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

747-400

Flight Crew Operations Manual

The Boeing Company

Document Number D6-30151-400
January 1, 1999

Revision Number: 23
Revision Date: October 1, 2009

Copyright Information

October 1, 2009

Preface — Chapter 0
Chapter Table of Contents — Section 0

Volume 1

Volume 2

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Preface — Chapter 0
Model Identification — Section 1

General

The airplanes listed in the table below are covered in this 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	Engine
405	Boeing Converted Freighter	P&W
109	Passenger	P&W
570	Freighter	GE

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General

This Flight Crew Operations Manual (FCOM) has been prepared by Boeing Commercial Airplanes, Commercial Aviation Services organization. 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 FCOM does not contain basic flight information considered prerequisite training.

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

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Organization

The FCOM 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
- Performance Dispatch chapter contains performance information necessary for self dispatch
- Performance Inflight chapter contains performance information necessary for inflight use

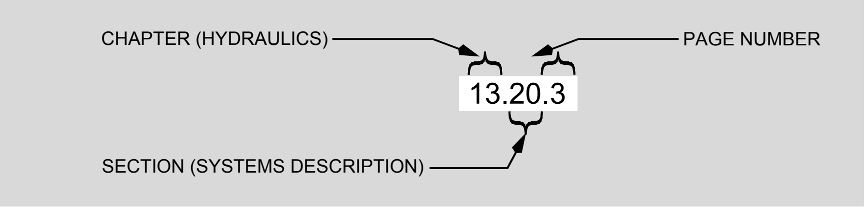
Volume 2 – Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

Quick Reference Handbook (QRH) – The QRH covers normal checklists, non-normal checklists, operational information, performance information necessary for inflight use on an expedited basis, and maneuvers.

Page Numbering

The FCOM 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.

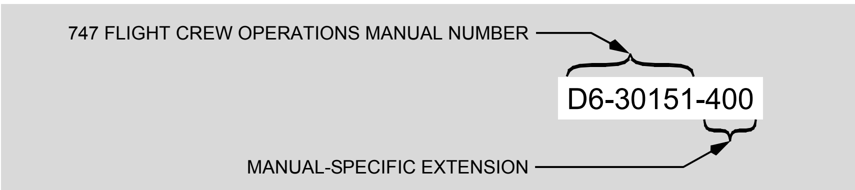
Example Page Number



Page Identification

Each page is identified by a document number and a page date. The document number is composed of the general 747 FCOM number, D6-30151–, and is followed by the manual-specific extension.

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.

Flight Crew 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 FCOM does not reflect customer originated modifications without special contract provisions.

Airplane Effectivities

Differences in airplane configuration are shown by use of airplane effectivities throughout Volumes 1 and 2, and the Quick Reference Handbook
The following rules are used to express airplane effectivities:

1. Airplane effectivities are listed in alpha-numeric order. A range of airplanes is defined by a dash, e.g. **N-MA - N-PQ** includes all "M" series airplanes and all "P" series aircraft. A comma in the effectivity range indicates a break in the range, e.g. **N-FA - N-FC, N-FE - N-FG**; that is, airplane N-FD is excluded from the range.

2. Airplane effectivities apply only to the paragraph, illustration, operational note, procedural step, etc. and to subordinate items (if any).

   Example (with subordinate items):

   N-AA - N-BB
   If FUEL BALLAST message displayed:
   CENTER L and R PUMP SWITCHES..OFF

   When jettison complete:
   FUEL JETTISON NOZZLE
   VALVE SWITCHES (Both)...OFF
   FUEL JETTISON SELECTOR...OFF

   In this example, the effectivity N-AA - N-BB applies to the first procedural step and further indented (subordinate) step only. The effectivity does not apply to the next equivalently indented step.

   The first step (If FUEL BALLAST message displayed:) is effective for airplanes N-AA - N-BB only, the second step (When jettison complete:) is effective for all airplanes:

   Example (without subordinate items):

   N-XX - N-YY
   Thrust reversers inoperative.

   Auto speedbrake deployment inoperative. When deployed manually, spoilers extend to flight position.

   Autobrake system inoperative.

In this example, the effectivity N-XX - N-YY applies to the first operational note only. The effectivity does not apply to the next two equivalently indented operational notes.

The first operational note (Thrust reverser inoperative.) is effective for airplanes N-XX - N-YY only, the next two operational notes (Auto speedbrake ...; Autobrake ...) are effective for all airplanes.

3. When airplane effectivities are stated immediately below a checklist title, the entire checklist applies to the listed airplanes only. In the following example, the FUEL STAB XFR checklist is applicable to N-XX - N-YY only:

FUEL STAB XFR

N-XX - N-YY

4. When Boeing has been notified airplanes are to be modified by service bulletin (SB), the effectivity statement will include ‘before’ and ‘after’ versions, as appropriate, in parentheses. Depending upon the modification, there may not be both a ‘before’ and an ‘after’ version.

   The text before the semicolon in the parentheses lists the range of airplanes being modified. The text after the semicolon indicates the ‘before’ or ‘after’ version and briefly describes what the SB does. The following examples illustrate this:

   Example (‘before’ version):

   (SB changes N-AA - N-BB ; before SB, thrust reverser locks not installed)
   One symmetrical pair of thrust reversers is inoperative.

   "SB changes N-AA - N-BB" means the incorporation of the SB (i.e. installation of thrust reverser locks in this example) is scheduled to begin for airplanes N-AA - N-BB. The words "before SB, thrust reverser locks not installed" indicate the associated operational note (One symmetircal pair of thrust reversers is inoperative.) applies to N-AA - N-BB until the SB has been incorporated.

Example ('after' version):

N-XX - N-YY
(SB changes N-AA - N-BB ; thrust reverser locks installed)
Thrust reversers inoperative.

For airplanes N-XX - N-YY, the SB (i.e. installation of thrust reverser locks in this example) has been incorporated. The associated operational note (Thrust reversers inoperative.) applies to N-XX - N-YY.

"SB changes N-AA - N-BB" means the incorporation of the SB (i.e. installation of reverser locks in this example) is scheduled to begin for airplanes N-AA - N-BB. The words "thrust reverser locks installed" indicate the associated operational note (Thrust reversers inoperative.) will apply to N-AA - N-BB when the SB has been incorporated.

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Preface Chapter 0
Abbreviations Section 3

General

The following abbreviations may be found throughout the manual. Some abbreviations may also appear in lowercase letters. Abbreviations having very limited use are explained in the chapter where they are used.

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
AVS	Alternate Ventilation System

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(H)	Decision Altitude (Height)
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
EFB	Electronic Flight Bag
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
FCC	Flight Control Computer
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
IAN	Integrated Approach Navigation
IAP	Initial Approach Point
IAS	Indicated Airspeed
IDENT	Identification
IDG	Integrated Drive Generator
IDS	Integrated Display System
IFE	In-flight Entertainment System
IN	Inches
IND LTS	Indicator Lights
ILS	Instrument Landing System
ISFD	Integrated Standby Flight Display

K	
K	Knots
KIAS	Knots Indicated Airspeed

L	
L	Left
LBS	Pounds
LDA	Localizer-type Directional Aid
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(H)	Minimum Descent Altitude (Height)
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
PM	Pilot Monitoring
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

S	
SAT	Static Air Temperature
S/C	Step Climb
SDF	Simplified Directional Facility
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	
VA	Design Maneuvering Speed
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	Takeoff Safety Speed

W	
WPT	Waypoint
WXR	Weather Radar

X	
X-BLD	Crossbleed
XTK	Cross Track
X FEED	Crossfeed

Z	
ZFW	Zero Fuel Weight

Revision Transmittal Letter

To: All holders of The Boeing Company 747 Flight Crew Operations Manual, Boeing Document Number D6-30151-400.

Subject: Flight Crew 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	No.	Revision Date	Date Filed
1	April 1, 1999		2	July 15, 1999	
3	October 1, 1999		4	April 1, 2000	
5	October 1, 2000		6	April 1, 2001	
7	November 1, 2001		8	May 1, 2002	
9	November 1, 2002		10	May 1, 2003	
11	November 1, 2003		12	May 1, 2004	
13	October 1, 2004		14	April 1, 2005	
15	October 1, 2005		16	April 1, 2006	
17	October 1, 2006		18	April 1, 2007	
19	October 1, 2007		20	April 1, 2008	
21	October 1, 2008		22	April 1, 2009	
23	October 1, 2009				

General

The Boeing Company issues FCOM 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 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.

Revised manual throughout to better reflect 747-400 fleet configurations.

Chapter 0 - Preface

Section 2 - Introduction

General

0.2.2 - Revised to reflect latest address.

Organization

0.2.3 - Revised to reflect changes associated with Phase 2 QRH.

Section 3 - Abbreviations

0.3.2-3 - Added abbreviation to reflect FCOM content.

Section 6 - Bulletin Record

0.6.2 - Revised to reflect current bulletin status.

Chapter L - Limitations

Section 10 - Operating Limitations

Autoflight

L.10.3 - Consolidated information and reorganized master document; no technical change

Engine Fuel System

L.10.5 - Removed extra space.

Reverse Thrust

L.10.6 - Consolidated redundant information in master document; no technical change.

QFE Selection

L.10.6 - Consolidated redundant information in master document.

Flap Operation

L.10.7 - Changed "speed brakes" to a single word for standardization.

Chapter NP - Normal Procedures

Section 11 - Introduction

Areas of Responsibility - First Officer as Pilot Flying or Taxiing

NP.11.7 - Revised to clarify intent is for First Officer to set the parking brake when the First Officer is the pilot flying.

Section 21 - Amplified Procedures

Preflight Procedure – First Officer

NP.21.10,16 - Revised to remove extra space.

NP.21.11 - Revised to allow flight crew selection of AUTO IGNITION selector to either 1 or 2. On PW engines without autostart, and on RR engines this can give longer igniter life. On PW airplanes with autostart, EECs can alternate igniters in either position for each ground start.

Engine Start Procedure

NP.21.29 - Revised to clarify if two engines are started at the same time, it may be necessary to set three packs off.

NP.21.30 - Revised to clarify if two engines are started at the same time, all packs may need to be off.

NP.21.31 - Revised for cross checklist commonality.

Takeoff Procedure

NP.21.34,36 - Revised to incorporate NTSB recommendations (NTSB/AAR-07/05) and SAFO 06013.

Landing Procedure - ILS

NP.21.46 - Deleted blank top row of table.

Shutdown Procedure

NP.21.56 - Revised to clarify intent is for First Officer to set the parking brake when the First Officer is the pilot flying.

NP.21.59 - Revised to reflect the demand pump selector is in the First Officer's area of responsibility.

Chapter SP - Supplementary Procedures

Section 11 - Flight Management, Navigation

Departure or Destination Airport Not in the FMC Navigation Database

SP.11.1 - Revised title for cross-procedure and cross model standardization.

SP.11.1 - Removed steps not directly related to the supplemental procedure.

SP.11.2 - Removed the second occurance of the step to clear the NAV DATA OUT OF DATE scratchpad message because the message will not show when the current FMC navigation database is made the active database.

SP.11.2 - Added step to clarify the origin should be left blank.

SP.11.2 - Combined and clarified the steps for entering the navaid frequency and course because they are entered on the same line

SP.11.2 - Added step to delete departure navaid frequency and course when no longer needed.

SP.11.3 - Revised title for cross-procedure and cross model standardization.

SP.11.3 - Revised to clarify a landing airport can be entered in flight.

SP.11.3 - Revised to reflect it may not be necessary to activate the route.

SP.11.4 - Combined steps for clarity.

Section 16 - Adverse Weather

Takeoff - Wet or Contaminated Runway Conditions

SP.16.1 - Revised for cross model standardization. Also revised to clarify combining a fixed derate with an assumed temperature.

Cold Weather Operation

SP.16.2 - Revised to "of one statute mile (1600 m) or less" for consistency with AFM.

SP.16.5 - Moved information relating to takeoff with reduced thrust to Takeoff - Wet or Contaminated Runway Conditions section.

Chapter PI - Performance Inflight

Section 10 - Table of Contents

PI.TOC.10.1 - 747-400 PW4056 KG FAA JAR was added as Section 10.

Chapter PI - Performance Inflight -

Section 10 - General

General

PI.10.1 - 747-400 PW4056 KG FAA JAR was added as Section 10.

Chapter PI - Performance Inflight

Section 20 - Table of Contents

PI.TOC.20.1 - 747-400F CF6-80C2B1F LB FAA was added as Section 20.

Chapter PI - Performance Inflight -

Section 20 - General

General

PI.20.1 - 747-400F CF6-80C2B1F LB FAA was added as Section 20.

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

Section 30 - Controls and Indicators

Flight Deck Lighting

1.30.10-12 - Consolidated redundant information in master document; no technical change.

1.30.11 - Revised for nomenclature consistency; no technical change.

UPPER DECK Crew Service Door

1.30.47 - Revised for nomenclature consistency; no technical change.

Escape Slide, UPPER DECK Crew Service Door

1.30.48 - Revised for nomenclature consistency; no technical change.

Section 40 - Systems Description

Emergency Lighting

1.40.7 - Consolidated redundant information in master document; no technical change.

Section 45 - Systems Description

Emergency Equipment Overview

1.45.1 - Introduction revised for cross-model standardization and clarity.

1.45.1 - Revised bullet for cross model standardization.

Emergency Evacuation Signal System

1.45.1 - No technical change; format only.

Fire Extinguishers

1.45.1 - Paragraph deleted for fleet consistency.

Miscellaneous Emergency Equipment

1.45.2 - Paragraph revised for cross-model standardization.

Passenger Cabin

1.45.3 - Revised for clarity and standardization.

Freighter Supernumerary Area

1.45.3 - Revised for clarity and standardization.

Chapter 2 - Air Systems

Section 30 - Pressurization System Description

Pressurization System Automatic Operation

2.30.2 - Corrected nomenclature to avoid possessive case.

Section 50 - EICAS Messages

EICAS Alert Messages

2.50.1 - Added BLEED HP ENG and BLEED ISLN messages incorrectly omitted when table format was changed.

Chapter 3 - Anti-Ice, Rain

Section 10 - Controls and Indicators

Anti-Ice Indications on EICAS Display

3.10.2 - Moved Anti-Ice Indications on EICAS Display from section 7.10.

Chapter 4 - Automatic Flight

Section 10 - Controls and Indicators

Autopilot Flight Director Roll and Pitch Controls

4.10.7 - Corrected note to reflect system operation in VNAV.

Section 20 - System Description

Autopilot Disengagement

4.20.2 - Deleted autopilot disconnect description, not applicable to the 747-400.

Chapter 5 - Communications

Section 40 - EICAS Messages

Communications EICAS Messages

5.40.1 - Revised wording for consistency; deleted "Alert."

EICAS Alert Messages

5.40.1 - Combined EICAS alert messages into one table for consistency with QRH.

5.40.1 - Revised message logic to standardize wording; replaced "is transmitting/more" with "keyed/longer."

EICAS Memo Messages

5.40.2 - Combined EICAS memo messages into one table for consistency.

Chapter 7 - Engines, APU

Section 10 - Primary Engine Indications

EPR Indications

7.10.4 - Added EPR fluctuation note for consistency with the Flight Crew Training Manual.

EGT Indications

7.10.10 - Anti-ice Indications moved to Chapter 3.

Section 11 - Secondary Engine Indications

Fuel Flow Indications

7.11.5 - No change to airplane information. Publishing data base revision only.

Oil Quantity Indications

7.11.8 - No change to airplane information. Publishing data base revision only.

7.11.8 - Deleted extra period.

Crossbleed Start Indications

7.11.11 - Added reference to a manual start to reflect procedural sequence.

Section 13 - Engine Controls

Section 14 - APU Controls and Indications

APU Indications

7.14.2 - Corrected spelling of Celsius.

Chapter 9 - Flight Controls

Section 10 - Controls and Indicators

Stabilizer Trim Controls

9.10.2 - Changed CUTOUT to a single word to match panel nomenclature.

Secondary Mode Expanded Flap Position Indication

9.10.11 - Added crosshatching to graphic for accuracy.

9.10.11 - Removed "up" and changed "flap" to "flaps" for clarity.

9.10.11 - Added crosshatching for accuracy and clarified amber description.

Alternate Mode Expanded Flap Position Indication

9.10.12 - Changed "flap" to "flaps" for clarity.

Surface Position Indication

9.10.12 - Surface position synoptic displayed on Secondary Engine page.

Flight Control Hydraulic Power Controls

9.10.14 - Revised border on graphic for standardization.

Section 20 - System Description

Elevator Control

9.20.2 - Surface position synoptic displayed on Secondary Engine page.

Stabilizer Trim

9.20.5 - Changed cut out to two words for accuracy when not referencing the switch position.

9.20.5 - Changed CUTOUT to a single word to match panel nomenclature. Changed cut out to two words for accuracy when not referencing switch position.

Stabilizer Control Diagram

9.20.6 - Changed CUTOUT to a single word to match panel nomenclature.

Aileron and Spoiler Roll Control

9.20.7 - Added airspeed for when the outboard ailerons are locked out for clarity.

9.20.7 - Added surface position synoptic displayed on Secondary Engine page paragraph to reflect fleet configuration.

Rudder Control and Trim

9.20.9 - Added surface position synoptic displayed on Secondary Engine page paragraph to reflect fleet configuration.

Rudder Control Diagram

9.20.10 - Corrected hydraulic system number for the lower rudder for accuracy.

Spoilers

9.20.11 - Added surface position synoptic displayed on Secondary Engine page paragraph to reflect fleet configuration.

Section 30 - EICAS Messages

Flight Controls EICAS Messages

9.30.2 - Changed CUTOUT to a single word to match panel nomenclature.

Chapter 10 - Flight Instruments, Displays

Section 10 - Controls and Indicators

Airspeed Displays

10.10.7 - Co located revised CAUTION with maximum maneuvering speed description for clarity.

10.10.7 - Non technical revision of Command Speed description.paragraph.

Reference Speeds

10.10.9-10 - Illustration added to show position of flap/VREF relative to speed tape.

10.10.11 - Revised for clarity.

Attitude Indications

10.10.13 - Corrected typographical error.

Approach Mode

10.10.58,60 - Corrected illustration to reflect north as "0" to reflect airplane configuration.

VOR Mode

10.10.62,64 - Corrected illustration to reflect north as "0" to reflect airplane configuration.

Integrated Standby Flight Display (ISFD)

10.10.88 - Corrected typographical error.

10.10.88 - Editorial, changed "intensity" to "brightness".

Standby Magnetic Compass

10.10.91 - Added to reflect C-5M Magnetic Compass installed.

Section 20 - System Description

Pitot Static System

10.20.8,10 - Added to reflect airplane configuration.

Air Data Computer (ADC) System

10.20.11 - Corrected typographical error.

Section 30 - Primary Flight Displays (PFDs)

Introduction

10.30.1 - Revised terminology to reflect Chapter 15 format.

Section 40 - Navigation Displays

Map Mode

10.40.1 - Corrected typographical error, "position".

Heading

10.40.2 - Removed extraneous space.

ND Symbology

10.40.32 - Deleted reference to color "pink", which is not used for display purposes.

Section 45 - Electronic Flight Bag (EFB)

Display Unit

10.45.2 - Revised to reflect system operation.

Main Menu (Typical)

10.45.7 - Editorial, "in the air" to "in flight".

10.45.7 - Added destination MAP display format for clarity.

Airport Maps (Typical)

10.45.11 - Editorial, changed "in the air" to "in flight".

10.45.13 - Editorial, changed "re-displays" to "displays".

10.45.13 - Editorial, deleted extraneous period.

10.45.13 - Editorial, added period.

Logbook (Typical)

10.45.33 - Editorial revision. Revised logbook home page illustration format.

10.45.36 - Editorial revision. Revised fault locator page illustration format.

Section 50 - EICAS Messages

Flight Instruments Source EICAS Alert Messages

10.50.1 - Corrected Source Select message formats.

Chapter 11 - Flight Management, Navigation

Section 20 - Navigation Systems Description

GPS Data

11.20.1 - Revised for consistency with AFM.

Transponder

11.20.7 - Revised to clarify the use of enhanced transponders and ADS-B.

Section 31 - Flight Management System Operation

Section 40 - FMC Preflight

Route Page 1/X

11.40.18 - Revised to clarify enhanced Mode S transponder operation.

Navigation Radio Page

11.40.30 - Deleted "MLS"; not applicable to 747-400.

Performance Initialization Page

11.40.34 - Revised for clarity.

Section 41 - FMC Takeoff and Climb

Takeoff Phase

11.41.1 - Added, "LNAV and" for consistency with other Boeing model airplanes.

11.41.1 - Activates automatic CDU page change from TAKEOFF REF to VNAV CLB page when flap lever moved to initiate flap retraction.

Section 42 - FMC Cruise

Progress Page 2/2

11.42.35 - Revised; combined two bullets into one; specified, "after all engines shut down".

Progress Page 2/3

11.42.38 - Revised; combined two bullets into one; specified, "after all engines shut down".

Position Report

11.42.42 - Added Position Report page for airplanes not having FANS ATS functionality.

Section 43 - FMC Descent and Approach

Descent Page

11.43.3 - FPA, V/B, and V/S activated.

Arrivals Page - IFR Approaches

11.43.14 - Added NDB and GPS approach information

Chapter 14 - Landing Gear

Section 20 - System Description

Alternate Brake System Diagram

14.20.8 - Corrected color on graphic; no technical change.

Brake Source Selection Diagram

14.20.9 - Corrected color on graphic; no technical change.

Chapter 15 - Warning Systems

Section 10 - Controls and Indicators

Ground Proximity Panel

15.10.11-12 - Corrected nomenclature to avoid possessive case.

Radio Altitude/Barometric Altitude Control

15.10.14 - Corrected nomenclature to avoid possessive case.

Section 20 - System Description

Takeoff Configuration Warnings

15.20.11 - Deleted redundat text; takeoff configuration inhibits are included in FCOM section 15.20 Alerts Inhibited During Takeoff

15.20.11 - Deleted Master Warning/Caution reset switch and the Master Warning lights description because switch and light operation is fully described in Aurals, Master Warning/Caution Switches and Lights, and Ground Proximity Light section.

Landing Configuration Warning

15.20.12 - Corrected CONFIG GEAR condition.

Speedbrake Lever Extend Beyond ARM During Climb

15.20.12 - Added description of thrust lever and speed brake lever positions in flight.

15.20.12 - Corrected message logic description.

Crew Alertness Monitor

15.20.13 - Corrected text for PILOT RESPONSE monitoring.

Altitude Voice Annunciations During Approach

15.20.32 - Corrected nomenclature to avoid possessive case.

GPWS Windshear Alert and PWS

15.20.33 - Corrected effectivity because scan rate is reduce dfor all Rockwell/Collins PWS.

ND Display Alert Inhibits and Automatic Display

15.20.38 - Corrected nomenclature to avoid possessive case.

Section 30 - EICAS Messages

Warning Systems EICAS Messages

15.30.1 - Added description of thrust lever and speed brake lever positions in flight.

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General

The Boeing Company issues Flight Crew Operations Manual Bulletins to provide important information to flight crews prior to the next formal revision of the Flight Crew 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 Flight Crew 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 Flight Crew Operations Manual. The bulletin remains active and should be retained in the manual
- Incorporated (INC) – the bulletin operating information has been incorporated into the Flight Crew 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 Flight Crew 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 Flight Crew Operations Manual or QRH, the included pages should be filed as instructed in the Flight Crew Operations Manual Information section of the bulletin.

Number	Subject	Date	Status
TB1-4 R1	EICAS Advisory Message NO AUTOLAND	November 11, 2002	IE
TB1-14 R2	Engine Bleed Air Shutoff Anomaly	May 1, 2002	INC
TB1-15 R2	Triple Flap Control Unit (FCU) Failure	June 2, 2003	INC
TB1-20 R1	Flight Deck Display Unit Blanking Anomaly	November 21, 2008	IE
TB1-21	Erroneous ATC Message Downlink Anomaly	April 25, 2003	IE
TB1-23 R1	General Electric (GE) CF6-80C2 Engine Flameout Mitigation	January 5, 2009	IE
TB1-24 R1	FMC Performance Predictions Anomaly	April 1, 2006	IE
TB1-26 R1	Potential Sequential Loss of Multiple Hydraulic Systems	October 2, 2008	IE
TB1-27 R1	Landing Gear Configuration Warning Anomaly	November 21, 2008	IE
TB1-28	Honeywell Flight Management Computer Anomaly	October 15, 2007	IE
TB1-29	Hand microphone use with flight deck PC power outlets	August 20, 2008	IE
TB1-30	Flight Deck Display Unit Blanking in 747-400F and 747-400BCF Airplanes	March 16, 2009	IE

Number	Subject	Date	Status

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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-4 R1

Date: November 11, 2002

Document Effectivity: D6-30151-400

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 to add Boeing Service Letter 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

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.

Operator action suggested in Boeing Service Letter 747-SL-22-027 corrects the flight control system anomaly described in this bulletin.

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

This bulletin replaces bulletin TB1-4 dated January 1, 1999. Discard Bulletin TB1-4. Revise the Bulletin Record to show TB1-4 as "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 TB1-4 R1 "In Effect" (IE).

This bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified as recommended in 747-SL-22-027. 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 MC 20-89 Seattle, WA 98124-2207 USA
Fax:	(206) 662-7812
Telex:	32-9430 Station 627
SITA:	SEABO7X

Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-14(R2)

Date: May 1, 2002

Document Effectivity: D6-30151-400

Subject: ENGINE BLEED AIR SHUTOFF ANOMALY

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

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 and PACK 1, PACK 2, and PACK 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 (passenger/combi), 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 (passenger/combi), opening a cabin door 1 and a cabin door 4 or door 5.

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

Operating Instructions

This bulletin does not apply to airplane number 203 and airplanes modified by Boeing Service Bulletin 747-36A2136.

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 PACK 1, 2, 3 non-normal checklist will be restored to its original configuration after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-36A2136.

Administrative Information

This bulletin replaces bulletin TB1-14(R1) dated August 1, 2001. Discard Bulletin TB1-14(R1). Revise the Bulletin Record to show TB1-14(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 TB1-14(R2) “Incorporated” (INC).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-36A2136. 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
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-15 R2

Date: June 2, 2003

Document Effectivity: D6-30151-400

Subject: Triple Flap Control Unit (FCU) Failure

Reason: To inform flight crews of the effects of failure of all three FCUs. Revised to add corrective Service Bulletin information.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-27A2386.

An operator recently experienced in-flight failure of all three FCUs. Engineering investigation has revealed malfunction of a leading edge flap position switch circuit 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.

Incorporation of Service Bulletin 747-27A2386 installs upgraded FCUs to prevent failure of all three FCUs caused by malfunction of a leading edge flap position switch circuit.

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 FLAPS CONTROL checklist will be restored to its original configuration after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-27A2386.

Administrative Information

This bulletin replaces bulletin TB1-15(R1) dated March 15, 2001. Discard Bulletin TB1-15(R1). Revise the Bulletin Record to show TB1-15(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 TB1-15 R2 "Incorporated" (INC).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-27A2386. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-20 R1

IssueDate: November 21, 2008

Airplane Effectivity: All Airplanes

Subject: Flight Deck Display Unit Blanking Anomaly

Reason: To provide flight crews with recommended action in the event all flight deck display units go blank in flight. Revised to add Boeing 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

This bulletin does not apply to airplanes modified by Service Bulletin 747-31-2368.

An operator recently reported two instances of all six flight deck display units blanking in flight. In the first instance, the flight crew elected to land with the display units blank. In the second, the flight crew cycled EFIS/EICAS Interface Unit (EIU) circuit breakers and restored display unit operation. The cause of this anomaly remains under investigation.

In the unlikely event all six display units blank, cycling Left and Center EIU circuit breakers may recover the display units.

For well-documented reasons, Boeing has long discouraged cycling circuit breakers in normal operations. However, in rare, specific cases such as this, cycling circuit breakers has no adverse effect on equipment or airplane operation, and may be necessary to restore system operation.

Operating Instructions

If all six flight deck display units go blank during flight, open Left and Center EIU circuit breakers, labeled EIU L and EIU C at P7-1 panel locations F-9 and F-10 respectively, for at least five seconds. Reset circuit breakers and record the time and flight deck effects in the airplane log.

Administrative Information

This bulletin replaces bulletin TB1-20 dated February 25, 2003. Discard TB1-20. Revise the Bulletin Record to show TB1-20 “Cancelled” (CANC).

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-20 R1 as "In Effect" (IE) .

This bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-31-2368.

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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-21

Date: April 25, 2003

Document Effectivity: D6-30151-400

Subject: Erroneous ATC Message Downlink Anomaly

Reason: To inform flight crews of an ATC datalink anomaly that may result in downlink of erroneous messages to ATC.

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

This bulletin applies to airplanes with the ATC datalink function activated.

Boeing has received operator reports of erroneous messages downlinked to ATC via the FMC ATC datalink function. Erroneous messages were transmitted when the downlink process was initiated from the right CDU.

The anomaly occurs when the left and right FMCs fail to synchronize correctly. When the synchronization fails, the right FMC will miss a change in ATC message status and display incorrect page data. As a result, initiating a message from the right CDU may downlink information different than actually displayed on the right CDU. The most common occurrence of the anomaly results in the left CDU displaying a clearance that has been previously accepted, and the right CDU displaying "REQUEST VOICE CONTACT". The anomaly can be readily detected on the ATC LOG page because left and right CDU data will be different.

Some flight crews have used the flight deck printer in an attempt to determine which CDU information is correct. The printer will respond to the right FMC data, even when a print message is activated on the left CDU. As a result, the printer is an unreliable means to determine which CDU information is correct.

Boeing has confirmed in all cases, information displayed on the left CDU is correct.

Operating Instructions

If both left and right CDUs are selected to the same datalink page and display different data during ATC datalink operations, initiate downlinks from the left CDU only.

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 TB1-21 “In Effect” (IE).

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

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-23 R1

IssueDate: January 5, 2009

Airplane Effectivity: All Airplanes

Subject: General Electric (GE) CF6-80C2 Engine Flameout Mitigation

Reason: To provide flight crews with updated background information on engine flameout events in visible moisture with TAT below 10°C in the vicinity of convective weather systems, and to provide revised operating instructions.

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 and General Electric (GE) are investigating several CF6-80C2 engine flameout events which have occurred on various airplane models since 1991. Investigation of weather, flight data, and pilot reports associated with these events suggest the flameout events have occurred at altitudes with Static Air Temperature (SAT) above 0°C in the vicinity of convective weather systems. Boeing and GE believe ice accumulated aft of the fan during a descent or deceleration may have been shed and ingested into the engine when the thrust levers were subsequently advanced.

Boeing and GE investigations conclude the airplanes most likely encountered ice crystals lifted by convective activity prior to the engine flameout. At very cold temperatures near thunderstorms the airplane can encounter visible moisture made up of high concentrations of small ice crystals. These ice crystals do not cause weather radar returns. Flight crews have reported deviating around strong weather radar returns when the flameout events have occurred. Flight crews have also reported rain on the windshield when the outside air temperature was too cold for liquid water to exist. Boeing attributes this to ice crystals that melt upon impact with the heated windshield, giving the appearance of rain. These types of ice crystals do not accumulate on cold aircraft surfaces.

Flight crew reports and airplane data have shown airplane TAT indication may erroneously indicate 0°C for a period of time just prior to engine flameout. This anomalous behavior is due to ice crystals partially blocking the probe and is not cause for engine flameout, but is a confirmation ice crystals were present.

The Operating Instructions contained in this bulletin use nacelle anti-ice, wing anti-ice and pack high flow operation. Increased bleed air extraction from the engine causes the combustor to operate at a higher fuel-to-air ratio, which reduces the probability of flameout. In some engine flameout events, nacelle anti-ice was already on. Boeing and GE understand that the Operating Instructions contained in this bulletin may not prevent all flameout events. However, increased engine bleed air extraction does provide a large increase in the margin to flameout.

These engine flameout events typically occur when the airplane is leveling off at an intermediate altitude. ATC permitting, make a continuous descent at idle thrust, which decreases exposure time to the ice crystal condition and potential engine flameout.

If an engine flameout occurs, the Electronic Engine Control (EEC) attempts to relight the engine when it detects N2 below 50% or rapid decrease in N2. Engines accelerate to idle very slowly at high altitudes. In some of these events, it has taken 120 seconds or more to reach commanded thrust levels. This may be incorrectly interpreted by the flight crew as an engine that is still flamed out instead of an engine already in the process of relighting. If N2 is steadily increasing and EGT remains within limits, the start is progressing normally. In all events investigated, affected engines successfully started, including some outside the in-flight start envelope. If N2 is steadily increasing and EGT remains within limits following a single engine flameout, the flight crew need not accomplish the ENG FAIL followed by the ENGINE IN-FLIGHT START checklist. The MULTIPLE ENGINE FLAMEOUT/STALL checklist should be accomplished for multiple engine flameout events.

Use of wing anti-ice at altitudes above 22,000 feet has not been included in the operating instructions to ensure no adverse impact on airplane systems that utilize engine bleed air.

Entering the TAI/ON ALT on the DESCENT FORECAST page adjusts the VNAV path calculation for approach idle conditions with nacelle anti-ice on.

Operating Instructions

When TAT is at or below 10°C in visible moisture with engine thrust reduced for a descent or a speed reduction even with SAT less than -40°C:

CAUTION: Do not operate nacelle or wing anti-ice when TAT is above 10°C

PACK HIGH FLOW switch ....ON

NACELLE ANTI-ICE switches/selectors ....ON

[Increases bleed-air extraction to improve engine flameout margin.]

At or below 22,000 feet:

WING ANTI-ICE switch/selector ....ON

[Increases bleed-air extraction to improve engine flameout margin.]

During flight in Instrument Meteorological Conditions (IMC), avoid flying directly above significant amber or red depicted map weather radar regions. Use of the weather radar gain and tilt functions ar recommended to assess weather radar return reflectivity.

During airplane descent and ATC permitting, attempt a continuous descent at idle thrust to decrease exposure to ice crystal conditions.

Nacelle and wing anti-ice may be selected OFF (or AUTO, as installed) when the conditions described above no longer exist and are not required for existing flight conditions.

Administrative Information

This bulletin replaces bulletin TB1-23 dated January 14, 2005. Discard TB1-23. Revise the Bulletin Record to show TB1-23 “Cancelled” (CANC).

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-23 R1 as "In Effect" (IE) .

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

CS3 3484

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-24 R1
Date: April 1, 2006

Document Effectivity: D6-30151-400

Subject: FMC Performance Predictions Anomaly

Reason: To inform flight crews of an FMC performance predictions anomaly.
Revised to correct a typographical error.

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 confirmed operator reports of erroneous performance predictions following execution of the ABEAM PTS function on the FMC LEGS Page. When OAT values have been previously entered in the ALT/OAT field at line-select key 5R on a waypoint WIND Page and the ABEAM PTS function is subsequently selected after a "direct-to" flight plan modification, the OAT value on the WIND Page erroneously changes to 0-degrees. After execution, fuel predictions are erroneously recalculated based upon 0-degrees instead of the previously-entered value for the respective cruise altitude. Operators have reported display of the INSUFFICIENT FUEL alert level scratch pad message with the fuel prediction values being much lower than originally planned. Additionally, there are no flight deck annunciations or alerts to indicate an OAT value on the WIND Page has erroneously changed.

Operating Instructions

Following selection and prior to executing the ABEAM PTS function, verify the OAT value on the respective WIND Page. If necessary, enter the airplane altitude and the indicated Static Air Temperature (SAT) from PROGRESS Page 2 into the ALT/OAT field for the next route waypoint. This OAT entry will propagate to all down-track waypoints. Following entry of the SAT value into the ALT/OAT field and execution of the route modification, FMC fuel predictions should be near those obtained from the flight plan.

Administrative Information

This bulletin replaces bulletin TB1-24 dated January 6, 2006. Discard Bulletin TB1-24. Revise the Bulletin Record to show TB1-24 "Cancelled" (CANC).

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-24 R1 "In Effect" (IE).

The corrective action for the anomaly described in the bulletin is still under investigation. This bulletin will be revised to include Service Bulletin information when available.

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-26 R1

IssueDate: October 2, 2008

Airplane Effectivity: All Airplanes

Subject: Potential Sequential Loss of Multiple Hydraulic Systems

Reason: This is a reissue of TB1-26, dated October 2, 2006. The purpose of this reissue is to remind flight crews that the non-normal checklists associated with the careted EICAS messages HYD QTY LOW 4 and >HYD QTY LOW 1 contain procedural steps and these checklists should be done when needed.

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

Two operators have reported loss of fluid from multiple hydraulic systems. The leaks sequentially affected system 4, then 1, then 2, then the brake accumulator.

Boeing has determined the condition is caused by an unannunciated failure preventing a brake metering valve from returning to the null position, combined with a hydraulic leak in the brake system downstream of the antiskid shuttle valve. The brake leak rate must be below 0.1 gallons per minute or the hydraulic brake fuses will set and stop the fluid loss. Each hydraulic system has enough fluid to last at least 35 minutes before failure once the >HYD QTY LOW message is shown.

Hydraulic system 3 is not associated with the brake system and is not affected by this failure combination. Additionally, if the hydraulic fluid loss does not originate with hydraulic system 4, the sequential failure of multiple hydraulic systems is very unlikely to occur.

Once system pressure is removed, the leak may automatically shift to the next hydraulic system. In the revised checklists, turning off the hydraulic pumps of the affected system, and depressurizing the system(s) at quantity low, retains the remaining fluid in those systems for configuring the airplane during approach, and for braking during landing rollout.

Operating Instructions

If the >HYD QTY LOW 4 or >HYD QTY LOW 1 message is shown in flight, do the non-normal checklists.

The current guidance in the QRH for careted messages states “Acaret symbol > precedes all EICAS alert messages where the associated checklist is informational, has no procedural steps, or the action is obvious (such as Overspeed). The checklist titles also have the caret symbol to agree with the EICAS alert message. The flight crew does not need to refer to the checklists for EICAS alert messages preceded with caret symbols.” However, the new checklists for >HYD QTY LOW 4 and >HYD QTY LOW 1 are included in the QRH for the careted messages and flight crews are required to do the appropriate checklist steps when needed.

If the HYD PRESS SYS 4 caution message is shown in addition to the >HYD QTY LOW 4 advisory message, do the HYD PRESS SYS 4 checklist.

Flight Crew Operations Manual Information

The caret will be removed from the >HYD QTY LOW 4 and >HYD QTY LOW 1 messages during the next available IDS software update, currently scheduled for release in November 2008.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-26 R1 as "In Effect" (IE) .

This bulletin will be cancelled after the IDS software has been released and Boeing is notified that all affected airplanes in your fleet have the updated IDS software installed.

CS3 3717

Flight Crew Operations Manual Bulletin
for
The Boeing Company

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

Number: TB1-27 R1
IssueDate: November 21, 2008

Airplane Effectivity: All Airplanes

Subject: Landing Gear Configuration Warning Anomaly

Reason: To inform flight crews the landing configuration gear warning system may not provide an alert to the flight crew when flaps are set at 20 degrees or less for landing. Revised to add Boeing 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

This bulletin does not apply to airplanes modified by Service Bulletin 747-31-2410.

The Modular Avionics and Warning Electronics Assembly (MAWEA) has exhibited an anomaly during the flight test program. While the MAWEA consistently provides the required landing gear configuration warnings at the normal landing flap settings of 25 or 30 degrees, flight testing has determined with flaps set at 20 degrees, landing gear up, radio altitude (RA) less than 800 feet, and one or more thrust lever resolver angle (TRA) less than 55 degrees, the landing gear configuration warning (EICAS warning message CONFIG GEAR, siren and master warning light) is annunciated intermittently. As a result, flight crews may not receive the gear warning under all required conditions.

To ensure the “TOO LOW GEAR” GPWS voice annunciation is available as a backup for the CONFIG GEAR warning message, the AFM is being revised to add the following requirement: “Mode 4 of the GPWS must be determined to be operational before takeoff by verifying that a GND PROX SYS status message is not displayed on EICAS before engine start, and a GND PROX SYS advisory message is not displayed on EICAS after engine start and before takeoff.” The AFM will also be revised to add a new Flaps Drive non-normal procedure.

Even though landing with flaps 20 or above is unlikely, it is possible a flaps 20 or less landing may be required under certain failure conditions of the flap drive system. Accordingly, a CAUTION is being added to the FLAPS DRIVE non-normal checklist to advise flight crews of the anomaly described in this bulletin.

Operating Instructions

Comply with the AFM GPWS mode 4 requirements described above.

If the EICAS caution message FLAPS DRIVE displays, accomplish the FLAPS DRIVE non-normal checklist.

Administrative Information

This bulletin replaces bulletin TB1-27 dated October 1, 2007. Discard TB1-27. Revise the Bulletin Record to show TB1-27 “Cancelled” (CANC).

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-27 R1 as "In Effect" (IE) .

This bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-31-2410.

CS3 3870

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-28

IssueDate: October 15, 2007

Airplane Effectivity: All Airplanes

Subject: Honeywell Flight Management Computer Anomaly

Reason: To inform flight crews of a Honeywell FMC anomaly that incorrectly deletes a speed constraint.

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 confirmed operator reports of a Honeywell FMC anomaly that incorrectly deletes a speed constraint. Some SIDs are designed to limit turn radius to maintain clearance with other traffic or restricted airspace. Some of these procedures also have an AT-OR-ABOVE altitude restriction inconjunction with the speed constraint. Typically, the airplane will be required to limit speed until passing the respective waypoint as well as climb above the altitude constraint. In these procedures, VNAV will incorrectly delete the speed constraint prior to reaching the waypoint if the altitude constraint has been satisfied. When this happens, VNAV will command speed to accelerate to ECON speed (or SEL speed) prior to reaching the constrained waypoint. This anomaly exists on all Boeing 747 / 757 / 767 / 777 airplanes equipped with the Honeywell FMC.

Honeywell is aware of this anomaly and has planned changes for the 747-8.

Operating Instructions

To prevent exceeding a speed restriction when accompanied by an AT-OR-ABOVE altitude constraint, use speed intervention (enter speed constraint in the MCP Speed Window) until the constrained waypoint is sequenced. After passing the waypoint, select VNAV as desired.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-28 as "In Effect" (IE) .

This bulletin will be incorporated in a future revision of your Flight Crew Operations Manual.

CS3 3944

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-29

IssueDate: August 20, 2008

Airplane Effectivity: 747 airplanes with PC power installed in the flight deck.

Subject: Hand microphone use with flight deck PC power outlets

Reason: To inform flight crews of a new restriction on using the flight deck PC power outlets when the hand microphone is used.

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 customer complaints of interference when using hand held microphones both on the ground and in flight. Investigation has shown interference may be caused by items plugged into the PC power outlets on the flight deck. Any item plugged into a PC power outlet, whether turned on or not, can cause interference. AC 91-21.1B prohibits the use of items that cause interference with communications.

Boeing is issuing placards that state: “WHEN USING HAND MIC REMOVE PWR CORD FROM OUTLETS”.

Operating Instructions

Remove any power cords from all flight deck PC power outlets before using a hand microphone.

Administrative Information

Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-29 as "In Effect" (IE) .

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

CS3 4131

BOEING

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: TB1-30

IssueDate: March 16, 2009

Airplane Effectivity: 203

Subject: Flight Deck Display Unit Blanking in 747-400F and 747-400BCF Airplanes

Reason: To inform flight crews of a method to reduce the risk of display unit blanking.

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 multiple reports of display unit blanking or blurring on 747-400F and 747-400BCF airplanes. Reports have ranged from a single display unit blurring to a recent BCF event where all 6 primary display units blanked during flight.

Reports indicate that air conditioning system faults, some operations in warm humid environments, or both, may result in one or more primary display units blanking or blurring. The failures are due to ice, water, moisture, or condensation entering the display units. This can be due to one or more of the following factors:

1. water separator failure
2. pack temperature sensor drift
3. pack temperature transients in warm humid environments, particularly in sensitive display units

Boeing is working on hardware and software fixes for all three factors.

The third factor - pack temperature transients in warm humid environments, particularly in sensitive display units - can be minimized by the flight crews. Some display units, often older units, ar more sensitive to this problem. If the LOWER LOBE CARGO COND AIR FLOW RATE selector is in AFT LOW, AFT HIGH, or BOTH LOW, turn the AFT CARGO HT switch off just before descending into warm humid environments. The condensation produced inside the displays is caused by the interaction of the Aft Cargo Heat System with aft cargo conditioned air. Therefore, the objective is to only operate one of these during this phase of flight. Since this action is taken just before descending into warmer air, floor freezing in the aft cargo compartment with aft cargo heat off should not be a problem.

Passenger airplane display units are not affected because of air conditioning system differences.

Operating Instructions

If the LOWER LOBE CARGO COND AIR FLOW RATE selector is in AFT LOW, AFT HIGH or BOTH LOW, turn the AFT CARGO HT switch off just before descending into warm humid environments.

Administrative Information

This condition is under investigation. This bulletin will remain in effect until further notice. Insert this bulletin behind the Bulletin Record page in Volume 1 of your Flight Crew Operations Manual. Amend the Bulletin Record to show bulletin TB1-30 as "In Effect" (IE) .

CS3 4244

Limitations — Chapter L

Table of Contents — Section 0

General

This chapter contains AFM limitations and Boeing recommended non-AFM operating limitations. Limitations that are obvious, shown on displays or placards, or incorporated within an operating procedure are not contained in this chapter.

Note: Information shown in this chapter is representative of typical limitations applicable to the 747-400 airplane and may not apply to airplanes in an operator's fleet. Refer to the FAA approved AFM to determine operating limitations applicable to specific airplanes.

Airplane General

Operational Limitations

Runway slope	+/- 2%	
Maximum Takeoff and Landing Tailwind Component	10 knots (405, 570)	15 knots (109)
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	

Non–AFM Operational Information

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

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

Do not operate HF radios during refueling operations.

Do not operate the weather radar in a hangar or within 50 feet of any personnel or a fuel spill.

Note: The hangar and personnel restrictions do not apply to the weather radar test mode.

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

109

Weights	Kilograms
Maximum Taxi Weight	395,986
Maximum Takeoff Weight	394,625
Maximum Landing Weight	285,763
Maximum Zero Fuel Weight	244,939

405

Weights	Kilograms
Maximum Taxi Weight	395,986
Maximum Takeoff Weight	394,625
Maximum Landing Weight	295,742
Maximum Zero Fuel Weight	276,691

570

Weights	Pounds
Maximum Taxi Weight	878,000
Maximum Takeoff Weight	875,000
Maximum Landing Weight	652,000
Maximum Zero Fuel Weight	610,000

Door Mounted Power Assists and Escape Slides

109

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

570

The upper deck escape slide must be in the forward locked position during taxi, takeoff, and landing whenever the upper deck cabin is occupied.

405

The emergency evacuation slide system must be in the AUTOMATIC mode, and engagement of each escape slide pack extractor must be verified by a check that the knob is visible in the AUTOMATIC viewing port prior to taxi, takeoff and landing whenever persons occupy the upper deck cabin.

Flight Deck Security Door

109

Verify that an operational check of the Flight Deck Access System has been accomplished according to approved procedures once each flight day.

Main Deck Occupancy

405

Occupancy of the main deck cargo area is prohibited during taxi, takeoff, landing and flight.

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

AFDS

Use of aileron trim with autopilot engaged is prohibited.

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.

Automatic Landing

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

Headwind	25 knots	
Tailwind	10 knots (405, 570)	15 knots (109)
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

109

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

ACARS (As installed)

The ACARS is limited to the transmission and receipt of messages which will not create an unsafe condition if the message is improperly received, such as the following conditions:

- the message or parts of the message are delayed or not received,
- the message is delivered to the wrong recipient, or
- the message content may be frequently corrupted.

However, Pre-Departure Clearance, Digital-Automatic Terminal Information Service, Oceanic Clearances, Weight and Balance, and Takeoff Data messages can be transmitted and received over ACARS if they are verified per approved operational procedures.

Air Traffic Control Datalink

405, 570

ATC clearance data received through the FMC which can only be viewed on the flight deck printer must be independently verified with the originating group station.

Engines, APU

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

Engine Oil System

109, 405

Oil temperature must be greater than 50 degrees C before advancing thrust levers to takeoff power.

Engine Fuel System

109, 405

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

570

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

109, 405

The maximum tank fuel temperature for Jet B or JP-4 is 43°C (110°F).

570

In-flight tank fuel temperature must be maintained at least 3°C above the fuel freezing point of the fuel being used. The use of Fuel System Icing Inhibitor additives does not change the minimum fuel tank temperature limit.

109, 405

Tank fuel temperature prior to takeoff must not be less than -43°C (-46°F) or 3°C above the fuel freezing point temperature, whichever is higher. In-flight tank fuel temperature must be maintained at least 3°C above the fuel freezing point of the fuel being used. The use of Fuel System Icing Inhibitor additives does not change the minimum fuel tank temperature limit.

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.

Flight Management, Navigation

QFE Selection

109

QFE operations are prohibited.

405, 570

A QFE altitude reference for the PFDs must be selected on the CDU Approach Reference page whenever QFE is used instead of QNH.

VNAV Selection

Non-AFM Operational Information

If leveling off within 2000 feet after changing altimeter setting from QNE to QNH, or QNH to QNE, do not use VNAV to execute the level-off if QNH is less than 29.70 in/1006 hPa. After the level-off is complete, VNAV may be re-engaged.

Airplane Structure

Flight Controls

Avoid rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw (e.g. large side slip angles) as they may result in structural failure at any speed, including below V_A.

Flap Operation

Do not extend flaps above 20,000 feet.

Non-AFM Operational Information

405
Use of speedbrakes in flight with flaps extended past 10 is not recommended.

109, 570
Use of speedbrakes in flight with flaps extended past 20 is not recommended.

Flight Instruments, Displays

(SB changes 570 ; installs electronic flight bag)

Electronic Flight Bag (EFB)

Do not use the Airport Map display as a primary navigation reference.

The EFB portable keyboard and attaching cable must be stowed during takeoff and landing.

Warning Systems

GPWS - Look-Ahead Terrain Alerting

405, 570

Do not use the terrain display for navigation.

The use of look-ahead terrain alerting and terrain display functions is prohibited within 15 nm of takeoff, approach or landing at an airport or runway not contained in the GPWS terrain database. Refer to Honeywell Document 060-4267-000 for airports and runways contained in the installed GPWS terrain database.

TCAS

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

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Normal Procedures — Chapter NP

Table of Contents — Section 0

Normal Procedures — Chapter NP
Introduction — Section 11

General

This chapter gives:

- an introduction to the normal procedures philosophy and assumptions
- step by step normal procedures

Normal Procedures Philosophy and Assumptions

Normal procedures verify for each phase of flight that:

- the airplane condition is satisfactory
- the flight deck configuration is correct

Normal procedures are done on each flight. Refer to the Supplementary Procedures (SP) chapter for procedures that are done as needed, for example the adverse weather procedures.

Normal procedures are used by a trained flight crew and assume:

- all systems operate normally
- the full use of all automated features (LNAV, VNAV, autoland, autopilot, and autothrottle)

Normal procedures also assume coordination with the ground crew before:

- hydraulic system pressurization, or
- flight control surface movement, or
- airplane movement

Normal procedures do not include steps for flight deck lighting and crew comfort items.

Normal procedures are done by memory and scan flow. The panel illustration in this section shows the scan flow. The scan flow sequence may be changed as needed.

Configuration Check

It is the crew member’s responsibility to verify correct system response. Before engine start, use lights or indications to verify each system's condition or configuration.

If there is an incorrect configuration or response:

- verify that the system controls are set correctly

- check the respective circuit breaker as needed. Maintenance must first determine that it is safe to reset a tripped circuit breaker on the ground
- test the respective system light as needed

Before engine start, review the EICAS alert messages and status display. If there are unexpected messages:

- check the Dispatch Deviations Guide (DDG) or the operator equivalent to decide if the condition has a dispatch effect
- decide if maintenance is needed

If, during or after engine start, there is an alert message:

- do the respective non-normal checklist (NNC)
- on the ground, check the DDG or the operator equivalent

After engine start, EICAS alert messages are the primary means of alerting the flight crew to non-normal conditions or incorrect configurations.

After engine start, there is no need to check status messages. Any message that has an adverse affect on safe continuation of the flight appears as an EICAS alert message.

Crew Duties

Preflight and postflight crew duties are divided between the captain and first officer. Phase of flight duties are divided between the Pilot Flying (PF) and the Pilot Monitoring (PM).

Each crewmember is responsible for moving the controls and switches in their area of responsiblity:

- The phase of flight areas of responsibility for both normal and non-normal procedures are shown in the Area of Responsibility illustrations in this section. Typical panel locations are shown.
- The preflight and postflight areas of responsibility are defined by the “Preflight Procedure - Captain” and “Preflight Procedure - First Officer”.

The captain may direct actions outside of the crewmember’s area of responsibility.

The general PF phase of flight responsibilities are:

- taxiing
- flight path and airspeed control
- airplane configuration
- navigation

The general PM phase of flight responsibilities are:

- checklist reading
- communications
- tasks asked for by the PF
- monitoring taxiing, flight path, airspeed, airplane configuration, and navigation

PF and PM duties may change during a flight. For example, the captain could be the PF during taxi but be the PM during takeoff through landing.

Normal procedures show who does a step by crew position (C, F/O, PF, or PM):

- in the procedure title, or
- in the far right column, or
- in the column heading of a table

The mode control panel is the PF’s responsibility. When flying manually, the PF directs the PM to make the changes on the mode control panel.

The captain is the final authority for all tasks directed and done.

Control Display Unit (CDU) Procedures

Before taxi, the captain or first officer may make CDU entries. The other pilot must verify the entries.

Make CDU entries before taxi or when stopped, when possible. If CDU entries must be made during taxi, the PM makes the entries. The PF must verify the entries before they are executed.

In flight, the PM usually makes the CDU entries. The PF may also make simple, CDU entries when the workload allows. The pilot making the entries executes the change only after the other pilot verifies the entries.

During high workload times, for example departure or arrival, try to reduce the need for CDU entries. Do this by using the MCP heading, altitude, and speed control modes. The MCP can be easier to use than entering complex route modifications into the CDU.

Autopilot Flight Director System (AFDS) Procedures

The crew must always monitor:

- airplane course
- vertical path
- speed

When selecting a value on the MCP, verify that the respective value changes on the flight instruments, as applicable.

The crew must verify manually selected or automatic AFDS changes. Use the FMA to verify mode changes for the:

- autopilot
- flight director
- autothrottle

During LNAV and VNAV operations, verify all changes to the airplane's:

- course
- vertical path
- thrust
- speed

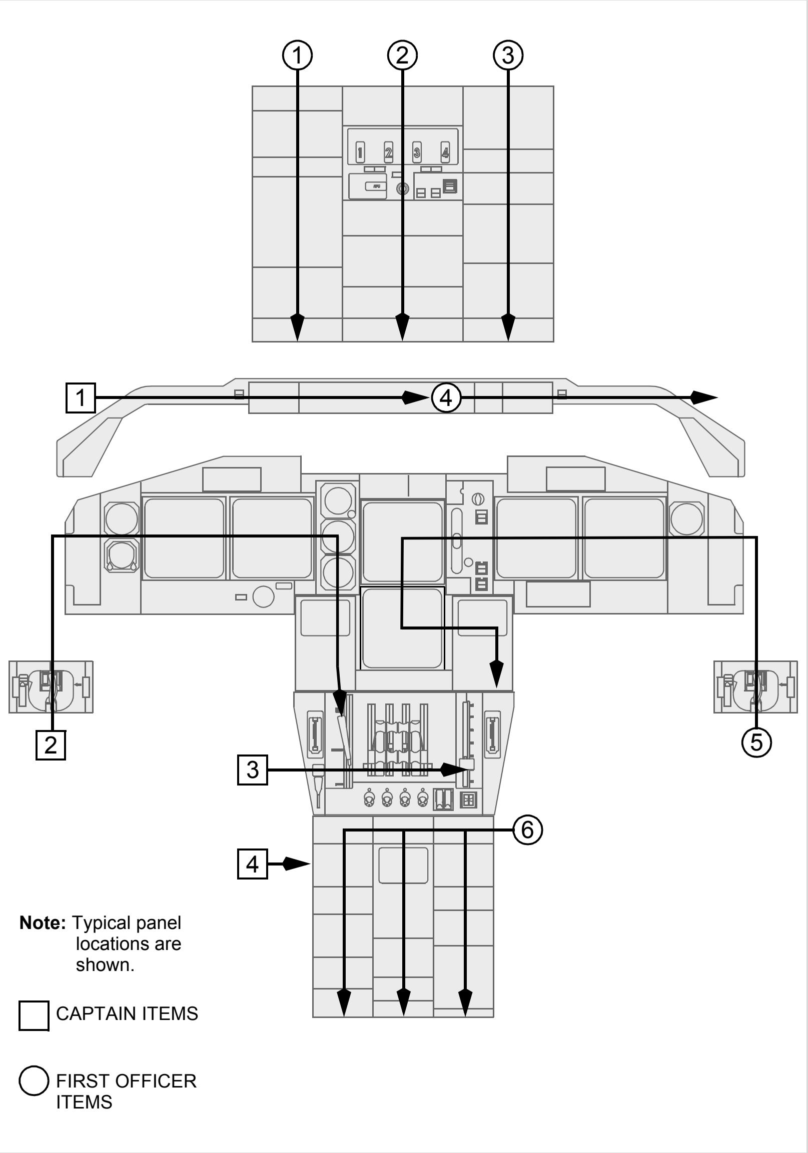
Announcing changes on the FMA and thrust mode display when they occur is a good CRM practice.

Scan Flow and Areas of Responsibility

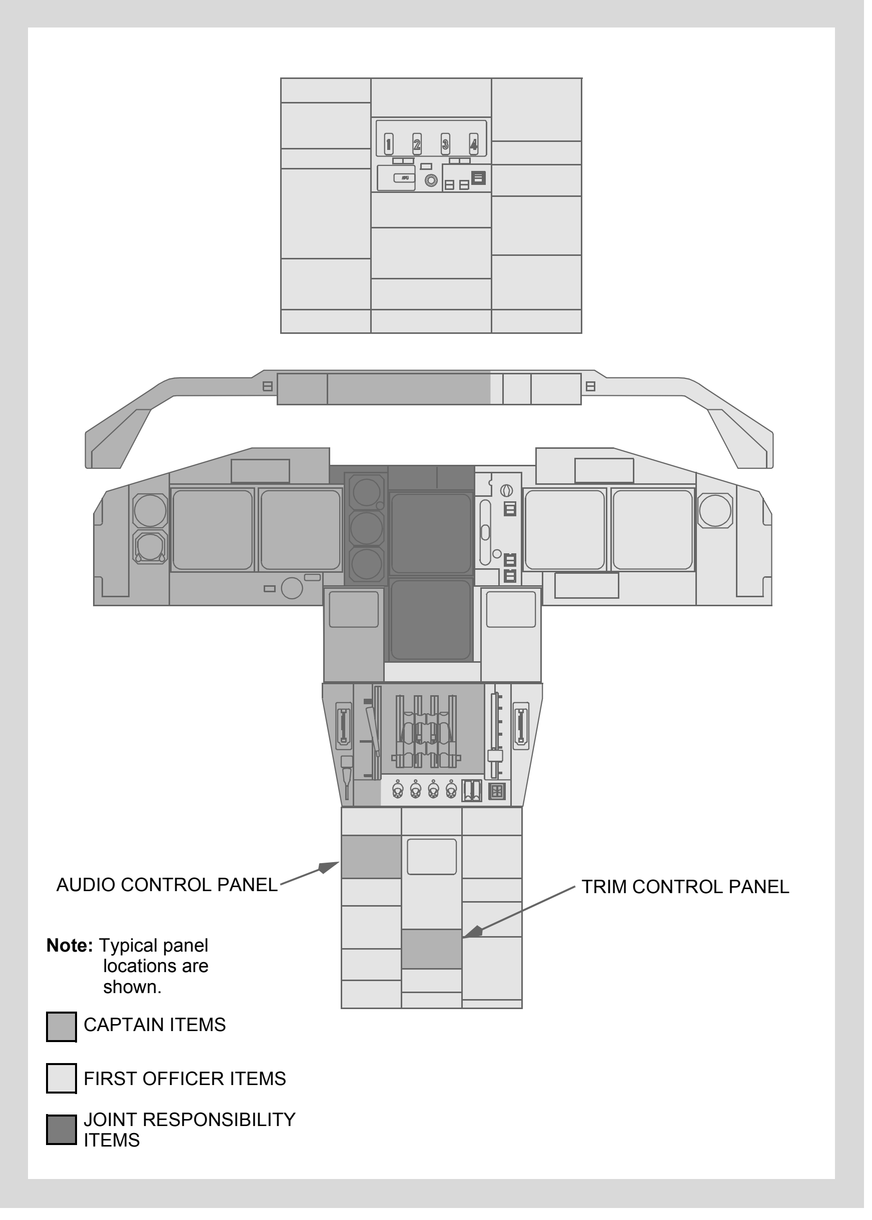
The scan flow and areas of responsibility diagrams shown below are representative and may not match the configuration(s) of your airplanes.

The scan flow diagram provides general guidance on the order each flight crew member should follow when doing the preflight and postflight procedures. Specific guidance on the items to be checked are detailed in the Normal Procedures. For example, preflight procedure details are in the Preflight Procedure - Captain, and Preflight Procedure - First Officer.

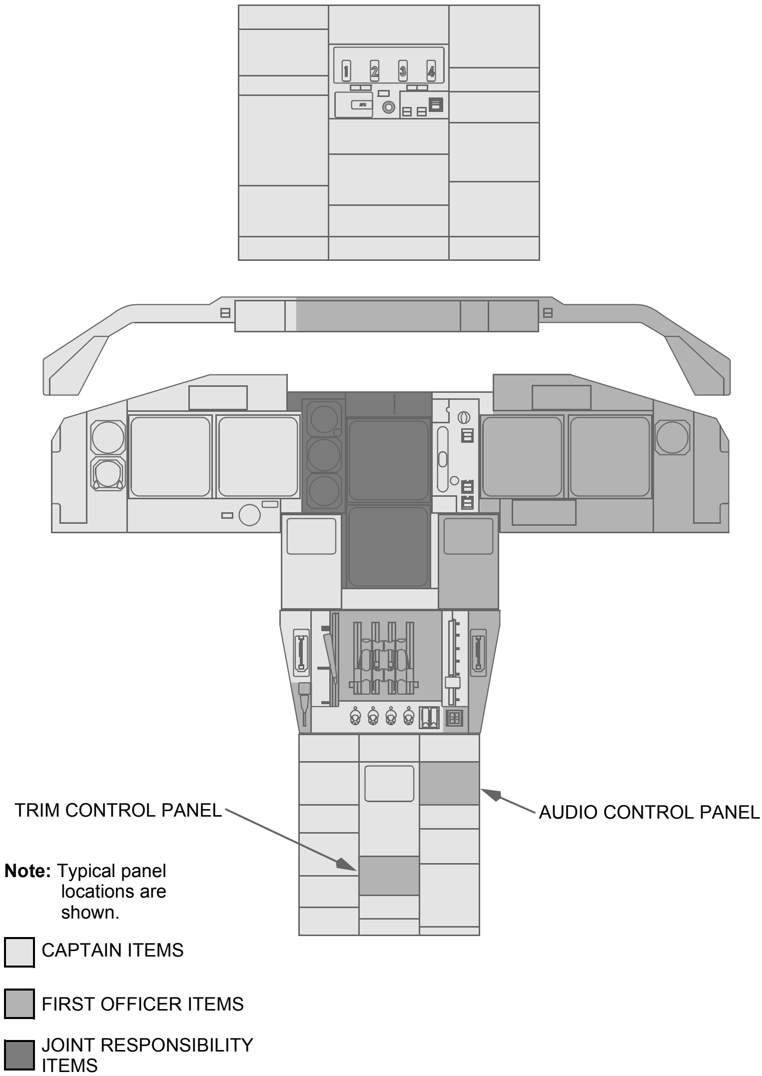
Preflight and Postflight Scan Flow



Areas of Responsibility - Captain as Pilot Flying or Taxiing



Areas of Responsibility - First Officer as Pilot Flying or Taxiing



Intentionally
Blank

Preliminary Preflight Procedure - Captain or First Officer

The Preliminary Preflight Procedure assumes that the Electrical Power Up supplementary procedure is complete.

IRS mode selectors ....OFF, then NAV

The UNABLE RNP message may show until IRS alignment is complete.

405
VOICE RECORDER switch ....As needed

STATUS display .... Check

Verify that only expected messages are shown.

Verify that the following are sufficient for flight:
- oxygen pressure
- hydraulic quantity
- engine oil quantity

Do the remaining actions after a crew change or maintenance action.

Maintenance documents .... Check

109
FLIGHT DECK ACCESS SYSTEM switch ....NORM

Circuit breakers .... Check

Emergency equipment .... Check

Fire extinguisher – Checked and stowed

Crash axe – Stowed

Emergency escape devices - Stowed

Other needed equipment - Checked and stowed

109
Hatch .... Closed and locked

Smoke evacuation handle .... Check

Overhead maintenance panel......................................Guards closed

The split system breaker OPEN light may be illuminated.

Verify that all other lights are extinguished.

570
APU START SOURCE switch .... TR

405, 570
LOWER LOBE CARGO CONDITIONED
AIR FLOW RATE selector .... As needed

Circuit Breakers .... Check

Parking brake .... As needed

Set the parking brake if brake wear will be checked during the exterior inspection.

CDU Preflight Procedure - Captain and First Officer

Start the CDU Preflight Procedure anytime after the Preliminary Preflight Procedure. The Initial Data and Navigation Data entries must be complete before the flight instrument check during the Preflight Procedure. The Performance Data entries must be complete before the Before Start Checklist.

The captain or first officer may make CDU entries. The other pilot must verify the entries.

Enter data in all the boxed items on the following CDU pages.

Enter data in the dashed items or modify small font items that are listed in this procedure. Enter or modify other items at pilot's discretion.

Failure to enter enroute winds can result in flight plan time and fuel burn errors.

Initial data .... Set

IDENT page:

Verify that the MODEL is correct.

Verify that the ENGINES are correct.

Verify that the navigation database ACTIVE date range is current.

POS INIT page:

Verify that the time is correct.

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

Navigation data ....Set

RTE page:

Enter the route.

570
Enter the FLIGHT NUMBER.

Activate and execute the route.

DEPARTURES page:

Select the runway and departure routing.

Execute the runway and departure routing.

Verify that the route is correct on the RTE pages. Check the LEGS pages as needed to ensure compliance with the flight plan.

Verify or enter correct RNP for departure.

NAV RADIO page:

Tune the navigation radios, as needed.

Performance data ....Set

PERF INIT page:

CAUTION: Do not enter the ZFW into the GR WT boxes. The FMC will calculate performance data with significant errors.

Enter the ZFW.

Verify that the FUEL on the CDU, the dispatch papers, and EICAS agree.

Verify that the fuel is sufficient for flight.

Verify that the GR WT on the CDU and the dispatch papers agree.

THRUST LIM page:

Select an assumed temperature, or a fixed derate takeoff, or both as needed.

Select a full or a derated climb thrust as needed.

TAKEOFF REF page:

109, 570
CG - Enter

405
CG - Select

Select or enter the takeoff V speeds.

Verify that the takeoff V speeds on both CDUs agree. If the speeds disagree, re-enter the takeoff V speeds.

Note: If any changes are made to the CDU entries, verify that the takeoff V speeds on both CDUs and PFDs agree. If the speeds disagree, re-enter the takeoff V speeds.

Exterior Inspection

Before each flight the captain, first officer, or maintenance crew must verify that the airplane is satisfactory for flight.

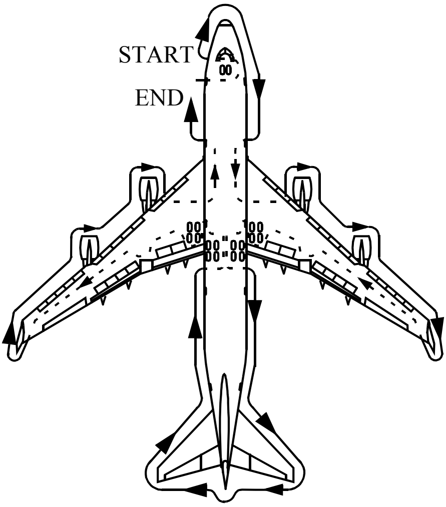
Items at each location may be checked in any sequence.

Use the detailed inspection route below to check that:

- the surfaces and structures are clear, not damaged, not missing parts and there are no fluid leaks
- the tires are not too worn, not damaged, and there is no tread separation
- the gear struts are not fully compressed
- the engine inlets and tailpipes are clear, the access panels are secured, the exterior is not damaged, and the reversers are stowed
- the doors and access panels that are not in use are latched
- the probes, vents, and static ports are clear and not damaged
- the skin area adjacent to the pitot probes and static ports is not wrinkled
- the antennas are not damaged
- the light lenses are clean and not damaged

For cold weather operations see the Supplementary Procedures.

Inspection Route



Left Forward Fuselage

Probes, sensors, ports, vents, and drains (as applicable) .... Check

Nose

Radome .... Check

Diverter strips – Secure

Windshield wipers .... Against stops

TAT probes .... Check

Nose Wheel Well

Tires and wheels .... Check

Gear strut and doors .... Check

Exterior lights .... Check

Nose wheel steering assembly ....Checked

Nose wheel steering lockout pin .... As needed

Gear pins .... As needed

Main electrical and electronic (E/E) compartment door ....Secure

Right Forward Fuselage

Probes, sensors, ports, vents, and drains (as applicable)................Check

Doors and access panels (not in use)... Latched

Negative pressure relief doors ....Closed

Oxygen pressure relief green disc .... In place

Right Wing Root, Pack, and Lower Fuselage

Probes, sensors, ports, vents, and drains (as applicable)................Check

Exterior lights ....Check

Pack inlet and pneumatic access doors .... Secure

Fuel measuring sticks .... Flush and secure

Leading edge flaps ....Check

Number 3 and 4 Engines

Access panels .... Latched

Probes, sensors, ports, vents, and drains (as applicable)................Check

Fan blades, probes, and spinner ....Check

Strut midspar fuse pins alignment stripes ....Check

A minimum of 1/2 of each stripe must align. A stripe is on the inboard and outboard side of each strut.

Thrust reversers .... Stowed

Exhaust area and tailcone ....Check

Fuel measuring sticks .... Flush and secure

Right Wing and Leading Edge

Access panels .... Latched

Leading edge flaps ....Check

Fuel measuring sticks .... Flush and secure

Wing Surfaces ....Check

Fuel tank vent .... Check

Right Wing Tip and Trailing Edge

Navigation and strobe lights .... Check

Static discharge wicks .... Check

Fuel jettison nozzle .... Check

Ailerons and trailing edge flaps .... Check

Right Wing and Body Gear

Tires, brakes and wheels .... Check

Verify that the wheel chocks are in place as needed.

If the parking brake is set, the brake wear indicator pins must extend out of the guides.

Gear strut, actuators, and doors .... Check

Hydraulic lines .... Secure

Gear pins .... As needed

Wheel wells .... Check

APU FIRE CONTROL handle .... In

Right Aft Fuselage

Doors and access panels (not in use) .... Latched

Negative pressure relief door .... Closed

Probes, sensors, ports, vents, and drains (as applicable) .... Check

Outflow valve .... Check

Tail

Vertical stabilizer and rudder .... Check

Static ports .... Check

Horizontal stabilizer and elevator .... Check

109

Fuel measuring sticks .... Flush and secure

109

Fuel tank vent .... Check

APU exhaust outlet .... Check

Static discharge wicks .... Check

Left Aft Fuselage

Doors and access panels (not in use).. Latched

Probes, sensors, ports, vents, and drains (as applicable)................ Check

Outflow valve .... Check

Left Body and Wing Gear

Tires, brakes and wheels .... Check

Verify that the wheel chocks are in place as needed.

If parking brake is set, the brake wear indicator pins must extend out of the guides.

Gear strut, actuators, and doors .... Check

Hydraulic lines .... Secure, no leaks

Gear pins .... Verify removed

Wheel wells .... Check

Left Wing Tip and Trailing Edge

Ailerons and trailing edge flaps .... Check

Fuel jettison nozzle .... Check

Static discharge wicks .... Check

Navigation and strobe lights .... Check

Left Wing and Leading Edge

Wing Surfaces .... Check

Fuel tank vent .... Check

Fuel measuring sticks .... Flush and secure

Leading edge flaps .... Check

Access panels ....Latched

Number 1 and 2 Engines

Exhaust area and tailcone .... Check

Probes, sensors, ports, vents, and drains (as applicable) .... Check

Thrust reversers ....Stowed

Strut midspar fuse pins alignment stripes .... Check

A minimum of 1/2 of each stripe must align. A stripe is on the inboard and outboard side of each strut.

Fuel measuring sticks ....Flush and secure

Fan blades, probes, and spinner .... Check

Left Wing Root, Pack, and Lower Fuselage

Fuel measuring sticks ....Flush and secure

Probes, sensors, ports, vents, and drains (as applicable) .... Check

Exterior lights .... Check

Pack inlet and pneumatic access doors ....Secure

Leading edge flaps .... Check

Positive pressure relief doors ....Closed

Preflight Procedure – First Officer

The first officer normally does this procedure. The captain may do this procedure if needed.

405, 570
ELT switch ....Guard closed

109
ENGINE AUTOSTART switches ....ON (guard closed)

ELECTRONIC ENGINE CONTROL switches ....NORM

Verify that the ALTN lights are extinguished.

Electrical panel ....Set

STANDBY POWER selector - AUTO

UTILITY power switches - ON

Verify that the OFF lights are extinguished.

BATTERY switch – ON

Verify that the OFF light is extinguished.

BUS TIE switches - AUTO

Verify the ISLN lights are extinguished.

GENERATOR CONTROL switches - ON

Verify that the OFF lights are illuminated.

Verify that the GENERATOR DISCONNECT DRIVE lights are illuminated.

APU selector (if needed) ....START, then ON

Do not allow the APU selector to spring back to the ON position.

Verify that the APU generator 1 and APU generator 2 AVAIL lights are illuminated.

APU GENERATOR 1 switch – Push

Verify that the ON light is illuminated.

APU GENERATOR 2 switch – Push

Verify that the ON light is illuminated.

HYDRAULIC panel ....Set

DEMAND pump selectors - OFF

Verify that the hydraulic SYS FAULT lights are illuminated.

Verify that the demand pump PRESS lights are illuminated.

ENGINE pump switches - ON

Verify that the engine pump PRESS lights are illuminated.

EMERGENCY LIGHTS switch ....ARMED (guard closed)

570

CAPTAIN'S AUDIO SYSTEM switch .... NORM

OBSERVER'S AUDIO SYSTEM switch ....NORM

SERVICE INTERPHONE switch .... OFF

405, 570
CARGO INTERPHONE switch..As needed

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

405
Verify that the VALVE light is extinguished.

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

109
CARGO FIRE DISCH light - Extinguished

405, 570
CARGO FIRE DEPRESS/DISCH lights - Extinguished

CARGO FIRE ARM switches - OFF

109
Verify that the FWD and AFT lights are extinguished.

405, 570
Verify that the MAIN DECK, FWD, and AFT lights are extinguished.

Engine START panel ....Set

START switches - In

Verify that the Engine start lights are extinguished.

STANDBY IGNITION selector - NORM

CONTINUOUS IGNITION switch - Off

570
AUTO IGNITION selector - SINGLE

109, 405
AUTO IGNITION selector - 1 or 2

570
AUTOSTART switch - ON

FUEL JETTISON panel .... Set

Fuel jettison selector - OFF

Fuel jettison NOZZLE valve switches - Off

Verify that the VALVE lights are extinguished.

Fuel panel .... Set

All X FEED valve switches - On

Verify that the VALVE lights are extinguished.

All fuel pump switches – Off

Verify that the main pump PRESS lights are illuminated.

405
Verify that the main 2 aft pump PRESS light is extinguished when APU is running.

109, 570
Verify that the main 2 and 3 aft pump PRESS lights are extinguished when APU running.

Verify that the override 2 and 3 pumps and center pumps PRESS lights are extinguished.

109
Verify that the stabilizer pump PRESS lights are extinguished.

Anti-ice panel .... Set

NACELLE ANTI-ICE switches OFF

Verify that the VALVE lights are extinguished.

WING ANTI-ICE SWITCH - OFF

Verify that the VALVE light is extinguished.

Windshield protection panel .... Set

WINDOW HEAT switches - ON

Verify that the INOP lights are extinguished.

Windshield WIPER selectors - OFF

Lighting panel .... Set

LANDING light switches - OFF

RUNWAY TURNOFF light switches - OFF

TAXI lights switch - OFF

109

Note: Do not push the PASSENGER OXYGEN switch. The switch causes deployment of the passenger oxygen masks.

405

Note: Do not push the PASSENGER OXYGEN switch. The switch causes deployment of the cabin oxygen masks.

570

Note: Do not push the SUPERNUMERARY OXYGEN switch. The switch causes deployment of the supernumerary oxygen masks.

109, 405
PASSENGER OXYGEN switch .... NORM (guard closed)

570
SUPERNUMERARY OXYGEN switch .... NORM (guard closed)

YAW DAMPER switches .... ON

INOP lights remain illuminated until first IRU aligns.

109
THERAPEUTIC OXYGEN switch .... Guard closed

CABIN ALTITUDE panel .... Set

LANDING ALTITUDE switch - AUTO

Outflow valve manual switches - Off

Cabin Altitude AUTO SELECTOR - NORM

109
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

GASPER switch - ON

HUMIDIFIER switch - ON

405, 570
ECS panel .... Set

FLIGHT DECK FAN switch - As needed.

FLIGHT DECK TEMP selector - AUTO

MAIN DECK (FWD and AFT) TEMP selectors - AUTO

ZONE SYS FAULT light - Extinguished

TRIM AIR switch - ON

LOWER LOBE (FWD and AFT) TEMP selectors - AUTO

EQUIPMENT COOLING selector - NORM

HIGH FLOW switch - Off

AFT CARGO HEAT switch - Off

Bleed air panel .... Set

Pack SYS FAULT light - Extinguished

Pack control selectors - NORM

LEFT and RIGHT ISOLATION valve switches - On

Verify that the VALVE lights are extinguished.

Engine bleed air SYS FAULT lights - Extinguished

APU bleed air switch - ON

Verify that the VALVE light is extinguished.

ENGINE BLEED air switches - ON

Lighting panel ....Set

BEACON light switch - OFF

NAVIGATION light switch - As needed

STROBE light switch - OFF

WING light switch - OFF

LOGO light switch - As needed

FLIGHT DIRECTOR switch ....ON

Select the status display.

EFIS control panel ....Set

405, 570
MINIMUMS reference selector – RADIO or BARO

109
MINIMUMS reference selector – DH or MDA

MINIMUMS selector - Set decision height or altitude reference

FLIGHT PATH VECTOR switch – As needed

METERS switch – As needed

BAROMETRIC reference and BAROMETRIC selectors – Set

Select INCHES or HECTOPASCALS.

Set local altimeter setting.

VOR/ADF switches – As needed

ND mode selector – MAP

ND CENTER switch – As needed

ND range selector – As needed

ND TRAFFIC switch – As needed

WEATHER RADAR switch – Off

Verify that the weather radar indication is not shown on the ND.

Map switches – As needed

(SB changes 570 ; installs electronic flight bag)
ELECTRONIC FLIGHT BAG .... Set

Oxygen .... Test and set

Select the status display.

Oxygen mask – Stowed and doors closed

Crew oxygen pressure – Check EICAS

Note oxygen pressure.

RESET/TEST switch - Push and hold

Verify that the yellow cross shows momentarily in the flow indicator.

EMERGENCY/TEST selector – Push and hold

While continuing to hold the RESET/TEST switch down, push the EMERGENCY/TEST selector for 10 seconds. Verify that the yellow cross appears continuously in the flow indicator.

Verify that the crew oxygen pressure does not decrease more than 100 psig.

If the oxygen cylinder valve is not in the full open position, pressure can:
- decrease rapidly, or
- decrease more than 100 psig, or
- increase slowly back to normal

Release RESET/TEST switch and EMERGENCY/TEST selector. Verify that the yellow cross no longer shows in the flow indicator.

Normal/100% selector - 100%

109
Crew and passenger oxygen pressure - Check EICAS

Verify that the pressure is adequate for dispatch.

405, 570
Crew and supernumerary oxygen pressure - Check EICAS

Verify that the pressure is 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

Accomplish the Initial Data and Navigation Data steps from the CDU Preflight Procedure and ensure IRS alignment is complete before checking flight instruments.

Flight instruments .... Check

Verify that the flight instrument indications are correct.

Verify that only the following flags are shown:
- TCAS OFF
- NO VSPD until takeoff V–speeds are selected

Verify that the flight mode annunciations are correct:
- autothrottle mode is blank
- roll mode is TO/GA
- pitch mode is TO/GA
- AFDS status is FD

Display the map mode

GND PROXIMITY panel .... Set

Ground PROX light - Extinguished

Ground proximity FLAP OVERIDE switch - Off

Ground proximity CONFIGURATION
GEAR OVERRIDE switch - Off

405, 570
GROUND PROXIMITY
TERRAIN 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

CRT BRIGHTNESS controls .... As needed

EIU selector .... AUTO

HEADING reference switch .... NORM

FMC master selector L

EICAS display .... Check

Upper EICAS display – Check

Verify that the primary engine indications display existing conditions.

Verify that no exceedance is shown.

Lower EICAS display – Check

Secondary ENGINE indications – Check

Verify that the secondary engine indications display existing conditions.

Verify that no exceedance is shown.

Select the status display

Status messages – Check

Left radio tuning panel .... Set

Verify that the OFF light is extinguished.

Center radio tuning panel .... Set

Verify that the OFF light is extinguished.

Observer audio control panel .... As needed

Weather radar panel .... Set

Passenger signs .... Set

109, 405
NO SMOKING selector - AUTO or ON

SEATBELTS selector - AUTO or ON

109, 405
AUTOBRAKES selector .... RTO

109
Emergency evacuation COMMAND switch .... Guard closed

Right radio tuning panel .... Set

Verify that the OFF light is extinguished.

First officer's audio control panel .... As desired

Transponder panel .... Set

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

Seat .... Adjust

Position the seat for optimum eye reference.

Rudder pedals .... Adjust

Adjust to permit full rudder pedal and brake application.

Accomplish the PREFLIGHT checklist on the captain's command.

Preflight Procedure – Captain

The captain normally does this procedure. The first officer may do this procedure if needed.

EFIS control panel .... Set

405, 570
MINIMUMS reference selector – RADIO or BARO

109
MINIMUMS reference selector – DH or MDA

MINIMUMS selector - Set decision height or altitude reference

FLIGHT PATH VECTOR switch – As needed

METERS switch – As needed

BAROMETRIC reference and BAROMETRIC selectors – Set

Select INCHES or HECTOPASCALS.

Set local altimeter setting.

VOR/ADF switches – As needed

ND mode selector – MAP

ND CENTER switch – As needed

ND range selector – As needed

ND TRAFFIC switch – As needed

WEATHER RADAR switch – Off

Verify that the weather radar indication is not shown on the ND.

Map switches – As needed

Mode control panel .... Set

FLIGHT DIRECTOR switch – ON

AUTOTHROTTLE ARM switch – ARM

BANK LIMIT selector - AUTO

Autopilot DISENGAGE bar – Up

(SB changes 570 ; installs electronic flight bag)
ELECTRONIC FLIGHT BAG .... Set

Oxygen .... Test and set

Select the status display

Oxygen mask – Stowed and doors closed

Crew oxygen pressure – Check EICAS

Note oxygen pressure.

RESET/TEST switch - Push and hold

Verify that the yellow cross appears momentarily in the flow indicator.

EMERGENCY/TEST selector – Push and hold

While continuing to hold the RESET/TEST switch down, push the EMERGENCY/TEST selector for 10 seconds. Verify that the yellow cross appears continuously in the flow indicator.

Verify that the crew oxygen pressure does not decrease more than 100 psig.

If the oxygen cylinder valve is not in the full open position, pressure can:
- decrease rapidly, or
- decrease more than 100 psig, or
- increase slowly back to normal

Release RESET/TEST switch and EMERGENCY/TEST selector. Verify that the yellow cross no longer appears in the flow indicator.

Normal/100% selector - 100%

109
Crew and passenger oxygen pressure - Check EICAS

Verify that the pressure is adequate for dispatch.

405, 570
Crew and supernumerary oxygen pressure - Check EICAS

Verify that the pressure is 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

405
RMI .... Check

VOR/ADF selectors - As desired

Magnetic Heading - Correct

CRT select panel .... Set

INBOARD CRT selector - NORM

LOWER CRT selector - NORM

405
ALTERNATE EFIS selector - As desired

Accomplish the Initial Data and Navigation Data steps from the CDU Preflight Procedure and ensure IRS alignment is complete before checking flight instruments.

Flight instruments .... Check

Verify that the flight instrument indications are correct.

Verify that only the following flags are shown:
- TCAS OFF
- NO VSPD until takeoff V–speeds are selected

Verify the flight mode annunciations are correct:
- autothrottle mode is blank
- roll mode is TO/GA
- pitch mode is TO/GA
- AFDS status is FD

Display the map mode.

570
AUTOBRAKES selector .... RTO

109, 405
Standby instruments .... Check

Attitude indicator caging control – Pull and release

Verify that the attitude indicator is correct and no flags are shown.

ILS selector – OFF

Verify that the airspeed indications are correct.

Set the standby altimeter.

570
Integrated standby flight display ....Set

Verify that the approach mode display is blank.

Set the altimeter.

Verify that the flight instrument indications are correct.

Verify that no flags or messages are shown.

SPEEDBRAKE lever ....DN

Reverse thrust levers ....Down

Forward thrust levers ....Closed

Flap lever ....Set

The flap position indicator does not show when the flaps are up.
Set the flap lever to agree with the flap position.

PARKING BRAKE ....Set

Verify that the PARK BRAKE SET message shows.

Note: Do not assume that the parking brake will prevent airplane movement. Accumulator pressure can be insufficient.

FUEL CONTROL switches .... CUTOFF

FUEL CONTROL switch fire warning lights ....Extinguished

STABILIZER TRIM cutout switches ....Guard closed

ALTERNATE STABILIZER TRIM switches ....Neutral

Captain's audio control panel ....As needed

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

Seat ....Adjust

Position seat for optimum eye reference.

Rudder pedals ....Adjust

Adjust to permit full rudder pedal and brake application.

Call "PREFLIGHT CHECKLIST".

Before Start Procedure

Start the Before Start Procedure after papers are on board.

109
Flight deck door .... Closed and locked F/O

Verify that the LOCK FAIL light is extinguished.

Do the CDU Preflight Procedure – Performance Data steps before completing this procedure.

CDU display .... Set C, F/O

Normally the PF selects the TAKEOFF REF page.

Normally the PM selects the LEGS page.

MCP .... Set C

When selecting a mode/value on the MCP, verify the corresponding display changes on the flight instruments or FMA, as appropriate.

IAS/MACH selector – Set V2

Arm LNAV as needed.

Arm VNAV.

Initial heading or track – Set

Initial altitude – Set

Taxi and Takeoff briefings .... Complete C, F/O

The pilot who will do the takeoff does the taxi and takeoff briefings.

Exterior doors .... Verify closed F/O

If pushback is needed:

Verify that the nose gear steering is locked out.

Start clearance .... Obtain C, F/O

570
Ensure that the main deck nose cargo door Control Panel and Latch Annunciator Panel lights have been verified to confirm nose cargo door closed, latched, and locked.

Obtain a clearance to pressurize hydraulic systems.

Obtain a clearance to start the engines.

HYDRAULIC panel .... Set F/O

WARNING: If the tow bar is connected, do not pressurize the hydraulic systems until the nose gear steering is locked out. Unwanted tow bar movement can occur.

Note: Pressurize number 4 system first to prevent fluid transfer between systems.

Hydraulic demand pump 4 selector – AUX

Verify that the SYS FAULT light is extinguished.

Verify that the PRESS light stays illuminated.

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

Verify that the SYS FAULT lights are extinguished.

Verify that the PRESS lights are extinguished.

Fuel panel .... Set F/O

All MAIN tank FUEL PUMP switches – ON

Verify that the PRESS lights are extinguished.

570
If there is 17,000 pounds or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify that the PRESS lights are extinguished.

109, 405
If there is 7,700 kgs or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify PRESS lights extinguished.

BEACON light switch ....BOTH F/O

RECALL switch ....Push F/O

Verify that only the expected alert messages are shown.

(SB changes 109 ; before SB, fuel quantity indicating system upgrade BLK B not installed)

If FUEL TANK/ENG message shows:

Verify that:

- the fuel quantity in tank 2 is less than or equal to tank 1, or
- the fuel quantity in tank 3 is less than or equal to tank 4

OVERRIDE pumps 2 and 3 switches - Off

CROSSFEED valve 1 and 4 switches - Off

570

If FUEL TANK/ENG message shows:

Verify that:

- the fuel quantity in tank 2 is less than or equal to tank 1, or
- the fuel quantity in tank 3 is less than or equal to tank 4, or
- the fuel quantity in tank 2 is less than or equal to tank 1 plus 1,000 pounds and that the fuel quantity in tank 3 is less than or equal to tank 4 plus 1,000 pounds

OVERRIDE pumps 2 and 3 switches - Off

CROSSFEED valve 1 and 4 switches - Off

405

(SB changes 109 ; fuel quantity indicating system upgrade BLK B installed)

If FUEL TANK/ENG message shows:

Verify that:

- the fuel quantity in tank 2 is less than or equal to tank 1, or
- the fuel quantity in tank 3 is less than or equal to tank 4, or
- the fuel quantity in tank 2 is less than or equal to tank 1 plus 500 kilograms and that the fuel quantity in tank 3 is less than or equal to tank 4 plus 500 kilograms

OVERRIDE pumps 2 and 3 switches - Off

CROSSFEED valve 1 and 4 switches - Off

CANCEL switch .... Push F/O

Verify messages cancelled

Trim ....____ Units, zero, zero C

Stabilizer trim – ___ UNITS

Set the trim for takeoff.

Check that the trim is in the greenband.

Aileron trim – 0 units

Rudder trim – 0 units

Call “BEFORE START CHECKLIST.”	C
Do the BEFORE START checklist.	F/O

Pushback or Towing Procedure

The Engine Start procedure may be done during pushback or towing.

Establish communications with ground handling personnel. C

CAUTION: Do not hold or turn the nose wheel tiller during pushback or towing. This can damage the nose gear or the tow bar.

CAUTION: Do not use airplane brakes to stop the airplane during pushback or towing. This can damage the nose gear or the tow bar.

Transponder .... As needed F/O

At airports where ground tracking is not available, select STANDBY. At airports equipped to track airplanes on the ground, select an active transponder setting, but not a TCAS mode.

Set or release parking brake as directed by ground handling personnel. C

When pushback or towing is complete:

Verify that the tow bar is disconnected. C

Verify that the nose gear steering is not locked out. C

Engine Start Procedure

570

Select the secondary engine indications.		F/O
Pack control selectors	SET	F/O

Set two or three packs off. To start two engines at the same time, it may be necessary to set three packs off.

Start sequence	Announce	C
Call “START ___ ENGINE”		C
Engine START switch	Pull	F/O
FUEL CONTROL switch	RUN	C
Verify that the oil pressure increases.		C, F/O
Verify that there is N1 rotation and an oil pressure indication by idle N2.		C, F/O

After the engine is stabilized at idle, start the other engines.

Autostart does corrective steps for:
- no EGT rise
- a hot start
- a hung start

Do the ABORTED ENGINE START checklist for one or more of the following abort start conditions:
- there is no N1 rotation by idle N2
- the fuel control switch is in RUN, the engine RPM is low, and the Autostart switch is off
- the oil pressure indication is not normal by the time the engine is stabilized at idle

Engine Start Procedure

109

Select the secondary engine indications. F/O

Pack control selectors .... SET F/O

Set two or three packs off. To start two engines at the same time, it may be necessary to set three packs off.

Start sequence ....Announce C

Call “START ___ ENGINE”. C

Engine START switch .... Pull F/O

FUEL CONTROL switch ....RUN C

Verify that the oil pressure increases. C, F/O

Verify that there is N1 rotation by 40% N2. C, F/O

After the engine is stabilized at idle, start the other engines.

Autostart does corrective steps for:
- no EGT rise
- a hot start
- a hung start

Do the ABORTED ENGINE START checklist for one or more of the following abort start conditions:
- there is no oil pressure indicated by idle N2
- the fuel control switch is in RUN, the engine RPM is low, and the Autostart switch is off
- the oil pressure indication is not normal by the time the engine is stabilized at idle

Engine Start Procedure

405

Select the secondary engine indications. F/O

Pack control selectors .... SET F/O

Set two or three packs off..

Start sequence .... Announce C

Call "START ___ ENGINE." C

Engine “START” switch .... Pull F/O

Verify that the N2 RPM increases. F/O

Verify that the oil pressure increases. C, F/O

At maximum motoring (N2 greater than or equal to the fuel-on indicator and no increase for five to ten seconds) and a minimum of the fuel-on indicator:

FUEL CONTROL switch .... RUN C

Verify that the EGT increases and stays below the EGT limit. C, F/O

After the engine is stabilized at idle, start the other engines.

