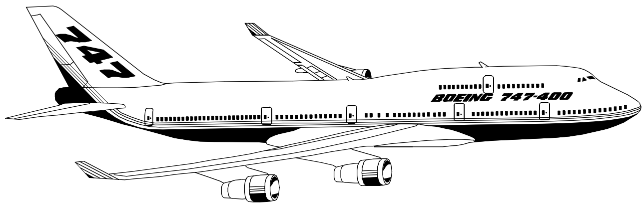

747-441
Operations Manual
International Lease Finance Corp.

Document Number D6-30151-425
May 1, 1992

Revision Number: 21
Revision Date: April 01, 2001

Preface — Chapter 0
Table of Contents — Section 0

Volume 1 — **Chapter**

Volume 2

Quick Reference Handbook (QRH)

General

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

The table permits flight crew correlation of configuration differences by Registry Number in alpha/numeric order within an operator's fleet for airplanes covered in this manual. Configuration data reflects the airplane as delivered configuration and is updated for service bulletin incorporations in conformance with the policy stated in the introduction section of this chapter.

Airplane Number is supplied by the operator. Registry Number is supplied by the national regulatory agency. Serial and Tabulation Numbers are supplied by Boeing.

Airplane Number	Registry Number	Serial Number	Tabulation Number
202	ZK-SUI	24957	RT932

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General

This Operations Manual has been prepared by Boeing Commercial Airplanes Group, Customer Services Division. The purpose of this manual is to:

- provide operating limitations, procedures, performance, and systems information the flight crew needs to safely and efficiently operate the 747-400 airplane during all anticipated airline operations
- serve as a comprehensive reference for use during transition training for the 747-400 airplane
- serve as a review guide for use in recurrent training and proficiency checks
- provide operational data from the FAA approved airplane flight manual (AFM) to ensure legal requirements are satisfied
- establish standardized procedures and practices to enhance Boeing operational philosophy and policy

This manual is prepared for the owner/operator named on the title page specifically for the airplanes listed in the "Model Identification" section. It contains operational procedures and information which apply only to these airplanes. The manual covers the Boeing delivered configuration of these airplanes. Changes to the delivered configuration are incorporated when covered by contractual revision agreements between the owner/operator and The Boeing Company.

This manual is not suitable for use for any airplanes not listed in the "Model Identification" section. Further, it may not be suitable for airplanes transferred to other owners/operators.

Owners/operators are solely responsible for ensuring the operational documentation they are using is complete and matches the current configuration of the listed airplanes. This includes the accuracy and validity of all information furnished by the owner/operator or any other party. Owners/operators receiving active revision service are responsible to ensure modifications to the listed airplanes are properly reflected in the operational procedures and information contained in this manual.

The manual is periodically revised to incorporate pertinent procedural and systems information. Items of a more critical nature will be incorporated in operational bulletins and distributed in a timely manner. In all cases, such revisions and changes must remain compatible with the approved AFM with which the operator must comply. In the event of conflict with the AFM, the AFM shall supersede.

This manual assumes the user has previous multi–engine jet aircraft experience and is familiar with basic jet airplane systems and basic pilot techniques common to airplanes of this type. Therefore, the operations manual does not contain basic flight information considered prerequisite training.

Any questions about the content or use of this manual can be directed to:

Customer Services Division
Boeing Commercial Airplanes Group
P. O. Box 3707, M/C 20–89
Seattle, Washington 98124–2207 USA

Attention: Senior Manager, Flight Technical Publications

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, bulletins, and a list of effective pages
- Limitations and Normal Procedures chapters cover operational limitations and normal procedures. All operating procedures are based on a thorough analysis of crew activity required to operate the airplane, and reflect the latest knowledge and experience available
- Supplementary Procedures chapter covers those procedures accomplished as required rather than routinely on each flight

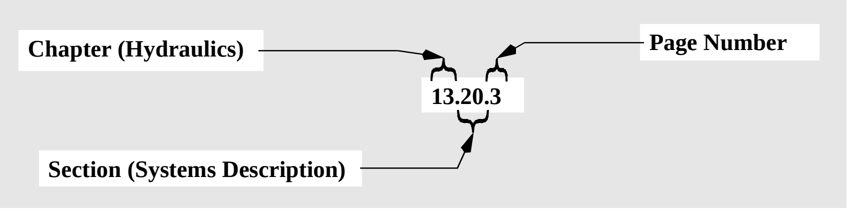
Volume 2 – Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

Quick Reference Handbook (QRH) – The QRH covers normal checklists, in–flight performance, non–normal checklists, and non–normal maneuvers.

Page Numbering

The operations 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.

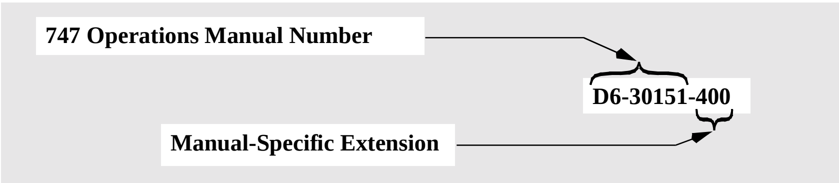
Example Page Number



Page Identification

Each page is identified by a document number and a page date. The document number is composed of the general 747 operations manual number, D6-30151–, and is followed by the manual-specific extension. The page date is the date of publication of the manual or the most recent revision date.

Example Page Identification



Warnings, Cautions, and Notes

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

WARNING: An operating procedure, technique, etc., that may result in personal injury or loss of life if not carefully followed.

CAUTION: An operating procedure, technique, etc., that may result in damage to equipment if not carefully followed.

Note: An operating procedure, technique, etc., considered essential to emphasize. Information contained in notes may also be safety related.

Operations Manual Configuration

Customer airplane configuration determines the data provided in this manual. The Boeing Company keeps a list of each airplane configuration as it is built and modified through the Service Bulletin process. The operations manual does not reflect customer originated modifications without special contract provisions.

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.

A	
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACT	Active
ADC	Air Data Computer
ADF	Automatic Direction Finder
ADP	Air Driven Pump/Air Driven Demand Hydraulic Pump
AFDS	Autopilot Flight Director System
AFM	Airplane Flight Manual (FAA approved)
AGL	Above Ground Level
ALT	Altitude
ALTN	Alternate
ANP	Actual Navigation Performance
AOA	Angle of Attack
A/P	Autopilot
APP	Approach
APU	Auxiliary Power Unit
ARPT	Airport
A/S	Airspeed
A/T	Autothrottle
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATT	Attitude
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available
AVM	Airborne Vibration Monitor

B	
BARO	Barometric
BAT	Battery
BRT	Bright
BTL DISCH	Bottle Discharge (fire extinguishers)
B/C	Back Course
BTB(S)	Bus Tie Breaker(s)

C	
C	Captain Celsius Center
CAS	Calibrated Airspeed

CANC/ RCL	Cancel/Recall
CB	Circuit Breaker
CG	Center of Gravity
CDU	Control Display Unit
CHKL	Checklist
CLB	Climb
CMD	Command
COMM	Communication
CON	Continuous
CONFIG	Configuration
CRZ	Cruise

D	
DA	Decision Altitude
DC	Direct Current
DDG	Dispatch Deviations Guide
DEP ARR	Departure Arrival
DES	Descent
DH	Decision Height
DISC	Disconnect
DME	Distance Measuring Equipment

E	
E/D	End of Descent
EEC	Electronic Engine Control
EFIS	Electronic Flight Instrument System
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
ELEC	Electrical
ELEV	Elevator
ENG	Engine
E/O	Engine Out
EPR	Engine Pressure Ratio
EXEC	Execute
EXT	Extend or External
E/E	Electrical and Electronic

F	
F	Fahrenheit
FCTL	Flight Control
F/D or FLT DIR	Flight Director
FLPRN	Flaperon
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FPA	Flight Path Angle
FPV	Flight Path Vector

G	
GA	Go–Around
GEN	Generator
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GW	Gross Weight

H	
HDG	Heading
HDG REF	Heading Reference
HDG SEL	Heading Select
HPA	Hectopascals

I	
IAF	Initial Approach Fix
IAP	Initial Approach Point
IAS	Indicated Airspeed
IDENT	Identification
IDG	Integrated Drive Unit
IDS	Integrated Display System
IN	Inches
IND LTS	Indicator Lights
ILS	Instrument Landing System

K	
K	Knots
KIAS	Knots Indicated Airspeed

L	
L	Left
LBS	Pounds
LDG ALT	Landing Altitude
LIM	Limit
LKD	Locked
LNAV	Lateral Navigation
LWR CTR	Lower Center
LWR DSPL	Lower Display

M	
M	Mach
MAG	Magnetic
MAN	Manual
MCP	Mode Control Panel
MDA	Minimum Descent Altitude
MEL	Minimum Equipment List
MIC	Microphone
MHZ	Megahertz
MIN	Minimum
MKR	Marker
MLW	Maximum Landing Weight
MMO	Maximum Mach Operating Speed
MOD	Modify
MSL	Mean Sea Level
MTOW	Maximum Takeoff Weight
MTRS	Meters
MTW	Maximum Taxi Weight
MZFW	Maximum Zero Fuel Weight

N	
NAV RAD	Navigation Radio
ND	Navigation Display
NM	Nautical Miles
NORM	Normal

N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed (Pratt & Whitney, General Electric engines) Intermediate Pressure Rotor Speed (Rolls–Royce engines)
N3	High Pressure Rotor Speed (Rolls–Royce engines)

O	
OAT	Outside Air Temperature
OVHD	Overhead
OVRD	Override

P	
PA	Passenger Address
PASS	Passenger
PERF INIT	Performance Initialization
PF	Pilot Flying
PFD	Primary Flight Display
PNF	Pilot Not Flying
PLI	Pitch Limit Indicator
PNL	Panel
POS	Position
POS INIT	Position Initialization
PRESS	Pressure
PSI	Pounds Per Square Inch
PTT	Push to Talk
PVD	Para-Visual Display
PWS	Predictive Windshear

Q	
QFE	Local Station Pressure
QNE	Standard Altimeter (29.92 in/1013 HPa)
QNH	Local Station Pressure Corrected to MSL

R	
R	Right
RA	Radio Altitude Resolution Advisory
RECIRC	Recirculation
REF	Reference
RET	Retract
RF	Refill
RMI	Radio Magnetic Indicator
RSV XFER	Reserve Transfer
RTO	Rejected Takeoff
RTP	Radio Tuning Panel
RWY	Runway
R	Right
RA	Radio Altitude Resolution Advisory
RECIRC	Recirculation
REF	Reference
RET	Retract
RF	Refill
RMI	Radio Magnetic Indicator

S	
SAT	Static Air Temperature
S/C	Step Climb
SEL	Select
SELCAL	Selective Call
SPD	Speed
STA	Station
STAB	Stabilizer
STAT	Status
STBY	Standby
STD	Standard
SYNC	Synchronous
SYS	System

T	
T or TRU	True
T or TK or TRK	Track
TA	Traffic Advisory
TACAN	Tactical Air Navigation
TAS	True Airspeed
T/C	Top-of-Climb
TCAS	Traffic Alert and Collision Avoidance System
T/D	Top of Descent
TFC	Traffic
TO	Takeoff
TO/GA	Takeoff/Go–Around
TRU	Transformer Rectifier Unit

U	
UNLKD	Unlocked
UPR DSPL	Upper Display
UTC	Coordinated Universal Time

V	
VHF	Very High Frequency
VMO	Maximum Operating Speed
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VR	Rotation Speed
VREF	Reference Speed
VSI	Vertical Speed Indicator
VTK	Vertical Track
V/S	Vertical Speed
V1	Takeoff Decision Speed
V2	Scheduled Takeoff Target Speed

W	
WPT	Waypoint
WXR	Weather Radar

X	
X-BLD	Crossbleed
XTK	Cross Track
X FEED	Crossfeed

Z	
ZFW	Zero Fuel Weight

Preface — Chapter 0
Revision Record — Section 4

Revision Transmittal Letter

To: All holders of International Lease Finance Corp. 747 Operations Manual, Boeing Document Number D6-30151-425.

Subject: Operations Manual Revision.

This revision reflects the most current information available to The Boeing Company 45 days before the subject revision date. The following revision highlights explain changes in this revision. General information below explains the use of revision bars to identify new or revised information.

Revision Record

No.	Revision Date	Date Filed
16	October 01, 1998	
17	April 01, 1999	
18	October 01, 1999	

No.	Revision Date	Date Filed
19	April 01, 2000	
20	October 01, 2000	
21	April 01, 2001	

General

The Boeing Company issues operations manual revisions to provide new or revised procedures and information. Formal revisions also incorporate appropriate information from previously issued operations manual bulletins.

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

Formal revisions include a Transmittal Letter, a new Revision Record, Revision Highlights, and a current List of Effective Pages. Use the information on the new Revision Record and List of Effective Pages to verify the operations manual content.

Pages containing revised technical material have revision bars associated with the changed text or illustration. Editorial revisions (for example, spelling corrections) may have revision bars with no associated highlight.

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

Filing Instructions

Consult the List of Effective Pages (0.5.1). Pages identified with an asterisk (*) are either replacement pages or new (original) issue pages. Remove corresponding old pages and replace or add new pages. Remove pages marked DELETED; there are no replacement pages for deleted pages.

Be careful when inserting changes not to throw away pages from the manual that are not replaced. The List of Effective Pages determines the correct content of the manual.

Revision Highlights

Generally, revision bars are displayed adjacent to all technical and non-technical changes. However, highlights are written only for technical revisions. In some sections, the information may have been extensively rewritten for clarity; in these cases a highlight is written, but change bars may not be provided.

Because of a publishing anomaly, unnecessary change bars and highlights may be printed. If the content is unchanged, ignore these change bars and highlights.

Chapter 0 - Preface

Section 6 - Bulletin Record

0.6.2 - Revised to reflect current bulletin status.

Chapter L - Limitations

Section 10 - Operating Limitations

Non–AFM Operational Information

L.10.1 - Deleted "demonstrated" from takeoff and landing crosswind information for consistency with AFM.

Engine Fuel System

L.10.3 - Added JP-8 to maximum fuel temperature limitation for consistency with AFM. JP-8 is acceptable alternative fuel for GE engines.

Chapter SP - Supplementary Procedures

Section 2 - Air Systems

Ground Air Conditioning Cart Use

SP.2.1 - Revised to correct typographical error. Recirculation fan switches should be placed ON.

Section 6 - Electrical

Electrical Power Up

SP.6.1 - Added procedural step for consistency with Normal Procedure.

Section 16 - Adverse Weather

Climb and Cruise

SP.16.6 - Deleted procedural steps not applicable to airplanes with automatic wing anti-ice.

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

Section 30 - Controls and Indicators

Flight Deck Lighting

1.30.8 - Expanded description of Flight Deck Access Lights Switch.

Section 40 - Systems Description

Exterior Lighting

1.40.2 - Corrected position of aft white position light.

Interior Emergency Lighting Locations

1.40.6 - Revised escape path lighting pattern.

Chapter 2 - Air Systems

Section 10 - Controls and Indicators

Air Conditioning

2.10.1 - Added with Humidifier switch removed.

Chapter 5 - Communications

Section 10 - Controls and Indicators

Audio Panel

5.10.1 - Deleted "Second push deselection" paragraph.

Radio Tuning Panel

5.10.4 - Revised text for clarity.

Section 33 - ATC Datalink

ATC Log Page X/X

5.33.30 - Added Callout previously omitted.

Section 40 - EICAS Messages

SATCOM Voice Mode

5.40.1 - Split out message into separate table.

Chapter 6 - Electrical

Section 20 - System Description

AC Standby Power System (AC Bus 3 Unpowered)

6.20.9 - Revised relay configuration to show correct power source for the APU standby bus.

Chapter 9 - Flight Controls

Section 10 - Controls and Indicators

Stabilizer Trim Controls

9.10.2 - Added new graphics and callouts for Stab Trim Indicator.

Yaw Damper Controls

9.10.4 - Added Yaw Damper Control Panel.

Flight Control Hydraulic Power Controls

9.10.14 - Added Flt Control Hydraulic Power Control Panel.

Section 20 - System Description

Elevator Control

9.20.2 - Revised text for clarity.

Chapter 10 - Flight Instruments, Displays

Section 10 - Controls and Indicators

EFIS Control Panels

10.10.27 - Added CDU model designation to accommodate CDU intermix.

Instrument Source Select Panels

10.10.32 - Deleted reference to auto IRU switching. Auto switching is an option transparent to aircrews.

Display Select Panel

10.10.34 - Added CDU model designation to accommodate CDU intermix.

EFIS Control Panel and Display Select Panel (DSP) – CDU Alternate Control

10.10.43 - Added CDU model number to accommodate CDU intermix.

10.10.43 - Added CDU model designation to accommodate CDU intermix.

CDU EFIS/DSP Control Selection (CDU-152)

10.10.43 - Added CDU model designation to accommodate CDU intermix.

CDU EFIS/DSP Control Selection (CDU-161)

10.10.44 - Added CDU model designation to accommodate CDU intermix.

EFIS Control Page (CDU-152)

10.10.45 - Added CDU model designation to accommodate CDU intermix.

EFIS Control Page (CDU-161)

10.10.46 - Added CDU model designation to accommodate CDU intermix.

EFIS Options Page (CDU-152)

10.10.48 - Added CDU model designation to accommodate CDU intermix.

10.10.48 - No technical change. Editorial, revised "AD" to "ADF".

EFIS Options Page (CDU-161)

10.10.49 - Added CDU model designation to accommodate CDU intermix.

Section 50 - EICAS Messages

Flight Instrument Disagree EICAS Alert Messages

10.50.1 - Added with IDS 16 or later software installation.

Flight Instruments Components EICAS Alert Messages

10.50.2 - Revised to reflect non-normal condition statement. Added CDU designation to accommodate CDU intermix.

10.50.2 - Revised to reflect upgraded CDU installed.

Chapter 11 - Flight Management, Navigation

Section 10 - Controls and Indicators

Flight Management System

11.10.1 - The control display units shown in the Operations Manual have been labeled CDU-152 or CDU -161 where necessary to distinguish between Part Numbers S242T102-152 and S242T102-161. The CDU -161 panel has a separate EXEC key and light and has become the standard in production and as a replacement.

Section 20 - Navigation Systems Description

Distance Measuring Equipment (DME)

11.20.4 - Added information to clarify FMC use of 5 channel DME transceivers.

Section 30 - Flight Management System Description

Control Display Units (CDUs)

11.30.2 - Deleted duplicate information; alternate control discussed in Chapter 10.10.

Section 32 - Flight Management Computer

Reduced Thrust Takeoff

11.32.2 - Deleted reference to PD; derated TO data not in the PD.

Section 40 - FMC Preflight

FMS-CDU Operation

11.40.1 - Corrected misspelling of resynchronization.

Section 42 - FMC Cruise

Fix Information Page

11.42.13 - Corrected valid entry; added distance display to nearest tenth nm .

Section 43 - FMC Descent and Approach

Route Hold Page With Holding Fix in Route

11.43.22 - Added information to explain FMC operation when climbing/descending through 14,000 feet with VNAV active.

Chapter 12 - Fuel

Section 20 - System Description

Operation With Fuel in Center Wing Tank

12.20.8 - Revised for clarity.

12.20.8 - No technical change. Editorial, (/) inserted.

Chapter 14 - Landing Gear

Section 10 - Controls and Indicators

Gear Synoptic Display

14.10.8-9 - Revised brake temperature values.

Section 20 - System Description

Antiskid Protection

14.20.4 - Revised text for clarity.

Chapter 15 - Warning Systems

Section 10 - Controls and Indicators

15.10.1 - This chapter is completely rvised. The addition of recent enhancements to TCAS, GPWS, and PWS encourages a consistent presentation of all warning systems in phase of flight sequence.

Engine Indication and Crew Alerting System (EICAS)

15.10.1 - Installation of the same model warning system LRUs in many Boeing airplane models, and similar flight deck displays and procedures, encourages a consistent presentaion for warning systems in Boeing airplanes.

15.10.1 - Revised to describe EICAS message displays in a uniform style.

GPWS Alerts on PFD

15.10.5 - Installed PWS.

Master WARNING/CAUTION Reset Switches and Lights

15.10.6 - Installed PWS.

Decision Height Display

15.10.10 - Added withlook-ahead terrain alerting installed.

Section 20 - System Description

Engine Indication and Crew Alerting System (EICAS)

15.20.1 - Revised EICAS message description to emphasise flight crew use of messages.

Aural Alerts, Master WARNING/CAUTION Switches and Lights, and GND PROX Light

15.20.4 - Added all aural and light alerts. Added description of flight crew actino to silence each aural alert and light alert while the alert is occuring. Formated as a table for consistent presentation.

Airspeed Alerts

15.20.5 - Consolidated airspeed alerts into one subsection.

TCAS ND Messages

15.20.10 - Reformated description text into a brief table format.

TCAS Voice Annunciations

15.20.11 - Reformated table with condition and response.

TCAS Ver. 6.04a installed.

GPWS Alerts

15.20.14 - Added with look-ahead terrain with peaks and obstacles alerting.

GPWS Windshear Alert

15.20.15 - PWS not installed.

GPWS Non-Normal Operation

15.20.16 - PWS installed.

Alert Inhibits

15.20.16 - Consolidated most alert inhibits in table format by phase of flight.

TCAS Inhibits

15.20.19 - TCAS Ver. 6.04a installed.

Alerts Inhibited During Landing

15.20.19 - PWS installed.

Chapter CI - Checklist Introduction

Section 2 - Non-Normal Checklists

Non–Normal Checklist Operation

CI.2.3 - Revised guidance for oxygen use for cross-model standardization.

CI.2.3 - Revised to reduce potential for in-flight electrical problems and/or smoke.

Chapter NNC - Non-Normal Checklists

Section 0 - Unannunciated Checklists

ABORTED ENGINE START (ENG 1, 2, 3, 4 AUTOSTART)

NNC.0.1 - Added Engine Start light condition for clarity.

FIRE ENGINE TAILPIPE

NNC.0.10 - Revised checklist title for clarity.

GEAR LEVER WILL NOT MOVE UP

NNC.0.14 - Revised procedural step for cross-model standardization.

SMOKE/FUMES AIR CONDITIONING

NNC.0.21 - Revised indenting for procedural clarity.

SMOKE/FUMES/FIRE ELECTRICAL

NNC.0.23 - Revised to reflect in-service data show fans have been a source of smoke. Turning off fans removes potential sources of smoke as well as stopping spread of existing smoke. Added steps to configure cabin lighting before turning off utility busses.

WINDOW DAMAGE

NNC.0.29 - Revised procedure (and title) for commonality, and to reflect resistance to damage capability based upon testing.

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

WINDOW DAMAGE

NNC.1.7 - Revised procedure (and title) for commonality, and to reflect resistance to damage capability based upon testing.

Section 6 - Electrical

ELEC AC BUS 1, 2, 3, 4

NNC.6.2 - An AC bus 1 or 4 failure will fail both pitot probes on one side of the airplane. An AC bus 1 failure in icing conditions can result in unreliable Captain’s and Standby flight instruments. An AC bus 4 failure in icing conditions can result in unreliable First Officer’s flight instrument indications.

Section 7 - Engines, APU

ENG 1, 2, 3, 4 AUTOSTART (ABORTED ENGINE START)

NNC.7.3 - Added Engine Start light condition for clarity.

Section 8 - Fire Protection

FIRE CARGO AFT

NNC.8.3 - Modified pack temperature controllers illuminate the SYS FAULT light when a pack is automatically turned off. Turning off the associated pack control selector returns the pack reset switch functionality for use in case of a subsequent failure of an operational pack.

FIRE CARGO FWD

NNC.8.4 - Modified pack temperature controllers illuminate the SYS FAULT light when a pack is automatically turned off. Turning off the associated pack control selector returns the pack reset switch functionality for use in case of a subsequent failure of an operational pack.

FIRE ENGINE TAILPIPE

NNC.8.6 - Revised checklist title for clarity.

FIRE WHEEL WELL

NNC.8.7 - Revised procedural step for cross-model standardization.

SMOKE/FUMES AIR CONDITIONING

NNC.8.9 - Revised indenting for procedural clarity.

>SMOKE DR 5 REST

NNC.8.10 - When the smoke alarm is triggered, the recirculation fans are turned off, which in turn places the packs in high flow. This adds an .8% fuel penalty. If the fire is small and easily extinguished, pushing the crew reset switch returns the packs to normal.

SMOKE/FUMES/FIRE ELECTRICAL

NNC.8.11 - Revised to reflect in-service data show fans have been a source of smoke. Turning off fans removes potential sources of smoke as well as stopping spread of existing smoke. Added steps to configure cabin lighting before turning off utility busses.

Section 9 - Flight Controls

FLAP INDICATION DISAGREE

NNC.9.1 - Added new procedure for flap indication lagging selected flap setting with no FLAPS CONTROL, FLAPS DRIVE, or FLAPS PRIMARY message displayed. 747-400 design allows the possibilty of the flap position indication lagging the actual flap position.

FLAPS DRIVE

NNC.9.3 - Revised procedure to reflect if TE flap split is more than 6 degrees, the amber minimum maneuvering speed band is based on flaps up. It does not change as the flaps are extended. This requires disconnecting the autothrottle.

Section 10 - Flight Instruments, Displays

>EFIS CONTROL L, R

NNC.10.1 - Added CDU designation to accommodate CDU intermix.

>EFIS/EICAS C/P

NNC.10.3 - Added CDU designation to accommodate CDU intermix.

NNC.10.3 - Corrected display panels to display panel. Added CDU designation to accommodate CDU intermix.

Section 14 - Landing Gear

BRAKE TEMP

NNC.14.3 - Revised procedural step for cross-model standardization.

GEAR LEVER WILL NOT MOVE UP

NNC.14.6 - Revised procedural step for cross-model standardization.

Section 15 - Warning Systems

WINDSHEAR SYS

NNC.15.4 - IDS software installs WINDSHEAR SYS EICAS message

Chapter NNM - Non-Normal Maneuvers

Section 1 - Non-Normal Maneuvers

Ground Proximity Warning

NNM.1.5 - Revised the Terrain Avoidance maneuver to provide more guidance for the step "Monitor vertical speed and radio altitude’. Added "radio altitude for terrain clearance and barometric altitude for a minimum safe altitude." "A minimum safe altitude" is a generic, to include Minimum Safe Altitudes, Minimum Obstacle Clearance Altitude, Minimum Sector Alittudes, etc.

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Page	Date
Volume 1	
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Copyright	
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* 0.4.1-12	April 01, 2001
* 0.5.1-12	April 01, 2001
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* 0.6.2	April 01, 2001
Limitations (tab)	
L.TOC.0.1-2	October 1, 2000
* L.10.1	April 01, 2001
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* NP.20.5-15	April 01, 2001
NP.20.16-26	December 19, 2000
NP.30.1	December 01, 1999
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* = Revised, Added, or Deleted

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* SP.TOC.0.1-4	April 01, 2001
SP.0.1	December 01, 1999
SP.0.2	April 1, 2000
* SP.1.1	April 01, 2001
SP.1.2	October 1, 2000
* SP.2.1	April 01, 2001
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General

The Boeing Company issues Operations Manual Bulletins to provide important information to flight crews prior to the next formal revision of the Operations Manual. The transmitted information may be of interest to only specific Operators or may apply to all Operators of this model airplane. Each bulletin will vary.

Bulletins are dated and numbered sequentially. Each bulletin identifies airplanes affected by the bulletin. Absence of airplane effectivity indicates the bulletin applies to all airplanes in an Operator's fleet. When appropriate, the next formal Operations Manual revision will include an updated bulletin record page to reflect current bulletin status.

Bulletin status is defined as follows:

- In Effect (IE) – the bulletin contains pertinent information not otherwise covered in the Operations Manual. The bulletin remains active and should be retained in the manual
- Incorporated (INC) – the bulletin operating information has been incorporated into the Operations Manual. However, the bulletin remains active and should be retained in the manual
- Cancelled (CANC) – the bulletin is no longer active and should be removed from the Operations Manual. All bulletins previously cancelled are no longer listed in the Bulletin Record.

The person filing a new or revised bulletin should amend the Bulletin Record as instructed in the Administrative Information section of the bulletin. When a bulletin includes replacement pages for the Operations Manual or QRH, the included pages should be filed as instructed in the Operations Manual Information section of the bulletin.

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-9(R4)	04-01-99	INC
-13(R2)	04-01-99	IE
-28(R2)	04-01-99	INC
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-48(R1)	04-01-01	IE
-49	07-05-00	INC
-50(R1)	03-15-01	INC
-51(R1)	12-19-00	IE

Number	Date	Status

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-9(R4)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: HYDRAULIC SYSTEM 1 OR 4 DEPRESSURIZATION - GROUND MODE ANOMALY

Reason: To inform flight crews of a ground mode condition which may result when hydraulic system 1 or 4 is depressurized. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There have been two reports by operator flight crews that after depressurizing hydraulic system 4 in flight, the airplane entered a “ground mode” of operation. If system 4 is depressurized, hydraulic pressure is no longer available to the wing gear truck tilt actuators. With loss of system 4 pressure, over time, both wing gear trucks may relax and move from the “tilted” position satisfying proximity sensor ground mode logic. There are few obvious flight deck indications which allow the crew to quickly or easily determine the airplane has entered the ground mode. However, several airplane systems operate differently in the “ground mode” than in the air mode”. Hydraulic system 1 and 4 non-normal procedures have been modified for flight crew accommodation of these conditions. These procedures conservatively assume that if hydraulic system 4 is depressurized, the airplane will enter the ground mode and if hydraulic system 1 is depressurized, the airplane will enter the ground mode when the gear are extended for landing. The effects of a ground mode encounter on short final are not considered to be as operationally significant as the potential cumulative effects of a ground mode condition which may result from a system 4 loss. This is essentially due to the phase of flight in which this condition may occur.

If the airplane enters the ground mode in flight, the following systems conditions will exist:

- Stabilizer fuel will not transfer
- Fuel in reserve tanks 2 & 3 will not transfer
- Wing anti-ice is inoperative
- Reverse thrust is available in flight if reverse thrust levers are raised
- Approach idle minimum thrust setting is inoperative
- Autothrottle is inoperative (hydraulic system 4 loss only)
- Cabin Pressurization system
  Below 15,000 feet outflow valves will gradually open to depressurize airplane. No effect above 15,000 feet.
- Transponder is disabled.
- TCAS is operative in TA ONLY mode
- Minimum maneuvering speed indication is inoperative
- Upper deck doors may be unlocked in flight
- Yaw dampers are inoperative
- Speedbrake lever flight detent automatic stop is inoperative

On the ground, stabilizer fuel and reserve fuel are inhibited from transferring. In flight, if the stabilizer or reserve fuel has not transferred and the airplane enters the ground mode, the fuel in these tanks will stop transferring or be inhibited from transferring. The EICAS messages FUEL RES XFR and FUEL STAB XFR, which alert the crew to anomalies in fuel transfer, will not be displayed as the logic sees this as correct (on ground) system operation.

The flight crew should use the direction specified in the Operations Manual for nacelle anti-ice use which requires selecting anti-ice when TAT is 10°C or less and visible moisture is present.

Wing anti-ice is inoperative on the ground under all circumstances, therefore, wing anti-ice is inoperative in flight if the airplane enters the ground mode. However, with hydraulic system 4 depressurized, wing anti-ice can be operated manually, until the airplane enters the ground mode and EICAS indicates the wing anti-ice is inoperative. It should be noted that wing anti-ice is ineffective when leading edge flaps are extended. The modified non-normal procedures address this condition.

Approach and minimum idle settings are controlled by the EEC. When the airplane is on the ground, the EEC selects minimum idle. If a ground mode condition is encountered in flight, the engines will operate at minimum idle. If hydraulic system 4 is depressurized or hydraulic system 1 is depressurized and the gear are extended for landing, the flight crew should maintain a minimum idle thrust setting which is equivalent to approach idle. The modified non-normal procedures address this condition.

Operating Instructions

The ground mode anomaly described in this bulletin is corrected through installation of upgraded Proximity Switch Electronic Unit (PSEU) software. Airplanes modified by SB 747-32-2426 incorporate upgraded PSEU software and are not affected by the ground mode anomaly.

In the event hydraulic system 4 is depressurized in flight or hydraulic system 1 is depressurized and the gear are extended for landing, flight crews should be aware of system conditions that may exist if the airplane enters the ground mode of operation.

Operations Manual Information

The FAA plans to grant terminating action for the governing Airworthiness Directive, AD 93-14-21, after 18 months of satisfactory service with upgraded PSEU software. Therefore, HYDRAULIC OVERHEAT SYSTEM and HYDRAULIC PRESSURE SYSTEM non-normal procedures will continue to reflect the ground mode anomaly until the FAA authorizes terminating action for AD 93-14-21, and all airplanes in an operator’s fleet have the upgraded software.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-9(R4) INCORPORATED (INC).

We will cancel this Operations Manual Bulletin and revise hydraulic non-normal procedures when:

1. The FAA authorizes the PSEU software upgrade as terminating action for AD 93-14-21, and
2. You notify Boeing all affected airplanes in your fleet have been modified by SB 747-32-2426.

If you do not plan to modify your affected airplanes and would like to have the contents of this bulletin remain in your Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 MS 20-89
Seattle, WA 98124-2207
USA

Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-13(R2)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: FUEL IN ENGINE OIL SYSTEM

Reason: To advise flight crews of the possibility of fuel entering the engine oil system. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There have been numerous reported events where engine oil has been contaminated with fuel. Several of these events resulted in uncontained engine failures in flight when a fire has occurred in the oil vent system shortly after takeoff.

There are four points where fuel can leak into and contaminate the oil:

1. Fuel/oil Heat Exchanger leakage.
2. N1 Hydro Mechanical Sensor.
3. Seal in the Fuel Control Unit.
4. Fuel lines on the Fuel Control Unit being switched.

GE Service Bulletin 72-648 has been issued to prevent uncontained engine failures in the event a fire occurs in the oil vent system.

Boeing previously advised internal leakage of fuel into the oil system should be suspected if the oil quantity indication was at or approaching 20 or more quarts after engine start. However, since issue of the original bulletin, several operators have reported oil quantity indications of approximately 21 quarts after engine start which, when investigated, were not due to fuel/oil contamination. The increase in oil quantity was due to a slight over-servicing, oil expansion due to temperature increase, or an increase in scavenge efficiency with the engine at idle. For these reasons, the oil quantity check after engine start has been increased to 22 quarts (21 liters).

Information from these events has shown inconsistent indications for fuel in the oil system which cannot provide a sound basis for in-flight crew procedures. Since flight crews do not continuously monitor oil system indications, changes in oil system parameters may not be noticed. However, if the oil quantity is observed to be increasing during steady state operation or if at any time during engine operation the oil quantity indication is at or approaching 21 liters or more, internal leakage of fuel into the oil system should be suspected. This condition should be entered in the Flight Log for maintenance action prior to the next flight.

The first cockpit indication of a fuel-contaminated oil system may be an increasing or overfilled oil tank quantity. The rate of oil quantity increase depends on the severity of the fuel leak. Leaks are normally detected by maintenance personnel during required checks, or while investigating flight crew complaints of increasing oil quantity. An extreme overfilled condition may be accompanied by increasing oil temperature, fluctuating or decreasing oil pressure, or fuel/oil fumes in the cabin. The Smoke Air Conditioning procedures was issued to handle smoke or fumes in the cabin.

Additional maintenance checks have been implemented following servicing of oil tanks or after maintenance on the engine oil or fuel system to detect fuel contamination of the oil. This results in more frequent checks of the oil system.

Operating Procedure

Since data on at least one uncontained failure indicates the oil tank was overfilled at engine start, accomplish the following check until GE SB 72-648 is incorporated.

At least 30 seconds after the engine reaches stabilized idle and prior to taxi:

OIL QUANTITY ....CHECK

If the oil quantity indicates 21 liters or more, maintenance investigation is required prior to takeoff.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-13(R2) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified all affected airplanes in your fleet have been modified by GE Service Bulletin 72-648. If you do not plan to modify all your airplanes and would like to have the contents of this Bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 MS 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207 747-400

Number: ILF2-28(R2)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: ENGINE OPERATION IN HEAVY RAIN OR HAIL

Reason: To inform flight crews of revised procedures for use of autothrottle in heavy rain or hail. Revised for administrative purposes.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received reports of GE engine flameout and subsequent engine recovery while operating in heavy rain. In one dual engine flameout incident, digital flight data recorder (DFDR) information revealed the autothrottle was engaged and commanding a thrust increase from approach idle when the flameouts occurred. While the reported flameouts occurred in heavy rain, water ingestion by itself has been ruled out as the sole cause of these events. Engineering analysis of DFDR data has determined the most likely cause to be rapid variable bleed valve (VBV) closure resulting from autothrottle thrust increases during sustained engine ingestion of supercooled water and ice.

General Electric has investigated the problem and is planning an EEC software update, which will reschedule VBV operation to reduce engine susceptibility to flameout under the conditions encountered during the reported incidents.

Operating Instructions

Flight through areas of heavy precipitation should be avoided. However, if heavy rain or hail cannot be avoided or is inadvertently encountered, disconnect the autothrottle and minimize thrust changes to reduce the possibility of engine flameout. The MODERATE TO HEAVY RAIN OR HAIL procedure reflects these instructions.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-28(R2) INCORPORATED (INC).

This condition is temporary until the system is modified. This bulletin will be revised to include Service Bulletin information when available.

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 MS 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-33(R2)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: UNCOMMANDED AUTOPILOT ENGAGEMENT, FLIGHT MODE CHANGES, AND IAS/MACH WINDOW SPEED CHANGES

Reason: To advise flight crews of the possibility of uncommanded autopilot engagement, flight mode changes, and IAS/Mach Window speed changes, and provide recommended temporary instructions for these situations. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

UNCOMMANDED AUTOPILOT ENGAGEMENT AND FLIGHT MODE CHANGES

Boeing has received reports from operators of uncommanded autopilot engagement and flight mode changes. The reports document at least one rejected takeoff and one undesired heading change. Engineering investigation has determined these anomalies are caused by faulty MCP push-button switches installed during production or subsequent component repair. Intermittent switch malfunction can cause this anomaly without pilot action. The normal means for disengaging the autopilot, Autopilot Disengage Switches and the Autopilot Disengage Bar, are unaffected by this anomaly and operate normally.

UNCOMMANDED IAS/MACH WINDOW SELECTED SPEED CHANGES

Boeing has also received reports from operators of unexpected transition from selected speed to 0.84 Mach upon multiple channel autopilot engagement during automatic approach, and upon autopilot disengagement. Under these conditions, the selected IAS/MACH Window speed changes to 0.84 Mach, requiring pilot intervention to regain airspeed control. Investigation has determined these anomalies occur only with older flight control computers (FCC S241T100-133 and earlier).

Operating Instructions

This bulletin does not apply to airplanes modified by SB 747-22A2214.

UNCOMMANDED AUTOPILOT ENGAGEMENT

Flight crews should closely monitor PFD flight mode annunciations for autopilot status, and be prepared to respond to uncommanded autopilot engagement during critical phases of flight, including takeoff. Uncommanded autopilot engagement can be corrected by disengaging the autopilot.

UNCOMMANDED FLIGHT MODE CHANGES

Flight crews should closely monitor PFD flight mode annunciations for autothrottle, roll, and pitch status, and be prepared to respond to uncommanded mode changes during critical phases of flight, including takeoff. Uncommanded flight mode changes can be corrected by selecting the desired mode on theMCP.

UNCOMMANDED IAS/MACH WINDOW SPEED CHANGES

Flight crews should closely monitor command speed on the PFD and be prepared to respond to uncommanded changes to 0.84 Mach under the following conditions:

1. multiple channel autopilot engagement during automatic approach
2. autopilot disengagement.

If the command speed changes to 0.84 Mach under either condition; disconnect the autothrottle, push the IAS/MACH Select Switch to change the IAS/MACH Window display to IAS, then set desired speed in the IAS/MACH Window. After resetting speed, the autothrottle may be reconnected.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-33(R2) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified all affected airplanes in your fleet have been modified by Service Bulletin 747-22A2214. If you do not plan to modify all your airplanes and would like to have the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 MS 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-34(R2)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: EARLY VNAV DESCENT AND ERRONEOUS FMC FUEL PREDICTIONS

Reason: To advise flight crews of erroneous FMC fuel predictions when VNAV descent is initiated using the FMS-CDU DESCEND NOW prompt. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received operator reports of FMC destination fuel predictions increasing as much as 8000 pounds (3600 kgs) during VNAV descent to an intermediate cruise altitude. In the documented instances, flight crews initiated descent with the DES NOW prompt approximately 300 nm from destination.

The FMC changes to VNAV descent phase at the Top of Descent (T/D). With MCP altitude set for descent, the autothrottle sets idle thrust for descent on the VNAV path.

The DES NOW prompt, displayed at 6R on the inactive VNAV Descent page, allows the flight crew to descend early. With MCP altitude set for descent, the autothrottle adjusts thrust to descend at approximately 1250 fpm. If VNAV path is captured, the autothrottle sets idle thrust to continue descent on VNAV path.

With the VNAV descent phase active, the FMC computes destination fuel assuming idle thrust on the VNAV path. Actual fuel flow using DES NOW is greater than idle fuel flow used for FMC fuel computations. As a result, early descent when more than 50 nm from T/D introduces a fuel computation error. The error increases with distance from T/D when descent is initiated.

Operating Instructions

Perform a cruise descent for descent to intermediate altitudes when more than 50 nm from T/D. During cruise descent the FMC computes a new T/D for the new cruise altitude and accurate destination fuel predictions.

Always cross-check FMC fuel predictions with flight plan data.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-34(R2) IN EFFECT (IE).

This condition is temporary until the system is modified. This bulletin will be revised to include Service Bulletin information when available.

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 MS 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company **Seattle, Washington 98124-2207** 747-400

Number: ILF2-36(R2)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: ERRONEOUS ILS RECEIVER OUTPUTS

Reason: To advise operators of possible erroneous outputs from the Allied Signal "Quantum" ILS receiver. Revised for administrative purposes.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

A potential failure within the Allied Signal "Quantum" ILS receiver may cause either an erroneous localizer deviation indication, or an erroneous glideslope deviation indication on a PFD, or ND (when displaying approach data). The localizer or glideslope deviation indication on the opposite PFD or ND is not affected if this failure occurs in a single ILS receiver.

The autopilot flight director system (AFDS) compares signals from the three ILS receivers and will not use signals from a failed receiver. The EICAS alert message NO LAND 3 is displayed when the AFDS senses a failed receiver. The AFDS will continue the approach with no degradation in performance and the AFDS status LAND 2 will be displayed on the PFD.

If the airplane was dispatched with two operable ILS receivers and a subsequent ILS receiver failure occurs while on approach, the autopilot will disengage and the flight director command bars will no longer be displayed. There is no available source of ILS data to verify correct approach information. No ILS or localizer approach can be flown.

Operating Instructions

This bulletin applies to all airplanes equipped with Allied Signal "Quantum" ILS Receivers (P/N 066-50006-0101).

Do not attempt a manual (no autopilot, no flight director) raw data ILS or localizer approach/departure.

Do not attempt an ILS or Localizer autopilot departure or approach/landing, or manual approach/departure using the flight director with the EICAS advisory message SNGL SOURCE ILS displayed.

While cross checking the Captain's and First Officer's flight displays, if a disagreement is noted between the two ILS raw data displays on an approach, attempt to isolate the failed signal as described below.

This should only be attempted as time permits, and should be completed above 1500 feet AGL.

- The Pilot Not Flying (PNF) should move the EIU SOURCE SELECTOR from the AUTO position to the C position. (Make sure Captain's and First Officer's EIU SOURCE SELECTORS are not selecting the same EIU.)
- If the Captain's and First Officer's displays agree, continue the approach and landing.
- If the displays disagree, the PNF should move the EIU SOURCE SELECTOR from the C position back to the AUTO position, and the Pilot Flying (PF) should move the EIU SOURCE SELECTOR from the AUTO position to the C position.
- If the Captain's and First Officer's displays agree, continue the approach and landing. Otherwise, initiate a go-around unless visual contact with the runway has been established.

If a go-around has been initiated, it is possible to inhibit display of erroneous ILS deviation indications by placing the ILS in PARK (DEL the ILS frequency on the NAV RAD page) for one minute, then re-selecting the desired ILS frequency and course.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-36(R2) IN EFFECT (IE).

This condition is under investigation. This bulletin will remain in effect until further notice.

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 MS 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-40(R3)

Date: April 1, 2001

Document Effectivity: D6-30151-425

Subject: CONSECUTIVE CONDITIONAL ALTITUDE WAYPOINTS MAP ANOMALY

Reason: To inform flight crews of an ND MAP display anomaly associated with routes containing two consecutive conditional altitude waypoints. Revised to add Service Bulletin information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

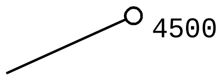
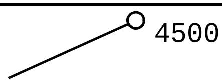
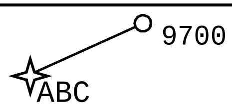
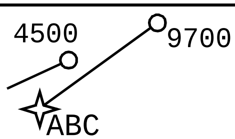
Background Information

During flight test, a Boeing crew experienced a MAP display anomaly. Simulator and lab tests show that when two consecutive conditional altitude waypoints exist in a procedure, the MAP display of the magenta line does not reflect the intended path on the active leg for the conditional altitude waypoint. The displayed magenta line may erroneously indicate a turn prior to the airplane satisfying the required altitude for the turn. Conditional altitude waypoints are depicted as small circles along with the altitude on the ND map display, and their location depends on the airplane satisfying the altitude associated with the leg.

Consecutive conditional altitude waypoints may appear in SIDS and Missed Approach procedures and are automatically entered into the route when a procedure is selected from the FMS-CDU DEPARTURES or ARRIVALS page. Procedures which use this combination of two consecutive altitude waypoints usually require a climb to a specified altitude followed by a small turn to intercept a VOR radial while climbing to a higher altitude. Approximately 400 procedures worldwide are affected by this anomaly. Tables listing all currently affected procedures in the navigation data base are included in this bulletin.

Honeywell and Boeing are investigating this anomaly.

The typical ND map display and corresponding RTE LEGS page display for conditional altitude waypoints are shown below:

Description	ND Map Display	CDU LEGS Page Display
Constant Heading to an Altitude		070° HDG (4500)
Constant Course to an Altitude		070° TRK (4500)
Outbound Radial to an Altitude		070° (9700)
Consecutive Course to an Altitude Followed by Outbound Radial to an Altitude		070° TRK (4500) 063° (9700)

Operating Instructions

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-34A2672 (FMC software load 15).

When flying a Standard Instrument Departure (SID) or missed approach procedure containing consecutive conditional altitude waypoints, the active route shown on the ND MAP is incorrect. However, LNAV guidance is reliable and may be flown using either the flight director or autopilot. Monitor LNAV progress and ensure all altitudes and turn points are consistent with the procedure and available raw data

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
EDFH	Hahn, Germany	RUWE1E	RW03
ENBO	Bodo, Norway	GLOM2B	RW26
ENBO	Bodo, Norway	STOB1B	RW26
ENDU	Bardufoss, Norway	BDF2	RW11
ENDU	Bardufoss, Norway	LAVN2A	RW11
ENDU	Bardufoss, Norway	TULD2A	RW11
ENZV	Stavanger/Sola, Norway	BANK1D	RW29
ENZV	Stavanger/Sola, Norway	DOGI1D	RW11
ENZV	Stavanger/Sola, Norway	DOLF1D	RW29
ENZV	Stavanger/Sola, Norway	FUND1D	RW29
ENZV	Stavanger/Sola, Norway	GRAM1D	RW11
ENZV	Stavanger/Sola, Norway	LUCK1D	RW29
ENZV	Stavanger/Sola, Norway	MADY1D	RW11
ENZV	Stavanger/Sola, Norway	OKLA1D	RW11
ENZV	Stavanger/Sola, Norway	SIRD1D	RW11
ENZV	Stavanger/Sola, Norway	STON1D	RW29
ESNN	Sundsvall-Harnosand, Sweden	LUE1C	RW34
ESNN	Sundsvall-Harnosand, Sweden	STEW2C	RW34
FACT	Cape Town, South Africa	OKTE2B	RW19
FACT	Cape Town, South Africa	PARI2B	RW19
GCFV	Fuerteventura, Canary Is	KORA1R	RW19
GCFV	Fuerteventura, Canary Is	LPC2R	RW19
GCFV	Fuerteventura, Canary Is	LT1R	RW19
GCFV	Fuerteventura, Canary Is	SAMA1R	RW19
GCFV	Fuerteventura, Canary Is	TFN1R	RW19
GCFV	Fuerteventura, Canary Is	TFS2R	RW19
GCFV	Fuerteventura, Canary Is	VAST1R	RW19
KBZN	Boseman/Gallatin, MT	BZN365	RW30

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
KBZN	Boseman/Gallatin, MT	BZN86S	RW30
KBZN	Boseman/Gallatin, MT	BZN86W	RW30
KHLN	Helena, MT	HLN2	RW05
KHLN	Helena, MT	HLN2	RW09
KLAX	Los Angeles, CA	BEVAN1	ALL
KMSO	Missoula, MT	MSOEAS	RW29
KSJC	San Jose, CA	SUNOL5	RW12
KSTS	Santa Rosa/Sonoma Co, CA	STS5	RW01
KSTS	Santa Rosa/Sonoma Co, CA	STS5	RW14
KSTS	Santa Rosa/Sonoma Co, CA	STS5	RW19
KSTS	Santa Rosa/Sonoma Co, CA	STS5	RW32
LEAS	Asturias, Spain	ARPO1B	RW11
LEAS	Asturias, Spain	LURI1B	RW11
LEAS	Asturias, Spain	MUSI1B	RW11
LEAS	Asturias, Spain	RATP1B	RW11
LEIB	Ibza, Spain	MHN1E	RW24
LEIB	Ibza, Spain	MJV1E	RW24
LEPA	Palma de Mallorca, Spain	MEBU1A	RW24
LEPA	Palma de Mallorca, Spain	MHN1A	RW24
LEPA	Palma de Mallorca, Spain	MJV1B	RW06
LEPA	Palma de Mallorca, Spain	OSGA1A	RW24
LFMI	Istres/Le Tube, France	LUC6D	RW15
LGAT	Athens, Greece	FALC1F	RW15
LGAT	Athens, Greece	KOR1F	RW15
LGAT	Athens, Greece	KRS1F	RW15
LGAT	Athens, Greece	TNG1F	RW15
LGAT	Athens, Greece	VILI1F	RW15
LGKL	Kalamata, Greece	KLM1V	RW17

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
LGKL	Kalamata, Greece	KLM1Y	RW17
LGKP	Karpathos, Greece	KRC1A	RW30
LGKP	Karpathos, Greece	KRC1B	RW12
LGKV	Kavala/Megas Alexandros, Greece	ALX3A	RW05
LGKV	Kavala/Megas Alexandros, Greece	ALX3B	RW23
LGKV	Kavala/Megas Alexandros, Greece	LMO3A	RW05
LGKV	Kavala/Megas Alexandros, Greece	LMO3B	RW23
LGKV	Kavala/Megas Alexandros, Greece	PERE3A	RW05
LGKV	Kavala/Megas Alexandros, Greece	RODO1A	RW05
LGKV	Kavala/Megas Alexandros, Greece	RODO1B	RW23
LGMK	Mikonos, Greece	RIPL1A	RW34
LGMK	Mikonos, Greece	RIPL1B	RW16
LGMT	Mitilini, Greece	LSV1A	RW33
LGRX	Araxos, Greece	ALAK1M	RW36
LGRX	Araxos, Greece	ARGU1M	RW36
LGRX	Araxos, Greece	IXON1M	RW36
LGRX	Araxos, Greece	KESA1M	RW36
LGRX	Araxos, Greece	KOR1M	RW36
LGRX	Araxos, Greece	KRK1M	RW36
LGRX	Araxos, Greece	TRL1M	RW36
LGSR	Santorini, Greece	ASTI1E	RW16
LGSR	Santorini, Greece	ATLA1B	RW34
LGSR	Santorini, Greece	ATLA1C	RW16
LGSR	Santorini, Greece	MIL1E	RW34
LGSR	Santorini, Greece	MIL1F	RW34
LGSR	Santorini, Greece	MIL1G	RW16
LGSR	Santorini, Greece	MIL1H	RW16
LGTG	Tanagra, Greece	AGH1C	RW28

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
LGTG	Tanagra, Greece	AGH1D	RW10
LGTG	Tanagra, Greece	ATH1C	RW28
LGTG	Tanagra, Greece	ATH1D	RW10
LGTG	Tanagra, Greece	IXON1C	RW28
LGTG	Tanagra, Greece	IXON1D	RW10
LGTG	Tanagra, Greece	OLID1C	RW28
LGTG	Tanagra, Greece	OLID1D	RW10
LGTG	Tanagra, Greece	SKL1F	RW28
LGTG	Tanagra, Greece	SKL1G	RW10
LGTS	Thessaloniki/Makedonia, Greece	ARNA1E	RW28
LGTS	Thessaloniki/Makedonia, Greece	FSK1E	RW28
LGTS	Thessaloniki/Makedonia, Greece	LAMB1E	RW28
LGTS	Thessaloniki/Makedonia, Greece	LOPO1E	RW28
LGTS	Thessaloniki/Makedonia, Greece	SKL1E	RW28
LGTS	Thessaloniki/Makedonia, Greece	TSL1F	RW28
LIBC	Crotone, Italy	CDC5A	RW35
LIBC	Crotone, Italy	CDC5B	RW17
LIMP	Parma, Italy	PAR5V	RW02
LIPZ	Venezia/Tessera, Italy	CHI5H	RW22
LIPZ	Venezia/Tessera, Italy	RON5H	RW22
LIPZ	Venezia/Tessera, Italy	ROTA5H	RW22
LIRQ	Florence, Italy	PIS5A	RW23
LSGC	Les Eplatures, Switzerland	FRI1B	RW24
LSGC	Les Eplatures, Switzerland	HOC1A	RW24
LSGC	Les Eplatures, Switzerland	HOC1B	RW24
LSGC	Les Eplatures, Switzerland	SPR1B	RW24
LSZG	Grenchen, Switzerland	SHU2T	RW25
LSZG	Grenchen, Switzerland	WIL2T	RW25

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
MGGT	Guatemala/La Aurora, Guatemala	SJOB	RW01
MGGT	Guatemala/La Aurora, Guatemala	PALEN	RW01
MKJP	Kingston/Norman Manley, Jamaica	MLY1	RW12
MUCU	Santiago de Cuba/Antonio Maceo, Cuba	CAOBA2	RW09
NFNA	Nausori, Fiji	ALFA	RW10
NFNA	Nausori, Fiji	BRAVO	RW10
NFNA	Nausori, Fiji	BRAVO	RW28
NFNA	Nausori, Fiji	CHARLI	RW10
NSFA	Apia/Faleolo, Samoa	ALFA	RW26
NTAA	Tahiti, Tahiti	EMIR1A	RW04
NTAA	Tahiti, Tahiti	KAIN1A	RW04
NTAA	Tahiti, Tahiti	METU1A	RW04
OIAW	Ahwaz, Iran	GABK1B	RW30
OIAW	Ahwaz, Iran	GABK1H	RW12
OIAW	Ahwaz, Iran	MIS1B	RW30
OIAW	Ahwaz, Iran	MIS1H	RW12
OIBB	Bushehr, Iran	KUGV1A	RW31
OIBB	Bushehr, Iran	KUGV1B	RW13
OIBB	Bushehr, Iran	KUGV1C	RW31
OICC	Kermanshah, iran	RULI1D	RW11
OIGG	Rasht, Iran	RALG1A	RW27
OIGG	Rasht, Iran	RALG1B	RW09
OIGG	Rasht, Iran	RART1A	RW27
OIGG	Rasht, Iran	RART1B	RW09
OIKB	Bandar Abbass, Iran	TAVN2A	RW03
OIKK	Kerman, Iran	ALGU2B	RW34
OIKK	Kerman, Iran	ALGU2D	RW34
OIKK	Kerman, Iran	ALGU2E	RW34

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
OIKK	Kerman, Iran	ALGU3A	RW34
OIKK	Kerman, Iran	ALGU3C	RW16
OIKK	Kerman, Iran	ALKE2C	RW34
OIKK	Kerman, Iran	ALKE3A	RW34
OIKK	Kerman, Iran	ALKE3B	RW16
OIKK	Kerman, Iran	ALKU2D	RW34
OIKK	Kerman, Iran	ALKU2E	RW16
OIKK	Kerman, Iran	ALKU3A	RW34
OIKK	Kerman, Iran	ALKU3B	RW16
OIKK	Kerman, Iran	ALKU3C	RW16
OIKK	Kerman, Iran	ALME2D	RW34
OIKK	Kerman, Iran	ALME3A	RW34
OIKK	Kerman, Iran	ALME3C	RW16
OIKK	Kerman, Iran	ALMI2A	RW34
OIKK	Kerman, Iran	ALMI2B	RW16
OIKK	Kerman, Iran	ALMI2C	RW16
OIKK	Kerman, Iran	ALMI2D	RW34
OIKK	Kerman, Iran	ALMO1A	RW34
OIKK	Kerman, Iran	ALMO2B	RW34
OIKK	Kerman, Iran	ALMO2C	RW16
OIKK	Kerman, Iran	ALMO2D	RW34
OIKK	Kerman, Iran	ALMO2E	RW34
OIMM	Mashhad, Iran	METK2A	RW13
OIMM	Mashhad, Iran	METK2B	RW31
OIMM	Mashhad, Iran	METK2C	RW31
OIMM	Mashhad, Iran	MIDM1A	RW13
OIMM	Mashhad, Iran	MIDM1B	RW31
OIMM	Mashhad, Iran	NOTS2A	RW13

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
OIMM	Mashhad, Iran	NOTS2B	RW13
OIMM	Mashhad, Iran	NOTS2C	RW31
OIMM	Mashhad, Iran	RAMI2A	RW13
OIMM	Mashhad, Iran	RAMI2B	RW31
OISS	Shiraz, Iran	KISE1B	RW11
OITR	Uromiyeh, Iran	BONA1B	RW21
OITR	Uromiyeh, Iran	ZAJ1B	RW21
OITT	Tabriz, Iran	RUDA1B	RW12
OITT	Tabriz, Iran	RUDA1D	RW12
OIZH	Zaheadan, Iran	DANO2B	RW17
OLBA	Beirut, Lebanon	KAD1C	RW18
OLBA	Beirut, Lebanon	KAD1C	RW21
RJCH	Hakodate, Japan	HWE2R	RW12
RJCN	Nakashibetsu, Japan	NSE2R	RW26
RJFE	Fukue, Japan	FUER1	RW21
RJFE	Fukue, Japan	JB2	RW03
RJFE	Fukue, Japan	OLE2	RW03
RJFY	Kanoya, Japan	EASTRE	RW08
RJFY	Kanoya, Japan	WESTRE	RW26
RJKA	Amami, Japan	AME1R	RW03
RJKA	Amami, Japan	AME1R	RW21
RJOB	Okayama, Japan	OKC2	RW07
RJOB	Okayama, Japan	OYE2R	RW07
RJOB	Okayama, Japan	WASYU1	RW07
RJOC	Izumo, Japan	OIE2	RW07
RJOC	Izumo, Japan	TRE4	RW07
RJOC	Izumo, Japan	XZE1R	RW07
RJOC	Izumo, Japan	XZE3E	RW07

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
RJOW	Iwami, Japan	IME1R	RW29
RJSA	Aomori, Japan	MRE1R	RW06
RJSA	Aomori, Japan	MRE1R	RW24
RJSF	Fukushima, Japan	GTC1	RW19
RJSF	Fukushima, Japan	SDE1	RW19
RJSF	Fukushima, Japan	YTE1	RW19
RJSY	Shonai, Japan	YSE1R	RW27
RJTH	Hachliojima, Japan	HCE1R	RW25
RJTH	Hachliojima, Japan	HCE2W	RW25
RJTO	Oshma, Japan	MJ1	RW21
RJTO	Oshma, Japan	SPENS2	RW03
RKJY	Yeosu, Korea	GOSB1A	RW17
RKJY	Yeosu, Korea	NIKE1A	RW17
ROAH	Naha, Japan	NHC2SR	RW18
RPMD	Davao/Francisco Bangoy, Phillipines	SID1B	RW23
RPMD	Davao/Francisco Bangoy, Phillipines	SID2	RW23
RPMD	Davao/Francisco Bangoy, Phillipines	SID3	RW23
RPMD	Davao/Francisco Bangoy, Phillipines	SID4	RW23
RPMZ	Zamboanga, Phillipines	SID1	RW09
RPMZ	Zamboanga, Phillipines	SID1	RW27
RPMZ	Zamboanga, Phillipines	SID2	RW09
RPMZ	Zamboanga, Phillipines	SID2	RW27
RPMZ	Zamboanga, Phillipines	SID7	RW09
RPMZ	Zamboanga, Phillipines	SID7	RW27
RPVM	Lapu-Lapu/Mactan, Phillipines	SID15	RW04
RPVM	Lapu-Lapu/Mactan, Phillipines	SID15A	RW04
RPVM	Lapu-Lapu/Mactan, Phillipines	SID16	RW04
SCFA	Antofagasta, Chile	ANCLA2	RW18

Table 1: Standard Instrument Departures

ICAO ID	Airport	Departure	Runway
SCFA	Antofagasta, Chile	ANCLA3	RW19
SCFA	Antofagasta, Chile	COLOSB	RW18
SCFA	Antofagasta, Chile	COLOSC	RW19
SCFA	Antofagasta, Chile	MOREK1	RW18
SCFA	Antofagasta, Chile	MOREK2	RW19
SCIE	Concepcion/Carriel, Chile	CORNL4	RW20
SCSE	La Serena/La Florida, Chile	LILEN1	RW29
SVCS	Charallave/Oscar Machado Zuoloaga, Venezuela	3NOL10	RW10
ZYTL	Dalian, China	D15T	RW28

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
CYDN	Dauphin, Manitoba, Canada	VOR14
CYXE	Saskatoon, Sask., Canada	VOR33
CYYB	North Bay, Ontario, Canada	VOR18
ENAT	Alta, Norway	ILS12
ENBO	Bodo, Norway	ILS08
ENKB	Kristiansund/Kvernberget, Norway	VOR25
FADN	Durban/Louis Botha, South Africa	VOR23
FYWH	Windhoek/Lughawe, Nambia	VOR26
GCRR	Arrecife/Lanzarote, Canary Is.	ILS04
KAHN	Athens/Ben Epps, GA	VOR02
KALW	Walla Walla, WA	VOR02
KBKE	Baker, OR	VOR12
KBLH	Blythe, CA	VOR26
KBOI	Boise, ID	VOR10R
KBOI	Boise, ID	ILS10R
KBPI	Big Piney/Marbleton, WY	VOR31
KCEC	Crescent City, CA	VOR11
KCEC	Crescent City, CA	ILS11
KCEC	Crescent City, CA	VOR11
KCMA	Camarillo, CA	VOR26
KCOE	Coeur D’alene, ID	VOR01
KCOE	Coeur D’alene, ID	ILS05
KDLF	Del Rio, TX	VOR13C
KDLF	Del Rio, TX	VOR31C
KDRO	Durango/La Plata Co., CO	VOR02
KDRO	Durango/La Plata Co., CO	ILS02
KEEO	Meeker, CO	RNV03
KFLG	Flagstaff, Puliam, AZ	VOR21

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
KGFK	Grand Forks, ND	VOR17R
KGFK	Grand Forks, ND	VOR35L
KHVR	Havre City-Co, MT	VOR07
KHYS	Hays, KS	VOR16
KHYS	Hays, KS	VOR34
KHYS	Hays, KS	VOR16
KHYS	Hays, KS	VOR34
KIGM	Kingman, AZ	VOR21
KJAC	Jackson Hole, WY	ILS18
KLMT	Klamath Falls, OR	VOR32
KLMT	Klamath Falls, OR	ILS32
KNGP	Corpus Christi, TX	VOR13R
KNQX	Key West, FL	VOR07
KONA	Winona Muni/Max Conrad, MN	VOR29
KOTH	North Bend Muni, OR	VOR04
KPMD	Palmdale, CA	VOR25
KPMD	Palmdale, CA	ILS25
KPNE	North Philadelphia, PA	VOR24
KPUC	Price/Carbon Co, UT	VOR36
KRWL	Rawlins Muni, WY	VOR22
KSBM	Sheboygan Co, WI	VOR03
KSBY	Salisbury/Wicomico Co., MD	ILS32
KSBY	Salisbury/Wicomico Co., MD	VOR14
KSBY	Salisbury/Wicomico Co., MD	VOR23
KSBY	Salisbury/Wicomico Co., MD	VOR32
KSVC	Silver City/Grant Co, NM	LOC26
KSVN	Savannah/Hunter, GA	VOR28
KTMA	Tifton, GA	VOR27
KTMA	Tifton, GA	VOR33

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
KTRM	Palm Springs Thermal, CA	VOR30
KTVF	Thief River Falls, MN	VOR31
KTWF	Twin Falls/Sun Valley, ID	VOR07
LEBL	Barcelona, Spain	VOR02
LEBL	Barcelona, Spain	ILS07
LGKO	Marathon/Kotroni, Greece	VOR15
LGKO	Marathon/Kotroni, Greece	VOR33
LIPE	Bologna/Borgo Panigale, Italy	VOR12
LIPE	Bologna/Borgo Panigale, Italy	ILS12
LTAQ	Samsun, Turkey	VOR21
MDBH	Barahona, Dominican Republic	VOR12
MDBH	Barahona, Dominican Republic	VOR30
MDPP	Puerto Plata, Dominican Republic	VOR26
MDSD	Santo Domingo/De Las Americas, Dominican Republic	VOR17
MDSD	Santo Domingo/De Las Americas, Dominican Republic	VOR35
MHTG	Tegucigalpa/Toncontin, Honduras	VOR01
MPDA	David/Enrique Malek, Panama	VOR04
MPTO	Panama/Tocumen, Panama	VOR03L
MUCU	Santiago de Cuba/Antonio Maceo, Cuba	ILS09
MUCU	Santiago de Cuba/Antonio Maceo, Cuba	LOC09
NCRG	Avarua/Rarotonga, Cook Is.	ILS08
NCRG	Avarua/Rarotonga, Cook Is.	ILS26
NSFA	Faleolo, Samoa	ILS08
NZNR	Napier, New Zealand	VOR16
OEBH	Bisha, Saudi Arabia	ILS18
OEDR	Dhahran, Saudi Arabia	VOR34L
OEDR	Dhahran, Saudi Arabia	ILS34L
OIBJ	Jam Tohid, Iran	VOR11

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
OIBJ	Jam Tohid, Iran	ILS11
OIFM	Esfahan, Iran	VOR26L
OIFM	Esfahan, Iran	VOR26R
PABI	Delta Junction, AK	VOR18
PAMC	McGrath, AK	VOR16
PAYA	Yakutat, AK	VOR11
PAYA	Yakutat, AK	VOR29
PHTO	Hilo, Hawaii	ILS26
RJBD	Nanki-Shirahama, Japan	VOR15
RJBD	Nanki-Shirahama, Japan	LOC15
RJCB	Obhiro, Japan	ILS35
RJCH	Hakodate, Japan	VOR12
RJCH	Hakodate, Japan	ILS12
RJCH	Hakodate, Japan	LOC12
RJCM	Memanbetsu, Japan	ILS18
RJDC	Yamaguchi-Ubi/Honshu Is., Japan	VOR07
RJDT	Tsushima, Japan	LOC32
RJDT	Tsushima, Japan	VOR32
RJFK	Kagoshima, Japan	VOR34
RJFK	Kagoshima, Japan	ILS34
RJKB	Okierabu, Japan	VOR22
RJKN	Tokunoshima Is., Japan	VOR01
RJNT	Toyama, Japan	LOC20
RJOB	Okayama, Japan	ILS07
RJOM	Matsuyama, Japan	ILS14
RJOR	Tottori, Japan	ILS10
RJOS	Tokushima, Japan	VOR29
RJSF	Fukushima, Japan	ILS01
RJSF	Fukushima, Japan	VOR01

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
RJSF	Fukushima, Japan	VOR19
RJSN	Nigata, Japan	VOR10
RJSN	Nigata, Japan	VOR28
RJSN	Nigata, Japan	ILS28
RJSY	Shonai, Japan	VOR27
RJSY	Shonai, Japan	VOR09
RKPK	Kimhae, Korea	VOR36
ROMY	Miyako, Japan	ILS22
ROMY	Miyako, Japan	VOR04
ROMY	Miyako, Japan	VOR22
RORY	Yoron, Japan	VOR14
RORY	Yoron, Japan	VOR32
RPLL	Manila, Phillipines	VOR06
RPLL	Manila, Phillipines	ILS06
RPMD	Davao/Francisco Bangoy, Phillipines	VOR23
RPMD	Davao/Francisco Bangoy, Phillipines	VOR05
RPVA	Tacloban/Daniel Z. Romualdez, Phillipines	VOR36
RPVB	Bacolod Negros Occidental, Phillipines	VOR04
SBFL	Florianopolis/Hercilioluz, Brazil	VOR32
SBUP	Castilho/Urubupunga, Brazil	VOR29
SLVR	Viru Viru, Bolivia	ILS33
SPIM	Lima-Callao, Peru	VOR33
TGPY	Point Salines, GranaVORa	VOR10
VAGO	Goa, India	VOR08
VOMM	Madras, India	VOR12
VOMM	Madras, India	VOR30
VTBU	Rayong/Utapao, Thailand	VOR18
VTSB	Surat Thani, Thailand	VOR22

Table 2: Approaches/Missed Approaches

ICAO ID	Airport	Approach
VTUW	Nakon Phanom, Thailand	VOR15
WAAU	Kendari/Wolter Monginsidi, Indonesia	VOR26
WAMM	Manado/Sam Ratulangi, India	ILS36
WAPP	Ambon/Patimura, Indonesia	ILS04
WRLL	Balikpapan/Sepinggan, Indonesia	ILS25
YMAY	Albury, Australia	VOR07
ZGNN	Nanning/Wuxu, China	VOR23

Administrative Information

This bulletin replaces bulletin ILF2-40(R2) dated April 1, 1999. Discard Bulletin ILF2-40(R2). Revise the Bulletin Record to show ILF2-40(R2) CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-40(R3) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-34A2672. If you do not plan to modify all your airplanes and would like the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 M/C 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-41(R5)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: CENTER WING TANK (CWT) OVERRIDE/JETTISON AND HORIZONTAL STABILIZER TANK TRANSFER/JETTISON PUMPS

Reason: To inform flight crews of possible fuel pump damage that could create a potential fuel vapor ignition source. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Previously, Boeing issued Alert Service Bulletin 747-28A2212 (May 14, 1998 Rev. 2) to inspect CWT override/jettison pump inlet adapters and inlet check valves. This was followed by FAA Airworthiness Directive 98-16-19. Until completion of the required inspection, flight crews were instructed to select the CWT override/jettison pumps OFF on airplanes with over 20,000 flight hours when CWT fuel decreased to 7,000 pounds (3,200 kilograms).

Boeing recently received reports from two 747-400 operators regarding low-time removal of override/jettison pump motor/impeller assemblies installed in main tanks 2 and 3, and center wing tanks, due to low fuel pressure indications. To date, Boeing has received reports of twelve low-time removals of override/jettison pumps, all of which had accumulated less than 700 airplane flight hours. Visual inspection of the removed pumps revealed damage to the inducer and impeller, with related score marks on the inner diameter of the inlet adapter. This sustained metal-to-metal contact is a possible ignition source. Testing by the pump manufacturer, Hydro-Aire, did not result in ignition. The FAA has issued Airworthiness Directive T98-25-52.

The following procedures apply to pumps manufactured, overhauled, or repaired between July 1996 and November 1998. Operators can determine specific airplane applicability through methods published in FAA letter 98-140S-440, “Approval of Alternative Method of Compliance with Airworthiness Directive T98-25-52”, and respective Service Bulletins.

If CWT override/jettison pumps are to be used for flight, the center wing tank must contain at least 17,000 pounds (7,720 kilograms) prior to engine start. This ensures both CWT override/jettison pumps remain covered during rapid acceleration and high nose attitudes during takeoff and climb.

If CWT fuel is less than 50,000 pounds (22,700 kilograms) prior to engine start, the flight crew should select the CWT override/jettison pumps OFF when fuel in the center wing tank reaches 7,000 pounds (3200 kilograms). This ensures a potentially damaged pump remains covered by fuel, and is not exposed to fuel vapors during climb. The flight crew may select the CWT fuel pumps ON when stabilized in cruise, then select the CWT fuel pumps OFF when CWT fuel reaches 3,000 pounds (1,360 kilograms).

Airplanes with electric CWT scavenge pumps will scavenge some or all of the remaining 7,000 pounds (3,200 kilograms) of fuel. However, this scavenging will not occur until the reserve tanks begin to transfer. Based on a minimum scavenge flow rate of 1,700 pounds per hour, approximately 3,400 pounds (1,540 kilograms) of fuel will be scavenged within the two hour scavenge pump activation cycle. The remaining 3,600 pounds (1,630 kilograms) is unusable. The scavenge flow rate is a function of several variables (pump efficiency, discharge pressure, etc.). On some airplanes, the majority of the 7,000 pounds (3,200 kilograms) of CWT fuel may be scavenged within the two hours. Operator experience may provide different values for scavenged and unusable fuel.

All of the remaining 7,000 pounds (3,200 kilograms) of CWT fuel is unusable in airplanes with CWT jet scavenge pumps. However, in a low fuel situation, the CWT fuel pumps may be selected ON and all CWT fuel used.

If CWT fuel is greater than or equal to 50,000 pounds (22,700 kilograms) prior to engine start, the crew should select the CWT override/jettison pumps OFF when CWT fuel reaches 3,000 pounds (1,360 kilograms). Increased CWT fuel ensures both CWT override/jettison pumps remain covered during rapid acceleration and high nose attitudes during takeoff and climb. Under these conditions, CWT pump shutoff is not required until the cruise phase of flight.

On airplanes with the electric CWT scavenge pump, all of the remaining 3,000 pounds (1,360 kilograms) of fuel will be scavenged and can be considered usable fuel.

On airplanes with jet scavenge pumps, some or all of the remaining fuel may not scavenge. With 3,000 pounds (1,360 kilograms) of fuel remaining in the center wing tank, it is likely the jet scavenge pumps will activate, but not until later in the flight when there may not be sufficient time to scavenge all remaining fuel. It will take approximately 2 hours to scavenge 3000 pounds (1,360 kilograms) of fuel. Initially, the 3000 pounds of fuel should be considered unusable. Operator experience may provide a different value of unusable fuel.

In the above cases, the 7,000 pounds (3,200 kilograms) or 3,000 pounds (1,360 kilograms) of CWT fuel would normally be considered as "fuel in lieu of payload" as described in the Weight and Balance Manual, Section 1-22-01. Boeing has reviewed the certification conditions for the 747-400 and determined for AD T98-25-52 only, CWT fuel up to 7,000 pounds (3,200 kilograms) need not be considered as fuel in lieu of payload.

Boeing Service Bulletin 747-28-2226 (December 22, 1998) provides an alternate means of compliance that allows use of the CWT override/jettison pumps after specified inspections/repairs. With the incorporation of this Service Bulletin, the CWT override/jettison pumps may be used normally.

These pumps are also used in the horizontal stabilizer tanks. Selecting the stabilizer tank pumps OFF with fuel remaining in the stabilizer tank results in unacceptable display of the EICAS caution message FUEL STAB XFR and violates the certified structural loads analysis. Therefore, fueling and use of the horizontal stabilizer tank is prohibited.

The FAA has approved an alternate means of compliance with AD T98-25-52 through inspection procedures contained in Boeing Service Bulletin 747-28-2225 (December 22, 1998 Rev 2). Upon completion of the required inspections/repairs, horizontal stabilizer fuel pumps may be used normally.

Pump damage may be accompanied by tripped fuel pump circuit breakers. Therefore, a tripped CWT fuel pump or horizontal stabilizer pump circuit breaker should not be reset.

Operating Instructions

Fueling and use of the horizontal stabilizer tank is prohibited until inspections/repairs required by SB 747-28-2225 have been accomplished.

The following CWT restrictions apply until inspections/repairs required by Service Bulletin 747-28-2226 have been accomplished:

If the CWT override/jettison pumps are required for flight, the center wing tank must contain a minimum of 17,000 pounds (7,700 kilograms) prior to engine start.

If CWT fuel is less than 50,000 pounds (22,700 kilograms) prior to engine start, select both CWT override/jettison pumps OFF at the first occurrence of any of the following:

- at or before CWT fuel reaches 7,000 pounds (3,200 kilograms), or
- when either CWT fuel pump low pressure light illuminates with CWT fuel below 7,000 pounds (3,200 kilograms); FUEL OVRD CTR L & R EICAS messages may be displayed, or
- when either FUEL OVRD CTR L or R EICAS message displays with CWT fuel below 7,000 pounds (3,200 kilograms).

The flight crew may select the CWT Override/Jettison pumps ON in stabilized cruise, then select them OFF when CWT fuel reaches 3,000 pounds (1,360 kilograms).

If CWT fuel is greater than or equal to 50,000 pounds (22,700 kilograms) prior to engine start, select both CWT override/jettison pumps OFF at the first occurrence of any of the following:

- at or before CWT fuel reaches 3,000 pounds (1,360 kilograms), or
- when either center tank fuel pump low pressure light illuminates with CWT fuel below 3,000 pounds (1,360 kilograms); FUEL OVRD CTR L & R EICAS messages may be displayed, or
- when either FUEL OVRD CTR L or R EICAS message displays with CWT fuel below 3,000 pounds (1,360 kilograms).

WARNING: Do not reset a tripped CWT override/jettison or horizontal stabilizer transfer/jettison pump circuit breaker.

NOTE:

- The CWT fuel quantity indication system must be operative to dispatch with CWT mission fuel.
- The center wing tank may be emptied during emergency fuel jettison.
- In a low fuel situation, both CWT pumps may be selected ON and all CWT fuel used.

Upon completion of the three Service Bulletins specified in this Operations Manual Bulletin, CWT override/jettison and horizontal stabilizer transfer/jettison pumps may be used normally.

Administrative Information

Insert this bulletin behind the Bulletin Record Page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-41(R5) IN EFFECT (IE).

This Operations Manual bulletin will be revised based on Service Bulletin completion reported by the operator. This bulletin will be cancelled after Boeing is notified all affected airplanes in an operator’s fleet have been inspected/repaired as prescribed in the following Service Bulletins:

- 747-28A2212 (Rev 2)
- 747-28-2225 (Rev2)
- 747-28-2226.

Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 MS 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company **Seattle, Washington 98124-2207**	747-400

Number: ILF2-42(R1)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: EICAS ADVISORY MESSAGE “NO AUTOLAND”

Reason: To inform flight crews of the possible loss of all autopilot capability if the EICAS advisory message NO AUTOLAND displays. Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An anomaly in the flight control system can cause simultaneous failure of both Stab Trim/Rudder Ratio Modules (SRMs). This condition displays the EICAS advisory message NO AUTOLAND, which is inhibited on the ground until engine start. With a failure of both SRMs, the autopilots cannot be engaged.

Operating Instructions

If the NO AUTOLAND message displays after engine start and prior to takeoff, contact maintenance to determine autopilot capability.

WARNING: If maintenance action involves engaging an autopilot on the ground to test autopilot capability, ensure the autopilot is disengaged before taxi.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-42(R1) IN EFFECT (IE).

This condition is temporary until the system is modified. This bulletin will be revised to include Service Bulletin information when available.

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 MS 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-43(R2)

Date: April 1, 2001

Document Effectivity: D6-30151-425

Subject: FMC ALERT MESSAGE “ENTER IRS POSITION”

Reason: To inform flight crews the FMC Alert Message ENTER IRS POSITION may not display when an incorrect present position is entered for IRS alignment. Revised to add Service Bulletin information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The FMC Alert Message ENTER IRS POSITION indicates the flight crew-entered present position did not pass an IRS comparison check, or the IRS is ready to enter the navigation mode and a present position has not been entered. Operators have reported isolated incidents of IRS alignment without display of the ENTER IRS POSITION message when an incorrect present position has been entered during preflight. As a result, airplanes have inadvertently dispatched with unreliable IRS position information. Engineering analysis indicates the anomaly is the result of a timing problem between the FMCs.

The TO/GA update (GPS not available) during takeoff does not correct the error. If the error is sufficiently large, FMC radio position updating will be locked out in flight. GPS position updating (if available) will function and slowly correct the position error at a rate of 4 NM per minute. In addition, large initial position errors can cause IRS magnetic variation errors affecting the accuracy of magnetic heading and track. Excessive magnetic track errors can cause AFDS localizer mode failure and subsequent inhibiting of automatic approaches. Complete correction of the FMC/IRS position error requires landing and full realignment in the navigation mode.

The flight crew can detect a large FMC position error by comparing relative positions of the airplane and runway symbols on the ND. On the POS REF page, individual IRS positions should be compared to the required alignment position (gate coordinates, etc.). If an initial position error is discovered before takeoff, a fast alignment with a correct position entry may not resolve the problem. A full alignment must be accomplished by rotating the IRS Mode Selectors to OFF, then to NAV, and entering the correct present position in the SET IRS POSITION line on the POS INIT page.

Also, due to an unrelated anomaly, the use of LAST POS for IRS alignment has not always resulted in correct IRS alignment. If the last positions stored in the FMCs differ, using either for IRS alignment may result in an incorrect alignment position.

Operating Instructions

This bulletin does not apply to airplanes modified by Service Bulletin 747-34A2672 (FMC software load 15).

During PREFLIGHT PROCEDURE - FIRST OFFICER:

after the GMT check, select the POS REF page and verify L, C, and R IRS position coordinates are correct.

If an incorrect initial position is discovered in flight, the situation cannot be corrected without full IRS realignment on the ground.

Operations Manual Information

The PREFLIGHT PROCEDURE - FIRST OFFICER has been revised to reflect the Operating Instructions of this bulletin.

Administrative Information

This bulletin replaces bulletin ILF2-43(R1) dated April 1, 1999. Discard Bulletin ILF2-43(R1). Revise the Bulletin Record to show ILF2-43(R1) CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-43(R2) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-34A2672. If you do not plan to modify all your airplanes and would like the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address: Manager, Flight Technical Publications (747-400)
Boeing Commercial Airplane Group
P.O. Box 3707 M/C 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-44(R1)

Date: April 1, 1999

Document Effectivity: D6-30151-425

Subject: FMC TAKEOFF SPEEDS ANOMALY

Reason: To inform flight crews of an FMC anomaly affecting takeoff speeds.
Revised for administrative purposes.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received reports of the left and right FMS-CDUs and/or PFDs displaying different takeoff speeds. In one instance the FMS-CDUs displayed the following:

	LEFT FMS-CDU	RIGHT FMS-CDU
V1	150 (small font)	150 (large font)
VR	150 (large font)	164 (large font)
V2	164 (large font)	177 (large font).

In another instance, the incorrect VR speed on an FMS-CDU was the same as the V1 speed on one PFD, while the other PFD displayed all speeds correctly. In other instances, FMS-CDUs displayed erroneous speeds, but all speeds were displayed correctly on both PFD's.

Boeing is investigating this anomaly. However, it is not yet known whether the takeoff speeds are calculated differently (small font), or the speeds change when selected (large font). Therefore, Boeing recommends when selecting takeoff speeds during the BEFORE START PROCEDURE, flight crews compare the captain's and first officer's takeoff speeds.

Operating Instructions

Before and after selecting takeoff speeds during the BEFORE START PROCEDURE, compare the captain's and first officer's takeoff speeds. If any speed is incorrect, manually enter and select the correct speed and compare the displayed values.

If this anomaly is observed, advise maintenance so FMC ACMS data can be forwarded to Boeing for analysis.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Operations Manual. Amend the Bulletin Record to show bulletin ILF2-44(R1) IN EFFECT (IE).

This condition is under investigation. This bulletin remains in effect until further notice.

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 MS 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-45(R1)

Date: April 1, 2001

Document Effectivity: D6-30151-425

Subject: REQUIRED TIME OF ARRIVAL (RTA) FUNCTION ANOMALY

Reason: To inform flight crews of an FMC anomaly resulting from data link entry of an RTA clearance. Revised to add Service Bulletin information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There has been one reported occurrence of FMCs failing to display the FIX (1L) on the RTA PROGRESS Page 3/3 after the flight crew loaded an RTA clearance from an ATC data link message. The RTA (1R) displayed and the EXEC light illuminated, however both FMCs subsequently restarted with loss of performance data and the active flight plan.

Operating Instructions

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-34A2672 (FMC software load 15).

To prevent occurrence of the RTA function anomaly, manually enter all RTA data. If the system does not accept and display FIX data, revert to non-RTA procedures and inform Air Traffic Control.

Administrative Information

This bulletin replaces bulletin ILF2-45 dated March 12, 1999. Discard Bulletin ILF2-45. Revise the Bulletin Record to show ILF2-45 CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-45(R1) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-34A2672. If you do not plan to modify all your airplanes and would like the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

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Boeing Commercial Airplane Group
P.O. Box 3707 M/C 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-47(R2)

Date: April 1, 2001

Document Effectivity: D6-30151-425

Subject: FMC ARRIVAL WAYPOINT SEQUENCE ANOMALY

Reason: To inform flight crews of an FMC software anomaly associated with duplicate route waypoints. Revised to add Service Bulletin information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

A software anomaly may cause both FMCs to reset and eventually fail while adding or modifying the arrival portion of the route. The anomaly may occur when flight plan arrival modifications duplicate a waypoint in the active route. The duplicate waypoints may be separated by a route discontinuity or may appear with other waypoints between them. This anomaly most frequently occurs if the second duplicate waypoint has an “at or above” altitude constraint, and one (or more) waypoint on the legs page prior to the first occurrence also has a descent altitude constraint. When the downtrack duplicate waypoint is selected to the scratchpad and then entered in the discontinuity boxes (or after the first occurrence of the waypoint), the FMC flight planning function may not identify the second occurrence of the waypoint and subsequently reset. The FMCs may reset alternately until one or both fail, or the modification is rejected. The FMC alert message RESYNCING OTHER FMC and/or the FMC advisory message TIME OUT - RESELECT may be observed.

Laboratory and incident analyses show up to eight minutes may elapse after the flight crew modifies the route and the effects of the anomaly become apparent. During this time the FMCs function normally. Once the anomaly is apparent, for example FMC messages appear or CDU pages disappear, it takes between 30 and 70 seconds for the resets to complete.

Note: While the FMCs are undergoing reset and resynchronization, any modifications or selections on either CDU will prolong the reset and resynchronization period. During one reported incident, reset/resynchronization exceeded eight minutes due to repeated flight crew CDU keystroke selections.

While the FMCs are undergoing reset and resynchronization, the ND MAP display blanks. The ND VOR and ND APP modes are still available. The navigation radios will remain on the same frequencies as before the FMC reset began.

Operating Instructions

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-34A2672 (FMC Software load 15).

1. A route discontinuity frequently results when adding or modifying the arrival portion of the flight plan. Should the modified route contain a waypoint that already exists in the active route, do not close a discontinuity by placing the downtrack duplicate waypoint in the discontinuity boxes, or in the waypoint sequence immediately after the first occurrence of the duplicate. Instead, close the discontinuity by entering the downtrack duplicate on top of the first occurrence of the waypoint.

Note: if the first occurrence of the waypoint is the active waypoint, the anomaly will not occur.

2. If the anomaly is experienced (duplicate waypoint not discovered prior to execution of the modification), the FMCs may reset several times. Three outcomes are possible:

A. Both FMCs may reset several times and recover with an inactive route and no performance data. Reenter performance data and the route. Begin by reentering origin and destination. This sequence is very important -- do not activate and execute the inactive route. If the inactive route is simply activated and executed, the FMCs will again reset and may fail. When reentering the route, follow the steps in paragraph one above for a route discontinuity.

B. Both FMCs may reset several times and recover with no flight plan data. Reenter performance data and the route. When reentering the route, follow the steps in paragraph one above for a route discontinuity.

C. Both FMCs may reset several times and fail. If the EICAS alert messages FMC LEFT and/or FMC RIGHT display, accomplish the FMC LEFT, RIGHT non-normal checklist.

Note: While the FMCs are undergoing reset and resynchronization, do not attempt any modifications or selections on either CDU. This will prolong the reset/resynchronization process.

Administrative Information

This bulletin replaces bulletin ILF2-47(R1) dated October 29, 1999. Discard Bulletin ILF2-47(R1). Revise the Bulletin Record to show ILF2-47(R1) CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-47(R2) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-34A2672. If you do not plan to modify all your airplanes and would like the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address:	Manager, Flight Technical Publications (747-400) Boeing Commercial Airplane Group P.O. Box 3707 M/C 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-48(R1)

Date: April 1, 2001

Document Effectivity: D6-30151-425

Subject: VNAV ALTITUDE CAPTURE ANOMALY

Reason: To inform flight crews the airplane may pitch over during VNAV cruise altitude capture at high altitude. Revised to add Service Bulletin information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received several in-service reports of an anomaly that may occur during VNAV cruise altitude capture following VNAV climb. If the FMC cruise altitude is near the FMC maximum altitude, and airplane climb speed is slightly below FMC command speed when cruise altitude capture occurs, the airplane may pitch over and descend attempting to accelerate to FMC command airspeed. Thrust reduction may occur during the descent.

Operating Instructions

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-34A2672 (FMC software load 15).

If this anomaly occurs, disengage the autopilot, disconnect the autothrottle, and level the airplane at cruise altitude. Once established at cruise altitude with the AFDS pitch mode VNAV PTH active, the autopilot may be reengaged and autothrottle reactivated.

Administrative Information

This bulletin replaces bulletin ILF2-48 dated January 14, 2000. Discard Bulletin ILF2-48. Revise the Bulletin Record to show ILF2-48 CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-48(R1) IN EFFECT (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-34A2672. If you do not plan to modify all your airplanes and would like the contents of this bulletin incorporated in your Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

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Boeing Commercial Airplane Group
P.O. Box 3707 M/C 20-89
Seattle, WA 98124-2207
USA

Fax: (206) 662-7812
Telex: 32-9430 Station 627
SITA: SEABO7X

CS3 2786

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-49

Date: July 5, 2000

Document Effectivity: D6-30151-425

Subject: ENGINE BLEED AIR SHUTOFF ANOMALY

Reason: To inform flight crews a system fault can result in the shutoff of all engine bleed air.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An operator recently reported shutoff of bleed air from all engines during flight. Investigation revealed a single fault in the Air Supply Control Test Unit (ASCTU) can result in closure of all engine bleed air valves and illumination of all Engine Bleed Air OFF lights. In the reported incident the fault was intermittent. When the fault was removed, low-pressure bleed air became available and all Engine Bleed Air OFF lights extinguished. Cycling the Engine Bleed Air Switches recovered normal engine bleed air.

With this fault the BLEED 1, 2, 3 and 4 messages do not display. With bleed air shut off to all using systems, the following indications will be observed:

- air conditioning packs shut down andPACK 1,PACK 2, andPACK 3 messages display (pressurization is gradually lost)
- air driven hydraulic pumps (ADPs) will be unpowered and respective HYD PRESS DEM messages display when ADPs are commanded to run
- when flaps are selected, leading and trailing edge flaps operate in the secondary mode (the FLAPS PRIMARY message displays)
- wing and nacelle anti-ice systems are inoperative
- thrust reversers are inoperative
- The >TRIM AIR OFF message displays.

Depending upon environmental conditions, cabin and flight deck temperatures can rise quickly. If necessary, remove as many sources of heat as possible by:

- turning off all in-flight entertainment systems
- turning off all galleys
- closing all window shades to block sunlight.

After descent to safe altitude, increase airflow throughout the airplane by:

- opening both outflow valves
- opening the smoke evacuation port
- if heat becomes excessive, opening a cabin door 1 and a cabin door 5.

The PACK 1, 2, 3 non-normal checklist has been revised to accommodate the conditions of this anomaly.

Operating Instructions

If the EICAS messages PACK 1, PACK 2, and PACK 3 display simultaneously, accomplish the revised PACK 1, 2, 3 non-normal checklist.

Operations Manual Information

The attached pages replace an entire Non-Normal Checklist section of your QRH. The List of Effective Pages and Non-normal Checklists Index will be updated in a future revision.

Remove Section 2 of Chapter NNC from your QRH and replace it with the attached pages.

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-49 “In Effect” (IE).

This condition is under investigation. This bulletin remains in effect until further notice.

CS3 2911

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Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-50(R1)

Date: March 15, 2001

Document Effectivity: D6-30151-425

Subject: TRIPLE FLAP CONTROL UNIT (FCU) FAILURE

Reason: To inform flight crews of the effects of failure of all three FCUs. Bulletin revised to provide additional information and forward a revised FLAPS CONTROL non-normal checklist.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An operator recently experienced in-flight failure of all three FCUs. Engineering investigation has revealed intermittent failure of a leading edge flap position sensing switch can result in failure of all three FCUs with the following indications:

- the EICAS caution message FLAPS CONTROL displays
- primary and secondary flap control and position indication displays are inoperative
- the alternate control mode remains operative, however the expanded flap position indication does not display.

Additionally, the following other systems are affected:

- autopilots are inoperative
- flight director command bars may not display on the PFD
- flap maneuvering speeds do not display on the PFD
- outboard ailerons unlock
- engine idle is limited to approach idle
- stick shaker (stall warning) margins are reduced due to reversion to a simplified maneuvering schedule

- GPWS warning “TOO LOW FLAPS” occurs at low altitude unless the Ground Proximity Flap Override switch is selected to OVRD.

The FLAPS CONTROL non-normal checklist has been revised to accommodate the additional information provided in this bulletin.

Operating Instructions

If the EICAS message FLAPS CONTROL displays, accomplish the revised FLAPS CONTROL non-normal checklist.

NOTE: the 20 knot crosswind limit for landing has been removed from the revised checklist.

Operations Manual Information

The attached pages replace pages in Chapter NNC of your QRH. The List of Effective Pages will be updated in a future revision.

Remove and replace pages in your QRH as follows:

Remove Page No.	Date	Insert Page No.	Date
NNC.9.1	November 15, 2000	NNC.9.1	November 15, 2000
NNC.9.2	November 15, 2000	NNC.9.2	March 15, 2001

Administrative Information

This bulletin replaces bulletin ILF2-50 dated November 15, 2000. Discard Bulletin ILF2-50. Revise the Bulletin Record to show ILF2-50 CANCELLED (CANC).

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-50(R1) “Incorporated” (INC).

This condition is temporary until the system is modified. This bulletin will be revised to include Service Bulletin information when available.

CS3 2944

Operations Manual Bulletin
for
International Lease Finance Corp.

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: ILF2-51

Date: December 19, 2000

Document Effectivity: D6-30151-425

Subject: INCORRECT MANEUVERING SPEEDS FOR FLAP RETRACTION

Reason: To inform flight crews of a revision to normal procedures to prevent takeoff with incorrect flap maneuvering speeds displayed on the PFD.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An operator recently reported a flight crew experienced stick shaker during flap retraction after takeoff. Engineering investigation shows flaps were retracted below the airspeed required for the airplane gross weight due to erroneous flap maneuvering speeds displayed on the PFD. The erroneous speeds resulted from an incorrect speed entry in the FLAP/SPEED line on the CDU APPROACH REF Page.

Displayed flap maneuvering speeds for takeoff are normally based on current airplane gross weight. However, when a speed has been entered in the FLAP/SPEED line (4R) on the APPROACH REF Page, the flap maneuvering speeds are based on that speed regardless of actual airplane gross weight. In normal operation, the entry made for approach on the previous flight is cleared when engines are shut down after landing and the FLAP/SPEED line remains blank for takeoff. If an entry is made in the FLAP/SPEED line prior to takeoff (for example, training on the CDU prior to preflight) and the entry is not deleted, the displayed flap maneuvering speeds will be based on that entry. The range of valid entries in the FLAP/SPEED line may be outside the normal operating parameters for existing airplane weight. Since the APPROACH REF page is not normally checked during preflight, an entry in the FLAP/SPEED line may go undetected by the flight crew and result in display of incorrect flap maneuvering speeds.

The amber minimum maneuvering speed display and pitch limit indicator are not affected by a speed entry in the FLAP/SPEED line and continue to provide valid data. While the AFDS is designed to prevent slowing into the amber minimum maneuvering speed band, when flaps are retracted early the AFDS may not react quickly enough to prevent stick shaker activation.

Operating Instructions

During preflight, verify the FLAP/SPEED line on the CDU APPROACH REF Page is blank. Refer to the revised Preflight Procedures provided with this bulletin.

Operations Manual Information

The attached pages replace an entire Normal Procedures section in your Operations Manual. The List of Effective Pages will be updated in a future revision.

Remove Section 20 of Chapter NP from Volume 1 of your Operations Manual and replace it with the attached pages.

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin ILF2-51 “In Effect” (IE).

This condition is under investigation. This bulletin remains in effect until further notice.

CS3 2962

Limitations — Chapter L

Table of Contents — Section 0

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General

This chapter contains Airplane Flight Manual (AFM) limitations and Boeing recommended non-AFM operating limitations. Boeing recommended limitations are provided for flight crew information. Limitations that are obvious, shown on displays or placards, or incorporated within an operating procedure are not contained in this chapter.

Airplane General

Operational Limitations

Runway slope	+/- 2%
Maximum Takeoff and Landing Tailwind Component	15 knots
Maximum Operating Altitude	45,100 feet pressure altitude
Maximum Takeoff and Landing Altitude	10,000 feet pressure altitude
Maximum speed operating in Reduced Vertical Separation Minimum (RVSM) Airspace	0.90 Mach
QFE Operations	Prohibited

Non–AFM Operational Information

The turbulent air penetration speed is 290 to 310 KIAS/.82 to .85M.

The maximum takeoff and landing crosswind is 30 knots (not limiting).

Do not operate HF radios or weather radar during refueling operations.

Altitude Display Limits for RVSM Operations

Standby altimeters do not meet altimeter accuracy requirements of RVSM airspace.

The maximum allowable in-flight difference between Captain and First Officer altitude displays for RVSM operations is 200 feet.

The maximum allowable on-the-ground altitude display differences for RVSM operations are:

Field Elevation	Max Difference Between Captain & F/O	Max Difference Between Captain or F/O & Field Elevation
Sea Level to 5,000 feet	35 feet	75 feet
10,000 feet	40 feet	75 feet

Weight Limitations

Weights	Kilograms
Maximum Taxi Weight	397,800
Maximum Takeoff Weight	396,893
Maximum Landing Weight	285,763
Maximum Zero Fuel Weight	246,073

Door Mounted Power Assists and Escape Slides

Main and upper deck door emergency power assists and evacuation slide systems must be armed with the mode select lever in the AUTOMATIC position prior to taxi, takeoff, and landing whenever passengers are carried in the respective area.

Air Systems

Cabin Pressurization

Maximum differential pressure (relief valves)	9.4 psi
Maximum allowable cabin pressure differential for takeoff and landing	0.11 psi

Autoflight

Autopilot/Flight Director System

The autopilot must not be engaged below a minimum engage altitude of 250 feet after takeoff.

The autopilot must be disengaged before the airplane descends more than 50 feet below the MDA unless it is coupled to an ILS glideslope and localizer or in the go–around mode.

For single channel ILS approaches, the autopilot must be disengaged before the airplane descends below 100 feet AGL.

Use of aileron trim with the autopilot engaged is prohibited.

Automatic Landing

Maximum allowable wind speeds when landing weather minima are predicated on autoland operations:

Headwind	25 knots
Tailwind	15 knots
Crosswind	25 knots

The maximum glideslope angle is 3.25 degrees.

The minimum glideslope angle is 2.5 degrees.

Automatic landings may be made with flaps 25 or 30 only.

Communications

VHF Radios

With an operational ACARS system, the use of center VHF radio is not approved for ATC voice communications.

Engines, APU

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

Engine Fuel System

The maximum fuel temperature for Jet A, Jet A–1, JP–5, or JP-8 is 54°C (130°F).

The use of Jet B and JP-4 fuels is prohibited.

Engine Ignition

Continuous ignition must be on encountering:

- heavy rain
- severe turbulence
- volcanic ash
- icing conditions
- standing water or slush on runway

Note: Continuous ignition is automatically provided when nacelle anti–ice is on.

Reverse Thrust

Intentional selection of reverse thrust in flight is prohibited.

Backing the airplane with use of reverse thrust is prohibited.

Non–AFM Operational Information

Do not start or shut down APU during refueling operations.

Airplane Structure

Flap Operation

Do not extend flaps above 20,000 feet.

Non-AFM Operational Information

Use of speed brakes in flight with flaps extended past 20 is not recommended.

Ground wind limits for all doors:

- 40 knots while opening or closing
- 65 knots while open

Warning Systems

TCAS

Pilots are authorized to deviate from their current ATC clearance to the extent necessary to comply with a TCAS II resolution advisory (RA).

Normal Procedures — Chapter NP

Table of Contents — Section 0

General

This chapter contains Normal Procedures. It incorporates routine normal procedures and associated flight patterns.

Controls and Indicators – Nomenclature

Controls and indications appear in all UPPERCASE type to correspond to the words on the control panel or display. For example, the following item has UPPERCASE words to match what is found on the panel:

PASSENGER OXYGEN switch .... NORM (guarded position)

The word PASSENGER is spelled out, even though it is abbreviated on the panel.

The following appears in all lower case because there are no words identifying the panel name:

Fuel panel .... Set

Normal Procedures

Normal procedures are used by the trained flight crew to ensure airplane condition is acceptable and the flight deck is correctly configured for each phase of flight. These procedures assume all systems are operating normally and automated features are fully used.

Procedures are performed from recall and follow a panel flow. These procedures are designed to minimize crew workload and are consistent with flight deck technology. If the correct indication is not observed during accomplishment of procedures, verify controls are positioned correctly. If necessary, check the appropriate circuit breaker(s) and test the related system light(s).

Before engine start, lights or indications verify systems' condition or configuration. Review EICAS alert messages and status display before engine start to determine if messages are displayed which may affect dispatch and require maintenance action or compliance with the Minimum Equipment List (MEL).

After engine start, it is not necessary to check status messages as any message having an adverse effect on safe continuation of the flight, and requiring crew attention, will appear as an EICAS alert message (warning, caution, or advisory).

EICAS alert messages are the primary means of alerting the flight crew to non–normal conditions or improper configuration. During engine start and prior to takeoff, any alert message requires accomplishment of the appropriate non–normal procedure. Upon completion of the procedure and prior to takeoff, the Dispatch Deviations Guide (DDG) should be consulted to determine if MEL relief is available.

Note: The EICAS advisory message TCAS OFF is displayed until TA/RA is selected just prior to takeoff.

Exterior lighting, flight deck lighting, and personal comfort items (such as shoulder heaters) are systems assumed to have obvious procedural requirements and are not addressed in this section.

Flight crew duties are organized in accordance with an area of responsibility concept. Each crewmember is assigned a flight deck area where the crewmember initiates actions for required procedures. The panel illustrations in this section describe each crewmember's area of responsibility for pre/post flight and phase–of–flight.

Pre/post flight duties are apportioned between the captain and first officer, while phase–of–flight duties are apportioned between the pilot flying (PF) and pilot not flying (PNF). A normal panel flow is encouraged; however, certain items may be handled in the most logical sequence for existing conditions. Actions outside the crewmember's area of responsibility are initiated at the direction of the captain. General phase–of–flight responsibilities are as follows:

Pilot flying:

- flight path and airspeed control
- airplane configuration
- navigation

Pilot not flying:

- checklist reading
- communications
- tasks requested by PF
- fuel control and fire switches (with PF concurrence)

Phase–of–flight duties, beginning when the airplane starts moving under its own power and ending when parked at the gate, are presented in table form in the appropriate procedures section.

The first officer, when flying the airplane, performs the duties listed under pilot flying and the captain performs those duties listed under pilot not flying.

Note: Although the mode control panel is designated as the pilot flying’s responsibility, the pilot not flying should operate the controls on the mode control panel at the direction of the pilot flying when the airplane is being flown manually.

The captain retains final authority for all actions directed and performed.

Autopilot Flight Director System and Flight Management System Monitoring

When the autopilot, flight director, or autothrottles are in use and a mode change is selected or is scheduled to occur, the annunciation must be verified on the primary flight display (PFD). Airplane course, vertical path, and speed must always be monitored.

Similarly, when a thrust reference mode change is selected or is scheduled to occur, the annunciation must be verified on the EICAS display.

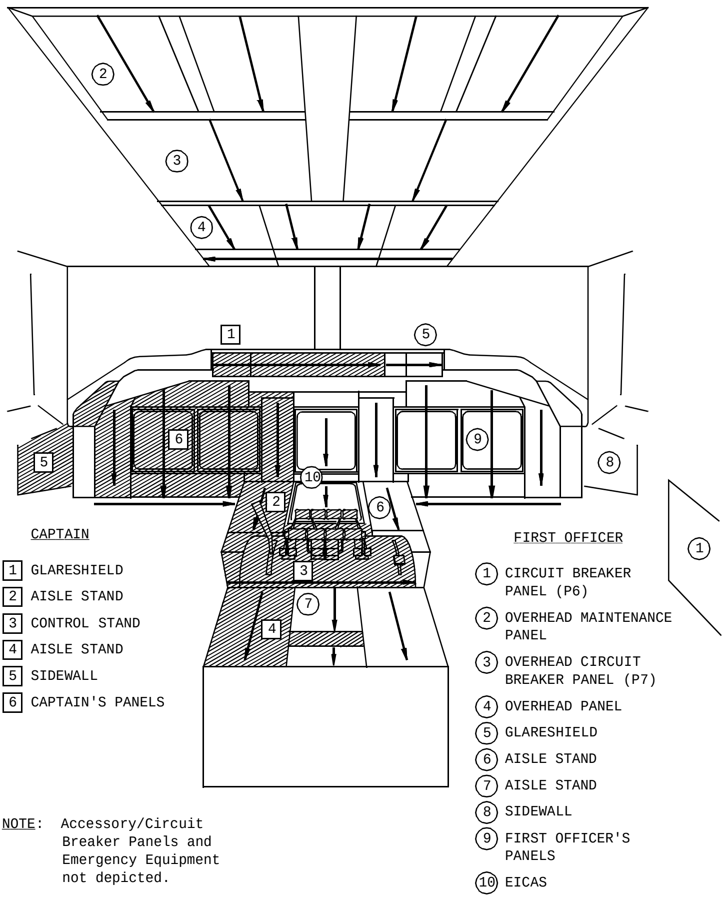
In LNAV and VNAV, all airplane course, vertical path, thrust, and speed changes must be verified.

CDU Operation

On the ground, the control display unit (CDU) manipulations are normally performed by the first officer and verified by the captain.

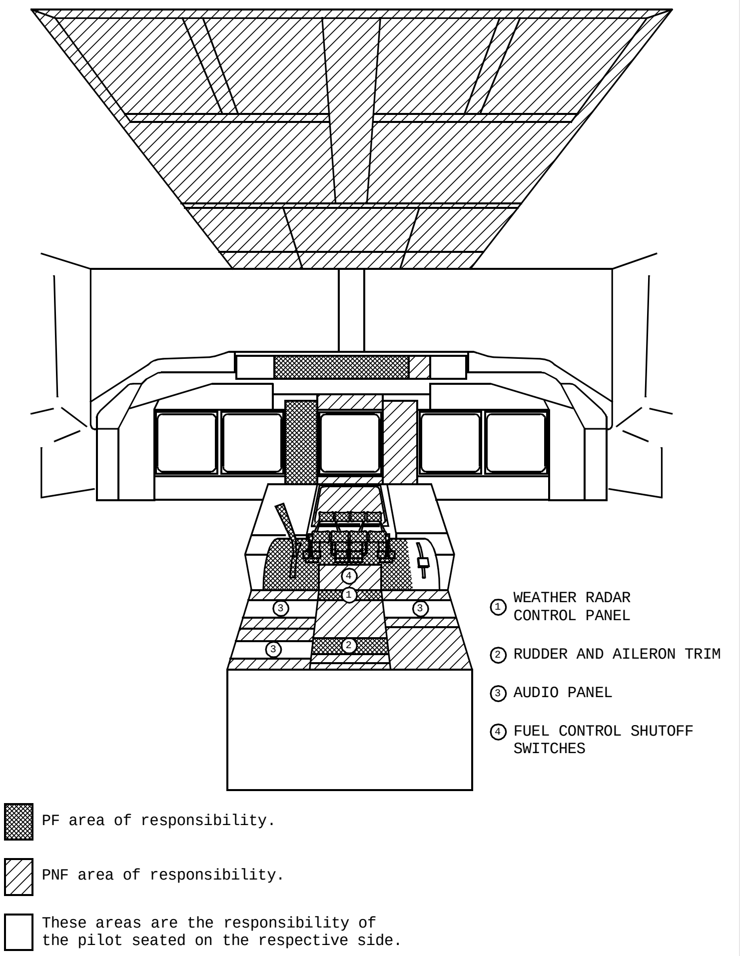
In flight, CDU entries are accomplished by the pilot not flying and verified by the pilot flying prior to execution. CDU manipulations should be accomplished prior to high workload periods such as departure, arrival, or holding. During high workload periods, using autopilot modes such as heading select, flight level change, and the altitude and speed intervention features, along with the ND map switches, may be more efficient than entering complex route modifications into the CDU.

Preflight and Postflight Areas of Responsibility and Panel Flow



LEGEND: Shaded area defines captain's area of responsibility.
Unshaded area defines first officer's area of responsibility.

Pilot Flying and Pilot Not Flying Areas of Responsibility



Intentionally
Blank

Exterior Inspection

Prior to each flight, a flight crew member or the maintenance crew must verify the airplane is acceptable for flight. Check:

Flight control surfaces unobstructed and all surfaces clear of ice, snow, or frost.

Door and access panels (not in use) properly secured.

Ports and vents unobstructed.

Airplane free of damage and fluid leakage.

Check strut midspar fuse pin alignment stripes on the inboard and outboard sides of all engines. If mismatch greater than 1/2 of paint stripe, midspar fitting and fuse pin should be investigated.

Wheel chocks in place and ground locking pins removed.

Tire condition.

Gear struts not fully compressed.

Preflight Procedure – First Officer

This procedure assumes the supplementary electrical power up procedure has been accomplished and electrical power is established.

Accomplish the following procedures in their entirety on each originating trip or crew change, or following maintenance action.

Normally this procedure is accomplished by the First Officer. However, it does not preclude the captain from completing the procedure if time and conditions dictate.

Maintenance documents .... Check

Circuit breakers (P6) .... Check

Emergency equipment .... Check

Fire extinguisher – Checked and stowed

Check trigger safety pin in place, handle safety wired, bottle pressure in green band.

Portable Oxygen Bottle – Checked and stowed

Verify pressure in green band and face mask attached.

Crash axe – Stowed

First aid kit – Stowed

Verify first aid kit seal in place.

Smoke goggles – Stowed

Life vests – Stowed

Verify vests in place.

Hatch - Closed and locked

Smoke evacuation handle - In

Emergency escape devices– Stowed

GROUND TESTS switch.................................... NORM (guard closed)

FLIGHT CONTROL HYDRAULIC
POWER switches .... NORM (guard closed)

Verify VALVE CLOSED lights extinguished.

APU START SOURCE switch... TR

GENERATOR FIELD MANUAL
RESET switches ....Guard closed

Verify FIELD OFF lights extinguished.

SPLIT SYSTEM BREAKER switch ....Guard closed

IRS ON BAT light ....Extinguished

ELECTRONIC ENGINE CONTROL
MAINTENANCE POWER switches..................NORM (guards closed)

CENTER WING TANK
SCAVENGE PUMP switch ....OFF (guard closed)

RESERVE 2 & 3 TRANSFER switch ....CLOSE (guard closed)

Circuit Breakers (P7)...Check

ELECTRONIC ENGINE CONTROL
switches ....NORM

Verify ALTN lights extinguished.

IRS selectors ....OFF, then NAV

APU selector ....START, release to ON

Electrical panel ....Set

STANDBY POWER selector - AUTO

UTILITY power switches - ON

Verify OFF lights extinguished.

BATTERY switch – ON

Verify OFF light extinguished.

BUS TIE switches - AUTO

Verify ISLN lights extinguished.

GENERATOR CONTROL switches - ON

Verify OFF and DRIVE lights illuminated.

HYDRAULIC panel ....Set

Hydraulic SYS FAULT and
demand pump PRESS lights - Illuminated

DEMAND pump selectors - OFF

ENGINE pump switches - ON

Verify engine pump PRESS lights illuminated.

EMERGENCY LIGHTS switch... ARMED

OBSERVER'S AUDIO SYSTEM switch ....NORM

SERVICE INTERPHONE switch .... OFF

FUEL TRANSFER MAIN 1 AND 4 switch .... OFF

Fire Panel ....Set

Engine fire switches - In

BTL A DISCH and BTL B DISCH lights - Extinguished

APU BTL DISCH light - Extinguished

APU fire switch - In

CARGO FIRE DISCH light - Extinguished

CARGO FIRE ARM switches - OFF

Verify FWD and AFT lights extinguished.

Engine START panel .... Set

START switches - In, extinguished

STANDBY IGNITION selector - NORM

CONTINUOUS IGNITION switch - Off

AUTO IGNITION selector - SINGLE

AUTOSTART switch - ON

FUEL JETTISON panel .... Set

Fuel jettison selector - OFF

Fuel jettison NOZZLE valve switches - Off

Verify VALVE light extinguished.

Fuel panel .... Set

All X FEED valve switches - On

Verify VALVE lights extinguished.

All fuel pump switches - Off

Main pump PRESS lights illuminated. Main 2 aft pump PRESS light extinguished when APU running. Override 2 and 3 pumps, center pumps, and stabilizer pumps PRESS lights extinguished.

Anti-ice panel ....Set

NACELLE ANTI-ICE switches - AUTO

WING ANTI-ICE switch - AUTO

Windshield protection panel ....Set

WINDOW HEAT switches - ON

Verify INOP lights extinguished.

Windshield WIPER selectors - OFF

PASSENGER OXYGEN switch...........................NORM (guard closed)

YAW DAMPER switches ....ON

INOP lights remain iluminated until first IRU aligns.

CABIN ALTITUDE panel..Set

OUTFLOW VALVES - OPEN

Verify outflow valves OPEN.

LANDING ALTITUDE switch - AUTO

Outflow valve manual switches - Off

Cabin Altitude AUTO SELECTOR - NORM

ECS panel ....Set

PASSENGER TEMPERATURE selector - AUTO

FLIGHT DECK TEMPERATURE selector - AUTO

ZONE SYS FAULT light - Extinguished

TRIM AIR switch - ON

UPPER and LOWER RECIRCULATION fan switches - ON

AFT CARGO HEAT switch - Off

EQUIPMENT COOLING selector - NORM

HIGH FLOW switch - Off

Bleed air panel ....Set

Pack SYS FAULT light - Extinguished

Pack control selectors - NORM

LEFT and RIGHT ISOLATION valve switches - On

Verify VALVE lights extinguished.

Engine bleed air SYS FAULT lights - Extinguished

APU bleed air switch - ON

Verify VALVE light extinguished.

ENGINE BLEED air switches - ON

Lighting panel .... Set

First Officer’s FLIGHT DIRECTOR switch .... ON

STATUS display switch .... Push

Verify status display appears.

EFIS control panel .... Set

CDU .... Check and set

IDENT page - Check

Verify airplane model number
and engine number displayed.
Verify ACTIVE navigation data
date current.

POS INIT line select key - Push

Present position - Enter

Enter present position on SET IRS POS line using
most accurate latitude and longitude.

UTC - Check

PREVIOUS PAGE key - Push

Verify L, C, and R IRS positions correct.

NEXT PAGE key - Push

ROUTE line select key - Push

Enter route.

ACTIVATE line select key - Push

EXEC key - push

DEP/ARR key - Push

Select runway and SID.

ROUTE line select key - Push

Verify SID and route correct.

EXEC key -Push

NAV/RAD key - Push

Verify navigation radios set.

INIT REF key - Push

INDEX line select key - Push

APPROACH line select key - Push

Verify FLAP/SPEED line blank.

INIT REF key - Push

Weather radar panel .... Set

Radio tuning panel .... Set

OFF light - Extinguished

Set panel - As desired

Audio panel .... Set

Set panel - As desired

Transponder panel .... Set

Transponder switch - As required

Transponder mode selector - STBY

AUTOBRAKES Selector .... RTO

Crew oxygen panel .... Set

Oxygen mask - Stowed

Verify doors stowed.

Crew oxygen pressure - Check EICAS

Note oxygen pressure.

Reset/test slide lever - Push and hold

Verify yellow cross appears momentarily in flow indicator.

Emergency/test selector - Push and hold

Simultaneously push emergency/test selector and reset/test slide lever; verify yellow cross appears continuously in flow indicator.

Emergency/test selector - Release

Reset/test slide lever - Release

Verify yellow cross no longer appears in flow indicator.

Normal/100% selector - 100%

Leave N/100% selector in 100% position.

Crew oxygen pressure - Check EICAS

Verify pressure decreases no more than 30 psi during test and pressure adequate for dispatch.

SOURCE SELECT panel .... Set

FLIGHT DIRECTOR source selector - R

NAVIGATION source selector - FMC R

EIU source selector - AUTO

IRS source selector - R

AIR DATA source selector - R

Clock ....Set

CRT select panel ....Set

LOWER CRT selector - NORM

INBOARD CRT selector - NORM

PFD .... Check

Flight mode annunciation - Check

Verify autothrottle mode blank.
Verify roll mode TO/GA.
Verify pitch mode TO/GA.
Verify AFDS status FD.

Displays - Normal

Verify no flags displayed.
Verify NO V SPD flag displayed until
V-speeds selected.

Heading - Check

Altimeter - Set

ND .... Check

Heading/Track - Displayed, correct

Route - Displayed, correct

Displays - Normal

Verify no flags displayed.

GROUND PROXIMITY panel ....Set

Ground PROX light - Extinguished

Ground proximity FLAP OVERIDE switch - Off

Ground proximity CONFIGURATION
GEAR OVERRIDE switch - Off

Alternate flaps and gear...Set

Landing gear lever - Down

ALTERNATE FLAPS selector - Off

Alternate flaps ARM switch - Off

ALTERNATE GEAR EXTEND switches - Off

EIU selector .... AUTO

HEADING reference switch .... NORM

FMC master selector L

Status display ....Check

Hydraulic quantity - RF not displayed

Oxygen pressure - Sufficient for flight

Status messages - Check

Seat .... Adjust

Adjust seat to obtain optimum eye reference position.

WARNING: Do not place objects between pilot's seat and aisle stand. Injury can occur when the seat is adjusted forward.

Rudder pedals .... Adjust

Adjust to permit full rudder pedal and brake application.

Accomplish BEFORE START checklist to
"CLEARED FOR START".

Preflight Procedure – Captain

Normally, this procedure is accomplished by the captain. However, it does not preclude the first officer from completing the procedure when time and conditions dictate.

EFIS control panel .... Set

Mode control panel .... Set

Captain's FLIGHT DIRECTOR switch – ON

AUTOTHROTTLE ARM switch – ARM

BANK LIMIT selector - AUTO

Autopilot DISENGAGE bar – Up

CDU .... Check

Active Navigation Data Date - Check

POSITION INITIALIZATION line select key - Push

Present Position - Check

UTC - Check

ROUTE line select key - Push

Verify correct route.

INIT REF key - Push

INDEX line select key - Push

APPROACH line select key - Push

Verify FLAP/SPEED line blank.

INIT REF key - Push

PARKING BRAKE ....Set

Verify PARK BRAKE SET message displayed.

Note: Accumulator pressure may be insufficient to prevent airplane from moving.

SPEEDBRAKE lever...DN

Reverse thrust levers..Down

Thrust levers ....Closed

FUEL CONTROL switches .... CUTOFF

STABILIZER TRIM cutout switches .... AUTO (guards closed)

Radio tuning panel...Set

OFF light - Extinguished

Set panel - As desired

Audio panel ....Set

Set panel - As desired

Passenger signs .... Set

NO SMOKING selector - AUTO or ON

SEATBELTS selector - AUTO

Emergency evacuation COMMAND switch .... ARM

Crew oxygen panel .... Set

Oxygen mask - Stowed

Verify doors stowed.

Crew oxygen pressure - Check EICAS

Note oxygen pressure.

Reset/test slide lever - Push and hold

Verify yellow cross appears momentarily in flow indicator.

Emergency/test selector - Push and hold

Simultaneously push emergency/test selector and reset/test slide lever; verify yellow cross appears continuously in flow indicator.

Emergency/test selector - Release

Reset/test slide lever - Release

Verify yellow cross no longer appears in flow indicator.

Normal/100% selector - 100%

Leave N/100% selector in 100% position.

Crew oxygen pressure - Check EICAS

Verify pressure decreases no more than 30 psi during test and pressure adequate for dispatch.

SOURCE SELECT panel .... Set

FLIGHT DIRECTOR source selector - L

NAVIGATION source selector - FMC L

EIU source selector - AUTO

IRS source selector - L

AIR DATA source selector - L

Clock .... Set

RMI .... Check

VOR/ADF selectors - As desired

Magnetic heading - Correct

CRT select panel .... Set

INBOARD CRT selector - NORM

LOWER CRT selector - NORM

PFD .... Check

Flight mode annunciation - Check

Verify autothrottle mode blank.
Verify roll mode TO/GA.
Verify pitch mode TO/GA.
Verify AFDS status FD.

Displays - Normal

Verify no flags displayed.
Verify no V SPD flag displayed until
V-speeds selected.

Heading - Check

Altimeter - Set

ND .... Check

Heading/Track - Displayed, correct

Route - Displayed, correct

Displays - Normal

Verify no flags displayed.

Standby attitude indicator .... Check

Caging control - Pull and release

Attitude - Correct

Verify no gyro flag.

APPROACH selector - OFF

Verify no ILS flags.

Standby airspeed indicator .... Check

Standby altimeter .... Check

Seat .... Adjust

Adjust seat to obtain optimum eye reference position.

WARNING: Do not place objects between pilot's seat and aisle stand. Injury can occur when seat adjusted forward.

Rudder pedals .... Adjust

Adjust to permit full rudder pedal and brake application.

Call for BEFORE START checklist to "CLEARED FOR START".

Before Start Procedure

Accomplish this procedure after papers are on board and flight crew is ready for push back and/or engine start.

CDU .... Set

Fuel quantity on CDU, manifest, and EICAS - Agree

Airplane zero fuel weight or gross weight - Enter

Fuel reserves - Enter

Cost index - Enter

Cruise altitude - Enter

THRUST LIM line select key – Push

Select desired takeoff and climb derate.

TAKEOFF line select key - Push

Takeoff flap setting - Enter

Takeoff data - Review

Takeoff speeds - Select

CG - Select

MCP ....Set

IAS/MACH selector – Rotate

Set V2 speed in IAS/MACH window.

LNAV switch – As required

VNAV switch – Push

Arm VNAV.

Initial heading – Set

Initial altitude – Set

Start clearance..Obtain

Obtain clearance to pressurize hydraulic systems and start engines.

Hydraulic demand pump 4 selector .... AUX

Verify SYS FAULT light extinguished.
PRESS light remains illuminated.

HYDRAULIC panel ....Set

Hydraulic demand pump 1, 2, and 3 selectors - AUTO

Verify demand pump PRESS and
SYS FAULT lights extinguished.

Fuel tank quantities.. Check

Fuel panel ....Set

Fuel pump switches – ON

Push fuel pump switches for tanks containing fuel to ON.Verify pump PRESS lights extinguished.

Pack control selectors .... SET

All packs may be off or one pack may be on for engine start.

BEACON light switch .... BOTH

RECALL switch .... Push

Verify only appropriate alert messages displayed.

If FUEL TANK/ENG message displayed:

Verify fuel quantity in tank 2 less than or equal to tank 1, or tank 3 less than or equal to tank 4 (fuel tank-to-engine); or fuel quantity in tank 2 less than or equal to tank 1 plus 500 kgs. and tank 3 less than or equal to tank 4 plus 500 kgs.:

OVERRIDE pumps 2 and 3 switches - Off

CROSSFEED valve 1 and 4 switches - Off

Cancel when review completed.

Status Display .... Select

Trim .... Set

Stabilizer trim – ___ UNITS

Set for takeoff.

Check in illuminated greenband.

Aileron trim – ZERO

Rudder trim – ZERO

Flight controls .... Check

Displace rudder, control wheel, and control column full travel in both directions. Verify freedom of movement, controls return to center, and proper flight control movement on secondary EICAS display.

Note: Hold nose wheel steering tiller stationary during rudder check to prevent nose wheel movement.

Secondary ENGINE display switch .... Push

Verify secondary engine display appears.

EICAS displays .... Check

Engine indications - Normal

Accomplish remaining items on BEFORE START checklist.

Engine Start Procedure

Normal start sequence is 4, 3, 2, 1.

Two engines may be started simultaneously.

<table>
<tr><th>Captain</th><th>First Officer</th></tr>
<tr><td>Call “START ____ .”</td><td>Pull engine start switch(es).</td></tr>
<tr><td>Position engine ____ fuel control switch(es) to run.</td><td></td></tr>
<tr><td colspan="2">Observe oil pressure increase. *</td></tr>
<tr><td colspan="2">Monitor engine displays for start parameters listed below until engine(s) are stabilized at idle:
• N1 rotation and *oil pressure must be indicated by idle N2.
After engine(s) stabilized at idle, repeat procedure to start remaining engines.
Autostart takes corrective action for the following non-normal conditions:
• No EGT rise
• Hot start
• Hung start.
(*During cold weather starts, initial oil pressure rise may be higher than normal.)</td></tr>
</table>

After Start Procedure

APU selector .... OFF

Hydraulic demand pump selectors .... AUTO

NACELLE ANTI–ICE switches .... As required

AFT CARGO HEAT switch .... As required

Pack control selectors .... NORM

RECALL switch .... Push

Verify only appropriate alert messages displayed.
Cancel when review completed.

CDU .... Check

Verify takeoff speeds selected.

Ground equipment .... Clear

Accomplish AFTER START checklist.

Before Takeoff Procedure

Pilot Flying	Pilot Not Flying
	Obtain taxi clearance
Brief taxi clearance	
Release parking brake.	
Call for “FLAPS _____” as required for takeoff.	Position Flap lever to takeoff setting.
Accomplish takeoff briefing.	
	Notify flight attendants.
Call for “BEFORE TAKEOFF CHECKLIST”.	Accomplish BEFORE TAKEOFF checklist.

Takeoff Procedure

Pilot Flying	Pilot Not Flying
Align airplane with runway.	Position Inboard Landing Lights and Strobe Light switches ON. Position Transponder Mode selector to TA/RA.
Advance Thrust levers to approximately 70% N1 and allow engines to stabilize. Push TO/GA switch to advance Thrust levers to takeoff thrust, or manually advance Thrust levers to takeoff thrust.	
Verify correct takeoff thrust set.	Monitor engine instruments throughout takeoff. Adjust takeoff thrust prior to 80 knots if required.
Note: After takeoff thrust is set, Captain's hand must be on Thrust levers until V1.	
Verify 80 knots.	Call "80 KNOTS."
Monitor airspeed noting V1. Rotate at VR. Establish positive rate of climb.	Call "V1." At VR, call "ROTATE." Monitor airspeed and vertical speed.
Call for "GEAR UP" when positive rate of climb established.	Verify positive rate of climb; then, position Landing Gear lever UP.
	Verify LNAV, VNAV engaged.
When above minimum altitude for autopilot engagement, engage A/P.	
Verify acceleration at acceleration height. Call for "FLAPS ____" according to flap retraction schedule.	Position Flap lever as directed.
Verify climb thrust set.	Position Landing Gear lever OFF.
Call for "AFTER TAKEOFF CHECKLIST."	Accomplish AFTER TAKEOFF checklist.

Climb and Cruise Procedure

Pilot Flying	Pilot Not Flying
	Nacelle Anti-ice selectors AUTO.
	Above 10,000 feet, position Inboard Landing Light switches OFF.
At transition altitude, set altimeters to standard (29.92/1013).	
	When FUEL PMP STAB L and R messages are displayed and tank quantity is zero, push both Stabilizer tank L and R Pump switches off.
	When FUEL OVRD CTR L or R messages are displayed and the tank quantity is less than 900 kgs, push both Center L and R Pump switches off.
	When FUEL TANK/ENG message is displayed and fuel quantity in tank 2 is less than or equal to tank 1 or tank 3 is less than or equal to tank 4, push Override Forward and Aft Pump switches 2 and 3 off and crossfeed valve switches 1 and 4 off.
	Prior to top of descent, modify active route as required for arrival and approach.
When cleared to descend, set clearance limit altitude on MCP.	

Approach and Landing Procedure

Pilot Flying	Pilot Not Flying
Review all messages.	Recall and review all messages.
Verify VREF speed.	Select VREF speed.
Verify correct arrival and approach procedures are selected.	
Set approach DH or MDA on PFD as required.	
Complete approach brief.	
At transition level, set all altimeters.	
Set Autobrakes selector to desired brake setting.* (*Refer to Flight Planning and Performance Manual for stopping distance information.)	
Call for “APPROACH CHECKLIST”.	Accomplish APPROACH checklist.
	At 10,000 feet, position Inboard Landing Light switches ON.
Call for “FLAPS ____” according to flap extension schedule.	Position Flap lever as directed.
When on localizer intercept heading: • verify ILS tuned and identified • LOC and G/S pointers displayed • arm APP mode.	Set Transponder selector to desired TCAS mode.
Call for “GEAR DOWN” and “FLAPS 20”.	Position Landing Gear lever DN and flap lever to 20.
Position Speedbrake lever to ARM.	
At glideslope capture, call for “FLAPS ____” as required for landing. Set missed approach altitude on MCP.	Position Flap lever as directed.
At final approach fix/OM, verify crossing altitude.	
Call for “LANDING CHECKLIST”.	Accomplish LANDING checklist.
Monitor approach progress.Verify autoland status.	

Go–Around Procedure

Pilot Flying	Pilot Not Flying
Push TO/GA switch. Call for "FLAPS 20."	Position Flap lever to 20.
Verify rotation to go–around attitude and thrust increase.	
	Verify thrust adequate for go–around; adjust if necessary.
After positive rate of climb established, call for "GEAR UP."	Verify positive rate of climb, then position Landing Gear lever UP.
Above 400 feet radio altitude, select LNAV.	
Above 1,000 feet radio altitude, select VNAV or FLCH.	
Call for "FLAPS __" according to flap retraction schedule.	Position Flap lever as directed.
Verify missed approach route being tracked and missed approach altitude captured.	
	Position Landing Gear lever OFF.
Call for "AFTER TAKEOFF CHECKLIST."	Accomplish AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Not Flying
Monitor rollout progress and proper autobrake operation.	
Verify Thrust levers closed and Speedbrake lever up. Without delay, raise Reverse Thrust levers to idle detent, hold light pressure until release, and then apply reverse thrust as required.	Verify Speedbrake lever UP and call "SPEEDBRAKES UP." If Speedbrake lever not UP, call "SPEEDBRAKES NOT UP."
By 60 knots, initiate movement of Reverse Thrust levers to reach reverse idle detent prior to taxi speed. Position levers full down (forward thrust) when engines have decelerated to reverse idle.	Call "60 KNOTS."
Prior to taxi speed, disarm autobrakes and continue manual braking as required.	
Disengage autopilot prior to runway turnoff.	

WARNING: After reverse thrust is initiated, a full stop landing must be made.

After Landing Procedure

Accomplish this procedure when clear of the active runway.

STROBE lights switch .... OFF

INBOARD landing lights switches .... OFF

APU selector .... START, release to ON

WEATHER radar switch .... OFF

Speedbrake lever .... DN

Flap lever .... UP

AUTOBRAKES selector .... OFF

Transponder mode selector .... STBY

Shutdown Procedure

Parking brake ....Set

Electrical power .... Establish

If external power desired:

External power 1 and/or external power 2 AVAIL lights - Illuminated

EXTERNAL POWER 1 and/or EXTERNAL POWER 2 switches - Push

Verify ON light(s) illuminated.

If APU power desired:

APU generator 1 and APU generator 2 AVAIL lights -Illuminated

APU GENERATOR 1 switch - Push

Verify ON light illuminated.

APU GENERATOR 2 switch - Push

Verify ON light illuminated.

Hydraulic demand pump 1, 2, and 3 selectors.................................. OFF

Hydraulic demand pump 4 selector .... AUX

FUEL CONTROL switches .... CUTOFF

SEATBELTS signs selector .... OFF

When all passenger doors are in manual mode, place SEATBELT signs selector OFF.

Fuel pump switches .... OFF

NACELLE and WING ANTI-ICE switches.................................... OFF

BEACON lights switch... OFF

FLIGHT DIRECTOR switches .... OFF

Status messages .... Check

Parking brake .... Release

When wheel chocks in place, release parking brake.

Hydraulic demand pump 4 selector .... OFF

Accomplish SHUTDOWN checklist down to “SECURE”.

Secure Procedure

IRS mode selectors .... OFF

EMERGENCY LIGHTS switch .... OFF

AFT CARGO HEAT switch .... OFF

Pack control selectors .... OFF

APU selector and/or EXTERNAL POWER switch(es) .... OFF

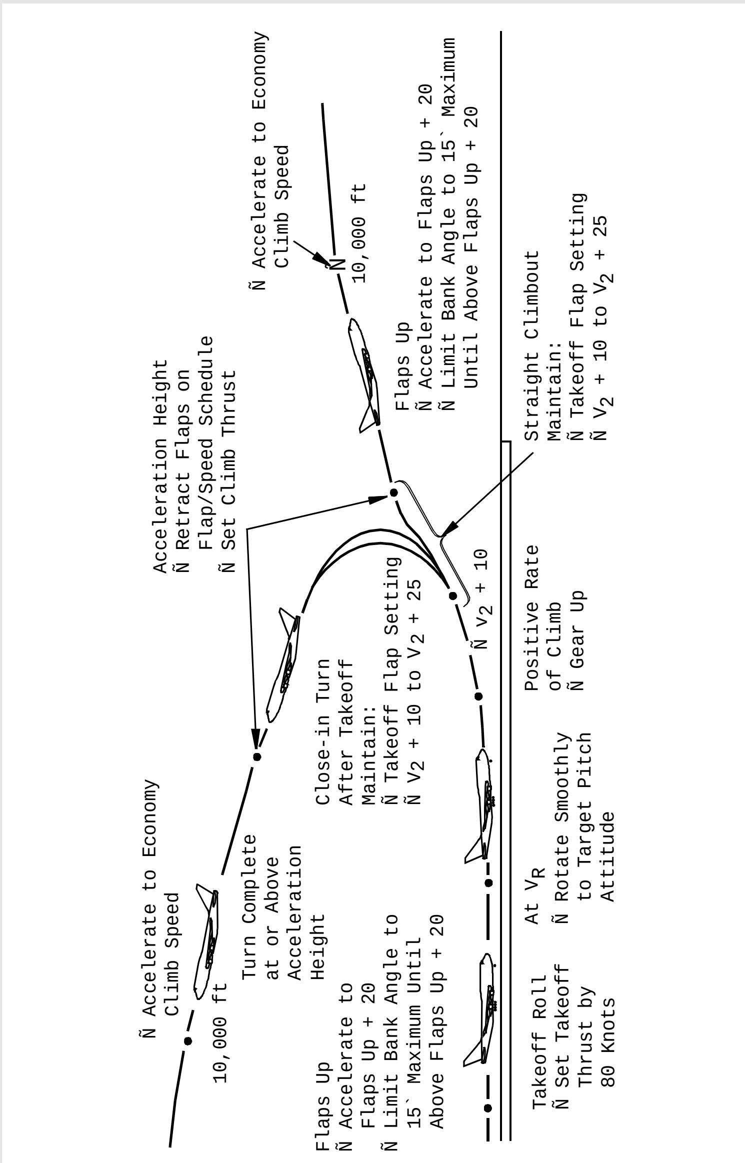
STANDBY POWER selector .... OFF

When APU has completed shutdown cycle:

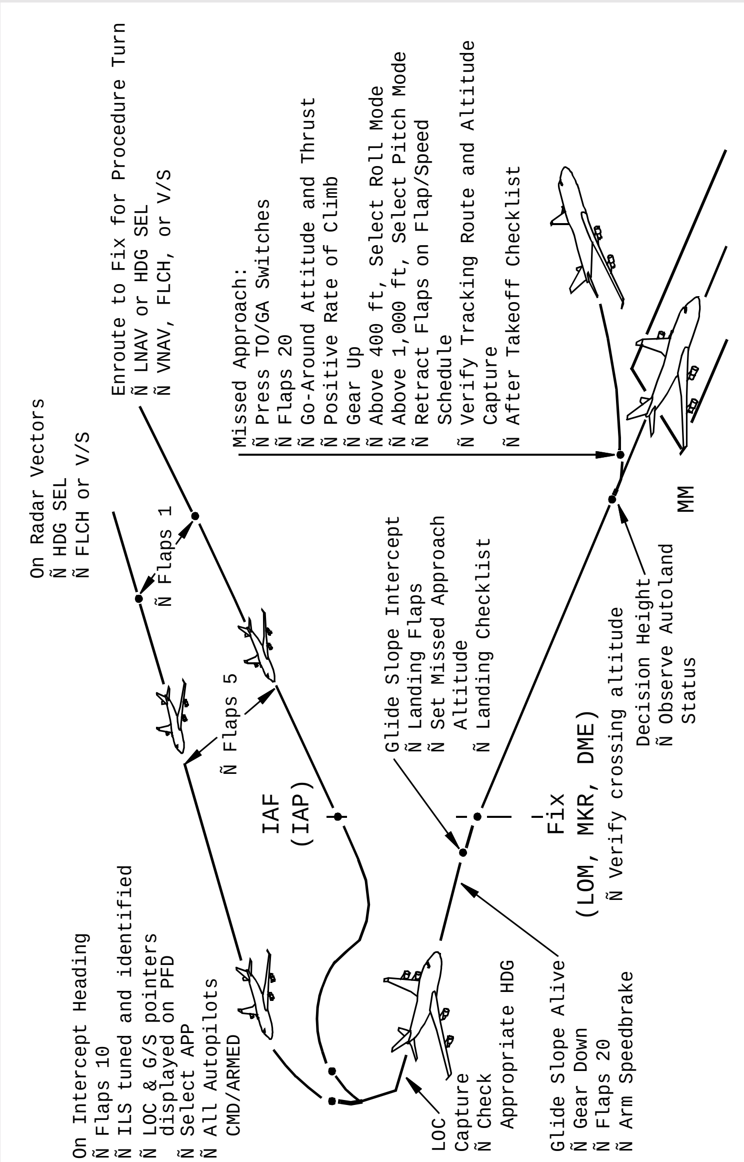
BATTERY switch .... OFF

Accomplish remaining items on SHUTDOWN checklist.

