMP selector turns on the bulk ventilation fan, which is provided for animal carriage. The system has automatic overheat protection. When an automatic overheat shutdown occurs, cargo heat to the related compartment cannot be restored in flight.

The lower forward cargo compartment is heated by warm air from the forward equipment ventilation system.

Air Conditioning System Schematic



Equipment Cooling, Equipment Ventilation, Lavatory and Galley Ventilation

The forward equipment cooling and ventilation provides cooling and ventilation for the electrical and electronic equipment on the flight deck and in the forward electrical and electronic (E & E) compartment equipment racks.

The forward systems use internal fans and valves to direct air drawn from the cabin to the equipment and ventilates the warm exhaust air into the forward outflow valve or the forward cargo compartment, if the compartment requires additional heat. There are two cooling system supply fans, a primary and a backup. If the primary supply fan fails, the backup supply fan operates automatically.

The forward system reconfigures automatically to an override mode when:

- the EQUIP COOLING switch is off, or
- in flight, both supply fans fail, or
- in flight, low airflow is detected, or
- smoke is detected in the forward equipment cooling system or the forward equipment ventilation system, or
- the FWD CARGO FIRE ARM switch is ARMED

In the override mode when the FWD CARGO FIRE ARM switch is not ARMED, the vent valve opens, both supply fans shut down, and the forward cargo heat valve closes. In the override mode when the FWD CARGO FIRE ARM switch is ARMED, the vent valve remains closed, both supply fans remain shut down, and the forward cargo heat valve is closed.

Cabin differential pressure draws air through the flight deck panels and into the E & E equipment compartment to create a reverse flow of air across the equipment, then through the override valve to an overboard vent.

The override mode supplies adequate cooling while the airplane is in cruise and the airflow decreases as the airplane descends as the cabin pressure differential decreases.

In flight, the EQUIP COOLING switch in OVRD aids smoke evacuation from the flight deck.

On the ground, the EICAS advisory message EQUIP COOLING is displayed and the ground crew call horn in the wheel well sounds if the forward equipment cooling system is inoperative.

The aft equipment cooling and ventilating system provides cooling and ventilating air for the aft electronic equipment and ventilating air for the lavatories and galleys.

Two aft ventilation fans, a primary and a backup, draw air through the aft electronic equipment and from the galleys and lavatories. The warm exhaust air is discharged through the aft outflow valve. Conditioned air is supplied to the galleys from the air distribution system.

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Air Systems

Pressurization System Description

Chapter 2

Section 30

Introduction

Cabin pressurization is controlled by regulating the discharge of conditioned cabin air through the outflow valves.

Two outflow valves are installed: one forward and one aft. Normally, most of the outflow is through the aft outflow valve. This improves ventilation and smoke removal. Cabin altitude and full ventilation rates can be maintained by either valve.

Positive and negative pressure relief valves protect the fuselage against excessive pressure differential.

The pressurization system has automatic and manual operating modes. Other than accomplishing normal procedures for entering FMC data, no specific flight crew action is required for fully automatic operation.

Pressurization System Automatic Operation

In flight, the cabin altitude controller operates in a climb mode, a cruise mode, or a descent mode.

The controller uses ambient pressure and flight plan data from the FMC to calculate a cabin pressurization schedule. The schedule provides a comfortable cabin climb to cruise altitude.

For takeoff, the system supplies a small positive pressurization prior to rotation to cause a smooth cabin altitude transition to the cabin altitude climb schedule.

In cabin altitude controller climb mode, cabin altitude increases on a schedule related to the airplane climb rate and flight plan cruise altitude. When the FMC climb path has a planned level segment, it is included in the total time required for the airplane to reach the top of climb. Cabin altitude continues to increase during the level segment. When the airplane climb flight path is above the FMC climb path and maximum cabin pressure differential is reached during the climb, cabin rate then becomes a function of airplane climb rate so maximum cabin differential pressure is not exceeded.

If cruise altitude is unavailable from the FMC in AUTO, the cabin altitude controllers assume a cruise altitude of 39,000 feet.

In cabin altitude controller cruise mode, maximum cabin altitude is 8,000 feet. When the takeoff field elevation is higher than 8,000 feet, the cabin descends to the cabin cruise altitude while the airplane is climbing.

When the destination airport elevation is greater than 8,000 feet, cabin altitude controller cruise mode maintains a cabin altitude of 8,000 feet.

The cabin altitude controllers enter cabin altitude controller descent mode at T/D or at initial descent of approximately 1,000 feet from cruise altitude, regardless of T/D.

In cabin altitude descent mode, cabin altitude decreases or increases to slightly below the FMC planned landing altitude in AUTO or the landing altitude set in MAN. The slight altitude difference ensures a small positive pressurization at touchdown. In MAN, FMC altitude information is bypassed and the cabin altitude controller uses internal rate schedules to control cabin altitude.

Landing elevation limits are 1,000 feet below sea level to 14,000 feet above sea level. The captain's altimeter setting provides landing altitude barometric pressure correction.

At touchdown, the outflow valves open to depressurize the cabin.

The cabin altitude limiter closes both outflow valves if cabin altitude exceeds 11,000 feet.

Full automatic operation of cabin altitude is possible with one outflow valve operating automatically and the other outflow valve not operating.

Cabin Altitude Controller Automatic Operation With Loss of Landing Altitude

If landing altitude is unavailable from the FMC, and not set in MAN, the EICAS advisory message LANDING ALT is displayed and the cabin altitude controller assumes a landing altitude of 2,000 feet.

Pressurization System Manual Operation

If both Outflow Manual switches are in MAN, all automatic cabin altitude control functions are bypassed.

The pressurization system is in the manual mode when the OUTFLOW VALVE switches are set to MAN.

The system is manually operated by:

- setting the OUTFLOW VALVE switches to MAN
- holding the related OUTFLOW VALVE MANUAL switch to OPEN or CLOSE.

Outflow valve position is displayed on the EICAS display. If the outflow valve position is not available on EICAS, holding the respective OUTFLOW VALVE MANUAL switch in the desired position for 30 seconds will move the valve from full open or close to the selected position.

Landing altitude (normally provided by the FMC) can be manually set using the LANDING ALTITUDE selector. Landing field selection limits are 2,000 feet below sea level to 14,000 feet above sea level. Pulling the selector out to the detent removes the FMC landing altitude and displays pressurization system indications on the EICAS display. The knob is rotated clockwise to increase or counterclockwise to decrease the landing altitude setting. Two rates of increase or decrease, low and high, are available in each direction from the spring-loaded center position.

Operation With Loss of Cabin Pressurization

With a sudden loss of cabin pressurization, the outflow valves will close immediately in an attempt to control the cabin pressure. After descent, when the airplane and cabin altitudes are approximately equal, the outflow valves open to protect the airplane against negative pressure differentials.

It is important that the flight crew not attempt to manually close the outflow valves during the descent.

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Air Systems

Bleed Air System Description

Chapter 2

Section 40

Introduction

Bleed air can be supplied by the engines, APU, or a ground air source.

Bleed air is used for:

- air conditioning
- pressurization
- wing and engine anti-ice
- APU and engine start
- aft cargo heat
- air driven hydraulic pumps
- hydraulic reservoir pressurization

7001 – 7008

- potable water tank pressurization
- TAT probe aspiration.

Engine Bleed Air Supply

Engine bleed air is supplied from either the high stage or the low stage engine sections. Low stage air is used during high power setting operations. High stage air is used during descent and other low power setting operations.

The engine bleed air valves are armed when the ENGINE bleed switches are selected ON. The valves are pressure actuated and remain closed until engine bleed air pressure is sufficient to cause forward flow. The engine bleed valves close automatically:

- during start
- for bleed source loss
- for bleed air overtemperature
- for bleed air overpressure
- for a bleed air duct leak
- when an engine fire switch is pulled
- when a ground cart is supplying air.

APU Bleed Air Supply

APU bleed air is used primarily during ground operations for pack operation and engine starting. In flight, APU bleed air is available below approximately 22,000 feet.

The check valve in the APU supply line prevents reverse flow of bleed air from the duct into the APU.

Ground Bleed Air Supply

External connectors are provided to connect a ground source of high pressure air directly to the bleed air duct.

Check valves prevent reverse flow of bleed air from the bleed air duct to the connectors.

Bleed Air Duct System

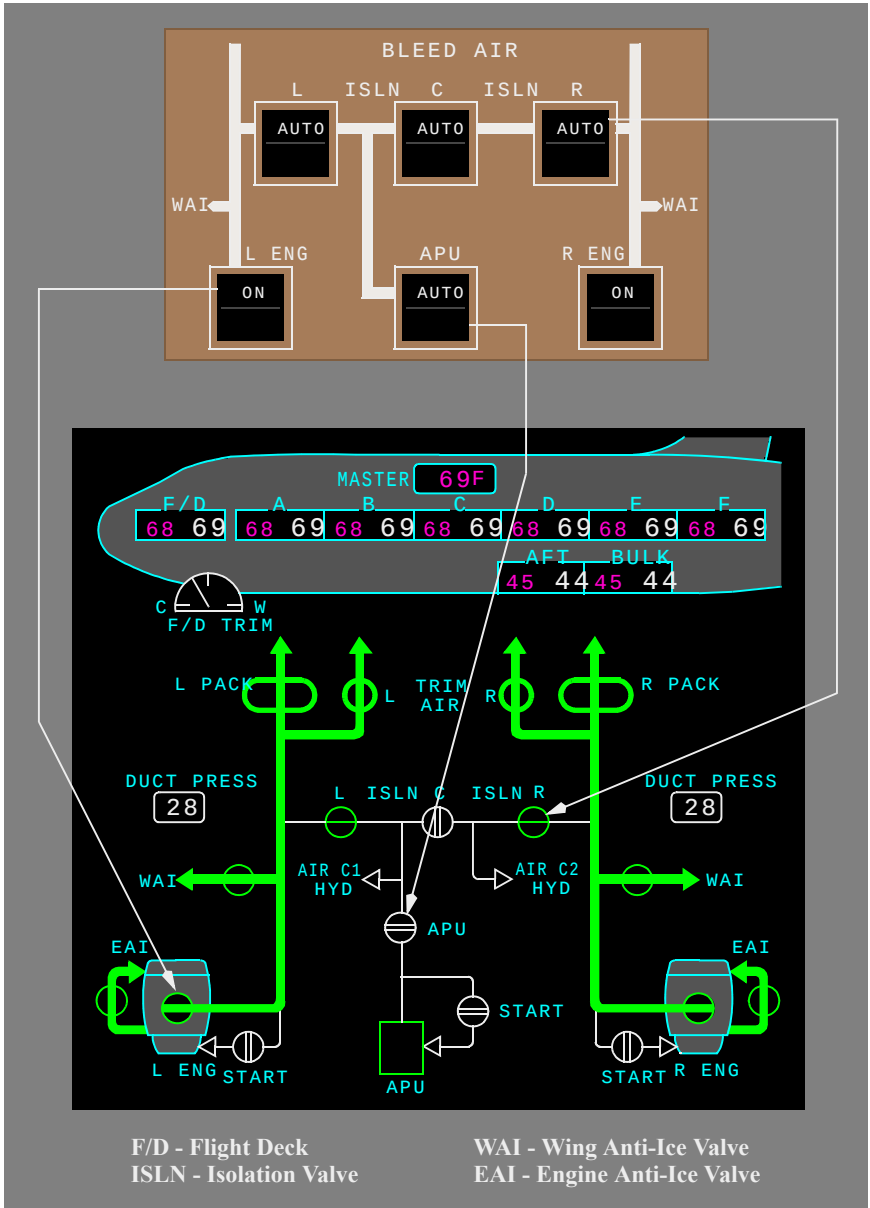
The left, center, and right isolation valves separate the bleed air duct into isolated segments. The automatic system operates with the left and right isolation valves normally open. The center isolation valve is normally closed, except for engine start or single bleed source operation.

Duct Leak and Overheat Detection System

If a duct leak is detected, the system automatically isolates the leak. The EICAS caution message BLEED LEAK is displayed. The automatic isolation logic may include one, two, or three sequential steps. During isolation, the ENGINE and/or APU bleed switch OFF lights and the ISOLATION switch CLOSED lights illuminate and extinguish as the respective valves close and open.

When the temperature in the affected duct area cools, the BLEED LEAK EICAS message is no longer displayed. The valves isolating the leak remain closed and the appropriate EICAS message BLEED LOSS is displayed. The switch OFF or CLOSED lights are illuminated for the respective valves which remain closed to isolate the affected duct area.

Bleed Air System Schematic



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Air Systems

EICAS Messages

Chapter 2

Section 50

Air Systems EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
BLEED ISLN CLOSED C, L, R	Advisory		The isolation valve is failed closed when commanded open or the bleed isolation switch is OFF.
BLEED ISLN OPEN C, L, R	Advisory		The isolation valve is failed open when commanded closed.
BLEED LEAK BODY	Caution	Beeper	A bleed air leak is detected in the body area.
BLEED LEAK L, R	Caution	Beeper	A bleed air leak is detected in the wing or pack bay area.
BLEED LEAK STRUT L, R	Caution	Beeper	A bleed air leak is detected in the strut area.
BLEED LOSS BODY	Advisory		Bleed air from the left and right body ducts is not available.
BLEED LOSS BODY L, R	Advisory		Bleed air from the body duct is not available.
BLEED LOSS WING L, R	Advisory		Bleed air from the wing duct is not available.
BLEED OFF APU	Advisory		The APU bleed valve is closed because of a system fault or the APU bleed switch is OFF.
BLEED OFF ENG L, R	Advisory		The engine bleed valve is closed because of a system fault or the engine bleed switch is OFF.
CABIN ALTITUDE	Warning	Siren	Cabin altitude is excessive.
CABIN ALTITUDE AUTO	Caution	Beeper	Automatic pressurization control is failed or both outflow valve switches are in manual.
CARGO HEAT AFT, BULK	Advisory		Cargo heat is inoperative or the cargo temperature selector is OFF.

Message	Level	Aural	Message Logic
EQUIP COOLING	Advisory		The forward equipment cooling is failed.
EQUIP COOLING OVRD	Advisory		The equipment cooling system is in override mode.
LANDING ALTITUDE	Advisory		The FMC does not supply a landing altitude or the landing altitude selector is pulled.
OUTFLOW VALVE AFT, FWD	Advisory		Automatic control of the outflow valve is inoperative or the outflow valve switch is in MAN.
PACK L, R	Advisory		Pack is inoperative.
PACK L+R	Caution	Beeper	Both packs are inoperative.
PACK MODE L, R	Advisory		The pack is in the standby mode.
TRIM AIR L, R	Advisory		The trim air valve is closed.

EICAS Memo Messages

Message	Level	Aural	Message Logic
RECIRC FANS OFF	Memo		One or both recirculation fan switches are off.

Anti-Ice, Rain
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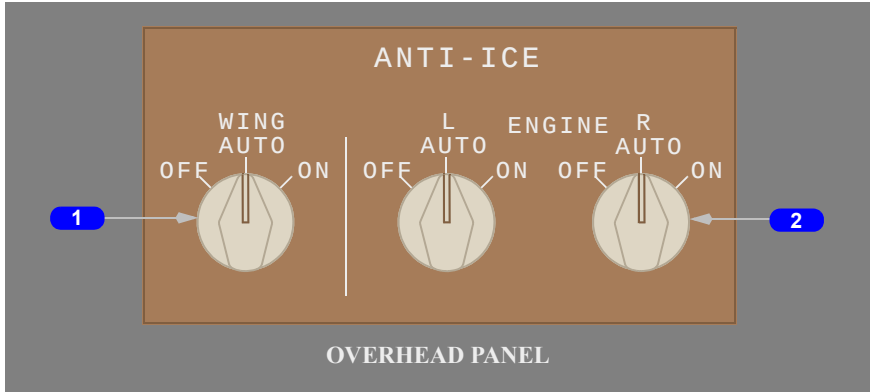
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Anti-Ice, Rain Controls and Indicators

Chapter 3 Section 10

Engine and Wing Anti Icing

Anti-Ice Panel



1 WING ANTI-ICE Selector

OFF – the wing anti-icing valves are commanded closed.

AUTO – in flight, the wing anti-icing valves open when wing icing conditions exist and bleed air pressure is available.

ON – in flight, the wing anti-icing valves are commanded open.

2 ENGINE ANTI-ICE Selectors

OFF – the engine anti-icing valve is commanded closed.

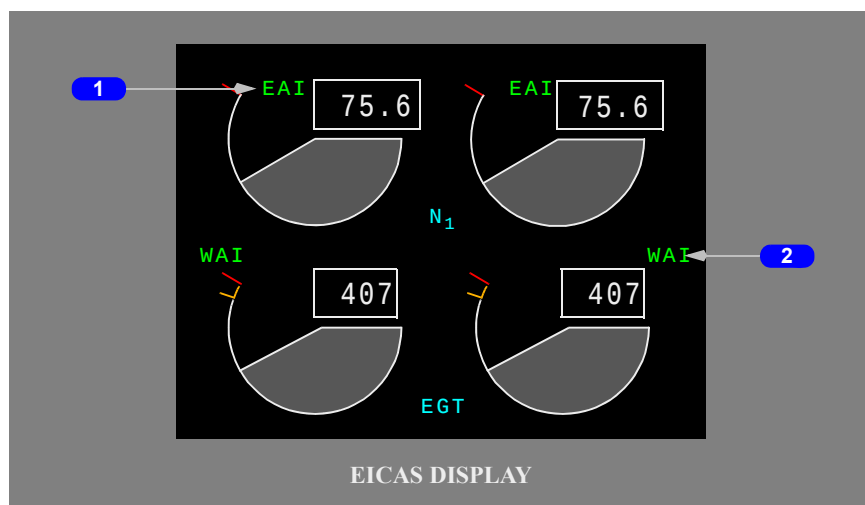
AUTO – in flight, the engine anti-icing operates when engine icing conditions exist.

ON – the engine anti-icing valve is commanded open.

Note: When the ENGINE ANTI-ICE selector is in AUTO and the anti-icing valve is commanded open or when the ENGINE ANTI-ICE selector is in ON, then:

- approach idle is commanded by the EEC

Anti-Icing Indications



1 Engine Anti-icing Indication

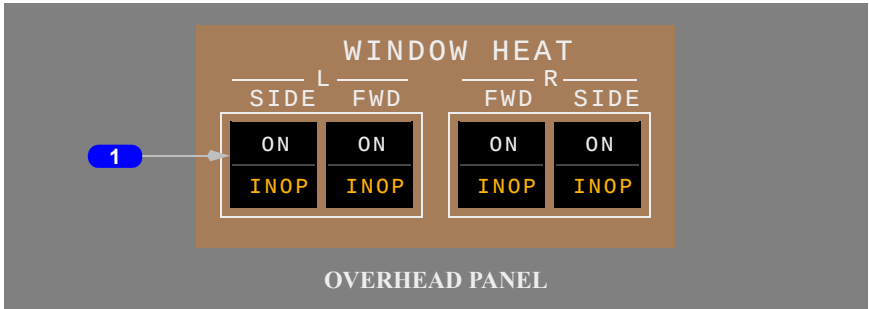
Displayed (green) – engine anti-icing valve is open.

2 Wing Anti-Icing Indication

Displayed (green) – wing anti-icing valve is open.

Window Heat and Wiper Panels

Window Heat Panel



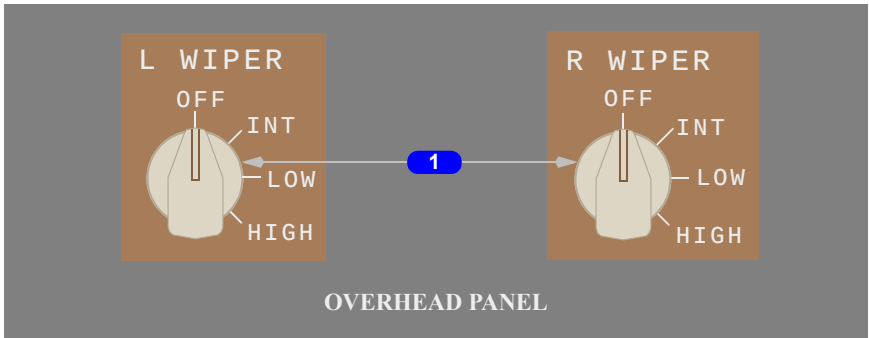
1 WINDOW HEAT Switches

ON – controlled heat is applied to the respective windows.

INOP (inoperative) illuminated (amber) –

- the switch is OFF, or
- an overheat has occurred, or
- a system fault has occurred

Wiper Panels



1 WIPER Selectors

OFF – the wiper is off and is sequenced to stowed position.

INT (intermittent) – the wiper operates intermittently at low speed.

LOW – the wiper operates at low speed.

HIGH – the wiper operates at high speed.

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Anti-Ice, Rain System Description

Chapter 3 Section 20

Introduction

The anti-icing and rain systems include:

- icing conditions detection
- engine anti-icing
- wing anti-icing
- flight deck window heat
- windshield wipers
- probe heat

Anti-Icing Systems

Engine and wing anti-icing is provided by distributing engine bleed air to the engine inlets and to the wing leading edges.

Icing Conditions Detection

The icing conditions detection system detects engine nacelle inlet icing conditions and wing icing conditions in flight. Two probes on the forward fuselage and system logic:

- control the engine and wing anti-icing valves
- display anti-icing system operating indications on EICAS, and
- display EICAS alert messages

Engine Anti-Icing

The engine anti-icing valves are opened by engine bleed air pressure. When an engine anti-icing valve is open, EAI is displayed on the primary EICAS display.

In flight, when an ENGINE ANTI-ICE selector is in AUTO and engine icing conditions exist, the respective engine anti-icing valve is commanded open.

When an ENGINE ANTI-ICE selector is ON, the respective engine anti-icing valve is commanded open.

Engine Anti-Icing System Leak Detection

Each engine has an anti-icing duct leak detection system. If an engine anti-icing duct leak is detected, the respective engine anti-icing valve closes.

Wing Anti-Icing

When a wing anti-icing valve is open, WAI is displayed on the primary EICAS display.

In flight, when the WING ANTI-ICE selector is in AUTO and wing icing conditions exist, the wing anti-icing valves are commanded open.

In flight, when the WING ANTI-ICE selector is ON the wing anti-icing valves are commanded open.

When TAT is above 10 degrees C, wing anti-icing is inhibited for five minutes after liftoff.

Automatic wing anti-icing operation is inhibited when:

- takeoff power is selected, and
- less than 10 minutes has elapsed after liftoff

If a bleed source is unavailable and bleed duct isolation has not occurred, the isolation valves open to maintain anti-icing to both wings. If one wing anti-icing valve fails closed, the wing anti-icing system closes the other valve to prevent asymmetrical wing anti-icing.

Wing Anti-Icing System Leak Detection

The bleed duct leak and overheat detection system provides wing anti-icing duct leak detection. Refer to Chapter 2, Air Systems, Bleed Air System Description, Duct Leak and Overheat Detection System.

Windshield Wipers

The three speed windshield wipers are independently controlled. When a WIPER selector is OFF, the wiper is off and stowed.

Probe Heat

Three pitot-static probes and two angle of attack probes are electrically heated for anti-icing protection when either engine is operating.

The total air temperature probe is electrically heated for anti-icing protection in flight.

Anti-Ice, Rain EICAS Messages

Chapter 3 Section 30

Anti-Ice, Rain System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
ANTI-ICE ENG L, R	Advisory		The engine anti-icing valve is closed when commanded open.
ANTI-ICE LEAK ENG L, R	Caution	Beeper	A bleed air leak occurs in the engine anti-icing duct.
ANTI-ICE LOSS ENG L, R	Advisory		Anti-icing bleed air for the engine is not available.
ANTI-ICE ON	Advisory		The ANTI-ICE selector is ON, and TAT is more than 10 degrees C, and icing conditions do not exist.
ANTI-ICE WING	Advisory		One or both wing anti-icing valves are failed closed.
HEAT PITOT C	Advisory		The center pitot probe heat is failed.
HEAT PITOT L	Advisory		The left pitot probe heat is failed.
HEAT PITOT L+C+R	Advisory		The left, center, and right pitot probe heats are failed.
HEAT PITOT R	Advisory		The right pitot probe heat is failed.
ICE DETECTORS	Advisory		The icing conditions detection system has failed.
ICING ENG	Caution	Beeper	Icing conditions exist and an engine ANTI-ICE selector is OFF.
ICING WING	Advisory		Icing conditions exist and the WING ANTI-ICE selector is OFF, or icing conditions exist and wing anti-icing is inhibited during takeoff.
WINDOW HEAT	Advisory		Two or more window heats are off.

Message	Level	Aural	Message Logic
WINDOW HEAT L, R FWD	Advisory		Primary window heat for the forward window is inoperative.
WINDOW HEAT L, R SIDE	Advisory		Window heat for the side window is inoperative.

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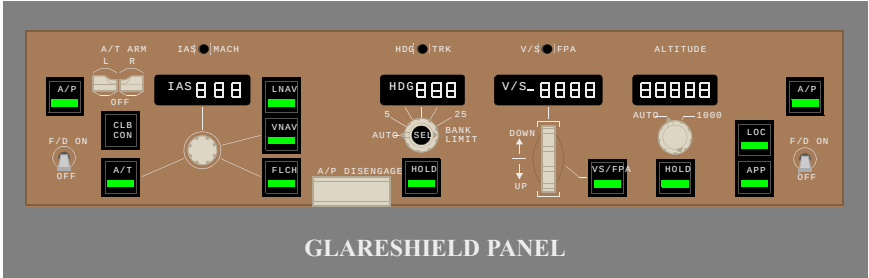
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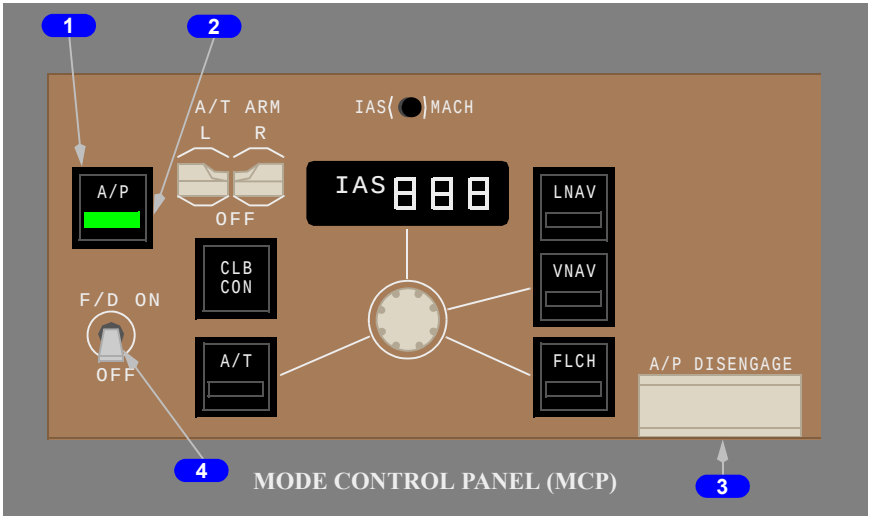
Automatic Flight Controls and Indicators

Chapter 4 Section 10

Mode Control Panel (MCP)



Autopilot Flight Director System Controls



1 Autopilot (A/P) Engage Switches

Push (either switch can engage the autopilot) –

- if either flight director switch is ON, the autopilot engages in the selected flight director mode(s)
- if both flight director switches are OFF, the autopilot engages in:
 - heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode, or if bank angle is greater than five degrees, attitude hold (ATT)
 - vertical speed (V/S) or flight path angle (FPA) as the pitch mode.

2 Autopilot Engaged Light

Illuminated (green) – all operating autopilots are engaged.

3 Autopilot (A/P) DISENGAGE Bar

Pull down –

- prevents autopilot engagement
- generates EICAS advisory message NO AUTOLAND
- disables bank angle protection
- exposes the amber and black stripes
- if an autopilot is engaged:
 - it disconnects
 - displays the EICAS warning message AUTOPILOT DISC
 - sounds an aural warning
 - illuminates the master warning lights.

Lift up –

- permits autopilot engagement
- hides the amber and black stripes.

4 Flight Director (F/D) Switches

The left flight director switch activates the flight director steering indications on the left PFD. The right flight director switch activates the flight director steering indications on the right PFD.

ON –

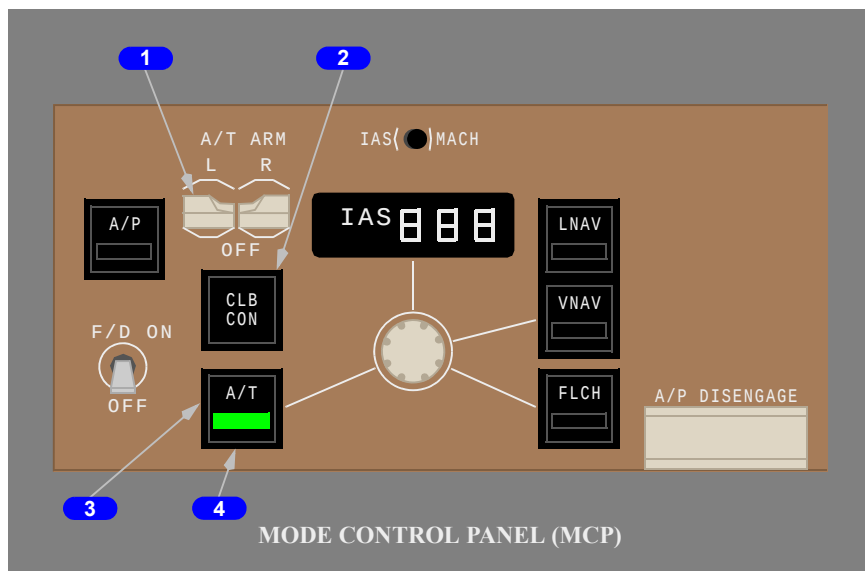
- On the ground with both flight director switches OFF, the first flight director switch positioned ON arms the flight director in takeoff go-around (TO/GA) roll mode. In addition, the first switch arms the flight director in TO/GA pitch mode when MCP selected altitude differs more than 20 feet from displayed baro altitude, or engages the flight director in altitude (ALT) pitch mode when selected altitude is within 20 feet of displayed baro altitude. If ALT mode engages, selecting an altitude more than 20 feet from displayed baro altitude and cycling the first switch arms the flight director in TO/GA roll and pitch modes. The flight mode annunciation appears on both PFDs. Positioning the second switch ON displays the flight director steering indications on the second PFD.
- In flight, with the autopilot disengaged and both flight director switches OFF, the first flight director switch positioned to ON engages the flight director in:
 - heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode, or if bank angle is greater than five degrees, attitude hold (ATT)

- vertical speed (V/S) or flight path angle (FPA) as the pitch mode.
- In flight, with the autopilot engaged and both flight director switches OFF, the first flight director switch positioned to ON engages the flight director in the currently selected autopilot mode(s).

OFF –

- the flight director steering indications are not displayed
- the flight director steering indications are displayed on the PFDs if a TO/GA switch is pushed when airspeed is greater than 80 knots on takeoff, or on a go-around with the flaps not retracted.

Autothrottle System Controls



1 Autothrottle (A/T) ARM Switches

The left autothrottle arm switch controls the left engine autothrottle. The right autothrottle arm switch controls the right engine autothrottle.

L and/or R – arms the selected autothrottle for mode activation. The selected autothrottle activates when an AFDS mode (VNAV, FLCH, or TO/GA) is selected.

OFF –

- disconnects the selected autothrottle
- prevents selected autothrottle activation.

2 Climb/Continuous (CLB/CON) Thrust Switch

On the ground and below 400 feet during takeoff, the switch is inoperative.

Push –

- with two engines operating, changes the engine thrust limit to the FMC selected climb thrust
- with only one engine operating, changes the thrust limit to maximum continuous (CON).

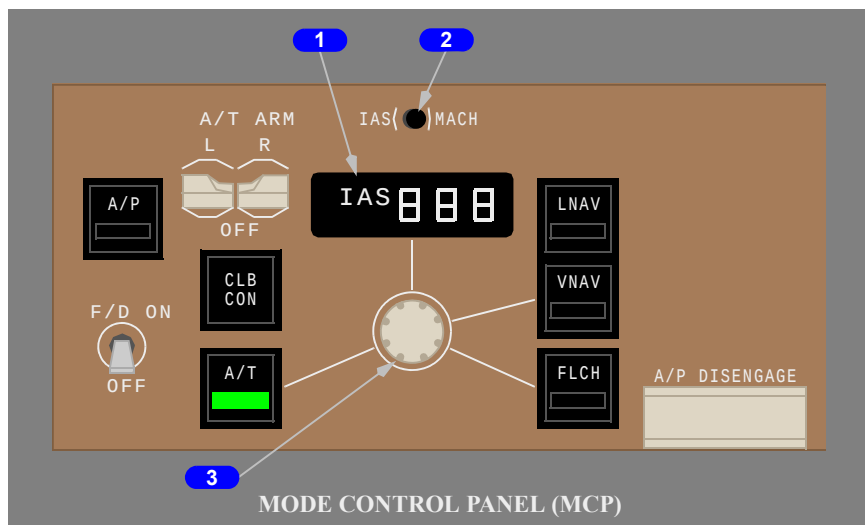
3 Autothrottle (A/T) Switch

Push – above 400 feet, with the autothrottle armed, activates the appropriate autothrottle mode for the selected AFDS pitch mode, or if no pitch mode, in the speed (SPD) mode.

4 Autothrottle Light

Illuminated (green) – an autothrottle mode is activated.

Autopilot Flight Director IAS/Mach Controls



1 IAS/Mach Window

Displays the speed selected by the IAS/Mach selector.

Blank when the FMC controls the speed. When changing from TO/GA to V/S, FPA, or ALT, the window automatically displays:

- the flap placard speed minus 5 knots (flaps extended)
- 250 knots (flaps up), or
- a speed value entered in the IAS/Mach window after TO/GA was pushed.

The display range is:

- 100 – 399 KIAS
- .400 – .950 Mach.

The selected speed is displayed as the PFD selected speed.

Displays 200 knots when power is first applied.

During climb, automatically changes from IAS to Mach at .840 Mach.

During descent, automatically changes from Mach to IAS at 310 KIAS.

2 IAS/Mach Reference Switch

Push –

- alternately changes the IAS/Mach window between IAS and Mach displays (Mach must be 0.4 or greater to switch from IAS to Mach)
- inoperative when the IAS/Mach window is blank.

3 IAS/MACH Selector

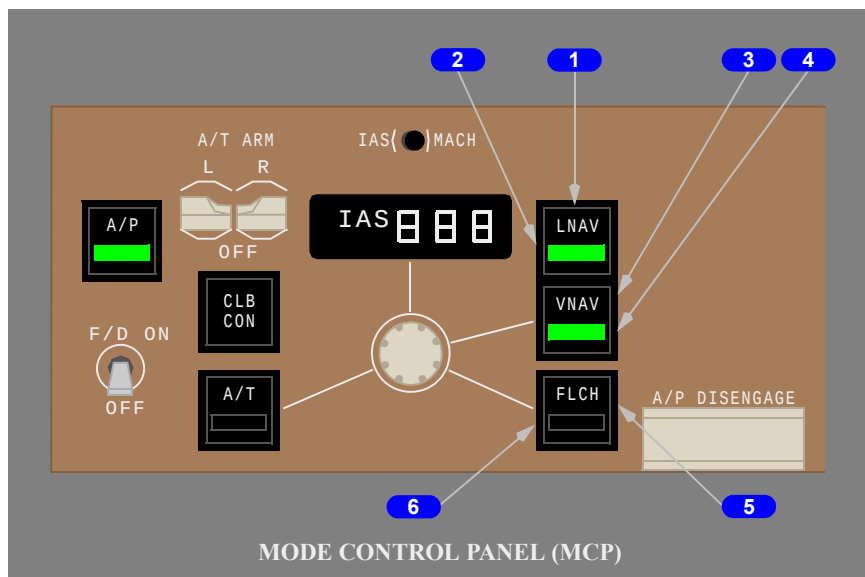
Rotate –

- Sets the speed in the IAS/MACH window and on the PFD as the selected speed.
- Inoperative when the IAS/MACH window is blank.

Push –

- With VNAV engaged, alternately opens or closes the IAS/MACH window:
 - when the window is closed, the FMC computed target speed is active and is displayed on the PFD
 - when the window is open, FMC speed–intervention is active and the IAS/MACH selector may be used to set the desired speed.
- Blanks when not in SPD, FLCH, or TO/GA.

Autopilot Flight Director Roll and Pitch Controls



1 Lateral Navigation (LNAV) Switch

Push –

- Arms, engages, or disarms LNAV as the roll mode.
- Displays LNAV in white (armed) on the PFD roll flight mode annunciator when armed. The previous roll mode remains active.
- LNAV engages if the airplane is above 50 feet radio altitude and:
 - within 2.5 NM of the active leg
 - if not within 2.5 NM of the active leg and on an intercept heading to the active leg, remains armed then engages when approaching the active leg
 - when engaged, displays LNAV in green on the PFD roll flight mode annunciator.
- Selection of LNAV with the airplane not on a heading to intercept the active leg, displays NOT ON INTERCEPT HEADING in the CDU scratch pad.
- Selection of LNAV when an active FMC route is not available displays NO ACTIVE ROUTE in the CDU scratchpad.
- LNAV maintains current heading when:
 - passing the last active route waypoint
 - passing the last waypoint prior to a route discontinuity
 - passing the last route offset waypoint

- activating the inactive route or activating an airway intercept and not within LNAV engagement criteria.

LNAV is disengaged:

- by selecting heading hold (HDG HOLD) or track hold (TRK HOLD)
- by selecting heading select (HDG SEL) or track select (TRK SEL)
- when the localizer captures
- if there is a dual FMC failure (LNAV may be re-engaged if there is an active CDU ALTN NAV route available).

LNAV is disarmed by pushing the LNAV switch a second time, or by arming LOC or APP.

2 LNAV Light

Illuminated (green) – the LNAV mode is armed or engaged.

3 Vertical Navigation (VNAV) Switch

Push –

- Arms, engages, or disarms VNAV as the pitch mode.
- Displays VNAV in white (armed) on the PFD pitch flight mode annunciator below 400 feet.
- VNAV engages 400 feet above runway elevation.
- If VNAV is selected and the FMC has insufficient data to provide VNAV guidance (such as the gross weight is invalid or there is no end-of-descent point in descent) displays PERF/VNAV UNAVAILABLE in the CDU scratchpad.
- VNAV SPD, VNAV PTH or VNAV ALT pitch mode is displayed in green (engaged) on the PFD pitch flight mode annunciator.
- In the VNAV SPD pitch mode, the AFDS commands pitch to hold target airspeed. The autothrottle operates in the THR REF, THR, IDLE or HOLD mode, as required by the phase of flight.
- In the VNAV PTH pitch mode, the AFDS commands pitch to maintain FMC target altitude or the VNAV path. The autothrottle maintains speed.
- In the VNAV ALT pitch mode, the AFDS commands pitch to maintain the MCP selected altitude when that altitude is lower than the VNAV commanded altitude in climb or higher than the VNAV commanded altitude in descent.
- If VNAV is selected and VNAV commands a descent with the MCP altitude window above the current airplane altitude, the autopilot maintains the altitude at which VNAV was selected. When on an instrument approach using VNAV, selecting the missed approach altitude does not interfere with the VNAV descent.

- If VNAV is selected and VNAV commands a climb with the MCP altitude window below the current airplane altitude, the autopilot maintains the altitude at which VNAV is selected.
- With the VNAV ALT pitch mode engaged, the autothrottle operates in the speed (SPD) mode.
- With the VNAV PTH pitch mode engaged, the autothrottle operates in the following modes:
 - for climb or cruise – operates in the speed (SPD) mode
 - for descent – operates in the IDLE, HOLD, or speed (SPD) mode.
- VNAV pitch guidance is available with one engine inoperative.

VNAV is disengaged:

- by engaging TO/GA, FLCH SPD, V/S, FPA, ALT or G/S pitch mode
- if there is a dual FMC failure.

VNAV is disarmed by:

- pushing the VNAV switch a second time, or
- arming APP.

4 VNAV Light

Illuminated (green) – the VNAV mode is armed or engaged.

5 Flight Level Change (FLCH) Switch

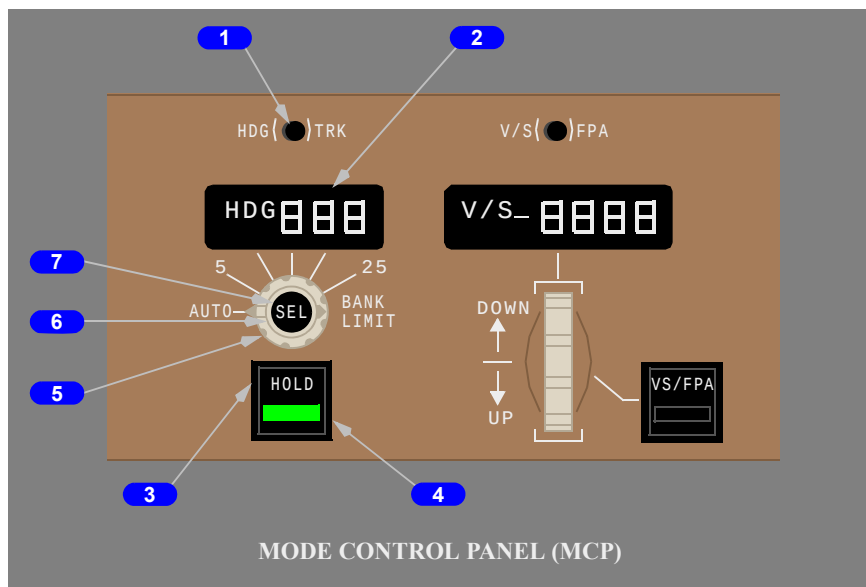
Push –

- FLCH SPD is displayed on the PFD pitch flight mode annunciator as the pitch mode.
- If the IAS/MACH window is blank, the IAS/MACH window opens to the FMC target speed, if valid. If not valid, the IAS/MACH window opens to the current speed.
- When changing from TO/GA to FLCH:
 - if the current speed is greater than the IAS/MACH window speed, the IAS/MACH window speed changes to the current speed.
 - if the current speed is less than the IAS/MACH window speed, the IAS/MACH window speed does not change.
- The autothrottle activates:
 - for climb – activates in THR mode; the thrust limit is CLB thrust
 - for descent – activates in THR mode, followed by HOLD if the thrust levers reach idle.

6 Flight Level Change Light

Illuminated (green) – the flight level change mode is engaged.

Autopilot Flight Director Heading, Track, and Bank Angle Controls



1 Heading/Track (HDG/TRK) Reference Switch

Push – alternately changes the heading/track window, PFD, and ND selected heading/track references between heading and track. Also changes the PFD roll flight mode annunciator, if the HDG or TRK mode is engaged.

2 Heading/Track Window

Displays the selected heading or track.

The selected heading or track is displayed on the PFD and ND.

If approach is armed, the numbers in the MCP heading/track window automatically change to the selected ILS front course at LOC capture.

Displays 360 degrees when power is first applied.

3 Heading/Track Hold (HOLD) Switch

Push –

- selects heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode
- displays HDG HOLD or TRK HOLD on the PFD roll flight mode annunciator
- the AFDS commands wings level and holds the heading or track established when wings level is established.

4 Heading/Track Hold Light

Illuminated (green) – the heading/track HOLD mode is engaged.

5 BANK LIMIT Selector (outer)

Rotate – sets the AFDS commanded bank limit when in the heading select (HDG SEL) or track select (TRK SEL) roll mode as follows:

- AUTO – varies between 15 – 25 degrees, depending on TAS
- 5, 10, 15, 20 or 25 – the selected value is the maximum, regardless of airspeed.

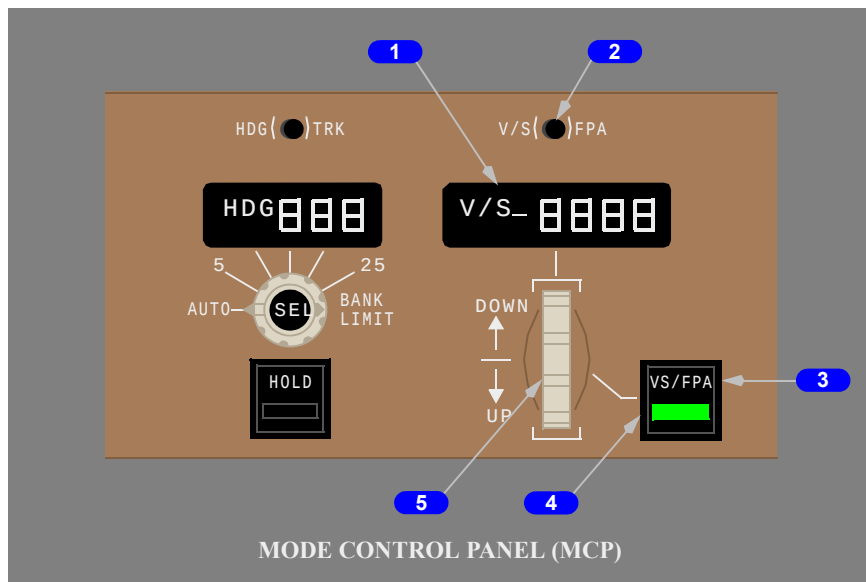
6 Heading/Track Selector (middle)

Rotate – sets heading or track in the heading/track window and on the PFDs and NDs.

7 Heading/Track Select (SEL) Switch (inner)

Push –

- selects heading select (HDG SEL) or track select (TRK SEL) as the roll mode
- displays HDG SEL or TRK SEL on the PFD roll flight mode annunciator
- the AFDS controls roll to fly the selected heading or track
- bank is limited by the bank limit selector.



3 V/S – FPA Switch

Push –

- Engages vertical speed (V/S) or flight path angle (FPA) as the pitch mode.
- Displays V/S or FPA on the PFD pitch flight mode annunciator.
- Displays the current vertical speed or flight path angle in the vertical speed/flight path angle window.
- When the selected altitude is reached, the pitch mode changes to altitude (ALT).
- AFDS commands pitch to maintain the vertical speed or flight path angle displayed in the vertical speed/flight path angle window.
- If vertical speed or flight path angle is selected while in FLCH or VNAV, the autothrottle activates in speed (SPD) mode, if armed.

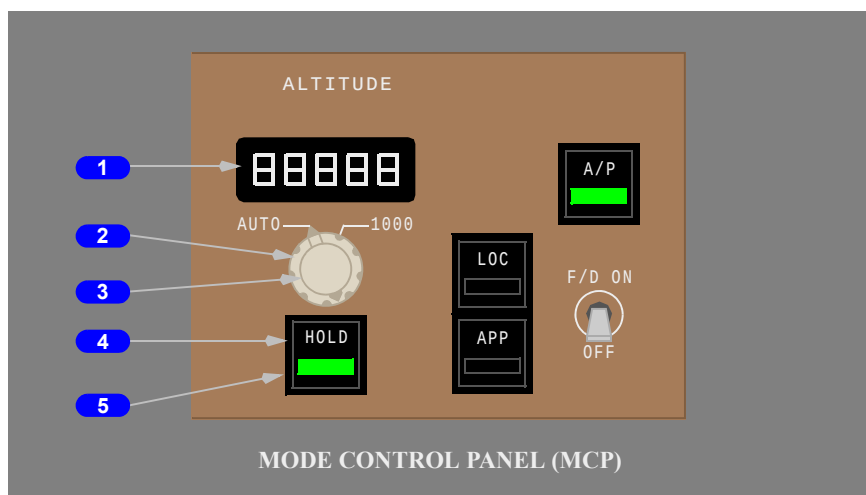
4 V/S – FPA Light

Illuminated (green) – the vertical speed/flight path angle mode is engaged.

5 V/S – FPA Selector

UP or DOWN – sets the vertical speed or flight path angle in the vertical speed/flight path angle window and on the PFDs.

Autopilot Flight Director Altitude Controls



1 Altitude Window

Displays the selected altitude.

The displayed altitude is the reference altitude for altitude alerting and level off.

The altitude range is 0 to 50,000 feet.

Displays 10,000 feet when power is first applied.

Displayed altitude transmitted to ATC when Eurocontrol-compliant transponder installed.

2 Altitude Increment Selector (outer)

AUTO –

- the altitude selector changes in 100 foot increments
- displays the selected BARO minimum as the selector passes through that altitude. If the BARO minimum is not a 10 foot increment, displays the next highest 10 foot increment.

1000 – the altitude selector changes in 1,000 foot increments.

3 Altitude Selector (inner)

Rotate – sets the altitude in the altitude window and on the PFD altitude indication display.

Push –

- During climb or descent with altitude constraints, each push deletes the next waypoint constraint between the airplane altitude and the altitude window.
- During climb with no altitude constraints, and the altitude window set above the FMC cruise altitude, the cruise altitude is changed to the altitude window value.
- During cruise:
 - with the altitude window set above or below FMC cruise altitude, the FMC cruise altitude resets to the altitude window altitude
 - if in VNAV PTH or VNAV ALT pitch mode, the airplane begins a climb or descent toward the altitude window altitude
 - within 50 NM of the top-of-descent (T/D) point, with the altitude window set below cruise altitude, the airplane initiates the descend now (DES NOW) feature.

4 Altitude HOLD Switch

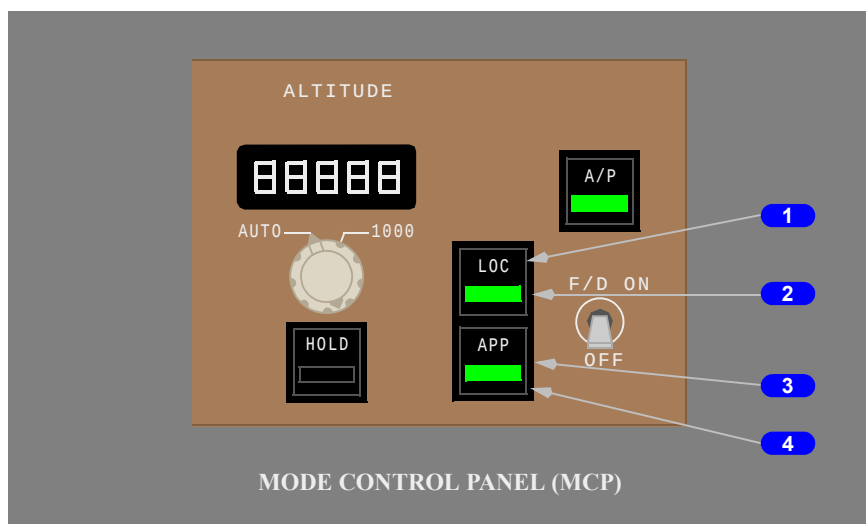
Push –

- engages altitude (ALT) as the pitch mode
- ALT is displayed on the PFD pitch flight mode annunciator
- the AFDS commands pitch to maintain the altitude when the switch was pushed.

5 Altitude Hold Light

Illuminated (green) – the altitude hold mode is engaged.

Autopilot Flight Director Approach Mode Controls



1 Localizer (LOC) Switch

Push –

- arms, disarms, engages, or disengages localizer (LOC) as the roll mode
- displays LOC in white (armed) on the PFD roll flight mode annunciator before localizer capture
- displays LOC in green (engaged) on the PFD roll flight mode annunciator after localizer capture
- arms the AFDS to capture and track inbound on the front course
- the capture point varies based on range and intercept angle
- localizer capture can occur when an intercept track angle is within 120 degrees of the localizer course.

The localizer mode can be disarmed before localizer capture by:

- pushing the localizer switch a second time, or
- selecting APP or any other roll mode.

The localizer mode can be disengaged after localizer capture by:

- selecting another roll mode,
- pushing a TO/GA switch,
- disengaging the autopilot and turning both flight director switches off, or
- pushing the localizer switch a second time above 1,500 feet radio altitude (reverts to the default roll mode).

2 Localizer Light

Illuminated (green) – the localizer mode is armed or engaged.

3 Approach (APP) Switch

Push –

- arms, disarms, engages, or disengages localizer (LOC) as the roll mode and glideslope (G/S) as the pitch mode
- displays LOC and G/S in white (armed) on the PFD roll and pitch flight mode annunciators prior to localizer and glideslope capture
- displays LOC and G/S in green (engaged) on the PFD roll and pitch flight mode annunciators after each one is captured
- the AFDS captures and tracks the localizer in the localizer (LOC) mode and captures the glideslope in the glideslope (G/S) mode upon interception
- localizer captures when the intercept track angle is within 120 degrees of the localizer course
- glideslope captures when the intercept track angle is within 80 degrees of the localizer course.

Glideslope can capture before localizer capture.

The approach mode can be disarmed with localizer and glideslope armed by selecting APP, LOC, LNAV, or VNAV.

The approach mode disengages:

- with localizer captured and glideslope armed, by selecting heading select (HDG SEL) or heading hold (HDG HOLD)
- with glideslope captured and localizer armed, by selecting any other pitch mode except VNAV
- after localizer and/or glideslope are captured, by engaging TO/GA mode, or by disengaging the autopilot and turning both flight director switches off
- after localizer and/or glideslope are captured, by pushing the approach switch a second time above 1,500 feet radio altitude (AFDS reverts to default roll and pitch modes).

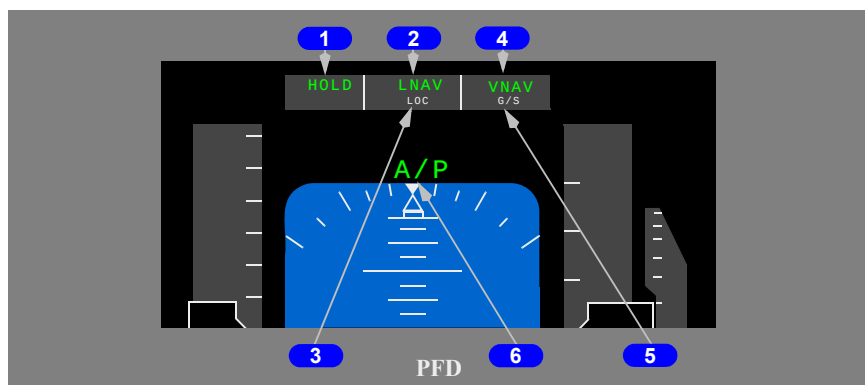
4 Approach Light

Illuminated (green) – the approach modes (LOC and G/S) are armed or engaged.

PFD Flight Mode Annunciations (FMAs)

Note: When first engaged/activated, AFDS/autothrottle mode changes are emphasized for 10 seconds by a green box drawn around the mode. A change to the AFDS mode NO AUTOLAND is emphasized by an amber box.

Note: An amber horizontal line is drawn through the appropriate ENGAGED pitch or roll mode when a flight mode fault is detected.



1 Autothrottle Modes (Active)

Displayed (green) –

- THR
- THR REF
- HOLD
- IDLE
- SPD

2 AFDS Roll Modes (Engaged)

Displayed (green) –

- HDG HOLD
- HDG SEL
- LNAV
- LOC
- ROLLOUT
- TO/GA
- TRK SEL
- TRK HOLD
- ATT

3 AFDS Roll Modes (Armed)

Displayed (white) –

- LOC
- ROLLOUT
- LNAV

4 AFDS Pitch Modes (Engaged)

Displayed (green) –

- TO/GA
- ALT
- V/S
- VNAV PTH
- VNAV SPD
- VNAV ALT
- G/S
- FLARE
- FLCH SPD
- FPA

5 AFDS Pitch Modes (Armed)

Displayed (white) –

- G/S
- FLARE
- VNAV

6 AFDS (Engaged)

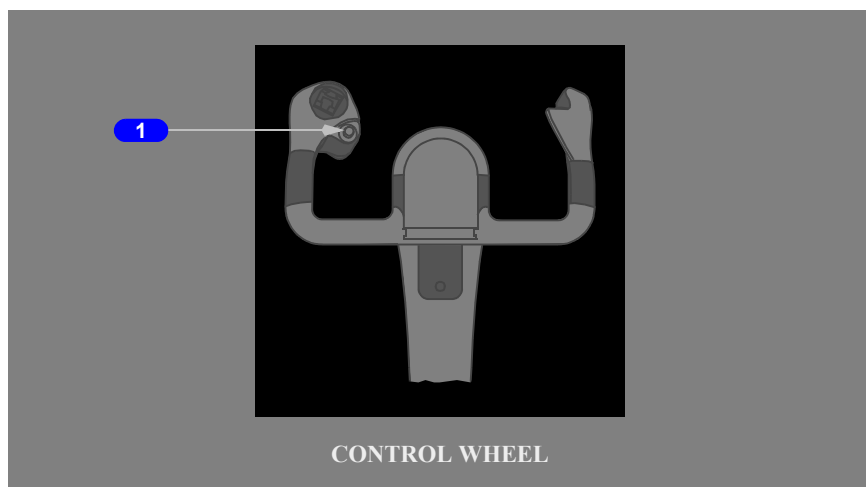
Displayed (green) –

- FLT DIR
- A/P
- LAND 3

Displayed (green with white triangles) – ▷LAND2◁

Displayed (amber) – NO AUTOLAND.

Autopilot Disconnect Switch



1 Autopilot Disconnect Switches

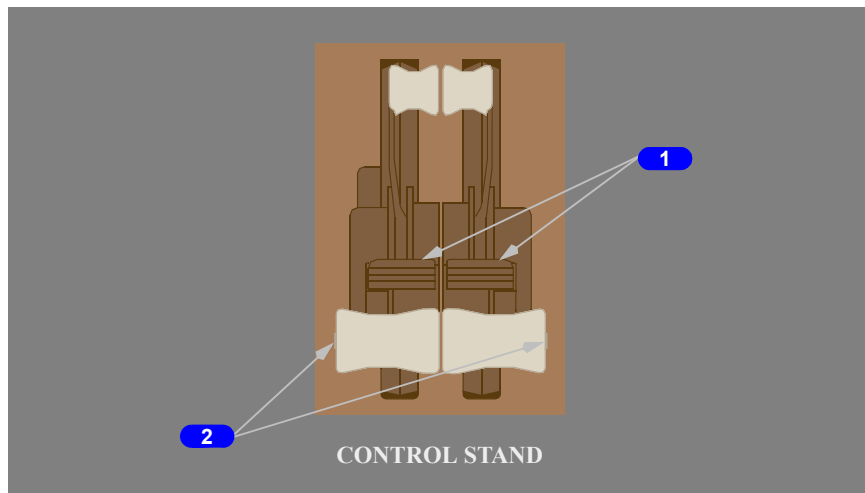
First push (either switch) –

- disconnects the autopilot
- the master warning lights illuminate
- displays the EICAS warning message AUTOPILOT DISC
- sounds an aural warning
- if the autopilot automatically disconnects, resets the master warning lights, EICAS warning message, and the aural warning.

Second push – resets:

- the master warning lights
- EICAS warning message
- the aural warning.

TO/GA and Autothrottle Disconnect Switches



1 Takeoff/Go-around (TO/GA) Switches

On the ground:

Push –

- below 50 knots and flaps out of up, activates autothrottle in THR REF mode at thrust limit selected on THRUST LIMIT page. If not pushed below 50 knots, autothrottle operation is inhibited until reaching 400 feet altitude
- pushing either switch above 80 knots disarms LNAV and VNAV

In flight:

Push (after lift-off with takeoff thrust limit displayed) –

- removes takeoff derates
- activates autothrottle in THR REF mode
- disarms AFDS modes
- between 50 feet and 400 feet, selects TO/GA roll mode
- above 400 feet, selects TO/GA roll and pitch modes

Push (on approach with flaps out of up or glideslope captured) –

- activates autothrottle in THR mode with GA thrust limit displayed
- disarms AFDS modes
- selects TO/GA roll and pitch modes
- arms or engages LNAV if an LNAV path is available
- second push – activates autothrottle in THR REF mode

2 Autothrottle Disconnect Switches

Push (either switch) –

- disconnects the autothrottle (both left and right)
- illuminates the master caution lights
- displays the EICAS message AUTOTHROTTLE DISC
- if the autothrottle automatically disconnects, resets the master caution lights and EICAS message.

Second push –

- resets the master caution lights and EICAS message
- the autothrottle remains armed.

Intentionally
Blank

Automatic Flight System Description

Chapter 4 Section 20

Introduction

The automatic flight control system consists of the autopilot flight director system (AFDS) and the autothrottle system. Both the AFDS and the autothrottle are controlled using the mode control panel (MCP) and the FMC.

Normally, the AFDS and autothrottle are controlled automatically by the FMC to perform climb, cruise, descent, and approach flight path guidance.

Autopilot Flight Director System

The AFDS consists of three autopilot flight director computers (AFDCs) and the MCP.

The MCP provides control of the autopilot, flight director, altitude alert, and autothrottle systems. The MCP is used to select and activate AFDS modes, and establish altitudes, speeds, and climb/descent profiles.

The AFDCs provide control of the flight directors, and autopilot. Flight director information is displayed on the primary flight displays (PFDs). The AFDS does not have direct control of the flight control surfaces. The autopilot controls the elevators, ailerons, flaperons, and spoilers through the fly-by-wire flight control system. Autopilot rudder commands are added only during an autopilot approach and landing. The autopilot controls nose wheel steering during rollout after an automatic landing.

MCP Mode Selection

MCP mode switches are used to select automatic flight control and flight director modes. A light in the lower half of each switch illuminates to indicate that the mode is armed or engaged. Mode engagement is indicated by the PFD roll and pitch flight mode annunciations. Autothrottle modes are discussed later in this section.

Most modes engage with a single push. These modes include:

- flight level change (FLCH SPD)
- heading hold (HDG HOLD)
- track hold (TRK HOLD)
- heading select (HDG SEL)
- track select (TRK SEL)
- vertical speed (V/S)
- flight path angle (FPA)
- altitude hold (ALT).

Other modes arm or engage with a single push. These modes are:

- lateral navigation (LNAV)
- vertical navigation (VNAV)
- localizer (LOC)
- approach (APP).

All modes except APP can be disengaged by selecting another mode. All modes can be disengaged by disconnecting the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can only be disengaged by disconnecting the autopilot and turning both flight directors off, engaging the go-around mode, or if above 1,500 feet radio altitude, by reselecting APP (roll and pitch will revert to default modes). The VNAV, LNAV, LOC and APP modes can be disarmed by pushing the mode switch a second time.

Desired target values can be selected on the MCP for:

- airspeed
- Mach
- heading
- track
- vertical speed
- flight path angle
- altitude.

All of these parameters except vertical speed and flight path angle can be preselected prior to autopilot and/or flight director engagement.

Autopilot Engagement

The autopilot is engaged by pushing either of the two MCP autopilot engage switches.

Autopilot Disengagement

Normal autopilot disengagement is through either control wheel autopilot disconnect switch. The autopilots can also be disengaged by:

- the MCP autopilot disengage bar, or
- overriding with the control column, control wheel, or rudder pedals (pedals will only disengage the autopilots with LAND 2 or LAND 3 annunciated).

An automatic autopilot disconnect occurs for some failures detected by the autopilot. The EICAS warning message AUTOPILOT DISC is displayed if the autopilot is manually or automatically disconnected. Depending upon the system failure, it may be possible to re-engage an autopilot by pushing the autopilot engage switch.

Autopilot and Flight Director Mode Degradations

Autopilot

The autopilot system can detect the degradation of a specific autopilot mode. When an engaged mode degrades, the autopilot remains engaged in an attitude stabilizing mode based on inertial data. If the degradation persists, the condition is annunciated on the PFD by an amber line drawn through the affected flight mode annunciation. If the degradation continues, the EICAS caution message AUTOPILOT is displayed to indicate the autopilot is operating in a degraded mode. When the degradation is no longer present the annunciations clear, the autopilot resumes using the mode, and a green box is drawn around the affected flight mode annunciation on the PFD for 10 seconds.

Flight Director

When a specific flight director mode degrades, the flight director provides an attitude stabilizing command based on inertial data. If the degradation persists, the condition is annunciated by removal of the affected (pitch or roll) flight director bar. When the degradation is no longer present the flight director commands immediately return to view.

ILS Signal Interference Monitor

The autopilot flight director system (AFDS) can detect significant ILS signal interference due to service vehicles or aircraft. If localizer or glideslope signal interference is detected, the autopilot disregards the ILS signal and remains engaged in an attitude stabilizing mode based on inertial data. Most ILS signal interferences last only a short period of time, so there is no annunciation other than erratic movement of the ILS raw data during the time the interference is present. If the condition persists, the annunciations described above for Autopilot and Flight Director Mode Degradation are provided.

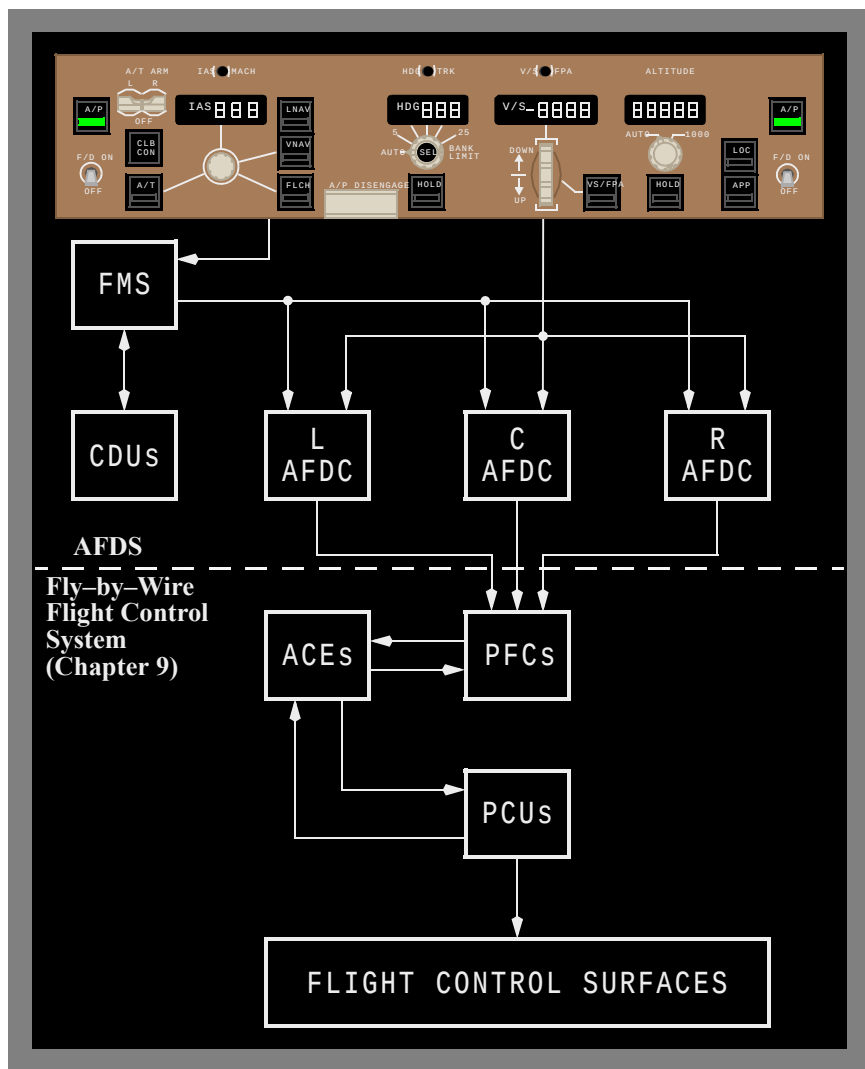
Flight Director Display

The flight director steering indications are normally displayed any time the related flight director switch is ON.

The steering indications are also displayed when the related flight director switch is OFF and a TO/GA switch is pushed, if airspeed is greater than 80 knots and the flaps are not retracted. In this case, the flight director display can be removed by cycling the respective flight director switch on and then off.

A flight director mode failure, in either pitch or roll, causes the respective steering bars to disappear. The stall and overspeed protection functions will also cause the pitch flight director bar to disappear.

Autopilot Flight Director System Schematic



AFDS Status Annunciation

The following AFDS status annunciations are displayed just above the PFD attitude display:

- FLT DIR (the flight director is ON and the autopilots are not engaged)
- A/P (the autopilots are engaged)
- LAND 3 (three autopilots are engaged and operating normally for an automatic landing)

-
- LAND 2 (AFDS redundancy is reduced; in some cases, only two autopilots are available)
 - NO AUTOLAND (the AFDS is unable to make an automatic landing).

With a LAND 3 indication, the autopilot system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing (fail operational).

With a LAND 2 indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path (fail passive).

An EICAS message is displayed for any fault which limits the capability of the automatic landing system. Aural alerts for EICAS messages not affecting safety of flight are inhibited until after touchdown. Changes in autoland status below 200 feet, other than a transition to NO AUTOLAND status, are inhibited.

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed just above the PFD AFDS status annunciations. The mode annunciations, from left to right, are:

- autothrottle
- roll
- pitch.

Engaged or captured modes are shown at the top of the flight mode annunciator boxes in large green letters. Armed modes (except for TO/GA in the air) are shown in smaller white letters at the bottom of the flight mode annunciator boxes.

Degradations of a specific mode while the autopilot is engaged are annunciated by an amber line drawn through the mode annunciations. A green box is drawn around the mode annunciation for 10 seconds when a mode first becomes active, and when the amber line through a degraded mode is removed.

Autothrottle Modes

The autothrottle modes are:

- THR – The autothrottle applies thrust to maintain the vertical speed required by the pitch mode.
- THR REF – Thrust is set to the selected thrust limit displayed on EICAS.
- IDLE – Displayed while the autothrottle moves the thrust levers to idle; IDLE mode is followed by HOLD mode.
- HOLD – The thrust lever autothrottle servos are inhibited. The pilot can set the thrust levers manually.
- SPD – The autothrottle maintains the selected speed displayed on the PFD. Speed can be set by the MCP IAS/MACH selector or by the FMC, as shown on the CDU CLIMB, CRUISE, or DESCENT page.

Note: In SPD mode, the autothrottle will not exceed the operating speed limits for the airplane configuration or the referenced thrust limits displayed on the EICAS.

Note: If only one thrust lever is active, “L” or “R” displays in front of SPD for the active thrust lever.

Roll Modes

The roll modes are:

LNAV –

- LNAV (armed) – LNAV is armed to engage when parameters are met.
- LNAV (engaged) – LNAV engages if above 50 feet, and within 2 1/2 NM of the active route leg. The AFDS follows the active leg displayed on the ND.

HDG –

- HDG SEL (engaged) – The airplane is turning to, or is on the heading selected in the MCP heading/track window.
- HDG HOLD (engaged) – The AFDS holds the present heading. If turning, the AFDS holds the heading reached after rolling wings level.

TRK –

- TRK SEL (engaged) – The airplane is turning to, or is on the track selected in the MCP heading/track window.
- TRK HOLD (engaged) – The AFDS holds the present track. If turning, the AFDS holds the track reached after rolling wings level.

ATT – (engaged) – When the autopilot is first engaged or the flight director is first turned on in flight, the AFDS holds a bank angle between 5 and 30 degrees and will not roll to wings level. If the bank angle is less than 5 degrees, the AFDS returns to wings level (HDG HOLD or TRK HOLD). If the bank angle is greater than 30 degrees, the AFDS returns to 30 degrees of bank

LOC –

- LOC (armed) – The AFDS captures the localizer when within range and within 120 degrees of the localizer track.
- LOC (engaged) – The AFDS follows the selected localizer course.

TO/GA –

- On the ground, TO/GA annunciates by positioning either flight director switch ON when both flight directors are OFF, or by pushing either TO/GA switch with airspeed greater than 80 KTS. TO/GA roll guidance becomes active at lift-off.
- In flight, TO/GA is armed when flaps are out of up or glideslope is captured. There is no flight mode annunciation for TO/GA armed. TO/GA is activated in flight by pushing a TO/GA switch. The roll steering indication provides guidance to maintain the ground track present at mode engagement.

ROLLOUT –

- ROLLOUT (armed) – Displayed below 1500 feet radio altitude and engages below 2 feet.
- ROLLOUT (engaged) – After touchdown, the AFDS uses rudder and nosewheel steering to keep the airplane on the localizer centerline.

Pitch Modes

The pitch modes are:

TO/GA –

On the ground, TO/GA annunciates by positioning either flight director switch ON when both flight directors are OFF, or by pushing either TO/GA switch with airspeed greater than 80 knots. The flight director PFD pitch bar indicates an initial pitch of eight degrees up.

After takeoff, the AFDS commands a pitch attitude to maintain:

- a target speed of V2 plus 15 knots
- if current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed, to a maximum of V2 plus 25 knots
- the IAS/MACH window speed if the IAS/MACH window speed is changed to a speed greater than the target speed.

Note: The AFDS uses the speed set in the IAS/MACH window prior to takeoff for V2.

In flight, TO/GA is armed when flaps are out of up or glideslope is captured.

When a go-around is initiated, the commanded speed is the MCP IAS/MACH window or current airspeed, whichever is higher, to a maximum of the IAS/MACH window speed plus 25 knots. GA displays as the thrust limit on the primary EICAS engine display.

VNAV –

VNAV is armed by pushing the VNAV switch (the switch bar is displayed and VNAV is annunciated on the PFD pitch mode annunciator in small white characters below the current pitch mode).

VNAV engages above 400 feet after takeoff, if armed. VNAV engages in the appropriate VNAV mode as required to maintain the current flight path:

- VNAV SPD (engaged) – The AFDS maintains the FMC speed displayed on the PFD airspeed indicator and/or the CDU CLIMB or DESCENT pages. If speed intervention is selected, the MCP IAS/MACH selector is used to manually select the speed.
- VNAV PTH (engaged) – The AFDS maintains FMC altitude or descent path with pitch commands. If the MCP altitude window is set to the current cruise altitude as the airplane approaches the top of descent, the CDU scratchpad message RESET MCP ALT displays.
- VNAV ALT (engaged) – When a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels and the pitch flight mode annunciation becomes VNAV ALT. VNAV ALT maintains altitude. To continue the climb or descent, change the MCP altitude and push the altitude selector or change the pitch mode.
- If an early descent is desired, FLCH, V/S, or FPA may be selected to descend below the VNAV descent path. If, during the decent, VNAV is armed and the airplane descent path subsequently intercepts the VNAV descent path, VNAV engages in VNAV PTH.

V/S (engaged) – Pushing the MCP VS/FPA switch, opens the vertical speed window to display the current vertical speed. Pitch commands maintain the rate of climb or descent selected in the VS/FPA window.

FPA (engaged) – Pushing the MCP VS/FPA switch opens the flight path angle window to display the current flight path angle. Pitch commands maintain the flight path angle selected in the VS/FPA window.

FLCH SPD (engaged) – Pushing the MCP FLCH switch opens IAS/MACH window (if blanked). Pitch commands maintain IAS/MACH window airspeed or Mach.

ALT (engaged) – Altitude hold mode is engaged by:

- pushing the MCP altitude HOLD switch, or
- capturing the selected altitude from a V/S, FPA, or FLCH climb or descent.

G/S (engaged) – The AFDS follows the ILS glideslope.

FLARE (armed) – During an autoland, FLARE is displayed below 1500 feet RA.

FLARE (engaged) – During an autoland, flare engages between 60 and 40 feet radio altitude. FLARE accomplishes the autoland flare maneuver so the AFDS can transition to the ROLLOUT mode.

Autothrottle System

The autothrottle system provides automatic thrust control from takeoff through landing.

Autothrottle operation is controlled from the MCP and the CDUs. The MCP provides mode and speed selection. The CDUs enable FMC thrust reference mode selection. When the VNAV mode is selected, the FMC selects the autothrottle modes and target thrust values. Refer to Chapter 11, Flight Management, Navigation, for FMS and CDU operation. Refer to Chapter 10, Flight Instruments, Displays, for PFD indications.

The autothrottle is either OFF, ARMED, or active. The autothrottle is off when the A/T arm switches are OFF. The autothrottle is armed when the A/T switches are ON and the autothrottle mode is blank. The autothrottle is active when the A/T arm switches are ON and there is an autothrottle mode shown. The active autothrottle modes are: IDLE, HOLD, THR, THR REF, and SPD.

Manual Flight

The autothrottle can be operated with flight directors OFF and the autopilot not engaged. When the autopilot is not engaged, but one or both flight directors are ON and the autothrottle is active, turning off both flight directors transitions the autothrottle to SPD. The autothrottle maintains the IAS/MACH window speed.

During a manual landing, when the active autothrottle mode is SPD, or the pitch mode is VNAV with the autothrottle active, thrust reduces to IDLE at 25 feet RA and the autothrottle mode transitions to IDLE.

Automatic Activation

The autothrottle can automatically activate to provide stall protection when armed and not active (A/T mode is blank).

With the autothrottle armed and not active, the autothrottle automatically activates when the pitch mode is ALT, V/S, FPA, VNAV ALT, VNAV PTH, G/S, or there is no active pitch mode, and:

- speed is less than an FMC calculated value for one second, and
- thrust is below reference thrust limit, and
- airplane barometric altitude is 400 feet above the airport on takeoff or airplane altitude is above 100 feet RA on approach.

If speed decreases to near stick shaker activation, the autothrottle automatically activates in SPD mode and advances thrust to maintain minimum maneuvering speed (approximately the top of the amber band) or the speed set in the IAS/MACH window, whichever is greater.

Note: During a climb in VNAV SPD with the autothrottle armed and not active, the autothrottle automatically activates in THR REF mode and advances thrust to the climb reference thrust limit.

Note: During a descent in VNAV SPD with the autothrottle armed and not active, the autothrottle can automatically activate in HOLD mode and will not advance thrust levers to support stall protection.

Note: The autothrottle will not automatically activate to support stall protection when the pitch mode is FLCH SPD or TOGA.

Note: The autothrottle will not support stall protection when the A/T mode is HOLD.

The EICAS advisory message AUTOTHROTTLE L or R displays when the respective autothrottle servo fails. If the autothrottle is active and only one autothrottle is armed, the PFD autothrottle flight mode annunciation displays L or R preceding the mode. For example, L SPD indicates only the left autothrottle is active in speed mode.

Autothrottle Thrust Lever Operation

The autothrottle system moves either or both thrust levers to provide speed or thrust control, depending on the active mode.

The thrust levers can be manually positioned without disconnecting the autothrottle. After manual positioning, the autothrottle system repositions the thrust levers to comply with the active mode. The autothrottle system does not reposition the thrust levers while in HOLD mode.

Note: When the pitch flight mode annunciation is FLCH SPD, the autothrottle can enter the HOLD mode. This occurs if the pilot overrides thrust levers; or, in a descent, when thrust levers retard to IDLE. When in HOLD mode, thrust lever servos are inhibited and the autothrottle does not control thrust or speed. Thrust levers can be manually advanced.

Autothrottle Disconnect

The autothrottle system can be disconnected manually by pushing either thrust lever autothrottle disconnect switch, except during conditions that cause the autothrottle to automatically activate. The autothrottle can also be disconnected manually by positioning both A/T ARM switches to OFF, or individually by positioning the left or right A/T ARM switch to OFF. Positioning one or both A/T ARM switches to OFF prevents activation of all autothrottle modes for the affected autothrottle.

Autothrottle disconnect occurs automatically:

- if a fault in the active autothrottle mode is detected
- when either reverse thrust lever is raised to reverse idle
- if the thrust levers are overridden during a manual landing, after the autothrottle has begun to retard the thrust levers to idle
- when both engines are shut down.

The EICAS caution message AUTOTHROTTLE DISC is displayed and an aural alert sounds when the autothrottle is manually or automatically disconnected. The EICAS caution message and aural alert are inhibited if the disconnect occurs because of reverse thrust.

Automatic Flight Operations

Automatic Flight Takeoff and Climb

Takeoff is a flight director only function of the takeoff/go-around (TO/GA) mode. The autopilot may be engaged after takeoff.

During preflight:

- With the autopilot disengaged and both flight director switches OFF, engagement of TO/GA roll and pitch mode occurs when the first flight director switch is positioned ON.
- The PFD displays FLT DIR as the AFDS status and TO/GA as the pitch and roll flight mode annunciations.
- The pitch command is a fixed attitude (about eight degrees up).
- The roll command is wings level.

During takeoff prior to lift-off:

- With speed less than 50 KIAS, pushing a TO/GA switch activates the autothrottle in the thrust reference (THR REF) mode. The thrust levers advance to the selected thrust limit. If the autothrottle is not active by 50 knots, it cannot be activated until above 400 feet.
- At 80 knots, the autothrottle mode annunciation changes to HOLD.

- With speed greater than 80 knots, pushing a TO/GA switch disarms LNAV and VNAV.
- During takeoff, the FMC records the barometric altitude as the airplane accelerates through 100 knots. This altitude is used to engage VNAV, enable autothrottle activation (if not active), command acceleration for flap retraction, and set climb thrust if an altitude has been selected. Radio altitude is used for engagement of LNAV.

At lift-off:

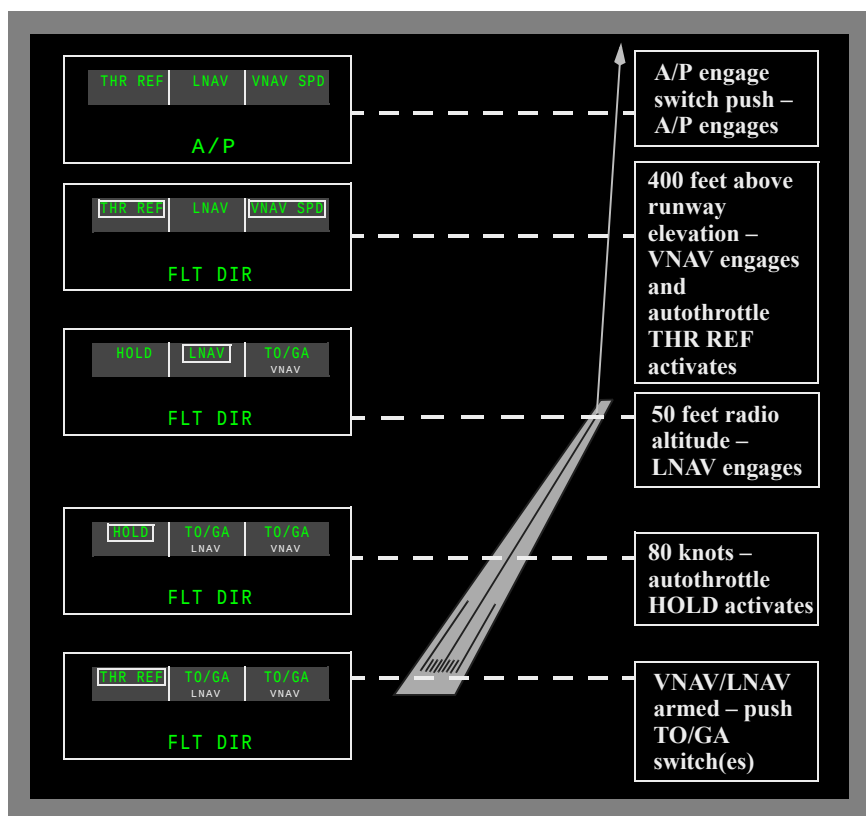
- The pitch command target speed is $V_2 + 15$. If current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed (limited to a maximum of $V_2 + 25$).
- If an engine failure occurs on the ground, the pitch command target speed at lift-off is V_2 or airspeed at lift-off, whichever is greater.
- The roll command maintains ground track.

After lift-off:

- If an engine failure occurs, the pitch command target speed is:
 - V_2 , if airspeed is below V_2
 - existing speed, if airspeed is between V_2 and $V_2 + 15$
 - $V_2 + 15$, if airspeed is above $V_2 + 15$.
- If a TO/GA switch is pushed:
 - takeoff derates are removed
 - the autothrottle activates in THR REF.
- At 50 feet radio altitude, LNAV engages, if armed. Roll commands bank to track the active route.
- At 400 feet above runway elevation, VNAV engages, if armed. Pitch commands the current airspeed. The autothrottle sets the selected reference thrust and annunciates THR REF.
- At acceleration height, pitch commands speed to 5 knots below takeoff flap placard speed. As flaps are retracted, pitch commands an acceleration to 5 knots below the placard speed of the commanded flap position.
- When flaps are up, pitch commands an acceleration to VNAV climb speed. VNAV climb speed is the greater of:
 - $V_{REF} + 80$ knots, or
 - speed transition associated with origin airport
- At thrust reduction point (either an altitude or a flap position), the FMC changes the thrust limit to the armed climb limit (CLB, CLB 1, or CLB 2).

The TO/GA mode is terminated by selecting any other pitch and roll mode; automatic LNAV/VNAV engage terminates TO/GA mode.

Automatic Flight Takeoff Profile



Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMS. Using LNAV and VNAV ensures the most economical operation.

Other roll modes available are:

- heading hold (HDG HOLD)
- heading select (HDG SEL)
- track hold (TRK HOLD)
- track select (TRK SEL).

Other pitch modes available are:

- altitude hold (ALT)
- flight level change (FLCH SPD)
- vertical speed (V/S)
- flight path angle (FPA).

Profile illustrations show the use of LNAV and VNAV.

Automatic Flight Approach and Landing

The AFDS provides autopilot guidance for ILS approaches.

Pushing the APP switch arms localizer in roll mode and glideslope in pitch mode. Either localizer or glideslope can be captured first.

Pushing the LOC switch arms the AFDS for localizer tracking. Descent on the localizer can be accomplished using VNAV, V/S, FLCH, or FPA pitch modes. The localizer mode cannot capture if the intercept angle exceeds 120 degrees. All other non-ILS approaches can be flown using LNAV and VNAV modes, or HDG SEL, TRK SEL, V/S, or FPA modes.

With a command speed of VREF+5 knots and landing flaps, there is sufficient wind and gust protection available with the autothrottle active. The autothrottle adjusts thrust quickly when the airspeed decreases below the command speed. The autothrottle decreases thrust slowly when the airspeed is more than the command speed. In turbulence, the result is that the thrust average is higher than necessary to keep the command speed. This causes the speed average to be more than the command speed.

Runway Alignment

Runway alignment is a submode of the approach mode. With crosswinds, the crab angle is reduced at touchdown. Runway alignment also compensates for a single engine approach.

For crosswinds requiring more than 10 degrees of crab angle, runway alignment occurs at 500 feet AGL. A sideslip of 5 degrees is established to reduce the crab angle. This configuration is maintained until touchdown. The airplane lands with the upwind wing low.

For crosswinds requiring a crab angle of between 5 and 10 degrees, an initial alignment occurs at 500 feet AGL, followed by a second alignment at 200 feet AGL. The initial alignment initiates a sideslip to reduce the crab angle to 5 degrees. This configuration is maintained to 200 feet AGL, where a second sideslip alignment increases the sideslip to further reduce the touchdown crab angle.

For crosswinds requiring a crab angle of less than 5 degrees, no runway alignment occurs until 200 feet AGL, where a sideslip is introduced to align the airplane with the runway.

If an engine fails prior to the approach, the AFDS introduces a sideslip at 1,300 feet AGL. This establishes a wings level configuration. If an engine fails during the approach, the wings level configuration is established when the engine failure is detected.

In the event of moderate or strong crosswinds from the side opposite the failed engine, no wings level sideslip is commanded, since the airplane is already banked into the wind.

Flare

The flare mode brings the airplane to a smooth automatic landing touchdown. The flare mode is not intended for single autopilot or flight director only operation.

Flare is armed when LAND 3 or LAND 2 is annunciated on the PFDs. At approximately 50 feet radio altitude, the autopilots start the flare maneuver. FLARE replaces the G/S pitch flight mode annunciation.

During flare:

- between 25 and 50 feet radio altitude, the autothrottle begins retarding the thrust levers to idle
- the PFD autothrottle annunciation changes from SPD to IDLE
- at touchdown, the FLARE annunciation is no longer displayed, and the nose is lowered to the runway.

Rollout

Rollout provides localizer centerline rollout guidance. Rollout is armed when LAND 3 or LAND 2 is annunciated on the PFDs.

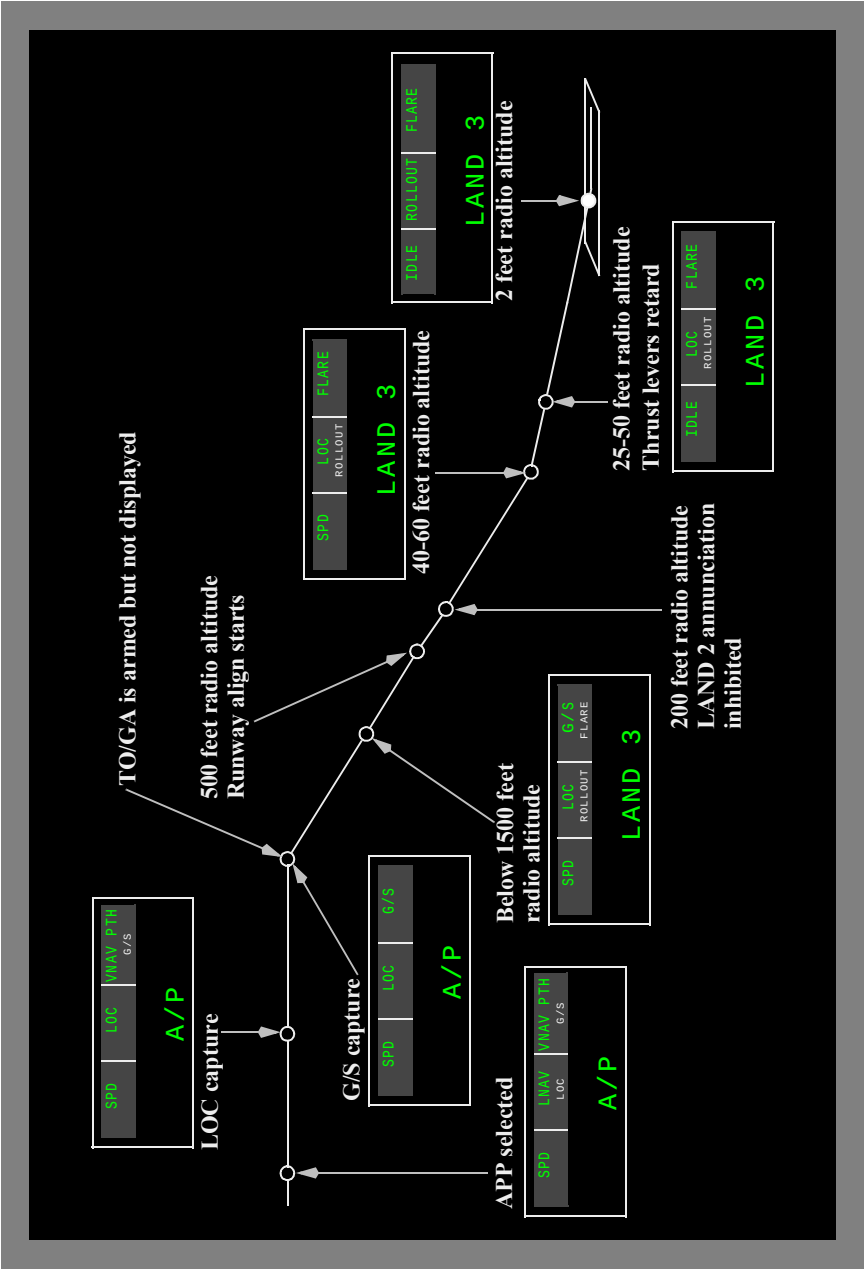
At less than two feet radio altitude, rollout engages. ROLLOUT replaces the LOC roll mode annunciation.

The autopilot controls the rudder and nose wheel steering to keep the airplane on the localizer centerline.

During rollout, the autothrottle IDLE mode remains active until the autothrottle is disconnected.

Rollout guidance continues until the autopilots are disengaged.

Automatic Flight Approach Profile



Go-Around

TO/GA is armed when flaps are out of UP or glideslope is captured. The thrust limit changes to GA when flaps are extended out of UP, flaps are extended to landing position, or glideslope is captured. The thrust limit is locked in GA when flaps are in landing position or glideslope is captured.

Pushing either TO/GA switch activates a go-around. The mode remains active even if the airplane touches down while executing the go-around.

When the flight director switches are not on, pushing either TO/GA switch displays the flight director bars.

The TO/GA switches are inhibited when on the ground and enabled again when in the air for a go-around or touch and go.

With the first push of either TO/GA switch:

- the PFDs display roll and pitch guidance to fly the go-around
- the autothrottle activates in thrust (THR) mode for a 2,000 FPM climb
- the AFDS increases pitch to hold the selected speed as thrust increases
- if current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed, (to a maximum of the IAS/MACH window speed plus 25 knots).
- if an LNAV path is available, LNAV automatically arms and engages:
 - above 50 feet radio altitude when autopilot is not engaged, or
 - above 200 feet radio altitude when autopilot is engaged.

Note: During go-around from a LAND 2 or LAND 3 approach, automatic LNAV engagement causes disconnect of autopilot rudder control. If executing an engine out missed approach with TAC inoperative, manual rudder control may be required to prevent large roll and yaw excursions.

With the second push of either TO/GA switch:

- the autothrottle activates in the thrust reference (THR REF) mode for full go-around thrust.

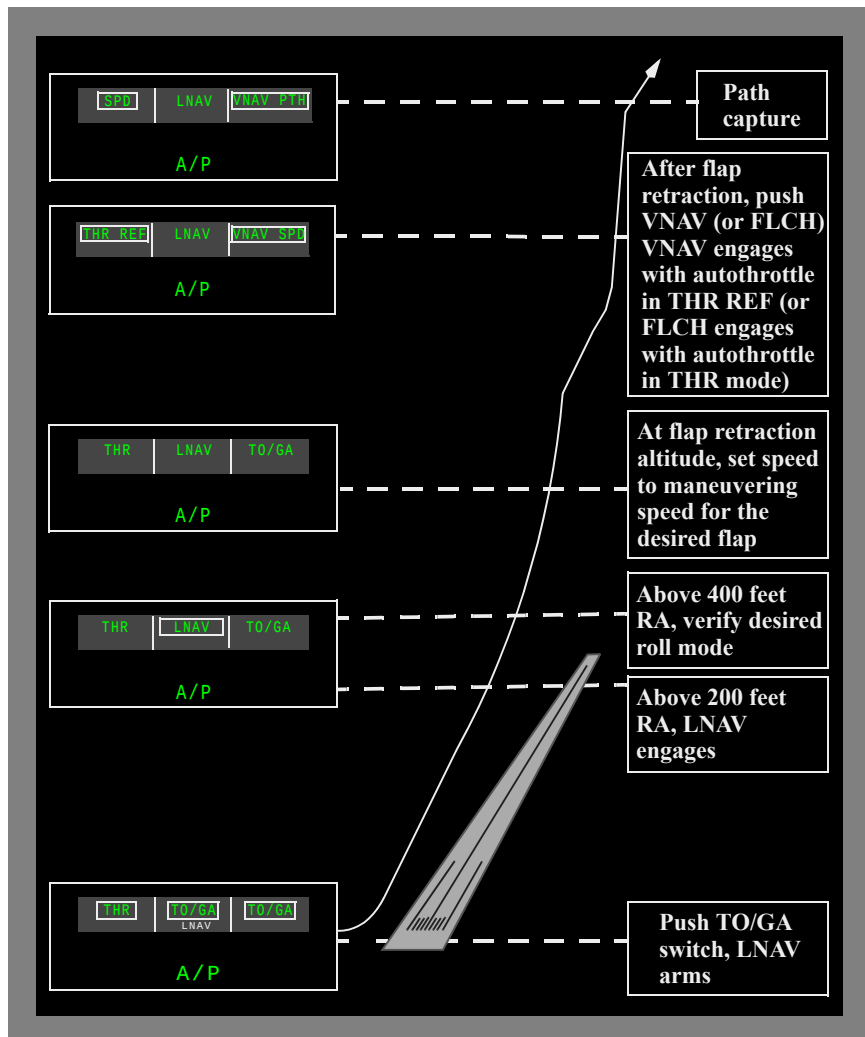
TO/GA level-off:

- at the selected altitude, the AFDS pitch mode changes to altitude hold (ALT)
- if altitude is captured, or if V/S or FPA is engaged, MCP speed is automatically set to:
 - the flap placard speed minus 5 knots
 - 250 knots if flaps are up, or
 - a speed value entered in the IAS/Mach window after TO/GA was pushed
- go-around remains the engaged roll mode until LNAV automatically engages or another mode is selected.

TO/GA mode termination:

- below 400 feet radio altitude, the AFDS remains in the go-around pitch and roll mode unless:
 - the autopilot is disconnected and both flight directors are turned off, or
 - LNAV automatically engages (after automatic LNAV engagement, a different roll mode can be selected)
- above 400 feet radio altitude, select a different MCP pitch or roll mode.

Automatic Flight Go-Around Profile



Automatic Flight Windshear Recovery

The AFDS provides windshear recovery guidance by means of the normal go-around pitch and roll modes. Go-around is engaged by pushing a TO/GA switch. The AFDS commands a pitch-up of 15 degrees or slightly below the pitch limit, whichever is lower.

As rate of climb increases, the AFDS transitions from pitch to airspeed control. The target airspeed is IAS/MACH window airspeed or current airspeed, whichever is greater when TO/GA is engaged. If current airspeed remains above the selected speed for 5 seconds, the selected airspeed is reset to current airspeed, (to a maximum of the IAS/MACH window speed plus 25 knots).

If the autopilot is not engaged when go-around is initiated, the pilot must fly the windshear recovery following the flight director commands. If the autothrottle is not armed, the thrust levers must be advanced manually.

Flight Envelope Protection

There are three forms of flight envelope protection in the autopilot:

- stall protection
- overspeed protection
- roll envelope bank angle protection.

An AUTOPILOT caution message and roll or pitch mode failures alert the pilot if the envelope is exceeded, and the autopilot prevents further envelope violations.

Refer to Chapter 9, Flight Controls, for a description of flight envelope protection.

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Automatic Flight EICAS Messages

Chapter 4 Section 30

Automatic Flight EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
AUTOPILOT	Caution	Beeper	Autopilot is operating in a degraded mode. Active roll and/or pitch mode may have failed, or the autopilot has entered envelope protection.
AUTOPILOT DISC	Warning	Siren	Autopilot has disengaged.
AUTOTHROTTLE DISC	Caution	Beeper	Both autothrottles have disconnected.
AUTOTHROTTLE L, R	Advisory		Affected autothrottle is OFF or has failed.
NO AUTOLAND	Caution	Beeper	Autoland is not available. Message is a caution if fault occurs after LAND 3 or LAND 2 is annunciated, or approach has been selected but does not engage by 600 feet AGL.
	Advisory		Message is an advisory if fault occurs before LAND 3 or LAND 2 is annunciated.
NO LAND 3	Caution	Beeper	Autoland system does not have redundancy for triple channel autoland. Message is a caution if fault occurs after LAND 3 is annunciated.
	Advisory		Message is an advisory if fault occurs before LAND 3 is annunciated.

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Communications

Chapter 5

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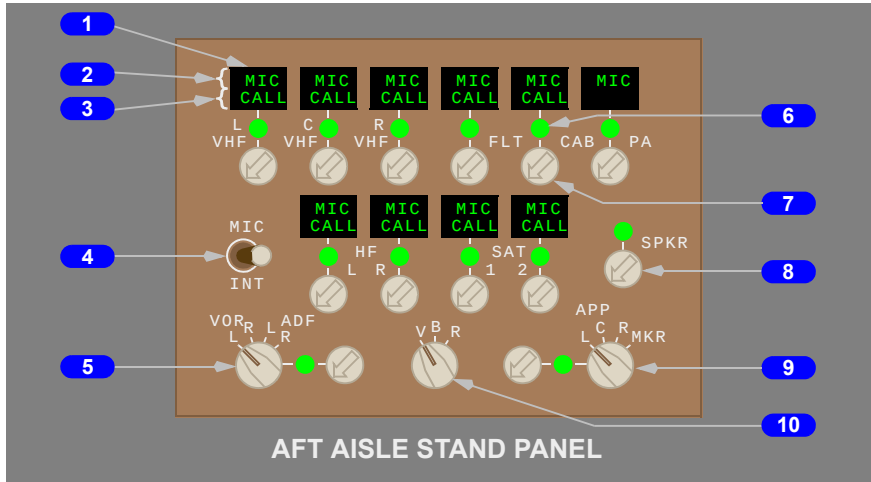
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Communications Controls and Indicators

Chapter 5 Section 10

Audio Control Panel (ACP)



1 Transmitter Select Switches

Push –

- the MIC light illuminates
- the MIC light for any other transmitter extinguishes
- selects the respective transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- selects the receiver audio on, if not already manually selected on
- pushing the CAB transmitter select switch twice within one second places a priority call to a selected cabin station.

Second push –

- deselects the transmitter
- deselects receiver audio.

Note: Second push of the CAB select switch deselects the transmitter and receiver audio only after one second has elapsed from the first push.

2 MIC Lights

Illuminated (green) – indicates the transmitter is selected.

3 CALL Lights

Illuminated (green) –

- indicates a call on SELCAL, the flight interphone (FLT), the cabin interphone (CAB), or SATCOM (SAT)
- resets when the respective transmitter select switch is pushed or, if already pushed, by pressing a MIC/INTERPHONE switch (the SATCOM CALL light remains illuminated until the call ends)
- PA does not have a CALL light.

4 MIC/Interphone (INT) Switch

MIC – keys the boom microphone or oxygen mask on the selected radio transmitter or other system.

Center – off position (spring-loaded to center).

INT – keys the boom microphone or oxygen mask on the flight interphone.

5 VOR/ADF Receiver Selector

Selects the VOR or ADF receiver to be monitored:

- VOR L – left VOR
- VOR R – right VOR
- ADF L – left ADF
- ADF R – right ADF.

6 Receiver Lights

Illuminated (green) – indicates the respective receiver volume control is manually selected on.

7 Receiver Volume Controls

Push – turns the respective receiver audio on or off.

Rotate – controls receiver volume.

8 Speaker (SPKR) Volume Control

Push – turns the respective flight deck speaker on or off.

Rotate – controls flight deck speaker volume.

Note: Inoperative on first and second observer (if installed) audio control panels.

9 Approach (APP) Receiver Selector

Selects the approach receiver to be monitored:

- APP L – left ILS
- APP C – center ILS
- APP R – right ILS
- MKR – marker beacon.

10 Navigation Filter Selector

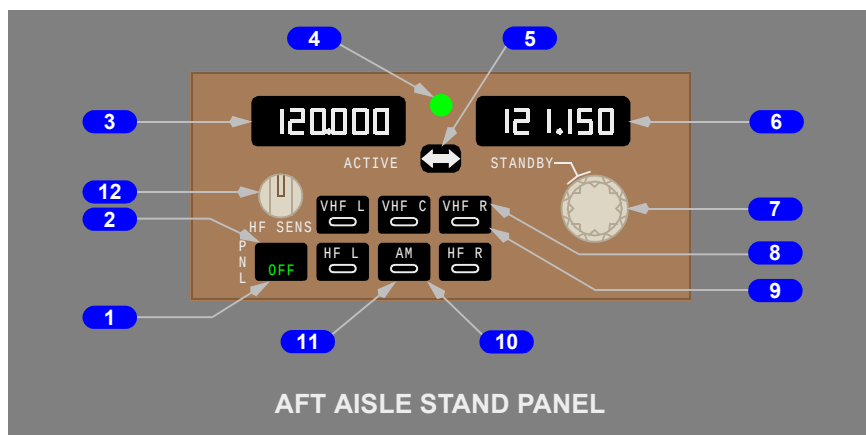
Filters VOR, ADF, ILS, or DME audio:

- V (voice) – only the voice audio is heard
- B (both) – both the voice and range audio are heard
- R (range) – range audio (navigation aid Morse code identifier) is heard.

Note: Marker beacon audio is available in all positions.

Radio System

Radio Tuning Panel



1 Radio Tuning Panel OFF Light

Illuminated (green) – the radio tuning panel is off.

2 Radio Tuning Panel OFF Switch

Push – disconnects the panel from the communication radios.

3 ACTIVE Frequency Window

Displays the tuned frequency of the selected radio.

Displays DATA if the selected radio is in the data mode (not applicable for VHF L).

4 Offside Tuning Light

Illuminated (green) –

- the radio normally associated with this panel is being tuned by another radio tuning panel, or
- the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

Note: The left radio tuning panel is normally associated with VHF L and HF L.
The right radio tuning panel is normally associated with VHF R and HF R.
The center radio tuning panel is normally associated with VHF C.

5 Frequency Transfer Switch

Push –

- transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency
- transfers the ACTIVE window frequency to the STANDBY window.

6 STANDBY Frequency Window

Displays the preselected or previously tuned frequency of the selected radio.

With data link installed, displays DATA when selection of the frequency transfer switch would reconfigure the selected radio to the data mode (not applicable for VHF L).

7 Frequency Selector

Rotate –

- outer knob – selects the portion of the STANDBY frequency to the left of the decimal point
- inner knob – selects the portion of the STANDBY frequency to the right of the decimal point.

8 Radio Tuning Switches

Push –

- selects the radio to be tuned
- the tuned frequency is displayed in the ACTIVE frequency window
- the standby frequency is displayed in the STANDBY frequency window.

9 Radio Tuning Lights

Illuminated – indicates the selected radio.

10 AM Switch

Push – sets the AM (amplitude modulation) or USB (upper side band) mode for the selected HF.

11 AM Light

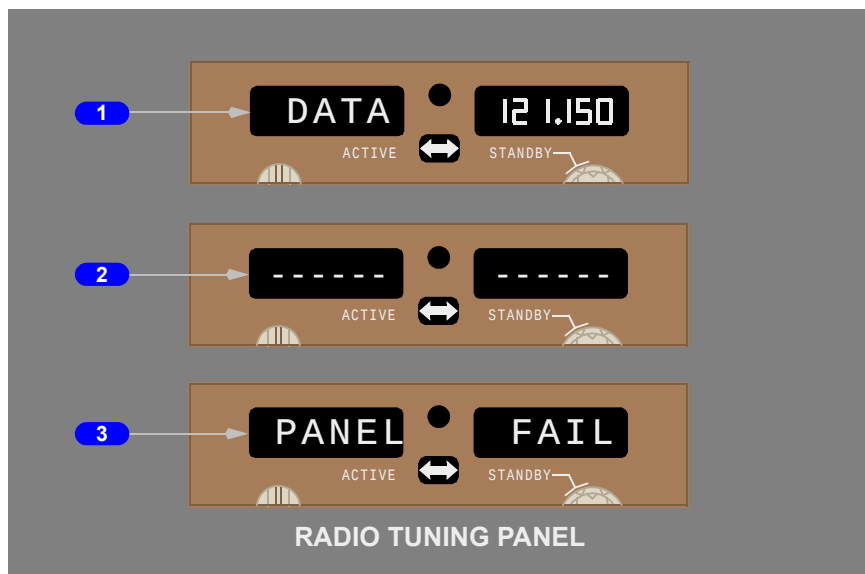
Illuminated – HF AM is selected.

Extinguished – HF USB is selected.

12 HF Sensitivity Control

Rotate – adjusts the sensitivity of the on-side HF receiver.

Radio Tuning Panel Indications



1 DATA Mode

Displays DATA in the ACTIVE frequency window when the selected radio is being used in the data mode.

2 Radio Fail

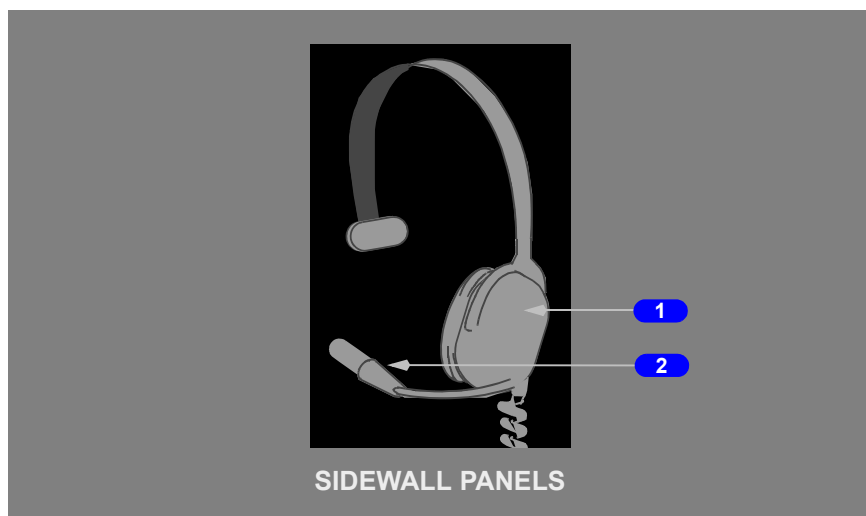
Displays dashes in both windows when the selected radio is failed or has been disconnected.

3 PANEL FAIL

The radio tuning panel is failed.

Miscellaneous Communication Controls

Headphone/Boom Microphone



1 Headphone

Used to monitor audio from the respective audio control panel.

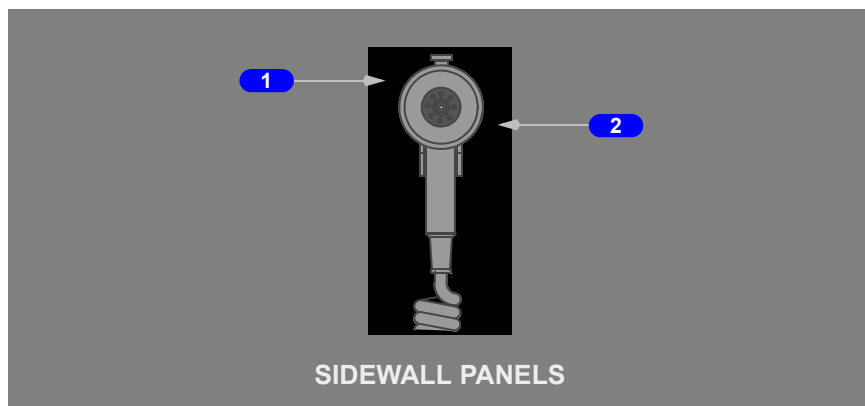
Audio volume is adjusted using audio control panel controls for the associated station.

Available at all flight deck stations.

2 Boom Mic

Activation of a control wheel, glareshield or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Hand Microphone



1 Hand Microphone Push-To-Talk Switch

Push – activates the hand microphone.

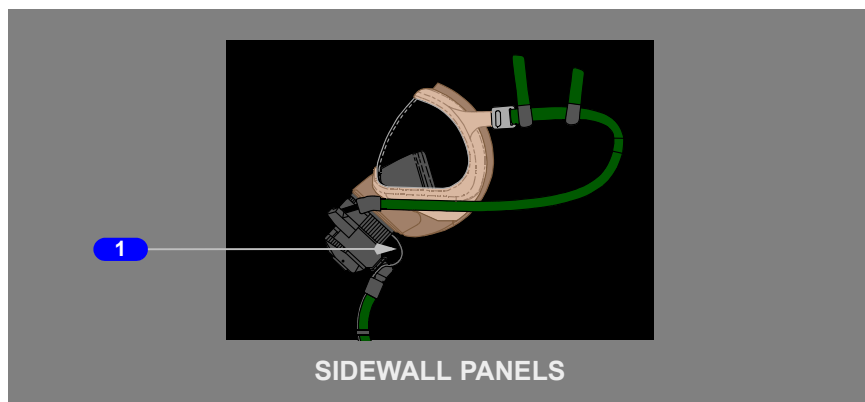
2 Hand Microphone

Transmits on the system selected by the audio control panel.

Available at the captain, first officer and first observer stations.

Optional for the second observer station.

Oxygen Mask Microphone

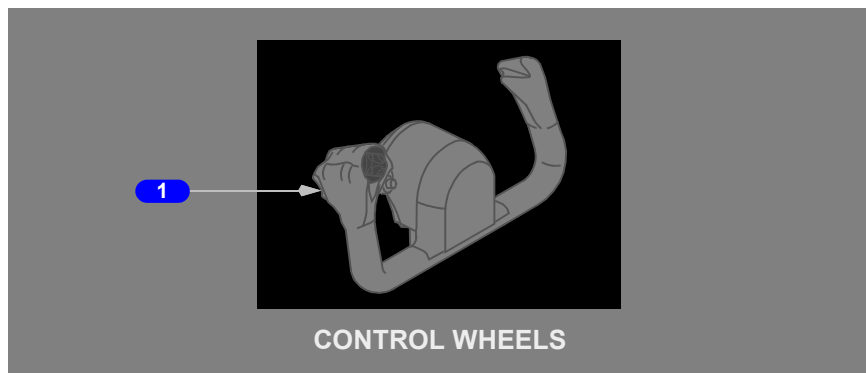


1 Oxygen Mask Microphone

Enabled when the oxygen mask right door is open. The boom microphone is disabled.

Activation of a control wheel, glareshield or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Control Wheel Microphone/Interphone Switch



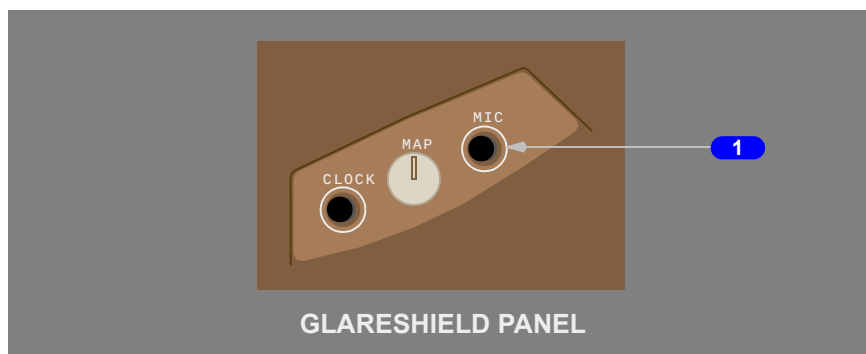
1 Control Wheel Mic/Interphone Switch

MIC – allows oxygen mask or boom microphone transmission on selected transmitter. Spring-loaded to center.

CENTER – off position.

INT – allows oxygen mask or boom microphone transmission on the flight interphone system. Spring-loaded to center.

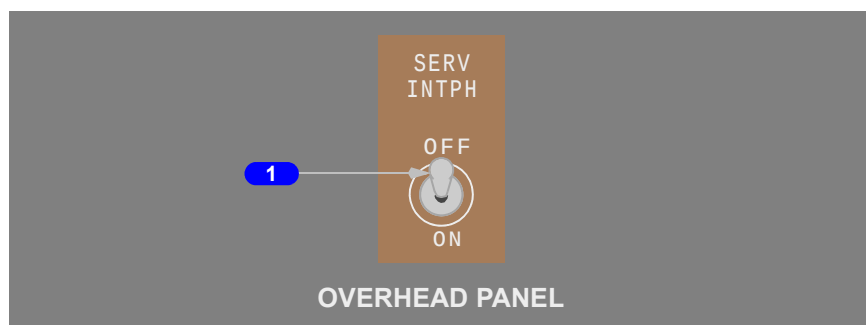
Glareshield Microphone Switch



1 Glareshield MIC Switch

Push – allows oxygen mask or boom microphone transmission on the selected transmitter.

Service Interphone Switch

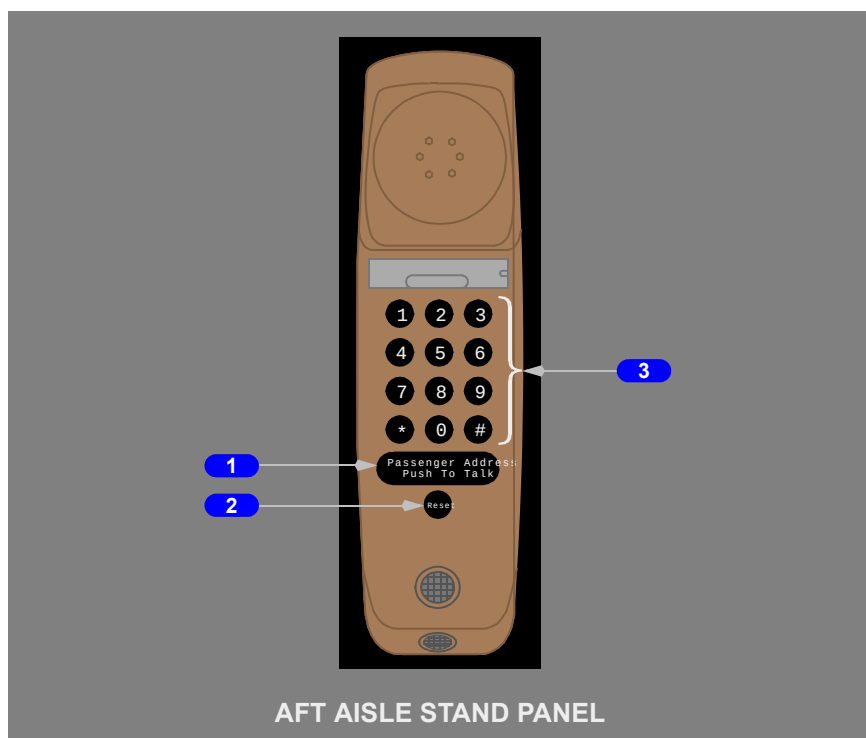


1 Service Interphone (SERV INTPH) Switch

OFF – allows independent operation of the service and flight interphone systems.

ON – connects the service and flight interphone systems.

Handset



1 Passenger Address Push To Talk Switch

Push –

- connects the handset microphone to the selected PA area
- only used in the PA mode.

2 Reset Switch

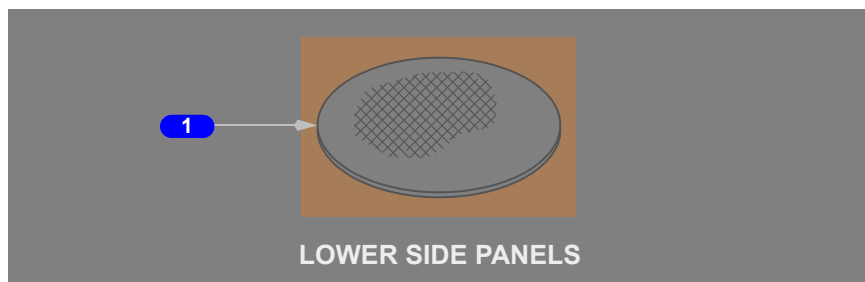
Push – cancels a call or incorrectly selected code.

3 Numeric Keys

Push – selecting a code calls the respective station or PA area.

Note: Dial codes entered using the handset are not displayed on the CDU cabin interphone pages.

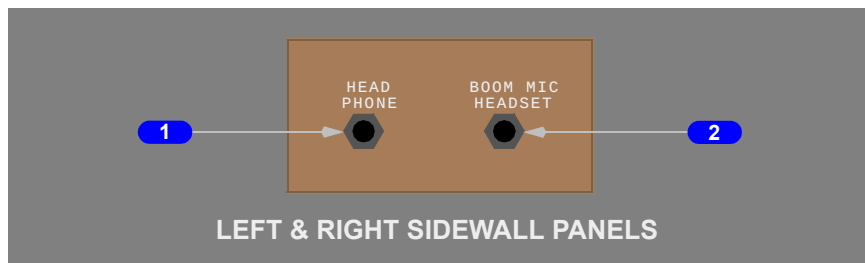
Flight Deck Speaker



1 Flight Deck Speaker

Controlled by the speaker volume control on the respective audio control panel.

Boom Microphone/Headphone Panel



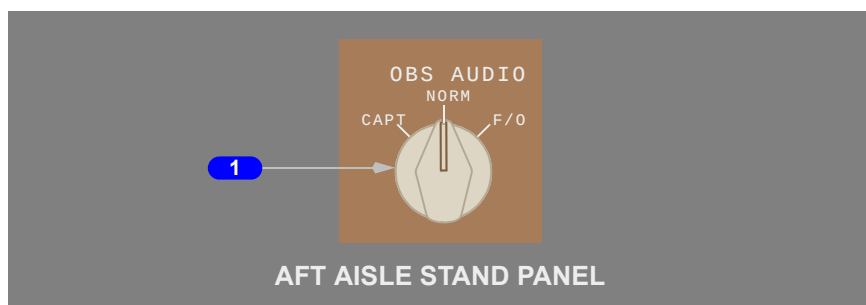
1 HEAD PHONE Jack

Accepts a flight crew headphone plug.

2 BOOM MIC HEADSET Jack

Accepts a flight crew boom mic plug.

Observer Audio Selector



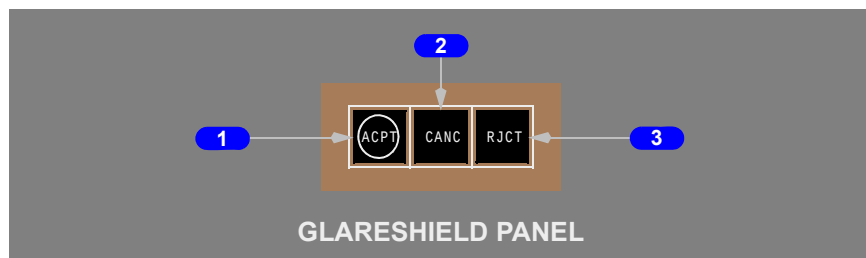
1 Observer (OBS) AUDIO Selector

Captain (CAPT) – connects the captain's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Normal (NORM) – the first observer audio control panel is connected to the first observer's hand microphone, headphone, boom microphone/headset and oxygen mask microphone.

First Officer (F/O) – connects the first officer's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Data Link Accept/Cancel/Reject Switches



1 Accept (ACPT) Switch

Push –

- a positive response to a displayed message is downlinked to the origin of the displayed message
- functions the same as selecting an MFD communications display ACCEPT command key.

2 Cancel (CANC) Switch

Push –

- the message is removed from the display
- functions the same as selecting an MFD communications display CANCEL command key.

3 Reject (RJCT) Switch

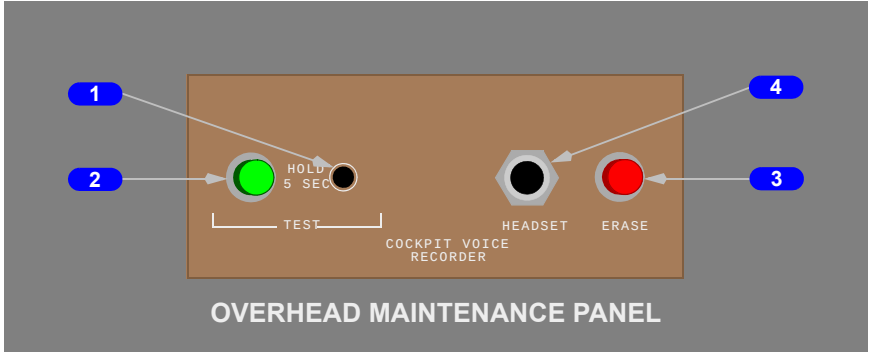
Push –

- a negative response to the displayed message is downlinked to the origin of the displayed message
- functions the same as selecting an MFD communications display REJECT command key.

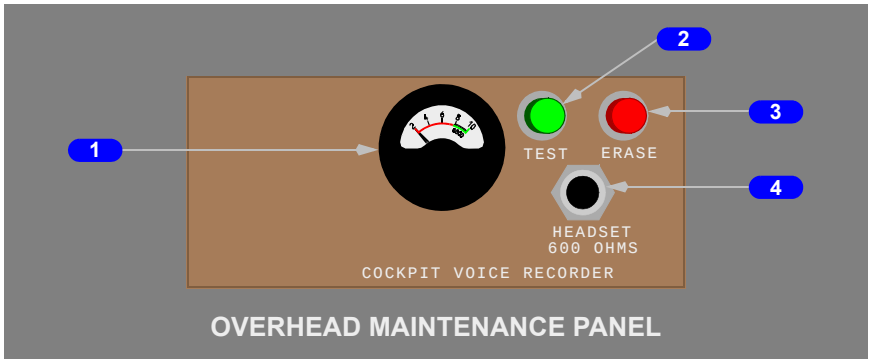
Cockpit Voice Recorder System

Cockpit Voice Recorder Panel

7101 - 7110



7001 - 7008



1 STATUS Indicator (green)

7101 - 7110

Illuminated – test completed successfully. Extinguished after button is released.

1 Cockpit Voice Monitor Indicator

7001 - 7008

Pointer deflection indicates recording or erasure on all channels.

During test, the pointer rises into the green band.

2 Cockpit Voice Recorder TEST Switch

Push and hold for five seconds – tests all four cockpit voice recorder channels (1 per second).

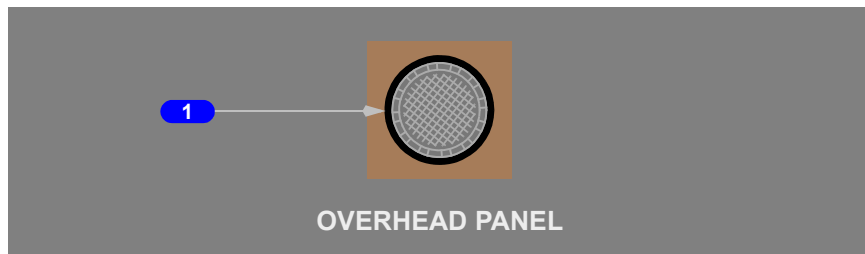
3 Cockpit Voice Recorder ERASE Switch

Push and hold for three seconds – erases voice recorder if on the ground, AC power on, and parking brake set.

4 Cockpit Voice Recorder Headset Jack

A headset may be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

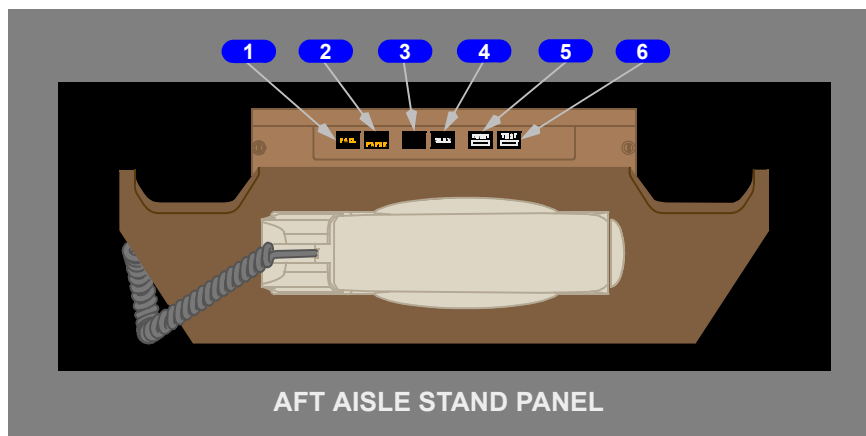
Cockpit Voice Recorder Microphone



1 Cockpit Voice Recorder Microphone

Area microphone for the voice recorder.

Printer Controls



1 Printer FAIL Light

Illuminated amber –

- the printer is failed.

2 Printer PAPER Light

Illuminated PAPER (amber):

- the printer is out of paper, or
- the paper is jammed.

3 Switch is not functional

4 Printer SLEW Switch

Push and hold – advances the printer paper.

5 Printer RESET Switch

Push – resets the printer if it stops operating.

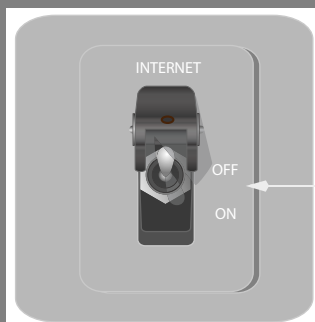
6 Printer TEST Switch

Push –

- tests the printer and printer lights
- prints a test pattern.

Wi-Fi

Wi-Fi Master Switch



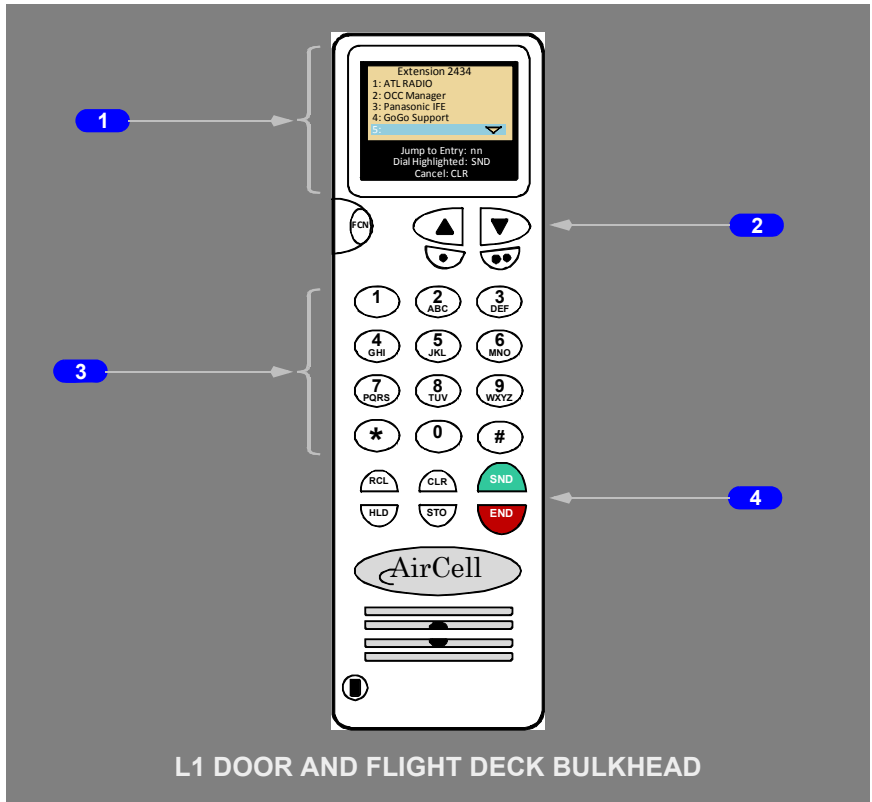
NEXT TO FLIGHT ATTENDANT PANEL AT L1 DOOR

1 Internet Master Switch

ON – provides power to the internet system.

OFF – removes power from the internet system.

Wi-Fi Handset



1 Pre-Programmed Connections

Select pre-programmed connections by using up/down keys. After highlighting selection, select SND.

2 Up/Down Keys to Locate Connections

Push to highlight desired connection.

3 Keypad

4 Function Buttons

Intentionally
Blank

Communications System Description

Chapter 5 Section 20

Introduction

The communication systems include:

- cockpit voice recorder system
- radio communication system
- SELCAL system
- SATCOM system
- communication crew alerting system
- interphone communication system (refer to Section 30 of this chapter)
- data communication system (refer to Section 40 of this chapter).

The communication systems are controlled using the:

- audio control panels
- radio tuning panels
- control display unit (CDU) communications pages (refer to Section 30 of this chapter)
- multifunction display (MFD) communications pages (refer to Section 40 of this chapter)

Audio Control Panels

The audio control panels are used to manage the radio and interphone communication systems. Navigation receiver audio can also be monitored. The captain, first officer, and first observer audio control panels are installed on the aft aisle stand.

Microphones are keyed by pushing the desired audio control panel transmitter select switch and using the MIC (microphone) position of a control wheel or audio control panel microphone/interphone switch, a glareshield MIC switch, or a hand microphone push-to-talk switch. Systems are monitored using headphones or speakers. An oxygen mask microphone is enabled and the boom microphone is disabled when the oxygen mask stowage right door is open. The oxygen mask microphone is disabled and the boom microphone is enabled when the right oxygen mask stowage box door is closed and the RESET/TEST switch is pushed.

Cockpit Voice Recorder System

The cockpit voice recorder records any transmitted or received flight deck audio as selected on the audio control panels. It also records flight deck area conversations using an area microphone. All inputs are recorded continuously.

Radio Tuning Panels

The radio tuning panels are used to tune the VHF and HF radios. The panels are designated left, center, and right, and are normally associated with the respective VHF and HF radios.

Radio Communication Systems

The radio communication systems consist of the very high frequency (VHF) communication system, the high frequency (HF) communication system, the satellite communication (SATCOM) system, and the selective calling (SELCAL) system.

VHF Communication System

Three independent VHF voice/data radios, designated VHF L (left), VHF C (center), and VHF R (right) are installed. Any VHF radio can be controlled by any radio tuning panel. The audio control panels are used to control voice transmission and receiver monitoring.

VHF L is configured for voice communication only. VHF C and VHF R can be configured for data or voice communication. However, only one VHF radio can operate in the data mode at a time. Data communication is normally selected on VHF C.

Data Mode

The data mode can be selected and deselected on the MFD COMM display or by pushing the frequency transfer switch on the radio tuning panel. If the selected VHF radio is the default data radio (selected on the MFD COMM display), then the word DATA is displayed in the radio tuning panel active frequency window. When a standby frequency is transferred to the active window, DATA is displayed in the standby window. If a new frequency is selected in the standby window when DATA is displayed, DATA is replaced by the new frequency. Data can be returned to the standby window by selecting a frequency higher or lower than the allowable VHF frequency range.

When a VHF radio is in the data mode, it is not available for voice communications. A VHF radio can be returned to the voice communication mode by transferring a voice frequency into the ACTIVE frequency window.

HF Communication System

There are two independent HF communication radios, designated HF L (left) and HF R (right). Each HF radio can be tuned by any radio tuning panel. HF radio sensitivity can only be set on the on-side radio tuning panel.

The audio control panels are used to control voice transmission and receiver monitoring.

When an HF transmitter is keyed after a frequency change, the antenna tunes while a continuous or intermittent tone may be heard through the audio system. A tone lasting longer than 7 seconds indicates failure of the system to tune. Data is stored in memory for the last 100 tuned frequencies. Stored frequencies may tune quickly and a tone may not be noticeable.

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.

Stuck Mic Protection

In the event a VHF or HF radio transmits for more than 30 seconds, the EICAS advisory message RADIO TRANSMIT is displayed. The message is removed when the transmission stops.

7101 - 7110

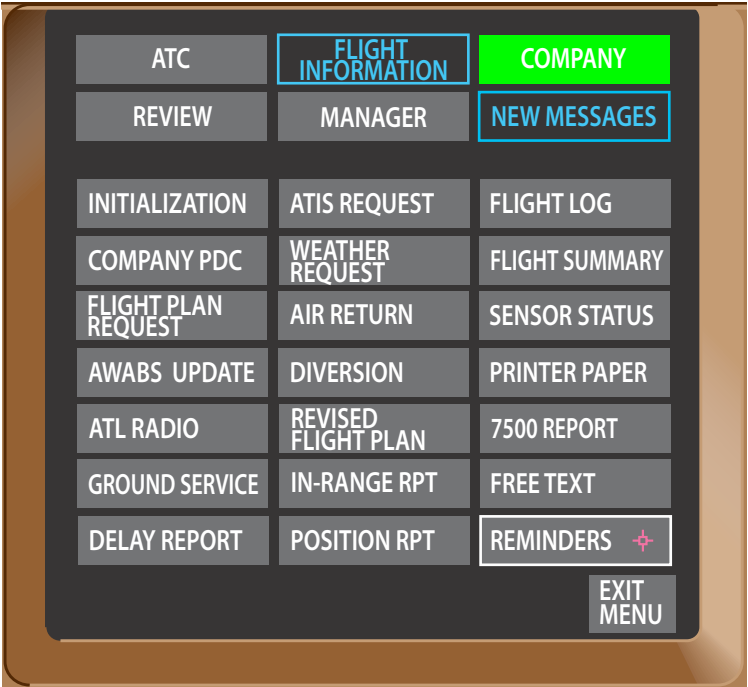
On the ground with both engines shut down, any VHF radio that transmits for more than 35 seconds is automatically disabled and an intermittent tone can be heard through the audio system for that radio. That radio is enabled when the microphone switch for that radio is released.

7001 - 7008

On the ground with both engines shut down, any VHF radio that transmits for more than 35 seconds is automatically disabled, dashes appear in the tuning panel frequency window, and an intermittent tone can be heard through the audio system for that radio. That radio is enabled when the microphone switch for that radio is released.

Reminders Function

Reminders function is a "timer" that allows crewmembers to enter a value and limited text to provide themselves or other crewmembers a visual reminder (COMM message) and aural reminder (hi-lo chime) during flight. The reminder functions are accessed by selecting REMINDERS from the COMPANY page.



The following 10 reminder functions are available:

- UTC Time 1
- Time to Top of Descent
- Reached Fuel Level
- Reached Latitude
- Reached Altitude
- UTC Time 2
- Time to Destination
- Crossed Waypoint
- Crossed Longitude
- Active Waypoint ETA Change

Selective Calling (SELCAL) System

The SELCAL system monitors the three VHF radios and the two HF radios. When the system receives a call from a ground station, the crew is alerted through the communication crew alerting system.

SATCOM System

The SATCOM system provides both data and voice communications. The system is managed by the satellite data unit. Flight deck voice calls are controlled using the CDUs and audio control panels.

The SATCOM control pages are displayed by selecting SAT on the CDU menu page. Directories are line-selectable or numbers may be manually entered.

Incoming SATCOM calls are annunciated by a SELCAL chime and illumination of a CALL light on the audio control panel. Pressing the respective transmitter select switch connects the call to the pilot headset/hand mic.

SATCOM calls are terminated when the CALL light extinguishes (ground party hang-up or pilot ends call).

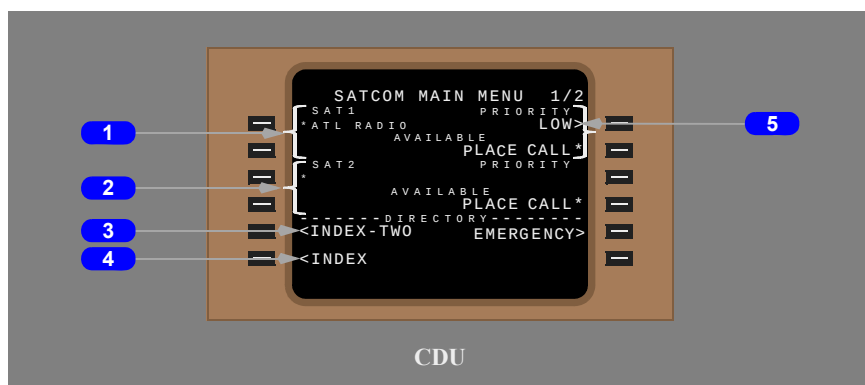
The EICAS communication message SATCOM MESSAGE displays when a SATCOM message requires flight crew attention. Servicing the message clears the EICAS message.

SATCOM Main Menu Pages

7101 - 7110

The SATCOM main menu pages allow the flight crew to initiate, answer and terminate calls, monitor call status, and access lower-level pages. Control functions are active when displayed with an asterisk.

SATCOM Main Menu Page 1/2



1 Channel 1 Control Field

Push – selects active control function, SATCOM priority page, or manual phone number entry. Channel 1 status information displays in center of field.

2 Channel 2 Control Field

Push – selects active control function, SATCOM priority page, or manual phone number entry. Channel 2 status information displays in center of field.

3 REGION

Displays last index label accessed. Index labels are defined by the operator.

Push – displays SATCOM directory page associated with displayed index label.

4 INDEX

Push – displays SATCOM directory (DIR) index page containing a list of regions. Selecting desired region displays associated SATCOM directory page.

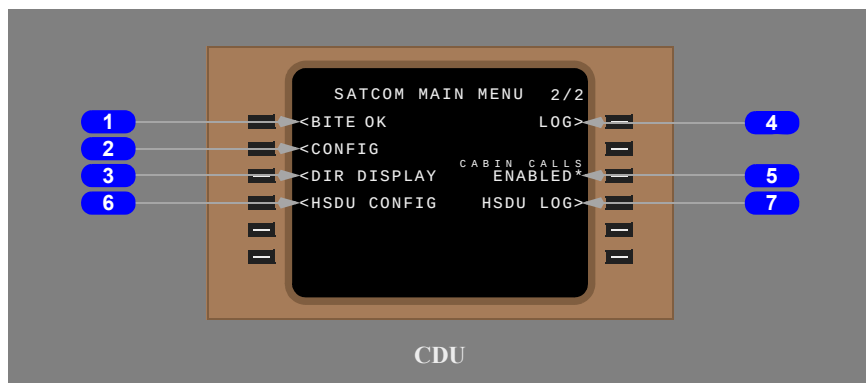
5 PRIORITY

The following call priority levels can display:

- EMG (Emergency) - emergency and distress calls (activates ground station alarm)
- HGH (High) - regulatory and flight safety calls
- LOW - non-safety related service calls
- PUB (Public) - passenger cabin calls

Push (channel not in use) – displays SATCOM priority page.

SATCOM Main Menu Page 2/2



1 Built-In-Test-Equipment (BITE)

Displays current BITE status.

Push – displays SATCOM BITE status page for access to system fault information.

2 CONFIG

Push – displays SATCOM config page for access to system configuration.

3 Directory (DIR) DISPLAY

Prompt does not display if both voice channels unavailable.

Push – displays SATCOM directory display page (XX of 20).

4 LOG

Push – displays SATCOM log page for manual selection and control of log-on.

5 CABIN CALLS

Push – selects desired cabin call status by toggling between enabled and disabled. Selecting enabled prompt displays the SATCOM cabin disable page for confirmation. If pilot confirms disabled, cabin calls in progress are not affected.

6 High Speed Data Unit (HSDU) Configuration (CONFIG)

Push – displays HSDU configuration page for access to high speed data unit configuration information.

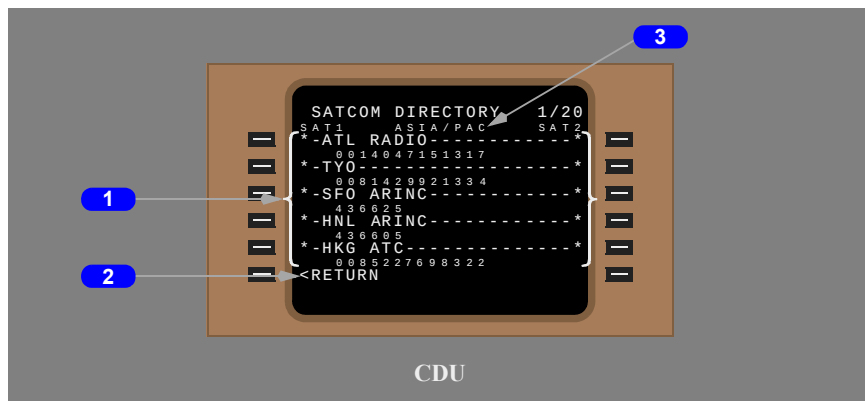
7 High Speed Data Unit (HSDU) LOG

Push – displays HSDU log page for access to high speed data unit log information.

SATCOM Directory Page

7101 - 7110

The SATCOM directory page (XX of 20) contains a list of phone numbers used for making line-selectable calls.



1 Phone Number List

Push – preselects phone number for making call, selects voice channel via left (SAT1) or right (SAT2) line select key, and returns display to SATCOM main menu page. Phone number labels and content are defined by the operator.

2 RETURN

Push – display returns to page displayed prior to entering SATCOM directory page.

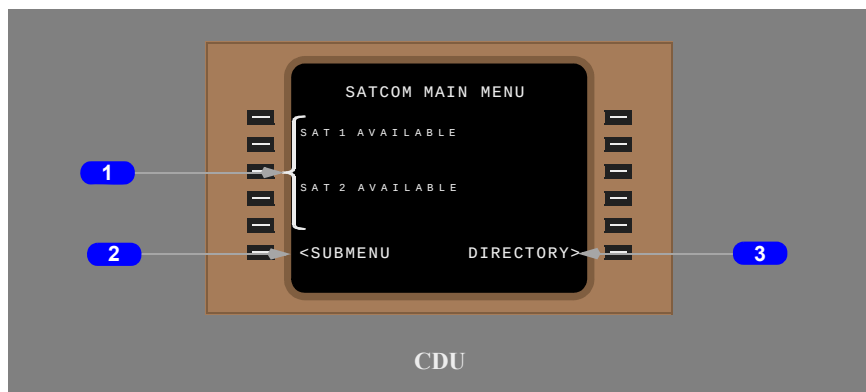
3 Index Label

Displays index label associated with current SATCOM directory page. Index labels and content are defined by the operator.

SATCOM Main Menu Page

7001 - 7008

The SATCOM main menu page allows the flight crew to initiate, answer and terminate calls, monitor call status, and access lower-level pages. Control functions are active when displayed with an asterisk.



1 Channel Status

Displays channel status.

2 SUBMENU

Push – displays SATCOM submenu page which allows access to SATCOM log-on, SATCOM channel status, and SATCOM maintenance pages.

3 DIRECTORY

Push – displays DIRECTORY page.

Directory Page

7001 - 7008

The directory page is used to access region pages or preselect manual calls.



1 Region Selection Prompts

Displays region numbers page.

2 MANUAL DIAL

Blank entries for telephone data.

3 SATCOM (SAT) Channel

Enter the desired satellite number for manual dial.

4 Priority (PRI)

Enter the desired priority number for a manual dial.

5 RETURN

Displays the SATCOM main menu page.

Region Numbers Page

7001 - 7008

The region numbers page contains a list of agency/phone numbers used for making line-selectable calls.



1 Agency/Telephone number

Agency/telephone number.

2 SORT

Sorts the agency numbers in the order they are entered in the region.

3 Selected Satellite

The pre-selected satellite number.

4 PRIORITY

The priority for the agency being called.

5 RETURN

Displays the SATCOM DIRECTORY page.

Communication Crew Alerting System

The communication crew alerting system provides aural and visual alerts for normal operations requiring crew awareness that may require crew action. Visual alerts are presented as EICAS messages preceded by a bullet symbol (•). The aural alert is a high–low chime. The following table shows communication crew alert categories and the respective aural and visual alerts for each category. Refer to section 50 of this chapter for a list of possible messages.

Crew Alert Categories

Communication Crew Alert Category	Aural Alert	Visual Alert	Comments
High	High–low chime	EICAS communication message	None currently implemented.
Medium	High–low chime	EICAS communication message	Message awareness required. Crew action may be required.
Low	None	EICAS communication message	Crew action may be required.

Wi-Fi

The GoGo International Wi-Fi system is installed. The satellite-based service connects passengers to the internet while the aircraft is above 10,000 ft.

The system receives power from the IFE/PASS SEATS switch and is controlled by a master switch labeled INTERNET above the cabin handset. The Wi-Fi system consists of an antenna housed in a large radome on top of the fuselage and uses ADIRU and file map data to receive a signal via geosynchronous satellites.

There are two identical handsets installed. The cabin handset is located next to the L1 door and the flight deck handset is mounted on the aft bulkhead. The handsets are available for crew use, but are limited to outgoing calls only using four pre-programmed phone numbers. The Wi-Fi system uses a separate antenna and connects to different satellites than the SATCOM system. For this reason, the handsets may be used as back-up if the SATCOM system fails. The handsets are not critical components of the Wi-Fi system. The loss of either or both handsets will not affect Wi-Fi connectivity.

System operation is completely automatic and requires no crew action. The guarded INTERNET SWITCH above the cabin handset must be ON. Wi-Fi is available to passengers while the aircraft is above 10,000 feet. Both handsets are available for crew use above 10,000 feet. During normal operations, the system has access to five different satellites. Passengers may experience a 1-4 minute delay in service when the antenna switches satellites. Similar to SATCOM, there is no satellite coverage near the poles. Passengers can expect service interruptions when above 75° latitude. Using the handset for voice over internet may be considered as a backup if SATCOM is inoperative. Refer to Vol 1, SP.5 for using handsets for voice over internet.

Wi-Fi Non-Normals

If smoke, fire, or fumes are suspected to be caused by the Wi-Fi system, accomplish the Smoke, Fire or Fumes checklist in the QRH/ECL. Power will be removed when the IFE/PASS SEATS switch is selected OFF.

Intentionally
Blank

Communications Interphone Systems

Chapter 5 Section 30

Interphone Communication System

The interphone communication system includes the:

- flight interphone system
- cabin interphone system
- service interphone system
- passenger address (PA) system.

The flight interphone, service interphone, and PA systems are normally operated through the audio control panel.

The cabin interphone system is operated through the audio control panel, CDU, and flight deck handset.

Flight Interphone System

The flight interphone system provides communications on the flight deck and between the flight deck and the ground crew through the flight interphone jack on the APU ground control fire protection panel in the nose landing gear wheel well.

The system is used by selecting the INT (interphone) position of a control wheel or audio control panel mic/interphone switch. The interphone can also be used by selecting the FLT transmitter selector on an audio control panel and then selecting one of the following microphone switches:

- MIC position of a control wheel switch
- MIC position of an audio control panel mic/interphone switch
- a hand microphone push to talk switch
- a glareshield MIC switch.

Crew alerting of a ground crew initiated call is provided by an aural alert chime, the GROUND CALL EICAS communications alert message, and a CALL light illuminated on the audio control panel transmitter select switch.

The ground crew is called by selecting the GND CREW dial code from the center CDU.

Service Interphone System

The service interphone system provides voice communications between ground crew stations at various locations around the airplane. The system can be connected to the flight interphone system through the service interphone switch on the overhead panel.

Passenger Address System

The passenger address (PA) system is used by the flight crew to make cabin announcements. Pushing a PA transmitter select switch on an audio control panel and activation of a microphone switch provides direct access to all PA areas.

The system is monitored by pushing the PA receiver volume control on an audio control panel. The PA system can also be selected through the cabin interphone system or the flight deck handset.

Cabin PA announcement priorities are:

- flight deck announcements from an audio control panel
- cabin handset direct access announcements
- priority (all area) announcements
- normal announcements from flight attendant or flight deck handsets.

Cabin Interphone System

The cabin interphone system provides voice communications between the flight deck and the flight attendant stations. Boom microphones, oxygen mask microphones, and hand microphones are used by selecting the CAB (cabin) transmitter select switch on an audio control panel and pushing the mic/interphone switch to the MIC position. A cabin interphone station(s) must be selected and a call initiated from the center CDU to alert the desired station to pick up the call.

EICAS communications alert messages and chimes alert the pilots to incoming cabin calls. Normal priority calls from the cabin display the CABIN CALL EICAS message. Normal priority calls made to the flight deck while another call is in progress will result in a busy signal at the handset, the calling station being displayed in the call queue, and the CABIN CALL memo message being set in EICAS. The call queue and memo messages will be cleared when communication is established between that calling station and the flight deck. Priority calls from the cabin display the CABIN ALERT EICAS message. Priority calls automatically disconnect lower priority cabin interphone calls. Priority calls placed while a priority call is in progress are automatically connected as a conference call.

The cabin interphone call queue, speed dial numbers, and directories are accessed from the center CDU cabin interphone menu.

Calls are initiated by:

- line selecting the call location on the CDU display, or
- entering the appropriate call code in the CDU scratchpad and selecting SEND.

Pushing the audio control panel CAB (cabin) transmitter select switch twice within one second places a priority call to 1L.

A station which is in use will be disconnected from the call in progress and connected to the flight deck.

Note: Flight deck initiated calls will not interrupt a current PA announcement from the dialed station.

Calls can be answered by selecting an audio control panel CAB transmitter select switch or, if a CAB transmitter select switch is already pushed in, by pressing a mic/interphone switch to the MIC position.

Calls can be ended by selecting the CDU prompt END CALL or de-selecting the CAB transmitter selector on the audio control panel. The call also ends if the other party terminates the call.

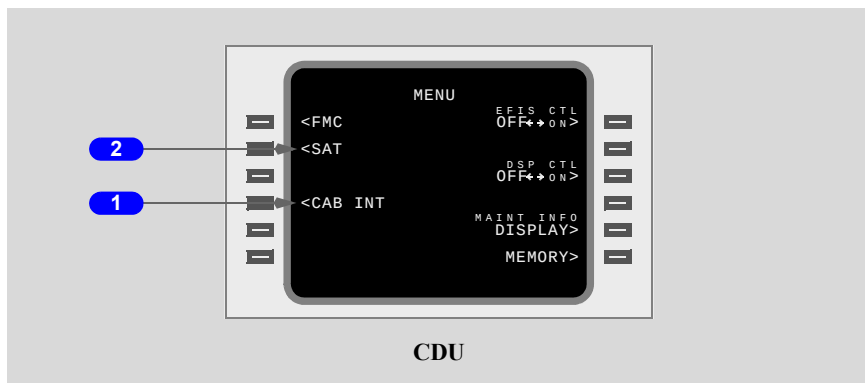
Calls can also be answered or placed using the flight deck handset. Desired call locations are entered using the numeric keys on the handset. Pressing the handset reset switch or placing the handset back on the cradle terminates the call.

Note: The handset PA push-to-talk switch is not required to operate the handset except for PA announcements.

CDU Menu Page

Pushing the CDU MENU key displays the CDU menu page.

Normally, the cabin interphone (CAB INT) and SATCOM (SAT) displays are viewed on the center CDU. The SATCOM prompt is available on all CDUs.



1 CAB INT

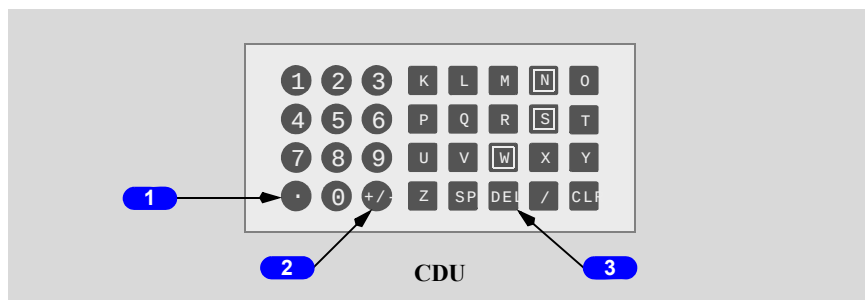
Push – displays the CDU cabin interphone pages.

Note: Available only on the center CDU.

2 SAT

Push – displays the CDU SATCOM pages.

Cabin Interphone CDU Controls



1 Period (.) key

Push – displays an asterisk (*) in the scratchpad.