Do the ABORTED ENGINE START checklist for one or more of the following abort start conditions:

- the EGT does not increase by 20 seconds after the fuel control switch is moved to RUN
- there is no N1 rotation by 40% N2
- the EGT quickly nears or exceeds the start limit
- the N2 is not at idle by 2 minutes after the fuel control switch is moved to RUN
- the oil pressure indication is not normal by the time the engine is stabilized at idle

Before Taxi Procedure

APU selector	OFF	F/O
Hydraulic demand pump selectors	AUTO	F/O
NACELLE ANTI–ICE switches	As needed	F/O
AFT CARGO HEAT switch	As needed	F/O
PACK selectors	NORM	F/O

109

Select the status display. F/O

Verify that the ground equipment is clear. C, F/O

Call “FLAPS___” as needed for takeoff. C

Flap lever .... Set takeoff flaps F/O

Flight controls .... Check C

Make slow and deliberate inputs, one direction at a time.

Move the control wheel and the control column to full travel in both directions and verify:
- freedom of movement
- that the controls return to center
- correct flight control movement on EICAS display.

Hold the nose wheel tiller during rudder check to prevent undesired nose wheel movement.

Move the rudder pedals to full travel in both directions and verify:
- freedom of movement
- that the rudder pedals return to center
- correct flight control movement on the EICAS display

Blank the lower EICAS display. F/O

Transponder .... As needed F/O

At airports where ground tracking is not available, select STANDBY. At airports equipped to track airplanes on the ground, select an active transponder setting, but not a TCAS mode.

Recall .... Check C, F/O

Verify that only expected alert messages shown.

(SB changes 570 ; installs electronic flight bag)
EFB AIRPORT MAP application .... Select C, F/O

Select map as desired.

CAUTION: Do not use the Airport Map application as a primary navigation reference. The Airport Map application is designed to aid flight crew positional awareness only.

Update changes to the taxi briefing, as needed. C or PF

Call "BEFORE TAXI CHECKLIST." C

Do the BEFORE TAXI checklist. F/O

Before Takeoff Procedure

570

Engine warm up requirements:

- engine oil temperature must be above the bottom of the temperature scale

Engine warm up recommendations:

- run the engines for at least 3 minutes
- use a thrust setting normally used for taxi operations

109, 405

Engine warm up requirements:

- engine oil temperature must be above the lower amber band before takeoff

Engine warm up recommendations (there is no need to delay the takeoff for these recommendations:

- when the engines have been shut down more than 2 hours:
  - run the engines for 5 minutes
  - when the taxi time is expected to be less than 5 minutes, start the engines as early as feasible
  - use a thrust setting normally used for taxi operations

109

Pilot Flying	Pilot Monitoring
	Notify cabin crew to prepare for takeoff. Verify that the cabin is secure.
The pilot who will do the takeoff updates changes to takeoff briefing as needed.	
Set the weather radar display as needed.	
Call "BEFORE TAKEOFF CHECKLIST."	Do the BEFORE TAKEOFF checklist.

405, 570

Pilot Flying	Pilot Monitoring
	Notify supernumerary(s) to prepare for takeoff. Verify that the upper deck is secure.
The pilot who will do the takeoff updates changes to takeoff briefing as needed.	
Set the weather radar display as needed. Set the terrain display as needed.	
Call "BEFORE TAKEOFF CHECKLIST."	Do the BEFORE TAKEOFF checklist.

Takeoff Procedure

570

Pilot Flying	Pilot Monitoring
Before entering the departure runway, verify that the runway and runway entry point are correct.	
	When entering the departure runway, set the STROBE light switch to ON. Use other lights as needed. Position transponder mode selector to TA/RA.
Verify that the brakes are released. Align the airplane with the runway.	
Verify that the runway heading agrees with the assigned runway heading.	
	When cleared for takeoff, set the inboard LANDING lights switches to ON.

Pilot Flying	Pilot Monitoring
Advance the thrust levers to approximately 70% N1. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify that the correct takeoff thrust is set.	
	Monitor the engine instruments throughout takeoff. Call out any abnormal indications. Adjust takeoff thrust prior to 80 knots as needed. During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust by 80 knots, manually advance the thrust levers.
After takeoff thrust is set, the captain's hand must be on the thrust levers until V1.	
Monitor airspeed. Maintain light forward pressure on the control column.	Monitor airspeed indications and call out any abnormal indications.
Verify 80 knots and call "CHECK".	Call "80 KNOTS".
Verify V1 speed.	Call "V1".
At VR rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR, call "ROTATE". Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE".
Verify a positive rate of climb on the altimeter and call "GEAR UP".	
	Set the Landing Gear lever to UP.
Above 400 feet radio altitude, call for a roll mode as needed.	Select or verify the roll mode. Verify VNAV engaged.
Verify that climb thrust is set.	
Verify acceleration at the acceleration height. Call "FLAPS____" according to the flap retraction schedule.	
	Position Flap lever as directed.

Pilot Flying	Pilot Monitoring
Engage the autopilot when above the minimum altitude for autopilot engagement.	
	After flap retraction is complete: • Set the Landing Gear lever OFF after landing gear retraction is complete. • Verify air conditioning packs operating.
Call “AFTER TAKEOFF CHECKLIST”.	
	Do the AFTER TAKEOFF checklist.

109, 405

Pilot Flying	Pilot Monitoring
Before entering the departure runway, verify that the runway and runway entry point are correct.	
	When entering the departure runway, set the STROBE light switch to ON. Use other lights as needed. Position transponder mode selector to TA/RA.
Verify that the brakes are released. Align the airplane with the runway.	
Verify that the runway heading agrees with the assigned runway heading.	
	When cleared for takeoff, set the inboard LANDING lights switches to ON.
Advance the thrust levers to approximately 1.10 EPR. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify that the correct takeoff thrust is set.	

Pilot Flying	Pilot Monitoring
	Monitor the engine instruments throughout takeoff. Call out any abnormal indications. Adjust takeoff thrust prior to 80 knots as needed. During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust by 80 knots, manually advance the thrust levers.
After takeoff thrust is set, the captain's hand must be on the thrust levers until V1.	
Monitor airspeed. Maintain light forward pressure on the control column.	Monitor airspeed indications and call out any abnormal indications.
Verify 80 knots and call "CHECK".	Call "80 KNOTS".
Verify V1 speed.	Call "V1".
At VR rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR, call "ROTATE". Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE".
Verify a positive rate of climb on the altimeter and call "GEAR UP".	
	Set the Landing Gear lever to UP.
Above 400 feet radio altitude, call for a roll mode as needed.	Select or verify the roll mode. Verify VNAV engaged.
Verify that climb thrust is set.	
Verify acceleration at the acceleration height. Call "FLAPS____" according to the flap retraction schedule.	
	Position Flap lever as directed.
Engage the autopilot when above the minimum altitude for autopilot engagement.	

Pilot Flying	Pilot Monitoring
	After flap retraction is complete: • Set the Landing Gear lever OFF after landing gear retraction is complete. • Verify air conditioning packs operating.
Call "AFTER TAKEOFF CHECKLIST".	
	Do the AFTER TAKEOFF checklist.

Flap Retraction Schedule

570

Takeoff Flaps	At Speedtape "Display"	Select Flaps
20	"10" "5" "1" "UP"	10 5 1 UP
10	"5" "1" "UP"	5 1 UP
Above 680,000 lbs, limit bank angle to 15° with flaps up until reaching UP + 20 knots.		

109, 405

Takeoff Flaps	At Speedtape "Display"	Select Flaps
20	"10" "5" "1" "UP"	10 5 1 UP
10	"5" "1" "UP"	5 1 UP
Above 309,000 kgs, limit bank angle to 15° with flaps up until reaching UP + 20 knots.		

Climb and Cruise Procedure

Complete the After Takeoff Checklist before starting the Climb and Cruise Procedure.

570

Pilot Flying	Pilot Monitoring
	Above 10,000 feet, position Inboard Landing Light switches OFF.
	Set the passenger signs as needed.
At transition altitude, set and crosscheck the altimeters to standard.	
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 7,000 pounds in climb (pitch 5° or greater), set both Center L and R Pump switches off.
	When the FUEL OVD CTR L or R message is shown and the tank quantity is 4,000 pounds or more in cruise (pitch less than 5°), set both Center L and R Pump switches ON.
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 3,000 pounds in cruise (pitch less than 5°), set both Center L and R Pump switches off.
	When the FUEL TANK/ENG message is shown and the fuel quantity in tank 2 is less than or equal to tank 1 or tank 3 is less than or equal to tank 4, set the Override Forward and Aft Pump switches 2 and 3 off and crossfeed valve switches 1 and 4 off.
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter the correct RNP for arrival.

405

Pilot Flying	Pilot Monitoring
	Above 10,000 feet, position Inboard Landing Light switches OFF.
	Set the passenger signs as needed.
At transition altitude, set and crosscheck the altimeters to standard.	
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 3,200 kgs in climb (pitch 5° or greater), set both Center L and R Pump switches off.
	When the FUEL OVD CTR L or R message is shown and the tank quantity is 1,800 kgs or more in cruise (pitch less than 5°), set both Center L and R Pump switches ON.
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 1,300 kgs in cruise (pitch less than 5°), set both Center L and R Pump switches off.
	When the FUEL TANK/ENG message is shown and the fuel quantity in tank 2 is less than or equal to tank 1 or tank 3 is less than or equal to tank 4, set the Override Forward and Aft Pump switches 2 and 3 off and crossfeed valve switches 1 and 4 off.
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter the correct RNP for arrival.

109

Pilot Flying	Pilot Monitoring
	Above 10,000 feet, position Inboard Landing Light switches OFF.
	Set the passenger signs as needed
At transition altitude, set and crosscheck the altimeters to standard.	

Pilot Flying	Pilot Monitoring
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 3,200 kgs in climb (pitch 5° or greater), set both Center L and R Pump switches off.
	When the FUEL OVD CTR L or R message is shown and the tank quantity is 1,800 kgs or more in cruise (pitch less than 5°), set both Center L and R Pump switches ON.
	When the FUEL PMP STB L or R message is shown and the tank quantity is 500 kgs or more, set both Stabilizer Tank L and R Pump switches ON.
	When the FUEL PRES STB L or FUEL PRES STB R message is shown and tank quantity is 900 kgs or less, set both Stabilizer Tank L and R Pump switches off. Under some conditions, fuel may be left in the stabilizer tank. If after approximately 5 minutes there is fuel still indicated in the stabilizer tank, the crew may turn the stabilizer pumps back on to transfer this fuel. Turn both pumps off at the first FUEL PRES STB message.
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 1,300 kgs in cruise (pitch less than 5°), set both Center L and R Pump switches off.

Pilot Flying	Pilot Monitoring
	When the FUEL TANK/ENG message is shown and the fuel quantity in tank 2 is less than or equal to tank 1 or tank 3 is less than or equal to tank 4, set the Override Forward and Aft Pump switches 2 and 3 off and crossfeed valve switches 1 and 4 off.
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter the correct RNP for arrival.

Descent Procedure

Start the Descent Procedure before the airplane descends below the cruise altitude for arrival at destination.

Complete the Descent Procedure by 10,000 feet MSL.

109, 405

Pilot Flying	Pilot Monitoring
Review all alert messages.	Recall and review all alert messages.
Verify VREF on the APPROACH REF page.	Enter VREF on the APPROACH REF page.
Set the RADIO/BARO minimums as needed for approach.	
	Set the NAV RADIO page for the approach.
	Set the AUTOBRAKES selector to the needed brake setting.
Do the approach briefing.	
Call “DESCENT CHECKLIST.”	Do the DESCENT checklist.

570

Pilot Flying	Pilot Monitoring
Review all alert messages.	Recall and review all alert messages.
Verify VREF on the APPROACH REF page.	Enter VREF on the APPROACH REF page.
Set the RADIO/BARO minimums as needed for approach.	

Pilot Flying	Pilot Monitoring
	Set the NAV RADIO page for the approach.
The captain sets the AUTOBRAKES selector to the needed brake setting.	
Do the approach briefing.	
Call “DESCENT CHECKLIST.”	Do the DESCENT checklist.

Approach Procedure

The Approach Procedure is normally started at transition level.

Complete the Approach Procedure before:

- the initial approach fix, or
- the start of radar vectors to the final approach course, or
- the start of a visual approach

Pilot Flying	Pilot Monitoring
	Set the passenger signs as needed.
	At or above 10,000 feet MSL, set the inboard landing light switches to ON.
At transition level, set and crosscheck the altimeters.	
Update changes to the arrival and approach procedures, as needed. Update the RNP, as needed.	
Update the approach briefing as needed.	
Call "APPROACH CHECKLIST."	Do the APPROACH checklist.

Flap Extension Schedule

570

Current Flap Position	At Speedtape "Display"	Select Flaps	Command Speed for Selected Flaps
UP*	"UP"	1	"1"
1	"1"	5	"5"
5	"5"	10 or 20**	"10" or "20"**
10	"10"	20	"20"
20	"20"	25 or 30	(VREF 25 or VREF 30) + wind additives
*Above 680,000 lbs, use UP + 20 knots.			
**Flaps 10 and Command Speed "10" are optional.			

109, 405

Current Flap Position	At Speedtape "Display"	Select Flaps	Command Speed for Selected Flaps
UP*	"UP"	1	"1"
1	"1"	5	"5"
5	"5"	10 or 20 **	"10" or "20"**

Current Flap Position	At Speedtape "Display"	Select Flaps	Command Speed for Selected Flaps
10	"10"	20	"20"
20	"20"	25 or 30	(VREF 25 or VREF 30) + wind additives
*Above 309,000 kgs, use UP + 20 knots.			
**Flaps 10 and Command Speed "10" are optional.			

Landing Procedure - ILS

405

Pilot Flying	Pilot Monitoring
Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.
When on localizer intercept heading: • verify that the ILS is tuned and identified • verify that the LOC and G/S pointers are shown	
Arm the APP mode.	
Use HDG SEL or HDG HOLD to intercept the final approach course, as needed.	
Verify that the localizer is captured.	
	Call “GLIDE SLOPE ALIVE.”
At glideslope alive, call: • “GEAR DOWN” • “FLAPS 20”	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARM.	
At glideslope capture, call “FLAPS __” as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
At final approach fix or OM, verify the crossing altitude.	
Monitor the approach. Verify the autoland status at 500 feet radio altitude.	

109

Pilot Flying	Pilot Monitoring
	Notify cabin crew to prepare for landing. Verify that the cabin is secure.
Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.
When on localizer intercept heading: • verify that the ILS is tuned and identified • verify that the LOC and G/S pointers are shown	

Pilot Flying	Pilot Monitoring
Arm the APP mode.	
WARNING: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. The airplane can then descend on the glide slope with the localizer not captured.	
Use HDG SEL or HDG HOLD to intercept the final approach course, as needed.	
Verify that the localizer is captured.	
	Call "GLIDE SLOPE ALIVE."
At glideslope alive, call: • "GEAR DOWN" • "FLAPS 20"	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARM.	
At glideslope capture, call "FLAPS __" as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call "LANDING CHECKLIST."	Do the LANDING checklist.
At final approach fix or OM, verify the crossing altitude.	
Monitor the approach. Verify the autoland status at 500 feet radio altitude.	

570

Pilot Flying	Pilot Monitoring
Call "FLAPS __" according to the flap extension schedule.	Set the flap lever as directed.
When on localizer intercept heading: • verify that the ILS is tuned and identified • verify that the LOC and G/S pointers are shown	
Arm the APP mode.	
WARNING: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. The airplane can then descend on the glide slope with the localizer not captured.	
Use HDG SEL or HDG HOLD to intercept the final approach course, as needed.	

Pilot Flying	Pilot Monitoring
Verify that the localizer is captured.	
	Call “GLIDE SLOPE ALIVE.”
At glideslope alive, call: • “GEAR DOWN” • “FLAPS 20”	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARM.	
At glideslope capture, call “FLAPS __” as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
At final approach fix or OM, verify the crossing altitude.	
Monitor the approach. Verify the autoland status at 500 feet radio altitude.	

Landing Procedure - Instrument Approach Using VNAV

Use the autopilot during the approach to give:

- autopilot alerts and mode fail indications
- more accurate course and glide path tracking
- lower RNP limits

This procedure is not authorized using QFE.

109

Pilot Flying	Pilot Monitoring
	Notify cabin crew to prepare for landing. Verify that the cabin is secure.
Call "FLAPS __" according to the flap extension schedule.	Set the flap lever as directed.
The recommended roll modes for the final approach are: • for a RNAV or GPS approach use LNAV • for a LOC-BC, VOR, or NDB approach use LNAV • for a LOC, SDF, or LDA approach use LNAV or LOC	
	Verify that the VNAV glide path angle is shown on the final approach segment of the LEGS page.
When on the final approach course intercept heading for LOC, LOC-BC, SDF, or LDA approaches: • verify that the localizer is tuned and identified • verify that the LOC pointer is shown	
Arm the LNAV or LOC mode.	
WARNING: When using LNAV to intercept the localizer, LNAV might parallel the localizer without capturing it. The airplane can then descend on the VNAV path with the localizer not captured.	
Use LNAV, HDG SEL or HDG HOLD to intercept the final approach course as needed.	
Verify that LNAV is engaged or that the localizer is captured.	

<table>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td>Approximately 2 NM before the final approach fix and after ALT, VNAV PTH, or VNAV ALT is annunciated:
• verify that the autopilot is engaged
• set DA(H) or MDA(H) on the MCP
• select or verify VNAV
• select or verify speed intervention</td><td>Call “APPROACHING GLIDE PATH.”</td></tr>
<tr><td>Approaching glide path, call:
“GEAR DOWN”
“FLAPS 20”</td><td>Set the landing gear lever to DN.
Set the flap lever to 20</td></tr>
<tr><td>Set the SPEEDBRAKE lever to ARM.</td><td></td></tr>
<tr><td>Beginning the final approach descent, call “FLAPS __” as needed for landing.</td><td>Set the flap lever as directed.</td></tr>
<tr><td>Call “LANDING CHECKLIST.”</td><td>Do the LANDING checklist.</td></tr>
<tr><td>When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.</td><td></td></tr>
<tr><td colspan="2">At the final approach fix, verify the crossing altitude and crosscheck the altimeters.</td></tr>
<tr><td colspan="2">Monitor the approach.</td></tr>
<tr><td>If suitable visual reference is established at MDA(H), DA(H), or the missed approach point, disengage the autopilot and autothrottle.
Maintain the glide path to landing.</td><td></td></tr>
</table>

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Pilot Flying	Pilot Monitoring
Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.
The recommended roll modes for the final approach are: • for a RNAV or GPS approach use LNAV • for a LOC-BC, VOR, or NDB approach use LNAV • for a LOC, SDF, or LDA approach use LNAV or LOC	
	Verify that the VNAV glide path angle is shown on the final approach segment of the LEGS page.
When on the final approach course intercept heading for LOC, LOC-BC, SDF, or LDA approaches: • verify that the localizer is tuned and identified • verify that the LOC pointer is shown	
Arm the LNAV or LOC mode.	
WARNING: When using LNAV to intercept the localizer, LNAV might parallel the localizer without capturing it. The airplane can then descend on the VNAV path with the localizer not captured.	
Use LNAV, HDG SEL or HDG HOLD to intercept the final approach course as needed.	
Verify that LNAV is engaged or that the localizer is captured.	
Approximately 2 NM before the final approach fix and after ALT, VNAV PTH, or VNAV ALT is annunciated: • verify that the autopilot is engaged • set DA(H) or MDA(H) on the MCP • select or verify VNAV • select or verify speed intervention	Call “APPROACHING GLIDE PATH.”
Approaching glide path, call: “GEAR DOWN” “FLAPS 20”	Set the landing gear lever to DN. Set the flap lever to 20
Set the SPEEDBRAKE lever to ARM.	

<table>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td>Beginning the final approach descent, call “FLAPS __” as needed for landing.</td><td>Set the flap lever as directed.</td></tr>
<tr><td>Call “LANDING CHECKLIST.”</td><td>Do the LANDING checklist.</td></tr>
<tr><td>When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.</td><td></td></tr>
<tr><td colspan="2">At the final approach fix, verify the crossing altitude and crosscheck the altimeters.</td></tr>
<tr><td colspan="2">Monitor the approach.</td></tr>
<tr><td>If suitable visual reference is established at MDA(H), DA(H), or the missed approach point, disengage the autopilot and autothrottle.

Maintain the glide path to landing.</td><td></td></tr>
</table>

Go–Around and Missed Approach Procedure

Pilot Flying	Pilot Monitoring
At the same time: • push the TOGA switch • call "FLAPS 20"	Set the flap lever to 20.
Verify: • the rotation to go-around attitude • that the thrust increases	
	Verify that the thrust is sufficient for the go-around or adjust as needed.
Verify a positive rate of climb on the altimeter and call "GEAR UP".	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE". Set the landing gear lever to UP.
Above 400 feet radio altitude, select a roll mode.	Verify that the missed approach altitude is set.
Verify that the missed approach route is being tracked.	
At acceleration height, select FLCH or VNAV. If FLCH is selected, set speed to the maneuvering speed for the planned flap setting. If VNAV is selected: • select speed intervention as needed • set speed to the maneuvering speed for the planned flap setting	
Call "FLAPS ___" according to the flap retraction schedule.	Set the flap lever as directed.
After flap retraction to the planned flap setting, if FLCH was selected, push the THRUST switch.	
Verify that climb thrust is set.	
Verify that the missed approach altitude is captured.	
	Set the landing gear lever OFF after landing gear retraction is complete.
Call "AFTER TAKEOFF CHECKLIST."	Do the AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP.	Verify that the SPEED BRAKE lever is UP. Call “SPEEDBRAKES UP.” If the SPEEDBRAKE lever is not UP, call “SPEEDBRAKES NOT UP.”
Monitor the rollout progress.	
Verify correct autobrakes operation.	
WARNING: After the reverse thrust levers are moved, a full stop landing must be made. If an engine stays in reverse, safe flight is not possible.	
Without delay, move the reverse thrust levers to the interlocks and hold light pressure until the interlocks release. Then apply reverse thrust as needed.	
By 60 knots, start movement of the reverse thrust levers to be at the reverse idle detent before taxi speed.	Call “60 KNOTS”.
After the engines are at reverse idle, move the reverse thrust levers full down.	
Before taxi speed, disarm the autobrakes. Use manual braking as needed.	
Before turning off the runway, disconnect the autopilot.	

(SB changes 570 ; installs electronic flight bag)

CAUTION: Do not use the Airport Map application as a primary reference. The Airport Map application is designed to aid flight crew postional awareness only.

After Landing Procedure

Start the After Landing Procedure when clear of the active runway.

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Engine cool down recommendations:

- run the engines for at least 3 minutes
- use a thrust setting normally used for taxi operations

109, 405

Engine cool down requirement:

- run the engines for at least 90 seconds
- use a thrust setting no higher than that normally used for taxi operations

Engine cool down recommendations:

- run the engines for at least 5 minutes
- use a thrust setting no higher than that normally used for taxi operations

109, 405

Pilot Flying	Pilot Monitoring
The captain moves or verifies that the SPEEDBRAKE lever is DOWN.	
	Set the APU selector to START, then ON, as needed. Do not allow the APU selector to spring back to the ON position.
	Set the exterior lights as needed.
Set the weather radar to off.	
	Set the AUTOBRAKES selector to OFF.
	Set the flap lever to UP.
	Set the transponder mode selector as needed. At airports where ground tracking is not available, select STANDBY. At airports equipped to track airplanes on the ground, select an active transponder setting, but not a TCAS mode.

570

Pilot Flying	Pilot Monitoring
The captain moves or verifies that the SPEEDBRAKE lever is DOWN.	
	Set the APU selector to START, then ON, as needed. Do not allow the APU selector to spring back to the ON position.
	Set the exterior lights as needed.
Set the weather radar to off.	
The captain sets the AUTOBRAKES selector to OFF.	
	Set the flap lever to UP.
	Set the transponder mode selector as needed. At airports where ground tracking is not available, select STANDBY. At airports equipped to track airplanes on the ground, select an active transponder setting, but not a TCAS mode.

Shutdown Procedure

Start the Shutdown Procedure after taxi is complete.

Parking brake .... Set   C or F/O

Verify that the PARK BRAKE SET message is shown.

109
Electrical power .... Set   F/O

If APU power is needed:

Verify that the APU generator 1 and APU generator 2 AVAIL lights are illuminated.

APU GENERATOR 1 switch - Push

Verify that the ON light is illuminated

APU GENERATOR 2 switch - Push

Verify that the ON light is illuminated

If external power is needed:

Verify that the external power 1 or external power 2, or both, AVAIL lights are illuminated.

EXTERNAL POWER 1 or EXTERNAL POWER 2, or both, switches - Push

Verify that the respective ON light is illuminated.

405, 570
Electrical power .... Establish

If APU power is needed:

Verify that the APU generator 1 and APU generator 2 AVAIL lights are illuminated.

APU GENERATOR 1 switch - Push

Verify that the ON light is illuminated.

APU GENERATOR 2 switch - Push when main deck cargo handling equipment is not needed.

Verify that the ON light is illuminated.

If external power is needed:

Verify that the external power 1 or external power 2, or both, AVAIL lights are illuminated.

EXTERNAL POWER 1 switch - Push

EXTERNAL POWER 2 switch - Push when main deck cargo handling equipment is not needed.

Verify that the respective ON light is illuminated.

Note: If both external power 2 and APU generator 2 AVAIL lights are illuminated, main deck cargo handling power is provided by external power 2. Selecting external power 2 ON transfers main deck cargo handling power to APU generator 2.

Hydraulic demand pump 4 selector .... AUX F/O

If parked (pushback or towing is not needed):

Hydraulic demand pump 1, 2, 3 selectors ....OFF F/O

FUEL CONTROL switches ....CUTOFF C

If pushback or towing is needed:

Establish communications with ground handling personnel. C

WARNING: If the nose gear steering is not locked out, any change to hydraulic power with the tow bar connected can cause unwanted tow bar movement.

Verify that the nose gear steering is locked out.

CAUTION: Do not hold or turn the nose wheel tiller during pushback or towing. This can damage the nose gear or the tow bar.

CAUTION: Do not use airplane brakes to stop the airplane during pushback or towing. This can damage the nose gear or the tow bar.

Set or release the parking brake as directed by ground handling personnel. C

When parked (pushback or towing is complete):

Hydraulic demand pump 1, 2, and 3 selectors ......OFF F/O

SEATBELTS selector ....OFF F/O

Fuel pump switches ....OFF F/O

NACELLE and WING ANTI-ICE switches ....OFF F/O

BEACON light switch ....OFF F/O

FLIGHT DIRECTOR switches ....OFF C, F/O

Status messages ....Check F/O

Record shown status messages in maintenance log.

Transponder mode selector .... STANDBY F/O

After wheel chocks are in place:

Parking brake ....Release C

Hydraulic demand pump 4 selector .... OFF		F/O
APU selector .... As needed		F/O
Call "SHUTDOWN CHECKLIST."		C
Do the SHUTDOWN checklist.		F/O

Secure Procedure

IRS mode selectors .... OFF		F/O
EMERGENCY LIGHTS switch .... OFF		F/O
AFT CARGO HEAT switch .... OFF		F/O
PACK control selectors .... OFF		F/O
Call "SECURE CHECKLIST."		C
Do the SECURE checklist.		F/O

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Supplementary Procedures — Chapter SP
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Introduction | Section 05

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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Flight Deck Door Access System Test

109

Flight Deck Access System switch ....NORM (guard closed)

Flight Deck Door .... Open

Flight Deck Door Lock selector ....AUTO

Emergency access code ....Enter

ENT key ....Push

Verify alert sounds.

Verify AUTO UNLK light illuminates.

Flight Deck Door Lock selector .... DENY

Verify AUTO UNLK light extinguishes.

Flight Deck Door Lock selector ....UNLKD

Flight Deck Access System switch .... OFF

Verify LOCK FAIL light illuminates.

Flight Deck Access System switch ....NORM (guard closed)

Verify LOCK FAIL light extinguishes.

Low Gross Weight, Aft CG Takeoff

405, 570

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Pilot Flying	Pilot Monitoring
	Confirm 15% (or greater) derate thrust for takeoff, or the equivalent using assumed temperature thrust reduction, or the equivalent using any fixed derate thrust and assumed temperature thrust reduction.
Align airplane with runway centerline*.	Position Inboard Landing Lights and Strobe Light switches ON. Position Transponder Mode selector to TA/RA.
Release brakes*. Advance Thrust levers to approximately 70% N1. 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.
Apply full forward control column deflection to approximately 80 knots to improve nose wheel steering.	Adjust takeoff thrust prior to 80 knots if required.
Note: After takeoff thrust is set, the captain's hand must be on Thrust levers until V1.	
Verify 80 knots.	Call "80 KNOTS."
Monitor airspeed noting V1. Rotate at VR. Establish a 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.

* The airplane may be stopped (brakes set) after aligning with the runway and centerline, but a rolling takeoff is recommended.

405

Pilot Flying	Pilot Monitoring
	Confirm 15% (or greater) or 30% derate thrust for takeoff, or the equivalent using assumed temperature thrust reduction, or the equivalent using any fixed derate thrust and assumed temperature thrust reduction.
Align airplane with runway centerline*.	Position Inboard Landing Lights and Strobe Light switches ON. Position Transponder Mode selector to TA/RA.
Release brakes.* Advance Thrust levers to approximately 1.1 EPR. ** 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 the takeoff.
Apply full forward control column deflection to approximately 80 knots to improve nose wheel steering.	Adjust takeoff thrust prior to 80 knots if required.
Note: After takeoff thrust is set, the captain's hand must be on Thrust levers until V1.	
Verify 80 knots.	Call "80 KNOTS."
Monitor airspeed noting V1. Rotate at VR. Establish a 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.

*The airplane may be stopped (brakes set) after aligning with the runway center line, but a rolling takeoff is recommended.

**During cold weather operation, oil temperature must increase to normal operating range before takeoff.

Low Gross Weight, Aft CG Takeoff (Cont.)	
Pilot Flying	**Pilot Monitoring**
	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.

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 Switch ....Push and Hold

Verify yellow cross appears momentarily in flow indicator.

EMERGENCY/TEST Selector ....Push and Hold

While continuing to hold the RESET/TEST switch, push the EMERGENCY/TEST selector for 10 seconds. Verify yellow cross appears continuously in flow indicator.

PUSH-TO-TALK Switch ....INT

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

EMERGENCY/TEST Selector ....Release

RESET/TEST Switch ....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 100 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

Packs Off Takeoff

109, 570

Converted Freighters are not certified for this procedure.

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.

Ground Conditioned Air Use

Before connecting ground conditioned air:

PACK control selectors - OFF

Prevents pack operation if bleed air is supplied to the airplane.

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RECIRCULATION FANS switches - OFF

Allows conditioned air unit to operate at maximum efficiency.

After disconnecting ground conditioned air:

PACK control selectors - NORM

109

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

Flight Deck Fan

405, 570

During preflight:

FLIGHT DECK FAN switch - As required

Turn Flight Deck Fan switch ON when extra cooling required.

Before takeoff:

FLIGHT DECK FAN switch - OFF

During shutdown:

FLIGHT DECK FAN switch - As required

Turn Flight Deck Fan switch ON when extra cooling required.

Landing Airport Elevation Between 8,000 Feet and 10,000 Feet

Before start:

Landing Altitude switch .... MAN

Landing Altitude selector ....8,000 feet

Before descent:

Landing Altitude switch ....AUTO

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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.

Instrument Approach Using Vertical Speed (V/S)

Note: Autopilot use is recommended until suitable visual reference is established.

Note: If required to remain at or above the MDA during the missed approach, missed approach must be initiated at least 50 feet above MDA.

Recommended roll modes:

- RNAV, GPS, LOC-BC, VOR or NDB approach: LNAV or HDG SEL
- LOC, SDF, or LDA approach: LOC or LNAV

Ensure appropriate navaids (VOR, LOC, or NDB) are tuned and identified prior to commencing the approach.

RNP appropriate for approach (if required) .... Verify/Enter

Allows appropriate alerting to occur if ANP exceeds RNP.

Before descent to MDA(H):

MCP altitude .... Set

Set the first intermediate altitude constraint or MDA(H). When the current constraint is assured, the next constraint may be set prior to ALT engaged to achieve continuous descent path.

If constraints or MDA(H) do not end in zero zero (00) (for example, 1820), set MCP ALTITUDE window to the closest 100 foot increment below the constraint.

At descent point:

V/S switch .... Push

Verify V/S mode annunciates.

Desired V/S .... Set

Set desired V/S to descend to MDA(H). Use a V/S that results in no level flight segment at MDA(H).

Approximately 300 feet above MDA(H):

MCP altitude ....Set Missed Approach Altitude

At MDA(H)/missed approach point:

If suitable visual reference is not established, execute missed approach.

After suitable visual reference is established:

A/P Disengage switch .... Push

Disengage autopilot before descending below MDA(H).

A/T Disconnect switch .... Push

Disconnect autothrottle before descending below MDA(H).

Circling Approach

Note: Autopilot use is recommended until intercepting the landing profile.

MCP Altitude selector .... Set

If the MDA(H) does not end in zero zero (00) (for example, 1820), set MCP ALTITUDE window to the closest 100 foot increment below the MDA.

Accomplish an instrument approach and establish suitable visual reference.

At MDA(H):

ALT HOLD switch (if required) .... Push

Enables level off at MDA(H). Verify ALT mode annunciates.

MCP altitude selector .... Set Missed Approach Altitude

HDG SEL switch .... Push

Verify HDG SEL mode annunciates.

Intercepting the landing profile:

Autopilot disengage switch .... Push

Autothrottle disconnect switch .... Push

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Aircraft Communications Addressing and Reporting System (ACARS) (As installed)

The following procedures are one means which may be used to verify Pre-Departure Clearance, Digital-Automatic Terminal Information Service, Oceanic Clearances, Weight and Balance and Takeoff Data messages transmitted over ACARS.

Pre-Departure Clearance

The flight crew shall manually verify (compare) the filed flight plan versus the digital pre-departure clearance and shall initiate voice contact with Air Traffic Control if any question/confusion exists between the filed flight plan and the digital pre-departure clearance.

Digital-Automatic Terminal Information Service

The flight crew shall verify the D-ATIS altimeter setting numeric and alphabetical values are identical. If the D-ATIS altimeter setting numeric and alphabetical values are different, the flight crew must not accept the D-ATIS altimeter setting.

Oceanic Clearances

The flight crew shall manually verify (compare) the filed flight plan versus the digital oceanic clearance and initiate voice contact with Air Traffic Control if any questions/confusion exists between the filed flight plan and the digital oceanic clearance.

Weight and Balance

The flight crew shall verify the Weight and Balance numeric and alphabetical values are identical. If the Weight and Balance numeric and alphabetical values are different, the flight crew must not accept the Weight and Balance data.

Takeoff Data

The flight crew shall verify the Takeoff Data numeric and alphabetical values are identical. If the Takeoff Data numeric and alphabetical values are different, the flight crew must not accept the Takeoff Data message.

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Electrical Power Up

The following procedure is accomplished to permit safe application of electrical power.

BATTERY switch .... ON

Verify OFF light extinguished.

STANDBY POWER selector .... AUTO

Hydraulic DEMAND pump selectors .... OFF

Windshield WIPER 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

109
EXTERNAL POWER 1 and/or
EXTERNAL POWER 2 switches – Push

Verify ON light(s) illuminated.

405, 570
EXTERNAL POWER 1 and/or
EXTERNAL POWER 2 switches – Push

Push if main deck cargo handling equipment power not required.

Verify ON light(s) illuminated.

405, 570

Note: If both external power 2 and APU generator 2 AVAIL lights illuminated, main deck cargo handling power is provided by external power 2. Selecting external power 2 ON transfers main deck cargo handling power to APU generator 2.

If APU power desired:

570
APU Start Source switch - TR

APU selector – START, then ON

Position APU selector back to ON position. Do not allow APU selector to spring back to ON position.

APU generator 1 and
APU generator 2 AVAIL lights - Illuminated

APU GENERATOR 1 switch - Push

Verify ON light illuminated.

109
APU GENERATOR 2 switch - Push

Verify ON light illuminated.

405, 570
APU GENERATOR 2 switch - Push

Push if main deck cargo handling equipment power not required.

Verify ON light illuminated.

Electrical Power Down

This procedure assumes the Secure procedure is complete.

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

STANDBY POWER selector .... OFF

When APU has completed shutdown cycle:

BATTERY switch – OFF

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.

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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 Start Procedure - Manual Start

570

Select the secondary engine indications.		F/O
Pack control selectors	SET	F/O
All packs may be off or one pack may be on for engine start.		
Start sequence	Announce	C
AUTOSTART switch	Off	F/O
Call “START ___ ENGINE”		C
Engine START switch	Pull	F/O
Verify that the N2 RPM increases.		F/O
Verify that the oil pressure increases.		C, F/O
At the fuel-on indicator:		
FUEL CONTROL switch	RUN	C
Verify that the EGT increases and stays below EGT limit.		C, F/O
After the engine is stable at idle:		
If autostart is operative:		
AUTOSTART switch	ON	F/O
The autostart switch may stay OFF between manual starts when more than one engine is to be started manually.		

After the engine is stabilized at idle, start the other engines.

Do the ABORTED ENGINE START checklist for one or more of the following abort start conditions:

- the EGT does not increase by 25 seconds after the fuel control switch is moved to RUN
- there is no N1 rotation by idle N2
- the EGT quickly nears or exceeds the start limit
- N2 does not stabilize at idle
- the oil pressure indication is not normal by the time the engine is stabilized at idle

Engine Start Procedure - Manual Start

109

Select the secondary engine indications.		F/O
Pack control selectors	SET	F/O
All packs may be off or one pack may be on for engine start.		
Start sequence	Announce	C
AUTOSTART switch	Off	F/O
Call “START ___ ENGINE”		C
Engine START switch	Pull	F/O
Verify that the N2 RPM increases.		F/O
Verify that the oil pressure increases.		C, F/O

At maximum motoring (N2 greater than or equal to the fuel-on indicator and no increase for five to ten seconds) and a minimum of the fuel-on indicator:

FUEL CONTROL switch	RUN	C
Verify that the EGT increases and stays below EGT limit.		C, F/O

After the engine is stabilized at idle:

If autostart is operative:

AUTOSTART switch	ON	F/O

The autostart switch may stay OFF between manual starts when more than one engine is to be started manually.

After the engine is stabilized at idle, start the other engines.

Do the ABORTED ENGINE START checklist for one or more of the following abort start conditions:

- the EGT does not increase by 20 seconds after the fuel control switch is moved to RUN
- there is no N1 rotation by 40% N2
- the EGT quickly nears or exceeds the start limit

- the N2 is not at idle by 2 minutes after the fuel control switch is moved to RUN
- the oil pressure indication is not normal by the time the engine is stabilized at idle

Engine/APU/Cargo Fire/Overheat Test

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

Note: EICAS warning message FIRE WHEEL WELL may momentarily display.

Observe:

EICAS warning message >TEST IN PROG displays.

Fire bell sounds.

Master WARNING lights illuminate.

Engine Fire Warning lights illuminate.

APU Fire Warning light illuminates.

Fuel Control switch Fire Warning lights illuminate.

CARGO FIRE FWD and AFT Warning lights illuminate.

405, 570
CARGO FIRE MAIN DECK Warning light illuminates.

EICAS warning message >FIRE TEST PASS displays.

405, 570
EICAS warning message >VLV TST IN PROG displays.

FIRE/OVERHEAT TEST switch .... Release

405, 570

EICAS warning message >VALVE TEST PASS displays.

Approximately 90 seconds after releasing the FIRE/OVERHEAT TEST switch, the message displays.

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.

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 the NAVRAD page.

QFE Operation

405, 570

Accomplish this procedure when ATC altitude assignments are referenced to QFE altimeter settings.

Note: Do not use LNAV or VNAV below transition altitude/level. VNAV altitudes in the navigation database are not referenced to QFE.

Altimeters .... Set

Set altimeters to QFE when below transition altitude/level.

Note: If the QFE altimeter setting is beyond the range of the altimeters, QNH procedures must be used with QNH set in the altimeters.

CDU .... Set

Select QFE on the APPROACH REF page. Set for departure and again for arrival.

Departure or Destination Airport Not in the FMC Navigation Database

When departing from or landing at an airport that is not in the FMC navigation database, the following items are affected:

- Cabin pressurization schedule
- Availability of departure, arrival, and approach procedures in the FMC
- Automatic tuning of VOR, DME, and ILS radios for departure, arrival, and approach procedures
- Format of altitudes and flight levels on the ND and CDU
- Barometric transition altitude alerts (amber display and box) on the PFD
- Touchdown zone indicator (amber crosshatched area) on the PFD altitude tape

Use the following procedures when departing from or landing at an airport that is not in the FMC navigation database.

Departure Airport Not in the FMC Navigation Database

CDU Preflight Procedure - Captain and First Officer

RTE key .... Select

If ORIGIN contains an ICAO identifier:

The following steps clear the ORIGIN and erase the previous route.

INIT REF key .... Select

INDEX .... Select

IDENT .... Select

Inactive date range .... Select

ACTIVE date range .... Select

Transfers the inactive navigation database to the ACTIVE line and removes the previously entered route.

Clear the NAV DATA OUT OF DATE scratchpad message.

Inactive date range .... Select

ACTIVE date range .... Select

Transfers the inactive navigation database to the ACTIVE line.

Verify that the ACTIVE date range is current.

RTE key .... Select

Leave ORIGIN blank.

DEST ....Enter

Route ....Enter

LEGS key .... Select

Enter the latitude and longitude of the departure airport as the first waypoint on the route.

ACTIVATE and execute the route.

VNAV key .... Select

Shows the CLB page.

TRANS ALT ....Enter

NAV RAD key .... Select

Departure navaid frequency and CRS (as needed) ....Enter

LDG ALT switch...MAN

LDG ALT selector..................Rotate to set the departure airport altitude

Reduces crew workload in the event of a return to the departure airport.

Do **not** accomplish the following checklist:

LANDING ALT

After engine start, cancel the LANDING ALT message.

Note: The touchdown zone indicator (amber crosshatched area) is not shown on the PFD altitude tape.

When no longer needed, delete the departure navaid frequency and CRS.

Before Descent

LDG ALT switch ....AUTO

The FMC sets the destination altitude automatically.

VNAV key ....Select

NEXT PAGE key ....Select

FORECAST ....Select

Shows the DESCENT FORECAST page.

TRANS LVL ....Enter

Overwrites the manually entered departure airport transition altitude.

Destination Airport Not in the FMC Navigation Database

CDU Preflight Procedure - Captain and First Officer

The following steps can also be done in flight:

LEGS key ....Select

Enter the latitude and longitude of the destination airport as the final waypoint on the route.

Enter a speed/altitude constraint for the final waypoint. The speed constraint should be the planned approach speed and the altitude constraint should be the destination airport elevation.

ACTIVATE (if needed) and execute the route.

Before Descent

VNAV key ....Select

NEXT PAGE key ....Select

FORECAST ....Select

Shows the DESCENT FORECAST page.

TRANS LVL ....Enter

LDG ALT switch ....MAN

LDG ALT selector ....Rotate to set the destination airport altitude

Do **not** accomplish the following checklist:

LANDING ALT

Cancel the LANDING ALT message.

Note: The touchdown zone indicator (amber crosshatched area) is not shown on the PFD altitude tape during landing.

Note: The ARRIVALS page is not available for the destination airport.

Before Approach

NAV RAD key .... Select

Destination navaid frequency and CRS (as needed) ....Enter

ND mode selector .... As needed

Select APP, VOR or MAP based on the type of approach to be flown.

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

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Weather Radar Mode selector ....TEST

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.

Weather Radar Mode selector .... As desired

Weather Radar Test

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Weather Radar Mode selector .... non-TEST mode

ND Mode selector .... MAP

EFIS WXR switch .... Push

Note: In the short time the weather radar is on and not in the TEST position, it will radiate.

Weather Radar Mode selector ....TEST

Observe the following sequence (approximately 20 seconds).

Amber windshear caution light illuminates and the aural message "monitor radar display" is initiated, then Master Warning light illuminates. The windshear fail message is displayed on the flight deck, then Red windshear warning light will illuminate and the aural message "go around, windshear ahead, windshear ahead, windshear ahead" is initiated. During this time period the "rainbow" (with embedded windshear icon) self-test is displayed.

EFIS WXR switch .... Push

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

Weather Radar Mode selector .... As desired

Weather Radar Test

570

Weather Radar Mode switch (non-TEST) ....Push

ND Mode selector ....MAP

EFIS WXR switch ....Push

Note: In the short time the weather radar is on and not in the TEST position, it will radiate.

Weather Radar Mode TEST switch ....Push

Observe the following sequence (approximately 20 seconds).

Amber windshear caution light illuminates and the aural message "monitor radar display" is initiated, then Master Warning light illuminates. The windshear fail message is displayed on the flight deck, then Red windshear warning light will illuminate and the aural message "go around, windshear ahead, windshear ahead, windshear ahead" is initiated. During this time period the "rainbow" (with embedded windshear icon) self-test is displayed.

EFIS WXR switch ....Push

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

Desired Mode switch ....Push

Intentionally
Blank

Fuel Balancing

Consider the possibility of an engine fuel leak. If fuel imbalance has occurred without indications of a fuel leak, fuel may be balanced.

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.

Intentionally
Blank

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.

Takeoff - Wet or Contaminated Runway Conditions

The following information applies to takeoffs on wet or contaminated runways:

- For wet runways, reduced thrust (fixed derate, assumed temperature method, or both) is allowed provided suitable takeoff performance accountability is made for the increased stopping distance on a wet surface
- For runways contaminated by slush, snow, standing water, or ice, reduced thrust (fixed derate) is allowed provided takeoff performance accounts for the runway surface condition. Reduced thrust using assumed temperature method, whether alone or in combination with a fixed derate is not allowed
- V1 may be reduced to minimum V1 to provide increased stopping margin provided the field length required for a continued takeoff from the minimum V1 and obstacle clearance meet the regulatory requirements. The determination of such minimum V1 may require a real-time performance calculation tool or other performance information supplied by dispatch
- Takeoffs are not recommended when slush, wet snow, or standing water depth is more than 1/2 inch (13 mm) or dry snow depth is more than 4 inches (102mm).

Cold Weather Operation

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

Icing conditions exist when OAT (on the ground) or TAT (in flight) is 10°C or below, and any of the following exist:

- visible moisture (clouds, fog with visibility of one statute mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on) is present, or
- ice, snow, slush, or standing water is present on the ramps, taxiways, or runways.

CAUTION: Do not use nacelle anti-ice when OAT (on the ground) is above 10°C. Do not use nacelle or wing anti–ice when TAT (in flight) is above 10°C.

Exterior Inspection

Although removal of surface snow, ice, and frost is normally a maintenance function, during preflight procedures, the captain or first officer should carefully inspect areas where surface snow or frost could change or affect normal system operations.

Do the normal Exterior Inspection with the following additional steps:

Surfaces .... 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.

Pitot probes and static ports .... Check

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

Air conditioning inlets and exits .... Clear

Verify that the air inlets and exits, including the outflow valves, are clear of snow or ice.

Engine inlets .... Clear

Verify that the inlet cowling is free of snow and ice.

Fuel tank vents .... Clear

Verify that all traces of ice or frost are removed.

Landing gear doors .... Check

Landing gear doors should be free of snow and ice.

APU air inlets .... Check

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

Engine Start Procedure

Do the normal Engine Start Procedure with the following considerations:

- Oil pressure may be slow to rise
- Initial oil pressure rise may be higher than normal
- Additional warm-up time may be needed to allow oil temperature to reach the normal range
- Airplanes with LCD displays: Displays may require additional warm-up time before displayed engine indications accurately show changing values. Displays may appear less bright than normal.

Nacelle Anti–Ice Operation – On the Ground

Nacelle anti–ice must be selected ON immediately after all engines are started and remain on during all ground operations when icing conditions exist or are anticipated except when temperature is less than -40°C OAT.

WARNING: Do not rely on airframe visual icing cues before activating nacelle anti–ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in damage or failure.

CAUTION: Do not use nacelle anti-ice when OAT is above 10° C.

When nacelle anti–ice is needed:

Nacelle anti-ice switches ....ON F/O

When nacelle anti-ice is no longer needed:

Nacelle Anti-ice switches .... OFF F/O

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

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

Call “FLAPS ___” as needed. C

Flap lever .... Set flaps, as needed F/O

Taxi-Out

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust evenly and smoothly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.

When nacelle anti-ice is required and the OAT is 3°C or below, do an engine run up, as needed, to minimize ice build-up. Use the following procedure: C

Check that the area behind the airplane is clear.

570
Run-up to a minimum of 60% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes.

109, 405
Run-up to a minimum of 50% N1 for approximately 1 second duration at intervals no greater than 15 minutes.

De-icing / Anti-icing

Testing of undiluted de-iciing/anti-icing fluids has shown that some of the fluid remains on the wing during takeoff rotation and initial climb. The residual fluid causes a temporary decrease in lift and increase in drag, however, the effects are temporary. Use the normal takeoff rotation rate.

CAUTION: Operate the APU during de-icing only if necessary. If the APU is running, ingestion of de-icing fluid causes objectionable fumes and odors to enter the airplane. Ingestion of snow, slush, ice, or de-icing/anti-icing fluid can also damage to the APU.

If de-icing / anti-icing is needed:

APU ....As needed F/O

The APU should be shut down unless APU operation is necessary.

Call “FLAPS UP”. C

Flaps .... UP F/O

Prevents ice and slush from accumulating in flap cavities during de-icing.

Thrust levers .... Idle C

Reduces the possiblity of injury to personnel at inlet or exhaust area.

Pack control selectors .... OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

APU bleed air switch (APU running) .... OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

After de-icing / anti-icing is completed:

APU ....As needed F/O

APU bleed valve switch (APU running) ....ON F/O

Wait approximately one minute after de-icing is completed to turn pack selectors on to ensure all de-icing fluid has been cleared from the engines.

Pack control selectors .... NORM F/O

Before Takeoff Procedure

Do the normal Before Takeoff Procedure with the following modification:

Call “FLAPS ___” as needed for takeoff. PF

Flap lever .... Set takeoff flaps, as needed PM

Extend the flaps to the takeoff setting at this time if they have been held due to slush, standing water, or icing conditions, or because of exterior de-icing / anti-icing.

Takeoff Procedure

Do the normal Takeoff Procedure with the following modifications.

When nacelle anti-ice is required and the OAT is 3°C or below, the takeoff must be preceeded by a static engine run-up. Use the following procedure: PF

570
Run-up to a minimum of 60% N1 for approximately 30 seconds duration and confirm stable engine operation before the start of the takeoff roll.

109, 405
Run-up to a minimum of 50% N1 and confirm stable engine operation before the start of the takeoff roll.

Nacelle Anti-ice Operation - In flight

Nacelle anti-ice must be ON 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 before entering icing conditions.

WARNING: Do not rely on airframe visual icing cues before activating nacelle anti-ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in engine damage or failure.

CAUTION: Do not use nacelle anti-ice when TAT is above 10°C.

When nacelle anti-ice is needed:

Nacelle anti-ice switches ....ON PM

When nacelle anti-ice is no longer needed:

Nacelle anti-ice switches .... OFF PM

Fan Ice Removal

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CAUTION: Avoid prolonged operation in moderate to severe icing conditions.

If moderate to severe icing conditions are encountered:

During flight in moderate to severe icing conditions for prolonged periods with N1 settings at or below 70%, or when fan icing is suspected due to high engine vibration, the fan blades must be cleared of any ice. Do the following procedure every 10 minutes on all engines, one engine at a time: increase thrust to a minimum of 70% N1 for 10 to 30 seconds.

Wing Anti-ice Operation - In flight

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.

The wing anti-ice system may be used as a de-icer or anti-icer in flight only. The primary method is to use it as a de-icer 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. Normally, it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).

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

CAUTION: Do not use wing anti-ice when TAT is above 10°C.

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

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

When wing anti-ice is needed:

WING ANTI-ICE switch .... ON PM

When wing anti-ice is no longer needed:

WING ANTI-ICE switch ....OFF PM

Cold Temperature Altitude Corrections

Extremely low temperatures create significant altimeter errors and greater potential for reduced terrain clearance. When the temperature is colder than ISA, true altitude will be lower than indicated altitude. Altimeter errors become significantly larger when the surface temperature approaches -30°C or colder, and also become larger with increasing height above the altimeter reference source.

Apply the altitude correction table when needed:

- no corrections are needed for reported temperatures above 0°C or if the airport temperature is at or above the minimum published temperature for the procedure being flown
- do not correct altimeter barometric reference settings
- corrections apply to QNH and QFE operations
- ATC assigned altitudes or flight levels should not be adjusted for temperature when under radar control
- apply corrections to all published minimum departure, enroute and approach altitudes, including missed approach altitudes according to the table below. Advise ATC of the corrections
- MDA/DA settings should be set at the corrected minimum altitudes for the approach
- subtract the elevation of the altimeter barometric reference setting source (normally the departure or destination airport elevation) from the published minimum altitude to be flown to determine “height above altimeter reference source”

- enter the table with Airport Temperature and with "height above altimeter reference source." Read the correction where these two entries intersect. Add the correction to the published minimum altitude to be flown to determine the corrected indicated altitude to be flown. To correct an altitude above the altitude in the last column, use linear extrapolation (e.g., to correct 6000 feet or 1800 meters, use twice the correction for 3000 feet or 900 meters, respectively). The corrected altitude must always be greater than the published minimum altitude
- if the corrected indicated altitude to be flown is between 100 foot increments, set the MCP altitude to the closest 100 foot increment above the corrected indicated altitude to be flown

Altitude Correction Table (Heights and Altitudes in Feet)

Airport Temp °C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0°	20	20	30	30	40	40	50	50	60	90	120	170
-10°	20	30	40	50	60	70	80	90	100	150	200	290
-20°	30	50	60	70	90	100	120	130	140	210	280	420
-30°	40	60	80	100	120	140	150	170	190	280	380	570
-40°	50	80	100	120	150	170	190	220	240	360	480	720
-50°	60	90	120	150	180	210	240	270	300	450	590	890

Altitude Correction Table (Heights and Altitudes in Meters)

Airport Temp °C	Height Above Altimeter Reference Source											
	60 MTRS	90 MTRS	120 MTRS	150 MTRS	180 MTRS	210 MTRS	240 MTRS	270 MTRS	300 MTRS	450 MTRS	600 MTRS	900 MTRS
0°	5	5	10	10	10	15	15	15	20	25	35	50
-10°	10	10	15	15	20	20	25	30	30	45	60	90
-20°	10	15	20	25	25	30	35	40	45	65	85	130
-30°	15	20	25	30	35	40	45	55	60	85	115	170
-40°	15	25	30	40	45	50	60	65	75	110	145	220
-50°	20	30	40	45	55	65	75	80	90	135	180	270

After Landing Procedure

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust evenly and smoothly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.

Do the normal After Landing Procedure with the following modifications:

After prolonged operation in icing conditions with the flaps extended, or when an accumulation of airframe ice is observed, or when operating on a runway contaminated with ice, snow, slush, or standing water:

Do not retract the flaps to less than flaps 25 until the flap areas have been checked to be free of contaminants.

Nacelle anti-ice must be selected ON and remain on during all ground operations when icing conditions exist or are anticipated, except when the temperature is below -40°C OAT.

WARNING: Do not rely on airframe visual cues before activating nacelle anti-ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in engine damage or failure.

CAUTION: Do not use nacelle anti-ice when OAT is above 10°C.

When nacelle anti-ice is needed:

Nacelle anti-ice switches ....ON F/O

When nacelle anti-ice is no longer needed:

Nacelle anti-ice switches .... OFF F/O

When nacelle anti-ice is required and the OAT is 3°C or below, do an engine run up as needed, to minimize ice build-up. Use the following procedure: C

Check that the area behind the airplane is clear.

570
Run-up to a minimum of 60% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes.

109, 405
Run-up to a minimum of 50% N1 for approximately 1 second duration at intervals no greater than 15 minutes.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the airplane will be attended:

PACK control selectors .... NORM F/O

If the airplane will not be attended, or if staying overnight at off-line stations or at airports where normal support is not available, the flight crew must arrange for or verify that the following steps are done:

Outflow valve manual switches ....ON F/O

Outflow valve manual control ....CLOSE F/O

Position the outflow valves fully closed to inhibit the intake of snow and ice.

Wheel chocks .... Verify in place C or F/O

Parking brake .... Released C

Reduces the possibility of frozen brakes.

Cold weather maintenance procedures for securing the airplane may be required. These procedures are found in the approved Airplane Maintenance Manual.

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

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- alternate takeoff procedures (Packs Off Takeoff, APU-to-Pack Takeoff, etc.)

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- alternate takeoff procedures (e.g. APU-to-Pack Takeoff)

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

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- 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, 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

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- open all passenger cabin gasper outlets and close all window shades on the sun–exposed side of the passenger cabin

Note: If only cooling air from ground air conditioning cart is supplied (no pressurized air from the APU or ground external air), then the TAT probes are not aspirated. Because of high TAT probe temperatures, the FMCs may not accept an assumed temperature derate. Delay selecting an assumed temperature derate until after bleed air is available.

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

Moderate to Heavy Rain, Hail, or Sleet

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Flight should be conducted to avoid thunderstorms, hail activity or visible moisture over storm cells. To the maximum extent possible, moderate to heavy rain, hail, or sleet should also be avoided.

If heavy rain or hail encountered or anticipated:

If TAT 10°C or below:

Nacelle Anti-ice switches ....ON

Provides continuous ignition for flameout protection and maintains a minimum thrust setting of approach idle.

During descent:

Autothrottles ....Disconnect

If TAT above 10°C:

Continuous Ignition switch ....ON

Provides flameout protection.

During descent:

Autothrottles ....Disconnect

Thrust levers ....Set

Set minimum of 50% N1 at or above 10,000 feet, 45% N1 below 10,000 feet, except for landing.

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.

Moderate to Heavy Rain, Hail, or Sleet

405, 570

Flight should be conducted to avoid thunderstorms, hail activity or visible moisture over storm cells. To the maximum extent possible, moderate to heavy rain, hail, or sleet should also be avoided.

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

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

405, 570
Advise supernumeraries to fasten seat belts prior to entering areas of reported or anticipated turbulence.

In moderate to severe turbulence:

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 benefits 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.

During cruise, VNAV and altitude hold modes each fly speed on autothrottles and can be used in turbulence.

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 altitude 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

Windshear is a change of wind speed and/or direction over a short distance along the flight path. Indications of windshear are listed in the Windshear Non-normal Maneuver in this manual.

Avoidance

The flight crew should search for any clues to the presence of windshear along the intended flight path. Presence of windshear may be indicated by:

- Thunderstorm activity
- Virga (rain that evaporates before reaching the ground)
- Pilot reports
- Low level windshear alerting system (LLWAS) warnings.

Stay clear of thunderstorm cells and heavy precipitation and areas of known windshear. If the presence of windshear is confirmed, delay takeoff or do not continue approach.

Precautions

If windshear is suspected, be especially alert to any of the danger signals and be prepared for the possibility of an inadvertent encounter. The following precautionary actions are recommended if windshear is suspected:

Takeoff

- Use maximum takeoff thrust instead of reduced thrust. Use of derate is acceptable when required for Low Gross Weight/Aft CG Takeoffs.
- For optimum takeoff performance, use flaps 20 for takeoff unless limited by obstacle clearance and/or climb gradient.
- Use the longest suitable runway provided it is clear of areas of known windshear.
- Use the flight director after takeoff.
- increasing the Vr speed to the performance limited gross weight rotation speed, not to exceed actual gross weight Vr + 20 knots. Set V speeds for the actual gross weight. Rotate at the adjusted (higher) rotation speed. This increased rotation speed results in an increased stall margin, and meets takeoff performance requirements. If windshear is encountered at or beyond the actual gross weight Vr, do not attempt to accelerate to the increased Vr, but rotate without hesitation.

- Be alert for any airspeed fluctuations during takeoff and initial climb. Such fluctuations may be the first indication of windshear.
- Know the all-engine initial climb pitch attitude. Rotate at the normal rate to this attitude for all non-engine failure takeoffs. Minimize reductions from the initial climb pitch attitude until terrain and obstruction clearance is assured, unless stick shaker activates.
- Crew coordination and awareness are very important. Develop an awareness of normal values of airspeed, attitude, vertical speed, airspeed buildup. Closely monitor vertical flight path instruments such as vertical speed and altimeters. The pilot monitoring should be especially aware of vertical path instruments and call out any deviations from normal.
- Should airspeed fall below the trim airspeed, unusual control column forces may be required to maintain the desired pitch attitude. Stick shaker must be respected at all times.

Approach and Landing

- Use Flaps 25 or 30 for landing.
- Establish a stabilized approach no lower than 1,000 feet above the airport to improve windshear recognition capability.
- Use the most suitable runway that avoids the areas of suspected windshear and is compatible with crosswind or tailwind limitations. Use ILS G/S, VNAV path or VASI/PAPI indications to detect flight path deviations and help with timely detection of windshear.
- If the autothrottle is disengaged, or is planned to be disengaged prior to landing, add an appropriate airspeed correction (correction applied in the same manner as gust), up to a maximum of 20 knots.
- Avoid large thrust reductions or trim changes in response to sudden airspeed increases, as these may by followed by airspeed decreases.
- Crosscheck flight director commands using vertical flight instruments.
- Crew coordination and awareness are very important, particularly at night or in marginal weather conditions. Closely monitor the vertical flight path instruments such as vertical speed, altimeters and glide slope displacement. The pilot monitoring should call out any deviations from normal. Use of the autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

Accomplish the WINDSHEAR maneuver found in the Non-Normal Maneuvers section of this manual.

Windshield Washer and Rain Repellent

109

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

Windshield Washer

405, 570

Note: Do not use windshield wipers on dry window.

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

Windshield Wiper selector .... As required

Intentionally
Blank

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747-400 PW4056 KG FAA JAR

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Performance Inflight - General

Chapter PI
Section 10

Maximum Allowable Clearway

FIELD LENGTH (M)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (M)
2000	160
2500	180
3000	200
3500	210
4000	220
4500	230

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (M)	NORMAL V1 (KIAS)				
	100	120	140	160	180
300	-3	-3	-3	-3	-3
200	-2	-2	-2	-2	-2
100	-1	-1	-1	-1	-1
0	0	0	0	0	0
-100	1	1	1	1	1
-200	2	2	2	2	2
-300	3	3	3	3	3

VREF (KIAS)

WEIGHT (1000 KG)	FLAPS	
	30	25
400	184	192
380	179	187
360	174	181
340	168	176
320	163	170
300	157	164
280	152	158
260	146	152
240	140	146
220	133	139
200	127	132

Increase VREF 1 knot/4000 ft above sea level.

Flap Maneuver Speeds

FLAP POSITION	MANEUVER SPEED
UP	VREF 30 + 80
1	VREF 30 + 60
5	VREF 30 + 40
10	VREF 30 + 20
20	VREF 30 + 10
25	VREF 25
30	VREF 30

ADVISORY INFORMATION

Slush/Standing Water Takeoff

2 Engine Reverse Thrust

Weight Adjustment (1000 KG)

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440				-35	-35	-35	-52	-52	-52
420	-27	-27	-27	-34	-34	-34	-51	-51	-51
400	-25	-25	-25	-32	-32	-32	-50	-50	-50
380	-24	-24	-24	-31	-31	-31	-48	-48	-48
360	-22	-22	-22	-29	-29	-29	-47	-47	-47
340	-21	-21	-21	-28	-28	-28	-46	-46	-46
320	-19	-19	-19	-26	-26	-26	-45	-45	-45
300	-18	-18	-18	-25	-25	-25	-44	-44	-44
280	-16	-16	-16	-23	-23	-23	-42	-42	-42

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
2400							204		
2600				203			240		
2800	215			241			278	208	
3000	254			278	207		314	244	
3200	292	220		316	245		351	281	211
3400	331	259		355	283		389	319	249
3600	371	297	224	393	321	250	427	356	286
3800	409	336	263	430	358	287		393	323
4000		374	301		396	325		429	360
4200		414	340		435	363			397
4400			379			401			
4600			419			438			

1. **Enter Weight Adjustment table with slush/standing water depth and field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 12000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-31	-29	-27	-27	-25	-23	-16	-14	-12
380	-32	-30	-28	-28	-26	-24	-17	-15	-13
360	-33	-31	-29	-29	-27	-25	-19	-17	-15
340	-34	-32	-30	-30	-28	-26	-21	-19	-17
320	-35	-33	-31	-31	-29	-27	-23	-21	-19
300	-35	-33	-31	-32	-30	-28	-25	-23	-21
280	-35	-33	-31	-32	-30	-28	-26	-24	-22

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Weight Adjustment (1000 KG)

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440	-32	-32	-32	-41	-41	-41	-64	-64	-64
420	-31	-31	-31	-39	-39	-39	-61	-61	-61
400	-29	-29	-29	-37	-37	-37	-58	-58	-58
380	-27	-27	-27	-35	-35	-35	-55	-55	-55
360	-25	-25	-25	-33	-33	-33	-52	-52	-52
340	-23	-23	-23	-30	-30	-30	-50	-50	-50
320	-21	-21	-21	-28	-28	-28	-47	-47	-47
300	-19	-19	-19	-26	-26	-26	-44	-44	-44
280	-18	-18	-18	-24	-24	-24	-41	-41	-41

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3000							236		
3200							274		
3400				246			313	248	
3600	239			289	216		352	286	221
3800	285	209		331	258		389	324	258
4000	329	253		374	301	229	428	362	297
4200	374	299	222	417	345	272	467	401	336
4400	418	342	266	459	387	314		439	374
4600	463	387	311		430	357		477	413

1. **Enter Weight Adjustment table with slush/standing water depth and field/obstacle limit weight to obtain adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 decrease VMCG limit weight by 14000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-39	-37	-34	-34	-31	-28	-21	-18	-15
380	-41	-38	-35	-35	-33	-30	-23	-20	-17
360	-42	-39	-36	-37	-34	-31	-24	-22	-19
340	-42	-39	-37	-38	-35	-32	-26	-24	-21
320	-43	-40	-37	-39	-36	-33	-29	-26	-23
300	-43	-40	-37	-39	-37	-34	-31	-28	-25
280	-43	-40	-38	-40	-38	-35	-33	-30	-27

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 3 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

Slippery Runway Takeoff
2 Engine Reverse Thrust
Weight Adjustment (1000 KG)

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-6	-6	-6	-18	-18	-18
380	0	0	0	-7	-7	-7	-17	-17	-17
360	0	0	0	-7	-7	-7	-16	-16	-16
340	0	0	0	-6	-6	-6	-15	-15	-15
320	0	0	0	-6	-6	-6	-14	-14	-14
300	0	0	0	-6	-6	-6	-12	-12	-12
280	0	0	0	-5	-5	-5	-11	-11	-11
260	0	0	0	-4	-4	-4	-9	-9	-9
240	0	0	0	-3	-3	-3	-7	-7	-7

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1800	226								
2000	296	210							
2200	367	281	195						
2400	437	351	265	200					
2600		422	336	257					
2800			407	316	237				
3000				373	294	216			
3200				431	352	274			
3400					410	331	224		
3600						389	263		
3800							303	234	
4000							342	274	205
4200							383	314	245
4400							422	353	284
4600								394	325
4800								433	367
5000									412

1. **Enter Weight Adjustment table with reported braking action and field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 10000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-6	-5	-4	-23	-19	-16	-43	-38	-33
380	-8	-7	-6	-25	-21	-18	-46	-41	-36
360	-9	-8	-7	-27	-23	-20	-48	-43	-38
340	-11	-10	-9	-29	-25	-22	-50	-45	-40
320	-13	-12	-11	-31	-27	-24	-52	-47	-42
300	-14	-13	-12	-32	-28	-25	-53	-48	-43
280	-15	-14	-13	-33	-29	-26	-54	-49	-44
260	-15	-14	-13	-34	-30	-27	-54	-49	-44
240	-15	-14	-13	-34	-30	-27	-54	-49	-44

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking, increase V1 by 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Weight Adjustment (1000 KG)

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-10	-10	-10	-21	-21	-21
380	0	0	0	-9	-9	-9	-20	-20	-20
360	0	0	0	-9	-9	-9	-19	-19	-19
340	0	0	0	-9	-9	-9	-18	-18	-18
320	-1	-1	-1	-8	-8	-8	-16	-16	-16
300	-1	-1	-1	-7	-7	-7	-14	-14	-14
280	-1	-1	-1	-7	-7	-7	-13	-13	-13
260	0	0	0	-6	-6	-6	-11	-11	-11
240	0	0	0	-4	-4	-4	-9	-9	-9

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1800	175								
2000	253	176							
2200	332	255	179						
2400	410	334	258						
2600		412	336						
2800			413	200					
3000				274	193				
3200				348	267	186			
3400				421	340	259			
3600					414	333			
3800						407			
4000									
4200							169		
4400							225		
4600							282		

1. **Enter Weight Adjustment table with reported braking action and field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find V1(MCG) limit weight for available field length and pressure altitude.For flaps 10 and poor reported braking action, decrease VMCG limit weight by 18000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-8	-6	-5	-28	-24	-21	-54	-50	-46
380	-10	-8	-7	-30	-27	-23	-56	-52	-48
360	-12	-10	-9	-33	-29	-26	-59	-55	-51
340	-14	-12	-11	-35	-31	-28	-61	-57	-53
320	-16	-14	-12	-37	-34	-30	-63	-59	-55
300	-17	-16	-14	-39	-36	-32	-65	-61	-57
280	-19	-17	-16	-41	-37	-34	-66	-62	-58
260	-20	-18	-16	-42	-38	-34	-67	-63	-59
240	-20	-18	-16	-42	-38	-35	-67	-63	-59

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking action, increase V1 by 2 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

Minimum Control Speeds

Max Takeoff Thrust

VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°C	°F	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
60	140	108	111	104	107	101	103	97	100	95	98	93	96	90	93	87	89
55	131	112	115	108	111	104	107	100	103	98	100	97	99	93	96	90	92
50	122	115	118	111	114	107	110	103	106	100	103	100	102	96	99	92	95
45	113	119	122	114	118	110	113	106	109	103	105	102	105	99	101	95	97
40	104	122	125	117	120	113	116	109	112	105	108	105	108	101	104	97	100
39	103	122	125	118	121	113	117	109	112	106	109	105	108	102	104	98	100
37	99	122	125	119	122	114	117	110	113	107	110	106	109	102	105	98	101
35	95	122	125	120	123	115	119	111	114	108	111	107	110	103	106	99	102
33	92	122	125	121	124	116	119	112	115	109	112	108	111	104	107	100	103
30	86	122	125	121	124	118	121	113	116	110	113	109	112	105	108	101	104
29	85	122	125	121	124	118	121	114	117	111	114	109	112	105	108	101	104
25	77	122	125	121	124	118	121	115	118	113	116	111	114	107	110	103	106
23	73	122	125	121	124	118	121	115	118	114	117	112	115	107	110	103	106
20	68	122	125	121	124	118	121	115	118	114	117	113	116	108	111	104	107
15	59	122	125	121	124	118	121	115	118	114	117	113	116	110	113	106	108
10	50	122	125	121	124	118	121	115	118	114	117	113	116	110	113	107	110
5	41	122	125	121	124	118	121	115	118	114	117	113	116	110	113	107	110
0	32	122	125	121	124	118	121	115	118	114	117	113	116	110	113	107	110
-55	-67	122	125	121	124	118	121	115	118	114	117	113	116	110	113	107	109

Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)																	
	89		90		95		100		105		110		115		120		125	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
260	104	22	105	21	109	20	115	19	121	18	127	17	133	17	139	17	145	17
240	104	20	104	20	109	19	115	18	121	18	127	17	133	17	139	17	145	17
220	103	19	104	19	109	18	115	18	121	17	127	17	133	17	140	17	146	18
200	103	18	104	18	109	18	115	18	121	17	128	17	134	17	140	18	147	18

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)																	
	89		90		95		100		105		110		115		120		125	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
240	105	23	106	23	111	21	116	21	123	20	129	19	135	19	141	19	147	19
220	105	22	106	21	111	21	116	20	123	19	129	19	135	19	142	20	148	20
200	105	21	106	20	111	20	117	19	123	19	129	19	136	19	142	20	149	20

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

8% Thrust Reduction

2 Engine Reverse Thrust

Weight Adjustment (1000 KG)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440				-34	-34	-34	-49	-49	-49
420	-27	-27	-27	-33	-33	-33	-48	-48	-48
400	-25	-25	-25	-31	-31	-31	-46	-46	-46
380	-24	-24	-24	-30	-30	-30	-45	-45	-45
360	-22	-22	-22	-28	-28	-28	-44	-44	-44
340	-20	-20	-20	-27	-27	-27	-43	-43	-43
320	-19	-19	-19	-25	-25	-25	-42	-42	-42
300	-17	-17	-17	-24	-24	-24	-40	-40	-40
280	-16	-16	-16	-22	-22	-22	-39	-39	-39

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L	4000	8000	S.L	4000	8000
2400							226		
2600	203			229			266		
2800	244			268			304	231	
3000	285	208		309	233		344	270	
3200	325	249		348	273		382	309	235
3400	366	289	212	387	312	237	421	347	274
3600	406	330	253	427	353	277		387	313
3800		370	293		392	317		426	352
4000		411	334		431	356			391
4200			375			397			429
4400			416			438			

1. **Enter Weight Adjustment table with slush/standing water depth and TO1 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 12000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
8% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-29	-27	-25	-24	-22	-20	-11	-9	-7
380	-30	-28	-26	-25	-23	-21	-12	-10	-8
360	-31	-29	-27	-26	-24	-22	-14	-12	-10
340	-32	-30	-28	-27	-25	-23	-17	-15	-13
320	-32	-30	-28	-28	-26	-24	-19	-17	-15
300	-33	-31	-29	-29	-27	-25	-21	-19	-17
280	-33	-31	-29	-29	-27	-25	-22	-20	-18

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

8% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 KG)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440	-31	-31	-31	-39	-39	-39	-62	-62	-62
420	-29	-29	-29	-37	-37	-37	-59	-59	-59
400	-27	-27	-27	-35	-35	-35	-56	-56	-56
380	-26	-26	-26	-33	-33	-33	-53	-53	-53
360	-24	-24	-24	-31	-31	-31	-51	-51	-51
340	-22	-22	-22	-29	-29	-29	-48	-48	-48
320	-20	-20	-20	-27	-27	-27	-45	-45	-45
300	-19	-19	-19	-25	-25	-25	-42	-42	-42
280	-17	-17	-17	-23	-23	-23	-40	-40	-40

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.5 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
2800							228		
3000							269		
3200				241			308	240	
3400	236			284			347	280	
3600	282			329	254		388	320	252
3800	328	250		373	298	222	427	359	291
4000	375	296		417	342	266		399	331
4200	421	342	263	462	387	311		439	371
4400	466	387	309		430	355			410
4600		433	355			399			451

1. **Enter Weight Adjustment table with slush/standing water depth and TO1 field/obstacle limit weight to obtain slush/standing water adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 14000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
8% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-34	-31	-28	-28	-25	-22	-13	-10	-7
380	-36	-33	-30	-30	-27	-23	-15	-12	-9
360	-37	-34	-31	-31	-28	-25	-17	-14	-11
340	-38	-34	-31	-33	-29	-26	-20	-16	-13
320	-38	-35	-32	-34	-30	-27	-22	-19	-16
300	-38	-35	-32	-34	-31	-28	-24	-21	-18
280	-39	-36	-32	-36	-32	-29	-27	-24	-21
260	-38	-35	-32	-35	-32	-29	-29	-25	-22
240	-36	-33	-29	-34	-30	-27	-28	-25	-22
220	-35	-32	-29	-33	-30	-27	-29	-26	-23
200	-35	-32	-28	-33	-30	-27	-30	-27	-23

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 3 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
8% Thrust Reduction
2 Engine Reverse Thrust
Weight Adjustment (1000 KG)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-4	-4	-4	-16	-16	-16
380	0	0	0	-5	-5	-5	-16	-16	-16
360	0	0	0	-6	-6	-6	-16	-16	-16
340	0	0	0	-6	-6	-6	-15	-15	-15
320	0	0	0	-6	-6	-6	-14	-14	-14
300	0	0	0	-6	-6	-6	-12	-12	-12
280	0	0	0	-5	-5	-5	-11	-11	-11
260	0	0	0	-5	-5	-5	-9	-9	-9
240	0	0	0	-4	-4	-4	-8	-8	-8
220	0	0	0	-3	-3	-3	-6	-6	-6

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1800	248								
2000	318	233							
2200	389	303	218						
2400	458	373	287	233					
2600		443	358	293	213				
2800			428	353	273	193			
3000				412	332	252			
3200					392	312	213		
3400					451	371	255		
3600						432	296	225	
3800							337	267	
4000							377	308	237
4200							420	349	279
4400								390	320
4600								431	361
4800									402

1. **Enter Weight Adjustment table with reported braking action and TO1 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 10000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
8% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-4	-3	-2	-19	-15	-12	-39	-34	-29
380	-6	-5	-4	-22	-18	-15	-41	-36	-31
360	-8	-7	-6	-25	-21	-18	-44	-39	-34
340	-10	-9	-8	-27	-23	-20	-47	-42	-37
320	-11	-10	-9	-29	-25	-22	-49	-44	-39
300	-12	-11	-10	-31	-27	-24	-50	-45	-40
280	-13	-12	-11	-32	-28	-25	-50	-45	-40
260	-14	-13	-12	-32	-28	-25	-50	-45	-40
240	-14	-13	-12	-32	-28	-25	-50	-45	-40
220	-14	-13	-12	-32	-28	-25	-50	-45	-40

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking, increase V1 by 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

8% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 KG)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-7	-7	-7	-19	-19	-19
380	0	0	0	-7	-7	-7	-18	-18	-18
360	0	0	0	-7	-7	-7	-17	-17	-17
340	0	0	0	-7	-7	-7	-16	-16	-16
320	0	0	0	-7	-7	-7	-15	-15	-15
300	0	0	0	-6	-6	-6	-14	-14	-14
280	0	0	0	-6	-6	-6	-12	-12	-12
260	0	0	0	-5	-5	-5	-10	-10	-10
240	0	0	0	-4	-4	-4	-9	-9	-9
220	0	0	0	-3	-3	-3	-7	-7	-7

VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L	4000	8000	S.L	4000	8000
1800	209								
2000	285	211							
2200	361	286	213						
2400	438	363	289						
2600		440	365	181					
2800			440	253	173				
3000				327	247	166			
3200				400	320	240			
3400				472	392	312			
3600					466	385			
3800						459			
4000							172		
4200							231		
4400							290	203	
4600							349	263	

1. **Enter Weight Adjustment table with reported braking action and TO1 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limited weight by 18000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
8% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-5	-3	-1	-22	-18	-15	-46	-42	-37
380	-7	-5	-3	-25	-21	-17	-50	-45	-40
360	-9	-7	-5	-28	-24	-20	-53	-48	-44
340	-11	-9	-7	-30	-26	-22	-56	-51	-46
320	-12	-11	-9	-33	-29	-25	-58	-53	-49
300	-14	-12	-11	-35	-31	-27	-60	-55	-51
280	-16	-14	-12	-37	-33	-28	-62	-57	-52
260	-17	-15	-13	-38	-34	-30	-62	-58	-53
240	-17	-15	-13	-38	-34	-30	-62	-58	-53
220	-16	-15	-13	-38	-34	-29	-62	-57	-52

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking action, increase V1 by 2 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

TO1 Minimum Control Speeds

8% Thrust Reduction

VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°C	°F	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
60	140	104	107	100	103	97	99	93	96	91	94	90	92	87	89	84	86
55	131	107	110	104	106	100	103	96	99	94	96	93	95	89	92	86	89
50	122	111	114	107	110	103	106	99	102	96	99	96	98	92	95	89	91
45	113	114	117	110	113	106	109	102	105	99	101	98	101	95	97	91	94
40	104	117	120	112	115	109	111	105	107	101	104	101	103	97	100	93	96
39	103	117	120	113	116	109	112	105	108	101	104	101	104	98	100	94	96
37	99	117	120	114	117	110	113	106	109	102	105	102	105	98	101	95	97
35	95	117	120	115	118	111	114	107	110	103	106	103	106	99	102	96	98
33	92	117	120	116	119	111	115	107	110	104	107	104	106	100	102	96	99
30	86	117	120	116	119	113	116	109	112	106	109	105	108	101	104	97	100
29	85	117	120	116	119	113	116	109	112	106	109	105	108	101	104	97	100
25	77	117	120	116	119	113	116	111	114	108	111	106	109	102	105	99	101
23	73	117	120	116	119	113	116	111	114	109	112	107	110	103	106	99	102
20	68	117	120	116	119	113	116	111	114	109	112	108	111	104	107	100	103
15	59	117	120	116	119	113	116	111	114	109	112	108	111	105	108	101	104
10	50	117	120	116	119	113	116	111	113	109	112	108	111	105	108	102	105
5	41	117	120	116	119	113	116	111	113	109	112	108	111	105	108	102	105
0	32	117	120	116	119	113	116	111	113	109	112	108	111	105	108	102	105
-55	-67	117	120	116	119	113	116	110	113	109	112	108	111	105	108	102	105

Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)															
	86		90		95		100		105		110		115		120	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
240	101	21	104	20	109	19	115	18	121	18	127	17	133	17	139	17
220	101	20	104	19	109	18	115	18	121	17	127	17	133	17	140	17
200	100	19	104	18	109	18	115	18	121	17	128	17	134	17	140	18

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)															
	86		90		95		100		105		110		115		120	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
220	102	22	106	21	111	21	116	20	123	19	129	19	135	19	142	20
200	102	21	106	20	111	20	117	19	123	19	129	19	136	19	142	20

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
20% Thrust Reduction
2 Engine Reverse Thrust
Weight Adjustment (1000 KG)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440				-34	-34	-34	-47	-47	-47
420	-27	-27	-27	-33	-33	-33	-46	-46	-46
400	-25	-25	-25	-31	-31	-31	-44	-44	-44
380	-24	-24	-24	-30	-30	-30	-43	-43	-43
360	-23	-23	-23	-28	-28	-28	-42	-42	-42
340	-21	-21	-21	-27	-27	-27	-41	-41	-41
320	-20	-20	-20	-25	-25	-25	-40	-40	-40
300	-18	-18	-18	-24	-24	-24	-38	-38	-38
280	-16	-16	-16	-22	-22	-22	-37	-37	-37

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440				-33	-33	-33	-46	-46	-46
420	-28	-28	-28	-32	-32	-32	-44	-44	-44
400	-26	-26	-26	-31	-31	-31	-43	-43	-43
380	-24	-24	-24	-29	-29	-29	-42	-42	-42
360	-23	-23	-23	-28	-28	-28	-41	-41	-41
340	-21	-21	-21	-26	-26	-26	-40	-40	-40
320	-20	-20	-20	-25	-25	-25	-38	-38	-38
300	-18	-18	-18	-23	-23	-23	-37	-37	-37
280	-16	-16	-16	-22	-22	-22	-36	-36	-36

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
20% Thrust Reduction
2 Engine Reverse Thrust
VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
2200							207		
2400				209			247		
2600	226			250			288	210	
2800	267	187		291	213		328	251	
3000	310	230		333	256		368	292	216
3200	353	272	192	374	297	219	409	332	256
3400	394	314	234	415	338	260		373	297
3600	436	357	277		379	301		413	337
3800		398	319		421	343			378
4000		441	361			384			418
4200			403			425			

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 12000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L	4000	8000	S.L	4000	8000
2200							223		
2400	201			228			265		
2600	245			269			306	228	
2800	288	207		312	232		347	269	
3000	332	250		355	275		389	311	232
3200	375	292	211	396	316	236	430	352	274
3400	417	336	255	439	359	279		393	315
3600		380	298		402	322		436	357
3800		424	341			363			398
4000			384			406			439

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 12000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

15% Thrust Reduction

20% Thrust Reduction

2 Engine Reverse Thrust

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-26	-24	-22	-21	-19	-17	-6	-4	-2
380	-27	-25	-23	-22	-20	-18	-8	-6	-4
360	-28	-26	-24	-23	-21	-19	-10	-8	-6
340	-30	-28	-26	-24	-22	-20	-13	-11	-9
320	-31	-29	-27	-26	-24	-22	-16	-14	-12
300	-31	-29	-27	-27	-25	-23	-17	-15	-13
280	-31	-29	-27	-27	-25	-23	-18	-16	-14

1. Obtain V1, VR and V2 for the actual weight.
2. If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-24	-22	-20	-18	-16	-14	-3	-1	0
380	-25	-23	-21	-20	-18	-16	-5	-3	-1
360	-27	-25	-23	-21	-19	-17	-7	-5	-3
340	-28	-26	-24	-22	-20	-18	-10	-8	-6
320	-28	-26	-24	-24	-22	-20	-12	-10	-8
300	-29	-27	-25	-25	-23	-21	-14	-12	-10
280	-29	-27	-25	-25	-23	-21	-17	-15	-13

1. Obtain V1, VR and V2 for the actual weight.
2. If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
20% Thrust Reduction
No Reverse Thrust
Weight Adjustment (1000 KG)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440	-34	-34	-34	-42	-42	-42	-64	-64	-64
420	-32	-32	-32	-40	-40	-40	-61	-61	-61
400	-30	-30	-30	-38	-38	-38	-58	-58	-58
380	-28	-28	-28	-35	-35	-35	-55	-55	-55
360	-26	-26	-26	-33	-33	-33	-52	-52	-52
340	-24	-24	-24	-31	-31	-31	-50	-50	-50
320	-22	-22	-22	-29	-29	-29	-46	-46	-46
300	-21	-21	-21	-27	-27	-27	-44	-44	-44
280	-19	-19	-19	-25	-25	-25	-41	-41	-41

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
440	-34	-34	-34	-42	-42	-42	-64	-64	-64
420	-32	-32	-32	-40	-40	-40	-61	-61	-61
400	-30	-30	-30	-38	-38	-38	-58	-58	-58
380	-28	-28	-28	-36	-36	-36	-55	-55	-55
360	-26	-26	-26	-34	-34	-34	-53	-53	-53
340	-24	-24	-24	-31	-31	-31	-50	-50	-50
320	-23	-23	-23	-29	-29	-29	-47	-47	-47
300	-21	-21	-21	-27	-27	-27	-44	-44	-44
280	-19	-19	-19	-25	-25	-25	-41	-41	-41

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
20% Thrust Reduction
No Reverse Thrust
VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
2600							215		
2800				183			256	186	
3000	176			228			296	227	
3200	224			273	196		337	268	198
3400	271	190		319	241	164	378	308	239
3600	319	238		364	287	209	419	349	279
3800	366	285	204	410	332	255		390	320
4000	414	333	252		378	300		431	361
4200		380	299		423	346			402
4400		428	347			391			443
4600			394			436			
4800			442						

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 15000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

FIELD LENGTH AVAILABLE (M)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
2600							234		
2800							277	205	
3000				254			320	248	
3200	253			302	221		362	290	217
3400	303			349	268		405	332	260
3600	352	268		397	316	235	448	375	303
3800	402	317	233	443	363	282		417	345
4000	451	367	282		410	330			388
4200		416	331		458	377			430
4400		466	381			424			
4600			431						

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 15000 kg.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
20% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-35	-32	-30	-28	-25	-23	-12	-9	-6
380	-37	-34	-32	-30	-27	-25	-14	-11	-9
360	-38	-35	-33	-32	-29	-26	-16	-14	-11
340	-39	-36	-33	-33	-30	-28	-19	-16	-13
320	-39	-37	-34	-34	-32	-29	-22	-19	-16
300	-40	-37	-34	-35	-33	-30	-24	-22	-19
280	-40	-37	-35	-37	-34	-31	-27	-25	-22
260	-39	-37	-34	-36	-34	-31	-29	-26	-23
240	-37	-34	-31	-35	-32	-29	-29	-26	-23
220	-36	-33	-30	-34	-31	-28	-29	-26	-24
200	-36	-33	-30	-34	-31	-28	-30	-27	-25

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 3 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-27	-23	-20	-20	-16	-12	-3	1	5
380	-29	-25	-21	-22	-18	-14	-5	-1	2
360	-30	-26	-23	-23	-20	-16	-7	-4	0
340	-31	-27	-23	-25	-21	-18	-10	-6	-3
320	-31	-27	-24	-26	-22	-19	-13	-9	-5
300	-31	-28	-24	-27	-23	-20	-16	-12	-8
280	-32	-29	-25	-29	-25	-21	-19	-15	-12
260	-32	-28	-25	-29	-25	-22	-21	-18	-14
240	-30	-26	-23	-27	-24	-20	-21	-18	-14
220	-29	-26	-22	-27	-24	-20	-22	-19	-15
200	-29	-26	-22	-28	-24	-20	-24	-20	-16

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10, decrease V1 by an additional 3 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
20% Thrust Reduction
2 Engine Reverse Thrust
Weight Adjustment (1000 KG)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-6	-6	-6	-17	-17	-17
380	0	0	0	-6	-6	-6	-16	-16	-16
360	0	0	0	-6	-6	-6	-16	-16	-16
340	0	0	0	-6	-6	-6	-15	-15	-15
320	0	0	0	-6	-6	-6	-14	-14	-14
300	0	0	0	-5	-5	-5	-12	-12	-12
280	0	0	0	-5	-5	-5	-11	-11	-11
260	0	0	0	-4	-4	-4	-9	-9	-9
240	0	0	0	-3	-3	-3	-8	-8	-8
220	0	0	0	-3	-3	-3	-6	-6	-6

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-7	-7	-7	-18	-18	-18
380	0	0	0	-7	-7	-7	-16	-16	-1
360	0	0	0	-6	-6	-6	-15	-15	-15
340	0	0	0	-5	-5	-5	-14	-14	-14
320	0	0	0	-5	-5	-5	-13	-13	-13
300	0	0	0	-4	-4	-4	-11	-11	-11
280	0	0	0	-4	-4	-4	-10	-10	-10
260	0	0	0	-3	-3	-3	-9	-9	-9
240	0	0	0	-2	-2	-2	-8	-8	-8
220	0	0	0	-2	-2	-2	-7	-7	-7

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

15% Thrust Reduction

20% Thrust Reduction

2 Engine Reverse Thrust
VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1600	204								
1800	271	189							
2000	339	257	174						
2200	406	324	242	201					
2400		391	309	261	180				
2600		458	376	320	240				
2800			444	380	300	220			
3000				439	359	280	199		
3200					419	339	241		
3400						399	282	211	
3600							325	253	181
3800							368	295	223
4000							410	337	265
4200								380	307
4400								422	350
4600									392
4800									434

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 10000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1600	216								
1800	284	201							
2000	352	270	186						
2200	420	337	255	220					
2400		405	322	279	198				
2600		472	390	338	259				
2800			458	398	318	238			
3000				457	377	297	215		
3200					437	357	260		
3400						417	304	229	
3600							348	273	197
3800							392	318	242
4000							435	361	286
4200								405	330
4400								449	374
4600									419

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 10000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
20% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-3	-2	-1	-17	-13	-10	-35	-30	-25
380	-5	-4	-3	-19	-15	-12	-39	-34	-29
360	-7	-6	-4	-22	-18	-15	-42	-37	-32
340	-9	-7	-6	-25	-21	-18	-44	-39	-34
320	-10	-9	-8	-27	-23	-20	-46	-41	-36
300	-11	-10	-9	-29	-25	-22	-48	-43	-38
280	-12	-11	-10	-31	-27	-24	-49	-44	-39
260	-13	-12	-11	-32	-28	-25	-49	-44	-39
240	-13	-12	-11	-32	-28	-25	-49	-44	-39
220	-12	-11	-10	-32	-28	-25	-49	-44	-39

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking, increase V1 by 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-4	-3	-2	-19	-15	-12	-39	-34	-29
380	-6	-5	-4	-22	-18	-15	-41	-36	-31
360	-8	-7	-6	-25	-21	-18	-44	-39	-34
340	-10	-9	-8	-27	-23	-20	-47	-42	-37
320	-11	-10	-9	-29	-25	-22	-49	-44	-39
300	-12	-11	-10	-31	-27	-24	-50	-45	-40
280	-13	-12	-11	-32	-28	-25	-50	-45	-40
260	-14	-13	-12	-32	-28	-25	-50	-45	-40
240	-14	-13	-12	-32	-28	-25	-50	-45	-40
220	-14	-13	-12	-32	-28	-25	-50	-45	-40

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking, increase V1 by 1 kt. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
20% Thrust Reduction
No Reverse Thrust
Weight Adjustment (1000 KG)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-9	-9	-9	-21	-21	-21
380	0	0	0	-8	-8	-8	-20	-20	-20
360	0	0	0	-8	-8	-8	-19	-19	-19
340	0	0	0	-8	-8	-8	-18	-18	-18
320	0	0	0	-8	-8	-8	-16	-16	-16
300	0	0	0	-7	-7	-7	-15	-15	-15
280	0	0	0	-7	-7	-7	-13	-13	-13
260	0	0	0	-6	-6	-6	-12	-12	-12
240	0	0	0	-5	-5	-5	-10	-10	-10
220	0	0	0	-4	-4	-4	-8	-8	-8

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-7	-7	-7	-19	-19	-19
380	0	0	0	-7	-7	-7	-18	-18	-18
360	0	0	0	-7	-7	-7	-17	-17	-17
340	0	0	0	-7	-7	-7	-16	-16	-16
320	0	0	0	-7	-7	-7	-15	-15	-15
300	0	0	0	-6	-6	-6	-14	-14	-14
280	0	0	0	-6	-6	-6	-13	-13	-13
260	0	0	0	-5	-5	-5	-11	-11	-11
240	0	0	0	-4	-4	-4	-9	-9	-9
220	0	0	0	-4	-4	-4	-8	-8	-8

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
20% Thrust Reduction
No Reverse Thrust
VMCG Limit Weight (1000 KG)

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1800	238								
2000	312	240							
2200	386	314	242						
2400		388	315						
2600			390	228					
2800				300	221				
3000				373	293	214			
3200				446	366	286			
3400					439	359			
3600						431			
4000							225		
4200							287	197	
4400							348	258	
4600							409	319	230

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limited weight by 19000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