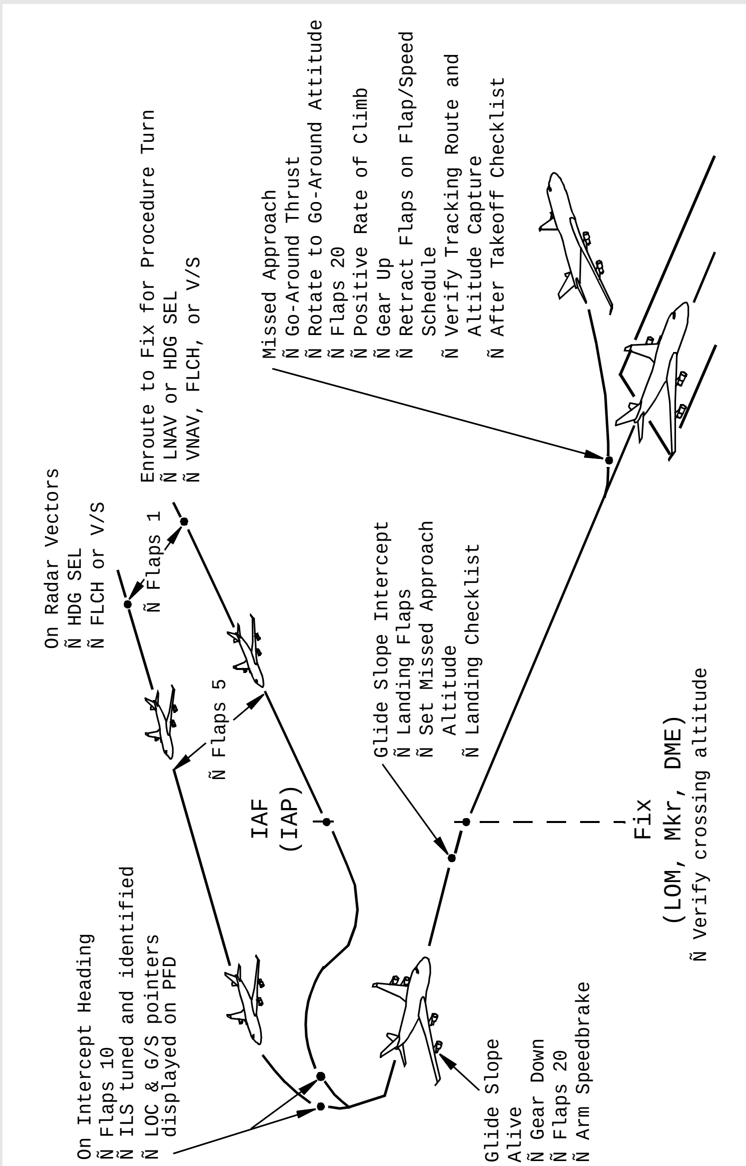
Takeoff


Takeoff Roll
Ñ Set Takeoff Thrust by 80 Knots
At V_R
Ñ Rotate Smoothly to Target Pitch Attitude
Positive Rate of Climb
Ñ Gear Up
Ñ V_2 + 10
Straight Climbout
Maintain:
Ñ Takeoff Flap Setting
Ñ V_2 + 10 to V_2 + 25
Flaps Up
Ñ Accelerate to Flaps Up + 20
Ñ Limit Bank Angle to 15` Maximum Until Above Flaps Up + 20
10,000 ft
Ñ Accelerate to Economy Climb Speed
Acceleration Height
Ñ Retract Flaps on Flap/Speed Schedule
Ñ Set Climb Thrust
Close-in Turn After Takeoff
Maintain:
Ñ Takeoff Flap Setting
Ñ V_2 + 10 to V_2 + 25
Turn Complete at or Above Acceleration Height
Flaps Up
Ñ Accelerate to Flaps Up + 20
Ñ Limit Bank Angle to 15` Maximum Until Above Flaps Up + 20
10,000 ft
Ñ Accelerate to Economy Climb Speed

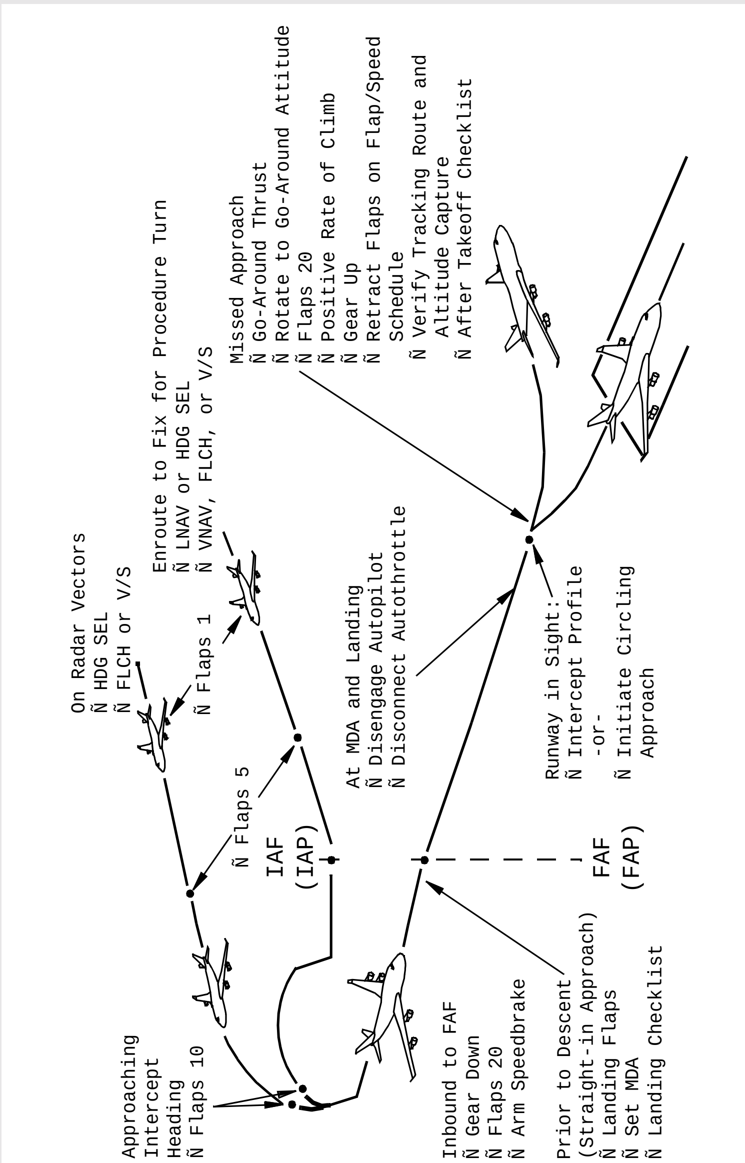
ILS Approach



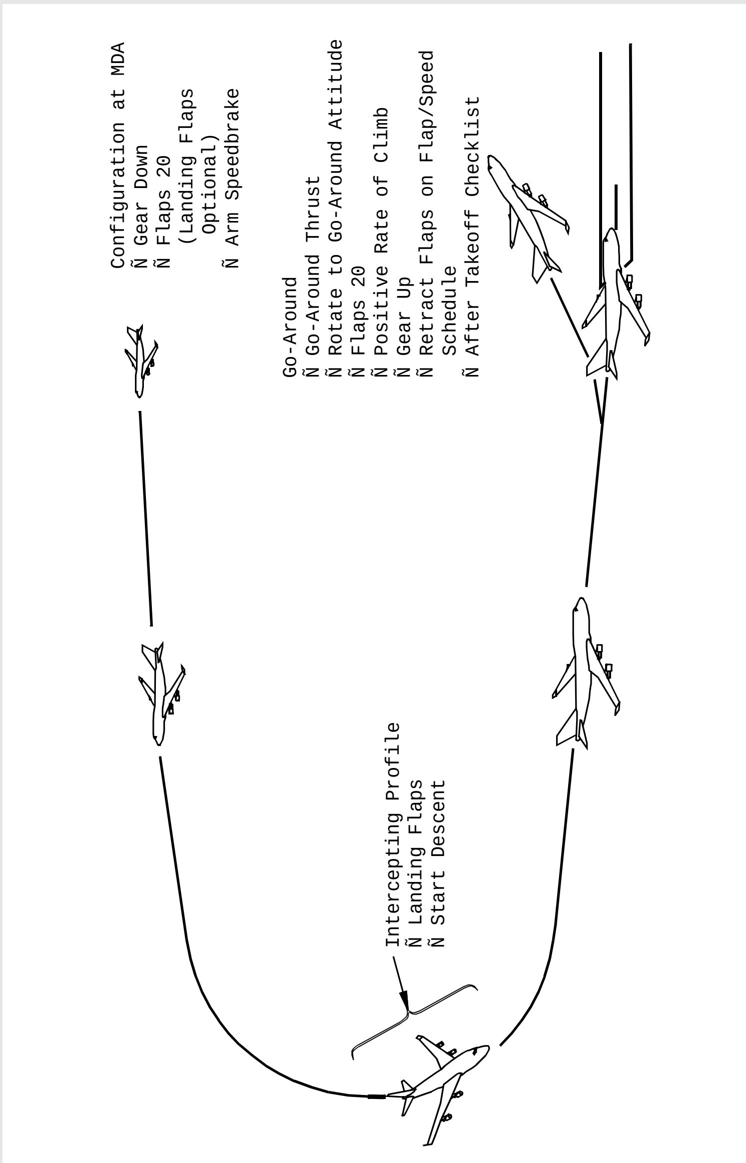
ILS Approach (Manual)



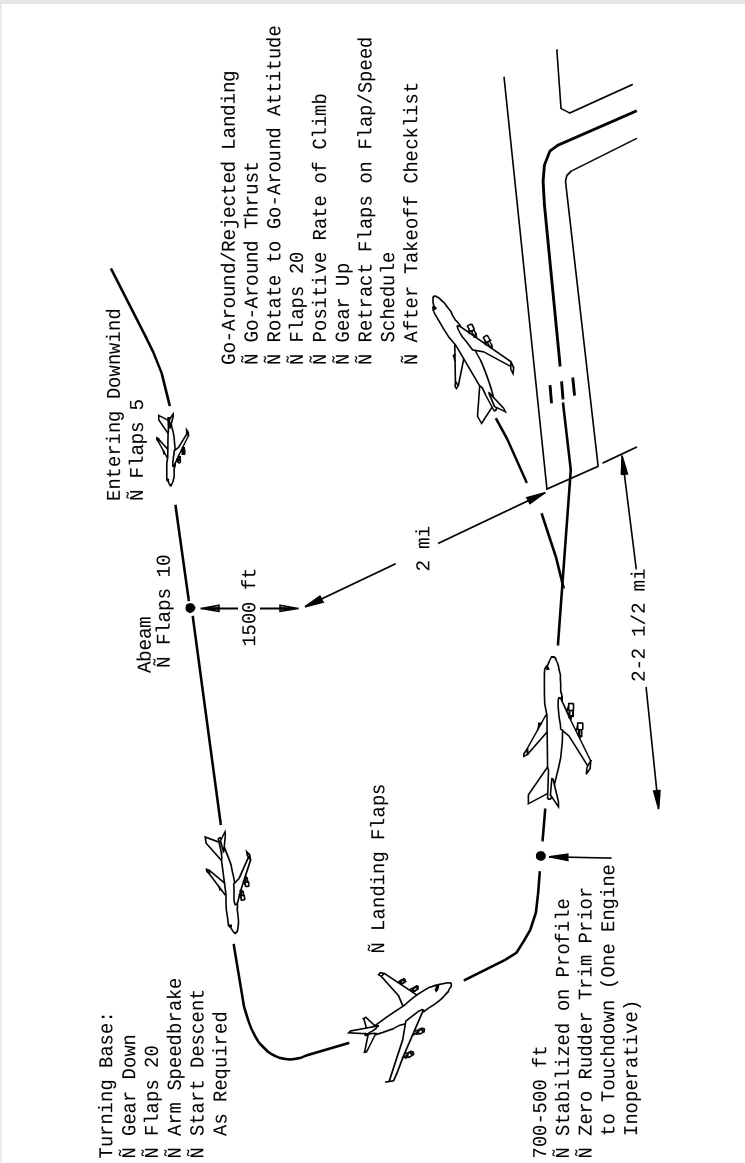
Non–Precision Approach



Circling


Configuration at MDA
Ñ Gear Down
Ñ Flaps 20
(Landing Flaps
Optional)
Ñ Arm Speedbrake
Go-Around
Ñ Go-Around Thrust
Ñ Rotate to Go-Around Attitude
Ñ Flaps 20
Ñ Positive Rate of Climb
Ñ Gear Up
Ñ Retract Flaps on Flap/Speed
Schedule
Ñ After Takeoff Checklist
Intercepting Profile
Ñ Landing Flaps
Ñ Start Descent

Visual Traffic Pattern



Supplementary Procedures — Chapter SP
Table of Contents — Section 0

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General

This chapter contains procedures (adverse weather operation, engine crossbleed start, and so on) accomplished as required rather than routinely performed on each flight. Systems tests are described in the System Description chapter of the applicable system.

Note: System tests are not normally a flight crew action.

Procedures accomplished in flight, or those that are an alternate means of accomplishing normal procedures (such as manual engine start), are usually accomplished by recall. Infrequently used procedures, not normally accomplished (such as engine crossbleed start) are usually accomplished by reference.

Supplementary procedures are provided by section. Section titles correspond to the related chapter title for the system being addressed except for the Adverse Weather section.

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Oxygen Test

Oxygen Mask .... Stowed

Verify doors closed.

FLIGHT INTERPHONE TRANSMITTER Selector .... MIC

SPEAKER Selector .... ON

STATUS DISPLAY Switch .... Push

Crew Oxygen Pressure .... Check EICAS

Note oxygen pressure.

RESET/TEST Slide Lever .... Push and Hold

Verify yellow cross appears momentarily in flow indicator.

EMERGENCY/TEST Selector .... Push and Hold

Simultaneously push Emergency/Test selector and Reset/Test slide lever. Verify yellow cross appears continuously in flow indicator.

PUSH-TO-TALK Switch .... INT

Verify oxygen flow sound is heard through the flight deck loudspeaker.

EMERGENCY/TEST Selector .... Release

RESET/TEST Slide Lever .... Release

Verify yellow cross no longer appears in flow indicator.

NORMAL/100% Selector 100%

Leave N/100% selector in 100% position.

Crew Oxygen Pressure .... Check EICAS

Verify pressure decreases no more than 30 psi during test and pressure adequate for dispatch.

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Air Conditioning Packs

APU-to-Pack Takeoff

After engine start:

LEFT and RIGHT ISOLATION valve switches - OFF

Leave APU running to supply air to pack 2.

Before takeoff:

PACKS 1 and 3 control selectors - OFF

After takeoff:

PACK control selector (One only) - NORM

After engine thrust is reduced from takeoff to climb, position one Pack Control selector to NORM.

PACK control selector (Remaining pack) - NORM

When cabin pressurization stabilizes, position remaining Pack Control selector to NORM.

LEFT and RIGHT ISOLATION valve switches - ON

APU selector - OFF

Ground Air Conditioning Cart Use

Before connecting ground air conditioning cart:

PACK control selectors - OFF

Allows cart to operate at maximum efficiency.

RECIRCULATION FANS switches - OFF

Allows cart to operate at maximum efficiency.

After disconnecting ground air conditioning cart:

PACK control selectors - AUTO

RECIRCULATION FANS switches - ON

High Cabin Temperatures During Cruise

If cabin temperatures stabilize above target temperatures during cruise:

HIGH FLOW switch - ON

High flow setting increases fuel flow approximately 1%.

When temperatures return to target temperatures:

HIGH FLOW switch - OFF

Packs Off Takeoff

Before takeoff:

PACK Control selectors - OFF

After takeoff:

PACK Control selector (One only) - NORM

After engine thrust is reduced from takeoff to climb and prior to reaching 3,000 feet above field elevation, position one Pack Control selector to NORM.

PACK control selectors (Remaining packs) - NORM

When cabin pressurization stabilizes, position remaining Pack Control selectors to NORM.

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AFDS

AFDS Operation

FLIGHT DIRECTOR switches ....ON
Verify FD pitch and roll bars display.

If autopilot desired:

AUTOPILOT engage switch ....Push
Verify CMD displays on AFDS status.

Heading Hold

If airplane position north of 82° N latitude (or north of 70° N between 80° W and 130° W) or south of 82° S latitude (or south of 60° S between 120° E and 160° E):

HEADING reference switch... TRUE

HEADING HOLD switch...Push
Verify HDG HOLD displays on flight mode annunciation.

Heading Select

If airplane position north of 82° N latitude (or north of 70° N between 80° W and 130° W) or south of 82° S latitude (or south of 60° S between 120° E and 160° E):

HEADING reference switch... TRUE

HEADING SELECT switch ....Push
Verify HDG SEL displays on flight mode annunciation.

HEADING selector...Rotate
Set desired heading in HDG window.

Altitude Hold

ALTITUDE HOLD switch ....Push
Verify ALT displays on flight mode annunciation.

Flight Level Change, Climb or Descent

ALTITUDE selector ....Rotate

Set desired altitude in ALT window.

FLCH switch .... Push

Verify FLCH SPD displays on flight mode annunciation.

IAS/MACH selector ....Rotate

Set desired speed in IAS/MACH window.

Vertical Speed, Climb or Descent

ALTITUDE selector ....Rotate

Set desired altitude in ALT window.

VERTICAL SPEED switch... Push

Verify V/S displays on PFD.

VERTICAL SPEED selector...Rotate

Set desired vertical speed in VERT SPD window.

If climb desired:

Select climb thrust limit on CDU THRUST LIM page.

Autothrottle Operation

To activate or reactivate an autothrottle mode:

AUTOTHROTTLE ARM switch ....ARM

If pitch mode TO/GA:

TO/GA switch ....Push
Verify THR REF displays on flight mode annunciation.

If pitch mode ALT, V/S, G/S, or no pitch mode:

SPEED switch ....Push
Verify SPD displays on flight mode annunciation.

To set desired airspeed:

IAS/MACH selector .... Rotate
Set desired speed in IAS/MACH window.

If FLCH desired:

FLCH switch ....Push
Pitch mode changes unless G/S and LOC captured. Verify THR, IDLE, or HOLD displays on flight mode annunciation.

If VNAV desired:

VNAV switch ....Push
Pitch mode changes when in V/S or ALT. Verify THR REF, THR, SPD, IDLE, or HOLD displays on flight mode annunciation.

If TO/GA is desired:

TO/GA switch ....Push
Pitch and roll modes change to TO/GA. Verify THR or THR REF displays on flight mode annunciation.

If pitch mode is VNAV PTH, VNAV ALT, VNAV SPD, or FLCH SPD:

AUTOTHROTTLE ARM switch ....OFF, then ARM
Verify THR REF, THR, SPD, IDLE, or HOLD displays on flight mode annunciation.

Localizer Approach

Pitch mode may be VNAV or V/S . If using VNAV, verify proper approach and altitudes have been entered in the CDU and use speed intervention for airspeed control.

LOCALIZER switch .... Push

When on an intercept heading to the localizer course with PFD localizer pointer displayed, push LOC switch.

Verify the armed roll flight mode annunciation is LOC.

Verify the engaged roll flight mode annunciation is LOC upon localizer capture.

Prior to descent to minimum descent altitude(MDA):

ALTITUDE window – Set

Set intermediate altitude constraint or MDA if no intermediate altitude constraint exists.

In descent, set each intermediate altitude constraint and MDA.

If constraints or MDA do not end in 00 (for example, 1820), set ALT window to closest 100 foot increment below.

If using VNAV:

Prior to minimum descent altitude:

Missed approach altitude – Set

Set in ALT window.

At minimum descent altitude and landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

At minimum descent altitude and circling to land:

ALTITUDE HOLD switch – Push

If landing:

Autopilot disengage switch - Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

If using V/S:

At descent point:

VERTICAL SPEED switch – Push

Verify V/S displays in flight mode annunciation.

Desired vertical speed – Set

Set desired vertical speed to descend to MDA.

At minimum descent altitude, straight-in or circle-to-land:

ALTITUDE HOLD switch - Push

Missed approach altitude – Set

Set in ALT window.

If landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

Localizer Back Course Approach

Pitch mode may be VNAV or V/S. When using VNAV, verify proper approach and altitudes have been entered in the CDU and use speed intervention for airspeed control.

Roll mode may be LNAV or HDG SEL. If LNAV does not track correct course, use HDG SEL.

Observe PFD localizer pointer.

Prior to descent to minimum descent altitude:

ALTITUDE window – Set

Set intermediate altitude constraint or MDA if no intermediate altitude constraint exists.

In descent, set each intermediate altitude constraint and MDA.

If constraints or MDA do not end in 00 (for example, 1820), set ALT window to closest 100 foot increment below.

If using VNAV:

Prior to minimum descent altitude:

Missed approach altitude – Set

Set in ALT window.

At minimum descent altitude and landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

At minimum descent altitude and circling to land:

ALTITUDE HOLD switch – Push

If landing:

Autopilot disengage switch - Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

If using V/S:

At descent point:

VERTICAL SPEED switch – Push

Verify V/S displays in flight mode annunciation.

Desired vertical speed – Set

Set desired vertical speed to descend to MDA.

At minimum descent altitude, straight-in or circle-to-land:

ALTITUDE HOLD switch - Push

Missed approach altitude – Set

Set in ALT window.

If landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

VOR Approach

Pitch mode may be VNAV or V/S. If using VNAV, verify proper approach and altitudes have been entered in the CDU and use speed intervention for airspeed control.

Roll mode may be LNAV or HDG SEL. If LNAV does not track correct course, use HDG SEL.

Prior to intercepting final approach course:

VOR/ADF switch(es) – VOR

Observe ND VOR pointers.

Prior to descent to minimum descent altitude:

ALTITUDE window – Set

Set intermediate altitude constraint or MDA if no intermediate altitude constraint exists.

In descent, set each intermediate altitude constraint and MDA.

If constraints or MDA do not end in 00 (for example, 1820), set ALT window to closest 100 foot increment below.

If using VNAV:

Prior to minimum descent altitude:

Missed approach altitude – Set

Set in ALT window.

At minimum descent altitude and landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

At minimum descent altitude and circling to land:

ALTITUDE HOLD switch – Push

If landing:

Autopilot disengage switch - Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

If using V/S:

At descent point:

VERTICAL SPEED switch – Push

Verify V/S displays in flight mode annunciation.

Desired vertical speed – Set

Set desired vertical speed to descend to MDA.

At minimum descent altitude, straight-in or circle-to-land:

ALTITUDE HOLD switch - Push

Missed approach altitude – Set

Set in ALT window.

If landing:

Autopilot disengage switch – Push

Disengage autopilot before descending below MDA.

Autothrottle disconnect switch - Push

Disconnect autothrottle before descending below MDA.

Non-precision Approach and Landing Procedure

Pilot Flying	Pilot Not Flying
Review all messages.	Recall and review all messages.
Verify VREF speed.	Select VREF speed.
Verify correct arrival and approach procedures are selected.	
Set approach MDA on PFD as required.	
Complete approach brief.	
At transition level, set altimeters.	
Set AUTOBRAKES selector as desired.* (*Refer to Flight Performance Planning Manual for stopping distance information.)	

Pilot Flying	Pilot Not Flying
Call for “APPROACH CHECKLIST”.	Accomplish APPROACH CHECKLIST.
	At 10,000 feet, position Inboard Landing Light switches ON.
Adjust speed as desired.	
Call for “FLAPS ____” according to flap extension schedule.	Position Flap lever as directed.
Use VNAV, V/S, or FLCH mode for altitude changes.	
Use LNAV or heading select mode to track the approach or to establish intercept course for localizer or localizer back course approach.	
Select LOC when on intercept course for localizer approach.	
Approaching final approach fix, call for “GEAR DOWN” and “FLAPS 20”.	Position Landing Gear lever DN and Flap lever to 20.
Position Speedbrake lever to ARM.	
Set intermediate altitude constraint or MDA (or closest 100 foot increment below).	

Pilot Flying (Cont)	Pilot Not Flying (Cont)
Prior to final approach fix, call "FLAPS ____" as required for landing.* (*If circling, selection of landing flaps may be delayed until turning final.)	Position Flap lever as directed.
Call for "LANDING CHECKLIST".	Accomplish LANDING CHECKLIST.
Use VNAV or select V/S mode and appropriate vertical speed to descend to MDA.	
In descent, set intermediate altitude constraints and MDA (or closest 100 foot increments below).	
If using VNAV: Prior to MDA, set or call for missed approach altitude in ALT window. At or above MDA and landing, disengage autopilot and disconnect autothrottle.	Set missed approach altitude in ALT window if requested by pilot flying.
If using V/S: At or slightly above MDA, select ALT HOLD. Set or call for missed approach altitude in ALT window. If landing, disengage autopilot and disconnect autothrottle before descending below MDA.	Set missed approach altitude in ALT window if requested by pilot flying.

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Electrical Power Up

Accomplish the following procedure to permit safe application of electrical power.

BATTERY switch .... ON

Verify OFF light extinguished.

STANDBY POWER selector .... AUTO

Hydraulic DEMAND pump selectors .... OFF

ALTERNATE FLAPS selector .... OFF

Landing gear lever .... DN

Flap position indication and flap lever .... Agree

Electrical power .... Establish

BUS TIE switches – AUTO

If external power desired:

External power 1 and/or
external power 2 AVAIL lights– Illuminated

EXTERNAL POWER 1 and/or
EXTERNAL POWER 2 switches – Push

Verify ON light(s) illuminated.

If APU power desired:

APU Start Source switch - TR

APU selector – START, RELEASE TO ON

APU generator 1 and
APU generator 2 AVAIL lights - Illuminated

APU GENERATOR 1 switch - Push

Verify ON light illuminated.

APU GENERATOR 2 switch - Push

Verify ON light illuminated.

Standby Power Test

Airplane must be on ground with all busses powered.

STANDBY POWER selector ....BAT

Verify EICAS advisory messages BAT DISCH MAIN and BAT DISCH APU display. Messages may take up to 3 minutes to display.

STANDBY POWER selector .... AUTO

Verify BAT DISCH MAIN and BAT DISCH APU messages no longer display.

Engine Continuous Ignition

Continuous ignition must be on when operating in:

- moderate to heavy rain
- hail or sleet
- moderate to severe turbulence
- volcanic ash
- upon entering icing conditions

Use standby ignition if continuous ignition is not available.

To manually select continuous ignition:

CONTINUOUS IGNITION switch .... ON

Confirm CON IGNITION ON memo message is displayed.

Engine Crossbleed Start

Verify the area behind the airplane is clear of equipment and personnel prior to increasing thrust on operating engine.

Thrust lever (operating engine) .... Advance

Advance Thrust lever to approximately 70% N2.

Accomplish normal engine start.

Engine Ground Pneumatic Start

Duct pressure .... Observe

Observe duct pressure is a minimum of 30 PSI (less 1 PSI per 1,000 feet of pressure altitude).

Accomplish normal engine start.

Engine Manual Start

Normal start sequence is 4, 3, 2, 1.

Captain	First Officer
	Push Autostart switch OFF.
Call “START _____”.	Pull Engine _____ Start switch and observe N2 rise.
Observe oil pressure increase.*	
Position engine _____ Fuel Control switch to RUN at fuel-on indicator.	
Observe initial EGT rise and EGT within limits.	
	When engine stabilized at idle, push Autostart switch ON if autostart is operative. If more than one engine is to be started manually, Autostart switch may remain OFF between manual starts.
Monitor engine displays for start parameters listed below until engine stabilized at idle: • EGT should rise within 25 seconds after selecting RUN • EGT must stay within limits • N2 should stabilize at idle • N1 rotation and *oil pressure must be indicated by idle N2 (*During cold weather starts, initial oil pressure may be higher than normal.)	

Engine/APU/ Cargo/Fire/Overheat Test

FIRE/OVERHEAT TEST switch...................................... Push and hold

Observe:

Fire bell sounds.

Master WARNING lights illuminate.

Engine Fire switches illuminate.

APU Fire switch illuminates.

Fuel Control switches fire lights illuminate.

Cargo fire FWD and AFT lights illuminate.

EICAS warning message >TEST IN PROG displays.

EICAS warning message >FIRE TESTPASS displays.

FIRE/OVERHEAT TEST switch.. Release

Squib Test

Squib TEST 1 switch ....Push

Observe:

Engine squib lights illuminate.

APU squib light illuminates.

Cargo squib lights illuminate.

Squib TEST 2 switch ....Push

Observe:

Engine squib lights illuminate.

APU squib light illuminates.

Cargo squib lights illuminate.

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Heading Reference Switch Operation

Use TRUE when operating in regions where true referencing is required. Use NORM in all other regions.

HEADING reference switch .... NORM or TRUE

Note: If using HDG SEL mode and the HEADING reference switch position is changed, the AFDS roll mode changes to HDG HOLD; HDG SEL may be reselected.

If making an ILS approach using true referencing, the localizer course referenced to true north must be entered on theNAVRAD page.

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IRS Fast Realignment

A fast realignment may be accomplished when the combined operating time from the last full IRS alignment to the expected next destination arrival time does not exceed 18 hours.

IRS Mode selectors .... ALIGN

CDU .... Set

Enter present position on SET IRS POSITION line of position initialization page.

IRS mode selectors .... NAV

IRS High Latitude Alignment

A high latitude alignment must be accomplished when the latitude of the origin airport is greater than 70°12.0’ and less than 78°15.0’.

IRS Mode selectors .... OFF, then ALIGN

The IRS Mode selectors must remain in ALIGN for a minimum of 17 minutes.

CDU .... Set

Enter present position on SET IRS POSITION line of position initialization page.

IRS mode selectors .... NAV

Weather Radar Test

Weather Radar TEST switch .... Push

ND Mode selector .... MAP

EFIS WXR switch .... Push

Verify radar test pattern displays on ND.

EFIS WXR switch .... Push

Select Captain’s and First Officer’s weather radar displays off.

Desired Mode switch .... Push

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Fuel Balancing

Excessive fuel imbalance adversely affects CG, aerodynamic drag, and therefore, fuel economy. To maintain CG and reduce drag, operate the airplane within limits of FUEL IMBALANCE EICAS advisories.

Fuel may be balanced:

- between main tanks 1 and 4 by opening crossfeed valves 1 and 4, closing crossfeed valves 2 and 3, turning off the fuel pumps in the low tank, and turning off the override pumps in main tanks 2 and 3
- between main tanks 2 and 3 by turning off the fuel pumps in the low tank
- longitudinally by opening all crossfeed valves and turning off the fuel pumps in the low tanks.

Avoid conditions which require fuel suction feed, unless directed by published non-normal procedure.

The fuel system should be returned to normal operating condition when the imbalance condition has been corrected or prior to landing.

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Supplementary Procedures — Chapter SP

Adverse Weather — Section 16

Introduction

Airplane operation in adverse weather conditions may require additional considerations due to effects of extreme temperatures, precipitation, turbulence, and windshear. Procedures in this section supplement normal procedures and should be observed when applicable.

The following recommendations apply to adverse weather operations in general:

- do not use reduced thrust (assumed temperatures) for takeoff on a contaminated runway, or if windshear conditions are suspected
- V1 may be reduced to minimum V1 (assuming all weight limitations are considered) for increased stopping distance performance
- takeoffs on slippery runways are not recommended if the crosswind exceeds 15 knots or when slush or wet snow is more than 1/2 inch (13mm) in depth
- improved stall margins can be achieved by the following:
  - if excess runway is available, consider using improved climb procedures for flaps 20
  - if runway is limited for the planned takeoff flap setting, consider using the next greater flap position with improved climb performance. This provides additional stall margins with minimum performance penalties

Cold Weather Operation

Considerations associated with cold weather operation are primarily concerned with low temperatures and with ice and snow on the airplane, ramps, taxiways and runways.

Icing conditions exist when TAT is 10°C (50°F) or below and:

- visible moisture (clouds, fog with visibility less than one mile, rain, snow, sleet, ice crystals, and so on) is present, or
- standing water, ice, or snow is present on the ramps, taxiways, or runways.

CAUTION: Do not operate nacelle or wing anti–ice when total air temperature (TAT) is above 10°C (50°F).

Preflight

Although removal of surface snow, ice or frost is normally a maintenance function, the flight crew should use additional care and scrutiny during preflight preparation to inspect areas where surface snow or frost could change or affect normal system operations.

Exterior Safety Inspection

Surface .... Check

Takeoff with light coatings of frost, up to 1/8 inch (3mm) in thickness on lower wing surfaces due to cold fuel, is permissible; however, all leading edge devices, all control surfaces, and upper wing surfaces must be free of snow or ice.

Thin hoarfrost is acceptable on the upper surface of the fuselage provided all vents and ports are clear. Thin hoarfrost is a uniform white deposit of fine crystalline texture, which usually occurs on exposed surfaces on a cold and cloudless night, and which is thin enough to distinguish surface features underneath, such as paint lines, markings, or lettering.

Landing gear doors .... Check

Landing gear doors should be free of snow or ice.

Air conditioning inlets and exits .... Clear

Verify air inlets and exits, including the outflow valve, are clear of snow or ice. If the APU is operating, check the outflow valve is full open.

Engine inlets .... Clear

Check inlet cowling free of ice or snow and verify the fan is free to rotate.

APU air inlets .... Check

The APU inlet door and cooling air inlet must be free of snow or ice prior to APU start.

Fuel tank vents .... Clear

Check all fuel tank vents. All traces of ice or frost should be removed.

Pitot probes and static ports .... Clear

Check all pitot probes and static ports free of ice and snow. Water rundown after snow removal may refreeze immediately forward of static ports and cause an ice buildup which disturbs airflow over the static ports resulting in erroneous static readings even when static ports themselves are clear.

Flight Deck Preparation

Packs .... NORM

Provides cabin heating.

Recirculation Fans ....ON

Airplane doors ....Closed

Keep airplane doors closed as much as possible to limit heat loss.

Engine Start

Use normal start procedures; oil pressure may be slow to rise.

After Start

Flight controls .... Check

Move flight controls through full travel to ensure freedom of movement.

Flaps .... Check

Move flaps through full travel to ensure freedom of movement.

CAUTION: Closely observe the flap position indicator for positive movement. If the flaps should stop, immediately place the flap lever in the same position as indicated.

Nacelle Anti–Ice Operation – On the Ground

Nacelle anti–ice must be ON during all ground operations when icing conditions exist or are anticipated except when SAT is less than -40°C.

WARNING: Do not rely on airframe visual icing cues before activating nacelle anti–ice. Use the temperature and visible moisture criteria.

CAUTION: Do not operate nacelle anti-ice when total air temperature (TAT) above 10° C.

When nacelle anti–ice required (on the ground):

Check area behind airplane is clear.

Nacelle Anti-ice switches ....ON

Engine run–up (As required) .... Accomplish

If icing conditions are present, nacelle anti-ice must be selected immediately after engine start. During prolonged ground operation, periodic engine run-up to as high a thrust setting as practical (60% N1 recommended) should be performed to reduce the possiblity of ice build-up. Run-ups of 30 seconds duration should be accomplished at 30 minute intervals.

When nacelle anti-ice is no longer required on the ground:

Nacelle Anti-ice switches .... AUTO

Taxi–Out

CAUTION: Use extreme caution when taxiing on ice-covered taxiways or runways, as excessive speed or high crosswinds may start a skid. Make all turns at a reduced speed. Use smaller tiller and rudder inputs, apply minimum thrust evenly and smoothly.

Nose wheel steering ....Check

Exercise nose wheel steering in both directions during taxi to circulate warm hydraulic fluid through steering cylinders and minimize steering lag caused by low temperatures.

Flaps (As required)...SET

If taxi route is through slush or standing water in low temperatures or if precipitation is falling with temperatures below freezing, taxi with flaps up. Taxiing with flaps extended subjects flaps and flap drives to snow and slush accumulations from the main gear wheels. Leading edge devices are also susceptible to slush accumulations.

If exterior deicing required:

Flaps ....UP

Prevents ice and slush from accumulating in flap cavities.

Thrust levers... CLOSE

Reduces possibility of injury to personnel at inlet or exhaust areas.

Nacelle Anti-ice switches .... ON

Pack control selectors ....OFF

Reduces possibility of fumes entering the air conditioning system.

If APU operations not required:

APU selector ....OFF

APU should be shut down when deicing surfaces around the inlet to eliminate the possibility of deicing fluid entering the APU.

If APU operations required:

APU bleed valve switch .... OFF

CAUTION: With APU operating, ingestion of deicing fluid causes objectionable fumes and odors to enter the airplane. This may also cause erratic operation or damage to the APU.

Wait approximately one minute after completion of deicing to turn Pack selectors on to ensure all deicing fluid has been cleared from the engines:

APU bleed valve switch ....ON

Pack control selectors ....ON

APU selector (As required) .... START, RELEASE TO ON

Before Takeoff

Flaps ....Set

Extend flaps to takeoff setting at this time if they have been held due to slush, standing water, or icing conditions.

BEFORE TAKEOFF Checklist .... Accomplish

Accomplish the complete BEFORETAKEOFF checklist to ensure the airplane is configured for takeoff.

If airplane deicing was accomplished:

A visual inspection of the airplane wings should be made just prior to takeoff.

Engine run–up (As required) .... Accomplish

Takeoff in icing conditions must be preceded by a static run–up to as high a thrust setting as practical (60% N1 recommended) for approximately 30 seconds and stable engine operation checked prior to start of takeoff run.

Climb and Cruise

Nacelle Anti–Ice Operation

Nacelle anti–ice must be used during all flight operations when icing conditions exist or are anticipated, except when the temperature is below –40°C SAT.

When operating in areas of possible icing, activate nacelle anti–ice prior to entering icing conditions. Late selection of nacelle anti–ice may allow inlet ice buildup and ice shedding into the engine.

In moderate to severe icing conditions for prolonged periods with N1 settings at or below 70%, or if fan icing is suspected due to high engine vibration, increase thrust on one engine at a time to a minimum of 70% N1 for 10 to 30 seconds every 10 minutes.

WARNING: Do not rely on airframe visual icing cues before activating nacelle anti–ice. Use the temperature and visible moisture criteria.

Nacelle Anti-ice switches .... AUTO

Wing Anti–Ice Operation

The wing anti–ice system may be used as a deicer or anti–icer in flight only. The primary method is to use the automatic ice detection system which acts as a deicer by allowing ice to accumulate before turning wing anti–ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty.

Note: After the flaps are up, wing anti–ice should be used to melt any accumulation of slush.

The secondary method is to use wing anti-ice prior to ice accumulation. Operate the wing anti–ice system as an anti–icer only during extended operations in moderate or severe icing conditions, such as holding.

Ice accumulation on the flight deck window frames, windshield center post, or windshield wiper arm, or side windows may be used as an indication of structural icing conditions and the need to turn on wing anti–ice.

Normally, it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).

CAUTION: Do not operate wing anti-ice when total air temperature (TAT) is above 10°C (50°F).

Note: Wing anti-icing is not effective with leading edge flaps extended. If icing conditions exist, turn wing anti-icing on after retraction of leading edge flaps; or complete wing anti-icing prior to extension of leading edge flaps.

Note: Prolonged operation in icing conditions with the leading edge and trailing edge flaps extended is not recommended.

Secure

The flight crew should ensure the following actions are accomplished as required:

Outflow Valve Manual switches ....ON

Outflow Valve Manual control .... CLOSE

Inhibits intake of snow and ice.

Wheel chocks ....Check in place

Parking brakes .... OFF

Eliminates the possibility of brakes freezing.

Protective covers and plugs ....Installed

Water storage containers...Drained

Toilets ....Drained

Doors ....Closed

Hot Weather Operation

During flight planning, consider the following:

- high temperatures inflict performance penalties which must be taken into account on the ground before takeoff
- alternate takeoff procedures (Packs Off Takeoff, APU-to-Pack Takeoff, etc.)

During ground operation, consider the following to help keep the airplane as cool as possible:

- all packs should be used (when possible) for maximum cooling
- recirculation fans should be off because the fans add warm air to the conditioned air
- if cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start
- keep all doors and windows, including cargo doors, closed as much as possible
- electronic components which contribute to a high temperature level in the flight deck should be turned off while not needed
- all air outlets on flight deck should be open

- close all window shades on the sun–exposed side of the passenger cabin

Brake temperature levels may be reached which can cause the wheel fuse plugs to melt and deflate the tires. Consider the following actions:

- be aware of brake temperature buildup when operating a series of short flight sectors. The energy absorbed by the brakes from each landing is cumulative
- extending the landing gear early during the approach provides additional cooling for tires and brakes
- in–flight cooling time can be determined from the “Brake Cooling Schedule” in the Performance–In flight section

Engine Operation in Heavy Rain or Hail

If heavy rain or hail encountered or anticipated:

Continuous Ignition switch .... ON

Provides flameout protection and maintains a minimum thrust setting of approach idle. Confirm CON IGNITION memo message is displayed.

During descent:

Autothrottles .... Disconnect

Note: In heavy precipitation, engine parameter fluctuations may occur, particularly a noticeable drop in EGT. Engine parameters will return to normal immediately upon leaving the area of heavy precipitation.

Turbulence

During flight in light to moderate turbulence, the autopilot and/or autothrottle may remain engaged unless performance is objectionable. Increased thrust lever activity can be expected when encountering wind, temperature, and large pressure changes. Short–time airspeed excursions of 10 to 15 knots can be expected.

Passenger Signs switches .... ON

Advise passengers to fasten seat belts prior to entering areas of forecast or suspected turbulence. Instruct flight attendants to check all passengers' seat belts are fastened.

Continuous Ignition switch .... ON

Severe Turbulence

The turbulent air penetration speed of 290-310 KIAS or .82-.85 Mach provides ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limit.

Flight test data substantiates important benfits are obtained from the use of the yaw dampers during turbulence penetration. Excursions in sideslip and roll are minimized and, even though the rudder control may be more active, the structural loads imposed on the vertical tail are considerably reduced.

The recommended procedures for flight in severe turbulence are summarized below.

Climb and Cruise

After takeoff and when established in a clean climb configuration, the autoflight system is recommended for flight through turbulence. To reduce pitch changes as the AFDS attempts to fly speed with elevators, climb and descend using vertical speed (speed on thrust) and cruise using altitude hold.

In extreme turbulence, it may be necessary to disconnect the autothrottles. With autothrottles disconnected, the FMC generates a target thrust setting for cruise which is displayed on EICAS. Set thrust at or slightly above the target thrust indicator. Change thrust setting only if required to reverse an unacceptable speed trend.

Descent

If severe turbulence is encountered at altitudes below 15,000 feet and the gross weight is less than the maximum landing weight, the airplane may be slowed to 250 KIAS in the clean configuration. Adequate stall margin exists under these conditions.

Delay flap extension in an area of known turbulence as long as possible because the airplane can withstand higher gust loads in the clean configuration. Diversion to another airfield is the best policy if severe turbulence persists in the area.

Manual Flight in Severe Turbulence

If manual flight in severe turbulence becomes necessary, trim the airplane for penetration speed, then do not change stabilizer position. Control the airplane pitch attitude with the elevators using the attitude indicator as the primary instrument. In extreme drafts, large attiude changes may occur. Do not make sudden large control inputs. Corrective actions to regain the desired attitude should be smooth and deliberate. Altitude variations are likely in severe turbulence and should be allowed to occur if terrain clearance is adequate. Control airplane attitude first, then make corrections for airspeed, altitude, and heading.

Windshear

If windshear conditions are suspected prior to takeoff, do not use the assumed temperature method for reduced thrust (i.e., entry of a SEL TEMP value on the THRUST LIM page of the FMC). Whenever possible, use maximum thrust available. Use flaps 20 for takeoff unless limited by obstacle clearance and/or climb gradient.

Windshield Washer and Rain Repellent

Note: Do not use windshield wipers or rain repellent on dry window. If rain repellent inadvertently applied, do not use windshield wipers unless windshield washer activated first.

Windshield Washer switch
(As required) .... ON

Rain Repellent switch
(As required) .... Push

Use on one window at a time.

Windshield Wiper selector .... As required

Airplane General, Emergency Equipment, Doors — Chapter 1

Table of Contents — Section 0

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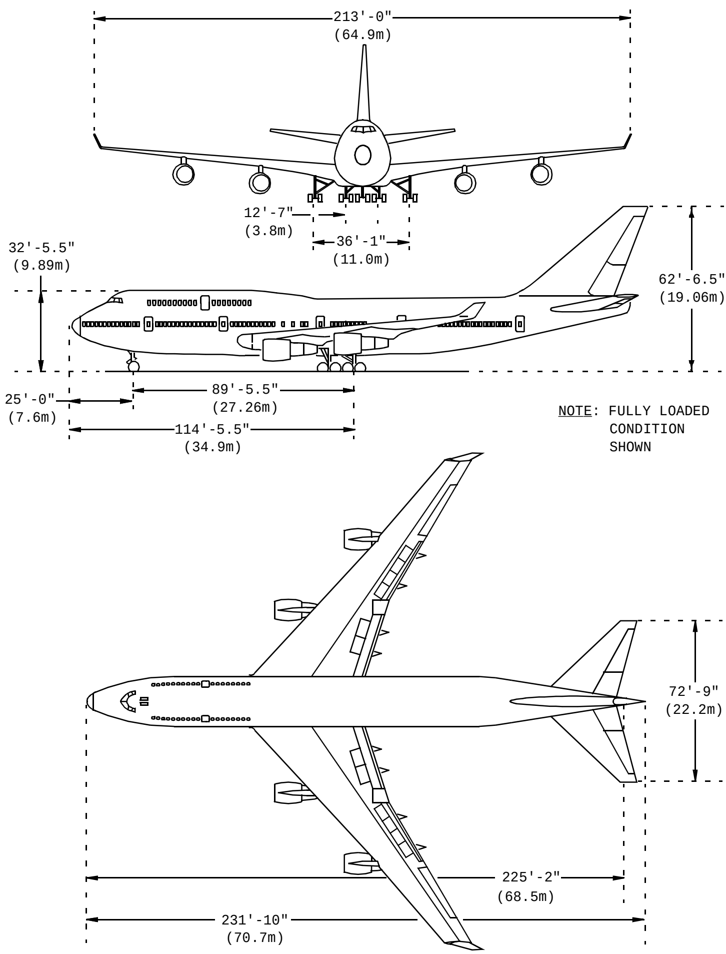
Principal Dimensions



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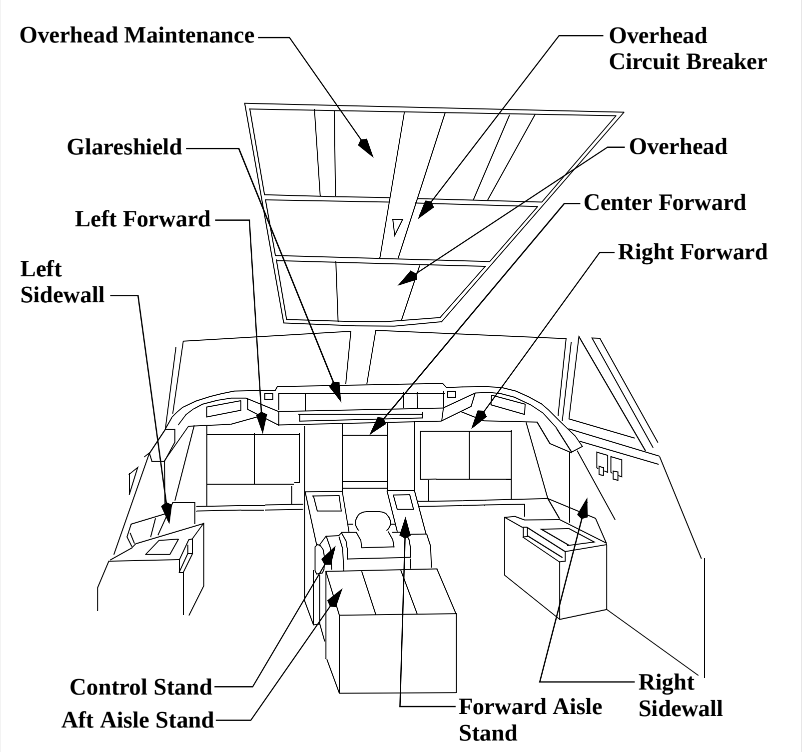
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Instrument Panels — Section 20

Flight Deck Panels



On the following pages, circled numbers refer to chapters where information on the item may be found.

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.

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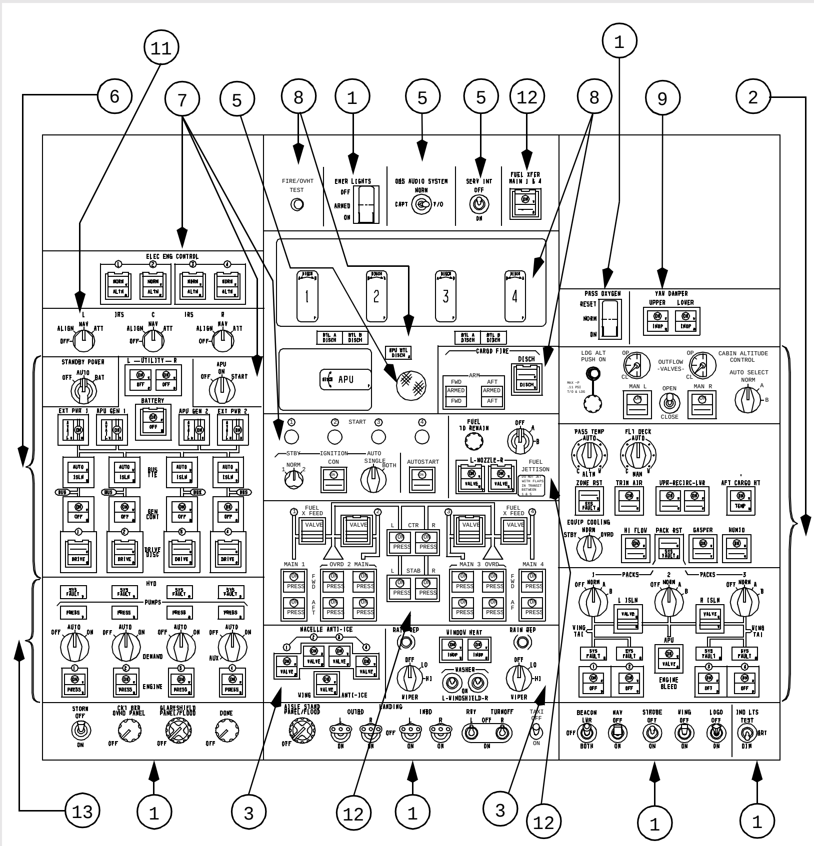
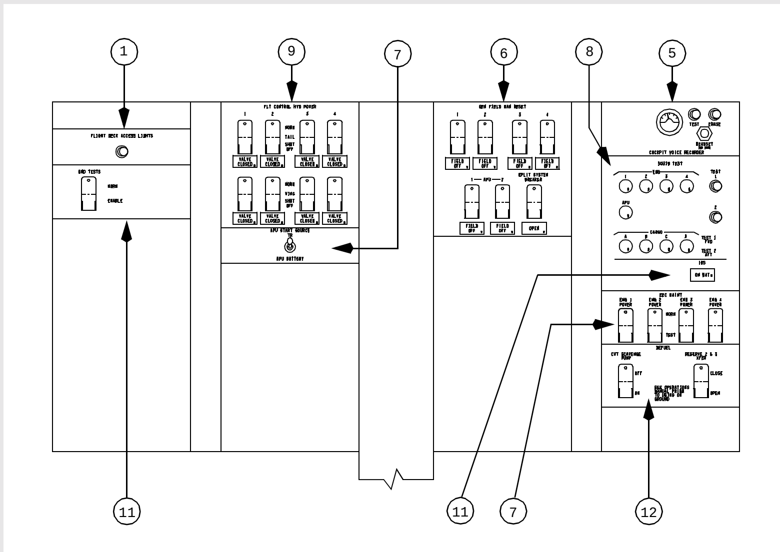
Overhead Panels

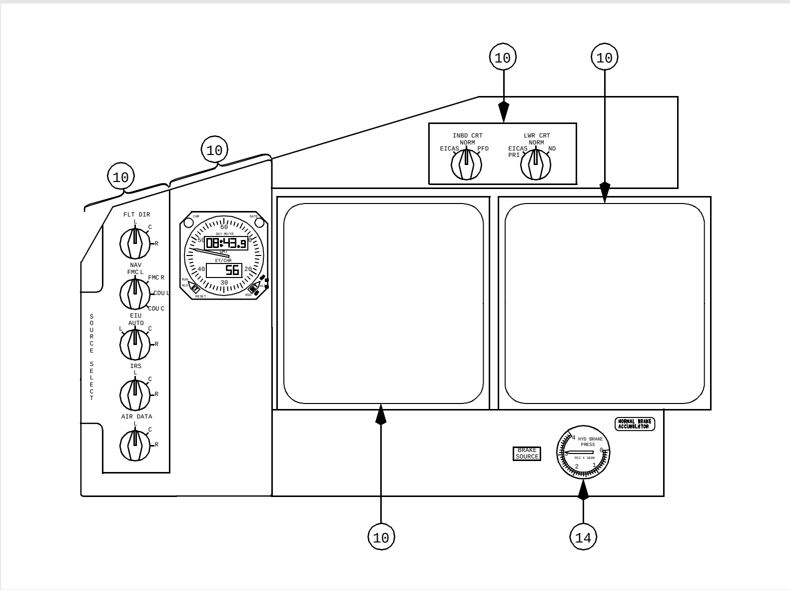
Overhead Panel



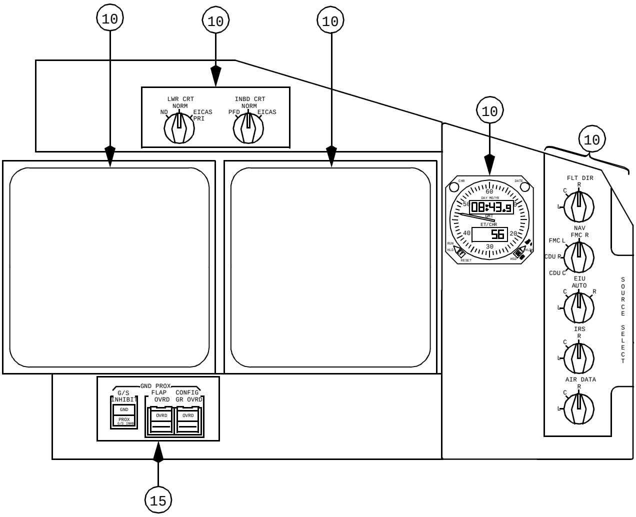
Overhead Maintenance Panel



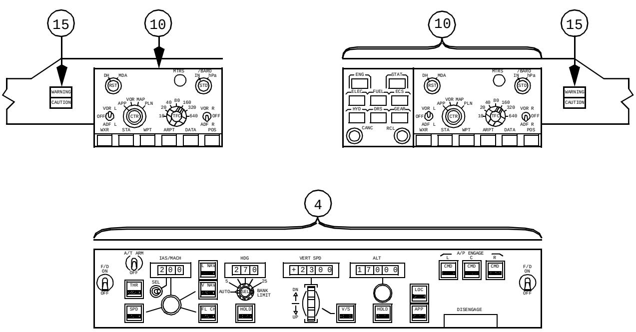
Left Forward Panel



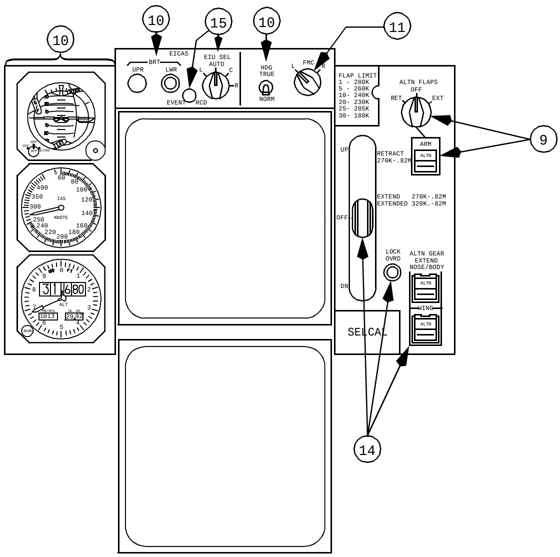
Right Forward Panel



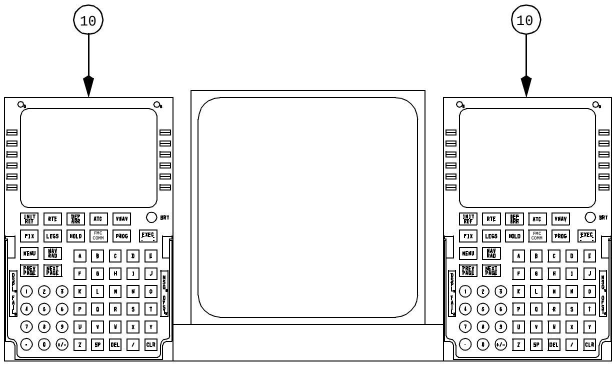
Glareshield Panel



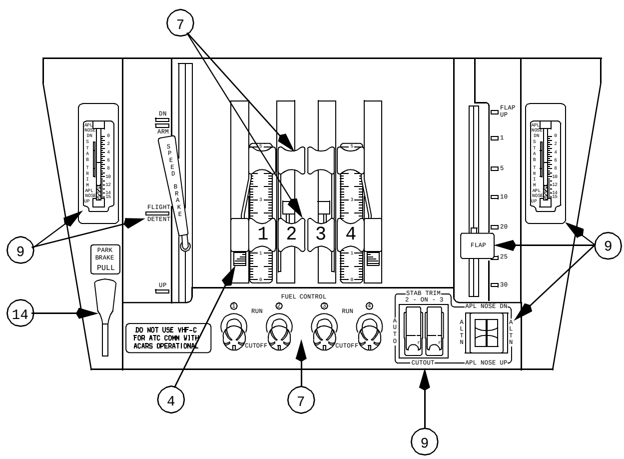
Center Instrument Panel



Forward Aisle Stand

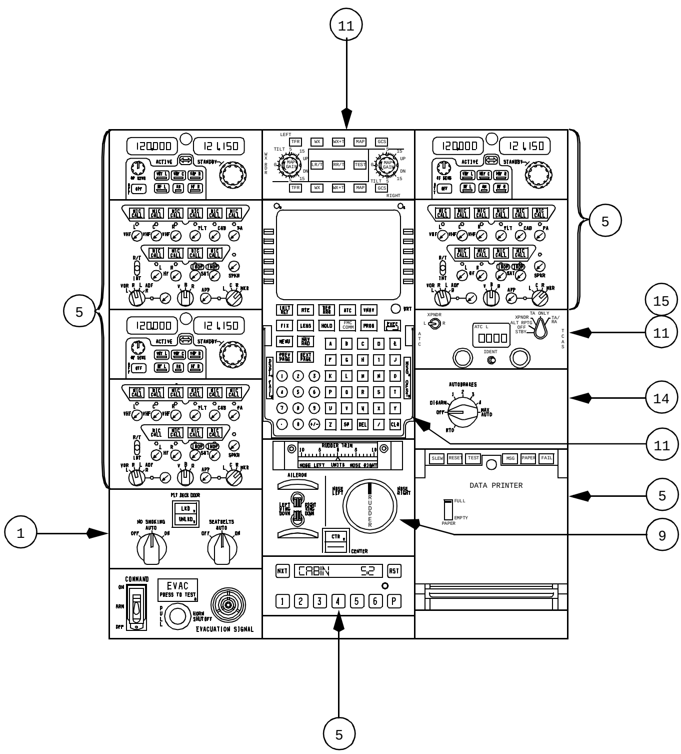


Control Stand

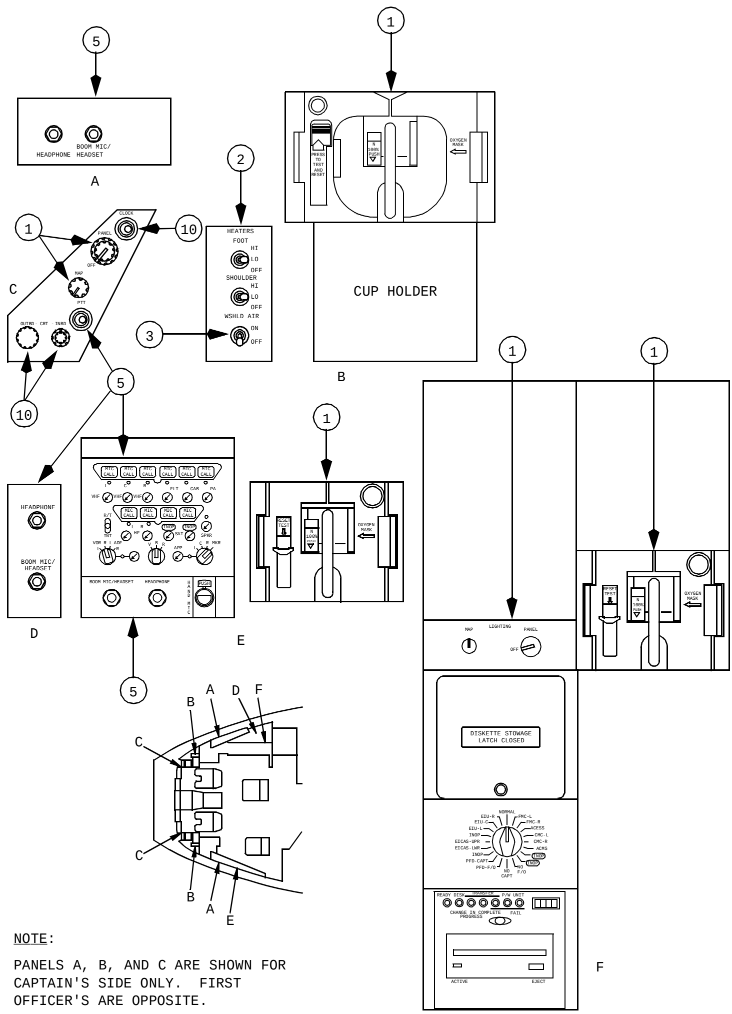


Aft Aisle Stand, Sidewall Panels

Aft Aisle Stand Panels



Left and Right Sidewall, First Observer, and Maintenance Access Terminal/Second Observer Panels



NOTE:

PANELS A, B, AND C ARE SHOWN FOR CAPTAIN'S SIDE ONLY. FIRST OFFICER'S ARE OPPOSITE.

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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.

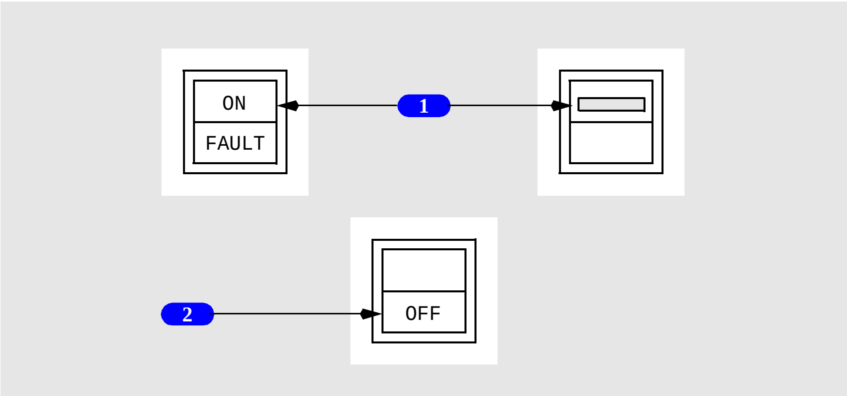
CAUTION: Flight crews should not change switch bulbs. Contact maintenance personnel whenever a bulb requires changing. Damage may result if bulbs are changed with the system powered. Switch bulb changes on the mode control panel may affect system operation in flight.

Alternate Action Switches

Alternate action switches have two positions: on and off.

When pushed in and flush with the panel, the switch is on. The switch indicates the system is on by displaying a word or flow bar.

When pushed out and extended, the switch is off. The switch indicates the system is off by not displaying a word or not displaying the flow bar.



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 activate or deactivate systems or reset system logic. The switch display indicates system status.

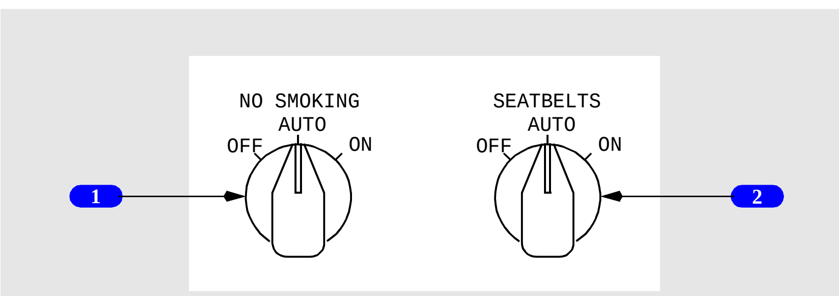
1 **Push to Reset**

Push – resets master lights and aural alerts.

2 **System Operation**

Push – activates or deactivates the system.

Passenger Signs



AFT AISLE STAND

1 **NO SMOKING Selector**

OFF – NO SMOKING signs are not illuminated.

AUTO – NO SMOKING signs illuminate or extinguish with reference to airplane altitude and system configuration (refer to Lighting System Description section).

ON – NO SMOKING signs illuminate.

Note: Anytime passenger oxygen deploys, NO SMOKING and FASTEN SEAT BELTS signs illuminate and RETURN TO SEAT signs extinguish, regardless of selector position.

2 SEAT BELTS Selector

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

AUTO – FASTEN SEAT BELTS and RETURN TO SEAT signs illuminate or extinguish with reference to airplane altitude and system configuration (refer to Lighting System Description section).

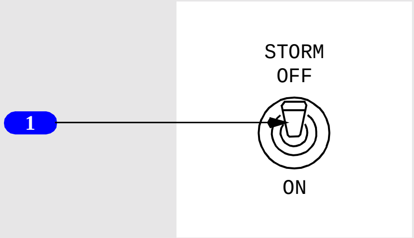
ON – FASTEN SEAT BELTS and RETURN TO SEAT signs illuminate.

Note: Anytime passenger oxygen deploys, NO SMOKING and FASTEN SEAT BELTS signs illuminate and RETURN TO SEAT signs extinguish, regardless of selector position.

Lighting

Flight Deck Lighting

Storm Lights Switch



OVERHEAD PANEL

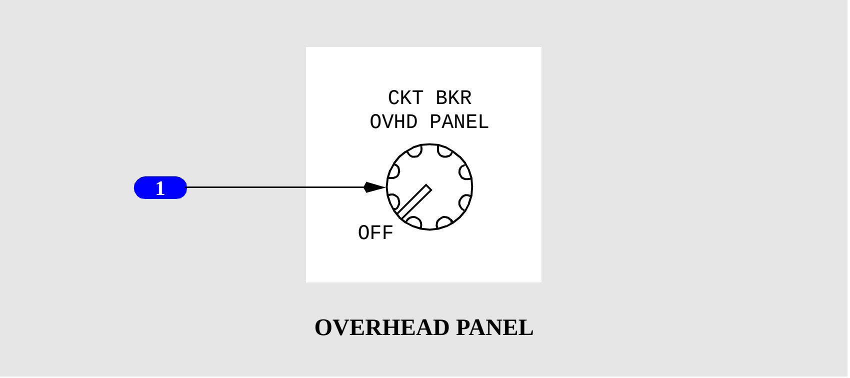
1 STORM Lights Switch

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

- Captain’s and First Officer’s lights
- glareshield lights

- aisle stand flood lights
- dome lights

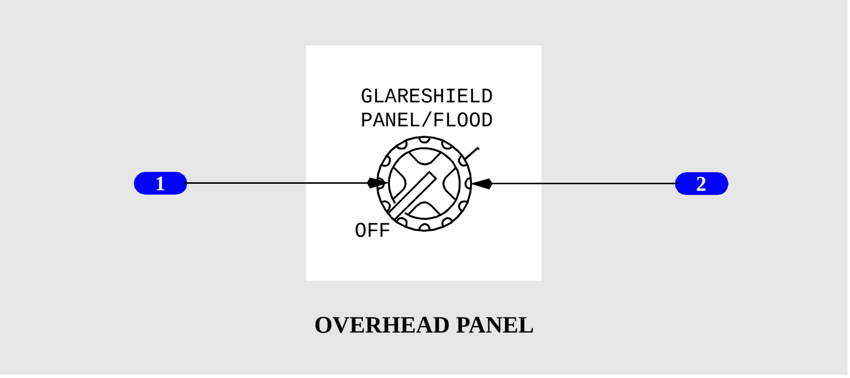
Circuit Breaker/Overhead Panel Lights Control



1 Circuit Breaker/Overhead (CKT BKR OVHD) Panel Lights Control

Rotate - controls circuit breaker panel and overhead panel brightness.

Glareshield Panel/Flood Lights Control



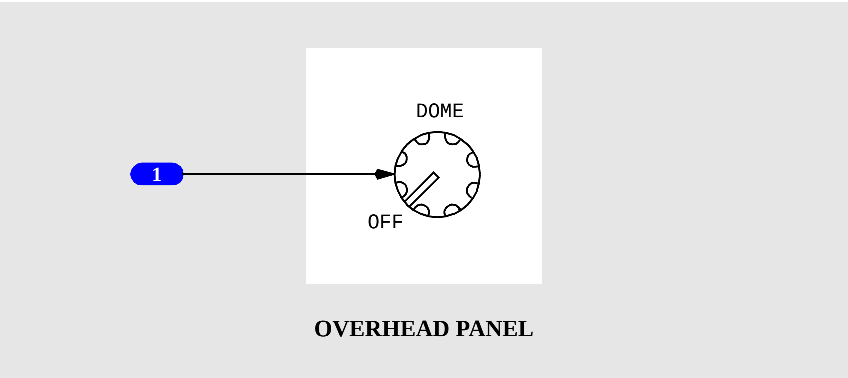
1 GLARESHIELD PANEL/FLOOD Lights Control (inner)

Rotate - controls left and right glareshield flood lights.

2 GLARESHIELD PANEL/FLOOD Lights Control (outer)

Rotate - controls glareshield panel lights.

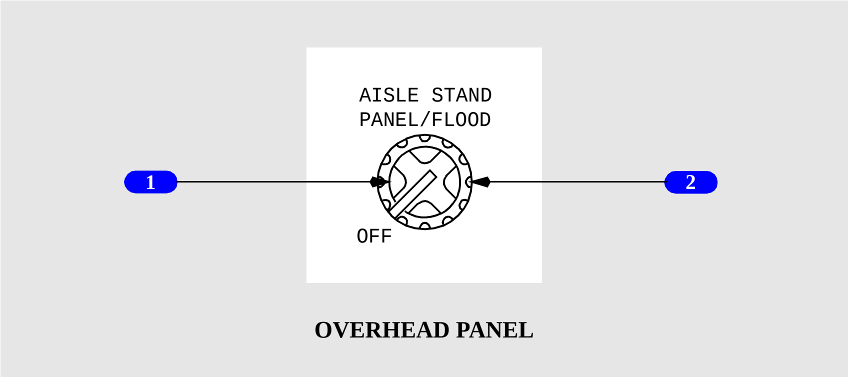
Dome Lights Control



1 DOME Lights Control

- controls dome light brightness
- overridden by storm lights switch

Aisle Stand Panel/Flood Lights Control



1 AISLE STAND PANEL/FLOOD Lights Control (inner)

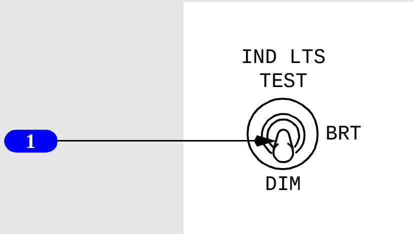
Rotate - controls aisle stand flood lights brightness.

2 AISLE STAND PANEL/FLOOD Lights Control (outer)

Rotate -

- controls aisle stand panel lights brightness
- overridden by storm lights switch

Indicator Lights Switch



OVERHEAD PANEL

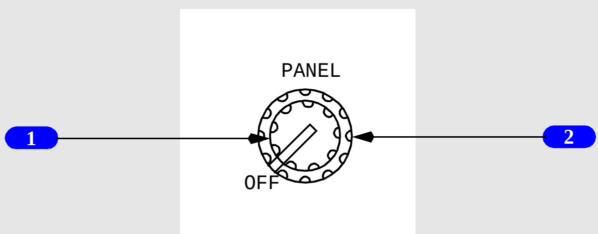
1 **Indicator Lights (IND LTS) Switch**

TEST (spring-loaded) - illuminates all annunciator lights to full brightness for 10 seconds to check the bulbs, then dims the lights as long as switch is held.

BRT - sets all illuminated annunciator lights to full brightness.

DIM - sets all illuminated annunciator lights to low brightness.

Captain's Panels Light Controls



GLARESHIELD

1 **Captain's Panels Light Controls (inner)**

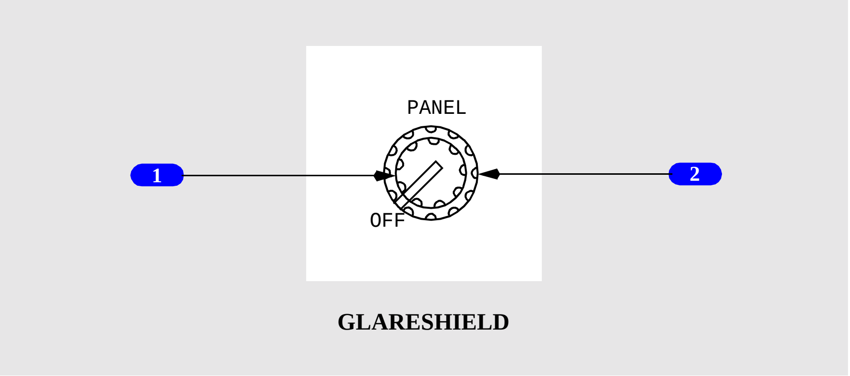
Rotate -

- controls Captain's and center panel floodlights brightness
- overridden by storm switch

2 **Captain's Panels Light Controls (outer)**

Rotate - controls Captain's main panel, left side of center panel, and Captain's lower auxiliary panel lighting.

First Officer's Panels Light Controls



1 First Officer's Panels Light Controls (inner)

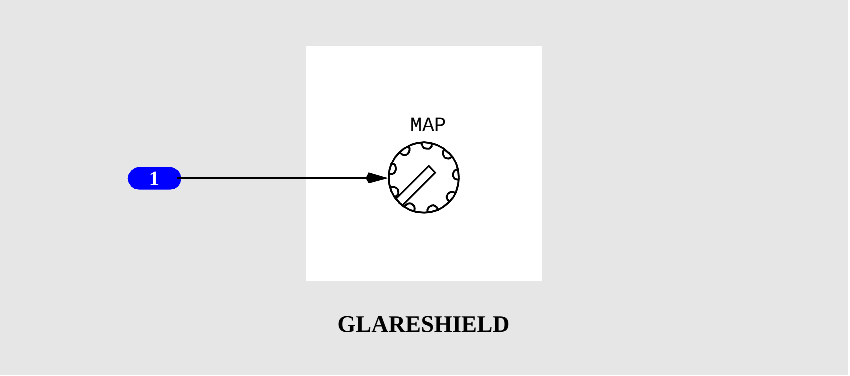
Rotate -

- controls First Officer's panel floodlights brightness
- overridden by storm switch

2 First Officer's Panels Light Controls (outer)

Rotate - controls First Oficer's main panel, right side of center panel, and First Officer's lower auxiliary panel lighting.

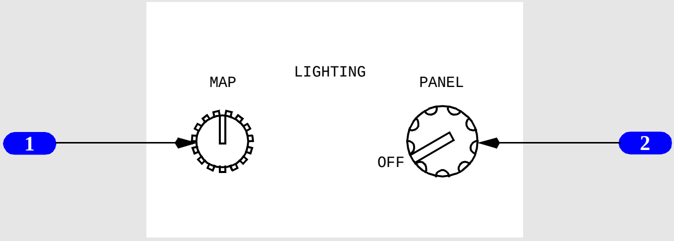
Captain's and First Officer's Map Light Controls



1 Captain's and First Officer's MAP Light Controls

Pull/Rotate - controls related Captain's and First Officer's map light brightness.

First Observer's Map Light Controls



FIRST OBSERVER'S SIDEWALL

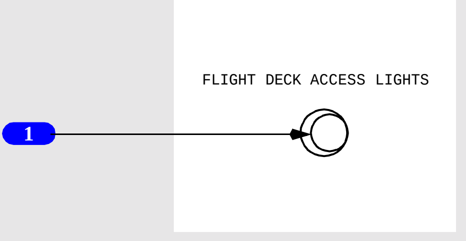
1 First Observer's MAP Light Switch

Pull/Rotate - controls First Observer's map light brightness.

2 First Observer's PANEL Light Switch

Rotate - controls First Observer's panel light brightness.

Flight Deck Access Lights Switches



OVERHEAD MAINTENANCE PANEL

1 FLIGHT DECK ACCESS LIGHTS Switch

Additional Access Lights switches are located at Door 2 left attendant's panel, and Main Equipment Center lower hatch.

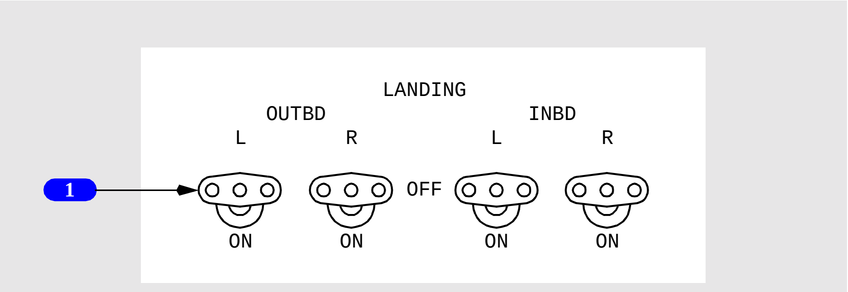
Push (any switch) - when the ground handling bus is powered, illuminates exit or entry path to or from flight deck; activates the following:

- Main Equipment Center lights
- direct ceiling light door 2
- direct ceiling lights upper deck

Second push (any switch) - extinguishes exit or entry path lighting.

Exterior Lighting

Landing Light Switches



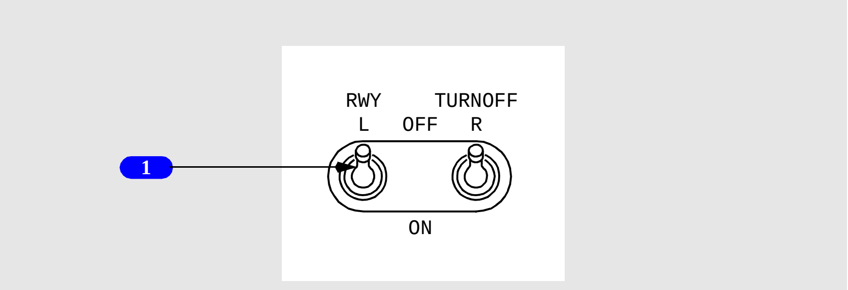
OVERHEAD PANEL

1 Outboard (OUTBD) and Inboard (INBD) LANDING Light Switches

ON (L or R)-

- illuminates related wing landing light
- light intensity at maximum when Landing Gear lever in DOWN position

Runway Turnoff Light Switches



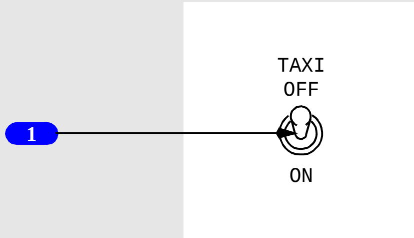
OVERHEAD PANEL

1 Runway (RWY) TURNOFF Light Switches

ON (L or R) -

- illuminates related runway turnoff light
- lights extinguish when air/ground sensing system in air mode

Taxi Lights Switch



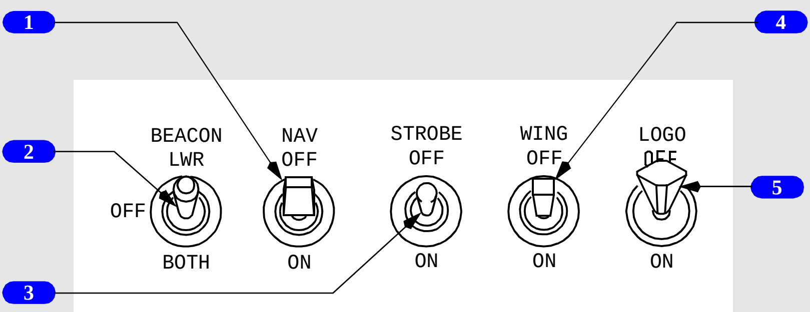
OVERHEAD PANEL

1 TAXI Lights Switch

ON -

- illuminates two taxi lights on nose landing gear
- lights extinguish when air/ground sensing system in air mode

Beacon, Navigation, Strobe, Wing, and Logo Light Switches



OVERHEAD PANEL

1 Navigation (NAV) Lights Switch

ON - illuminates both wing and tail navigation lights.

2 BEACON Lights Switch

Lower (LWR) - activates lower red anti-collison beacon light.

BOTH - activates upper and lower red anti-collision beacon lights.

3 **STROBE Lights Switch**

ON - activates strobe lights.

4 **WING Lights Switch**

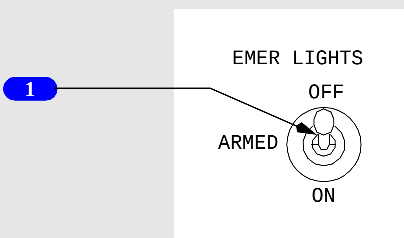
ON - illuminates wing leading edge illumination lights.

5 **LOGO Lights Switch**

ON - illuminates logo lights.

Emergency Lighting Controls

Flight Deck Emergency Lights Switch



OVERHEAD PANEL

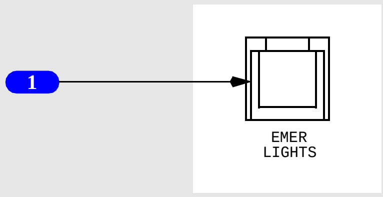
1 **Flight Deck Emergency (EMER) LIGHTS Switch**

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

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

ON – all emergency lights illuminate.

Passenger Cabin Emergency Lights Switch



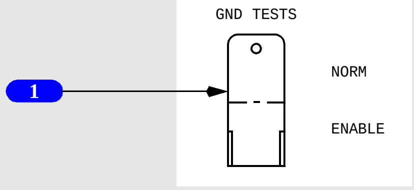
FLIGHT ATTENDANT PANEL
HANDSET CRADLE DOOR 2L

1 Passenger Cabin Emergency (EMER) LIGHTS Switch

Push –

- Illuminated (red):
  - all passenger cabin and exterior emergency lights illuminate
  - bypasses flight deck emergency lights switch
- Extinguished: all passenger cabin and exterior emergency lights extinguish

Ground Tests Switch



OVERHEAD MAINTENANCE
PANEL

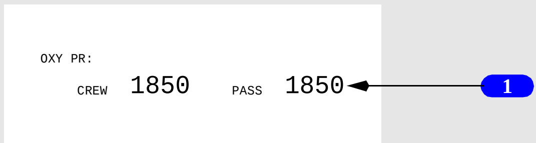
1 Ground (GND) TESTS Switch

ENABLE – allows CMC to initiate ground tests of airplane systems.

NORM (Normal) - systems configured for flight.

Oxygen Systems

Oxygen Indications



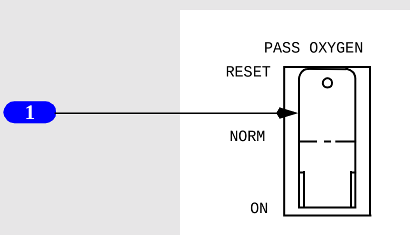
SECONDARY EICAS DISPLAY

1 Oxygen Pressure (OXY PR) Display

Displays crew and passenger oxygen cylinder pressure (PSI).

Note: Access is through display select panel STAT switch.

Passenger Oxygen Switch



OVERHEAD PANEL

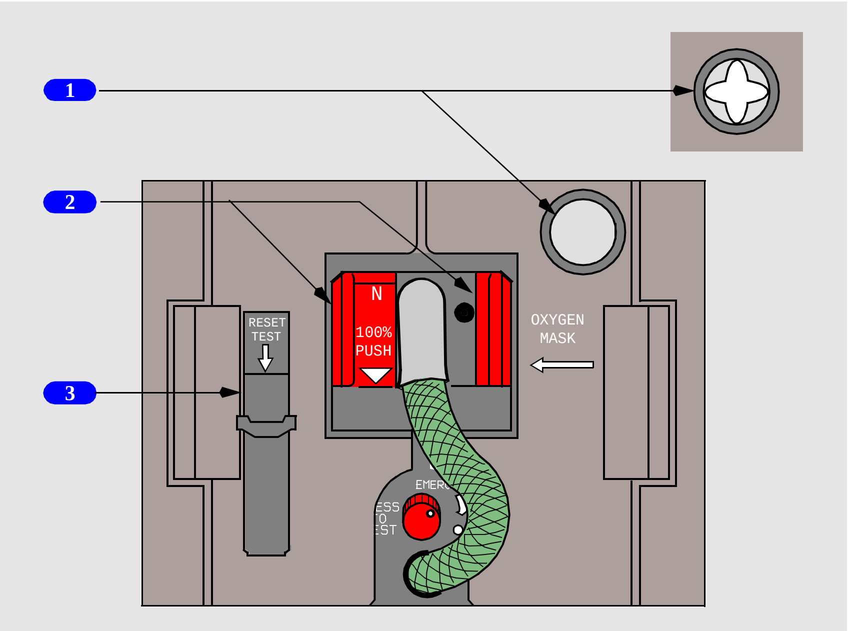
1 PASSENGER (PASS) OXYGEN Switch

RESET (spring–loaded) – flow control units closed electrically when cabin altitude below 12,000 feet

NORM – system activates if cabin altitude reaches approximately 14,000 feet

ON (spring-loaded) – passenger cabin oxygen masks drop.

Oxygen Mask Panel



CREW MEMBER STATION

1 Oxygen Flow Indicator

Shows a yellow cross when oxygen flowing.

2 Oxygen Mask Release Levers

Squeeze and pull –

- unlocks oxygen panel doors
- releases mask
- oxygen turns on when oxygen panel doors open
- flow indicator shows a yellow cross momentarily as harness inflates
- when Captain's or First Officer's left-hand door opens, activates Captain's and First Officer's mask microphones

Squeeze (right lever) – inflates mask harness.

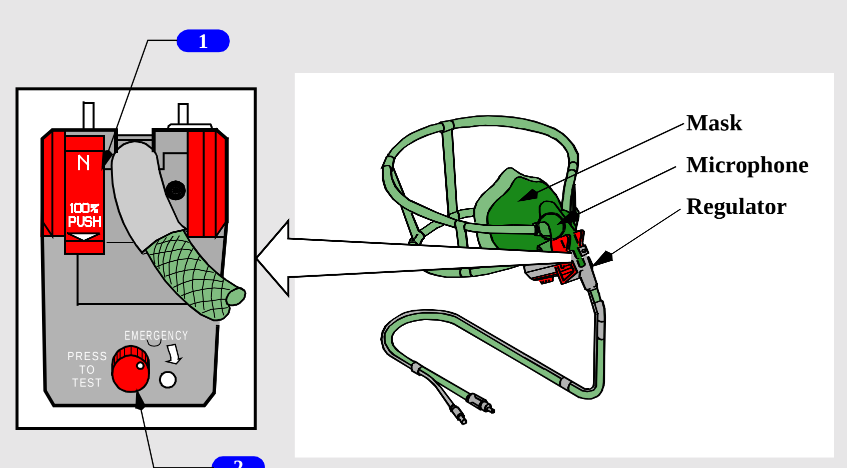
Release – deflates mask harness into position on head and face.

3 RESET/TEST Switch

Push –

- with left oxygen panel door closed and OXY ON not displayed, turns oxygen on momentarily to test regulator
- with the left oxygen panel door closed and the OXY ON flag displayed, turns oxygen off, deactivates the mask microphone, and activates the boom microphone

Oxygen Mask and Regulator



CREWMEMBER STATION
(1 each)

1 NORMAL/100% Switch

N – supplies an air/oxygen mixture on demand (the ratio depends on cabin altitude).

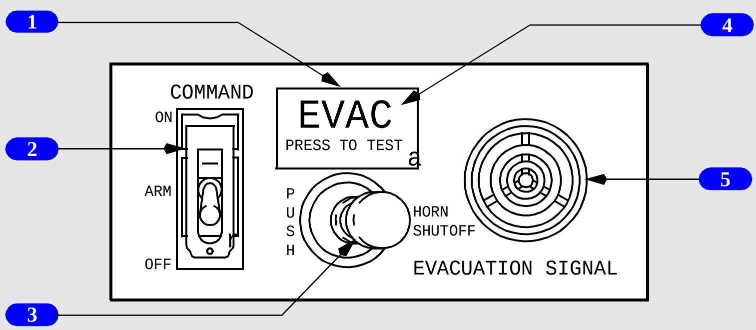
100% – supplies 100% oxygen on demand (not an air/oxygen mixture).

2 Oxygen Mask Emergency/Test Selector

Rotate (in the direction of the arrow) – supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke and harmful vapors).

PRESS TO TEST– tests the positive pressure supply to the regulator.

Emergency Evacuation Panel



AFT AISLE STAND PANEL

1 Evacuation (EVAC) PRESS TO TEST Switch

Push – tests the EVAC light.

2 Evacuation COMMAND Switch

ON –

- activates evacuation signal system
- amber EVAC light (flight deck) and amber EVAC lights (attendant panels) flash
- audio horn sounds at each panel.

ARM – evacuation signal can be activated at flight attendant panel

OFF – allows activation at a flight attendant panel of EVAC COMMAND switch. Activation sounds the pulsating audio signal at the flight deck panel and illuminates a flashing amber light at the flight deck panel and the flight attendant emergency evacuation panel which was activated.

3 Evacuation HORN SHUTOFF Switch

PUSH – silences flight deck evacuation signal horn.

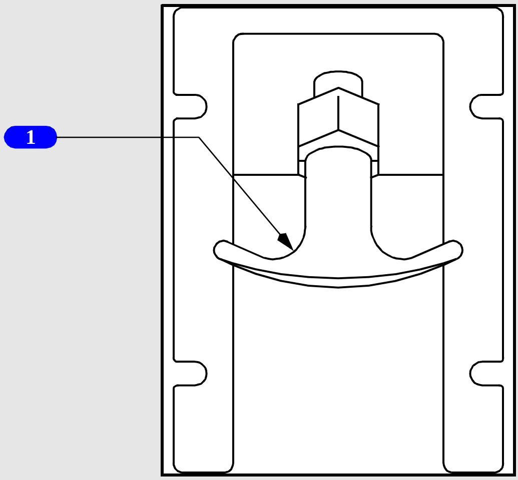
4 Evacuation (EVAC) Light

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

5 EVACUATION SIGNAL Horn

Sounds an audio signal.

Smoke Evacuation Handle



OVERHEAD CIRCUIT
BREAKER PANEL

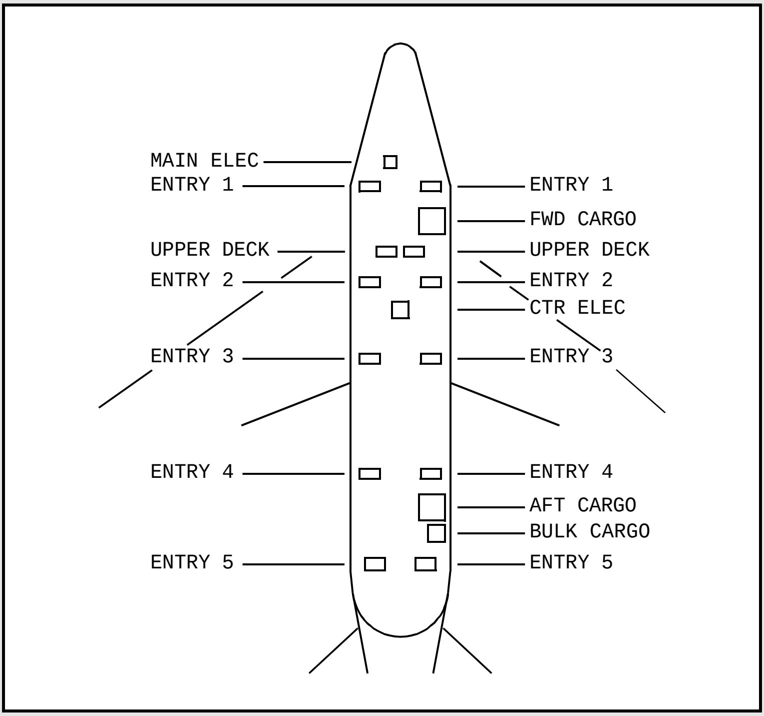
1 Smoke Evacuation Handle

Pull –

- opens flight deck smoke evacuation port
- effective only if airplane pressurized.

Doors

Doors Synoptic Display

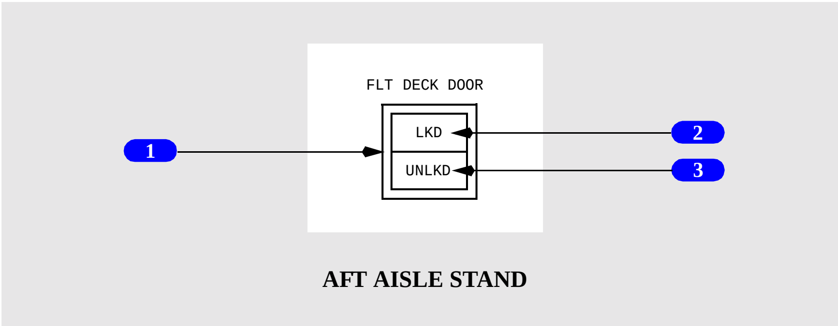


SECONDARY EICAS DISPLAY

(amber) – door open
(blank) – door closed

cyan nomenclature displayed continuously

Flight Deck Door Switch



1 Flight Deck Door Switch

LKD (Locked) -

- locks flight deck door
- lock engaged when door closed

UNLKD (Unlocked) -

- unlocks flight deck door
- door remains in closed position
- door unlocks with loss of electrical power

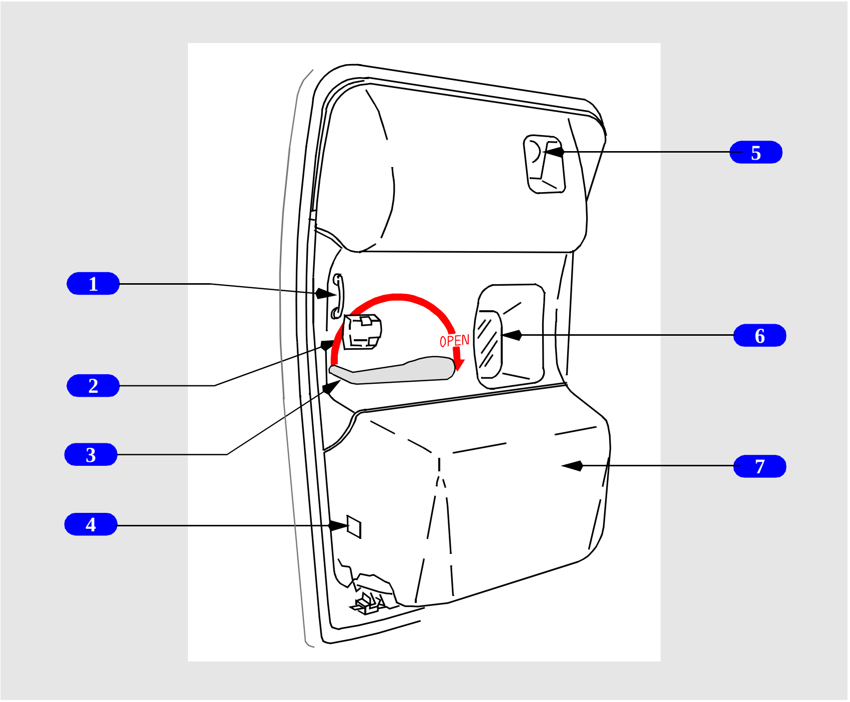
2 Flight Deck Door Locked (LKD) Light

Illuminated dim (white) - solenoid latch locked.

3 Flight Deck Door Unlocked (UNLKD) Light

Illuminated bright (white) - solenoid latch unlocked.

Passenger Entry Doors



1 Door Assist Handle

Allows manual assistance of door-opening motion.

2 Door Mode Select Panel

See following graphic.

3 Door Operating Handle

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

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

4 Slide/Raft Gas Bottle Pressure Gage

If gage needle outside green zone, system is unusable.

5 Escape Slide Lamp

Illuminates escape slide if door opened in automatic mode.

6 Viewing Window

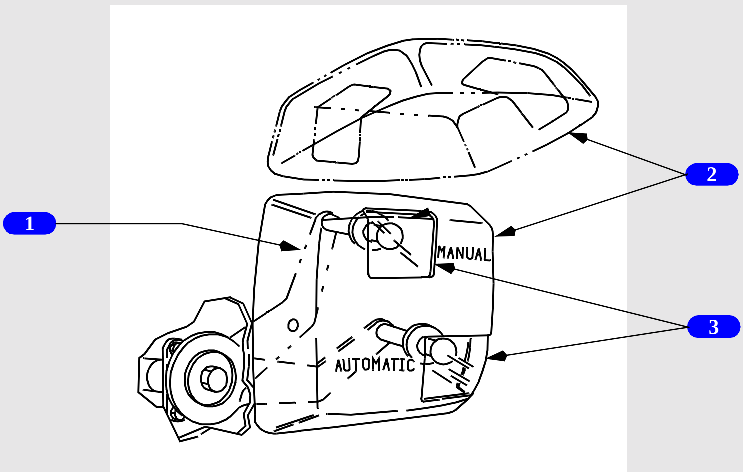
Allows observation outside the airplane.

7 Slide/Raft Bustle

Bustle contains the slide/raft.

Door Mode Select Panel

When door is opened from outside, door mode select lever moves to MANUAL. Lockout pin with warning flag may be installed. Lockout pin prevents handle movement from MANUAL.



DOOR

1 Door Mode Select Lever

AUTOMATIC – if door operating handle moved to open position, door is powered open, and slide/raft deploys.

MANUAL – disables power assist door opening and automatic slide/raft deployment.

2 Access Cover

Open – allows access to door mode select lever.

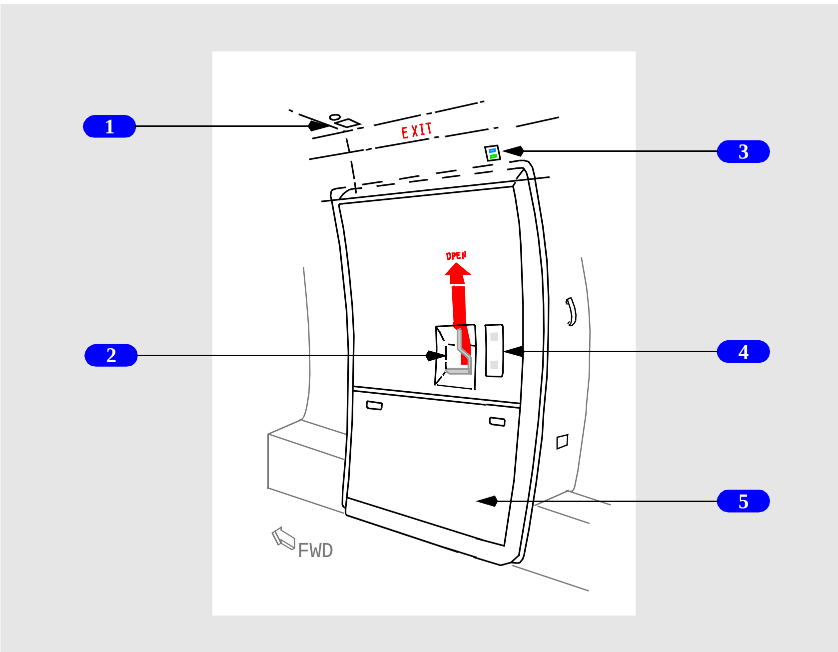
Closed - allows verification of door mode select lever position.

3 Clear Plastic Viewports

AUTOMATIC – knob visible in viewport verifies automatic mode armed.

MANUAL – knob visible in viewport verifies manual mode selected.

Upper Deck Emergency Escape Doors



1 Door Operating Gas Bottle Pressure Gage

If gage needle outside green zone, system is unusable.

2 Door Operating Handle

OPEN -

- unlatches door and permits opening
- deploys slide with door mode selector handle in AUTOMATIC

Down - closes door and engages latches.

3 Door Ground Mode Light/Battery Test Panel

See following graphic.

4 Door Mode Select Lever

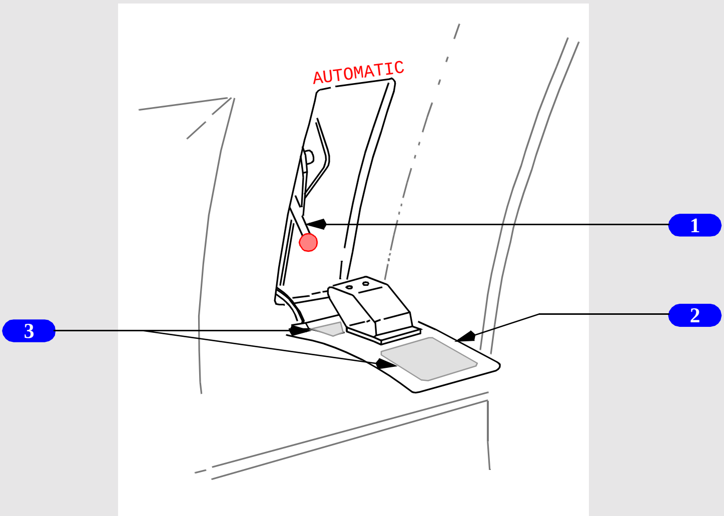
See following graphic.

5 Escape Slide Pack

- pressure in slide inflation bottles checked by maintenance
- rotates through the door when door opened with door mode selector lever in AUTOMATIC

Upper Deck Emergency Escape Door Mode Select Panel

Lockout pin with warning flag may be installed. Lockout pin prevents door mode selector lever movement from MANUAL.



UPPER DECK EMERGENCY ESCAPE DOORS

1 Door Mode Select Handle

AUTOMATIC – if door operating handle moved to open position, door is powered open, and slide/raft deploys.

MANUAL – disables power assist door opening and automatic slide/raft deployment.

2 Access Cover

Open – allows access to door mode select lever.

Closed - allows verification of door mode select lever position.

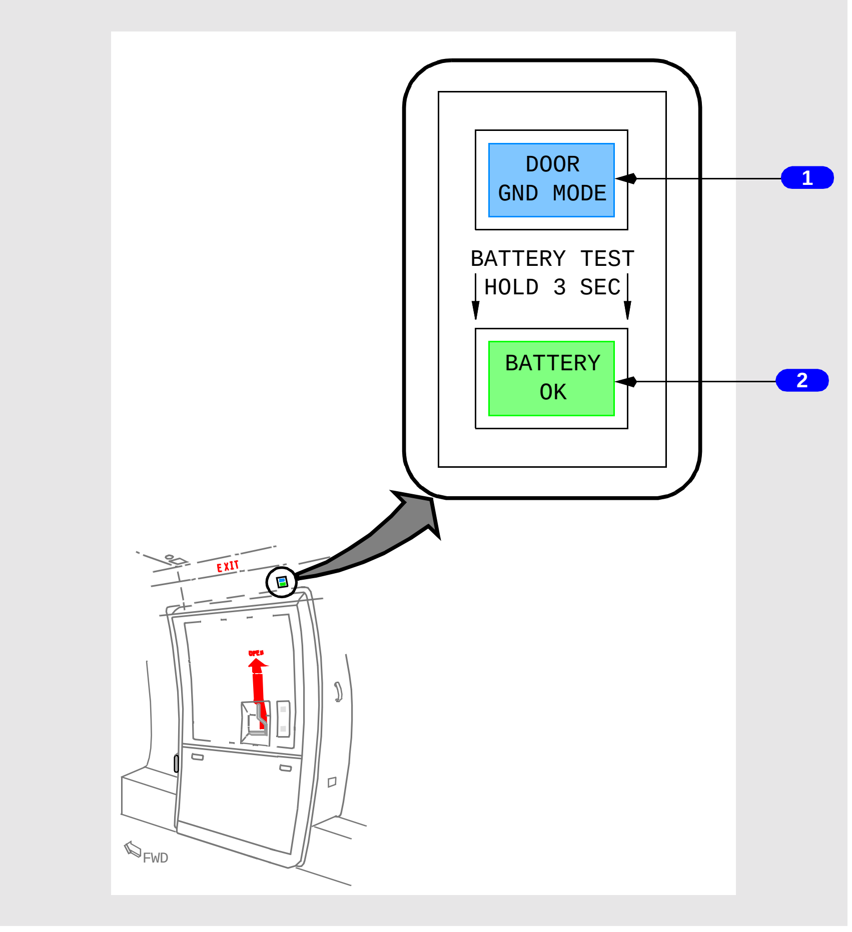
Cover will not close unless door mode select lever fully in MANUAL or AUTOMATIC position.

3 Clear Plastic Viewports

AUTOMATIC – knob visible in viewport verifies automatic mode armed.

MANUAL – knob visible in viewport verifies manual mode selected.

Door Ground Mode/Battery OK Panel



1 DOOR Ground (GND) MODE Light

Illuminated (blue) - on ground or in flight when the flight lock mechanism is not in the locked position.

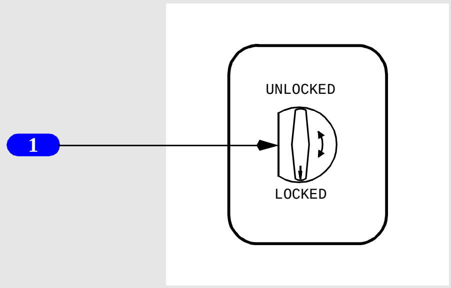
2 BATTERY OK Test Switch/Light

Push -

Illuminated (green) - battery charge is sufficient for door operation.

Note: Light must be pushed and held for 3 - 5 seconds before it will illuminate.

Overhead Escape Hatch Handle



Interior View

1 Overhead Escape Hatch Handle

Rotate handle to unlock hatch.

Pull hatch inward.

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Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- emergency equipment
- doors
- 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

Two landing lights are installed in the leading edge of each wing.

With the Landing Gear lever UP or OFF and the Landing Light switch ON, the wing landing lights are dimmed. With the Landing Gear lever in DOWN position and the switches ON, the wing landing lights are maximum brightness.

Runway Turnoff Lights

Two runway turnoff lights are mounted on the nose gear structure and are aimed approximately 65 degrees to left and right of the airplane center line. The runway turnoff lights illuminate only when the air/ground sensing system is in ground mode.

Taxi Lights

Taxi lights are installed on the nose landing gear. The taxi lights illuminate only when the air/ground sensing system is in the ground mode.

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 standard red (left forward wingtip), green (right forward wingtip), and white (tail cone) position lights.

Logo Lights

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

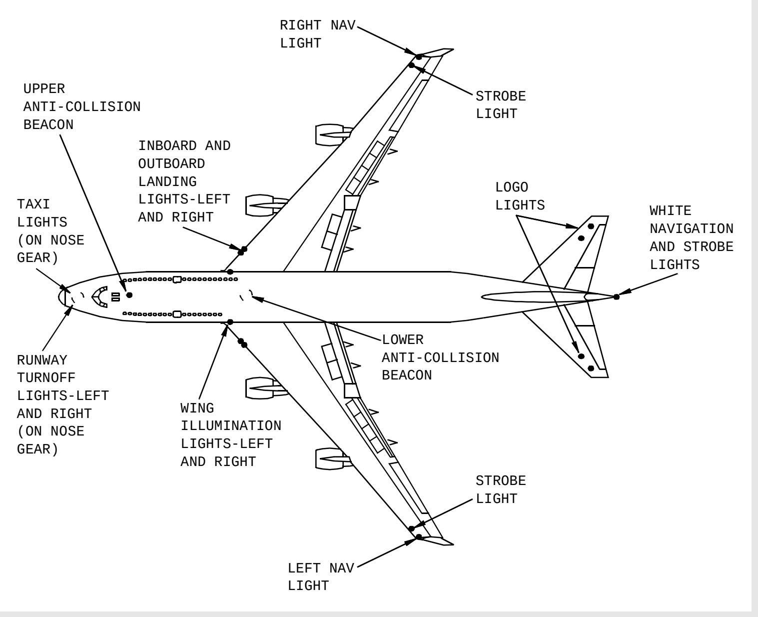
Wing Lights

Wing lights are installed on the fuselage and illuminate the wings and engine nacelles.

Service Lights

Service lights are located at various work areas, such as the wheel wells. Switches for these lights are located at the individual service areas.

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 utility light for each pilot 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, the flood lights operate from standby electrical power. If normal power is lost to aisle stand integral panel lights, the aisle stand flood light illuminates at a reduced intensity.

Cabin Signs

The cabin signs are controlled by selectors on the aisle stand. The 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 10,300 feet, or
- cabin altitude above 10,000 feet, or
- passenger oxygen on

NO SMOKING signs (AUTO selected):

- landing gear not up and locked, or
- cabin altitude above 10,000 feet, or
- passenger oxygen on.

All signs can be controlled manually by positioning the related selector to ON or OFF. When the Fasten Seat Belts and No Smoking selectors are in OFF position, and oxygen is ON, the FASTEN SEAT BELTS and NO SMOKING signs illuminate.

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

The memo message SEATBELTS ON displays when FASTEN SEAT BELTS signs are manually selected ON.

The memo message NO SMOKING ON displays when NO SMOKING signs are manually selected ON.

When FASTEN SEAT BELTS signs and NO SMOKING signs are both selected ON, the memo message PASS SIGNS ON displays, and memo messages SEATBELTS ON and NO SMOKING ON are inhibited.

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

Emergency Lighting

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

Escape path lighting consists of floor mounted locator lights spaced at intervals in the aisles, cross-aisles, and stairway.

Additional battery powered exit identifier lights are located at each cabin exit.

When illuminated, the escape path lighting provides visual guidance for emergency evacuation if all sources of cabin lighting more than four feet above the aisle floor are obscured by smoke.

Exterior emergency lighting consists of escape slide and overwing lights.

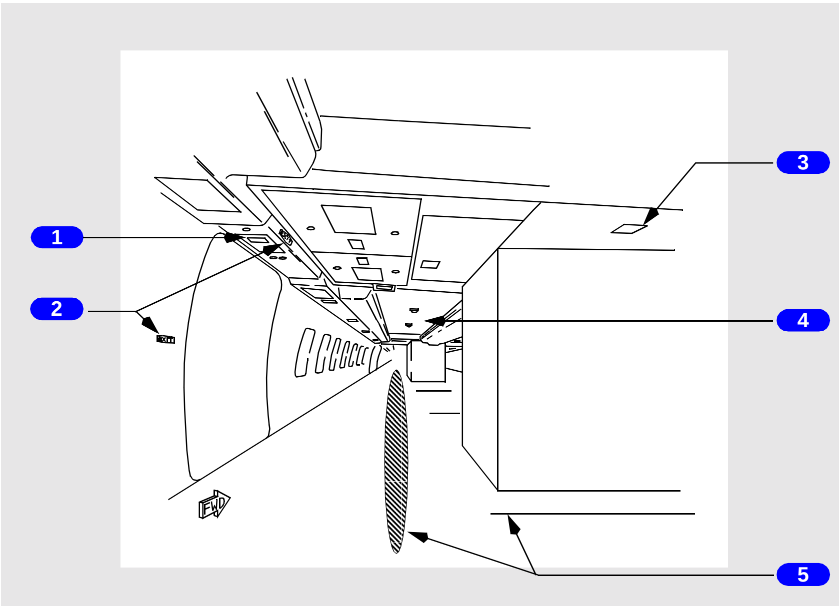
Emergency lighting is controlled by the Emergency Lights switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also 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 door mode select lever is in the armed position, moving the door handle to the open position causes the exterior fuselage light and the interior emergency lights at that door to illuminate.

The emergency lighting system is powered by remote batteries. Battery charge is maintained by DC bus 4. A fully charged battery provides at least 15 minutes of operation.

Interior Emergency Lighting Locations

All Emergency lights and EXIT signs are powered by remote NiCad batteries and are controlled by the Emergency Lights switch.



1 **Emergency Door Light**

2 **EXIT Signs**

3 **Emergency Cross Aisle Light**

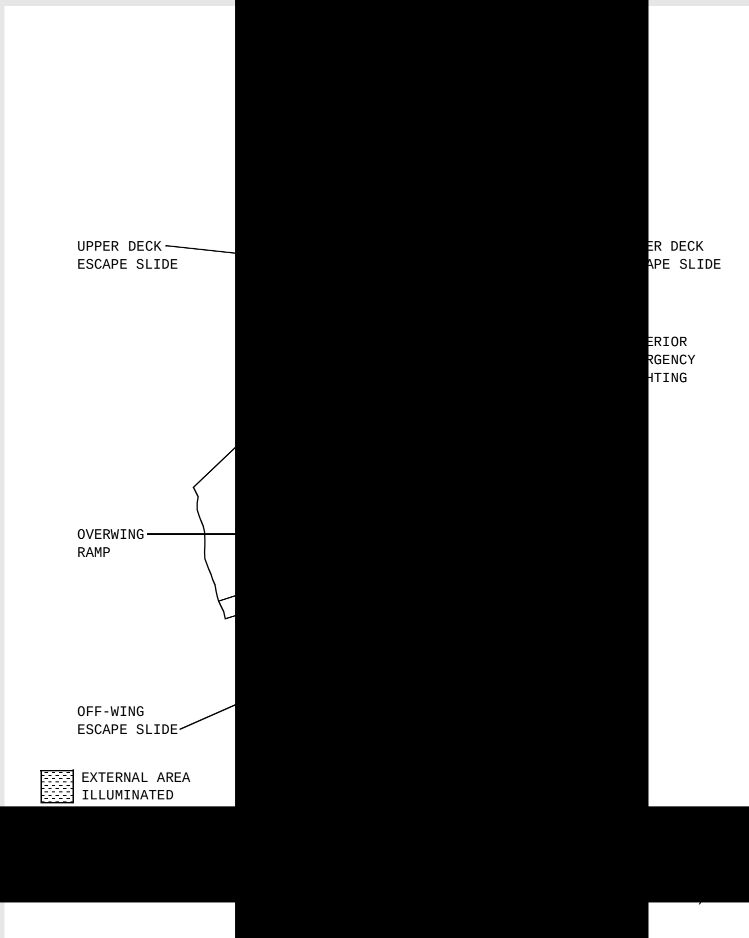
4 **Emergency Aisle Lights**

5 **Emergency Escape Path Lighting**

Exterior Emergency Lighting

External emergency lighting illuminates all escape slides, ramps, and overwing areas.

Exterior Emergency Ligh[redacted]



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Oxygen Systems

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

Oxygen pressure displays on the EICAS STATUS page.

Flight Crew Oxygen System

The flight crew oxygen system uses quick–donning diluter-demand masks located at each crew station. Oxygen flow is controlled by a regulator mounted on each mask.

During the preflight check of the crew oxygen mask, a drop of 30 psi or greater for each mask tested indicates the crew oxygen cylinder shutoff valve may be closed, and oxygen is unavailable.

Squeezing the red release levers with the thumb and forefinger allows the mask to be removed from stowage, inflates the mask harness and momentarily displays the yellow cross in the flow indicator. Releasing the levers after placing the mask over the head deflates the mask harness, fitting it securely to the head and face.

When the left-hand door to the mask stowage box is opened, the mask microphone activates in the removed mask and the First Observer's mask.

An OXYGEN ON flag appears in the mask compartment near the left-hand door of the stowage box, indicating the oxygen supply valve is open. The oxygen system is shut off by closing the left-hand door of the stowage box and pushing and releasing the RESET/TEST slide lever. This action shuts off oxygen to the mask, stows the flag, deactivates the mask microphone, and activates the boom microphone. The oxygen system can be reactivated by opening the left-hand door of the stowage box.

Passenger Oxygen System

The passenger oxygen system is supplied by bottled gaseous oxygen. The oxygen bottles provide oxygen to the passenger, attendant station, and lavatory service units. The passenger oxygen masks are located above the passenger seats in passenger service units (PSUs). The masks automatically drop from the PSUs if cabin altitude exceeds approximately 14,000 feet. Passenger oxygen masks can be manually deployed from the flight deck by positioning the overhead panel Passenger Oxygen switch to ON position.

Oxygen flow to a mask begins when the mask is pulled down.

Oxygen flow can be reset by selecting the Passenger Oxygen switch to RESET position.

Passenger oxygen pressure displays on the EICASSTATUS page.

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.

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Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 45

Emergency Equipment

Emergency equipment described in this chapter includes:

- emergency evacuation signal system
- fire extinguishers
- miscellaneous emergency equipment

Fire Extinguishers

Water and Halon fire extinguishers are located throughout the passenger cabin.

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.

To use the water fire extinguisher, remove it from stowage and rotate the handle fully clockwise. Aim the nozzle at the base of the fire and press the trigger.

CAUTION: Antifreeze compound has been added to the water which makes it unfit for drinking.

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

Halon Fire Extinguishers

Halon fire extinguishers contain a liquified gas agent under pressure. The extinguisher pressure indicator shows three pressure ranges:

- acceptable
- recharge
- overcharged

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.

To use the Halon fire extinguisher, hold the extinguisher upright, and remove the ringed safety pin. From a distance of 8 to 10 feet, aim the extinguisher nozzle at the base of the flames and press the top lever.

WARNING: If a 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.

Miscellaneous Emergency Equipment

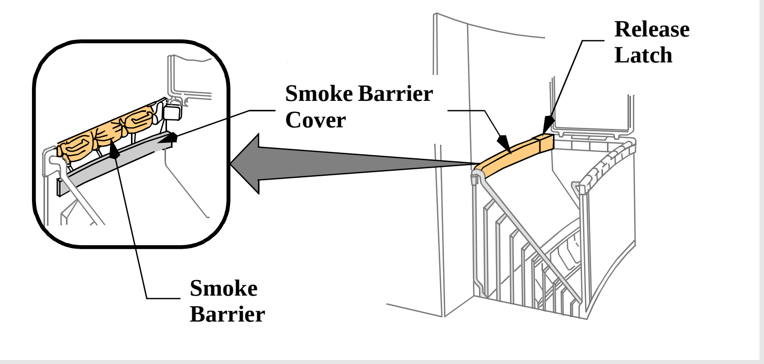
Additional emergency equipment is stowed at strategic locations throughout the airplane as shown in the Emergency Equipment diagram.

Emergency Locator Transmitters (ELTs)

ELTs are installed as shown in the Emergency Equipment diagram. ELTs transmit when slide/rafts are deployed into water.

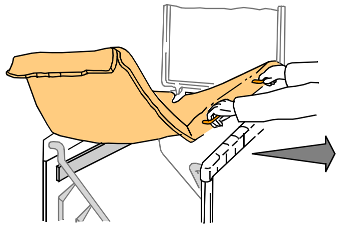
Smoke Barrier

The smoke barrier can be used on the ground to prevent smoke migration by covering the stairwell between the main deck and the upper deck.

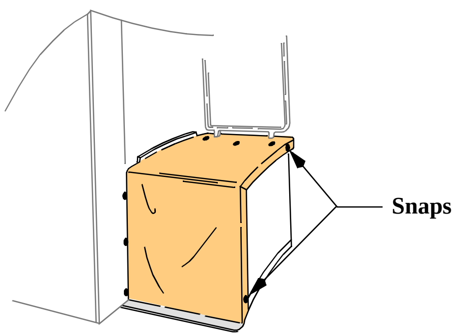


To deploy the smoke barrier:

- pull latch release
  - allows cover to fall free and expose the smoke barrier



- insert fingers in barrier loops
- pull barrier toward railing

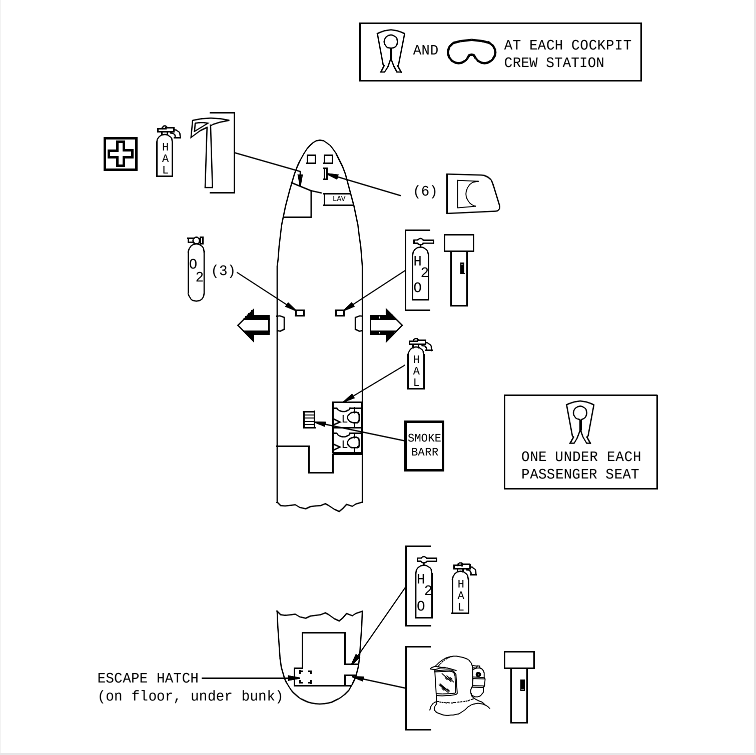


- drape barrier over railing
- engage snaps along top of stairwell and railing sides
- press flap at bottom of barrier against carpet
  - ensures good contact between velcro flap and carpet.

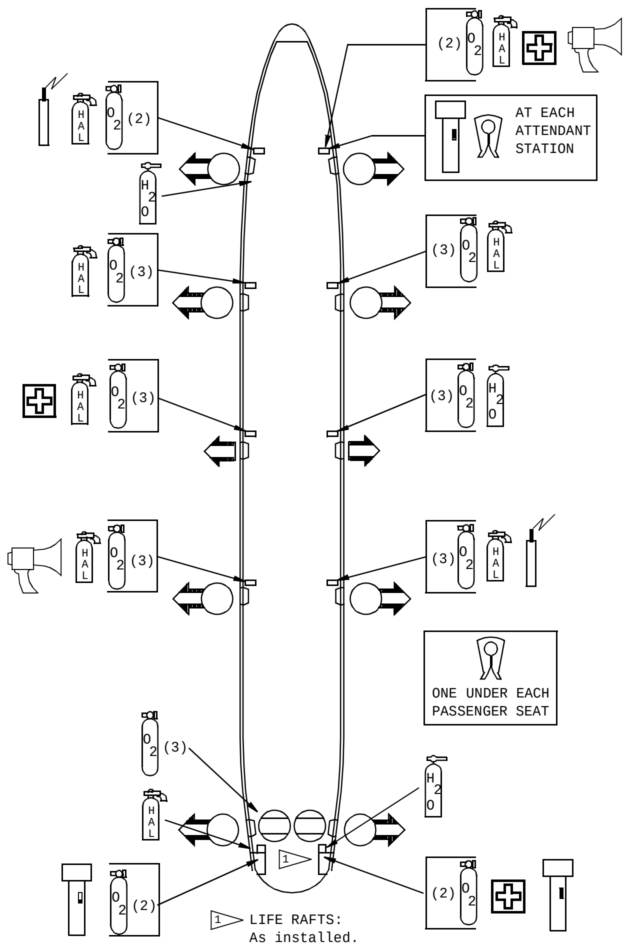
CAUTION: The smoke barrier is for ground use only.

Emergency Equipment Symbols

Emergency Equipment Location Flight/Upper Deck



Emergency Equipment Location Main Deck



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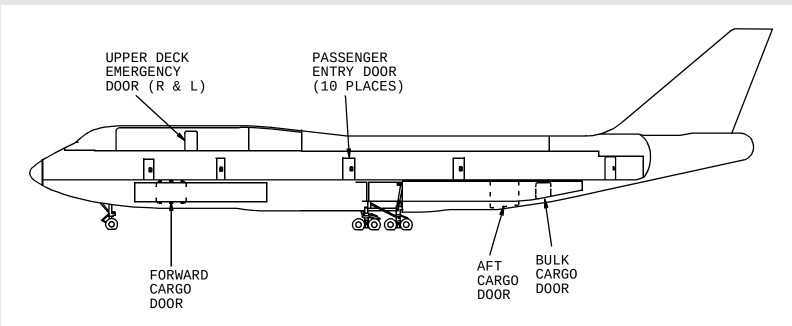
Doors

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

Door Locations



PASSENGER

Flight Deck Door

The flight deck door opens into the flight deck. When the door is closed, a viewing lens in the door allows observation of the passenger cabin.

An electric lock latch mechanism, controlled by the flight deck door switch, allows the flight deck door to be locked. The door can be opened any time from the flight deck side. When the door is locked, a key is required to open the door from the passenger cabin side. The door unlocks with the loss of electric power.

A break–away panel in the base of the door allows the door to open if the bottom of the door is jammed. A door latch mechanism allows the locked door to be forced open without permanent damage to the lock. Application of sufficient force opens the locked door in either direction. An angled door jam forces the door open into the flight deck in case of surrounding bulkhead deformation.

CAUTION: Forcing the door open into the passenger cabin causes permanent damage.

Passenger Entry Doors

The main deck passenger entry doors are used to enter and exit the airplane, and serve as emergency exits. The ten passenger entry doors are paired along the airplane fuselage. The doors are identified 1 through 5 left, and 1 through 5 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 the airplane.

Passenger Entry Door 1, 2, 4, and 5 Slide/Raft Operation

When the door mode select lever is in AUTOMATIC position and the door operating handle is rotated 180 degrees, the door begins to open and the power assist opening system activates.

The flight attendant must release the door operating handle and continue to assist the door opening motion by using the assist handles on the door and on the door surround panel until the door is in the full open and latched position. The door-mounted escape slide/raft deploys and inflates. If the slide/raft does not inflate automatically, pulling the manual inflation handle inflates the slide/raft.

When the door is to be opened from the interior and slide deployment is not desired, the door mode select lever must be in MANUAL position.

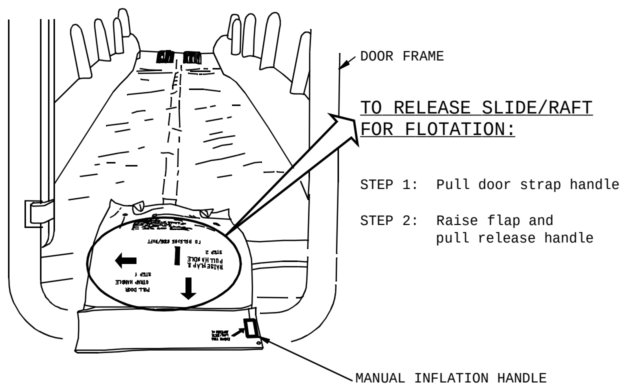
When the door mode select lever is in AUTOMATIC position and the door is opened using the exterior door handle, the door mode select lever handle mechanically positions to MANUAL and the door may be opened without slide deployment.

When the door is closed using either the exterior or interior door handles, the door mode select lever remains in MANUAL and must be positioned to AUTOMATIC to provide automatic slide deployment.

The door mode select lever should not be moved from MANUAL to AUTOMATIC or AUTOMATIC to MANUAL unless the door is fully closed.

Note: If both body gear are not extended, the airplane may tip tail down on the ground. Door 1 escape slides are then unusable.

Slide/Raft Deployed

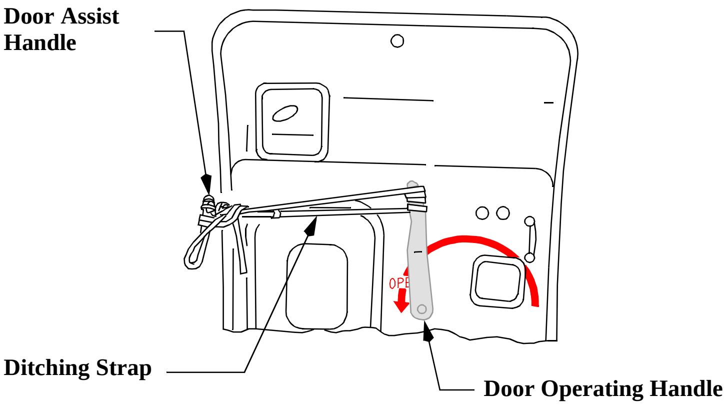


Securing Main Deck Doors 1, 2, 4, or 5 In The Open Position

To accomplish the smoke removal procedure, main entry doors (as designated by the Captain) need to be secured in the partially open position as follows:

- ditching straps forward of doors 3 left and right can be used to secure door 2 or 4 without detaching strap from its compartment
- attach snap end of strap to door assist handle on AFT door frame, place door operating handle to vertical (12 o’clock position), secure handle with several loops, return strap through assist handle and tie as shown below
- pressure on the door maintains tension on the strap so it may be left unattended.

Note: If strap is not available, use any satisfactory item in the same manner to secure the doors.



DOOR SECURED WITH DITCHING STRAP

Passenger Door 3

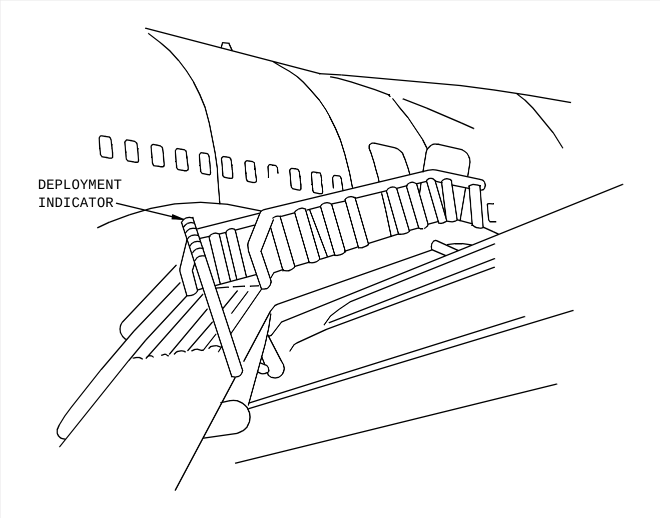
When the door mode select lever is in AUTOMATIC position and the door operating handle is rotated 180 degrees, the door begins to open and the power assist opening system activates.

The flight attendant must release the door operating handle and continue to assist the door opening motion by using the assist handles on the door and on the door surround panel until the door is in the full open and latched position. The door-mounted escape slide deploys and inflates. An off-wing deployment indicator is visible to the flight attendant at door 3 when the off-wing escape slide is properly deployed.

If the ramp/slide does not open automatically, pulling the manual inflation handle inflates it manually.

If door 3 is used during a ditching situation, placing the door mode select lever in MANUAL allows the door to be opened without deploying the ramp slide.

Door 3 Slide Deployed



Upper Deck Doors

Upper deck doors are used for emergency evacuation only. The escape slides cannot be used as rafts.

With the door mode select lever in AUTOMATIC position, lifting the door operating handle acutates the emergency power system for the door, moving the door up and out to full-open position. The escape slide deploys and inflates as the door opens.

A gas bottle powers each upper deck door opening mechanism. A pressure gage is located above each upper deck door for checking bottle pressure.

A green push-to-test battery OK light is located above each upper deck door.

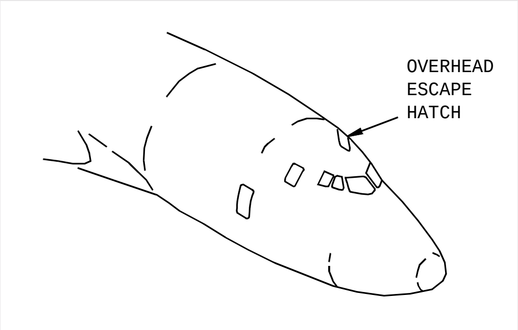
An automatic lock activates in flight to lock the upper deck door operating handles to prevent inadvertent operation. If the automatic lock fails to activate after takeoff, it is possible to open an upper deck door when cabin differential pressure is low.

Flight Deck Overhead Hatch

The flight deck overhead hatch located just aft of the overhead panels can be opened from either inside or outside the airplane.

The hatch is opened from inside the airplane by rotating the interior handle. The hatch is opened from the outside by pressing the release trigger which allows the exterior handle to spring out from its recessed position. Rotating the handle then unlocks the hatch.

Flight Deck Overhead Hatch Location



Emergency Escape Devices

Six emergency escape devices are stowed adjacent to the flight deck overhead hatch.

The emergency escape device is used by removing it from the holder and departing through the escape hatch opening while holding the device handle. Inertial reels limit the speed of descent.

Cargo Doors

The three cargo doors are on the right side of the airplane. 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.

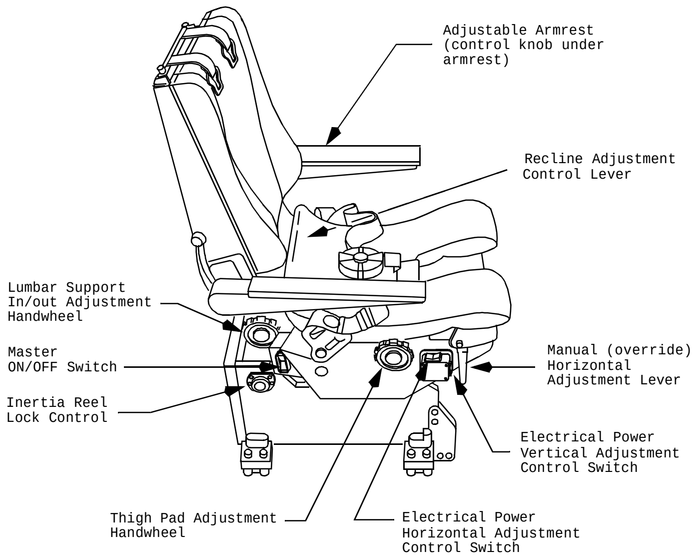
The bulk cargo door is manually opened and closed, and is counterbalanced for ease of operation.

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 four inches of aft travel. Electric and manual controls provide forward, aft, and vertical adjustment. Manual levers provide other adjustments.

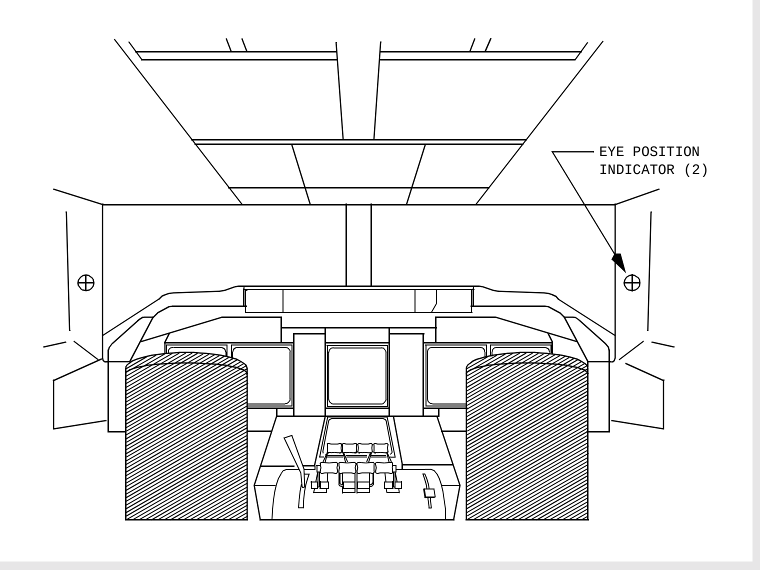
A master ON/OFF switch is located behind the lumbar support in/out adjustment handwheel.

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.

Adjusting the seat obtains the optimum eye position as shown on the following illustration. The vertical line on the eye position indicator just passes out of peripheral vision (looking straight ahead) when the seat is properly adjusted.

Note: The recline adjustment will be in an optimum position near or slightly aft of the full upright position.

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
- crotch strap
- inertial–reel shoulder harness with manual locks
- lap belt
- adjustable headrest

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

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

Door 5 Overhead Crew Rest

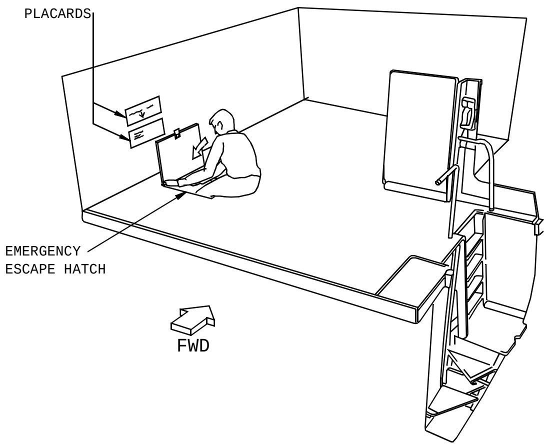
The door 5 overhead crew rest area is entered through a locked door on the right side of the airplane aft of door 5R. An emergency escape hatch is located on the floor on the left side of the crew rest area. To use the emergency escape hatch follow the placarded instructions. In some cases, a bunk must be moved to access the emergency escape hatch.

Crew members occupying crew rest must be trained in the use of evacuation routes in accordance with FAA approved evacuation procedures contained in Boeing document D926U303, Appendix D.

Evacuation Using Emergency Escape Hatch

The following can be used as a general guideline for evacuation of door 5 crew rest area. For egress, open the emergency escape hatch and latch it open. If the ceiling panel is in place, sit on floor with legs in hatch and kick out ceiling panel. Lower legs into hatch opening and sit on floor facing outboard, reach out and grab the outboard handholds (keeping elbows close to sides), and swing down to main deck.

Door 5 Overhead Crew Rest Emergency Escape Hatch



Airplane General, Emergency Equipment, Doors EICAS Messages

The following EICAS messages can be displayed.

Doors EICAS Alert Messages

Message	Level	Aural	Condition
DOOR U/D FLT LK	Caution	Beeper	Affected door automatic lock fails to activate after takeoff.
DOOR L, R UPPER DK	Advisory		Upper deck door not closed and latched.
DOOR AFT CARGO	Caution	Beeper	Aft cargo door not closed, latched, and locked.
DOOR BULK CARGO	Advisory		Bulk cargo door not closed and latched.
DOOR ELEC CTR	Advisory		Center electrical equipment door not closed and latched.
DOOR ELEC MAIN	Advisory		Main electrical equipment door not closed and latched.
DOOR ENTRY 1L, 2L, 3L, 4L, 5L, 1R, 2R, 3R, 4R, 5R	Advisory		Entry door not closed and latched.
DOOR FWD CARGO	Caution	Beeper	Forward cargo door not closed, latched, and locked.
DOORS ELEC	Advisory		Both electrical equipment doors are not closed and latched.
DOORS ENTRY L, R	Advisory		Two or more entry doors on the same side are not closed and latched.
DOORS UPR DECK	Advisory		Both upper deck doors are not closed and locked.

Emergency Lights EICAS Alert Messages

Message	Level	Aural	Condition
>EMER LIGHTS	Advisory		Emergency Lights switch not in ARM position, or Emergency Lights switch in ARMED position and emergency lights activated by switch at flight attendant's panel.

Oxygen System EICAS Alert Messages

Message	Level	Aural	Condition
>CREW OXY LOW	Advisory		Crew oxygen pressure low.

Message	Level	Aural	Condition
PASS OXYGEN ON	Advisory		Passenger oxygen system has activated.

Emergency Lights and Passenger Signs EICAS Memo Messages

Message	Condition
NO SMOKING ON	No Smoking switch in ON position.
PASS SIGNS ON	No Smoking and Seat Belts switches in ON position.
SEATBELTS ON	Seat Belts switch in ON position.

Oxygen System EICAS Memo Messages

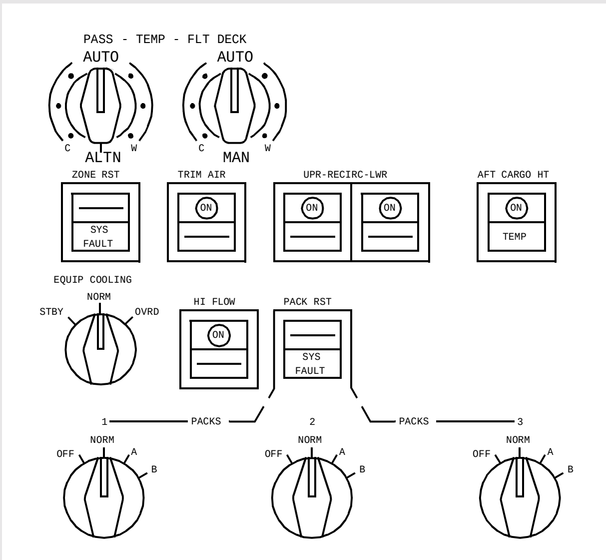
Message	Condition
PASS OXYGEN ON	Passenger oxygen system activated.

Air Systems — Chapter 2
Table of Contents — Section 0

Air Conditioning System

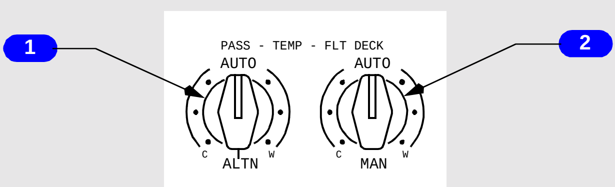
Air Conditioning

ECS Control



OVERHEAD PANEL

Passenger and Flight Deck Temperature Selectors



ECS PANEL

1 Passenger Temperature (PASS TEMP) Selector

AUTO -

- provides automatic control of passenger zone temperatures
- sets master temperature for all zones
- range C to W sets temperature from 65°F (18°C) to 85°F (29°C)
- in backup mode, range C to W sets average cabin temperature from 65°F (18°C) to 85°F (29°C) and cabin temperatue panel control of zone temperatures is inhibited

ALTN -

- zone trim air valves remain in last position and master trim air valve remains open
- zone temperature controller bypassed
- pack output temperature regulated to provide average cabin temperature of 75°F (24°C)
- cabin temperature panel control of zone temperatures inhibited

2 Flight (FLT) DECKTemperature (TEMP) Selector

AUTO -

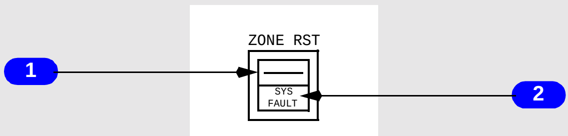
- provides automatic control of flight deck temperature
- range C to W sets flight deck temperature from 65°F (18°C) to 85°F (29°C)

MAN (spring loaded to 6 o'clock position) - flight deck trim air valve controlled manually

C (cool) - valve moves toward closed to provide cooler air

W (warm) - valve moves toward open to provide warmer air

Zone Reset Switch and Zone System Fault Light



ECS PANEL

1 ZONE Reset (RST) Switch

Push -

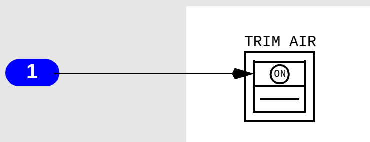
- resets zone temperature controller if fault no longer exists
- reopens master trim air valve if duct overheat no longer exists

2 Zone System (SYS) FAULT Light

Illuminated (amber) -

- temperature zone duct overheat or zone temperature controller fault has occured
- master trim air valve failed closed
- Trim Air switch off
- master trim air valve closed and pack air continues to flow

Trim Air Switch



ECS PANEL

1 TRIM AIR Switch

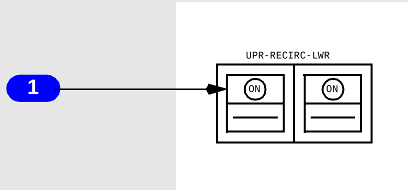
ON –

- master trim air valve open and zone trim air valves operate automatically
- automatic and manual selection of pack controller A or controller B enabled

Off -

- master trim air valve closed
- pack output temperature in backup mode regulated to provide average passenger cabin temperature from 65°F (18°C) to 85°F (29°C) as selected by passenger temperature selector in AUTO
- cabin temperature panel control of temperatures inhibited
- pack controller A selected and both automatic and manual selection of pack controller B inhibited
  - if pack controller A failed, pack controller B selected automatically

Recirculation Fans Switch



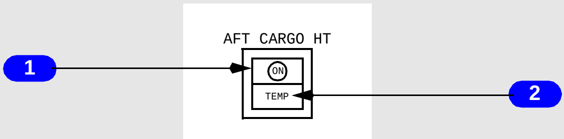
ECS PANEL

1 Recirculation (RECIRC) Fans Switch

ON - recirculation fans controlled automatically.

Off - recirculation fans off.

Aft Cargo Heat Switch



ECS PANEL

1 AFT CARGO Heat (HT) Switch

ON –

- overheat shutoff valve opens to provide bleed air heat to aft and bulk cargo compartments
- temperature control valve closes and opens to maintain temperature
- overheat shutoff valve closes and opens for overheat protection

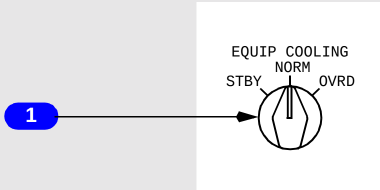
Off - shuts off aft cargo heat bleed air to compartment.

2 Aft Cargo Temperature (TEMP) Light

Illuminated (amber) –

- compartment temperature excessive
- overheat shutoff valve closes
- inhibited on the ground and during climb

Equipment Cooling Selector



ECS PANEL

1 Equipment (EQUIP) COOLING Selector

STBY -

- equipment cooling ground exhaust valve closed and inboard exhaust valve open; automatic control bypassed to configure system for flight
- all other automatic system operation same as in NORM

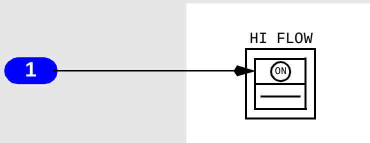
NORM -

- ground operation based on ambient temperature; equipment cooling air exhausted overboard or exhausted into forward cargo compartment
- with two or more engines running, cooling air exhausted into forward cargo compartment and equipment cooling ground exhaust valve closed
- with a single internal fault, inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

OVRD -

- equipment cooling ground exhaust valve and inboard exhaust valve closed
- equipment cooling supply valve closed; cooling air supplied through flight panels
- smoke/override valve open; differential pressure exhausts cooling air overboard

Pack High Flow Switch



ECS PANEL

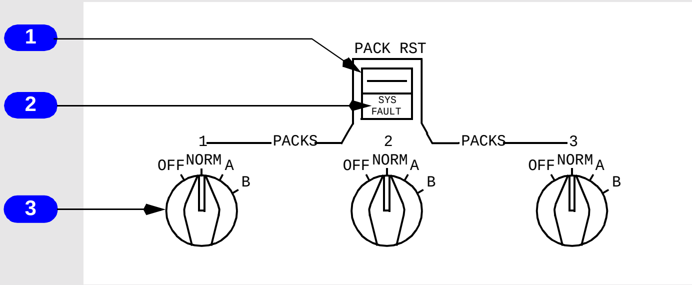
1 Pack High (HI) FLOW Switch

ON –

- all operating packs provide high air flow
- memo message PACKS HIGH FLOW displayed on EICAS

Off - pack air flow controlled automatically.

Pack Control



ECS PANEL

1 PACK Reset (RST) Switch

Push –

- resets pack fault protection system
- restarts pack after automatic shutdown if fault no longer exists

2 Pack System (SYS)FAULT Light

Illuminated (amber) –

- pack overheat or other system fault has occured

3 PACK Control Selector

OFF –

- pack valve closed
- rextinguishes SYS FAULT light for pack selected off
- resets pack fault protection system

Normal (NORM) -

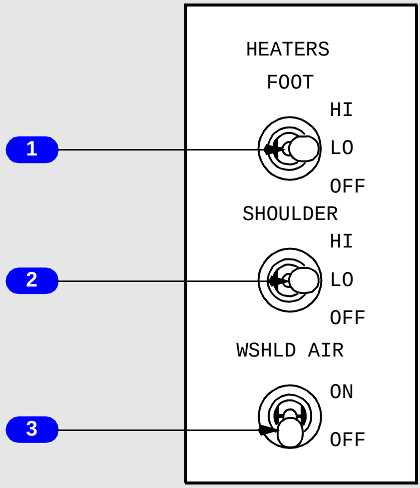
- pack controller A or B selected automatically on alternate flights
- selected controller is primary controller; selects secondary controller if primary controller fails

A - selects pack controller A as primary controller; selects B if A fails.

B - selects pack controller B as primary controller; selects A if B fails.

Pilot's Auxiliary Heat and Windshield Air

Electric shoulder heater and foot heater operate only in flight.



CAPTAIN'S AND FIRST OFFICER'S SIDEWALL PANELS

1 FOOT Heater Switch

HI - under-floor electric heater operates on high setting.

LO - under-floor electric heater operates on low setting.

OFF - under-floor electric heater off.

2 SHOULDER Heater Switch

HI - electric heater adds heat at high setting to conditioned air flow to side windows.

LO - electric heater adds heat at low setting to conditioned air flow to side windows.

OFF - electric heater off.

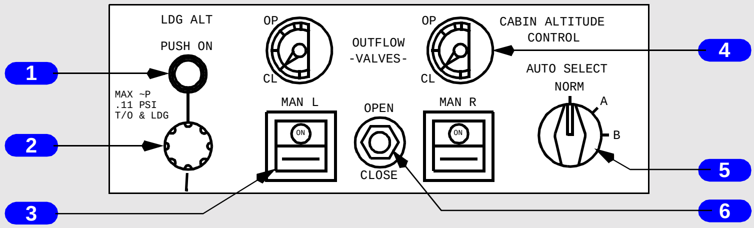
3 Windshield (WSHLD) AIR Switch

ON - supplemental anti-fogging air supplied to windshield.

OFF - anti-fogging air off.

Pressurization System

Cabin Altitude Control



OVERHEAD PANEL

1 Landing Altitude (LDG ALT) Switch

Push - alternately changes landing altitude control between Automatic and Manual.

Manual -

- landing altitude set by rotating Landing Altitude selector
- landing altitude information displays on primary EICAS followed by MAN

Automatic -

- landing altitude set automatically from FMS
- landing altitude information displays on primary EICAS followed by AUTO

2 Landing Altitude (LDG ALT) Selector

Rotate – sets landing altitude when MAN displayed on primary EICAS.

3 Outflow Valve Manual (MAN) Switch

ON -

- outflow valve in manual mode
- bypasses automatic outflow valve control and cabin altitude limiter

Off - outflow valve controlled automatically.

4 OUTFLOW VALVES Position Indicator

OP (Open) - outflow valve open.

CL (Closed) - outflow valve closed.

5 Cabin Altitude AUTO Selector (SELECT)

NORM -

- cabin altitude controller A or B selected automatically on alternate flights
- selected controller is the primary controller; selects secondary controller if primary controller fails

A - selects cabin altitude controller A as primary controller; selects B if A fails.