2 Plus/Minus (+/-) Key

Push – displays a pound sign (#) in the cabin interphone scratchpad.

3 Delete Key

Push –

- displays DELETE in the cabin interphone scratchpad
- used to delete calls from the call queue.

Cabin Interphone Main Menu

The cabin interphone menu allows the pilots to send or end calls. Calls are sent by selecting a station from the speed dial page or the directory. Two digit station codes can be manually entered into the scratchpad and the call sent using the SEND prompt. A list of the two digit station codes is located on the handset.

The directory of stations is created by the customer airline and is not shown here. The following depict typical main menu pages and selected options.

Speed Dial

The speed dial menu provides a quick means to call up to five predefined stations or groups of stations. A single push initiates the selected call.

Call Queue

When the flight deck is involved in a call, additional incoming calls are displayed in the queue. Up to four calls can be displayed in order of the priority assigned as follows:

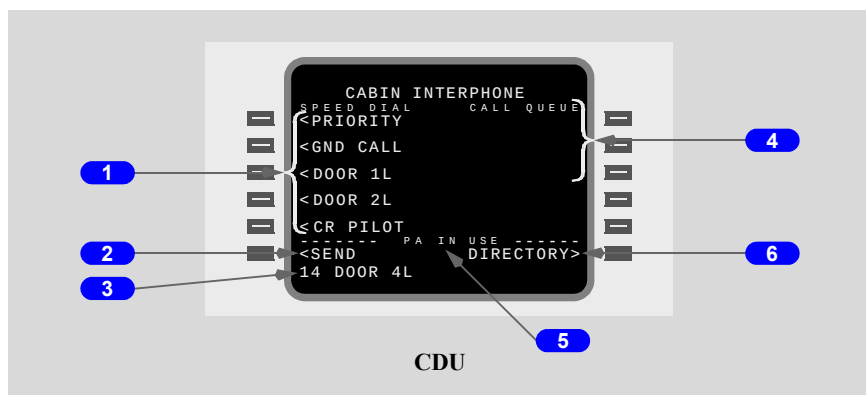
- PILOT ALERT
- conference calls

- cabin calls
- other calls.

The PILOT ALERT queue entry is displayed only when the flight deck is using the PA and an incoming call is received.

When there are four calls in the queue and a new, higher priority call is received, the lowest priority call is removed from the queue and the new call is displayed in the proper priority.

Cabin Interphone Main Menu Page



1 SPEED DIAL Labels

Lists the dial code labels of predefined stations, station groups, or functions:

- PRIORITY – selects all cabin interphone stations
- GND CALL – activates an alert horn in the nose wheel well. When selected, the horn sounds briefly to alert the ground crew for communications with the flight crew.
- DOOR 1L – selects the attendant station at door 1L
- DOOR 2L – selects the attendant station at door 2L
- CR PILOT – selects the interphone system in door 1 overhead crew rest

Push – directly dials the selected station, station group or enables the selected call function.

2 SEND

A two-digit dial code may be manually entered with the CDU keyboard. If the dial code is valid, the dial code, dial code label, and SEND are displayed. If the dial code is invalid, INVALID CODE is displayed in the scratchpad.

Push – initiates a call to the selected station.

2 END CALL

Displayed during a connect call.

Push – disconnects all existing call connections.

3 CURRENT CALL

Displays the most recently selected dial code and label when a call is being connected. Dial code is removed when call is established.

Note: XX BUSY appears in the scratchpad when a cabin interphone call is attempted from the CDU to a handset that is off the hook. Line selecting <END CALL will remove the XX BUSY annunciation.

4 CALL QUEUE Labels

Lists the dial code labels of unanswered calls to the flight deck.

Push –

- initiates a call back to the displayed station(s)
- adds station(s) to the existing call (if the flight deck is currently connected in a call).

5 IN USE Status

PA IN USE –

- a portion of the airplane PA system is in use, or
- both the PA and video entertainment systems are in use.

VIDEO IN USE – a portion of the video entertainment system is in use.

Blank (dashes) – neither the PA or video system is in use.

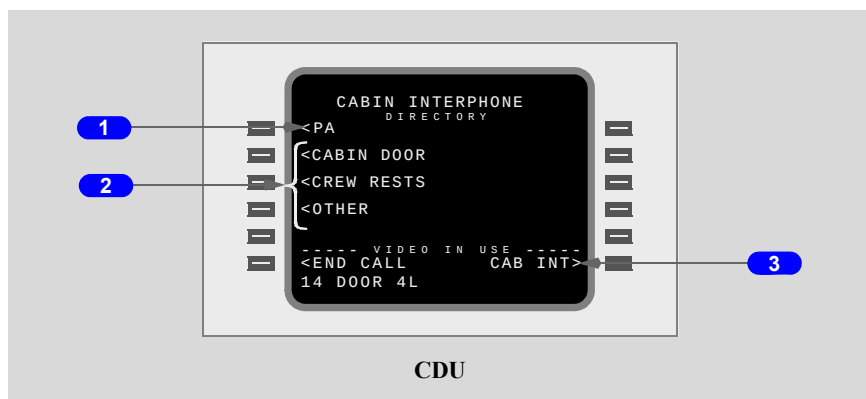
6 DIRECTORY

Push – displays the cabin interphone DIRECTORY page.

Cabin Interphone Directory Page

The cabin interphone directory pages are used to access subdirectory pages. CDU cabin interphone directory pages and individual directory entries are predefined by the airline. Each directory label is the name of a subdirectory where the dial code labels of the individual stations or functions are listed.

Selection of the specific location(s) is accomplished on the subdirectory page.



1 PA

Push – selects the passenger address system

2 Directories

Up to 20 subdirectories can be predefined.

Push – displays the appropriate subdirectory page

3 CAB INT

Push – returns the display to the cabin interphone main menu page.

Cabin Interphone Subdirectory Pages

Selecting a dial code label on the subdirectory page initiates a call to that station or station group.

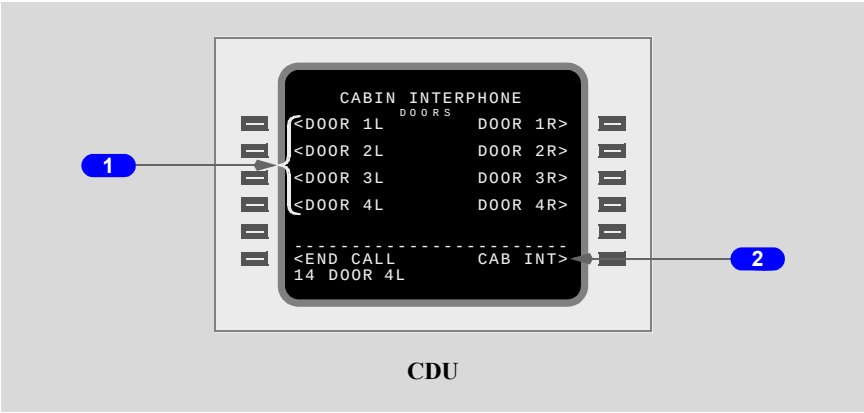
The cabin interphone subdirectory pages are used to view and select individual locations through their dial code labels.

Typical stations or station groups are:

- individual cabin station
- two or more cabin stations for conference calls
- PA call to all cabin areas
- PA call to individual cabin areas

- PA priority call to all cabin areas
- ground crew alert
- gate station (on the ground).

Cabin Door Subdirectory



1 Dial Code Labels

Push – initiates a call to the selected door station(s).

2 CAB INT

Push – returns the display to the cabin interphone main menu page.

Crew Rests Subdirectory



1 Dial Code Labels

Push – initiates a call to the selected crew rest station(s).

2 CAB INT

Push – returns the display to the cabin interphone main menu page.

Other Subdirectory



1 Dial Code Labels

Push – initiates a call to the selected station(s).

2 CAB INT

Push – returns the display to the cabin interphone main menu page.

Cabin Medical Communication System

A cabin medical communication system is installed to permit direct communication between the cabin and a ground based medical consultant using the first observer's audio control panel.

In the cabin, six sets of communication jacks are installed on the Passenger Service Units above center seat rows 3, 12, 33, 40, 47 and 55.

A headset is provided for communication and is stored in the aft cabin overhead bin with the AED and EEMK equipment. The headset assembly includes a 12 foot cord, equipped with a Push-To-Talk switch. Once communication is established from the first observer's audio control panel, the cabin crew will have direct communication via the headset.

Intentionally
Blank

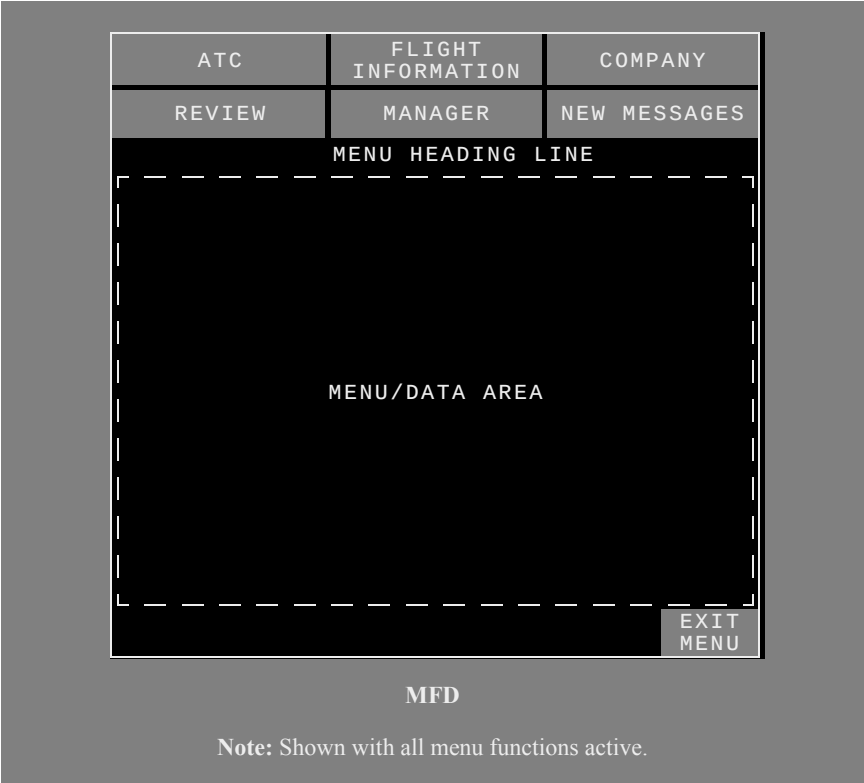
Introduction

The MFD communications functions are used to control data link features. Data link messages not processed by the FMC are received, accepted, rejected, reviewed, composed, sent, and printed using communications functions on the MFD. Data link communications can be established with participating ATC and company locations. ACARS and data link radio management functions are provided through communications management menus.

The display select panel communication (COMM) display switch displays the communications main menu on the selected multifunction display (MFD). Communications functions are selected using the cursor control device. Message text entry is accomplished by entering data into the CDU scratchpad and transferring it to the appropriate area. Messages can be printed on the flight deck printer. Incoming message traffic is annunciated by EICAS communications messages.

Illustrations shown in this section depict the COMM menu with all features enabled. ATC data link requires appropriate airplane and ATC capability.

Communications Menus



Company communications functions can be customized by airlines. Descriptions and illustrations provided in this section are examples of a typical installation with all communications functions active (depending on airline configuration or function availability, some functions may be inhibited).

Selectable menu items (active functions) have white text on a gray background. Inhibited items have cyan text on a black background with a cyan border. Inhibited items cannot be selected. The background color for a selected top level function is green.

Selecting ATC, FLIGHT INFORMATION, COMPANY, REVIEW, MANAGER, or NEW MESSAGES selection:

- places the appropriate title in the menu heading line
- displays the subordinate menu selections for that function in the menu/data area.

Subordinate menu items which lead to subsequent subordinate menu(s) are followed by three dots (...). Making a selection from the subordinate menu places the title of that function in the menu heading and displays a new subordinate menu or data below. Making a selection from the subordinate menu displays the appropriate title, the menu heading, and the data below.

ATC provides downlink messages to ATC, where available.

FLIGHT INFORMATION provides for future downlink messages to the National Weather Service or a similar provider.

COMPANY provides for downlink messages to airline facilities.

REVIEW displays a list of all transmitted messages, received messages not requiring a response, or received messages with the response already sent. REVIEW is inhibited if there are no listed messages.

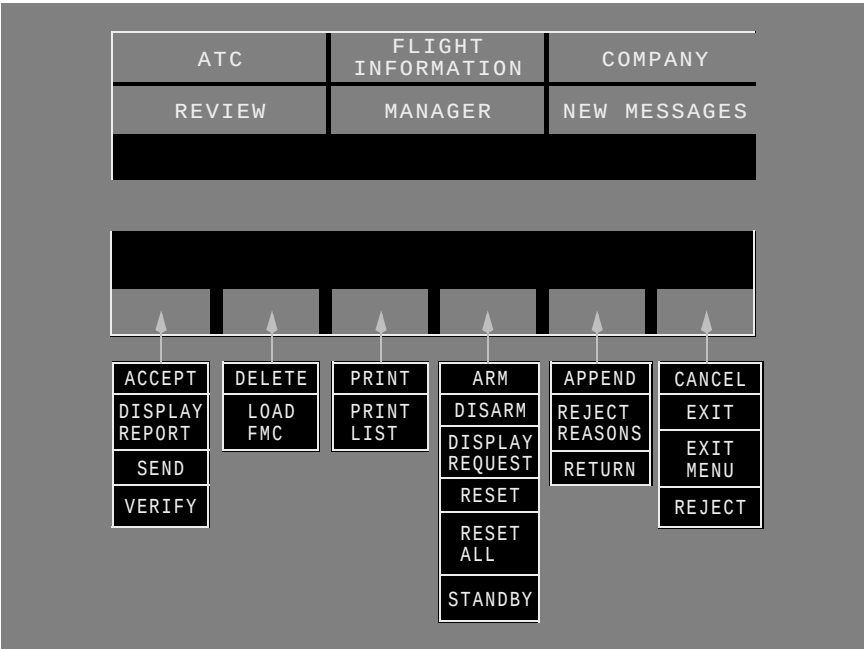
MANAGER provides the controls for data link and communications systems in general.

NEW MESSAGES displays a list of uplinked messages that have not been displayed or responded to. NEW MESSAGES is inhibited when there are no new messages.

Communications Control and Input Functions

Communications menus, controls, and data input methods are similar for ATC, FLIGHT INFORMATION, and COMPANY functions. Basic functions are explained here.

Command Key Locations



Communications command keys are displayed at the bottom of communications pages. Command keys change as appropriate for pages displayed. Each key has a label which changes based on the page displayed and the possible action. Only one label is displayed in a single location for a specific condition on the page.

Command Key Functions

The following table describes the key functions and labels for all ATC, FLIGHT INFORMATION, and COMPANY functions.

Command key label	Displayed/Inhibited	Key function
ACCEPT (uplink messages)	Displayed when: - message requires an accept/reject response, and - all message pages have been displayed. Inhibited for first 2 seconds of message display.	Select: - message acceptance downlinked to message sender - ACCEPT & REJECT keys removed - message status displayed in info box - CANCEL command key displayed.
APPEND (company downlink accept/reject response)	Displayed when: - all pages of the uplinked message have been displayed, and - company data link capability is operational. Inhibited when: - for first 2 seconds of uplink display, or - when company data link capability is not operational.	Select: - uplink message is removed, and - downlinked message page is displayed.
ARM (ATC downlink reports)	Displayed when an armable report is open: - REPORT LEAVING - REPORT LEVEL - REPORT PASSING - REPORT REACHING.	Select: - arms the report for automatic downlink to ATC when report conditions are met - key function changes to DISARM - report status changes from OPEN to ARMED

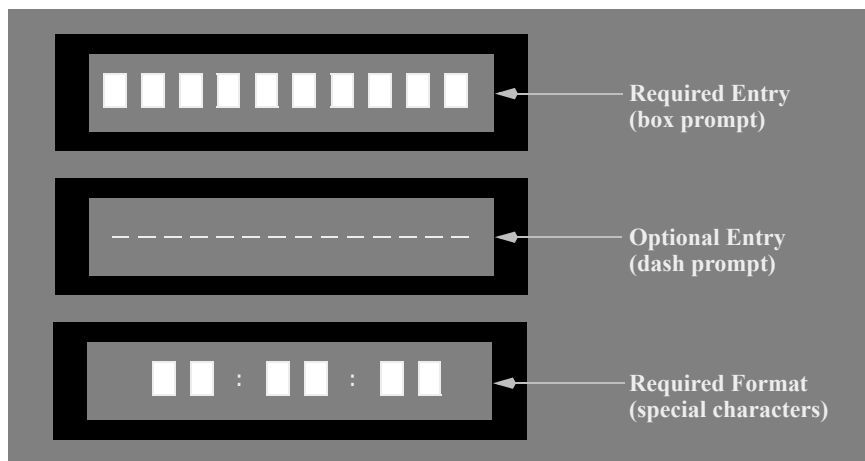
Command key label	Displayed/Inhibited	Key function
CANCEL	Displayed when: • uplink message is displayed which does not require an accept or reject response, or • an uplink message is displayed which has been accepted, rejected, or • review message is displayed. Inhibited for first 2 seconds of message display.	Message is removed.
DELETE (ATC reports)	Displayed when a downlink report page is open for entry.	Select: • deletes the report without sending. • displays the COMM menu.
DISARM (ATC reports)	Displayed when an armable report is ARMED: • REPORT LEAVING • REPORT LEVEL • REPORT PASSING • REPORT REACHING	Select: • disarms automatic report downlink to ATC • key function changes to ARM • Report status changes from ARMED to OPEN
DISPLAY REPORT	Displayed after accepting an uplink message which contains a report.	Displays the downlink report attached to an uplinked message.
DISPLAY REQUEST	Displayed after accepting an ATC uplink message which contains a request.	Downlink request which required an ATC response is displayed,
EXIT	Displayed when: • a downlink message is displayed, or • a manager page is displayed.	COMM main menu is displayed.

Command key label	Displayed/Inhibited	Key function
EXIT MENU	Displayed when menu is displayed.	COMM main menu is displayed.
LOAD FMC (ATC uplink)	Displayed when uplinked ATC message contains data which can be loaded into the FMC. Inhibited when active route is in a MOD condition.	Select: • FMC data is transferred into the active route, and • FMC modification is started.
PRINT	Displayed when: • displayed message can be printed, and • printer is available. Inhibited when printer is not available.	Message is sequenced for printing.
PRINT LIST	Displayed when: • new message list page is displayed, or • review list page is displayed. Inhibited when printer is not available.	All messages in the list are sequenced for printing.
REJECT (uplink messages)	Displayed when: • message requires an accept/reject response, and • all message pages have been displayed. Inhibited for first 2 seconds of message display.	Select: • message rejection downlinked to message sender • ACCEPT and REJECT command keys removed • CANCEL command key displayed • message status displayed in info box, and • message cleared from the display 5 seconds after status changes to REJECTED.

Command key label	Displayed/Inhibited	Key function
REJECT REASONS (ATC reject downlink)	Displayed when an uplink message requires an accept or reject response.	Displays REJECT REASON page.
RESET (downlink pages)	Displayed when downlink page is displayed.	Message parameters are reset to their default values.
RESET ALL (ATC downlink pages)	Displayed when ATC VERIFY REQUEST page is displayed.	Select: - all request parameters on the VERIFY REQUEST are set to reset/default values - ATC combined request pages are reset, or - COMM main menu is displayed.
RETURN	Displayed when: - a review message is displayed, or - a downlink message is displayed, or - a VERIFY REQUEST page is displayed, or - a manager page is displayed.	Previous list page, request page, or menu is displayed.
SEND (downlink messages)	Displayed when: - required data complete, and - all company message pages have been displayed. Inhibited when transmission queue is full.	Select: - message transmission initiated - message status displayed in info box, and - message cleared from the display 5 seconds after status changes to SENT.

Command key label	Displayed/Inhibited	Key function
STANDBY (ATC uplink messages)	Displayed when: • uplinked message is received which requires an accept/reject response, and • STANDBY has not been previously selected for this message.	Standby response is sent.
VERIFY	Displayed when data is entered on more than one of the following ATC pages: • ALTITUDE REQUEST • ROUTE REQUEST • SPEED REQUEST.	Displays VERIFY REQUEST page.

Text Entry



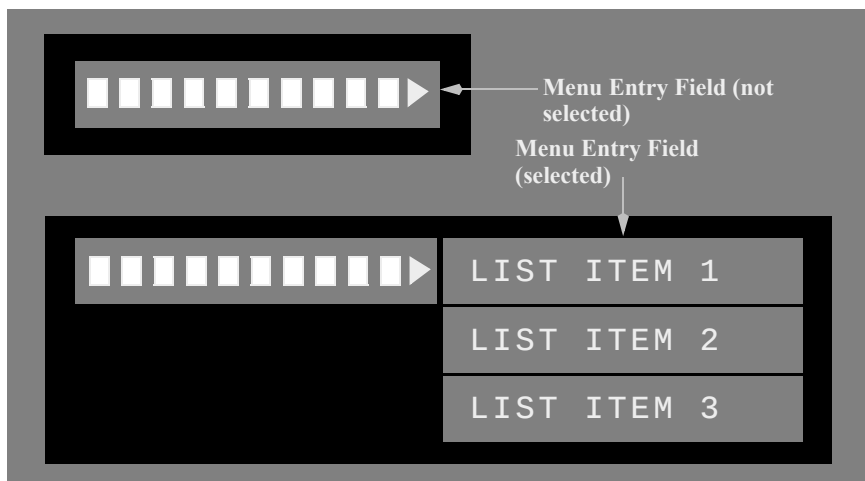
Downlink message pages provide text entry fields. Scratchpad entries transfer to selected entry fields when a cursor select switch is pushed. Scratchpad entries blank when successfully transferred. Scratchpad entries remain and an INVALID ENTRY message is displayed on the MFD when the entry is not valid.

An entry field resets to a default value when a blank scratchpad is transferred. An entry field resets to the default entry prompt when DELETE is transferred.

Box and dash prompts indicate the maximum number of characters allowed.

Some entry fields have format requirements. Entry prompts display the required entry format, with special characters separating entry boxes. The required data is entered without the special characters or spaces. Scratchpad data is transferred to entry boxes after being checked for proper format. Invalid data or format prevents transfer and displays an INVALID ENTRY message.

Menu Entry Fields



Menu entry fields are used to make text entry selections from a list. Menu entry fields distinguish mandatory versus optional entry in the same manner as CDU entry field.

The menu entry field is distinguished from other entry fields by the pointer to the right of the field.

When initially selected, a list of menu items is displayed to the side of the pointer. If an item from the list is then selected using the cursor and cursor select switch, that item is transferred to the entry field. If the menu prompt is selected again and the CDU contains a valid value, that CDU value is transferred to the entry field. Actions for invalid values, an empty scratchpad, space characters, and the delete key are the same as for the CDU entry field. When the entry field is selected with text already inserted, the menu list is removed from the display.

Invalid Entries

When the scratchpad contains invalid data for the entry field, the INVALID ENTRY message is displayed in the INFO BOX. Re-entering valid data clears the INVALID ENTRY message on an ATC downlink page. Selecting the EXIT INFO key also clears the INVALID ENTRY message and removes the info box.

INVALID ENTRY messages on a company downlink page must be individually cleared by selecting the EXIT INFO key before valid data is re-entered into the field.

Message List

Message titles and related information can be displayed in a list. The illustration shows the REVIEW message list. A similar list is available for NEW MESSAGES.

The NEW MESSAGE list is sorted by the time of receipt, the most current message at the top. ATC uplink messages have an ATC label to the right of the message block. The message remains in the list until it is accepted, rejected, or displayed. Messages requiring an accept/reject remain in the list until the accept/reject response is accomplished.

Selecting an item from the list with the cursor and pushing the cursor select switch displays the message page. Lists are also used to view new messages.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1848Z	RECEIVED	
1842Z	VHF-VOICE CONTACT	ACCEPTED
1832Z	WEATHER	DISPLAYED
1820Z	ATIS	DISPLAYED

1 Current Time

Displays current time.

2 Message Time

For new messages – time the message is received.

For review messages – time the message is received or sent.

3 Message Title

Displays message title information.

4 Message Status

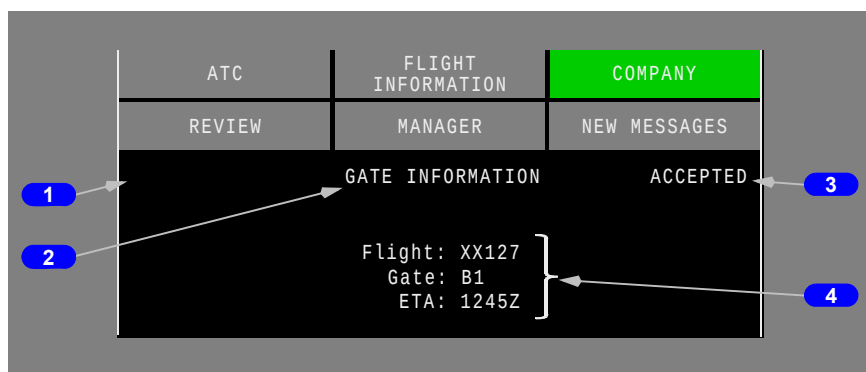
Only displayed for review list boxes.

The appropriate status indicator is displayed.

Message Display Format

A typical message display format is shown. Messages selected from a list are displayed in this format.

Note: Selection of a main menu item exits the message page.



1 Message Time

For downlink messages – current time.

For new messages – time the message is received.

For review messages – time the message is received or sent.

2 Message Title

Displays message title information.

3 Review State

Only displayed for review messages.

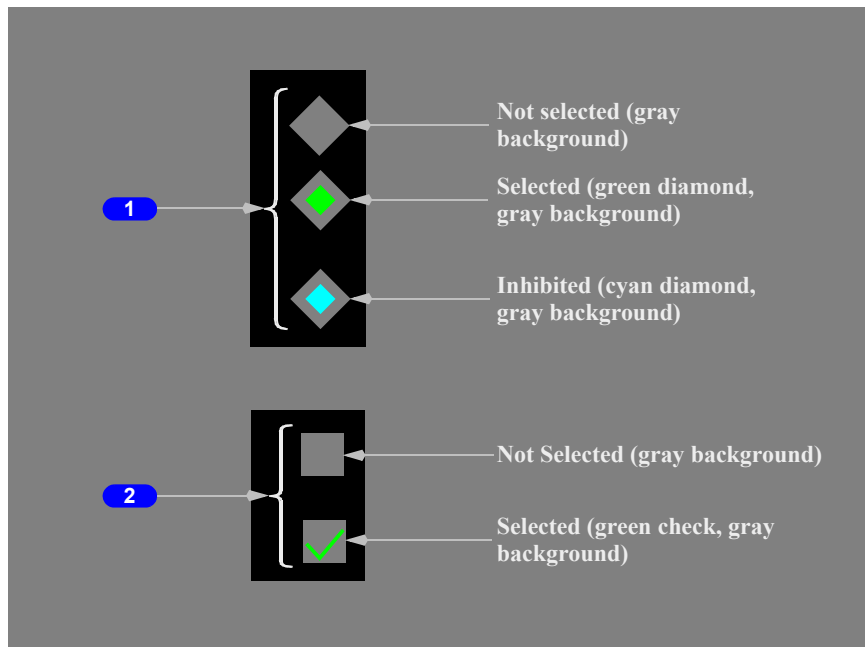
The appropriate state indicator is displayed.

4 Message Content

Located between the title and the keys.

Exclusive and Nonexclusive Select Keys

Manager and new message pages can contain select keys to activate features. Pushing the cursor select switch when the key is highlighted makes the selection. A second selection of a nonexclusive key toggles to the deselected state.



1 Exclusive Select Key

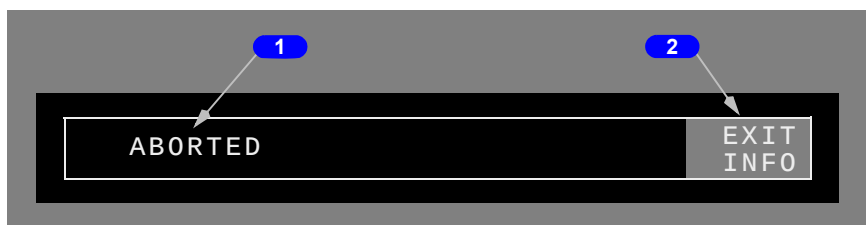
The diamond-shaped exclusive select keys are used to select a single feature from a group. Selecting a key activates the feature and all other exclusive select keys in that group are deselected. The keys are displayed in their selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

2 Nonexclusive Select Key

The square-shaped nonexclusive select keys are used to select multiple features. Selecting a key activates the feature. The keys are displayed in their previously selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

Information Messages

Messages are displayed in an information box at the bottom of the MFD. The information box covers command keys. Information messages, such as INVALID ENTRY, are cleared by selecting EXIT INFO. Some information messages automatically disappear.



1 Information Message Text

The text starts at the left of the box.

2 EXIT INFO Key

Select – removes the information box for the displayed message from the display.

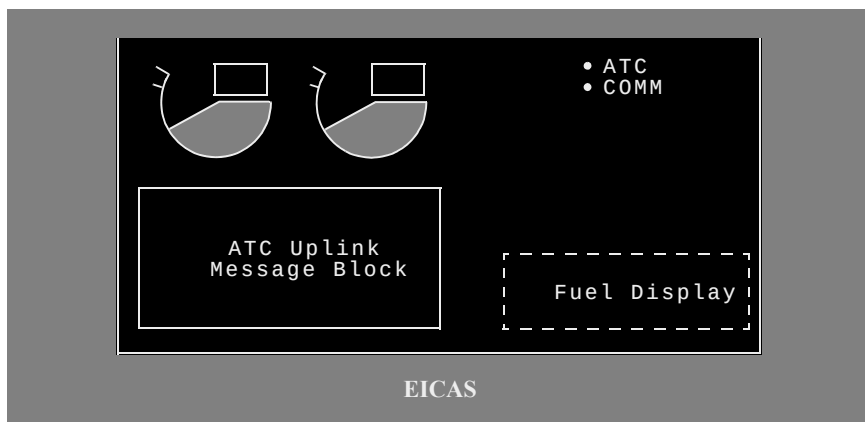
Communications Information Messages

Communications information messages are described in the following table.

Information Message	Condition
ABORTED	ATC connection not established, lost, or loss of handoff to a new active center, while a message is transmitting, or before acceptance.
ACCEPTED	ACCEPT response received.
ACCEPTING	ACCEPT response sent.
DISPLAYED	All pages of a message not requiring an ACCEPT or REJECT response have been displayed.
COMM CONTROL TRANSITION – COMPANY MESSAGES LOST	Airplane data link system switched to a new AIMS master. Company datalink information may be lost. Incomplete company downlink messages are lost and must be created/transmitted again. If previously received Company messages are required, they must be requested again. ATC connections, data, and messages are not affected.
CONNECTING	Logon request sent, network acknowledgment received, and connect or start request not received.

Information Message	Condition
INCOMPLETE MESSAGE	Only part of the displayed message is received.
INVALID ENTRY	An entry box is selected and the CDU scratchpad value is not valid.
LOADED	ATC uplink route modification is successfully loaded into the FMC.
LOAD ABORTED	Loading of ATC uplink route modification into the FMC is aborted.
LOADING	ATC uplink route modification is loading into the FMC.
MESSAGE TO PRINTER	Selected message(s) sent to printer.
MESSAGE LIMIT EXCEEDED	Maximum number of characters that can be transmitted in ATC downlink message is exceeded.
NO ACCEPT (company)	ACCEPT response is not successfully transmitted or an ACCEPT response is not required.
NO PRINT	An attempt to send a message(s) to the printer is unsuccessful.
NO REJECT (company)	REJECT response is not successfully transmitted or a REJECT response is not required by the message.
NO SEND	An attempt to send a downlink message is unsuccessful.
PARTIAL LOAD	ATC uplink route modification was partially loaded into the FMC.
PRINTING	ATC message is printing.
REJECTED	REJECT response received.
REJECTING	REJECT response transmitting.
SENDING	The downlink message is sent.
SENT	The downlink message is received.
UNABLE TO LOAD	ATC uplink route modification can not be loaded into the FMC.

Uplink Message



ATC Uplinks

Arriving ATC uplink messages are annunciated by an •ATC communications message, an aural chime, and the display of the EICAS ATC message block. The message text is displayed below the normal EICAS engine display. Uplink messages too large to fit in the message area display the message LARGE ATC MESSAGE. The message text is displayed using the NEW MESSAGE menu selection.

Flight Information Uplinks

Arriving flight information uplink messages are annunciated by a •COMM communications message and an aural chime. The message text is displayed using the NEW MESSAGE menu selection.

Company Uplinks

Arriving company uplink messages are annunciated by a •COMM communications message and an optional aural chime.

Accept/Reject Uplinks

ATC messages requiring an accept or reject response display those options on the EICAS display. The MFD message page displays ACCEPT, STANDBY, REJECT REASONS, and REJECT keys at the bottom. Select ACCEPT or REJECT to respond to the uplink message. The REJECT REASONS key can be selected to inform ATC why the message is being rejected.

Company messages can also be accepted or rejected on the message page.

After making a selection, the status changes to ACCEPTING/REJECTING while the response is transmitting. When the communications network sends a response indicating that the message was received, the message status changes to ACCEPTED/REJECTED. After a message has been accepted or rejected, a CANCEL key is displayed at the bottom of the page. Selecting CANCEL will clear the message from the display. Rejected messages are automatically removed 5 seconds after the message status changes to REJECTED.

The ACCEPT, CANCEL, and REJECT buttons on the glareshield perform the same function as the same keys on the MFD.

Reject Reasons Page

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z REJECT REASONS		
☐ DUE TO AIRCRAFT PERFORMANCE ☐ DUE TO WEATHER ☐ NOT CONSISTENT, PLEASE RE-SEND		
FREE TEXT: ----- ----- -----		
RESET RETURN REJECT		

If the response to an ATC uplink message is to reject the message, the REJECT REASONS key can be selected to inform ATC why the clearance message is being rejected. Up to three lines of text can be included. Select REJECT to send the reject message with the applicable reasons.

Standby Response

When more time is required to respond to an ATC uplink, use the STANDBY key to send a delay notification.

ATC Sidelinks

ATC sidelinks are system generated ATC communication messages. They are annunciated by an •ATC communications message, aural chime, and display of the EICAS ATC message block. The message text is displayed below the normal EICAS engine display. Selecting CANCEL with the cursor control device or glareshield button will clear the message from the display.

ATC Data Link

ATC data link communicates with participating air traffic control centers, reducing the need for VHF voice communications. Airplane situation reports, route changes, speed and vertical clearances, and voice contact requests can be sent or received as appropriate. The COMM display ATC menu selection allows display of downlink message pages.

Uplink and downlink messages are stored. All messages are assigned the time of receipt/transmission and are printable.

ATC data link requires manual logon to a participating ATC facility. Once logged on, transfer to adjacent ATC facilities is normally automatic.

Crew Feedback

ATC uplinks containing clearance data that the crew can set on the MCP or EFIS control panel have a crew feedback display function. When the message is displayed on EICAS or the message page, the data values change from white to green when properly set by the crew. Data which provides feedback is:

- MCP speed
- MCP heading
- MCP altitude
- barometer setting
- transponder code
- VHF frequency
- HF frequency.

FMC Data Loading

Some ATC uplinks contain data for loading into the FMC. Display of the LOAD FMC command key indicates that FMC data is available for loading. Selecting LOAD FMC transfers data to the FMC and creates an FMC modification.

Both MFD information messages and FMC scratchpad messages provide indications of loading progress.

Downlink Pages

ATC Menu

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS...
SPEED REQUEST	LOGON / STATUS	POSITION REPORT
CLEARANCE REQUEST		FREE TEXT MESSAGE

ATC Menu

The ATC menu provides access to ATC downlink pages.

The ATC REQUESTED REPORTS menu selection is inhibited (cyan) when no reports are requested by ATC.

Note: This menu is not repeated when describing individual pages.

Altitude Request

The ALTITUDE REQUEST page allows selection of an altitude, an altitude block, or a VMC descent. A second request page allows selection of a reason for the request.

1 ALTITUDE

The requested altitude is entered into the dash prompt and the SEND key becomes active.

Pushing the SEND key requests a normal climb at climb power unless otherwise requested, or a normal descent.

Additional climb or descent options are:

- STEP AT – allows entering a time or position for the start of the climb or descent
- CRUISE CLIMB – begin a cruise climb from present position.

STEP AT is inhibited when the ALTITUDE value is less than 150 feet from current airplane altitude. Altitude entries are any valid FMC altitude. Time entries are in four digit, hours and minutes, optionally followed by a Z. Position entries are any valid FMC position.

2 BLOCK

BLOCK is the beginning of a block altitude. TO is the end of the altitude block. Altitude entries are any valid FMC altitude.

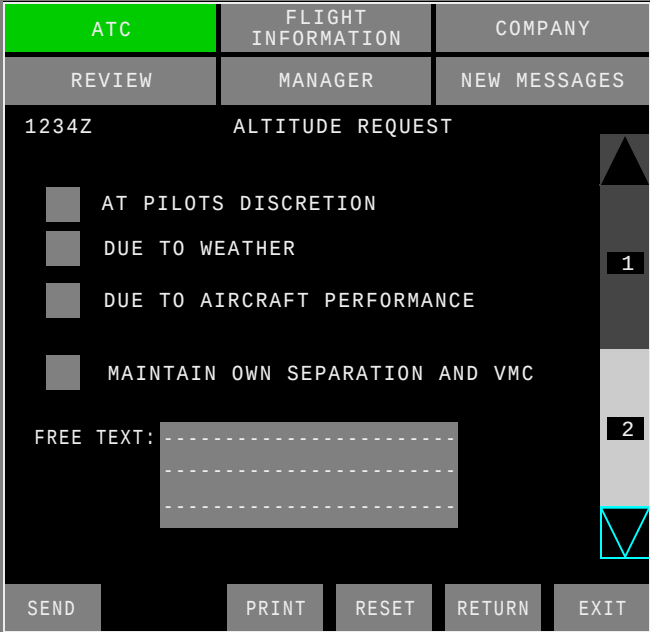
The SEND key becomes active with an entry.

3 REQUEST VMC DESCENT

A VMC descent is begun from present position.

The SEND key becomes active with this selection.

Altitude Request Reason Page



The page scroll bar selects a second ALTITUDE REQUEST page. Reasons for a request are optionally entered on this page. Up to three lines of free text can be included.

Route Request

The ROUTE REQUEST page allows selection of a direct to waypoint, new route, heading or track, departure and transition, arrival and transition, weather deviation, or a route offset. A second request page allows selection of a reason for the request.

ATC		FLIGHT INFORMATION		COMPANY		
REVIEW		MANAGER		NEW MESSAGES		
1234Z		ROUTE REQUEST				
1	◆	DIRECT TO: -----		▲ 1 2 ▼		
2	◆	ROUTE 1	◆			ROUTE 2
3	◆	HEADING: ---				
4	◆	TRACK: ---				
5	◆	DEP/ARR: -----				
6	◆	WEATHER DEVIATION UP TO: -----NM				
7	◆	OFFSET: ---NM				
8	▶	OFFSET AT: -----				
SEND		PRINT		RESET RETURN EXIT		

1 DIRECT TO

Enter any valid FMC waypoint. The SEND key becomes active with this selection.

2 ROUTE

Selects FMC route 1 or 2. Sends the selected route, including any modifications. The SEND key becomes active with this selection.

3 HEADING

Enter desired heading. When displays are referenced to true north, a TRU label is displayed right of the heading. The SEND key becomes active with this selection.

4 TRACK

Enter desired ground track. When displays are referenced to true north, a TRU label is displayed right of the ground track. The SEND key becomes active with this selection.

5 Departure (DEP)/Arrival (ARR)

Enter one of the following:

- departure
- arrival
- departure and transition
- arrival and transition.

Default entries are:

- departure procedure/transition selected for the selected route
- the approach procedure/transition selected for the active route when the airplane is in the air and an arrival procedure/transition is not selected.

The SEND key becomes active when one of the check boxes is selected.

6 WEATHER DEVIATION UP TO

Enter desired offset in nautical miles. Valid entries are L, R, or no prefix (either side) and NNN (NNN is any number from 1 to 128). The SEND key becomes active with this selection.

7 OFFSET

Enter desired FMC route offset in nautical miles. Valid entries are L (left) or R (right) XX (XX is any number from 1 to 99). The SEND key becomes active with this selection.

8 OFFSET AT

Enter a time or position to begin the offset. Time entries are in four digit, hours and minutes, optionally followed by a Z. Position entries are any valid FMC position.

Route Request Reason Page

The page scroll bar selects a second ROUTE REQUEST page similar to the ALTITUDE REQUEST page previously described. The reasons for a request are optionally entered on this page. Up to three lines of free text can be included.

Speed Request

The SPEED REQUEST page allows selection of speed. A second request page allows selection of a reason for the request.

1 SPEED

Enter any valid FMC speed or mach number. IAS entries are rounded to the nearest 10 knots. The SEND key becomes active with this entry.

Speed Request Reason Page

The page scroll bar selects a second SPEED REQUEST page similar to the ALTITUDE REQUEST page previously described. The reasons for a request are optionally entered on this page. Up to three lines of free text can be included.

Clearance Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z CLEARANCE REQUEST		
☐ REQUEST CLEARANCE		
FREE TEXT: ----- ----- -----		
SEND	PRINT	RESET RETURN EXIT

Selecting REQUEST CLEARANCE informs ATC that the crew is ready for a clearance, such as predeparture or pushback. Up to three lines of free text can be included. The SEND key becomes active with this selection.

Combination Downlink Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z
ALTITUDE REQUEST
▲

ALTITUDE: FL330

STEP AT: -----

CRUISE CLIMB

1

SEND
PRINT
RESET
RETURN
EXIT

1234Z
SPEED REQUEST
▲

SPEED: .84

1

VERIFY
PRINT
RESET
RETURN
EXIT

1234Z
VERIFY REQUEST

REQUEST CRUISE CLIMB TO FL 330,
REQUEST SPEED .84

SEND
PRINT
RESET
RETURN
EXIT

Requests from the altitude, speed, and route pages can be combined into one downlink request. Each request is individually selected and filled out. Select subsequent request pages by selecting RETURN, and selecting additional downlink pages from the ATC main menu. When data is entered into the second request page, the SEND key changes to VERIFY.

The SEND key is active on the VERIFY REQUEST page. A combined request is limited to five elements. Selecting a sixth request element displays the MESSAGE LIMIT EXCEEDED information message.

The verify page provides a display of the combined request elements. Each element is displayed on separate lines. Elements requiring revision before sending are revised on their respective request page. Selecting SEND transmits the combined downlink message to ATC.

The example shows a combined altitude and speed request. The altitude request is created first.

When Can We Expect

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z

WHEN CAN WE EXPECT

☐

 ALTITUDE:

☐

 CRUISE CLIMB

☐

 HIGHER ALT

☐

 LOWER ALT:

☐

 SPEED:

☐

 BACK ON ROUTE

FREE TEXT:

SEND

PRINT

RESET

RETURN

EXIT

Making selections asks ATC the time or location the crew can expect clearance for the requested items. Altitude, speed, and cruise climb entry rules are the same as on the ALTITUDE REQUEST and SPEED REQUEST pages. Up to three lines of free text can be included. The SEND key becomes active when a check box is selected.

Voice Contact Request

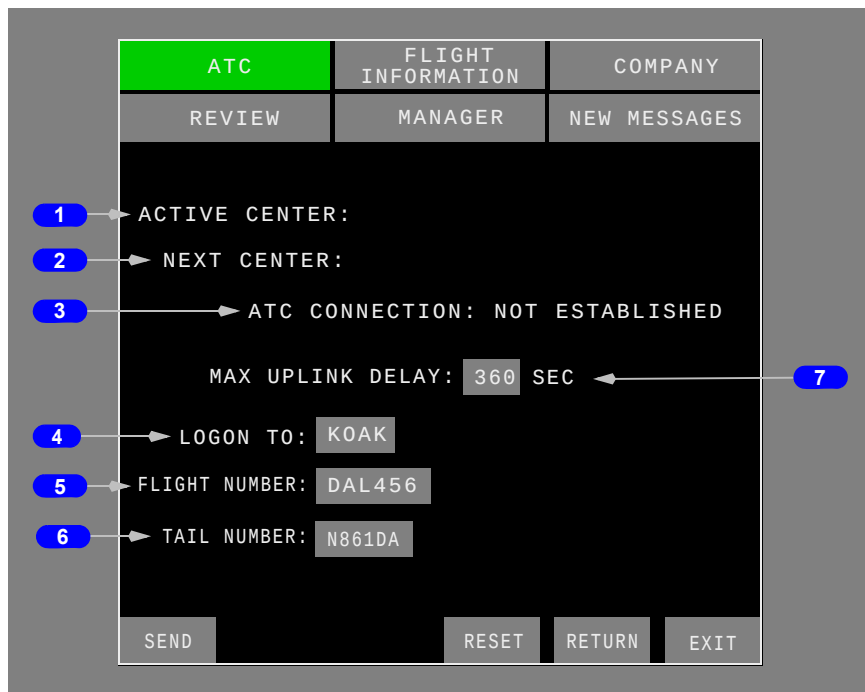
ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z VOICE CONTACT REQUEST		
☐ REQUEST VOICE CONTACT		
FREE TEXT: ----- ----- -----		
SEND	PRINT	RESET
	RETURN	EXIT

Making selection asks ATC for a voice contact. Up to three lines of free text can be included. The SEND key becomes active when the request for voice contact box is selected.

ATC Logon/Status

The ATC LOGON/STATUS page allows entry of the desired ATC facility for establishment of a data link connection.

The SEND key is displayed after all logon entries are completed. Selecting the SEND key displays SENDING status during logon transmission. Five seconds after the logon status changes to SENT, the page is exited.



The screenshot shows the ATC Logon/Status page with the following layout:

- Top Navigation:** Three tabs: **ATC** (highlighted in green), **FLIGHT INFORMATION**, and **COMPANY**.
- Sub-headers:** Below the tabs are three buttons: **REVIEW**, **MANAGER**, and **NEW MESSAGES**.
- Main Display Area:** A black background with white text.
 - 1** points to **ACTIVE CENTER:**
 - 2** points to **NEXT CENTER:**
 - 3** points to **ATC CONNECTION: NOT ESTABLISHED**
 - 7** points to **MAX UPLINK DELAY: 360 SEC**
 - 4** points to **LOGON TO: KOAK**
 - 5** points to **FLIGHT NUMBER: DAL456**
 - 6** points to **TAIL NUMBER: N861DA**
- Bottom Buttons:** A row of four buttons: **SEND**, **RESET**, **RETURN**, and **EXIT**.

1 ACTIVE CENTER

Displays the ATC facility identifier where a connection is established.

2 NEXT CENTER

Displays the ATC facility identifier to which an automatic handoff transfers the connection.

3 ATC CONNECTION

Displays the status of the ATC connection, ESTABLISHED or NOT ESTABLISHED.

4 LOGON TO

Box prompts are initially displayed. Enter the ICAO four letter identifier for the desired ATC center. The display changes to dashed prompts after establishing an ATC connection.

5 FLIGHT NUMBER

Normally displays the flight number entered on the FMC route page. When the flight number is not available, box prompts are displayed. Flight number entry on this page is copied to the FMC route page. Changing this entry after establishing an ATC connection cancels the ATC connection.

6 TAIL NUMBER

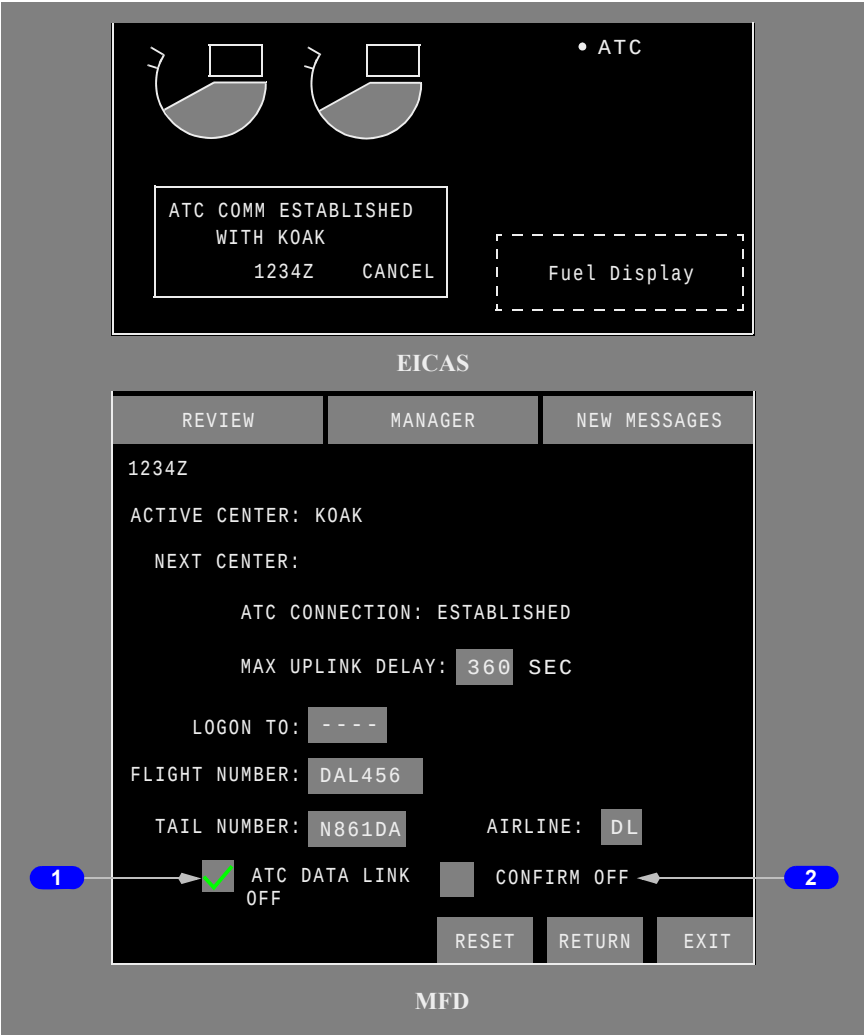
Normally supplied by the airplane system once it has been manually entered, unless battery power to AIMS is interrupted. When the airplane tail number is not available to the system, box prompts are displayed. Changing this entry after establishing an ATC connection cancels the ATC connection. Tail number is provided on the SELCAL placard.

7 MAX UPLINK DELAY

Elapsed time from transmission to receipt of an ATC uplink message that triggers a late annunciation. The words “UPLINK DELAY EXCEEDED” precede any late ATC uplink message. Valid entries are from 1 to 999. Resets to off and displays dashes at:

- power-up
- datalink system reset
- ATC connection terminated
- “DELETE” entry.

ATC Connection Displays



1 ATC DATA LINK OFF

Displayed when an ATC connection is established.
Selecting ATC DATA LINK OFF displays the CONFIRM OFF selection.

2 CONFIRM OFF

Selecting CONFIRM OFF sends the termination request.

Loss of ATC Connection

Once an ATC connection is terminated or lost, the logon entries revert to the default values.

Emergency Report

This page informs ATC of an emergency. Sending this report places automatic dependant surveillance (ADS) into the emergency mode.

ATC		FLIGHT INFORMATION		COMPANY	
REVIEW		MANAGER		NEW MESSAGES	
1234Z EMERGENCY REPORT					
1	◆	MAYDAY	◆	PAN	◆ CANCEL EMERGENCY
2	■	DIVERTING	----- VIA- ROUTE X		
		TO:			
3	■	FUEL	[_ _ _ _ _]		
		REMAINING			
4	→	-----	HOURS+MINUTES		
5	→	SOULS ON BOARD:	---		
6	→	DESCENDING TO:	-----		
7	→	OFFSETTING:	---		
8	→	FREE TEXT:	-----		
SEND		PRINT		RESET	RETURN EXIT

1 MAYDAY, PAN, CANCEL EMERGENCY

Select MAYDAY or PAN emergency. The SEND key becomes active. CANCEL EMERGENCY informs ATC that a previous emergency is now canceled and returns ADS to the normal mode. CANCEL EMERGENCY is inhibited until MAYDAY or PAN downlink is sent.

2 DIVERTING TO

Defaults to the destination airport from the active route. The default route number is displayed. Enter any valid FMC position.

3 FUEL REMAINING

Displays the FMC fuel remaining from the PROGRESS page.

4 FUEL REMAINING – HOURS + MINUTES

Defaults to time provided from the FMC. Manually enter fuel remaining in hours and minutes. Use two numeric characters for hours followed by two numeric characters for minutes.

5 SOULS ON BOARD

Manual entry of number of souls on board is required. Enter up to three numeric characters.

6 DESCENDING TO

Enter the altitude for an immediate descent. The default value is the MCP altitude when it is more that 150 feet below current altitude.

7 OFFSETTING

Enter any valid FMC route offset value.

8 FREE TEXT

24 characters of free text can be included.

ATC Reports

ATC Requested Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1230Z ATC UPLINK CLIMB TO AND MAINTAIN FL330, REPORT REACHING FL330.		

DISPLAY REPORT		CANCEL

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC REPORT REACHING FL330		

SEND	DELETE	PRINT	ARM	RETURN	CANCEL

ATC uplink messages can contain a request for a report. When the uplink is accepted, the DISPLAY REPORT key is displayed. Selecting DISPLAY REPORT displays the ATC requested report. A displayed report can be sent. Some reports can be armed for automatic transmission when conditions are met.

Armable Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS...
SPEED REQUEST	LOGON / STATUS	POSITION REPORT
CLEARANCE REQUEST		FREE TEXT MESSAGE

ATC REPORTARMED

LEAVING FL330

ATC REPORTARMED

LEVEL FL330

ATC REPORTARMED

PASSING SEA

ATC REPORTARMED

REACHING FL330

All reports requested by ATC can be displayed using the ATC REQUESTED REPORT menu selection. The LEAVING, LEVEL, PASSING, and REACHING reports can be armed for automatic transmission. Selecting the ARM key for a report displays ARMED for the report status. When a report is armed, the ARM key changes to DISARM. When a report is automatically transmitted, an ATC uplink message confirms the report was sent.

Position Report

Use the POSITION REPORT page to manually send a position report.

Note: When the POSITION REPORT page is displayed during waypoint sequencing, the data fields may not update properly. If this occurs, the page can be updated by selecting RESET, or EXIT then reselect.

ATC		FLIGHT INFORMATION		COMPANY		
REVIEW		MANAGER		NEW MESSAGES		
POSITION REPORT						
1 → POS: 4038.2N12045.1E	7 ← ATA: 1234Z					
2 → ALTITUDE: 32000 FT	1					
3 → EST: 4038.4N13045.3E	8 ← ETA: 1314Z					
4 → NEXT: 4038.6N14045.8E	2					
5 → SPEED: .89		10 ← TEMP: -52C				
6 → POS FUEL: xxx.xx X 1000	11 ← WIND: 145/030 KT					
SEND		PRINT		RESET	RETURN	EXIT

1 Position (POS)

Displays the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

Latitude and longitude are displayed in the same order as the FMC position report page. Degree and minute values precede the compass letter, just as the crew uses in a voice report.

2 ALTITUDE

Displays the altitude at last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

3 EST

Displays the next FMC waypoint. Accepts any valid FMC waypoint entry. Requires manual entry for ATC reporting position which is not a route waypoint.

4 NEXT

Displays the next FMC waypoint following EST waypoint. Accepts any valid FMC waypoint entry. Requires manual entry for ATC reporting position which is not a route waypoint.

5 SPEED

Displays the current FMC speed. Accepts valid speed entry. Displays all asterisks (*) when no FMC data is available.

6 Position (POS) FUEL

Displays FMC calculated fuel remaining at the POS waypoint. Displays all asterisks (*) when no FMC data is available.

7 ATA

Displays actual time of arrival at the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

8 ETA

Displays estimated time of arrival for the next FMC waypoint. Accepts valid time entry.

9 Destination (DEST) ETA

Displays estimated time of arrival for the last FMC waypoint. Accepts a valid time entry. Displays all asterisks (*) when no FMC data is available.

10 Temperature (TEMP)

Displays current air temperature. Displays all asterisks (*) when no FMC data is available.

11 WIND

Displays current wind bearing and speed. Displays all asterisks (*) when no FMC data is available.

Optional Position Report Items

ATC	FLIGHT INFORMATION	COMPANY		
REVIEW	MANAGER	NEW MESSAGES		
POSITION REPORT				
TURBULENCE:		ICING:		▲
◆ LIGHT	◆ TRACE			1
◆ MODERATE	◆ LIGHT			
◆ SEVERE	◆ MODERATE			2
	◆ SEVERE			▼
SEND	PRINT	RESET	RETURN	EXIT

A report of current turbulence and icing conditions can be included with the position report.

Free Text Message

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z FREE TEXT		
◆ FLT CTRL ◆ MISC RPT ◆ MAINT ◆ OTHER		
FRM: ----- CDL: ----		
FRC: -----		
FRC: -----		
FRC: -----		
FRC: -----		
FRC: -----		
SEND	PRINT	RESET RETURN EXIT

Nine lines of text can be transmitted.

Flight Information

The flight information function is reserved for future use. The communications main menu FLIGHT INFORMATION selection is inhibited.

Company Menu

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
COMPANY		
FLIGHT INITIALIZATION	DEPARTURE REPORT	WEATHER REQUESTS
REQUEST AUTO- INITIALIZATION	POSITION REPORT	CREW REQUESTS...
DELAY REPORTS	ARRIVAL REPORT	MAINTENANCE REPORT
DIVERSION	MESSAGE TO GROUND	MISCELLANEOUS CODES
ETA REPORT	VOICE CONTACT REQUEST	SITUATION
FLIGHT TIMES		

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
CREW REQUESTS		
WEIGHT & BALANCE	CLEARANCE	RE-CLEARANCE
FLIGHT PLAN	FLIGHT RELEASE	GATE ASSIGNMENT
ATIS	NOTAMS	

Typical COMPANY Menu

Company downlink menus are accessed by selecting the COMPANY function. Actual menu and page layout is determined by the airline. An example of a typical menu and report page are provided to show common features.

Company Downlink Message Page

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z

DELAY/DIVERT

 PLANNING TO DIVERT

 ACTUAL DIVERT

DIVERT STATION: KEGG

EXPECTED ON TIME: 

 REASON:

-----▶

MEDICAL EMERGENCY

MEDICAL EMERGENCY

WEATHER

SEND

PRINT

RESET

RETURN

EXIT

Typical COMPANY Page

This COMPANY report page shows both exclusive and nonexclusive selections, a required entry, and optional menu selections.

Review Menu

The diagram illustrates the Review Menu interface across three sequential states:

Menu 1 (Initial State):

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
REVIEW		
ATC UPLINK...	FLIGHT INFORMATION	SENT...
ATC DOWNLINK...		RECEIVED...
		WEATHER...

Menu 2 (ATC Downlink Messages):

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1420Z ATC DOWNLINKS		
1350Z	ALTITUDE REQUEST	SENT
1315Z	SPEED ALTITUDE ROUTE REQUEST	RESP RCVD
1240Z	WHEN CAN WE EXPECT	RESP RCVD
1234Z	CLEARANCE REQUEST	ABORTED

Menu 3 (Detailed View):

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1420Z	VERIFY REQUEST	RESPONSE RCVD
REQUEST .82, REQUEST CRUISE CLIMB TO FL410 DUE TO WEATHER, REQUEST DIRECT GANDER. FREE TEXT: ROUGH RIDE HERE AT FL350		

Typical REVIEW Menu

Review messages are accessed by selecting the REVIEW menu. Both uplink and downlink messages are displayed in review lists. The review menu is inhibited (cyan) if there are no review messages in that category.

Review State Indicators

Each review message list field and each review message displays the last state of the referenced message. Only one state can apply to a message at a time.

State Indicator	Condition
ABORTED	ATC data link connection lost before sending response to uplink message or completing a downlink message.
ACCEPTING	The received message was displayed and an ACCEPT response was initiated.
ACCEPTED	The received message was displayed, an ACCEPT response was initiated, and the service provider has acknowledged receipt of the response.
DISPLAYED	The received message was displayed (no accept/reject response was required).
NO ACCEPT	The received message was displayed, an ACCEPT response was initiated, but the service provider did not acknowledge receipt of the response.
NO REJECT	The received message was displayed, a REJECT response was initiated, but the message destination did not acknowledge receipt of the response.
NO SEND	The downlink message was initiated to be sent and the service provider did not acknowledge receipt of the message.
REJECTING	The received message was displayed and a REJECT response was initiated.
REJECTED	The received message was displayed, a REJECT response was initiated, and the message destination has acknowledged receipt of the response.
RESPONSE RCVD	ATC uplink message received in response to a downlink request.
SENDING	The downlink message was initiated to be sent.
SENT	The downlink message was initiated to be sent and the service provider has acknowledged receipt of the message.

Manager Functions

Manager Menu

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
MANAGER		
ACARS	SYSTEM INFORMATION	
VHF	PRINTER	
SATCOM	AUTOMATIC MESSAGES	
ADS	MASTER	

Typical MANAGER Menu

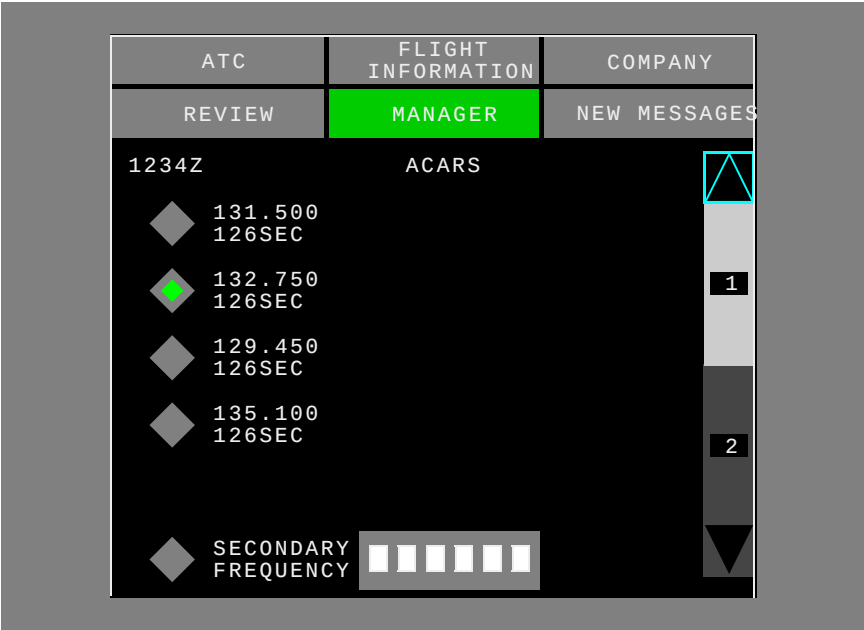
The MANAGER menu page provides access to the manager functions.

ACARS Manager

7101 - 7110

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	ACARS	
◆ 131.725	◆ 131.825	
◆ 131.550		1
◆ 131.450		
◆ 136.850	◆ AUTOTUNE FREQUENCY 136.975	2
	 AUTOMATIC	

7001 - 7008



The ACARS manager page provides selection of ACARS frequencies. Manager messages related to ACARS are on ACARS page two.

7101 - 7110

The AUTOMATIC key is selected by default and frequency selection is controlled by ACARS. Manually selecting a frequency or deselecting the AUTOMATIC key places ACARS in manual mode and disables automatic frequency scanning. If the AUTOMATIC key is subsequently selected, the system returns to automatic mode and frequency selection is controlled by ACARS. If the service provider uplinks a request to change frequency, the AUTOTUNE FREQUENCY key displays and ACARS tunes to the requested frequency.

7001 - 7008

If a FREQUENCY key is selected, the ACARS system tunes to the appropriate frequency. If a secondary frequency is entered, the SECONDARY FREQUENCY key is automatically selected and ACARS tunes to the secondary frequency. Frequency selections can be changed automatically by ACARS.

ACARS Manager Page 2/2

This page allows the operator to select/deselect VHF or SATCOM transmission of data. ACARS is set to auto mode (both boxes selected) at power-up or data communication system reset. Normally, this permits ACARS to automatically use VHF or SATCOM (if VHF is unavailable). If both boxes are deselected, ACARS loses the capability to send downlink messages, but can receive and display uplink messages.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z ACARS ☒ VHF ENABLE ☒ SATCOM ENABLE 1457Z SATCOM ENABLE 1457Z VHF ENABLE 1106Z ACARS CONNECTION ESTABLISHED (ACARS Manager Messages)		

VHF Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z VHF ☒ DEFAULT RADIO CENTER ☐ DEFAULT RADIO RIGHT ☒ DEFAULT RADIO MODE: DATA ☐ DEFAULT RADIO MODE: VOICE 1106Z VHF DATA MODE RADIO NORMAL 1106Z VHF LINK ESTABLISHED (VHF Manager Messages)		

The VHF manager page provides the capability to select the default radio and to configure the default radio to the voice or data mode. Manager messages related to the VHF system are also presented on this page.

If the DEFAULT RADIO CENTER key is selected, the center VHF radio becomes the default radio. If the DEFAULT RADIO RIGHT key is selected, the right VHF radio becomes the default radio.

Note: To select another VHF default radio, the SATCOM ENABLE key must be deselected on ACARS manager page 2.

If the DEFAULT RADIO MODE DATA key is selected, the default radio is set to data mode. If the DEFAULT RADIO MODE VOICE key is selected, the default radio is set to voice mode.

Note: The default radio can also be set to data or voice mode using the Radio Tuning Panel.

SATCOM Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	SATCOM	
(SATCOM Manager Messages)		

The SATCOM manager page displays manager messages related to the SATCOM system.

Automatic Dependent Surveillance Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	ADS	
 ADS ARM	 ADS OFF	
 ADS EMERGENCY	 ADS EMERGENCY OFF	
1225Z ADS CONNECTION NOT ESTABLISHED -OAKXGXA		
1120Z ADS CONNECTION ESTABLISHED -OAKXGXA		
1020Z ADS CONNECTION ESTABLISHED -SEAXGXA		

When automatic dependant surveillance (ADS) is armed, AUTOMATIC position report messages are sent to ATC and COMPANY.

The ADS page controls the following airplane ADS functions:

- ADS ARM – allows airplane ADS functions
- ADS OFF – inhibits airplane ADS functions
- ADS EMERGENCY – sends an alert to ATC indicating an emergency situation (resets to ADS EMERGENCY OFF at power-up)
- ADS EMERGENCY OFF – cancels emergency indication to ATC.

A list of ADS connection status is displayed on the ADS page.

System Information Manager

The system information manager page displays manager messages for all applicable systems.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z SYSTEM INFORMATION 1 → TAIL NUMBER N861DA AIRLINE: DL ← 2 (All Manager Messages)		

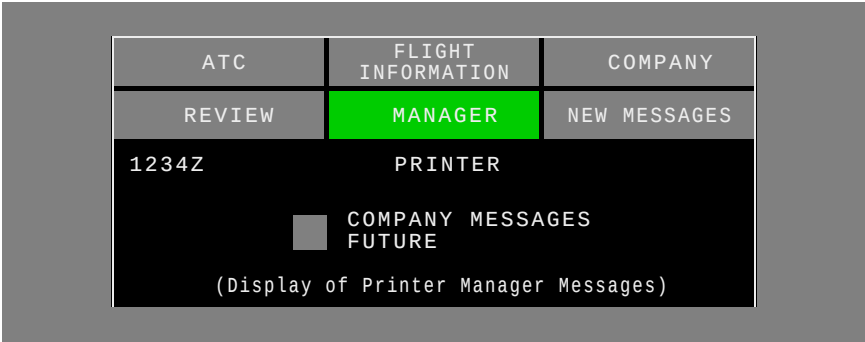
1 TAIL NUMBER

Normally supplied by the airplane system. When the airplane tail number (registry number) is not available from the system, box prompts are displayed and a value can be entered. A manual entry will remain until power to AIMS is interrupted. Changing this entry after establishing an ATC connection cancels the ATC connection. Tail number is provided on the SELCAL placard.

2 AIRLINE

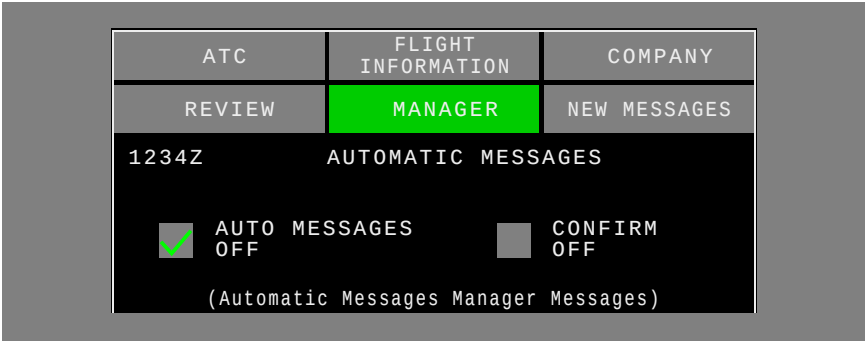
Normally supplied by the airplane system, but can be manually entered or overwritten. When the airline identifier is not available from the system, box prompts are displayed. A valid entry is two alphanumeric characters and will remain until power to AIMS is interrupted. Changing this entry after establishing an ATC connection cancels the ATC connection.

Printer Manager



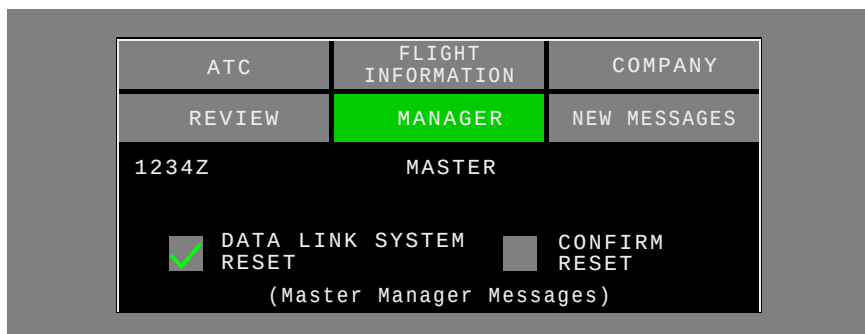
The printer manager page can be set to send messages directly to the printer. Manager messages related to the printer system are also presented on this page. If the COMPANY MESSAGES FUTURE key is selected, company messages are sent directly to the printer and the •PRINTER EICAS message is displayed. Future messages are not included in the new messages or review categories.

Automatic Messages Manager



The AUTO MESSAGES OFF selection inhibits automatic sending of flight operations related messages. Manager messages related to the automatic messages capability are also presented on this page. When the AUTOMATIC MESSAGES OFF key is selected, the CONFIRM OFF key is displayed. Selecting the CONFIRM OFF key turns off the capability to automatically send flight operations related messages.

Master Manager



The master manager page provides the capability to reset the data communication system. Manager messages related to the master features are also presented on this page.

If the DATA LINK SYSTEM RESET key is selected, the CONFIRM RESET key is displayed. If the CONFIRM RESET key is selected, the following occurs.

On the ground:

- all new messages are deleted
- all messages queued for downlink are deleted
- all review messages are deleted
- ATC reports are deleted

In flight:

- flight information and company new messages are deleted
- flight information and company messages queued for downlink are deleted
- flight information and company review messages are deleted
- ATC displays reset to default values

On the ground or in flight:

- flight information and company displays reset to default values
- center VHF radio is selected as the default and set to data mode on the ground or voice mode in flight
- AUTO MESSAGES OFF is deselected
- COMPANY MESSAGES FUTURE is deselected
- ADS OFF is selected
- ADS EMERGENCY OFF is selected
- all manager status messages are deleted
- two seconds after selection, the CONFIRM RESET key is removed from the display and the DATA LINK SYSTEM RESET key is displayed as not selected

This reset does not occur at power-up.

Except for configuration of ACARS data radios, the data link system is automatically reset after each flight. Reset occurs approximately 10 minutes after the last engine is shut down, and with any entry door open.

Data link capability for the flight management system, OMS, and EICAS related maintenance functions, and cabin functions are not reset with this feature.

Manager Messages

Manager messages are displayed in reverse chronological order (the newest message is nearest the top of the display). The time of occurrence is displayed with each message. The manager messages are listed in the following table.

Function	Manager Message
ACARS	ACARS CONNECTION ESTABLISHED
	NO ACARS CONNECTION
	ACARS MODE VHF - ENABLE
	ACARS MODE VHF - NOT ENABLE
	ACARS MODE SATCOM - ENABLE
	ACARS MODE SATCOM - NOT ENABLE
ADS	ADS CONNECTION ESTABLISHED – ATC facility
	ADS CONNECTION LOST – ATC facility
	ALL ADS CONNECTIONS LOST
VHF	VHF LINK ESTABLISHED
	NO VHF LINK
	VHF DATA MODE RADIO FAILURE
	VHF DATA MODE RADIO NORMAL
SATCOM	SATCOM LINK ESTABLISHED
	NO SATCOM LINK
	SATCOM DATA MODE FAILED
	SATCOM DATA MODE NORMAL
PRINTER	PRINTER OPERABLE
	PRINTER NOT OPERABLE
	PRINTER BUFFER FULL
	COMPANY FUTURE MESSAGES TO PRINTER – ON
	COMPANY FUTURE MESSAGES TO PRINTER – OFF
AUTOMATIC MESSAGES	AUTOMATIC MESSAGES – ON
	AUTOMATIC MESSAGES – OFF
MASTER	DATA LINK SYSTEM – RESET

New Messages

New Messages Menu

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	NEW MESSAGES	
1228Z	CLIMB AND MAINTAIN FL330	ATC
1233Z	PASSENGER INFORMATION - CONNECTING FLIGHTS	
1220Z	WEATHER INFORMATION FOR KPDX, KSFO, KLAX	
1215Z	CONTACT DISPATCH	

Typical NEW MESSAGE List

New uplink messages are displayed with ATC messages displayed above flight information messages which are displayed above company messages. Within ATC, flight information and company, messages are listed by the time they are received. The newest message is at the top of the group. Messages are removed from the list when displayed or an accept/reject response is sent.

New messages can also be accessed by selecting the NEW MESSAGES menu, which displays list boxes for all pending messages. A message is displayed by selecting the appropriate message line.

New ATC uplinks which respond to downlink requests display a key which displays the original downlink request.

New Message – No Response Required

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1233Z GATE INFORMATION Flight: XX127 Gate: B1 ETA: 1245Z PRINT CANCEL		

Received messages remain in the new messages list until after they are displayed. If an ACCEPT or REJECT response is required, the message remains in the list until accepted or rejected.

The display above shows a received message that does not require a response. The ACCEPT and REJECT keys are not displayed for this message. The message can be cleared by selecting the CANCEL key on the MFD or pushing the CANCEL switch on the glareshield.

New Message – Response Required



The display above shows a message that requires an ACCEPT or REJECT response. The ACCEPT and REJECT keys are displayed.

An APPEND capability is provided for certain received messages which require an accept or reject response. In this case, the APPEND key is displayed.

Communications

EICAS Messages

Chapter 5

Section 50

Communications EICAS Alert Messages

The following EICAS alert messages can be displayed.

Message	Level	Aural	Message Logic
DATALINK LOST	Advisory		Datalink is temporarily lost.
DATALINK SYS	Advisory		Datalink system has failed.
RADIO TRANSMIT	Advisory		A VHF or HF radio is keyed for 30 seconds or more.
SATCOM	Advisory		SATCOM system has failed.
SATCOM DATALINK	Advisory		SATCOM datalink has failed.
SATCOM DATALINK OFF	Memo		SATCOM system has a voice or data mode and the data mode is not selected in ACARS Manager.
SATCOM VOICE	Advisory		SATCOM voice communication has failed.
SATVOICE LOST	Advisory		SATCOM voice communication is temporarily lost.
VHF DATALINK	Advisory		VHF datalink has failed.
VHF DATALINK OFF	Memo		Default datalink VHF radio is in voice mode.

EICAS Communication Messages

The following EICAS communication messages can be displayed.

Message	Level	Message Logic	Crew Action
•ATC	Medium	An ATC data link message has been received or an armed report has been sent.	Respond to message displayed on EICAS or select the MFD communications display.
•CABIN ALERT	Medium	Pilot alert received over cabin interphone.	Respond to the alert.
•CABIN CALL	Medium	Pilot call received over cabin interphone.	Respond to the call.
•CABIN READY	Medium	CABIN READY received over cabin interphone.	Crew awareness. Automatically removed after one minute.
•COMM	Medium/ low	A data link message has been received.	Select COMM display on the MFD.
•COMM BUSY	Medium	Communications system pending data link message queue is full.	Respond to current pending data link messages.
•DATA LINK AVAIL	Low	A lost data link connection has been re-established.	Resume use of data link communication.

Message	Level	Message Logic	Crew Action
•FMC	Medium	An FMC related data link message has been received.	Select FMC from the CDU MENU page if not already in the FMC mode. View the message title in the CDU scratchpad. View the message on the appropriate CDU page.
•GROUND CALL	Medium	Pilot call received over flight interphone from nose wheel well.	Respond to the call.
•PRINTER (with data link installed)	Medium/ low	A data link message has been received and sent to the printer.	Review the printed message.
•SATCOM MESSAGE	Medium/ low	SATCOM voice system information available if SATCOM system is selected on a CDU.	View the SATCOM CDU message.
•SATVOICE AVAIL	Low	SATCOM voice capability re-established after a temporary loss.	Resume use of SATCOM voice.
•SELCAL	Medium	SELCAL received or any SATCOM voice call received.	Respond to the call.

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Electrical

Chapter 6

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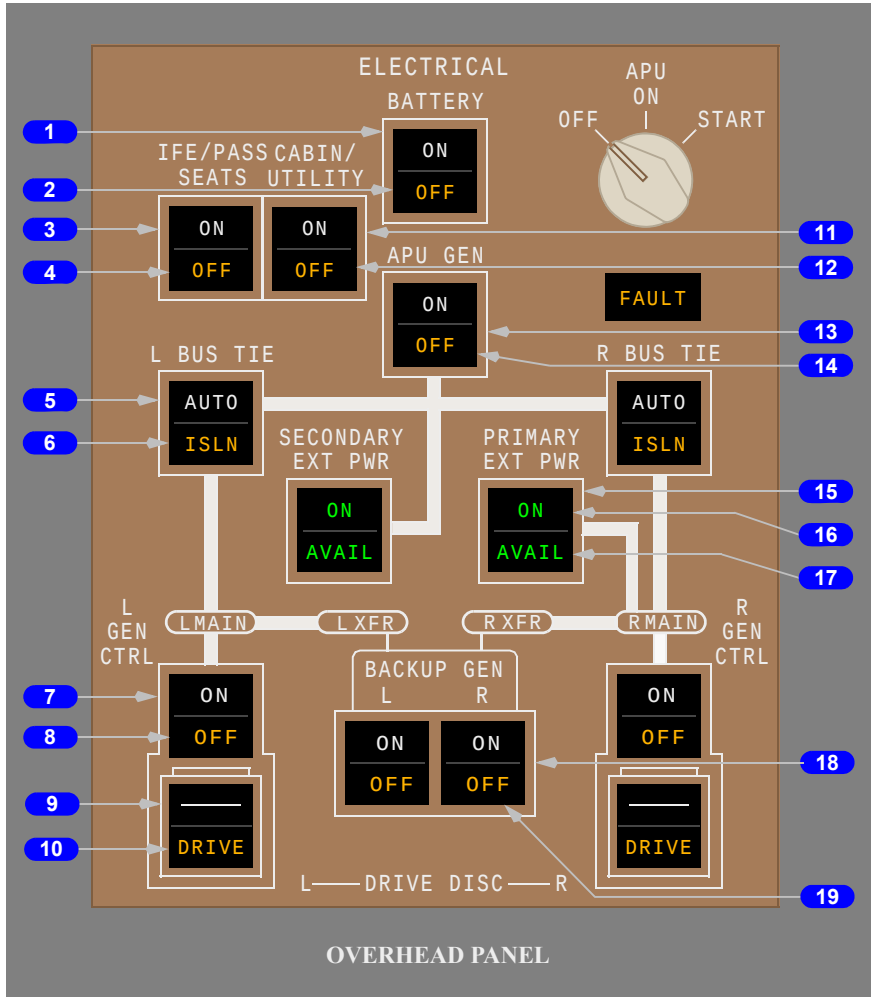
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Electrical Controls and Indicators

Chapter 6 Section 10

Electrical Panel



1 BATTERY Switch

ON –

- unpowered airplane on the ground:
 - some switch annunciator lights are illuminated

- allows the APU to be started
- on the ground after AC power is removed or lost:
 - standby busses and emergency lighting are powered
 - the left inboard, outboard, and upper center displays, and the left CDU are powered.

OFF –

- on the ground, battery power is removed and the EICAS advisory message ELEC BATTERY OFF is displayed
- in flight, the EICAS advisory message ELEC BATTERY OFF is displayed.

2 Battery OFF Light

Illuminated (amber) – the battery switch is OFF.

3 In-Flight Entertainment System/Passenger Seats (IFE/PASS SEATS) Power Switch

ON – powers IFE and passenger seat systems when AC power is available.

OFF – removes power from IFE and passenger seat systems.

4 IFE/PASS SEATS OFF Light

Illuminated (amber) – the IFE/PASS SEATS Power switch is OFF.

5 BUS TIE Switches

AUTO – arms automatic AC bus tie circuits.

ISLN (isolation) (AUTO not visible) – commands the bus tie open.

6 Bus Isolation (ISLN) Lights

Illuminated (amber) –

- bus tie breaker is locked open (ISLN selected with bus tie switch), or
- a fault has occurred, automatically opening the bus tie breaker.

7 Generator Control (GEN CTRL) Switches

ON – arms the generator breaker to close automatically when generator power is available.

OFF –

- opens field and generator breakers
- resets fault trip circuitry.

8 Generator OFF Lights

Illuminated (amber) – the generator breaker is open.

9 Drive Disconnect Switches

Push –

- disconnects the integrated drive generator (IDG) input from the engine
- requires maintenance action on the ground to reconnect the IDG.

10 Generator DRIVE Lights

Illuminated (amber) – IDG oil pressure is low.

11 Cabin/Utility (CABIN/UTILITY) Power Switch

ON – powers cabin and utility systems when AC power is available.

OFF – removes power from cabin and utility systems and turns on some cabin lighting.

12 CABIN/UTILITY Power OFF Light

Illuminated (amber) – CABIN/UTILITY power switch is selected OFF.

13 APU Generator (APU GEN) Switch

ON – arms APU generator breaker to automatically close.

OFF – opens APU generator breaker.

14 APU Generator OFF Light

Illuminated (with the APU running) (amber) –

- the APU generator breaker is open because of a fault, or
- the APU GENERATOR switch is selected OFF.

15 External Power (EXT PWR) Switches

Push – if AVAIL light is illuminated, closes external power contactor. Subsequent action opens external power contactor.

ON – external power is connected to the bus(es).

OFF (ON not visible) – external power is disconnected from the bus(es).

16 External Power ON Lights

Illuminated (green) – external power is powering the busses.

17 External Power AVAIL Lights

Illuminated (green) –

- external power is plugged in and power quality is acceptable
- extinguishes when the ON light illuminates.

18 Backup Generator (BACKUP GEN) Switches

ON – backup generator operation is armed.

OFF –

- opens the backup generator control relay
- resets the fault circuitry.

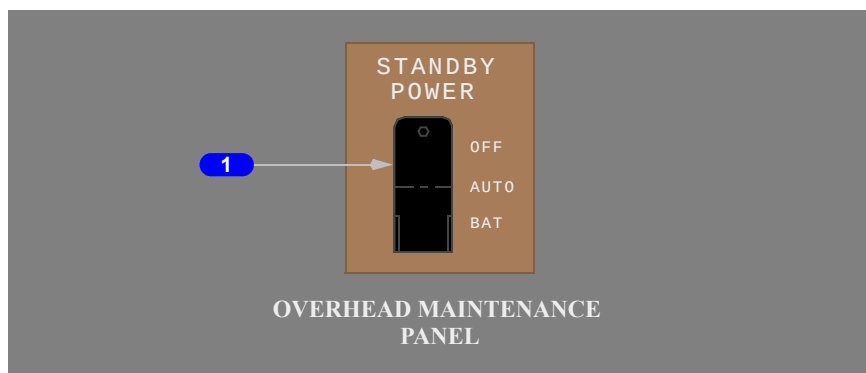
19 Backup Generator OFF Lights

Illuminated (amber) –

- the backup generator has failed, or
- a circuit fault has been detected, or
- backup generator switch selected off, or
- both OFF lights illuminated – backup system (converter) has failed.

Overhead Maintenance Panel

Standby Power Switch



1 STANDBY POWER Switch

Note: Ground operation only.

OFF – the AC standby bus is not powered.

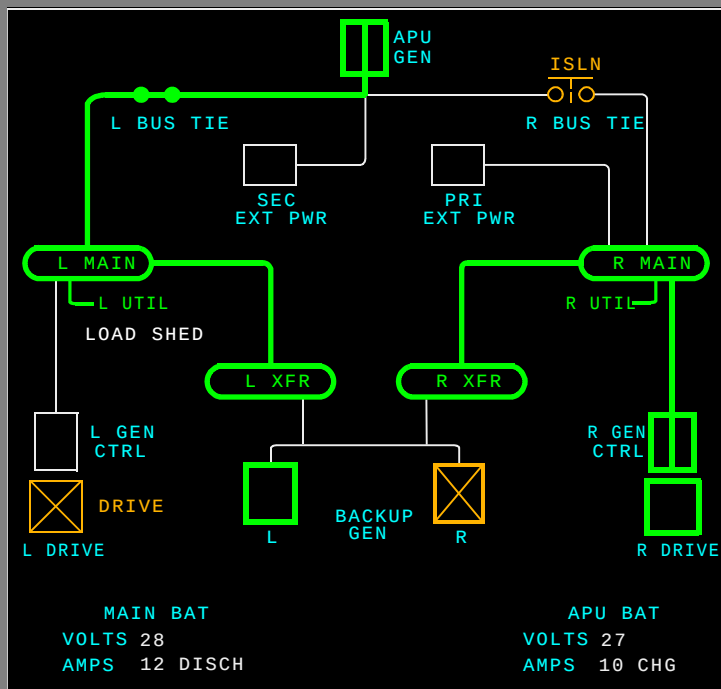
AUTO (guarded) – the standby busses transfer to battery power if normal AC power is lost.

BAT (momentary) –

- the standby busses are powered from the battery if AC power is not available
- initiates a DC/standby self-test if AC power is available.

Electrical Synoptic Display

The electrical synoptic is displayed by pushing the ELEC synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.



MULTIFUNCTION DISPLAY

CHG ... BATTERY CHARGING	 DRIVE DISCONNECTED ENGINE RUNNING (AMBER)	 NOT SUPPLYING POWER OR FAILED (AMBER)
CTRL .. CONTROL		
DISCH . BATTERY DISCHARGING	 ON OR AVAILABLE (GREEN)	 POWER FLOWING (GREEN)
DRIVE . OIL PRESSURE LOW (AMBER)		
ISLN .. BUS TIE OPEN DUE TO ELECTRICAL FAULT OR BUS TIE SWITCH OFF (AMBER)	 OFF (WHITE)	 POWER NOT FLOWING (WHITE)

Electrical System Description

Chapter 6 Section 20

Introduction

The electrical system generates and distributes AC and DC power to other airplane systems, and is comprised of: main AC power, backup power, DC power, standby power, and flight controls power. System operation is automatic. Electrical faults are automatically detected and isolated.

AC Electrical System

The AC electrical system is the main source for airplane electrical power.

Electrical Load Management System (ELMS)

The ELMS provides load management and protection to ensure power is available to critical and essential equipment.

If the electrical loads exceed the power available (airplane or external), ELMS automatically sheds AC loads by priority until the loads are within the capacity of the airplane or ground power generators. The load shedding is galleys first, then utility busses. Utility busses are followed by individual equipment items powered by the main AC busses. When an additional power source becomes available or the loads decrease, ELMS restores power to shed systems (in the reverse order). The message LOAD SHED displays on the electrical synoptic when load shed conditions exist.

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The ELMS also provides inputs for display of EICAS messages for manual center tank fuel pump shut off during climb/cruise, and automatic shut off to prevent unintentional dry fuel pump operation when the center fuel tank is empty.

AC Electrical System Power Sources

The entire airplane AC electrical load can be supplied by any two main AC power sources.

The main AC electrical power sources are:

- left and right engine integrated drive generators (IDGs)
- APU generator
- primary and secondary external power.

The power sources normally operate isolated from one another. During power source transfers on the ground (such as switching from the APU generator to an engine generator) operating sources are momentarily paralleled to prevent power interruption.

Integrated Drive Generators (IDGs)

Each engine has an IDG. Each IDG has automatic control and system protection functions.

When an engine starts, with the GENERATOR CONTROL switch selected ON, the IDG automatically powers the respective main bus. The previous power source is disconnected from that bus.

The IDG can be electrically disconnected from the busses by pushing the GENERATOR CONTROL switch to OFF. The IDG can also be electrically disconnected from its respective bus by selecting an available external power source prior to engine shutdown. (See Primary External Power and Secondary External Power in this section.)

The DRIVE light illuminates and the EICAS message ELEC GEN DRIVE L or R displays when low oil pressure is detected in an IDG. The IDG drive can be disconnected from the engine by pushing the respective DRIVE DISCONNECT switch. The IDG cannot be reconnected by the flight crew.

High drive temperature causes the IDG to disconnect automatically.

APU Generator

The APU generator is electrically identical to the IDG generators. The APU generator can power either or both main busses, and may be used in flight as a replacement to an IDG source.

If no other power source is available when the APU generator becomes available, the APU generator automatically connects to both main AC busses. If the primary external source is powering both main busses, the APU powers the left main bus, and the primary external source continues to power the right main bus. If the primary external source is powering the right main bus, and the secondary external source is powering the left main bus, the APU then powers the left main bus and the primary external source continues to power the right main bus. If the secondary external source is powering both main busses, the APU then powers both main busses.

The APU generator OFF light illuminates when the APU is operating and the APU generator breaker is open because of a fault or the APU GENERATOR switch is selected OFF. When the APU GENERATOR switch is ON and a fault is detected, the APU generator cannot connect to the busses.

In flight, when both transfer busses are unpowered, the APU starts automatically, regardless of APU selector position. Refer to Chapter 7, Engines, APU for APU starter operation.

Primary External Power

Primary external power can power the left and right main busses. When the primary power source voltage and frequency are within limits, the primary external power AVAIL (available) light illuminates. If no AC power is applied, either external power source will power the airplane if the BATTERY switch is ON.

If no other source is powering the main busses, with the BATTERY switch ON, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both main busses. When primary external power is connected to a main bus, the PRIMARY EXTERNAL POWER ON light illuminates and the AVAIL light extinguishes.

If a single IDG powers both busses, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both busses and removes the IDG source.

If both IDGs are powering their respective busses, the APU generator is NOT running and secondary external power is NOT available, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both busses and removes the IDG sources.

If both IDGs are powering their respective busses, and secondary external power is available, pushing the PRIMARY EXTERNAL POWER switch to ON connects primary external power to the right main bus, leaving the left main bus powered from the left IDG.

If the APU generator is running, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to the right main bus, leaving the previous source connected to the left main bus.

If both busses are powered from secondary external power, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to the right main bus, leaving secondary external power connected to the left main bus.

Pushing the PRIMARY EXTERNAL POWER switch while primary external power is ON, disconnects primary external power. The previously connected power source is reconnected, if available.

Secondary External Power

Secondary external power can power the left and right main busses. When the secondary external power source voltage and frequency are within limits, the secondary external power AVAIL (available) light illuminates.

If no AC power is applied, the BATTERY switch must be ON or primary external power must be available for secondary external power to power the airplane. If the BATTERY switch is ON and no other source is powering the main busses, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to both main busses. When secondary external power is connected to a main bus, the SECONDARY EXTERNAL POWER ON light illuminates and the AVAIL light extinguishes.

If a single IDG powers both main busses, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to both busses and removes the IDG source. Similarly, if only secondary external power is available and both IDGs are powering their respective busses, pushing the SECONDARY EXTERNAL switch ON connects secondary external power to the left main bus. When the right engine is shut down, there is a no-break transfer of power of secondary external power to the right main bus.

If both IDGs are powering their respective busses, and both secondary and primary external power are available, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving the right main bus powered from the right IDG.

If the APU generator is running, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving the right IDG or primary external power connected to the right main bus.

If both busses are powered from primary external power, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving primary external power connected to the right main bus. If no other source is available, secondary external power is connected to both main busses.

Pushing the SECONDARY EXTERNAL POWER switch while secondary external power is ON disconnects secondary external power. The previously connected power source is reconnected, if available.

AC Electrical Power Distribution

AC power is distributed through the left and right main busses and the ground service bus.

AC Main Busses

The right IDG normally powers the right main bus and the left IDG normally powers the left main bus. The APU normally powers both main busses when they are not powered by any other source.

When external power is connected:

- primary external power normally powers the right main bus
- secondary external power normally powers the left main bus.

Bus tie relays, controlled by BUS TIE switches, isolate or parallel the right and left main busses. When both BUS TIE switches are set to AUTO, the bus tie system operates automatically to maintain power to both main busses.

Power transfers are made without interruption when the airplane is on the ground, except when switching between primary and secondary external power sources.

The source order for powering left and right main busses in flight is the:

- respective IDG
- APU generator
- opposite IDG.

The main busses power individual equipment items such as:

- cooling vent fan
- electric hydraulic pumps
- recirculation fans
- IFE
- lavatory/galley fans

Each main bus also powers its associated busses (typical loads are shown in parentheses):

- transfer bus (DC system transformer–rectifiers, AC standby bus)
- utility bus (forward galley heater, chiller boost fan, gasper fan, captain's and first officer's foot and shoulder heaters, door area heaters, lavatory water heaters and shavers)
- galley busses.

Ground Service Bus

The ground service bus is normally powered by the right main bus. Alternate sources of power for the ground service bus are:

- the APU generator
- primary external power.

The ground service bus powers:

- the main battery charger
- miscellaneous cabin and system loads.
- the APU battery charger

Ground Handling Bus

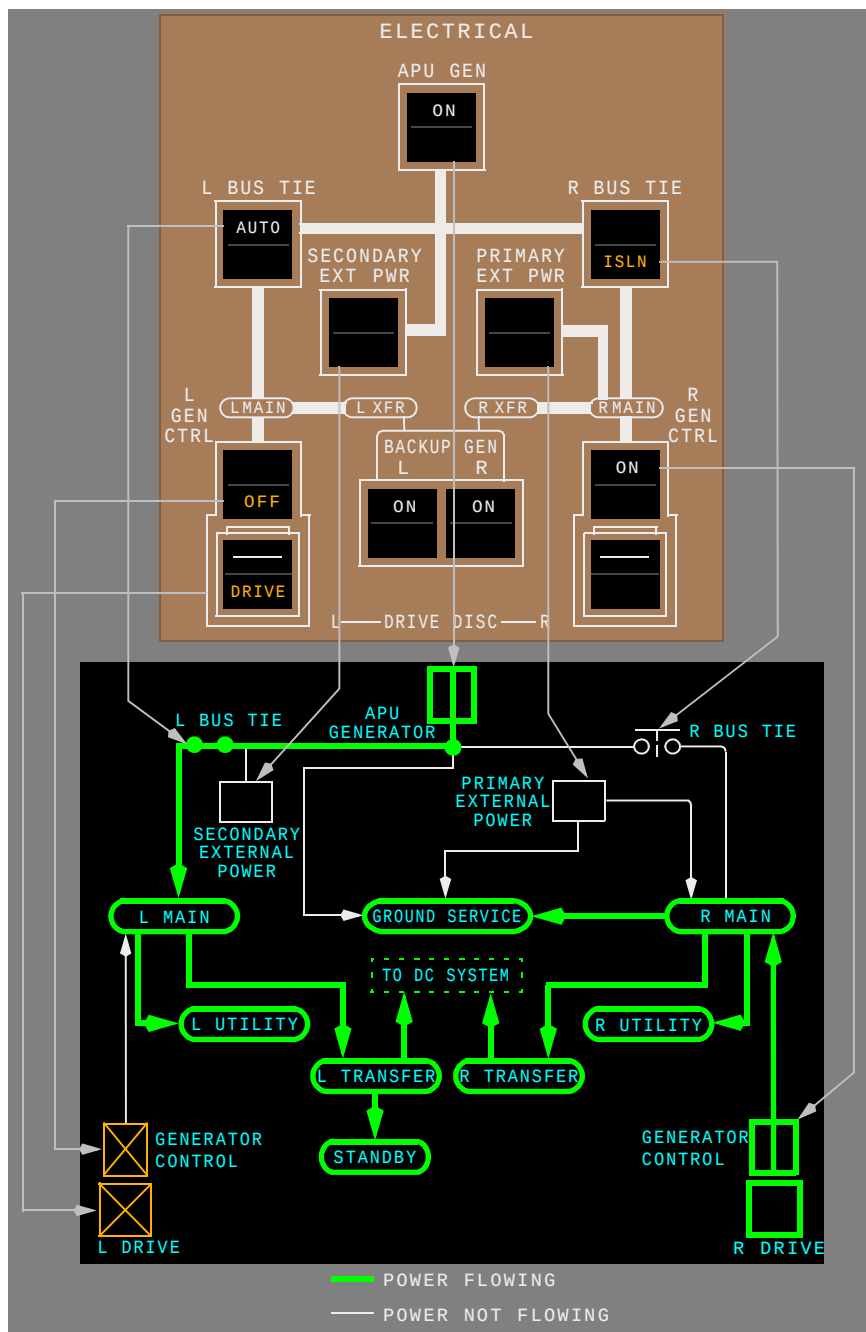
The ground handling bus can be powered on the ground only from the APU generator or from the primary external power source. It is provided for loads such as cargo handling, fueling/defueling operations, and other equipment energized only during ground operations.

Autoland

During autoland, the busses isolate to allow three independent sources to power the three autopilots:

- the left IDG powers the left AC transfer bus, the left main DC bus, and the captain's flight instrument bus
- the right IDG powers the battery bus and AC standby bus through the main battery charger
- the backup system powers the right AC transfer bus, the right DC bus, and the first officer's flight instrument bus.

AC Electrical System Schematic



Backup AC Electrical System

The backup electrical system is designed to automatically provide power to selected airplane systems. The backup electrical system automatically powers one or both transfer busses when:

- only one main AC generator (includes APU) is available
- power to one or both of the main AC busses is lost
- approach (APP) mode is selected for autoland
- the system is automatically tested after engine starts.

The system transfers power without interruption.

Backup Generators

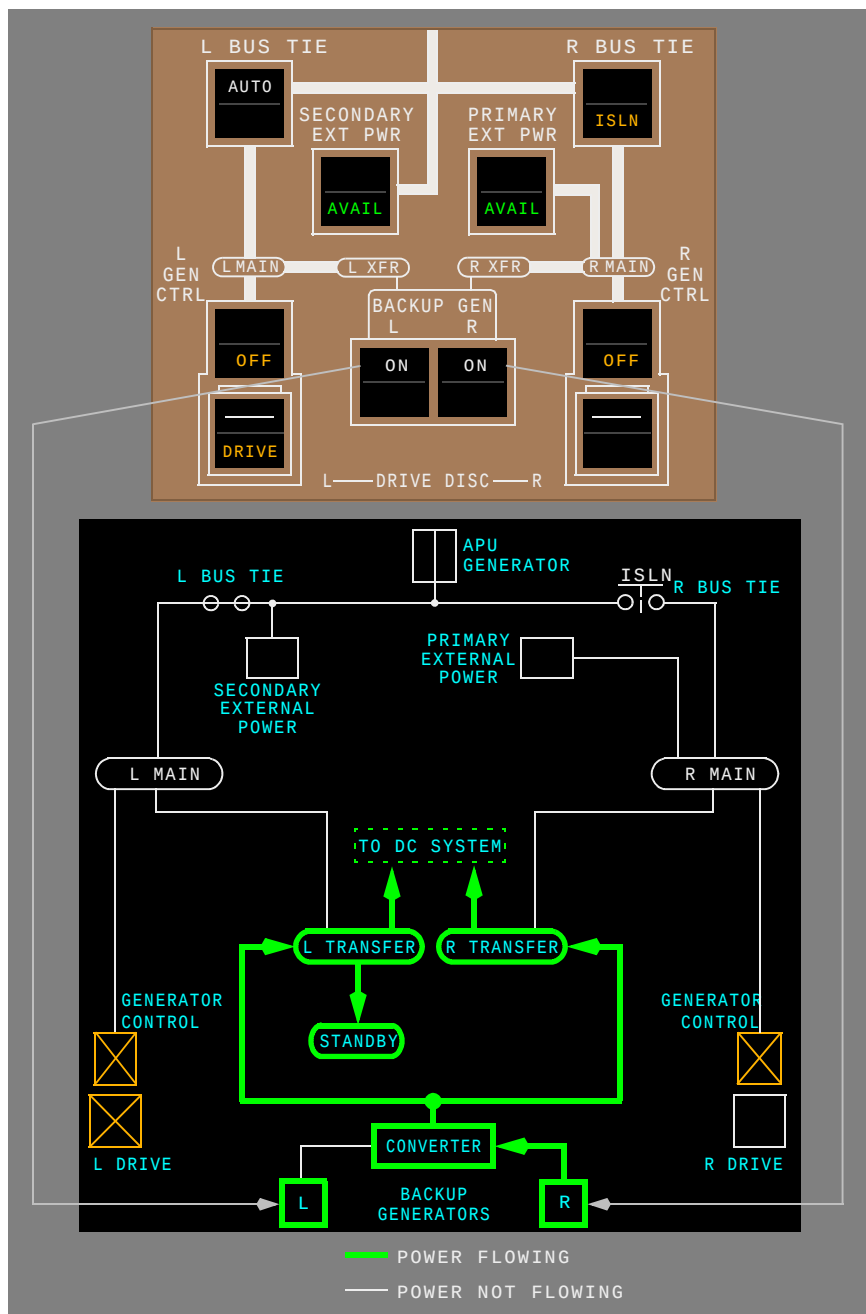
Backup power is provided by one variable speed, variable frequency generator mounted on each engine. A frequency converter converts the generator frequency to a constant 400 Hz. Only one backup generator can power the converter at a time.

Each backup generator contains two permanent magnet generators (PMGs) that supply power to the flight control DC electrical system (refer to DC Electrical System).

If both IDGs and the APU generator are inoperative, a backup generator powers essential airplane equipment. To reduce electrical loading on the backup generator, the following systems are inoperative:

- TCAS
- SATCOM
- Right HF radio
- Center tank override/jettison pumps (center tank fuel is unusable and cannot be jettisoned)
- Position and other exterior lights (except nose gear landing lights)
- All non-essential cabin equipment (galleys, entertainment systems, etc.)
- Passenger cabin lighting (except night, galley and cross-aisle lights)
- Cabin temperature control (remains operative, but in degraded mode)

Backup AC Electrical System Schematic



DC Electrical System

The DC electrical system includes the main DC electrical system and the flight control DC electrical system.

Main DC Electrical System

The main DC electrical system uses four transformer–rectifier units (TRUs) to produce DC power. The TRUs are powered by the AC transfer busses.

Main DC Power Distribution

TRU DC electrical power is distributed to various DC busses as follows:

The left TRU powers the left main DC bus, which provides a second DC power source for:

- left flight control power supply assembly (PSA)
- right main DC bus.

The right TRU powers the right main DC bus, which provides a second DC power source for:

- right flight control PSA
- left main DC bus.

The C1 TRU powers the captain's flight instrument bus and the battery bus. The captain's flight instrument bus provides a second DC power source for:

- center flight control PSA
- first officer's flight instrument bus

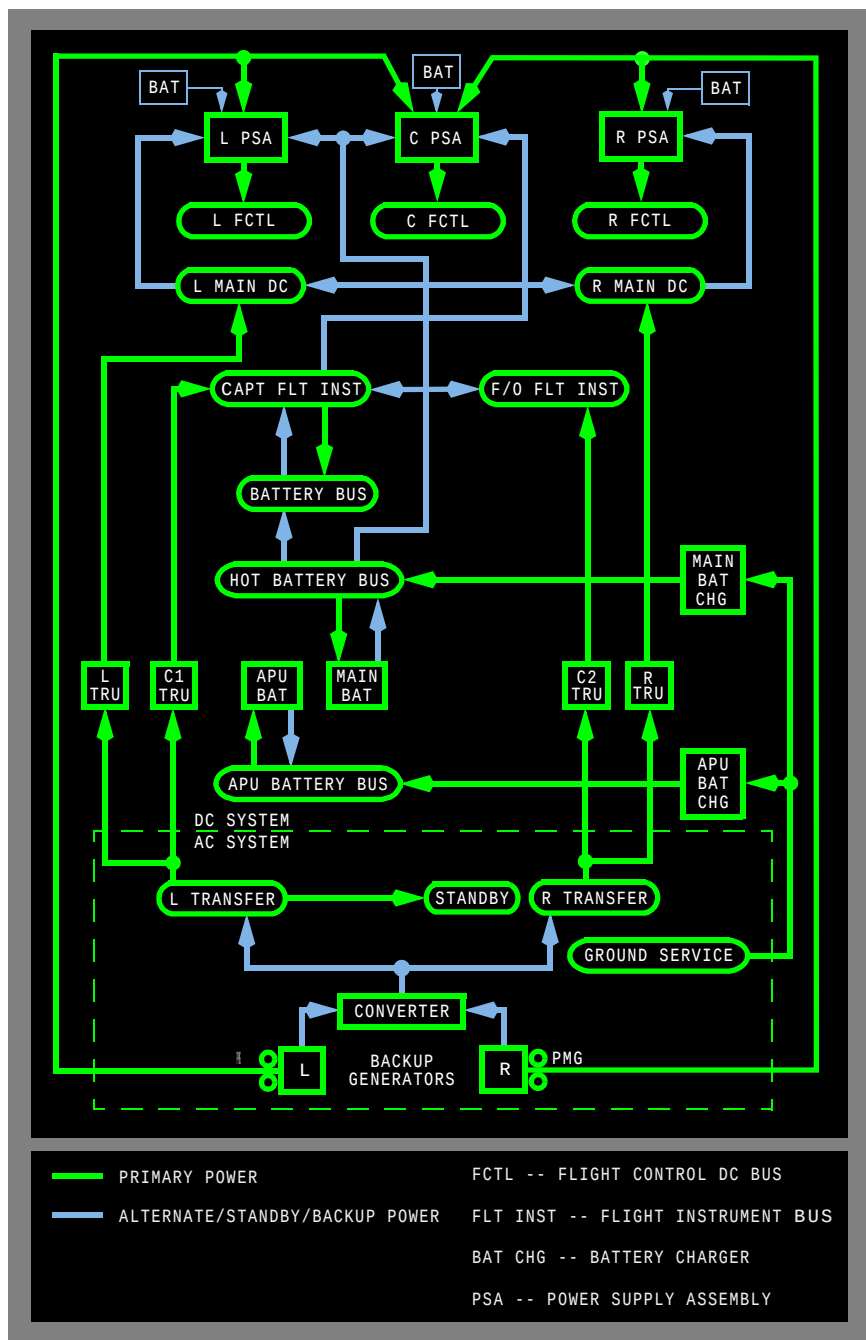
The C2 TRU powers the first officer's flight instrument bus, which provides a second DC power source for the captain's instrument bus.

Batteries

The main battery is connected directly to the hot battery bus and provides standby power to other busses (See Standby Electrical System). The main battery charger normally powers the hot battery bus and maintains the main battery fully charged.

The APU battery is connected directly to the APU battery bus and provides dedicated power to the APU electric starter, which is used when sufficient bleed air duct pressure is unavailable for the APU air turbine starter. The APU battery charger normally powers the APU battery bus and maintains the APU battery fully charged.

DC and Flight Control Electrical Systems Schematic



Flight Control DC Electrical System

The flight control DC electrical system is a dedicated power source for the primary flight control system.

Primary power for the flight control DC electrical system comes from permanent magnet generators (PMGs) housed within each backup generator. Variable frequency PMG AC power is used by individual power supply assemblies (PSAs) to provide DC power to the three flight control DC busses.

To ensure a high level of system reliability, each PSA also has multiple DC power sources. If primary PMG AC power is not available, secondary power for the left and right PSAs is provided by the related main DC bus. Secondary power for the center PSA is provided by the captain's flight instrument bus. The hot battery bus provides additional backup power for the left and center PSAs only.

Each PSA also uses a dedicated battery to prevent power interruptions to the related flight control DC bus. The batteries have limited capacity and are incorporated to supply power for brief periods during PSA power source transfers.

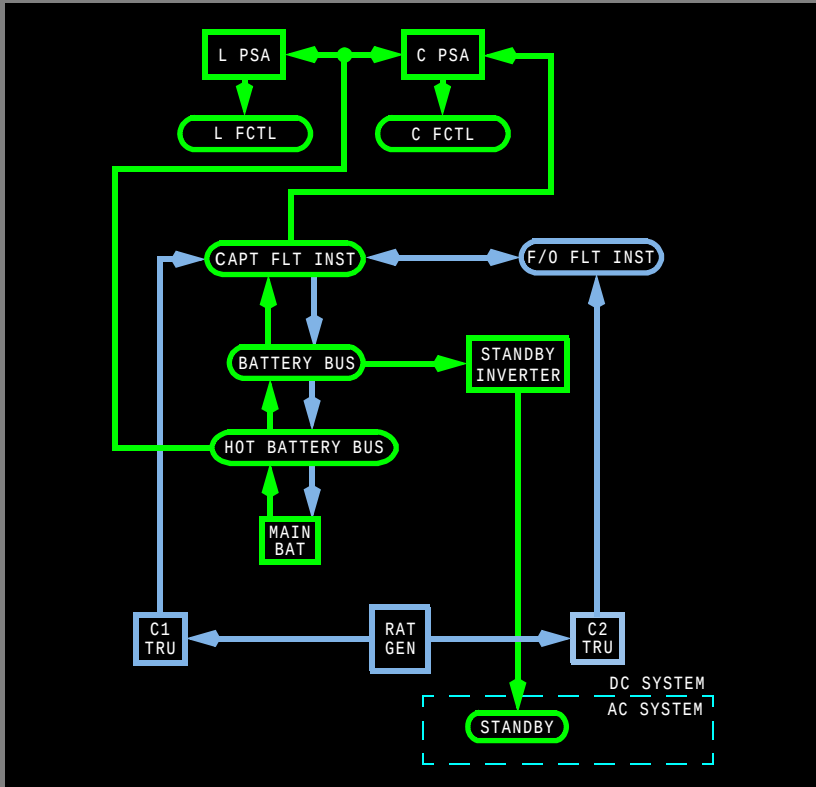
Standby Electrical System

The standby electrical system can supply AC and DC power to selected flight instruments, communications and navigation systems, and the flight control system, if there are primary electrical power system failures.

The standby electrical system consists of:

- the main battery
- the standby inverter
- the RAT generator and its associated generator control unit
- the C1 and C2 TRUs.

Standby Electrical System Schematic



Main Battery

The main battery provides standby power to the following:

- hot battery bus
- battery bus
- captain's flight instrument bus
- left and center flight control PSAs
- standby inverter.

Standby Inverter

The standby inverter converts DC power to AC power. The inverter powers the AC standby bus if the left transfer bus is not powered.

Ram Air Turbine (RAT) Generator

The RAT generator provides standby power to the C1 and C2 TRUs. The RAT generator has no operating time limits, and operates at all airspeeds and altitudes.

The RAT can supply electrical and hydraulic power simultaneously. If the RAT is unable to maintain RPM, the RAT generator electrical load is shed until RPM is satisfactory. Power for standby electrical loads is provided by the main battery during deployment of the RAT and when RAT generator loads are shed.

The RAT is deployed automatically if both AC transfer busses lose power in flight. The RAT can be manually deployed by pushing the RAM AIR TURBINE switch on the overhead panel.

RAT deployment and operation are described in Chapter 13, Hydraulics.

Cabin Systems and Utility Power

Electrical power to various cabin and utility systems can be controlled from the flight deck.

IFE and Passenger Seats

The IFE/PASS SEATS Power switch controls power to the IFE and passenger seats. Pushing the switch OFF removes power from the following:

- IFE (all components)
- passenger seats (including seat motor power, personal computer power outlets, and telephones)

Cabin and Utility Systems

The CABIN/UTILITY Power switch controls power to various cabin and utility systems. Pushing the switch OFF removes power from items such as:

- ground service bus (except main and APU battery chargers, and left forward fuel pump)
- utility busses
- galleys
- gasper fan
- fluorescent cabin lighting
- beacon, logo, and wing lights

Additionally, when the CABIN/UTILITY power switch is selected OFF, the following cabin lights are turned on:

- night and supplemental night lights
- reading lights
- attendant work lights
- some galley/crew rest lights.

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Electrical EICAS Messages

Chapter 6 Section 30

Electrical EICAS Alert Messages

Message	Level	Aural	Message Logic
ELEC AC BUS L, R	Caution	Beeper	AC bus is unpowered.
ELEC BACKUP GEN L, R	Advisory		Backup generator has failed.
ELEC BACKUP SYS	Advisory		Backup power system has failed.
ELEC BATTERY OFF	Advisory		Battery switch is OFF.
ELEC BUS ISLN L, R	Advisory		Bus tie breaker is open due to an AC electrical system fault or Bus Tie switch is OFF.
ELEC CABIN/UTIL OFF	Advisory		Cabin/utility power switch is OFF.
ELEC GEN DRIVE L, R	Advisory		Generator drive oil pressure is low.
ELEC GEN OFF APU	Advisory		APU generator control breaker is open.
ELEC GEN OFF L, R	Advisory		Generator control breaker is open.
ELEC GNDHDLG BUS	Advisory		Ground handling bus relay has failed.
ELEC IFE/SEATS OFF	Advisory		In-Flight Entertainment System/Passenger Seats Power switch is OFF.
ELEC STANDBY SYS	Advisory		A fault is detected in the standby power system.
MAIN BATTERY DISCH	Advisory		Main battery is discharging or hot battery bus is unpowered. The main battery can power the standby system for a minimum of 10 minutes.

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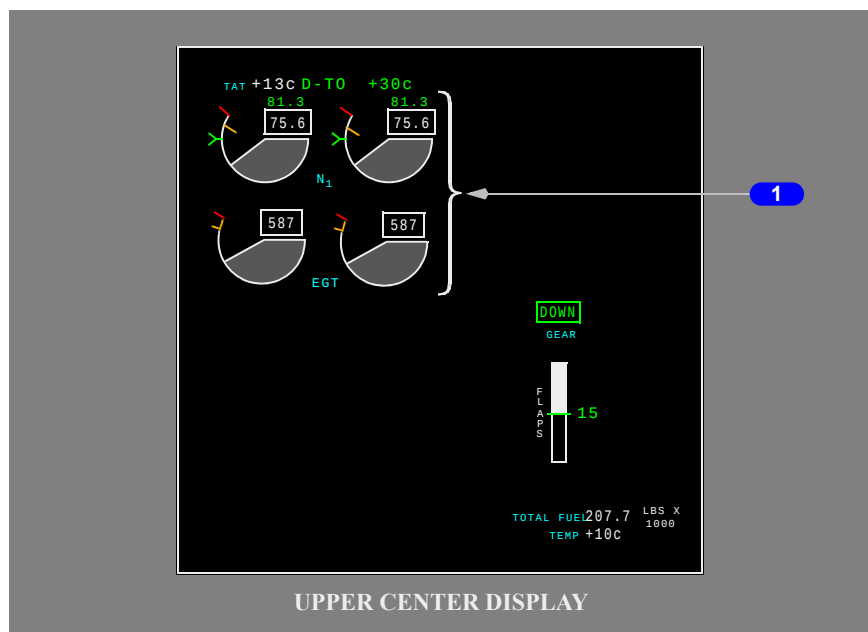
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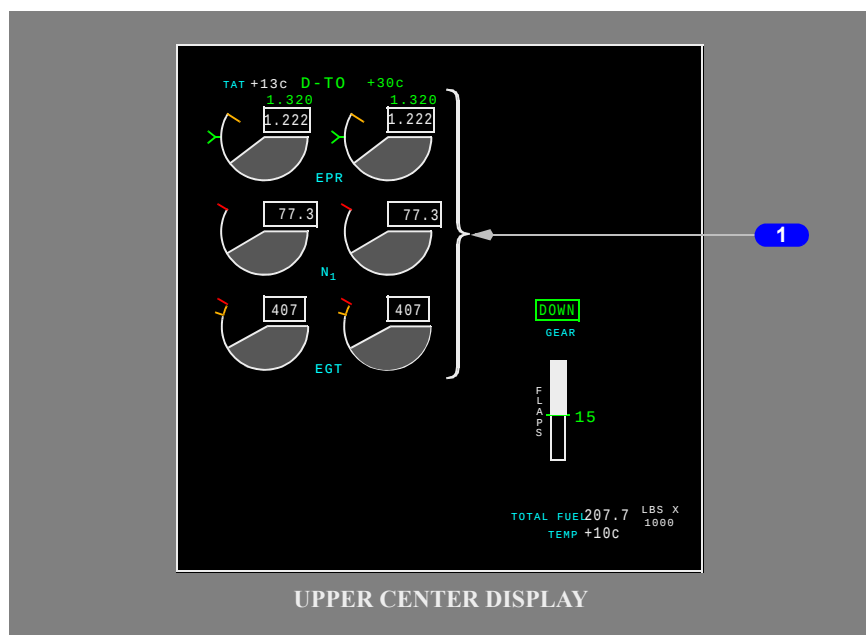
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EICAS Display [AFM]

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1 Primary Engine Indications

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Displayed full time on the EICAS display:

- N1
- EGT.

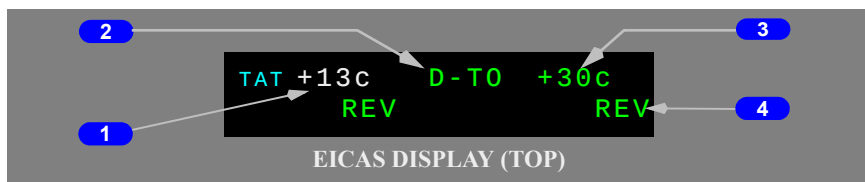
1 Primary Engine Indications

7001 - 7008

Displayed full time on the EICAS display:

- EPR
- N1
- EGT.

Mode Indications



1 Total Air Temperature (TAT)

Displayed (white) – TAT (degrees C).

2 Thrust Reference Mode

Displayed (green) – selected FMS thrust reference mode:

- TO – maximum rated takeoff thrust
- TO 1 – derate one takeoff thrust
- TO 2 – derate two takeoff thrust
- D-TO – assumed temperature derated takeoff thrust
- D-TO 1 – derate one assumed temperature derated takeoff thrust
- D-TO 2 – derate two assumed temperature derated takeoff thrust
- CLB – maximum rated climb thrust
- CLB 1 – derate one climb thrust
- CLB 2 – derate two climb thrust
- CON – maximum rated continuous thrust
- CRZ – maximum rated cruise thrust
- G/A – maximum go-around thrust.
- 7101 - 7110**
- TO B – provides additional takeoff thrust. Refer to the Airplane Flight Manual (AFM) for the performance limitations and data required to use this feature.
- 7101 - 7110**
- A-TO, A-TO 1, A-TO 2, A-TO B – APU-to-Pack or APU-to-Pack derated or APU-to-Pack takeoff bump thrust

3 Assumed Temperature

Displayed (green) – selected assumed temperature (degrees C) for reduced thrust takeoff.

4 Thrust Reverser Indication

Displayed REV (amber) – reverser in transit.

Displayed REV (green) – reverser fully deployed.

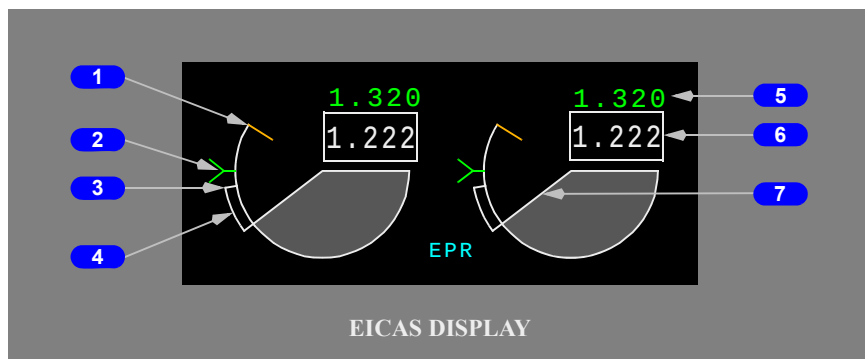
EPR Indications

7001 - 7008

Note: During tailwind conditions, slight EPR fluctuations may occur prior to 5 knots forward airspeed.

Note: When reverse thrust is activated, the following indications are not displayed:

- maximum EPR line
- commanded EPR
- reference/target EPR indication
- reference EPR.



1 Maximum EPR Line

Displayed (amber).

2 Reference/Target EPR indication

Displayed (green) – reference EPR limit.

Displayed magenta – target FMC commanded EPR when VNAV is engaged and:

- the autothrottle is engaged in THR or THR REF mode, or
- the autothrottle is not engaged.

3 Commanded EPR

Displayed (white).

4 Commanded EPR Sector

Displays momentary difference between engine EPR and EPR commanded by thrust lever position.

5 Reference EPR

Displayed (green).

6 Actual EPR

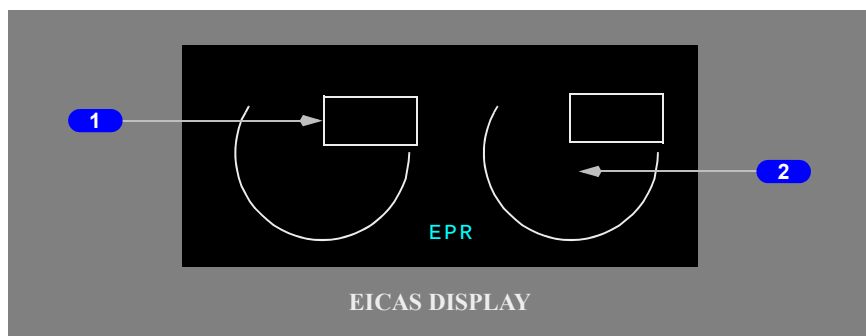
Displayed (white).

7 Actual EPR indication

Displayed (white).

EPR Indications (Alternate Mode)

7001 - 7008



1 Actual EPR

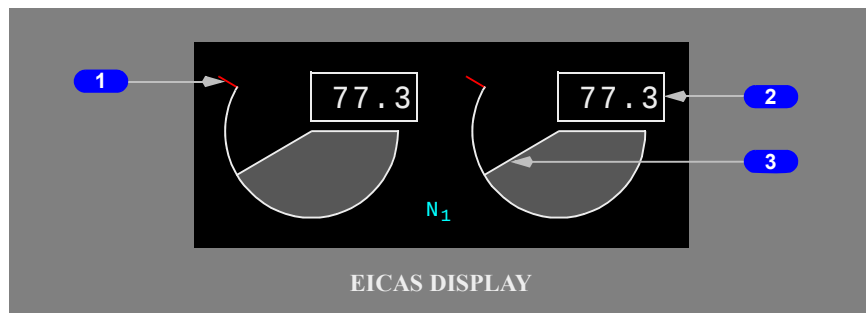
Displayed (blank).

2 Actual EPR Indication

Displayed (blank).

N1 Indications

7001 - 7008



1 N1 Red Line

Displayed (red) – N1 RPM operating limit.

2 N1

Digital N1 RPM (%), displayed:

- (white) – normal operating range
- displayed (red) – operating limit reached.

3 N1 Indication

N1 RPM, displayed:

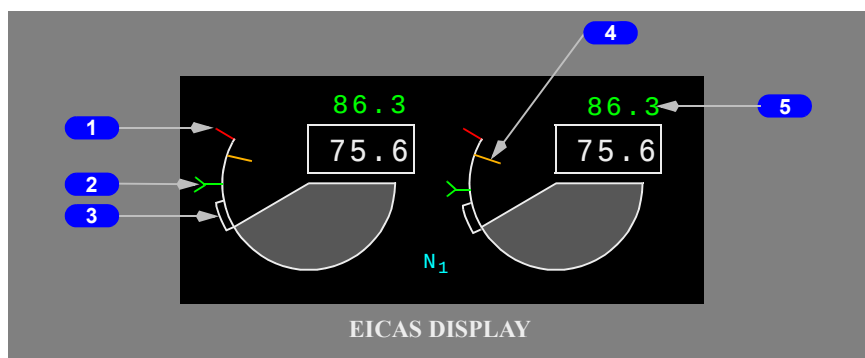
- (white) – normal operating range
- displayed (red) – operating limit reached.

N1 Indications (Hard Alternate Mode)

7001 - 7008

Note: When reverse thrust is activated, the following indications are not displayed:

- maximum N1 line
- commanded N1
- reference/target N1 indication
- reference N1.



1 N1 Red Line

Displayed (red).

2 Reference/Target N1 Indication

Displayed (green) – reference N1 limit.

Displayed (magenta) – target FMC commanded N1 when VNAV is engaged and:

- the autothrottle is engaged in THR or THR REF mode, or
- the autothrottle is not engaged.

3 Commanded N1 Sector

Displays momentary difference between engine N1 and N1 commanded by thrust lever position.

4 Maximum N1 Line

Displayed (amber).

5 Reference N1

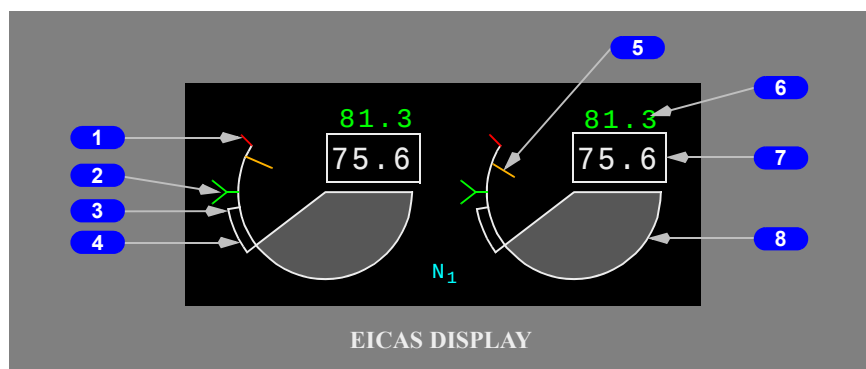
Displayed (green) – thrust reference calibrated for N1.

N1 Indications (All Modes)

7101 - 7110

Note: When reverse thrust is activated, the following indications are not displayed:

- maximum N1 line
- commanded N1
- reference/target N1 indication
- reference N1.



1 N1 Red Line

Displayed (red) – N1 RPM operating limit.

2 Reference/Target N1

Displayed (green) – reference N1 limit.

Displayed (magenta) – target FMC commanded N1 when VNAV is engaged and:

- the autothrottle is engaged in THR or THR REF mode, or
- the autothrottle is not engaged.

3 Commanded N1

Displayed (white).

4 Commanded N1 Sector

Displays momentary difference between engine N1 and N1 commanded by thrust lever position.

5 Maximum N1 Line

Displayed (amber).

6 Reference N1

Displayed (digital, green).

7 N1

Digital N1% RPM, displayed:

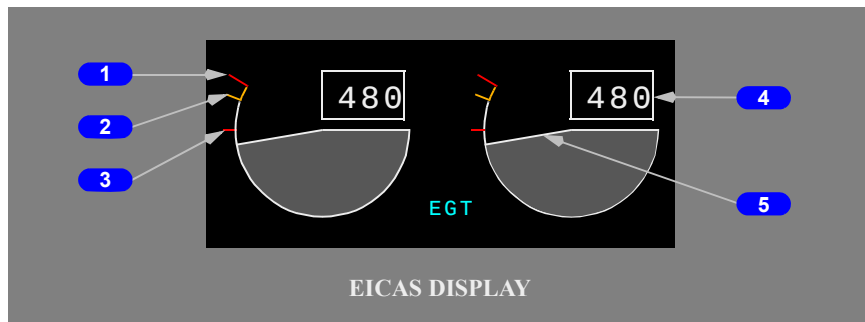
- (white) – normal operating range
- displayed (red) – operating limit reached.

8 N1 Indication

N1 RPM, displayed:

- (white) – normal operating range
- displayed (red) – operating limit reached.

EGT Indications



1 EGT Red Line

Displayed (red) – maximum takeoff EGT limit.

2 EGT Amber Band

Displayed (amber) – maximum continuous EGT limit.

3 EGT Start Limit Line

Displayed (red):

- with the FUEL CONTROL switch in CUTOFF, or
7101 - 7110
- with the N2 RPM below idle.
7001 - 7008
- with the N3 RPM below idle.

4 EGT

EGT (degrees C), displayed:

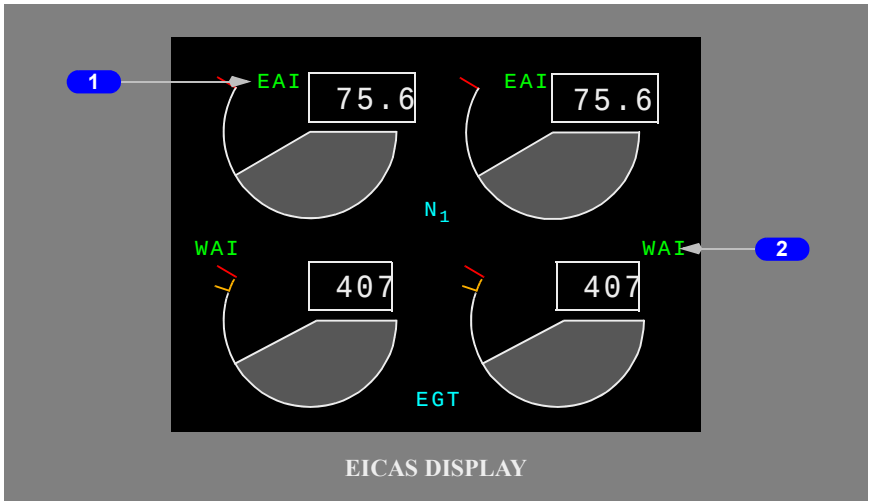
- (white) – normal operating range
- (amber) – maximum continuous limit reached
- (red) – maximum start or takeoff limit reached.

5 EGT Indication

Displayed:

- (white) – normal operating range
- (amber) – maximum continuous limit reached
- (red) – maximum start or takeoff limit reached.

Anti-Ice Indications



1 Engine Anti-ice Indication

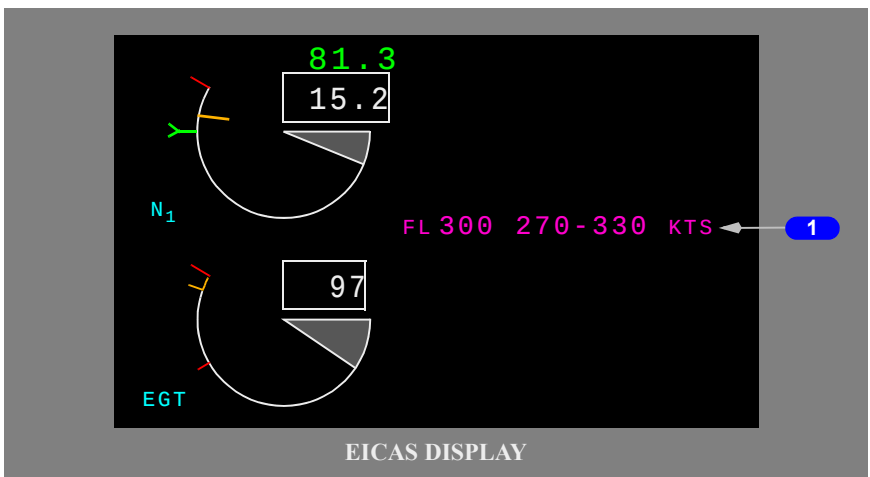
Displayed (green) – engine anti-ice is on.

2 Wing Anti-Ice Indication

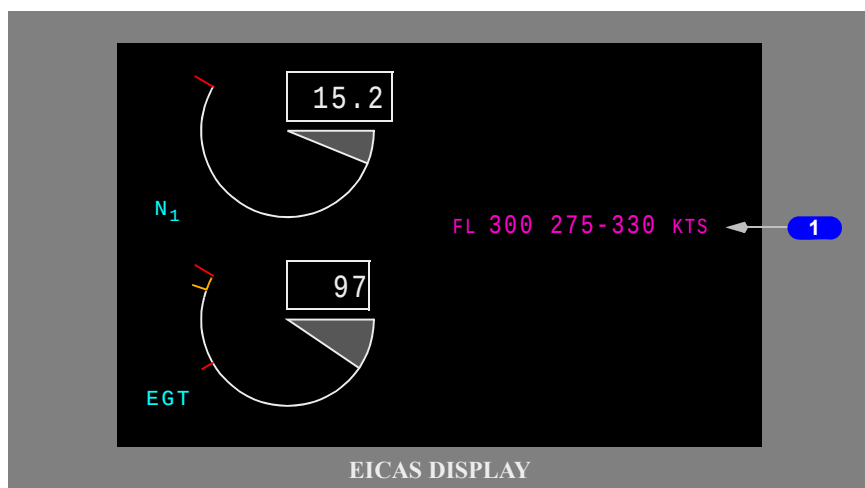
Displayed (green) – wing anti-ice is on.

In-Flight Start Envelope

7101 - 7110



7001 - 7008



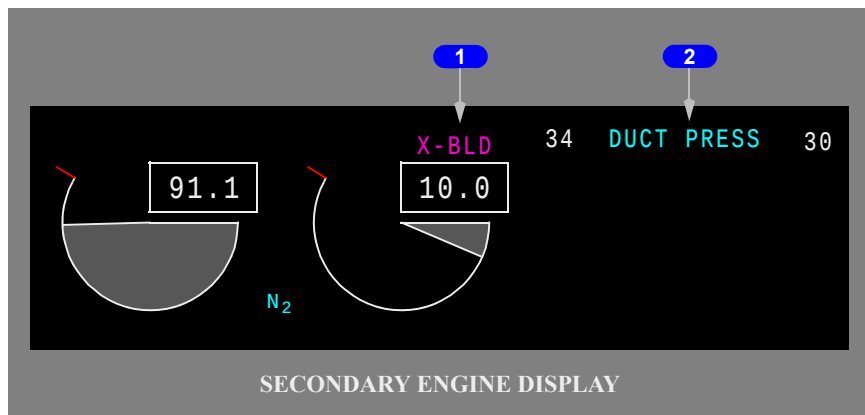
1 In-Flight Start Envelope

Displayed (magenta) – airspeed range for an in-flight start at the current flight level or maximum flight level (whichever is less) when the respective engine fire switch is in and:

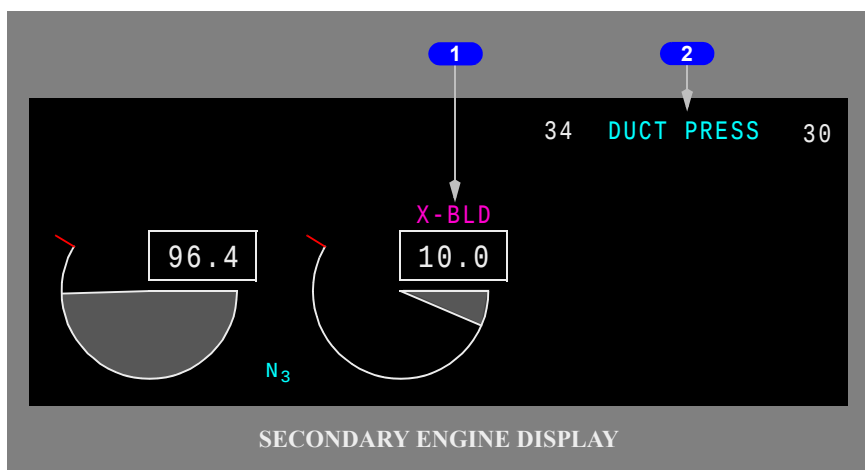
- a FUEL CONTROL switch is in CUTOFF, or
7101 - 7110
- engine N2 RPM is below idle.
7001 - 7008
- engine N3 RPM is below idle.

Crossbleed Start Indications

7101 - 7110



7001 - 7008



1 Crossbleed (X-BLD) Start Indication

Indicates crossbled air is recommended for an in-flight start.

Displayed (magenta):

- the in-flight start envelope is displayed, and
- airspeed is lower than that for a windmilling start.

2 DUCT Pressure (PRESS)

Displayed (white numbers) – pressure in the left and right bleed air ducts in psi when the respective engine fire switch is in and:

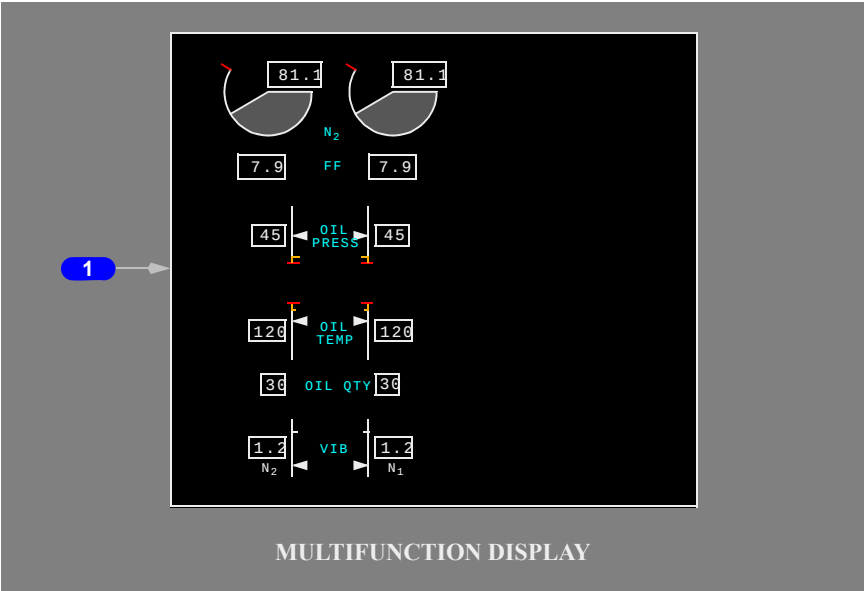
- a FUEL CONTROL switch is in CUTOFF, and
7101 - 7110
- engine N2 RPM is below idle.
7001 - 7008
- engine N3 RPM is below idle.

Secondary Engine Indications [AFM]

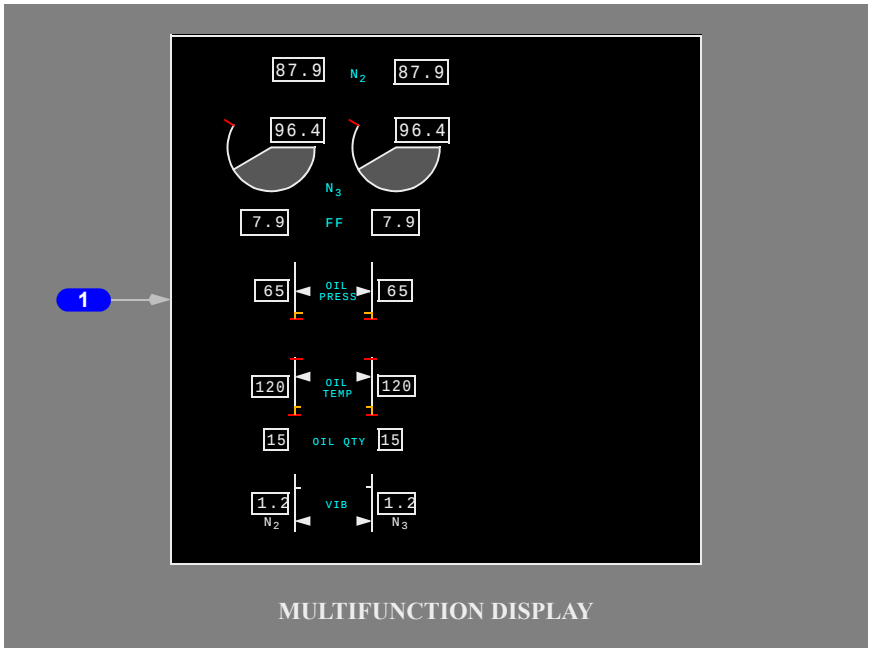
See Chapter 10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

Secondary Engine Display

7101 - 7110



7001 - 7008



1 Secondary Engine Display
7101 - 7110

Displays:

- N2 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration.

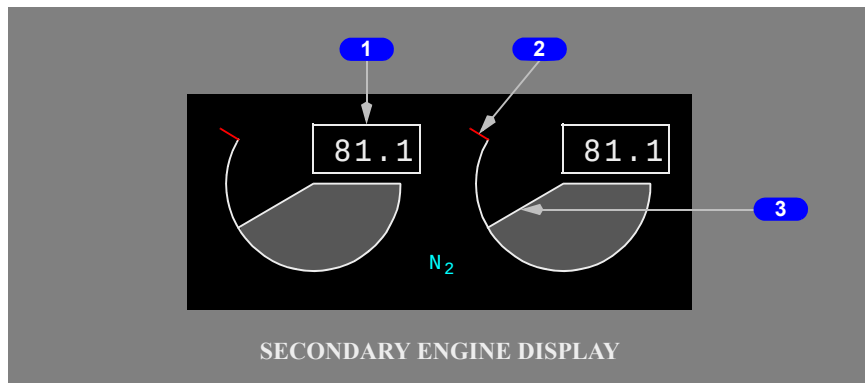
1 Secondary Engine Display
7001 - 7008

Displays:

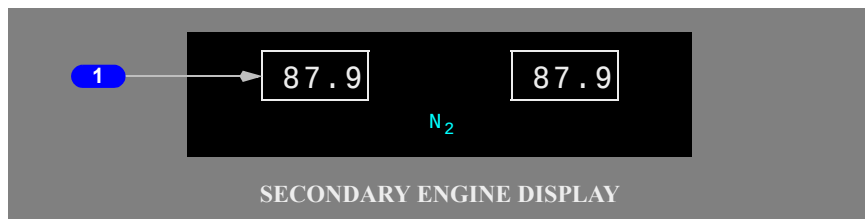
- N2 RPM
- N3 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration.

N2 Indications

7101 - 7110



7001 - 7008



1 N2

N2 RPM (%), displayed:

- (white) – normal operating range
- (red) – operating limit reached.

2 N2 Red Line

7101 - 7110

N2 RPM operating limit, displayed (red).

3 N2 Indication

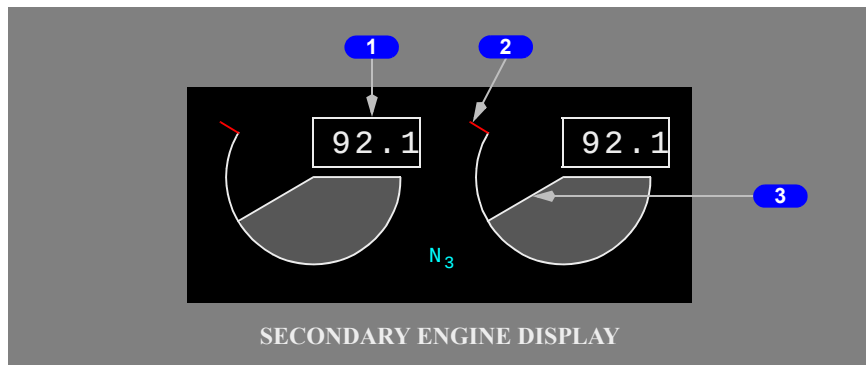
7101 - 7110

N2 RPM, displayed:

- (white) – normal operating range
- (red) – operating limit reached.

N3 Indications

7001 - 7008



1 N3

N3 RPM (%), displayed:

- (white) – normal operating range
- (red) – operating limit reached.

2 N3 Red Line

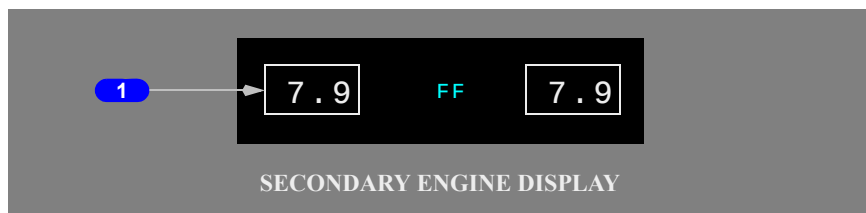
N3 RPM operating limit, displayed (red).

3 N3 Indication

N3 RPM, displayed:

- (white) – normal operating range
- (red) – operating limit reached.

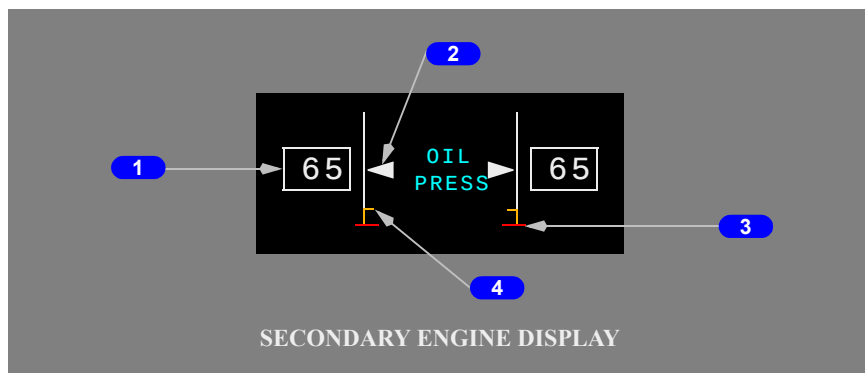
Fuel Flow Indications



1 Fuel Flow

Displayed (white) – fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications



1 Oil Pressure

Engine oil pressure (psi), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

2 Oil Pressure Pointer

Engine oil pressure, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

3 Oil Pressure Red Line

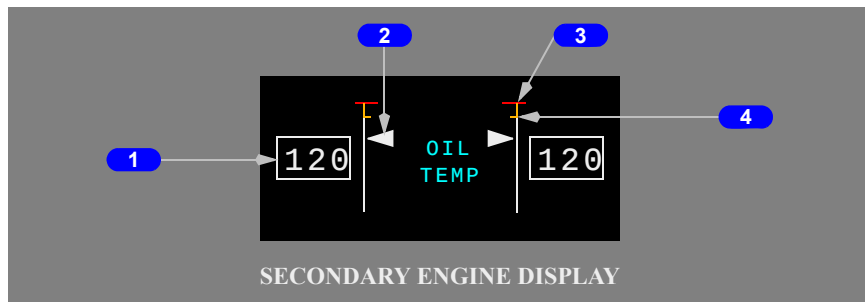
Displayed (red) – oil pressure operating limit.

4 Oil Pressure Amber Band

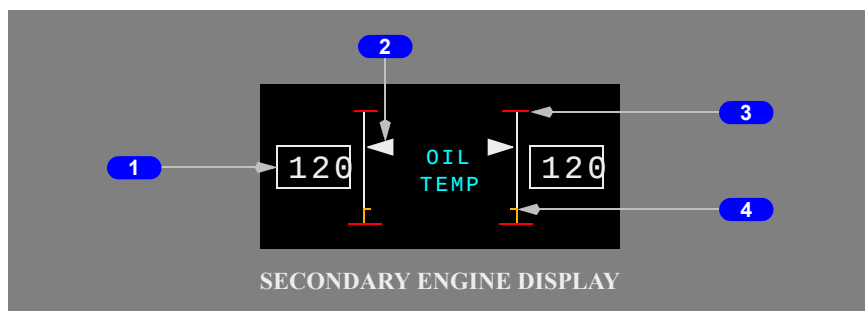
Displayed (amber) – oil pressure caution range.

Oil Temperature Indications

7101 - 7110



7001 - 7008



1 Oil Temperature

Engine oil temperature (degrees C), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

2 Oil Temperature Pointer

Engine oil temperature, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

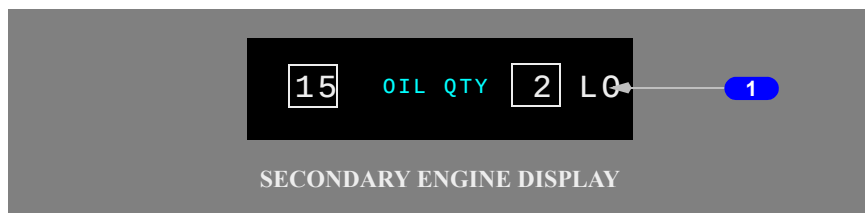
3 Oil Temperature Red Line

Displayed (red) – oil temperature operating limit.

4 Oil Temperature Amber Band

Displayed (amber) – oil temperature caution range.

Oil Quantity Indications



1 Oil Quantity

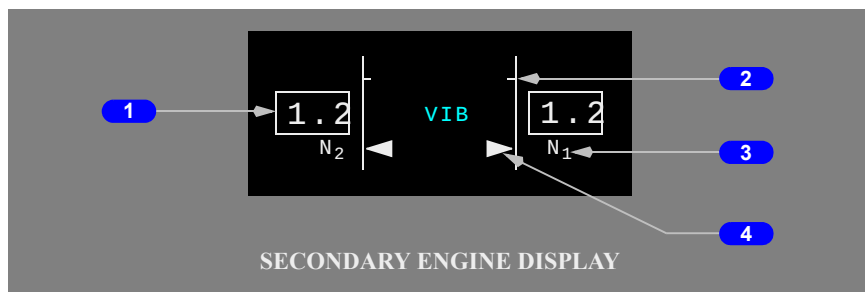
Usable oil quantity (quarts).

Displayed:

- (white) – normal quantity
- (reverses the display to show black numbers on white background) – low quantity.

Note: LO – displayed (white) when quantity is low.

Engine Vibration Indications



1 Engine Vibration

Engine vibration, displayed:

- (white) – normal operating range
- (black numbers, white background) – high vibration.

2 Engine Vibration High Band

Displayed (white) – vibration level at which automatic display of secondary engine indications occurs.

3 Vibration Source

Identifies the vibration source being displayed.

Displayed (white) – vibration source with the highest vibration:

- N1 rotor vibration
- N2 rotor vibration.
- 7001 - 7008
- N3 rotor vibration.

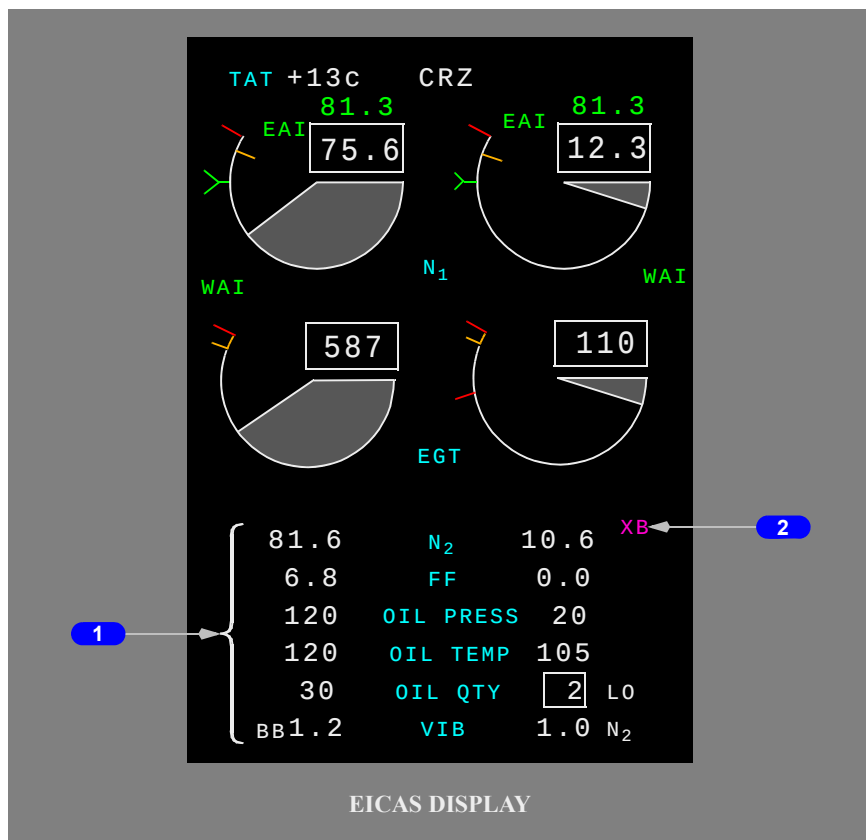
If the vibration source BB (broad band vibration) is displayed, the source is unknown and average vibration is displayed.