FIELD LENGTH AVAILABLE (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
1600	184								
1800	255	185							
2000	327	257	187						
2200	401	329	258						
2400		402	330	186					
2600			405	258	180				
2800				330	251	172			
3000				403	324	245			
3200					396	316			
3400						389			
3600									
3800							205		
4000							268	177	
4200							330	238	
4400							392	300	209
4600								363	272

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limited weight by 19000 kg.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

15% Thrust Reduction

20% Thrust Reduction

No Reverse Thrust

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	-5	-3	-2	-21	-17	-13	-44	-40	-36
380	-6	-4	-3	-23	-19	-15	-47	-43	-39
360	-8	-6	-5	-25	-22	-18	-50	-46	-42
340	-10	-8	-7	-28	-25	-21	-53	-49	-45
320	-12	-10	-9	-31	-27	-24	-56	-52	-48
300	-14	-12	-11	-33	-30	-26	-58	-54	-50
280	-16	-15	-13	-36	-33	-29	-61	-57	-53
260	-16	-15	-13	-37	-33	-29	-61	-57	-53
240	-18	-16	-14	-38	-34	-31	-62	-58	-54
220	-16	-14	-13	-37	-33	-29	-60	-56	-52

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking action, increase V1 by 2 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
400	0	0	0	-14	-10	-6	-35	-29	-24
380	-2	-1	0	-17	-13	-9	-40	-34	-28
360	-4	-3	-1	-20	-16	-12	-44	-38	-32
340	-6	-5	-3	-23	-19	-14	-50	-44	-37
320	-8	-7	-5	-26	-21	-17	-57	-51	-45
300	-10	-8	-7	-29	-24	-19	-65	-59	-53
280	-12	-10	-9	-31	-26	-22	-62	-56	-50
260	-14	-12	-10	-33	-28	-23	-59	-53	-47
240	-14	-12	-10	-34	-29	-24	-56	-51	-45
220	-14	-12	-10	-33	-28	-23	-56	-50	-44

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. For flaps 10 and good reported braking action, increase V1 by 2 kts. If adjusted V1 is less than VMCG, set V1 = VMCG.**

TO2 Minimum Control Speeds

15% Thrust Reduction

20% Thrust Reduction

VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°C	°F	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
60	140	100	103	96	99	93	95	90	92	88	90	86	88	83	86	81	82
55	131	103	106	100	103	96	99	92	95	91	92	90	91	86	88	83	85
50	122	106	109	102	105	99	102	95	98	92	95	92	94	89	91	85	87
45	113	110	112	105	109	102	104	98	101	95	97	94	97	91	93	88	89
40	104	113	114	108	110	104	107	101	104	97	100	97	100	93	96	90	92
39	103	113	114	109	111	104	108	101	104	98	101	97	100	94	96	90	92
37	99	113	114	110	112	105	108	102	104	99	102	98	101	94	97	90	93
35	95	113	114	111	113	106	110	102	105	100	103	99	102	95	98	91	94
33	92	113	114	112	114	107	110	103	106	101	104	100	103	96	99	92	95
30	86	113	114	112	114	109	111	104	107	102	104	101	104	97	100	93	96
29	85	113	114	112	114	109	111	105	108	103	105	101	104	97	100	93	98
25	77	113	114	112	114	109	111	106	109	104	107	102	105	99	102	95	98
23	73	113	114	112	114	109	111	106	109	105	108	103	106	99	102	95	98
20	68	113	114	112	114	109	111	106	109	105	108	104	107	100	103	96	99
15	59	113	114	112	114	109	111	106	109	105	108	104	107	102	104	98	100
10	50	113	114	112	114	109	111	106	109	105	108	104	107	102	104	99	102
5	41	113	114	112	114	109	111	106	109	105	108	104	107	102	104	99	102
0	32	113	114	112	114	109	111	106	109	105	108	104	107	102	104	99	102
-55	-67	113	114	114	114	109	111	106	109	105	108	104	107	102	104	99	102

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°C	°F	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
60	140	97	100	94	96	90	93	87	90	86	88	84	87	81	84	78	81
55	131	100	103	97	99	93	96	90	93	88	90	87	89	84	86	81	83
50	122	103	106	100	102	96	99	93	95	90	92	89	92	86	89	83	86
45	113	106	109	102	105	99	101	95	98	92	95	92	94	89	91	85	88
40	104	109	112	105	108	101	104	98	100	94	97	94	97	91	93	87	90
39	103	109	112	105	108	102	104	98	101	95	97	94	97	91	94	88	90
37	99	109	112	106	109	102	105	99	102	96	98	95	98	92	94	88	91
35	95	109	112	107	110	103	106	100	102	97	99	96	99	93	95	89	92
33	92	109	112	108	111	104	107	100	103	97	100	97	99	93	96	90	92
30	86	109	112	108	111	105	108	101	104	99	102	98	100	94	97	91	93
29	85	109	112	108	111	106	108	102	104	99	102	98	101	95	97	91	94
25	77	109	112	108	111	106	108	103	106	101	104	99	102	96	98	92	95
23	73	109	112	108	111	106	108	103	106	102	105	100	103	96	99	93	95
20	68	109	112	108	111	106	108	103	106	102	105	101	104	97	100	93	96
15	59	109	112	108	111	106	108	103	106	102	105	101	104	98	101	95	97
10	50	109	112	108	111	106	108	103	106	102	105	101	104	98	101	96	98
-55	-67	109	112	108	111	106	108	103	106	102	104	101	104	98	101	96	98

TO2 Minimum Control Speeds
15% Thrust Reduction
20% Thrust Reduction
Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)															
	82		85		90		95		100		105		110		114	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
220	97	21	100	20	104	19	109	18	115	18	121	17	127	17	132	17
200	97	20	100	19	104	18	109	18	115	18	121	17	128	17	133	17

WEIGHT (1000 KG)	VRMIN (KIAS)															
	81		85		90		95		100		105		110		112	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
220	96	21	100	20	104	19	109	18	115	18	121	17	127	17	130	17
200	96	20	100	19	104	18	109	18	115	18	121	17	128	17	130	17

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)															
	82		85		90		95		100		105		110		114	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
220	98	24	101	23	106	21	111	21	116	20	123	19	129	19	134	19
200	98	22	101	21	106	20	111	20	115	19	123	19	129	19	135	19

WEIGHT (1000 KG)	VRMIN (KIAS)															
	81		85		90		95		100		105		110		112	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
220	97	24	101	23	106	21	111	21	116	20	123	19	129	19	131	19
200	97	22	101	21	106	20	111	20	117	19	123	19	129	19	132	19

Initial Climb EPR

Based on engine bleed for 3 packs on, engine and wing anti-ice off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)												
°C	°F	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	129	1.25	1.25	1.25	1.25									
50	122	1.27	1.27	1.27	1.27	1.27	1.27	1.27						
45	113	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.28			
40	104	1.32	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.30	1.30	1.30
35	95	1.34	1.34	1.34	1.34	1.34	1.34	1.33	1.33	1.33	1.33	1.33	1.33	1.32
30	86	1.34	1.35	1.37	1.37	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.35	1.35
25	77	1.34	1.35	1.37	1.38	1.39	1.40	1.40	1.39	1.39	1.39	1.39	1.39	1.38
20	68	1.34	1.35	1.37	1.38	1.39	1.40	1.42	1.43	1.43	1.43	1.43	1.43	1.42
15	59	1.34	1.35	1.37	1.38	1.39	1.40	1.42	1.43	1.45	1.46	1.47	1.47	1.46
10 & BELOW	50 & BELOW	1.34	1.35	1.37	1.38	1.39	1.40	1.42	1.43	1.45	1.46	1.48	1.49	1.50

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (FT)	
	-2000	10000
NACELLE ANTI-ICE	-0.01	-0.02
WING ANTI-ICE	-0.01	-0.02
NACELLE AND WING ANTI-ICE	-0.02	-0.02
EACH 20 KTS ABOVE 200 KIAS	-0.01	-0.02

Max Climb EPR

Based on engine bleed for 3 packs on, engine and wing anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	45
	340	340	340	340	340	340	0.84	0.84	0.84	0.84
60	1.19	1.19	1.18							
50	1.23	1.23	1.22	1.21						
40	1.25	1.29	1.28	1.27	1.25					
30	1.25	1.30	1.35	1.35	1.33	1.32				
20	1.25	1.30	1.35	1.39	1.42	1.42	1.42	1.39		
10	1.25	1.30	1.35	1.39	1.43	1.48	1.52	1.48	1.44	1.41
0	1.25	1.30	1.35	1.39	1.43	1.48	1.57	1.58	1.54	1.51
-10	1.25	1.30	1.35	1.39	1.43	1.48	1.57	1.64	1.61	1.58
-20 & BELOW	1.25	1.30	1.35	1.39	1.43	1.48	1.57	1.64	1.61	1.58

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	0	10	20	30	40
ENGINE ANTI-ICE ON	-0.01	-0.02	-0.03	-0.04	-0.05
ENGINE & WING ANTI-ICE ON	-0.03	-0.04	-0.06	-0.07	-0.08

Go-around EPR

Based on engine bleed for 3 packs on

REPORTED OAT		TAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
°C	°F		-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
51	124	54	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	
47	117	50	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	
42	108	45	1.46	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.44	1.44	1.44	1.44
37	99	40	1.46	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48
32	90	35	1.46	1.48	1.51	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
27	81	30	1.46	1.48	1.51	1.53	1.54	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
22	72	25	1.46	1.48	1.51	1.53	1.54	1.56	1.57	1.59	1.59	1.59	1.59	1.59	1.59
17	63	20	1.46	1.48	1.51	1.53	1.54	1.56	1.57	1.59	1.61	1.63	1.63	1.63	1.63
12	54	15	1.46	1.48	1.51	1.53	1.54	1.56	1.57	1.59	1.61	1.63	1.64	1.65	1.66
7 & BELOW	45 & BELOW	10 & BELOW	1.46	1.48	1.51	1.53	1.54	1.56	1.57	1.59	1.61	1.63	1.64	1.65	1.67

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	10000
2 PACKS OFF	0.01	0.01
3 PACKS OFF	0.02	0.02

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Climb (290/.84)

Flaps Up, Set Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		200	250	300	350	390
40000	**PITCH ATT**	**3.5**	**3.5**			
	V/S (FT/MIN)	1500	700			
35000	**PITCH ATT**	**4.5**	**4.0**	**4.0**	**3.5**	
	V/S (FT/MIN)	2900	1900	1200	500	
30000	**PITCH ATT**	**4.5**	**4.5**	**4.5**	**4.5**	**5.0**
	V/S (FT/MIN)	2700	1900	1400	900	500
20000	**PITCH ATT**	**7.5**	**7.0**	**6.5**	**6.5**	**6.5**
	V/S (FT/MIN)	4100	3100	2400	1800	1400
10000	**PITCH ATT**	**10.5**	**9.5**	**9.0**	**8.5**	**8.5**
	V/S (FT/MIN)	5300	4100	3200	2600	2100
SEA LEVEL	**PITCH ATT**	**13.0**	**11.5**	**10.5**	**10.5**	**10.0**
	V/S (FT/MIN)	6100	4700	3800	3000	2600

Cruise (.84/290)

Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		200	250	300	350	390
40000	**PITCH ATT**	**2.0**	**2.5**			
	EPR	1.16	1.31			
	(Alt Mode %N1)	(83.2)	(88.0)			
35000	**PITCH ATT**	**1.0**	**2.0**	**2.5**	**3.0**	
	EPR	1.08	1.14	1.24	1.43	
	(Alt Mode %N1)	(80.6)	(83.0)	(86.3)	(92.2)	
30000	**PITCH ATT**	**1.0**	**2.0**	**3.0**	**3.5**	**4.0**
	EPR	1.02	1.07	1.13	1.21	1.32
	(Alt Mode %N1)	(77.3)	(79.8)	(82.6)	(85.7)	(89.3)
20000	**PITCH ATT**	**1.5**	**2.5**	**3.0**	**4.0**	**4.5**
	EPR	0.97	0.99	1.03	1.07	1.11
	(Alt Mode %N1)	(70.5)	(72.7)	(75.3)	(78.1)	(80.8)
10000	**PITCH ATT**	**1.5**	**2.5**	**3.5**	**4.5**	**5.0**
	EPR	0.96	0.98	1.00	1.02	1.04
	(Alt Mode %N1)	(64.3)	(66.3)	(68.7)	(71.1)	(73.3)
0	**PITCH ATT**	**1.5**	**2.5**	**3.5**	**4.5**	**5.0**
	EPR	0.97	0.98	0.99	1.00	1.01
	(Alt Mode %N1)	(55.6)	(57.8)	(60.4)	(63.2)	(65.7)

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Descent (.84/290)
Flaps Up, Set Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		200	250	300	350	390
40000	**PITCH ATT**	**-1.5**	**-0.5**			
	V/S (FT/MIN)	-2800	-2700			
35000	**PITCH ATT**	**-3.5**	**-2.0**	**-1.5**	**-0.5**	
	V/S (FT/MIN)	-3800	-3400	-3200	-3300	
30000	**PITCH ATT**	**-2.0**	**-0.5**	**0.0**	**1.0**	**1.5**
	V/S (FT/MIN)	-2600	-2300	-2200	-2100	-2200
20000	**PITCH ATT**	**-2.0**	**-1.0**	**0.0**	**1.0**	**1.5**
	V/S (FT/MIN)	-2500	-2200	-2100	-2000	-2000
10000	**PITCH ATT**	**-2.5**	**-1.0**	**0.5**	**1.5**	**2.0**
	V/S (FT/MIN)	-2200	-1900	-1800	-1700	-1700
SEA LEVEL	**PITCH ATT**	**-2.5**	**-1.0**	**0.5**	**1.5**	**2.0**
	V/S (FT/MIN)	-1900	-1700	-1500	-1500	-1500

Holding
Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		200	250	300	350	390
10000	**PITCH ATT**	**5.5**	**6.0**	**6.0**	**5.5**	**5.5**
	EPR	1.01	1.02	1.03	1.04	1.04
	(Alt Mode %N1)	(55.9)	(61.4)	(66.5)	(70.5)	(73.3)
	KIAS	208	224	242	266	283

Terminal Area (5000 FT)
Set Thrust for Level Flight

FLAP POSITION (VREF + INCREMENT)		WEIGHT (1000 KG)					
		200	250	300	350	400	410
FLAPS UP (VREF30+80) (GEAR UP)	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.5**	**6.5**
	EPR	1.01	1.03	1.04	1.06	1.07	1.08
	(Alt Mode %N1)	(51.4)	(57.5)	(62.5)	(67.1)	(70.8)	(71.5)
	KIAS	208	224	239	253	266	269
FLAPS 1 (VREF30+60) (GEAR UP)	**PITCH ATT**	**6.5**	**7.0**	**7.0**	**7.5**	**7.5**	**7.5**
	EPR	1.03	1.05	1.06	1.08	1.10	1.10
	(Alt Mode %N1)	(53.9)	(60.2)	(64.8)	(68.9)	(72.7)	(73.4)
	KIAS	188	204	219	233	246	249
FLAPS 5 (VREF30+40) (GEAR UP)	**PITCH ATT**	**7.5**	**7.5**	**8.0**	**8.0**	**8.0**	**8.0**
	EPR	1.06	1.08	1.10	1.12	1.15	1.15
	(Alt Mode %N1)	(57.9)	(63.6)	(68.4)	(72.7)	(76.5)	(77.2)
	KIAS	168	184	199	213	226	229
FLAPS 10 (VREF30+20) (GEAR UP)	**PITCH ATT**	**8.5**	**8.5**	**8.5**	**9.0**	**9.0**	**9.0**
	EPR	1.07	1.09	1.11	1.14	1.16	1.17
	(Alt Mode %N1)	(57.8)	(63.8)	(68.8)	(73.1)	(77.0)	(77.7)
	KIAS	148	164	179	193	206	209
FLAPS 20 (VREF30+10) (GEAR DOWN)	**PITCH ATT**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**
	EPR	1.10	1.13	1.17	1.21	1.25	1.26
	(Alt Mode %N1)	(64.0)	(69.9)	(75.2)	(79.9)	(83.7)	(84.4)
	KIAS	138	154	169	183	196	199

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Final Approach (1500 FT)

Gear Down, EPR for 3° Glideslope

FLAP POSITION (VREF + INCREMENT)		WEIGHT (1000 KG)					
		200	250	300	350	400	410
FLAPS 25 (VREF25+10)	**PITCH ATT**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
	EPR	1.05	1.06	1.07	1.08	1.10	1.10
	(Alt Mode %N1)	(48.8)	(54.8)	(59.7)	(63.7)	(67.2)	(67.9)
	KIAS	143	159	175	189	203	205
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**1.0**	**1.0**			
	EPR	1.07	1.09	1.11			
	(Alt Mode %N1)	(55.8)	(61.8)	(66.8)			
	KIAS	138	154	168			

Performance Inflight - All Engines

Long Range Cruise Maximum Operating Altitude

Max Climb Thrust

ISA + 10°C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
400	27600	6	33300*	32900	32100	30500	28900
380	28800	3	34500*	34000	33200	31600	30100
360	30000	1	35700*	35100	34300	32700	31300
340	31200	-2	36800*	36300	35500	34000	32500
320	32500	-5	38000*	37600	36800	35200	33800
300	33900	-8	39200*	38900	38100	36600	35100
280	35400	-12	40400*	40400	39600	38000	36600
260	36900	-13	41800*	41800*	41100	39600	38100
240	38600	-13	43300*	43300*	42800	41200	39800
220	40400	-13	45000	45000	44600	43000	41600
200	42400	-13	45000	45000	45000	45000	43600
180	44600	-13	45000	45000	45000	45000	45000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
400	27600	12	33300*	32900	32100	30500	28900
380	28800	9	34500*	34000	33200	31600	30100
360	30000	6	35700*	35100	34300	32700	31300
340	31200	4	36800*	36300	35500	34000	32500
320	32500	1	37900*	37600	36800	35200	33800
300	33900	-3	39100*	38900	38100	36600	35100
280	35400	-6	40400*	40400	39600	38000	36600
260	36900	-7	41800*	41800*	41100	39600	38100
240	38600	-7	43300*	43300*	42800	41200	39800
220	40400	-7	45000	45000	44600	43000	41600
200	42400	-7	45000	45000	45000	45000	43600
180	44600	-7	45000	45000	45000	45000	45000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
400	27600	17	32400*	32400*	32100	30500	28900
380	28800	15	33700*	33700*	33200	31600	30100
360	30000	12	35000*	35000*	34300	32700	31300
340	31200	9	36200*	36200*	35500	34000	32500
320	32500	6	37300*	37300*	36800	35200	33800
300	33900	3	38500*	38500*	38100	36600	35100
280	35400	0	39800*	39800*	39600	38000	36600
260	36900	-2	41100*	41100*	41100	39600	38100
240	38600	-2	42600*	42600*	42600*	41200	39800
220	40400	-2	44300*	44300*	44300*	43000	41600
200	42400	-2	45000	45000	45000	45000	43600
180	44600	-2	45000	45000	45000	45000	45000

***Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.**

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT) 27	29	31	33	35	37	39	41	43	45
400	EPR	1.19	1.25	1.36							
	MACH	.852	.862	.861							
	KIAS	347	337	322							
	FF/ENG	3467	3466	3513							
380	EPR	1.16	1.21	1.29	1.42						
	MACH	.844	.858	.861	.860						
	KIAS	343	335	323	308						
	FF/ENG	3286	3274	3284	3375						
360	EPR	1.13	1.18	1.24	1.34	1.48					
	MACH	.834	.850	.861	.861	.860					
	KIAS	339	332	323	309	295					
	FF/ENG	3116	3092	3092	3124	3256					
340	EPR	1.11	1.15	1.20	1.27	1.39					
	MACH	.824	.840	.855	.862	.860					
	KIAS	334	328	320	309	295					
	FF/ENG	2950	2920	2907	2912	2973					
320	EPR	1.09	1.13	1.17	1.22	1.31	1.45				
	MACH	.811	.829	.846	.859	.861	.860				
	KIAS	329	323	316	308	295	282				
	FF/ENG	2787	2758	2735	2731	2743	2850				
300	EPR	1.08	1.10	1.14	1.18	1.25	1.35				
	MACH	.797	.816	.834	.850	.861	.861				
	KIAS	323	318	311	304	295	282				
	FF/ENG	2622	2597	2572	2555	2554	2598				
280	EPR	1.06	1.08	1.11	1.15	1.20	1.28	1.39			
	MACH	.782	.802	.821	.838	.854	.862	.860			
	KIAS	316	311	306	300	293	282	269			
	FF/ENG	2463	2437	2413	2391	2378	2391	2472			
260	EPR	1.04	1.06	1.09	1.12	1.16	1.22	1.30	1.43		
	MACH	.765	.786	.805	.825	.842	.857	.861	.860		
	KIAS	309	304	300	294	288	281	269	257		
	FF/ENG	2303	2278	2255	2233	2211	2218	2252	2341		
240	EPR	1.03	1.05	1.07	1.10	1.13	1.17	1.23	1.32	1.46	
	MACH	.745	.767	.788	.808	.827	.845	.859	.861	.860	
	KIAS	300	297	292	288	282	276	269	257	245	
	FF/ENG	2144	2119	2096	2075	2054	2049	2074	2102	2196	
220	EPR	1.01	1.03	1.05	1.07	1.10	1.13	1.18	1.24	1.34	
	MACH	.726	.746	.768	.789	.810	.829	.846	.860	.861	
	KIAS	291	288	284	280	276	270	264	257	245	
	FF/ENG	1991	1960	1937	1917	1896	1890	1901	1921	1943	
200	EPR	1.00	1.01	1.03	1.05	1.07	1.10	1.14	1.18	1.25	1.34
	MACH	.706	.724	.745	.767	.789	.810	.829	.846	.860	.861
	KIAS	283	279	275	272	268	263	258	252	245	234
	FF/ENG	1850	1810	1785	1759	1738	1733	1740	1755	1760	1775

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
671	629	591	557	527	500	480	461	443	427	412
1346	1260	1183	1115	1055	1000	960	924	889	857	828
2029	1897	1779	1675	1583	1500	1441	1386	1335	1288	1244
2720	2541	2379	2238	2113	2000	1922	1849	1781	1717	1659
3420	3190	2983	2803	2644	2500	2403	2311	2226	2148	2075
4128	3845	3590	3370	3176	3000	2883	2773	2671	2577	2490
4844	4505	4202	3939	3709	3500	3363	3235	3116	3006	2905
5570	5173	4818	4512	4243	4000	3843	3696	3560	3434	3319
6303	5846	5437	5086	4778	4500	4323	4158	4005	3863	3732
7046	6525	6061	5662	5314	5000	4803	4619	4448	4290	4145

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
500	14.1	1:20	12.7	1:16	11.6	1:14	10.7	1:13	10.0	1:11
1000	28.4	2:38	26.0	2:29	24.0	2:24	22.2	2:20	21.0	2:16
1500	42.4	3:58	39.1	3:43	36.1	3:34	33.5	3:28	31.8	3:22
2000	56.0	5:21	51.8	4:59	47.9	4:46	44.6	4:36	42.3	4:29
2500	69.3	6:47	64.3	6:17	59.5	5:58	55.4	5:46	52.6	5:37
3000	82.2	8:16	76.4	7:38	70.8	7:12	66.0	6:57	62.7	6:45
3500	94.8	9:47	88.3	9:01	81.9	8:28	76.4	8:08	72.5	7:54
4000	107.1	11:20	100.0	10:28	92.8	9:46	86.5	9:21	82.2	9:05
4500	119.1	12:57	111.3	11:57	103.4	11:06	96.4	10:34	91.6	10:16
5000	130.9	14:35	122.4	13:29	113.8	12:29	106.1	11:49	100.8	11:28

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-1.5	-0.7	0.0	2.6	8.3
20	-3.3	-1.6	0.0	4.9	14.1
30	-5.0	-2.5	0.0	6.9	19.3
40	-6.7	-3.4	0.0	8.8	23.9
50	-8.3	-4.2	0.0	10.5	27.8
60	-9.9	-5.1	0.0	12.0	31.2
70	-11.5	-5.9	0.0	13.3	34.0
80	-13.0	-6.7	0.0	14.5	36.2
90	-14.5	-7.5	0.0	15.4	37.8
100	-16.0	-8.3	0.0	16.2	38.8
110	-17.4	-9.1	0.0	16.8	39.2
120	-18.7	-9.8	0.0	17.2	39.0
130	-20.0	-10.6	0.0	17.4	38.3
140	-21.3	-11.3	0.0	17.4	36.9

Long Range Cruise Enroute Fuel and Time - High Altitudes

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS) 100	80	60	40	20	GROUND DISTANCE (NM	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS) 20	40	60	80	100
3862	3654	3464	3295	3141	3000	2883	2773	2671	2577	2490
4512	4268	4045	3846	3666	3500	3363	3235	3116	3006	2905
5164	4884	4627	4398	4191	4000	3843	3696	3560	3434	3319
5819	5501	5210	4951	4716	4500	4323	4158	4005	3863	3732
6476	6120	5794	5504	5241	5000	4803	4619	4448	4290	4145
7137	6741	6380	6058	5767	5500	5283	5080	4891	4717	4557
7800	7364	6967	6613	6293	6000	5763	5541	5335	5144	4969
8468	7991	7556	7169	6820	6500	6242	6001	5777	5570	5380
9141	8622	8148	7727	7348	7000	6722	6461	6219	5996	5790
9819	9256	8742	8286	7876	7500	7200	6921	6660	6420	6199
10506	9896	9340	8848	8405	8000	7679	7379	7100	6844	6608

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT) 25 FUEL (1000 KG)	25 TIME (HR:MIN)	29 FUEL (1000 KG)	29 TIME (HR:MIN)	33 FUEL (1000 KG)	33 TIME (HR:MIN)	37 FUEL (1000 KG)	37 TIME (HR:MIN)
3000	62.7	6:45	59.1	6:31	56.3	6:20	55.2	6:13
3500	72.5	7:54	68.4	7:37	65.2	7:24	63.7	7:15
4000	82.2	9:05	77.4	8:44	73.8	8:28	72.0	8:18
4500	91.6	10:16	86.3	9:52	82.3	9:33	80.1	9:20
5000	100.8	11:28	95.0	11:01	90.5	10:39	88.0	10:24
5500	109.8	12:41	103.5	12:11	98.5	11:46	95.7	11:28
6000	118.7	13:55	111.8	13:22	106.4	12:53	103.2	12:32
6500	127.3	15:11	120.0	14:33	114.1	14:01	110.6	13:37
7000	135.9	16:28	128.0	15:46	121.7	15:10	117.8	14:43
7500	144.2	17:47	135.9	17:00	129.1	16:21	124.8	15:49
8000	152.5	19:09	143.7	18:14	136.5	17:31	131.7	16:57

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG) 200	250	300	350	400
50	-9.4	-5.0	0.0	10.6	28.1
60	-11.1	-5.9	0.0	11.9	30.9
70	-12.9	-6.7	0.0	13.2	33.6
80	-14.7	-7.6	0.0	14.4	36.1
90	-16.5	-8.5	0.0	15.6	38.4
100	-18.4	-9.3	0.0	16.7	40.6
110	-20.3	-10.2	0.0	17.8	42.6
120	-22.3	-11.1	0.0	18.8	44.5
130	-24.3	-12.1	0.0	19.8	46.2
140	-26.3	-13.0	0.0	20.7	47.8
150	-28.4	-13.9	0.0	21.5	49.1
160	-30.5	-14.9	0.0	22.3	50.4

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)										
	400	380	360	340	320	300	280	260	240	220	200
45									75	34	10
43								66	30	9	1
41							54	25	8	1	2
39					74	42	19	6	0	2	10
37			88	55	30	13	3	0	3	10	22
35		63	38	20	8	2	0	4	11	22	36
33	43	25	12	4	0	1	5	13	23	36	51
31	14	6	1	0	2	7	15	25	37	51	66
29	2	0	1	4	10	18	27	39	51	65	80
27	0	3	7	13	21	30	41	53	66	79	94
25	5	11	17	25	34	44	55	67	79	93	106

The above wind factor table is for calculation of wind required to maintain present range capability at new pressure altitude, i.e., break-even wind.

Method:

1. **Read wind factors for present and new altitudes from table.**
2. **Determine difference (new altitude wind factor minus present altitude wind factor); this difference may be negative or positive.**
3. **Break-even wind at new altitude is present altitude wind plus difference from step 2.**

Descent at .84/290/250

PRESSURE ALT (1000 FT)	27	29	31	33	35	37	39	41	43	45
DISTANCE (NM)	96	103	110	117	124	129	134	140	145	150
TIME (MINUTES)	19	20	21	22	23	23	24	25	25	26

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	45000
400	EPR	1.02	1.03	1.05	1.08	1.09	1.16	1.30			
	KIAS	286	286	286	286	313	317	322			
	FF/ENG	3360	3290	3200	3170	3270	3340	3550			
380	EPR	1.02	1.03	1.04	1.07	1.08	1.14	1.25			
	KIAS	280	280	280	280	306	310	314			
	FF/ENG	3190	3130	3030	3000	3090	3130	3270			
360	EPR	1.02	1.02	1.04	1.06	1.07	1.12	1.21			
	KIAS	271	271	271	271	297	300	305			
	FF/ENG	3020	2970	2880	2820	2910	2920	3040			
340	EPR	1.02	1.02	1.03	1.05	1.06	1.10	1.19	1.48		
	KIAS	261	261	261	261	288	291	295	302		
	FF/ENG	2840	2810	2730	2650	2740	2730	2820	3480		
320	EPR	1.02	1.02	1.03	1.05	1.05	1.09	1.16	1.31		
	KIAS	251	251	251	251	279	282	286	291		
	FF/ENG	2670	2640	2590	2490	2560	2550	2620	2830		
300	EPR	1.01	1.02	1.03	1.05	1.04	1.08	1.14	1.25		
	KIAS	242	242	242	242	270	272	276	281		
	FF/ENG	2500	2480	2440	2350	2390	2380	2420	2550		
280	EPR	1.01	1.02	1.03	1.04	1.03	1.07	1.12	1.21		
	KIAS	233	233	233	233	260	262	266	270		
	FF/ENG	2340	2310	2280	2210	2230	2220	2230	2330		
260	EPR	1.01	1.01	1.02	1.03	1.03	1.05	1.10	1.17	1.37	
	KIAS	228	228	228	228	251	253	255	259	264	
	FF/ENG	2170	2150	2130	2060	2060	2050	2050	2130	2430	
240	EPR	1.01	1.01	1.02	1.03	1.02	1.04	1.08	1.14	1.27	
	KIAS	221	221	221	221	240	242	244	248	252	
	FF/ENG	2010	2000	1980	1920	1900	1890	1880	1920	2100	
220	EPR	1.00	1.01	1.01	1.02	1.02	1.03	1.07	1.12	1.22	
	KIAS	215	215	215	215	229	231	234	236	240	
	FF/ENG	1860	1850	1840	1780	1760	1750	1740	1740	1870	
200	EPR	1.00	1.00	1.01	1.01	1.01	1.02	1.05	1.09	1.17	1.34
	KIAS	208	208	208	208	219	220	222	224	228	233
	FF/ENG	1710	1700	1690	1650	1620	1600	1600	1600	1660	1850

This table includes 5% additional fuel for holding in a racetrack pattern.

Holding
Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
400	EPR	1.07	1.08	1.11	1.16	1.23
	KIAS	245	246	248	251	251
	FF/ENG	3570	3520	3480	3470	3560
380	EPR	1.06	1.07	1.10	1.14	1.21
	KIAS	240	241	243	245	245
	FF/ENG	3390	3350	3300	3280	3350
360	EPR	1.06	1.07	1.09	1.13	1.19
	KIAS	234	236	238	240	240
	FF/ENG	3210	3180	3120	3090	3150
340	EPR	1.05	1.06	1.08	1.11	1.17
	KIAS	229	230	232	234	234
	FF/ENG	3030	3000	2950	2900	2940
320	EPR	1.05	1.06	1.07	1.10	1.15
	KIAS	223	224	226	228	228
	FF/ENG	2850	2830	2790	2730	2740
300	EPR	1.04	1.05	1.07	1.09	1.13
	KIAS	218	219	220	222	222
	FF/ENG	2660	2650	2620	2560	2550
280	EPR	1.04	1.04	1.06	1.08	1.11
	KIAS	212	213	215	216	216
	FF/ENG	2480	2470	2460	2400	2370
260	EPR	1.03	1.04	1.05	1.07	1.10
	KIAS	207	207	209	210	210
	FF/ENG	2300	2300	2290	2240	2200
240	EPR	1.03	1.03	1.04	1.06	1.08
	KIAS	200	201	202	203	203
	FF/ENG	2130	2120	2120	2080	2050
220	EPR	1.02	1.03	1.04	1.05	1.07
	KIAS	194	194	195	196	196
	FF/ENG	1950	1960	1960	1920	1900
200	EPR	1.02	1.02	1.03	1.04	1.06
	KIAS	187	188	189	190	190
	FF/ENG	1790	1800	1800	1770	1760

This table includes 5% additional fuel for holding in a racetrack pattern.
Holding at Flaps 1 in icing conditions is not recommended.

Intentionally
Blank

Performance Inflight - Advisory Information

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 30
Dry Runway

	LANDING DISTANCE AND ADJUSTMENT (M)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF30	2 REV	NO REV
MAX MANUAL	1055	20/-15	30	-55	180	15	-15	30	-30	115	25	55
MAX AUTO	1270	20/-20	40	-65	215	0	0	35	-35	150	0	0
AUTOBRAKE 4	1555	30/-30	50	-85	280	0	0	45	-45	190	0	0
AUTOBRAKE 3	1825	35/-35	60	-100	340	10	-15	55	-55	210	5	10
AUTOBRAKE 2	2055	40/-40	70	-115	395	30	-40	70	-65	190	30	35
AUTOBRAKE 1	2275	45/-45	80	-135	460	60	-70	80	-70	190	145	210

Good Reported Braking Action

MAX MANUAL	1600	30/-30	50	-85	310	45	-40	50	-45	165	85	195
MAX AUTO	1655	30/-30	50	-90	315	35	-30	50	-45	180	85	200
AUTOBRAKES 4	1800	35/-35	55	-100	335	10	-5	50	-50	220	10	70
AUTOBRAKES 3	2100	40/-40	70	-115	390	15	-15	65	-65	240	5	10

Medium Reported Braking Action

MAX MANUAL	2145	40/-40	75	-130	490	105	-85	75	-65	190	220	530
MAX AUTO	2145	40/-40	75	-130	490	105	-75	75	-65	215	215	520
AUTOBRAKES 4	2145	45/-40	75	-130	490	105	-75	75	-65	205	220	535
AUTOBRAKES 3	2265	45/-45	75	-140	500	85	-55	75	-70	240	150	455

Poor Reported Braking Action

MAX MANUAL	2770	60/-60	100	-195	780	275	-165	105	-80	215	460	1210
MAX AUTO	2770	60/-60	100	-195	775	275	-160	105	-80	220	465	1225
AUTOBRAKES 4	2770	60/-60	100	-195	775	275	-160	105	-80	220	460	1220
AUTOBRAKES 3	2770	60/-60	100	-195	785	275	-150	105	-80	240	465	1230

Reference distance is for sea level, standard day, no wind or slope, and four engine max reverse.
Max manual braking reference distance assumes use of auto spoilers. For manual spoilers, add 85 m.
Autobrake reference distance good for auto or manual spoilers.
Reference distances include distance from 50 ft above threshold (approximately 305 m flare distance).
Good, Medium, and Poor Reported Braking Action distances and adjustments have been factored by 1.15.
Assumes VREF30 approach speed.

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

Dry Runway

	LANDING DISTANCE AND ADJUSTMENTS (M)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF25	2 REV	NO REV
MAX MANUAL	1120	30/-20	35	-55	185	20	-15	30	-30	115	30	60
MAX AUTO	1360	25/-25	40	-65	220	0	0	40	-40	155	0	0
AUTOBRAKES 4	1670	30/-30	55	-85	290	0	0	50	-50	200	0	0
AUTOBRAKES 3	1985	40/-40	65	-105	350	5	-15	60	-60	225	5	10
AUTOBRAKES 2	2250	45/-45	75	-120	410	20	-45	75	-70	210	25	25
AUTOBRAKES 1	2495	50/-50	90	-140	480	65	-75	90	-75	210	180	220

Good Reported Braking Action

MAX MANUAL	1695	35/-30	55	-90	315	45	-40	50	-45	165	105	230
MAX AUTO	1750	35/-35	55	-90	320	40	-35	55	-50	180	105	235
AUTOBRAKES 4	1930	35/-35	65	-105	345	10	-5	55	-60	230	10	75
AUTOBRAKES 3	2285	45/-45	75	-120	405	5	-15	70	-70	260	5	10

Medium Reported Braking Action

MAX MANUAL	2305	45/-45	80	-140	500	120	-90	80	-70	200	265	655
MAX AUTO	2305	45/-45	80	-140	500	115	-80	80	-70	220	255	645
AUTOBRAKES 4	2305	45/-45	80	-140	500	110	-75	80	-70	220	265	650
AUTOBRAKES 3	2450	45/-45	80	-145	520	80	-55	80	-75	260	175	565

Poor Reported Braking Action

MAX MANUAL	2995	65/-65	110	-200	805	295	-185	115	-85	225	560	1530
MAX AUTO	2995	65/-55	110	-200	800	300	-170	115	-85	225	565	1545
AUTOBRAKES 4	2995	65/-55	110	-200	800	295	-170	115	-85	230	565	1545
AUTOBRAKES 3	2995	65/-55	110	-200	805	285	-155	115	-85	255	570	1560

Reference distance is for sea level, standard day, no wind or slope, and four engine max reverse.
Max manual braking reference distance assumes use of auto spoilers. For manual spoilers, add 85 m.
Autobrake reference distance good for auto or manual spoilers.
Reference distances include distance from 50 ft above threshold (approximately 305 m flare distance).
Good, Medium, and Poor Reported Braking Action distances and adjustments have been factored by 1.15.
Assumes VREF25 approach speed.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Dry Runway

		LANDING DISTANCE AND ADJUSTMENT (M)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	1265	25/ -20	45	-65/ 220	30/ -30	40/ -40	180		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	1910	35/ -35	75	-125/ 455	115/ -85	75/ -65	180	205	485
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	1385	25/ -20	50	-65/ 215	25/ -25	45/ -45	140	50	105
FLAPS UP	VREF30+70	1950	75/ -35	120	-100/ 410	45/ -40	105/ -95	230	115	310
JAMMED STABILIZER FLAPS 25	VREF30+20	1265	30/ -20	45	-65/ 210	25/ -20	45/ -40	115	45	95
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	1345	30/ -20	45	-65/ 210	25/ -25	45/ -45	125	45	100
ONE BODY GEAR UP FLAPS 30	VREF30	1135	35/ -25	45	-70/ 230	30/ -25	40/ -40	120	50	105
ONE WING GEAR UP FLAPS 30	VREF30	1185	35/ -20	45	-70/ 230	35/ -30	45/ -40	130		60
TWO WING GEAR UP FLAPS 30	VREF30	1455	60/ -40	85	-95/ 450	65/ -55	70/ -55	205		125
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	1840	30/ -30	65	-85/ 285	70/ -60	60/ -60	280		
REVERSER UNLOCKED FLAPS 25	VREF30+20	1305	30/ -20	45	-65/ 215	30/ -25	45/ -45	120		50

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Good Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (M)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	1780	30/ -30	65	-105/ 345	90/ -70	60/ -60	230		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	1910	35/ -35	75	-125/ 455	115/ -85	75/ -65	180	205	485
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	1785	30/ -30	70	-90/ 310	55/ -50	65/ -60	160	125	280
FLAPS UP	VREF30+70	2495	40/ -35	95	-105/ 355	75/ -65	95/ -85	170	195	510
JAMMED STABILIZER FLAPS 25	VREF30+20	1680	30/ -30	65	-90/ 305	55/ -45	60/ -55	160	115	260
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	1775	30/ -30	70	-90/ 310	60/ -50	65/ -60	165	125	290
ONE BODY GEAR UP FLAPS 30	VREF30	1390	25/ -25	55	-85/ 285	45/ -40	50/ -45	155	80	185
ONE WING GEAR UP FLAPS 30	VREF30	1590	30/ -30	60	-95/ 315	70/ -60	60/ -55	200		130
TWO WING GEAR UP FLAPS 30	VREF30	1475	55/ -25	85	-95/ 450	65/ -55	70/ -55	205		125
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	2440	40/ -40	90	-125/ 405	150/ -120	85/ -85	330		
REVERSER UNLOCKED FLAPS 25	VREF30+20	1785	30/ -30	65	-95/ 325	65/ -55	65/ -60	170		145

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Medium Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (M)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	2665	45/ -45	95	-170/ 595	270/ -185	95/ -90	290		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	2450	50/ -50	105	-185/ 715	275/ -170	105/ -85	200	425	1095
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	2310	40/ -40	95	-135/ 480	125/ -100	95/ -80	180	280	670
FLAPS UP	VREF30+70	3435	55/ -55	145	-165/ 565	180/ -145	145/ -120	215	505	1300
JAMMED STABILIZER FLAPS 25	VREF30+20	2250	40/ -40	90	-135/ 480	130/ -100	90/ -80	185	285	695
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	2370	45/ -45	100	-140/ 490	135/ -105	95/ -85	190	310	755
ONE BODY GEAR UP FLAPS 30	VREF30	1875	35/ -35	75	-125/ 450	115/ -90	75/ -65	180	210	500
ONE WING GEAR UP FLAPS 30	VREF30	2215	45/ -40	90	-145/ 515	175/ -130	85/ -80	230		355
TWO WING GEAR UP FLAPS 30	VREF30	2090	40/ -40	80	-140/ 495	155/ -115	80/ -75	205		300
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	3655	60/ -60	135	-205/ 695	420/ -285	130/ -125	385		
REVERSER UNLOCKED FLAPS 25	VREF30+20	2515	45/ -45	100	-150/ 530	175/ -130	100/ -90	210		410

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Poor Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (M)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	250000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 250000 KG	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	3975	65/ -65	140	-290/ 1060	925/ -450	145/ -130	335		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	3370	65/ -65	135	-320/ 1570	1335/ -410	150/ -100	215	1080	3490
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	2870	55/ -55	120	-195/ 740	285/ -180	125/ -100	190	520	1355
FLAPS UP	VREF30+70	4450	80/ -80	200	-240/ 885	425/ -280	210/ -160	250	1050	2935
JAMMED STABILIZER FLAPS 25	VREF30+20	2875	55/ -55	125	-200/ 755	305/ -195	125/ -105	205	575	1535
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	3015	60/ -55	130	-205/ 765	320/ -205	135/ -110	210	615	1645
ONE BODY GEAR UP FLAPS 30	VREF30	2420	50/ -50	105	-185/ 710	280/ -175	105/ -85	200	435	1125
ONE WING GEAR UP FLAPS 30	VREF30	2985	60/ -55	120	-225/ 845	465/ -265	125/ -105	250		800
TWO WING GEAR UP FLAPS 30	VREF30	2870	55/ -55	115	-220/ 825	435/ -250	115/ -100	235		715
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	5405	80/ -80	185	-345/ 1225	1350/ -645	195/ -180	420		
REVERSER UNLOCKED FLAPS 25	VREF30+20	3410	60/ -60	140	-235/ 880	480/ -280	140/ -120	240		955

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy per Brake (Millions of Foot Pounds)

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT (1000 KG)	OAT (°C)	PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT		
		0	4	8	0	4	8	0	4	8	0	4	8	0	4	8	0	4	8
400	0	19.9	21.8	24.1	28.8	32.1	35.8	39.1	43.7	49.0	50.5	56.5	63.4	62.4	69.9	78.4	74.3	83.2	
	15	20.8	22.9	25.2	30.3	33.7	37.5	41.1	45.9	51.4	53.0	59.3	66.6	65.5	73.3	82.2	77.9	87.1	
	20	21.1	23.2	25.6	30.7	34.2	38.1	41.7	46.6	52.2	53.8	60.3	67.6	66.5	74.4	83.4	79.1	88.4	
	40	21.8	24.0	26.6	32.0	35.6	39.8	43.5	48.7	54.6	56.3	63.1	70.8	69.6	78.0	87.5	82.9	92.7	
	60	21.7	24.0	26.6	32.1	36.0	40.4	44.3	49.7	55.9	57.6	64.7	72.8	71.6	80.3	90.3	85.5	95.9	
350	0	18.0	19.7	21.6	25.9	28.8	32.0	35.0	39.1	43.7	45.0	50.4	56.6	55.7	62.4	70.1	66.4	74.4	83.5
	15	18.8	20.6	22.6	27.2	30.2	33.6	36.8	41.0	45.9	47.3	52.9	59.4	58.5	65.5	73.5	69.7	78.0	87.4
	20	19.1	20.9	23.0	27.6	30.7	34.1	37.4	41.7	46.7	48.1	53.8	60.3	59.4	66.5	74.6	70.8	79.2	88.7
	40	19.6	21.6	23.8	28.7	31.9	35.5	38.9	43.5	48.8	50.2	56.2	63.1	62.2	69.7	78.2	74.2	83.0	93.1
	60	19.5	21.5	23.7	28.8	32.0	35.9	39.5	44.3	49.7	51.3	57.5	64.8	63.8	71.6	80.5	76.3	85.7	96.2
300	0	16.1	17.5	19.1	23.1	25.5	28.2	31.0	34.5	38.5	39.7	44.3	49.7	49.0	54.9	61.6	58.5	65.5	73.6
	15	16.8	18.3	20.0	24.2	26.7	29.6	32.5	36.2	40.4	41.6	46.5	52.2	51.4	57.6	64.6	61.4	68.8	77.1
	20	17.1	18.6	20.3	24.5	27.1	30.1	33.0	36.8	41.1	42.3	47.3	53.0	52.3	58.5	65.6	62.4	69.8	78.3
	40	17.5	19.1	21.0	25.4	28.2	31.3	34.4	38.3	42.9	44.2	49.4	55.4	54.7	61.2	68.7	65.3	73.2	82.1
	60	17.2	18.9	20.8	25.5	28.3	31.4	34.7	38.9	43.6	44.9	50.4	56.7	55.9	62.8	70.6	67.0	75.3	84.6
250	0	14.2	15.4	16.7	20.1	22.1	24.4	26.8	29.7	33.1	34.0	38.0	42.5	41.8	46.7	52.4	50.2	56.2	63.1
	15	14.8	16.1	17.4	21.1	23.2	25.6	28.1	31.2	34.7	35.7	39.9	44.6	43.9	49.1	55.0	52.7	59.0	66.2
	20	15.0	16.3	17.7	21.4	23.6	26.0	28.5	31.7	35.3	36.3	40.5	45.3	44.6	49.8	55.9	53.5	59.9	67.2
	40	15.4	16.7	18.2	22.1	24.4	27.0	29.6	33.0	36.8	37.8	42.3	47.3	46.6	52.1	58.5	56.0	62.7	70.4
	60	15.0	16.4	17.9	22.0	24.4	27.0	29.8	33.2	37.2	38.3	42.9	48.2	47.4	53.2	59.9	57.3	64.3	72.4
200	0	12.4	13.3	14.3	17.3	18.9	20.7	22.6	25.0	27.6	28.3	31.5	35.1	34.4	38.3	42.9	40.7	45.5	51.1
	15	13.0	13.9	15.0	18.1	19.8	21.7	23.7	26.2	29.0	29.7	33.0	36.8	36.1	40.2	45.0	42.8	47.8	53.6
	20	13.1	14.1	15.2	18.3	20.1	22.0	24.1	26.6	29.5	30.2	33.6	37.4	36.7	40.9	45.8	43.5	48.6	54.5
	40	13.4	14.4	15.5	18.9	20.7	22.7	24.9	27.6	30.6	31.4	34.9	39.0	38.2	42.7	47.8	45.4	50.8	57.0
	60	13.0	14.0	15.2	18.7	20.5	22.7	24.9	27.7	30.8	31.5	35.3	39.6	38.7	43.4	48.7	46.2	51.8	58.3

To correct for wind, enter table with the brakes on speed minus one half the headwind or plus 1.5 times the tailwind.
If ground speed is used for brakes on speed, ignore wind, altitude, and OAT effects, and enter table at sea level and 15°C.

No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)								
EVENT		10	20	30	40	50	60	70	80	90
RTO MAX MAN		10	20	30	40	50	60	70	80	90
LANDING	MAX MAN	3.5	12.6	21.7	30.8	39.9	49.1	58.3	67.7	77.2
	MAX AUTO	3.5	11.9	20.5	29.2	38.2	47.3	56.5	66.0	75.7
	AUTOBRAKE 4	3.2	11.3	19.2	27.2	35.3	43.7	52.5	61.9	71.9
	AUTOBRAKE 3	3.2	10.7	18.2	25.6	33.1	40.8	48.9	57.5	66.7
	AUTOBRAKE 2	3.2	10.2	17.0	23.8	30.7	37.7	45.1	52.8	61.1
	AUTOBRAKE 1	2.7	9.1	15.2	21.1	26.9	32.8	38.8	45.1	51.8

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Four Engine Reverse

EVENT		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)								
		10	20	30	40	50	60	70	80	90
RTO MAX MAN		10	20	30	40	50	60	70	80	90
LANDING	MAX MAN	3.6	11.8	20.1	28.3	36.5	44.8	53.0	61.3	69.5
	MAX AUTO		7.7	16.1	24.5	32.9	41.3	49.7	58.1	66.6
	AUTOBRAKE 4		5.0	12.4	19.8	27.1	34.5	41.9	49.3	56.7
	AUTOBRAKE 3		3.6	9.9	16.2	22.5	28.7	35.0	41.3	47.6
	AUTOBRAKE 2		2.2	7.2	12.2	17.2	22.1	27.1	32.1	37.1
	AUTOBRAKE 1		0.7	4.3	7.8	11.3	14.8	18.4	21.9	25.4

Cooling Time (Minutes)

	ADJUSTED BRAKE ENERGY PER BRAKE (MILLION OF FOOT POUNDS)								
	15 & BELOW	16	20	22	24	27	31	34 TO 45	45 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE REQUIRED	1	3	4	5	6	7	CAUTION	FUSE PLUG MELT ZONE
GROUND		10	28	35	42	52	62		
BTMS	UP TO 2	2	2	3	3	3	4	5 TO 6	7 & ABOVE

Observe maximum quick turnaround limit.
Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.
Add 1.0 million foot pounds for each taxi mile.
For one brake deactivated, increase brake energy by 7 percent.
For two brakes deactivated, increase brake energy by 15 percent.
When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 8 minutes.
When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not attempt to taxi for one hour. Tire, wheel, and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.
Brake temperature monitor system (BTMS) indication on EICAS may be used 10 to 15 minutes after airplane has come to a complete stop, or inflight with gear retracted, to determine recommended cooling schedule.

Performance Inflight - One Engine Inoperative

Chapter PI
Section 13

1 ENGINE INOP

Max Continuous EPR

45000 FT to 25000 FT Pressure Altitudes
Based on engine bleed for 3 packs on

PRESSURE ALTITUDE (FT)		KIAS					MACH NUMBER				
		150	200	250	300	350	.70	.75	.80	.85	.90
45000	EPR		1.61	1.52			1.61	1.61	1.59	1.56	1.52
	MAX TAT		-16	-4			-19	-15	-12	-8	-4
	EPR CORR		0.08	0.10			0.07	0.08	0.09	0.10	0.10
43000	EPR		1.62	1.55	1.43		1.62	1.62	1.60	1.57	1.53
	MAX TAT		-18	-7	7		-19	-15	-12	-8	-4
	EPR CORR		0.07	0.09	0.10		0.07	0.08	0.09	0.10	0.10
41000	EPR		1.64	1.59	1.48		1.64	1.63	1.62	1.59	1.55
	MAX TAT		-20	-9	3		-19	-15	-12	-8	-4
	EPR CORR		0.06	0.09	0.10		0.07	0.08	0.09	0.10	0.10
39000	EPR		1.67	1.63	1.53		1.66	1.65	1.64	1.61	1.57
	MAX TAT		-22	-12	0		-19	-15	-12	-8	-4
	EPR CORR		0.05	0.09	0.10		0.07	0.08	0.09	0.10	0.10
37000	EPR		1.69	1.66	1.58		1.68	1.67	1.65	1.62	1.59
	MAX TAT		-24	-14	-4		-19	-15	-12	-8	-4
	EPR CORR		0.04	0.09	0.10		0.07	0.08	0.09	0.10	0.10
35000	EPR		1.70	1.67	1.61		1.68	1.67	1.66	1.63	1.59
	MAX TAT		-18	-12	-4		-16	-13	-9	-6	-2
	EPR CORR		0.05	0.08	0.10		0.07	0.08	0.09	0.10	0.10
33000	EPR		1.71	1.67	1.62		1.67	1.66	1.64	1.61	1.57
	MAX TAT		-18	-11	-2		-12	-8	-4	-1	3
	EPR CORR		0.05	0.08	0.10		0.08	0.09	0.09	0.10	0.10
31000	EPR		1.72	1.66	1.61	1.52	1.65	1.64	1.61	1.57	1.53
	MAX TAT		-16	-8	1	8	-7	-4	0	4	8
	EPR CORR		0.06	0.08	0.10	0.10	0.08	0.09	0.09	0.10	0.10
29000	EPR		1.71	1.65	1.58	1.49	1.62	1.60	1.57	1.53	1.48
	MAX TAT		-14	-6	3	12	-3	0	4	8	12
	EPR CORR		0.06	0.08	0.09	0.10	0.08	0.09	0.10	0.10	0.10
27000	EPR	1.69	1.69	1.64	1.56	1.47	1.58	1.56	1.52	1.48	1.43
	MAX TAT	-12	-9	-4	4	13	1	5	9	13	17
	EPR CORR	0.06	0.07	0.08	0.09	0.10	0.09	0.09	0.10	0.10	0.10
25000	EPR	1.68	1.67	1.62	1.53	1.45	1.54	1.52	1.48	1.43	
	MAX TAT	-10	-6	-1	7	15	6	9	13	17	
	EPR CORR	0.07	0.08	0.09	0.09	0.10	0.09	0.09	0.10	0.10	

Decrease EPR by the EPR CORR for every 10°C above the MAX TAT shown.

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	0	10	20	30	40	45
1 PACK OFF	0.01	0.01	0.01	0.01	0.01	0.01
2 PACKS OFF	0.02	0.02	0.02	0.02	0.02	0.02
ENGINE ANTI-ICE ON	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05
ENGINE & WING ANTI-ICE ON	-0.03	-0.04	-0.06	-0.07	-0.08	-0.08

1 ENGINE INOP

Max Continuous EPR
24000 FT to Sea Level Pressure Altitudes
Based on engine bleed for 3 packs on

PRESSURE ALTITUDE (FT)		KIAS					MACH NUMBER				
		150	200	250	300	350	.70	.75	.80	.85	.90
24000	EPR	1.68	1.66	1.61	1.52	1.45	1.52	1.49	1.46	1.41	
	MAX TAT	-10	-5	0	8	16	8	11	15	19	
	EPR CORR	0.07	0.08	0.09	0.09	0.10	0.09	0.09	0.10	0.10	
22000	EPR	1.67	1.64	1.58	1.50	1.43	1.48	1.45	1.41		
	MAX TAT	-7	-3	4	11	18	12	16	20		
	EPR CORR	0.07	0.09	0.09	0.09	0.09	0.09	0.09	0.09		
20000	EPR	1.65	1.61	1.56	1.48	1.40	1.44	1.41			
	MAX TAT	-3	1	6	13	20	17	20			
	EPR CORR	0.08	0.09	0.09	0.09	0.09	0.09	0.09			
18000	EPR	1.63	1.59	1.54	1.47	1.39	1.41	1.38			
	MAX TAT	0	4	9	15	23	21	24			
	EPR CORR	0.08	0.09	0.09	0.09	0.08	0.08	0.09			
16000	EPR	1.60	1.56	1.51	1.45	1.38	1.38				
	MAX TAT	4	8	12	18	25	25				
	EPR CORR	0.09	0.09	0.09	0.09	0.08	0.08				
14000	EPR	1.57	1.54	1.49	1.43	1.36	1.34				
	MAX TAT	8	11	15	21	27	30				
	EPR CORR	0.09	0.09	0.09	0.08	0.08	0.08				
12000	EPR	1.54	1.51	1.46	1.40	1.35					
	MAX TAT	11	15	19	24	30					
	EPR CORR	0.08	0.08	0.08	0.08	0.07					
10000	EPR	1.51	1.48	1.44	1.38	1.33					
	MAX TAT	16	18	22	27	33					
	EPR CORR	0.08	0.08	0.08	0.07	0.07					
5000	EPR	1.43	1.41	1.38	1.33	1.28					
	MAX TAT	25	27	30	34	40					
	EPR CORR	0.06	0.06	0.06	0.06	0.06					
1500	EPR	1.38	1.37	1.33	1.29	1.25					
	MAX TAT	31	33	37	41	45					
	EPR CORR	0.05	0.05	0.05	0.05	0.05					
0	EPR	1.37	1.35	1.32	1.28	1.24					
	MAX TAT	33	36	39	43	47					
	EPR CORR	0.05	0.05	0.05	0.05	0.05					

Decrease EPR by the EPR CORR for every 10°C above the MAX TAT shown.

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	0	10	20	30	40	45
1 PACK OFF	0.01	0.01	0.01	0.01	0.01	0.01
2 PACKS OFF	0.02	0.02	0.02	0.02	0.02	0.02
ENGINE ANTI-ICE ON	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05
ENGINE & WING ANTI-ICE ON	-0.03	-0.04	-0.06	-0.07	-0.08	-0.08

1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	390	304	25000	24900	23800
380	371	297	26600	26600	25500
360	351	290	28300	28300	27300
340	332	282	29900	29900	29000
320	313	275	31600	31500	30700
300	294	267	33100	33100	32300
280	274	259	34600	34600	33900
260	255	249	36000	36000	35400
240	235	239	37500	37400	36900
220	215	229	39000	39000	38400
200	196	217	40700	40700	40100

Altitude reduced by 1000 ft for additional margin.

Long Range Cruise Altitude Capability
Based on engine bleed for packs on or off

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	22200	22100	20100
390	23200	23100	21200
380	24200	24100	22300
370	25200	25100	23400
360	26200	26100	24500
350	27200	27100	25500
340	28200	28100	26600
330	29200	29100	27600
320	30100	30000	28700
310	31000	31000	29700
300	32000	31900	30700
290	32800	32700	31700
280	33600	33500	32600
270	34400	34300	33400
260	35100	35100	34300
250	35800	35800	35200
240	36600	36500	35900
230	37300	37300	36600
220	38100	38000	37400
210	38900	38900	38200
200	39800	39700	39000

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capabilty by 1800 ft.
With engine and wing anti-ice on, decrease altitude capability by 3500 ft.

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	14	20	25	27	29	31	33	35	37
400	EPR	1.11	1.17	1.29							
	MACH	.627	.680	.765							
	KIAS	349	352	356							
	FF/ENG	4632	4772	4958							
380	EPR	1.10	1.15	1.26	1.42						
	MACH	.612	.662	.750	.806						
	KIAS	340	343	348	340						
	FF/ENG	4361	4455	4670	4752						
360	EPR	1.09	1.13	1.23	1.37	1.46					
	MACH	.596	.644	.732	.792	.815					
	KIAS	331	333	340	334	331					
	FF/ENG	4100	4164	4375	4424	4511					
340	EPR	1.08	1.11	1.20	1.32	1.40	1.50				
	MACH	.580	.626	.711	.778	.800	.824				
	KIAS	322	323	329	327	324	321				
	FF/ENG	3850	3893	4066	4135	4180	4283				
320	EPR	1.06	1.10	1.18	1.28	1.35	1.43	1.53			
	MACH	.565	.607	.688	.762	.784	.807	.833			
	KIAS	313	313	318	320	317	314	311			
	FF/ENG	3609	3632	3752	3865	3877	3937	4078			
300	EPR	1.05	1.08	1.15	1.25	1.30	1.37	1.46	1.57		
	MACH	.549	.589	.665	.743	.768	.791	.815	.841		
	KIAS	304	304	307	312	310	306	303	301		
	FF/ENG	3381	3385	3447	3593	3610	3628	3706	3868		
280	EPR	1.05	1.07	1.13	1.22	1.26	1.32	1.39	1.49		
	MACH	.533	.571	.642	.719	.749	.773	.796	.821		
	KIAS	296	294	296	301	302	299	296	293		
	FF/ENG	3168	3148	3170	3305	3344	3359	3389	3481		
260	EPR	1.04	1.06	1.11	1.19	1.23	1.27	1.33	1.42	1.52	
	MACH	.517	.552	.619	.691	.724	.754	.778	.801	.827	
	KIAS	287	284	284	288	291	291	288	285	282	
	FF/ENG	2967	2919	2913	3001	3063	3097	3114	3155	3248	
240	EPR	1.03	1.05	1.09	1.15	1.19	1.23	1.28	1.35	1.43	1.54
	MACH	.502	.534	.595	.662	.693	.727	.757	.781	.805	.831
	KIAS	278	274	273	276	278	280	280	277	274	271
	FF/ENG	2775	2699	2667	2709	2763	2820	2853	2871	2911	3031
220	EPR	1.03	1.04	1.07	1.13	1.16	1.19	1.24	1.29	1.35	1.45
	MACH	.485	.516	.572	.633	.662	.694	.729	.759	.783	.807
	KIAS	269	265	262	263	264	266	269	268	265	262
	FF/ENG	2584	2496	2432	2441	2471	2524	2579	2611	2627	2685
200	EPR	1.02	1.03	1.06	1.10	1.13	1.15	1.19	1.24	1.29	1.36
	MACH	.468	.497	.548	.604	.631	.660	.693	.728	.758	.783
	KIAS	259	255	251	250	251	252	254	256	256	253
	FF/ENG	2383	2306	2205	2193	2201	2233	2285	2339	2366	2394

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
281	260	242	226	212	200	191	183	175	168	162
843	781	726	679	637	600	575	553	531	512	494
1410	1306	1212	1132	1063	1000	960	922	887	855	825
1982	1833	1700	1587	1489	1400	1343	1291	1242	1197	1155
2556	2362	2190	2043	1915	1800	1727	1659	1596	1538	1485
3135	2895	2682	2500	2342	2200	2111	2028	1951	1879	1814
3718	3431	3176	2958	2769	2600	2494	2396	2305	2220	2143
4306	3970	3671	3417	3197	3000	2878	2764	2658	2561	2472
4899	4512	4169	3878	3626	3400	3261	3131	3011	2900	2799
5496	5058	4668	4339	4055	3800	3644	3499	3364	3240	3126
6099	5607	5171	4802	4484	4200	4027	3866	3716	3578	3452
6708	6160	5676	5267	4915	4600	4410	4233	4068	3916	3777
7323	6718	6183	5733	5346	5000	4792	4599	4419	4253	4102

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		22		25		29		33	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.4	0:37	3.9	0:33	3.5	0:32	3.2	0:32	3.0	0:32
600	16.5	1:47	13.4	1:31	12.8	1:27	12.1	1:24	12.0	1:22
1000	27.7	2:58	22.9	2:30	22.1	2:23	21.1	2:16	20.9	2:12
1400	38.6	4:10	32.2	3:30	31.1	3:19	29.7	3:09	29.5	3:02
1800	49.3	5:23	41.2	4:30	39.9	4:16	38.2	4:03	37.8	3:53
2200	59.8	6:38	50.1	5:32	48.5	5:14	46.5	4:57	46.0	4:45
2600	70.1	7:53	58.7	6:35	56.9	6:14	54.7	5:51	53.9	5:37
3000	80.3	9:10	67.2	7:38	65.1	7:14	62.6	6:47	61.6	6:30
3400	90.2	10:28	75.4	8:43	73.0	8:15	70.3	7:43	69.0	7:23
3800	99.8	11:48	83.5	9:50	80.8	9:18	77.9	8:41	76.3	8:17
4200	109.3	13:09	91.4	10:57	88.4	10:21	85.2	9:40	83.5	9:11
4600	118.6	14:31	99.2	12:05	95.9	11:26	92.4	10:39	90.4	10:06
5000	127.7	15:56	106.7	13:15	103.1	12:32	99.4	11:40	97.3	11:02

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-1.7	-0.8	0.0	2.1	4.9
20	-3.4	-1.6	0.0	4.1	9.4
30	-5.1	-2.5	0.0	6.1	13.7
40	-6.9	-3.3	0.0	7.9	17.7
50	-8.7	-4.2	0.0	9.6	21.5
60	-10.5	-5.1	0.0	11.2	24.9
70	-12.3	-6.0	0.0	12.6	28.1
80	-14.2	-6.9	0.0	14.0	31.0
90	-16.1	-7.8	0.0	15.2	33.6
100	-18.0	-8.7	0.0	16.3	35.9
110	-20.0	-9.7	0.0	17.2	38.0
120	-21.9	-10.6	0.0	18.1	39.8
130	-23.9	-11.6	0.0	18.8	41.3
140	-26.0	-12.6	0.0	19.4	42.5

1 ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	40000
400	EPR	1.07	1.10	1.14	1.22	1.29	1.47			
	KIAS	286	286	286	286	313	317			
	FF/ENG	4320	4280	4330	4430	4690	4950			
380	EPR	1.07	1.09	1.13	1.19	1.26	1.41			
	KIAS	280	280	280	280	306	310			
	FF/ENG	4100	4050	4060	4150	4390	4580			
360	EPR	1.06	1.08	1.11	1.18	1.23	1.37			
	KIAS	271	271	271	271	297	300			
	FF/ENG	3890	3830	3810	3880	4090	4250			
340	EPR	1.06	1.07	1.11	1.16	1.21	1.33	1.54		
	KIAS	261	261	261	261	288	291	295		
	FF/ENG	3680	3620	3580	3620	3790	3940	4280		
320	EPR	1.06	1.07	1.10	1.14	1.18	1.29	1.47		
	KIAS	251	251	251	251	279	282	286		
	FF/ENG	3460	3410	3360	3370	3510	3650	3870		
300	EPR	1.05	1.06	1.09	1.13	1.16	1.25	1.40		
	KIAS	242	242	242	242	270	272	276		
	FF/ENG	3250	3210	3150	3130	3250	3360	3520		
280	EPR	1.05	1.06	1.08	1.11	1.14	1.22	1.35	1.61	
	KIAS	233	233	233	233	260	262	266	270	
	FF/ENG	3030	3000	2950	2910	3000	3070	3220	3590	
260	EPR	1.04	1.05	1.07	1.10	1.12	1.19	1.30	1.50	
	KIAS	228	228	228	228	251	253	255	259	
	FF/ENG	2800	2780	2740	2680	2750	2800	2930	3160	
240	EPR	1.03	1.04	1.06	1.08	1.10	1.16	1.26	1.42	
	KIAS	221	221	221	221	240	242	244	248	
	FF/ENG	2580	2560	2540	2470	2510	2550	2650	2800	
220	EPR	1.03	1.03	1.05	1.07	1.08	1.13	1.22	1.35	
	KIAS	215	215	215	215	229	231	234	236	
	FF/ENG	2360	2350	2330	2270	2280	2300	2380	2500	
200	EPR	1.02	1.03	1.04	1.05	1.07	1.11	1.18	1.29	1.49
	KIAS	208	208	208	208	219	220	222	224	228
	FF/ENG	2160	2150	2140	2090	2080	2060	2110	2220	2430

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight - Two Engines Inoperative

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	386	296	10100	10100	8300
390	376	292	11200	11100	9500
380	367	289	12200	12200	10600
370	357	286	13200	13200	11700
360	348	282	14300	1 4200	12900
350	338	279	15300	15200	13900
340	329	275	16300	16300	15000
330	319	271	17300	17300	16100
320	310	267	18400	18300	17200
310	300	263	19400	19400	18300
300	290	259	20500	20400	19400
290	281	255	21500	21500	20500
280	271	251	22600	22600	21700
270	261	247	23700	23700	22800
260	252	243	24800	24700	24000
250	242	238	25900	25800	25100
240	233	233	27000	27000	26300
230	223	229	28100	28100	27500
220	214	224	29200	29200	28700
210	204	219	30200	30200	29800
200	195	213	31200	31200	30900

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
271	253	237	223	211	200	190	181	173	165	158
808	756	710	669	633	600	571	544	520	497	477
1345	1258	1182	1114	1054	1000	951	907	867	830	796
1882	1761	1654	1560	1476	1400	1332	1270	1213	1162	1114
2420	2264	2127	2006	1897	1800	1712	1633	1560	1494	1433
2960	2769	2601	2452	2319	2200	2093	1995	1906	1825	1750
3503	3275	3076	2899	2741	2600	2473	2357	2252	2156	2067
4048	3784	3552	3347	3164	3000	2852	2718	2597	2485	2383
4598	4295	4030	3796	3587	3400	3232	3079	2940	2814	2697
5152	4810	4510	4246	4010	3800	3611	3439	3283	3141	3010
5711	5328	4993	4697	4435	4200	3989	3798	3625	3466	3321
6277	5850	5478	5150	4860	4600	4367	4156	3965	3790	3630
6849	6378	5967	5605	5285	5000	4744	4513	4303	4112	3937

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)											TIME (HR:MIN)
	WEIGHT AT START OF DRIFTDOWN (1000 KG)											
	200	220	240	260	280	300	320	340	360	380	400	
200	3.2	3.5	3.8	4.1	4.4	4.6	4.8	5.0	5.2	5.4	5.7	0:31
600	10.8	11.8	12.8	13.8	14.8	15.8	16.7	17.8	18.7	19.8	21.0	1:33
1000	17.9	19.5	21.2	22.9	24.5	26.2	27.8	29.6	31.3	33.2	35.1	2:34
1400	24.6	27.0	29.3	31.6	33.9	36.3	38.6	41.1	43.5	46.2	48.8	3:35
1800	31.2	34.1	37.1	40.1	43.1	46.1	49.1	52.2	55.3	58.8	62.1	4:37
2200	37.5	41.1	44.6	48.2	51.9	55.6	59.2	63.0	66.8	71.1	75.1	5:39
2600	43.7	47.8	52.0	56.2	60.4	64.8	69.0	73.4	77.9	83.0	87.6	6:42
3000	49.6	54.3	59.1	63.9	68.7	73.7	78.6	83.6	88.7	94.5	99.8	7:46
3400	55.4	60.6	65.9	71.3	76.8	82.3	87.8	93.4	99.2	105.8	111.6	8:51
3800	60.9	66.7	72.6	78.5	84.6	90.7	96.8	103.0	109.4	116.7	123.1	9:58
4200	66.4	72.6	79.0	85.5	92.2	98.9	105.6	112.3	119.3	127.3	134.3	11:07
4600	71.6	78.4	85.3	92.3	99.5	106.8	114.1	121.3	129.0	137.6	145.2	12:17
5000	76.7	83.9	91.4	98.9	106.7	114.5	122.3	130.1	138.3	147.7	155.8	13:30

Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	3900	3800	700
380	6700	6600	3900
360	9300	9300	6900
340	11800	11700	9800
320	14200	14100	12500
300	16500	16400	15000
280	18900	18800	17500
260	21300	21300	20100
240	23900	23800	22800
220	26400	26400	25500
200	29100	29100	28300

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		10	14	17	20	23	25	27	29	31
360	EPR	1.32								
	MACH	.596								
	KIAS	331								
	FF/ENG	6512								
340	EPR	1.28								
	MACH	.580								
	KIAS	322								
	FF/ENG	6070								
320	EPR	1.25	1.35							
	MACH	.565	.607							
	KIAS	313	313							
	FF/ENG	5640	5785							
300	EPR	1.22	1.31	1.39						
	MACH	.549	.589	.624						
	KIAS	304	304	305						
	FF/ENG	5227	5334	5446						
280	EPR	1.20	1.27	1.34	1.45					
	MACH	.533	.571	.604	.642					
	KIAS	296	294	294	296					
	FF/ENG	4841	4907	4972	5134					
260	EPR	1.18	1.23	1.30	1.38	1.50				
	MACH	.517	.552	.583	.619	.660				
	KIAS	287	284	284	284	286				
	FF/ENG	4466	4500	4534	4655	4814				
240	EPR	1.15	1.20	1.26	1.33	1.43	1.51			
	MACH	.502	.534	.562	.595	.633	.662			
	KIAS	278	274	273	273	274	276			
	FF/ENG	4095	4119	4117	4202	4324	4438			
220	EPR	1.13	1.17	1.22	1.28	1.36	1.43	1.52		
	MACH	.485	.516	.542	.572	.607	.633	.662		
	KIAS	269	265	263	262	262	263	264		
	FF/ENG	3748	3752	3724	3776	3857	3938	4050		
200	EPR	1.11	1.15	1.18	1.23	1.30	1.36	1.43	1.51	1.62
	MACH	.468	.497	.521	.548	.580	.604	.631	.660	.693
	KIAS	259	255	252	251	250	250	251	252	254
	FF/ENG	3411	3388	3363	3379	3420	3475	3553	3654	3802

ALTERNATE MODE EEC

Alternate Mode EEC Limit Weight

Takeoff Field Limit Weight Adjustment

AIRPORT OAT (°C)	WEIGHT ADJUSTMENT (1000 KG)
54	-43.0
50	-42.0
45	-40.5
40	-39.0
35	-37.5
30	-36.5
25	-34.5
20	-32.0
15	-30.5
10	-29.0
5	-27.5
0 & BELOW	-27.0

The minimum takeoff field length required is 5400 ft.

Takeoff Climb Limit Weight Adjustment

AIRPORT OAT (°C)	WEIGHT ADJUSTMENT (1000 KG)											
	AIRPORT PRESSURE ALTITUDE (FT)											
	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	-56.0	-56.0	-56.0	-56.0								
50	-54.0	-54.0	-54.0	-54.0	-54.0	-54.0						
45	-52.0	-52.0	-52.0	-52.0	-52.0	-52.0	-52.0	-52.0	-52.0			
40	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	-49.5	
35	-37.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0
30	-25.5	-36.5	-41.5	-44.5	-44.5	-44.5	-44.5	-44.5	-44.5	-44.5	-44.5	-44.5
25	-25.5	-25.0	-28.0	-34.0	-37.0	-40.0	-42.5	-42.5	-42.5	-42.5	-42.5	-42.5
20	-26.0	-25.0	-23.5	-23.0	-26.0	-29.5	-33.0	-40.5	-40.5	-40.5	-40.5	-40.5
15	-26.0	-25.0.	-23.5	-23.0	-22.0	-20.5	-22.0	-30.0	-34.5	-38.5	-38.5	-38.5
10	-26.0	-25.0	-23.0	-23.0	-22.0	-20.5	-19.0	-19.0	-24.5	-29.0	-32.0	-35.0
5	-25.5	-25.0	-23.0	-23.0	-22.0	-20.5	-19.0	-18.0	-18.5	-19.0	-22.5	-26.0
0 & BELOW	-25.5	-25.0	-23.0	-23.0	-22.0	-20.5	-19.0	-18.0	-18.5	-18.0	-17.0	-16.0

Takeoff Obstacle Limit Weight Adjustment

AIRPORT OAT(°C)	WEIGHT ADJUSTMENT (1000 KG)											
	AIRPORT PRESSURE ALTITUDE (FT)											
	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
45	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0
40	-50.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0	-53.0
35	-45.0	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5
30	-39.5	-44.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
25	-34.5	-37.5	-41.0	-42.5	-48.5	-48.5	-48.5	-48.5	-48.5	-48.5	-48.5	-48.5
20	-29.5	-31.5	-34.0	-36.0	-38.5	-41.0	-45.0	-45.0	-45.0	-45.0	-45.0	-45.0
15	-26.5	-25.5	-27.5	-29.0	-31.5	-34.0	-35.5	-36.5	-37.0	-42.0	-42.0	-42.0
10	-26.5	-25.5	-25.0	-23.5	-24.5	-26.5	-28.5	-29.5	-31.5	-39.0	-36.5	-36.5
5	-26.5	-25.5	-25.0	-23.5	-23.5	-23.0	-22.0	-23.0	-25.0	-32.5	-28.0	-30.0
0	-26.0	-25.5	-25.0	-23.5	-23.5	-23.0	-22.0	-20.5	-20.0	-25.5	-21.5	-23.5
-5 & BELOW	-26.0	-25.5	-25.0	-23.5	-23.5	-23.0	-22.0	-20.5	-20.0	-18.0	-17.5	-17.0

ALTERNATE MODE EEC

Takeoff Tire Speed Limit Weight Adjustment

AIRPORT OAT (°C)	WEIGHT ADJUSTMENT (1000 KG)
54	-6.5
50	-6.0
45	-6.0
40	-6.0
35	-5.5
30	-5.0
25	-4.5
20	-4.0
15	-3.0
10	-2.5
5	-2.5
0	-2.0
-5	-1.5
-10 & BELOW	-1.5

Landing Climb Limit Weight Adjustment

AIRPORT OAT (°C)	WEIGHT ADJUSTMENT (1000 KG)							
	AIRPORT PRESSURE ALTITUDE (FT)							
	3000	4000	5000	6000	7000	8000	9000	10000
54	-54.0							
50	-51.0	-51.0						
45	-48.0	-48.0	-48.0	-48.0	-48.0			
40	-45.0	-45.0	-45.0	-45.0	-45.0	-45.0	-45.0	
35	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0
30	-39.0	-39.0	-39.0	-39.0	-39.0	-39.0	-39.0	-39.0
25	-30.0	-36.0	-36.0	-36.0	-36.0	-36.0	-36.0	-36.0
20	-18.0	-24.0	-28.0	-33.5	-33.5	-33.5	-33.5	-33.5
15	-13.5	-14.0	-16.5	-23.0	-27.0	-30.0	-30.0	-30.0
10	-13.5	-13.5	-13.5	-13.0	-16.5	-20.0	-23.5	-26.5
5	-13.5	-13.5	-13.5	-11.5	-10.0	-10.0	-14.0	-17.0
0 & BELOW	-13.5	-13.5	-13.5	-11.5	-10.0	-9.5	-8.5	-8.0

ALTERNATE MODE EEC

Takeoff Speed Adjustment

V1 Adjustment

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)											
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	130	9	9	9	9								
50	122	9	9	9	9	9	9						
45	113	9	9	9	9	9	9	9	9	9			
40	104	7	8	8	8	8	8	8	8	8	8	8	8
35	95	5	7	8	8	8	8	8	8	8	8	8	8
30	86	3	5	6	7	8	8	8	8	8	8	8	8
25	77	3	3	4	5	6	6	7	7	7	7	7	7
20	68	3	3	3	3	4	5	5	7	7	7	7	7
15	59	3	3	3	3	3	3	3	5	6	6	6	6
10	50	3	3	3	3	3	3	3	3	4	5	5	6
5	41	3	3	3	3	3	3	3	3	3	3	4	4
0	32	3	3	3	3	3	3	3	3	3	3	2	2
-55	-67	3	3	3	3	3	3	3	3	3	3	2	2

VR Adjustment

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)											
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	130	4	4	4	4								
50	122	4	4	4	4	4	4						
45	113	4	4	4	4	4	4	4	4	4			
40	104	4	4	4	4	4	4	4	4	4	4	4	4
35	95	2	3	3	3	3	3	3	3	3	3	3	3
30	86	2	2	3	3	3	3	3	3	3	3	3	3
25	77	2	2	2	2	3	3	3	3	3	3	3	3
20	68	2	2	2	2	2	2	2	3	3	3	3	3
15	59	2	2	2	2	1	1	2	2	2	3	3	3
10	50	2	2	2	2	1	1	1	1	2	2	2	3
5	41	2	2	2	2	1	1	1	1	1	1	2	2
0 & BELOW	32 & BELOW	2	2	2	2	1	1	1	1	1	1	1	1

ALTERNATE MODE EEC

Minimum Control Speeds

VMCG, VRMIN (KIAS)

-2000 FT to 4000 FT Pressure Altitudes

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)							
		-2000		0		2000		4000	
°C	°F	VMCG	VRMIN	VMCG	VRMIN	VMCG	VRMIN	VMCG	VRMIN
60	140	108	111	104	107	101	103	97	100
55	131	112	115	108	111	104	107	100	103
50	122	115	118	111	114	107	110	103	106
45	113	119	122	114	118	110	113	106	109
40	104	123	126	117	120	113	116	109	112
39	103	124	127	118	121	113	117	109	112
37	99	125	128	119	122	114	117	110	113
35	95	125	128	120	123	115	119	111	114
33	92	125	129	122	125	116	119	112	115
30	86	126	129	123	126	118	122	113	116
29	85	126	129	123	126	118	122	114	117
25	77	126	129	124	127	120	123	115	118
23	73	126	129	124	127	120	123	115	118
20	68	126	129	124	127	121	124	116	119
15	59	126	129	124	127	121	124	117	120
10	50	126	129	124	127	121	124	117	120
5	41	126	129	124	127	121	124	117	120
0	32	126	129	124	127	121	124	117	120
-55	-67	126	129	124	127	121	124	117	120

5000 FT to 10000 FT Pressure Altitudes

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)							
		5000		6000		8000		10000	
°C	°F	VMCG	VRMIN	VMCG	VRMIN	VMCG	VRMIN	VMCG	VRMIN
60	140	95	98	93	96	90	93	87	89
55	131	98	100	97	99	93	96	90	92
50	122	100	103	100	102	96	99	92	95
45	113	103	105	102	105	99	101	95	97
40	104	105	108	105	108	101	104	97	100
39	103	106	109	105	108	102	104	98	100
37	99	107	110	106	109	102	105	98	101
35	95	108	111	107	110	103	106	99	102
33	92	109	112	108	111	104	107	100	103
30	86	110	113	109	112	105	108	101	104
29	85	111	114	109	112	105	108	101	104
25	77	113	116	111	114	107	110	103	106
23	73	114	117	112	115	107	110	103	106
20	68	114	117	113	116	108	111	104	107
15	59	116	119	113	116	110	113	106	108
10	50	116	119	115	118	110	114	107	110
5	41	116	119	115	118	111	114	107	110
0	32	116	119	115	118	111	114	108	111
-55	-67	116	119	115	118	111	114	109	111

ALTERNATE MODE EEC

Minimum Control Speeds

Flaps 20 V2 for VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)																	
	89		90		95		100		105		110		115		120		125	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
260	104	22	105	21	109	20	115	19	121	18	127	17	133	17	139	17	145	17
240	104	20	104	20	109	19	115	18	121	18	127	17	133	17	139	17	145	17
220	103	19	104	19	109	18	115	18	121	17	127	17	133	17	140	17	146	18
200	103	18	104	18	109	18	115	18	121	17	128	17	134	17	140	18	147	18

Flaps 10 V2 for VRMIN (KIAS)

WEIGHT (1000 KG)	VRMIN (KIAS)																	
	89		90		95		100		105		110		115		120		125	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
240	105	23	106	23	111	21	116	21	123	20	129	19	135	19	141	19	147	19
220	105	22	106	21	111	21	116	20	123	19	129	19	135	19	142	20	148	20
200	105	21	106	20	111	20	117	19	123	19	129	19	136	19	142	20	149	20

ALTERNATE MODE EEC

Takeoff EPR

Based on engine bleed for 3 packs on

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)												
°C	°F	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	130		1.31	1.31	1.31	1.31	1.31							
50	122		1.35	1.35	1.35	1.35	1.35	1.35	1.35					
45	113		1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39		
40	104		1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
35	95	1.45	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
30	86	1.47	1.48	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
25	77	1.47	1.48	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51
20	68	1.47	1.48	1.51	1.52	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
15	59	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.56	1.56	1.56	1.56	1.56	1.56
10	50	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.59	1.59	1.59	1.59
5	41	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.61	1.62	1.62	1.62
0 & BELOW	32 & BELOW	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.61	1.62	1.63	1.64

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	10000
2 PACKS OFF	0.01	0.01
3 PACKS OFF	0.02	0.02

Go-around EPR

Based on engine bleed for 3 packs on

REPORTED OAT		TAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
°C	°F		-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	130	57		1.31	1.31	1.31	1.31	1.31							
52	126	55		1.33	1.33	1.33	1.33	1.33	1.33	1.33					
47	117	50		1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37		
42	108	45		1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
37	99	40	1.43	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
32	90	35	1.46	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.47
27	81	30	1.47	1.48	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.48	1.48	1.48
22	72	25	1.47	1.48	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51
17	63	20	1.47	1.48	1.51	1.52	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
12	54	15	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.56	1.56	1.56	1.56	1.56	1.56
7	45	10	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.59	1.59	1.59	1.59
2	36	5	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.61	1.62	1.62	1.62
-3 & BELOW	27 & BELOW	0 & BELOW	1.47	1.48	1.51	1.52	1.54	1.55	1.56	1.57	1.59	1.61	1.62	1.63	1.64

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	10000
2 PACKS OFF	0.01	0.01
3 PACKS OFF	0.02	0.02

GEAR DOWN

Takeoff Climb Limit

Based on engine bleed for 3 packs on and anti-ice off

Weight (1000 KG)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)												
°C	°F	-2000	-1000	SL	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
55	131	284	272											
50	122	300	288	276	265	253								
45	113	317	304	292	280	268	256	245						
40	104	335	322	309	296	283	271	259	247	236	225			
35	95	355	342	328	314	301	287	275	263	251	239	228	217	
30	86	359	353	348	334	320	306	293	280	267	255	243	230	218
25	77	359	353	348	342	336	326	312	298	285	272	259	246	233
20	68	359	353	348	342	336	330	323	316	303	289	275	262	248
15	59	359	353	348	342	336	330	323	316	309	302	292	278	264
10 & BELOW	50 & BELOW	359	353	348	341	335	329	323	316	309	302	294	286	278

Applicable for flaps 10 or 20 takeoff.

Weight Adjustment for Bleed Configuration

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (KG)	
	A/C PACKS OFF	A/C PACKS ON
A/I OFF	+6650	0
NACELLE A/I ON	-950	-10500
NACELLE AND WING A/I ON	-10350	-21200

Landing Climb Limit

Based on engine bleed for 3 packs on and anti-ice off

Weight (1000 KG)

AIRPORT OAT	AIRPORT PRESSURE ALTITUDE (FT)												
°C	-2000	-1000	SL	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
55	328	316	305	294	284	276							
50	300	348	337	326	318	303	292	281	272	263			
45	371	358	346	334	322	310	299	287	278	268	258		
40	392	378	365	352	339	327	315	303	292	280	270	260	250
35	395	389	385	369	354	342	330	318	307	294	283	271	261
30	395	389	385	380	370	356	343	331	318	306	295	283	272
25	396	389	385	380	372	363	354	342	329	316	304	292	281
20	396	389	385	380	372	363	355	346	339	326	314	301	290
15	396	389	385	380	372	363	355	346	340	331	322	308	297
10 & BELOW	396	389	385	380	372	364	355	346	340	331	322	313	304

Applicable for flaps 25 or 30 landing.
For 1 A/C Pack ON, add 3300 kg.
For A/C Packs OFF and 4900 kg.
Reduce Landing Climb Limit Weight by 36700 kg. when operating in icing conditions during any part of the flight with forecast landing temperature below 8°C.

GEAR DOWN

Max Climb EPR

Based on engine bleed for 3 packs on, engine and wing anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)												
	0	5	10	12	14	16	18	20	22	24	26	28	30
	240	240	240	240	240	240	240	240	240	240	240	0.60	0.60
55	1.25												
50	1.27	1.27											
45	1.29	1.29	1.29										
40	1.32	1.32	1.32	1.31	1.30								
35	1.33	1.35	1.35	1.34	1.34	1.33							
30	1.33	1.38	1.38	1.38	1.37	1.37	1.36	1.36					
25	1.33	1.39	1.42	1.42	1.41	1.41	1.40	1.40	1.40	1.40			
20	1.33	1.39	1.46	1.46	1.45	1.45	1.45	1.45	1.45	1.45	1.45		
15	1.33	1.39	1.46	1.48	1.50	1.49	1.49	1.49	1.49	1.49	1.49	1.49	
10	1.33	1.39	1.46	1.48	1.50	1.53	1.54	1.54	1.54	1.54	1.54	1.54	1.54
5	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.58	1.58	1.58	1.58	1.58
0	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.61	1.62	1.62	1.62	1.63
-5	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.61	1.63	1.65	1.66	1.66
-10	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.61	1.63	1.65	1.68	1.70
-15	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.61	1.63	1.65	1.68	1.71
-20	1.33	1.39	1.46	1.48	1.50	1.53	1.56	1.58	1.61	1.63	1.65	1.68	1.71

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	0	10	20	30
ENGINE ANTI-ICE ON	-0.01	-0.02	-0.03	-0.04
ENGINE & WING ANTI-ICE ON	-0.03	-0.04	-0.06	-0.07

Long Range Cruise Altitude Capability

Max Climb Thrust, 100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	19100	19000	17300
380	20600	20600	18900
360	22000	21900	20400
340	23200	23200	21700
320	24900	24800	23600
300	26800	26800	25700
280	28900	28800	27900
260	31000	31000	30000
240	32900	32800	32100
220	34800	34800	34100
200	36700	36700	36200

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	14	17	20	23	25	27	29	31	33
400	EPR	1.25	1.33								
	MACH	.488	.525								
	KIAS	270	270								
	FF/ENG	5036	5128								
380	EPR	1.23	1.30	1.37							
	MACH	.488	.525	.556							
	KIAS	270	270	270							
	FF/ENG	4841	4920	4929							
360	EPR	1.21	1.28	1.35							
	MACH	.488	.525	.556							
	KIAS	270	270	270							
	FF/ENG	4671	4737	4736							
340	EPR	1.20	1.26	1.32							
	MACH	.488	.524	.552							
	KIAS	270	269	268							
	FF/ENG	4524	4561	4533							
320	EPR	1.18	1.23	1.29	1.36						
	MACH	.481	.511	.538	.570						
	KIAS	266	263	261	261						
	FF/ENG	4297	4271	4231	4281						
300	EPR	1.16	1.21	1.26	1.32	1.41					
	MACH	.468	.499	.523	.552	.589					
	KIAS	259	256	254	252	254					
	FF/ENG	4021	3999	3936	3958	4030					
280	EPR	1.15	1.19	1.23	1.28	1.36	1.42	1.50			
	MACH	.456	.485	.509	.536	.568	.595	.624			
	KIAS	252	249	246	245	245	246	248			
	FF/ENG	3760	3724	3657	3664	3695	3755	3840			
260	EPR	1.13	1.17	1.21	1.25	1.31	1.37	1.44	1.52		
	MACH	.441	.471	.494	.520	.548	.572	.599	.630		
	KIAS	244	242	239	237	236	236	238	240		
	FF/ENG	3500	3454	3395	3380	3376	3415	3477	3564		
240	EPR	1.12	1.15	1.18	1.22	1.27	1.32	1.37	1.45	1.53	
	MACH	.426	.456	.479	.503	.529	.550	.574	.602	.634	
	KIAS	235	234	232	229	227	227	227	229	231	
	FF/ENG	3239	3191	3129	3110	3086	3092	3134	3197	3279	
220	EPR	1.10	1.13	1.16	1.19	1.24	1.27	1.32	1.38	1.45	1.54
	MACH	.409	.439	.462	.486	.511	.529	.550	.575	.604	.636
	KIAS	226	225	223	221	219	218	217	218	219	222
	FF/ENG	2979	2935	2869	2848	2812	2801	2812	2853	2917	2992
200	EPR	1.09	1.11	1.14	1.17	1.20	1.23	1.27	1.32	1.37	1.45
	MACH	.390	.421	.444	.468	.492	.509	.528	.548	.574	.603
	KIAS	215	215	214	213	211	209	208	207	208	209
	FF/ENG	2713	2680	2622	2588	2553	2532	2523	2535	2577	2636

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
285	264	245	228	213	200	191	183	175	168	161
597	545	500	462	429	400	381	364	348	333	320
906	825	754	695	644	600	571	545	521	499	479
1215	1105	1008	928	860	800	762	726	694	664	638
1527	1386	1263	1161	1076	1000	952	907	866	829	796
1841	1669	1519	1396	1292	1200	1141	1088	1038	993	953
2159	1955	1777	1631	1508	1400	1331	1268	1210	1157	1110
2480	2243	2036	1867	1725	1600	1521	1448	1381	1321	1266
2804	2533	2297	2104	1942	1800	1710	1628	1552	1484	1423
3133	2826	2559	2342	2160	2000	1900	1807	1723	1646	1578
3466	3122	2823	2581	2378	2200	2089	1986	1892	1808	1732
3804	3421	3089	2821	2597	2400	2277	2165	2062	1969	1886
4147	3724	3357	3061	2816	2600	2466	2343	2231	2130	2040
4495	4030	3627	3303	3035	2800	2655	2522	2401	2291	2193
4850	4340	3900	3547	3255	3000	2844	2700	2569	2451	2346
5210	4654	4175	3791	3476	3200	3032	2878	2737	2611	2498
5578	4973	4453	4038	3697	3400	3220	3055	2905	2770	2650
5954	5297	4733	4286	3919	3600	3408	3232	3072	2928	2800
6338	5627	5017	4535	4142	3800	3596	3409	3239	3086	2950
6731	5962	5304	4786	4366	4000	3784	3585	3405	3244	3100

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	10.3	0:40	9.6	0:39	8.7	0:38	8.0	0:36	7.5	0:35
400	20.3	1:23	19.0	1:19	17.5	1:16	16.4	1:12	15.7	1:09
600	30.3	2:05	28.4	2:00	26.4	1:54	24.9	1:48	23.9	1:43
800	40.3	2:48	37.9	2:40	35.3	2:33	33.4	2:24	32.1	2:17
1000	50.3	3:30	47.3	3:20	44.2	3:11	41.8	3:01	40.3	2:52
1200	59.9	4:15	56.3	4:02	52.6	3:50	49.8	3:38	48.1	3:27
1400	69.4	4:59	65.2	4:44	61.1	4:30	57.8	4:15	55.8	4:03
1600	78.6	5:45	74.0	5:26	69.3	5:10	65.6	4:53	63.3	4:39
1800	87.7	6:31	82.5	6:10	77.3	5:51	73.2	5:32	70.6	5:16
2000	96.7	7:18	91.0	6:54	85.3	6:32	80.8	6:11	77.9	5:53
2200	105.3	8:07	99.1	7:39	92.8	7:14	88.0	6:50	84.9	6:31
2400	113.8	8:56	107.2	8:24	100.4	7:57	95.2	7:30	91.8	7:09
2600	122.2	9:46	115.1	9:11	107.8	8:40	102.2	8:11	98.5	7:48
2800	130.3	10:38	122.8	9:59	115.1	9:24	109.1	8:52	105.1	8:27
3000	138.5	11:30	130.5	10:47	122.3	10:08	115.9	9:34	111.7	9:07
3200	146.2	12:26	137.8	11:37	129.2	10:54	122.4	10:16	117.9	9:47
3400	153.8	13:21	145.1	12:28	136.0	11:41	128.8	10:59	124.2	10:28
3600	161.3	14:19	152.2	13:19	142.8	12:28	135.2	11:43	130.2	11:10
3800	168.5	15:18	159.1	14:13	149.3	13:16	141.4	12:28	136.1	11:52
4000	175.7	16:18	166.0	15:07	155.9	14:05	147.5	13:12	142.1	12:34

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
20	-3.7	-1.9	0.0	2.5	5.8
30	-5.5	-2.8	0.0	3.9	8.5
40	-7.4	-3.7	0.0	5.2	11.2
50	-9.3	-4.6	0.0	6.6	13.9
60	-11.2	-5.5	0.0	8.0	16.6
70	-13.2	-6.4	0.0	9.3	19.3
80	-15.3	-7.4	0.0	10.7	21.9
90	-17.4	-8.4	0.0	12.0	24.6
100	-19.6	-9.5	0.0	13.4	27.3
110	-21.8	-10.5	0.0	14.7	30.0
120	-24.1	-11.6	0.0	16.0	32.6
130	-26.5	-12.7	0.0	17.4	35.3
140	-28.9	-13.9	0.0	18.7	38.0
150	-31.4	-15.0	0.0	20.0	40.6
160	-33.9	-16.2	0.0	21.3	43.3

Descent at .66/240

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	18	27	37	40	44	48	52	55	59	63	67	71	74	77
TIME (MINUTES)	5	7	9	10	11	12	12	13	14	14	15	15	16	16

GEAR DOWN

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
400	EPR	1.14	1.18	1.25	1.35			
	KIAS	270	270	270	270			
	FF/ENG	5230	5210	5290	5350			
380	EPR	1.13	1.16	1.23	1.32			
	KIAS	270	270	270	270			
	FF/ENG	5060	5030	5080	5130			
360	EPR	1.13	1.15	1.21	1.30			
	KIAS	270	270	270	270			
	FF/ENG	4910	4870	4910	4940			
340	EPR	1.11	1.14	1.19	1.27			
	KIAS	261	261	261	261			
	FF/ENG	4600	4560	4550	4580			
320	EPR	1.10	1.13	1.17	1.24	1.38		
	KIAS	251	251	251	251	270		
	FF/ENG	4280	4240	4210	4220	4700		
300	EPR	1.09	1.12	1.15	1.21	1.35		
	KIAS	242	242	242	242	270		
	FF/ENG	4000	3950	3910	3900	4540		
280	EPR	1.09	1.10	1.14	1.19	1.31		
	KIAS	233	233	233	233	260		
	FF/ENG	3720	3660	3620	3580	4180		
260	EPR	1.08	1.09	1.12	1.17	1.27	1.41	
	KIAS	228	228	228	228	251	253	
	FF/ENG	3510	3450	3400	3350	3830	3930	
240	EPR	1.07	1.08	1.11	1.15	1.24	1.35	1.53
	KIAS	221	221	221	221	240	242	244
	FF/ENG	3270	3220	3160	3100	3470	3550	3690
220	EPR	1.06	1.07	1.10	1.13	1.20	1.30	1.46
	KIAS	215	215	215	215	229	231	234
	FF/ENG	3050	3010	2940	2890	3140	3190	3320
200	EPR	1.06	1.07	1.09	1.12	1.17	1.25	1.38
	KIAS	208	208	208	208	219	220	222
	FF/ENG	2810	2780	2730	2660	2820	2850	2940

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight - Gear Down, One Engine Inop

Chapter PI Section 17

GEAR DOWN

1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

Based on engine bleed for 3 packs on

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	383	266	8400	8400	6200
390	374	264	9500	9500	7400
380	365	261	10500	10500	8600
370	356	259	11600	11500	9700
360	347	256	12600	12600	10800
350	337	254	13700	13600	11900
340	328	251	14700	14700	13000
330	319	248	15700	15700	14100
320	309	246	16700	16700	15200
310	300	243	17700	17700	16300
300	291	240	18800	18800	17500
290	281	237	19800	19800	18600
280	271	234	20900	20900	19800
270	262	231	22000	21900	20900
260	252	228	23100	23100	22100
250	242	225	24200	24200	23300
240	233	222	25200	25200	24400
230	223	219	26400	26300	25600
220	213	215	27500	27400	26700
210	204	212	28500	28500	27900
200	195	209	29500	29500	29000

Altitude reduced by 1000 ft for additional margin.