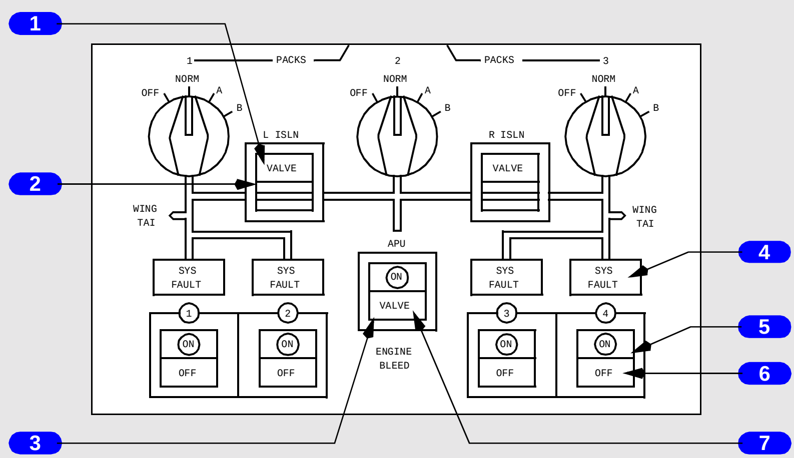
B - selects cabin altitude controller B as primary controller; selects A if B fails.

6 Outflow Valves Manual Control

OPEN - valve moves toward open in manual mode.

CLOSE - valve moves toward closed in manual mode.

Bleed Air Control



OVERHEAD PANEL

1 Isolation (ISLN) VALVE Light

Illuminated (amber) – isolation valve position disagrees with switch position

2 Isolation (ISLN) Valve Switch

ON (bar in view) – valve open.

Off - valve closed.

3 APU Bleed Air Switch

ON - valve commanded open when EICAS memo message APU RUNNING displayed.

Off - valve closed.

4 Engine Bleed Air System (SYS) FAULT Light

Illuminated (amber) -

- bleed air overheat, or
- bleed air overpressure, or
- HP bleed valve open when commanded closed, or
- PRV open when commanded closed

5 ENGINE BLEED Air Switch

ON -

- engine bleed air valve opens for engine start
- engine bleed air valve, PRV, and HP bleed valve open by system logic when bleed air pressure available

Off -

- engine bleed air valve, PRV, and HP bleed valve closed
- PRV opens when nacelle anti-ice on, unless PRV closed by:
  - prior or present bleed air overheat, or
  - start valve not closed, or
  - HP bleed valve failed open
- HP bleed valve and PRV open for thrust reverse, unless PRV closed by:
  - prior or present bleed air overheat, or
  - start valve not closed

6 ENGINE BLEED Air OFF Light

Illuminated (amber) - engine bleed air valve closed.

7 APU Bleed Air VALVE Light

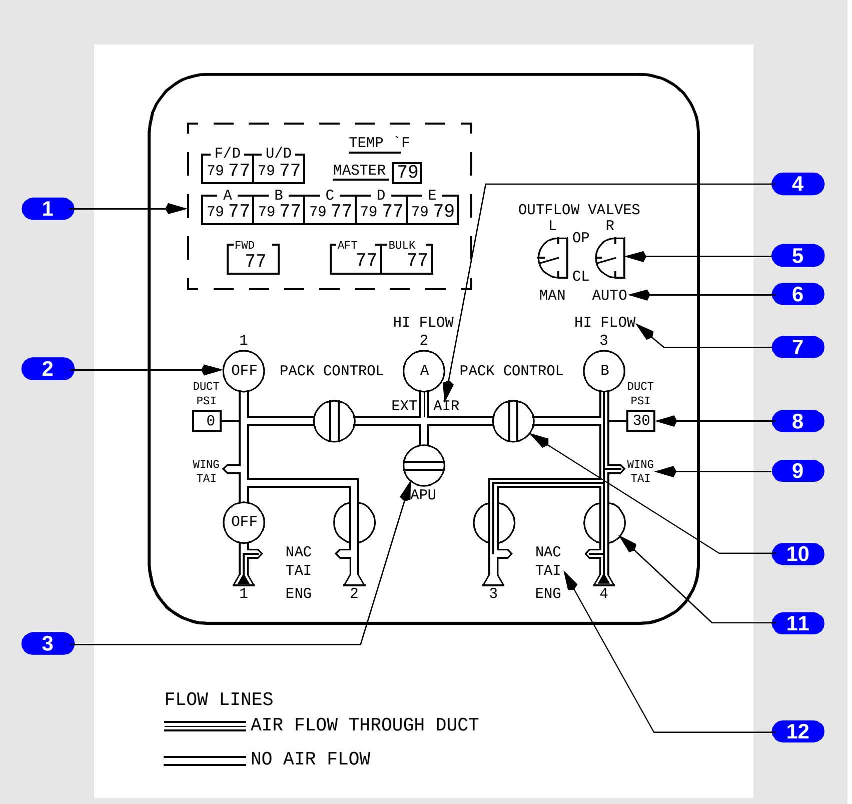
Illuminated (amber) - APU bleed air isolation valve position disagrees with switch position.

ECS Displays and Indications

ECS Synoptic Display

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

Air flow displayed is generated by displayed valve positions, switch positions, and pack status. It does not display actual air flow, therefore the display may not represent actual system operation.



LOWER EICAS DISPLAY

1 Zone Temperatures

F/D, U/D, A, B, C, D, and E - zone target temperatures on left and actual temperatures on right for respective air conditioning zone.

MASTER - temperature setting of Passenger Temperature selector.

FWD, AFT, BULK - actual temperature of cargo compartment.

2 Pack Control

OFF - pack valve closed.

A - indicates pack controller A in use.

B - indicates pack controller B in use.

3 APU Bleed Air Isolation Valve

Indicates open or closed position of isolation valve.

4 External Air Indication

- displayed if a pack operating with APU and engines off, or bleed air ducts pressurized with APU and engines off
- indication remains displayed momentarily after external air source removed

5 Outflow Valves Position

Indicates position of outflow valves.

6 Outflow Valve Control Source

MAN - indicates manual control of outflow valves.

AUTO - indicates FMS control of outflow valves.

7 High Flow Indication

HI FLOW -

- pack operating in high flow mode
- indication removed in normal flow or when pack OFF

8 Bleed Air Duct Pressure

White - 12 psi and above.

Amber - 11 psi and below.

9 Wing Anti-ice Indication

Indicates wing anti-ice on.

10 Isolation Valve

Indicates open or closed position of isolation valve.

11 Engine Bleed Air Valve

Indicates open or closed position of engine bleed air valve.

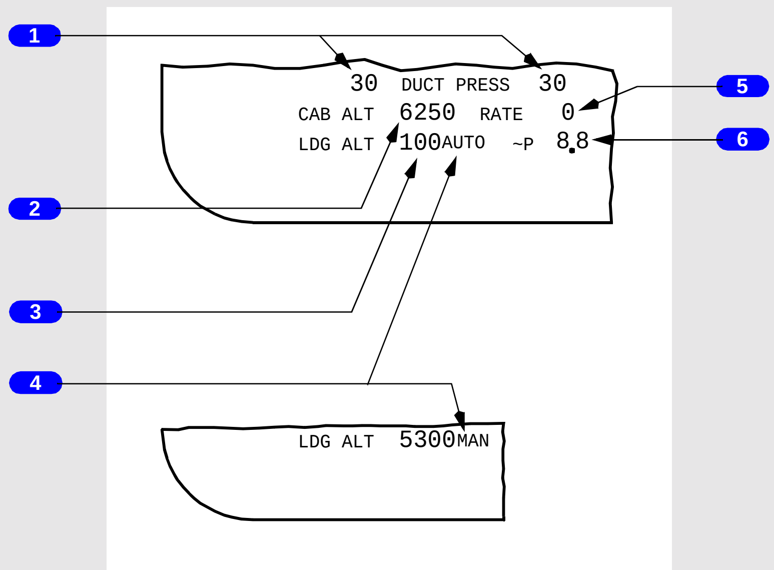
12 Nacelle Anti-ice Indication

Indicates nacelle anti-ice on.

Duct Pressure and Cabin Altitude Indications

Duct pressure, cabin altitude, rate, landing altitude, and differential pressure are displayed when:

- landing altitude MAN
- cabin altitude in caution (amber) or warning (red) range
- cabin differential pressure in caution (amber) or warning (red) range
- ECS or ENG synoptic selected on secondary EICAS display



PRIMARY EICAS DISPLAY

1 Bleed Air Duct Pressure

White - 12 psi and above.

Amber - 11 psi and below.

2 Cabin Altitude

Indicates cabin altitude.

3 Landing Altitude

- inhibited if both cabin altitude controllers A and B fail
- inhibited if both left and right outflow valves are in manual control

4 Landing Altitude Selection

AUTO (white) - altitude set automatically from FMC.

MAN (amber) - altitude set by Landing Altitude selector.

5 Cabin Rate of Climb

Indicates cabin altitude rate of climb.

6 Cabin Differential Pressure

Indicates cabin differential pressure.

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
- flight deck crew rest
- door 5 crew rest

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

The airplane is divided into seven temperature zones:

- flight deck
- upper deck
- five main deck cabin zones A through E

Air Conditioning Packs

Three 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, A and B. Each controller has three separate channels, one for each pack. Control of the packs switches automatically to the other controller at touchdown. If a controller detects a fault in a pack channel, control of the respective pack switches to the other controller.

Pack output increases during high pack demand periods (to compensate for a failed pack or recirculation fan), or is limited during high bleed air demand periods (such as for gear retraction).

When a pack controller is placed in NORM, A, or B, the pack valve opens, which allows bleed air to flow into the pack.

The pack valve is controlled electrically by the pack controller and opens by bleed air pressure.

Each pack valve has two flow settings, normal and high. During cruise, normal flow minimizes bleed air demand on the engine to reduce fuel consumption.

Packs may be set manually to high flow by pushing the High Flow switch ON.

Pack Non–Normal Operation

Pack control, fault detection, and overheat protection are all automatic. When an overheat or controller fault is detected, the respective pack valve closes resulting in a pack shut down.

If a pack controller does not switch automatically to the other controller, selecting A or B manually selects the respective controller when the Trim Air switch is ON. An attempt to restore pack operation may be made by pressing the Pack Reset switch.

If the pack cannot be reset, placing the respective Pack Control Selector to OFF extinguishes the pack system fault light for use by the operating packs.

If both pack controllers A and B fail, air conditioning packs continue to operate and the pack overheat protection system continues to operate normally. A pack overheat results in a shut down.

Air Distribution

Recirculation Fans

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. Two fans are located above the main passenger compartments and two fans are located below the main passenger cabin floor. If a fan overheat is detected, electrical power is removed.

The number of recirculation fans operating is configured by:

- phase of flight,
- the number of operating air conditioning packs, and
- pack flow rates

On the ground, during climb, and during descent, two of the four recirculation fans operate. During cruise, all four of the recirculation fans operate.

Lavatory and GalleyVentilation

Two ventilation fans, a primary and a backup, draw air from the galleys and lavatories. The fans operate automatically. If the primary fan fails, the backup fan automatically operates.

Conditioned air is provided to the galleys from the air distribution system.

Temperature Control

Hot trim air from the bleed air system added to the pack conditioned air controls the temperature in each zone.

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

Zone Target Temperatures

The Passenger Temperature selector sets the master passenger cabin temperature to between 65°F (18°C) and 85°F (29°C).

The target temperatures of each passenger zone may be modified plus or minus 10°F (6°C) within the range of 65°F (18°C) to 85°F (29°C) from the comfort corrected master temperature. This is accomplished with the cabin temperature panel located at door two right.

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

Temperature Control With Loss of Trim Air System - Passenger Backup Temperature Control

If trim air is not available to the distribution system, a backup mode activates. Pack outlet temperature is regulated to achieve an average temperature between 65°F (18°C) and 85°F (29°C), as set by the Passenger Temperature selector. If the passenger temperature selector setting is unavailable to the pack temperature controller, pack outlet temperature is regulated to achieve either the last passenger temperature set or an average cabin temperature of 75°F (24°C).

Trim air is not available if master trim air switch is OFF, the EICAS alert message TEMP ZONE message is displayed, or the center section of the bleed duct is isolated.

Temperature Control Non-Normal Operations

If a system fault or overheat occurs in the flight deck or a passenger zone, the master trim air valve closes and a backup mode is activated. An attempt to restore zone temperature control can be made by pressing the zone temperature controller reset switch.

Cargo Heat

When the equipment cooling system inboard exhaust valve is open, the heated air exhausted from the electrical and electronic (E & E) compartment heats the forward cargo compartment.

Aft cargo heat is provided by bleed air from the center section of the bleed air duct. A thermal switch in the compartment opens and closes the temperature control valve. When the compartment is cool, the thermal switch opens the valve. When the compartment warms, the thermal switch closes the valve.

An overheat thermal switch provides overheat protection by opening and closing an overheat/shutoff valve at higher temperatures.

Aft cargo heat is normally off until after engine start to increase bleed air available for engine start. With the switch off, the electrically operated aft cargo heat valves are prevented from opening to decrease APU and ground source bleed air demand.

Air Distribution Diagram

Pilot Auxiliary Heat

Flight crew shoulder heat is provided by electric elements in the side window and pilot shoulder air diffusers. The foot heaters have electric heating elements under the pilot foot area. Shoulder heat and foot heat are available in flight.

Equipment Cooling

The equipment cooling system provides cooling air for flight deck equipment and the electrical and electronic (E & E) compartment equipment racks. The system uses internal fans and valves to direct cool cabin air from inside the lower fuselage into the equipment racks. The warm exhaust air is ducted into the forward cargo compartment, recirculated in a closed loop mode through the E & E compartment cooling racks, or ducted overboard.

On the ground, with the engines not operating, the Equipment Cooling selector in NORM, and ambient temperatures moderate or high, the warm exhaust air is ducted overboard through the ground exhaust valve. With lower ambient temperatures, the ground exhaust valve is closed and the system is configured for flight.

On the ground, when one or more engines on each wing are operating, the system configures for flight to allow cabin pressurization. Positioning the Equipment Cooling selector to STBY closes the overboard exhaust valve to manually configure the airplane for flight.

In flight configuration, the inboard exhaust valve is open and the warmed equipment cooling exhaust air discharges into the forward cargo compartment.

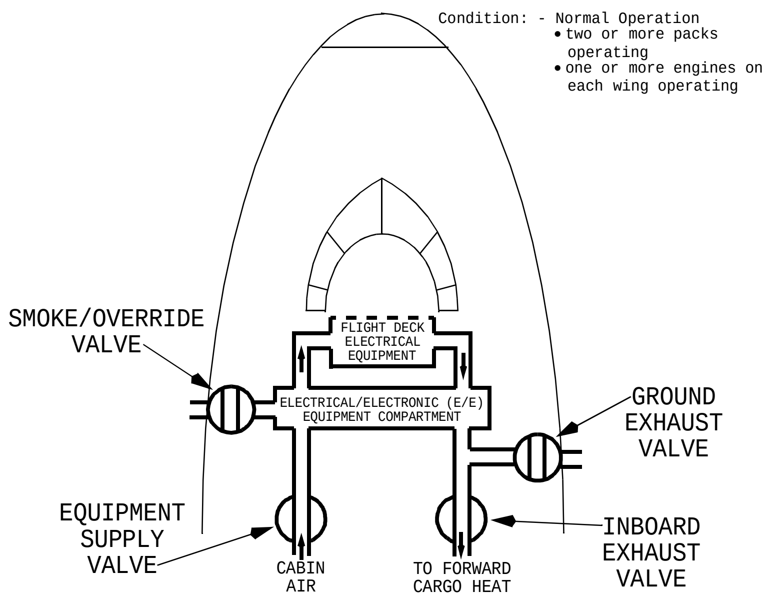
With the Equipment Cooling selector in NORM or STBY, the system normally configures to closed loop mode if a single internal fan fails. In closed loop mode, the inboard exhaust valve is closed.

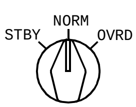
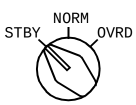
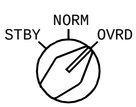
Equipment Cooling Non-Normal Operation

With the Equipment Cooling selector in NORM, the airplane on the ground, and with one or more engines on each wing operating, the EICAS alert message EQUIP COOLING is displayed if the equipment cooling system is not configured for flight. Positioning the selector to STBY configures the system for flight.

An override mode provides equipment cooling in flight if internal fans are inoperative. With the Equipment Cooling selector in OVRD, the internal fans deactivate and the smoke/override valve opens with all other valves closed. The smoke/override valve opens to an overboard vent allowing cabin differential pressure to draw air from the panels area on the flight deck, through the equipment cooling ducts to the E & E compartment equipment racks, to create a reverse flow of air across the equipment, then through the supply duct, and overboard.

Equipment Cooling Control Diagram



EQUIPMENT COOLING SWITCH POSITION	SYSTEM OPERATION	EQUIPMENT COOLING VALVE CONFIGURATION
	• Normal Operation • Normal Operation includes reconfiguring after supply and exhaust fan failure to maintain E/E equipment cooling: - Inboard Exhaust valve closes - no airflow to forward cargo - no EICAS message displayed	Above 45°F (7°C), Ground Exhaust valve opens and Inboard Exhaust valve closes. Below 45°F (7°C), Ground Exhaust valve closes and Inboard Exhaust valve opens.
		Ground Exhaust valve closes and Inboard Exhaust valve opens
	• Cooling system operates in reverse flow using differential pressure to exhaust cooling air through Smoke/Override valve • No cooling exhaust airflow to forward cargo	Smoke/Override valve opens. Equipment Supply valve Inboard Exhaust valve, and Ground Exhaust valve close.

Introduction

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

Two outflow valves are installed at the rear of the cabin. The valves normally operate in parallel. Cabin altitude and full ventilation rates can be maintained by either valve.

There are two cabin altitude controllers, A and B. Each controller controls both outflow valves.

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

The pressurization system has automatic and manual operating modes.

Pressurization System Automatic Operation

The cabin pressure controllers use 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 provides a small positive pressurization prior to rotation to cause a smooth transition to the cabin altitude climb schedule. During climb, cabin altitude increases on a schedule related to 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 and cabin altitude continues to increase during the level segment. If 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.

In cruise, maximum cabin altitude is 8,000 feet. During descent, cabin altitude decreases to slightly below the FMC planned landing altitude to ensure the airplane is slightly pressurized on landing. Landing altitude barometric pressure correction comes from the captain’s altimeter setting. 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. For this configuration, one pack is selected off to ensure cabin doors may be opened regardless of the position of the outflow valves if an emergency evacuation is required immediately after landing.

If landing altitude is set manually using the landing altitude selector and cabin differential pressure is less than maximum cabin differential pressure, cabin altitude begins to decrease or increase to the altitude set by the landing altitude selector. 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 maximum cabin altitude in cruise is 8,000 feet, regardless of the manual selected landing altitude.

Pressurization System Manual Operation

If both Outflow Manual switches are ON, all automatic cabin altitude control functions are bypassed. For this configuration, one pack is selected off to ensure cabin doors may be opened regardless of the position of the outflow valves if an emergency evacuation is required immediately after landing.

Pressurization Relief

Two mechanical positive pressure relief valves prevent overpressurization of the airplane. One or both valves open if cabin pressure becomes excessive, and close when cabin pressure is no longer excessive. Pack two shuts down to assist in relieving excess cabin pressure. Pack two resets when both cabin pressure relief valves close.

Negative pressure relief valves in the forward and aft cargo doors open when the airplane cabin pressure is slightly less than outside air pressure. The valves also open to relieve any existing differential pressure when a cargo door is unlatched.

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
- engine start
- leading edge flaps
- aft cargo heat
- cargo smoke detection
- hydraulic reservoir pressurization
- potable water tank pressurization
- air driven hydraulic demand pumps
- thrust reversers

Engine Bleed Air Supply

Engine bleed air is supplied from either intermediate pressure (IP) or high pressure (HP) engine sections. IP air is used during high power setting operations. HP air is used during descent and other low power setting operations.

To prevent damage to ducting and equipment downstream, the pressure regulating valve (PRV) limits bleed air pressure. The fan air precooler regulates bleed air temperature.

With an Engine Bleed Air switch ON, system logic allows bleed air to open the HP bleed valve and the PRV and allows bleed air to open the respective engine bleed air valve and flow into the bleed air duct.. The bleed air valves are pressure actuated and remain closed until engine bleed air pressure causes forward flow.

The engine bleed air valve regulates the engine bleed air to provide normal bleed air system pressure. It also prevents reverse flow of bleed air from the duct, except during the engine start sequence. When air pressure in the bleed air duct from another source (APU, ground air cart, another engine) is higher than the bleed air from an engine, the engine bleed air valve closes to prevent reverse flow.

During engine start, the engine bleed air valve opens and allows reverse flow of air from the bleed air duct to open the start valve. The PRV is positively closed to prevent reverse air flow into the engine compressor sections. Any time the engine start valve is not fully closed, the PRV remains positively closed. After N2 increases past 50%, the start valve closes which enables the PRV to open and the engine bleed air valve reverse flow prevention is enabled.

If the engine start valve fails to close, bleed air is isolated from the engine starter because both the PRV and the engine bleed air valve remain closed. Nacelle anti-ice is not available for the respective engine.

If an Engine Bleed Air switch is off, the respective engine bleed air valve, PRV, and HP bleed valve are closed.

If a bleed air overheat is detected, the PRV and HP bleed valves close. Pushing an Engine Bleed Air switch from off to ON resets the engine bleed fault detection system.

Bleed air is available for nacelle anti-ice operation with the Engine Bleed Air switch ON except when:

- the PRV has failed closed, or
- the PRV has been closed due a bleed air overheat, or
- the start valve is not closed

Bleed air is available for nacelle anti-ice operation with the Engine Bleed Air switch off except when:

- the PRV has failed closed, or
- the PRV has been closed due a bleed air overheat, or
- the start valve is not closed, or
- the HP bleed valve is failed open

Bleed air is available for thrust reverser operation with the Engine Bleed Air switch either ON or off except when:

- the PRV has failed closed, or
- the PRV has been closed due a bleed air overheat, or
- the start valve is not closed

APU Bleed Air Supply

APU bleed air is used primarily during ground operations for pack operation and engine starting. APU bleed air is available in flight.

With the APU bleed air switch ON, the APU bleed valve opens when the APU can supply bleed air. The EICAS memo message APU RUNNING is displayed when APU N1 is 95% and higher. APU bleed air is supplied through the center section of the bleed air duct. The check valve in the APU supply line prevents reverse flow of bleed air from the duct into the APU.

Bleed duct overheat protection is provided in the APU bleed air system to detect leaks. If the APU shuts down for an overheat, it cannot be restarted.

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 and right isolation valves separate the bleed air duct into three sections: left, center, and right. The system normally operates with the isolation valves open. The valves are controlled by the left and right isolation valve switches.

Duct Leak and Overheat Detection System

A bleed duct overheat system is provided to detect leaks. If a duct leak is detected, the bleed air duct section affected can be isolated by closing the respective isolation and engine bleed air valves.

Bleed Air System Non-normal Operations

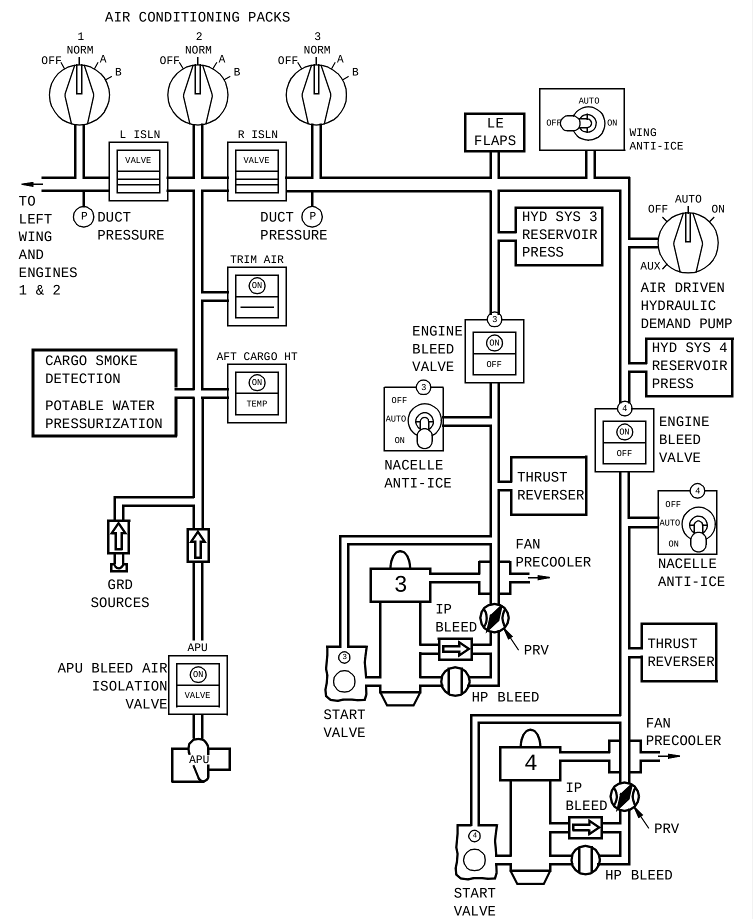
If a bleed duct leak is detected, closing the respective isolation and engine bleed valves prevents further air loss.

If the center duct section is isolated, pushing the Aft Cargo Heat switch off closes the electrically operated aft cargo heat valves to prevent cabin air flowing in reverse through the aft cargo heat supply duct and into the leaking center dect section. All temperature zones operate in backup temperature control mode without trim air. Potable water pressurization and cargo smoke detection are not available.

If the left or right duct section is isolated, the respective leading edge flaps operate electrically in secondary mode. The respective hydraulic demand pump one or four is selected OFF to avoid the EICAS alert message HYD PRESS DEMAND from being displayed during approach. A maximum of one air conditioning pack on assures sufficient thrust is available from the two engines which supply air to the unaffected duct sections.

The EICAS alert message BLEED is displayed for bleed overpressure, or PRV or HP bleed valve failed to close when commanded. If the respective NAI VALVE message is displayed after pushing the related Nacelle Anti-ice switch ON, the PRV is closed because the HP bleed valve failed open and nacelle anti-ice is not available.

Bleed Air System Schematic



Air Systems EICAS Messages

The following EICAS messages can be displayed.

EICAS Alert Messages

Message	Level	Aural	Condition
BLD DUCT LEAK L, C, R	Caution	Beeper	Bleed air leak or overheat along the left, center, or right duct section.

Message	Level	Aural	Condition
BLD OVHT/PRV 1, 2, 3, 4	Advisory		Engine bleed air overheat or PRV failed closed.
BLEED 1, 2, 3, 4	Advisory		Engine bleed air overpressure, or HP bleed valve or PRV failed to close when commanded.

Message	Level	Aural	Condition
>BLEED 1, 2, 3, 4 OFF	Advisory		Engine Bleed Air switch OFF, engine operating, and engine bleed air valve closed.
BLEED HP ENG 1, 2, 3, 4	Advisory		HP bleed valve failed closed.
BLEED ISLN L, R	Advisory		Isolation Valve switch position and valve position disagree.

Message	Level	Aural	Condition
>BLEED ISLN APU	Advisory		APU bleed isolation valve position disagrees with commanded position.

Message	Level	Aural	Condition
CABIN ALT AUTO	Caution	Beeper	Both cabin altitude controllers inoperative or both Outflow Valve Manual switches ON.
CABIN ALTITUDE	Warning	Siren	Cabin altitude exceeds 10,000 feet
>E/E CLNG CARD	Advisory		Fault in equipment cooling system and system not fully functional. Message inhibited in flight.
EQUIP COOLING	Caution	Beeper	With Equipment Cooling selector in NORM or STBY, airflow is inadequate, or overheat or smoke detected; or with selector in OVRD, differential pressure for reverse flow cooling is inadequate; or ground exhaust valve not in commanded position

Message	Level	Aural	Condition
LANDING ALT	Advisory		Disagreement between controller landing altitude and FMC landing altitude.

Message	Level	Aural	Condition
OUTLFOW VLV L, R	Advisory		Automatic control of outflow valve is inoperative, or respective Outflow Valve Manual switch is ON.

Message	Level	Aural	Condition
PACK 1, 2, 3	Advisory		Pack controller fault, or pack operation fault, or pack overheat, or pack 2 shutdown with either cabin pressure relief valve open.

Message	Level	Aural	Condition
PACK CONTROL	Advisory		Automatic control of outlet temperature of all packs has failed.

Message	Level	Aural	Condition
PRESS RELIEF	Advisory		Either pressure relief valve opens with all packs on high flow and pack 2 does not shut down autonmatically.

Message	Level	Aural	Condition
TEMP CARGO HEAT	Advisory		Overheat detected in aft cargo compartment when aft cargo heat is operating.

Message	Level	Aural	Condition
TEMP ZONE	Advisory		Zone duct overheat, or master trim air valve failed closed, or zone temperature controller has failed. Master trim air valve driven closed and temperature controlled in backup mode.
>TRIM AIR OFF	Advisory		Master trim air valve closed. Flight deck and passenger cabin temperature control in backup mode.

EICAS Memo Messages

Message	Condition
PACK 1, 2, 3 OFF	Pack has been selected off.
PACKS 1 + 2, 1 + 3, 2 + 3 OFF	Packs have been selected off.
PACKS HIGH FLOW	High flow switch ON. Pack flow setting not controlled automatically.
PACKS OFF	All packs have been selected off.

Intentionally
Blank

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Intentionally
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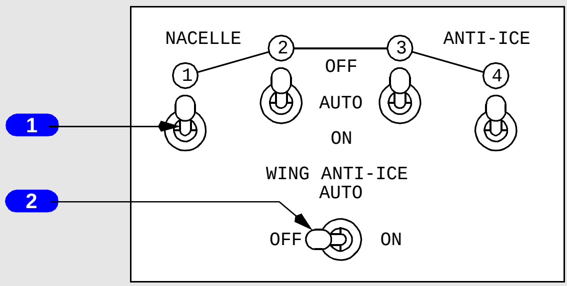
Nacelle and Wing Anti-Ice

Nacelle and Wing Anti-Ice Panel



OVERHEAD PANEL

1 NACELLE ANTI–ICE Switches

OFF – nacelle anti–ice valves commanded closed

AUTO –

- in flight, nacelle anti-ice operates in response to inputs from the ice detection system. Requirements for valve operation are the same as ON position
- on the ground, system off

ON –

- valve opens when bleed air pressure available
- engine igniters selected by Auto Ignition selector and EEC operate continuously
- PRV opens when nacelle anti-ice on, unless PRV closed by:
  - prior or present bleed air overheat, or
  - start valve not closed, or
  - HP bleed valve failed open

2 WING ANTI–ICE Switch

OFF – wing anti–ice valves commanded closed

AUTO –

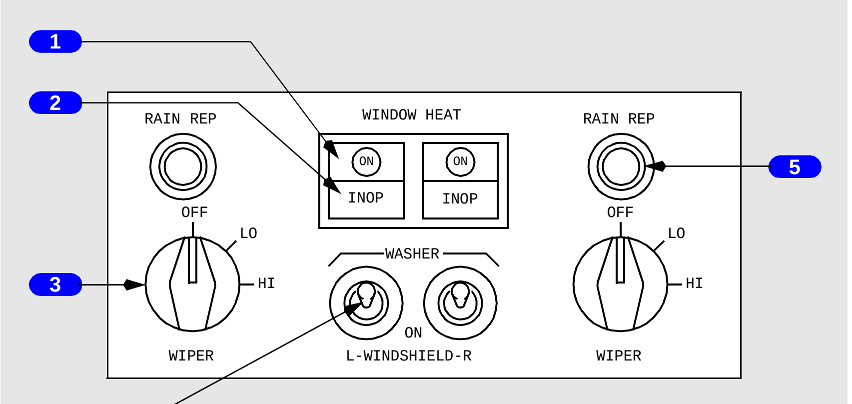
- in flight with leading edge flaps retracted, wing anti-ice valves open in response to inputs from the ice detection system
- on the ground, system off

ON –

- in flight with leading edge flaps retracted, wing anti-ice valves open to supply bleed air to the left and right wing leading edges
- on the ground, system off

Windshield Heat and Washers

Windshield Heat and Washers Panel



OVERHEAD PANEL

1 WINDOW HEAT Switch

ON – controlled heat applied to the windshield

2 WINDOW HEAT Inoperative (INOP) Light

Illuminated (amber) -

- windshield overheat or controller fault has been detected
- power removed from windshield

3 Windshield WIPER Selector

OFF - wipers off and sequenced to stowed position

LO - wipers operate at low speed

HI - wipers operate at high speed

4 WINDSHIELD L, R WASHER Switch

Spring loaded to neutral

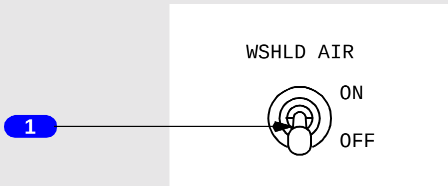
ON - applies washer fluid

5 RAIN Repellent (REP) Switch

Push - measured amount of rain repellent applied to windshield

Note: Do not use on dry windshield.

Windshield Air Switch



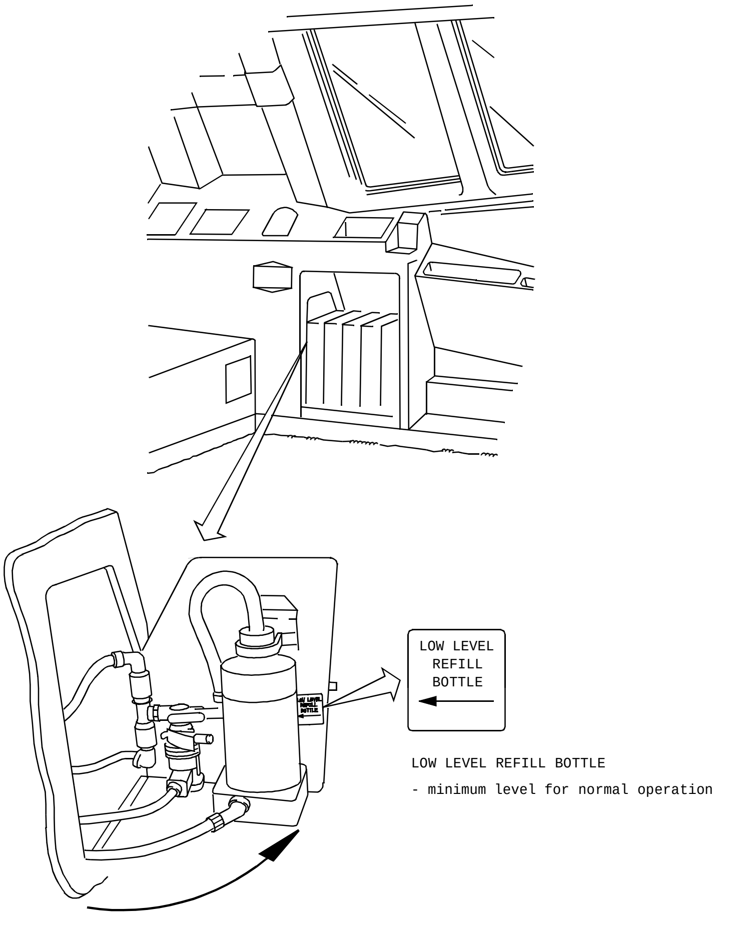
CAPTAIN'S AUXILIARY PANEL
FIRST OFFICER'S AUXILIARY PANEL

1 Windshield (WSHLD) AIR Switch

ON – turns on air to windshield

OFF - windshield air off

Windshield Washer Fluid



**LEFT HAND SIDE PANEL
IN BOOK STOWAGE**

Introduction

The anti–ice and rain systems include:

- automatic ice detection
- engine anti–ice
- wing anti–ice
- flight deck window heat
- windshield wipers
- probe heat

Anti-Ice Systems

Automatic Ice Detection System

The automatic ice detection system detects airplane icing in flight.

The system consists of two ice detector probes on the forward fuselage. The system provides signals to control the nacelle and wing anti–ice systems when those systems are in automatic mode.

Nacelle Anti–Ice System

The nacelle anti–ice system uses engine bleed air to provide engine cowl inlet ice protection. Nacelle anti–ice can be operated in flight or on the ground. The nacelle anti–ice indication NAI is displayed beside the EICAS N1 indication when the nacelle anti–ice valve is open.

When nacelle anti-ice is commanded on, the selected engine igniters operate continuously.

Nacelle Anti–Ice System Automatic Operation

In flight, when the NACELLE ANTI-ICE switch is in AUTO, nacelle anti–ice system operation is automatic. When ice is detected, bleed air opens the nacelle anti–ice valve and bleed air is supplied to the engine cowl inlet.

When ice is no longer detected, the nacelle anti–ice valve closes and bleed air is no longer supplied to the engine inlet cowl.

Nacelle Anti–Ice System Manual Operation

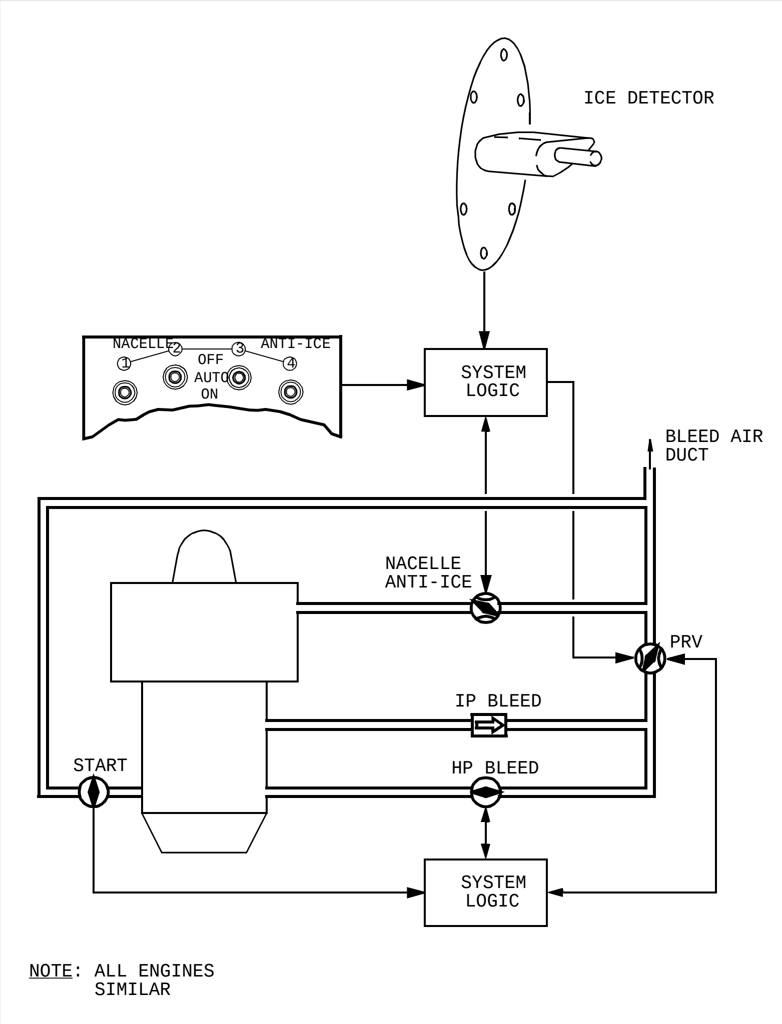
On the ground and in flight, when the NACELLE ANTI-ICE switch is ON, bleed air opens the nacelle anti-ice valve and bleed air is supplied to the engine inlet cowl.

Nacelle Anti-Ice Non-normal Operation

Bleed air is not available for nacelle anti-ice operation when the pressure regulating valve (PRV) has been closed due to a bleed air overheat, HP bleed valve failed open, or if the start valve is not closed.

When nacelle anti-ice is commanded on with the engine bleed valve closed, the HP bleed valve remains closed. Bleed air is supplied by IP bleed only.

Nacelle Anti–Ice System Schematic



Wing Anti–Ice System

The wing anti–ice system provides bleed air to each wing. When anti-ice is commanded on, a valve opens in each wing, allowing bleed air to flow from the engines to a spray tube in the leading edge. Wing anti–ice is inhibited in flight when leading edge flaps are extended and on the ground.

The wing anti–ice indication WAI is displayed beside the respective wing EICAS N1 indication when the wing anti–ice valve is open.

Wing Anti–Ice System Automatic Operation

In flight, when the WING ANTI-ICE switch is in AUTO and the leading edge flaps are retracted, wing anti–ice system operation is automatic. When ice is detected, the wing anti–ice valves open and bleed air is supplied to the leading edges. When ice is no longer detected, the wing anti–ice valves close and bleed air is no longer supplied.

Wing Anti–Ice System Manual Operation

In flight, when the WING ANTI-ICE is ON and the leading edge flaps are retracted, the wing anti–ice valve in each wing opens.

Flight Deck Window Heat

All flight deck windows are electrically heated. The forward windows have exterior surface anti–icing, and interior surface antifogging protection. The side windows have interior surface antifogging protection only.

The window heat switches control heating for the windshields only. With the WINDOW HEAT switches ON, electric power is supplied to the windshields. Electric power for the windshields modulates to maintain a constant temperature.

Side window heating is automatic and no flight deck controls are provided. Electric power is applied to the side windows whenever the AC electrical system is powered. Power for the side windows is thermostatically controlled.

Power is removed from the system if a fault or overheat condition is sensed. Pushing a WINDOW HEAT switch off for 10 seconds, then ON, resets a windshield heat controller fault.

Windshield Air

Air for anti-fogging is drawn from the flight deck conditioned air supply and directed across the windshields. WSHLD AIR switches on the Captain’s and First Officer’s auxiliary panels turn on anti-fogging air to the related windshields.

Windshield Wipers and Washers

The Captain’s and First Officer’s windshields are equipped with independently controlled, two speed windshield wipers. With a WIPER selector in OFF position, the related wiper is off and stowed.

Scratching of the windshield surface may occur if the wipers are used on a dry windshield.

The Captain’s and First Officer’s windshields are equipped with a windshield washer system. Windshield Washer switches command a continuous application of washer fluid while held ON.

The washer fluid reservoir is located behind the door in the book storage area on the Captain’s side panel. It is equipped with a sight gage and a refill reference mark.

Probe Heat

Four pitot-static probes and two angle of attack probes are electrically heated for anti-ice protection when any engine is operating. Two total air temperature probes are electrically heated for anti-ice protection in flight.

Anti–Ice, Rain EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
>ANTI-ICE NAC	Advisory		Any nacelle anti-ice system on,TAT greater than 12°C, and ice detector does not detect ice.
>ANTI-ICE WING	Advisory		Either wing anti-ice system on, TAT greater than 12°C, and ice detector does not detect ice.

Message	Level	Aural	Condition
HEAT L, R AOA	Advisory		Heater failure on respective AOA probe.
HEAT L, R TAT	Advisory		Heater failure on respective TAT probe, or ground/air logic has failed to remove power and a TAT probe is heated on the ground.
HEAT P/S CAPT, FO, L AUX, R AUX	Advisory		Heater failure on respective P/S probe.
HEAT WINDOW L, R	Advisory		Window heat of respective windshield not powered.

Message	Level	Aural	Condition
>ICE DETECTORS	Advisory		Ice detection system has failed.

Message	Level	Aural	Condition
>ICING NAC	Caution	Beeper	Ice detector detects ice and any nacelle anti-ice system is off in flight.
>ICING WING	Advisory		Ice detector detects ice and wing anti-ice system is off in flight.

Message	Level	Aural	Condition
NAI VALVE 1, 2, 3, 4	Advisory		Respective nacelle anti-ice valve not in commanded position.

Message	Level	Aural	Condition
WAI VALVE L, R	Advisory		Respective wing anti-ice valve not in commanded position.

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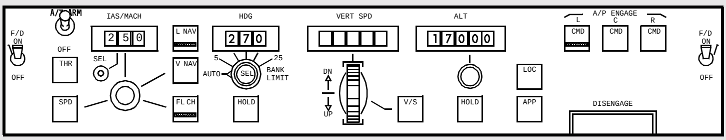
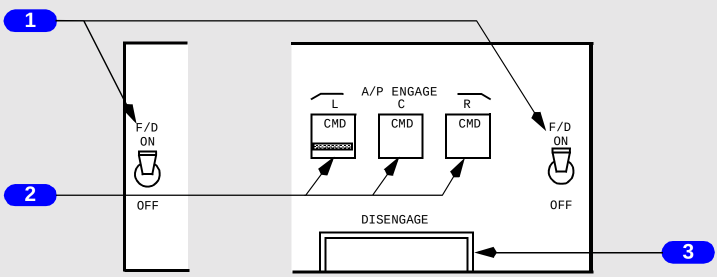
Mode Control Panel (MCP)



GLARESHIELD PANEL

Autopilot Flight Director System (AFDS) Controls



Mode Control Panel (MCP)

1 Flight Director (F/D) Switches

The left F/D switch activates F/D steering indications on the left primary flight display (PFD). The right F/D switch activates F/D steering indications on the right PFD.

ON –

- on the ground with no autopilot (A/P) engaged and both F/D switches OFF, the first F/D switch positioned ON arms the F/D in the takeoff go–around (TO/GA) roll and pitch modes. Positioning the second F/D switch ON displays the flight direction steering indications on the second PFD
- in flight, with the A/P disengaged and both F/D switches OFF, the first F/D switch positioned to ON activates the F/D in:
  - vertical speed (V/S) as the pitch mode, and

- heading hold (HDG HOLD) as the roll mode, or if bank angle greater than five degrees, attitude hold (ATT)
- in flight, with the A/P engaged and both F/D switches OFF, the first F/D switch positioned to ON activates the F/D in the selected A/P mode(s)

OFF –

- F/D steering indications do not display, unless
- a TO/GA switch is pushed when airspeed is greater than 80 knots and flaps out of up

2 Autopilot (A/P) ENGAGE Switches

Push (any switch engages the autopilot) –

- when either F/D switch is ON, the A/P engages in the selected F/D mode(s)
- when both F/D switches are OFF, the A/P engages in:
  - vertical speed (V/S) as the pitch mode and
  - heading hold (HDG HOLD) or attitude hold (ATT) as the roll mode

3 Autopilot DISENGAGE Bar

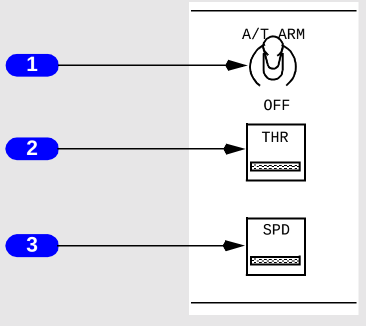
Push down –

- disengages all three A/Ps
- prevents A/P engagement
- exposes amber stripe

Lift up -

- enables A/P engagement
- conceals amber stripe

Autothrottle (A/T) System Controls



Mode Control Panel (MCP)

1 Autothrottle (A/T) ARM Switch

ARM -

- disconnects if more than one engine inoperative
- arms A/T system for mode selection
- A/T operates when VNAV, FLCH, or TO/GA switch pushed
- A/T operates when speed switch pushed and pitch mode isALT, V/S, or G/S
- when A/T flight mode annunciation blank and pitch mode is VNAV XXX or FLCH SPD, cycling the A/T ARM switch to OFF and back to ARM operates the A/T

OFF –

- disconnects A/T
- disables A/T activation
- disables engine trim equalization

2 Thrust (THR) Switch

Operative from 400 feet after takeoff until landing.

Push –

Light extinguished (thrust limit function) -

- after takeoff and during climb, changes reference thrust limit to armed climb thrust limit
- changes reference thrust limit to CLB, unless engine inoperative or CON selected, then reference thrust limit is CON

Note: Reference thrust limit remains GA when flaps in landing position or pitch mode is G/S.

Light illuminated (A/T mode function) - Changes A/T mode to THR REF when:

- reference thrust limit is CLB, CLB1, CLB2, CRZ, or CON and pitch mode is ALT or V/S
- reference thrust limit is GA and pitch mode is G/S or FLARE, or pitch mode is ALT or V/S and flaps in landing position

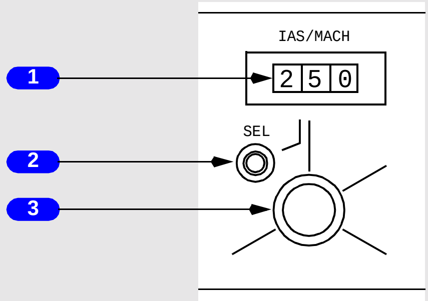
3 Speed (SPD) Switch

Operative from 400 feet after takeoff until landing.

Push (light illuminates) –

- selects A/T SPD mode
- displays SPD on both PFDs
- A/T controls thrust to maintain IAS or Mach displayed in IAS/MACH window subject to minimum and maximum speed limits
- inactive in VNAV XXX, FLCH SPD, or TO/GA pitch modes

Autopilot Flight Director IAS/Mach Controls



Mode Control Panel (MCP)

1 IAS/MACH Window

Displays selected speed when IAS/MACH selector controls command speed.

Blank when FMC controls command speed.

IAS/Mach window and PFD speeds set to 200 knots when power first applied.

Display range:

- 100 - 399 KIAS
- .400 - .950 Mach, three digit Mach displayed

Displays selected speed on PFD.

In climb, changes from IAS to Mach at approximtely .840 Mach.

In descent, changes from Mach to IAS at approximately 310 knots.

2 IAS/MACH Select (SEL) 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 –

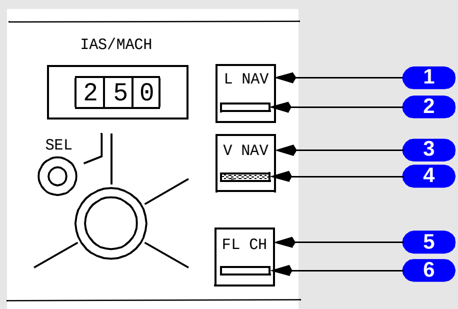
- sets speed in IAS/MACH window and command speed on both PFDs
- inoperative when IAS/MACH window blank

Push – with VNAV active, alternately opens or closes the IAS/MACH window:

- when window closed, FMC computed target speed is active and displays on PFDs
- when window open, FMC speed–intervention is active and IAS/MACH selector may be used to set command speed. Pitch mode annunciator changes to VNAV SPD when descending in VNAV PTH. Selected speed maintained by pitch until airplane intercepts an altitude constraint and VNAV PTH annunciates. When on approach, pitch mode remains VNAV PTH and A/T controls speed

IAS/MACH window open if pitch mode is FLCH SPD, V/S , TO/GA, ALT, or G/S.

Autopilot Flight Director Roll and Pitch Controls



Mode Control Panel (MCP)

1 Lateral Navigation (LNAV) Switch

Push –

- arms, selects, or disarms LNAV as roll mode
- displays LNAV in white (armed) on both PFD roll flight mode annunciations when armed. The previous roll mode remains active
- LNAV activates when the airplane is 50 feet above runway elevation and:
  - within 2.5 NM of the active leg
  - when not within 2.5 NM of the active leg but on an intercept heading to the active leg, remains armed then activates when approaching the active leg
  - when active, displays LNAV in green on 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
- 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 deactivated:

- by selecting heading hold (HDG HOLD)
- by selecting heading select (HDG SEL)
- when localizer captures
- with dual FMC failure

LNAV is disarmed by pushing LNAV switch a second time.

2 LNAV Light

Illuminated – LNAV roll mode armed or active.

3 Vertical Navigation (VNAV) Switch

Push –

- arms, selects, or disarms VNAV as pitch mode
- displays VNAV in white (armed) on both PFD pitch flight mode annunciations below 400 feet
- VNAV activates 400 feet above runway elevation
- when VNAV selected and FMC has insufficient data to provide VNAV guidance (such as invalid gross weight or there is no end–of–descent point in descent) displays PERF/VNAV NOT AVAILABLE in CDU scratchpad
- VNAV SPD, VNAV PTH, or VNAV ALT pitch mode displays in green (active) on PFD pitch flight mode annunciator
- in VNAV SPD pitch mode, AFDS commands pitch to hold target airspeed. The A/T operates in THR REF, THR, IDLE or HOLD mode, as required by phase of flight
- in VNAV PTH pitch mode, AFDS commands pitch to maintain FMC target altitude or VNAV path; A/T operates is speed (SPD) mode

- in VNAV ALT pitch mode, AFDS commands pitch to maintain MCP selected altitude; A/T operates in SPD mode
- VNAV pitch guidance available with one or two engines inoperative

Note: In VNAV, if a conflict exists between the VNAV profile and the MCP altitude, the airplane levels and the pitch flight mode annunciation becomes VNAV ALT. Selecting another pitch mode, resetting the MCP altitude window and pushing the altitude selector, or intercepting the VNAV path continues the climb or descent.

VNAV deactivated:

- by selecting TO/GA, FLCH SPD, V/S, ALT, or G/S pitch mode
- with a dual FMC failure

VNAV is disarmed by pushing VNAV switch a second time.

4 VNAV Light

Illuminated – VNAV pitch mode armed or active.

5 Flight Level Change (FLCH) Switch

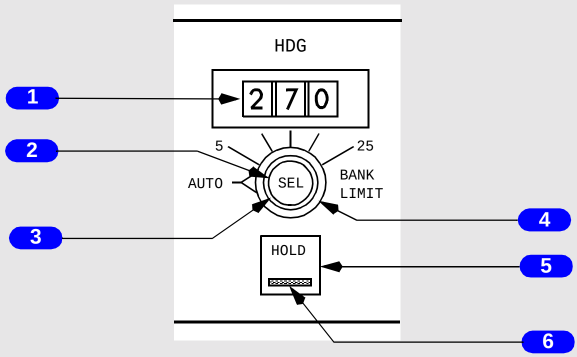
Push –

- selects FLCH SPD pitch mode
- FLCH SPD pitch mode displays in green (active) on PFD flight mode annunciator
- when IAS/MACH window blank, IAS/MACH window opens to FMC target speed, if valid. If not valid, IAS/MACH window opens to current speed
- when IAS/MACH window open, displays command speed
- when changing from TO/GA to FLCH, IAS/MACH window displays highest value of current airspeed or selected speed
- AFDS pitch holds selected speed. When selected altitude captured, pitch flight mode annunciator changes to ALT
- A/T annunciates THR, followed by HOLD mode in descent. When selected altitude captured, A/T mode changes to SPD. A/T advances or retards thrust levers to maintain a vertical speed proportional to the altitude change requested
- with higher altitude set in the ALT window, reference thrust limit changes to CLB when CRZ displayed and to CON with an engine inoperative

6 Flight Level Change Light

Illuminated – flight level change pitch mode active.

Autopilot Flight Director Heading and Bank Angle Controls



Mode Control Panel (MCP)

1 Heading Window

Displays selected heading.

Displays selected heading on PFDs and NDs.

HDG window, PFD, and ND headings set to 000 when power first applied.

Changes to ILS front course at LOC capture.

2 Heading Select (HDG SEL) Switch

Push -

- selects HDG SEL roll mode
- HDG SEL roll mode displays in green (active) on PFD roll flight mode annunciation
- AFDS controls roll to acquire and hold selected heading
- bank is limited by bank limit selector

3 Heading (HDG) Selector (inner)

Rotate – sets heading in HDG window and selected heading on PFDs and NDs.

4 BANK LIMIT Selector (outer)

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

- AUTO – varies between 15 – 25 degrees, dependingon TAS, flap position, and V2
- 5, 10, 15, 20, or 25 – selected value is maximum, regardless of airspeed

5 Heading (HDG) HOLD Switch

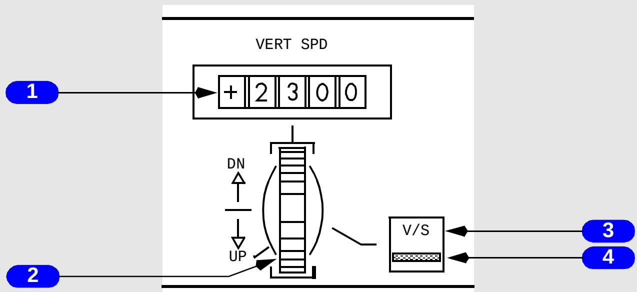
Push -

- selects HDG HOLD roll mode
- HDG HOLD roll mode displays in green (active) on PFD roll flight mode annunciation
- AFDS rolls wings level, then holds present heading

6 Heading Hold Light

Illuminated – HDG HOLD roll mode active.

Autopilot Flight Director Vertical Speed (V/S) Controls



Mode Control Panel (MCP)

1 Vertical Speed (VERT SPD) Window

Blank when vertical speed (V/S) pitch mode not selected.

Displays current V/S when V/S pitch mode selected.

Displays selected V/S in 100 fpm increments.

Display range is -8000 to +6000 fpm.

Vertical speed displays on the PFD V/S indication.

2 Vertical Speed (V/S) Selector

UP or Down (DN) - sets V/S in VERT SPD window and on both PFDs.

3 Vertical Speed (V/S) Switch

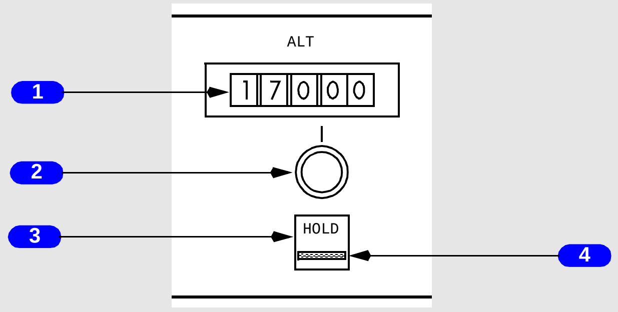
Push –

- selects V/S pitch mode
- V/S pitch mode displays in green (active) on PFD pitch flight mode annunciation
- displays current V/S in V/S window
- AFDS pitch maintains V/S displayed in the V/S window. When selected altitude reached, pitch flight mode annunciation changes to ALT
- A/T operates in speed (SPD) mode, if armed

4 Vertical Speed (V/S) Light

Illuminated – vertical speed pitch mode is active.

Autopilot Flight Director Altitude Controls



Mode Control Panel (MCP)

1 Altitude Window

Displays selected altitude in 100 feet increments. Display range is 0 to 50000 feet.

Displays selected altitude on PFDs.

Displayed altitude is reference altitude for altitude alerting and level off.

ALT window and PFD altitudes set to 10000 feet when power first applied.

2 Altitude Selector

Rotate – sets altitude in ALT window and selected altitude on both PFDs.

Push –

- during climb or descent with altitude constraints, each push deletes the next waypoint constraint between the airplane altitude and the altitude window setting
- during climb with no altitude constraints, and the altitude window set above the FMC cruise altitude, changes cruise altitude to the altitude window value
- during cruise:
  - with the altitude window set above or below FMC cruise altitude, resets the FMC cruise altitude to the altitude window altitude
  - when in VNAV PTH or VNAV ALT pitch mode, initiates 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, initiates a reduced rate descent

3 Altitude HOLD Switch

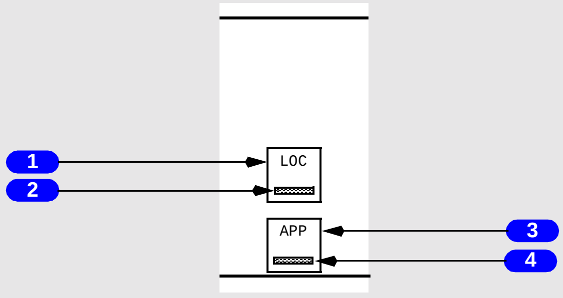
Push –

- selects altitude (ALT) pitch mode
- ALT pitch mode displays in green (active) on PFD pitch mode annunciation
- AFDS commands pitch to maintain the altitude when the switch was pushed

4 Altitude Hold Light

Illuminated – altitude hold mode active.

Autopilot Flight Director Approach Mode Controls



Mode Control Panel (MCP)

1 Localizer (LOC) Switch

Push –

- arms, disarms, captures localizer (LOC) as roll mode
- displays LOC in white (armed) on both PFD roll flight mode annunciations before localizer capture; current roll mode remains active until LOC capture
- displays LOC in green (active) on PFD roll flight mode annunciations after localizer capture
- arms AFDS to capture and track inbound on front course
- capture point varies based on range and intercept angle
- localizer capture can occur when intercept track angle is within 120 degrees of the localizer course

Note: After localizer capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

Localizer mode can be disarmed before localizer capture by:

- pushing localizer switch a second time, or
- selecting another roll mode

Localizer mode can be deactivated after localizer capture by:

- selecting a roll mode other than LNAV
- pushing a TO/GA switch
- disengaging the autopilot and positioning both F/D switches off

2 Localizer Light

Illuminated – localizer roll mode armed or active.

3 Approach (APP) Switch

Push –

- AFDS captures and tracks localizer and captures glideslope mode upon interception
- localizer captures when intercept track angle is within 120 degrees of localizer course
- below 1,500 feet radio altitude, A/P systems powered by separate sources with three A/Ps engaged
- arms, disarms, or captures localizer (LOC) as roll mode and glideslope (G/S) as pitch mode
- displays LOC and G/S in white (armed) on PFD roll and pitch flight mode annunciations prior to localizer and glideslope capture
- displays LOC and G/S in green (active) on both PFD roll and pitch flight mode annunciations after each is captured
- either localizer or glideslope can be captured first

- glideslope captures when the intercept track angle is within 80 degrees of localizer course
- arms other A/P systems (CMD switch lights illuminated) for engagement at localizer and glideslope capture and radio altitude less than 1,500 feet

Note: After localizer capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

Approach mode can be disarmed before localizer or glideslope capture by:

- pushing approach switch a second time, or
- selecting LOC, LNAV, or VNAV

Approach mode deselects:

- with localizer captured and glideslope armed, by selecting another roll mode other than LNAV; selecting LOC mode initiates a localizer approach
- with glideslope captured and localizer armed, by selecting another pitch mode other than VNAV
- after localizer and/or glideslope are captured, by selecting TO/GA mode or disengaging autopilot and positioning both F/D switches off

4 Approach Light

Illuminated – approach modes (LOC and G/S) armed or active.

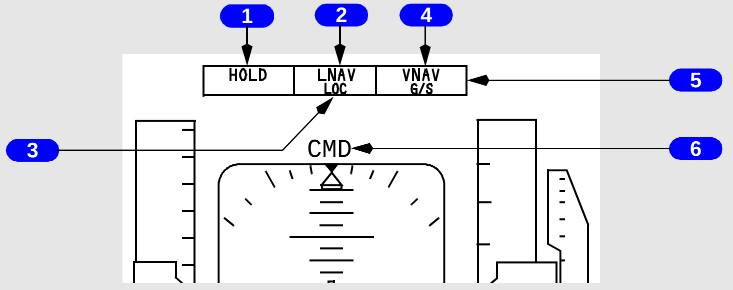
PFD Flight Mode Annunciations (FMAs)

Note: A/T, roll, or pitch mode changes are emphasized for 10 seconds by a green box around the mode.

Note: An amber horizontal line displays through the affected ACTIVE pitch or roll mode when a flight mode fault is detected.

Note: NO AUTOLAND displays on the PFD if failures cause the system to degrade from multi-channel engage status (LAND 3 or LAND 2) to single channel status during an autoland. The mode change is emphasized for 10 seconds by an amber box.

NO AUTOLAND also displays on PFD if multi-channel approach selected but multi-channel engage status (LAND 3 or LAND 2) has not been annunciated by 600 feet AGL. Under these conditions, flare and rollout modes are not armed.



PFD

1 Autothrottle Modes (Active)

Displayed (green) –

- THR
- THR REF
- HOLD
- IDLE
- SPD

2 AFDS Roll Modes (Active)

Displayed (green) –

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

3 AFDS Roll Modes (Armed)

Displayed (white) –

- LOC
- ROLLOUT
- LNAV

4 AFDS Pitch Modes (Active)

Displayed (green) –

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

5 AFDS Pitch Modes (Armed)

Displayed (white) –

- G/S
- FLARE
- VNAV

6 AFDS (Active)

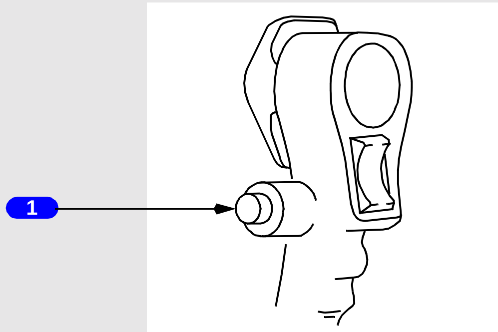
Displayed (green) –

- FD
- CMD
- LAND 2
- LAND 3
- TEST

Displayed (amber) –

- NO AUTOLAND

Autopilot Disengage Switch



CONTROL WHEELS

1 Autopilot Disengage Switches

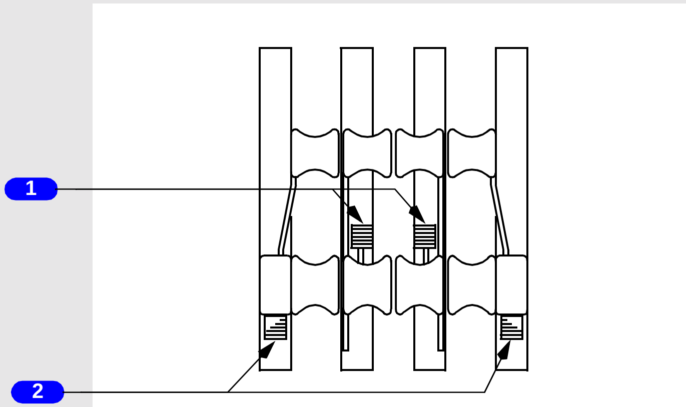
First push (either switch) –

- disengages all autopilots
- master warning lights illuminate
- displays the EICAS warning message AUTOPILOT DISC
- if A/P automatically disengages, resets master warning lights, EICAS warning message, and aural warning
- sounds an aural warning different from all other aural warnings for a minimum of one second

Second push – resets:

- master warning lights
- EICAS warning message
- aural warning

Autothrottle Disconnect and TO/GA Switches



CONTROL STAND

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

On the ground:

Push –

- below 50 knots, activates autothrottle in THR REF mode at reference thrust limit selected on THRUST LIMIT page
- between 50 knots and 400 feet altitude, A/T will not activate
- updates FMC position to runway landing threshold or position shift point if GPS updating not active

In flight (after takeoff, until climb reference thrust limit active):

Push - removes takeoff derates.

In flight (flaps out of up or glideslope captured):

Push -

- selects TO/GA roll and pitch modes. If A/T armed, activates autothrottle in THR mode
- second push selects THR REF autothrottle mode

Note: With no A/P or FD active and TO/GA armed for Go Around, pushing a TO/GA switch displays FD, THR, TO/GA, and TO/GA on both PFDs. Thrust adjusts to provide a 2000 feet per minute climb.

2 Autothrottle Disconnect Switches

Push (either switch) –

- disconnects A/T
- illuminates master caution lights
- displays EICAS message AUTOTHROTTLE DISC
- if A/T automatically disconnects, resets master caution lights and EICAS message

Second push - resets:

- master caution lights
- EICAS caution message

Autothrottle remains armed.

Automatic Flight — Chapter 4
System Description — Section 20

Introduction

The automatic flight control system consists of the autopilot flight director system (AFDS) and the autothrottle system (A/T). The mode control panel (MCP) and flight management computer (FMC) control the AFDS and the autothrottle system to perform climb, cruise, descent, and approach.

Autopilot Flight Director System

The AFDS consists of three flight control computers (FCC) and the MCP.

The MCP provides control of the autopilot, flight director, altitude alert, and autothrottle systems. The MCP selects and activates AFDS modes, and establishes altitudes, speeds, and climb/descent profiles.

The three FCCs, left, center, and right, control separate hydraulically powered A/P control servos to operate flight controls. The A/P controls ailerons and elevators. Rudder commands are added only during a multi-A/P approach. Nose wheel steering is also added during rollout from an automatic landing. During an ILS approach with all three A/Ps engaged, separate electrical sources power the three FCCs.

The FCCs also provide inputs for AFDS operating mode displays and FD commands on the PFD.

MCP Switches

MCP switches select automatic flight control and flight director modes. A light in the lower half of the switch illuminates PFD roll and pitch flight mode annunciations to indicate the mode is armed or active. Autothrottle modes are discussed later in this section.

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

- flight level change (FLCH SPD)
- heading hold (HDG HOLD)
- heading select (HDG SEL)
- vertical speed (V/S)
- altitude hold (ALT)

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

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

All modes deactivate by disengaging the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can only be deactivated by disengaging the autopilot and turning both flight directors off or by selecting TO/GA mode. 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
- vertical speed
- altitude

All parameters except vertical speed can be preselected before autopilot and/or flight director engagement.

Autopilot Engagement

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

Autopilot Disengagement

Normal autopilot disengagement is through either control wheel autopilot disengage switch. The autopilots can also be disengaged by the MCP autopilot disengage bar. The EICAS warning message AUTOPILOT DISC displays when the autopilot has been manually or automatically disengaged.

AFDS Failures

During autopilot operation, failures affecting the active mode annunciate on the PFD. If the failure affects only the active mode:

- the autopilot remains engaged in an attitude stabilizing mode
- an amber line is drawn through the mode annunciation
- the EICAS caution message AUTOPILOT displays

Failures affecting all autopilot modes result in an autopilot disengagement accompanied by an aural warning. Depending on the system failure, it may be possible to reengage an autopilot by pushing the autopilot engage switch.

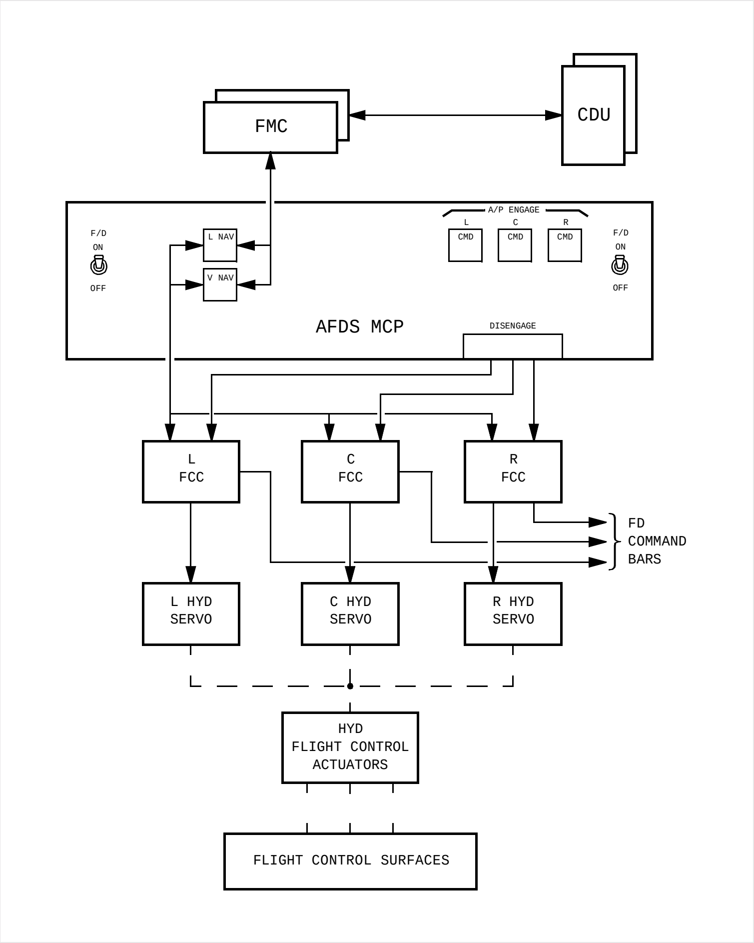
A flight director mode failure, in either pitch or roll, causes the related command bar to disappear.

Flight Director Display

The flight director steering indications normally display any time the related Flight Director switch is ON.

Pushing a TO/GA switch when airspeed is greater than 80 knots and the flaps are out of up displays steering indications when the Flight Director switch(es) is OFF. In this case, steering indications can be removed by cycling the flight director switch(es) ON and OFF.

Autopilot Flight Director System Schematic



AFDS Status Annunciation

The following AFDS status annunciations display above the attitude display:

- FD - flight director ON and autopilots not engaged
- CMD - autopilot engaged
- LAND 3 - three autopilots engaged and operating normally for an automatic landing

- LAND 2 - AFDS redundancy reduced; in some cases, only two autopilots available
- NO AUTOLAND - AFDS 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 displays for any fault limiting the capability of the automatic landing system. Below 200 feet RA, a change from LAND 3 to LAND 2 is not annunciated. Faults not requiring immediate crew action or awareness are annunciated after touchdown.

AFDS Flight Mode Annunciations

Flight mode annunciations display above AFDS status annunciations. Mode annunciations, from left to right, are:

- autothrottle
- roll
- pitch

Active modes display at the top of the flight mode annunciation boxes in large green letters. Armed modes (except for TO/GA in flight) display in smaller white letters at the bottom of the flight mode annunciator boxes.

Autothrottle Modes

Autothrottle annunciations are:

THR - autothrottle applies thrust to maintain the climb/descent rate required by the pitch mode.

THR REF – thrust set to the reference thrust limit displayed on EICAS.

IDLE – displays while the autothrottle moves thrust levers to idle; IDLE mode is followed by HOLD mode.

HOLD – thrust lever autothrottle servos are inhibited. The pilot can set the thrust levers manually.

SPD – autothrottle maintains command speed. Command speed can be set using the MCP IAS/Mach selector or, by the FMC, as displayed on the CDU CLIMB, CRUISE, or DESCENT page. Autothrottle will not exceed thrust limits displayed on EICAS. Speed protection is not provided when the pitch mode is V/S.

Roll Modes

Roll annunciations are:

LNAV –

Arm LNAV by pushing the LNAV switch (the light illuminates and LNAV annunciates on the PFD roll mode annunciator in white characters below the current roll mode).

- LNAV (armed) – LNAV is armed to activate when parameters are met
- LNAV (active) – LNAV activates when above 50 feet and in position to turn onto the active route leg. In flght, selection causes immediate activation if within 2 1/2 NM of the active leg

HDG –

- HDG SEL (active) – airplane turns to or maintains the heading set in the MCP heading window
- HDG HOLD (active) – AFDS holds present heading. When turning, AFDS holds the heading reached after rolling wings level

ATT – (active) – when the autopilot is first engaged or the flight director is first turned on in flight, AFDS holds a bank angle between 5 and 30 degrees and will not roll to wings level. When the bank angle is less than 5 degrees, AFDS rolls to wings level (HDG HOLD). When the bank angle is greater than 30 degrees, AFDS rolls to 30 degrees of bank.

LOC –

- LOC (armed) – AFDS captures the localizer when within range and within 120 degrees of the localizer course
- LOC (active) – AFDS follows the localizer course

TO/GA –

- On the ground, TO/GA annunciates by positioning either flight director switch ON when both flight directors are OFF. TO/GA roll and pitch guidance become active at lift–off
- In flight, TO/GA arms with flaps out of up or at glideslope capture. There is no flight mode annunciation for TO/GA armed in flight; although the reference thrust limit changes to GA. 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) – displays below 1,500 feet radio altitude and activates below 5 feet
- ROLLOUT (active) – after touchdown, AFDS uses rudder and nosewheel steering to steer the airplane on the localizer centerline

Pitch Modes

Pitch annunciations are:

TO/GA –

On the ground, TO/GA annunciates by positioning either flight director switch ON when both flight directors are OFF. The flight director pitch bar indicates an initial pitch of eight degrees up.

After takeoff, the AFDS commands a pitch attitude to maintain:

- during rotation, a pitch attitude, less than the pitch limit indicator (PLI), to maintain a target speed of V2 plus 10 knots or airspeed at rotation (pitch attitude greater than two degrees) plus 10 knots, whichever is greater
- if current airspeed remains above the target speed for 5 seconds, target airspeed resets to current airspeed, to a maximum of V2 plus 25 knots
- IAS/MACH window speed if IAS/MACH window speed is changed to a speed greater than the target speed

Note: AFDS uses the speed set in the IAS/MACH window for V2.

After the reference thrust limit changes from takeoff to climb, TO/GA arms whenever flaps are out of up or at glideslope capture.

When a go–around is initiated, the command speed is the MCP IAS/Mach window or current airspeed, whichever is higher. If the airspeed increases and remains above the initial target airspeed for five seconds, target airspeed resets to current airspeed to a maximum of the IAS/MACH window speed plus 25 knots. If airspeed at inititation of go-around is greater than IAS/Mach window plus 25 knots, that speed is maintained. GA displays as the reference thrust limit on the primary EICAS engine display.

VNAV –

Arm VNAV by pushing the VNAV switch (the light illuminates and VNAV annunciates on the PFD pitch mode annunciator in white characters below the current pitch mode).

VNAV activates at 400 feet and provides pitch commands to maintain the FMC computed airspeed/path:

- VNAV SPD (active) – AFDS maintains the FMC speed displayed on the PFD and/or the CDU CLIMB or DESCENT pages. During speed intervention, use the MCP IAS/MACH selector to manually set the speed
- when a VNAV descent is initiated before the top of descent (T/D) and the airplane subsequently intercepts the VNAV descent path, the pitch annunciation may change from VNAV SPD to VNAV PTH

- VNAV PTH (active) – AFDS maintains FMC altitude or descent path with pitch commands. For a non-entered headwind, thrust may increase to maintain the VNAV descent path. If the MCP altitude window remains set to the current cruise altitude and the airplane is within two minutes of the top of descent, the CDU scratchpad message RESET MCP ALT displays
- VNAV ALT (active) - If a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels and the pitch flight mode annunciation becomes VNAV ALT. The airplane maintains altitude. To continue the climb or descent, change the MCP altitude and push the altitude selector or change the pitch mode

V/S –

Pushing the V/S switch opens the vertical speed window and displays the current vertical speed. It also opens the IAS/MACH window (if blanked). Pitch commands maintain the rate of climb or descent selected in the V/S window.

FLCH SPD –

Pushing the FLCH switch opens the IAS/MACH window (if blanked). Pitch commands maintain IAS/MACH window airspeed or Mach.

ALT –

Altitude hold mode is activated by:

- pushing the MCP altitude HOLD switch, or
- capturing the selected altitude from a V/S or FLCH climb or descent

G/S -

AFDS follows the ILS glideslope.

FLARE –

- FLARE (armed) - during autoland, FLARE displays below 1,500 feet RA
- FLARE (active) - during autoland, flare activates between 60 and 40 feet RA. FLARE deactivates at touchdown and the nosewheel smoothly lowers to the runway

Autothrottle System

The autothrottle system provides thrust control from takeoff through landing.

Autothrottle operation is controlled from the MCP and the CDUs. The MCP allows mode and speed selection. The CDU allows FMC reference thrust limit selection. When a pitch mode is active, FMC selects autothrottle modes and target thrust values. Refer to Chapter 11, Flight Management, Navigation, for FMS and CDU operation.

The autothrottle can be operated without using the flight director or the autopilot.

The autothrottle can be manually overridden or disconnected by using either autothrottle disconnect switch.

Autothrottle Thrust Lever Operation

The autothrottle system moves thrust levers to control speed or thrust, depending on the active mode.

Thrust levers can be manually positioned without disconnecting the autothrottle. After manual positioning and release, the autothrottle repositions thrust levers to comply with the active mode. The autothrottle system does not reposition thrust levers while in HOLD mode.

Autothrottle Disconnect

The autothrottle system can be disconnected manually by positioning the Autothrottle Arm switch to OFF or by pushing either Autothrottle Disconnect switch. The EICAS caution message AUTOTHROT DISC displays when the autothrottle has been manually or automatically disconnected.

Autothrottle disconnect occurs if a fault in the active autothrottle mode is detected, or when a reverse thrust lever is raised to reverse idle. The autothrottle also disconnects and cannot be reactivated if both FMCs fail or two or more engines are shut down. The autothrottle disconnects when the FMC Master switch is switched, but can be reactivated.

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, activation of TO/GA roll and pitch mode occurs when the first Flight Director switch is positioned ON
- PFD displays FD as AFDS status and TO/GA as the pitch and roll flight mode annunciations
- pitch command is set to approximately eight degrees up
- 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 thrust reference (THR REF) and advances Thrust levers to the selected reference thrust limit. If the autothrottle is not engaged by 50 knots, it cannot be engaged until above 400 feet
- at 65 knots, autothrottle annunciation changes to HOLD
- during takeoff, the FMC records barometric altitude as the airplane accelerates through 100 knots. This altitude is used to activate LNAV and VNAV, enable autothrottle activation (if not active), command acceleration for flap retraction, and set climb thrust if an altitude has been selected

At lift–off:

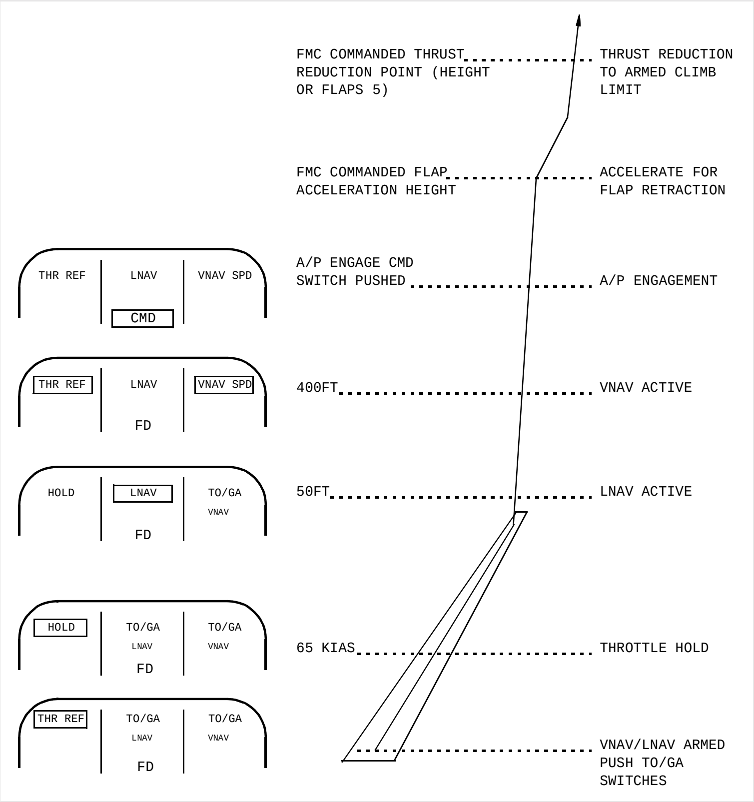
- pitch command target speed is V2 + 10. If current airspeed remains above target speed for 5 seconds, target airspeed is reset to current airspeed (limited to a maximum of V2 + 25)
- roll command maintains ground track

After lift–off:

- if an engine failure occurs, the pitch command target speed is:
  - V2, if airspeed is below V2
  - existing speed, if airspeed is between V2 and V2 + 10
  - V2 + 10, if airspeed is above V2 + 10
- if a TO/GA switch is pushed before the reference thrust limit changes to climb:
  - takeoff derates are removed
  - autothrottle annunciation is THR REF
- at 50 feet, LNAV activates when armed. Roll commands bank to track the active route
- at 400 feet, VNAV activates when armed. Pitch commands the current airspeed. 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:
  - 250 knots,
  - VREF + 100 knots, or
  - speed transition associated with origin airport
- at thrust reduction point (either an altitude or flaps 5), the FMC changes the reference thrust limit to the armed climb limit (CLB, CLB 1, or CLB 2)

TO/GA mode terminates by selecting any other pitch and roll mode, or by activation of LNAV/VNAV modes

Automatic Flight Takeoff Profile



Automatic Flight - Cruise

The autopilot and/or flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC. Using LNAV and VNAV ensures the most economical operation.

Profile illustrations show the use of LNAV and VNAV.

Automatic Flight - Approach and Landing

The AFDS provides guidance for single or multiple autopilot precision 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 only the localizer. Localizer capture can occur when the intercept angle is less than 120 degrees.

Runway Alignment and Asymmetric Thrust Compensation

AFDS controls the rudder during multiple A/P approaches to compensate for crosswind landings and engine-out asymmetric thrust conditions. With LAND 2 or LAND 3 annunciated, A/P control of the rudder is active.

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, runway alignment occurs at 200 feet AGL, where a sideslip is introduced to align the airplane with the runway.

If an engine fails prior to the approach, 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.

If moderate or strong crosswinds are from the side opposite the failed engine, no wings level sideslip is commanded, since the airplane is already banked into the wind.

If the A/Ps are disengaged, manually or automatically, in an asymmetric thrust condition with rudder control active, the rudder moves to the trimmed position. The pilot may need to exert rudder pedal force to maintain a smooth transition to manual flying.

Flare

The flare maneuver brings the airplane to a smooth automatic landing touchdown. The flare mode is not intended for single autopilot or flight director only operation.

Flare arms when LAND 3 or LAND 2 annunciates. At approximately 50 feet radio altitude, the autopilots start the flare maneuver. FLARE replaces the G/S pitch flight mode annunciation.

During flare:

- at 25 feet radio altitude, the autothrottle retards thrust levers to idle
- IDLE replaces the SPD autothrottle flight mode annunciation
- at touchdown, the FLARE annunciation no longer displays, and the nose lowers to the runway

Rollout

Rollout provides localizer centerline rollout guidance. Rollout arms when LAND 3 or LAND 2 annunciates.

At approximately five feet radio altitude, rollout activates. ROLLOUT replaces the LOC roll flight mode annunciation.

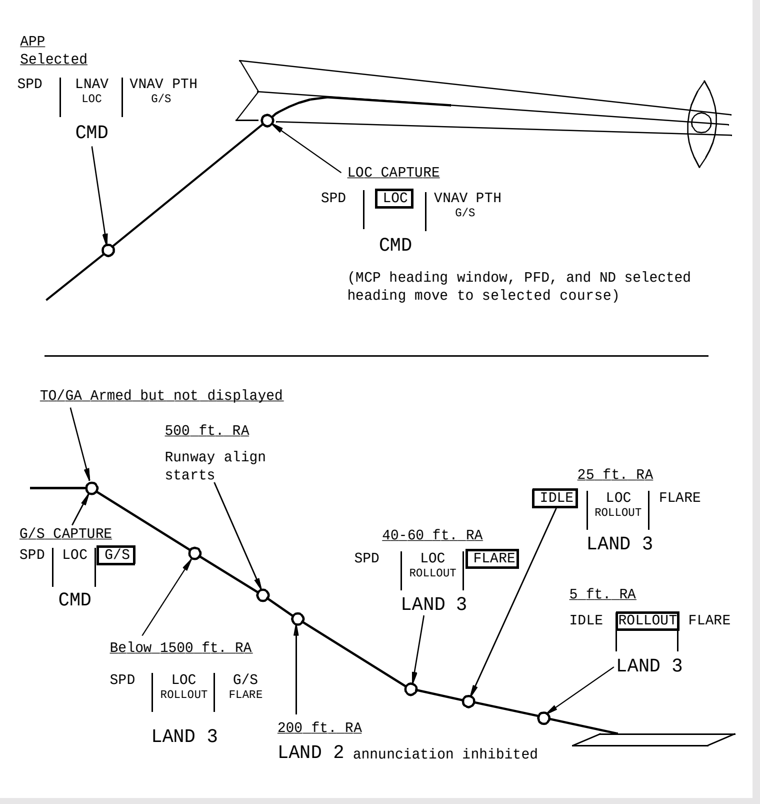
The autopilot controls rudder and nose wheel steering to track the localizer centerline.

During rollout, autothrottle IDLE mode remains active until the autothrottle disconnects with thrust levers in reverse.

Rollout guidance continues until the autopilots are disengaged.

Note: Ten seconds after reverse thrust levers are down, autothrottle is armed until flaps are UP. Pushing a TO/GA switch while the autothrottle is armed activates the autothrottle in THR REF mode.

Automatic Flight Approach Profile



Automatic Flight - Go–Around

Go-around arms and the reference thrust limit changes to GA when the flaps are out of UP 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 two seconds after radio altitude decreases through five feet on landing. TO/GA is enabled again three seconds after radio altitude increases through five feet for a rejected landing or touch and go.

With the first push of either TO/GA switch:

- roll and pitch activate in TO/GA
- autothrottle activates in thrust (THR) to establish a 2000 FPM climb
- 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)

With the second push of either TO/GA switch:

- autothrottle activates in thrust reference (THR REF) at full go–around thrust

TO/GA level–off:

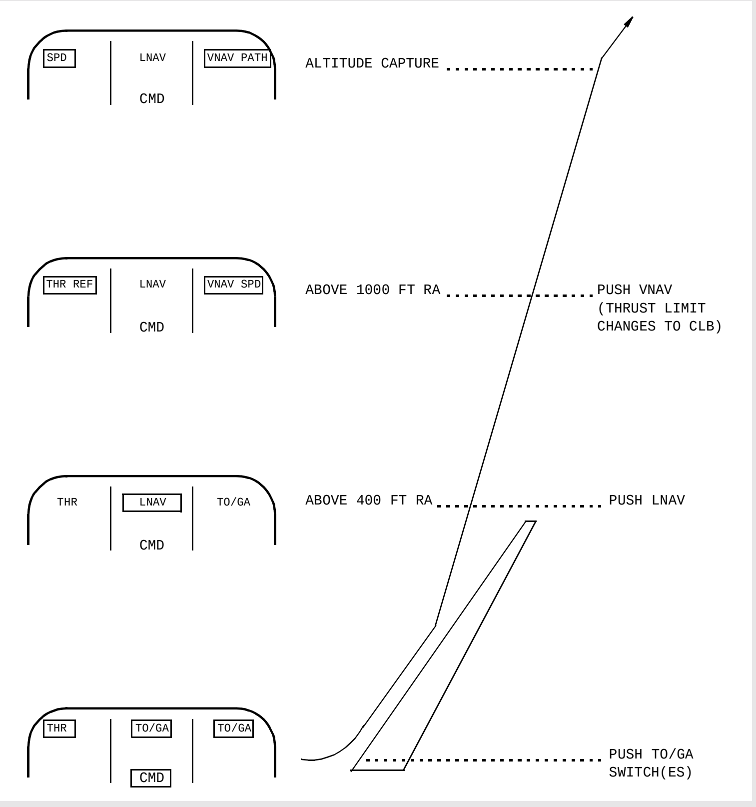
- at the set altitude, the AFDS pitch flight mode annunciation changes to altitude hold (ALT); all autopilots, except first in CMD, disengage
- A/T remains in THR or THR REF until SPD mode is selected. Speed protection prevents exceeding the maximum operating, gear extended, or flap placard speed
- TO/GA remains the active roll mode until another mode is selected

TO/GA mode termination:

- below 400 feet radio altitude, disengage autopilot and turn off both flight directors
- above 400 feet radio altitude, select a different roll or pitch mode; all autopilots, except first in CMD, disengage

If the A/P systems are compensating for an assymmetric thrust condition when they revert to a single A/P in CMD configuration, the rudder returns to the trimmed position unless the pilot exerts the rudder pedal force required to maintain the rudder position.

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. With go–around armed, pushing a TO/GA switch commands a pitch–up of 15 degrees or slightly below the pitch limit, whichever is lower.

As rate of climb increases, 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 activated. 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).

When 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:

- stall protection
- overspeed protection: maximum operating, gear extended, flap placard
- roll envelope bank angle protection

Speed protection prevents exceeding the maximum operating, gear extended, or flap placard speed. To minimize transient speed overshoots, the FMC uses a five knot margin. Speed reduction below the minimum maneuvering speed is also prevented.

With the autothrottle active, speed protection is normally available for all operations except V/S pitch mode. Autothrottle control is limited to the current reference thrust limit (CLB, CRZ, CON, etc.) and idle.

Speed protection is also provided through the elevators in the following pitch modes: VNAV SPD, FLCH SPD, or TO/GA. Minimum and maximum speeds are normally supplied by the FMC. If FMC data is invalid, internal FCC speed limits are calculated. FCC minimum speed is a function of flap setting. FCC maximum speed is the air data computer VMO/MMO for flaps up and flap placard speeds.

With an engine failure during cruise, the AFDS maintains level flight. If above maximum engine-out altitude, delaying descent results in a gradual airspeed loss.

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Automatic Flight EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
>AUTOPILOT	Caution	Beeper	Autopilot is operating in a degraded mode. Engaged roll and/or pitch mode may have failed.
>AUTOPILOT DISC	Warning	Siren	Autopilot has disengaged.
>AUTOTHROT DISC	Caution	Beeper	Autothrottle has disconnected. Message and aural are inhibited when disconnect occurs due to selection of reverse thrust.
>NO AUTOLAND	Caution Advisory	Beeper	Autoland is not available. Message is a caution if fault occurs after LAND 3 or LAND 2 annunciates. Message is an advisory if fault occurs before LAND 3 or LAND 2 annunciates.
>NO LAND 3	Caution Advisory	Beeper	Autoland system does not have redundancy for triple channel autoland. Message is a caution if fault occurs after LAND 3 or LAND 2 annunciates. Message is an advisory if fault occurs before LAND 3 or LAND 2 annunciates.

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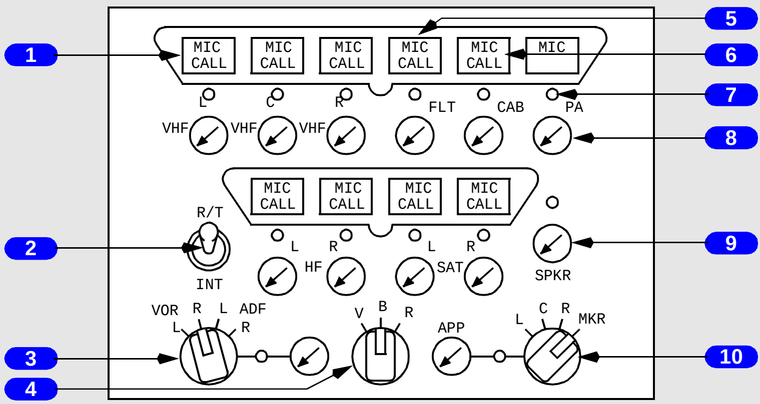
Audio Panel



AFT AISLE STAND AND
OBSERVER'S PANEL

1 Transmitter Select Switches

Push –

- MIC light illuminates
- MIC light for any other transmitter extinguishes
- selects related transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- selects receiver audio on, if not previously selected on manually
- pushing CAB transmitter select switch twice within one second places a priority call to a selected cabin station.

Note: Do not select VHF C for ATC voice communication with ACARS operational.

2 Push-to-Talk Switch

R/T – keys boom microphone or oxygen mask microphone on the selected radio transmitter or interphone system.

Center - off.

INT - keys boom microphone or oxygen mask microphone on flight interphone.

Note: Oxygen mask microphone active when oxygen mask stowage box left-hand door open. Boom microphone active when oxygen mask stowage box left-hand door closed and Reset/Test slide lever pushed and released.

3 VOR/ADF Receiver Selector

Selects VOR or ADF receiver to be monitored:

- VOR L - left VOR
- VOR R - right VOR
- ADF L - left ADF
- ADF R - right ADF.

4 Navigation Filter Selector

Filters VOR, ADF, or ILS audio:

- V (voice) – voice audio is heard
- B (both) – voice and range audio are heard
- R (range) – range audio (navigation aid Morse code identifier) is heard.

5 MIC Lights

Illuminated (white) – indicates related transmitter is selected.

6 CALL Lights

Illuminated (white) - indicates a call on:

- cabin interphone (CAB)
- flight interphone (FLT)
- ACARS (VHF C)
- SATCOM (SAT)
- SELCAL (VHF or HF).

Resets when related transmitter select switch pushed or; when already pushed, by pressing a MIC/INTERPHONE switch.

SATCOM CALL light remains illuminated until call ends.

PA does not have a call indication.

7 Receiver Lights

Illuminated (green) - indicates related receiver audio manually selected on.

8 Receiver Volume Controls

Push - selects related receiver audio on.

Rotate - controls receiver volume.

Second push - deselects related receiver audio.

Note: Will not select off when related transmitter selected ON, or 121.500 tuned in radio tuning panel Active Frequency indicator.

9 Speaker (SPKR) Volume Control

Push - turns related flight deck speaker on.

Rotate - controls flight deck speaker volume.

Second push - deselects related receiver audio.

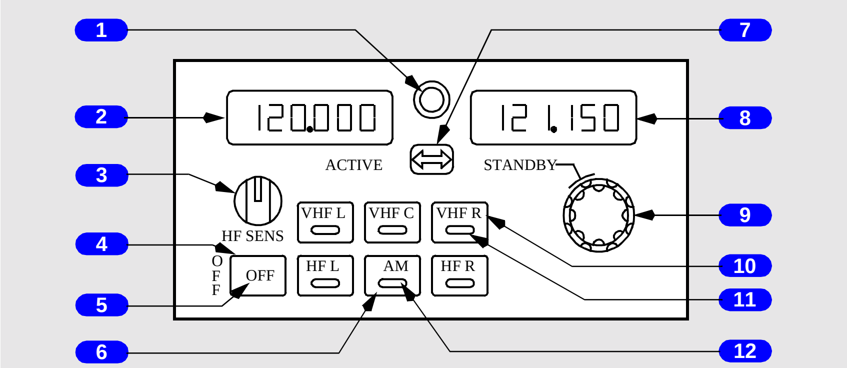
10 Approach (APP) Receiver Selector

Selects approach receiver to be monitored:

- APP L - left ILS
- APP C - center ILS
- APP R - right ILS
- MKR - marker beacon.

Radio System

Radio Tuning Panel



AFT AISLE STAND

1 Offside Tuning Light

Illuminated – indicates one of the following conditions:

- the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel
- the radio normally associated with this panel is being tuned by another radio tuning panel
- another radio tuning panel is off

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.

2 ACTIVE Frequency Window

Displays tuned frequency of selected radio.

Displays ACARS on VHF C when ACARS selected.

3 HF Sensitivity Control

Rotate – adjusts sensitivity of related HF receiver.

Control not affected by radio tuning panel failure or by OFF switch.

Note: Right radio tuning panel HF SENS control operative only when right HF radio installed. Center radio tuning panel HF SENS control inoperative.

4 Radio Tuning Panel (PNL) OFF Switch

Push – disconnects panel from communication radios.

5 Radio Tuning Panel OFF Light

Illuminated (white) – radio tuning panel is disconnected from communication radios.

6 AM Switch

Push – sets AM (amplitude modulation) or USB (upper side band) mode for selected HF.

7 Frequency Transfer Switch

Push –

- transfers STANDBY window frequency to ACTIVE window and tunes selected radio to new active frequency
- transfers ACTIVE window frequency to STANDBY window.

8 **STANDBY Frequency Window**

Displays preselected or previously tuned frequency of selected radio.

Displays ACARS on VHF C when selection of the frequency transfer switch would reconfigure VHF C to the data mode.

9 **Frequency Selector**

Rotate – to set frequency in the STANDBY window:

- outer knob – selects the portion of the frequency to the left of the decimal point
- inner knob – selects the portion of the frequency to the right of the decimal point.

10 **Radio Tuning Switches**

Push –

- selects radio to be tuned
- tuned frequency displays in ACTIVE frequency window
- standby frequency displays in STANDBY frequency window.

Note: Selection of VHF C inhibits ACARS operation.

11 **Radio Tuning Lights**

Illuminated (white) – indicates selected radio.

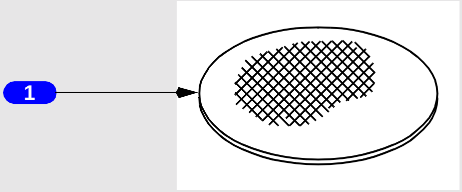
12 **AM Light**

Illuminated (white) – HF AM selected.

Extinguished – HF USB is selected.

Miscellaneous Communication Controls

Flight Deck Speaker

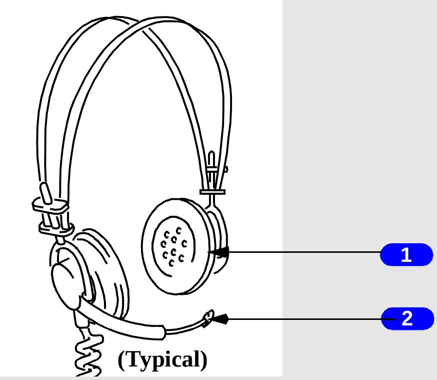


UPPER SIDE PANELS

1 **Flight Deck Speaker**

Controlled by speaker volume control on related audio control panel.

Headphone/Boom Microphone



SIDEWALL PANELS

1 **Headphone**

Used to monitor audio from related audio control panel.

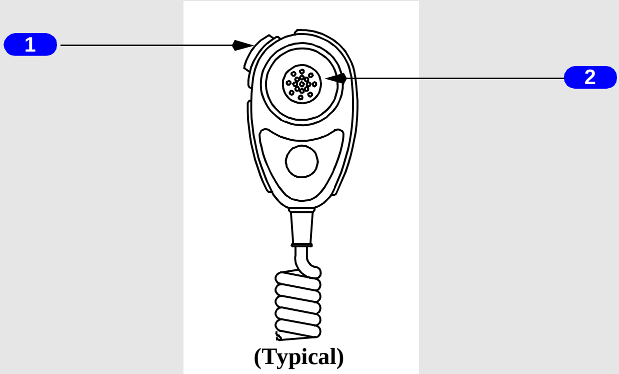
Audio volume adjusted using audio control panel controls for the related station.

Available at all four 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



SIDEWALL PANELS

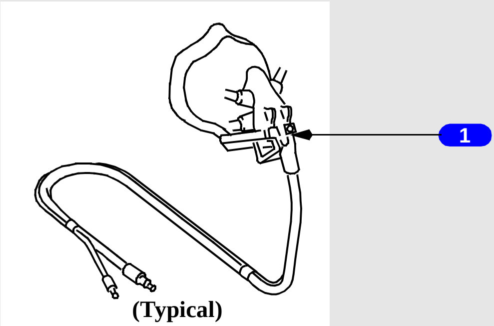
1 Hand Microphone Push–To–Talk Switch

Push – activates hand microphone.

2 Hand Microphone

Transmits on system selected by audio control panel.

Oxygen Mask Microphone



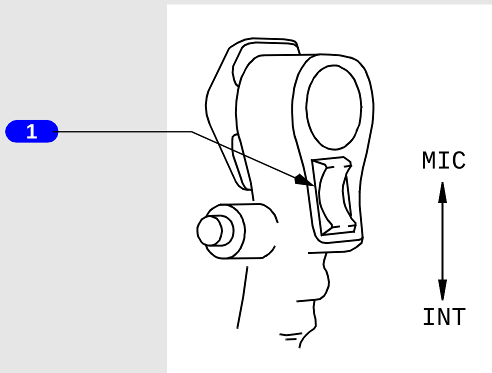
SIDEWALL PANELS

1 Oxygen Mask Microphone

Enabled when oxygen mask doors open. 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



CONTROL WHEELS

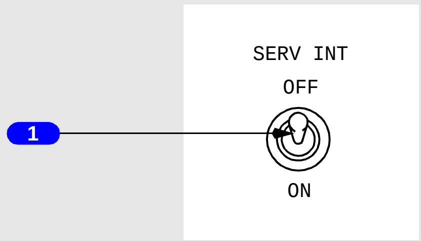
1 Control Wheel Mic/Interphone Switch

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 flight interphone system. Spring–loaded to center.

Service Interphone Switch



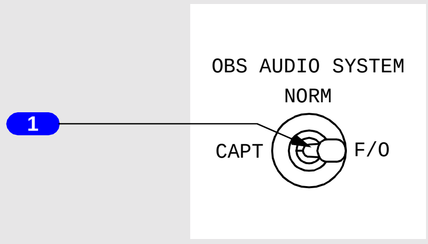
OVERHEAD PANEL

1 Service Interphone (SERV INT) Switch

OFF – allows independent operation of service and flight interphone systems.

ON – connects service and flight interphone systems.

Observer Audio System Switch



OVERHEAD PANEL

1 Observer (OBS) AUDIO SYSTEM Switch

Allows Captain or First Officer to use Observer's audio panel.

CAPT - connects Observer's audio panel to Captain's:

- hand mic
- boom mic/headset
- headphone
- oxygen mask mic
- speaker
- push-to-talk switches.

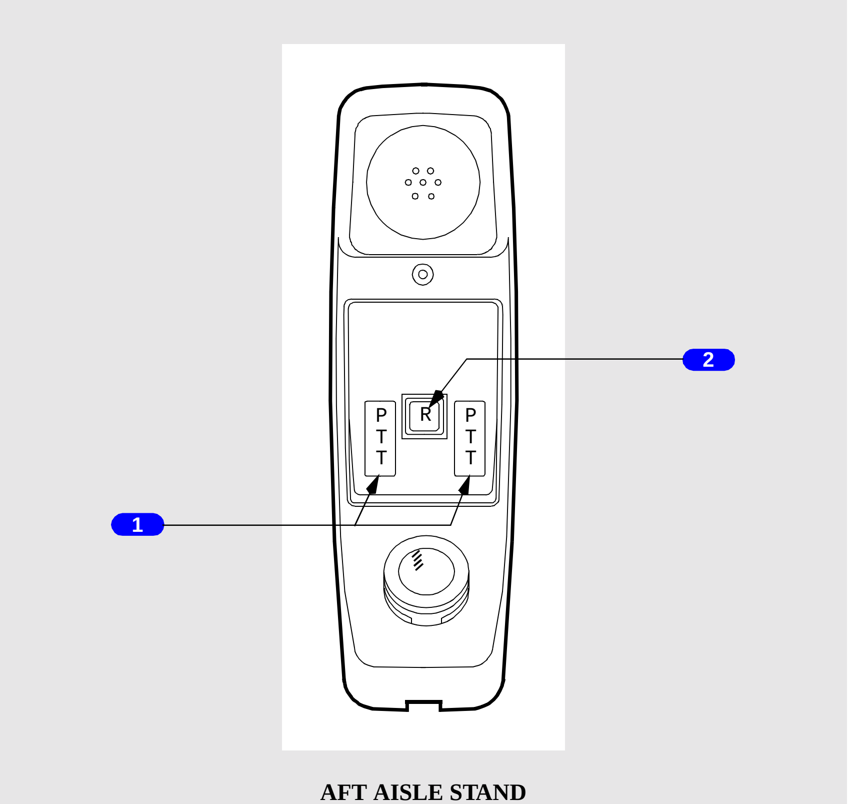
NORM - audio panel normal operation.

F/O - connects Observer's audio panel to First Officer's:

- hand mic
- boom mic/headset
- headphone
- oxygen mask mic
- speaker
- push-to-talk switches.

Handset

Handset provides communication with other handsets or PA system.



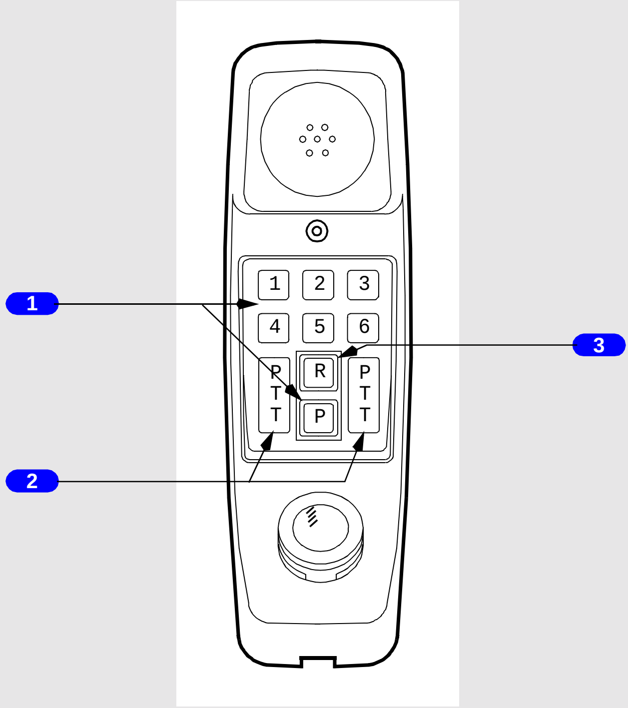
AFT AISLE STAND

1 PA Push-to-Talk Switches

Push – in PA mode connects handset mic to selected PA area.

2 **Reset Switch**

Push _ cancels call.



FLIGHT ATTENDANTS' PANELS

1 **Interphone Keys**

Push – selecting two digit code calls related station or PA area.

2 **PA Push-to-Talk Switches**

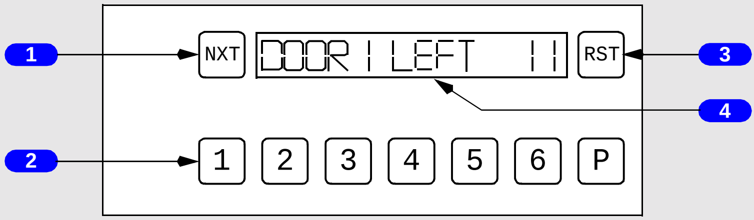
Push – in PA mode connects handset mic to selectedPA area.

3 **Reset Switch**

Push – cancels call or incorrectly selected code.

Interphone Panel

Provides control for either PA (passenger address) or CAB (cabin) interphone communications using either the handset or an audio panel.



AFT AISLE STAND

1 Next (NXT) Switch

Push –

- reviews stored call locations
- when no other calls, scrolls through directory.

2 Interphone Switches

Push -

- selecting two digit code calls related station orPA area
- speak by selecting CAB (cabin) transmitter switch on audio panel or handset.

3 Reset (RST) Switch

Push - cancels call or incorrectly selected code.

4 Interphone Station Indicator

Indicator displays:

- location and code of station calling or being called
- number of stored call locations
- station code and location when reviewing directory or other calls to the flight deck.

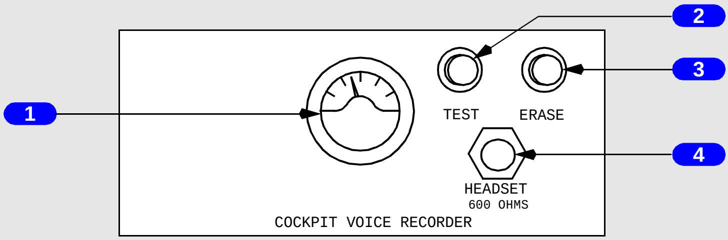
Other interphone panel displays are:

- CABIN READY
- PA IN USE
- PILOT ALERT
- VIDEO IN USE
- PARTY LINE

Note: Interphone directory located on handset. Light sensor adjusts intensity of interphone station indicator.

Cockpit Voice Recorder System

Cockpit Voice Recorder Panel



OVERHEAD MAINTENANCE PANEL

1 Monitor Indicator

2 TEST Switch

Push - tests all four channels.

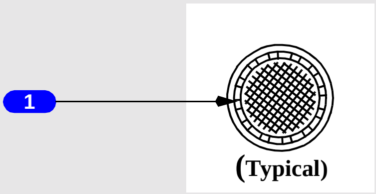
3 ERASE Switch

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 can be plugged in to monitor playback of voice audio, or monitor tone during test.

Cockpit Voice Recorder Microphone

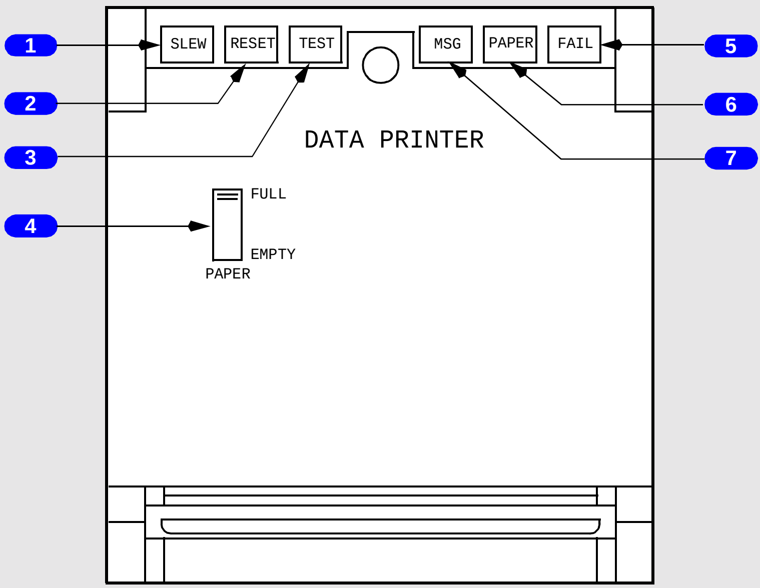


OVERHEAD PANEL

1 Cockpit Voice Recorder Microphone

Area microphone for the voice recorder.

Printer Controls



AFT AISLE STAND

1 SLEW Switch

Push and hold - advances paper.

2 RESET Switch

Push - resets Message (MSG) light.

3 TEST Switch

Push –

- tests printer
- when pushed with RESET switch, prints test pattern.

4 PAPER Indicator

Indicates amount of paper in printer.

5 FAIL Light

Illuminated (amber) - indicates printer failure.

6 PAPER Light

Illuminated (amber) - indicates printer out of paper.

7 Message (MSG) Light

Illuminated (blue) - indicates message sent to printer.

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Introduction

The communication system includes:

- radio communication system
- cockpit voice recorder system
- interphone communication system
- SATCOM communication system
- ATC data communication system
- company data communication system

The radio tuning and audio panels control the communications systems.

Audio Panels

The audio panels control 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.

The second observer audio panel is installed on the sidewall panel.

Microphones are keyed by pushing the desired audio panel transmitter select switch and then selecting one of the following:

- the MIC position of a control wheel switch
- the R/T position of an audio panel Push-to-Talk (PTT) switch
- the PTT position of a hand microphone switch

Systems are monitored using headphones or speakers.

An oxygen mask microphone is enabled and the boom microphone is disabled when the oxygen mask left stowage door is open. The oxygen mask microphone is disabled and the boom microphone is enabled when the left oxygen mask stowage box door is closed and the RESET/TEST lever is pushed.

Cockpit Voice Recorder System

The cockpit voice recorder records any transmissions from the flight deck made through 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 tune the VHF and HF radios. The panels are designated left, center, and right, and are normally associated with the related VHF and HF radios.

If a radio tuning panel fails, the panel can be disconnected from the communication radios using the Off switch.

An offside tuning indicator on each radio tuning panel indicates one of the following conditions when illuminated:

- the panel is selected to a radio normally associated with another radio tuning panel
- a communication radio not normally associated with that radio tuning panel has been selected and may be tuned by another radio tuning panel
- another radio tuning panel is off

Radio Communication System

The radio communication system consists of:

- Very High Frequency (VHF)
- High Frequency (HF)
- Aircraft Communication Addressing and Reporting System (ACARS)
- Selective Calling (SELCAL)
- Satellite Communications (SATCOM)

VHF and HF

There are three independent VHF radios (VHF L, C, R) and two independent HF radios (HF L, R). Any VHF or HF radio can be controlled by any radio tuning panel. The audio panels control voice transmission and receiver monitoring.

VHF L and VHF R are configured for voice communication only. VHF C can be configured for voice or ACARS data communication. Normally, VHF C is configured for ACARS data communication.

HF radio sensitivity can only be adjusted using the on–side radio tuning panel. Sensitivity control is not affected by radio tuning panel status. When an HF transmitter is keyed after a frequency change, the antenna tunes. While the antenna is being tuned, a steady or intermittent tone can be heard through the audio system (tuning takes a maximum of 15 seconds).

Stuck Mic Protection

On the ground, any VHF radio transmitting more than 35 seconds is disabled and dashes appear in the tuning panel frequency window. The radio is enabled when the microphone switch for that radio is released.

Aircraft Communication Addressing and Reporting System (ACARS)

ACARS data and voice modes provide automatic and manual means to transmit and receive operational, maintenance, and administrative information between the airplane and a ground station. ACARS is operational when electrical power is established and is accessed by selecting the ACARS prompt on the CDU main menu.

ACARS communicates through either VHF C or SATCOM.

If ACARS is not available due to lost communication, information to be transmitted is stored and transmitted automatically when communication is regained.

VHF C data mode can be selected and deselected by pushing the frequency transfer switch on the radio tuning panel. VHF C is in the data mode when the word ACARS is displayed in the radio tuning panel active frequency window.

If the data mode is deselected, ACARS is still operational and an ACARS failure may cause interference with voice operation of the radio. Therefore, ATC voice communication on VHF C is prohibited.

Satellite Communications (SATCOM)

The SATCOM system provides ACARS data communications.

ACARS uses the SATCOM system when the airplane is beyond VHF communication range. Switching between VHF and SATCOM is automatic. ACARS data is controlled through the control display units (CDUs).

The SATCOM system also provides voice communications. Voice transmission is controlled using the CDUs and audio panels. Calls can be initiated using the CDU.

The SATCOM CDU control pages display by selecting SAT on the MENU page.

Selective Calling (SELCAL)

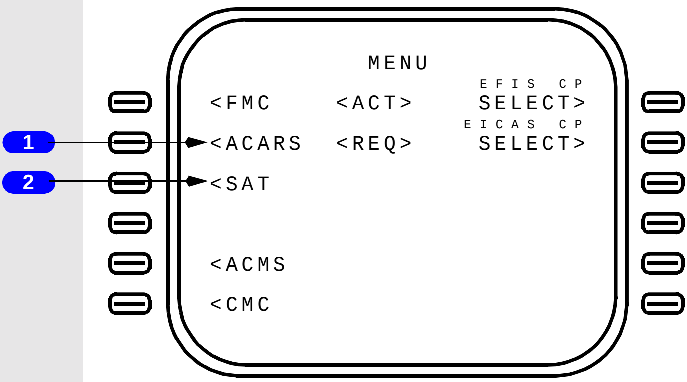
The SELCAL system monitors the VHF and HF radios. When the system receives a call from a ground station, the related radio CALL light illuminates and a chime sounds. The CALL light is reset by selecting the related transmitter selector, or transmitting on that radio.

CDU Menu Page

Pushing the CDU MENU key displays the CDU menu page.

CDU ACARS and SATCOM Access

Normally, ACARS and SATCOM displays are viewed on the center CDU. ACARS and SATCOM prompts are available on the menu page of all CDUs.



CDU

1 ACARS

Push –

- displays ACARS page
- activates ACARS control of CDU

2 SAT

Push –

- displays SATCOM page
- activates SATCOM control of CDU

Interphone Communication System

The interphone communication system includes the:

- flight interphone system
- cabin interphone system
- passenger address (PA) system
- service interphone system.

The flight interphone, service interphone, and PA systems are normally operated through the audio select panel.

The cabin interphone is operated through the audio panel or flight deck handset.

Flight Interphone System

The flight interphone system provides communications between flight deck crew members.The flight interphone system also provides communications between the flight deck and ground crew through the flight interphone jack in the nose landing gear wheel well.

The system is used by selecting the INT (interphone) position on a control wheel switch or on an audio panel Push-to-Talk (PTT) switch. The interphone can also be used by selecting the FLT transmitter selector on an audio panel and then selecting one of the following:

- the R/T position of an audio panel PTT switch
- the MIC position of a control wheel switch
- the PTT position of a hand microphone switch

Crew alerting of a ground crew initiated call is provided by an aural alert chime and illumination of the FLT call indication. The call indication is reset by selecting the FLT transmitter selector or transmitting on that transmitter. The call indication is also reset after a 30 second delay. The ground crew is called by selecting P-1 on the interphone panel.

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.The PA system is accessed using the boom microphone, or oxygen mask microphone, or hand microphone, or the pilot's interphone handset located behind the aisle stand.

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.

The boom or oxygen mask microphone is used by selecting the PA transmitter selector and using the R/T position of a push-to-talk switch. The hand microphone is also used with the PA transmitter selected. The system is monitored by selecting the PA receiver selector/volume control.

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.

The cabin interphone system is accessed by using the boom microphone, or oxygen mask microphone, or hand microphone, or the pilots' interphone handset located behind the aisle stand.

The boom or oxygen mask microphone is used by selecting the CAB transmitter selector and using the R/T position of a push-to-talk switch. The hand microphone is also used with the CAB transmitter selected. The system is monitored by selecting the CAB receiver selector/volume control.

Selecting the CAB transmitter selector or removing the pilots' interphone handset from the hook activates the interphone panel. The interphone panel is used to select the desired station to be called.

Interphone system calls from the flight deck to attendant stations are prioritized according to the code dialed (PA announcements, Priority 33, ALL CALL, and station to station). A higher priority call will override and disconnect a lower priority call.

A priority line can be established only to the primary station (normally primary DR 1L), by dialing 33 or pushing the CAB transmitter selector on the audio panel twice within three seconds. This action also joins an existing priority call between the primary and alternate station.

Any station may call the flight deck on Pilot Alert and override a Priority call but not a PA announcement.

Calls may be transferred to any other station by dialing the code of the station the call is to be transferred to and then hanging up. Up to four stations may be connected in a conference call by dialing the station to be added.

Flight attendants desiring communication with the flight deck use the flight attendant handsets. The incoming call illuminates the CAB call indication on the audio panel, displays the location of the calling station on the interphone panel, and sounds a chime.

The CAB call indication is reset by selecting the related transmitter selector, or transmitting on that transmitter. The call indication is also reset by picking up the pilots' interphone handset.

The flight deck can receive up to three incoming calls at the same time from callers using dial code 31. With a call in progress, up to two additional callers may access the same line and PARTY LINE displays on the flight deck interphone panel. When more than three calls are made to the flight deck at the same time from callers using dial code 31, the additional callers get a busy signal and the caller's location is stored.

When calls are stored, the interphone panel displays a "W" followed by the number of stored calls. After completing the call, stored locations can be reviewed with the NEXT switch on the interphone panel.

Intentionally
Blank

Air Traffic Control Datalink

For airplanes with the Air Traffic Control (ATC) datalink function installed, these functions are accomplished on the CDU. These functions include Air Traffic Services Facilities Notification, Automatic Dependent Surveillance (ADS), and ATC Datalink.

The ATC LOGON/STATUS page provides the capability to initiate an AFN downlink to a specified ATS facility and to display the ADS, ATC DL, and datalink status.

THE ATC UPLINK pages display messages uplinked by an ATS facility and provide the capability to respond to uplinked messages and to load clearances which contain loadable data.

The ATC REQUEST pages provide capability to create downlink requests for vertical and speed clearances, lateral offsets, and route changes.

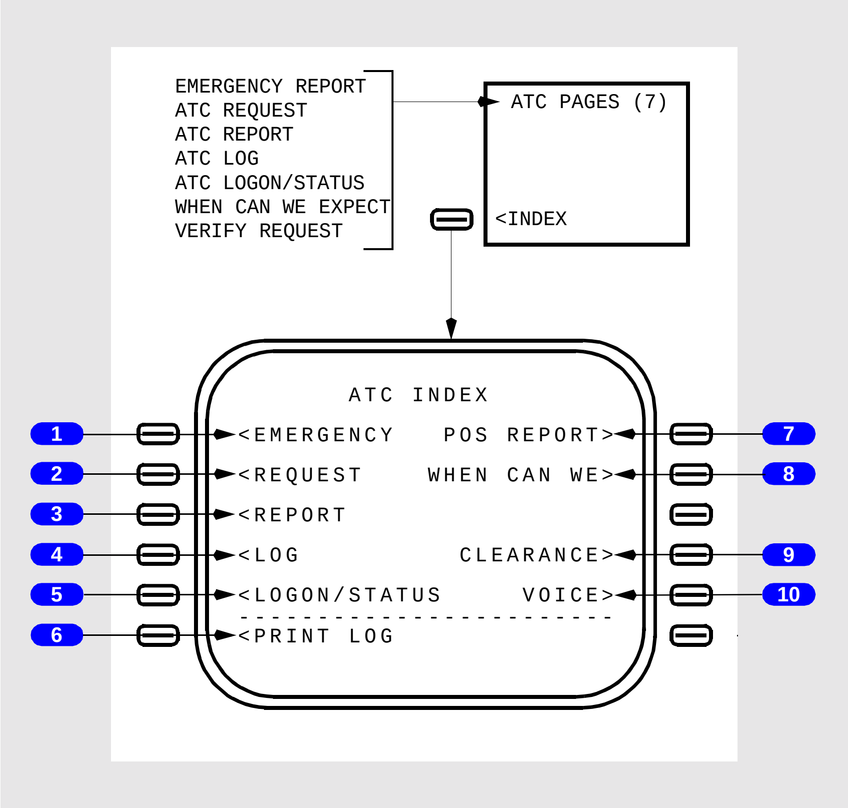
The FMC formats reports in response to requests from an ATS facility for reports and confirmation. These reports are accessible via the ATC REPORT page and display for review or modification on the VERIFY REPORT pages.

The ATC LOG page provides a list of all uplinks and downlinks stored in the ATC Log and provides access to the XXXXz ATC UPLINK, XXXXz ATC REQUEST, XXXXz ATC REPORT, and XXXXz EMERGENCY pages corresponding to each logged uplink or downlink.

To accomplish Automatic Dependent Surveillance, the FMC can simultaneously receive requests from four ATC centers and one airline center. Airline ADS addresses are stored in the airline policy file. The ADS functions include periodic, event, and on-demand reporting. The type and content of a report is initiated by uplink request. These functions are automatic. The flight crew can disable this function on the ATC LOGON/STATUS page.

ATC Index Page

The ATC INDEX CDU page provides access to pages used for ATC datalink functions.



1 EMERGENCY

Push - displays EMERGENCY REPORT page.

2 REQUEST

Push - displays ATC REQUEST page.

3 REPORT

Push - displays ATC REPORT page.

4 LOG

Push - displays ATC LOG page.

5 **LOGON/STATUS**

Push - displays ATC LOGON/STATUS page.

6 **PRINT LOG**

Push - transmits contents of ATC log to printer.

7 **Position (POS) REPORT**

Push - displays POS REPORT page.

8 **WHEN CAN WE EXPECT**

Push - displays WHEN CAN WE EXPECT page.

9 **CLEARANCE**

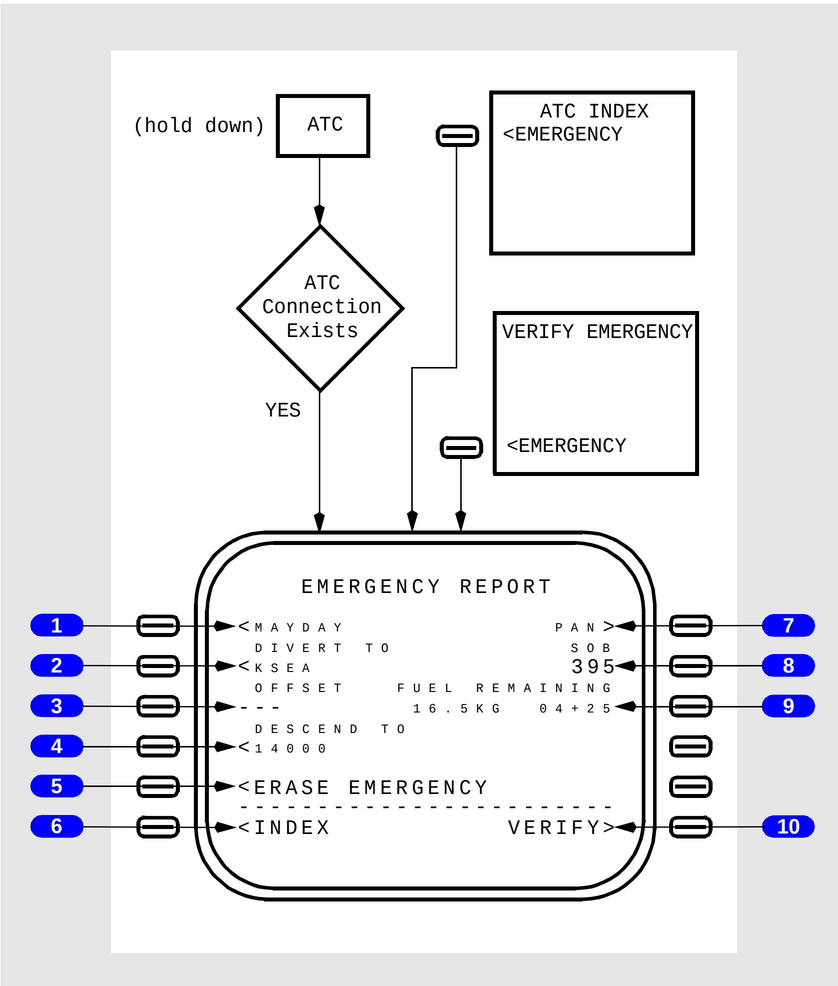
Push - displays VERIFY REQUEST pages for clearance request.

10 **VOICE**

Push - displays VERIFY REQUEST page for voice contact request.

Emergency Report Page

The EMERGENCY REPORT pages provide the capability to create downlink messages to alert an ATS facility to an aircraft emergency and to the lateral and vertical maneuvers the flight crew intend to execute.



1 MAYDAY

Push -

- displays VERIFY EMERGENCY page
- displays MAYDAY MAYDAY MAYDAY message
- when current altitude more than 150 feet above altitude in 4L, displays DESCENDING TO on VERIFY EMERGENCY page

2 DIVERT TO

Displays active destination airport.

Valid entries are: waypoint, navaid, airport, latitude-longitude, or place bearing/distance.

Entered position may be deleted.

Push -

- message includes remainder of route if active destination airport displayed
- message includes direct to routing if entered position displayed

3 OFFSET

Valid entry is L (or R) XX. (XX is any number from 1 to 99).

Message includes entered offset.

Entered offset may be deleted.

4 DESCEND TO

Displays MCP altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm.

Entered altitude may be deleted.

Push - message indicates crew intention to descend to displayed altitude.

5 ERASE EMERGENCY, CANCEL EMERGENCY

Initial display is blank.

Entry or selection of data on any line displays ERASE EMERGENCY.

Displays CANCEL EMERGENCY after EMERGENCY REPORT sent.

ERASE EMERGENCY -

Push - erases all emergency data.

CANCEL EMERGENCY -

Push - selects CANCEL EMERGENCY message.

6 **INDEX**

Push - displays ATC INDEX page.

7 **PAN**

Push -

- displays VERIFY EMERGENCY page
- displays PAN PAN PAN message

8 **Souls On Board (SOB)**

Valid entry is number of persons on airplane.

Message includes SOB.

Entered SOB may be deleted.

9 **FUEL REMAINING**

Initial display is blank.

Displays FMC computed fuel remaining in quantity and time when a SOB number is entered.

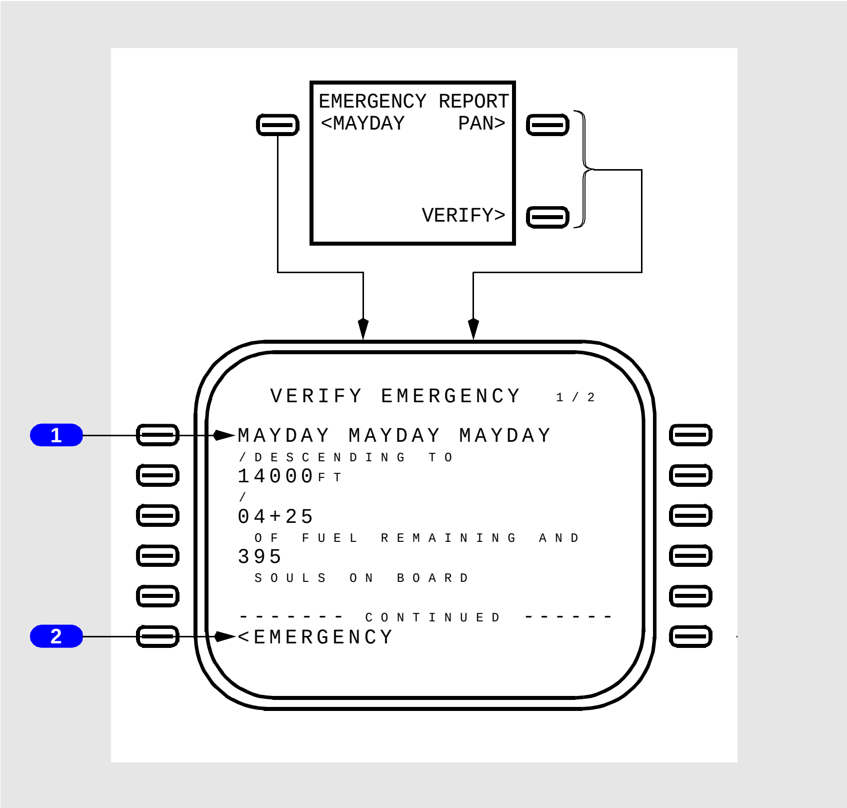
Valid entry is HH+MM (hours and minutes).

10 **VERIFY**

Push - displays VERIFY EMERGENCY page.

Verify Emergency Page 1/X

The VERIFY EMERGENCY page displays the EMERGENCY REPORT for review before it is sent. The page allows entering a free text message.



1 Lines 1 - 5

Pages 1/X to X/X display data from the EMERGENCY REPORT page and provide at least one line for free text entry.

Page 1/X line 1 displays MAYDAY MAYDAY MAYDAY message or PAN PAN PAN message as selected on EMERGENCY REPORT page.

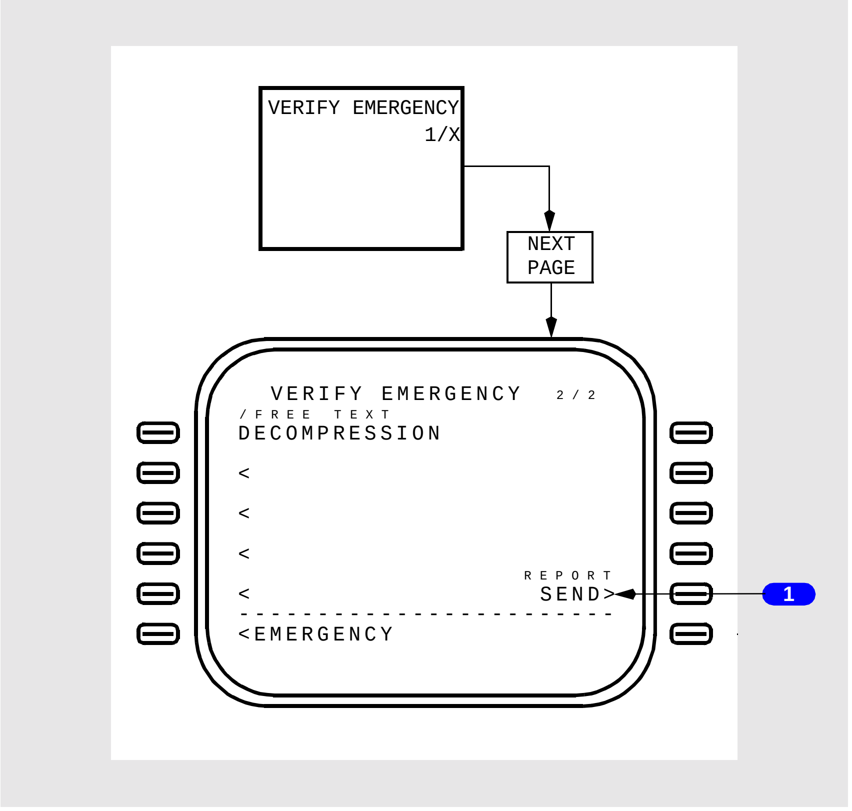
- MAYDAY MAYDAY MAYDAY message andPAN PAN PAN messages may be deleted
- deletion of MAYDAY MAYDAY MAYDAY message deletes DESCENDING TO line

2 **EMERGENCY**

Push - displays EMERGENCY REPORT page.

Verify Emergency Page X/X

Pages X/X are available when lines 1 - 5 are filled on page 1/X.



1 **REPORT SEND**

Push - displays EMERGENCY REPORT page.

- transmits EMERGENCY REPORT
- creates log entry of transmitted message
- when MAYDAY selected and when enabled in airline policy file: transmits POSITION REPORT, activates ADS in emergency mode, and transmits an AOC emergency report

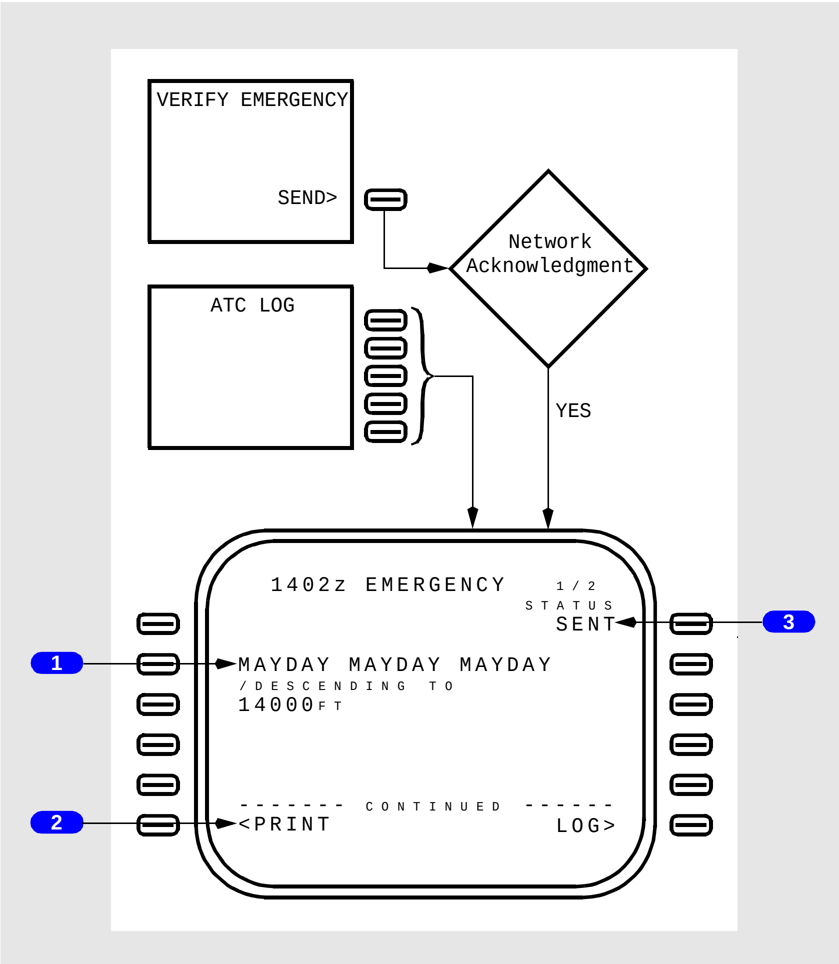
When CANCEL EMERGENCY displayed in 5L:

Push -

- sends CANCEL EMERGENCY message
- deactivates ADS emergency mode
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

XXXXZ Emergency Page X/X

XXXXZ EMERGENCY page displays the transmitted report. XXXXZ is the time the report was transmitted.



1 Lines 1 - 5

Pages 1/X to X/X display message transmitted to ATC at time of page title. Line 1 is blank on page 1/X.

2 PRINT, PRINTERROR, PRINTING, BUSY, FAIL

Displays on last XXXXZ EMERGENCY page.

PRINT displayed - printer READY.

PRINTERROR displayed - printer state ERROR.

PRINTING displayed - printing displayed page.

BUSY displayed - printing other than displayed page.

FAIL displayed - printer failed.

PRINT -

Push - prints XXXXZ EMERGENCY report.

PRINT ERROR -

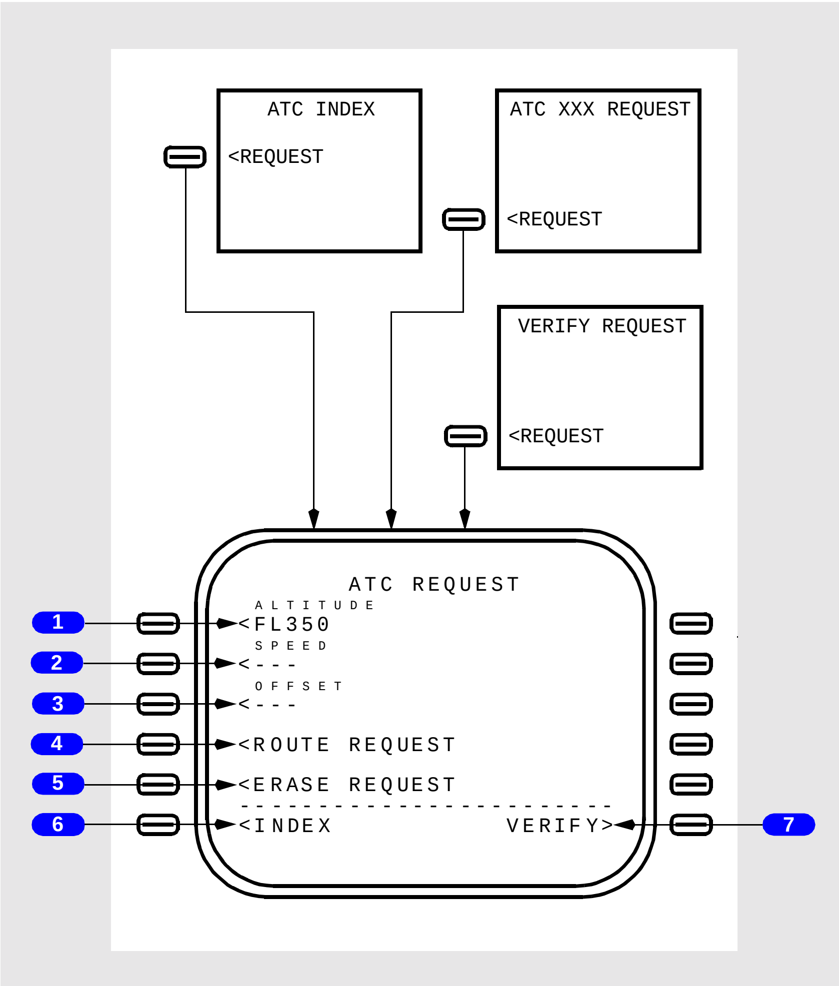
Push - prints XXXXZ EMERGENCY report.

3 STATUS

Displays emergency report status from ATC LOG page.

ATC Request Page

The ATC REQUEST page allows entry of altitude, speed, and offset direction and distance requests.



1 ALTITUDE

Initially displays dashes.

Valid entries are XXX or FLXXX (flight level), XXXXX (feet), XXXXXM (meters), XXXXX/XXXXX, FLXXX/FLXXX, or XXXXXM/XXXXXM.

Entry may be deleted.

Push -

- with altitude/flight level entered, displays ATC ALT REQUEST page with altitude/flight level on altitude line
- with dashes displayed, displays ATC ALT REQUEST page with dashes on altitude line

2 SPEED

Intially displays dashes.

Valid entry is IAS or Mach.

Entry may be deleted.

Push -

- with speed/Mach entered, displays ATC SPEED REQUEST page with speed/Mach on speed line
- with dashes displayed, displays ATC SPEED REQUEST page with dashes on speed line

3 OFFSET

Initially displays dashes.

Valid entry is L (or R) XX (XX is any number from 1 to 99).

Entry may be deleted.

Push -

- with offset entered, displays ATC OFFSET REQUEST page with offset on offset line
- with dashes displayed, displays blank ATC OFFSET REQUEST page

4 ROUTE REQUEST

Push - displays ATC ROUTE REQUEST page.

5 ERASE REQUEST

Push - erases all entered or selected data and any of the four ATC REQUEST pages.

6 INDEX

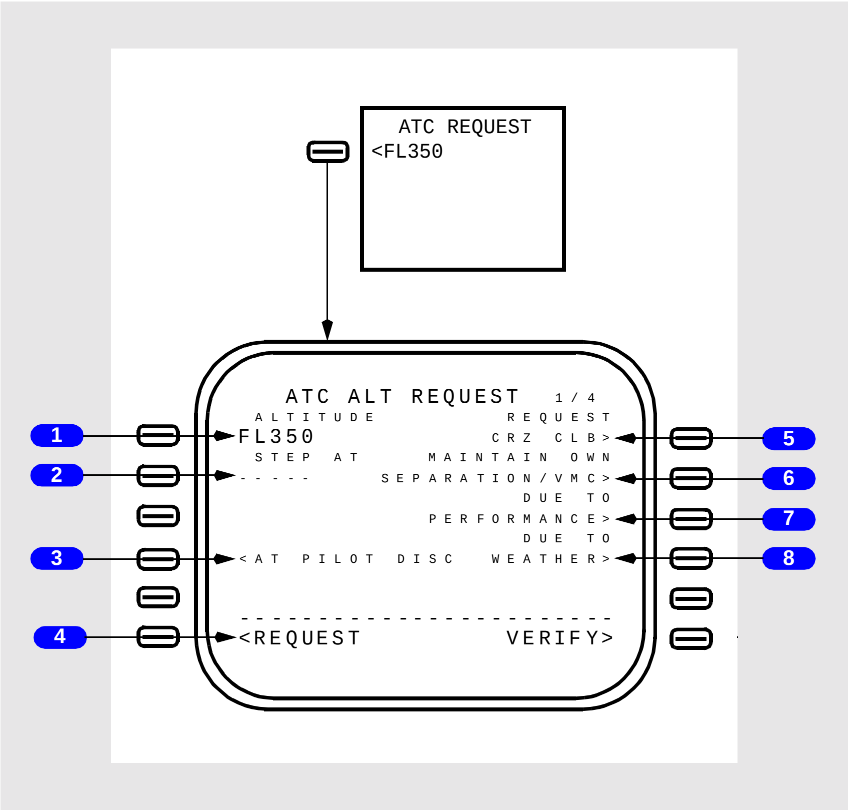
Push - displays ATC INDEX page.