4 Engine Vibration Pointer

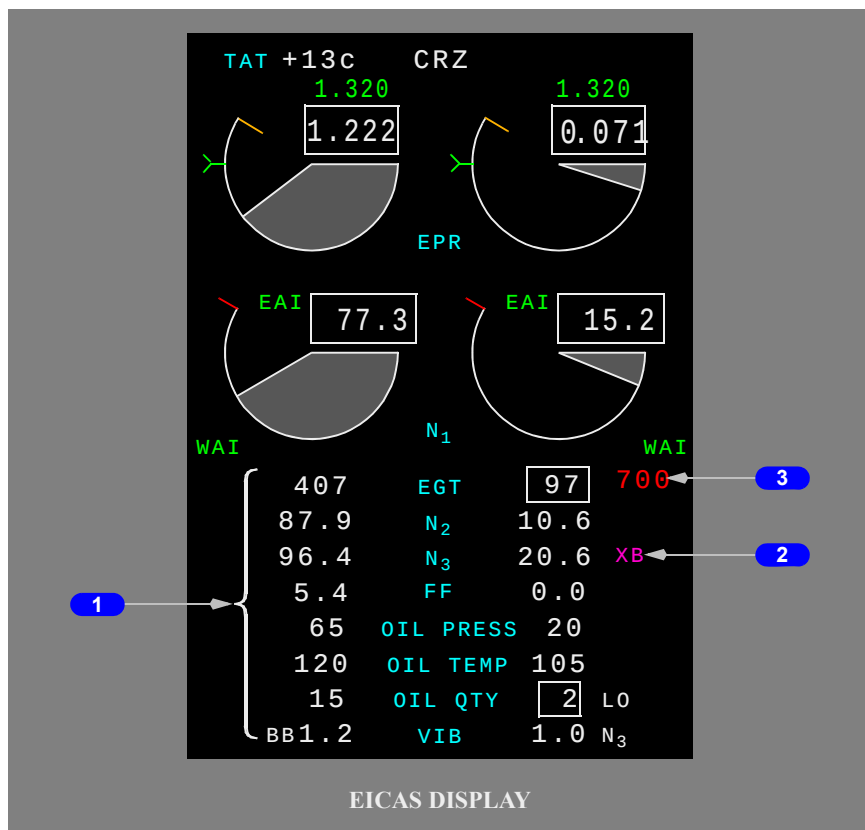
Displayed (white) – engine vibration.

Compact Engine Indications [AFM]

7101 - 7110



7001 - 7008



1 Compact Engine Indications

The following changes to EICAS and the normal secondary engine display occur:

7101 - 7110

- N2 changes from round dial displays to a digital display. The digital display is framed by an amber or red box if limits are exceeded.

7001 - 7008

- EGT and N3 change from round dial displays to digital displays. The digital displays are framed by an amber or red box if limits are exceeded.
(All)
- FF, OIL PRESS, OIL TEMP are displayed as digital readouts only. The digital displays turn amber or red if limits are exceeded.
(All)
- OIL QTY and VIB are displayed as digital readouts only. Low oil quantity and high vibrations are displayed the same as in the normal format.

2 Crossbleed (XB) Start Indication

Displayed (magenta).

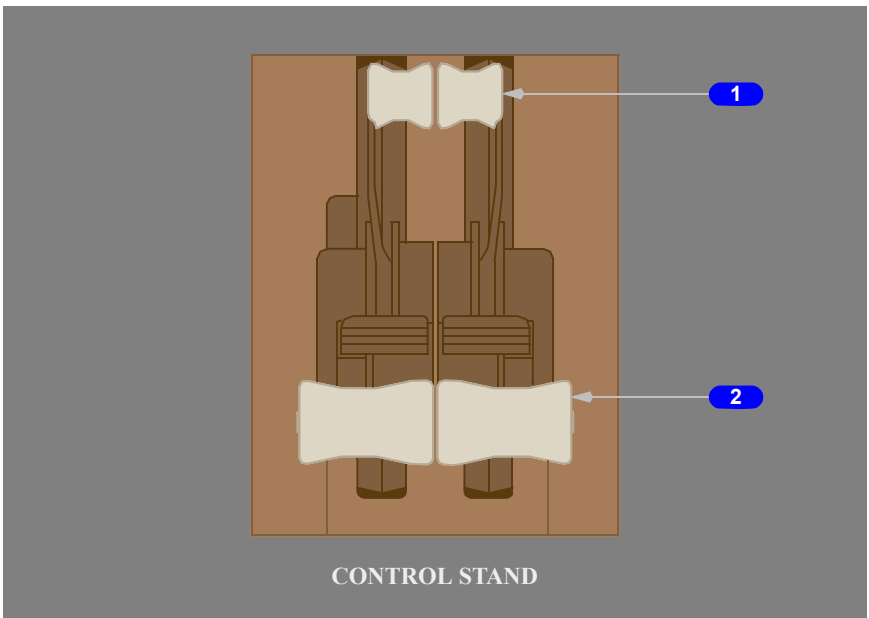
3 EGT start limit

7001 - 7008

Displayed (red).

Engine Controls

Thrust Levers



1 Reverse Thrust Levers

Control engine reverse thrust.

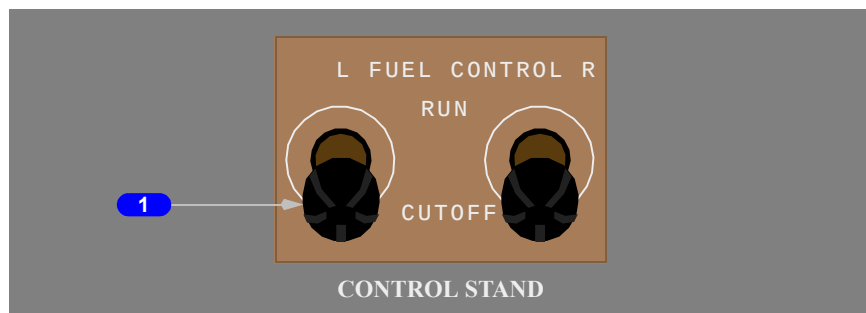
Reverse thrust can only be selected when the forward thrust levers are closed.
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Controls engine forward thrust.

The thrust levers can only be advanced if the reverse thrust levers are down.

Fuel Control Switches



1 FUEL CONTROL Switch

RUN (AUTOSTART ON) –

- Opens the spar fuel valve
- arms the engine fuel valve (the EEC opens the valve when required)
- arms the selected ignitors(s) (the EEC turns the ignitors on when required).

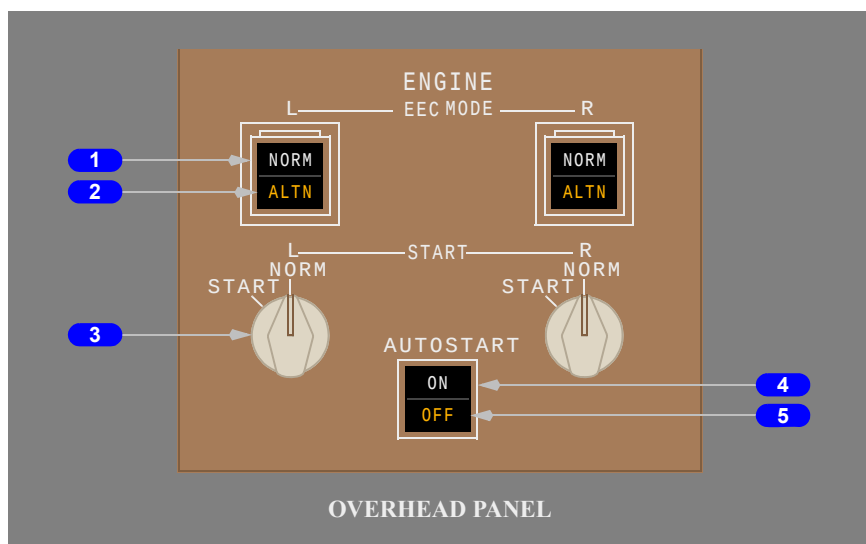
RUN (AUTOSTART OFF) –

- opens the spar fuel valve
- opens the engine fuel valve
- turns ignitors on.

CUTOFF –

- closes the fuel valves
- removes ignitor power
- unlocks the engine fire switch.

Engine Control Panel



1 Electronic Engine Control (EEC) Mode Switch

NORM –

- selects the normal engine control mode for engine control
7101 - 7110
- the EEC sets thrust using N1 RPM as the controlling parameter.
7001 - 7008
- the EEC sets thrust using EPR as the controlling parameter.

Off (ALTN visible) –

- selects the alternate engine control mode for engine control
- thrust is set using N1 RPM as the controlling parameter.

2 Electronic Engine Control (EEC) Alternate (ALTN) Light

Illuminated (amber) – the alternate engine control mode is either automatically or manually selected.

3 START Selector

START –

- initiates engine start by opening the start valve
- releases to NORM at start valve cutout.

NORM –

- the start valve closes
- ignition is automatically provided during engine start-up or if engine flameout occurs (if the FUEL CONTROL switch is in RUN).

4 AUTOSTART Switch

ON – arms the autostart system.

OFF –

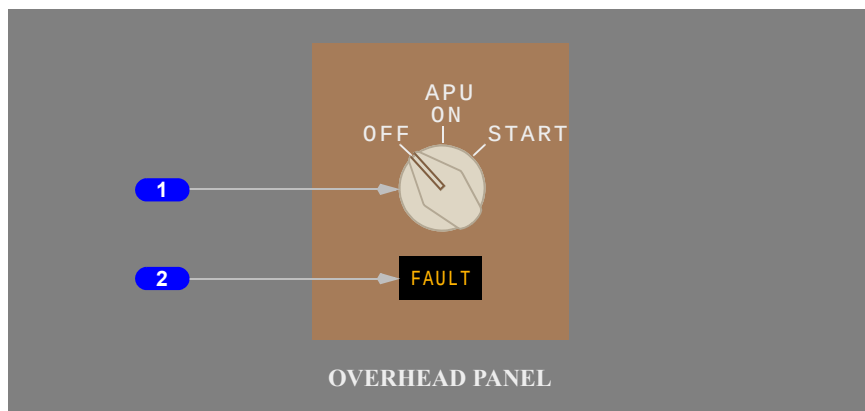
- the autostart system is disabled
- the start is manually controlled.

5 AUTOSTART OFF Light

Illuminated (amber) – the AUTOSTART switch is OFF.

Auxiliary Power Unit (APU)

APU Controls



1 APU Selector

OFF –

- closes the APU bleed air isolation valve
- initiates normal shutdown
- resets auto shutdown fault logic.

ON (APU operating position –

- opens the APU fuel valve and inlet door
- activates AC or DC fuel pump
- powers the APU controller.

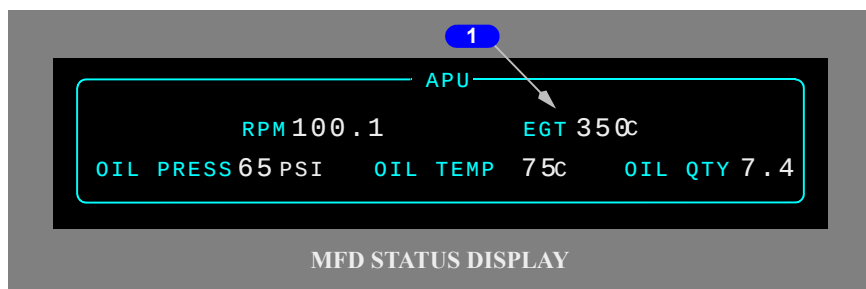
START (momentary position, spring-loaded to ON) – initiates automatic start sequence.

2 APU FAULT Light

Illuminated (amber):

- APU fault and/or fire is detected
- APU shutdown due to fault and/or fire
- momentarily during APU controller self-test.

APU Indications



1 APU Status Display

RPM – APU rotation speed in percent RPM.

EGT – APU exhaust gas temperature.

OIL PRESS – APU oil pressure in PSI.

OIL TEMP – APU oil temperature.

OIL QTY – APU oil quantity (quarts).

Intentionally
Blank

Engines, APU Engine System Description

Chapter 7 Section 20

Introduction

7101 - 7110

The airplane is powered by two General Electric Model GE90–110B1 engines. The engines are rated at approximately 110,760 pounds of takeoff thrust each.

7001 - 7008

The airplane is powered by two Rolls Royce Trent 895 engines. The engines are rated at approximately 92,940 pounds of takeoff thrust each.

7101 - 7110

The engines are dual rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of a fan, a low pressure compressor section, and a low pressure turbine section on a common shaft. The N2 rotor consists of a high pressure compressor section and a high pressure turbine section on a common shaft. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine accessory gearbox.

7001 - 7008

The engines are three-rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of the fan and a low pressure turbine section on a common shaft. The N2 rotor consists of an intermediate pressure compressor section and an intermediate pressure turbine section on a common shaft. The N3 rotor consists of a high pressure compressor section and a high pressure turbine section on common shaft. The N1, N2, and N3 rotors are mechanically independent. The N3 rotor drives the engine accessory gearbox.

Each engine is controlled by an electronic engine controller (EEC). The EECs monitor autothrottle and flight crew inputs through the thrust levers to automatically control the engines.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. See Chapter 11, Flight Management, Navigation, Section 32, for a description of FMC thrust management functions.

Engine indications are displayed on the engine indication and crew alerting system (EICAS) display.

Engine Intermix

7101 - 7110

Both engines are set to operate at the same thrust rating. Replacement engine thrust rating is increased or decreased to match the thrust rating of the installed engine configuration. An EGT amber band (maximum continuous limit) difference between engines may be indicated, but these indications are normal.

Takeoff Bump Thrust Reference Mode

7101 - 7110

Takeoff bump (when use is approved) can be selected on the CDU THRUST LIM page. When selected, TO B is displayed as the EICAS thrust reference mode.

Takeoff bump thrust is also available whenever the airplane is in the takeoff bump region (altitude and ambient temperature range). If the thrust levers are manually positioned full forward while in the takeoff bump region, the EECs will allow thrust to increase up to the takeoff bump rating even though another thrust limit is selected on the CDU THRUST LIM page.

Engine Indications

Primary and secondary engine indications are provided. Engine indications are displayed on the EICAS display and any selected multifunction display (MFD).

Primary Engine Indications

N1, (RR) EPR, and EGT are the primary engine indications. The primary engine indications are always displayed on the EICAS display. Normally the EICAS is on the upper center display unit. If that unit fails the EICAS display automatically moves to the lower center display unit.

Secondary Engine Indications

N2, (RR) N3, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are secondary engine indications. Secondary engine indications are displayed on the selected MFD. The secondary engine indications can be displayed by pushing the secondary engine display switch (the ENG switch on the display select panel). The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power
- a FUEL CONTROL switch is moved to CUTOFF in flight
- an engine fire switch is pulled in flight
- a secondary engine parameter is exceeded, or
- engine (GE) N2/(RR) N3 RPM is below idle in flight.

When the secondary engine parameters are automatically displayed (on the lower MFD, if available) due to any of the above conditions, they cannot be cleared until the condition is no longer present. Once the condition is no longer present, the secondary engine parameters can be cleared by pushing the secondary engine display switch.

Normal Display Format

Primary engine indications and the (GE) N2/(RR) N3 indications are both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and vibration indications are both digital readouts and vertical indication/moving pointers. Fuel flow, (RR) N2, and oil quantity are digital readouts only. All digital readouts are enclosed by boxes. The dial and vertical indications display the normal operating range, caution range, and operating limits (as applicable).

Normal operating range is displayed on a dial or vertical indication in white.

The oil temperature and oil pressure vertical indication has caution ranges displayed by amber bands. If oil temperature or oil pressure reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber.

N1, (GE) N2/(RR) N3, EGT, oil pressure, and oil temperature indications have operating limits indicated by red lines. If one of these indications reaches the red line, the digital readout, box, and pointer change color to red for that indication.

The EGT indication has a maximum continuous limit represented by an amber band. The maximum continuous limit does not apply during takeoff or go-around. If EGT reaches the maximum continuous limit, the digital indication, box, pointer, and dial all change color to amber. EGT indications are inhibited from changing to amber during takeoff or go-around for five minutes. The EGT indication is often in the amber band during takeoff; this is acceptable. The inhibit is extended to ten minutes for single-engine operation. The EGT indication has a maximum takeoff limit displayed by a red line. If EGT reaches the maximum takeoff limit, the digital indication, box, pointer and dial, all change color to red.

If an N1, (GE) N2/(RR) N3, or EGT red line is exceeded, the box enclosing the digital readout remains red after the exceeded limit returns to the normal range. The red box color can be canceled to white or recalled to red by pushing the cancel/recall switch on the display select panel. An indication changes color back to white when it returns to the normal operating range.

For low oil quantity, the oil quantity digital readout changes to black text on a white background. The white text LO is displayed adjacent to the readout.

For high engine vibration, the vibration digital readout changes to black text on a white background.

7001 - 7008

The maximum EPR limit is indicated by an amber line at the top of the EPR dial. The EPR indication does not change color when maximum EPR is reached. The reference/target EPR indication displays the FMS reference or target EPR. The commanded EPR indication displays the EEC calculated EPR commanded by thrust lever position.

Compact Display Format

In compact format, primary and secondary engine indications are combined on the same display. The N1, and (RR) EPR/(GE) EGT indications are displayed as they are normally (moving pointer/round dial and digital indications). All other indications change to digital readouts only, with the exception that the (GE) N2 digital readout is boxed if a parameter is exceeded. If an amber or red line parameter for a digital indication is exceeded, the digital indication changes color to amber or red (as does the box that appears around an N2, (RR) N3, or (RR) EGT indication for a red line exceedance). If the N1, N2, N3, or EGT red line is exceeded, the red color of the box around the digital indication can be returned to white (if the exceeded parameter has returned to normal) by pushing the display select panel CANCEL/RECALL switch.

Primary and secondary engine indications are displayed on EICAS in compact format whenever:

- secondary engine display is automatically selected, and the lower multifunction display is failed, unpowered, or is occupied, or
- secondary engine display is manually selected to the lower center MFD and the lower MFD is failed, unpowered, or occupied with EICAS.

Electronic Engine Control (EEC)

7101 - 7110

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to automatically control forward thrust and reverse thrust. The EEC has two control modes: normal and alternate. In both normal and alternate modes, the EEC uses N1 RPM as the parameter for setting thrust.

7001 - 7008

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to automatically control forward thrust and reverse thrust. The EEC has two control modes: normal and alternate. In the normal mode, the EEC uses EPR as the parameter for setting thrust. In the alternate mode, the EEC uses N1 RPM as the controlling parameter.

EEC Normal Mode

7101 - 7110

In the normal mode, the EEC sets thrust by controlling N1 based on thrust lever position. N1 is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew.

7001 - 7008

In the normal mode, the EEC sets thrust by controlling EPR based on thrust lever position. EPR is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew.

7101 - 7110

Maximum N1 represents the maximum rated thrust available from the engine. The EEC continuously computes maximum N1.

7001 - 7008

Maximum EPR represents the maximum rated thrust available from the engine. The EEC continuously computes maximum EPR.

Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions.

EEC Alternate Mode

If the required signals are not available to operate in the normal mode, the EEC automatically uses the alternate mode. In the alternate mode, the EEC schedules N1 as a function of thrust lever position. The alternate mode provides soft and hard levels of control:

- **Soft** – When the EEC automatically switches an engine to the alternate mode and the EEC mode switch remains in NORM, the EEC is in the soft alternate mode (the switch position is NORM, the EEC mode is alternate). At a fixed thrust lever position, thrust does not change.
- **Hard** – When ALTN is manually selected on an EEC mode switch, that engine is switched to the hard alternate mode (the switch position is ALTN, the EEC mode is alternate). Reference and target N1, and maximum and commanded N1 values are displayed on the N1 indication during the hard alternate mode. Thrust may change to set the commanded N1 when ALTN is manually selected.

7001 - 7008

EEC mode switch – NORM EEC mode – Normal	EEC mode switch – NORM EEC mode – Soft Alternate	EEC mode switch – ALTN EEC mode – Hard Alternate
• EPR: actual, command, reference/target, maximum • N1: actual, red line.	• EPR: blank • N1: actual, red line.	• EPR: blank • N1: actual, command, reference/target, maximum, red line.

7101 - 7110

For the normal, soft alternate, and hard alternate modes, actual, command, reference/target, maximum, and red line N1 information is displayed.

Automatic reversion or manual selection to the alternate mode is indicated by the EICAS advisory message ENG EEC MODE (L, R) and illumination of the EEC ALTN light on the associated EEC mode switch. Selecting the alternate mode on both engines eliminates thrust lever stagger at equal thrust settings, or asymmetric thrust when the thrust levers are operated together.

The autothrottles remain engaged whenever the EEC automatically switches to the alternate mode. The alternate mode N1 reference/target values are computed by the FMC.

Note: Autothrottles remains engaged in the soft or hard alternate mode.

The alternate mode schedule (N1 schedule) provides equal or greater thrust than the normal mode for the same thrust lever position.

Thrust protection is not provided in the alternate mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions. The EICAS caution message ENG LIMIT PROT (L, R) is displayed if the thrust lever position commands an N1 greater than the maximum rated thrust (maximum N1).

7101 - 7110

N1 and N2 red line protection is provided in the alternate control mode.

7001 - 7008

N1, N2, and N3 red line protection is provided in the alternate control mode.

Overspeed Protection

7101 - 7110

The EEC also provides N1 and N2 red line overspeed protection. If N1 or N2 approaches overspeed, the EEC commands reduced fuel flow. The EICAS advisory message ENG RPM LIMITED (L or R) is provided when overspeed protection is provided.

7001 - 7008

The EEC also provides N1, N2, and N3 red line overspeed protection. If N1, N2, or N3 approaches overspeed, the EEC commands reduced fuel flow. The EICAS advisory message ENG RPM LIMITED (L or R) is provided when overspeed protection is provided.

If the EECs are in alternate mode, advancing the thrust levers full forward provides some overboost and should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent.

Engine Idle

7101 - 7110

The EEC selects minimum idle or approach idle. Minimum idle is a lower thrust than approach idle.

7001 - 7008

The EEC selects minimum idle, intermediate idle, or approach idle. Minimum idle is a lower thrust than approach idle or intermediate idle. Intermediate idle is selected when the landing gear lever DN.

Approach idle is selected in flight when:

- engine anti-icing is operating
- the flaps are commanded to 25 or greater
- one hydraulic system air-driven demand pump is inoperative, and the flaps are out of the UP position
- the opposite engine bleed air valve is closed

Approach idle decreases acceleration time for go-around. Approach idle is maintained until after touchdown, when minimum idle is selected.

Thrust Control Malfunction Protection

7001 - 7110

The EEC provides protection against an uncontrolled high thrust malfunction during ground operation. The EEC shuts down the affected engine when:

- airplane is on ground,
- thrust lever is at idle, and
- engine is above idle speed and not decelerating normally.

The EICAS caution message ENG FAIL (L or R) is displayed when the engine falls below idle speed.

Engine Start and Ignition System

The engines can be started using the autostart system or manually. Autostart is the normal starting mode. Selecting OFF on the AUTOSTART switch disables autostart and allows manual, pilot-monitored, starting.

Bleed air powers the starter motor, which is connected to the (GE) N2/(RR) N3 rotor. The starter air source is normally the APU, but air from ground carts or another running engine can be used.

The START selectors control the starter air valves. Ignition and fuel flow are controlled through the FUEL CONTROL switches.

7101 - 7110

At approximately idle N2 RPM, the EEC commands starter cutout, and the START selector releases to the NORM position.

7001 - 7008

The EEC monitors the start and commands starter cutout at 50 percent N3 RPM. The START selector releases to the NORM position.

A maximum start limit line (red) is displayed on the EGT indication when the FUEL CONTROL switch is moved to CUTOFF or engine (GE) N2/(RR) N3 RPM is below idle. It remains displayed after the FUEL CONTROL switch is moved to RUN until the engine is stabilized at idle. The EGT indication changes color to red if the EGT start limit is reached during starting.

Autostart

7101 - 7110

Autostart allows the EEC to control fuel and ignition. With the AUTOSTART switch ON, the autostart sequence is initiated by rotating the START selector to START and moving the FUEL CONTROL switch to RUN. For in-flight windmill starts the autostart sequence is initiated by moving the FUEL CONTROL switch to RUN.

The START selector opens the starter air valve to begin dry motoring the engine. Moving the FUEL CONTROL switch to RUN opens the spar fuel valve, but not the engine fuel valve. The proper sequencing of fuel and ignition is controlled by the autostart system. With the FUEL CONTROL switch positioned to RUN, the EEC opens engine fuel valve and energizes the igniter(s) at the appropriate N2 RPM.

During autostart, the EEC monitors EGT, N2 RPM, and other engine parameters until the engine reaches idle. During ground start, the autostart system monitors engine parameters and will abort the start for any of the following:

- hot start
- hung start
- no EGT rise
- compressor stall
- starter shaft failure
- no N1 rotation
- insufficient air pressure for starter operation
- start time exceeds the starter duty cycle timer.

Note: The autostart system does not monitor oil pressure and temperature.

If a hot start, hung start, no EGT rise, or compressor stall is detected, and N2 is less than starter cutout speed, the EEC turns off fuel and ignition and motors the engine for 6 or 30 seconds (depending on the detected condition) before making a second attempt. The second attempt uses both igniters. If the second attempt fails, a third attempt is made. If N2 is greater than starter cutout speed, the EEC turns off fuel and ignition, closes the starter air valve and allows the engine to spool down below 30 percent N2. It then reopens the starter air valve and motors the engine before re-introducing fuel and ignition for subsequent attempt(s).

On the ground, if all attempts fail, the EEC aborts the start. Fuel and ignition are shut off and the engine is motored to clear residual fuel. The starter air valve then closes and the START selector releases to the NORM position. The EICAS caution message ENG AUTOSTART (L or R) is displayed.

On the ground, autostart does not attempt a second or third start if there is no N1 rotation, insufficient air pressure, the starter shaft fails, the EGT exceeds the red line limit, or the start time exceeds the starter duty cycle. The EICAS caution message ENG AUTOSTART (L or R) is displayed.

Note: For in-flight starts, the autostart system temporarily discontinues the start if a preset EGT between the start and takeoff EGT redline limits is reached, or a hung start is detected. Autostart takes corrective action if some start problems are detected, but does not abort the start.

Whenever the AUTOSTART switch is selected OFF, the EICAS advisory message ENG AUTOSTART OFF is displayed and the AUTOSTART switch OFF light illuminates.

Autostart

7001 - 7008

Autostart allows the EEC to control fuel and ignition. With the AUTOSTART switch ON, the autostart sequence is initiated by rotating the START selector to START and moving the FUEL CONTROL switch to RUN. For in-flight windmill starts the autostart sequence is initiated by moving the FUEL CONTROL switch to RUN.

The START selector opens the starter air valve to begin dry motoring the engine. Moving the FUEL CONTROL switch to RUN opens the spar fuel valve, but not the engine fuel valve. The proper sequencing of fuel and ignition is controlled by the autostart system. With the FUEL CONTROL switch positioned to RUN, the EEC opens engine fuel valve and energizes the igniter(s) above the appropriate N2 and N3 RPM.

During autostart, the EEC monitors EGT, N3 RPM, and other engine parameters until idle N3 RPM is achieved. During ground start, the autostart system monitors engine parameters and will abort the start for any of the following:

- hot start
- hung start
- no EGT rise
- compressor stall
- starter shaft failure
- no N1 rotation
- insufficient air pressure for starter operation
- start time exceeds the starter duty cycle timer.

Note: The autostart system does not monitor oil pressure and temperature.

If a hot start, hung start, no EGT rise, or compressor is detected and N3 RPM is less than starter cutout speed, the EEC turns off fuel and ignition and motors the engine for 20 to 30 seconds (depending on the detected condition). Following motoring and after EGT falls below 100 degrees C, the EEC re-introduces fuel and ignition using both igniters. If the second attempt fails and N3 is less than starter cutout speed, the EEC turns off fuel and ignition and motors the engine for 30 seconds and until the EGT is below 100 degrees C. The starter air valve then closes and the START selector releases to the NORM position. The EICAS caution message ENG AUTOSTART (L or R) is displayed.

If no N1 rotation, low starter air pressure, starter shaft failed condition is detected, if the starter duty cycle timer expires, or the start is aborted above starter cutout speed, the EEC aborts the autostart sequence without motoring and will not make a second attempt. The starter air valve then closes and the START selector releases to the NORM position. The EICAS caution message ENG AUTOSTART (L or R) is displayed.

Note: For in-flight starts, the autostart system temporarily discontinues the start if the takeoff EGT redline limit is reached, or if a no light-off or a hung start is detected. If one of these conditions is detected, autostart will windmill the engine for 30 seconds before making another attempt. For starter assisted in-flight starts, autostart does not motor the engine with the starter between attempts. Instead, windmill motoring is used and the starter is re-engaged on the following start attempt. Autostart takes corrective action if some start problems are detected, but does not abort the start. During the second or subsequent start attempts autostart re-introduces fuel and ignition when the EGT falls below 200 degrees C.

Whenever the AUTOSTART switch is selected OFF, the EICAS advisory message ENG AUTOSTART OFF is displayed and the AUTOSTART switch OFF light illuminates.

Manual Start

The AUTOSTART switch must be OFF to accomplish a manual start. The start is accomplished in accordance with the Manual Engine Start procedure (refer to Chapter SNP.7). Ignition and fuel are provided as soon as the FUEL CONTROL switch is positioned to RUN. The start must be monitored until the engine stabilizes at idle.

7001 - 7008

For ground starts, the FUEL CONTROL switch should not be moved to RUN until EGT is below 100 degrees C.

In-Flight Start

In-flight start envelope information is displayed on the EICAS display when an engine is not running in flight [(GE) N2/(RR) N3 RPM below idle RPM] or when an engine is shut down in flight and the respective engine fire switch is not pulled. The in-flight start envelope indicates the airspeed range necessary to ensure an in-flight start at the current flight level. If the current flight level is above the maximum start altitude, the maximum start altitude and respective airspeed range are displayed.

Secondary engine indications are displayed automatically when a FUEL CONTROL switch is moved to CUTOFF in flight or if N2 RPM goes below idle RPM while in flight. A crossbleed start indication is displayed next to the (GE) N2/(RR) N3 indication if airspeed is below that recommended for a windmilling start.

Refer to Engine In-Flight Start, Chapter NNC.7 for the in-flight start procedure.

For in-flight starts, autostart makes continuous start attempts until the engine either starts or the pilot aborts the start attempt by positioning the FUEL CONTROL switch to CUTOFF (and positioning the start switch to NORM if it was a starter assisted attempt).

7001 - 7008

During a windmilling in-flight start, the EEC monitors engine parameters to provide the best fuel schedule to ensure the shortest possible start time.

Engine Ignition

Each engine has two ignitors. The EEC automatically selects the appropriate ignitor(s). The EEC alternates ignitors for successive engine ground starts. Dual ignitors are always used for in-flight starts.

Main AC power is the normal power source for ignition. Standby AC power provides a backup source.

Auto-Relight

7101 - 7110

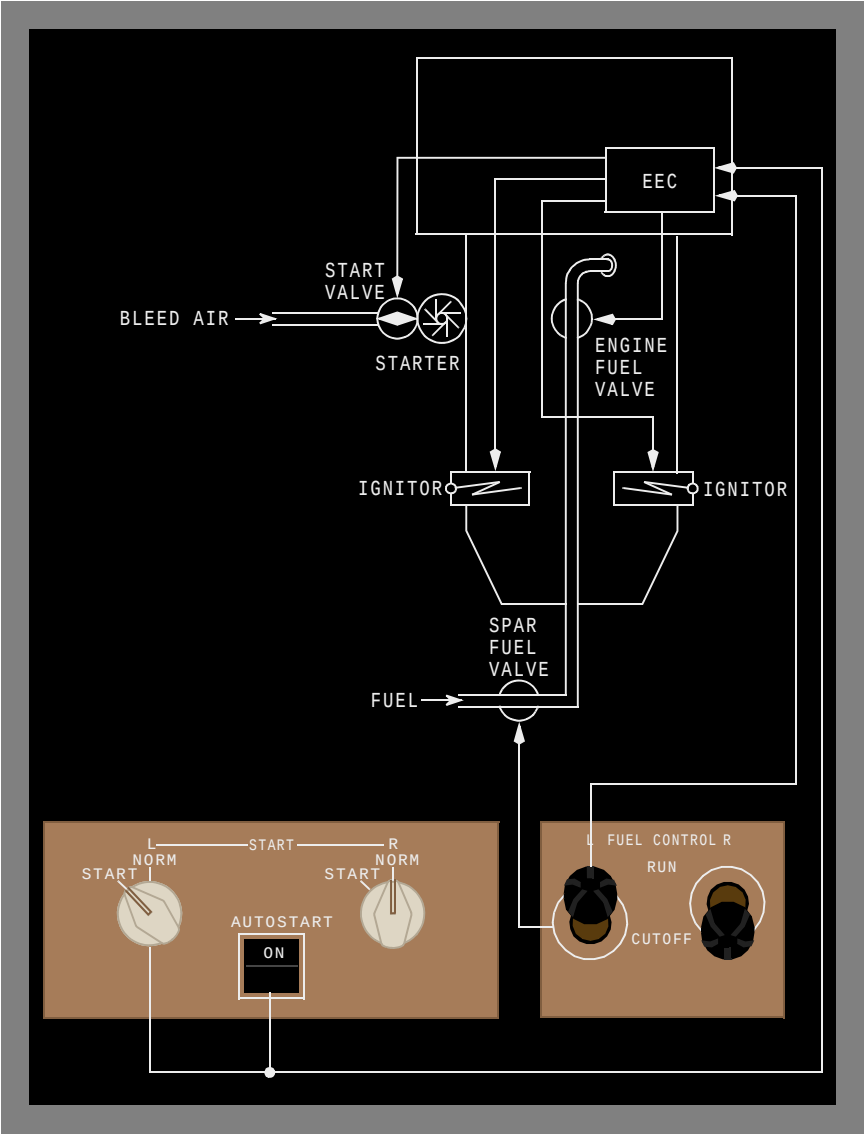
An auto-relight capability is provided for flameout protection and sub-idle stall recovery. If the EEC detects an engine flameout, both ignitors activate. A flameout is detected when a rapid decrease in N2 occurs, or N2 is less than idle RPM. If a sub-idle stall is detected, fuel is shut off for one second in an attempt to clear the stall. Relight attempts are discontinued if the EGT exceeds the red line limit.

7001 - 7008

There is no manual continuous ignition selection or automatic continuous ignition function. Engine flameout protection is provided for an auto–relight and rain/hail ingestion. The auto–relight function is activated whenever an engine is at or below idle with the FUEL CONTROL switch in RUN. When the EEC detects an engine flameout, the respective engine ignitors are activated. If the engine does not recover and continues to run down below 35% N3, the EEC shuts off fuel and ignition and disables the auto–relight function.

The EEC also provides protection against flameout during periods of excessive rain/hail ingestion. When a flameout is detected, the EEC energizes both ignitors.

Engine Start and Ignition System Schematic



Engine Fuel System

7101 - 7110

Fuel is supplied by fuel pumps located in the fuel tanks. The fuel flows through a spar fuel valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added. The second stage of the engine fuel pump adds more pressure. It flows through a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants. The fuel then reaches the fuel metering unit. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel then flows through the engine fuel valve into the engine.

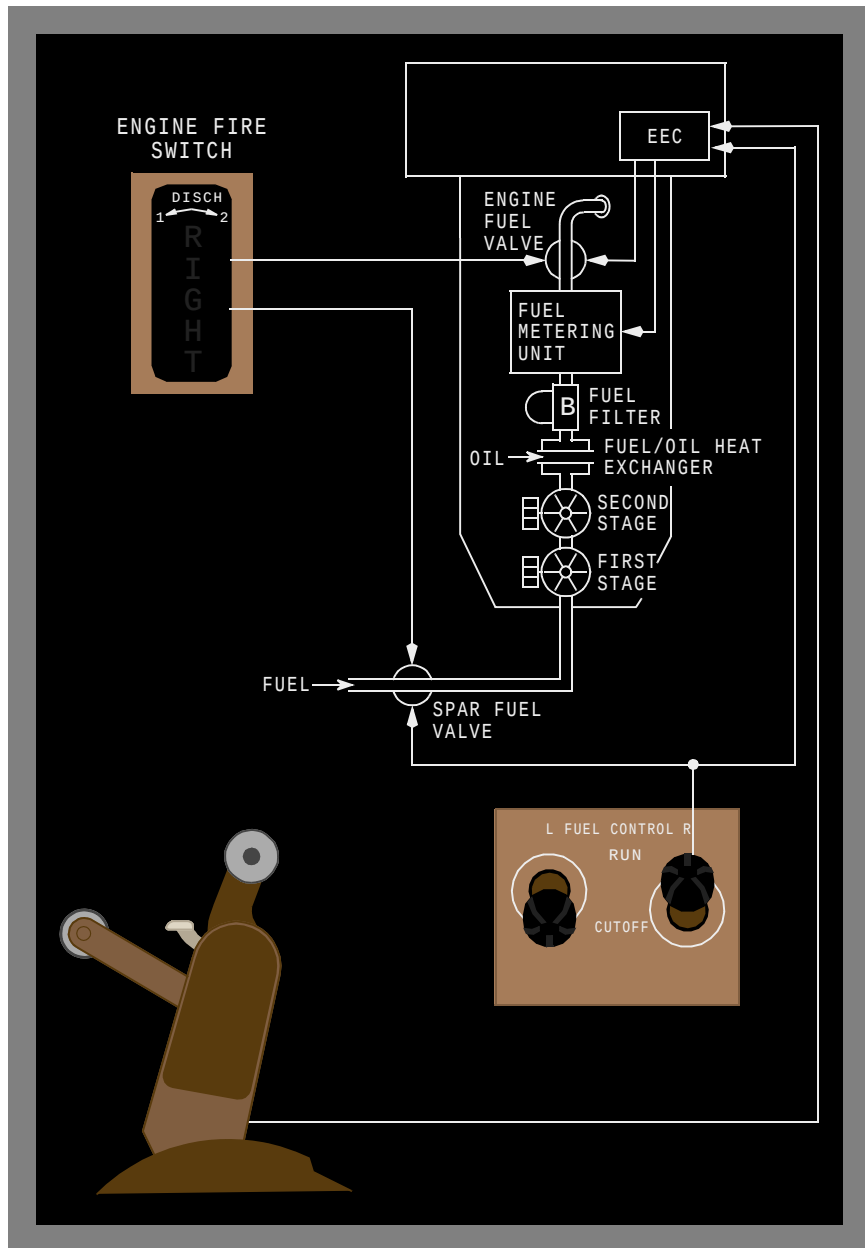
7001 - 7008

Fuel is supplied by fuel pumps located in the fuel tanks. The fuel flows through a spar fuel valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added. It flows through a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants. The second stage of the engine fuel pump adds more pressure before the fuel reaches the fuel metering unit. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel then flows through the engine fuel valve into the engine.

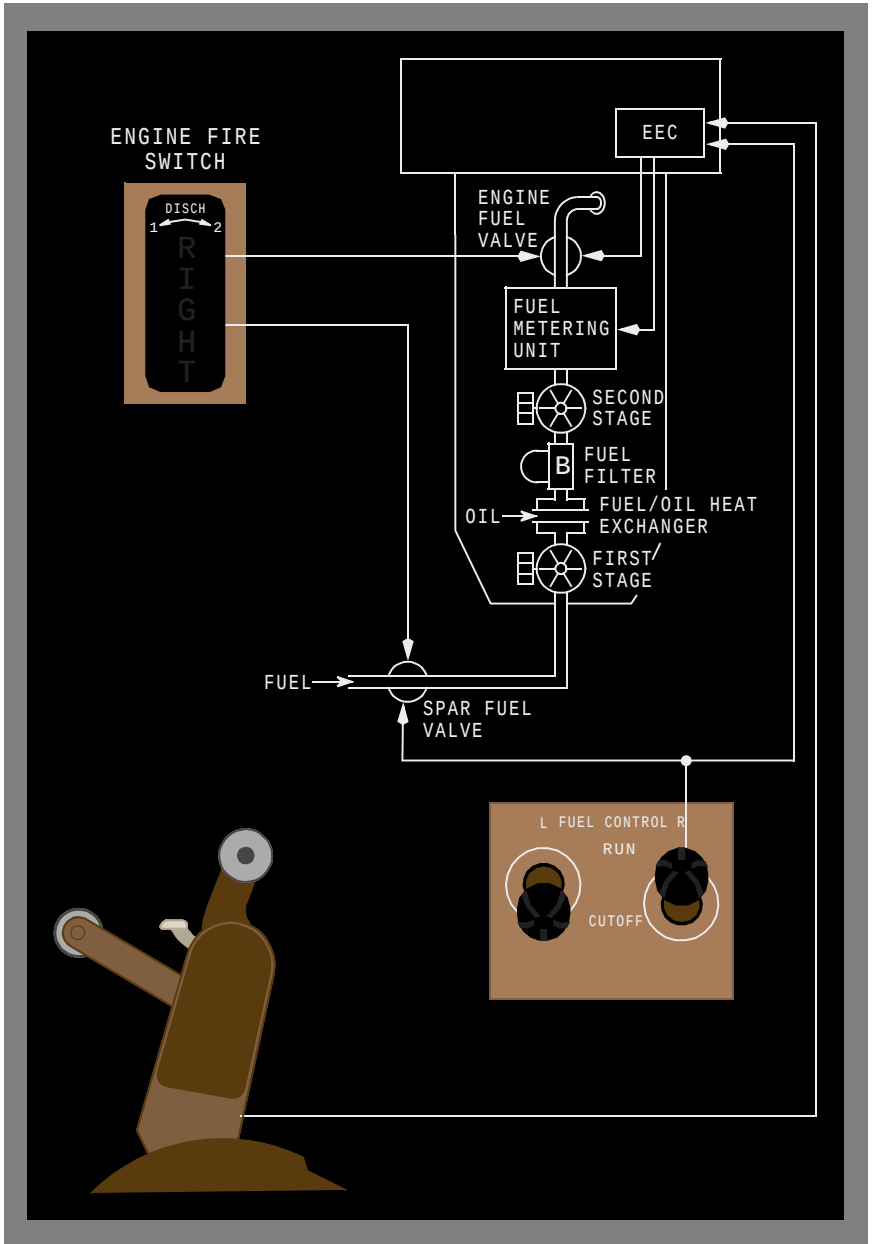
The spar and engine fuel valves allow fuel flow to the engine when both valves are open. The valves open when the engine fire switch is IN and the FUEL CONTROL switch is in RUN. Both valves close when either the FUEL CONTROL switch is in CUTOFF or the engine fire switch is OUT.

Fuel flow is measured after passing through the engine fuel valve. Fuel flow is displayed on the secondary engine display. Fuel flow information is also provided to the FMS.

7101- 7110



7001 - 7008



Engine Oil System

The oil system provides pressurized oil to lubricate and cool the engine main bearings, gears and accessory drives. The oil system also provides automatic fuel heating for fuel system icing protection.

7101 - 7110

Oil is pressurized by an engine-driven oil pump. From the pump, the oil flows through the oil filter. If the oil filter becomes clogged, then oil bypasses the oil filter and the EICAS advisory message ENG OIL FILTER (L, R) is displayed. The oil flows through the fuel/oil heat exchangers and then through the backup generator oil/oil heat exchanger, and is then delivered to the engine main bearings, gears, and accessory drives. A scavenge pump returns the oil to the reservoir.

7001 - 7008

Oil is pressurized by an engine-driven oil pump. From the pump, the oil flows through the high pressure oil filter. The oil flows through the air/oil heat exchanger, and fuel/oil heat exchangers and is then delivered to the engine main bearings, gears, and accessory drives. A scavenge pump returns the oil to the reservoir. Prior to the reservoir, the oil flows through a scavenge oil filter. If the scavenge oil filter becomes clogged, then oil bypasses the filter.

Oil pressure, temperature, and quantity are displayed on the secondary engine display.

7101 - 7110

Oil pressure and oil temperature are measured prior to entering the engine.

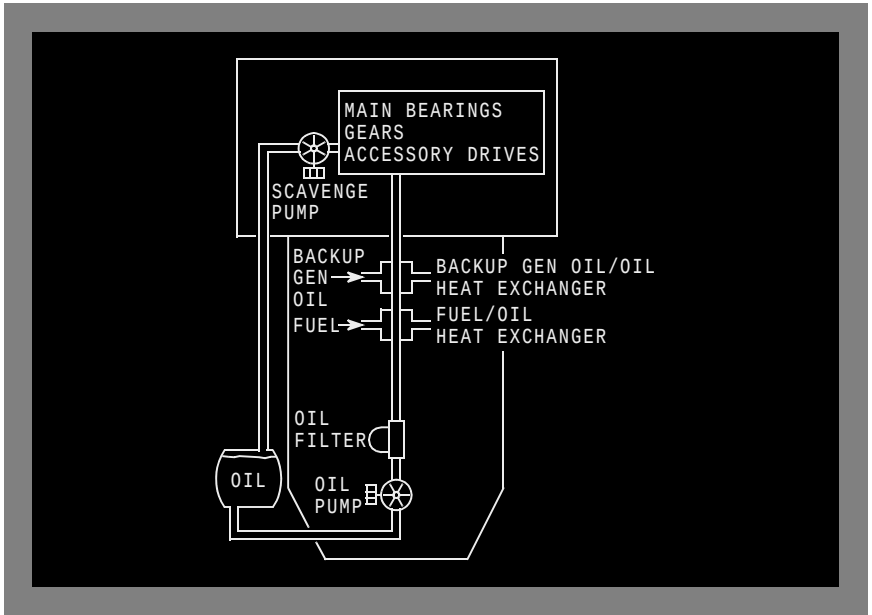
7001 - 7008

Oil pressure is measured prior to entering the engine. Oil temperature is measured after leaving the engine, prior to entering the reservoir.

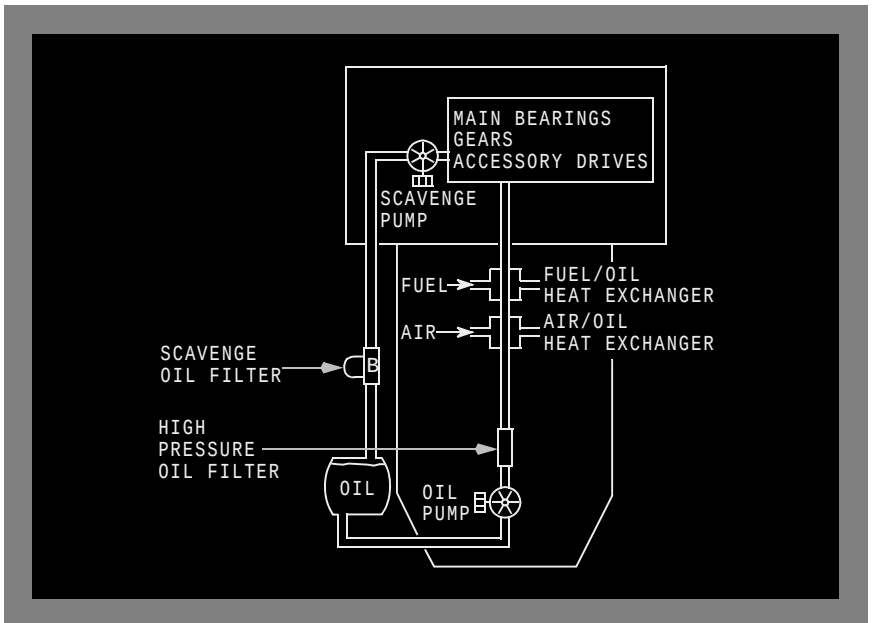
There is no minimum oil quantity limit (no amber or red line limit); however, a low oil quantity causes automatic display of the secondary engine display and reverses the display indication to show black numbers on a white background. There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based solely on a response to low oil quantity.

Engine Oil System Schematic

7101 - 7110



7001 - 7008



Thrust Reverser System

Each engine has an hydraulically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

The reverse thrust levers can be raised only when the forward thrust levers are in the idle position. When the reverse thrust levers are raised, the EEC opens the reverser isolation valve. The EEC inhibits reverser isolation valve actuation and reverser deployment unless the airplane is on the ground with the engine running. The EECs also control thrust limits during reverser operation.

When either reverse thrust levers are pulled aft to the interlock position:

- the autothrottle disengages
- the auto speedbrakes deploy.

When the reverser system is activated:

- the reverser translating sleeves hydraulically move aft
- the fan flow blocker doors rotate into place to direct fan air through stationary cascade guide vanes
- the reverser indication (REV) is displayed above each digital (GE) N1/(RR) EPR indication (REV is displayed in amber when the reverser is in transit).

When the interlock releases:

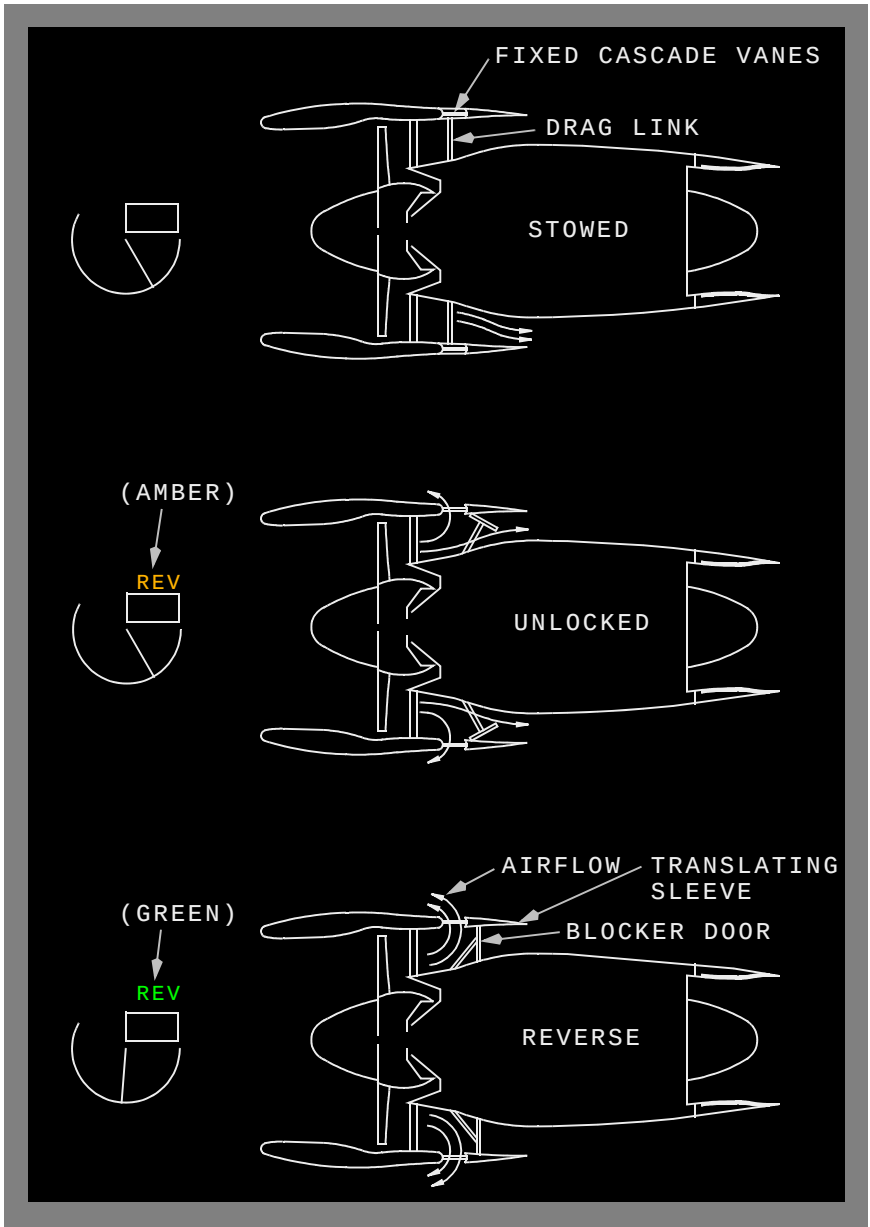
- the reverse thrust levers can be raised to the maximum reverse thrust position
- the REV indication changes to green when the reverser is fully deployed.

Pushing the reverse thrust levers to the full down position retracts the reversers to the stowed and locked position. The thrust levers cannot be moved forward until the reverse thrust levers are fully down.

The EICAS advisory message ENG REV LIMITED (L or R) is displayed if the reverser cannot deploy when commanded, or can deploy only with reverse thrust limited to idle. Not all conditions limiting or preventing reverse thrust can be detected before reverse thrust selection. For these conditions, the reverse thrust levers cannot be moved beyond the interlock position.

The EICAS advisory message ENG REVERSER (L or R) is displayed on the ground to indicate a reverser system fault.

Thrust Reverser Schematic



Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications are displayed on the secondary engine display. The vibration source indication is also displayed. If the vibration monitoring system cannot determine the source (N1, N2, or (RR) N3), broadband (BB) is displayed for the affected engine. Broadband vibration is the average vibration detected.

The airborne vibration monitoring system is primarily intended for engine condition monitoring, but it is also a useful tool for isolating and determining corrective action for engine anomalies. There is no certified vibration limit, but when a high vibration level is reached, the secondary engine parameters are automatically displayed. Since there are no operating limitations for the airborne vibration monitoring system, there are no specific flight crew actions (or procedures) based solely on vibration indication. High N1 vibration indication would most likely be accompanied by tactile vibration. This is not the case with high N2 or (RR) N3 vibration indication. N1, N2, and N3 high vibrations may be accompanied by anomalies in other engine parameters and will usually respond to thrust lever adjustment.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

Engine Failure Alert System

The engine failure alert system provides alerts when actual engine performance is less than commanded engine performance during a part of the takeoff and for other phases of flight.

A red ENG FAIL is displayed on the PFD if actual thrust is less than commanded thrust during takeoff with airspeed between 65 knots and 6 knots prior to V1. The PFD display is accompanied by the voice annunciation ENGINE FAIL and the Master WARNING lights illuminating.

The EICAS caution message ENG FAIL (L or R) is displayed if an engine unexpectedly decelerates to less than idle speed. The message remains displayed until the engine recovers or the fuel control switch is moved to CUTOFF.

The EICAS caution message ENG THRUST (L or R) is displayed if:

- actual thrust is significantly less than commanded thrust
- actual thrust is not increasing to commanded thrust, and
- airspeed is V1 or greater.

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Engines, APU

APU System Description

Chapter 7

Section 30

Introduction

The auxiliary power unit (APU) is a self-contained gas turbine engine located in the airplane tail cone.

The APU can be started and operated to the airplane maximum certified altitude.

The APU supplies bleed air and electrical power. Electrical power has priority over bleed air. Electrical power is available throughout the airplane operating envelope. Bleed air is available at or below 22,000 feet.

Refer to the following chapters for additional information:

- Chapter 2, Air Systems, for a description of APU bleed air operation
- Chapter 6, Electrical, for a description of APU electrical operation
- Chapter 8, Fire Protection, for a description of the APU fire protection system
- Chapter 12, Fuel, for a description of the APU fuel system.

APU Operation

APU Start

The APU is started either by an electric start motor or an air turbine starter.

The electric starter is powered by the APU battery. The main airplane battery powers the inlet door, fuel valve, and fire detection system.

The air turbine starter uses engine bleed air or ground cart air to start the APU.

Starter selection is automatic. The air turbine starter has priority over the electric start motor when there is sufficient bleed air duct pressure.

Rotating the APU selector to START begins the automatic start sequence.

APU fuel is supplied from the left fuel manifold by any operating AC fuel pump or the DC fuel pump. With AC power available and the APU selector in the ON position, the left forward fuel pump operates automatically.

If AC power is not available or no AC pump pressurizes the left fuel manifold, the DC pump in the left main tank provides APU fuel. On the ground, the APU can be started with no pumps operating.

When the APU air inlet door reaches the full open position the starter engages. After the APU reaches the proper speed, ignition and fuel are provided. When the APU reaches approximately 50 percent, the starter disengages and ignition is turned off.

If the start fails, the APU shuts down automatically. The EICAS message APU SHUTDOWN is displayed.

The APU's starter motors duty cycle for the electric starter motor and air turbine starter is 3 start attempts in 60 minute periods each.

APU Automatic Start

In flight, if both AC transfer busses lose power, the APU automatically starts, regardless of APU selector position. The APU can be shut down by positioning the selector to ON, then OFF.

APU Run

The EICAS memo message APU RUNNING is displayed when the APU is operating normally.

APU Shutdown

Rotating the APU selector to OFF begins the shutdown cycle by closing the APU bleed air valve. The APU continues running for a cooldown period. The EICAS memo message APU COOLDOWN is displayed during the cooldown period. When the cooldown period finishes, the APU shuts down.

APU Operating Modes

The APU has attended and unattended operating modes. The attended mode operates when either engine is running or starting, or when the airplane is in flight. The unattended mode operates at all other times on the ground.

APU Attended Mode

In the attended mode, any of the following faults cause the APU to shut down immediately:

- APU fire/inlet overtemperature
- overspeed/loss of overspeed protection
- APU controller failure
- speed droop.

There is no cool down period. The EICAS advisory message, APU SHUTDOWN, displays.

For the following faults, the APU continues to operate and the EICAS message APU LIMIT displays:

- high EGT
- high oil temperature
- low oil pressure.

There is no cooldown period when the APU is shut down after the APU LIMIT message is displayed.

APU Unattended Mode

In the unattended mode, any of the following faults cause the APU to shutdown immediately:

- APU fire/inlet overtemperature
- overspeed/loss of overspeed protection
- high EGT
- low oil pressure
- high oil temperature
- generator oil filter approaching bypass
- intake door failure
- APU controller failure
- speed droop
- no combustion on start
- no acceleration on start.

There is no cooldown period.

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Engines, APU EICAS Messages

Chapter 7 Section 40

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

APU

Message	Level	Aural	Message Logic
APU COOLDOWN	Memo		APU is in cool down mode.
APU LIMIT	Caution	Beeper	APU operation has exceeded a limit.
APU RUNNING	Memo		APU running, and not in cool down mode.
APU SHUTDOWN	Advisory		APU has automatically shut down.

Engine

Control

Message	Level	Aural	Message Logic
ENG CONTROL L, R	Advisory		Fault is detected in the affected engine control system.
ENG EEC MODE L, R	Advisory		Control for the affected engine is operating in alternate mode.
ENG FAIL L, R	Caution	Beeper	Engine speed is below idle.
ENG IDLE DISAGREE	Advisory		One engine is at approach idle and the other engine is at minimum idle.
ENG LIMIT PROT L, R	Caution	Beeper	Engine control is operating in the alternate mode and commanded N1 exceeds maximum N1.
ENG REV LIMITED L, R	Advisory		Engine thrust reverser will not deploy or reverse thrust will be limited to idle on landing.
ENG REVERSER L, R	Advisory		Fault is detected in the affected engine reverser system.

Message	Level	Aural	Message Logic

7101 - 7110

ENG RPM LIMITED L, R	Advisory		Engine control is limiting affected engine thrust to prevent N1 or N2 from exceeding the RPM operating limit.

7001 - 7008

ENG RPM LIMITED L, R	Advisory		Engine control is limiting affected engine thrust to prevent N1, N2, or N3 from exceeding the RPM operating limit.

ENG SHUTDOWN	Caution		Both engines were shutdown on the ground by the fuel control switches or fire switches.
ENG SHUTDOWN L, R	Caution		Engine was shutdown by the fuel control switch or fire switch.
ENG THRUST L, R	Caution	Beeper	Engine is not producing commanded thrust.

Start

Message	Level	Aural	Message Logic
ENG AUTOSTART L, R	Caution	Beeper	During a ground start, any of the following conditions occurs: • autostart did not start the engine • fuel control switch is in RUN at low engine RPM with the autostart switch off.
ENG AUTOSTART OFF	Advisory		Engine autostart switch is OFF.
ENG START VALVE L, R	Advisory		Engine start valve is not in commanded position.
ENG STARTER CUTOFF L, R	Caution	Beeper	Start selector remains in START or engine start valve is open when commanded close.

Fuel

Message	Level	Aural	Message Logic
ENG FUEL FILTER L, R	Advisory		An impending fuel filter bypass condition exists on the affected engine.
ENG FUEL VALVE L, R	Advisory		Engine fuel or spar valve position disagrees with commanded position.

Oil

Message	Level	Aural	Message Logic

7101 - 7110

ENG OIL FILTER L, R	Advisory		Affected engine oil filter contamination has caused filter bypass.
ENG OIL PRESS L, R	Caution	Beeper	Engine oil pressure is low.
ENG OIL TEMP L, R	Advisory		Engine oil temperature is high.

Intentionally
Blank

Fire Protection
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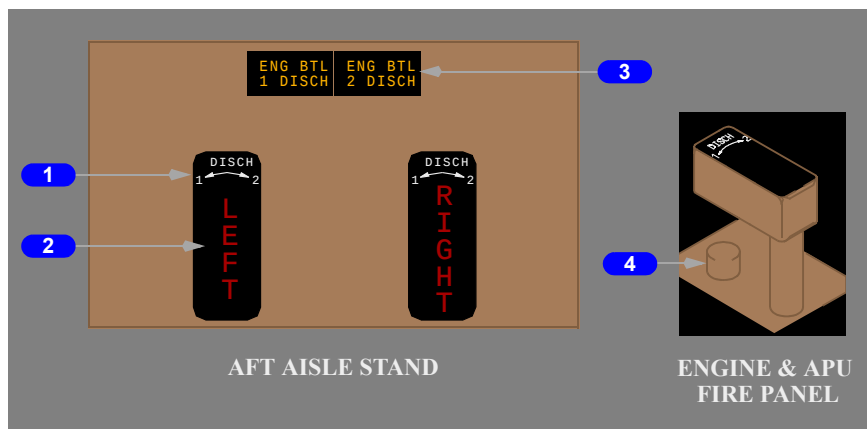
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Fire Protection Controls and Indicators

Chapter 8 Section 10

Engine Fire Protection

Engine Fire Panel



1 Engine Fire Switches

In (normal position, mechanically locked) – unlocks automatically for a fire warning, or when the FUEL CONTROL switch is in CUTOFF.

Out –

- arms both engine fire extinguisher bottles
- closes the associated engine and spar fuel valves
- closes the associated engine bleed air valves
- trips the associated engine generators off
- shuts off hydraulic fluid to the associated engine–driven hydraulic pump
- depressurizes the associated engine–driven hydraulic pump
- removes power to the respective thrust reverser isolation valve.

Rotate to position 1 or 2 – discharges the selected fire extinguisher into the engine.

2 Engine Fire Warning Lights

Illuminated (red) –

- an engine fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

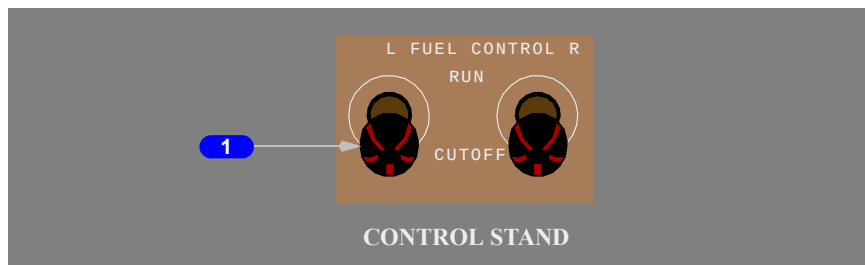
3 Engine Bottle Discharged (ENG BTL DISCH) Lights

Illuminated (amber) – the extinguisher bottle is discharged or has low pressure.

4 Engine and APU Fire Override Switches

Push – unlocks the fire switch.

Fuel Control Switches

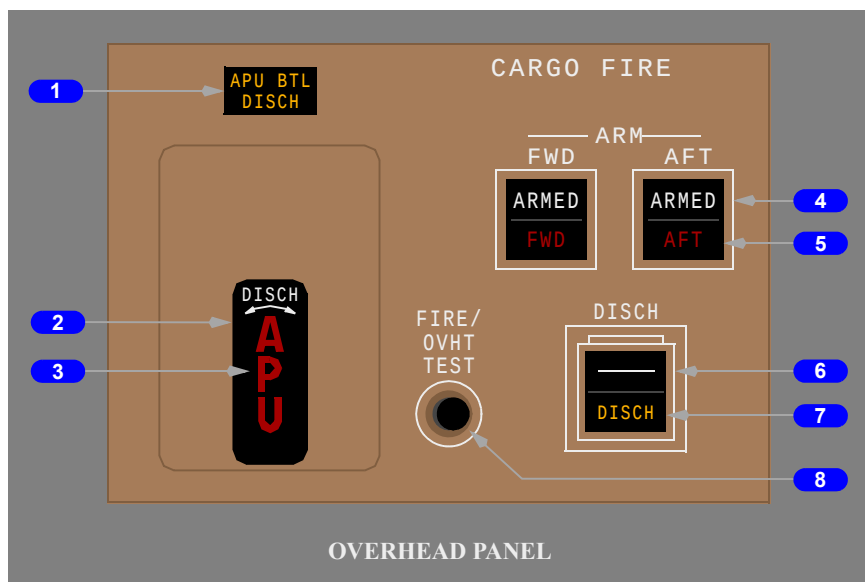


1 FUEL CONTROL Switch Fire Warning Lights

Illuminated (red) –

- an associated engine fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

APU and Cargo Fire Panel



1 APU Bottle Discharge (APU BTL DISCH) Light

Illuminated (amber) – the extinguisher bottle is discharged or has low pressure.

2 APU Fire Switch

In – normal position, mechanically locked; unlocks automatically for a fire warning.

Out –

- arms the APU fire extinguisher bottle
- closes the APU fuel valve
- closes the APU bleed air valve
- closes the APU air inlet door
- trips the APU generator field and generator breaker
- shuts down the APU (if automatic shutdown does not occur).

Rotate – either direction discharges the APU fire extinguisher into the APU compartment.

3 APU Fire Warning Light

Illuminated (red) –

- an APU fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

The APU automatically shuts down for a detected fire.

4 CARGO FIRE ARM Switches

ARMED –

- arms all cargo fire extinguisher bottles
- arms the selected compartment extinguisher valve
- turns off both lower recirculation fans
- commands the packs to provide the minimum air flow required to provide pressurization
- shuts down cargo heat to respective compartment
- shuts down In-Flight Entertainment (IFE) system
- shuts down the bulk cargo compartment ventilation system operation (aft cargo fire only)
- shuts down the lavatory/galley vent fan (aft cargo fire only)
- puts the equipment cooling system into the override mode (forward cargo fire only)
- shuts down Nitrogen Generation System

Off (blank) – normal position.

5 CARGO FIRE Warning Lights

Illuminated (red) – the FIRE/OVERHEAT TEST switch is pushed, or associated cargo compartment smoke is detected and aircraft systems are commanded to shut down –

- AFT or FWD illuminated –
 - both lower recirculation fans
 - lavatory/galley vent fans
 - cargo heat in respective compartment
- FWD illuminated –
 - equipment cooling system in the override mode

6 CARGO FIRE Discharge (DISCH) Switch

Push – discharges the fire extinguisher bottles into the ARMED cargo compartment.

Note: The bulk cargo compartment is included in the AFT cargo fire extinguishing system.

7 CARGO FIRE Discharge (DISCH) Light

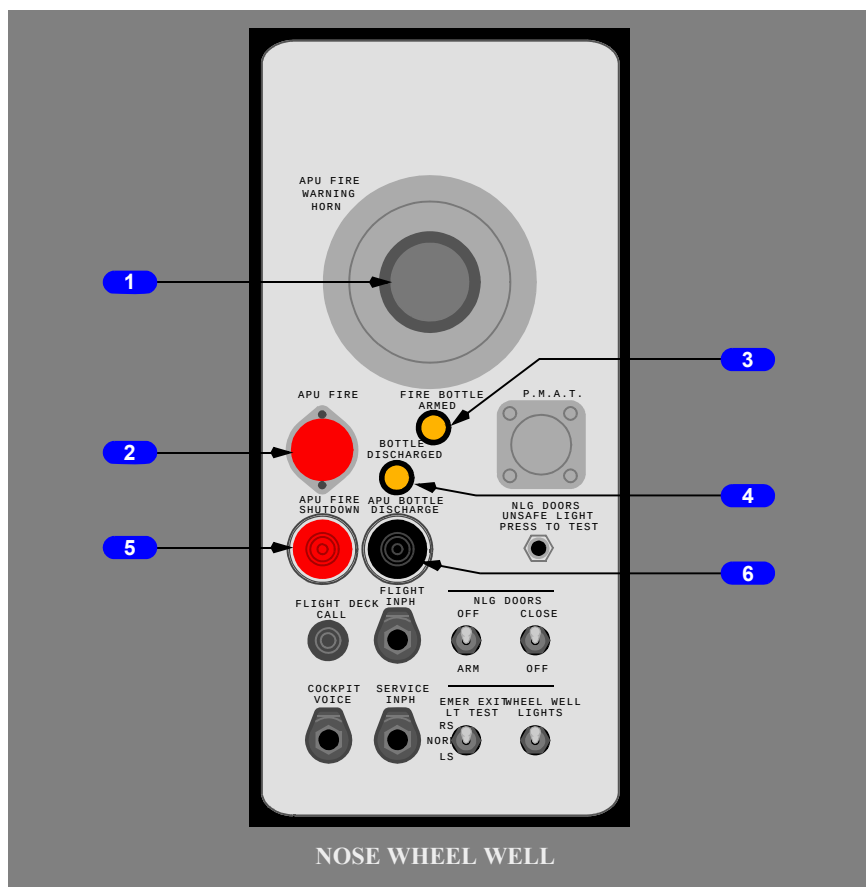
Illuminated (amber) – the fire extinguishers have discharged.

8 FIRE/OVERHEAT TEST Switch

Push and hold –

- sends fire/overheat test signals to the engine, APU, wheel well, and cargo compartment fire detector systems
- tests flight deck fire and overheat indications (see Fire and Overheat Detection System Manual Fault Test, Section 20).

APU Ground Control Fire Protection Panel



1 APU FIRE WARNING HORN

Sounds intermittently during ground operation for an APU fire or fire test.

2 APU FIRE Light

Illuminated (red) –

- an APU fire is detected, or
- a fire/overheat test is in progress.

The APU automatically shuts down for a detected fire.

3 APU FIRE BOTTLE ARMED Light

Illuminated (amber) – the APU fire extinguisher is armed.

4 APU BOTTLE DISCHARGED Light

Illuminated (amber) – the extinguisher bottle is discharged or pressure is low.

5 APU FIRE SHUTDOWN Switch

Push (red) –

- shuts down the APU
- arms the APU fire extinguisher.

6 APU BOTTLE DISCHARGE Switch

Push – discharges the APU fire extinguisher into the APU compartment.

Fire Protection System Description

Chapter 8 Section 20

Introduction

There are fire detection and extinguishing systems for the:

- APU
- cargo compartments
- engines
- lavatories.

The door 1 upper crew rest compartment has a fire detection system, but no fire extinguishing system.

7001 – 7008

The door 3 upper crew rest compartment has a fire detection system, but no fire extinguishing system.

7101 - 7110

The door 4 upper crew rest compartment has a fire detection system, but no fire extinguishing system.

The engines also have overheat detection systems.

The main gear wheel wells have a fire detection system, but no fire extinguishing system.

Refer to the following chapters for additional information:

- Chapter 2 – Air Systems, for descriptions of equipment smoke evacuation, and bleed duct leak and overheat detection.
- Chapter 3 – Anti-Ice, Rain, for a description of engine anti-ice system leak protection.

Engine Fire Protection

Engine fire protection consists of these systems:

- engine fire and overheat detection
- engine fire extinguishing.

Engine Fire and Overheat Detection

There are two detector loops in each engine nacelle. Each detector loop provides both fire and overheat detection. Normally, both loops must detect a fire or overheat condition to cause an engine fire warning or overheat caution.

If a fault is detected in one loop, the system automatically switches to single loop operation. If the operating loop senses a fire or overheat, the system provides the appropriate fire warning or overheat caution.

If there are faults in both detector loops in an engine nacelle, no fire or overheat detection is provided. The EICAS advisory message DET FIRE ENG (L or R) is displayed if the engine fire detection system fails.

Engine Fire Warning

The indications of an engine fire are:

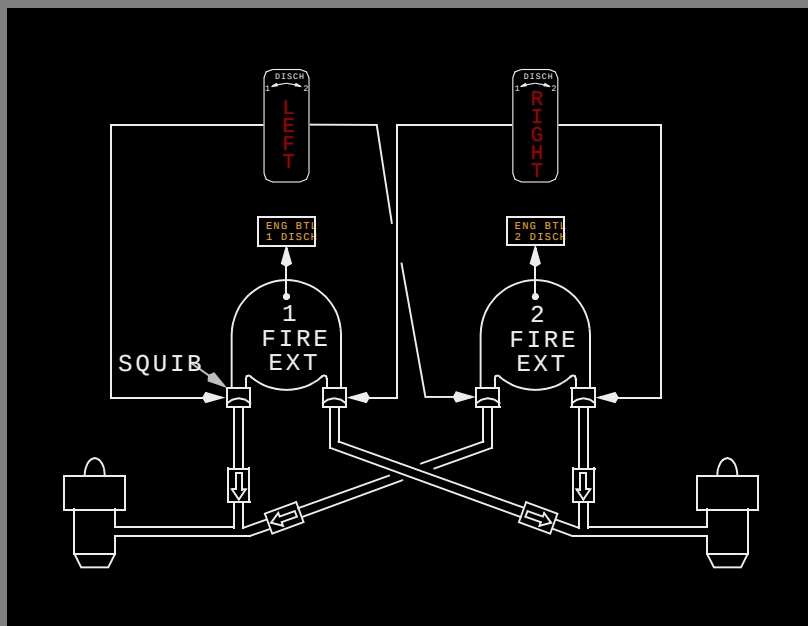
- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE ENG (L or R) is displayed
- the engine fire switch LEFT or RIGHT fire warning light illuminates
- the engine fire switch unlocks
- the engine FUEL CONTROL (L or R) switch fire warning light illuminates.

Engine Overheat Caution

The indications of an engine overheat are:

- the caution beeper sounds
- the master CAUTION lights illuminate
- the EICAS caution message OVERHEAT ENG (L or R) is displayed.

Engine Fire Extinguishing



ENGINE FIRE EXTINGUISHING DIAGRAM

There are two engine fire extinguisher bottles. Either or both bottles can be discharged into either engine.

When the engine fire switch is pulled out, rotating the fire switch in either direction discharges a single extinguisher bottle into the associated engine. Rotating the engine fire switch in the other direction discharges the remaining extinguisher bottle into the same engine.

If an extinguisher bottle is discharged or has low pressure:

- the ENG BTL (1 or 2) DISCH light illuminates
- the EICAS advisory message BOTTLE (1 or 2) DISCH ENG is displayed.

APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection
- APU fire extinguishing.

APU Fire Detection

The APU compartment has dual fire detector loops. There is no APU overheat detection.

Normally, both loops must detect a fire to produce a fire warning. An APU fire warning automatically shuts down the APU.

If a fault is detected in one loop, the system automatically switches to single loop operation. If the operating loop detects a fire, an APU fire warning occurs and the APU shuts down.

The EICAS advisory message DET FIRE APU is displayed if the APU fire detection system fails.

APU Fire Warning

The indications of an APU fire warning are:

- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE APU is displayed
- the APU fire switch fire warning light illuminates
- the APU fire switch unlocks.

APU Fire Extinguishing

There is one APU fire extinguisher bottle. When the APU fire switch is pulled out, rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. If the bottle is discharged or has low pressure:

- the APU BTL DISCH light illuminates
- the EICAS advisory message BOTTLE DISCH APU is displayed.

On the ground with both engines off an APU fire signal from either APU fire detector loop causes APU shutdown and extinguisher bottle discharge.

Main Wheel Well Fire Protection

The main wheel well has fire detection only. There is no fire extinguishing system. The nose wheel well does not have a fire detection system.

Main Wheel Well Fire Detection

The main wheel well fire detection system consists of dual fire detector loops.

Main Wheel Well Fire Warning

The indications for a main wheel well fire are:

- the fire bell sounds
- the EICAS warning message FIRE WHEEL WELL is displayed
- the master WARNING lights illuminate.

Cargo Compartment Fire Protection

Cargo compartment fire protection consists of these systems:

- cargo compartment smoke detection
- cargo compartment fire extinguishing.

Note: The bulk cargo compartment is included in the aft cargo fire detection and extinguishing systems.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors. Each compartment is divided into three detection zones. If smoke is detected in any zone, a fire warning occurs.

Whenever cargo compartment smoke detection is inoperative, the EICAS advisory message DET FIRE CARGO (FWD or AFT) is displayed.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE CARGO (FWD or AFT) is displayed
- the CARGO FIRE (FWD or AFT) fire warning light illuminates.

Cargo Compartment Fire Extinguishing

Five fire extinguisher bottles are installed for cargo compartment fire extinguishing. Pushing the FWD or AFT CARGO FIRE ARM switch (ARMED visible) arms the extinguishers.

In flight, pushing the CARGO FIRE DISCHARGE switch causes the immediate total discharge of two extinguisher bottles into the selected compartment. After a time delay, the remaining three extinguisher bottles discharge at a reduced flow rate into the selected compartment. If the airplane lands before all of the bottles discharge, one of the remaining bottles discharges at the reduced rate on touchdown.

On the ground, if a CARGO FIRE DISCHARGE switch is pushed, two extinguisher bottles discharge into the selected compartment, but only one of the remaining extinguisher bottles discharges after the time delay.

When cargo fire extinguisher bottle discharge is initiated:

- The CARGO FIRE DISCHARGE switch light illuminates when the first two extinguisher bottles begin to discharge.
- The EICAS advisory message BOTTLE DISCH CARGO is displayed when the first two extinguisher bottles have completely discharged.

Crew Rest Compartment Fire Protection

Door 1 Upper Crew Rest Compartment Smoke Detection

Smoke detectors are installed in the door 1 upper crew rest compartment. If smoke is detected, an aural alert sounds in the door 1 crew rest compartment. The EICAS caution message SMOKE REST UPR DR 1 indicates smoke in the compartment.

Door 4 Upper Crew Rest Compartment Smoke Detection

7101 - 7110

Smoke detectors are installed in the door 4 upper crew rest compartment. If smoke is detected, an aural alert sounds in the door 4 crew rest compartment. The EICAS caution message SMOKE REST UPR DR 4 indicates smoke in the compartment.

Door 3 Upper Crew Rest Compartment Smoke Detection

7001 - 7008

Smoke detectors are installed in the door 3 upper crew rest compartment. If smoke is detected, an aural alert sounds in the door 3 upper crew rest compartment. The EICAS caution message SMOKE REST UPR DR 3 indicates smoke in the compartment.

Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory fire detection
- lavatory waste container fire extinguishing.

Lavatory Fire Detection

Each lavatory has a single smoke detector. If smoke is detected, an aural alert sounds in the lavatory and in the cabin. In addition, the lavatory call light flashes and the master call light at the associated attendant station illuminates. The EICAS advisory message SMOKE LAVATORY is displayed.

Lavatory Fire Extinguishing

Each lavatory has a fire extinguisher located in the waste container cabinet. Fire extinguisher operation is automatic. There is no flight deck indication.

Fire and Overheat Detection System Fault Test

The fire and overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic Fault Test

Fire and overheat detection system testing is automatic. The engine and APU systems continuously monitor the fire/overheat detector loops for faults. The cargo and wheel well systems continuously monitor for any system faults.

If a fault is detected, the system automatically reconfigures for single loop operation. Complete system failures are indicated by an EICAS advisory message for the failed system:

- DET FIRE ENG (L or R)
- DET FIRE APU
- DET FIRE CARGO (FWD or AFT).

Fire and Overheat Detection System Manual Fault Test

The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/OVERHEAT TEST switch.

The indications for a manual fire and overheat detection system test are:

- the fire bell sounds
- the nose wheel well APU fire warning horn sounds (on the ground)
- the EICAS warning message FIRE TEST IN PROG is displayed
- these lights illuminate:
 - the master WARNING lights
 - the LEFT and RIGHT engine fire warning lights
 - the APU fire warning light
 - the nose wheel well APU fire warning light
 - the FWD and AFT CARGO FIRE warning lights
 - the LEFT and RIGHT FUEL CONTROL switch fire warning lights.

When the test is complete, the EICAS warning message FIRE TEST PASS or FIRE TEST FAIL replaces the FIRE TEST IN PROG message; the switch can be released. The appropriate system EICAS messages are displayed with the FIRE TEST FAIL message:

• DET FIRE ENG (L or R)	• DET FIRE WHEEL WELL
• DET FIRE APU	• DET OVERHEAT ENG
• DET FIRE CARGO (FWD or AFT)	(L or R).

All test messages clear when the test switch is released. If the switch is released with the FIRE TEST IN PROG message displayed, the test ends without completing.

Fire Protection

EICAS Messages

Chapter 8

Section 30

Fire Protection EICAS Messages

The following EICAS messages can be displayed.

Airplane System EICAS Messages

Message	Level	Aural	Message Logic
BOTTLE 1, 2 DISCH ENG	Advisory		Engine fire extinguisher bottle 1 or bottle 2 pressure is low.
BOTTLE DISCH APU	Advisory		APU fire extinguisher bottle pressure is low.
BOTTLE DISCH CARGO	Advisory		Both rapid discharge cargo fire extinguisher bottle pressures are low.
DET FIRE APU	Advisory		APU fire detection is inoperative.
DET FIRE CARGO AFT, FWD	Advisory		Affected cargo compartment smoke detection is inoperative.
DET FIRE ENG L, R	Advisory		Affected engine fire detection and overheat are inoperative.
FIRE APU	Warning	Fire Bell	Fire is detected in the APU.
FIRE CARGO AFT, FWD	Warning	Fire Bell	Smoke is detected in the affected cargo compartment.
FIRE ENG L, R	Warning	Fire Bell	Fire is detected in the engine.
FIRE WHEEL WELL	Warning	Fire Bell	Fire is detected in a main wheel well.
OVERHEAT ENG L, R	Caution	Beeper	Overheat is detected in the affected nacelle.

Cabin System EICAS Messages

Cabin Area

Message	Level	Aural	Message Logic
SMOKE LAVATORY	Advisory		Smoke is detected in one or more lavatories.

Crew Rest Area

Message	Level	Aural	Message Logic
SMOKE REST UPR DR 1	Caution	Beeper	Smoke is detected in door 1 upper crew rest compartment.

7101 - 7110

SMOKE REST UPR DR 4	Caution	Beeper	Smoke is detected in door 4 upper crew rest compartment.

7001 - 7008

SMOKE REST UPR DR 3	Caution	Beeper	Smoke is detected in door 3 upper crew rest compartment.

System Test Messages

The following messages are associated only with the manually-initiated fire test.

Message	Level	Aural	Message Logic
DET FIRE WHEEL WELL	Advisory		Wheel well fire detection system is failed.
DET OVERHEAT ENG L, R	Advisory		Affected engine overheat detection system is failed.
FIRE TEST FAIL	Warning		One or more fire/overheat detection systems have failed to successfully complete the manually initiated fire/overheat test.
FIRE TEST IN PROG	Warning		A manually initiated fire/overheat detection system test is in progress.
FIRE TEST PASS	Warning		A manually initiated test of the fire/overheat detection system has been completed.

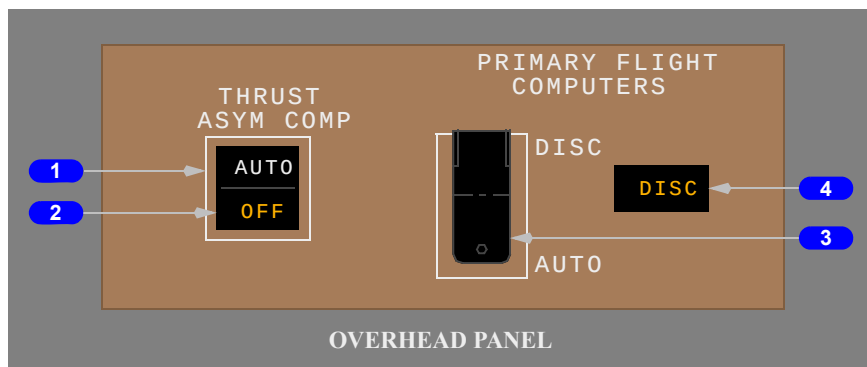
Flight Controls
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Thrust Asymmetry Compensation and Primary Flight Computers Controls



1 Thrust Asymmetry Compensation (THRUST ASYM COMP) Switch

AUTO – the thrust asymmetry compensation system operates automatically if a thrust asymmetry condition is detected.

OFF – disconnects the thrust asymmetry compensation system from the flight control system.

2 Thrust Asymmetry Compensation OFF Light

Illuminated (amber) – the thrust asymmetry compensation system has been automatically or manually disconnected.

3 PRIMARY FLIGHT COMPUTERS Disconnect Switch

DISC –

- disconnects the primary flight computers (PFCs) from the flight control system
- puts the flight control system in the direct mode
- **AUTO** can be reselected to attempt restoration of secondary or normal mode operation.

AUTO –

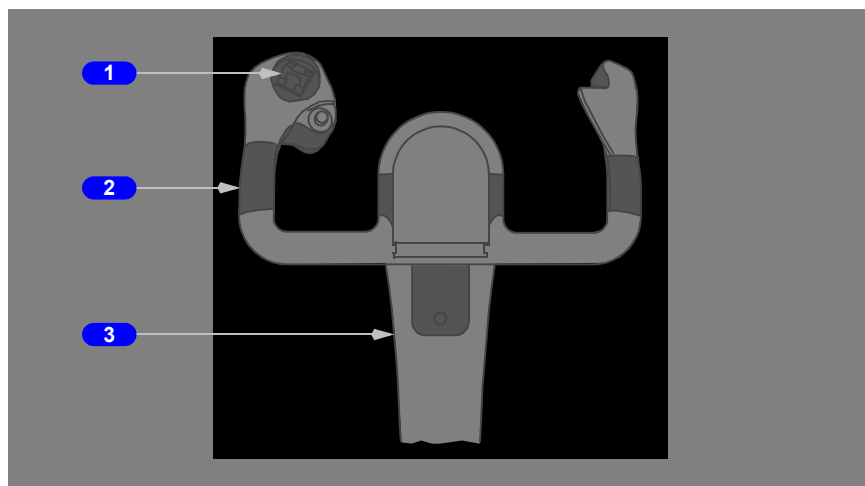
- the flight control system operates in the normal mode
- system faults automatically cause the system to switch to the secondary or direct modes.

4 PRIMARY FLIGHT COMPUTERS Disconnect (DISC) Light

Illuminated (amber) – the primary flight computers are disconnected automatically or manually and the system is in the direct mode.

Pitch and Stabilizer Trim Systems

Control Wheel and Column



1 Pitch Trim Switches

Spring-loaded to neutral.

Push (both switches) –

- in the normal mode in flight, changes the trim reference airspeed
- in the normal mode on the ground, moves the stabilizer
- in the secondary and direct modes, moves the stabilizer.

2 Control Wheel

Rotate – deflects the ailerons, flaperons, and spoilers in the desired direction.

Moves and remains displaced with aileron trim.

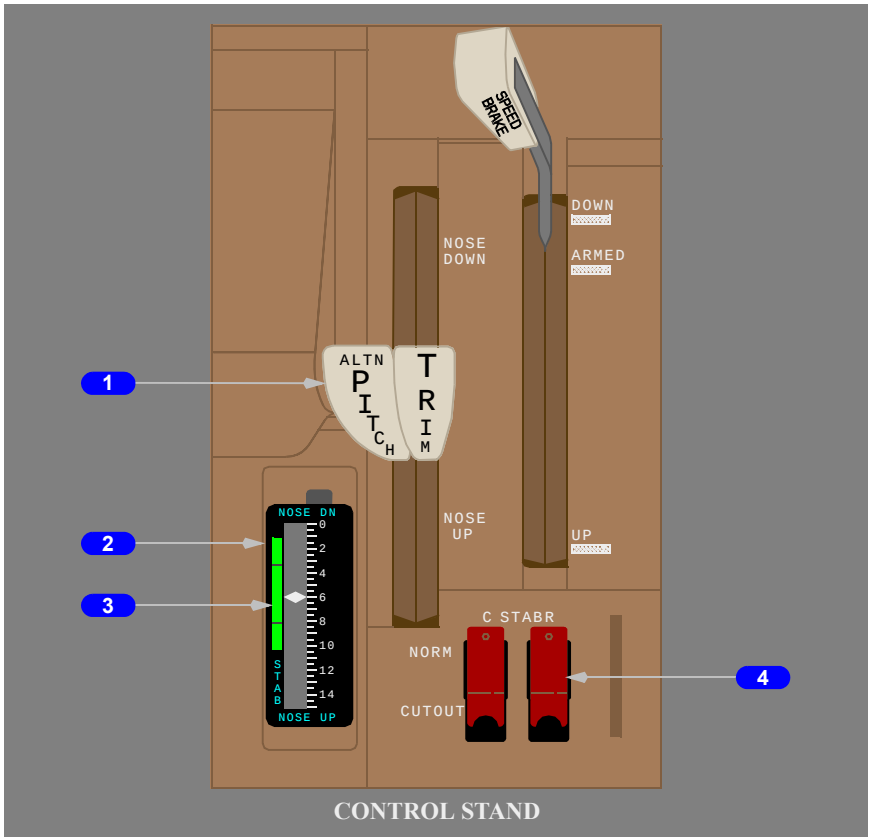
3 Control Column

Push/pull – commands the airplane to pitch in the desired direction:

- in the normal mode, deflects the elevator and horizontal stabilizer
- in the secondary and direct modes, deflects the elevator.

Does not move with pitch trim operation.

Stabilizer Trim System



1 Alternate (ALTN) PITCH TRIM Levers

Spring-loaded to neutral.

Push/pull (both levers) –

- in the normal mode, changes trim reference airspeed and moves the stabilizer directly
- in the secondary and direct modes, moves the stabilizer directly.

2 Stabilizer (STAB) Position Indicator

Indicates stabilizer position in units of trim.

3 Takeoff Trim Green Band

The green band indicates the allowable takeoff trim range, based on gross weight, takeoff thrust, and CG information from the FMC. When no information is available, or V1 speed is not selected or entered, the green band defaults to midrange.

If the stabilizer signal is not present or is invalid, the green band and the pointer are not displayed.

4 Stabilizer (STAB) Cutout Switches

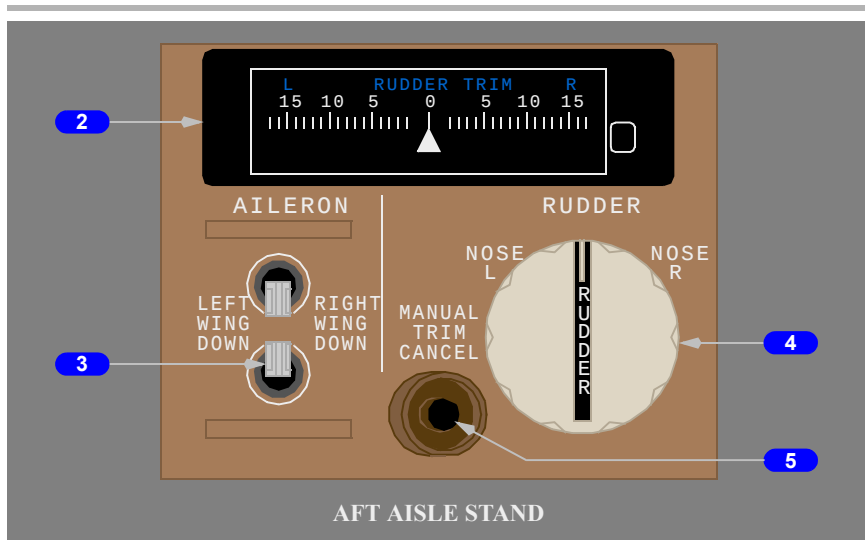
NORM –

- hydraulic power is supplied to the related stabilizer trim control module
- if unscheduled stabilizer motion is detected, center and/or right system hydraulic power to the related stabilizer trim control module is automatically shut off.

CUTOUT – shuts off the respective center or right hydraulic system power to the related stabilizer trim control module.

Aileron and Rudder Trim Controls





1 AILERON TRIM Indicator

Indicates units of aileron trim.

2 RUDDER TRIM Indicator

Indicates units of rudder trim.

3 AILERON Trim Switches

Push (both switches) – moves the control wheel, ailerons, flaperons, and spoilers in the desired direction (spring-loaded to neutral).

4 RUDDER Trim Selector

Spring-loaded to neutral.

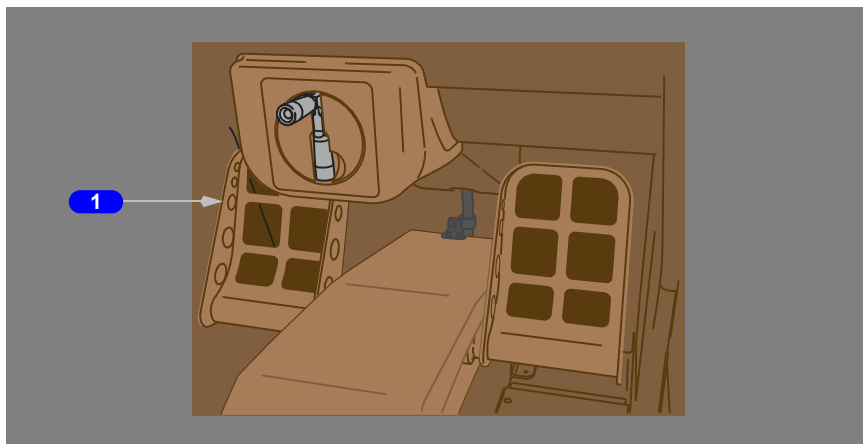
Rotate –

- trims the rudder in the desired direction
- the trim runs at high speed with the knob rotated past the first left or right detent
- the rudder pedals move with rudder trim operation.

5 MANUAL TRIM CANCEL Switch

Push – cancels manual rudder trim in the normal and secondary flight control system modes.

Rudder/Brake Pedals



1 Rudder Pedals

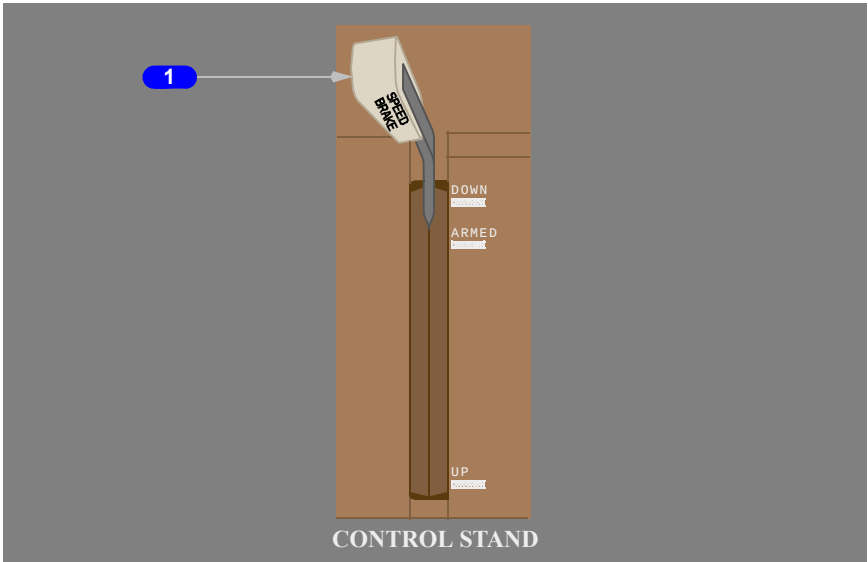
Push – deflects the rudder in the desired direction.

Refer to Chapter 14, Landing Gear, for brakes and nosewheel steering description.

Speedbrake Lever

On the ground:

- the speedbrake lever moves to DOWN and all spoiler panels retract if either thrust lever is advanced to the takeoff thrust position
- the speedbrake lever moves to UP and all spoiler panels extend if either reverse thrust lever is raised to the reverse idle detent.



1 Speedbrake Lever

DOWN (detent) – all spoiler panels are retracted.

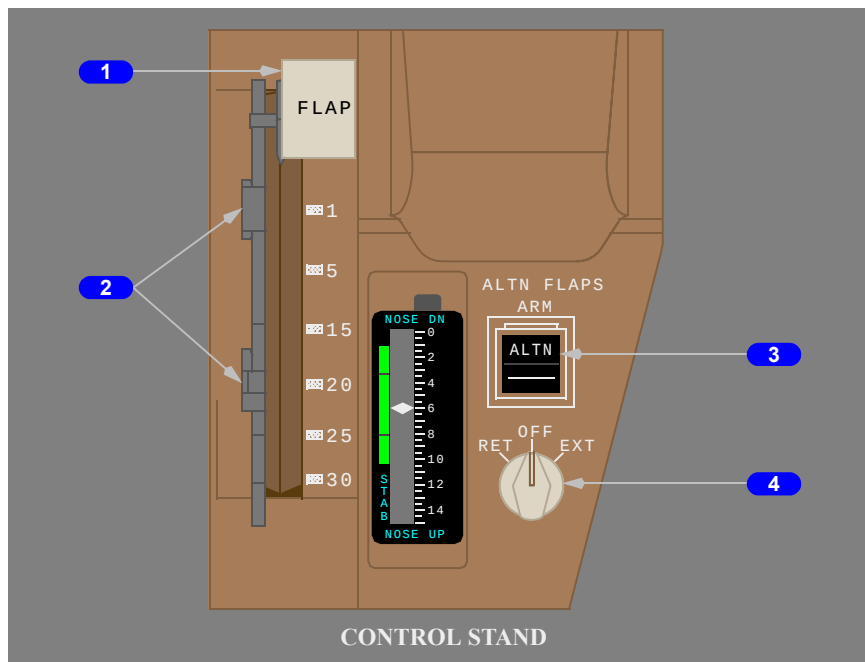
ARMED –

- the auto speedbrake system is armed
- after landing, the speedbrake lever automatically moves to UP and the spoiler panels extend.

UP – the required spoiler panels extend to their maximum in-flight or on-ground position (intermediate positions can be selected).

Flap System

Flap Controls



1 Flap Lever

Primary mode – positions the slats and flaps hydraulically.

Secondary mode – positions the slats and/or flaps electrically if hydraulic operation fails.

2 Flap Gates

1 – prevents inadvertent retraction of the slats.

20 – prevents inadvertent retraction of the flaps past the go-around position.

3 Alternate Flaps Arm (ALTN FLAPS ARM) Switch

Push (ALTN displayed) –

- arms the alternate flap control mode
- arms the alternate flaps selector
- disables primary and secondary flap/slat mode operation

- asymmetry/skew and uncommanded motion protection, autoslat, and flap/slat load relief are not available
- the flap lever is inoperative.

4 Alternate Flaps Selector

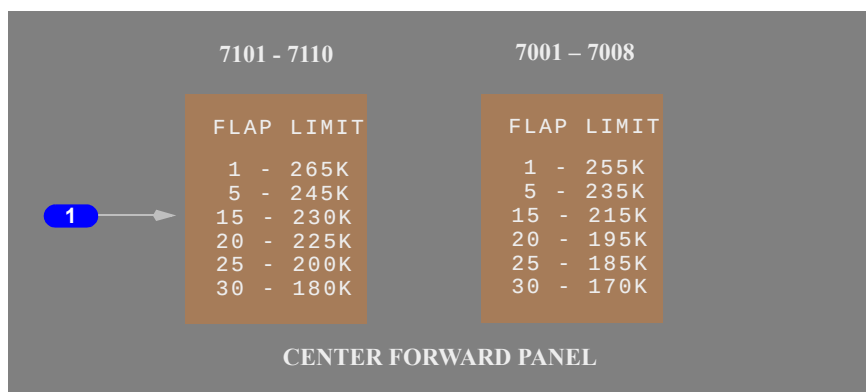
RET – the slats and flaps are electrically retracted.

OFF – alternate flaps are deactivated.

EXT –

- the slats and flaps are electrically extended
- maximum extension is flap 20, with the slats at the midrange position.

Flap Limit Placard



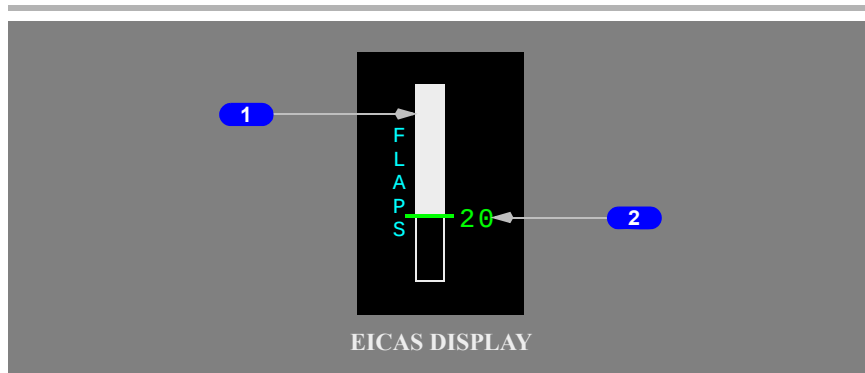
1 Flap Limit Placard

Flaps extended speed limits.

Normal Flap Position Indication

Displays combined flap and slat positions when all surfaces are operating normally and control is in the primary (hydraulic) mode. The indicator shows continuous motion.

The indication is no longer displayed 10 seconds after slat retraction.



1 Flap Position (white)

UP – the slats and flaps are retracted.

1 – the slats extend to the midrange position.

5, 15, and 20 –

- the slats remain in the midrange position
- the flaps extend to the commanded position.

25 – the slats extend to the fully extended position. The flaps extend to 25.

30 – the flaps extend to 30.

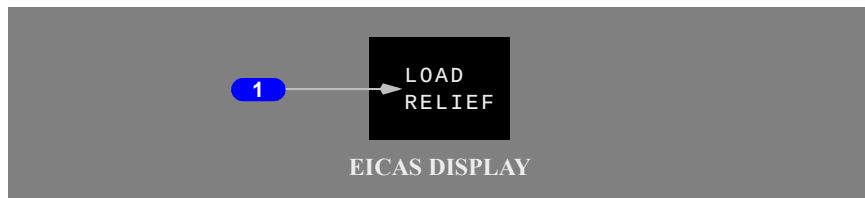
2 Flap Lever Position (line and number)

Magenta – the slats or flaps are in transit to the commanded position.

Green – the slats and flaps are in the commanded position.

The line and number change color.

Flap Load Relief Indication



1 Flap LOAD RELIEF Indication

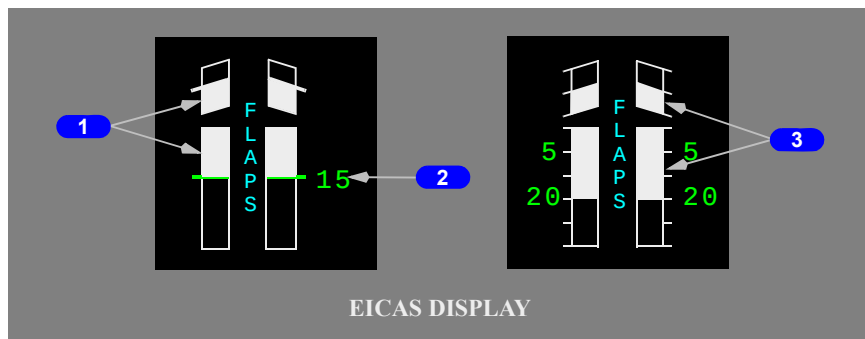
Displayed (white) –

- flap load relief is retracting the flaps, or inhibiting extension, as required to prevent air load damage due to excessive airspeed
- extension from UP is being inhibited due to either excessive airspeed or altitude.

Expanded Flap and Slat Position Indication

If any flap/slat is non-normal or if control is in the secondary mode, slat and flap positions are shown independently. Each wing is also shown separately.

Indicator motion is continuous between flap detents.



1 Expanded Flap and Slat Position Indications

The slat indication fills up (forward) for extension.

The flap indication fills down (aft) for extension.

Indication colors of outline and fill are:

- white when operating in secondary mode
- amber when the respective FLAPS DRIVE or SLATS DRIVE EICAS message is displayed.

Loss of position information is shown as a white outline with no fill and no flap lever position indication.

2 Flap Lever Position (line and number)

Magenta – the slats or flaps are in transit to the commanded position.

Green – the slats or flaps are in the commanded position.

The numbers are shown next to the flap position indicator only.

3 Alternate Flap and Slat Position Indications (white)

Slat and flap extension is limited to slats midrange and flaps 20.

Displayed automatically when the alternate control mode is armed.

Slats – displays the position of the slats.

Flaps – displays the position of the flaps.

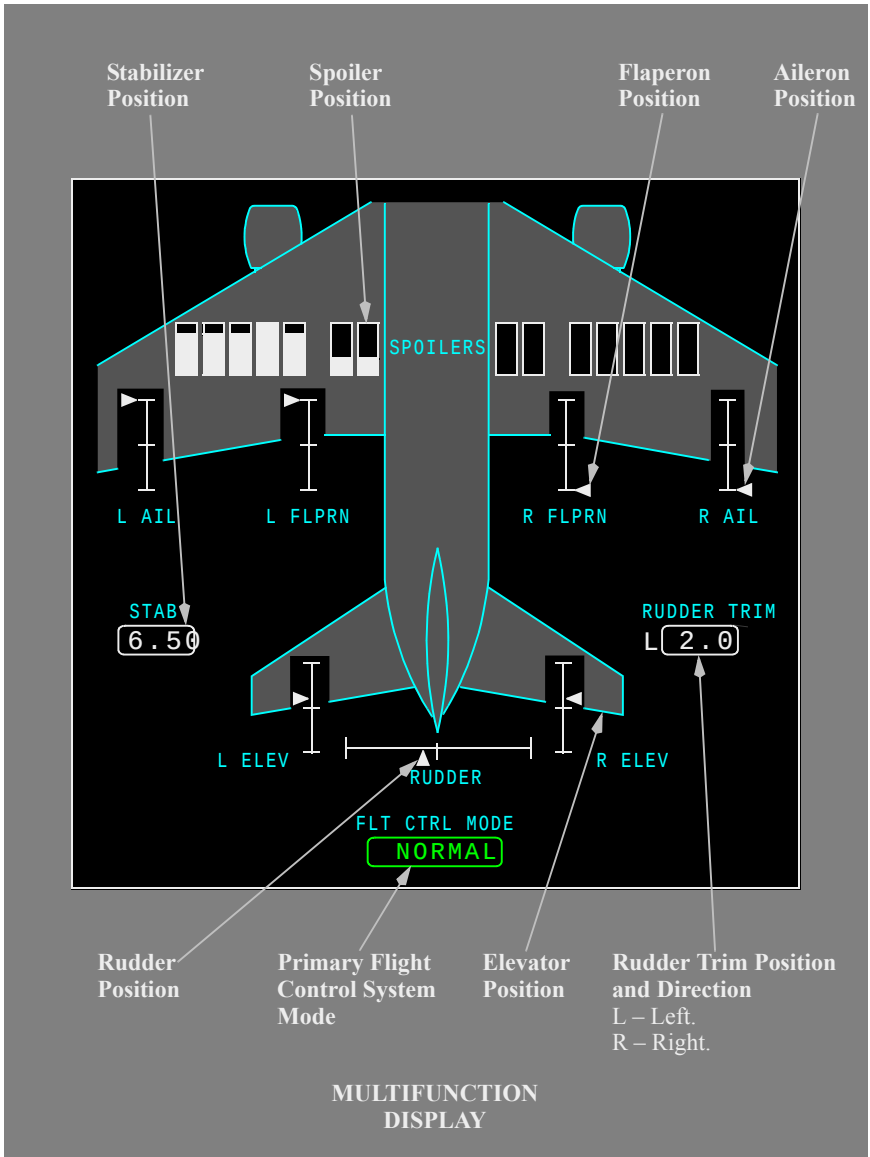
Flap position index marks – reference flaps 5 and 20.

Loss of position information is indicated as a white outline with no fill and no position index marks or numbers.

Flight Control Synoptic Displays

The flight control synoptic is displayed by pushing the FCTL synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

Normal Flight Control Synoptic



Unknown Aileron Position

Failed Control Surface or Trim Function (amber)

Unknown Spoiler Condition

L AIL

L FLPRN

R FLPRN

R AIL

STAB

RUDDER TRIM L 0.0

L ELEV

RUDDER

R ELEV

HYDRAULICS L C R

FLT CTRL MODE SECONDARY

ACES L1 L2 C R

Hydraulic System Failure Indications (amber)

Flight Control Mode SECONDARY or DIRECT Indication (amber)

Actuator Control Electronic Failure Indications (amber)

MULTIFUNCTION DISPLAY

Flight Controls

System Description

Chapter 9

Section 20

Introduction

The primary flight control system uses conventional control wheel, column, and pedal inputs from the pilot to electronically command the flight control surfaces. The system provides conventional control feel and pitch responses to speed and trim changes. The system electronic components provide enhanced handling qualities and reduce pilot workload.

The primary flight control system is highly redundant, with three operating modes: normal mode, secondary mode, and direct mode. The primary flight controls are powered by redundant hydraulic sources. The secondary flight controls, high lift devices consisting of flaps and slats, are hydraulically powered with an electrically powered backup system.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- control wheel pitch trim switches
- alternate pitch trim levers
- the speedbrake lever
- the flap lever
- aileron trim switches
- rudder trim selector
- manual rudder trim cancel switch.

The columns and wheels are connected through jam override mechanisms. If a jam occurs in a column or wheel, the pilots can maintain control by applying force to the other column or wheel to overcome the jam.

The F/O's control wheel can be rotated approximately 8 degrees beyond the initial stop if sufficient force is applied during ground checks.

The rudder pedals are rigidly connected between the two sides.

The speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

The pilot controls command these system electronic components:

- four actuator control electronics (ACEs)
- three primary flight computers (PFCs).

The ACEs receive input signals from all pilot controls. The ACEs send control signals to the primary flight control surfaces. Each ACE is assigned to different actuators on the control surfaces. No single ACE controls more than one actuator on a control surface. Some ACEs are not assigned to all control surfaces.

The EICAS caution message FLIGHT CONTROLS is displayed if:

- multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces, or
- other flight control system faults are detected.

The ACEs can transmit pilot control inputs directly to the control surfaces, or they can send the pilot inputs to the PFCs. When the ACEs are sending pilot inputs to the PFCs, the ACEs receive control commands back from the PFCs and use the commands to position the flight control surfaces.

The PFCs use information from other airplane systems (such as air data, inertial data, flap and slat position, engine thrust, and radio altitude) to compute control surface commands for enhanced handling qualities. See Primary Flight Control System Modes in this Section for a description of these handling quality enhancements.

The autopilot also sends commands to the PFCs, which then produce control surface commands. See Chapter 4, Automatic Flight.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

- two flaperons
- two ailerons
- fourteen spoilers.

Yaw control is provided by:

- single rudder
- partial span tab.

The two elevators and horizontal stabilizer work together to provide pitch control. A detailed description of pitch control is given in a separate section later in this chapter.

The flaperons and ailerons provide roll control, assisted by asymmetric spoilers.

The flaperons are located between the inboard and outboard flaps on both wings. In the normal mode, they are used for roll control with the flaps either retracted or extended. For increased lift, the flaperons move down and aft in proportion to trailing edge flap extension.

The ailerons are located outboard of the outboard flaps on each wing. For increased lift, the ailerons move down for flaps 5, 15, and 20, to improve takeoff performance.

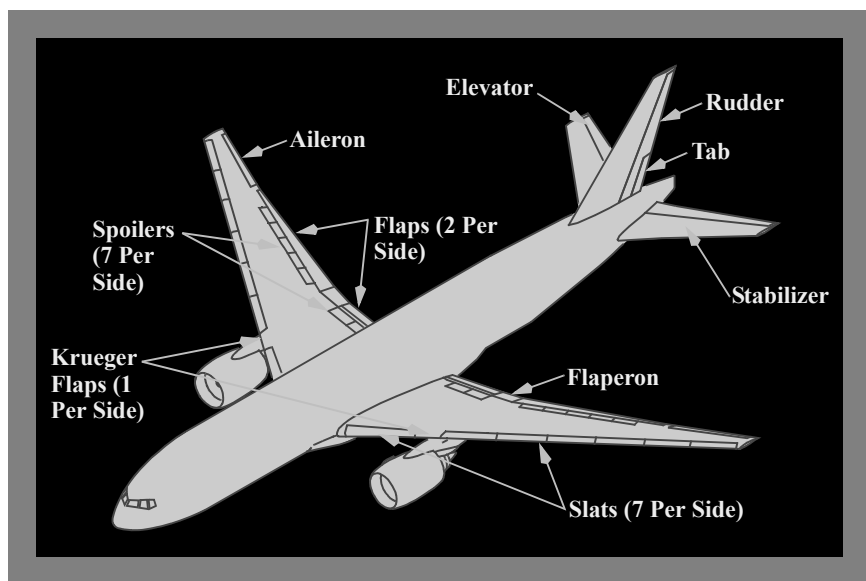
In the normal mode, the ailerons and spoilers 5 and 10 are locked out during high-speed flight; the flaperons and remaining spoilers provide sufficient roll control. During low speed flight, these panels augment roll control.

Yaw control is provided by a single rudder, which is almost the same height as the vertical tail. The lower portion of the rudder has a hinged section (tab) that deflects twice as far as the main rudder surface to provide additional yaw control authority. During takeoff, the rudder becomes aerodynamically effective at approximately 60 knots.

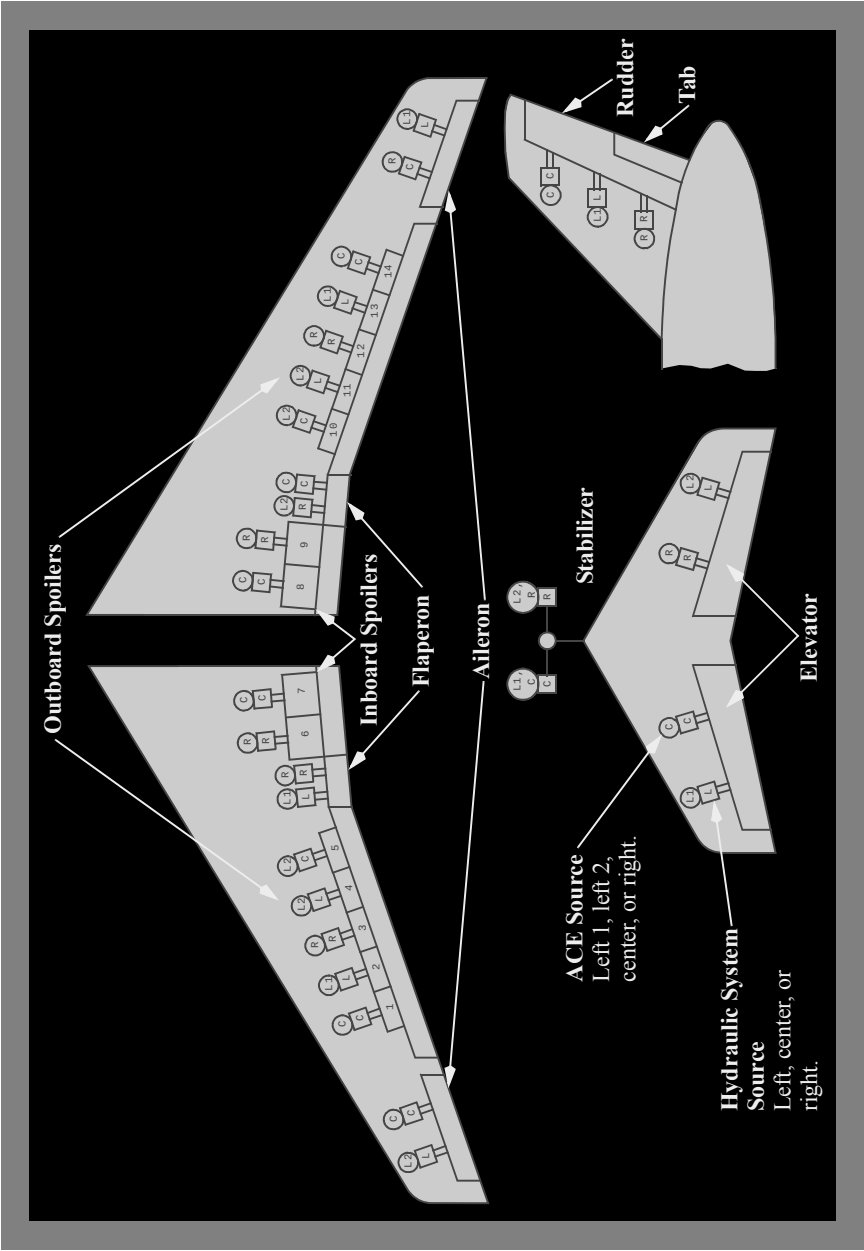
Flaps and slats provide high lift for takeoff, approach, and landing.

Symmetric spoilers are used as speedbrakes.

Flight Control Surface Locations



Actuator Control Electronics/Hydraulic Power Distribution



Primary Flight Control System Modes

There are three primary flight control system modes (flap and slat system modes are described later in this section):

- normal
- secondary
- direct.

All the modes use the same pilot controls and flight control surfaces.

Flight Control System Normal Mode

In the normal mode during manual flight, the ACES receive pilot control inputs and send these signals to the three PFCs. The PFCs verify these signals and information from other airplane systems in order to compute control surface commands. These commands are then sent back to the ACES. The four ACES send enhanced signals to the flight control surface actuators.

When the autopilot is engaged, the autopilot system sends commands to the PFCs. The PFCs generate control surface commands, which are then sent to the ACES in the same manner as pilot control inputs. The autopilot commands move the pilot controls to provide indications of what the autopilot is doing. If the pilot overrides the autopilot with control inputs, the PFCs disconnect the autopilot and use the pilot control inputs. The autopilot is only available during normal mode operation. Refer to Chapter 4, Automatic Flight, for autopilot operation.

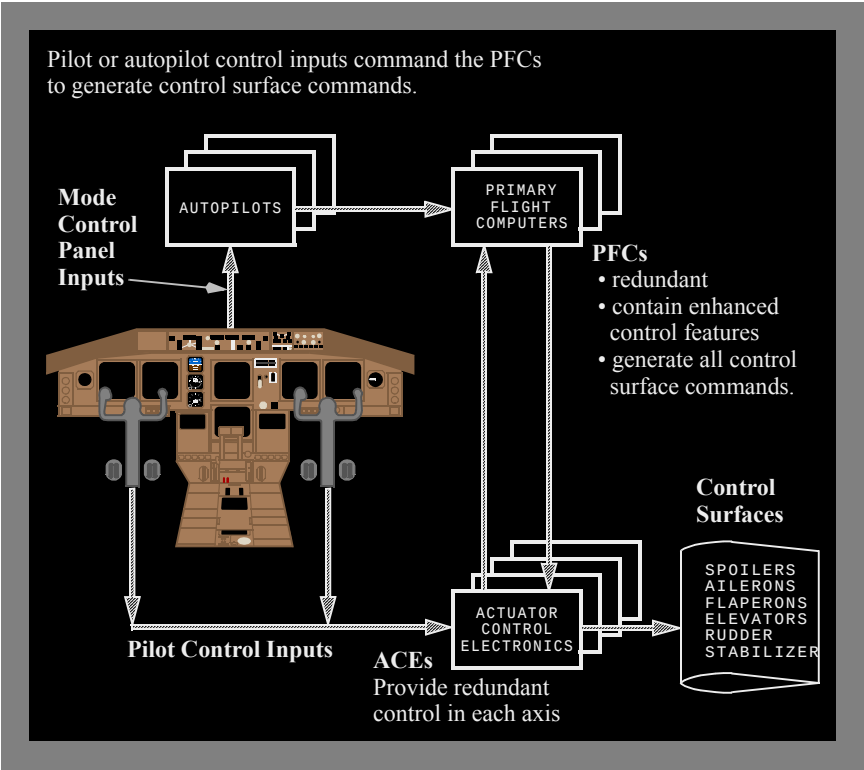
After the hydraulic systems are shut down, the PFCs self-test. During the test, various EICAS alert and status messages display, trim indicator information blinks, and various failure indications display on the flight controls synoptic. When the self test is complete, the EICAS messages disappear, and the trim indicator and synoptic display return to normal. This happens about two minutes after the EICAS caution message HYD PRESS SYS L+C+R is displayed.

Flight Envelope Protection

The flight envelope protection system reduces the possibility of inadvertently exceeding the airplane's flight envelope. The flight envelope protection system provides crew awareness of envelope margins through tactile, aural, and visual cues. The protection functions do not reduce pilot control authority. The protection functions are described later in this section and include:

- stall protection
- overspeed protection
- roll envelope bank angle protection.

Normal Mode



Flight Control System Secondary Mode

When the PFCs can no longer support the normal mode due to internal faults or lack of required information from other airplane systems, they automatically revert to the secondary mode. The ACEs continue to receive pilot control inputs and send these signals to the three PFCs. However, the PFCs use simplified computations to generate flight control surfaces commands. These simplified commands are sent back to the ACEs, where they are sent to the control surface actuators the same way as in the normal mode.

The simplified PFC control laws used in the secondary mode affect airplane handling qualities. All flight control surfaces remain operable. The elevator and rudder are more sensitive at some airspeeds.

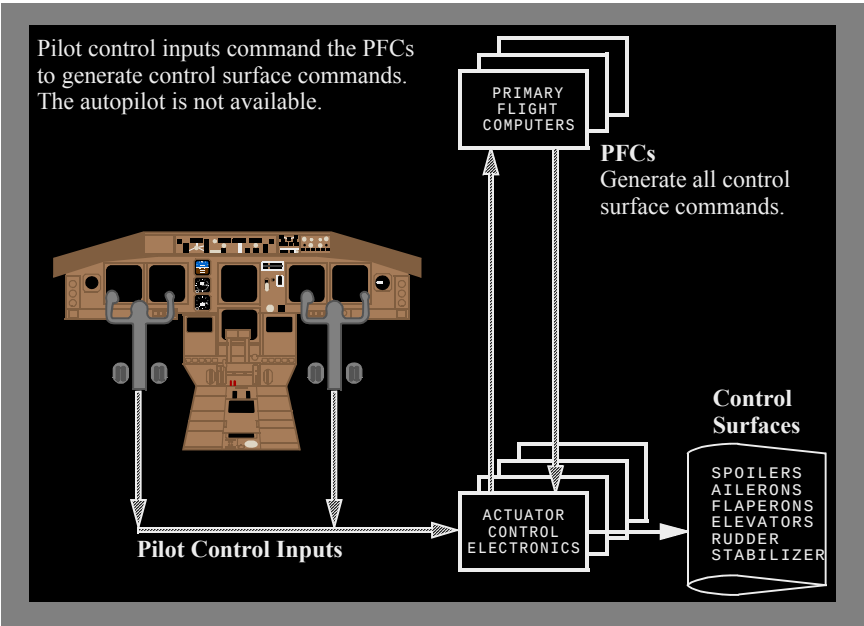
The following functions are not available in the secondary mode:

- autopilot
- auto speedbrakes
- envelope protection
- gust suppression
- tail strike protection
- thrust asymmetry compensation
- yaw damping (may be degraded or inoperative)

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The EICAS caution message FLIGHT CONTROL MODE is displayed when the primary flight control system is in the secondary mode. The secondary mode cannot be manually selected.

Secondary Mode



Flight Control System Direct Mode

The ACEs automatically transition to the direct mode when they detect the failure of all three PFCs or lose communication with the PFCs. The direct mode can also be manually selected by moving the PRIMARY FLIGHT COMPUTERS DISCONNECT switch to DISC.

In the direct mode, the PFCs no longer generate control surface commands. Pilot inputs received by the ACEs are sent directly to the control surface actuators.

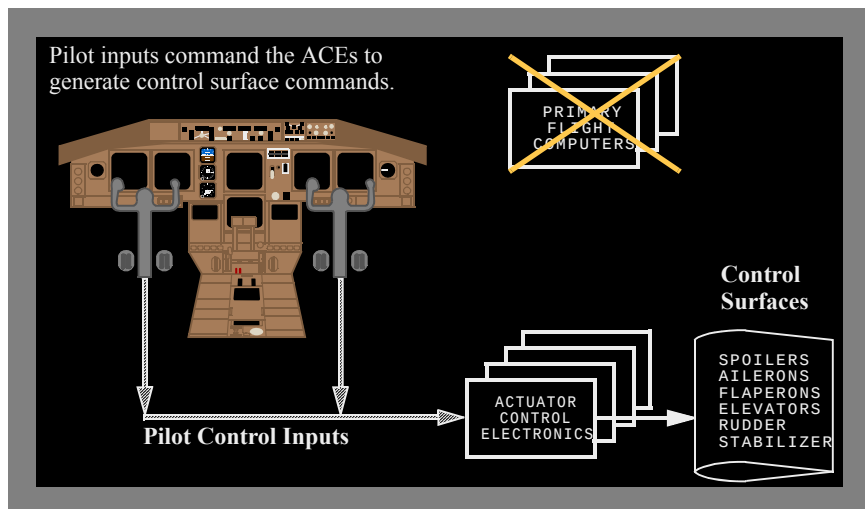
The direct mode provides full airplane control for continued safe flight and landing. Airplane handling qualities are approximately the same as in the secondary mode. The EICAS caution message PRI FLIGHT COMPUTERS is displayed when the system is in the direct mode.

In the direct mode, the following functions are not available:

- autopilot
- auto speedbrakes
- envelope protection
- gust suppression
- tail strike protection
- manual rudder trim cancel switch
- thrust asymmetry compensation
- yaw damping

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Direct Mode



Mechanical Backup

In the unlikely event of a complete electrical system shut-down, cables from the flight deck to the stabilizer and selected spoilers allow the pilot to fly straight and level until the electrical system is restarted.

Normal Mode Pitch Control

In the normal mode, airplane pitch control characteristics are like conventional airplanes, with improved handling qualities. Unlike conventional airplanes, the control column does not directly position the elevator in flight. The control column commands the PFCs to generate a pitch maneuver. The PFCs automatically position the elevator and the stabilizer to generate the commanded maneuver. The PFCs constantly monitor airplane response to pilot commands and reposition the elevator and stabilizer to carry out these commands. Airplane pitch responses to thrust changes, gear configuration changes, and turbulence are automatically minimized by PFC control surface commands.

The PFCs also provide compensation for flap and speedbrake configuration changes, and turns up to 30° of bank. The PFCs automatically control pitch to maintain a relatively constant flight path. This eliminates the need for the pilot to make control column inputs to compensate for these factors. For turns up to 30° of bank, the pilot does not need to add additional column back pressure to maintain altitude. For turns of more than 30° of bank, the pilot does need to add column back pressure.

As airspeed changes, the PFCs provide conventional pitch control characteristics by requiring the pilot to make control column inputs or trim changes to maintain a constant flight path.

Primary Pitch Trim Control

Primary pitch trim is controlled by the dual pitch trim switches on each control wheel. Both switches must be moved to command trim changes. The primary pitch trim switches are inhibited when the autopilot is engaged. Pitch trim does not move the control column.

In the normal mode, primary pitch trim operates differently on the ground than it does in flight. On the ground, the stabilizer is directly positioned when the pilot uses the pitch trim switches. In flight, the pitch trim switches do not position the stabilizer directly, but make inputs to the PFCs to change the trim reference speed. The trim reference speed is the speed at which the airplane would eventually stabilize if there were no control column inputs. Once the control column forces are trimmed to zero, the airplane maintains a constant speed with no column inputs. Thrust changes result in a relatively constant indicated airspeed climb or descent, with no trim inputs needed unless airspeed changes.

When pilot trim inputs are made, the PFCs automatically move the elevators to achieve the trim change, then move the stabilizer to streamline the elevator. Stabilizer motion may also automatically occur to streamline the stabilizer and elevator for thrust and configuration changes.

Alternate Pitch Trim

Alternate pitch trim is controlled by the dual alternate pitch trim levers on the control stand. Both levers must be moved to command trim changes. These levers move the trim reference airspeed (normal mode) and also move the stabilizer (all modes). The alternate pitch trim levers are linked to the stabilizer trim control modules (STCM) via control cables, and then mechanically to the stabilizer. Alternate pitch trim commands have priority over wheel pitch trim commands in all flight control modes.

Moving the alternate pitch trim levers with the autopilot engaged does not disconnect the autopilot, but does move the stabilizer. Moving the alternate pitch trim levers during stall or overspeed protection does move the stabilizer, but does not remove column forces.

Note: The alternate pitch trim levers should not be used with the autopilot engaged, or during stall or overspeed protection.

Pitch Envelope Protection

The pitch envelope protection functions include:

- stall protection
- overspeed protection.

Stall Protection

Stall protection reduces the likelihood of inadvertently exceeding the stall angle of attack by providing enhanced crew awareness of the approach to a stall or to a stalled condition.

Stall protection limits the speed to which the airplane can be trimmed. The trim reference speed is limited by inhibiting trim in the nose up direction when the airplane slows to a speed where maneuver margin is limited. This trim inhibit speed is approximately the minimum maneuvering speed (top of the amber band) at lower altitudes, and can be 10 to 20 knots lower than the top of the amber band at higher altitudes. The pilot must apply continuous aft column pressure, at higher than normal force, to maintain airspeed below trim inhibit speed.

The autothrottle can support stall protection if armed and not activated. If speed decreases to near stick shaker activation, the autothrottle automatically activates in the appropriate mode (SPD or THR REF) and advances thrust to maintain minimum maneuvering speed (approximately the top of the amber band) or the speed set in the mode control panel speed window, whichever is greater. The EICAS message AIRSPEED LOW is displayed.

Note: When the pitch mode is FLCH or TOGA, or the airplane is below 400 feet above the airport on takeoff, or below 100 feet radio altitude on approach, the autothrottle will not automatically activate.

Note: During a descent in VNAV SPD, the autothrottle may activate in HOLD mode and will not support stall protection.

Refer to Chapter 10, Flight Instruments, Displays, for PFD indications.

Refer to Chapter 4, Automatic Flight, for an explanation of PFD flight mode annunciations, and for mode control panel and autothrottle operation.

Overspeed Protection

Overspeed protection limits the speed to which the airplane can be trimmed. At VMO/MMO, overspeed protection limits the trim reference speed so that trim is inhibited in the nose down direction. The pilot must apply continuous forward column force to maintain airspeed above VMO/MMO. Use of the alternate pitch trim levers does not reduce column forces.

Elevator Variable Feel

The PFCs calculate feel commands based on airspeed. In general, control column forces increase:

- as airspeed increases for a given column displacement, or
- as column displacement increases.

Tail Strike Protection

During takeoff or landing, the PFCs calculate if a tail strike is imminent and decrease elevator deflection, if required, to reduce the potential for tail skid ground contact. Activation of tail strike protection does not provide feedback to the control column.

Secondary and Direct Mode Pitch Control

Airplane pitch control is different in the secondary and direct flight control modes. The control columns now command a proportional elevator deflection instead of a maneuver command. Secondary and direct modes do not provide automatic pitch compensation for:

- thrust changes
- gear configuration changes
- turbulence
- flap and speedbrake configuration changes
- turns to 30° bank angle.

In secondary and direct modes, the elevator variable feel system provides two feel force levels instead of a continuous variation with airspeed. The force levels change with flap position. With the flaps up, the feel forces provide maneuver force levels that discourage overcontrol in the pitch axis at high speeds. With flaps extended (flaps 1 or greater), the feel forces decrease to provide force levels appropriate for approach and landing.

In the secondary and direct modes, both the primary pitch trim switches and the alternate pitch trim levers move the stabilizer directly. There is no trim reference speed.

Stabilizer Hydraulic Power and Non-Normal Operation

The stabilizer is powered by the center and right hydraulic systems. Stabilizer position commands from the PFCs and alternate pitch trim levers are sent to the stabilizer trim control modules, which control hydraulic power to the stabilizer. There are two modules, one for each stabilizer hydraulic source.

Stabilizer Shutdown

If uncommanded stabilizer motion is sensed, hydraulic power to the stabilizer trim control module that caused the motion is automatically shut off. If a module is inoperative due to an automatic shutdown or another failure, the EICAS advisory message STABILIZER C or STABILIZER R is displayed. The stabilizer remains operative through the remaining stabilizer trim control module.

If both stabilizer trim control modules automatically shut down or fail, the EICAS warning message STABILIZER is displayed. The STABILIZER warning is also displayed if automatic shutdown fails to stop uncommanded motion.

The center and right stabilizer cutout switches, located on the aisle stand, control hydraulic power to the respective stabilizer trim control module. Placing both switches in the CUTOUT position removes all hydraulic power from the stabilizer. The EICAS advisory message STABILIZER CUTOUT is displayed when both stabilizer cutout switches are in the CUTOUT position. The STABILIZER warning message is no longer displayed.

In the normal flight control mode, when the stabilizer is manually shut down or failed, pitch trim is still available. Pilot pitch trim inputs change the PFC trim reference speed. The PFCs then reposition the elevators to trim the airplane.

The control column can be used to interrupt pitch trim commands from the wheel pitch trim switches. This feature allows the pilot to quickly stop uncommanded trim changes due to stuck pitch trim switches. The pitch trim commands are interrupted if the control column is displaced in the opposing direction.

Stabilizer Position Indication and Green Band

Stabilizer position is displayed on two stabilizer position indicators located on the aisle stand. Stabilizer position is also displayed on the flight controls synoptic.

The stabilizer position indicators also display the takeoff green band indication. The green band automatically displays the acceptable range for takeoff stabilizer positions. There are three green band segments that can be illuminated for takeoff:

- the midband
- the nose down band (which includes the midband)
- the nose up band (which includes the midband).

The green band is calculated using the FMC inputs of CG, gross weight, takeoff thrust and V1. A nose gear oleo pressure switch provides an automatic cross-check of the CG to ensure that the correct green band has been selected. When either the nose up or nose down band is selected, the pressure switch position is compared to the computed green band. The EICAS advisory message STAB GREENBAND is displayed if the pressure switch and the green band disagree. If the stabilizer signal is not present or is invalid, the green band and the pointer are not displayed.

Normal Mode Roll Control

Roll control is similar to conventional airplanes. Aileron and flaperon surface deflections are proportional to control wheel displacement. Spoilers begin to extend to augment roll control after several degrees of control wheel rotation. Control wheel forces increase as control displacement increases. Control wheel forces do not change with airspeed changes. The ailerons are locked out at high speeds.

Spoilers 4 and 11 are mechanically controlled through a cable from the control wheel. These spoilers are available for roll control until the speedbrake lever is moved to near the UP position, when they function as speedbrakes only. Spoilers 5 and 10 are locked out at high speed.

Aileron Trim

Dual aileron trim switches located on the aisle stand must be pushed simultaneously to command trim changes. Use of aileron trim causes control wheel rotation.

The amount of aileron trim is indicated on a scale on the top of each control column.

Aileron trim is inhibited when the autopilot is engaged.

Roll Envelope Bank Angle Protection

Bank angle protection reduces the likelihood of exceeding the bank angle boundary due to external disturbances, system failures, or inappropriate pilot action.

Bank angle protection provides roll control wheel inputs when airplane bank angle exceeds the bank angle protection boundary of approximately 35°. If the boundary is exceeded, the control wheel force rolls the airplane back within 30° of bank. This roll command can be overridden by the pilot. Maximum control wheel deflection always commands maximum control surface deflection. The autopilot disengage bar disables bank angle protection.

Excessive bank angles are indicated on the PFD bank indicator. The indicator changes color to amber at bank angles exceeding 35°. Refer to Chapter 10, Flight Instruments, Displays, for PFD indications.

Secondary and Direct Mode Roll Control

Roll control in the secondary and direct modes is very similar to roll control in the normal mode. Bank angle protection is not available in either the secondary or direct mode. Spoilers 5 and 10 are always locked out.

Normal Mode Yaw Control

Yaw control operation is similar to a conventional airplane. Rudder surface deflections are proportional to rudder pedal movements.

Pedal forces increase as pedal displacement increases. Pedal forces do not change with airspeed changes.

The rudder ratio changer automatically reduces rudder deflection (for a given pedal input) as airspeed increases. This protects the vertical tail structure from stresses resulting from large rudder surface deflections at high airspeeds. Sufficient rudder authority is provided at all airspeeds to maintain airplane control in engine-out conditions, as well as during takeoffs and landings in crosswinds.

Thrust Asymmetry Compensation

The thrust asymmetry compensation (TAC) system significantly reduces uncommanded flight path changes associated with an engine failure. TAC continually monitors engine data to determine the thrust level from each engine. If the thrust level on one engine differs by 10 percent or more from the other engine, TAC automatically adds rudder to minimize yaw. When TAC is operating, the pilot can still recognize the initial onset of an engine failure through airplane roll/yaw cues. These roll/yaw cues are greatly reduced when compared to an airplane operating without TAC. After several seconds, TAC applies sufficient rudder to make it possible for the pilot or autopilot to center the control wheel. The amount of rudder used is proportional to the engine thrust difference. Rudder movement is back-driven through the rudder pedals and the rudder trim indicator to provide rudder control awareness to the pilot.

TAC is available except:

- when airspeed is below 70 knots on the ground, or
- when reverse thrust is applied, or
- when automatically disengaged due to system malfunction or loss of engine thrust data.

TAC automatically disengages if engine thrust data is lost. Also, if the engine is damaged or surges, TAC disengages because there is no accurate prediction of engine thrust. TAC may still cause some rudder deflection in the appropriate direction just before automatically disengaging.

TAC can be manually overridden by making manual rudder pedal inputs. TAC is only available in the normal flight control mode. To manually disarm TAC, push the THRUST ASYM COMP switch on the overhead panel. If TAC is automatically or manually disconnected, the EICAS advisory message THRUST ASYM COMP displays.

Wheel to Rudder Cross-Tie

A wheel to rudder cross-tie function provides the capability of being able to control the initial effects of an engine failure using control wheel inputs only. Control wheel inputs can deflect the rudder up to 8 degrees.

Wheel to rudder cross-tie is operative in flight below 210 knots in the normal mode.

Yaw Damping

In the normal mode, the yaw damping function provides turn coordination and Dutch roll damping.

Gust Suppression

A gust suppression function reduces the effects of lateral gusts and improves lateral ride quality through a combination of yaw and roll commands. Operation does not result in either rudder pedal or control wheel movement.

Rudder Trim

The rudder trim control can be used to command manual rudder trim in all three flight control modes. Two rudder trim speeds are available. Low rate rudder trim is commanded by rotating the control to the detent. High rate rudder trim is commanded by rotating the control past the detent. Manual Trim Cancel switch actuation causes manually set rudder trim to move to the zero units position at the high speed trim rate. The zero position achieved by actuating the switch is not as accurate as manually rotating the trim selector to zero units. The switch has no effect on rudder trim inputs from TAC.

Secondary and Direct Mode Yaw Control

Secondary and direct mode yaw control is similar to normal mode yaw control. Pedal feel forces are unchanged from normal mode; however, rudder response is slightly different.

In secondary and direct modes, the rudder ratio changer is degraded to two fixed ratios determined by flap position. With flaps up, the rudder response to pedal inputs is less than with the flaps down.

In the secondary mode:

- gust suppression is inoperative
- yaw damping is degraded (for some failures, it may be inoperative)
- thrust asymmetry compensation is inoperative.

In the direct mode the following are inoperative:

- gust suppression
- yaw damping
- the manual rudder trim cancel switch
- thrust asymmetry compensation.

Spoilers

There are 7 sets of spoilers, 5 outboard and 2 inboard of the flaperons, on the upper surface of each wing. The spoilers are numbered from left to right, 1 through 14. Spoilers on opposing wings are symmetrically paired.

Spoiler panels are used as speedbrakes to increase drag and reduce lift, both in flight and on the ground. The spoilers also supplement roll control in response to control wheel commands. Spoiler panels 5 and 10 are locked out during cruise, depending on altitude and airspeed.

All three hydraulic systems supply the spoilers. Each hydraulic system is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure. If a single spoiler fails, the corresponding spoiler on the other wing retracts. Failure of a single or multiple spoiler pairs causes the EICAS advisory message SPOILERS to display.

Spoiler Speedbrake Operation

The 14 spoiler panels are used as speedbrakes. In the normal mode, when used as speedbrakes, spoilers 5 and 10 are available as ground speedbrakes only. In the secondary and direct modes, spoilers 4, 5, 10, and 11 are locked out.

The speedbrake spoilers are controlled by the speedbrake lever located on the control stand. The speedbrake lever has three marked positions:

- DOWN
- ARMED
- UP.

The speedbrake lever can be placed in intermediate positions between ARMED and UP.

In the ARMED position, the speedbrake lever is driven aft to the UP position when the landing gear is fully on the ground (not tilted) and the thrust levers are at idle.

On the ground when either reverse thrust lever is moved to the reverse idle detent, the speedbrakes automatically extend. The speedbrake lever does not need to be in the ARMED position. A mechanical link between the speedbrake lever and the reverse thrust levers raises the speedbrake lever out of the DOWN detent. The speedbrake lever is then driven aft and the speedbrakes extend. If either thrust lever is advanced to a takeoff position, the speedbrake lever is driven to the down position.

Automatic speedbrakes are not available in the secondary and direct modes.

There is no limitation for extension of speedbrakes in a landing configuration.

Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, approach, and landing.

The airplane has an inboard and an outboard flap on the trailing edge of each wing, and one inboard and six outboard slats on the leading edge. A two-position Krueger flap provides a seal between the inboard slat and engine nacelle on each wing.

In the flaps 1 position, only the slats move. Flaps 5, 15, and 20 are takeoff flap positions. Flaps 25 and 30 are landing flaps positions. Flaps 20 is used for non-normal landing conditions only.

To protect against inadvertent deployment during cruise, flap and slat extension from the UP position is inhibited when speed is more than (LR) 275 knots (ER) 265 knots or altitude is above approximately 20,000 feet. [AFM]

If the flap handle is moved out of UP while the flaps are inhibited, LOAD RELIEF displays.

Flap and Slat Sequencing

When the flap lever is in the UP detent, all flaps and slats are commanded retracted. Moving the flap lever aft allows selection of flap detent positions 1, 5, 15, 20, 25 and 30. The flaps and slats sequence so that the slats extend first and retract last.

Starting from flaps UP, selection of flaps 1 commands the slats to move to the midrange position. The flaps remain retracted.

Selection of the flaps 5, 15, and 20 positions commands the flaps to move to the position selected. The slats remain in the midrange position.

Selection of flaps 25 commands both the flaps and slats to move to landing positions. First the slats extend to the fully extended position, then the flaps extend to the landing flaps 25 position.

Selection of flaps 30 commands the flaps to extend to the primary landing position.

During retraction, flap and slat sequencing is reversed.

The mechanical gate at the flaps 20 detent prevents inadvertent retraction of the flaps past the go-around flap setting. The mechanical gate at flaps 1 prevents inadvertent retraction of the slats past the midrange position.

Flap and Slat Modes

Three modes of flap and slat operation are possible:

- primary (hydraulic)
- secondary (electric)
- alternate (electric).

The flaps and slats can operate independently in either the primary or secondary mode. However, independent flap and slat operation in the alternate mode is not possible.

Primary mode hydraulic power is supplied by the center hydraulic system. Secondary and alternate mode electrical power is supplied by the left and right AC busses.

The secondary mode is automatically engaged whenever the primary mode fails to move the flaps or slats to the selected position. Once engaged, the secondary mode remains engaged until the affected system surfaces are fully retracted or center hydraulic system pressure is restored.

In the secondary mode, the flaps and slats are positioned by electric motors. Because autoslats are unavailable, the slats are fully extended at all flap positions if airspeed is less than (LR) 256 knots (ER) 239 knots to improve stall handling characteristics. If airspeed exceeds (LR) 256 knots (ER) 239 knots respectively, the slats retract to the midrange position (the midrange index on the slat position indicator), or will not extend beyond the midrange position.

If the slats are in the midrange position (flaps 1 through 20) when the secondary mode is engaged, they remain in that position until the flaps are retracted to UP, or extended beyond 20.

On the ground, secondary electric mode extension or retraction is inhibited when groundspeed is less than 40 knots, center hydraulic system pressure is low, and two of the following three items are true:

- left engine (GE) N2/(RR) N3 is less than 50 percent,
- right engine (GE) N2/(RR) N3 is less than 50 percent,
- primary external power is available.

The alternate mode allows direct manual operation of the flaps and slats through the secondary drive electric motors. The alternate flaps ARM switch:

- disables normal control
- arms the alternate mode
- engages the electric motors
- the flap lever no longer controls flaps/slats.

The three-position alternate flaps selector extends and retracts the flaps and slats. The flaps and slats extend simultaneously, but slat retraction is inhibited until the flaps are up. Alternate mode flap and slat extension is limited to slats midrange and flaps 20. Asymmetry protection, uncommanded motion protection, autoslats, and flap/slat load relief are not available in the alternate mode.

The alternate mode must be manually selected. Slat and flap operation time in the secondary and alternate modes is greatly increased.

Flap/Slat Load Relief

In the primary mode, the flap load relief system protects the flaps from excessive air loads. If flap airspeed placard limits are exceeded with the flaps in the 15 through 30 position, LOAD RELIEF is displayed and the flaps automatically retract to a position appropriate to the airspeed. Load relief retraction is limited to flaps 5.

When airspeed is reduced, the flaps automatically re-extend as airspeed allows. Re-extension is limited to the commanded flap position.

If a flap overspeed exists, load relief prevents flap extension beyond the 5, 15, 20, or 25 positions until airspeed is sufficiently reduced. Flap load relief is available only in the primary mode. The EICAS flap display indicates an in-transit flap condition and shows actual flap position. The flap lever does not move during flap load relief operation. Load relief for slats is not required in the primary or alternate modes.

Slat load relief is available in the secondary mode. If airspeed exceeds (LR) 256 knots (ER) 239 knots with the slats fully extended, they retract to midrange and LOAD RELIEF is displayed.

Autoslats

The autoslat system enhances airplane stall characteristics. Upon receiving a signal from the stall warning system, the slats automatically extend from the midrange position to the fully extended landing position. The slats retract a few seconds after the signal is removed. Slats are fully extended to improve stall handling characteristics.

Autoslat operation is armed at flaps 1, 5, 15 and 20 and is available only in the primary slat mode.

Flap and Slat Asymmetry Detection

A detection system detects asymmetrical extension or retraction of an individual flap. After detection, the flap drive shuts down and the EICAS message **FLAPS DRIVE** is displayed.

A detection system detects slat asymmetry. Loss of all but the most outboard slats on each wing is also detected. When slat loss or asymmetry occurs, the system shuts down the slat drive and displays the **SLATS DRIVE** EICAS message.

Uncommanded Flap or Slat Motion

Uncommanded motion is detected when the slats or flaps:

- move away from the commanded position
- continue to move after reaching a commanded position
- or move in a direction opposite to that commanded.

If the flap or slat is operating in the primary mode, uncommanded motion first causes an automatic transfer to the secondary mode. The EICAS message **FLAPS PRIMARY FAIL** or **SLATS PRIMARY FAIL** is displayed. If motion continues, the system shuts down. The EICAS message **FLAPS DRIVE** or **SLATS DRIVE** is displayed.

Flap Indications

Flap position indications are displayed on the primary EICAS display. A single vertical indicator displays combined flap and slat position. The position commanded by the flap lever is also displayed. Ten seconds after all flaps and slats are up, the entire indication is no longer displayed. A loss of position sensing removes the tape fill and flap lever position indications.

If flap/slat control is in the secondary or alternate mode, or if any non-normal condition is detected, an expanded flap indication is displayed automatically. The position of the left and right flaps and slats are separately indicated. In the alternate mode, the position commanded by the flap lever is replaced by flap position index marks at all flap and slat positions, and numbers at flaps 5 and flaps 20. The index marks are used as a guide to position the flaps to the desired setting.

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Flight Controls

EICAS Messages

Chapter 9

Section 30

Flight Control System EICAS Messages

Note: Configuration (CONFIG) warning messages are described in Chapter 15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
AUTO SPEEDBRAKE	Advisory		A fault is detected in the automatic speedbrake system.
FLAPS DRIVE	Caution	Beeper	Flap drive mechanism has failed.
FLAPS PRIMARY FAIL	Caution	Beeper	Flaps are operating in the secondary mode.
FLAP/SLAT CONTROL	Caution	Beeper	Flap/slat electronics units are inoperative.
FLIGHT CONTROL MODE	Caution	Beeper	Flight control system is operating in the secondary mode.
FLIGHT CONTROLS	Caution	Beeper	Multiple flight control surfaces are inoperative or other flight control system faults are detected.
FLT CONTROL VALVE	Advisory		One or more flight control valves are failed closed or one or more flight control shutoff switches are in SHUTOFF.
PITCH DOWN AUTHORITY	Caution	Beeper	Pitch down authority is limited.
PITCH UP AUTHORITY	Caution	Beeper	Pitch up and flare authority is limited.
PRI FLIGHT COMPUTERS	Caution	Beeper	Flight control system is operating in the direct mode.
SLATS DRIVE	Caution	Beeper	Slat drive mechanism has failed.
SLATS PRIMARY FAIL	Caution	Beeper	Slats are operating in the secondary mode.

Message	Level	Aural	Message Logic
SPEEDBRAKE ARMED	Memo		Speedbrakes are armed.
SPEEDBRAKE EXTENDED	Caution	Beeper	Speedbrake is extended when radio altitude is between 15 and 800 feet, or when the flap lever is in a landing position, or when either thrust lever is not closed.
SPOILERS	Advisory		One or more spoiler pairs are inoperative.
STAB GREENBAND	Advisory		Nose gear pressure switch disagrees with computed stabilizer green band.
STABILIZER	Warning	Siren	Uncommanded stabilizer motion is detected or stabilizer is inoperative.
STABILIZER C	Advisory		Center stabilizer control path is inoperative.
STABILIZER CUTOUT	Advisory		Both stabilizer cutout switches are in CUTOUT.
STABILIZER R	Advisory		Right stabilizer control path is inoperative.
THRUST ASYM COMP	Advisory		Thrust asymmetry compensation is inoperative.

Flight Instruments, Displays

Chapter 10

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Flight Instruments, Displays

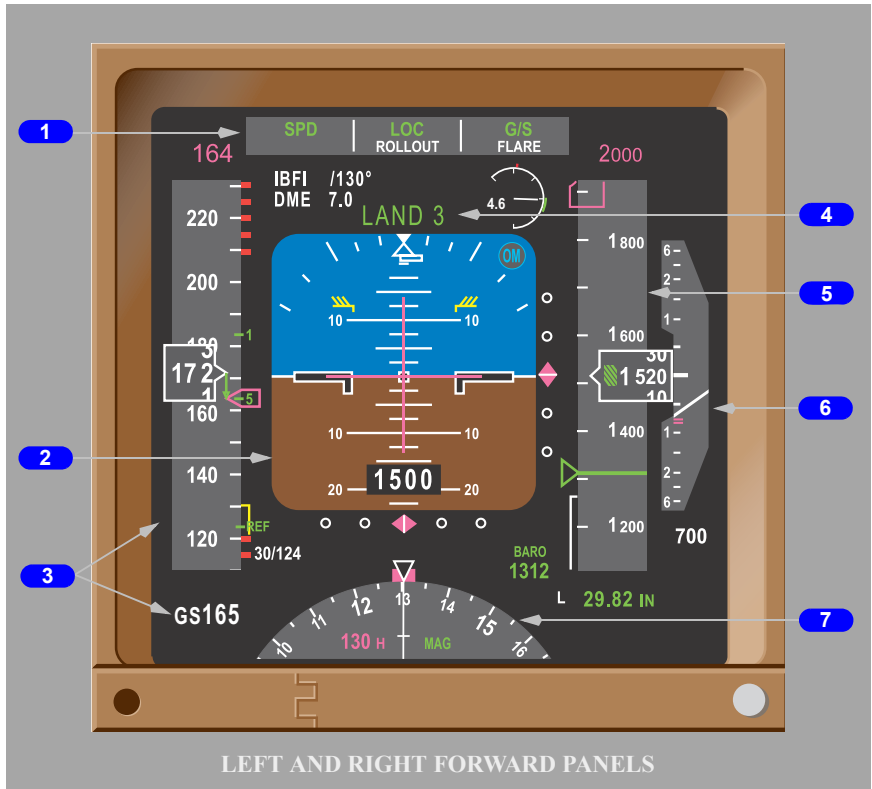
Controls and Indicators

Chapter 10

Section 10

Primary Flight Display (PFD)

PFD Indications



1 Flight Mode Annunciations

Refer to Chapter 4, Automatic Flight.

2 Attitude, Steering, and Miscellaneous Indications

Displays ADIRS attitude information.

3 Airspeed/Mach Indications

Displays air data inertial reference system (ADIRS) airspeed information and other airspeed related information.

4 Autopilot, Flight Director System Status

Refer to Chapter 4, Automatic Flight.

5 Altitude Indications

Displays ADIRS altitude and other altitude-related information.

6 Vertical Speed Indication

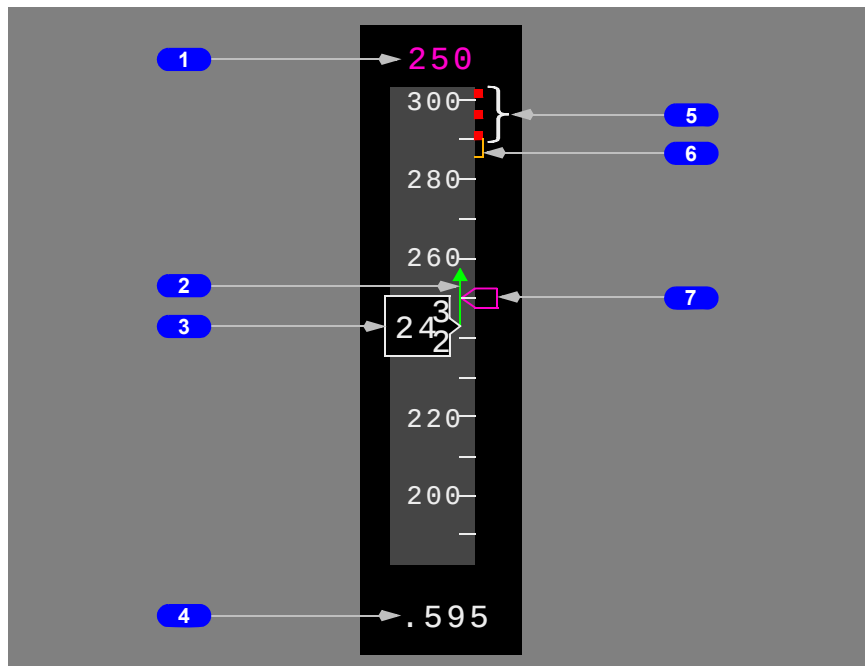
Displays ADIRS vertical speed and other vertical speed information.