GEAR DOWN
1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability

Based on engine bleed for 3 packs on

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	6200	6100	3100
390	7200	7100	4200
380	8100	8100	5400
370	9000	8900	6400
360	9800	9700	7300
350	10500	10500	8200
340	11400	11300	9100
330	12700	12600	10500
320	14000	13900	11900
310	15200	15100	13300
300	16400	16300	14700
290	17600	17500	16100
280	18800	18800	17400
270	20000	20000	18800
260	21200	21200	20100
250	22500	22400	21400
240	23700	23700	22800
230	25000	24900	24100
220	26200	26200	25500
210	27500	27500	26800
200	28800	28700	28200

Altitude reduced by 1000 ft for additional margin.

GEAR DOWN
1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)							
		10	14	17	20	23	25	27	29
360	EPR	1.39							
	MACH	.488							
	KIAS	270							
	FF/ENG	6506							
340	EPR	1.37							
	MACH	.487							
	KIAS	270							
	FF/ENG	6240							
320	EPR	1.33	1.44						
	MACH	.474	.510						
	KIAS	262	262						
	FF/ENG	5806	5930						
300	EPR	1.29	1.39	1.50					
	MACH	.461	.494	.525					
	KIAS	255	254	254					
	FF/ENG	5392	5459	5579					
280	EPR	1.26	1.34	1.43					
	MACH	.447	.479	.507					
	KIAS	247	246	246					
	FF/ENG	4974	5030	5082					
260	EPR	1.24	1.30	1.38	1.48				
	MACH	.433	.464	.489	.519				
	KIAS	239	238	237	237				
	FF/ENG	4578	4623	4612	4746				
240	EPR	1.21	1.27	1.33	1.41	1.53			
	MACH	.419	.448	.472	.499	.533			
	KIAS	231	229	228	228	229			
	FF/ENG	4199	4217	4191	4266	4422			
220	EPR	1.18	1.23	1.28	1.35	1.44	1.53	1.64	
	MACH	.402	.432	.455	.480	.510	.532	.560	
	KIAS	222	221	220	219	219	219	222	
	FF/ENG	3829	3829	3796	3832	3922	4023	4197	
200	EPR	1.16	1.20	1.24	1.30	1.37	1.44	1.52	1.64
	MACH	.385	.414	.436	.461	.487	.507	.530	.558
	KIAS	212	212	211	210	208	209	209	211
	FF/ENG	3469	3459	3412	3434	3466	3530	3622	3774

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
311	281	255	233	216	200	190	181	173	166	159
632	568	513	469	432	400	380	362	346	331	318
956	859	774	706	650	600	570	543	518	495	475
1284	1151	1036	943	867	800	759	722	689	658	631
1616	1446	1300	1182	1085	1000	949	902	859	820	786
1952	1744	1565	1421	1303	1200	1138	1082	1030	983	941
2293	2045	1832	1662	1522	1400	1327	1259	1198	1144	1095
2639	2350	2101	1903	1741	1600	1516	1438	1368	1304	1248
2990	2657	2372	2146	1961	1800	1704	1616	1536	1464	1400
3348	2969	2645	2389	2181	2000	1892	1793	1703	1623	1551

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	8.8	0:46	8.1	0:44	7.5	0:42	7.0	0:40	6.8	0:38
400	18.2	1:31	17.1	1:27	16.0	1:23	15.3	1:18	15.0	1:14
600	27.3	2:17	25.8	2:10	24.2	2:04	23.3	1:57	23.0	1:51
800	36.2	3:04	34.3	2:55	32.2	2:45	31.1	2:36	30.6	2:28
1000	44.9	3:52	42.6	3:40	40.1	3:28	38.6	3:16	38.1	3:06
1200	53.5	4:41	50.6	4:26	47.7	4:11	46.0	3:56	45.3	3:44
1400	61.8	5:31	58.5	5:12	55.2	4:55	53.1	4:38	52.3	4:23
1600	69.9	6:22	66.2	6:00	62.4	5:39	60.1	5:19	59.1	5:03
1800	77.8	7:14	73.7	6:48	69.5	6:24	66.9	6:02	65.7	5:44
2000	85.5	8:07	81.1	7:37	76.5	7:10	73.5	6:45	72.1	6:25

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-1.1	0.0	1.3	2.8	5.1
20	-2.3	0.0	3.1	5.8	10.1
30	-3.6	0.0	5.0	9.0	15.1
40	-4.8	0.0	7.0	12.5	20.3
50	-6.1	0.0	9.0	16.2	25.5
60	-7.4	0.0	11.1	20.2	30.8
70	-8.7	0.0	13.3	24.4	36.1
80	-10.0	0.0	15.5	28.8	41.6
90	-11.3	0.0	17.8	33.5	47.1

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)					
		1500	5000	10000	15000	20000	25000
400	EPR	1.26	1.32				
	KIAS	270	270				
	FF/ENG	7080	7220				
380	EPR	1.24	1.30				
	KIAS	270	270				
	FF/ENG	6790	6910				
360	EPR	1.23	1.28	1.39			
	KIAS	270	270	270			
	FF/ENG	6540	6630	6830			
340	EPR	1.20	1.25	1.35			
	KIAS	261	261	261			
	FF/ENG	6080	6130	6310			
320	EPR	1.19	1.23	1.31	1.45		
	KIAS	251	251	251	251		
	FF/ENG	5640	5650	5790	5960		
300	EPR	1.17	1.20	1.28	1.40		
	KIAS	242	242	242	242		
	FF/ENG	5230	5220	5320	5430		
280	EPR	1.15	1.18	1.25	1.35		
	KIAS	233	233	233	233		
	FF/ENG	4840	4820	4870	4940		
260	EPR	1.14	1.17	1.22	1.31	1.53	
	KIAS	228	228	228	228	251	
	FF/ENG	4530	4510	4520	4570	5400	
240	EPR	1.12	1.15	1.20	1.27	1.45	
	KIAS	221	221	221	221	240	
	FF/ENG	4190	4170	4160	4170	4840	
220	EPR	1.11	1.13	1.18	1.24	1.38	1.58
	KIAS	215	215	215	215	229	231
	FF/ENG	3890	3870	3850	3830	4320	4570
200	EPR	1.10	1.12	1.15	1.21	1.32	1.48
	KIAS	208	208	208	208	219	220
	FF/ENG	3590	3560	3540	3500	3840	4020

This table includes 5% additional fuel for holding in a racetrack pattern.

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Performance Inflight - Text

Chapter PI
Section 18

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General

Clearway and Stopway V1 Adjustments

Takeoff speed adjustments are to be applied to V1 speed when using takeoff weights based on the use of clearway and stopway.

Adjust V1 speed by the amount shown in the table. The adjusted V1 speed must not exceed VR.

Maximum allowable clearway limits are provided for guidance when more precise data is not available.

VREF

The Reference Speed table contains flaps 30 and 25 landing speeds for a given weight. Apply adjustments shown as required.

Flap Maneuver Speeds

This table provides the flap speed schedule for recommended maneuvering speeds. Using VREF as the basis for the schedule makes it variable as a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction, selection to the next position should be initiated when at and accelerating above the recommended flap speed for the new position. During flap extension, selection of the flaps to the next position should be made prior to decelerating below the recommended flap speed for the current flap setting.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in field/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff. Data is shown for 2 engine reverse thrust and for no reverse thrust.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 13mm (0.5 inches) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the field/obstacle limit weight for the takeoff flap setting.

2. Enter the Weight Adjustment table with the field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.

3. Enter the VMCG Limit Weight table with the available field length and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for VMCG speed.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 3.

Takeoff speed determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Takeoff Speeds from the FMC or Takeoff Analysis.

2. If VMCG limited, set V1=VMCG. If not limited by VMCG considerations, reenter the V1 Adjustment table with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than VMCG, set V1=VMCG.

Tables for no reverse thrust are also provided in the same format.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. Good reported braking action denotes wet runway conditions or runways covered by compacted snow. Similarly, poor reported braking action denoted runways covered with wet ice. Performance is based on two symmetric reversers operating and a 15 ft. screen height at the end of the runway. The tables provided are used in the same manner as the Slush/ Standing Water tables. Data is provided for 2 engine reverse thrust and for no reverse thrust.

Tables for no reverse thrust are also provided in the same format.

Minimum Control Speeds

Regulations prohibit scheduling takeoff with a V1 less than minimum speed for control on the ground, VMCG, and VR less than minimum VR, (1.05) VMCA. Therefore, compare the adjusted V1 and VR to the VMCG and VRMIN respectively. To find VMCG and VRMIN, enter the VMCG, VRMIN table with the airport pressure altitude and actual OAT. If the adjusted V1 is less than VMCG, set V1 equal to VMCG. If the adjusted VR is less than VRMIN, set VR equal to VRMIN. If VR is less than VMCG, set VR equal to VMCG. If VR is limited by either VMCG or VRMIN, V2 must be adjusted to account for the increase in VR. This adjusted V2 speed can be obtained from the V2 for VRMIN table by entering with weight and VRMIN. If the V2 for VRMIN is greater than V2, set V2 equal to V2 for VRMIN.

Anti-skid Inoperative

When operating with anti-skid inoperative, the field length/obstacle limited weight and the V1 speed must be reduced to allow for the effect on accelerate-stop performance as detailed in the Airplane Flight Manual. Obstacle clearance capability must also be considered since the reduced V1 speed will increase the distance required to achieve a given height above the runway following engine failure at V1.

A simplified method which conservatively accounts for the effects of anti-skid inoperative is to reduce the normal runway/obstacle limited weight by the amount shown in the table below. Then, reduce the V1 associated with the reduced weight by the V1 amount shown in the table below. If takeoff weight is below the anti-skid inoperative limited weight, it is only necessary to ensure that the V1 speed does not exceed the anti-skid limited V1 speed. If the resulting V1 speed is less than the minimum ground control speed (see Minimum Control Speeds table), takeoff is permitted with V1 set equal to VMCG provided the accelerate stop distance available exceeds approximately 4050 m.

ANTI-SKID INOPERATIVE ADJUSTMENTS		
FIELD LENGTH (M)	WEIGHT (1000 KG)	V1 (KTS)
3000	-42	-44
3500	-30	-48
4000	-25	-47
4500	-25	-44
5000	-28	-41

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Initial Climb EPR

This table is used to set initial climb power once the takeoff segment is complete and enroute configuration is achieved (i.e. flaps up). The power settings shown are based on 200 KIAS at 1000 ft above the airport pressure altitude. Upon accelerating to the normal enroute climb speed of 340 KIAS, the power settings provided in the Max Climb table should be used. EPR adjustments are shown for anti-ice operation.

Max Climb EPR

This table shows Max Climb EPR for a 340/.84 climb speed schedule, normal engine bleed for 3 packs on and anti-ice off. Enter the table with airport pressure altitude and TAT and read EPR. EPR adjustments are shown for anti-ice operation.

Go-around EPR

To find Max Go-around EPR based on normal engine bleed for 3 packs on, enter the Go-around EPR table with airport pressure altitude and reported OAT or TAT and read EPR. For packs off operation, apply the EPR adjustments provided below the table. No EPR adjustment is required for engine and wing anti-ice operations.

Flight with Unreliable Airspeed / Turbulent Air Penetration

Pitch attitude and average EPR information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration.

Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

Note that optimum altitudes shown in the table result in buffet related maneuver margins of 1.5g (48° bank) or more. The altitudes shown in the table are limited to the maximum certified altitude of 45000 ft.

Long Range Cruise Control

The table provides target EPR, Long Range Cruise Mach number, KIAS and standard day fuel flow per engine for the airplane weight and pressure altitude. The shaded area in this table approximates optimum altitude. At optimum altitude the Long Range Cruise Mach schedule is approximated by .86M.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .84/290/250 descent. Tables are presented for low altitudes and high altitudes.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with air distance from the Ground to Air Miles Conversion table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference Fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent

Distance and time for descent are shown for a .84/290/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target EPR, indicated airspeed and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed for the selected flap setting. Flaps 1 data is based on VREF30 + 60 speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read EPR, KIAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distance on dry runways and slippery runways with good, medium, and poor reported braking action. These values are actual landing distances and do not include the 1.67 regulatory factor. Therefore, they cannot be used to determine the dispatch required landing field length. Landing distances for slippery runways are 115% of the actual landing distance.

To use these tables, determine the reference landing distance for the selected braking configuration. Then adjust the reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers to obtain landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice and the braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. Since it cannot be determined quickly when this becomes a factor, it is conservative to add the effects of slope and inoperative reversers when using the autobrake system.

Non-normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances are provided for dry runway and runways with good, medium, and poor reported braking action.

Enter the table with the applicable non-normal configuration and read the normal approach speed (VREF). The reference landing distance is measured from 50 ft above the threshold to stop and is based on reference weight and speed at sea level, zero wind, zero slope and max manual braking with maximum reverse thrust. Subsequent columns provide corrections for off-reference landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is independently added to the reference landing distance. Landing distance includes the effect of maximum manual braking and reverse thrust.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Recommended Brake Cooling Schedule table with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the table with the reference brake energy per brake and the type of braking used during landing (Max Manual or Max Auto). The resulting number is the adjusted brake energy per brake and represents the energy absorbed in each brake during the landing. The recommended cooling time is found in the final table by entering with the adjusted brake energy per brake. Times are provided for ground cooling and inflight gear down cooling.

Brake Temperature Monitor System (BTMS) indications are also shown. If brake cooling is determined from the BTMS, the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted, may be used to determine recommended cooling schedule by entering at the bottom of the chart. An EICAS advisory message, BRAKE TEMP, will appear when any brake registers 5 on the GEAR synoptic display and disappears as the hottest brake cools to an indication of 4. Note that even without an EICAS advisory message, brake cooling is recommended.

One Engine Inoperative

Max Continuous EPR

Power setting is based on one engine inoperative with 3 packs on and all anti-ice bleeds off. Enter the table with pressure altitude and KIAS or Mach to read EPR.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

The level off altitude is dependent on air temperature (ISA deviation). The level off altitude shown is 1000 ft below the maximum altitude. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on Long Range Cruise speed and Max Continuous thrust. Note that the maximum altitude shown has been reduced by 1000 ft. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Control

The table provides target EPR, one engine inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on three engine Long Range Cruise speed and .84/290/250 descent. Enter with Air Distance as determined from the Ground to Air Miles Conversion table and read Fuel and Time required at the cruise pressure altitude. Adjust the fuel obtained for deviation from the reference weight at checkpoint as required by entering the Fuel Required Adjustment table with the fuel required for the reference weight and the actual weight at checkpoint.

Holding

One engine inoperative holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Two Engines Inoperative

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

The level off altitude is dependent on air temperature (ISA deviation). The level off altitude shown is 2000 ft below the maximum altitude. This reduction in altitude is consistent with the FMC.

Driftdown/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to Long Range Cruise speed. Cruise is continued at level off altitude and Long Range Cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table with air distance and weight at start of driftdown to determine fuel and time required.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on Long Range Cruise speed and Max Continuous thrust. Note that the maximum altitude shown has been reduced by 2000 ft. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Control

The table provides target EPR, two engines inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

Alternate Mode EEC

The ALTERNATE EEC mode has not been programmed into the FMC. Therefore, the use of the autothrottle is prohibited and takeoff thrust must be set manually. One Engine Pressure Ratio (EPR) indicating system may be inoperative at dispatch. All four EEC's must be in the ALTERNATE mode. The anti-skid system must be operative. Use of improved climb performance is prohibited. Thrust reduction in addition to those required for ALTERNATE Mode EEC operation are prohibited.

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in the ALTERNATE mode is to reduce the PRIMARY mode (normal) performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, and tire speed limit weights. To determine limit weights for operations with the EEC in the ALTERNATE mode, enter the table with airport OAT and pressure altitude where appropriate, and apply the weight reduction to the normal full rate limit weights. The most limiting of the takeoff weights must be used. The ALTERNATE MODE EEC Landing Climb limit must be compared to the Landing Field Length Limit and the more limiting of the two must be used as the landing limit weight. Analysis from the Airplane Flight Manual may yield less restrictive limit weights.

Takeoff Speed Adjustments

Takeoff speeds can be determined by applying increments to the normal full rate V1 and VR from the tables provided. For brake energy limit reduce the normal VMBE for the actual weight by 1 knot.

NOTE: The FMC does not incorporate ALTERNATE MODE EEC performance in its takeoff speeds calculations.

Minimum Control Speeds

Regulations prohibit scheduling takeoff with a V1 less than minimum speed for control on the ground, VMCG and VR less than minimum VR, (1.05) VMCA. Therefore, compare the adjusted V1 and VR to the VMCG and VRMIN respectively. To find VMCG and VRMIN, enter the VMCG, VRMIN table with the airport pressure altitude and actual OAT. If the adjusted V1 is less than VMCG, set V1 equal to VMCG. If the adjusted VR is less than VMCG, set VR equal to VRMIN. If VR is less than VMCG, set VR equal to VMCG. If VR is limited by either VMCG or VRMIN, V2 must be adjusted to account for the increase in VR. This adjusted V2 speed can be obtained from the V2 for VRMIN table by entering with weight and VRMIN. If the V2 for VRMIN is greater than V2, set V2 equal to V2 for VRMIN.

Takeoff EPR/Go-around EPR

Takeoff and Go-around power setting are presented for normal air conditioning bleed. Takeoff or Go-around EPR may be read directly from the tables for the desired pressure altitude and airport OAT.

Thrust protection is not provided in the ALTERNATE MODE EEC and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight. The data is based on engine bleeds for normal air conditioning.

NOTE: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), maximum altitude, and compute overly shallow descent path. To obtain accurate ETA predictions, gear down cruise speed and altitude should be entered on the CLB and CRZ pages. Gear down cruise speed should also be entered on the DES page and a STEP SIZE of zero should be entered on the PERF INIT or CRZ page. Use of the VNAV during descent under these circumstances is not recommended.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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Maximum Allowable Clearway

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
6000	500
8000	600
10000	650
12000	700
14000	750
16000	750

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)				
	100	120	140	160	180
900	-3	-3	-3	-3	-3
600	-2	-2	-2	-2	-2
300	-1	-1	-1	-1	-1
0	0	0	0	0	0
-300	1	1	1	1	1
-600	2	2	2	2	2
-900	3	3	3	3	3

VREF (KIAS)

WEIGHT (1000 LB)	FLAPS	
	30	25
900	186	194
850	181	188
800	175	182
750	169	176
700	162	169
650	156	163
600	150	156
550	143	149
500	136	141
450	128	134
400	121	126

Increase VREF 1 knot/4000 ft above sea level.

Flap Maneuver Speeds

FLAP POSITION	MANEUVER SPEED
UP	VREF 30 + 80
1	VREF 30 + 60
5	VREF 30 + 40
10	VREF 30 + 20
20	VREF 30 + 10
25	VREF 25
30	VREF 30

ADVISORY INFORMATION

Slush/Standing Water Takeoff
2 Engine Reverse Thrust
Weight Adjustment (1000 LB)

FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960				-73	-73	-73	-118	-118	-118
920	-54	-54	-54	-70	-70	-70	-114	-114	-114
880	-50	-50	-50	-66	-66	-66	-109	-109	-109
840	-47	-47	-47	-63	-63	-63	-104	-104	-104
800	-44	-44	-44	-60	-60	-60	-99	-99	-99
760	-41	-41	-41	-56	-56	-56	-94	-94	-94
720	-38	-38	-38	-53	-53	-53	-89	-89	-89
680	-35	-35	-35	-50	-50	-50	-84	-84	-84
640	-32	-32	-32	-46	-46	-46	-79	-79	-79
600	-29	-29	-29	-43	-43	-43			

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
8200							500		
8600				488			546		
9000				535			593		
9400	538			581			639	481	
9800	585			628	470		686	528	
10200	632			674	516		732	574	
10600	679	520		720	563		778	621	463
11000	726	566		767	609	451	825	667	509
11400	773	613		813	655	498	871	713	556
11800	819	660	500	859	702	544		760	602
12200	866	707	547	906	748	590		806	648
12600	912	754	594		794	637		852	695
13000		801	641		841	683		898	741
13400		847	688		887	730			788
13800		893	735			776			834
14200			782			822			
14600			828			867			
15000			874						

1. **Enter Weight Adjustment table with slush/standing water depth and field/obstacle limit weight to obtain slush/standing water adjustment.**
2. **Find VMCG limited weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 12000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-28	-27	-26	-23	-22	-21	-13	-12	-11
840	-29	-28	-27	-24	-23	-22	-13	-12	-11
800	-30	-29	-28	-25	-24	-23	-15	-14	-13
760	-31	-30	-29	-26	-25	-24	-16	-15	-14
720	-31	-30	-29	-27	-26	-25	-18	-17	-16
680	-32	-31	-30	-28	-27	-26	-20	-19	-18
640	-32	-31	-30	-29	-28	-27	-22	-21	-20
600	-31	-30	-29	-29	-28	-27			

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff
No Reverse Thrust
Weight Adjustment (1000 LB)

FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960	-72	-72	-72	-93	-93	-93	-138	-138	-138
920	-68	-68	-68	-88	-88	-88	-132	-132	-132
880	-64	-64	-64	-84	-84	-84	-127	-127	-127
840	-61	-61	-61	-79	-79	-79	-122	-122	-122
800	-57	-57	-57	-75	-75	-75	-117	-117	-117
760	-53	-53	-53	-70	-70	-70	-112	-112	-112
720	-50	-50	-50	-66	-66	-66	-107	-107	-107
680	-46	-46	-46	-61	-61	-61	-102	-102	-102
640	-42	-42	-42	-57	-57	-57	-97	-97	-97
600	-38	-38	-38	-53	-53	-53	-92	-92	-92

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
11000							539		
11400							586		
11800							632		
12200				521			678	525	
12600				569			724	572	
13000				618			771	618	
13400	552			667			817	664	
13800	602			715	555		863	711	558
14200	653			764	603		910	757	604
14600	703	537		813	652		956	803	650
15000	753	587		861	701	540		849	697

1. **Enter Weight Adjustment table with slush/standing water depth and field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 50000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-40	-37	-34	-34	-32	-29	-21	-19	-16
840	-41	-38	-36	-36	-33	-30	-23	-20	-17
800	-42	-39	-37	-37	-34	-31	-25	-22	-19
760	-43	-40	-37	-38	-35	-33	-26	-24	-21
720	-44	-41	-38	-39	-37	-34	-28	-26	-23
680	-44	-41	-38	-40	-38	-35	-31	-28	-25
640	-44	-42	-39	-41	-38	-36	-33	-30	-28
600	-44	-41	-39	-42	-39	-36	-35	-32	-29

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

Slippery Runway Takeoff

2 Engine Reverse Thrust

Weight Adjustment (1000 LB)

FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-10	-10	-10	-37	-37	-37
860	0	0	0	-13	-13	-13	-37	-37	-37
820	0	0	0	-14	-14	-14	-37	-37	-37
780	0	0	0	-13	-13	-13	-34	-34	-34
740	0	0	0	-12	-12	-12	-29	-29	-29
700	0	0	0	-11	-11	-11	-27	-27	-27
660	0	0	0	-10	-10	-10	-24	-24	-24
620	0	0	0	-8	-8	-8	-22	-22	-22
580	0	0	0	-7	-7	-7	-18	-18	-18
540	0	0	0	-6	-6	-6	-15	-15	-15
500	0	0	0	-6	-6	-6	-13	-13	-13

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6400	581	412							
6800	663	496							
7200	747	580	412						
7600	831	663	496						
8000	915	747	580	486					
8400		831	663	554					
8800		915	747	622	466				
9200			831	690	533				
9600			915	758	602	446			
10000				825	669	514			
10400				893	737	581			
10800					805	649	503		
11200					873	717	552		
11600						785	601		
12000						853	650	493	
12400							700	542	
12800							749	591	
13200							798	641	483
13600							848	690	532
14000							897	739	581
14400								788	631
14800								838	680
15200								887	729

1. **Enter Weight Adjustment table with reported braking action and field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight 6000 lb.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-4	-3	-2	-19	-17	-14	-37	-33	-29
860	-5	-4	-3	-21	-19	-16	-39	-35	-31
820	-7	-6	-5	-22	-20	-17	-41	-37	-33
780	-8	-7	-6	-24	-22	-19	-43	-39	-35
740	-10	-9	-8	-26	-24	-21	-45	-41	-37
700	-11	-10	-9	-28	-26	-23	-47	-43	-39
660	-13	-12	-11	-29	-27	-24	-49	-45	-41
620	-13	-12	-11	-30	-28	-25	-50	-46	-42
580	-14	-13	-12	-31	-29	-26	-51	-47	-43
540	-14	-13	-12	-31	-29	-26	-51	-47	-43
500	-13	-12	-11	-31	-29	-26	-51	-47	-43

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   For flaps 10 and poor reported braking action, decrease V1 by an additional 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
Weight Adjustment (1000 LB)

FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-21	-21	-21	-48	-48	-48
860	0	0	0	-21	-21	-21	-47	-47	-47
820	0	0	0	-21	-21	-21	-44	-44	-44
780	0	0	0	-20	-20	-20	-42	-42	-42
740	-1	-1	-1	-20	-20	-20	-39	-39	-39
700	-1	-1	-1	-18	-18	-18	-36	-36	-36
660	-1	-1	-1	-17	-17	-17	-33	-33	-33
620	-1	-1	-1	-15	-15	-15	-30	-30	-30
580	-1	-1	-1	-14	-14	-14	-26	-26	-26
540	-1	-1	-1	-11	-11	-11	-22	-22	-22
500	0	0	0	-9	-9	-9	-18	-18	-18

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
7000	506								
7400	614								
7800	723	527							
8200	832	636	440						
8600	940	745	549						
9000		853	658						
9400		962	767						
9800			875						
10200				459					
10600				557					
11000				654	469				
11400				751	567				
11800				849	664	479			
12200				946	761	576			
12600					858	674			
13000					955	771			
13400						868			
13800						965			

1. **Enter Weight Adjustment table with reported braking action and field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-7	-5	-3	-27	-24	-20	-53	-49	-45
860	-9	-7	-5	-29	-26	-23	-56	-52	-48
820	-11	-9	-7	-32	-29	-25	-59	-55	-51
780	-13	-11	-9	-34	-31	-28	-61	-57	-53
740	-14	-12	-10	-36	-33	-30	-63	-59	-55
700	-16	-14	-12	-38	-35	-32	-65	-61	-57
660	-18	-16	-14	-40	-37	-34	-67	-63	-59
620	-19	-17	-15	-42	-39	-36	-68	-64	-60
580	-20	-18	-16	-43	-40	-37	-69	-65	-61
540	-20	-18	-16	-44	-41	-37	-69	-65	-61
500	-20	-18	-16	-44	-40	-37	-69	-65	-61

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG.

Minimum Control Speeds
Max Takeoff Thrust
VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°F	°C	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
140	60	112	113	111	111	108	108	104	104	102	103	101	101	96	96	92	93
130	54	116	116	113	113	109	110	106	106	104	104	103	103	98	98	94	94
120	49	120	120	117	117	112	112	108	108	106	106	104	105	100	100	96	96
110	43	122	122	120	120	116	116	111	111	109	109	107	107	102	102	98	98
100	38	125	125	123	123	119	119	114	114	112	112	110	110	105	105	100	100
95	35	126	126	124	124	120	120	116	116	114	114	111	112	106	106	101	101
90	32	126	126	125	125	121	121	117	117	115	115	113	113	108	108	103	103
86	30	126	126	125	125	122	122	118	118	116	116	114	114	109	109	104	104
85	29	126	126	125	125	122	122	118	118	116	116	114	114	110	110	104	104
82	28	126	126	125	125	123	123	119	119	117	117	114	115	110	110	105	105
80	27	126	126	125	126	123	123	119	119	117	117	115	115	111	111	106	106
78	25	126	126	125	125	123	123	120	120	117	117	115	115	111	111	106	107
73	23	126	126	125	125	123	123	121	121	118	118	116	116	112	112	107	107
70	21	126	126	125	125	123	123	121	121	119	119	117	117	112	112	108	108
69	20	126	126	125	125	123	123	121	121	119	119	117	117	113	113	108	108
66	19	126	126	125	125	123	123	121	121	119	119	117	117	113	113	108	108
60	16	126	126	125	126	123	123	121	121	119	119	118	118	114	114	109	109
50	10	126	126	126	126	123	123	121	121	119	119	118	118	115	115	111	111
40	4	126	126	126	126	123	124	121	121	119	119	118	118	115	115	111	111
30	-1	126	126	126	126	124	124	121	121	119	119	118	118	115	115	111	111
-67	-55	127	127	126	126	124	124	121	122	120	120	119	119	115	115	112	112

Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	106		110		115		120		125		127	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
600	121	24	126	22	132	21	138	21	144	20	146	20
550	122	22	126	22	132	21	138	20	144	20	147	20
500	122	21	127	21	133	20	139	20	145	20	147	20
450	122	20	127	20	133	20	139	20	146	20	148	20
400	122	20	127	20	134	20	140	20	146	21	149	21

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	106		110		115		120		125		127	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
550	123	25	128	24	134	23	140	23	146	22	149	22
500	123	24	128	23	134	23	141	22	147	22	149	22
450	123	23	129	22	135	22	141	22	148	22	150	22
400	124	23	129	22	135	22	142	23	148	23	151	23

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

5% Thrust Reduction

2 Engine Reverse Thrust

Weight Adjustment (1000 LB)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960				-72	-72	-72	-117	-117	-117
920	-53	-53	-53	-69	-69	-69	-112	-112	-112
880	-50	-50	-50	-66	-66	-66	-107	-107	-107
840	-47	-47	-47	-62	-62	-62	-102	-102	-102
800	-44	-44	-44	-59	-59	-59	-97	-97	-97
760	-41	-41	-41	-56	-56	-56	-92	-92	-92
720	-38	-38	-38	-52	-52	-52	-87	-87	-87
680	-35	-35	-35	-49	-49	-49	-82	-82	-82
640	-32	-32	-32	-46	-46	-46	-78	-78	-78
600	-29	-29	-29	-42	-42	-42			

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
8200				463			521		
8600				510			568		
9000	515			558			616	454	
9400	563			606	444		664	502	
9800	611			653	491		711	549	
10200	659	496		701	539		759	597	
10600	707	544		748	587	425	806	644	479
11000	755	591		796	634	472	854	692	527
11400	803	640	476	843	682	520	901	740	574
11800	851	688	524	891	729	567		787	622
12200	899	736	572		777	615		834	669
12600		784	620		824	663		882	717
13000		832	668		872	710			765
13400		880	717			758			812
13800			765			805			860
14200			813			853			
14600			861						

1. **Enter Weight Adjustment table with slush/standing water depth and TO1 field/obstacle limit weight to obtain slush/standing water adjustment.**
2. **Find VMCG limited weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 12000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
5% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-26	-25	-24	-21	-20	-19	-11	-10	-9
840	-27	-26	-25	-22	-21	-20	-11	-10	-9
800	-29	-28	-27	-24	-23	-22	-13	-12	-11
760	-30	-29	-28	-25	-24	-23	-14	-13	-12
720	-30	-29	-28	-26	-25	-24	-16	-15	-14
680	-31	-30	-29	-27	-26	-25	-18	-17	-16
640	-31	-30	-29	-28	-27	-26	-20	-19	-18
600	-30	-29	-28	-28	-27	-26			

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

5% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 LB)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960	-69	-69	-69	-90	-90	-90	-133	-133	-133
920	-65	-65	-65	-85	-85	-85	-128	-128	-128
880	-62	-62	-62	-81	-81	-81	-124	-124	-124
840	-58	-58	-58	-77	-77	-77	-119	-119	-119
800	-55	-55	-55	-73	-73	-73	-114	-114	-114
760	-51	-51	-51	-68	-68	-68	-109	-109	-109
720	-48	-48	-48	-64	-64	-64	-104	-104	-104
680	-44	-44	-44	-60	-60	-60	-99	-99	-99
640	-40	-40	-40	-55	-55	-55	-94	-94	-94
600	-37	-37	-37	-51	-51	-51	-89	-89	-89

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
10600							529		
11000							576		
11400							623		
11800							671		
12200				562			718	562	
12600				612			765	609	
13000	547			662			813	656	
13400	599			712	548		860	704	548
13800	650			761	597		907	751	595
14200	701	532		811	647		954	798	642
14600	753	583		861	697	533		846	689
15000	804	634		911	746	582		893	737

1. **Enter Weight Adjustment table with slush/standing water depth and TO1 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 52000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
5% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-44	-41	-38	-38	-35	-32	-24	-21	-18
840	-45	-42	-39	-39	-36	-33	-25	-22	-19
800	-45	-42	-39	-40	-37	-34	-26	-23	-20
760	-46	-43	-40	-41	-38	-35	-28	-25	-22
720	-47	-44	-41	-42	-39	-36	-30	-27	-24
680	-47	-44	-41	-43	-40	-37	-33	-30	-27
640	-48	-45	-42	-44	-41	-38	-36	-32	-29
600	-48	-45	-41	-45	-42	-39	-38	-34	-31

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
5% Thrust Reduction
2 Engine Reverse Thrust
Weight Adjustment (1000 LB)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-11	-11	-11	-35	-35	-35
860	0	0	0	-11	-11	-11	-35	-35	-35
820	0	0	0	-12	-12	-12	-35	-35	-35
780	0	0	0	-13	-13	-13	-31	-31	-31
740	0	0	0	-11	-11	-11	-29	-29	-29
700	0	0	0	-11	-11	-11	-27	-27	-27
660	0	0	0	-11	-11	-11	-24	-24	-24
620	0	0	0	-8	-8	-8	-21	-21	-21
580	0	0	0	-7	-7	-7	-20	-20	-20
540	0	0	0	-6	-6	-6	-17	-17	-17
500	0	0	0	-4	-4	-4	-14	-14	-14

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
5600	438								
6000	522								
6400	605	438							
6800	688	522							
7200	772	605	438						
7600	855	688	522	449					
8000	939	772	605	517					
8400		855	688	585					
8800		939	772	653	497				
9200			855	721	565				
9600			939	790	633	476			
10000				858	701	544			
10400				926	769	612	480		
10800					837	681	531		
11200					905	749	581		
11600						817	632	470	
12000						885	683	521	
12400							734	571	
12800							784	622	460
13200							835	673	510
13600							886	724	561
14000								774	612
14400								825	663
14800								876	713
15200									764

1. **Enter Weight Adjustment table with reported braking action and TO1 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 6000 lb.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
5% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-3	-2	-1	-18	-16	-13	-34	-30	-26
860	-4	-3	-2	-20	-18	-15	-36	-32	-28
820	-6	-5	-4	-22	-20	-17	-39	-35	-31
780	-7	-6	-5	-24	-22	-19	-41	-37	-33
740	-9	-8	-7	-26	-24	-21	-43	-39	-35
700	-11	-10	-9	-28	-26	-23	-45	-41	-37
660	-12	-11	-10	-29	-27	-24	-47	-43	-39
620	-13	-12	-11	-30	-28	-25	-48	-44	-40
580	-13	-12	-11	-31	-29	-26	-49	-45	-41
540	-13	-12	-11	-31	-29	-26	-50	-46	-42
500	-13	-12	-11	-31	-29	-26	-49	-45	-41

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   For flaps 10 and poor reported braking action, decrease V1 by an additional 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG.

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

5% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 LB)

TO1 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-17	-17	-17	-44	-44	-44
860	0	0	0	-17	-17	-17	-43	-43	-43
820	0	0	0	-18	-18	-18	-41	-41	-41
780	0	0	0	-17	-17	-17	-39	-39	-39
740	0	0	0	-17	-17	-17	-37	-37	-37
700	0	0	0	-16	-16	-16	-34	-34	-34
660	0	0	0	-15	-15	-15	-31	-31	-31
620	0	0	0	-14	-14	-14	-28	-28	-28
580	0	0	0	-12	-12	-12	-25	-25	-25
540	0	0	0	-10	-10	-10	-21	-21	-21
500	0	0	0	-8	-8	-8	-17	-17	-17

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6600	441								
7000	548								
7400	655	462							
7800	762	569							
8200	869	676	484						
8600	975	783	591						
9000		890	698						
9400			804						
9800			911	429					
10200				526					
10600				623	439				
11000				719	536				
11400				816	632	449			
11800				913	729	545			
12200					826	642			
12600					923	739			
13000						836			
13400						932			

1. **Enter Weight Adjustment table with reported braking action and TO1 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for adjusted field length and pressure altitude.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
5% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-12	-10	-8	-31	-27	-24	-56	-52	-47
860	-14	-12	-10	-33	-30	-26	-59	-54	-50
820	-15	-13	-11	-35	-32	-28	-61	-57	-53
780	-17	-15	-13	-37	-34	-30	-64	-59	-55
740	-18	-16	-14	-39	-36	-33	-66	-62	-57
700	-20	-18	-16	-42	-38	-35	-68	-64	-59
660	-22	-20	-18	-44	-40	-37	-70	-66	-61
620	-23	-21	-19	-45	-42	-39	-71	-67	-63
580	-24	-22	-20	-47	-43	-40	-72	-68	-64
540	-25	-23	-21	-48	-44	-41	-73	-68	-64
500	-25	-23	-21	-48	-45	-41	-73	-68	-64

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG.

TO1 Minimum Control Speeds
5% Thrust Reduction
VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°F	°C	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
140	60	110	110	108	108	105	105	102	102	100	100	98	98	94	94	90	90
130	54	113	113	110	111	107	107	103	104	102	102	100	100	96	96	92	92
120	49	117	117	114	114	110	110	106	106	104	104	102	102	98	98	94	94
110	43	120	120	117	118	113	113	108	108	106	106	104	104	100	100	96	96
100	38	122	122	120	120	116	116	112	112	110	110	107	107	102	102	98	98
95	35	123	123	121	121	117	117	113	113	111	111	109	109	104	104	99	99
90	32	123	123	122	122	118	119	114	114	112	112	110	111	106	106	100	100
86	30	123	123	122	122	119	119	115	115	113	113	111	111	107	107	101	101
85	29	123	123	122	122	120	120	115	115	113	113	111	111	107	107	102	102
82	28	123	123	122	123	120	120	116	116	114	114	112	112	108	108	103	103
80	27	123	123	122	123	120	120	116	116	114	114	112	112	108	108	103	103
78	25	123	123	122	123	120	120	117	117	115	115	113	113	109	109	104	104
73	23	123	123	123	123	120	121	118	118	116	116	114	114	109	109	105	105
70	21	123	123	123	123	120	121	118	118	116	116	114	114	110	110	105	105
69	20	123	123	123	123	120	121	118	118	116	117	114	114	110	110	106	106
66	19	123	123	123	123	120	121	118	118	117	117	115	115	110	111	106	106
60	16	123	123	123	123	121	121	118	118	117	117	115	115	112	112	107	107
50	10	123	124	123	123	121	121	118	118	117	117	115	115	112	112	108	109
40	4	123	124	123	123	121	121	118	118	117	117	115	115	112	112	109	109
-67	-55	124	124	123	123	121	121	119	119	117	117	116	116	113	113	109	109

Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	103		105		110		115		120		124	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
550	118	23	120	23	126	22	132	21	138	20	143	20
500	118	22	120	22	127	21	133	20	139	20	144	20
450	118	21	121	21	127	20	133	20	139	20	144	20
400	118	20	121	20	127	20	134	20	140	20	145	21

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	103		105		110		115		120		124	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
500	120	24	122	24	128	23	134	23	141	22	146	22
450	120	23	122	23	129	22	135	22	141	22	146	22
400	120	23	122	23	129	22	135	22	142	23	147	23

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

15% Thrust Reduction

2 Engine Reverse Thrust

Weight Adjustment (1000 LB)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960				-73	-73	-73	-117	-117	-117
920	-54	-54	-54	-70	-70	-70	-112	-112	-112
880	-51	-51	-51	-66	-66	-66	-107	-107	-107
840	-49	-49	-49	-63	-63	-63	-102	-102	-102
800	-46	-46	-46	-60	-60	-60	-97	-97	-97
760	-43	-43	-43	-56	-56	-56	-92	-92	-92
720	-40	-40	-40	-53	-53	-53	-87	-87	-87
680	-37	-37	-37	-50	-50	-50	-82	-82	-82
640	-33	-33	-33	-46	-46	-46	-77	-77	-77
600	-30	-30	-30	-43	-43	-43			

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
7800							522		
8200				513			571		
8600	520			563			621	452	
9000	570			613			671	502	
9400	620			663	493		721	551	
9800	671	500		713	543		771	601	432
10200	721	550		762	593	423	820	651	482
10600	772	600		812	643	474	870	701	532
11000	821	651	480	861	693	523		751	581
11400	872	701	530	912	742	573		800	631
11800	923	752	580		792	623		850	681
12200		802	630		842	673		900	731
12600		851	681		891	722			780
13000		900	731			772			830
13400			782			822			880
13800			832			872			
14200			882						

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water adjustment.**
2. **Find VMCG limited weight for available field length and pressure altitude. For flaps 10, decrease VMCG limited weight by 13000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-24	-23	-22	-19	-18	-17	-7	-6	-5
840	-25	-24	-23	-20	-19	-18	-7	-6	-5
800	-26	-25	-24	-21	-20	-19	-9	-8	-7
760	-27	-26	-25	-22	-21	-20	-10	-9	-8
720	-28	-27	-26	-23	-22	-21	-13	-12	-11
680	-29	-28	-27	-25	-24	-23	-15	-14	-13
640	-29	-28	-27	-26	-25	-24	-17	-16	-15
600	-28	-27	-26	-26	-25	-24			

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

15% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 LB)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
960	-74	-74	-74	-94	-94	-94	-135	-135	-135
920	-70	-70	-70	-90	-90	-90	-130	-130	-130
880	-66	-66	-66	-85	-85	-85	-125	-125	-125
840	-63	-63	-63	-81	-81	-81	-120	-120	-120
800	-59	-59	-59	-76	-76	-76	-115	-115	-115
760	-55	-55	-55	-72	-72	-72	-110	-110	-110
720	-52	-52	-52	-67	-67	-67	-105	-105	-105
680	-48	-48	-48	-63	-63	-63	-100	-100	-100
640	-44	-44	-44	-59	-59	-59	-95	-95	-95
600	-40	-40	-40	-54	-54	-54	-90	-90	-90

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
10200							550		
10600							600		
11000							649		
11400				542			699	536	
11800				594			748	585	
12200	531			646			797	634	
12600	584			698	527		847	684	521
13000	638			750	578		896	733	570
13400	691			802	630		945	782	620
13800	745	568		853	682		995	832	669
14200	798	622		905	734	563		881	718
14600	852	675		957	786	615		931	768
15000	905	729	552		838	667		980	817

1. **Enter Weight Adjustment table with slush/standing water depth and TO2 field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10, decrease VMCG limit weight by 54000 lb.**
3. **Max allowable slush/standing water limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
15% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
880	-36	-33	-29	-29	-25	-22	-13	-9	-6
840	-37	-33	-30	-30	-27	-23	-14	-10	-7
800	-38	-34	-31	-31	-28	-24	-16	-12	-9
760	-39	-35	-32	-33	-29	-26	-18	-14	-11
720	-39	-36	-32	-34	-31	-27	-20	-17	-13
680	-40	-36	-33	-35	-32	-28	-23	-20	-16
640	-40	-36	-33	-36	-32	-29	-26	-22	-19
600	-39	-36	-32	-36	-32	-29	-28	-24	-21

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than VMCG, set V1 = VMCG.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
2 Engine Reverse Thrust
Weight Adjustment (1000 LB)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-10	-10	-10	-32	-32	-32
860	0	0	0	-10	-10	-10	-32	-32	-32
820	0	0	0	-10	-10	-10	-32	-32	-32
780	0	0	0	-10	-10	-10	-32	-32	-32
740	0	0	0	-12	-12	-12	-31	-31	-31
700	0	0	0	-11	-11	-11	-28	-28	-28
660	0	0	0	-10	-10	-10	-25	-25	-25
620	0	0	0	-9	-9	-9	-22	-22	-22
580	0	0	0	-7	-7	-7	-20	-20	-20
540	0	0	0	-6	-6	-6	-18	-18	-18
500	0	0	0	-5	-5	-5	-15	-15	-15

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6400	656	490							
6800	738	573	408						
7200	821	656	490	443					
7600	904	738	573	513					
8000		821	656	583					
8400		904	738	652	492				
8800			821	722	562				
9200			904	792	632	471			
9600				861	701	541	434		
10000				931	771	611	487		
10400					840	680	539		
10800						750	592		
11200						820	645	476	
11600						889	697	529	
12000							750	582	
12400							803	634	466
12800							855	687	518
13200								740	571
13600								792	624
14000								845	676
14400								897	729
14800									782
15200									834
15600									887

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for available field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limit weight by 7000 lb.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
2 Engine Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-2	-1	0	-14	-12	-9	-29	-25	-21
860	-4	-3	-2	-16	-14	-11	-32	-28	-24
820	-6	-5	-4	-18	-16	-13	-35	-31	-27
780	-7	-6	-5	-21	-19	-16	-37	-33	-29
740	-9	-8	-7	-23	-21	-18	-40	-36	-32
700	-10	-9	-8	-25	-23	-20	-43	-39	-35
660	-12	-11	-10	-27	-25	-22	-45	-41	-37
620	-13	-12	-11	-28	-26	-23	-46	-42	-38
580	-13	-12	-11	-29	-27	-24	-47	-43	-39
540	-13	-12	-11	-29	-27	-24	-48	-44	-40
500	-12	-11	-10	-28	-26	-23	-47	-43	-39

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   For flaps 10 and poor reported braking action, decrease V1 by an additional 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG.

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

15% Thrust Reduction

No Reverse Thrust

Weight Adjustment (1000 LB)

TO2 FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	0	0	0	-19	-19	-19	-46	-46	-46
860	0	0	0	-19	-19	-19	-44	-44	-44
820	0	0	0	-19	-19	-19	-43	-43	-43
780	0	0	0	-19	-19	-19	-41	-41	-41
740	0	0	0	-18	-18	-18	-39	-39	-39
700	0	0	0	-18	-18	-18	-36	-36	-36
660	-1	-1	-1	-17	-17	-17	-34	-34	-34
620	-1	-1	-1	-16	-16	-16	-31	-31	-31
580	-1	-1	-1	-14	-14	-14	-27	-27	-27
540	-1	-1	-1	-12	-12	-12	-24	-24	-24
500	-1	-1	-1	-10	-10	-10	-20	-20	-20

VMCG Limit Weight (1000 LB)

FIELD LENGTH AVAILABLE (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6200	426								
6600	529								
7000	633	447							
7400	736	550							
7800	839	653	467						
8200	942	757	571						
8600		860	674						
9000		963	777						
9400			880	468					
9800				563					
10200				659	477				
10600				755	573				
11000				850	669	487			
11400				946	764	583			
11800					860	678			
12200					955	774			
12600						869			
13000						965			
13400									
13800									
14200							444		
14600							517		
15000							591		

1. **Enter Weight Adjustment table with reported braking action and TO2 field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Find VMCG limit weight for adjusted field length and pressure altitude. For flaps 10 and poor reported braking action, decrease VMCG limited weight by 37000 lb.**
3. **Max allowable slippery runway limited weight is lesser of weights from 1 and 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
15% Thrust Reduction
No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
900	-6	-4	-2	-22	-18	-15	-45	-40	-35
860	-8	-5	-3	-24	-21	-17	-49	-44	-38
820	-9	-7	-5	-27	-23	-19	-52	-47	-41
780	-11	-9	-6	-29	-25	-22	-54	-49	-44
740	-12	-10	-8	-32	-28	-24	-57	-52	-47
700	-14	-12	-10	-34	-30	-27	-60	-55	-49
660	-15	-13	-11	-36	-32	-29	-61	-56	-51
620	-17	-15	-12	-37	-34	-30	-62	-57	-52
580	-18	-15	-13	-39	-35	-31	-64	-59	-54
540	-18	-16	-14	-40	-36	-32	-66	-61	-56
500	-18	-16	-14	-40	-36	-33	-67	-62	-57

1. **Obtain V1, VR and V2 for the actual weight.**
2. **If VMCG limited, set V1 = VMCG. If not VMCG limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment.**
   For flaps 10 and good reported braking action, increase V1 by 1 kt.
   If adjusted V1 is less than VMCG, set V1 = VMCG.

TO2 Minimum Control Speeds
15% Thrust Reduction
VMCG, VRMIN (KIAS)

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)															
		-2000		0		2000		4000		5000		6000		8000		10000	
°F	°C	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN	V MCG	VR MIN
140	60	105	105	103	103	100	100	97	97	95	95	94	94	90	90	86	86
130	54	108	108	105	105	102	102	99	99	97	97	95	96	91	92	88	88
120	49	111	111	109	109	104	104	101	101	99	99	97	97	93	93	90	90
110	43	114	114	112	112	108	108	103	103	101	101	99	99	95	95	91	92
100	38	116	116	114	114	111	111	106	106	104	105	102	102	97	98	93	93
95	35	117	117	115	115	112	112	108	108	106	106	104	104	99	99	94	94
90	32	117	117	117	117	113	113	109	109	107	107	105	105	101	101	95	96
86	30	117	117	117	117	114	114	109	110	108	108	106	106	102	102	96	97
85	29	117	117	117	117	114	114	110	110	108	108	106	106	102	102	97	97
82	28	117	117	117	117	115	115	110	110	109	109	107	107	103	103	98	98
80	27	117	117	117	117	115	115	111	111	109	109	107	107	103	103	98	98
78	25	117	117	117	117	115	115	111	111	109	109	107	107	103	104	99	99
73	23	117	118	117	117	115	115	112	112	110	110	108	108	104	104	100	100
70	21	117	118	117	117	115	115	112	112	111	111	109	109	105	105	100	100
69	20	117	118	117	117	115	115	112	112	111	111	109	109	105	105	101	101
66	19	117	118	117	117	115	115	112	112	111	111	109	109	105	105	101	101
60	16	118	118	117	117	115	115	112	112	111	111	110	110	106	106	102	102
50	10	118	118	117	117	115	115	112	113	111	111	110	110	107	107	103	103
40	4	118	118	117	117	115	115	113	113	111	111	110	110	107	107	103	103
-67	-55	118	118	118	118	116	116	113	113	112	112	110	110	107	107	104	104

Flaps 20 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	98		100		105		110		115		118	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
500	112	23	114	23	120	22	127	21	133	20	136	20
450	112	22	114	22	121	21	127	20	133	20	137	20
400	112	21	115	21	121	20	127	20	134	20	137	20

Flaps 10 V2 For VRMIN (KIAS)

WEIGHT (1000 LB)	VRMIN (KIAS)											
	98		100		105		110		115		118	
	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT	V2	ATT
450	113	24	116	24	122	23	129	22	135	22	139	22
400	113	24	116	23	122	23	129	22	135	22	139	22

Initial Climb %N1

Based on engine bleed for 3 packs on, engine and wing anti-ice off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)												
°F	°C	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
129	54	96.7	97.3											
122	50	97.2	97.7	98.0	98.3									
113	45	97.8	98.3	98.6	98.8	99.0	99.3							
104	40	98.4	98.9	99.1	99.4	99.6	99.8	100.0	100.1	100.3				
95	35	99.0	99.5	99.8	100.0	100.2	100.3	100.5	100.7	100.8	100.9	101.0		
86	30	99.6	100.1	100.3	100.6	100.8	101.0	101.1	101.3	101.4	101.5	101.5	101.6	101.5
77	25	99.1	100.2	100.9	101.2	101.4	101.6	101.7	101.9	102.0	102.1	102.1	102.2	102.1
68	20	98.5	99.5	100.3	101.0	101.7	102.2	102.4	102.5	102.6	102.7	102.7	102.8	102.6
59	15	97.7	98.7	99.6	100.3	101.0	101.7	102.4	103.1	103.2	103.3	103.3	103.3	103.3
50	10	96.9	97.9	98.7	99.5	100.3	101.0	101.7	102.3	102.9	103.5	103.9	103.9	103.8
41	5	96.0	97.1	97.9	98.6	99.4	100.1	100.8	101.5	102.2	102.8	103.3	103.9	104.4
32	0	95.2	96.2	97.0	97.8	98.5	99.3	100.0	100.6	101.3	101.9	102.5	103.1	103.6
14	-10	93.5	94.5	95.3	96.1	96.8	97.5	98.2	98.8	99.5	100.1	100.7	101.3	101.8
-4	-20	91.7	92.7	93.5	94.2	95.0	95.7	96.3	97.0	97.7	98.3	98.9	99.5	100.0
-22	-30	89.9	90.9	91.7	92.4	93.1	93.8	94.5	95.1	95.8	96.4	97.0	97.6	98.1
-40	-40	88.1	89.0	89.8	90.5	91.2	91.9	92.6	93.2	93.9	94.5	95.1	95.6	96.1
-65	-42	85.5	86.4	87.1	87.8	88.5	89.2	89.8	90.5	91.1	91.7	92.3	92.8	93.3

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
ENGINE ANTI-ICE ON	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6	-0.6	-0.6	-0.6
ENGINE & WING ANTI-ICE ON	-0.9	-0.9	-0.9	-1.0	-1.0	-1.0	-1.0	-1.1	-1.1	-1.1	-1.1	-1.2	-1.2

Max Climb %N1

Based on engine bleed for 3 packs on, engine and wing anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	45
	340	340	340	340	340	340	0.84	0.84	0.84	0.84
50	99.4	100.8								
45	99.9	101.3	102.0	101.1						
40	100.3	101.9	102.6	101.6						
35	99.7	102.5	103.1	102.1	102.0					
30	99.0	102.3	103.7	102.8	102.6					
25	98.2	101.6	103.9	103.4	103.2	103.2	101.9			
20	97.4	100.8	103.2	104.1	103.6	104.1	102.7			
15	96.6	99.9	102.4	103.5	104.3	104.9	103.6	101.1	100.9	
10	95.8	99.1	101.6	102.7	104.1	105.9	104.4	101.9	101.5	101.1
5	95.0	98.3	100.7	101.8	103.3	105.8	105.2	102.7	102.3	101.9
0	94.1	97.4	99.9	100.9	102.6	105.0	106.3	103.7	103.2	102.8
-5	93.3	96.6	99.0	100.0	101.7	104.2	105.7	104.6	104.1	103.7
-10	92.5	95.7	98.1	99.1	100.8	103.2	104.9	105.6	105.0	104.5
-15	91.6	94.8	97.2	98.2	99.9	102.3	104.0	105.5	105.4	105.1
-20	90.7	93.9	96.3	97.3	99.0	101.3	103.0	104.7	104.6	104.3
-25	89.9	93.0	95.4	96.4	98.1	100.4	102.1	103.9	103.8	103.5
-30	89.0	92.1	94.5	95.5	97.1	99.4	101.1	102.9	102.8	102.5
-35	88.1	91.2	93.6	94.5	96.2	98.4	100.1	101.8	101.8	101.5
-40	87.2	90.3	92.6	93.6	95.2	97.4	99.0	100.8	100.8	100.4

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	45
ENGINE ANTI-ICE ON	-0.5	-0.5	-0.6	-0.6	-0.7	-0.8	-0.9	-1.1	-1.6	-2.0
ENGINE & WING ANTI-ICE ON	-0.9	-1.0	-1.2	-1.1	-1.3	-1.5	-1.7	-2.0	-3.0	-4.0

Go-around %N1

Based on engine bleed for 3 packs on

REPORTED OAT		TAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
°F	°C		-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
129	54	57	102.9	103.0	103.2	103.4	103.6	103.6	103.6	103.9	104.0	104.0	103.9	103.9	103.8
116	47	50	104.0	104.7	105.3	105.5	105.1	104.5	104.0	104.3	104.5	104.4	104.4	104.3	104.3
107	42	45	104.6	105.3	106.0	106.2	106.2	106.1	105.6	105.4	105.0	104.7	104.7	104.6	104.6
98	37	40	105.2	105.9	106.6	106.9	107.0	106.9	106.7	106.9	106.9	106.3	105.6	104.9	104.8
90	32	35	104.6	105.9	107.3	107.7	107.8	107.7	107.5	107.8	107.8	107.8	107.6	106.9	106.1
81	27	30	103.7	105.1	106.4	107.4	108.4	108.5	108.4	108.6	108.7	108.7	108.6	108.2	107.8
72	22	25	102.9	104.2	105.5	106.6	107.5	108.3	109.0	109.3	109.4	109.5	109.6	109.2	108.8
63	17	20	102.0	103.4	104.7	105.7	106.6	107.4	108.1	109.0	109.8	110.2	110.3	110.1	109.8
54	12	15	101.2	102.5	103.8	104.8	105.7	106.5	107.2	108.0	108.8	109.6	110.3	110.8	110.9
45	7	10	100.3	101.6	102.9	103.9	104.8	105.5	106.2	107.1	107.9	108.6	109.3	109.9	110.4
36	2	5	99.4	100.7	102.0	103.0	103.9	104.6	105.3	106.2	107.0	107.7	108.4	108.9	109.4
27	-3	0	98.5	99.8	101.1	102.1	103.0	103.7	104.4	105.2	106.0	106.7	107.4	107.9	108.5
9	-12	-10	96.7	98.0	99.2	100.2	101.1	101.9	102.5	103.4	104.2	104.8	105.5	106.0	106.5
-8	-22	-20	94.9	96.1	97.3	98.3	99.2	100.0	100.6	101.5	102.2	102.9	103.6	104.4	104.6
-26	-32	-30	93.0	94.2	95.4	96.4	97.3	98.0	98.7	99.5	100.3	100.9	101.6	102.1	102.5
-44	-42	-40	91.1	92.3	93.5	94.4	95.3	96.0	96.7	97.5	98.3	98.9	99.5	100.0	100.5
-62	-52	-50	89.2	90.3	91.5	92.4	93.3	94.0	94.7	95.5	96.2	96.9	97.5	97.9	98.4

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)												
	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
2 PACKS OFF	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6
3 PACKS OFF	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.8	0.9
ENGINE ANTI-ICE ON	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6	-0.7	-0.7	-0.8	-0.8	-0.8	-0.7	-0.7

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Climb (290/.84)

Flaps Up, Set Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		450	550	650	750	850	870
40000	**PITCH ATT**	**4.0**	**4.0**				
	V/S (FT/MIN)	+1600	+900				
35000	**PITCH ATT**	**4.5**	**4.0**	**4.0**	**4.0**		
	V/S (FT/MIN)	+2900	+2000	+1300	+700		
30000	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**
	V/S (FT/MIN)	+2900	+2100	+1600	+1100	+700	+600
20000	**PITCH ATT**	**8.0**	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**
	V/S (FT/MIN)	+4300	+3300	+2600	+2100	+1600	+1500
10000	**PITCH ATT**	**11.0**	**10.0**	**9.5**	**9.0**	**9.0**	**9.0**
	V/S (FT/MIN)	+5700	+4500	+3700	+3000	+2500	+2400
SEA LEVEL	**PITCH ATT**	**14.0**	**12.5**	**11.5**	**11.0**	**11.0**	**11.0**
	V/S (FT/MIN)	+6500	+5200	+4300	+3500	+3000	+2900

Cruise (.84/290)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		450	550	650	750	850	870
40000	**PITCH ATT**	**2.0**	**3.0**				
	%N1	88.4	92.6				
35000	**PITCH ATT**	**1.0**	**2.0**	**2.5**	**3.0**		
	%N1	85.8	88.1	90.9	95.0		
30000	**PITCH ATT**	**1.0**	**2.0**	**3.0**	**3.5**	**4.0**	**4.0**
	%N1	81.8	84.4	86.9	89.9	93.7	94.6
20000	**PITCH ATT**	**1.5**	**2.0**	**3.0**	**4.0**	**4.5**	**4.5**
	%N1	74.4	76.6	79.2	81.8	84.9	85.5
10000	**PITCH ATT**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**	**5.0**
	%N1	67.1	69.1	71.4	73.9	76.8	77.4
SEA LEVEL	**PITCH ATT**	**1.5**	**2.5**	**3.0**	**4.0**	**5.0**	**5.0**
	%N1	60.0	61.9	64.0	66.3	68.9	69.5

Descent (.84/290)

Flaps Up, Set Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		450	550	650	750	850	870
40000	**PITCH ATT**	**-1.5**	**-0.5**				
	V/S (FT/MIN)	-3000	-2900				
35000	**PITCH ATT**	**-3.0**	**-2.0**	**-1.0**	**-0.5**		
	V/S (FT/MIN)	-3600	-3300	-3100	-3200		
30000	**PITCH ATT**	**-2.0**	**-0.5**	**0.0**	**1.0**	**1.5**	**1.5**
	V/S (FT/MIN)	-2500	-2200	-2100	-2100	-2100	-2100
20000	**PITCH ATT**	**-1.5**	**-0.5**	**0.0**	**1.0**	**2.0**	**2.0**
	V/S (FT/MIN)	-2200	-2000	-1900	-1800	-1800	-1800
10000	**PITCH ATT**	**-2.0**	**-0.5**	**0.5**	**1.5**	**2.0**	**2.5**
	V/S (FT/MIN)	-2000	-1800	-1700	-1600	-1600	-1600
SEA LEVEL	**PITCH ATT**	**-1.5**	**-0.5**	**0.5**	**1.5**	**2.5**	**2.5**
	V/S (FT/MIN)	-1600	-1400	-1300	-1300	-1300	-1300

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Holding (VREF30+80)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		450	550	650	750	850	870
10000	**PITCH ATT**	**5.5**	**6.0**	**6.0**	**5.5**	**5.5**	**5.5**
	%N1	59.7	64.9	69.3	73.2	76.8	77.4
	KIAS	209	224	240	261	282	284

Terminal Area (5000 FT)

%N1 for Level Flight

FLAP POSITION (VREF + INCREMENT)		WEIGHT (1000 LB)					
		400	500	600	700	800	900
FLAPS UP (VREF30+80) (GEAR UP)	**PITCH ATT**	**4.5**	**5**	**5.5**	**6**	**6**	**6.5**
	%N1	54.3	59.9	64.8	69.1	72.9	76.3
	KIAS	202	217	231	244	256	268
FLAPS 1 (VREF30+60) (GEAR UP)	**PITCH ATT**	**6**	**6.5**	**7**	**7**	**7.5**	**7.5**
	%N1	56.6	62.0	66.9	71.2	75.0	78.3
	KIAS	182	197	211	224	236	248
FLAPS 5 (VREF30+40) (GEAR UP)	**PITCH ATT**	**7**	**7.5**	**8**	**8**	**8**	**8**
	%N1	59.4	65.5	70.7	75.1	79.0	82.4
	KIAS	162	177	191	204	216	228
FLAPS 10 (VREF30+20) (GEAR UP)	**PITCH ATT**	**8.5**	**8.5**	**8.5**	**8.5**	**9**	**9**
	%N1	66.5	72.8	78.2	82.8	86.7	90.2
	KIAS	142	157	171	184	196	208
FLAPS 20 (VREF30+10) (GEAR DOWN)	**PITCH ATT**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**	**7.5**
	%N1	71.1	77.6	83.1	87.7	91.9	95.5
	KIAS	132	147	161	174	186	198

Final Approach (1500 FT)

Gear Down, %N1 for 3° Glideslope

FLAP POSITION (VREF + INCREMENT)		WEIGHT (1000 LB)					
		400	500	600	700	800	900
FLAPS 25 (VREF25+10)	**PITCH ATT**	**2**	**2**	**2**	**2**	**2**	**2**
	%N1	50.9	56.3	61.2	65.2	68.9	72.2
	KIAS	136	152	166	180	193	205
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1**	**1**	**1**	
	%N1	56.6	62.5	67.5	71.9	75.8	
	KIAS	131	146	160	173	185	

Performance Inflight - All Engines

Chapter PI
Section 21

Long Range Cruise Maximum Operating Altitude

Max Climb Thrust

ISA + 10°C and Below

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
880	29200	2	33800	33000	32100	30500	29000
840	30200	0	34800	33900	33100	31500	30000
800	31300	-3	35800	35000	34100	32600	31100
760	32400	-5	36900	36000	35200	33700	32200
720	33600	-8	38000	37200	36400	34800	33300
680	34800	-11	39200	38400	37500	36000	34500
640	36000	-14	40500	39600	38800	37300	35800
600	37400	-14	41800	41000	40100	38600	37200
560	38800	-14	43200	42400	41600	40000	38600
520	40400	-14	44700*	43900	43100	41600	40100
480	42000	-14	45000	45000	44800	43200	41800
440	43800	-14	45000	45000	45000	45000	43600

ISA + 15°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
880	29200	8	33100*	33000	32100	30500	29000
840	30200	5	34200*	33900	33100	31500	30000
800	31300	3	35400*	35000	34100	32600	31100
760	32400	0	36400*	36000	35200	33700	32200
720	33600	-2	37600*	37200	36400	34800	33300
680	34800	-5	38800*	38400	37500	36000	34500
640	36000	-8	40000*	39600	38800	37300	35800
600	37400	-8	41300*	41000	40100	38600	37200
560	38800	-8	42600*	42400	41600	40000	38600
520	40400	-8	44000*	43900	43100	41600	40100
480	42000	-8	45000	45000	44800	43200	41800
440	43800	-8	45000	45000	45000	45000	43600

ISA + 20°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
880	29200	13	32000*	32000*	32000*	30500	29000
840	30200	11	33200*	33200*	33100	31500	30000
800	31300	9	34400*	34400*	34100	32600	31100
760	32400	6	35600*	35600*	35200	33700	32200
720	33600	4	36700*	36700*	36400	34800	33300
680	34800	1	37900*	37900*	37500	36000	34500
640	36000	-2	39200*	39200*	38800	37300	35800
600	37400	-2	40500*	40500*	40100	38600	37200
560	38800	-2	41800*	41800*	41600	40000	38600
520	40400	-2	43200*	43200*	43100	41600	40100
480	42000	-2	44800*	44800*	44800	43200	41800
440	43800	-2	45000	45000	45000	45000	43600

***Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.**

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		27	29	31	33	35	37	39	41	43	45
880	%N1	92.9	94.3	96.2	99.3						
	MACH	.846	.851	.853	.853						
	KIAS	344	332	319	305						
	FF/ENG	7487	7445	7501	7707						
840	%N1	91.8	93.1	94.7	97.1	101.0					
	MACH	.841	.849	.852	.853	.853					
	KIAS	342	331	319	305	292					
	FF/ENG	7145	7084	7063	7192	7451					
800	%N1	90.7	91.9	93.3	95.2	98.2					
	MACH	.833	.846	.851	.853	.853					
	KIAS	339	330	318	305	292					
	FF/ENG	6803	6740	6692	6731	6887					
760	%N1	89.6	90.8	92.1	93.6	96.0	100.2				
	MACH	.822	.840	.849	.852	.853	.853				
	KIAS	334	328	317	305	292	279				
	FF/ENG	6450	6412	6350	6317	6395	6684				
720	%N1	88.5	89.7	90.9	92.2	94.0	97.3				
	MACH	.809	.830	.844	.850	.853	.853				
	KIAS	328	323	316	304	292	279				
	FF/ENG	6110	6076	6025	5967	5968	6144				
680	%N1	87.3	88.5	89.7	90.9	92.4	95.0	99.4			
	MACH	.796	.817	.837	.847	.852	.853	.853			
	KIAS	322	318	312	303	292	279	266			
	FF/ENG	5785	5731	5708	5643	5597	5678	5953			
640	%N1	86.0	87.3	88.4	89.6	90.9	93.0	96.5			
	MACH	.782	.803	.824	.842	.849	.852	.853			
	KIAS	316	312	307	301	291	279	266			
	FF/ENG	5462	5406	5371	5337	5272	5277	5443			
600	%N1	84.6	85.9	87.1	88.3	89.5	91.3	94.1	98.1		
	MACH	.766	.788	.809	.830	.845	.851	.853	.853		
	KIAS	309	305	301	296	289	278	266	254		
	FF/ENG	5145	5087	5039	5019	4963	4937	5013	5203		
560	%N1	83.1	84.4	85.7	86.9	88.1	89.7	92.1	95.2	99.6	
	MACH	.750	.771	.793	.814	.835	.847	.852	.853	.853	
	KIAS	302	298	295	290	285	277	266	254	243	
	FF/ENG	4828	4771	4717	4681	4657	4622	4637	4740	4958	
520	%N1	81.4	82.9	84.2	85.5	86.6	88.2	90.3	92.8	96.1	
	MACH	.730	.754	.775	.798	.819	.839	.848	.852	.853	
	KIAS	293	291	287	284	279	274	265	254	243	
	FF/ENG	4494	4460	4396	4354	4322	4318	4314	4339	4454	
480	%N1	79.6	81.1	82.5	83.8	85.1	86.6	88.7	90.8	93.4	96.9
	MACH	.706	.732	.756	.778	.801	.823	.841	.849	.852	.853
	KIAS	283	282	280	276	272	268	262	253	243	232
	FF/ENG	4156	4134	4083	4029	3996	3991	4007	4006	4037	4158
440	%N1	77.7	79.1	80.6	82.0	83.3	84.9	86.9	89.0	91.1	93.8
	MACH	.683	.707	.733	.758	.780	.803	.825	.843	.850	.852
	KIAS	273	272	270	268	264	261	257	251	242	232
	FF/ENG	3835	3800	3759	3713	3675	3665	3683	3697	3695	3728

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
682	636	595	559	528	500	479	460	442	426	411
1366	1274	1192	1120	1057	1000	959	922	887	855	826
2057	1917	1791	1683	1587	1500	1440	1384	1333	1285	1241
2754	2565	2395	2247	2118	2000	1920	1846	1777	1713	1655
3460	3218	3001	2814	2649	2500	2401	2308	2222	2142	2069
4174	3877	3611	3382	3181	3000	2881	2770	2666	2570	2482
4896	4542	4225	3953	3715	3500	3361	3231	3110	2998	2895
5626	5212	4843	4526	4249	4000	3841	3692	3553	3425	3307
6364	5888	5464	5101	4785	4500	4320	4152	3995	3851	3719
7108	6569	6088	5678	5321	5000	4799	4612	4438	4277	4129

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
500	28.1	1:23	25.6	1:21	23.6	1:19	21.8	1:16	20.6	1:14
1000	56.6	2:44	52.1	2:39	48.4	2:33	45.3	2:27	43.1	2:22
1500	84.4	4:07	78.0	3:57	72.7	3:49	68.2	3:39	65.0	3:32
2000	111.6	5:32	103.3	5:17	96.4	5:06	90.5	4:53	86.5	4:42
2500	138.3	7:00	128.2	6:39	119.6	6:24	112.4	6:07	107.5	5:54
3000	164.3	8:30	152.4	8:02	142.3	7:43	133.7	7:23	128.0	7:06
3500	189.7	10:03	176.2	9:28	164.5	9:03	154.6	8:40	148.0	8:20
4000	214.6	11:38	199.4	10:56	186.2	10:25	175.1	9:58	167.6	9:36
4500	238.9	13:15	222.1	12:27	207.5	11:48	195.1	11:17	186.8	10:52
5000	262.7	14:54	244.2	14:00	228.4	13:14	214.7	12:37	205.6	12:09

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)				
	400	500	600	700	800
20	-2.8	-1.4	0.0	3.2	8.2
40	-5.8	-2.9	0.0	6.5	16.0
60	-8.9	-4.4	0.0	9.5	23.2
80	-12.0	-6.0	0.0	12.5	30.0
100	-15.0	-7.5	0.0	15.3	36.3
120	-18.1	-9.0	0.0	18.0	42.1
140	-21.2	-10.6	0.0	20.5	47.4
160	-24.2	-12.1	0.0	22.9	52.3
180	-27.3	-13.6	0.0	25.1	56.6
200	-30.4	-15.2	0.0	27.3	60.5
220	-33.4	-16.7	0.0	29.2	63.8
240	-36.5	-18.2	0.0	31.1	66.7
260	-39.5	-19.8	0.0	32.8	69.1
280	-42.6	-21.3	0.0	34.3	71.0

Long Range Cruise Enroute Fuel and Time - High Altitudes

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1301	1228	1161	1102	1049	1000	959	922	887	855	826
1951	1842	1742	1654	1573	1500	1440	1384	1333	1285	1241
2604	2458	2324	2205	2098	2000	1920	1846	1777	1713	1655
3261	3076	2908	2758	2624	2500	2401	2308	2222	2142	2069
3921	3697	3494	3312	3150	3000	2881	2770	2666	2570	2482
4584	4320	4080	3867	3676	3500	3361	3231	3110	2998	2895
5250	4946	4668	4423	4202	4000	3841	3692	3553	3425	3307
5921	5574	5259	4980	4729	4500	4320	4152	3995	3851	3719
6594	6205	5851	5538	5257	5000	4799	4612	4438	4277	4129
7272	6839	6445	6097	5785	5500	5278	5071	4879	4701	4539
7953	7474	7040	6656	6314	6000	5757	5530	5320	5126	4948
8637	8113	7637	7217	6843	6500	6236	5990	5761	5550	5356
9326	8755	8236	7780	7372	7000	6714	6447	6200	5972	5763
10020	9400	8837	8343	7902	7500	7193	6906	6639	6394	6169
10719	10049	9442	8909	8433	8000	7670	7362	7077	6815	6575

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)							
	25		29		33		37	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
1000	43.1	2:22	40.2	2:17	37.9	2:13	36.4	2:11
1500	65.0	3:32	61.0	3:23	57.5	3:17	55.4	3:13
2000	86.5	4:42	81.3	4:30	76.7	4:21	73.8	4:15
2500	107.5	5:54	101.1	5:38	95.4	5:26	91.8	5:18
3000	128.0	7:06	120.5	6:47	113.7	6:31	109.3	6:20
3500	148.0	8:20	139.4	7:56	131.5	7:38	126.3	7:24
4000	167.6	9:36	157.9	9:07	148.9	8:45	143.0	8:28
4500	186.8	10:52	176.0	10:19	165.9	9:53	159.2	9:32
5000	205.6	12:09	193.7	11:32	182.5	11:01	175.0	10:38
5500	223.9	13:28	211.0	12:47	198.7	12:11	190.5	11:44
6000	241.9	14:48	227.9	14:02	214.6	13:22	205.6	12:51
6500	259.6	16:09	244.4	15:19	230.1	14:34	220.3	13:58
7000	276.9	17:32	260.6	16:37	245.2	15:47	234.8	15:07
7500	293.8	18:56	276.5	17:57	260.0	17:01	248.9	16:16
8000	310.4	20:22	292.0	19:17	274.6	18:16	262.7	17:26

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)				
	400	500	600	700	800
120	-22.0	-11.4	0.0	17.8	41.6
140	-25.7	-13.2	0.0	20.4	47.1
160	-29.5	-15.1	0.0	23.0	52.4
180	-33.3	-17.0	0.0	25.4	57.4
200	-37.1	-18.8	0.0	27.7	62.1
220	-41.0	-20.7	0.0	30.0	66.5
240	-44.9	-22.5	0.0	32.2	70.7
260	-48.8	-24.4	0.0	34.3	74.6
280	-52.7	-26.2	0.0	36.3	78.2
300	-56.7	-28.0	0.0	38.3	81.5
320	-60.7	-29.9	0.0	40.1	84.6
340	-64.7	-31.7	0.0	41.9	87.4

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 LB)											
	880	840	800	760	720	680	640	600	560	520	480	440
45										39	16	3
43								60	32	13	2	0
41							45	23	9	1	0	4
39					55	32	16	5	0	0	5	13
37			59	37	21	9	2	0	1	6	15	26
35	59	39	23	12	4	0	0	3	8	16	27	40
33	24	13	6	1	0	1	5	11	19	29	41	55
31	6	2	0	0	3	7	14	22	32	43	55	69
29	0	0	2	6	11	18	26	35	46	57	70	83
27	2	5	9	15	22	30	39	49	60	71	83	96
25	9	14	20	27	34	43	52	63	73	85	96	108

The above wind factor table is for calculation of wind required to maintain present range capability at new pressure altitude, i.e., break-even wind.

Method:

1. **Read wind factors for present and new altitudes from table.**
2. **Determine difference (new altitude wind factor minus present altitude wind factor); this difference may be negative or positive.**
3. **Break-even wind at new altitude is present altitude wind plus difference from step 2.**

Descent at .84/290/250

PRESSURE ALT (1000 FT)	19	21	23	25	27	29	31	33	35	37	39	41	43	45
DISTANCE (NM)	75	82	89	97	104	112	119	126	133	138	144	149	155	159
TIME (MINUTES)	16	17	18	19	21	22	23	23	24	25	26	26	27	28

Holding
Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	45000
880	%N1	70.9	73.7	77.7	81.8	85.9	90.1	94.5			
	KIAS	286	286	286	286	304	308	312			
	FF/ENG	6770	6710	6710	6750	6890	7100	7470			
840	%N1	69.6	72.4	76.4	80.5	84.6	88.8	93.1	100.7		
	KIAS	280	280	280	280	297	300	305	279		
	FF/ENG	6460	6400	6380	6400	6520	6680	6980	7560		
800	%N1	68.2	70.9	75.0	79.1	83.3	87.4	91.7	97.6		
	KIAS	272	272	272	272	289	292	297	279		
	FF/ENG	6140	6080	6060	6060	6140	6290	6540	6920		
760	%N1	66.9	69.5	73.5	77.7	81.9	86.0	90.2	95.4		
	KIAS	263	263	263	263	282	285	289	279		
	FF/ENG	5830	5770	5740	5740	5790	5910	6110	6420		
720	%N1	65.3	68.0	72.0	76.2	80.5	84.5	88.8	93.4		
	KIAS	255	255	255	255	274	277	280	279		
	FF/ENG	5520	5460	5430	5420	5450	5550	5710	5990		
680	%N1	63.6	66.5	70.5	74.7	78.9	83.0	87.3	91.7		
	KIAS	246	246	246	246	266	268	272	276		
	FF/ENG	5220	5160	5120	5100	5130	5190	5320	5580		
640	%N1	61.9	64.8	68.8	73.0	77.3	81.4	85.7	90.0	98.2	
	KIAS	238	238	238	238	258	260	263	267	249	
	FF/ENG	4930	4870	4820	4790	4810	4850	4940	5150	5610	
600	%N1	60.2	63.0	67.1	71.2	75.6	79.8	83.9	88.3	95.3	
	KIAS	231	231	231	231	249	251	254	257	249	
	FF/ENG	4640	4580	4520	4480	4510	4520	4570	4740	5110	
560	%N1	58.5	61.2	65.4	69.4	73.8	78.0	82.2	86.5	92.8	
	KIAS	226	226	226	226	240	242	245	248	249	
	FF/ENG	4360	4300	4230	4180	4210	4210	4230	4350	4690	
520	%N1	56.5	59.3	63.4	67.4	71.8	76.1	80.3	84.6	90.7	100.7
	KIAS	219	219	219	219	231	233	235	238	242	222
	FF/ENG	4090	4020	3950	3890	3920	3910	3890	3980	4250	4750
480	%N1	54.6	57.3	61.3	65.4	69.8	74.0	78.3	82.5	88.6	96.2
	KIAS	214	214	214	214	222	223	226	228	231	222
	FF/ENG	3830	3750	3680	3610	3630	3630	3570	3630	3840	4170
440	%N1	52.6	55.2	59.2	63.3	67.5	71.8	76.0	80.3	86.3	93.1
	KIAS	207	207	207	207	212	214	215	218	221	222
	FF/ENG	3570	3490	3410	3340	3350	3340	3270	3290	3450	3730

This table includes 5% additional fuel for holding in a racetrack pattern.

Holding
Flaps 1

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
880	%N1	74.5	77.4	81.5	85.7	89.8
	KIAS	245	246	248	250	250
	FF/ENG	7570	7550	7590	7660	7670
840	%N1	73.0	76.1	80.1	84.3	88.5
	KIAS	240	241	243	245	245
	FF/ENG	7210	7190	7220	7280	7270
800	%N1	71.6	74.7	78.8	82.9	87.2
	KIAS	235	236	238	240	240
	FF/ENG	6860	6830	6860	6910	6880
760	%N1	70.2	73.1	77.3	81.5	85.7
	KIAS	230	231	233	235	235
	FF/ENG	6500	6480	6500	6540	6500
720	%N1	68.5	71.5	75.8	80.0	84.3
	KIAS	225	226	228	230	230
	FF/ENG	6150	6130	6140	6170	6130
680	%N1	66.9	69.9	74.2	78.4	82.7
	KIAS	220	221	223	224	224
	FF/ENG	5810	5780	5790	5810	5770
640	%N1	65.2	68.2	72.5	76.8	81.0
	KIAS	215	216	218	219	219
	FF/ENG	5470	5440	5440	5460	5410
600	%N1	63.4	66.3	70.7	75.0	79.2
	KIAS	210	211	212	214	214
	FF/ENG	5150	5100	5100	5100	5070
560	%N1	61.5	64.5	68.8	73.2	77.4
	KIAS	205	205	207	208	208
	FF/ENG	4830	4780	4760	4760	4740
520	%N1	59.5	62.5	66.7	71.2	75.4
	KIAS	199	200	201	202	202
	FF/ENG	4510	4450	4430	4420	4420
480	%N1	57.6	60.3	64.6	69.0	73.3
	KIAS	193	194	195	196	196
	FF/ENG	4210	4140	4110	4090	4100
440	%N1	55.4	58.2	62.4	66.8	71.2
	KIAS	187	188	189	189	189
	FF/ENG	3910	3840	3790	3770	3800

This table includes 5% additional fuel for holding in a racetrack pattern.
Holding at Flaps 1 in icing conditions is not recommended.

Intentionally
Blank

Performance Inflight - Advisory Information

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

Dry Runway

	LANDING DISTANCE AND ADJUSTMENT (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF30	2 REV	NO REV
MAX MANUAL	3310	60/-50	100	-170	580	50	-50	90	-90	360	110	250
MAX AUTO	4160	70/-70	120	-210	700	0	-10	120	-120	470	0	0
AUTOBRAKES 4	5090	90/-90	160	-270	920	0	-20	150	-150	600	0	0
AUTOBRAKES 3	5900	100/-100	200	-320	1100	60	-90	190	-180	580	70	100
AUTOBRAKES 2	6430	120/-120	220	-370	1250	140	-150	220	-200	570	380	410
AUTOBRAKES 1	6950	140/-140	260	-420	1440	220	-230	250	-210	570	760	1190

Good Reported Braking Action

MAX MANUAL	4300	70/-70	140	-240	850	110	-100	130	-120	440	310	720
MAX AUTO	4530	80/-80	150	-250	870	90	-80	140	-130	460	320	750
AUTOBRAKES 4	5120	90/-90	160	-280	960	20	-30	150	-150	600	30	200
AUTOBRAKES 3	5900	100/-100	200	-320	1100	70	-90	190	-180	580	70	100

Medium Reported Braking Action

MAX MANUAL	5650	100/-100	190	-360	1340	270	-210	180	-160	500	730	1880
MAX AUTO	5690	110/-100	200	-360	1340	250	-190	190	-160	540	710	1840
AUTOBRAKES 4	5760	110/-100	200	-360	1350	210	-150	190	-170	600	670	1830
AUTOBRAKES 3	6250	110/-110	210	-380	1410	200	-170	200	-180	580	420	1490

Poor Reported Braking Action

MAX MANUAL	7170	130/-130	250	-530	2180	730	-400	240	-190	550	1400	4040
MAX AUTO	7170	140/-130	250	-520	2180	720	-390	240	-190	560	1400	4100
AUTOBRAKE 4	7170	140/-130	250	-520	2180	720	-390	240	-190	560	1400	4090
AUTOBRAKE 3	7310	140/-130	260	-530	2200	700	-380	250	-190	580	1300	4030

Reference distance is for sea level, standard day, no wind or slope, and four engine reverse.
Max manual braking reference distance assumes use of auto spoilers. For manual spoilers add 240 ft.
Autobrake reference distance good for auto or manual spoilers.
Actual (unfactored) distances are shown and include distance from 50 ft above threshold (approximately 1000 ft flare distance).
Assumes VREF30 approach speed.