7 VERIFY

Push - displays VERIFY REQUEST page.

ATC Altitude Request Page 1/4

The ATC ALT REQUEST page 1/4 allows downlink requests for altitude changes.



1 ALTITUDE

Initially displays dashes or altitude requestedon ATC REQUEST page.

Valid entries are XXX or FLXXX (flight level), XXXXX (feet), XXXXXM (meters), XXXXX/XXXXX, FLXXX/FLXXX, or XXXXXM/XXXXXM.

Entry selects a message requesting a level altitude, climb, or descent based on current altitude.

Altitude may be deleted.

2 STEP AT

Initially displays dashes.

Valid entries are: fix name, navaid, airport, latitude-longitude, place bearing/distance, or time.

Entry of a position or time with an altitude request selects a message requesting a step up or down at a specified time based on current altitude.

Entry may be deleted.

3 AT PILOT Discretion (DISC)

Push - displays AT PILOTS DISCRETION in large font and selects as message element.

Selection may be deleted.

4 REQUEST

Push - displays ATC REQUEST page.

5 REQUEST Cruise Climb (CRZ CLB)

Push - displays CRZ CLB in large font and selects message requesting cruise climb to entered altitude.

Selection may be deleted.

6 MAINTAIN OWN SEPARATION/VMC

Push - displays SEPARATION/VMC in large font and selects MAINTAIN OWN SEPARATION/VMC mesage element.

Selection may be deleted.

7 DUE TO PERFORMANCE

Push - displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

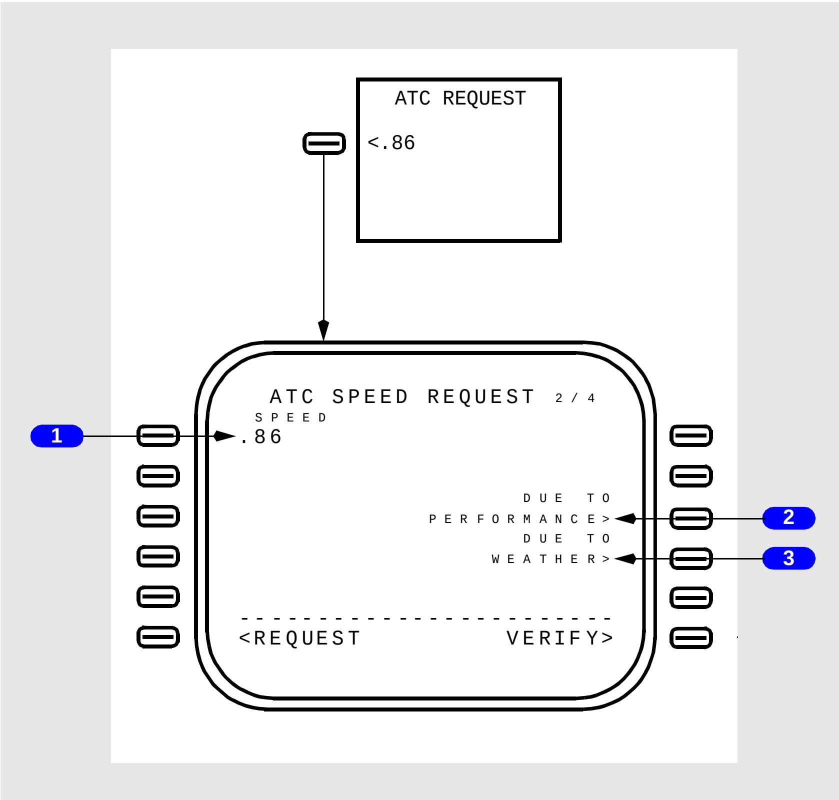
8 DUE TO WEATHER

Push - displays WEATHER in large font and selects DUE TO WEATHER message element.

Selection may be deleted.

ATC Speed Request Page 2/4

The ATC SPEED REQUEST page 2/4 allows downlink requests for speed changes.



1 SPEED

Initially displays dashes or speed/Mach requested on ATC REQUEST page.

Valid entry is IAS or Mach.

Entry selects a message requesting the speed or Mach.

Entry may be deleted.

2 DUE TO PERFORMANCE

Push - displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

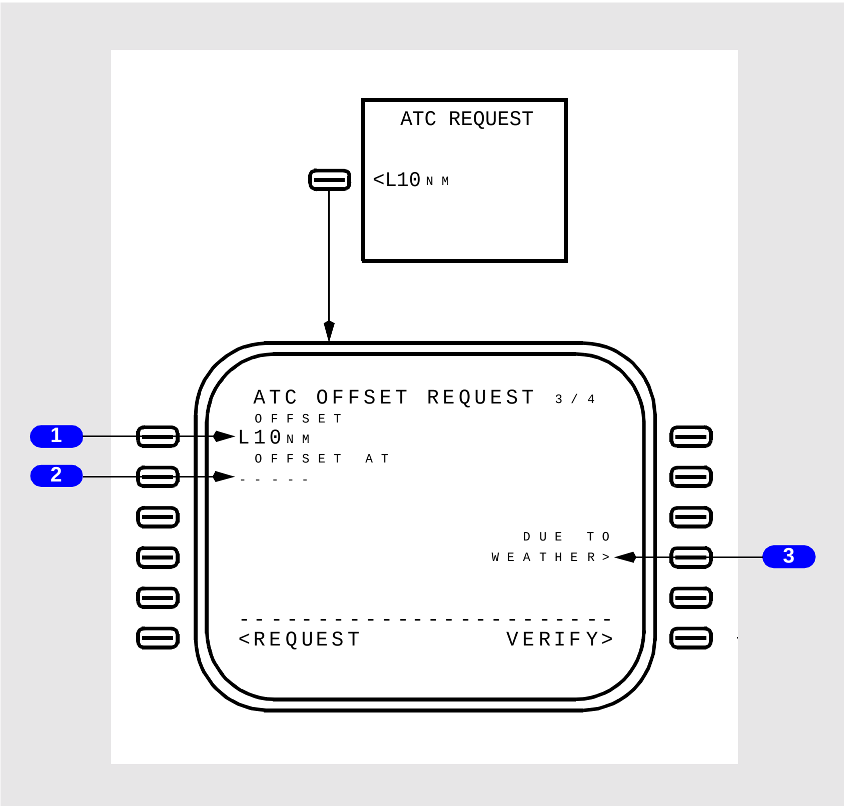
3 **DUE TO WEATHER**

Push - displays WEATHER in large font and selects DUE TO WEATHER message element.

Selection may be deleted.

ATC Offset Request Page 3/4

The ATC OFFSET REQUEST page 3/4 allows downlink requests for later offsets.



1 **OFFSET**

Initially displays dashes or offset requested onATC REQUEST page.

Valid entry is L (or R) XX (XX is any number from 1 to 99).

Entry selects a message requesting an offset from the active route.

Entry may be deleted.

2 OFFSET AT

Entry of a position or time with an offset request selects a message requesting an offset at the specified position or time.

Valid entries are: fix name, navaid, airport, latitude-longitude, place bearing/distance, or time.

Entry may be deleted.

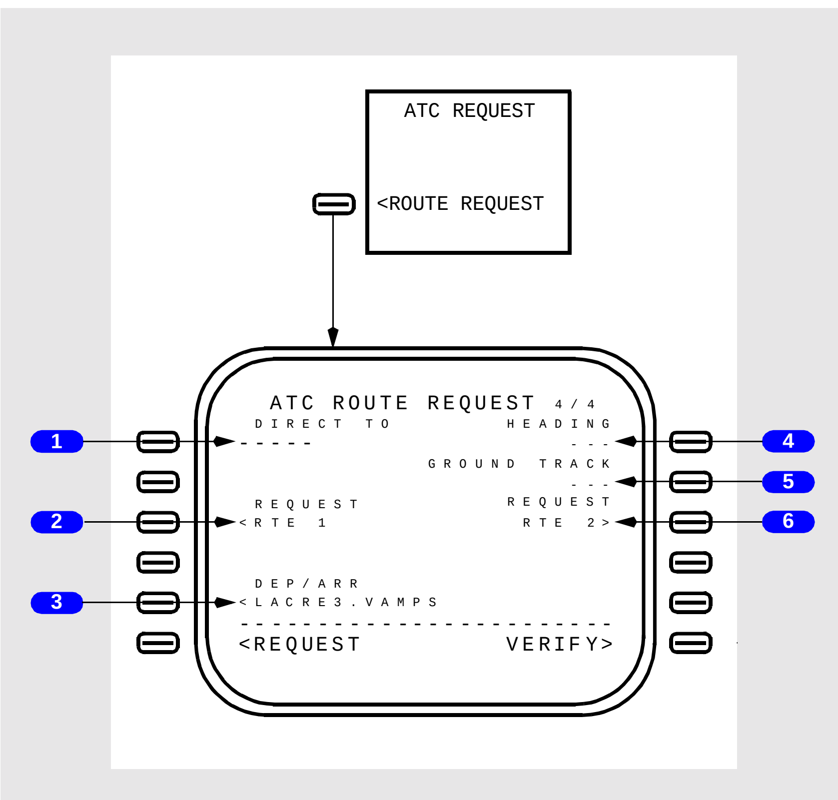
3 DUE TO WEATHER

Push - displays WEATHER in large font and selects REQUEST WEATHER DEVIATION UP TO entered message element.

Selection may be deleted.

ATC Route Request Page 4/4

The ATC ROUTE REQUEST page 4/4 allows downlink requests for route changes.



1 **DIRECT TO**

Entry selects a message requesting a clearance direct to the position.

Valid entries are: fix name, navaid, airport, latitude-longitude, or place bearing/distance.

Entry may be deleted.

2 **REQUEST Route 1 (RTE 1)**

Push - selects route stored in RTE 1 for route request. When RTE 1 has a pending modification, the modified route is requested.

Selection may be deleted.

3 **Departure/Arrival/Transition (DEP/ARR)**

Initially displays dashes or selections made on DEP/ARR page.

Valid entry is departure or arrival, or departure or arrival and transition.

Entry may be deleted.

Push - displays selected entry in large font and selects a message element requesting the selected entry.

4 **HEADING**

Entry selects a message requesting the specified heading.

Valid entry is XXX (heading).

Entry may be deleted.

5 **GROUND TRACK**

Entry selects a message requesting the specified ground track.

Valid entry is XXX (ground track).

Entry may be deleted.

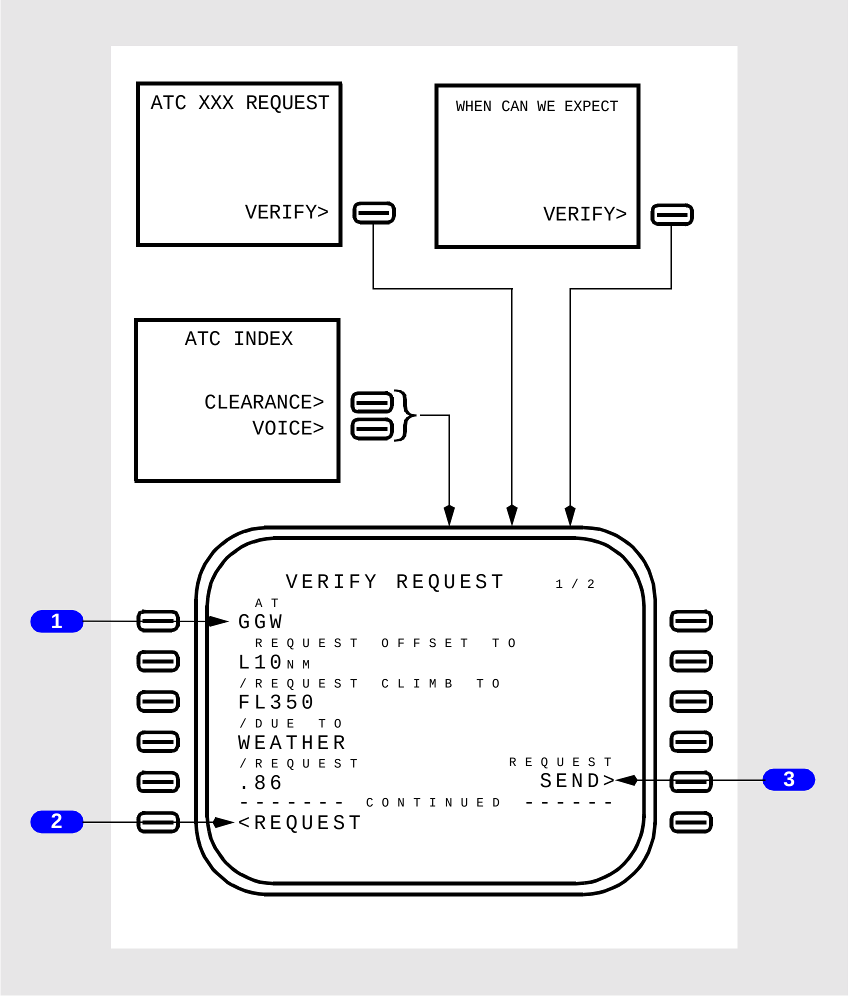
6 **REQUEST Route 2 (RTE 2)**

Push - selects route stored in RTE 2 for route request. When RTE 2 has a pending modification, the modified route is requested.

Selection may be deleted.

Verify Request Page X/X

The VERIFY REQUEST pages display the request for review before it is sent.



1 Lines 1 - 5

Pages 1/X to X/X display data which reflect the request and provide at least one line for free text entry.

Any entered free text included in downlink request.

2 REQUEST, INDEX, WHEN CAN WE

Displays REQUEST when page accessed fromATC REQUEST page.

Displays INDEX when page accessed fromATC INDEX page.

Displays WHEN CAN WE when page accessed from WHEN CAN WE EXPECT page.

REQUEST -

Push - displays ATC REQUEST page.

INDEX -

Push - displays ATC INDEX page.

WHEN CAN WE -

Push - displays WHEN CAN WE REQUEST page.

3 REQUEST SEND

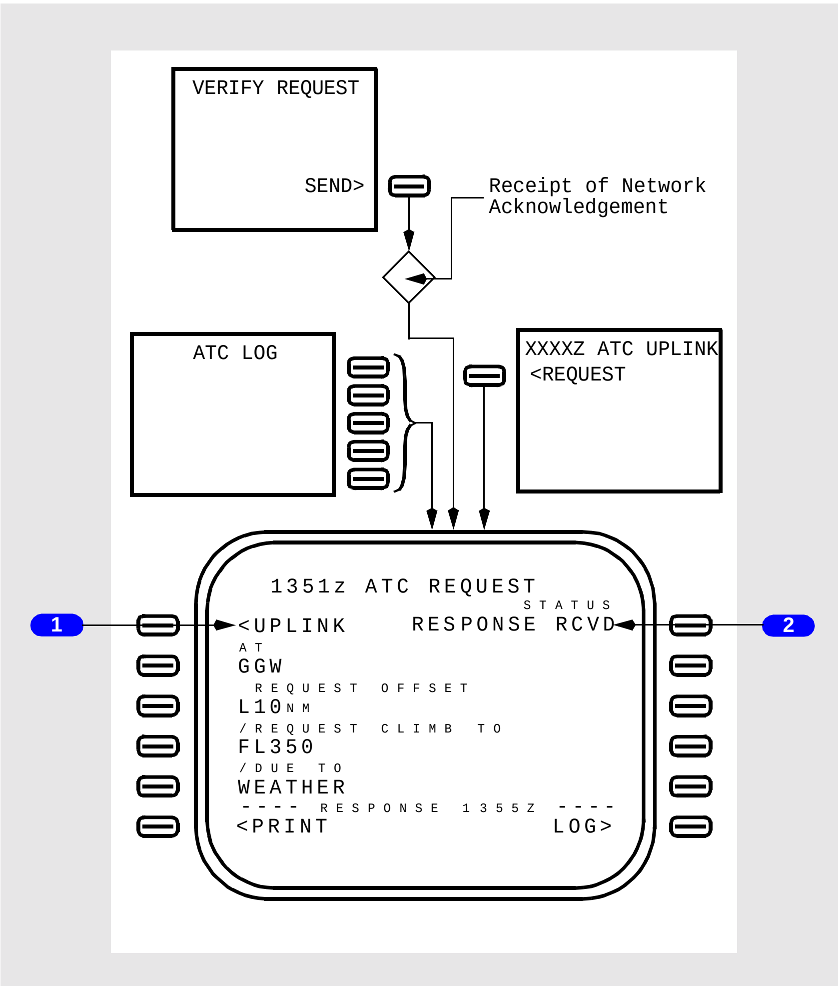
Displays on last VERIFY REQUEST page.

Push -

- initiates ATC request
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

XXXXZ ATC Request Page X/X

The ATC REQUEST pages display the transmitted request. XXXXZ is the time request was transmitted.



1 Lines 1 - 5

Pages 1/X to X/X display data transmitted toATC at the time in page title.

Page 1/X line 1 displays UPLINK when ATC response to displayed downlink request exists.

Response time of ATC uplink displays following text.

UPLINK -

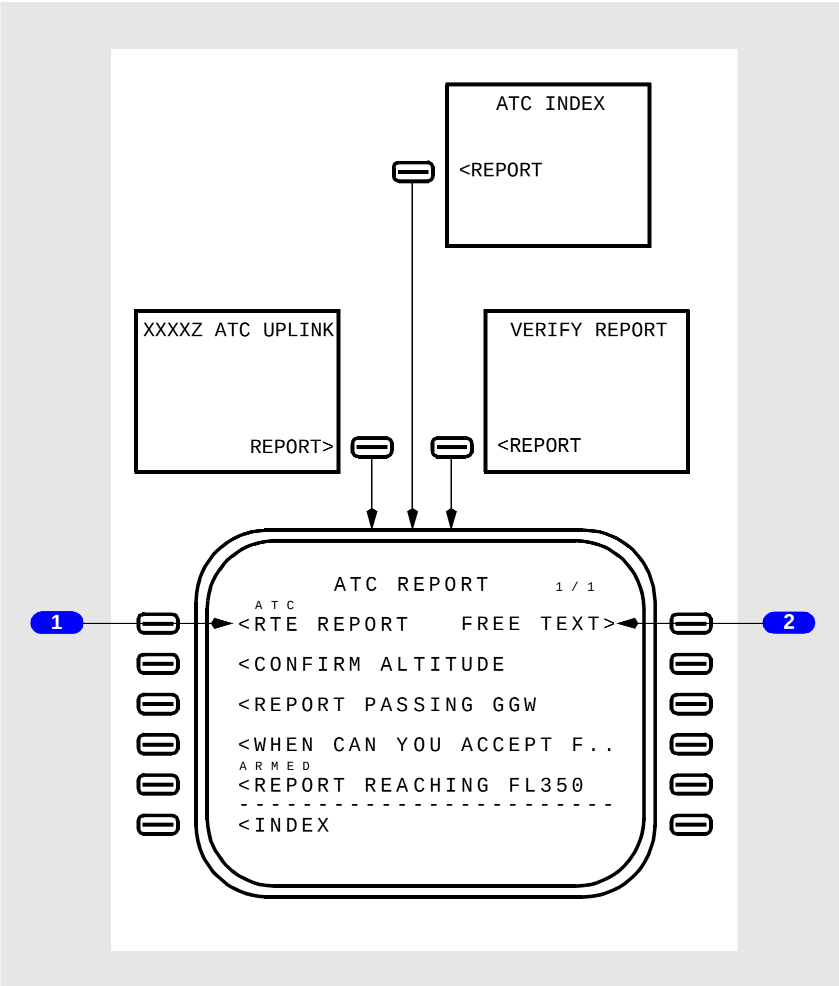
Push - displays the XXXXZ ATC UPLINK 1/X page displaying ATC uplink to displayed request.

2 STATUS

Displays request downlink message status from ATC LOG page.

ATC Report Page X/X

The ATC REPORT pages provide access to VERIFY REPORT pages for ATC RTE REPORT and ATC request reports and confirmations.



1 Lines 1 - 5

Pages 1/X to X/X lines 1 to 5 display uplinked report or confirmation requests transmitted by ATC.

Page 1/X line 1 displays ATC RTE REPORT.

Long messages are abbreviated and followed by two periods.

Title displays ARMED when report armed for automatic transmission.

ATC RTE REPORT -

Push - displays VERIFY REPORT page for the ATC RTE REPORT.

Report or confirmation request -

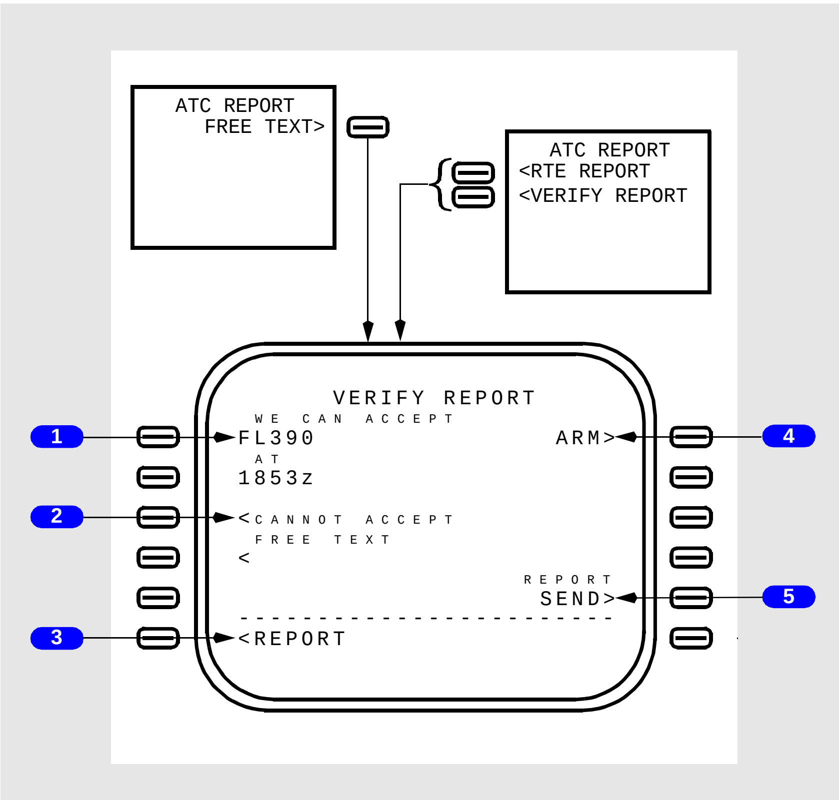
Push - displays ATC requested report or confirmation VERIFY REPORT page.

2 FREE TEXT

Push - displays a clear VERIFY REPORT page .

Verify Report Page

The VERIFY REPORT page displays reports in clearance language and allows review/modification and entry of free text before report is sent.



1 Lines 1 - 4

Display message text and data for each message.

Display boxes for pilot entry.

Entry includes data in report message.

Entry may be deleted.

At least one line is available for free text entry.

2 CANNOT ACCEPT

Displays in reponse to WHEN CAN YOU ACCEPT uplinks.

Push - selects a CANNOT ACCEPT messsage.

Selection may be deleted.

3 REPORT

Push - displays ATC REPORT page.

4 ARM

Push -

- arms report for transmission when condition is satisfied
- displays ARMED
- ARMED may be deleted

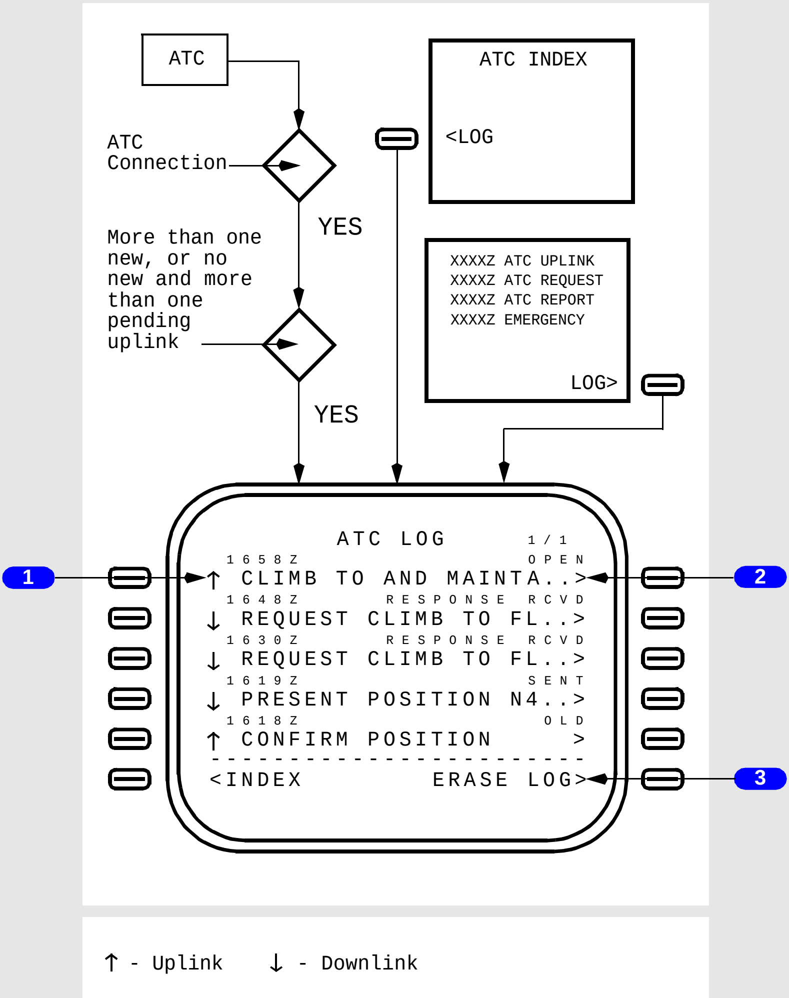
5 SEND

Push -

- transmits ATC REPORT
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

ATC Log Page X/X

The ATC LOG pages display stored uplinks and downlinks. Log automatically erases after flight completion.



1 Lines 1 - 5

Display text of uplink and downlink messages. Long messages abbreviated and followed by two periods.

Deleting a line deletes the log entry.

Title displays message receipt (uplink) or transmission (downlink) time.

2 Message Status

Title displays one of six possible uplink or seven possible downlink states:

Uplink -

- NEW - message not reviewed by crew; message considered pending
- OLD - message reviewed by crew and message does not require response; message considered non-pending
- OPEN - message reviewed by crew, message requires response, crew has not sent response or has sent STANDBY; message considered pending
- ACCEPTED - message reviewed by crew, message requires response, positive response sent, network acknowledgement of positive response received; message considered non-pending
- REJECTED - message reviewed by crew, message requires response, negative response sent, network acknowledgement of negative response received; message considered non-pending
- ABORTED - message pending when all terminations terminated or transfer of communications occured

Downlink -

- SENDING - SEND or RESEND prompt selected, network acknowledgement not yet received, message considered pending. Displays SENDING in field 5R on page downlink was initiated
- NO ACK - SEND or RESEND prompt selected, network acknowledgement not received within time-out period; message considered non-pending. Displays SENDING in field 5R on page downlink was initiated
- SENT - SEND or RESEND prompt selected, network acknowledgement received, message does not require response; message considered non-pending
- OPEN - SEND or RESEND prompt selected, network acknowledgement received, message requires response, response not received or STANDBY response received, message considered pending
- DEFERRED - SEND or RESEND prompt selected, network acknowledgement received, message requires response, REQUEST DEFERRED response received; message considered pending

- RESPONSE RCVD - SEND or RESEND prompt selected, network acknowledgement received, message requires response, response other than STANDBY or REQUEST DEFERRED received; message considered non-pending
- ABORTED - message pending when all connections terminated

Push - displays XXXXZ: ATC UPLINK, ATC REQUEST, ATC REPORT, or EMERGENCY page related to line selected.

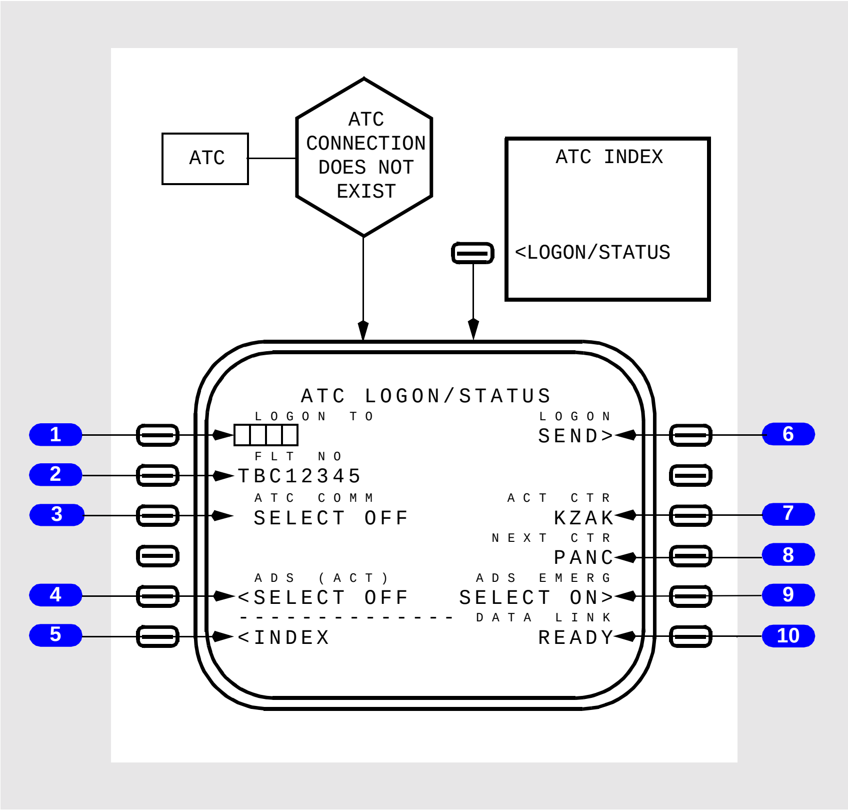
3 Erase Log

Push -

- arms deletion of all non-pending messages in the ATC Log
- displays CONFIRM
- selection of CONFIRM deletes all non-pending messages in the ATC log
- leaving the ATC Log page when CONFIRM is displayed cancels the ERASE selection

ATC Logon/Status Page

The ATC LOGON/STATUS page is used to initiate an ATC connection. The page displays ADS, ATC DL, and datalink status.



1 LOGON TO

Initial display is boxes.

Valid entry is a four letter ATC identifier.

Entry of an identifier and a flight number displays send in 1R when datalink status is ready.

Deletion of identifier displays boxes and blanks SEND.

Displays dashes when ATC COMM established.

2 Flight Number (FLT NO)

Displays flight number from route page.

Valid entry is flight number.

Display clears at flight completion.

3 **ATC COMM**

Display is blank when no ATC connection exists.

Displays SELECT OFF when ATC connection exists.

Push - terminates active ATC DL connection and next if it exits.

4 **ADS (ARM), (ACT), (OFF)**

ADS (ARM) -

- ADS on and no ADS connection exists
- displays SELECT OFF prompt

Push -

- no ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt

ADS (ACT) -

- ADS armed and one or more ADS connection exists
- displays SELECT OFF prompt

Push -

- terminates all ADS connections and ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt

ADS (OFF)

- ADS selected off
- displays ADS SELECT ARM prompt

Push -

- arms ADS reporting
- displays SELECT OFF prompt

5 **INDEX**

Push - displays ATC INDEX page.

6 **LOGON SEND**

Push -

- sends logon message to ATC center
- displays SENT

- displays RESEND if no network acknowledgement
- displays ACCEPTED or REJECTED after ATC response

7 Active Center (ACT CTR)

Displays four character identifier of active ATC center.

8 Next Center (NEXT CTR)

Displays four character identifier of next ATC center when known; otherwise, blank.

9 ADS Emergency (EMER)

Displays SELECT ON when ADS not in emergency mode.

Displays SELECT OFF when ADS in emergency mode.

Display is blank when ADS selected off.

SELECT ON -

Push - initiates ADS emergency mode.

SELECT OFF -

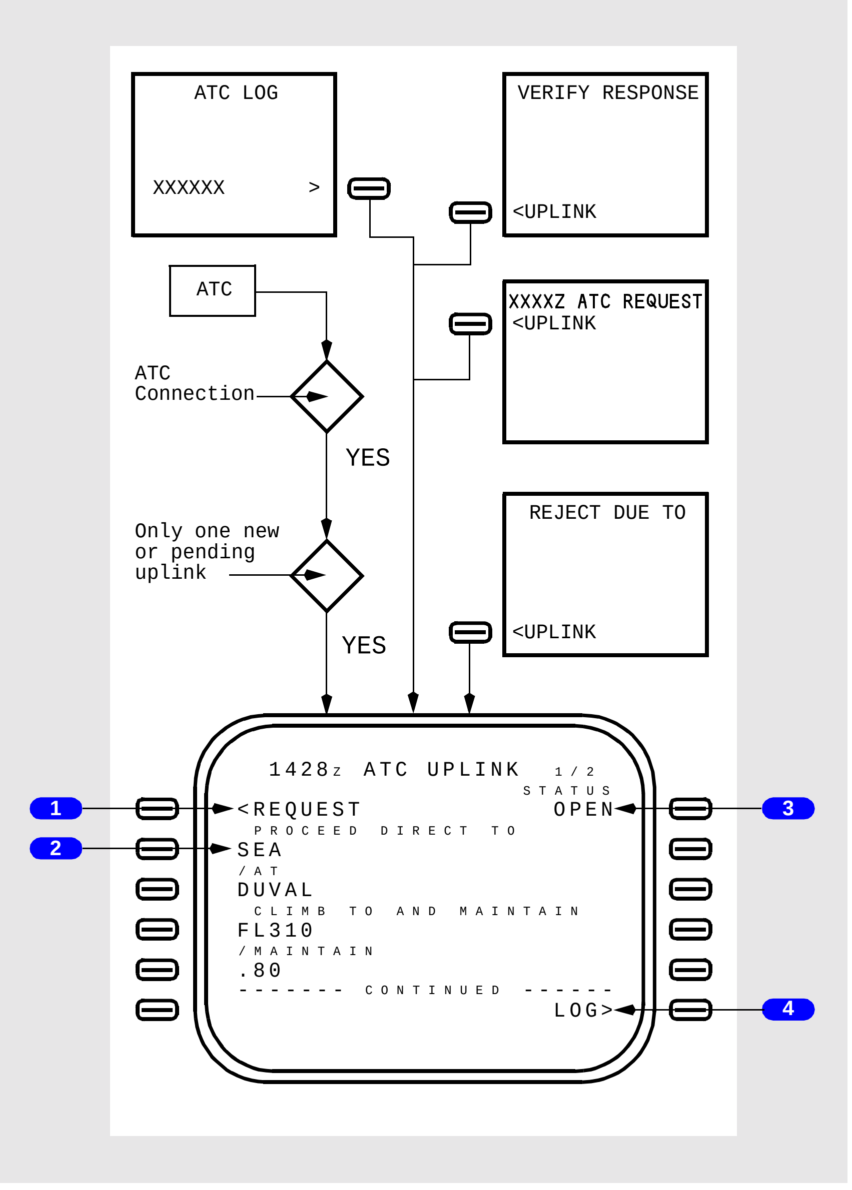
Push - terminates ADS emergency mode.

10 DATA LINK Status

Displays status: READY, NOCOMM, VOICE, or FAIL.

XXXXZ ATC Uplink Page 1/X

The ATC UPLINK pages display messages uplinked by ATC. The pages provide the capability to respond to uplinked messages and to load clearances.



1 REQUEST

Displays REQUEST when displayed uplink is in response to a downlink request not deleted from the ATC log.

Push - displays the related XXXXZ ATC REQUEST page.

Title displays message receipt (uplink) or transmission (downlink) time.

2 Message Text

Lines 2 to 5 of XXXXZ ATC uplink page 1/X display text of uplinked ATC message.

3 STATUS

Displays status ofATC uplink message fromATC log page.

4 LOG, REPORT

Displays LOG when uplink message does not include a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

Displays REPORT when uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

LOG -

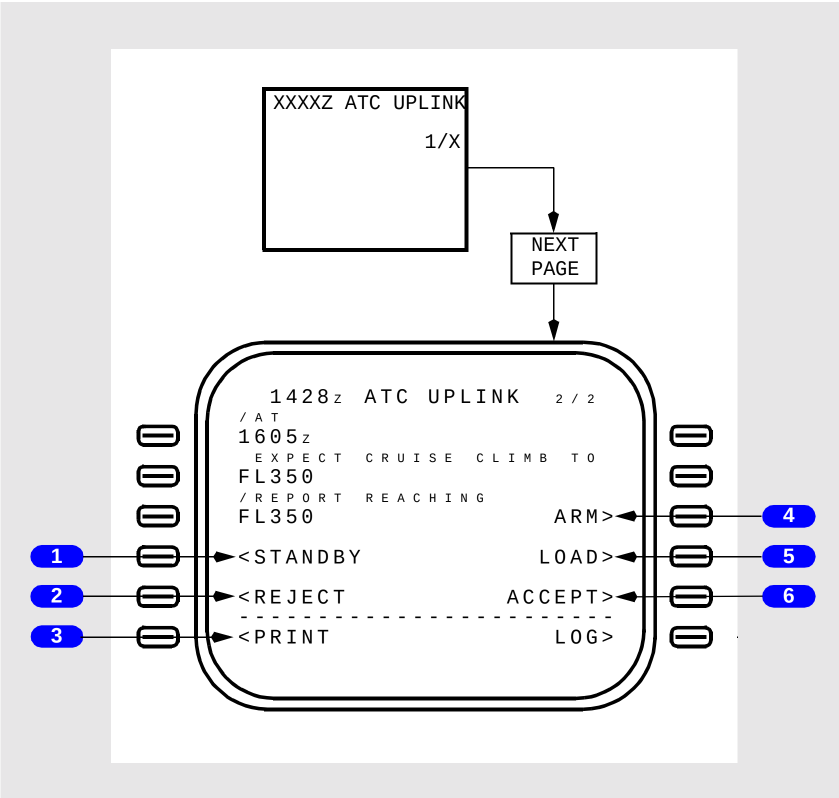
Push - displays ATC LOG page.

REPORT -

Push - displays ATC REPORT page.

XXXXZ ATC Uplink Page X/X

Last XXXXZ ATC UPLINK page continues text of uplinkedATC message. Page provides capablilty to respond to uplinked messages and to load clearances.



1 STANDBY

Displays STANDBY when response is required until response has been made.

Push - displays VERIFY RESPONSE page with STANDBY in 1L.

2 REJECT

Displays REJECT when UNABLE or NEGATIVE is a valid response until response has been made.

Push - displays REJECT DUE TO page.

3 **PRINT, PRINTERROR, PRINTING, BUSY, FAIL**

Displays on last page.

PRINT displayed - printer is READY.

PRINTERROR displayed - printer state is ERROR.

PRINTING displayed - printing displayed page.

BUSY displayed - printing other than displayed page.

FAIL displayed - printer is failed.

PRINT -

Push - prints XXXXZ ATC UPLINK text.

PRINT ERROR -

Push - prints XXXXZ ATC UPLINK text.

4 **ARM, ARMED**

Displays ARM when report is armable.

Push -

- arms report for transmission
- displays ARMED
- deleting ARMED displays ARM and disarms report transmission

5 **LOAD**

Displays LOAD when uplink message has loadable data.

Push - loads data into route.

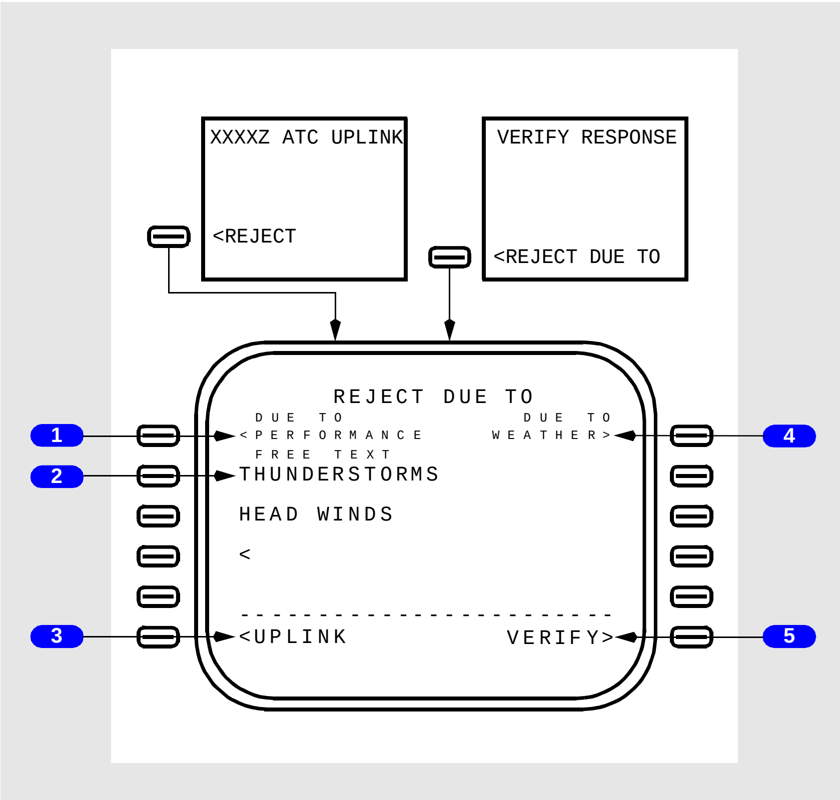
6 **ACCEPT**

Displays ACCEPT when WILCO, ROGER, or AFFIRM is a valid response until response has been made.

Push - displays VERIFY RESPONSE page with WILCO, ROGER, AFFIRM in 1L.

Reject Due To Page

The REJECT DUE TO page is used to include a reason for rejection of an ATC UPLINK message.



1 DUE TO PERFORMANCE

Initially displays PERFORMANCE in small font.

Push - selects DUE TO AIRCRAFT PERFORMANCE message element in response downlink message.

2 FREE TEXT

Text entered in lines 2 to 5 are included in response message.

Initial display is blank with a caret.

3 UPLINK

Push - displays ATC UPLINK page.

4 DUE TO WEATHER

Initially displays WEATHER in small font.

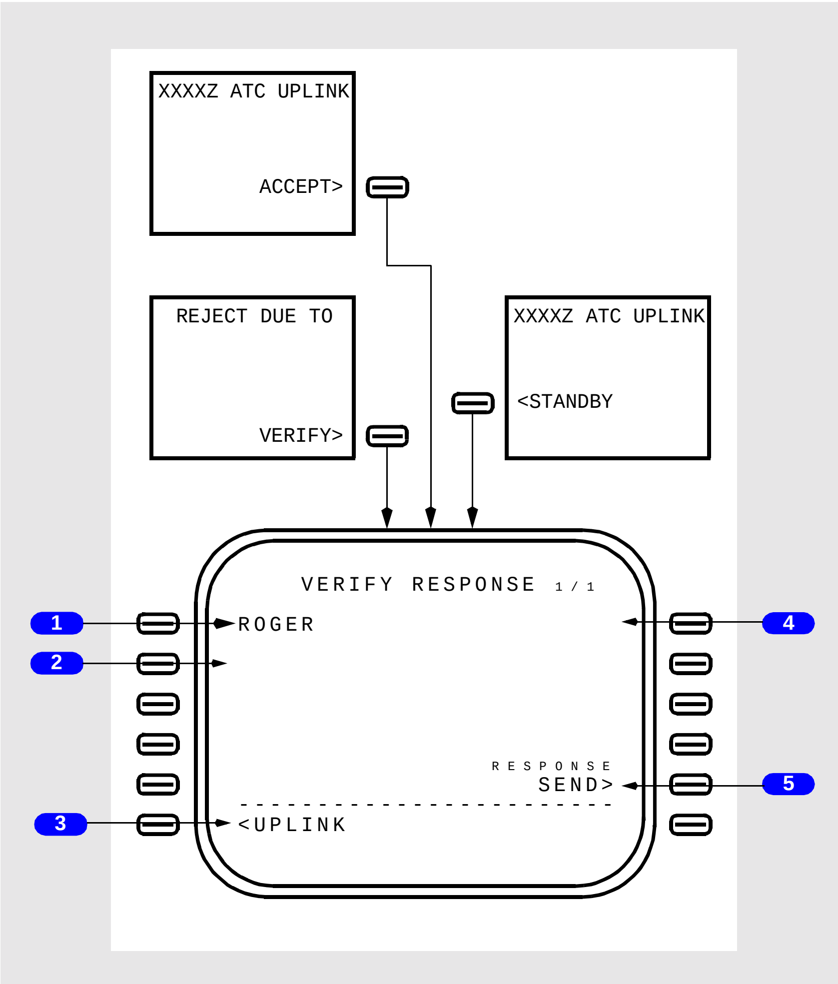
Push - selects DUE TO WEATHER message element in response downlink message.

5 VERIFY

Push - displays VERIFY RESPONSE.

Verify Response Page

The VERIFY RESPONSE page provides capability to respond to uplinked messages.



1 ROGER, WILCO, AFFIRM, UNABLE, NEGATIVE, STANDBY

Displays ROGER, WILCO, or AFFIRM, as appropriate, when ACCEPT is selected on XXXXZ ATC UPLINK page.

Displays UNABLE or NEGATIVE, as appropriate, when VERIFY is selected on REJECT DUE TO page.

Displays STANDBY when STANDBY selected on XXXXZ ATC UPLINK page.

2 Lines 2 - 5

Display free text from REJECT DUE TO page.

3 UPLINK, REJECT DUE TO

Displays UPLINK when 1L is ROGER, WILCO, AFFIRM, or STANDBY.

Displays REJECT DUE TO when 1L is UNABLE or NEGATIVE.

UPLINK -

Push - displays ATC UPLINK page.

REJECT DUE TO -

Push - displays REJECT DUE TO page.

4 STATUS ACCEPTED

Displays STATUS ACCEPTED when ATC acknowledges receipt of message.

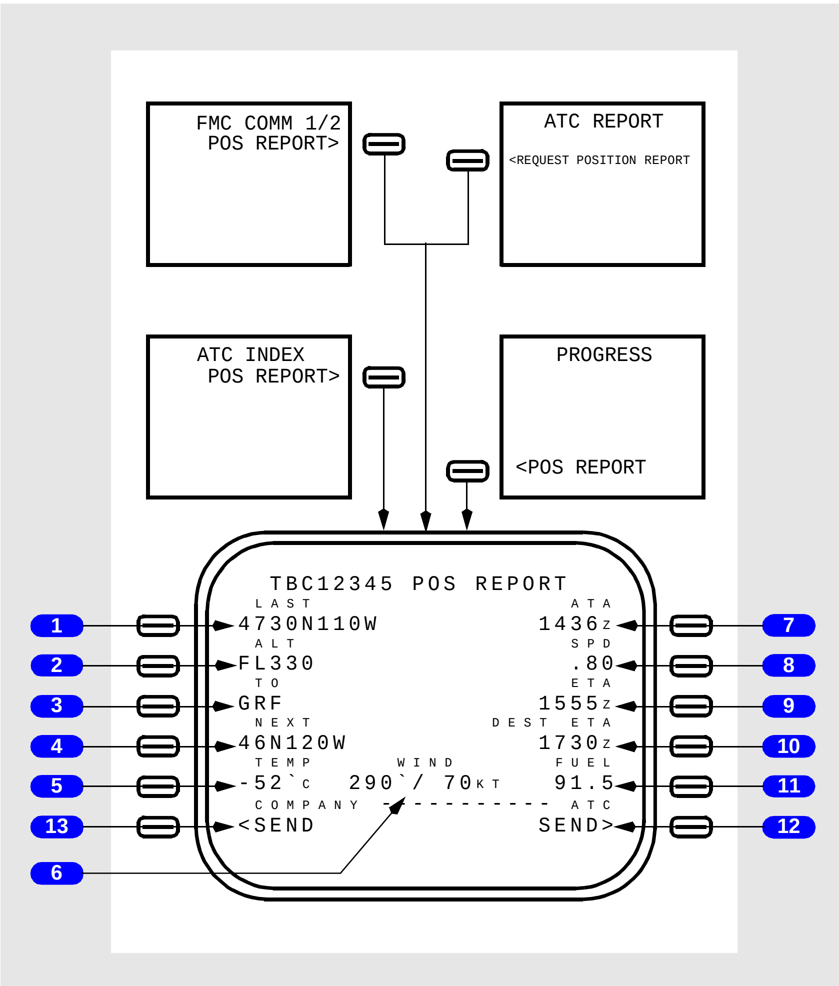
5 RESPONSE SEND

Push -

- transmits downlink response to ATC uplink message
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

XXXX Position Report Page

The XXXX POS REPORT page allows review and sending of position report to company and/or ATC. Entered data is sent to ATC only. XXXX is the flight number.



1 **LAST Waypoint**

Displays waypoint identifier for last sequenced leg.

2 **Altitude (ALT)**

Displays current altitude.

3 **TO Waypoint**

Displays waypoint identifier of current leg.

Valid entries are waypoint identifiers in the navigation database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns current leg waypoint.

4 **NEXT Waypoint**

Displays waypoint identifier of leg following the TO leg.

Valid entries are waypoint identifiers in the navigation database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns default waypoint.

5 **Temperature (TEMP)**

Displays current static air temperature.

6 **WIND**

Displays current wind direction and magnitude.

7 **Actual Time of Arrival (ATA)**

Displays ATA at last sequenced waypoint.

8 **Speed (SPD)**

Displays current airspeed/Mach.

Valid entry is airspeed or Mach.

Entry overrides displayed airspeed/Mach.

Deletion or page change returns default airspeed/Mach.

9 **Estimated Time of Arrival (ETA)**

Displays ETA at TO waypoint.

Valid entry is XXXXZ.

Entry overrides displayed time.

Deletion of entry returns default time.

10 Destination Estimated Time of Arrival (DEST ETA)

Displays ETA at destination.

Valid entry is XXXXZ.

Entry overrides displayed time.

Deletion of entry returns default time.

11 FUEL

Displays lesser of calculated or totalizer fuel remaining at LAST waypoint.

12 ATC SEND

Push -

- sends downlink position report to ATC
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY andno ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

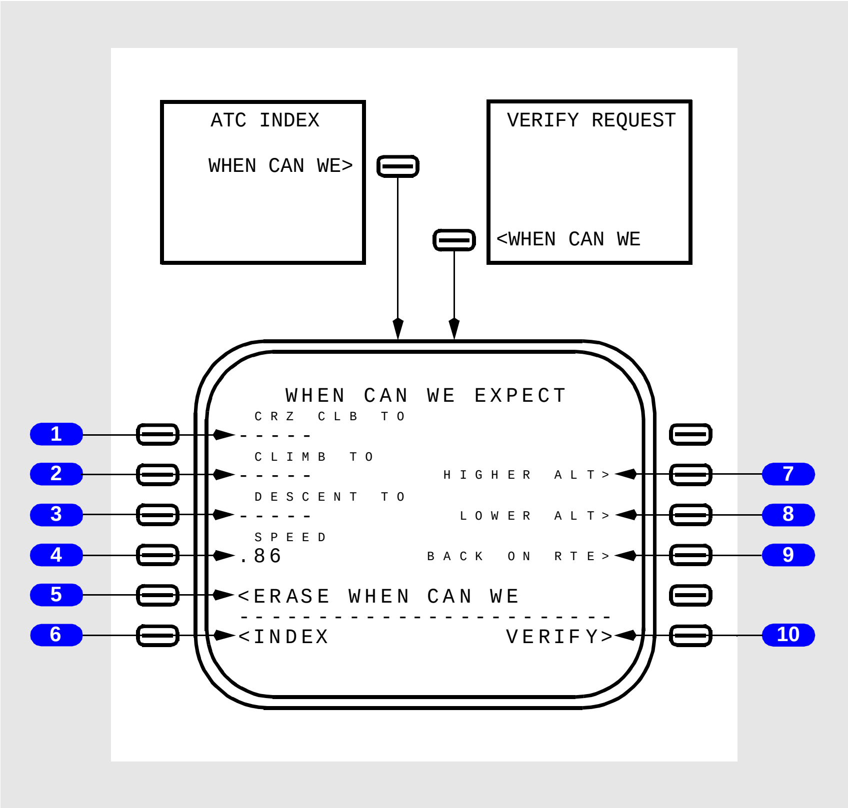
13 COMPANY SEND

Push -

- sends downlink position report to company
- default values are used for TO, NEXT, SPD, and ETA
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit
- displays SEND upon network acknowledgement
- displays NO ATC COM when datalink READY andno ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

When Can We Expect Page

The WHEN CAN WE EXPECT page allows query to ATC about when to expect a certain clearance.



1 Cruise Climb To (CRZ CLB TO)

Entry of an altitude selects a message querying ATC when to expect a cruise climb to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

2 CLIMB TO

Entry of an altitude selects a message querying ATC when to expect a climb to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

3 DESCENT TO

Entry of an altitude selects a message querying ATC when to expect a descent to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

4 SPEED

Entry of a speed selects a message querying ATC when to expect the entered speed.

Valid entry is IAS or Mach.

Entry may be deleted.

5 ERASE WHEN CAN WE

Push - erases all entered or selected data and returns default values.

6 INDEX

Push - displays ATC INDEX page.

7 HIGHER Altitude (ALT)

Push - selects a message querying ATC when to expect a higher altitude.

Selection may be deleted.

8 LOWER Altitude (ALT)

Push - selects a message querying ATC when to expect a lower altitude.

Selection may be deleted.

9 BACK ON Route (RTE)

Push - selects a message querying ATC when to expect to be cleared back on route.

Selection may be deleted.

10 VERIFY

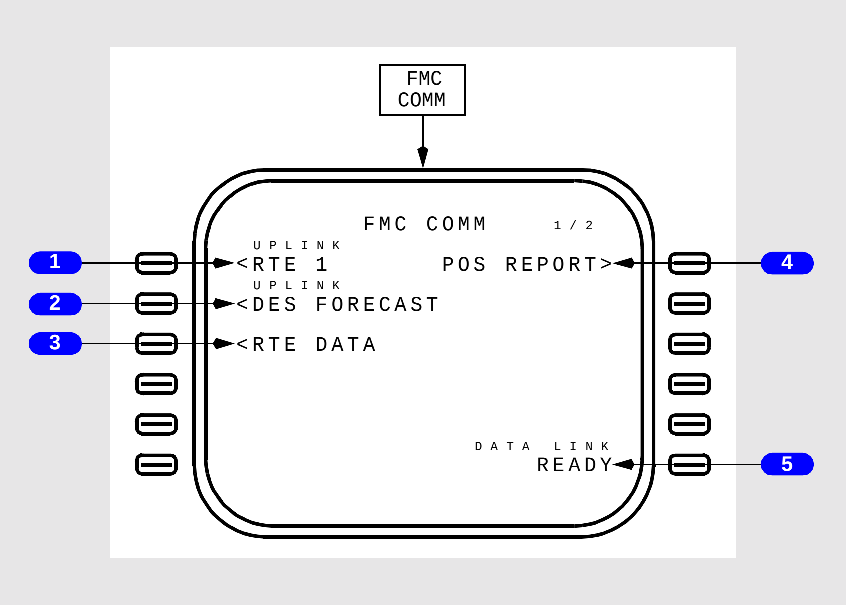
Push - displays VERIFY REQUEST page.

Company Datalink

For airplanes with the company datalink function installed, the airplane communications system enables two–way datalink communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMC. Data may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.

FMC Communications Page 1/2

FMC COMM page 1/2 provides access to pages used for company datalink functions.



1 UPLINK Route (RTE)

Displays UPLINK in line title when an uplink containing flight plan information has been received.

Push - displays ROUTE page.

2 **UPLINK Descent (DES) FORECAST**

Displays UPLINK in line title when an uplink containing descent forecast data has been received.

Push - displays DESCENT FORECAST page.

3 **Route (RTE) DATA**

Display is blank when there is no active route.

Displays UPLINK in line title when an uplink containing route wind information has been received.

Push - displays ROUTE DATA page.

4 **Position (POS) REPORT**

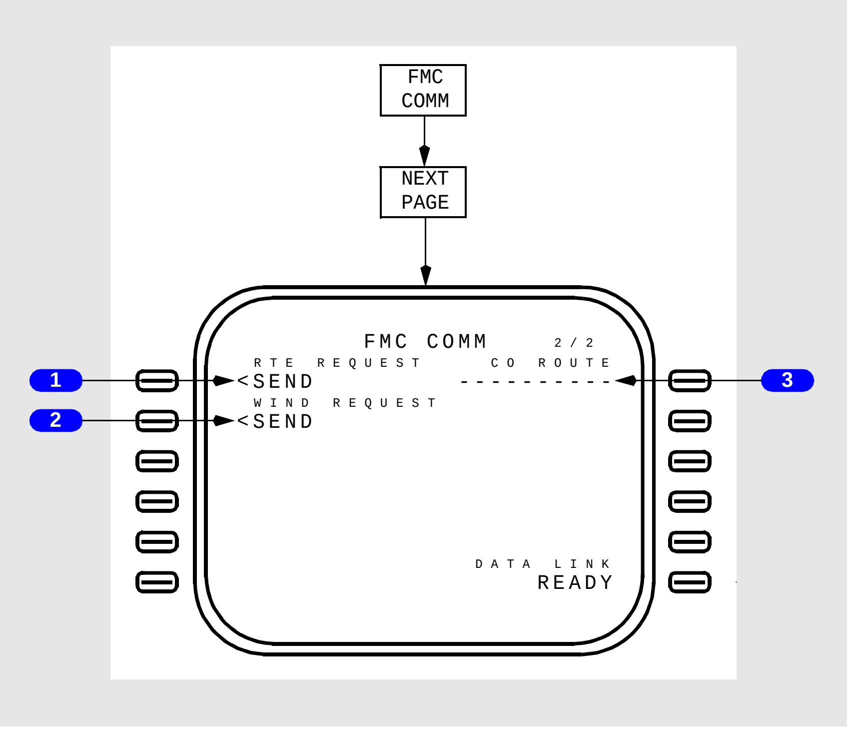
Push - displays POS REPORT page.

5 **DATA LINK**

Displays datalink status: READY, NO COMM, VOICE, or FAIL.

FMC Communications Page 2/2

FMC COMM page 2/2 allows writing a downlink request for flight plan information or wind data.



1 Route (RTE) REQUEST

Push -

- initiates downlink request for flight plan information
- when company route identifier displayed, the request includes the company route
- displays SENDING
- after network acknowledgement, displays SENDsent

2 WIND REQUEST

Push -

- initiates downlink request for wind information and descent forecast data
- displays SENDING
- after network acknowledgement, displays SENDsent

3 Company (CO) ROUTE

Valid entry is a company route request identifier. The identifier need not be in the navigation data base.

Deletion invalidates company route request and resets downlink request status to SEND.

Communications EICAS Alert Messages

The following EICAS Alert messages can display.

ACARS

Message	Level	Aural	Condition
>DATALINK AVAIL	Advisory		ACARS capability reestablished after a temporary loss.

Message	Level	Aural	Condition
>DATALINK LOST	Advisory		ACARS not available due to lost communications.

Message	Level	Aural	Condition
>DATALINK SYS	Advisory		ACARS has failed and is not available.

SATCOM and SATCOM Data Mode

Message	Level	Aural	Condition
>SATCOM	Advisory		SATCOM has failed and not available.
>SATCOM DATA	Advisory		ACARS data communication through SATCOM system not available.

SATCOM Voice Mode

Message	Level	Aural	Condition
>SATVOICE AVAIL	Advisory		SATCOM voice capability reestablished after a temporary loss.
>SATVOICE LOST	Advisory		SATCOM voice capability temporarily lost due to a reason other than SATCOM system failure.

Message	Level	Aural	Condition
>SATCOM VOICE	Advisory		SATCOM voice communication not available due to SATCOM voice system failure.

Communications EICAS Memo Messages

The following EICAS Memo messages can display.

ACARS

Message	Condition
ACARS MESSAGE	Crew required to access ACARS on CDU or when a message has been received for viewing on the CDU.
PRINTER MESSAGE	ACARS message printing.
VHF DATA OFF	VHF C radio in voice mode and not available for ACARS data communication.

ATC

Message	Condition
ATC MESSAGE	ATC uplinked message received.

SATCOM Voice Mode

Message	Condition
SATCOM CALL	Ground-to-air voice call received.
SATCOM MESSAGE	Information of voice call status available on CDU SATCOM pages.

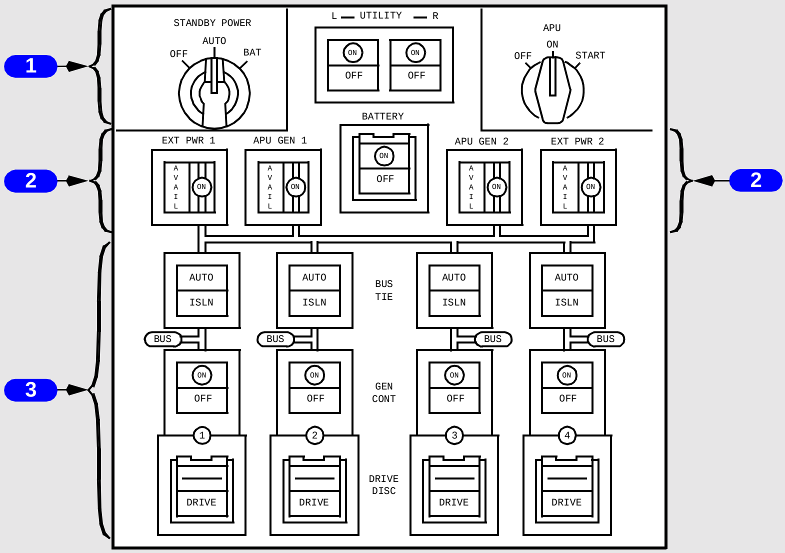
FMC Messages

For FMC Message information, refer to Chapter 11.60.

Electrical — Chapter 6
Table of Contents — Section 0

Intentionally
Blank

Electrical Panel



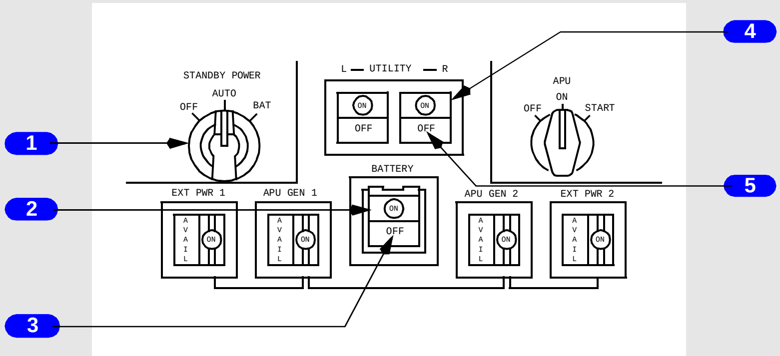
OVERHEAD PANEL

1 **Standby Power and Utility Bus Controls**

2 **External Power, APU Generator, and Battery Controls**

3 **AC Bus and Generator Controls**

Standby Power, Battery, and Utility Bus Controls



OVERHEAD PANEL

1 STANDBY POWER Selector

Push to turn.

OFF –

- standby power not available
- main and APU standby busses disconnected from all power sources

AUTO – allows main and APU standby busses to be powered from available sources.

BAT –

- powers main battery bus from main battery through the main hot battery bus with battery switch ON
- powers APU battery bus from APU battery through the APU hot battery bus with battery switch ON
- disables main and APU battery chargers
- powers main and APU standby busses from their related batteries through their hot battery busses and standby inverters with Battery switch ON

Note: BAT position for ground maintenance use only.

2 BATTERY Switch

ON -

- main battery available as backup power source for main battery bus and main standby bus
- APU battery available as backup power source for APU battery bus and APU standby bus

OFF - disconnects main and APU batteries from related battery busses.

3 BATTERY Switch OFF Light

Illuminated (amber) - Battery switch off.

4 UTILITY Power Switches

ON - each switch powers two utility ELCUs and two galley ELCUs.

OFF -

- removes power from related ELCUs
- resets fault logic circuitry

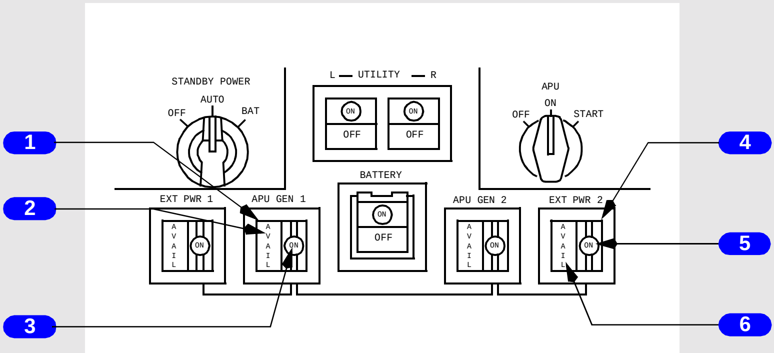
5 UTILITY Power OFF Lights

Illuminated (amber) -

- power removed from related ELCUs by fault protection logic, or
- related Utility Power switch OFF, or
- at least one Galley Emergency Power Off switch OFF

Note: Not illuminated during load shedding.

APU Generator and External Power Controls



OVERHEAD PANEL

1 APU Generator (APU GEN) Control Switches

Push –

- AVAIL light illuminated: connects related APU generator to AC electrical system
- ON light illuminated: disconnects related APU generator from AC electrical system

2 APU Generator Power Available (AVAIL) Lights

Illuminated (white) -

- APU generator power quality acceptable
- extinguishes when ON light illuminates

3 APU Generator Power ON Lights

Illuminated (white) -

- related APU generator connected to AC electrical system
- extinguishes when AVAIL light illuminates

4 External Power (EXT PWR) Control Switches

Push -

- AVAIL light illuminated: connects related external power to AC electrical system
- ON light illuminated: disconnects related external power from AC electrical system

5 External Power ON Lights

Illuminated (white) -

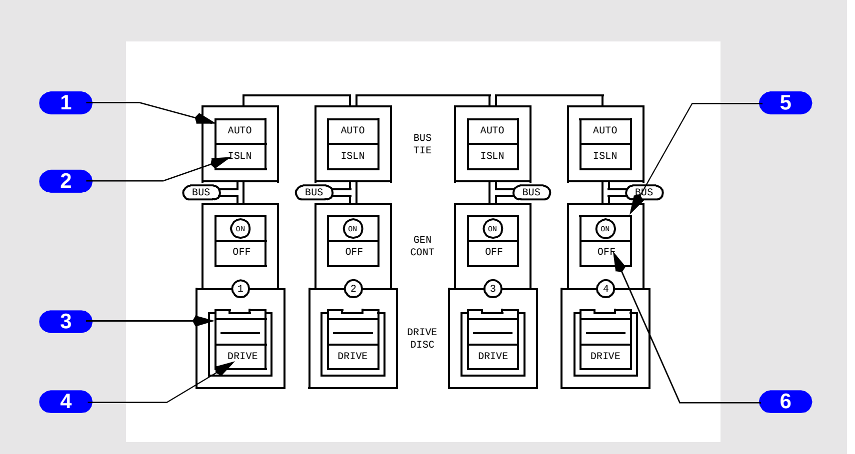
- related external power connected to AC electrical system
- extinguishes when AVAIL light illuminates

6 External Power Available (AVAIL) Lights

Illuminated (white) -

- related external power source plugged in, power quality acceptable
- extinguishes when ON light illuminates

AC Bus and Generator Controls



OVERHEAD PANEL

1 BUS TIE Switches

AUTO –

- arms automatic AC bus tie circuitry
- closes related DC isolation relay

OFF -

- opens AC bus tie breaker and related DC isolation relay
- resets fault logic circuitry

2 Bus Isolation (ISLN) Lights

Illuminated (amber) -

- AC bus tie breaker open
- AC bus isolated from synchronous bus

3 Generator Drive Disconnect (DRIVE DISC) Switches

Push -

- disconnects integrated drive generator (IDG) from engine when above idle speed
- opens related generator control breaker

Note: Ground maintenance action required to reconnect IDG.

4 Generator DRIVE Lights

Illuminated (amber) -

- IDG oil pressure low, or
- IDG oil temperature high

5 Generator Control (GEN CONT) Switches

ON - arms generator control breaker to close when generator power quality acceptable.

OFF -

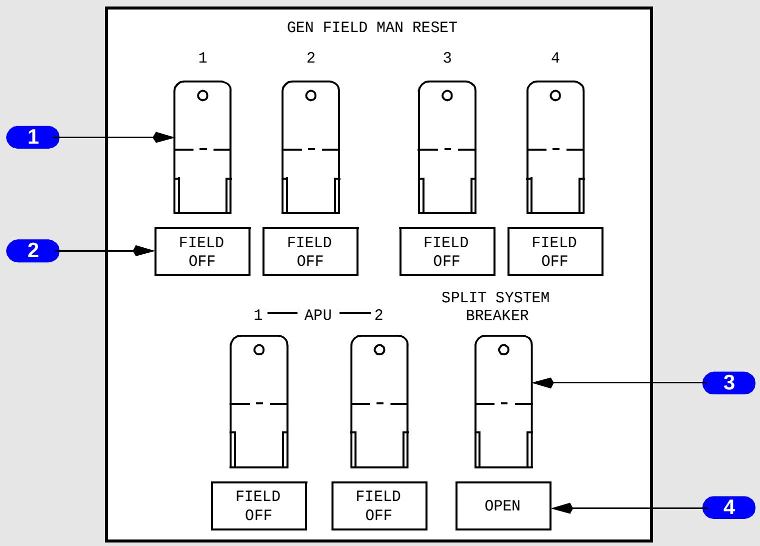
- opens field and generator control breakers
- resets fault control logic circuitry
- isolates generator from its related AC bus

6 Generator OFF Lights

Illuminated (amber) - generator control breaker open.

Overhead Maintenance Panel

Generator Field Manual Reset and Split System Breaker Switches



OVERHEAD MAINTENANCE PANEL

1 Generator Field Manual Reset (GEN FIELD MAN RESET) Switches

Push - (spring-loaded toggle, guarded) opens or closes generator field if related Generator Control or APU Generator Control switch off.

2 Generator FIELD OFF Lights

Illuminated (white) - generator field open.

3 SPLIT SYSTEM BREAKER Switch

Push - (spring-loaded toggle, guarded) opens or closes split system breaker.

Note: Operative on ground only.

4 Split System Breaker OPEN Light

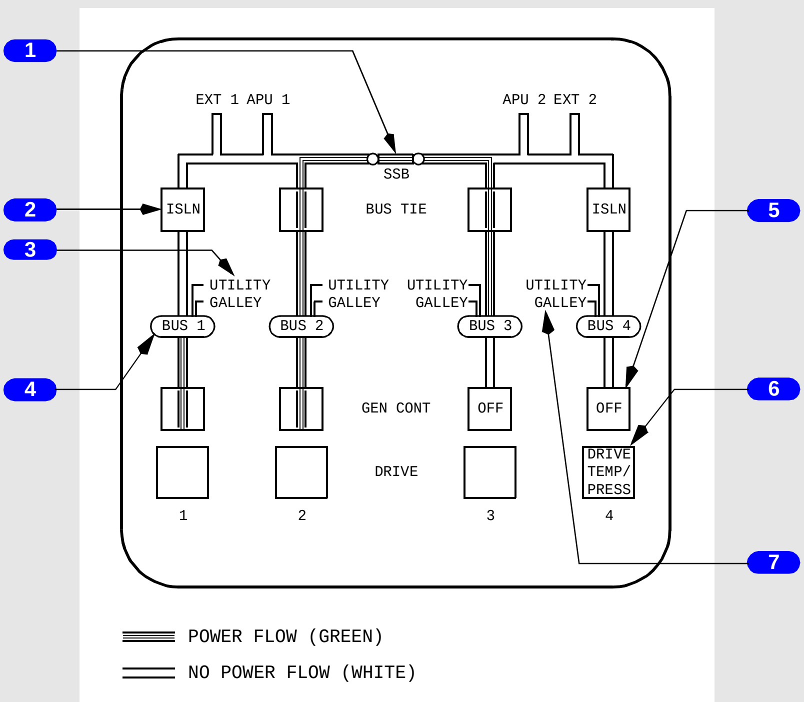
Illuminated (white) - split system breaker open.

Electrical Synoptic Display

The electrical synoptic displays by pushing the ELEC Synoptic switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

The synoptic displays the configuration of the AC power system in a simplified schematic format. DC power flow is not represented. The depiction is generated by the status of various system breakers and conductors and does not represent actual power flow. Therefore, the display may not be an accurate representation of system operation. Symbols display in low intensity white when source data is invalid or unavailable.

During autoland, with bus tie breakers 1, 2, and 3 open, the message “ELECTRICAL SYNOPTIC INHIBITED FOR AUTOLAND” appears on the synoptic display.



LOWER EICAS DISPLAY

1 Split System Breaker (SSB)

Closed - both sides of synchronous bus connected

Open - synchronous bus split.

2 Bus Tie (ISLN)

- power flow bar present - bus tie breaker closed
- ISLN (amber) - bus tie breaker open

3 UTILITY Bus

UTILITY -

- green - utility bus powered
- amber - utility bus not powered

4 AC BUS

BUS 1, 2, 3, 4 -

- green - AC bus powered
- amber - AC bus not powered

5 Generator Control Breaker (GEN CONT)

- power flow bar present - generator control breaker closed
- OFF (amber) - generator control breaker open

6 Generator Drive (DRIVE)

- blank - normal operation
- DRIVE TEMP/PRESS (amber) - drive has high oil temperature or low oil pressure

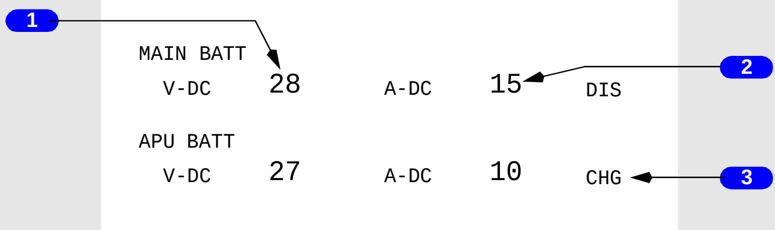
7 GALLEY Bus

GALLEY -

- green - galley bus powered
- amber - galley bus unpowered

Battery Condition

Battery condition displays on the status page by pushing STAT Display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.



LOWER EICAS DISPLAY

1 Battery Voltage (V-DC)

Main and APU battery voltage.

2 Battery Current (A-DC)

Main and APU battery amperage.

3 Battery Charge Status

DIS (Discharge) - battery discharging.

CHG (Charge)

- battery charging
- if battery current is zero, charge status is blank

Introduction

The electrical system generates and distributes AC and DC power to other airplane systems and is comprised of main AC power, DC power, and standby power components. System operation is automatic. Electrical faults are automatically detected and isolated.

AC Electrical System

The AC electrical system is the main source of airplane electrical power.

Electrical Load Management and Load Shedding

Electrical system overload protection is provided by a load management system configured to ensure power is available to critical and essential equipment.

If electrical loads exceed power available (airplane or external), the load management system sheds AC loads by priority until the loads are within the capacity of airplane or ground power generators. Loads are shed one at a time through electrical load control units (ELCUs) in a programmed sequence until the overload condition is relieved. Galley busses are shed first, followed by utility busses. When an additional AC power source is available, loads are restored in reverse order.

During load shedding, the ELEC UTIL BUS L and R messages and utility off lights are inhibited. However, the following EICAS alert messages may display in the order shown depending upon fuel system configuration and the extent of load shedding:

- FUEL PUMP 3 FWD
- FUEL OVRD 2 FWD
- FUEL OVRD 3 FWD
- FUEL OVRD CTR L
- FUEL PUMP 2 FWD

AC Electrical System Power Sources

The main AC electrical power sources are:

- four integrated drive generators (IDGs)
- two APU generators
- two external power sources

During normal operation, IDG power output to the four AC busses is synchronized. Each bus is interconnected through a single synchronous bus, which distributes electrical power and allows individual AC busses to remain powered when their related generators are inoperative.

Integrated Drive Generators (IDGs)

One IDG is mounted on each engine. Each IDG incorporates an AC generator, drive unit with self-contained lubrication system, and automatic control and protection components.

When an engine is started with external power or APU generators powering the electrical system, Generator Control switches ON, and Bus Tie switches AUTO, the IDG powers its side of the synchronous bus when voltage and frequency are acceptable. The previous power source is disconnected. When an engine on the opposite side of the airplane is started, the IDG powers its side of the synchronous bus. The previous power source is disconnected, and the SSB closes.

When a single external power source is powering the synchronous bus and an engine is started, the IDG powers the entire synchronous bus when voltage and frequency are acceptable. The SSB remains closed and external power is disconnected.

During power source transfers on the ground, such as switching from IDG to APU or external power, output from both power sources is momentarily synchronized before one source is disconnected. This provides smooth, uninterrupted electrical power switching.

Each IDG can be electrically disconnected from its related bus by pushing the Generator Control switch OFF. On the ground, an IDG can also be disconnected from its related bus by selecting an available APU or external power source.

The EICAS message ELEC DRIVE displays and the related generator drive light illuminates if low oil pressure or high oil temperature is sensed in an IDG.

Pushing the Generator Drive Disconnect switch manually disconnects the IDG from its engine and opens the related GCB if not already open. The IDG cannot be reconnected in flight.

Auxiliary Power (External and APU)

Auxiliary power is available from external power sources or generators mounted on the APU. External power and APU generators can power the main AC busses through connection to the synchronous bus only when the airplane is on the ground. A split system breaker (SSB) divides the synchronous bus. This allows each side of the AC electrical system to be powered by separate auxiliary power sources. External power and an APU generator cannot be connected to the same side of the synchronous bus simultaneously.

On an unpowered airplane, when one auxiliary power source is selected ON with the related AVAIL light illuminated, the SSB closes and power is provided to the entire synchronous bus. When another auxiliary power source is applied to the opposite side of the airplane, the SSB opens and each source powers its side of the synchronous bus. If one auxiliary power source is disconnected or fails, the SSB closes maintaining power to the entire synchronous bus.

When IDGs are powering the electrical system with APU generators or external power available, selecting one auxiliary power source opens the SSB. The selected auxiliary power source powers its side of the synchronous bus, while the opposite side remains powered by IDGs. Selecting a second auxiliary power source on the opposite side completes the power transfer from IDGs to auxiliary power. The SSB remains open.

AC Electrical Power Distribution

AC power is distributed by the following busses:

- four main busses
- two transfer busses
- ground service and ground handling busses
- four galley busses
- four utility busses
- two standby busses

AC Main Busses

Each IDG normally powers its related AC bus through a generator control breaker (GCB). Each AC bus is connected to the synchronous bus by a bus tie breaker (BTB). With the Bus Tie switch in AUTO, the related BTB controls the AC bus connection to the synchronous bus.

If power on an AC bus is unacceptable, the related BTB opens and the bus disconnects from the synchronous bus. However, the AC bus remains powered by its IDG. If the IDG is not able to maintain acceptable power quality, the GCB opens and the BTB closes to provide power from the synchronous bus.

The EICAS message ELEC BUS ISLN displays if the BTB is open. Pushing the Bus Tie switch OFF, then AUTO, resets logic circuitry and allows the BTB to close if the fault is corrected. The AC bus is reconnected to the synchronous bus.

The main AC busses power individual equipment items such as:

- transformer-rectifier units (TRUs)
- navigation radios and flight control computers
- flight deck lighting
- pitot and window heat

The main AC busses also power other AC busses:

- AC bus 1 powers the ground service bus and provides back-up power for both transfer busses
- AC bus 2 powers the First Officer’s transfer bus
- Each AC bus powers a utility and galley bus
- AC bus 3 powers the Captain’s transfer bus and the main standby bus

Ground Service Bus

The ground service bus is powered on the ground and in flight whenever AC bus 1 is powered. The ground service bus powers individual equipment items such as:

- main and APU battery chargers
- fuel pumps for APU start
- upper deck doors
- flight deck flood, navigation, and service lights
- miscellaneous service outlets and equipment
- horizontal stabilizer fuel pump for defueling

On the ground when AC bus 1 is not powered, the ground service bus can be connected to the same source powering the ground handling bus by pushing the Ground Service switch on the flight attendant’s panel at door 2L.

Ground Handling Bus

The ground handling bus is powered on the ground when APU generator 1 or external power 1 is available. If both are available, external power is automatically used. The ground handling bus powers individual equipment items such as:

- lower cargo handling equipment and compartment lights
- fueling system
- auxiliary hydraulic pump 4

Transfer Busses

Two transfer busses provide AC power to critical flight-related equipment. The transfer busses have a common back-up power source. Transfer to the back-up power source is automatic.

Captain’s Transfer Bus

The Captain’s transfer bus is normally powered by AC bus 3. If AC bus 3 is unpowered, AC bus 1 powers the Captain’s transfer bus. The Captain’s transfer bus powers the APU standby bus.

The Captain’s transfer bus powers individual equipment items such as:

- center EIU
- left HF

First Officer’s Transfer Bus

The First Officer’s transfer bus is normally powered by AC bus 2. If AC bus 2 is unpowered, AC bus 1 powers the First Officer’s transfer bus. The First Officer’s transfer bus powers individual equipment items such as:

- FMCS autothrottle servo
- lower EICAS display
- right ADC, right EFIS control, right EIU, right FMC
- right CDU, right HF, right ND, right PFD

Utility and Galley Busses

Each main AC bus powers one utility bus and one galley bus. Each utility/galley bus is controlled by an electrical load control unit (ELCU) that protects the electrical system from utility and galley bus faults, and provides load management through automatic load shedding. With the Left Utility Power switch ON, utility busses 1 and 2 and galley busses 1 and 2 are powered according to ELCU logic. With the Right Utility Power switch ON, utility busses 3 and 4 and galley busses 3 and 4 are powered according to ELCU logic.

Utility busses power individual equipment items such as:

- forward main fuel pumps 2 and 3
- forward override/jettison pumps 2 and 3
- center override/jettison pump
- recirculating fans

Galley busses power the galleys located throughout the cabin.

The EICAS message ELEC UTIL BUS displays and the utility OFF light illuminates if one or more utility or galley bus become unpowered due to a fault. Cycling the Utility Power switch OFF, then ON restores power to the affected bus if the fault is corrected.

A guarded ON Galley Emergency Power Off switch is located at each galley. If a Galley Emergency Power Off switch is selected OFF, the related ECAS message ELEC UTIL BUS displays and utility OFF light illuminates. Cycling the flight deck Utility Power switch OFF, then ON will not reset the indications. The flight deck Utility Power switch should remain ON after cycling, which permits the remaining utility and galley busses to be powered and controlled by their related ELCU.

Electrical bus Isolation during Autoland

During automatic precision approach below 1,500 feet radio altitude, AC and DC busses 1, 2, and 3 are automatically isolated. This provides an independent power source for each of the three autopilots. AC bus 4 continues to power the synchronous bus, and will power any other AC bus if its generator fails. During autoland, the AC bus isolation lights 1, 2, and 3 do not illuminate, the EICAS message ELEC BUS ISLN does not display, and the message "ELECTRICAL SYNOPTIC INHIBITED FOR AUTOLAND" appears on the electrical synoptic.

Autoland is disengaged and the electrical system returned to normal configuration under the following conditions:

- TO/GA mode active
- autopilot disengaged
- loss of autoland redundancy

AC Standby Power System

The AC standby power system provides electrical power to critical flight deck equipment.

Major components of the system include:

- main and APU standby busses
- main and APU batteries
- main and APU standby inverters
- Standby Power selector

Main Standby Bus

The main standby bus is normally powered by AC bus 3. With the Battery switch ON, Standby Power selector in AUTO, and AC bus 3 not powered, the main standby bus is powered by the main standby inverter. The main standby inverter is powered by the main battery charger through the main hot battery bus. The main battery charger is normally powered by AC bus 1 through the ground service bus.

With the Battery switch ON, Standby Power selector in AUTO, and both AC bus 1 and AC bus 3 not powered, the main standby bus is powered by the main standby inverter. The main standby inverter is powered by the main battery through the main hot battery bus. With the main battery charger unpowered, the main battery can provide power to the main standby bus for a minimum of 30 minutes.

The main standby bus powers individual equipment items such as:

- left EIU, left FMS-CDU, left ILS, left VOR
- various flight control components
- standby ignition for all engines
- primary EICAS display, RMI, standby instrument lights
- left ADC, left EFIS control panel

APU Standby Bus

The APU standby bus is normally powered by the Captain's transfer bus. With the Battery switch ON, Standby Power selector in AUTO, and the Captain's transfer bus not powered (loss of AC busses 1 and 3), the APU standby bus is powered by the APU standby inverter. The APU standby inverter is powered by the APU battery through the APU hot battery bus. With the APU battery charger unpowered, the APU battery can provide power to the APU standby bus for a minimum of 30 minutes.

The APU standby bus powers these equipment items:

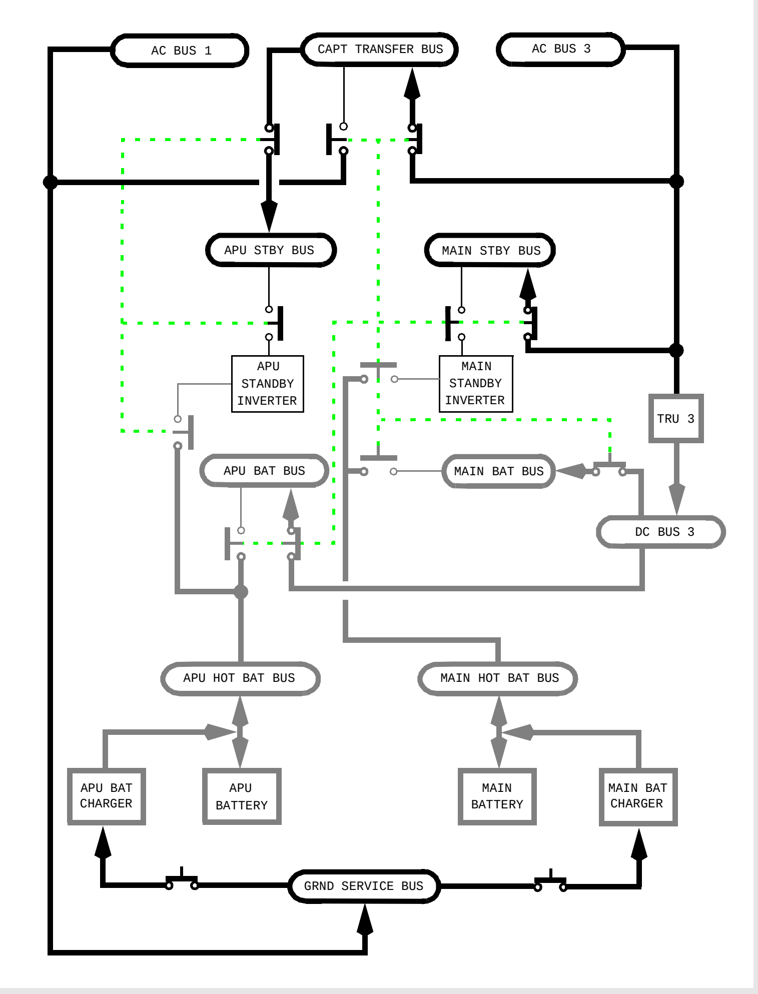
- left FMC
- left ND
- left PFD

Standby Power Selector - BAT Position

With the Battery switch ON and Standby Power selector in BAT, main and APU battery chargers are disabled. Each AC standby bus is powered by its related battery and inverter. Each battery can provide power for a minimum of 30 minutes.

Note: The Standby Power selector must be in AUTO for flight. The BAT position is for ground maintenance use only.

AC Standby Power System Schematic

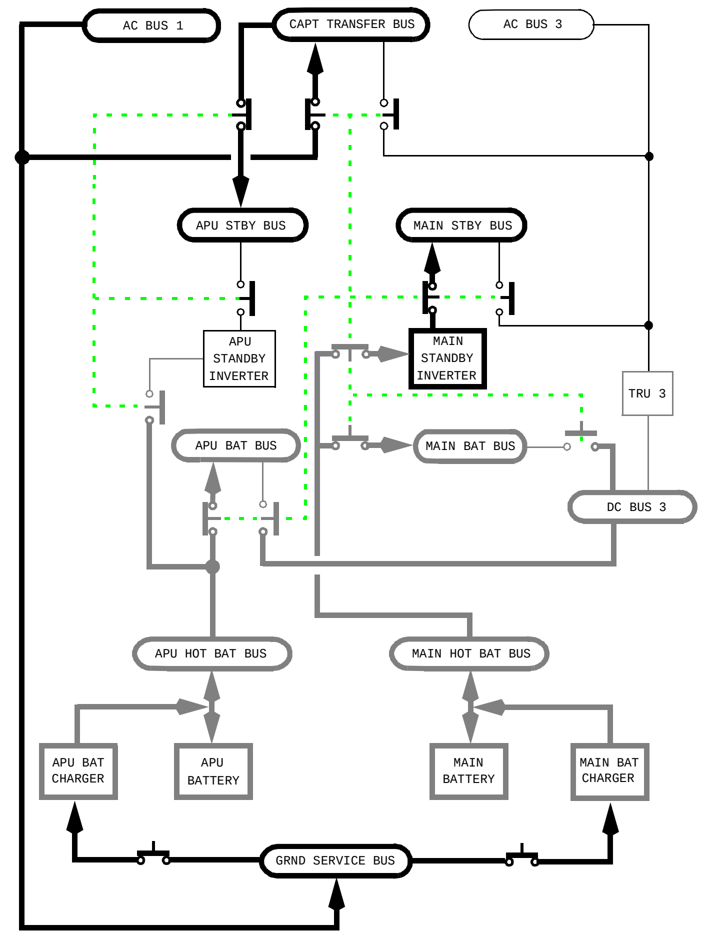


Conditions

1. Battery Switch - ON
2. Standby Power Selector - AUTO
3. All busses powered normally

Powered (AC)
Powered (DC)
Unpowered

AC Standby Power System (AC Bus 3 Unpowered)

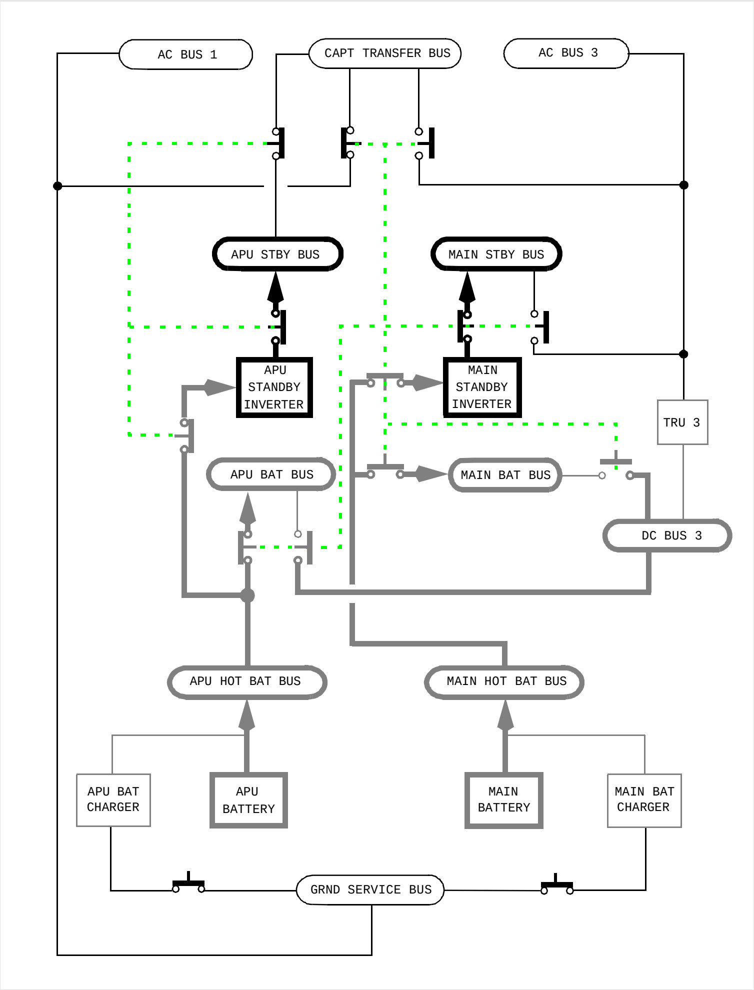


Conditions

1. Battery Switch - ON
2. Standby Power Selector - AUTO
3. AC Bus 3 - unpowered
4. Standby power available without limitation

Powered (AC)
Powered (DC)
Unpowered

AC Standby Power System (AC Busses 1 and 3 Unpowered)

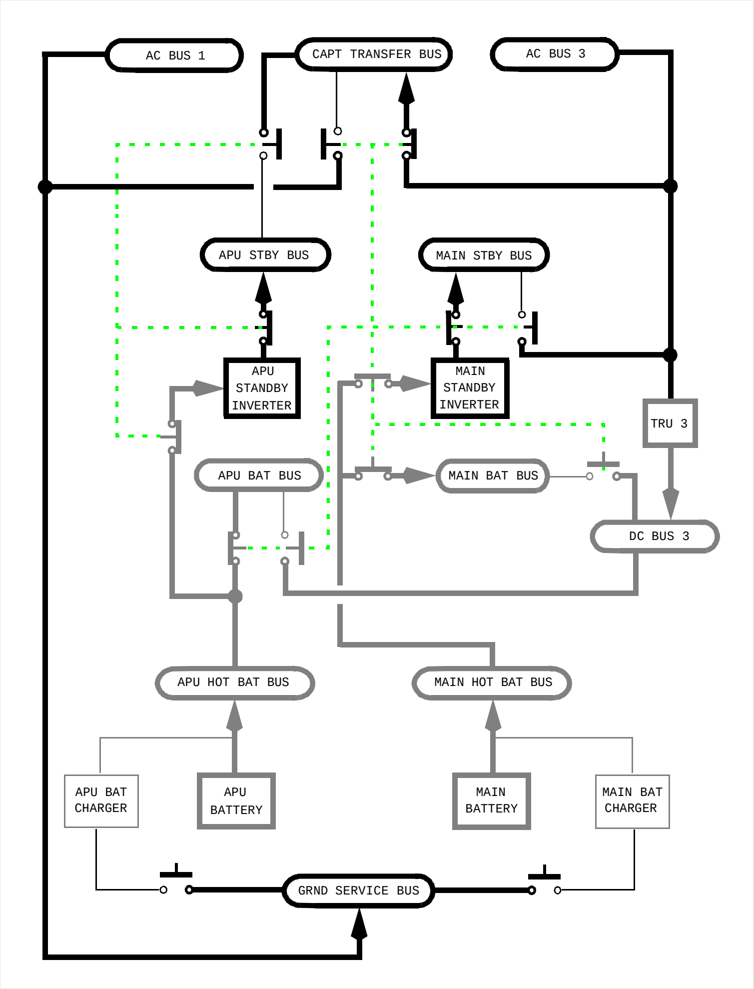


Conditions

1. Battery Switch - ON
2. Standby Power Selector - AUTO
3. AC Busses 1 and 3 - unpowered
4. Standby power available minimum 30 minutes

Powered (AC)
Powered (DC)
Unpowered

AC Standby Power System (Standby Power selector - BAT)



Conditions

1. Battery Switch - ON
2. Standby Power Selector - BAT
3. Battery chargers disabled
4. Battery power available minimum 30 minutes

Powered (AC)
Powered (DC)
Unpowered

DC Electrical System

The DC electrical system includes the main DC electrical system and the battery busses.

Main DC Electrical System

The main DC electrical system uses four transformer-rectifier units (TRUs) to produce DC power. Each TRU is powered by its related AC bus and provides DC power to a DC bus. The four DC busses are connected through DC isolation relays (DCIRs) to the DC tie bus. This allows each DC bus to remain powered if its related AC bus is unpowered or TRU fails. Pushing the Bus Tie switch to AUTO closes the related BTB and DCIR. Pushing the Bus Tie switch OFF opens the BTB and DCIR. This isolates the DC bus from the DC tie bus, leaving it powered by its AC bus and TRU. Automatic isolation of an AC bus due to an electrical fault opens the BTB, but does not open the DC isolation relay.

Main DC Power Distribution

TRU DC electrical power is distributed to four main DC busses. Main DC busses power individual equipment items such as:

- cabin pressure, fuel jettison, and pack temperature controllers
- wing anti-ice control
- engine-driven and hydraulic demand pump control
- fuel transfer and jettison valve control

  (SB changes ZK-SUI ; modification to maintain normal system operation upon loss of APU battery bus power installed)
- individual nacelle anti-ice control

Battery Busses

The following battery busses distribute DC power in addition to the four main DC busses:

- Main battery bus
- APU battery bus
- Main hot battery bus
- APU hot battery bus

The main and APU battery busses are normally powered by DC bus 3. If DC bus 3 is unpowered, each bus is powered, with the Battery Switch on, by its related hot battery bus.

The main battery bus provides power to individual equipment such as:

- APU controller (alternate), fuel valves (all engines), all crossfeed valves
- dome, storm, and selected indicator lights

- IDG disconnect (all engines), manual pressurization control, trailing edge flap control

(SB changes ZK-SUI ; modification to maintain normal system operation upon loss of APU battery bus power installed)

- Captain's interphone, left radio tuning panel, left VHF

The APU battery bus powers individual equipment items such as:

- APU DC fuel pump, engine start air control
- Cargo, First Officer's, and service interphones, PA system
- APU fire warning horn, APU and engine fire detectors A and B

(SB changes ZK-SUI ; before SB, modification to maintain normal system operation upon loss of APU battery bus power not installed)

- Captain's interphone, left radio tuning panel, left VHF, nacelle anti-ice control (all engines)

Each hot battery bus is normally powered by the ground service bus through its related battery charger, which acts as a TRU for the hot battery bus while simultaneously maintaining its related battery fully charged. Each battery is directly connected to its related hot battery bus.

With the Battery switch ON, the main and APU hot battery busses power their related battery busses if DC bus 3 is unpowered.

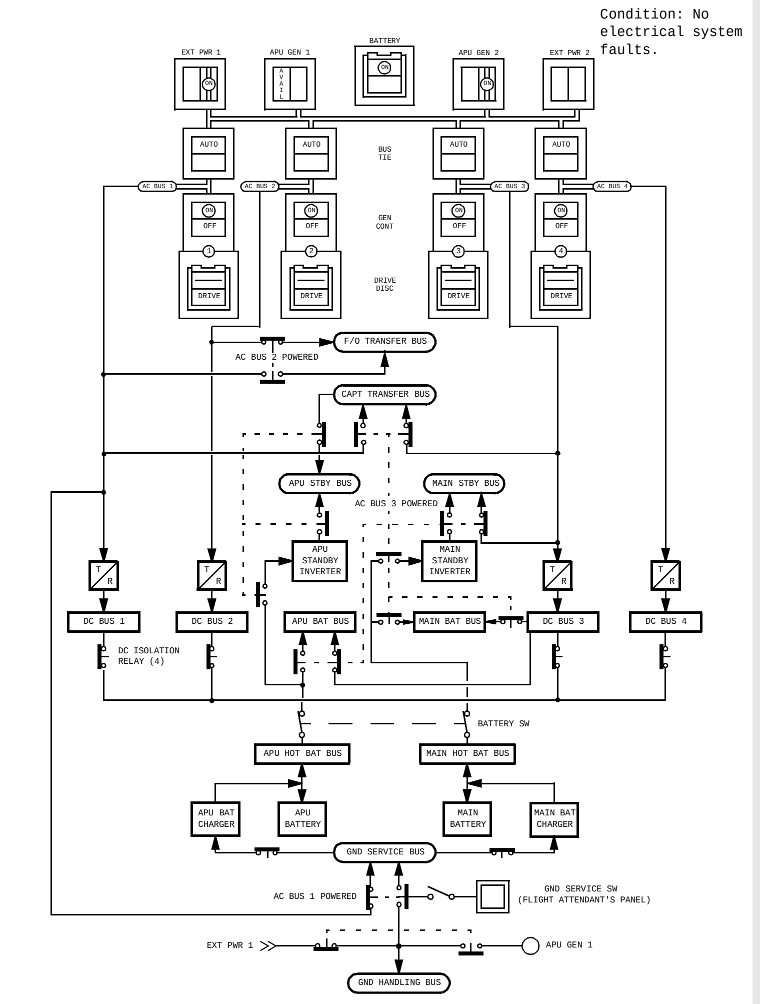
The main hot battery bus powers individual equipment items such as:

- APU fuel shutoff valve, spar valves (all engines)
- APU and lower cargo fire extinguishers
- engine fire extinguishers (all engines), fire switch unlock (all engines)

The APU hot battery bus powers individual equipment items such as:

- IRU left, center, right DC power
- left and right outflow valves
- APU inlet door, APU controller (primary), and APU fire warning horn

Electrical Power System Schematic



ELECTRICAL POWER SYSTEM DIAGRAM

Electrical EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
>BAT DISCH APU	Advisory		APU battery discharging.
>BAT DISCH MAIN	Advisory		Main battery discharging.
>BATTERY OFF	Advisory		Battery switch OFF.
>DRIVE DISC 1, 2, 3, 4	Advisory		Generator Drive Disconnect switch pushed, IDG manually disconnected.
ELEC AC BUS 1, 2, 3, 4	Caution	Beeper	AC bus unpowered. Additional related messages displayed for unpowered equipment items.
ELEC BUS ISLN 1, 2, 3, 4	Advisory		Bus tie breaker open. Inhibited when ELEC AC BUS message displayed.

Message	Level	Aural	Condition
ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low or oil temperature high. Inhibited when IDG manually disconnected.

Message	Level	Aural	Condition
ELEC GEN OFF 1, 2, 3, 4	Advisory		Generator control breaker open and related engine running. Inhibited when ELEC AC BUS message displayed.

Message	Level	Aural	Condition
>ELEC SSB OPEN	Advisory		SSB open when commanded closed.

Message	Level	Aural	Condition
ELEC UTIL BUS L, R	Advisory		One or more utility or galley busses not powered due to electrical fault, or related Utility Power switch OFF, or one or more Galley Emergency Power switches OFF. Inhibited during load shedding.

Message	Level	Aural	Condition
>STBY BUS APU	Advisory		APU standby bus not powered.
>STBY BUS MAIN	Advisory		Main standby bus not powered.

Engines, APU — Chapter 7
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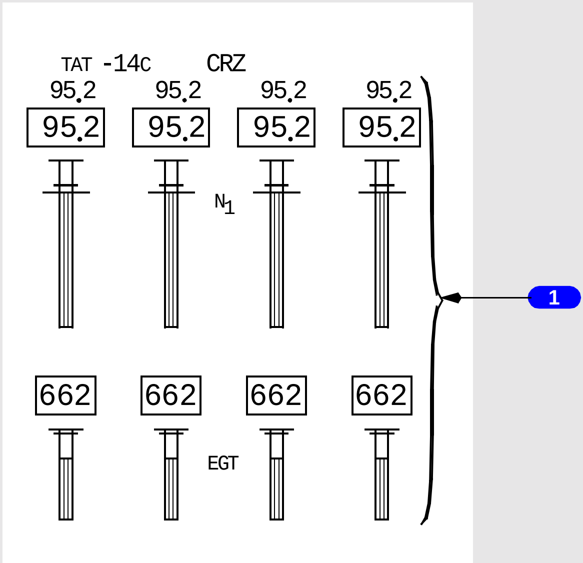
Primary Engine Indications

Primary Engine Display



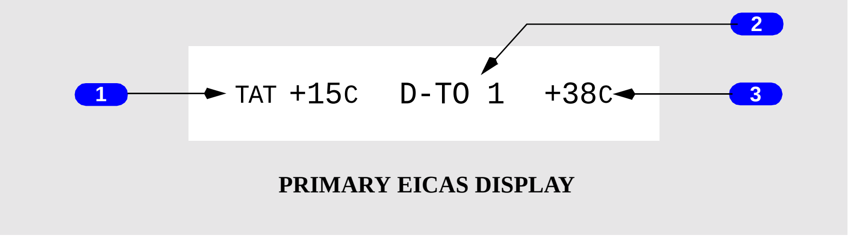
PRIMARY EICAS DISPLAY

1 Primary Engine Indications

Displayed full time on EICAS display:

- 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
- GA - maximum rated go-around thrust

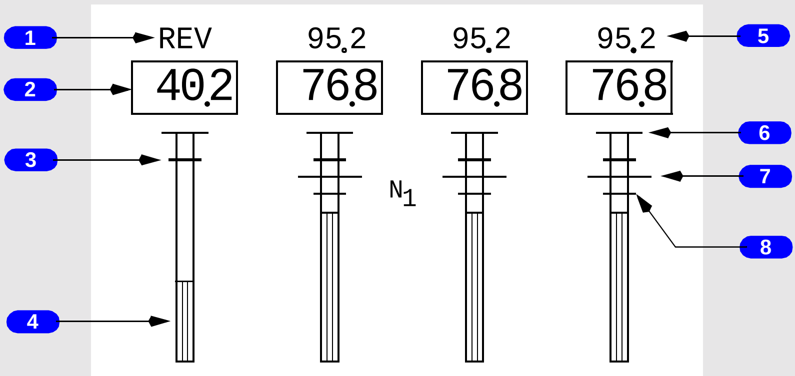
3 Assumed Temperature

Displayed (green) – selected assumed temperature (degrees C) for reduced thrust takeoff.

N1 Indications

Note: When reverse thrust activated, the following indications are not displayed:

- command N1
- reference N1



PRIMARY EICAS DISPLAY

1 Thrust Reverser Indication

Displayed REV (amber) – reverser in transit.

Displayed REV (green) – reverser fully deployed.

2 N1

Digital N1% RPM displayed:

- (white) – normal operating range
- (red) – operating limit reached

3 Maximum N1 Line

Displayed (amber).

4 N1 Indication

N1 RPM, displayed:

- (white) – normal operating range
- (red) – operating limit reached

5 **Reference N1**

Displayed (digital, green) - reference thrust selected by FMC.

6 **N1 Red Line**

Displayed (red) – N1 RPM operating limit.

7 **Reference N1 Indicator**

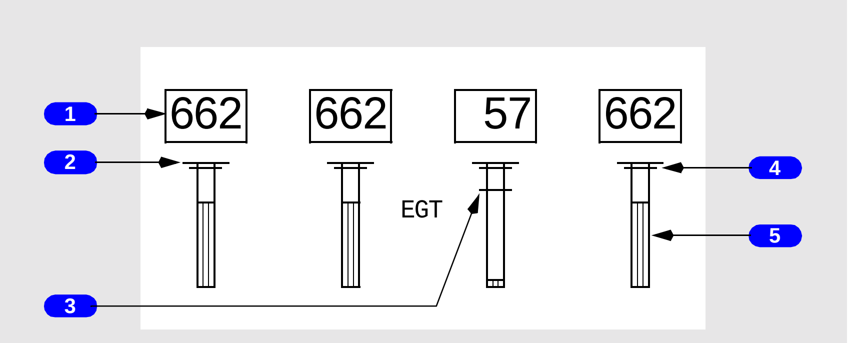
Displayed (green) – reference N1.

Displayed (magenta) – target N1 commanded by FMC.

8 **Command N1 Indicator**

Displayed (white) – N1 RPM commanded by thrust lever position.

EGT Indications



PRIMARY EICAS DISPLAY

1 EGT

EGT (degrees C), displayed:

- (white) – normal operating range
- (amber) – continuous limit reached
- (red) – start or takeoff limit reached

Note: Indication remains white during TO or GA for five minutes (or ten minutes if one engine fails or is shut down) even though continuous EGT limit is reached.

2 EGT Red Line

Displayed (red) – takeoff EGT limit.

3 EGT Start Limit Line

Displayed (red):

- with Fuel Control switch in CUTOFF
- until engine reaches idle

4 EGT Amber Band

Displayed (amber) – continuous EGT limit.

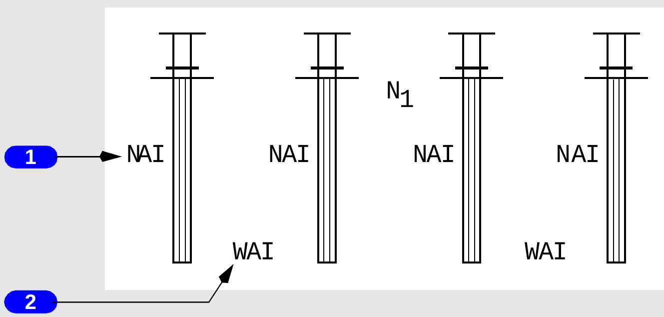
5 **EGT Indication**

Displayed:

- (white) – normal operating range
- (amber) – continuous limit reached
- (red) – start or takeoff limit reached

Note: Indication remains white during TO or GA for five minutes (or ten minutes if one engine fails or is shut down) even though continuous EGT limit is reached.

Anti–Ice Indications



PRIMARY EICAS DISPLAY

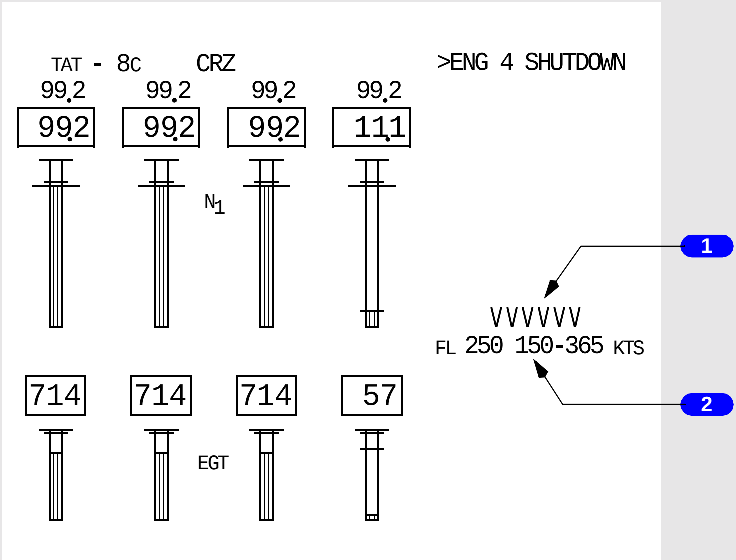
1 **Nacelle Anti-ice Indication**

Displayed (green) – nacelle anti-ice on.

2 **Wing Anti-Ice Indication**

Displayed (green) – wing anti-ice on.

Secondary Exceedance Cue and In-flight Start Envelope



PRIMARY EICAS DISPLAY

1 Secondary Engine Exceedance Cue

Displayed (cyan) -

- when a secondary engine parameter exceedance occurs
- until exceeding parameter returns to normal operating range
- uses same character field as status cue (replaces status cue if displayed)

2 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 related Engine Fire switch is in and a Fuel Control switch is in CUTOFF.

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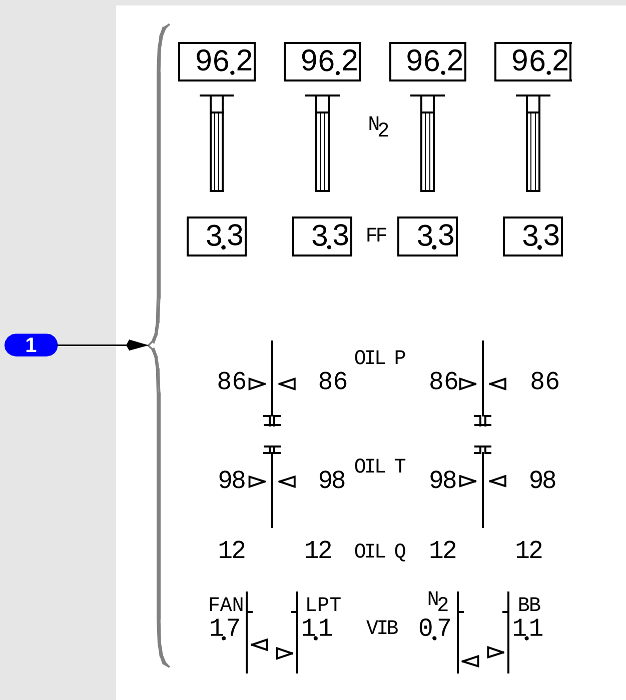
Secondary Engine Indications

See Chapter 10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

Secondary Engine Display



SECONDARY EICAS DISPLAY

1 Secondary Engine Display

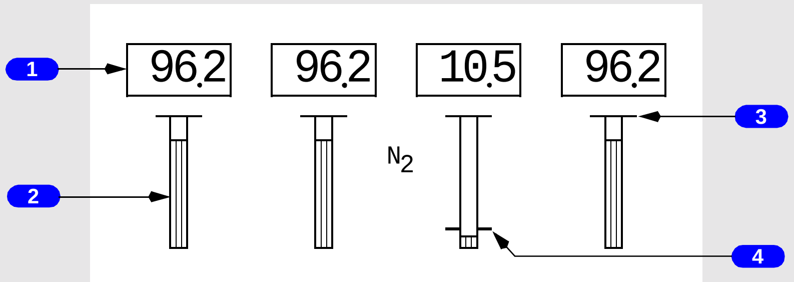
Displays:

- N2 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration

Displays when:

- EICAS initially receives power
- in flight, when a Fuel Control switch is moved to CUTOFF

N2 Indications



SECONDARY EICAS DISPLAY

1 N2

N2 RPM (%), displayed:

- (white) – normal operating range
- (red) – operating limit reached

2 N2 Indication

N2 RPM, displayed:

- (white) – normal operating range
- (red) – operating limit reached

3 N2 Red Line

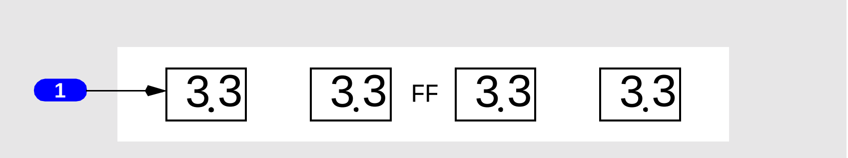
N2 RPM operating limit, displayed (red).

4 Fuel-On Indicator

Displayed - minimum N2 RPM at which Fuel Control switch should be moved to RUN during start.

Displayed when Fuel Control switch in CUTOFF.

Fuel Flow Indications

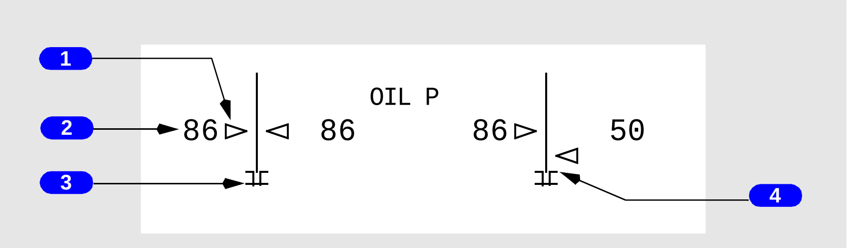


SECONDARY EICAS DISPLAY

1 Fuel Flow

Displayed (white) – fuel flow to the engine (kilograms per hour x 1000).

Oil Pressure Indications



SECONDARY EICAS DISPLAY

1 Oil Pressure Indicator

Engine oil pressure, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached
- indication remains white when engine shutdown and during start

2 Oil Pressure

Engine oil pressure (psi), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached
- indication remains white when engine shutdown and during start

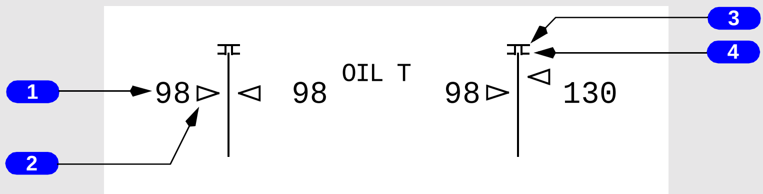
3 Oil Pressure Red Line

Displayed (red) – oil pressure operating limit.

4 Oil Pressure Amber Band

Displayed (amber) – oil pressure caution range.

Oil Temperature Indications



SECONDARY EICAS DISPLAY

1 Oil Temperature

Engine oil temperature (degrees C), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached

2 Oil Temperature Indicator

Engine oil temperature, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached

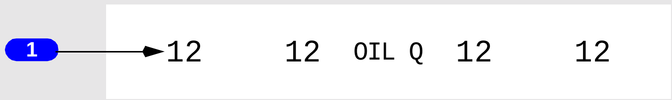
3 Oil Temperature Red Line

Displayed (red) – oil temperature operating limit.

4 Oil Temperature Amber Band

Displayed (amber) – oil temperature caution range.

Oil Quantity Indications



SECONDARY EICAS DISPLAY

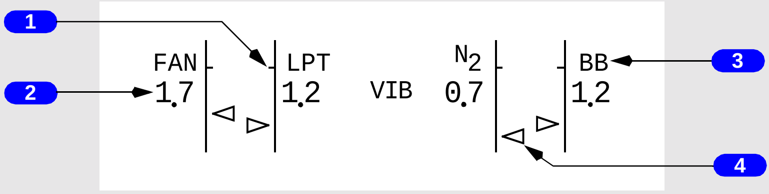
1 Oil Quantity

Usable oil quantity (liters).

Displayed:

- (white) – normal quantity
- (magenta) – low quantity, or oil differential reached

Engine Vibration Indications



SECONDARY EICAS DISPLAY

1 Engine Vibration High Band

Displayed (white) – vibration level at which automatic display of vibration indications occurs.

2 Engine Vibration

Displayed (white) - engine vibration.

3 Engine Vibration Source

Identifies the vibration source being displayed.

Displayed (white) – vibration source with the highest vibration:

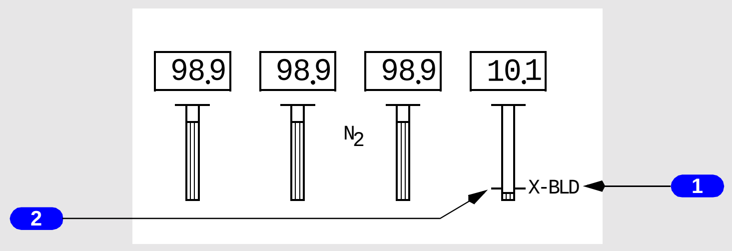
- FAN - fan vibration
- LPT - N1 turbine vibration
- N2 - N2 rotor vibration

If vibration source BB (broad band vibration) displayed, source is unknown and average vibration displayed.

4 Engine Vibration Indicator

Displayed (white) – engine vibration.

Crossbleed Start Indications



SECONDARY EICAS DISPLAY

1 Crossbleed (X-BLD) Start Indication

Indicates crossbleed air is recommended for in-flight start.

Displayed (magenta):

- in-flight start envelope displayed, and
- airspeed lower than for a windmilling start

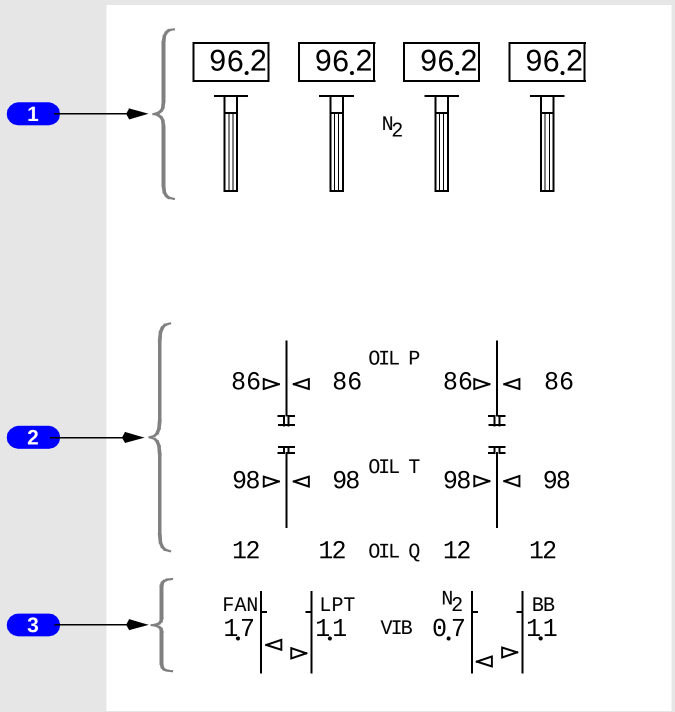
2 Fuel-on Indicator

Displayed (magenta):

- a Fuel Control switch is in CUTOFF
- minimum N2 RPM at which Fuel Control switch should be moved to RUN during start

Partial Secondary Engine Indications

Partial secondary engine indications can display when the secondary engine display is not selected.



SECONDARY EICAS DISPLAY

1 **N2**

Displays if an operating limit reached.

2 **OIL P, OIL T, OIL Q**

Displays if:

- a caution range or operating limit reached
- oil differential exceeded
- oil quantity low

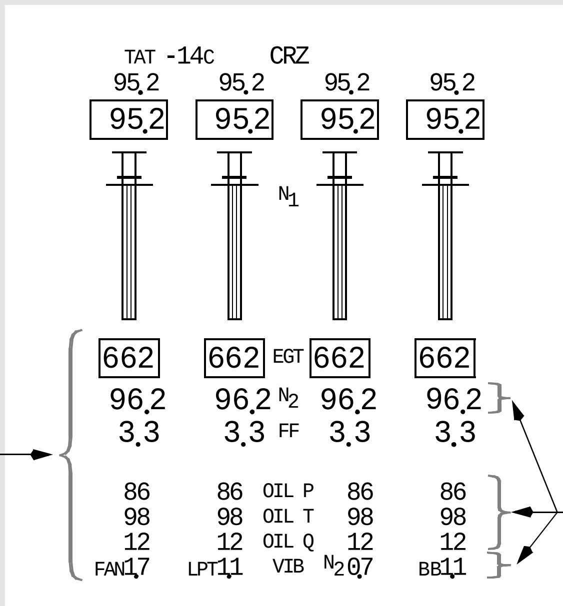
3 **VIB**

Displays if a display indicator reached.

Compact Engine Indications

Compact engine indications display when only one CRT is available for EICAS.

Compact Engine Display



PRIMARY EICAS DISPLAY

1 Compact Engine Indications

Displayed continuously:

- N1
- EGT

Displayed when selected by secondary engine display switch, or in flight if a Fuel Control switch is moved to CUTOFF:

- N2
- FF
- OIL P

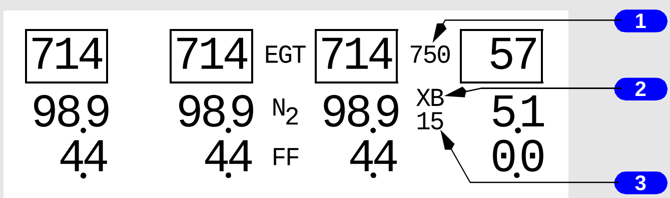
- OIL T
- OIL Q
- VIB

2 **Partial Compact Engine Indications**

N2, or OIL P, OIL T, OIL Q, or VIB display if:

- a secondary engine parameter exceedance occurs when secondary engine indications are not selected, or
- a secondary EICAS display other than secondary engine is selected when partial secondary engine indications are displayed on secondary EICAS

Compact Start Indications



PRIMARY EICAS DISPLAY

1 **EGT Start Limit**

Displays red.

2 **Crossbleed Start**

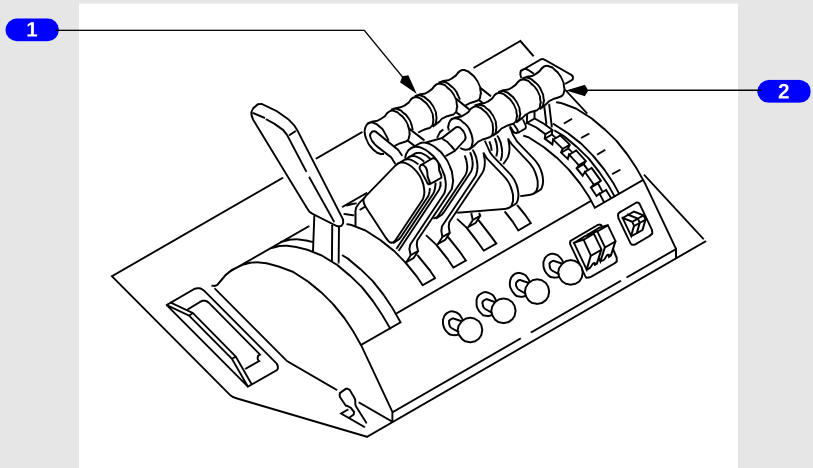
Displays magenta.

3 **Fuel-on Indicator**

Displays magenta.

Engine Controls

Thrust Levers



CONTROL STAND

1 Reverse Thrust Levers

Control engine reverse thrust.

Reverse thrust can only be selected when Forward Thrust levers are closed.

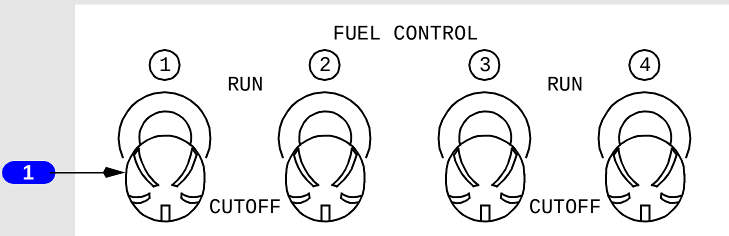
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Controls engine forward thrust.

Thrust levers can only be advanced when Reverse Thrust levers are down.

Fuel Control Switches



CONTROL STAND

1 FUEL CONTROL Switches

RUN (Autostart switch ON) –

- opens spar fuel valve
- opens engine fuel valve
- EEC sequences start valve, fuel metering valve, and igniter operation

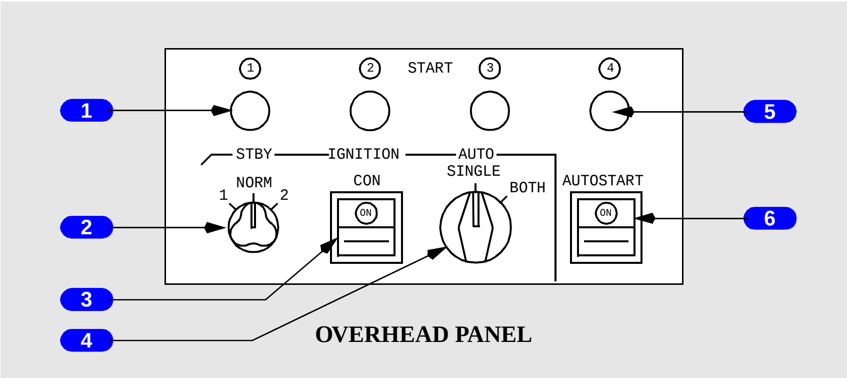
RUN (Autostart switch OFF) –

- opens spar fuel valve
- opens engine fuel valve
- energizes igniter(s)

CUTOFF –

- closes fuel valves
- removes igniter power
- commands related hydraulic demand pump to operate when Demand Pump selector in AUTO
- unlocks Engine Fire switch

Engine Start Panel



1 Engine START Switches

Pull (Autostart switch ON) –

- arms start valve
- opens engine bleed air valve

Pull (Autostart switch OFF)–

- opens start valve
- opens engine bleed air valve

Releases at 50% N2 RPM -

- start valve closes
- engine bleed air valve closes

2 Standby (STBY) IGNITION Selector

NORM –

- AC power system supplies power to selected igniter
- standby power system supplies power continuously to both igniters if AC power system is not powered

1 or 2 - standby power system supplies power continuously to related igniter.

3 Continuous (CONT) IGNITION Switch

ON –

- selected igniter operates continuously
- commands approach idle minimum

4 **AUTO IGNITION Selector**

SINGLE -

- EEC alternates igniter 1 and igniter 2 for each ground start
- EEC selects both igniters for in-flight start or flameout

BOTH - selects both igniters.

Selected igniter operates when any of the following occur:

- during start when N2 RPM less than 50%
- trailing edge flaps out of up position
- nacelle anti-ice ON
- engine flameout

5 **Engine Start Lights**

Illuminated (white) – start valve is open.

6 **AUTOSTART Switch**

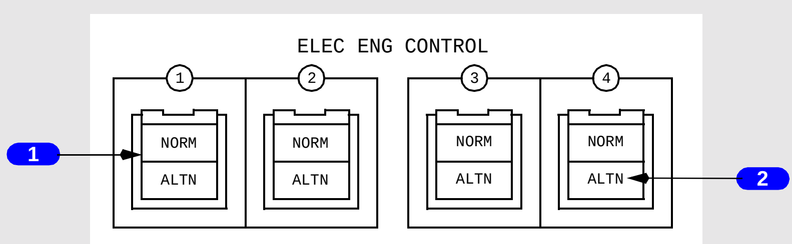
ON – arms the autostart system.

OFF –

- autostart system is disabled
- start is manually controlled

Electronic Engine Control

Electronic Engine Control Panel



OVERHEAD PANEL

1 Electronic (ELEC) Engine (ENG) CONTROL Switches

NORM (Normal) –

- selects normal engine control mode
- electronic engine control sets thrust using N1 RPM as the controlling parameter

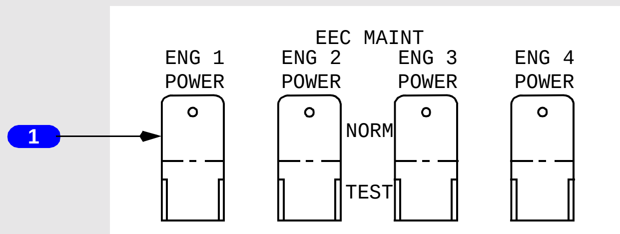
Alternate -

- selects alternate engine control mode
- thrust set using N1 RPM as controlling parameter

2 EEC Alternate (ALTN) Lights

Illuminated (amber) - alternate engine control mode selected.

Electronic Engine Control Maintenance Panel



OVERHEAD MAINTENANCE PANEL

1 EEC Maintenance (MAINT) POWER Switches

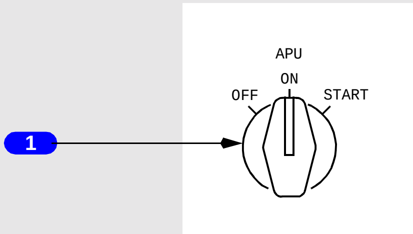
Normal (NORM) – supplies electrical power for normal EEC operation.

TEST - supplies electrical power for EEC maintenance testing when engine not running.

Intentionally
Blank

APU Controls and Indications

APU Selector



OVERHEAD PANEL

1 APU Selector

OFF –

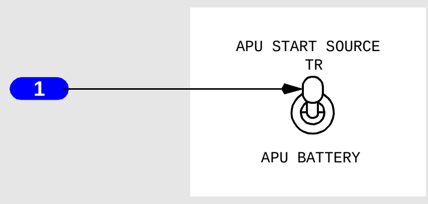
- closes APU bleed air isolation valve
- initiates normal shutdown
- resets auto shutdown fault logic except when shutdown due to APU bleed duct leak

ON (APU operating position) –

- opens APU fuel valve and inlet door
- arms APU bleed air isolation valve
- activates DC or AC fuel pump

START (momentary position, spring–loaded to ON) – initiates automatic start sequence.

APU Start Source



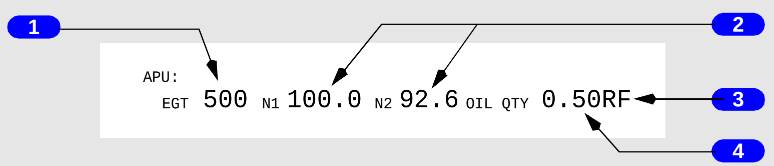
OVERHEAD MAINTENANCE PANEL

1 APU START SOURCE

TR - normal switch position. Selects TR or APU battery for start (except when TR fails).

APU BATTERY - selects APU battery power for APU starting. Removes TR from APU starting circuit.

APU Indications



SECONDARY EICAS DISPLAY

1 EGT

APU exhaust gas temperature.

2 RPM

APU rotation speeds in percent.

3 Refill (RF)/Low (LO)

Displayed RF or LO (magenta) - oil quantity below prescribed level.

4 APU OIL Quantity

APU oil quantity (1.00 indicates full).

Introduction

The airplane is powered by four General Electric CF6-80C2-B1F engines. The engines are rated at 57,900 pounds takeoff thrust each.

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. The N2 rotor consists of a high pressure compressor section and a high pressure turbine section. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine accessory gearbox.

Each engine has individual flight deck controls and an electronic engine controller (EEC). The Thrust levers are positioned by the autothrottle system or by the flight crew. See Chapter 11, Flight Management, Navigation, Section 40, for a description of FMC thrust management functions.

Engine Indications

Engine indications display on the engine indication and crew alerting system (EICAS) display.

Primary Engine Indications

N1 and EGT are primary engine indications and always display on primary EICAS.

Secondary Engine Indications

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are secondary engine indications and normally display on secondary EICAS. The secondary engine indications display when:

- selected using the Secondary Engine Display switch (the ENG switch on the Display Select panel)
- the displays initially receive electrical power
- a Fuel Control switch is moved to CUTOFF in flight

The secondary engine parameters can be cleared by pushing the Secondary Engine Display switch.

Normal Display Format

Each engine indication consists of a digital indicator and, except for fuel flow and oil quantity, a moving vertical indicator. The digital readouts display numerical values while the moving indicators display relative value. The digital indicator for N1, EGT, N2, and fuel flow is enclosed in a box. The vertical indicator displays the normal operating range, caution range, and operating limit.

The normal operating range display on the vertical indicator is white. An indication is white when the engine parameter is in the normal operating range.

Oil pressure and oil temperature indicators have caution ranges displayed by amber bands. The indication changes color to amber if the parameter reaches the caution range.

The EGT indicator has a continuous limit displayed by an amber band. The indication changes color to amber if EGT reaches the continuous limit.

EGT indications are inhibited from changing color to amber during takeoff or go-around for five minutes after the TO/GA switch is pushed, even though EGT reaches the continuous limit. The amber color change is inhibited for ten minutes if one engine fails or is shutdown.

The EGT indicator has a takeoff limit displayed by a red line. The indication changes color to red if EGT reaches the takeoff limit.

N1, N2, oil pressure, and oil temperature indicators have operating limits displayed by red lines. The indication changes color to red if the parameter reaches the operating limits.

An indication changes color back to white when the parameter returns to the normal operating range. The box enclosing the digital indicator remains red as a reminder of the exceedance. The red box color can be selectively canceled to white or recalled to red by pushing the cancel or recall switch on the EICAS Display Select panel.

The oil quantity indication changes color to magenta if low oil quantity is detected or if the oil quantity differential is exceeded.

Maximum N1 is displayed by an amber line. The N1 indication does not change color when maximum N1 is reached. The reference N1 indicator displays the reference N1 selected by the FMC. The command N1 indicator displays N1 RPM commanded by Thrust lever position. It equals actual N1 RPM when the engine is stabilized. The command N1 indicator moves when the Thrust lever moves to display the new commanded N1.

Compact Display Format

If only one CRT is available for use by EICAS, primary EICAS always displays. Primary engine indications display in the normal format. Secondary engine indications are selected by pushing the Secondary Engine Display switch. Pushing the switch displays the primary and secondary engine indications on primary EICAS in compact format. In compact format, N1 displays by digital and vertical indicators while all other engine indications display by digital indicators. Pushing the switch again removes the secondary engine indications and returns the primary engine indications to normal format.

Partial Display Format

Secondary engine indications display in partial format if a secondary engine parameter exceeds the normal operating range when the secondary engine display is not selected. The secondary engine exceedance cue displays on primary EICAS when an exceedance occurs.

If an N2 RPM increases to the operating limit, the N2 indications display. If an oil pressure decreases or an oil temperature increases to the caution range or operating limit, or if an oil quantity decreases to the low level, or the oil quantity differential is exceeded, the oil indications display. If an engine vibration increases to the display indicator, the vibration indications display.

Pushing the Secondary Engine Display switch while the secondary engine display is in the partial format displays the entire secondary engine display. Pushing the switch again returns the secondary engine display to partial format.

Selecting another secondary EICAS display while the secondary engine display is in partial format removes the secondary engine display from secondary EICAS. The partial secondary engine indications display with the primary engine indications on primary EICAS in compact format.

If only one CRT is available for use by EICAS and a secondary engine parameter exceedance occurs, the primary and partial secondary engine indications display on primary EICAS in compact format.

If the secondary engine exceedance cue displays and partial secondary engine indications are not displayed, pushing the Status Display switch displays the primary and partial secondary engine indications on primary EICAS in compact format.

In all cases, the partial secondary engine indications and secondary engine exceedance cue remain displayed until the exceeding engine parameter returns to the normal operating range.

Electronic Engine Control (EEC)

Each EEC has full authority over engine operation. The EEC uses Thrust lever inputs to control forward 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 controlling parameter for setting thrust.

The EEC calculates an N1 value between idle and maximum N1. Maximum N1 is the maximum allowable thrust available from the engine. The calculated N1 is compared to actual N1 RPM. The EEC commands the fuel metering unit to adjust fuel flow until actual N1 equals calculated N1.

EEC Normal Mode

In normal mode, EEC sets thrust by controlling N1 based on Thrust lever position. N1 is commanded by positioning the Thrust levers either with the autothrottles, or by the flight crew.

When the engine is stabilized, EEC keeps thrust constant independent of outside air temperature and pressure. The EEC adjusts thrust for changes in nacelle and wing anti-ice and airplane pressurization bleed requirements. This allows a fixed Thrust lever position throughout a climb.

Maximum N1 represents the maximum rated thrust available from the engine. The EEC continuously computes maximum N1. Thrust is limited to maximum N1 at the full forward Thrust lever position. Maximum thrust is available during any phase of flight by moving the Thrust lever to the full forward position.

EEC Alternate Mode

The EEC uses alternate mode as a backup to normal mode. If EEC detects a fault and can no longer control the engine using the normal mode, it transfers control to alternate mode. Alternate mode can also be selected manually using the EEC Mode switch.

Alternate mode does not provide thrust limiting at maximum N1. Maximum N1 is reached at a Thrust lever position less than full forward. Thrust levers must be adjusted to maintain desired thrust as environmental conditions and bleed requirements change.

Alternate mode provides equal or greater thrust than normal mode for the same Thrust lever position. Thrust does not change when EEC transfers control from normal mode to alternate mode. Thrust increases when alternate mode is selected manually. When thrust is greater than idle, the Thrust lever should be moved aft prior to manually selecting alternate mode so thrust does not exceed maximum N1.

If control for any EEC transfers from normal to alternate, the autothrottle disconnects. The autothrottle can be activated after all EECs are manually transferred to alternate mode.

EEC Idle Selection

The EEC selects minimum idle or approach idle. Minimum idle is a lower thrust than approach idle. Approach idle is selected in flight when:

- nacelle anti–ice is ON
- flaps are in landing position
- Continuous Ignition switch is ON
- during thrust reverser operation

Approach idle decreases acceleration time for go–around. Approach idle is maintained until five seconds after touchdown, when minimum idle is selected.

EEC Overspeed Protection

At thrust settings above idle, the EEC monitors N1 and N2 RPM to prevent rotor overspeed. If a rotor approaches overspeed, the EEC commands the fuel metering unit to reduce fuel flow to keep rotor speed from exceeding the operating limit even though the Thrust lever is commanding more thrust.

Engine Start and Ignition System

The engines can be started using the autostart system or manually. Autostart is the normal starting mode. During autostart, the EEC sequences start valve, engine fuel valve, and igniter operation. Selecting OFF on the Autostart switch disables autostart and allows manual, pilot–monitored, starting. During manual start, the flight crew sequences the operation of the start valve, engine fuel valve, and the selected igniter.

Air from the bleed air duct powers the starter motor, which is connected to the N2 rotor. The starter air source is normally the APU, but air from ground carts or another running engine can be used.

Start Indications

Start indicators display with engine indications when an engine is shutdown. A start limit displays on the EGT indication when the Fuel Control switch is in CUTOFF. It remains displayed until the engine stabilizes at idle. The EGT indication changes color to red if the EGT start limit is reached. A fuel-on indicator displays on the N2 indication when the Fuel Control switch is in CUTOFF. The fuel-on indicator displays the minimum N2 RPM at which the Fuel Control switch should be moved from CUTOFF to RUN.

An in-flight start envelope displays on primary EICAS and the secondary engine indications display when a Fuel Control switch is moved to CUTOFF in flight. The in-flight start envelope displays the airspeed range to ensure an in-flight at the current flight level. If the current flight level is greater than the maximum start altitude, the maximum start altitude and related airspeed range display. X-BLD displays next to the N2 indication if crossbleed air is necessary for start.

Autostart

Autostart allows the EEC to control fuel and ignition and automatically abort the start for certain malfunctions. Pushing the Autostart switch ON arms autostart. Pulling the Start switch out (held out by a solenoid) arms the start valve and opens the engine bleed air valve. Moving the Fuel Control switch to RUN initiates the autostart sequence.

The EEC opens the start valve and the Start light illuminates. At a predetermined N2, the EEC opens the fuel metering valve and energizes the selected igniter. One igniter is normally selected for ground start, while two igniters are selected for in-flight start.

Starter cutout occurs at 50% N2 RPM. At starter cutout, the Start switch is released to the in position, the start and engine bleed air valves close, the Start light extinguishes, and ignition discontinues.

During autostart, the EEC monitors EGT and N2 RPM until the engine stabilizes at idle.

Ground Autostart

During ground start, the autostart system monitors engine parameters and aborts the start for any of the following malfunctions:

- hot start
- hung start
- no EGT rise

Note: The autostart system does not monitor oil pressure or N1 rotation.

If the EEC detects no EGT rise, it cuts off fuel and ignition. The engine motors for 30 seconds. The EEC applies fuel and ignition to both igniters for another attempt. The EEC makes three attempts before aborting the autostart sequence. The engine motors for 30 seconds before the start and bleed air valves close.

If there is an EGT rise, but the EEC detects an impending hot start or a hung start before starter cutout, it cuts off fuel, adjusts the fuel schedule, then reapplies fuel for another attempt. The EEC makes three attempts before aborting the autostart sequence. Fuel and ignition are cut off. The engine motors for 30 seconds before the start and bleed air valves close.

If the EEC detects an impending hot start or a hung start after starter cutout, the autostart sequence is aborted immediately. The engine does not motor.

In-flight Autostart

During in-flight flameout and/or start, the EEC reacts to a hung start or to EGT reaching the takeoff limit. The crew reacts to a hot start or no EGT rise. If the EEC detects the EGT reaching the takeoff limit or a hung start, it cuts off and then reapplies fuel. The EEC allows the EGT to increase past the ground/single engine in-flight start limit to the takeoff limit before cutting off fuel. The autostart sequence is not automatically aborted. The EEC continues making start attempts until the engine stabilizes at idle or the Fuel Control switch is moved to CUTOFF.

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 SP.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.

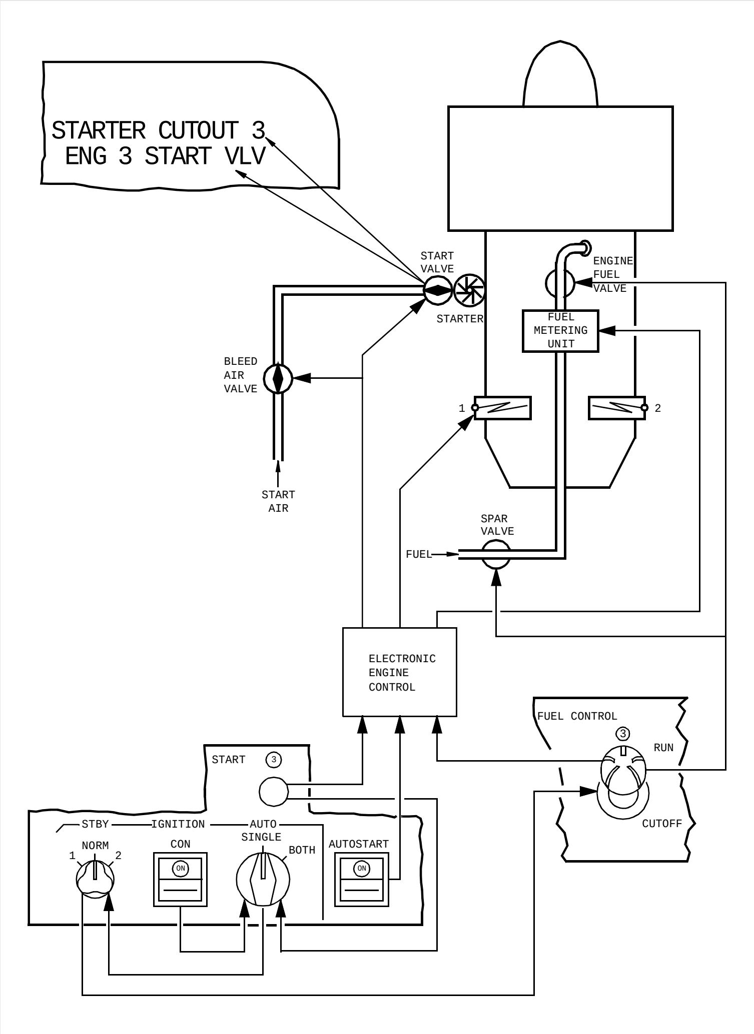
Engine Ignition

Each engine has two igniters. The igniters operate separately or together as selected by the Auto Ignition selector and the EEC.