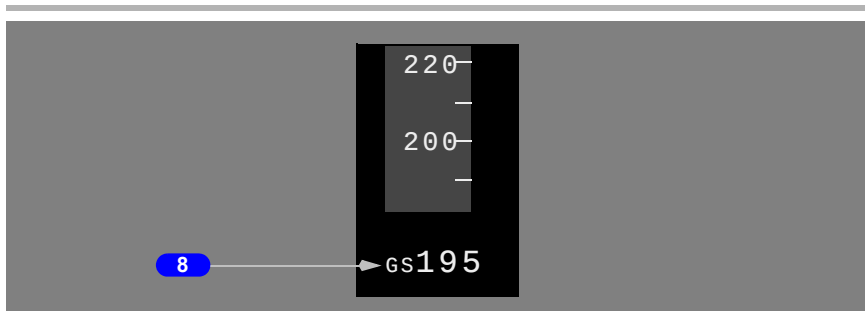
7 Heading and Track Indications

Displays current ADIRS heading, track and other heading information.

PFD Airspeed Indications

[AFM]





1 Selected Speed

Displays the airspeed/Mach selected in the mode control panel MCP IAS/MACH window (refer to Chapter 4, Automatic Flight).

Displays the FMC-computed airspeed/Mach when the MCP IAS/MACH window is blank.

2 Speed Trend Vector

Indicates predicted airspeed in ten seconds based on current acceleration or deceleration.

3 Current Airspeed

Indicates current ADIRS airspeed.

The box around the current airspeed indication turns amber when airspeed is below minimum maneuvering speed.

4 Current Mach

Displays current ADIRS Mach at or above 0.40.

5 Maximum Speed

Indicates maximum permissible airspeed as limited by the lowest of the following:

- Vmo/Mmo
- landing gear placard speed, or
- flap placard speed.

6 Maximum Maneuvering Speed

When displayed, indicates maneuver margin to high speed buffet. Bottom of the bar is the airspeed that provides 1.3 g maneuver capability (or an alternative approved maneuver capability as preset by maintenance). Bar may be displayed when operating at high altitude at relatively high gross weights.

Note: 1.3 g maneuver capability occurs at 40 degrees of bank in level flight.

7 Speed Bug

Points to the airspeed/Mach selected in the MCP IAS/MACH window.

Indicates FMC-computed airspeed when the MCP IAS/MACH window is blank.

The bug is five knots in height.

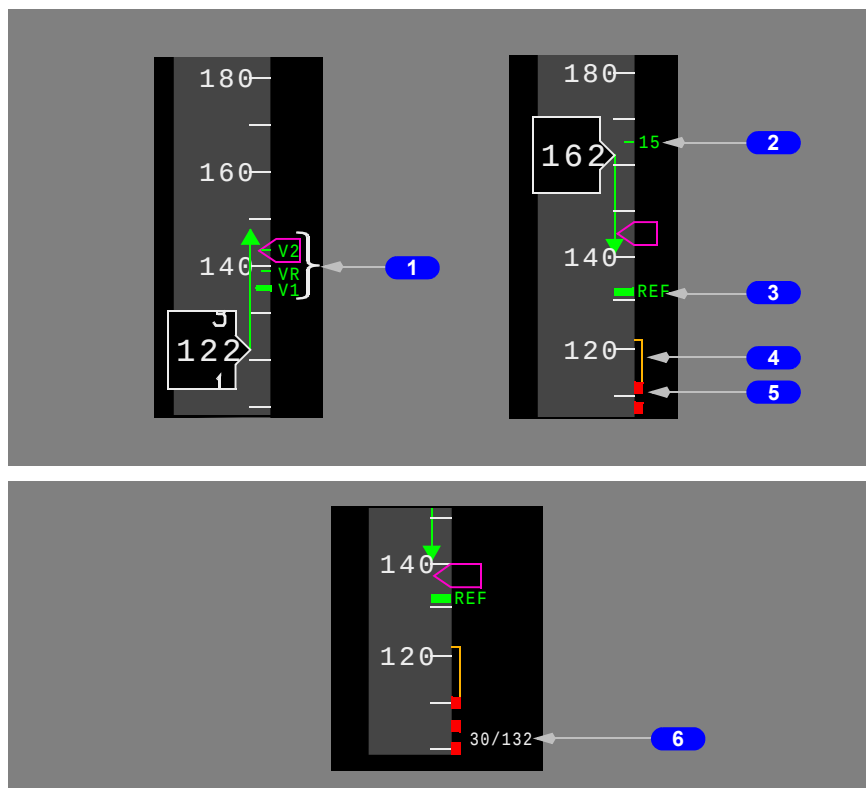
When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

8 Current Ground Speed

Displays ground speed when Mach number is less than 0.40.

When a transition occurs between the display of ground speed and Mach number, the new display is highlighted with a white box for 10 seconds.

PFD Reference Speeds



1 Takeoff Reference Speeds

Displays the takeoff reference speeds V1, VR (displays R if VR is within 4 knots of V1 or V2), and V2, selected on the CDU (refer to Chapter 11, Flight Management, Navigation):

- displayed for takeoff
- NO V SPD is displayed if V speeds are not selected on the CDU
- V1 is displayed at the top of the airspeed indication when selected and if the value is off the scale
- V1 and VR are removed at lift-off
- V2 is removed on climb-out:
 - when flap retraction begins, or
 - after 10 minutes have passed without flap lever movement, or
 - after VREF has been selected (for a turn-back).

2 Flap Maneuvering Speeds

Indicates flap maneuvering speed for flap retraction or extension.

Not displayed above approximately 20,000 feet altitude.

3 Landing Reference Speed

Displays the VREF speed as selected on the CDU (refer to Chapter 11, Flight Management, Navigation).

4 Minimum Maneuvering Speed

Indicates maneuver speed margin to stick shaker or low speed buffet. Top of the bar is the airspeed that provides:

- 1.3 g maneuver capability to stick shaker with flaps down.
- 1.3 g maneuver capability to stick shaker or VREF + 80, whichever is less, with flaps up at or below 20,200 feet altitude.
- 1.3 g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance), with flaps up above 20,200 feet altitude.

Displayed with first flap retraction after takeoff.

Note: 1.3 g maneuver capability occurs at 40 degrees of bank in level flight.

5 Minimum Speed

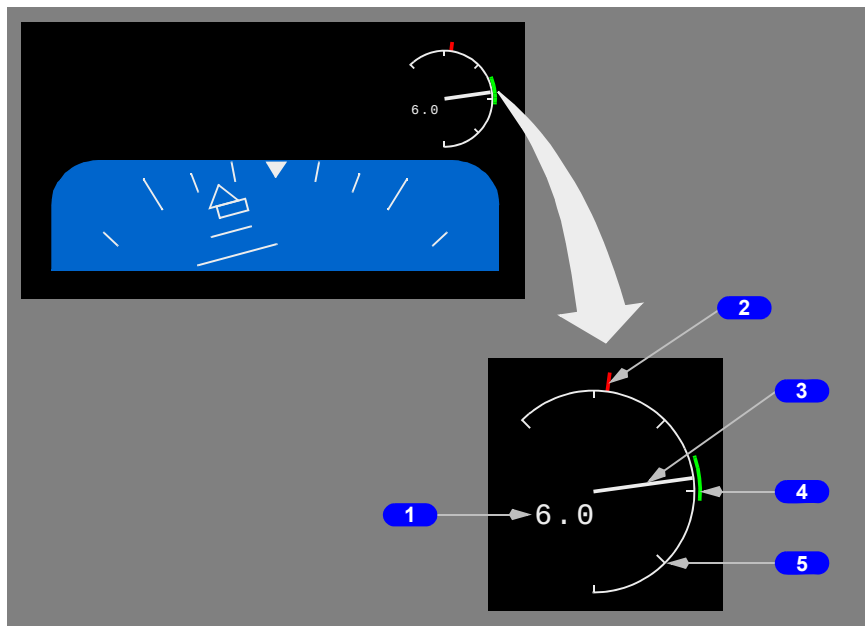
Indicates the airspeed where stick shaker activates.

6 Selected Landing Flap and VREF Speed

Landing flap and VREF speed are displayed at the bottom of the airspeed indication.

PFD Angle of Attack (AOA) Indications

The angle of attack indications display ADIRU aircraft body angle of attack.



1 Digital AOA Readout

Indicates digital AOA value to the nearest 0.2 degrees. When on the ground and ground speed less than 80 knots, the readout is fixed at 0.0 degrees. Captain and first officer values can differ by 0.2 degrees.

2 Stick Shaker Indicator (red)

Indicates point at which stick shaker activation occurs for existing flight conditions, blank if AOA signal is invalid.

3 Analog Needle

Indicates analog AOA value.

- needle travel is limited to a range of -6 degrees and +21 degrees
- fixed at 0.0 degrees when on the ground and ground speed is less than 80 knots.

4 Approach Reference Band (green)

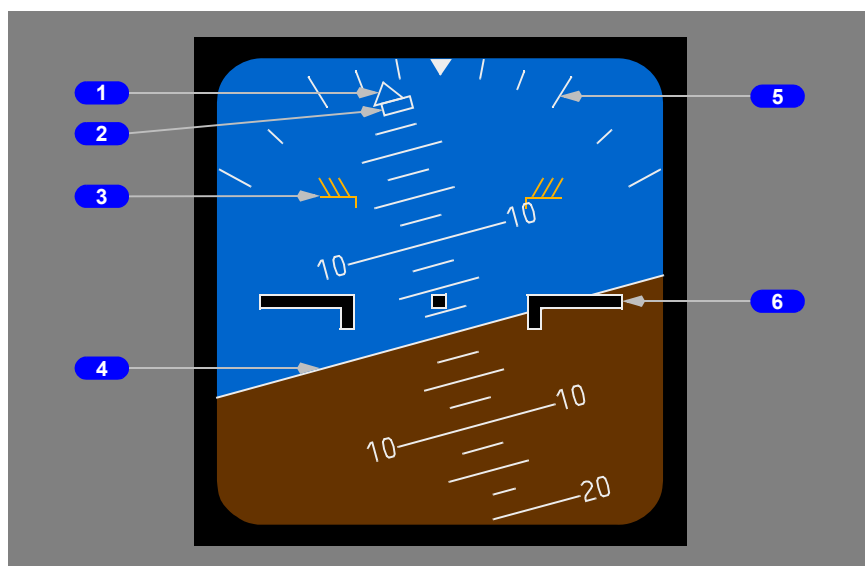
Indicates appropriate range of approach AOA for a $V_{ref}(xx) + 5$ approach.

- displayed when in normal or single engine landing flaps (20, 25, 30)
- moves with flap position
- inhibited on takeoff and initial climb.

5 Zero Degree Reference Line

Indicates zero degrees angle of attack. Reference lines are displayed every 5 degrees from -5 degrees to +20 degrees.

PFD Attitude Indications



1 Bank Pointer

Indicates:

- ADIRS bank in reference to the bank scale
- direction towards wings level

Fills and turns amber if bank angle is 35 degrees or more.

2 Slip/Skid Indication

Displaces beneath the bank pointer to indicate slip or skid.

Fills white at full scale deflection.

Turns amber if bank angle is 35 degrees or more; fills amber if the slip/skid indication is also at full deflection.

3 Pitch Limit Indication

Indicates pitch limit (stick shaker activation point for existing flight conditions). Limited to a maximum of +30 degrees.

Displayed when the flaps are not retracted, or at slow speeds with the flaps retracted.

4 Horizon Line and Pitch Scale

Indicates the ADIRS horizon relative to the airplane symbol.

Pitch scale is in 2.5 degree increments.

5 Bank Scale

Fixed reference for the bank pointer.

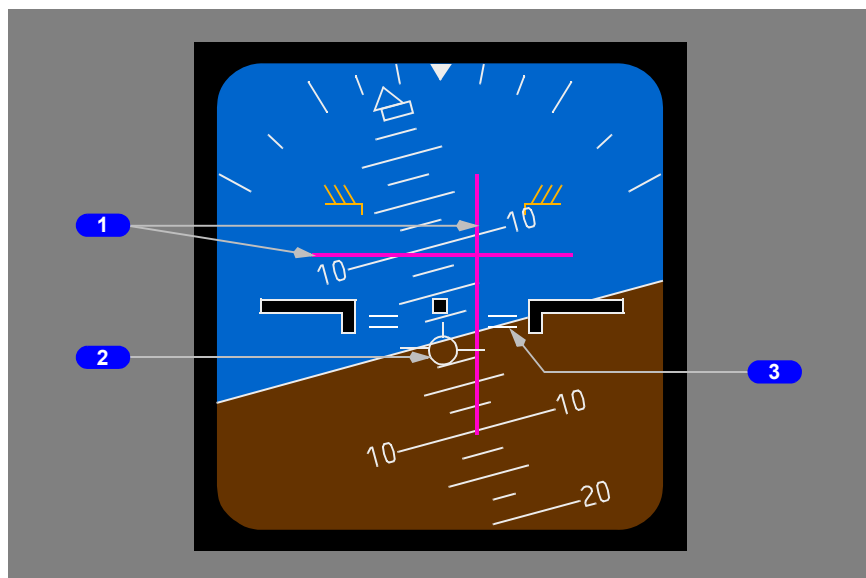
Scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

6 Airplane Symbol

Indicates airplane attitude with reference to the ADIRS horizon.

PFD Steering Indications

Note: Refer to Chapter 15, Warning Systems, for TCAS Steering Indications and Time Critical Warnings.



1 Flight Director Pitch and Roll Bars

Indicates flight director pitch and roll steering commands.

Refer to Chapter 4, Automatic Flight.

2 Flight Path Vector (FPV)

Displays flight path angle and drift angle if:

- FPV is selected on the EFIS control panel, or
- FPA (flight path angle) is selected on the MCP.

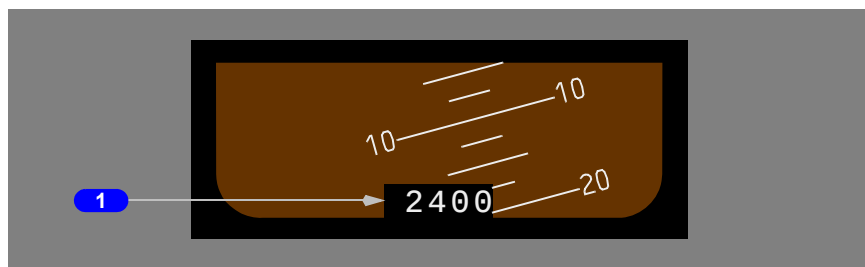
Flight path angle is displayed relative to the horizon line.

Drift angle is represented by the perpendicular distance from the centerline of the pitch scale to the FPV symbol.

3 Selected Flight Path Angle (FPA)

Indicates the selected flight path angle when FPA is selected on the MCP.

PFD Radio Altitude Indications



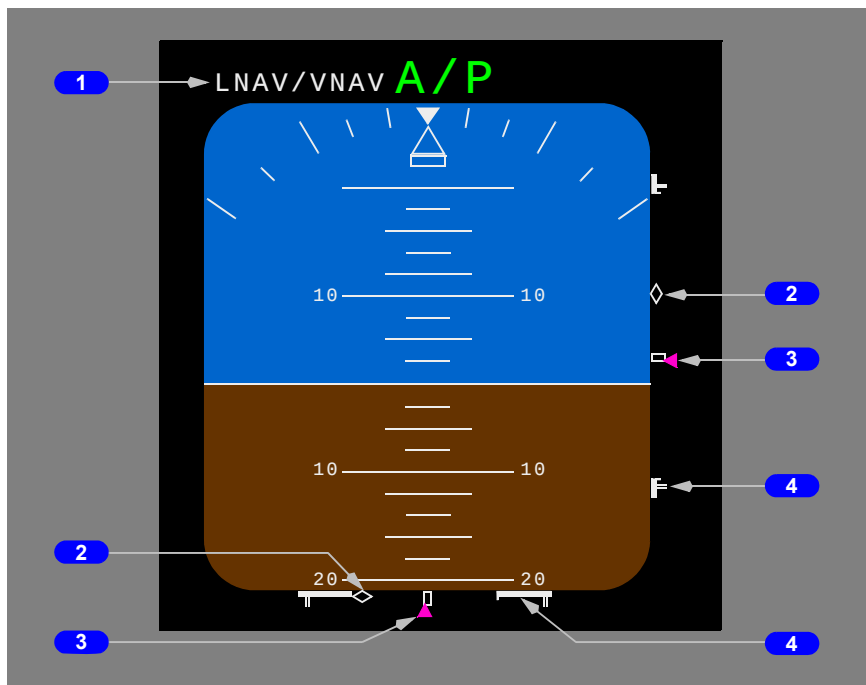
1 Radio Altitude

Displays radio altitude below 2500 feet AGL.

The display box is highlighted in white for 10 seconds when passing below 2500 feet.

Turns amber when below radio altitude minimums.

Navigation Performance Scales display when LNAV, VNAV, or TOGA are active modes or when LNAV is armed. Vertical scales do not display during cruise with VNAV PTH active.



Displays the source of navigation performance for the navigation scales.

- LOC/VNAV – Localizer with VNAV deviation
- LNAV/G/S – LNAV deviation with glideslope
- LNAV/VNAV – LNAV and VNAV deviation

Represents the relative position of the path for the selected and activated approach.

3 Deviation Pointer

Pointer:

- unfilled magenta symbol when parked at deflection limit
- filled magenta when not parked at deflection limit
- indicates relative position from the annunciated navigation source
- flashes for ten seconds if pointer migrates into bar area for more than five seconds.

4 Deviation Scale

Indicates RNP for the active phase of flight.

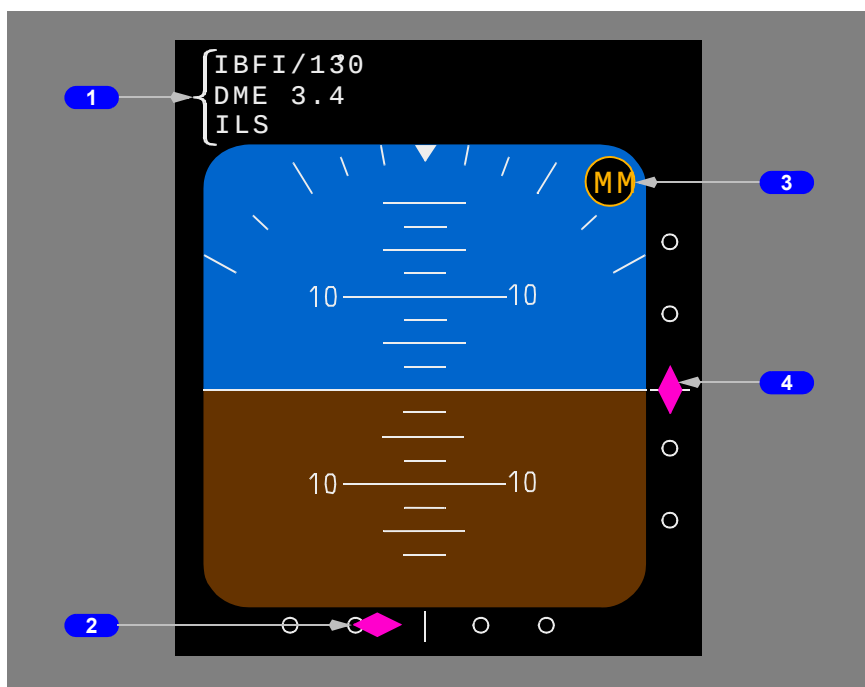
Deviation:

- bars represent Actual Navigation Performance (ANP)
- area between bars indicates margin available to remain within Required Navigation Performance (RNP) criteria
- ANP bars and scale turn amber if pointer migrates into bar area for more than five seconds.

If ANP equals RNP the:

- bars meet in the middle
- bars turn amber
- UNABLE RNP EICAS message displays

PFD Instrument Landing System Indications



1 Approach Reference

Displays the selected ILS identifier or frequency, approach front course, ILS DME distance, and source annunciation.

If the tuned ILS frequencies disagree, the frequency turns amber with an amber horizontal line through it.

If the approach courses in the ILS receivers disagree, the course turns amber with an amber horizontal line through it.

2 Localizer Pointer and Scale

The localizer pointer:

- indicates localizer position relative to the airplane
- is in view when the localizer signal is received
- fills in solid when within 2 1/2 dots from the center.

The scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

3 Marker Beacon Indication

The marker beacon indication appears flashing when over one of the marker beacon transmitters:

- IM – an airway or inner marker beacon
- MM – a middle marker beacon
- OM – an outer marker beacon.

The indication flashes in cadence with the beacon identifier.

4 Glideslope Pointer and Scale

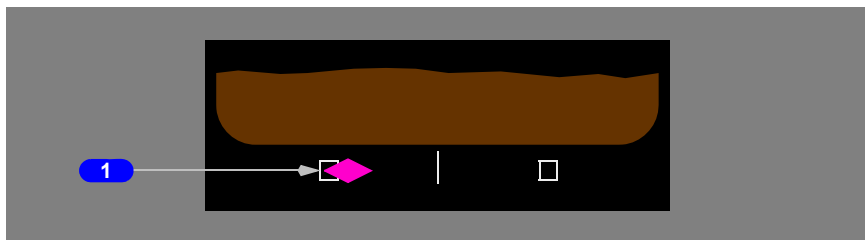
The glideslope pointer:

- indicates glideslope position relative to the airplane, and:
 - is in view when the glideslope signal is received
 - fills in solid when within 2 1/2 dots from the scale center.

The scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, the scale turns amber and the pointer flashes to indicate excessive glideslope deviation.

PFD Expanded Localizer Indications

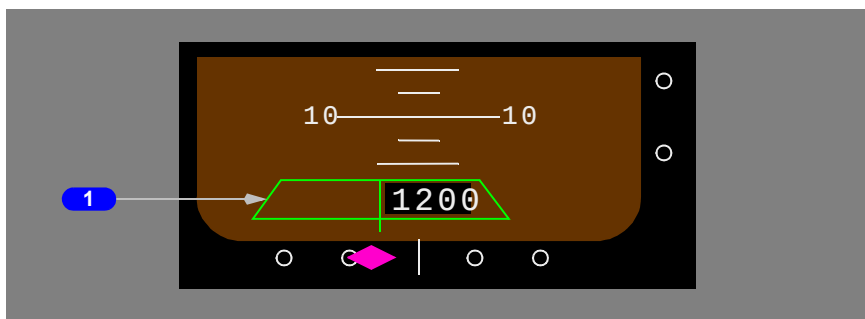


1 Expanded Localizer Scale

Displays when the autopilot or flight director is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

A rectangle equals 1/2 dot deviation.

PFD Rising Runway Indications



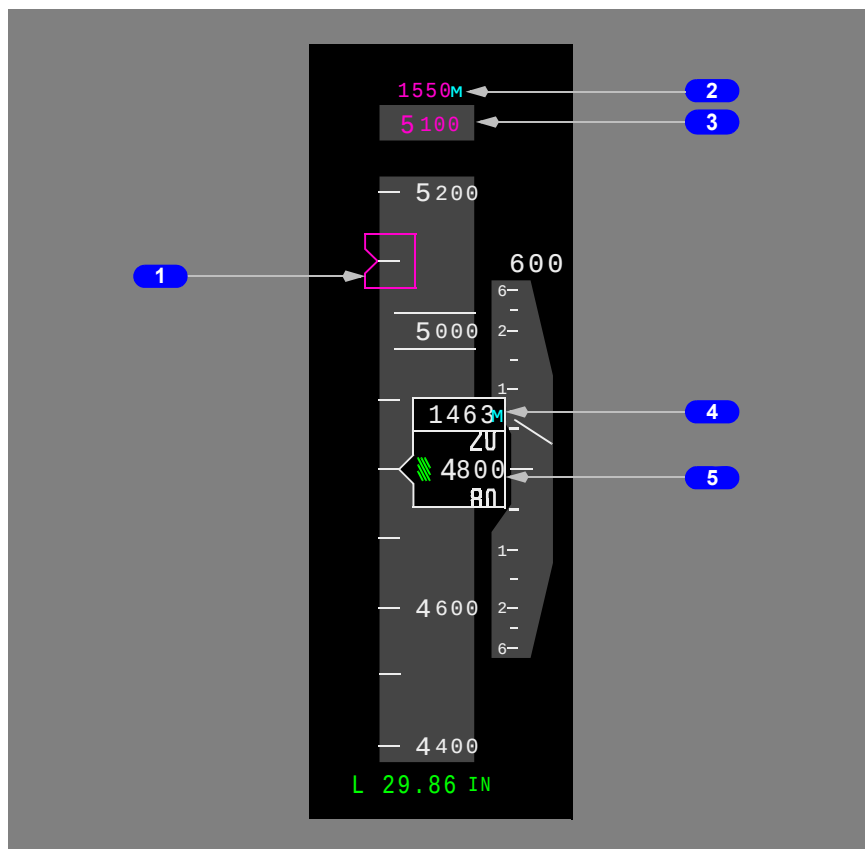
1 Rising Runway

Displayed below 2500 feet radio altitude when the localizer pointer is in view for both front and back courses.

Moves toward the airplane symbol below 200 feet radio altitude.

The stem of the rising runway symbol flashes when localizer deviations cause the diamond to flash.

PFD Altitude Indications



1 Selected Altitude Bug

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

2 Selected Altitude – Meters

Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Indicates selected altitude in meters (selected in feet in the MCP altitude window).

Displays in 10 meter increments.

3 Selected Altitude

Displays the altitude set in the MCP altitude window.

The selected altitude box is highlighted in white between 750 feet and 250 feet prior to reaching the selected altitude.

4 Current Altitude – Meters

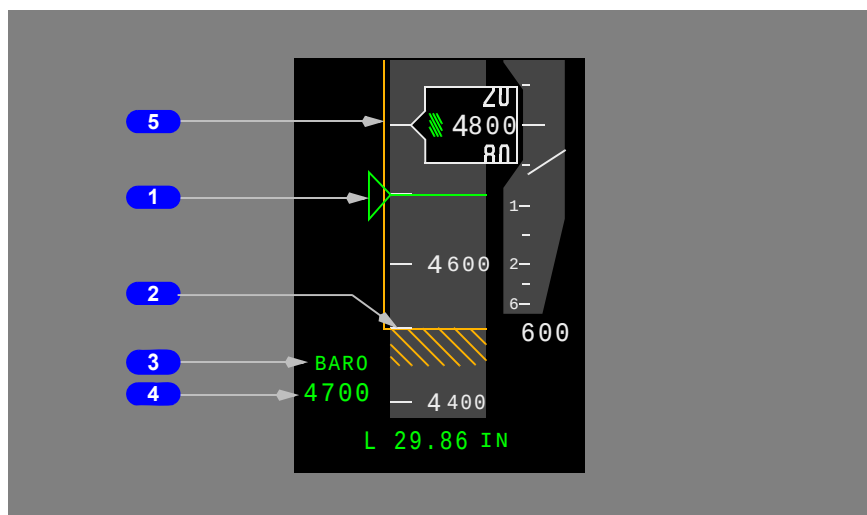
Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Displays altitude in meters.

5 Current Altitude

Indicates current ADIRS altitude.

PFD Landing Altitude/Minimums Indications



1 BARO Minimums Pointer

When BARO minimums are displayed, the number is also represented as a pointer and line on the altitude scale.

Turns steady amber when the airplane descends below baro minimums.

2 Landing Altitude Indication

The crosshatched area indicates the FMC landing altitude for the destination runway or airport.

Indicates the landing altitude for the departure runway or airport until 400 NM or one-half the distance to the destination, whichever occurs first.

3 Minimums Reference

Displays BARO when the EFIS control panel MINS reference selector is set to BARO.

Displays RADIO when the EFIS control panel MINS reference selector is set to RADIO (no corresponding pointer or line on the altitude scale).

Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

4 Minimums

Displays the approach minimums altitude set using the EFIS control panel MINS selector:

- BARO minimums are feet MSL
- RADIO minimums are radio altitude feet AGL.

Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

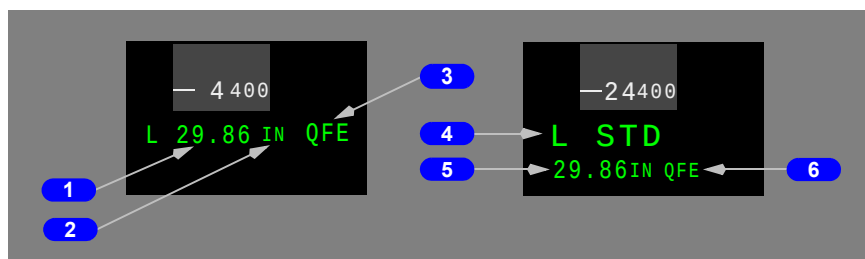
5 Landing Altitude Reference Bar

Indicates the height above touchdown.

White bar – 500 to 1000 feet above landing altitude.

Amber bar – 0 to 500 feet above landing altitude.

PFD Barometric Indications



1 Barometric Setting

Indicates the barometric setting selected on the EFIS control panel barometric selector.

STD is displayed when STD is selected on the EFIS control panel barometric STD switch.

Display is boxed and changes to amber if a barometric setting is selected, MCP altitude is above transition altitude, and airplane climbs more than 300 feet above transition altitude; or if STD is selected, MCP altitude is below transition flight level, and airplane descends more than 300 feet below transition flight level.

2 Barometric Reference

Indicates the barometric setting units selected on the EFIS control panel barometric reference selector:

- IN is inches of mercury
- HPA is Hectopascals.

3 QFE Altitude Reference

Indicates QFE altitude reference selected on the CDU APPROACH REF page.

When selected, QFE is boxed for 10 seconds.

The altitude tape is shaded green during QFE operation.

When QNH is selected, the green shading is removed; QNH is displayed for 10 seconds, then blanks.

4 Autopilot/Flight Director Barometric Source

L or R indicates that the left or right EFIS control panel is the barometric setting reference for the autopilot or flight director (the same indication is displayed on both PFDs).

Displayed when a flight director switch is ON or the autopilot is engaged.

- F/D – one turned on and one not on determines L or R
- F/D – both on – L is displayed
- A/P – first one pushed on determines L or R.

5 Preselected Barometric Setting

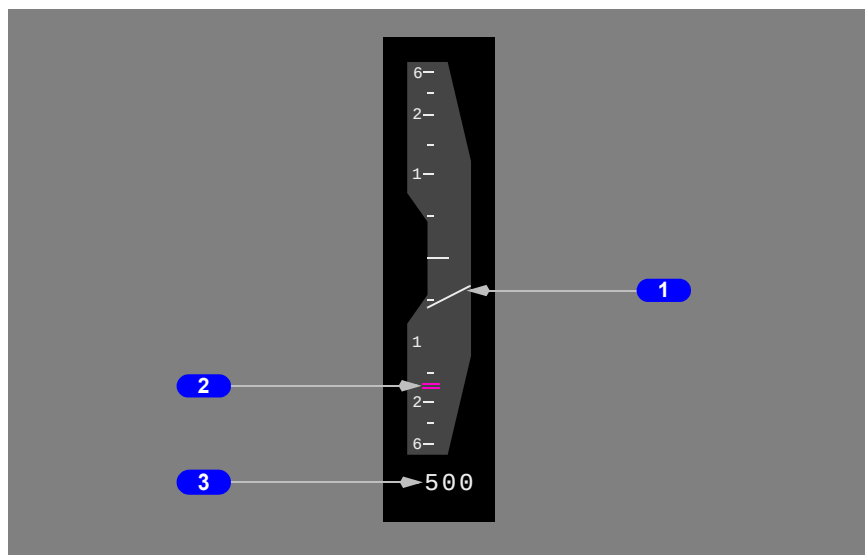
A barometric setting can be preselected when STD is displayed.

The preset barometric setting is selected on the EFIS control panel barometric selector and is displayed below STD.

6 QFE

When STD is selected, a small QFE appears when QFE is selected.

PFD Vertical Speed Indications



1 Vertical Speed Pointer

Indicates current vertical speed.

2 Selected Vertical Speed Bug

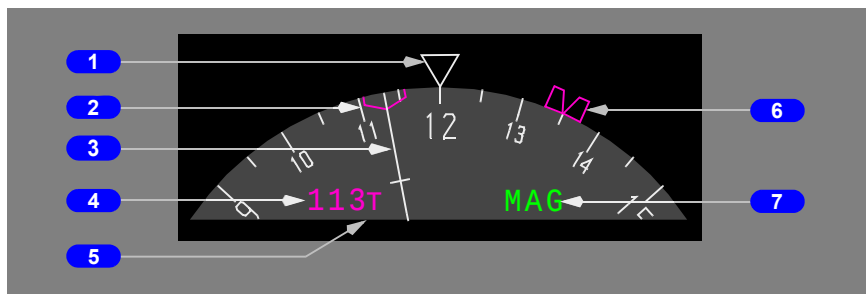
Indicates the speed selected in the MCP vertical speed window with the V/S pitch mode engaged.

3 Vertical Speed

Displays vertical speed when greater than 400 feet per minute.

The display is located above the vertical speed indication when climbing and below when descending.

Note: The selected track bug and selected heading bug are not displayed at the same time.



Indicates current heading.

The selected track bug is displayed on the inside of the compass rose.

If selected track exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the track.

Indicates the current track.

Digital display of the selected heading or track bug.

When HDG (heading) is selected, an H is displayed.

When TRK (track) is selected, a T is displayed.

The selected heading bug is displayed on the outside of the compass rose.

If selected heading exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

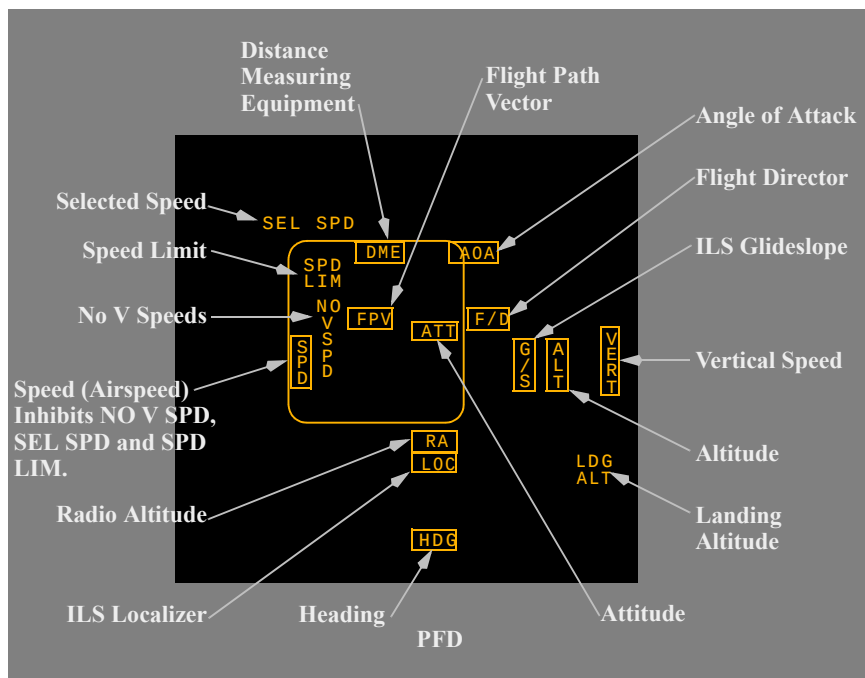
7 Heading/Track Reference

Displays the automatic or manually selected heading/track reference:

- MAG (magnetic north)
- TRU (true north).

PFD Failure Flags

Note: PFD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.

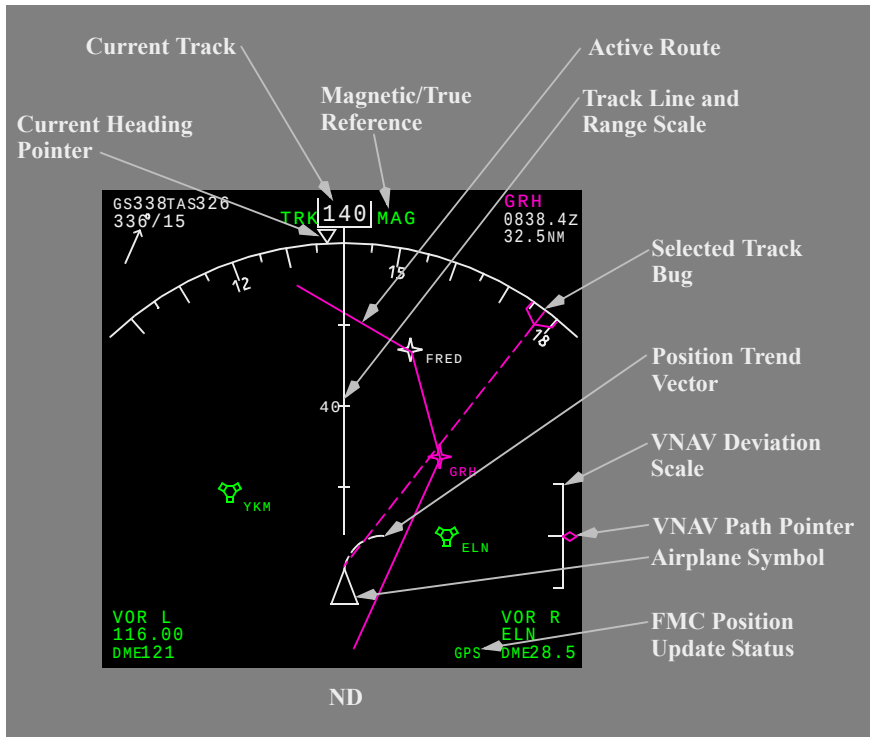


Navigation Display (ND)

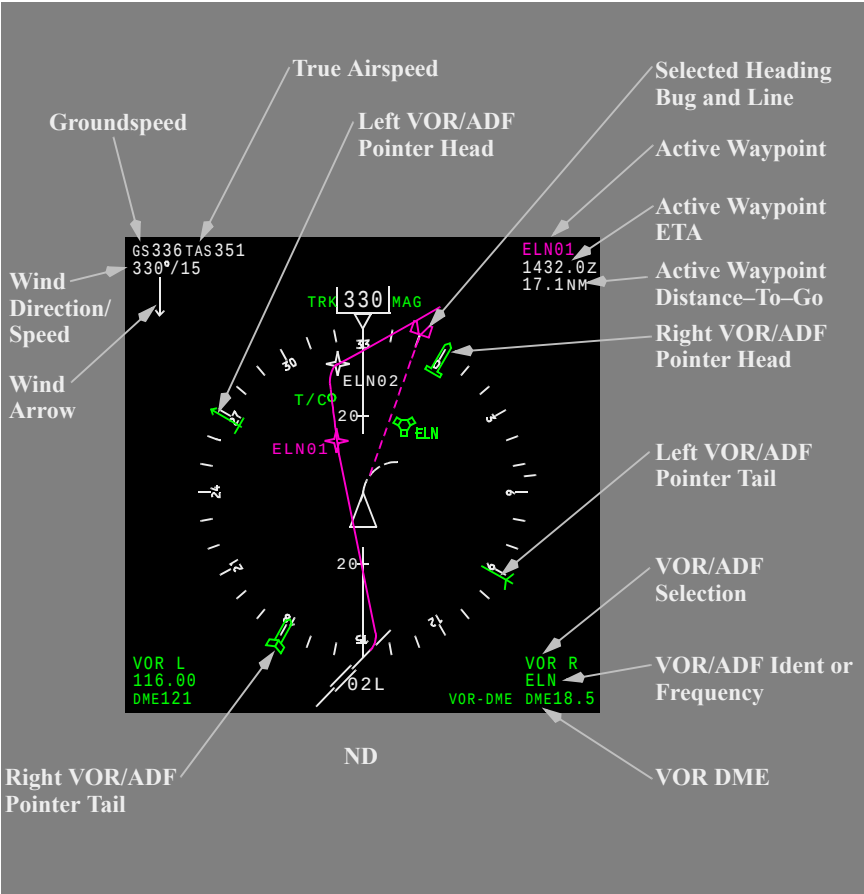
Note: Refer to the Navigation Display section of this chapter for a detailed explanation of the ND symbology shown on the following pages.

ND Map Mode

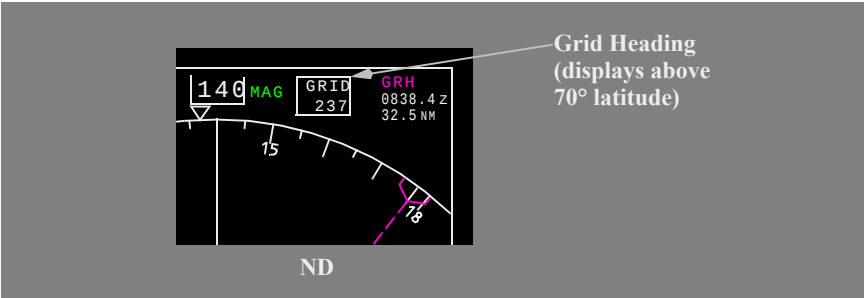
Expanded Map Mode



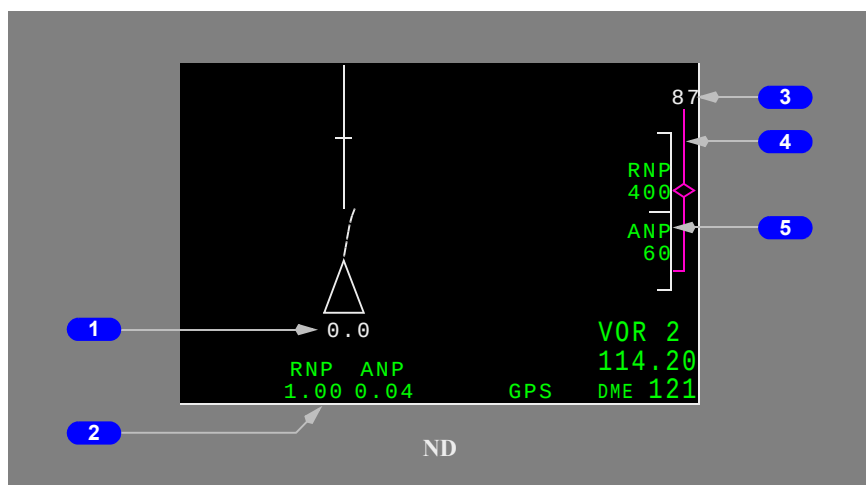
Centered Map Mode



ND Grid Heading Display



ND Navigation Performance Indications



1 Lateral Path Deviation

A digital value is displayed below the airplane symbol to show the lateral deviation (in NM) when an active path is defined. The numeric value is followed by an R or L to indicate the airplane position relative to the path.

2 Lateral RNP / ANP

Digital display (in NM) of the RNP and ANP. The RNP can be changed on the CDU RNP PROGRESS page 4.

Normally green, changes to amber when ANP exceeds RNP.

3 Vertical Path Deviation

Digital vertical path deviation (in feet) displays when value exceeds 20 feet.

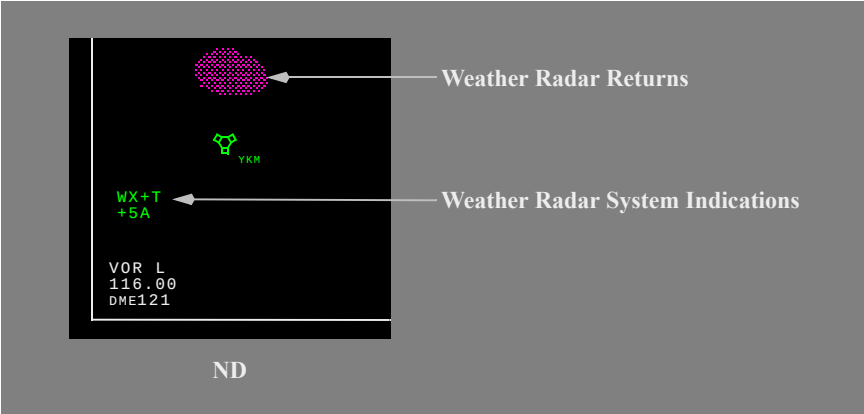
4 Vertical Path Deviation Band

Band is centered on VNAV path pointer and represents current vertical RNP.

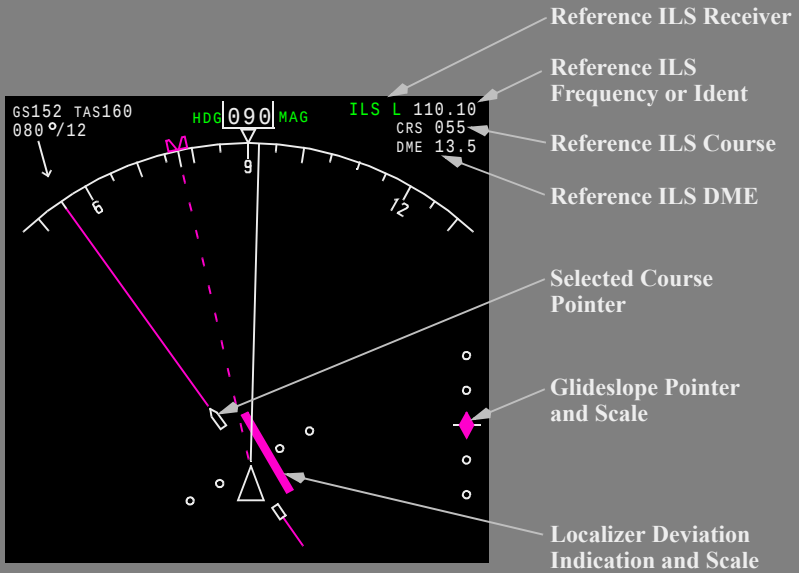
5 Vertical RNP /ANP

Digital vertical deviation values (in feet). RNP can be changed on the CDU RNP PROGRESS page 4.

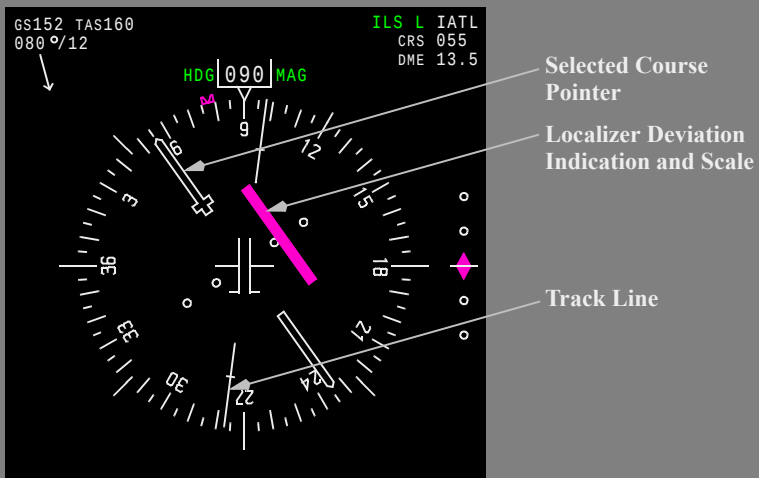
ND Weather Radar System Display Indications



ND Approach Mode

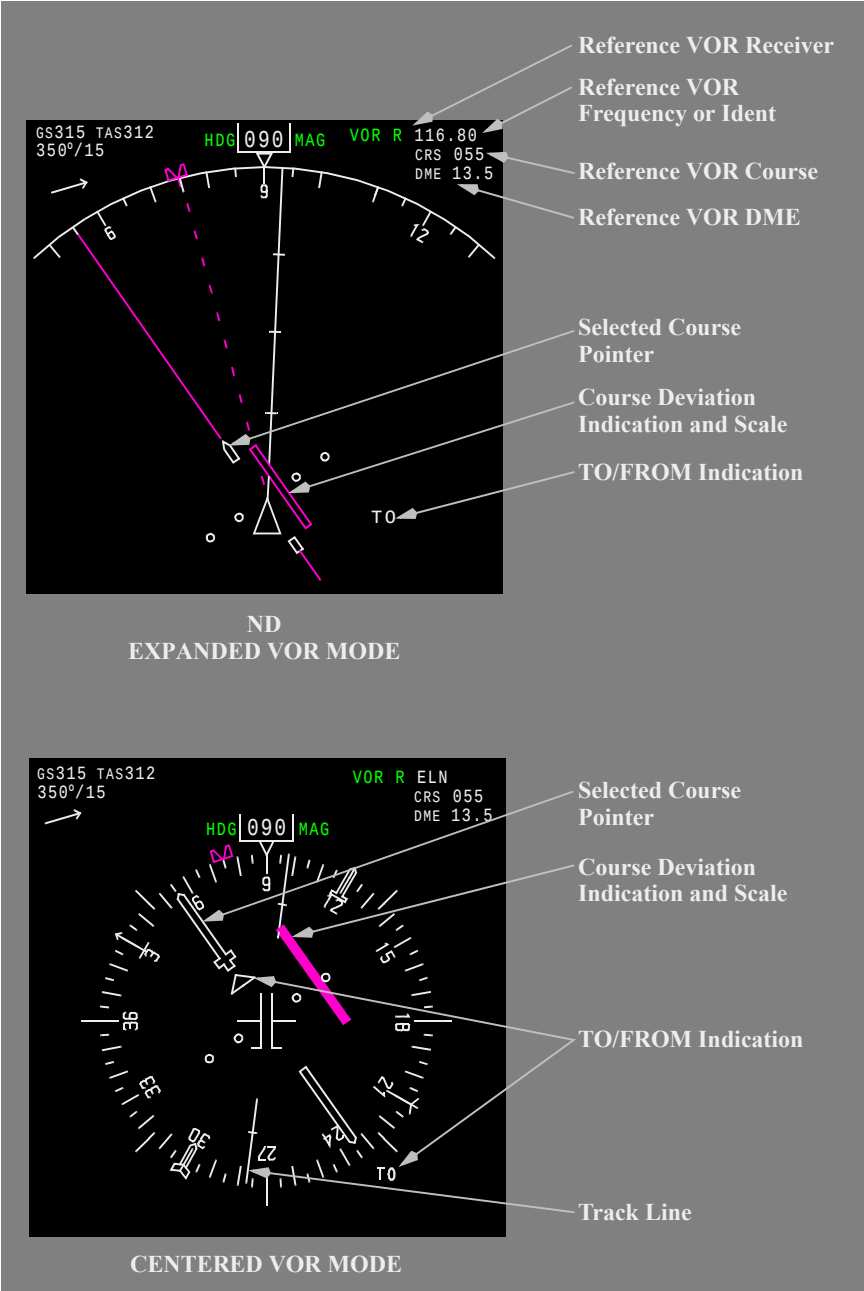


ND
EXPANDED APPROACH MODE

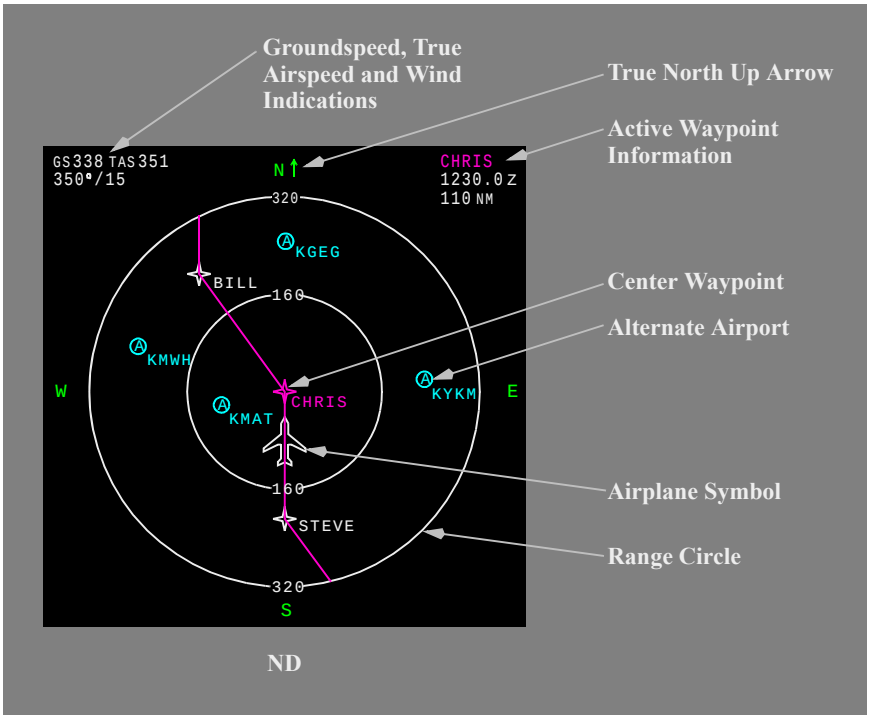


CENTERED APPROACH MODE

ND VOR Mode

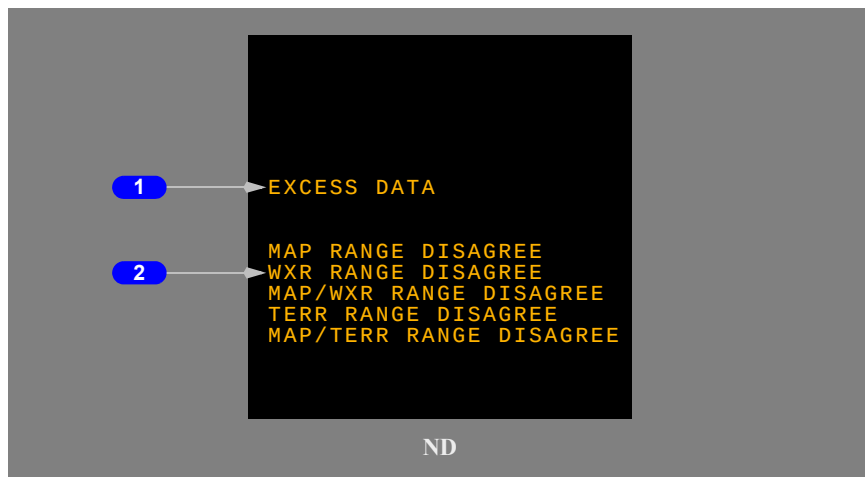


ND Plan Mode



ND Failure Indications and Flags

ND Failure Messages



1 Excess Data

The amount of map information sent to the primary display system is too great to display.

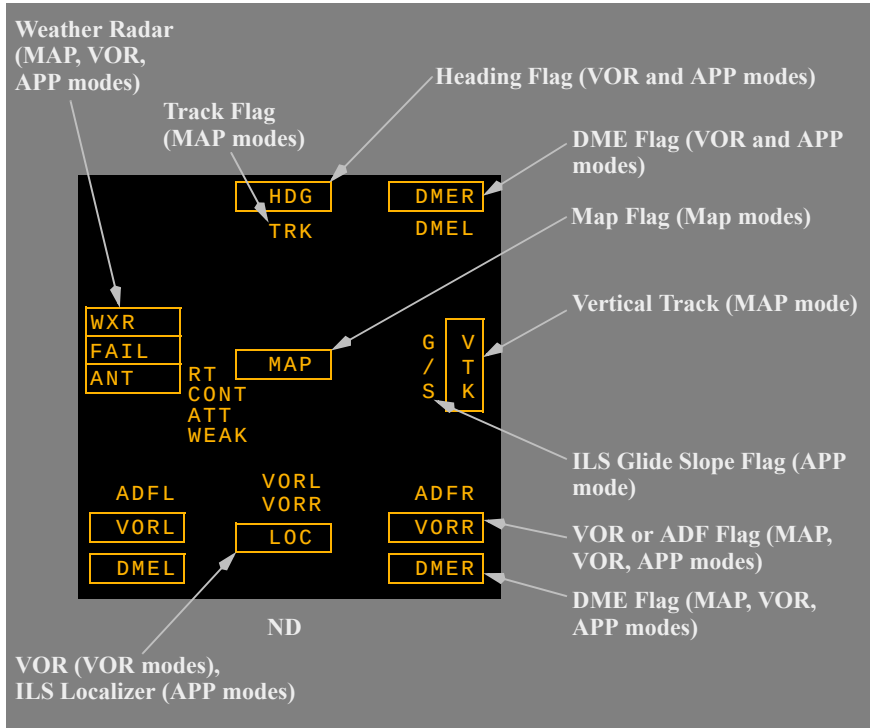
2 MAP/WXR Range Disagree

The selected range and range of display information disagree.

Map information is removed.

ND Failure Flags

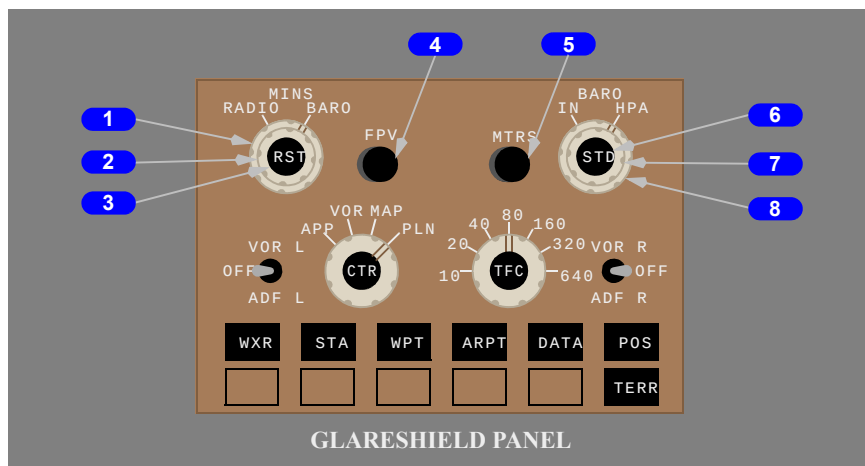
Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate. Flag location varies, depending on the ND mode selected.



EFIS Control Panels

The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

EFIS Control Panel PFD Controls



1 Minimums (MINS) Reference Selector (outer)

RADIO – selects radio altitude as the PFD minimums reference.

BARO – selects barometric altitude as the PFD minimums reference.

2 Minimums (MINS) Selector (middle)

Rotate (slew)– adjusts the PFD radio or baro minimums altitude.

3 Minimums Reset (MINS RST) Switch (inner)

Push –

- resets the PFD minimums alert display
- blanks the minimums display when green.

4 Flight Path Vector (FPV) Switch

Push – displays the PFD flight path vector.

5 Meters (MTRS) Switch

Push – displays PFD altitude meters indications.

6 Barometric Standard (BARO STD) Switch (inner)

Push –

- selects the standard barometric setting (29.92 inches Hg/1013 HPA) for the PFD barometric reference
- if STD is displayed, selects the preselected barometric setting
- if no preselected barometric setting is displayed, displays the last value before STD was selected.

7 Barometric (BARO) Selector (middle)

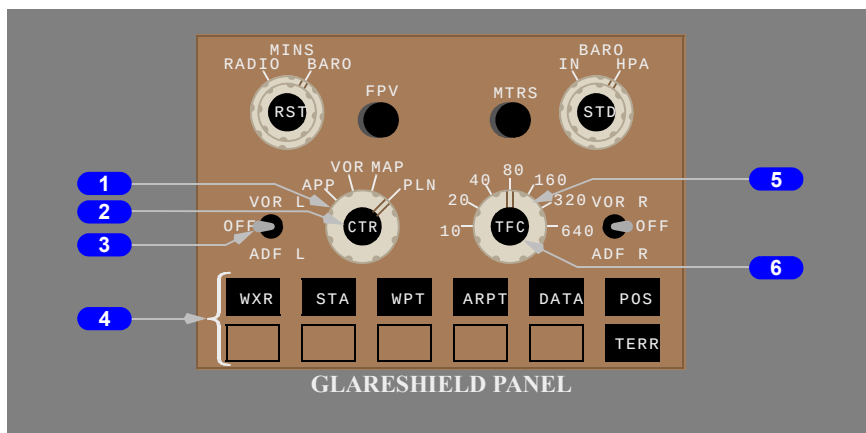
Rotate (slew) – adjusts the PFD barometric reference.

8 Barometric (BARO) Reference Selector (outer)

IN – selects inches of mercury as the PFD barometric reference.

HPA – selects Hectopascals as the PFD barometric reference.

EFIS Control Panel ND Controls



1 ND Mode Selector (outer)

Selects the desired ND map display.

APP –

- displays localizer and glideslope information in heading-up format
- displays reference ILS receiver, ILS frequency or identification, course, and DME
- weather radar and TCAS are not displayed in CTR APP mode.

VOR –

- displays VOR navigation information in heading-up format
- displays reference VOR receiver, VOR frequency or identification, course, DME, and TO/FROM indication
- weather radar and TCAS are not displayed in CTR VOR mode.

MAP –

- displays FMC-generated route and map information, airplane position, heading, and track
- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

PLN –

- displays a nonmoving, true north-up, route depiction
- the airplane symbol represents actual airplane position
- allows route step-through using the CDU legs page
- weather radar and TCAS are not displayed in PLN mode.

2 ND Center (CTR) Switch (inner)

Push –

- displays the full compass rose (centered) for APP, VOR, and MAP modes
- subsequent pushes alternate between expanded and centered displays.

3 VOR/ADF Switches

Displays VOR or ADF information on the respective ND.

VOR – displays the VOR pointer, VOR frequency or identification and associated DME information in all modes except PLAN.

OFF – removes VOR and ADF displays.

ADF – displays the ADF pointer and ADF frequency or identification in all modes except PLAN.

4 Map Switches

The map switches:

- select detailed ND information displays
- displays can be selected simultaneously
- second push removes the information.

WXR (weather radar) – displays weather radar information (refer to Chapter 11, Flight Management, Navigation). Also displays range information when in the expanded APP or VOR modes.

STA (station) –

- displays high and low altitude navigation aids, if the ND range selector is in the 10, 20 or 40 NM range
- displays high altitude navigation aids, if the ND range selector is in the 80, 160, 320, or 640 NM range.

WPT (waypoint) – displays waypoints, if the ND range selector is in the 10, 20 or 40 NM range.

ARPT (airport) – displays airports on all ranges.

DATA – displays the FMC estimated time of arrival, altitude at each waypoint, and altitude constraints at each waypoint.

POS (Position) –

- displays ADIRU and GPS positions
- displays VOR raw data radials extended from the nose of the airplane to the stations displayed on the CDU NAV RAD page.

TERR (terrain) – displays terrain data. (Refer to Chapter 15, Warning Systems.)

5 ND Range Selector (outer)

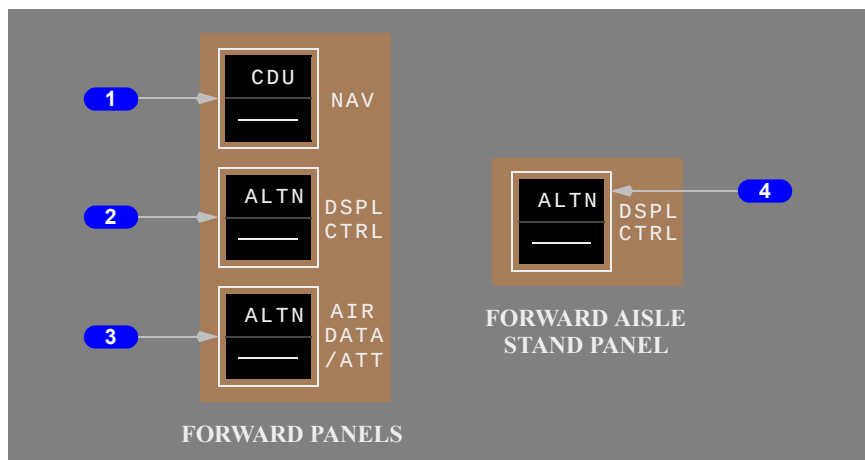
Selects the desired ND nautical mile range scale.

6 ND Traffic (TFC) Switch (inner)

Push – displays TCAS ND information. (Refer to Chapter 15, Warning Systems.) Also displays range information when in the expanded APP or VOR modes.

Instrument Source Select Panels

The instrument source switches are provided for use if a display-related failure is not detected by automatic system monitors. Normally, the display system automatically reconfigures for failures without the pilot having to use these switches.



1 Navigation (NAV) Source Switch

Off – normal position (CDU not visible, switch out):

- with the FMC selector in AUTO, the active FMC provides the information to generate the ND map
- if both FMCs fail, the CDU provides navigation data.

CDU – non-normal position (CDU visible, switch in). The selected CDU generates the ND map. Normally, the sources are:

- left ND map – left CDU
- right ND map – right CDU.

2 Display Control (DSPL CTRL) Source Switch

Off – normal position (ALTN not visible, switch out):

- automatically selects display processing channels for the left outboard and inboard, or right outboard and inboard display pairs
- reconfigures display processing channels as required for display unit or processing channel failures.

ALTN – non-normal position (ALTN visible, switch in). An alternate display processing channel is selected to replace the current display processing channel.

3 Air Data / Attitude (AIR DATA/ATT) Source Switch

Off – normal position (ALTN not visible, switch out):

- the ADIRU provides air data and attitude information to the PFD and ND
- Alternate sources or the SAARU are automatically selected to replace ADIRU air data or attitude, as required.

ALTN – non-normal position (ALTN visible, switch in). The PFD and ND alternate air data/attitude source is selected as follows:

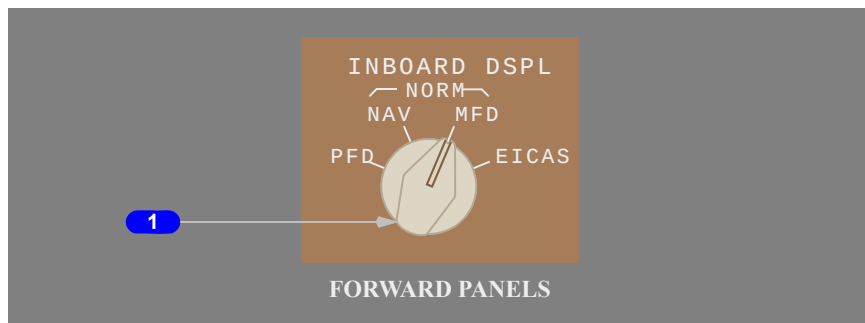
- air data (captain): SAARU single channel
- air data (first officer): ADIRU single channel
- attitude (captain and first officer): SAARU.

4 Center Display Control (DSPL CTRL) Source Switch

Same as the display control source switches for the left and right inboard and outboard display units, except this switch controls the upper center and lower center display units.

Heading Reference and Inboard Displays

Inboard Display Controls



1 INBOARD Display (DSPL) Selector

Selects what is displayed on each inboard display unit.

PFD – displays the PFD, blanks the PFD on the outboard display unit, and inhibits selections made from the display select panel.

NAV – displays the ND and inhibits selections made from the display select panel.

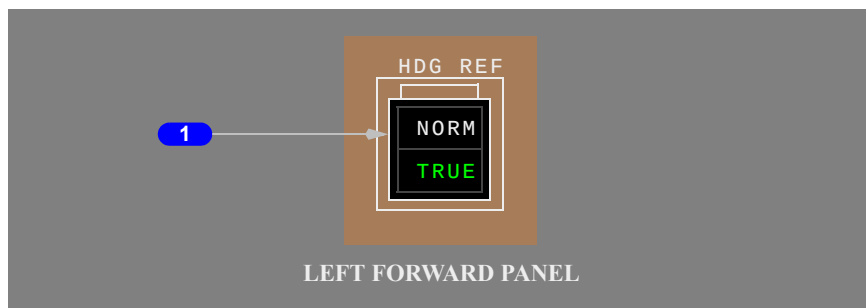
MFD – displays the selection made on the display select panel.

EICAS –

- displays EICAS
- inhibits most selections made from the display select panel (limited ENG, FUEL, and AIR displays can be selected)
- blanks the upper center display unit.

Note: The PFD automatically appears on an inboard display unit if the adjacent outboard display unit fails, regardless of switch position.

Heading Reference Controls



1 Heading Reference (HDG REF) Switch

Pushing alternately selects the heading reference for the PFDs, NDs, AFDS, and FMCs.

NORM –

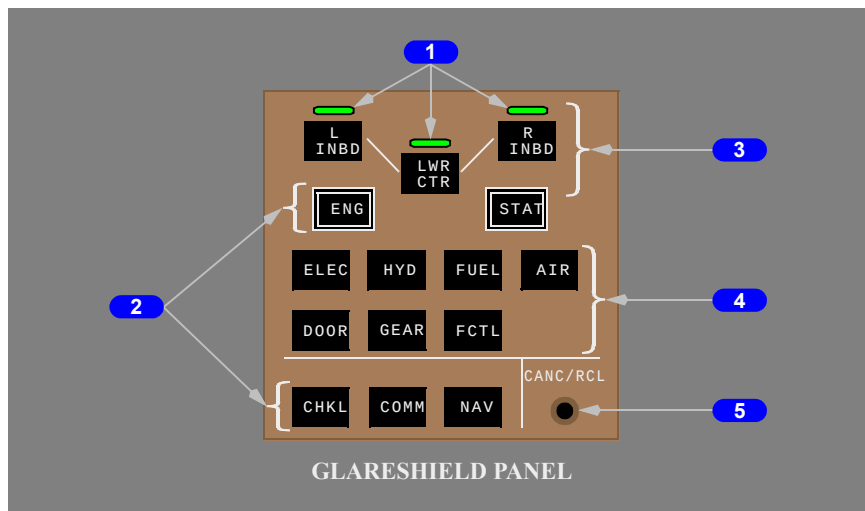
- normally references magnetic north
- automatically references true north when north of 82°N or south of 82°S latitude or within the vicinity of the magnetic poles (PFDs, NDs, and FMCs)
- provides no reference for AFDS roll modes other than LNAV when north of 82°N or south of 82°S latitude or in the vicinity of the magnetic poles.

TRUE – references true north regardless of latitude.

When the AFDS roll mode is HDG SEL, switching the heading reference switch from NORM to TRUE or TRUE to NORM engages the HDG HOLD mode.

When the AFDS roll mode is TRK SEL, switching the heading reference switch from NORM to TRUE or TRUE to NORM engages the TRK HOLD mode.

Display Select Panel



1 Display Lights

Illuminates to show the display unit the display select panel controls.

2 Display Switches

Pushing the switch displays the associated display. Pushing the same switch a second time blanks the display or (left and right inboard display units) redisplay the ND if there is only one page of messages. If there are more than one page of messages, pushing STAT pages through the messages.

ENG – secondary engine EICAS (Ch. 7).

STAT – status page:

- hydraulic system indications (Ch. 13)
- APU indications (Ch. 7)
- oxygen system indications (Ch. 1)
- status messages for dispatch determination (Ch. 15).

CHKL – checklist (this chapter).

COMM – communications (Ch. 5).

NAV – navigation display (this chapter).

3 Multifunction Display (MFD) Switches

Selects the active MFD (left inboard, lower center, or right inboard display unit) for display selection.

The appropriate left or right INBOARD DISPLAY selector must be in the MFD or EICAS position. The other display select panel switches determine what is displayed on the selected MFD.

4 Synoptic Switches

Pushing the switch displays the associated synoptic. Synoptics present a simplified view of system status as an aid for crew situational awareness. Pushing the same switch a second time blanks the display or (left and right inboard display units) redisplay the ND.

ELEC – electrical system (Ch. 6).

HYD – hydraulic system (Ch. 13).

FUEL – fuel system (Ch. 12).

AIR – air systems (Ch. 2).

DOOR – doors (Ch. 1).

GEAR – landing gear and brake systems (Ch. 14).

FCTL – flight control system (Ch. 9).

5 Cancel/Recall (CANC/RCL) Switch

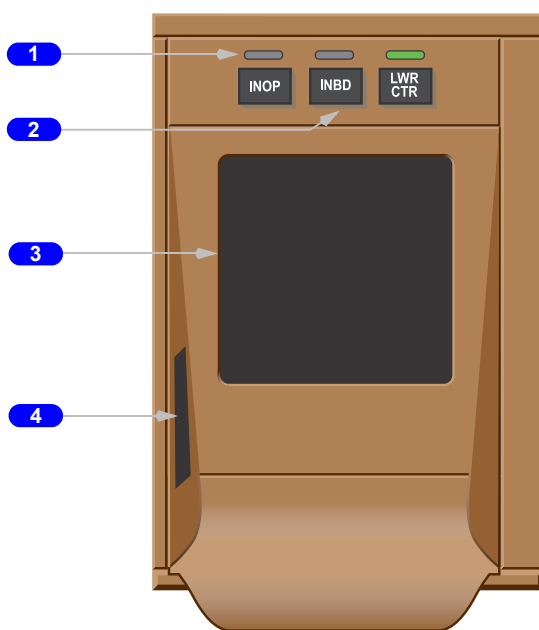
Refer to Warning Systems, Chapter 15.

Cursor Control Device (CCD)

The left CCD controls the left inboard and lower center display unit cursor position and operation.

The right CCD controls the right inboard and lower center display unit cursor position and operation.

The left CCD is shown; the right CCD is similar, except the cursor select switch and the LWR CTR switches are located on the opposite side of the CCD.



CONTROL STAND

1 Cursor Location Lights

The associated annunciator light illuminates to indicate which display unit is selected.

2 Cursor Location Switches

Selects the display unit where the cursor appears (inboard or lower center display) and automatically deselects the previous display unit.

3 Touch Pad

Finger movement on the touch pad moves the cursor on the selected display. Lifting the finger off the pad and putting it back down in a different location (except the corner areas) does not move the cursor. The cursor only moves when the finger is moved on the touch pad surface.

Corner areas – placing a finger in one of the four corners puts the cursor in that respective corner of the screen. Moving the cursor into a corner region without lifting the finger from the pad does not have this effect.

4 Cursor Select Switch

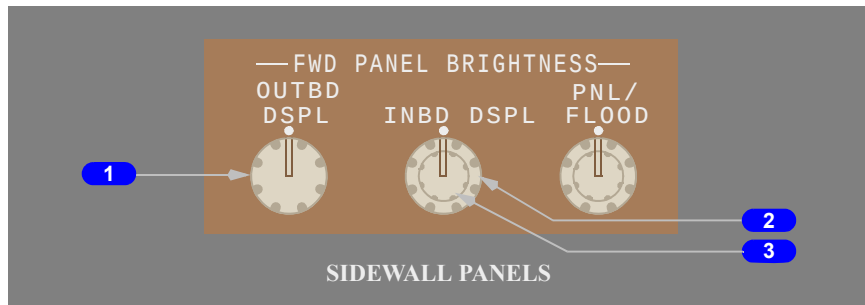
Push – activates the area of the screen that the cursor is currently in, such as a menu item or command button. The area is highlighted by a white border to indicate it can be selected.

The switch is used to select menus, checklists, checklist steps, and other functions.

Display Brightness Controls

Forward Panel Brightness Controls

The left panel is shown.



1 Outboard Display (OUTBD DSPL) Brightness Control

Rotate – adjusts the brightness of the outboard display unit.

2 Inboard Display (INBD DSPL) Brightness Control (outer)

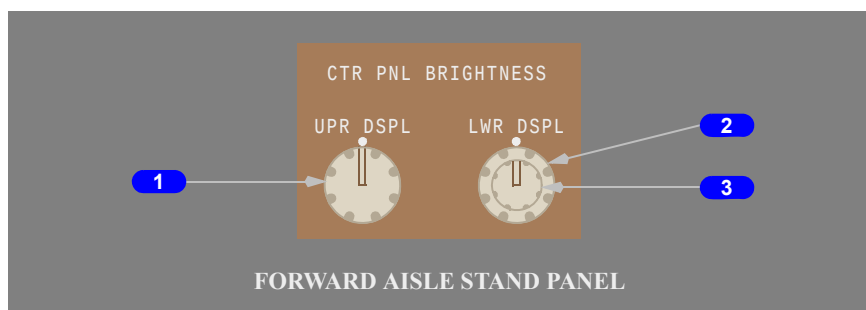
Rotate – adjusts the brightness of the inboard display unit.

3 Inboard Display (INBD DSPL) Brightness Control (inner)

Rotate – adjusts weather radar or terrain display brightness on the inboard display unit.

Weather radar and terrain data cannot be displayed at the same time.

Center Panel Brightness Controls



1 Upper Display (UPR DSPL) Brightness Control

Rotate – adjusts the brightness of the upper center display unit.

2 Lower Display (LWR DSPL) Brightness Control (outer)

Rotate – adjusts the brightness of the lower center display unit.

3 Lower Display (LWR DSPL) Brightness Control (inner)

Rotate – adjusts weather radar or terrain display brightness on the lower center display unit.

Weather radar and terrain data cannot be displayed at the same time.

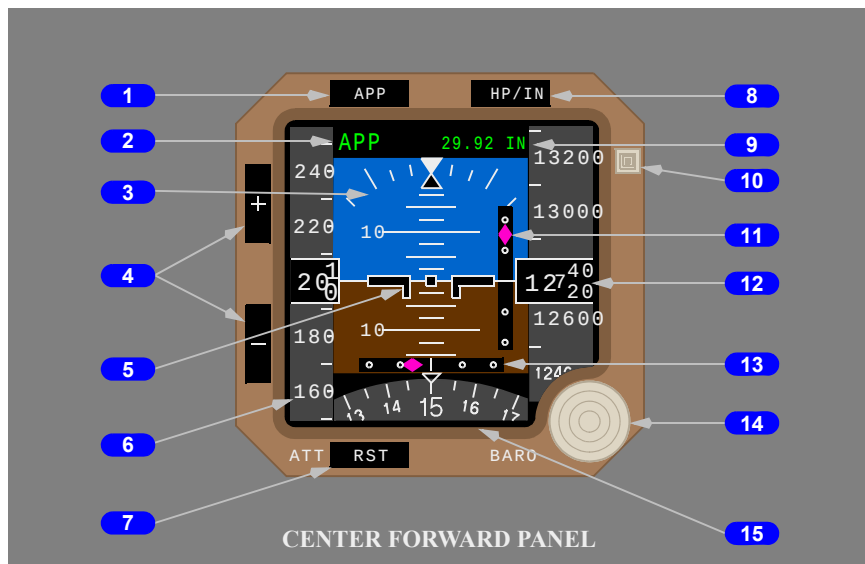
Standby Flight Instruments

The standby flight instruments include the:

- integrated standby flight display
- standby magnetic compass

Integrated Standby Flight Display (ISFD)

Provides an independent source of attitude, airspeed, and altitude information.



1 Approach (APP) Switch

Push -

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks.

2 Approach Mode Annunciation

Indicates approach mode selected.

Blank - no approach deviation data displayed.

APP - ILS localizer and glideslope deviation data displayed.

BCRS (back course) - reverses sensing for localizer pointer during back course approaches.

3 Attitude Display

Displays airplane attitude.

Indicates bank in reference to the bank scale.

Indicates the horizon relative to the airplane symbol.

Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive and the direction to the horizon line.

4 Display Brightness Switches

Push -

- + increases display brightness
- - decreases display brightness.

5 Airplane Symbol

Indicates airplane position with reference to the horizon.

6 Airspeed Indications

Indicates airspeed when above 30 knots.

7 Attitude Reset (ATT RST) Switch

Push and hold at least two seconds -

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds
- starts new initialization sequence if previous attempt failed (ground only).

8 Hectopascal/Inch (HP/IN) Switch

Push - changes units of barometric reference.

9 Barometric Setting

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

10 Ambient Light Sensor

Automatically adjusts display intensity for ambient lighting condition.

11 Glideslope Pointer and Scale

The glideslope pointer indicates glideslope position relative to the airplane -

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the BCRS mode is selected.

12 Current Altitude

13 Localizer Pointer and Deviation Scale

The localizer pointer indicates localizer position relative to the airplane -

- the pointer is in view when the localizer signal is received
- the scale is in view when either the APP or BCRS mode is selected.

14 Barometric Selector (BARO)

Rotate - changes barometric setting.

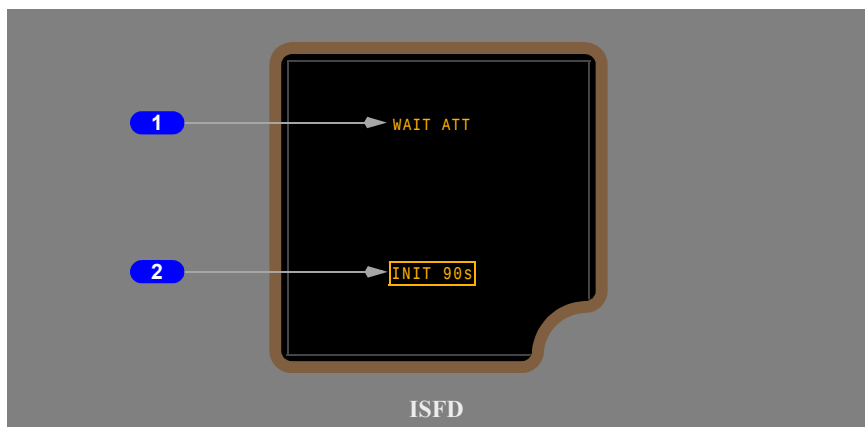
Push -

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD displayed, selects the preselected barometric setting.

15 Heading Indication

Displays airplane heading.

ISFD Messages



1 Attitude Messages

Indicates attitude display status.

ATT:RST (amber) - attitude must be reset using the attitude reset switch.

ATT 10s (amber) - 10 second attitude realignment in progress.

WAIT ATT (amber) - indicates temporary self correcting loss of attitude.

2 Initialization message

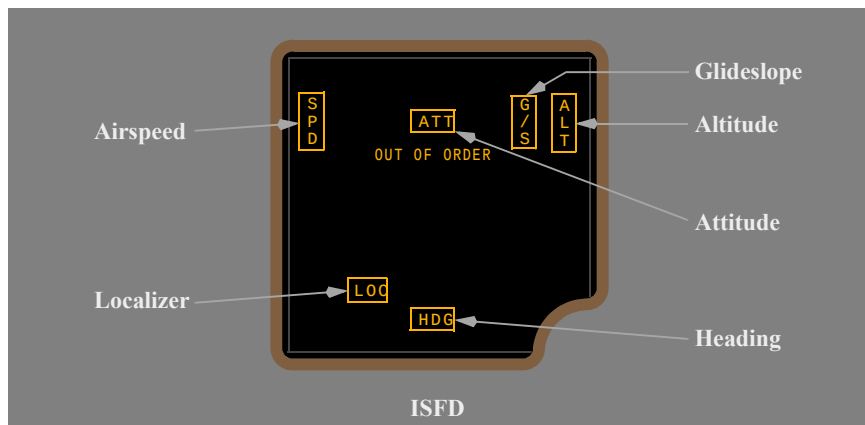
INIT 90s (amber) - countdown of 90 second initialization -

- countdown stops if excessive motion is detected
- countdown resumes when motion stops
- ATT:RST displays if initialization is not complete within six minutes.

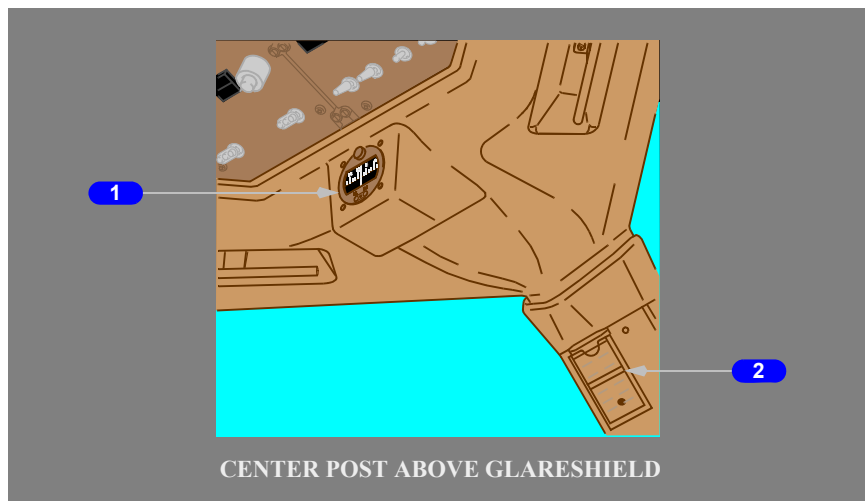
ISFD Failure Flags

Failure flag replaces appropriate display.

OUT OF ORDER indicates instrument system failure.



Standby Magnetic Compass



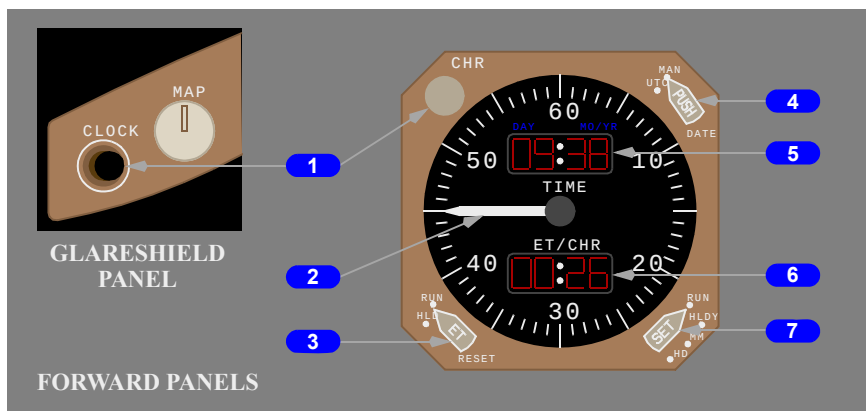
1 Standby Magnetic Compass

Displays magnetic heading.

2 Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

Clock



1 Chronograph (CHR or CLOCK) Switch

Push – subsequent pushing starts, stops, resets the chronograph.

2 Chronograph Pointer

Indicates chronograph seconds.

3 Elapsed Time (ET) Selector

Controls the elapsed time function.

RESET – returns ET display to zero (spring loaded to HLD).

HLD (hold) – stops the elapsed time display.

RUN – starts the elapsed time display.

4 Time/Date Selector

MAN (Manual) – the clock is manually set to a time and date.

UTC – the clock is automatically set to the UTC date and time.

Push –

- alternately displays the day–month, then year in the time/date window
- subsequent selection displays only the time in the time/date window.

5 Time/Date Window

Displays time (hours, minutes) when time is selected on the time/date selector.

Alternately displays day–month and year when date is selected on the time/date selector.

6 Elapsed Time (ET)/Chronograph (CHR) Window

Displays elapsed time (hours, minutes) or chronograph minutes.

The chronograph display replaces the elapsed time display.

Elapsed time continues to run in the background and will be displayed after the chronograph is reset.

7 Clock Set Selector

Sets the time and date when the time/date selector is set to manual.

HD (hours, day) –

- advances hours when time is selected on the time/date selector
- advances days when date is selected on the time/date selector.

MM (minutes, month) –

- advances minutes when time is selected on the time/date selector
- advances months when date is selected on the time/date selector.

HLDY (hold, year) –

- stops the time indicator and sets the seconds to zero when time is selected on the time/date selector
- advances years when date is selected on the time/date selector.

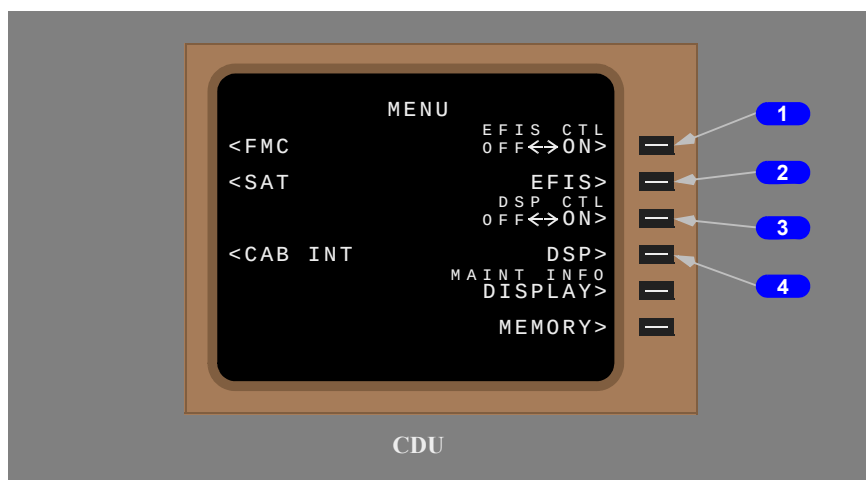
RUN – starts the time indicator.

EFIS Control Panels and Display Select Panel (DSP) – CDU Alternate Control

The CDU provides an alternate way to control the functions of the EFIS control panel and/or the display select panel.

Note: The control callouts on the following pages correspond to the control names on the EFIS control panels and the display select panel.
Explanations of the CDU functions are the same as on the related control panels.

CDU EFIS/DSP Control Selection



1 EFIS Control (CTL) Select Key

Transfers control of the EFIS from the EFIS control panel to the CDU (left EFIS control panel transfers to the left CDU, right EFIS control panel transfers to the right CDU).

2 EFIS Page Select Key

Selects the EFIS CONTROL page when EFIS control is on.

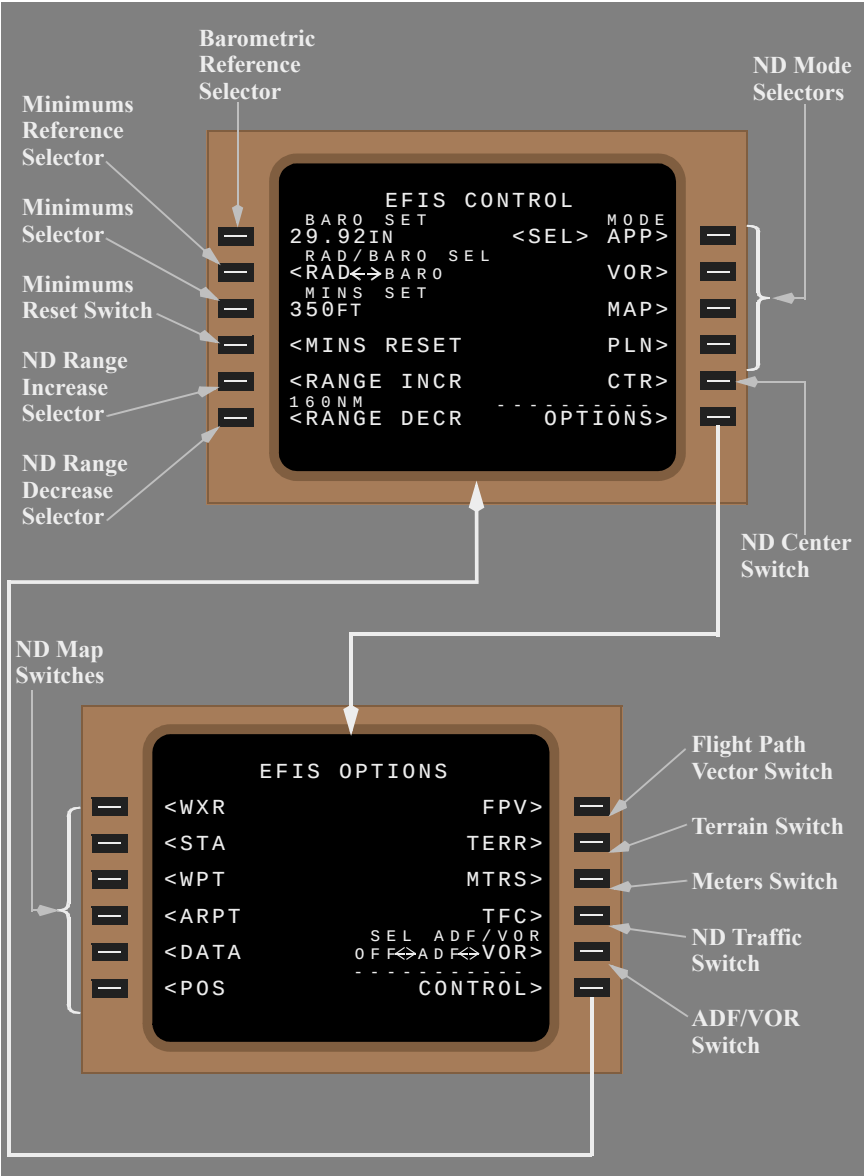
3 Display Select Panel Control (DSP CTL) Select Key

Transfers control of the display select panel control from the display select panel to the CDU.

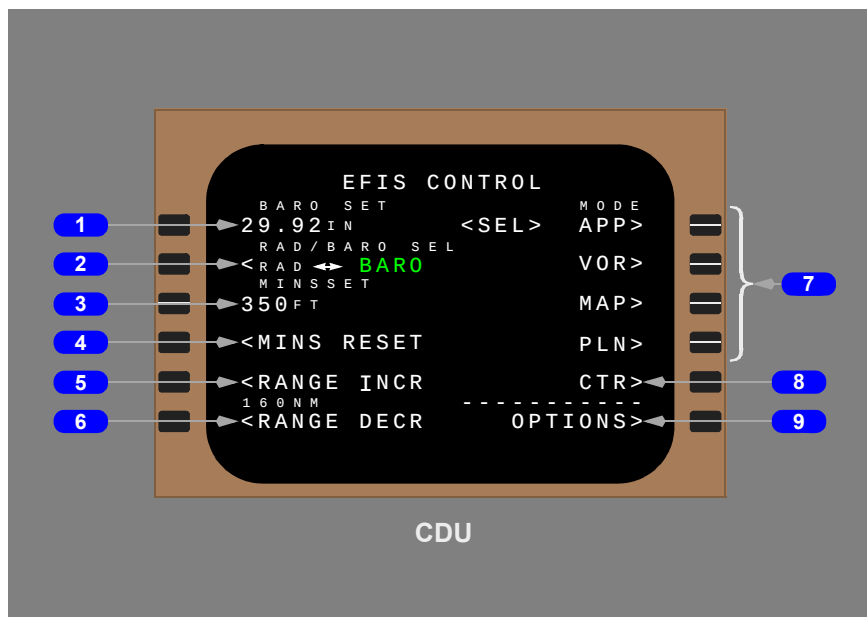
4 Display Select Panel (DSP) Page Select Key

Selects the DISPLAY SELECT PANEL CONTROL page when the DSP control is on.

EFIS Control CDU Pages



EFIS Control Page



1 Barometric (BARO) SET

Valid entry is reference barometric setting.

- entries of 22.00 to 32.00 or 2200 to 3200 display as IN (inches of mercury)
- entries of 745 to 1084 display as HPA (hectopascals)
- entry of "I" to change the displayed value to IN
- entry of "H" to change the displayed value to HPA
- entry of "S" or "STD" displays 29.92 IN or 1013 HPA (depending on units being displayed on BARO SET line) and displays STD on the PFD.

2 Radio (RAD) or Barometric (BARO) Select (SEL)

- Push - alternately selects RAD (radio altimeter) or BARO (barometric altimeter) as the minimums reference on the PFD. Selected mode displays in large green font.

3 Minimums (MINS) SET

- Entered minimums display on respective PFD.
- BARO selected in 2L, valid entries are -101 to 15000 feet.
- RAD selected in 2L, valid entries are -20 to 999 feet.

4 Minimums (MINS) RESET

Push - resets the minimums alert on the PFD.

5 RANGE Increase (INCR)

Push - increases ND nautical mile range scale.

6 RANGE Decrease (DECR)

Push - decreases ND nautical mile range scale.

7 MODE

Push - selects desired ND display.

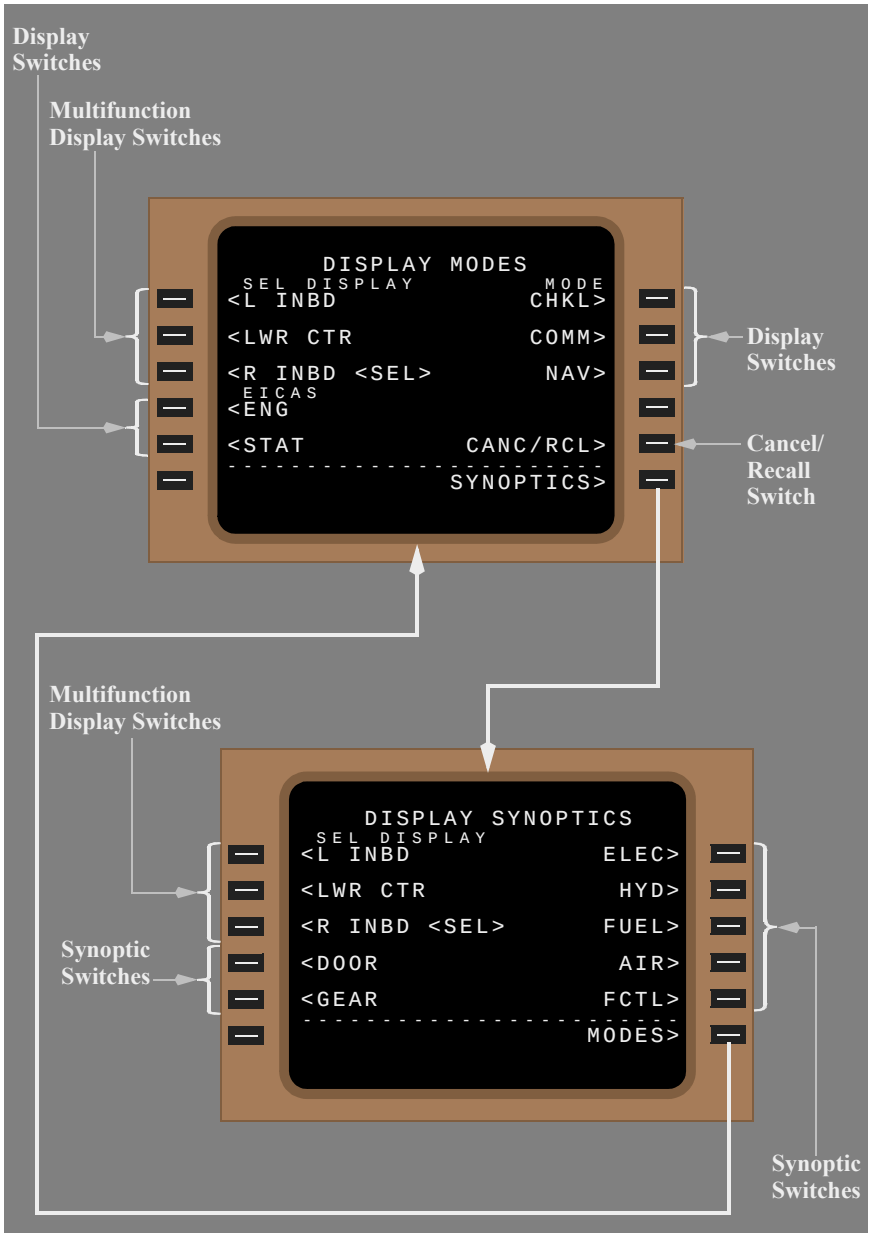
8 Center (CTR)

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

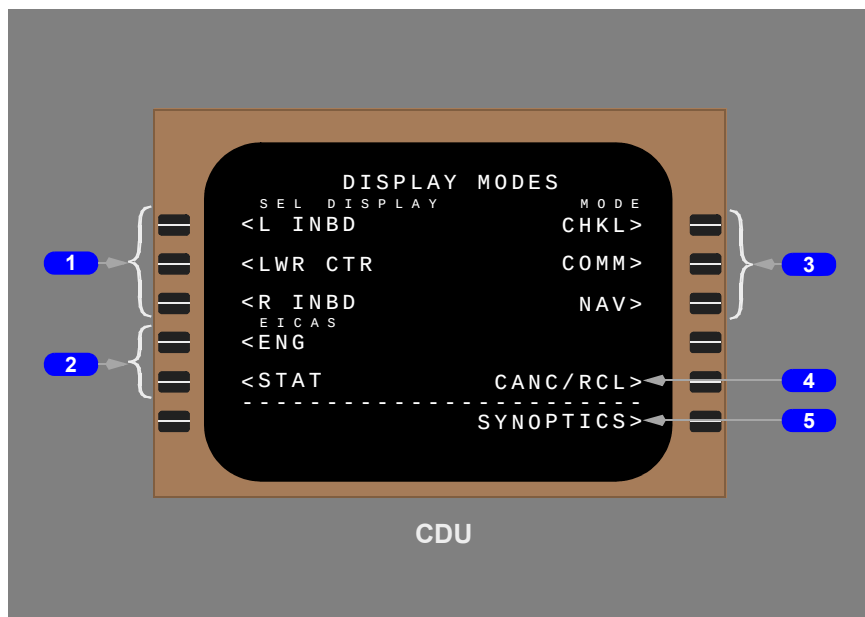
9 OPTIONS

Push - displays EFIS OPTIONS page.

Display Select CDU Pages



Display Modes Page



1 SEL DISPLAY

Push - selects display to be used.

2 EICAS

Push - selects EICAS display mode.

3 MODE

Push - selects display mode.

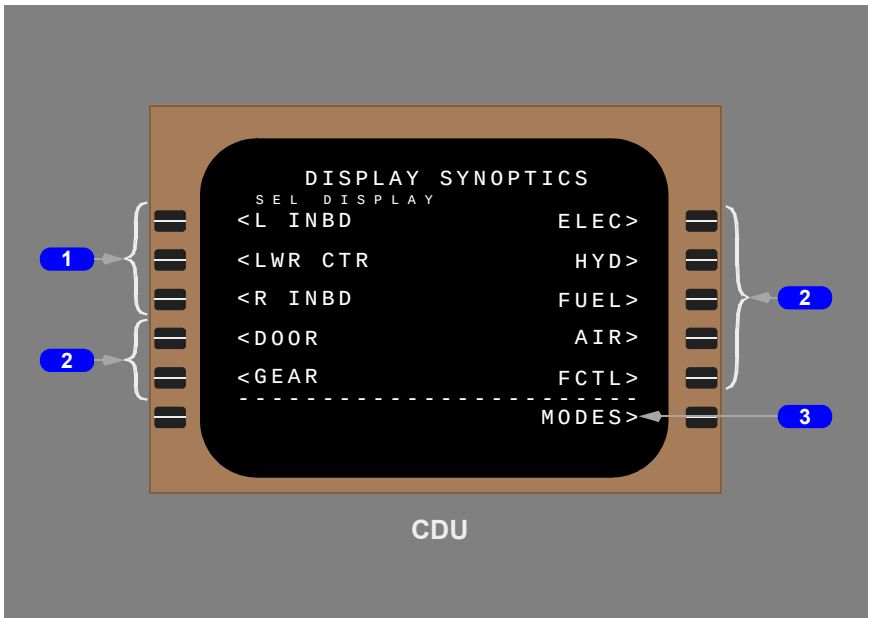
4 CANC/RCL

Push - cancels/recalls EICAS messages. Refer to Warning Systems, chapter 15.

5 SYNOPTICS

Push - selects DISPLAY SYNOPTICS page.

Display Synoptics Page



1 SEL DISPLAY

Push - selects display to be used.

2 Synoptics

Push - selects desired synoptic.

3 MODES

Push - selects DISPLAY MODES page.

Intentionally
Blank

Flight Instruments, Displays

System Description

Chapter 10

Section 20

Introduction

The flight instruments and displays supply information to the flight crew on six flat panel liquid crystal display units. The units display four primary groups of information:

- the primary flight display (PFD)
- the navigation display (ND)
- the engine indication and crew alerting system (EICAS)
- the multifunction display (MFD).

Detailed information on the following subjects is found in other sections of this chapter:

- PFD – Section 30
- ND – Section 40
- Electronic Checklist – Sections 50 and 60.

Display Selection and Control

During normal operations:

- the inboard display selectors are set to MFD
- PFDs are displayed on the two outboard display units
- NDs are displayed on the two inboard display units
- EICAS is displayed on the upper center display unit
- the display select panel–selected MFD information is displayed on the lower center display unit, or the display is blank. (The secondary engine display is the default display at power–up.)

Inboard Display Selectors

The inboard display selectors are used to select PFD, ND (NAV position), MFD, or EICAS displays on the inboard display units.

The normal position is MFD. With MFD selected, ND information is displayed on the inboard display units if NAV is selected on the display select panel (refer to Display Select Panel in this section).

In the ND, PFD, and EICAS positions, only the selected displays can appear on the inboard display units.

With MFD selected on the inboard display selector, the following ND and EFIS control logic applies:

- if both pilots have an ND on the inboard displays, then each EFIS control panel controls its corresponding ND display
- if there is an ND display on one inboard display unit and on the lower center display unit, then the pilot who does not have an ND on the inboard display unit controls the ND on the lower center display unit
- if neither pilot has an ND display on the inboard display unit, and there is an ND display on the lower center display unit, then the left EFIS control panel controls the lower center display unit
- if both pilots have an ND display on the inboard display unit, and there is an ND on the lower center display unit, then the left EFIS control panel controls the left inboard display unit and the lower center display unit. The ND on the left inboard and the lower center display units are identical.

EFIS Control Panels

The EFIS control panels control display options, mode, and range for the respective PFDs and NDs. Refer to the PFD and ND sections of this chapter.

If an EFIS control panel fails, the displays can be controlled through the related CDU. This CDU capability is available at all times, but inhibits inputs from the respective EFIS control panel.

Display Select Panel

The display select panel controls the MFD format on the left and right inboard display units and the lower center display unit. The selected display is indicated by the illuminated annunciator light on the display select panel (L INBD, R INBD, LWR CTR).

After a display unit is selected, the appropriate display is selected (ENG, STAT, ELEC, HYD, FUEL, AIR, DOOR, GEAR, FCTL, CHKL, COMM, or NAV).

A new display selection automatically replaces the previous one. A second selection of the same display for the lower center display unit blanks the display. A second selection of the same display on either inboard display causes display of the ND. If there is more than one page of messages, pushing STAT pages through the messages.

Pushing the COMM or CHKL switch for either inboard display unit shows the selected display. The cursor automatically appears on the selected display.

Display select panel control is also available through any CDU. This capability is available at all times. Once display select panel control is selected on one CDU, it cannot be selected on the other two CDUs.

When used as an MFD, the lower center display unit and the two inboard display units can display the following displays:

- ND (NAV switch)
- status page (STAT switch)
- secondary engine EICAS (ENG switch)
- system synoptics (ELEC, HYD, FUEL AIR, DOOR, GEAR, FCTL switches)
- communications pages (COMM switch)
- electronic checklist (CHKL switch)

When an inboard display selector is in the PFD position, new displays selected from the display select panel to that inboard display are inhibited. The annunciator light above the associated display select panel switch is also inhibited.

When an inboard display selector is in the EICAS position, only the ENG, AIR, and FUEL switches can affect the display. Pushing one of those switches causes the display of the respective compacted blocks of information on the EICAS display. The cancel/recall switch operates normally. Refer to these chapters for more information on compact EICAS displays:

- Chapter 2, Air Systems
- Chapter 7, Engines, APU
- Chapter 12, Fuel.

The inboard display selectors have no effect on the inboard displays if an outboard display unit fails; the PFD automatically moves to the inboard display unit regardless of the position of the inboard display selector.

Upper center display unit failure automatically switches the EICAS display to the lower center display unit. A subsequent EICAS selection on either of the inboard display selectors brings the EICAS display to that inboard display unit, and assuming no latched condition exists, the lower center display unit initially displays secondary engine instruments. Following this initial display configuration, the lower center display unit can be used in its usual MFD mode.

Display Brightness Control

The MASTER BRIGHTNESS control provides simultaneous brightness adjustment for all displays and panel lighting. Also, each display unit has an individual control with limited range control when master brightness is on, and full range control when master brightness is off.

Two remote light sensors, located left and right on the top of the glareshield, measure brightness in the forward field of view and adjust the overall display brightness as required. Individual sensors on the front of each display unit also affect display brightness. The CDUs, mode control panel displays, standby flight instruments, and aisle stand panel displays are also controlled by the automatic display brightness control system.

Note: If display brightness cannot be set as desired when master brightness is on, pushing the MASTER BRIGHTNESS switch off may allow setting display brightness to an appropriate level using individual brightness controls.

Instrument Display Source Selection

The display system automatically reconfigures to compensate for most faults. The instrument display source select panels provide manual switches for the pilots to use if certain faults are not corrected automatically.

Instrument source select switches provide alternate information sources for the PFDs and NDs. These switches provide automatic source selection when in the off position (switch out, with the ALTN and CDU switch annunciations not visible).

If there is an undetected source failure (a display is missing or parts of a display appear faulty), the non-normal (ALTN or CDU) position provides the capability for manual selection of PFD and ND sources.

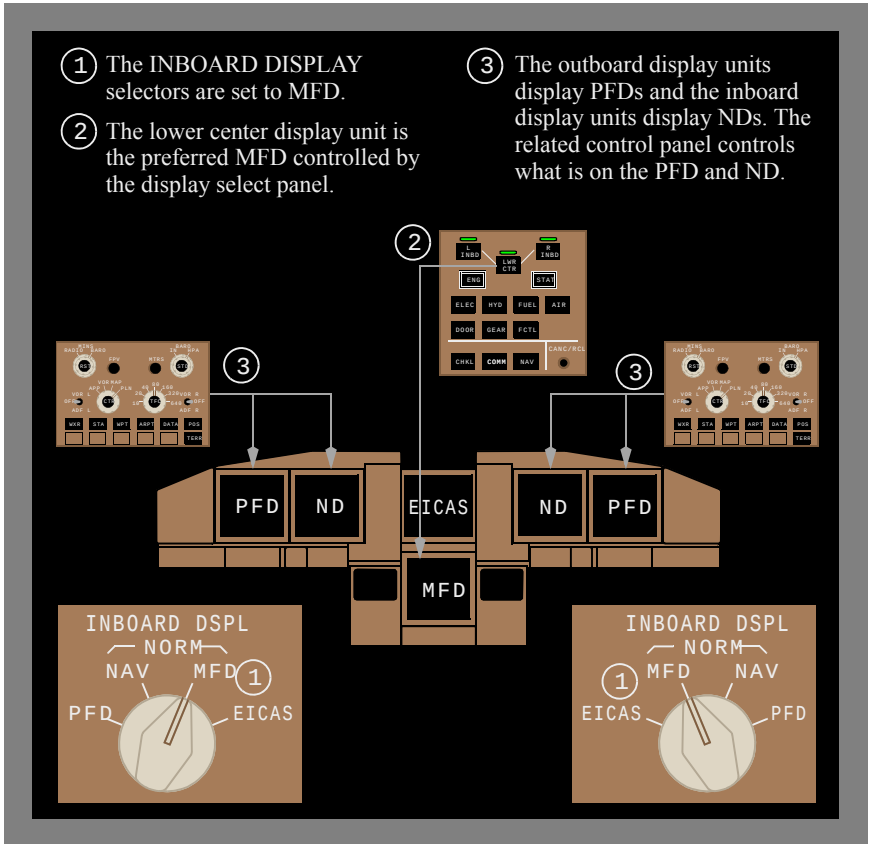
Undetected display source failures, such as missing/faulty display information or intermittent display blanking, may not result in automatic switching. The CDU position of the NAV switch or the ALTN position of the DSPL CTRL or AIR DATA/ATT switches provide the capability to manually select PFD and ND sources.

A center display control source switch is provided for the center displays.

Display Selection and Control Examples

The following examples show display selections.

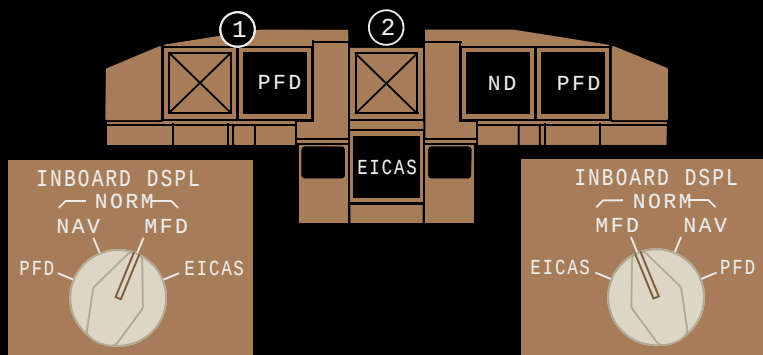
Normal Display Configuration



Display Unit Failure Automatic Switching

- ① If an outboard display unit fails, the PFD automatically moves to the inboard display unit. The INBOARD DISPLAY selector and the display select panel no longer have any control over that inboard display unit.
- ② If the upper center display unit fails, the EICAS display automatically moves to the lower center display unit.

Pushing the ENG display switch switches EICAS between primary and compacted modes if no pop-up condition is active. The display select panel can still display compact engine, air and fuel synoptics. The CANCEL/RECALL switch operates normally.

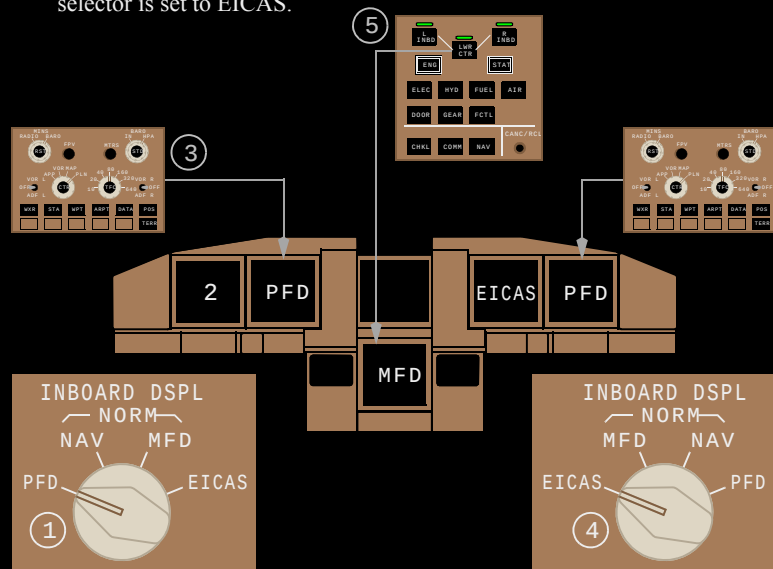


Inboard Display Switching

- ① The left INBOARD DISPLAY selector is set to PFD. With an INBOARD DISPLAY selector in any position other than MFD, the selector alone determines what is displayed on the display unit. The left inboard display cannot display any selections made on the display select panel.
- ② The left outboard display blanks and the PFD moves to the left inboard display unit.
- ③ The left EFIS control panel controls the PFD.
- ④ The right INBOARD DISPLAY selector is set to EICAS.

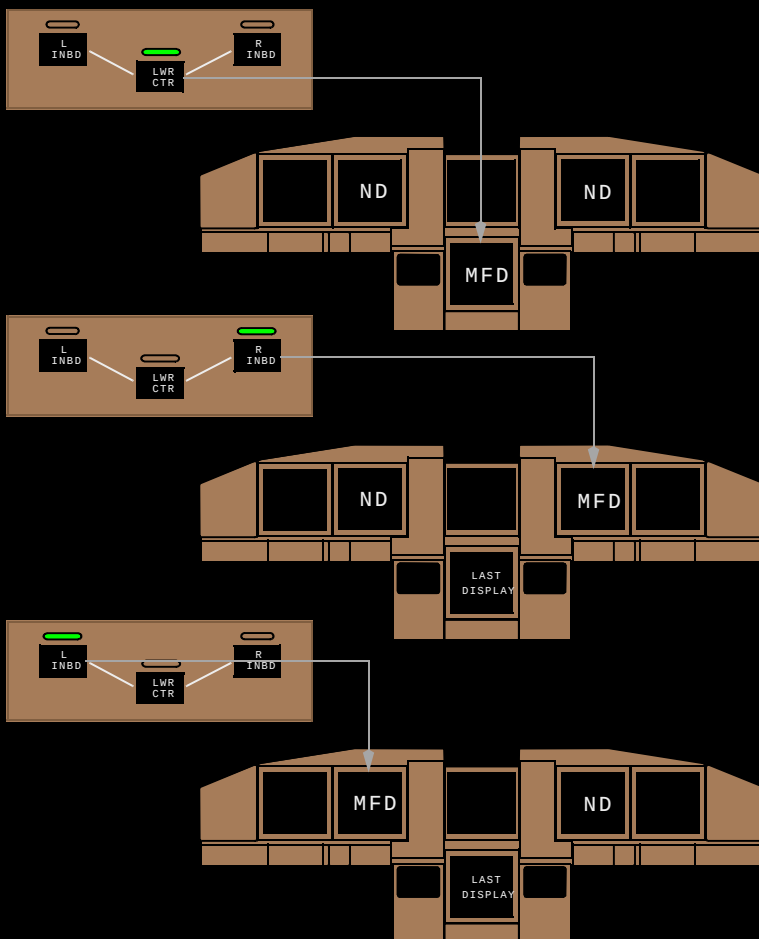
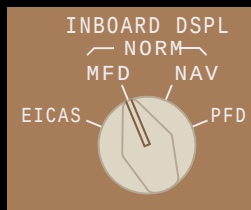
The right inboard display cannot display selections made on the display select panel, except for compact engine, air and fuel synoptics, and the CANCEL/RECALL switch functions.

- ⑤ The upper center display blanks and the EICAS display moves to the right inboard display unit. Now there is no ND visible. Either pilot could use the display select panel to display an ND on the lower center display unit (refer to the following pages).



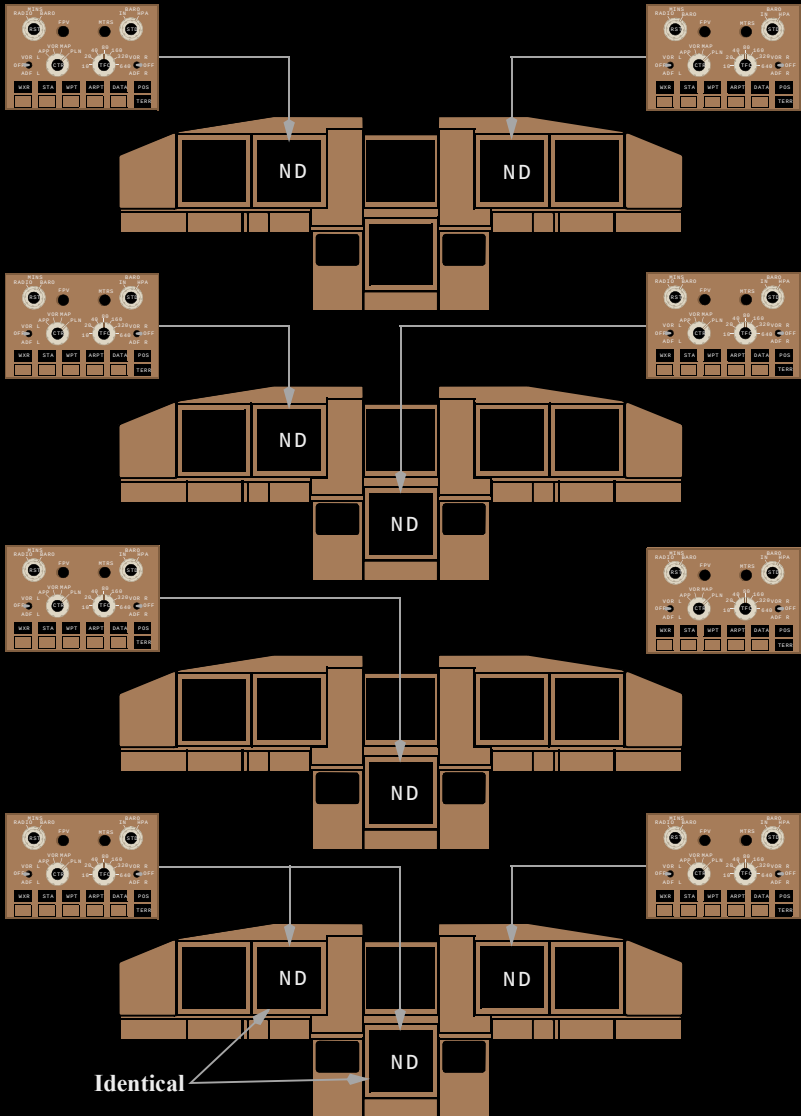
Display Select Panel MFD Selection

With the INBOARD DISPLAY selectors set to MFD, the display select panel display switches are used to designate a display as an MFD. The designated display (L INBD, LWR CTR, or R INBD) is then controlled by the other display select panel selections (ENG, STAT, CHKL, COMM, NAV or one of the system synoptics).



EFIS Control Panel Multiple ND Control

This shows which EFIS control panel controls which ND when multiple NDs are displayed, or when the ND is displayed on the lower center display unit.



Cursor Control Devices (CCD)

The CCDs provide control of the display cursor.

For detailed information on the following subjects, refer to:

- Chapter 5, Communications
- the Electronic Checklist sections in this chapter

CCD Touch Pad

The CCD uses a touch pad. Touching the pad translates the touch location coordinates to the affected display, placing a cursor at those coordinates on the selected display.

The cursor moves relative to finger movement across the touch pad. Except for the four corners of the touch pad, lifting the finger off the touch pad and touching a different location does not move the cursor. Only finger motion in contact with the touch pad moves the cursor.

Touching a corner immediately places the cursor in the corresponding corner of the display. This helps the pilot quickly locate the cursor and speeds access to the selections at the four corners of the display.

CCD Cursor Location Control

Selecting a menu, communications, or checklist function requires the use of the cursor location switches.

If a new function is selected on an inboard display that requires a communication, checklist, or maintenance function, then the system automatically selects the respective cursor control device to that display.

If a new function requiring a cursor is selected on the lower center display, then the system automatically selects the CCD not currently being used on an inboard display to the lower center display. If neither cursor is in use, it selects the CCD cursor that was previously displayed on the lower center display. Cursor selection defaults to the left CCD on power-up.

The cursor location light above the switch illuminates to indicate the selected display unit.

Selecting a display where there is no function requiring a cursor has no effect. For example, if the inboard display does not display a communications or checklist page, pushing an INBD cursor location switch has no effect on the selected inboard display.

Only one CCD can access a given display at a time. The last pilot who selects the cursor on the selected MFD has control. The other cursor disappears from the display and the cursor location light on that CCD extinguishes. The cursors are visually different so the pilots know who is currently in control of the cursor on a display.

If both pilots are accessing the same checklist or communications functions on different displays, both are forced to the same page, with that page controlled by the pilot with cursor control.

Standby Flight Instruments

The standby flight instruments include:

- integrated standby flight display
- standby magnetic compass.

Integrated Standby Flight Display (ISFD)

The ISFD displays attitude, airspeed, altitude, ILS, and magnetic heading information. The ISFD receives airspeed and altitude from a dedicated pitot and static air data module. Attitude information is provided by internal inertial sensors. ILS information is provided by the center ILS receiver. The display receives its heading information from the same source as the captain's primary flight display. Heading information is not available in polar regions.

Note: The standby magnetic compass must be used to validate heading information.

The left flight control DC bus powers the ISFD. The left flight control DC bus is initially powered when the main ac busses are powered and remains powered with the main busses out. Ten seconds after receiving power, a 90 second initialization sequence begins. ATT and INIT 90s messages display during initialization. Initialization will stop if airplane movement is excessive and will resume when airplane movement is acceptable for initialization. Upon completion of the initialization sequence, attitude information displays.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. When the ATT:RST message displays, pushing the Attitude Reset switch resets the horizon line with the airplane symbol.

On the ground, pushing the Attitude Reset switch must be accomplished with the airplane stationary. In flight, pushing the Attitude Reset switch must be accomplished with the airplane in wings level, non-accelerated flight. During attitude reset, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If attitude reset is unsuccessful, the ATT:RST message remains displayed and the attitude will not be displayed.

Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Clocks

A clock is located on each forward panel. Each clock displays airplane information management system (AIMS) generated UTC time and date, or manually set time and date. The AIMS UTC time comes from the global positioning system (GPS). In addition to time, the clocks also provide alternating day and month-year, elapsed time and chronograph functions.

Flight Recorder

The flight data recorder (FDR) receives and stores selected airplane parameters from various airplane systems and sensors in a crash-protected solid state memory.

The FDR records the most recent 25 hours of flight.

The flight data recorder system (FDRS) operates during any engine start, while any engine is running, during test or when the airplane is in the air.

Display System Information Sources

Air Data Inertial Reference System (ADIRS)

The ADIRS provides:

- primary, secondary and standby air data
- inertial reference information.

The major components of the ADIRS are:

- one air data inertial reference unit (ADIRU)
- one secondary attitude air data reference unit (SAARU)
- eight air data modules
- six static ports
- three pitot probes
- two angle-of-attack vanes
- one total air temperature probe.

Air Data Inertial Reference Unit (ADIRU)

The ADIRU is the primary source for speed, altitude, attitude and inertial navigation position information. The ADIRU processes information measured by its internal gyros and accelerometers, and from air data module inputs, angle-of-attack vanes and other systems.

The ADIRU is described in Chapter 11, Flight Management, Navigation.

Secondary Attitude Air Data Reference Unit (SAARU)

The SAARU is the secondary source for speed, altitude, and attitude information. The SAARU processes information measured by its internal gyros and accelerometers, and from air data module inputs, angle-of-attack vanes, and other systems.

The SAARU does not provide navigational position data. The SAARU is described in Chapter 11, Flight Management, Navigation.

Air Data

Three static ports are located on the left side of the airplane and three static ports are located on the right side of the airplane. Left and right static ports are paired through pneumatic tubing to each of the left, center and right air data modules. The air data modules convert static air pressure to a digital output for use by other systems. The center static ports are also connected to an independent air data module to provide static pressure to the standby airspeed indicator and the standby altimeter.

Two pitot probes (right and center) are mounted on the right forward section of the airplane. One pitot probe (left) is mounted on the left forward section of the airplane. An air data module is connected to each pitot probe. These air data modules convert dynamic air pressure to a digital output for use by other systems. The center pitot probe also provides dynamic pressure to the standby air data module.

Angle-of-Attack

There are two angle-of-attack vanes, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

The primary source of data for the AOA indicator on the PFD is supplied by the ADIRU, with the SAARU as the backup source. The source selection is automatic in the event of primary source failure.

Total Air Temperature

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADIRU and the SAARU to compute total air temperature.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRU, using total air temperature probe information. In the event the ADIRU value is invalid, the SAARU computed value is displayed.

Flight Instruments, Displays

Primary Flight Displays (PFDs)

Chapter 10

Section 30

Introduction

The PFDs present a dynamic color display of all the parameters necessary for flight path control. The PFDs provide the following information:

- flight mode annunciation
- airspeed
- ground speed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- angle of attack
- instrument landing system display
- approach minimums
- heading/track indications
- engine fail, GPWS, and PWS alerts

Failure flags are displayed for airplane system failures. Displayed information is removed or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Displays are removed when a source fails or when no system source information is available.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

Airspeed

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is greater than 0.40. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the airspeed tape. Maximum and minimum airspeeds are also displayed along the right edge of the airspeed tape.

CAUTION: Reduced maneuver capability exists when operating within the amber regions below the minimum maneuvering speed or above the maximum maneuvering speed. During non-normal conditions the target speed may be below the minimum maneuvering speed.

Ground Speed

Ground speed is digitally displayed below the airspeed tape when the Mach number is less than 0.40.

Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. When meters is selected on the EFIS control panel:

- current altitude in meters is also shown above the altitude window
- selected altitude in meters is displayed above the altitude tape.

Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape.

The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and green line.

A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

The current barometric reference is displayed below the altitude tape. A preselected barometric reference can be displayed when STD is displayed.

Landing reference is selectable between QNH and QFE on the APPROACH REF page of the FMC. QNH is the normal operating mode. Selecting QFE sets the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb mode active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the altitude tape background color changing from green back to normal. A description of QFE operation is contained in the Landing Reference description in Chapter 11, Flight Management, Navigation.

Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. It is displayed above with positive vertical speed and below with negative vertical speed. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

Attitude

The attitude indication displays the airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5 degree increments.

A pointer indicates bank angle in increments of 10, 20, and 30 degrees. Single marks indicate 45 and 60 degrees of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

A pitch limit indication is displayed at low speeds when the flaps are up and at all times when the flaps are down.

Steering Indications

The flight director steering indications are displayed when the associated flight director switch is on.

TCAS resolution advisories are displayed in the attitude indication area. Refer to Chapter 15, Warning Systems.

The flight path vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on, or the MCP FPA reference switch is selected on. The FPV shows the Flight Path Angle (FPA) above or below the horizon line and drift angle left or right of the pitch scale's center. The FPA uses inertial and barometric altitude inputs. The vertical FPA is unreliable with unreliable primary altitude displays.

The flight path angle (FPA) symbol shows the selected flight path angle when the MCP FPA reference switch is selected on and either the flight director or autopilot is engaged.

The FPV and FPA symbols are displayed in two sizes and brightness levels. The large, bright FPV/FPA symbols are displayed when the previously stated selections are made and the flight director is off. The small, dim FPV/FPA symbols are displayed when the previously stated selections are made and the flight director is displayed.

Radio Altitude

The current radio altitude is displayed in the bottom center of the attitude indication area when radio altitude is below 2,500 feet AGL.

Angle of Attack

The angle of attack is displayed above the upper right corner of the attitude indication area. Digital and round dial formats are used.

Stick shaker indicator, zero reference line, and approach reference band are displayed on the round dial.

The zero degree reference line is the 4:30 position with additional reference lines every 5 degrees from -5 to +20 degrees.

Instrument Landing System Indications

ILS glide slope and localizer deviation, frequency/identification, DME, course, and marker beacon indications are provided.

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed.

The marker beacon indication (OM – outer marker, IM – inner marker, or MM – middle marker) is displayed in the upper right corner of the attitude display area.

The glideslope pointer and scale appear on the right side of the attitude indication.

The localizer pointer and scale appear at the bottom of the attitude indication.

Below 2500 feet radio altitude, with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol rises toward the airplane symbol.

Approach Minimums

The selected radio altitude or barometric approach minimums set on the EFIS control panel are displayed near the bottom left of the altitude display.

Heading/Track Indications

Selected heading/track information is displayed in the bottom section of the PFD on a section of the compass rose. Current heading is displayed under a pointer at the top of the compass rose. The MCP selected heading bug is displayed on the outside of the compass rose. The MCP selected track bug is displayed on the inside of the compass rose.

Heading or track is displayed based on the position of the MCP HDG/TRK reference switch. The selected heading or selected track is annunciated in the left half of the compass rose. The current heading/track reference (MAG/TRU) is shown in the right half of the compass rose. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

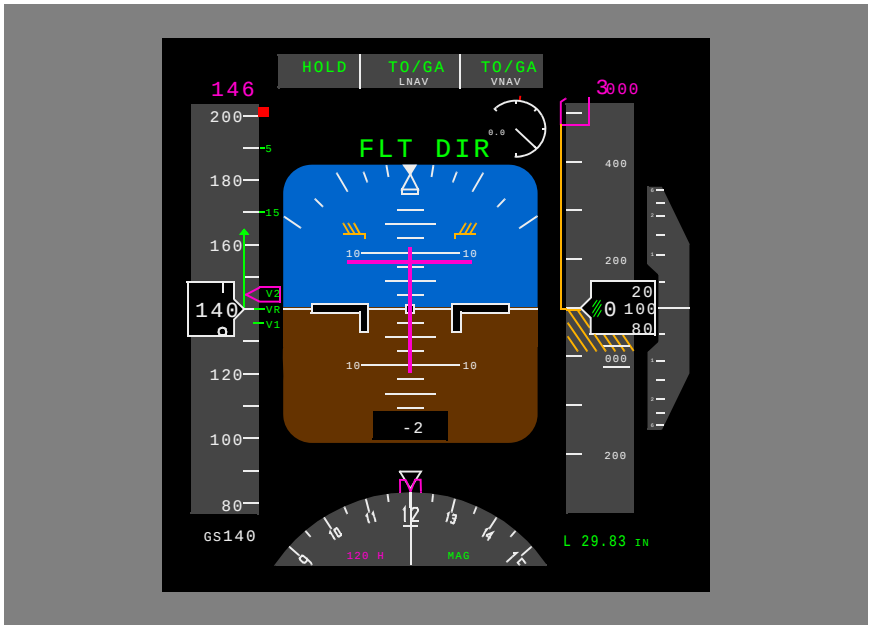
Engine Fail, GPWS, and PWS Alerts

Engine fail, GPWS, and PWS alerts are displayed in large capital letters between the attitude display and the heading/track compass rose. Refer to Chapter 15, Warning Systems.

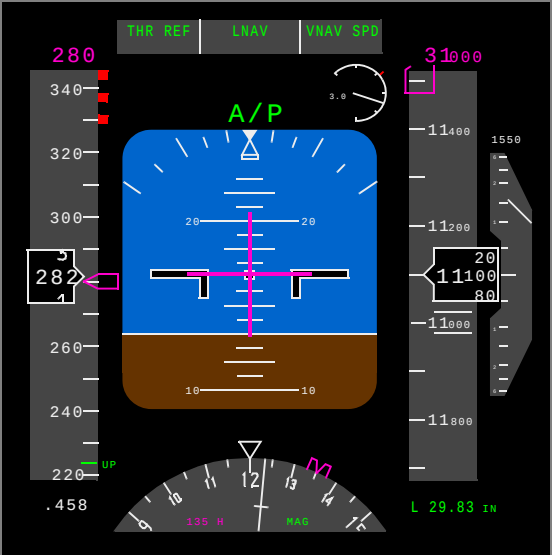
Typical PFD Displays

Typical PFD configurations for six phases of flight follow. The autopilot, LNAV, and VNAV are engaged for climb, cruise, descent, approach, and landing. The AFDS approach mode is used for approach and landing.

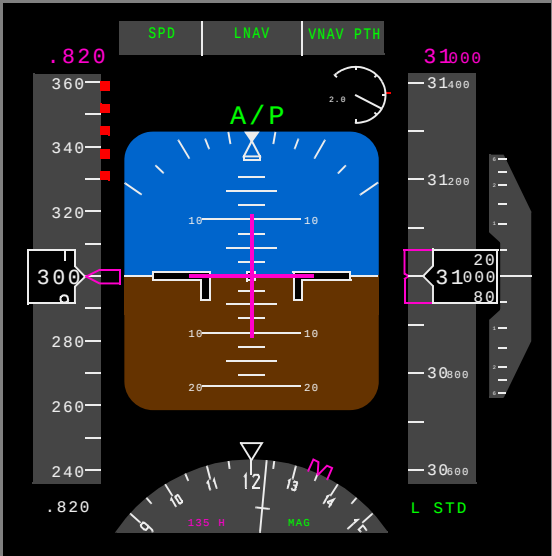
PFD Takeoff Display

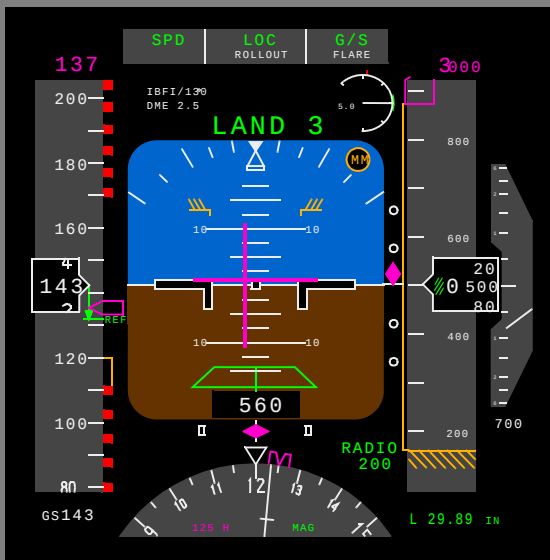
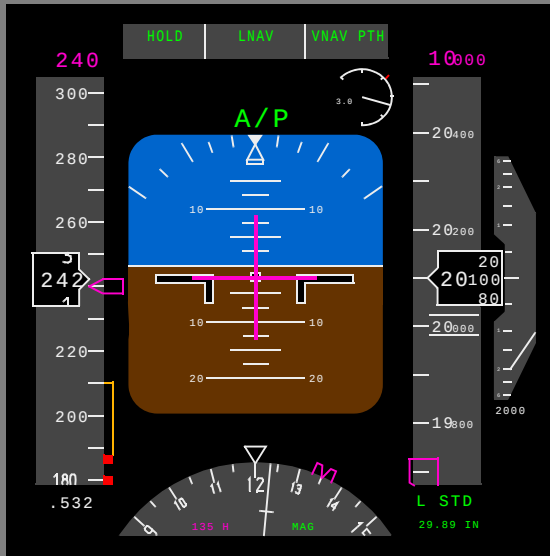


PFD Climb Display

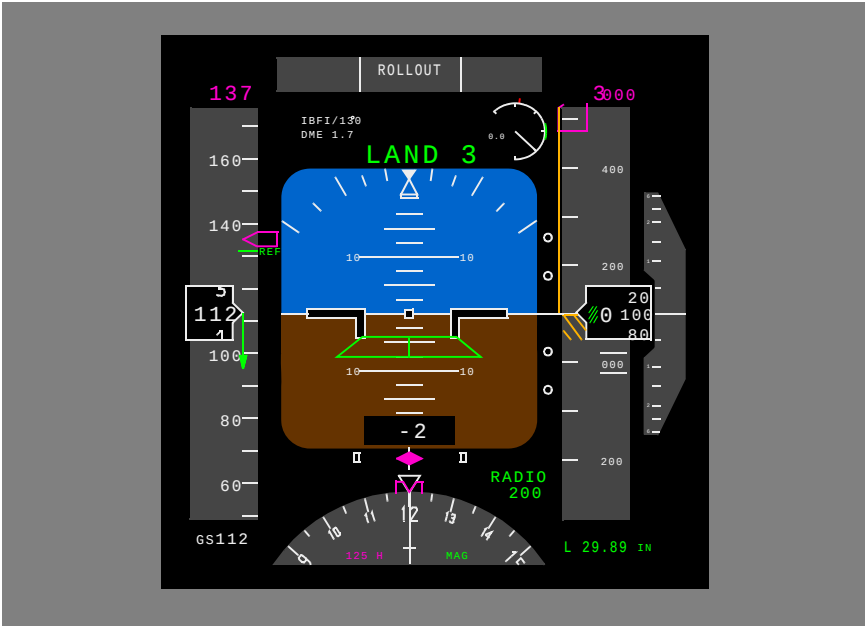


PFD Cruise Display





PFD Landing Display



Flight Instruments, Displays

Navigation Displays

Chapter 10

Section 40

Introduction

The NDs provide a mode-selectable color flight progress display. The modes are:

- MAP
- APP (approach)
- VOR
- PLN (plan).

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

Map Mode

The MAP mode is recommended for most phases of flight.

Presented track up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- selected and current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display on the ND in both the expanded and center map modes.

VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or ILS approach information.

Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

ND Information

Heading

Heading is supplied by the FMC or air data inertial reference system (ADIRS). The ND compass rose can be referenced to magnetic north or true north. The heading reference switch is used to manually select magnetic or true reference. The compass display is automatically referenced to true north when the airplane is north of 82° north or south of 82° south latitude, or near the magnetic poles with the heading reference switch in NORM.

Track

Track is supplied by the FMC during normal operation and by the CDU when in alternate navigation.

Traffic

Traffic information from the TCAS can be displayed on the ND. TCAS is described in Chapter 15, Warning Systems.

Weather Radar

Weather radar information can be displayed on the ND. The weather radar system is described in Chapter 11, Flight Management, Navigation.

Failure Flags and Messages

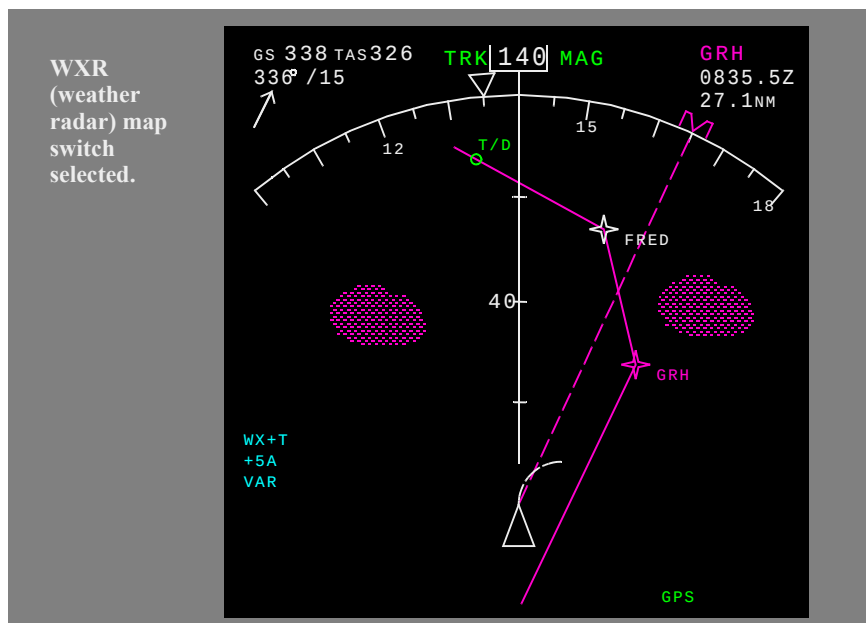
Failure flags are displayed for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

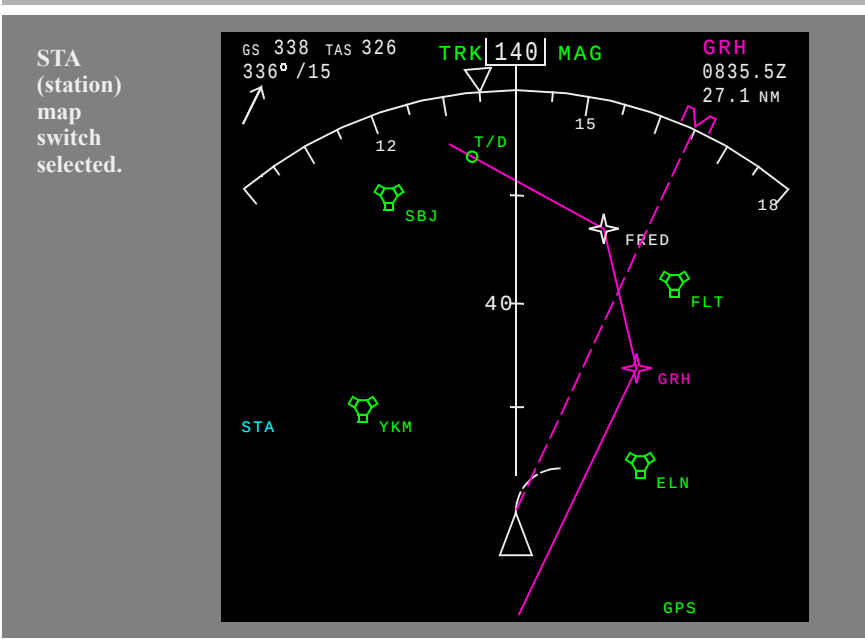
The message EXCESS DATA is displayed if the amount of information sent to the ND exceeds the display capability. When this occurs, the primary display system removes information from the center of the display outward; information near the outer selected range area is still displayed. The message can be removed by:

- reducing the amount of map information
- reducing range, or
- deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA, POS).

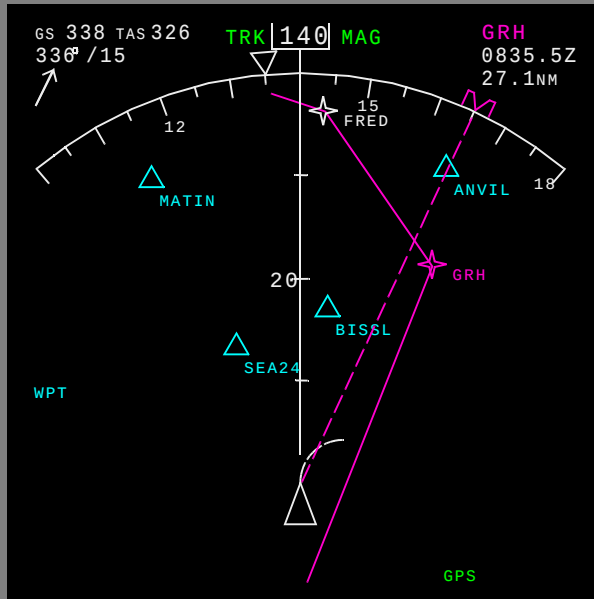
Typical ND Map Displays

Typical ND map displays are shown on the following pages. Examples of other ND displays (centered map, approach, VOR, and plan modes) are shown in Section 10 of this chapter.

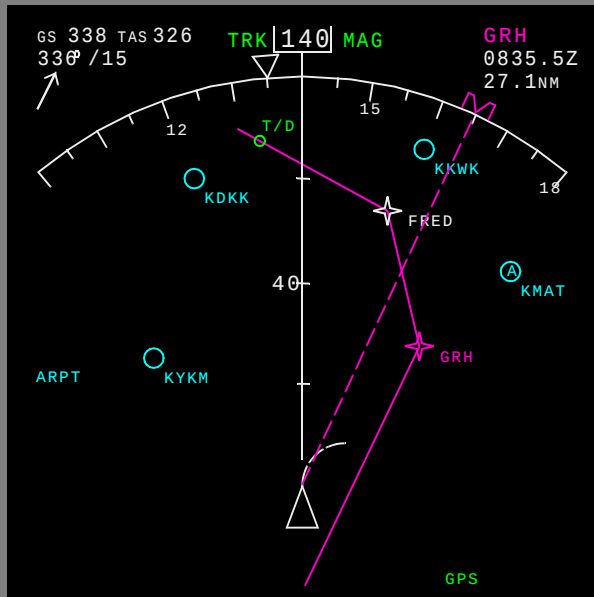




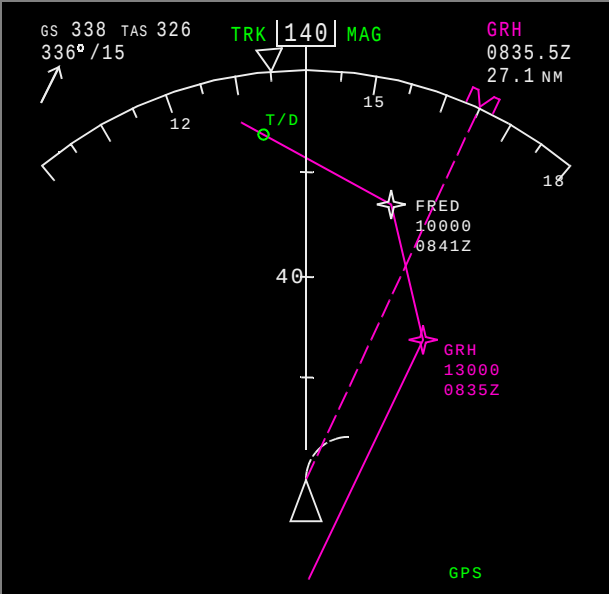
WPT
(waypoint)
map switch
selected.



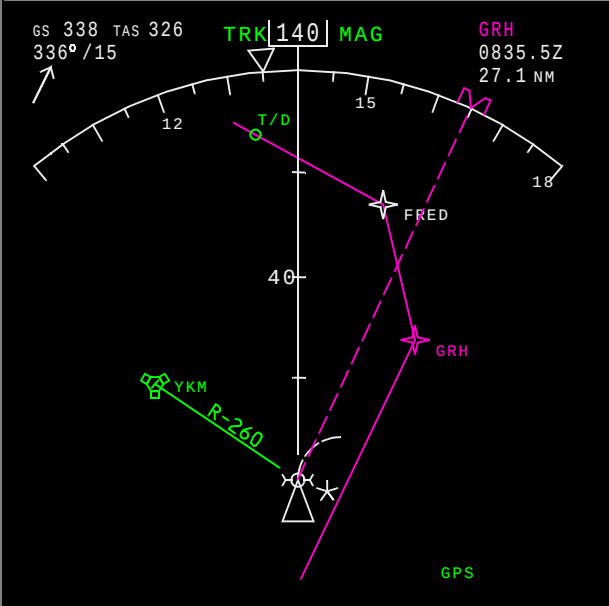
ARPT
(airport)
map switch
selected.



DATA map
switch
selected.



POS
(position)
map switch
selected.

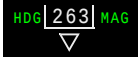


ND Symbolology

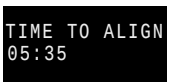
The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

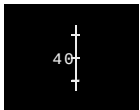
- W (white) – present status, range scales
- G (green) – dynamic conditions
- M (magenta or pink) – command information, pointers, symbols, fly-to condition
- B (blue or cyan) – nonactive or background information
- A (amber or yellow) – cautions, faults, flags
- R (red) – warnings.

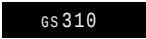
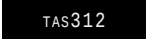
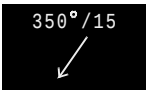
Heading, Track, and Speed

Symbol	Name	ND Mode	Remarks
	Track orientation (G), current track (W), and track reference (G)	Shows track in MAP, MAP CTR.	Displays TRK as the orientation, the current track, and MAG or TRU as the reference, and points to the heading on the compass rose.
	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	Shows HDG (heading) in VOR, VOR CTR, APP, APP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.

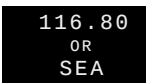
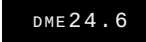
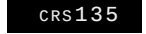
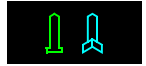
Symbol	Name	ND Mode	Remarks
	Grid heading (W)	MAP, MAP CTR, PLAN	Displays above 70 degrees latitude.

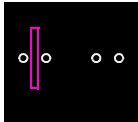
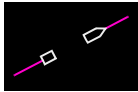
Symbol	Name	ND Mode	Remarks
	ADIRU time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction/speed and wind arrow, on the ground, during alignment.

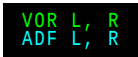
Symbol	Name	ND Mode	Remarks
	Selected heading bug (M)	All except PLAN	Displays the MCP–selected heading. A dashed line (M) may extend from the marker to the airplane symbol. In the MAP mode with LNAV, LOC, or ROLLOUT engaged, the dashed line is removed 10 seconds after the selected heading bug is moved.
	Selected track bug (M)	All except PLAN	Displays the MCP–selected track. A dashed line (M) may extend from the marker to the airplane symbol.
	Track line and range scale (W)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Indicates current track. Number indicates range (VOR CTR and APP CTR do not display range).
	Heading/track reference (G) box (W) in TRU, box (A) if TRU displayed in descent	All except PLAN	Indicates heading/track is referenced to magnetic north or true north. Switching from TRU to MAG displays a box around MAG for 10 seconds.
	Expanded compass (W)	MAP, APP, VOR	Displays 90 degrees of compass rose.
	Current heading pointer (W)	MAP, MAP CTR	Points to current heading on the compass rose.

Symbol	Name	ND Mode	Remarks
	Groundspeed (W)	All	Current ground speed.
	True airspeed (W)	All	Current true airspeed displayed above 100 knots.
	Wind direction/ speed and wind arrow (W)	All	Indicates wind bearing, speed, and direction, with respect to display orientation and heading/track reference. Arrow not displayed in the PLAN map mode.

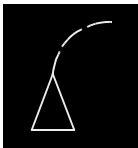
Radio Navigation

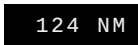
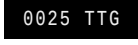
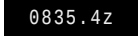
Symbol	Name	ND Mode	Remarks
	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Indicates the selected receiver as the display reference.
	ILS (W)/VOR (W) Reference receiver frequency or identifier display	VOR, VOR CTR, APP, APP CTR	Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.
	DME distance (W)	VOR, VOR CTR, APP, APP CTR	Indicates DME distance to the reference navaid.
	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Indicates the VOR course or ILS localizer course.
	Left VOR (G) or ADF (B) pointer head and tail	All except PLAN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.
	Right VOR (G) or ADF (B) pointer head and tail		

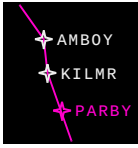
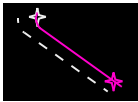
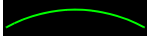
Symbol	Name	ND Mode	Remarks
	ILS localizer or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC or VOR course deviation. Deviation indicator points in direction of VOR or ILS selected course. For ILS deviation, indicator fills (M) when less than 2 1/2 dots from center.
	Selected course pointer (W) and line (M)	VOR, VOR CTR, APP, APP CTR	Displays CDU–selected course.
	Glide slope pointer (M) and scale (W)	APP, APP CTR	Displays glideslope position and deviation. Deviation indicator fills (M) when less than 2 1/2 dots from center.
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.
	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (B, G), DME/TACAN (B, G), VORTAC (B, G)	MAP, MAP CTR	When the EFIS control panel STA map switch is selected on, appropriate nav aids are displayed (B). Tuned VHF nav aids are displayed in green, regardless of switch selection. When a nav aid is manually tuned, the selected course and reciprocal are displayed.
	VOR/DME raw data radial and distance (G)		When the POS map switch is selected on, the station radial extends to the airplane.

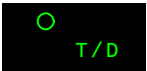
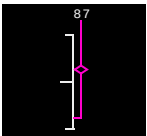
Symbol	Name	ND Mode	Remarks
	VOR (G) or ADF (B) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Located lower left or right corner. Represents positions of the EFIS control panel VOR/ADF switches.
	VOR frequency or identifier (G), ADF frequency or identifier (B)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.
	DME distance (G)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Indicates DME distance to the referenced navaid.

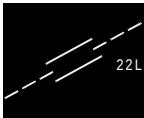
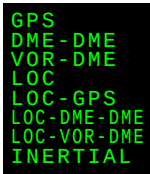
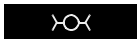
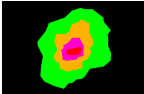
Map

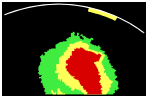
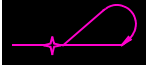
Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	MAP, MAP CTR, VOR, APP	Current airplane position is at the apex of the triangle.
	Airplane symbol (W)	VOR CTR, APP CTR	Current airplane position is at the center of the symbol.
	Position trend vector (W) (dashed line)	MAP, MAP CTR	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: • greater than 20 NM, 3 segments • = 20 NM, 2 segments • = 10 NM, 1 segment.

Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	PLAN	Indicates actual position and track along the flight plan route in plan mode only. Inhibited north of 82N latitude and south of 82S latitude.
	Active waypoint identifier (M)	MAP, MAP CTR, PLAN	Indicates the active flight plan waypoint, the next waypoint on the route of flight.
	Active waypoint distance (W)	MAP, MAP CTR, PLAN	Distance to the active waypoint.
	Active waypoint time to go during alternate navigation (W)	MAP, MAP CTR, PLAN	Indicates CDU calculated time to go in hours and minutes to active waypoint during alternate navigation.
	Active waypoint ETA (W)	MAP, MAP CTR, PLAN	Indicates ETA at the active waypoint. Time is based on distance to go and ground speed. It does not consider FMC performance predictions and may differ from other FMC ETAs that do.
	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
	Off route waypoint (B)	MAP, MAP CTR	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, in ND ranges of 10, 20, or 40.

Symbol	Name	ND Mode	Remarks
	Flight plan route: active (M), modified (W), inactive (B)	MAP, MAP CTR, PLAN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. Inactive routes are displayed with long dashes (B) between waypoints.
	Offset path and identifier: active route (M), modified route (W)	MAP, MAP CTR, PLAN	Presents a dashed line parallel to and offset from the active or modified route.
	Route data: active waypoint (M), inactive waypoint (W)	MAP, MAP CTR	When the EFIS control panel DATA map switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed. Times consider FMC performance predictions and wind data.
	Altitude range arc (G)	MAP, MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.

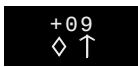
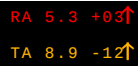
Symbol	Name	ND Mode	Remarks
	Altitude profile point and identifier (G)	MAP, MAP CTR	Indicates the approximate map position of the FMC-calculated T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent) points. Predicted altitude/ETA points entered on the FIX page display the altitude/ETA along with the profile point. Deceleration points have no identifier.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ± 400 feet deviation. Digital display is provided when the pointer indicates more than ± 400 feet.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Displayed when selected as the origin or destination and ND range is 80, 160, 320, or 640 NM.
	Airport (B)	MAP, MAP CTR, PLAN	Displayed on MAP or MAP CTR mode when the EFIS control panel ARPT map switch is selected on. Display of origin and destination airports on MAP, MAP CTR, or PLAN mode is not affected by ARPT map switch selection.

Symbol	Name	ND Mode	Remarks
	Airport and runway (W)	MAP, MAP CTR, PLAN	Displayed when selected as the origin or destination and ND range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Energy management circles (B, W)	MAP, MAP CTR	Indicates clean (B) and speedbrake (W) energy management circles as defined on the CDU OFFPATH DES page.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	FMC position update status (G)	MAP, MAP CTR	Indicates the system providing FMC position update.
	GPS position (W)	MAP, MAP CTR	When the EFIS POS map switch is selected on, indicates GPS position relative to FMC position.
	ADIRU position (W)	MAP, MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMC position.
	Weather radar returns (R, A, G, M)	MAP, MAP CTR, VOR, APP	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.

Symbol	Name	ND Mode	Remarks
	Weather radar path attenuation compensation (A)	MAP, MAP CTR, VOR, APP	Attenuated region behind rainfall (radar shadow) is indicated by amber arc on outer range ring.
	Selected map options (B)	MAP, MAP CTR	Displays EFIS control panel selected map options.
	Map source annunciation (G)	MAP, MAP CTR	Displays ND source if: • CDU is selected on respective navigation source select switch • both FMCs fail, or • a manually selected FMC fails.
	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.
	Holding pattern: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	A holding pattern appears when in the flight plan. Depicts entry path until entry completed.
	Procedure turn: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	A procedure turn appears when in the flight plan. It increases in size upon entering the procedure turn. Also used for procedure hold course reversal.

Symbol	Name	ND Mode	Remarks
	Alternate airports (B)	MAP, MAP CTR, PLAN	PLAN: displays up to four alternate airports. When 640 NM range is selected, offscale airports are displayed with a directional arrow relative to PLAN center point and distance blanked. MAP, MAP CTR: displays the FMC or pilot selected primary alternate airport. When EFIS control panel APRT map switch is selected on, displays up to four alternate airports. When 640 NM range is selected, offscale airports are displayed with a directional arrow and distance relative to airplane position.

TCAS

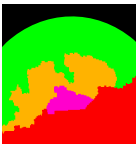
Symbol	Name	ND Mode	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, APP, VOR	Refer to Chapter 15, Warning Systems for display criteria.
	TCAS traffic advisory (TA), relative altitude (A)		The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed.
	TCAS proximate traffic, relative altitude (W)		For relative altitude symbols, the number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.
	TCAS other traffic, relative altitude (W)		For absolute altitude symbols, the number indicates altitude of traffic in thousands and hundreds of feet. Relative versus absolute altitude display is selected on the transponder/TCAS control panel.
	TCAS TA, absolute altitude		For both relative and absolute altitude, the number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
	TCAS no bearing message (RA-R, TA-A)	MAP, MAP CTR, APP, VOR	Message provides traffic type, range in NM, altitude and vertical direction.
	TCAS traffic alert message (RA-R, TA-A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.

Symbol	Name	ND Mode	Remarks
OFFSCALE	TCAS off scale message (RA–R, TA–A)	MAP, MAP CTR, APP, VOR	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Refer to Chapter 15, Warning Systems for display criteria.
TFC	TCAS mode (B)	MAP, MAP CTR, APP, VOR	Indicates the ND TCAS display is active.
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA, if traffic is selected. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Indicates TCAS failure, if traffic is selected.

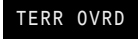
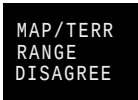
Radar

Symbol	Name	ND Mode	Remarks
TEST	Weather radar (WXR) test mode (B) (A)	MAP, MAP CTR, APP, VOR	Weather radar system is selected on the EFIS control panel (refer to Chapter 11, Flight Management, Navigation).
WXR	WXR precipitation only mode (B)		
WX+T	WXR and turbulence mode (B)		
VAR	WXR receiver gain (B)		
MAP	Mode used with down-tilt when ground mapping (B)		
+5A	WXR antenna automatic tilt mode selected (B)		
+5M	WXR antenna manual tilt mode selected (B)		
WXR FAIL	WXR system failure (A)		
RT	WXR receiver transmitter failure (A)		
ANT	WXR antenna failure (A)		
AUTOTILT FA	Automatic tilt mode failure (A)		
CONT	WXR control panel failure (A)		
ATT	WXR loss of attitude data (A)		
WEAK	WXR calibration fault (A)		

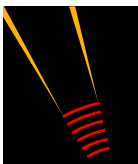
Look-Ahead Terrain

Symbol	Name	ND Mode	Remarks
	Obstacle display (R, A, G)	MAP, MAP CTR, APP, VOR	Displays obstacle data from the GPWS obstacle data base. Color displays using same rules as terrain display.
	Terrain display (R, A, G, M)	MAP, MAP CTR, APP, VOR	Displays terrain data from the GPWS terrain data base. When airplane higher than 2,000 feet above terrain; peaks contours displayed in three densities (G), highest peaks displayed as solid, intermediate height terrain peaks displayed as high density, lowest terrain peaks displayed as low density. When airplane lower than 2,000 feet above terrain; terrain 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude (G), terrain 500 feet (250 feet with gear down) below to 2000 feet above the airplane's current altitude (A), terrain more than 2,000 feet above airplane's current altitude (R), no terrain data available (M).
	Obstacle annunciation (R, A)	All	Obstacle caution alert (A), obstacle warning alert (R).

Symbol	Name	ND Mode	Remarks
	Terrain mode annunciation (C) and highest and lowest terrain or obstacle altitudes (R, A, G, M)	MAP, MAP CTR, APP, VOR	Terrain display enabled (manual or automatic display). Numbers displayed below TERR are altitudes, in hundreds of feet, of highest and lowest contours displayed on ND. Color corresponds to colors of highest and lowest terrain or obstacle displayed. Altitudes not displayed when terrain data unavailable.
	Terrain test mode annunciation (C)	All	GPWS operating in self-test mode.
	Terrain annunciation (R, A)	All	Look-ahead terrain caution alert (A), look-ahead terrain warning alert (R).

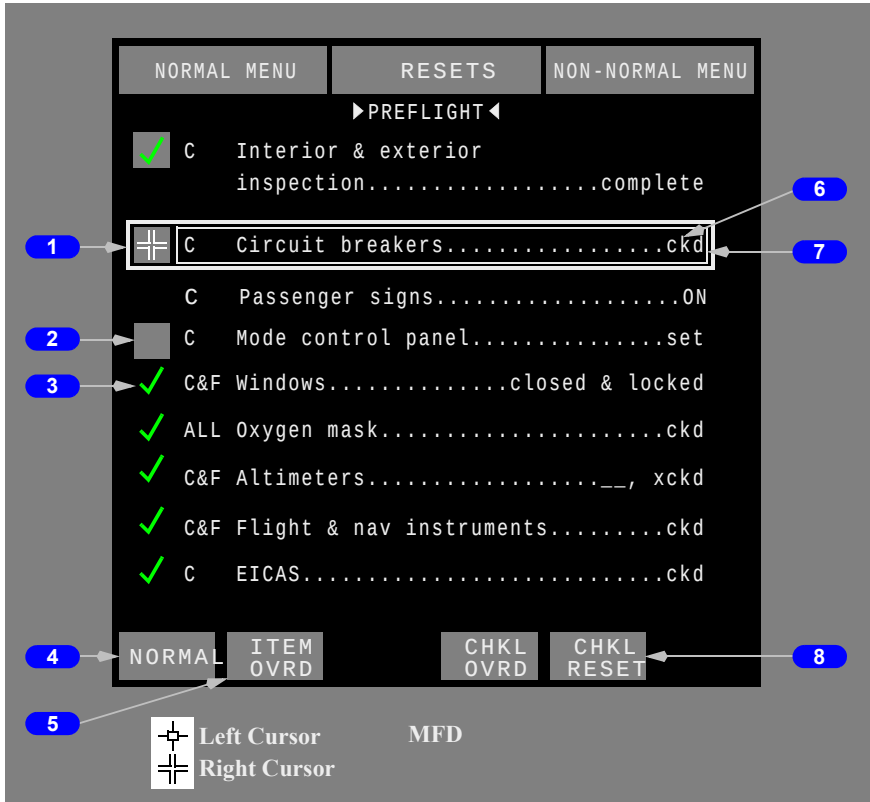
Symbol	Name	ND Mode	Remarks
	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display have failed.
		MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display unavailable due to GPS position uncertainty.
		MAP, MAP CTR, APP, VOR	GPWS terrain inhibit switch in TERR INHIBIT position.
	Terrain range status annunciations (A)	MAP, MAP CTR, APP, VOR	Terrain output range disagrees with range selected by EFIS control.
		MAP, MAP CTR	Terrain output range and map display output range disagree with range selected by EFIS control.

Predictive Windshear

Symbol	Name	ND Mode	Remarks
	Predictive windshear symbol (R, B, A)	MAP, MAP CTR, APP, VOR	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).

Intentionally
Blank

Normal Checklist



1 Cursor Selection Box

Highlights cursor selection area.

2 Open Loop Indicator

Indicates line item is an open loop action item. Requires crew confirmation to become complete.

3 Complete Indicator

Indicates line item is complete.

4 Normal Checklist (NORMAL) Key

Select –

- shows the next incomplete normal checklist
- shows normal checklists menu page when all normal checklists are complete.

5 Line Item Override (ITEM OVRD) Key

Select – overrides line item in current line item box. Item is displayed cyan.

6 Checklist Line Item

Displayed (white) –

- when action is required, line item is incomplete
- when action is not required, line item remains white and is complete.

Displayed (green) – line item is complete.

Displayed (cyan) – line item is inactive or overridden.

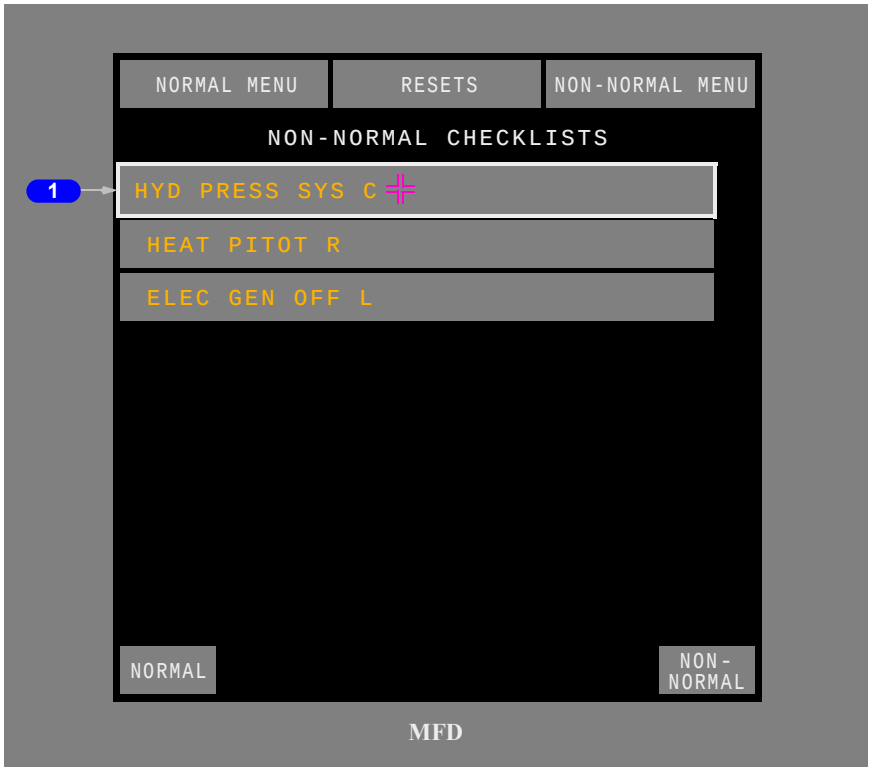
7 Current Line Item Box

Highlights current incomplete line item.

8 Checklist Reset (CHKL RESET) Key

Select - starts the current checklist from the beginning. All line items become incomplete and the current line item box, the cursor selection box, and the cursor move to the first incomplete line item.

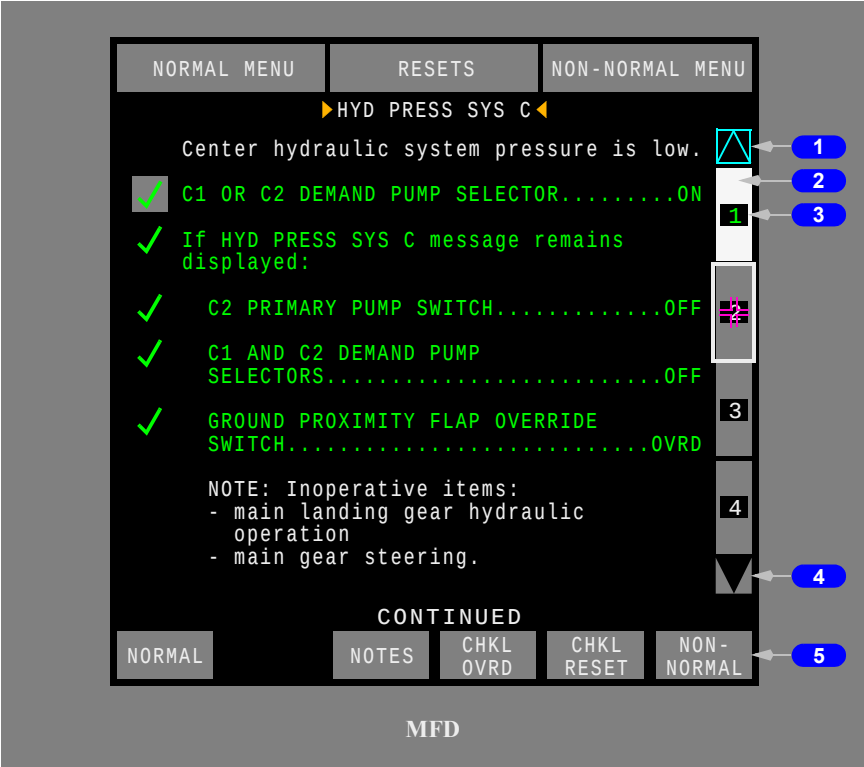
Non-Normal Checklist Queue



1 Checklist Key

Select – shows the checklist corresponding to title on key.

Non-Normal Checklist



1 Previous Page Key

Select - shows the previous checklist page.

Shows (gray) - the previous page is available.

Shows (cyan) - the key is inactive. The first page of the checklist is shown.

2 Checklist Page Key

Select - shows the checklist page corresponding to the page number on the key.

Shows (white) - the checklist page corresponding to the page number on the key is currently shown.

Shows (gray) - the checklist page corresponding to the page number on the key is not currently shown.

3 Checklist Page Number

Shows (white) - the checklist page is incomplete.

Shows (green) - the checklist page is complete.

4 Next Page Key

Select - shows the next checklist page.

Shows (gray) - the next page is available.

Shows (cyan) - the key is inactive. The last page of the checklist is shown.

5 Non-Normal checklist (NON-NORMAL) Key

Shows when there are additional incomplete non-normal checklists in the checklist queue.

Select -

- shows the next incomplete non-normal checklist when one incomplete non-normal checklist is in the checklist queue
- shows the non-normal checklist queue when more than one incomplete non-normal checklist is in the checklist queue

Shows (white) - an incomplete non-normal checklist has not been shown.

Shows (amber) - an incomplete non-normal checklist has been shown but is not currently shown.

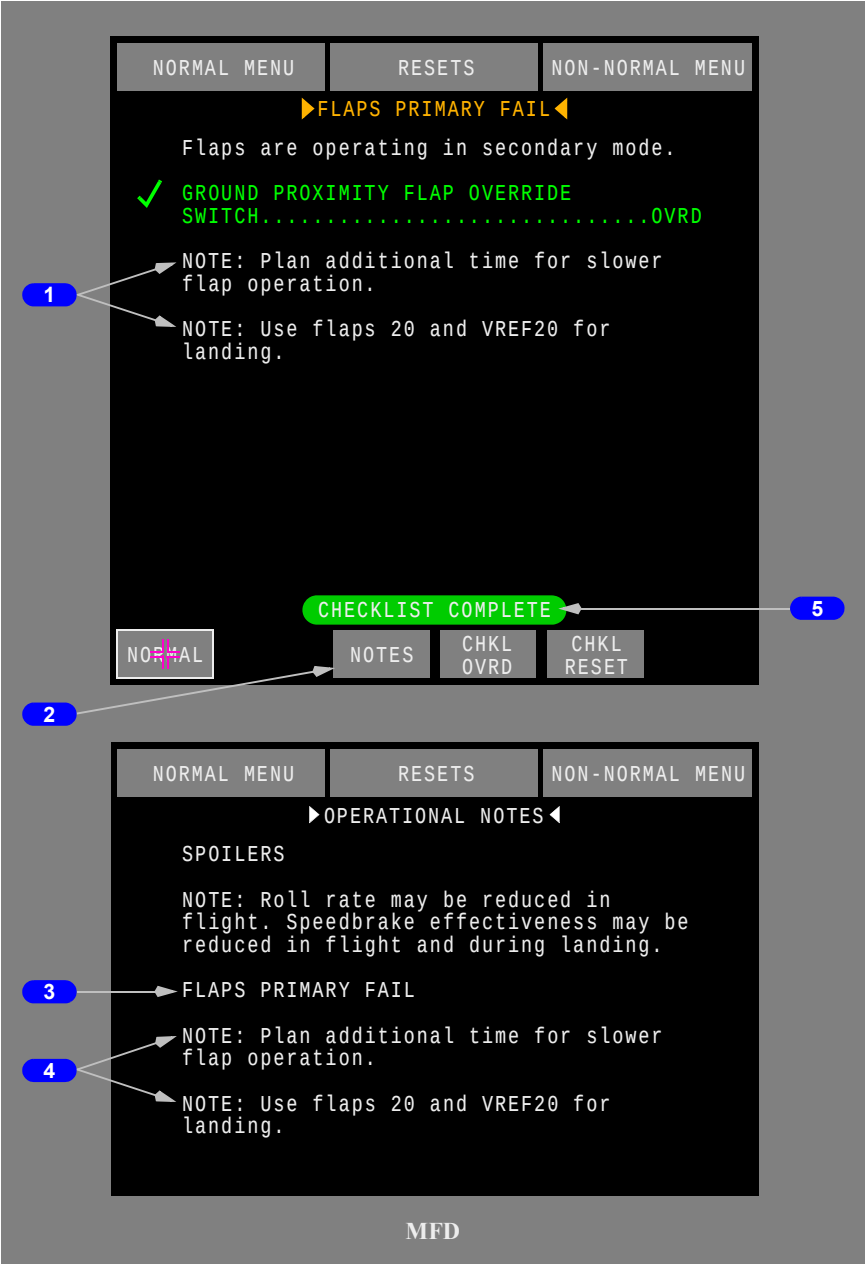
Checklist Timer



1 Timer

Shows the time remaining of a time delay for the current line item. If the line item is complete, the current line item box stays on the line item until the timer expires.

Operational Note



The diagram illustrates the sequence of events on the Delta 777 Electronic Checklist Display (ECD) for a Flaps Primary Fail. It shows two screens with various callouts:

- Screen 1 (Top):**
 - Buttons: NORMAL MENU, RESETS, NON-NORMAL MENU
 - Header: ► FLAPS PRIMARY FAIL ◀
 - Text: Flaps are operating in secondary mode.
 - Item: ✓ GROUND PROXIMITY FLAP OVERRIDE SWITCH.....OVRD
 - Notes:
 - NOTE: Plan additional time for slower flap operation.
 - NOTE: Use flaps 20 and VREF20 for landing.
 - Bottom Buttons: NORMAL, NOTES, CHKL OVRD, CHKL RESET
- Screen 2 (Bottom):**
 - Buttons: NORMAL MENU, RESETS, NON-NORMAL MENU
 - Header: ► OPERATIONAL NOTES ◀
 - Section: SPOILERS
 - Text: NOTE: Roll rate may be reduced in flight. Speedbrake effectiveness may be reduced in flight and during landing.
 - Item: FLAPS PRIMARY FAIL
 - Notes:
 - NOTE: Plan additional time for slower flap operation.
 - NOTE: Use flaps 20 and VREF20 for landing.

Callouts (1-5) indicate specific elements:

- 1:** Points to the first NOTE on Screen 1.
- 2:** Points to the NORMAL button on Screen 1.
- 3:** Points to the FLAPS PRIMARY FAIL item on Screen 2.
- 4:** Points to the second NOTE on Screen 2.
- 5:** Points to the CHECKLIST COMPLETE message on Screen 1.

MFD

1 Operational Notes

Shown in a non-normal checklist.

2 Operational Notes (NOTES) Key

Select - shows the operational notes page.

3 Checklist Reference

Indicates the non-normal checklist from which operational notes originated.

4 Operational Notes

Shown on the operational notes page.

5 CHECKLIST COMPLETE Indicator

Shows when all of the line items are either complete, inactive, or overridden, and all the pages have been shown.

Conditional Line Item

NORMAL MENU
RESETS
NON-NORMAL MENU

▶ DET FIRE APU ◀

APU fire detection is inoperative.

✓ If APU not running:

NOTE: Do not start the APU unless use is required.

✓ If APU is running:

Plan to shut down the APU as soon as practical.

NORMAL MENU
RESETS
NON-NORMAL MENU

▶ FLAPS DRIVE ◀

✓ Flap position between 1 and 5 or at 5:

◆ YES
◆ NO

NOTE: Use current flaps and VREF30 + 40 for landing.

Flap position between 5 and 20:

◆ YES
◆ NO

NOTE: Use current flaps and VREF30 + 20 for landing.

CONTINUED

NORMAL
NOTES
CHKL OVRD
CHKL RESET

MFD

1 Closed Loop Conditional Line Items

Shows (white) - the conditional line item is incomplete.

Shows (cyan) - the conditional line item is sensed false. All line items indented below the conditional line item become inactive and show cyan. The current line item box, cursor selection box, and cursor skip the inactive items and move to the next incomplete line item.

Shows (green) - the conditional line item is sensed true. The current line item box, cursor selection box, and cursor move to the next incomplete line item.

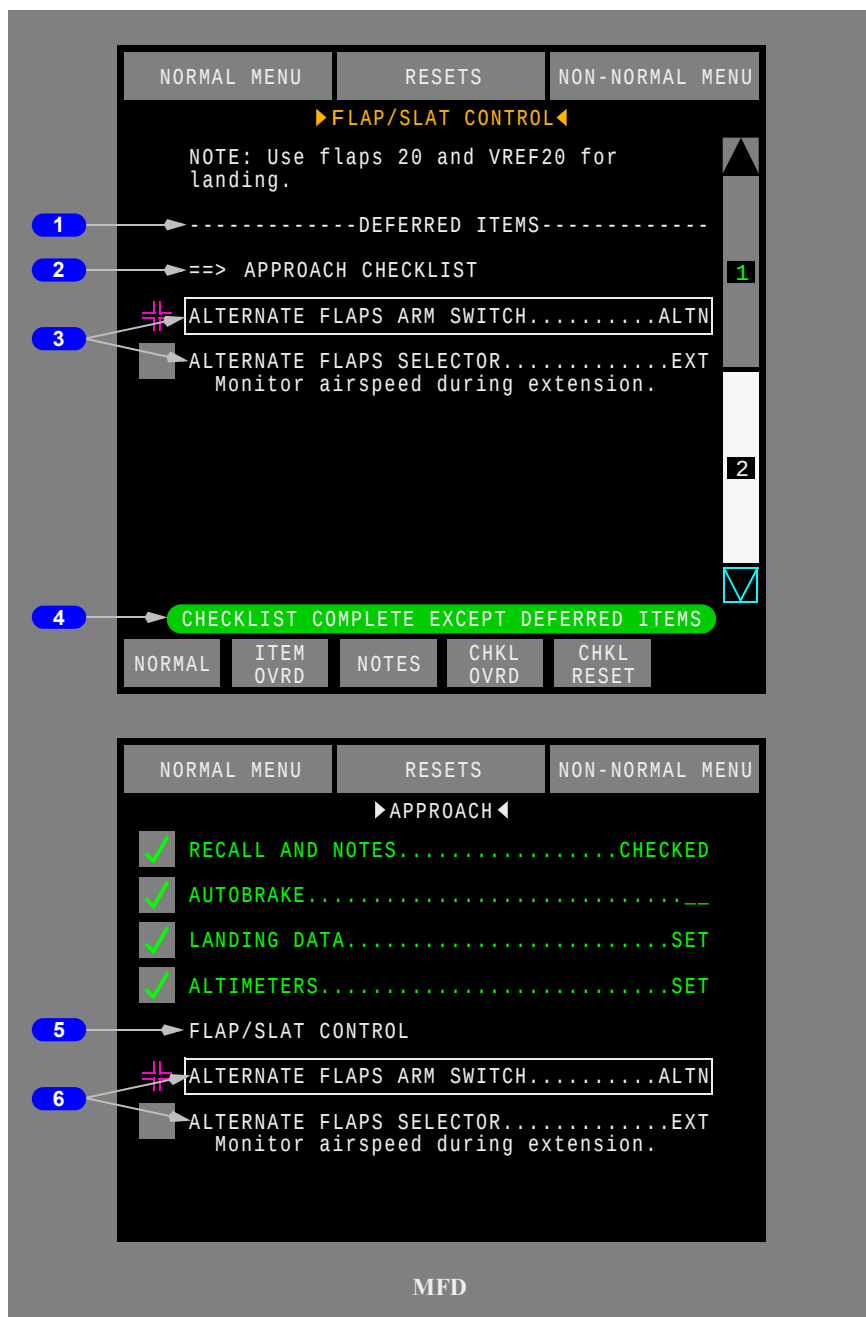
2 Open Loop Conditional Line Items

Shows (white) - the conditional line item is incomplete.

Shows (cyan) - the conditional line item is selected NO. All line items indented below the conditional line item become inactive and show cyan. The current line item box, cursor selection box, and cursor skip the inactive items and move to the next incomplete line item.

Shows (green) - the conditional line item is selected YES. The current line item box, cursor selection box, and cursor move to the next incomplete line item.

Deferred Line Item



1 Deferred Line Items Separator

Separates deferred line items from non-normal checklist line items. All the line items below the separator are deferred.

2 Checklist Reference

Indicates the normal checklist to which deferred line items go.

3 Deferred Line Items

Shown in a non-normal checklist.

4 CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS Indicator

Shows when all line items except deferred line items are either complete, inactive, or overridden, and all pages before the deferred line items separator have been shown.

5 Checklist Reference

Indicates the non-normal checklist from which deferred line items originated.

6 Deferred Line Items

Shown in a normal checklist.

Inhibit Checklist Line Item



1 Inhibit Checklist Line Item

Shows checklists which are inhibited or removed from the checklist queue and whose checklist icons are inhibited or removed from the EICAS display.

Checklist Override

NORMAL MENU

RESETS

NON-NORMAL MENU

▶HYD PRESS DEM L◀

Left demand pump output pressure is low
when commanded on.

✚

LEFT DEMAND PUMP SELECTOR.....ON

If HYD PRESS DEM L message remains
displayed:

LEFT DEMAND PUMP SELECTOR.....OFF

1

NORMAL

ITEM
OVRD

CHKL
OVRD

CHKL
RESET

NORMAL MENU

RESETS

NON-NORMAL MENU

▶HYD PRESS DEM L◀

Left demand pump output pressure is low
when commanded on.

LEFT DEMAND PUMP SELECTOR.....ON

If HYD PRESS DEM L message remains
displayed:

LEFT DEMAND PUMP SELECTOR.....OFF

2

NORMAL

CHKL
RESET

CHECKLIST OVERRIDDEN

MFD

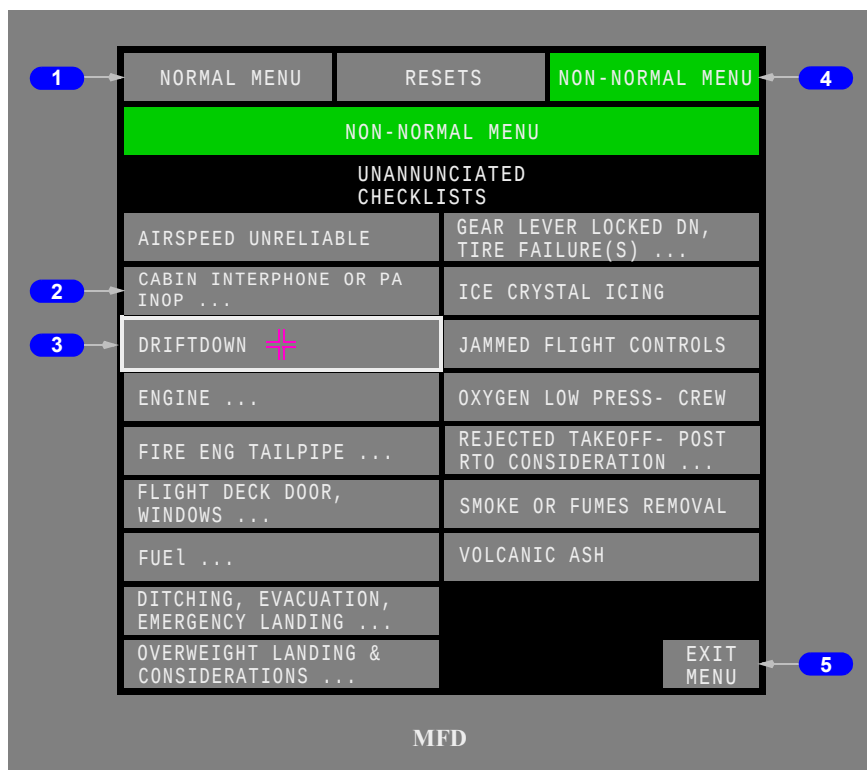
1 Checklist Override (CHKL OVRD) Key

Select - overrides the current checklist.

2 CHECKLIST OVERRIDDEN Indicator

Shows when the checklist is overridden. All the line items show cyan.

Checklists Menu Page



1 Normal Menu (NORMAL MENU) Key

Select - shows the normal checklists menu. The menu contains checklist keys for the normal checklists.

2 Menu Key

Indicated by three dots after the menu title.

Select - shows the checklists menu page for the title on the key.

3 Checklist Key

Select - shows the checklist for the title on the key.

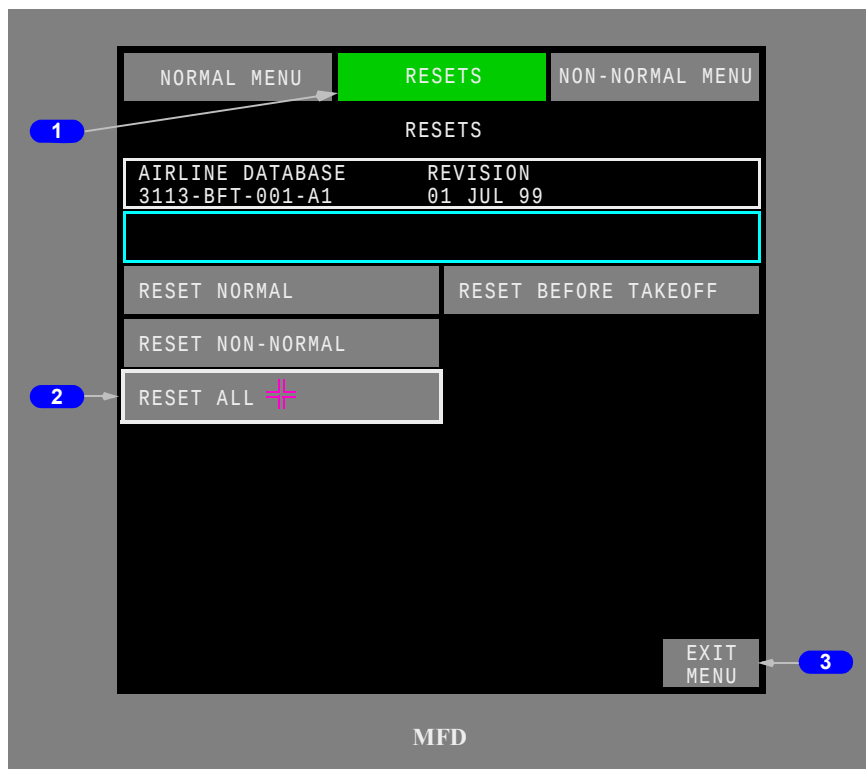
4 Non-Normal Menu (NON-NORMAL MENU) Key

Select - shows the non-normal checklists menu page. The page contains menu keys for the airplane systems.

5 Exit Menu (EXIT MENU) Key

Select - exits page for access to the normal and non-normal checklist keys.

Resets Menu Page



1 Resets Menu (RESETS) Key

Select - shows the checklist resets page.

2 Reset Key

Select - resets checklists corresponding to the title on the key. All affected checklists become incomplete.

3 Exit Menu (EXIT MENU) Key

Select - exits page for access to the normal and non-normal checklist keys.

Intentionally
Blank

Flight Instruments, Displays

Electronic Checklist Description

Chapter 10

Section 60

Introduction

The electronic checklist (ECL) system shows normal and non-normal checklists on a multifunction display (MFD). The electronic checklist system is not required for dispatch, and a paper checklist must be available on the flight deck.

The checklist display switch on the display select panel opens the electronic checklist. The flight crew operates the checklist with the cursor control devices (CCDs). Cursor control devices and MFD selection are described in the System Description section of this chapter.

Electronic Checklist Operation

Pushing the checklist display switch on the display select panel shows the correct checklist (see Checklist Priority, this section, for the checklist priority order). Only one checklist can show at a time.

Three types of checklists can be shown:

- normal
- non-normal for an EICAS message (annunciated)
- non-normal for a condition without an EICAS message (unannunciated)

After each normal checklist is complete, pushing the checklist display switch twice or selecting the normal key shows the next normal checklist in sequence.

Some checklist steps must be checked off by the flight crew to show as complete. Other checklist steps are automatically checked off from sensed flight deck control positions, airplane system status, or EICAS messages.

Checklist Pages

A checklist can have one or more pages. If a checklist is longer than one page, page keys show on the right side of the page.

When a checklist has more than one page and the line items on the current page are complete, the cursor moves to the checklist page key for the next page. CONTINUED shows at the bottom of the page. Pressing the CCD cursor select switch shows the next checklist page.

When a checklist is complete and there are no additional checklists in the non-normal checklist queue, the cursor automatically moves to the normal checklist key in the lower left corner of the page. Pressing the CCD cursor select switch shows the next normal checklist in sequence. If there are checklists in the non-normal queue, the cursor moves to the non-normal key in the lower right corner of the page. Pressing the CCD cursor select switch shows the next non-normal checklist (if only one is in the queue) or the non-normal checklist queue.

Checklist Status

The checklist complete indicator shows at the bottom of all pages of the checklist when all of the line items are either complete, inactive, or overridden, and every page has been shown. If the flight crew chooses not to do a line item, the line item can be overridden with the line item override key at the bottom of the page. When a line item is overridden, the text changes color to cyan and the current line item box moves down to the next incomplete line item. If the flight crew chooses to not complete a checklist, the checklist can be overridden by selecting the checklist override key at the bottom of the page. When a checklist is overridden, the text of the entire checklist changes color to cyan, and the checklist overridden indicator shows at the bottom of all pages.

Checklist Line Items

A checklist has one or more line items. These are the types of line items:

- free text
- action item
- operational note
- conditional
- inhibit checklist

Free text items show text and have no further function. The other line item types are described below.

Incomplete line items have white text. Complete line items have green text with a complete indicator (a green check mark) to the left. Overridden and inactive line items have cyan text.

When the checklist is opened, the current line item box moves to the first incomplete line item. When the cursor is on that line item, the cursor selection box encloses the current line item box. When the line item becomes complete, the cursor, the cursor selection box, and the current line item box move to the next incomplete line item.

Action Items

Each step in a checklist that requires a flight crew action is an action item. There are two types of action items: closed loop and open loop.

Closed Loop Action Items

Closed loop action items continuously monitor the position of a flight deck switch, lever, or selector. In a few cases, actual system state, such as flap or landing gear position, is monitored. When the control is in the required position, the action item color changes to green and the complete indicator shows to the left of the action item. The current line item box then moves to the next incomplete line item.

Open Loop Action Items

Open loop action items require the flight crew to manually confirm completion with the CCD. Open loop action items do not monitor control position or system state. Open loop action items look different from closed loop action items. Open loop action items have an open loop indicator, a gray box to the left of the line item. When the cursor is within the current line item box or the open loop indicator, and the CCD cursor select switch is pushed, the action item color changes from white to green and a complete indicator shows on the open loop indicator. The current line item box then moves to the next incomplete line item.

Operational Notes

Operational notes are for the ongoing consequences of a non-normal condition, such as inoperative equipment or operational limitations. The flight crew should read all operational notes, but the current line item box does not stop on an operational note because no immediate flight crew action is required. Operational notes have white text, unless inactive or overridden.

The operational notes page stores active operational notes for easy access and review by the flight crew later in flight. After a non-normal checklist that has operational notes is opened, the operational notes are available for the rest of the flight on the operational notes page. Access to the operational notes page is by the operational notes key at the bottom of the checklist page. Operational notes on the operational notes page have a checklist reference with the title of the checklist from which they came.

If there is more than one page of operational notes, page keys show.

The status of an operational note is based on the status of the EICAS message for the checklist with the note. If the EICAS message blanks, unneeded notes can also blank from the notes page.

Conditional Line Items

Conditional line items control the path through a complex checklist. The current line item box steps through line items or it skips line items based on a condition.

There are two types of conditional line items: open loop and closed loop.

Open Loop Conditional Line Items

Open loop conditional line items have choices labeled YES and NO. When the conditional line item becomes the current line item, the cursor moves to the YES - NO line. The flight crew uses the CCD to select the correct answer.

If the flight crew selects YES, the line items indented below the conditional line item become active. The current line item box moves to the first incomplete line item.

If the flight crew selects NO, the line items indented below the conditional line item become inactive and change color to cyan. The current line item box skips the inactive items. Inactive operational notes are removed from the operational notes page. Inactive deferred line items are removed from their normal checklist. Inactive inhibit checklist line items have no effect.

The YES - NO choices remain available after a selection is made. The flight crew can change selections at any time.

A group of two or more open loop conditional line items can be a mutually exclusive set. When the flight crew selects YES on any one of the items in the exclusive set, all of the other items are automatically set to NO. However, the opposite is not true. If all but one of the items are selected NO, the last item is not automatically set to YES. The flight crew must manually select YES on one of the conditional line items in the exclusive set.

Closed Loop Conditional Line Items

A closed loop conditional line item works the same as an open loop item except the choice is made automatically based on a monitored flight deck control, an EICAS message, or an airplane system state. If the condition is true, the conditional line item changes color to green and the line items indented below it become active. If the condition is false, the conditional line item and the line items indented below it become inactive and change color to cyan. The current line item box skips the inactive items.

Inhibit Checklist Line Items

One airplane system failure can cause more than one EICAS alert message (a primary message and one or more consequential messages). The flight crew should do the checklist for the primary message not the consequential messages. Inhibit checklist line items remove unneeded non-normal checklists (consequential checklists) from the checklist queue.

Consequential EICAS alert messages can show for a primary failure condition. For example, the AUTO SPEEDBRAKE message shows due to a HYD PRESS SYS C condition. Consequential EICAS alert messages can also show due to flight crew actions in a non-normal checklist. For example, a PACK L message shows when the flight crew selects the pack off in the SMOKE, FIRE AND FUMES checklist. An inhibit checklist line item in the primary checklist inhibits the consequential checklists.

The inhibit checklist line item shows the consequential checklists which are inhibited. The inhibit has the following effects on a consequential checklist:

- the checklist icon is removed from the consequential EICAS message
- the consequential checklist is removed from the checklist queue
- operational notes from the consequential checklist are removed from the operational notes page
- deferred line items are removed from the normal checklists

If a consequential checklist has steps, notes, and information that are needed for the primary failure condition, then these are included in the primary checklist.

An inhibit checklist line item becomes active when the message for the primary condition shows, before its checklist is opened.

In the paper checklist, an inhibit checklist line item shows as "Do not accomplish the following checklist".

Deferred Line Items

Deferred line items are items that are part of a non-normal checklist, but must be done later in the flight, usually during approach.

When a non-normal checklist that has deferred line items is opened, the deferred line items are automatically added to the end of a normal checklist. Deferred line items in a normal checklist have a checklist reference with the title of the checklist from which they came. Any type of line item can be a deferred line item.

A non-normal checklist that has deferred line items is complete when all line items before the deferred line items are complete. The checklist complete except deferred items indicator shows at the bottom of the page.

If the non-normal condition occurs after completion of the normal checklist that would get the deferred line items, the non-normal checklist is complete when all line items, including the deferred line items, are complete.

Timers

Timers help the flight crew keep track of time delays that are part of checklists. The timer shows in the upper right hand corner of the checklist page. All timers are countdown timers. Timers can be part of action items or conditional line items.

A timer on a line item starts when the line item just before it is complete. Timers run in the background. This allows the flight crew to leave the checklist to accomplish other tasks and then return to the checklist. Timers are white when they are running. When the timer is done, it shows ":00" and the color changes to amber.

The current line item box does not move to the next incomplete line item until the line item with the timer is complete and the timer is done.

Checklist Menu Operation

Usually, the flight crew uses the checklist display switch on the display select panel and the normal and non-normal keys to select checklists. Checklists can also be selected and opened with menus. The normal menu, the resets page, and the non-normal menu can be selected with the keys at the top of the checklist page, using the CCD.

An exit menu key is in the lower right corner of all menu pages. This exits the menu page to allow access to the normal and non-normal checklist keys.

Normal Menu

Normal checklists are on the normal menu in the sequence they are completed in a normal flight.

Non-Normal Menu

The non-normal menu has submenus by airplane system. An airplane system submenu has the checklists for that system. If a system has more checklists than can fit on a page, additional submenus group checklists by name. Submenu titles end with "...".

Resets Page

The resets page shows the checklist database part number and revision information and the following manual resets:

- RESET NORMAL
- RESET NON-NORMAL
- RESET ALL

Other manual resets can also be on this page. These can reset more than one checklist. See Checklist Resets in this section.

Note: RESET NORMAL, RESET NON-NORMAL, and RESET ALL are intended for ground use only. If they are used in flight, RESET NON-NORMAL and RESET ALL will reset completed non-normal checklists, requiring the crew to start the checklists over. It can also cause needed operational notes and deferred line items to be lost.

Checklist Priority

Air/ground logic, fuel control switch and start selector position, and EICAS message level determine the priority for checklists when the checklist display switch is pushed.

On the ground with both fuel control switches in CUTOFF and both engine start selectors in NORM, the priority is:

- checklists for EICAS warning messages
- NORMAL checklists (incomplete or not yet opened)

On the ground with one or both fuel control switches in RUN, one or both engine start selectors in START; or in the air, the priority is:

- checklists for any EICAS alert messages that have icons
- incomplete unannunciated checklists
- NORMAL checklists

Normal Checklists

Normal electronic checklists are used the same way as paper checklists. The flight crew does the normal procedures from memory, then they read the checklist to confirm the actions.

Normal Checklist Access

The checklist sequence is:

- PREFLIGHT
- PUSHBACK
- AFTER START
- TAXI
- BEFORE TAKEOFF
- AFTER TAKEOFF
- CLIMB
- DESCENT
- APPROACH
- LANDING
- AFTER LANDING
- SHUTDOWN
- AFTER SHUTDOWN REMINDERS
- SECURE
- DEPARTURE RUNWAY CHANGE
- ARRIVAL RUNWAY CHANGE

When each normal checklist is complete, the normal checklist key shows the next incomplete normal checklist in the sequence.

The flight crew can open any normal checklist from the normal menu. If a completed normal checklist is opened from the menu, it is reset.

Normal Checklist Completion

When all of the line items in a checklist are complete, the checklist complete indicator (white text on a green background) shows at the bottom of the checklist page.

When a checklist is overridden, the checklist overridden indicator (white text on a cyan background) shows at the bottom of the checklist page.

Non-Normal Checklists

Non-normal electronic checklists are used the same way as paper checklists. Non-normal checklists are done by read-and-do. If a checklist has memory steps, the flight crew does those steps before opening the checklist.

Non-Normal Checklist Access and Checklist Icon

Usually, the flight crew opens annunciated non-normal checklists by pushing the checklist display switch. Any non-normal checklist can be opened using the non-normal menu.

EICAS messages determine which non-normal checklist shows automatically. If the checklist for an EICAS alert message has not been opened or is incomplete, the message has an icon, a white box to the left of the message. (See section 10.50 for information about the checklist icon.)

If an EICAS alert message has no icon, the checklist is complete, there is no checklist for the message, or another checklist inhibits the icon.

If one EICAS alert message with an icon shows, pushing the checklist display switch shows the checklist for that message. If more than one EICAS alert message with an icon shows, pushing the checklist display switch shows a list with the non-normal checklist queue. If there are more than ten checklists in the queue, the queue has more than one page.

Checklists in the queue are in the same order as the messages show on EICAS. If there are any active unannunciated checklists, they show in the queue after all of the annunciated checklists.

When an EICAS alert message shows, its checklist automatically goes into the queue. When the checklist is complete, the EICAS alert message can still show, but the checklist is removed from the queue. A checklist is also removed from the queue when it is inhibited by another checklist that becomes active.

The flight crew uses the CCD to select a checklist from the queue. When a checklist is open, the non-normal checklist key returns to the queue if there are other non-normal checklists in the queue.

If EICAS alert messages show or blank while the checklist queue is shown, the queue does not change automatically. The flight crew must exit the queue and open it again to see the checklists for the new EICAS messages.

Non-Normal Unannunciated Checklists

Non-normal checklists for conditions that do not have EICAS messages are unannunciated checklists. Unannunciated checklists can be opened only from menus. UNANNUNCIATED CHECKLISTS is the first submenu on the non-normal menu. This submenu provides quick access to all unannunciated checklists.

When an unannunciated checklist is opened, it remains in the checklist queue until it is complete.

If the flight crew opens an unannunciated checklist and chooses not to complete it, the checklist must be overridden.

Non-Normal Checklist Completion

When all of the line items in a checklist are complete or inactive, the checklist complete indicator (white text on a green background) shows at the bottom of the checklist page.

When all of the line items in a checklist are complete or inactive, except for the deferred items, the checklist complete except deferred items indicator (white text on a green background) shows at the bottom of the checklist page.

When a checklist is overridden, the checklist overridden indicator (white text on a cyan background) shows at the bottom of the checklist page.

If a checklist is opened and not completed, then another checklist is opened, the text in the non-normal checklist key changes color to amber.

Checklist Resets

If a checklist is complete or partially complete and the flight crew wishes to begin the checklist again, the checklist can be reset. Selecting the checklist reset key at the bottom of the page resets the checklist: all action items and conditionals become incomplete. The current line item box moves to the first incomplete line item.

For some conditions, such as go-around, resets set the normal checklists back to a previous phase of flight. There are automatic resets and manual resets.

Normal Checklist Automatic Reset Conditions

Automatic checklist resets occur for the following conditions:

- go-around - if the airplane is in the air, the landing gear is not up, and TO/GA is selected, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset
- touch-and-go - if the airplane has transitioned from air to ground, takeoff thrust is reached with ground speed greater than 80 knots, and the thrust reversers not deployed, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset
- normal menu selection - if a previously completed normal checklist is opened from the normal menu, it automatically resets

Normal Checklist Manual Resets

The following manual resets are available for normal checklists:

- reset normal - the RESET NORMAL key resets all normal checklists. The flight sequence begins again
- individual checklist reset - the checklist reset key at the bottom of a checklist page resets the current checklist. The checklist can be started again

Non-Normal Checklist Manual Resets

The following manual resets are available for non-normal checklists:

- reset non-normal - the RESET NON-NORMAL key resets all non-normal checklists. Icons show on any active EICAS messages with checklists that were previously completed. Use of the RESET NON-NORMAL function in flight is not recommended
- individual checklist reset - the checklist reset key at the bottom of a checklist page resets the current checklist. The checklist can be started again

Manual Reset All

The RESET ALL key resets all normal and non-normal checklists. The flight sequence begins again for normal checklists. Icons show on any active EICAS messages with checklists that were previously completed. Use of the RESET ALL function in flight is not recommended.

Overrides

There are two types of override functions: item override and checklist override.

Item Override

The flight crew uses item override when they choose not to complete an action item. If the action has been done but the closed-loop sensing does not show the action item as complete, the flight crew can override the action item. This allows the checklist to be complete.

The line item override key is available on all checklists. When an item is overridden the color changes to cyan. Closed loop and open loop action items can be overridden.

Conditional line items (open loop or closed loop) cannot be overridden. Action items indented below a conditional line item can be overridden.

Checklist Override

The flight crew uses checklist override when a checklist in the non-normal queue will not be completed or if the flight crew opens a checklist from a menu but chooses not to complete it.

The checklist override key overrides the current checklist. All of the line items change color to cyan. The checklist overridden indicator shows at the bottom of the page. For a non-normal checklist, all of its operational notes are removed from the operational notes page, deferred line items are removed from their normal checklists, and inhibit checklist line items become inactive.

Electronic Checklist System Inoperative

If the checklist display switch is pushed and the electronic checklist system is inoperative, the message CHECKLIST NOT AVAILABLE shows on the MFD. If the electronic checklist system has been disabled by maintenance, the message CHECKLIST DISABLED shows on the MFD.

When the electronic checklist system is inoperative or disabled, checklist icons do not show with any EICAS messages.

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Flight Instruments, Displays

EICAS Messages

Chapter 10

Section 70

Flight Instruments, Displays EICAS Messages

Note: The OVERSPEED warning and the ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
ALTN ATTITUDE	Advisory		Both AIR DATA/ATTITUDE source switches are in the ALTN position.
BARO SET DISAGREE	Advisory		Captain's and first officer's barometric settings disagree.
DISPLAY SELECT PNL	Advisory		Left, center, or right CDU control of the display select panel is active.
EFIS CONTROL PNL L, R	Advisory		EFIS control panel is inoperative or CDU control of the EFIS control panel is active.
SGL SOURCE AIR DATA	Advisory		Both PFDs are receiving air data from the same single channel source.
SGL SOURCE DISPLAYS	Caution	Beeper	A single source of display information is being used by some or all display units.
SGL SOURCE RAD ALT	Advisory		Both PFDs are using the same source for radio altimeter information.
SINGLE SOURCE F/D	Advisory		Both PFDs are using the same source for flight director information.
VMO GEAR DOWN	Memo		Vmo value set for dispatch with landing gear extended.

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Flight Management, Navigation

Chapter 11

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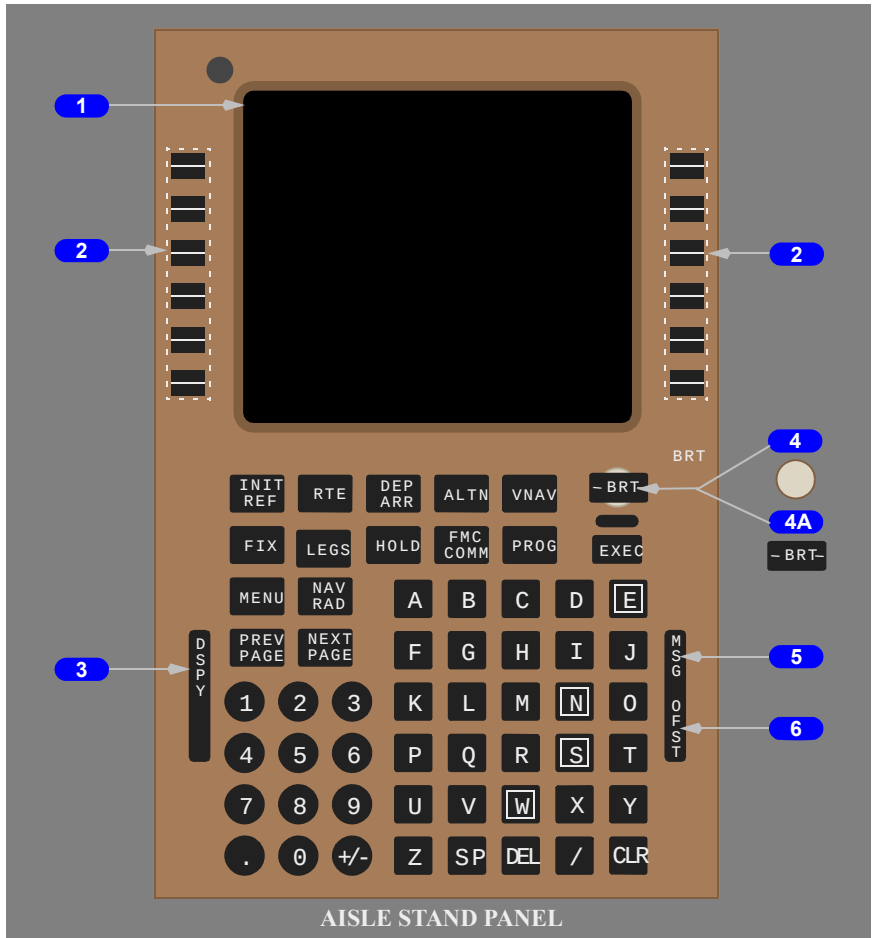
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Flight Management System

Control Display Unit (CDU)



1 Control Display Unit (CDU) Display

Displays FMS data pages.

2 Line Select Keys

Push –

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE displays in scratchpad.

Conventions -

- scratchpad must be blank for line select transfer
- data can not be transferred to a blank line
- a blank scratchpad can not be transferred to a line
- not all data can be modified
- message displays if inappropriate entries attempted.

3 Display (DSPY) Light

Illuminated (white) –

- when RTE page 3 or greater, RTE LEGS page 2 or greater, RTE DATA page 2 or greater is displayed
- when airplane is not in holding pattern shown on HOLD page
- when modification is in progress, and any RTE, RTE LEGS, RTE DATA, HOLD, or VNAV page is shown.

4 Brightness (BRT) Control

Rotate – controls display brightness.

4A Brightness (BRT) Control

Push –

- “+” increases brightness
- “-” decreases brightness
- 24 segment light brightness bar displays in the scratchpad and remains displayed for 2 seconds after release of the + or - push. Existing scratchpad information is saved and displays following fade of the brightness bar

5 Message (MSG) Light

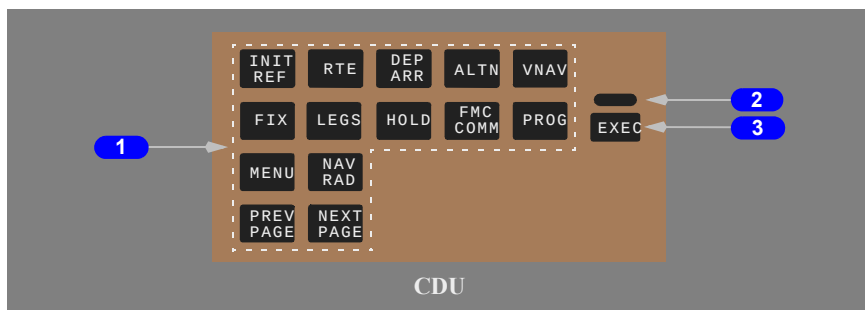
Illuminated (white) –

- scratchpad displays message
- pushing clear key extinguishes light and clears message.

6 Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset.

Function and Execute Keys



1 CDU Function Keys

Push –

- INIT REF – displays page for data initialization or for reference data
- RTE – displays page to input or change origin, destination, or route
- DEP ARR – displays page to input or change departure and arrival procedures
- ALTN – displays page to modify destination and route for alternate diversion
- VNAV – displays page to view or change vertical navigation path data
- FIX – displays page to create reference points on ND map
- LEGS –
 - displays page to evaluate or modify lateral and vertical route data
 - displays page to correlate route waypoints on the ND
- HOLD – displays page to create holding patterns and display holding pattern data, or to exit holding pattern
- FMC COMM – displays FMC data link status page
- PROG – displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, arrival estimates, and RTA and RNP information
- MENU – displays page to choose subsystems controlled by CDU
- NAV RAD – displays page to view or control navigation radio tuning
- PREV PAGE – displays previous page of multiple page displays (for example, LEGS pages)
- NEXT PAGE – displays next page of multiple page displays.

2 Execute Light

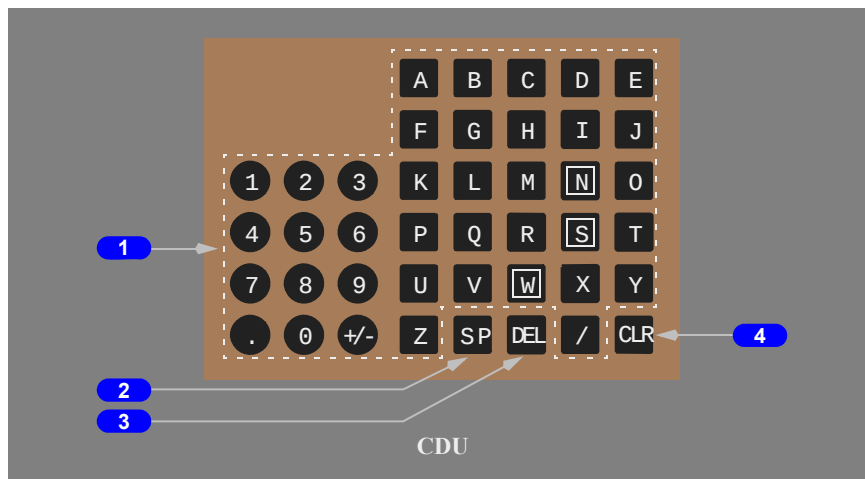
Illuminated (white) – active data is modified but not executed.

3 Execute (EXEC) Key

Push –

- activates data modification(s)
- extinguishes execute light.

Alpha/Numeric and Miscellaneous Keys



1 Alpha/Numeric Keys

Push –

- puts selected character in scratchpad
- Slash (/) key – enters “/” in scratchpad
- Plus Minus (+/-) key – first push enters “-” in scratchpad. Subsequent pushes alternate between “+” and “-”.

2 Space (SP) Key

Push –

- enters space in scratchpad
- enters underscore character “_” in scratchpad when CDU is used as input device for systems other than FMC.

3 Delete (DEL) Key

Push – enters “DELETE” in scratchpad.

4 Clear (CLR) Key

Push –

- clears last scratchpad character
- clears scratchpad message.

Push and hold – clears all scratchpad data.

CDU Page Components



1 Page Title

Subject or name of data displayed on page.

ACT (active) or MOD (modified) indicates whether page contains active or modified data.

2 Boxes

Data input is mandatory.

3 Line Title

Title of data on line below.

4 Line

Displays –

- prompts
- selectors
- data associated with line title.

Large font indicates crew entered or verified data. Small font indicates FMC computed data.

5 Page Number

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

6 Dashes

Data input is optional.

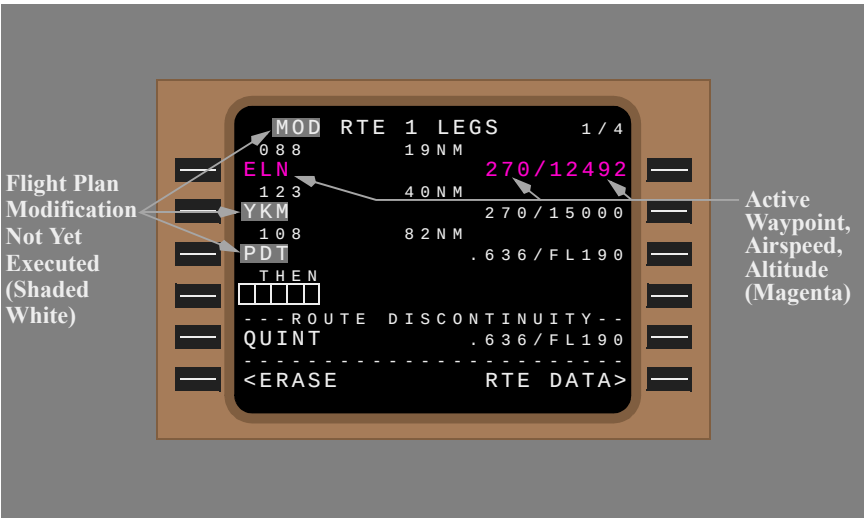
7 Prompts

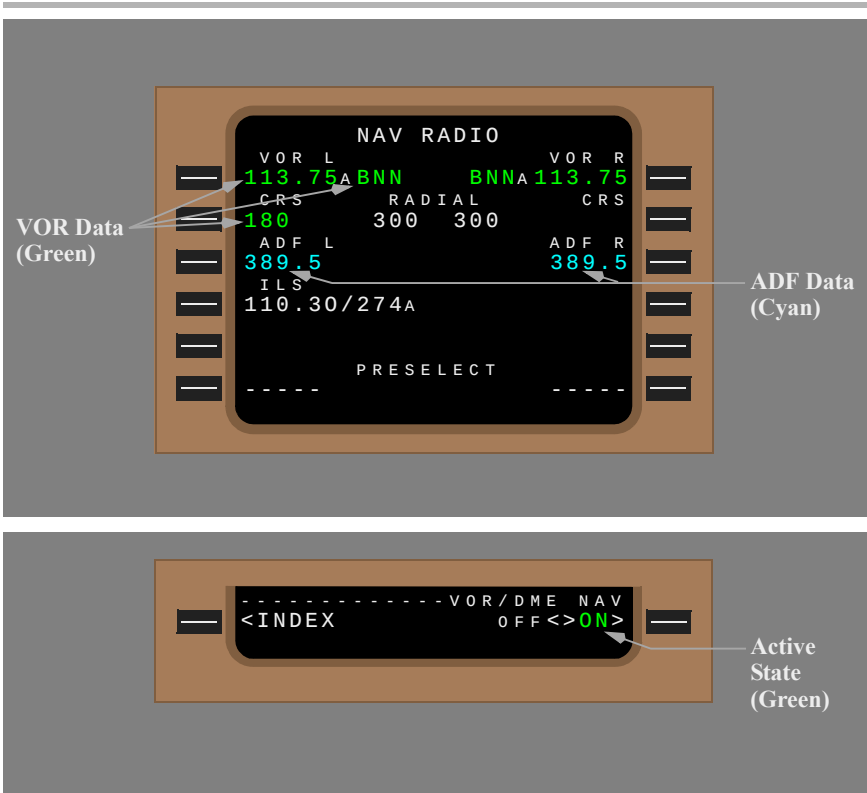
Display pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

8 Scratchpad

Displays messages, alphanumeric entries, or line selected data.

CDU Page Color

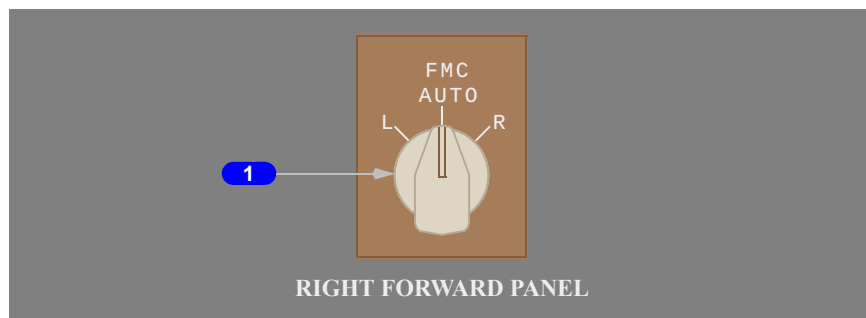




Color is used as follows:

- black – background color of page
- cyan –
 - ADF frequencies
 - inactive RTE page title
- green –
 - navigation radio data
 - active state of two-position and three-position selectors
- magenta – data used by FMC for lateral and vertical flight commands
 - active waypoint
 - active airspeed
 - active altitude
- shaded white –
 - modifications
 - MOD precedes page titles of modified pages
- white – most data.

FMC Selector



1 FMC Selector

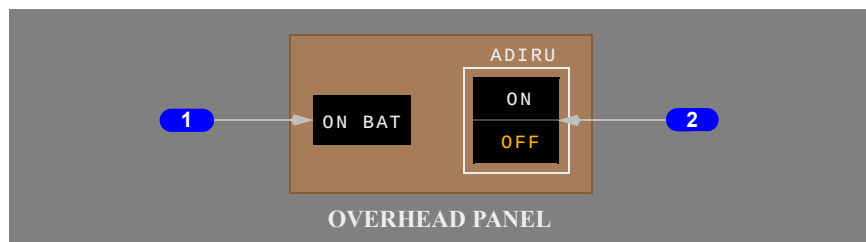
L – selects left FMC to provide guidance commands.

AUTO – automatically selects other FMC if one FMC fails.

R – selects right FMC to provide guidance commands.

Inertial System

Air Data Inertial Reference Unit (ADIRU)



1 On Battery (ON BAT) Light

Illuminated (white) – airplane battery powers ADIRU.

Note: ON BAT light illuminates only when ADIRU has been aligned on airplane or ground power, and primary power is subsequently removed or failed (battery power only remains).

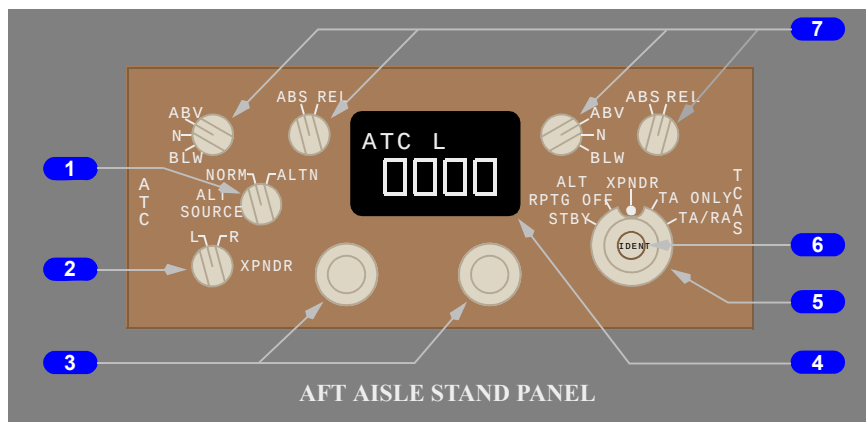
2 ADIRU Switch

ON – applies power to ADIRU.

OFF – removes power when airspeed is less than 30 knots.

Radio Navigation Systems

Transponder Panel



1 Altitude (ALT) SOURCE Selector

NORM (normal) – selects ADIRU as source for altitude reporting.

ALTN (alternate) – selects SAARU as source for altitude reporting.

2 Transponder (XPNDR) Selector

L – selects left transponder.

R – selects right transponder.

3 Transponder Code Selectors

Rotate – Sets transponder code in transponder.

4 Transponder Code Window

ATC L, ATC R – transponder selected.

Displays transponder code.

5 Transponder Mode Selector

STBY (standby) – transponder not active.

ALT RPTG (altitude reporting) OFF –

- transponder enabled
- altitude reporting disabled

XPNDR (transponder) –

- transponder enabled
- in flight, altitude reporting enabled

TA (traffic advisory) ONLY and TA/RA (resolution advisory) – Refer to Chapter 15, Warning Systems.

6 Identification (IDENT) Switch

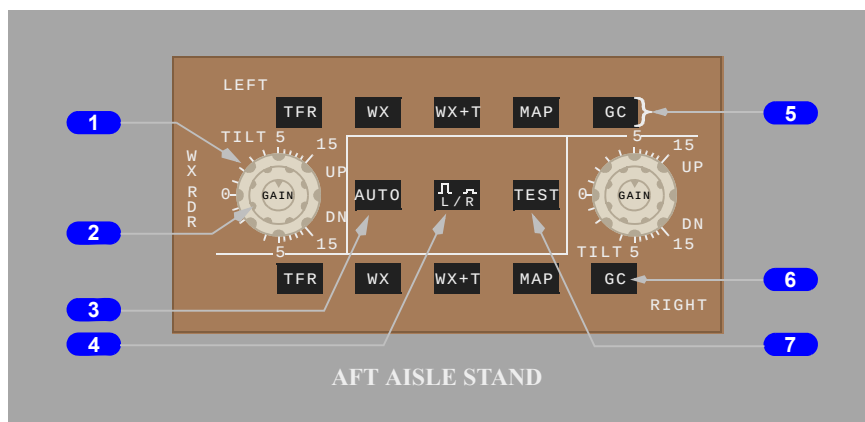
Push – transmits an identification signal.

7 TCAS Controls

Refer to Chapter 15, Warning Systems.

Weather Radar

Radar Control Panel



1 TILT Control

Rotate outer knob clockwise – tilts radar antenna up.

Rotate outer knob counterclockwise – tilts radar antenna down.

2 GAIN Control

Rotate inner knob - adjusts receiver sensitivity (by detent) in MAP, WX, and WX+T modes. The 12 o'clock position sets radar sensitivity to the standard calibrated reflectivity level and is the recommended position for normal operation. Rotating the control clockwise increases sensitivity; rotating counterclockwise decreases sensitivity.

Note: When using AUTO, ensure the GAIN control knob is in the “calibrated” position. The calibrated position is achieved by aligning the word “GAIN” horizontally with the arrow at the 12 o'clock position pointing down.

3 AUTO Switch

IN - both Captain's and First Officer's controls operate in automatic mode to optimize long and short range weather detection. Ground clutter suppression is operative. Manual tilt control is not available.

OUT - both Captain's and First Officer's controls operate manually. Ground clutter suppression is not available.

4 System Select Switch

IN - selects right system.

OUT - selects left system.

5 Mode Switches

Control display on respective ND.

Push -

TFR (transfer) - selects opposite display.

Note: Selecting both TFR switches at the same time results in the TEST mode; test pattern displays.

WX (weather) - displays weather returns.

WX + T (weather + turbulence) - displays weather returns and turbulence within precipitation. Turbulence displays out to 40 nm for all selected ranges.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP - displays ground returns at selected gain level.

6 Ground Clutter (GC) Switch

Push - allows ground clutter to display when pushed and held.

7 TEST Switch

Push –

- tests weather radar system operation without transmitting
- displays test pattern and PWS symbol at the end of the test and any fault message on ND with WXR selected (except in PLAN, CTR VOR, and CTR APP modes)
- when on the ground, selecting WXR on the EFIS control panel and TEST on the weather radar control panel activates a 12 second test. To activate the aural messages, TEST must be selected after WXR is selected on the EFIS control panel. Initially, the amber WINDSHEAR annunciation displays and the aural MONITOR RADAR DISPLAY sounds. Next, Master Warning Light illuminates and the EICAS alert message WINDSHEAR SYS displays. Finally, the red WINDSHEAR annunciation displays and the aural GO AROUND WINDSHEAR AHEAD, and then WINDSHEAR AHEAD, WINDSHEAR AHEAD sounds
- the test pattern and PWS symbol remain displayed until WXR is selected off on the EFIS control panel, another mode is selected on the Mode Selector, or an actual PWS alert is detected. The source of any faults displays in the weather radar tilt field on the ND

Flight Management, Navigation Navigation Systems Description

Chapter 11 Section 20

Introduction

Navigation systems include global positioning system (GPS), air data inertial reference system (ADIRS), VOR, DME, ILS, ADF, ATC transponder, weather radar, and the flight management system (FMS). The FMS is described in the Flight Management System Description section of this chapter.

Navigation Systems Flight Instrument Displays

Refer to Chapter 10, Flight Instruments, Displays for flight instrument display system operations and typical instrument displays.

Global Positioning System (GPS)

Left and right GPS receivers are independent and supply very accurate geographical data to the FMC. All GPS tuning is automatic.

GPS Displays

POS REF 3/3 page displays the left and right GPS position. The ND annunciates GPS when the FMC uses GPS position updates.

When the POS (position) switch on the EFIS control panel is selected, the ND map displays the left and right GPS symbols. The GPS symbols are identical and display as a single symbol when the GPS receivers calculate the same position.

GPS Data

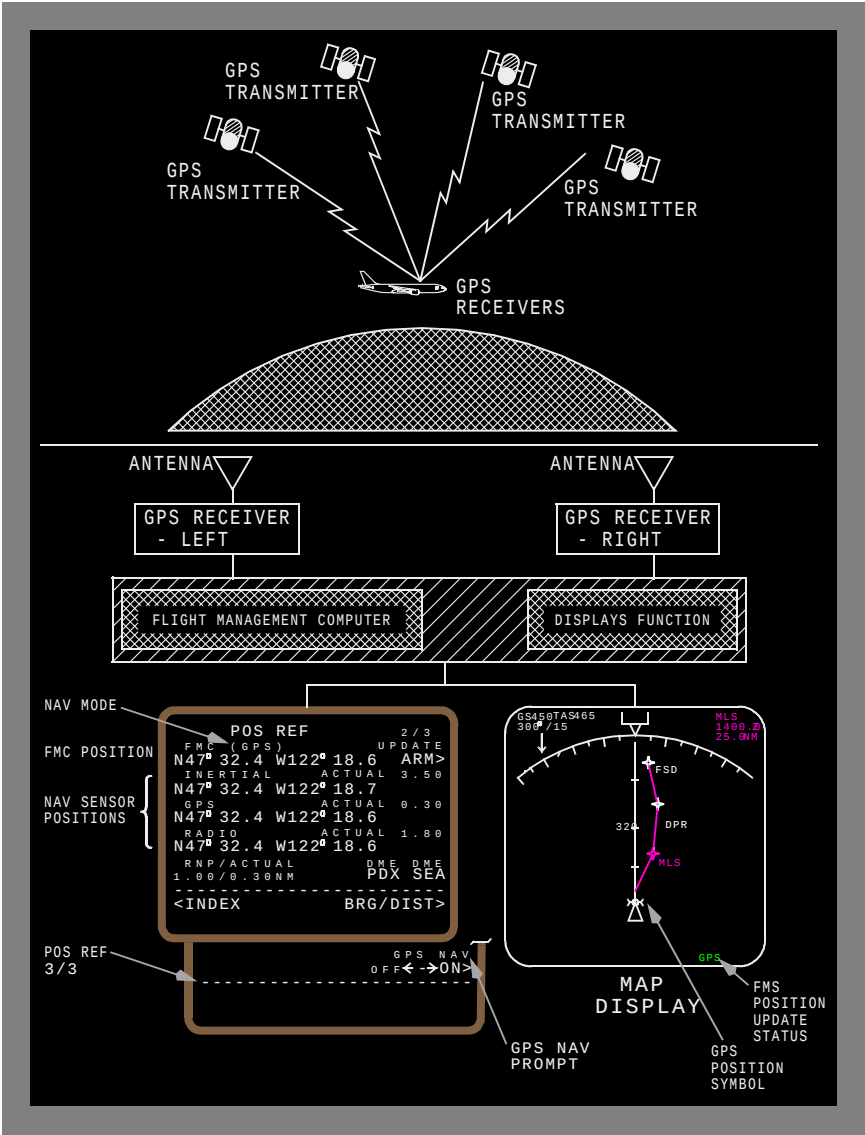
If the ADIRU becomes inoperative during flight, the EICAS displays the message NAV ADIRU INERTIAL and the FMC uses only GPS data to navigate.

Use the GPS NAV prompt on the POS REF page to inhibit GPS navigation data. The EICAS message GPS alerts the crew when both GPS systems have failed.

GPS position updates should be used during all approaches in which the FMC database and approach procedures are referenced to the WGS-84 reference datum. GPS updates should be inhibited for other approach operations not based on WGS-84 unless other appropriate procedures are used.

GPS position updates should be used for all other operations unless a specific state requires the use of other update provisions within their airspace (eg, to accommodate a non-WGS reference datum or other reason).

GPS System Schematic



Inertial System

Air Data Inertial Reference System (ADIRS)

The ADIRS calculates airplane altitude, airspeed, attitude, heading, and position data for the displays, flight management system, flight controls, engine controls, and other systems. The major components of ADIRS are the air data inertial reference unit (ADIRU), secondary attitude and air data reference unit (SAARU), and air data modules.

Air Data Inertial Reference Unit (ADIRU)

The ADIRU supplies primary flight data, inertial reference, and air data. The ADIRU is fault-tolerant and fully redundant.

ADIRU Power

Initial power-up requires battery bus power and the ADIRU switch to be ON. If the ADIRU is switched off, it must complete a full realignment cycle before the airplane can be moved.

If electrical power is subsequently removed from the airplane and the Battery switch is switched OFF, the hot battery bus continues to supply electrical power to the ADIRU. The ON BAT light illuminates, and the horn in the landing gear wheel well sounds to alert maintenance personnel the ADIRU is on battery power.

When the ADIRU switch is OFF, the ADIRU remains powered for a few seconds.

In flight, system logic prevents the ADIRU from becoming unpowered if the ADIRU switch is inadvertently switched OFF.

ADIRU Alignment

On initial power-up, the ADIRU enters the align mode. The EICAS memo message ADIRU ALIGN MODE displays. Attitude or heading/track data is removed from the PFDs. Airplane latitude/longitude position must be entered on the CDU POS INIT page. The airplane should not move until alignment is complete.

If the latitude/longitude position is not close to the position of the origin airport, the scratchpad message INERTIAL/ORIGIN DISAGREE displays. If the crew-entered latitude/longitude position does not pass internal ADIRU comparison tests, the scratchpad message ENTER INERTIAL POSITION displays.

If a new airplane present position entry fails the internal check twice, the scratchpad message ALIGNMENT REINITIATED displays. The system automatically starts a new alignment cycle.

In rare cases, a new airplane present position update of the ADIRU may cause the EICAS message NAV UNABLE RNP to momentarily display. This occurs if the entered ADIRU position is far different than the GPS position. The message displays until the FMC reconciles the difference between the new ADIRU position and the GPS position.

When the alignment is complete, the ADIRU changes to the navigate mode and the airplane can be moved. If the airplane stops for an extended period, the ADIRU changes to the automatic realign mode and refines the alignment until the airplane moves again.

In the automatic realign mode, ADIRU velocity and acceleration errors are reset to zero. The inertial position can be manually updated when the ADIRU is in the automatic realign mode by entering a new latitude/longitude position on the POS INIT 1/3 page. The ADIRU cannot be realigned in flight.

Note: A position update is recommended if the total time in the navigation mode is expected to exceed 24 hours.

Secondary Attitude and Air Data Reference Unit (SAARU)

The SAARU is a secondary source of critical flight data for displays, flight control systems, and other systems. If the ADIRU fails, the SAARU automatically supplies attitude, heading, and air data. SAARU heading must be manually set to the standby compass magnetic heading periodically.

If ADIRU inertial data fails, the EICAS caution message NAV ADIRU INERTIAL displays. The SAARU supplies attitude data to the PFD and three minutes of backup heading. The heading is based on ADIRU heading prior to failure. The CDU POS INIT page displays the SET HDG prompt three minutes after ADIRU failure. Use the SET HDG prompt to periodically set the SAARU heading to the standby compass magnetic heading. There are no other prompts to remind the crew to enter or to update the SAARU heading.

The following functions are inoperative after failure of the inertial reference portion of the ADIRU:

AFDS Modes:

- LNAV
- VNAV
- TO/GA
- LOC
- GS
- FPA
- TRK HOLD/SEL
- HDG HOLD/SEL*

Navigation Functions:

- FMC VNAV pages
- FMC Performance Predictions
- ND Wind Direction and Speed (wind arrow)

PFD Functions:

- Flap Maneuver Speeds
- PFD Heading*

Note: *This function is operative when standby magnetic compass heading is entered on the POS INIT page.

Note: ND map mode display following ADIRU failure references TRK.

Note: Autobrakes are also inoperative.

The following additional functions are inoperative after failure of the inertial reference portion of the ADIRU and loss of GPS information:

- ND Map (center and expanded)
- CDU active leg course and distance
- CDU direct-to a waypoint
- FMC Alternate Airport DIVERT NOW
- FMC navigation radio autotuning

Restoration of the SAARU heading allows navigation in the ND VOR mode using radio navigation data. The FMC navigation data LNAV/VNAV guidance is no longer available when the ADIRU fails.

SAARU power-up is completely automatic at airplane power-up. There are no SAARU controls.

Air Data and Attitude Sources

The ADIRU and SAARU receive air data from the same three sources. The ADIRU and SAARU validate the air data before it may be used for navigation.

The three air data sources are the left, center, and right pitot and static systems. Air data is valid when two or more sources agree in the ADIRU, SAARU, or both.

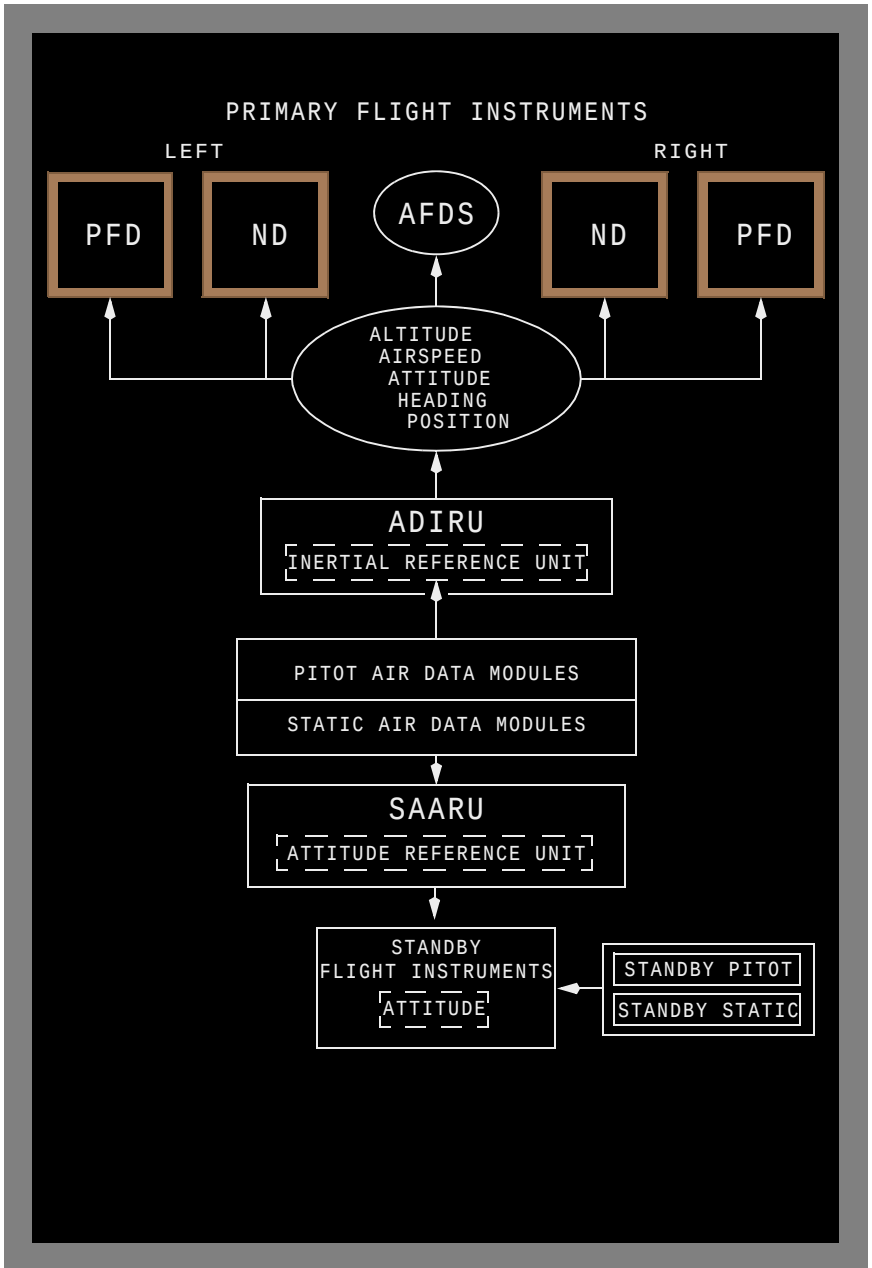
When ADIRU air data is invalid and the AIR DATA/ATT switch is in the off position, valid SAARU air data is used. Refer to Chapter 10, Flight Instruments, Displays for a description of the AIR DATA/ATT switch.

Single channel operation occurs when the ADIRU and SAARU air data are invalid. The left PFD displays the ADIRU air data from the left pitot static system (left channel). The right PFD displays the SAARU air data from the right pitot static system (right channel). The EICAS message NAV AIR DATA SYS displays.

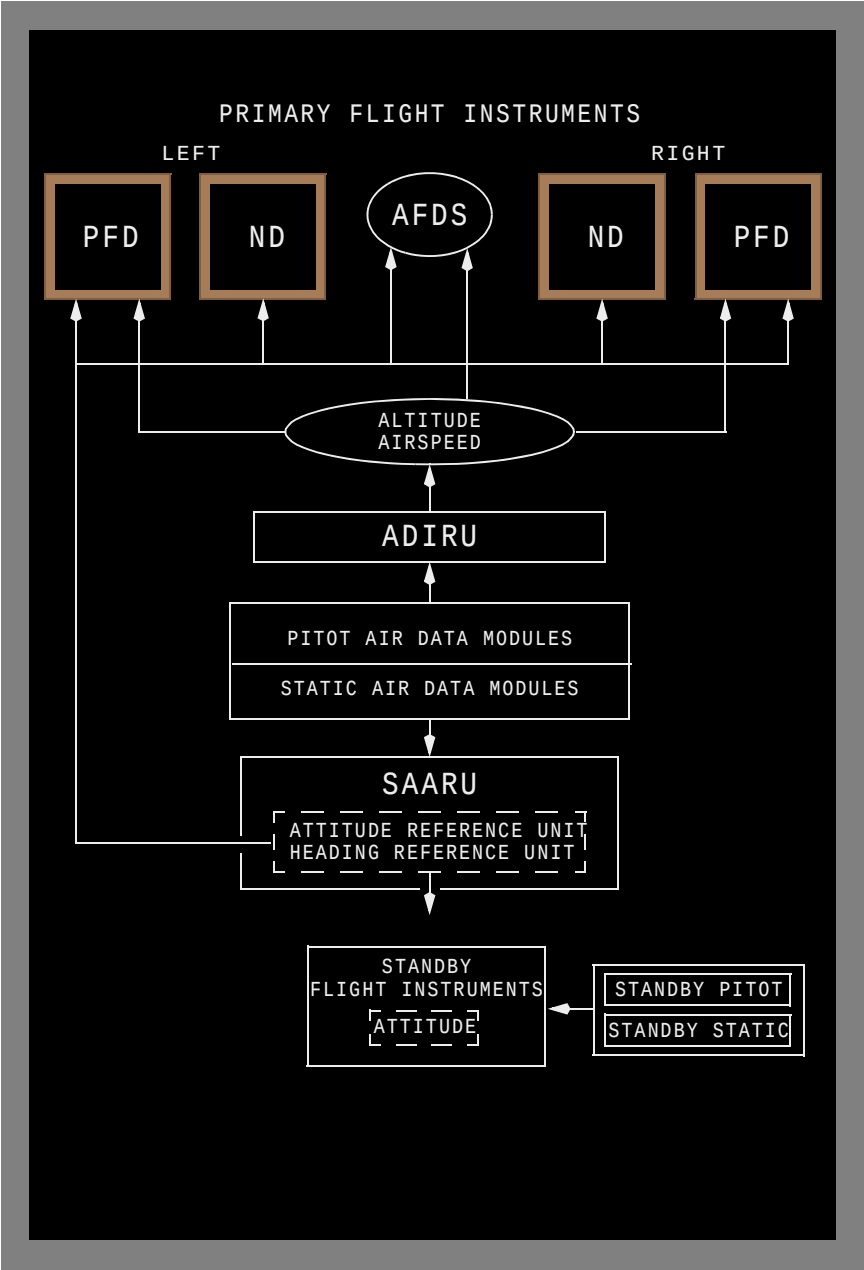
The air data modules are remote sensors for the air data functions within the ADIRU and SAARU. They measure static and pitot pressure. Both the ADIRU and SAARU receive data from all air data modules. In addition, the ADIRU and SAARU each receive data from the two angle of attack vanes and a dual element total air temperature probe.

The integrated standby flight instrument display receives data from the center pitot and static ports through standby air data modules. Altitude, attitude, and airspeed are independent of ADIRU and SAARU values.

ADIRS Schematic, Normal Mode



ADIRS Schematic, With NAV ADIRU INERTIAL Message



Radio Navigation Systems

Automatic Direction Finding (ADF)

Two ADF systems are installed. Either ADF can be manually tuned from the left or right CDU on the NAV RADIO page.

ADF Displays

Left and right ADF bearings display on the ND when the related VOR/ADF switch is in the ADF position. ADF data is cyan.

If both FMCs fail, the left and right ADF radios are tuned on the related left and right CDU ALTN NAV RADIO page.

Distance Measuring Equipment (DME)

Two DME systems are installed. The DMEs are usually tuned by the FMC, but may be tuned manually.

DME Tuning

DME is tuned manually when the VOR portion of a VOR/DME pair is entered on the NAV RADIO page. The FMC tunes DME as necessary for radio position updates. Manual DME tuning does not inhibit FMC DME tuning.

The FMC uses two DMEs for position updates. DME/DME position updates are usually more accurate than VOR/DME updates. The FMC cannot tune specific DMEs if the nav aids are inhibited on the REF NAV DATA page.

After dual FMC failure, the left DME is tuned with the left CDU and the right DME is tuned with the right CDU. Each DME is tuned to the VOR displayed on the CDU unless the related EFIS control panel ND mode selector is set to APP. In APP, the DME is tuned to the ILS.

DME Displays

DME distance displays on the ND map when operating in the VOR mode. DME distances also display when the ND mode selector is in the VOR or APP position, and either or both VOR L or VOR R switches are selected. DME distance also displays on the PFD when the ILS receivers are tuned to a collocated DME and localizer facility.

POS REF page 2/3 displays the identifiers of the DME stations used for FMC position updates.

Instrument Landing System (ILS)

Three ILS receivers are installed. They are usually tuned by the FMC, but can be tuned manually on the NAV RADIO page.

ILS Tuning

Two conditions must be met for FMC ILS autotuning to occur:

- an ILS, LOC, back course, LDA (localizer–type directional aid), or SDF (simplified directional facility) approach have been selected to the active route, and
- the airplane is within 50 NM from the top of descent, 150 NM of the landing runway threshold, or the FMC is in descent mode

On initial takeoff, ILS autotuning is inhibited for 10 minutes to prevent clutter on the PFD. Selection and execution of a new approach in the active flight plan causes the ILS to autotune to the new approach frequency, even if this is accomplished during the 10 minute takeoff inhibit period. ILS autotune inhibit does not apply to subsequent takeoffs on the same flight (for example, touch-and-go or stop-and-go landings).

All three ILS receivers can be manually tuned from the NAV RADIO page at anytime unless ILS approach tuning inhibit is active.

ILS approach tuning inhibit is active when:

- the autopilot is engaged and either the localizer or glideslope is captured
- Only the flight director is engaged, and either the localizer or the glideslope is captured, and the airplane is below 500 feet radio altitude, or
- on the ground, the localizer is alive, airplane heading is within 45 degrees of the localizer front course, and ground speed is greater than 40 knots

ILS tuning is again enabled when:

- either TOGA switch is pushed
- the autopilot is disengaged and both flight director switches are switched off, or
- the MCP approach mode is deselected above 1500 feet radio altitude

The ILS frequency is automatically retuned when ILS tuning is enabled and a new approach is selected on the CDU.

After dual FMC failure, the left and center ILS receivers are tuned with the left CDU on the ALTN NAV RADIO page. The right ILS receiver is tuned with the right CDU on the ALTN NAV RADIO page.

ILS Displays

The tuned ILS frequency displays on the PFD and on the ND in the approach mode.

Localizer and glideslope deviation display on the PFD. Localizer and glideslope deviation, and selected course display on the ND when that ND is in the approach mode. Front or back course deviation is determined from airplane heading.

Navaid Identifier Decoding

The Morse code identifier of a tuned VOR, ILS, DME, or ADF can be converted to alpha characters. The decoded identifier then displays on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC data base.

Due to the large variation in ground station identifier quality, the decode feature may incorrectly convert the intended identifier name. Examples: the Hong Kong localizer “KL” may display as “KAI”, or the Boeing Field ILS may display as “QBFI” or “TTTT” instead of “IBFI.”

Pilots should verify the identity of the tuned navigation station from the audio Morse code when the tuned frequency remains displayed or an incorrect identifier displays.

VOR

Two VOR receivers are usually tuned by the FMC but, can be tuned manually by the crew. The tuned VORs display on the ND and may be used for position updates.

VOR Tuning

The crew manually tunes VORs on the NAV RADIO page.

The FMC can tune a VOR and a collocated DME for position updates. The FMC uses VOR/DME radio position updates when more accurate sources are not available. Specific VOR/DME pairs can be inhibited on the REF NAV DATA page. If the crew enters two VOR identifiers on the NAV RADIO page, then the FMC cannot tune any other station for VOR/DME updates.

After dual FMC failure, the VOR radios can be manually tuned on the CDU ALTN NAV RADIO page. The left VOR is tuned with the left CDU and the right VOR is tuned with the right CDU.

VOR Displays

The NAV RADIO page displays FMC–tuned or manually–tuned VOR data. POS REF page 2/3 displays the identifier of the VOR and DME pair used for position updates.

The ND displays the identifier or frequency of the VORs tuned on the NAV RADIO page. The FMC usually tunes the same VOR in the left and the right. The ND VOR L VOR R data are usually the same.

Left and right VOR bearings display on the ND map when the related EFIS control panel VOR/ADF switch is in the VOR position. VOR bearings also display when the ND mode selector is in the VOR or APP position, and either or both VOR L or VOR R switches are selected. The VOR frequency and selected course display in the upper right hand corner of the ND when operating in the VOR mode. The ND also displays course deviation when operating in the VOR mode.

Transponder

The transponder panel controls two ATC transponders and the traffic alert and collision avoidance system (TCAS). Traffic displays if the transponder mode selector is in TA ONLY or TA/RA. The transponder responds to Mode S interrogations in all modes except STBY, and when on the ground, it provides airport position. In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPNDR, TA ONLY, or TA/RA. The EICAS advisory message TRANSPONDER L or TRANSPONDER R displays if a transponder fails. If altitude reporting fails, the transponder can be switched to the alternate altitude source. Refer to Chapter 15, Warning Systems, for a description of TCAS.

Transponders may also transmit information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Airport equipment monitors airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). TCAS modes should not be used on the ground for ground tracking.

The left (right) GPS is connected to the left (right) transponder. If GPS input to the selected transponder is unavailable, ADS-B Out position reporting is lost or degraded and ATC is alerted. If advised by ATC ADS-B Out communications are lost or degraded, selection of the other transponder restores communication and reporting.

Weather Radar

All 777s are equipped with dual weather radar systems. Each system consists of receiver–transmitter unit, antenna, and control panel. Radar returns display on the ND in all modes except:

- plan
- VOR center
- approach center

The EFIS control panel weather radar (WXR) map switch controls power to the transmitter/receiver and controls the weather radar display on the ND. The radar display range automatically adjusts to the ND range selected on the EFIS control panel.

The weather radar system performs various levels of self test on power up, during each sweep, and when descending through 2,300 feet AGL.

The MultiScan features automated functions that reduce crew work load and provide additional weather information not found on previous systems.

The automatic “MultiScan” operation allows the flight crew to view weather targets from takeoff to landing without the workload to manually adjust tilt, gain, and mode. MultiScan automatically scans the antenna over multiple tilt settings while saving the scan data in memory. The internal memory is continually refreshed and converted for aircraft motion. The display to the flight crew is a composite of multiple scans which have been post-processed to remove ground clutter and provide an optimal display for weather interpretation.

If the radar is taken out of the AUTO mode, the system operates like a standard radar system. In manual, it is not possible to adjust the tilt/gain and create the same display to the flight crew that MultiScan provides in auto mode because of the digital processing function performed by the R/T in AUTO mode. The AUTO mode includes several algorithms that identify ground clutter within the reflectivity data using scan-to-scan correlation, and beam-to-beam correlation.

It is recommended that crews use the automatic MultiScan feature in lieu of manual. AUTO is far superior in conveying comprehensive weather information with greater accuracy than using the manual mode.

Automatic Antenna Tilt and System Gain

The MultiScan radar can scan weather at multiple and sequential antenna tilt angles and adjust system gain automatically. This feature allows the radar to reliably detect weather out to 320 nautical miles at all altitudes, at all times, with no action (other than range selection) required by the flight crew.

Ground Clutter Suppression (GCS)

Ground data suppression is accomplished through multiple scan comparison and "signature data" interpretation to separate weather and ground data. Ground Clutter Suppression is only operational when the system is in AUTO.

Path Attenuation Compensation (PAC) Alerting

When precipitation is so heavy that it obstructs or attenuates the radar returns behind a particular echo, the MultiScan PAC feature displays a yellow arc behind these areas to alert the flight crew that heavy weather could exist behind the echoes. PAC Alert is only operational when the aircraft is within 80 NM of a thunderstorm, the system is in AUTO, and GAIN control knob is in the calibrated position.

Note: The calibrated GAIN position is achieved by aligning the word “GAIN” horizontally with the arrow at the 12 o’clock position pointing down.

Over-Flight Protection

Over-flight protection is designed to prevent thunderstorms that are in the aircraft flight path from falling below the radar beam and off the radar display during high altitude cruise. At extended ranges, the upper radar beam scans the wet, reflective portion of a thunderstorm in the same manner that conventional radars scan weather today. As the aircraft approaches the storm and the cell begins to fall below the upper radar beam, MultiScan utilizes 6,000 feet of bottom beam information to keep the reflective part of the storm in view. Within approximately 15 NM of the aircraft, MultiScan compares the stored digital image of the thunderstorm with the latest sweep information and displays whichever return is greater. If a cell that is a threat to the aircraft begins to fall below the radar beam, MultiScan displays the digital image of the storm. This ensures any threatening thunderstorm will remain on the display until it moves behind the aircraft. Over-flight protection is operational above 22,000 feet MSL and only available when the system is in AUTO.

Flight Management, Navigation

Flight Management System Description

Chapter 11

Section 30

Introduction

The flight management system (FMS) aids the flight crew with navigation, in-flight performance optimization, automatic fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help in flying efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting system data to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios and sets courses. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Cruise altitudes and crossing altitude restrictions are used to calculate VNAV commands. Lateral offsets from the programmed route can be calculated and commanded.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer function. Since the term FMC is universally understood, it is used here for standardization and simplification.

Under normal conditions, one FMC accomplishes the flight management tasks while the other FMC monitors. The second FMC is ready to replace the first FMC if system faults occur.

The FMC uses flight crew-entered flight plan data, airplane systems data, and data from the FMC navigation database to calculate airplane present position and pitch, roll, and thrust commands necessary to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route data are sent to the NDs. The EFIS control panels select the necessary data for the ND. The mode control panel selects the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays.

The FMC is certified for area navigation when used with navigation radio and/or GPS updating. The FMC and CDU are used for enroute and terminal area navigation, RNAV approaches, and to supplement primary navigation during all types of instrument approaches.

Control Display Units (CDUs)

The flight crew controls the FMC using three CDUs. The CDUs give alternate display, communications control, and navigation capability if there is a dual FMC failure (refer to the Alternate Navigation section of this chapter). The center CDU is a backup for the left or right CDU in case of a failure and automatically takes over functionality of the failed CDU. Only the left and right CDUs tune navigation radios when alternate navigation is active.

Left and right CDUs provide backup to the left and right EFIS control panels, while the center CDU provides EFIS control panel backup for a failed left or right CDU. If the EFIS control panel or the display select panel fails, a manual selection of the CDU backup mode can be made on the MENU page.

Refer to Chapter 10, Flight Instruments, Displays for a description of alternate display control. Refer to Chapter 5, Communications, for a description of communications control.

Flight Management, Navigation

Flight Management System Operation

Chapter 11

Section 31

Introduction

When first powered, the FMS is in the preflight phase. When completing a phase, the FMS changes to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete

Preflight

During preflight, the flight crew enters the flight plan and load sheet data into the CDU. Some data can be entered by data link. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet data provide performance data to initialize VNAV.

Required preflight data consists of:

- initial position
- route of flight
- performance data
- takeoff data

Optional preflight data includes:

- navigation database selection
- route 2
- alternate airport
- standard instrument departure (SID)
- standard terminal arrival route (STAR)
- thrust limits
- wind

Preflight starts with the IDENT page. If the IDENT page is not displayed, it can be selected with the IDENT prompt on the INIT/REF INDEX page. Visual prompts help the flight crew select CDU preflight pages. Preflight pages can be manually selected in any order.

After data on each preflight page is entered and checked, pushing the lower right line select key selects the next preflight page. After selecting ACTIVATE on the ROUTE page, the execute (EXEC) light illuminates. Pushing the EXEC key activates the route.

The departure/arrival (DEP/ARR) page can be used to select a SID. Selection of the SID may cause a route discontinuity. Resolution of the discontinuity and execution of the modification should be accomplished on the ROUTE or LEGS page.

When all required preflight entries are complete, the PRE–FLT line title on the TAKEOFF REF page is replaced by dashes and the THRUST LIM prompt displays at the next page select line location.

Takeoff

The takeoff phase starts with selection of TO/GA and terminates with thrust reduction for climb. LNAV and VNAV can be armed before takeoff to activate at the applicable altitude (refer to Chapter 4, Automatic Flight).

Climb

The climb phase starts at thrust reduction for climb and terminates at the top of climb (T/C) point. The T/C is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase starts at the T/C point and terminates at the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase starts at the T/D point or when the VNAV descent page becomes active, and terminates at the start of the approach phase.

Approach

The approach phase starts when the first waypoint of the procedure sequences or when the runway is the active waypoint and the distance to go is less than 25 nm.

Flight Complete

Thirty seconds after engine shutdown, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

Operational Notes

When operating in the LNAV and VNAV modes, observe system operation for unwanted pitch, roll, or thrust commands. If unwanted operation is observed, select heading select and flight level change modes.

The system must be carefully monitored for errors following:

- activation of a new data base
- power interruption
- ADIRU failure

The FMC will not sequence the active waypoint when more than 21 nm off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO/FROM procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) use the first waypoint in the route.

Some SIDs or STARS contain a heading vectors leg. VECTORS waypoints display on the ND as a magenta line without an end point leading away from the airplane symbol. If LNAV is active, the DIRECT TO or INTERCEPT COURSE TO/FROM procedures can be used to start waypoint sequencing beyond the vectors leg.

When entering airways in a route page, the start and end waypoints must be in the data base. A route segment must be entered as a DIRECT leg.

If the engines remain operating between flights, entering a new cruise altitude before the next flight recalculates the proper vertical profile.

If a climb to cruise altitude is necessary after completing a descent, a new cruise altitude entry must be made. Cruise altitude can be entered on the CLB page.

DIRECT TO courses are segments of a great circle route. When entering a DIRECT TO waypoint on the LEGS page, the course above the waypoint before execution is the arrival course at the waypoint. However, after execution, the course is the current course to fly to the waypoint. These courses may not be the same.

Terminology

The following paragraphs describe FMC and CDU terminology.

Active – flight plan data used to calculate LNAV or VNAV guidance commands.

Activate – changing a route from inactive to active for navigation by:

- selecting the ACTIVATE prompt
- pushing the execute (EXEC) key

Altitude constraint – a crossing restriction at a waypoint.

Delete – using the DELETE key removes FMC data and reverts to default values, dash or box prompts, or a blank entry.

Econ – a speed schedule calculated to minimize operating cost. The economy speed is based on the cost index. A low cost index causes a lower cruise speed. Maximum range cruise or the minimum fuel speed schedule may be obtained by entering a cost index of zero. This speed schedule ignores the cost of time. A minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds. A low cost index may be used when fuel costs are high compared to operating costs.

Enter – putting data in the CDU scratchpad and line selecting the data to the applicable location. New characters can be typed or existing data can be line selected to the scratchpad for entry.

Erase – removing entered data, which has resulted in a modification, by selecting the ERASE prompt.

Execute – pushing the illuminated EXEC key to make modified data active.

Inactive – data not being used to calculate LNAV or VNAV commands.

Initialize – entering data required to make the system operational.

Message – FMC information displayed in the scratchpad.

Modify – changing active data. When a modification is made to the active route or performance mode, MOD displays in the page title, ERASE displays next to line select key 6 left, and the execute key illuminates.

Prompt – CDU symbols that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a caret (< or >) line to remind the flight crew to enter or validate data.

Purge – select the PURGE prompt to remove all airports uplinked to the ALTN LIST.

Select – pushing a key to obtain the necessary data or action, or to copy selected data to the scratchpad.

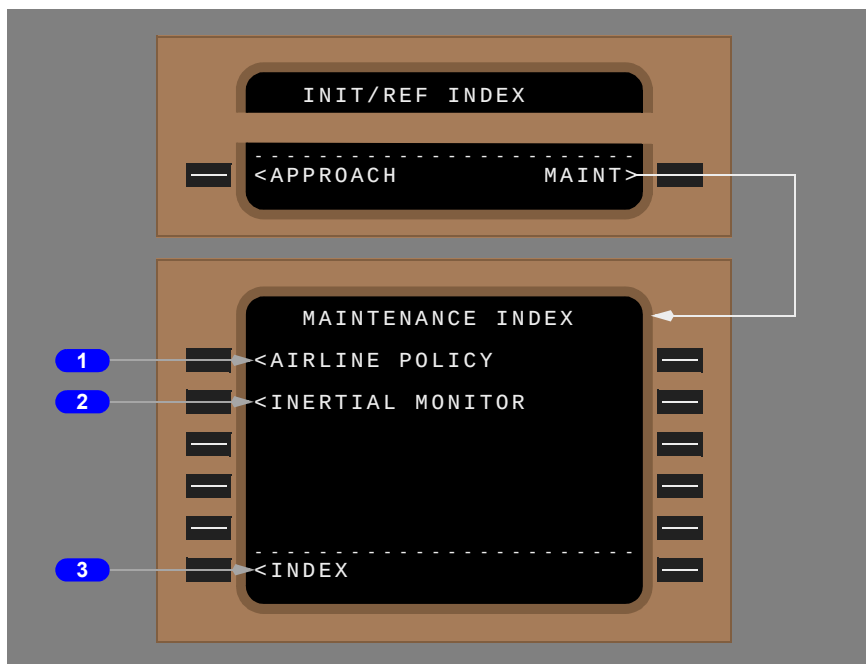
Speed restriction – an airspeed limit associated with a specified altitude entered by the flight crew.

Speed transition – an airspeed limit associated with a specified altitude entered by the FMC.

Waypoint – a point on the route or in the navigation database. It can be a fixed point such as a latitude and longitude, VOR or ADF station, or an airway intersection. A conditional waypoint is not associated with a land reference; it is based on a time or altitude requirement. An example of a conditional waypoint is “when reaching 4,000 feet”.

Maintenance Index

The MAINTENANCE INDEX page prompts are used only on the ground.



1 AIRLINE POLICY

Displays the AIRLINE POLICY page.

2 INERTIAL MONITOR

This is a maintenance function.

3 INDEX

Push – displays the INIT/REF INDEX page.

Airline Policy

The airline policy pages display operating parameters kept in the airline maintained file. The FMC references this file for data before it calculates default values. These pages are not usually used by the flight crew.

Push – displays the AIRLINE POLICY 1/2 page.

Navigation Position

The FMC determines present position from these navigation systems: ADIRS, GPS, and navigation radios. When receiving reliable GPS data, the primary mode of navigation is from a GPS updated FMC position. If GPS data is not available, cannot be validated, or is inhibited, the FMC position is updated using navigation radios. When navigation radios are not available or not reliable, the FMC position comes from the ADIRU.

FMC Position Update

FMC position may be manually updated to any of the navigation system positions. This update is accomplished on POS REF page 2.

On the ground, the FMC calculates present position based on ADIRU and/or the GPS data.

With GPS NAV OFF, pushing a TO/GA switch updates the FMC position to the runway threshold or to the position shift position, when entered. When making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page. With GPS NAV ON, the TO/GA update is inhibited.

In flight, the FMC position is continually updated from the GPS, navigation radios, and ADIRU. Updating priority is based on the availability of valid data from the supporting systems.

The FMC automatically tunes VOR, DME, and ILS radios for position updating and displays them on the ND and NAV RADIO page. Selection is related to the active route and any procedure (SID, STAR, etc.) in the active route. Manually selecting VOR frequencies or identifiers precludes the FMC from autotuning other VOR/DME frequencies for position updating; however, the FMC continues to tune DME-DME pairs for position updating.

FMC position updating using ADIRU and navigation sensor positions occurs in the following priority order:

- LOC and GPS
- LOC and DME-DME
- LOC and collocated VOR/DME
- ADIRU and LOC
- ADIRU and GPS
- ADIRU and DME-DME
- ADIRU and a collocated VOR/DME
- ADIRU

The selected station identifiers of the radio navigation aids display on the POS REF page 2.

Primary FMC Position Update Source	POS REF page 2/3	ND Annunciation
LOC, GPS valid*	LOC–GPS	LOC–GPS
LOC, DME DME valid; GPS invalid*	LOC–RADIO	LOC–DME–DME
LOC, VOR DME valid; GPS invalid*	LOC–RADIO	LOC–VOR–DME
LOC valid; GPS, DME, VOR invalid*	LOC	LOC
GPS valid, LOC invalid	GPS	GPS
DME valid; GPS invalid	RADIO	DME–DME
VOR DME valid; GPS invalid	RADIO	VOR–DME
GPS, VOR, DME invalid	INERTIAL	INERTIAL
GPS valid, ADIRU failed	GPS	GPS
GPS invalid; ADIRU failed	blank	map not available
* The FMC changes to LOC updating when: • the tuned localizer is associated with the destination runway • the airplane is less than 6,000 feet above localizer navaid elevation • the airplane is less than 20 nm from the localizer navaid for a front course approach or less than 12 nm for a back course approach • the airplane is within a 25° sector of the inbound localizer course • the difference between airplane track and the localizer course is less than a 45° intercept angle		

FMC Polar Operations

When entering the polar region, automatic switching to a true north reference is annunciated by a white box around the word TRU on the ND. A TRUE heading reference can be selected with the heading reference switch inside or outside the polar region. The ND displays a green box around the word MAG to annunciate the change back to magnetic reference when leaving the polar region. If the heading reference is TRU in the descent phase, the ND displays a flashing amber box around the word TRU.

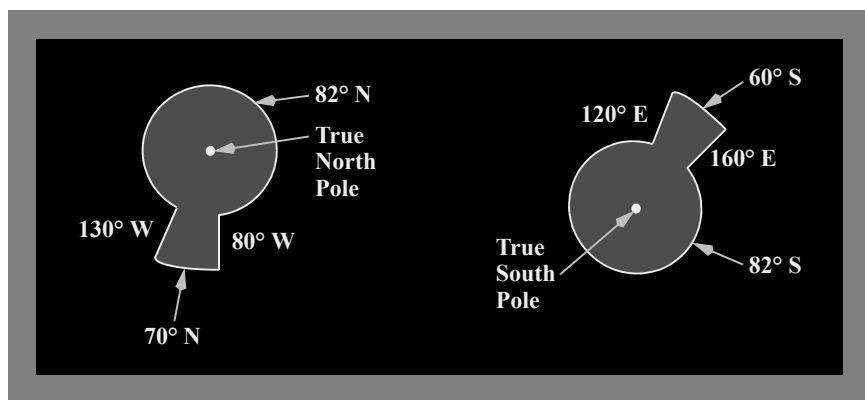
The current GRID heading displays near the top of both NDs when the airplane is north of 70°N or south of 70°S. The GRID heading is not used by any airplane system.

Note: When operating the autopilot in the polar region in other than LNAV, the TRUE position on the heading reference switch must be selected.

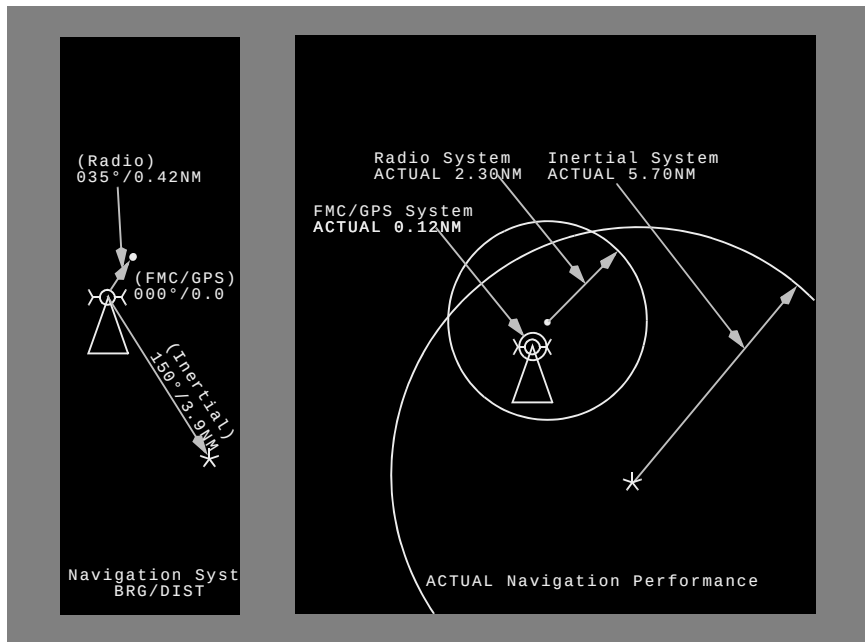
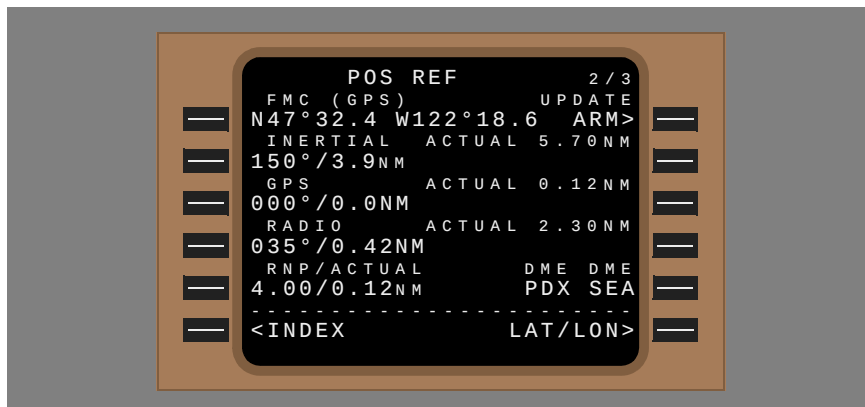
Note: When operating north of 82°N or south of 82°S using the ND PLAN mode, the airplane position symbol does not display.

Note: If the ADIRU fails in a polar region, the EICAS message NAV ADIRU INERTIAL displays and all autopilot and AFDS roll modes fail. When heading information is restored by entry of a reference heading on the POS INIT page, HDG SEL and HDG HOLD roll modes are restored. GPS continues to provide navigation data to the FMC and active route information displays on the ND. When operating in this degraded mode, heading on the POS INIT page may be referenced to magnetic, true, or grid heading. The heading display drifts significantly under these conditions. Periodic updating of the heading reference on the POS INIT page should be accomplished at least every 10 minutes.

FMC Polar Regions



Navigation Performance



The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position displays on line 1 of the POS REF page 2. The primary source of update displays in parentheses above the FMC position.

Navigation system positions display on the left side of lines 2 through 4. The bearing/distance is from the FMC position to the individual navigation system position.

The FMC position displays on the ND at the tip of the triangle. All other positions display relative to the FMC. The RADIO position is shown above as a •, but is not shown on the ND. The ACTUAL navigation performance circles shown above do not display on the ND.

Actual Navigation Performance

Actual navigation performance (ANP) is the FMC position accuracy. It displays on the POS REF page 2, lines 1 - 3, for the navigation source displayed on the left side. ACTUAL navigation performance is a circular prediction centered at the FMC position. Airplane position is estimated to be within this ACTUAL navigation performance circle 95 percent of the time.

After a manual position update using the ARM function on the POS REF page 2, the ACTUAL navigation performance of the FMC changes to the ACTUAL navigation performance of the selected navigation source. In the example above, selection of the NOW> prompt on the INERTIAL line would change the FMC ACTUAL navigation performance to 5.7 NM. The FMC then updates from the best available navigation system and eventually, the manual update has no effect on position calculation. Some automatic updates can be inhibited; GPS on POS REF page 3 and VOR/DME updates on the REF NAV DATA page.

Radio navaid updating is inhibited unless the RAD NAV INHIBIT toggle is selected to OFF on the REF NAV DATA page.

Required Navigation Performance

Required Navigation Performance (RNP) is the navigation accuracy required for operation within a defined airspace. It is expressed in nautical miles. RNP values have been published for areas of operation around the world. Operations in these areas require on-board navigation systems to alert the flight crew if ANP exceeds RNP. The FMC supplies a default RNP value for takeoff, en route, oceanic/remote, terminal, and approach phases of flight. The flight crew may enter an RNP value, if required. RNP displays on POS REF page 2.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint or the selected route intercept point. When armed on takeoff, LNAV engages at or above 50 feet, when laterally within 2.5 nautical miles of the active route leg. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC data base is entered into the active route, the FMC commands a heading, track, or a DME arc to comply with the procedure.

The FMC creates a path allowing the airplane to turn before reaching a fly-by waypoint. When a waypoint is defined as a fly-over, the FMC directs the airplane to fly directly over the waypoint before turning. The flight path shows on the ND using reduced range.

Waypoints

Waypoint (navigation fix) identifiers display on the CDU and navigation display. The CDU message NOT IN DATABASE displays if a manually entered waypoint identifier is not kept in the data base. The waypoint can still be entered as a latitude/longitude, place–bearing/distance or place–bearing/place–bearing waypoint.

FMC–generated waypoints contain a maximum of five characters assigned according to the following rules:

Navaid Waypoints

VHF – waypoints located at VHF nav aids (VOR/DME/LOC) are identified by one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC – LAX
- Tyndall TACAN – PAM
- Riga Engure, Latvia – AN

NDB – waypoints located at NDBs are identified by use of the station identifier. Example: FORT NELSON, CAN – YE.

Fix Waypoints

Waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA

Long Waypoints

Waypoints with more than five characters are abbreviated using the following rules sequentially until five characters remain. For double letters, one letter is deleted. Example:

- KIMMEL becomes KIMEL

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Example:

- BAILEY becomes BAILY

The next rule abbreviates names even further. Apply the previous rule, then delete consonants from right to left. Example:

- BRIDGEPORT becomes BRIDGPRT then BRIDT

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD

Unnamed Waypoints

If an unnamed turn point, intersection, or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID – DISTANCE – IDENT):

- INW – 18 – INW18
- CSN – 106 – 06CSN

Waypoint located at unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points are identified by the three-letter airspace type identification followed by a two-digit sequence number. Example:

- FRA01

Unnamed oceanic control area reporting points in the northern hemisphere use the letters N and E, while points in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three digit value are used.

Placement of the designator in the five character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

• N50° W040° becomes 5040N	• S52° W075° becomes 5275W
• N75° W170° becomes 75N70	• S07° W120° becomes 07W20
• N50° E020° becomes 5020E	• S50° E020° becomes 5020S
• N06° E110° becomes 06E10	• S06° E110° becomes 06S10

Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles and so forth. Example:

- EPH252°/24 = D252X

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified by the station identifier and the DME radius. Example:

- CPR338°/29 = CPR29

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. Examples:

- CPR134°/29 = CP29A
- CPR190° /29 = CP29B

DME step down fixes are identified by the distance and a “D”.
Examples: 138D, 106D, 56D, 3D.

Procedure Fix Waypoints

Marker beacons are identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21

Runway-related fixes – waypoints located at unnamed runway-related fixes are identified by adding a two-letter prefix to the runway number. The following list is used to determine the applicable prefix:

• RX – runway extension fix	• BM – back course marker
• FA – VFR final approach fix	• MD – minimum descent altitude
• CF – final approach course fix	• A – (+ an alpha) step down fix
• FF – final approach fix	• RW – runway threshold
• IF – initial approach fix	• MA – missed approach point other than RW
• OM – outer marker	• TD – touchdown point inboard of RW
• MM – middle marker	
• IM – inner marker	

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

-
• C() – final approach course fix	• ()L – localizer only()B
• F() – final approach fix	–backcourse ILS
• P() – missed approach point	• ()D – VOR/DME
• I() – initial approach fix	• ()V – VOR only
• D() – minimum descent altitude	• ()S – VOR with DME points
• T() – touch down point	• ()N – NDB
• R() – runway centerline intercept.	• ()Q – NDB with DME points
• ()I – ILS	• ()M – MLS
	• ()T – Tacan
	• ()R – RNAV

Examples: CI32R, PV15, FN24L.

Unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page.

Airport reference points are identified by the ICAO identifier.

Duplicate Waypoints

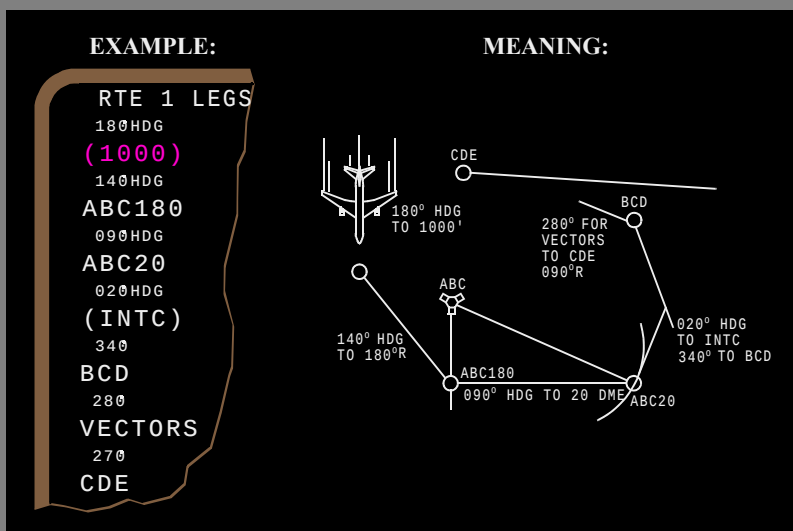
Application of the abbreviation rules may create identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Select the latitude/longitude of the correct waypoint to enter the correct waypoint on the original page.

Conditional Waypoints

Conditional waypoints may display in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically-fixed position. The types of conditions are:

• climb/descent through an altitude	• intercepting a course
• flying a heading to a radial or DME distance	• heading vectors to a course or fix

Altitude and course intercept conditional waypoints display on the CDU inside (parenthesis) marks. The diagram below shows conditional waypoints.



Note: All waypoints except BCD and CDE are examples of conditional waypoints.

Manually Entered Latitude/ Longitude Waypoints

Pilot defined waypoints entered as a latitude and longitude display in a seven-character format. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displays as N47W008
- N47° 15.4' W008° 3.4' is entered as N4715.4W00803.4 and displays as N47W008

Manually Entered Place Bearing/Distance or Place Bearing/Place Bearing Waypoints

Waypoints entered as a place bearing/distance or place bearing/place bearing are identified by the first three characters of the entry followed by a two-digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02

The two digit sequence numbers reserved for RTE1 are 01 through 49. The two digit sequence numbers reserved for RTE2 are 51 through 99.

Manually Entered Airway Crossing Waypoints

Airway crossing fixes are entered as a five character waypoint name or by entering consecutive airways on the ROUTE page. In the latter case, the display is an X followed by the second airway name. Example: entering J70 on the VIA line of the ROUTE page causes box prompts to display opposite on the same line. Leaving the box prompts empty and entering J52 on the next VIA line, directly below J70, causes the FMC to calculate the intersection of the two airways and replace the boxes with the waypoint identifier, XJ52.

Manually Entered Latitude or Longitude Reporting Point Waypoints

Latitude or longitude reporting waypoints are entered as the full latitude or longitude followed by a dash, then the increment chosen for the following multiple waypoints. Example:

- W060–10 adds waypoints starting at W060 in ten degree increments from that point to the destination
- the entry must be made on a LEGS page on any line before the first reporting point
- usually, this entry is made on the active waypoint line and proper sequencing is performed by the FMC

Manually Entered Along–Track Waypoints

Along–track waypoints are created on the active route and do not cause route discontinuities when they are created.

Along–track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along–track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route and displays as VAM01
- ELN/-30 is 30 miles before ELN on the present route and displays as ELN01

ND Map Displays

The route displays on the ND in the map, map center, and plan modes. The display color and format represent the following status:

- an inactive route displays as a cyan dashed line
- an activated, but not yet executed route, displays as an alternating cyan/white dashed line
- the active route displays in magenta

-
- modifications to an active route display as dashed white lines
 - modified waypoints display in white
 - executed route offsets display as a dashed magenta line

The ND displays the FMC position at the apex of the airplane symbol. All ND map data displays relative to this apex.

When adequate GPS or radio updating is not available, the ND map may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids being shifted from their actual position. An undetected, across track map shift may result in the airplane flying a ground track that is offset from the desired track. An undetected, along track map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the ND map with data from the ILS, VOR, DME, and ADF systems.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Constraints

VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Barometric altitude constraints must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and display in small font.

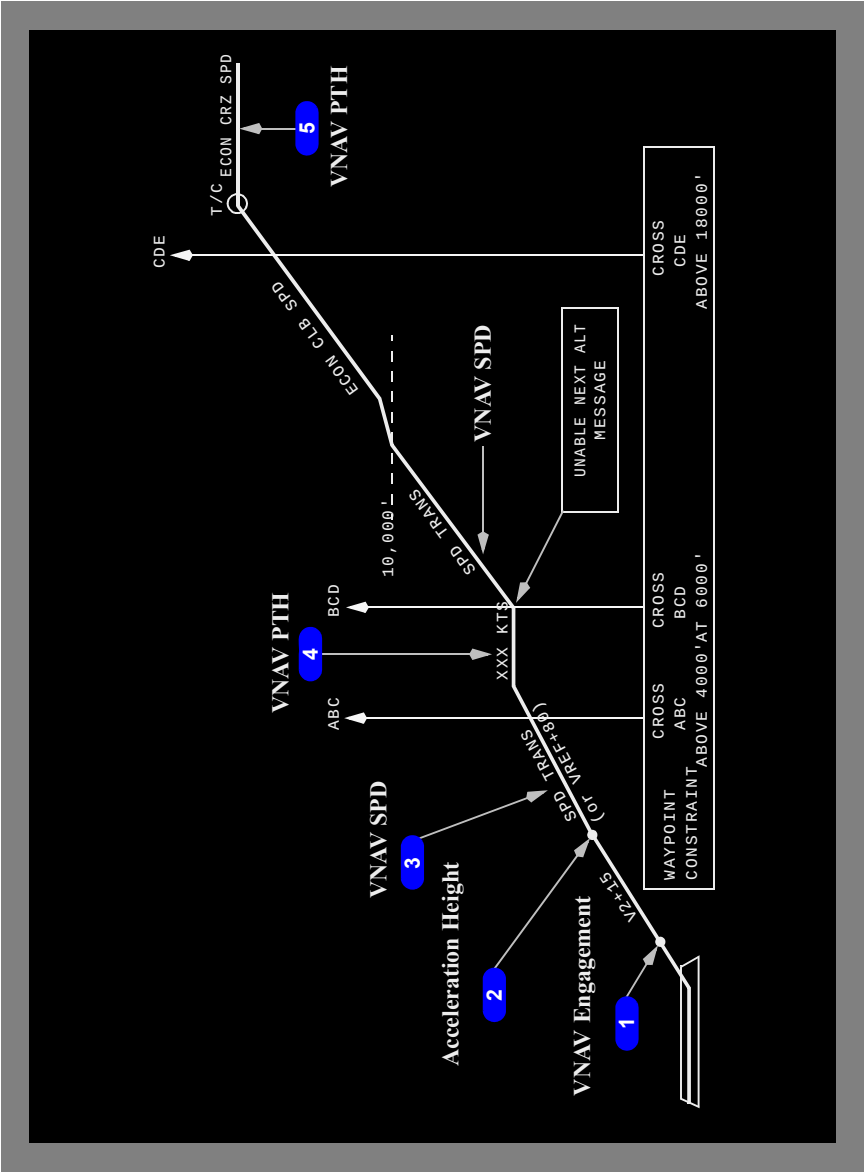
A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or airspeed/altitude constraints.

Modified waypoint constraints are shaded white until they are executed. Speed constraint entries require an altitude constraint at the same waypoint. All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (example: 220A240B or 240B220A).

Takeoff and Climb



1 Takeoff

If armed for takeoff, VNAV activates at 400 feet and pitch guidance continues to maintain the target airspeed.

During takeoff, the FMC updates the target airspeed to the current airspeed until VNAV activates. The target airspeed is between $V_2 + 15$ and $V_2 + 25$ knots.

2 Acceleration Height

At acceleration height or flap retraction, VNAV commands an airspeed increase to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted or at an AFDS capture altitude, VNAV commands the greater of $V_{REF} + 80$ knots or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the thrust reference limit to the selected climb thrust at the thrust reduction point.

3 VNAV Climb

VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints of an active route Standard Instrument Departure. Autothrottle uses the armed climb thrust limit.

If the climb speed profile cannot achieve an altitude constraint, the UNABLE NEXT ALT scratchpad message displays.

4 Climb Constraints

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed

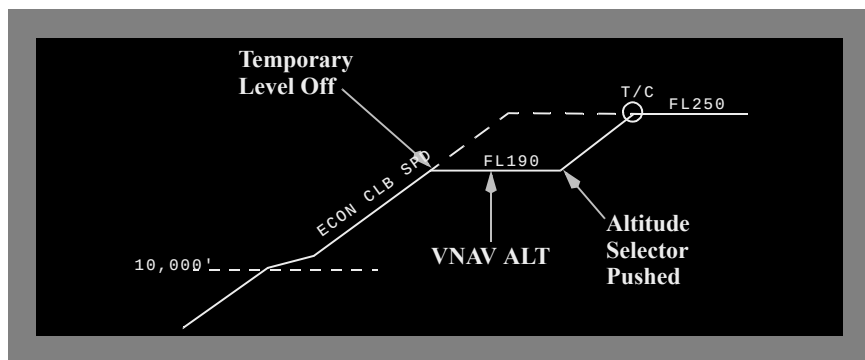
If the FMC predicts the airplane will not reach an altitude constraint, the FMS-CDU message UNABLE NEXT ALT displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the THRUST LIMIT page.

5 Top Of Climb (T/C)

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from climb phase to cruise phase. The T/C displays any time the FMC calculates a change from climb phase to cruise phase, such as step climb.

The T/C point displays on the map as a green open circle with the label T/C.

MCP Altitude Intervention



Whenever the airplane levels off at an MCP altitude not in the FMC, VNAV ALT annunciates. For example, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the example, the speed after the temporary level off would be ECON CLB SPEED.

Setting the clearance altitude in the MCP window and pushing the altitude selector continues the climb. VNAV SPD activates. Pitch maintains FMC speed and thrust increases to the armed reference thrust limit. In the example, the airplane climbs to FMC CRZ ALT and then levels at FL250 in cruise.

Cruise

During cruise, the FMC commands economy cruise speed or the pilot entered speed until reaching the top-of-descent (T/D) point. Other cruise speed options are:

- long range (LRC)
- engine out (ENG OUT)
- flight crew entered speed
- flight crew entered constant Mach between two or more waypoints
- required time of arrival (RTA)

The FMC commands maximum range cruise speed with the cost index set to zero. Cost index modifications are allowed until within ten miles of the top of descent.

Step Climb

Fuel and ETA calculations assume the airplane climbs at each calculated step climb point as airplane weight decreases. FMC calculated step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise.

Flight crew entry of a STEP TO altitude on the CRZ page or "S" on a waypoint on the LEGS page overrides FMC step climb calculations. Entry of a step altitude on the LEGS page overrides a STEP TO entry made on the CRZ page.

Calculated step altitudes display on the LEGS page. The distance and ETA to the next step point (calculated or flight crew entered) display on the CRZ and PROGRESS pages. They also display on the ND map display with a green circle and "S/C".

The FMC calculates step climb locations and altitudes as a function of lateral flight plan, current cruise speed mode and altitude, entered forecast winds and temperatures, step size, cruise cg, and gross weight.

The primary factor affecting step climb calculation is the entry of accurate forecast cruise winds and temperatures on the WINDS page. Unless enroute winds are entered, all step climb locations and altitudes are calculated assuming zero wind. IRS winds are not used in the calculation of step climb data.

For ECON cruise, step climbs are optimized to provide minimum trip cost according to the entered Cost Index. For other selected speeds, calculated step climbs minimize trip fuel.

Calculated step locations display on the ND (S/C); the next step displays on the ECON CRZ page. Flight plan calculations of time and fuel at destination are based on executing step climbs as calculated. Legs page waypoint altitudes reflect the optimum step climb profile.

Inflight entry of a STEP TO altitude in 1R causes the FMC to use the entered enroute winds and temperatures to calculate the optimum location for a climb to the step altitude; the ETA and DTG for the step display in 2R. Following entry of an altitude in 1R, the FMC uses only that altitude to calculate data for 2R. When the FMC calculates an immediate step climb to the entered altitude is optimal, 2R displays NOW. If the FMC determines remaining at the current altitude for the duration of the flight is more optimal than flying at the entered altitude, 2R displays NONE.

Planned step climb points (S/C) may be entered on the LEGS page at selected waypoints. In this case, both altitude and step location are constrained. With planned step climb points entered, flight plan calculations assume a constant cruise altitude until reaching the planned step waypoint. Optimized step climb calculations resume after passing the last planned step climb waypoint.

When the last planned step is a step descent, step climbs are no longer calculated.

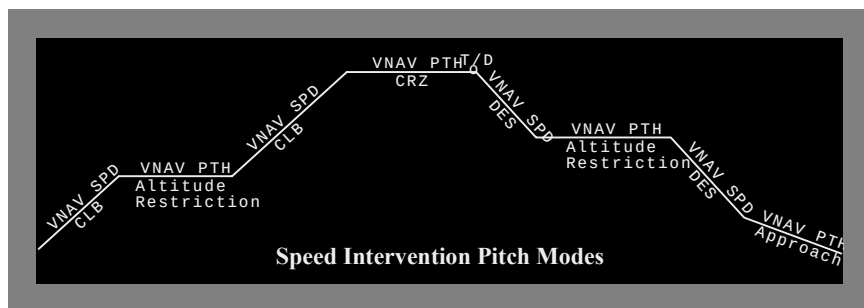
Optimum (OPT) altitude calculation does not use forecast or IRS winds and temperatures. Recommended (RECMD) altitude calculation is based on step size, current CRZ ALT, and entered forecast enroute winds and temperatures.

All altitude calculations are limited by maximum (MAX) altitude.

Cruise Descent

Setting an altitude below the current cruise altitude in the MCP altitude window and pushing the altitude selector (more than 50 nm from a T/D) causes the cruise altitude to be set to the MCP altitude and the airplane to descend to the new cruise altitude. The CRZ page displays ACT ECON CRZ DES. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by flight crew action.

Mode Control Panel Speed Intervention



With VNAV active, pushing the IAS MACH selector enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

The above illustration shows the VNAV pitch flight mode annunciation for each phase of flight when using speed intervention.

In a VNAV descent after the T/D, VNAV PTH changes to VNAV SPD during speed intervention. In all other phases, the pitch mode does not change with speed intervention. Pitch controls speed in VNAV SPD mode, and during the VNAV PTH descent prior to speed intervention. Otherwise, thrust controls speed in VNAV PTH mode.

During a VNAV, non-ILS approach while using speed intervention, the pitch mode is VNAV PTH. The vertical path is maintained regardless of IAS MACH selector changes.

If a “direct to” is executed to a waypoint in the approach, VNAV transitions to the approach phase when the airplane passes the “direct to” waypoint. If a waypoint located after the first waypoint of an FMC database approach is added and executed, VNAV will not transition to approach phase when passing the first waypoint of the approach.

Descent

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point. Dashes display on the LEGS page for speed and altitude descent waypoints. When an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan, the FMC creates an E/D. The E/D is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point; which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D is also created when an altitude constraint is entered on the LEGS page on a downstream waypoint.

The top of descent (T/D) is the point where the cruise phase changes to the descent phase. A green circle T/D symbol displays on the ND at the start descent phase point. The FMC displays a T/D symbol at each point in the descent profile which represents a transition from a level segment to a descent segment. The descent path starts at the T/D and includes waypoint altitude constraints. The path to the first constraint is based on:

- idle thrust
- speedbrakes retracted
- FMC cruise wind
- wind entries on the DESCENT FORECAST page
- predicted use of anti-ice
- applicable target speed

The descent may be planned at economy Mach/CAS (based on Cost Index) or a manually entered Mach/CAS. VNAV will not command an economy target speed greater than 314 knots (VMO/MMO minus 16 knots) or a pilot entered speed greater than 319 knots (VMO/MMO minus 11 knots).

The FMC creates the descent path with a deceleration at the speed transition altitude (typically 250 knots below 10,000 feet). VNAV plans a speed target 10 knots below the transition speed to allow for unknown tailwinds.

Descent path segments after the first altitude constraint waypoint are constructed as straight line point-to-point segments. If the VNAV path segment is too shallow to be flown satisfactorily at IDLE thrust, the FMC commands speed on thrust levers (SPD). Elevators control the shallow descent path.

If flight plan modifications or unknown winds occur when above the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

- with greater than 15 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 5 knots above the greater of best holding speed or minimum maneuvering speed, and the scratchpad message THRUST REQUIRED displays again
- with greater than 314 knots (VMO/MMO minus 16 knots), the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 319 knots (VMO/MMO minus 11 knots) to maintain the path. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 314 knots (VMO/MMO minus 16 knots), and the scratchpad message DRAG REQUIRED displays again

If flight plan modifications or unknown winds occur when below the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

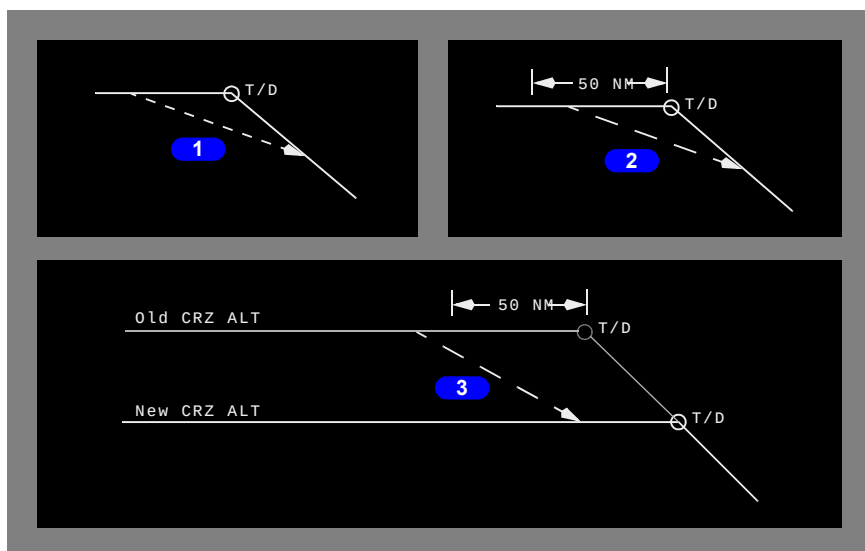
- with greater than 10 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV commands a speed 10 knots less than the transition speed for the destination airport (not less than minimum maneuvering speed), and the scratchpad message THRUST REQUIRED displays again

- with greater than 10 knots above target speed, the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 15 knots above target speed to maintain the path. The maximum speed excursion allowed is 5 knots above the transition speed after the airplane is below transition altitude for the destination airport or 5 knots below the flaps placard speed if flaps are extended. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path to stop the acceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV commands a speed 10 knots less than the transition speed for the destination airport, and the scratchpad message DRAG REQUIRED displays again

Early Descent

When a descent is started before the T/D, VNAV commands a descent at a reduced descent rate until the idle descent path is intercepted.

Start an early descent by selecting the DES NOW prompt on the DES page or by pushing the MCP altitude selector. In an early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.



1 DES NOW

Use the DES NOW prompt on the VNAV DES page. VNAV starts an early descent and captures the idle descent path.

2 Within 50 NM of Top of Descent Point

Use the MCP altitude selector to start an early descent. Within 50 NM of the top of descent point, VNAV starts an early descent and captures the idle descent path.

3 More than 50 NM from Top of Descent Point

Use the MCP altitude selector to start a cruise descent. If the distance from the top of descent is more than 50 NM, VNAV begins a cruise descent to the new cruise altitude. VNAV may not capture the idle descent path since the target airspeed is economy cruise and the descent path is based on idle thrust and economy descent airspeed. In the example, VNAV levels at the new cruise altitude.

Approach

The FMC transitions to "on approach" under the following conditions:

- the airplane is in the descent phase and flaps are out of UP
- a VFR approach has been created and incorporated in the active flight plan and,
 - the airplane has sequenced the FAXXX or
 - the airplane is enroute to a direct-to or intercept-to the RWYYY waypoint and the airplane is within 25 NM of the runway threshold
- a published instrument approach has been selected and incorporated in the active flight plan and,
 - the airplane has sequenced the first waypoint on the published approach or
 - the airplane is enroute to a direct-to or intercept-to waypoint (DIRECT displays at 1L on RTE page) and the airplane is within 12 NM of the runway threshold

The approach condition may be delayed if the flight crew manually inserts, bypasses, or deletes an approach waypoint on the LEGS page

The FMC transitions out of "on approach" under the following conditions:

- the pilot selects TOGA
- the airplane lands
- the airplane flies beyond the last waypoint in the approach (missed approach waypoint or runway). The VNAV page title changes from "ACT xxxxx DES" to "ACT END OF DES"

When the FMC is "on approach", the following features are available:

- the IAS/MACH window can be opened and the command speed can be set while VNAV remains in VNAV PTH descent; VNAV commands the set speed
- the MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current airplane altitude, VNAV continues to command a descent

- VNAV remains in VNAV PTH and follows the descent path unless the airplane accelerates to within 5 knots of the current flap placard and the airplane rises more than 150 feet above the path. In this case, VNAV PTH changes to VNAV SPD
- When a glide path angle is specified for one or more legs on the approach, it displays on the LEGS page and VNAV provides VNAV PTH guidance at the displayed angle. When sequencing a waypoint prior to a descent leg specified by a glide path angle, VNAV commands level flight until the airplane intercepts the descent path

Note: Display of a specified glide path angle is not limited to approaches. A glide path angle may be defined for a leg in a STAR and displays on the LEGS page for the procedure.

A side step to another approach can be accomplished by selection of the new approach on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the "INTC CRS TO" line on the LEGS page or by selecting the "XXXXXX INTC>" prompt on the ARRIVALS page.

Missed Approach

A missed approach is accomplished by selection of either TOGA switch. The following features are available:

- VNAV can only be activated when the airplane climbs above 400 feet radio altitude
- if an LNAV path is available, LNAV automatically arms and engages:
 - above 50 feet radio altitude when autopilot is not engaged, or
 - above 200 feet radio altitude when autopilot is engaged

Note: Route discontinuities after the missed approach will prevent the TO/GA to LNAV function from engaging.

- all descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan
- the highest altitude in the missed approach procedure becomes the new cruise altitude
- the FMC transitions from active descent to active climb. This transition also occurs when the airplane climbs toward the MCP altitude and flaps are retracted from a landing position (25 or 30 towards 20, or 20 towards 5). For example, when a missed approach is accomplished without pushing the TOGA switch.
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected
- when cruise phase is active, the speed target is the most restrictive of speed transition, best hold speed, or ECON cruise (above speed transition altitude)

Executing a missed approach causes the flight phase transition from descent or end of descent to climb when:

- the MCP altitude window is set to an altitude greater than current altitude, and
- the airplane is climbing at a rate greater than 600 fpm, and
- flaps have been retracted from the landing position.

1 Cruise

Before the top of descent, FMC is in cruise mode and commands VNAV PTH and ECON cruise speed.

2 Level Deceleration Phase

At top of descent, FMC transitions to descent and commands the airspeed to ECON descent speed and maintains altitude in VNAV PTH.

3 Descent

Nearing descent speed, VNAV commands a descent in VNAV PTH at ECON descent speed.

4 Descent Deceleration Phase

Before the speed restriction altitude, the FMC commands the target descent airspeed. The pitch mode remains VNAV PTH and the descent rate approximates 500 feet per minute.

5 Descent and Approach

When at target speed, VNAV commands a descent and starts approach in VNAV PTH at commanded speed.

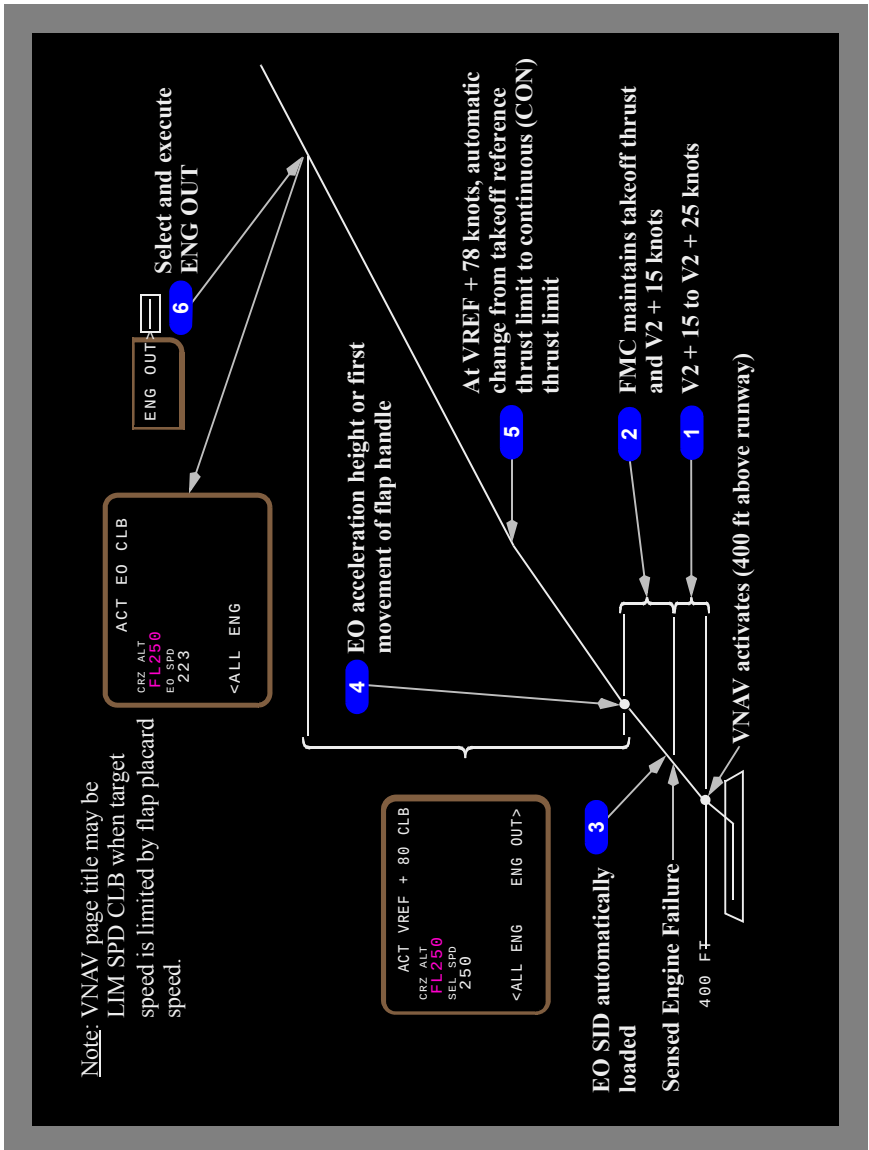
6 Missed Approach

When selected during missed approach, VNAV activates in VNAV SPD.

7 Missed Approach Level Off

At missed approach altitude, VNAV SPD changes to VNAV PTH.

Takeoff and Climb (Engine Out)



1 Takeoff

Condition: before a sensed engine failure and above VNAV activation altitude.

Result: VNAV SPD commands a climb at $V_2 + 15$ to $V_2 + 25$ knots. Autothrottle annunciation is THR REF and the thrust limit is takeoff.

2 **Sensed Engine Failure**

Condition: after VNAV activation, engine failure is sensed, airplane below engine out acceleration height and below the thrust reduction point entered on the TAKEOFF REF page.

Result: VNAV remains in VNAV SPD and commands $V_2 + 15$ knots. Autothrottle remains in THR REF and the thrust limit remains takeoff (TO).

3 **EO SID**

Condition: flaps extended and an engine out standard instrument departure (EO SID) in the FMC database.

Result: FMC loads the EO SID as a flight plan modification. The modification may be either executed or erased.

4 **Acceleration Height**

Condition: at acceleration height or flap retraction has started.

Result: VNAV commands an acceleration to $V_{REF} + 80$ knots, limited by the airplane configuration (flap placard). Pushing the VNAV function key displays the ACT $V_{REF} + 80$ CLB page.

5 **Thrust Reduction**

Condition: airplane has accelerated to $V_{REF} + 78$ knots

Result: thrust is automatically reduced from selected takeoff to continuous (CON) thrust. If the engine failure occurs above the thrust reduction point, the current climb thrust is maintained.

6 **VNAV Climb (Engine Out)**

Condition: Select the ENG OUT> prompt on the VNAV CLB page to display the applicable engine out performance data. The airline company engine out company speed (CO SPD) or long range cruise (LRC) speed may be selected. Execute to make the data active.

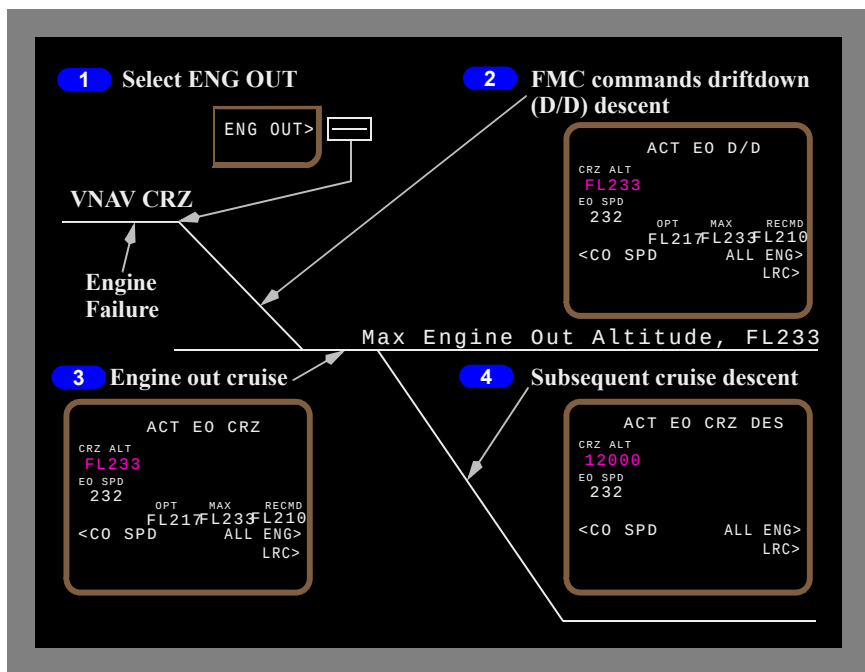
Result: FMC engine out climb function is active, VNAV is in VNAV SPD, CON thrust is selected, if not previously selected. A different thrust limit may be selected on the THRUST LIM page.