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 25
Dry Runway

	LANDING DISTANCE AND ADJUSTMENT (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF25	2 REV	NO REV
MAX MANUAL	3480	80/-50	100	-170	590	50	-50	100	-90	360	130	280
MAX AUTO	4450	70/-70	130	-220	720	0	-10	130	-130	500	0	0
AUTOBRAKES 4	5460	90/-90	180	-280	950	0	-10	170	-170	640	0	0
AUTOBRAKES 3	6410	110/-110	220	-340	1150	40	-100	210	-200	630	80	110
AUTOBRAKES 2	7000	130/-130	250	-380	1310	140	-170	240	-210	610	420	440
AUTOBRAKES 1	7550	150/-150	290	-430	1500	240	-260	280	-230	610	960	1320

Good Reported Braking Action

MAX MANUAL	4560	80/-80	150	-250	870	120	-100	140	-130	440	360	850
MAX AUTO	4780	80/-80	160	-250	890	90	-70	150	-130	490	360	870
AUTOBRAKES 4	5490	90/-90	180	-290	990	20	-20	170	-170	640	20	210
AUTOBRAKES 3	6410	110/-110	220	-340	1150	50	-100	210	-200	630	80	110

Medium Reported Braking Action

MAX MANUAL	6030	110/-110	210	-370	1370	280	-220	200	-170	520	860	2290
MAX AUTO	6030	110/-110	210	-370	1370	270	-190	200	-170	570	830	2240
AUTOBRAKES 4	6130	110/-110	210	-370	1380	220	-140	200	-180	650	770	2190
AUTOBRAKES 3	6750	120/-120	230	-400	1460	180	-170	220	-200	630	460	1810

Poor Reported Braking Action

MAX MANUAL	7690	150/-140	270	-540	2250	770	-420	260	-200	580	1670	5060
MAX AUTO	7690	150/-140	280	-540	2240	770	-410	260	-200	600	1680	5130
AUTOBRAKES 4	7690	150/-140	280	-540	2240	760	-410	260	-200	590	1670	5120
AUTOBRAKES 3	7850	150/-140	280	-550	2270	720	-390	270	-210	630	1550	5040

Reference distance is for sea level, standard day, no wind or slope, and four engine reverse.
Max manual braking reference distance assumes use of auto spoilers. For manual spoilers, add 240 ft.
Autobrake reference distance good for auto or manual spoilers.
Actual (unfactored) distances are shown and include distance from 50 ft above threshold (approximately 1000 ft flare distance).
Assumes VREF25 approach speed.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Dry Runway

		LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	4150	70/ -60	150	-220/ 730	110/ -90	130/ -130	580		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	5910	110/ -100	290	-400/ 1440	320/ -250	220/ -190	560	790	1970
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	4410	70/ -60	170	-210/ 680	80/ -70	150/ -140	440	220	480
FLAPS UP	VREF30+70	6140	190/ -100	410	-310/ 1270	140/ -120	320/ -280	690	500	1150
JAMMED STABILIZER FLAPS 25	VREF30+20	4040	80/ -60	160	-200/ 670	70/ -70	140/ -130	360	190	430
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	4280	80/ -60	160	-210/ 680	80/ -70	140/ -130	390	210	460
ONE BODY GEAR UP FLAPS 30	VREF30	3610	90/ -70	150	-220/ 740	90/ -80	130/ -120	370	210	480
ONE WING GEAR UP FLAPS 30	VREF30	3650	90/ -60	160	-220/ 710	90/ -80	130/ -120	390	220	500
TWO WING GEAR UP FLAPS 30	VREF30	4350	140/ -100	270	-280/ 1290	160/ -140	200/ -150	570	400	940
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	4820	70/ -70	210	-230/ 740	120/ -110	170/ -150	640	350	810
REVERSER UNLOCKED FLAPS 25	VREF30+20	4210	90/ -60	160	-210/ 700	90/ -80	140/ -130	390		230

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Good Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	5820	90/ -90	220	-340/ 1140	290/ -230	200/ -180	760		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	5910	110/ -100	290	-400/ 1440	320/ -250	220/ -190	560	790	1970
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	5590	90/ -90	250	-290/ 990	160/ -140	200/ -180	500	500	1180
FLAPS UP	VREF30+70	7710	100/ -110	340	-330/ 1110	200/ -180	280/ -250	520	800	1900
JAMMED STABILIZER FLAPS 25	VREF30+20	5260	80/ -80	230	-280/ 970	160/ -140	190/ -170	490	470	1100
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	5550	90/ -90	250	-290/ 990	170/ -150	200/ -180	510	520	1220
ONE BODY GEAR UP FLAPS 30	VREF30	4380	70/ -70	190	-260/ 910	140/ -120	150/ -140	480	340	790
ONE WING GEAR UP FLAPS 30	VREF30	4670	80/ -80	210	-280/ 950	160/ -140	170/ -150	560	430	1010
TWO WING GEAR UP FLAPS 30	VREF30	4400	140/ -70	270	-280/ 1290	160/ -140	200/ -150	570	400	940
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	6130	100/ -100	300	-320/ 1080	230/ -200	230/ -200	700	780	1960
REVERSER UNLOCKED FLAPS 25	VREF30+20	5690	90/ -90	230	-310/ 1040	200/ -170	200/ -180	550		630

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Medium Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	8700	140/ -140	340	-560/ 1950	880/ -610	320/ -260	950		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	7490	140/ -130	400	-590/ 2310	840/ -500	290/ -240	610	1520	4200
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	7090	120/ -120	360	-420/ 1520	360/ -280	270/ -240	550	1060	2680
FLAPS UP	VREF30+70	10260	160/ -160	550	-500/ 1750	480/ -390	410/ -350	640	1920	5100
JAMMED STABILIZER FLAPS 25	VREF30+20	6890	120/ -110	350	-420/ 1520	370/ -290	270/ -230	570	1080	2780
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	7240	120/ -120	370	-430/ 1550	380/ -300	280/ -240	590	1170	3020
ONE BODY GEAR UP FLAPS 30	VREF30	5770	110/ -100	290	-390/ 1430	330/ -260	220/ -190	550	810	2030
ONE WING GEAR UP FLAPS 30	VREF30	6070	110/ -110	320	-410/ 1480	370/ -280	230/ -200	620	950	2440
TWO WING GEAR UP FLAPS 30	VREF30	5820	110/ -100	290	-400/ 1440	330/ -260	220/ -190	560	830	2090
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	7800	140/ -130	440	-460/ 1640	480/ -370	320/ -270	750	1590	4390
REVERSER UNLOCKED FLAPS 25	VREF30+20	7870	130/ -130	370	-480/ 1690	520/ -400	300/ -260	660		1700

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Poor Reported Braking Action

		LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	
LANDING CONFIGURATION	VREF	550000 LB LANDING WEIGHT	PER 10000 LB ABOVE/ BELOW 550000 LB	PER 1000 FT ABV SEA LEVEL	HEAD/ TAIL	DOWN HILL/ UP HILL	ABV ISA/ BLW ISA	PER 10 KTS ABV VREF	TWO REV	NO REV
AIR/GROUND LOGIC IN AIR MODE FLAPS 30	VREF30	12990	190/ -190	520	-960/ 3480	3040/ -1470	490/ -320	1090		
ANTI-SKID INOPERATIVE FLAPS 30	VREF30	11000	160/ -110	540	-1160/ 6020	4940/ -1480	400/ -180	650	3600	12060
ASYMMETRIC/ SPLIT TRAILING EDGE FLAPS FLAPS 25	VREF30+25	8730	150/ -140	480	-610/ 2400	880/ -530	340/ -280	580	1860	5170
FLAPS UP	VREF30+70	12960	220/ -210	800	-730/ 2770	1180/ -750	550/ -430	730	3650	11210
JAMMED STABILIZER FLAPS 25	VREF30+20	8690	150/ -150	490	-620/ 2430	930/ -560	350/ -280	630	2030	5820
LEADING EDGE FLAPS INOP FLAPS 25	VREF30+25	9090	160/ -150	520	-630/ 2460	960/ -580	370/ -290	640	2160	6230
ONE BODY GEAR UP FLAPS 30	VREF30	7370	140/ -130	400	-580/ 2300	850/ -510	290/ -240	600	1560	4310
ONE WING GEAR UP FLAPS 30	VREF30	7660	140/ -140	430	-600/ 2350	910/ -540	300/ -250	650	1750	4940
TWO WING GEAR UP FLAPS 30	VREF30	7450	140/ -130	410	-590/ 2320	870/ -510	290/ -240	620	1610	4480
TWO HYDRAULIC SYSTEMS INOP FLAPS 25	VREF30+20	9630	180/ -170	600	-670/ 2570	1100/ -670	400/ -320	770	2750	8510
REVERSER UNLOCKED FLAPS 25	VREF30+20	10540	180/ -170	540	-750/ 2820	1450/ -830	420/ -320	740		3790

Actual (unfactored) distances are shown.
Includes distances from 50 ft above threshold (4.22 sec flare time).
Assumes max manual braking and maximum available reverse thrust.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy per Brake (Millions of Foot Pounds)

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT (1000 LB)	OAT (°F)	PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT			PRESS ALT		
		0	4	8	0	4	8	0	4	8	0	4	8	0	4	8	0	4	8
900	20	19.9	21.9	24.0	28.9	32.1	35.7	39.2	43.8	49.1	50.6	56.7	63.8	62.5	70.2	78.9	74.5	83.6	93.7
	60	21.4	23.5	26.0	31.1	34.5	38.5	42.2	47.1	52.9	54.4	60.9	68.6	67.1	75.2	84.6	79.8	89.3	100.0
	100	22.3	24.6	27.1	32.7	36.4	40.6	44.5	49.8	55.9	57.5	64.5	72.6	71.1	79.6	89.5	84.4	94.3	105.4
	140	22.3	24.6	27.1	33.1	37.0	41.1	45.5	51.0	57.2	59.2	66.5	74.7	73.5	82.4	92.5	87.5	97.8	109.0
800	20	18.2	19.9	21.8	26.3	29.1	32.3	35.5	39.6	44.3	45.7	51.2	57.5	56.6	63.5	71.4	67.5	75.8	85.1
	60	19.5	21.3	23.5	28.3	31.3	34.9	38.2	42.6	47.8	49.2	55.1	62.0	60.8	68.2	76.7	72.5	81.2	91.2
	100	20.3	22.3	24.5	29.7	32.9	36.7	40.3	45.0	50.5	52.0	58.3	63.0	64.4	72.2	81.2	76.7	85.8	96.3
	140	20.2	22.3	24.4	30.0	33.4	37.1	41.1	46.0	51.5	53.4	60.0	67.4	66.4	74.6	83.7	79.4	89.0	99.5
700	20	16.4	17.9	19.5	23.7	26.1	28.9	31.9	35.4	39.6	40.9	45.7	51.3	50.6	56.7	63.8	60.4	67.8	76.2
	60	17.6	19.2	21.1	25.4	28.1	31.1	34.2	38.1	42.6	44.0	49.1	55.3	54.4	60.9	68.6	64.9	72.7	81.9
	100	18.3	20.0	22.0	26.6	29.5	32.7	36.1	40.2	45.0	46.4	51.9	58.4	57.5	64.5	72.6	68.7	77.0	86.6
	140	18.1	19.9	21.7	26.8	29.8	33.0	36.7	41.0	45.8	47.5	53.3	59.8	59.2	66.6	74.7	71.0	79.7	89.4
600	20	14.6	15.9	17.2	21.0	23.1	25.5	28.1	31.2	34.7	36.0	40.1	44.9	44.4	49.6	55.8	53.1	59.6	67.0
	60	15.7	17.0	18.6	22.5	24.8	27.4	30.2	33.5	37.4	38.7	43.1	48.4	47.7	53.4	60.0	57.1	64.0	72.1
	100	16.3	17.7	19.4	23.6	26.0	28.8	31.8	35.3	39.5	40.8	45.6	51.1	50.4	56.5	63.5	60.4	67.8	76.2
	140	16.0	17.5	19.0	23.6	26.1	28.8	32.2	35.9	40.0	41.6	46.6	52.2	51.8	58.1	65.3	62.3	70.0	78.6
500	20	13.1	14.1	15.3	18.5	20.2	22.2	24.4	27.0	29.9	30.9	34.3	38.3	37.8	42.2	47.2	45.0	50.3	56.6
	60	14.0	15.1	16.4	19.8	21.7	23.9	26.2	29.0	32.2	33.2	36.9	41.3	40.6	45.4	50.9	48.4	54.1	60.9
	100	14.5	15.7	17.1	20.7	22.7	25.1	27.5	30.5	33.9	35.0	38.9	43.6	42.9	47.9	53.9	51.1	57.3	64.4
	140	14.1	15.4	16.6	20.6	22.7	24.9	27.7	30.8	34.1	35.5	39.7	44.3	43.8	49.1	55.0	52.5	59.0	66.2
400	20	11.6	12.4	13.4	16.0	17.4	19.0	20.7	22.8	25.1	25.8	28.5	31.7	31.0	34.5	38.4	36.5	40.7	45.6
	60	12.4	13.3	14.4	17.1	18.6	20.4	22.2	24.4	27.0	27.7	30.6	34.1	33.4	37.1	41.5	39.2	43.8	49.1
	100	12.8	13.8	14.9	17.8	19.4	21.3	23.3	25.6	28.4	29.1	32.2	36.0	35.1	39.1	43.7	41.4	46.2	51.9
	140	12.4	13.4	14.4	17.6	19.3	21.1	23.3	25.7	28.4	29.3	32.6	36.2	35.7	39.9	44.5	42.3	47.3	53.1

To correct for wind, enter the table with the brakes-on speed minus 0.5 times headwind or plus 1.5 times tail-wind.

If ground speed is used for brakes-on speed, ignore wind, altitude and OAT effects, and enter the table at sea level and 60°F.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Adjusted Brake Energy per Brake (Millions of Foot Pounds)

No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)								
EVENT		10	20	30	40	50	60	70	80	90
RTO MAX MAN		10	20	30	40	50	60	70	80	90
LANDING	MAX MAN	4.2	12.9	21.9	30.8	39.8	48.8	58.0	67.4	77.0
LANDING	MAX AUTO	4.2	12.4	20.8	29.3	38.1	47.0	56.3	65.7	75.5
LANDING	AUTOBRAKE 4	3.6	11.7	19.5	27.4	35.4	43.6	52.4	61.7	71.8
LANDING	AUTOBRAKE 3	3.5	11.2	18.5	25.8	33.2	40.8	48.8	57.4	66.8
LANDING	AUTOBRAKE 2	3.5	10.6	17.4	24.1	30.9	37.8	45.1	52.9	61.4
LANDING	AUTOBRAKE 1	3.1	9.6	15.7	21.6	27.3	33.0	39.1	45.5	52.4

Four Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)								
EVENT		10	20	30	40	50	60	70	80	90
RTO MAX MAN		10	20	30	40	50	60	70	80	90
LANDING	MAX MAN	2.7	11.2	19.5	27.6	35.7	43.7	51.9	60.1	68.6
LANDING	MAX AUTO	1.4	8.9	16.1	23.4	30.7	38.3	46.4	55.0	64.3
LANDING	AUTOBRAKE 4	0.0	6.5	12.6	18.7	24.9	31.5	38.8	47.0	56.5
LANDING	AUTOBRAKE 3		4.6	9.6	14.4	19.3	24.6	30.6	37.8	46.4
LANDING	AUTOBRAKE 2		3.0	7.0	10.6	14.1	18.0	22.5	28.2	35.3
LANDING	AUTOBRAKE 1		1.8	4.7	7.2	9.6	12.1	15.2	19.3	24.5

Cooling Time (Minutes)

	ADJUSTED BRAKE ENERGY PER BRAKE (MILLION OF FOOT POUNDS)								
	15 & BELOW	16	20	24	28	32	34	35 TO 45	45 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE REQUIRED	1	3	5	6	8	8	CAUTION	FUSE PLUG MELT ZONE
GROUND		10	28	42	55	65	70		
BTMS	UP TO 2	2	2	3	4	4	4	5 TO 6	7 & ABOVE

Observe maximum quick turnaround limit.
Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.
Add 1.0 million foot pounds for each taxi mile.
For one brake deactivated, increase brake energy by 7 percent.
For two brakes deactivated, increase brake energy by 15 percent.
When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 8 minutes.
When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not attempt to taxi for one hour. Tire, wheel, and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.
Brake temperature monitor system (BTMS) indication on EICAS may be used 10 to 15 minutes after airplane has come to a complete stop, or inflight with gear retracted, to determine recommended cooling schedule.

Performance Inflight - One Engine Inoperative

Chapter PI Section 23

1 ENGINE INOP

Max Continuous %N1

39000 FT to 29000 FT Pressure Altitudes
Based on engine bleed for 3 packs on

39000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	.66	100.4	101.5	102.6	103.6	104.7	105.8	106.8	106.0	105.0	104.2	103.4	102.9
240	.78	100.0	101.1	102.1	103.2	104.2	105.0	105.8	105.5	104.7	103.7	102.8	102.1
280	.89	96.8	97.8	98.9	99.9	100.9	102.0	102.9	103.6	104.3	103.8	102.9	101.9
37000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	.63	100.4	101.5	102.6	103.6	104.7	105.8	106.8	106.0	105.1	104.3	103.6	101.4
240	.74	100.4	101.5	102.6	103.6	104.7	105.8	106.4	105.6	104.7	103.7	102.9	102.1
280	.86	97.7	98.7	99.7	100.8	101.8	102.8	103.6	104.4	104.2	103.4	102.5	101.5
35000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	.60	100.4	101.5	102.6	103.6	104.7	105.8	106.8	106.9	106.0	105.1	104.3	102.7
240	.71	100.4	101.5	102.6	103.6	104.7	105.8	106.8	106.7	105.7	104.7	103.9	103.1
280	.82	98.8	99.9	100.9	102.0	103.0	104.0	104.9	105.6	105.2	104.3	103.3	102.4
33000 FT PRESS ALT		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	.58	101.5	102.6	103.6	104.7	105.8	106.8	107.9	107.2	106.3	105.4	104.7	100.9
240	.68	101.5	102.6	103.6	104.7	105.8	106.8	107.9	106.9	106.0	105.0	104.2	103.5
280	.79	100.3	101.4	102.4	103.5	104.5	105.4	106.2	106.5	105.4	104.6	103.6	102.8
320	.89	97.5	98.5	99.5	100.5	101.5	102.5	103.5	104.3	105.1	104.6	103.7	102.8
31000 FT PRESS ALT		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	.55	101.5	102.6	103.6	104.7	105.8	106.8	107.9	108.3	107.4	106.5	105.7	104.4
240	.65	101.5	102.6	103.6	104.7	105.8	106.8	107.9	107.9	107.0	106.1	105.3	104.4
280	.76	100.6	101.6	102.7	103.7	104.7	105.7	106.5	107.4	106.5	105.6	104.8	103.9
320	.85	97.5	98.6	99.6	100.6	101.6	102.6	103.5	104.4	105.2	105.4	104.3	103.5
29000 FT PRESS ALT		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
200	.53	102.6	103.6	104.7	105.8	106.8	107.9	108.9	108.0	107.1	106.2	105.5	102.3
240	.63	102.6	103.6	104.7	105.8	106.8	107.9	108.6	107.6	106.8	105.9	105.0	104.2
280	.72	101.5	102.5	103.5	104.5	105.5	106.4	107.3	107.4	106.3	105.5	104.6	103.8
320	.82	98.7	99.8	100.8	101.7	102.7	103.7	104.6	105.4	106.3	105.2	104.4	103.5
360	.91	96.5	97.5	98.5	99.5	100.5	101.4	102.4	103.3	104.1	104.9	104.9	103.9

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	29	31	33	35	37	39
PACKS OFF	0.4	0.4	0.4	0.5	0.6	0.6
ENGINE ANTI-ICE ON	-0.8	-0.9	-1.0	-1.1	-1.3	-1.5
ENGINE & WING ANTI-ICE ON	-1.6	-1.8	-1.9	-2.1	-2.5	-2.9

1 ENGINE INOP

Max Continuous %N1
27000 FT to 18000 FT Pressure Altitudes
Based on engine bleed for 3 packs on

27000 FT PRESS ALT		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	.50	103.6	104.7	105.8	106.8	107.9	108.9	108.1	107.2	106.3	105.5	104.9	100.0
240	.60	103.6	104.7	105.8	106.8	107.9	108.8	107.8	106.9	106.0	105.1	104.3	103.7
280	.69	101.6	102.6	103.6	104.6	105.6	106.4	107.3	106.4	105.5	104.6	103.8	102.9
320	.79	99.5	100.5	101.5	102.5	103.4	104.4	105.2	106.1	105.8	104.9	104.0	103.2
360	.87	97.5	98.5	99.5	100.4	101.4	102.3	103.2	104.1	104.9	105.5	104.5	103.7
25000 FT PRESS ALT		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	.48	103.6	104.7	105.8	106.8	107.9	108.9	108.1	107.2	106.3	105.4	104.7	102.6
240	.57	103.2	104.2	105.2	106.2	107.1	108.0	107.8	106.8	105.9	105.1	104.2	103.5
280	.66	100.6	101.6	102.6	103.6	104.5	105.4	106.3	106.4	105.4	104.5	103.6	102.8
320	.75	98.8	99.8	100.7	101.7	102.7	103.6	104.5	105.3	105.9	104.9	104.1	103.2
360	.84	97.3	98.3	99.2	100.2	101.1	102.1	103.0	103.9	104.7	105.5	105.0	104.1
24000 FT PRESS ALT		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	.47	104.7	105.8	106.8	107.9	108.9	108.1	107.3	106.4	105.6	104.8	103.9	99.2
240	.56	103.7	104.7	105.7	106.6	107.4	107.8	106.9	106.0	105.2	104.4	103.6	103.0
280	.65	101.3	102.3	103.2	104.2	105.1	105.9	106.5	105.5	104.7	103.9	103.1	102.3
320	.74	99.3	100.3	101.3	102.2	103.2	104.1	104.9	105.7	104.9	104.1	103.3	102.5
360	.82	97.9	98.8	99.8	100.7	101.6	102.5	103.4	104.3	105.1	104.9	104.1	103.3
22000 FT PRESS ALT		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	.45	104.5	105.5	106.4	107.3	108.1	108.0	107.2	106.5	105.8	105.0	104.4	102.0
240	.54	102.5	103.5	104.5	105.4	106.2	107.1	106.7	106.0	105.3	104.6	103.9	103.2
280	.62	100.5	101.4	102.4	103.3	104.2	105.1	105.9	105.6	104.9	104.2	103.5	102.8
320	.71	98.4	99.4	100.3	101.3	102.2	103.1	103.9	104.7	104.8	104.0	103.3	102.7
360	.79	97.0	97.9	98.9	99.8	100.7	101.6	102.5	103.3	104.1	104.6	103.8	103.2
20000 FT PRESS ALT		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	.43	104.0	104.9	105.9	106.7	107.4	106.8	106.2	105.7	105.1	104.4	103.8	99.9
240	.51	102.1	103.1	104.0	104.9	105.7	106.3	105.6	105.1	104.5	103.9	103.2	102.7
280	.60	100.3	101.2	102.1	103.0	103.9	104.7	105.3	104.6	104.1	103.6	102.9	102.3
320	.68	98.4	99.3	100.3	101.2	102.1	102.9	103.7	104.4	103.7	103.2	102.7	102.1
360	.76	97.0	97.9	98.8	99.7	100.6	101.4	102.3	103.0	103.8	103.4	102.9	102.4
18000 FT PRESS ALT		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	.41	103.0	103.9	104.8	105.7	106.6	107.2	106.5	106.0	105.5	104.8	104.1	102.6
240	.49	101.1	102.1	103.0	103.9	104.8	105.7	105.9	105.3	104.8	104.2	103.6	102.8
280	.57	99.4	100.4	101.3	102.2	103.1	104.0	104.8	104.9	104.3	103.9	103.3	102.7
320	.65	97.9	98.8	99.7	100.6	101.5	102.4	103.2	104.1	104.3	103.7	103.2	102.7
360	.72	96.4	97.3	98.2	99.1	100.0	100.9	101.7	102.6	103.4	103.9	103.2	102.8

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	18	20	22	24	25	27
PACKS OFF	0.4	0.4	0.4	0.4	0.4	0.4
ENGINE ANTI-ICE ON	-0.6	-0.7	-0.7	-0.7	-0.8	-0.8
ENGINE & WING ANTI-ICE ON	-1.2	-1.4	-1.4	-1.4	-1.6	-1.6

1 ENGINE INOP

Max Continuous %N1

16000 FT to 5000 FT Pressure Altitudes

Based on engine bleed for 3 packs on

16000 FT PRESS ALT		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	.39	101.5	102.4	103.4	104.3	105.2	106.0	106.0	105.4	104.8	104.2	103.6	102.9
240	.47	100.2	101.1	102.0	103.0	103.9	104.7	105.6	105.2	104.6	104.0	103.4	102.8
280	.54	98.8	99.7	100.6	101.5	102.4	103.3	104.2	105.0	104.4	103.8	103.2	102.7
320	.62	97.3	98.2	99.1	100.0	100.9	101.8	102.7	103.5	104.3	103.8	103.2	102.6
360	.69	95.8	96.7	97.6	98.5	99.4	100.3	101.1	102.0	102.8	103.6	103.3	102.7

14000 FT PRESS ALT		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
200	.37	100.0	100.9	101.8	102.7	103.6	104.4	103.9	103.3	102.6	102.1	101.5	100.8
240	.45	99.4	100.3	101.2	102.1	103.0	103.9	104.4	103.8	103.1	102.5	101.9	101.4
280	.52	98.7	99.6	100.5	101.4	102.3	103.2	104.0	104.3	103.7	103.0	102.4	101.9
320	.59	97.7	98.6	99.5	100.4	101.3	102.1	103.0	103.8	104.0	103.4	102.8	102.1
360	.67	95.9	96.8	97.7	98.6	99.4	100.3	101.2	102.0	102.8	103.1	102.5	101.9

12000 FT PRESS ALT		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
200	.36	99.2	100.1	101.0	102.0	102.8	103.7	104.2	103.6	103.0	102.3	101.8	101.2
240	.43	98.7	99.6	100.5	101.4	102.3	103.1	103.9	104.0	103.4	102.8	102.2	101.6
280	.50	98.0	98.9	99.8	100.7	101.6	102.5	103.3	104.1	103.9	103.3	102.7	102.1
320	.57	97.3	98.2	99.1	100.0	100.9	101.7	102.6	103.4	104.2	103.8	103.2	102.6
360	.64	95.6	96.5	97.4	98.3	99.2	100.0	100.9	101.7	102.5	103.3	102.9	102.3

10000 FT PRESS ALT		TAT (°C)											
KIAS	M	-15	-10	-5	0	5	10	15	20	25	30	35	40
200	.34	99.3	100.2	101.1	102.0	102.8	103.6	103.7	103.1	102.6	102.0	101.4	100.9
240	.41	98.8	99.7	100.6	101.4	102.3	103.1	103.9	103.5	103.0	102.4	101.8	101.3
280	.48	98.2	99.1	99.9	100.8	101.7	102.5	103.3	103.9	103.4	102.8	102.3	101.7
320	.54	97.5	98.4	99.3	100.1	101.0	101.9	102.7	103.4	103.9	103.3	102.8	102.2
360	.61	96.1	97.0	97.9	98.8	99.6	100.5	101.3	102.1	102.9	103.2	102.7	102.2

5000 FT PRESS ALT		TAT (°C)											
KIAS	M	-10	-5	0	5	10	15	20	25	30	35	40	45
200	.30	97.3	98.2	99.1	99.9	100.8	101.6	102.3	102.1	101.5	100.9	100.3	99.7
240	.36	96.9	97.7	98.6	99.5	100.3	101.2	101.9	102.4	101.8	101.2	100.6	100.1
280	.42	96.4	97.2	98.1	99.0	99.8	100.7	101.4	102.2	102.2	101.6	101.0	100.4
320	.48	95.8	96.7	97.5	98.4	99.2	100.1	100.9	101.6	102.3	102.3	102.1	101.5
360	.55	95.2	96.0	96.9	97.7	98.6	99.4	100.2	101.0	101.8	102.5	102.0	101.4

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	5	10	12	14	16
PACKS OFF	0.2	0.2	0.3	0.3	0.4
ENGINE ANTI-ICE ON	-0.5	-0.6	-0.6	-0.6	-0.6
ENGINE & WING ANTI-ICE ON	-1.0	-1.2	-1.2	-1.2	-1.2

1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10 °C & BELOW	ISA + 15°C	ISA + 20°C
900	883	309	26300	24800	23000
850	838	301	27900	26600	25100
800	790	293	29500	28500	27300
750	739	284	31200	30200	29200
700	689	275	32900	32000	31000
650	639	265	34500	33800	32800
600	593	255	36000	35300	34500
550	543	245	37700	37100	36300
500	494	234	39500	39000	38200
450	444	222	41500	41000	40200
400	395	209	43800	43200	42400

Altitude reduced by 1000 ft for additional margin.

Long Range Cruise Altitude Capability

Based on engine bleed for packs on or off

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
880	25100	22800	20400
860	25900	23700	21400
840	26600	24600	22300
820	27300	25400	23200
800	28100	26200	24100
780	28800	27000	25100
760	29500	27800	26000
740	30100	28600	26900
720	30800	29300	27700
700	31500	30100	28600
680	32200	30800	29400
660	32900	31600	30200
640	33600	32400	31000
620	34300	33200	31800
600	35000	34000	32600
580	35600	34700	33400
560	36300	35400	34300
540	37000	36200	35000
520	37700	36900	35800
500	38500	37700	36600
480	39300	38500	37400
460	40100	39300	38200
440	40900	40100	39000

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 1300 ft.
With engine and wing anti-ice on, decrease altitude capability by 2400 ft.

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		10	14	20	25	27	29	31	33	35	37
880	%N1	88.5	91.4	96.0	100.2						
	MACH	.633	.678	.755	.818						
	KIAS	352	351	351	346						
	FF/ENG	9860	10013	10174	10472						
840	%N1	87.2	90.1	94.7	98.8	100.8					
	MACH	.621	.663	.741	.805	.828					
	KIAS	345	343	344	340	336					
	FF/ENG	9360	9473	9611	9863	9977					
800	%N1	86.0	88.8	93.4	97.3	99.2	101.4				
	MACH	.609	.649	.726	.791	.816	.836				
	KIAS	339	336	336	334	331	326				
	FF/ENG	8884	8959	9065	9262	9407	9474				
760	%N1	84.7	87.5	92.0	95.9	97.6	99.6				
	MACH	.597	.636	.709	.775	.802	.826				
	KIAS	332	329	328	326	325	321				
	FF/ENG	8429	8467	8523	8694	8811	8922				
720	%N1	83.3	86.1	90.5	94.4	96.1	97.9	100.1			
	MACH	.584	.622	.691	.759	.786	.812	.834			
	KIAS	325	321	319	319	318	316	311			
	FF/ENG	7982	7982	7997	8157	8234	8364	8439			
680	%N1	81.9	84.7	89.1	93.0	94.5	96.3	98.2	100.7		
	MACH	.571	.608	.674	.742	.768	.795	.821	.840		
	KIAS	317	314	311	311	310	309	306	300		
	FF/ENG	7547	7520	7495	7634	7686	7782	7888	7990		
640	%N1	80.5	83.2	87.5	91.4	93.0	94.6	96.4	98.4		
	MACH	.558	.594	.656	.723	.750	.777	.804	.828		
	KIAS	310	306	302	303	302	301	299	296		
	FF/ENG	7130	7076	7004	7121	7175	7230	7327	7418		
600	%N1	78.9	81.7	85.9	89.7	91.3	92.9	94.6	96.5	98.7	
	MACH	.544	.579	.638	.701	.730	.758	.785	.812	.834	
	KIAS	302	298	294	293	293	293	291	289	285	
	FF/ENG	6715	6642	6541	6604	6663	6712	6775	6857	6926	
560	%N1	77.2	80.0	84.2	88.0	89.6	91.2	92.8	94.5	96.5	99.5
	MACH	.529	.563	.620	.680	.708	.736	.764	.792	.819	.840
	KIAS	293	290	285	283	284	284	283	281	279	274
	FF/ENG	6300	6218	6085	6112	6152	6204	6248	6308	6370	6515
520	%N1	75.3	78.2	82.5	86.1	87.7	89.3	90.9	92.5	94.3	96.8
	MACH	.513	.547	.603	.657	.684	.713	.742	.770	.798	.824
	KIAS	284	282	277	273	274	274	274	273	271	268
	FF/ENG	5883	5801	5649	5627	5653	5697	5744	5787	5831	5945
480	%N1	73.3	76.3	80.6	84.2	85.7	87.3	88.9	90.5	92.2	94.4
	MACH	.495	.530	.584	.636	.660	.687	.716	.746	.774	.803
	KIAS	274	272	268	264	263	263	264	263	262	261
	FF/ENG	5464	5382	5227	5172	5168	5195	5243	5284	5322	5400
440	%N1	71.2	74.2	78.5	82.1	83.6	85.1	86.7	88.3	90.0	92.1
	MACH	.476	.511	.564	.613	.636	.660	.688	.718	.748	.777
	KIAS	263	262	258	254	253	252	252	253	253	251
	FF/ENG	5045	4964	4820	4733	4714	4712	4742	4786	4821	4884

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
705	652	605	566	531	500	479	460	442	426	411
1415	1309	1215	1134	1063	1000	959	922	887	855	826
2133	1971	1827	1703	1596	1500	1440	1384	1331	1283	1239
2857	2637	2441	2274	2130	2000	1920	1845	1776	1712	1653
3589	3309	3060	2848	2665	2500	2400	2306	2219	2139	2065
4329	3986	3682	3424	3200	3000	2879	2766	2662	2565	2477
5079	4670	4308	4001	3737	3500	3358	3226	3104	2991	2888
5840	5361	4938	4581	4274	4000	3838	3687	3546	3416	3297
6612	6061	5574	5165	4814	4500	4316	4145	3986	3840	3706
7398	6770	6216	5752	5354	5000	4795	4603	4426	4263	4113

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		22		29		33	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
500	28.0	1:31	25.7	1:27	21.9	1:20	19.3	1:14	18.2	1:11
1000	56.4	3:00	52.5	2:52	45.7	2:36	41.1	2:22	39.2	2:16
1500	84.1	4:31	78.6	4:18	68.8	3:54	62.4	3:32	59.6	3:21
2000	111.2	6:04	104.0	5:46	91.3	5:13	83.0	4:42	79.5	4:28
2500	137.6	7:39	128.8	7:16	113.3	6:33	103.1	5:54	98.8	5:35
3000	163.3	9:16	153.0	8:47	134.7	7:55	122.7	7:07	117.6	6:43
3500	188.4	10:57	176.6	10:21	155.6	9:18	141.8	8:22	135.8	7:53
4000	213.0	12:40	199.6	11:57	176.0	10:43	160.4	9:38	153.6	9:04
4500	236.9	14:27	222.1	13:36	195.9	12:10	178.5	10:55	171	10:15
5000	260.2	16:17	244.0	15:17	215.4	13:38	196.1	12:14	187.8	11:29

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)				
	400	500	600	700	800
20	-3.0	-1.6	0.0	4.8	13.4
40	-6.4	-3.2	0.0	9.2	24.3
60	-9.8	-4.9	0.0	13.2	34.3
80	-13.2	-6.5	0.0	17.0	43.2
100	-16.6	-8.2	0.0	20.4	51.2
120	-20.0	-9.9	0.0	23.6	58.3
140	-23.4	-11.6	0.0	26.4	64.3
160	-26.8	-13.3	0.0	28.9	69.4
180	-30.2	-15.0	0.0	31.1	73.5
200	-33.6	-16.7	0.0	33.1	76.6
220	-37.0	-18.4	0.0	34.7	78.8
240	-40.3	-20.2	0.0	36.0	80.0
260	-43.7	-21.9	0.0	37.0	80.2
280	-47.1	-23.6	0.0	37.8	79.5

1 ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	40000
880	%N1	78.6	81.4	85.6	89.7	94.0	98.9			
	KIAS	286	286	286	286	304	308			
	FF/ENG	8900	8870	8960	9150	9460	9950			
840	%N1	77.2	80.1	84.2	88.3	92.6	97.3			
	KIAS	280	280	280	280	297	300			
	FF/ENG	8460	8430	8500	8650	8910	9290			
800	%N1	75.8	78.6	82.7	86.9	91.2	95.7	101.9		
	KIAS	272	272	272	272	289	292	297		
	FF/ENG	8030	8000	8040	8160	8370	8680	9350		
760	%N1	74.3	77.1	81.2	85.4	89.8	94.1	99.7		
	KIAS	263	263	263	263	282	285	289		
	FF/ENG	7600	7560	7590	7680	7860	8130	8670		
720	%N1	72.7	75.6	79.6	83.9	88.3	92.5	97.6		
	KIAS	255	255	255	255	274	277	280		
	FF/ENG	7170	7140	7160	7220	7370	7590	8000		
680	%N1	71.1	73.9	78.1	82.2	86.6	90.8	95.7		
	KIAS	246	246	246	246	266	268	272		
	FF/ENG	6760	6720	6740	6780	6900	7060	7370		
640	%N1	69.2	72.2	76.3	80.5	85.0	89.2	93.8	100.3	
	KIAS	238	238	238	238	258	260	263	267	
	FF/ENG	6340	6310	6320	6350	6440	6560	6800	7330	
600	%N1	67.3	70.4	74.6	78.7	83.2	87.5	91.9	97.6	
	KIAS	231	231	231	231	249	251	254	257	
	FF/ENG	5950	5910	5910	5930	6000	6070	6270	6650	
560	%N1	65.5	68.4	72.6	76.8	81.3	85.6	89.9	95.1	
	KIAS	226	226	226	226	240	242	245	248	
	FF/ENG	5560	5520	5510	5510	5560	5610	5770	6030	
520	%N1	63.4	66.3	70.6	74.8	79.3	83.6	87.9	92.7	
	KIAS	219	219	219	219	231	233	235	238	
	FF/ENG	5180	5130	5120	5100	5140	5160	5260	5470	
480	%N1	61.2	64.3	68.5	72.7	77.1	81.4	85.8	90.3	98.2
	KIAS	214	214	214	214	222	223	226	228	231
	FF/ENG	4820	4770	4740	4710	4740	4730	4790	4950	5400
440	%N1	59.1	61.9	66.1	70.4	74.7	79.1	83.5	87.9	94.9
	KIAS	207	207	207	207	212	214	215	218	221
	FF/ENG	4460	4400	4360	4320	4350	4330	4330	4440	4790

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight - Two Engines Inoperative

Chapter PI Section 24

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
880	851	296	12600	11000	9400
860	832	293	13500	11900	10300
840	813	290	14400	12800	11200
820	795	287	15300	13700	12100
800	776	283	16100	14700	13000
780	757	280	17000	15600	14100
760	737	276	17900	16500	15200
740	719	273	18900	17400	16200
720	702	269	19900	18400	17100
700	684	265	20900	19500	18000
680	663	262	22000	20700	19300
660	645	258	22900	21700	20300
640	624	255	23800	22800	21500
620	605	251	24700	23800	22600
600	585	248	25600	24900	23700
580	565	243	26400	25800	24800
560	545	240	27200	26800	25900
540	526	235	28000	27700	27000
520	504	230	29000	28600	28000
500	487	227	29700	29500	29000
480	467	222	30500	30300	29900
460	448	218	31400	31300	31000
440	428	213	32300	32200	31900

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
670	628	590	557	527	500	476	454	434	415	399
1335	1251	1177	1111	1053	1000	952	909	869	833	800
1998	1874	1764	1666	1579	1500	1429	1364	1305	1251	1201
2662	2497	2351	2221	2105	2000	1905	1819	1740	1668	1602
3328	3121	2939	2776	2631	2500	2382	2274	2175	2085	2002
3997	3748	3528	3332	3157	3000	2857	2728	2610	2501	2401
4671	4378	4119	3890	3685	3500	3333	3181	3042	2915	2799
5350	5012	4714	4449	4213	4000	3808	3633	3474	3328	3194
6038	5651	5312	5010	4742	4500	4282	4084	3904	3738	3587
6734	6297	5914	5574	5271	5000	4755	4533	4331	4146	3976

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 LB) WEIGHT AT START OF DRIFTDOWN (1000 LB)											TIME (HR:MIN)
	440	480	520	560	600	640	680	720	760	800	840	
500	18.7	20.4	21.9	23.5	25.1	26.4	28.0	29.3	30.8	32.1	33.8	1:16
1000	36.5	39.8	42.8	46.1	49.2	52.1	55.2	58.1	61.3	64.3	67.8	2:30
1500	53.5	58.4	63.0	67.7	72.4	76.8	81.4	86.0	90.8	95.5	100.6	3:44
2000	69.8	76.2	82.3	88.6	94.7	100.6	106.7	112.9	119.3	125.6	132.4	4:58
2500	85.6	93.4	100.9	108.6	116.2	123.5	131.2	138.9	146.9	154.8	163.1	6:13
3000	100.9	109.9	118.8	127.9	136.8	145.6	154.8	164.0	173.6	183.0	192.9	7:29
3500	115.6	126.0	136.2	146.5	156.8	167.0	177.6	188.4	199.4	210.4	221.8	8:46
4000	130.0	141.5	152.9	164.5	176.2	187.7	199.7	211.9	224.4	236.9	249.9	10:06
4500	143.8	156.6	169.2	182.0	194.9	207.7	221.1	234.7	248.6	262.6	277.1	11:28
5000	157.3	171.2	185.0	199.0	213.1	227.1	241.8	256.8	272.1	287.6	303.5	12:52

Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

Long Range Cruise Altitude Capability

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
900	5600	2300	
850	8500	6100	2700
800	11000	9100	6800
750	13600	11600	9700
700	16400	14400	12300
650	19100	17200	15500
600	22100	20400	18400
550	25300	23500	21800
500	28000	26900	25400
450	30200	29700	28700
400	32700	32400	31600

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)								
		10	14	17	20	23	25	27	29	31
840	%N1	99.3								
	MACH	.621								
	KIAS	345								
	FF/ENG	14463								
800	%N1	97.8								
	MACH	.609								
	KIAS	339								
	FF/ENG	13683								
760	%N1	96.4	99.6							
	MACH	.597	.636							
	KIAS	332	329							
	FF/ENG	12943	13127							
720	%N1	94.9	98.0	100.7						
	MACH	.584	.622	.654						
	KIAS	325	321	319						
	FF/ENG	12216	12329	12494						
680	%N1	93.3	96.4	98.9						
	MACH	.571	.608	.638						
	KIAS	317	314	312						
	FF/ENG	11502	11567	11671						
640	%N1	91.8	94.7	97.1	99.9					
	MACH	.558	.594	.623	.656					
	KIAS	310	306	304	302					
	FF/ENG	10805	10846	10881	11030					
600	%N1	90.1	93.0	95.3	97.9	101.0				
	MACH	.544	.579	.607	.638	.674				
	KIAS	302	298	296	294	293				
	FF/ENG	10111	10140	10126	10205	10439				
560	%N1	88.3	91.2	93.5	95.9	98.7	100.9			
	MACH	.529	.563	.591	.620	.654	.680			
	KIAS	293	290	288	285	283	283			
	FF/ENG	9417	9449	9404	9412	9550	9753			
520	%N1	86.3	89.3	91.5	93.8	96.4	98.4	100.8	104.3	
	MACH	.513	.547	.574	.603	.634	.657	.684	.713	
	KIAS	284	282	279	277	274	273	274	274	
	FF/ENG	8727	8757	8696	8665	8734	8834	9049	9338	
480	%N1	84.2	87.2	89.5	91.7	94.1	95.9	97.9	100.4	
	MACH	.495	.530	.556	.584	.614	.636	.660	.687	
	KIAS	274	272	270	268	265	264	263	263	
	FF/ENG	8045	8060	8014	7941	7962	8016	8113	8324	
440	%N1	82.0	85.0	87.2	89.5	91.8	93.4	95.3	97.3	99.9
	MACH	.476	.511	.537	.564	.593	.613	.636	.660	.688
	KIAS	263	262	261	258	256	254	253	252	252
	FF/ENG	7385	7370	7330	7246	7239	7254	7293	7385	7574

Intentionally
Blank

Performance Inflight - Gear Down

Chapter PI
Section 25

GEAR DOWN

Takeoff Climb Limit

Based on engine bleed for 3 packs on and anti-ice off

Weight (1000 LB)

AIRPORT OAT (°F)	AIRPORT PRESSURE ALTITUDE (FT)												
	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
130	621	595	562										
120	663	639	616	588	567	537							
110	703	681	658	633	609	585	559	527					
100	745	723	698	673	648	623	598	571	541	512	485		
90	790	768	741	715	689	663	636	609	583	557	530	499	466
80	814	802	785	759	732	705	677	648	620	592	566	537	506
70	817	810	800	785	769	748	719	688	657	629	601	572	543
60	817	810	800	789	777	763	746	728	696	666	636	606	577
50	817	810	800	789	777	763	748	731	714	695	672	640	609
41 & BELOW	817	810	800	789	777	763	748	731	713	695	677	659	639

Anti-Ice Adjustments

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (LB)	
	PACKS OFF	PACKS ON
ANTI-ICE OFF	4800	0
ENGINE ANTI-ICE ON	-13400	-21300
ENGINE AND WING ANTI-ICE ON	-32900	-38000

Landing Climb Limit

Based on engine bleed for 3 packs on and anti-ice off

Weight (1000 LB)

AIRPORT OAT (°F)	AIRPORT PRESSURE ALTITUDE												
	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
130	710	669	665	661	601								
120	757	740	726	694	662	627	593						
110	794	780	767	744	717	681	646	617	587	552			
100	828	818	804	781	755	723	692	666	638	605	572	538	
90	844	841	833	816	790	758	727	703	678	649	621	586	553
80	844	844	842	831	815	792	762	736	710	683	656	623	594
70	844	844	842	831	820	802	782	764	738	711	706	698	692
60	844	844	842	831	820	802	785	769	753	732	713	685	660
50 & BELOW	844	844	842	831	820	802	785	769	754	734	717	694	675

Applicable for flaps 25 or 30 landing.

Anti-Ice Adjustments

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (LB)		
	3 A/C PACKS ON	1 A/C PACKS ON	A/C PACKS OFF
ANTI-ICE OFF	0	13600	20400
ENGINE ANTI-ICE ON	-12500	-800	6100

Reduce landing climb limit weight by 78150 lb when operating in icing conditions during any part of the flight with forecast landing temperature below 46°F.

GEAR DOWN

Max Climb %N1

Based on engine bleed for 3 packs on, engine and wing anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)												
	0	5	10	12	14	16	18	20	22	24	26	28	30
	240	240	240	240	240	240	240	240	240	240	240	0.60	0.60
55	97.8												
50	98.4	99.7											
45	99.0	100.3	101.0										
40	99.6	100.8	101.5	101.3	101.0								
35	100.1	101.4	102.0	101.9	101.7	102.4							
30	100.1	102.0	102.6	102.5	102.3	103.2	103.2	103.0					
25	99.4	102.6	103.2	103.1	102.8	103.7	103.9	103.6	103.6	103.4			
20	98.7	102.1	103.7	103.7	103.5	104.3	104.6	104.3	104.2	104.0	104.0		
15	97.8	101.3	104.2	104.3	104.1	105.0	105.1	104.9	105.0	104.8	104.7	104.8	
10	97.0	100.5	103.4	104.2	104.8	105.6	105.6	105.4	105.7	105.6	105.5	105.6	105.5
5	96.2	99.7	102.6	103.4	104.2	105.9	106.2	105.9	106.4	106.4	106.4	106.4	106.4
0	95.3	98.8	101.7	102.6	103.3	105.0	106.0	106.7	107.1	107.2	107.3	107.3	107.3
-5	94.5	97.9	100.8	101.7	102.5	104.2	105.1	106.0	107.4	108.2	108.2	108.2	108.1
-10	93.6	97.0	99.9	100.8	101.6	103.3	104.2	105.2	106.6	107.8	108.9	108.9	108.9
-15	92.8	96.1	99.0	99.9	100.6	102.4	103.3	104.3	105.7	107.0	107.9	107.9	107.9
-20	91.9	95.2	98.1	99.0	99.7	101.4	102.3	103.4	104.8	106.0	106.8	106.8	106.8

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)												
	0	5	10	12	14	16	18	20	22	24	26	28	30
ENGINE ANTI-ICE ON	-0.5	-0.5	-0.6	-0.6	-0.6	-0.6	-0.6	-0.7	-0.7	-0.7	-0.8	-0.8	-0.8
ENGINE & WING ANTI-ICE ON	-0.9	-1.0	-1.2	-1.2	-1.1	-1.2	-1.2	-1.3	-1.4	-1.5	-1.6	-1.6	-1.7

GEAR DOWN

Long Range Cruise Altitude Capability

Max Climb Thrust, 100 ft/min residual rate of climb

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
880	21000	19500	18300
860	21800	20100	18900
840	22400	20800	19400
820	23000	21500	19900
800	23600	22200	20600
780	24100	22700	21200
760	24900	23500	22100
740	25600	24500	23100
720	26400	25400	24100
700	27300	26300	25000
680	28000	27200	26000
660	28800	28100	27100
640	29600	29000	28100
620	30300	29900	29100
600	31000	30600	30100
580	31700	31400	30900
560	32500	32200	31700
540	33200	33100	32600
520	34000	33900	33500
500	34800	34800	34300
480	35700	35600	35200
460	36500	36400	36100
440	37400	37300	36900

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		10	14	17	20	23	25	27	29	31	33
880	%N1	91.3	94.6	97.4	100.7						
	MACH	.488	.525	.556	.589						
	KIAS	270	270	270	270						
	FF/ENG	10408	10554	10690	10935						
840	%N1	90.5	93.7	96.3	99.5						
	MACH	.488	.525	.556	.589						
	KIAS	270	270	270	270						
	FF/ENG	10088	10206	10300	10496						
800	%N1	89.7	92.8	95.4	98.3	101.8					
	MACH	.488	.525	.556	.589	.624					
	KIAS	270	270	270	270	270					
	FF/ENG	9802	9904	9964	10102	10383					
760	%N1	88.9	92.0	94.5	97.1	100.3	103.2				
	MACH	.488	.525	.555	.585	.620	.646				
	KIAS	270	270	270	268	268	268				
	FF/ENG	9537	9626	9640	9683	9892	10184				
720	%N1	87.7	90.7	93.0	95.4	98.4	100.7	104.1			
	MACH	.480	.515	.543	.572	.605	.629	.657			
	KIAS	266	265	263	262	261	261	262			
	FF/ENG	9106	9136	9084	9078	9207	9412	9735			
680	%N1	86.1	89.2	91.4	93.8	96.5	98.6	101.2			
	MACH	.468	.503	.530	.558	.589	.613	.639			
	KIAS	259	258	257	255	254	254	254			
	FF/ENG	8571	8596	8543	8504	8565	8691	8930			
640	%N1	84.4	87.5	89.8	92.1	94.6	96.6	98.8	101.8		
	MACH	.454	.489	.516	.544	.574	.596	.621	.648		
	KIAS	251	251	250	249	247	247	247	247		
	FF/ENG	8040	8060	8013	7952	7971	8031	8185	8442		
600	%N1	82.6	85.8	88.1	90.4	92.7	94.6	96.6	99.0	102.4	
	MACH	.440	.475	.502	.530	.559	.580	.603	.628	.656	
	KIAS	243	243	243	242	240	240	239	239	240	
	FF/ENG	7511	7530	7486	7412	7411	7431	7499	7675	7950	
560	%N1	80.7	83.9	86.3	88.6	90.9	92.5	94.4	96.5	99.0	103.1
	MACH	.425	.459	.486	.514	.543	.563	.584	.608	.635	.664
	KIAS	235	235	235	235	233	232	232	231	231	232
	FF/ENG	6980	7002	6962	6887	6868	6873	6889	6970	7147	7466
520	%N1	78.6	81.8	84.2	86.7	88.9	90.5	92.2	94.1	96.3	99.0
	MACH	.410	.443	.470	.498	.526	.546	.566	.588	.613	.640
	KIAS	226	227	227	227	226	225	224	223	223	223
	FF/ENG	6450	6474	6440	6372	6341	6335	6335	6351	6439	6615
480	%N1	76.3	79.6	82.1	84.5	86.9	88.4	90.0	91.7	93.7	95.9
	MACH	.394	.426	.452	.480	.508	.528	.547	.568	.591	.617
	KIAS	217	218	218	218	218	217	216	215	215	215
	FF/ENG	5923	5946	5921	5862	5827	5812	5805	5801	5826	5898
440	%N1	73.7	77.2	79.7	82.1	84.6	86.2	87.7	89.3	91.1	93.1
	MACH	.377	.408	.433	.460	.489	.508	.528	.548	.569	.593
	KIAS	208	208	209	209	209	209	208	207	206	206
	FF/ENG	5402	5416	5406	5354	5322	5305	5287	5281	5279	5307

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
780	704	638	584	540	500	474	451	430	411	394
1586	1426	1287	1175	1082	1000	948	901	858	819	784
2418	2165	1947	1772	1627	1500	1421	1349	1283	1224	1172
3278	2923	2617	2374	2174	2000	1893	1796	1707	1627	1556
4170	3702	3300	2983	2725	2500	2365	2242	2129	2028	1938
5099	4505	3998	3600	3279	3000	2835	2685	2549	2426	2318
6068	5334	4710	4225	3836	3500	3305	3127	2966	2821	2694
7084	6192	5438	4858	4397	4000	3774	3567	3380	3213	3066
8147	7080	6182	5499	4962	4500	4241	4005	3792	3602	3434
9257	7998	6942	6148	5530	5000	4708	4442	4202	3987	3798

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
500	50.6	1:51	47.2	1:45	43.7	1:39	40.6	1:34	38.6	1:31
1000	100.2	3:45	94.3	3:31	87.8	3:19	82.0	3:08	78.4	3:00
1500	147.3	5:45	139.0	5:23	129.8	5:03	121.4	4:45	116.3	4:33
2000	191.8	7:51	181.3	7:20	169.8	6:51	159.0	6:26	152.4	6:09
2500	233.8	10:04	221.4	9:23	207.9	8:45	194.9	8:11	186.8	7:48
3000	273.5	12:25	259.3	11:33	244.1	10:43	229.0	10:00	219.6	9:31
3500	311.0	14:53	295.1	13:49	278.7	12:48	261.7	11:54	250.9	11:18
4000	346.5	17:29	329.1	16:14	311.5	15:00	292.9	13:53	280.7	13:09

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)				
	400	500	600	700	800
40	-7.6	-3.6	0.0	6.4	13.6
60	-11.9	-5.7	0.0	9.4	20.1
80	-16.1	-7.9	0.0	12.2	26.4
100	-20.3	-10.0	0.0	15.0	32.5
120	-24.5	-12.1	0.0	17.6	38.2
140	-28.7	-14.2	0.0	20.2	43.8
160	-32.9	-16.3	0.0	22.7	49.1
180	-37.0	-18.4	0.0	25.2	54.1
200	-41.2	-20.4	0.0	27.5	58.9
220	-45.3	-22.5	0.0	29.7	63.5
240	-49.3	-24.6	0.0	31.9	67.8
260	-53.4	-26.6	0.0	34.0	71.8
280	-57.4	-28.7	0.0	36.0	75.6
300	-61.4	-30.8	0.0	37.9	79.2
320	-65.4	-32.8	0.0	39.7	82.5

Descent at .66/240

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	18	28	37	41	45	49	53	57	61	65	70	73	76	80
TIME (MINUTES)	6	8	9	10	11	12	13	13	14	15	15	16	16	17

GEAR DOWN

Holding
Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
880	%N1	84.6	87.3	91.3	95.5	100.7		
	KIAS	270	270	270	270	270		
	FF/ENG	10850	10830	10930	11130	11480		
840	%N1	83.8	86.5	90.5	94.5	99.5		
	KIAS	270	270	270	270	270		
	FF/ENG	10550	10520	10590	10750	11020		
800	%N1	83.1	85.8	89.7	93.7	98.3		
	KIAS	270	270	270	270	270		
	FF/ENG	10280	10240	10290	10420	10610		
760	%N1	81.6	84.3	88.2	92.2	97.3	103.4	
	KIAS	263	263	263	263	270	270	
	FF/ENG	9740	9690	9730	9830	10250	10770	
720	%N1	79.8	82.5	86.4	90.5	96.4	101.8	
	KIAS	255	255	255	255	270	270	
	FF/ENG	9130	9080	9100	9180	9930	10350	
680	%N1	77.9	80.7	84.6	88.6	95.1	100.4	
	KIAS	246	246	246	246	266	268	
	FF/ENG	8530	8490	8500	8540	9430	9860	
640	%N1	75.9	78.8	82.8	86.8	93.2	98.2	
	KIAS	238	238	238	238	258	260	
	FF/ENG	7960	7920	7920	7950	8750	9080	
600	%N1	74.2	77.0	81.1	85.1	91.2	96.0	102.8
	KIAS	231	231	231	231	249	251	254
	FF/ENG	7470	7430	7430	7440	8090	8310	8900
560	%N1	72.4	75.3	79.4	83.4	89.3	93.9	99.6
	KIAS	226	226	226	226	240	242	245
	FF/ENG	7040	6990	6990	6990	7470	7640	8050
520	%N1	70.6	73.5	77.6	81.6	87.2	91.5	96.8
	KIAS	219	219	219	219	231	233	235
	FF/ENG	6590	6540	6530	6530	6850	6960	7230
480	%N1	68.7	71.6	75.8	79.8	85.0	89.2	94.2
	KIAS	214	214	214	214	222	223	226
	FF/ENG	6170	6120	6100	6090	6290	6330	6500
440	%N1	66.6	69.5	73.7	77.8	82.6	86.8	91.4
	KIAS	207	207	207	207	212	214	215
	FF/ENG	5740	5680	5660	5650	5720	5730	5830

This table includes 5% additional fuel for holding in a racetrack pattern.

DO NOT USE FOR FLIGHT

Performance Inflight - Gear Down, One Engine Inop

Chapter PI
Section 26

GEAR DOWN
1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

Based on engine bleed for 3 packs on

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
880	847	266	10300	8600	6600
860	829	264	11200	9500	7600
840	810	261	12000	10400	8600
820	791	259	12900	11300	9600
800	770	256	13900	12200	10500
780	752	254	14800	13100	11500
760	734	252	15800	14000	12400
740	715	250	16800	15100	13300
720	696	248	17600	16200	14400
700	676	245	18400	17100	15600
680	656	243	19400	18100	16800
660	638	240	20500	19000	17700
640	619	237	21400	20100	18600
620	600	235	22400	21200	19800
600	582	232	23300	22200	20900
580	562	229	24100	23200	22000
560	543	227	24900	24200	23000
540	525	224	25800	25200	24100
520	505	221	26500	26100	25200
500	486	218	27300	27000	26200
480	466	215	28100	27900	27200
460	447	212	28800	28800	28200
440	429	209	29600	29600	29200

Altitude reduced by 1000 ft for additional margin.

GEAR DOWN
1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
Based on engine bleed for 3 packs on

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
880	8500	6400	3700
860	9200	7100	4700
840	9800	7800	5500
820	10400	8500	6200
800	11000	9100	6900
780	11900	9900	7600
760	13000	11000	9000
740	14100	12200	10200
720	15400	13300	11300
700	16600	14500	12500
680	17700	16000	13600
660	18700	17300	15300
640	20000	18300	17000
620	21200	19600	18100
600	22400	21000	19300
580	23500	22300	20800
560	24400	23500	22100
540	25400	24700	23400
520	26300	25800	24800
500	27200	26800	26000
480	28100	27900	27200
460	29000	28900	28400
440	30000	29900	29600

Altitude reduced by 1000 ft for additional margin.
With engine bleed for 1 pack on, increase altitude capability by 300 ft.
With engine anti-ice on, decrease altitude capability by 1900 ft.
With engine and wing anti-ice on, decrease altitude capability by 3600 ft.

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)							
		10	14	17	20	23	25	27	29
840	%N1	99.2							
	MACH	.488							
	KIAS	270							
	FF/ENG	13801							
800	%N1	98.3							
	MACH	.488							
	KIAS	270							
	FF/ENG	13367							
760	%N1	96.9	100.6						
	MACH	.481	.514						
	KIAS	266	264						
	FF/ENG	12746	12910						
720	%N1	95.3	98.8						
	MACH	.471	.502						
	KIAS	260	258						
	FF/ENG	12019	12112						
680	%N1	93.7	96.9	99.9					
	MACH	.460	.491	.516					
	KIAS	254	252	250					
	FF/ENG	11312	11362	11478					
640	%N1	92.0	95.1	97.8	101.0				
	MACH	.448	.479	.503	.530				
	KIAS	247	245	244	242				
	FF/ENG	10614	10631	10665	10860				
600	%N1	90.1	93.2	95.8	98.7	102.7			
	MACH	.435	.466	.490	.516	.545			
	KIAS	240	239	237	235	234			
	FF/ENG	9914	9920	9913	10016	10291			
560	%N1	88.2	91.3	93.7	96.4	99.7	102.9		
	MACH	.421	.452	.476	.501	.529	.549		
	KIAS	233	232	230	228	227	226		
	FF/ENG	9210	9229	9189	9200	9365	9629		
520	%N1	86.1	89.3	91.6	94.1	97.1	99.4	102.8	
	MACH	.406	.438	.462	.486	.512	.531	.552	
	KIAS	224	224	223	221	220	219	218	
	FF/ENG	8503	8542	8486	8450	8509	8659	8934	
480	%N1	83.8	87.1	89.4	91.8	94.5	96.5	99.0	102.6
	MACH	.390	.422	.446	.470	.496	.514	.533	.554
	KIAS	215	216	215	214	212	211	210	210
	FF/ENG	7794	7847	7799	7742	7734	7781	7951	8210

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time
Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
308	279	253	233	215	200	190	180	172	164	158
625	564	511	467	432	400	380	361	344	328	314
945	851	769	703	648	600	569	540	514	491	470
1268	1140	1030	940	866	800	758	720	685	653	625
1596	1433	1291	1177	1083	1000	947	899	855	815	780
1927	1727	1554	1415	1301	1200	1136	1077	1024	976	934
2263	2025	1819	1655	1519	1400	1325	1256	1194	1138	1088
2603	2325	2086	1895	1738	1600	1513	1434	1362	1298	1241
2948	2629	2354	2136	1957	1800	1702	1613	1531	1458	1393
3298	2936	2625	2378	2176	2000	1890	1790	1699	1618	1546

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT) 10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
200	19.6	0:45	18.0	0:43	16.5	0:42	15.3	0:40	14.8	0:39
400	40.6	1:30	37.8	1:25	35.3	1:21	33.5	1:17	33.0	1:15
600	61.1	2:15	57.3	2:08	53.7	2:01	51.2	1:55	50.5	1:51
800	81.2	3:01	76.4	2:51	71.7	2:42	68.4	2:34	67.5	2:28
1000	100.9	3:47	95.1	3:35	89.3	3:23	85.2	3:13	84.0	3:05
1200	120.2	4:35	113.4	4:19	106.6	4:05	101.6	3:53	100.0	3:43
1400	139.1	5:24	131.4	5:04	123.5	4:48	117.6	4:33	115.5	4:22
1600	157.5	6:13	148.9	5:51	140.0	5:31	133.3	5:13	130.7	5:00
1800	175.5	7:04	166.1	6:38	156.2	6:15	148.6	5:54	145.5	5:40
2000	193.2	7:56	182.9	7:26	172.1	6:59	163.6	6:36	159.9	6:20

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB) 400	500	600	700	800
20	-3.6	-1.8	0.0	3.8	8.2
40	-7.7	-3.7	0.0	8.3	17.4
60	-11.8	-5.8	0.0	12.6	26.2
80	-15.9	-7.8	0.0	16.8	34.8
100	-20.0	-9.8	0.0	20.7	43.0
120	-24.2	-11.9	0.0	24.4	50.9
140	-28.4	-13.9	0.0	28.0	58.5
160	-32.6	-16.0	0.0	31.4	65.8
180	-36.8	-18.1	0.0	34.5	72.7
200	-41.0	-20.3	0.0	37.5	79.4
220	-45.3	-22.4	0.0	40.3	85.7

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)					
		1500	5000	10000	15000	20000	25000
880	%N1	92.8	95.6				
	KIAS	270	270				
	FF/ENG	14560	14610				
840	%N1	92.0	94.8	99.2			
	KIAS	270	270	270			
	FF/ENG	14140	14170	14490			
800	%N1	91.2	93.9	98.3			
	KIAS	270	270	270			
	FF/ENG	13760	13770	14040			
760	%N1	89.7	92.4	96.6			
	KIAS	263	263	263			
	FF/ENG	13000	13000	13200			
720	%N1	87.9	90.6	94.6	99.5		
	KIAS	255	255	255	255		
	FF/ENG	12150	12150	12290	12610		
680	%N1	85.9	88.7	92.7	97.2		
	KIAS	246	246	246	246		
	FF/ENG	11320	11320	11430	11650		
640	%N1	83.9	86.8	90.8	95.0		
	KIAS	238	238	238	238		
	FF/ENG	10540	10530	10630	10780		
600	%N1	82.1	84.9	89.0	93.1	100.9	
	KIAS	231	231	231	231	249	
	FF/ENG	9880	9860	9940	10040	11400	
560	%N1	80.3	83.2	87.3	91.4	98.3	
	KIAS	226	226	226	226	240	
	FF/ENG	9300	9270	9320	9400	10400	
520	%N1	78.4	81.3	85.4	89.5	95.6	102.2
	KIAS	219	219	219	219	231	233
	FF/ENG	8680	8660	8690	8750	9410	10010
480	%N1	76.5	79.4	83.5	87.6	93.1	98.6
	KIAS	214	214	214	214	222	223
	FF/ENG	8110	8080	8110	8150	8550	8880
440	%N1	74.4	77.3	81.4	85.5	90.4	95.4
	KIAS	207	207	207	207	212	214
	FF/ENG	7520	7490	7510	7530	7700	7890

This table includes 5% additional fuel for holding in a racetrack pattern.

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Performance Inflight - Text
Chapter PI Section 27

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General

Clearway and Stopway V1 Adjustments

Takeoff speed adjustments are to be applied to V1 speed when using takeoff weights based on the use of clearway and stopway.

Adjust V1 speed by the amount shown in the table. The adjusted V1 speed must not exceed VR.

Maximum allowable clearway limits are provided for guidance when more precise data is not available.

VREF

The Reference Speed table contains flaps 30 and 25 landing speeds for a given weight. Apply adjustments shown as required.

Flap Maneuver Speeds

This table provides the flap speed schedule for recommended maneuvering speeds. Using VREF as the basis for the schedule makes it variable as a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction, selection to the next position should be initiated when at and accelerating above the recommended flap speed for the new position. During flap extension, selection of the flaps to the next position should be made prior to decelerating below the recommended flap speed for the current flap setting.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in field/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff. Data is shown for 2 engine reverse thrust and for no reverse thrust.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 0.5 inches (13mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the field/obstacle limit weight for the takeoff flap setting.

2. Enter the Weight Adjustment table with the field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.

3. Enter the VMCG Limit Weight table with the available field length and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for VMCG speed.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 3.

Takeoff speed determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Takeoff Speeds from the FMC or Takeoff Analysis.

2. If VMCG limited, set V1=VMCG. If not limited by VMCG considerations, reenter the V1 Adjustment table with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than VMCG, set V1=VMCG.

Tables for no reverse thrust are also provided in the same format.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. Good reported braking action denotes wet runway conditions or runways covered by compacted snow. Similarly, poor reported braking action denoted runways covered with wet ice. Performance is based on two symmetric reversers operating and a 15 ft. screen height at the end of the runway. The tables provided are used in the same manner as the Slush/ Standing Water tables. Data is provided for 2 engine reverse thrust and for no reverse thrust.

Tables for no reverse thrust are also provided in the same format.

Minimum Control Speeds

Regulations prohibit scheduling takeoff with a V1 less than minimum speed for control on the ground, VMCG, and VR less than minimum VR, (1.05) VMCA. Therefore, compare the adjusted V1 and VR to the VMCG and VRMIN respectively. To find VMCG and VRMIN, enter the VMCG, VRMIN table with the airport pressure altitude and actual OAT. If the adjusted V1 is less than VMCG, set V1 equal to VMCG. If the adjusted VR is less than VRMIN, set VR equal to VRMIN. If VR is less than VMCG, set VR equal to VMCG. If VR is limited by either VMCG or VRMIN, V2 must be adjusted to account for the increase in VR. This adjusted V2 speed can be obtained from the V2 for VRMIN table by entering with weight and VRMIN. If the V2 for VRMIN is greater than V2, set V2 equal to V2 for VRMIN.

Anti-skid Inoperative

When operating with anti-skid inoperative, the field length/obstacle limited weight and the V1 speed must be reduced to allow for the effect on accelerate-stop performance as detailed in the Airplane Flight Manual. Obstacle clearance capability must also be considered since the reduced V1 speed will increase the distance required to achieve a given height above the runway following engine failure at V1.

A simplified method which conservatively accounts for the effects of anti-skid inoperative is to reduce the normal runway/obstacle limited weight by the amount shown in the table below. Then, reduce the V1 associated with the reduced weight by the V1 amount shown in the table below. If takeoff weight is below the anti-skid inoperative limited weight, it is only necessary to ensure that the V1 speed does not exceed the anti-skid limited V1 speed. If the resulting V1 speed is less than the minimum ground control speed (see Minimum Control Speeds table), takeoff is permitted with V1 set equal to VMCG provided the accelerate stop distance available exceeds approximately 14700 ft.

ANTI-SKID INOPERATIVE ADJUSTMENT		
FIELD LENGTH (FT)	WEIGHT (1000 LB)	V1 (KTS)
12000	-55	-46
13000	-55	-46
14000	-55	-46
15000	-61	-45
16000	-61	-43
17000	-57	-40

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Initial Climb %N1

This table is used to set initial climb power once the takeoff segment is complete and enroute configuration is achieved (i.e. flaps up). The power settings shown are based on 200 KIAS at 1000 ft above the airport pressure altitude. Upon accelerating to the normal enroute climb speed of 340 KIAS, the power settings provided in the Max Climb table should be used. %N1 adjustments are shown for anti-ice operation.

Max Climb %N1

This table shows Max Climb %N1 for a 340/.84 climb speed schedule, normal engine bleed for 3 packs on and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. %N1 adjustments are shown for anti-ice operation.

Go-around %N1

To find Max Go-around %N1 based on normal engine bleed for 3 packs on, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. For packs off operation, apply the %N1 adjustments provided below the table. %N1 adjustments are shown for engine anti-ice operation. No %N1 adjustment is required for wing anti-ice operation.

Flight with Unreliable Airspeed / Turbulent Air Penetration

Pitch attitude and average %N1 information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration.

Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

Note that optimum altitudes shown in the table result in buffet related maneuver margins of 1.5g (48° bank) or more. The altitudes shown in the table are limited to the maximum certified altitude of 45000 ft.

Long Range Cruise Control

The table provides target %N1, Long Range Cruise Mach number, KIAS and standard day fuel flow per engine for the airplane weight and pressure altitude. The shaded area in this table approximates optimum altitude. At optimum altitude the Long Range Cruise Mach schedule is approximated by .85M.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .84/290/250 descent. Tables are presented for low altitudes and high altitudes.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with air distance from the Ground to Air Miles Conversion table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference Fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent

Distance and time for descent are shown for a .84/290/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed for the selected flap setting. Flaps 1 data is based on VREF30 + 60 speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, KIAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distance on dry runways and slippery runways with good, medium, and poor reported braking action. These values are actual landing distances and do not include the 1.67 regulatory factor. Therefore, they cannot be used to determine the dispatch required landing field length.

To use these tables, determine the reference landing distance for the selected braking configuration. Then adjust the reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers to obtain the actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice and the braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. Since it cannot be determined quickly when this becomes a factor, it is conservative to add the effects of slope and inoperative reversers when using the autobrake system.

Non-normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances are provided for dry runway and runways with good, medium, and poor reported braking action.

Enter the table with the applicable non-normal configuration and read the normal approach speed (VREF). The reference landing distance is measured from 50 ft above the threshold to stop and is based on reference weight and speed at sea level, zero wind, zero slope and max manual braking with maximum reverse thrust. Subsequent columns provide corrections for off-reference landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is independently added to the reference landing distance. Landing distance includes the effect of maximum manual braking and reverse thrust.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Recommended Brake Cooling Schedule table with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the table with the reference brake energy per brake and the type of braking used during landing (Max Manual or Max Auto). The resulting number is the adjusted brake energy per brake and represents the energy absorbed in each brake during the landing. The recommended cooling time is found in the final table by entering with the adjusted brake energy per brake. Times are provided for ground cooling and inflight gear down cooling.

Brake Temperature Monitor System (BTMS) indications are also shown. If brake cooling is determined from the BTMS, the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted, may be used to determine recommended cooling schedule by entering at the bottom of the chart. An EICAS advisory message, BRAKE TEMP, will appear when any brake registers 5 on the GEAR synoptic display and disappears as the hottest brake cools to an indication of 4. Note that even without an EICAS advisory message, brake cooling is recommended.

One Engine Inoperative

Max Continuous %N1

Power setting is based on one engine inoperative with 3 packs on and all anti-ice bleeds off. Enter the table with pressure altitude and KIAS or Mach to read %N1.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

The level off altitude is dependent on air temperature (ISA deviation). The level off altitude shown is 1000 ft below the maximum altitude. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on Long Range Cruise speed and Max Continuous thrust. Note that the maximum altitude shown has been reduced by 1000 ft. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Control

The table provides target %N1, one engine inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on three engine Long Range Cruise speed and .84/290/250 descent. Enter with Air Distance as determined from the Ground to Air Miles Conversion table and read Fuel and Time required at the cruise pressure altitude. Adjust the fuel obtained for deviation from the reference weight at checkpoint as required by entering the Fuel Required Adjustment table with the fuel required for the reference weight and the actual weight at checkpoint.

Holding

One engine inoperative holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Two Engines Inoperative

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

The level off altitude is dependent on air temperature (ISA deviation). The level off altitude shown is 2000 ft below the maximum altitude. This reduction in altitude is consistent with the FMC.

Driftdown/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to Long Range Cruise speed. Cruise is continued at level off altitude and Long Range Cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table with air distance and weight at start of driftdown to determine fuel and time required.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on Long Range Cruise speed and Max Continuous thrust. Note that the maximum altitude shown has been reduced by 2000 ft. This reduction in altitude is consistent with the FMC logic.

Long Range Cruise Control

The table provides target %N1, two engines inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight. The data is based on engine bleeds for normal air conditioning.

NOTE: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), maximum altitude, and compute overly shallow descent path. To obtain accurate ETA predictions, gear down cruise speed and altitude should be entered on the CLB and CRZ pages. Gear down cruise speed should also be entered on the DES page and a STEP SIZE of zero should be entered on the PERF INIT or CRZ page. Use of the VNAV during descent under these circumstances is not recommended.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Dimensions — Section 10

Principal Dimensions

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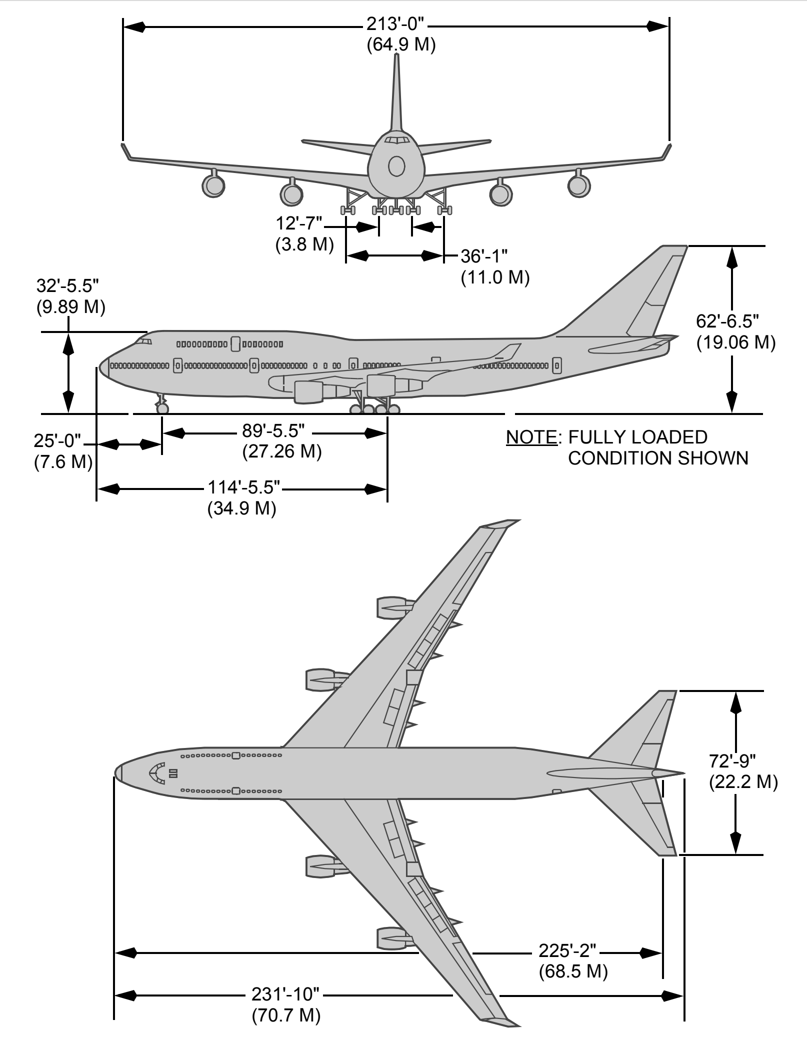

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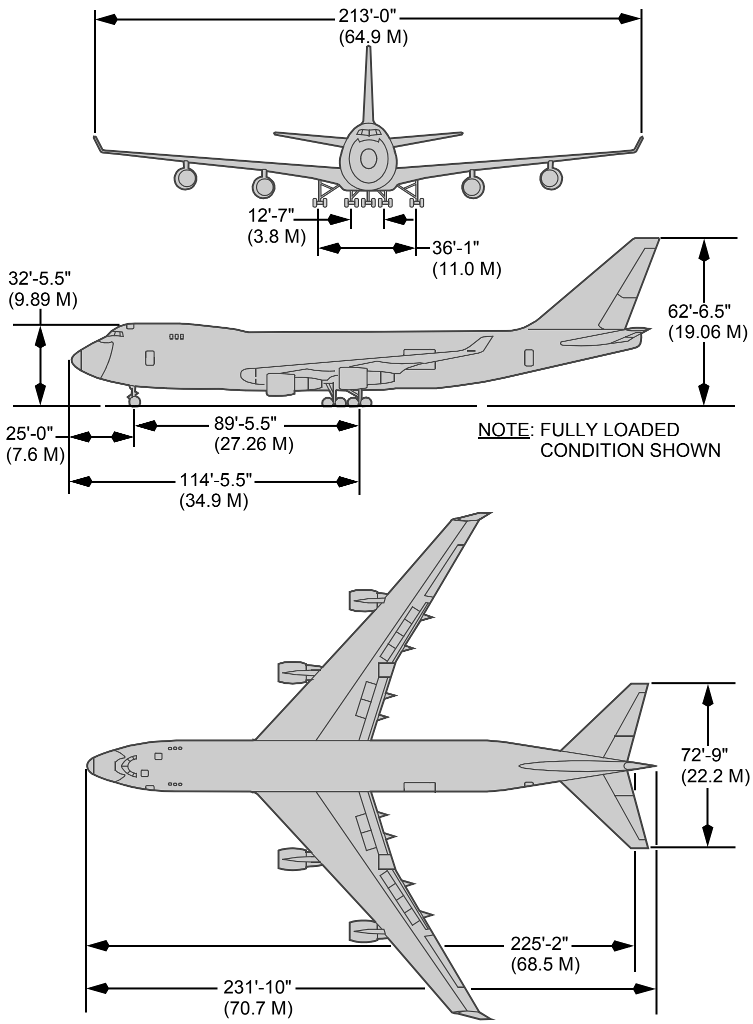
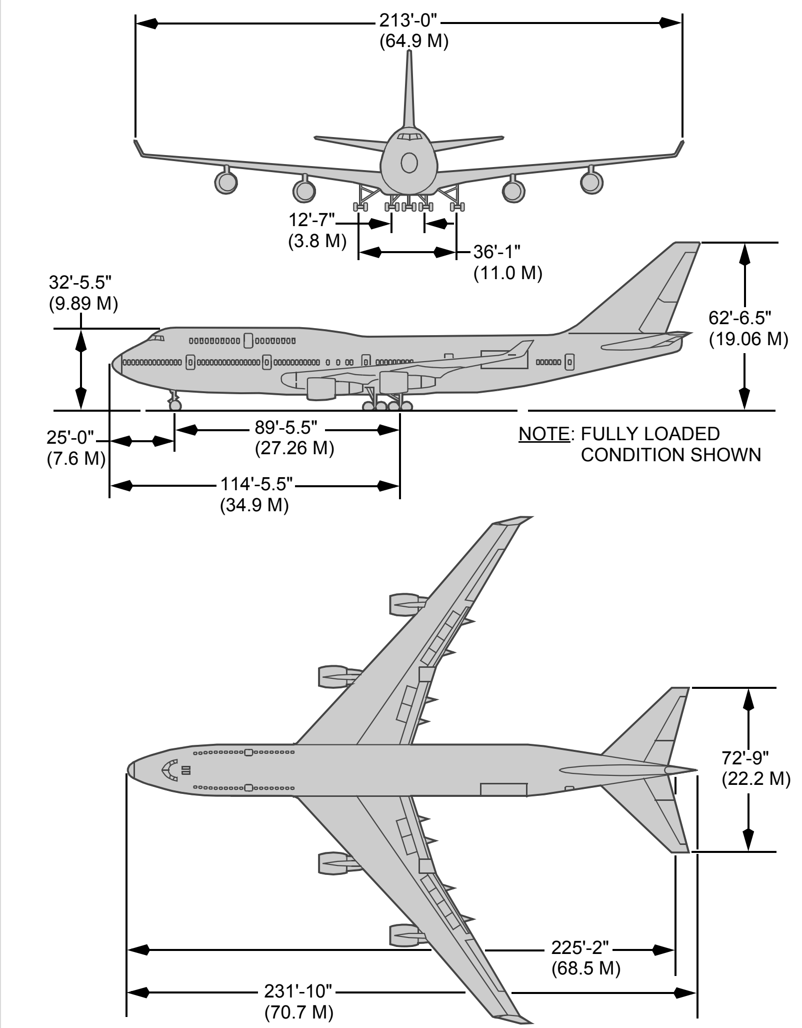

213'-0"
(64.9 M)
12'-7"
(3.8 M)
36'-1"
(11.0 M)
32'-5.5"
(9.89 M)
62'-6.5"
(19.06 M)
25'-0"
(7.6 M)
89'-5.5"
(27.26 M)
114'-5.5"
(34.9 M)
NOTE: FULLY LOADED CONDITION SHOWN
72'-9"
(22.2 M)
225'-2"
(68.5 M)
231'-10"
(70.7 M)

405


213'-0"
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12'-7"
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36'-1"
(11.0 M)
32'-5.5"
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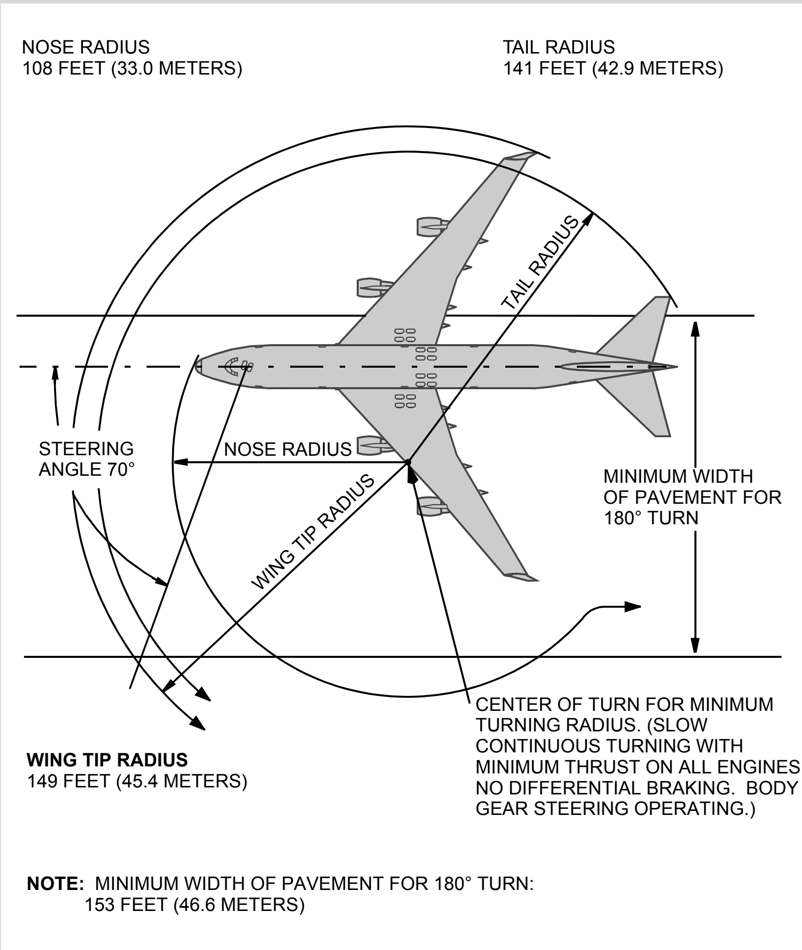
62'-6.5"
(19.06 M)
25'-0"
(7.6 M)
89'-5.5"
(27.26 M)
114'-5.5"
(34.9 M)
NOTE: FULLY LOADED CONDITION SHOWN
72'-9"
(22.2 M)
225'-2"
(68.5 M)
231'-10"
(70.7 M)

Turning Radius

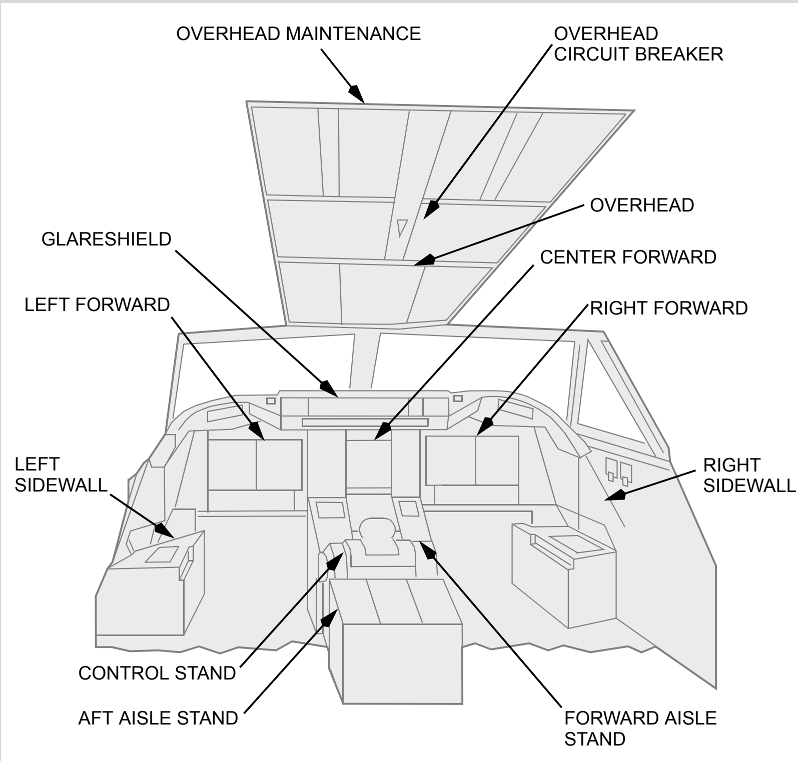
The wing tip swings the largest arc while turning and determines the minimum obstruction clearance path. All other portions of the airplane structure remain within this arc.



CAUTION: Do not attempt to make a turn away from an obstacle within (15 feet/4.6m) of the wing tip or within (56 feet/16.9m) of the nose.

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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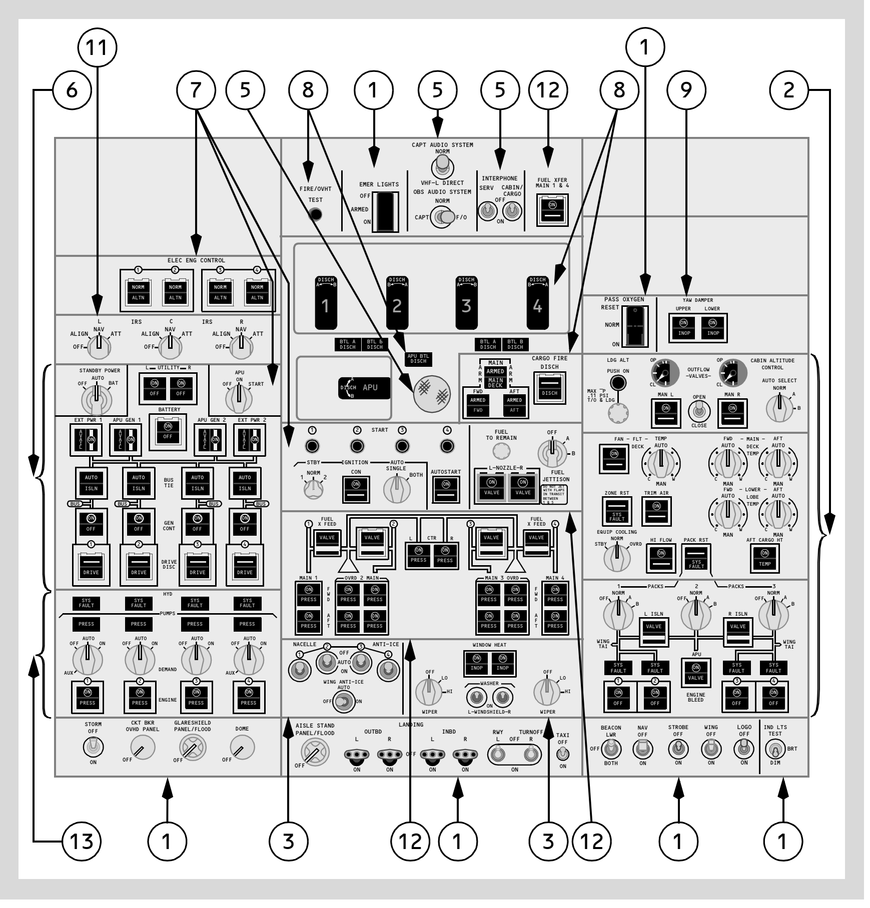
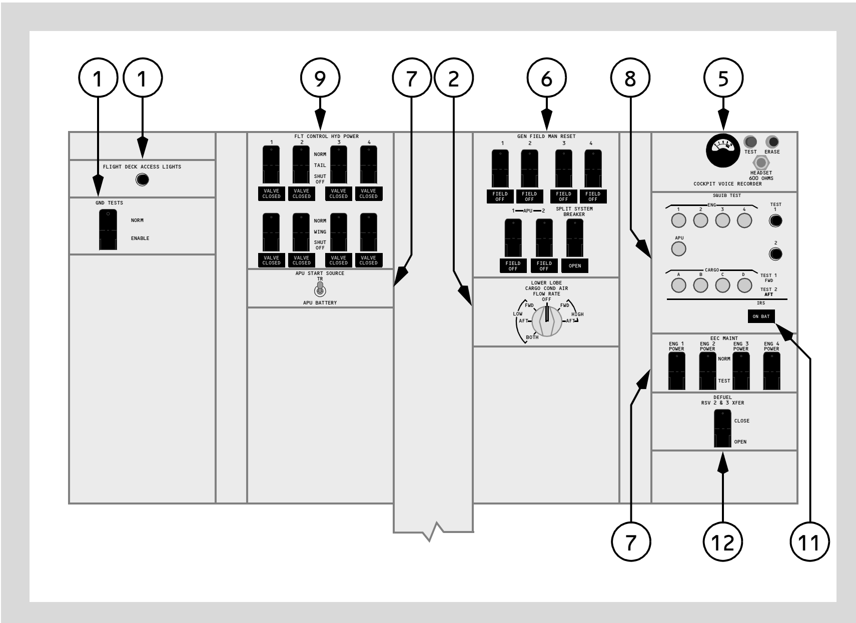
Overhead Panels

Overhead Panel

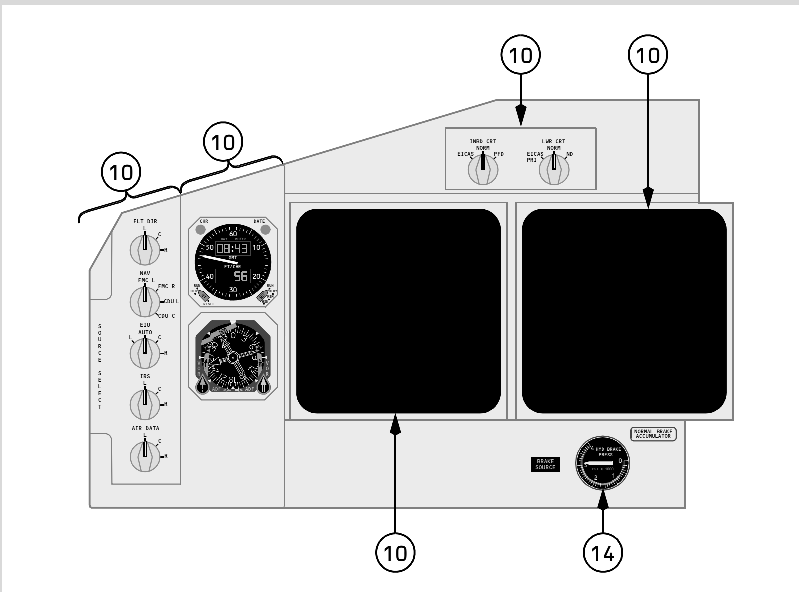


Overhead Maintenance Panel

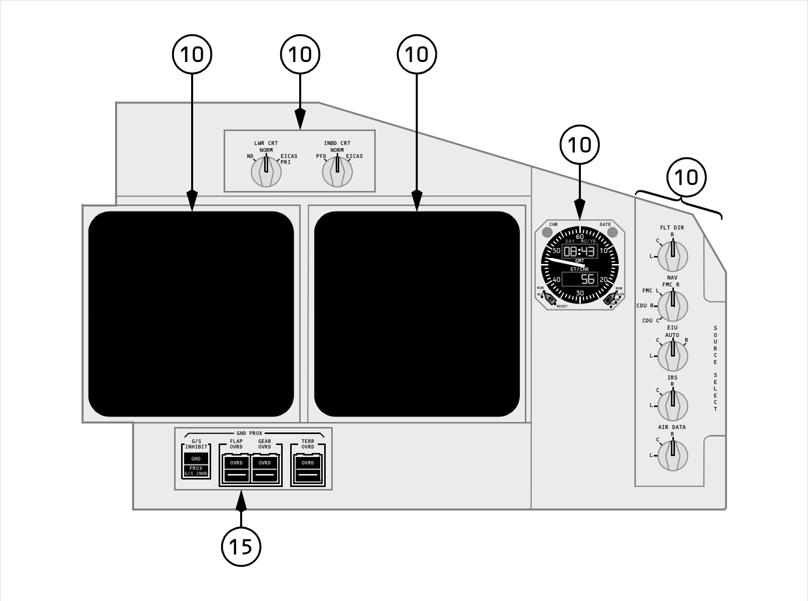


Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Inst. Panels, Forward — Section 22

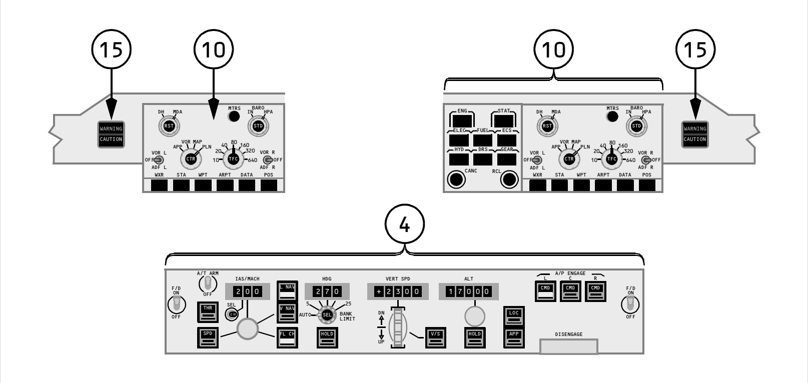
Left Forward Panel



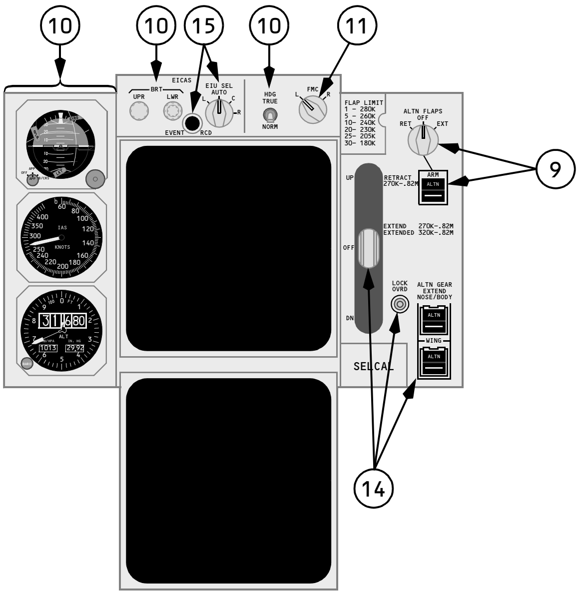
Right Forward Panel



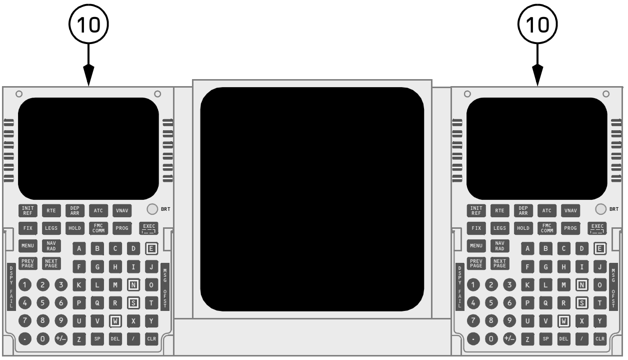
Glareshield Panel



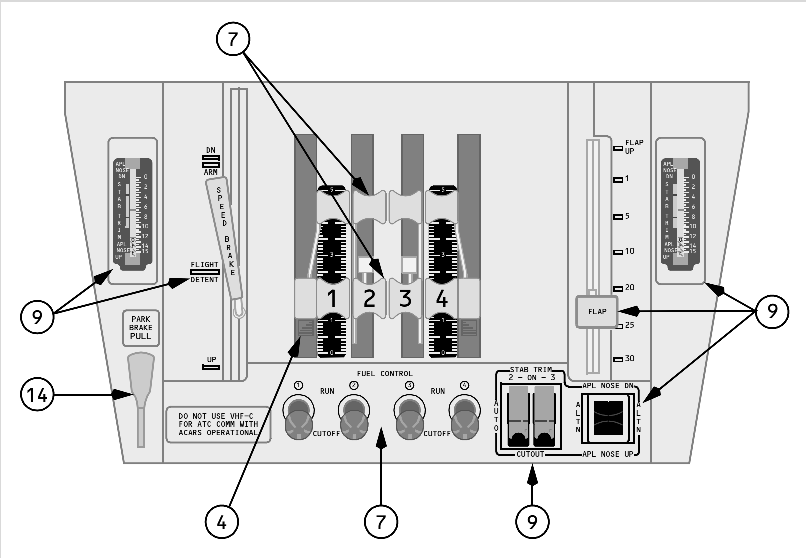
Center Instrument Panel



Forward Aisle Stand

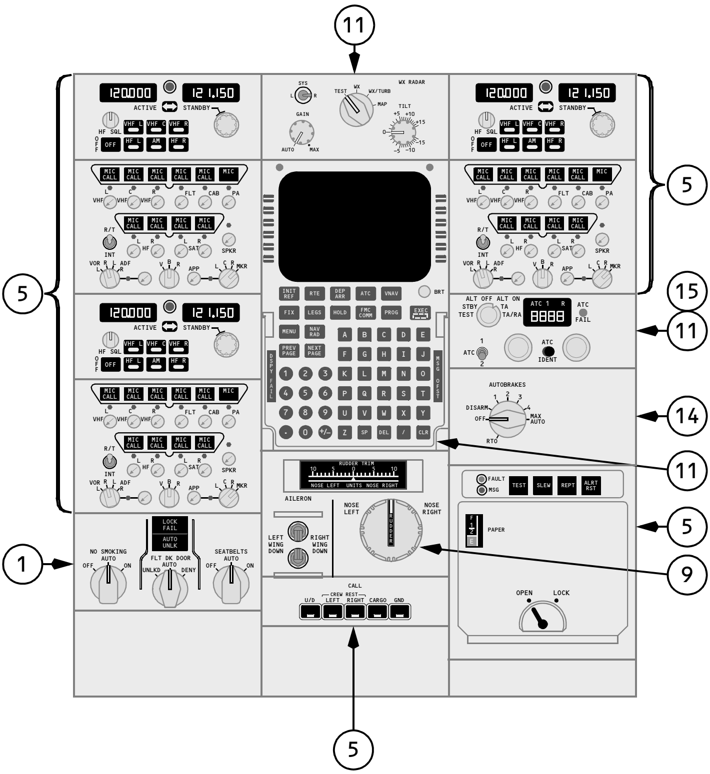


Control Stand

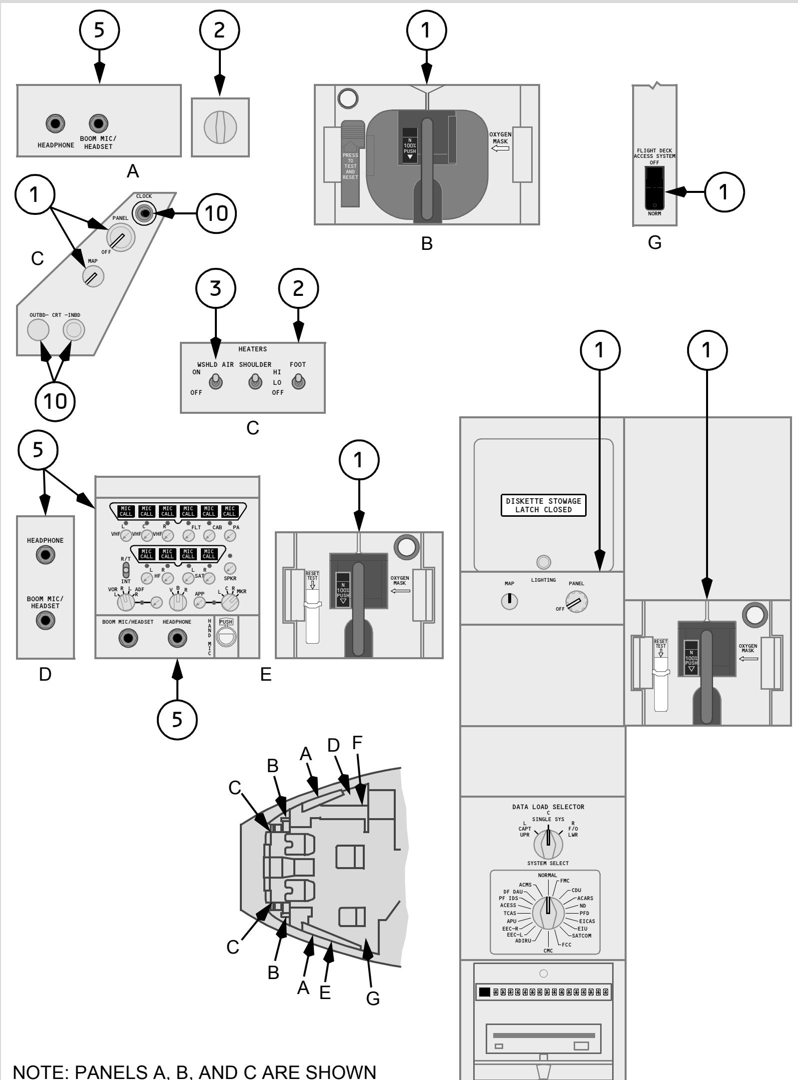


Aft Aisle Stand, Sidewall Panels

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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Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Controls and Indicators — Section 30

Push-Button Switches

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

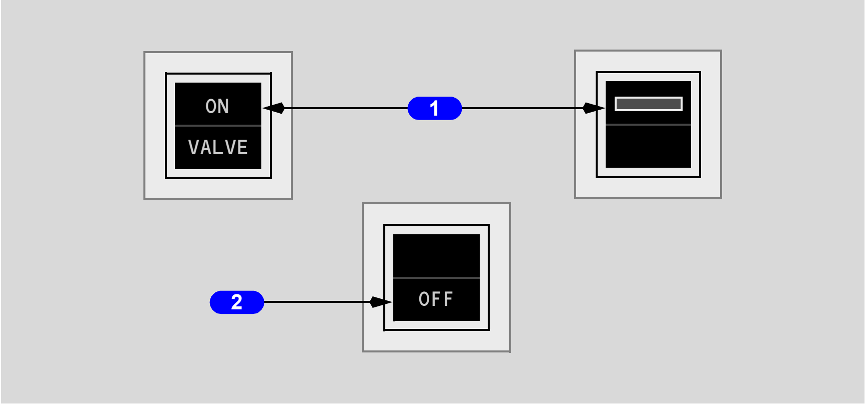
CAUTION: Flight crews should not change switch bulbs. Contact maintenance personnel whenever a bulb requires changing. Damage may result if bulbs are changed with the system powered. Switch bulb changes on the mode control panel may affect system operation in flight.