Ignition is selected for each engine when the related Start switch is out, nacelle anti-ice is on, or a flameout is detected. Ignition is selected for all engines when trailing edge flaps are out of the up position or the Continuous Ignition switch is ON. When ignition is selected, the selected igniter on each engine energizes when the related Fuel Control switch is in RUN and, during autostart, when commanded by the EEC. The selected igniter deenergizes when the Fuel Control switch is placed in CUTOFF.

The AC power system is the normal power source for ignition. The standby power system provides a backup source. When the Standby Ignition selector is in NORM, the AC power system supplies power to the selected igniters. If the AC power system is not powered, the standby power system supplies power continuously to both igniters. When the Standby Ignition selector is in 1 or 2, the standby power system supplies power continuously to the related igniter regardless of Auto Ignition selector position or EEC selection.

Engine Start and Ignition System Schematic



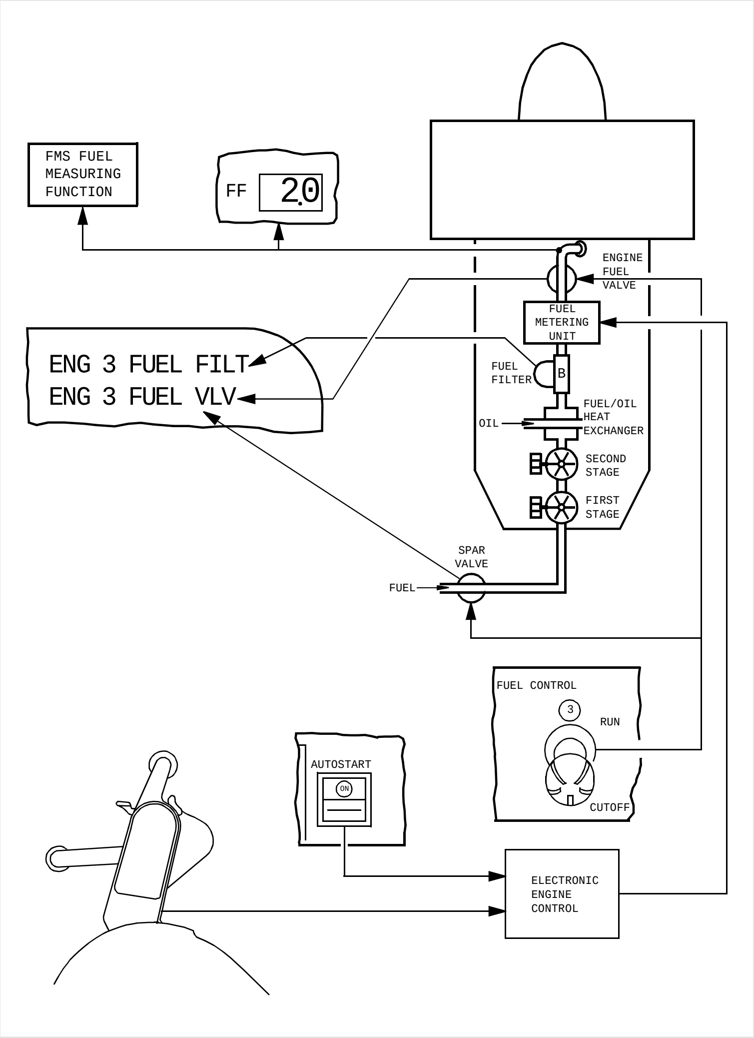
Engine Fuel System

Fuel is supplied under pressure from pumps located in the fuel tanks. Fuel for each engine flows through a spar fuel valve located in the related main tank. The first and second stage engine fuel pumps add additional pressure to the fuel. Engine oil heats the fuel as it flows through the fuel/oil heat exchanger. A fuel filter removes contaminants. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel flows through the engine fuel valve to the engine.

The engine fuel valve, fuel metering valve, and spar valve allow fuel flow to the engine when all valves are open. The valves open when the Engine Fire switch is in and the Fuel Control switch is in RUN, and the engine pumps are supplying fuel pressure. The pumps supply pressure when the N2 rotor is turning. During autostart, the fuel metering valve is additionally controlled by the EEC. The engine fuel valve, fuel metering valve, and spar valve close when either the Fuel Control switch is in CUTOFF or the Engine Fire switch is out.

Fuel flow is measured downstream of the engine fuel valve and displays on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic



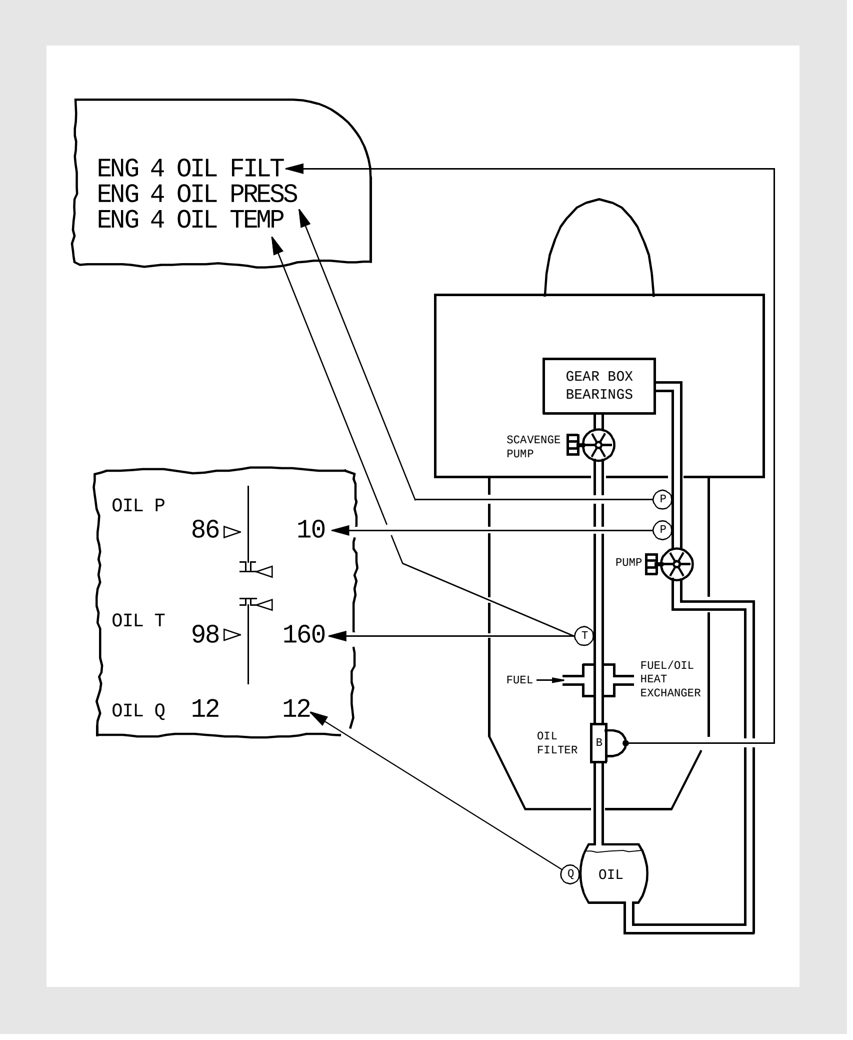
Engine Oil System

The oil system cools and lubricates engine bearings and the accessory gearbox. Oil is pressurized by an oil pump. The oil cools and lubricates the engine. The scavenge pump scavenges oil from the engine. The oil is cooled by fuel as it flows through the fuel/oil heat exchanger. An oil filter removes contaminants. If the filter becomes saturated with contaminants, oil bypasses the filter. Oil then returns to the oil reservoir.

Oil pressure, temperature, and quantity display on the secondary engine display. Oil pressure is measured upstream of the engine. Oil temperature is measured downstream of the engine.

During cruise, oil quantity displays on EICAS whenever oil quantity on one engine differs from any other engine by a predetermined amount. When this occurs, the lowest oil quantity is shown in magenta. If there is an increase in oil quantity during cruise (indicator malfunction or leaking fuel/oil heat exchanger), the EICAS oil partial engine indications display may appear. However, for this condition the low quantity displays in magenta, even though that oil quantity may be normal.

Engine Oil System Schematic



Thrust Reverser System

Each engine has a pneumatically actuated fan air thrust reverser. Each thrust reverser is powered by bleed air from the related engine. The reverser does not operate if the engine is not running. Reverse thrust is available only on the ground.

An interlock mechanism in the Thrust lever assembly prevents simultaneous movement of the Forward and Reverse Thrust levers. The Reverse Thrust levers can be raised only when the Forward Thrust levers are in the closed position. When the Reverse levers are down, the reversers are locked in the stowed position.

Raising the Reverse Thrust levers to the idle detent locks the Forward Thrust levers in position. Bleed air unlocks and extends the reversers aft to the deployed position. A thrust reverser status annunciator displays above the digital indicator of each N1 indication. The annunciator displays in amber when the related reverser is unlocked or moving. The annunciation changes color to green when the reverser is fully deployed. The interlock releases and the Reverse Thrust levers can be moved to full reverse,.

Pushing the Reverse Thrust levers to the full down position retracts the reversers to the stowed and locked position. The REV indication changes color back to amber while the reverser is moving. When the reverser is stowed and locked, the REV indication is removed. The Thrust levers cannot be moved forward until the Reverse Thrust levers are fully down.

The thrust reversers are protected against deploying inadvertently. If a reverser unlocks and deploys inadvertently, the reverser system applies bleed air to stow and lock the reverser.

Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications display on the secondary engine display. The vibration source indication also displays. If the vibration monitoring system cannot determine the source (fan, N1, or N2), broadband (BB) displays for the affected engine. Broadband vibration is the average vibration detected.

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.

Introduction

The auxiliary power unit (APU) is a self–contained gas turbine engine located in the airplane tail cone.

The APU can be started on the ground and when left running for takeoff can be operated in flight up to 20,000 feet.

The APU drives two generators capable of supplying the entire electrical load of the airplane for normal ground operations. Electrical power is not available in flight. The APU also provides air to the pneumatic system for operation of components which require bleed air. The APU has bleed air capacity to run all air conditioning packs except during engine start. APU bleed air is available in flight for one pack up to 15,000 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 DC electric starter is powered by an APU start transformer rectifier (TR) whenever galley bus 2 is powered. Galley bus 2 may be powered from either an external or internal AC power source through the synchronous bus. If galley bus 2 is not powered, starter power is supplied by the 24 volt APU battery. The battery has a charger which disconnects during APU starter engagement. The APU battery powers the inlet door, APU controller, DC fuel pump, and APU fire detection system. The main battery supplies power for the APU fire extinguisher, APU fuel valve, and standby power for the APU controller. During a battery start sequence, the APU starter is powered by the APU battery and all APU components except the starter are powered by the main battery while the APU starter is engaged.

Rotating the APU selector momentarily to START begins the start sequence. The APU fuel valve and inlet door open simultaneously. Starter engagement occurs when the inlet door is fully open. The start sequence continues with ignition, lightoff, and engine acceleration to rated speed.

APU start cycle restrictions are:

Between starts	TR wait:	Battery wait:
1 and 2	1 minute	1 minute
2 and 3	10 minutes	5 minutes
3 and 4	20 minutes	1 minute
4 and 5	20 minutes	20 minutes
5 and 6	20 minutes	1 minute
For additional starts with TR power, wait 20 minutes between each start. For additional starts with battery power, wait 60 minutes then alternate between one and 60 minutes for further starts.		

If the TR should overheat with the start source switch in TR, starting power is transferred to the battery and the start continued on battery power. Any further start attempts with an overheated TR are inhibited.

A failure of the TR, other than an overheat, does not provide automatic switching to the APU battery. Under these conditions, moving APU Start Source switch to BATTERY removes the TR from the starting circuit and allows APU starting on battery power.

APU Run

The EICAS memo message APU RUNNING is displayed when the APU selector is ON and APU N1 RPM exceeds 95% N1.

APU Shutdown

Rotating the APU selector to OFF begins the shutdown cycle by closing the APU bleed air valve. The APU continues running unloaded for a sixty second cooldown period. When the cooldown period finishes, the APU shuts down.

Shutdown may be monitored on the EICAS status display if AC power is not available. The Battery switch should remain ON until APU shutdown is complete.

Note: If the Battery switch is positioned OFF prior to completion of the cooldown period, the APU will shut down immediately.

A complete shutdown sequence with fire detection capability can be assured by waiting at least 2 minutes after the APU selector is rotated to OFF before placing the battery switch OFF.

If a limit is exceeded or a fire detected, the APU shuts down immediately.

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

Engine Alert Messages

Message	Level	Aural	Condition
>AUTOSTART OFF	Advisory		Autostart switch OFF.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 AUTOSTART	Caution	Beeper	Autostart system has failed to start the engine, or fault detected in autostart system.

Message	Level	Aural	Condition
>ENG 1, 2, 3, 4 CONTROL	Advisory		EEC system fault present. Inhibited in flight.
>ENG CONTROLS	Advisory		Three or four EEC systems operating in a degraded condition and lack complete redundancy. Inhibited in flight.
ENG 1, 2, 3, 4 EEC MODE	Advisory		Engine EEC in alternate control mode.
ENG 1, 2, 3, 4 FAIL	Caution	Beeper	Engine failure or flameout in flight.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 FUEL FILT	Advisory		An impending fuel filter bypass exists on the affected engine.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 FUEL VLV	Advisory		Engine fuel valve or fuel spar valve position disagrees with commanded position.

Message	Level	Aural	Condition
ENG IGNITION	Advisory		Ignition system fails to provide ignition when Continuous Ignition switch ON.

Message	Level	Aural	Condition
>ENG 1, 2, 3, 4 LIM PROT	Caution	Beeper	EEC in alternate control mode and command N1 exceeds maximum rating.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 LOW IDLE	Advisory		Engine idle not in approach setting when commanded.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 OIL FILT	Advisory		Engine oil filter contamination approaching bypass condition.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 OIL PRESS	Advisory		Oil pressure reaches red line limit.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 OIL TEMP	Advisory		Oil temperature reaches amber band.

Message	Level	Aural	Condition
ENG 1, 2, 3, 4 REVERSER	Advisory		Fault detected in the reverser system.

Message	Level	Aural	Condition
>ENG 1, 2, 3, 4 RPM LIM	Advisory		Engine thrust is limited by N2 red line limit.

Message	Level	Aural	Condition
>ENG 1, 2, 3, 4 SHUTDOWN	Caution		Engine Fire switch pulled, or engine Fuel Control switch in CUTOFF. Master Caution lights do not illuminate.
ENG 1, 2, 3, 4 START VLV	Advisory		Start valve position disagrees with commanded position.
>IDLE DISAGREE	Advisory		One or more engine idle settings disagrees with idle commanded.
STARTER CUTOUT 1, 2, 3, 4	Caution	Beeper	Start valve fails to close.

APU Alert Messages

Message	Level	Aural	Condition
APU	Advisory		Automatic shutdown of APU with APU selector ON, or APU N1 RPM exceeds 95% with APU selector OFF.
APU DOOR	Advisory		APU door not in commanded position.
APU FUEL	Advisory		APU fuel pressure low.

Engine Memo Messages

Message	Level	Condition
CON IGNITION ON	Memo	Continuous Ignition switch ON. Inhibited if ENG IGNITION message displayed.
STBY IGNITION ON	Memo	Standby Ignition selector is in 1 or 2.

APU Memo Messages

Message	Level	Condition
APU RUNNING	Memo	APU selector in ON and APU N1 RPM exceeds 95%.

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Fire Protection — Chapter 8
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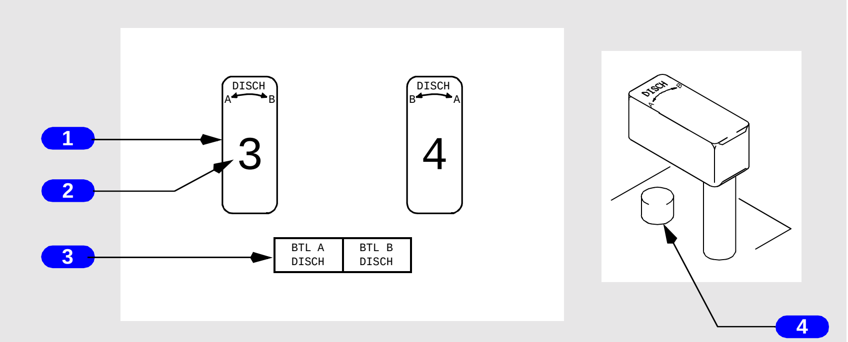
Engine Fire Protection

Engine Fire Panel



OVERHEAD PANEL

1 Engine Fire Switches

In (normal position, mechanically locked) – unlocks for a fire warning, or when the Fuel Control switch is in CUTOFF.

Out –

- closes the related engine and spar fuel valves
- closes the related engine bleed air valve
- trips off the related engine generator
- shuts off hydraulic fluid to the related engine–driven hydraulic pump
- depressurizes the related engine–driven hydraulic pump
- arms both related engine fire extinguishers

Rotate to A or B – discharges selected fire extinguisher into the engine nacelle.

2 Engine Fire Warning Lights

Illuminated (red) –

- an engine fire is detected, or
- the Fire/Overheat Test switch is pushed

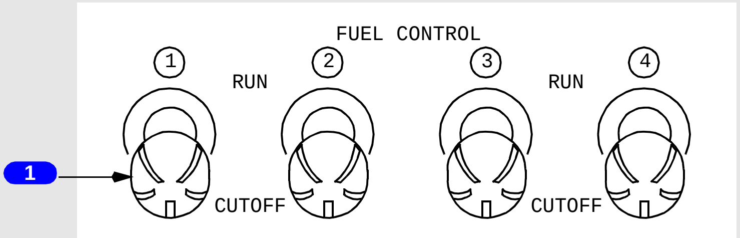
3 Bottle Discharged (BTL DISCH) Lights

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



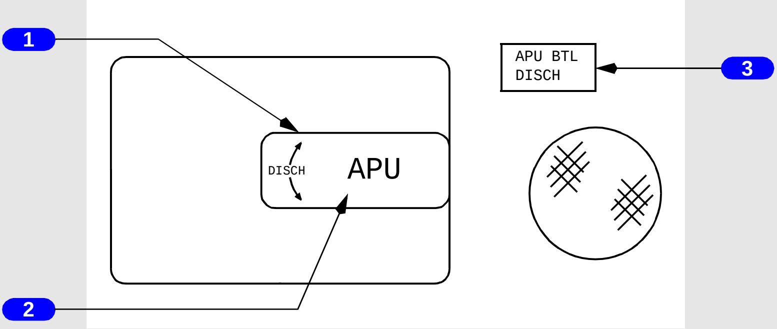
CONTROL STAND

1 FUEL CONTROL Switch Fire Warning Lights

Illuminated (red) –

- a related engine fire is detected, or
- the Fire/Overheat Test switch is pushed

APU Fire Panel



OVERHEAD PANEL

1 APU Fire Switch

In – normal position, mechanically locked; unlocks for a fire warning.

Out –

- arms APU fire extinguisher bottle
- closes APU fuel valve
- closes APU bleed air valve
- trips APU generator field and generator breaker
- shuts down APU (if automatic shutdown does not occur)

Rotate - discharges APU fire extinguisher into APU compartment.

2 APU Fire Warning Light

Illuminated (red) –

- an APU fire is detected, or
- the Fire/Overheat Test switch is pushed

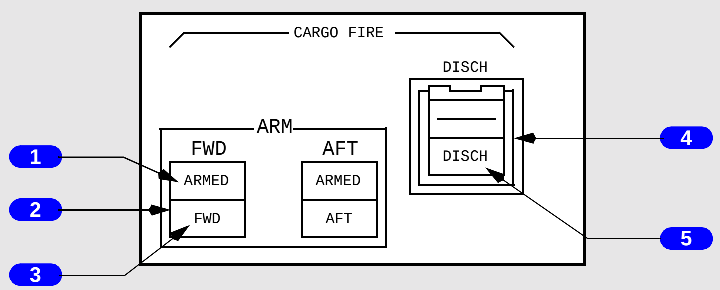
APU automatically shuts down for a detected fire.

On the ground, the APU extinguisher automatically discharges.

3 APU Bottle Discharged (BTL DISCH) Light

Illuminated (amber) – extinguisher bottle is discharged or has low pressure.

Cargo Fire Panel



OVERHEAD PANEL

1 CARGO FIRE ARMED Light

Illuminated (white) –

- arming circuit complete
- cargo fire extinguishers armed

2 CARGO FIRE ARM Switch

Push -

FWD –

- turns off pack 3 and all fans
- arms cargo fire extinguishers
- configures equipment cooling to override mode and turns off airflow and heat into forward compartment

AFT –

- turns off pack 3 and all fans
- arms cargo fire extinguishers
- configures equipment cooling to override mode and turns off airflow and heat into forward compartment
- turns off aft cargo heat

3 CARGO FIRE Warning Light

Illuminated (red) -

- fire in related cargo compartment, or
- the Fire/Overheat Test switch is pushed

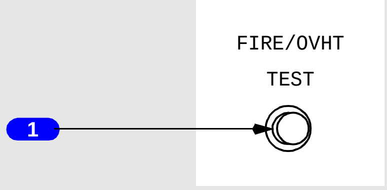
4 CARGO FIRE Discharge (DISCH) Switch

Push - initiates extinguisher discharge sequence to provide effective agent concentration for 215 minutes.

5 CARGO FIRE Discharged (DISCH) Light

Illuminated (amber) - cargo fire extinguishers discharged.

Fire/Overheat Test Switch



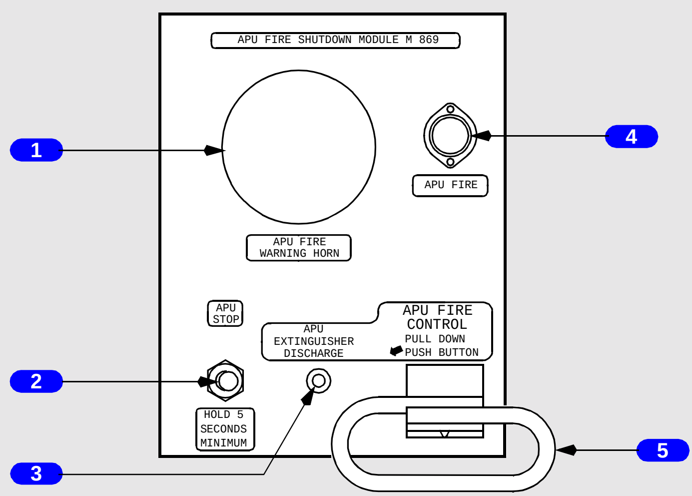
OVERHEAD PANEL

1 FIRE/Overheat (OVHT) TEST Switch

Push and hold -

- sends fire/overheat test signals to the engine, APU, wheel well, cargo, and bleed duct leak detectors
- tests flight deck fire and overheat indications (see Fire and Overheat Detection System Manual Fault Test, Section 20)

APU Ground Control Fire Protection Panel



RIGHT BODY GEAR
WHEEL WELL

1 APU FIRE WARNING HORN

Sounds intermittently during ground operation for an APU fire or fire test.

2 APU STOP Switch

Push – shuts down APU.

3 APU EXTINGUISHER DISCHARGE Switch

Push – discharges APU fire extinguisher, when armed, into APU compartment.

4 APU FIRE Light

The APU automatically shuts down for a detected fire.

Illuminated (red) –

- fire in APU compartment, or
- the Fire/Overheat Test switch is pushed

5 APU FIRE CONTROL Switch

Pull down -

- shuts down APU
- arms APU fire extinguisher

Introduction

There are fire detection and extinguishing systems for the:

- APU
- cargo compartments
- engines
- lavatories

The crew rest compartments and main gear wheel wells have fire detection systems, but no fire extinguishing systems.

The engines also have overheat detection systems.

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 protection.

Fire Warnings

If a fire is detected, the flight deck warning bell rings one second on, then 10 seconds off. If an APU fire occurs on the ground, the APU fire warning horn also sounds on the APU ground control panel in the right body gear wheel well.

The fire bell (and wheel well horn for APU fire) can be silenced by any of the following actions

- extinguishing the fire
- pushing either Master Warning/Caution Reset switch (wheel well horn continues to sound).
- pulling the APU Fire Control switch in the right wheel well

In addition to the aural warning, an EICAS FIRE message is displayed as long as the fire condition exists.

The following lights illuminate if a fire is detected and remain illuminated as long as the fire signal exists:

- both Master Warning lights (may be reset while fire signal exists)
- related Engine, APU, or Cargo Fire Warning lights
- for an engine fire, related Fuel Control switch Fire light.

Overheat Cautions

If an engine overheat condition is detected, the caution beeper sounds, the Master Caution lights illuminate, and an EICAS overheat message displays.

Fire/Overheat Detection

Engine Fire/Overheat Detection

A dual loop fire detector is installed in each engine nacelle. In addition, each engine has a dual loop overheat detector. In normal operation, both loops in a detector must detect a fire or overheat condition to cause an engine fire warning or overheat caution unless configured for single loop operation.

APU Fire/Overheat Detection

A dual loop fire detector is installed in the APU compartment. There is no overheat detection in the APU compartment. Either loop detecting a fire activates an APU fire warning which shuts down the APU and, on the ground, discharges the APU fire extinguisher bottle.

Cargo Compartment Fire Detection

The forward and aft cargo compartments each have two dual loop smoke detectors. Sample air from throughout each compartment is drawn through the detectors. Both loops in a detector must sense smoke to activate the cargo fire warning unless reconfigured for single loop operation.

Wheel Well Fire Detection

Each main gear wheel well has a single loop detector.

Crew Rest Smoke Detection

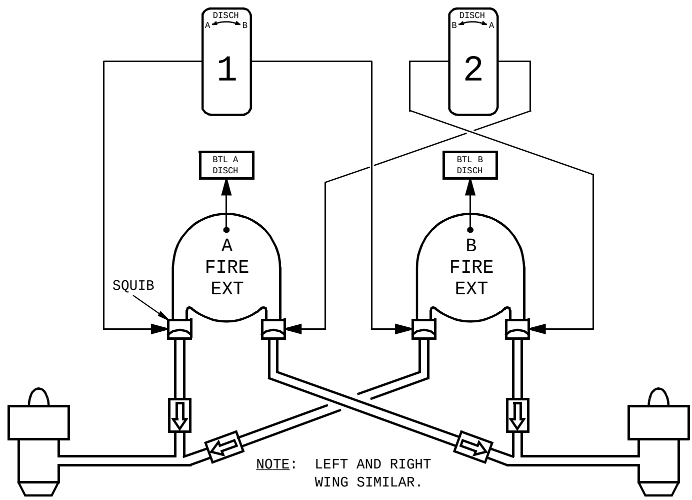
Smoke detectors are installed in crew rest areas. An aural warning sounds in the crew rest compartment when smoke is detected in that compartment.

Lavatory Smoke Detection

Smoke detectors are installed in the lavatories. An aural warning sounds in a lavatory when smoke is detected in that lavatory. An automatic fire extinguisher is located in the waste compartment in each lavatory.

Fire Extinguishing

Engine Fire Extinguishing



ENGINE FIRE EXTINGUISHING DIAGRAM

There are two fire extinguisher bottles in each wing for the two engines on that wing. One or both bottles can be discharged in either engine on a wing.

The Engine Fire switches are mechanically locked in. If an engine fire occurs, the related switch is electrically unlocked and can be pulled out.

Pulling an Engine Fire switch arms a squib in each bottle for discharge to the related engine. Rotating the Fire switch selects a fire extinguishing bottle and discharges it into the related engine nacelle.

The switches can be individually unlocked by pushing the Fire Override switch beneath each Fire switch. The Engine Fire switches are unlocked when the related Fuel Control switches are in CUTOFF.

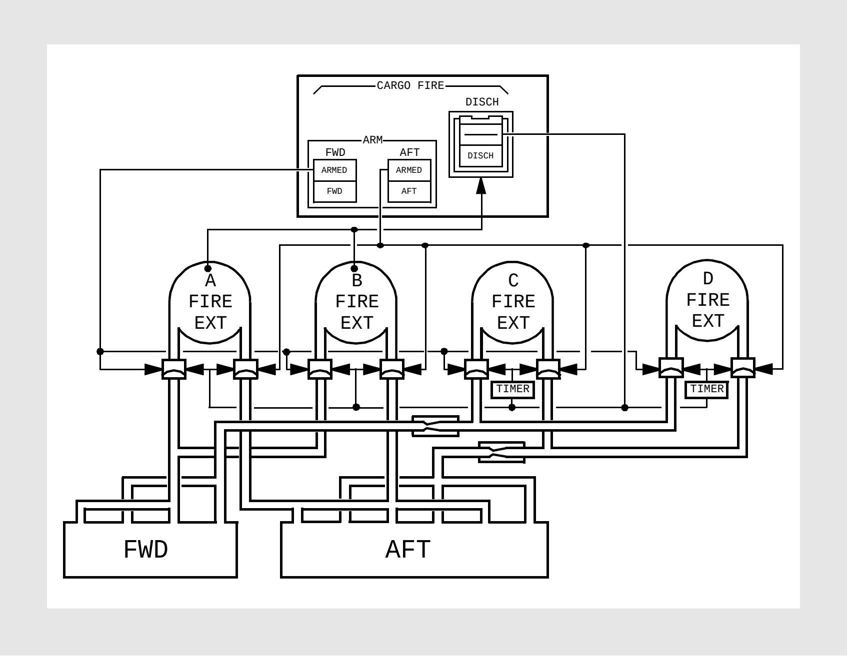
APU Fire Extinguishing

There is one APU fire extinguisher bottle controlled by the APU Fire switch.

The APU Fire switch is mechanically locked in. If an APU fire occurs, the related switch is electrically unlocked and can be pulled out. Pulling the APU Fire switch arms the fire extinguisher discharge squibs. Rotating the APU Fire switch discharges a fire extinguisher into the APU compartment.

The APU Fire switch can be unlocked by pushing the Fire Override switch beneath the Fire switch.

Cargo Compartment Fire Extinguishing



There are four fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other two bottles discharge after a brief delay, or upon touchdown.

Fire and Overheat Detection System FaultTest

The fire and overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic FaultTest

The engine and APU detector loops are continuously monitored for faults. In addition to continuous testing of engine and APU detection systems, testing of all dual loop fire/overheat detectors and cargo compartment smoke detectors occurs when electrical power is initially applied.

Fully operable systems configure for dual loop operation upon completion of any test. Systems with a fault in one loop reconfigure for single loop operation. If the operable loop senses a fire or overheat condition, the related fire warning or overheat caution activates.

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 rings
- the APU fire warning horn sounds (on the ground)
- the EICAS message FIRE TEST IN PROG is displayed
- these lights illuminate:
  - the master WARNING lights
  - the engine fire warning lights
  - the APU fire warning light
  - the FWD and AFT cargo fire warning lights
  - the 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. Failed system EICAS messages are displayed with the FIRE TEST FAIL message.

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.

The wheel well fire detector loop and the bleed duct leak detector loops are tested only during the manually initiated test.

Squib Test

All extinguisher discharge squibs are tested for electrical continuity and the squib control circuit is tested using the Squib Test switches and Squib lights located on the overhead maintenance panel.

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Fire Protection EICAS Messages

The following EICAS messages can be displayed.

Alert Messages

Message	Level	Aural	Condition
>BOTTLE LOW APU	Advisory		APU fire extinguisher bottle pressure low.

Message	Level	Aural	Condition
>BTL LO L, R ENG A, B	Advisory		Left or right wing engine fire extinguisher bottle A or bottle B pressure low.

Message	Level	Aural	Condition
>CARGO DET AIR	Advisory		Cargo smoke detection airflow insufficient.
>CGO BTL DISCH	Advisory		On the ground, a cargo fire extinguisher bottle pressure low. In flight, bottles A and B discharged.
>DET FIRE APU	Advisory		APU fire detection loops A and B failed.
>DET FIRE/OHT 1, 2, 3, 4	Advisory		Engine fire or overheat detection loops A and B have failed.
FIRE APU	Warning	Fire Bell	Fire detected in the APU.
FIRE CARGO AFT, FWD	Warning	Fire Bell	Smoke detected in the affected lower cargo compartment.
FIRE ENG 1, 2, 3, 4	Warning	Fire Bell	Fire detected in the engine.

Message	Level	Aural	Condition
FIRE WHEEL WELL	Warning	Fire Bell	Fire detected in a main wheel well.

Message	Level	Aural	Condition
OVHT ENG 1, 2, 3, 4 NAC	Caution	Beeper	Overheat detected in an engine nacelle.

Message	Level	Aural	Condition
>SMOKE DR 5 REST	Caution	Beeper	Smoke detected in door 5 crew rest area.

System Test Messages

The following messages are associated only with the manually-initiated fire test.

Message	Level	Aural	Condition
>FIRE TEST FAIL	Warning		One or more fire/overheat detection systems have failed to successfully complete the manually initiated fire/ overheat test.
>FIRE TEST PASS	Warning		A manually initiated test of the fire/overheat detection system has been completed.
>TEST IN PROG	Warning		A manually initiated fire/overheat detection system test in progress.

Flight Controls — Chapter 9
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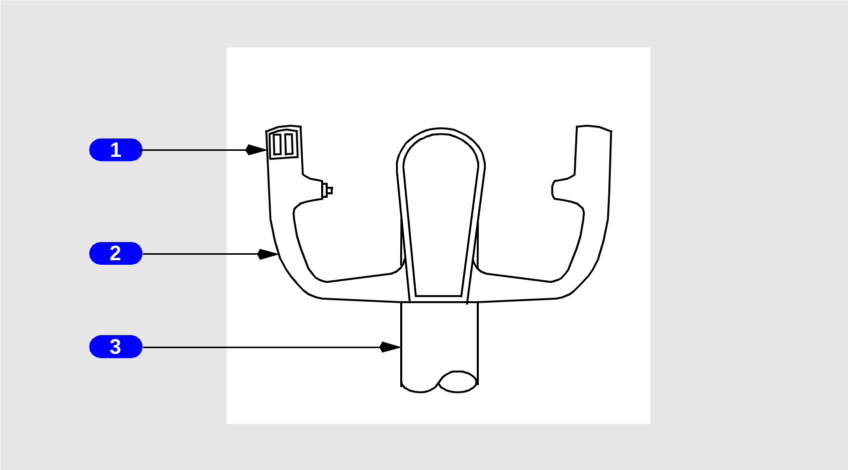
Pitch and Stabilizer Trim Systems

Control Wheel and Column



1 Stabilizer Trim Switches

Spring–loaded to neutral.

Push (both switches) – trims stabilizer in desired direction.

2 Control Wheel

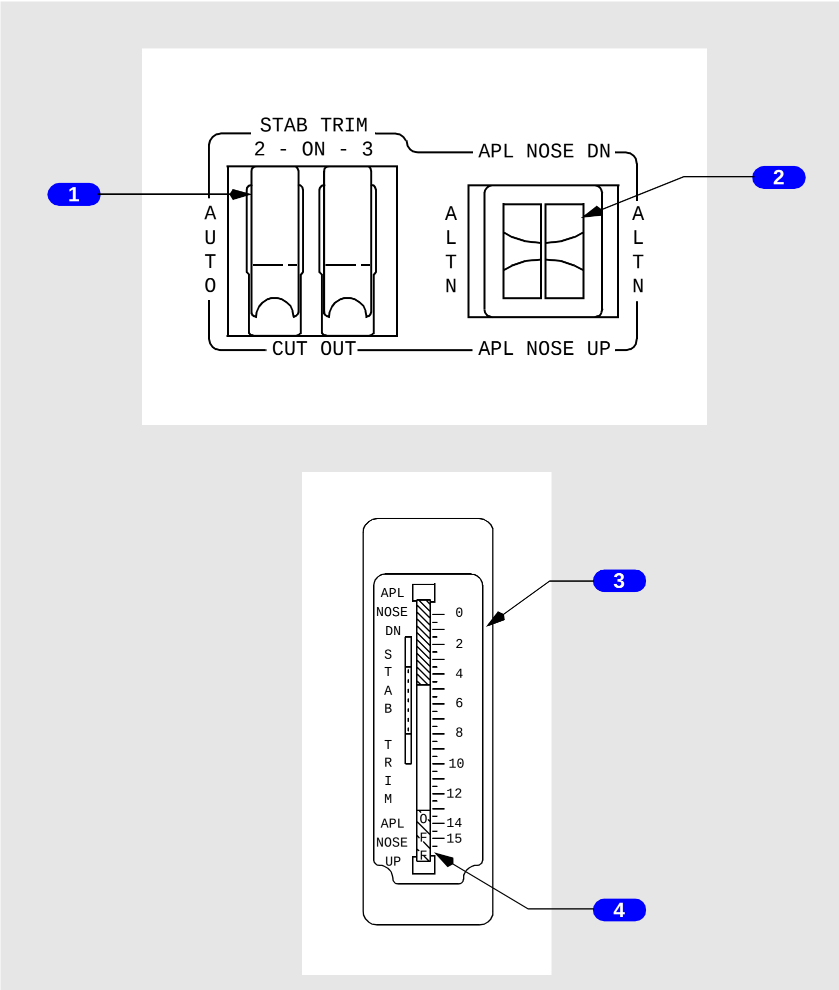
Rotate – deflects ailerons and spoilers in desired direction.

3 Control Column

Push/pull –

- deflects elevators in desired direction
- prevents stabilizer trim in opposite direction

Stabilizer Trim Controls



CONTROL STAND

1 Stabilizer (STAB) Trim Cut Out Switches

ON - supplies hydraulic power for stabilizer trim.

AUTO –

- supplies hydraulic power for stabilizer trim
- shuts off related system hydraulic power if unscheduled trim detected

CUT OUT - shuts off related hydraulic power to stabilizer trim.

2 Alternate (ALTN) Stabilizer Trim Switches

Push (both switches) - trims stabilizer in desired direction using alternate control channel.

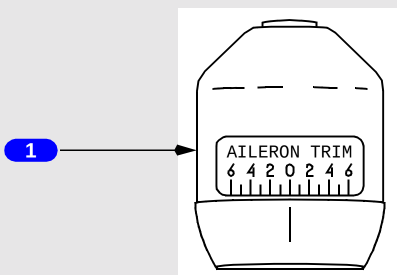
3 Stabilizer Trim Indicator

- indicates stabilizer position in units of trim
- illuminated greenband indicates allowable range for takeoff

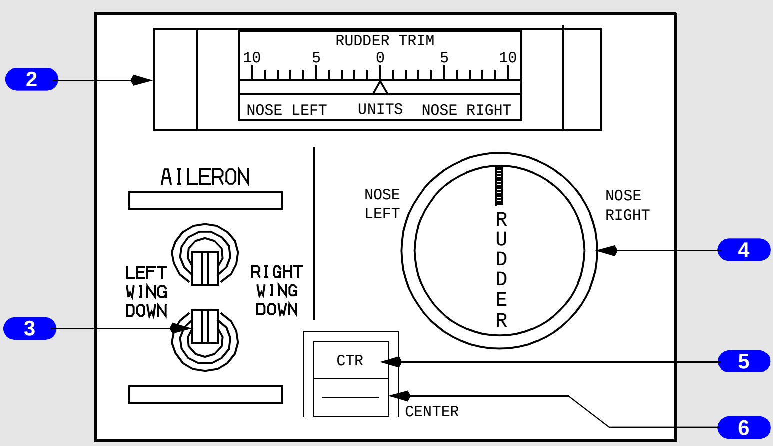
4 Stabilizer Trim Indicator Off Flag

In View - trim indicator inoperative.

Aileron and Rudder Trim Controls



CONTROL WHEEL/COLUMN



AFT AISLE STAND

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) – trims ailerons in desired direction.

4 RUDDER Trim Selector

Spring–loaded to neutral.

Rotate -

- trims rudder in desired direction
- cancels rudder trim centering

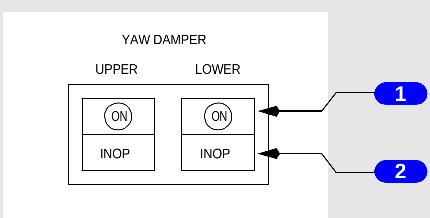
5 Rudder Trim Centering (CTR) Light

Illuminated - Rudder Trim Centering switch has been pushed and trim is moving to zero.

6 Rudder Trim Center Switch

Push – rudder trim moves to zero units.

Yaw Damper Controls



OVERHEAD PANEL

1 Yaw Damper Switches

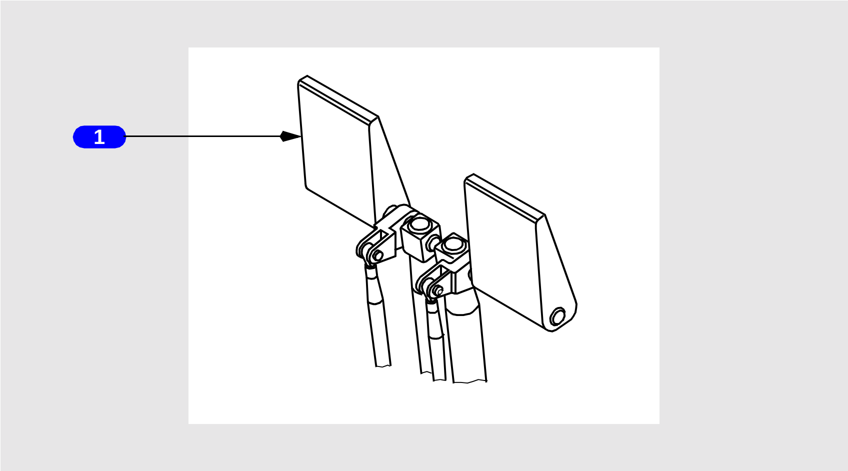
ON – yaw damper powered.

2 Yaw Damper Inoperative Light

Illuminated –

- yaw damper switch OFF, or
- yaw damper inoperative.

Rudder/Brake Pedals



1 Rudder Pedals

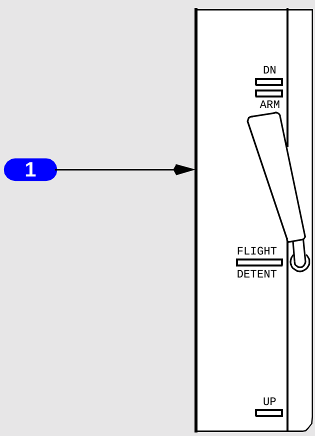
Push – deflects rudders in desired direction.

Refer to Chapter 14, Landing Gear, for brakes and nosewheel steering description.

Speedbrake Lever

On the ground -

- speedbrake lever moves to UP and all spoiler panels extend when either engine 2 or engine 4 reverse thrust lever raised to idle detent with engine 1 and engine 3 thrust levers retarded
- speedbrake lever moves to DN and all spoiler panels retract if engine 1 or engine 3 thrust lever advanced



CONTROL STAND

1 Speedbrake Lever

DN (down) (detent) – all spoiler panels retracted

ARM (armed) –

- automatic speedbrake system armed
- after landing, speedbrake lever moves to UP and spoiler panels extend if engine 1 and engine 3 thrust levers retarded

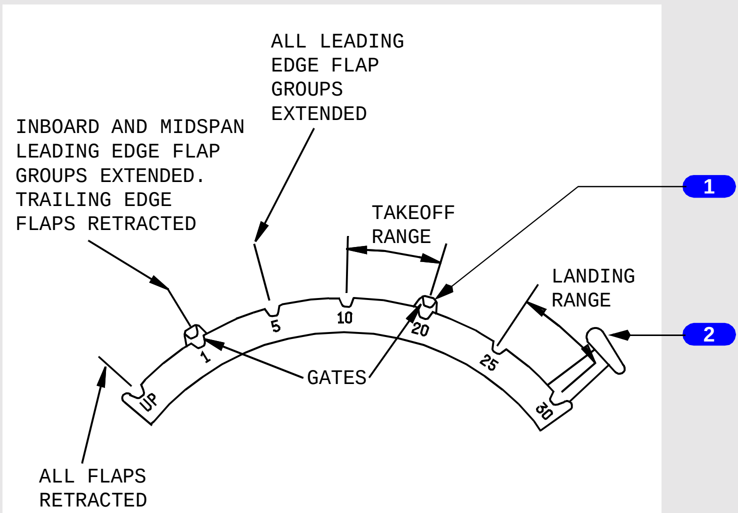
FLIGHT DETENT -

- spoiler panels extend to their maximum in-flight positions
- in flight, aft movement of speed brake lever limited to FLIGHT DETENT by an automatic stop

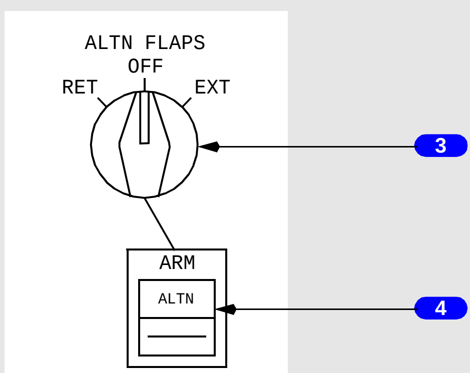
UP – all spoiler panels extend to their maximum in–flight or on–ground position (intermediate positions can be selected).

Flap System

Flap Controls



CONTROL STAND



CENTER PANEL

1 Flap Gate

1 – prevents inadvertent retraction of remaining leading edge flap groups

20 – prevents inadvertent retraction of flaps past go-around position.

2 Flap Lever

Primary mode - postions leading edge flaps pneumatically and trailing edge flaps hydraulically.

Secondary Mode - positions leading and/or trailing edge flaps electrically if flaps fail to drive pneumatically or hydraulically.

3 Alternate (ALTN) Flaps Selector

RET (retract) – leading and trailing edge flaps electrically retracted.

OFF – alternate flaps deactivated.

EXT (extend) –

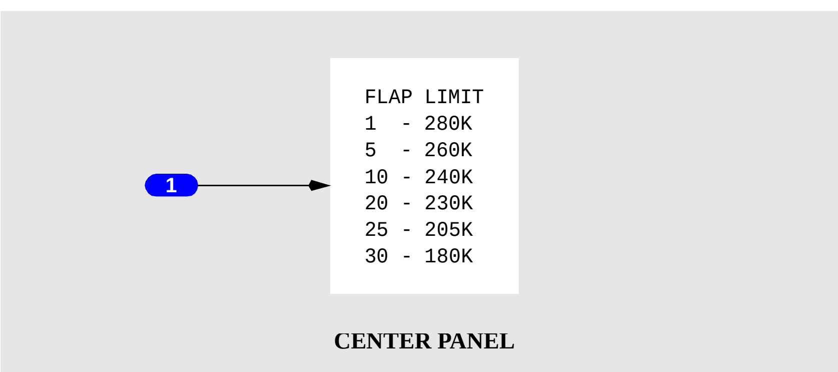
- leading and trailing edge flaps electrically extend
- maximum extension is flaps 25

4 Alternate (ALTN) Flaps Arm Switch

ALTN –

- arms flap alternate control mode
- arms Alternate Flaps selector
- shuts off primary and secondary mode operation
- asymmetry protection not available
- Flap lever inoperative

Flap Limit Placard



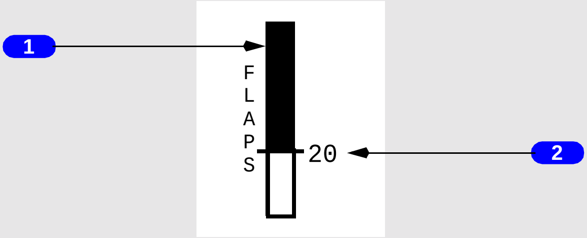
1 Flap Limit Placard

Flaps extended speed limits.

Normal Flap Position Indication

Displays combined leading and trailing edge flap positions when all surfaces are operating normally and control is in the primary (hydraulic) mode. The indicator shows continuous motion.

Indication is no longer displayed 10 seconds after flap retraction.



EICAS DISPLAY

1 Flap Position (white)

UP – all leading and trailing edge flaps retracted.

Between UP and 1 -

- inboard or midspan leading edge flap groups in transit
- all trailing edge flaps retracted

1 –

- inboard and midspan leading edge flap groups extended
- all trailing edge flaps retracted

Between 1 and 30 – actual position of slowest trailing edge flap group.

2 Flap Lever Position (line and number)

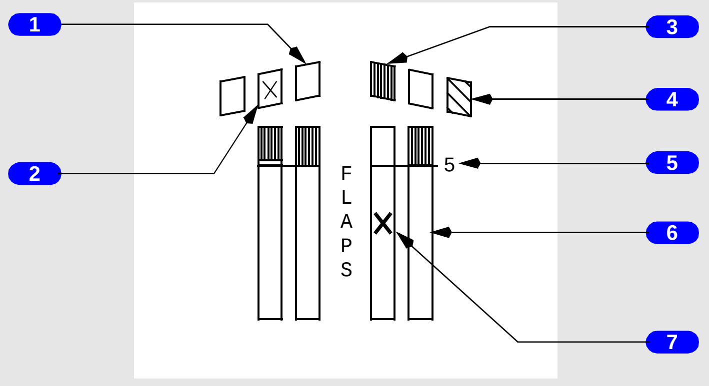
Magenta – flaps in transit to position selected by Flap lever.

Green – flaps in selected position.

Secondary Mode Expanded Flap Position Indication

If any flap position is non–normal or if flap control is in secondary mode, all flap positions are displayed.

Indicator motion is continuous between flap detents.



EICAS DISPLAY

1 Leading Edge Flap Up Indication

White - leading edge flap group up.

Amber - leading edge flap group disagrees with Flap lever position.

2 Inoperative Sensor (amber)

Position sensor for related leading edge flap has failed.

3 Leading Edge Flap Down Indication

Green - leading edge flap group down.

Amber - leading edge flap group disagrees with Flap lever position.

4 Leading Edge Flap In Transit Indication

White - leading edge flap group in transit.

Amber - leading edge flap group in transit after normal in-transit time.

5 Flap Lever Position (line and number)

Magenta – flaps in transit to position selected by Flap lever.

Green – all leading and trailing edge flaps in position selected by Flap lever.

6 Trailing Edge Flaps Indication

White - position of inboard and outboard trailing edge flaps.

Amber - asymmetry or drive failure has occured in related group.

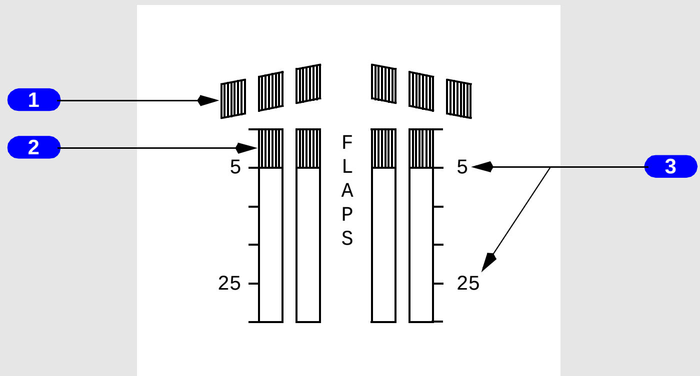
7 Inoperative Sensor (amber)

Position sensor for related trailing edge flap has failed.

Alternate Mode Expanded Flap Position Indication

If alternate flaps armed, expands to display all flap positions.

Indicator motion is continuous between flap detents.



EICAS DISPLAY

1 Leading Edge Flap Indication

Position of leading edge flap groups.

2 Trailing Edge Flap Indication

Position of inboard and outboard trailing flaps.

3 Flap Position Index Marks

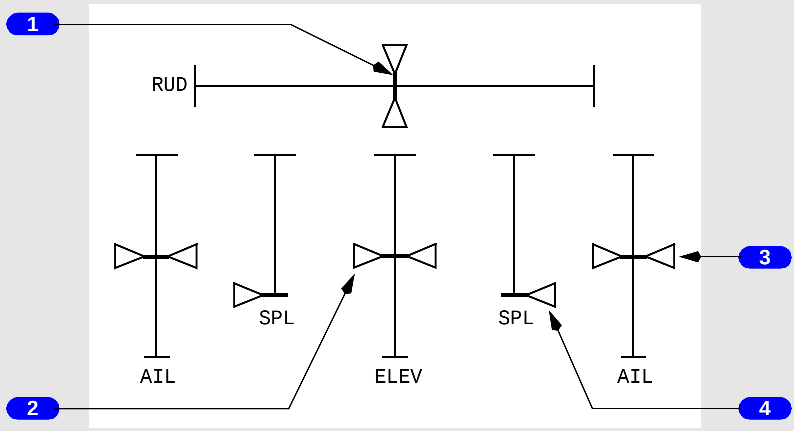
Reference flaps 5 and 25 positions.

Surface Position Indication

The surface position indication is displayed by pushing the STAT synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

Full pointer deflection indicates full control surface displacement.

Surface Position Indication



SECONDARY
EICAS DISPLAY

1 Rudder Position

Indicates upper and lower rudder positions.

2 Elevator Position

Indicates left and right outboard elevator positions.

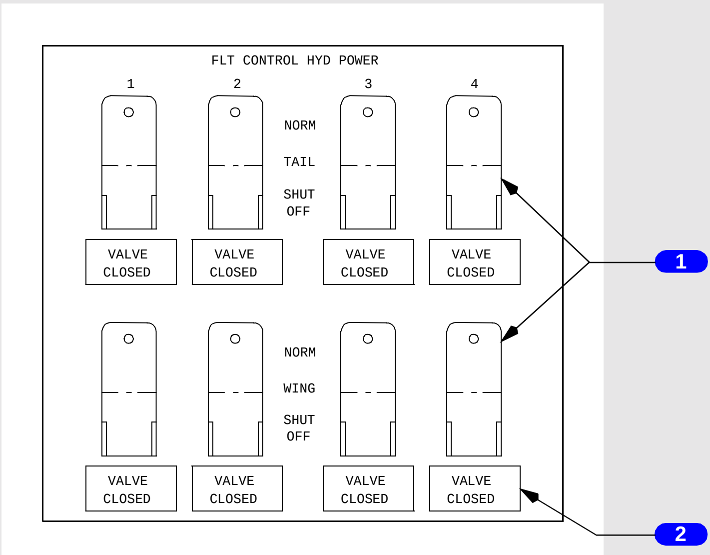
3 Aileron Position

Indicates inboard and outboard aileron positions.

4 Spoiler Position

- indicates flight spoiler positions
- indicates in-flight speedbrake position on left wing only

Flight Control Hydraulic Power Controls



OVERHEAD MAINTENANCE PANEL

1 Flight Control Shutoff Switches

NORM – supplies hydraulic power for flight control surfaces.

SHUT OFF – shuts off hydraulic power to respective flight control surfaces.

2 Valve Closed Light

Illuminated (amber) – hydraulic system flight control valve is closed.

Introduction

The primary flight controls are elevators, ailerons, and rudders. The control column, control wheel, and rudder pedals control these flight control surfaces. The primary flight controls are redundantly powered from the four airplane hydraulic systems; there is no manual reversion.

Secondary flight controls include a moveable horizontal stabilizer, spoilers, and leading and trailing edge flaps. Spoilers operate differentially to assist ailerons for roll control and symmetrically as speedbrakes.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- control wheel stabilizer trim switches
- alternate stabilizer trim switches
- speedbrake lever
- flap lever
- aileron trim switches
- rudder trim control

The control columns and rudder pedals are connected through jam shearout mechanisms. Control Wheels are connected through jam override and shearout mechanisms. If a jam occurs, the pilots can maintain control by applying force to the other control.

The Speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

Trim switches allow the pilots to adjust flight control surfaces to reduce flight control pressures.

Flight Control Surfaces

Pitch control is provided by:

- four elevator surfaces
- a moveable horizontal stabilizer

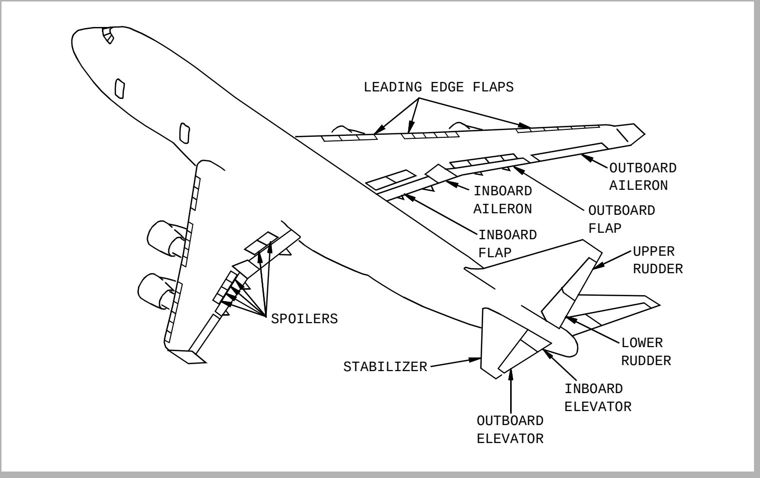
Roll control is provided by:

- four ailerons
- ten spoilers

Yaw control is provided by an upper and lower rudder.

Increased lift and decreased stall speed for takeoff and landing are provided by leading and trailing edge flaps.

Flight Control Surface Locations



Pitch Control

Four elevator surfaces hinged at the rear of the horizontal stabilizer and a moveable horizontal stabilizer provide pitch control.

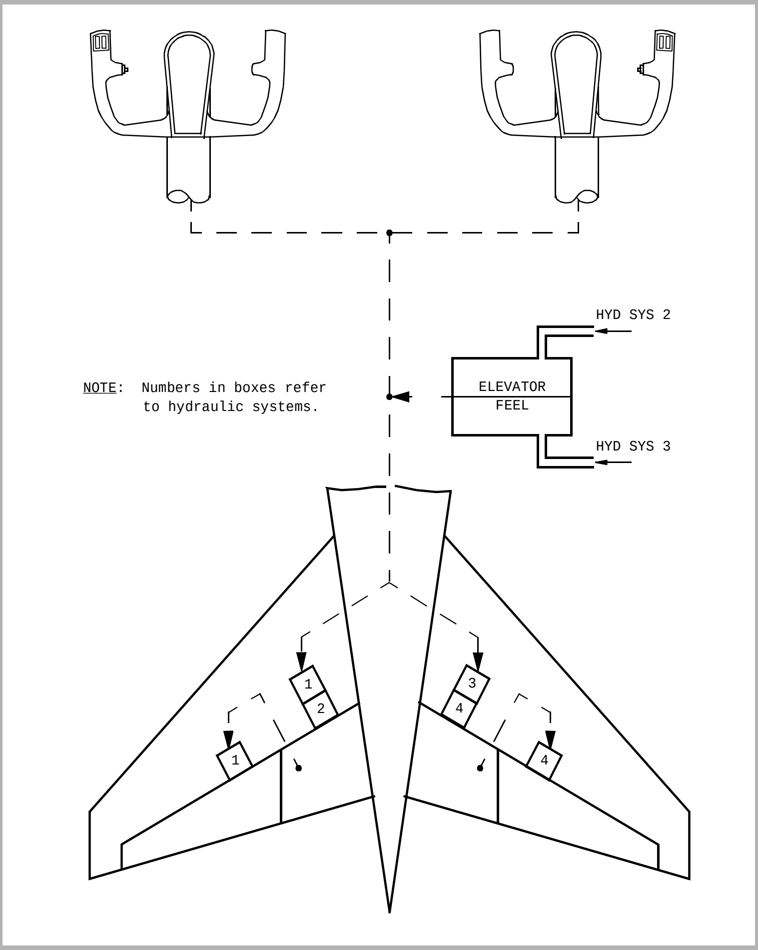
Elevator Control

Control column inputs transfer mechanically to hydraulic actuators on the inboard elevator control surfaces. Inboard elevator position controls input for the related adjacent outboard elevator actuator. Shearouts between the inboard and outboard elevators allow elevator control to be regained if a jam occurs and a significant manual force is applied to the control columns.

Left and right outboard elevator positions display on the EICAS status display. A full scale indication corresponds to maximum elevator deflection.

An elevator feel mechanism provides artificial feel at control columns. The force increases as airspeed increases. Hydraulic systems 2 and 3 power the feel mechanism. Loss of one of the hydraulic systems does not affect feel forces. If both hydraulic systems fail, mechanical springs provide feel forces. Feel force is no longer a function of airspeed.

Elevator Control Diagram



Stabilizer Trim

The stabilizer trim system provides pitch trim by varying the angle of incidence of the horizontal stabilizer. Normal and alternate electrical channels control two stabilizer trim control modules. Each control module hydraulically powers a trim actuator. Actuator outputs mechanically sum to drive the stabilizer. Trim rate is reduced at high airspeeds.

Trim Control

Stabilizer Trim switches on the pilots' Control Wheels or Alternate Stabilizer Trim switches on the control stand control stabilizer trim. Pushing both switches in a pair in the same direction power the actuators, which drive the stabilizer in the desired direction. The Alternate Stabilizer Trim switches provide trim commands in the same manner as the Stabilizer Trim switches through a separate control channel. The Alternate Stabilizer Trim switches also provide an increased range of stabilizer travel. If the Alternate Stabilizer Trim switches and Control Wheel switches are held in opposite directions, no trim is commanded. Holding the Captain's and First Officer's Control Wheel switches in opposite directions commands no trim.

Stabilizer Trim Position Indication and Greenband

Stabilizer position, measured in trim units, displays on trim indicators on both sides of the control stand. A stabilizer trim indicator OFF flag displays if the trim indicator is inoperative.

The stabilizer trim indicators incorporate a multiple greenband which indicates the acceptable range of trim settings for takeoff. There are three possible greenbands: a mid-band, a nose down band which includes the mid-band plus additional nose down trim, and a nose up band which includes the mid-band plus additional nose up trim.

The mid-band segment is a highly visible green paint stripe illuminated by ambient light and integral panel lighting.

The FMCs use entered center of gravity, gross weight, and takeoff thrust setting to calculate the correct greenband.

A nose gear oleo pressure switch provides a crosscheck to ensure the correct greenband has been selected. With either nose up or nose down band selected, the pressure switch position is compared to the selected greenband.

Stabilizer Trim Cutout

Hydraulic systems 2 and 3 power stabilizer trim. Two guarded Stabilizer Trim Cutout switches control stabilizer trim. With the guards closed, the switches are held in AUTO position, allowing automatic cutout of the related hydraulic system if unscheduled stabilizer trim is detected. With a Stabilizer Trim Cutout switch in CUT OUT, hydraulic power to the related trim control module is shut off. Positioning a Stabilizer Trim Cutout switch from CUT OUT to AUTO, activates the related actuator after a short time delay. Positioning a switch to ON overrides the automatic cutout function and supplies hydraulic power to the related control module. If automatic cutout has occurred, hydraulic power remains shut off until the related cutout switch is placed ON. If one actuator fails to operate, trim commanded by the flight crew reduces to half the normal scheduled rate.

Trimming with Autopilots Engaged

If a single autopilot is engaged, using the control wheel stabilizer trim switches causes the autopilot to disengage. If multiple autopilots are engaged, the Control Wheel Stabilizer Trim switches are inhibited. The Alternate Stabilizer Trim switches override autopilot trim commands with any number of autopilots engaged and do not cause disengagement.

Control Column Cutoff

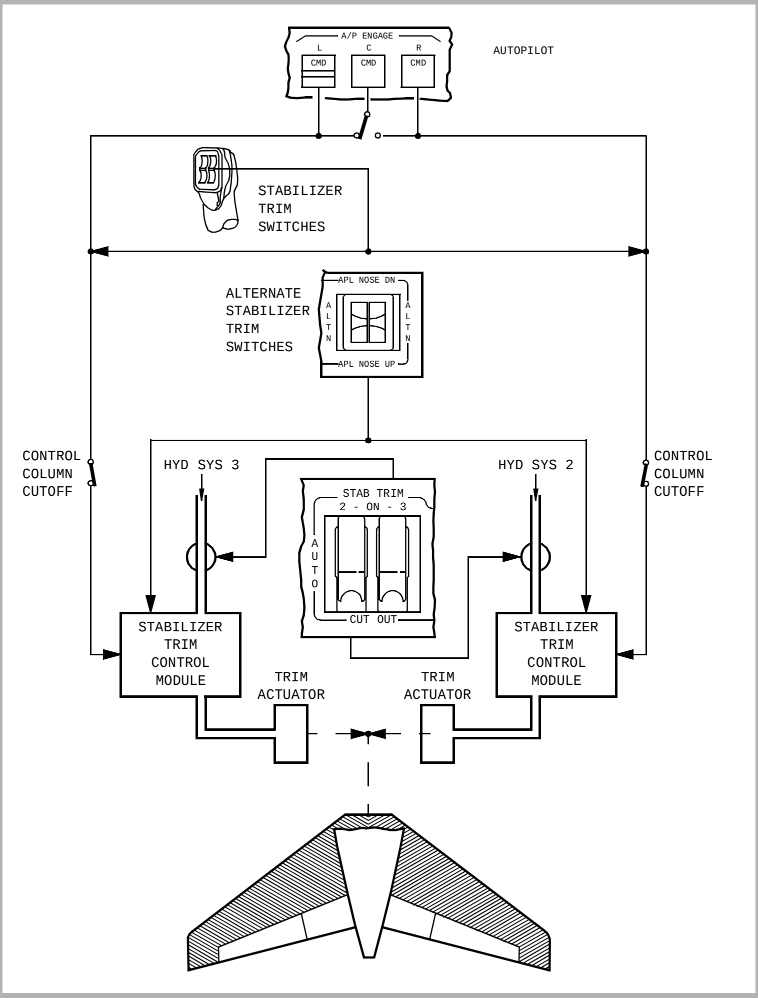
Control column inputs in the direction opposing stabilizer trim will cutoff electric trim commands to the control modules. The control column trim cutoff function does not affect alternate trim inputs.

Speed Stability Trim

Speed stability trim uses stabilizer trim to improve handling characteristics of the airplane in the lower speed range.

Activating the Stabilizer Trim switches or engaging an autopilot inhibits speed stability trim.

Stabilizer Control Diagram



Roll Control

Hydraulically powered inboard and outboard ailerons and spoilers provide roll control.

Aileron and Spoiler Roll Control

Rotating either Control Wheel positions ailerons and spoilers to provide roll control. An aileron lockout system locks the outboard ailerons in the neutral position at high airspeeds and permits full travel of the outboard ailerons at low airspeeds. This prevents overcontrolling at high airspeeds and provides the required roll authority at low airspeeds.

All spoilers, except the inboard spoiler on each wing, function as flight spoilers which operate with the ailerons to provide roll control. Spoiler mixers combine Speedbrake Lever and Control Wheel inputs allowing roll inputs to deflect spoiler panels up or down from their deployed positions when speedbrakes or ground spoilers are in use.

Aileron positions display on the EICAS status display. Separate pointers indicate the inboard and outboard aileron positions on each wing. A full scale deflection of the position indicator corresponds to maximum aileron travel.

The control wheels connect through an override mechanism which allows either wheel to move independently if the other wheel jams and significant manual force is applied to the free wheel. Roll control is then available through the ailerons on the wing corresponding to the free wheel. Approximately half of the flight spoilers are also available for roll control under these conditions.

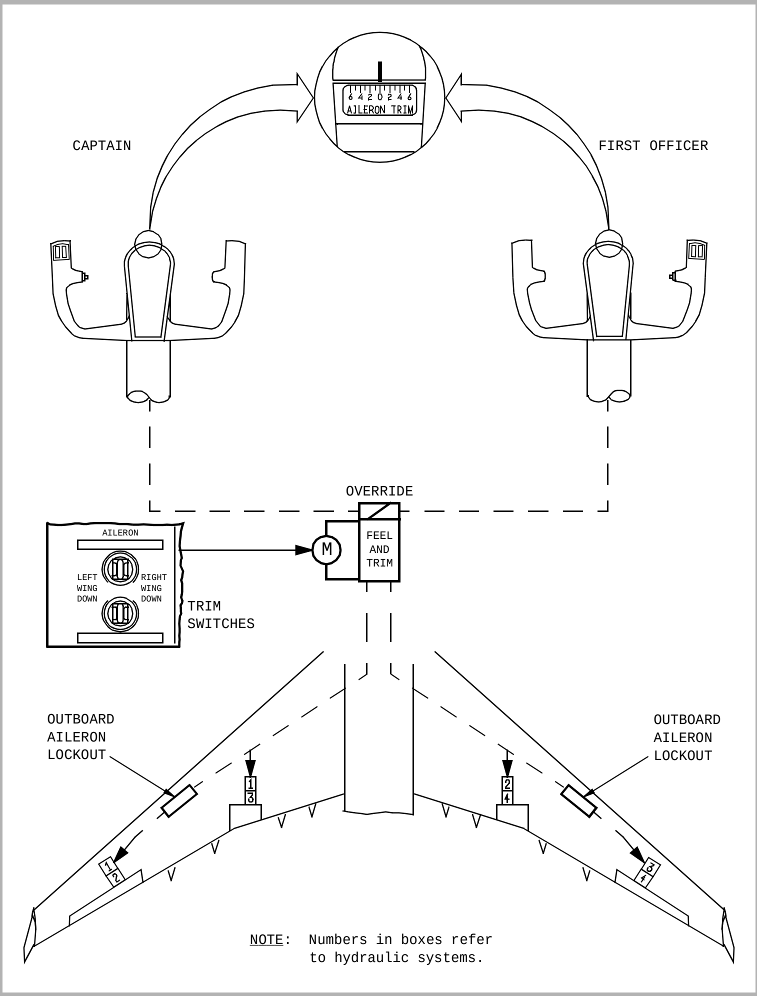
Each side of the mechanical system also incorporates shearouts which may allow the jammed control wheel to be freed when a significant manual force is applied to the jammed wheel.

Aileron Trim

Pushing both Aileron Trim switches in the desired direction causes the feel and trim mechanism to reposition the aileron neutral point. Both control columns have an aileron trim indicator.

If the Aileron Trim switches are activated with an autopilot engaged, the aileron neutral point is repositioned. When the autopilot is disengaged, the wheel and ailerons move to the repositioned aileron neutral point. The airplane responds with roll proportional to the amount of aileron trim input.

Aileron Control Diagram



Yaw Control

The rudder control system provides yaw control.

Rudder Control and Trim

Either pilot's rudder pedals control the hydraulically powered upper and lower rudders. Rudder pedal inputs mechanically transfer to a single feel and trim mechanism, then transfer through separate ratio changers to the upper and lower rudder hydraulic actuators.

Rudder positions display on the EICAS status display. On the ground, pushing a rudder pedal to the stop causes a full scale deflection of the upper and lower rudder position indicators.

The rudder system shearouts allow rudder control to be regained if a jam occurs and a significant manual force is applied to the rudder pedals.

When the Rudder Trim control is rotated in the desired direction, the rudder feel and trim mechanism repositions the rudder pedal neutral point. The rudder trim indicator displays units of rudder trim.

Pushing the Rudder Trim Centering switch causes rudder trim to move to the zero units position. The zero position achieved by the centering function is not as accurate as manually trimming to zero units.

Rudder Ratio Changers

Two rudder ratio changer systems gradually reduce each rudder surface's response to pedal inputs as airspeed increases. This protects the vertical tail structure from stresses which could result from large rudder surface deflections at high airspeeds.

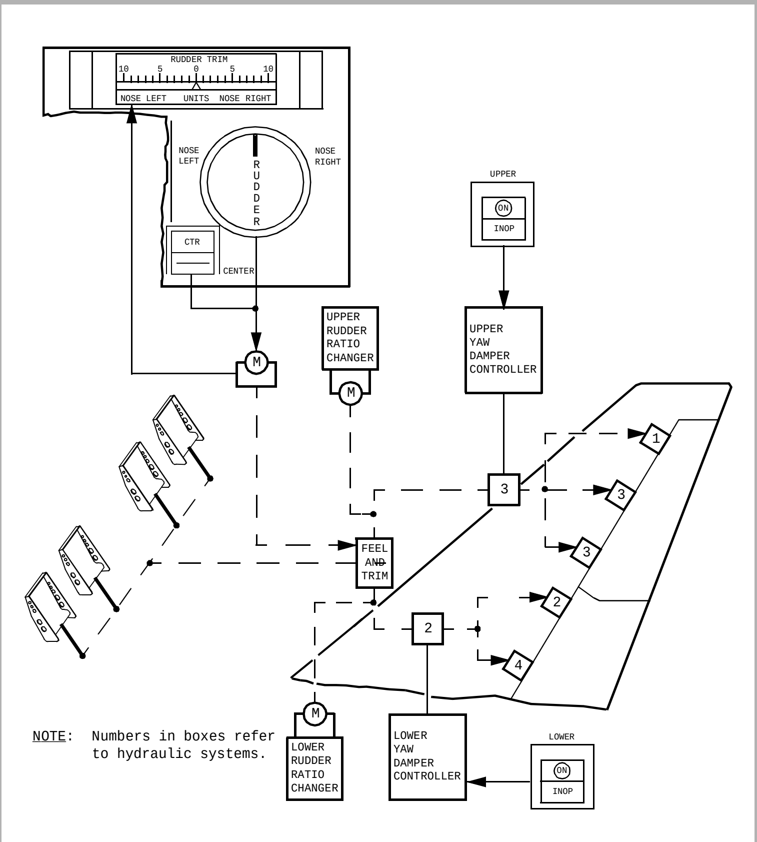
If a ratio changer system fails, the response of the related rudder surface to pedal inputs remains the same as when the failure occurred, regardless of changes in airspeed. Pilot inputs to the rudder may no longer be limited by the ratio changer and abrupt rudder pedal inputs at high airspeeds could result in excessive rudder deflections. At low airspeeds, full rudder deflection may not be available. The airplane crosswind capability is reduced for both manual and automatic landings.

Yaw Dampers

Two independent yaw damper systems operate continuously in flight to improve airplane directional stability and provide turn coordination. The upper and lower yaw damper actuators are powered by hydraulic systems 3 and 2 respectively. Yaw damper inputs do not result in rudder pedal motion.

With the Yaw Damper switches ON, the systems are powered. If a yaw damper fault exists, hydraulic power is removed from the system and the related yaw damper INOPERATIVE light illuminates.

Rudder Control Diagram



Spoilers

There are six spoiler panels on each upper wing surface just forward of the trailing edge flaps. The four inboard panels on each wing function as speedbrakes in flight. On the ground, all six spoiler panels on each wing function as ground spoilers. The speedbrake and ground spoiler functions are controlled with the Speedbrake lever.

The position of one spoiler on each wing is displayed on the EICAS status display. On the left wing, the position of the fourth spoiler panel in from the wingtip is displayed. This panel functions as a flight spoiler, speedbrake, and ground spoiler. On the right wing, the position of the outboard-most spoiler panel is displayed. This panel functions as a flight spoiler and ground spoiler only. Therefore, speedbrake extension is not indicated on the right wing spoiler position indicator.

Speedbrakes

Speedbrake lever in-flight input is limited to mid-travel position by an automatic stop. With the Speedbrake lever in flight detent position, the two inboard spoiler panels on each wing extend to mid-travel position and the two middle spoiler panels on each wing extend to full travel position.

Ground Spoilers

On the ground, the Speedbrake lever stop retracts allowing the Speedbrake lever to be moved fully aft to UP position. All six spoiler panels on each wing extend to their full travel positions.

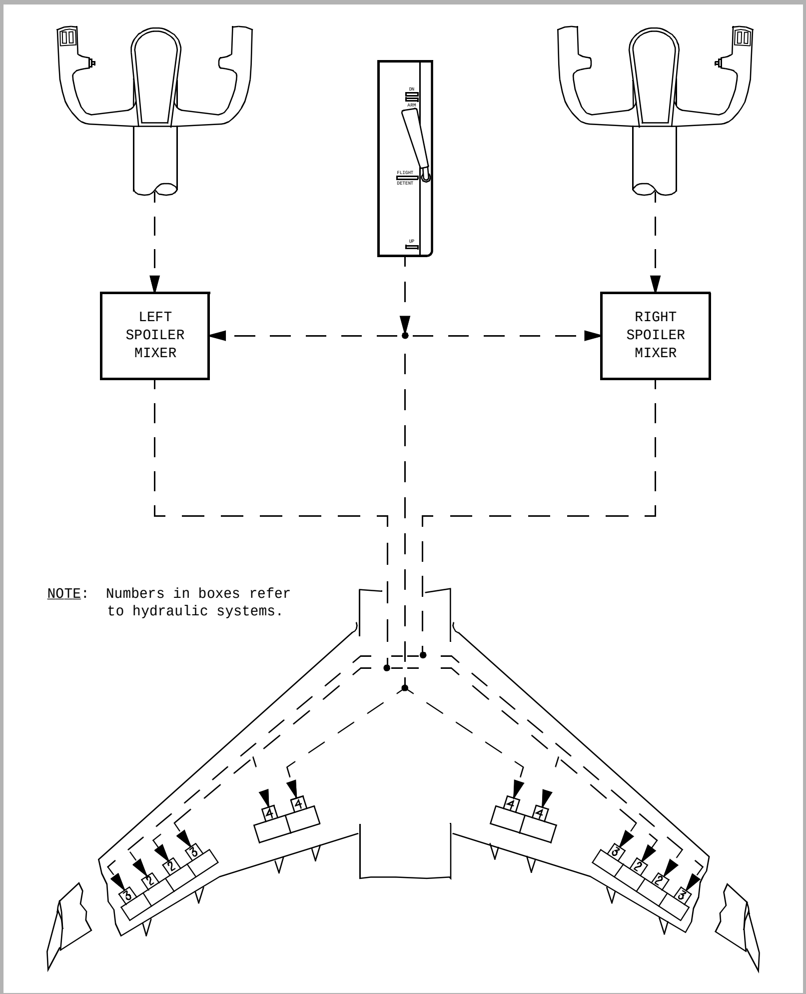
When the Speedbrake lever is in ARMED position, thrust levers 1 and 3 are near the closed position, and the main landing gear touch down, the Speedbrake lever is driven to UP position, extending all spoiler panels.

If the Speedbrake lever is in DN position with the main gear on the ground and thrust levers 1 and 3 near the closed position, and reverse thrust levers 2 or 4 are pulled up to idle detent, the Speedbrake lever is raised out of DN detent and driven to UP position. This provides an automatic ground spoiler function for RTO and provides a backup automatic ground spoiler function for landing when the Speedbrake lever is not armed during approach.

For go-around protection, if Thrust lever 1 or 3 is advanced from closed position, the Speedbrake lever is driven to DN position. This occurs whether ground spoilers were automatically or manually extended. The Speedbrake lever can be manually returned to DN position.

The EICAS advisory message SPEEDBRAKE AUTO indicates a fault which could result in the loss of the automatic ground spoiler function. If the Speedbrake lever is in ARM position, the message indicates a fault which could result in inadvertent spoiler extension in flight. No inadvertent spoiler extension can occur with the Speedbrake lever in DN position. The spoilers can be operated manually.

Spoiler Control Diagram



Flaps

Increased lift and decreased stall speed for takeoff and landing are provided by leading and trailing edge flaps. There are three groups of leading edge flaps on each wing: outboard flap section, midspan section, and inboard section. The leading edge flaps are normally pneumatically powered from the bleed air duct. The trailing edge flaps consist of an inboard group normally powered by hydraulic system 1 and an outboard group normally powered by hydraulic system 4. Opposite trailing edge flaps are mechanically connected to maintain symmetry.

Flap Control

Flap lever position is transmitted to three identical flap control units (FCUs) which sequence and monitor flap operation. Each FCU is capable of performing any or all of the three basic functions: primary control, secondary control, and indication and annunciation. They also provide trailing edge flap asymmetry protection in the primary and secondary modes, control the flap load relief function in primary mode only, and provide flap position information to EICAS and other systems.

The FCUs operate in two control modes, primary and secondary. In primary mode, the FCUs drive the leading edge flaps pneumatically and the trailing edge flaps hydraulically to the selected position. If any flap group fails to move to the commanded position, the FCUs switch to secondary mode for the related group driving the flap group through electric motors. The change from primary to secondary mode for both leading and trailing edge flaps is by symmetrical flap groups on both wings. If a primary control failure occurs in either the inboard or midspan leading edge flap group, both groups switch to secondary mode. For all other flap groups, only the failed group operates in secondary mode. Secondary mode flap operation is much slower than primary mode operation. If a failure occurs in a leading edge flap group on one wing, the flap groups on both wings change to secondary mode. However, due to the rapid rate of primary mode flap movement, the non-affected side completes movement before changing to secondary mode.

If a trailing edge flap group is driven in secondary mode due to a lack of hydraulic system pressure, the FCUs switch back to primary mode operation once hydraulic pressure is restored. However, if a trailing edge flap group is driven in secondary mode with hydraulic pressure available, the group remains in secondary mode until fully retracted. For leading edge flaps, if any groups are driven in secondary mode, the groups remain in secondary mode until they reach the commanded position.

If a trailing edge asymmetry is detected, primary mode operation is immediately shut down for the asymmetric group and the FCUs do not use secondary mode. The EICAS caution message FLAPS CONTROL displays if all three FCUs fail in their control function. EICAS flap indications from the FCUs may still be valid.

An alternate control mode which bypasses the FCUs can be manually selected. All flaps are extended or retracted by a simplified control system and electric motors. There is no asymmetry protection in alternate mode. When the Alternate Flaps Arm switch is pushed to ALTN, the Flap lever is inoperative. Flaps are extended and retracted using the Alternate Flaps selector.

Flap Sequencing

When the Flap lever is moved from UP detent to flaps 1 detent, the trailing edge flaps remain retracted and the inboard and midspan leading edge flap groups extend. When the Flap lever is moved from flaps 1 detent to flaps 5 detent, the trailing edge flaps move to flaps 5 position and the outboard leading edge flap groups extend. When the Flap lever is moved to the flaps 10, 20, 25, or 30 detents, the trailing edge flaps move to the selected position. The reverse sequence occurs during flap retraction. Secondary mode sequencing is the same as primary mode.

During alternate control mode extension, all leading and trailing edge flap groups begin extending immediately. Trailing edge flaps extend to a maximum position of flaps 25. During retraction, all leading edge flap groups retract after the inboard trailing edge flaps are completely retracted.

Flap Load Relief

The flap load relief function of the FCUs operates if flap airspeed limits are exceeded with flaps 25 or 30. Automatic retraction protects the flaps from excessive airloads. If the airspeed limit is exceeded with flaps 30 selected, the flaps retract to flaps 25. If airspeed is still excessive at flaps 25, the flaps retract to 20. Similary, if the airspeed limit is exceeded with flaps 25 selected, the flaps retract to 20.

The Flap lever does not move. The flaps extend to the selected position when airspeed is sufficiently reduced. Maximum flap speeds are placarded on the center panel.

Flap load relief is not available in secondary or alternate modes.

Flap Indications

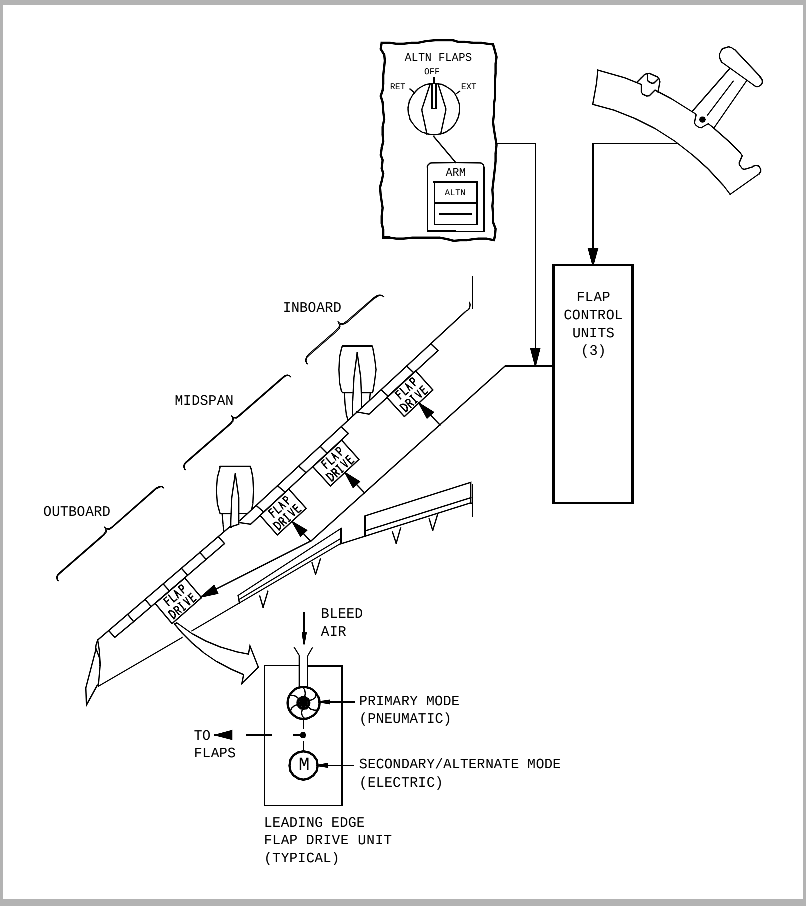
Flap position indications are displayed on the primary EICAS display. A single vertical indicator displays combined leading and trailing edge flap position. The position commanded by the flap lever is also displayed. Ten seconds after all flaps are up, the entire indication is no longer displayed.

If flap control is in secondary or alternate mode, or if any non-normal flap position is detected, an expanded flap indication is displayed. The position of each flap group is separately indicated. In alternate mode, the position commanded by the Flap lever is replaced by flap position index marks at flaps 5 and flaps 25. The index marks are used by the flight crew as a guide to position the flaps at the desired setting.

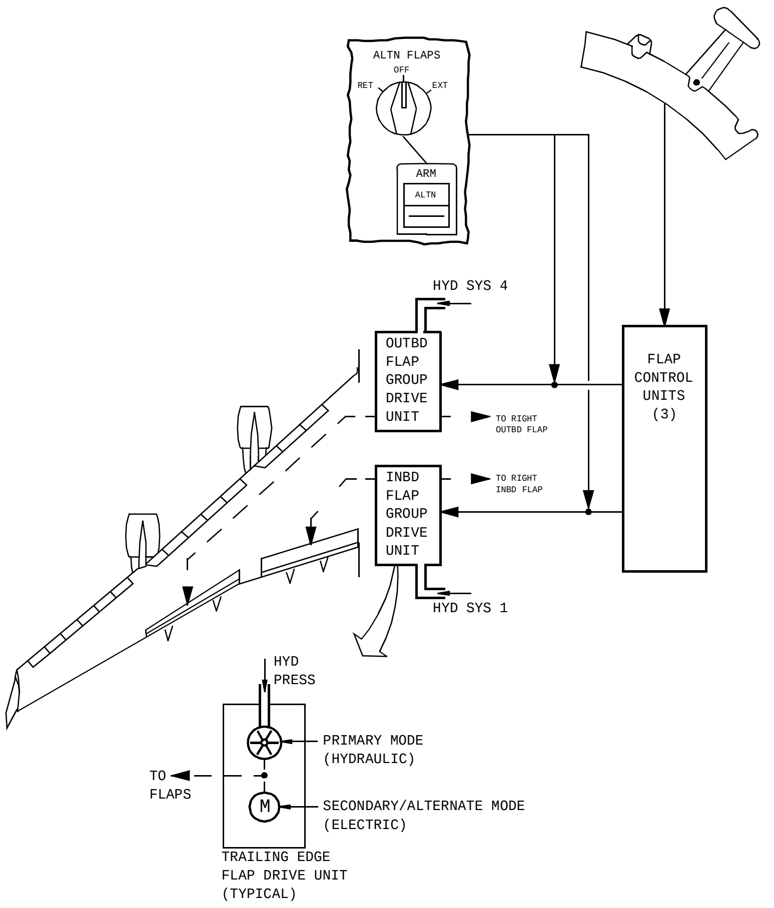
If the standby bus is the only powered AC bus, the left wing trailing edge flap position sensors are not powered. An expanded indication is displayed with an amber X on the left outboard and inboard trailing edge flap indications.

During engine reverse thrust operation, automatic retraction of inboard and midspan leading edge flaps changes the flap postion indicator to reflect flaps in transit.

Leading Edge Flaps Control Diagram



Trailing Edge Flaps Control Diagram



Flight Controls EICAS Messages

Note: Configuration (CONFIG) warning messages are described in Chapter 15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
AILERON LOCKOUT	Advisory		A fault has occurred in the aileron lockout system. One or both outboard ailerons may be unlocked at high airspeeds or locked out at low airspeeds.
>FLAP RELIEF	Advisory		Flap load relief system is active.
FLAPS CONTROL	Caution	Beeper	All three FCUs have failed in their control function, or the Alternate Flaps Arm switch is in ALTN.
FLAPS DRIVE	Caution	Beeper	A trailing edge flap asymmetry condition, or a leading or trailing edge drive failure which cannot be corrected by use of electric motors has occurred.
FLAPS PRIMARY	Caution	Beeper	A flap group is in secondary mode.
>FLT CONT VLVS	Advisory		One or more flight control shutoff valves are closed.

Message	Level	Aural	Condition
RUD RATIO DUAL	Advisory		A fault has occurred in both ratio changer systems.
RUD RATIO SNGL	Advisory		A fault has occurred in one ratio changer system.
SPEEDBRAKE AUTO	Advisory		A fault has occurred which could result in the loss of the automatic ground spoiler function, or in flight with Speedbrake lever in ARM position could result in inadvertent spoiler extension.

Message	Level	Aural	Condition
>SPEEDBRAKES EXT	Caution	Beeper	Speedbrake lever is aft of ARMED detent, and radio altitude is between 800 feet and 15 feet, or flaps are in a landing position, or two or more Thrust levers are forward of closed position.
>STAB GREENBAND	Advisory		Nose gear oleo pressure switch position disagrees with selected greenband.
>STAB TRIM 2, 3	Advisory		Automatic cutout has occurred, or a Stabilizer Trim Cutout switch is in CUT OUT, or a stabilizer actuator fails to operate when trim is commanded by the control wheel Stabilizer Trim switches or the Alternate Stabilizer trim switches.
STAB TRIM UNSCHD	Caution	Beeper	Stabiliizer moves with no flight crew or autopilot trim command and automatic cutout does not occur, or if Alternate Stabilizer Trim switches are used with autopilot engaged.
>YAW DAMPER LWR, UPR	Advisory		A yaw damper fault has occurred, or related Yaw Damper switch is OFF.

Flight Instruments, Displays — Chapter 10
Table of Contents — Section 0

Intentionally
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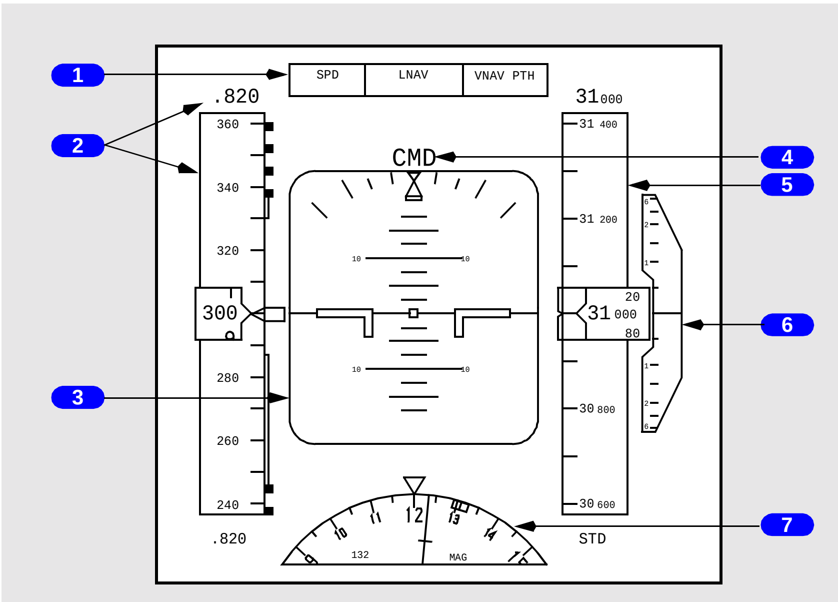
Primary Flight Display (PFD)



LEFT AND RIGHT FORWARD PANELS

1 Flight Mode Annunciations

Refer to Chapter 4, Automatic Flight.

2 Airspeed/Mach Displays

Displays ADC airspeed information and other airspeed related information.

3 Attitude, Steering, and Miscellaneous Displays

Displays IRU attitude information.

4 Autopilot, Flight Director System Status

Refer to Chapter 4, Automatic Flight.

5 Altitude Displays

Displays ADC altitude and other altitude–related information.

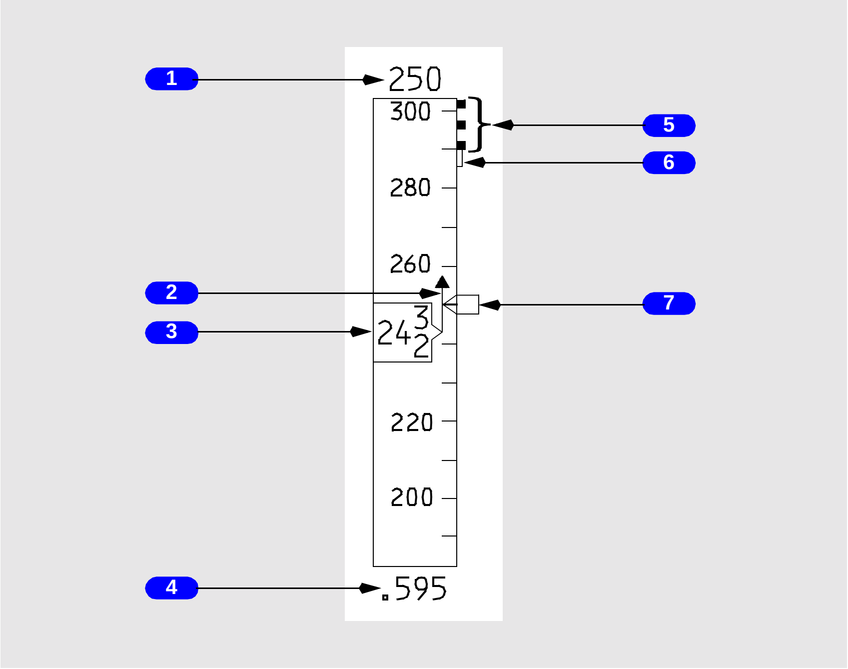
6 **Vertical Speed Display**

Displays IRS vertical speed and other vertical speed information.

7 **Heading and Track Displays**

Displays current IRS heading, track, and other heading information.

Airspeed Displays



1 **Command Speed**

Displays airspeed/Mach set in the MCP IAS/MACH window (refer to Chapter 4, Automatic Flight).

Displays FMC–computed airspeed/Mach when the IAS/MACH window is blank.

2 **Trend Indication**

Indicates predicted airspeed in ten seconds based on current acceleration or deceleration.

3 **Current Airspeed**

Displays ADC airspeed.

Displays 30 knots with no computed information.

Airspeed box changes to amber if current airspeed less than minimum maneuvering speed.

4 Current Mach

Displays ADC Mach.

5 Maximum Speed

Indicates maximum airspeed limited by lowest of the following:

- Vmo/Mmo
- landing gear placard speed, or
- flap placard speed

6 Maximum Maneuvering Speed

When displayed, indicates maneuver margin to buffet. May display operating at high altitude at relatively high gross weights.

7 Command Speed

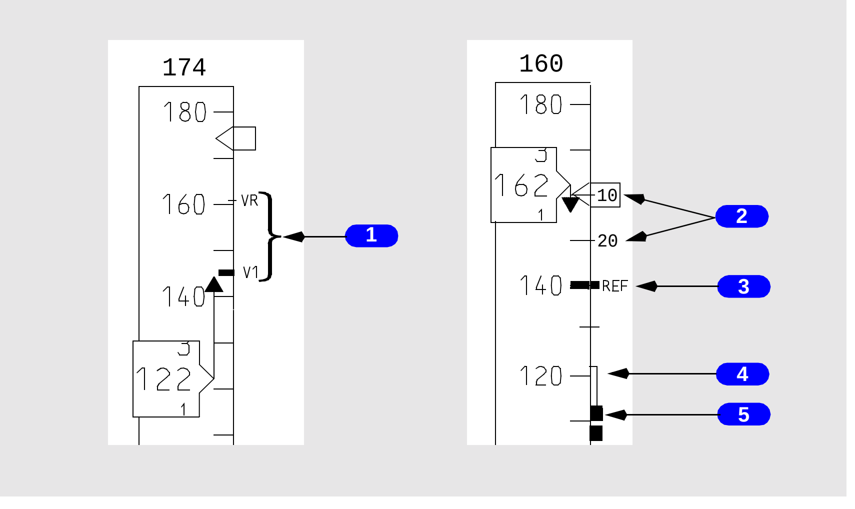
Points to airspeed/Mach set in MCP IAS/MACH window.

Indicates FMC–computed airspeed when MCP IAS/MACH window blank.

Pointer is five knots in height.

When selected speed off scale, pointer parked at the top or bottom of the tape, with half the pointer visible.

Reference Speeds



1 Takeoff Reference Speeds

Displays takeoff reference speeds V1 and VR (displays R when VR within 4 knots of V1) selected on the CDU (refer to Chapter 11, Flight Management, Navigation):

- displayed for takeoff
- NO V SPD displays when V speeds are not selected on the CDU
- V1 displays 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

2 Flap Maneuvering Speeds

Displays flap maneuvering speed for flap retraction or extension for current flap setting and next lesser flap setting.

Not displayed above approximately 20,000 feet altitude.

3 Landing Reference Speed

Displays VREF speed selected on the CDU (refer to Chapter 11, Flight Management, Navigation).

VREF speed displays at the bottom of the airspeed indication when the value is off the scale.

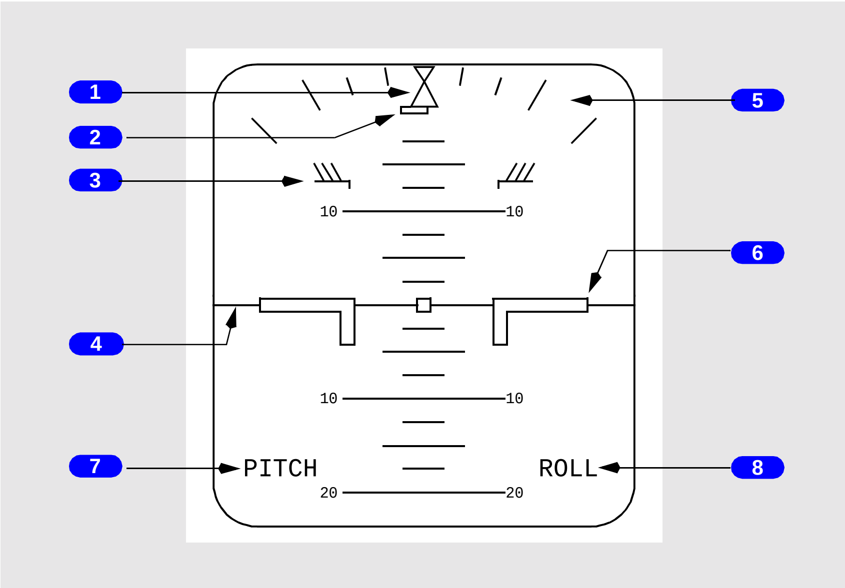
4 Minimum Maneuvering Speed

Indicates maneuver speed margin to stick shaker or low speed buffet.

5 Minimum Speed

Indicates airspeed where stick shaker or low speed buffet occurs.

Attitude Indications



1 Bank Pointer

Indicates IRS bank in reference to bank scale.

2 Slip/Skid Indication

Displaces beneath bank pointer to indicate slip or skid.

3 Pitch Limit Indication

Indicates pitch limit (stick shaker activation point for existing flight conditions).

Displayed when flaps are not up.

4 Horizon Line and Pitch Scale

Indicates IRS 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, and 45 degrees.

6 **Airplane Symbol**

Indicates airplane attitude with reference to the IRS horizon.

7 **PITCH Disagree Flag**

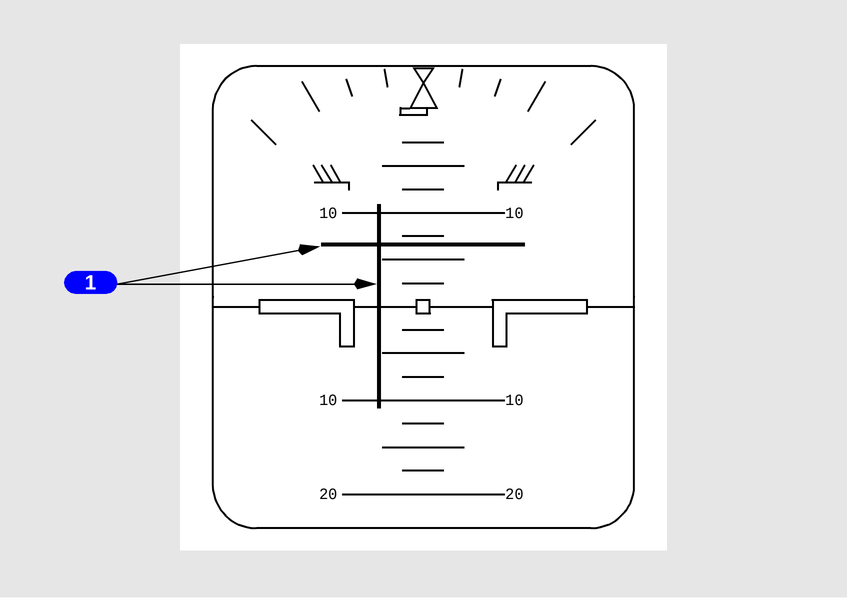
Displays if Captain’s and First Officer’s PFD pitch attitude disagree.

8 **ROLL Disagree Flag**

Displays if Captain’s and First Officer’s roll attitude disagree.

Steering Indications

Note: Refer to Chapter 15, Warning Systems, for TCAS Steering Indications and Time Critical Warnings.

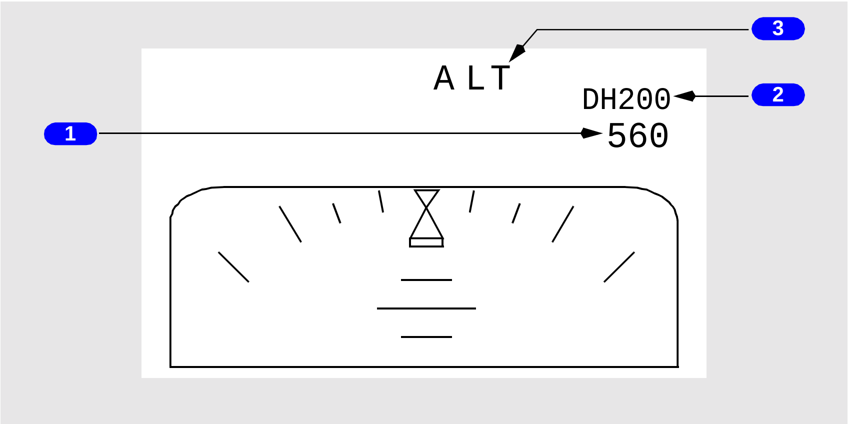


1 **Flight Director Command Bars**

Indicates flight director pitch and roll steering commands.

Refer to Chapter 4, Automatic Flight.

Radio Altitude Indications



1 Radio Altitude

Displays airplane radio altitude below 2,500 feet AGL.

2 Decision Height

Displays radio altitude set on EFIS control panel.

Display replaced with a large flashing amber DH when radio altitude is at or below the set DH.

DH not displayed when set below 0 feet.

Flashing amber DH resets:

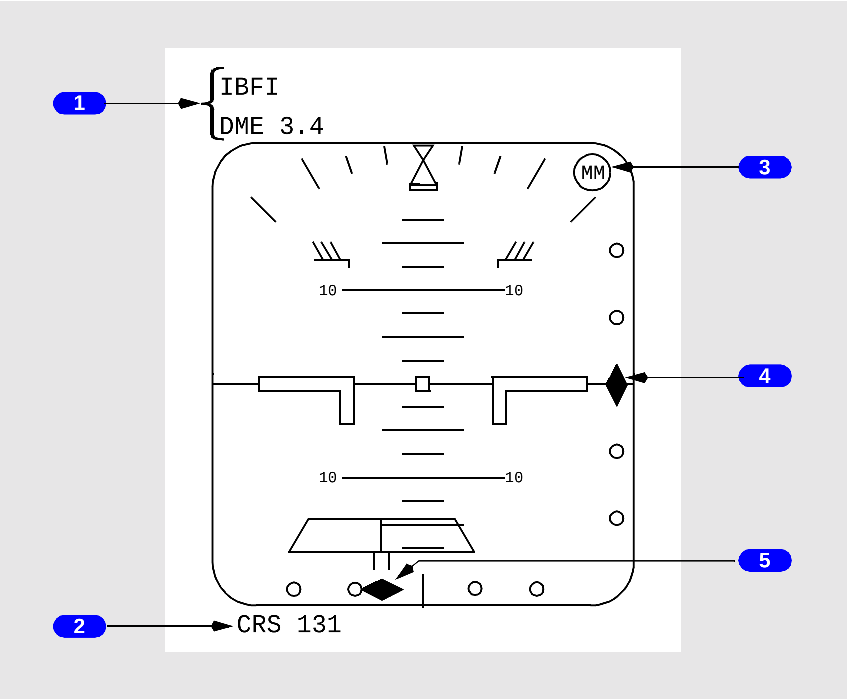
- upon landing
- on go-around at 75 feet above the set DH
- when DH reset switch is pushed

3 Height Alert

Displays between 1,000 feet and 500 feet AGL during descent.

Does not display when DH reset switch pushed.

Instrument Landing System Indications



1 Approach Reference

Displays the selected ILS identifier or frequency and ILS DME distance.

Refer to Chapter 11, Flight Management, Navigation.

2 Approach Course

Displays the selected ILS approach course.

3 Marker Beacon Annunciation

The marker beacon annunciation 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

Annunciation flashes in cadence with the beacon identifier.

4 Glideslope Pointer and Scale

Glideslope pointer indicates glideslope position relative to the airplane and:

- is in view when receiving the glideslope signal
- fills in solid when within 2 1/3 dots of the scale center

Scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, scale turns amber and the pointer flashes to indicate excessive glideslope deviation.

5 Localizer Pointer and Scale

Localizer pointer:

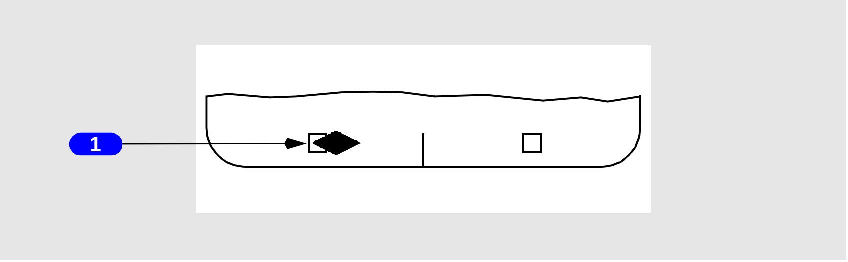
- indicates localizer position relative to the airplane
- is in view when the localizer signal is received
- fills in solid when within 2 1/3 dots from the center

Scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, scale turns amber and the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV engaged and LOC armed, localizer scale turns amber and the pointer flashes if localizer is not captured.

Expanded Localizer Indications

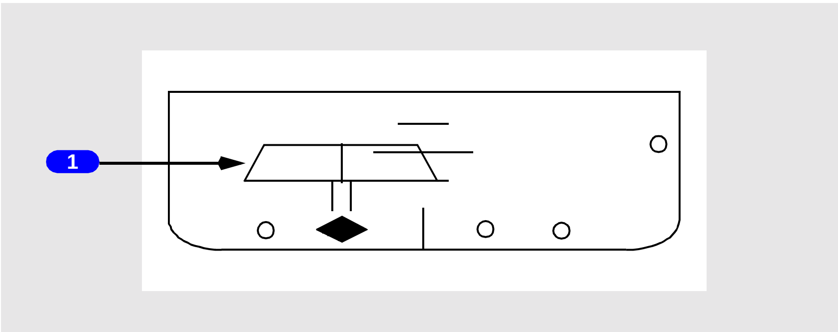


1 Expanded Localizer Deviation Scale

Displays when the airplane is close to the localizer centerline. Provides a more sensitive display.

A rectangle equals 1/2 dot deviation.

Rising Runway Indications

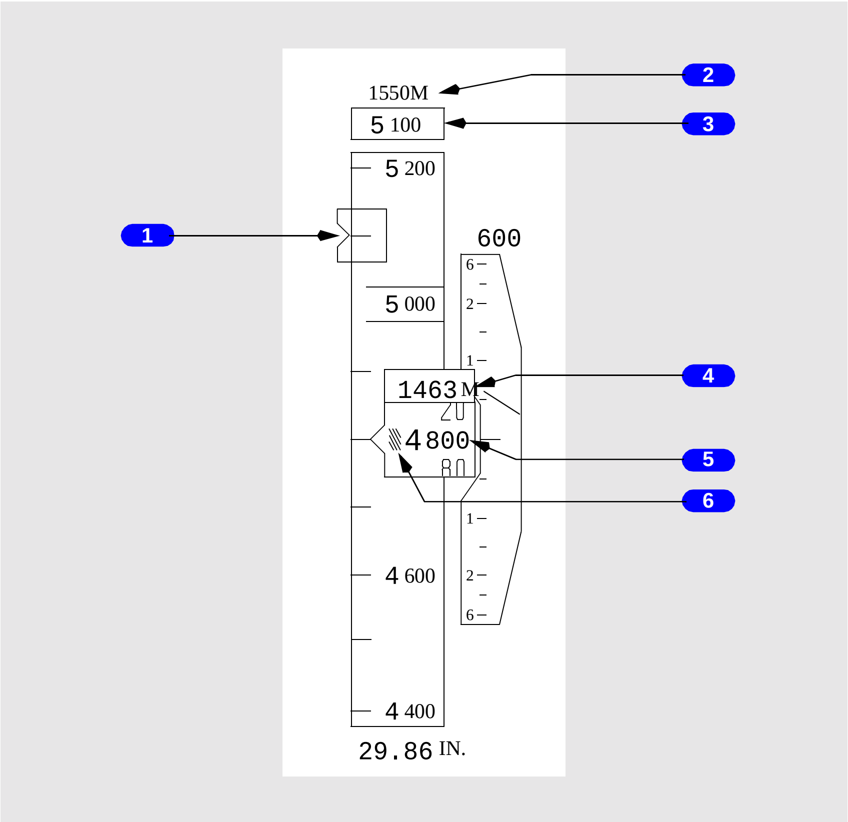


1 Rising Runway

Displays below 2,500 feet radio altitude when the localizer pointer is in view.

Moves toward the airplane symbol below 200 feet radio altitude.

Altitude Indications



1 Selected Altitude Pointer

Indicates altitude set in the MCP altitude window.

When selected altitude is off scale, pointer displays at the top or bottom of the tape with half the pointer visible.

2 Selected Altitude – Meters

Displays when MTRS selected on EFIS control panel MTRS switch.

Indicates selected altitude in meters (selected in feet in MCP altitude window).

Displays in 10 meter increments.

3 Selected Altitude

Displays altitude set in altitude window on MCP.

Selected altitude box is highlighted in white between 900 feet and 300 feet prior to reaching the selected altitude.

4 Current Altitude – Meters

Displays when MTRS selected on EFIS control panel MTRS switch.

Displays altitude in meters.

5 Current Altitude

Displays barometric altitude from selected ADC.

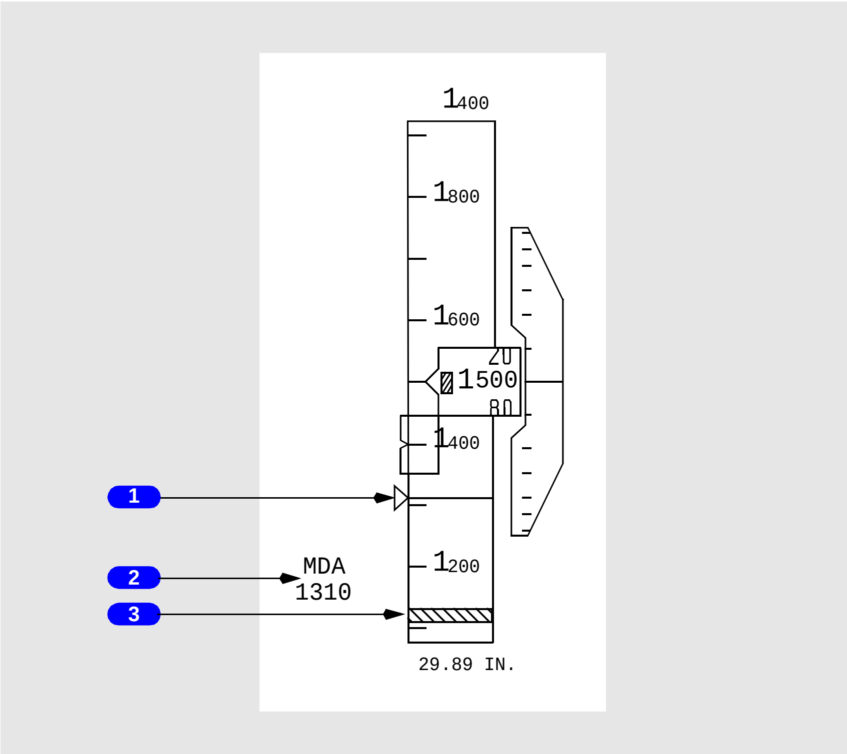
Altitude box is highlighted in white between 900 feet and 300 feet when approaching selected altitude.

Altitude box changes to amber when deviating from selected altitude between 300 feet and 900 feet.

6 Ten Thousand Digit Display

Cross hatch displays when altitude is below 10,000 feet.

Landing Altitude/Minimums Indications



1 MDA Pointer

Indicates barometric altitude set on EFIS control panel.

2 MDA Display

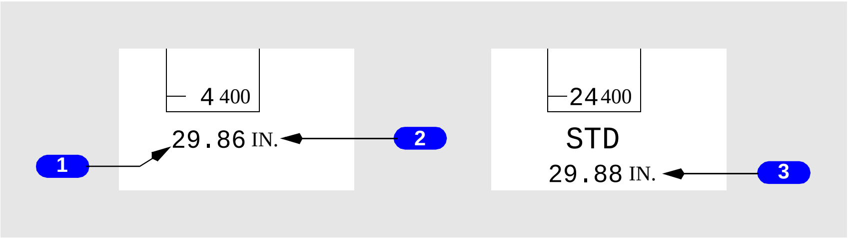
Displays barometric altitude set on EFIS control panel.

Not displayed when MDA set below -100 feet.

3 Touchdown Zone Indicator

Upper edge of crosshatched area indicates FMC landing altitude for destination runway or airport.

Barometric Indications



1 Barometric Setting

Displays barometric setting set on EFIS control panel barometric control.

STD displays when STD selected on EFIS control panel barometric standard switch.

Display is boxed and changes to amber if a barometric setting is set and altitude climbs 300 feet above transition altitude, or if STD is selected and altitude descends 300 feet below transition flight level.

2 Barometric Reference

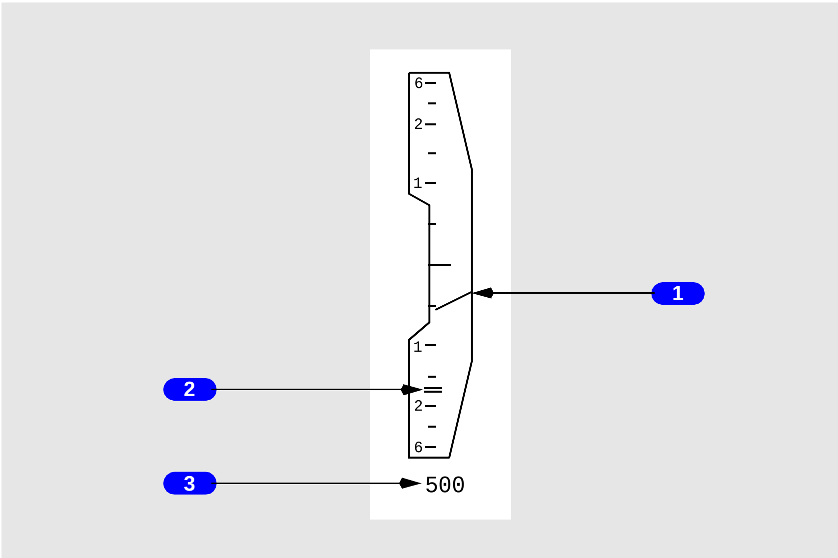
Displays barometric units selected on EFIS control panel barometric reference selector:

- IN - inches of mercury
- HPA - Hectopascals

3 Preset Barometric Setting

When STD is displayed, a preset barometric setting can be set using the barometric selector on EFIS control panel.

Vertical Speed Indications



1 Vertical Speed Pointer

Indicates vertical speed.

2 Selected Vertical Speed Pointer

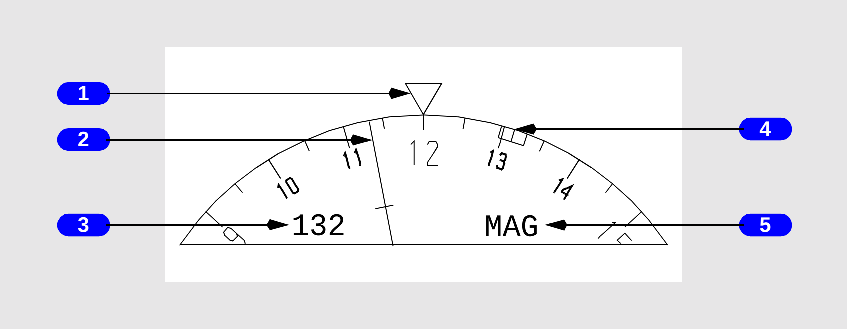
Indicates vertical speed set in MCP vertical speed window with V/S pitch mode active.

3 Vertical Speed

Displays vertical speed when greater than 400 feet per minute.

Display is above the vertical speed display when climbing and below when descending.

Heading/Track Displays



1 Heading Pointer

Indicates IRS heading.

2 Track Indicator

Indicates airplane track from selected FMC or selected IRU if FMC data invalid.

3 Selected Heading

Displays heading set in heading window.

4 Selected Heading Indicator

Indicates heading set in heading window.

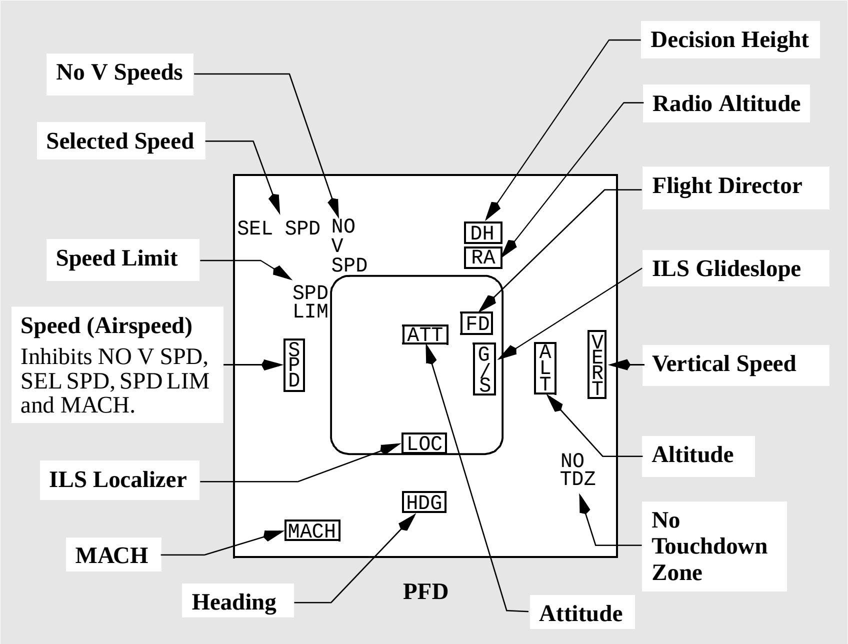
5 Heading Reference

Displays selected heading reference:

- MAG - magnetic north
- TRU - true north, boxed for emphasis

PFD Failure Flags

Note: PFD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.



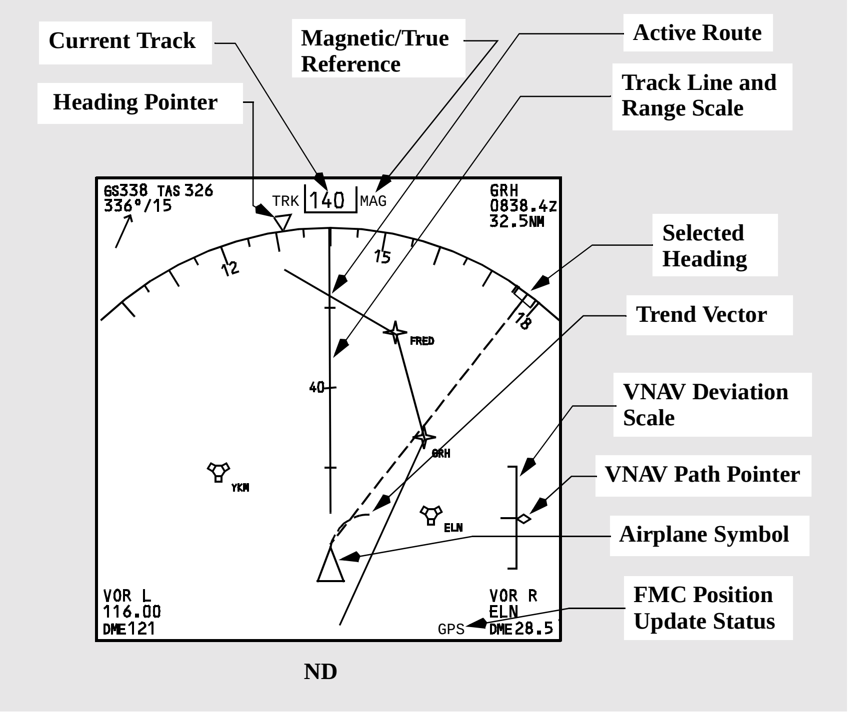
PFD

Navigation Display (ND)

Note: Refer to Navigation Display section of this chapter for a detailed explanation of ND symbology shown on the following pages.

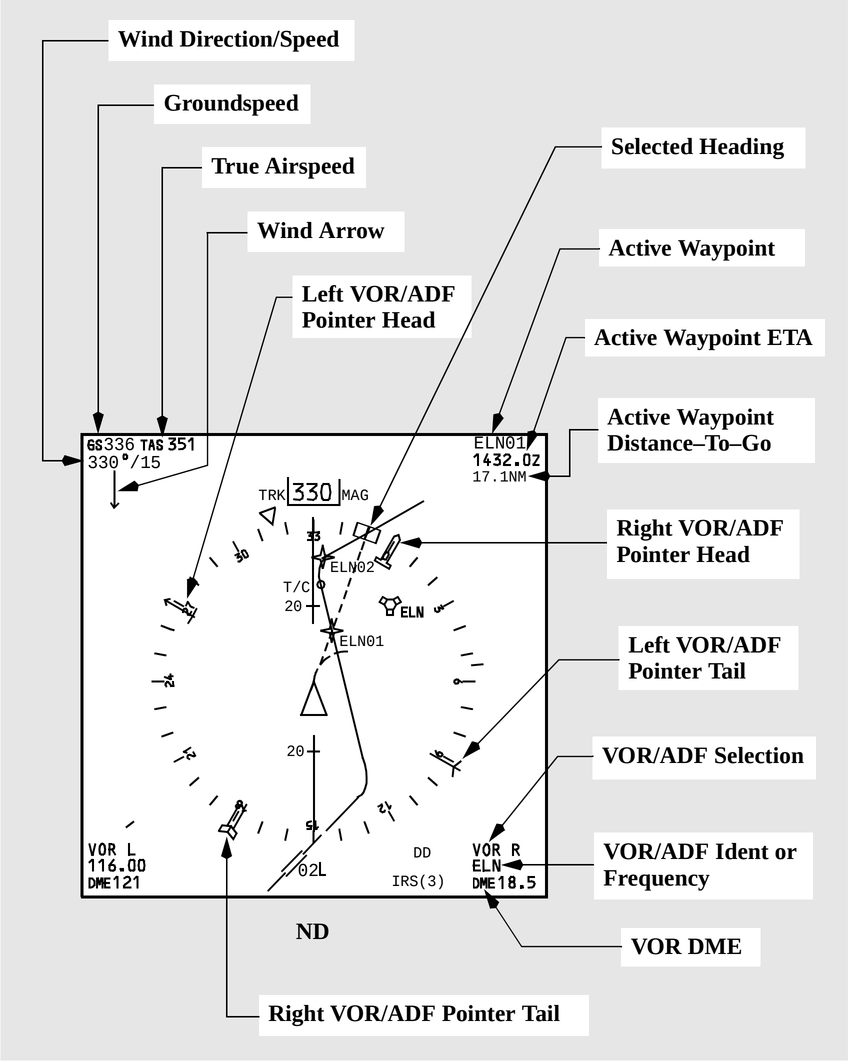
Map Mode

Expanded Map Mode



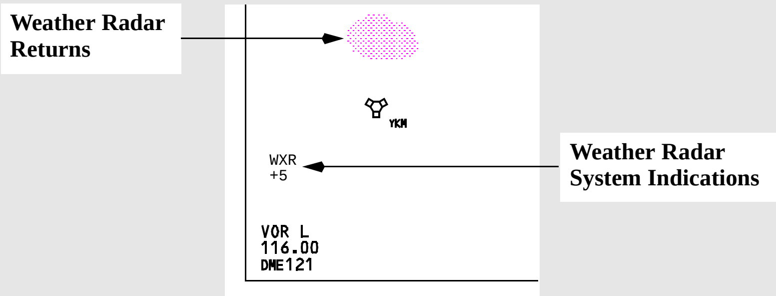
ND

Centered Map Mode

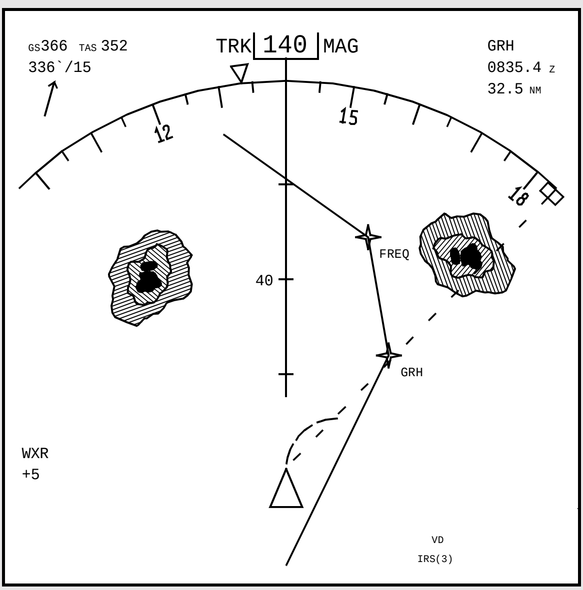


ND

Weather Radar System Display Indications

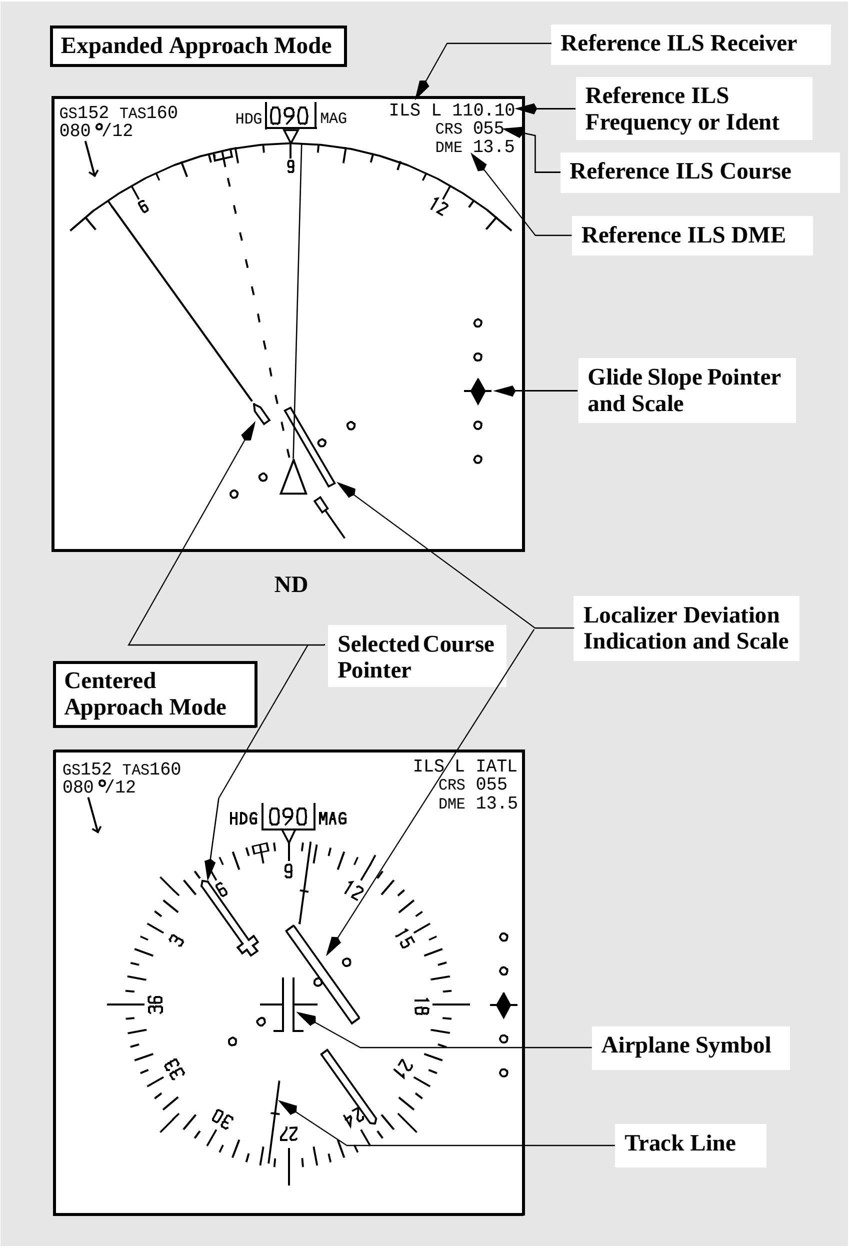


ND

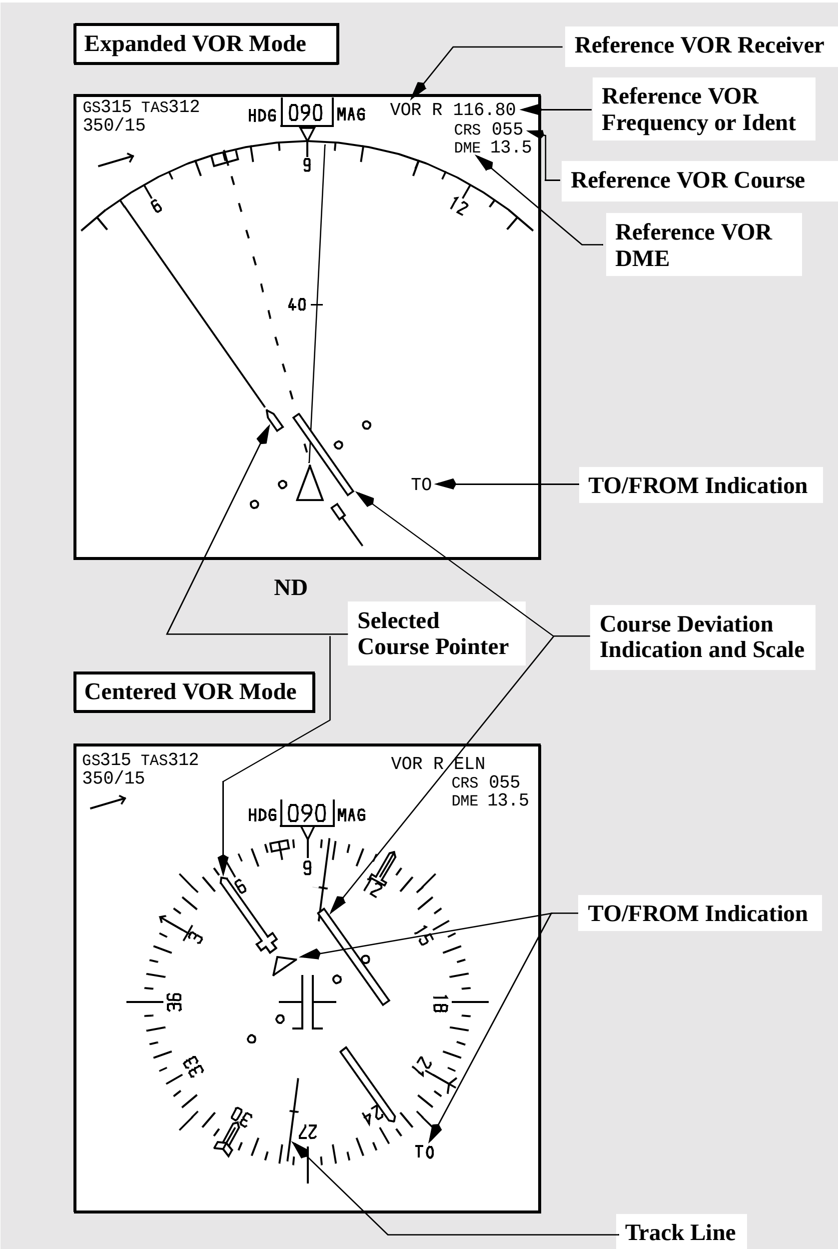


ND

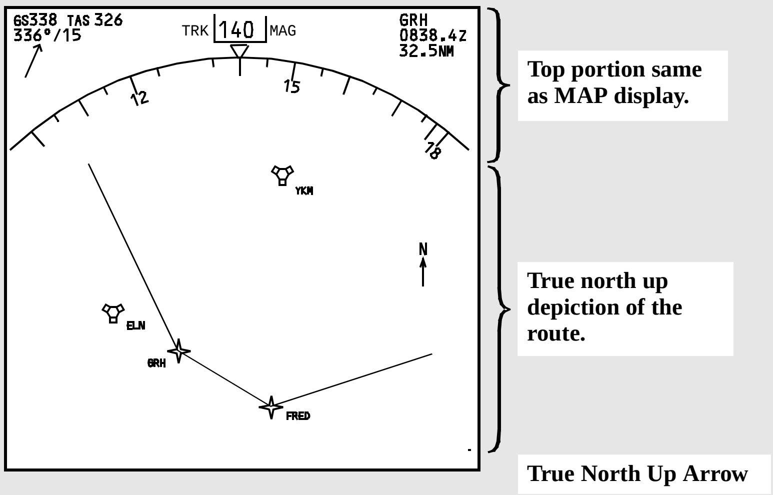
Approach Mode



VOR Mode


Expanded VOR Mode
Reference VOR Receiver
GS315 TAS312
350/15
HDG 090 MAG
VOR R 116.80
CRS 055
DME 13.5
Reference VOR Frequency or Ident
Reference VOR Course
Reference VOR DME
40
TO
TO/FROM Indication
ND
Selected Course Pointer
Course Deviation Indication and Scale
Centered VOR Mode
GS315 TAS312
350/15
VOR R ELN
CRS 055
DME 13.5
HDG 090 MAG
TO
TO/FROM Indication
Track Line

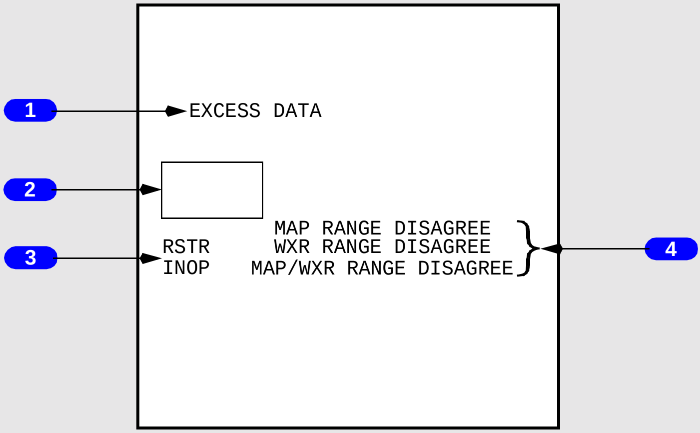
Plan Mode



ND

ND Failure Indications and Flags

Failure Messages



ND

1 **Excess Data**

Amount of map information sent to the primary display system is too great to display. Deselecting EFIS WXR, STA, WPT, ARPT, DATA, or POS switches may clear the condition.

2 **Weather Radar Failure**

Displays weather radar failure messages (refer to section 40, this chapter).

3 **Raster Inoperative (RSTR INOP)**

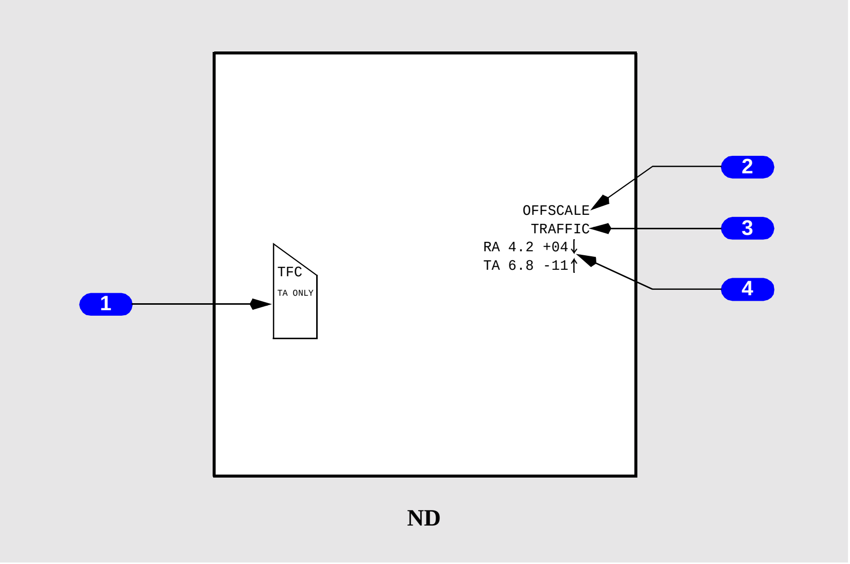
Displays overheat condition.

4 **MAP/WXR Range Disagree**

Selected range and range of display information disagree.

Map information is removed.

TCAS Messages



ND

1 **TCAS Mode Display**

TCAS modes displayed -

TFC (blue) - traffic selected for display on ND from EFIS control panel in MAP, MAP CTR, VOR, and APP ND modes.

TCAS TEST (blue) - TCAS in test mode and displayed in all ND modes.

TCAS FAIL (amber) - TCAS failed and displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

TA ONLY (blue) - TCASTA ONLY mode selected; displayed in all ND modes.

TCAS OFF (amber) - TCAS selected off and displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

2 Offscale

TA (amber) or RA (red) traffic beyond ND display range.

Displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

3 Traffic

Displayed during aTA (amber) or RA (red) condition.

Displayed in all ND modes.

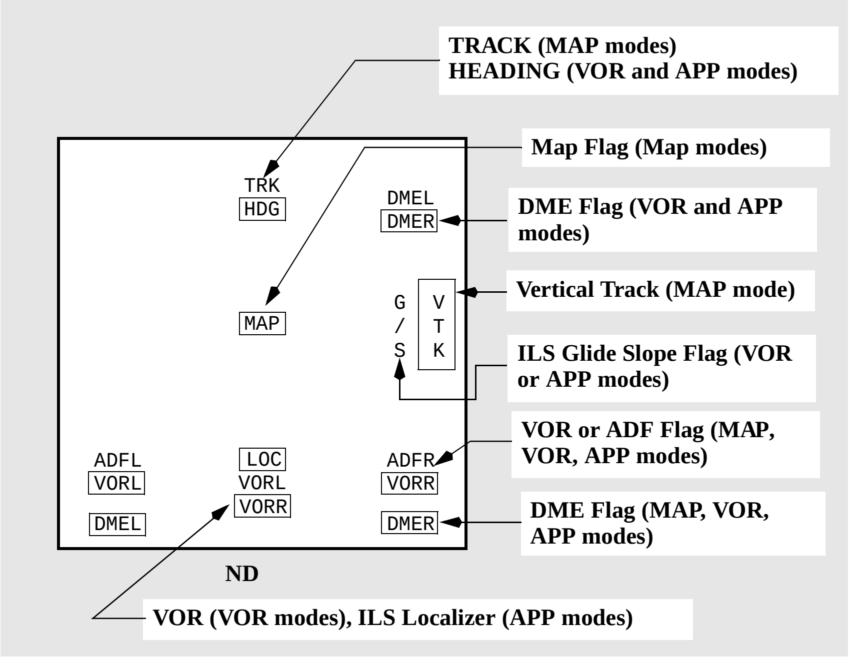
4 No Bearing Traffic Messages

Displayed when no bearing information is available for traffic (see ND symbology chart for display).

Displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

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 ND mode selected. Expanded compass rose locations are shown in the following displays.


TRACK (MAP modes)
HEADING (VOR and APP modes)
Map Flag (Map modes)
DME Flag (VOR and APP modes)
Vertical Track (MAP mode)
ILS Glide Slope Flag (VOR or APP modes)
VOR or ADF Flag (MAP, VOR, APP modes)
DME Flag (MAP, VOR, APP modes)
VOR (VOR modes), ILS Localizer (APP modes)
TRK
HDG
DMEL
DMER
MAP
G / S
V T K
ADFL
VORL
DMEL
LOC
VORL
VORR
ADFR
VORR
DMER
ND

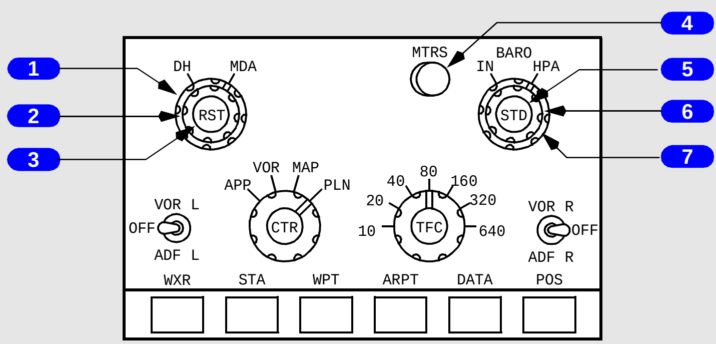
EFIS Control Panels

The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

If an EFIS control panel fails, displays are controlled through the related CDU (CDU-152).

Displays can also be controlled through the related CDU (CDU-161).

Control Panel PFD Controls



GLARESHIELD PANEL

1 Decision Height/Minimium Descent Altitude Selector (outer)

DH – selects radio altitude as PFD minimums reference.

MDA – selects barometric altitude as PFD minimums reference.

2 Decision Height (DH)/Minimum Descent Altitude (MDA) Control (middle)

Rotate –

- when DH selected, sets a radio altitude reference in DH display
- when MDA selected, sets a barometric altitude reference in MDA display. MDA pointer indicates the same altitude on the altitude display

3 Decision Height Reset (RST) Switch (inner)

Push – resets PFD flashing amber DH.

Clears HEIGHT ALERT display on related PFD.

4 Meters (MTRS) Switch

Push – displays PFD altitude meters indications.

5 Barometric Standard (BARO STD) Switch (inner)

Push –

- selects standard barometric setting (29.92 inches Hg/1013HPA) for PFD barometric reference
- when STD displayed, selects preselected barometric setting
- if no preselected barometric setting displayed, displays the last value before STD was selected

6 Barometric (BARO) Selector (middle)

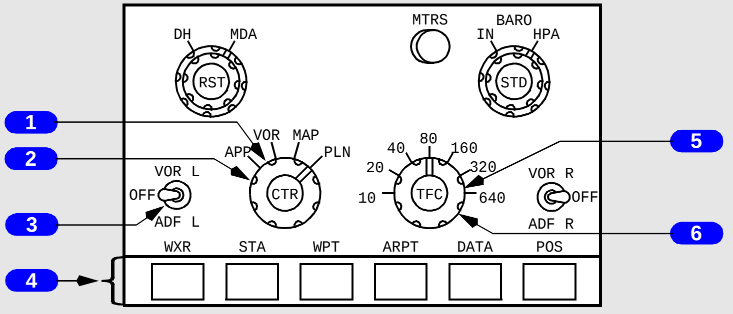
Rotate – adjusts PFD barometric reference.

7 Barometric (BARO) Reference Selector (outer)

IN – selects inches of mercury as PFD barometric reference.

HPA – selects Hectopascals as PFD barometric reference.