Climb (Engine Out above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of ENG OUT> on the VNAV CLB page or the XXXX ALTN page creates a modification and displays applicable engine out driftdown (D/D) performance data enabling the descent to the engine out maximum altitude. Execution of the modification activates the engine out driftdown function.

Cruise (Engine Out Above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of ENG OUT> on the VNAV CRZ page or the XXX ALTN page creates a modification and displays applicable engine out driftdown (D/D) performance data. When executing the ENG OUT modification, the reference thrust limit becomes CON, thrust levers advance to CON, the default command speed is EO SPD, and the EO MAX altitude shows as the cruise altitude in 1L. The EO MAX altitude shown in 1L does not change with time or changes in command speed.



1 Engine Out Modification

Selecting ENG OUT> creates a modification and displays the applicable engine out driftdown (D/D) performance data.

2 Drift Down Execution

A driftdown descent can be initiated by setting the MCP altitude at or below EO MAX altitude and executing the modification.

Result:

- VNAV commands EO SPD
- when EO SPD is achieved, VNAV controls the driftdown descent rate to a minimum of 300 feet per minute (fpm)
- time and distance for the D/D to EO MAX altitude show at 2R
- VNAV captures the MCP altitude and commands EO CRZ

Executing the ENG OUT modification without descending changes the pitch mode to VNAV ALT. A driftdown descent does not start until setting the altitude at or below EO MAX altitude and pushing the altitude selector. The result above describes the driftdown.

A normal enroute cruise descent can be initiated by setting the MCP altitude to a lower altitude and pushing the altitude selector.

Result:

- the airplane descends in a normal VNAV cruise descent at two-engine ECON speed
- the reference thrust limit is CLB/CRZ
- the airplane descends at ECON CRZ and approximately 1,250 fpm

During the enroute cruise descent, when the airplane is above EO MAX altitude, executing the ENG OUT modification commands a driftdown descent to the EO MAX altitude. The command speed is EO SPD. The rate of descent decreases to a minimum of 300 fpm.

3 Engine Out Cruise

When VNAV captures the EO MAX altitude, the VNAV cruise page title becomes EO CRZ and the pitch annunciation is VNAV PTH, regardless of the MCP altitude window setting. Calculations for EO Step Climb display at 2R. Thrust limit remains in CON.

4 Subsequent Cruise Descent

The FMC is in engine out mode. When the airplane is more than 50 nm from T/D, setting a lower MCP altitude and pushing the altitude selector executes an engine-out cruise descent.

Result: VNAV cruise descent at approximately 1,250 fpm at EO SPD. When the EO cruise descent intersects the planned descent profile, descent mode becomes active.

Required Time of Arrival (RTA)

VNAV controls cruise speed to arrive at a specified waypoint within ± 30 seconds of a specified time. If the RTA is not achievable, the FMC displays the scratchpad message UNABLE RTA.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (XXX), four digit (XXXX), five digit (XXXXX), or flight level (FLXXX) numbers. The FMC displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (XXX, FLXXX) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008; displays as 800
- 1,500 feet is entered as 015 or FL015; displays as 1500
- 11,500 feet is entered as 115 or FL115; displays as FL115
- 25,000 feet is entered as 250 or FL250; displays as FL250

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (XXXX) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050; displays as 50
- 835 feet is entered as 0835; displays as 840
- 1,500 feet is entered as 1500; displays as 1500
- 8,500 feet is entered as 8500; displays as 8500
- 9,994 feet is entered as 9994; displays as 9990

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet.

Examples of five (XXXXX) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050; displays as 50
- 835 feet is entered as 00835; displays as 840
- 1,500 feet is entered as 01500; displays as 1500
- 8,500 feet is entered as 08500; displays as FL085
- 9,995 feet is entered as 09995; displays as FL100
- 11,500 feet is entered as 11500; displays as FL115
- 25,000 feet is entered as 25000; displays as FL250

Negative altitude entries are allowed to -1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed, CAS, or Mach number, M. Calibrated airspeeds are entered as three digits (XXX) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash “/.” Examples of these pairs include wind direction/speed and waypoint airspeed/altitude constraints. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an INVALID ENTRY message.

Flight Management, Navigation

Flight Management Computer

Chapter 11

Section 32

FMC Databases

The FMC contains three databases:

- performance
- navigation
- airline modifiable information (AMI).

The performance database supplies performance data to the flight crew. It supplies the FMC with data to calculate pitch and thrust commands. All pertinent data can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

The navigation database includes most data found on navigation charts. This data can be displayed on the CDU or ND. The database contains:

- location of VHF navigation aids
- airports
- runways
- other airline selected data, such as SIDs, STARs, approaches, and company routes
- transition altitudes.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the usual navigation chart revision cycle. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and transferred to the FMC before the expiration date of the active data.

The AMI file contains airline specified data. If the FMC senses a conflict in an AMI value after a new AMI data load, the scratchpad displays the message CHECK AIRLINE POLICY.

Thrust Management

The thrust management function operates the autothrottle in response to flight crew mode control panel inputs or to FMC commands. Reference thrust limits can be selected on the THRUST LIM page. FMC autothrottle commands are made while VNAV is engaged. Thrust management:

- calculates reference thrust limits and thrust settings, or follows FMC thrust settings
- commands thrust levers

- senses and transmits autothrottle failures
- commands thrust equalization through the engine electronic controls.

7101 - 7110

Thrust limits are expressed as N1 limits. Thrust equalization references N1.

7001 - 7008

Thrust limits are expressed as EPR limits. Thrust equalization references EPR.

Thrust management calculates a reference thrust for the following thrust settings:

7101 - 7110

• TO – takeoff	• TO B – takeoff bump (increased takeoff thrust)
• TO 1 – takeoff one	• CLB – climb
• TO 2 – takeoff two	• CLB 1 – climb one
• D-TO – assumed temperature takeoff	• CLB 2 – climb two
• D-TO 1 – derate one assumed temperature takeoff	• CRZ – cruise
• D-TO 2 – derate two assumed temperature takeoff	• CON – continuous
	• G/A – go-around.

7001 - 7008

• TO – takeoff	• CLB – climb
• TO 1 – takeoff one	• CLB 1 – climb one
• TO 2 – takeoff two	• CLB 2 – climb two
• D-TO – assumed temperature takeoff	• CRZ – cruise
• D-TO 1 – derate one assumed temperature takeoff	• CON – continuous
• D-TO 2 – derate two assumed temperature takeoff	• G/A – go-around.

7101 - 7110

In addition, with APU-to-Pack takeoff, “A-TO”, “A-TO 1”, “A-TO 2”, or “A-TO B” thrust setting displays.

7101 - 7110

With VNAV active, the reference thrust limit changes for the phase of flight. Thrust settings can be selected on the THRUST LIM page. The reference thrust limit displays above EICAS N1 indications.

7001 - 7008

With VNAV active, the reference thrust limit changes for the phase of flight. Thrust settings can be selected on the THRUST LIM page. The reference thrust limit displays above EICAS EPR indications.

The flight crew can specify the thrust reduction height where the change from takeoff to climb thrust takes place by making an entry on the CDU TAKEOFF REF page. This can be an altitude from 400 feet to 9,999 feet, an entry of 1 for Flaps 1, or an entry of 5 for flaps 5.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life.

Derate/Variable Takeoff Rating

7101 - 7110

Two fixed derates can be selected on the THRUST LIM page. TO 1 and TO 2 reduce takeoff thrust by percentages specified by the operator. The derate percentages can be set between maximum takeoff thrust and the maximum certified derate in one percent increments. The Airplane Flight Manual (AFM) provides performance data for these derates.

With both TO 1 and TO 2, the thrust setting parameter is considered a limitation for takeoff; therefore, thrust levers should not be advanced further except in an emergency. A further thrust increase following an engine failure could result in a loss of directional control. Use the takeoff speeds calculated by the FMC for the selected derate or variable takeoff rating condition.

Derate/variable takeoff rating can be further reduced by assumed temperature.

Assumed Temperature Thrust Reduction Takeoff

Entering an assumed temperature higher than the actual temperature reduces takeoff thrust.

The maximum thrust reduction authorized is 25 percent below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where more thrust is necessary, the crew can manually apply full thrust.

Note: When the flight crew enters an assumed temperature resulting in thrust reduction, and manually arms CLB, a decrease in OAT may cause the FMC to recalculate V-speeds and arm CLB 1 or 2 on the THRUST LIM page. The scratchpad message TAKEOFF SPEEDS DELETED displays.

Derated Thrust Climb

During climb, CLB 1 and CLB 2 derates are gradually removed. In cruise, the thrust reference defaults to CRZ. The reference can be manually selected on the THRUST LIM page.

Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a 10 percent derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 30,000 feet. CLB 2 uses of a 20 percent derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 30,000 feet.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of climb derate. For a thrust reduction less than 10 percent, maximum climb thrust is automatically selected by the FMC. For takeoff thrust reductions or derates from 10 percent to less than 20 percent, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions or derates equal to or greater than 20 percent. On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

Use of derated climb thrust reduces engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity system or from manual entries. Fuel quantity values display on the PERF INIT page as calculated (CALC), MANUAL, or SENSED. They display on PROGRESS page 2 as TOTALIZER and CALCULATED. TOTALIZER and SENSED values are the same data with different names.

The FMC usually uses the calculated value for performance computations. Before engine start, the calculated value is set to agree with the fuel quantity indicating system value. When the FMC receives a positive fuel flow signal at engine start, the calculated value is independent of the fuel quantity system and decreases at the fuel flow rate.

During fuel jettison, the calculated value is set equal to the fuel quantity system value. When fuel jettison is completed, the calculated value is independent of the fuel quantity indicating system and decreases at the fuel flow rate. This fuel quantity value displays as CALC (calculated) on the PERF INIT page and CALCULATED on PROGRESS page 2.

If the flight crew inputs a fuel quantity, the line title changes to MANUAL and replaces the calculated value. Like the calculated value, the manual value is updated by fuel flow rate.

The calculated value is invalid if fuel flow data is invalid. The FMC uses the fuel quantity indicating system quantity for performance computations. The line title on the PERF INIT page changes to SENSED and displays as TOTALIZER on PROGRESS page 2.

The fuel used by each engine is calculated with its related fuel flow signal. FUEL USED displays on PROGRESS page 2. FUEL USED values are retained through flight completion and are subsequently cleared at engine start or following a long-term power interrupt on the ground. If the fuel flow signal is invalid for greater than two minutes after engine start or is invalid while on the ground, the display blanks.

The FMC continually estimates the fuel at the destination airport if the active route is flown. The CDU message INSUFFICIENT FUEL displays if the estimate is less than the fuel reserve value entered on the PERF INIT page.

Note: FMC calculated fuel predictions assume a clean configuration. Flight with gear or flaps extended cause fuel prediction errors. Fuel predictions are accurate after the gear and flaps are retracted.

When actual fuel temperature reaches the displayed value plus 3 degrees C, the EICAS advisory message FUEL TEMP LOW displays.

Loss of FMC Electrical Power

The FMC must have continuous electrical power to operate. When the electrical power is interrupted and returns, the FMC restarts.

After restart, the performance data displayed on the PERF INIT page must be re-entered. The route previously in use is available but must be reactivated.

The flight crew must modify the active waypoint to activate LNAV. Selecting the applicable active waypoint and proceeding direct or intercepting a course to the waypoint allows LNAV activation.

FMC Failure

Single FMC Failure

The scratchpad message SINGLE FMC L or SINGLE FMC R displays after loss of a single FMC. The EICAS advisory message FMC MESSAGE displays. Crew action is not necessary to change to single FMC operation. LNAV and VNAV, if active, remain active and all flight plan and performance data is retained.

A software reset may occur while in single FMC operation. The active route becomes inactive, the performance data is erased, and LNAV and VNAV (if engaged) modes fail. To regain FMC operation, activate and execute the flight plan, enter the necessary performance data, and engage LNAV and VNAV.

Note: If the MENU page and the scratchpad message TIMEOUT RESELECT display, the FMC is no longer connected to the CDU. Selecting the <FMC prompt connects the CDU to the FMC.

Dual FMC Failure

If both FMCs fail, LNAV and VNAV fail. The EICAS advisory message FMC displays. The CDUs supply route data to the NDs, and one of the CDUs supplies LNAV guidance to the autopilot. LNAV can be reselected on the mode control panel. FMS alternate navigation using the CDUs is discussed in Section 50 of this chapter.

Dual FMC failure may inhibit the autothrottle system. If it is available, it may be used in conjunction with any valid autopilot roll and/or pitch mode.

Note: If the MENU page displays and the <FMC prompt is not displayed in line 1, pushing the LEGS function key displays the ALTN NAV LEGS page, the PROG key displays the ALTN NAV PROGRESS page, and the NAV RAD key displays the ALTN NAV RADIO page.

Flight Management, Navigation

Air Traffic Control Data Link

Chapter 11

Section 33

Air Traffic Control Data Link

Most Air Traffic Control data link functions are accomplished on the MFD. The CDU is used as an input keyboard for downlink message forms. Uplink messages which contain route modifications are loaded into the FMC using the LOAD FMC function on the MFD ATC page. Execution of an ATC loaded modification is accomplished using normal FMC modification procedures.

Refer to chapter 5, Communications, section 40, MFD Communications, for a description of ATC data link.

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Flight Management, Navigation

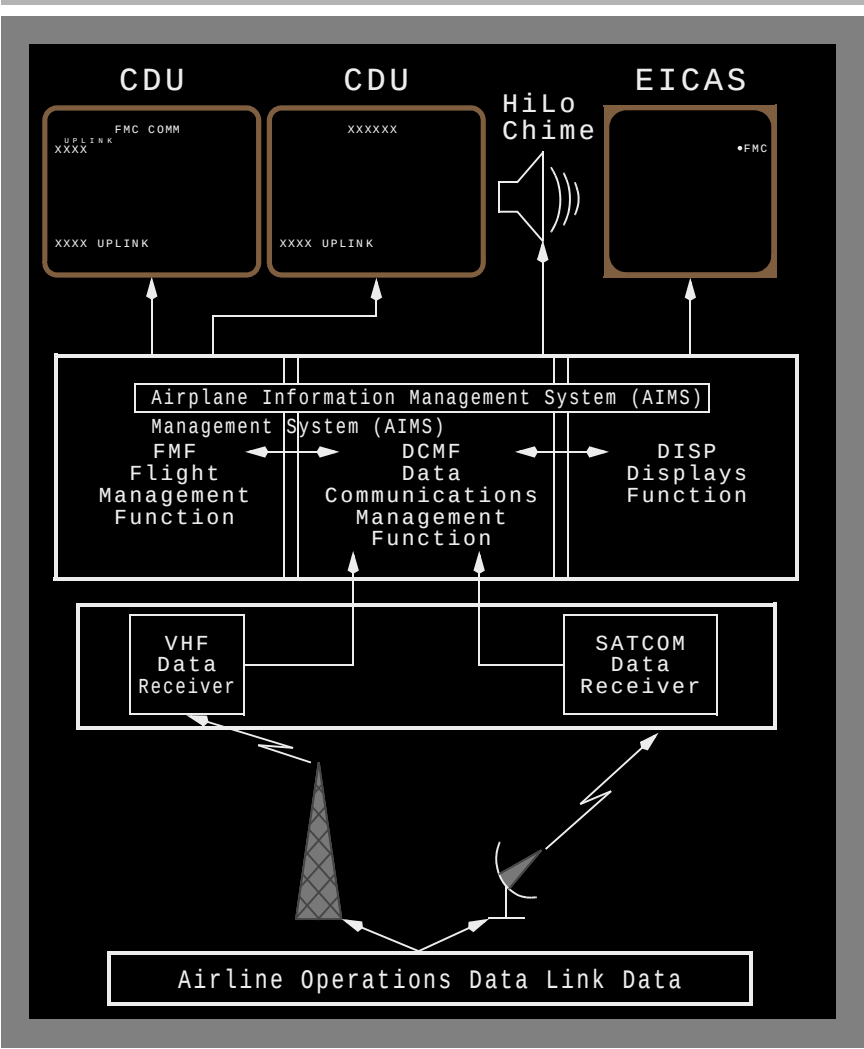
Company Data Link

Chapter 11

Section 34

FMS Data Link

The airplane communications system enables two-way data link communications between the FMS and Delta's FMS data link server. A downlink occurs when data is transferred from the FMS and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMS either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMS. Data may be uplinked automatically or in response to a downlink request.



Data Link

Downlinks are data link messages transmitted to a ground station. Requests for data and reports of FMS data are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane.

Manual Downlinks

Select a REQUEST prompt to start the downlink request for data. REQUEST prompts are on PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages. Downlink reports of the active route may be accomplished by selection of the REPORT prompt on the RTE page and a position report may be downlinked by selection of the REPORT prompt on the POS REPORT page.

When the communications function is unable to prepare FMS downlinks, the words FAIL, NO COMM, or VOICE display on CDU pages in place of REQUEST and REPORT prompts. The data link status also displays on the FMC COMM page. Radios supporting data link operations can be reconfigured by the crew through the MFD COMM function; refer to chapter 5, Communications. The status messages are:

- FAIL –
 - the AIMs data communications management function is inoperative, or
 - both the VHF and SATCOM data radios have failed.
- NO COMM –
 - the VHF and SATCOM data radios are operational but not available
 - the VHF data radio has failed and the SATCOM data radio is not available, or
 - the SATCOM data radio has failed and the VHF data radio is not available.
- VOICE – all available radios are operating in the VOICE mode.

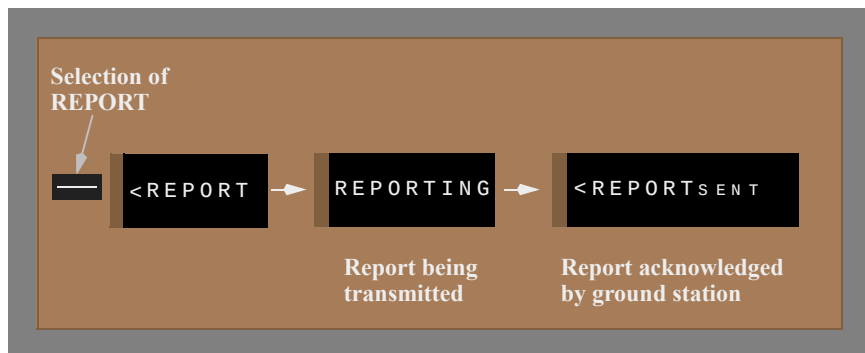
Reports

Pushing the line select key for the REPORT sends a downlink report applicable to that page. The pages below contain report prompts.



Report Status

Below is a typical sequence of status in response to sending a report.



Automatic Downlinks

The FMS can be configured by the airline to automatically transmit downlinks of FMS data at predetermined points during the flight or in response to specific data requests from the airline dispatcher. The FMS response in these cases is completely automatic and no flight crew action is necessary.

Uplinks

Uplinked data may be loaded automatically (TDU) or may require flight crew action (RTE). Uplinked data that waits in system memory for flight crew action are considered to be pending.

A pending uplink is included or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with ACCEPT/REJECT or LOAD/PURGE prompts, FMS modification ERASE prompt or EXEC key, or when the page with the uplink is selected. Glareshield-mounted accept and reject switches operate the same as MFD ACCEPT/REJECT prompts.

Data can be uplinked from the FMS data link server directly to the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, and WIND pages. The uplinks are annunciated to the crew by the •FMC EICAS communications alert and a Hi-Lo Chime. The uplink is identified by a CDU scratchpad message and by the presence of an UPLINK label over the applicable FMC COMM page prompt.

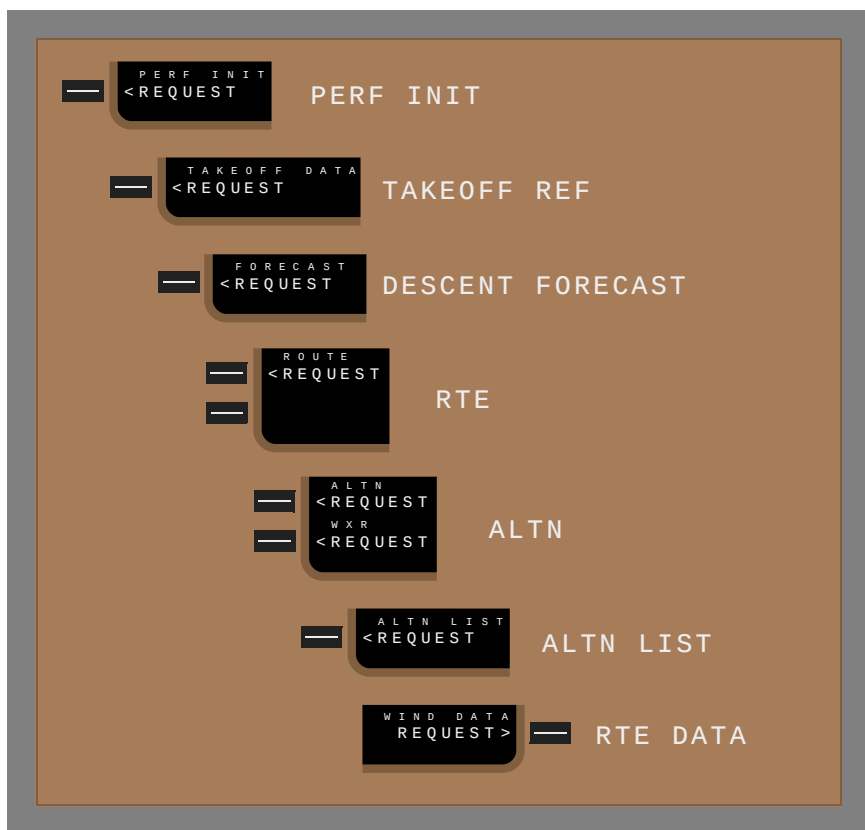
Takeoff uplinks are not annunciated until:

- ZFW or gross weight is entered on the PERF INIT page
- a route is activated
- the active route has a departure runway (and intersection, if applicable) matching the TAKEOFF uplinks (up to six takeoff records can be uplinked).

If there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the FMC COMM page is not shown.

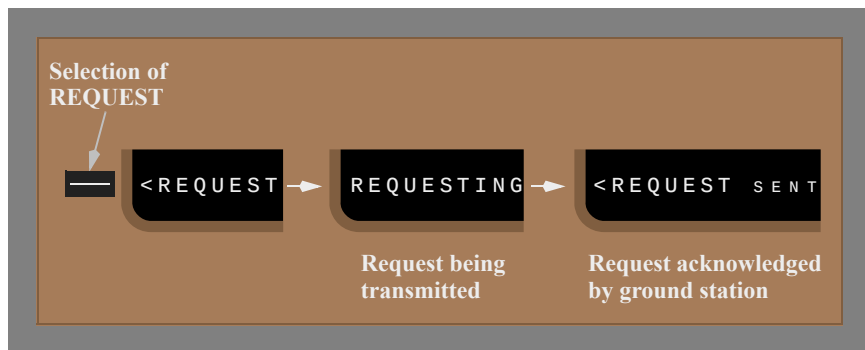
Requests

A REQUEST prompt on each page downlinks a unique request applicable to that page. The pages below contain request prompts.



Request Status

Below is a typical sequence of status in response to sending a request.



FMS Data Link Uplinks (Accept/Reject)

ACCEPT and REJECT display on the PERF INIT, TAKEOFF 1/2, and ALTN pages after receipt of uplink data.

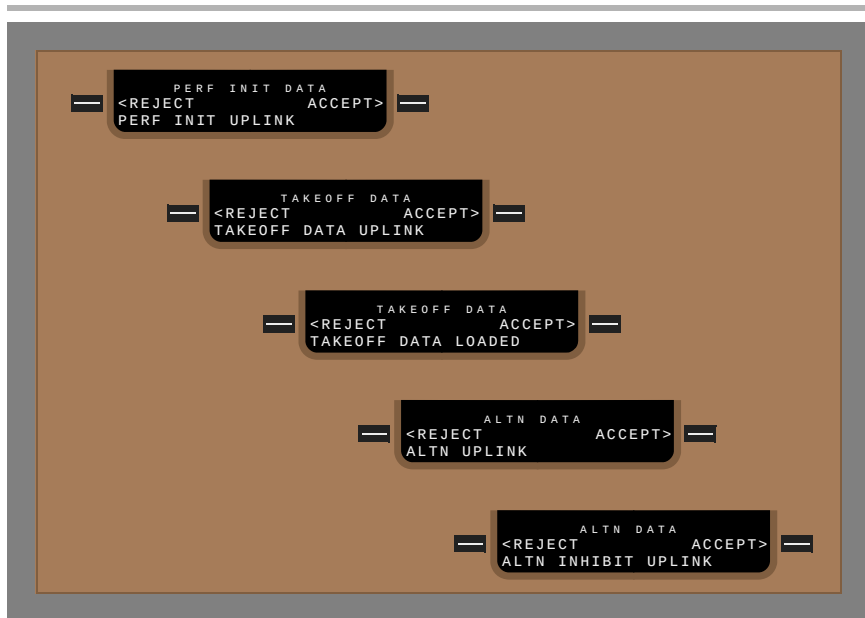
Uplink data displays initially in small font for preview.

Select ACCEPT prompt:

- displays uplinked data in large font
- replaces previous data with uplinked data
- changes page to pre-uplink format
- clears scratchpad message
- transmits a downlink accept message (if enabled).

Select REJECT prompt:

- replaces uplinked data with previous data
- changes page to pre-uplink format
- clears scratchpad message
- transmits a downlink reject message (if enabled).



FMS Data Link Uplinks (Load/Purge)

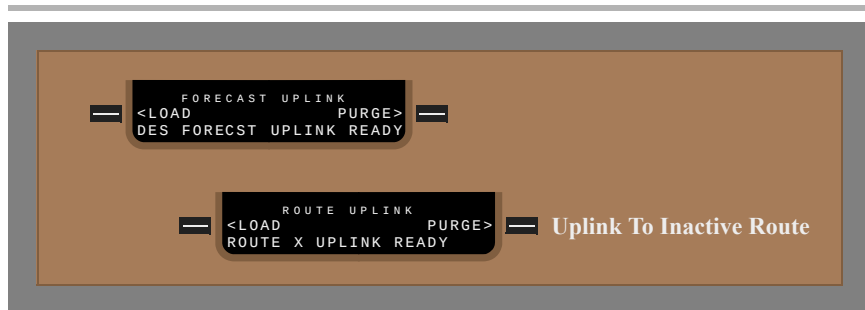
LOAD and PURGE display on the DESCENT FORECAST page after receipt of uplink data. LOAD and PURGE display on the active RTE 1 or RTE 2 page when there is an uplink to the inactive route.

Select LOAD prompt:

- loads uplinked data into FMS for viewing
- clears scratchpad message
- replaces previous data with uplinked data
- changes page to pre-uplink format
- transmits a downlink accept message (if enabled).

Select PURGE prompt:

- replaces uplinked data with previous data
- changes page to pre-uplink format
- clears scratchpad message
- transmits a downlink reject message (if enabled).



FMS Data Link Uplinks (Load/Exec-Erase)

LOAD displays on the RTE and WIND pages after receipt of uplink data.

After the uplinked data is loaded, the EXEC light illuminates and the ERASE prompt displays.

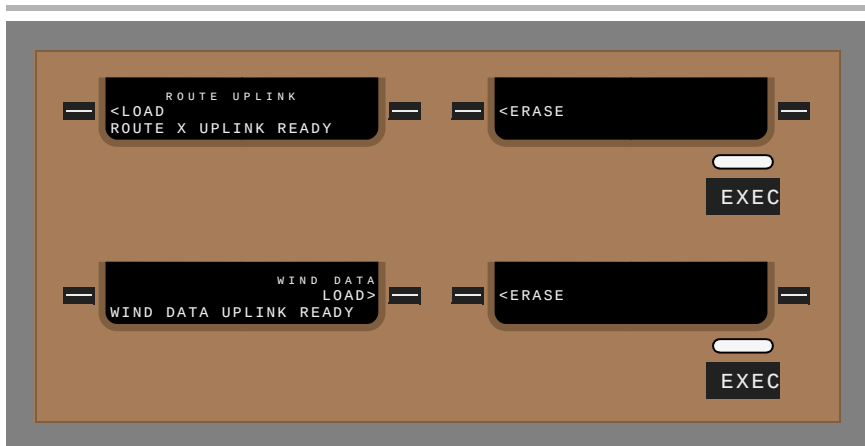
Select LOAD prompt:

- loads uplinked data into FMS
- loaded data can be viewed
- clears scratchpad message
- replaces existing data with modified uplinked data
- changes page title to MOD
- shows ERASE prompt
- illuminates EXEC light

Push the EXEC key to:

- put modified data in active flight plan
- change page format to pre-uplink format
- transmit a downlink accept message (if enabled).

Select ERASE prompt to:



- remove modified data
- return page display to pre-uplink format
- transmit a downlink reject message (if enabled).

FMS Data Link Uplinks (Automatic)

FLT NO and ALTN LIST data can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page without flight crew action. The list of 20 alternates automatically loads into the ALTN LIST page without flight crew action.

The scratchpad messages FLIGHT NUMBER UPLINK or ALTN LIST UPLINK stay in the scratchpad display queue until the applicable CDU page is selected.



FMS Data Link Management

The flight crew should monitor system status of FMS data link. This is accomplished on various CDU pages or on the FMC COMM page. Changes to data link system operating modes are accomplished with the COMM function on the display select panel.

CDU Data Link Status Displays

Data link operation is verified when the correct line title displays above the prompt. In the example below, the line title ROUTE is above the REQUEST and REPORT prompts on the RTE page.

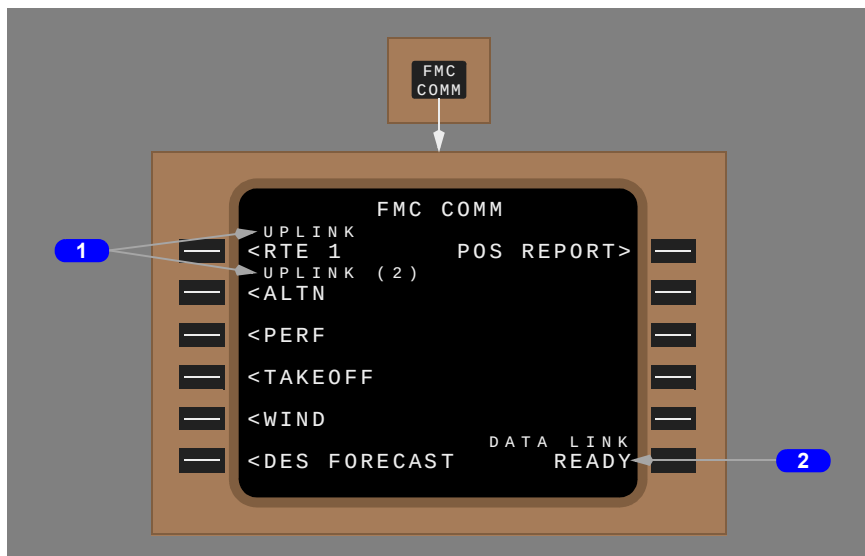


When the data link system is not operating, the CDU data line changes to NO COMM, VOICE, or FAIL and the line title changes to DATA LINK.



FMC Communications Page

General data link status displays on the FMC COMM page. Page select prompts display for each FMS page with access to data link data.



1 Uplink Status

The page line title displays UPLINK when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks ensures prerequisite data is available before the uplink message can be selected. Examples of preprocessing include:

- RTE ALTN, ALTN LIST, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete
- Subsequent uplinks of the same type are held until previous uplinks are included or discarded by the flight crew
- TAKEOFF uplink is held until ZFW or gross weight is entered, a pending PERF uplink is included or discarded, or a takeoff runway is entered

When both ALTN and ALTN LIST uplinks are pending, (2) displays to the right of UPLINK in the line title.

The EICAS message •FMC displays whenever any UPLINK message is pending.

2 DATA LINK

Displays the data link system status.

System status can be:

- READY
- NO COMM
- VOICE
- FAIL.

Page Select Prompts

Selection of any of these prompts displays the related page:

• RTE X	• WIND
• ALTN	• DES FORECAST
• PERF	• POS REPORT.
• TAKEOFF	

Introduction

Completion of the FMC preflight requires data entry in all minimum required data locations. Entry of all required and optional preflight data optimizes FMC accuracy.

Data link can load preflight data from airline ground stations. Using data link reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

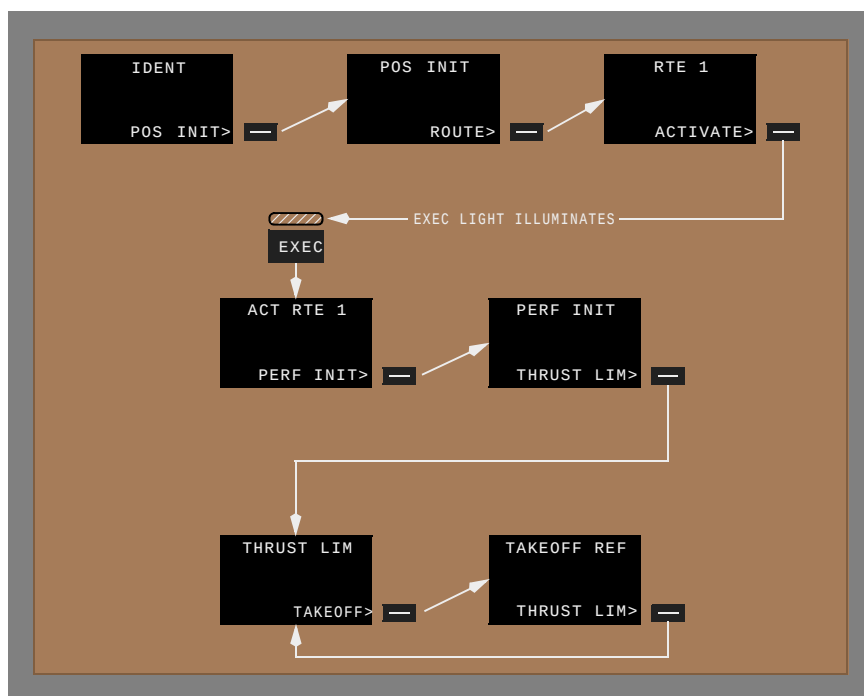
Preflight Page Sequence

The identification page usually displays when power is applied to the FMC. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- route (RTE) page
- DEPARTURES page (no prompt)
- navigation radios (NAV RAD) page (no prompt)
- performance initialization (PERF INIT) page
- thrust limit (THRUST LIM) page
- takeoff reference (TAKEOFF REF) page

Some of these pages are also used in flight.

Minimum Preflight Sequence



During preflight, a prompt in the lower right directs the flight crew through the minimum requirements for preflight completion. Selecting the prompt key displays the next page in the flow. If a required entry is missed, a prompt on the TAKEOFF page leads the flight crew to the preflight page missing data.

Airplane inertial position is necessary for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route data is origin and destination airports, and a route leg.

Performance data requires entry of airplane weights, fuel reserves, cost index, and cruise altitude.

Takeoff data requires a flap setting and center of gravity.

Supplementary Pages

Supplementary pages are sometimes required. These pages have no prompts and interrupt the usual sequence. Discussions of each page includes methods to display the page.

When the route includes SIDs and STARs, they can be entered using the DEPARTURES or ARRIVALS pages.

Route discontinuities can be removed using the RTE LEGS pages. Similarly, speed/altitude restrictions are entered and removed on the RTE LEGS page described in the FMC Cruise section of this chapter.

Alternate airports are added on the ALTN page. The ALTN page is described in the FMC Descent/Approach section of this chapter.

Waypoints, navigation, airport, and runway data is referenced on the REF NAV DATA page. The REF NAV DATA page is described in the FMC Cruise section of this chapter.

Fixed takeoff thrust derates can be changed on the AIRLINE POLICY page.

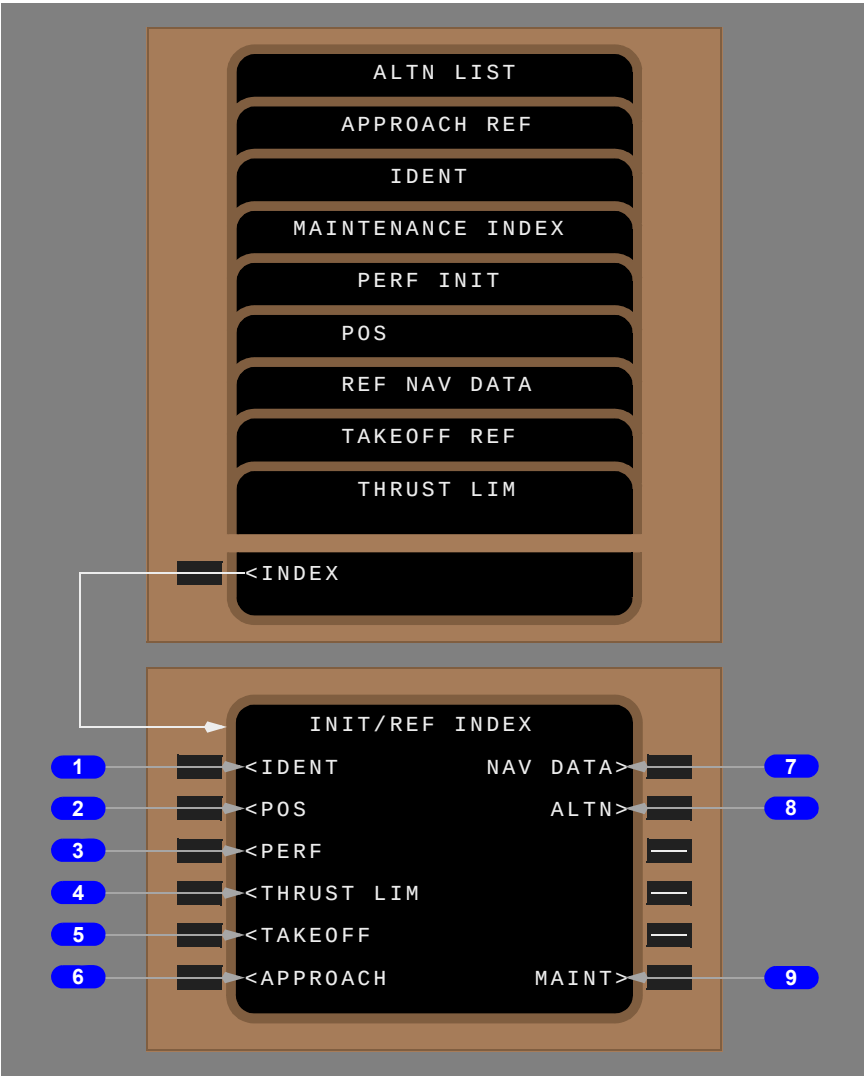
VNAV performance is improved if forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints is entered on the WIND page. The WIND page is described in the FMC Cruise section of this chapter.

Preflight Pages – Part 1

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The initialization/reference index page allows manual selection of FMC pages. It gives access to pages used during preflight and not usually used in flight.



1 Identification (IDENT)

The IDENT page is used to verify basic airplane data and currency of the navigation database.

2 Position (POS)

The POS INIT page is used for ADIRU initialization.

The POS INIT page is also used for initialization of SAARU heading in the event the ADIRU fails.

3 Performance (PERF)

The PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

4 Thrust Limit (THRUST LIM)

The THRUST LIM page is used to select thrust limits and derates.

5 TAKEOFF

The TAKEOFF REF page is used to enter takeoff reference data and V speeds.

6 APPROACH

The APPROACH REF page is used for entry of the approach VREF speed.

7 NAV DATA

The REF NAV DATA page is used for data on waypoints, navaids, airports, and runways. NAV DATA pages are accessible only from this page.

8 Alternate (ALTN)

The ALTN page is used for alternate airport planning and diversions.

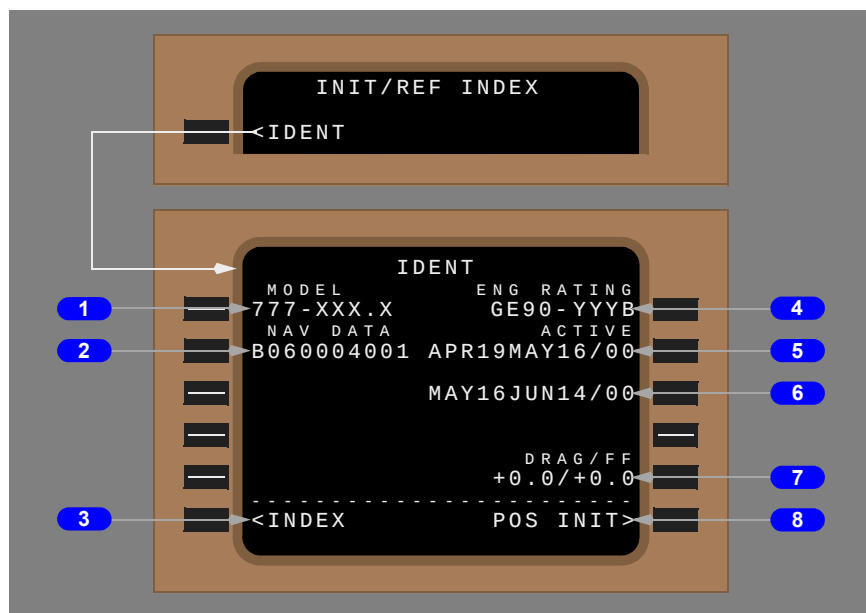
9 Maintenance (MAINT)

For maintenance use only; displays maintenance pages.

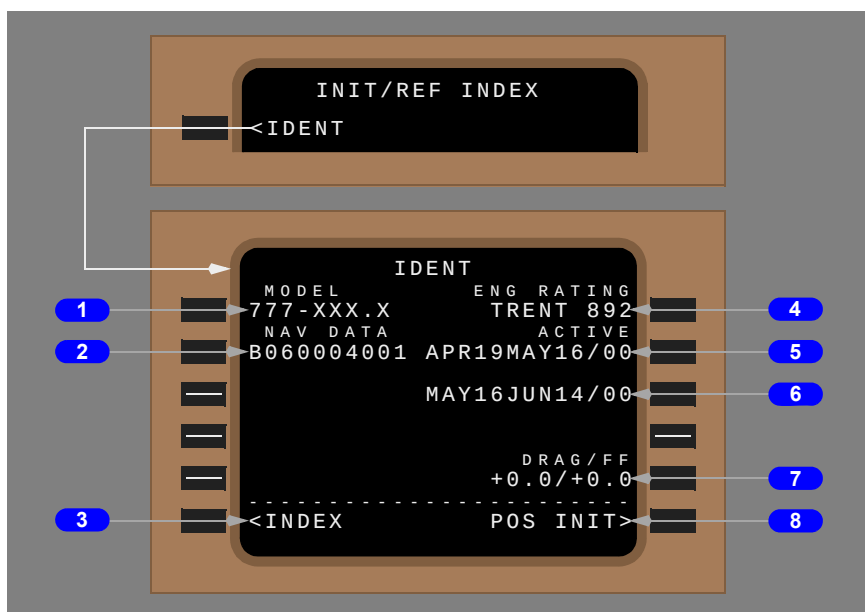
Identification Page

Most of the data on this page is for flight crew verification. Active date and drag/fuel flow accept manual entries.

The flight crew verifies FMC data, selects a navigation database, and checks drag and fuel flow factors on the identification page. Drag and fuel flow factors represent the deviation in drag characteristics and fuel flow from new aircraft and engine performance. Fuel flow factor is updated regularly based on each aircraft's individual historic fuel burn. This data is used to provide more accurate fuel burn and performance predictions. It is expressed as a percentage of deviation (+/-9.9).

7101 - 7110

7001 - 7008



1 MODEL

Displays airplane model as follows:

7101 - 7110

Ident Page Model	Airplane
777-200.2	777-200LR

7001 - 7008

Ident Page Model	Airplane
777-200.1	777-200ER

2 NAV DATA

Displays the navigation database identifier.

3 INDEX

Push – displays the INIT/REF INDEX page.

4 ENG RATING

Displays engine model and thrust rating. Header displays INTERMIX RATING for engine intermix installations. YY or YYY is the engine thrust rating.

5 ACTIVE

Displays the effectivity date range for the active navigation database.

If the active navigation database is out of date, it can be changed to the inactive navigation database. Pushing the date range prompt of the inactive navigation database copies that date into the scratchpad. Pushing the date range prompt of the active navigation database transfers the scratchpad date up to the ACTIVE database line. The previous active date moves to the inactive date line.

The line title ACTIVE is above the active navigation database date. No line title is above the inactive navigation database date. The navigation database date can only be changed on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database is used until the active date is changed after landing. The data base expires at 0900Z on the last day in the range.

6 Inactive Date Range

Displays the effectivity date range for the inactive navigation database. This database becomes active at 0901Z on the first day in the range.

7 DRAG/FF

Displays the airplane drag and fuel flow correction factors.

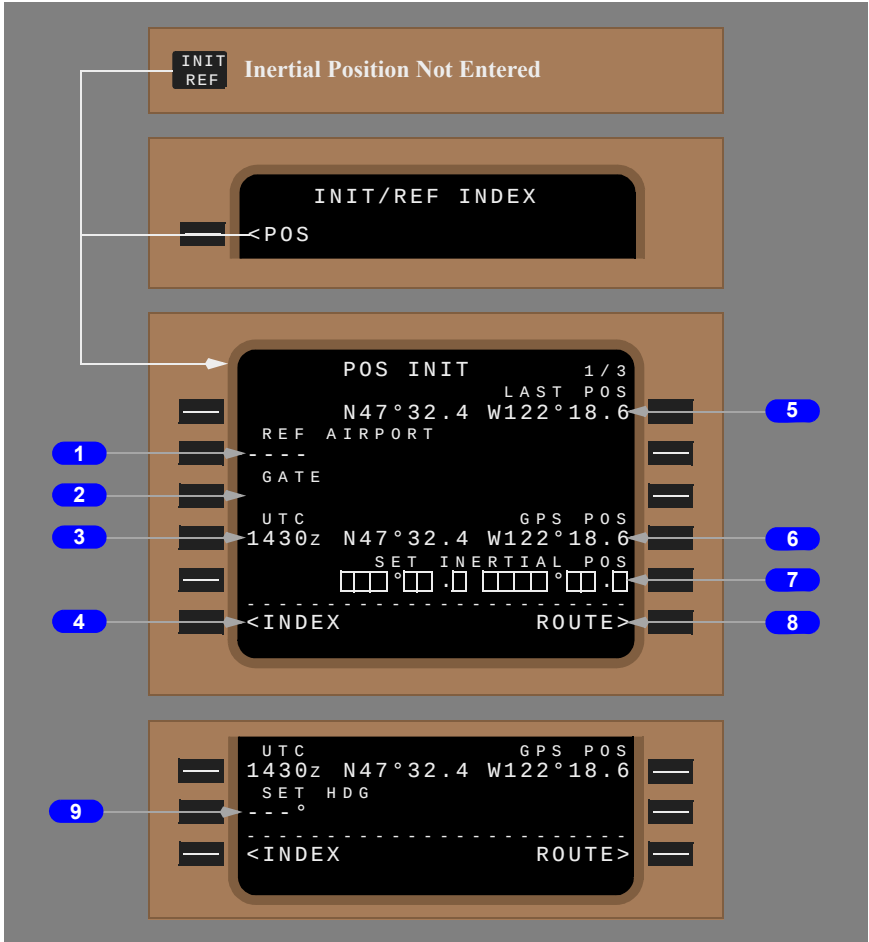
8 Position Initialization (POS INIT)

Push – displays the POS INIT page.

Position Initialization Page 1/3

The position initialization page allows entry of airplane present position for ADIRU alignment. The same page is used to enter the heading for SAARU initialization when the ADIRU is inoperative.

Data on the first page is used to initialize the ADIRU. In the event the ADIRU becomes inoperative in flight, initialization of the SAARU heading is accomplished on this page.



The diagram illustrates the Position Initialization Page 1/3, showing three sequential screens with numbered callouts (1-9) indicating specific fields and actions:

- Screen 1 (Top):** Displays "INIT REF" and "Inertial Position Not Entered". Below this is the "INIT/REF INDEX" screen with a "<POS" field.
- Screen 2 (Middle):** Displays "POS INIT" and "1 / 3". It includes fields for "REF AIRPORT", "GATE", "UTC", "GPS POS", "SET INERTIAL POS", and "<INDEX". Callouts 1 through 4 point to the "REF AIRPORT" field, the "GATE" field, the "UTC" field, and the "<INDEX" field, respectively. Callouts 5 through 8 point to the "LAST POS", "GPS POS", "SET INERTIAL POS", and "ROUTE" fields, respectively.
- Screen 3 (Bottom):** Displays "UTC", "GPS POS", "SET HDG", and "<INDEX". Callout 9 points to the "SET HDG" field.

1 Reference Airport (REF AIRPORT)

Entry of the reference airport displays the airport latitude/longitude. Optional entry.

Valid entries are ICAO four letter airport identifiers.

Removes previous GATE entry.

Entry blanks at lift-off.

2 GATE

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after reference airport entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate.

Changes to dashes when a new reference airport entered.

Entry blanks at lift-off.

3 Coordinated Universal Time (UTC)

UTC (GPS) – displays time from GPS.

UTC (MAN) –

- displays time from captain's clock when operative; otherwise, displays time from first officer's clock
- hours set by entering desired hour reference
- minutes set by resetting appropriate pilot's clock

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Last Position (LAST POS)

Displays the last FMC calculated position.

6 GPS Position (GPS POS)

Displays the GPS present position. During preflight, the GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

7 Set Inertial Position (SET INERTIAL POS)

The set inertial position entry is required to initialize the ADIRU. Select the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or make a manual entry to initialize the ADIRU.

If an entry is not made before the ADIRU completes the initial alignment, the scratchpad message ENTER INERTIAL POSITION displays.

If an entered position fails the ADIRU internal check, the scratchpad message ENTER INERTIAL POSITION displays. If the entered position fails the ADIRU check after the position is entered a second time, the scratchpad message ALIGNMENT REINITIATED displays.

The entered position is also compared with the FMC origin airport position. If the entered position is not within 6 NM of the FMC origin airport position, the scratchpad message INERTIAL/ORIGIN DISAGREE displays.

Dashes display when the ADIRU is in the automatic realignment mode and can receive a new position update. Enter the most accurate inertial position to remove any accumulated ADIRU position errors.

Enter airplane position latitude and longitude.

Boxes display within one minute of ADIRU power-up.

Blanks when the ADIRU changes from the alignment to the navigation mode.

Blanks when the airplane is moving or has not been stationary for a minimum of six minutes.

Dashes display when the ADIRU enters the automatic realignment mode on the ground.

New inertial position entries can be made after dashes display during ADIRU automatic realignment. New entries display for 2 seconds. After 2 seconds, dashes display to allow entry of another position.

8 ROUTE

Push – displays the ROUTE page.

9 SET HDG

Dashes display in flight when ADIRU is inoperative.

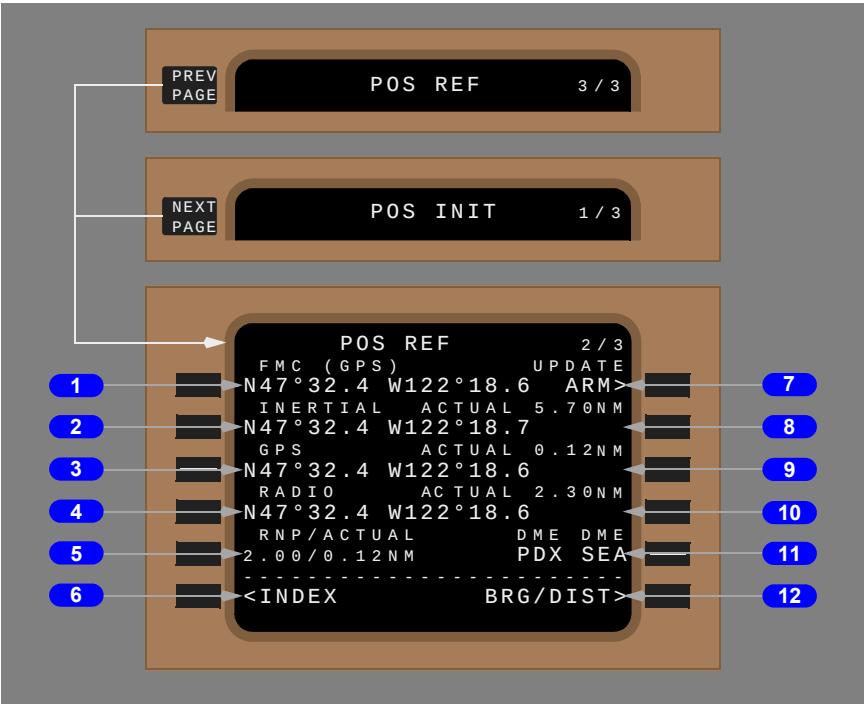
Entry of magnetic heading initializes SAARU.

Valid entry is 0 to 360 (0 or 360 displays as 360°). Entered heading displays in large font for two seconds, followed by dashes.

Position Reference Page 2/3

Position reference page 2 displays positions calculated by the FMC, ADIRU, GPS, and radio navigation receivers. The FMC position can be updated to ADIRU, GPS, or radio position on this page.

This page displays latitude/longitude or bearing/distance. All position displays are in actual latitude and longitude, as calculated by the related system. The ADIRU, GPS, and radio position data can be changed to bearing/distance.



1 FMC

The source used by the active FMC for position data displays next to the FMC line title. In the example, the FMC uses GPS for position data.

Displays the FMC calculated latitude/longitude.

Identifies the source for calculating the FMC position:

- GPS – position calculated from GPS position data
- INERTIAL – position calculated from ADIRU position data
- RADIO – position calculated from navigation radio position data
- LOC-RADIO or LOC-INERTIAL – position updated by localizer data

2 INERTIAL

Displays latitude/longitude position determined by the ADIRU.

3 GPS

Displays latitude/longitude position determined by the GPS.

4 RADIO

After airborne, displays latitude/longitude position determined by navigation radios.

5 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Displays RNP values stored in the navigation database for departure and arrival procedures; or, if there are none, displays the default values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Default RNP is in small font.

Valid RNP entries are in the range 0.01 to 99.9. Manual entry displays in large font; propagated to 2L RNP PROGRESS page 4. ACTUAL entry not allowed.

When ACTUAL exceeds RNP, the EICAS message NAV UNABLE RNP displays.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 UPDATE ARM

Push –

- arms FMC position update function
- changes prompt to ARMED
- adds NOW prompts to right side of INERTIAL, GPS, and RADIO lines

Push a NOW prompt key to update FMC position to the selected source.

8 ACTUAL – INERTIAL

Displays actual navigation performance of the ADIRU.

9 ACTUAL – GPS

Displays actual navigation performance of the GPS.

10 ACTUAL – RADIO

Displays actual navigation performance of radio updating.

11 Radio Update Station(s)/Mode

Displays radio station identifiers.

Position update mode is indicated in the line title:

- DME DME
- VOR DME

12 Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)

Push – alternates position data format between bearing/distance or latitude/longitude.

The page illustration is shown in the latitude/longitude display format.

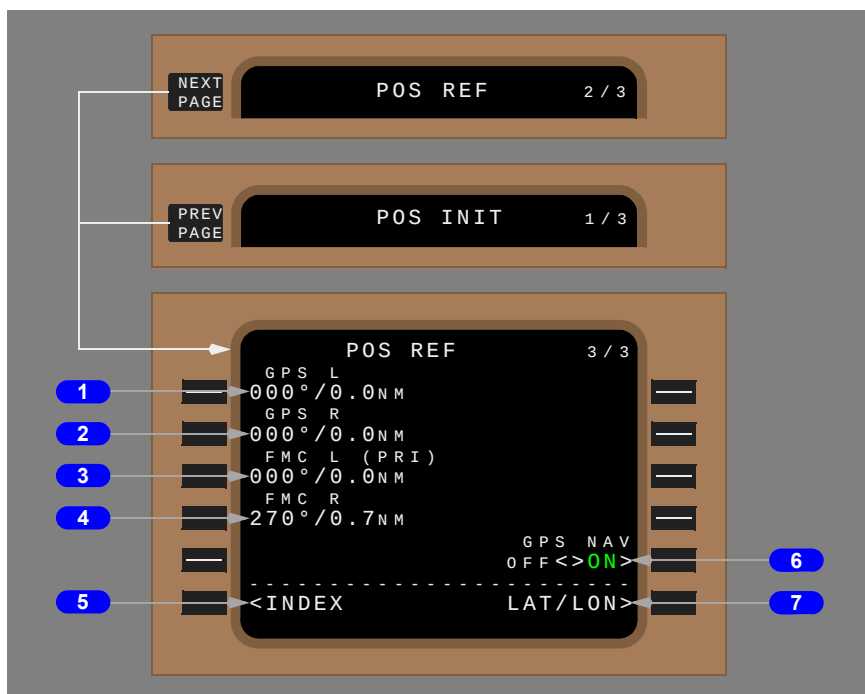
Latitude/longitude format displays are actual position.

Bearing/distance format displays the bearing and distance of other position sources relative to the FMC position.

Position Reference Page 3/3

On position reference page 3, the flight crew can observe the calculated positions from the left and right GPS receivers and the left and right FMC calculations. This page also allows the flight crew to enable or disable GPS position updates.

This page can display the bearing/distance or latitude/longitude format. The bearing/distance format displays bearing and distance of the position sources relative to the active FMC position on the POS REF 2/3 page. In the example, both the left and right GPS agree with the left FMC position.



1 GPS L

Displays the left GPS position.

2 GPS R

Displays the right GPS position.

3 FMC L

Displays the left FMC calculated position.

Primary (PRI) displays when the left FMC is active and the right FMC is inactive.

4 FMC R

Displays the right FMC calculated position.

PRI displays when the right FMC is active and the left FMC is inactive.

5 INDEX

Push – displays the INIT/REF INDEX page.

6 GPS NAV

Push – alternately selects GPS NAV ON (enabled) and OFF (disabled).

OFF – GPS position data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters.

ON – GPS position data is available to the FMC. ON displays in large green letters; OFF displays in small white letters.

Note: When power is initially applied to the airplane or when engines are shut down, GPS NAV is set to ON.

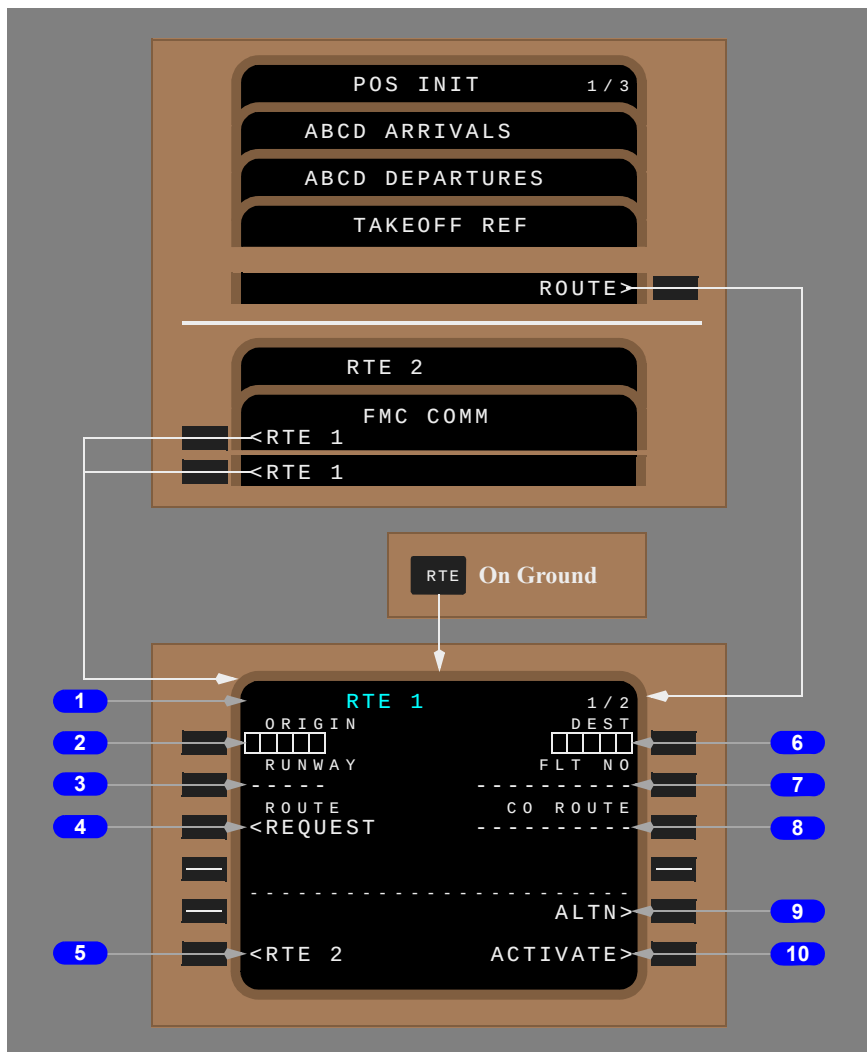
7 Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)

Push – alternately changes the display of position data on POS REF 2/3 and 3/3 to latitude/longitude format or bearing/distance format.

The page illustration is shown in the bearing/distance display mode.

Route Page 1/X

Two routes (RTE 1 and RTE 2) can be displayed in air traffic control format. Routes can be entered by the flight crew or uplinked through data link. All routes have two or more pages. The first route page displays origin and destination data. Subsequent route pages display route segments between waypoints or fixes. ROUTE 1 and ROUTE 2 allow management of alternate or future routes while leaving the active route unmodified. ROUTE 2 has an identical page structure as ROUTE 1. When RTE 2 is active, page display logic is the same as RTE 1.



1 Page Title

White when the route is active.

Cyan when the route is inactive.

The white shaded word MOD precedes the page title when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title. The minimum number of route pages is 2.

2 ORIGIN

Entry:

- must be a valid ICAO identifier in the navigation database
- is made automatically when a company route is entered
- enables direct selection of departure and arrival procedures
- displays MOD in page title of an active route
- entry on the ground deletes route; in flight, entries are valid on the inactive route

3 RUNWAY

Enter the applicable runway for the origin airport. Runway must be in the navigation database. Entry is optional.

New entries on an active route cause MOD to display in the route title.

Automatically entered when part of a company route.

Can be selected on the DEPARTURES page.

FMC deletes runway after the first waypoint is crossed.

4 ROUTE REQUEST

Push – transmits a data link request for a flight plan route uplink.

Flight crew can operationally fill in origin, destination, runway, flight number, company route name, or route definition to qualify request.

5 RTE 2

Push – displays the RTE 2 page 1/x.

Allows access to an inactive route for creation and modification or activation.

Inactive route modifications do not alter the active route.

Prompt changes to RTE 1 when RTE 2 is displayed.

6 Destination (DEST)

Entry:

- must be a valid ICAO identifier in the navigation database
- is made automatically when a company route is entered
- enables selection of departure and arrival procedures

7 Flight Number (FLT NO)

Valid entry is any ATC filed and flight crew entered, or uplinked company flight number up to 10 characters.

A pilot entry on the ATC LOGON/STATUS page propagates to the ROUTE page.

The flight number displays in the PROGRESS pages 1/4 and 2/4 title.

Transponder transmits flight number to ATC.

8 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data supplied with a company route can include origin and destination airports, departure runway, SID and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Enter a company route identifier.

Valid entry is any flight crew entered or uplinked company route name. If the name is not contained in the NAV database, the entry is allowed and the scratchpad message NOT IN DATABASE displays.

Entry of a new company route replaces the previous route.

In-flight entry is inhibited for the active route.

Delta does not use company routes at this time.

9 Alternate (ALTN)

Push – displays the ALTN page.

10 ACTIVATE

Push the ACTIVATE key to arm the route for execution as the active route. When the EXECUTE key is pushed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Push – prepares the selected route for execution as the active route.

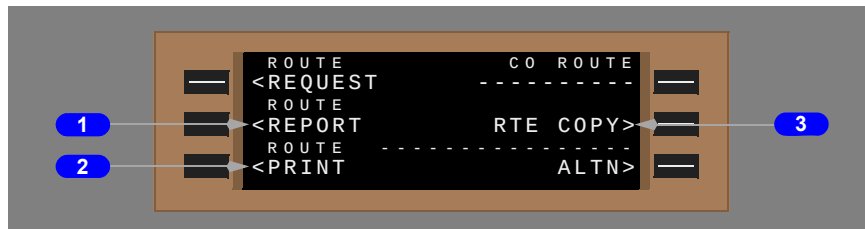
Activation of a route is required for completion of the preflight.

Displayed on inactive route pages.

After route activation, the ACTIVATE prompt is replaced by:

- PERF INIT, when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete

More Route Page Prompts for an Active Route



1 ROUTE REPORT

Push – transmits the active route to the company via data link downlink.

2 ROUTE PRINT

Push – sends the active route to the flight deck printer.

3 Route Copy (RTE COPY)

Push – copies the entire active route (RTE x) into the inactive route (RTE y).

Displayed only on the active route page.

Displays COMPLETE after the route is copied.

Route Page 2/X

The subsequent route pages 2/X through X/X, display route segments in air traffic control format. Route segments are defined as direct routing, airways, or procedures with start and end points such as waypoints, fixes, navaids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.



1 VIA

The VIA column displays the route segment to the waypoint or termination in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and boxes display in the TO column.

Valid entries can also include procedures or DIRECT. Procedures are usually entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is usually entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the fix entered in the TO waypoint, and
- contain the previous TO waypoint, or
- intersect the previous VIA route segment

Dashes change to DIRECT if the TO waypoint is entered first.

Dashes display for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad INVALID ENTRY message.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways that do not intersect the previous airway
- airways or company routes that are not in the navigation database

The start and end waypoints determine whether the entered airway is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the start point of the next route segment or a route discontinuity is created between the segments.

Entry of a SID or transition enters the VIA and TO data for the route segments of the SID. A SID links to the next route segment when the final SID waypoint is part of the route segment.

When no SID is used, entering an airway on the first line of page 2 initiates an airway intercept from the runway heading and:

- replaces the airway with dashes in the first line VIA
- shows boxes in the first line TO waypoint
- moves the airway to line 2 after the TO waypoint is entered
- enters the first fix on the airway nearest to being abeam of the departure heading in the airway line TO waypoint

A route can contain segments formed by the intersection of two airways. Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one segment to the next. The FMC created waypoint intersection (INTC) displays in the first airway segment TO waypoint.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 and V336 are examples of airway entries.

APP TRANS is an example of a STAR selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

2 TO

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway shows DIRECT in the VIA column.

Data input is mandatory when boxes are displayed.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

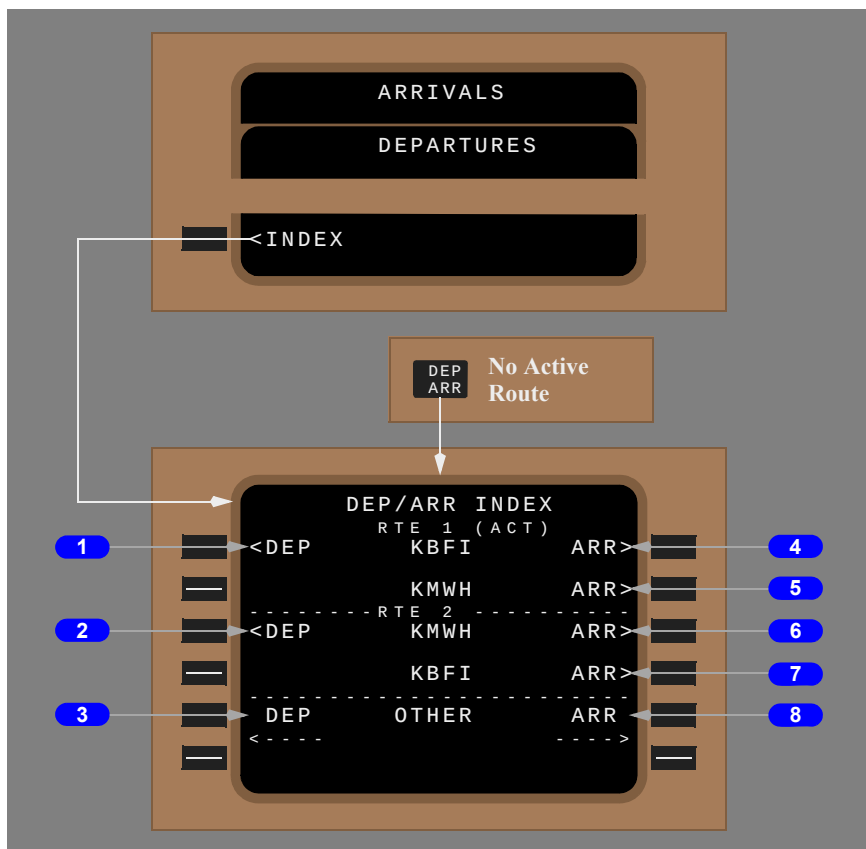
Valid waypoint entries for airways are waypoints or fixes on the airway.

Dashes display on the first TO waypoint after the end of the route.

Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival data for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



1 Departure (DEP) – Route 1

Push – displays the departure page for route 1 origin airport.

2 Departure (DEP) – Route 2

Push – displays the departure page for route 2 origin airport.

3 Departure (DEP) — Other

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allows display of departure data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

4 Arrival (ARR) – Route 1 Origin

Push – displays the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn-back situation.

5 Arrival (ARR) – Route 1 Destination

Push – displays the arrival page for route 1 destination airport.

6 Arrival (ARR) – Route 2 Origin

Push – displays the arrival page for route 2 origin airport. Origin airport arrivals selection is used during a turn-back situation.

7 Arrival (ARR) – Route 2 Destination

Push – displays the arrival page for route 2 destination airport.

8 Arrival (ARR) – Other

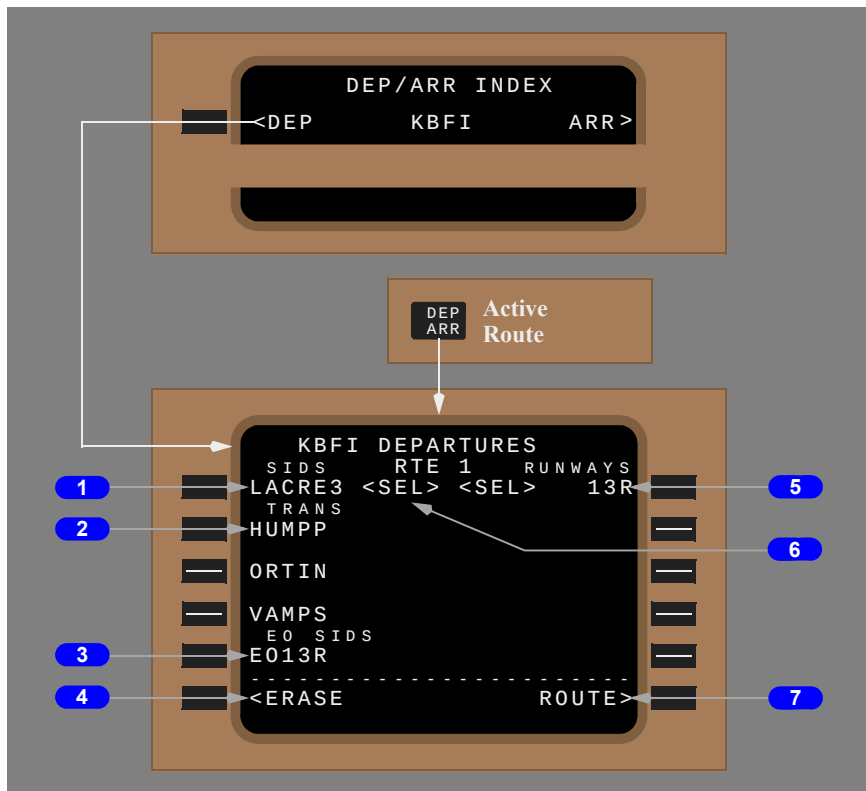
Displays the arrival page for the airport entered in this line through the scratchpad.

ARR prompt for OTHER allows display of arrival data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

Departures Page

The departures page is used to select the departure runway, SID, and transition for the route origin airport.

Pushing the DEP ARR function key displays the departures page for the inactive route when an inactive RTE or RTE LEGS page is displayed.



1 Standard Instrument Departures (SIDS)

Displays a list of SIDS for the airport.

Push –

- selects SID for use in the route
- other SIDS no longer display and transitions for the selected SID display
- runways for selected SID remain and others no longer display

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

Push –

- selects transition for entry in the route
- other transitions no longer display

3 Engine Out (EO) SIDS

Displays airline-defined single engine-out SIDs for selected airport. EO SID can be viewed before takeoff by line selecting and selecting the Legs page. EO SID automatically selected during takeoff if an engine-out detected prior to “flaps up”. The modification can be either executed or erased. If an EO SID does not exist, NONE displays.

PUSH - displays EO SID as the selected SID.

4 ERASE or INDEX

Erase displays when a route modification is pending. INDEX displays when no route modification is pending.

ERASE push – removes route modifications not executed and displays the original route.

INDEX push – displays the DEP/ARR INDEX page.

5 RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE 1/X page displays as <SEL> or <ACT>.

Push –

- selects runway for use in the route. All other runways no longer display
- SIDs associated with selected runway remain, all others no longer display
- subsequent change of a runway deletes departure procedures previously selected

6 Selecting Options

Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>.

Executing a modification or leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

7 ROUTE

Push – displays the related RTE page.

Navigation Radio Page

VOR and ILS navigation radios are normally autotuned by the FMC. ADF radios are manually tuned. The NAV RADIO page displays the VOR, ILS, and ADF radio status and allows manual control of these radios. Entering data on this page tunes the selected navigation radio. VOR courses can also be entered.

VOR



1 VOR Frequency and Tune Status

The tuning status displays adjacent to left and right VOR frequencies. Entry of a frequency or identifier manual-tunes a VOR. FMC autotunes VORs for procedure flying and route operations. The FMC also tunes related DMEs. The tuning status displays are:

- P (procedure autotuning) – FMC selects nav aids for approach or departure procedure guidance
- R (route autotuning) – FMC selects nav aids on the active route. The nav aid is the previous VOR or a downpath VOR within 250nm of aircraft position
- A (autotuning) – FMC selects a nav aid for best position orientation
- M (manual) – VOR is manual-tuned. Manual-tuning takes priority over FMC autotuning. Deletion of a manual-tuned frequency returns system to autotuning

Valid entries:

- VOR or non-ILS DME identifier or VOR frequency (XXX.X or XXX.XX)
- VOR identifier or frequency/course; the course displays on the CRS line

The identifier and frequencies are green and tuning status is white.

Note: When magnetic variation at the airplane and VOR locations are significantly different, the ND VOR radial and ND POS green radial do not point directly to the VOR. This difference decreases as the airplane approaches the VOR.

2 CRS

Blank when in autotune.

Valid entry is a three-digit course. Data can be entered when dashes or a course are displayed.

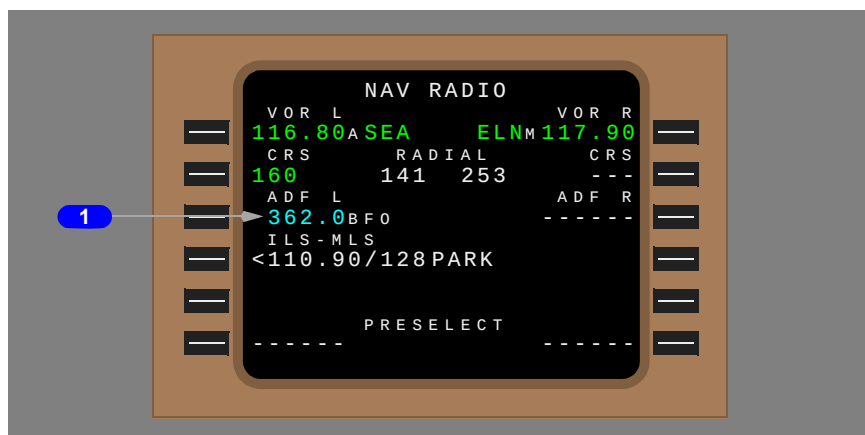
With a VOR approach selected, sequencing an IAF/FAF causes the FMC to procedure autotune the VOR frequency. When the approach has a runway waypoint, the FMC selects the inbound course.

VOR course is green. Radial is white.

3 RADIAL

Displays radial from left and right VOR stations to the airplane.

ADF



1 ADF Frequency and Tune Status

The tuning status displays adjacent to the left and right ADF frequencies. The tuning status displays are:

- ANT (antenna) – mode optimizes audio reception and removes ADF bearing data
- BFO (beat frequency oscillator) – mode for audio identification of stations transmitting unmodulated (CW) signals

Default tuning mode is ADF (no indication) giving both bearing data and audio.

Valid entries are XXX.X or XXXX.X.

Manual entry can be followed by A (ANT), B (BFO), or none, which defaults to the ADF mode.

Frequency is cyan and status is white.

ILS



1 ILS Frequency/Course and Tune Status

The tuning status displays adjacent to the ILS frequency and course. The ILS receivers operate in FMC autotune or manual-tuning modes. The FMC autotunes the ILS frequency and course. When the ILS is not necessary, the FMC sets the ILS to PARK. This removes the displays from the PFD.

Airplane position on the route determines the ILS operating mode. The operating mode displays are:

- PARK – the ILS is not being used and is not tuned
- XXX.XX/YYY PARK – the ILS is tuned for the selected approach but is not being used
- “A” indicates autotuning under FMC control for approach guidance
- “M” indicates the ILS is manually tuned

ILS autotuning is inhibited for ten minutes after takeoff and during manual-tuning. Autotuning and manual-tuning are inhibited when:

- the autopilot is engaged and either the localizer or glideslope is captured
- only the flight director is ON and either the localizer or glideslope is captured and the airplane is below 500 feet radio altitude
- on the ground with the localizer alive, the airplane heading within 45 degrees of the localizer front course and the ground speed is greater than 40 knots

Subsequent manual-tuning is enabled when:

- either TOGA switch is pushed
- the autopilot is disengaged and both flight directors are switched off
- the MCP approach switch is deselected when the airplane is above 1500 feet radio altitude

Valid entries:

- ILS frequency and front course (XXX.XX/YYYY)
- front course, with a frequency and course already entered (/YYY)

2 PRESELECT

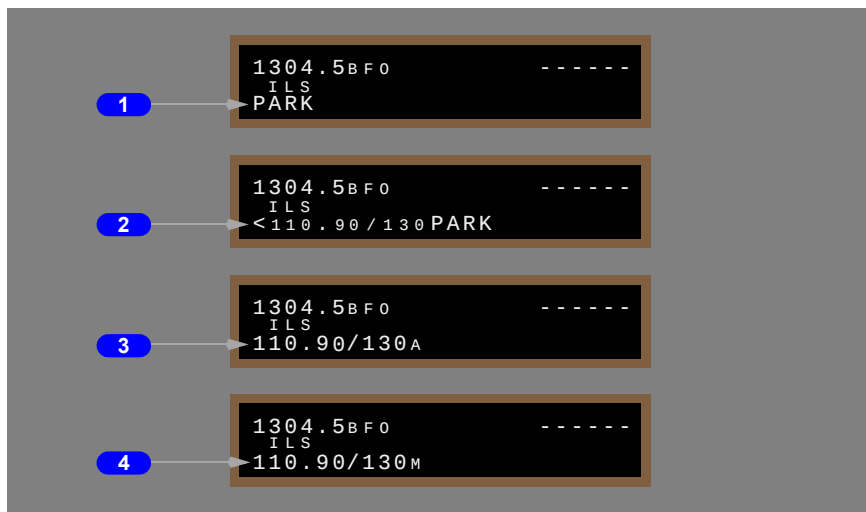
Any valid page data may be entered.

Put data into this line for later use. Data can be moved to the appropriate line when necessary.

ILS Tuning Status

The display initializes to PARK. When PARK displayed, the ILS is not tuned. The tuning status displays are:

- XXX.XX/YYY PARK – the ILS is autotuned for the selected approach but is not being used
- A (autotune) – ILS is autotuned for approach guidance
- M (manual) – ILS is manual-tuned



1 Park

PARK displays when:

- electrical power is first applied
- more than 200 NM from the T/D, or
- less than halfway to the destination

2 Tuning Status – Frequency, Course, and Park

ILS frequency, front course, and PARK display when an ILS, LOC, back course, localizer-type directional aid (LDA), or simplified directional facility (SDF) is selected, and:

- less than 200 NM from the T/D, or
- more than halfway to the destination, whichever represents the lesser distance to destination

Line selection manually tunes ILS.

3 Tuning Status – Autotune

ILS frequency, front course, and A display when an ILS, LOC, back course, LDA (localizer-type directional aid), or SDF (simplified directional facility) is selected, and:

- less than 50 NM from the T/D, or
- less than 150 NM from the runway threshold, or
- FMC is in descent mode

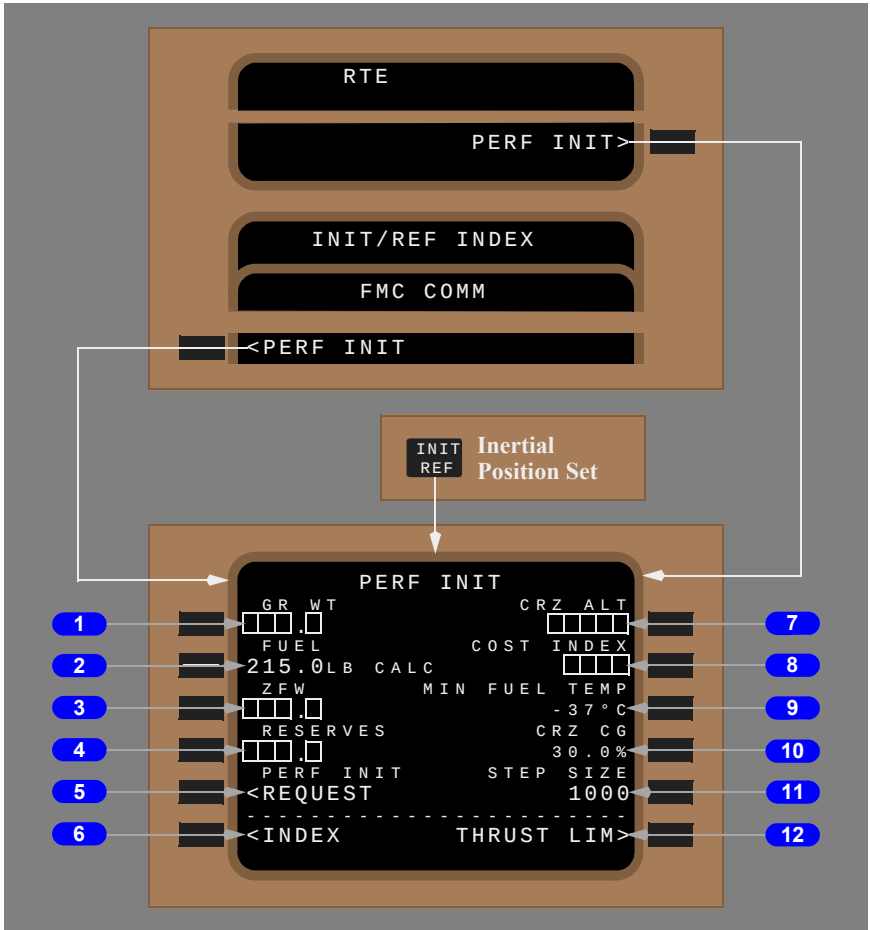
4 Tuning Status – Manual

Receiver tuned manually and valid frequency/course display.

Preflight Pages – Part 2

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This data is required for VNAV calculations.



1 Gross Weight (GR WT)

Airplane gross weight can be entered by the flight crew or calculated by the FMC after entry of zero fuel weight.

Valid entries are XXX or XXX.X.

Entering zero fuel weight first displays calculated gross weight.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 FUEL

Fuel on board displays when the fuel totalizer calculations are valid. The source for the display is included in the line:

- SENSED – fuel quantity is from the totalizer. Manual entry is not possible
- CALC (calculated) – fuel quantity is from FMC calculations. Manual entry is possible
- MANUAL – fuel quantity has been manually entered. Manual entries blank totalizer on PROGRESS page 2/3

Valid entry is XXX or XXX.X.

Only manual entries can be deleted.

3 Zero Fuel Weight (ZFW)

Normally, ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Valid entry is XXX or XXX.X.

Calculated zero fuel weight displays when airplane gross weight is entered first and fuel on board is valid.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

ZFW be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) display beside the entered values (large font).

4 RESERVES

Valid entry is XXX or XXX.X.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) display beside the entered values (large font).

5 Performance Initialization Request (PERF INIT REQUEST)

Push – transmits a data link request for performance data uplink.

Flight crew can fill in ZFW, CG, cruise altitude, reserves, cost index, or fuel temperature to qualify request.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 Cruise Altitude (CRZ ALT)

Cruise altitude can be entered by the flight crew or from a company route or uplink.

Entry displays this cruise altitude on the CLB and CRZ pages.

8 COST INDEX

Cost index is used to calculate ECON climb, cruise, and descent speeds. Larger values increase ECON speeds. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route or uplink.

Valid entries are 0 to 9999.

9 Fuel Freeze Temperature (FUEL FRZ TEMP)

Displays fuel freeze temperature.

Default value from the AIRLINE POLICY page displays in small font and may not be deleted.

A PERF INIT uplink containing a fuel freeze temperature value pending ACCEPT/REJECT displays in small font. Accepting causes the value to display in large font.

Valid entries are -99 to -1 in degrees C.

Flight crew entered value displays in large font.

When actual fuel temperature reaches the displayed value plus 3 degrees C, the EICAS advisory message FUEL TEMP LOW displays.

10 Cruise Center of Gravity (CRZ CG)

Used by FMC to compute maximum altitude and maneuver margin to buffet.

7101 - 7110

Displays default value of 14.0% in small font and may not be deleted.

7001 - 7008

Displays default value of 30.0% in small font and may not be deleted.

Flight crew entered value displays in large font.

A PERF INIT uplink containing a cruise cg value pending ACCEPT/REJECT displays in small font. Accepting causes the value to display in large font.

Valid entry is 14.0 through 44.0.

11 STEP SIZE

Displays the climb altitude increment used for planning the optimum climb profile.

Default value is 1,000.

Valid entries are:

- "0" to inhibit predicted step climbs, or
- altitudes from 1000 to 9900 in 100 foot increments, or
- "I" for ICAO, or
- "R" for RVSM

In flight entries are inhibited. In flight step size changes are made on the CRZ page.

For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

12 Thrust Limit (THRUST LIM)

Push – shows the THRUST LIM page.

Thrust Limit Page

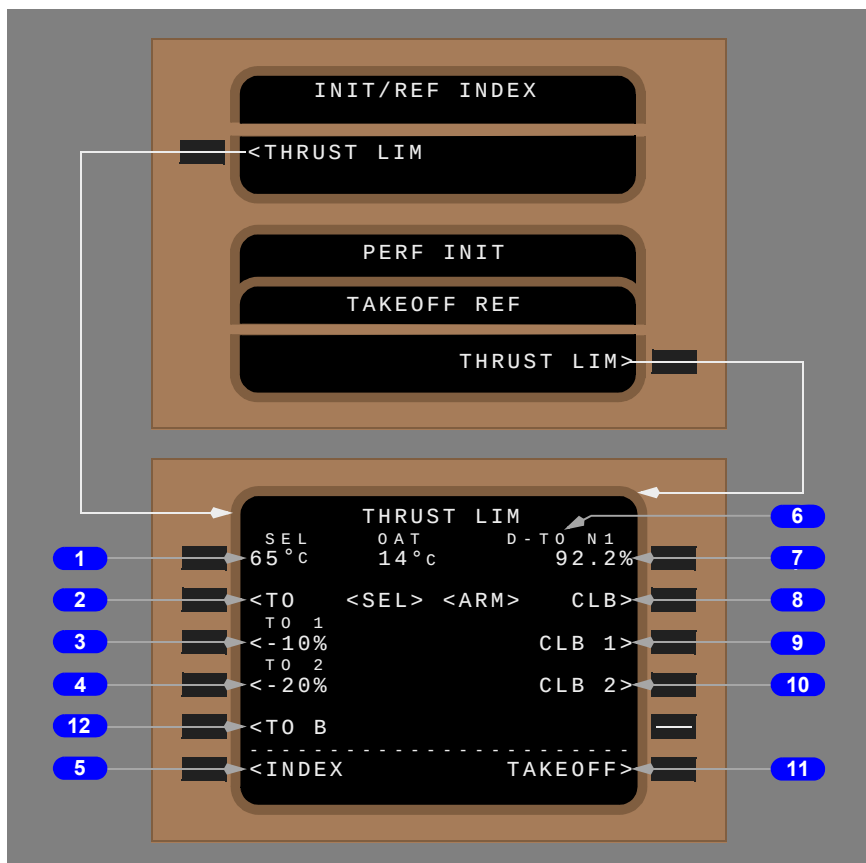
The thrust limit page allows selection and display of reference thrust for takeoff. Takeoff thrust derate by use of assumed temperature is also accomplished on this page.

Additional page data displays are:

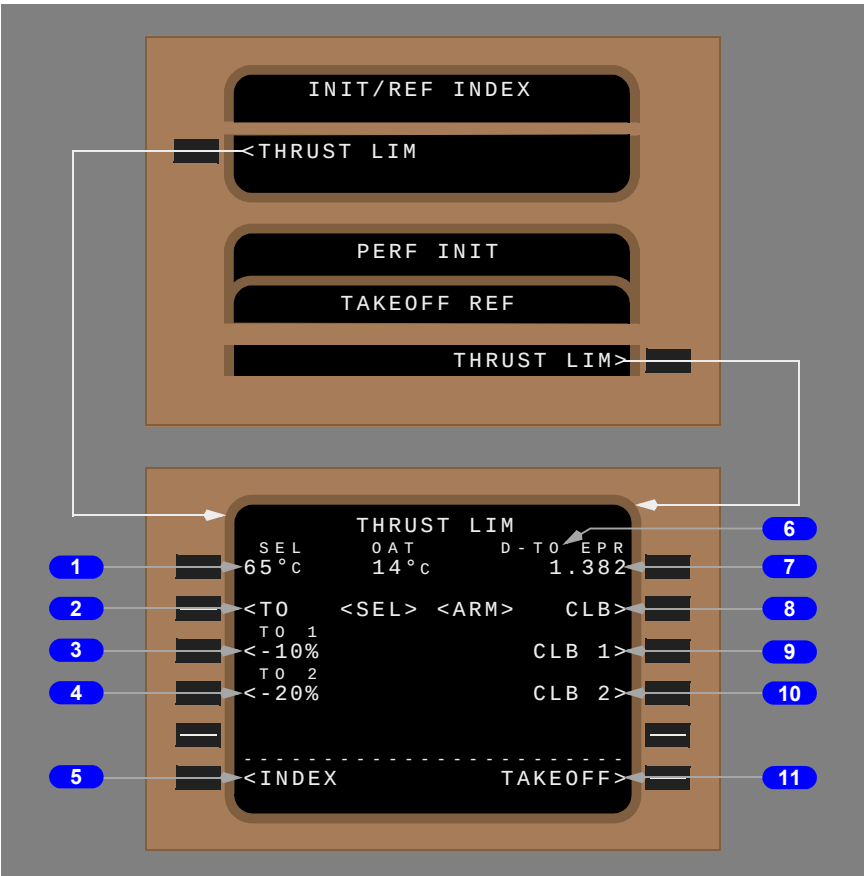
- <SEL> – identifies the selected takeoff thrust reference mode
- <ARM> – identifies the armed climb thrust reference mode

The <ARM> prompt changes to <SEL> when the armed climb mode becomes active.

7101 - 7110



7001 - 7008



1 Assumed Temperature (SEL), APU-to-Pack, Outside Air Temperature (OAT)

7101 - 7110

Entry is allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Entry of an assumed temperature warmer than the OAT reduces takeoff thrust and displays D as part of the thrust reference mode.

Valid entries are 0 to 99 degrees Celsius (C) or 32 to 210 degrees Fahrenheit (F).

Entry of one, two, or three character temperature followed by “F” displays assumed temperature in degrees F; otherwise, assumed temperature displays in degrees C.

Uplinked temperatures display on both the THRUST LIM and TAKEOFF REF pages.

Flight crew entered or uplinked values replace previously displayed values.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

“SEL-APU” displays in the header when the APU is running. Selection of “APU” from the scratchpad displays “APU” in the data line in small font representing the ARMED state. Approximately one minute after the second engine start, “APU” displays in large font representing the ACTIVE state. Entry of an assumed temperature, shutting down the APU, selecting another TO rating, or deleting the entry; deletes the APU selection.

OAT displays outside air temperature in degrees C. When SEL temperature is in degrees F, the OAT converts to degrees F.

The assumed temperature thrust derate is not the same as TO 1 and TO 2 fixed thrust derates described below. If TO 1 or TO 2 is selected and an assumed temperature is then entered, thrust is further derated.

1 Assumed Temperature (SEL), Outside Air Temperature (OAT) **7001 - 7008**

Entry of assumed temperature is allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Entry of an assumed temperature warmer than the OAT reduces takeoff thrust and displays D as part of the thrust reference mode.

Valid entries are 0 to 99 degrees Celsius (C) or 32 to 210 degrees Fahrenheit (F).

Entry of one, two, or three character temperature followed by “F” displays assumed temperature in degrees F; otherwise, assumed temperature displays in degrees C.

Uplinked temperatures display on both the THRUST LIM and TAKEOFF REF pages.

Flight crew entered or uplinked values replace previously displayed values.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

OAT displays outside air temperature in degrees C. When SEL temperature is in degrees F, the OAT converts to degrees F.

2 Takeoff (TO)

Push – selects full rated (TO) takeoff thrust limit.

Selection of a new rating after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

3 Takeoff 1 (TO 1)

7101 - 7110

Push – selects 10 percentage derate (TO 1) for takeoff thrust limit.

Takeoff thrust derate can be entered by uplink.

TO 1 default thrust derate can be modified on the AIRLINE POLICY page.

Selecting TO 1 arms CLB 1.

4 Takeoff 2 (TO 2)

7101 - 7110

Push – selects 20 percentage derate (TO 2) for takeoff thrust limit.

Takeoff thrust derate can be entered by uplink.

TO 2 default thrust derate can be modified on the AIRLINE POLICY page.

Selecting TO 2 arms CLB 2.

5 INDEX

Push – displays the INIT/REF INDEX page.

6 Thrust Reference Mode

Displays selected takeoff thrust mode.

D displays when the takeoff thrust derate uses an assumed temperature.

7101 - 7110

The suffix B is added to the line title TO when Takeoff Bump is selected.

7101 - 7110

The prefix “A-” is added to the line title TO when APU-to-Pack takeoff is selected.

7 Takeoff N1 Limit

7101 - 7110

Displays takeoff N1 calculated by the thrust management system.

7 Takeoff EPR Limit

7001 - 7008

Displays the takeoff EPR calculated by the thrust management system. Displays N1 when the engines are operated in the alternate mode.

8 Climb (CLB)

Push – selects the full rated (CLB) climb thrust limit.

Pushing a climb line select key overrides an automatic selection.

9 Climb 1 (CLB 1)

Push – selects -10% derate (CLB 1) climb thrust limit.

Climb thrust derate can be entered by uplink.

10 Climb 2 (CLB 2)

Push – selects -20% derate (CLB 2) climb thrust limit.

Climb thrust derate can be entered by uplink.

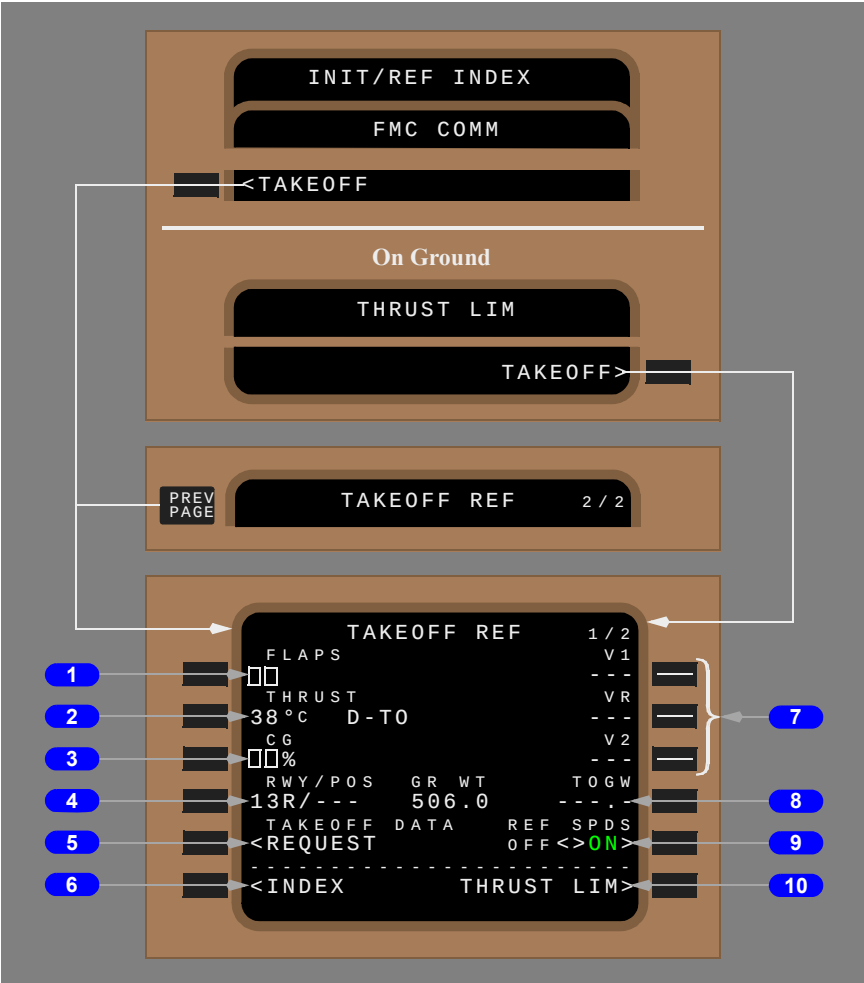
11 TAKEOFF

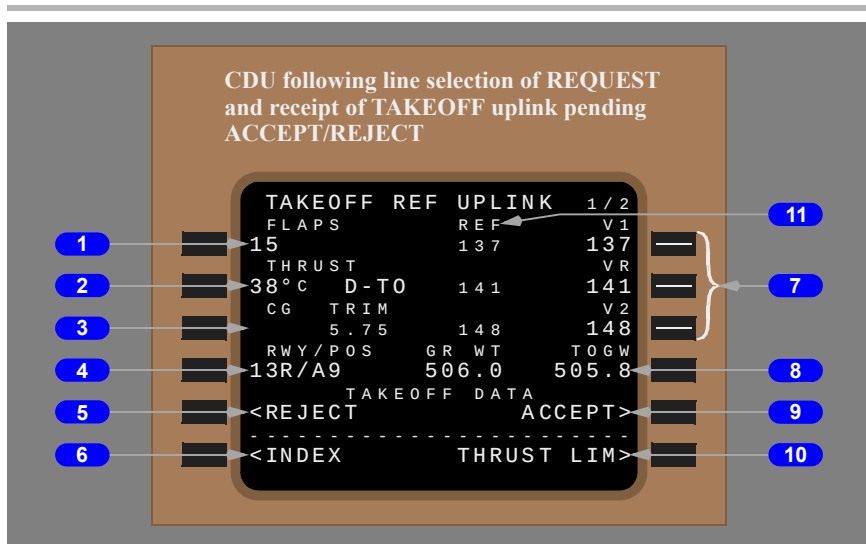
Push – displays the TAKEOFF REF page.

Takeoff Reference Page 1/2

The takeoff reference page allows the flight crew to manage takeoff performance. Takeoff flap setting and V speeds are entered and verified. Thrust limits, takeoff position, and takeoff gross weight can be verified or changed. Preflight completion status is annunciated until complete.

Takeoff reference page entries finish the normal preflight. The takeoff flap setting must be entered and V speeds should be set before completion.





1 FLAPS

Displays takeoff flap setting. Valid entries are 5, 15, or 20.

Flight crew entry or uplink.

Entry of 5 when FLAPS 5 is the climb thrust reduction point displays the scratchpad message INVALID ENTRY.

Flap position is required for takeoff V speed calculations.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 THRUST

7101 - 7110

Displays takeoff thrust selected on THRUST LIM page, or flight crew or uplink entered assumed temperature for takeoff thrust derate calculations.

Entry is only allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Dashes display with TO B selected even though assumed temperature is not allowed. This indicates “APU” entry is allowed.

Entry of “APU” from scratchpad displays “A-XXX” with “XXX” being the takeoff thrust limit.

Valid entries are 0 to 99 degrees C or 32 to 210 degrees F.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 THRUST

7001 - 7008

Displays takeoff thrust selected on THRUST LIM page, or flight crew or uplink entered assumed temperature for takeoff thrust derate calculations.

Entry is only allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Valid entries are 0 to 99 degrees C or 32 to 210 degrees F.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

3 Center of Gravity (CG) and TRIM

Valid entry is CG within the valid range.

After CG entered, the FMC:

- calculates and displays stabilizer takeoff setting to the right of the CG entry (trim display is in 0.25 unit increments)
- updates the takeoff green band displayed on stabilizer position indicators.

4 Runway/Position (RWY/POS)

Displays the takeoff runway from the active RTE page.

Flight crew may enter or uplink runway, or intersection data, when planning an intersection takeoff.

Valid position entry is a one or two numeric in the range 0-99. It must be followed by two zeros and preceded by a slash (preceding the entry with a “-” means a longer takeoff distance is available; for example, -300 is 300 feet before the runway threshold).

Valid entry of a runway intersection is an alphanumeric up to three characters, preceded by a slash (/).

Entry of a runway or intersection after takeoff speeds are selected deletes V-speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

FMC position updating is inhibited when GPS is the primary FMC navigation source. When an intersection or position shift has been selected and an FMC position update is desired, GPS must be selected OFF.

5 TAKEOFF DATA REQUEST

REQUEST

Push – transmits a data link request for takeoff data uplink.

Flight crew can enter RWY, intersection or position shift, CG, TOGW, or OAT to qualify the request.

REJECT

Push – rejects the takeoff data uplink and returns the REQUEST prompt.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 V Speeds (V1, VR, V2)

Displays dashes when:

- required information not entered
- performance calculations are inhibited
- ADIRU is not aligned

Calculated speeds display in small font.

7101 - 7110

Flight crew entry or uplink speeds replace calculated speeds. Manually entered and accepted uplink speeds less than V1MIN, VRMIN, or V2MIN; but greater than 80 knots, are allowable. "MINV1", "MINVR", or "MINV2" do not display in the header line and speeds do not display on data lines.

7001 - 7008

Flight crew entry or uplink speeds replace calculated speeds. Manually entered and accepted uplinked speeds less than V1MIN, VRMIN, or V2MIN are indicated by display of "MINV1", "MINVR", or "MINV2" in the header line and the value of V1MIN, VRMIN, or V2MIN in the data line.

Push –

- selects V1, VR, and V2 to be sent to using systems, or
- crew entered V speeds replace calculated speeds
- display changes to large font; REF and caret no longer display

If performance data changes:

- FMC replaces existing speeds with FMC calculated speeds in small font
- V speeds are removed from the PFD
- PFD speed tape message NO V SPD displays
- scratchpad message TAKEOFF SPEEDS DELETED displays

Note: After an engine is started, the FMC recalculates the takeoff speeds. Any combination of gross weight, OAT, or pressure altitude resulting in a takeoff speed change of two or more knots from the previously calculated speeds, causes the FMC to recalculate takeoff speeds.

8 Gross Weight (GR WT), Takeoff Gross Weight (TOGW)

GR WT displays airplane gross weight from the PERF INIT page.

TOGW – entry of airplane takeoff gross weight different from GR WT requests new takeoff data using data link.

Valid entry is any weight within the allowable airplane takeoff gross weight range. Flight crew entered value is downlinked when the REQUEST prompt is selected.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Deletion of the TOGW value returns V speeds to small font; displays REF and caret.

A takeoff uplink displays the uplinked TOGW and associated V speeds.

9 Reference Speeds (REF SPDS), ACCEPT

REF SPDS:

Enables or disables display of the FMC calculated reference (V) speeds in the center column to the left of the V speed lines.

Push toggles between ON and OFF.

ON – displays FMC calculated takeoff speeds for comparison with the V speeds in the right column.

OFF – deletes speeds from the center column.

The active state, ON or OFF, displays in large green font; the inactive state displays in small white font.

ACCEPT:

Push – accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

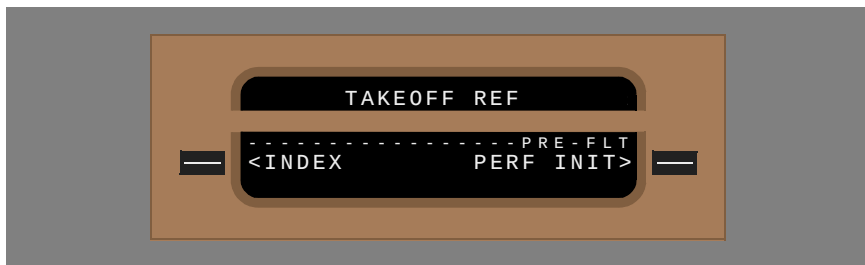
10 Thrust Limit (THRUST LIM)

Push – displays THRUST LIM page.

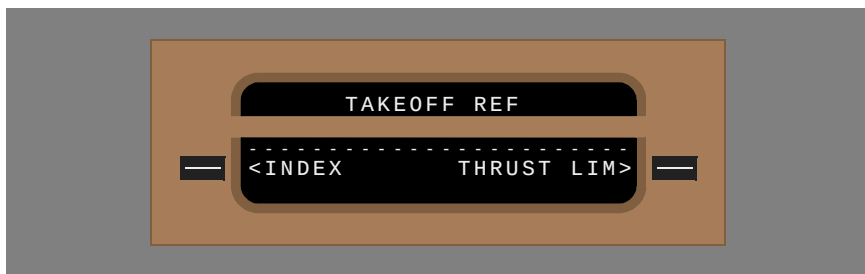
11 Reference (REF)

Displays the FMC calculated V speeds for comparison with flight crew entered or uplinked values. Display is enabled and inhibited by the REF SPDS prompt.

Preflight Status



If the required preflight entries are not complete, the words PRE-FLT display on the right side of the dashed line. Preflight pages requiring entries display below the dashed line as prompts.



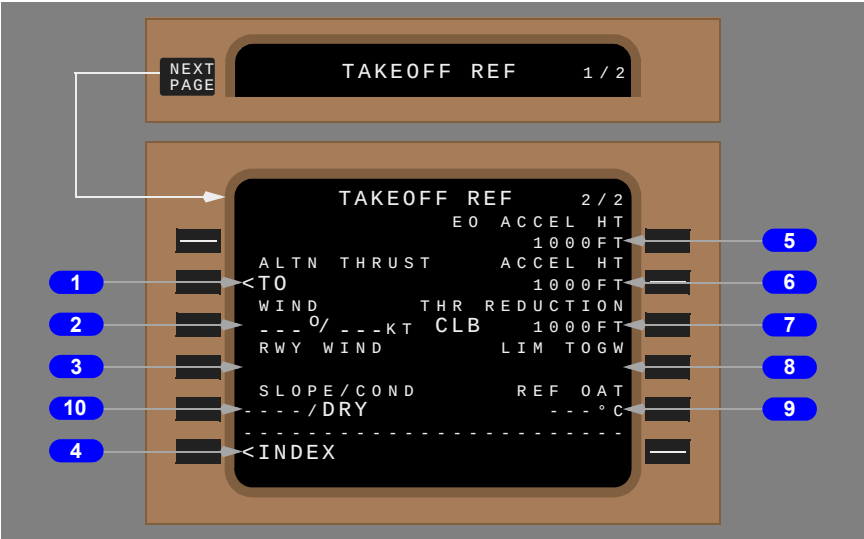
When preflight entries are complete, a dashed line displays below the takeoff reference page data. The THRUST LIM prompt displays below the dashed line.

Takeoff Reference Page 2/2

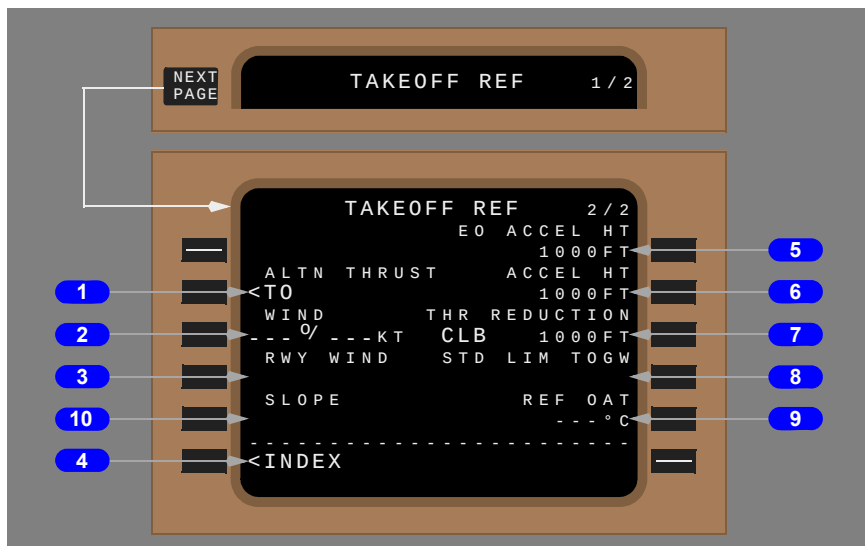
The page title displays TAKEOFF REF UPLINK when a takeoff uplink is pending; otherwise, the title is TAKEOFF REF.

Note: Acceleration/thrust reduction heights are added to runway elevation causing acceleration/thrust reduction at the desired MSL altitude. For example, for a runway elevation of 980 feet, an entry of 2020 acceleration height causes acceleration at 3,000 feet MSL.

7101 - 7110



7001 - 7008



1 Alternate Thrust (ALTN THRUST)

Display is active if a TAKEOFF REF uplink has been accepted which includes alternate thrust data.

Line title may display:

- ALTN THRUST
- ALTN THRUST/FLAPS.

Data may display temperature and:

- TO, TO/FLAPS
- TO 1, TO 1/FLAPS
- TO 2, TO 2/FLAPS
- yy° TO x (assumed temperature), yy° TO x/FLAPS.

Push (with data on the line) – selects alternate thrust or alternate thrust/flaps for takeoff resulting in:

- recomputation of V speeds
- the line title displays STD THRUST or STD THRUST/FLAPS
- the ACCEPT/REJECT prompt displays on the TAKEOFF REF page 1/2
- new takeoff data displays
- the EICAS •FMC message displays
- the scratchpad message TAKEOFF DATA LOADED displays.

2 WIND

Displays uplinked surface wind direction and speed.

Wind direction and speed can be entered by the flight crew or uplink.

Valid directions are from 0 to 360 degrees. (0 and 360 are shown as 000).

Valid speeds are from 0 to 250 knots.

Subsequent entries may be wind direction or speed only.

Entry of wind direction/speed results in calculation and display of RWY WIND.

Entry or uplink of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

3 Runway Wind (RWY WIND)

Displays the calculated headwind/tailwind and crosswind components for the takeoff runway and surface wind.

Calculated values display in small font.

Speed displays in knots and:

- H for headwind
- T for tailwind
- R for right crosswind
- L for left crosswind.

Flight crew entry is limited to headwind/tailwind entry.

Valid flight crew entries are a two digit number followed by H or T.

Flight crew speed entry without a letter defaults to a headwind component.

A flight crew entry clears the WIND line.

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Engine Out Acceleration Height (EO ACCEL HT)

Displays acceleration height for flap retraction with an engine out.

Default value is from the airline policy file.

Valid entry is a height from 400 to 9999 feet.

6 Acceleration Height (ACCEL HT)

Displays acceleration height for flap retraction.

Default value is from the airline policy file.

Entry is optional. Valid entry is a height from 400 to 9999 feet.

7 Climb Thrust and Thrust Reduction (THR REDUCTION) Altitude

Displays armed climb thrust rating and the altitude for reduction from takeoff thrust to climb thrust. Default THR REDUCTION value is from the AIRLINE POLICY file.

Entry

- is optional for preflight completion
- is a height from 400 to 9999 feet, or
- 1 for flaps 1 and 5 for flaps 5 (entry of 5 when FLAPS 5 is specified as the takeoff flap setting displays the scratchpad message INVALID ENTRY).

8 Limit Takeoff Gross Weight (LIM TOGW)

Displays takeoff gross weight limit for the uplinked data. Manual entry not allowed.

Prefix ALT or STD is added to line title when alternate or standard takeoff data is pending.

9 Reference Outside Air Temperature (REF OAT)

Enter an outside air temperature:

- the FMC recalculates takeoff V speeds
- after takeoff speeds are selected, deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED
- for a downlink transmission.

Flight crew entered or uplinked data entry.

Valid entries are -54 to 99 degrees C, or -65 to 199 degrees F

10 Slope/Condition (SLOPE/COND)

7101 - 7110

Flight crew entered or uplinked data entry.

Valid runway slope is U for up or D for down followed by 0.0 through 2.0 in percent gradient.

Valid runway condition is “D” or “DRY” for dry or “W” or “WET” for wet.

Entry of “S” or “WET SK-R” displays “WET SK-R” and FMC computes V1 for a skid resistant runway.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

10 SLOPE

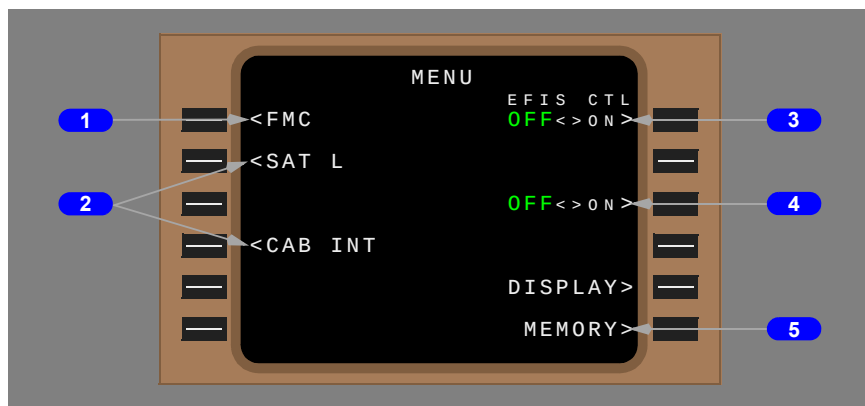
7001 - 7008

Flight crew entered or uplinked data entry.

Valid runway slope is U for up or D for down followed by 0.0 through 2.0 in percent gradient.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Menu Page



1 FMC

Push – Connects FMC to CDU.

2 Satellite Communication/Cabin Interphone (SAT/CAB INT)

See Chapter 5, Communications.

3 EFIS Control (EFIS CTL)

See Chapter 10, Flight Instruments, Displays.

4 Display Select Panel Control (DSP CTL)

See Chapter 10, Flight Instruments, Displays

5 Memory

Accessible only on the ground. For maintenance use only.

Flight Management, Navigation

FMC Takeoff and Climb

Chapter 11

Section 41

Introduction

The FMC takeoff phase starts with the selection of takeoff/go-around (TO/GA). Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase changes to the climb phase when the FMC commands climb thrust. The climb phase continues to the top of climb point, where the cruise phase starts.

During takeoff and climb, the specific page listed below is used to:

- TAKEOFF REF page – make last minute changes to the departure runway
- DEPARTURES page – make last minute changes to the SID
- CLIMB page – modify climb parameters and monitor airplane climb performance
- RTE X LEGS page – modify the route and monitor route progress
- PROGRESS page – monitor the overall progress of the flight
- THRUST LIM page – select alternate climb thrust limits
- DEP/ARR INDEX page – select an approach during a turn-back.

Takeoff

When changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modified data are entered the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V2+15 and V2+25 knots, based on rate of rotation.

Usually, VNAV is armed before takeoff. When armed before takeoff, LNAV activates at 50 feet radio altitude and commands roll to fly the active route leg. VNAV activates at 400 feet above runway elevation and commands pitch to fly the climb profile.

Climb

At acceleration height or the first movement of the flap handle during flap retraction, VNAV commands acceleration to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted, VNAV commands the speed displayed on the SPD TRANS line.

At the climb thrust reduction point, the FMC commands a reduction to the armed climb thrust. Passing the transition altitude displayed on the SPD TRANS line, VNAV commands an acceleration to economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than VREF+80 or the transition speed.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level-off for a crossing altitude restriction is accomplished at the commanded speed. The commanded speed is magenta.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALT. A different speed profile that gives a steeper climb angle must be manually selected.

Altitude Intervention

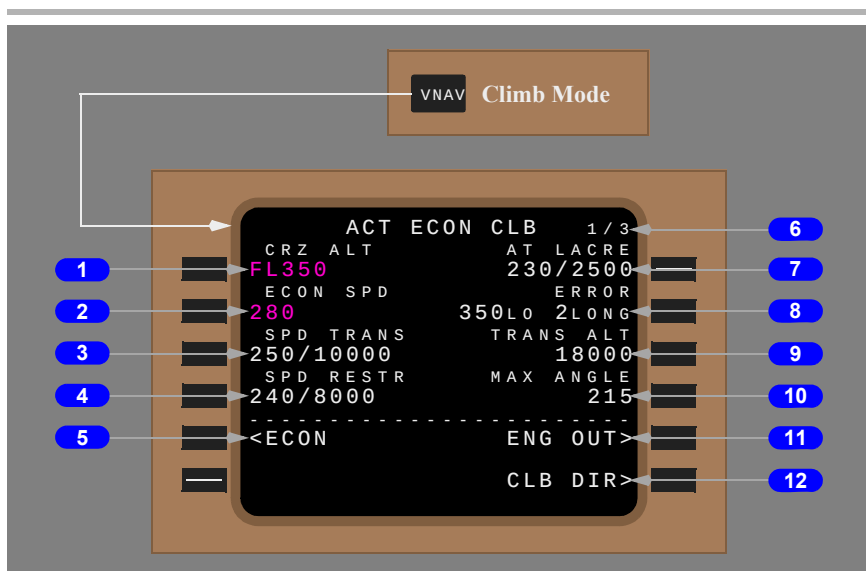
If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. VNAV SPD changes to VNAV ALT. The climb can be continued by setting the altitude window to a higher altitude and pushing the altitude selector. If the altitude window is set to an altitude above other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. If cruise altitude is set in the altitude window, all waypoint altitude climb constraints to the T/C can be deleted by selection of the CLB DIR> prompt on the CLB page.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages, and from the airline policy file.

The climb page is the first of the three pages selected with the VNAV function key. When the FMC changes to the cruise mode, the climb page data is blanked.

FMC climb can be economy, fixed speed, or engine out.



1 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on transition altitude.

The altitude can be changed by two methods:

- A new cruise altitude can be manually entered from the CDU at any time. The modified cruise altitude displays in shaded white until executed.
- A new cruise altitude can be entered from the MCP, if intermediate altitude constraints do not exist between the airplane altitude and the MCP altitude. Set cruise altitude in the altitude window and push the altitude selector. The cruise altitude changes without modification or execution.

2 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

ECON SPD:

- speed based on cost index in CAS or Mach
- used by FMC at altitudes above all waypoint speed constraints, speed restrictions, and speed transition altitudes.

Valid entries are CAS or Mach.

SEL SPD:

- displays when intermediate level off required below an existing speed constraint
- displays when flight crew enters speed

Valid entries are CAS or Mach.

The FMC commanded speed is magenta. Below CAS/Mach transition altitude, CAS is magenta and Mach is white. Above CAS/Mach transition altitude, Mach is magenta and CAS is white.

3 Speed Transition (SPD TRANS)

The speed transition line displays the transition speed/altitude from one of these sources:

- the navigation database value for the origin airport
- the greater of the transition speed associated with the origin airport or VREF+80 knots (example 250/10000)

Magenta when it is FMC command speed.

Not displayed above transition.

Can be deleted.

4 Speed Restriction (SPD RESTR)

Speed restrictions for an altitude less than the cruise altitude are manually entered on this line.

Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

An entry creates a modification. Entry is shaded white until executed; magenta when it is FMC command speed.

5 Economy (ECON)

Push – changes climb speed to ECON. Must be executed.

Prompt displays when the climb speed is not ECON.

6 Page Title

The page title displays the type of climb:

- ECON – speed based on a cost index
- LIM SPD – speed based on airplane configuration limiting speed
- MCP SPD – MCP speed intervention selected
- EO – engine out mode selected
- XXXKT – fixed CAS climb speed profile
- M.XXX – fixed Mach climb speed profile
- ACT – displays prefix when climb phase active.

Fixed climb speeds are for:

- takeoff/climb acceleration segment constraints
- waypoint speed constraints
- a speed constraint associated with an altitude
- a speed transition
- a flight crew selected speed (SEL SPD).

7 Waypoint Constraint (AT XXXXX)

Displays airspeed and/or altitude constraint at waypoint XXXXX.

Can also display HOLD AT XXXXX followed by a speed/altitude constraint.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

Magenta when it is FMC command speed or altitude.

8 ERROR at Waypoint

Displays altitude discrepancy and distance past waypoint where altitude will be reached.

Blank if no error exists.

9 Transition Altitude (TRANS ALT)

Transition altitude for origin airport contained in navigation database. FMC uses 18,000 feet if transition altitude is not available.

Manually change transition altitude here or on DESCENT FORECAST page.

Valid entries are XXX, XXXX, XXXXX, or FLXXX.

CDU altitude data change from altitudes to flight levels above the transition altitude.

10 Maximum Angle (MAX ANGLE)

Displays maximum angle of climb speed.

Entry not allowed.

11 Engine Out (ENG OUT)

Push (below speed transition or restriction altitude) –

- displays MOD EO CLB page
- deletes climb speed transition or restriction data

Push (below engine-out maximum altitude) – displays MOD EO CLB page.

Push (above engine-out maximum altitude) –

- displays MOD EO D/D page
- cruise altitude (1L) lowered to engine-out maximum altitude if that altitude is less than the active cruise altitude

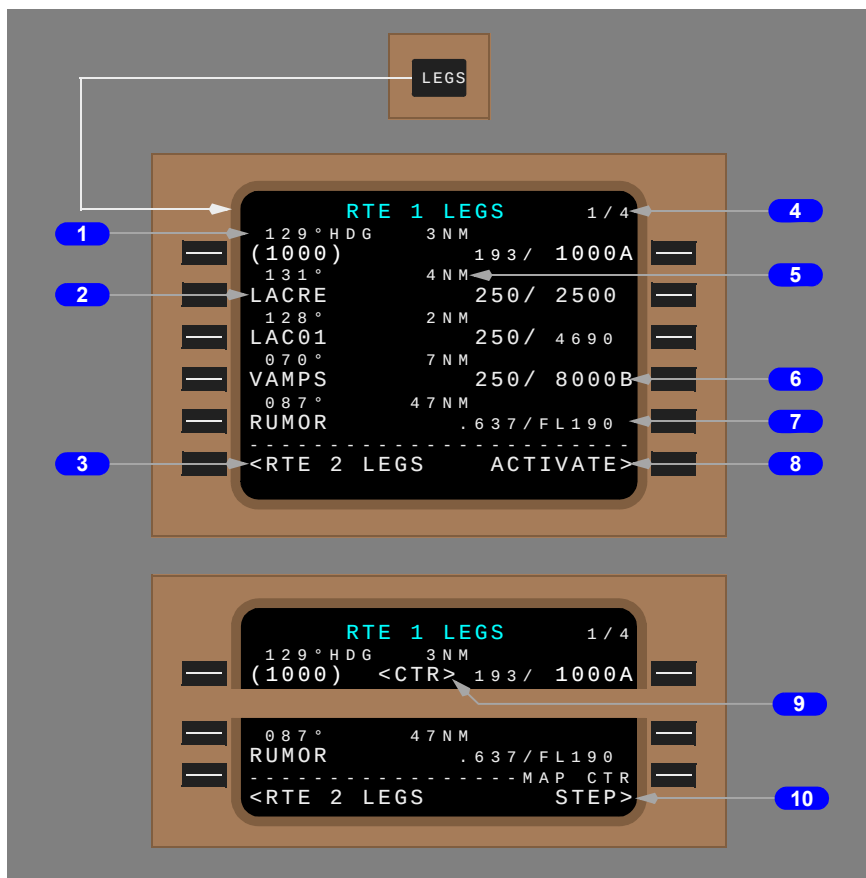
Shaded white until the modification executed. Upon execution, thrust reference limit becomes CON in all cases above.

12 Climb Direct (CLB DIR)

Displays when climb altitude constraint exists between current altitude and FMC cruise altitude.

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude or FMC cruise altitude, whichever is lower. FMC cruise altitude is not affected.

RTE X LEGS Page



1 Leg Direction

Leg segment data in line title:

- courses – magnetic (xxx°) or true (xxx° T)
- arcs – arc radius in miles, ARC, turn direction (example: 12 ARC L)
- heading leg segments – xxx° HDG
- track leg segments – xxx° TRK
- special procedural instructions from database - HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry).

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

2 Waypoint Identifier

Active leg is always the first line of the first active RTE X LEGS page.

Active waypoint is on active leg and is magenta. Modified waypoints are shaded white until executed.

All route waypoints display in flight sequence. Waypoints on an airway are included on the route legs page.

Waypoints can be modified. Examples:

- add waypoints
- delete waypoints
- change waypoint sequence
- connect route discontinuities.

Displays the waypoint by name or condition.

Boxes display for route discontinuities.

Dashes display after the end of the route.

3 Route 2 Legs (RTE 2 LEGS)

Push –

- displays the RTE 2 LEGS
- when RTE 2 LEGS page displayed, prompt changes to RTE 1 LEGS.

4 Page Title

Title format displays route status:

- RTE X LEGS (cyan) – inactive route
- ACT RTE X LEGS (white) – active route
- MOD (shaded white) RTE X LEGS (white) – modified active route.

5 Distance to Waypoint

Distance (decreasing) from airplane to active waypoint or from waypoint to waypoint. Blank for some leg types (e.g. HDG or VECTORS).

6 Waypoint Speed/Altitude Constraints

Waypoint speed or altitude constraints display in large font.

Manual entry allowed in climb or descent phase. Entered by FMC when constraints are part of a procedure.

Magenta when it is an FMC commanded speed/altitude. Airspeed constraint may be magenta in one line with magenta altitude in another line.

Speed constraint is assumed to be at or below the displayed speed.

Valid entries are:

- speed entry can be airspeed or Mach
- altitude entry can be thousands of feet or flight level (19000, FL190)
- XXX/XXXXXX – airspeed/altitude entered simultaneously
- XXX, XXXX, XXXXX or /XXX, /XXXX, /XXXXX– altitude only.
- enter FL 190 or 19,000 feet as 190 or 19000. Enter FL090 or 9,000 feet as 090 or 9000. Enter 900 feet as 009 or 0900. Enter 90 feet as 0090.

Altitude constraint suffixes:

- blank – cross at altitude
- A – cross at or above altitude
- B – cross at or below altitude
- both – altitude block. If constraint is to cross between two altitudes when climbing, enter lower altitude followed by “A”; then, enter higher altitude followed by “B”. Example: 220A240B. Reverse the order for descent.
- S – planned step climb (refer to Flight Management, Navigation, Cruise).

7 Waypoint Speed/Altitude Predictions

Waypoint speed and altitude predictions display in small font.

Dashes display in predicted descent region prior to descent path calculation.

Descent path calculation requires an altitude constraint below cruise altitude.

Manual entry allowed in climb or descent phase.

8 ACTIVATE, Route (RTE) DATA

RTE DATA displays when active or modified LEGS exist (not in PLAN mode).

ACTIVATE displays on an inactive LEGS page (not in PLAN mode).

Push –

- ACTIVATE – prepares inactive flight plan for activation; illuminates the EXEC key, and displays LEGS page 1/X with first waypoint of the route at the top. Other pages may be accessed and modifications performed before execution.
- RTE DATA – displays route data page

MAP CTR STEP prompt displays when the EFIS control panel ND mode selector is in PLAN position.

9 Center (<CTR>)

Displays when PLAN mode selected.

Displays adjacent to the waypoint around which ND PLAN mode is centered.

10 MAP Center (CTR) STEP

Replaces ACTIVATE or RTE DATA when PLAN mode selected.

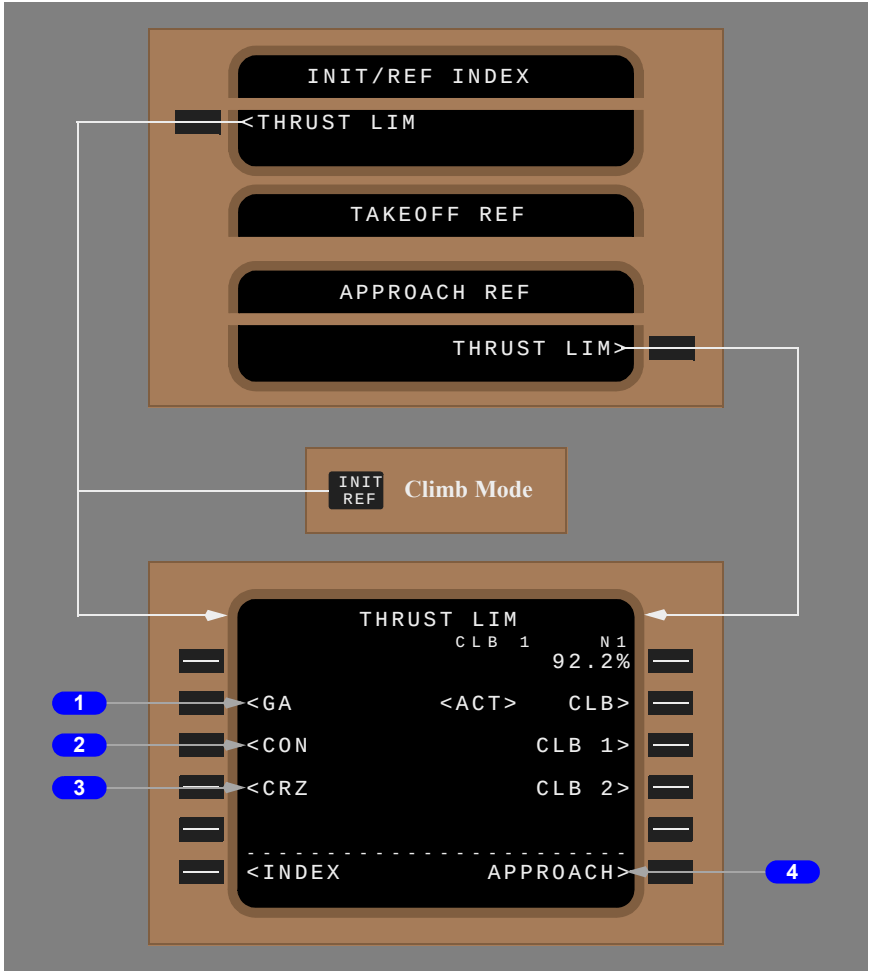
Push - steps <CTR> to next waypoint. ND PLAN mode recenters.

Thrust Limit Page

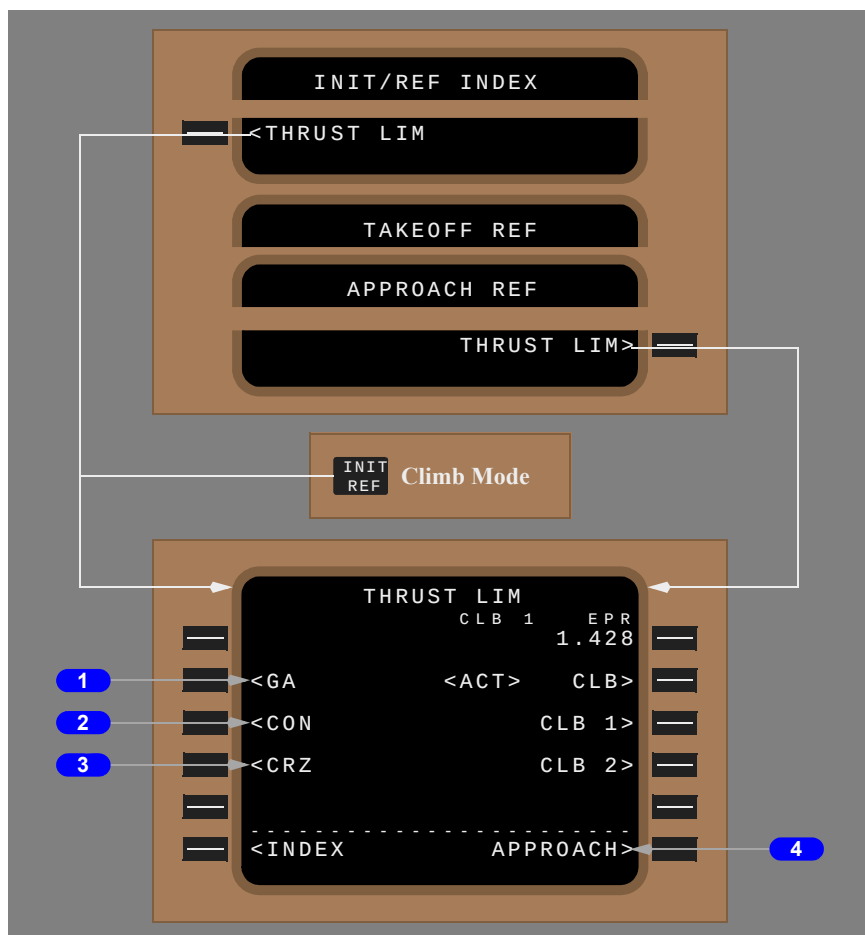
Thrust limits are selected on the thrust limit page. In flight, this display replaces the takeoff thrust limits with applicable thrust limits for climb. The selected limits display here and on the EICAS Display.

Fixed thrust derates can be selected for climb. Go-around, continuous and cruise thrust limits are available also.

7101 - 7110



7001 - 7008



1 Go-Around (GA)

Push – selects go-around thrust limit.

2 Continuous (CON)

Push – selects maximum continuous thrust limit.

3 Cruise (CRZ)

Push – selects cruise thrust limit.

4 APPROACH

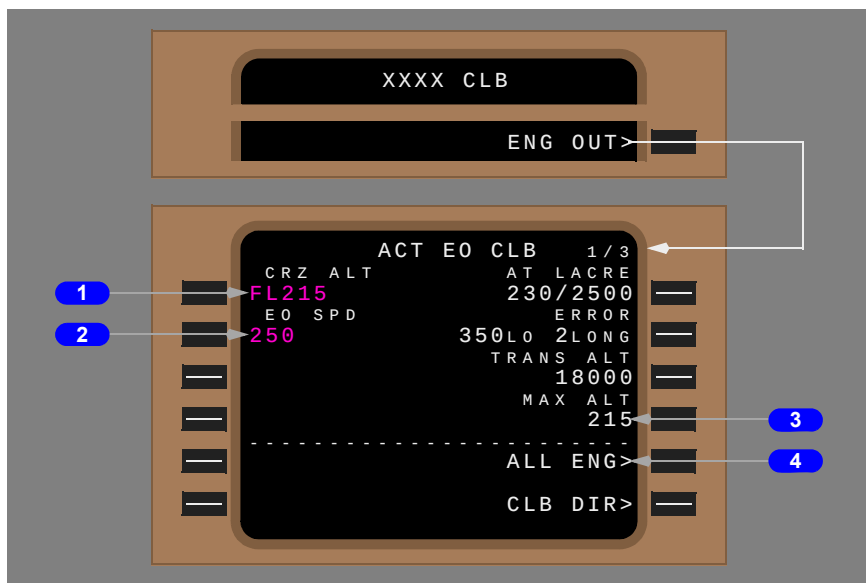
Push – displays APPROACH REF page.

Engine Out Climb

Engine out (EO) VNAV climb guidance is available on the EO CLB page. EO data with both engines operating can be displayed by selecting the ENG OUT prompt on the CLB page, without executing. Following an engine failure and selection of the ENG OUT prompt, execution displays the EO climb page.

EO CLB Page

The modified page displays engine out performance limitations. Manual entries are allowed. After execution, VNAV gives EO guidance in the climb and reference thrust limit changes to CON.



1 Page Title

Page title displays active (ACT) or modified (MOD) climb. Usually, the title contains ECON for economy climb.

Page titles include:

- ACT EO CLB - engine out selected with minimum drag climb speed
- ACT EO MCP CLB - MCP speed intervention selected
- ACT EO XXXKT CLB - fixed CAS climb speed selected
- ACT EO M.XXX CLB - fixed Mach climb speed selected

| 2 Cruise Altitude (CRZ ALT)

Displays cruise altitude if less than MAX ALT.

Displays EO MAX ALT if less than cruise altitude.

Manual entry is allowed.

| 3 Engine Out Speed (EO SPD)

Displays engine out climb speed.

Valid entry is xxx for CAS.

Valid entry is o.xxx for Mach. Trailing zeros can be omitted.

A manual entry may cause MAX ALT to change.

| 4 Maximum Altitude (MAX ALT)

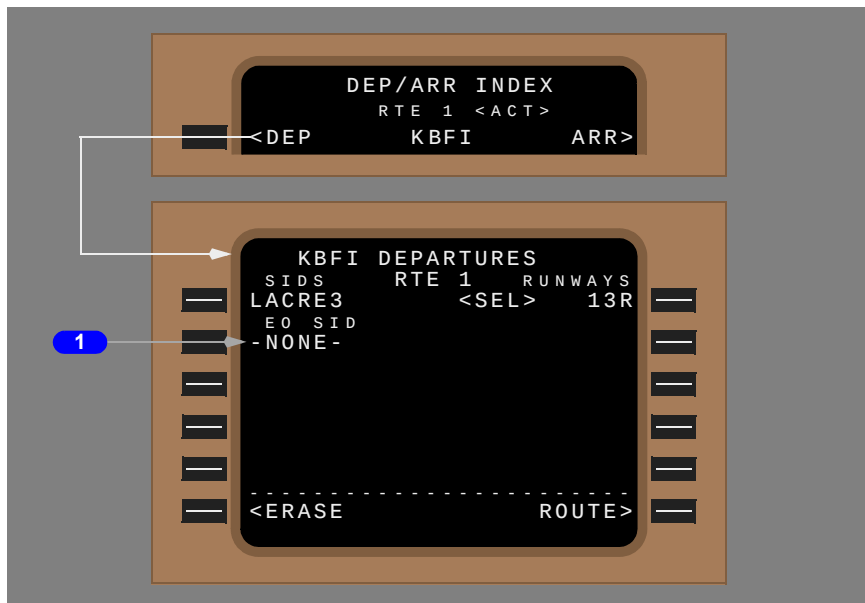
Displays lower of maximum altitude at engine out climb speed or cruise speed.

Entry not allowed.

| 5 ALL ENG

Push – modifies page to display all engine (ALL ENG) performance data.

Engine Out Departure



1 Engine Out Standard Instrument Departure (EO SID)

Engine out SIDs can be created by the airline for specific runways.

The FMC puts the EO SID into the route as a modification if:

- an engine failure is sensed
- flaps extended
- and the navigation database has an EO SID for the departure runway.

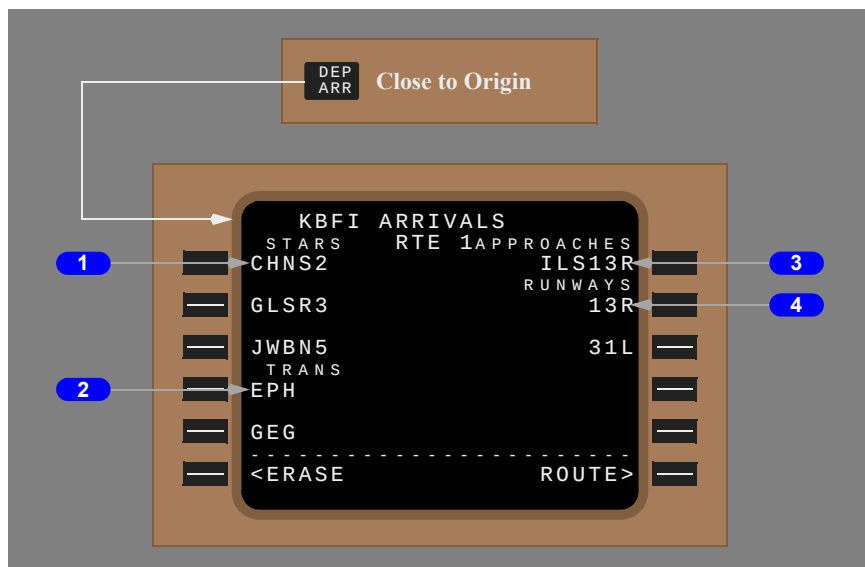
The modification can be executed or erased.

Air Turnback

Arrivals Page

During a turn-back situation, the flight crew requires quick access to the arrivals data for the origin airport. The arrivals page allows access without changing the destination on the route page.

During climb, less than 400 miles from the origin, and while nearer to the origin than the destination, push the DEP ARR function key to show the ARRIVALS page for the origin airport.



1 STARS

Displays STARS for origin airport.

2 Transitions (TRANS)

Displays transitions for origin airport.

3 APPROACHES

Displays approaches for origin airport.

4 RUNWAYS

Displays runways for origin airport.

Flight Management, Navigation

FMC Cruise

Chapter 11

Section 42

Introduction

The cruise phase starts at the top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- CRZ
- PROGRESS.

The RTE LEGS pages are used to modify the route. The CRZ pages display VNAV related data. The PROGRESS pages display flight progress data. During cruise, the specific page listed below is used to:

- POS REF page – verify the FMC position
- RTE DATA page – display progress data for each waypoint on the RTE LEGS page
- WINDS page – enter forecast wind and temperature
- REF NAV DATA page – display data about waypoints, nav aids, airports, or runways, and can be used to inhibit nav aids
- RTE X page – use to select a route offset
- FIX INFO page – display data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page – shows a list of duplicate waypoints from the navigation database. The flight crew selects the correct waypoint from the list
- POS REPORT page – display data for a position report.

The CLB page changes to CRZ at the top of climb. The CRZ CLB and CRZ DES pages change to CRZ at the new cruise altitude. The CRZ page changes to DES at top of descent.

LNAV Modifications

This section describes typical techniques to modify the route. The modifications include:

- add and delete waypoints
- remove discontinuities
- change waypoint's sequence
- intercept a course.

RTE LEGS Page Modifications

When modifications are made to a RTE LEGS page, several prompt or identifying features help the flight crew make the modifications, such as:

- ERASE
- INTC CRS TO
- INTC CRS FROM.

Modified entries display in shaded white.

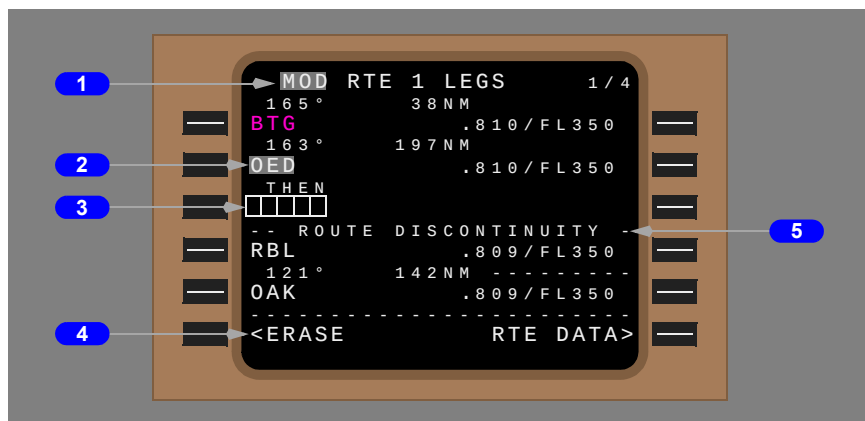
Add Waypoints

Waypoints can be added to the route at any point. Added waypoints are followed by route discontinuities.

First, enter the waypoint name in the scratchpad.

Second, locate the desired line in the flight plan and push the adjacent line select key. The scratchpad waypoint name is put into the selected line. The entered waypoint is connected to the waypoint above it via a direct route. A route discontinuity follows the waypoint.

For example, OED is typed into the scratchpad. Push line select key 2L to put OED into line 2. The FMC assumes BTG direct OED. RBL and the rest of the flight plan follow the route discontinuity.



1 Page Title

MOD (shaded white) – replaces ACT when modification in progress.

ACT (white) – replaces MOD when ERASE selected or execute key pushed.

2 Modified Waypoint

Waypoint name is shaded white until executed.

OED waypoint entered into the route after BTG. Modification creates a route discontinuity because OED was not in active route. The FMC now requires routing beyond OED.

3 Discontinuity Waypoint

Discontinuity is removed when applicable waypoint is entered in boxes.

4 ERASE

Push – removes all modifications and shows active data.

Displays when the FMC contains modified data.

Removed when selected or modifications executed.

5 ROUTE DISCONTINUITY

Line title separates route segments when there is a discontinuity.

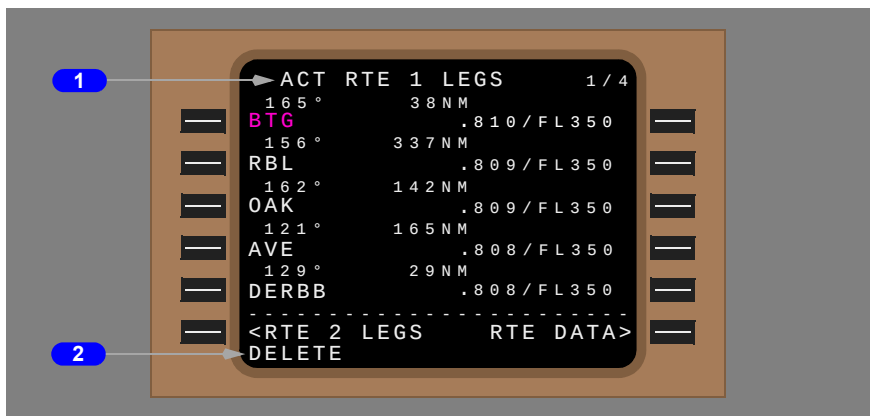
Note: Performance predictions to destination on the PROGRESS page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

Delete Waypoints

Use the RTE LEGS page to remove waypoints from the route. The active waypoint can not be deleted. Two methods to remove a waypoint are:

- delete the waypoint with the DELETE function key
- change the waypoint's sequence.

The data in the route before and after the deleted waypoint does not change. A discontinuity is put in the route when the DELETE function key is used to remove a waypoint.





1 Active Route

The active route shows RBL followed by OAK and AVE.

2 DELETE Entry

Pushing the DEL function key arms the delete function and selects DELETE to the scratchpad.

3 Route Discontinuity

With DELETE in the scratchpad, pushing the line select key for RBL deletes the waypoint. Boxes replace RBL and a route discontinuity displays.

Change Waypoint Sequence

Waypoints moved from one position in the flight plan to another do not cause route discontinuities.

The waypoint may be typed in the scratchpad or copied from the flight plan. To copy a waypoint from the flight plan, find the applicable waypoint on one of the RTE LEGS pages. Push the line select key adjacent to the waypoint.

The example below shows the flight plan being modified to fly from BTG direct OAK. Push the line select key adjacent to OAK to put OAK in the scratchpad. Push the line select key adjacent to RBL. RBL is removed from the flight plan and the routing is direct from BTG to OAK to AVE. The modification does not cause a route discontinuity. Several waypoints can be removed from the flight plan at a time with this method.



1 Active Route

The active route shows RBL followed by OAK and AVE. The clearance is to fly from BTG direct OAK. The OAK waypoint is selected to the scratchpad.

2 Change OAK's Sequence

OAK is selected to the waypoint after BTG. RBL is removed with no discontinuity.

Remove Discontinuities

A discontinuity exists when two waypoints are not connected by a route segment. Connect a route segment after the discontinuity to the route segment before the discontinuity to remove the discontinuity.

Copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity, just as when adding a waypoint.



1 Route Discontinuity

The active route has a discontinuity after BTG. The example shows how to fly direct from BTG to OAK. Copy OAK to the scratchpad. Any subsequent waypoint in the route can be selected to the scratchpad to remove the discontinuity.

2 Continuous Route

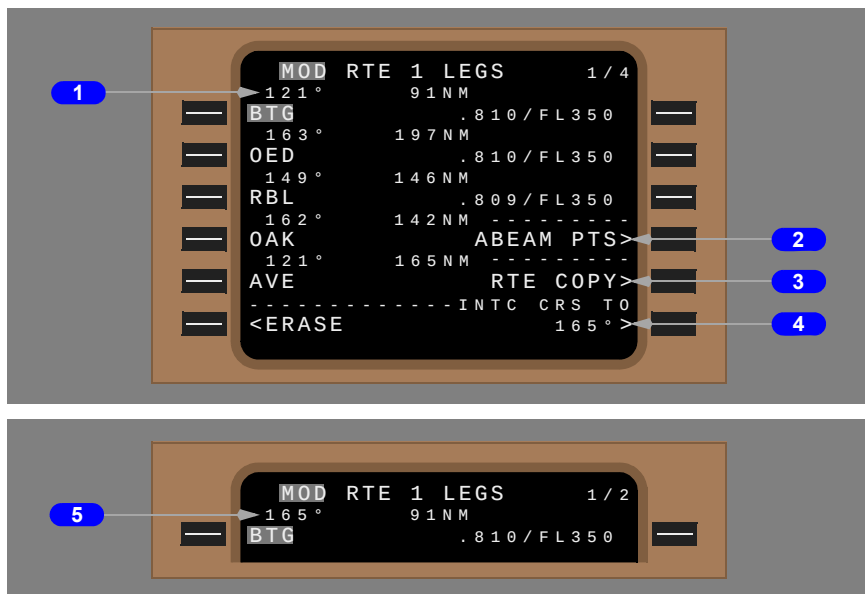
Select OAK to the boxes to remove the discontinuity.
Entering a waypoint in the boxes which does not already exist on the route moves the discontinuity one waypoint further down the route.

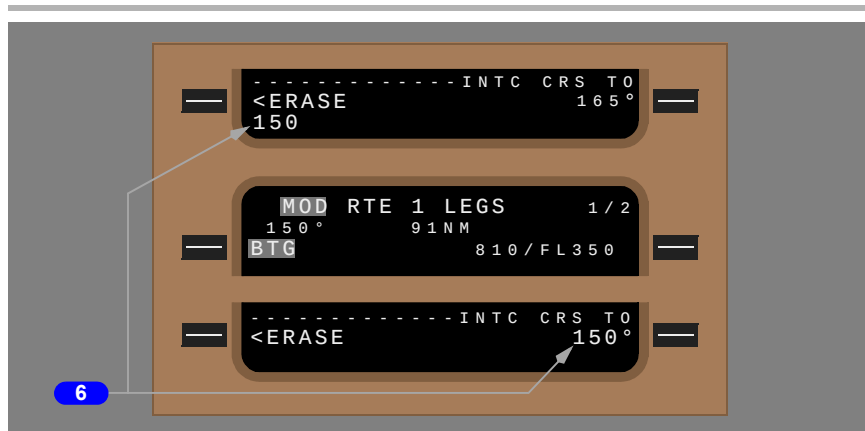
Direct To And Intercept Course To

If the airplane passes the last active route waypoint (or offset) or the last waypoint prior to a route discontinuity, LNAV maintains the current heading and a scratchpad message displays. If LNAV is not active, activation can be accomplished in the following three ways:

- When the airplane is within 2.5 miles of the active leg and on an intercept heading to the active leg, pushing the LNAV switch activates LNAV. The airplane turns to intercept the active leg. If the intercept angle is large, the airplane may overshoot the active leg.
- When more than 2.5 miles from the active leg, pushing the LNAV switch when the airplane is on an intercept heading to the active leg arms LNAV. Activation occurs as necessary to intercept the active leg with no overshoot. The intercept heading must intersect the active leg inbound before the active waypoint.
- Fly direct to a waypoint or intercept a course to a waypoint. Enter a waypoint in the RTE LEGS page active waypoint line to fly direct. Use the INTC CRS TO prompt in line 6R to create an intercept course to the waypoint. Pushing the LNAV switch arms or activates LNAV, depending on the distance to the active leg.

The example below depicts the airplane being off course to the right, followed by a modification to fly direct to BTG.





1 Leg Direction

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2 Abeam Points (ABEAM PTS)

Push –

- creates place bearing distance waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a database airport, navaid, NDB, or waypoint
- creates latitude/longitude waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a latitude/longitude waypoint
- creates a new place bearing distance waypoint based on the original “place” on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a place bearing distance waypoint
- creates a new latitude/longitude reporting point on the Direct To leg based on the entered latitude or longitude reporting point.
- line title displays ABEAM PTS and line data displays SELECTED
- altitude/speed constraints for bypassed waypoints are removed

ABEAM PTS prompt displays whenever the active waypoint name is modified, usually for direct-to routing.

Abeam waypoints created from designated position reporting waypoints become positions reporting waypoints.

3 Route Copy (RTE COPY)

Push –

- copies the active route into the inactive route
- erases previous inactive route
- line title displays RTE COPY and line data displays COMPLETE
- subsequent route modifications remove RTE COPY prompt.

4 Intercept Course TO (INTC CRS TO) – Select

Displays whenever the active waypoint name is modified.

Displays boxes if entered waypoint not in the active route.

Displays current route course and prompt caret if entered waypoint in the active route.

When boxes displayed, valid entry is intercept course from 000° through 360°. May be changed until executed. Entered or selected value displays in large font.

Push –

- when current route course (165°) displayed, selects it as intercept course to active waypoint
- displays entry or current route course as course to active waypoint
- removes ABEAM PTS and RTE COPY prompts.