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 (for example, MAN, OFF, VALVE) may be shown in the lower half of the switch.

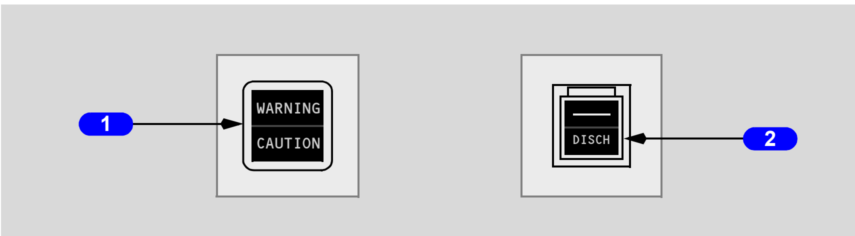
2 Switch is OFF

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.

Cabin Signs

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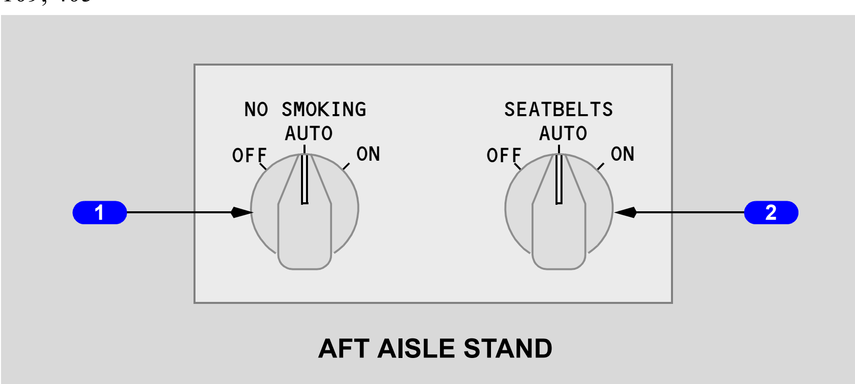

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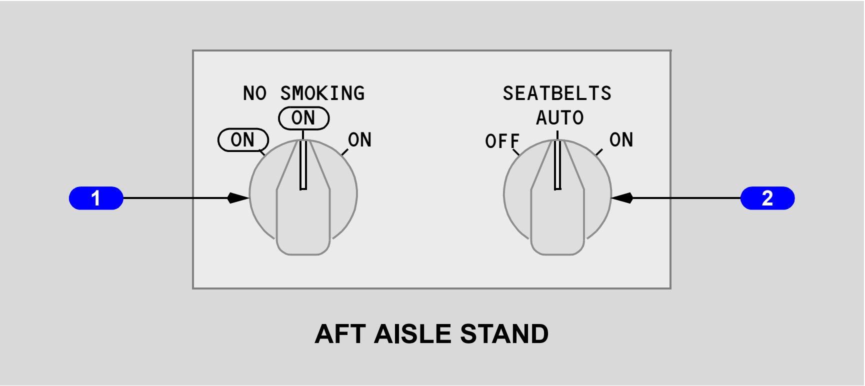

1 NO SMOKING Selector
109, 405

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.

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

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

1 NO SMOKING Selector
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Selector is inoperative. The NO SMOKING signs are illuminated when electrical power is applied to the airplane.

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.

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

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

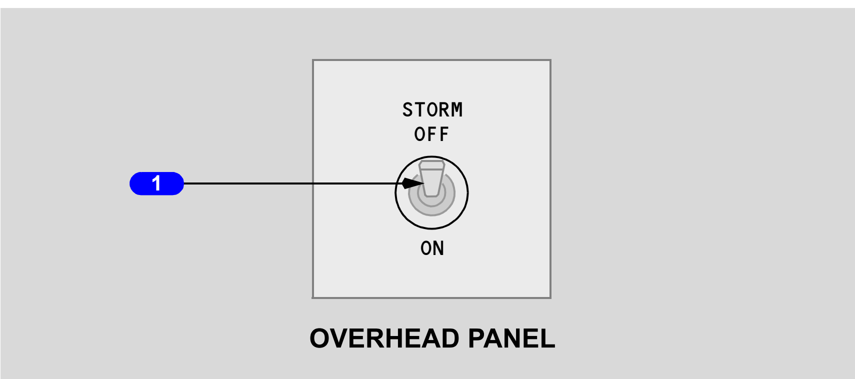
570

Note: Anytime supernumerary oxygen deploys, RETURN TO SEAT signs extinguish, regardless of selector position.

Lighting

Flight Deck Lighting

Storm Lights Switch

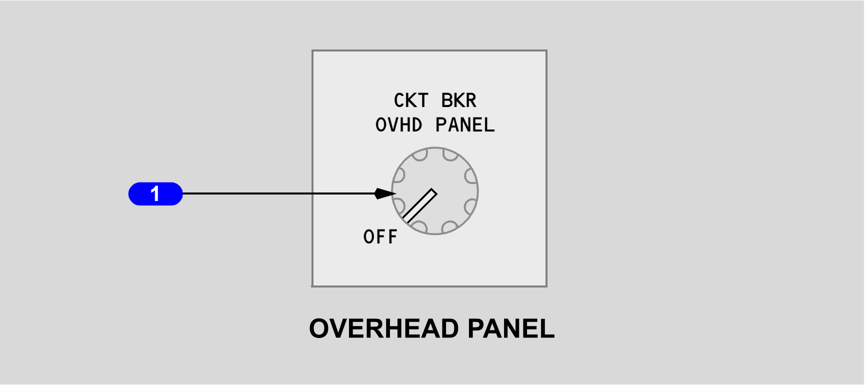


1 STORM Lights Switch

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

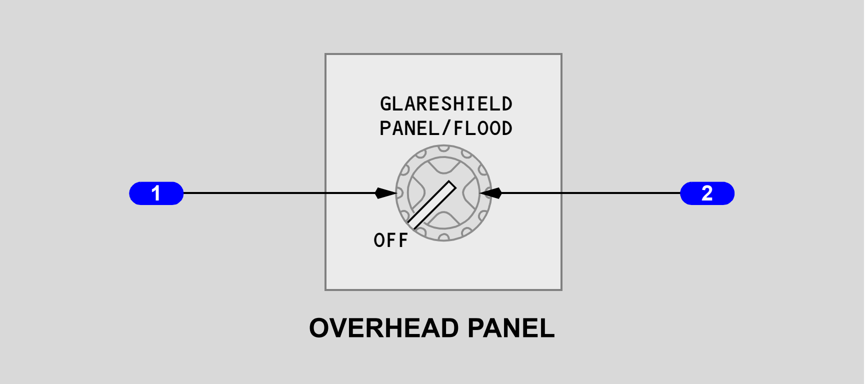
Circuit Breaker/Overhead Panel Lights Control



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

Rotate - controls circuit breaker panel and overhead panel brightness.

Glareshield Panel/Flood Lights Control



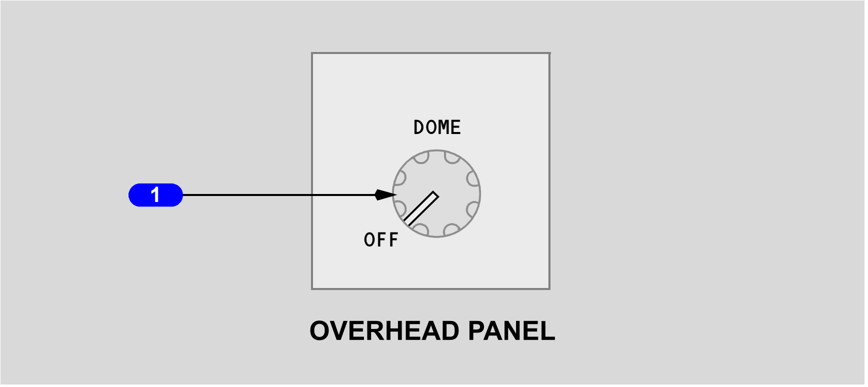
1 GLARESHIELD PANEL/FLOOD Lights Control (inner)

Rotate - controls left and right glareshield flood lights.

2 GLARESHIELD PANEL/FLOOD Lights Control (outer)

Rotate - controls glareshield panel and standby magnetic compass lights.

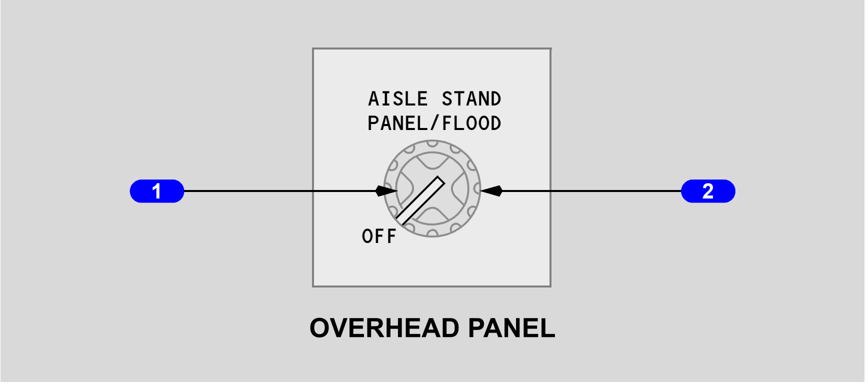
Dome Lights Control



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)

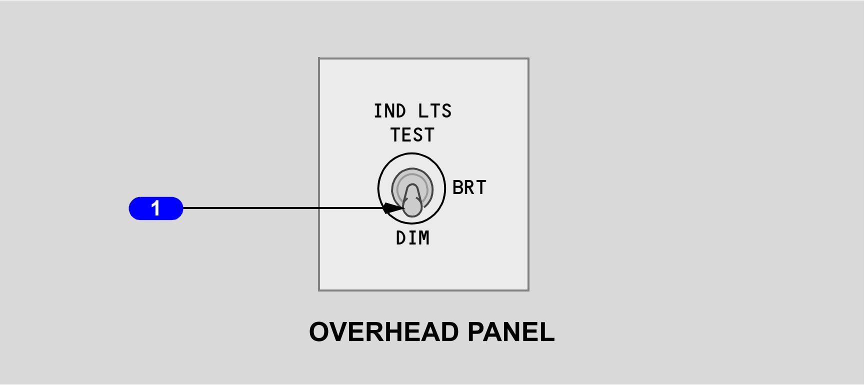
Rotate - controls aisle stand flood lights brightness.

2 AISLE STAND PANEL/FLOOD Lights Control (outer)

Rotate -

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

Indicator Lights Switch



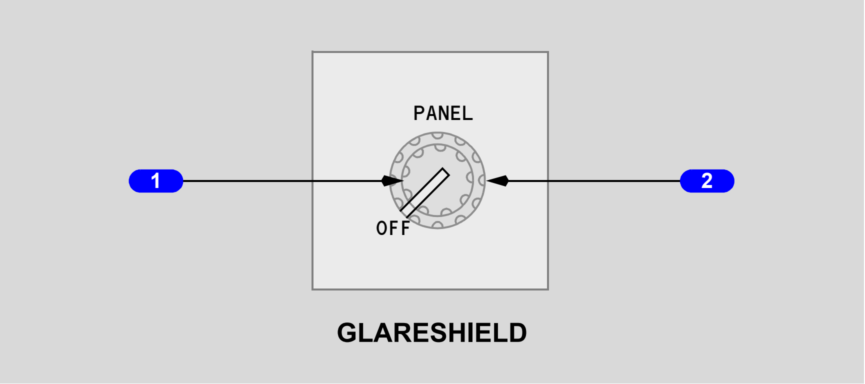
1 Indicator Lights (IND LTS) Switch

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



1 Captain’s Panels Light Controls (inner)

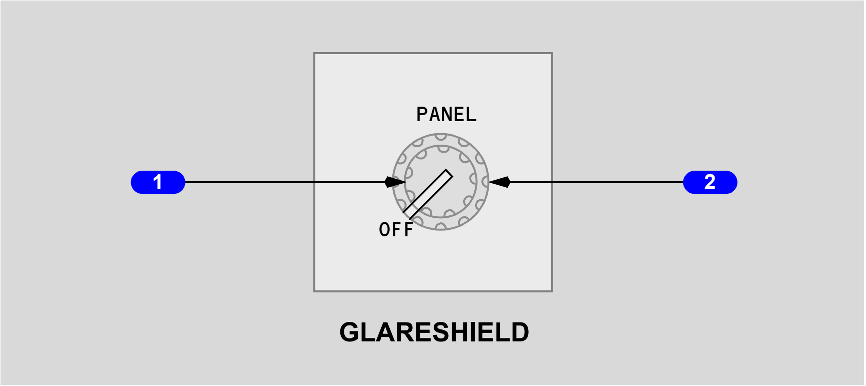
Rotate -

- 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)

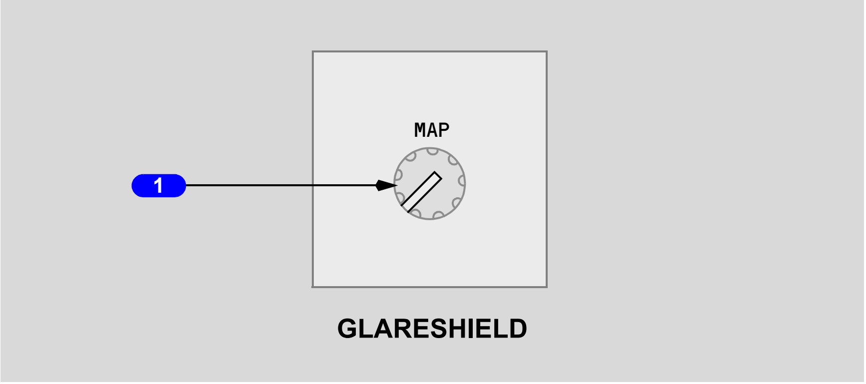
Rotate -

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

2 First Officer's Panels Light Controls (outer)

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

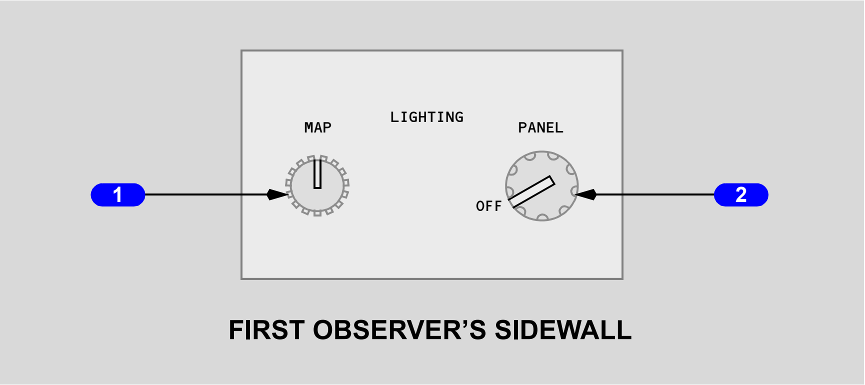
Captain's and First Officer's Map Light Controls



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

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

First Observer's Map Light Controls



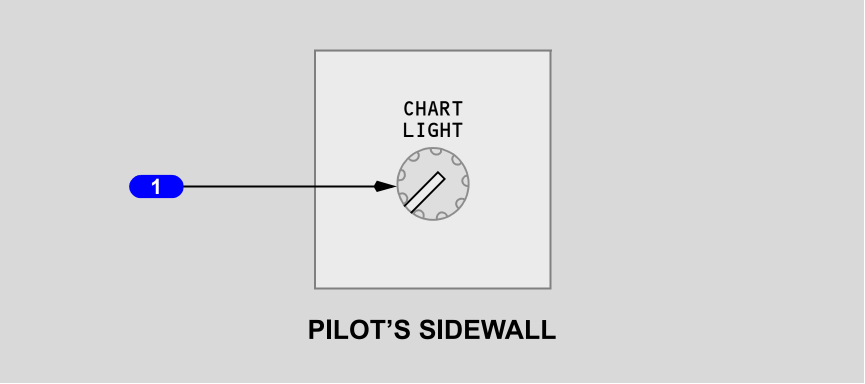
1 First Observer's MAP Light Switch

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

2 First Observer's PANEL Light Switch

Rotate - controls First Observer's panel light brightness.

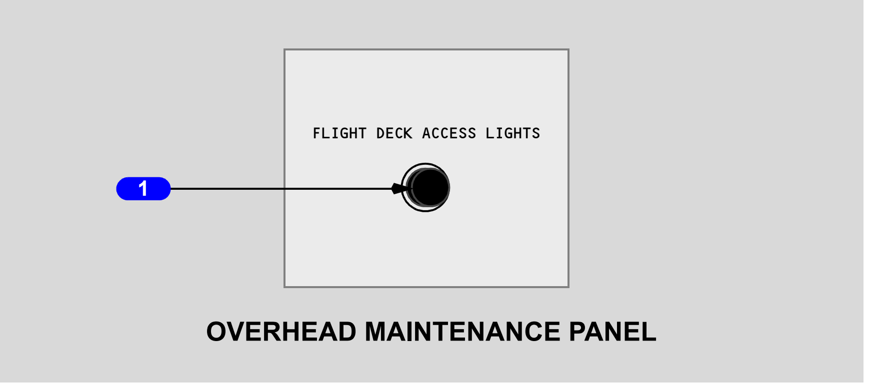
Captain's and First Officer's Chart Light Controls



1 Captain's and First Officer's CHART LIGHT Controls

Pull/Rotate - controls respective Captain's and First Officer's chart light brightness.

Flight Deck Access Lights Switches
109



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.

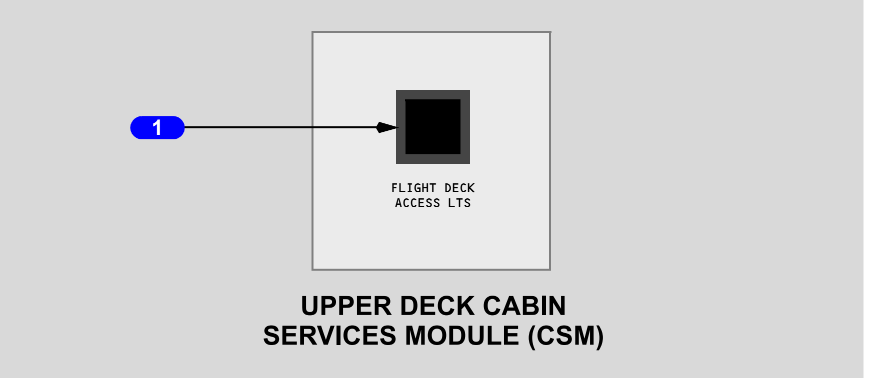
Push (any switch) - when the ground handling bus is powered, illuminates exit or entry path to or from flight deck; activates the following:

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

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

Flight Deck Access Lights Switches

405, 570



1 FLIGHT DECK ACCESS Lights (LTS) Switch

570

Additional Access Lights switches are located on the overhead maintenance panel, at Door 1 left, at the right UPPER DECK crew service door, and at the Main Equipment Center lower hatch.

405

Additional Access Lights switches are located on the overhead maintenance panel, at Door 1 left, at the forward upper deck lavatory partition, and at the Main Equipment Center lower hatch.

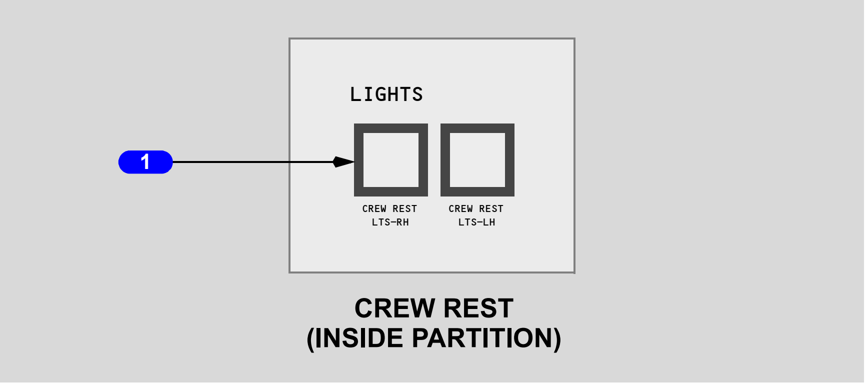
Push (any switch) - when the ground handling bus is powered, illuminates exit or entry path to or from flight deck; activates the following:

- Main Equipment Center lights
- left sidewall light forward of Door 1L
- threshold light at Door 1L
- upper deck lights above crew access ladder
- upper deck dome lights

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

Crew Rest Lights Switches

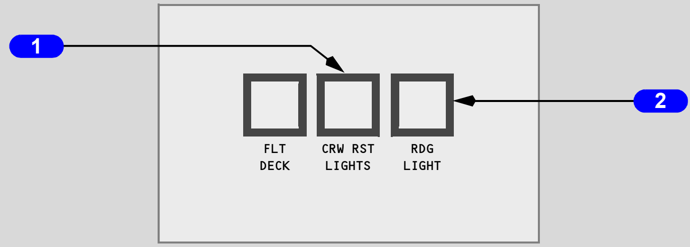
570



1 CREW REST LIGHTS Switches

Illuminated (white) - crew rest lights on respective side (left or right) extinguished.

Push - activates respective side (left or right) crew rest lights.



CREW REST
(LEFT AND RIGHT BUNKS)

1 CREW REST (CRW RST) LIGHTS Switch

Illuminated (white) - crew rest lights extinguished.

Push - activates crew rest bunk area lights.

2 Crew Rest Reading (RDG) LIGHT Switch

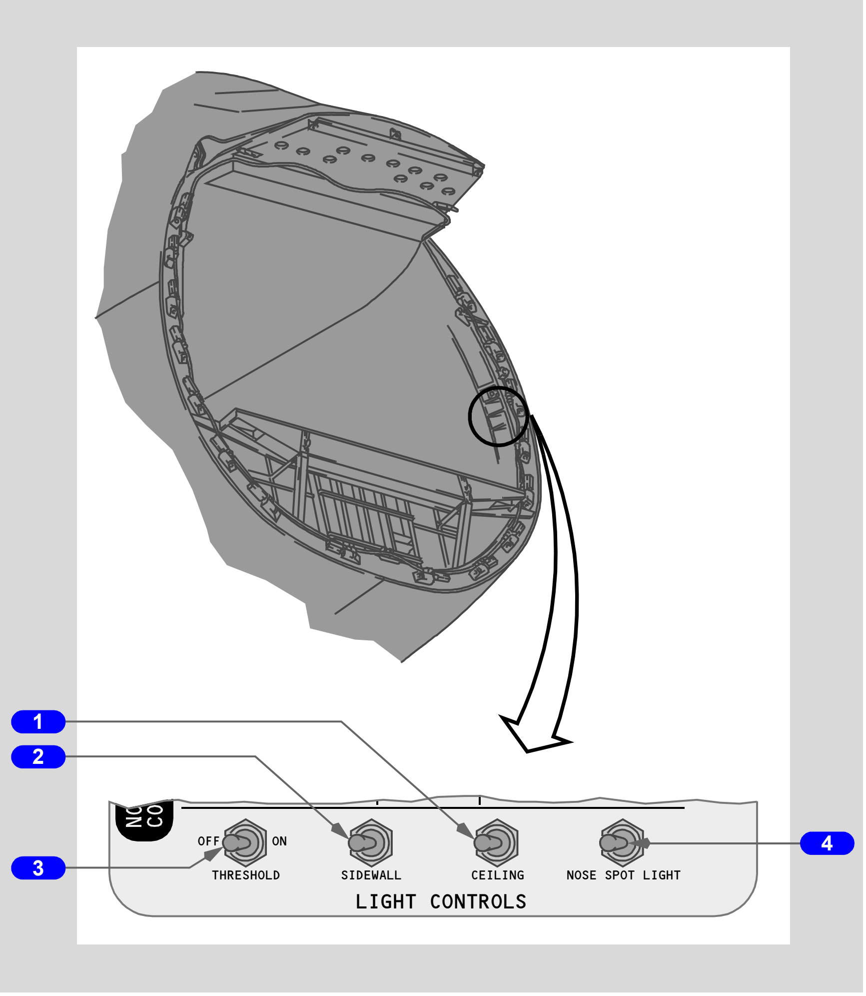
Illuminated (white) - crew rest reading lights extinguished.

Push - activates crew rest bunk area reading lights.

Nose/Cabin Light Controls

405, 570

Nose Light Controls
570



1 CEILING Light Switch

ON - illuminates ceiling lights in main deck cargo area.

2 SIDEWALL Light Switch

ON - illuminates sidewall lights in main deck cargo area.

3 THRESHOLD Light Switch

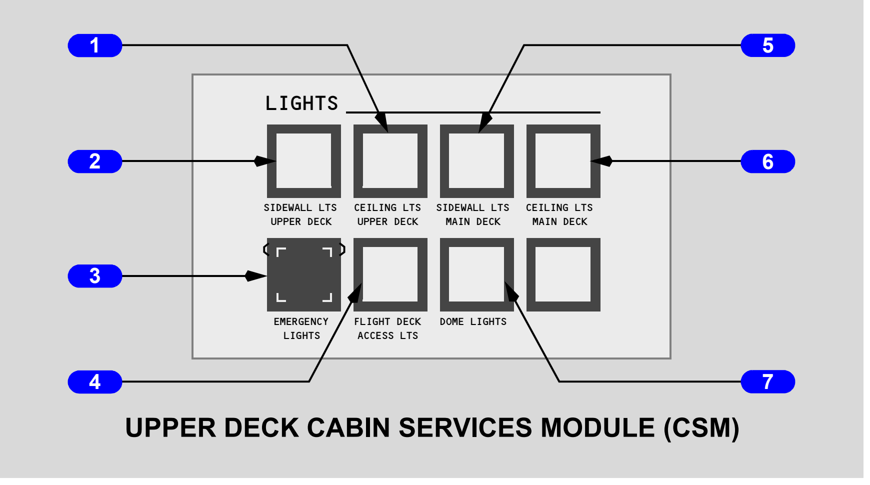
ON - illuminates two cargo loading ramp lights on nose cargo door.

4 NOSE SPOT LIGHT Switch

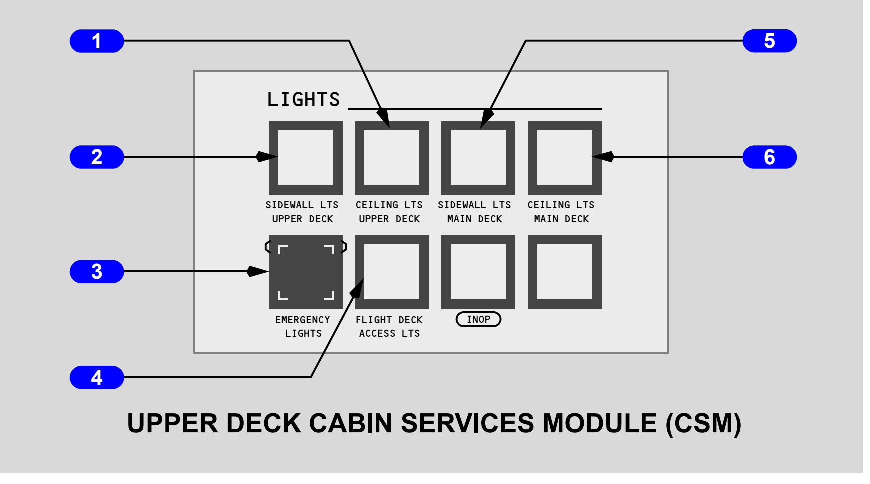
ON - illuminates nose cargo door spot light.

Cabin Light Controls

570



405



1 **CEILING Lights (LTS) UPPER DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates upper deck ceiling lights.

2 **SIDEWALL Lights (LTS) UPPER DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates upper deck sidewall lights.

3 **EMERGENCY LIGHTS Switch**

See Emergency Lighting Controls, this section.

4 **FLIGHT DECK ACCESS Lights (LTS) Switch**

See Flight Deck Access Lights, this section.

5 **SIDEWALL Lights (LTS) MAIN DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates main deck sidewall lights.

6 **CEILING Lights (LTS) MAIN DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates main deck ceiling lights.

7 **DOME LIGHTS Switch**

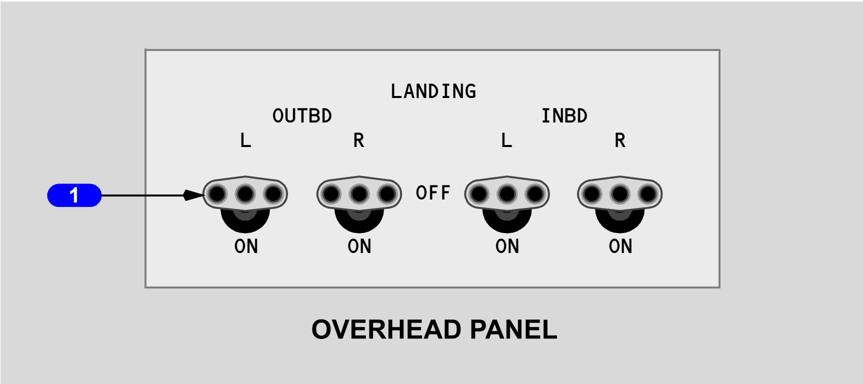
570

Illuminated (white) - confirms switch selection.

Push - activates dome light at upper deck door and ceiling dome light.

Exterior Lighting

Landing Light Switches

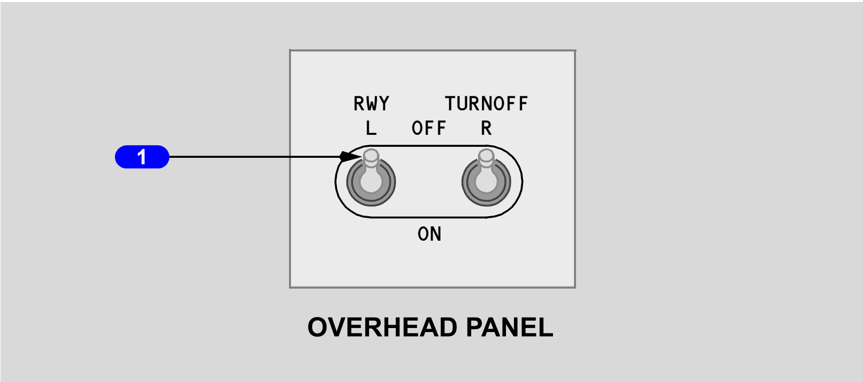


1 Outboard (OUTBD) and Inboard (INBD) LANDING Light Switches

ON (L or R)-

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

Runway Turnoff Light Switches

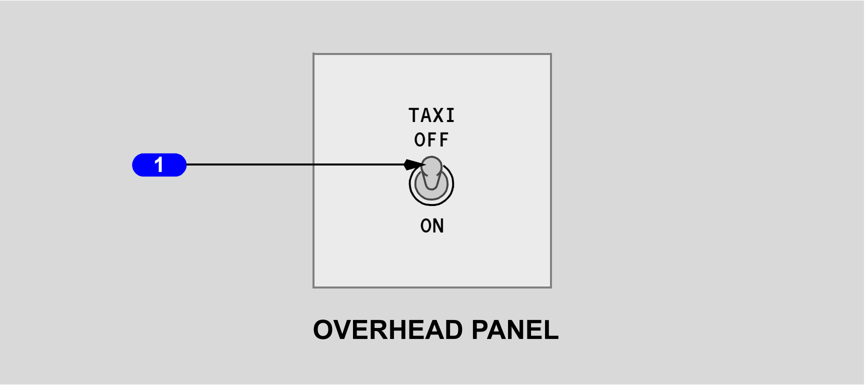


1 Runway (RWY) TURNOFF Light Switches

ON (L or R) -

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

Taxi Lights Switch

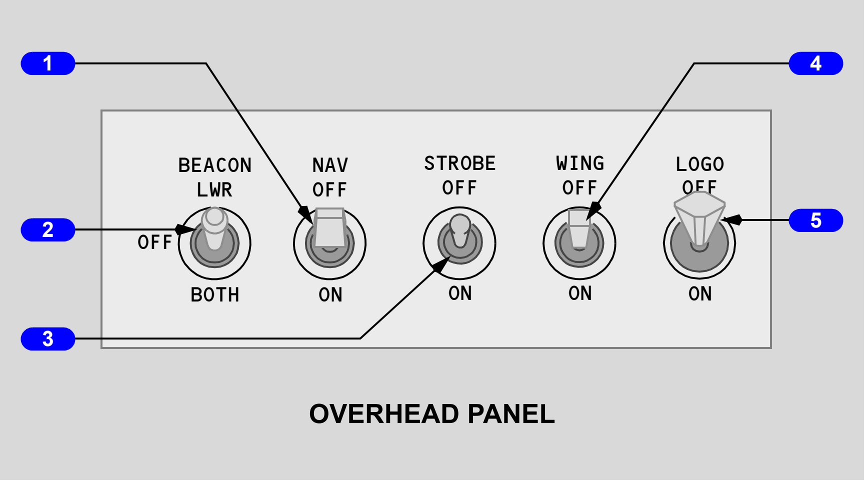


1 TAXI Lights Switch

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



1 Navigation (NAV) Lights Switch

ON - illuminates both wing and tail navigation lights.

2 BEACON Lights Switch

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

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

3 STROBE Lights Switch

ON - activates strobe lights.

4 WING Lights Switch

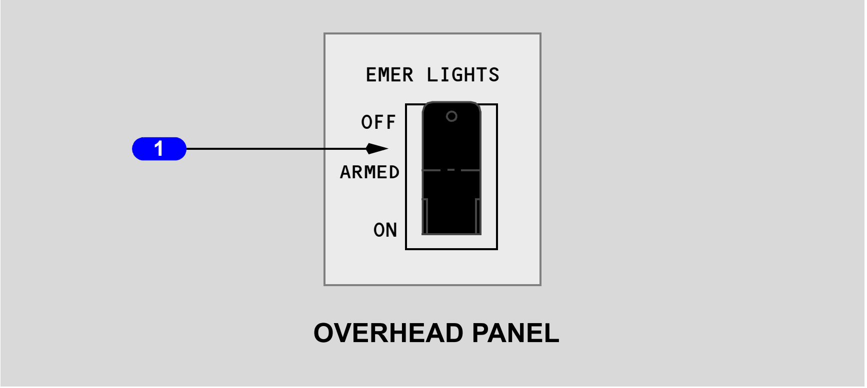
ON - illuminates wing leading edge illumination lights.

5 LOGO Lights Switch

ON - illuminates logo lights.

Emergency Lighting Controls

Flight Deck Emergency Lights Switch



1 Flight Deck Emergency (EMER) LIGHTS Switch

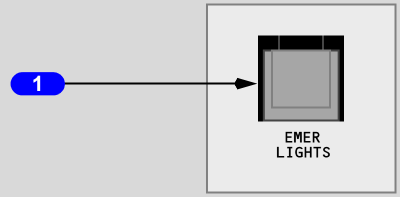
OFF - prevents emergency lights system operation if airplane electrical power fails or is turned off.

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

ON - all emergency lights illuminate.

Cabin Emergency Lights Switch

109



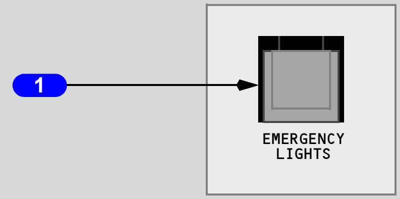
FLIGHT ATTENDANT PANEL
HANDSET CRADLE DOOR 1L

1 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

405, 570



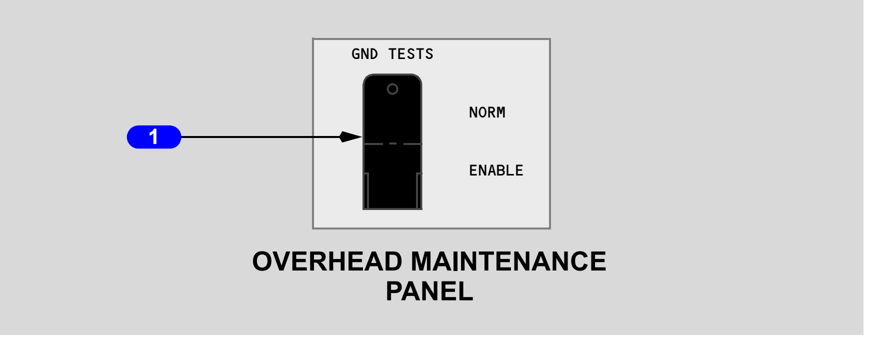
UPPER DECK CABIN
SERVICES MODULE (CSM)

1 Cabin EMERGENCY LIGHTS Switch

Push -

- Illuminated (red) -
  - exit signs, emergency aisle lights, upper deck door and door 1L sill lights, flight deck dome light, and exterior slide light illuminate
  - bypasses flight deck emergency lights switch
- Extinguished - exit signs, emergency aisle lights, upper deck door and door 1L sill lights, flight deck dome light, and exterior slide light extinguish

Ground Tests Switch



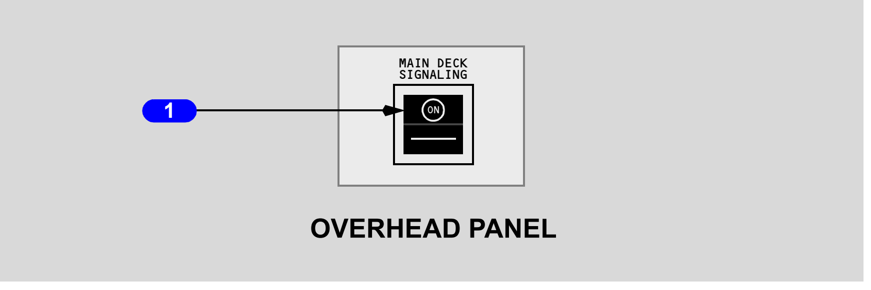
1 Ground (GND) TESTS Switch

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

NORM (Normal) - systems configured for flight.

Main Deck Signaling Switch

570



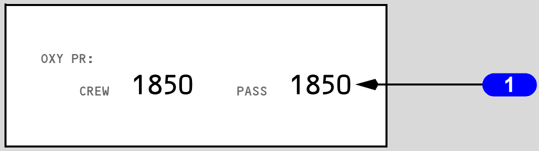
1 MAIN DECK SIGNALING Switch

Push -

- flashes main deck ceiling lights for several seconds
- ON light illuminates to indicate system activation
- ON light extinguishes after several seconds to indicate system deactivation

Oxygen Systems

Oxygen Indications



SECONDARY EICAS DISPLAY

1 Oxygen Pressure (OXY PR) Display
109

Displays crew and passenger oxygen cylinder pressure (PSI).

Note: Access is through display select panel STAT switch.

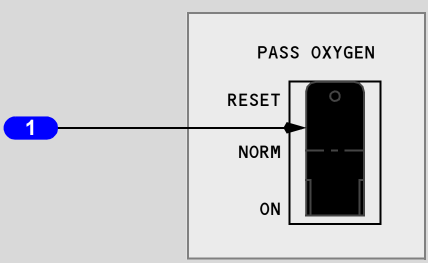
1 Oxygen Pressure (OXY PR) Display
405, 570

Displays crew and supernumerary oxygen cylinder pressure (PSI).

Note: Access is through display select panel STAT switch.

Passenger Oxygen Switch

109



OVERHEAD PANEL

1 PASSENGER (PASS) OXYGEN Switch

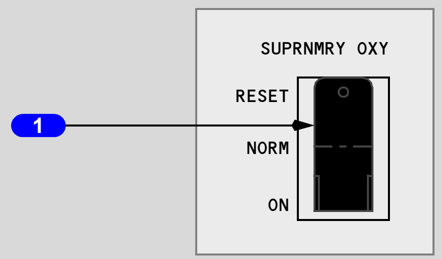
RESET (spring-loaded) - flow control units closed electrically when cabin altitude below 12,000 feet.

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

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

Supernumerary Oxygen Switch

405, 570



OVERHEAD PANEL

1 Supernumerary Oxygen (SUPRNMRY OXY) Switch

405

RESET (spring-loaded) - flow control unit closed electrically when cabin altitude below 12,000 feet.

570

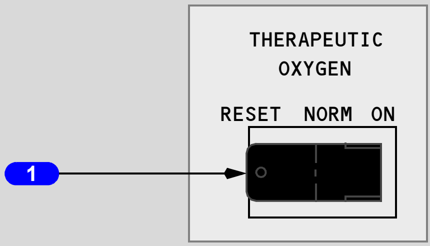
RESET (spring-loaded) - flow control unit closed electrically in lavatory and crew rest areas when cabin altitude below 12,000 feet.

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

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

Therapeutic Oxygen Switch

109



OVERHEAD PANEL

1 THERAPEUTIC OXYGEN Switch

RESET (spring-loaded) - flow control unit closed electrically if cabin altitude is below 12,000 feet.

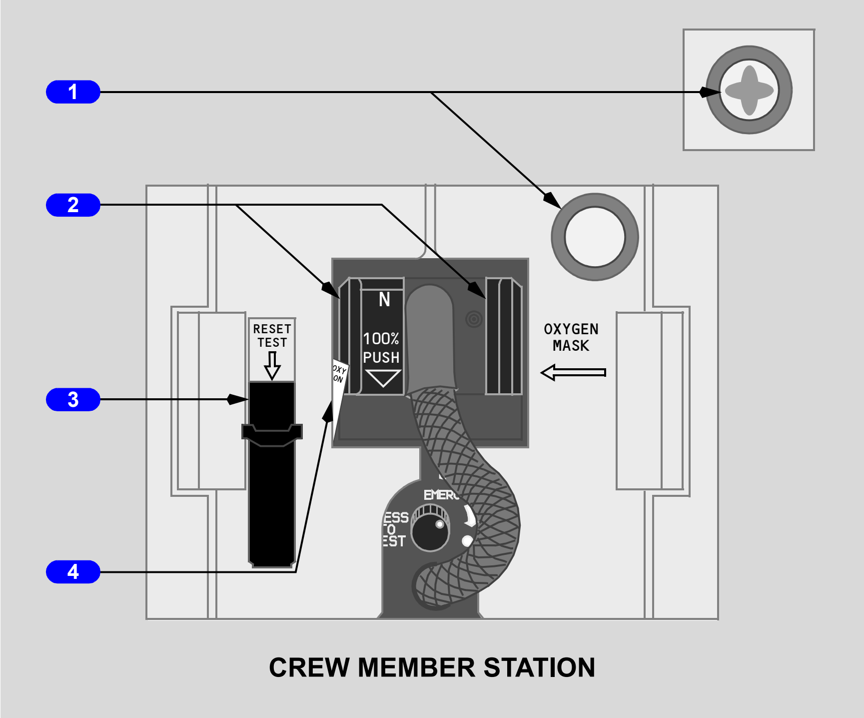
NORM - system activates when cabin altitude reaches approximately 14,000 feet.

ON - oxygen flow is provided to therapeutic oxygen outlets.

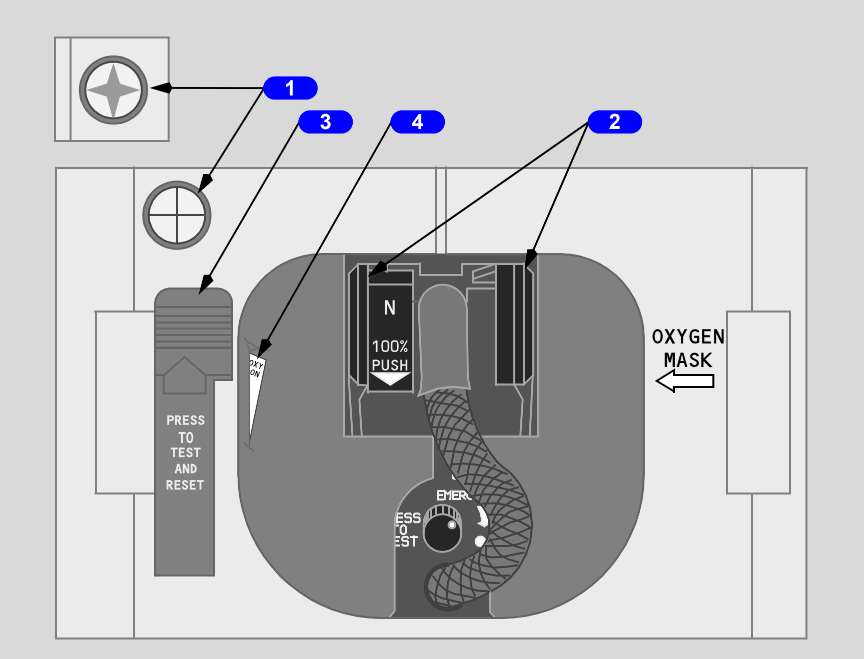
Note: At least one therapeutic oxygen mask must be connected prior to activating the therapeutic oxygen system. All therapeutic oxygen masks must be disconnected prior to resetting the therapeutic oxygen system.

Oxygen Mask Panel

570



109, 405



CRER 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 left-hand door opens, activates mask microphone

Squeeze (right lever) - inflates mask harness.

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

3 RESET/TEST Switch

Push -

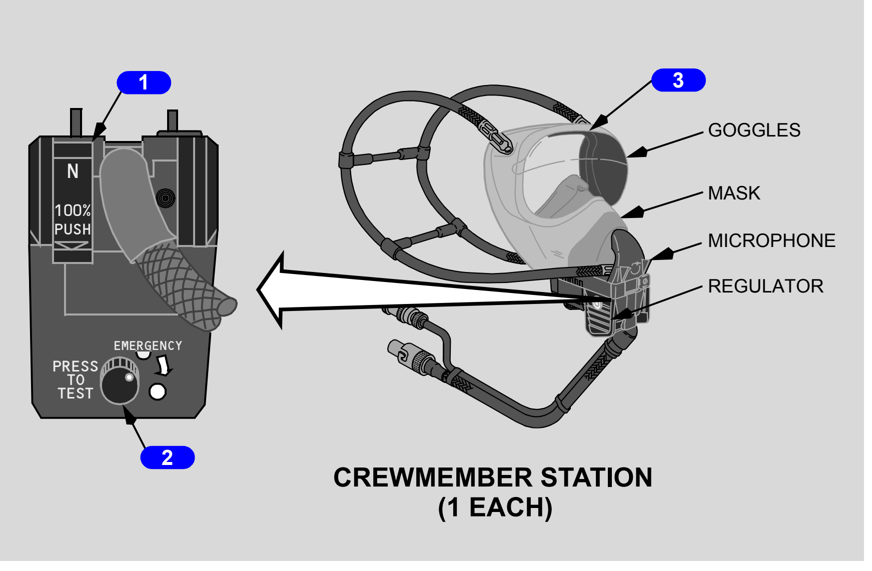
- with left oxygen panel door closed and OXY ON not displayed, turns oxygen on momentarily to test regulator
- with the left oxygen panel door closed and the OXY ON flag displayed, turns oxygen off, deactivates the mask microphone, and activates the boom microphone

4 Oxygen (OXY) ON Flag

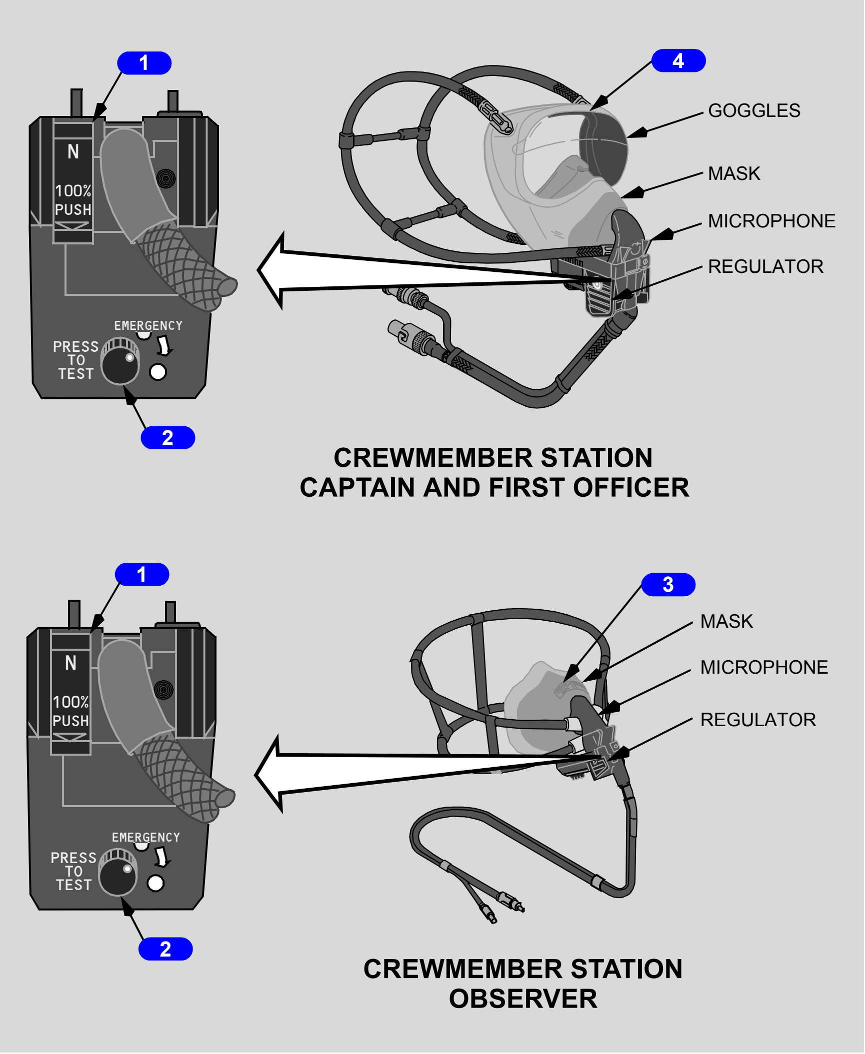
In view - oxygen is on.

Oxygen Mask and Regulator

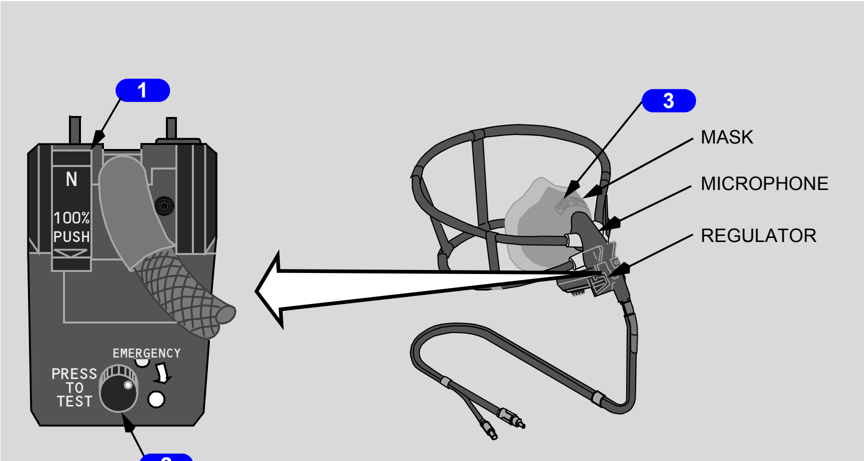
(SB changes 109 ; full-face masks installed at all crew stations)



405
(SB changes 109 ; before SB, full-face masks not installed at observer stations)



570



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.

3 Protective Strip

(SB changes 109 ; before vendor SB, oxygen mask protective strip installed)

There is a protective strip of clear plastic on the top portion of the lens. In case of condensation build-up caused by rapid depressurization, vision can be restored by peeling off this strip using the tab on the right side.

3 Observer's Smoke Vent Valve Selector

405

(SB changes 109 ; before SB, full-face masks not installed at observer stations)

Up - vent valve closed.

Down - vent valve open, allowing oxygen flow to smoke goggles.

3 **Smoke Vent Valve Selector**

570

Up - vent valve closed.

Down - vent valve open, allowing oxygen flow to smoke goggles.

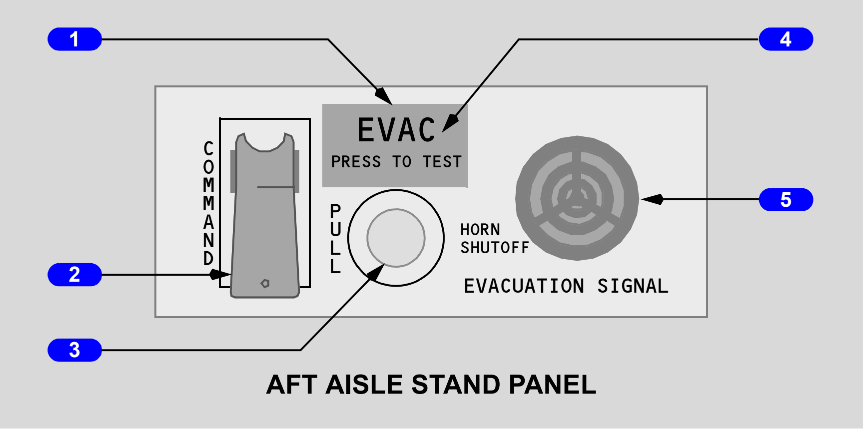
4 **Protective Strip**

109, 405

There is a protective strip of clear plastic on the top portion of the Captain's and First Officer's lens. In case of condensation build-up caused by rapid depressurization, vision can be restored by peeling off this strip using the tab on the right side.

Emergency Evacuation Panel

109



1 **Evacuation (EVAC) PRESS TO TEST Switch**

Push - tests the EVAC light.

2 **Evacuation COMMAND Switch**

ON -

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

OFF (guarded position) - allows activation of the evacuation signals from any flight attendant panel. Activation sounds the pulsating audio signal and illuminates the flashing light at the flight deck and all flight attendant panels.

3 Evacuation HORN SHUTOFF Switch

PULL - silences flight deck evacuation signal horn.

4 Evacuation (EVAC) Light

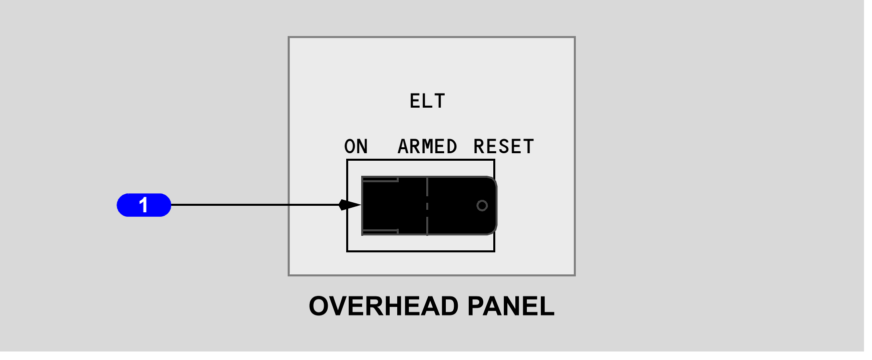
Illuminated (red) - a command switch is in the ON position.

5 EVACUATION SIGNAL Horn

Sounds an audio signal.

Emergency Locator Transmitter

405, 570



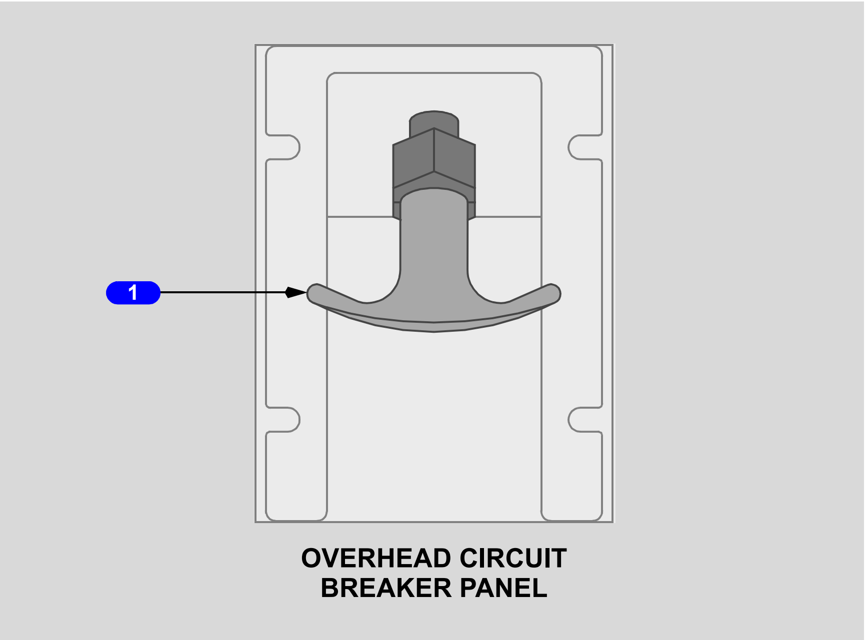
1 Emergency Locator Transmitter (ELT) Switch

ON - transmits emergency locator signal.

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

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

Smoke Evacuation Handle



1 Smoke Evacuation Handle

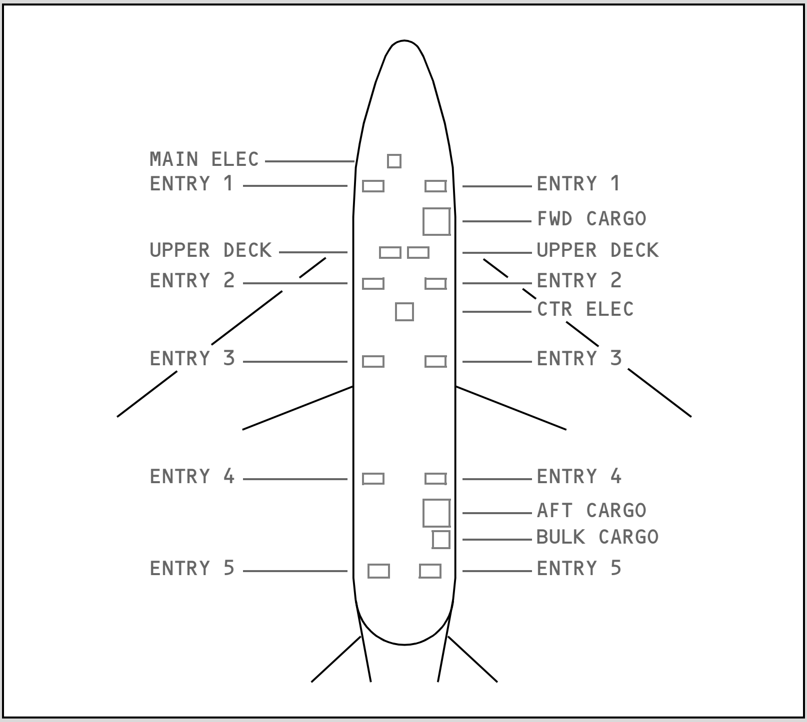
Pull -

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

Doors

Doors Synoptic Display

109



SECONDARY EICAS DISPLAY

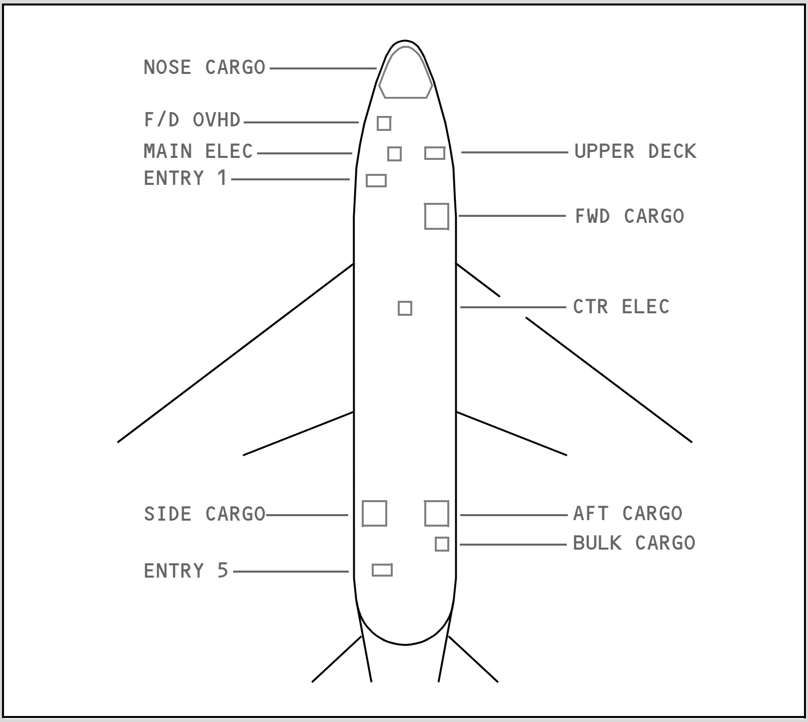
(AMBER) - DOOR OPEN
(BLANK) - DOOR CLOSED

CYAN NOMENCLATURE
DISPLAYED CONTINUOUSLY

Doors Synoptic Display

405, 570

570

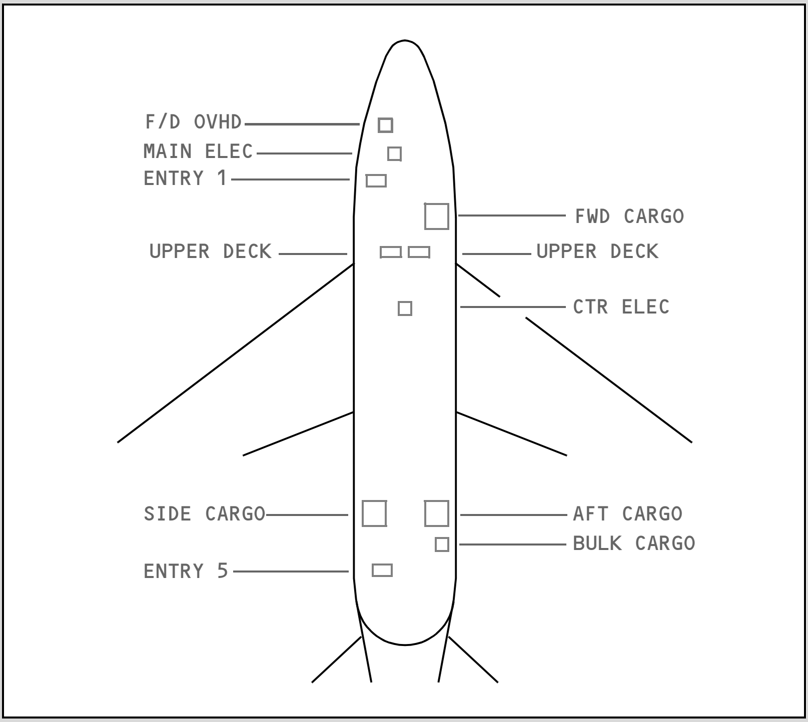


SECONDARY EICAS DISPLAY

(AMBER) - DOOR OPEN
(BLANK) - DOOR CLOSED

CYAN NOMENCLATURE
DISPLAYED CONTINUOUSLY

405



SECONDARY EICAS DISPLAY

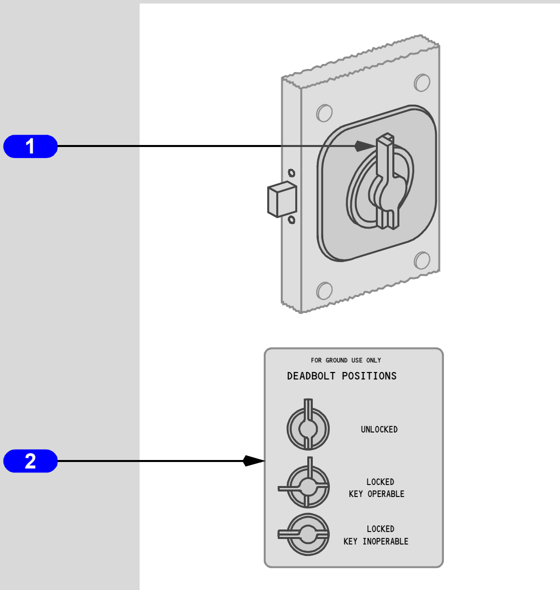
(AMBER) - DOOR OPEN
(BLANK) - DOOR CLOSED

CYAN NOMENCLATURE DISPLAYED CONTINUOUSLY

Flight Deck Door

109

Deadbolt

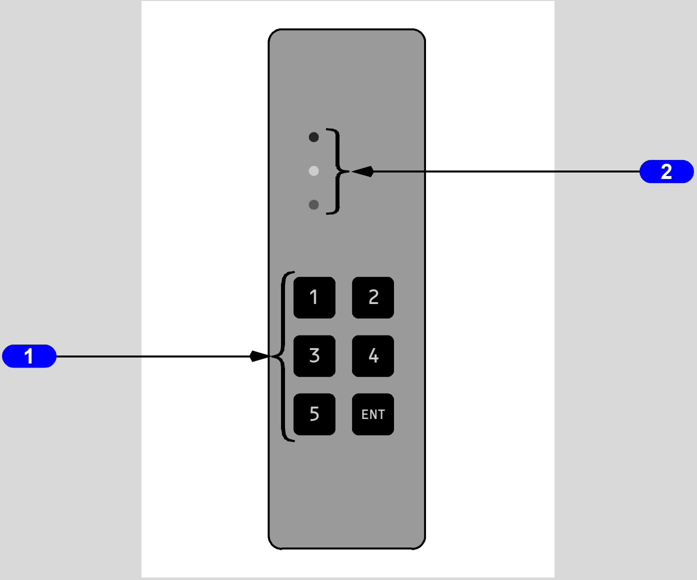


FLIGHT DECK DOOR
(TYPICAL)

1 **Deadbolt Levers**

2 **Deadbolt Positions Placard**

Flight Deck Emergency Access Panel



PASSENGER SIDE DOOR POST

1 Keypad

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

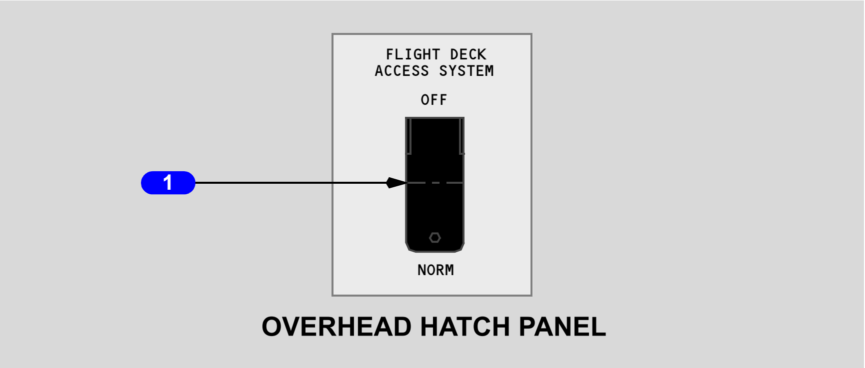
2 Access Lights

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

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlocked.

Flight Deck Access System Switch

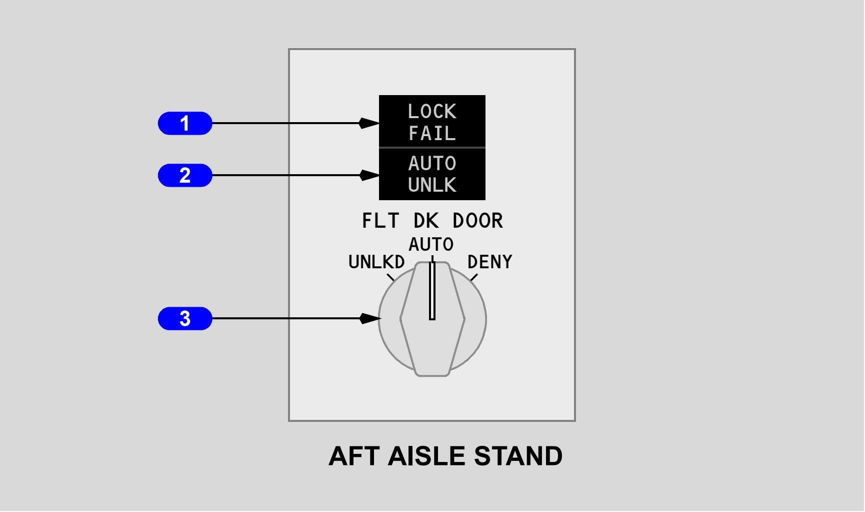


1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

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

Flight Deck Door Lock Panel



1 LOCK FAIL Light

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

2 **AUTO Unlock (UNLK) Light**

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

3 **Flight Deck (FLT DK) Door Lock Selector**

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

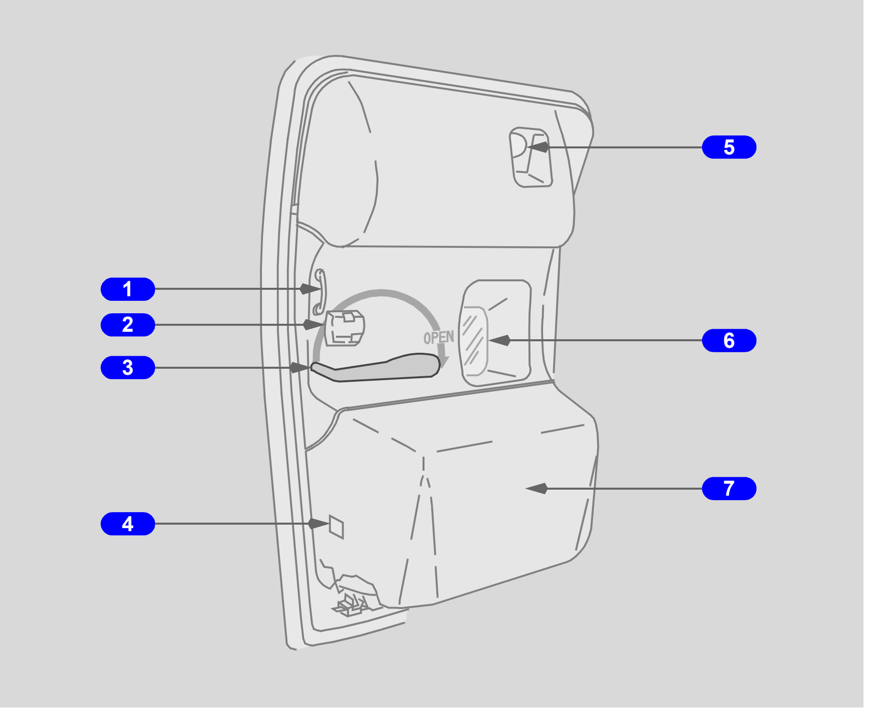
UNLKD - door unlocked while selector in UNLKD.

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

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

Passenger Entry Doors

109



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**

Maintenance use only.

5 **Escape Slide Lamp**

Illuminates escape slide if door opened in automatic mode.

6 **Viewing Window**

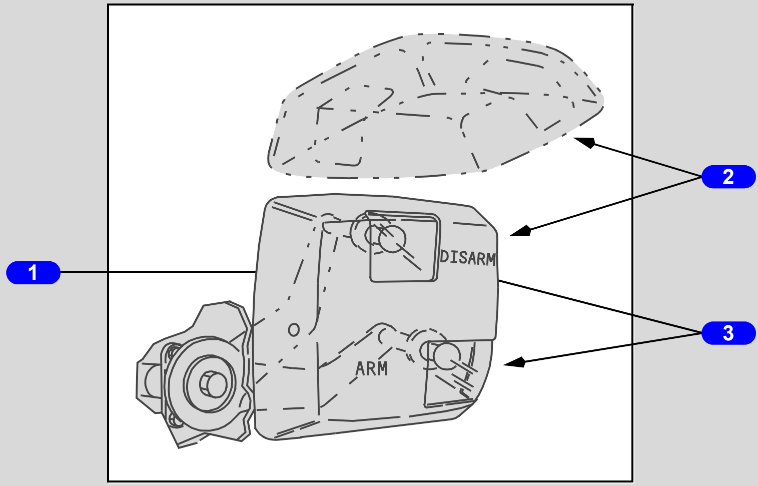
Allows observation outside the airplane.

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 DISARM. Lockout pin with warning flag may be installed. Lockout pin prevents handle movement from DISARM.



DOOR

1 Door Mode Select Lever

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

DISARM - 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.

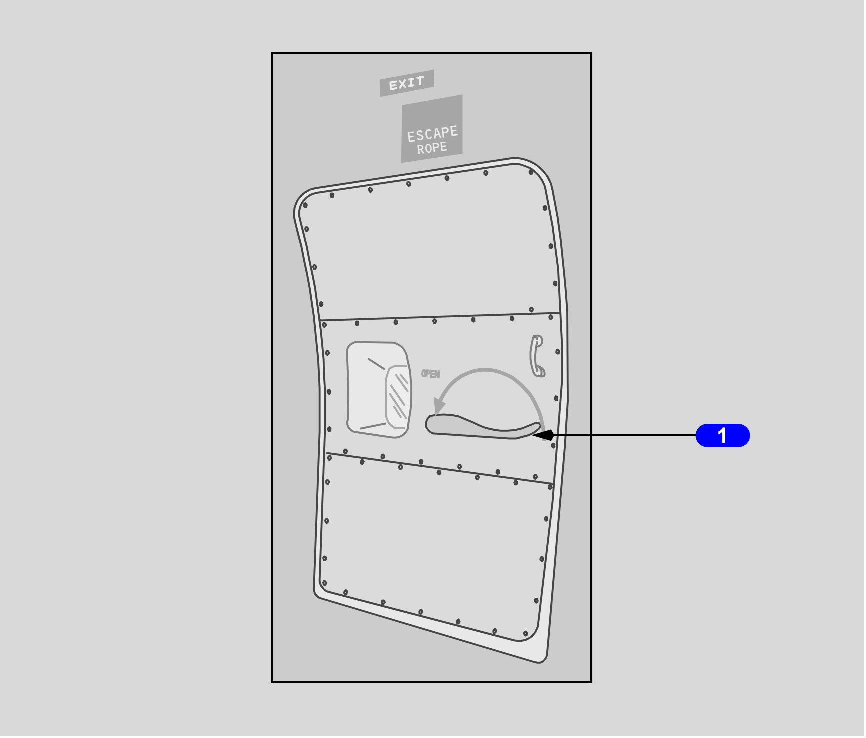
3 Clear Plastic Viewports

ARM - knob visible in viewport verifies arm mode armed.

DISARM - knob visible in viewport verifies disarm mode selected.

Main Deck Doors 1L and 5L

405, 570



1 Door Operating Handle

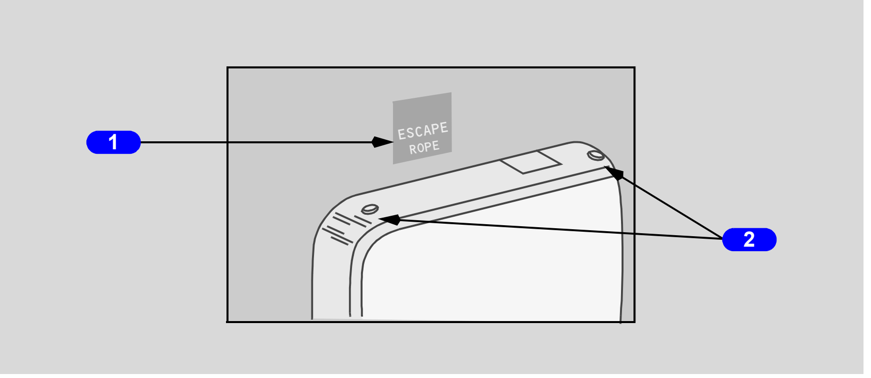
OPEN -

- unlatches door when handle rotated
- door moves inward, then outward

Close - latches door in closed position when handle rotated.

Note: Main Deck Cargo Entry Doors 1L and 5L are manually operated and have no power assist.

Threshold Lights Door 1L, and Escape Rope Doors 1L and 5L



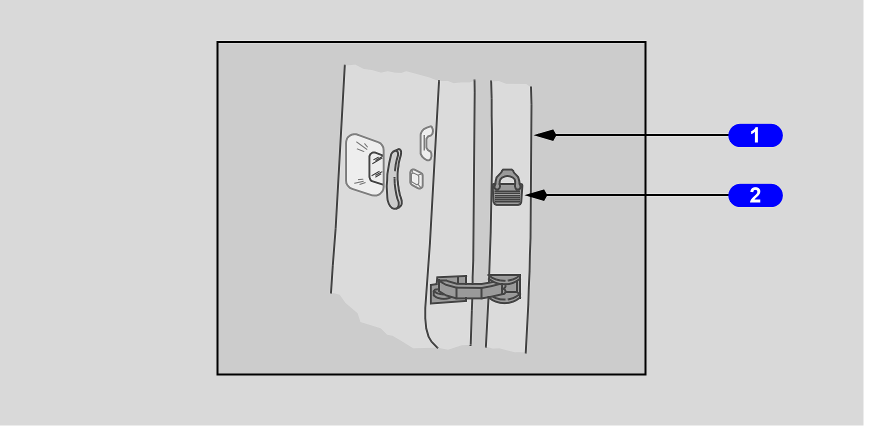
1 Escape Rope

Stowed.

2 Threshold Lights

Door 1L only.

Door Open Latch Doors 1L and 5L



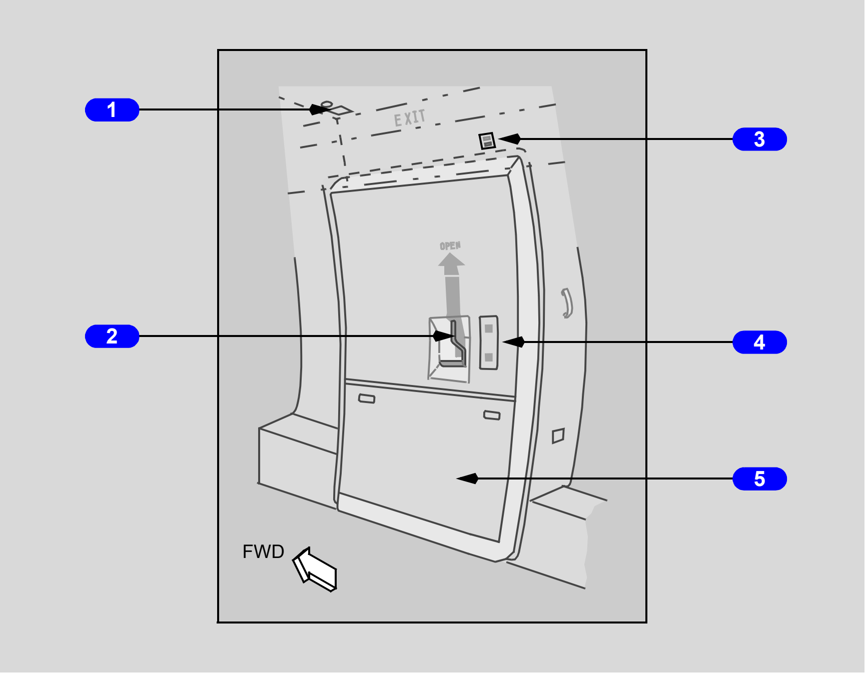
1 Door Sill

2 Door Open Latch

Disengages when door handle rotated closed.

Upper Deck Emergency Doors

109



1 Door Operating Gas Bottle Pressure Gage

If gage needle is below green zone, system is unusable.

2 Door Operating Handle

OPEN -

- unlatches door and permits opening
- deploys slide with door mode select lever in ARM

Down - closes door and engages latches.

3 Door Ground Mode Light/Battery Test Panel

See following graphic.

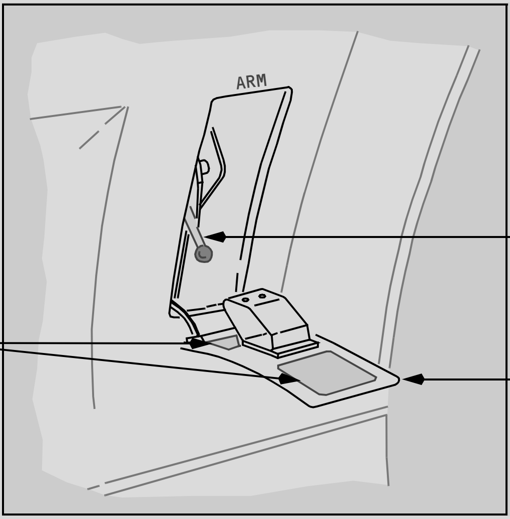
4 Door Mode Select Lever

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 select lever in ARM

Upper Deck Emergency Door Mode Select Panel



UPPER DECK
EMERGENCY DOORS

1 **Door Mode Select Lever**

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

DISARM - 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.

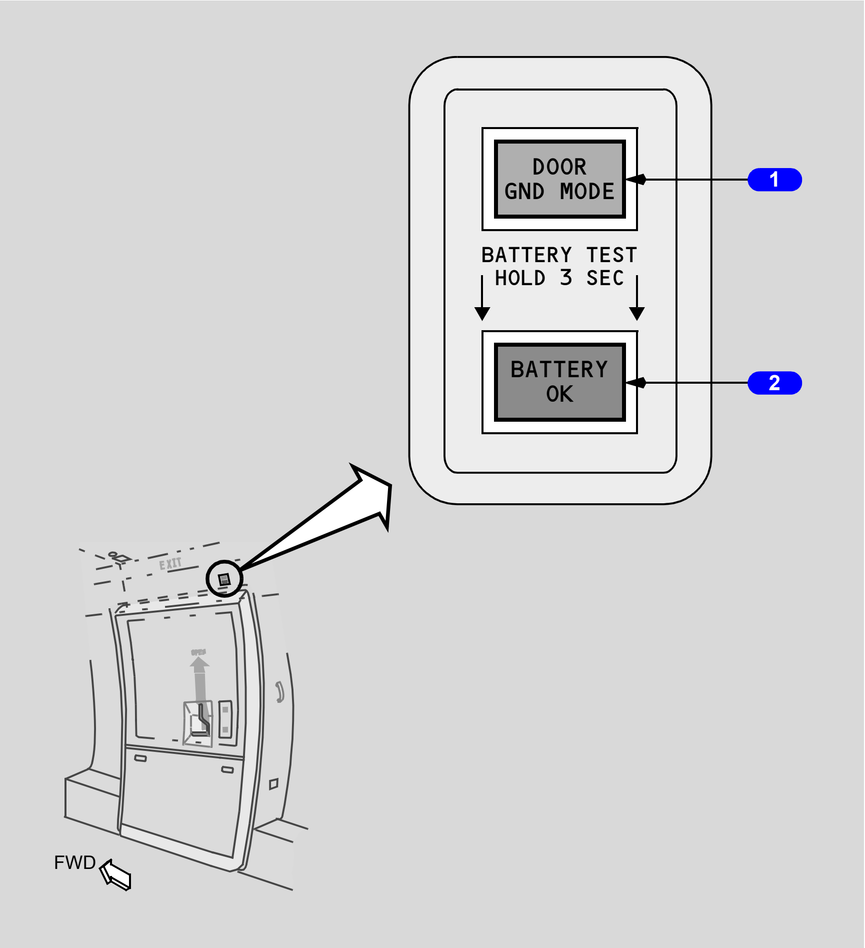
Cover will not close unless door mode select lever fully in ARM or DISARM position.

3 Clear Plastic Viewports

ARM - knob visible in viewport verifies arm mode armed.

DISARM - knob visible in viewport verifies disarm 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.

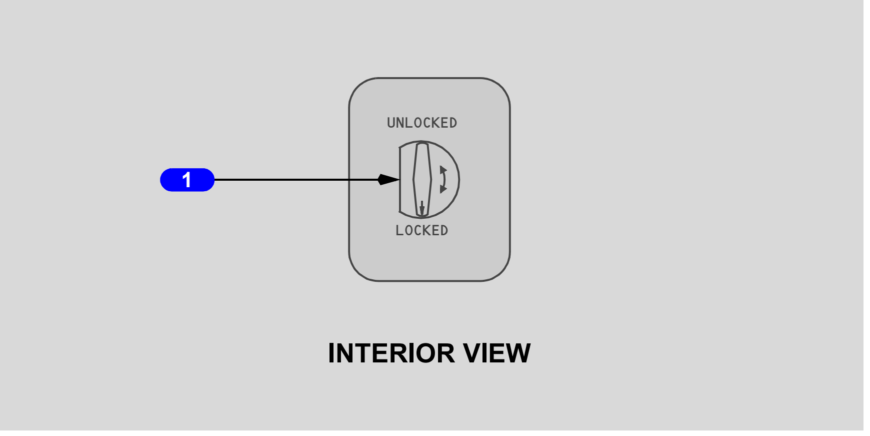
2 BATTERY OK Test Switch/Light

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



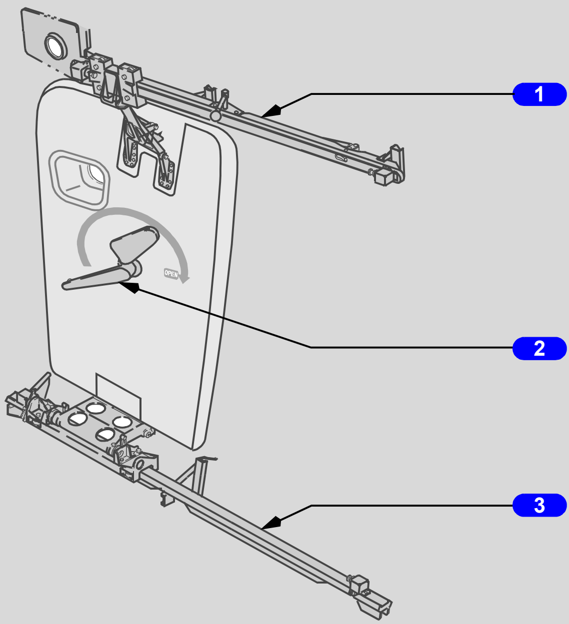
1 Overhead Escape Hatch Handle

Rotate handle to unlock hatch.

Pull hatch inward.

UPPER DECK Crew Service Door

570



INTERIOR VIEW

1 Door Latch Manual Handle

Push - releases door from aft stowed position.

2 Door Handle

Rotate - unlocks latches and continues door movement inboard on upper and lower hinges.