Control Panel ND Controls



GLARESHIELD PANEL

1 ND Mode Selector (outer)

Selects desired ND 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 APP CTR 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 VOR CTR mode

MAP –

- displays track up, full compass rose, FMC–generated route and map information, airplane position, heading, and track
- displays active waypoint data
- displays vertical path deviation at T/D

PLN –

- displays a non-moving, true north–up, route depiction
- airplane symbol represents actual airplane position
- allows route step–through using CDU legs page
- weather radar and TCAS are not displayed in PLN mode

2 ND Center (CTR) Switch (inner)

Push –

- displays full compass rose (centered) for APP, VOR, and MAP modes
- subsequent pushes alternate between expanded and centered displays

3 VOR/ADF Switches

Display VOR or ADF information on the respective ND.

VOR – displays VOR pointer, VOR frequency or identification and associated DME information in all modes except PLAN.

OFF – removes VOR and ADF displays.

ADF – displays ADF pointer and frequency or identification in all modes except PLAN.

4 WXR, STA, WPT, ARPT, DATA, POS, Switches

The switches:

- select detailed ND information displays
- displays can be selected simultaneously

- EXCESS DATA message displays on ND if amount of information selected is more than can be displayed
- second push removes information

WXR (weather radar) –

- powers radar transceiver selected on weather radar control panel
- displays in MAP, MAP CTR, VOR, and APP modes
- displays weather radar information (refer to Chapter 11, Flight Management, Navigation)
- with WXR FAIL displayed on ND, cancels WXR FAIL message

STA (station) – in MAP and MAP CTR modes:

- displays high and low altitude navigation aids when ND Range selector is in 10, 20, or 40 NM range
- displays high altitude navigation aids when ND Range selector is in 80, 160, 320, or 640 NM range.

WPT (waypoint) – in MAP and MAP CTR modes, displays waypoints when ND Range selector is in the 10, 20, or 40 NM range.

APRT (airport) – in MAP and MAP CTR modes, displays airports on all ranges.

DATA – in PLAN, MAP, and MAP CTR modes, displays FMC estimated time of arrival, altitude at each waypoint, and altitude constraints at each waypoint.

POS (position) – in MAP and MAP CTR modes:

- displays IRU and GPS positions
- displays VOR raw data radials extended from the nose of the airplane to the VOR stations displayed on the CDU NAV RAD page. When co-located DME data received, tick mark displayed at DME distance; radial extends to edge of display if no valid DME data received

5 ND Range Selector (outer)

Selects desired ND nautical mile range scale.

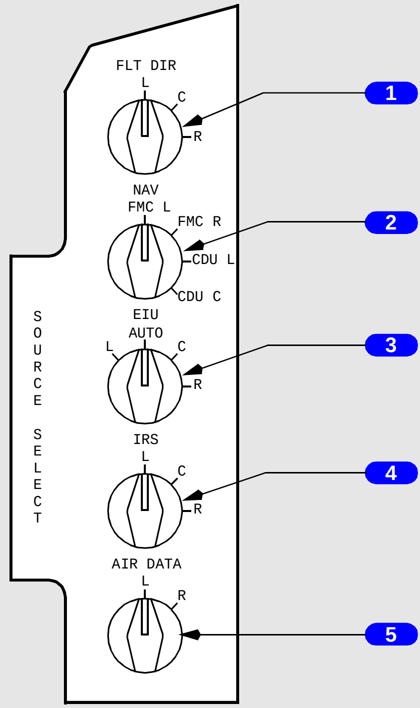
6 ND Traffic (TFC) Switch (inner)

Push – in VOR, APP, MAP, and MAP CTR modes:

- enables TCAS traffic display (Refer to Chapter 15, Warning Systems)
- with TCAS FAIL displayed on ND, cancels TCAS FAIL message.

Instrument Source Select Panels

The left panel is shown.



PILOT'S PANELS

1 Flight Director (FLT DIR) Source Selector

L - left FCC selected

C - center FCC selected

R - right FCC selected

2 Navigation (NAV) Source Selector

FMC L - left FMC provides information to PFD and ND.

FMC R - right FMC provides information to PFD and ND.

CDU L (Captain's panel) - left CDU provides information to ND during alternate navigation.

CDU C - center CDU provides information to ND during alternate navigation.

CDU R (F/O's panel) - right CDU provides information to ND during alternate navigation.

3 EFIS/EICAS Interface Unit (EIU) Source Selector

L - left EIU provides information to PFD and ND.

AUTO - selects operable EIU. Captain's selects left, then center, then right; F/O's selects right, then center, then left.

C - center EIU provides information to PFD and ND.

R - right EIU provides information to PFD and ND.

Determines which localizer and glideslope receivers provide information to the respective PFD and ND.

4 IRS Source Selector

L - left IRU provides attitude and vertical speed information to PFD.

C - center IRU provides attitude and vertical speed information to PFD.

R - right IRU provides attitude and vertical speed information to PFD.

Source for heading, wind direction and speed, slip/skid, track angle, drift angle, and ground speed displayed on PFD and ND depends on the status of the FMCs, IRUs, and position of the Navigation and IRS source selectors.

IRU selected by Captain provides autobrakes reference. IRU selected by F/O provides RMI reference.

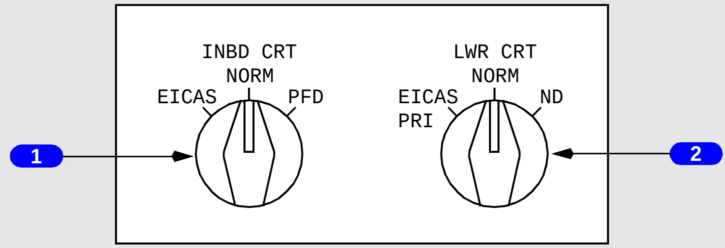
5 AIR DATA Source Selector

L - left ADC provides information to the PFD and ND.

R - right ADC provides information to the PFD and ND.

Heading Reference and CRT Displays

CRT Display Controls



FORWARD PANELS

1 Inboard (INBD) CRT Selector

EICAS - displays secondary or primary EICAS display on inboard CRT.

NORM - displays ND on inboard CRT. Displays PFD if outboard CRT fails.

PFD – displays PFD on inboard CRT.

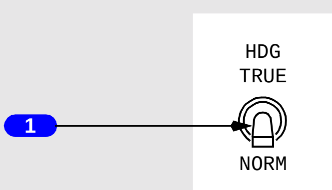
2 Lower (LWR) CRT Selector

EICAS PRI - displays primary EICAS on lower CRT.

NORM - displays on lower CRT as selected on EICAS display select panel. Displays primary EICAS if upper CRT fails.

ND - displays ND on lower CRT.

Heading Reference Switch



CENTER PANEL

1 Heading (HDG) Reference Switch

Selects heading reference for PFDs, NDs, AFDS, FMCs and RMI.

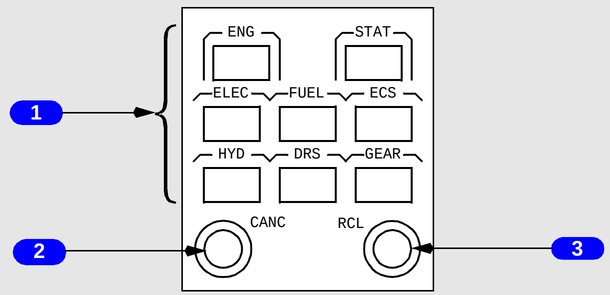
TRUE – references true north.

NORM -

- references magnetic north
- references true north when north of 82°N latitude (or north of 70°N between 80°W and 130°W) or south of 82°S latitude (or south of 60°S between 120°E and 160°E) for PFDs, NDs, and FMCs. Provides no reference for RMI and AFDS roll modes other than LNAV in these areas; HDG SEL, HDG HOLD, and localizer modes are inoperative.

When AFDS roll mode is HDG SEL, switching the Heading Reference switch from NORM to TRUE or TRUE to NORM activates HDG HOLD mode.

Display Select Panel



GLARESHIELD PANEL

1 Synoptic/Display Switches

Pushing a switch displays the related synoptic/display on the lower CRT. Pushing the same switch a second time blanks the display. Pushing STAT pages through more than one page of status messages. Synoptics present a simplified view of system status as an aid for crew situational awareness.

If the display select panel fails, displays are controlled through the CDU (CDU-152).

Displays can also be controlled through the CDU (CDU-161).

ENG - secondary engine display (Ch 7).

STAT - status display, (Ch. 15).

ELEC – electrical system synoptic (Ch. 6).

FUEL – fuel quantity indications and fuel system synoptic (Ch. 12).

ECS – air systems synoptic (Ch. 2).

HYD – hydraulic system synoptic (Ch. 13).

DRS – doors synoptic (Ch. 1).

GEAR – landing gear and brake systems syoptic (Ch. 14).

2 Cancel (CANC) Switch

Refer to Warning Systems, Chapter 15.

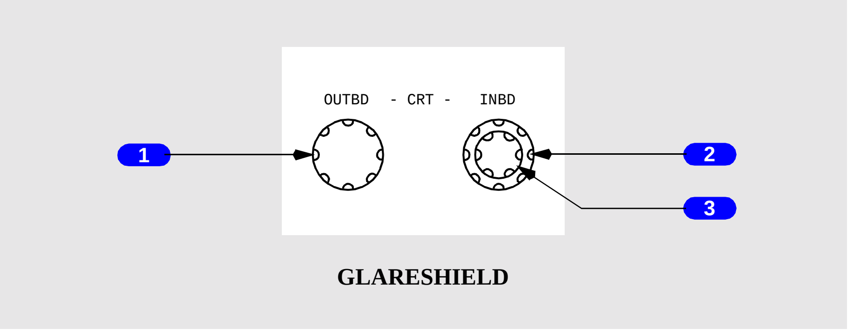
3 Recall (RCL) Switch

Refer to Warning Systems, Chapter 15.

Display Brightness Controls

The left panel is shown.

Outboard/Inboard CRT Brightness Controls



1 Outboard (OUTBD) CRT Brightness Control

Rotate – adjusts brightness of outboard CRT.

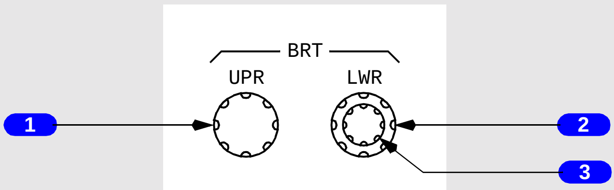
2 Inboard (INBD) CRT Brightness Control (outer)

Rotate – adjusts brightness of inboard CRT.

3 Inboard (INBD) CRT Brightness Control (inner)

Rotate – adjusts weather radar display brightness on inboard CRT.

Upper/Lower CRT Brightness Controls



CENTER PANEL

1 Upper (UPR) CRT Brightness Control

Rotate – adjusts brightness of upper CRT.

2 Lower (LWR) CRT Brightness Control (outer)

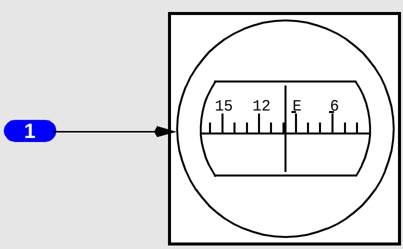
Rotate – adjusts brightness of lower CRT.

3 Lower (LWR) CRT Brightness Control (inner)

Rotate – adjusts weather radar brightness on lower CRT .

Standby Flight Instruments

Standby Magnetic Compass



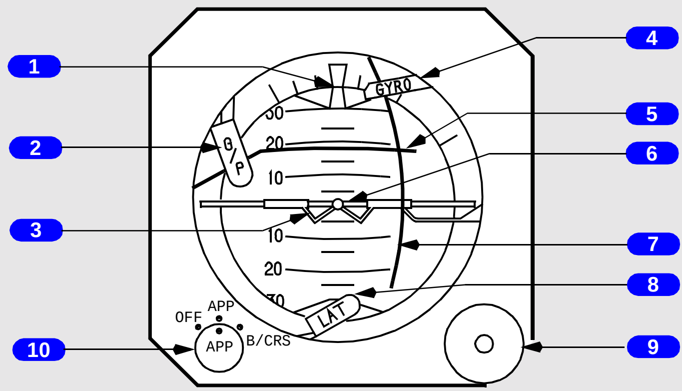
CENTER POST ABOVE GLARESHIELD

1 Standby Magnetic Compass

Displays magnetic heading.

Standby Attitude Indicator

Standby attitude indicator displays airplane attitude.



CENTER PANEL

1 Bank Indicator and Scale

Indicates airplane bank.

Scale marks at 0, 10, 20, 30, 45 degrees.

2 Glide Path (G/P) Flag

Displays when glide slope information unreliable.

3 Airplane Symbol

Indicates airplane position.

4 Attitude (GYRO) Flag

Displays when attitude information unreliable.

5 Glide Slope Indicator

Indicates glide slope position relative to the airplane.

6 Horizon Line and Pitch Scale

Indicates position of horizon relative to the airplane.

Scale marks in five degree increments.

7 Localizer Indicator

Indicates localizer position relative to the airplane.

8 Localizer (LAT) Flag

Displays when localizer information unreliable.

9 Caging Control

Pull - levels horizon with airplane symbol.

10 Approach Selector

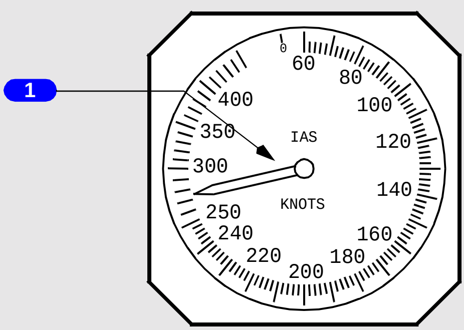
OFF - glide slope and localizer indicators and flags retracted from view.

APP (Approach) - glide slope and localizer information displayed. Left ILS receiver used.

B/CRS (Back Course) - reverses sensing for localizer information.

Standby Airspeed Indicator

Standby airspeed indicator displays airspeed from auxiliary pitot 1 and alternate static source.



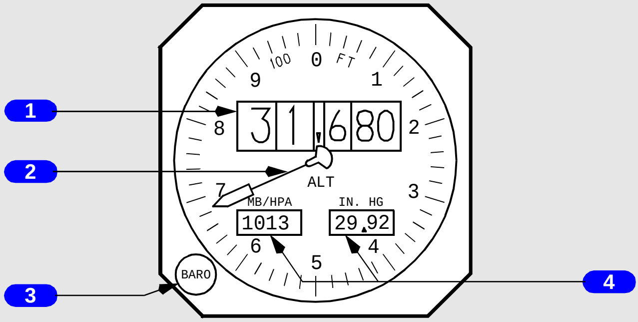
CENTER PANEL

1 Airspeed Pointer

Indicates uncorrected airspeed.

Standby Altimeter

Standby altimeter displays barometric altitude from alternate static source.



CENTER PANEL

1 Altitude Display

Displays uncorrected barometric altitude.

2 Altitude Pointer

Indicates uncorrected barometric altitude.

One full rotation of pointer is 1,000 feet.

3 Barometric Setting Control

Rotate – sets altimeter barometric setting.

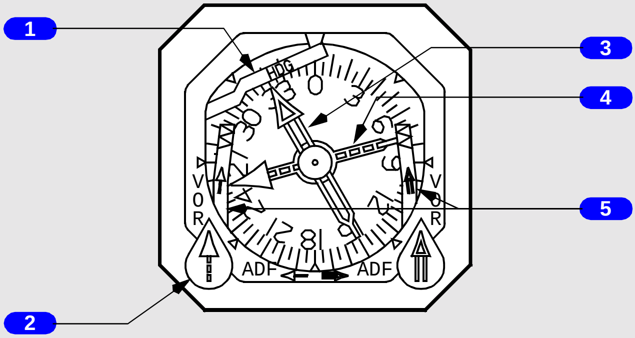
4 Barometric Setting Display

Displays selected barometric reference in Hectopascals (MB/HPA) and inches (IN. HG).

Radio Magnetic Indicator

Radio magnetic indicator displays heading and VOR and ADF bearing to the selected station.

Heading information is provided by the right or center IRU as selected by the F/O IRS source selector.



CAPTAIN'S PANEL

1 Heading (HDG) Flag

Displays when heading invalid.

2 VOR/ADF Selectors

VOR - VOR information provided to related pointer.

ADF - ADF information provided to related pointer.

3 Wide Pointer

Indicates right VOR or ADF bearing to selected station.

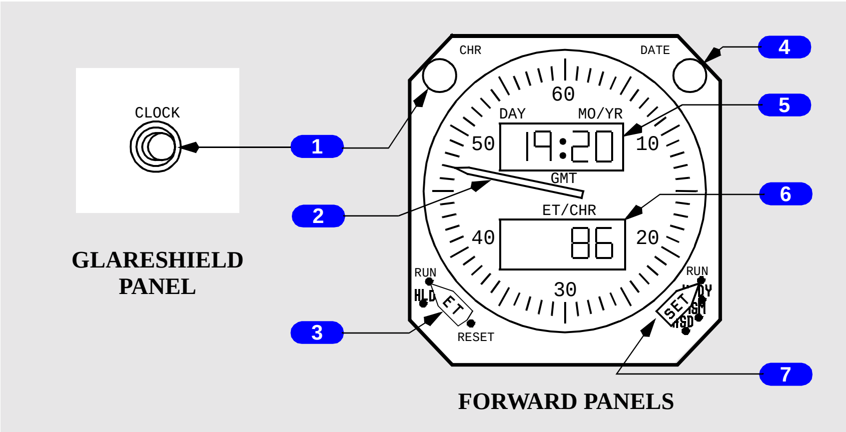
4 Narrow Pointer

Indicates left VOR or ADF bearing to selected station.

5 Pointer Flags

Display when selected information invalid.

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 elapsed time function.

RESET – returns elapsed time display to zero (spring loaded to HLD).

HLD (Hold) – stops elapsed time display.

RUN – starts elapsed time display.

4 DATE Switch

Push -

- displays date (alternates day and month, then year) on GMT display
- subsequent push returns display to time (hours, minutes) on GMT display.

5 GMT Display

Displays time (hours, minutes).

Displays date when date switch pushed.

6 Elapsed Time (ET)/Chronograph (CHR) Display

Displays elapsed time (hours, minutes) or chronograph minutes.

Chronograph display replaces elapsed time display.

Elapsed time continues to run in the background and will be displayed after chronograph is reset.

7 Clock Set Selector

Sets time and date.

Hours Slew, Day (HS D) –

- advances hours when time selected on time/date selector
- advances days when date selected on time/date selector

Minutes Slew, Month (MS M) –

- advances minutes when time selected on time/date selector
- advances months when date selected on time/date selector

Hold, Year (HLD Y) –

- stops time indicator and sets seconds to zero when time selected on time/date selector
- advances years when date selected on time/date selector

RUN – starts time indicator.

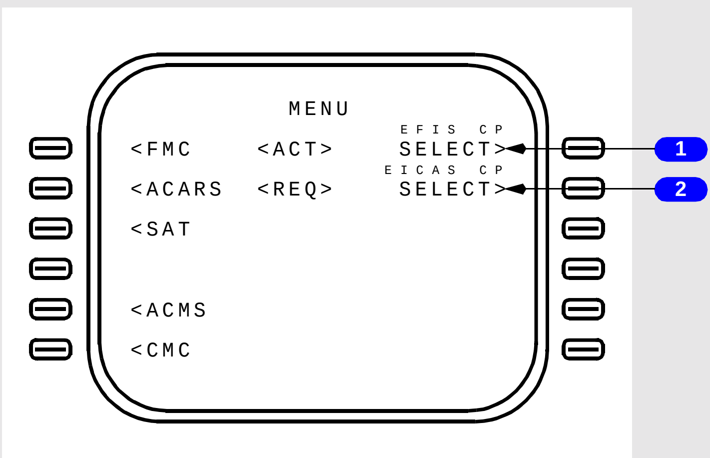
EFIS Control Panel and Display Select Panel (DSP) – CDU Alternate Control

The CDU provides an alternate way to control the functions of the EFIS control panel and the display select panel except for TCAS if the panel fails (CDU-152).

The CDU provides an alternate way to control the functions of the EFIS control panel and the display select panel (CDU-161).

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 except where described.

CDU EFIS/DSP Control Selection (CDU-152)



CDU-152

1 Alternate EFIS Control

Push -

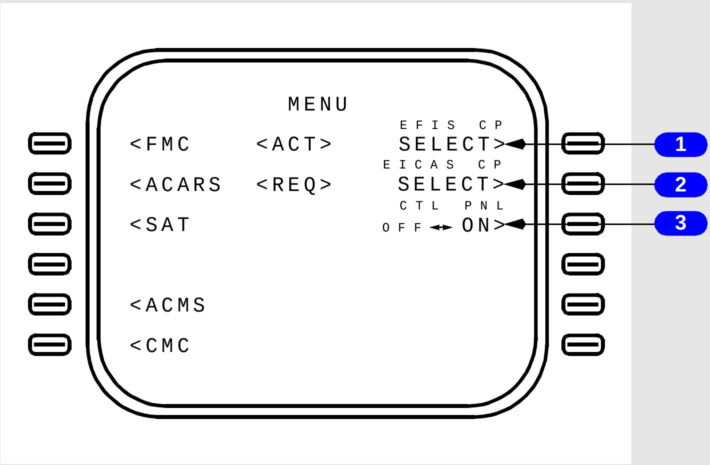
- displays alternate EFIS control page
- available if EFIS control panel fails

2 **Alternate EICAS Control**

Push -

- displays alternate EICAS control page
- available if EICAS control panel fails

CDU EFIS/DSP Control Selection (CDU-161)



CDU-161

1 **Alternate EFIS Control**

Push - (with SELECT displayed) displays alternate EFIS CONTROL page.

SELECT is displayed when the control panel (CTL PNL) prompt is selected ON or there is a failure of the associated control panel. The line title EFIS CP remains when the SELECT prompt is removed.

2 **Alternate EICAS Control**

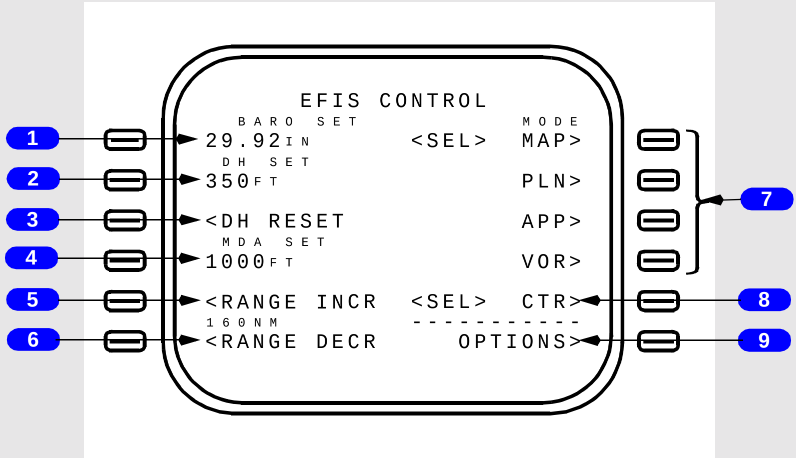
Push - (with SELECT displayed) displays alternate EICAS CONTROL page.

SELECT is displayed when the control panel (CTL PNL) prompt is selected ON or there is a failure of the control panel. The line title EICAS CP remains when the SELECT prompt is removed.

3 **Control Panel Switch**

Push - alternately selects the EFIS CP SELECT prompt ON and OFF. ON is displayed if the associated control panel fails. The selected mode (ON or OFF) is displayed in large font. The SELECT prompts are blank when OFF is displayed in large font.

EFIS Control Page (CDU-152)



CDU-152

1 **Barometric (BARO SET) Reference**

Valid entry is reference barometric setting.

Entry of S or STD displays 29.92 IN or 1013 HPA on BARO SET line and displays STD on the PFD.

2 **Decision Height (DH SET)**

Valid entry is decision height.

3 **Decision Height Reset (DH RESET)**

Push - resets PFD flashing amber DH.

4 **Minimum Descent Altitude**

Valid entry is minimum descent altitude.

5 **ND Range Increase (RANGE INCR)**

Push - increases ND nautical mile range scale.

6 **ND Range Decrease (RANGE DECR)**

Push - decreases ND nautical mile range scale.

7 **ND Mode**

Push - selects desired ND display.

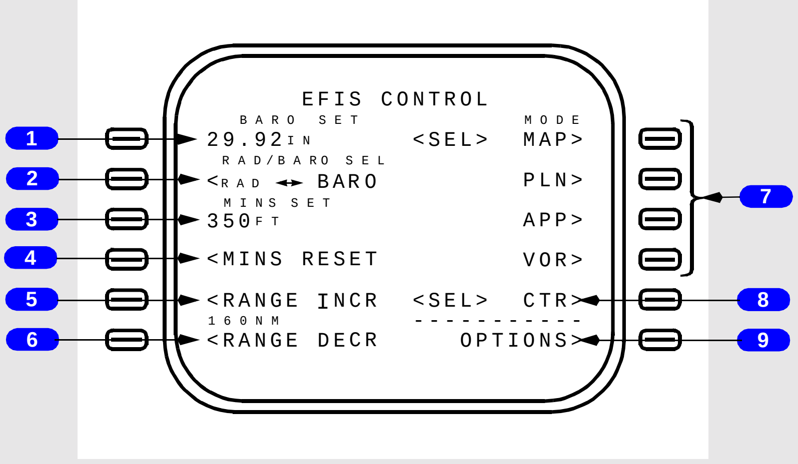
8 **ND Center (CTR)**

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

9 **EFIS OPTIONS**

Push - displays EFIS OPTIONS page.

EFIS Control Page (CDU-161)



CDU-161

1 **Barometric (BARO SET) Reference**

Valid entry is reference barometric setting.

- entries of 22.00 to 32.00 or 2200 to 3200 display as inches of Hg
- entries of 745 to 1084 display as hecto pascals
- entry of "I" to change the displayed value to inches Hg

- 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)**

Not available.

3 **Minimums (MINs) SET**

- Entered minimums display on respective PFD.
- BARO selected in 2L, valid entries are -1001 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 (RANGE INCR)**

Push - increases ND nautical mile range scale.

6 **Range Decrease (RANGE DECR)**

Push - decreases ND nautical mile range scale.

7 **Mode**

Push - selects desired ND display.

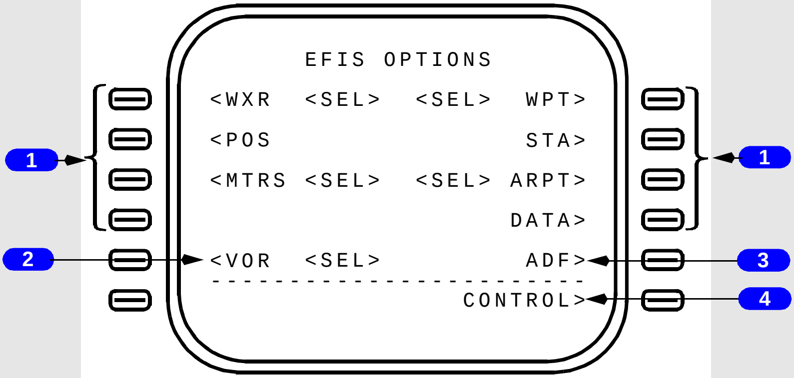
8 **Center (CTR)**

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

9 **OPTIONS**

Push - displays EFIS OPTIONS page.

EFIS Options Page (CDU-152)



CDU-152

1 WXR, POS, MTRS, WPT, STA, ARPT, DATA

Push - select related PFD/ND options.

2 VOR

Push - selects left and right VORs for display on ND and deletes ADFs when previously selected.

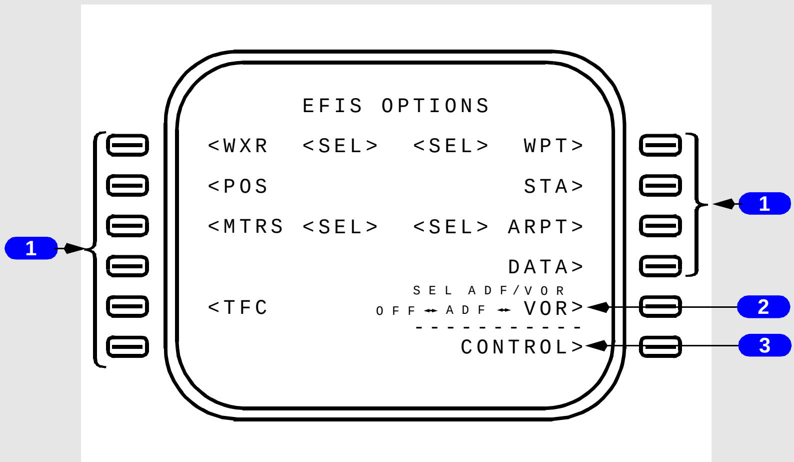
3 ADF

Push - selects left and right ADFs for display on ND and deletes VORs when previously selected.

4 EFIS CONTROL

Push - selects EFIS CONTROL CDU page.

EFIS Options Page (CDU-161)



CDU-161

1 WXR, POS, MTRS, TFC, WPT, STA, ARPT, DATA

Push - selects related PFD/ND options.

2 ADF/VOR

Push - sequentially selects ADF, VOR, or OFF for the pointer display on the ND.

ADF - displays the ADF pointers and frequency on the ND in all modes except PLAN.

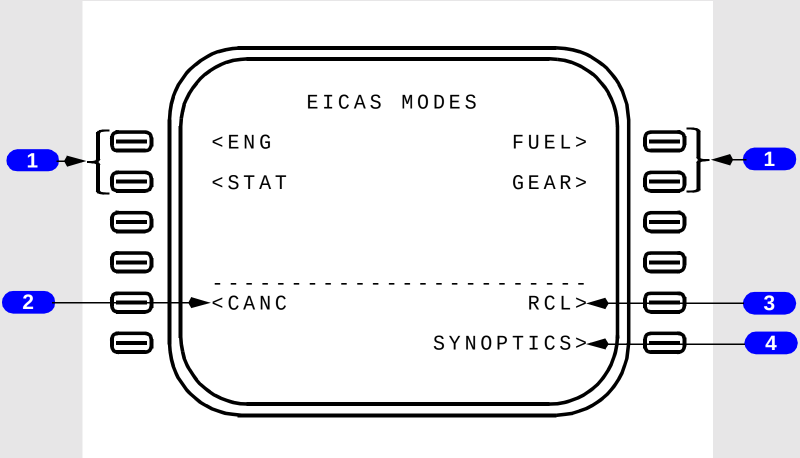
VOR - displays the VOR pointer, frequency, and associated DME on the ND in all modes except PLAN.

OFF - removes ADF and VOR data from the ND.

3 CONTROL

Push - selects EFIS CONTROL CDU page.

EICAS Modes Page



CDU

1 Synoptic/Display

Push - displays related synoptics/displays.

2 Cancel (CANC)

Refer to Warning Systems, Chapter 15.

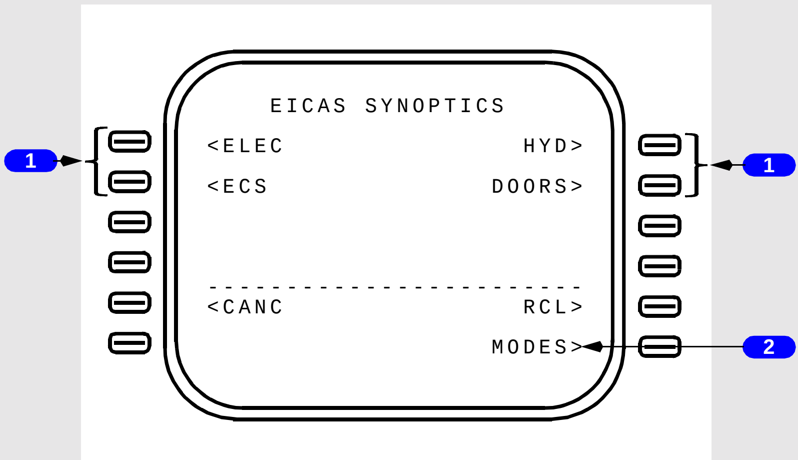
3 Recall (RCL)

Refer to Warning Systems, Chapter 15.

4 EICAS SYNOPTICS

Push - selects EICAS SYNOPTICS page.

EICAS Synoptics Page



CDU

1 Synoptic/Display

Push - displays related synoptics/display.

2 EICAS MODES

Push - selects EICAS MODES page.

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Flight Instruments, Displays — Chapter 10
System Description — Section 20

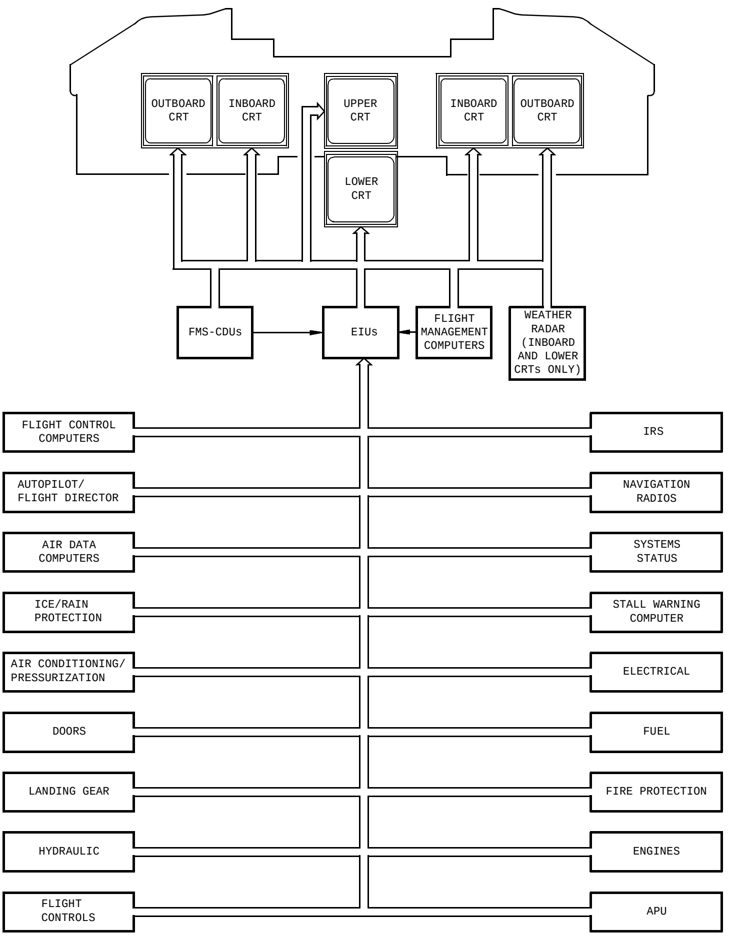
Introduction

The integrated display system consists of three identical EFIS/EICAS interface units (EIUs) which receive airplane systems information. The EIUs supply information to the flight crew on six cathode ray tubes (CRTs). The CRTs display three primary groups of information:

- primary flight display (PFD)
- navigation display (ND)
- engine indication and crew alerting system (EICAS)

The Electronic Flight Instrument System (EFIS) consists of the PFD and ND. Detailed information on the PFD and ND is found in Sections 30 and 40 of this chapter.

Integrated Display System



Display Selection and Control

During normal operations:

- inboard and lower CRT selectors are set to NORM
- PFDs display on two outboard CRTs
- NDs display on two inboard CRTs
- EICAS displays on upper and lower CRTs

Instrument Display Source Selection

The information sources for PFDs and NDs are selected with the source selectors. The desired flight director, navigation source, EIU, IRU, and ADC can be selected.

CRT Brightness Control

The brightness of each CRT can be adjusted. The outboard and inboard CRT brightness controls are on the glareshield. The upper and lower CRT brightness controls are on the center panel. The inner brightness control on the inboard and lower CRT controls the weather radar returns.

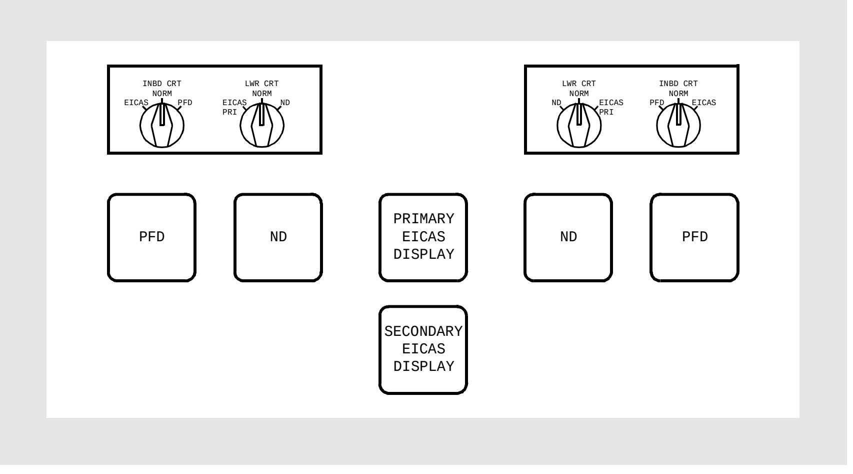
If a CRT color fails, the display changes color but all indications remain distinguishable and no information is lost.

Light sensors above the glareshield and near each CRT and CDU measure ambient light level and adjust CRT brightness to maintain the desired illumination.

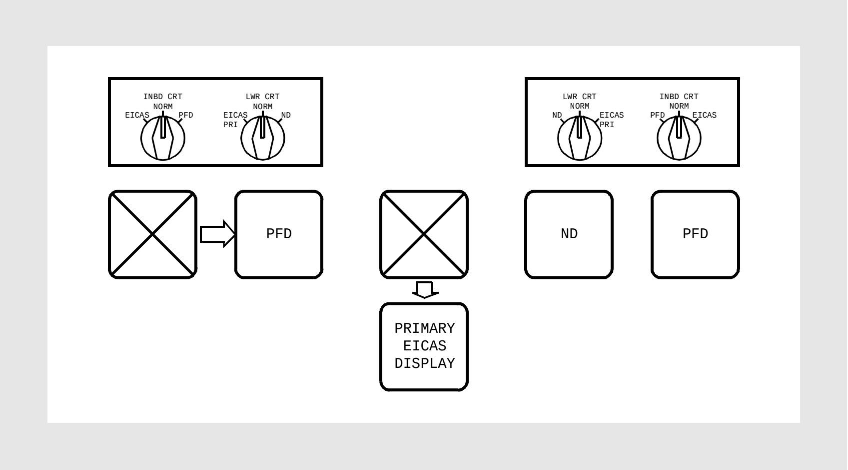
Display Selection and Control Examples

The following examples depict display selections.

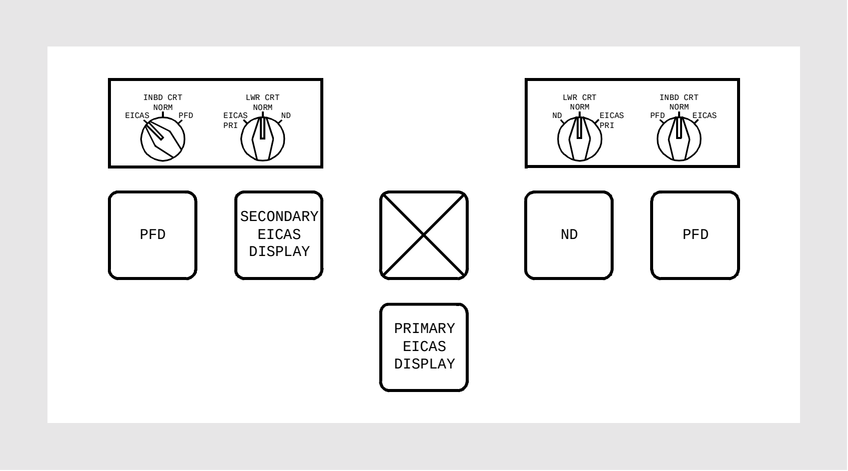
Normal Display Configuration



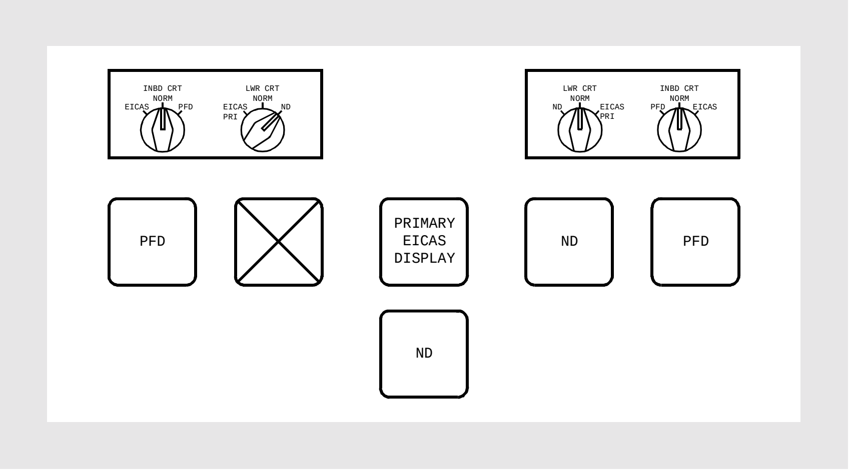
CRT Failure Automatic Switching



Inboard CRT Display Switching



Lower CRT Display Switching



Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- standby attitude indicator
- standby airspeed indicator
- standby altimeter
- radio magnetic indicator

Standby Magnetic Compass

A standard liquid–damped magnetic standby compass is located on the center post above the glareshield. A card located near the compass provides heading correction factors.

Standby Attitude Indicator

The standby attitude indicator on the center instrument panel incorporates an (APP) display, a bank indicator, and a pitch scale display. The main battery powers the standby attitude indicator. The left ILS receiver provides approach information.

Standby Airspeed Indicator

The standby airspeed indicator on the center instrument panel receives pitot pressure from auxiliary pitot source 1 and static pressure from the alternate static source.

Standby Altimeter

The standby altimeter on the center instrument panel receives static pressure from the alternate static source. The pointer completes one revolution every 1,000 feet.

Radio Magnetic Indicator

The radio magnetic indicator displays selected VOR and ADF bearings. The right IRU provides heading information when the F/O's IRS source selector is in RIGHT. The center IRU provides heading information when center or left is selected.

When the Heading Reference switch is in NORM, a heading flag is in view north of 82° latitude (or north of 70°N between 80°W and 130°W) or south of 82° latitude (or south of 60°S between 120°E and 160°E). When the switch is in TRUE, true heading displays and selecting a VOR displays the VOR failure flag.

Clocks

The Captain's clock provides time and date to the FMCs. If the Captain's clock fails, the F/O's clock provides this information. In addition to time, the clocks provide alternating day and month–year, elapsed time, and chronograph functions. Chronograph switches on the glareshield control the clock chronograph function.

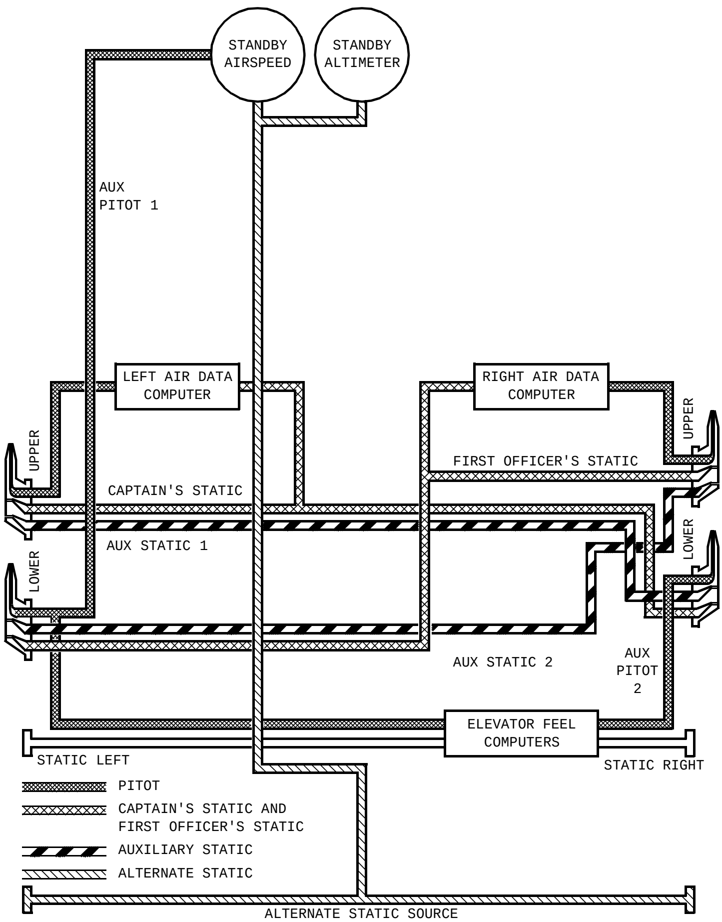
Time and date no longer display if APU battery bus power is removed. However, all internal clock functions continue to operate and the correct time and date display when power is restored. All display and internal clock functions fail if the main hot battery bus power is removed. The clock must be reset when battery power is restored.

Display System Information Sources

Pitot Static System

The pitot static system provides pitot pressure and static pressure to the air data computers, standby airspeed indicator, standby altimeter, and elevator feel computer.

Pitot Static Diagram



Air Data Computer (ADC) System

The ADC system supplies air data information to various airplane systems. Air data information enables the EIUs to display altitude, airspeed, Mach, and air temperature.

There are two ADCs, left and right. Each ADC receives inputs from AOA sensors, TAT probes, pitot static system, and barometric settings from the EFIS control panels sent through the related CDUs . Either ADC can provide flight information to the Captain’s and F/O’s flight instruments, depending on the position of the Air Data Source selectors. Normally, each ADC provides flight information to the PFD and ND on its related side.

Angle–of–Attack (AOA)

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.

Total Air Temperature (TAT)

Left and right dual total air temperature probes sense outside air temperature (OAT) and heat of compression. TAT displays on primary EICAS. TAT indication on the ground approximates OAT.

Static Air Temperature (SAT)

Left and right dual static probes sense static air temperature. SAT displays on Progress page 2.

Introduction

PFDs present a dynamic color display of parameters necessary for flight path control. PFDs provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- time critical warnings

Failure flags display 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.

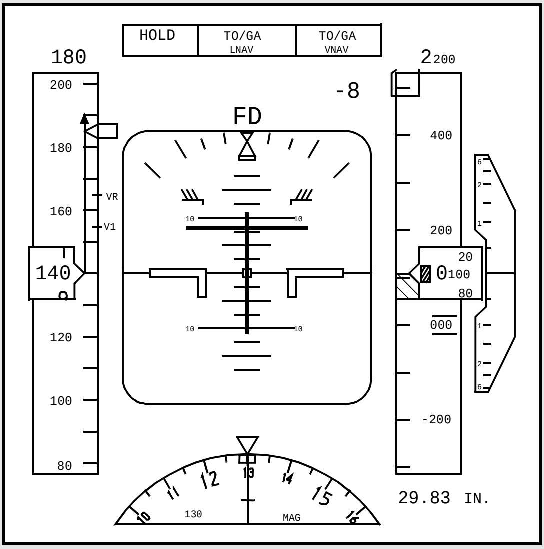
TCAS resolution advisories are described in Chapter 15, Warning Systems.

PFD time critical warnings display in large capital letters between the attitude display and the compass rose. Refer to Chapter 15, Warning Systems.

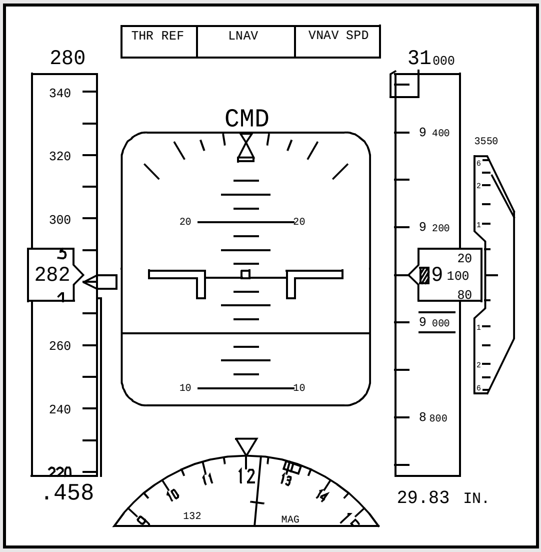
Typical PFD Displays

Typical PFD configurations for six phases of flight follow. The autopilot, LNAV, and VNAV are active for climb, cruise, descent, approach, and landing. The AFDS approach mode is used for approach and landing.

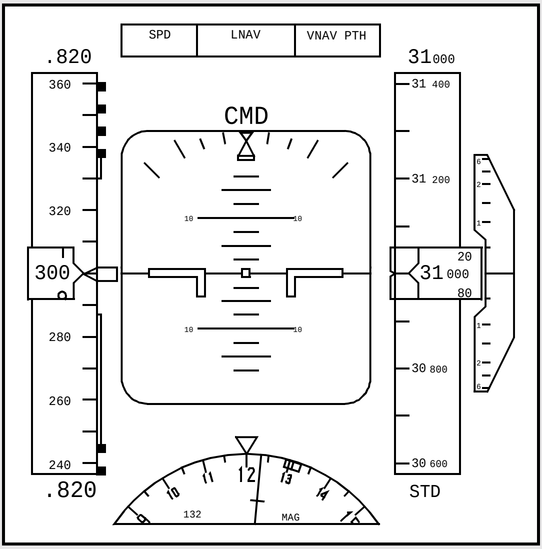
PFD Takeoff Display



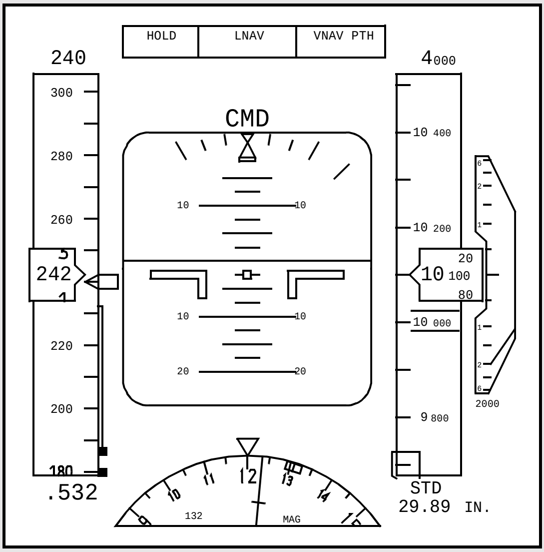
PFD Climb Display



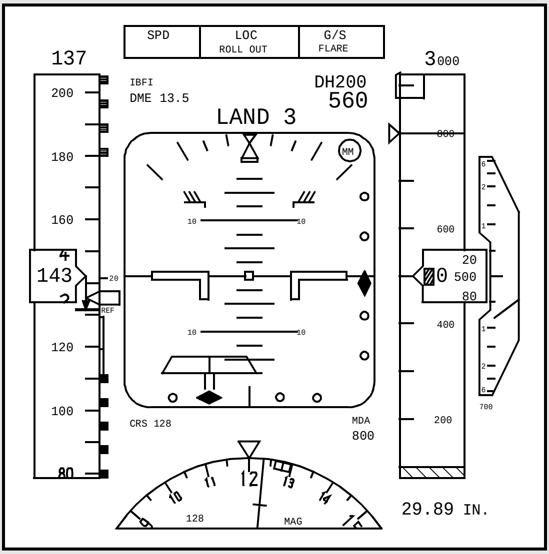
PFD Cruise Display



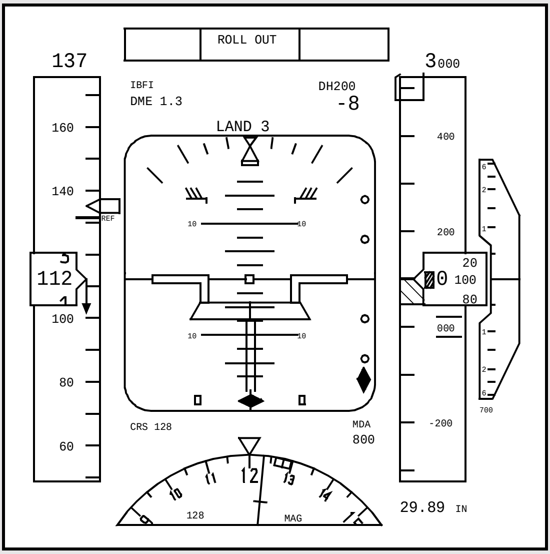
PFD Descent Display



PFD Approach Display



PFD Landing Display



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Flight Instruments, Displays — Chapter 10
Navigation Displays — Section 40

Introduction

The NDs provide a mode–selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan)

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

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:

- track
- heading
- route
- postion 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
- TCAS Traffic Display

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA), and position (POS) data may be displayed on the ND in both the expanded and center map modes.

VOR and Approach Modes

VOR and APP modes display heading up. VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or ILS approach information.

Plan Mode

PLN mode displays true north up. The active route may be viewed using the STEP prompt on Legs pages. Position DATA is available for display in plan mode

ND Information

Heading

Heading is supplied by the selected IRU. 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 references true north when the airplane is north of 82° N latitude (or north of 70°N between 80° W and 130° W) or south of 82° S latitude (or south of 60°S between 120° E and 160°E).

If the ND is referenced to true north and the airplane descends 2,000 feet at more than 800 feet per minute, the heading reference box changes color to amber and flashes for 10 seconds. The box returns to white when the airplane climbs 2,000 feet at more than 500 feet per minute.

Track

Track is supplied by the FMC during normal operation and by the CDU 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 displays on the ND. The weather radar system is described in Chapter 11, Flight Management, Navigation.

Failure Flags and Messages

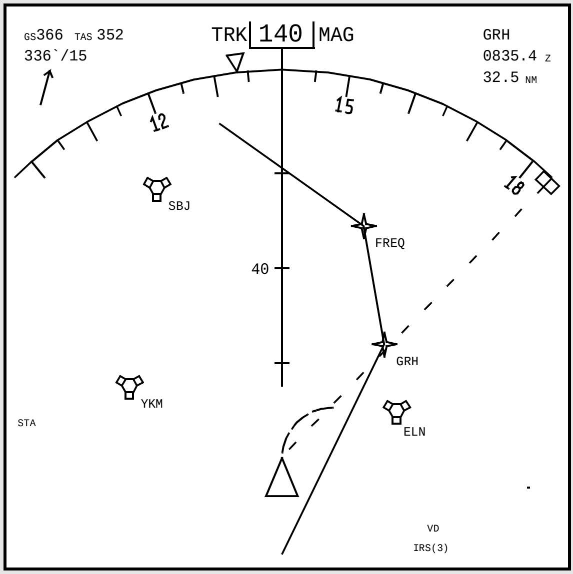
Failure flags display for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

The message EXCESS DATA displays on the ND if the amount of information sent to the ND exceeds the display capability. The message can be removed by deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA).

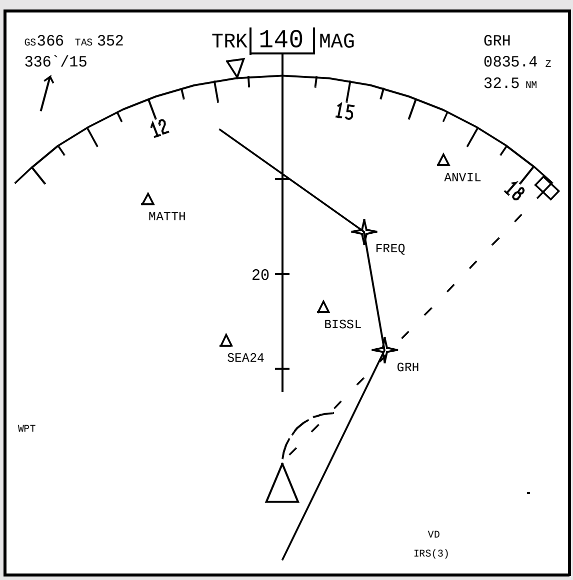
Typical ND Map Displays

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.

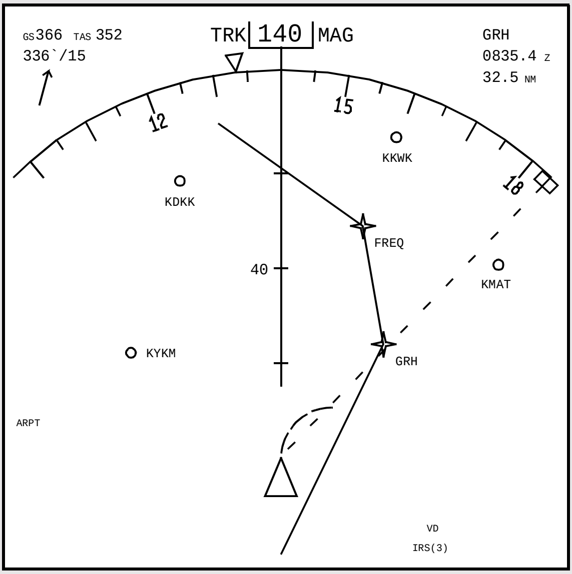
STA (station) selected.



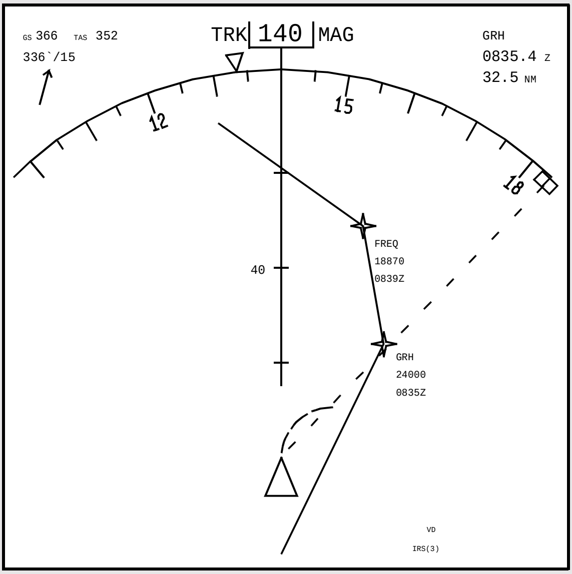
WPT (waypoint) selected.



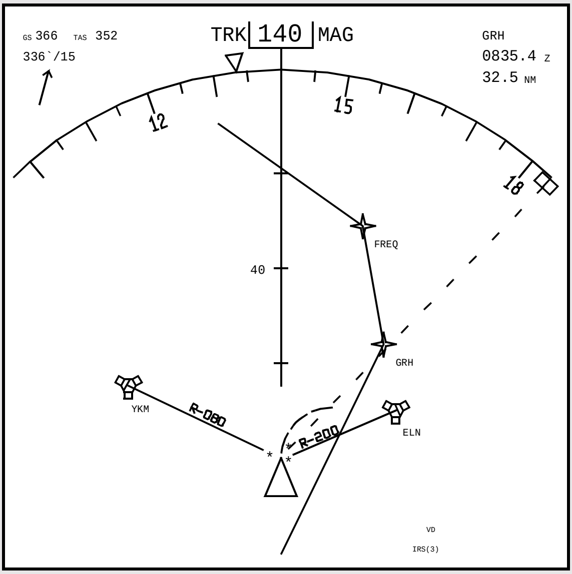
ARPT (airport) selected.



DATA selected.



POS (position) selected.



ND Symbology

The following symbols display on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

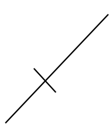
- W (white) – present or modified status, range scales, armed flight mode annunciations
- G (green) – dynamic conditions, active flight mode annunciations
- M (magenta or pink) – active waypoint and route, command information, pointers, symbols, fly–to condition
- B (blue) – inactive or background information, ADF symbols
- A (amber) – cautions, faults, flags
- R (red) – warnings

Heading, Track, and Speed

Symbol	Name	ND Mode	Remarks
TRK 062 MAG	Track orientation (G), current heading (W), heading reference (G), and heading pointer (W)	MAP, MAP CTR, PLAN	Displays TRK as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.
HDG 263 MAG ▽	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	VOR, VOR CTR, APP, APP CTR	Displays HDG as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.

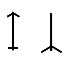
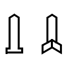
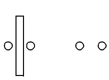
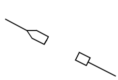
Symbol	Name	ND Mode	Remarks
TAS 312	True airspeed (W)	All	Displays true airspeed above 100 knots.

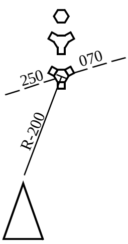
Symbol	Name	ND Mode	Remarks
TIME TO ALIGN L 4 MIN C 7+ MIN R 5 MIN	IRU time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction/speed and wind arrow, on the ground, during alignment.

Symbol	Name	ND Mode	Remarks
GS310	Groundspeed (W)	All	Displays ground speed in large font below 30 knots; small font at 30 knots and above.
350°/15 	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 PLAN map mode.
MAG OR $\boxed{\text{TRU}}$	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, PLAN	Displays 90 degrees of compass rose.
▽	Current heading pointer (W)	MAP, MAP CTR, PLAN	Points to current heading on the compass rose.
	Track indicator (W)	VOR, VOR CTR, APP, APP CTR	Indicates airplane track when selected mode has heading orientation.
	Selected heading (M)	All except PLAN	Displays MCP–selected heading. A dashed line (M) may extend from the marker to the airplane symbol. In MAP mode with LNAV, LOC, or ROLLOUT engaged, dashed line is removed 10 seconds after the selected heading is moved.

Symbol	Name	ND Mode	Remarks
	Track line and range scale (W)	MAP, MAP CTR, VOR, APP	Indicates current track. Number indicates range. Displays in VOR or APP mode when WXR on.

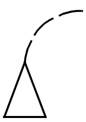
Radio Navigation

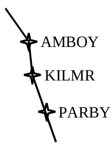
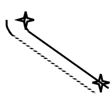
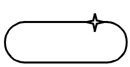
Symbol	Name	ND Mode	Remarks
VOR L, R ILS L, C, R	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Displays selected receiver as display reference.
116.80 OR SEA	ILS/VOR (G) Reference receiver frequency or identifier display	VOR, VOR CTR, APP, APP CTR	Displays frequency before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.
DME24.6	DME distance (G)	VOR, VOR CTR, APP, APP CTR	Displays DME distance to the reference navaid.
CRS 135	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Displays VOR course or FMC runway course.
	Left VOR (G) or ADF (B) pointer head and tail	MAP, MAP CTR, VOR, VOR CTR, PLAN	Indicates bearing to (head) or from (tail) the tuned station, if selected on related EFIS control panel.
	Right VOR (G) or ADF (B) pointer head and tail		
	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	Indicates 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.

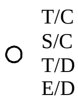
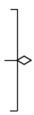
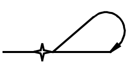
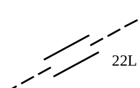
Symbol	Name	ND Mode	Remarks
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (B, G), DME/TACAN (B, G), VORTAC (B, G)	MAP, MAP CTR	Displays appropriate navaids (B) when EFIS control panel STA switch selected on. Tuned VHF navaids display in green, regardless of switch selection. When a navaid is manually tuned, the selected course and reciprocal display.
	VOR/DME raw data radial and distance (G)		Extends the station radial from the airplane to the CDU-tuned VOR when EFIS control panel POS switch selected on. If co-located DME data received, tick mark displays at DME distance from airplane; extends to edge of display if no valid DME data displayed.

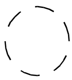
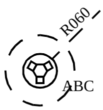
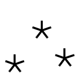
Symbol	Name	ND Mode	Remarks
VOR L, R ADF L, R	VOR (G) or ADF (B) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Located lower left or right corner. Represents positions of VOR/ADF switches.
116.80 OR SEA OR 520 OR BF	VOR frequency or identifier (G), ADF frequency or identifier (B)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays frequency before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.
DME 24.6	DME distance (G)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays 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
ABCDE	Active waypoint identifier (M)	MAP, MAP CTR, PLAN	Displays active flight plan waypoint, the next waypoint on the route of flight.
124 NM	Active waypoint distance (W)	MAP, MAP CTR, PLAN	Distance to active waypoint.
0835.4z	Active waypoint ETA (W)	MAP, MAP CTR, PLAN	Displays FMS–calculated ETA at the active waypoint.
 AMBOY	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.

Symbol	Name	ND Mode	Remarks
	Off route waypoint (B)	MAP, MAP CTR	Displays waypoints not on selected route displayed in ND ranges of 10, 20, or 40 when WPT switch selected on.
	Flight plan route: active (M), modified (W), inactive (B)	MAP, MAP CTR, PLAN	Displays active route with a continuous line (M) between waypoints. Active route modifications display with short dashes (W) between waypoints. Inactive routes display 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	Displays entered or procedural altitude and ETAs for applicable route waypoints when DATA switch selected on.
	Holding pattern: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	Displays a holding pattern when in flight plan. Pattern increases to correct size when entering holding.
	Altitude range arc (G)	MAP, MAP CTR	Displays position where MCP altitude will be reached based on vertical speed and groundspeed.

Symbol	Name	ND Mode	Remarks
	Altitude profile point and identifier (G)	MAP, MAP CTR	Displays position of FMC–calculated T/C (top–of–climb), S/C (step climb), T/D (top–of–descent), 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 displays when the pointer indicates more than ± 400 feet.
	Procedure turn: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	Displays procedure turn when in the flight plan. It increases in size upon entering the procedure turn.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Display when selected as the origin or destination and ND range is 80, 160, 320, or 640 NM.
	Airport (B)	MAP, MAP CTR, PLAN	Displays when ARPT switch selected on. Origin and destination airports always display, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Display when selected as the origin or destination and ND range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.

Symbol	Name	ND Mode	Remarks
	Energy management circles (B, W)	MAP, MAP CTR	Displays clean (B) and drag (W) energy management circles as defined on CDU OFFPATH DES page.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLAN	Displays reference point selected on CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
IRS (3) IRS (L) IRS (C) IRS (R)	FMC-IRS position update status (G)	MAP, MAP CTR	Displays FMC-IRS status based on IRUs. Transition from IRS (3) to any other annunciation highlighted by a green box for 10 seconds.
DD VD LOC LOC DD LOC VD	FMC-radio position update status (G)	MAP, MAP CTR	Displays FMC-radio update mode. DD, DME DME; VD, VOR DME; LOC, localizer; LOC DD, localizer and DME DME; LOC VD, localizer and VOR DME.
LOCGPS GPS	FMC-GPS position update status (G)	MAP, MAP CTR	Displays FMC-GPS update mode. LOCGPS, localizer and GPS; GPS, GPS, GPS.
	GPS position (W)	MAP, MAP CTR	Displays GPS position relative to FMC position when POS switch selected on.
	IRU positions (W)	MAP, MAP CTR	Displays IRU positions relative to FMC position when POS switch selected on.

Symbol	Name	ND Mode	Remarks
	Weather radar returns (R, A, G, M)	MAP, MAP CTR, VOR, APP	Displayed when WXR switch selected on. Most intense areas display in red, lesser intensity in amber, and lowest intensity green. Turbulence displays in magenta.
STA WPT ARPT WXR	Selected map options (B)	MAP, MAP CTR	Indicates STA, WPT, ARPT, and WXR switches selected on.
CDU L, C, R	Map source annunciation (G)	MAP, MAP CTR	Displays ND source if: • CDU is selected on related Navigation Source Select switch • both FMCs fail, or • a manually selected FMC fails
N↑	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.

TCAS

Symbol	Name	ND Mode	Remarks
■ ↑ -03	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, APP, VOR	These symbols display only when TFC switch selected on. Refer to Chapter 15, Warning Systems. Proximate traffic is traffic within 1,200 feet vertical and 6 miles lateral of present position. Other traffic is greater than 1,200 feet vertical or 6 miles lateral from present position. Arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, arrow is not displayed. Number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane. 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.
+02 ● ↓	TCAS traffic advisory (TA), relative altitude (A)		
♦ ↓ -05	TCAS proximate traffic, relative altitude (W)		
+09 ◊ ↑	TCAS other traffic, relative altitude (W)		
RA 5.3 +03 ↑ TA 8.9 -12 ↑	TCAS no bearing message (RA–R, TA–A)	MAP, MAP CTR, APP, VOR	Message provides traffic type, range in NM, altitude and vertical direction.
TRAFFIC	TCAS traffic alert message (RA–R, TA–A)	All	Displays when TCAS RA or TA is active. 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	Displays whenever RA or TA traffic is outside the traffic area covered by the ND range. Displays only when TFC switch selected on.
TFC	TCAS mode (B)	MAP, MAP CTR, APP, VOR	Indicates ND TCAS display is active; TFC switch selected on.
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs. Displays whether TFC switch selected on or off.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in test mode. Displays whether TFC switch selected on or off.
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Displays when TCAS/ATC mode switch is not in TA ONLY or TA/RA, when traffic is selected. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Indicates TCAS failure, when traffic is selected.

Radar

Symbol	Name	ND Mode	Remarks
TEST	Weather radar (WXR) test mode (A) (B)	MAP, MAP CTR, APP, VOR	Weather radar system selected on EFIS control panel (refer to Chapter 11, Flight Management, Navigation).
WXR	WXR precipitation only mode (B)		
WX+T	WXR and turbulence mode (B)		
CAL	WXR receiver gain (B)		
MAP	Mode used with down–tilt, when ground mapping (B)		
+15 to -15	WXR antenna tilt (B)		
ANT	WXR antenna failure (A)		
ATT	IRS stabilization signal failure (A)		
WEAK	AUTOMATIC gain control failure (A)		
CONT	WXR control panel failure (A)		
RT	WXR receiver transmitter failure (A)		

Intentionally
Blank

Flight Instruments, Displays EICAS Messages

Note: OVERSPEED warning and ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

The following EICAS messages can display.

Flight Instrument Source EICAS Alert Messages

Message	Level	Aural	Condition
>SNGL SOURCE RA	Advisory		Both pilots displays referenced to the same radio altimeter.
>SOURCE SELECT ADC	Advisory		Both pilots displays referenced to the same ADC source.
>SOURCE SELECT EIU	Advisory		Both pilots displays referenced to the same EIU source.
>SOURCE SELECT F/D	Advisory		Both pilots displays referenced to the same FCC source.
>SOURCE SELECT IRS	Advisory		Both pilots displays referenced to the same IRU source.
>SOURCE SELECT NAV	Advisory		Both pilots displays referenced to the same NAV source.

Flight Instrument Disagree EICAS Alert Messages

Message	Level	Aural	Condition
ALT DISAGREE	Caution	Beeper	Captain’s and F/O’s uncorrected barometric altitudes differ more than two hundred feet for more than five seconds.

Message	Level	Aural	Condition
>ATTITUDE	Caution	Beeper	Captain’s and F/O’s PFD attitude indications differ.

Message	Level	Aural	Condition
>BARO DISAGREE	Advisory		Captain’s and F/O’s barometric reference settings differ for more than one minute.

Message	Level	Aural	Condition
IAS DISAGREE	Caution	Beeper	Captain’s and F/O’s airspeed indicators differ more than five knots for more than five seconds.

Flight Instruments Components EICAS Alert Messages

Message	Level	Aural	Condition
>EFIS CONTROL L, R	Advisory		(CDU-152) EFIS control panel inoperative. (CDU-161) EFIS control panel inoperative or CDU control of the EFIS control panel is active.

Message	Level	Aural	Condition
>EFIS/EICAS C/P	Advisory		(CDU-152) Both EFIS control panels and EICAS display select panel inoperative. (CDU-161) Both EFIS control panels and EICAS display select panel inoperative or CDU control of both EFIS control panels and EICAS display panel is active.

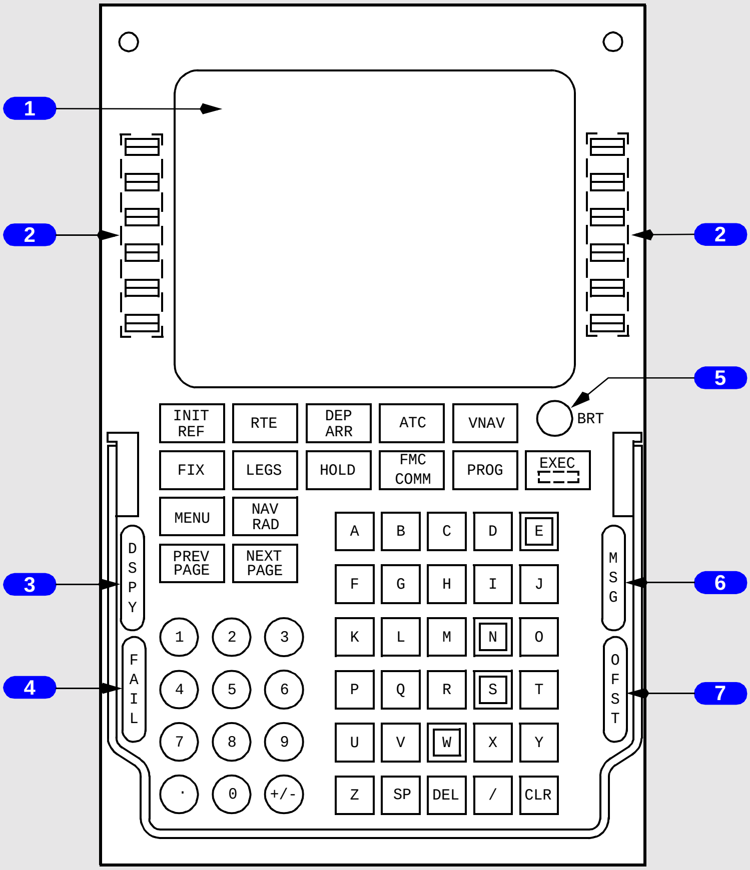
Message	Level	Aural	Condition
>EIU LEFT	Advisory		Left EIU has failed. Inhibited in flight.

Flight Managment, Navigation — Chapter 11
Table of Contents — Section 0

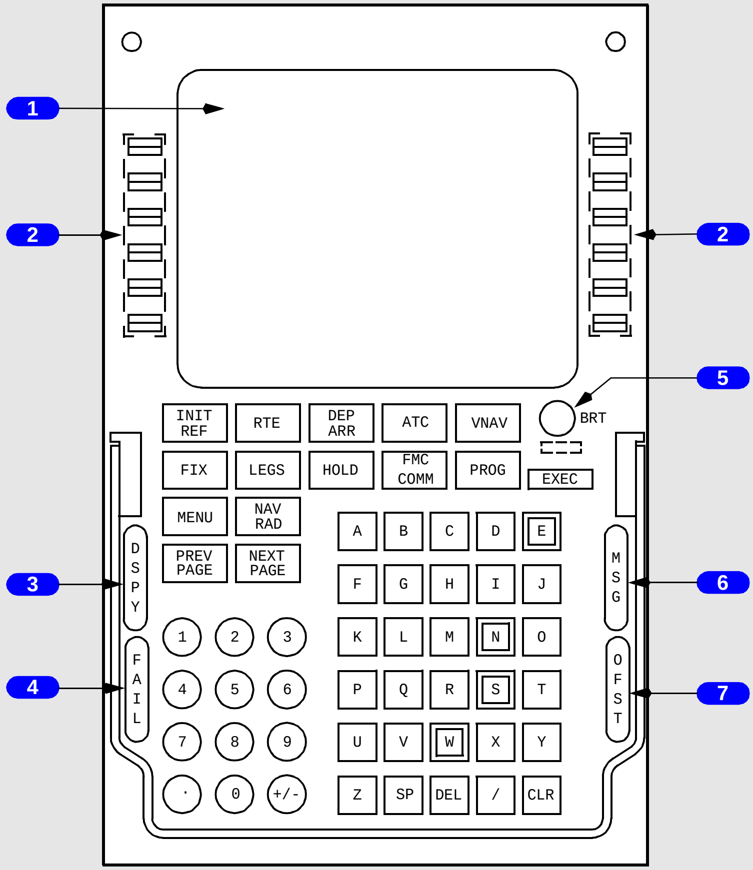
Flight Management System

The control display units shown in the Operations Manual have been labeled CDU-152 or CDU-161 where necessary to distinguish between Part Numbers S242T102-152 and S242T102-161. The CDU-161 panel has become the standard in production and as a replacement. Because the CDU-152 may be replaced with the CDU-161, both panels have been shown in the following pages.

Control Display Unit (CDU)



CDU -152
FORWARD AISLE STAND PANEL



CDU -161
FORWARD AISLE STAND PANEL

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 is displayed in scratchpad

Conventions -

- scratch pad must be blank for line select transfer
- data cannot be transferred to a blank line
- a blank scratch pad cannot be transferred to a line
- not all data can be modified
- message displays if inappropriate entries attempted

3 Display (DSPY) Light

Illuminated (white) – indicates current display is not related to the active leg or current performance mode.

4 FAIL Light

Illuminated (amber) – indicates fault detected in FMC.

5 Brightness (BRT) Control

Rotate – controls display brightness.

Light sensors located near each CDU measure ambient light level and adjust CDU brightness to maintain desired illumination.

6 Message (MSG) Light

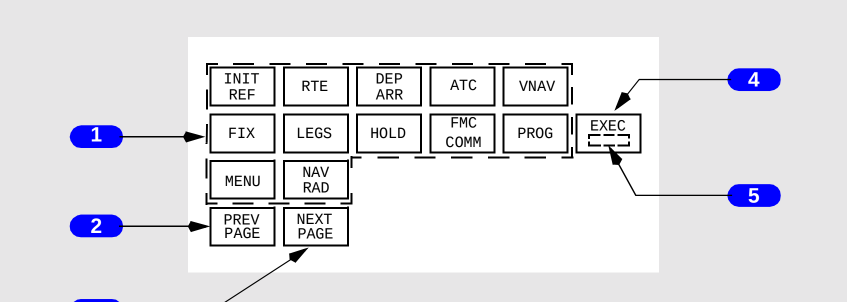
Illuminated (white) –

- scratchpad displays message
- pushing clear key extinguishes light and clears message

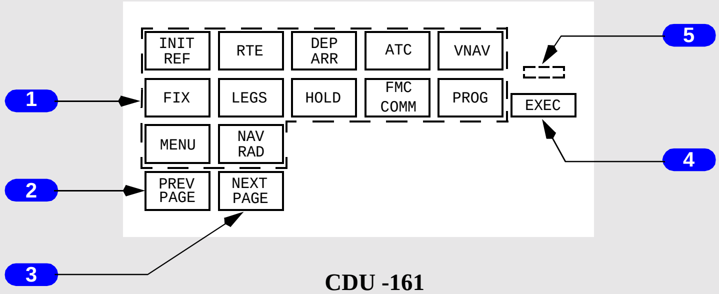
7 Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset.

Function and Execute Keys



CDU -152



CDU -161

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
- ATC - displays ATC/ADS STATUS page
- 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 ND
- HOLD - displays page to create holding patterns and holding pattern data, or to exit holding pattern
- FMC COMM - displays pages that access datalink, provides datalink status
- PROG - displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU -displays page to choose subsystems controlled by CDU
- NAV RAD - displays page to view or control navigation radio tuning

2 Previous (PREV) PAGE Key

Push - displays previous page in multiple page displays.

3 NEXT PAGE Key

Push - displays next page in multiple page displays.

4 Execute (EXEC) Key

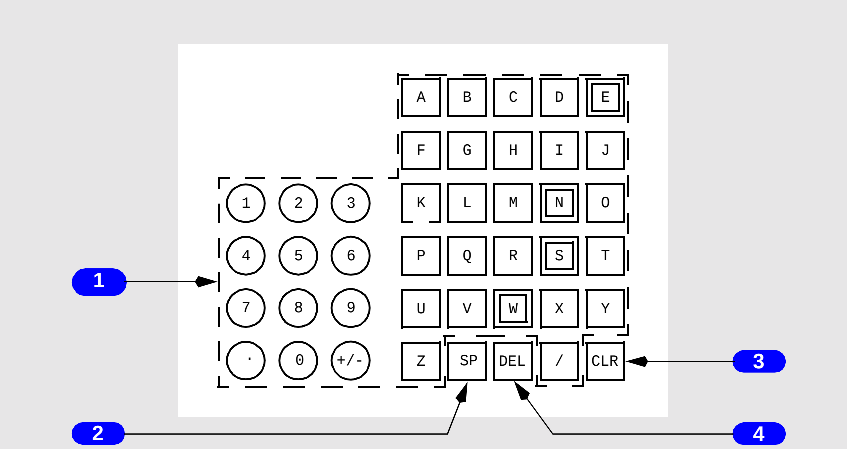
Push –

- makes data modification(s) active
- extinguishes execute light

5 Execute Light

Illuminated (white) – active data modified but not executed.

Alpha/Numeric and Miscellaneous Keys



CDU

1 Alpha/Numeric Keys

Push –

- enters 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 a space in scratchpad when using ACARS or SATCOM.

3 Clear (CLR) Key

Push –

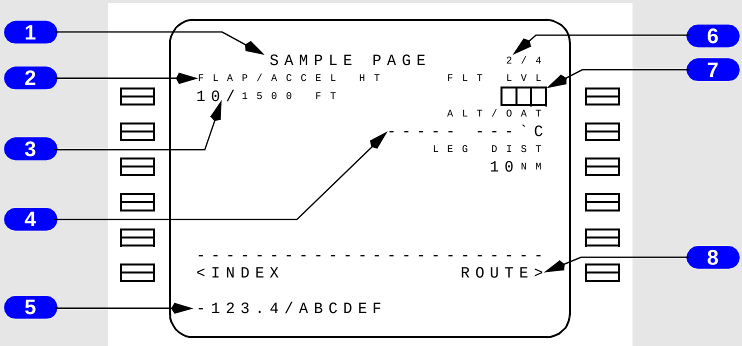
- clears last scratchpad character
- clears scratchpad message

Push and hold – clears all scratchpad data.

4 Delete (DEL) Key

Push – enters “DELETE” in scratchpad.

CDU Page Components



CDU

1 Page Title

Subject or name of data displays on page.

ACT (active) or MOD (modified) indicates whether page contains active or modified data.

2 Line Title

Title of data on line below.

3 Line

Displays –

- prompts
- data associated with line title

Large font indicates crew entered or verified data. Small font indicates FMC computed data.

4 Dashes

Data input is optional.

5 Scratchpad

Displays messages, alphanumeric entries, or line selected data.

6 Page Number

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

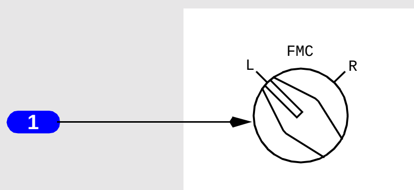
7 Boxes

Data input is mandatory.

8 Prompts

Display pages and control displays. Caret “<” or “>” is before or after prompt.

FMC Selector



CENTER PANEL

1 FMC Master Selector

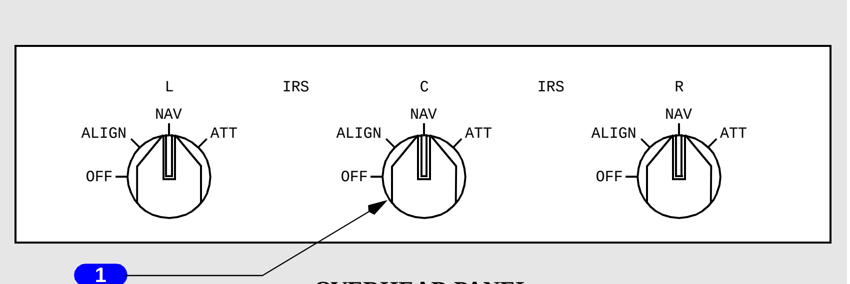
L – selects left FMC to provide guidance commands

R – selects right FMC to provide guidance commands.

Note: Switching between FMCs with autothrottle active causes autothrottle to disconnect.

Inertial Reference System (IRS)

Inertial Reference Unit (IRU) Selectors



OVERHEAD PANEL

1 IRU Mode Selectors

IRU mode selector must be pulled out to move from NAV position.

OFF - alignment lost.

ALIGN (alignment)- when parked and momentarily selected:

- initiates alignment
- removes sensor errors when selected from navigation mode

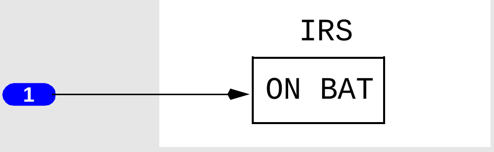
NAV (navigation) -

- system enters navigation mode after completing alignment
- provides IRS information to airplane systems for normal operations

ATT (attitude) -

- system enters attitude move
- position and velocity information lost until system realigned on ground
- requires magnetic heading input from CDU

IRS On Battery Light



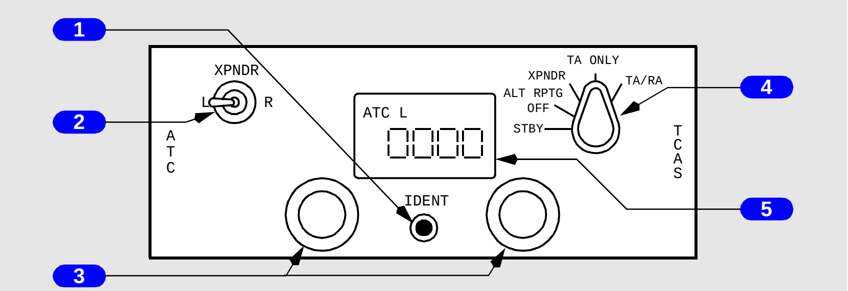
OVERHEAD MAINTENANCE PANEL

1 IRS ON Battery (BAT) Light

Illuminated (white) – IRS operating on backup electrical power (APU hot battery bus).

Transponder

Transponder Panel



AFT AISLE STAND

1 Identification (IDENT) Switch

Push – transmits an identification signal.

2 Transponder (XPNDR) Switch

L or R – selects desired transponder.

3 Transponder Code Selectors

Rotate – Sets transponder code.

4 Transponder Mode Selector

STBY (standby) – transponder not active.

ALT RPTG (altitude reporting) OFF – transponder operates in flight without altitude reporting.

XNPDR (transponder) - transponder operates in flight with altitude reporting.

TA ONLY (traffic avoidance) and TA/RA (traffic avoidance/resolution advisory) – Refer to Chapter 15, Warning Systems.

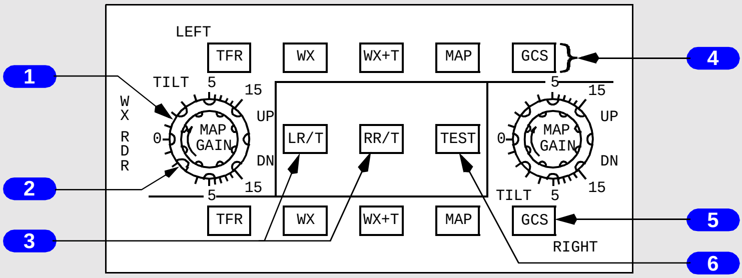
5 Transponder Code Indicator

Displays transponder code.

Displays operating transponder (L or R).

Weather Radar

Weather Radar Panel



AFT AISLE STAND

1 TILT Control

Controls antenna tilt angle with reference to horizon.

2 MAP GAIN Control

Rotate - sets receiver sensitivity in MAP mode. Full clockwise sets receiver sensitivity at preset calibrated level.

3 Receiver/transmitter (R/T) Switches

LR/T - selects left R/T. Radar antenna stabilized by left and center IRU.

RR/T - selects right R/T. Radar antenna stabilized by right and center IRU.

4 Mode Switches

Control display on respective ND.

Push -

TFR (transfer) - selects opposite display.

Note: Selecting both TFR switches at the same time places R/T in standby.

WX (weather) - displays weather returns with gain controlled automatically.

WX + T (weather + turbulence) - displays weather returns and turbulence within precipitation with gain controlled automatically. Turbulence display available with display ranges of 40 nm or less.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP - displays ground returns at selected gain level.

5 Ground Clutter Suppression (GCS) Switch

IN - reduces amount of ground returns.

OUT - returns radar to normal operating mode.

Note: Continuous operation is not recommended; weather return intensity may be reduced.

6 TEST Switch

Displays maintenance test pattern and any fault messages with WXR selected (except in PLAN mode). R/T does not transmit.

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Introduction

Navigation systems include global positioning system (GPS), inertial reference system (IRS), 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 independently supply geographical data to the FMC. 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.

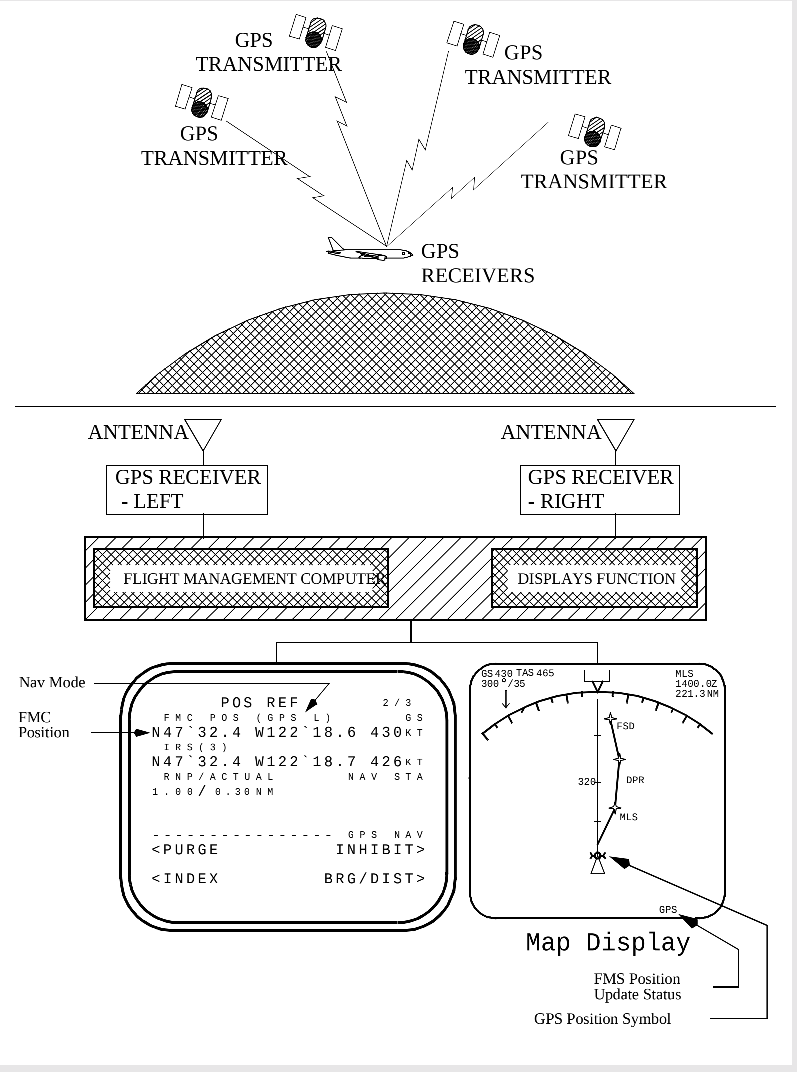
Pushing the POS (position) switch on the EFIS control panel displays left and right GPS positions on the ND. The GPS symbols are identical and display as a single symbol when the GPS receivers calculate the same position.

GPS Data

The FMC uses GPS position data to estimate errors in the inertial reference system (IRS) position and velocity. The flight crew can manually inhibit GPS updating. This is accomplished on the CDU POS REF 2/3 page.

GPS position updates are allowed for all United States National Airspace approach operations. Outside of this region, GPS position updates are allowed during approaches only if the FMC database and approach charts are referenced to the WGS-84 reference datum. GPS updates should be inhibited for all other approach operations, unless other appropriate procedures are used.

GPS System Schematic



Inertial Reference System

The inertial reference system (IRS) calculates airplane position, acceleration, track, vertical speed, ground speed, true and magnetic heading, wind speed and direction, and attitude data for the displays, flight management system, flight controls, engine controls, and other systems. The IRS consists of three inertial reference units (IRUs) and the IRS mode selector panel.

IRS Alignment

Full Alignment

Rotating the IRS mode selector from OFF to NAV begins IRS alignment. Alignment requires approximately ten minutes. Present position (latitude and longitude) must be entered on the CDU position initialization page to complete alignment. Alignment can be accomplished only when the airplane is parked. Alignment stops if an IRU detects motion during alignment. Alignment continues and completes in approximately ten minutes after motion stops. The IRS is aligned when all IRUs enter the navigation mode. Latitude and longitude entries then blank on the SET IRS POS line on the CDU position initialization page. Alignment is lost if the selector is moved out of theNAV position.

A full alignment, accomplished by rotating the IRS mode selector to OFF and back to NAV, must be accomplished when the time from the last full alignment to the next expected arrival time exceeds 18 hours.

Fast Alignment

Following operation in the navigation mode and with the airplane parked, performing a fast alignment removes accumulated track, ground speed, and attitude errors, relevels the system, and updates present position. This is accomplished by positioning selectors to ALIGN, entering present position, and repositioning selectors to NAV. Fast alignment completes in approximately 30 seconds.

Fast alignment can be accomplished without entering present position. However, greater navigational accuracy is attained by entering present position.

IRS Attitude

If alignment is lost in flight, the navigation mode is inoperative for the remainder of the flight. Attitude information can be obtained by moving the selector to ATT. The IRU enters align mode for 30 seconds. This relevels the system and provides attitude displays on the PFD. For best accuracy, the airplane must be in straight and level flight. Some attitude errors may occur during acceleration. After acceleration, errors are slowly removed.

The attitude mode can also provide heading information. A magnetic heading input is required to initialize the IRU while in attitude mode. This heading is available for backup if all three IRUs fail. Heading information displayed on the PFD and ND is from an IRU operating in the navigation mode. This information is independent of the IRS source selector position if an operating FMC is selected by the navigation source selector.

IRS Power

The IRS can operate on AC or DC power. The center IRU operates on DC power for five minutes, then shuts down. If an IRU loses both AC and DC power, alignment is lost.

Radio Navigation Systems

Automatic Direction Finding (ADF)

ADF Tuning

Two ADF receivers 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 VOR/ADF switch is in the ADF position. ADF data is cyan.

If both FMCs fail, left and right ADF radios can be tuned on the related left and right CDU ALTN NAV RADIO page.

Distance Measuring Equipment (DME)

The FMC usually tunes the two, five channel DME transceivers. Channels 3 and 4 can be tuned manually.

DME Tuning

Entering the VOR portion of a VOR/DME pair on the NAV RADIO page manually tunes the DME. Manual DME tuning does not inhibit FMC DME tuning.

The FMC tunes DME channels 1-4 for radio position updates. DME/DME position updates are usually more accurate than VOR/DME updates. The FMC cannot tune DMEs inhibited on the REF NAV DATA page. Channel 5 is reserved for tuning the selected ILS frequency.

If both FMCs fail, left and right DME transceivers can be tuned by entering the VOR portion of a VOR/DME pair on the related left and right CDU ALTN NAV page. Each DME channel 1 is tuned to the VOR shown on the CDU unless the related EFIS control panel ND mode selector is set to APP. In APP mode, DME channel 1 is tuned to the ILS.

DME Displays

DME distance displays at the top of the ND with the VOR mode selected. DME distance displays on the PFD when ILS receivers are tuned to a collocated DME and localizer facility. DME distances also display at the bottom of the ND when either or both VOR L or VOR R switches are selected.

POS REF page 2 displays the identifiers of the DME stations used for FMC position updates.

Instrument Landing System (ILS)

The FMC usually tunes the three ILS receivers. The receivers can be tuned manually on the NAV RADIO page.

ILS Tuning

Receivers tune and frequency/course display after selecting an ILS, LOC, back course, VOR, runway, or a VFR approach to an ILS/LOC equipped runway and the airplane is within 150 nm of the destination airport, 50 nm of T/D, or in FMC descent.

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 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 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
- 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 enabled by disengaging the autopilot and turning OFF both flight director switches.

If both FMCs fail, ILS receivers can be tuned on the CDU ALTN NAV RADIO page. The left ILS receiver is tuned with the left CDU, the center receiver is tuned with the center CDU, and the right receiver is tuned with the right CDU.

ILS Displays

The tuned ILS frequency displays on the PFD; and, on the ND in the approach mode. When receiving the identification signal, the decoded identifier displays.

Localizer and glideslope deviation display on the PFD. Localizer and glideslope deviation, and selected course display on the ND when the related ND is in the approach mode.

VOR

The FMC usually tunes the two VOR receivers. The receivers can be tuned manually on the NAV RADIO page.

VOR Tuning

The FMC tunes a VOR and a collocated DME for position updating 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/frequencies on the NAV RADIO page, the FMC cannot tune any other VOR/DME station for updating.

If both FMCs fail, left and right VOR receivers can be tuned on the related CDU ALTN NAV RADIO page.

VOR Displays

Left and right VOR bearings display on the ND when the VOR/ADF switch is in VOR position. VOR data is green. With the VOR mode selected, the VOR frequency and selected course display at the top of the ND and course deviation displays.

The NAV RADIO page displays FMC–tuned or manually–tuned VOR data. POS REF page 2 displays identifiers of the VOR stations used for FMC position updating.

Navaid Identifier Decoding

The Morse code identifier of a tuned VOR, ILS, DME, or ADF can be converted to alpha characters. The decoded identifier displays on the PFD and ND. Monitoring this identifier ensures 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 show as “KAI”, or the Boeing Field ILS may show as “QBFI” or “TTTT” instead of “IBFI.”

It is essential to verify the identity of the tuned navigation station from the audio Morse code if the tuned frequency remains displayed or an incorrect identifier displays.

Transponder

The transponder panel controls two ATC transponders and the traffic alert and collision avoidance system (TCAS). Mode S operates continuously when the transponder mode selector is out of standby.

In flight, traffic displays if the transponder mode selector is in TA ONLY or TA/RA.

In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPNDR, TA ONLY, or TA/RA.

Refer to Chapter 15, Warning Systems, for a description of TCAS.

Weather Radar

The weather radar system consists of two receiver-transmitter units, an antenna, and a control panel.

Radar returns display on the navigation display (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 adjusts to the ND range selected on the EFIS control panel. Weather radar operating modes and fault conditions display on the ND.

If the EFIS control panel fails, the CDU can control the EFIS control panel functions, including the WXR

Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Clear air turbulence can not be sensed by radar.

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Introduction

The flight management system (FMS) aids the flight crew with navigation, in–flight performance optimization, fuel monitoring, and flight deck displays using Flight Management Computers (FMCs). 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 fly 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

Under normal conditions, the left FMC is designated the master for CDU operations. The left FMC determines which key pushes should be executed and in what order. It then transmits the key-push messages to the right FMC. Each FMC processes the key-push message and updates its own CDU.

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 en route and terminal area navigation, RNAV approaches, and to supplement primary navigation means when conducting other types of nonprecision approaches.

Two IRUs in conjunction with one FMC and two FMS-CDUs meet the requirements as the sole means of navigation for flights up to 18 hours duration.

Control Display Units (CDUs)

The flight crew controls the FMC using three CDUs. The CDUs give alternate display and navigation capability if both FMCs fail (refer to the Alternate Navigation section of this chapter). Refer to Chapter 10, Flight Instruments, Displays for a description of alternate display control.

Introduction

When first powered, the FMS is in 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 flight plan and load sheet data into the CDU. 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.

Some ATC information can be entered into the CDU by data link.

Some company information can be entered into the CDU by data link.

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 the 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

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

Climb phase starts at thrust reduction for climb and terminates at the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

Cruise phase starts at the T/C point and terminates at top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

Descent phase starts at the T/D point or when the VNAV descent page becomes active and terminates at the start of approach phase.

Approach

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, 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 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 observed for errors following:

- activation of a new data base
- power interruption
- IRU failure

When operating more than 21 nm off the active route, the FMC does not sequence the active waypoint when the airplane passes the waypoint. LNAV can only capture the active leg. It cannot capture an inactive leg in the active route. The DIRECT TO or INTERCEPT COURSE TO procedures can be used to create an active leg for capture.

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 procedures can be used to start waypoint sequencing beyond the vectors leg.

When entering airways on a route page, the start and end waypoints must be in the data base. Otherwise, the 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 ACTIVATE prompt
- pushing execute (EXEC) key

Altitude constraint – a crossing restriction at a waypoint.

Delete – using 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. 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 careted (< or >) line to remind the flight crew to enter or validate data.

Resynchronization - one FMC loading data into the other when a significant difference between the two FMCs is detected.

Select – pushing a key to obtain necessary data or action, or to copy selected data to the scratchpad.

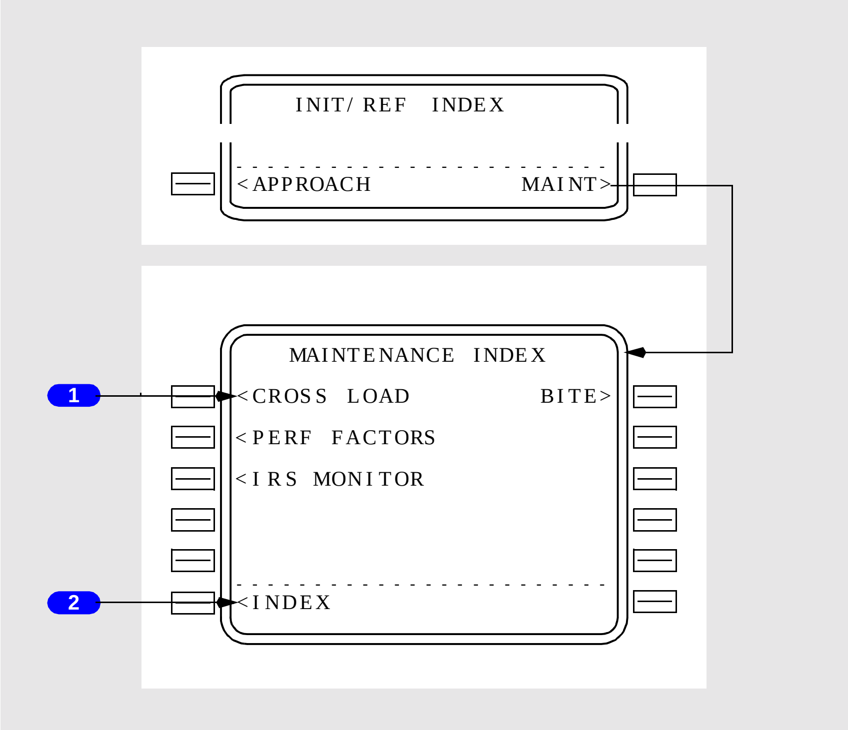
Speed restriction – an airspeed limit.

Speed transition – an airspeed limit associated with a specified altitude entered by the FMC.

Waypoint – a point on the route or in the navigation data base. 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

MAINTENANCE INDEX page prompts are only used on the ground.



1 Maintenance Prompts

All prompts on this page are maintenance functions.

2 INDEX

Push - displays the INIT/REF INDEX page.

Navigation Position (GPS equipped airplanes)

The FMC determines present position from these navigation systems: GPS, navigation radios, and IRS. 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 reliable, the FMC position comes from the IRS. In the case of IRS-only navigation, at least one IRU is required. The FMC requires position data from the IRS. All other position sources are validated against the IRS position.

FMC Position Update

The FMC position may be manually updated to the mixed IRS position. This update is accomplished using the PURGE prompt on the POS REF page 2.

On the ground, the FMC calculates present position based on IRS and/or GPS data.

When GPS is not active, pushing a TO/GA switch updates the FMC position to the landing 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 theTAKEOFF REF page.

In flight, the FMC position is continually updated from the GPS, navigation radios, and IRS. Updating priority is based on the availability of valid data from the supporting systems.

During an ILS/LOC approach, localizer signals (LOC, LOC DD, LOC VD, or LOCGPS) update the FMC.

The navigation radios update the FMC position using two DME stations (DD) or one VOR and its colocated DME(VD).

FMC selected stations display on the POS REF page 2. Position error can be detected by selecting the EFIS POS switch and observing calculated VOR (Chapter 10, VOR navigation display symbology) positions relative to VOR/DME RAW DATA radial and distance information.

The FMC automatically tunes VOR, DME, and ILS radios and displays them on the ND and CDU NAV RADIO page. Selection is related to the active route and any procedure (SID, STAR, etc.) in the active route. Manually selecting VOR frequencies 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 from navigation sensor positions occurs in the following priority order:

- one LOC and GPS
- one LOC and collocated DME
- GPS
- two DME stations
- one VOR with a collocated DME
- IRS

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
GPS valid, LOC invalid	GPS L, GPS R	GPS
LOC, GPS valid*	LOC–GPS	LOC GPS
LOC, DME DME valid; GPS invalid*	LOC–RADIO	LOC DD
LOC, VOR DME valid; GPS invalid*	LOC–RADIO	LOC VD
LOC valid; GPS, DME, VOR invalid*	LOC	LOC
DME valid; GPS invalid	RADIO	DD
VOR DME valid; GPS invalid	RADIO	VD
GPS, VOR, DME invalid	INERTIAL	IRS(X)

* 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 the navaid elevation
- the airplane track is within 45° of the localizer course for a frontcourse approach or 135° for a backcourse approach
- the airplane is less than 20 nm from the localizer navaid for a frontcourse approach or less than 12 nm for a backcourse approach
- the airplane is within 25° of the localizer center for a frontcourse approach or 155° for a backcourse approach

FMC Polar Operations

Polar operation begins when the FMC calculated airplane position passes north of 84°N or south of 84°S. FMCs revert to split IRS operation, the CDU message SPLIT IRS OPERATION displays, and each FMC connects to a different IRU. Radio update corrections are lost and FMCs incrementally remove the difference between FMC and IRU positions.

Split IRS operation may result in differences between Captain’s and F/O’s NDs if GPS updating is not available.

When GPS is available, GPS updating continues until the FMC position passes north of 88.5°N or south of 88.5°S. At this point, GPS update corrections are lost and the FMC position becomes a single IRU position. When the FMC position passes south of 88.5°N or north of 88.5°S, GPS updating resumes.

When both FMC positions pass south of 83.5°N or north of 83.5°S latitude, FMCs return to normal operation using the triple mixed IRU position.

High Latitude Operations

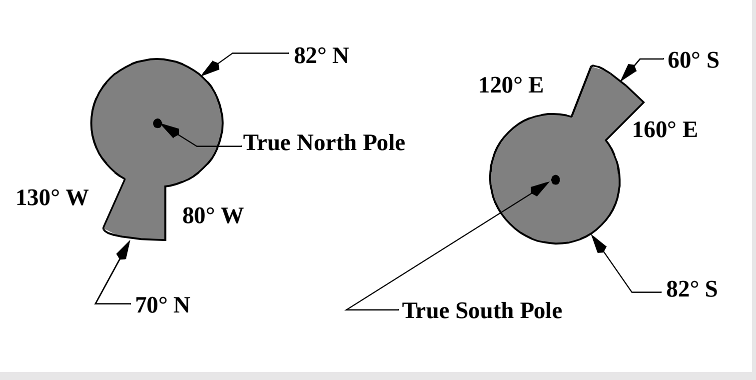
The heading reference for PFDs, NDs, and RMI changes to true north at 82°N (or north of 70°N between 80°W and 130°W) or at 82°S (or south of 60°S between 120°E and 160°E).

At latitudes between 82°N (or south of 70°N between 80°W and 130°W) and 82°S (or north of 60°S between 120°E and 160°E), the FMC and IRU reference is determined by Heading Reference switch position. Outside this region, the FMC and IRUs reference true north regardless of Heading Reference switch position.

Automatic switching to a true north reference annunciates by a flashing white box around the word TRU on the ND. A TRUE heading reference can be selected with the Heading Reference switch inside or outside high latitudes. The ND displays a green box around the word MAG to annunciate the change back to magnetic reference. If the heading reference is TRU in the descent phase, the ND displays an amber box around the word TRU.

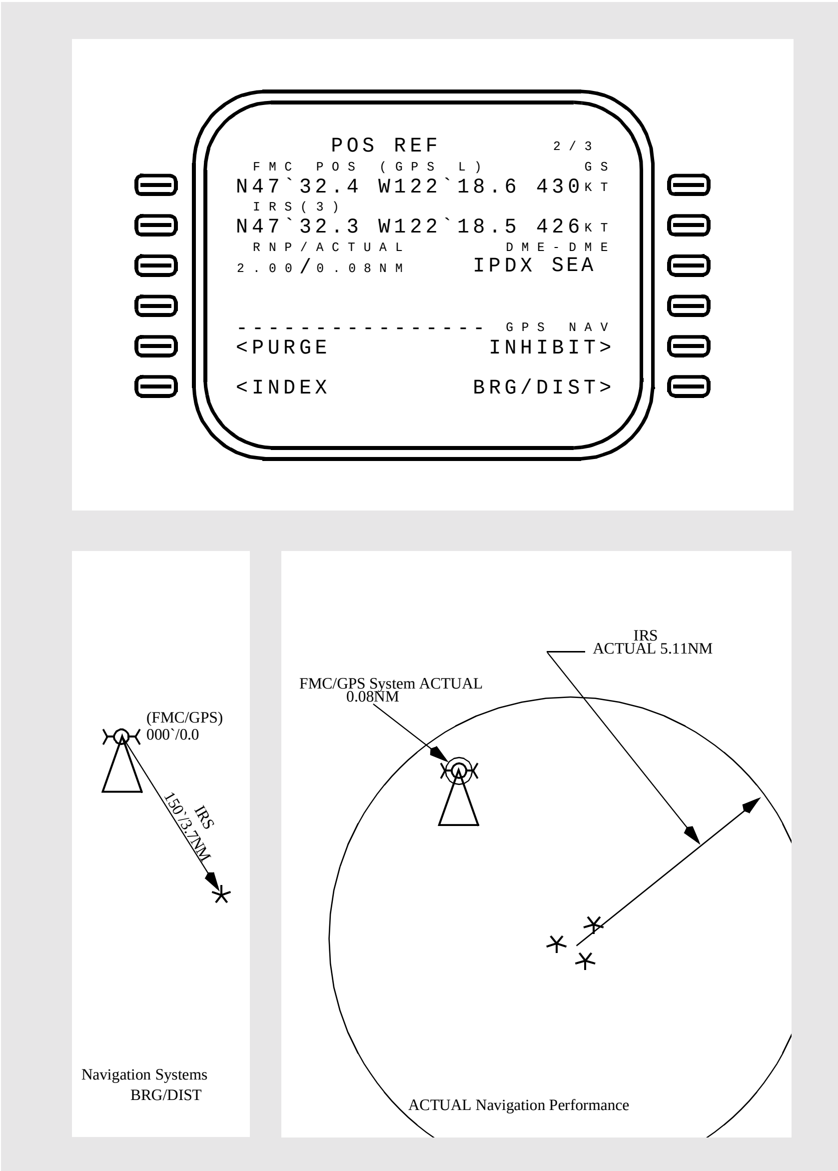
Note: For autopilot operation in high latitudes using a roll mode other than LNAV, the TRUE position on the Heading Reference switch should be selected.

Areas of High Latitude Operations (with expanded MAGVAR)



Navigation Performance

The FMC uses data from navigation systems to accurately calculate the position of the airplane. The current FMC position is on line 1 of the POS REF page 2. The primary source of update is in parentheses above the FMC position. The inertial reference system position is on line 2. The FMC position displays on the ND at the tip of the triangle. The IRS position displays relative to the FMC position. The ACTUAL navigation performance circles shown below do not display on the ND.


POS REF 2/3
FMC POS (GPS L) GS
N47`32.4 W122`18.6 430KT
IRS(3)
N47`32.3 W122`18.5 426KT
RNP/ACTUAL DME-DME
2.00/0.08NM IPDX SEA
---------------- GPS NAV
<PURGE INHIBIT>
<INDEX BRG/DIST>
(FMC/GPS)
000`/0.0
IRS
150`/3.7NM
Navigation Systems
BRG/DIST
IRS
ACTUAL 5.11NM
FMC/GPS System ACTUAL
0.08NM
ACTUAL Navigation Performance

Actual Navigation Performance

Actual navigation performance (ANP) is the FMC current computed position accuracy. It is titled ACTUAL and displays on the POS REF page 2 for the navigation system displayed in title line 1. 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.

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, when required. RNP is on POS REF page 2.

Lateral Navigation (LNAV)

LNAV normally provides great circle courses between waypoints making up the active route. When an FMC database procedure is entered in the active route, the FMC commands a heading, a track, or a DME arc to comply with the procedure.

Waypoints

Waypoint identifiers display on the CDU and navigation display.

The CDU message NOT IN DATABASE displays if a manually entered waypoint identifier is not in the database. Waypoints can be entered as latitude/longitude, place/bearing/distance, or place bearing/place bearing.

FMC–generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoints

VHF – waypoints located at VHF navaids (VOR/DME/LOC) are identified by one, two, three, or four character facility identifier. Example: Los Angeles VORTAC – LAX.

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. Example: 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. Example: ROUGH ROAD becomes RROAD

Unnamed Waypoints

When 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 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

Waypoints 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
- N75° W170° becomes 75N70
- N50° E020° becomes 5020E
- N06° E110° becomes 06E10
- S52° W075° becomes 5275W
- S07° W120° becomes 07W20
- S50° E020° becomes 5020S
- S06° E110° becomes 06S10

Procedure Arc Fix Waypoints

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.

Runway–related fixes – waypoints located at unnamed runway–related fixes are identified by adding a two–letter prefix to the runway number:

- RX – runway extension fix
- FA – VFR final approach fix
- CF – final approach course fix
- FF – final approach fix
- IF – initial approach fix
- OM – outer marker
- MM – middle marker
- IM – inner marker
- BM – back course marker
- MD – minimum descent altitude
- A – (+ an alpha) step down fix
- RW – runway threshold
- MA – missed approach point other than RW
- TD – touchdown point inboard of RW

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:

- C( ) – final approach course fix
- F( ) – final approach fix
- P( ) – missed approach point
- I( ) – initial approach fix
- D( ) – minimum descent altitude
- T( ) – touch down point
- R( ) – runway centerline intercept.
- ( )I – ILS
- ( )L – localizer only
- ( )B – backcourse ILS
- ( )D – VOR/DME
- ( )V – VOR only
- ( )S – VOR with DME points
- ( )N – NDB
- ( )Q – NDB with DME points
- ( )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. Selecting the latitude/longitude of the correct waypoint enters the correct waypoint on the original page.

When a waypoint which has a duplicate identifier in the active route is entered in the scratchpad and line selected, the SELECT DESIRED WPT page does not display. A direct-to the downtrack waypoint displays on the ND. Entering the local waypoint (the duplicate) using latitude/longitude, place/bearing/distance, or place bearing/place bearing enables the modification.

Conditional Waypoints

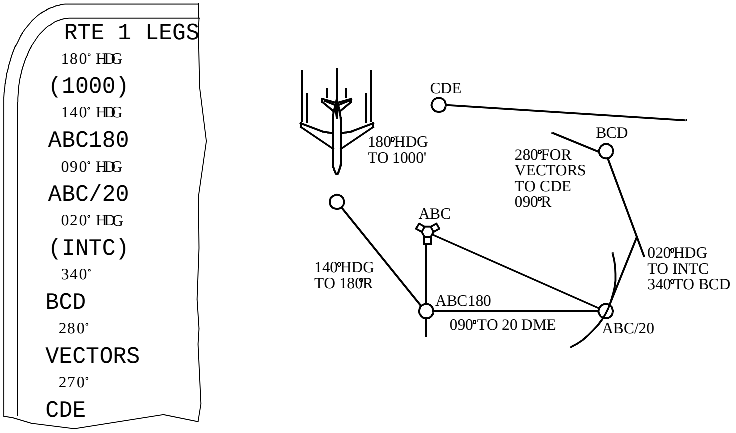
Conditional waypoints may display in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically–fixed position. The types of conditions are:

- climb/descent through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- 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.

(1000) is a conditional waypoint. LNAV guidance is to hold a 180° heading until above 1,000 feet; then, turn to a heading of 140°.

EXAMPLE: **MEANING:**



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 displayed as N47W008
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displayed 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
- SEA240/OLM320 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.

If the number of waypoints in the existing route plus the new waypoints added to reach the new intersection (XJ52) exceeds 120, the FMC rejects the second entry. Repeated attempts to enter the second airway result in an FMC resynchronization. Delaying modification of the route until the number of waypoints to reach the new intersection does not exceed 120 prevents resynchronization.

Manually Entered Latitude or Longitude Reporting Point Waypoints

Latitude or longitude reporting waypoints are entered as the latitude or longitude followed by a dash, then the increment chosen for the following 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 where they are created.

Along–track waypoints are created 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 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 radio (or GPS) 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 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.

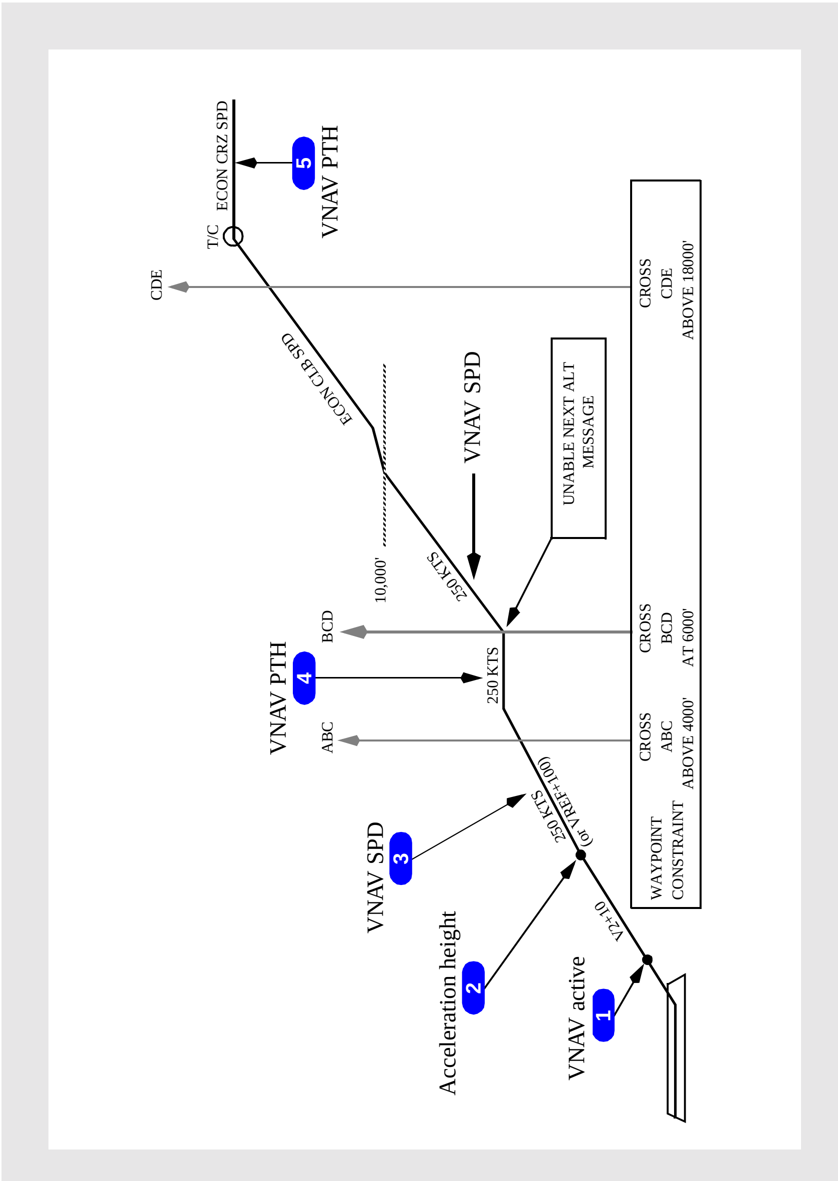
Vertical Navigation (VNAV)

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 display in large font. FMC predicted values do not act as constraints, and display in small font.

Takeoff and Climb



1 Takeoff

When 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 V2 + 10 and V2 + 25.

2 Acceleration Height

At acceleration height, flap retraction, or AFDS altitude capture below acceleration height, VNAV commands an airspeed increase to the greater of 250 knots, VREF + 100 knots, or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the reference thrust limit to the armed 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 that are part of the SID entered into the active route. Autothrottle uses the armed climb reference 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

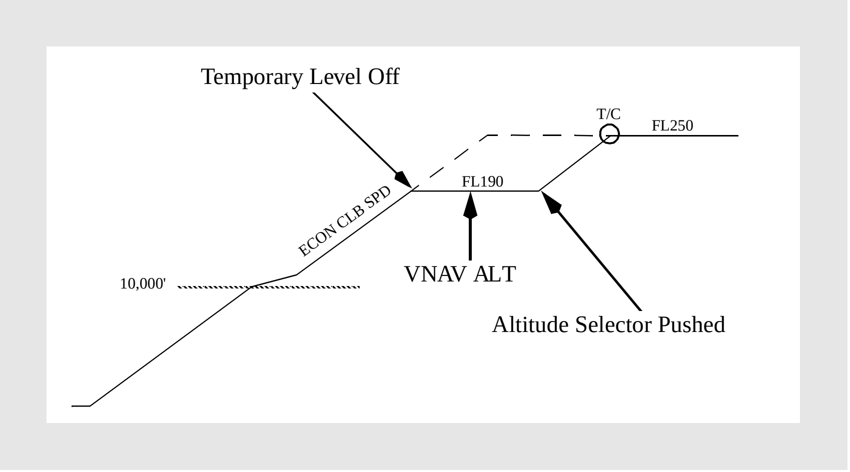
If the FMC predicts the airplane will not reach an altitude constraint, the FMS-CDU message UNABLE NEXT ALTITUDE displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower arispeed to provide a steeper climb; or, climb derates can be deleted on the Thrust Limit page.

5 Top Of Climb (T/C)

The point where 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 circle with the label T/C.

MCP Altitude Intervention



Whenever the airplane levels 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 altitude 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 levels at FL250 in cruise.

Cruise

During cruise, the FMC commands economy cruise speed until reaching the top–of–descent (T/D) point. Alternate cruise speed options are:

- long range (LRC)
- engine out (ENG OUT), or
- flight crew entered speed

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.

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 CRZ page displays ACT ECON CRZ CLB.

Step Climb

Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted 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 altitude on the CRZ or RTE LEGS page overrides the FMC step climb predictions. Entry of a step altitude on the RTE LEGS page overrides a “Step To” entry made on the CRZ page.

Predicted step altitudes display on the RTE LEGS page. The distance and ETA to the next step point (predicted or flight crew entered) display on the CDU CRZ and PROG pages. They also display on the ND map display with a green circle and S/C label.

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.

Descent

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point. An E/D is created when an altitude constraint is added to a waypoint in the descent phase. The altitude constraint can be entered manually or may be part of a selected VFR or instrument approach procedure.The E/D can be created at one of these positions:

- the final approach fix
- the outer marker (for some ILS approaches)
- the runway threshold for a VFR approach
- the runway threshold for a nonprecision approach with a runway waypoint on the RTE LEGS page, or
- the missed approach point for a nonprecision approach not showing a runway waypoint on the RTE LEGS page

Entering an arrival procedure provides an E/D.

The top of descent (T/D) point is calculated back the active route from the E/D. It is the point where the cruise phase changes to the descent phase. The T/D displays on the ND as a green circle with the label T/D.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
- descent wind speed decreasing with decreasing altitude
- applicable target speed

With the MCP altitude set below the current airplane altitude and at the T/D point, the FMC commands idle thrust for the level deceleration segment and pitch to track the descent path. Usually, the descent speed is economy above 10,000 feet and 240 knots below 10,000 feet. Final deceleration is commanded to arrive at the final approach fix or the outer marker at 170 knots.VNAV ALT annunciates if the airplane levels at an MCP altitude not in the FMC, or if the airplane passes the T/D and the altitude window has not been set lower.

Target speeds are changed by entries on the LEGS or DESCENT pages. Forecast descent winds and TAI/ON ALT for approach idle thrust may be entered on the CDU FORECAST page.

If an unexpected (no entries on the DESCENT FORECASTS page) headwind results in a significant reduction in airspeed to maintain path, thrust increases. The FMS-CDU message THRUST REQUIRED displays if the A/T is disconnected and thrust is required to maintain path. The FMS-CDU message DRAG REQUIRED displays if an unexpected tailwind results in a significant increase in airspeed to maintain path. If the airspeed deviation to maintain path is excessive, the FMC directs the airplane to depart the descent path.

Approach

For VFR and nonprecision approaches displaying a runway waypoint on the RTE LEGS page, the FMC calculated path is to a point 50 feet above the runway threshold.

For a non–precision approach without a runway waypoint on the RTE LEGS page, the VNAV path is calculated to the MDA or a calculated altitude at the missed approach point. The calculated altitude may be below the MDA to ensure a flight path angle and normal threshold crossing height.

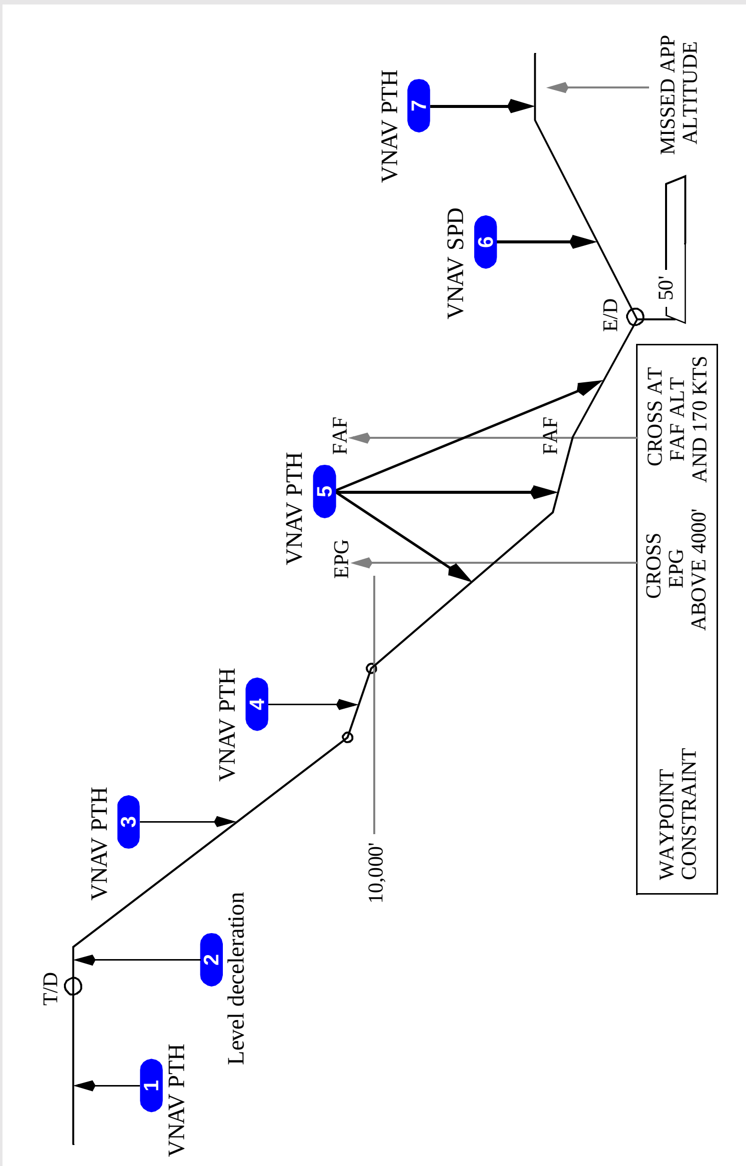
Note: It is the flight crew’s responsibility not to descend below the MDA until adequate visual contact is achieved.

VNAV provides pitch guidance through the descent to the MDA. The autothrottle controls airspeed to the active FMC speed.

Go-Around

Pushing a TO/GA switch activates go-around and deletes altitude constraints through the end of descent. VNAV may be selected to complete the climb to missed approach altitude.

Cruise and Descent Profile (Nonprecision Approach)



1 **Cruise**

Before top of descent, FMC is in cruise and commands VNAV PATH 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 PATH.

3 **Descent**

Nearing descent speed, VNAV commands a descent in VNAV PATH at ECON descent speed.

4 **Descent deceleration phase**

Before the speed restriction altitude, 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 PATH at commanded speed.

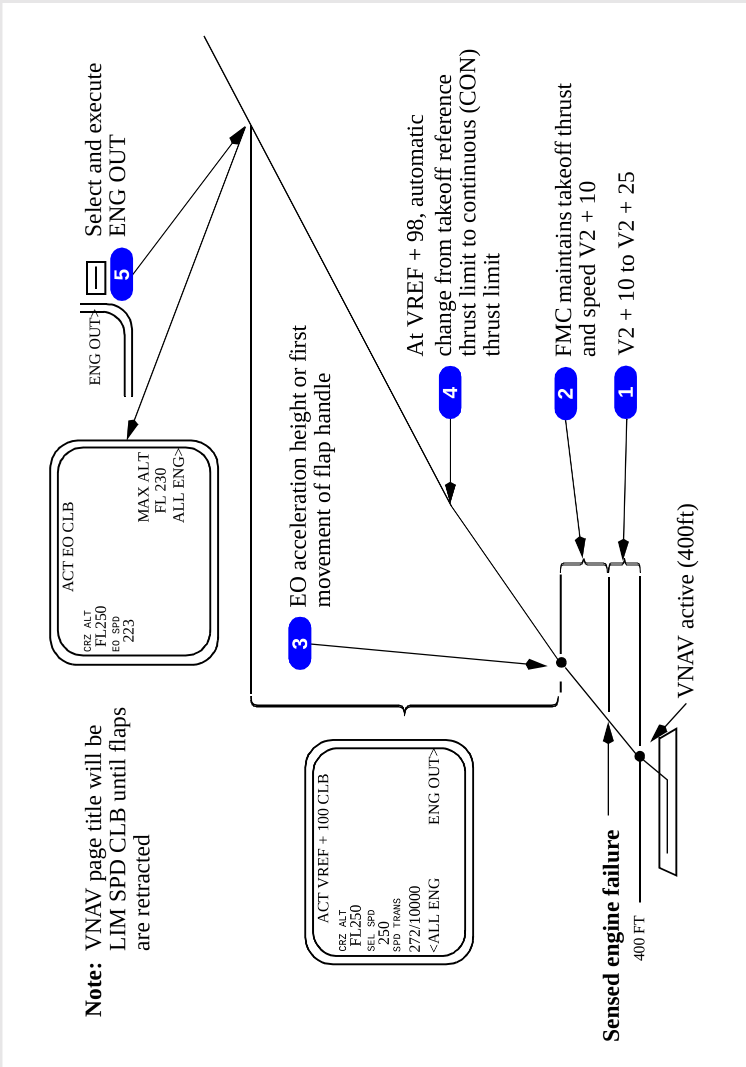
6 **Missed Approach**

When selected during missed approach, VNAV activates in VNAV SPD.

7 **Missed Approach Level Off**

At missed approach altitude, VNAV SPD changes to VNAV PATH.

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 V2+10 to V2+25 knots. Autothrottle mode is THR REF and the reference thrust limit is takeoff.

2 **Sensed Engine Failure**

Condition: after VNAV active, engine failure 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 a speed of V2 + 10. Autothrottle remains in THR REF at the selected reference thrust limit for takeoff.

3 **Acceleration Height**

Condition: at acceleration height or flap retraction has started.

Result: VNAV commands an acceleration to VREF + 100 limited by airplane configuration (flap placard). The VNAV climb page shows the ACT VREF + 100 CLB page.

4 **Thrust Reduction**

Condition: airplane has accelerated to the commanded VREF + 98 speed

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.

5 **VNAV Climb (Engine Out)**

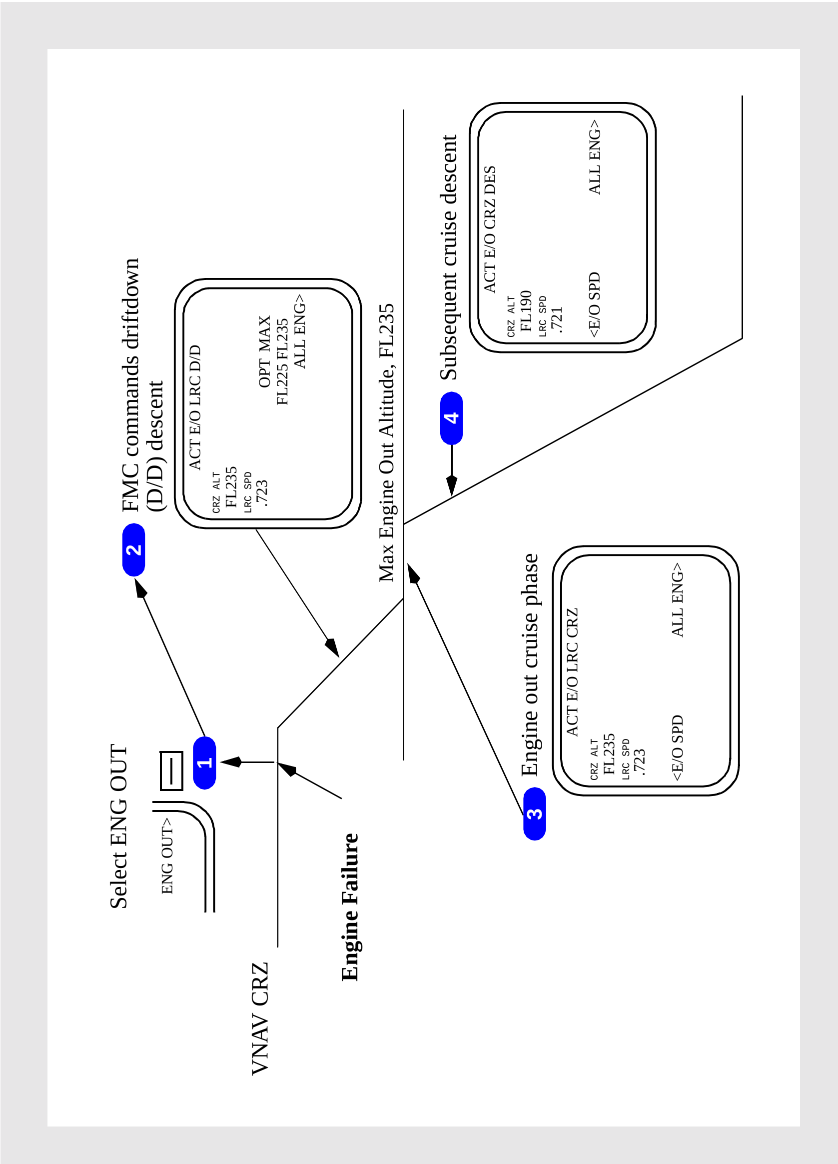
Condition: Selecting the ENG OUT> prompt on the VNAV CLB page displays applicable engine out performance data. The airline engine out speed (E/O SPD) may be selected. Execution activates engine out performance data.

Result: the FMC engine out climb function is active, the pitch mode is VNAV SPD, and CON is the reference thrust limit. A different thrust limit may be selected on the THRUST LIM page.

VNAV Climb (Engine Out above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of the ENG OUT> prompt creates a modification and displays applicable engine out driftdown (D/D) performance data. Setting the altitude window lower and executing the modification activates engine out driftdown.

Cruise (Engine Out Above EO Max Alt)



1 Engine Out Modification

Condition: Select the ENG OUT> prompt on the VNAV CRZ page.

Result: The FMC creates a modification and displays applicable engine out driftdown (D/D) performance data.

2 Drift Down Execution

Condition 1: Set the MCP altitude at or below E/O MAX altitude and execute the FMC modification. This Condition assumes clearance is approved to descend slowly to an non-standard altitude; for example, FL235.

Result: The autothrottle advances operating engines to CON thrust. VNAV commands the driftdown and E/O LRC SPD. The E/O MAX altitude becomes the cruise altitude displayed in 1L. VNAV captures the E/O MAX altitude and commands engine out LRC cruise. The descent rate is controlled to a minimum of 300 feet per minute (fpm). Time and distance for the D/D to E/O MAX altitude display at 2R.

Two other ways to activate EO D/D (to the clearance altitude) are discussed below.

Condition 2: Execute the ENG OUT modification. Then, set the clearance altitude (lower than E/O MAX) in the MCP and push the MCP altitude selector.

Result: Initially, the airplane remains at the MCP altitude, the pitch mode changes to VNAV ALT, the reference thrust limit is CON, and FMC speed is E/O LRC SPD. After setting the MCP altutude window and pushing the altitude selector, the airplane descends in a VNAV driftdown to the clearance altitude in 1L. Initial descent rate may be greater than Condition 1, depending how much airspeed is lost before pushing the altitude selector. If the airspeed has decreased below E/O LRC SPD, the descent rate increases to regain the airspeed.

Condition 3: Set the clearance altitude (lower than E/O MAX) in the MCP, push the altitude selector; then, after the descent is established, execute the FMC modification (ENG OUT).

Result: After pushing the altitude selector, the airplane descends in a normal VNAV cruise descent at four–engine economy cruise speed. The thrust limit is CLB/CRZ and the autothrottle maintains cruise airspeed. Executing the FMC modification while still above E/O MAX altitude sets the driftdown descent airspeed to E/O LRC SPD. The reference thrust limit becomes CON. The airplane initially descends at economy cruise airspeed and approximately 1,250 fpm. After executing the ENG OUT modification, the commanded airspeed is E/O LRC SPD. The rate of descent decreases to a minimum of 300 fpm.

3 Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. Thrust limit remains in CON. VNAV PTH displays as the pitch mode.

4 Subsequent Cruise Descent

Condition: FMC in engine out mode, setting a lower MCP altitude, and pushing the altitude selector.

Result: VNAV cruise descent at approximately 1,250 feet per minute at E/O LRC airspeed. The thrust limit remains CON and the autothrottle adjusts to maintain the E/O LRC airspeed. The altitude set on the MCP becomes the CRZ ALT on the EO CRZ page.

Required Time of Arrival (RTA)

VNAV controls cruise speed to arrive at a specified waypoint within ± 30 seconds of a specified time. The FMC displays the scratchpad message, UNABLE RTA, if the RTA is not achievable. RTA is not available with engine out.

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.

FMC Databases

The FMC contains two databases:

- performance
- navigation

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 crew can enter correction factors for drag and fuel flow to refine the database.

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 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.

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

Thrust limits are expressed as N1 limits. Thrust equalization references N1.

Thrust management calculates a reference thrust for the following thrust settings:

- TO – takeoff
- TO 1 – takeoff one
- TO 2 – takeoff two
- D–TO – assumed temperature takeoff
- D–TO 1 – derate one assumed temperature takeoff
- D–TO 2 – derate two assumed temperature takeoff
- CLB – climb
- CLB 1 – climb one
- CLB 2 – climb two
- CRZ – cruise
- CON – continuous
- GA – go–around

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 at the top of the EICAS display.

With VNAV active, an engine failure, and flaps fully retracted, the reference thrust limit changes to CON at VREF + 98. The planned thrust reduction point is inhibited.

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 or an entry of 5 for flaps 5.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life.

Derate/Variable Takeoff Rating

Two fixed derates, TO1 and TO2, can be selected on the THRUST LIM page.

With both TO1 and TO2, 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.

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.

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.

Derated Thrust Climb

During climb, CLB 1 and CLB 2 derates are gradually removed. In cruise, the thrust reference defaults to CLB or CRZ as set by maintenance.

Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a 10% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 15,000 feet. CLB 2 uses a 20% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 15,000 feet.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of climb derate. For a thrust reduction of up to 5 percent, maximum climb thrust is selected by the FMC. For takeoff thrust reductions or derates from 5 percent to 15 percent, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions or derates greater than 15 percent. On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity indicating system (FQIS) or from manual entries. Fuel quantity values display on the PERF INIT page as calculated (CALC), MANUAL, or SENSED. They also display on the PROGRESS page as totalizer and calculated.

The FMC usually uses the calculated value for performance computations. Before engine start, the calculated value is automatically set to agree with the FQIS value. When the FMC receives a positive fuel flow signal at engine start, the calculated value disconnects from the FQIS and decreases at the fuel flow rate.

During fuel jettison, the calculated value is set equal to the FQIS value. When fuel jettison is completed, the calculated value disconnects from the FQIS and decreases at the fuel flow rate. This fuel quantity value displays as CALC on the PERF INIT page and as CALCULATED on the PROGRESS page.

If the flight crew inputs a fuel quantity, the line title changes to MANUAL. The manual value replaces the FQIS value and is updated by the FMC using fuel flow rate, the same as for the calculated value.

If fuel flow data becomes invalid after engine start, the calculated value is considered invalid and the FMC uses FQIS quantity for performance computations. In this case, fuel quantity displays as SENSED on the PERF INIT page and as TOTALIZER on the PROGRESS page.

Fuel flow signals are also used to calculate the fuel used by the engines. FUEL USED displays on PROGRESS page. It is reset to zero on the ground after engine shutdown, and when the FMC receives a positive fuel flow at the next engine start.

The scratchpad message FUEL DISAGREE–PROG 2 displays if the FMC calculates a large difference between the total sensed fuel quantity and calculated value. The flight crew should select PROGRESS page 2, and select the fuel value for the FMC to use for the remainder of flight.

The FMC continually estimates the fuel at the destination airport if the active route is flown. FMC calculated fuel predictions are based on landing gear and flaps up during climb, cruise, and descent. Any prolonged flight with landing gear and/or flaps extended increases fuel required. The increased fuel consumption will not be correctly displayed on the FMC fuel predictions pages. The CDU message INSUFFICIENT FUEL displays if the estimate is less than the fuel reserve value entered on the PERF INIT page.

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, performance data displayed on the PERF INIT page must be reentered. The route previously in use may be available. If so, it must be activated. If the route is not available, the route must be reentered.

Before activating LNAV, the FMC must be given guidance to the route. Selecting the appropriate waypoint and performing a direct to or course intercept to the waypoint enables LNAV activation.

FMC Failure

Single FMC Failure

After loss of a single FMC, a resynchronization may occur. The active route may become inactive, the performance data may be lost, and LNAV and VNAV modes may fail. To regain FMC operation, activate and execute the flight plan, enter the necessary performance data, and select LNAV and VNAV.

Note: If the MENU page and the scratchpad message TIMEOUT - RESELECT display, the FMC is no longer connected to the CDU. Use the <FMC prompt on the MENU page to connect the CDU to the FMC.

On the ground, the scratchpad message SINGLE FMC OPERATION displays after loss of either FMC.

In flight, the scratchpad message SINGLE FMC OPERATION displays on only one CDU after loss of the FMC not selected on the FMC selector. The scratchpad message TIMEOUT - RESELECT displays on the CDU with the operative FMC.

In flight, the scratchpad message TIMEOUT - RESELECT displays on both CDUs after loss of the selected FMC. The FAIL light illuminates in all three CDUs. The navigation display with the NAV source selector selected to the failed FMC is lost. There is a time delay before the FMC message FMC LEFT, RIGHT displays. When the FMC selector is rotated to the operative FMC, the FMC is available through the CDU. Once an FMC page is accessed, the scratchpad message SINGLE FMC OPERATION displays on the CDU with the operative FMC.

Dual FMC Failure

If both FMCs fail, LNAV and VNAV fail. The CDUs supply route data to their related ND. Alternate navigation using CDUs is discussed in Section 50 of this chapter. Autothrottle operation is not available.

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.

Intentionally
Blank

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 load takeoff data onto the TAKEOFF REF pages.

FMS-CDU Operation

Work in a slow, deliberate manner while operating the CDU. Avoid pushing more than one key at a time. Avoid entering information in both CDUs at the same time. Do not push keys when the system is resynchronizing. Resynchronizations complete in approximately 15 seconds. During this time, the respective CDU displays a failed condition, while the other CDU displays the message RESYNCHING OTHER FMC.

Uncareted, small font, or default values are not required to be line-selected to be valid. For example, acceleration heights and the thrust reduction point on the Takeoff Ref page are valid in small font.

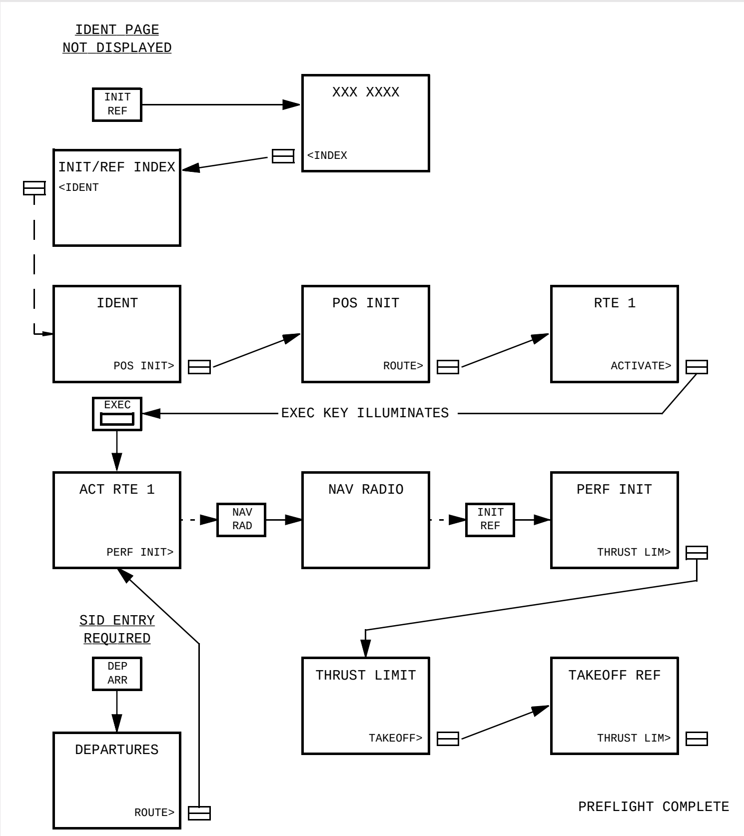
Preflight Page Sequence

The usual FMC power–up page is the identification page. 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 TAKEOFF page leads the flight crew to the preflight page missing data.