5 Intercept Course

After pushing INTC CRS TO and prior to execution, displays direct-to inbound course at the waypoint; changed by entry in intercept course to (INTC CRS TO) line or by selecting intercept course to. After execution, displays current required track to fly inbound course to the waypoint.

6 Intercept Course TO (INTC CRS TO)

To change intercept course:

- enter the inbound intercept course (150°) in the scratchpad
- select the INTC CRS TO line to change the leg direction; intercept course to BTG of 150° is entered in the INTC CRS TO line and above the active waypoint.

Intercept Course From

The steps to create an intercept course from a waypoint are like the steps for an intercept course to. The waypoint name in the scratchpad is suffixed with the outbound course.

An intercept course can be created outbound from a waypoint in the navigation data base or from present position. The waypoint does not have to be in the route. Entering a waypoint and course pair in the active waypoint line displays the INTC CRS FROM prompt. The FMC calculates a route leg with the waypoint as the origin of the entered course.

The example shows a 090° course from BTG, entered as BTG090. When this course intercept is line selected to the active waypoint line, the course (090°) displays in the leg direction and the waypoint displays as a conditional waypoint consisting of a course intercept (090°).



1 Waypoint and Outbound Course

Enter the waypoint name and outbound course in the scratchpad.

2 Present Position and Outbound Course

Enter P/P and outbound course in the scratchpad.

3 Active Outbound Course Entry

After the active waypoint line is selected, the outbound course displays. The waypoint name is not used.

For example, BTG090 is entered into the active waypoint line. The FMC calculates a new route leg with BTG as the origin on a outbound course of 090°.

4 Intercept Course From (INTC CRS FROM)

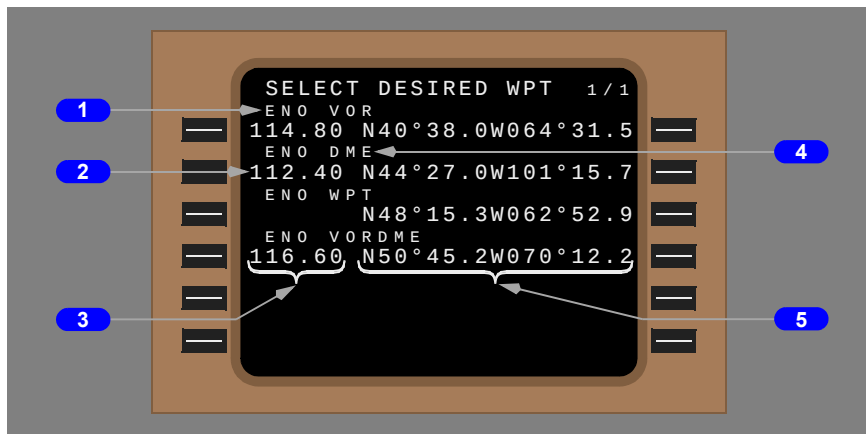
Displays outbound course from entered waypoint.

Shows the active waypoint name is modified with P/P or waypoint outbound entry.

Valid input is any course from 000° through 360°. May be changed until executed.

Select Desired Waypoint Page

The SELECT DESIRED WPT page displays after a waypoint entry when the FMC encounters more than one location for the same waypoint name. Selection of a waypoint returns the display to the previous page.



1 Identifier

Displays the identifier for the duplicate named waypoints. Select the correct waypoint by pushing the applicable left or right line select key.

2 Waypoint Lines

Display a sorted list of waypoints with identifier, navaid type, frequency, and coordinates;

- when page is accessed as a result of a flight plan modification, sort is based on proximity to the waypoint preceding the entered waypoint
- when page is accessed as a result of a DIR/INTC or REF NAV DATA entry, sort is based on proximity to current aircraft position.

Push - selects waypoint location for use; returns display to page previously in use.

Pushing any CDU function key exits page without selecting a waypoint.

3 Frequency

Displays frequency of the navaid.

Blank if the waypoint is not a navaid.

4 Type

Displays the type of navaid for each duplicate name.

Blank if the waypoint is not a navaid.

5 Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

Airway Intercept

Just as in intercept to/from, LNAV can be used to intercept an airway. An airway intercept changes the active waypoint on the RTE and LEGS pages.

Enter the airway identifier under VIA on line 1 of the RTE page. Boxes display under TO. Enter the desired airway exit waypoint in the boxes. For this open-ended airway intercept, the FMC selects the waypoint preceding the closest abeam location as the starting waypoint of the airway. This waypoint displays on line 1. The entered airway and the desired exit point display on line 2. Executing the modification makes the leg to the FMC selected airway start waypoint the active leg segment.

If the clearance heading intercepts the active leg segment, LNAV can be armed and the intercept will occur. In most airway intercept situations, the commanded heading will not intercept the active leg.

If the clearance heading does not intercept the active leg segment, use the intercept–course–to procedure to make the course inbound to the waypoint (after the crossing location) the active leg segment.

Example

The active route is direct to EPH, then direct to MWH. ATC clears the airplane to:

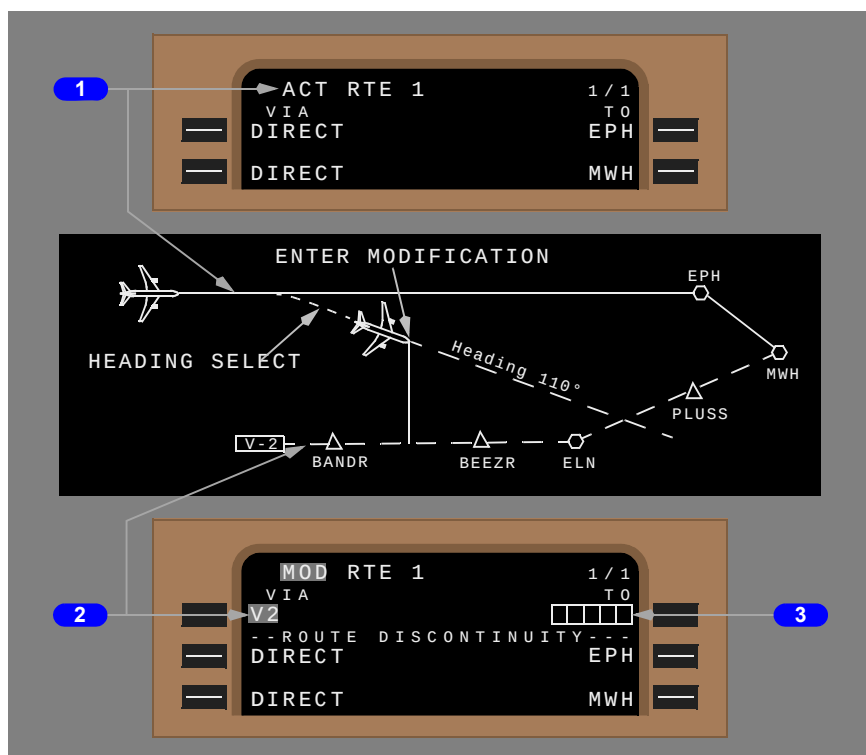
- turn right heading 110°
- intercept V2 to MWH.

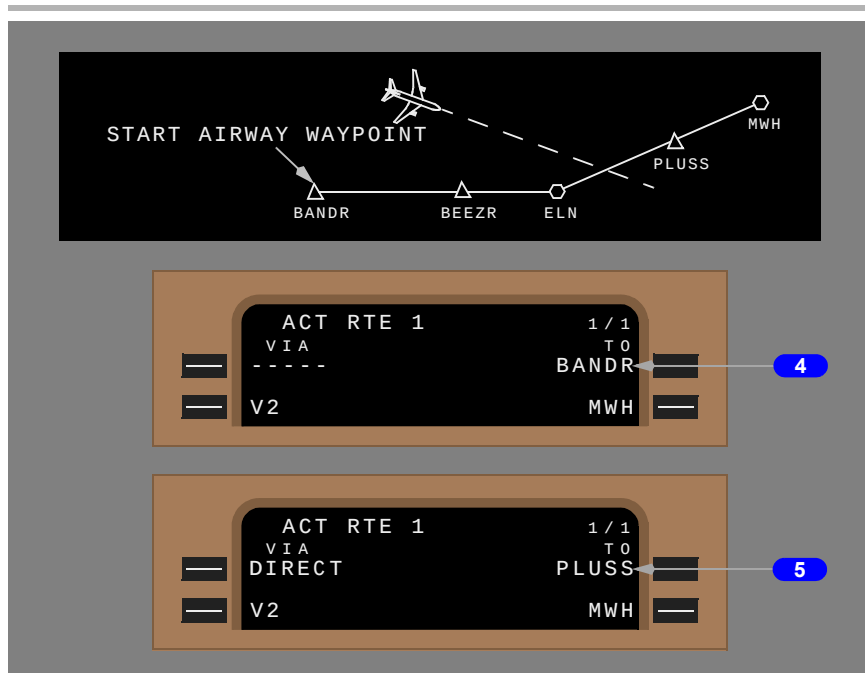
Following the V2 modification to MWH and execution, the LEGS page displays this waypoint sequence:

- BANDR
- BEEZR
- ELN
- PLUSS
- MWH.

Modify the LEGS page using a course intercept to the waypoint after the crossing location. In this case, it would be PLUSS. PLUSS becomes the active waypoint on the V2 airway. The LEGS page now displays:

- PLUSS
- MWH





1 Active RTE 1 Page

The route page before the ATC clearance.

2 Input Airway

Enter the airway in the first VIA position on the RTE page. Boxes display in the TO position. A route discontinuity follows on the next line.

3 Airway Exit

Enter desired airway exit point in the boxes.

4 Start Airway Waypoint

After entering MWH in the boxes:

- the FMC selects BANDR as the airway start waypoint
- the airway line moves down one line
- dashes display in the VIA to the start airway waypoint.

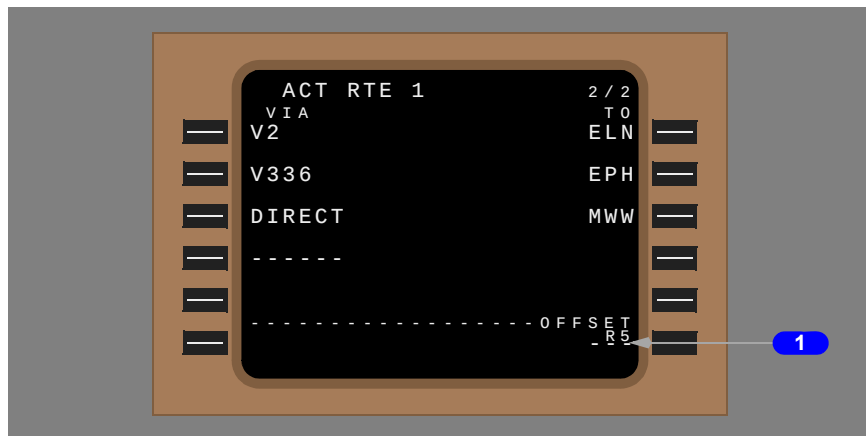
5 **New Active Waypoint**

Following modification and execution of the course intercept procedure to PLUSS, the LEGS page displays PLUSS as the active waypoint. LNAV can be armed and the airway intercept can be completed.

Route Offset

The OFFSET function is available when the airplane is in flight and not on a SID, STAR, or transition. The offset route displays as a white dashed line on the ND until executed or erased. An executed offset route displays as a dashed magenta line and extends along the route to a STAR, approach or approach transition, discontinuity, end of route, track change greater than 135 degrees, or holding pattern. The original route displays as a solid magenta line. When executing the offset modification with LNAV active, the airplane turns to capture the offset course.

When on the route offset, active route waypoints sequence normally. However, during transition to or from an offset route greater than 21 nm, the crosstrack limit is extended to 200 nm.



1 **OFFSET**

Valid entry is L (left) or R (right) XX (XX is any number from 0 to 99). When executed, the CDU OFST light illuminates.

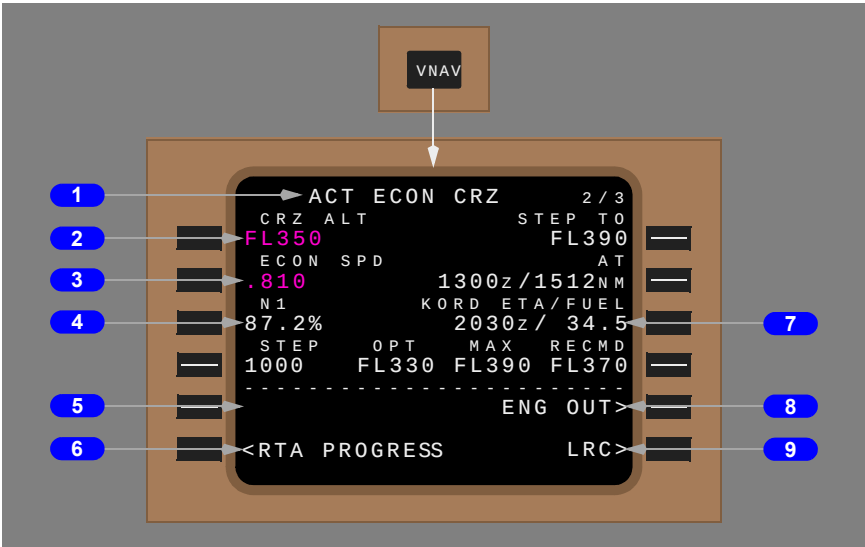
Offset removed by deleting, entering zero, or proceeding direct to a waypoint.

Cruise Page

All Engine Cruise

The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually selected or automatically selected with the selection of other VNAV modes. Cruise climbs, cruise descents, and step climbs can be accomplished from the cruise page.

When using VNAV in economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in the engine out mode, the data reflects airplane capabilities with one engine inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.



1 Page Title

The page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Selected speeds, engine out, and long range cruise modify the title.

Page titles include:

- ECON CRZ – speed based on cost index
- ECON CRZ CLB or CRZ DES – cruise climb or descent with ECON selected
- LRC CRZ – long range cruise selected
- LRC CRZ CLB or DES - cruise climb or descent with LRC selected
- RTA CRZ - RTA cruise selected
- RTA CRZ CLB or DES - cruise climb or descent with RTA selected
- MCP SPD CRZ – selected MCP cruise speed.
- EO CRZ – engine out mode with EO SPD selected
- EO D/D – engine out mode with the airplane altitude above the maximum altitude for engine out performance
- CO CRZ – engine out mode with CO speed selected
- LRC D/D - engine out mode with LRC selected
- EO LRC CRZ - displays after descending to engine out maximum altitude

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, OR FLXXX. Altitude displays in feet or flight level depending on the transition altitude.

Modified values display in shaded white.

A new entry changes the page title to CRZ CLB or CRZ DES.

Changing the MCP altitude and pushing the altitude selector enters the MCP altitude as the active cruise altitude, without creating a modification.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Displays target speed or Mach in magenta.

MOD displays in the page title in shaded white until the modification is erased or executed.

SEL SPD displays when flight crew enters speed.

LRC or company (CO SPD) display when selected, depending on the VNAV mode.

4 N1 (or EPR)

7101 - 7110

Displays N1 to maintain level flight at the target airspeed.

7001 - 7008

Displays EPR to maintain level flight at the target airspeed.

5 Economy Speed or Required Time Of Arrival RTA/Economy (ECON, RTA/ECON)

ECON

- Push – selects VNAV ECON mode.
- Displays when an RTA waypoint is not in the flight plan and VNAV is not in the economy mode.

RTA/ECON

- Push – selects RTA speed mode. Displays ECON prompt.
- Displays when an RTA waypoint is in the flight plan and VNAV is not in the RTA mode.

6 Required Time Of Arrival (RTA) PROGRESS

Push – displays RTA PROGRESS 3/4.

7 Destination ETA/FUEL, ETA/FUEL W/MOD

Displays estimated time of arrival and calculated fuel remaining at the destination.

Line Title displays "ETA/FUEL W/MOD" when a modified route is displayed.

Displays the same data for the alternate airport when a DIVERT NOW modification is selected from the ALTN page.

Calculations are based on optimum step climbs and cruise altitudes.

8 Engine Out (ENG OUT)

Push (below engine-out maximum altitude) –

- displays MOD EO LRC CRZ page
- changes target speed line title to LRC SPD
- upon execution, thrust reference limit changes to CON

Push (above engine-out maximum altitude) –

- displays MOD EO D/D page
- lowers CRZ ALT to engine-out maximum altitude
- changes target speed line title to EO SPD
- upon execution, thrust reference limit becomes CON

9 Long Range Cruise (LRC)

Push – displays long range cruise page.

Engine Out Cruise

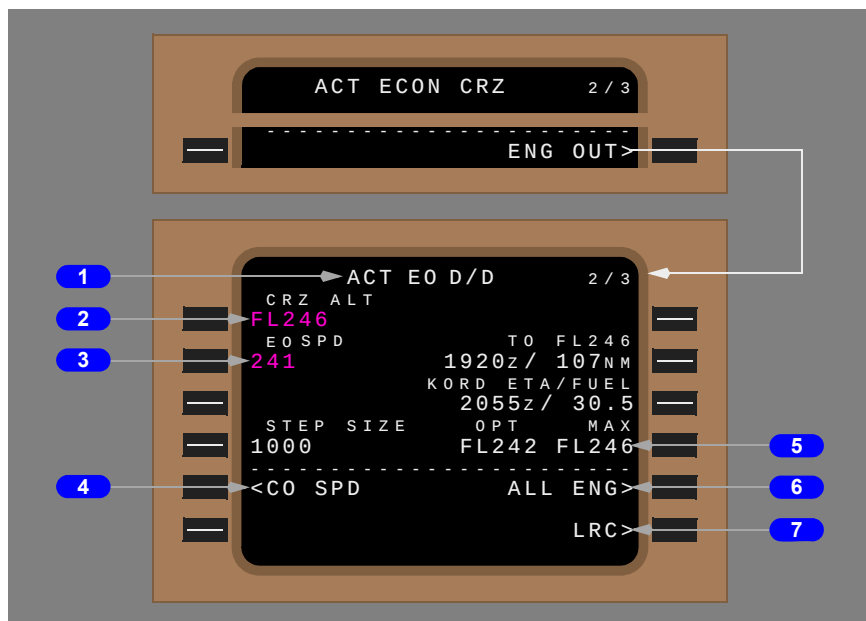
Engine out VNAV guidance displays on the EO CRZ or EO D/D page. Engine-out data is also available with both engines operating by selecting the EO OUT prompt.

The modified page displays engine-out performance limitations. Manual entries are allowed. When above the maximum engine-out cruise altitude, VNAV calculates engine-out guidance for drift down (D/D). The EO D/D page changes to the EO CRZ page when reaching the engine-out cruise altitude. LRC speed may be selected at 6R.

Subsequent engine-out cruise climb or descent is accomplished the same as two engine cruise climb or descent.

As the airplane gross weight decreases, maximum altitude increases. A step climb may be possible under these conditions.

The example is based on a cruise altitude above the maximum engine-out altitude. When ENG OUT is selected, the default target speed is EO SPD.



1 Page Title

Displays LRC D/D when LRC selected

Displays MCP SPD D/D when MCP speed selected

Displays EO LRC CRZ when reaching engine out cruise altitude

Displays EO CRZ CLB or EO CRZ DES when EO SPD selected and the airplane is below the engine-out maximum altitude.

2 Cruise Altitude (CRZ ALT)

Displays altitude from MAX ALT line when current CRZ ALT above MAX ALT.

Manual entry of an altitude above maximum engine-out altitude results in the scratchpad message, “MAX ALT FLXXX”.

Valid entries are the same as all engine cruise page.

3 Engine Out Speed (EO SPD)

Displays the target speed or Mach in magenta.

Manual entry is allowed.

Valid entries are the same as all engine cruise page.

A manually entered speed changes the line title to SEL SPD.

Selecting any speed shows engine out speed (EO SPD) as a select prompt at 6L.

Manual entries may change MAX altitude.

4 Company Speed (CO SPD)

Push – Modifies the page with company speed, engine out data from the Airline Policy page.

5 Optimum Altitude and Maximum Altitude (OPT, MAX)

OPT – calculation of OPT altitude is based on gross weight, cost index, cruise speed schedule, and cruise cg. Wind and temperature deviations from standard day are not used in the calculation. The optimum altitude is not calculated during an RTA cruise segment.

MAX – displays the maximum cruise altitude based on:

- current gross weight minus calculated fuel burn to climb to MAX altitude
- temperature
- engine out operation
- cruise reference thrust limit default set by airline (CRZ or CLB)
- speed (ECON, LRC, SEL, EO, or CO)

- residual rate of climb default set by airline (range: 100 to 999 feet per minute)
- disregards altitude or speed constraints
- cruise CG

6 ALL Engine (ENG)

Push – displays a MOD XXX CRZ page with performance based on both engines operating.

Selection and execution allows subsequent selection of two engine economy VNAV modes.

7 Long Range Cruise (LRC)

Push – enables execution of engine out long range cruise.

Displayed when EO or SEL SPD is the active mode.

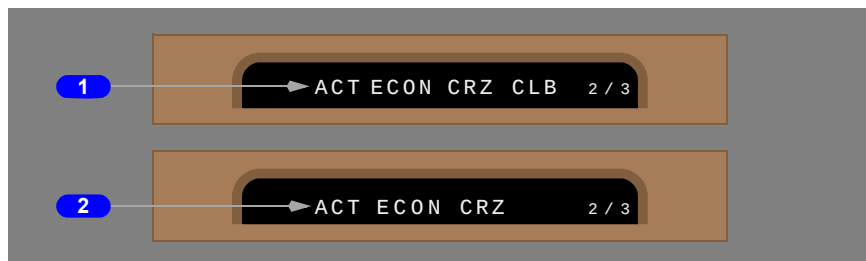
VNAV Modifications

During the cruise phase, VNAV can calculate two types of climbs: cruise and step climbs. Cruise and planned climbs can be entered by the flight crew. Optimum step climbs are calculated by the FMC. In all cases, the new climb altitude must be selected in the MCP altitude window before VNAV commands the climb.

Cruise Climb

Setting an altitude above the current cruise altitude in the MCP altitude window and pushing the altitude selector causes the cruise altitude to be set to the MCP altitude and the airplane to climb to the new cruise altitude. The reference thrust limit is CLB and the pitch flight mode annunciation is VNAV SPD.

Another method to accomplish a cruise climb: set a higher MCP altitude, enter the altitude in the CRZ ALT line, and execute.



1 During Cruise Climb

VNAV page title displays CRZ CLB in a climb to cruise altitude.

2 End of Cruise Climb

VNAV page title displays ECON CRZ after level off at cruise altitude.

Planned Step Climb

When a step climb is planned to start at a waypoint, the data can be entered on the RTE LEGS page. The FMC performance predictions assume the airplane will start the climb at the identified waypoint.

The FMC displays the distance and ETA to the step point on the PROGRESS page. The corresponding altitude profile point and identifier is shown on the ND.

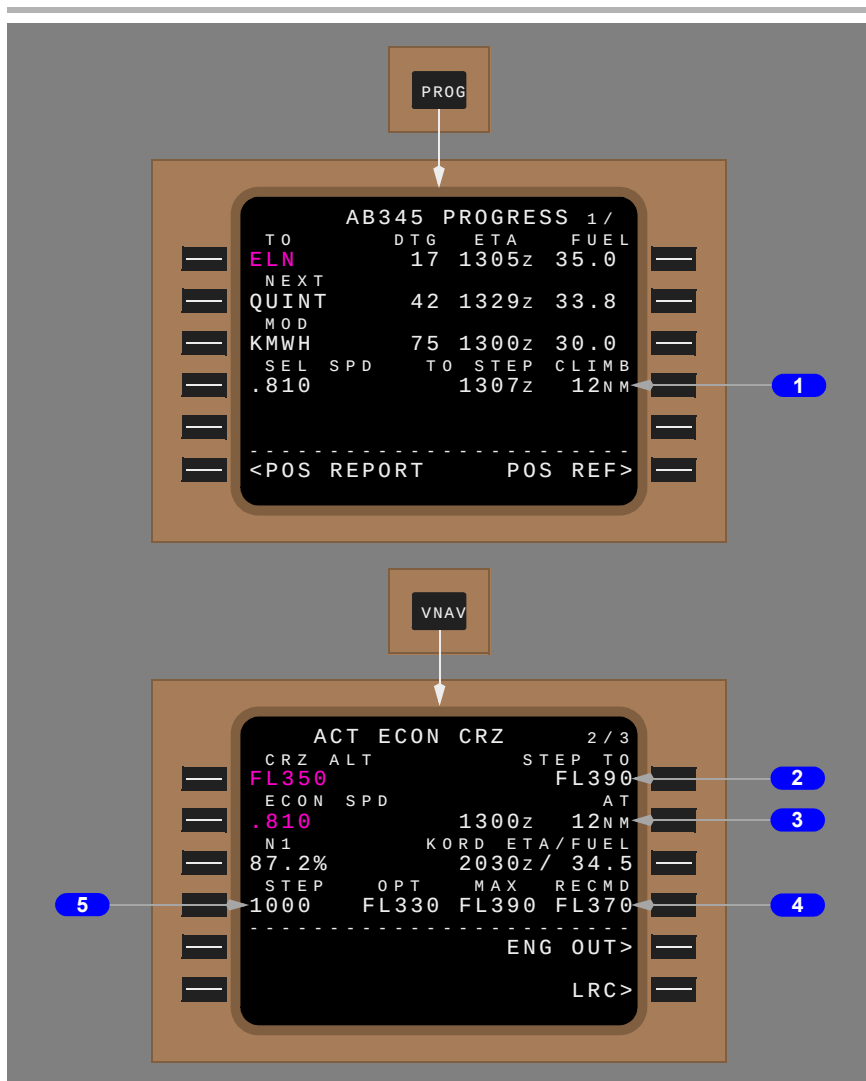


1 Step Climb Altitude

Enter the cruise altitude as an altitude constraint and the letter S. The FMC assumes the step climb starts at the waypoint. Accomplish the step climb at the waypoint with the steps described in cruise climb.

Calculated Step Climb

When a non-zero value is entered into the STEP SIZE line on the PERF INIT or CRZ page, the FMC calculates optimum points for step climbs as the airplane performance permits. The climb altitude is determined by the value in STEP SIZE. Multiple step climbs are possible based on performance and route length. VNAV commands the step climbs, if the MCP altitude and the FMC CRZ ALT are set to the new altitude.



1 TO STEP CLIMB

When the cruise climb start point is the next VNAV event, the line title changes to TO STEP CLIMB.

Displays the ETA and DTG to the point where the step climb starts.

If the airplane passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word NOW.

When the FMC calculates a step climb is not advised, the ETA and DTG are replaced with the word NONE.

2 STEP TO

STEP TO displays when all the following are true:

- an active route exists and no pending activation or flight plan modification exists
- the airplane is more than 200 nm from the T/D for calculated or planned steps
- the airplane is more than 500 nm from the destination airport for calculated steps
- an engine out drift down is not active
- step size is not zero or a planned step exists when the step size is zero

The FMC calculates performance based on accomplishing step climbs at calculated step climb points throughout the flight plan.

An altitude can be entered to evaluate a step climb. The FMC calculates the step climb location using entered forecast winds and temperatures and displays data on this page and on the PROGRESS page 1, 4R.

Valid entries are FLXXX (or XXX flight level) or XXXXX (feet).

Entry of zero for step size causes the FMC to calculate performance data at the entered CRZ ALT with no step climbs.

Preflight entry of a non-zero increment, ICAO, or RVSM step size causes the FMC to calculate STEP TO altitudes correct for the direction of flight based on the entered CRZ ALT. Inflight changes to CRZ ALT affect calculation of STEP TO altitudes when using ICAO or RVSM step size.

Displays STEP TO altitude based on entering "S" (following altitude) on a waypoint on the Legs page. The altitude displayed in 1R can be overwritten with a manual entry above or below CRZ ALT.

When using a non-zero step size, the STEP TO altitude is the next higher altitude, calculated by adding the step size increment to the current CRZ ALT. If step climbs have not been accomplished as calculated, multiple step increments may be used.

Entering an altitude above maximum altitude displays the scratchpad message MAX ALT FLXXX.

Blank when:

- there is no active flight plan, or
- within 200 NM of the T/D, or
- within 500 NM of the destination airport with no planned steps in the flight plan, or
- engine out drift down is active.

3 TO FLXXX, AVAIL AT, AT XXXXXXX, AT, TOT/D

AT:

Displays when there is an altitude in 1R not derived from a specified climb point. Displays the ETA and DTG to the optimum climb point.

AT XXXXXXX:

Displays the LEGS page step climb waypoint when the FMC calculates the step climb can occur within 5 NM of the step climb waypoint. The data line displays ETA and DTG to the climb point. Displays NOW when passing the step climb point.

AVAIL AT:

Displays when a STEP TO the next step altitude entered on a LEGS page waypoint can not occur within 5 NM of the planned step point. The data line displays the ETA and DTG to the climb point. Displays NOW when passing the step climb point. Displays NONE when the planned step climb cannot be accomplished.

TO FLXXX:

Displays when the airplane is more than 200 NM from the T/D or more than 500 nm from the destination airport and engine out drift down is active. The data line displays the ETA and DTG to the climb point to the TO FLXXX altitude.

TO T/D:

Displays when the airplane is within 200 NM of the T/D or within 500 NM of the destination airport with no planned step climbs in the flight plan. The data line displays ETA and DTG to the T/D point.

NONE:

Displays when planned step climb cannot be accomplished.

4 Optimum, Maximum, and Recommended Altitude (OPT, MAX, RECMD)

Blank when RTA is active.

OPT – calculation of OPT altitude is based on gross weight, cost index, cruise speed schedule, and cruise cg. Wind and temperature deviations from standard day are not used in the calculation.

MAX – displays maximum altitude based on:

- current gross weight minus calculated fuel burn to climb to MAX altitude
- temperature
- number of engines operating
- cruise reference thrust limit default set by airline (CRZ or CLB)
- speed (ECON, LRC, SEL, EO, or CO) option
- residual rate of climb default set by airline (range: 100 to 999 feet per minute)
- disregards altitude or speed constraints
- cruise CG

RECMD – displays the most economical altitude to fly for the next 500 NM based on gross weight, selected speed, pressure altitude, and entered forecast winds and temperatures at cruise altitudes. The FMC evaluates altitudes between 9,000 feet below the current CRZ ALT and up to less than MAX altitude. Recommended altitudes are consistent with the specified step size and step climb schedule. If the step size is zero, the recommended cruise level is calculated assuming a 2,000 foot step size. The recommended altitude is set to the CRZ ALT when within 200 NM of the T/D or within 500 NM of the destination airport. The recommended altitude is not calculated during an RTA cruise segment.

5 STEP SIZE

Used for calculation of optimum step point and step climb predictions.

Displays default step climb size 1,000.

Valid entries are:

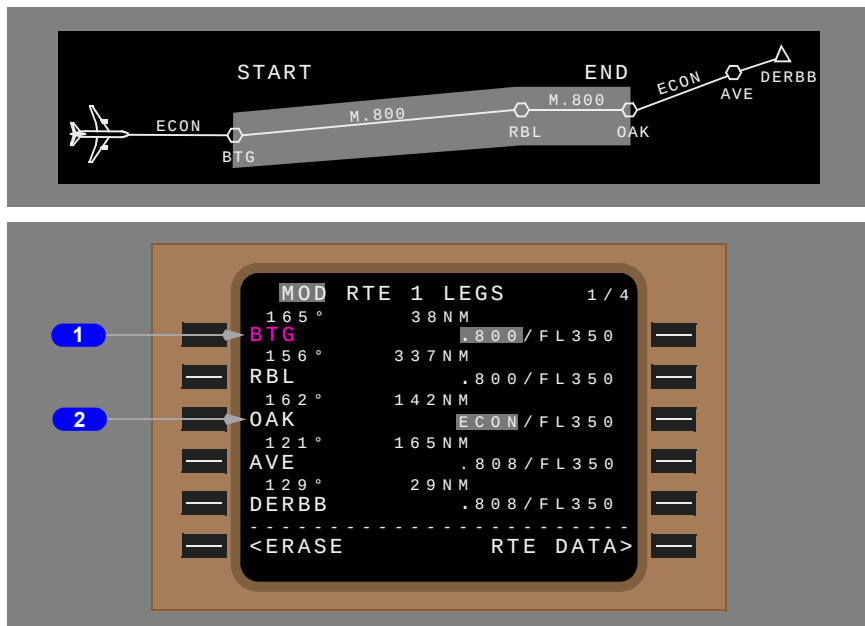
- "0" to inhibit predicted step climbs, or
- altitudes from 1000 to 9900 in 100 foot increments, or
- "I" for ICAO, or
- "R" for RVSM

Deletion of a manual entry returns step size to the default value.

Constant Speed Cruise

A speed for a cruise segment can be specified. A cruise segment has a start waypoint and an end waypoint. The airplane maintains a constant speed between the two waypoints. The waypoints must be in the cruise phase. The FMC controls the speed after the end waypoint or top of descent.

Modification must be executed.



1 Start Waypoint for Constant Speed Cruise

The constant speed cruise starts at BTG at .800 Mach. Entry is in Mach.

2 End Waypoint for Constant Speed Cruise

The constant speed cruise ends at OAK then ECON speed is used. If an RTA waypoint exists at RBL or OAK, the RTA is deleted.

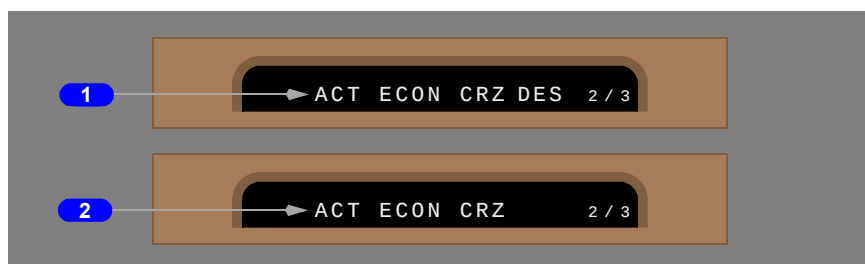
Entry can be a Mach number, ECON/ or E/, LRC/ or L/. If an RTA waypoint is in the flight plan, RTA/ or R/ may be entered.

If no end waypoint is specified, the constant speed terminates at top of descent.

The FMC may select the end waypoint if an RTA waypoint is entered. The FMC selects the end waypoint to allow enough distance to arrive at the RTA waypoint on time. In the example, if the FMC selected OAK as the end waypoint, RTA would replace ECON. See RTA PROGRESS page 3/4.

Cruise Descent

Setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector (more than 50 nm from a T/D) causes the cruise altitude to be set to the MCP altitude and the airplane to descend to the new altitude. The CRZ page displays ACT ECON CRZ DES. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by flight crew action. The autothrottle sets a calculated thrust value for an approximate 1250 feet per minute descent. Pitch changes maintain the commanded cruise speed. Thrust levers can be manually positioned to adjust the descent rate.



1 During Cruise Descent

VNAV page title displays cruise phase in a descent to a new cruise altitude.

2 End of Cruise Descent

VNAV page title displays cruise phase after level off at new cruise altitude.

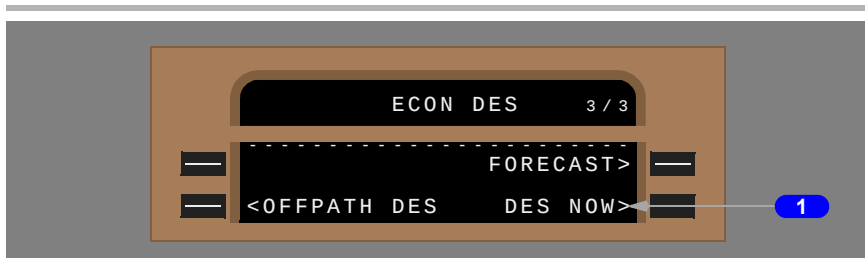
Early Descent

An early descent is a descent started prior to the T/D. The VNAV descent page becomes active.

During cruise, setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector activates the DES NOW function when the airplane is within 50 nm of the T/D or if the MCP altitude is set below the highest descent altitude constraint in the VNAV descent profile.

The autothrottle sets thrust to maintain the target descent rate; then annunciates HOLD. Pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

Another method to accomplish an early descent: set a lower MCP altitude, page forward to the VNAV DES page and line select DES NOW, and execute.



1 Descend Now (DES NOW)

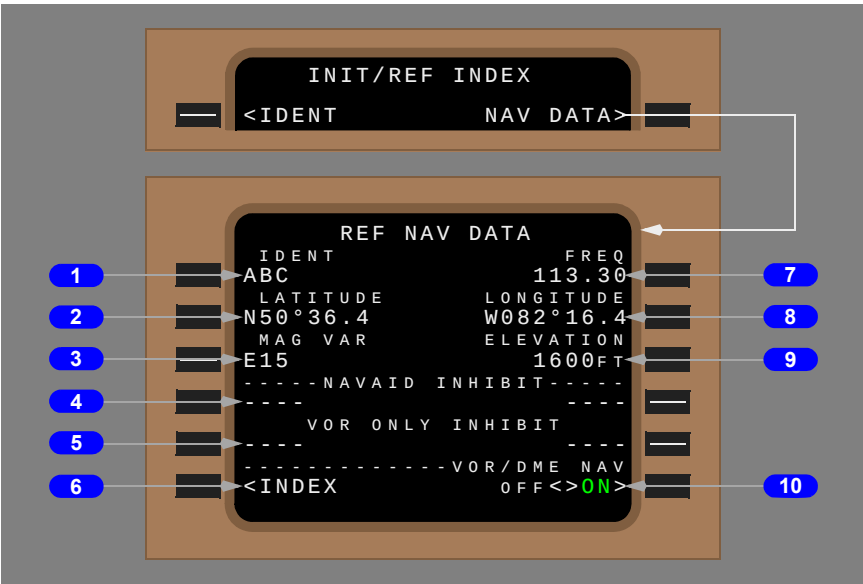
The DES NOW prompt is shown on the descent page when the cruise phase is active. Select the DES NOW prompt and execute to start a VNAV ECON descent of approximately 1250 feet per minute at ECON speed.

Upon reaching the planned descent path, VNAV commands pitch to maintain the planned descent path and ECON speed. If the airplane reaches an altitude constraint, VNAV changes to VNAV ALT until the planned descent path is intercepted.

Navigation Data

Reference Navigation Data Page

The reference navigation data page displays data about waypoints, nav aids, airports, and runways. Use this page to inhibit FMC position updates from radio nav aids. The nav aids are always available for manual tune, autotune and the ND.



1 Identification (IDENT)

Valid entries are any waypoint, navaid, airport, or runway from the navigation database.

Entry changes to dashes when page is exited and then reselected.

2 LATITUDE

Displays latitude of entered identifier.

3 Magnetic Variation (MAG VAR), LENGTH

MAG VAR - displays magnetic variation when entered identifier is a navaid.

LENGTH - displays runway length when entered identifier is a runway.

4 NAVAID INHIBIT

Valid entries are: VOR, VOR/DME, VORTAC, or DME identifiers from the navigation database.

Entries not allowed when RAD NAV INHIBIT displays ON in large font, green letters.

Inhibits use of entered nav aids for updating by both FMCs.

Entries clear at flight completion. "ALL" displays.

Deleting or overwriting removes a previous inhibit nav aid.

5 VOR ONLY INHIBIT

Valid entries are VOR identifiers from the navigation database.

Entries not allowed when RAD NAV INHIBIT displays ON or VOR in large font, green letters.

Inhibits use of only VOR portion of entered nav aid for updating by both FMCs. DME–DME position updating is not inhibited.

Entries clear at flight completion. "ALL" displays.

Deleting or overwriting removes a previous inhibit VOR.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 Frequency (FREQ)

Displays frequency of entered identifier when it is a nav aid.

8 LONGITUDE

Displays longitude of entered identifier.

9 ELEVATION

Displays elevation of entered identifier when it is a nav aid, airport, or runway.

10 VOR/DME NAV

Push – alternately selects VOR/DME NAV ON (active) and OFF (inactive).

ON – VOR/DME data is supplied to the FMC for position updates. ON displays in large green letters; OFF displays in small white letters.

OFF – VOR/DME data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters. DME–DME position updating is not inhibited.

Selecting OFF displays ALL in both locations of the VOR ONLY INHIBIT line.

Fix Information Page

7101 - 7110

Four identical FIX INFORMATION pages are used to create waypoint fixes and waypoints for the ND. Some of the created waypoints can be copied into the route. The page can be cleared by selecting the ERASE FIX prompt or by using the DEL key.

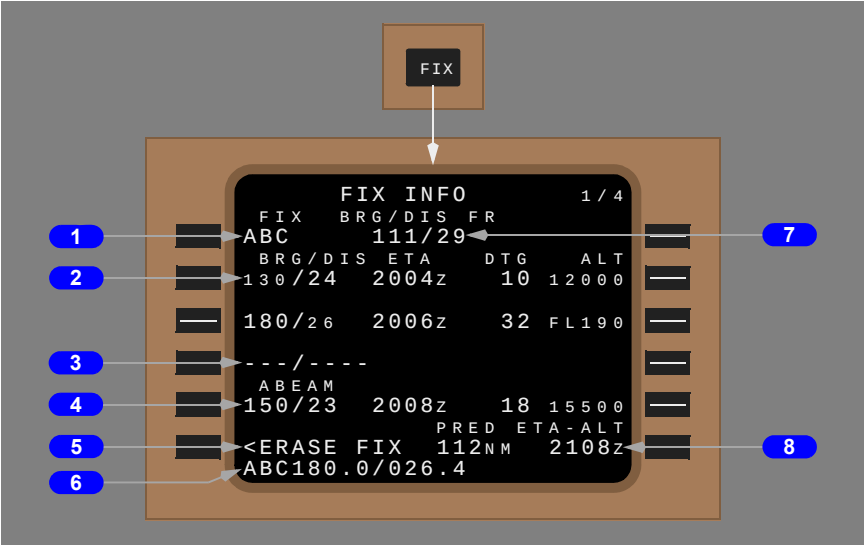
7001 - 7008

Two identical FIX INFORMATION pages are used to create waypoint fixes and waypoints for the ND. Some of the created waypoints can be copied into the route. The page can be cleared by selecting the ERASE FIX prompt or by using the DEL key.

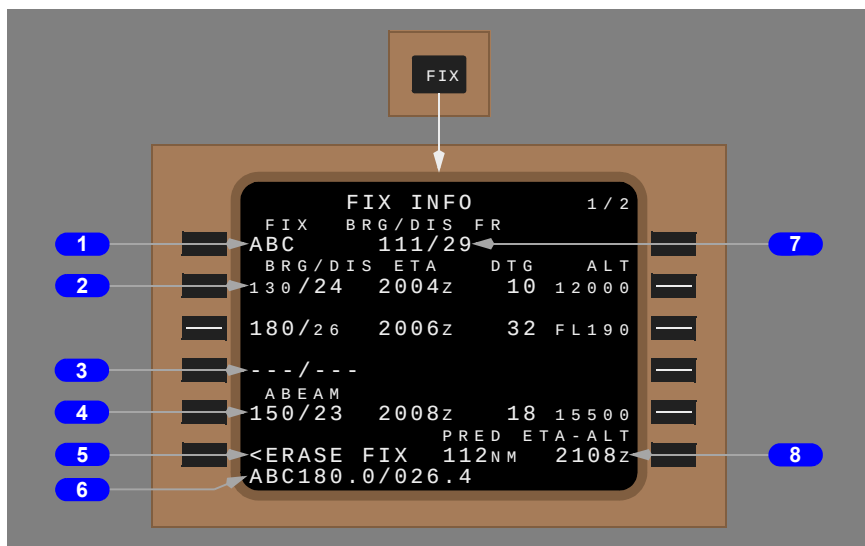
Magnetic/True Bearing

Magnetic or true fix bearings depend on airplane location. Refer to FMC Polar Operations, Flight Management Navigation, section 31.

7101 - 7110



7001 - 7008



1 FIX 7101 - 7110

Valid entries are airports, nav aids, place bearing distance, place bearing/place bearing, along track, latitude/longitude, and waypoints from the navigation database. The selected fix displays on the ND and is highlighted by a green circle.

1 FIX 7001 - 7008

Valid entries are airports, nav aids, and waypoints from the navigation database. The selected fix displays on the ND and is highlighted by a green circle.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT 7101 - 7110

Valid entries are XXX/YYY.Y:

- leading zeros can be omitted for distance entries
- distance (up to 9999 nm) only entries must start with a slash (/)

Distances from the fix display on the ND as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the intersection display for the closest of the two intersections.

Bearings from the fix display on the ND as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

Push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT

7001 - 7008

Valid entries are XXX/YYY.Y:

- leading zeros can be omitted for distance entries
- distance (up to 511 nm) only entries must start with a slash (/)

Distances from the fix display on the ND as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the closest intersection display.

Bearings from the fix display on the ND as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

Push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

3 Bearing/Distance (BRG/DIS) – Dashes

Enter a bearing, distance, or both bearing and distance from the fix. A bearing and distance from the fix displays on the ND as a waypoint fix point. ETA, DTG, and predicted do not display.

4 ABEAM

Displays ABEAM prompt.

Push - displays bearing and distance from the fix perpendicular to the nearest segment of the flight plan path, and ETA, DTG, and altitude at the intersection point.

Second push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

5 ERASE FIX

Push – removes all fix data from the page and the ND.

6 Route Intersection Point Copied

Pushing the line select key for one of the BRG/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

7 Bearing/Distance From (BRG/DIS FR)

Displays the bearing and distance of the airplane from the fix.

8 Predicted Distance to ETA or Altitude (PRED ETA-ALT)

Valid entry is altitude, flight level, or time. Time entry must be followed by “Z”.

Entering an altitude or flight level displays the predicted along track distance and altitude or flight level on this line. The predicted airplane position displays on the ND route line as a green circle with the entered altitude/flight level.

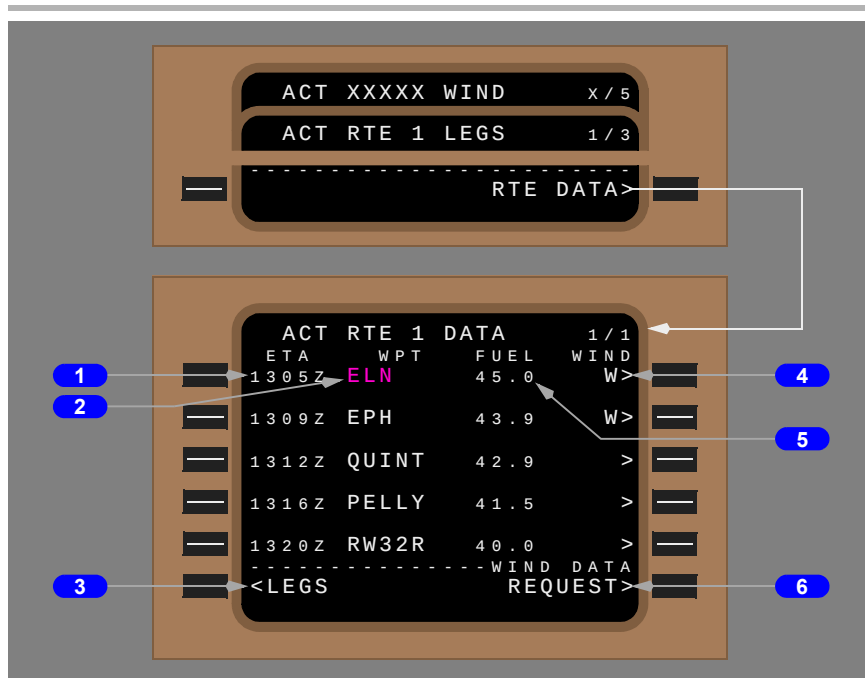
Entering a time displays the predicted along track distance and the time on this line. The predicted airplane position displays on the ND route line as a green circle with the entered ETA.

Route and Waypoint Data

Route Data Page

The route data page displays data for each waypoint on the ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

The ETA and calculated fuel remaining at the waypoint display for each waypoint. Manual entry is not possible.



1 ETA

Displays ETA for waypoint.

2 Waypoint (WPT)

Displays identifier for waypoint.

3 LEGS

Push –displays RTE LEGS page.

4 WIND (W>/>)

W> - indicates waypoint winds have been entered.

> - winds not entered.

Push – selects WIND page for the selected waypoint.

5 FUEL

Displays the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

6 WIND DATA REQUEST

Push – transmits a data link request for wind and descent forecast data.

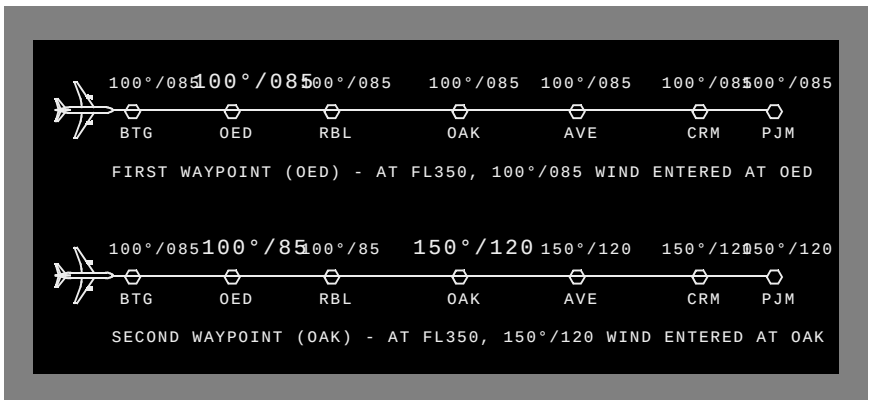
Flight crew may enter up to four altitudes on any wind page to qualify the request.

Wind Data

The FMC uses wind data to improve performance prediction accuracy. Wind data includes altitude and direction/speed.

The FMC applies the first entered wind data to all waypoints in the flight plan. Wind data entered at another waypoint (at the same altitude) changes wind data downtrack from the second entered waypoint either to the end of the track, or to the next entered wind. The wind data before the second entered waypoint does not change. Therefore, enter wind data for waypoints closest to the airplane, then enter wind data for waypoints downtrack from the airplane.

For example: at FL 350, 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK and through the end of the route.



Entered wind data are mixed with sensed wind data for performance predictions. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. The FMC mixes these winds for predictions in between. Sensed winds display on the progress page 2/4.

Inaccurate forecast wind and temperature information degrades the accuracy of the recommended altitude displayed on the cruise page.

The FMC adjusts ECON climb speed and top of climb using entered and/or sensed wind speed. FMC calculated ECON climb speed may fluctuate if top of climb is near a waypoint with approximately a 45 degree or larger track change and if a significant wind velocity has been entered or is predicted for that waypoint. This fluctuation does not occur when using a manually entered climb speed or speed intervention.

Wind Page

The wind page is used to enter forecast winds and temperatures at waypoints for up to four altitudes to enhance VNAV performance.

This data can be uplinked or manually entered.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any one altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.

The altitudes are entered first. The altitudes can be entered in any order and are sorted and displayed in ascending order.

The FMC calculates step climb points as a function of lateral flight plan, speed mode, present and step to altitude, and gross weight. The gross weight for a step from present CRZ ALT to STEP TO altitude is the gross weight at which the optimum altitude is halfway between the two altitudes.

ACT RTE 1 DATA			
ETA	WPT	FUEL	WIND
1305Z	ELN	45.0	W

MOD ELN WIND			
ALT	OAT	DIR / SPD	
FL250	-41 °C	280° / 70KT	
FL210	-33 °C	300° / 50KT	
17000	-25 °C	--- ° / --- KT	
		ALT / OAT	
		FL200 / -31 °C	
<ERASE>		RTE DATA>	

1 Page Title

Displays ACT XXXXX, where XXXXX is the waypoint at which winds have been entered.

When a route is being modified, MOD in shaded white as shown in the page title.

2 Altitude (ALT)

Enter altitude or flight level for wind entries. Altitude data entry possible only on line 1L.

After data entry, data is sorted by altitude and placed in lines 1 through 4. Dashes display on right side of line for wind direction and speed entry.

When all four lines have data, one must be deleted before new data can be entered.

3 Altitude/Flight Level Data

Displays the altitude or flight level for wind or OAT entries.

Data entered on 1L displays on lines 1 through 4. Data entry is not possible in lines 2L through 4L.

OAT entries made using the ALT/OAT line display in large font. Calculated OAT based on standard lapse rate display in small font.

4 ERASE

Push – removes modified data.

5 Direction and Speed (DIR/SPD)

Displays dashes after altitude/flight level entry in the ALT line. Enter wind direction and speed for the altitude.

Displays entered wind direction and speed for related altitude.

Values propagate in both directions for the first wind entered and downtrack for other entered winds. Propagated values display in small white font.

Manual entries display in shaded white until executed, then in large white font.

6 Altitude/Outside Air Temperature (ALT/OAT)

Enter altitude and OAT. The altitude for OAT does not have to be one of the wind altitudes. The FMC uses standard lapse rate to calculate the temperature at the other altitudes.

Manual entries display in shaded white until executed.

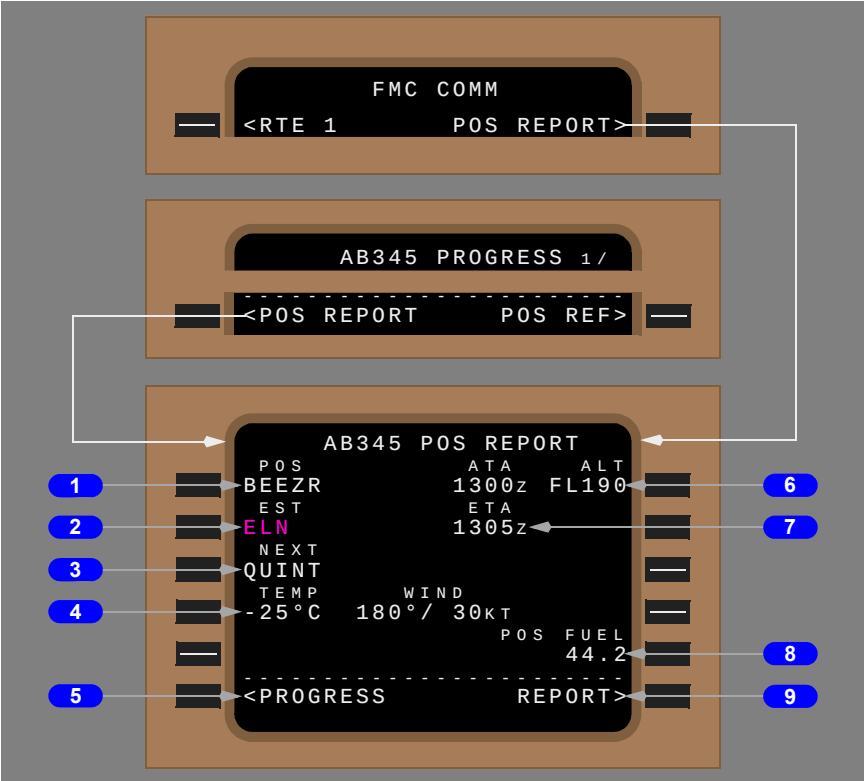
7 Route Data (RTE DATA)

Push – displays the RTE DATA page.

Position Report Page

The position report page displays data for a position report. A position report can be data linked from the page.

The page contains reference data only. Manual entries are inhibited.



1 Position (POS)

Waypoint used to report position. This is the previous active waypoint.

2 Estimate (EST)

The active waypoint displays in magenta.

3 NEXT

Waypoint after active waypoint.

4 Temperature and Wind (TEMP WIND)

TEMP displays the OAT in degrees C.

WIND displays the wind direction and speed.

5 PROGRESS

Push – displays the PROGRESS page.

6 Actual Time of Arrival and Altitude (ATA ALT)

ATA displays the actual time of arrival for the POS waypoint.

ALT displays the airplane altitude at last waypoint.

7 ETA

Displays the estimated time of arrival for the active waypoint.

8 Position Fuel (POS FUEL)

Displays the fuel on board at the POS waypoint.

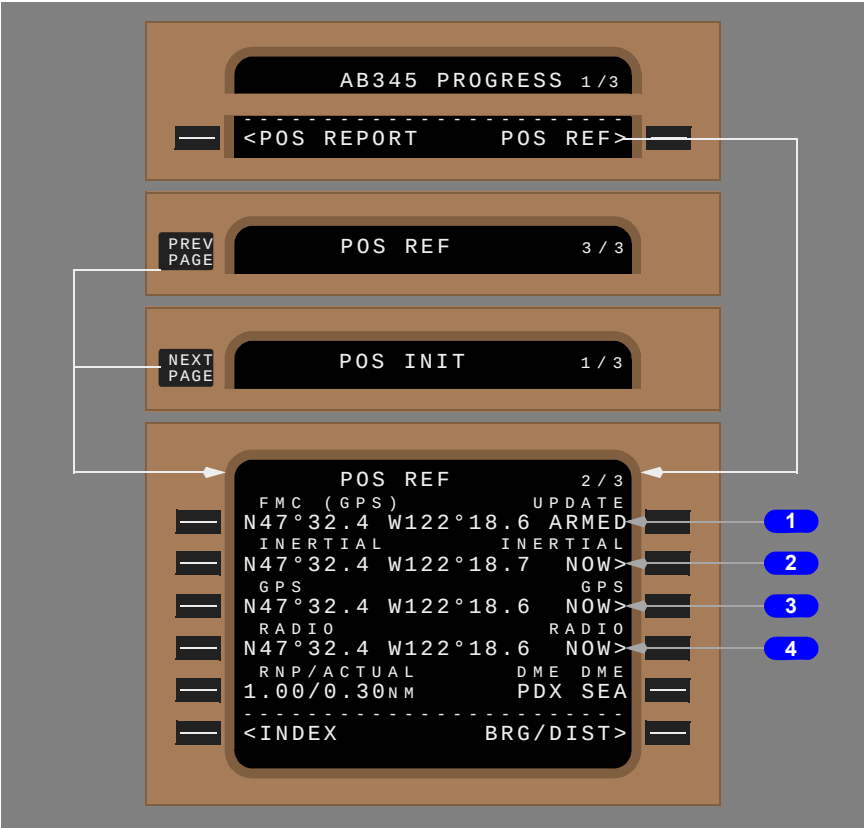
9 REPORT

Push – transmits a data link downlink of the data on this page.

The data link transmission of a position report requires the data link option be enabled, operational, and not in the voice or no-communications mode.

In-Flight Position Update

FMC position update can be accomplished on the POS REF 2/3 page in flight.



1 UPDATE ARMED

Pushing the ARM prompt arms the position update function. ARM changes to ARMED. Each of the position update sources have a NOW prompt.

2 INERTIAL NOW

Push – to update the FMC position from the inertial position.

3 GPS NOW

Push – to update the FMC position from the GPS position.

4 RADIO NOW

Push – to update the FMC position from the navigation radio position.

Progress Pages

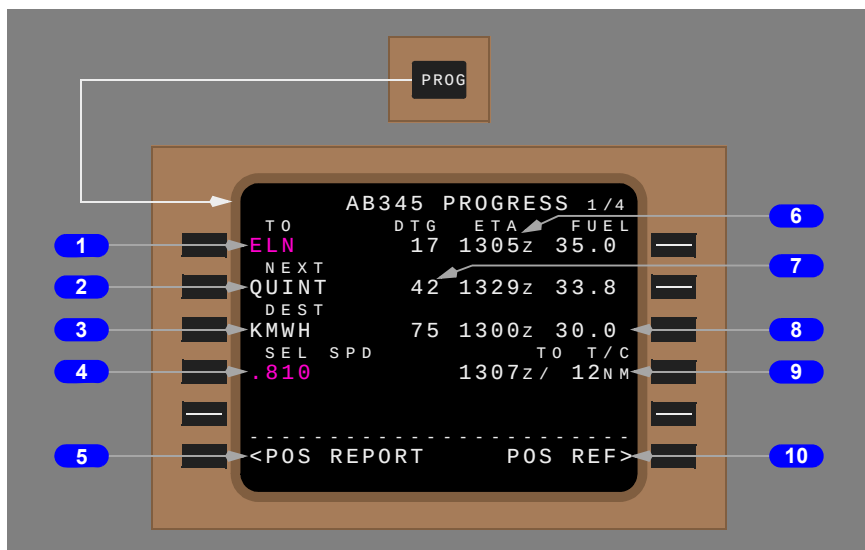
Progress Page 1

The progress page displays general flight progress data. The FMC Communication section of Chapter 5, Communications describes position reports.

The page title displays the company flight number entered on the RTE page.

Page one of the progress pages displays general data about:

- waypoints (active and next)
- destination data
- FMC speed
- T/C, T/D, etc.



1 TO

Active waypoint displays in magenta.

Can not be modified.

2 NEXT

Waypoint after TO waypoint displays in white.

Can not be modified

3 Destination (DEST)

Any waypoint or airport in navigation database can be entered. The line titles are:

- DEST – performance predictions to destination. Default display
- DIR TO FIX – when entered waypoint is not in flight plan. Data is based on flying present position direct to the waypoint
- EN ROUTE WPT – when entered waypoint is in flight plan. Line data are based on flying the flight plan route to the waypoint
- MOD – a modification has been made on another page. Performance predictions include modification.

Remove entries with DELETE key or change all CDUs to a different page.

4 Selected Speed (SEL SPD)

The FMC active command speed displays in magenta.

The active speed mode is the same as on the performance page, unless changed by the MCP or a limit. The speed modes are:

- ECON SPD – economy speed
- LRC SPD – long range cruise speed
- SEL SPD – selected speed manually entered on the CDU
- EO SPD – engine out speed
- CO SPD – engine out operations at airline specified engine out company speed
- LIM SPD – speed is limited by VMO, MMO, flap limit, or buffet limit
- MCP SPD – MCP speed entered on the MCP IAS/MACH indicator
- VREF +80 – for engine out operations during takeoff
- RTA SPD – RTA speed is active

5 Position Report (POS REPORT)

Push – displays the POS REPORT page.

6 ETA

Estimated time of arrival at waypoint or destination.

7 Distance To Go (DTG)

Distance to go to waypoint or destination.

8 FUEL

Estimated fuel remaining at waypoint or destination.

9 TO T/C

Data line displays ETA and DTG to line title point.

Data line displays NOW when the airplane is past the climb/descent point when STEP CLB or T/D displays in the line title.

Data line displays NONE when the line title is STEP CLB and the step has not been entered on the CRZ page or the FMC calculates a step climb is not advised.

Line titles are:

- T/C - top of climb
- STEP CLB – step climb data
- T/D – top of descent data
- E/D – end of descent data
- LEVEL AT – time and distance to level off in Drift Down mode.

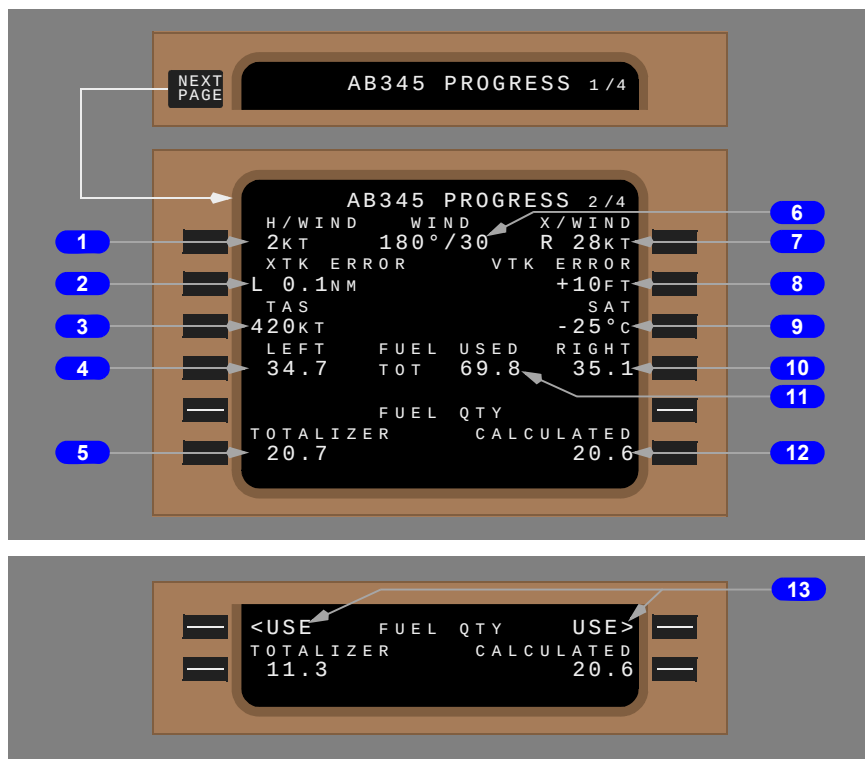
10 Position Reference (POS REF)

Push – displays position reference page.

Progress Page 2

Progress page two contains:

- wind data
- fuel data
- static air temperature
- true airspeed
- track error data.



1 Headwind (H/WIND), Tailwind (T/WIND)

Displays headwind (H/WIND) or tailwind (T/WIND) component.

Wind component data is relative to the airplane.

2 Crosstrack Error (XTK ERROR)

Displays crosstrack (XTK) error in nautical miles left or right of the active route.

3 TAS

Displays airplane true airspeed.

4 LEFT FUEL USED

Displays fuel used by left engine sensed by fuel flow meters.

5 Fuel Quantity Totalizer (FUEL QTY TOTALIZER)

Displays fuel quantity calculated by the fuel system quantity processor.

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations.

6 WIND

Displays current wind direction and speed referenced to true north.

7 Crosswind (X/WIND)

Displays left (L) or right (R) crosswind component relative to airplane heading.

8 Vertical Track Error (VTK ERROR)

Displays vertical path (VTK) error above (+) or below (-) vertical path.

9 Static Air Temperature (SAT)

Displays outside static air temperature.

10 RIGHT FUEL USED

Displays fuel used by right engine sensed by fuel flow meters.

11 FUEL USED Total (TOT)

Displays sum of the LEFT and RIGHT fuel used values.

12 FUEL Quantity (QTY) CALCULATED

Displays fuel remaining as calculated by the FMC with these methods:

- before engine start, displays fuel quantity calculated by fuel quantity system totalizer
- after engine start, displays fuel quantity at engine start decreased by total fuel flow (FUEL USED)
- after fuel dump, resets to fuel quantity system totalizer
- after landing, resets to fuel quantity system totalizer.

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations. Fuel flow rate sensing tolerances may allow the CALCULATED and the TOTALIZER fuel quantities to be different by as much as 60 to 85 pounds per hour.

13 USE

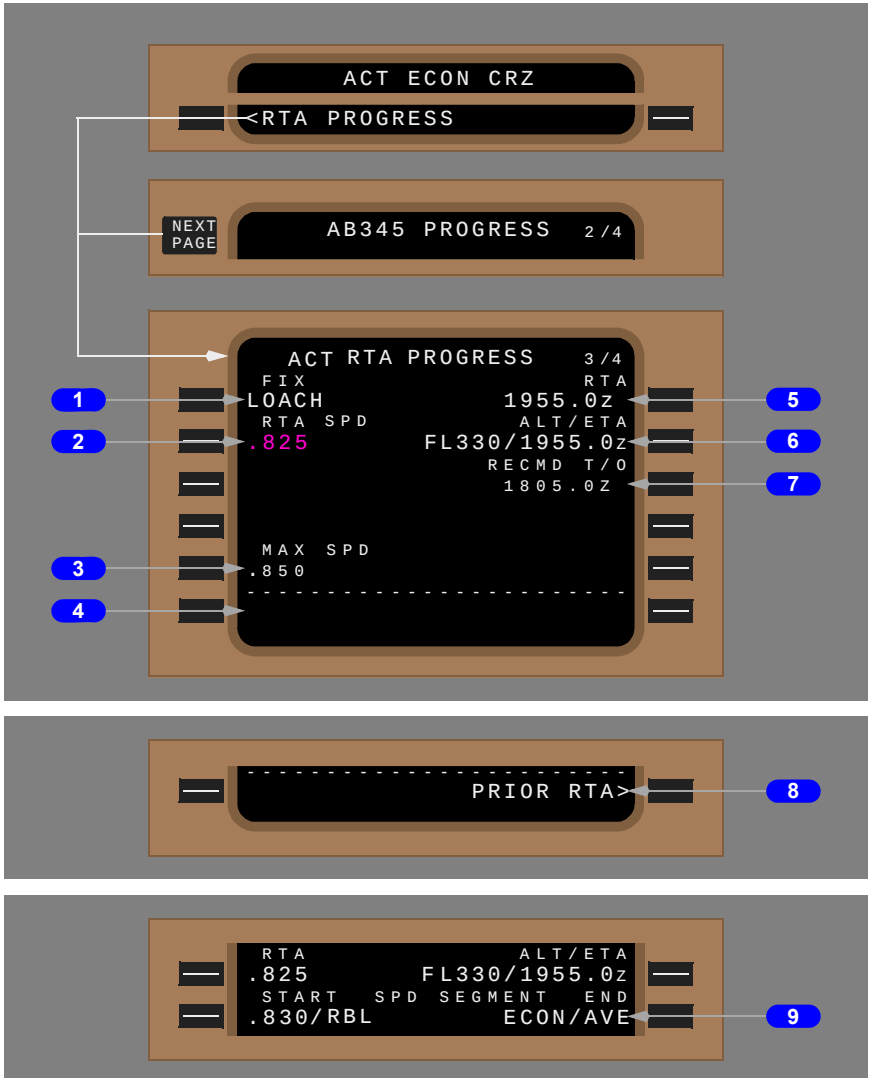
Push – selects method to calculate fuel quantity, either TOTALIZER or CALCULATED.

When one is selected:

- it is used for remainder of flight
- the other fuel calculation method blanks
- scratchpad clears.

RTA Progress Page 3

Progress page three is used to enter data for required time of arrival (RTA). RTA can be entered or changed during preflight or in flight. Creating an RTA changes CRZ page title to RTA CRZ. RTA operates only in cruise.



The diagram illustrates the RTA Progress Page 3 FMC display, which is divided into three main sections. The top section shows the current page title and the next page. The middle section displays the RTA progress data for a specific flight segment, and the bottom section shows the prior RTA data.

Top Section:

- ACT ECON CRZ
- RTA PROGRESS
- NEXT PAGE
- AB345 PROGRESS 2 / 4

Middle Section:

- ACT RTA PROGRESS 3 / 4
- FIX LOACH RTA 1955.0Z
- RTA SPD FL330/1955.0Z
- REC'D T/O 1805.0Z
- MAX SPD .850

Bottom Section:

- PRIOR RTA
- RTA .825 ALT/ETA FL330/1955.0Z
- START SPD SEGMENT END
- .830/RBL ECON/AVE

Numbered callouts (1-9) point to specific fields or controls:

- 1: RTA PROGRESS
- 2: RTA SPD
- 3: MAX SPD
- 4: MAX SPD
- 5: RTA
- 6: ALT/ETA
- 7: REC'D T/O
- 8: PRIOR RTA
- 9: ECON/AVE

1 FIX

Valid entry is a waypoint in the active or pending active route. Waypoints defined by coordinates must be down selected to the scratchpad, then selected to the FIX line.

Entry by flight crew or data link.

Entry displays ALT/ETA data in line 2R.

When RTA active, deletion of FIX terminates RTA and resumes ECON. Display returns to boxes.

When RTA not active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

Displays boxes when an active or modified route exists.

Displays blank if engine out has been selected.

2 Required Time Of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA.

Displays blank if no RTA fix or time entered.

3 Maximum Speed (MAX SPD)

Valid entry is Mach .100 to .990; displays in large font.

Deletion of entered value displays default Mach .850 in small font.

4 Displays ERASE when modification pending

Push - displays previous unmodified page, or if no previous active values, deletes RTA in 1R.

5 Required Time Of Arrival (RTA)

Boxes display after entry of RTA FIX in 1L.

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

Suffix to RTA indicates:

- no suffix – arrive at entered time
- A – arrive at or after entered time
- B – arrive at or before entered time.

Entry before takeoff causes recommended T/O time to display in small font.

Deletion terminates RTA and returns ECON as cruise mode.

6 Altitude/ETA (ALT/ETA)

Displays predicted altitude and ETA at RTA fix after entry of FIX in 1L.

Blank until performance data is entered.

7 Recommended Takeoff (RECMD T/O)

Displays T/O in line title and dashes until FIX entered.

Displays RECMD T/O in line title on the ground when a performance calculated takeoff time to met an entered FIX displays in the data line.

Displays NOW when no takeoff time has been entered and the current time is later than the calculated time to meet an RTA at ECON speed.

Blanks in flight.

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

8 PRIOR RTA

Displays when an RTA fix and time exists, and the RTA fix is deleted or another cruise speed mode is selected prior to sequencing the RTA fix.

Push -

- displays previous RTA fix and time
- initiates RTA flight plan modification.

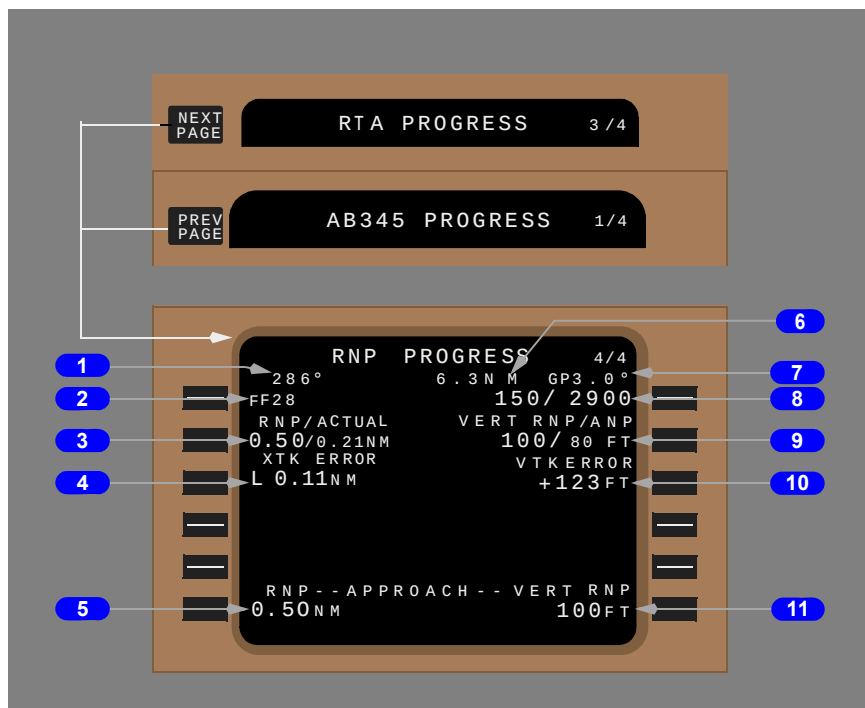
9 Cruise Speed Segment

Displays cruise speed segment start and end waypoints when entered on the Legs page. Valid entries on the Legs page are: Mach, LRC or L, RTA or R, or ECON or E. The cruise speed segment shown ends at AVE and ECON airspeed is resumed. If an end waypoint has not been entered, the cruise speed segment ends at the T/D.

Entry of RTA or R after an RTA fix or entry of ECON or E before an RTA results in the scratchpad message INVALID ENTRY.

RNP Progress Page 4

Progress page four displays concise RNP information. Some of the information on page 2 has been repeated to display all related RNP information together.



1 Leg Direction

Leg segment data in line title:

- courses – magnetic (xxx°) or true (xxx° T)
- arcs – distance in miles, ARC, turn direction (example: 24 ARC L)
- heading leg segments – xxx° HDG
- track leg segments – xxx° TRK
- special procedural instructions from database - HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry).

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

2 Waypoint Identifier

Displays the next waypoint.

3 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Display same as 5L POS REF 2/3. Manual entry displays in large font; propagated to 5L POS REF 2/3 page.

4 Crosstrack Error (XTK ERROR)

Displays present crosstrack error from the desired LNAV course. L or R indicates left or right of course. Blank if error is greater than 99.9 NM.

5 Lateral RNP (Approach)

Displays lowest applicable RNP for the approach. Entry not allowed at 6L.

Manual entry at 3L displays in large font.

RNP values from the navigation database display in small font; or, if there are none, displays the default value for the approach navigation flight phase stored in the FMC.

6 Distance To Go

Displays the distance remaining to the next waypoint.

7 Glidepath

Displays the FMC computed glidepath for the approach.

8 Waypoint Speed/Altitude

Displays waypoint speed or altitude constraints in large font. Displays FMC predicted value in small font when no restrictions have been specified.

9 Vertical Navigation Performance

Displays both vertical RNP and ANP for the current leg.

Valid display range for vertical ANP is 0 to 999 feet.

Manual entries are allowed and display in large font.

Valid entries are 10 to 999 feet and may be suffixed with an optional "/".

Entries clear at flight completion.

Values from the navigation database display in small font.

10 Vertical Deviation

Displays present vertical deviation from the FMC computed glidepath.

11 Vertical RNP (Approach)

Displays the lowest applicable vertical RNP for the approach.

Manual entries (entered in 2R) display in large font.

Values from the navigation database display in small font.

Flight Management, Navigation

FMC Descent and Approach

Chapter 11

Section 43

Introduction

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for the descent phase starts during cruise.

The approach phase starts when the airplane is in the descent phase and flaps are out of up. In general, the approach starts no later than sequencing the final approach fix. For a detailed explanation of “on approach” refer to Chapter 11.31.

Alternates are available from preflight through approach phase of flight and can be selected or updated at any time. Diversion to an alternate can be accomplished during all phases of flight.

The only automatic page change in the descent/approach phases is the VNAV selected page change from cruise to descent at the top of descent.

Early Descent

Early descents are discussed in Section 42, FMC Cruise.

Descent

During descent, LNAV is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

During descent, the specific page listed below is used to:

- DESCENT FORECAST page – enter forecast wind data to aid descent planning
- OFFPATH DES page – analyze descent performance with and without the use of speedbrakes
- ALTN page – manage the selection of alternate airports and diversions

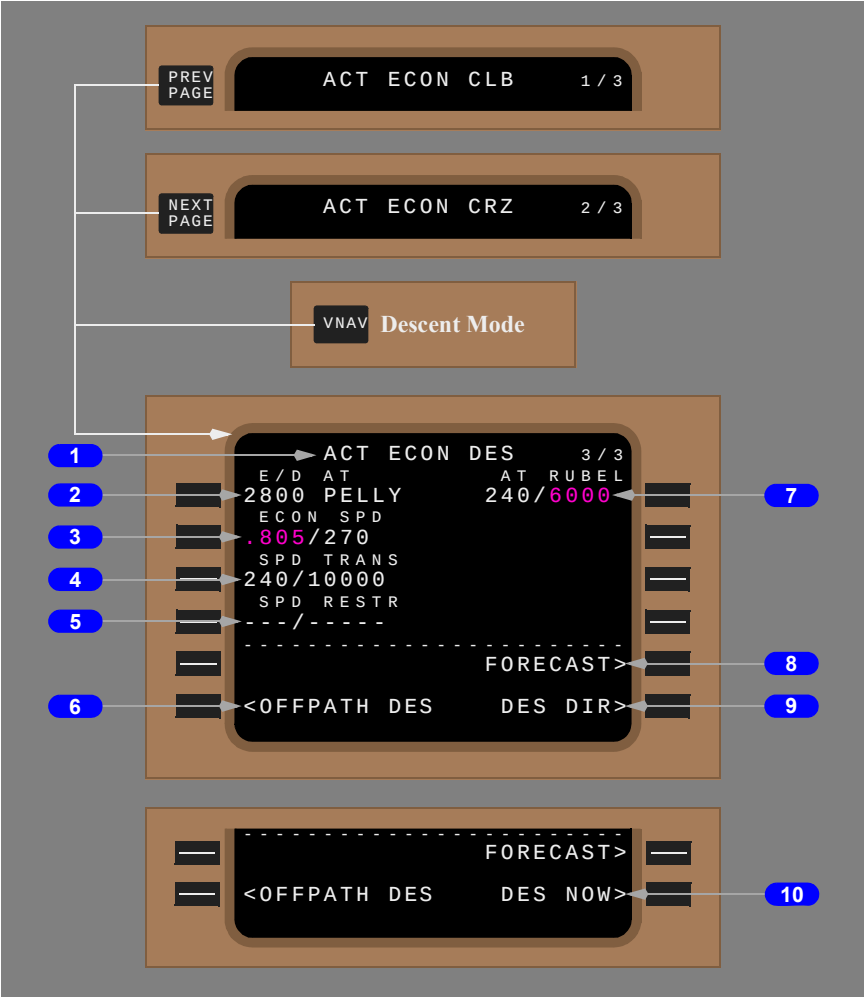
Altitude Intervention

If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. VNAV PTH changes to VNAV ALT. The descent can be continued by setting the altitude window to a lower altitude and pushing the altitude selector. If the altitude window is set to an altitude below other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. Or, all waypoint altitude constraints between the current airplane altitude and the altitude window setting can be deleted by selection of the DES DIR> prompt on the DES page.

Descent Page

The descent page is used to monitor and revise the descent path. Descent speeds are economy (ECON) and fixed speed (SEL). The default VNAV descent mode is ECON. A fixed speed descent is flown when speed intervention is used or a speed is entered on the DES page. The descent page is blank with DES as the title until an altitude constraint below the cruise altitude is entered.

This page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a lower speed restriction. The fixed speed mode controls descent speed at the fixed speed until a lower speed restriction is reached.



1 Page Title

The page title displays active (ACT) or modified (MOD) descent. Usually, the title displays ECON for economy descent. Fixed speed descents modify the title.

The page title displays the type of descent:

- ACT ECON DES – speed based on a cost index
- ACT MCP SPD DES – MCP speed intervention is selected
- ACT XXXKT DES – fixed CAS descent speed profile
- ACT M.XXXDES – fixed Mach descent speed profile
- ACT LIM SPD DES – speed based on an envelope limiting speed
- ACT END OF DES – airplane has sequenced E/D constraint

Fixed descent speeds are for:

- a flight crew entered selected speed (SEL SPD)
- a speed transition
- a speed restriction associated with an altitude constraint
- waypoint speed constraints

2 End Of Descent At (E/D AT)

Displays the end of descent altitude and waypoint.

The end of descent point is a waypoint in the descent phase with the lowest altitude constraint.

The altitude displays in magenta when altitude becomes the FMC altitude target.

Page is blank if no E/D point exists.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Both CAS and Mach values display.

ECON SPD –

- economy speed based on cost index
- displays CAS and Mach values.

SEL SPD –

- displays when flight crew enters speed
- displays constraint speed on transitioning into a selected speed segment (waypoint speed constraint, SPD RESTR, or SPD TRANS)
- valid entries are CAS or Mach

The FMC commanded speed is magenta. Initially, Mach is magenta and CAS is white. Below CAS/Mach transition altitude, CAS is magenta and Mach is white.

4 Speed Transition (SPD TRANS)

The transition speed is usually 10 knots less than the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 240 knots displays. The transition altitude is the point the transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet displays.

Speed displays in magenta when it is the FMC speed target.

Blanks below SPD TRANS altitude.

Deleting causes the airplane to fly economy or selected speed if not limited by a waypoint constraint or speed restriction.

5 Speed Restriction (SPD RESTR)

Speed restrictions at altitudes higher than E/D altitude and not associated with specific waypoints are manually entered on this line.

Valid entry is a CAS and altitude (example 240/8000). Entry may be deleted.

Magenta when it is FMC command speed.

6 Off Path Descent (OFFPATH DES)

Push – displays the OFFPATH DES page.

7 AT XXXXX

Displays the next waypoint constraint from the RTE LEGS page.

XXXX is:

- the waypoint identifier
- HOLD AT XXXXX
- AT VECTORS
- AT (INTC)

The constraint is speed/altitude. Blank when no constraint exists.

Can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

Speed and/or altitude display in magenta when they are the FMC target values.

8 FORECAST

Push – displays the DESCENT FORECAST page.

9 Descend Direct (DES DIR)

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Displays in descent phase with altitude constraint between airplane and E/D.

10 Descend Now (DES NOW)

Push –

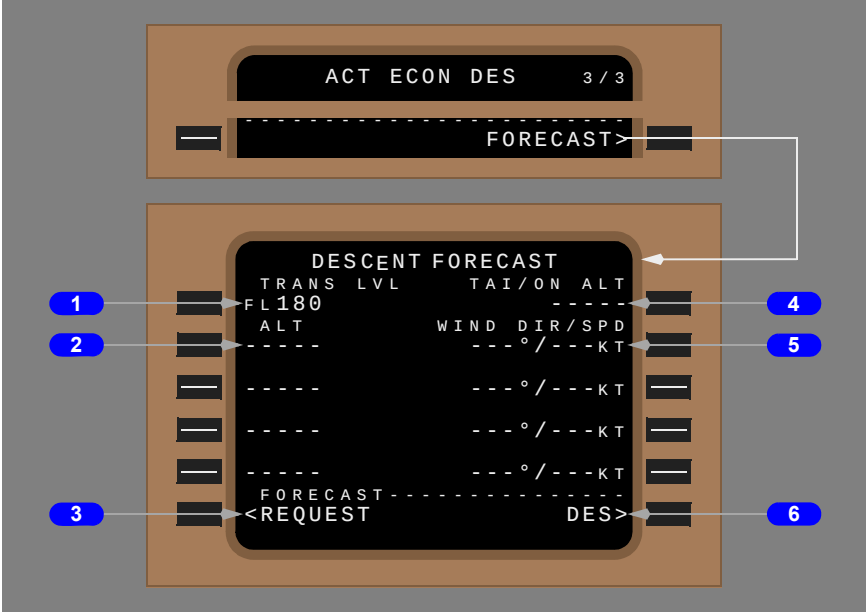
- starts a 1250 feet per minute descent schedule until intercepting the planned descent path
- activates the FMC descent phase

Displays when the descent phase is not active.

Descent Forecast Page

The descent forecast page is used to enter wind data for descent, and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

The primary entries are wind direction and speed for up to four descent altitudes, and the altitude that anti-ice is turned on.



ACT ECON DES 3 / 3

FORECAST

DESCENT FORECAST

TRANS LVL	TAI/ON ALT
FL 180 ALT	
---	WIND DIR/SPD
---	--- ° / --- KT
---	---
---	--- ° / --- KT
---	---
---	--- ° / --- KT
---	---
FORECAST - REQUEST	DES

1 Transition Level (TRANS LVL)

Displays the transition level.

The transition level can be specified by the arrival procedure. The default transition level is FL 180.

Above transition level, altitudes are in flight levels. Below transition level, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

2 Altitude (ALT)

Enter altitude of forecast wind data.

Altitudes and flight levels can be entered in any order. Entries are not sorted.

Execute not necessary.

3 FORECAST REQUEST

Push – transmits a data link request for descent wind data.

4 Thermal Anti-Ice On Altitude (TAI/ON ALT)

Enter the altitude where anti-ice is first turned on during the descent.

5 Wind Direction/Speed (WIND DIR/SPD)

Enter the wind direction/speed for the specified altitude. Initial entry must have wind direction and speed, subsequent entries may have one or the other.

Execute not necessary.

6 Descent (DES)

Push – displays the DES page.

Offpath Descent Page

The offpath descent page allows the analysis of descent performance off the present route of flight, direct to a selected waypoint. Data entered on the page shows clean and drag descent ranges on the page and on the ND. The ranges are based on an entered waypoint and altitude constraint. The range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC puts the last descent waypoint with an altitude constraint into DES TO.

The ECON SPD, SPD TRANS, SPD RESTR, and DES data are the same as the DES page.



1 Descend To (DES TO)

The waypoint for a direct-to descent. Usually, this is the E/D waypoint from the active route. Manual entry of waypoints on or off of the route are allowed. The DTG calculations are for a descent direct to the selected waypoint.

When within 150 feet of the DES TO altitude for a waypoint other than the E/D waypoint, the display automatically changes the DES TO waypoint to the E/D waypoint from the DES page.

A waypoint is entered for direct-to analysis.

2 Distance To Go (DTG)

Displays the straight line distance to the entered waypoint.

3 Speed/Altitude (SPD/ALT)

Displays the speed/altitude constraint for the entered waypoint.

A manual waypoint entry displays boxes for manual speed and altitude entry.

4 TO CLEAN

Distance to the clean descent circle. The distance is negative when a clean descent is no longer possible.

A clean circle assumes no drag devices are used for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the clean circle. The clean circle displays on the ND when the DISPLAY prompt is ON.

5 TO DRAG

Distance to the drag descent circle. The distance is negative when a drag descent is no longer possible.

A drag circle assumes speedbrakes are UP for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the drag circle. The drag circle displays on the ND when the DISPLAY prompt is ON and the airplane is inside the clean circle.

6 DISPLAY

Push – alternates between ON and OFF.

ON – displays the clean and drag circles on the ND. The drag circle does not display until the airplane position is inside the clean circle.

OFF – removes the clean and drag circles from the ND.

Selected state is large green font, otherwise small white font.

Automatically changes to OFF within 150 feet of the waypoint constraint altitude.

Engine Out Descent

There are no specific engine out pages for descent. Use the two engine descent planning features and pages.

Approach

During approach, roll and pitch modes usually change to the approach guidance supplied by navigation radios. The FMC continues to calculate and show present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- ARRIVALS page – to select arrival and approach procedures
- APPROACH REF page – to specify approach flap settings and set the approach VREF
- HOLD page – to manage holding patterns

Holding is described in this section but it can be used during any phase of flight.

Accessing the arrivals page more than 400 NM from the departure airport, more than halfway along the active route, beyond the top of climb and within two minutes of top of descent, or beyond the top of descent, displays arrivals for the destination airport. Prior to these points, accessing the arrivals page displays arrivals for the departure airport.

Sequencing any of the above points also causes the FMC to send landing altitude data to the cabin altitude controller. Until an arrival approach has been selected into the active flight plan, the destination airport altitude is used by the cabin altitude controller.

Arrivals Page

The arrivals page allows selection of a runway, approach, approach transition, standard terminal arrival route (STAR) or profile descent, and an arrival transition to the destination airport. The INDEX key accesses the DEP/ARR INDEX and provides arrival/departure data for any other airport in the navigation database. Route 1 and route 2 have separate arrival pages.

Airports are using multiple RNAV/ILS approaches to the same runway. ICAO has developed a naming convention which adds an additional character to the approach name; Z, Y, X, ... in the approach title following the guidance source. The primary approach is identified as the “Z” approach; all subsequent procedures (normally with different missed approach paths) use the alpha characters in reverse order beginning with Y. This change requires approach names with up to eight characters, rather than the current maximum of six, to be encoded in the navigation database.

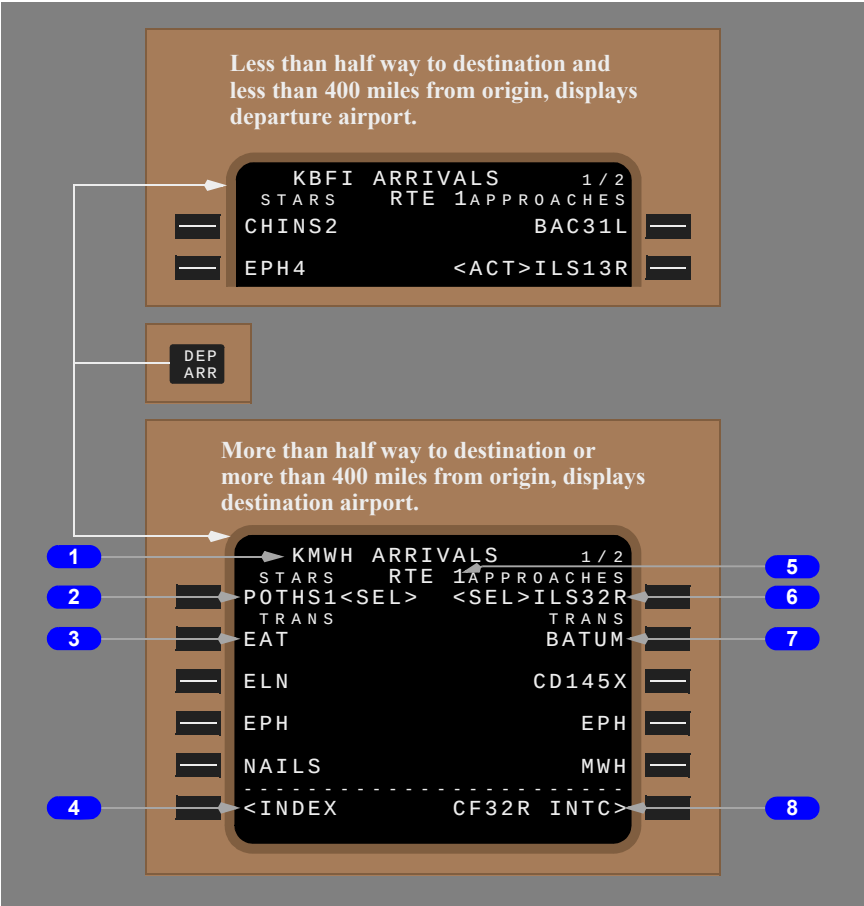
Selecting Options

Selecting a runway, approach, approach transition, STAR/profile descent, or arrival transition displays <SEL> inboard of the selection and displays MOD in the page title. The other options within the same category are removed from the list. When the modification is executed, <SEL> changes to <ACT>. Selecting another page and returning to ARRIVALS displays all options; the applicable <SEL> or <ACT> prompts display.

When a STAR is selected followed by selection of an approach or runway and a transition exists in the navigation database, the transition waypoints with associated speed/altitude constraints are inserted into the flight plan linking the STAR to the approach or runway. If more than one transition exists, selection of the applicable transition is made under TRANS on the left side of the page. Some STARs serve more than one runway. If a STAR and runway are selected and subsequently a different runway is selected, and if the STAR is compatible with the new runway, the transition waypoints are inserted into the flight plan linking the STAR to the runway.

If a different STAR, runway, or STAR-runway combination is desired, selecting another page and returning to the ARRIVALS displays all options.

Arrivals Page – IFR Approaches



1 Page Title

The destination airport identifier displays in the title.
Airports with more than 5 runways or STARS produce multiple arrivals pages.

2 Standard Terminal Arrivals (STARS), Profile Descents (PROF DES)

STARS display in a list under the STAR line title. Profile descents display below STARS under the PROF DES line title.
NONE displays when no STARS in the database.

Push -

- selects STAR or PROF DES for entry into the route, <SEL> displays
- all other arrival procedures no longer display and transitions for the selected procedure display
- deletes a previously selected procedure
- displays ERASE prompt

3 STAR Transitions (TRANS)

Displays list of transitions for the selected arrival procedure.

Push -

- selects transition for entry into the route
- all other transitions no longer display

4 INDEX

Push – displays the DEP/ARR INDEX page.

5 Route 1 (RTE 1)

Displays the active route number (RTE 1 or RTE 2).

6 APPROACHES

Displays the destination airport approaches.

Selection and execution of an ILS approach autotunes the ILS receivers and displays the course. Selection and execution of a back course (BAC) approach autotunes the ILS and displays the front course. BAC approaches cannot be flown in the MCP LOC or APP mode.

Push -

- selects approach for entry into the route; <SEL> displays; TRANS replaces RUNWAYS
- displays profile descents for the selected approach; deletes all other approaches and runways
- displays INTC prompt for the selected approach
- displays ERASE prompt

7 Approach Transitions (TRANS)

Displays a list of transitions to the selected approach.

Approach transitions include IAFs, feeder fixes, and fixes providing routing to the FAF.

When transition not selected, approach will be a straight-in approach starting at a waypoint 4 to 8 miles outside the FAF. Waypoint may be a charted fix or CFXXX (XXX is the runway number).

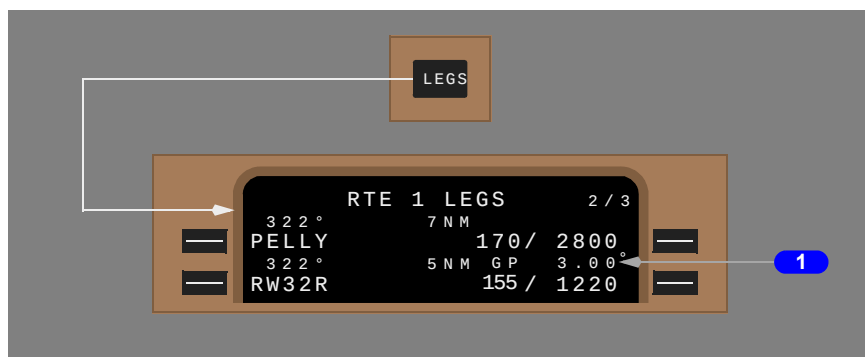
Push –

- selects transition for entry into the route
- deletes all other transitions
- displays INTC prompt for selected transition

8 Final Approach Fix Intercept (XXXXX INTC)

Selecting the prompt displays a modified RTE LEGS page with an intercept course to the approach transition fix (usually the IAF) for the selected approach.

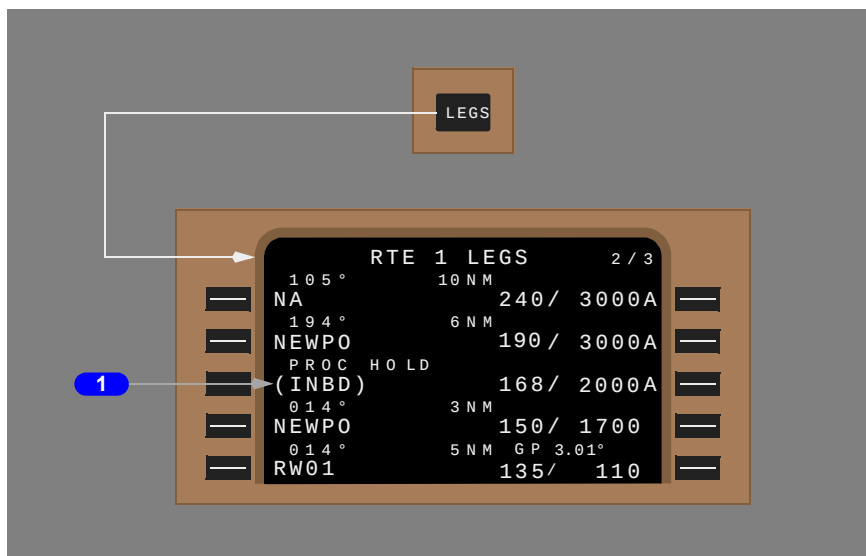
Arrivals Legs Page



1 Glide Path Display

Displays the glide path angle used by VNAV on final approach to the runway. If the runway was selected as part of a published approach, the displayed angle will be close to the published glide path angle, but may differ slightly.

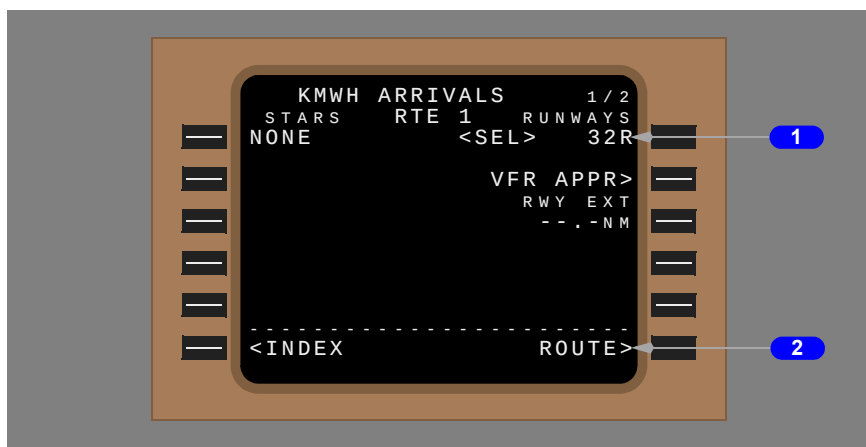
Procedure Hold (in lieu of procedure turn) Legs Page

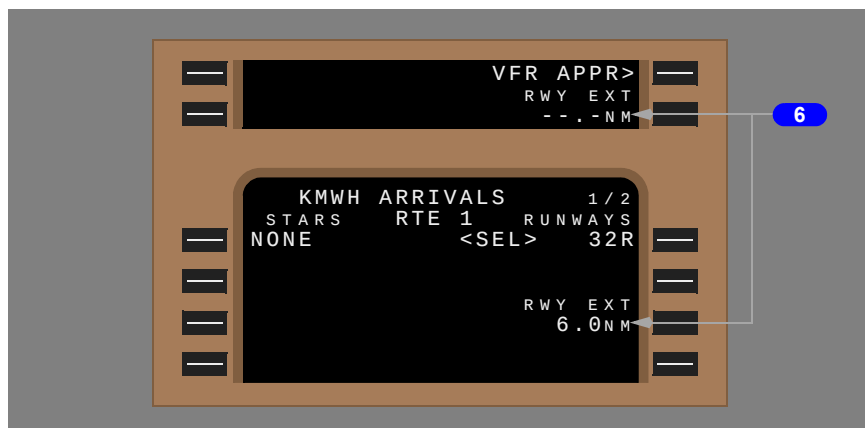
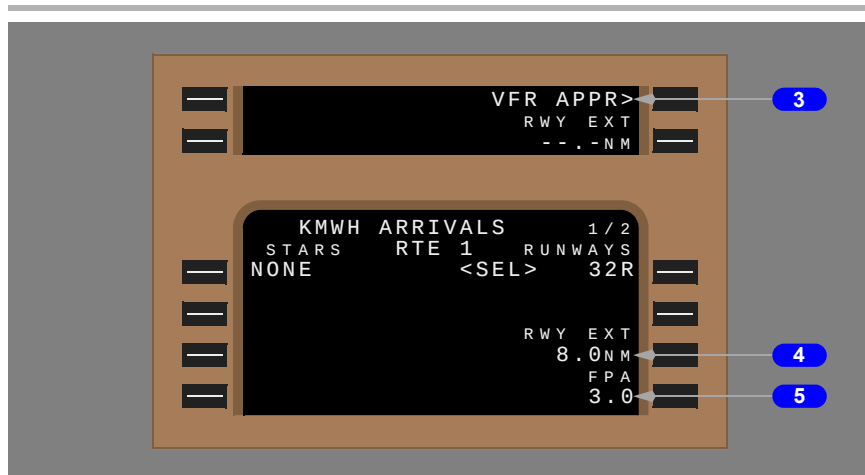


1 Inbound Waypoint

A conditional waypoint (“INBD”) is created at the end of the procedure turn. This waypoint displays on the ND as a small circle. The next line displays inbound heading and distance to the holding fix. The procedure hold is not displayed on a Hold page.

Arrivals Page – VFR Approaches





1 RUNWAYS

Displays a list of runways for destination airport.

Push –

- selects runway for entry into the route
- deletes previously selected approach
- displays runway extension; and, VFR APPR when enabled in the navigation database
- deletes all other runways and approaches
- displays approach intercept fix for selected runway

2 ROUTE

Push – displays the active route page 2/X.

3 VFR Approach (VFR APPR)

Push – makes a transition waypoint, FAXXX at 8 NM and 2000 feet above the runway.

Displays when a VFR approach is in navigation data base for selected runway.

LNAV and VNAV guidance to the runway is available. VNAV programs arrival at the FAF at 170 knots.

4 Runway Extension (RWY EXT)

After VFR APPR selected, displays RWY EXT 8.0; RWY EXT can not be modified.

5 Flight Path Angle (FPA)

Displays flight path angle. Displays only after VFR APPR is selected.

Default is 3.0 degrees. Valid entries are from 2.4 to 3.7 degrees.

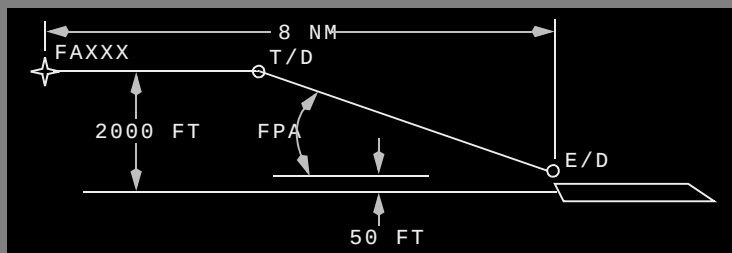
6 Runway Extension (RWY EXT)

Valid entries are from 1.0 to 25.0 miles from the runway threshold.

Entry allowed if VFR APPR is not selected. Entry removes VFR APPR prompt. Example shows 6 NM entered.

Makes waypoint RXYYY, where YYY is the runway; example: RX32R. Makes a route discontinuity before and after the waypoint.

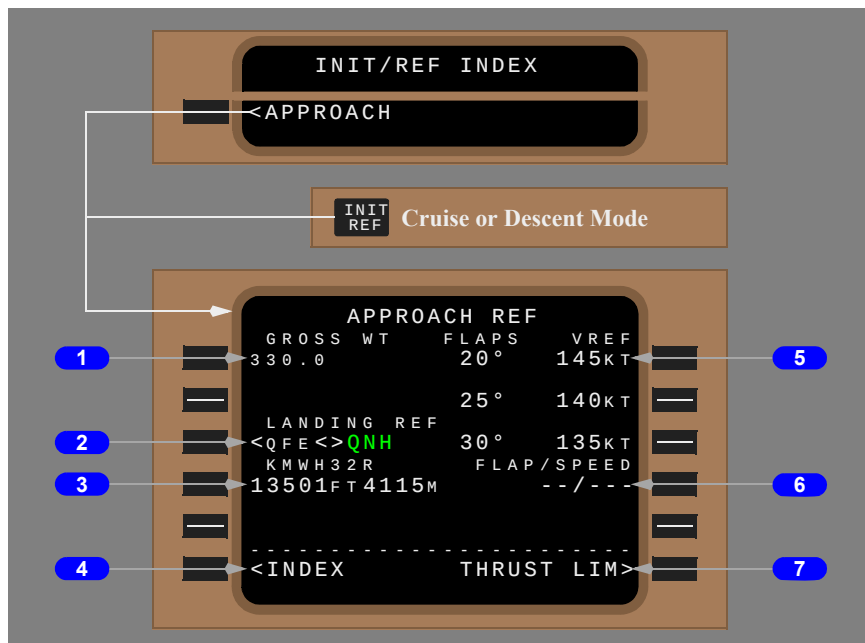
VFR Approach Path



The VFR approach is a level path until the VNAV descent path is intercepted. The descent path begins at the FAXXX waypoint altitude and terminates at the runway threshold at 50 feet. Default values display in RWY EXT and FPA.

Approach Reference Page

The approach reference page displays approach planning data and approach reference speed (VREF) selection.



1 Gross Weight (GROSS WT)

FMC calculated airplane gross weight usually displays.

Manual entry is allowed in case the FMC calculated gross weight is unavailable or invalid, or to allow previewing recommended approach speeds at other than the calculated FMC gross weight. The manually entered gross weight will become the FMC calculated gross weight when a different page is selected and the APPROACH REF page is reselected. Permanent changes to gross weight result in recalculation of all performance data and may only be made on the PERF INIT page.

Displays boxes when gross weight is not available from the FMC.

Valid entry is XXX.X.

2 Landing Reference (LANDING REF)

Landing reference is selectable between QNH and QFE. Usually, QNH is the operating mode.

Selecting QFE sets the cabin pressurization schedule, and the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb phase active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the green background color is removed.

For QFE operations, refer to Supplementary Procedures, Flight Instruments, Displays.

Toggles between QFE and QNH. The active mode displays in large green font. The inactive mode displays in small white font.

3 Runway Length

The displayed runway reference changes based on route progress. The destination runway is the reference when the present position is more that halfway to the destination or more than 400 NM from the origin airport. The origin airport runway is the reference when less than halfway or less than 400 NM from the origin airport.

Displays the length in feet and meters of the referenced runway.

4 INDEX

Push – displays the INT/REF INDEX page.

5 FLAPS VREF

A gross weight is necessary for VREF speed calculation. Push the applicable line select key to select the correct VREF speed. The three VREF speeds are based on landing flap setting.

Displays the calculated reference speed for flaps 20°, 25°, and 30°.

The display is blank until a gross weight is displayed.

6 FLAP/SPEED

The flap position and VREF speed is entered for landing.

The VREF speed displays on the PFD.

Deletion of the data removes VREF from the PFD.

7 Thrust Limit (THRUST LIM)

Push – displays the THRUST LIM page.

Alternate Airport Diversions

ALTN page 1/2 data aids the flight crew in finding a suitable alternate airport. The page displays four airports in an ETA sequence. Each airport on the list has an XXXX ALTN page with more data. Select the XXXX ALTN page with a caret. ALTN LIST page 2/2 may contain a list of uplinked alternate airports.

Three alternate airport uplinks can be received. ALTN LIST page 1/2 can get an uplink for the entire page or for just the ALTN INHIB line. ALTN LIST page 2/2 can receive an uplink of alternate airport names.

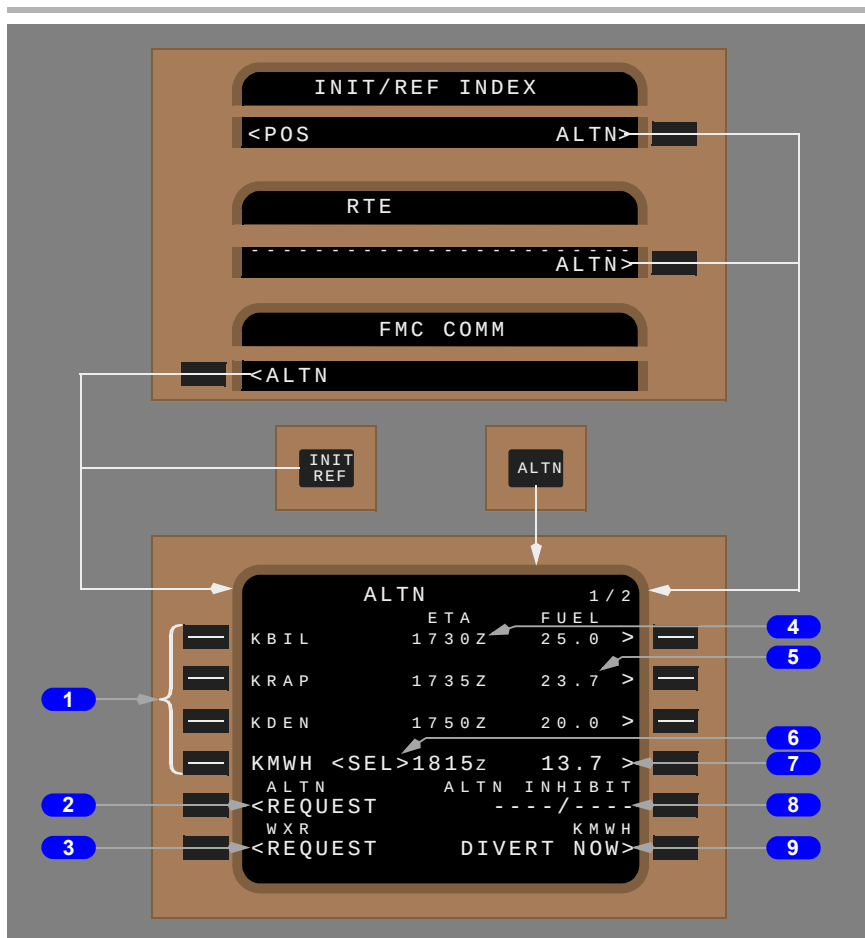
Alternate Page 1/2

The first alternate page displays alternate airport data. An alternate airport can be selected to change the flight plan destination.

The source of alternate airports can be:

- an uplink directly to this page
- automatic selection from the ALTN LIST page
- automatic selection from the navigation database
- manual entry

Alternate airports automatically selected from the alternate list or the navigation database display in small font. All four alternates display on the ND in cyan. The alternate airport symbols display when the ND is in the plan mode. The selected alternate airport displays at all times on the ND map. Other alternates display on the ND when the ARPT switch is on.



1 Alternate Airports

Displays the identifier of the four alternate airports in ETA order when airborne; and, in distance order when on the ground.

Valid manual entry is an airport from the navigation database.

A manual entry into a field displaying a small font value overwrites the small font value, but does not delete it from the Alternates Candidates list. After predictions are complete, the overwritten small font value is placed on the list according to ETA order. A manual entry into a field displaying a large font value overwrites and deletes the large font value. Manual entries display in large font.

The DELETE function key can be used to remove manually entered alternate airports from the ALTN page.

2 Alternate Request (ALTN REQUEST)

Push – transmits a data link request for a preferred list of alternates (up to four).

Uplinked airports display in ETA order but are assigned a preference number by the transmitting site. The scratchpad displays the message ALTN UPLINK when the alternate airport data arrives.

3 Weather Request (WXR REQUEST)

Push – transmits a data link request for alternate airport weather data.

Uplinked weather is sent to the flight deck printer.

4 ETA

ETA is calculated based on the routing, altitude, and speed displayed on the XXXX ALTN page. ETA is blank when the airplane is on the ground.

Displays the alternate airport ETA.

Blank when airplane is on the ground.

5 FUEL

Predicted arrival fuel is calculated based on the routing, altitude, and speed displayed on the XXXX ALTN page. The message UNABLE FUEL displays in the FUEL column if the predicted arrival fuel is less than zero.

Fuel values are blank when the airplane is on the ground.

Displays the alternate airport predicted arrival fuel.

Blank when airplane is on the ground.

6 Selected (<SEL>)

The selected alternate is identified with an <A> or <SEL> to the right of the airport identifier. Usually, the closest alternate is selected and identified with <A>. Manually selecting an alternate places <SEL> to the right of the airport identifier. The selected alternate identifier displays in the line title of the DIVERT NOW prompt.

The FMC selects the alternate airport with the earliest ETA. FMC selected alternates display <A> to the right of the airport identifier.

A manual selection of an alternate airport is made by pushing the line select key left of the airport identifier. Manually selected alternates display <SEL> to the right of the airport identifier.

Entering a new airport into the list of four does not select the new airport.

An alternate airport can be manually selected.

Use the DELETE function key on a manually selected alternate to remove <SEL>. The automatic selection function selects a new alternate.

7 Alternate Select

Push - displays the XXXX ALTN page for the alternate airport adjacent to the > prompt.

8 Alternate Inhibit (ALTN INHIBIT)

An airport will not be one of the four alternate airports if entered into the alternate inhibit line.

One or two airports can be entered.

Alternate inhibits can be manually entered or uplinked. The inhibited airports may be uplinked with the ALTN UPLINK or separately. If uplinked separately, the scratchpad displays the message ALTN INHIBIT UPLINK.

Valid entries are airports from the navigation database.

9 DIVERT NOW

Selecting DIVERT NOW displays the route from the present position to the selected alternate using the route displayed on the XXXX ALTN page for the diversion airport. The details of the route can be confirmed or modified before the diversion is executed.

Execution of the diversion:

- changes the route destination airport
- includes the route modification into the active flight plan
- deletes all parts of the original route that are not part of the diversion
- if a descent path exists, deletes all descent constraints (the scratchpad message DESCENT PATH DELETED displays when DIVERT NOW is selected)

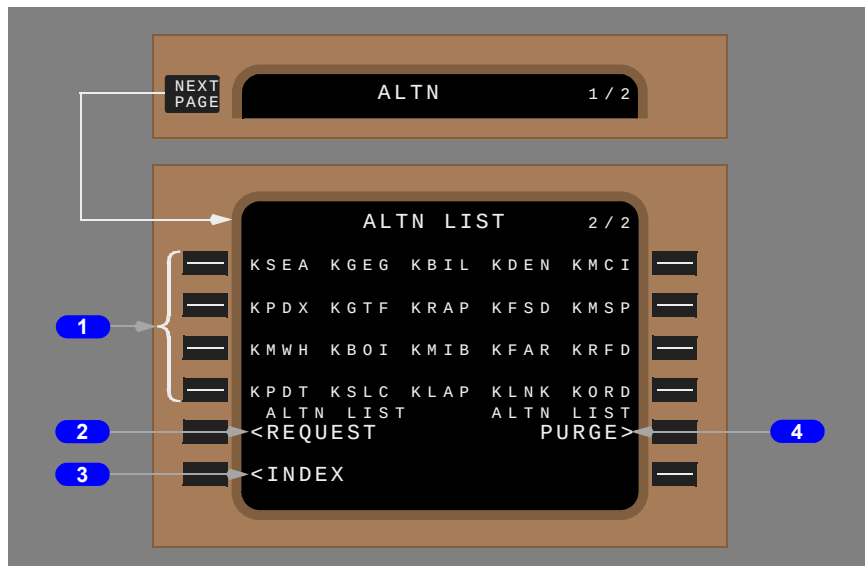
After a divert is executed the XXXX ALTN page is not updated until all CDUs are selected off of the XXXX ALTN page.

Push –

- makes an LNAV route modification for a divert to the selected alternate
- displays the MOD XXXX ALTN page for the selected alternate
- displays SELECTED in place of DIVERT NOW
- blank on ground
- blank in the air when a diversion is not permitted

Alternate List Page 2/2

The second alternate page displays a list of previously uplinked alternate airports. The alternates on the ALTN 1/2 page are selected from this list or from the navigation database when a list does not exist.



1 Alternate Airports List

These four lines contain up to 20 airports from which alternates can be selected and displayed on ALTN page 1/2 when preferred uplinked airports do not use all four lines.

The list is uplinked directly to this page. No manual entry is allowed. Manual airport entries are accomplished on the ALTN 1/2 page.

2 Alternate List Request (ALTN LIST REQUEST)

Push – transmits a data link request for an alternate airport list uplink.

3 INDEX

Push – displays the INIT/REF INDEX page.

4 Alternate List Purge/Confirm (ALTN LIST PURGE/CONFIRM)

When no list exists, alternate airports can be selected from the navigation database.

Selecting the PURGE prompt arms the purge function and displays a CONFIRM prompt before the list is deleted.

Push – deletes all airports from the list.

A new list must be uplinked after a purge.

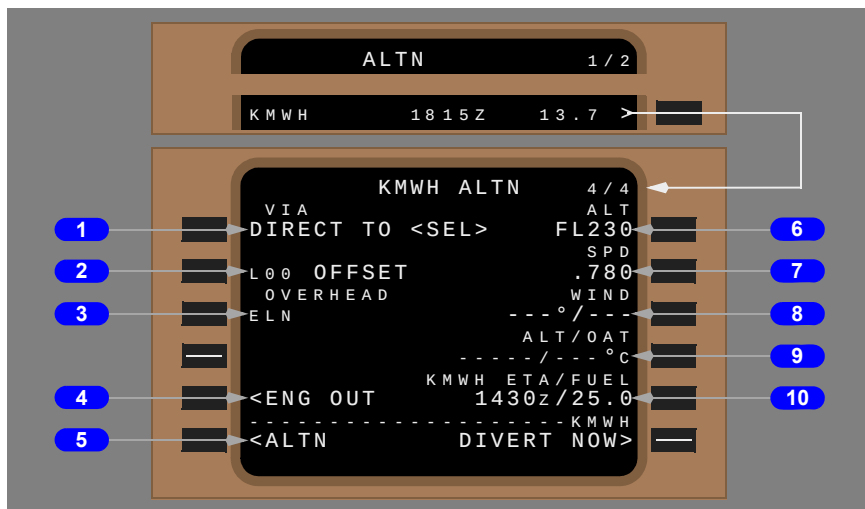
XXXX Alternate Page

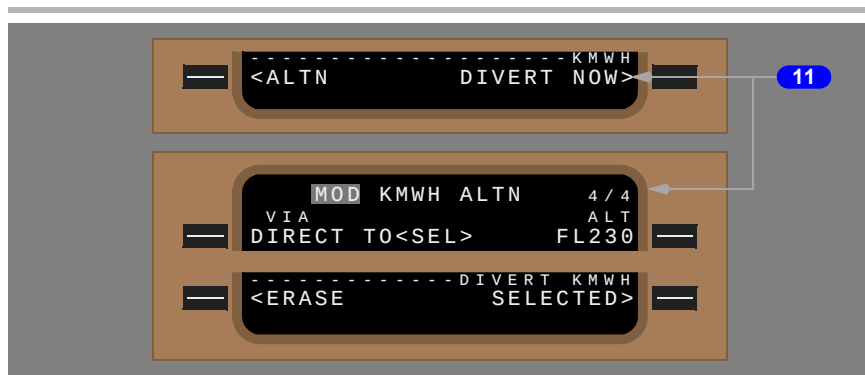
Each of the four alternate airports displayed on the ALTN page 1/2 has a related XXXX ALTN page. The XXXX ALTN pages display specific data about alternate airports, the route used for a diversion, and the conditions on which the ETA and fuel calculations are based. All data on the page is related to the alternate airport displayed in the page title.

Three route options to the airport can be selected:

- DIRECT TO – direct to alternate
- OFFSET – flight plan route with an offset
- OVERHEAD – flight plan route to a waypoint, then direct to alternate

The selected route option has an effect on ETA and fuel remaining. It is identified by <SEL>. Selection of a route option for one alternate selects the same route option for the other three alternates.





1 VIA DIRECT TO

Push – selects DIRECT TO route option.

All flight plan waypoints are deleted.

2 VIA OFFSET

Push –

- with scratchpad empty, selects OFFSET route option
- with offset data in scratchpad, enters offset data. Does not select option.

Entry and exit to the offset is the same as for the RTE page offset. Flight plan waypoints are retained.

3 VIA OVERHEAD

Push –

- with scratchpad empty, selects OVERHEAD option
- with overhead data in scratchpad, enters overhead data. Does not select route option

Displays active waypoint in flight plan.

The waypoints up to the selected or entered overhead waypoint are retained, then routing is direct to the alternate airport. All waypoints after overhead waypoint are deleted.

Enter any waypoint in the active or modified route.

4 Engine Out (ENG OUT)

This prompt performs the same function as described on the cruise page in the FMC Cruise section. It can be selected before or after the diversion is selected.

5 Alternate (ALTN)

Push – displays the ALTN 1/2 page.

6 Altitude (ALT)

Entry of any valid altitude or flight level into this line causes a recomputation of ETA and arrival fuel. Altitude entries do not become part of the diversion modification. Altitude entries apply to all four alternates.

Displays the altitude for which ETA and arrival fuel are calculated.

The scratchpad message UNABLE ALT displays if the entry is above maximum altitude or the top of climb point for divert is after top of descent point for divert.

7 Speed (SPD)

Entry of speed or Mach number into this line causes a recomputation of ETA and arrival fuel. Speed entries do not become part of the diversion modification. Speed entries apply to all four alternates.

Speed modes available are:

- ECON (economy)
- LRC (long range cruise)
- EO (engine out)
- EO LRC (engine out long range cruise)
- CO (company speed)
- any CAS or Mach

8 WIND

Entry of data causes recomputation of ETA and arrival fuel. A wind entry may be made for each of the four alternates. A wind entry applies to only one alternate.

Valid entry is a direction in degrees/speed in knots from 1 to 999.

9 Altitude/Outside Air Temperature (ALT/OAT)

Entry of data into these lines causes a recomputation of ETA and arrival fuel. A separate ALT/OAT entry may be made for each of the four alternates.

Displays the OAT for a specific altitude.

Valid entry is an altitude/temperature in degrees C.

10 Alternate Airport ETA/Fuel (XXXX ETA/FUEL)

Displays calculated airport ETA and arrival fuel based on the selected route, altitude, and speed displayed on this page.

11 XXXX DIVERT NOW

This prompt performs the same function as described on the ALTN 1/2 page.

Note: After a divert is executed, the XXXX ALTN page data is not updated until all CDUs change to a page other than the XXXX ALTN page.

Holding

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- airplane track, not heading or direction from which the active route approaches the holding pattern, determines the entry method used (parallel, teardrop, or direct entry)
- the airplane flies the initial outbound leg a computed distance from the holding fix, rather than a specific time. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active
- teardrop entries use a 40 degree offset angle

Holding Entry

Airplane track to the holding fix determines the entry type; direct, teardrop, or parallel. To make efficient use of the holding airspace, lateral guidance may direct the initial turn to the holding pattern prior to crossing the holding fix (fly-by). The holding entry path displays on the ND. For all holding entry types, lateral guidance directs the airplane to fly-by or fly-over the holding fix and to remain on the holding side of the inbound holding course. Depending on the entry track for a direct entry, the flight path may extend slightly beyond the displayed outbound holding turn. For teardrop and parallel entries, the flight path remains within the confines of the depicted holding pattern displayed on the ND. Remaining within the prescribed holding airspace requires the airplane to be at holding airspeed at the holding fix.

Hold Page (First Hold)

The hold page is used to enter a holding pattern in the route.

When the flight plan does not contain a holding pattern, pushing the HOLD function key displays the RTE X LEGS page with the HOLD AT line.

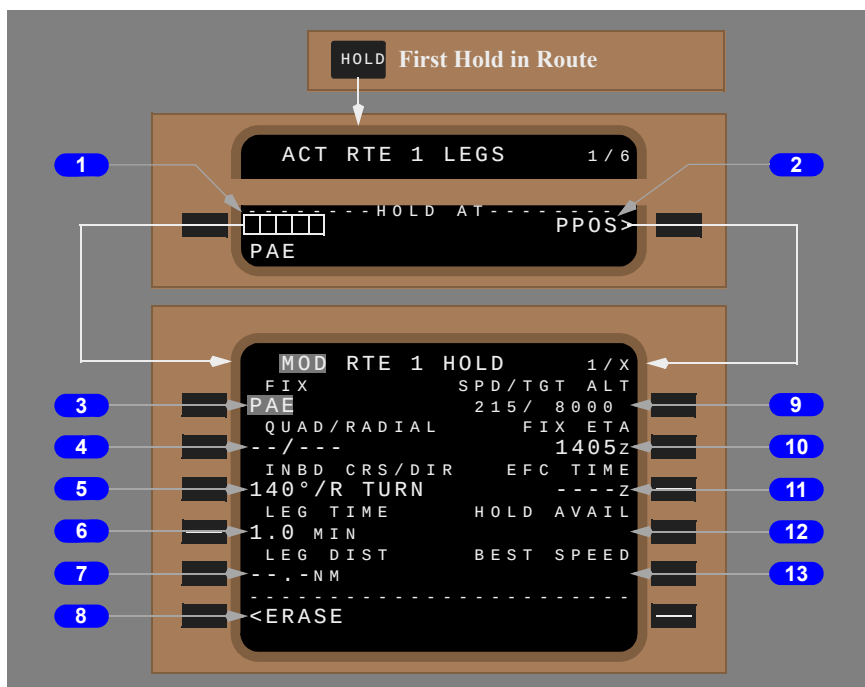
Two versions of the hold page are possible:

- an airway or procedure holding pattern
- a flight crew–entered holding pattern

The holding page displays actual or default data about the holding pattern.

Entries modify the route. Modifications can be erased or executed.

Active holding patterns are magenta on the ND.



1 HOLD AT

Displays boxes to enter the holding fix: a RTE LEGS, database, or pilot-defined waypoint; a navaid or airport identifier; or a FAF already in the flight plan.

Entering a holding fix displays the RTE X HOLD page.

2 HOLD AT Present Position (PPOS)

Push -

- creates a holding pattern at present position
- execution establishes the holding fix at the position when EXEC is pushed and displays RTE HOLD

3 Holding FIX

Displays the holding fix.

4 Quadrant/Radial (QUAD/RADIAL)

Normally displays dashes.

Valid entry is X/XXX, XX/XXX, or /XXX. Example: NW/330.

Entry changes INBD CRS/DIR to agree.

5 Inbound Course/Direction (INBD CRS/DIR)

Displays inbound course and turn direction.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Entry changes QUAD/RADIAL to agree.

Displays magenta when the holding fix is the active waypoint.

6 Leg Time (LEG TIME)

Displays 1.0 MIN (minute) at or below 14,000 feet.

Displays 1.5 MIN above 14,000 feet.

Displays dashes when an entry made on LEG DIST line.

Valid entry is X, X.X, or .X.

When climbing/descending through 14,000 feet with VNAV active and the SPD/TGT ALT at 1R displays in large font, the FMC adjusts the leg time (1.0 MIN at or below 14,000 feet; 1.5 MIN above 14,000 feet).

7 Leg Distance (LEG DIST)

Normally displays dashes. Allows entry of leg distance for hold.

Entry displays dashed on LEG TIME line.

Valid entry is XX.X or X.X.

8 ERASE

Erases all FMC modifications.

9 Speed/Target Altitude (SPD/TGT ALT)

Dashes display or fix speed/altitude constraint from the RTE LEGS page.

Manual entries are in large font.

During cruise, entry of a target altitude lower than CRZ ALT modifies the DESCENT page and displays a T/D. After T/D, the DESCENT page remains active unless a new cruise altitude is entered.

Altitude, or speed and altitude may be entered.

Note: When descending to a HOLD with VNAV active and the entry altitude is expected to be above the clearance holding altitude, the clearance altitude must be entered in 1R to prevent the airplane from leveling when sequencing the holding fix.

10 FIX ETA

With no EFC TIME entry, displays time the airplane will next pass the holding fix.

With EFC TIME entry, displays time the airplane will pass the holding fix after the EFC time. The FMC uses this time to calculate downtrack ETAs and fuel values based on departing the holding fix at the new FIX ETA.

11 Expect Further Clearance Time (EFC TIME)

Normally displays dashes.

Valid entry is XXXX (time).

Entry changes performance predictions for the route after holding.

12 Hold Available (HOLD AVAIL)

Displays holding time available before requiring reserve fuel to reach the destination.

13 BEST SPEED

Displays the best holding speed for the airplane gross weight, altitude, and flap setting.

Note: May exceed ICAO limit speed.

HOLD Page (Existing Hold)

When one or more holding patterns exist in the route, push the HOLD key to display the hold page for the first holding pattern. When the hold is the next LNAV event, active commands display in magenta. Holding parameters can be monitored and changed on this page. New holding patterns are added using the NEXT HOLD prompt.

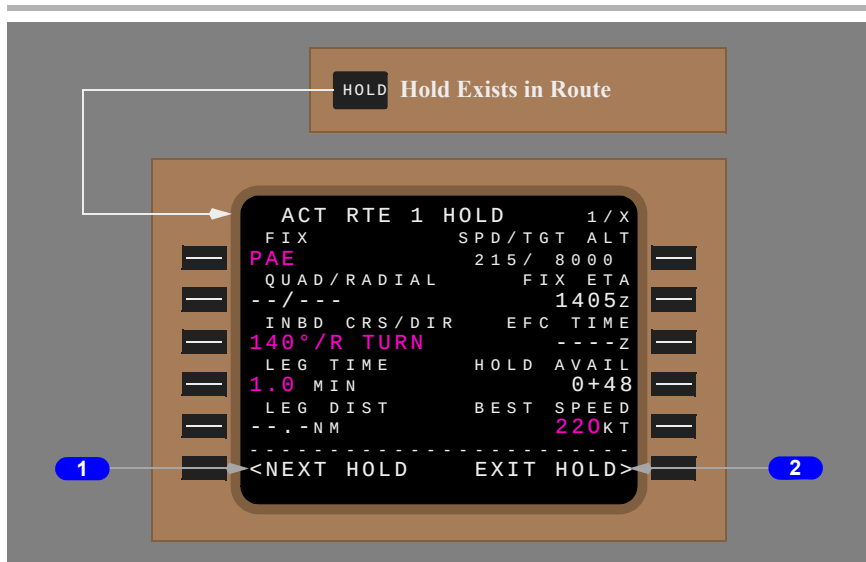
Most holding patterns are part of a procedure or airway and remain active until the flight crew executes an exit from holding. This may be accomplished in one of two ways.

- on the ACT RTE LEGS page, deleting or bypassing the HOLD AT waypoint causes LNAV to command a direct to the next waypoint
- on the ACT RTE HOLD page, selecting and executing EXIT HOLD> causes LNAV to command the airplane to continue in the holding pattern until arriving at the holding fix, at which time the airplane exits the holding pattern

Following execution of the exit hold, only the remaining portion of the holding pattern back to the holding fix displays. Exit from the holding pattern may occur prior to crossing the holding fix (“fly-by”) if the course to the next waypoint is not closely aligned with the holding inbound course. The exiting flight path will remain within the confines of the protected holding airspace. The exit flight path displays on the ND. At high groundspeed and extreme exit track angles (angle between the course to the next route waypoint and the inbound course to the holding fix), a path discontinuity, typically in the shape of a “Z”, may display on the ND as the exit flight path. In all instances, LNAV provides appropriate lateral guidance to intercept the active leg to the next route waypoint.

The FMC automatically commands an exit from some holding patterns in procedures under the following conditions.

- for instrument approach holding patterns designed as a course reversal in lieu of a procedure turn, the airplane exits holding upon arrival at the holding fix inbound. Header at 1L displays PROC HOLD
- for some holding patterns in SIDs, the airplane exits holding when arriving at an altitude. Header at 1L displays HOLD AT



1 NEXT HOLD

Push – displays a new hold page for a new holding pattern entry.

2 EXIT HOLD

Push –

- arms a holding pattern exit
- EXIT ARMED displays in shaded white; when executed, airplane returns to the holding fix via the inbound course for holding pattern exit

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Introduction

The CDUs can be used as an alternate navigation system if both FMCs fail. The CDUs calculate lateral navigation for the autopilot flight director system (AFDS). Pushing the LNAV switch engages the lateral steering commands. A master CDU is selected and uses ADIRU position data for navigation. VNAV is not available. Autothrottles may be available. The CDU can be used to tune the navigation radios.

During normal FMC operation, all system capabilities are contained within the FMCs. During alternate navigation operation, the CDUs use their own internal memory and computing capability. Active flight plan data from one CDU is copied to the other CDUs. Modifications display on the CDU used for the modifications. The other CDU displays the changes after execution.

All three CDUs receive inputs from the ADIRU. Usually, the left CDU provides information to the left ND map and the right CDU provides information to the right ND map. The center CDU is automatically selected after failure of the left or right CDU.

The autopilot selects a master CDU for lateral steering commands in this order:

- left CDU if functioning, then
- center CDU if functioning, then
- right CDU.

Alternate Navigation Waypoints

The CDUs do not have a performance or navigation database. The CDUs continuously copy the active route from the FMC. If both FMCs fail, the CDUs retain flight plan waypoints, except for conditional waypoints, offsets, holding patterns, and missed approach waypoints. Waypoints on the copied route can be referenced by either their identifier, or latitude and longitude.

New waypoints can only be entered in latitude and longitude. This includes waypoints the flight crew has deleted from the copied route.

Alternate Lateral Navigation

All CDU calculations are based on a great-circle course between waypoints. The CDU does not accept undefined waypoints or conditional waypoints. Complete departure or arrival/approach procedures cannot be manually entered or cross-loaded from the FMC if they contain undefined or conditional waypoints. The CDU makes a discontinuity at those waypoints. However, individual legs of a procedure can be manually entered or cross-loaded if they constitute a great-circle course.

Route Changes

Route changes are made on the ALTERNATE NAVIGATION LEGS page in almost the same manner as normal FMC operations. All courses between waypoints are direct routes. When the active waypoint is modified, the only navigational choice is present position direct to the modified active waypoint.

A route change to any one CDU displays on the other CDUs when the modification is executed.

Course Reference

The ADIRU supplies magnetic variation for present position. Only the active waypoint course can be referenced to magnetic north. All subsequent waypoint courses are true courses.

Alternate Navigation Radio Tuning

The radios must be manually tuned on left and right CDUs in alternate navigation. The left CDU tunes the left VOR, DME, ADF, and left and center ILS. The right CDU tunes the right VOR, DME, ADF, and right ILS. Manual tuning is accomplished on the ALTERNATE NAVIGATION RADIO page.

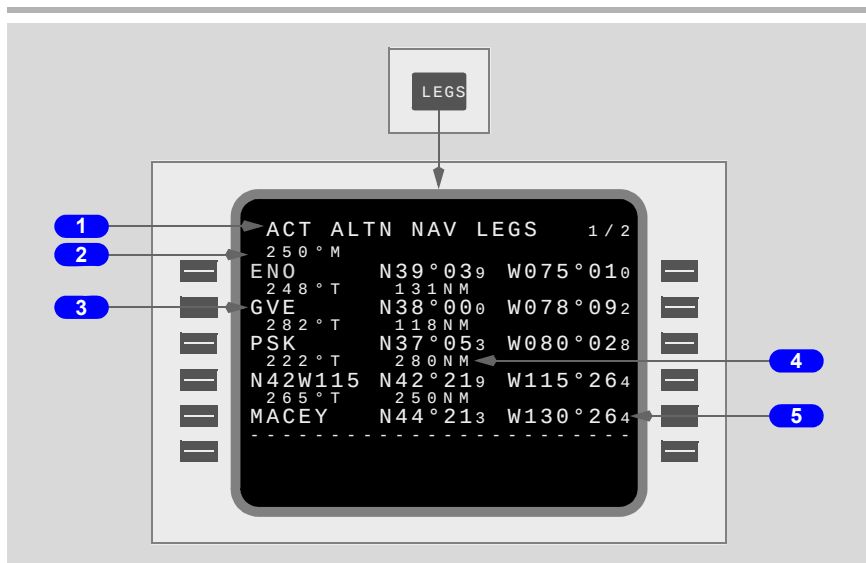
Alternate Navigation CDU Pages

The alternate navigation system operates from three CDU pages:

- ALTERNATE NAVIGATION LEGS
- ALTERNATE NAVIGATION PROGRESS
- ALTERNATE NAVIGATION RADIO.

Alternate Navigation Legs Page

This page displays data about each leg of the route. The route can be modified. Waypoint speed and altitude restrictions are not displayed because performance data is not available.



1 Page Title

If the ACT ALTN NAV LEGS page is modified, MOD ALTN NAV LEGS displays until the EXEC key is pushed.

2 Leg Direction

Displays course to the waypoint.

Course reference is M for magnetic, T for true.

Active waypoint leg direction can be magnetic or true. Subsequent waypoint leg directions are true.

3 Waypoint Identifier

Displays the waypoint by name or latitude/longitude.

Valid entries are waypoint names in the route or latitude/longitude for new waypoints.

4 Distance to Waypoint

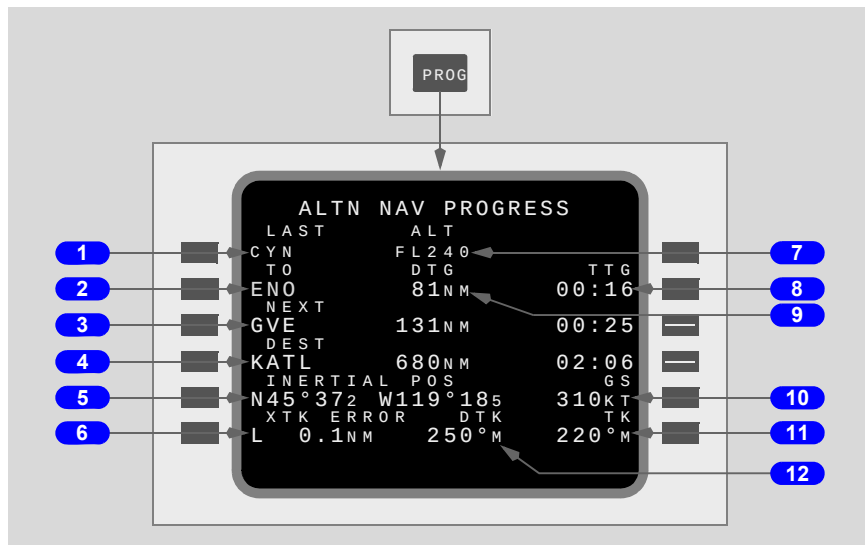
Displays the great circle distance between waypoints.

5 Waypoint Coordinates

Displays the waypoint coordinates.

Alternate Navigation Progress Page

This page displays general data about flight progress.



1 LAST

Displays the identifier of the last waypoint.

2 TO

Displays the active waypoint on the route. The waypoint identifier displays in magenta. This distance and time to go display to the right of the waypoint.

3 NEXT

Displays the waypoint after the TO waypoint. NEXT data displays in white.

4 Destination (DEST)

Displays the identifier for the route destination waypoint or airport. Any waypoint on or off the route can be entered. Time and distance data temporarily displays for that waypoint.

Display options:

- destination airport identifier; distance and time to go along track to the destination airport.
- entry of an existing flight plan waypoint (identifier or latitude/longitude) causes the line title to change to ENROUTE WPT. Time and distance to go are from present position along the flight plan route to the entered waypoint
- entry of a waypoint not in the flight plan causes the line title to change to DIR TO ALTERNATE. Time and distance to go are from the present position direct to the new waypoint.

5 Inertial Position (INERTIAL POS)

Displays ADIRU present position.

6 Cross Track Error (XTK ERROR)

Displays airplane left or right cross-track error in nautical miles from the active route track.

7 Altitude (ALT)

Displays airplane altitude when the LAST waypoint was crossed.

8 Time to Go (TTG)

Displays time to go to associated waypoint or destination.

9 Distance to Go (DTG)

Displays distance to go to associated waypoint or destination.

10 Ground Speed (GS)

Displays ADIRU groundspeed.

11 Track (TK)

Displays airplane track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

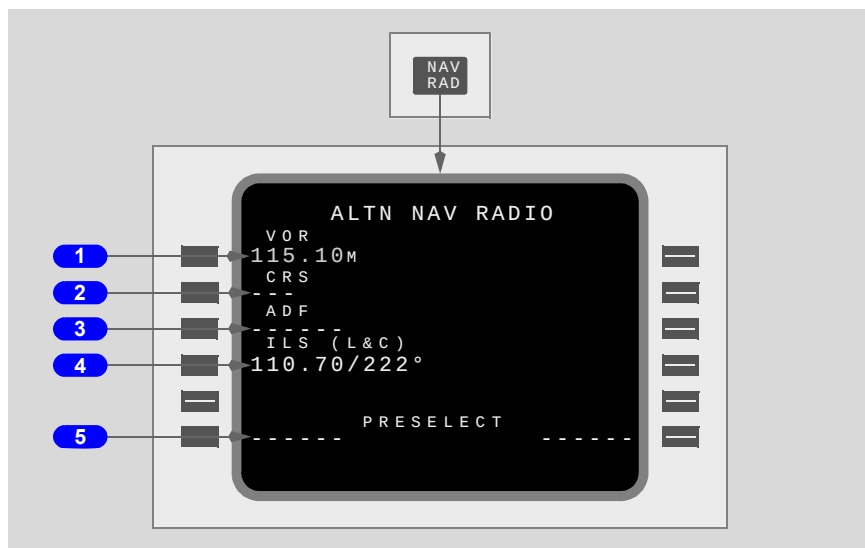
12 Desired Track (DTK)

Displays desired track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

Alternate Navigation Radio Page

Navigation radios are tuned on this page and related parameters display. Autotune is not available. The CDUs operate independently for navigation radio tuning:

- the left CDU tunes the left radios and center ILS
- the right CDU tunes the right radios.



1 VOR

Displays last selected VOR frequency. Tuning status displays as manual (M).

Valid entry is VOR frequency or VOR frequency/course.

Entry tunes related DME frequency.

2 Course (CRS)

Displays selected VOR course.

Valid entry is VOR course or VOR frequency/course.

3 ADF

Displays ADF frequency. Tuning status displays as ANT or BFO.

Displays dashes if no ADF frequency entered on NAV RAD or ALTN NAV RAD pages after initial power up.

Valid entry is ADF frequency or ADF frequency suffixed with A or B. Suffix may be changed after entry.

4 ILS

Displays last selected ILS frequency, ILS frequency and course, or PARK.

Valid entries are:

- ILS frequency
- ILS frequency/front course
- front course only (a frequency must already be displayed).

Note: If the ILS was in autotune at the time of the FMC failure, the frequency and course are automatically copied to the ALTN NAV RADIO page.

Note: The ILS frequency displays PARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note: ILS course and frequency must be entered on the left, center, and right ALTN NAV RADIO page.

The line title is L & C on the left CDU and R on the right CDU.

DME data for the ILS displays when the EFIS control panel ND mode selector is set to APP.

5 PRESELECT

Allows entry of two separate preselected frequencies and/or frequencies/courses.

Valid entries are any of the entries that can be made on the other lines.

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Flight Management, Navigation

EICAS Messages

Chapter 11

Section 60

Navigation EICAS Messages

The following EICAS messages can display.

Message	Level	Aural	Message Logic
ADIRU ALIGN MODE	Memo		ADIRU is in align mode.
FMC	Advisory		Both FMCs have failed or FMC selector is in L with left FMC failed or in R with right FMC failed.
FMC L, R	Advisory		Affected FMC has failed.
FMC MESSAGE	Advisory		A message is in the FMC scratchpad.
FMC RUNWAY DISAGREE	Caution	Beeper	Airplane is not on FMC origin runway when either engine's thrust is in the takeoff range.
GPS	Advisory		GPS has failed.
ILS ANTENNA	Caution	Beeper	Two or more ILS receivers are not using the correct antennas for best reception.
NAV ADIRU INERTIAL	Caution	Beeper	ADIRU is not capable of providing valid attitude, position, heading, track, and groundspeed.
NAV AIR DATA SYS	Advisory		Information from the air data sources is no longer being combined for display.
NAV UNABLE RNP	Caution	Beeper	Navigation performance does not meet required accuracy during all phases of flight.
SINGLE SOURCE ILS	Caution	Beeper	Both PFDs and NDs are using the same source for ILS information.
TRANSPONDER L, R	Advisory		Affected transponder has failed.

FMC Messages

FMC messages indicate: degraded system operation, data input errors, or data link status. The messages are categorized as:

- alerting messages
- advisory messages
- communications messages
- entry-error advisory messages.

The scratchpad messages display according to their level of importance. A less important message replaces another message in the scratchpad when the CLEAR key is pushed or the condition is corrected.

The EICAS displays the advisory message FMC MESSAGE when there is an FMC alerting message. The EICAS displays the message •FMC when there is an FMC communications message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

FMC Alerting Messages

FMC alerting messages:

- display in the CDU scratchpad
- cause the EICAS advisory message FMC MESSAGE to display
- illuminate the CDU message light (MSG).

Use the CLEAR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALIGNMENT REINITIATED – ADIRU alignment has automatically restarted due to airplane motion, or if the flight crew–entered initial position fails the alignment comparison tests.

CHECK ALT TGT – VNAV activates when the airplane is between the MCP and FMC altitudes. VNAV maintains level flight.

CHECK AIRLINE POLICY – after loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the loaded value and notifies the flight crew of the difference. This is a maintenance function.

Note: If the scratchpad message is cleared, it does not display again for that load.

DESCENT PATH DELETED – VNAV active and all waypoint altitude constraints defining the descent profile deleted.

Note: This message displays before execution of the modification which deletes the descent path.

DISCONTINUITY – LNAV active and the route is not defined after the waypoint (except when the waypoint is before a manually terminated leg, such as FM, VM, HM legs).

- FM – a course from a fix to a flight crew entered manual route termination
- VM – a heading leg from a fix to a flight crew entered manual route termination
- HM – a holding pattern to a flight crew entered manual route termination.

DRAG REQUIRED – VNAV active and additional drag required or autothrottle off and less thrust required to maintain the VNAV descent path.

END OF OFFSET – LNAV active and two minutes prior to end of active route offset. AFDS maintains last heading if active route offset overflowed.

END OF ROUTE – LNAV active and end of active route overflowed. AFDS maintains last heading.

ENTER INERTIAL POSITION – the flight crew–entered present position did not pass one of the ADIRU comparison checks, or the ADIRU is ready to change to navigate mode and has not received a present position entry. Use the CLEAR key to remove this message.

ILS TUNE INHIBIT - MCP - flight control computers inhibiting changes in ILS tuning and either a manual operation in the ILS tuning field attempted or a new arrival ILS approach activated.

INERTIAL/ORIGIN DISAGREE – the airplane is on the ground and one of these conditions exist:

- The inertial position entered on the POS INIT page differs from the position of the origin airport in the active route by more than 6 NM.
- A route is activated and executed containing an origin airport with a position that differs from the ADIRU inertial position by more than 6 NM.

INSUFFICIENT FUEL – estimated fuel at destination less than entered RESERVES value. This may indicate an engine fuel leak.

LIMIT ALT FLXXX – the flight crew– or FMC–selected altitude is greater than the VNAV limit altitude.

LNAV BANK ANGLE LIMITED - before entering or while flying a curved path or holding pattern, the FMC predicts the LNAV roll command will be limited by thrust or buffet based roll limits.

NAV DATA OUT OF DATE – the clock calendar date is after the active navigation database valid calendar cycle.

NAV INVALID–TUNE XXXX – RNAV or VOR approach procedures must have a specific navaid tuned. It is either not tuned or a valid signal is not being received.

NO ACTIVE ROUTE – LNAV selected and no active route activated.

NO ROUTE DATA – in ALTN NAV, LNAV selected and the CDU does not have an active lateral route.

PERF/VNAV UNAVAILABLE – VNAV selected and gross weight, cost index, or cruise altitude are not entered.

RESET MCP ALT – 2 minutes prior to the top of descent point with VNAV active and MCP not set to altitude below cruise altitude.

RTA FIX DELETED – RTA fix has been deleted from the modified flight plan.

RW/ILS CRS ERROR –

- the airplane is within ILS automatic tuning range and the tuned ILS course does not match the course for the active arrival runway, or
- the FMC is not receiving valid course data from the same ILS the FMC is using for frequency data
- inhibited if scratchpad message ILS TUNE INHIBITED–MCP displayed.

RW/ILS FREQ ERROR –

- the airplane is within ILS automatic tuning range and the tuned ILS frequency does not match the frequency for the active arrival runway, or
- the FMC is not receiving valid frequency data from either ILS
- inhibited if scratchpad message ILS TUNE INHIBITED – MCP displayed.

SINGLE FMC L OPERATION – the right FMC is not operational.

SINGLE FMC R OPERATION – the left FMC is not operational.

TAKEOFF SPEEDS DELETED – selected V speeds are invalid.

THRUST REQUIRED – VNAV active, autothrottle disconnected, and additional thrust required to track VNAV descent path and maintain speed.

UNABLE FLXXX AT RTA FIX – predicted crossing altitude at RTA fix less than FLXXX, but predicted ETA within tolerance.

UNABLE HOLD AIRSPACE - the radius of the holding pattern calculated by the FMC exceeds the FMC maximum protected airspace limits.

UNABLE RTA – RTA not achievable within applicable arrival time tolerance.

UNABLE NEXT ALT – VNAV active and climb not sufficient to comply with waypoint altitude constraint.

VERIFY POSITION – the FMC calculation of airplane present position is based on conflicting data. The possible conflicts are:

- the primary and secondary FMC positions differ by more than the greater of RNP or 0.4 NM for 5 seconds, or
- the difference between the FMC and the navigation aid being used (GPS, DME, VOR, or inertial) positions is greater than 12NM for 5 seconds.

VERIFY RNP – POS REF 2/3 – the default RNP has changed due to a change in flight phase and the flight crew entered RNP value exceeds the new default RNP value.

VIA OFFSET INVALID – flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.

FMC Communications Messages

FMC communications messages:

- display in the CDU scratchpad
- cause the EICAS communications message •FMC to display
- illuminate the CDU message light (MSG)
- cause the communications aural high–low chime to sound.

ALTN UPLINK – Up to four company–preferred alternate airports and associated data has been received and is available for preview on the ALTN page.

ALTN INHIBIT UPLINK – uplink contains two airports for the ALTN page 1/2 ALTN INHIB line.

ALTN LIST UPLINK – a company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.

DES FORECAST UPLINK READY – descent forecast data has been received and is available for loading on the DESCENT FORECAST page.

FLT NUMBER UPLINK – a new flight number has been received and is available on the RTE page 1/X.

INVALID TAKEOFF XXX/YYY – takeoff data for up to six runways or runway intersection pairs has been received but some data for one runway or runway intersection pair (RWXXX/YYY) is invalid.

PARTIAL ROUTE X UPLINK – a new route has been uplinked to the FMC but a portion of the route could not be loaded.

PERF INIT UPLINK – performance initialization data has been received and is available for preview on the PERF INIT page.

ROUTE X UPLINK READY – a new route or route modification has been received and is available for loading on the RTE X page.

TAKEOFF DATA LOADED – An uplink containing takeoff data matching the runway/position entry on the takeoff page is available for preview (only displays after an initial takeoff uplink has been received) or alternate thrust and/or flaps have been selected.

TAKEOFF DATA UPLINK – an uplink containing takeoff data matching the runway on the takeoff page is available for preview.

WIND DATA UPLINK READY – wind data has been received and is available for loading into the active route.

FMC Advisory Messages

FMC advisory messages display:

- on the CDU scratchpad
- and illuminate the CDU message light (MSG).

DELETE – DELETE key pushed.

HOLD AT XXXX – a waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, after selection of the HOLD function key. Selection of HOLD AT XXXX into a RTE LEGS page waypoint line makes a holding fix at the XXXX waypoint.

INVALID ALTN UPLINK – a company-preferred list of alternate airports and associated alternate data has been received; the data is not valid and cannot be displayed.

INVALID ALTN LIST UPLINK – a company list of up to 20 alternate airports has been received; the data is not valid and cannot be displayed.

INVALID FLT NO UPLINK – a new flight number has been received; the data is not valid and cannot be displayed.

INVALID FORECAST UPLINK – descent forecast data has been received; the data is not valid and cannot be displayed.

INVALID PERF INIT UPLINK – performance initialization data has been received; the data is not valid and cannot be displayed.

INVALID ROUTE UPLINK – a new flight plan route or modification to the active flight plan route has been received; the data is not valid and cannot be displayed.

INVALID TAKEOFF UPLINK – takeoff data for up to six runways or runway–intersection pairs has been received; the data is not valid and cannot be displayed.

INVALID WIND DATA UPLINK – enroute wind data has been received; the data is not valid and cannot be displayed.

MAX ALT FLXXX – the altitude entry on any CDU page is above the performance calculated maximum altitude.