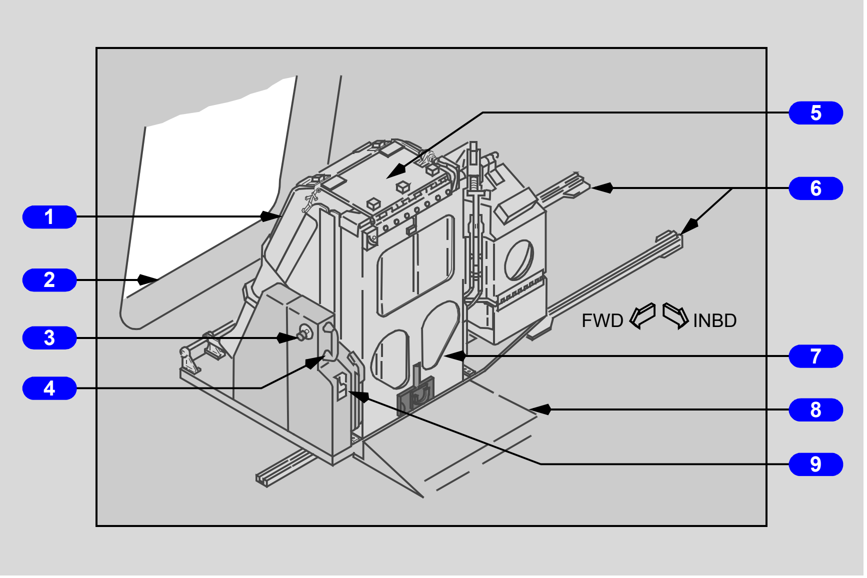
3 Door Tracks

Upper and lower tracks.

Escape Slide, UPPER DECK Crew Service Door

570

Escape Slide Deployment Position



1 Escape Slide Pack

2 Entry Doorway

3 Platform Lock Control

4 Assist Handle

5 Chute Extension Panel

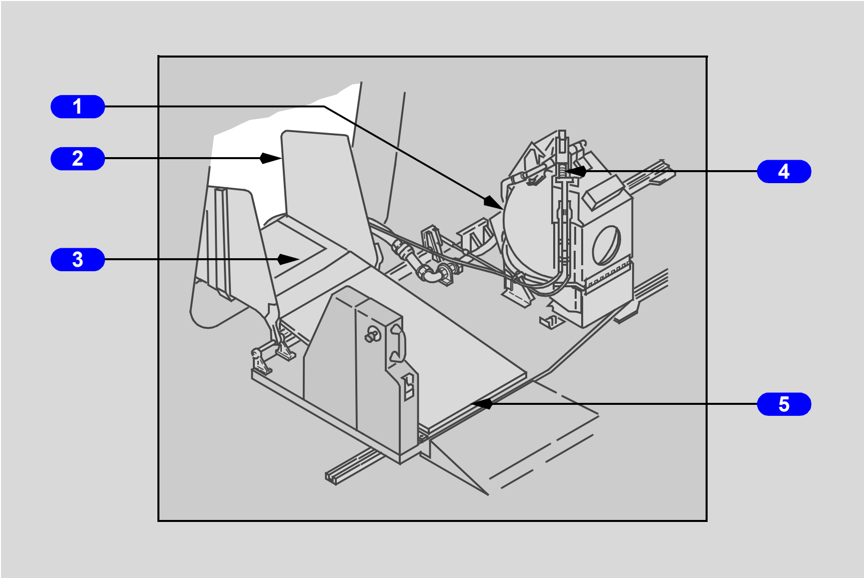
6 Floor Tracks

7 Packboard

8 Floor Ramp

9 Packboard Manual Release Handle

Escape Slide Deployed



1 **Stored Gas Bottle**

2 **Chute**

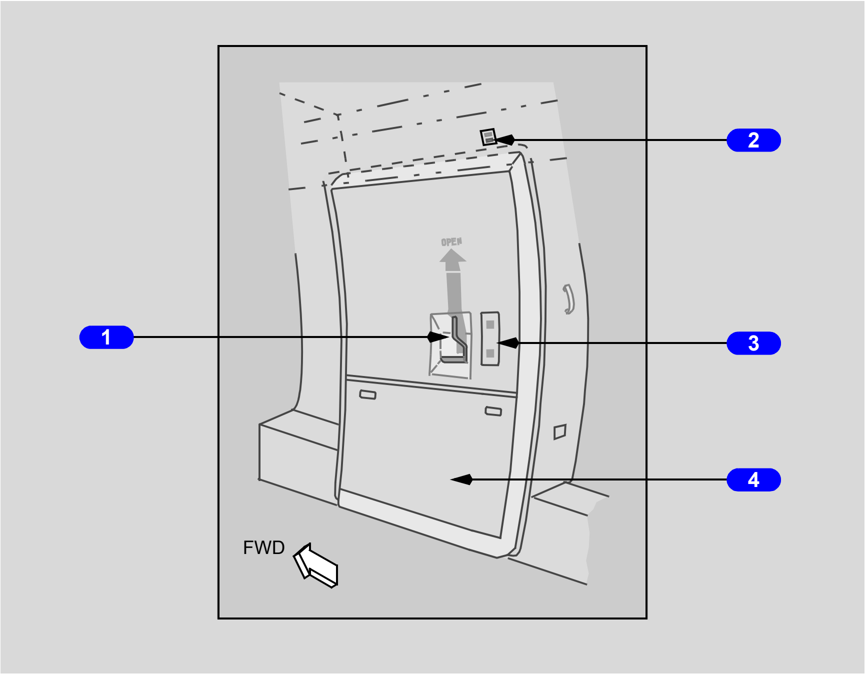
3 **Escape Slide Girt**

4 **Manual Inflation Handle**

CAUTION: DO NOT PULL MANUAL INFLATION HANDLE UNLESS PACKBOARD IS OUT THROUGH DOORWAY.

5 **Ramp Plate**

Upper Deck Emergency Doors
405



1 Door Operating Handle

OPEN -

- unlatches door and permits opening
- deploys slide with door mode select lever in AUTOMATIC

Down - closes door and engages latches.

2 Door Ground Mode Light/Battery Test Panel

See following graphic.

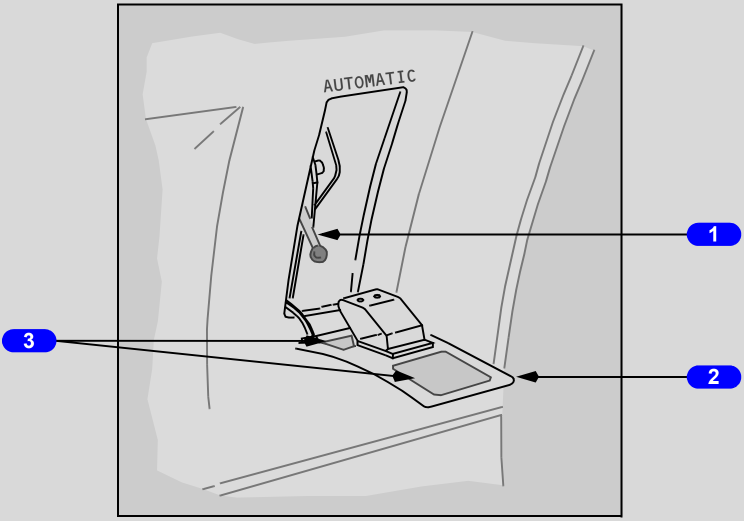
3 Door Mode Select Lever

See following graphic.

4 Escape Slide Pack

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

Upper Deck Emergency Door Mode Select Panel



UPPER DECK
EMERGENCY DOORS

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.

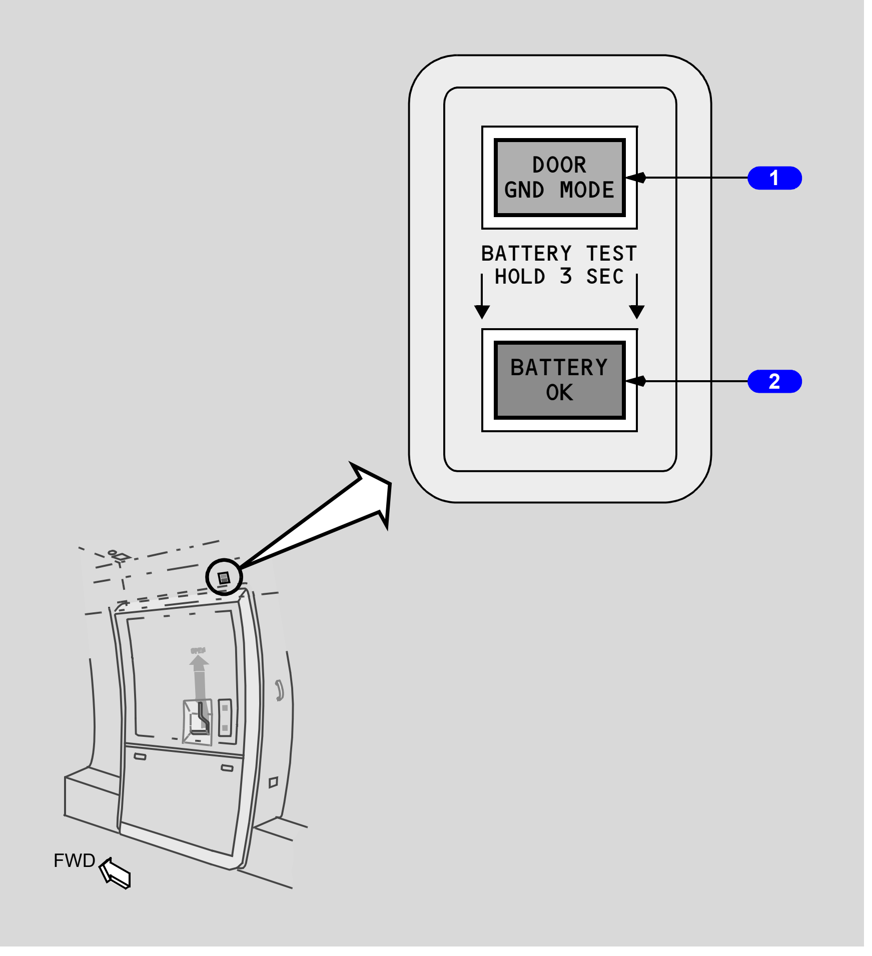
Cover will not close unless door mode select lever fully in MANUAL or AUTOMATIC position.

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 -

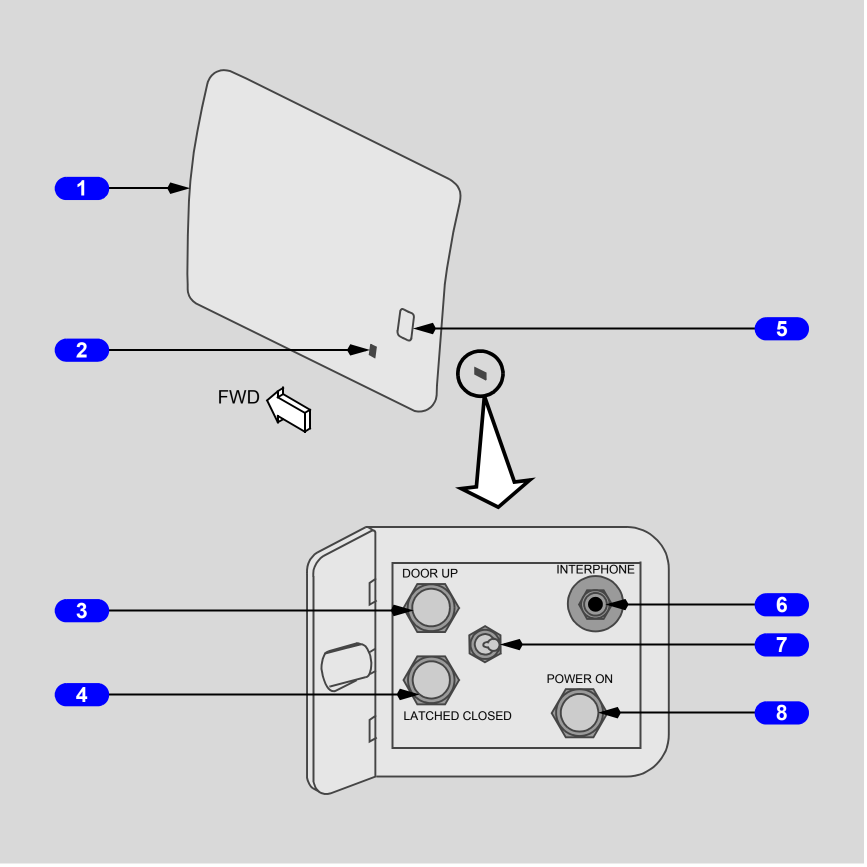
Illuminated (green) - battery charge is sufficient for door operation.

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

Side Cargo Door

405, 570

Side Cargo Door Exterior Controls



1 **Side Cargo Door**

2 **Exterior Latch Lock Handle**

Upper handle area release -

Press - releases exterior and interior Latch Lock handles.

Latch Lock handle -

Pull down - powers Door Control switch.

3 DOOR UP Light

Illuminated (green) - side cargo door in full open position.

4 LATCHED CLOSED Light

Illuminated (green) - Latch Lock handles are released with door in closed position and latches engaged.

5 Window

6 INTERPHONE Jack

7 Door Control Switch

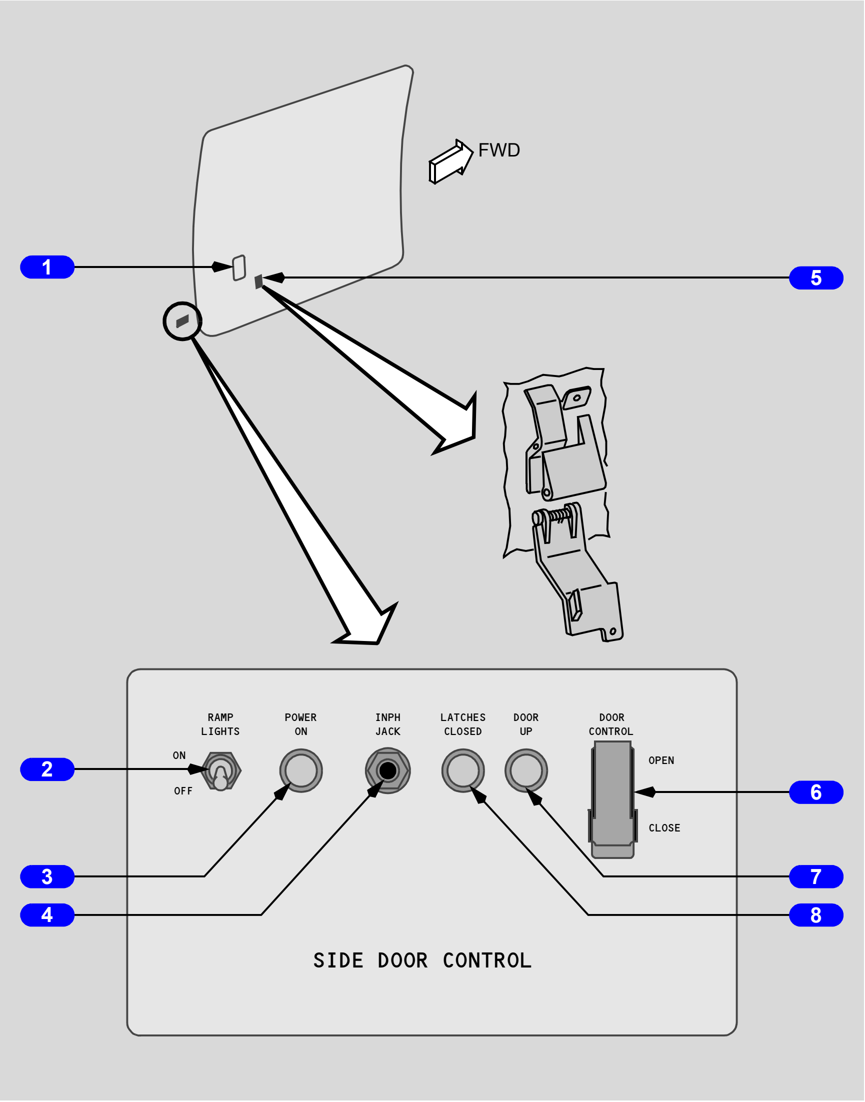
Electrically powered when POWER ON light illuminated and Latch Lock handle in extended position.

Hold - switch in either DOOR UP or LATCHED CLOSED position operates door.

8 POWER ON Light

Illuminated (green) - electrical power available to operate door.

Side Cargo Door Interior Controls



1 Side Cargo Door Window

2 RAMP LIGHTS Switch

ON - illuminates lights in upper part of door to light loading area.

OFF - lights extinguished.

3 **POWER ON Light**

Illuminated (green) - electrical power available to open door.

4 **Interphone (INPH) JACK**

5 **Latch Lock Handle**

6 **DOOR CONTROL Switch**

Electrically powered when POWER ON light illuminated and Latch Lock handle in extended position.

Hold - switch in either OPEN or CLOSED position operates door.

7 **DOOR UP Light**

Illuminated (green) - side cargo door in full open position.

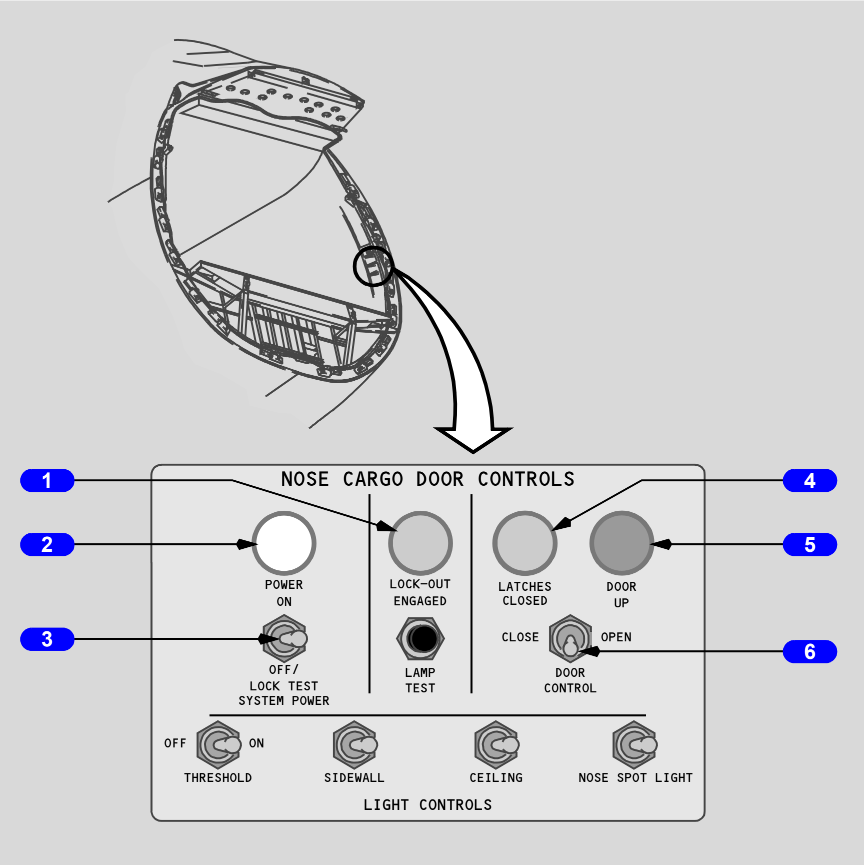
8 **LATCHED CLOSED Light**

Illuminated (green) - Latch Lock handles released with door in closed position and latches engaged.

Nose Cargo Door

570

Nose Cargo Door Control Panel



1 NOSE CARGO DOOR LOCK-OUT ENGAGED Light

Illuminated (green) - Door Control switch in OFF position and main deck cargo handling bus has AC power.

2 NOSE CARGO DOOR POWER ON Light

Illuminated (white) - main deck cargo handling bus powered and System Power switch in ON position.

3 NOSE CARGO DOOR SYSTEM POWER Switch

ON -

- nose cargo door control system powered
- lamp test and door control available
- POWER ON light illuminates
- momentary position, nose cargo door operation stops when released

OFF/LOCK TEST -

- lock out engaged
- Lock-Out Engage light illuminates

4 NOSE CARGO DOOR LATCHES CLOSED Light

Illuminated (green) - all latch pins fully latched.

5 NOSE CARGO DOOR UP Light

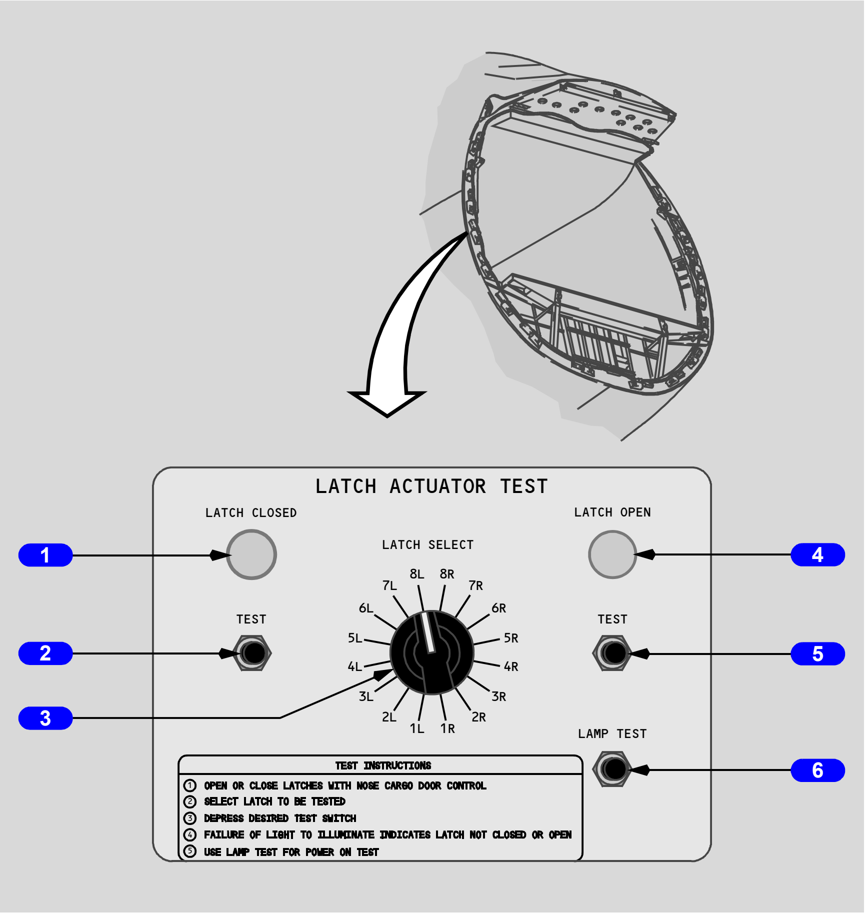
Illuminated (blue) - nose cargo door in full up position.

6 NOSE CARGO DOOR CONTROL Switch

CLOSE - powers door actuation system closed when System Power switch ON.

OPEN - powers door actuation system open when System Power switch ON.

Nose Cargo Door Latch Actuator Test Panel



1 LATCH CLOSED Light

Illuminated (green) - selected latch closed.

2 LATCH CLOSED TEST Switch

Push - illuminates LATCH CLOSED light when selected latch closed.

3 LATCH ACTUATOR TEST Selector (LATCH SELECT)

XL, XR - selects latch for test by Latch Closed and Latch Open Test switches.

4 LATCH OPEN Light

Illuminated (green) - selected latch open.

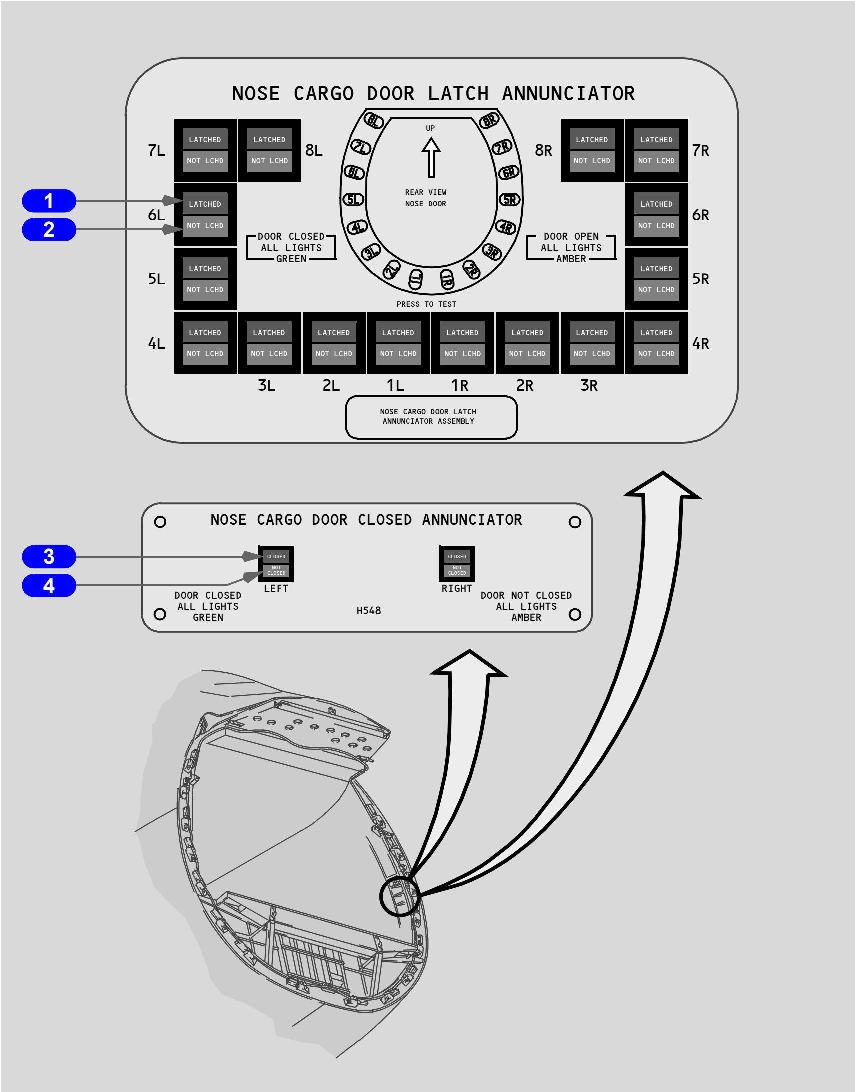
5 LATCH OPEN TEST Switch

Push - illuminates LATCH OPEN light when selected latch open.

6 LAMP TEST Switch

Push - illuminates LATCH CLOSED and LATCH OPEN lights when test power available.

Nose Cargo Door Latch Annunciator and Door Closed Annunciator Panels



1 NOSE CARGO DOOR LATCHED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (green) - respective latch closed and latched.

2 NOSE CARGO DOOR NOT Latched (LCHD) ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (amber) - respective latch not latched.

3 NOSE CARGO DOOR CLOSED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (green) - door closed.

Push - light test.

4 NOSE CARGO DOOR NOT CLOSED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (amber) - door not closed.

Push - light test.

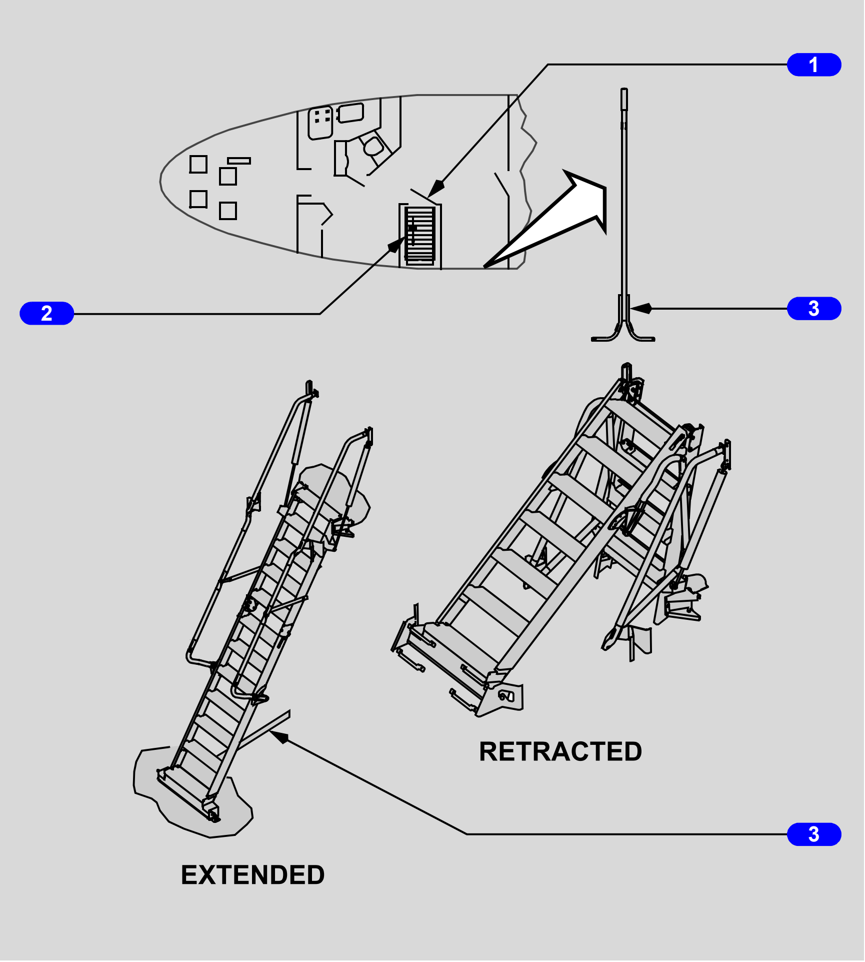
Upper Deck Crew Access Ladder

405, 570

The upper deck crew access ladder is retracted to the ceiling during cargo loading/unloading and extended at all other times. The smoke barrier door must be closed during taxi, takeoff, flight, and landing

CAUTION: Always use the handrail when climbing or descending the ladder.

Note: The user should face the ladder when climbing or descending.



1 Smoke Barrier Door

2 Crew Access Ladder

3 Stow Assist Tool

Stow assist tool is mounted on the side panel adjacent to Door 1L.

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

109

Lighting systems described in this chapter include:

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

405, 570

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting

570
- nose/main deck lighting

405
- main deck 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.

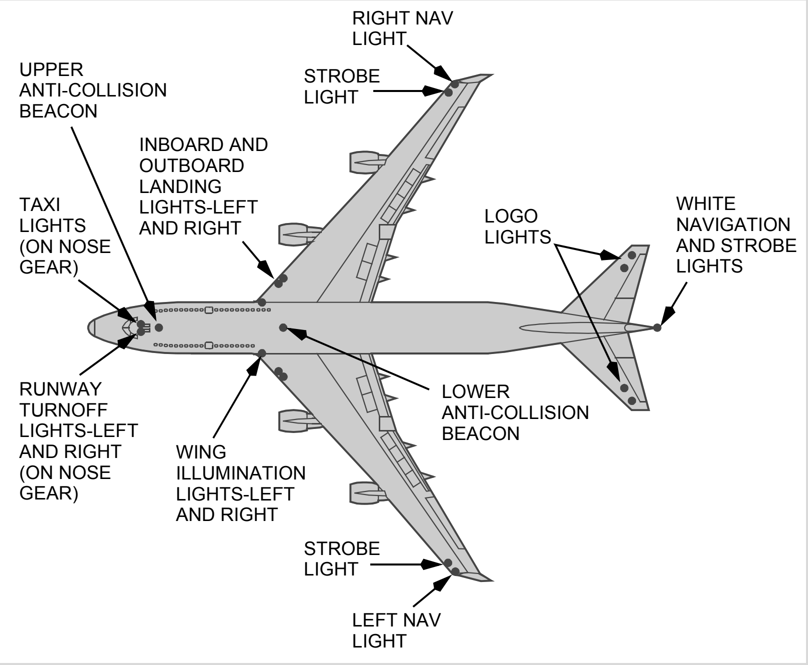
Wing Lights

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 provides panel illumination, area lighting, and localized illumination. Flood lights and light plates provide panel illumination. Dome lights provide flight deck area lighting. A chart light and a utility light for each pilot, and map lights 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

109, 405

The cabin signs are controlled by selectors on the aisle stand and illuminate when the following conditions are satisfied:

570

The FASTEN SEAT BELTS signs are controlled by a selector on the aisle stand and 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
  109
- passenger oxygen on

109, 405

NO SMOKING signs (AUTO selected):

- landing gear not up and locked, or
- cabin altitude above 10,000 feet, or
  109
- passenger oxygen on.
  405
- supernumerary oxygen on

109, 405

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

570

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

109, 405

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

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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.

109, 405

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

570

When the FASTEN SEAT BELTS signs illuminate or extinguish, a low tone sounds over the PA system.

570

The NO SMOKING signs are permanently illuminated and cannot be controlled by the No Smoking selector.

Nose/Main Deck Lighting

Main Deck Lighting

405, 570

Threshold Lights
570

Two cargo loading ramp lights are mounted on the inside of the nose cargo door. The nose cargo door must be in the full open position for the lights to illuminate. When the nose cargo door is in the full open position, the lights are exposed and illuminate the loading ramp below the raised nose.

Sidewall Lights

The sidewall lights are spaced along both sides of the main deck cargo compartment. These lights illuminate the sidewall and adjacent floor. The forward left sidewall light also functions as a flight deck access light.

Ceiling Lights

570

The ceiling lights are spaced along the centerline of the ceiling from the crew ladder to the aft end of the main deck cargo compartment. The ceiling light adjacent to the crew ladder opening also functions as a flight deck access light. The seven forward ceiling lights also function as threshold lights.

405

The ceiling lights are spaced along the centerline of the ceiling from the crew ladder to the aft end of the main deck cargo compartment. The ceiling light adjacent to the crew ladder opening also functions as a flight deck access light.

Nose Spot Light
570

The nose spot light is located in the lower left side of the nose cargo door. When the nose cargo door is closed, the light illuminates the forward portion of the main deck. The nose spot light is used with the mirror to verify the end locks raised when cargo is loaded in the forward location.

Emergency Lighting
109

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.

Emergency Lighting
405, 570

Interior emergency lighting illuminates the aisle and area by the exit doors. There are luminescent and battery powered exit signs.

Exterior emergency lighting illuminates the escape slide and the area at the base of the slide.

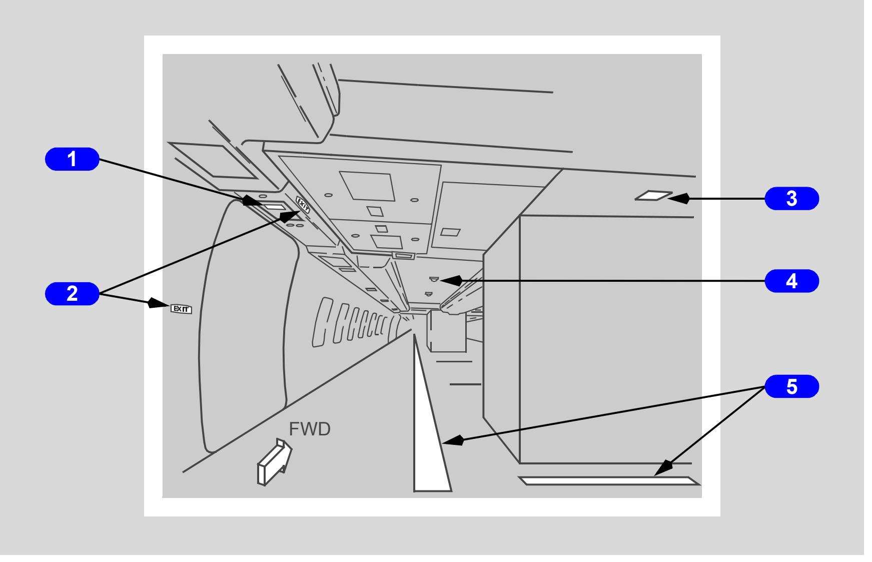
Emergency lighting is controlled by the Emergency Lights switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also be activated by the Emergency Lights switch on the upper deck panel regardless of the flight deck switch position.

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

109

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

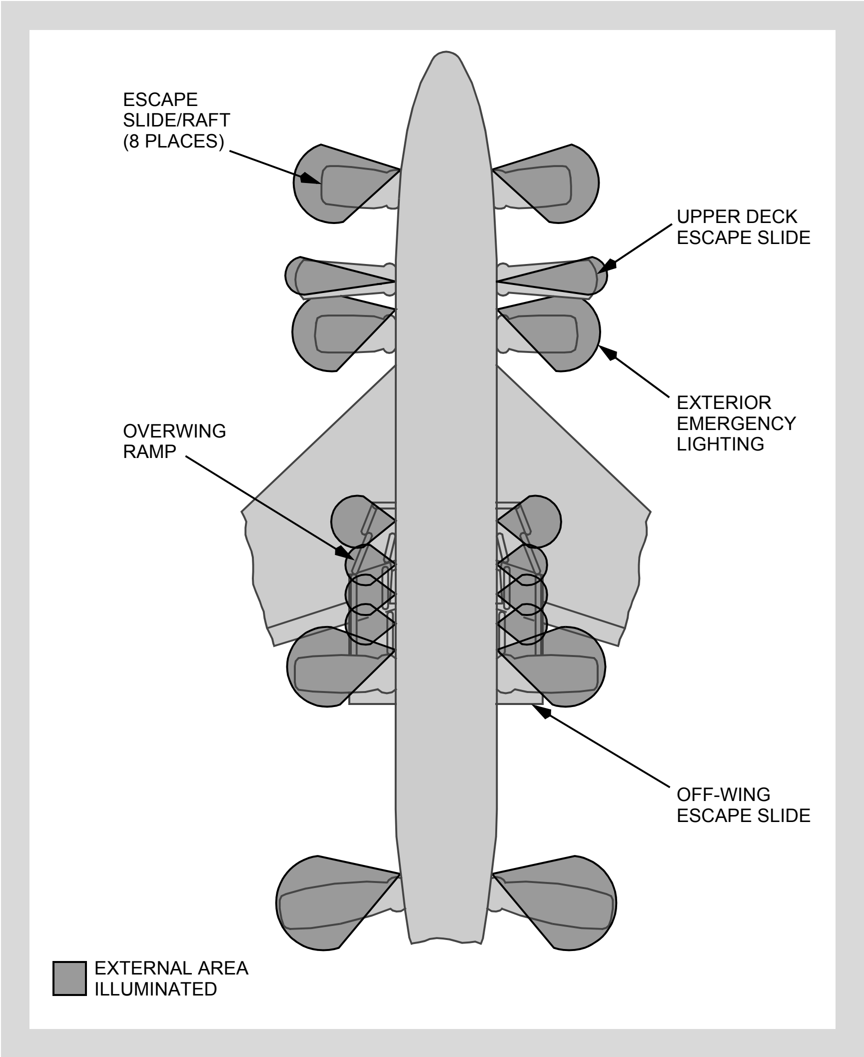
5 Emergency Escape Path Lighting

Exterior Emergency Lighting

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

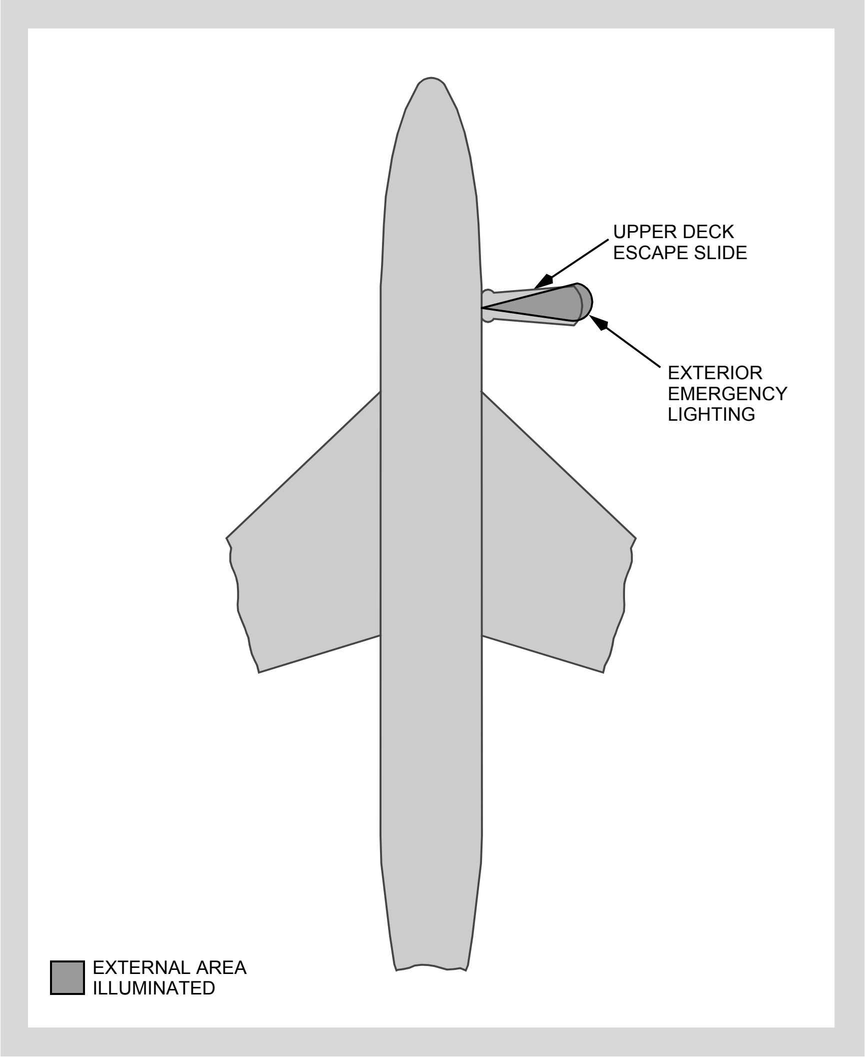
Exterior Emergency Lighting Locations

109



Exterior Emergency Lighting Locations
405, 570

570



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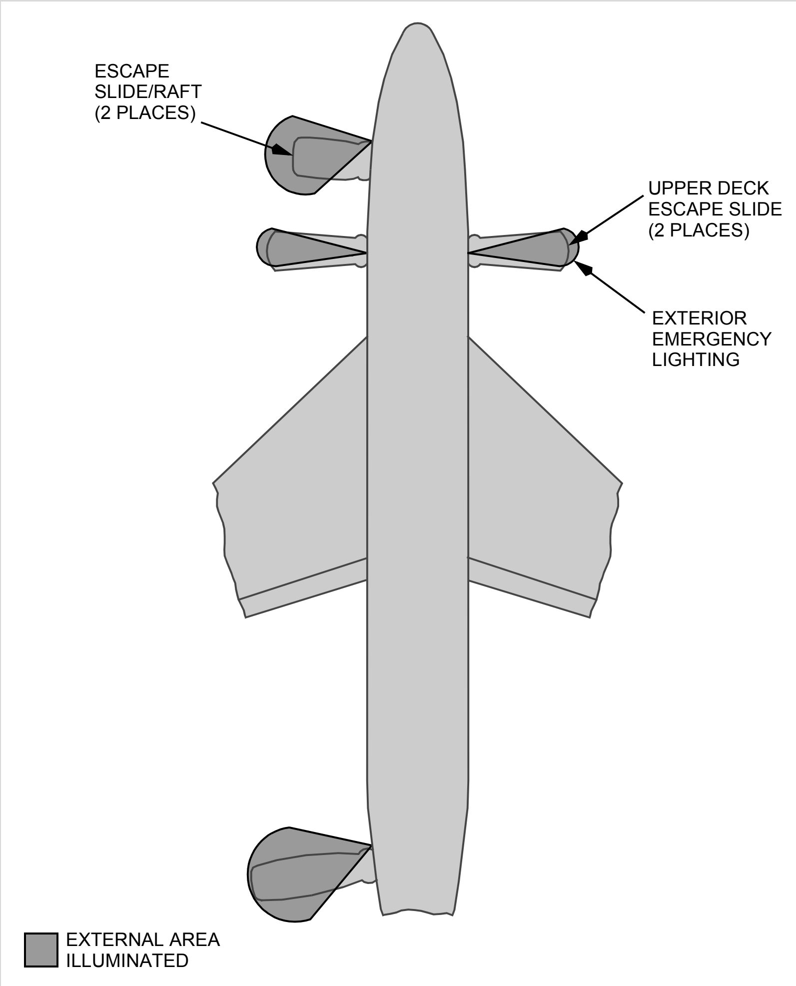

ESCAPE
SLIDE/RAFT
(2 PLACES)
UPPER DECK
ESCAPE SLIDE
(2 PLACES)
EXTERIOR
EMERGENCY
LIGHTING
EXTERNAL AREA
ILLUMINATED

Oxygen Systems

109

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

405, 570

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

Oxygen pressure displays on the EICAS STATUS page.

Flight Crew Oxygen System

570

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. The Captain and First Officer's masks have automatic pressure breathing regulators.
(SB changes 109 ; full-face masks installed at all crew stations)

The flight crew oxygen system uses quick-donning diluter-demand full-face masks located at each crew station. Oxygen flow is controlled by an automatic pressure breathing regulator mounted on each mask.

405
(SB changes 109 ; before SB, full-face masks not installed at observer stations)

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. The Captain and First Officer have full face masks with automatic pressure breathing regulators.

During the preflight check of the crew oxygen mask, a pressure decrease may indicate the crew oxygen cylinder shutoff valve is 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.

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 switch. 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

109

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 EICAS STATUS page.

Supernumerary Oxygen System

405

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

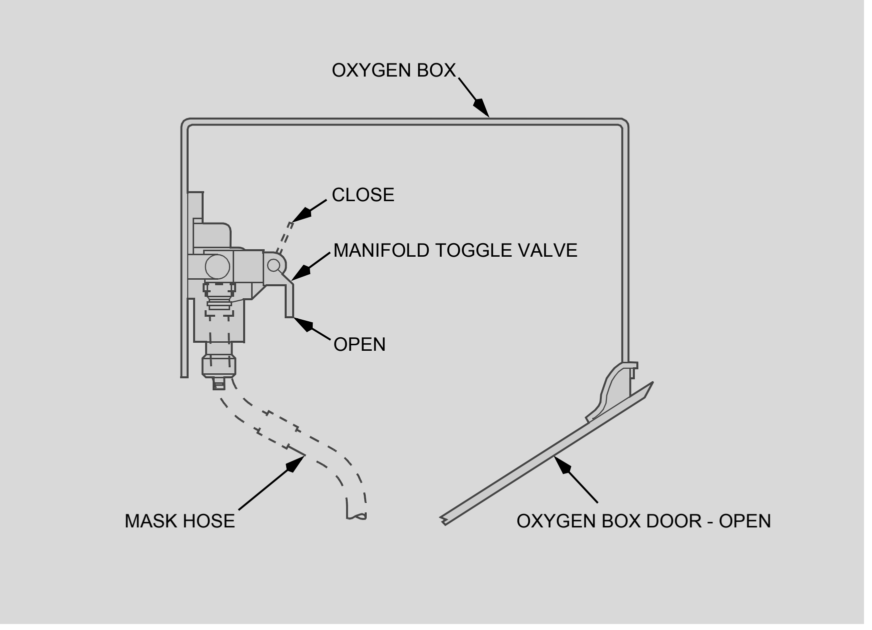
Oxygen flow to a mask begins when the mask is pulled down.

The supernumerary oxygen system provides 195 minutes of oxygen at a cabin altitude of 25,000 feet. When an oxygen mask is not in use, the manifold toggle valve in the PSU(s) should be in CLOSE position.

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

Supernumerary oxygen pressure displays on the EICAS STATUS page.

Passenger Service Unit



Supernumerary Oxygen System

570

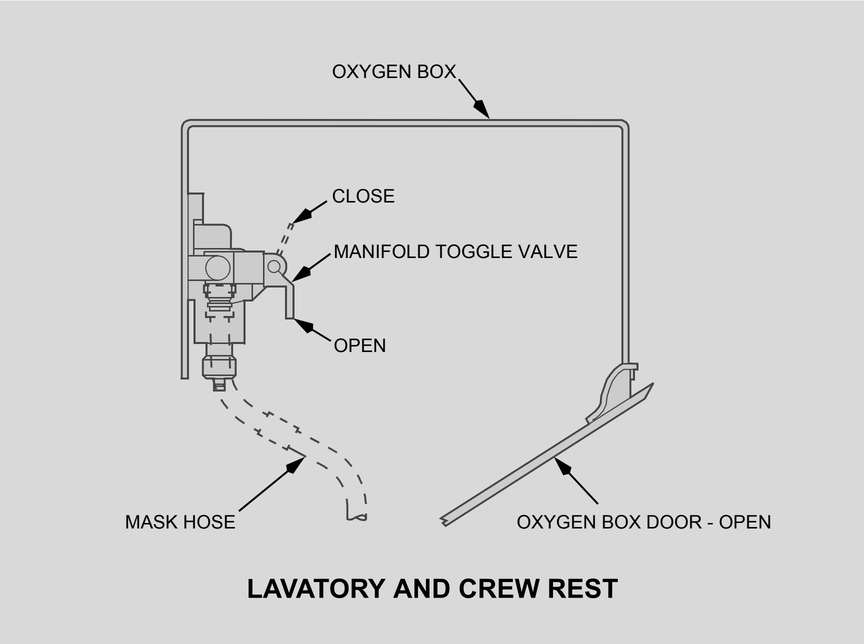
The supernumerary oxygen system is supplied by bottled gaseous oxygen. The oxygen bottles provide oxygen to the passenger and lavatory service units. The supernumerary oxygen masks are installed in these units and automatically deploy if cabin altitude exceeds approximately 14,000 feet. Supernumerary masks can be manually deployed from the flight deck by pushing the overhead panel Supernumerary Oxygen switch to ON position.

The supernumerary oxygen masks installed above the passenger seats in passenger service units are quick-donning diluter-demand masks. Oxygen flow is controlled by a regulator mounted on each mask. Squeezing the red release levers with the thumb and forefinger inflates the mask harness. Releasing the levers after placing the mask over the head deflates the mask harness, fitting it securely to the head and face.

Oxygen flow to a supernumerary oxygen mask in the lavatory or crew rest area begins when the mask is pulled down. Oxygen flow to these masks can be reset by selecting the Supernumerary Oxygen switch to RESET position.

Supernumerary oxygen pressure displays on the EICAS STATUS page.

Passenger Service Unit



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.

Therapeutic Oxygen System

109

The therapeutic oxygen system is an integral part of the passenger oxygen system. The therapeutic oxygen outlets are capable of providing oxygen to therapeutic masks without actuating all passenger masks.

The therapeutic oxygen system can be activated at any altitude during normal flight by placing the Therapeutic Oxygen switch to the ON position. Prior to activation, at least one therapeutic oxygen mask must be plugged into an outlet. Therapeutic oxygen also activates automatically whenever the passenger oxygen system automatically activates.

Passengers receive therapeutic oxygen through therapeutic masks plugged into the outlet on the PSUs. No oxygen flows from therapeutic oxygen outlets when masks are not plugged in. Oxygen flow can be reset by selecting the Therapeutic Oxygen switch to RESET position after all therapeutic masks are unplugged from the system.

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

Emergency Equipment Overview

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

109
- emergency evacuation signal system

570
- main deck signalling system
- fire extinguishers
- emergency equipment locations

Emergency Evacuation Signal System
109

The emergency evacuation signal system alerts the flight attendants to evacuate the passenger cabin.

An Emergency Evacuation Signal command switch is located in the flight deck and at the door 2L attendant station. Evacuation system panels, with evacuation horn and light, are located at the door 4L attendant station and the upper deck right door attendant station. The flight deck evacuation signal COMMAND switch positions are OFF, ARM, and ON.

Placing the flight deck evacuation signal COMMAND switch to ON activates the evacuation signals on the flight deck panel and on the flight attendant panels. With the flight deck evacuation signal COMMAND switch in ARM, pressing the EVAC COMMAND switch on the door 2L flight attendant panel activates the evacuation signals on the flight deck and on the flight attendant panels.

Main Deck Signaling System
570

The main deck signaling system consists of a visual alert in the main cargo deck to alert supernumerary personnel to return to the upper deck. When the MAIN DECK SIGNALING switch is pushed, the ceiling lights flash for several seconds.

Fire Extinguishers

Water and halon fire extinguishers are located throughout the airplane.

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.

WARNING: 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 liquefied 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.

Direction for use of the fire extinguisher is printed on the extinguisher.

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

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

Miscellaneous Emergency Equipment

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

Emergency Locator Transmitter (ELT)

Passenger Cabin

109

On the passenger airplane, emergency locator transmitters (ELTs) are installed:

- 1 ELT - door 1L
- 1 ELT - door 4R

  Note: ELTs installed in slide/rafts transmit when the slide/raft is deployed into water.

Freighter Supernumerary Area

405, 570

On the freighter, emergency locator transmitters (ELTs) are installed:

570

- 1 ELT - on the upper deck lavatory exterior wall near the flight deck overhead escape hatch

405

- 2 ELTs - on the upper deck partition forward of the left door

Fuselage Mounted Emergency Locator Transmitter

405, 570

405

A fixed emergency locator transmitter is installed forward of Door 5. The ELT activates by high deceleration forces or when the ELT switch is ON. The ELT can be deactivated by moving the ELT switch to RESET momentarily, then ARMED.

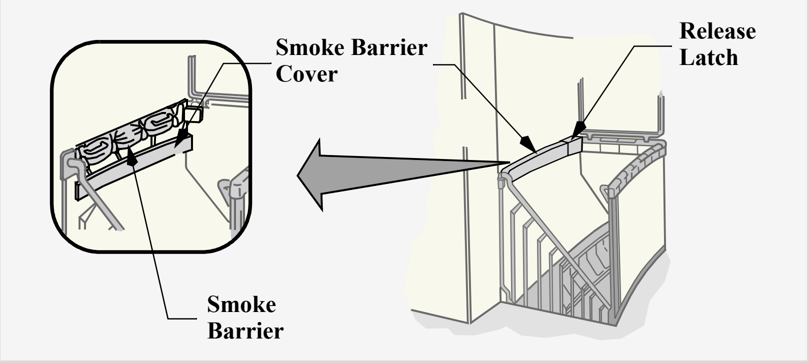
570

A fixed emergency locator transmitter is installed forward of Door 5. The ELT activates by high deceleration forces or when the ELT switch is ON. The ELT can be deactivated by moving the ELT switch to RESET momentarily (between 1 and 3 seconds), then ARMED.

Smoke Barrier

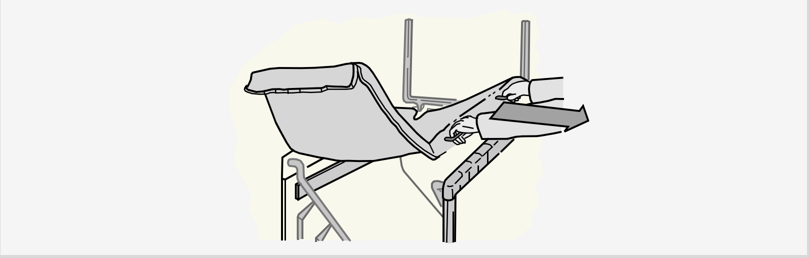
109

A smoke barrier is installed at the top of the stairs on the upper deck. The smoke barrier may be used on the ground to prevent smoke migration by covering the stairwell between the main deck and the upper deck.

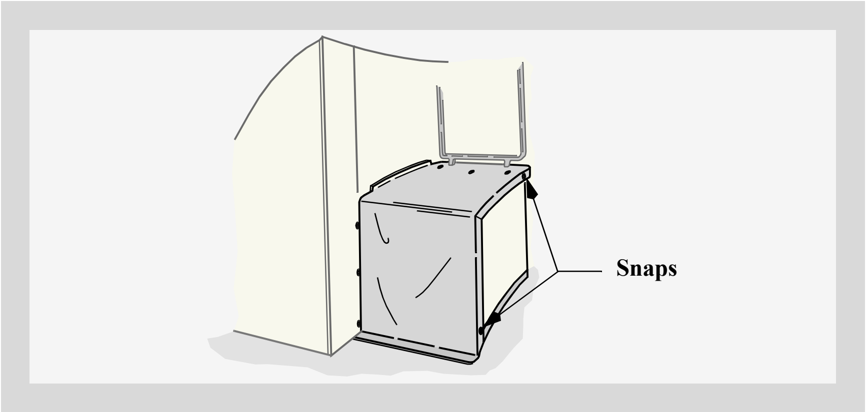


To deploy the smoke barrier:

- 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.

WARNING: The smoke barrier is for ground use only.

Note: The smoke barrier is used on the ground to prevent smoke from rising up the stairway into the upper deck area. In flight, normal airplane ventilation minimizes smoke migration into the upper deck area.

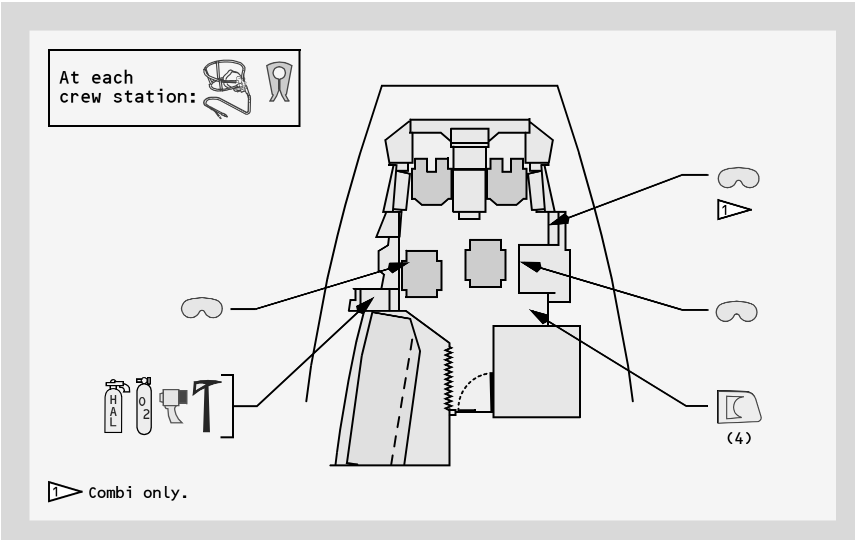
Emergency Equipment Symbols

NOTE: Some symbols do not apply to all configurations.

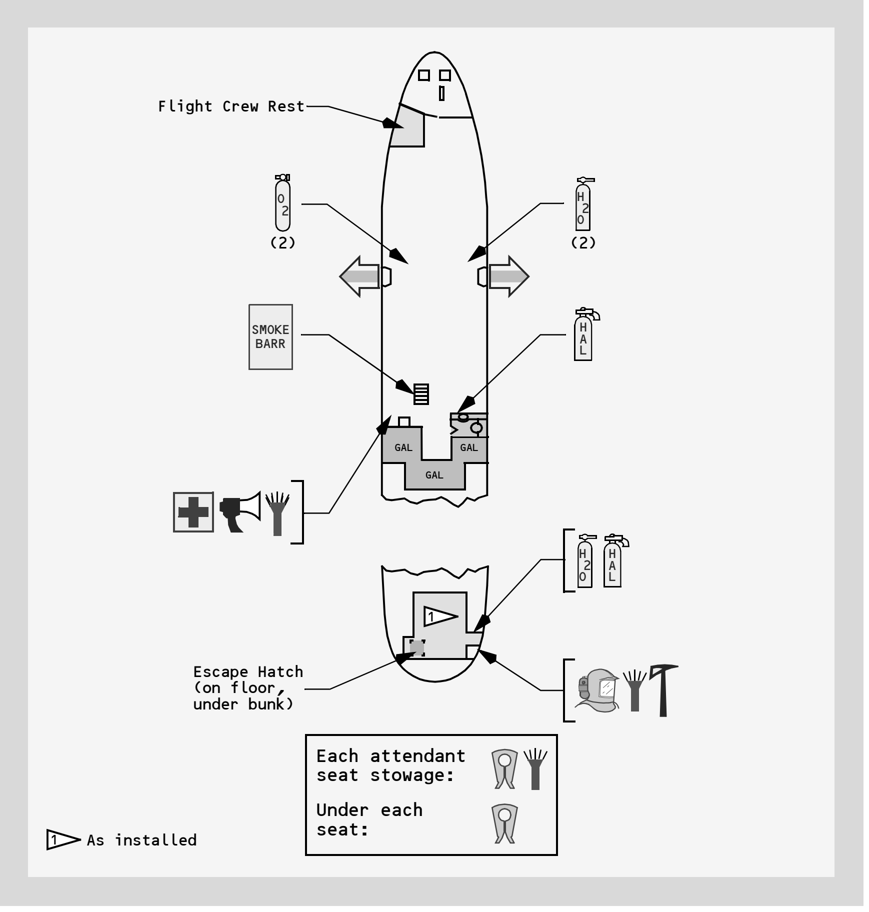
Emergency Equipment Location

109

Flight Deck - Passenger Airplane

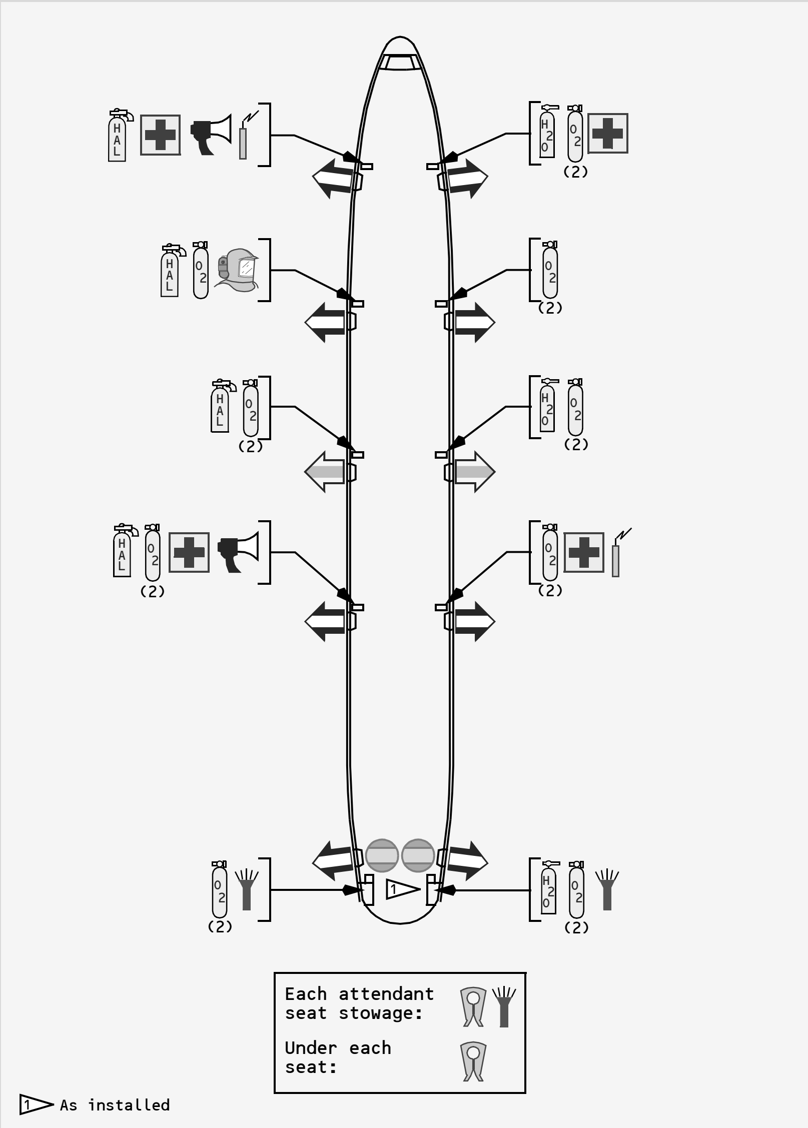


Upper Deck/Door 5 Overhead Crew Rest - Passenger Airplane



Note: Door 5 overhead crew rest installed.

Main Deck



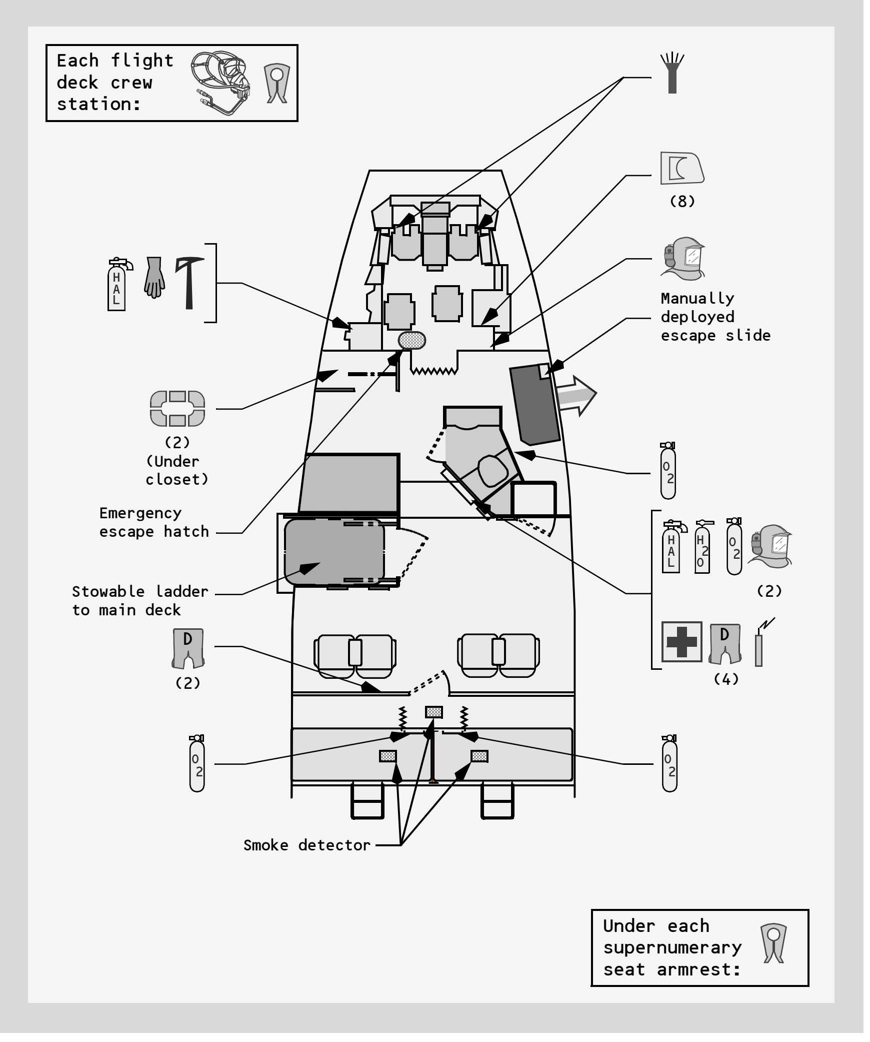
Passenger

Freighter

405, 570

Flight Deck/Upper Deck

570



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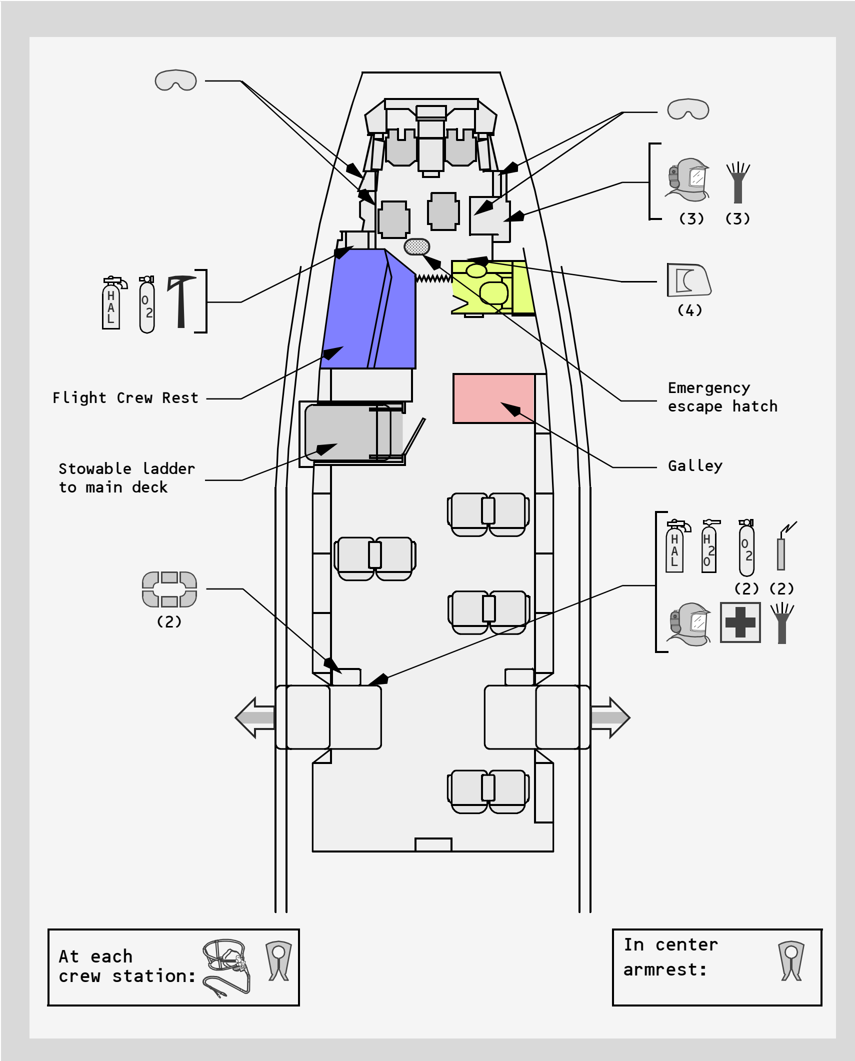
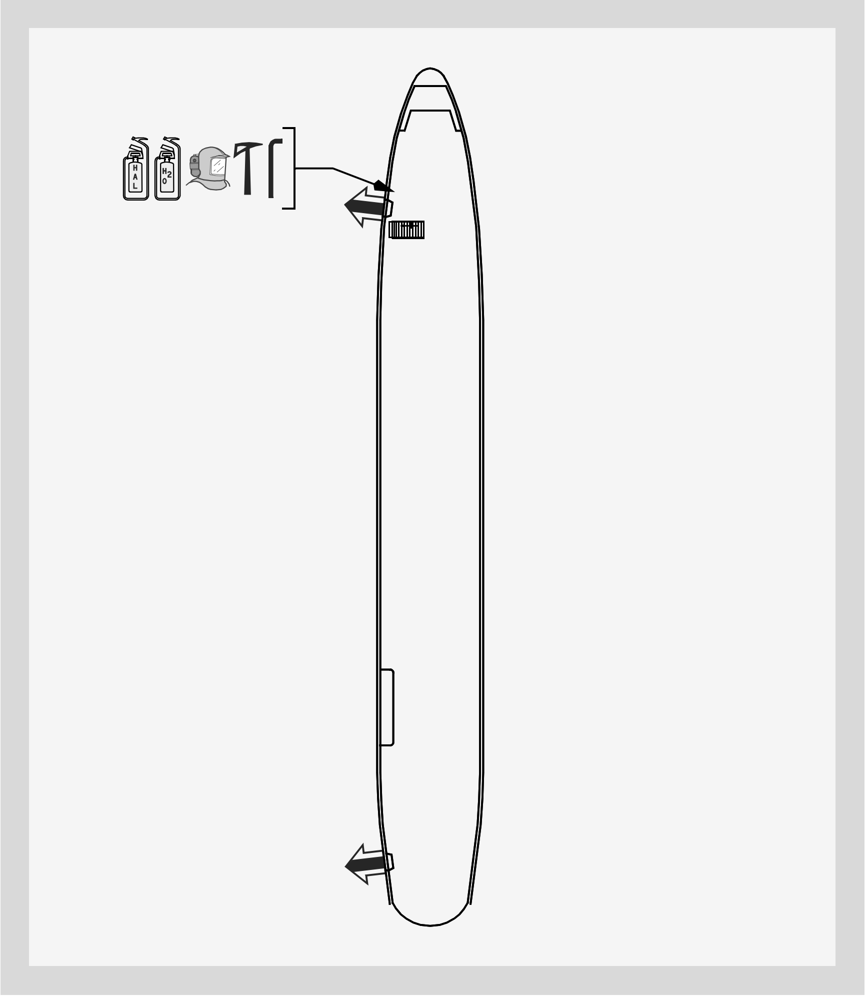

H A L
O 2
Flight Crew Rest
Stowable ladder to main deck
(2)
(3) (3)
(4)
Emergency escape hatch
Galley
H A L
H 2 O
O 2
(2) (2)
At each crew station:
In center armrest:

Main Deck



Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 50

Doors

109

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.

570

The airplane has two main deck entry doors, one UPPER DECK crew service door, and four cargo doors. It also has two electrical and electronic (E/E) equipment access doors.

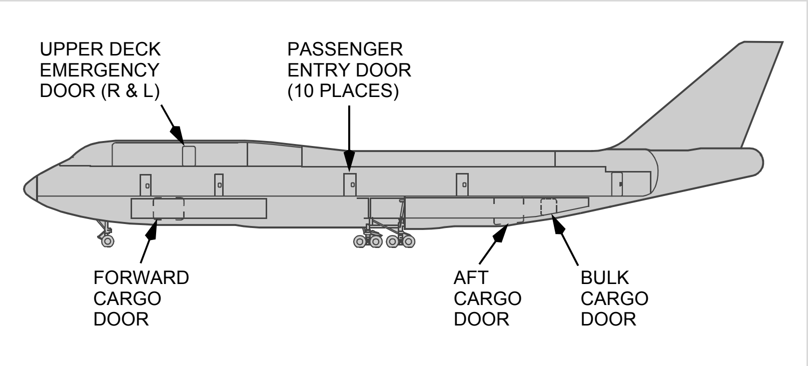
405

The airplane has two main deck entry doors, two upper deck emergency doors, and four cargo doors. It also has two electrical and electronic (E/E) equipment access doors.

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

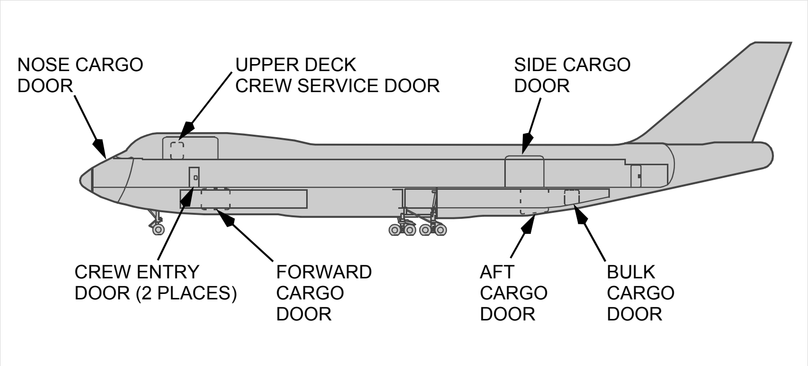
Door Locations

109



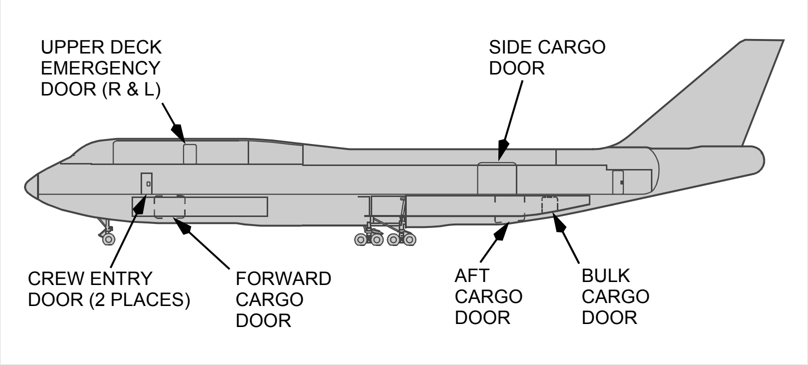
PASSENGER

570



FREIGHTER

405



FREIGHTER

Flight Deck Door

109

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

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

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

Two indicator lights and a three position rotary Door Lock selector are located on the aft aisle stand. Illumination of the amber LOCK FAIL light indicates the door lock has failed or the Access System switch is in the OFF position.

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

By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

The door latch system incorporates a pressure rate-sensor that unlocks the door in the event of flight deck depressurization.

Passenger Entry Doors

109

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

109

When the door mode select lever is in ARM 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 DISARM position.

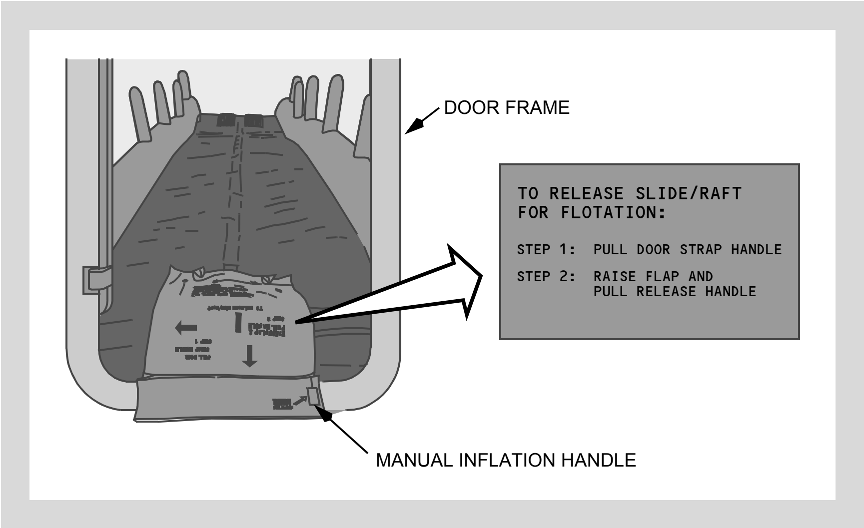
When the door mode select lever is in ARM position and the door is opened using the exterior door handle, the door mode select lever mechanically positions to DISARM and the door may be opened without slide deployment.

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

The door mode select lever should not be moved from DISARM to ARM or ARM to DISARM 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

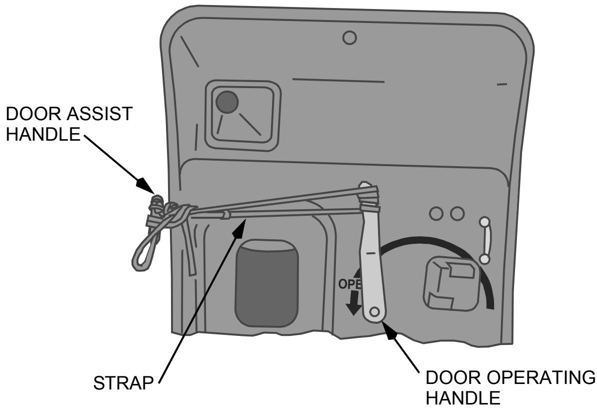


Securing Main Deck Doors 1, 2, 4, or 5 In The Open Position

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

109

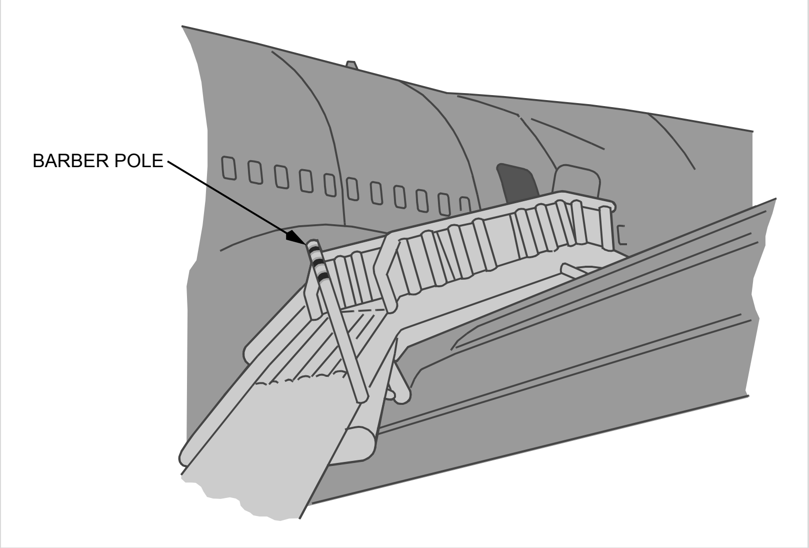
When the door mode select lever is in ARM position and the door operating handle is rotated 180 degrees, the door begins to open and the power assist opening system activates.

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 DISARM allows the door to be opened without deploying the ramp slide.

Door 3 Slide Deployed



Main Deck Doors 1L and 5L

405, 570

Main deck Doors 1L and 5L can be opened from either outside or inside the airplane. An escape rope is stowed above both doors. Threshold lights illuminate at Door 1L with the emergency lights activated.

Upper Deck Emergency Doors

109

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

With the door mode select lever in ARM position, lifting the door operating handle actuates 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.

UPPER DECK Crew Service Door

570

The UPPER DECK crew service door is used for normal entry and exit and for emergency exit.

Outside the airplane, pushing the tabs releases the handles. Rotating the handles unlatches and opens the door. The exterior handles must be stowed prior to moving the door aft on the tracks.

Inside the airplane, pulling the handle and rotating towards OPEN opens the door.

The UPPER DECK crew service door can be closed from either inside or outside the airplane.

Pushing the Door Latch Manual handle releases the door from the aft stowed position and allows the door to slide forward on the tracks.

Rotating either the interior or exterior handle closes and latches the door.

Escape Slide, UPPER DECK Crew Service Door

570

The escape slide for the UPPER DECK crew service door is mounted on tracks parallel to the door and the right bulkhead. The escape slide can be moved along the tracks to either of two maintained positions:

- forward (in front of door)
- aft (clear of door)

Placing the Platform Lock Control lever to Unlocked and using the assist handle moves the escape slide on the tracks into either the forward or aft position.

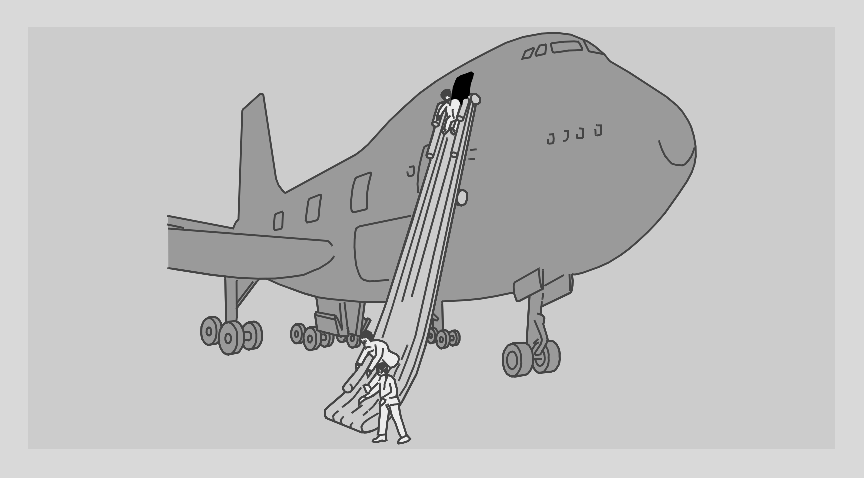
To use the UPPER DECK crew service door as an emergency exit, the slide must be in the forward position and the UPPER DECK crew service door must be open. Pulling the Packboard Manual Release handle and rotating the escape slide through the open doorway deploys the slide.

WARNING: USE CAUTION WHEN PUSHING THE SLIDE OUT THE DOOR TO AVOID FALLING OUT THE OPEN DOOR.

The slide inflates automatically. If automatic inflation does not occur, pulling down on the Manual Inflation handle inflates the slide.

Note: If both body gear are not extended, the airplane may tip tail down on the ground. The escape slide is then unusable.

UPPER DECK Crew Service Door Slide Deployed



Upper Deck Emergency Doors
405

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 actuates 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.

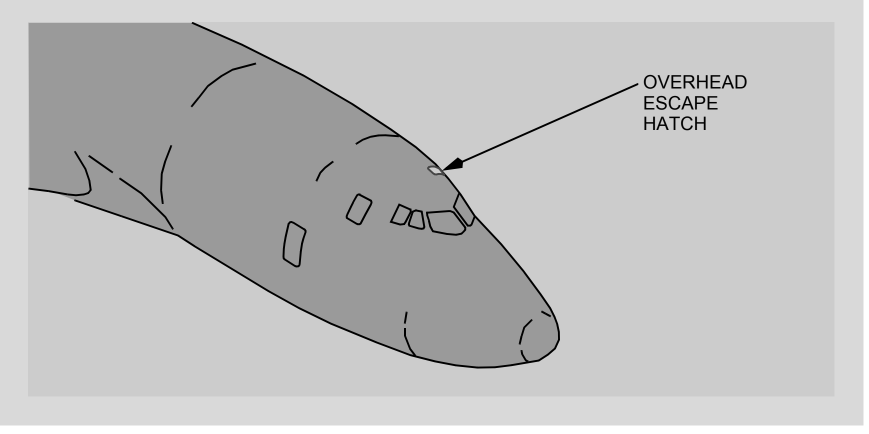
An automatic lock activates in flight to lock the upper deck door operating handles to prevent inadvertent operation. If the automatic lock fails to activate after takeoff, it is possible to open an upper deck door when cabin differential pressure is low.

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

109, 405

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

570

Eight 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.

Emergency Escape Harnesses

570

Six emergency escape harnesses are stowed in the upper deck cabin. The harness is used by donning the garment, attaching the hook to the fastening ring on an escape device handle, and departing through the overhead escape hatch.

Cargo Doors
109

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.

Cargo Doors
405, 570

405

There are three lower cargo doors, one forward, one aft, and one bulk; and one side cargo door.

570

There are three lower cargo doors, one forward, one aft, and one bulk; one side cargo door; and one nose cargo door.

405

There are three lower cargo doors, one forward, one aft, and one bulk; and one side cargo door.

Lower Cargo Doors

The three lower 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.

Side Cargo Door

The left side cargo door can be operated from inside or outside the airplane when the retainer over the interior latch lock handle is open. Electric power to operate the door is supplied by the main deck cargo handling bus.

The door is operated by checking the POWER ON light is illuminated and extending the interior or exterior latch lock handle. The LATCHES CLOSED light illuminates when handles are released. The interior or exterior DOOR CONTROL switch opens or closes the door. The LATCHES CLOSED light extinguishes as the door opens. The DOOR UP light illuminates when the door is fully open.

Nose Cargo Door

570

The nose cargo door receives electrical power from the main deck cargo handling bus. It is controlled from the nose cargo door and light control panel. A mechanical system operates the door when electrical power is not available.

With the System Power switch in ON position, the POWER ON and LATCHES CLOSED lights illuminate.

With the System Power switch held in ON position and the Door Control switch held in OPEN position, the door actuation system opens the nose cargo door.

With the System Power switch held in ON position and the Door Control switch held in CLOSE position, the door actuation system closes the nose cargo door.

The nose cargo door can be stopped and held in position at any point by releasing the System Power switch or the Door Control switch.

When the System Power switch is placed in OFF/LOCK-TEST position, the nose cargo door control system is unpowered, lock-out is engaged, LOCK-OUT ENGAGED light illuminates, and LATCHES CLOSED lights extinguish.

When the System Power switch is released, the LOCK-OUT ENGAGED light extinguishes. This verifies power is removed and electrical lock-out is engaged. A doors EICAS alert message displays if power is not removed from the control system.

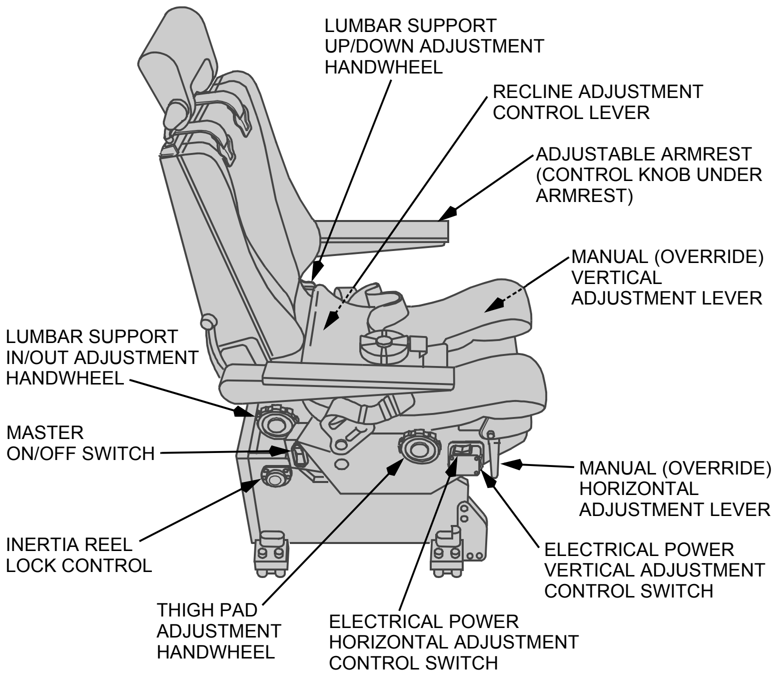
CLOSED and NOT CLOSED lights on the nose cargo door closed annunciator panel and LATCHED and NOT LCHD lights on the nose cargo door latch annunciator panel provide indication of closed and latched conditions when the control system is unpowered.

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.

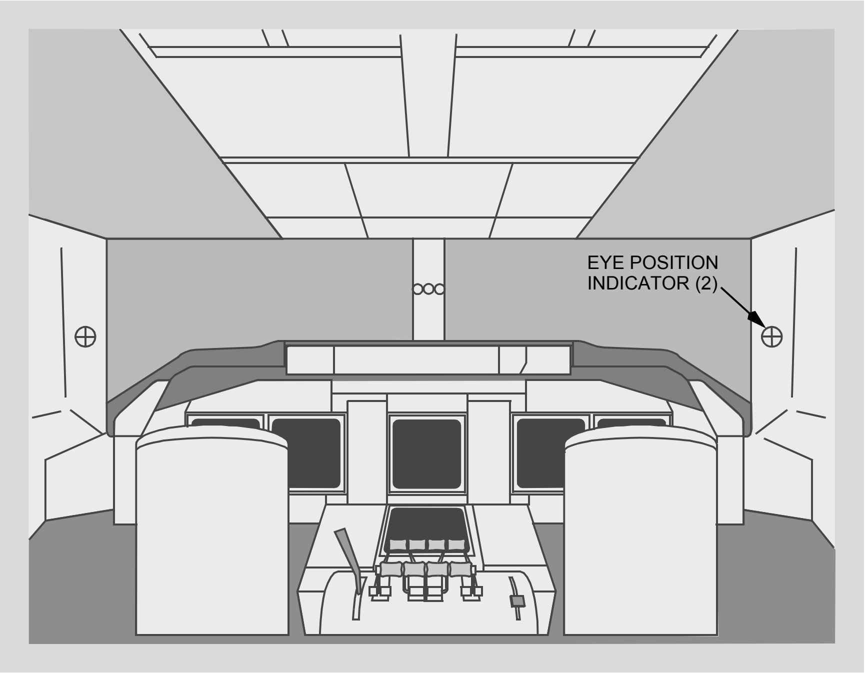
A master ON/OFF switch is located behind the lumbar support in/out adjustment handwheel.

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

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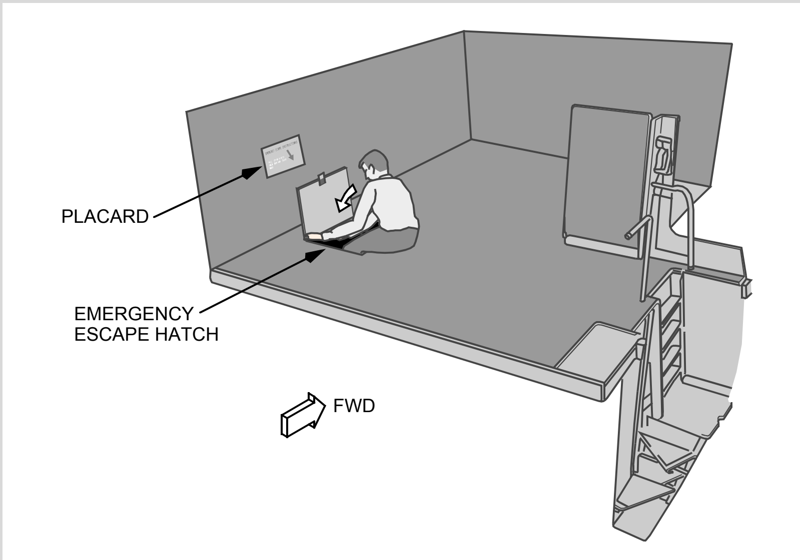
The door 5 overhead crew rest area is entered through a locked door on the right side of the airplane aft of door 5R. An emergency escape hatch is located on the floor on the left side of the crew rest area. To use the emergency escape hatch follow the placarded instructions. In some cases, a bunk must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



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Airplane General, Emergency Equipment, Doors EICAS Messages

The following EICAS messages can be displayed.

EICAS Alert Messages

Message	Level	Aural	Message Logic
>CREW OXY LOW	Advisory		Crew oxygen pressure low.
DOOR AFT CARGO	Caution	Beeper	Aft cargo door not closed and latched and locked condition sensed.
DOOR BULK CARGO	Advisory		Bulk cargo door not closed and latched condition sensed.
DOOR ELEC CTR	Advisory		Electrical equipment door not closed and latched condition sensed.
DOOR ELEC MAIN	Advisory		Electrical equipment door not closed and latched condition sensed.

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DOOR ENTRY L1, L2, L3, L4, L5, R1 R2, R3, R4, R5	Advisory		Main deck entry door not closed and latched condition sensed.

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DOOR ENTRY L1, L5	Advisory		Main deck entry door not closed and latched condition sensed.

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DOOR F/D OVHD	Advisory		Flight deck overhead door not closed and latched condition sensed.

DOOR FWD CARGO	Caution	Beeper	Forward cargo door not closed and latched and locked condition sensed.