Airplane inertial position is required 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. Discussion of each page includes a method to display the page.

When the route includes SIDs and STARs, they can be entered using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed and the route is modified on the ROUTE and RTE LEGS pages. Speed/altitude restrictions are entered and removed on the RTE LEGS page. RTE LEGS page is described in the FMC Takeoff and Climb section of this chapter.

Waypoint, navigation, airport, and runway data is referenced on REF NAV DATA page. REF NAV DATA page is described in the FMC Cruise section of this chapter.

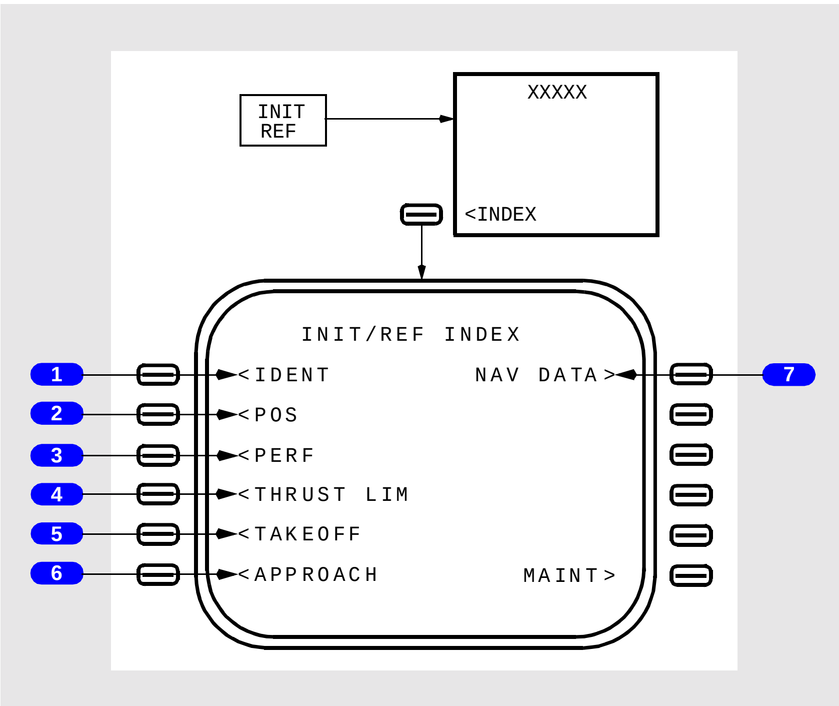
VNAV performance is improved if forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints is entered on the the WIND page. WIND page is described in the FMC Cruise section of this chapter.

Preflight Pages – Part 1A

Preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

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)

IDENT page is used to verify basic airplane data and currency of the navigation database.

2 Position (POS)

POS INIT page is used for IRU initialization.

3 Performance (PERF)

PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

4 Thrust Limit (THRUST LIM)

THRUST LIM page is used to select thrust limits and derates.

5 TAKEOFF

TAKEOFF REF page is used to enter takeoff reference data and V speeds.

6 APPROACH

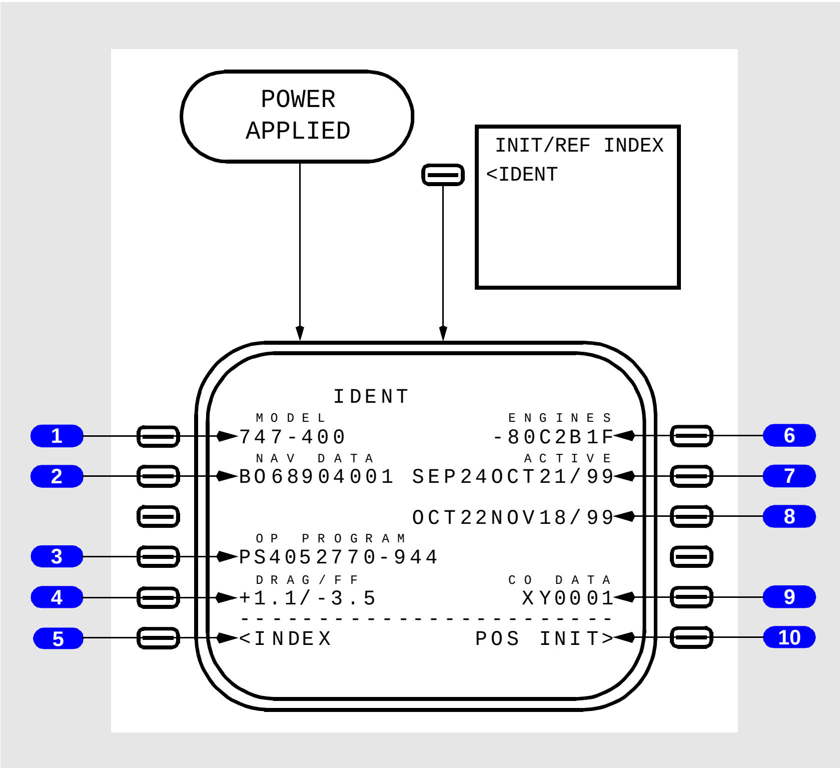
APPROACH REF page is used for entry of the approach VREF speed.

7 Navigation Data (NAV DATA)

REF NAV DATA page is used for data on waypoints, navaids, airports, and runways. NAV DATA pages are accessible only from this page.

Identification Page

Most data on this page is for flight crew verification. The active navigation database can be selected.



1 MODEL

Displays airplane model from FMC performance database.

2 Navigation Data (NAV DATA)

Displays navigation database identifier.

3 Operating (OP) PROGRAM

Displays systems operating program identifier (FMC software load).

4 DRAG/Fuel Flow (FF)

Displays airplane drag and fuel flow correction factors.

5 **INDEX**

Push – displays INIT/REF INDEX page.

6 **ENGINES**

Displays engine model from the FMC performance database.

7 **ACTIVE**

Displays the effectivity date range for the active navigation database.

The active navigation database may be 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 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.

Note: The navigation database extending into calendar year 2000 will display as follows: “DECXX/JANXX111”. The “/” and year are replaced with “111”. This will display on all navigation databases thereafter. However, installation of FMC software load 14 displays the usual format; that is, “DECXX/JANXX/00”.

8 **Inactive Date Range**

Displays the effectivity date range for the inactive navigation database.

9 **Company (CO) DATA**

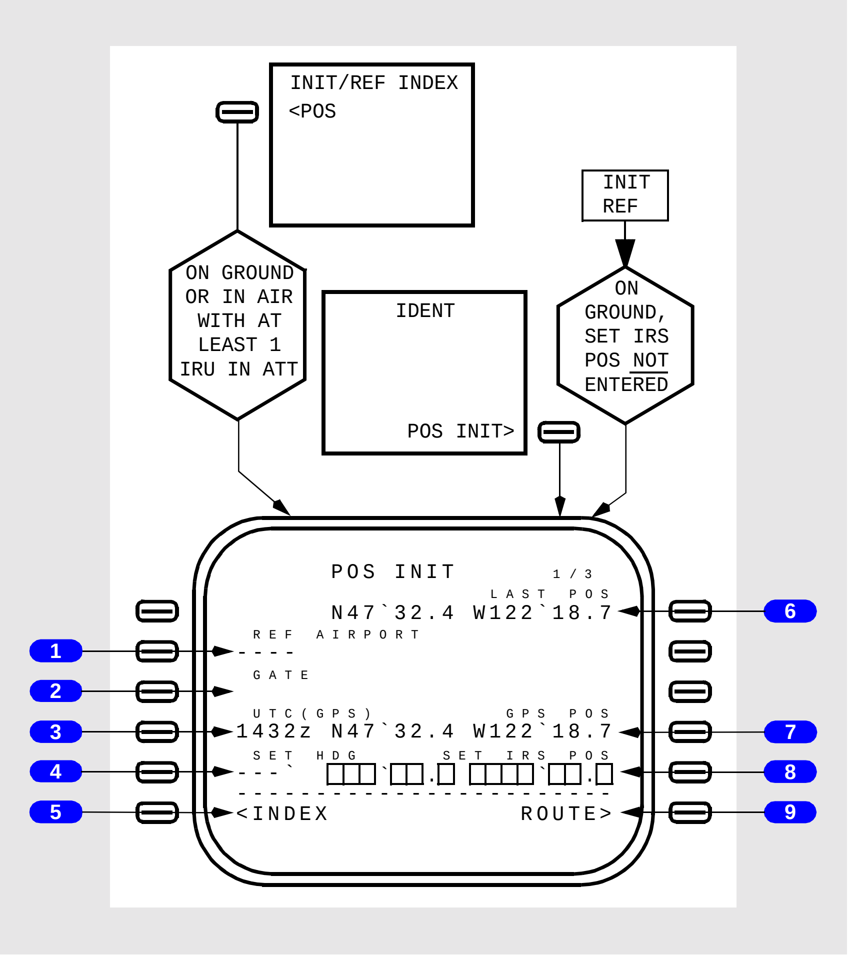
Displays airline policy file identifier.

10 **Position Initialization (POS INIT)**

Push – displays POS INIT page.

Position Initialization Page 1/3

Position initialization page allows entry of airplane present position for IRU alignment. The same page is used to enter the heading for IRUs in attitude mode.



1 Reference (REF) AIRPORT

Entry of the reference airport displays airport latitude/longitude.

Valid entries are ICAO four letter airport identifiers.

Entry blanks at lift–off.

2 GATE

Gate entry allows further refinement of the latitude/longitude position.

Valid entry is a gate number at the reference airport.

Displays latitude and longitude of the reference airport gate.

Changes to dashes when a new reference airport entered.

Entry blanks at lift–off.

3 UTC

UTC (GPS) - displays time from a GPS sensor.

UTC (MAN) -

- displays time from Captain’s clock when operative; otherwise, displays time from F/O’s clock
- time set by resetting appropriate pilot’s clock

4 SET Heading (HDG)

Dashes display if an IRU is in attitude mode.

Entering heading updates IRS magnetic heading signal for all IRUs in attitude mode.

Valid entry is 0 to 360 (0 or 360 is shown as 360°). Dashes display two seconds after entry to allow another entry.

5 INDEX

Push – displays INIT/REF INDEX page.

6 LAST Position (POS)

Displays the last FMC calculated position.

7 GPS Position (POS)

Displays GPS position. During preflight, GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

8 SET IRS Position (POS)

IRS position entry is required to initialize the IRUs.

Enter airplane position latitude and longitude. Select the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or make a manual entry.

If an entry is not made before the IRUs finish initial alignment, the scratchpad message ENTER IRS POSITION displays. If an entry has been made and the message displays, check the accuracy of the entered position for each IRU on the POS REF page and enter again even if positions are correct.

Boxes display when any IRU in align mode and present position not entered.

Blank except when an IRU in align mode.

9 ROUTE

Push – displays the ROUTE page.

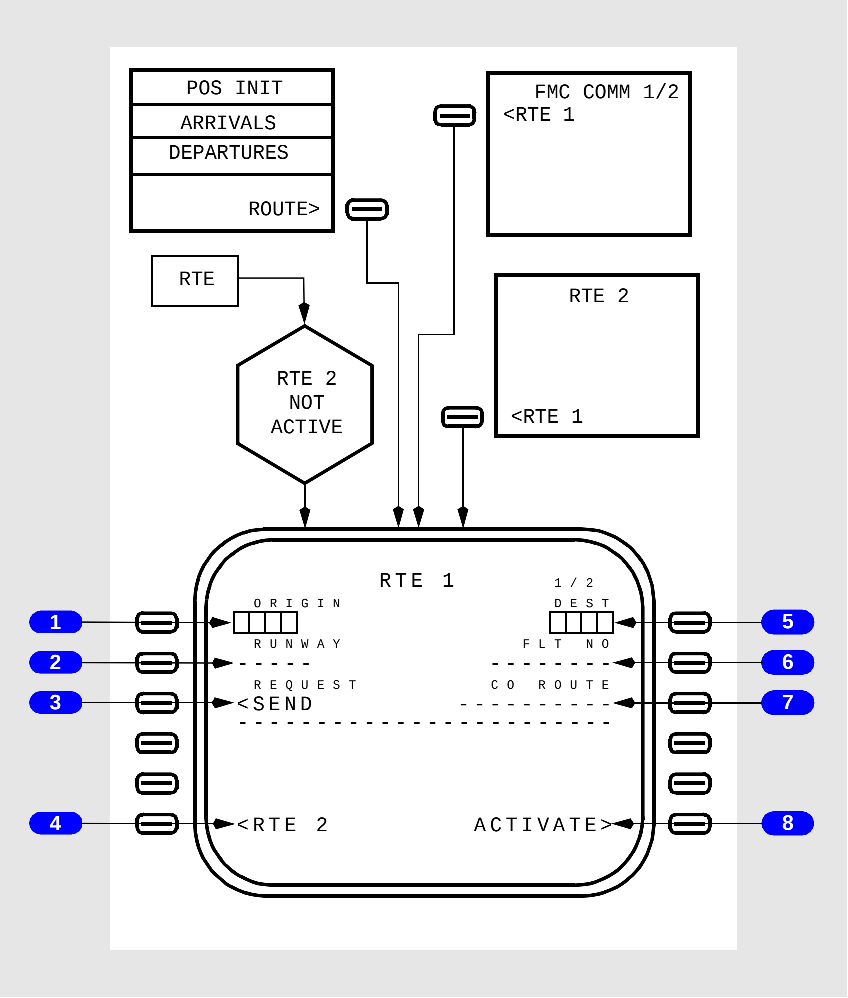
Preflight Pages – Part 1B

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 the 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. The minimum number of route pages is 2.

When RTE 2 is active, page display logic is the same as RTE 1.

Active Route With Uplink Pending



1 ORIGIN

Valid entries are ICAO airport identifiers in the navigation database.

On the ground, entry of a new origin erases the previous route. In flight, entries are valid on the inactive route.

Enables selection of departure and arrival procedures for the origin airport.

Automatically entered as part of a company route.

2 RUNWAY

Valid entries are origin airport runways in the navigation database.

Automatically entered when part of a company route.

Can be selected on DEPARTURES page.

FMC deletes runway after sequencing the first waypoint.

3 Route REQUEST

Title line displays REQUEST. Title line blank if flight plan load pending.

Flight crew can fill in origin, destination, runway, flight number, company route name, or route definition to qualify request.

Push –

- transmits data link request for a flight plan route uplink
- data line displays SENDING
- upon acknowledgement receipt, data line displays SENDsent

If data link fault occurs, title line displays DATA LINK, data line displays NO COMM, VOICE, or FAIL.

4 RTE 2

Push –

- displays RTE 2 page 1/x
- data line displays RTE 1

5 Destination (DEST)

Valid entries are ICAO airport identifiers in the navigation database.

Enables selection of arrival procedures for the destination airport.

Automatically entered as part of a company route.

6 Flight Number (FLT NO)

Valid entry is any flight crew entered or uplinked company flight number.

Flight crew entered or uplinked.

Flight number displays in PROGRESS page title.

Data line blanks at flight completion.

7 Company (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 route of flight. All company route data is entered when the route identifier is entered.

Valid entry is any flight crew entered or uplinked company route name. If the name is not contained in the NAV database, entry is allowed and the scratchpad message NOT IN DATABASE displays.

On the ground, entry of a new company route replaces the previous route.

In flight, entry of a new company route manually, or as a result of a route request downlink, may only be accomplished into the inactive route.

8 ACTIVATE

Displays on inactive route pages.

Activation of a route is required for completion of the preflight.

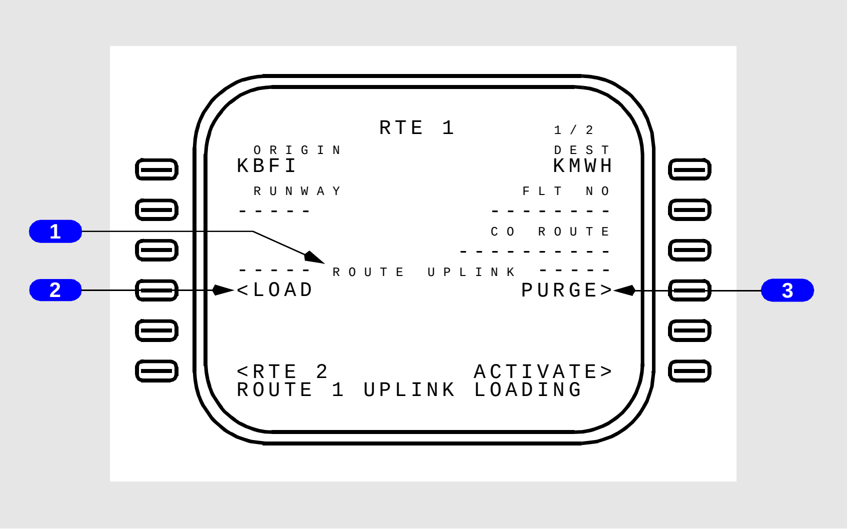
Push – arms the selected route for execution as the active route.

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.

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

Active Route After Ground Station Uplink



1 ROUTE UPLINK

Displays ROUTE UPLINK when flight plan uplink received; otherwise, dashes.

2 LOAD

Displays LOAD when uplink received and passes error check.

PUSH -

- loads uplinked flight plan
- in flight, when uplinked flight plan applies to active route, EXECUTE light illuminates and ERASE displays at 6L
- when route inactive, blanks PURGE at 4R
- displays scratchpad message ROUTE 1 UPLINK LOADING

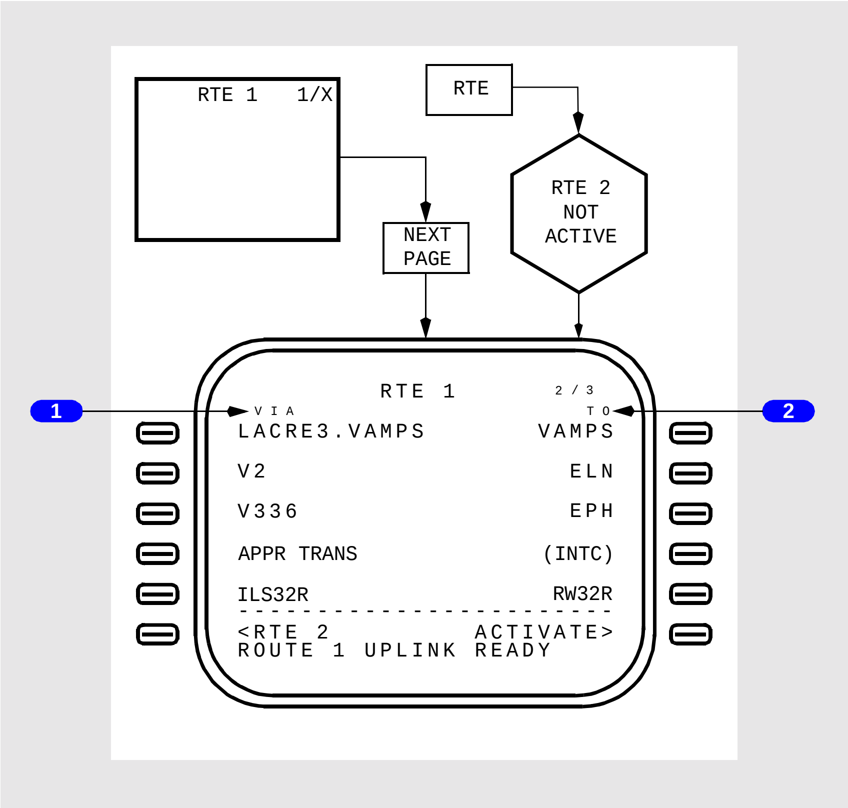
3 PURGE

Displays PURGE when an uplink has been received, passes an error check, and applies to an inactive route.

Push - rejects uplinked flight plan data.

Route Page 2/X

Subsequent route pages 2/X through X/X show the 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 display on the RTE LEGS page.



1 VIA

VIA column displays the route segment to the waypoint or termination in the TO column.

Entry of an airway in the VIA column displays boxes in the TO column.

Valid entries can also include procedures or DIRECT. Procedures are usually entered through selections on DEPARTURES and ARRIVALS pages. DIRECT usually results from 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 entering the TO waypoint first.

Dashes display for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad message INVALID ENTRY.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways not intersecting the previous airway
- airways or company routes not in the navigation database

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 and displays boxes in the first line TO waypoint. Entering a waypoint in the boxes:

- replaces the airway with dashes in the first VIA line
- enters the fix preceding the nearest abeam location on the airway in the TO waypoint
- moves the airway to line 2

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. The FMC created waypoint intersection (INTC) displays as 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 transition selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

2 TO

TO column displays the selected end waypoint or termination of the route segment in the VIA columnn.

During preflight when entering a runway on RTE page 1 and entering a waypoint in the TO column without first entering a VIA airway displays a DIRECT segment on the first VIA line from the runway threshold. When a runway has not been entered on RTE page 1, dashes display on the first VIA line.

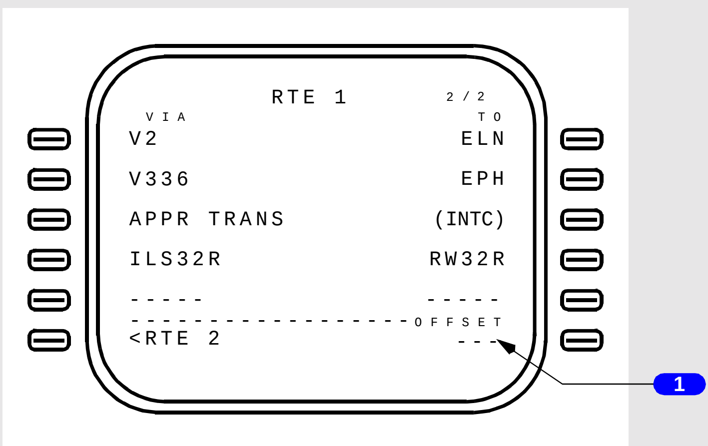
Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

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.

Route Offset

Select route offsets on the route page. OFFSET prompt displays when the airplane is in flight and not on a SID, STAR, or transition. Offset displays as a white dashed line on the ND until the offset modification is executed or erased. After execution, the offset route displays as a dashed magenta line. The original route continues to display as a solid magenta line. When executing the offset modification with LNAV active, the airplane turns to capture the offset course.



1 Route Offset

Valid entry is L (left) or R (right) XX (XX is any number between 1 and 99).

Offset propagates along the route to a Standard Terminal Arrival Route (STAR), approach or approach transition, discontinuity, end of route, track change greater than 135 degrees, or holding pattern.

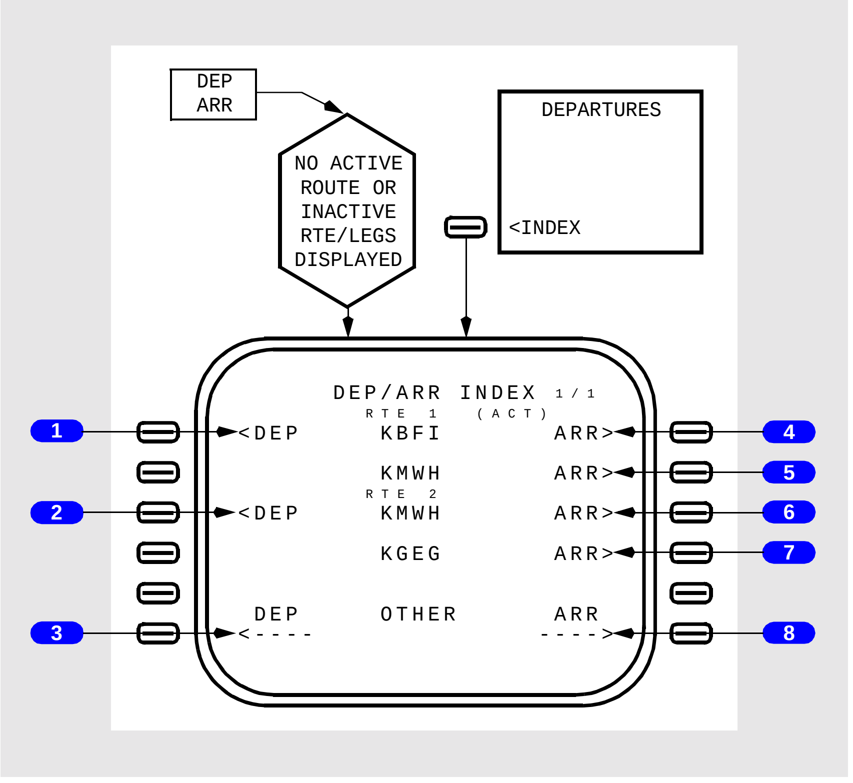
Offset removed by deleting, entering zero, or proceeding direct to a waypoint.

Preflight Pages - Part 1C

Departure/Arrival Index Page

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 page 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 departure page for route 1 origin airport.

2 Departure (DEP) – Route 2

Push – displays departure page for route 2 origin airport.

3 Departure (DEP) — Other

Displays departure page for the entered airport. Data can be viewed, but not selected because the airport is not in the route.Valid entry is four character ICAO airport identifier in the database.

4 Arrival (ARR) – Route 1 Origin

Push – displays arrival page for route 1 origin airport. Origin airport arrivals selection may be used during an air turnback.

5 Arrival (ARR) – Route 1 Destination

Push – displays arrival page for route 1 destination airport.

6 Arrival (ARR) – Route 2 Origin

Push – displays arrival page for route 2 origin airport. Origin airport arrivals selection may be used during an air turnback.

7 Arrival (ARR) – Route 2 Destination

Push – displays arrival page for route 2 destination airport.

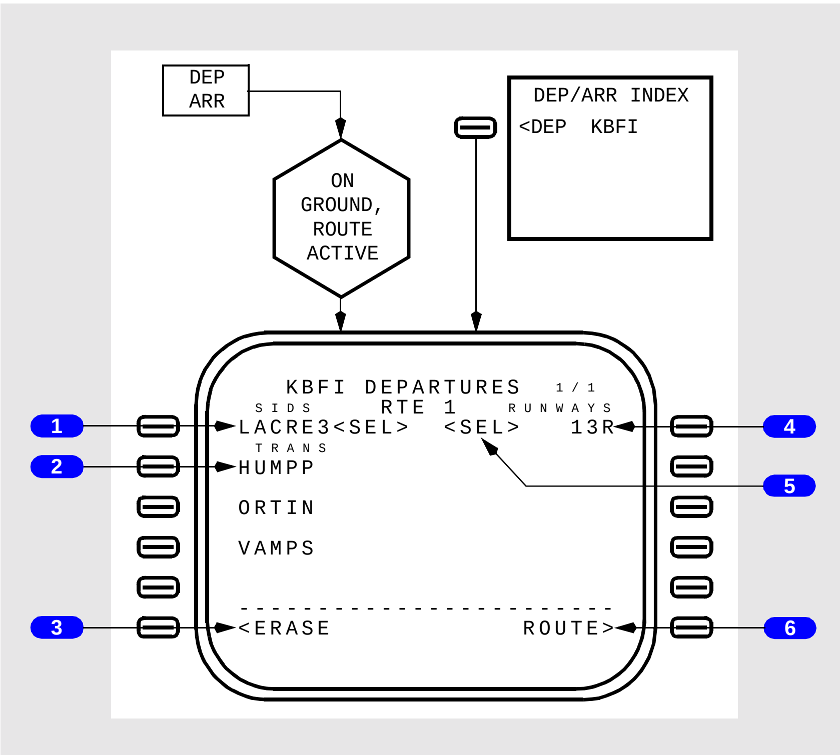
8 Arrival (ARR) – Other

Displays arrival page for the entered airport. Data can be viewed, but not selected because the airport is not on the route. Valid entry is four character ICAO airport identifier in the database.

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 into the route
- other transitions no longer display

3 ERASE, INDEX

ERASE displays when a route modification is pending. INDEX displays when no route modification pending.

ERASE -

Push – removes route modifications not executed and displays the original route.

INDEX -

Push – displays DEP/ARR INDEX page.

4 RUNWAYS

Displays a list of runways for the selected airport.

A 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

5 <SEL>, <ACT>

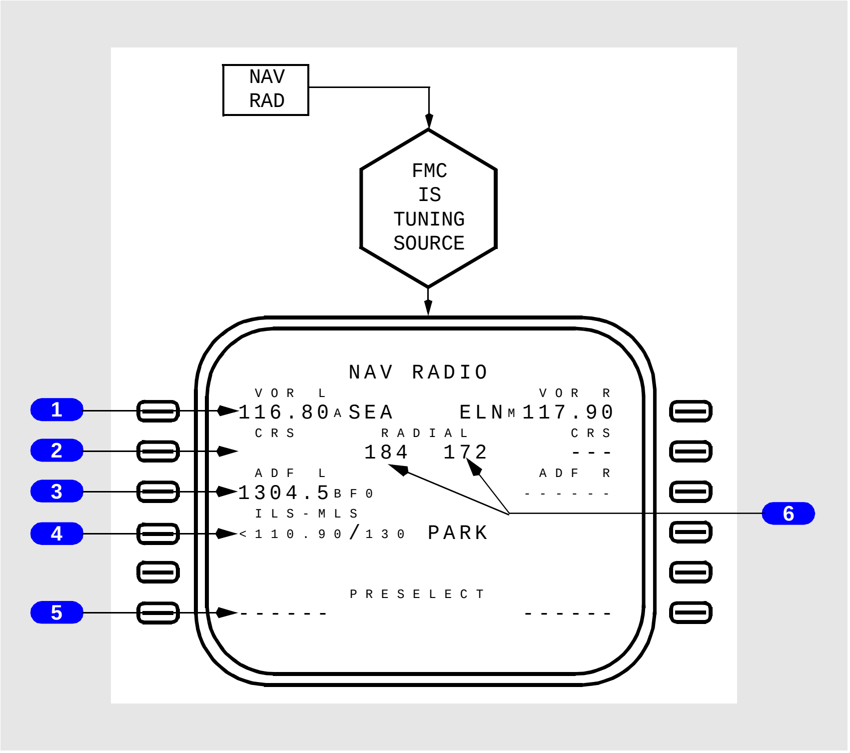
Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>. Executing a modification or leaving the page and returning displays all options and <SEL> or <ACT> prompts.

6 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. 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.



1 VOR Frequency and Tune Status

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. Tuning status displays are:

- P (procedure autotuning) – FMC selects navaids for approach or departure procedure guidance
- R (route autotuning) - FMC selects navaids on the active route. The navaid is the previous VOR or a downpath VOR within 250 nm of aircraft position
- A(autotuning) - FMC selects a navaid 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

Tunes related DME.

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 Course (CRS)

Blank when in autotune.

Valid entry is a three–digit course. Data can be entered when dashes or a course display.

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.

3 ADF Frequency and Tune Status

Tuning status displays adjacent to left and right ADF frequencies. Tuning status displays are:

- ANT (antenna) - mode for bearing data
- BFO (beat frequency oscillator) - mode for audio data used during manual tuning
- none - default tuning mode gives both bearing data and audio

Valid entries are XXX.X or XXXX.X

Entry can be followed by A (ANT), B (BFO), or none, which defaults to the ADF mode. A or B can be entered with a frequency already displayed.

4 ILS Frequency and Course

Tuning status displays adjacent to ILS frequency and course. The ILS receivers operate in FMC autotune or manual-tuning modes. The FMC autotunes ILS frequency and course. When the ILS is not necessary, the FMC sets the ILS to PARK. This removes the displays from the PFD.

ILS autotuning is inhibited for ten minutes after takeoff and during manual-tuning. The ten minute inhibit is canceled when making a change to the active flight plan destination runway. 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, airplane heading within 45 degrees of the localizer front course, and ground speed greater than 40 knots

Manual ILS tuning is enabled when:

- pushing either TOGA switch
- disengaging the autopilot and switching off both flight directors.

Valid entries:

- ILS frequency and front course (XXX.XX/YYY)
- front course, with a frequency and course already entered (/YYY)

5 PRESELECT

Any valid page data may be entered.

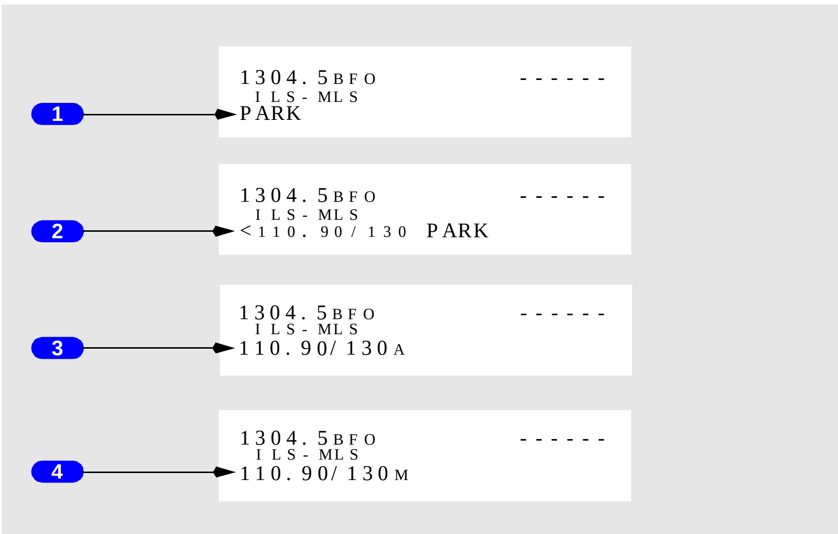
6 RADIAL

Displays radial from left and right VOR stations to the airplane.

ILS Tuning Status

Display initializes to PARK. Tuning status displays are:

- XXX.XX/YYY PARK – ILS autotuned for selected approach but not being used
- A (autotune) - ILS autotuned for approach guidance
- M (manual) - ILS 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; or a VOR, runway, or VFR approach to an ILS/LOC equipped runway is selected, and:

- less than 200 NM from the T/D, or
- more than halfway to the destination

Line selection manually tunes ILS–MLS.

3 **Tuning Status – Autotune**

ILS frequency, front course, and A display when an ILS, LOC, Back Course; or a VOR, runway, or VFR approach to an ILS/LOC equipped runway 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**

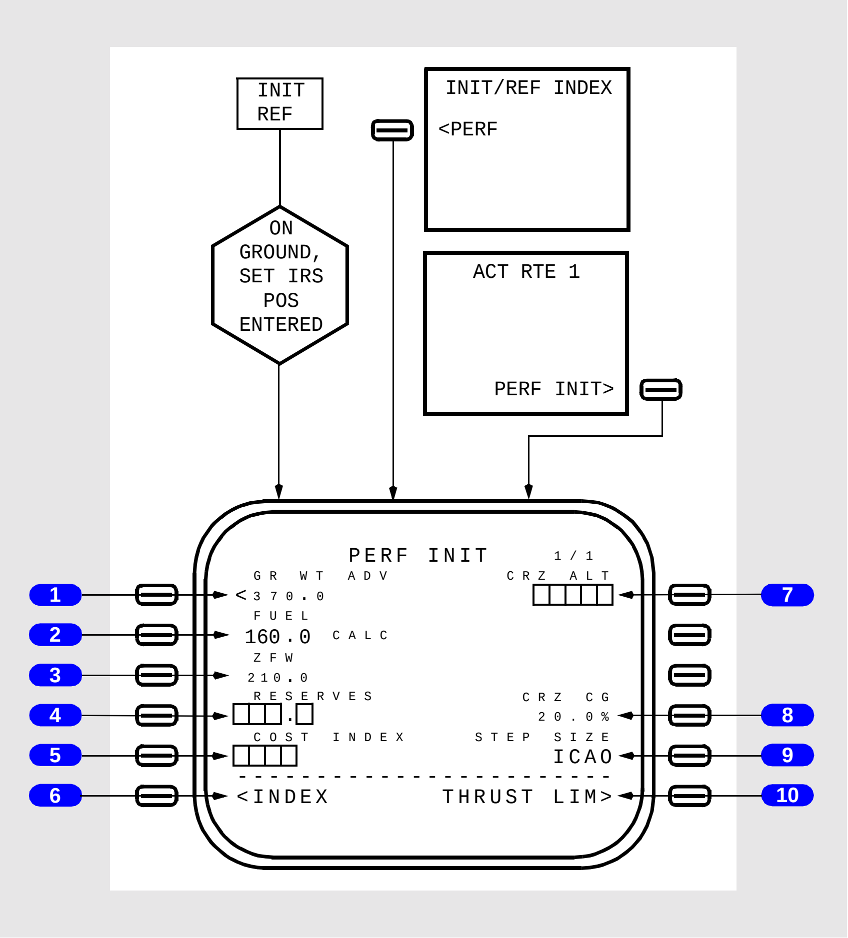
Receiver tuned manually and valid frequency/course display.

Preflight Pages – Part 2A

Performance Initialization Page

The performance initialization page allows entry of airplane and route data to initialize performance calculations. This data is required for VNAV calculations.

Entered values clear with loss of electrical power or at engine shutdown after flight.



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.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

The following displays indicate operative or inoperative weight and balance (WBS):

- “GR WT ADV” and careted gross weight for operational WBS
- “GR WT” and prompt boxes for failure of WBS computer

The FMC gross weight calculated using WBS inputs displays in small font with a caret. Line selection or pilot entry of gross weight changes display to large font with WBS/FMC computed gross weight displayed in small font.

2 FUEL

Fuel on board displays when 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

Definitions of SENSED and CALC are found on PROGRESS page 2/3 in Section 42, FMC Cruise.

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 deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

ZFW can 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 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.

Cost index can also be entered by uplink.

Valid entries are 0 to 9999.

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.

Cruise altitude can also be entered by uplink.

Valid entry is XXX, XXXX, XXXXX, or FLXXX.

Altitude displays in feet or flight level depending on transition altitude.

Entry displays this cruise altitude on the CLB and CRZ pages.

8 Cruise Center of Gravity (CRZ CG)

Used by FMC to calculate maximum altitude and maneuver margin to buffet.

Displays default center of gravity.

Default value displays in small font.

A flight crew entered value displays in large font.

An uplinked value displays in large font.

Valid entry is XX.X.

9 STEP SIZE

Displays climb altitude increment used for planning the optimum climb profile.

Default display is ICAO.

Valid entries are 0 to 9000 in 1000 foot increments.

For a non–zero entry or ICAO, performance predictions are based on step climbs at calculated step climb points. For a zero entry, performance predictions are based on a constant CRZ ALT.

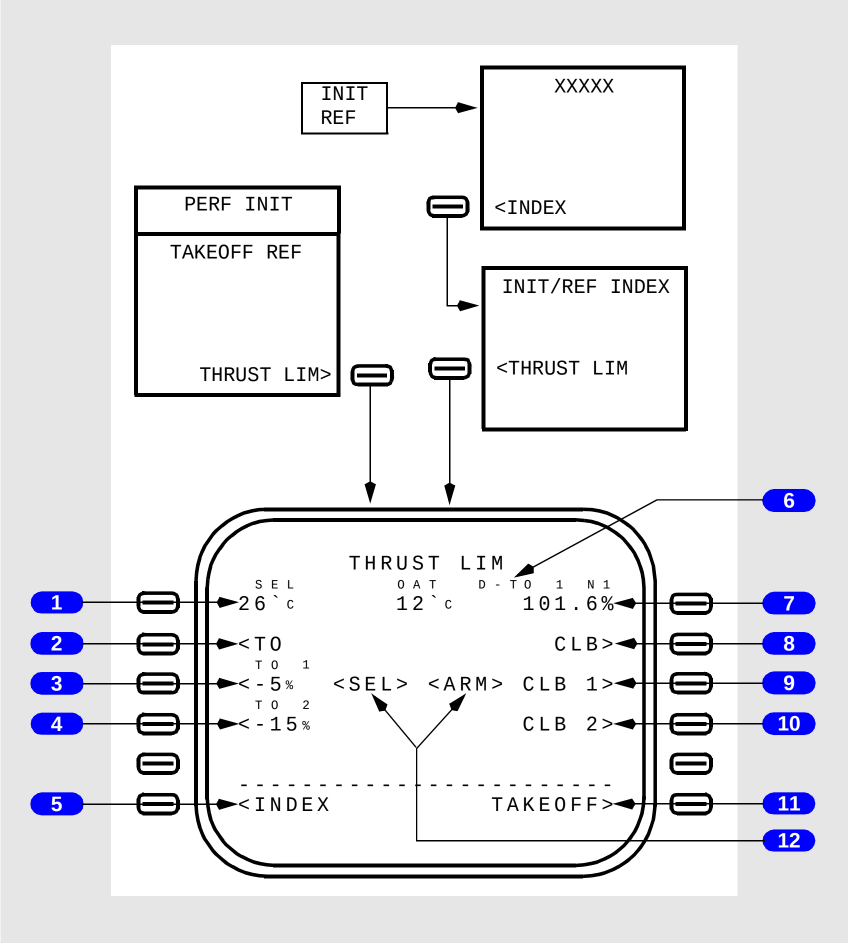
10 Thrust Limit (THRUST LIM)

Push – displays THRUST LIM page.

Preflight Pages – Part 2B

Thrust Limit Page

The thrust limit page allows selection and display of reference thrust for takeoff. Derating takeoff thrust by use of assumed temperature is also accomplished on this page.



1 Assumed Temperature (SEL), Outside Air Temperature (OAT)

Initially blank. Displays entered assumed temperature up to the maximum thrust reduction limits.

Entry of an assumed temperature warmer than OAT reduces takeoff thrust and displays D as part of thrust mode.

Valid entries are 0 to 99 degrees Celsius (C) or 32 to 210 degrees F.

Entry in degrees Fahrenheit (F) causes OAT to display degrees F.

Uplinked temperatures display on both THRUST LIM and TAKEOFF REF pages.

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)

Push – selects percentage derate (TO 1) takeoff thrust limit.

Takeoff thrust derate can be entered by uplink.

Selecting TO 1 arms CLB 1.

4 Takeoff 2 (TO 2)

Push – selects percentage derate (TO 2) takeoff thrust limit.

Takeoff thrust derate can be entered by uplink.

Selecting TO 2 arms CLB 2.

5 INDEX

Push – displays INIT/REF INDEX page.

6 Thrust Reference Mode

Displays selected takeoff thrust mode.

7 Takeoff N1 Limit

Displays takeoff N1 calculated by the thrust management system.

8 Climb (CLB)

Push – selects the full rated (CLB) climb thrust limit.

Pushing any climb line select key overrides an automatic selection.

9 **Climb 1 (CLB 1)**

Push – selects a percentage derate (CLB 1) climb thrust limit.

Climb thrust derate can be entered by uplink.

10 **Climb 2 (CLB 2)**

Push – selects a percentage derate (CLB 2) climb thrust limit.

Climb thrust derate can be entered by uplink.

11 **TAKEOFF**

Push – displays TAKEOFF REF page.

12 **<SEL>, <ACT>**

<SEL> - identifies selected takeoff thrust reference mode.

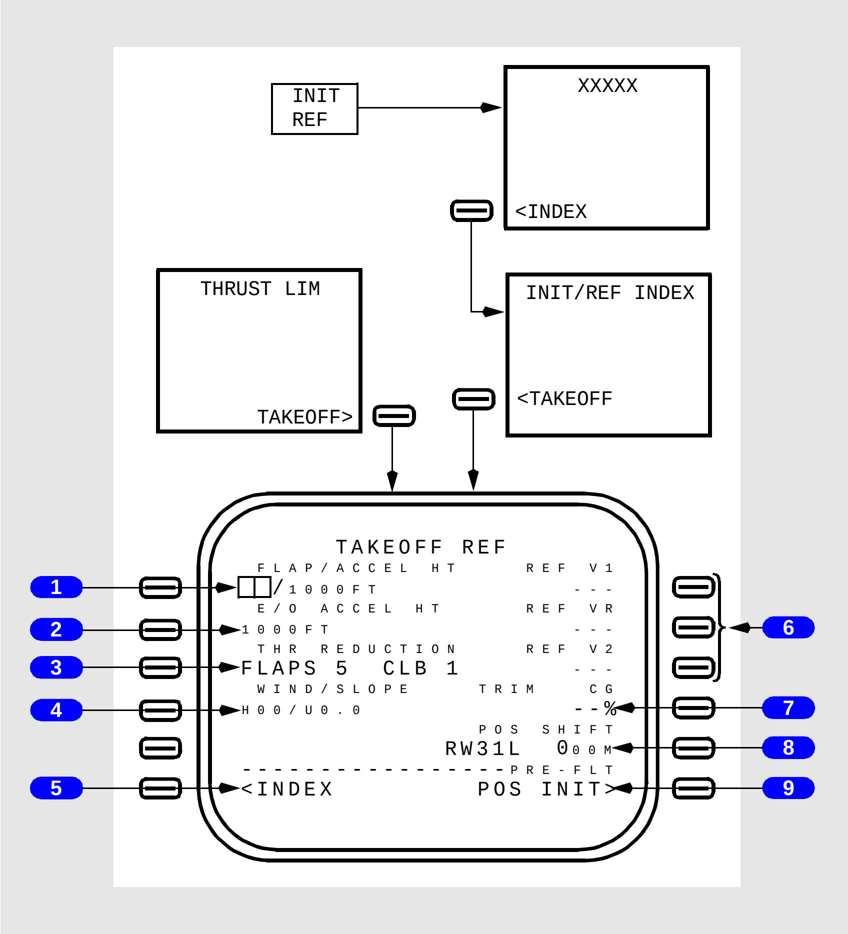
<ARM> - identifies armed climb thrust reference mode. <ARM> changes to <SEL> when armed climb mode becomes active.

Takeoff Reference Page 1

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. Takeoff flap setting must be entered and V speeds should be set before completion.

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.



1 FLAP/Acceleration Height (ACCEL HT)

Displays takeoff flap setting.

Valid entries are 10 or 20.

Flap position is required for takeoff V speed calculations.

Displays acceleration height for flap retraction.

Valid entry is a height from 400 to 9999 feet.

Selection of a new rating after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 Engine Out Acceleration Height (E/O ACCEL HT)

Displays acceleration height for flap retraction with an engine out.

Valid entry is a height from 400 to 9999 feet.

3 Thrust (THR) REDUCTION

Displays flap setting or height for reduction from selected takeoff thrust to armed climb thrust.

Displays armed climb thrust rating.

Valid entries are:

- 5 for flaps 5, or
- a height from 400 to 9999 feet

4 WIND/SLOPE

Displays wind and runway slope after crew entry.

Valid entries are:

- WIND - HXX, XX for headwind, TXX for tailwind
- SLOPE - UX.X, X.X for upslope, DX.X for downslope

5 INDEX

Push - displays INIT/REF INDEX page.

6 V Speeds (V1, VR, V2)

Displays dashes when:

- required information not entered
- performance calculations inhibited
- IRUs not aligned

Displays FMC calculated speeds when required information entered.

Flight crew entered or selected speeds display in large font and replace calculated speeds.

Calculated speeds display in small font.

FMC calculated speeds provide VMCA and VMCG protection.

Uplinked speeds replace calculated speeds.

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 deleted from the PFD
- PFD speed tape message NO V SPD displays
- scratchpad message TAKEOFF SPEEDS DELETED displays

Note: After third engine started, 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.

7 TRIM, Center of Gravity (CG)

CG displays in small font with caret. Calculated by FMC using WBS inputs.

Valid CG range is 0 to 40.

Line selection or pilot entry displays CG in large font.

Dash prompts display if required WBS inputs not available.

Trim field blank until CG and GR WT selected or entered.

FMC computed trim displays in small font if within the stab trim green band range. Otherwise, the trim field remains blank.

8 Position (POS) SHIFT

Displays the selected takeoff runway and TO/GA “push” distance from the runway threshold.

Valid entries are X, XX in + or - hundreds of meters(3 or 03 is 300 meters beyond the runway threshold; -3 or -03 is 300 meters prior to runway threshold).

Entered value updates FMC position to the TO/GA push point when GPS updating not active.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

9 PRE-FLIGHT

Displays PRE-FLIGHT and title (XXXXX) of incomplete page when preflight is not complete.

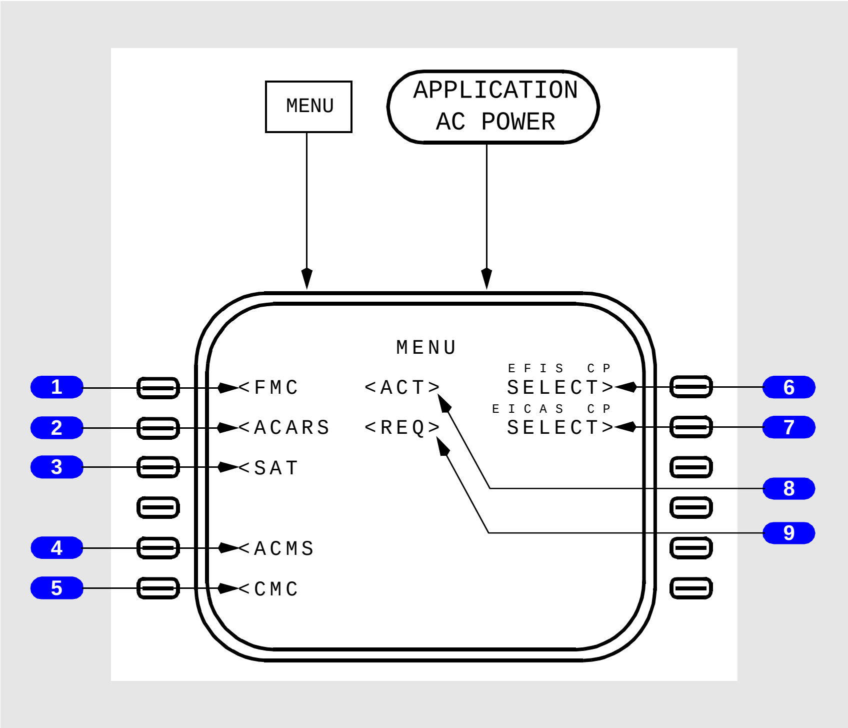
Displays dashes and THRUST LIM when preflight is complete.

Push -

- displays THRUST LIM page when THRUST LIM displayed
- displays incomplete page (XXXXX) when PRE-FLIGHT displayed

Menu Page

Provides access to other systems that use CDU.



1 FMC

Push –

- connects FMC to the CDU
- displays last page used
- displays INITIALIZATION page on initial application of AC power

2 Aircraft Communication Addressing and Reporting System (ACARS)

See Chapter 5, Communications.

3 Satellite Communication System (SATCOM)

See Chapter 5, Communications.

4 Airplane Condition Monitoring System (ACMS)

Push -

- displays ACMS page
- activates ACMS control of CDU for maintenance use

5 Central Maintenance Computer (CMC)

Operational on ground and in flight above 10,000 feet.

Push -

- displays CMC menu page
- activates CMC control of the CDU for maintenance use

6 Alternate EFIS Control (CP)

See Chapter 10, Flight Instruments, Displays

7 Alternate EICAS Control (CP)

See Chapter 10, Flight Instruments, Displays

8 Active (ACT)

Indicates active CDU controller.

9 REQ

Indicates non-active CDU controller requires pilot action.

Intentionally
Blank

Flight Management, Navigation — Chapter 11
FMC Takeoff and Climb — Section 41

Introduction

FMC takeoff phase starts with selection of takeoff/go–around (TO/GA). Preparation for this phase starts in preflight phase and includes entry of TAKEOFF REF page data.

Takeoff phase changes to climb phase when the FMC commands climb thrust. Climb phase continues to the top of climb point, where 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 SID selections
- 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 Phase

When changes are made to the departure runway and SID, 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 takeoff roll, autothrottle commands thrust and the FMC commands acceleration to between V2+10 and V2+25 knots, based on rate of rotation.

Usually, VNAV is armed before takeoff. When armed before takeoff, LNAV activates at 50 feet above runway elevation 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 Phase

At acceleration height or the first movement of the flap handle during flap retraction, VNAV commands acceleration to:

- 250 knots,
- VREF+100 knots, or
- speed transition associated with the origin airport, whichever is greater

VNAV commanded speed is limited by airplane configuration. At acceleration height, VNAV commands a speed 5 knots below the flap placard speed, based on flap handle position.

At the climb thrust reduction point, the FMC commands a reduction to the armed climb thrust. Passing 10,000 feet, 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+100 or 250 knots.

During climb, VNAV complies with LEGS page waypoint altitude and speed constraints. A temporary level–off for a crossing altitude restriction is accomplished at the commanded speed.

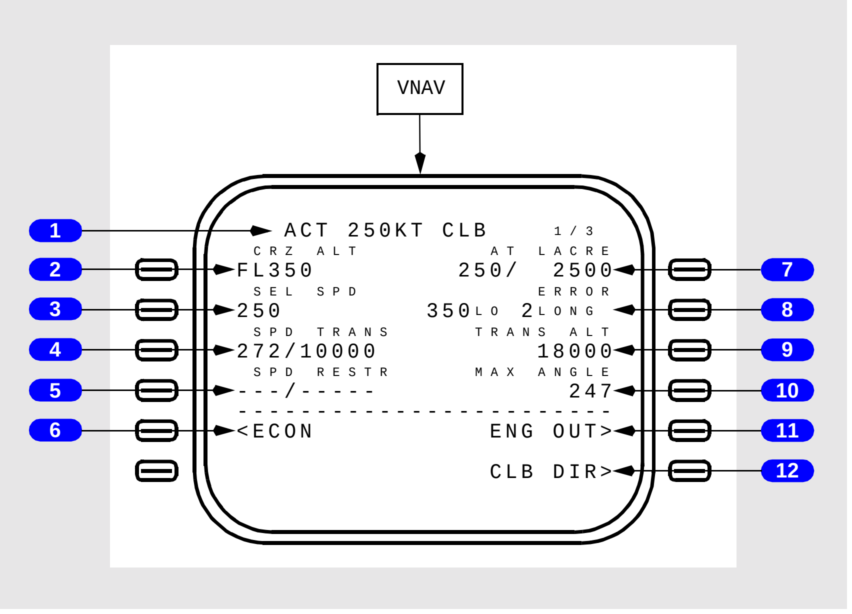
When the climb profile fails to reach a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALTITUDE. Deleting climb derates or selecting a reduced climb speed thus giving a steeper climb angle, may enable the airplane to reach the altitude constraint.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb path. Data on climb page comes from preflight entries made on the route and performance pages.

The climb page is the first of the three pages selected with the VNAV function key.

FMC climb can be economy, fixed speed, or engine out.



1 Page Title

The page title displays active (ACT) or modified (MOD) climb. Usually, the title contains ECON for economy climb. Fixed speed and engine out modify the title.

- ECON – speed based on a cost index
- LIM SPD – speed based on airplane configuration limiting speed
- MCP SPD – MCP speed intervention selected
- XXXKT – fixed CAS climb speed profile
- M.XXX – fixed Mach climb speed profile
- E/O – engine out mode selected

Fixed climb speeds are for:

- takeoff/climb acceleration segment constraints
- a flight crew selected speed (SEL SPD)
- a speed transition

- a speed restriction associated with an altitude
- waypoint speed constraints

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 transition altitude.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

ECON SPD -

- speed based on cost index in CAS or Mach
- used by the FMC at altitudes above all waypoint speed constraints, speed restrictions, and speed transition altitudes

Valid entries are CAS or Mach.

SEL SPD - displays when flight crew enters speed.

4 Speed Transition (SPD TRANS)

Speed transition line displays the transition speed/altitude from one of these sources:

- the navigation database value for the origin airport
- the greater of a default speed of 250 knots or VREF+100 knots and 10,000 feet (example 272/10000)

Not displayed above transition.

Can be deleted.

5 Speed Restriction (SPD RESTR)

Speed restrictions at an altitude less than the cruise altitude and not associated with a waypoint are manually entered on this line.

Displays dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

6 Economy (ECON)

Push – changes climb speed to ECON.

Displays when the climb speed is not ECON.

7 Waypoint Constraint (AT XXXXX)

Displays next airspeed and/or altitude constraint at waypoint XXXXX.

Can also display HOLDAT XXXXX followed by a speed/altitude constraint.

FMC commands the slower of constraint speed or performance speed.

Constraints entered on RTE LEGS page.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

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 changes from altitudes to flight levels above the transition altitude.

10 **Maximum Angle (MAX ANGLE)**

Displays maximum angle climb speed.

Entry not allowed.

11 **Engine Out (ENG OUT)**

Push – displays E/O CLB page.

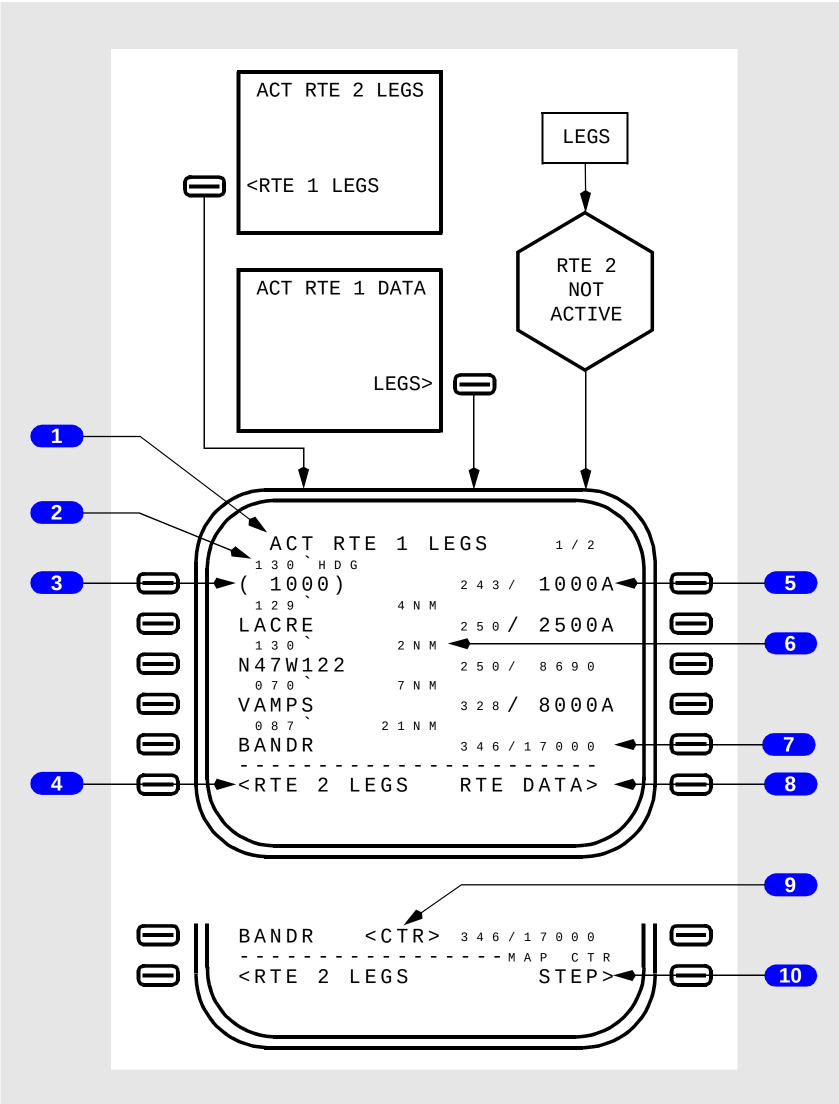
12 **Climb Direct (CLB DIR)**

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

Route legs page provides means of entering and displaying details of each leg of the route. Valid entries same as on route pages TO line.



1 Page Title

Title format displays route status:

- RTE X LEGS – inactive route
- ACT RTE X LEGS – active route
- MOD RTE X LEGS – modified active route

2 Leg Direction

Leg segment data in line title:

- computed course to waypoint - XXX°
- specified procedural course/track from database - XXX°
- 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

Directions are magnetic unless followed by T (131° T).

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

3 Waypoint Identifier

Active leg is the first line of the first active RTE X LEGS page.

Active waypoint is on active leg.

All route waypoints display in flight sequence. Airway waypoints display 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.

4 Route 2 Legs (RTE 2 LEGS)

Push –

- displays RTE 2 LEGS page
- when RTE 2 LEGS page displayed, changes to RTE 1 LEGS

5 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.

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 feet or flight level
- XXX/XXXXX – airspeed/altitude entered simultaneously
- XXX, XXXX, XXXXX or /XXX, /XXXX, /XXXXX – altitude only, less than cruise altitude
- enter FL190 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)

6 Distance to Waypoint

Distance (decreasing) from airplane to active waypoint or distance from waypoint to waypoint. Blank for some leg types (e.g. HDG or VECTORS).

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 altitude constraint below cruise altitude.

Manual entry allowed in climb or descent phase.

8 ACTIVATE, Route (RTE) DATA

Push –

- ACTIVATE – activates inactive flight plan; ready for execution
- RTE DATA – displays route data page

ACTIVATE displays when RTE and RTE LEGS flight plan is inactive.

RTE DATA displays after pushing ACTIVATE prompt.

9 Center (<CTR>)

Displays when PLAN mode selected.

Displays adjacent to the waypoint around which ND plan mode is centered.

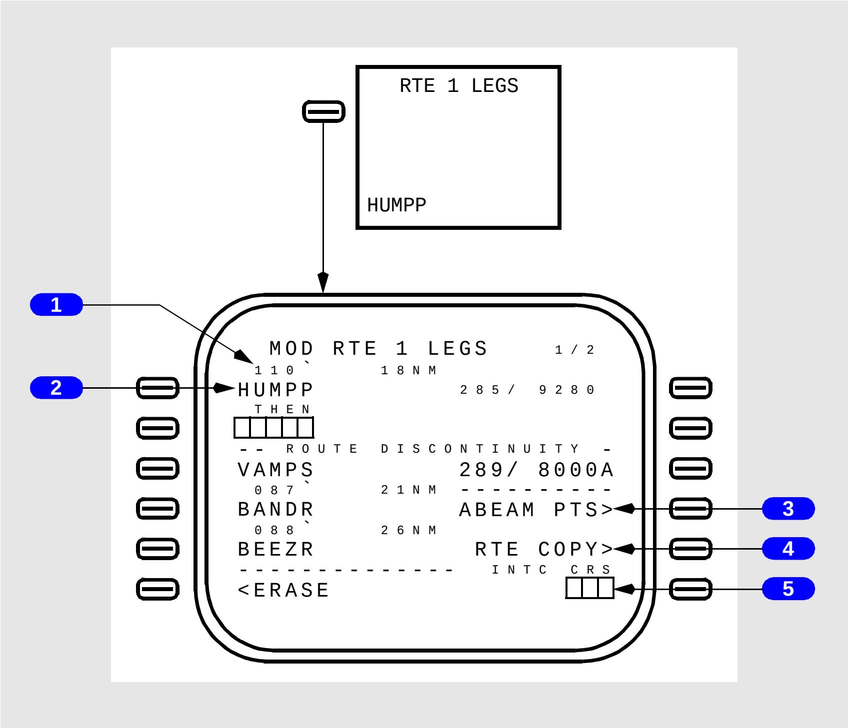
10 MAP Center (CTR) STEP

Replaces ACTIVATE or RTE DATA when PLAN mode selected.

Push - steps <CTR> to next waypoint. ND plan mode recenters.

Direct/Intercept Course

Used to fly direct to or intercept a course to a waypoint. Entering a waypoint over the active waypoint displays direct/intercept prompts.



1 Course to Active Waypoint

Prior to execution, displays direct-to inbound course at waypoint; changed by entry in INTC CRS line or by selecting intercept course.

After execution, displays current required track to fly inbound course to waypoint.

2 Active Waypoint

Displays crew entered direct/intercept waypoint.

3 ABEAM Points (PTS)

Push -

- line title displays ABEAM PTS, line data displays SELECTED
- creates abeam points on new route to indicate waypoints bypassed by direct to function
- abeam points are perpendicular to the waypoints bypassed
- subsequent route modifications remove ABEAM PTS prompt

4 Route (RTE) COPY

Push -

- copies active unmodified route into inactive route
- erases previous inactive route
- line title displays RTE COPY, line data displays COMPLETE
- subsequent route modifications remove RTE COPY prompt

5 Intercept Course

Displays boxes if entered waypoint not in the active route; valid entry is intercept course from 000° to 360°.

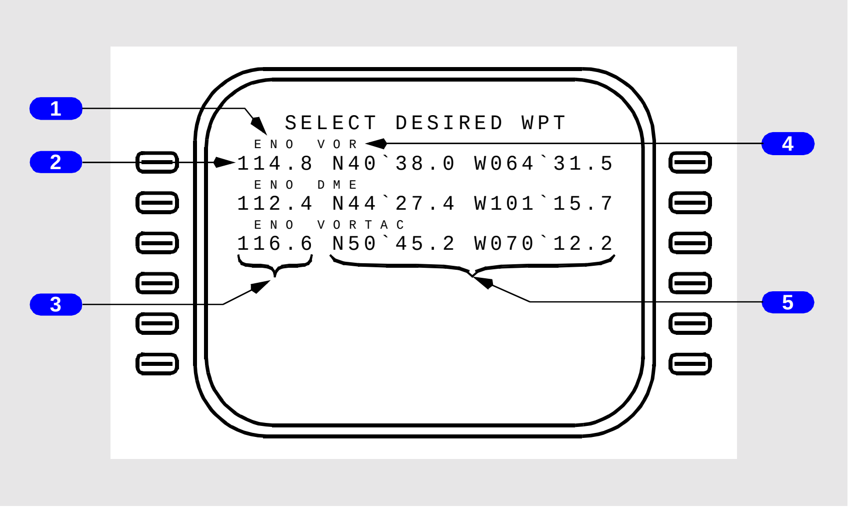
Displays current route course and prompt caret if entered waypoint in the active route.

Push -

- when current route course 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

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.

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 and returns display to page previously in use.

Pushing any CDU function key exits page without selecting a waypoint.

3 Frequency

Displays the 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.

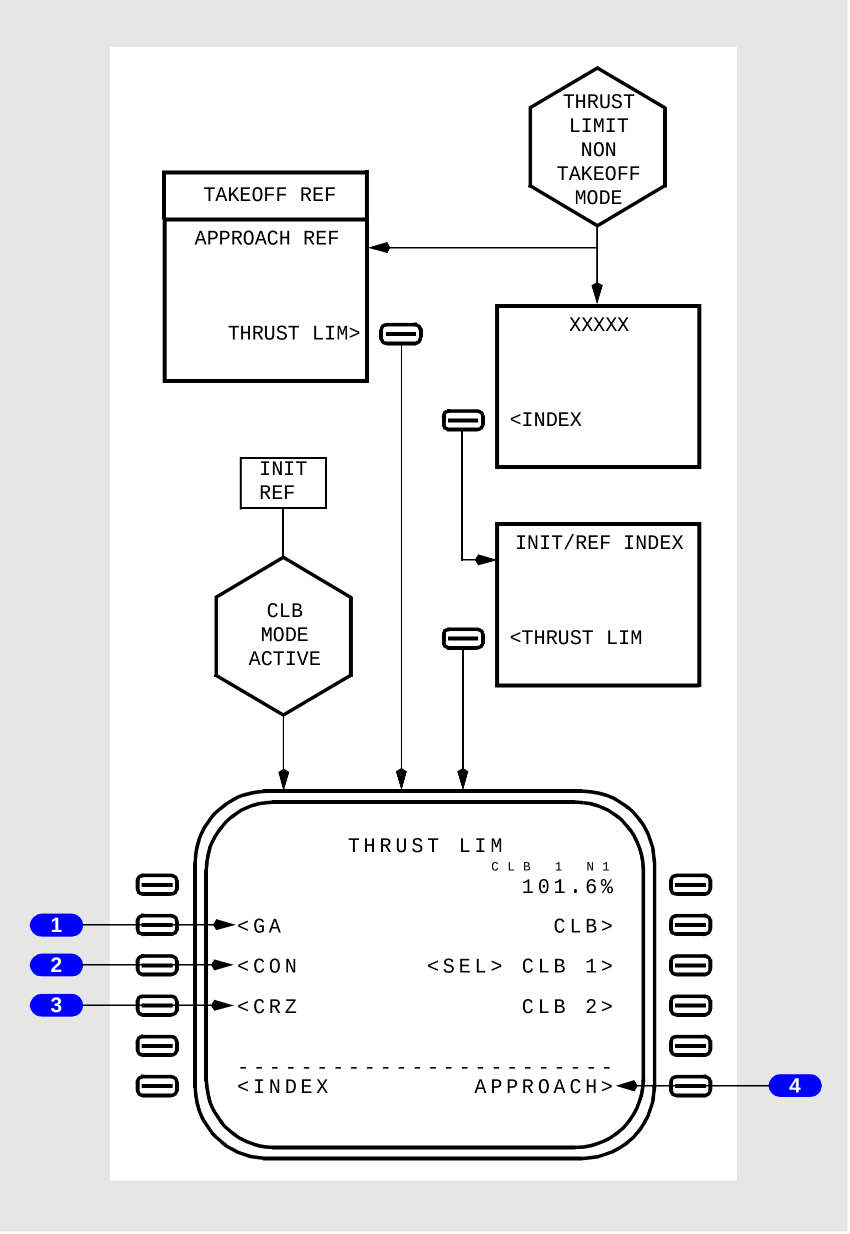
5 Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

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.



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

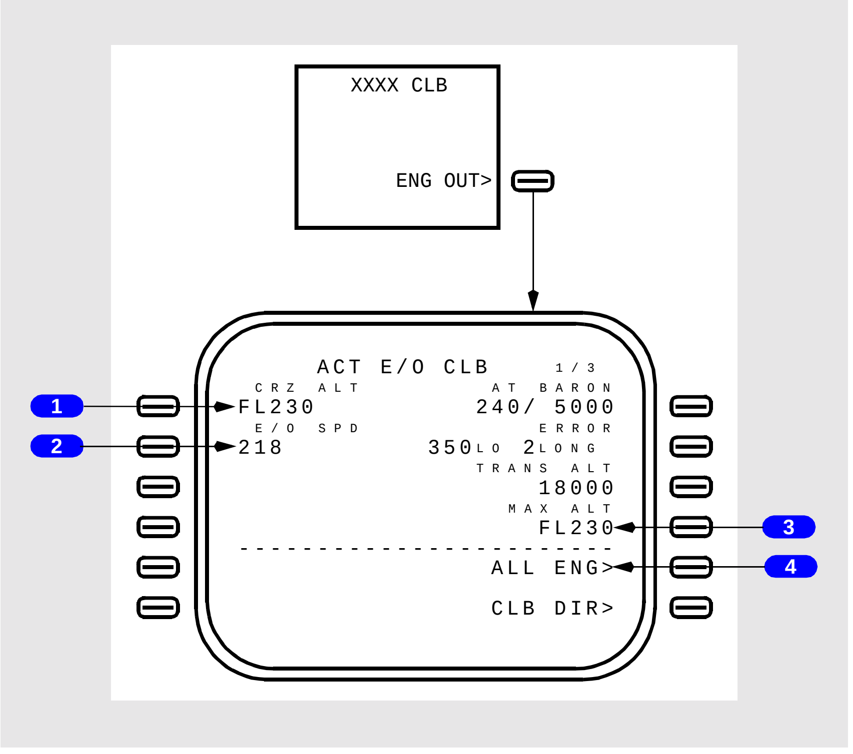
Push – displays APPROACH REF page.

Engine Out Climb

Engine out (E/O) VNAV climb guidance displays on the E/O CLB page. The E/O CLB page must be selected and executed by the flight crew. Engine out data is available with all engines operating. Engine out climb changes to engine out cruise at the top of climb.

E/O CLB Page

The modified page displays engine out performance limitations based on one or two engines out. Manual entries are allowed. After execution, VNAV gives E/O guidance in the climb and reference thrust limit changes to CON.



1 Cruise Altitude (CRZ ALT)

Displays cruise altitude if less than MAXALT.

Displays MAX ALT if less than cruise altitude.

Manual entry is allowed.

2 Engine Out Speed (E/O SPD)

Displays engine out climb speed.

Valid entry is XXX for CAS.

Valid entry is 0.XXX for Mach. Trailing zeros can be omitted.

A manual entry may cause MAX ALT to change.

3 Maximum Altitude (MAX ALT)

Displays lower of maximum altitude at engine out climb speed or cruise speed.

Entry not allowed.

4 ALL ENG

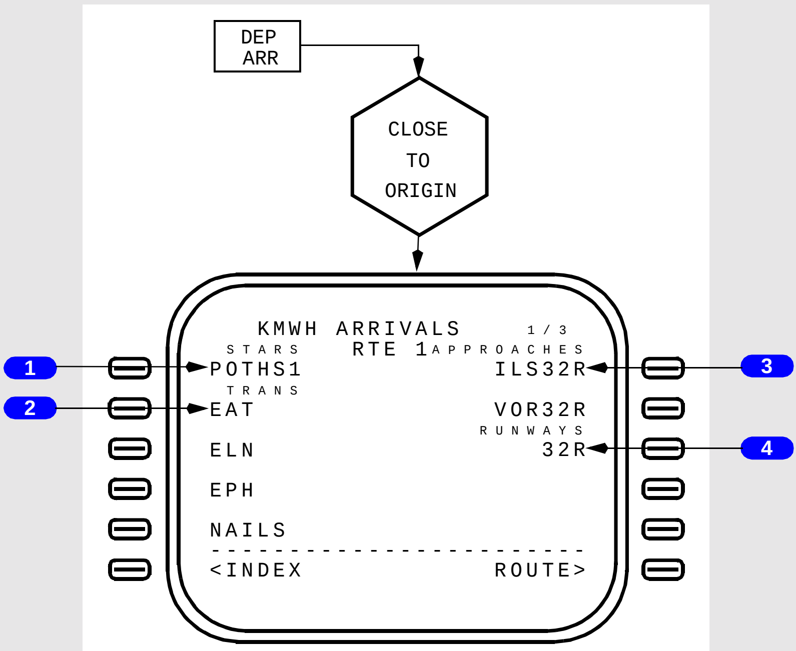
Push – modifies page to display all engine (ALL ENG) performance data.

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, pushing the DEP ARR function key displays the ARRIVALS page for the origin airport.



1 Standard Terminal Arrival Routes/Profile Descents (STARS)

Displays STARS for origin airport.

2 Transitions (TRANS)

Displays transitions for the selected arrival procedure.

3 **APPROACHES**

Displays approaches for origin airport.

4 **RUNWAYS**

Displays runways for origin airport.

Intentionally
Blank

Introduction

Cruise phase starts at top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- CRZ
- PROGRESS

RTE LEGS pages are described in section 11.41, this chapter. CRZ pages display VNAV related data. 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, navaids, airports, or runways, and can be used to inhibit navaids
- FIX INFO page – display data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- POS REPORT page –display data for a position report

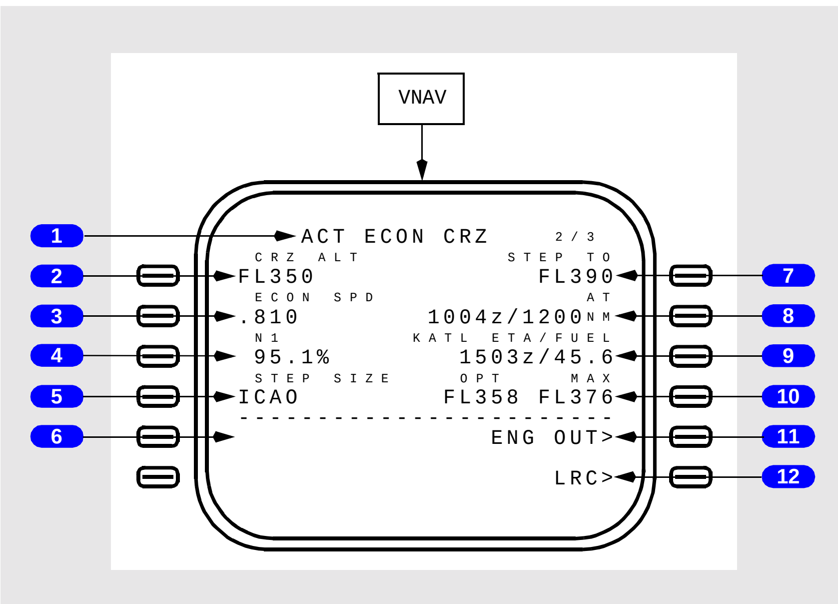
CLB page changes to CRZ at top of climb. CRZ CLB and CRZ DES pages change to CRZ at the new cruise altitude. CRZ page changes to DES at top of descent.

Cruise Page

All Engine Cruise

The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually entered or selected using speed intervention while in 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 engine out mode, the data reflects airplane capabilities with one or two engines inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.



1 Page Title

Page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Fixed speed, engine out, and long range cruise modify the title.

Page titles include:

- ECON – speed based on cost index
- LIM SPD – speed based on an airplane configuration limiting speed
- MCP SPD – MCP speed intervention selected

- XXXKT – fixed CAS cruise speed
- M.XXX – fixed Mach cruise speed
- CRZ CLB or CRZ DES – cruise climb or descent
- LRC – long range cruise selected
- E/O – engine out mode selected
- E/O LRC D/D – long range cruise drift down displays when EO selected and the airplane altitude is above the maximum altitude for engine out performance

Fixed cruise speeds are for:

- a flight crew selected speed (SEL SPD)
- a speed restriction associated with an altitude
- waypoint speed constraints

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on the PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on the transition altitude.

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 the command speed or Mach.

Valid entries are CAS or Mach.

SEL SPD - displays when flight crew enters speed.

LRC - displays when LRC selected.

4 N1

Displays N1 to maintain level flight at command airspeed.

5 STEP SIZE

Displays climb altitude increment used by FMC to calculate optimum step climb.

Defaults to ICAO.

Valid entries are 0 to 9000 feet in increments of 1000 feet.

6 Economy (ECON)

Push – selects economy cruise speed.

Displays when speed or Mach entered manually; or, when LRC selected.

7 STEP TO Altitude

Displays calculated step climb altitude based on STEP SIZE. May be overwritten with manual entry above CRZ ALT.

Valid entry is FLXXX or XXX (flight level), or XXXXX (feet).

Displays STEP TO altitudes entered on LEGS page. These altitudes may be greater or less than CRZ ALT and cannot be overwritten on the CRZ page.

Blank when no active flight plan or when within 200 miles of T/D.

Note: Calculated STEP TO altitude is always higher than OPT altitude.

When using ICAO STEP SIZE, the STEP TO altitude is the next higher altitude above OPT altitude corresponding to the direction of flight determined by the CRZ ALT entered before takeoff. For example: with an ICAO STEP SIZE, a CRZ ALT of FL280 entered before takeoff, and an OPT altitude of FL337; the STEP TO altitude will be FL350. In-flight changes to CRZ ALT will not affect the calculation of STEP TO altitudes when using ICAO step size. However, if an alternate route (for example, Route 2) is activated in flight, the hemispheric altitude will be calculated based on the current CRZ ALT.

When using an altitude increment STEP SIZE, the STEP TO altitude is the next higher altitude above OPT altitude calculated by adding the STEP SIZE increment to the current CRZ ALT.

8 AT

Displays ETA and distance to go to the optimum step point where a climb to the STEP TO altitude minimizes either trip cost (ECON CRZ) or fuel (other CRZ speeds).

Displays NOW passing the optimum step climb point.

Line title changes to AVAIL AT when STEP TO altitude entered at a waypoint on the LEGS page and MAX altitude at the waypoint is less than the STEP TO altitude. AVAIL AT indicates where MAX altitude will be equal to the STEP TO altitude.

Line title changes to TO T/D within 200 miles of T/D. ETA and distance are to T/D.

9 Destination ETA/FUEL

Estimated time of arrival and calculated fuel remaining at the destination assuming step climbs are made at optimum points to the STEP TO altitude.

Calculations are based on optimum and planned step climbs and cruise altitudes.

10 Optimum Altitude and Maximum Altitude (OPT, MAX)

OPT –

- displays altitude which minimizes trip cost when ECON speed selected
- displays altitude which minimizes trip fuel when LRC or SEL speed selected

MAX – displays the maximum cruise altitude based on:

- current gross weight
- number of engines operating
- selected speed option
- disregarding any altitude or speed constraints
- residual rate of climb set by airline (range: 0 to 500 feet per minute; default is 100)

11 Engine Out (ENG OUT)

Push –

- displays E/O CRZ page
- commands engine out performance calculations
- changes CRZ ALT if above maximum engine out altitude
- changes command speed to engine out LRC speed
- upon execution, reference thrust limit changes to CON

12 Long Range Cruise (LRC)

Push – displays LRC CRZ page.

Engine Out Cruise

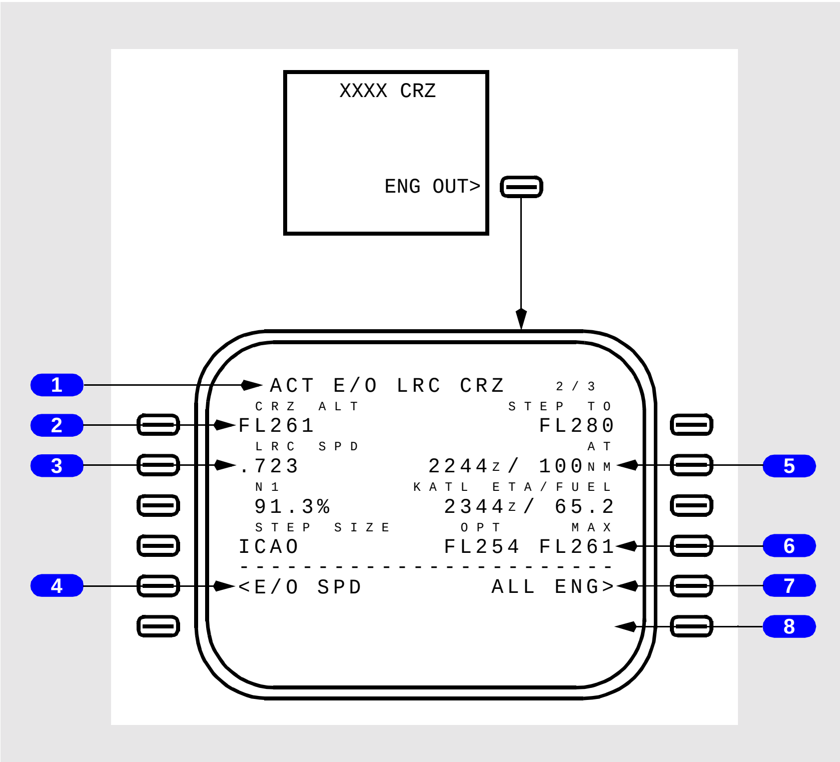
Engine out (E/O) VNAV cruise guidance displays on E/O CRZ page. E/O CRZ page must be selected and executed by the flight crew. Engine out data is also available with all engines operating.

EO Cruise Page

The modified page displays engine out performance limitations based on one or two engines out. Manual entries are allowed. When above the maximum engine out cruise altitude, VNAV calculates engine out guidance for drift down (D/D). The E/O LRC (long range cruise) D/D page changes to the E/O LRC CRZ page when reaching the engine out cruise altitude.

As the airplane gross weight decreases, maximum altitude increases. A step climb may be possible under these conditions.

The following example uses a cruise altitude above the maximum engine out altitude.



1 Page Title

The page title displays active (ACT) and modified (MOD) cruise.

Page titles include:

- E/O - minimum drag speed
- E/O LIM SPD - speed based on airplane configuration limiting speed
- E/O MCP SPD - MCP speed intervention selected
- E/O XXXKT - fixed CAS descent speed
- E/O M.XXX - fixed Mach descent speed
- E/O LRC D/D - airplane is above MAX altitude
- E/O LRC - airplane is level at CRZ ALT; less than MAX
- E/O CRZ CLB/DES - cruise climbs or descents when the CRZ ALT is below MAX altitude

2 **Cruise Altitude (CRZ ALT)**

Displays altitude from MAX ALT line when current CRZ ALT above MAX ALT.

Displays CRZ ALT from all engine cruise page if ENG OUT executed prior to engine shutdown.

Valid entries are the same as all engine cruise page.

3 **Long Range Cruise Speed (LRC SPD)**

Displays computed engine out LRC speed.

Valid entries are the same as all engine cruise page.

SEL SPD - displays when flight crew enters speed.

E/O SPD - displays when E/O SPD prompt selected.

Manual entries may change MAX altitude.

4 **Engine Out (EO SPD)**

Push – enables execution of engine out minimum drag speed profile.

Displays when LRC or SEL SPD is the active speed mode.

5 **AT**

Same as all engine display.

Displays time and distance to reach cruise altitude during driftdown.

6 **Optimum Altitude and Maximum Altitude (OPT, MAX)**

OPT - displays optimum altitude at speed displayed on speed line.

MAX - displays the maximum cruise altitude based on the same parameters as MAX for all engines.

7 **ALL Engine (ENG)**

Push – displays and enables execution of MOD XXX CRZ page with performance based on all engines operating.

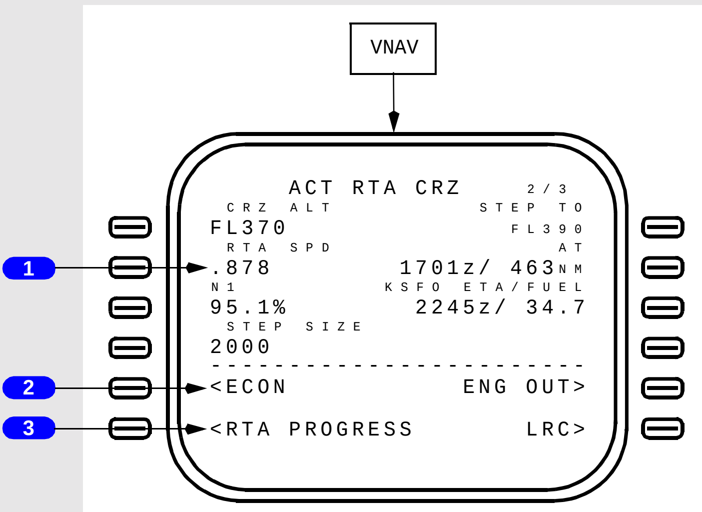
8 **Long Range Cruise (LRC)**

Push – enables execution of engine out long range cruise.

Displays when EO or SEL SPD is the active mode.

Required Time of Arrival (RTA) Cruise

The required time of arrival cruise page is available after entry of Fix and Time on RTA PROG page. This page provides cruise speed required to accomplish RTA.



1 Required Time of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA.

2 Economy Speed (ECON)

Displays when LRC, SPD SEL, or RTA SPD displayed in 2L.

Push -

- selects ECON CRZ page
- execution activates ECON CRZ and terminates RTA function

3 RTA PROGRESS, ERASE

RTA PROGRESS displays when no modification pending.

RTA PROGRESS -

Push - displays RTA PROGRESS page.

ERASE displays when modification pending.

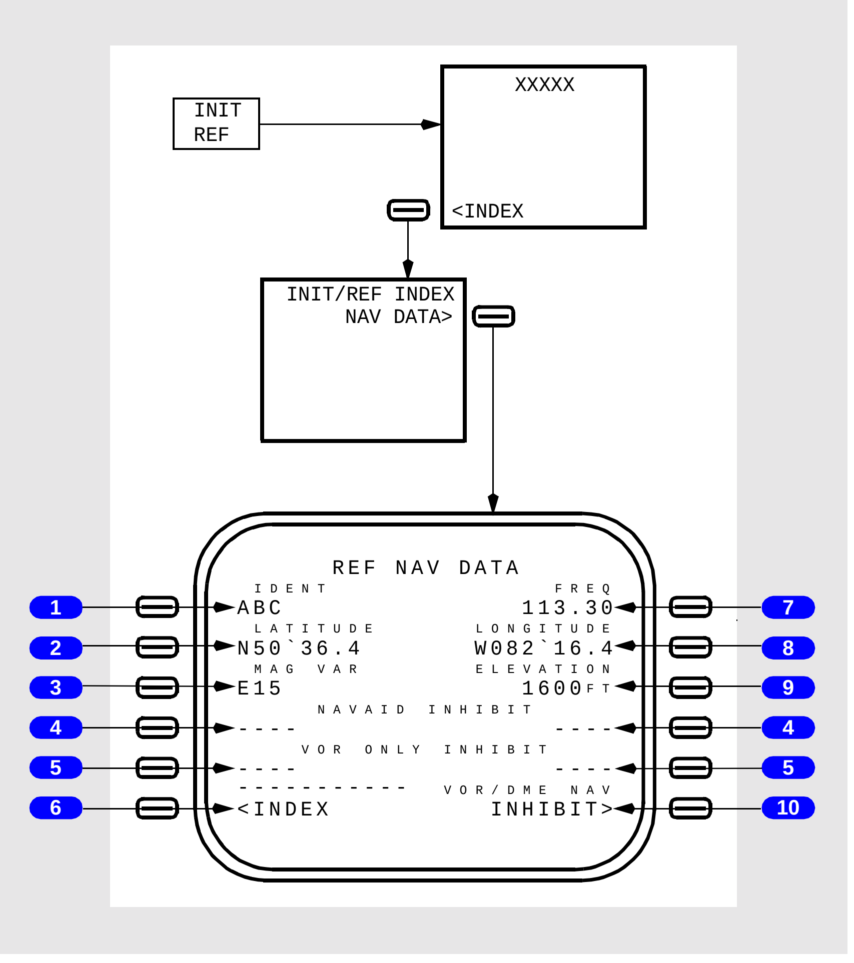
ERASE -

Push - erases pending modification.

Navigation Data

Reference Navigation Data Page

Reference navigation data page displays data about waypoints, navaids, airports, and runways. This page is used to inhibit FMC position updates from radio navaids. The navaids are available for manual, route, and procedure tuning.



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 data base.

Inhibits use of entered navaids for updating by both FMCs.

Entries blank at flight completion.

Deleting or overwriting removes a previous inhibit.

5 VOR ONLY INHIBIT

Valid entries are VOR identifiers from the navigation database.

Inhibits use of only the VOR portion of entered navaid for updating by both FMCs.

Entries blank at flight completion.

Deleting or overwriting removes a previous inhibit.

6 INDEX

Push – displays INIT/REF INDEX page.

7 Frequency (FREQ)

Displays frequency of entered identifier when it is a navaid.

8 LONGITUDE

Displays longitude of entered identifier.

9 ELEVATION

Displays elevation of entered identifier when it is a navaid, airport, or runway.

10 VOR/DME NAV INHIBIT, ENABLE

INHIBIT -

Push -

- inhibits both FMCs from using VOR/DME radio position updating
- displays ENABLE
- does not affect DME/DME radio position updating
- overwrites VOR ONLY INHIBIT entries and displays ALL
- entries clear at flight completion and INHIBIT displays

ENABLE -

Push -

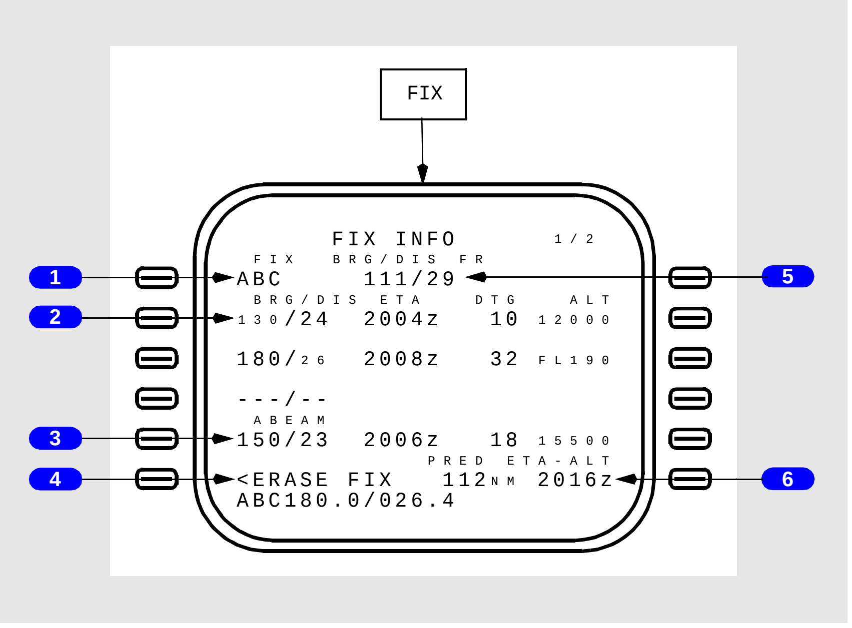
- allows VOR/DME radio position updating
- displays INHIBIT

Fix Information Page

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.

Magnetic/True Bearing

Magnetic or true fix bearings depend on airplane location. Refer to FMC Polar Operations, Flight Management Navigation, section 31.



1 FIX

Valid entries are airports, navaids, and waypoints from the navigation database.

Selected fix displays on the ND.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT

Distance Entry:

- valid entry is /YYY
- leading zeros can be omitted for distance entries

Distances from the fix display on the ND as a circle around the fix.

When the distance intersects the active route, the ETA, DTG, and altitude at the intersection display for the closest of the two intersections.

Bearing Entry:

- valid entry is a bearing from the fix, XXX
- slash (/) not required

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 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.

Bearing/distance entries do not display ETA, DTG, or predicted altitude.

Line selection copies the fix place/bearing/distance into the scratchpad. Distance displays to the nearest tenth of a nautical mile. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

3 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 definition into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

4 ERASE FIX

Push – removes all fix data from the page and the ND.

5 Bearing/Distance From (BRG/DIS FR)

Displays the bearing and distance of the airplane from the fix.

6 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.

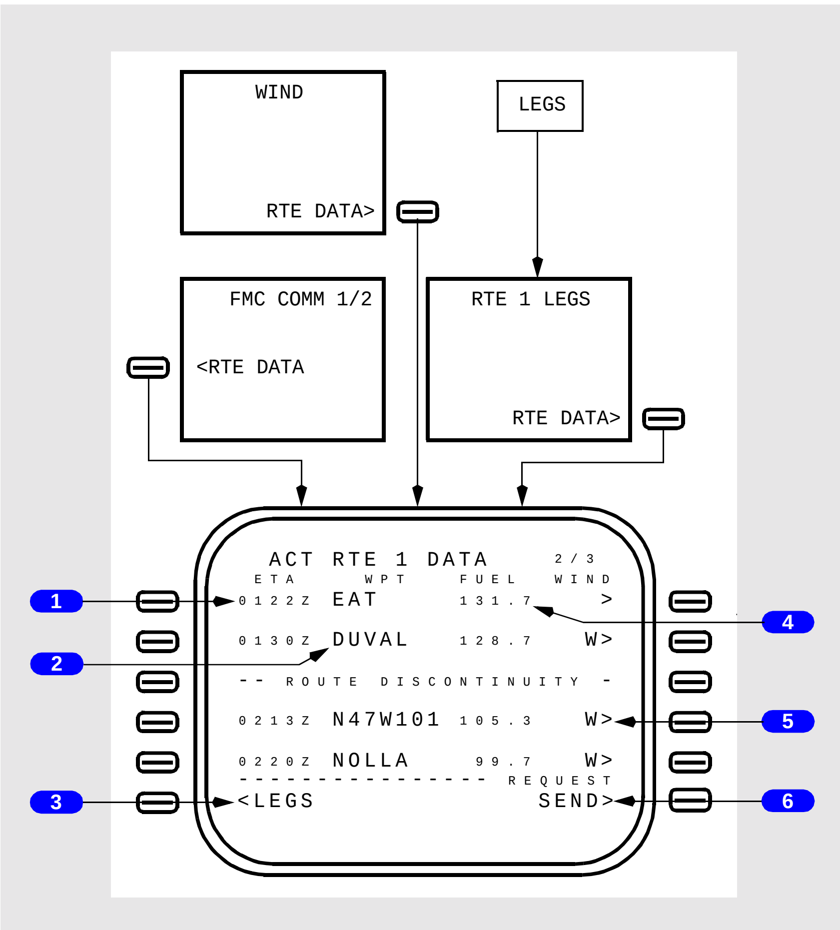
Route and Waypoint Data

Route Data Page

The route data page displays data for each waypoint on ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

This page allows a downlink request for enroute wind information and allows review of uplinked enroute wind information.

The ETA and calculated fuel remaining display for each waypoint. Manual entry is not possible.



1 ETA

Displays ETA for waypoint.

2 Waypoint (WPT)

Displays identifier for waypoint.

3 LEGS, ERASE

LEGS -

Push – displays RTE LEGS page.

Displays ERASE prompt when an uplink containing enroute wind data is loaded.

ERASE -

Push -

- rejects uplinked enroute wind data
- displays LEGS prompt

4 FUEL

Displays the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

5 WIND (W>/>)

W> - indicates waypoint winds have been entered.

> - winds not entered.

Push – displays WIND page for the selected waypoint.

6 REQUEST SEND, WIND DATA LOAD

Blank when airplane is active on descent or approach.

Displays SEND prompt when datalink ready and airplane is not active on descent or approach.

Displays LOAD prompt when uplink containing enroute wind data received and error checks passed.

SEND -

Push –

- transmits a datalink request for wind and descent forecast data
- displays LOAD prompt and scratchpad message WIND DATA UPLINK READY when an uplink containing enroute wind data received and error checks passed
- displays scratchpad message DES FORECST UPLINK READY and displays LOAD and PURGE prompts on the DESCENT FORECAST page when an uplink containing descent forecast uplink data received and error checks passed

LOAD -

Push -

- applies enroute wind data to route and results in a modification
- displays ERASE and SEND prompts

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.

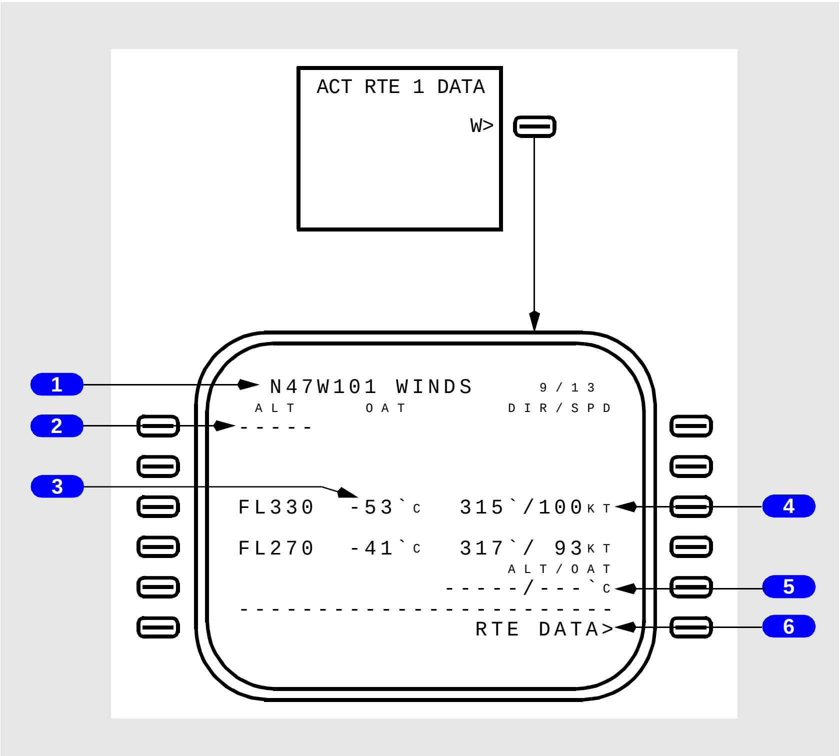
Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.

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.

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 PROGRESS page 2.

The FMC calculates step climb points based on several performance factors, but does not calculate step climb points based on entered winds at the STEP TO altitude.



1 Page Title

Displays XXXXX, where XXXXX is the waypoint for which winds display.

2 Altitude (ALT)

Valid entry is altitude or flight level on line 1L.

After entry, data are sorted by altitude and display 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 altitude can be entered.

3 OAT

Data entry not possible.

OAT displays the outside air temperature. Entries made using the ALT/OAT line display in large font. Calculated OAT based on standard lapse rate display in small font.

4 Direction and Speed (DIR/SPD)

Displays dashes after altitude/flight level entered in the ALT line.

Valid entries are wind direction and speed.

Displays wind direction and speed for related altitude.

Manual entries display in large font.

Values propagate in both directions for the first wind entered and downtrack for other entered winds. Propagated values display in small font.

5 Altitude/Outside Air Temperature (ALT/OAT)

Valid entries are altitude or flight level/andOAT.

OATs display in OAT column.

The altitude for OAT does not have to be one of the wind altitudes. The FMC uses standard lapse rate to calculate and display the temperature at the other altitudes.

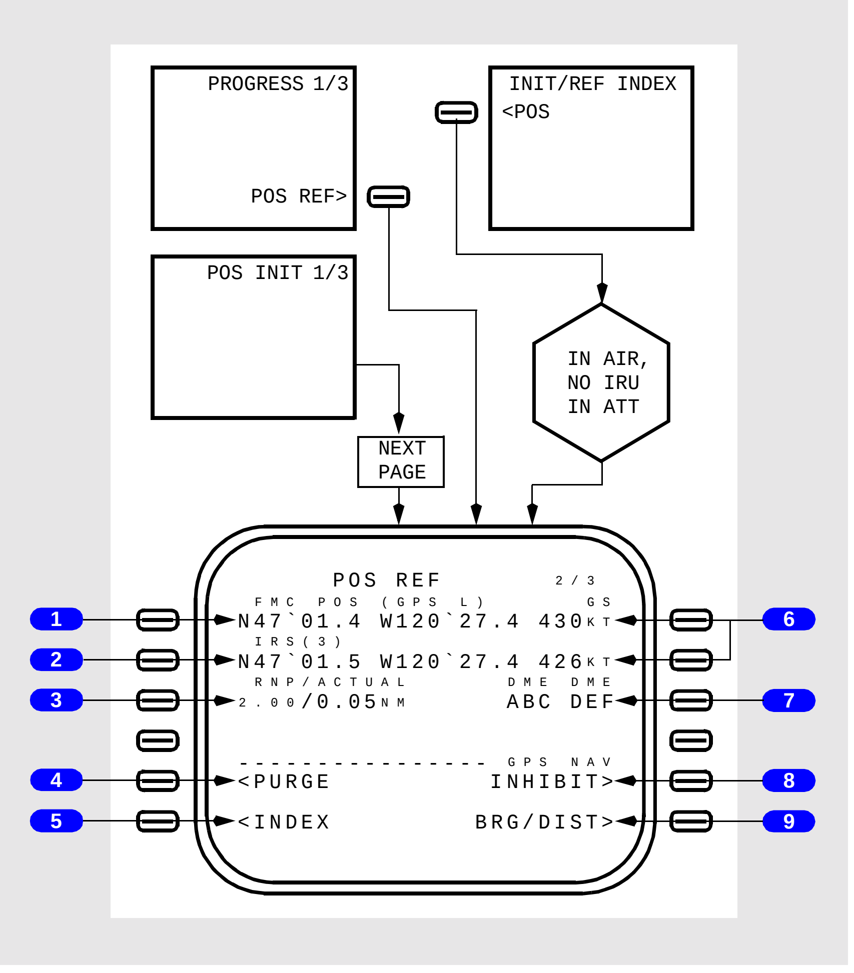
6 Route Data (RTE DATA)

Push – displays RTE DATA page.

Position Reference Page 2/3

Position reference page 2 displays the position and ground speed calculated by the FMC and IRS.

GPS position updating can be enabled and inhibited and radio and GPS updates to the FMC position can be purged on this page. The IRS position can be changed to bearing/distance.



1 **FMC Position (POS)**

Displays the FMC calculated latitude/longitude position.

Line title identifies the source for calculating the FMC position:

- GPS L, GPS R – FMC calculates position using GPS data
- RADIO – FMC calculates position using navigation radio data
- LOC-GPSL, LOC-GPSR - FMC calculates position using localizer and GPS data
- LOC-DD - FMC calculates position using localizer and DME data
- LOC-VD - FMC calculates position using localizer, VOR, and DME data
- LOC - FMC calculates position using localizer data

Displays IRS (X) position when CONFIRM displayed in purge line; becomes active FMC position if purge is confirmed.

2 IRS

Displays the IRS latitude/longitude position.

Following selection of BRG/DIST, displays bearing/distance of IRS position from FMC position.

Blank when FMC receiving no valid IRU data.

3 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Displays the RNP and actual navigational performance (ACTUAL) of the FMC. Displays IRS (X) position accuracy when CONFIRM displayed in purge line.

Default RNP is in small font. Manual RNP entry displays in large font. Deletion of manual entry returns display to default RNP.

Valid RNP entries are in the range 0.01 to 99.9. ACTUAL entry not allowed.

Note: The FMC stops GPS updates if the GPS ACTUAL is twice the RNP. This occurs if the GPS ACTUAL has increased or the flight crew inputs a small RNP value. Subsequently, the FMC changes updates to another system.

4 PURGE

Push -

- displays mixed IRS position on the FMC POS line. Line title displays PURGE and data line displays CONFIRM
- selection of CONFIRM replaces FMC position with mixed IRS position. FMC resumes radio updating when valid stations available. Line title blanks and PURGE prompt displays

Leaving this page on both CDUs with CONFIRM displayed returns the initial display.

5 INDEX

Push – displays INIT/REF INDEX page.

6 Ground Speed (GS)

Displays ground speed associated with FMC POS and IRS (X).

Blank from power application until IRU enters navigation mode.

Value frozen at engine shutdown following a flight until power removed, any IRU in ALIGN mode, or engine start.

7 Navigation Station

Displays indentifiers of navigation stations in use by FMC for radio position computation.

Title line displays type of radio station, DME-DME or VOR-DME.

Title line displays NAV STA and data line blanks when no radio position computation occurring.

8 GPS Navigation (NAV)

Initially displays INHIBIT. GPS data enabled for FMC position updating.

Push -

- inhibits GPS data for FMC position updating and displays ENABLE. Inhibiting retained through power interruption
- selection when ENABLE displayed enables GPS data for FMC position updating and displays INHIBIT. Defaults to INHIBIT following flight completion

9 Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)

Initially displays BRG/DIST.

Push –

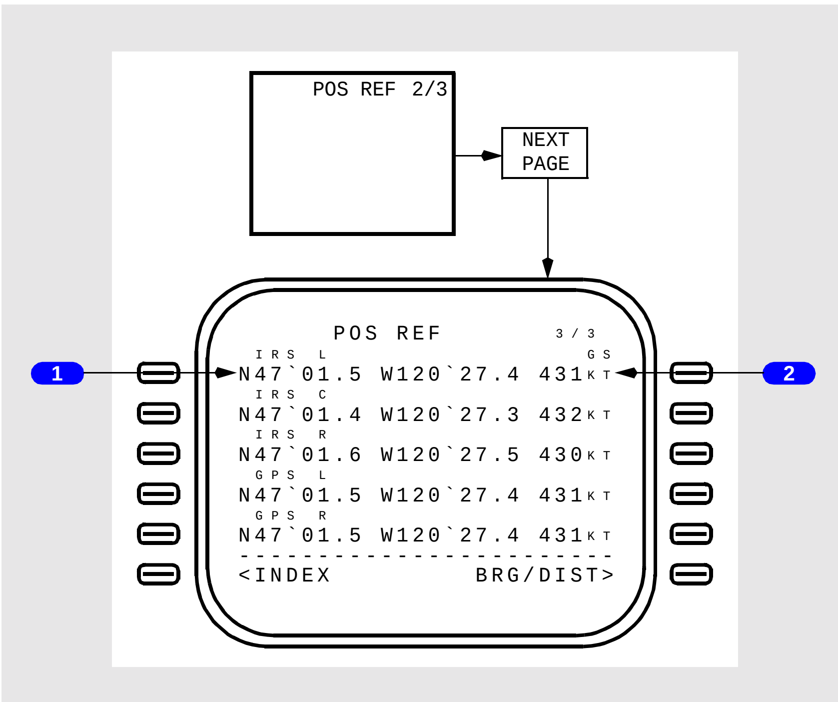
- displays bearing/distance in IRS (X) line relative to FMC position and displays LAT/LON
- if distance is zero, bearing displays 000
- selection when LAT/LON displayed or leaving the POS REF pages on both CDUs returns displays to latitude/longitude and BRG/DIST

The page illustration is shown in the latitude/longitude display format.

Position Reference Page 3/3

On position reference page 3, the flight crew can observe the positions and ground speed from the GPS receivers and the IRUs.

This page can be displayed in the bearing/distance or latitude/longitude format. The bearing/distance format displays the bearing and distance of the position sources relative to the active FMC position on POS REF 2/3 page.



1 IRU, GPS Position

Displays position computed by related system.

GPS data blanks if GPS unavailable or inhibited.

2 Ground Speed (GS)

Displays ground speed associated with IRS (X) or GPS (X).

IRS values frozen at engine shutdown following a flight until power removed, any IRU in ALIGN mode, or engine start.

GPS data blanks if GPS unavailable or inhibited.

Progress Pages

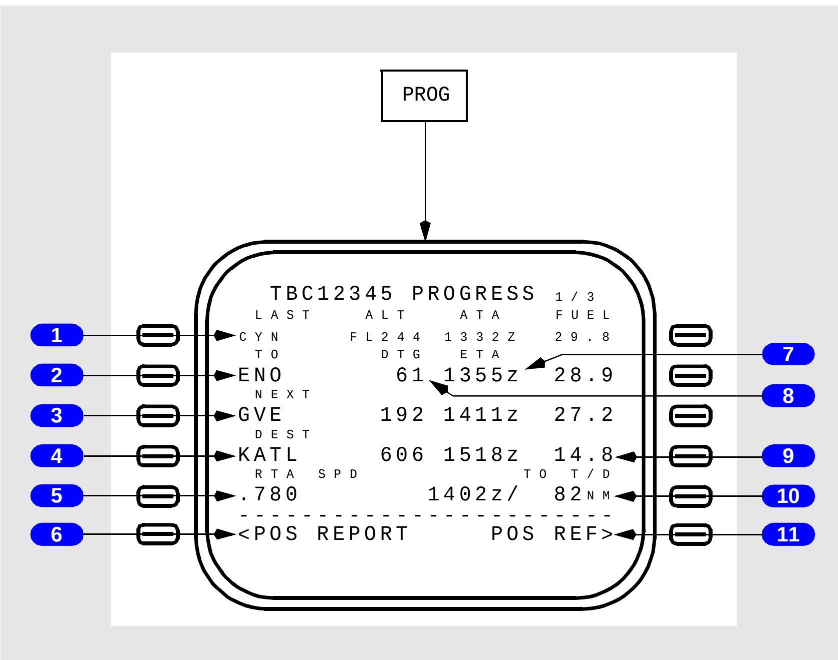
Progress Page 1/3

Progress page displays general flight progress data. The FMC Communication section of Chapter 05, Communications describes CDU 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 (last, active, and next)
- destination data
- RTA speed
- top of descent



1 **LAST**

Displays last waypoint identifer and altitude (ALT), actual time of arrival (ATA), and fuel (FUEL) remaining at that waypoint.

2 **TO**

Displays active waypoint identifier.

3 NEXT

Displays waypoint identifier of waypoint after the active waypoint.

4 Destination (DEST)

Displays destination identifier.

Valid entry is any airport in navigation database or waypoint in the flight plan. The line titles are:

- DEST – performance predictions to destination. Default display
- DIR TO ALTERNATE - performance predictions to alternate. Line data based on flying direct to the alternate
- EN ROUTE WPT – when entered waypoint is in flight plan. Line data 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.

5 Selected Speed (SEL SPD)

Displays active command speed and mode.

The active speed mode is the same as displayed on the performance page, unless changed by the MCP or a limit. Speed modes are:

- LRC SPD – long range cruise speed
- ECON SPD – economy speed
- SEL SPD – selected speed manually entered on the CDU
- LIM SPD – speed is limited by VMO, MMO, flap limit, or alpha limit
- MCP SPD – MCP speed entered on the MCP IAS/MACH indicator
- EO SPD – engine out speed
- VREF +100 - engine out during takeoff, engine out not selected, and speed not restricted by limit speed (e.g., flap placard)
- RTA SPD - RTA SPD when RTA mode active

6 Position Report (POS REPORT)

Push – displays the POS REPORT page.

7 ETA

Displays estimated time of arrival at waypoint or destination.

8 Distance To Go (DTG)

Displays distance to go to waypoint or destination.

9 **FUEL**

Displays estimated fuel remaining at waypoint or destination.

10 **TO**

Displays ETA and DTG to various points as flight progresses.

The line title and data change to display data for phases of flight. Line titles are:

- T/C - top of climb data
- 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 when drift down active

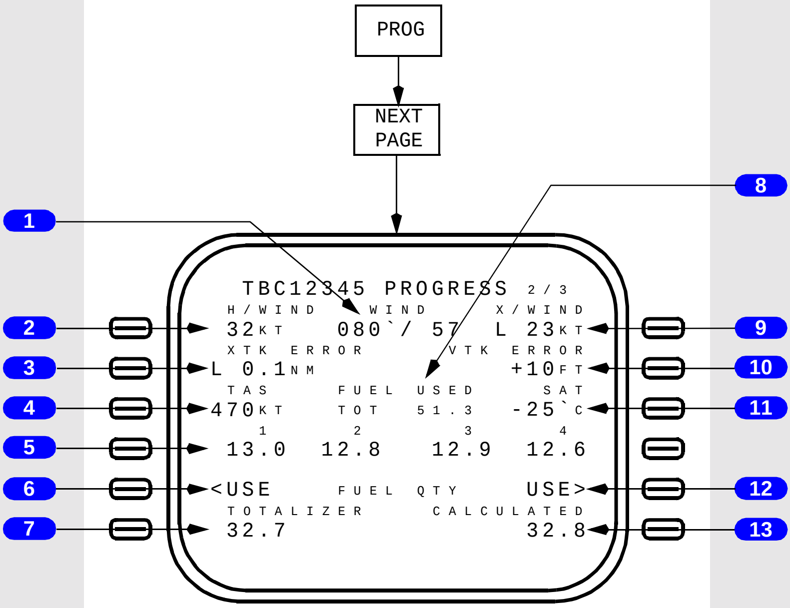
11 **Position Reference (POS REF)**

Push – displays position reference page 2/3.

Progress Page 2/3

Progress page two contains:

- wind data
- fuel data
- static air temperature
- true airspeed
- track error data



1 **WIND**

Displays current wind direction and speed referenced to true north.

2 **Headwind (H/WIND), Tailwind (T/WIND)**

Displays headwind (H/WIND) or tailwind (T/WIND) component.

Wind component data is relative to airplane heading.

3 **Crosstrack Error (XTK ERROR)**

Displays crosstrack (XTK) error in nautical miles left or right of the active route.

4 **TAS**

Displays airplane true airspeed.

5 **FUEL USED 1, 2, 3, 4**

Displays fuel used by engines 1, 2, 3, 4 sensed by fuel flow meters.

6 USE TOTALIZER

Displays USE prompt and scratchpad message FUEL DISAGREE - PROG 2 if a difference of 4,080 kilograms or more exists between TOTALIZER and CALCULATED fuel quantity.

Push -

- FMC uses fuel quantity processor computations to determine fuel quantity
- blanks CALCULATED and FUEL USED displays
- PERF INIT page fuel quantity retitled SENSED

7 FUEL Quantity (QTY) TOTALIZER

Displays fuel quantity calculated by fuel quantity processor.

Blank if fuel value manually entered on PERF INIT page.

8 FUEL USED Total (TOT)

Displays total fuel used as calculated from fuel flow.

9 Crosswind (X/WIND)

Displays left (L) or right (R) crosswind component relative to airplane heading.

10 Vertical Track Error (VTK ERROR)

Displays vertical path (VTK) error above (+) or below (-) vertical path.

Blank when descent not active.

11 Static Air Temperature (SAT)

Displays outside static air temperature.

12 USE CALCULATED

Displays USE prompt and scratchpad message FUEL DISAGREE - PROG 2 if a difference of 4,080 kilograms or more exists between TOTALIZER and CALCULATED fuel quantity.

Push -

- FMC uses calculated fuel quantity values
- blanks TOTALIZER display

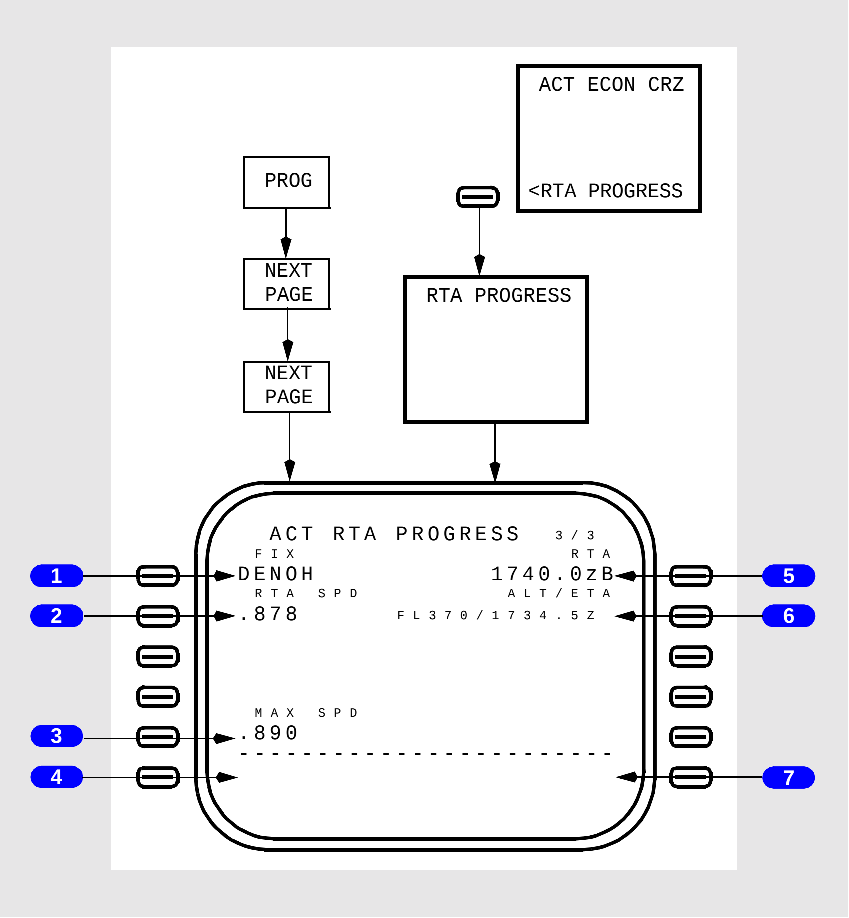
13 FUEL Quantity (QTY) CALCULATED

Fuel remaining as calculated by the FMC:

- before engine start, displays fuel quantity calculated by fuel quantity processor
- after engine start, displays fuel quantity calculated by decreasing fuel on board at engine start at EICAS fuel flow signal rate

RTA Progress Page 3/3

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 PROGRESS and CRZ page titles to include RTA. RTA operates only in cruise.



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 mode and resumes ECON. Display returns to boxes.

When RTA not active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

Defaults to boxes except when on ground or an engine-out mode active; then it is blank.

2 Required Time Of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA.

Blank if no RTA fix or time entered, or with descent active.

3 Maximum Speed (MAX SPD)

Valid entry is Mach .100M to .99M.

Deletion of entered value displays default Mach.

Default Mach .880 displays in small font.

4 ERASE

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 FIX in 1L.

Valid entry is time from 0000.0 to 2359.9. Decimal entry o f.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

Deletion terminates RTA and returns ECON as cruise mode.

6 Altitude/ETA (ALT/ETA)

Displays predicted altitude and ETA at RTA fix.

Blank until performance data is entered.

7 PRIOR RTA

Displays after RTA waypoint deleted and executed.

Push -

- displays previously active RTA fix and time
- initiates RTA modification

Execution activates RTA function.

Introduction

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for descent phase starts during cruise.

The approach phase starts at the end of descent point and continues to touchdown or missed approach. If a go–around is accomplished, the FMC climb mode activates.

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 cruise altitude in the MCP altitude window and pushing the altitude selector activates the DES NOW function when the aircraft 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.

Descent

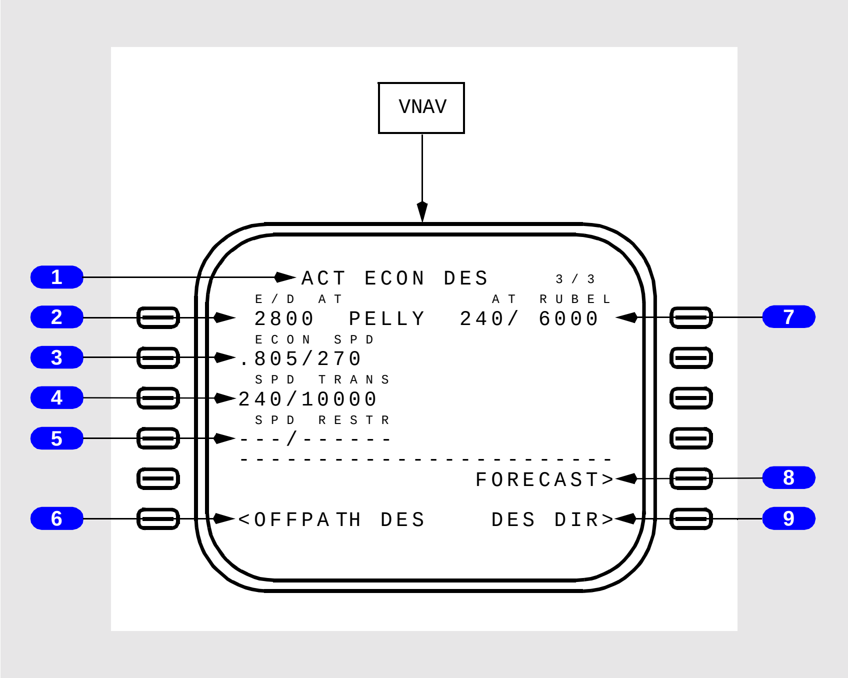
During descent, the RTE LEGS and PROGRESS pages are used to control the lateral route. The DES page is used to control the vertical descent profile.

The additional descent pages listed below are 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

Descent Page

The DES page is used to monitor and revise the descent path. Descent speeds are economy (ECON) and selected speed (SEL). The default VNAV descent speed is ECON. A selected speed descent is flown when speed intervention is used or a speed is entered on the DES page. The DES page is blank with DES as the title until an altitude constraint below the cruise altitude is entered.



1 Page Title

The page title displays active (ACT) or modified (MOD) descent. Usually, the title contains ECON for economy descent. Other fixed or selected speeds modify the title.

The page title displays the type of descent:

- ECON – speed based on a cost index
- LIM SPD – speed based on airplane configuration limiting speed
- MCP SPD – MCP speed intervention is selected
- XXXKT – fixed CAS descent speed profile
- M.XXX – fixed Mach descent speed profile
- END OF DES - E/DAT waypoint reached if not followed by a climb segment

Fixed or selected descent speeds are for:

- a flight crew selected speed (SEL SPD)
- a speed transition
- a speed restriction associated with an altitude constraint
- waypoint speed constraints

2 End Of Descent At (E/DAT)

Displays end of descent altitude and waypoint.

End of descent point is a point in descent phase with the lowest altitude constraint.

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 transitioning from ECON speed into a selected speed segment (waypoint speed constraint, SPD RESTR, or SPD TRANS)
- displays when flight crew enters speed
- valid entries are CAS or Mach value

4 Speed Transition (SPD TRANS)

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. Transition altitude is the point transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet displays.

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 an altitude higher than E/D altitude and not associated with specific waypoints are manually entered on this line.

Displays dashes before entry by flight crew.

Valid entry is a CAS and altitude (example: 240/8000).

6 Off Path Descent (OFFPATH DES)

Push – displays OFFPATH DES page.

7 AT XXXXX

Displays the next waypoint constraint from 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.

8 FORECAST

Push – displays DESCENT FORECAST page.

9 Descend Direct (DES DIR), Descend Now (DES NOW)

DES DIR -

Displays in descent phase with altitude constraint between airplane and E/D.

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

DES NOW -

Displays when T/D created and the descent phase is not active.

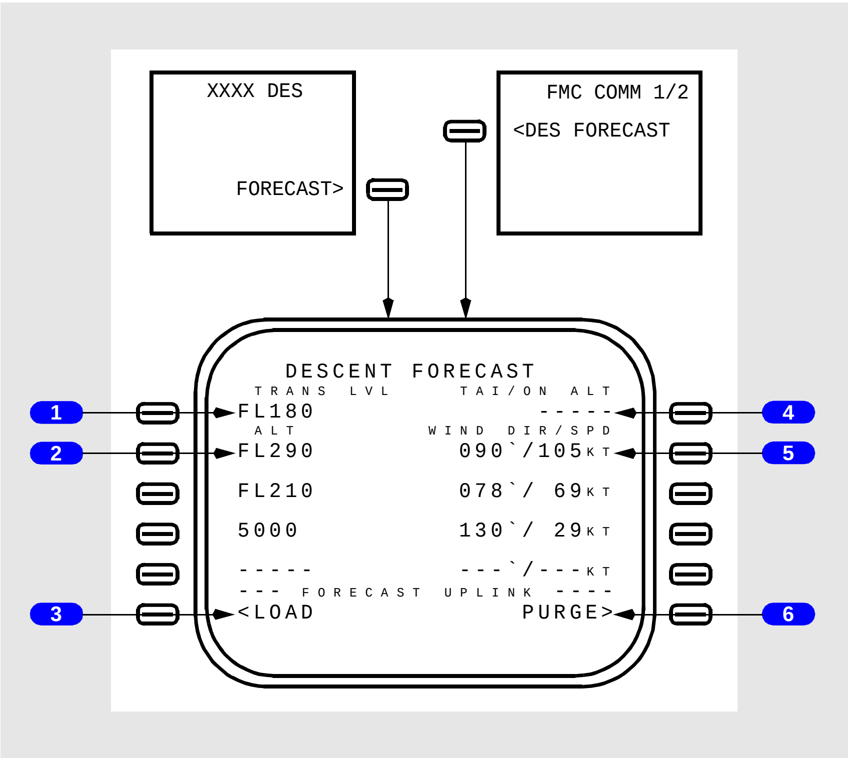
Push –

- provides guidance to descend at approximately 1,250 feet per minute using the active descent speed schedule. Thrust levers may be manually repositioned to adjust vertical speed. Upon intercepting the planned descent path, the airplane transitions to the planned descent path
- activates FMC descent phase

Descent Forecast Page

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.

Primary entries are wind direction and speed for up to four descent altitudes, and the altitude anti–ice is to be turned on. Entries can be manual or uplinked.



1 **Transition Level (TRANS LVL)**

Transition level can be specified by the arrival procedure. The default transition level is FL180.

Valid entry is an altitude or flight level.

The FMC uses transition level to change displays between FL and feet.

2 **Altitude (ALT)**

Valid entries are altitudes and flight levels.

Altitudes and flight levels can be entered in any order. Entries are not sorted.

3 REQUEST SEND, FORECAST UPLINK LOAD, DATALINK

Displays SEND prompt when datalink READY and no uplink pending.

SEND -

Push -

- transmits datalink request for descent wind data
- displays scratchpad message DES FORECST UPLINK READY and displays LOAD and PURGE prompts when an uplink containing descent forecast uplink data received and error checks passed

LOAD -

Push -

- accepts and displays request for descent wind data
- displays SEND prompt
- changes PURGE prompt to DES prompt

Displays DATA LINK and data line NO COMM, VOICE, or FAIL if datalink is not READY.

4 Thermal Anti–Ice On Altitude (TAI/ON ALT)

Valid entry is altitude or flight level where anti–ice is to be first turned on during the descent.

5 Wind Direction/Speed (WIND DIR/SPD)

Valid entry is wind direction/speed for the specified altitude. Initial entry must have wind direction and speed, subsequent entries may have one or the other.

6 FORECAST UPLINK PURGE, Descent (DES)

Displays PURGE prompt when an uplink containing descent forecast uplink data received and error checks passed.

PURGE -

Push - rejects uplinked descent forecast data.

DES -

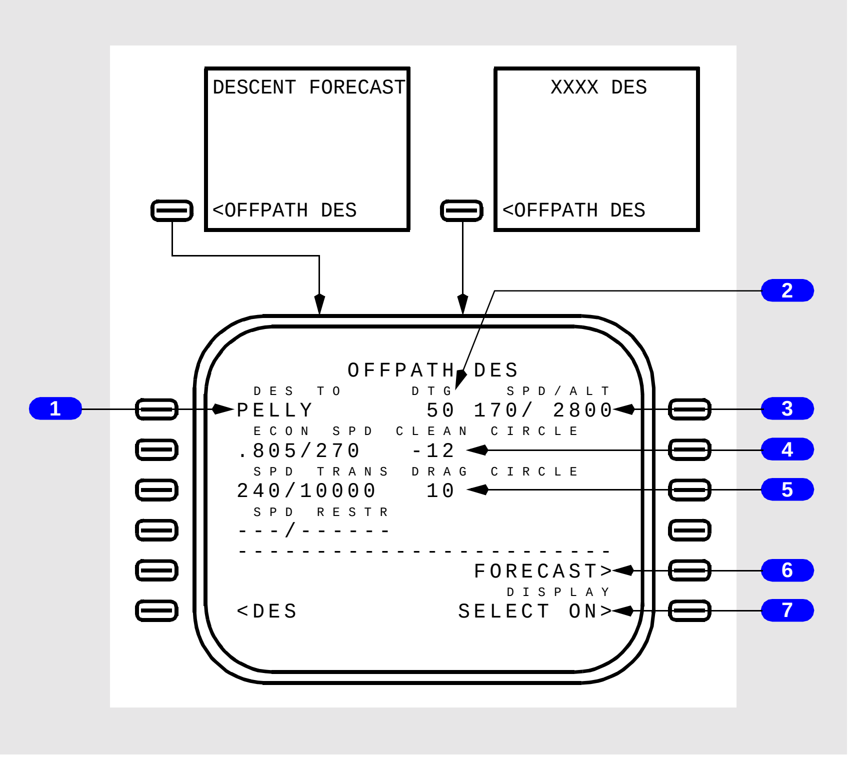
Push - displays the DES page.

Offpath Descent Page

Offpath descent page allows the analysis of descent performance direct to a selected waypoint. Data entered displays clean and drag descent ranges on the page and on the ND. Ranges are based on an entered waypoint and altitude constraint. Range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC displays the last descent waypoint with an altitude constraint in 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 DES page. DTG calculations are for a descent direct to the DES TO waypoint.

Valid entry is any navigation data base waypoint.

When within 150 feet of the DES TO waypoint altitude for a waypoint other than the E/D waypoint, the display changes from DES TO waypoint to the E/D waypoint from DES page.

2 Distance To Go (DTG)

Displays straight line distance to the entered waypoint.

3 Speed/Altitude (SPD/ALT)

Displays the speed/altitude constraint from the E/D waypoint on the DES page or from an entered active waypoint which has a speed/altitude constraint. Other entries cause prompt boxes to display.

4 CLEAN CIRCLE

Displays distance to the clean descent circle. 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.

5 DRAG CIRCLE

Displays distance to the drag descent circle. 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.

6 FORECAST

PUSH - displays DESCENT FORECAST page.

7 DISPLAY SELECT ON, SELECT OFF

SELECT ON -

Push –

- displays CLEAN CIRCLE on ND
- displays DRAG CIRCLE on ND after aircraft inside CLEAN CIRCLE

SELECT OFF -

Push – removes clean and drag circles from the ND.

Engine Out Descent

There are no specific engine out pages for descent. Use the all-engine descent planning features and pages.

Approach

During an ILS or LOC approach, roll and pitch modes change to approach guidance supplied by navigation radios. The FMC continues to calculate and display present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active.

During approach, the specific page listed below is used to:

- APPROACH REF page – specify approach flap settings and set the approach VREF
- ARRIVALS page – select arrival and approach procedures
- HOLD page – manage holding patterns

Arrivals Page – IFR Approaches

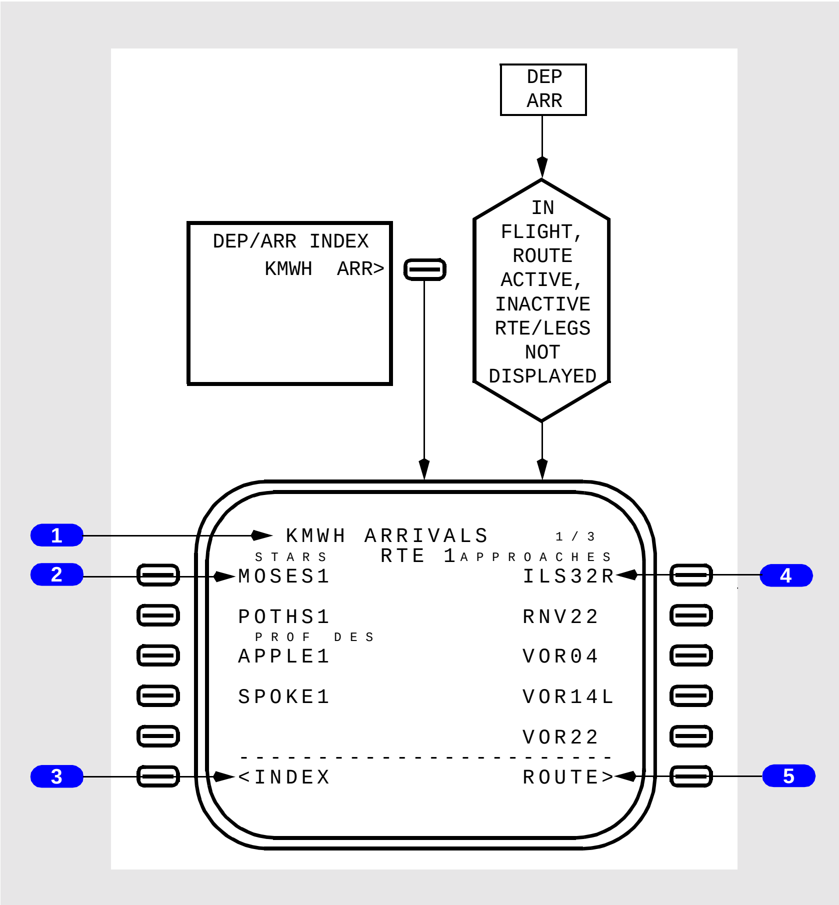
The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

Accessing the arrivals page less than 400 NM from the departure airport or less than halfway along the active route, displays arrivals for the departure airport.

The approaches, STARS/profile descents, and transitions are displayed and selected on this page.

Selecting Options

Selecting a runway, approach, approach transition, STAR/profile descent, or descent transition option shows <SEL> inboard of the selection, and makes a route modification. The other options within the same category are removed from the list. When executing the modification, <SEL> changes to <ACT>. Selecting another page and returning to ARRIVALS displays all options; the applicable <SEL> or <ACT> prompts are displayed.



1 Page Title

The destination airport identifier displays in the title.

Second line displays route number.

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 INDEX

Push – displays the DEP/ARR INDEX page.

4 APPROACHES

Displays the destination airport approaches.

Push -

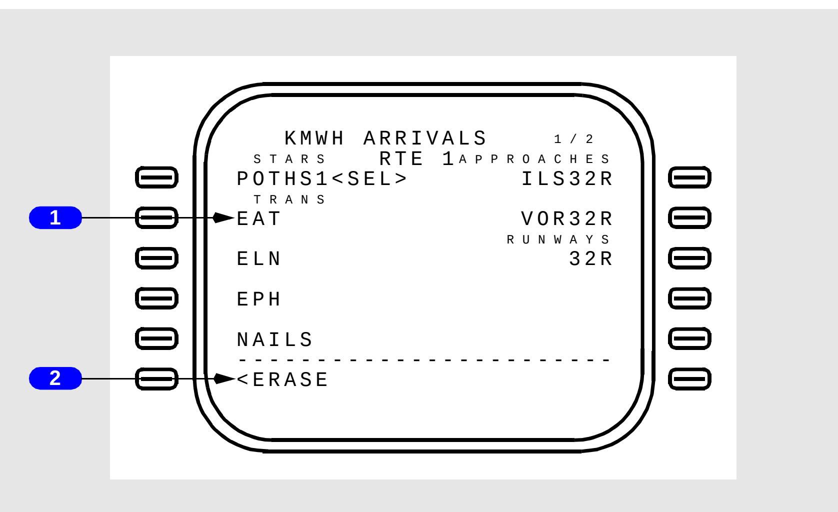
- selects approach for entry into the route, <SEL> displays
- all other approaches and runways no longer display; transitions and profile descents for the selected approach display
- displays INTC prompt for selected approach
- displays ERASE prompt

5 ROUTE

Push -

- displays route page for related route
- displayed only on ground or for inactive route

Arrivals Page With STAR Selected



1 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

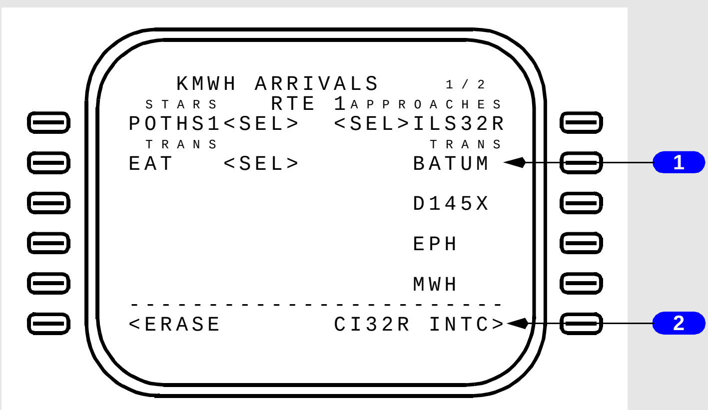
2 ERASE

Displayed when STAR, PROF DES, or APPROACH selected.

Push -

- deletes selections made to active route
- displays lists of STARS, PROF DES, APPOACHES, and RUNWAYS
- displays INDEX prompt

Arrivals Page With STAR, STAR Transition, and Approach Selected



1 Approach Transitions (TRANS)

Displays list of transitions for the selected approach procedure.

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
- all other transitions no longer display
- displays INTC prompt for selected transition

2 Approach Intercept

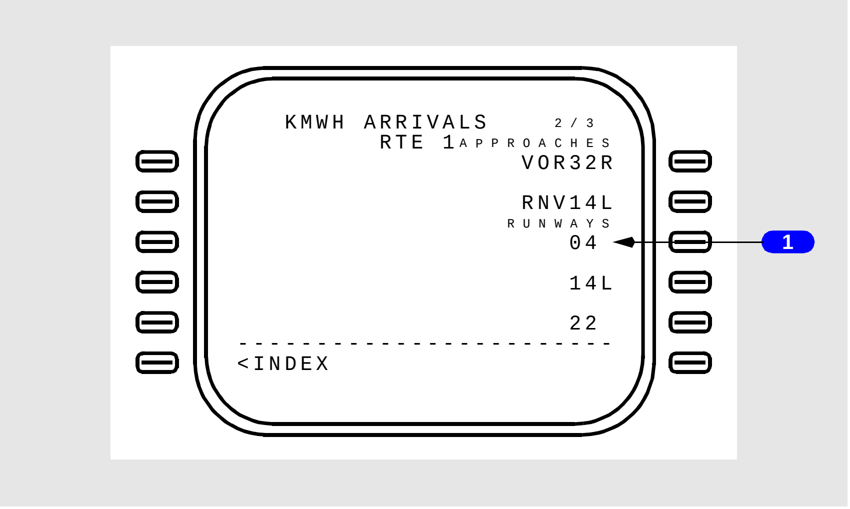
Selecting an arrival runway or approach displays an approach intercept waypoint on the approach course for selected approach or runway.

Following selection of a transition, the charted fix or CFXXX is replaced with the final approach fix (FAF) intercept (example: PELLY INTC).

Push -

- displays RTE LEGS page and modifies route with approach intercept fix as the active waypoint
- selects approach course for selected approach as inbound course to approach intercept fix on LEGS page

Arrivals Page – VFR Approaches



1 RUNWAYS

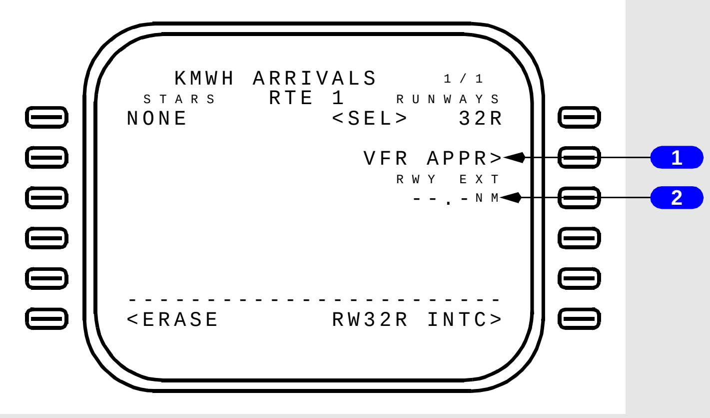
Displays list of runways for destination airport.

Push -

- selects runway for entry into the route; <SEL> displays
- deletes previously selected approach
- displays VFR APP and runway extension

- all other runways and approaches no longer display
- displays approach intercept fix for selected runway

Arrivals Page With Runway Selected



1 VFR Approach (VFR APPR)

Push - following discontinuity, enters straight-in VFR approach.

VFR approach begins with a VFR Final Approach Fix (FAXXX) 8 miles from runway threshold with airspeed/altitude constraint of 170 kts/2,000 feet above runway elevation.

VFR approach ends with a runway altitude constraint of 50 feet.

Displays RWY EXT 8.0 NM.

Displays FPA 3.0°.

2 Runway Extension (RWY EXT)

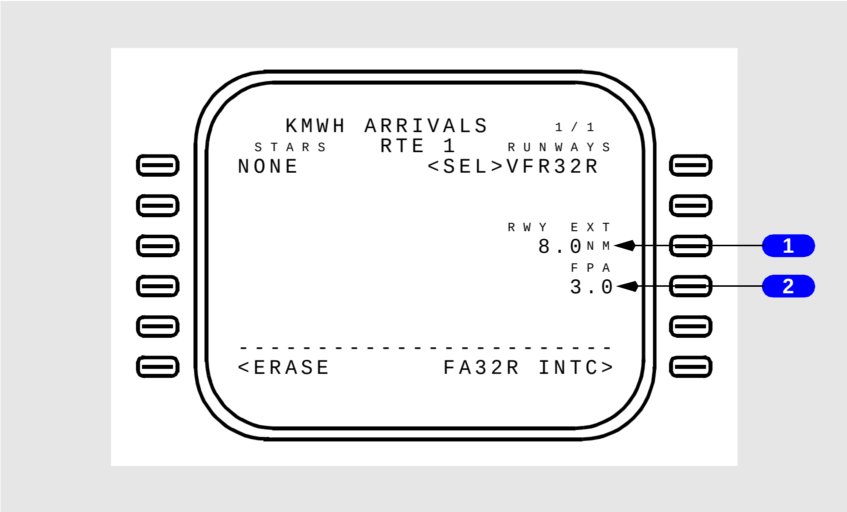
Allows entry of end of descent target for VNAV guidance.

Creates a runway extension fix along runway centerline for LNAV guidance.

Valid entry is 1.0 nm to 25.0 nm.

Entry deletes VFR APPR prompt.

Arrivals Page With VFR Approach Selected



1 **Runway Extension (RWY EXT)**

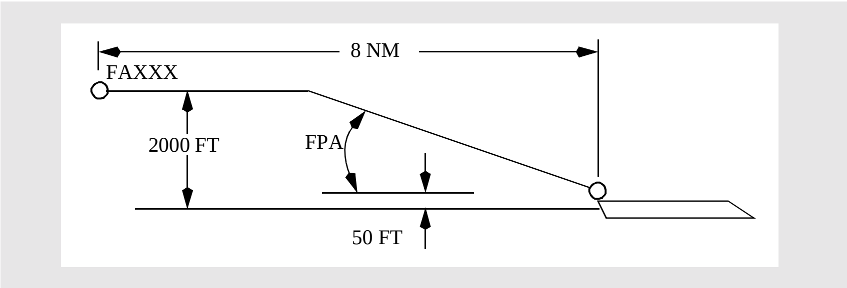
Displays RWY EXT 8.0. FAXXX is part of VFR APPR and distance cannot be changed.

2 **Flight Path Angle (FPA)**

Displays descent path angle to 50 foot runway waypoint. Default is 3.0°.

Valid entry is 2.4° to 3.7°.