NOT ON INTERCEPT HEADING – LNAV selected and the airplane is outside active capture criteria and the present heading will not intercept the active leg.

ROUTE X UPLINK LOADING – a new flight plan route or modification to the active flight plan route has been received and is being loaded after flight crew selection of the LOAD prompt.

STANDBY ONE – the FMC requires more than 4 seconds to display data.

TIMEOUT–RESELECT – communication between the FMC and the CDU has failed. The flight crew must reselect FMC on the CDU MENU page.

UNABLE CRZ ALT – performance predicts a zero cruise time at the entered cruise altitude.

FMC Entry Error Messages

FMC entry–error messages:

- display in the CDU scratchpad
- illuminate the CDU message light (MSG)
- push the CLEAR key to remove the message before any data can be entered into the scratchpad.

ARR N/A FOR RUNWAY – the runway/approach selected is not compatible with arrival selected.

CRS REVERSAL AT FA FIX – a conflict exists between the default final approach (FA) waypoint (result of a runway or VFR approach selection) and the flight plan before it.

ENG OUT SID MOD – an engine failure is sensed after takeoff before the flaps are fully retracted; the FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.

ILS TUNE INHIBITED – MCP – ILS tuning is inhibited with the:

- autopilot engaged, and localizer or glideslope captured
- only the flight director is engaged and either the localizer or the glideslope is captured, and the airplane is below 500 feet radio altitude.

Any attempt to manually change the ILS frequency or select another ILS approach on the CDU displays this message. To make the necessary changes:

- above 1500 feet radio altitude – deselect approach on the MCP
- below 1500 feet radio altitude – select TO/GA

or,

- disengage the autopilot
- turn both flight directors OFF, and
- turn at least one flight director ON.

INVALID DELETE – deletion of selected data is not allowed.

INVALID ENTRY – entry format or range is incorrect for the selected field or the entered airway or TO waypoint does not coincide with the navigation database.

NOT IN DATABASE – data is not in the route or the navigation database.

ROUTE FULL – the route is filled to the allowable capacity.

RUNWAY N/A FOR SID – selected runway not compatible with SID.

TAKEOFF FLAPS DELETED – the FMC has deleted the takeoff flap setting on the TAKEOFF REF page. This occurs when the THRUST REDUCTION value is changed to the same value as the takeoff flap setting.

STANDBY ONE – the FMC temporarily prevents further CDU inputs.

UNABLE TO SEND MSG – the selected data link message cannot be transmitted.

V-SPEEDS UNAVAILABLE – for certain high thrust/low gross weight takeoff conditions, FMC V-speeds are not calculated. Adjust gross weight and/or takeoff thrust limit to enable V-speed calculations.

VERIFY RNP ENTRY – the entered RNP value is greater than the default RNP value for the present flight phase or, less than the present Actual Navigation Performance.

CDU Annunciator Lights

These annunciator lights illuminate when certain conditions exists.

DSPY – a flight plan modification is pending and the RTE, RTE LEGS, RTE DATA, or RTE HOLD page not containing the active leg or route segment is displayed, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is displayed.

OFST – an offset path has been entered and executed.

MSG – an FMC message is waiting to display or is displayed.

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Fuel

Chapter 12

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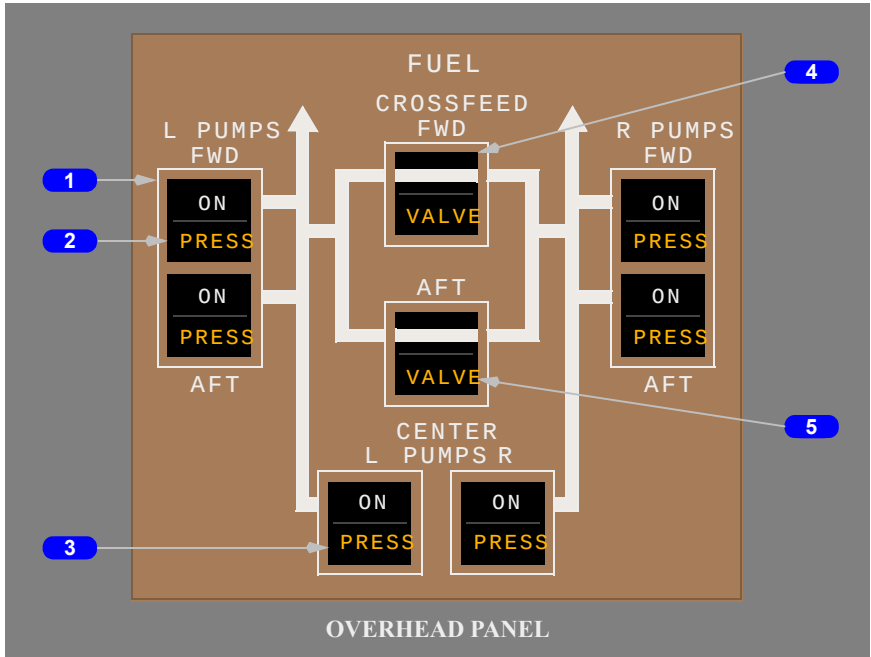
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Fuel Controls and Indicators

Chapter 12 Section 10

Fuel System



1 Fuel PUMPS Switches

ON – the fuel pump is commanded on.

2 Forward and Aft Fuel Pumps Pressure (PRESS) Lights

Illuminated (amber) – fuel pump output pressure is low.

3 Center Fuel Pumps Pressure (PRESS) Lights

Illuminated (amber) –

- fuel pump output pressure is low with the pump commanded on.
- illumination is inhibited when the center tank fuel pump switch is off.

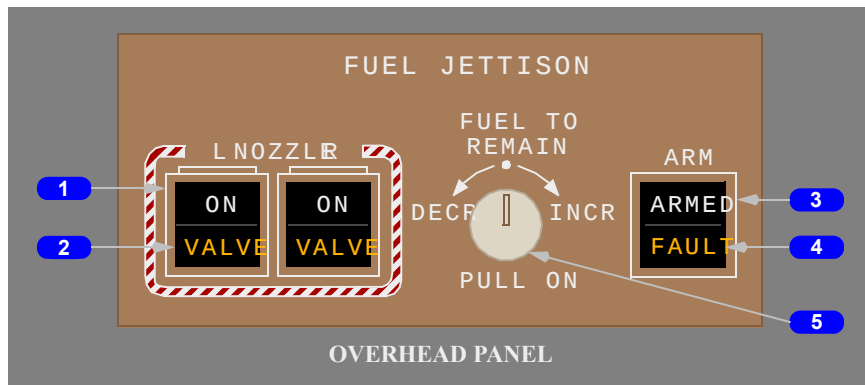
4 Fuel CROSSFEED Switches

On (bar visible) – the crossfeed valve is commanded open.

5 Fuel Crossfeed VALVE Lights

Illuminated (amber) – the crossfeed valve is not in the commanded position.

Fuel Jettison System



1 Fuel Jettison NOZZLE Switches

ON – in flight, with the Fuel Jettison Arm switch in ARMED, and the total fuel quantity is greater than the fuel-to-remain:

- the center tank fuel jettison isolation valves, the main tank jettison pumps, and the fuel jettison nozzle valves are commanded by the fuel jettison to jettison fuel
- when both CENTER PUMPS switches are off, fuel will not be jettisoned from the center tank

2 Fuel Jettison Nozzle VALVE Lights

Illuminated (amber) – the jettison nozzle valve is not in the commanded position.

3 Fuel Jettison ARM Switch

ARMED –

- arms the fuel jettison system
- sets the fuel-to-remain to the maximum landing weight (MLW) quantity

4 Fuel Jettison FAULT Light

Illuminated (amber) –

- a fuel jettison system fault has occurred
- the fuel jettison system is inoperative

5 FUEL TO REMAIN Selector

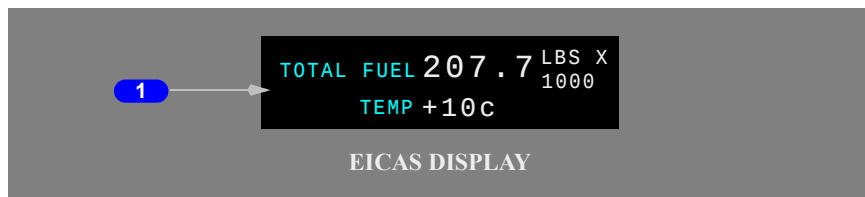
PULL ON –

- changes the mode from MLW to MAN
- rotate (spring loaded to 12 o'clock position) –
 - (first detent) – decreases (DECR) or increases (INCR) the MAN fuel-to-remain quantity at the slow set rate
 - (second detent) – decreases (DECR) or increases (INCR) the MAN fuel-to-remain quantity at the fast set rate

Off– sets the fuel-to-remain to the FMC maximum landing weight (MLW) fuel quantity.

Fuel Indications

Normal Fuel Indications

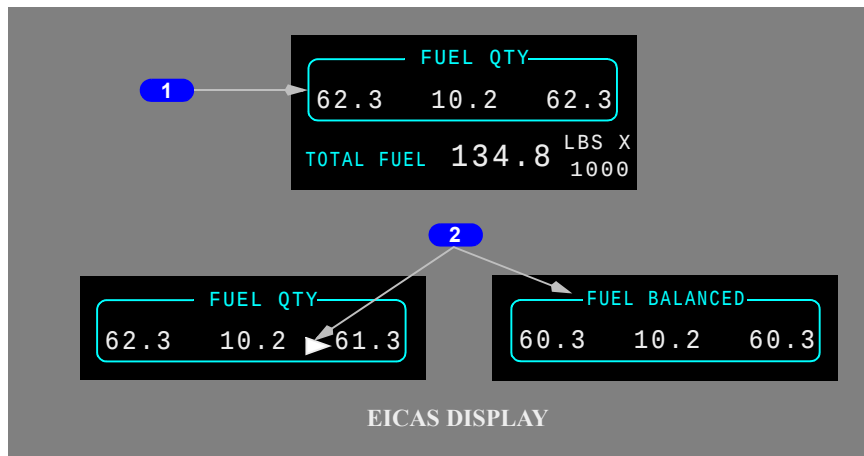


1 Normal Fuel Indications

Total fuel quantity (pounds x 1000).

Fuel temperature (degrees Celsius).

Expanded Fuel Indications [AFM]



1 Expanded Fuel Indications

The expanded FUEL QUANTITY display (left main, center, and right main tank quantities) appears for any of the following conditions:

- one or both crossfeed valves open
- one or more fuel tank quantity indications are inoperative
- the FUEL IN CENTER alert message is displayed (center tank quantity is amber)
- the FUEL QTY LOW alert message is displayed (low main tank quantity is amber)
- the FUEL IMBALANCE alert message is displayed
- the airplane is on the ground and one or both engine(s) off

2 Fuel Imbalance Indications

A fuel imbalance pointer is displayed on the expanded fuel quantity display next to the low tank quantity for the following imbalance conditions.

A solid white pointer is displayed if:

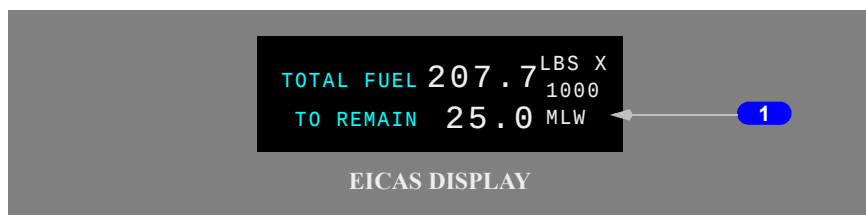
- main tank fuel differs more than 1000 pounds
- main tank fuel differs more than 200 pounds and a crossfeed valve is open.

A solid amber fuel imbalance pointer replaces the white pointer if the FUEL IMBALANCE message is displayed. The difference in fuel quantity which causes the FUEL IMBALANCE message to be displayed varies with total main tank fuel quantity.

The fuel imbalance pointer flashes if fuel balancing is going in the wrong direction.

When fuel is back in balance within 200 pounds between the main tanks – FUEL BALANCED replaces FUEL QTY on the expanded fuel quantity display and flashes for 5 seconds.

Fuel Jettison Indications



1 Fuel Jettison Indications

Fuel to remain (fuel jettison ARMED):

- the fuel to remain defaults to a fuel quantity that will leave the airplane at maximum landing weight (MLW) when jettison is complete
- the fuel to remain display replaces the fuel temperature display.

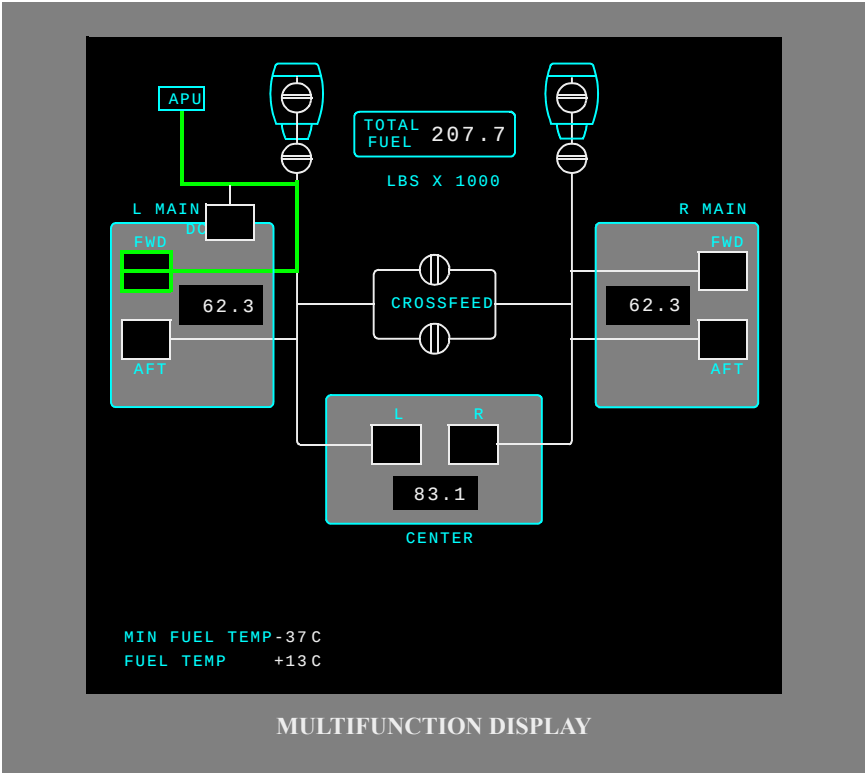
Fuel to remain MAN (manual) selection is displayed:

- fuel jettison system is ARMED
- the FUEL TO REMAIN selector is pulled on
- the quantity to remain can be changed by rotating the FUEL TO REMAIN selector to the slow or fast rate position.

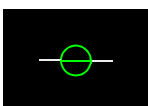
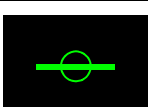
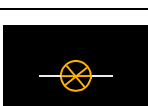
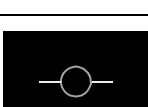
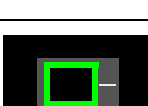
Fuel Synoptic Display

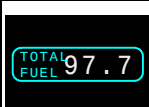
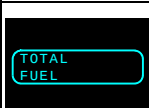
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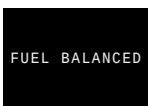
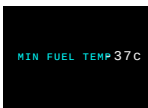
The fuel synoptic is displayed by pushing the FUEL synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

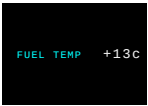
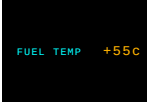


Fuel Synoptic Indications

Symbol	Indication	Description
	Fuel Valve (white)	Fuel valve is closed.
	Fuel Valve (green)	Fuel valve is in transit.
	Fuel Valve (green)	Fuel valve is open.
	Fuel Valve (amber with crossout)	Fuel valve is failed. Valve is commanded open but remains closed.
	Fuel Valve (amber with crossout)	Fuel valve is failed. Valve is commanded closed but remains open or in transit.
	Fuel Valve (gray)	Fuel valve state is invalid.
	Fuel Pump (green rectangle)	Fuel pump is ON.
	Fuel Pump (white rectangle)	Fuel pump is OFF or invalid signal.

	Fuel Pump (amber rectangle with crossout)	Fuel pump failed or pump switch is ON and pressure sensor detects low pressure. Also shown following automatic shutoff of center tanks.
	Fuel Pump (gray rectangle)	Fuel pump state is invalid.
	Normal Fuel Feed (green)	Fuel line is pressurized.
	Suction Feed (amber)	Fuel line is unpressurized and suction flow is occurring.
	Fuel Jettison (green)	Fuel is being jettisoned.
	Total Fuel (white)	Normal indication.
	Total Fuel (blank)	Invalid indication or any individual tank quantity blank
	Main Tank Quantity (white)	Normal indication.
	Main Tank Quantity (amber)	Fuel tank quantity is low. FUEL QTY LOW message is displayed

	Tank Quantity (blank)	Tank quantity is invalid.
	Center Tank Quantity (white)	Normal indication.
	Center Tank Quantity (amber)	FUEL IN CENTER message is displayed.
	Center Tank Quantity (amber)	Center fuel tank quantity is low. FUEL LOW CENTER message is displayed.
	Pointer (amber)	FUEL IMBALANCE is displayed. Points toward the main tank with the lower quantity. Flashes if fuel balancing is going the wrong direction.
	Pointer (white)	Main tank fuel differs by more than 1000 lbs (or 500 kgs), or the crossfeed switch is on and the main tank quantities differ by more than 200 lbs (or 100 kgs). Points toward the main tank with the lower quantity.
	Fuel Balanced (white)	Balanced indication. When fuel balance is re-established, the fuel balanced indication flashes for five seconds when the fuel is within 200 lbs (or 100 kgs) of balanced.
	Minimum Fuel Temperature (temperature displayed white)	Normal indication. Refer to Chapter 11, Flight Management, Navigation, Section 40, for a description of Minimum Fuel Temperature.
	Minimum Fuel Temperature (temperature displayed as blank)	Invalid indication.

	Fuel Temperature (temperature displayed white)	Normal indication. Displays the left main tank fuel temperature.
	Fuel Temperature (temperature displayed amber)	High fuel temperature indication when "+" is displayed. Low fuel temperature indication when "-" is displayed.
	Fuel Temperature (temperature displayed as blank)	Invalid indication.

Fuel

System Description

Chapter 12

Section 20

Introduction

The fuel system supplies fuel to the engines and the APU. The fuel is contained in a center tank, and left and right main tanks.

Refer to Chapter 7, Engines, for a description of the engine fuel system.

Fuel Quantity

Fuel quantity is measured by sensors in each tank. Total fuel quantity is displayed on the primary EICAS display. Tank quantities and total fuel quantity are displayed on the FUEL synoptic display.

Expanded fuel indications showing the left main, center, and right main tank quantities are displayed when non-normal conditions occur.

Fuel Temperature

Fuel temperature is displayed on the primary EICAS display. The temperature is normally displayed in white. It is displayed in amber when the fuel temperature approaches the fuel freeze temperature entered on the flight management system CDU. During jettison, the TO REMAIN quantity replaces the EICAS display fuel temperature indication.

Fuel temperature and minimum fuel temperature are also displayed on the fuel synoptic display.

Fuel Pumps

Each fuel tank contains two AC-powered fuel pumps. A single pump can supply sufficient fuel to operate one engine under all conditions.

The two center tank fuel pumps are override/jettison pumps. These pumps have a higher output pressure than the left and right main tank fuel pumps. The center tank pumps override the main tank pumps so that center tank fuel is used before wing tank fuel.

The center tank fuel pumps will shut off automatically after 15 seconds of continuous low pressure. The auto-shutoff feature is disabled during jettison.

When the main tank fuel pump switches are off, the switch PRESS lights illuminate and the EICAS advisory messages FUEL PUMP (L, R, FWD, or AFT) display. When the center fuel pump switches are off, the switch PRESS lights and pump pressure EICAS messages are inhibited.

On the ground, both center fuel pumps operate only when two electrical power sources are available. With only one power source available and the center fuel pump switches on, the switch PRESS light on the non-powered side is illuminated and the pump pressure EICAS message is inhibited.

The left main tank contains a DC-powered fuel pump. It has no controls or indicators, other than the fuel synoptic display. The DC pump operates automatically to provide fuel to the APU when AC power is not available and the APU selector is ON.

Surge tanks are provided in each wing, outboard of each main tank. Fuel in the surge tanks and fuel remaining in the refueling manifold is drained into the main tanks.

Fuel Pump Operations

Before start, the main tank pump switches should all be pushed ON.

Before start, with center tank quantity more than 10,500 pounds, the center tank switches should be pushed ON.

During flight, when the FUEL IN CENTER message displays the center tank pump switches should be pushed ON, when the FUEL LOW CENTER message displays the center tank pump switches should be pushed off. The condition statements for these messages are contained in Section 12.30, Fuel System EICAS Messages.

If a center pump has low output pressure, the fuel pump switch PRESS light illuminates and the message FUEL PUMP CENTER (L or R) displays.

7101 - 7110

With the main tank pumps ON, a scavenge system operates automatically to transfer any remaining center tank fuel to the main tanks. Fuel transfer begins when either main tank quantity is less than 52,600 pounds. Center tank quantity must be below 35,000 pounds.

7001 - 7008

With the main tank pumps ON, a scavenge system operates automatically to transfer any remaining center tank fuel to the main tanks. Fuel transfer begins when either main tank quantity is less than 29,000 pounds. Center tank quantity must be below 35,000 pounds.

Center Tank Fuel Pump Operation

7101 - 7110

The LR center tank fuel pumps will automatically shut off when the center fuel tank becomes empty. There is no procedural change since the fuel pumps should be selected OFF manually when the fuel pump PRESS lights illuminate.

Due to FAR certification of the B777LR, the procedure for operating the center tank fuel pumps with less than 10,500 lbs of fuel is different. The center tank fuel pump switches should remain OFF during pushback, taxi, and takeoff if the center fuel tank has less than 10,500 lbs. The pumps should then be selected ON above 10,000 feet. The purpose of this certification is to prevent the fuel pumps from operating dry when uncovered during takeoff. The LR has different fuel pump and fuel tank indication logic that will aid the crew for this procedural change. The bullets below describe the modified logic of the FUEL IN CENTER advisory message:

- On the ground and during takeoff, the FUEL IN CENTER advisory message is inhibited when there is less than 10,500 lbs of fuel in the center tank and both center fuel pump switches are OFF.
- After takeoff above 10,000 feet, the FUEL IN CENTER advisory message will be displayed when there is fuel in the center tank and both center fuel pump switches are OFF, and the aircraft is less than 5 degrees body pitch angle for 10 minutes.

Note: The LR will normally operate on long haul routes; therefore, seldom will it be dispatched with less than 10,500 lbs of center tank fuel.

Refer to Volume 1, NP.20 for fuel pump operating procedure.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the airplane climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine should effectively operate on suction feed.

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve(s). Continued crossfeed use will result in a progressive fuel imbalance.

Fuel Crossfeed

The fuel manifolds are arranged so that any fuel tank pump can supply either engine. The crossfeed valves are closed during normal operations. The closed crossfeed valves isolate the left and right systems. Either valve can be opened to feed an engine from the opposite fuel tank. If the valve position does not agree with the switch position, the CROSSFEED switch VALVE light illuminates and the EICAS advisory message FUEL CROSSFEED FWD or AFT displays.

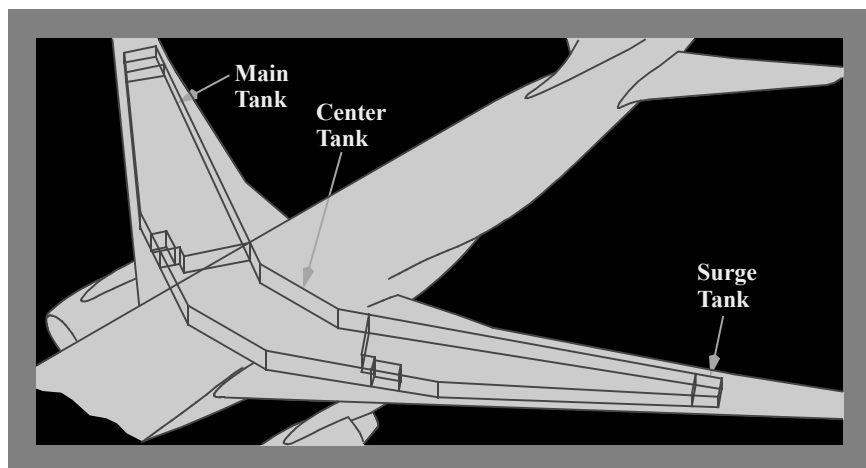
Fuel Imbalance

When the fuel quantity in left and right main tanks differ by an excessive quantity, the EICAS alert message FUEL IMBALANCE displays.

Fuel balancing is accomplished by opening either crossfeed valve and turning off the fuel pump switches for the fuel tank that has the lowest quantity. Fuel balancing may be done in any phase of flight.

Fuel Tank Locations and Capacities

Fuel Tank Locations



Fuel Tank Capacities

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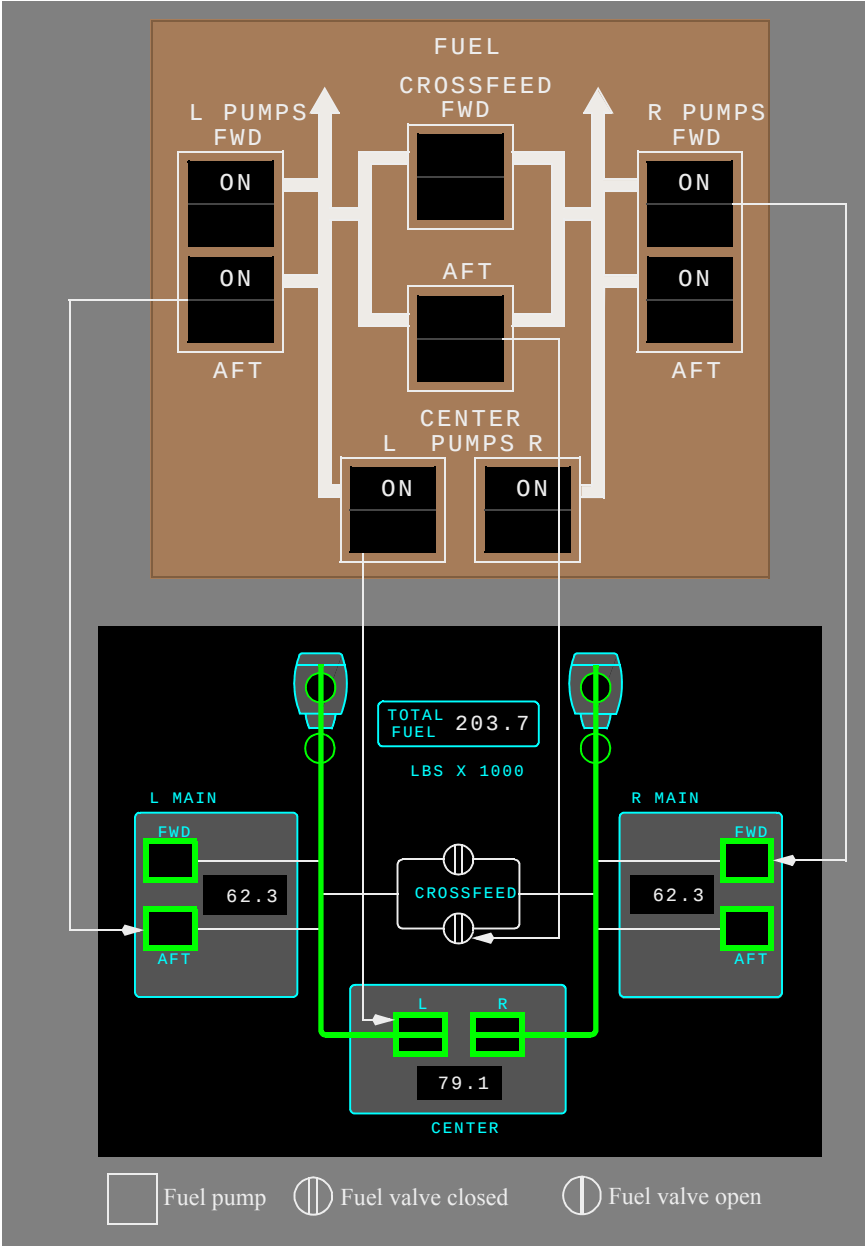
7101 - 7110

Tank	Gallons	Pounds *
Left Main	10,300	69,000
Right Main	10,300	69,000
Center	27,290	182,800
Total	47,890	320,800
*Usable fuel at level attitude, fuel density = 6.7 pounds per US gallon.		

7001 - 7008

Tank	Gallons	Pounds *
Left Main	9,560	64,100
Right Main	9,560	64,100
Center	26,100	174,900
Total	45,220	303,100
*Usable fuel at level attitude, fuel density = 6.7 pounds per US gallon.		

Fuel System Schematic



APU Fuel Feed

APU fuel is supplied from the left fuel manifold. APU fuel can be provided by any AC fuel pump supplying fuel to the left fuel manifold or by the left main tank DC fuel pump.

On the ground, with the APU switch ON and no AC power available, the DC pump runs automatically. With AC power available, the left forward AC fuel pump operates automatically, regardless of fuel pump switch position, and the DC fuel pump turns off.

In flight, the DC fuel pump operates automatically for quick left engine relight with the loss of both engines and all AC power.

Fuel Jettison

The fuel jettison system allows jettison from all fuel tanks. Fuel is jettisoned through jettison nozzle valves inboard of each aileron. Jettison pumps in the main tanks and override/jettison pumps in the center tank pump fuel overboard through the jettison nozzle valves.

Fuel jettison is initiated by pushing the FUEL JETTISON ARM switch to select ARMED. The jettison system automatically sets the fuel-to-remain to the maximum landing weight (MLW) fuel quantity. The TO REMAIN quantity replaces fuel temperature on the EICAS display.

Pull on and rotate the FUEL TO REMAIN selector to manually decrease or increase the TO REMAIN quantity.

Main tank jettison begins when:

- the FUEL JETTISON NOZZLE switches are pushed ON
- the jettison nozzle valves open, and
- the main tank jettison pumps operate.

If the center tank override/jettison pumps are on, center tank fuel also jettisons. Center tank fuel will not jettison if the center tank override/jettison pumps are off.

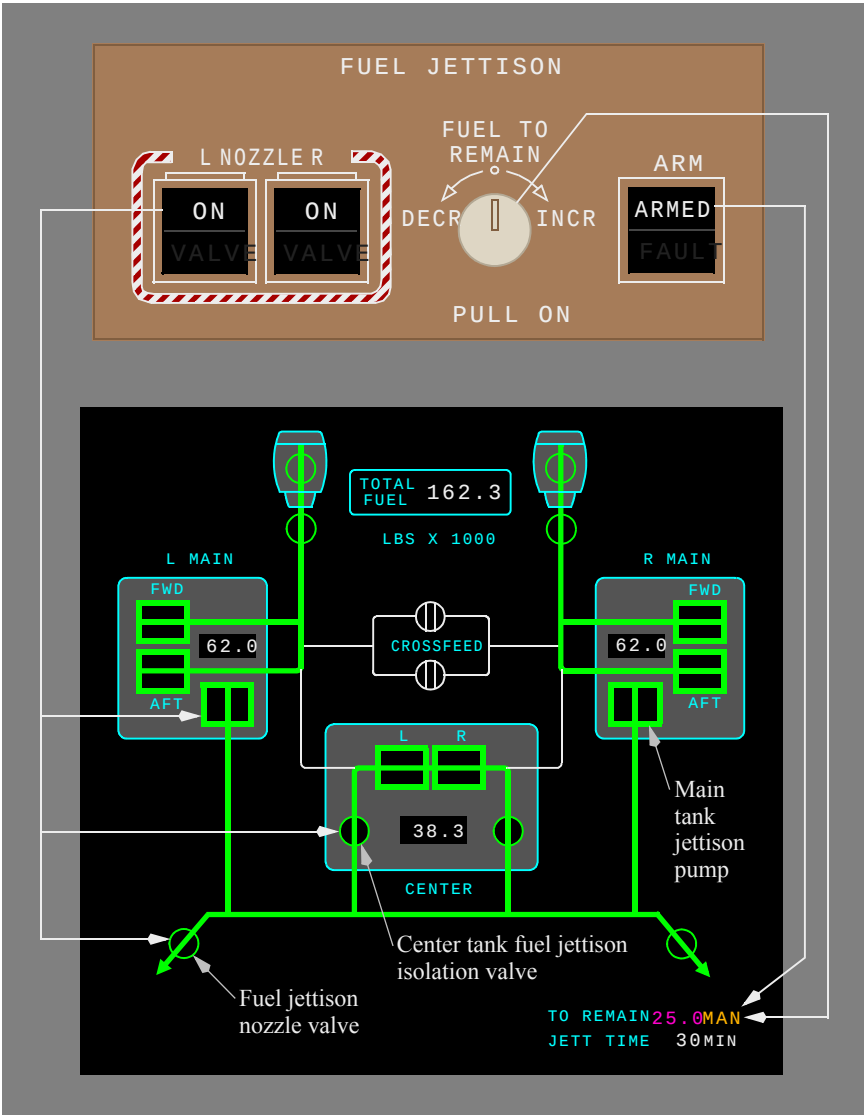
The nozzles cannot open on the ground, regardless of switch positions.

In flight, jettison time is displayed in minutes on the fuel synoptic when the jettison arm switch is positioned on while in the air. Jettison automatically stops when a value just above the TO REMAIN quantity is reached. The system shuts off the main tank jettison pumps and closes the center tank jettison isolation valves.

When the airplane is heavy and loaded near the forward CG, fuel is jettisoned from the center tank first to keep CG within limits; main tank jettison pump operation is delayed. The computed jettison time is automatically adjusted to reflect the increased jettison time.

At least 11,500 pounds of fuel remains in each main tank after jettison is complete.

Fuel Jettison Schematic



Fuel EICAS Messages

Chapter 12 Section 30

FMS Fuel Messages

The CDU can display the following message:

- INSUFFICIENT FUEL - FMC estimated fuel at destination is less than entered RESERVES fuel.

See Chapter 11, Flight Management, Navigation, Sections 32 and 60, for additional information.

Fuel System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
FUEL AUTO JETTISON	Caution	Beeper	Total fuel quantity is less than or equal to the selected TO REMAIN quantity and a nozzle valve is open, or the fuel jettison automatic shutoff is failed.
FUEL CROSSFEED AFT, FWD	Advisory		Crossfeed valve is not in the commanded position.
FUEL DISAGREE	Advisory		Totalizer fuel quantity and FMC calculated fuel quantity disagree.
FUEL IMBALANCE	Advisory		Fuel imbalance between the main tanks is excessive.
FUEL IN CENTER	Advisory		Both center fuel pump switches are OFF with fuel in the center tank.
FUEL JETT NOZZLE L, R	Advisory		Jettison nozzle valve in not in the commanded position.
FUEL JETTISON MAIN	Advisory		Fuel jettison from the main tanks is inoperative.
FUEL JETTISON SYS	Caution	Beeper	Fuel jettison system is inoperative.
FUEL LOW CENTER	Advisory		One or both CENTER PUMPS switches are ON and center tank quantity is low.

Message	Level	Aural	Message Logic
FUEL PRESS ENG L, R	Caution	Beeper	Engine is on suction feed.
FUEL PRESS ENG L+R	Advisory		Fuel pressure to both engines is low on the ground with the engines shut down.
FUEL PUMP CENTER L, R	Advisory		Center fuel pump output pressure is low.
FUEL PUMP L AFT, FWD	Advisory		Left aft or forward fuel pump output pressure is low.
FUEL PUMP R AFT, FWD	Advisory		Right aft or forward fuel pump output pressure is low.
FUEL QTY LOW	Caution	Beeper	Fuel quantity is low in either main tank.
FUEL SCAVENGE SYS	Advisory		Either main tank is less than 18,000 lbs and the center tank quantity is greater than 500 lbs for 15 minutes.
FUEL TEMP LOW	Advisory		Fuel temperature is approaching minimum.
FUEL VALVE APU	Advisory		APU fuel valve is not in the commanded position.

Hydraulics

Chapter 13

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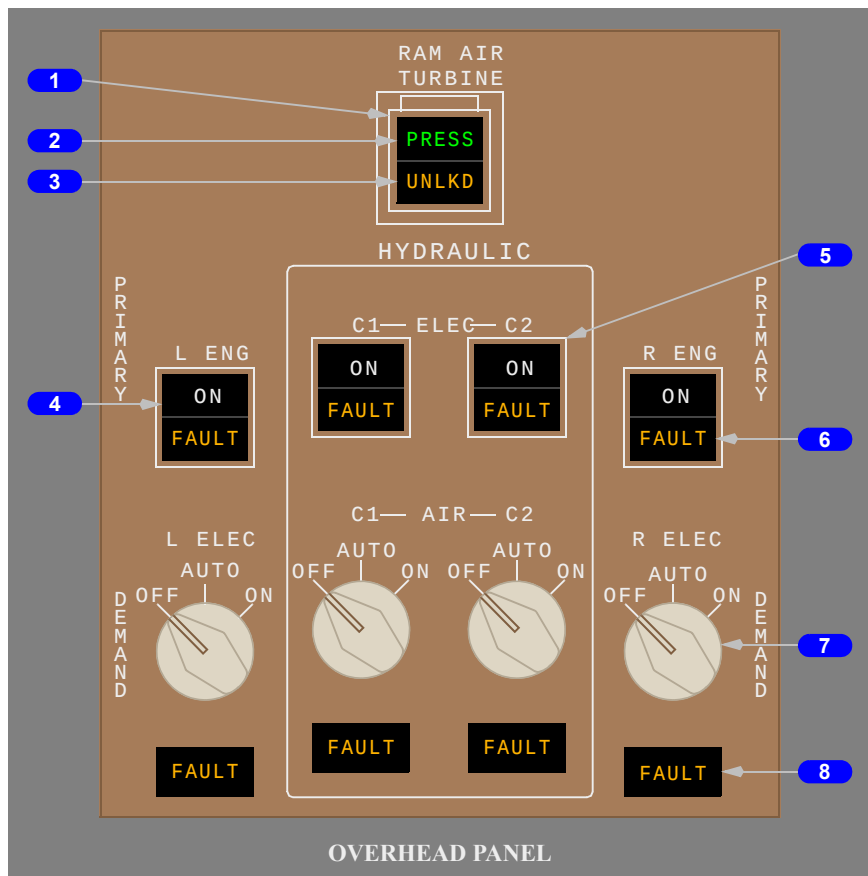
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Intentionally
Blank

Hydraulics Controls and Indicators

Chapter 13 Section 10

Hydraulic Panel



1 RAM AIR TURBINE Switch

Push – deploys the RAT.

2 Ram Air Turbine Pressure (PRESS) Light

Illuminated (green) –

- the RAT is deployed
- center system primary flight control hydraulic pressure is greater than 1500 psi.

3 Ram Air Turbine Unlocked (UNLKD) Light

Illuminated (amber) – the RAT is not in the stowed position.

4 Left/Right Engine (L/R ENG) PRIMARY Pump Switches

ON – the engine–driven hydraulic pump pressurizes the related left or right hydraulic system when the engine rotates.

Off (ON not visible) – the engine–driven hydraulic pump is turned off and depressurized.

5 C1/C2 Electrical (C1/C2 ELEC) PRIMARY Pump Switches

ON –

- the electric motor–driven hydraulic pump operates
- pressurizes the center hydraulic system.

Off (ON not visible) – the electric motor–driven hydraulic pump is turned off.

6 Primary Pump FAULT Lights

Illuminated (amber) –

- low primary pump pressure
- excessive primary pump fluid temperature, or
- pump selected OFF.

7 DEMAND Pump Selectors

ON – the pump runs continuously.

AUTO – the pump operates when system and/or primary pump(s) pressure is low, or when control logic anticipates a large system demand.

OFF – the pump is off.

Note: If both air–driven pumps are selected to ON, only air–driven pump C1 operates; the two air–driven pumps cannot operate simultaneously when both are selected ON.

8 Demand Pump FAULT Lights

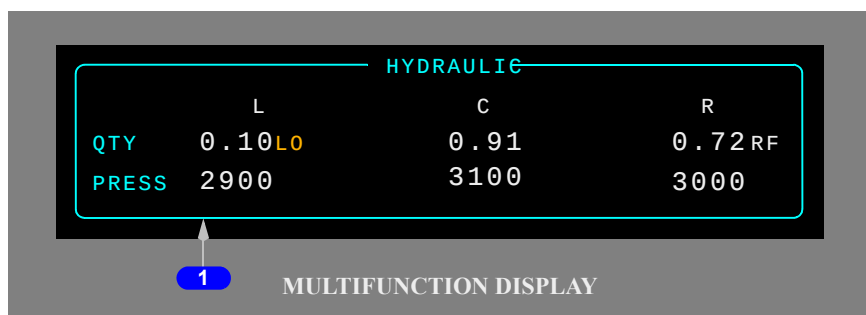
Illuminated (amber) –

- low demand pump output pressure
- excessive demand pump fluid temperature, or
- demand pump is selected OFF.

Hydraulic System Indications

To view the status display, push the STAT display switch on the display select panel. To view the hydraulic synoptic, push the HYD synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

Status Display



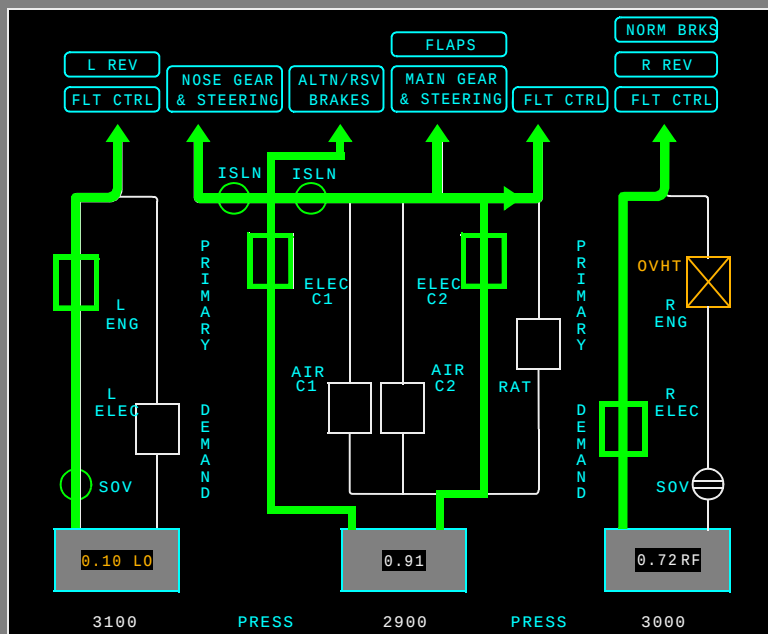
1 Hydraulic Display

QTY –

- displays system reservoir quantity as a percentage of the normal service level (1.00 is the normal service level)
- LO (amber) – displayed when the reservoir quantity is low
- OF (white) – displayed when the reservoir is over-full (inhibited in flight)
- RF (white) – displayed when the reservoir requires refilling (inhibited in flight).

PRESSURE – displays hydraulic pressure in pounds per square inch of the pump with the highest pressure.

Hydraulic Synoptic Display



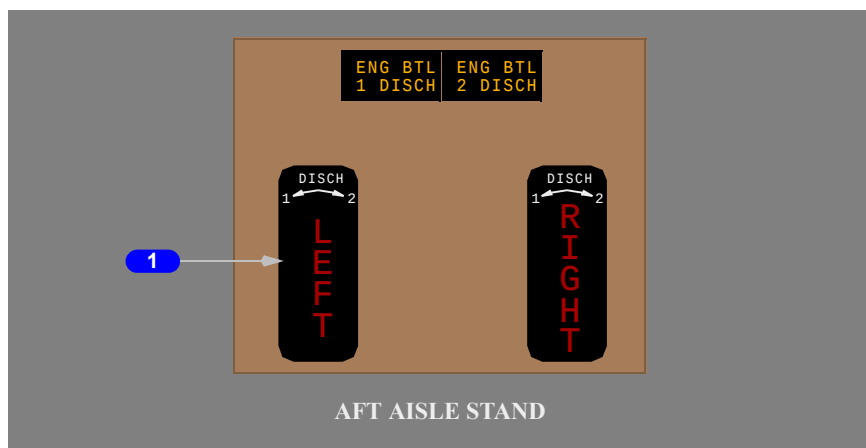
MULTIFUNCTION DISPLAY

AIR – air-driven pump
ELEC – electric-driven pump
ENG – engine-driven pump
ISLN – isolation valve
LO – reservoir quantity low
OF – reservoir quantity over-full
OVHT – pump overheat indication

RAT – ram air turbine pump
RF – reservoir requires refilling
SOV – shutoff valve
Closed valve – 
Failed pump – 

Miscellaneous Hydraulic System Controls

Engine Fire Panel



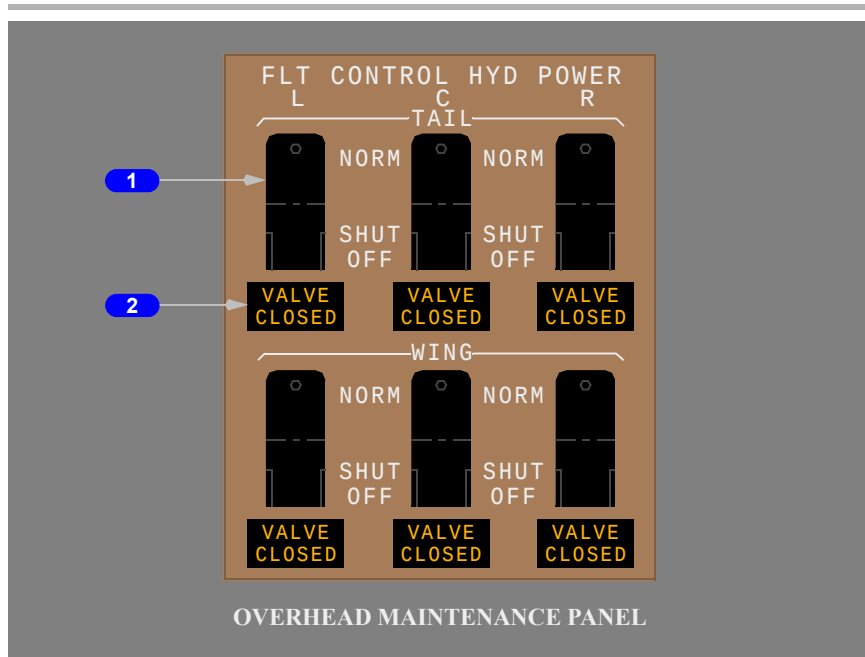
1 Engine Fire Switches

Pull –

- closes the engine–driven pump hydraulic supply shutoff valve
- depressurizes the engine–driven pump.

Flight Control Hydraulic Power Switches

Note: No flight crew normal or non–normal procedures require operation of the flight control shutoff switches. These switches are for ground maintenance use only.



1 Flight Control Hydraulic Power Shutoff Switches

NORM – hydraulic system power is available to the flight control actuators.

SHUT OFF – hydraulic system power to the flight control actuators is shut off.

Note: In flight, the center system flight control shut off valves are isolated from electrical power and cannot be closed.

2 Flight Control Hydraulic Power VALVE CLOSED Lights

Illuminated (amber) – the related valve is closed.

Hydraulics

System Description

Chapter 13

Section 20

Introduction

The airplane has three independent hydraulic systems: left, right, and center. The hydraulic systems power the:

- flight controls
- leading edge slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose and main gear steering
- thrust reversers.

Flight control system components are distributed so that any one hydraulic system can provide adequate airplane controllability.

Hydraulic fluid is supplied to each hydraulic pump from the associated system reservoir. The reservoirs are pressurized by the bleed air system.

Left and Right Hydraulic Systems

The left and right hydraulic systems are identical. They differ only in the components they power.

The left hydraulic system powers:

- flight controls
- the left engine thrust reverser.

The right hydraulic system powers:

- flight controls
- normal brakes
- the right thrust reverser.

Left and Right Hydraulic System Primary Pumps

The left and right hydraulic systems each have a primary pump. The left and right primary pumps are engine-driven by the related left and right engines.

Left and Right Hydraulic System Demand Pumps

The left and right hydraulic systems each have a demand pump. The demand pumps are electric motor-driven. The demand pumps provide supplementary hydraulic power for periods of high system demand. The demand pumps also provide a backup hydraulic power source for the engine-driven primary pumps.

The pumps are controlled by the DEMAND L and R pump selectors. In the AUTO position, the L and R demand pumps operate for takeoff, landing, and when system or primary pump pressure is low. In the ON position, the demand pump runs continuously.

Note: In the AUTO position the right demand pump operates continuously when the airplane is on the ground.

Center Hydraulic System

The center hydraulic system powers:

- flight controls
- leading edge slats
- trailing edge flaps
- landing gear actuation
- alternate brakes
- reserve brakes
- nose gear steering
- main gear steering.

The ram air turbine (RAT) can provide hydraulic power to the center hydraulic system primary flight control components only.

Center Hydraulic System Primary Pumps

Two electric motor-driven primary pumps are the primary hydraulic power sources for the center hydraulic system. The PRIMARY C1 and C2 pump switches control pump operation.

On the ground:

With only a single ground power source, including the APU, the C2 pump will not run if the C1 pump is selected. The pump will not be load shed if one engine generator is operating, or the following sources are operating:

- primary external power and secondary external power
or
- APU generator and primary external power.

In flight:

The C2 pump may be load shed by the electrical load management system when the following conditions exist:

- all other electric pumps are running
- there is a single source of electrical power
- generator capacity is exceeded.

The pump will start automatically when the conditions that shed the pump no longer exist.

Center Hydraulic System Demand Pumps

The center hydraulic system has two air-driven demand pumps. The demand pumps provide supplementary hydraulic power for periods of high system demand. The demand pumps also provide a backup hydraulic power source for the center system electric motor-driven primary pumps.

The pumps are controlled by the DEMAND C1 and C2 pump selectors. In the AUTO position, a demand pump operates when system and/or primary pumps pressure is low, or when system logic anticipates a large demand. In the ON position, the demand pump runs continuously. Selecting both demand pumps ON results in only pump C1 operating. Both pumps cannot operate simultaneously when ON is selected for both pumps.

Center Hydraulic System Non-Normal Operation

If center hydraulic system quantity is sensed to be low and airspeed is greater than 60 knots the:

- reserve brakes are isolated from the center system and remain operable (the C1 pump and reserve fluid are dedicated to operating reserve brakes and nose gear steering)
- nose gear actuation and steering are isolated
- leading edge slats are isolated and not allowed to operate in the primary (hydraulic) mode.

The leading edge slats are reconnected to the center hydraulic system and allowed to operate in primary mode when:

- center hydraulic fluid quantity recovers to normal for 5 seconds, and
- the system determines that both engines have been running for more than 30 seconds.

Nose gear actuation and steering are reconnected when:

- airspeed decreases below 60 knots, or
- hydraulic pressure to the center system flight controls goes low, or
- the landing gear is selected down, both engines are normal, and both engine-driven pumps are providing pressure.

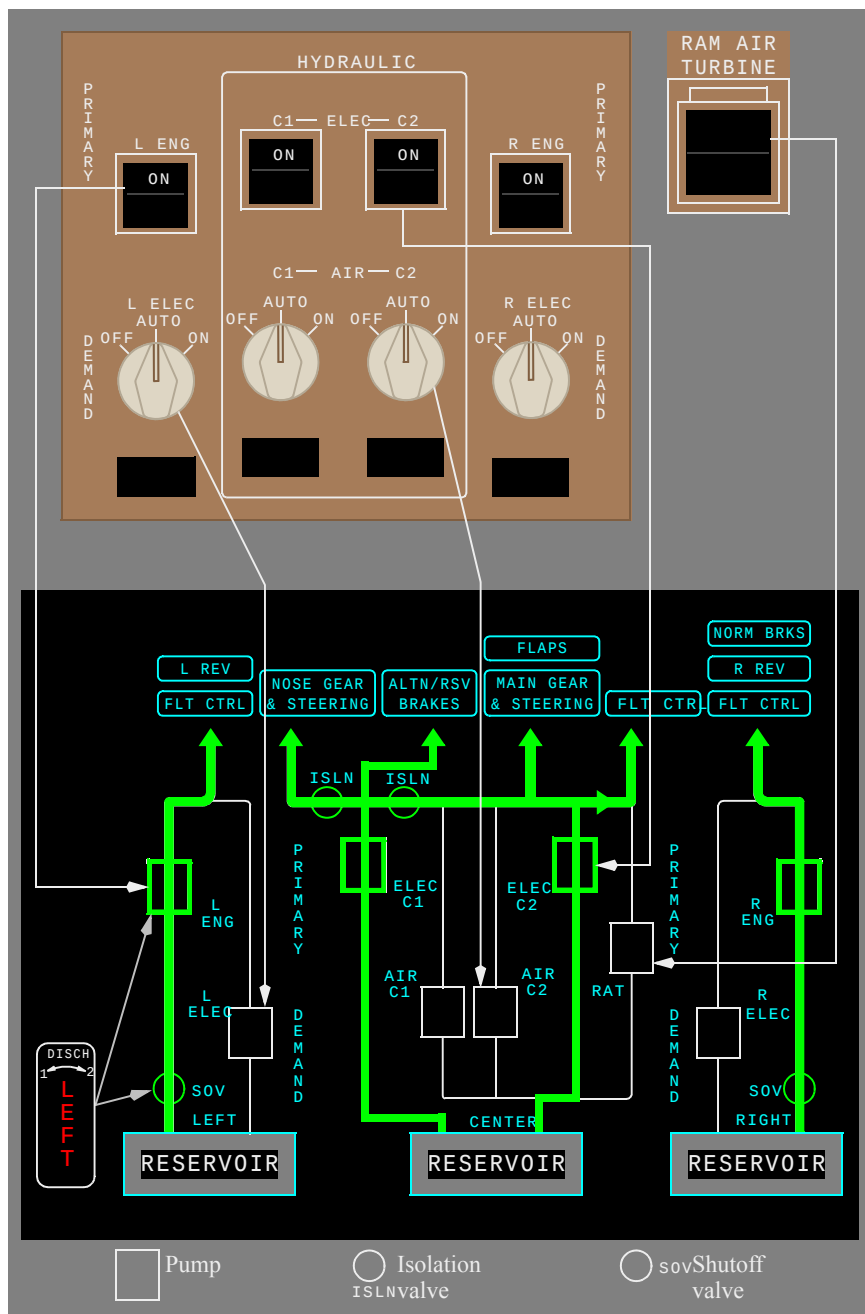
Ram Air Turbine (RAT)

The RAT, when deployed, provides hydraulic power only to the primary flight control components connected to the center hydraulic system. The RAT provides hydraulic and electrical power throughout the flight envelope. In flight, the RAT deploys automatically if:

- both engines are failed and center system pressure is low, or
- both AC transfer busses are unpowered, or
- all three hydraulic system pressures are low.

The RAT can be deployed manually by pushing the RAM AIR TURBINE switch. The hot battery or APU battery bus must be powered. The center hydraulic system does not need to be powered. The RAT is deployed by a compressed spring. Once deployed, the RAT cannot be stowed in flight.

Hydraulic Systems Schematic



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Hydraulics EICAS Messages

Chapter 13 Section 30

Hydraulics, Ram Air Turbine EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
HYD AUTO CONTROL C	Advisory		Both center demand pump AUTO functions and all center hydraulic system indications are inoperative.
HYD AUTO CONTROL L, R	Advisory		Demand pump AUTO function and all left or right system indications are inoperative.
HYD OVERHEAT DEM C1, C2, L, R	Advisory		Demand pump temperature is high.
HYD OVERHEAT PRI C1, C2, L, R	Advisory		Primary pump temperature is high.
HYD PRESS DEM C1, C2, L, R	Advisory		Demand pump output pressure is low when commanded on.
HYD PRESS PRI C1, C2	Advisory		Primary pump output pressure is low.
HYD PRESS PRI L, R	Advisory		Primary pump output pressure is low.
HYD PRESS SYS C	Caution	Beeper	Center hydraulic system pressure is low.
HYD PRESS SYS L	Caution	Beeper	Left hydraulic system pressure is low.
HYD PRESS SYS L+C	Caution	Beeper	Left and center hydraulic system pressures are low.
HYD PRESS SYS L+R	Caution	Beeper	Left and right hydraulic system pressures are low.

Message	Level	Aural	Message Logic
HYD PRESS SYS L+C+R	Caution	Beeper	All hydraulic system pressures are low.
HYD PRESS SYS R	Caution	Beeper	Right hydraulic system pressure is low.
HYD PRESS SYS R+C	Caution	Beeper	Right and center hydraulic system pressures are low.
HYD QTY LOW C	Advisory		Center hydraulic system quantity is low.
HYD QTY LOW L, R	Advisory		Hydraulic quantity is low.
HYD QTY LOW L+C	Caution	Beeper	Left and center hydraulic system quantities are low.
HYD QTY LOW L+C+R	Caution	Beeper	All three hydraulic system quantities are low.
HYD QTY LOW L+R	Caution	Beeper	Left and right system quantities are low.
HYD QTY LOW R+C	Caution	Beeper	Right and center system quantities are low.
RAT UNLOCKED	Advisory		RAT is not stowed and locked.

Landing Gear

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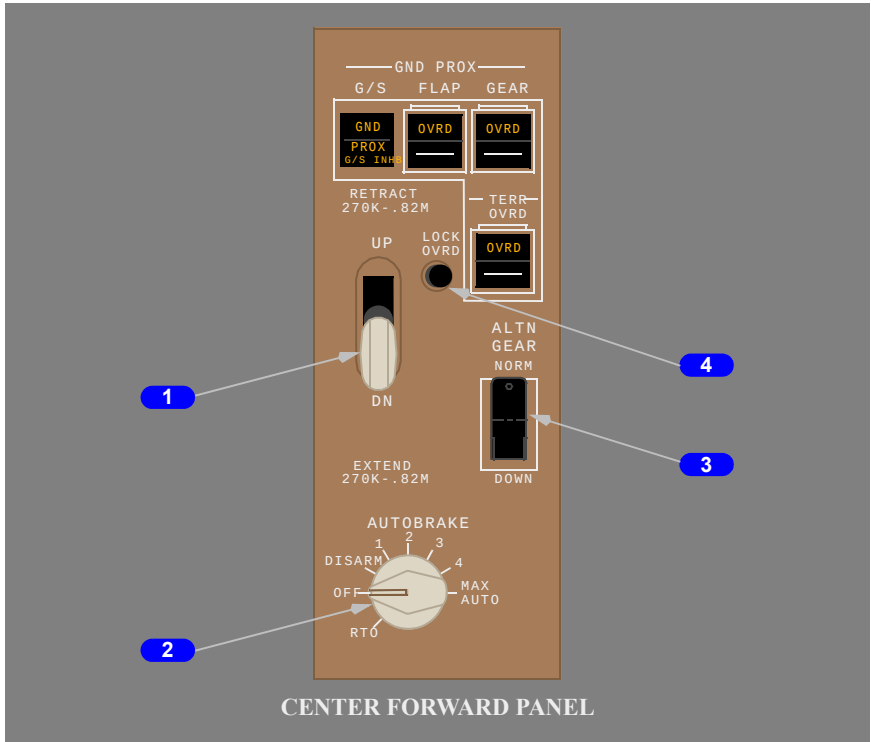
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Landing Gear Controls and Indicators

Chapter 14 Section 10

Landing Gear Panel



1 Landing Gear Lever

UP – the landing gear retracts.

DN – the landing gear extends.

2 AUTOBRAKE Selector

OFF – deactivates and resets the autobrake system.

DISARM –

- disengages the autobrake system
- releases brake pressure.

1, 2, 3, 4, MAX AUTO – selects the desired deceleration rate.

RTO – automatically applies maximum brake pressure when the thrust levers are retarded to idle above 85 knots.

3 Alternate Gear (ALTN GEAR) Switch

NORM – the landing gear lever operates normally.

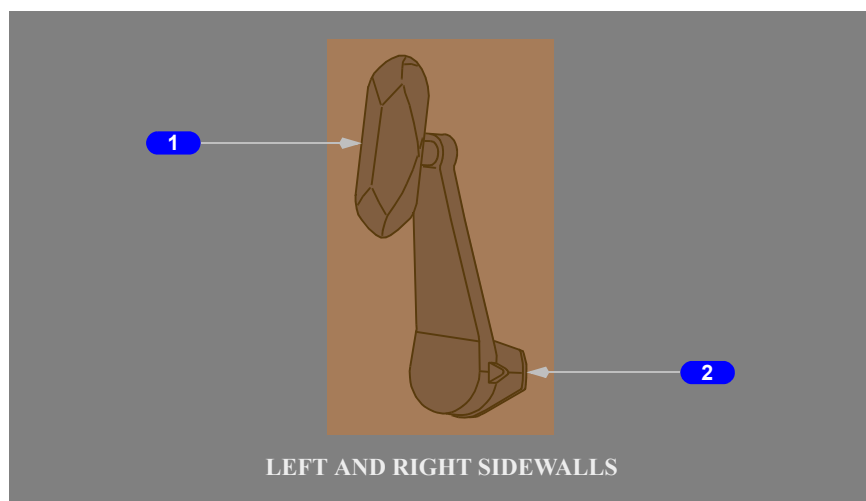
DOWN – the landing gear extends by the alternate extension system.

Note: Alternate extension may be selected with the landing gear lever in any position.

4 Landing Gear Lever Lock Override (LOCK OVRD) Switch

Push – releases the landing gear lever lock.

Nose Wheel Steering Tiller



1 Nose Wheel Steering Tiller

Rotate –

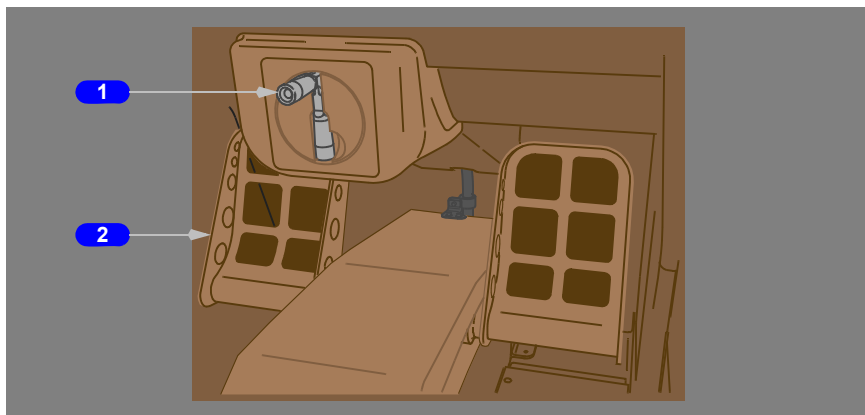
- turns the nose wheels up to 70 degrees in either direction
- overrides rudder pedal steering
- main gear aft axle steering is slaved to nose wheel steering.

2 Tiller Position Indicator

Shows tiller displacement from the straight-ahead, neutral position.

Brake System

Rudder/Brake Pedals



1 Rudder Pedal Adjust Crank

Adjusts the rudder pedals forward or aft.

Note: To avoid inadvertent rudder pedal movement, the crank handle should be stowed when not in use.

2 Rudder/Brake Pedals

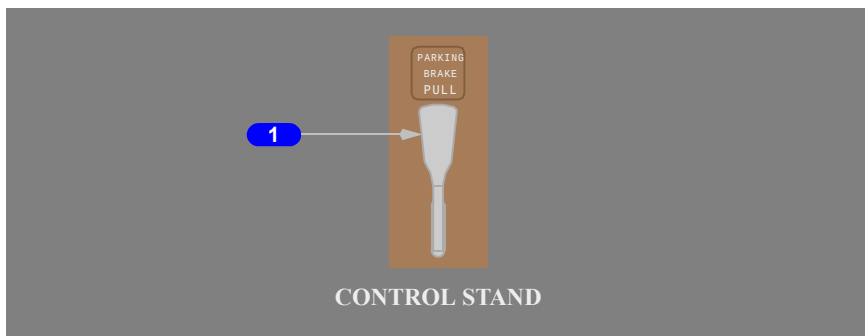
Push the full pedal –

- turns the nose wheel up to 7 degrees in either direction
- does not activate main gear steering.

Push the top of the pedals – actuates the wheel brakes.

Refer to Chapter 9, Flight Controls for the description of rudder operation.

Parking Brake Lever

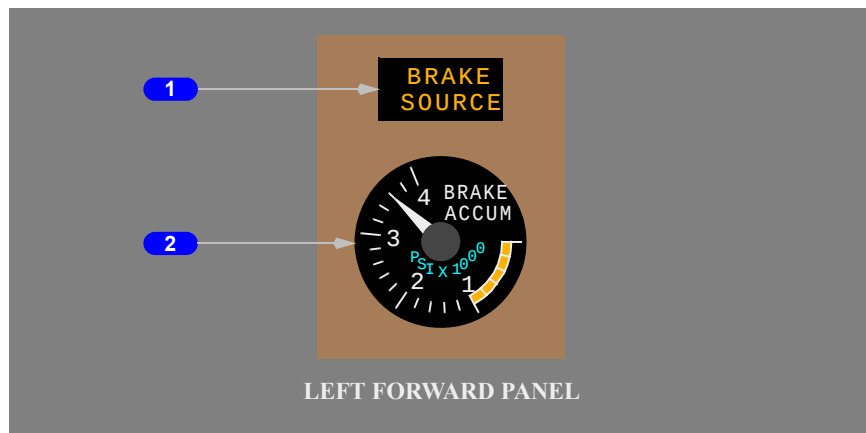


1 Parking Brake Lever

Pull – sets the parking brake when both brake pedals are simultaneously depressed.

Release – simultaneously depress both brake pedals.

Brake Accumulator Pressure Indicator



1 BRAKE SOURCE Light

Illuminated (amber) – both active brake hydraulic sources (right and center/reserve hydraulic systems) have low pressure.

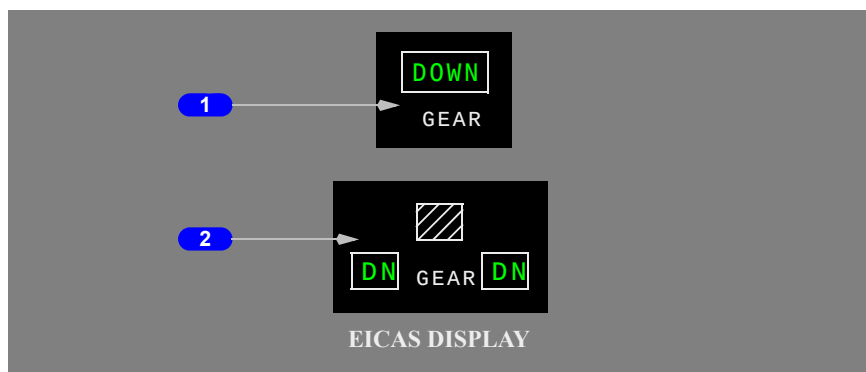
2 BRAKE ACCUMULATOR PRESSURE Indicator

Indicates brake accumulator pressure.

Amber Band - brake accumulator pressure is low.

Landing Gear System Indications

Landing Gear Position Indications



1 GEAR Position Indication (Normal Display)

DOWN (green) – all landing gear are down and locked.

Crosshatched (white) – one or more landing gear are in transit.

UP (white) – all landing gear are up and locked (blanks after 10 seconds).

Empty box (white) – all landing gear position indicators are inoperative.

2 Expanded GEAR Position Indication (Non-Normal Display)

DN (green) – the associated landing gear is down and locked.

Crosshatched (white) – the associated landing gear is in transit.

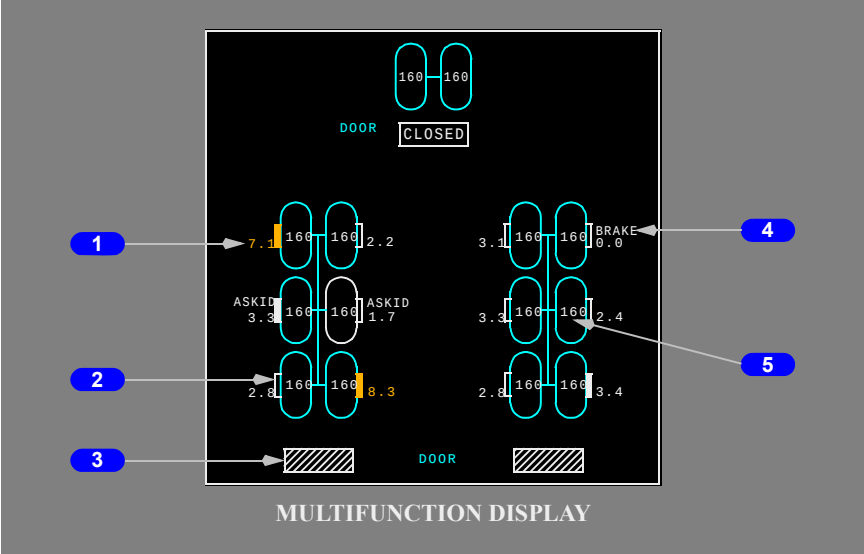
UP (white) – the associated landing gear is up and locked.

Empty box(es) (white) – the associated landing gear position indicators are inoperative.

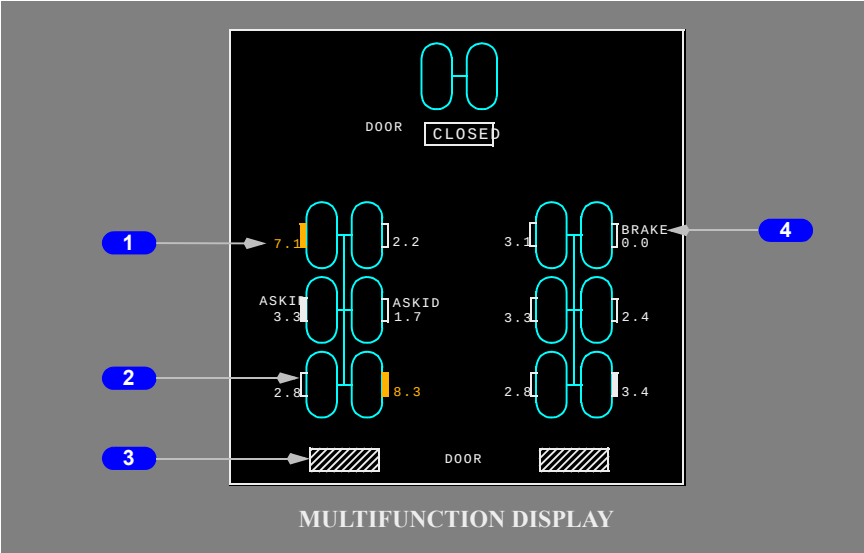
Gear Synoptic Display

The landing gear synoptic is displayed by pushing the GEAR synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

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7001 - 7008



1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0.0 to 9.9
- white – normal range
- amber – high range.

2 Brake Symbol

Blank box indicates any brake less than 3.0.

Solid white box indicates hottest brake on each main gear within range of 3.0 to 4.9.

Solid amber box indicates brake overheat condition on each wheel within range of 5.0 to 9.9.

3 Gear Door Status

Crosshatched – the door is not closed.

CLOSED (white) – the door is closed.

Empty box(es) (white) – the associated landing gear door position indicators are inoperative.

4 Fault Indication (amber)

BRAKE – indicates brake deactivation on the associated wheel.

ASKID – indicates antiskid fault on the associated wheel.

5 Tire Pressure Indication

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Displays individual tire pressures:

- white – normal range
- amber – abnormal high or low range.

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Landing Gear System Description

Chapter 14 Section 20

Introduction

The airplane has two main landing gear and a single nose gear. The nose gear is a conventional steerable two-wheel unit. Each main gear has six wheels in tandem pairs. To improve turning radius, the aft axle of each main gear is steerable.

Hydraulic power for retraction, extension, and steering is supplied by the center hydraulic system. An alternate extension system is also provided.

7101 - 7110

The normal brake hydraulic system is powered by the right hydraulic system. The alternate/reserve brake hydraulic system is powered by the center hydraulic system. Antiskid protection is provided with both systems, but the autobrake system is available only through the normal system. A brake temperature monitor system and tire pressure indication system displays each brake temperature and tire pressure on the GEAR synoptic display.

7001 - 7008

The normal brake hydraulic system is powered by the right hydraulic system. The alternate/reserve brake hydraulic system is powered by the center hydraulic system. Antiskid protection is provided with both systems, but the autobrake system is available only through the normal system. A brake temperature monitor system displays each brake temperature on the GEAR synoptic display.

Air/Ground Sensing System

In-flight and ground operation of various airplane systems are controlled by the air/ground sensing system.

The system receives air/ground logic signals from sensors located on each main landing gear beam. These signals are used to configure the airplane systems to the appropriate air or ground status.

Landing Gear Operation

The landing gear are normally controlled by the landing gear lever. On the ground, the lever is held in the DN position by an automatic lever lock. The lever lock can be manually overridden by pushing and holding the landing gear lever LOCK OVERRIDE switch. In flight, the lever lock is automatically released through air/ground sensing.

Landing Gear Retraction

When the landing gear lever is moved to UP, the landing gear begins to retract. The landing gear doors open and the main gear wheels tilt to the retract position. The EICAS landing gear position indication display changes from a green DOWN indication to a white crosshatch in-transit indication as the landing gear retract into the wheel wells. After retraction, the landing gear are held up by uplocks. The EICAS landing gear position indication changes to UP for 10 seconds and then blanks. With the landing gear retracted and all doors closed, the landing gear hydraulic system is automatically depressurized.

If any gear is not up and locked up after the normal transit time, the EICAS caution message GEAR DISAGREE is displayed. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in-transit or down, if the gear never unlocked from the down position. The EICAS advisory message GEAR DOOR is displayed if any hydraulically actuated door is not closed after normal transit time.

Landing Gear Extension

When the landing gear lever is moved to DN, the landing gear doors open, the gear are unlocked, and the in-transit indication is displayed on the EICAS landing gear position indication.

The gear free-fall without hydraulic power to the down and locked position. The downlocks are powered to the locked position, all hydraulically actuated gear doors close, and the main gear trucks hydraulically tilt to the flight position. When all gear are down and locked, the EICAS gear position indication displays DOWN.

The EICAS caution message GEAR DISAGREE is displayed if any gear is not locked down (side and drag brace on the same main gear not locked, or nose gear drag brace not locked) after the normal transit time. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in transit (or UP if the gear never unlocked from the up position).

If only one brace on a main gear is locked (either drag or side brace not locked) after the normal transit time, the EICAS caution message MAIN GEAR BRACE L or R is displayed for the affected gear. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in transit. The EICAS advisory message GEAR DOOR displays if any hydraulically actuated door is not closed after the normal transit time.

Landing Gear Alternate Extension

The alternate landing gear extension system uses a dedicated DC powered electric hydraulic pump and center hydraulic system fluid to extend the landing gear. Selecting DOWN on the ALTERNATE GEAR switch releases all door and gear uplocks. The landing gear free-fall to the down and locked position. The landing gear lever position has no effect on landing gear alternate extension.

The EICAS landing gear position indication displays the expanded gear position indication when the alternate extension system is used. During alternate extension, the EICAS message GEAR DOOR is displayed because all the hydraulically powered gear doors remain open.

Following an alternate extension, the landing gear can be retracted by the normal system, if it is operating. Select DN then UP to retract the landing gear using the normal system.

Nose Wheel and Main Gear Aft Axle Steering

The airplane is equipped with nose wheel steering and main gear aft axle steering.

Nose wheel steering is powered by the center/reserve hydraulic system. Main gear aft axle steering is powered by the center hydraulic system.

Primary steering control is provided by a nose wheel steering tiller for each pilot. Limited steering control is available through the rudder pedals. The tillers can turn the nose wheels up to 70 degrees in either direction. A pointer on the tiller assembly shows tiller position relative to the neutral setting. The rudder pedals can be used to turn the nose wheels up to 7 degrees in either direction. Tiller inputs override rudder pedal inputs.

Main gear aft axle steering automatically operates when the nose wheel steering angle exceeds 13 degrees to reduce tire scrubbing.

The EICAS warning message CONFIG GEAR STEERING, accompanied by the takeoff configuration aural alert, is displayed if the main gear aft axles are not centered and locked when takeoff thrust is applied. The EICAS advisory message MAIN GEAR STEERING is displayed if the main gear steering actuators are not locked in the centered position when commanded to the center position.

Brake System

Each main gear wheel has a multiple disc carbon brake. The nose wheels have no brakes. The brake system includes:

- normal brake hydraulic system
- alternate/reserve brake hydraulic system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake.

Normal Brake Hydraulic System

The normal brake hydraulic system is powered by the right hydraulic system. The brake pedals provide independent control of the left and right brakes.

Alternate/Reserve Brake Hydraulic System

Alternate/reserve brake hydraulic system selection is automatic. If the right hydraulic system pressure is low, the center/reserve hydraulic system automatically supplies pressure to the alternate/reserve brake hydraulic system. Pushing a brake pedal then sends hydraulic pressure through the alternate antiskid valves to the brakes. If center hydraulic system fluid quantity is low, the C1 primary pump is isolated from the center hydraulic system to provide a reserve braking pressure source.

Loss of the right and center/reserve hydraulic systems causes the BRAKE SOURCE light to illuminate and the EICAS advisory message BRAKE SOURCE to display.

Brake Accumulator

The brake accumulator is located in the normal brake hydraulic system. If right and center/reserve brake hydraulic power is lost, the brake accumulator can provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate/reserve brake hydraulic systems. Antiskid protection is also provided when the brake system is being supplied pressure only from the brake accumulator.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When a wheel speed sensor detects a skid, the associated antiskid valve reduces brake pressure until skidding stops.

The alternate/reserve brake hydraulic system provides antiskid protection to tandem wheel pairs for the forward and middle axle wheels. The aft axle wheels remain individually controlled.

Touchdown and hydroplaning protection is provided using airplane inertial ground speed. Locked wheel protection is provided using a comparison with other wheel speeds.

The EICAS advisory message ANTISKID is displayed if an antiskid fault affecting the brake hydraulic system in use is detected, or if the parking brake valve is not fully open with the parking brake released, or if the system is completely inoperative.

Autobrake System

The autobrake system provides automatic braking at preselected deceleration rates for landing and full pressure for rejected takeoff. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

EICAS memo messages display the selected autobrake settings:

- AUTOBRAKE 1 through 4
- AUTOBRAKE MAX
- AUTOBRAKE RTO.

The EICAS advisory message AUTOBRAKE is displayed if the autobrake system is disarmed or inoperative, or autobrake solenoid valve pressure is high when not commanded on.

Rejected Takeoff

Selecting RTO (rejected takeoff) prior to takeoff arms the autobrake system. The RTO mode can be selected only on the ground. The RTO autobrake setting commands maximum braking pressure if:

- the airplane is on the ground
- groundspeed is above 85 knots, and
- both thrust levers are retarded to idle.

Maximum braking is obtained in this mode. If an RTO is initiated below 85 knots, the RTO autobrake function does not operate.

Taxi Brake Release

During each taxi brake application, the antiskid system releases the brakes of one axle pair of each main landing gear (if wheel speeds are less than 45 knots). The system sequences through the axle pairs at each brake application, thereby reducing the number of brake applications by each brake. This extends service life and reduces brake sensitivity during taxi.

All active brakes are applied for a heavy brake application, landing rollout, RTO, or when setting the parking brake.

The taxi brake release system operates only with the normal brake hydraulic system.

Landing

Five levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both thrust levers are retarded to idle, and
- the wheels have spun up.

Autobrake application occurs slightly after main gear touchdown. If MAX AUTO is selected, deceleration is limited to the AUTOBRAKE 4 level until pitch angle is less than one degree, then deceleration is increased to the MAX AUTO level. The deceleration level can be changed (without disarming the system) by rotating the selector.

To maintain the selected airplane deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The system provides braking to a complete stop or until it is disarmed.

Autobrake – Disarm

The autobrake system disarms and the EICAS advisory message AUTOBRAKE is displayed if any of the following occur:

- pedal braking applied
- either thrust lever advanced after landing
- speedbrake lever is moved to the DOWN detent after the speedbrakes have deployed on the ground
- DISARM or OFF position selected on the AUTOBRAKE selector
- autobrake fault
- normal antiskid system fault
- loss of inertial data from the ADIRU
- autobrakes are applied after loss of normal brake hydraulic pressure.

When the autobrake system disarms after landing, the AUTOBRAKE selector automatically moves to the DISARM position, and removes power from the autobrake system.

When the autobrake system disarms during takeoff, the autobrake selector remains in the RTO position, but automatically moves to OFF after takeoff.

Parking Brake

The parking brake can be set with the normal or alternate brake hydraulic system pressurized. If the normal and alternate brake systems are not pressurized, parking brake pressure is maintained by the brake accumulator. The brake accumulator is pressurized by the right hydraulic system. Accumulator pressure is shown on the BRAKE ACCUMULATOR PRESSURE indicator.

The parking brake is set by fully depressing both brake pedals, pulling the parking brake lever up, then releasing the pedals. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the parking brake lever releases.

When the parking brake is set, the EICAS memo message PARKING BRAKE SET is displayed. If the parking brake is set and either engine is set to takeoff thrust, the takeoff configuration aural alert sounds and the EICAS warning message CONFIG PARKING BRAKE is displayed.

Brake Temperature Indication

Wheel brake temperatures are displayed on the GEAR synoptic display. Numerical values related to wheel brake temperature are displayed adjacent to each wheel/brake symbol. These values range from 0.0 to 9.9 in increments of 0.1. The values tend to increase after the brakes are used.

Normal range values of 0 to 4.9 are white. For values of 3.0 to 4.9, the brake symbol for the hottest brake becomes solid white. Values of 5.0 and above are amber. For values of 5.0 and above, the EICAS advisory message BRAKE TEMP is displayed.

Tire Pressure Indication

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Individual tire pressures, from 0 to 400 PSI, are displayed inside the individual wheel symbols on the GEAR synoptic display.

The EICAS advisory message TIRE PRESS is displayed if any tire pressure is above or below the normal range, or there is an excessive pressure difference between two tires on the same axle.

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Landing Gear EICAS Messages

Chapter 14 Section 30

Landing Gear EICAS Messages

The following EICAS messages can be displayed.

Note: Configuration warning messages are covered in Chapter 15, Warning Systems.

Brakes

Message	Level	Aural	Message Logic
ANTISKID	Advisory		A fault is detected in the antiskid system.
AUTOBRAKE	Advisory		Autobrake is disarmed or inoperative.
AUTOBRAKE 1, 2, 3, 4, MAX, RTO	Memo		Indicates selected autobrake level.
BRAKE SOURCE	Advisory		Normal and alternate brake system pressures are low, and reserve hydraulic source for alternate brake system is low.
BRAKE TEMP	Advisory		Temperature of one or more brakes is excessive.
PARKING BRAKE SET	Memo		The parking brake lever is up and the parking brake valve is closed
RESERVE BRAKES/STRG	Advisory		Alternate brakes from the reserve hydraulic source, normal nose gear extension, or nose wheel steering may not be available.

Landing Gear

Message	Level	Aural	Message Logic
GEAR DISAGREE	Caution	Beeper	Gear position disagrees with landing gear lever position.
GEAR DOOR	Advisory		One or more gear doors are not closed.
MAIN GEAR BRACE L, R	Caution	Beeper	Affected main gear is down with one brace unlocked.
MAIN GEAR STEERING	Advisory		Main gear steering is unlocked when centered.

Tires

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Message	Level	Aural	Message Logic
TIRE PRESS	Advisory		One or more tire pressures are not normal.

Warning Systems

Chapter 15

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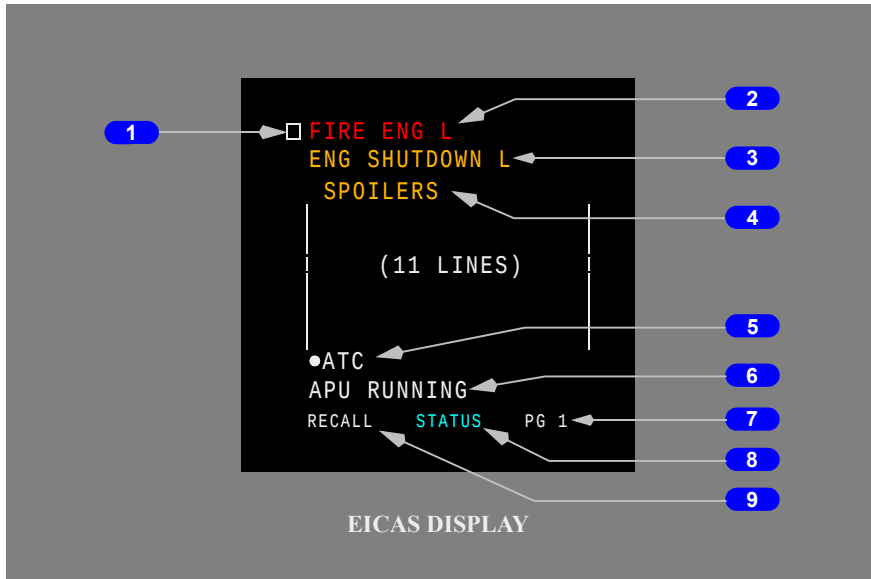
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Engine Indication and Crew Alerting System (EICAS)

EICAS Messages



1 Checklist Icon

Displayed (white) –

- when checklist with procedural steps, notes, or other information of which the crew must be made aware exists for respective message
- no longer displayed when checklist complete
- no longer displayed when inhibited by checklist of another message

2 Warning Messages

Displayed (red) –

- highest priority alert messages
- red alert messages remain displayed and cannot be canceled by pushing the CANC/RCL switch.

3 Caution Messages

Displayed (amber) –

- next highest priority alert messages after warning messages
- amber alert messages can be canceled or recalled by pushing the CANC/RCL switch

4 Advisory Messages

Displayed (amber) –

- lowest priority alert messages; indented one space
- amber alert messages can be canceled or recalled by pushing the CANC/RCL switch

5 Communication Messages

Displayed (white) –

- prefaced with white dot
- COMM low messages indented one space
- cannot be canceled by pushing the CANC/RCL switch

6 Memo Messages

Displayed (white) –

- reminder of selected state of controls or systems
- cannot be canceled by pushing the CANC/RCL switch
- EICAS alert messages have display priority over memo messages; some or all memo messages not displayed on current EICAS message page if insufficient message lines are available below alert messages

7 Page (PG) Number

Displayed (white) –

- more than one page of alert or memo messages exists
- indicates number of page selected

8 STATUS Cue

Displayed (cyan) –

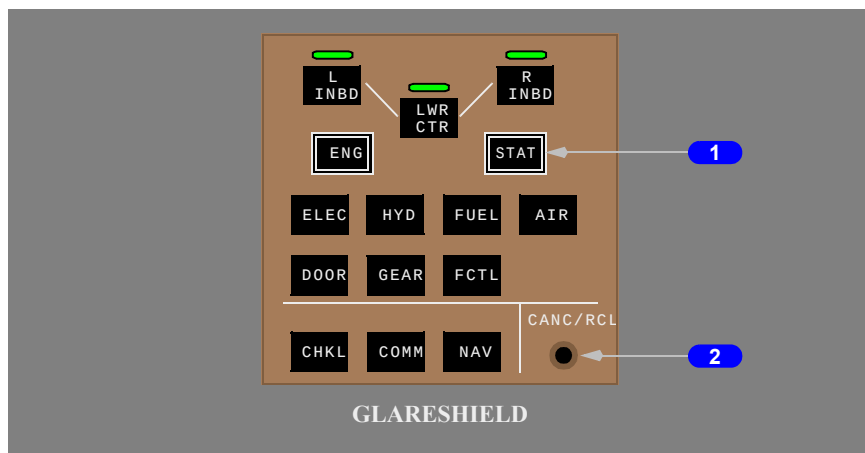
- new status message exists
- no longer displayed when status display selected
- inhibited from beginning of first engine start until 30 minutes after lift-off

9 RECALL Indication

Displayed (white) –

- when CANCEL/RCL switch pushed
- remains displayed for one second after switch released

Display Select Panel



1 Status (STAT) Display Switch

Push – displays status display on selected MFD.

Subsequent pushes –

- displays next page of status messages when additional pages exist
- lower center MFD blanks when last page of status messages displayed
- inboard MFDs return to NAV display after last page of status messages displayed

2 Cancel/Recall (CANC/RCL) Switch

Push (when EICAS caution or advisory messages displayed) –

- displays the next page of EICAS messages when additional pages exist
- cancels caution and advisory messages when last page displayed; warning, memo, and communications messages remain displayed
- cancels red box for any engine parameter previously exceeded when displayed parameter no longer exceeds the limit

Push (when no EICAS caution or advisory messages displayed) –

- redisplay all caution and advisory EICAS messages, when non-normal condition exists
- displays first page of messages when multiple pages exist
- redisplay red box for parameters previously exceeded

Engine Fail, GPWS, and PWS Alerts on PFD



1 Alert on PFD

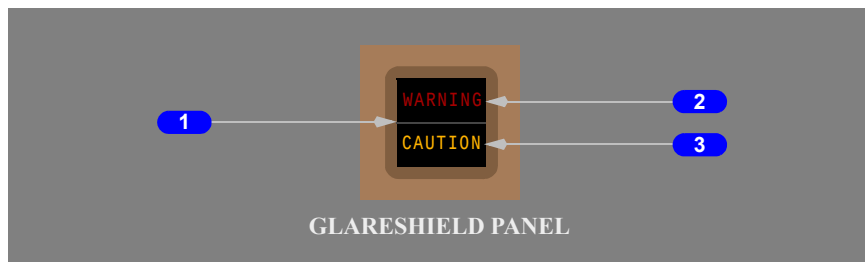
ENG FAIL (red) – ENGINE FAIL alert is occurring.

PULL UP (red) – PULL UP alert is occurring.

WINDSHEAR (red) –

- predictive WINDSHEAR AHEAD alert or immediate WINDSHEAR alert is occurring
- all other GPWS alerts inhibited

Master WARNING/CAUTION Reset Switches and Lights



1 Master WARNING/CAUTION Reset Switch

Push –

- extinguishes master WARNING lights
- extinguishes master CAUTION lights
- silences the aural that accompanies the EICAS warning messages:

- CABIN ALTITUDE
- CONFIG GEAR, if displayed because landing gear not down and locked, any thrust lever at idle, and radio altitude less than 800 feet
- FIRE
- OVERSPEED
- PILOT RESPONSE

2 Master WARNING Light

Illuminated (red) –

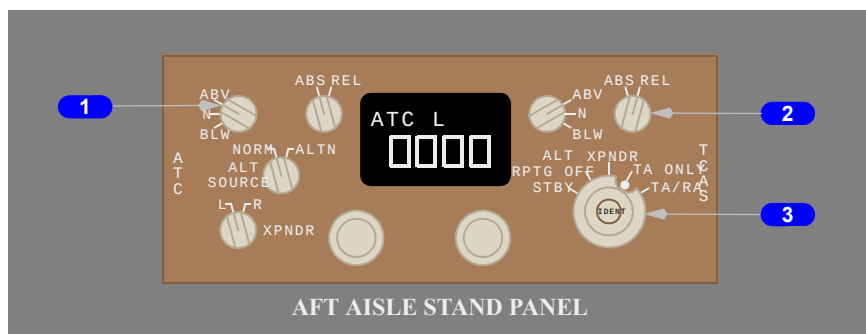
- new EICAS warning message displayed, or
- ENGINE FAIL, PULL UP, or WINDSHEAR alert displayed on PFD

3 Master CAUTION Light

Illuminated (amber) – new EICAS caution message displayed

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls (Transponder Panel)



1 TCAS Airspace Selector

Left switch controls Captain TCAS display. Right switch controls First Officer TCAS display.

ABV (above) – altitude reporting traffic from 2,700 feet below to 7,000 feet above current altitude displayed.

N (normal) – altitude reporting traffic from 2,700 feet below to 2,700 feet above current altitude displayed.

BLW (below) – altitude reporting traffic 7,000 feet below to 2,700 feet above current altitude displayed.

2 TCAS Absolute/Relative (ABS/REL) Altitude Selector

Left switch controls Captain TCAS display. Right switch controls First Officer TCAS display.

ABS (absolute) – absolute altitude displayed in TCAS traffic symbol data tags.

REL (relative) – relative altitude displayed in TCAS traffic symbol data tags.

3 Transponder Mode Selector

TA ONLY (traffic advisory) –

- transponder and TCAS TA modes enabled
- all aircraft that would have been predicted as a RA are predicted as a TA

TA/RA (traffic advisory/resolution advisory) – transponder and TCAS TA and RA modes enable.

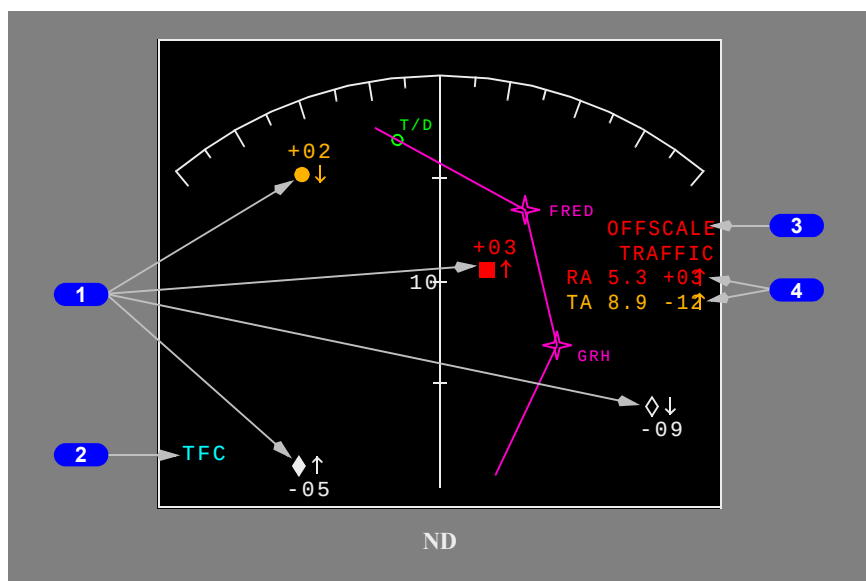
TCAS Traffic and TCAS Alert Message TRAFFIC Display

TCAS Traffic Display

Displayed when TFC selected and respective ND is in MAP, MAP CTR, VOR, or APP mode.

Displayed automatically when:

- a RA or TA is occurring, and
- TFC not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode



1 Traffic Targets

Indicates relative position of traffic.

- filled red square indicates a resolution advisory (RA)
- filled amber circle indicates a traffic advisory (TA)
- filled white diamond indicates proximate traffic
- unfilled white diamond indicates other traffic
- number is relative or absolute altitude of traffic in hundreds and thousands of feet; not displayed when altitude unknown
- vertical motion arrow indicates traffic climbing or descending at 500 feet per minute or greater; not displayed for vertical motion less than 500 feet per minute

2 TCAS Mode Annunciations

TFC (cyan) –

- TCAS traffic display enabled
- TCAS traffic displayed in MAP, MAP CTR, APP, and VOR modes

TA ONLY (cyan) –

- TCAS cannot provide RAs
- all traffic that would have been RAs are predicted as TAs

3 OFFSCALE Message

Displayed (red) – RA is beyond selected map range

Displayed (amber) – TA is beyond selected map range

4 TCAS No Bearing Messages

RA (red) – data tag displayed for no-bearing RA.

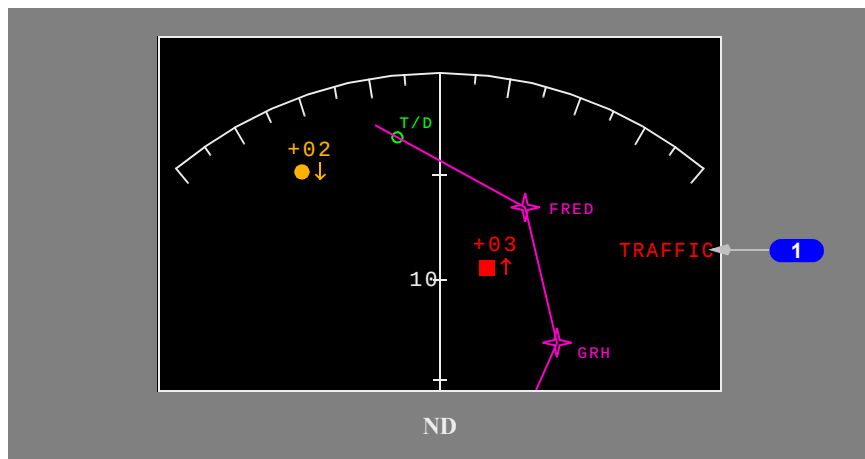
TA (amber) – data tag displayed for no-bearing TA.

Data tag contains distance, altitude, and vertical motion arrow.

TCAS Alert Message TRAFFIC

Displayed:

- in all ND modes and ranges
- whether TCAS traffic is displayed or not

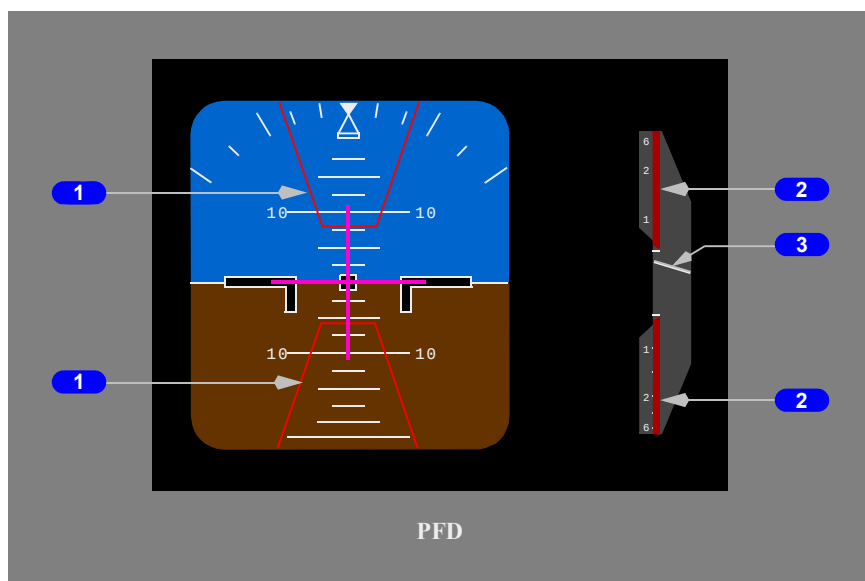


1 TRAFFIC Alert Message

Displayed: (red) – RA is occurring.

Displayed: (amber) – TA is occurring, and RA is not occurring.

TCAS PFD Vertical Guidance



1 RA Pitch Region To Avoid (red outlined)

Note: For a single RA, only one red outlined RA pitch region, either above or below, is displayed at a time. For two or more RAs, two red outlined RA pitch regions may be displayed.

To ensure vertical separation, the center of the airplane symbol must be outside the red outlined RA pitch regions to avoid.

2 RA Vertical Speed Region to Avoid (red)

To ensure vertical separation, vertical speed must be outside the red RA vertical speed region to avoid.

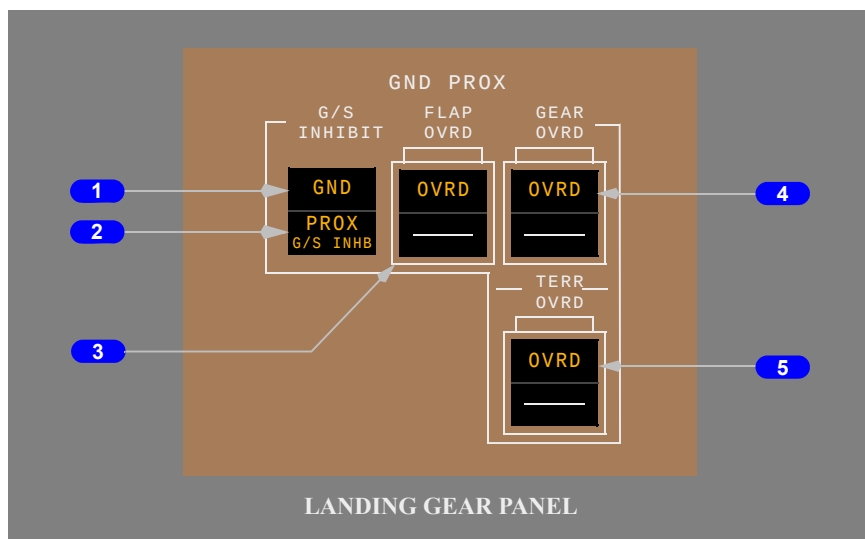
3 Vertical Speed Pointer

Red – present vertical speed does not ensure RA traffic is avoided.

White – present vertical speed ensures RA traffic is avoided.

Ground Proximity Warning System (GPWS) Controls

Ground Proximity Panel



1 Ground Proximity (GND PROX) Glideslope (G/S) INHIBIT (INHIB) Switch

Push – inhibits GLIDE SLOPE alert when pushed below 1,000 feet radio altitude.

2 Ground Proximity (GND PROX) Light

Illuminated (amber) –

- GPWS alert is occurring
- inhibited for GLIDE SLOPE, or TOO LOW FLAPS, or TOO LOW GEAR alert when respective inhibit or override switch is pushed

3 Ground Proximity (GND PROX) FLAP Override (OVRD) Switch

Push (OVRD visible) –

- inhibits TOO LOW FLAPS alert
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 250 knots for more than 60 seconds

4 Ground Proximity (GND PROX) GEAR Override (OVRD) Switch

Push (OVRD visible) –

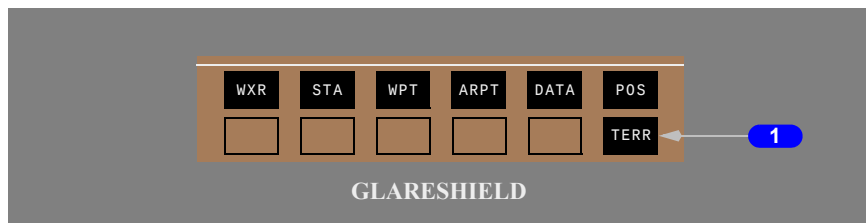
- inhibits TOO LOW GEAR alert
- inhibits CONFIG GEAR alert
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 290 knots for more than 60 seconds

5 Ground Proximity (GND PROX) Terrain (TERR) Override (OVRD) Switch

Push (OVRD visible) – inhibits look-ahead terrain alerts and display.

GPWS Look–Ahead Terrain Alerting Display and Annunciations

GPWS Terrain Display Select Switch



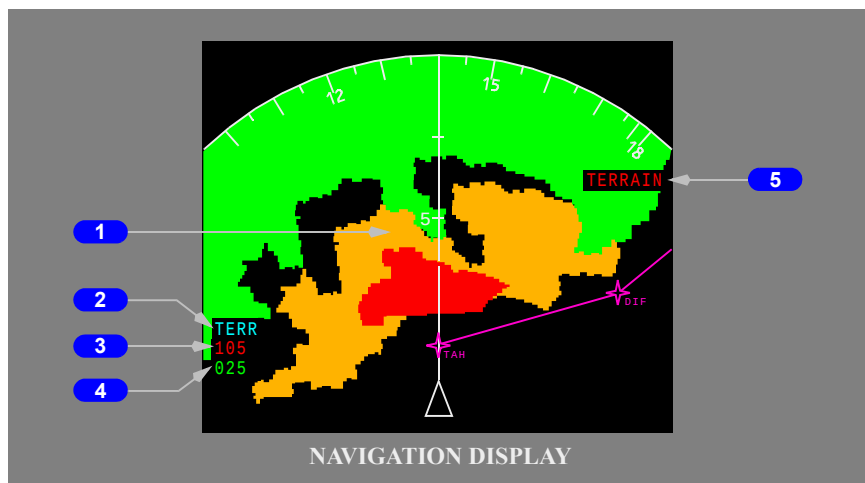
1 Terrain (TERR) Display Select Switch

Push –

- terrain data displayed in MAP, MAP CTR, VOR, and APP modes
- deselects weather radar display regardless of switch position

Second push – deselects terrain data display.

Terrain Display



1 Terrain Display

When airplane is higher than 2,000 feet above terrain, density based on obstacle height, peaks height, and airplane altitude:

- solid green – highest obstacles or peaks displayed
- high density green – intermediate height obstacles or terrain peaks displayed
- low density green – lowest obstacles or terrain peaks displayed

When airplane is lower than 2,000 feet above terrain, color and density based on obstacle height, terrain height, and airplane altitude:

- dotted green – obstacles or terrain from 2,000 feet below to 500 feet (250 feet with gear down) below airplane altitude
- dotted amber – obstacles or terrain 500 feet (250 feet with gear down) below to 2,000 feet above airplane altitude
- dotted red – obstacles or terrain more than 2,000 feet above airplane altitude
- dotted magenta – no terrain data available
- solid amber – look-ahead terrain caution alert is occurring
- solid red – look-ahead terrain warning alert is occurring

Note: In areas without obstacle or terrain data, look-ahead terrain alerting and display functions not available. GPWS immediate alerts function normally.

Displayed automatically when:

- a look-ahead obstacle or terrain alert occurs, and
- TERR not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

Display updates with a display sweep similar to weather radar display.

2 Terrain Mode Annunciation

TERR (cyan) – terrain display enabled.

3 Highest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

4 Lowest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

5 OBSTACLE and TERRAIN Annunciation

OBSTACLE (amber) – obstacle caution alert is occurring.

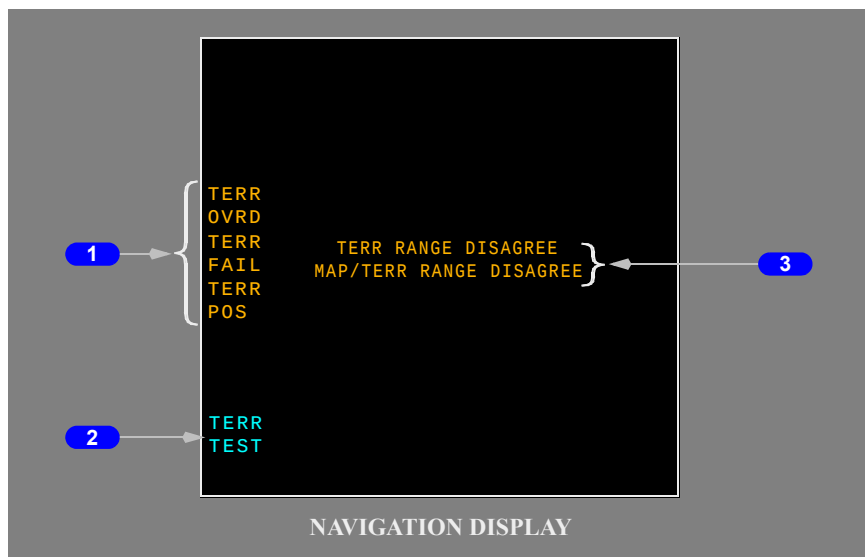
OBSTACLE (red) – obstacle warning alert is occurring.

TERRAIN (amber) – look-ahead terrain caution alert is occurring.

TERRAIN (red) – look-ahead terrain warning alert is occurring.

Displayed in all ND display modes.

Terrain Navigation Display Annunciations



1 Terrain Status Annunciation

TERR FAIL (amber) – Look-ahead terrain alerting and display failed.

TERR OVRD (amber) – TERR OVRD switch pushed.

TERR POS (amber) – Look-ahead terrain alerting and display unavailable due to GPS position uncertainty. During time between GPS position failure and display of TERR POS message, ADIRS provides position for look-ahead terrain alerting and display.

2 Terrain Mode Annunciation

TERR TEST (cyan) – GPWS operating in self-test mode.

3 Terrain Range Status Annunciation

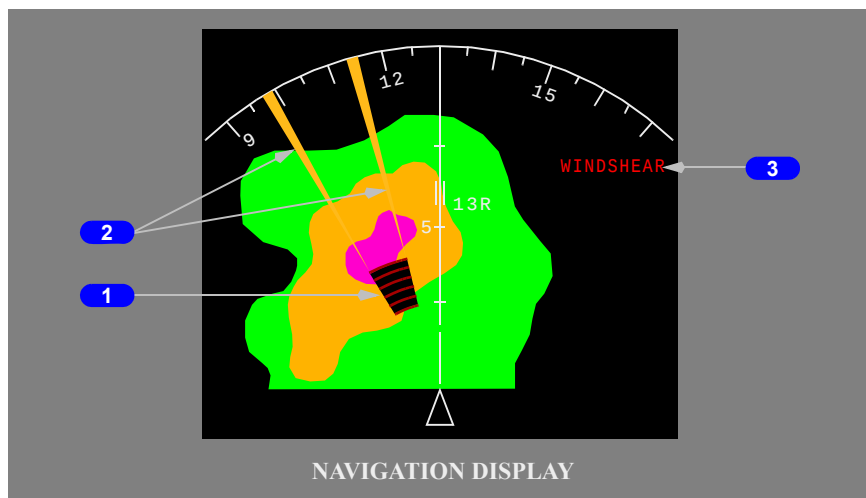
TERR RANGE DISAGREE (amber) –

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel

MAP/TERR RANGE DISAGREE (amber) –

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel, and
- map display output range disagrees with range selected by EFIS control panel

Predictive Windshear (PWS) Display and Annunciations



1 PWS Symbol

Displayed (red and black) –

- PWS alert is occurring
- displays windshear location and approximate geometric size (width and depth)

Symbol, radials, and weather radar returns displayed automatically when:

- PWS alert occurs, and
- WXR is not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

When terrain display is selected and PWS alert occurs, weather radar display replaces terrain display.

2 PWS Radials

Displayed (amber) –

- PWS alert is occurring
- extend from PWS symbol to help locate windshear event

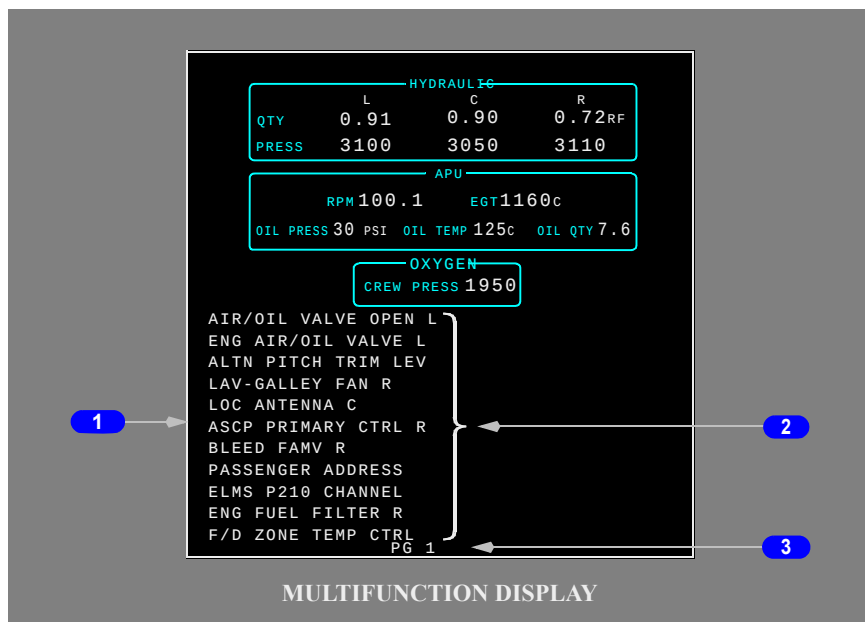
3 WINDSHEAR Annunciation

WINDSHEAR (amber) – PWS caution alert is occurring.

WINDSHEAR (red) – PWS warning alert is occurring.

Displayed in all navigation display modes.

Status Display



1 Status Display

Displays hydraulic, APU, and oxygen system indications and status messages.

2 Status Messages

Status messages indicate equipment faults requiring MEL reference for dispatch.

3 Page (PG) Number

Displayed –

- additional pages of status messages exist
- displays number of page selected

EICAS Event Record Switch



1 EICAS EVENT Record (RCD) Switch

Push – records up to five EICAS events into memory.

Intentionally
Blank

Warning Systems

System Description

Chapter 15

Section 20

Introduction

Warning systems consist of:

- engine indication and crew alerting system (EICAS)
- airspeed alerts
- tail strike detection system
- takeoff and landing configuration warning system
- MCP selected altitude alerts
- crew alertness monitor
- traffic alert and collision avoidance system (TCAS)
- windshear alerts
- ground proximity warning system (GPWS)

Engine Indication and Crew Alerting System (EICAS)

EICAS consolidates engine and airplane system indications and is the primary means of displaying system indications and alerts to the flight crew. The most important indications are displayed on EICAS which is normally displayed on the upper center display.

EICAS Messages

Systems conditions and configuration information is provided to the crew by four types of EICAS messages:

- EICAS alert messages are the primary method to alert the crew to non-normal conditions
- EICAS communication messages direct the crew to normal communication conditions and messages
- EICAS memo messages are crew reminders of certain flight crew selected normal conditions
- EICAS status messages indicate equipment faults which may affect airplane dispatch capability

An EICAS alert, communications, or memo message is no longer displayed when the respective condition no longer exists.

EICAS Alert Messages

From after engine start until engine shut down, EICAS alert messages are the primary means to alert the crew to non-normal conditions which may impact other operations during the flight.

There is a non-normal procedure for each EICAS alert message. The procedure for every EICAS alert message is included as a checklist in the QRH. Procedures for some EICAS alert messages have steps to reconfigure airplane systems. A rectangular symbol  prefaces an alert message that has procedural steps. The rectangular symbol  also prefaces EICAS alert messages for checklists that have notes or information of which the crew must be made aware.

EICAS alert messages are grouped into three priority levels: warning, caution, and advisory. Prioritization is an aid to flight crew decision making when more than one EICAS alert message is displayed.

EICAS warning messages are displayed red and EICAS caution and advisory messages are displayed amber. Red EICAS alert messages remain displayed and cannot be canceled by pushing the CANC/RCL switch. Amber EICAS alert messages can be canceled and recalled by pushing the CANC/RCL switch.

EICAS Communication Messages

EICAS communication messages direct crew attention to normal communication conditions which may require crew attention. There is a crew action for each EICAS communications message.

EICAS communications messages are grouped into three priority levels: high, medium, and low. Prioritization is an aid to flight crew decision making when more than one message is displayed.

EICAS communications messages are displayed in white below EICAS alert messages. Communication messages can not be cancelled by pushing the CANC/RCL switch.

EICAS Memo Messages

EICAS memo messages are crew reminders of certain flight crew selected normal conditions. They are displayed in white at the bottom of the last page of EICAS alert messages on the primary EICAS display.

Pushing the CANC/RCL switch when the last page of EICAS alert messages is displayed ensures all current memo messages have been displayed.

EICAS Status Messages

All EICAS status messages are listed in the Dispatch Deviation Guide (DDG) or airline equivalent and provide a cross reference to the Minimum Equipment List (MEL) for dispatch capability.

Display and Manipulation of EICAS Messages

If more than one EICAS alert message is displayed, the messages are displayed in a list which is grouped by priority level. EICAS warning messages are displayed in red at the top of the message list.

EICAS caution messages are displayed in amber below the lowest warning message. EICAS advisory messages are displayed in amber below the lowest caution message and are indented one character so they may be distinguished from EICAS caution messages.

The most recent EICAS alert message is displayed at the top of its priority group and all messages move down one display line. If a message is no longer displayed because the respective system non-normal condition no longer exists, all messages previously displayed move up one display line.

If there are more messages in the list than can be displayed on one page, multiple pages are created and numbered sequentially. The page number is normally displayed at the bottom of each list. Multiple pages of EICAS caution and advisory messages can be displayed one page at a time by pushing the CANC/RCL switch. If there are more EICAS warning messages in the list than can be displayed on one page, no page number is displayed and it is not possible to display other pages. In all other cases, pushing the CANC/RCL switch displays the next page of EICAS caution and advisory messages. EICAS warning messages are displayed at the top of each page.

Pushing the CANC/RCL switch when the last page of the list is displayed causes all EICAS caution and advisory messages to be no longer displayed.

EICAS alert messages for new system non-normal conditions are displayed on the page being viewed.

For example, if page three is displayed and an EICAS caution message is displayed because a new system non-normal occurs, the message is displayed immediately below any EICAS warning messages. If the CANC/RCL switch is subsequently pushed to redisplay page one, the message is displayed as the first EICAS caution message on page one.

When no EICAS caution or advisory messages are displayed, pushing the CANC/RCL switch redisplay page one of the EICAS caution and advisory messages for all system non-normal conditions and the RECALL message is displayed briefly.

The most recent EICAS communication message is displayed at the top of its priority group and all messages move down one display line. If a message is no longer displayed because the respective communication condition no longer exists, all messages previously displayed move up one display line.

The most recent EICAS memo message is displayed at the bottom of the memo messages.

The STATUS cue is displayed on primary EICAS when a new EICAS status message is displayed. When the STAT switch is pushed, the status display is displayed on the secondary EICAS display. The most recent status message is displayed at the top of the message list.

The STAT switch controls the display of single and multiple pages of status messages in a manner similar to the way the CANCEL/RCL switch controls the display of EICAS alert messages.

Aurals, Master WARNING/CAUTION Switches and Lights, and GND PROX Light

Aurals, two master WARNING and CAUTION lights, and the GND PROX light call attention to the following alerts:

- in the following table, parans () describe crew action to silence the aural or extinguished the light while the alert is occurring.

Aural	Light	Calls Attention To:
Bell (Silence by pushing Master WARNING/CAUTION Reset switch)	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG L, R FIRE WHEEL WELL
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	EICAS warning message: AUTOPILOT DISC CONFIG DOORS CONFIG FLAPS CONFIG GEAR STEERING CONFIG PARKING BRAKE CONFIG RUDDER CONFIG SPOILERS CONFIG STABILIZER
Siren (Silence by pushing Master WARNING/CAUTION Reset switch.	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	EICAS warning message: CABIN ALTITUDE OVERSPEED PILOT RESPONSE

Voice annunciation VEE ONE	None	Airspeed at V1 during takeoff
Voice annunciation ENGINE FAIL	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	Red ENG FAIL on both PFDs
Beeper	Master CAUTION lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	New EICAS caution message, except: ENGINE SHUTDOWN L ENGINE SHUTDOWN R
High-low chime	None	New EICAS medium level communication message
Voice annunciation: DON'T SINK, DON'T SINK TOO LOW, TERRAIN	GND PROX light	GPWS immediate alert.

Voice annunciation: ADJUST VERTICAL SPEED, ADJUST CLIMB, CLIMB CLIMB, CLIMB NOW, CLIMB, CLIMB NOW CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB DESCEND, DESCEND DESCEND, DESCEND NOW, DESCEND, DESCEND NOW DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND INCREASE CLIMB, INCREASE CLIMB INCREASE DESCENT, INCREASE DESCENT MAINTAIN VERTICAL SPEED, MAINTAIN MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN MONITOR VERTICAL SPEED	None	Red regions to avoid on PFD Red TRAFFIC message and TCAS RA traffic display on ND
Voice annunciation CLEAR OF CONFLICT	None	Red regions to avoid on PFD, Red TRAFFIC message, and TCAS RA traffic display on ND are no longer displayed.
Voice annunciation TRAFFIC, TRAFFIC	None	Amber TRAFFIC message and TCAS TA traffic display on ND

Voice annunciation: OBSTACLE, OBSTACLE, PULL UP TERRAIN, TERRAIN, PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	Red PULL UP on both PFDs Red OBSTACLE or TERRAIN message and obstacle or terrain display on ND
Voice annunciation: CAUTION OBSTACLE CAUTION TERRAIN	GND PROX light	Amber OBSTACLE or TERRAIN message and obstacle or terrain display on ND
Voice annunciation: WINDSHEAR AHEAD GO AROUND, WINDSHEAR AHEAD	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	Red WINDSHEAR on both PFDs Red WINDSHEAR message and PWS display on ND
Voice annunciation MONITOR RADAR DISPLAY	None	Amber WINDSHEAR message and PWS display on ND
Siren, followed by voice annunciator WINDSHEAR, WINDSHEAR, WINDSHEAR	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	Red WINDSHEAR on both PFDs
Voice annunciation PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch)	Red PULL UP on both PFDs
Siren (If caused by Thrust lever at idle, silence by pushing Master WARNING/CAUTION Reset switch)	Master WARNING lights (If caused by Thrust lever at idle, extinguish by pushing Master WARNING/CAUTION Reset switch)	EICAS warning message CONFIG GEAR for: • Thrust lever at idle, and • radio altitude less than 800 feet, and • gear not down and locked.

Voice annunciation: GLIDE SLOPE SINK RATE TERRAIN TOO LOW, FLAPS TOO LOW, GEAR TOO LOW, TERRAIN	GND PROX light	GPWS immediate alert
Altitude voice annunciations	None	Altitude voice annunciations during approach

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used with EICAS messages to:

- help locate and identify affected systems and controls
- reduce potential for error

Airspeed Alerts

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns.

Airspeed Low

The EICAS caution message AIRSPEED LOW is displayed and the box around the current airspeed indication on the PFD is highlighted amber when airspeed is below minimum maneuvering speed.

Overspeed Warning

The EICAS warning message OVERSPEED is displayed if airspeed is greater than VMO/MMO. The message remains displayed until airspeed is reduced below VMO/MMO.

Tail Strike Detection System

The tail strike alert system detects ground contact which could damage the airplane pressure hull. A two inch blade target and two proximity sensors are installed on the aft body of the airplane. The EICAS caution message TAIL STRIKE is displayed when a tail strike is detected.

Takeoff And Landing Configuration Warning System

The takeoff and landing configuration warning system alerts the crew that the airplane is not configured for normal takeoff or normal landing.

Takeoff Configuration Warnings

The respective EICAS warning message CONFIG is displayed if:

- airplane is on the ground, and
- FUEL CONTROL switches are in RUN position, and
- either engine thrust is in takeoff range, and
- thrust reversers are not unlocked or deployed, and
- airspeed is less than V₁, or airspeed is less than 80 knots for EICAS warning message CONFIG GEAR STEERING, and
- any of the following configurations exist;
 - any door not closed, latched, and locked, or
 - flaps or slats not in takeoff position, or
 - main gear steering not locked, or
 - parking brake set, or
 - rudder trim not centered, or
 - SPEED BRAKE lever not in DOWN detent, or
 - stabilizer trim not in green band

When the EICAS warning message CONFIG is displayed, pushing either Master WARNING/CAUTION reset switch resets the Master WARNING lights but does not silence the siren. If thrust is decreased below takeoff range and airspeed is less than V₁ but the airplane is still not configured for takeoff, the Master WARNING lights are extinguished and the siren is silenced. The CONFIG message remains displayed for 10 seconds after thrust is reduced to aid in identifying the takeoff configuration.

Landing Configuration Warning

The landing configuration warning system alerts the crew the landing gear is not extended for landing. The EICAS warning message CONFIG GEAR is displayed if:

- the airplane is in flight, and
- any landing gear is not down and locked, and
- any of the following configurations exist;
 - either Thrust lever closed and radio altitude less than 800 feet, or
 - FLAP lever in landing position

If the message is displayed because a Thrust lever is closed at low radio altitudes, pushing either Master WARNING/CAUTION reset switch silences the siren and extinguishes the Master WARNING lights. The message remains displayed until the Thrust levers are advanced or landing gear is down and locked.

If the message is displayed because the FLAP lever is in landing position, the siren cannot be silenced by pushing a Master WARNING/CAUTION reset switch and the message remains displayed. The siren sounds and the message is displayed until the landing gear is down and locked or the GND PROX GEAR OVRD switch is pushed.

Speedbrake Lever Extend Beyond ARM During Climb

In flight, the EICAS warning message CONFIG SPOILERS alerts the crew if:

- the SPEEDBRAKE lever is extended beyond ARMED, and
- climb or higher thrust is set on either thrust levers

When the EICAS warning message CONFIG SPOILERS is displayed in flight, pushing either Master WARNING/CAUTION Reset switch silences the siren and extinguishes the Master WARNING lights. The EICAS message remains displayed until:

- the SPEEDBRAKE lever is DOWN or at ARMED, or
- both thrust levers are set below climb thrust

Configuration Warning System Non-normal Operation

If the takeoff and landing warning system fails, the EICAS advisory message CONFIG WARN SYS will be displayed. If the takeoff and landing configuration system fails, CONFIG messages may or may not be displayed. If the messages are displayed with the CONFIG WARN SYS message, the CONFIG messages may not be correct.

MCP Selected Altitude Alert

Altitude alerting is provided when approaching or departing the altitude selected in the MCP altitude window.

Approaching MCP Selected Altitude

At 750 feet prior to reaching the selected altitude a highlighted white box is displayed around the selected altitude and the current altitude on the PFD. The highlights are no longer displayed when within 250 feet of the selected altitude.

Departing MCP Selected Altitude

When departing the selected altitude by 250 feet, the EICAS alert message ALTITUDE ALERT is displayed, and a highlighted amber box is displayed around the current altitude. The message and amber highlight is no longer displayed when:

- subsequently reapproaching to within 250 feet of the selected altitude, or
- a new MCP altitude is selected, or
- departing more than 750 feet from the selected altitude.

MCP Selected Altitude Alert Inhibits

MCP selected altitude alerts are inhibited when:

- glideslope captured, or
- landing flaps selected and landing gear down and locked.

Crew Alertness Monitor

The FMC continuously monitors switch action on the MCP, EFIS control panel, display select panel, CDUs, and radio transmitter microphone switches. When a predefined time elapses after the last switch action was detected, the EICAS advisory message PILOT RESPONSE is displayed.

If there is still no switch action after a brief time, the EICAS caution message PILOT RESPONSE is displayed.

If there is still no switch action the EICAS warning message PILOT RESPONSE is displayed.

The PILOT RESPONSE message is no longer displayed after pushing any monitored switch.

The PILOT RESPONSE message is inhibited during climb below 20,000 feet when flaps are not up.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other airplanes, tracks the other airplanes by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides TCAS ND messages, voice annunciations, PFD vertical flight path guidance, and traffic displays of the other airplanes to the flight crew. Neither ND messages, voice annunciations, PFD vertical guidance, nor traffic display is provided for other airplanes that do not have operating transponders. TCAS operation is independent of ground-based air traffic control.

TCAS identifies a three-dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are contingent upon the closure rate with conflicting traffic.

TCAS provides:

- resolution advisory (RA) and display
- traffic advisory (TA) and display
- proximate traffic display
- other traffic display.

TCAS messages and TCAS traffic symbols can be displayed on the ND in the map, map centered, VOR, and approach modes. TCAS messages and TCAS traffic symbols cannot be displayed on the ND in the VOR-centered, approach-centered, or plan modes.

TCAS messages TRAFFIC, TA ONLY, and TCAS TEST may be displayed in all ND modes.

TCAS processing priorities may reduce display of certain air traffic on the ND. Reduced display of air traffic does not affect system collision avoidance alerting capability.

Resolution Advisories (RA) and Display

An RA is a prediction that another airplane will enter the TCAS conflict airspace within approximately 20 to 30 seconds. If altitude data from the other airplane is not available, no RA can be provided.

When TCAS predicts an RA:

- the TCAS red message TRAFFIC is displayed on the ND
- a TCAS voice annunciation sounds
- TCAS PFD vertical guidance is displayed

When the TCAS cyan message TFC is displayed on the ND, and the RA is within the display range of the ND, the TCAS RA Traffic aircraft symbol and its accompanying data tag are displayed on the ND.

The TCAS RA Traffic aircraft symbol is a filled red square. The RA data tag contains the altitude and the vertical motion arrow.

For no-bearing RAs, the red RA label is displayed below the red message, TRAFFIC, and the RA data tag information is displayed to the right of the label. The RA red data tag contains the distance, altitude, and the vertical motion arrow.

When the RA is further from the airplane than the ND range currently displayed, the TCAS red message OFFSCALE is displayed on the ND.

Traffic Advisories (TA) and Display

A TA is a prediction another aircraft will enter the conflict airspace in 25 to 45 seconds. TAs assist the flight crew in establishing visual contact with the other aircraft.

When TCAS predicts a TA:

- the TCAS amber message TRAFFIC is displayed on the ND
- the TCAS voice annunciation TRAFFIC, TRAFFIC sounds once

When the TCAS cyan message TFC is displayed on the ND and the TA is within the display range of the ND, the TCAS TA Traffic aircraft symbol and its accompanying data tag are displayed on the ND.

The TA Traffic aircraft symbol is a filled amber circle. The TA data tag contains the altitude and vertical motion arrow.

For no-bearing TAs, the amber TA label is displayed below the TRAFFIC message, and the TA data tag information is displayed to the right of the label. The TA labels are displayed below the RA labels. The TA data tag contains the distance, altitude, and vertical motion arrow.

When the TA is further from the airplane than the ND range currently displayed, the TCAS amber message OFFSCALE is displayed on the ND.

Proximate Traffic Display

Proximate traffic is another airplane that is neither an RA or a TA but is within:

- six miles
- 1,200 feet vertically.

When the TCAS cyan message TFC is displayed on the ND, and the Proximate Traffic aircraft is within the ND display range, the TCAS Proximate Traffic aircraft symbol is displayed on the ND.

The TCAS Proximate Traffic aircraft symbol is a filled white diamond. When TCAS is receiving and processing altitude data from the Proximate Traffic aircraft, the proximate traffic data tag is displayed on the ND. The proximate traffic data tag contains the altitude and vertical motion arrow.

Other Traffic Display

Other Traffic aircraft is an aircraft that is within the ND display limits but is neither a RA, a TA, or proximate traffic aircraft. When TCAS is not receiving and processing altitude data from the Other Traffic aircraft, the Other Traffic aircraft becomes Proximate Traffic aircraft automatically when within six miles.

When the TCAS cyan message TFC is displayed on the ND and the Other Traffic aircraft is within the ND display range, the TCAS Other Traffic symbol is displayed on the ND.

The TCAS Other Traffic symbol is a hollow white diamond. When TCAS is receiving and processing altitude data from the Other Traffic aircraft, a data tag like that described in Proximate Traffic Display is displayed.

TCAS PFD Vertical Guidance

When TCAS predicts an RA, TCAS vertical guidance is displayed on the PFD for a maneuver to ensure vertical separation. Traffic avoidance is ensured by adjusting or maintaining a pitch attitude and vertical speed outside the red RA regions.

If the traffic airplane also has TCAS and a mode S transponder, TCAS vertical guidance is coordinated with the traffic aircraft TCAS.

TCAS ND Messages

ND Message	Color	Description
TFC	Cyan	TCAS traffic display enabled. Inhibited if following TCAS messages are displayed: TCAS FAIL, TCAS OFF, TCAS TEST
TRAFFIC	Amber	TA is occurring.
OFFSCALE	Amber	TA is occurring at range greater than current ND range. Replaced by red OFFSCALE when RA is also occurring at range greater than current ND range.
TRAFFIC	Red	RA is occurring.
OFFSCALE	Red	RA is occurring at range greater than current ND range.
TA ONLY	Cyan	TCAS can not provide RAs. All traffic that would have been RAs are predicted as TAs.
TCAS FAIL	Amber	TCAS failed, or TCAS information cannot be displayed on ND.
TCAS OFF	Amber	TFC switch pushed to display traffic but TCAS not selected on transponder panel.
TCAS TEST	Cyan	TCAS in test mode. Message is displayed on all ND modes and ranges.

TCAS Voice Annunciations

Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions.	Continue to keep pitch attitude and vertical speed outside the red RA regions.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions.	
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions. Airplane will pass through the altitude of the traffic.	
CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Increase pitch attitude and vertical speed to remain outside the red RA regions.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions. Airplane will climb through the altitude of the traffic.	

Voice Annunciation	Condition	Response
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Decrease pitch attitude and vertical speed to remain outside the red RA regions.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions. Airplane will descend through the altitude of the traffic.	
INCREASE CLIMB, INCREASE CLIMB	Existing RA, TCAS requires change in vertical rate.	Adjust pitch attitude and vertical speed to remain outside the red RA regions.
INCREASE DESCENT, INCREASE DESCENT	Present pitch attitude and vertical speed are within the red RA regions.	
ADJUST VERTICAL SPEED, ADJUST	Existing RA, minimum vertical speed required to ensure separation has decreased, present pitch attitude and vertical speed are outside the red RA regions, or, new RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Continue to keep pitch attitude and vertical speed outside the red RA regions. Vertical speed may be decreased, or, change pitch attitude and vertical speed to remain outside the red RA regions.

Voice Annunciation	Condition	Response
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude and vertical speed are within the red RA regions.	Decrease pitch attitude and vertical speed to remain outside the red RA regions.
CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	Existing RA, previous TCAS vertical guidance was to descend. Present pitch attitude and vertical speed are within the red RA regions.	Increase pitch attitude and vertical speed to remain outside the red RA regions.
CLEAR OF CONFLICT	TCAS PFD vertical guidance is no longer displayed and traffic changes to a TA symbol. Separation is increasing and the RA will not occur. However, the voice annunciation will not sound if TCAS can no longer predict the track of the RA aircraft.	Attempt to visually locate the traffic.

TCAS Normal Operation

TCAS is controlled from the transponder panel. TA/RA is normally selected. However, it is sometimes necessary to select TA ONLY to prevent nuisance RAs. TA ONLY is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands.

TCAS Non–Normal Operation

The EICAS advisory message TCAS OFF is displayed if TCAS is not operating. The message is inhibited below 400 feet radio altitude. No TCAS RA guidance is displayed on the PFDs, no TCAS traffic symbols are displayed on the NDs, and no TCAS voice alerts sound. An amber TCAS OFF message is displayed on both NDs.

The EICAS advisory message TCAS RA (CAPTAIN or F/O) is displayed if TCAS cannot display RA guidance on the respective PFD. The ND traffic displays and voice alerts are unaffected.

The EICAS advisory message TCAS is displayed if TCAS cannot display TCAS RA guidance on either PFD, and cannot display TCAS traffic symbols on either ND. TCAS voice alerts will not occur. An amber TCAS FAIL message is displayed on both NDs.

Ground Proximity Warning System (GPWS)

Introduction

GPWS provides immediate alerts, and look-ahead obstacle and terrain alerts for potentially hazardous flight conditions involving imminent impact with the obstacles and the ground.

GPWS immediate alerts are based on radio altitude, barometric altitude, ADIRS, glide slope deviation, and airplane configuration. GPWS immediate alerts are provided for:

- altitude loss after takeoff or go-around
- excessive and severe descent rate
- excessive terrain closing rate
- unsafe terrain clearance when not in the landing configuration
- excessive deviation below ILS glide slope
- windshear

GPWS provides altitude voice annunciations during approach.

GPWS also provides look-ahead terrain mode alerts by monitoring obstacle and terrain proximity using a world-wide terrain data base and an obstacle data base. The obstacle data base is not yet world wide. Proximate obstacle and terrain data may be displayed on the ND. If there is a potential obstacle or terrain hazard, GPWS look-ahead alerts are provided based on estimated time to impact.

Altitude used for look-ahead terrain mode alerts are a weighted combination of radio altitude, barometric altitude, GPS, and previous flight path. Weighting is reduced for an altitude source which becomes less reliable.

Estimated time to impact is based on airplane position, barometric altitude, present track, vertical path, and ground speed. FMC VNAV and LNAV path is not considered in the estimated time to impact.

Note: Obstacles or terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning does not guarantee obstacle or terrain clearance.

GPWS Look–Ahead Obstacle and Terrain Mode

A GPWS terrain data base contains detailed terrain and man made obstacle data. Obstacle and terrain data is not designed to be used as an independent navigation aid.

When the TERR switch is pushed on, the TERR symbol is displayed on the ND and obstacle and terrain contours may be displayed. When obstacle and terrain contours are displayed, the altitudes of the highest and lowest displayed obstacle or terrain are displayed below the TERR symbol. The color of each altitude corresponds to the altitude of the respective contour.

When the airplane is higher than 2,000 feet above the terrain, obstacles and terrain peaks are displayed using solid, high density, and low density contours of green. The highest obstacles or terrain is represented by solid green, and the lowest obstacles or terrain displayed is represented by low density green.

When the airplane is lower than 2,000 feet above the terrain, all obstacles and terrain within 2,000 feet of airplane barometric altitude is displayed on the navigation display.

When a obstacle or terrain alert occurs, the respective message is displayed on the ND. When an OBSTACLE alert occurs while a TERRAIN alert message is displayed, the OBSTACLE alert message replaces the TERRAIN alert message. Both messages will not be displayed at the same time.

The terrain display is correlated to GPS position, or to ADIRU position if GPS position is intermittently unavailable.

Terrain and weather radar cannot be simultaneously displayed on the ND. When one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps. All other navigation displays can be simultaneously displayed with terrain data.

GPWS Look-Ahead Obstacle and Terrain Alerts

Voice Annunciation	PFD and ND Display and Light	Description
OBSTACLE, OBSTACLE, PULL UP	Red PULL UP on both PFDs Master WARNING lights Red OBSTACLE message on both NDs Solid red obstacle on ND	20 to 30 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TERRAIN, TERRAIN, PULL UP	Red PULL UP on both PFDs Master WARNING lights Red TERRAIN message on both NDs Solid red terrain on ND	20 to 30 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
CAUTION OBSTACLE	Amber OBSTACLE message on both NDs Solid amber obstacle on ND GND PROX light	40 to 60 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
CAUTION TERRAIN	Amber TERRAIN message on both NDs Solid amber terrain on ND GND PROX light	40 to 60 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	Amber TERRAIN message on both NDs GND PROX light	Descent below unsafe altitude while too far from any airport in the terrain database. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.

GPWS Immediate Alerts

Voice Annunciation	PFD and ND Display and Light	Description
DON'T SINK	GND PROX light	Altitude loss with flaps and/or gear up after takeoff or go-around.
GLIDE SLOPE	GND PROX light	Excessive deviation below glide slope. Volume and repetition rate increase as deviation increases. Pushing the GND PROX G/S INHIB switch inhibits the alert when pushed below 1,000 feet radio altitude.
PULL UP	Red PULL UP message on both PFDs Master WARNING lights	Follows SINK RATE alert when descent rate becomes severe, or follows TERRAIN alert with flaps and/or gear not in landing configuration when excessive terrain closing rate continues.
SINK RATE	GND PROX light	Excessive descent rate.
TERRAIN	GND PROX light	Excessive terrain closing rate.

Voice Annunciation	PFD and ND Display and Light	Description
TOO LOW, FLAPS	GND PROX light	Unsafe terrain clearance with flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert.
TOO LOW, GEAR	GND PROX light	Unsafe terrain clearance with gear not in landing configuration at low altitude and airspeed with gear not down. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light	Follows DON'T SINK alert with gear and/or flaps up after takeoff or go-around for altitude loss at low altitude, or unsafe terrain clearance with gear and/or flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert, when the alert is due to flaps not in landing position. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert, when the alert is due to gear not down.

Altitude Voice Annunciations During Approach

GPWS provides the following altitude voice annunciations during approach:

- 50 feet – FIFTY
- 40 feet – FORTY
- 30 feet – THIRTY
- 20 feet – TWENTY
- 10 feet – TEN

Minimums Voice Annunciation

GPWS provides the voice annunciation MINIMUMS, MINIMUMS at the altitude set by the Captain's MINS selector on the EFIS Control Panel.

GPWS Windshear Alert and PWS

Windshear alerts are enabled during takeoff, approach, and landing:

- GPWS provides an immediate windshear alert when an excessive downdraft or tailwind is occurring
- PWS provides windshear alerts when an excessive windshear condition is detected ahead of the airplane

PWS Alert System

Weather radar uses radar imaging to detect disturbed air ahead of the airplane.

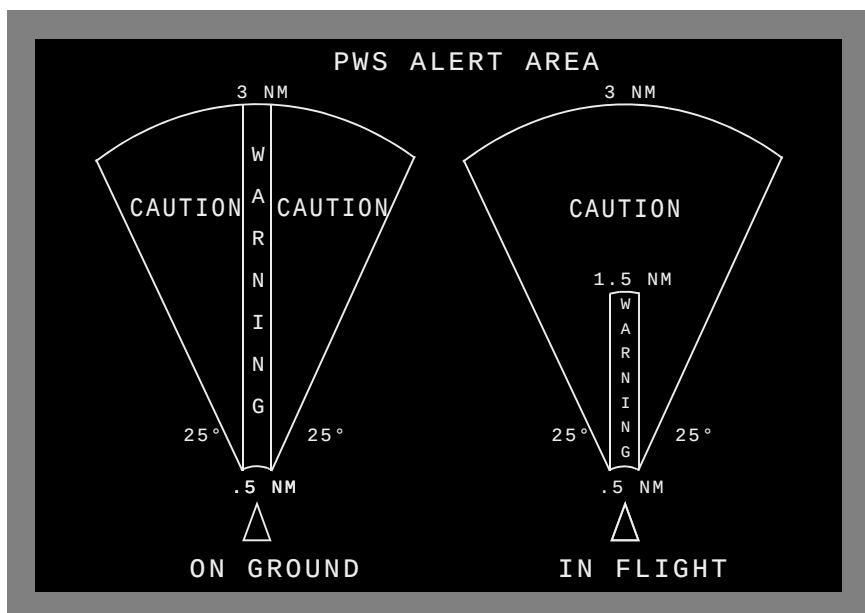
PWS is enabled to provide windshear alerts 12 seconds after weather radar begins scanning for windshear.

When PWS is scanning for windshear, radar antenna scan sweep is reduced.

Prior to takeoff, PWS alerts can be enabled by pushing the WXR switch on the EFIS control panel. On the ground with the WXR switch pushed or not pushed, weather radar begins scanning for windshear when the thrust of either engine is in the takeoff range and thrust reversers are not unlocked or deployed.

In flight with the WXR switch pushed or not pushed, weather radar begins scanning for windshear below 2,300 feet radio altitude and PWS alerts are enabled below 1,200 feet radio altitude.

When windshear is not predicted by PWS, weather radar returns are displayed only when the WXR on the EFIS control panel is pushed.



PWS Alerts

Voice Annunciation	PFD and ND Display and Light	Description
WINDSHEAR AHEAD, WINDSHEAR AHEAD	Red WINDSHEAR on both PFDs Master WARNING lights Red WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted close to and directly ahead of airplane. Enabled during takeoff, below 1,200 feet radio altitude. Windshear position displayed by PWS symbol on the ND in MAP, MAP CTR, VOR, or APP modes only.
GO AROUND, WINDSHEAR AHEAD	Red WINDSHEAR on both PFDs Master WARNING lights Red WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 1.5 miles and directly ahead of the airplane. Enabled during approach, below 1,200 feet radio altitude. Windshear position displayed by PWS symbol on the ND in MAP, MAP CTR, VOR, or APP modes only.
MONITOR RADAR DISPLAY	Amber WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 3 miles and ahead of the airplane. Enabled during takeoff and approach, below 1,200 feet radio altitude. Windshear position displayed on PWS on ND in MAP, MAP CTR, VOR, or APP modes only.

Note: Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

Note: Weather radar detects microbursts and other windshears with similar characteristics. Weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

Immediate Windshear Alerts

Voice Annunciation	PFD Display and Light	Description
(Siren) WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both PFDs Master WARNING lights	Excessive windshear detected by GPWS. Enabled below 1,500 feet radio altitude. GPWS windshear detection begins at rotation.

Alert Inhibits

Alerts are inhibited when they are operationally unnecessary or inappropriate. Alerts are inhibited during normal system operation, and during part of the takeoff and landing to prevent distracting the crew.

GPWS immediate windshear alert inhibits all PWS, TCAS, and other GPWS alerts.

When TA/RA is selected on the transponder panel and a GPWS or PWS warning alert occurs, TCAS automatically inhibits RA mode. During the inhibit, all aircraft that would have been predicted as an RA are predicted as a TA. When GPWS and PWS warning alerts are no longer occurring, the RA mode inhibit ends.

Alert Messages Inhibited During Normal System Operation

Certain EICAS alert messages are time delayed, even though related flight deck panel annunciator lights are illuminated. Time delay inhibits prevent normal in-transit indications from being displayed as EICAS alert messages. For example, valves are generally only sensed open or closed, not in-transit. When a valve is in-transit, the message indicating the valve has failed to open or close is inhibited to allow the valve time to move to the commanded position. If the valve is not in the commanded position at the end of the inhibit time delay, the respective EICAS alert message is displayed.

Alert Messages Inhibited By Other Alert Messages

Some EICAS alert messages are inhibited if another related alert message is displayed. For example, individual hydraulic pump pressure messages are inhibited if a hydraulic system pressure message is displayed.

Voice Annunciation Inhibits

Voice annunciations for warning alerts inhibit new voice annunciations for caution alerts.

All voice annunciations are prioritized to aid flight crew decision making when more than one alert could occur.

ND Display Alert Inhibits and Automatic Display

Alert displays on the NDs are prioritized to aid flight crew decision making when more than one alert occurs. The displays are also prioritized when neither ND is in MAP, MAP CTR, VOR, or APP mode.

Immediate windshear alert inhibits the automatic display of a new TCAS, look-ahead terrain, or PWS alerts.

TCAS traffic can be displayed concurrently with either TERR and WXR display.

New TCAS TRAFFIC TA or RA alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TFC is selected automatically for both NDs and TCAS traffic is displayed on both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TFC is selected automatically for that ND and TCAS traffic is displayed. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TCAS display and TFC will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, both NDs are armed for TCAS display and TFC will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected.

New look-ahead terrain alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, both NDs are armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed for either ND by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode on the respective ND.

New PWS alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, both NDs are armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.

Alerts Inhibited Before Engine Start and After Shutdown

Alert Inhibited	For Message	Inhibit Occurs
Master CAUTION lights Beeper	For all EICAS caution messages	On the ground, and both FUEL CONTROL switches in CUTOFF
Respective EICAS messages: BLEED OFF ELEC BACKUP GEN ELEC DRIVE, ELEC GEN OFF ENG OIL PRESS HYD PRESS PRI	For EICAS caution messages: ENG SHUTDOWN L ENG SHUTDOWN R ENG SHUTDOWN	On the ground, and both FUEL CONTROL switches in CUTOFF

Alerts Inhibited During Engine Start

Alert Inhibited	Inhibit Begins	Inhibit Ends
All new EICAS caution and advisory messages, except: APU LIMIT APU SHUTDOWN ENG AUTOSTART ENG FUEL VALVE ENG SHUTDOWN ENG START VALVE ENG STARTER CUTOUT OVERHEAT ENG	Engine START /IGNITION selector to START	Engine reaches idle RPM, or start is aborted, or five minutes elapse.

Alerts Inhibited During Takeoff

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
TCAS TA voice alerts	TCAS TAs	On ground	Approximately 500 feet radio altitude
All TCAS RAs	TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode and TCAS message TA ONLY is displayed on ND		Approximately 1,000 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Red ENG FAIL on PFD	Engines not producing commanded thrust and rate of thrust increase insufficient; same condition as EICAS messages ENG THRUST L, R	Engine start	65 knots airspeed
EICAS caution message ENG THRUST L, R	Messages are inhibited		Six knots before V1
STATUS cue	All EICAS status messages		30 minutes after lift-off.
All EICAS communication messages except: CABIN ALERT Hi-Lo Chime	Messages are inhibited	Either engine in takeoff thrust range	400 feet radio altitude or 20 seconds after lift-off, whichever occurs first, or on the ground and thrust on both engines reduced below takeoff thrust range
EICAS warning message CONFIG GEAR STEERING	Message is inhibited	80 knots airspeed	Landing

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master CAUTION lights Beeper If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends. If new EICAS caution messages are displayed during the inhibit, the beeper will sound when the inhibit ends.	New EICAS caution messages displayed during inhibit	80 knots airspeed	400 feet radio altitude or 20 seconds after lift-off, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
All EICAS advisory messages	Messages are inhibited		400 feet radio altitude or 20 seconds after lift-off, whichever occurs first, or if takeoff thrust not selected on both engines. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
New PWS caution alerts	Messages are inhibited		400 feet radio altitude
New PWS warning alerts	Messages are inhibited	100 knots airspeed	50 feet radio altitude
New red ENG FAIL on PFD	EICAS caution message ENG THRUST L, R	Six knots before V1	Landing

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Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master WARNING lights Bell If the Master WARNING lights illuminate and fire bell sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded. If new FIRE messages are displayed during the inhibit, the bell will sound when the inhibit ends.	New EICAS warning messages FIRE displayed during inhibit.	V1 or rotation, whichever occurs first.	400 feet radio altitude or 25 seconds after inhibit began, whichever occurs first.
Master WARNING lights Siren If the Master WARNING lights illuminate and siren sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded If new EICAS warning messages are displayed during the inhibit, the siren will sound when the inhibit ends.	New EICAS warning messages displayed during inhibit, except FIRE		
EICAS warning messages CONFIG, except CONFIG GEAR STEERING, for takeoff configuration warnings	Messages are inhibited		Landing
Master WARNING lights Siren	EICAS warning message CONFIG GEAR for landing configuration warnings.	Gear unlock for retraction	825 feet radio altitude or 150 seconds after inhibit began, whichever occurs first.
All PWS alerts	Messages are inhibited	1,200 feet radio altitude	Approach

Alerts Inhibited During Landing

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
All PWS alerts	Alerts are inhibited	2,300 feet radio altitude	1,200 feet radio altitude
TCAS INCREASE DESCENT RAs	Alerts are inhibited	Approximately 1,500 feet radio altitude	Go-around at approximately 1,500 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited	Approximately 1,100 feet radio altitude	Go-around at approximately 1,100 feet radio altitude
All TCAS RAs	Alerts are inhibited When RA selected on panel, TCAS switches automatically to TA only mode and TCAS message TA ONLY is displayed on ND	Approximately 1,000 feet radio altitude	Go-around at approximately 1,000 feet radio altitude
All EICAS communication messages, except: CABIN ALERT	Messages are inhibited	800 feet radio altitude	75 knots airspeed
STATUS cue	All EICAS status messages		
TCAS voice alerts	TCAS TAs	Approximately 500 feet radio altitude	Go-around at approximately 500 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS alert message WINDSHEAR SYS	Message is inhibited	400 feet radio altitude	80 knots airspeed
New PWS caution alerts	Alerts are inhibited		
Master CAUTION lights Beeper	All EICAS caution messages, except: AUTOPILOT AUTOTHROTTLE DISC NO AUTOLAND SPEEDBRAKE EXTENDED	LAND 2 or LAND 3 displayed on PFD, and 200 feet radio attitude	75 knots airspeed, or 40 seconds elapse, or 800 feet radio altitude
New PWS warning alerts	Alerts are inhibited	50 feet radio altitude	100 knots airspeed

EICAS Event Record

Pushing the EICAS EVENT RCD switch records currently displayed engine indications and additional EICAS maintenance information. Up to five events may be recorded by the first five pushes. The system also records out of limit parameters and related conditions automatically when a system parameter is exceeded.

Intentionally
Blank

Warning Systems

EICAS Messages

Chapter 15

Section 30

Warning Systems EICAS Alert Messages

Message	Level	Aural	Message Logic
AIRSPPEED LOW	Caution	Beeper	Airspeed is below minimum maneuvering speed.
ALTITUDE ALERT	Caution	Beeper	Airplane has deviated from MCP selected altitude.
ALTITUDE CALLOUTS	Advisory		Altitude and minimums voice annunciations during approach are no longer provided.
CONFIG DOORS	Warning	Siren	An entry, forward cargo, or aft cargo door is not closed, latched, and locked when either engine's thrust is in the takeoff range on the ground.
CONFIG FLAPS	Warning	Siren	Flaps or slats are not in a takeoff position when either engine's thrust is in the takeoff range on the ground.
CONFIG GEAR	Warning	Siren	Any landing gear is not down and locked when either thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.
CONFIG GEAR STEERING	Warning	Siren	Main gear steering is unlocked when either engine's thrust is in the takeoff range on the ground.
CONFIG PARKING BRAKE	Warning	Siren	Parking brake is set when either engine's thrust is in the takeoff range on the ground.
CONFIG RUDDER	Warning	Siren	Rudder trim is not centered when either engine's thrust is in the takeoff range on the ground.

Message	Level	Aural	Message Logic
CONFIG SPOILERS	Warning	Siren	Speedbrake lever is not DOWN when either engine's thrust is in the takeoff range on the ground; or, speedbrake lever extended beyond ARMED in flight, and climb thrust or greater set on either thrust lever.
CONFIG STABILIZER	Warning	Siren	Stabilizer is not within the greenband when either engine's thrust is in the takeoff range on the ground.
CONFIG WARNING SYS	Advisory		A fault is detected in the configuration warning system.
GND PROX SYS	Advisory		Ground proximity alerts are no longer provided.
OVERSPEED	Warning	Siren	Airspeed has exceeded Vmo/Mmo.
PILOT RESPONSE	Warning	Siren	After caution message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specified time.
PILOT RESPONSE	Caution	Beeper	After advisory message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specified time.
PILOT RESPONSE	Advisory		FMC does not detect crew activity in monitored area within a specific time.
TAIL STRIKE	Caution	Beeper	A tail strike has been detected.
TCAS	Advisory		TCAS has failed.
TCAS OFF	Advisory		TCAS is in standby mode.

Message	Level	Aural	Message Logic
TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on the affected PFD.
TERR OVRD	Advisory		Ground proximity terrain override switch is in OVRD.
TERR POS	Advisory		Terrain position data has been lost. Look-ahead terrain alerting and display unavailable because GPS has failed. During time between GPS failure and display of TERR POS message, IRS provides position for look-ahead alerting and display.
WINDSHEAR SYS	Advisory		Windshear alerts may not be provided.

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