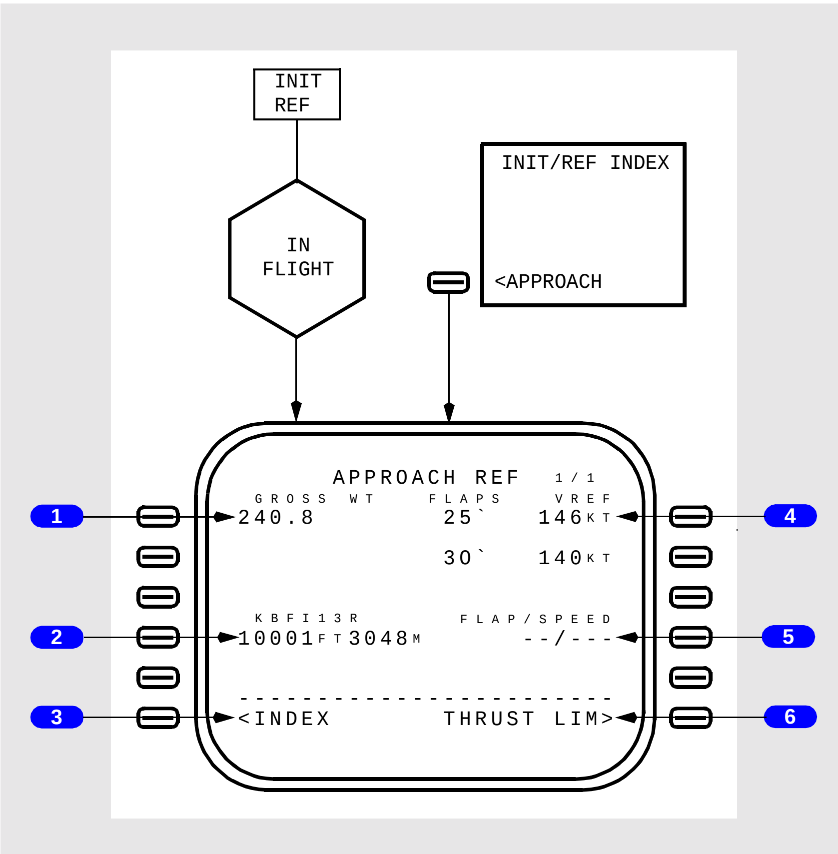
VFR Approach Path



The VFR approach is a level path until the VNAV descent path is intercepted. It terminates at the runway threshold at 50 feet (and 170 knots). Default values display in RWY EXT and FPA.

Approach Reference Page

The approach reference page displays approach planning data and the approach reference speed (VREF) selection.



1 Gross Weight (GROSS WT)

Displays FMC calculated airplane gross weight.

Displays boxes when gross weight is not available from FMC.

Valid entry is XXX.X. Leaving this page and returning displays the FMC calculated gross weight.

2 **Runway Length**

Displays length of departure runway until destination runway or approach entered into active route and airplane is 50 NM from departure airport or halfway to destination.

Displays runway length in feet and meters.

Display clears at flight completion.

3 **INDEX**

Push – displays INT/REF INDEX page.

4 **FLAPS VREF**

Displays computed VREF for the indicated landing flap settings at displayed gross weight. Blank until gross weight entered.

Push - displays flaps/VREF in scratchpad for entry in 4R.

5 **FLAP/SPEED**

Valid entries are: XX/YYY, /YYY, or YYY. XX is flap setting, YYY is airspeed.

Entry displays VREF speed on PFD. Entry of an airspeed greater than VREF increases the entire flap speed schedule by the increased amount. If no VREF is selected or an entry is not made, displayed flap speeds are based on flap position increments above VREF 30 for the current gross weight.

Deletion of data removes VREF from PFD.

6 **Thrust Limit (THRUST LIM)**

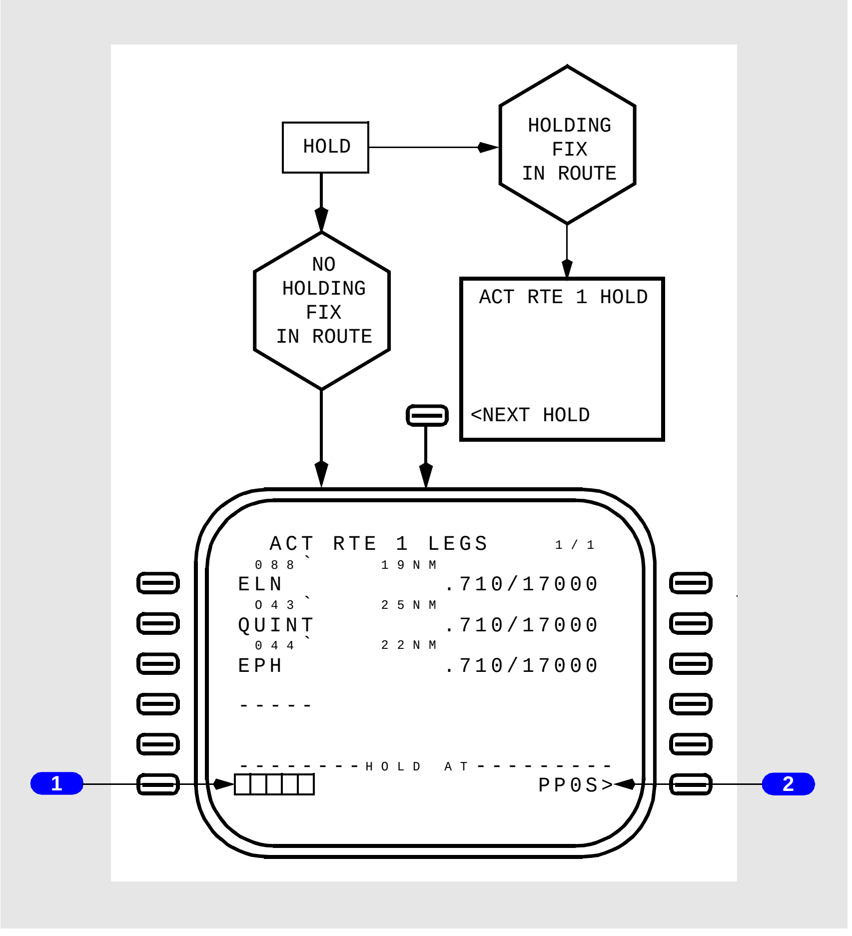
Push – displays THRUST LIM page.

Holding

The route hold page is used to enter holding information in the route or to view or modify an existing holding pattern. Modifications made to a holding pattern while active in the hold become effective on the next crossing of the holding fix.

Route Hold Page With No Holding Fix in Route

When no hold exists in route, pushing the HOLD key displays RTE LEGS page. RTE LEGS page displays prompts to enter the holding fix as a route waypoint or at present position.



1 HOLD AT Boxes

Boxes can be displayed on any RTE LEGS page.

Valid entry is any RTE LEGS waypoint, database waypoint, or pilot-defined waypoint.

Along-track waypoints must be entered over the original waypoint, then in the boxes.

If holding fix not in active route, waypoint is entered in scratch pad, then selected to HOLD AT boxes. HOLD AT XXXXX displays in scratch pad. Selecting HOLD AT XXXX to desired line displays RTE HOLD page; cannot be selected as the active waypoint.

2 HOLD AT PPOS

Push -

- creates holding pattern at present position
- execution establishes the holding fix at the position when EXEC is pushed and displays RTE HOLD page

Route Hold Page After Pushing PPOS And Executing

Route Hold Page With Holding Fix in Route

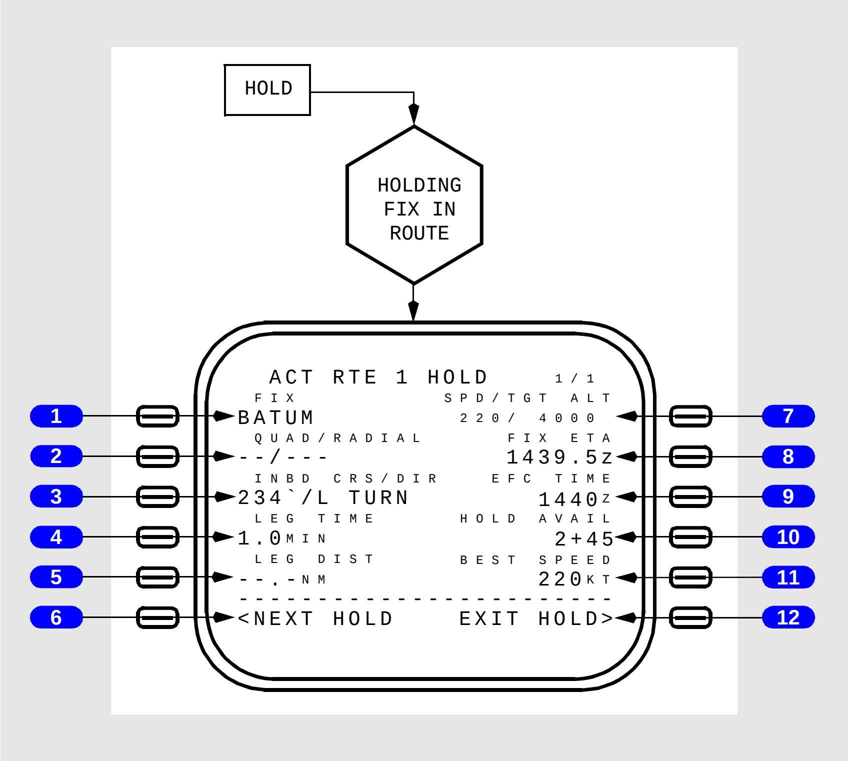
When a hold(s) exists in the route, hold page 1/X displays first existing hold. When more than one hold exists, pushing NEXT PAGE displays succeeding holds.

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

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
- for some holding patterns in SIDs, the airplane exits holding when arriving at an altitude



1 Holding FIX

Displays the holding fix.

2 Quadrant/Radial (QUAD/RADIAL)

Normally displays dashes.

Valid entry is X/XXX OR XX/XXX, or /XXX. Example: NW/330.

Entry changes INBD CRS/DIR to agree.

3 Inbound Course/Direction (INBD CRS/DIR)

Displays inbound course and direction of turn.

Valid entry is XXX (course), XXX/X, /X, or X (turn direction).

Entry changes QUAD/RADIAL to agree.

4 LEG TIME

Displays 1.0 MIN (minute) at or below 14,000 feet.

Displays 1.5 MIN above 14,000 feet.

Displays dashes when entry made on LEG DIST line.

Valid entry is XXX.X.

Entry displays dashes on LEG DIST line.

When climbing/descending through 14,000 feet with VNAV active and the SPD/TGT ALT at 1R is displayed in large font, the FMC adjusts the leg time.

5 LEG Distance (DIST)

Normally displays dashes. Allows entry of leg distance for hold.

Valid entry is XX.X or X.X.

Entry displays dashes on LEG TIME line.

6 NEXT HOLD, ERASE

NEXT HOLD -

Push – displays prompts for entering another hold in route.

ERASE -

Displayed when hold modified.

Push -

- erases modification to hold
- displays NEXT HOLD prompt

7 Speed/Target Altitude (SPD/TGT ALT)

Displays dashes or fix target speed/altitude from RTE LEGS page.

Display is small font for FMC predictions, large font for constraints or manual entries.

Valid entry is XXX/ (speed); YYY, YYYY, or YYYYY (target altitude), or a combination of speed/target altitude.

- speed entry requires altitude constraint
- altitude entry must be below cruise altitude

Entry displays on HOLDAT waypoint on RTE LEGS page.

During cruise, entry of a target altitude lower than CRZ ALT modifies DESCENT page and displays a T/D. After T/D, the DESCENT page remains active unless a new cruise altitude is entered.

8 FIX ETA

With no EFC TIME entry, displays time the fix will be passed.

With EFC TIME entry, displays the first time the fix will be passed after the EFC time.

9 Expect Further Clearance Time (EFC TIME)

Normally displays dashes.

Valid entry is XXXX (time).

Entry changes ETA and fuel predictions for the route after holding.

10 HOLD Available (HOLD)

Displays holding time available before requiring reserve fuel to reach the destination.

11 BEST SPEED

Displays best holding speed for airplane gross weight, altitude, and flap setting.

Note: BEST SPEED may exceed regulatory maximum holding speeds.

12 EXIT HOLD, EXIT ARMED

EXIT HOLD -

Push -

- arms a holding pattern exit
- displays EXIT ARMED prompt

EXIT ARMED -

When executed, airplane returns to the fix via the inbound course and exits holding pattern.

Intentionally
Blank

Introduction

The CDUs can be used as an alternate navigation system if both FMCs fail. The CDUs perform lateral navigation computations; however,LNAV, VNAV, and autothrottle are not available. The CDU can be used to tune 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.

Each CDU performs its calculations based on inputs from its own IRU. 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 can be selected as an alternate to the left or 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, and holding patterns. 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.

Waypoint Operations

Waypoint operations include:

- add new waypoints (latitude/longitude entry only)
- remove existing waypoints
- change the sequence of existing waypoints
- connect discontinuities.

Alternate Lateral Navigation

All CDU calculations are based on a great–circle course between waypoints.

Route Changes

Route changes are made on 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 does not change the other two. The Captain may view the route entered in either the left or center CDU on the ND using the NAV source select switch. The First Officer may view the route entered in either the right or center CDU on the ND using the NAV source select switch.

When displaying center CDU data on the First Officer's ND, the ND range selector must agree with the range selected on the Captain's selector. If different, the message MAP RANGE DISAGREE displays on the First Officer's ND.

Course Reference

The IRU 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 each CDU in alternate navigation. The left CDU tunes the left VOR, DME, ADF, and left ILS. The right CDU tunes the right VOR, DME, ADF, and right ILS. The center CDU tunes the center ILS. Manual tuning is accomplished on the ALTERNATE NAVIGATION RADIO page.

Alternate Navigation CDU Pages

Alternate navigation is accomplished from three CDU pages:

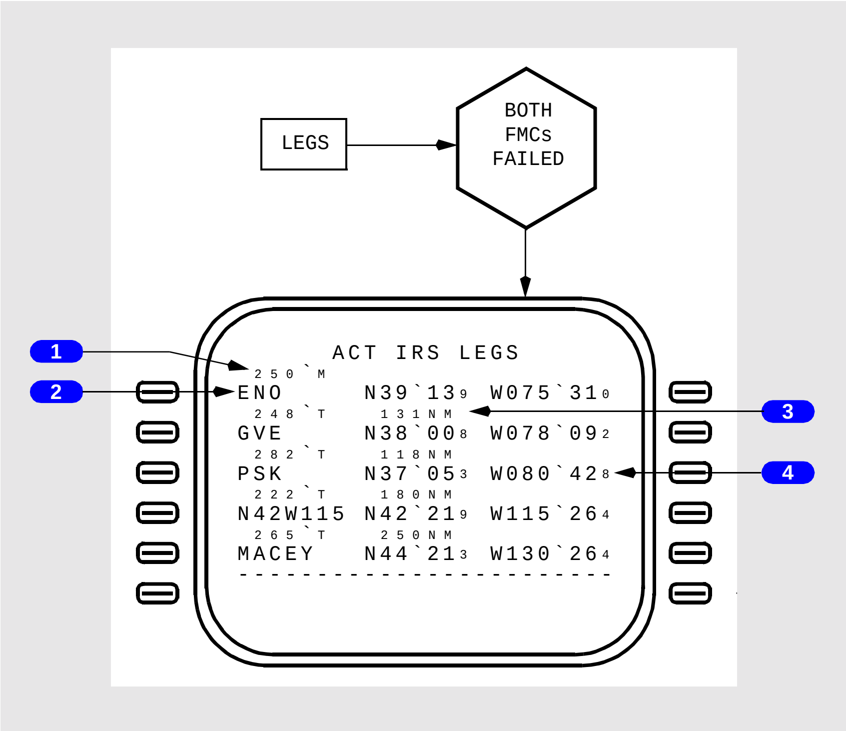
- ALTERNATE NAVIGATION LEGS
- ALTERNATE NAVIGATION PROGRESS
- ALTERNATE NAVIGATION RADIO.

Failure of an FMC displays the related CDU MENU page and the scratchpad message TIMEOUT-RESELECT. Rotating the related Navigation Source Selector to the operable FMC restores the CDU display and NDs to normal.

If both FMCs fail, the IRS LEGS, IRS PROGRESS, and ALTN NAV RADIO pages are available on all CDUs. Rotating Navigation Souce Selectors to a CDU position restores NDs and the alternate navigation pages.

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 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.

2 Waypoint Identifier

Displays the waypoint by name or latitude/longitude.

Valid entries are waypoints currently in the route or latitude/longitude for new waypoints.

3 **Distance to Waypoint**

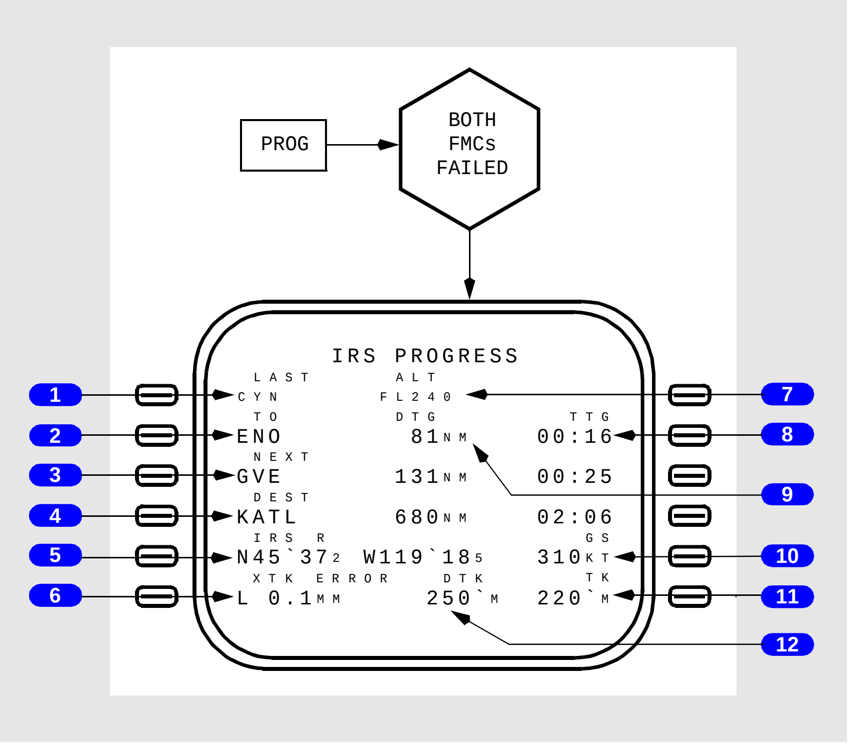
Displays the great circle distance between waypoints.

4 **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.

3 NEXT

Displays the waypoint after the TO waypoint.

4 Destination (DEST)

Displays identifier for 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 the present position direct to the new 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 IRU present position.

Line title displays IRU source for 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 waypoint or destination.

9 Distance to Go (DTG)

Displays distance to go to waypoint or destination.

10 Ground Speed (GS)

Displays IRU groundspeed.

11 Track (TK)

Displays airplane track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

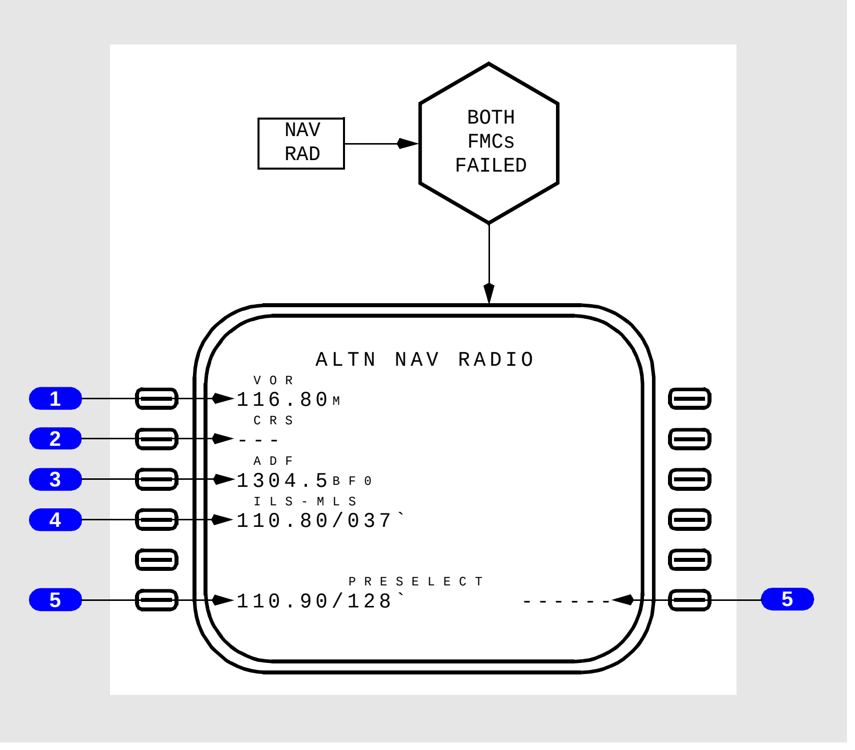
12 Desired Track (DTK)

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
- the right CDU tunes the right radios
- the center CDU tunes the center ILS.



1 VOR

Displays last selected VOR frequency. Tuning status displays as manual (M).

Display is blank on center CDU.

Valid entry is VOR frequency or VOR frequency/course.

Entry tunes related DME frequency.

2 Course (CRS)

Displays selected VOR course.

Display is blank on center CDU.

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).

Front course defaults to runway course if runway on active route and only frequency entered. Otherwise, front course defaults to 000 or the last entered front course.

Note: If ILS was in autotune at the time of the FMC failure, the frequency and course are copied to the ALTN NAV RADIO page.

Note: The ILS frequency displaysPARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

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.

Flight Management, Navigation EICAS Messages

The following EICAS messages can display.

EICAS Alert Messages

Message	Level	Aural	Condition
>FMC LEFT, RIGHT	Advisory		Affected FMC has failed.
>FMC MESSAGE	Advisory		High priority FMC message exists.

Message	Level	Aural	Condition
>GPS	Advisory		Dual GPS failure.
>GPS LEFT, RIGHT	Advisory		GPS sensor fault.

Message	Level	Aural	Condition
ILS ANTENNA	Caution	Beeper	Glide slope or localizer antenna fails to switch.
>IRS CENTER, LEFT, RIGHT	Advisory		IRU fault detected.
>IRS AC CENTER, LEFT, RIGHT	Advisory		IRU AC power failure.
>IRS DC CENTER, LEFT, RIGHT	Advisory		IRU backup DC power failure.
>IRS MOTION	Advisory		Excessive airplane motion detected during alignment.
>SNGL SOURCE ILS	Advisory		Both pilots’ displays referenced to the same localizer or glideslope receiver.
>TRANPONDER L, R	Advisory		Affected ATC transponder has failed.

Message	Level	Aural	Condition
UNABLE RNP	Advisory		Navigation performance does not meet required accuracy during navigation phases other than approach.
UNABLE RNP	Caution	Beeper	Navigation performance does not meet required accuracy during navigation approach phase.

EICAS Memo Messages

Message	Condition
IRS ALIGN MODE C, L, R	IRS in align mode. Message no longer displayed when all IRUs enter navigation mode.

FMC Messages

FMC messages indicate degraded system operation or data input errors. The messages are categorized as alert messages and advisory messages.

FMC messages also indicate data link status.

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.

FMC alert messages display the EICAS message FMC MESSAGE. All FMC messages illuminate the CDU message (MSG) light. Pushing the CLEAR key or correcting the condition cancels the message.

FMC Alert Messages

ATC COMM ESTABLISHED - ATC COMM available or control passed to a new ATC center.

ATC MSG NOT ACKNOWLEDGED - ATC message has been transmitted and no network acknowledgment is received.

ATC REPORT LIST FULL - nine reports have been generated and are awaiting transmission and a tenth report request has been received.

CHECK ALT TGT - VNAV activates when airplane between MCP and FMC target altitudes. VNAV maintains level flight.

CYCLE IRS OFF-NAV - IRS align problem requires cycling IRS mode switch OFF, then back to NAV.

DESCENT PATH DELETED - VNAV active and all waypoint altitude constraints defining descent path deleted.

DES FORECST UPLINK READY - receipt of an uplink message containing descent forecast data which passes error checks and is ready to be loaded on the DESCENT FORECAST page.

DISCONTINUITY - LNAV active and airplane enters route discontinuity. AFDS maintains last heading.

DRAG REQUIRED - VNAV active and additional drag required or autothrottle off and less thrust required to maintain descent path.

END OF OFFSET - LNAV active and 5 NM prior to end of active route offset. AFDS maintains last heading if active route offset overflown.

END OF ROUTE - LNAV active and end of active route overflown. AFDS maintains last heading.

ENTER IRS POSITION - the flight crew-entered present position did not pass an IRS comparison check or the IRS is ready to enter the navigation mode and a present position has not been entered.

FLT NUMBER UPLINK - receipt of an uplink message containing flight number data which passes error checks and is inserted in the flight plan.

FMC L/R OUTPUT DATA LOSS - some information used by systems other than the FMS is not available.

FUEL DISAGREE - PROG 2 - fuel totalizer and calculated values disagree by 4,080 Kg or more.

ILS TUNE INHIBITED - MCP - flight control computers inhibiting changes in ILS tuning, and either a manual operation in the ILS-MLS tuning field attempted or a new arrival ILS approach activated.

INSUFFICIENT FUEL - estimated fuel at destination less than entered RESERVES value.

INVALID ATC UPLINK - ATC uplink message received by FMC contains format or other errors. FMC rejects the uplink and sends a downlink response to ATC center.

INVALID FLT NO UPLINK - receipt of an uplink message containing route data, which is at least partially loaded, and flight number data which fails error checks and is rejected or upon receipt of an uplink message containing only flight number data which fails error checks and is rejected. FMC sends a downlink response rejecting the message and explaining why.

INVALID FORECAST UPLINK - receipt of an uplink message containing only descent forecast data in which all data fails error checks and is rejected, or receipt of an uplink message containing waypoint wind data which is loaded into the flight plan and descent forecast data in which all data fails error check and is rejected. FMC sends a downlink response rejecting the message and explaining why.

INVALID ROUTE UPLINK - receipt of an uplink message containing route data which fails error checks and is rejected. FMC sends a downlink response rejecting the message and explaining why.

INVALID WIND DATA UPLINK - receit of an uplink message in which all waypoint wind data is invalid and cannot be loaded into the flight plan. FMC sends a downlink response rejecting the message and explaining why.

IRS POS/ORIGIN DISAGREE - valid IRS position differs from active origin airport.

LIMIT ALT FLXXX - VNAV active and cruise altitude greater than VNAV limit altitude.

MESSAGE LIMIT EXCEEDED - attempted selection of a sixth request of an ATC request.

NAV DATA OUT OF DATE - clock calendar date exceeds navigation data base valid (active) calendar cycle.

NAV INVALID-TUNE AAA (AAA = required navaid) - signals not received from navaid required for approach procedure.

NO ACTIVE ROUTE - LNAV selected, but no active route activated.

PARTIAL CLEARANCE LOADED - FMC was able to load only a portion of the loadable data in an uplink message. If pilot unable to determine which portion of the clearance did not load, REJECT the corresponding uplink message.

PARTIAL ROUTE X UPLINK - receipt of a flight plan uplink message containing route data errors which do not cause total rejection, and part of the route data has been loaded into RTE 1 or RTE 2, as appropriate. FMC sends a downlink response rejecting the message and explaining why.

PERF/VNAV UNAVAILABLE - VNAV selected without gross weight, cost index, or cruise altitude entered.

PURGE UPDATES - POS 2 - incorrect FMC position results in raw radio data being rejected due to DME reasonableness checks.

RE-LOGON TO ATC COMM - ATC LOGON message was sent from the airplane and ATC did not respond within the required time, or ATC sent a negative response or, an error occurs which causes ATC center in communication to be disconnected without ATC COMM transferring to anotherATC center.

RESET MCP ALT - two minutes prior to T/D point with VNAV active and MCP not set to altitude below cruise altitude.

RESPOND TO ATC UPLINKS - ATC uplink received and causes storage to be full or uplink received when storage is full.

RESYNC FAIL - SINGLE FMC - resynchronization is unsuccessful and one FMC has shutdown.

RESYNCING OTHER FMC - FMC synchronization in progress.

ROUTE X UPLINK LOADING - uplinked (company or ATC DL) route data being loaded into RTE 1 or RTE 2, as appropriate; or uplink message containing route data being loaded into RTE 1 or RTE 2, as appropriate, and a CDU button is pushed.

ROUTE X UPLINK READY - receipt of a flight plan uplink message that contains route data which has passed error checks and is ready to be loaded into RTE 1 or RTE 2, as appropriate.

RTA FIX DELETED - RTA fix has been deleted from the modified flight plan.

RW/ ILS FREQ ERROR - selected ILS frequency does not match course for destination runway in active route or valid course data not received.

RW/ILS CRS ERROR - Selected ILS course does not match course for destination runway in active route or valid course data not received.

SET CLOCK TO UTC TIME - UTC from GPS is more than 12 seconds different from Captain’s (or FO’s if Captain’s failed) flight deck clock.

SINGLE FMC OPERATION - one FMC data not available.

SPLIT IRS OPERATION - FMCs have selected single IRU position updating while operating in polar latitudes or with significant position or velocity differences.

TAKEOFF SPEEDS DELETED - selected V speeds are invalid.

THRUST REQUIRED - VNAV active, autothrottle disconnected, and additional thrust required to track 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 NEXT ALT - VNAV active and climb not sufficient to comply with waypoint altitude constraint.

UNABLE RTA - RTA not achievable within applicable arrival time tolerance.

UNABLE TO LOAD CLEARANCE - FMC unable to load any of the loadable data in an uplink message.

UNABLE TO SEND MESSAGE - transmission of a downlink message has been initiated and cannot be delivered to the ACARS MU.

VERIFY POSITION - updating sensor, radio or GPS, and FMC positions; or left and right FMC positions differ.

VERIFY RNP - POS REF 2 - RNP option is selected in the APF, the default (based on phase of flight) RNP changes, and the manually entered RNP exceeds the new default RNP value.

WIND DATA UPLINK READY - receipt of an uplink message containg waypoint wind data which passes error checks and is ready to be loaded into RTE DATA page.

FMC Advisory Messages

ARR N/A FOR RUNWAY - runway/approach selected not compatible with arrival selected.

CRS REVERSAL AT FA FIX - entered route contains a course reversal at final approach fix and does not contain a procedure turn.

DELETE - DELETE key pushed.

INVALID DELETE - deletion of data displayed in selected field 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 nav data base.

KEY/FUNCTION INOP - function selected is not availabe in existing FMC data base.

MAX ALT FLNNN - entered cruise altitude greater than performance maximum altitude.

NOT IN DATA BASE - data not in system.

NOT ON INTERCEPT HEADING - LNAV selected and airplane outside active leg capture criteria and current heading will not intercept active leg.

ROUTE FULL - last route modification fills FMC beyond its capacity of 120 waypoints. Last selection not entered in route.

RUNWAY N/A FOR SID - runway not compatible with SID.

STANDBY ONE - FMC requires more than four seconds to display data.

TIME OUT - RESELECT - communications with selected system have failed. Menu page displayed. Systems with a caret symbol are available for selection. Selecting < FMC displays last page used.

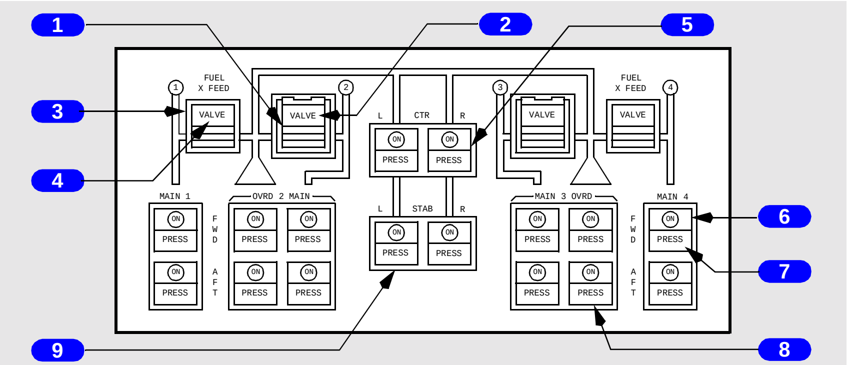
UNABLE CRZ ALT - entered cruise altitude results in climb intersecting the descent path or the time in cruise prior to top of descent less than minimum allowable.

VERIFY RNP ENTRY - RNP option selected in the APF and the manually entered RNP exceeds the default RNP value or is less than the ANP.

Fuel — Chapter 12

Table of Contents — Section 0

Fuel System



OVERHEAD PANEL

1 Crossfeed (X FEED) Valve Switches 2 and 3

ON (bar visible) - crossfeed valve opens when commanded by system logic.

2 Crossfeed VALVE Lights 2 and 3

Illuminated (amber) – crossfeed valve not in system logic commanded position.

3 Crossfeed (X FEED) Valve Switches 1 and 4

ON (bar visible) - crossfeed valve opens.

4 Crossfeed VALVE Lights 1 and 4

Illuminated (amber) - crossfeed valve position does not agree with switch position.

5 Center (CTR) Wing Tank Pump Switches

ON - fuel pump selected ON.

Off (ON not visible) - fuel pump selected OFF.

6 MAIN Pump Switches

ON – fuel pump selected ON.

Off (ON not visible) – fuel pump selected off.

7 **Forward (FWD) and AFT Fuel Pump Pressure (PRESS) Lights**

Illuminated (amber) – fuel pump output pressure low.

8 **Override (OVRD) Fuel Pump Switches**

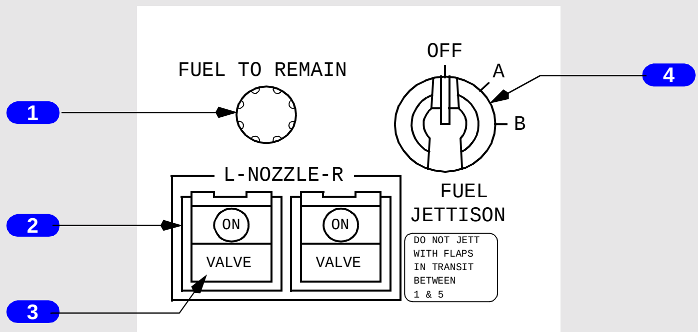
ON - fuel pump operates when commanded by system logic.

Off (ON not visible) - fuel pump selected off.

9 **Stabilizer (STAB) Tank Pump Switches**

ON - fuel pump operates when commanded by system logic.

Fuel Jettison System



OVERHEAD PANEL

1 **FUEL TO REMAIN Selector**

Rotate –

- selects fuel to remain after jettison
- displays value on EICAS

2 **Fuel Jettison NOZZLE Valve Switches**

ON -

- jettison nozzle valve selected open
- when jettison system armed, activates override/jettison and transfer/ jettison pumps in tanks containing fuel (pump switches must be ON)

Off - jettison nozzle valve selected closed.

3 **Fuel Jettison Nozzle VALVE Lights**

Illuminated (amber) – jettison nozzle valve not in selected position.

4 **Fuel Jettison Selector**

OFF –

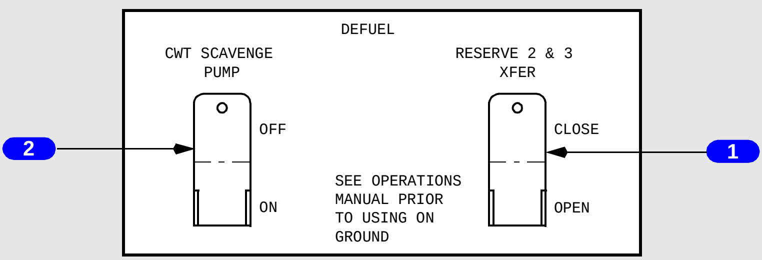
- disarms jettison system
- removes EICAS fuel to remain indication

A or B –

- arms jettison system
- displays preselected fuel to remain on EICAS

Miscellaneous Fuel Control

Defuel Panel



OVERHEAD MAINTENANCE PANEL

1 **Reserve (RSV) 2 & 3 Transfer (XFER) Switch**

CLOSE -

- reserve 2 and 3 transfer valves closed
- reserve 2 and 3 transfer valves open when commanded by system logic

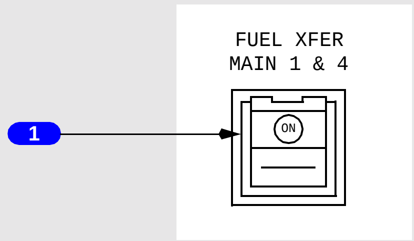
OPEN - reserve 2 and 3 transfer valves open.

2 **Center Wing Tank (CWT) SCAVENGE PUMP**

ON - pump operates.

OFF - pump operates when commanded by system logic.

Fuel Transfer Main 1 & 4 Switch



OVERHEAD PANEL

1 FUEL Transfer (XFER) MAIN 1 & 4 Switch

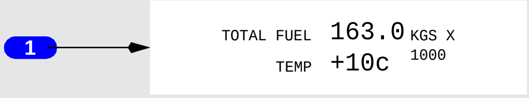
ON - main 1 and 4 transfer valves open.

Off -

- main 1 and 4 transfer valves closed
- main 1 and 4 transfer valves open when commanded by system logic

Fuel Indications and Displays

Normal Fuel Indications



EICAS DISPLAY

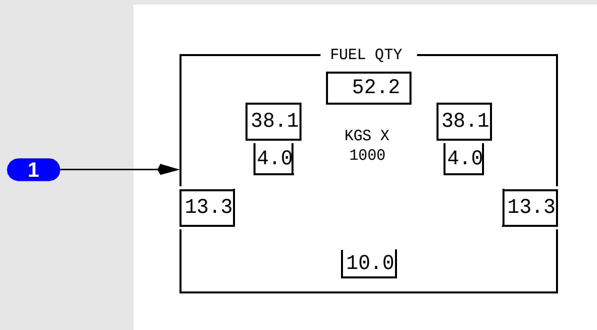
1 Normal Fuel Indications

Total fuel quantity (kilograms x 1000).

Fuel temperature (degrees Celsius).

Amber - fuel temperature is -37°C and below.

Compacted Fuel Indications



EICAS DISPLAY

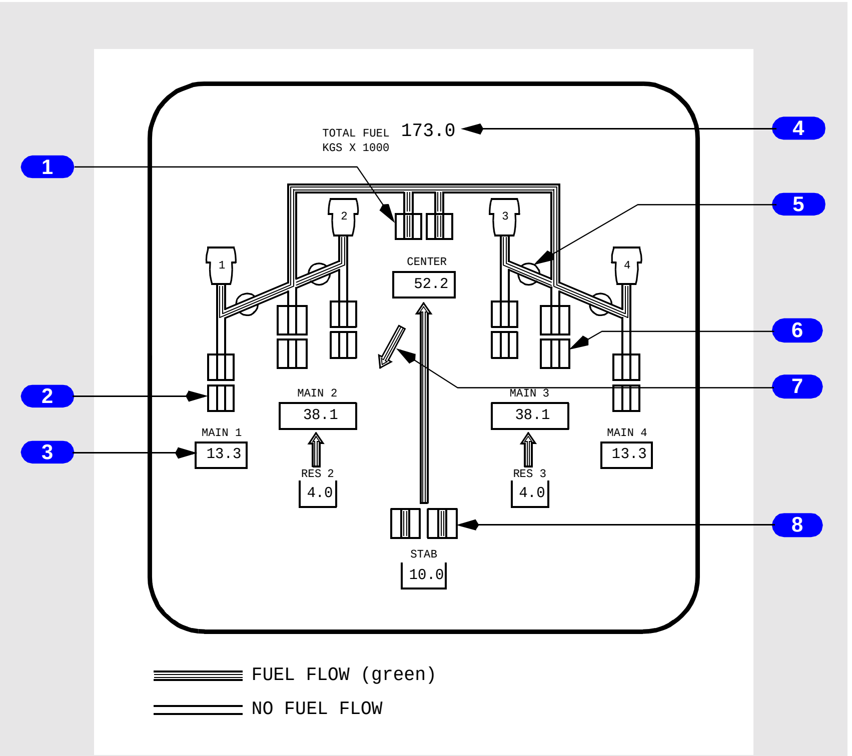
1 Compacted Fuel Indications

Compacted fuel quantity indications display on primary EICAS if only one CRT is available for EICAS.

Fuel Synoptic Display

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.

The fuel flow displayed is generated by displayed valve positions and pump status. It does not display actual fuel flow, therefore the display may not represent actual system operation.



SECONDARY EICAS DISPLAY

1 Center Wing Tank Pump

White - pump switch off.

Green - pump on.

Amber - pump pressure low.

2 **Main Pump**

White - pump switch off.

Green - pump on.

Amber - pump pressure low.

3 **Tank Quantity**

White - indicates fuel quantity in tank.

Amber (main tank only) - imbalance condition or quantity less than 900 kg.

4 **Total Fuel Quantity**

White - indicates total fuel quantity.

5 **Crossfeed Valve**

White - indicates open or closed position of crossfeed valve.

Green - indicates open or closed position of crossfeed valve with fuel.

Amber - valve position disagrees with commanded position.

6 **Override Pump**

White - pump switch off.

Cyan - armed for system logic operation.

Green - pump on.

Amber - pump pressure low.

7 **Scavenge Pump Transfer**

White - pump on

Green - fuel pressure.

8 **Stabilizer Tank Pump**

White - pump switch off.

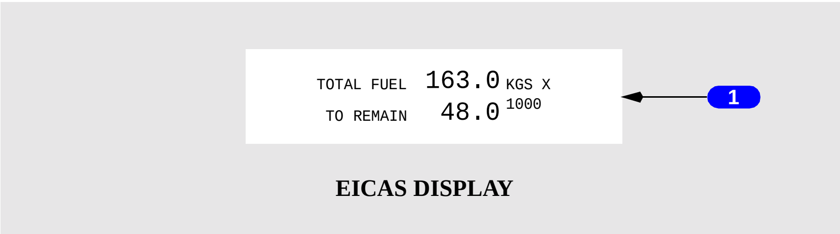
Cyan - armed for system logic operation.

Green - pump on.

Amber - pump pressure low.

Fuel Jettison Indications

Fuel Jettison Indications, Primary EICAS



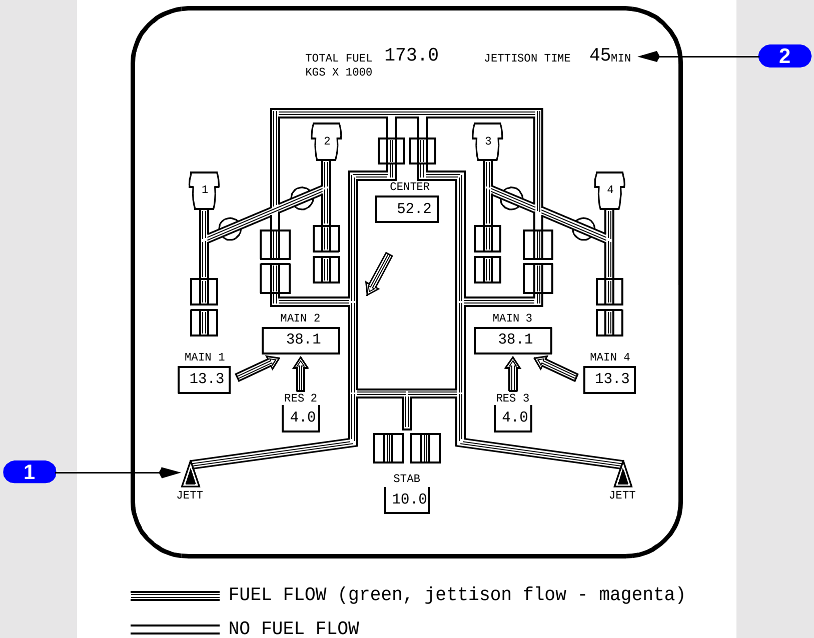
1 Fuel Jettison Indications

Fuel to remain replaces fuel temperature during jettison operation.

Magenta - indicates fuel to remain at completion of jettison.

White (flashes for five seconds) - indicates jettison has completed.

Fuel Jettison Indications, Fuel Synoptic



SECONDARY EICAS DISPLAY

1 Jettison Nozzle

Magenta - fuel jettison system operating.

2 Time To Complete Jettison

White - time remaining to complete jettison.

Intentionally
Blank

Fuel — Chapter 12
System Description — Section 20

Introduction

The fuel system supplies fuel to the engines and the APU. The fuel is contained in a center wing tank, main tanks 1, 2, 3, 4, reserve tanks 2 and 3, and the horizontal stabilizer tank. Surge tanks are located in the outer portion of each wing and the outer portion of the right horizontal stabilizer.

Refer to Chapter 7, Engines, APU, for a description of the engine and APU fuel systems.

Fuel Quantity

Fuel quantity is measured by sensors in each tank. Total fuel quantity displays on primary EICAS. Tank quantities and total fuel quantity display on the fuel synoptic.

Compacted fuel quantity indications display on primary EICAS if only one CRT is available for EICAS.

Fuel Temperature

Fuel temperature is measured in main tank 1 and displays on primary EICAS. The temperature normally displays in white. It displays in amber when the fuel temperature is -37°C or below. During jettison, the TO REMAIN quantity replaces the EICAS display fuel temperature indication.

Fuel Pumps

Each main tank contains two AC–powered fuel pumps. A single pump supplies sufficient fuel to operate one engine at takeoff thrust conditions or two engines at cruise thrust. Main tank 2 and main tank 3 also contain two AC-powered override/jettison pumps which can operate to a standpipe level of approximately 3,200 kilograms remaining in the tank. Each override/jettison pump supplies sufficient fuel to operate two engines during takeoff and cruise conditions.

The two center wing tank (CWT) fuel pumps are override/jettison pumps. These pumps have a higher output pressure than the left and right main tank fuel pumps. The CWT pumps override the main tank pumps so CWT fuel is used before wing tank fuel. One CWT pump does not override 2 and 3 override/jettison pumps or the outboard main pumps.

CWT fuel is scavenged by an electric pump activated by system logic when one CWT override/jettison pump has low output pressure. The scavenged fuel is pumped into main tank 2.

The horizontal stabilizer tank contains two AC-powered transfer/jettison pumps. Each pump can transfer all fuel in the horizontal stabilizer tank to the CWT.

Fuel Crossfeed

A common fuel manifold connects all main tanks and the CWT. There are four crossfeed valves in the fuel manifold. In flight, the combination of active pumps and automatically or manually controlled crossfeed valves direct the flow of fuel from tanks to engines.

Fuel Imbalance

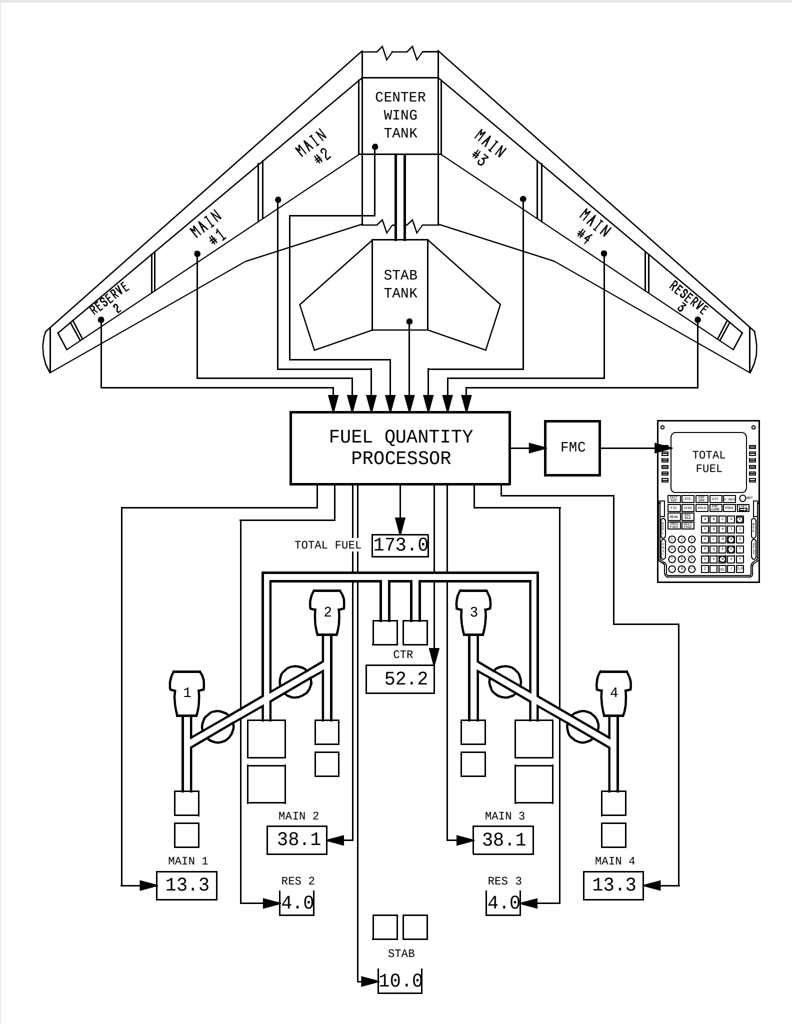
Excessive fuel imbalance adversely affects CG, aerodynamic drag, and fuel economy.

Fuel balancing is accomplished by opening or closing crossfeed valves and turning off and on fuel pump switches.

Fuel Tank Capacities

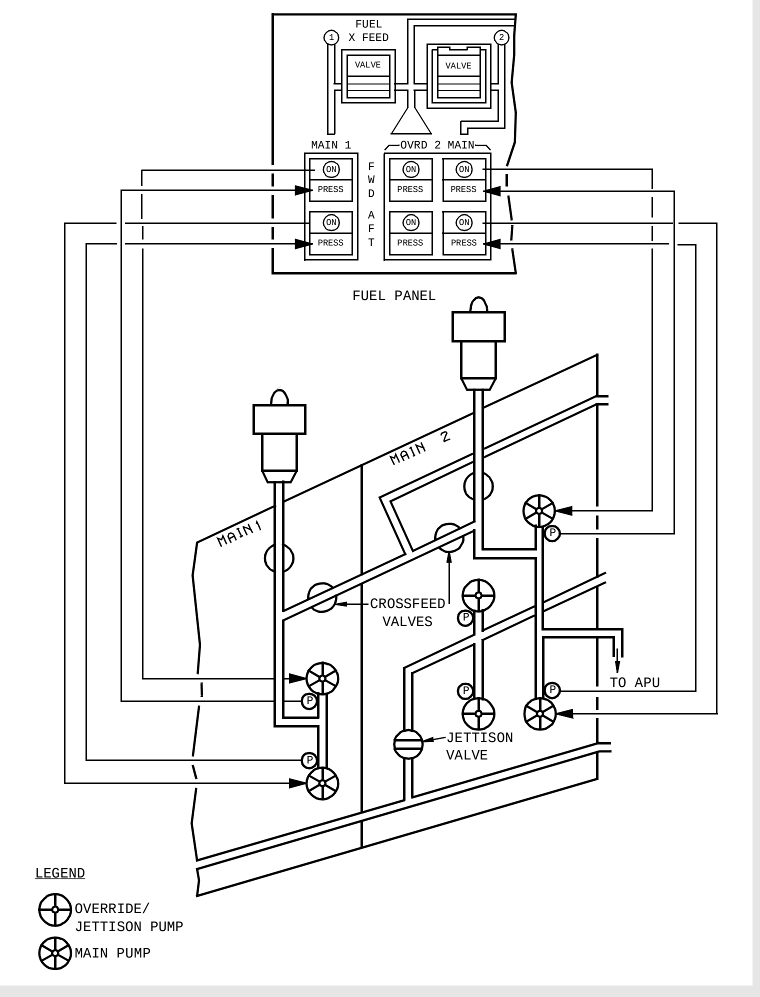
Tank	Liters	Kilograms *
1 and 4 Main	33,100	26,576
2 and 3 Main	94,984	76,263
Center	64,973	52,167
Reserves	10,009	8,036
Stabilizer	12,492	10,030
Total	215,558	173,072
* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.		

Fuel Quantity Indication

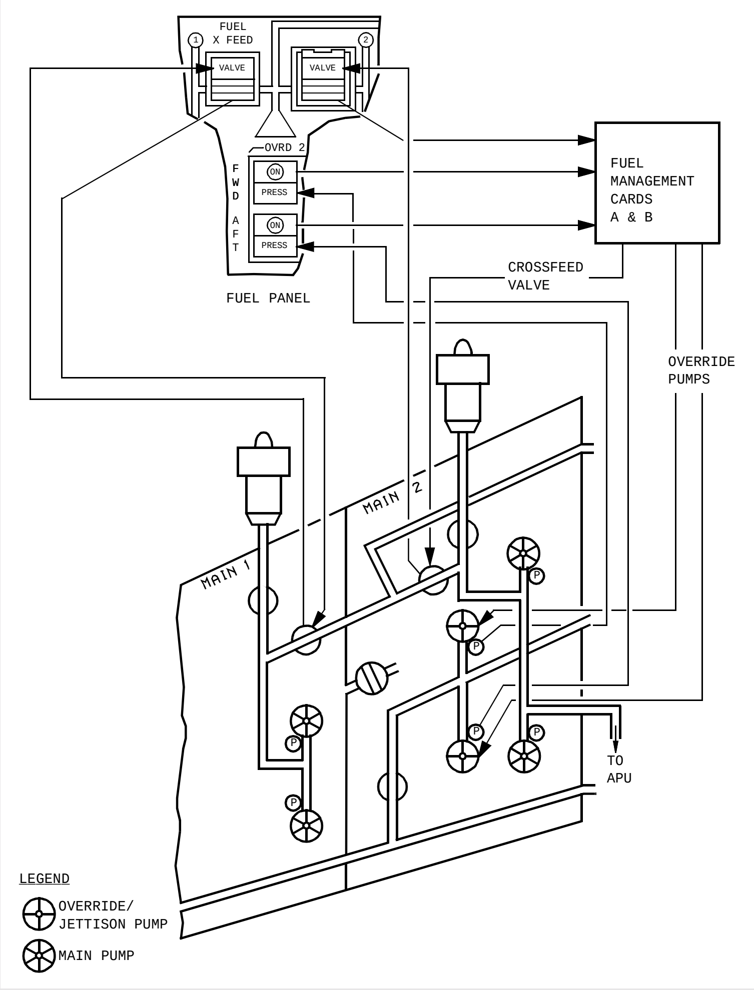


Fuel System Schematics

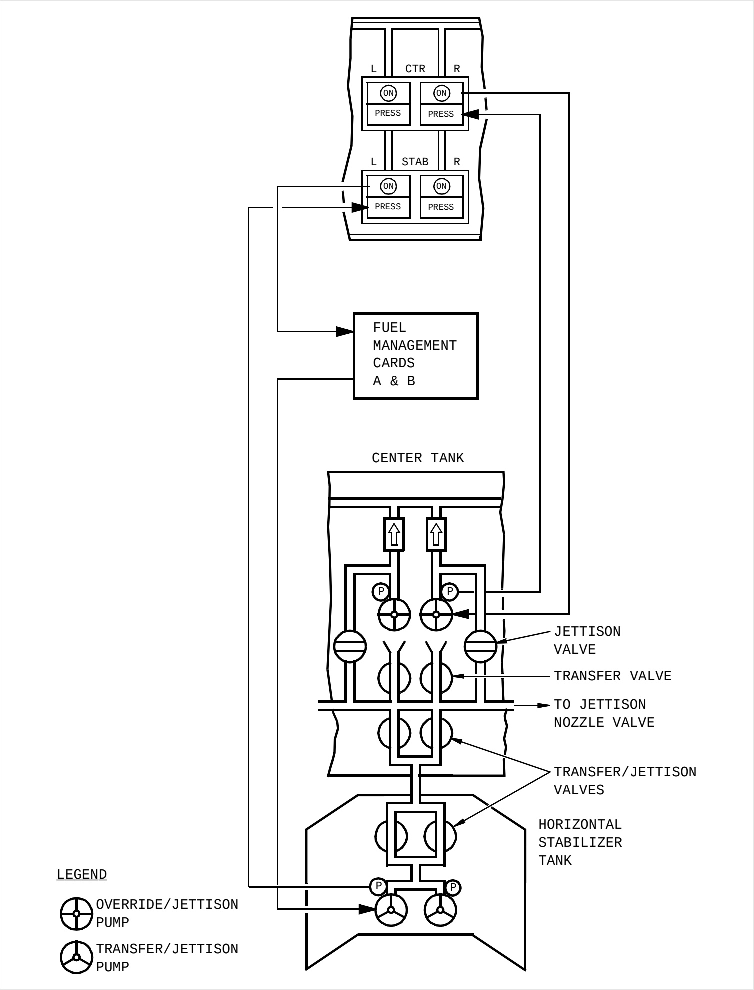
Main Tank Main Pump Schematic



Main Tank Override/Jettison Pump and Fuel Crossfeed Schematic



Center Wing and Horizontal Stabilizer Pump Schematic



Reserve Tank 2 and 3Transfer

Each reserve tank contains two transfer valves. The valves open and fuel gravity transfers to the inboard main tanks when main tank 2 or 3 fuel quantity decreases to 18,140 kilograms.

Main Tank 1 and 4 Transfer

Main tank 1 and 4 each contain one transfer valve. When the valves open, fuel gravity transfers from the outboard main tanks to the inboard main tanks. Fuel transfers to approximately 3,200 kilograms remaining in each outboard main tank.

During fuel jettison, the valves open when either main tank 2 or 3 fuel quantity decreases to 9,072 kilograms. The valves may be opened manually using the Fuel Transfer Main 1 & 4 switch on the overhead panel.

APU Fuel Feed

APU fuel is normally supplied from main tank 2. When AC power is available, fuel is supplied by main pump 2 aft. If AC power is not available, a dedicated DC pump in main tank 2 supplies fuel to the APU.

Fuel System Operation

Fuel system management cards (FSMCs) command fuel valves open or closed and fuel pumps on or off according to fuel management logic.

Preflight

When fuel pump switches are off before engine start, low pressure lights are illuminated on the main pump switches and extinguished on the override, CWT, and stabilizer tank pump switches.

Operation With Fuel in Center Wing Tank

The FSMCs close crossfeed valves 2 and 3 when flaps extend to takeoff position on the ground. Override/jettison pumps 2 and 3 are inhibited from operating when pressure is detected from both CWT override/jettison pumps. The CWT override/jettison pumps provide fuel to engines 1 and 4 and main pumps 2 and 3 provide fuel to their related engine.

The FSMCs open crossfeed valves 2 and 3 when the flaps are retracted. The CWT override/jettison pumps provide fuel to all engines.

When CWT fuel quantity decreases to 36,470 kilograms, the FSMCs open the appropriate valves and activate the transfer/jettison pumps to transfer fuel from the stabilizer tank to the CWT.

The Stabilizer Tank Pump switches are pushed off when both FUEL PMPSTAB messages are displayed and fuel quantity indications show the stabilizer tank empty.

The CWT pump switches are pushed off when either FUEL OVRD CTR message displays and CWT fuel quantity is less than 900 kilograms.

An electrical scavenge pump in the CWT activates automatically to pump the remaining CWT fuel to main tank 2.

Note: With CWT fuel quantity less than 2,700 kilograms, the EICAS message FUEL OVRD CTR may display due to an uncovered pump inlet. With CWT fuel quantity between 2,700 and 4,500 kilograms, the EICAS message FUEL OVRD CTR may display temporarily during taxi, takeoff, or climb due to fuel movement in the tank. The message no longer displays after the airplane is level and no longer accelerating.

Note: When CWT quantity drops below approximately 2,300 kilograms and total fuel consumption is greater than 6,800 kilograms per hour, the CWT override/jettison pumps can no longer provide full override of the outboard main tank pumps. As a result, a shared flow situation between the CWT and outboard main tanks is established. During this shared flow situation, approximately 900 kilograms of fuel are consumed from each outboard main tank prior to display of the EICAS message FUEL OVRD CTR.

The FMSCs activate override/jettison pumps 2 and 3 when low pressure is detected from either CWT override/jettison pump. Override/jettison pumps 2 provide fuel to engines 1 and 2 and override/jettison pumps 3 provide fuel to engines 3 and 4.

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to 18,140 kilograms. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

The electrical CWT scavenge pump is automatically activated. Each activation terminates after 120 minutes, or no pressure, whichever occurs first.

The EICAS message FUEL TANK/ENG displays when main tank 2 quantity is equal to or less than main tank 1 quantity, or when main tank 3 quantity is equal or less than main tank 4 quantity. The override pump switches and crossfeed valve switches 1 and 4 are pushed off after confirming tank quantities. Main pumps provide fuel to their related engine until engine shutdown.

Note: On the ground, the FUEL TANK/ENG message can be displayed with as much as 500 kilograms more fuel in an inboard main tank than the adjacent outboard main tank.

Operation With No Fuel in Center Wing Tank

With no fuel in center wing tank, the FSMCs activate override/jettison pumps 2 and 3. The FSMCs close crossfeed valves 2 and 3 when the flaps extend to takeoff position on the ground. Override/jettisons pumps 2 provide fuel to engine 1 and override/jettison pumps 3 provide fuel to engine 4. Main pumps 2 and 3 provide fuel to their related engine.

The FSMCs open crossfeed valves 2 and 3 when the flaps are retracted. Override/jettison pumps 2 provide fuel to engines 1 and 2 and override/jettison pumps 3 provide fuel to engines 3 and 4. Reserve fuel transfer and tank-to-engine configuration are identical to operating with fuel in the CWT.

Note: On the ground, the FUEL TANK/ENG message can display with as much as 500 kilograms more fuel in an inboard main tank than the adjacent outboard main tank.

Fuel Jettison

The fuel jettison system allows jettison from all fuel tanks. Override/jettison pumps in main tanks 2 and 3 and the center wing tank pump fuel overboard through the jettison nozzle valves.

Fuel jettison is initiated by rotating the fuel jettison selector to A or B. When a jettison control system is selected, the fuel temperature indication on EICAS is replaced with the fuel to remain quantity indication. The jettison manifold and jettison time display on the fuel synoptic.

Rotating the Fuel To Remain selector decreases or increases the fuel to remain quantity.

Pushing either fuel jettison nozzle valve switch ON activates all override/jettison and transfer/jettison pumps in the tanks containing fuel (pump switches must be ON) and opens the required jettison and transfer/jettison valves. The related jettison nozzle valve also opens. The jettison time is initially estimated using preprogrammed rates. The system begins updating the estimate based on actual fuel quantity rate of change ninety seconds after jettison begins.

If override/jettison pumps 2 and 3 are providing fuel to the engines when jettison begins, the EICAS message FUEL OVRD may be displayed due to reduced pressure caused by the jettison nozzles valves opening. Jettison is verified by observing decreasing tank quantities.

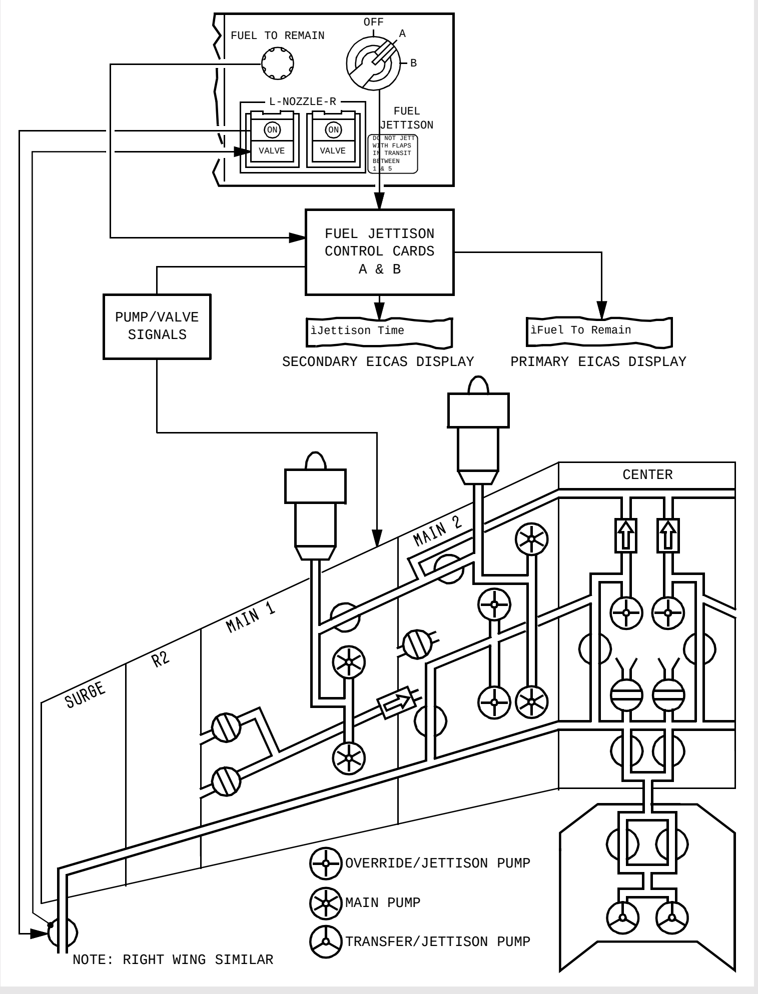
The jettison control system controls fuel balancing between main tanks 2 and 3 as fuel is jettisoned. If fuel balancing is necessary, the override/jettison pumps in the low tank deactivate until the tanks are balanced.

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to 18,140 kilograms. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

When either main tank 2 or 3 fuel quantity decreases to 9,072 kilograms during jettison, both main tank 1 and 4 transfer valves open.

Jettison terminates when total fuel quantity decreases to the fuel to remain quantity. The fuel to remain quantity indication changes color from magenta to white and flashes for five seconds. The jettison control system deactivates all operating override/jettison and transfer/jettison pumps. The related FUEL OVRD pump EICAS messages display until the Fuel Jettison selector is OFF.

Fuel Jettison Schematic



Fuel System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
FUEL IMBAL 1-4	Advisory		Fuel difference of 1,360 kilograms between main tanks 1 and 4. Message no longer displayed when difference less than 450 kilograms.
FUEL IMBAL 2-3	Advisory		Fuel difference of 2,720 kilograms between main tanks 2 and 3. Message no longer displayed when difference less than 450 kilograms.
FUEL IMBALANCE	Advisory		Fuel difference of 2,720 kilograms between inboard main tanks (2 and 3) and outboard main tanks (1 and 4) after reaching FUEL TANK/ENG condition. Message no longer displayed when difference less than 450 kilograms.

Message	Level	Aural	Condition
>FUEL JETT A, B	Advisory		Jettison control system has failed. Inhibited when FUEL JETT SYS message displayed.
FUEL JETT SYS	Caution	Beeper	Fuel total less than fuel to remain and one nozzle valve open or both jettison cards fail.
FUEL OVRD 2, 3 AFT	Advisory		Override Pump switch OFF before tank-to-engine configuration, or low pump pressure detected with Override Pump switch ON and pump activated by system logic.
FUEL OVRD 2, 3 FWD	Advisory		Override Pump switch OFF before tank-to-engine configuration, or low pump pressure detected with Override Pump switch ON and pump activated by system logic.

Message	Level	Aural	Condition
FUEL OVRD CTR L, R	Advisory		Center wing tank low pump pressure detected with the Center Wing Tank Pump switch ON, or Center Wing Tank Pump switch OFF and center wing tank fuel quantity more than 2,700 kilograms.

Message	Level	Aural	Condition
FUEL PMP STAB L, R	Advisory		Stabilizer tank low pump pressure detected, or low pump pressure detected with Stabilizer Tank Pump switch ON and pump activated by system logic, or Stabilizer Tank Pump switch OFF and stabilizer tank fuel quantity more than 1,100 kilograms. Inhibited when FUEL STAB XFER message displayed.

Message	Level	Aural	Condition
FUEL PRESS ENG 1, 2, 3, 4	Caution	Beeper	Both main pumps in a tank fail with the related crossfeed valve closed.
FUEL PUMP 1, 2, 3, 4 AFT	Advisory		Main pump has failed. Inhibited when FUEL PRESS ENG message displayed.
FUEL PUMP 1, 2, 3, 4 FWD	Advisory		Main pump has failed. Inhibited when FUEL PRESS ENG message displayed.

Message	Level	Aural	Condition
FUEL QTY LOW	Caution	Beeper	Fuel quantity in any main tank less than 900 kilograms.

Message	Level	Aural	Condition
FUEL RES XFR 2, 3	Advisory		Both reserve tank transfer valves on one side have failed.

Message	Level	Aural	Condition
FUEL STAB XFR	Caution	Beeper	Horizontal stabilizer fuel fails to transfer.

Message	Level	Aural	Condition
>FUEL TANK/ENG	Advisory		Main tank 2 quantity equal to or less than main tank 1 quantity, or main tank 3 quantity equal to or less than main tank 4 quantity and crossfeed valve 1 or 4 open, or on the ground after fueling, initial electrical power established, or after CMC ground test, main tank 2 quantity less than or equal to tank 1 plus 500 kilograms and tank 3 less than or equal to tank 4 plus 500 kilograms and crossfeed valve 1 or 4 open.

Message	Level	Aural	Condition
>FUEL TEMP LOW	Advisory		Fuel temperature -37°C or less.
FUEL TEMP SYS	Advisory		Fuel temperature sensing inoperative.

Message	Level	Aural	Condition
FUEL X FEED 1, 2, 3, 4	Advisory		Fuel crossfeed valve position disagrees with commanded position.
>FUEL XFER 1+4	Advisory		Fuel Transfer Main 1 & 4 switch ON with inboard main tank quantities greater than outboard main tank quantities in flight, or switch ON while airplane on the ground.
>JETT NOZ ON	Advisory		Both fuel jettison nozzle valves open.
>JETT NOZ ON L, R	Advisory		Fuel jettison nozzle valve open. Inhibited when JETT NOZ ON message displayed.
>JETT NOZZLE L, R	Advisory		Jettison nozzle valve position disagrees with commanded position.

Message	Level	Aural	Condition
>SCAV PUMP ON	Advisory		Center wing tank scavenge pump operating while airplane on the ground.

Message	Level	Aural	Condition
>X FEED CONFIG	Advisory		Crossfeed valve 1 or 4 closed and main tanks not equal, or crossfeed valve 2 or 3 closed and flaps not in takeoff position.

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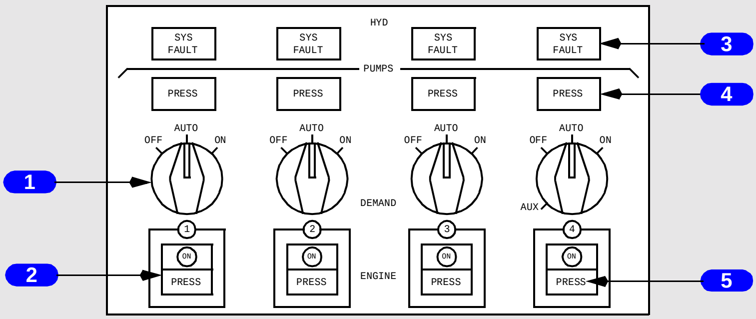
Hydraulic Panel



OVERHEAD PANEL

1 Hydraulic DEMAND Pump Selector

OFF – demand pump off.

AUTO -

- demand pump operates when related engine pump output pressure is low, or when related fuel control switch is in CUTOFF
- demand pumps 1 & 4 also operate when flaps are in transit, or flaps out of up in flight

ON - demand pump operates

Auxiliary (AUX) (System 4) -

- auxiliary pump operates on ground until related engine pump pressurizes
- related demand pump off
- does not trip OFF when EDP pressurizes system

2 ENGINE Hydraulic Pump Switch

ON – engine hydraulic pump pressurizes system when engine rotates.

3 Hydraulic System (SYS) Light

Illuminated (amber) –

- low hydraulic system pressure
- low hydraulic reservoir quantity
- excessive hydraulic fluid temperature

4 Demand Pump Low PRESS Light

Illuminated (amber) –

- demand pump selector positioned to OFF or AUX
- demand pump operates and output pressure is low
- demand pump fails to operate

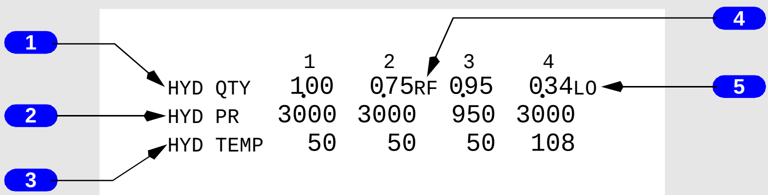
5 ENGINE Hydraulic Pump Low PRESS Light

Illuminated (amber) – low engine hydraulic pump pressure.

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



SECONDARY EICAS DISPLAY

1 Hydraulic Fluid Quantity (HYD QTY)

Hydraulic reservoir quantity of each system displays as a percentage of the normal service level (1.00).

2 Hydraulic System Pressure (HYD PR)

Hydraulic pressure of each system displays in psi.

3 Hydraulic System Temperature (HYD TEMP)

Hydraulic fluid temperature of each system displays in degrees C.

4 Reservoir Refill

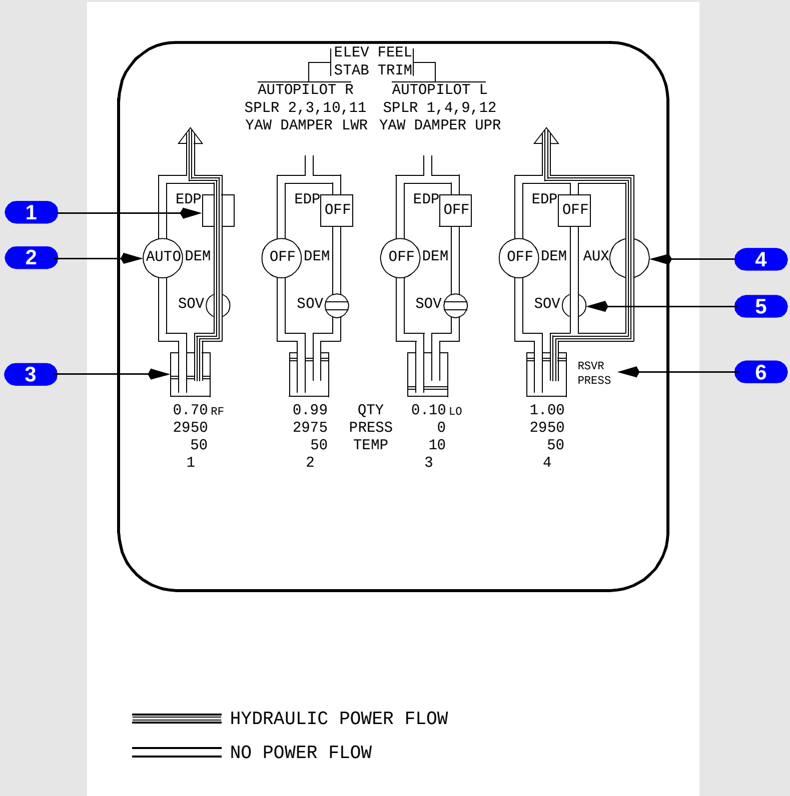
RF (Refill) (magenta) - displays on ground when reservoir requires refill.

5 Low Reservoir Quantity

LO (magenta) - displays when a reservoir quantity is low.

Hydraulic Synoptic Display

The hydraulic power flow displayed is generated by the displayed valve positions, pump status, and fluid levels. It does not display actual hydraulic power flow, therefore the display may not represent actual system operation.



SECONDARY EICAS DISPLAY

1 Engine Driven Pump

OFF - engine driven pump is not operating.

2 Demand Pump

OFF - demand pump is not operating.

3 **Hydraulic Reservoir**

Fluid Level - displays relative fluid level in the hydraulic reservoir.

4 **Auxiliary Pump**

OFF - auxiliary pump is not operating.

5 **Shut Off Valve**

Indicates open or closed position of shut off valve.

6 **Reservoir Pressure**

RSVR PRESS - displays when reservoir bleed air pressure is low.

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Introduction

The airplane has four independent hydraulic systems, numbered by the engine which powers it. The hydraulic systems power the:

- primary flight controls
- autopilot servos
- spoilers
- stabilizer trim
- elevator feel
- landing gear
- flaps
- brakes
- steering.

Hydraulic Systems

Each system is powered by an engine driven pump and a demand pump installed in parallel.

Engine Driven Pumps

Each system has an engine driven pump (EDP). The EDP is pressurized when the engine is running and the engine pump switch is ON.

Demand Pumps

The demand pumps supply normal system demands if an engine or EDP fails. Systems 1 and 4 have air driven demand pumps. The bleed air manifold provides pneumatic power for the air driven pumps. Systems 2 and 3 have electric motor driven demand pumps.

Auxiliary Pump

System 4 has an electric auxiliary pump for ground handling operations.

Fluid Supply

Independent reservoirs supply fluid to each hydraulic system. The bleed air system pressurizes the reservoirs to prevent pump cavitation and ensure positive flow during high demand conditions. RSVR PRESS displays next to the synoptic reservoir symbol when reservoir bleed air pressure is low.

Fluid temperature and reservoir quantity are displayed on the EICAS status display and hydraulic synoptic display. The letters RF display next to the reservoir quantity indication when refill is required. RF is inhibited in flight. The letters LO replace RF when a system low quantity exists. Hydraulic quantity levels fluctuate with variations in temperature and as devices that use hydraulic power activate.

For a single hydraulic system failure, the inoperative items display on the hydraulics synoptic above the affected system graphic. If multiple hydraulic systems are inoperative, additional items common to those systems display above the single system items and are connected by indentifying lines to the failed systems.

A hydraulic fluid shutoff valve is installed in the fluid supply line to each EDP. If an engine fire switch is pulled, the related hydraulic fluid shutoff valve closes, the EDP depressurizes, and the related demand pump operates.

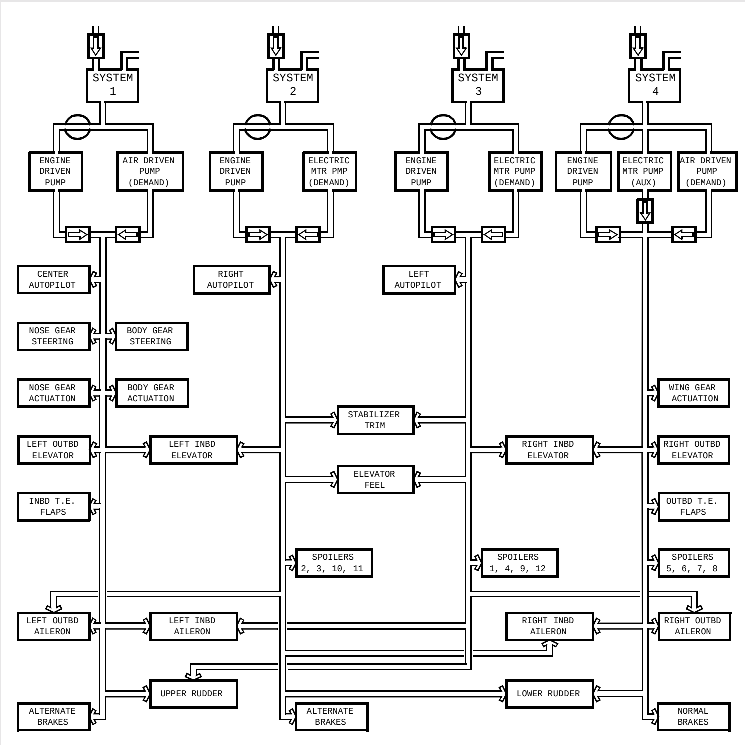
Load Assignments

Systems 1 and 4 power the trailing edge flaps, landing gear, normal brakes (SYS 4), alternate brakes (SYS 1), and steering. Systems 1 and 4 also provide redundant power to the primary flight controls.

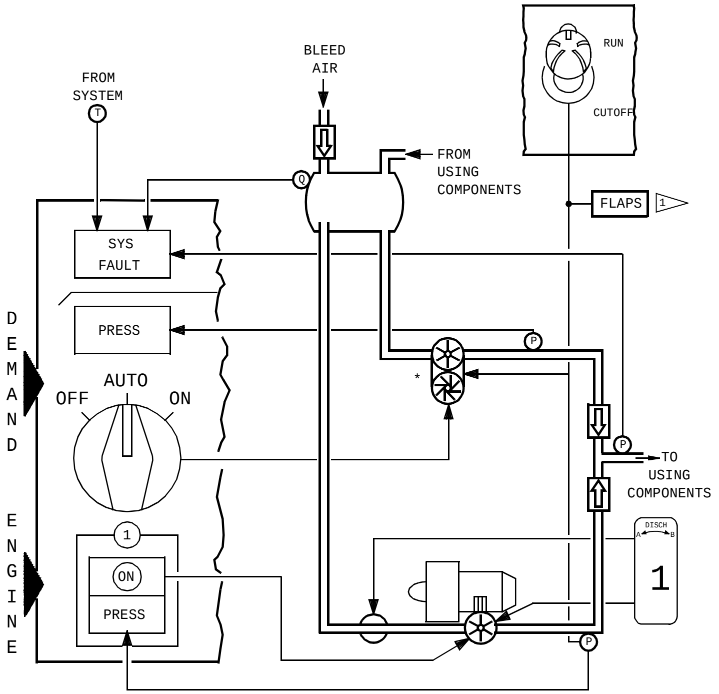
Systems 2 and 3 power the primary flight controls, stabilizer trim, and elevator feel. System 2 also powers the alternate brakes and lower yaw damper. System 3 powers the upper yaw damper.

Systems 1, 2, and 3 power the related center, right, and left autopilot servos. Systems 2, 3, and 4 power the spoilers.

Hydraulic System Diagram



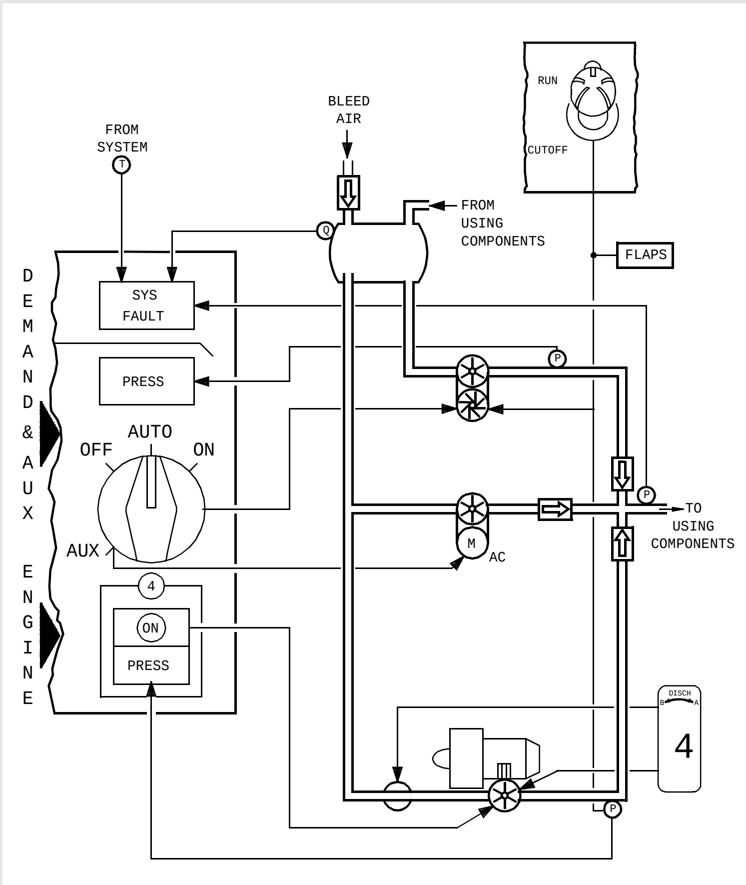
Hydraulic Systems 1, 2, and 3 Diagram



*NOTE: SYSTEMS 2 & 3 USE ELECTRIC MOTOR DRIVEN DEMAND PUMPS

1 Hydraulic System 1 only

Hydraulic Systems Diagram 4



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Hydraulics EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
HYD CONTROL 1, 4	Advisory		Hydraulic control module inoperative; demand pump automatic switching and/or hydraulic systems may not be available.
HYD OVHT SYS 1, 2, 3, 4	Advisory		Hydraulic fluid temperature excessive.

Message	Level	Aural	Condition
HYD PRESS DEM 1, 2, 3, 4	Advisory		Demand pump selector OFF, or demand pump commanded to run and demand pump output pressure low, or system 4 demand pump selector is in AUX. Inhibited by HYD PRESS SYS message in a system low pressure condition.

Message	Level	Aural	Condition
HYD PRESS ENG 1, 2, 3, 4	Advisory		Engine drive pump output pressure low. Inhibited by HYD PRESS SYS message in a system low pressure condition.
HYD PRESS SYS 1, 2, 3, 4	Caution	Beeper	Hydraulic system pressure low.

Message	Level	Aural	Condition
>HYD QTY LOW 1, 2, 3, 4	Advisory		Hydraulic system fluid quantity low.

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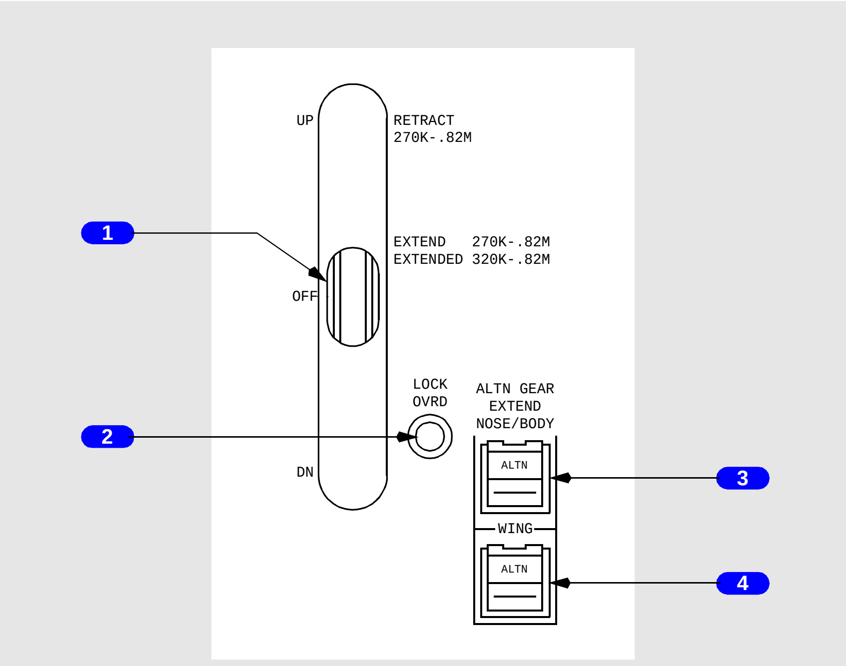
Landing Gear Panel



CENTER PANEL

1 Landing Gear Lever

UP – landing gear retracts.

OFF - landing gear hydraulic system depressurized.

DN – landing gear extends.

2 Landing Gear Lever LOCK Override (OVRD) switch

Push –releases Landing Gear lever lock.

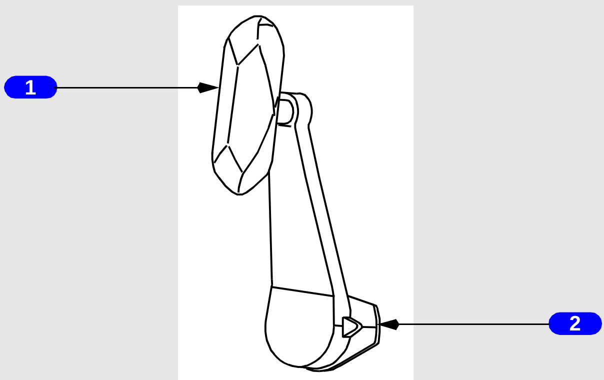
3 NOSE/BODY Alternate (ALTN) GEAR EXTEND switch

ALTN – nose/body landing gear extends by alternate extension system.

4 **WING Alternate (ALTN) GEAR EXTEND switch**

ALTN – wing landing gear extends by alternate extension system.

Nose Wheel Steering Tiller



LEFT AND RIGHT SIDEWALLS

1 **Nose Wheel Steering Tiller**

Rotate –

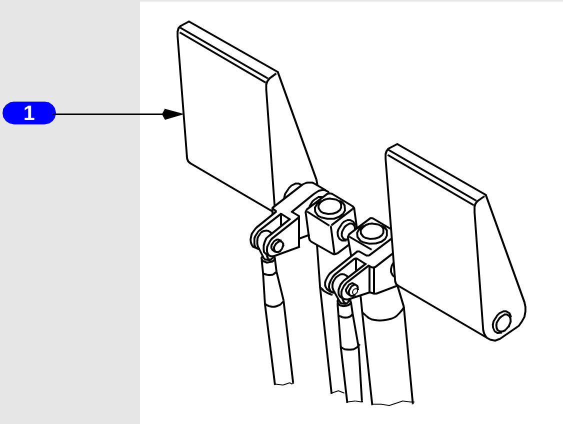
- turns nose wheels up to 70 degrees in either direction
- overrides rudder pedal steering

2 **Tiller Position Indicator**

Shows tiller displacement from straight–ahead, neutral position.

Brake System

Rudder/Brake Pedals



1 Rudder/Brake Pedals

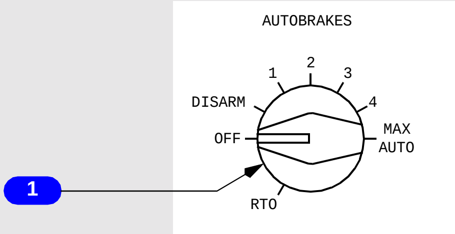
Push full pedal –

- turns nose wheel up to 7 degrees in either direction
- does not activate body gear steering

Push top of pedals – actuates wheel brakes.

Refer to Chapter 9, Flight Controls for the description of rudder operation.

Autobrakes Selector



AISLE STAND

1 AUTOBRAKE Selector

OFF - deactivates and resets system.

DISARM -

- disengages autobrakes
- releases brake pressure

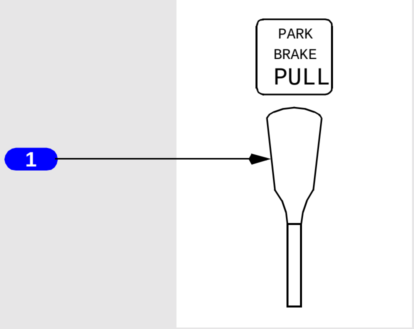
1, 2, 3, 4, MAX AUTO -

- increasing autobrakes deceleration rates
- brakes apply at touchdown

RTO -

- rejected takeoff braking
- applies maximum brake pressure when thrust levers retarded to idle above 85 knots

Parking Brake Lever



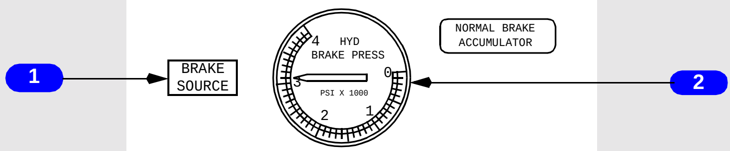
CONTROL STAND

1 Parking Brake Lever

Pull – sets parking brake when both brake pedals simultaneously depressed.

Releases when both brake pedals simultaneously depressed.

Brake Accumulator Pressure Indicator



CAPTAIN'S PANEL

1 BRAKE SOURCE Light

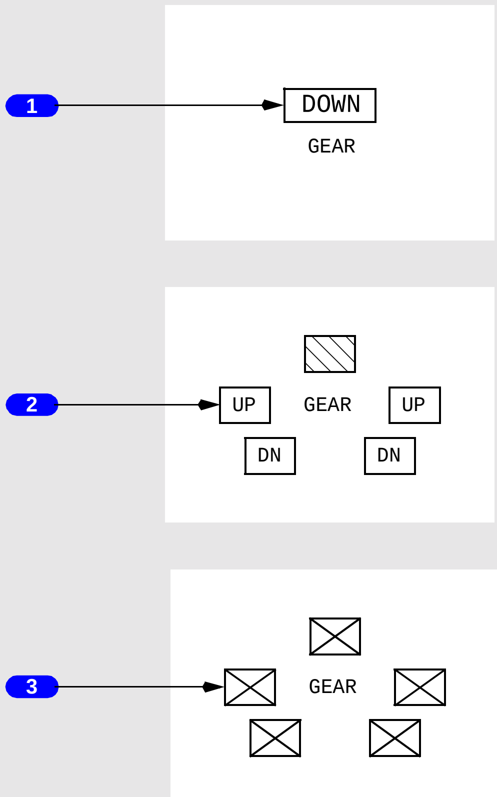
Illuminated (amber) – active brake hydraulic sources (hydraulic systems 4, 1, and 2) have low pressure.

2 BRAKE ACCUMULATOR PRESSURE Indicator

Indicates brake accumulator pressure.

Landing Gear System Indications

Landing Gear Position Indications



EICAS DISPLAY

1 Gear Position Indication (Normal Display)

DOWN (green) – all landing gear down and locked.

Crosshatched (white) – one or more landing gear in transit.

UP (white) – all landing gear up and locked (blanks after 10 seconds).

Empty box (white) – all landing gear position indicators inoperative.

2 Expanded Gear Position Indication (Non–Normal Display)

DN (green) – related landing gear down and locked.

Crosshatched (white) – related landing gear in transit.

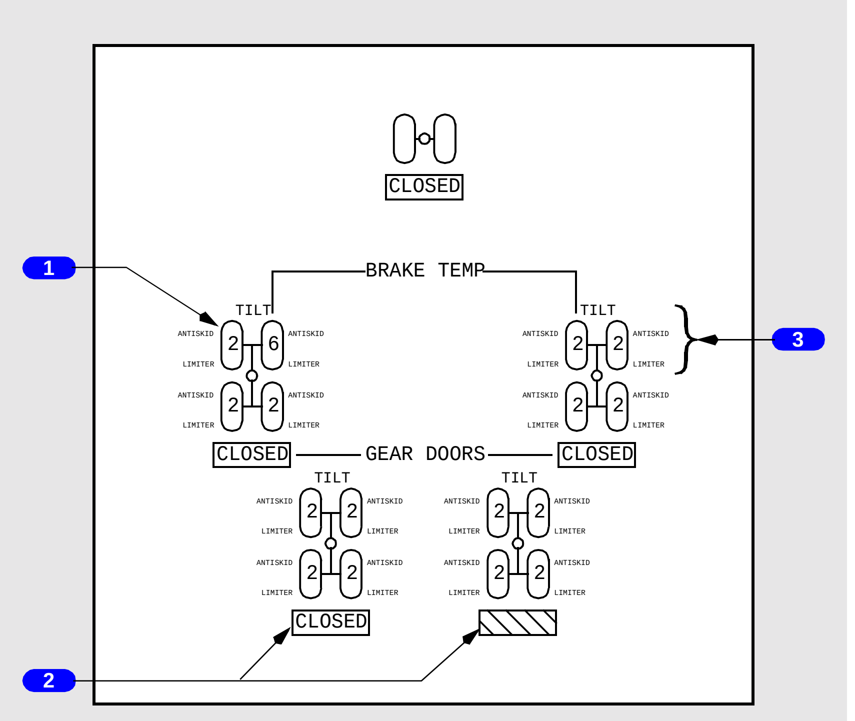
UP (white) – related landing gear up and locked.

3 Expanded Gear Position Indication (Inoperative Display)

X (amber) – landing gear position indicators 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.



SECONDARY EICAS DISPLAY

1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0 to 9
- white – normal range
- amber – high range

2 Gear Door Status

Crosshatched – door not closed.

CLOSED (white) – door closed.

Empty box(es) (white) – related landing gear door position indicators inoperative.

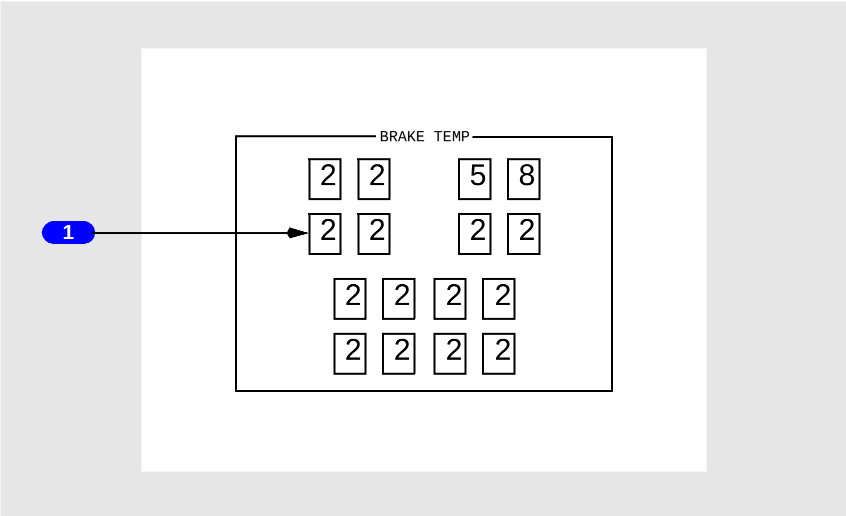
3 Disabled System Messages

TILT (amber) - main gear truck not in full tilt positions.

ANTISKID (white or amber) - loss of antiskid protection to related wheels.

LIMITER (white or amber) - torque limiting control fault detected.

Compacted Brake Temperature Indications



1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0 to 9
- white – normal range
- amber – high range

Intentionally
Blank

Landing Gear — Chapter 14
System Description — Section 20

Introduction

The airplane has four main landing gear and a single nose gear. The nose gear is a conventional steerable two–wheel unit. The main gear consist of two steerable body gear and two non-steerable wing gear. Each main gear has four wheels per truck in tandem pairs. The main gear trucks must be tilted and centered to allow retraction into the wheel wells.

Hydraulic power for nose and body gear retraction and extension is supplied by hydraulic system 1. Power to retract and extend the wing gear is provided by hydraulic system 4. An alternate extension system is also provided.

The normal brake system is powered by hydraulic system 4. The alternate brake system is powered by the hydraulic systems 1 or 2. Pressure-operated selector valves provide automatic brake source selection. 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 and a nose gear extension sensing system.

All four main gear tilt as the airplane lifts off the runway. When a combination of main gear tilt sensors indicate the gear are tilted (air mode) or not tilted (ground mode), an air/ground signal is provided to relays which control various system functions.

Nose gear extension sensing provides a signal to relays controlling functions in the stall warning and nose gear steering systems.

Landing Gear Operation

The landing gear are normally controlled by the Landing Gear lever. On the ground, the lever is held in 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 released when the main gear are tilted and the body gear is centered.

If any main gear is not tilted in flight, the disabled system message TILT displays on the gear synoptic adjacent to the affected gear.

Each main gear has one hydraulically actuated and one mechanically acutated gear door. The nose gear has two hydraulically actuated and two mechanically actuated gear doors.

Landing Gear Retraction

When the Landing Gear lever is moved to UP, the landing gear begin to retract and automatic braking occurs. The landing gear doors open and the main gear 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 main gear are held in the up position by uplocks. The nose gear is mechnically locked in the up position. The EICAS landing gear position indication changes to UP for 10 seconds and then blanks. Positioning the Landing Gear lever to OFF depressurizes the landing gear system.

If any gear is not up and locked up 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 down if the gear never unlocked from the down position.

The disabled system message TILT displays on the gear synoptic adjacent to the affected gear.

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.

If any gear position disagrees with lever position 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).

Landing Gear Alternate Extension

Alternate gear extension is activated by pushing the Alternate Gear Extend switches. The gear uplocks and gear door latches are released, allowing the gear to free fall. Gravity and airloads extend the gear and springs pull the downlocks into the locked position. All gear doors remain open after alternate extension.

The EICAS landing gear position indication displays the expanded gear position indication when the alternate extension system is used.

Nose Wheel and Body Gear Steering

Nose wheel and body gear steering is powered by hydraulic system 1.

Primary low speed 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.

Body gear steering operates when the nose wheel steering angle exceeds 20 degrees. This reduces tire scrubbing and lets the airplane turn in a minimum radius. Body gear steering is activated when ground speed decreases through 15 knots. As speed increases through 20 knots, the body gear is centered and body gear steering is deactivated.

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 hydraulic system 4. The brake pedals provide independent control of the left and right brakes.

Alternate Brake Hydraulic System

If hydraulic system 4 pressure is low, hydraulic system 1 supplies pressure to the alternate brake hydraulic system. If hydraulic pressure in systems 4 and 1 are low, system 2 powers the alternate brake system.

Loss of hydraulic systems 4, 1, and 2 causes the brake source light to illuminate.

Brake Accumulator

The brake accumulator provides for parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake hydraulic systems.

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 brake hydraulic system provides antiskid protection to tandem wheel pairs (fwd and/or aft pair on each truck) rather than to individual wheels.

Touchdown and hydroplaning protection is provided using airplane inertial ground speed. Locked wheel protection is provided using a comparison with other wheel speeds.

If antiskid power is off on all wheels, or the parking brake valve is not fully open, or a brake system control unit power loss occurs, the disabled system message ANTISKID displays on the gear synoptic adjacent to the affected wheels.

Brake Torque Limiter

A brake torque sensor is provided at each wheel. The sensors detect excessive torque during braking to prevent damage to landing gear. When excessive torque is detected, a signal is sent to the antiskid valve to release brake pressure to that wheel. If the alternate brake system is used, brake torque is sensed on an individual wheel basis, however the signal is sent to the alternate antiskid valve and brake pressure is released on a laterally paired wheel basis.

If a brake torque limiter failure occurs on more than one wheel per truck, or the parking brake lever is released and the parking brake valve is not fully open, or a brake system control unit power loss occurs, the disabled system message LIMITER displays on the gear synoptic adjacent to the affected wheels.

Autobrake System

The autobrake system provides 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.

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
- all thrust levers are closed.

Maximum braking is obtained in this mode. If an RTO is initiated below 85 knots, the RTO autobrake function does not operate.

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:

- all thrust levers are closed,
- ground mode is sensed, and
- the wheels have spun up.

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 system disarms immediately if any of the following occur:

- pedal braking applied
- any Thrust lever advanced after landing
- Speedbrake lever moved to DOWN detent after speedbrakes have deployed on the ground
- DISARM or OFF position selected on Autobrake selector
- autobrake fault
- normal antiskid system fault
- loss of normal brake hydraulic pressure.

When the autobrake system disarms after landing, the Autobrake selector moves to DISARM position. Rotating the Autobrakes selector to OFF removes power from the autobrake system.

When the autobrake system disarms during takeoff, the Autobrake selector remains in RTO position, but 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 hydraulic system 4. Accumulator pressure is shown on the brake accumlator pressure indicator.

Sufficient pressure is stored in the accumulator to set and hold the parking brake, but the accumulator is not designed to stop the aircraft.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the Parking Brake lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

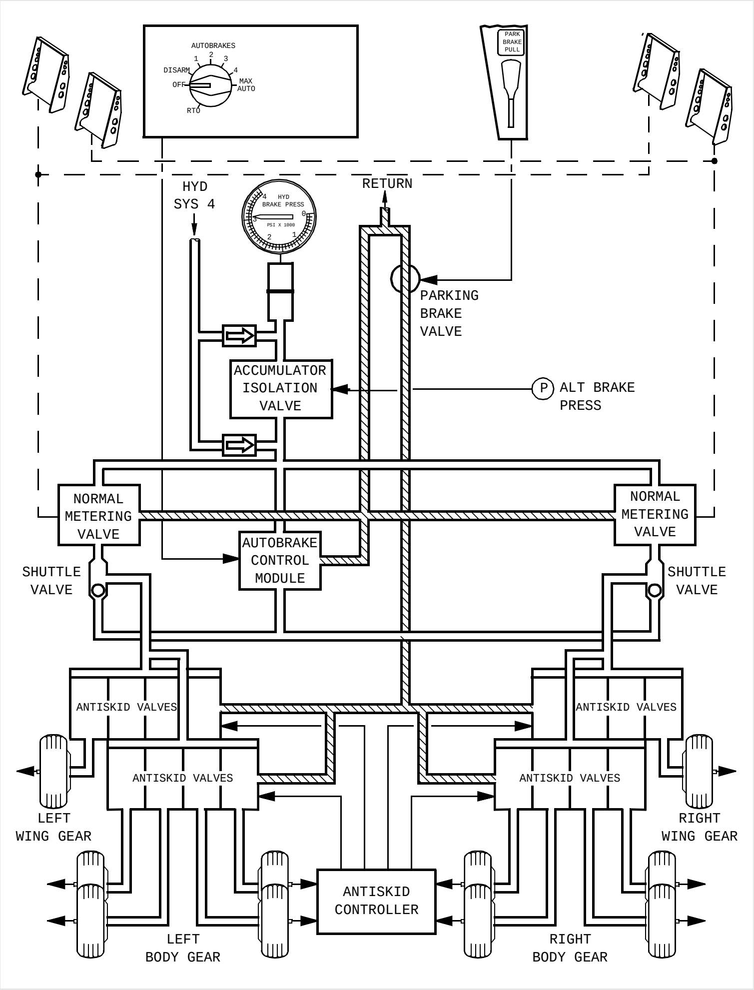
When the parking brake is set, the first hydraulic system pressurized may supply a small amount of fluid to the brake lines. When brakes are released, that small amount of fluid returns to system 4. Pressurizing system 4 before pressurizing the other systems precludes the transfer of hydraulic fluid from system 1 or 2 into system 4.

The parking brake is released by depressing the pedals until the Parking Brake lever releases.

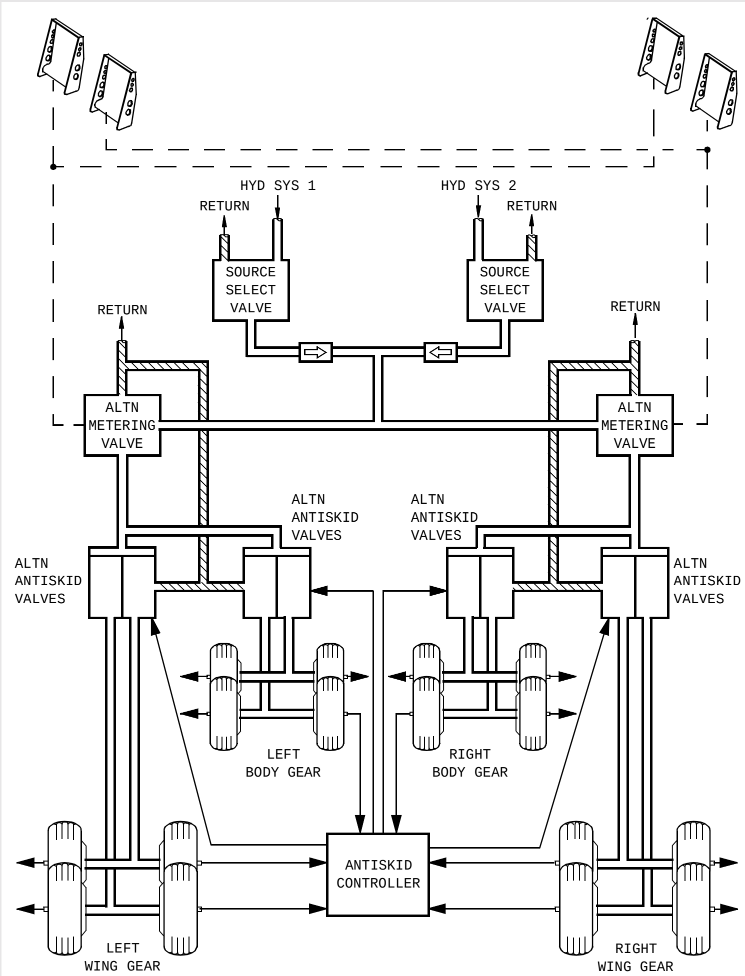
Brake Temperature Indication

Wheel brake temperatures display on the GEAR synoptic display. Numerical values related to wheel brake temperature display inside each wheel/brake symbol.

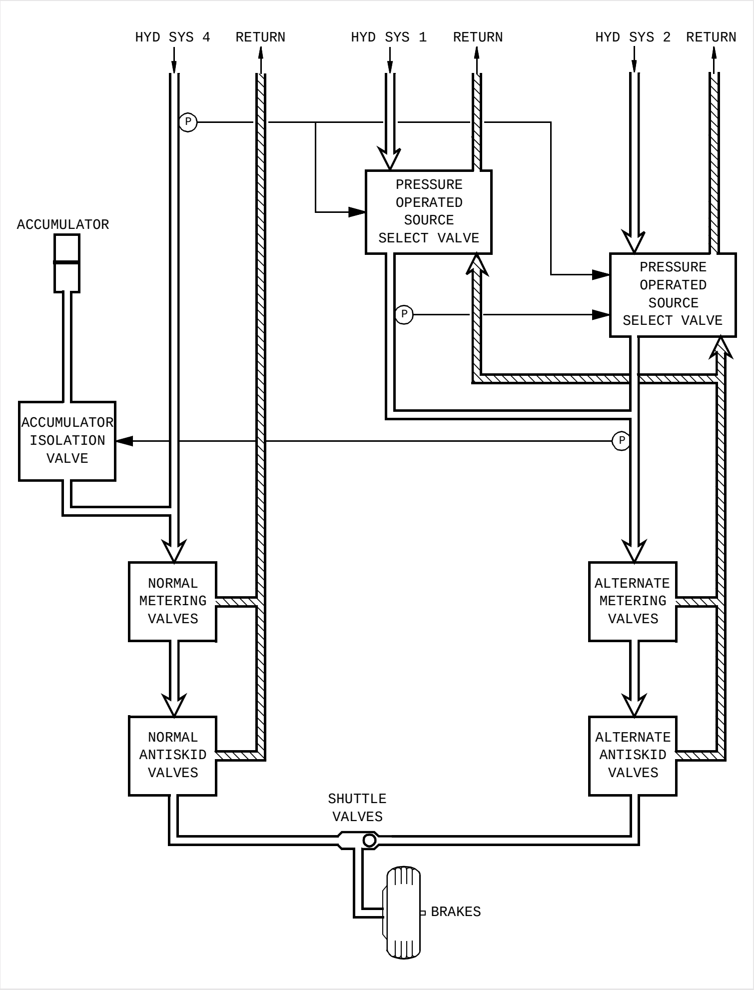
Normal Brake System Diagram



Alternate Brake System Diagram



Brake Source Selection Diagram



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Landing Gear EICAS Messages

The following EICAS messages can be displayed.

Note: Configuration warning messages are covered in Chapter 15, Warning Systems.

EICAS Alert Messages

Message	Level	Aural	Condition
AIR/GND SYSTEM	Advisory		Air/ground sensing system failed to the air position.

Message	Level	Aural	Condition
ANTISKID	Advisory		Fault which results in the loss of antiskid protection to one or more wheels has occured in the active antiskid system, either normal or alternate.
ANTISKID OFF	Advisory		Antiskid power off on all wheels, or parking brake lever released and parking brake valve is not fully open, or a brake system control unit power loss occurs.
AUTOBRAKES	Advisory		Autobrake system disarmed or inoperative, or Autobrake selector OFF and system armed, or RTO initiated above 85 knots and brakes have not been applied.
>BODY GEAR STRG	Advisory		Body gear steering unlocked or pressurized when not commanded.
BRAKE LIMITER	Advisory		A brake torque limiter failure has occured on more than one wheel per truck, or parking brake lever released and parking brake valve not fully open, or a brake system control unit power loss occurs.
>BRAKE SOURCE	Caution	Beeper	Hydraulic systems 4, 1, and 2 have low pressure.
BRAKE TEMP	Advisory		Any brake temperature equal to or greater than 5 units.

Message	Level	Aural	Condition
GEAR DISAGREE	Caution	Beeper	Gear position disagrees with Landing Gear lever position after normal gear extension time.
GEAR DOOR	Advisory		Any hydraulically actuated gear door not closed after normal gear transit time. Inhibited if alternate gear extension selected.
GEAR TILT	Caution	Beeper	Any main gear not tilted in flight.

EICAS Memo Messages

Message	Condition
AUTOBRAKES 1, 2, 3, 4	Autobrake level selected.
AUTOBRAKES MAX	Autobrakes MAX selected.
AUTOBRAKES RTO	Autobrakes RTO selected.
PARK BRAKE SET	Parking brake valve closed.

Warning Systems — Chapter 15
Table of Contents — Section 0

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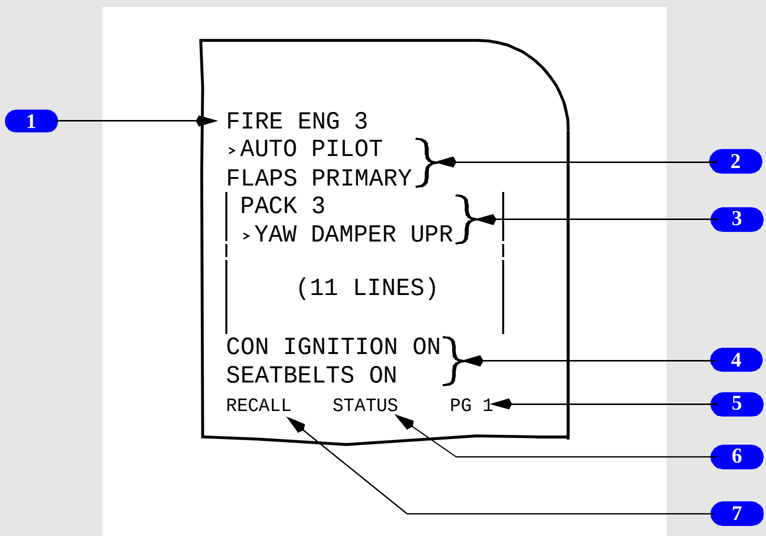
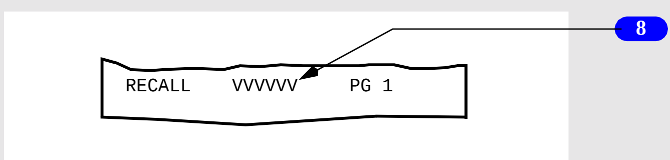
Engine Indication and Crew Alerting System (EICAS)

EICAS Messages



EICAS DISPLAY



EICAS DISPLAY

1 Warning Messages

Displayed (red) –

- highest priority alert messages
- red alert messages remain displayed and cannot be canceled by pushing the CANC switch.

2 Caution Messages

Displayed (amber) –

- next highest priority alert messages after warning messages
- amber alert messages can be canceled by pushing the CANC switch or recalled by pushing the RCL switch

3 Advisory Messages

Displayed (amber) –

- lowest priority alert messages; indented one space
- indented one space
- amber alert messages can be canceled by pushing the CANC switch or recalled by pushing the RCL switch

4 Memo Messages

Displayed (white) –

- reminder of selected state of controls or systems
- cannot be canceled by pushing the CANC 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

5 Page (PG) Number

Displayed (white) –

- more than one page of alert or memo messages exists
- indicates the number of page selected

6 STATUS Cue

Displayed (cyan) –

- new status message exists
- no longer displayed when status display selected
- inhibited from after engine start until 30 minutes after lift-off
- inhibited if Secondary Engine Exceedance cue is displayed

7 RECALL Indication

Displayed (white) –

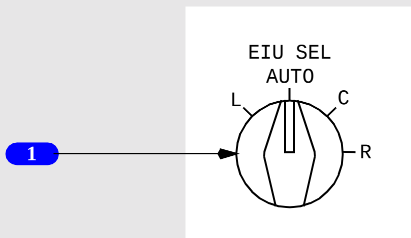
- when RCL switch pushed
- remains displayed for one second after switch released

8 **Secondary Engine Exceedance Cue**

Displayed (cyan) –

- engine parameter on secondary display is exceedanced
- displayed until displayed parameter returns to normal operating range
- inhibits display of Status cue

EFIS/EICAS Interface Unit (EIU) Selector



CENTER PANEL

1 **EIU Selector**

L –

- left EIU provides data to EFIS and EICAS
- if left EIU fails, automatic switching to an operable EIU is inhibited; if airplane is on standby power and left EIU fails, all CRT displays fail

AUTO –

- selects an operable EIU to provide data to EFIS and EICAS
- Selects left, then center, then right

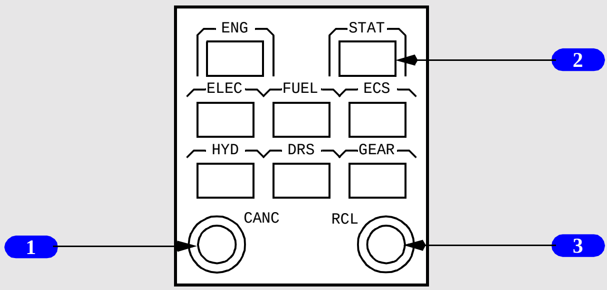
C –

- center EIU provides data to EFIS and EICAS
- if center EIU fails, automatic switching to an operable EIU is inhibited

R –

- right EIU provides data to EFIS and EICAS
- if right EIU fails, automatic switching to an operable EIU is inhibited

Display Select Panel



GLARESHIELD

1 Cancel (CANC) Switch

Push –

- displays next page of caution and advisory messages when additional pages exist
- cancels caution and advisory messages when last page displayed; warning and memo messages remain displayed
- cancels red box for any engine parameter previously exceeded when displayed parameter no longer exceeds the limit

2 Status (STAT) Display Switch

Push – displays status display on secondary EICAS.

Subsequent pushes –

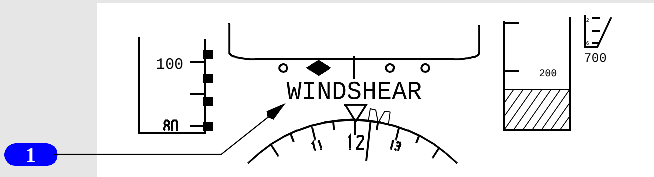
- display next page of status messages when additional pages exist
- secondary EICAS blanks when last status message page displayed

3 Recall (RCL) Switch

Push –

- redisplays all caution and advisory EICAS messages, when respective non-normal condition exists
- displays first page of messages when multiple pages exist
- redisplays red box for parameters previously exceeded
- displays RECALL indication for one second after switch released

GPWS Alerts on PFD



PFD

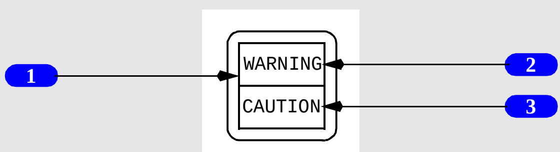
1 Alert on PFD

PULL UP (red) – GPWS PULL UP alert is occurring.

WINDSHEAR (red) –

- GPWS WINDSHEAR alert is occurring
- all other GPWS alerts inhibited

Master WARNING/CAUTION Reset Switches and Lights



GLARESHIELD PANEL

1 Master WARNING/CAUTION Reset Switch

Push –

- extinguishes master WARNING lights
- extinguishes master CAUTION lights
- silences the aural alert that accompany 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

2 Master WARNING Light

Illuminated (red) –

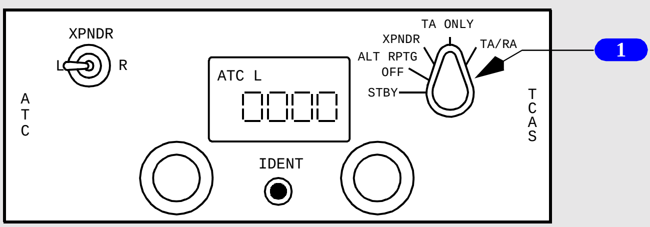
- new EICAS warning message displayed, or
- red PULL UP or WINDSHEAR message displayed on PFD

3 Master CAUTION Light

Illuminated (amber) – new EICAS caution message displayed

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls (Transponder Panel)



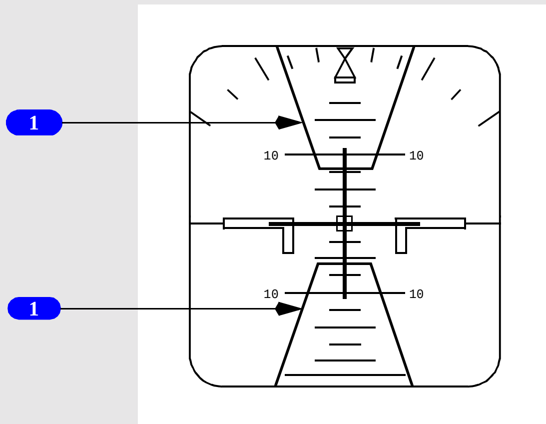
AFT AISLE STAND

1 Transponder Mode Selector

Traffic Advisory (TA) ONLY – transponder and TCAS TA modes enabled. Provides TA data for TCAS.

Traffic Advisory/Resolution Advisory (TA/RA) – transponder and TCAS TA and RA modes enabled. Provides TA and RA data for TCAS.

TCAS PFD Vertical Guidance



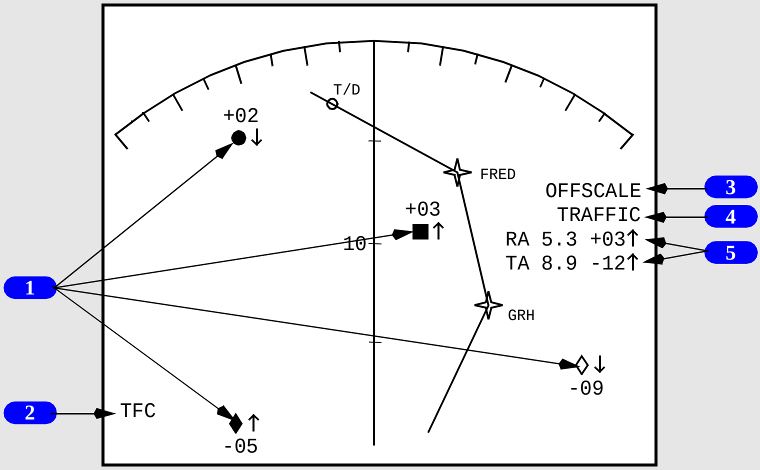
PFD

1 RA Pitch Region To Avoid Traffic (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 traffic.

TCAS Traffic Displays



ND

1 Traffic Display

Indicates relative position of traffic.

Displayed when TCAS enabled:

- 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 altitude of traffic in hundreds 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

Displayed automatically when:

- a RA or TA occurs, and
- TFC is not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

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
- only when TCAS enabled

Displayed (amber):

- TA is beyond selected map range
- only when TCAS enabled

4 TRAFFIC Alert Message

Displayed: (red) – RA is occurring.

Displayed: (amber) – TA is occurring, and RA is not occurring.

Displayed whether TCAS traffic is displayed or not.

Displayed in all ND modes and ranges.

5 TCAS No-Bearing Messages

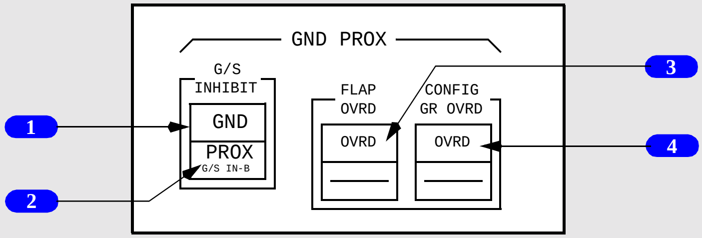
RA (red) – data tag displayed for no-bearing RA.

TA (amber) – data tag displayed for no-bearing TA.

Data tag contains distance, altitude, and vertical moton arrow.

Ground Proximity Warning System (GPWS) Controls

Ground Proximity Panels



FIRST OFFICER’S PANEL

1 **Ground Proximity (GND PROX) Glideslope (G/S) Inhibit Switch**

Push – inhibits GPWS GLIDESLOPE alert when pushed below 1,000 feet radio altitude.

2 **Ground Proximity (GND PROX) Light**

Illuminated (amber) –

- GPWS alert is occuring
- Inhibited for GLIDESLOPE, or TOO LOW FLAPS, or TOO LOW GEAR alerts when respective inhibit or override switch is pushed

3 **Ground Proximity (GND PROX) Flap Override (OVRD) Switch**

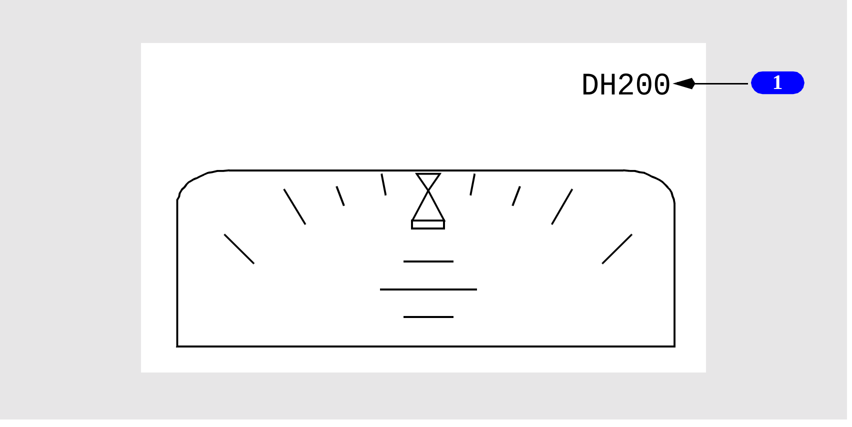
Push (OVRD illuminated) – inhibits TOO LOW FLAPS alert.

4 **Ground Proximity (GND PROX) Configuration (CONFIG) Gear (GR) Override (OVRD) Switch**

Push (OVRD illuminated) –

- inhibits TOO LOW GEAR alert
- inhibits CONFIG GEAR alert

Decision Height Display



1 **Decision Height**

Displays radio altitude set by DH/MDA Altitude control.

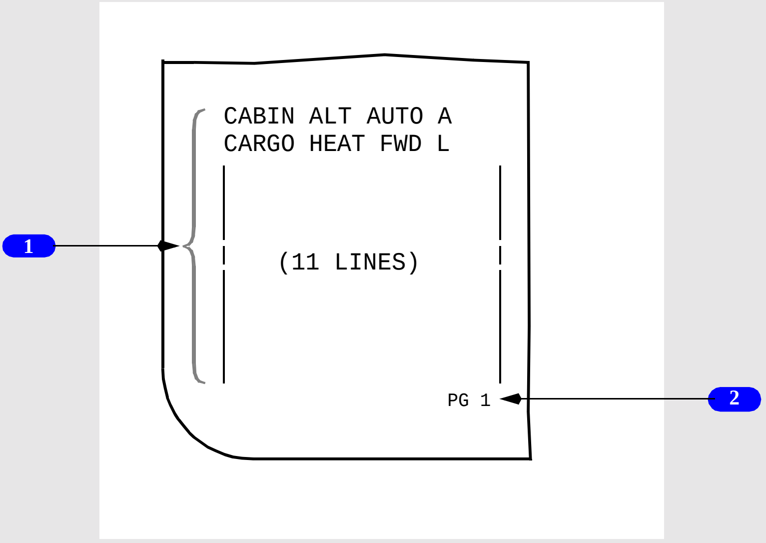
Display changes to large flashing amber DH when descending below the altitude set.

DH not displayed when set below zero feet.

Flashing amber display resets:

- upon landing
- on go-around at 75 feet above the altitude set
- when DH RST switch pushed

Status Display



SECONDARY EICAS

1 Status Messages

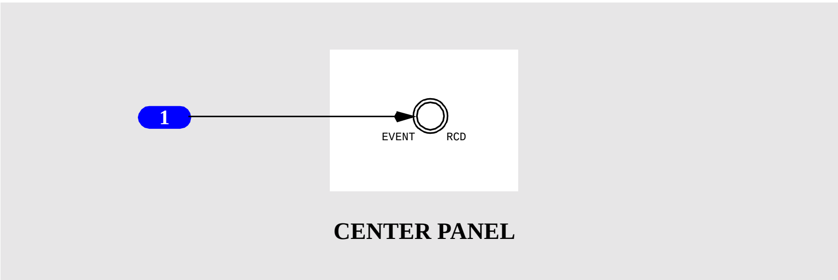
Status messages indicate equipment faults requiring MEL reference for dispatch.

2 Page (PG) Number

Displayed –

- additional pages of status messages exist
- displays number of page selected

EICAS Event Record Switch



1 EICAS Event Record (EVENT RCD) Switch

Push – records up to five EICAS events.

Introduction

Warning systems consist of:

- engine indication and crew alerting system (EICAS)
- airspeed alerts
- takeoff and landing configuration warning system
- MCP selected altitude alerts
- crew alertness monitor
- traffic collision avoidance system (TCAS)
- windshear alerts
- ground proximity warning system (GPWS)
- maintenance event recording

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 primary EICAS.

EFIS/EICAS Interface Unit (EIU)

The EIUs monitor all airplane systems continuously and control the information displayed on the EICAS displays. Data from airplane systems is provided to three EIUs and one of the three EIUs controls all EICAS displays. The EIU selector provides either automatic or manual selection of the controlling EIU.

EICAS Messages

Systems conditions and configuration information is provided to the crew by three types of EICAS messages:

- EICAS alert messages are the primary method to alert the crew to non-normal conditions
- EICAS memo messages are crew reminders of certain flight crew selected normal conditions
- EICAS status messages indicate equipment faults requiring MEL reference for dispatch.

An EICAS alert 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 caret symbol (>) prefaces an alert message that has no procedural steps.

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 switch. Amber EICAS alert messages can be canceled by pushing the CANC switch and recalled by pushing the RCL switch.

EICAS Memo Messages

EICAS memo messages are crew reminders of certain flight crew selected normal conditions. They display in white at the bottom of the last page of EICAS alert messages on the primary EICAS display.

Pushing the CANC 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 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 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 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 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 RCL switch redisplays 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 CANC and RCL switches control the display of EICAS alert messages.

Aural Alerts, Master WARNING/CAUTION Switches and Lights, and GND PROX Light

Aural alerts, 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 alert or extinguish the light while the alert is occurring.

Aural Alert	Light Alert	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 FIRE WHEEL WELL

Aural Alert	Light Alert	Calls Attention To:
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 CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG SPOILERS CONFIG STAB PILOT RESPONSE

Aural Alert	Light Alert	Calls Attention To:
Wailer	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message AUTO PILOT

Aural Alert	Light Alert	Calls Attention To:
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message OVERSPEED

Aural Alert	Light Alert	Calls Attention To:
Beeper	Master CAUTION lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	New EICAS caution message, except: ENG SHUTDOWN

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 alert message OVERSPEED is displayed if VMO/MMO is exceeded. The message remains displayed until airspeed is reduced below VMO/MMO.

The EICAS memo message VMO GEAR DOWN is displayed when gear down dispatch has been selected in the electronics bay. When gear down dispatch is selected, the VMO/MMO calculated by the ADC are based on maximum gear extended speed.

The EICAS memo message VMO SPARE ENGINE is displayed when spare engine dispatch has been selected in the electronics bay. When spare engine dispatch is selected, the VMO/MMO calculated by the ADC is based on maximum spare engine carriage speed.

Takeoff And Landing Configuration Warning System

The takeoff and landing configuration warning system alerts the crew that the airplane is not configured for a normal takeoff or a normal landing.

The warning system also provides takeoff and landing configuration and stall warnings.

Takeoff Configuration Warnings

The respective EICAS alert message CONFIG is displayed if:

- airplane is on the ground, and
- FUEL CONTROL switches are in RUN position, and
- engine two or three thrust is in takeoff range, and
- airspeed is less than V1, and
- any of the following configurations exist;
  - flaps not in a takeoff position, or
  - body gear not centered, or
  - parking brake is set, or
  - Speedbrake lever not in DN detent, or
  - stabilizer trim not in takeoff range

Takeoff configuration warnings are inhibited at V1.

If engine 2 and 3 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 extinguish and the siren is silenced. The CONFIG messge remains displayed until the airplane is configured for a normal takeoff.

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;
  - any Thrust lever is closed and radio altitude is less than 800 ft, or
  - Flap lever in a landing position (Flaps 25 or Flaps 30)

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 a landing position, the siren and alert message cannot be silenced by pushing a Master Warning/Caution Reset switches. The siren sounds and the EICAS message is displayed until the landing gear is down and locked or the Ground Proximity Gear Override switch is pushed.

Configuration Warning System Non-normal Operation

If the takeoff warning system fails or if the takeoff warning system input to the EIU fails, the EICAS alert message CONFIG WARN SY 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 SY message, the CONFIG messages may not be correct.

MCP Selected Altitude Alerts

Altitude alerting occurs when approaching or deviating from altitude selected on the MCP.

Approaching MCP Selected Altitude

Between 900 feet and 300 feet prior to reaching the selected altitude, a highlighted white box is displayed around the selected altitude and the current altitude on the PFD.

Deviating From MCP Selected Altitude

When departing the selected altitude by 300 feet, the EICAS alert message ALTITUDE ALERT is displayed, and a highlighted amber box is displayed around the selected altitude and the current altitude. The message and amber highlights are no longer displayed when:

- subsequently reapproaching to within 300 feet of the selected altitude, or
- a new MCP altitude is selected, or
- departing more than 900 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 activation of switches on the MCP, EFIS control panel, EICAS control panel, CDUs, and VHF/HF press-to-talk switches. When a predefined time elapses after the last control movement, the EICAS advisory message PILOT RESPONSE is displayed.

If there is still no response after a brief time, the EICAS caution message PILOT RESPONSE is displayed.

If there is still no response, the EICAS warning message PILOT RESPONSE is displayed.

The PILOT RESPONSE message is no longer displayed after pushing any control on any of the monitored systems or panels.

The PILOT RESPONSE message is inhibited below 20,000 feet.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other aircraft, tracks the other aircraft by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides advisory, flight path guidance, and traffic displays of the other aircraft to the flight crew. Neither advisory, guidance, nor traffic display is provided for other aircraft that do not have operating transponders. TCAS operation is independent of ground–based air traffic control.

To provide advisories, 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 advisories and traffic displays:

- 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.

Resolution Advisories (RA) and Display

A RA is a prediction another aircraft will enter TCAS conflict airspace within approximately 20 to 30 seconds. If altitude data from the other aircraft is not available, no RA can be provided.

When TCAS predicts an RA:

- a TCAS voice annunciation sounds
- TCAS PFD vertical guidance is displayed
- the TCAS red message TRAFFIC is displayed on the ND.

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 symbol and its accompanying data tag are displayed on the ND.

The TCAS RA traffic 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 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 voice annunciation TRAFFIC, TRAFFIC sounds once
- the TCAS amber message TRAFFIC is displayed on the ND.

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 symbol and its accompanying data tag are displayed on the ND.

The TA traffic 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 aircraft 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 is within the ND display range, the TCAS proximate traffic symbol is displayed on the ND.

The TCAS proximate traffic symbol is a filled white diamond. If the other aircraft is providing altitude data, 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 is another aircraft that is within the ND display limits but is neither an RA, a TA, or proximate traffic. If the other aircraft is not providing altitude information, other traffic becomes proximate traffic automatically when within six miles.

When the TCAS cyan message TFC is displayed on the ND and the other traffic is within the ND display range, then the TCAS other traffic symbol is displayed on the ND.

The TCAS other traffic symbol is a hollow white diamond. If the other aircraft is providing altitude data, a data tag like that described in the proximate traffic display is displayed.

TCAS PFD Vertical Guidance

When TCAS predicts an RA, TCAS PFD vertical guidance is displayed for a traffic avoidance maneuver to ensure vertical separation. Traffic avoidance is ensured by adjusting or maintaining a pitch attitude outside the red outlined RA pitch region.

If the traffic aircraft 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.

ND Message	Color	Description
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 annunciaion.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude is outside the red RA regions.	Continue to keep pitch attitude outside the red RA regions.
CLIMB, CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude is within the red RA regions.	Increase pitch attitude to remain outside the red RA regions.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude is within the red RA regions. Airplane will climb through the altitude of the traffic.	Increase pitch attitude to remain outside the red RA regions.
DESCEND, DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude is within the red RA regions.	Decrease pitch attitude to remain outside the red RA regions.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude is within the red RA regions. Airplane will descend through the altitude of the traffic.	Decrease pitch attitude to remain outside the red RA regions.

Voice Annunciation	Condition	Response
INCREASE CLIMB, INCREASE CLIMB REDUCE CLIMB, REDUCE CLIMB INCREASE DESCENT, INCREASE DESCENT REDUCE DESCENT, REDUCE DESCENT	Existing RA, TCAS requires change in vertical rate. Present pitch attitude is within the red RA regions.	Adjust pitch attitude to remain outside the red RA regions..
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude is within the red RA regions.	Decrease pitch attitude 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 is within the red RA regions.	Increase pitch attitude 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

The TCAS operating mode is controlled from the transponder panel. TCAS is normally operated in the TA/RA mode. However, it is sometimes necessary to operate in TA ONLY mode to prevent nuisance RAs.

TA ONLY mode is used during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, TA ONLY mode can be used when intentionally operating near other traffic that may cause RAs, such as during parallel approaches and VFR operations.

TCAS Non–Normal Operation

The EICAS alert message TCAS OFF is displayed if TCAS is not operating. 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 alert 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 alert message TCAS is displayed if TCAS cannot display TCAS RA guidance on either PFD, and cannot display TCAS traffic symbols on either ND. An amber TCAS FAIL message is displayed on both NDs, and TCAS voice alerts will not occur.

Ground Proximity Warning System (GPWS) Alerts

Introduction

GPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

GPWS alerts are based on radio altitude, barometric altitude, IRS, airspeed, glide slope deviation, and airplane configuration. GPWS alerts are provided for the following:

- 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 an ILS glide slope
- altitude advisories
- windshear.

GPWS warning aletrts are accompanied by the Master WARNING light illuminating and voice aural alerts. GPWS caution alerts are accompanied by the ground proximity light illuminating and voice aural alerts.

If illuminated, pushing a Master WARNING/CAUTION Reset switch resets the Master WARNING lights but does not inhibit the GPWS warning.

GPWS caution alerts are accompanied by the ground proximity light illuminating. The master CAUTION lights do not illuminate for GPWS caution alerts.

GPWS alerts are prioritized based on the level of hazard and the required flight crew response. A windshear warning alert inhibits all other GPWS alerts.

Note: GPWS does not provide an alert for flight toward vertically sheer terrain or slow descents into terrain while in landing configuration.

GPWS Alerts

Aural Alert	Visual Alert	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 GND PROX light	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.

Aural Alert	Visual Alert	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:

- 100 feet – ONE HUNDRED
- 50 feet – FIFTY
- 30 feet – THIRTY
- 10 feet – TEN

GPWS Windshear Alert

Windshear alerts are enabled during takeoff, approach, and landing:

- GPWS provides an immediate windshear alert when an excessive downdraft or tailwind is occurring

Windshear warning alerts are accompanied by the master WARNING light illuminating.

Pushing a Master WARNING/CAUTION reset switch extinguishes the master WARNING lights and resets the master WARNING lights but does not inhibit windshear alerts.

Immediate Windshear Warning

Aural Alert	Visual Alert	Description
Two–tone siren followed by WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both PFDs Red WINDSHEAR message on both NDs Master WARNING lights	Excessive windshear detected by GPWS. Enabled below 1,500 feet radio altitude. GPWS windshear detection begins at rotation.

GPWS Non-Normal Operation

If there is a fault in any GPWS mode, the alerts are inhibited for the mode in which the fault occurs. If there is a fault in any other GPWS mode, the alerts are inhibited for the mode in which the fault occurs, but there is no indication to the flight crew of which modes are inhibited. GPWS will provide alerts for the modes for which no fault has occurred.

Alert Inhibits

Alerts are inhibited when they are operationally unnecessary or inappropriate. Alerts are also inhibited during part of the takeoff to prevent distracting the crew.

Alert Messages Inhibited By Other Alert Messages

Some EICAS alert messages are inhibited if another related alert message is displayed. For example, individual fuel or hydraulic pump pressure messages are inhibited if a hydraulic system pressure message is displayed.

Certain alert messages are time delayed, even though related flight deck panel annunciation lights are illuminated. Time delay inhibits prevent normal in–transit indications from being displayed as EICAS system alert messages. For example, valves are generally only sensed open and/or closed, not in–transit. When a valve is in–transit, the alert 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 period, the respective EICAS alert message is displayed.

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 all FUEL CONTROL switches CUTOFF.
Respective EICAS messages: ELEC GEN OFF ENG CONTROL, ENG EEC MODE ENG FAIL ENG OIL PRESS NAI VALVE	For EICAS caution messages: ENG SHUTDOWN	On the ground, and respective FUEL CONTROL switch in CUTOFF or Engine Fire switch out.

Alerts Inhibited During Engine Start

Alert Inhibited	Inhibit Begins	Inhibit Ends
All new EICAS caution and advisory messages, except: BLEED ENG AUTOSTART ENG FUEL VALVE ENG SHUTDOWN ENG START VLV STARTER CUTOUT	Engine START switch pulled.	Engine reaches idle RPM, or start is aborted, or five minutes elapse.

Alerts Inhibited During Takeoff

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
STATUS cue	All EICAS new status messages	Engine start	30 minutes after lift-off
Master CAUTION lights Beeper	All EICAS caution messages	80 knots airspeed	400 feet radio altitude or 20 seconds after rotation, whichever occurs first. If rejected takeoff initialed above 80 knots, inhibit continues until airspeed is less than 75 knots.
All EICAS advisory messages	(Messages are inhibited)	80 knots airspeed	400 feet radio altitude or 20 seconds after rotation, whichever occurs first, or if takeoff thrust not selected on both engines. If rejected takeoff initialed above 80 knots, inhibit continues until airspeed is less than 75 knots.
Master WARNING lights Bell	FIRE	V1	400 feet radio altitude or 25 seconds after V1, whichever occurs first.
Master WARNING lights Siren	CABIN ALTITUDE OVERSPEED	V1	400 feet radio altitude or 25 seconds after V1, whichever occurs first.
Master WARNING lights Siren	EICAS warning message CONFIG GEAR	Lift-off	800 feet radio altitude or 140 seconds after nose gear strut lift-off, whichever occurs first
EICAS advisory message FUEL TANK/ENG	FUEL TANK/ENG	Lift-off	Ten minumtes after lift-off

If the Master WARNING lights are illuminated and the siren or fire bell sound before reaching V1, they continue to be illuminated and to sound when V1 is exceeded.

If the Master CAUTION lights are illuminated before reaching V1, they continue to be illuminated when V1 is exceeded and cannot be reset until the inhibit ends.

If an EICAS warning or caution message continues to be displayed when the inhibit ends, the respective Master WARNING or CAUTION lights illuminate and aural alert sounds.

TCAS Inhibits

Alert Inhibited	Inhibited
INCREASE DESCENT RAs	Below approximately 1,500 feet radio altitude.
DESCENT RAs	Below approximately 1,100 feet radio altitude.
All RAs	Below approximately 1,000 feet radio altitude. When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND.
All TCAS voice alerts	Below approximately 1,000 feet radio altitude.
All TCAS alerts.	GPWS and windshear warnings.

Alerts Inhibited During Landing

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
STATUS cue	All EICAS status messages	800 feet radio altitude	Airspeed less than 75 knots
EICAS alert message WINDSHEAR SYS	(Message is inhibited)	400 feet radio altitude	Airspeed less than 80 knots
Master CAUTION lights Beeper	All EICAS caution messages, except: AUTOPILOT AUTOTHROTTLE DISC NO AUTOLAND SPEEDBRAKES EXT	LAND 2 or LAND 3 displayed on PFD, and 200 feet radio attitude	Airspeed less than 75 knots, or 40 seconds elapse, or 800 feet radio altitude

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

The following EICAS messages can be displayed.

Configuration EICAS Alert Messages

Message	Level	Aural	Condition
>CONFIG FLAPS	Warning	Siren	Flaps are not in a takeoff position when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in takeoff range.
>CONFIG GEAR	Warning	Siren	Any landing gear is not down and locked when any Thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.
>CONFIG GEAR CTR	Warning	Siren	Body gear are not centered when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in takeoff range.
>CONFIG PARK BRK	Warning	Siren	Parking brake is set when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in takeoff range.
>CONFIG SPOILERS	Warning	Siren	Speedbrake lever is not DOWN when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in takeoff range.
>CONFIG STAB	Warning	Siren	Stabilizer is not within the greenband when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in takeoff range.
>CONFIG WARNING SY	Advisory		A fault is detected in the configuration warning system.

GPWS EICAS Alert Messages

Message	Level	Aural	Condition
>ALT CALLOUTS	Advisory		Altitude advisories and Minimums annunciations are no longer provided.

Message	Level	Aural	Condition
GND PROX SYS	Advisory		GPWS alerts may not be provided.

Message	Level	Aural	Condition
WINDSHEAR SYS	Advisory		Windshear alerts may not be provided.

TCAS EICAS Alert Messages

Message	Level	Aural	Condition
>TCAS OFF	Advisory		TCAS mode (TA or TA/RA) not selected.

Message	Level	Aural	Condition
>TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on the respective PFD.
>TCAS SYSTEM	Advisory		TCAS has failed.

Airspeed and Altitude EICAS Alert Messages

Message	Level	Aural	Condition
>AIRSPEED LOW	Caution	Beeper	Airspeed less than minimum maneuvering airspeed.

Message	Level	Aural	Condition
>ALTITUDE ALERT	Caution	Beeper	Airplane has deviated more than 300 feet from MCP selected altitude.
>OVERSPEED	Warning	Siren	Airspeed exceeds Vmo/Mmo.

Pilot Response EICAS Alert Message

Message	Level	Aural	Condition
>PILOT RESPONSE	Warning	Siren	After caution message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specific time.
>PILOT RESPONSE	Caution	Beeper	After advisory message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specific time.
>PILOT RESPONSE	Advisory		FMC does not detect crew activity in monitored area within a specific time.

Miscellaneous EICAS Memo Messages

Message	Condition
VMO GEAR DOWN	Gear down dispatch has been selected in the electronics bay.
VMO SPARE ENGINE	Spare engine dispatch has been selected in the electronics bay.

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