Message	Level	Aural	Message Logic
109, 405			
DOOR L, R UPPER DK	Advisory		Upper deck door not closed and latched condition sensed.
570			
DOOR NOSE CARGO	Caution	Beeper	Nose cargo door not closed and latched and locked condition sensed.
570			
DOOR R UPPER DK	Advisory		Upper deck door not closed and latched condition sensed.
405, 570			
DOOR SIDE CARGO	Caution	Beeper	Side cargo door not closed and latched and locked condition sensed.
109, 405			
DOOR U/D FLT LK	Caution	Beeper	Upper deck door automatic lock failed to activate after takeoff.
DOORS ELEC	Advisory		Both electrical equipment doors not closed and latched condition sensed.
109			
DOORS ENTRY L, R	Advisory		Two or more entry doors on the same side not closed and latched condition sensed.
109, 405			
DOORS UPR DECK	Advisory		Both upper deck doors not closed and latched condition sensed.
405, 570			
>ELT ON	Advisory		Emergency locator transmitter activated.

Message	Level	Aural	Message Logic

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

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Message	Level	Aural	Message Logic
>EMER LIGHTS	Advisory		Emergency Lights switch not ARMED, or Emergency Lights switch ARMED and emergency lights activated by switch at upper deck panel.

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

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Message	Level	Aural	Message Logic
SUPRNMRY OXY ON	Advisory		Supernumerary oxygen system activated.

EICAS Memo Messages

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Message	Level	Aural	Message Logic
NO SMOKING ON	Memo		No Smoking switch in ON position.
PASS SIGNS ON	Memo		No Smoking and Seat Belts switches in ON position.
SEATBELTS ON	Memo		Seat Belts switch in ON position.
THERAP OXYGEN ON	Memo		Therapeutic oxygen system activated.

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Air Systems — Chapter 2
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Air Conditioning System

Air Conditioning

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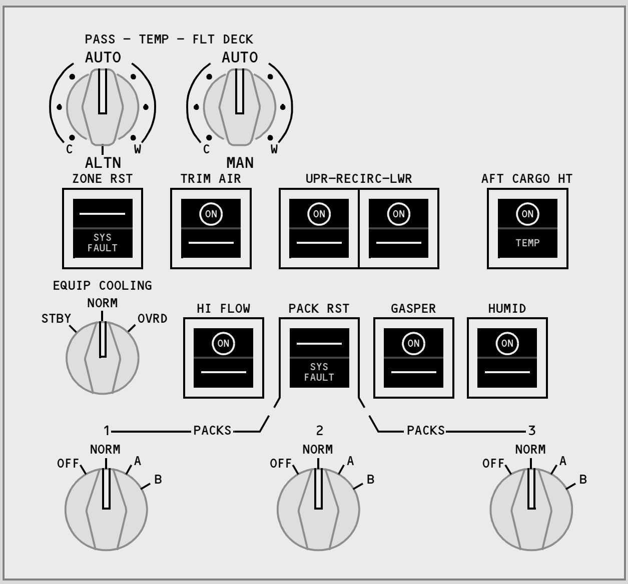
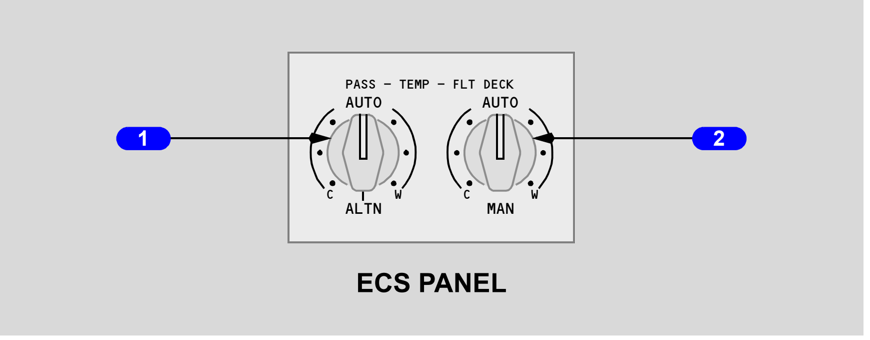
ECS Control



OVERHEAD PANEL

Passenger and Flight Deck Temperature Selectors



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) DECK Temperature (TEMP) Selector

AUTO -

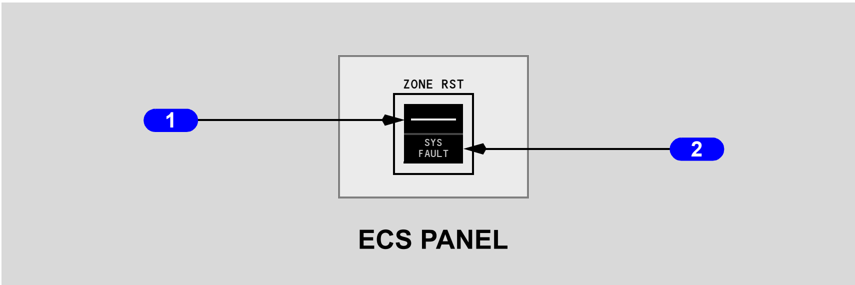
- provides automatic control of flight deck temperature
- range C to W sets flight deck temperature from 65°F (18°C) to 85°F (29°C)

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



1 ZONE Reset (RST) Switch

Push -

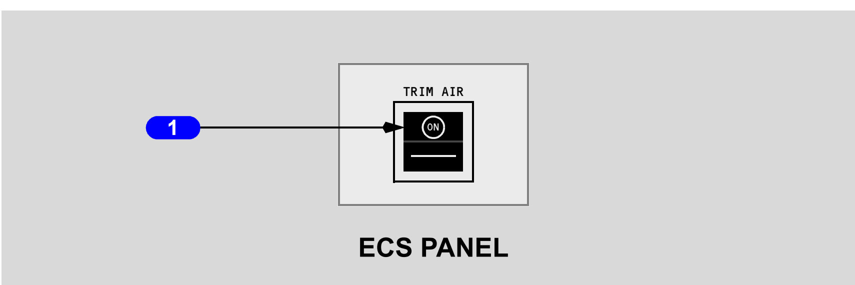
- resets zone temperature controller if fault no longer exists
- reopens master trim air valve if duct overheat no longer exists

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



1 TRIM AIR Switch

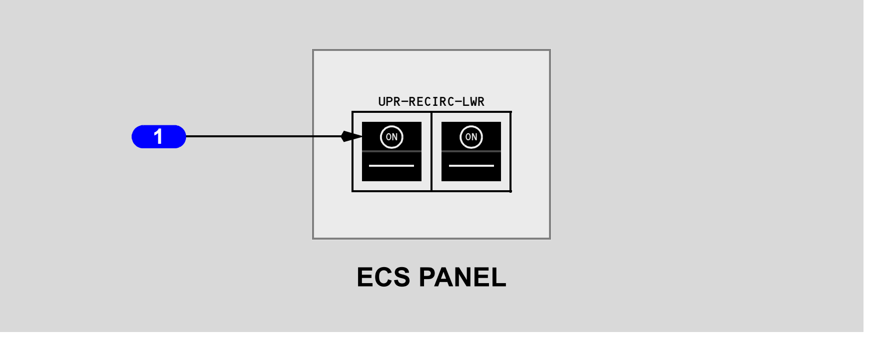
ON -

- 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

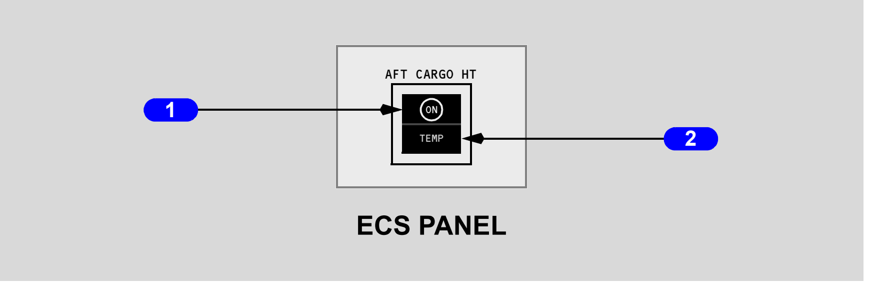


1 Recirculation (RECIRC) Fans Switch

ON - recirculation fans controlled automatically.

Off - recirculation fans off.

Aft Cargo Heat Switch



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

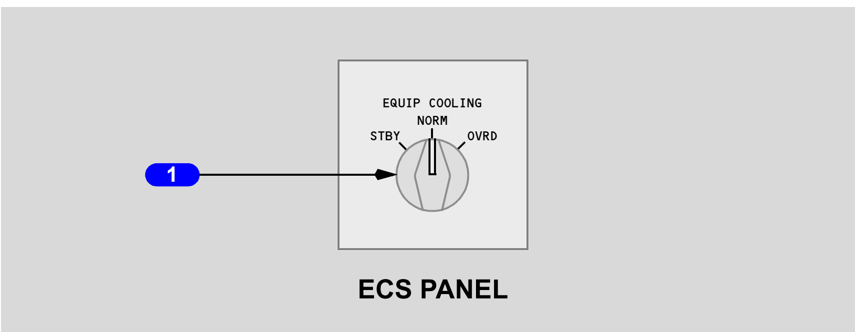
Off - shuts off aft cargo heat bleed air to compartment.

2 Aft Cargo Temperature (TEMP) Light

Illuminated (amber) -

- compartment temperature excessive
- overheat shutoff valve closes

Equipment Cooling Selector



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

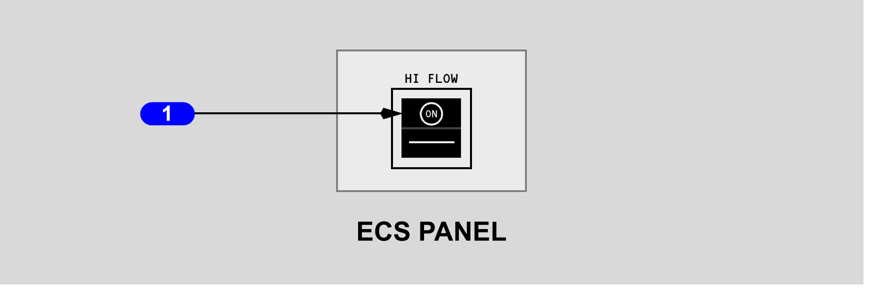
NORM -

- 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



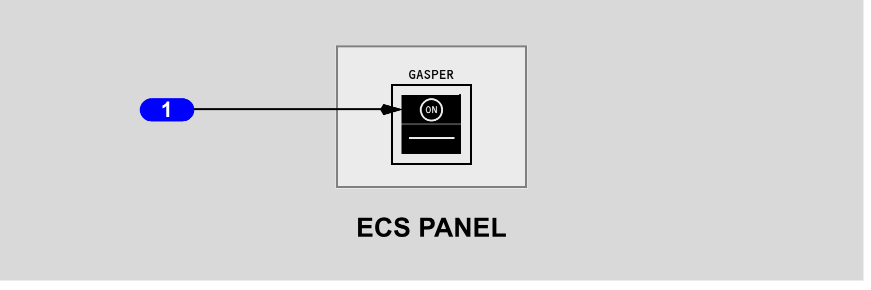
1 Pack High (HI) FLOW Switch

ON -

- all operating packs provide high air flow
- EICAS memo message PACKS HIGH FLOW displays

Off - pack air flow controlled automatically.

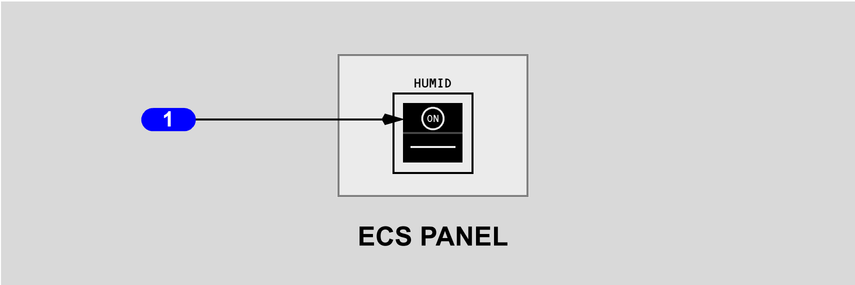
Gasper Switch



1 Gasper Switch

ON - gasper system operates

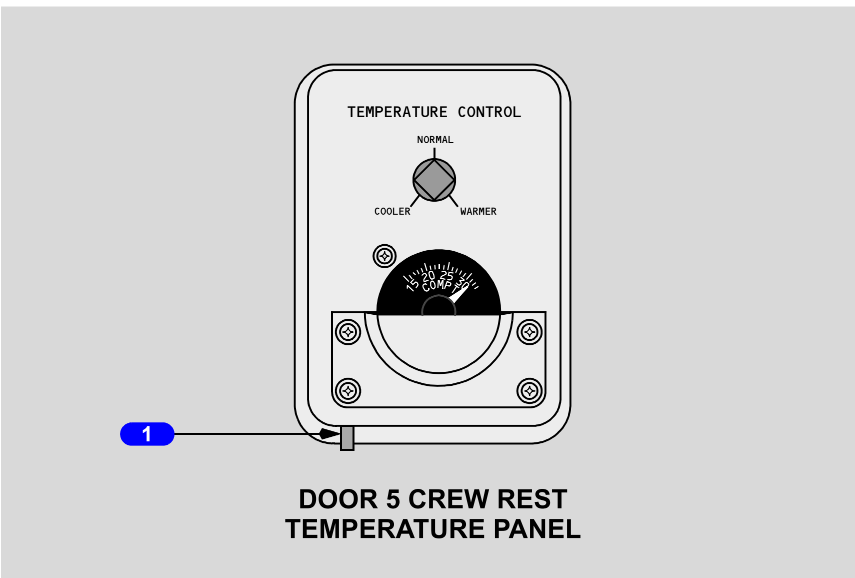
Humidifier Switch



1 Humidifier (HUMID) Switch

ON - flight deck humidifier operates automatically.

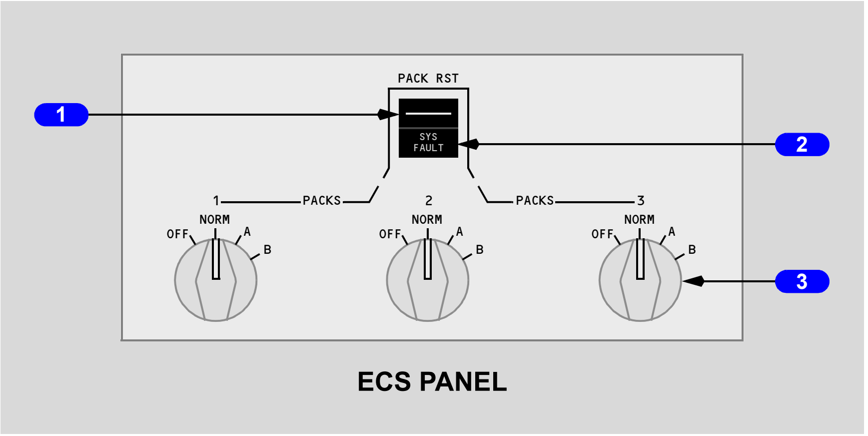
Crew Rest Reset Switch



1 Door 5 Crew Rest Reset Switch

Push - opens door 5 crew rest air supply valves, and resets recirculation fans and valves, if recirculation fans were shut down and valves were closed by crew rest smoke detection system and smoke is no longer detected.

Pack Control



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 Selectors

OFF -

- pack valve closed
- extinguishes 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.

Air Conditioning

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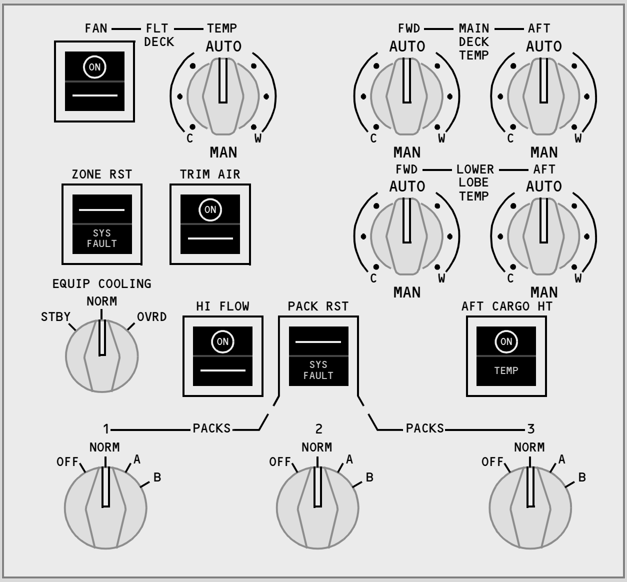
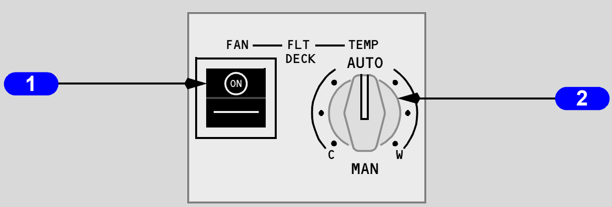
ECS Control



OVERHEAD PANEL

Flight Deck Fan Switch and Flight Deck Temperature Selector



ECS PANEL

1 Flight Deck Fan Switch

ON -

- with all packs off, recirculated cabin air supplied to flight deck
- with at least one pack on, fan increases flow of conditioned air supplied to flight deck

570

- fan disabled in flight

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- fan enabled in flight when windshield air is on.

2 Flight (FLT) DECK Temperature (TEMP) Selector

AUTO -

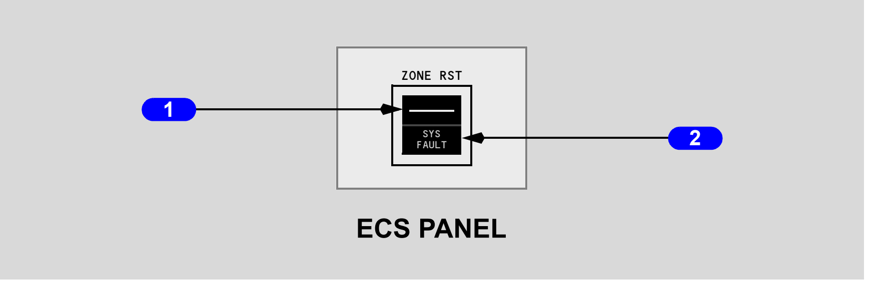
- provides automatic control of flight deck temperature
- range C to W sets flight deck temperature from 65°F (18°C) to 85°F (29°C)
- in backup mode, range C to W sets average flight deck temperature from 65°F (18°C) to 85°F (29°C), cabin temperature panel control of zone temperatures is inhibited, and automatic control of main deck zone temperature is inhibited

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



1 ZONE Reset (RST) Switch

Push -

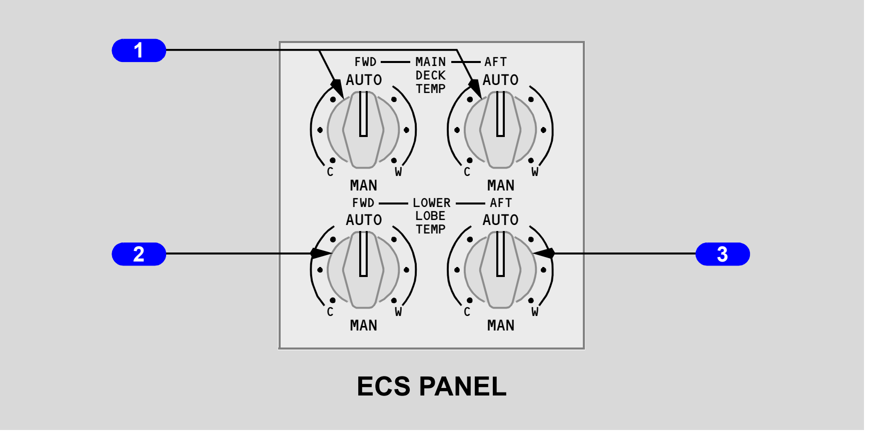
- resets zone temperature controller if fault no longer exists
- reopens master trim air valve if duct overheat no longer exists
- reopens forward or aft lower lobe cargo trim air shut off valve if duct overheat no longer exists

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

Main Deck Temperature Selectors



1 MAIN DECK Temperature (TEMP) Selectors

AUTO -

- provides automatic control of main deck conditioned air temperature
- range C to W sets temperature from 40°F (4°C) to 85°F (29°C)
- in backup mode, automatic control of main deck temperature is inhibited

MAN (spring loaded to 6 o'clock position) - main 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.

2 Forward (FWD) LOWER LOBE Temperature (TEMP) Selector

AUTO -

- provides automatic control of forward lower lobe cargo conditioned air temperature when Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD HIGH, BOTH LOW, or FWD LOW
- range C to W sets temperature from 40°F (4°C) to 85°F (29°C)

MAN (spring loaded to 6 o'clock position) -

- forward lower lobe cargo trim air valve controlled manually when Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD HIGH, BOTH LOW, or FWD LOW
- resets forward lower lobe cargo conditioned air supply duct shutoff valve if valve closed by duct overheat

C (cool) - valve moves toward closed to provide cooler air.

W (warm) - valve moves toward open to provide warmer air.

3 AFT LOWER LOBE Temperature (TEMP) Selector

AUTO -

- provides automatic control of aft lower lobe cargo conditioned air temperature when Lower Lobe Cargo Conditioned Air Flow Rate selector in AFT HIGH, BOTH LOW, or AFT LOW
- range C to W sets temperature from 40°F (4°C) to 85°F (29°C)

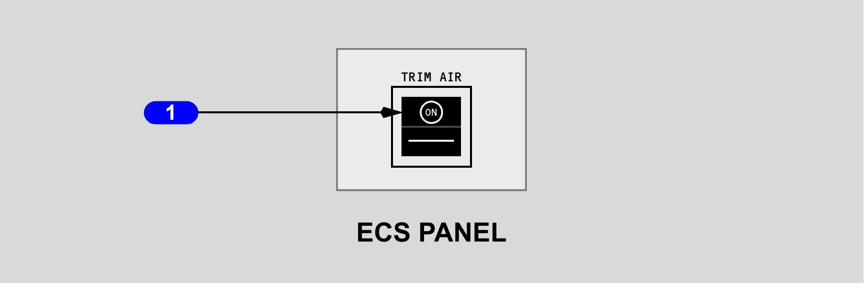
MAN (spring loaded to 6 o'clock position) -

- aft lower lobe cargo trim air valve controlled manually when Lower Lobe Cargo Conditioned Air Flow Rate selector in AFT HIGH, BOTH LOW, or AFT LOW
- resets aft lower lobe cargo conditioned air supply duct shutoff valve if valve closed by duct overheat

C (cool) - valve moves toward closed to provide cooler air.

W (warm) - valve moves toward open to provide warmer air.

Trim Air Switch



1 TRIM AIR Switch

ON -

405

- master trim air valve open and flight deck, upper deck, and main deck zone trim air valves operate automatically

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- master trim air valve open and flight deck, upper deck, crew rest, and main deck 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 flight deck temperature from 65°F (18°C) to 85°F (29°C) as selected by Flight Deck Temperature selector in AUTO

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- cabin temperature panel control of upper deck zone temperatures inhibited

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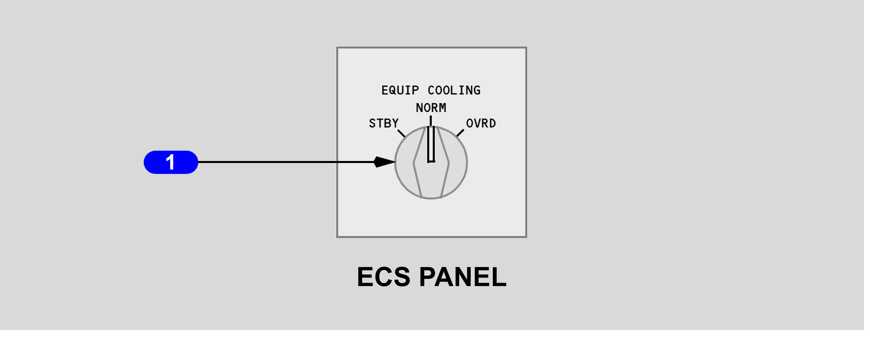
- cabin temperature panel control of crew rest and upper deck zone temperatures inhibited
- pack controller A selected and both automatic and manual selection of pack controller B inhibited
    - if pack controller A failed, pack controller B selected automatically

Equipment Cooling Selector



1 Equipment (EQUIP) COOLING Selector

STBY -

- ground exhaust valve closed
- automatic control bypassed to configure system for flight; inboard exhaust valve open
- with a single internal fault, equipment inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

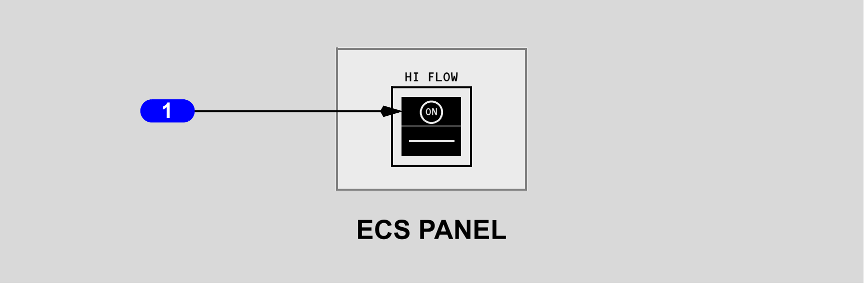
NORM -

- ground operation based on ambient temperature, position of Lower Lobe Cargo Conditioned Air Flow Rate selector, and temperature selected by the Forward LowerLobe Cargo Temperature Selector; equipment cooling air exhausted overboard, or exhausted into forward cargo compartment
- with two or more engines running, Lower Lobe Cargo selector in OFF, AFT LOW, or AFT HIGH; cooling air exhausted into forward cargo compartment and ground exhaust valve closed
- with two or more engines running, Lower Lobe Cargo selector in FWD LOW, BOTH LOW, or FWD HIGH and forward lower lobe cargo temperature selected less than 50°F (10°C), inboard exhaust valve closed and equipment cooling air recirculated in a closed loop mode
- with a single internal fault, equipment inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

OVRD -

- inboard exhaust valve closed
- ground exhaust valve closed
- equipment supply valve closed; cooling air supplied through flight panels
- smoke/override valve open; differential pressure exhausts cooling air overboard

Pack High Flow Switch



1 Pack High (HI) FLOW Switch

ON -

- all operating packs configured to high flow
- EICAS memo message PACKS HIGH FLOW displays

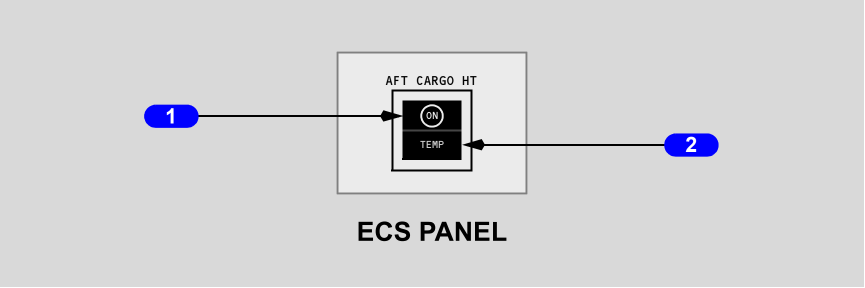
Off (Lower Lobe Cargo Conditioned Air Flow Rate selector in HIGH or BOTH LOW) - no effect on pack flow rates. All packs remain in high flow.

Off (Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD LOW) - packs one and two contolled automatically. Pack three remains in high flow.

Off (Lower Lobe Cargo Conditioned Air Flow Rate selector in AFT LOW) - packs one and three contolled automatically. Pack two remains in high flow.

Off (Lower Lobe Cargo Conditioned Air Flow Rate selector in OFF) - pack air flow controlled automatically.

Aft Cargo Heat Switch



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

Crew Rest Reset Switch
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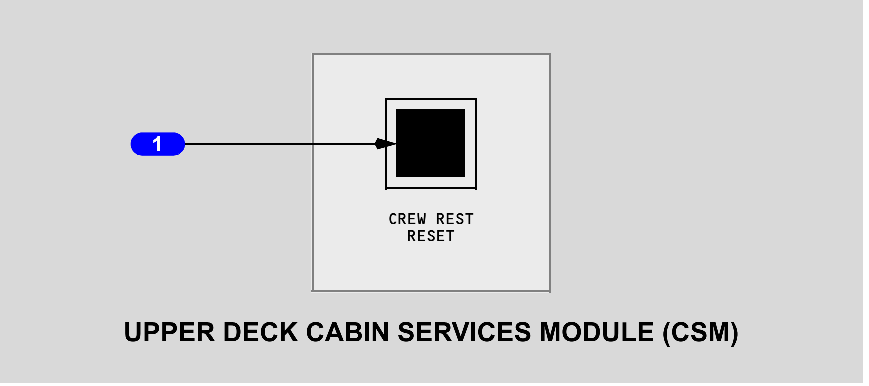
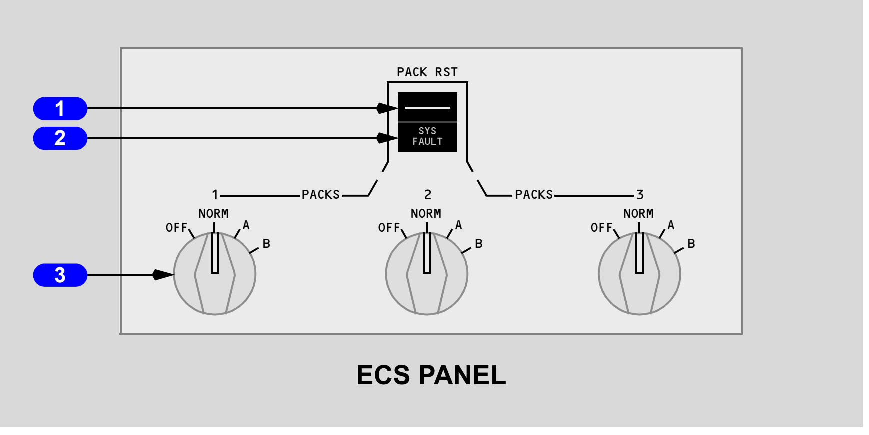


1 Crew Rest Reset Switch

Push - opens and resets crew rest air supply valves if valves were closed by crew rest smoke detection system and smoke is no longer detected.

Pack Control



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
  570
- may illuminate briefly when automatically or manually switching from pack temperature controller A to B or B to A

3 PACK Control Selectors

OFF -

- pack valve closed
- extinguishes SYS FAULT light for pack selected off
- resets pack fault protection system

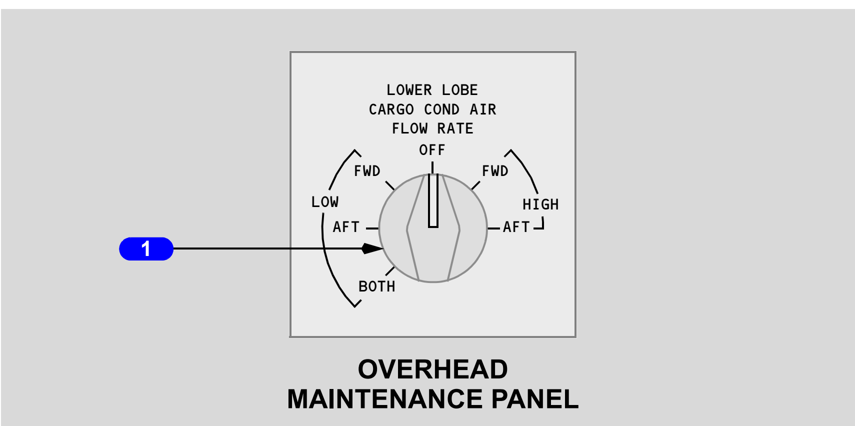
Normal (NORM) -

- 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.

Lower Lobe Cargo Conditioned Air Flow Rate Selector



1 LOWER LOBE CARGO Conditioned (COND) AIR FLOW RATE Selector

OFF -

- forward and aft lower lobe cargo air conditioning off
- resets lower lobe cargo conditioned air supply duct shutoff valves if valves closed by duct overheat

FWD LOW - two-thirds of pack three conditioned air distributed to forward lower lobe cargo compartment.

AFT LOW - two-thirds of pack two conditioned air distributed to aft lower lobe cargo compartment.

BOTH LOW - two-thirds of pack three and pack two conditioned air distributed respectively to forward and aft lower lobe cargo compartments.

FWD HIGH - all pack three conditioned air distributed to forward lower lobe cargo compartment.

AFT HIGH - all pack two conditioned air distributed to aft lower lobe cargo compartment.

Pilot Auxiliary Heat and Windshield Air

Electric shoulder heater and foot heater operate only in flight.

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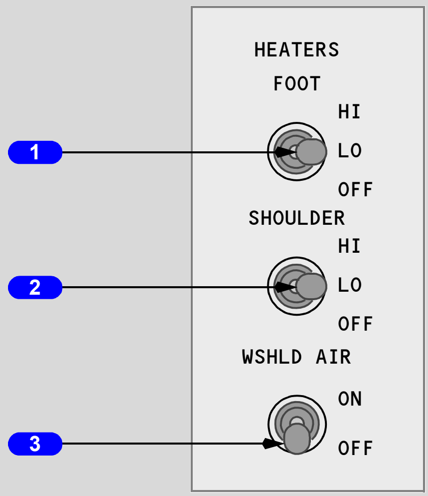

CAPTAIN AND FIRST OFFICER
SIDEWALL PANELS

1 FOOT Heater Switch

Control temperature is the same in HI and LO. Heater is inhibited when temperature of foot heater plate is warmer than 65°F (18°C).

HI - under-floor electric heater operates at high heating rate.

LO - under-floor electric heater operates at low heating rate.

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.

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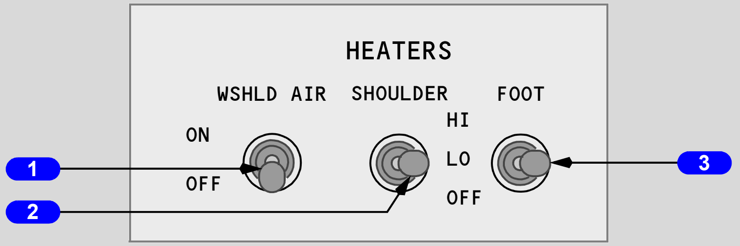

CAPTAIN AND FIRST OFFICER
SIDEWALL PANELS

1 Windshield (WSHLD) AIR Switch

ON - supplemental anti-fogging air supplied to windshield.

OFF - anti-fogging air 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 FOOT Heater Switch

Control temperature is the same in HI and LO. Heater is inhibited when temperature of foot heater plate is warmer than 65°F (18°C).

HI - under-floor electric heater operates at high heating rate.

LO - under-floor electric heater operates at low heating rate.

OFF - under-floor electric heater off.

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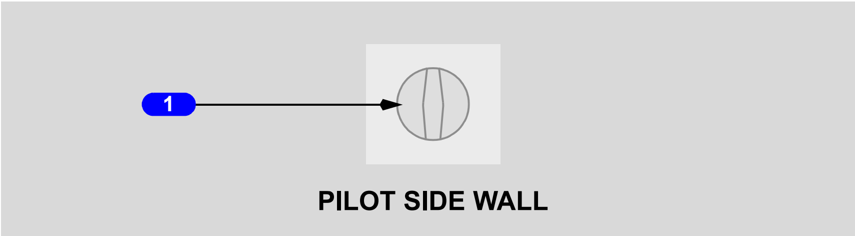
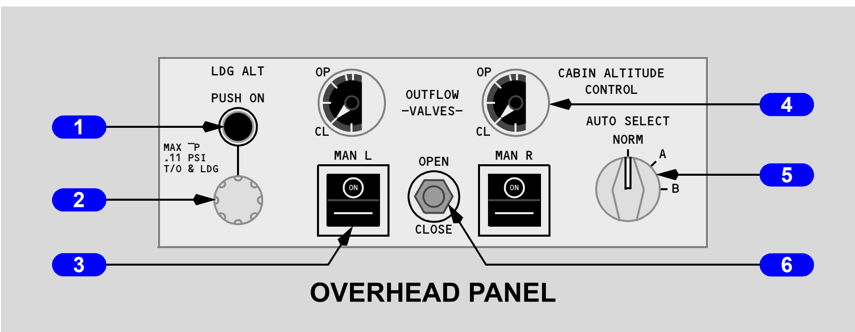


1 Shoulder Air Selector

Rotate - Sets air flow to side window shoulder air outlet

Pressurization System

Cabin Altitude Control



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 followed by MAN displayed on primary EICAS
- the EICAS advisory message LANDING ALTITUDE is displayed

Automatic -

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

2 Landing Altitude (LDG ALT) Selector

Rotate - sets landing altitude when MAN displayed on primary EICAS.

3 Outflow Valve Manual (MAN) Switches

ON -

- outflow valve in controlled manually
- 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.

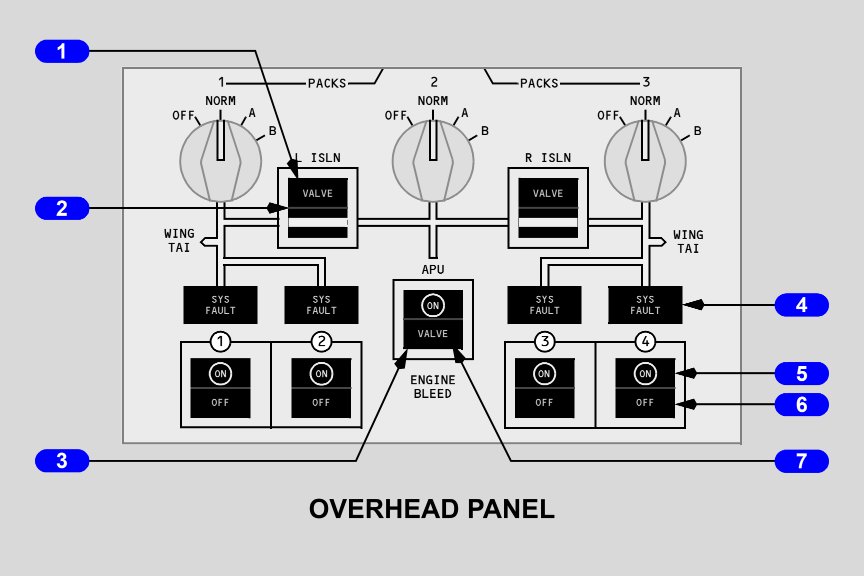
B - selects cabin altitude controller B as primary controller; selects A if B fails.

6 Outflow Valves Manual Control

OPEN - moves the outflow valve toward open.

CLOSE - moves the outflow valve toward closed.

Bleed Air Control



1 Isolation (ISLN) VALVE Lights

Illuminated (amber) - isolation valve position disagrees with switch position

2 Isolation (ISLN) Valve Switches

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 Lights

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 Switches

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 switch ON, unless PRV closed by:
  - prior or present bleed air overheat, or
  - start valve not closed, or
  - HP bleed valve failed open

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- 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 Lights

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.

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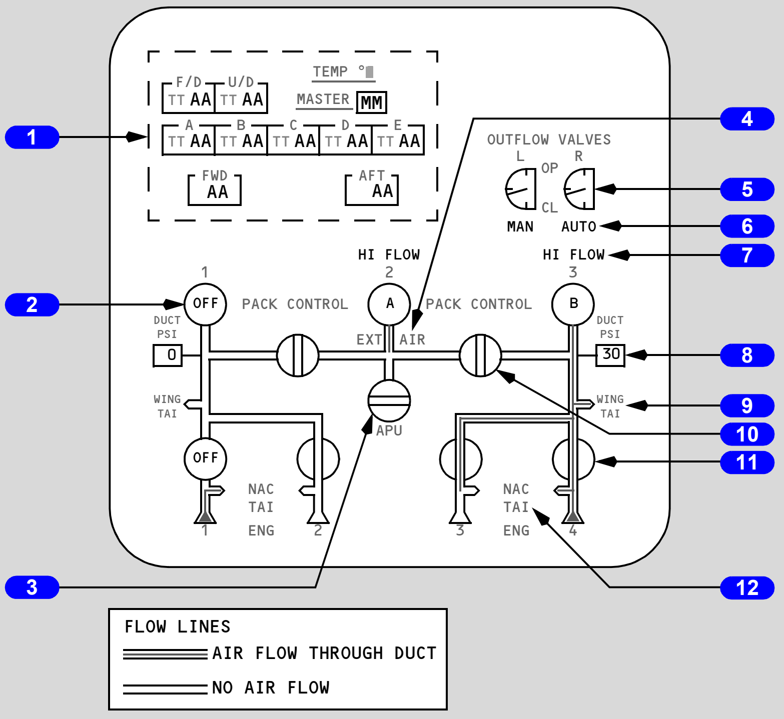

LOWER EICAS DISPLAY

1 Zone Temperatures

F/D, U/D, A, B, C, D, and E - zone target and actual temperatures for respective air conditioning zone:

- (TT) target temperature on left; displayed when:
  - at least one pack operating, and
  - Passenger Temperature selector in AUTO, and
  - temperature control not in backup made
- (AA) actual temperature on right

MASTER - (MM) temperature setting of Passenger Temperature selector.

FWD, AFT - (AA) 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 cabin altitude controller controls 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

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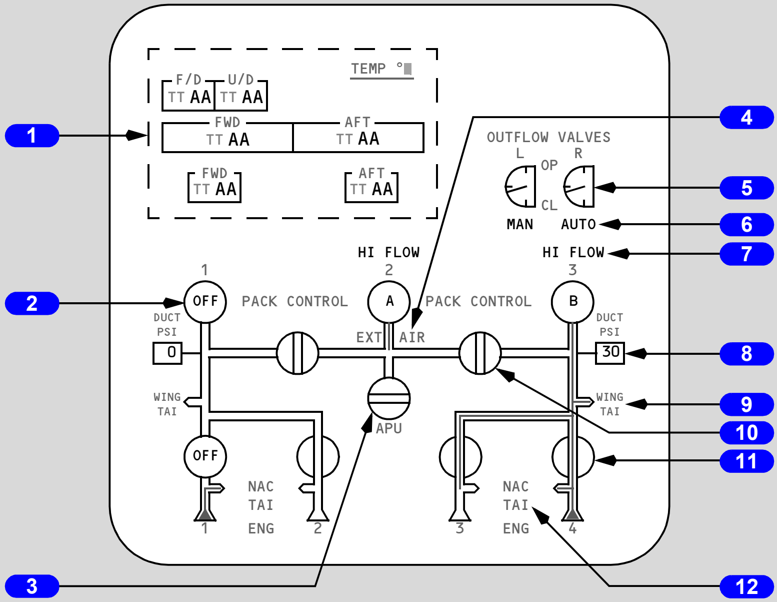

LOWER EICAS DISPLAY

1 Zone Temperatures

F/D, U/D, FWD main deck, and AFT main deck -

- (TT) target temperature on left; displayed when:
  - at least one pack operating, and
  - temperature control not in backup made
- (AA) actual temperature on right

FWD lower lobe cargo -

- (TT) target temperature on left, (AA) actual temperature on right, when Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD LOW, FWD HIGH, or BOTH
- (AA) actual temperature only, when Lower Lobe Cargo Conditioned Air Flow Rate selector AFT LOW, AFT HIGH, or OFF

AFT lower lobe cargo -

- (TT) target temperature on left, (AA) actual temperature on right, when Lower Lobe Cargo Conditioned Air Flow Rate selector in AFT LOW, AFT HIGH, or BOTH
- (AA) actual temperature only, when Lower Lobe Cargo Conditioned Air Flow Rate selector FWD LOW, FWD HIGH, or OFF

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

- 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

OP - open.

CL - closed.

6 Outflow Valve Control Source

MAN - manual control.

AUTO - indicates cabin altitude controller controls outflow valves.

7 High Flow

HI FLOW - pack in high flow

Blank - pack in normal flow or pack OFF.

8 **Bleed Air Duct Pressure**

White - 12 psi and above.

Amber - 11 psi and below.

9 **Wing Anti-ice**

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**

Indicates nacelle anti-ice on.

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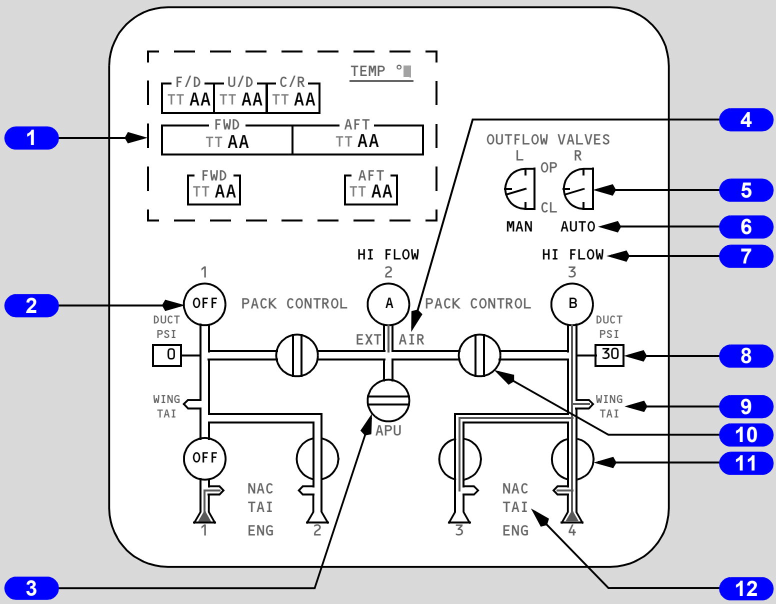


LOWER EICAS DISPLAY

1 Zone Temperatures

F/D, U/D, C/R, FWD main deck, and AFT main deck -

- (TT) target temperature on left; displayed when:
  - at least one pack operating, and
  - temperature control not in backup made
- (AA) actual temperature on right

FWD lower lobe cargo -

- (TT) target temperature on left, (AA) actual temperature on right, when Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD LOW, FWD HIGH, or BOTH
- (AA) actual temperature only, when Lower Lobe Cargo Conditioned Air Flow Rate selector AFT LOW, AFT HIGH, or OFF

AFT lower lobe cargo -

- (TT) target temperature on left, (AA) actual temperature on right, when Lower Lobe Cargo Conditioned Air Flow Rate selector in AFT LOW, AFT HIGH, or BOTH
- (AA) actual temperature only, when Lower Lobe Cargo Conditioned Air Flow Rate selector FWD LOW, FWD HIGH, or OFF

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

- 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

OP - open.

CL - closed.

6 Outflow Valve Control Source

MAN - manual control.

AUTO - indicates cabin altitude controller controls outflow valves.

7 High Flow

HI FLOW - pack in high flow

Blank - pack in normal flow or pack OFF.

8 Bleed Air Duct Pressure

White - 12 psi and above.

Amber - 11 psi and below.

9 Wing Anti-ice

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.

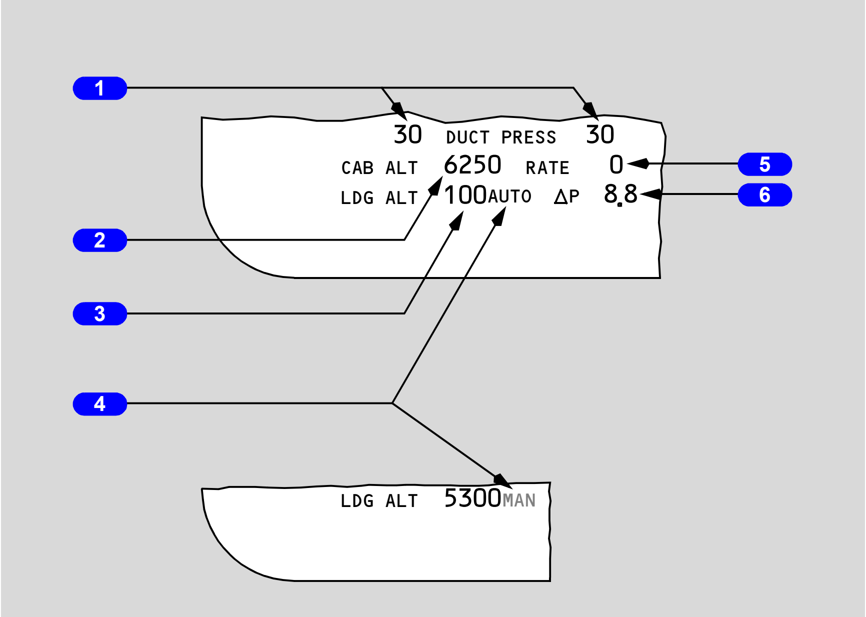
12 Nacelle Anti-ice

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

White - normal range.

Amber - above normal range.

Red - excessive cabin altitude.

3 **Landing Altitude**

- inhibited if both cabin altitude controllers A and B fail
- inhibited if both outflow valves are in MAN

4 **Landing Altitude Selection**

AUTO (white) - altitude set automatically from FMC - Refer to Chapter 11, Flight Management Navigation, Arrivals Page - IFR Approaches.

MAN (amber) - altitude set by Landing Altitude selector.

5 **Cabin Altitude Rate**

+ (plus) - rate of climb.

- (minus) - rate of descent.

6 **Cabin Differential Pressure**

White - normal range.

Amber - above normal range.

Red - excessive cabin differential pressure.

Introduction

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

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The air conditioning system supplies conditioned bleed air at controlled temperature throughout the airplane.

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

109

The system supplies ventilation for the passenger cabin:

- lavatories
- galleys
- flight deck crew rest
- individual passenger seat gaspers
- door 5 crew rest

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The system supplies ventilation for the lavatory, crew rest, and upper deck.

405

The system supplies ventilation for the lavatory and crew rest.

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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.

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

109

The airplane is divided into seven temperature zones:

- flight deck
- upper deck
- five main deck cabin zones A through E

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The airplane is divided into six temperature zones:

- flight deck
- upper deck
- forward and aft main deck
- forward and aft lower lobe cargo zones

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The airplane is divided into seven temperature zones:

- flight deck
- upper deck
- crew rest
- forward and aft main deck
- forward and aft lower lobe cargo zones

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 temperature controllers (PTCs), A and B. Each PTC has three separate channels, one for each pack. Control of the packs switches automatically to the other PTC at touchdown. If a PTC detects a fault in a pack channel, control of the respective pack switches to the other PTC.

When a PACK Control selector is placed in NORM, A, or B, the respective pack valve opens, which allows bleed air to flow into the pack. The pack valve is controlled electrically by the PTC 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. Fuel consumption is reduced approximately 0.3% for each pack in normal flow.

In cruise, pushing the Pack High Flow switch ON configures all three packs to high flow.

Pack Non-Normal Operation

Pack control, fault detection, and overheat protection are all automatic. When an overheat or PTC fault is detected, the respective pack valve closes resulting in a pack shut down.

If a PTC does not switch automatically to the other PTC, selecting A or B manually selects the respective PTC when the Trim Air switch is ON. An attempt to restore pack operation may be made by pushing 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 PTCs 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.

Conditioned Air Distribution

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Recirculation fans assist the packs to maintain a constant ventilation rate throughout the passenger 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.

Pack flow rate and recirculation fan operation are configured by:

- the phase of fight,
- the number of air conditioning packs operating, and
- the number of recirculation fans operating.

The system reconfigures pack flow rate and recirculation fan operation automatically when fans or packs are shut down or fail.

Cargo Fire Arm

When a Cargo Fire Arm switch is pushed, pack operation and air distribution is configured to starve the affected zone of fresh air, minimize air movement, purge smoke from the flight deck and passenger cabin, and assure the supply of fresh air to the flight deck.

Crew Rest Smoke Detection Mode

If smoke is detected in the door five crew rest, the crew rest air supply valves close and the recirculation fans shutdown. The valves remain closed and the fans remain shutdown until reset. Pushing the Door 5 Crew Rest Reset switch opens and resets the valves and resets the recirculation fans if smoke is no longer detected.

Air Distribution Diagram

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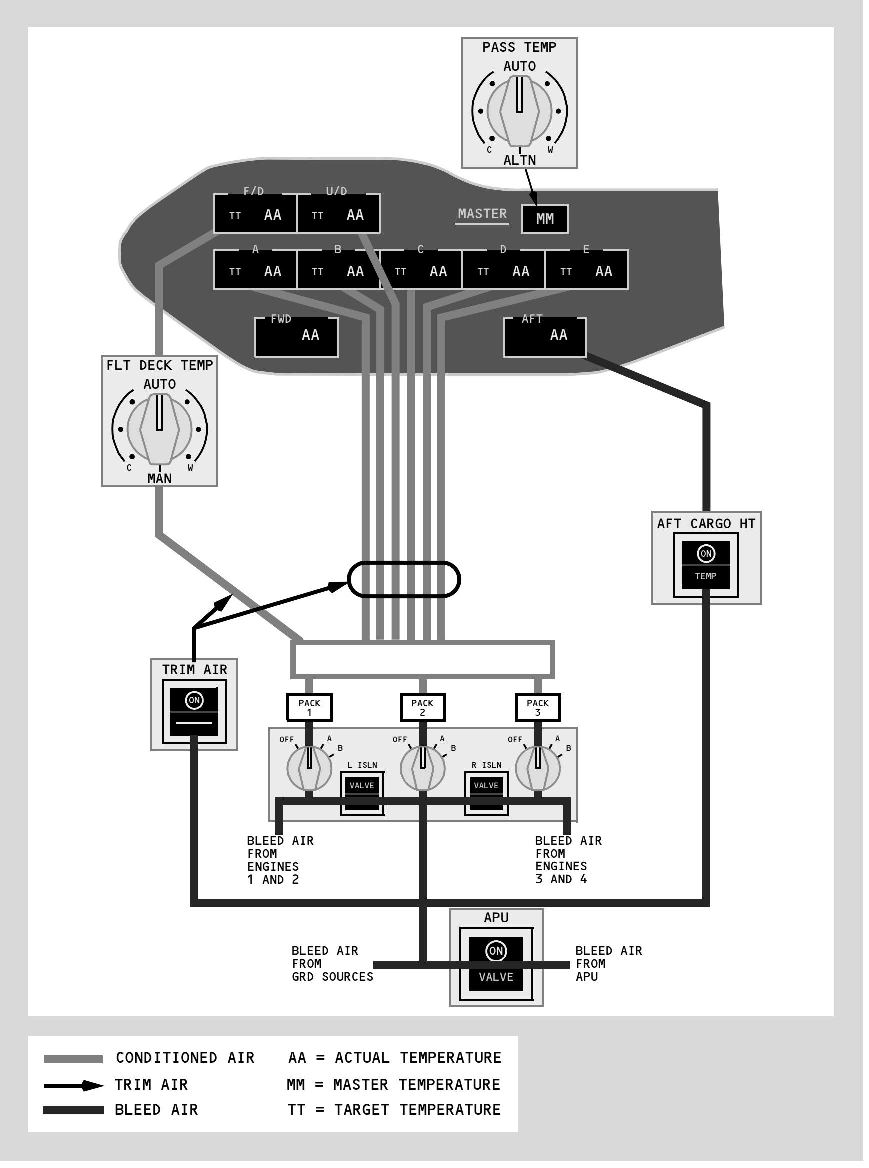

Temperature Control

109

Zone temperatures are controlled by the zone temperature controller (ZTC).

Hot trim air from the bleed air system is added through trim air valves in the zone conditioned air supply ducts. The ZTC modulates the zone trim air valves to regulate the temperature of the conditioned air in each zone.

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

Passenger 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 master passenger cabin temperature for all passenger temperature zones is automatically increased or decreased and manually modified to set target temperatures for each passenger temperature zone.

Automatic Passenger Comfort Compensation Of Zone Target Temperatures

For passenger comfort, the ZTC compensates for temperature changes as cabin air humidity and passenger activity decrease during flight. The passenger cabin zone target temperatures slowly increase automatically during the early part of the flight. The flight crew does not have to manually increase target temperatures to compensate for the increase in humidity and decrease in passenger activity. Target temperatures decrease slowly automatically during descent until all passenger comfort temperature compensation is removed.

Manual Modifications To Zone Target Temperatures

The target temperatures of each passenger zone may be further modified plus or minus 10°F (6°C) within the range of 65°F (18°C) to 85°F (29°C) from the comfort compensated master temperature. This is accomplished with the cabin temperature panel located at door two right.

The cabin temperature panel accepts temperature modifications when at least two engines are operating.

Temperature Control With Loss of Trim Air System

Trim air is not available to the flight deck and main deck conditioned air distribution system if:

- the EICAS advisory message TEMP ZONE is displayed,
- the center section of the bleed duct is isolated,
- the EICAS advisory message TRIM AIR OFF is displayed, or
- the Master Trim Air switch is OFF.

If trim air is not available to the distribution system, backup modes control temperature in the passenger temperature zones of the cabin:

- if the Passenger Temperature selector setting is available to the PTC, 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, or
- if the Passenger Temperature selector setting is unavailable to the PTC, pack outlet temperature is regulated to achieve the last passenger temperature set, or
- if the last passenger temperature set is unavailable to the PTC, pack outlet temperature is regulated to achieve an average cabin temperature of 75°F (24°C)

Temperature Control Non-Normal Operation

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 controls cabin temperature. An attempt to restore zone temperature control can be made by pushing the Zone Reset switch.

Conditioned Air Distribution

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Pack flow rate is configured by:

- the position of the Lower Lobe Cargo Conditioned Air Flow Rate selector,
- the phase of fight, and
- the number of operating air conditioning packs.

The system reconfigures pack flow rate automatically when packs are shut down or fail.

Forward Lower Lobe Cargo Conditioned Air Distribution

Forward lower lobe cargo conditioned air is supplied directly from pack three. The volume of conditioned air supplied to forward lower lobe cargo is controlled by the position of the Lower Lobe Cargo Conditioned Air Flow Rate selector.

With the selector in FWD HI:

- all pack three air is distributed to forward lower lobe cargo
- all packs remain in high flow during cruise

With the selector in FWD LOW:

- pack three air is distributed to both forward lower lobe cargo and the cabin
- pack three remains in high flow during cruise

With the selector in BOTH LOW:

- pack three air is distributed to both forward lower lobe cargo and the cabin
- all packs remain in high flow during cruise

With the Lower Lobe Cargo Conditioned Air Flow Rate selector in OFF or AFT, conditioned air to the forward lower lobe cargo compartment is shut off. All pack three air is distributed to the cabin.

The cargo exhaust system discharges the forward lower lobe cargo conditioned air overboard to prevent offensive odors from migrating from the cargo compartment into the cabin. The flight exhaust system discharges the air overboard through the overboard valve on the fuselage side skin.

Aft Lower Lobe Cargo Conditioned Air Distribution

Aft lower lobe cargo conditioned air is supplied directly from pack two. The volume of conditioned air supplied to aft lower lobe cargo is controlled by the position of the Lower Lobe Cargo Conditioned Air Flow Rate selector.

With the selector in AFT HI:

- all pack two air is distributed to aft lower lobe cargo
- all packs remain in high flow during cruise

With the selector in AFT LOW:

- pack two air is distributed to both aft lower lobe cargo and the cabin
- pack two remains in high flow during cruise

With the selector in BOTH LOW:

- pack two air is distributed to both aft lower lobe cargo and the cabin
- all packs remain in high flow during cruise

With the Lower Lobe Cargo Conditioned Air Flow Rate selector OFF or FWD, conditioned air to the aft lower lobe cargo compartment is shut off. All pack two air is distributed to the cabin.

Aft cargo heat is normally selected ON when aft lower lobe cargo conditioned air is selected. This configuration ensures the compartment floor temperature is maintained above freezing.

Flight Deck Fan

On the ground, the flight deck fan increases flow of conditioned air to the flight deck when at least one pack is operating and supplies recirculated air to the flight deck when all packs are off.

405

In flight, the flight deck fan is enabled when windshield air is on.

Cargo Fire Arm

When a Cargo Fire Arm switch is pushed, pack operation and air distribution is configured to starve the affected zone of fresh air, minimize air movement, purge smoke from the flight deck and upper deck, and increase the supply of fresh air to the flight deck.

Air Distribution Diagram

405, 570

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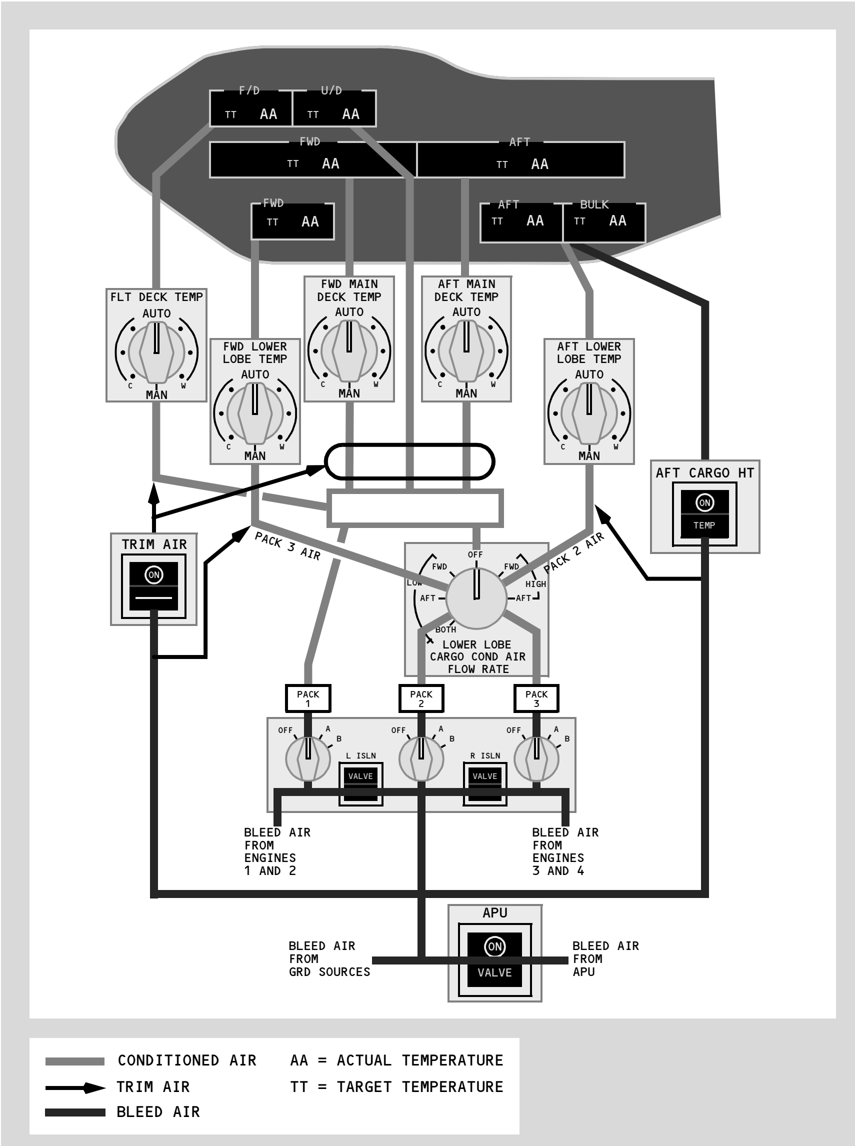

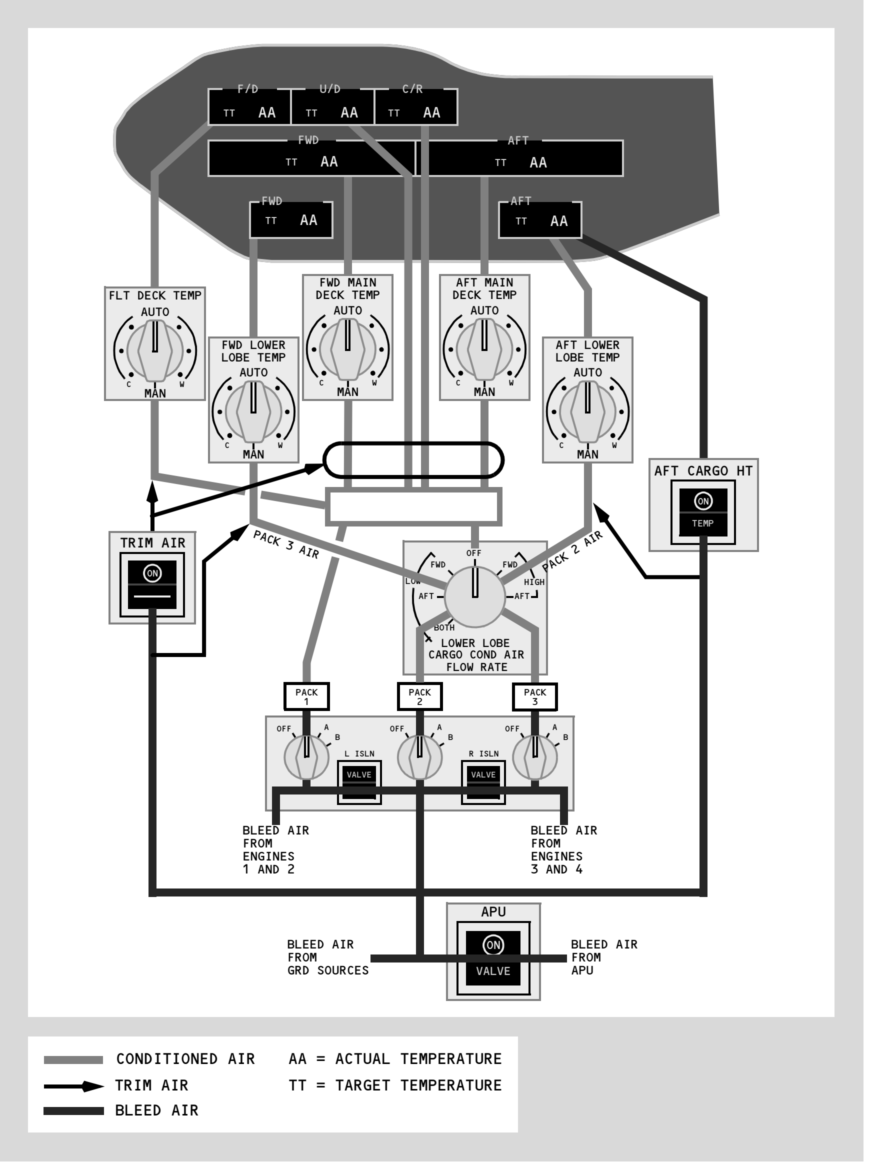
F/D
TT AA
U/D
TT AA
C/R
TT AA
FWD
TT AA
AFT
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FWD
TT AA
AFT
TT AA
FLT DECK TEMP
AUTO
C W
MAN
FWD LOWER LOBE TEMP
AUTO
C W
MAN
FWD MAIN DECK TEMP
AUTO
C W
MAN
AFT MAIN DECK TEMP
AUTO
C W
MAN
AFT LOWER LOBE TEMP
AUTO
C W
MAN
AFT CARGO HT
ON
TEMP
TRIM AIR
ON
PACK 3 AIR
PACK 2 AIR
OFF
FWD
FWD
LOW
HIGH
AFT
AFT
BOTH
LOWER LOBE CARGO COND AIR FLOW RATE
PACK 1
PACK 2
PACK 3
OFF A B
L ISLN
VALVE
R ISLN
VALVE
BLEED AIR FROM ENGINES 1 AND 2
BLEED AIR FROM ENGINES 3 AND 4
APU
ON
VALVE
BLEED AIR FROM GRD SOURCES
BLEED AIR FROM APU
CONDITIONED AIR
TRIM AIR
BLEED AIR
AA = ACTUAL TEMPERATURE
TT = TARGET TEMPERATURE

Temperature Control

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Zone temperatures are controlled by the zone temperature controller (ZTC).

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When the Lower Lobe Cargo Conditioned Air Flow Rate selector is OFF, the flight deck, upper deck, or main deck temperature zone requiring the coolest temperature controls pack outlet temperature.

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When the Lower Lobe Cargo Conditioned Air Flow Rate selector is OFF, the flight deck, upper deck, crew rest, or main deck temperature zone requiring the coolest temperature controls pack outlet temperature.

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When the Lower Lobe Cargo Conditioned Air Flow Rate selector is in FWD HI, pack three outlet temperature is controlled to maintain the lower lobe forward cargo compartment at the temperature set by the Cargo Temperature Selector. The flight deck, upper deck, or main deck cargo temperature zone requiring the coolest temperature controls pack outlet temperature of packs one and two.

570

When the Lower Lobe Cargo Conditioned Air Flow Rate selector is in FWD HI, pack three outlet temperature is controlled to maintain the lower lobe forward cargo compartment at the temperature set by the Cargo Temperature Selector. The flight deck, upper deck, crew rest, or main deck cargo temperature zone requiring the coolest temperature controls pack outlet temperature of packs one and two.

405

When the Lower Lobe Cargo Conditioned Air Flow Rate selector is in AFT HI, pack two outlet temperature is controlled to maintain the lower lobe aft cargo compartment at the temperature set by the Cargo Temperature Selector.The flight deck, upper deck, or main deck cargo temperature zone requiring the coolest temperature controls pack outlet temperature of packs one and three.

570

When the Lower Lobe Cargo Conditioned Air Flow Rate selector is in AFT HI, pack two outlet temperature is controlled to maintain the lower lobe aft cargo compartment at the temperature set by the Cargo Temperature Selector.The flight deck, upper deck, crew rest, or main deck cargo temperature zone requiring the coolest temperature controls pack outlet temperature of packs one and three.

When the Lower Lobe Cargo Conditioned Air Flow Rate selector is in LOW, the ZTC limits outlet temperature of the pack supplying the selected lower lobe cargo compartment to be not higher than the outlet temperature of the other two packs. The ZTC regulates the temperature of the selected lower lobe cargo compartment by;

- closing the trim air modulating valve and supplying cooler air from the pack supplying conditioned air to the compartment, or
- modulating the cargo trim air valve to supply warmer conditioned air.

Trim air for each lower lobe cargo zone is supplied directly from the bleed air duct and is not controlled by the Master Trim Air valve.

405

The ZTC regulates the temperature of the flight deck, upper deck, and main deck cargo zones by modulating the respective zone trim air valves.

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The ZTC regulates the temperature of the flight deck, upper deck, crew rest, and main deck cargo zones by modulating the respective zone trim air valves.

Zone Target Temperatures

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The upper deck zone target temperature is set to 75°F (24°C) when electrical power is initially applied to the airplane.

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The upper deck and crew rest zone target temperatures are set to 75°F (24°C) when electrical power is initially applied to the airplane.

Modifications To Zone Target Temperatures

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The target temperatures of the upper deck 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 master temperature. This is accomplished with the cabin temperature panel located on the upper deck. The cabin temperature panel accepts temperature modifications whenever the ZTC is powered.

570

The target temperatures of the upper deck and crew rest zones may be modified plus or minus 10°F (6°C) within the range of 65°F (18°C) to 85°F (29°C) from master temperature. This is accomplished with the cabin temperature panel located on the upper deck. The cabin temperature panel accepts temperature modifications whenever the ZTC is powered.

Temperature Control With Loss of Trim Air System

405

Trim air is not available to the flight deck, upper deck, and main deck conditioned air distribution system if:

- the EICAS advisory message TEMP ZONE is displayed,
- the center section of the bleed duct is isolated,
- the EICAS advisory message TRIM AIR OFF is displayed, or
- the Master Trim Air switch is OFF.

570

Trim air is not available to the flight deck, upper deck, crew rest, and main deck conditioned air distribution system if:

- the EICAS advisory message TEMP ZONE is displayed,
- the center section of the bleed duct is isolated,
- the EICAS advisory message TRIM AIR OFF is displayed, or
- the Master Trim Air switch is OFF.

405

If trim air is not available to the flight deck, upper deck, and main deck distribution system, backup modes control temperature in the cabin:

- if the Flight Deck Temperature selector setting is available to the PTC, pack outlet temperature of all packs is regulated to achieve an average flight deck temperature between 65°F (18°C) and 85°F (29°C), as set by the Flight Deck Temperature selector, or
- if the Flight Deck Temperature selector setting is unavailable to the PTC, pack outlet temperature is regulated to achieve the last flight deck temperature set, or
- if the last flight deck temperature set is unavailable to the PTC, pack outlet temperature is regulated to achieve an average flight deck temperature of 75°F (24°C).

570

If trim air is not available to the flight deck, upper deck, crew rest, and main deck distribution system, backup modes control temperature in the cabin:

- if the Flight Deck Temperature selector setting is available to the PTC, pack outlet temperature of all packs is regulated to achieve an average flight deck temperature between 65°F (18°C) and 85°F (29°C), as set by the Flight Deck Temperature selector, or
- if the Flight Deck Temperature selector setting is unavailable to the PTC, pack outlet temperature is regulated to achieve the last flight deck temperature set, or
- if the last flight deck temperature set is unavailable to the PTC, pack outlet temperature is regulated to achieve an average flight deck temperature of 75°F (24°C).

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Temperature of the air distributed to upper deck, and main deck is not regulated.

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Temperature of the air distributed to crew rest, upper deck, and main deck is not regulated.

Temperature Control of Forward Lower Lobe Cargo With Loss of Trim Air

Trim air is not available to forward lower lobe cargo if:

- the center section of the bleed duct is isolated, or
- the EICAS advisory message TEMP ZONE is displayed because a forward lower lobe cargo zone duct overheat has occured, or
- the EICAS advisory message TEMP ZONE is displayed for a ZTC fault that also causes the forward lower cargo trim air valve to close.

If trim air is not available to the forward lower lobe cargo distribution system, backup modes control temperature in the lower lobe temperature zone:

- if the Forward Lower Lobe Temperature selector setting is available to the PTC, pack three outlet temperature is regulated to achieve the temperature set by the selector, or
- if the Forward Lower Lobe Temperature selector setting is unavailable to the PTC, pack three outlet temperature is regulated to achieve the cargo temperature sensed at the time backup mode was initiated, or
- if forward lower lobe temperature is unavailable to the PTC, pack three outlet temperature is controlled to the outlet temperature sensed at the time backup mode was initiated.

Temperature Control of Aft Lower Lobe Cargo With Loss of Trim Air

Trim air is not available to aft lower lobe cargo if:

- the center section of the bleed duct is isolated, or
- the EICAS advisory message TEMP ZONE is displayed because an aft lobe cargo zone duct overheat has occured, or
- the EICAS advisory message TEMP ZONE is displayed for a ZTC fault that also causes the aft lower cargo trim air valve to close.

If trim air is not available to the aft lower lobe cargo distribution system, backup modes control temperature in the lower lobe temperature zone:

- if the Aft Lower Lobe Temperature selector setting is available to the PTC, pack two outlet temperature is regulated to achieve the temperature set by the selector, or
- if the Aft Lower Lobe Temperature selector setting is unavailable to the PTC, pack two outlet temperature is regulated to achieve the cargo temperature sensed at the time backup mode was initiated, or
- if aft lower lobe temperature is unavailable to the PTC, pack two outlet temperature is controlled to the outlet temperature sensed at the time backup mode was initiated.

Temperature Control Non-Normal Operation

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If a system fault or overheat occurs in the flight deck, upper deck, or main deck, the master trim air valve closes and a backup mode controls cabin temperature. An attempt to restore zone temperature control can be made by pushing the Zone Reset switch.

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If a system fault or overheat occurs in the flight deck, upper deck, crew rest, or main deck, the master trim air valve closes and a backup mode controls cabin temperature. An attempt to restore zone temperature control can be made by pushing the Zone Reset switch.

If a system fault or overheat occurs in the lower cargo air conditioning air zone, a cargo zone trim air shutoff valve closes and a backup mode controls temperature. Positioning the Cargo Temperature selector from AUTO to MAN or from MAN to AUTO resets cargo air conditioning, allows the cargo zone trim air shutoff valve to reopen, and clears the backup mode. Positioning the Lower Lobe Cargo Conditioned Air Flow Rate selector to OFF also resets cargo air conditioning, allows the cargo zone trim air shutoff valve to reopen when cargo conditioned air is reselected, and clears the backup mode.

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.

The Aft Cargo Heat switch 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 remain closed, thus decreasing bleed air demand from the APU and ground source.

Cargo Heat With Aft Cargo Conditioned Air

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The Aft Cargo Heat switch is normally pushed ON when aft cargo conditioned air is selected. This configuration ensures the compartment floor temperature is maintained above freezing.

Gasper System

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The gasper system supplies recirculated air drawn from the upper passenger cabin area. Gasper air is distributed to the passenger service unit air gasper outlets above each passenger seat.

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.

Humidification

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The humidification system operates when the Humidification switch is ON. The system uses water from the potable water system to introduce moisture into the circulation air. Minerals in the potable water may precipitate as solids when the humidification system operates. These solids may circulate in the cabin as dust or haze.

Lavatory and Galley Ventilation

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Two ventilation fans, a primary and a backup, draw air from the galleys and lavatories. If the primary fan fails, the backup fan operates automatically.

Conditioned air is provided to the galleys from the air distribution system.

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.

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In flight configuration, the inboard exhaust valve is open and the warmed equipment cooling exhaust air discharges into the forward cargo compartment.

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Flight configuration depends on the position of the Lower Lobe Cargo Conditioned Air Flow Rate selector and the temperature selected by the Forward Lower Lobe Temperature selector. With temperature selected lower than 50°F (10°C), the Lower Lobe Cargo Conditioned Air Flow Rate selector in FWD LOW, BOTH LOW, or FWD HIGH, the inboard exhaust valve is closed and equipment cooling air is recirculated in a closed loop mode. With higher selected temperatures or all other positions of the Lower Lobe Cargo Conditioned Air Flow Rate selector, the inboard exhaust valve is open and the warm 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.

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With two or three packs operating, the flight deck equipment cooling source valve directs conditioned air into the flight deck electrical equipment.

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 are not powered 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

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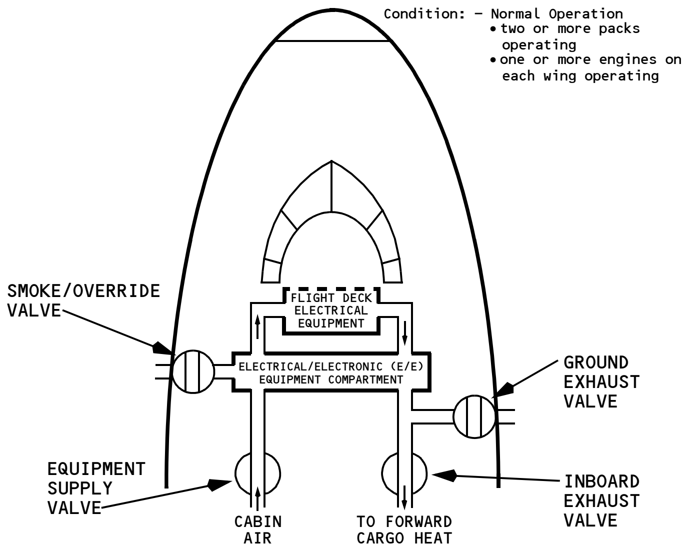
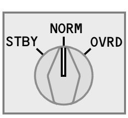
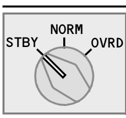
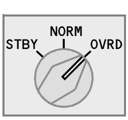


EQUIPMENT COOLING SWITCH POSITION	SYSTEM OPERATION	EQUIPMENT COOLING VALVE CONFIGURATION
	• Normal Operation • Normal Operation includes reconfiguring after supply and exhaust fan failure to maintain E/E equipment cooling: – Inboard Exhaust valve closes – no airflow to forward cargo – no EICAS message 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.

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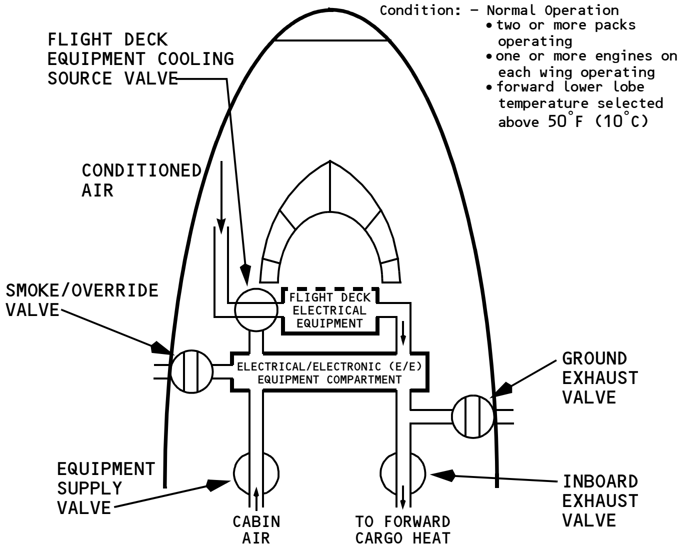
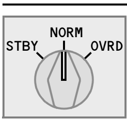
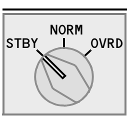
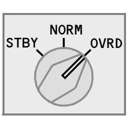


EQUIPMENT COOLING SWITCH POSITION	SYSTEM OPERATION	EQUIPMENT COOLING VALVE CONFIGURATION
	• Normal Operation • Flight Deck Equipment Cooling Source valve directs conditioned air into flight deck electrical equipment • Normal Operation includes reconfiguring after supply and exhaust fan failure to maintain 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 • Flight Deck Equipment Cooling Source valve opens to E/E equipment cooling duct • No 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. Other than accomplishing normal procedures for entering FMC data, no specific flight crew action is required for fully automatic operation for all flights with a landing below 8,000 feet.

Pressurization System Automatic Operation

In flight, the cabin altitude controllers operate in a climb mode, a cruise mode, or a descent mode.

The 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.

In cabin altitude contoller climb mode, 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. Cabin altitude continues to increase during the level segment. When the airplane climb flight path is above the FMC climb path and maximum cabin pressure differential is reached during the climb, cabin rate then becomes a function of airplane climb rate so maximum cabin differential pressure is not exceeded.

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

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

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

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

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

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

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

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

Supplemental Procedure Landing Airport Between 8,000 Feet and 10,000 Feet

To avoid the cabin altitude controllers inadvertently entering descent mode during cruise, which would allow cabin altitude to immediately begin increasing to FMC landing altitude, the landing altitude is set to 8,000 feet or in MAN during climb and cruise.

Cabin Altitude Controller Automatic Operation With Loss of Landing Altitude

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

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.

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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.

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Negative pressure relief valves in the side cargo door and 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.

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Air Systems — Chapter 2
Bleed Air System Description — Section 40

Introduction

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

Bleed air is used for:

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- 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

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- 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

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- air conditioning
- pressurization
- wing and engine anti–ice
- engine start
- leading edge flaps
- aft cargo heat
- hydraulic reservoir pressurization
- potable water tank pressurization
- air driven hydraulic demand pumps

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 the APU, ground air, or 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

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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 duct 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
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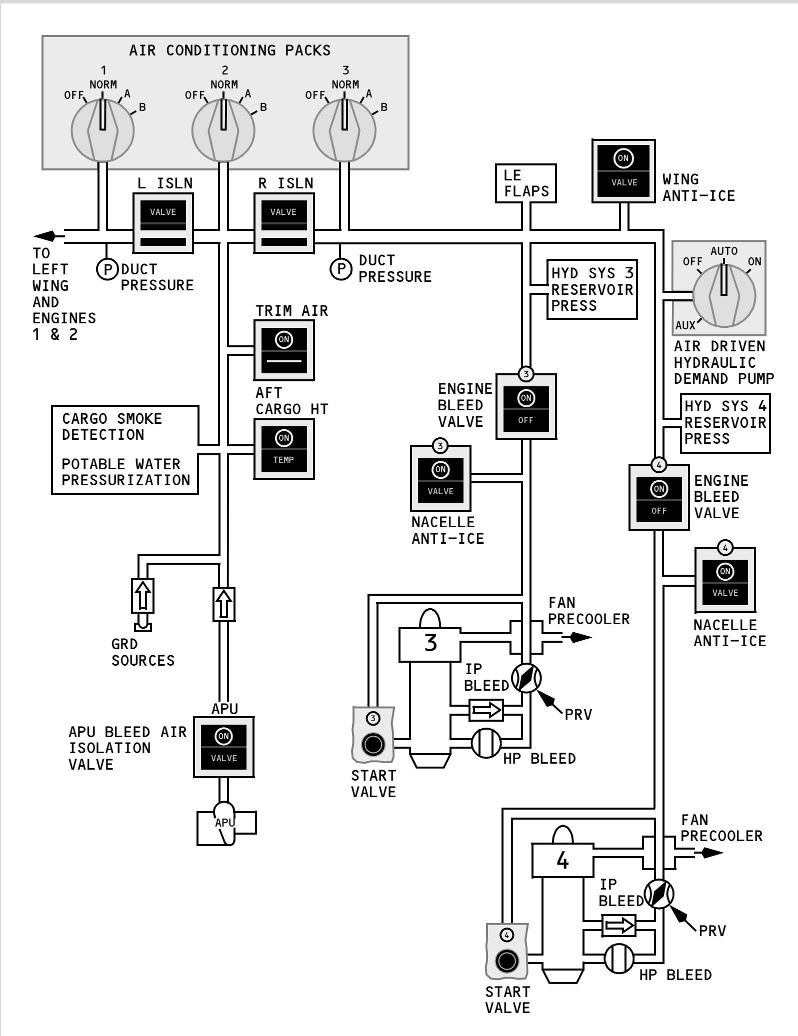

Bleed Air System Schematic

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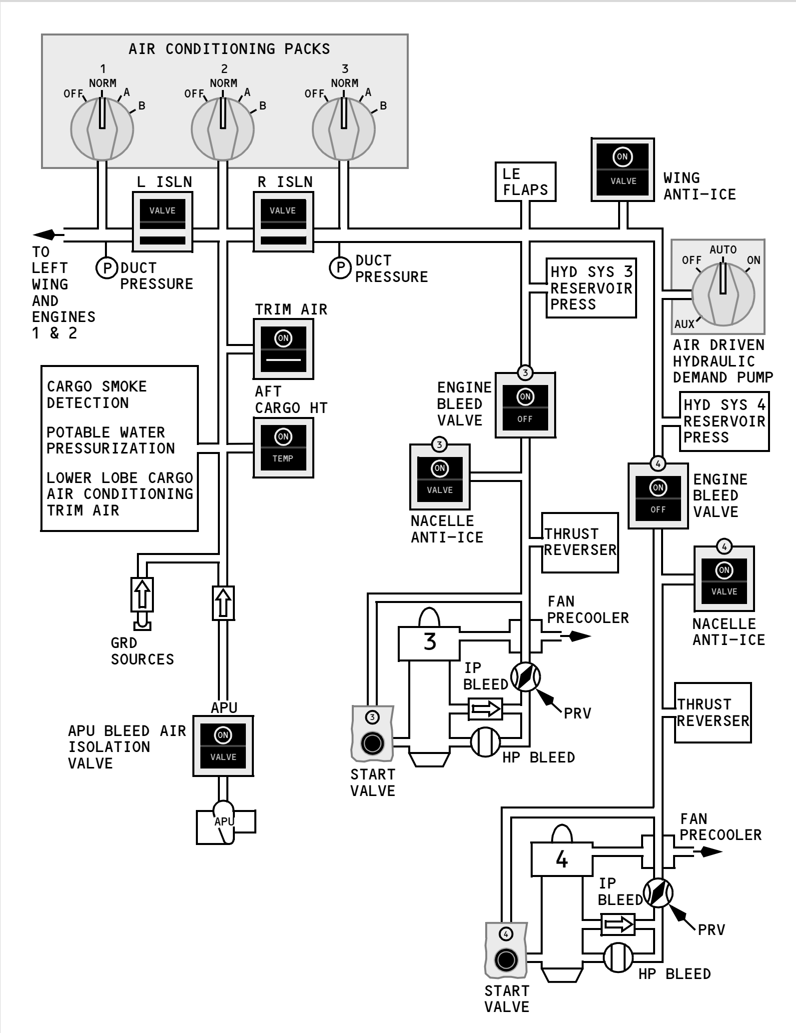

Bleed Air System Schematic

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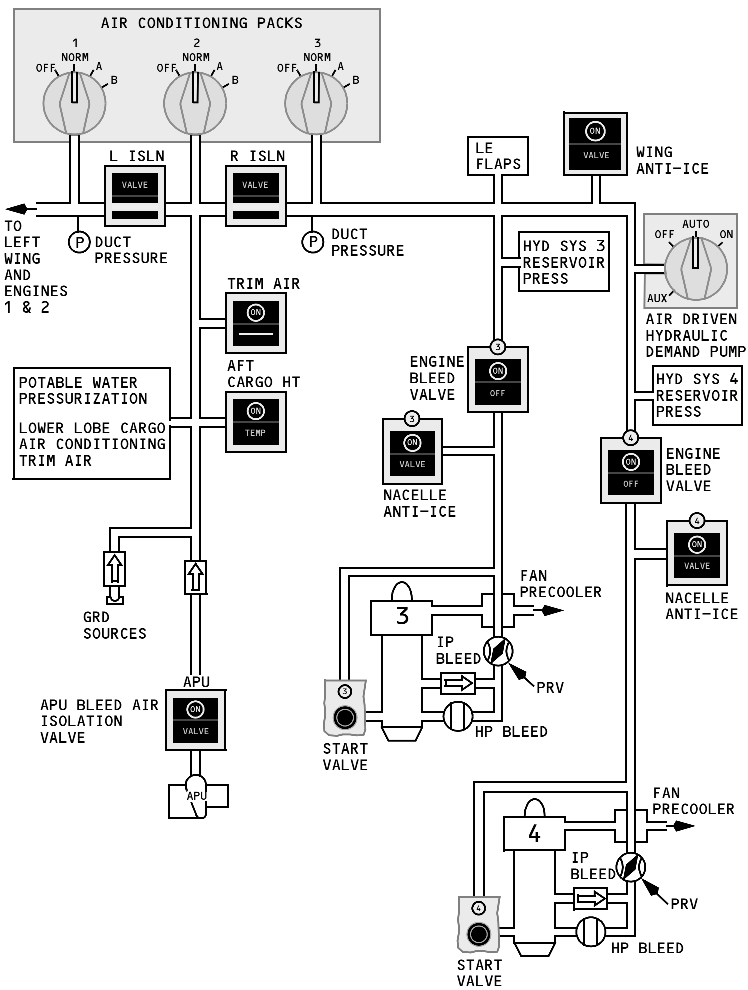

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Air Systems — Chapter 2
EICAS Messages — Section 50

EICAS Alert Messages

Message	Level	Aural	Message Logic
BLD DUCT LEAK L, C, R	Caution	Beeper	Bleed air leak or overheat along left, center, or right duct section.
BLD 1, 2, 3, 4 OVHT/PRV	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.
>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	Beeper	HP bleed valve failed closed..
BLEED ISLN L, R	Advisory	Beeper	Isolation Valve switch position and valve position disagree.
>BLEED ISLN APU	Advisory		APU bleed isolation valve position disagrees with commanded position.
CABIN ALT AUTO	Caution	Beeper	Both cabin altitude controllers failed or both Outflow Valve Manual switches ON.
CABIN ALTITUDE	Warning	Siren	Cabin altitude excessive.
>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 inadequate, or overheat or smoke detected; or with selector in OVRD, differential pressure for reverse flow cooling inadequate; or ground exhaust valve not in commanded position

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>HUMID FLT DK	Advisory		Fault in flight deck humidifier.

Message	Level	Aural	Message Logic
LANDING ALT	Advisory		Disagreement between controller landing altitude and FMC landing altitude, or landing altitude in MAN.
OUTFLOW VLV L, R	Advisory		Automatic control of outflow valve inoperative, or respective Outflow Valve Manual switch ON.
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.
PACK CONTROL	Advisory		Automatic control of outlet temperature of all packs has failed.
PRESS RELIEF	Advisory		Either pressure relief valve opens with all packs operating.
TEMP CARGO HEAT	Advisory		Overheat detected in aft cargo compartment when aft cargo heat system operating.

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TEMP ZONE	Advisory		Zone duct overheat, or master trim air valve failed closed, or zone temperature controller failed. Master trim air valve driven closed and temperature controlled in backup mode.

Message	Level	Aural	Message Logic
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TEMP ZONE	Advisory		Zone duct overheat, or master trim air valve failed closed, or forward or aft lower lobe cargo zone trim air valve failed closed, or forward or aft lower lobe cargo compartment overheat, or zone temperature controller has failed. Master trim air valve driven closed with flight deck, upper deck, crew rest, and main deck temperature control in backup mode; or, respective forward or aft lower lobe cargo zone trim air shut off valve driven closed and respective zone in backup mode
405			
TEMP ZONE	Advisory		Zone duct overheat, or master trim air valve failed closed, or forward or aft lower lobe cargo zone trim air valve failed closed, or forward or aft lower lobe cargo compartment overheat, or zone temperature controller has failed. Master trim air valve driven closed with flight deck, upper deck, and main deck temperature control in backup mode; or, respective forward or aft lower lobe cargo zone trim air shut off valve driven closed and respective zone in backup mode
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>TRIM AIR OFF	Advisory		Master trim air valve closed. Flight deck and passenger cabin temperature controlled in backup mode.

Message	Level	Aural	Message Logic

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Message	Level	Aural	Message Logic
>TRIM AIR OFF	Advisory		Master trim air valve closed. Flight deck upper deck, crew rest, and main deck temperature controlled in backup mode. Trim air no longer added to flight deck, upper deck, crew rest, or main deck conditioned air.

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Message	Level	Aural	Message Logic
>TRIM AIR OFF	Advisory		Master trim air valve closed. Flight deck, upper deck, and main deck temperature controlled in backup mode. Trim air no longer added to flight deck, upper deck, or main deck conditioned air.

EICAS Memo Messages

Message	Level	Aural	Message Logic
PACK 1, 2, 3 OFF	Memo		Pack switch off.
PACKS 1 + 2, 1 + 3, 2 + 3 OFF	Memo		Pack switches off.
PACKS HIGH FLOW	Memo		High flow switch ON. Pack flow setting not controlled automatically.
PACKS OFF	Memo		All pack switches off.

Anti-Ice, Rain — Chapter 3
Table of Contents — Section 0

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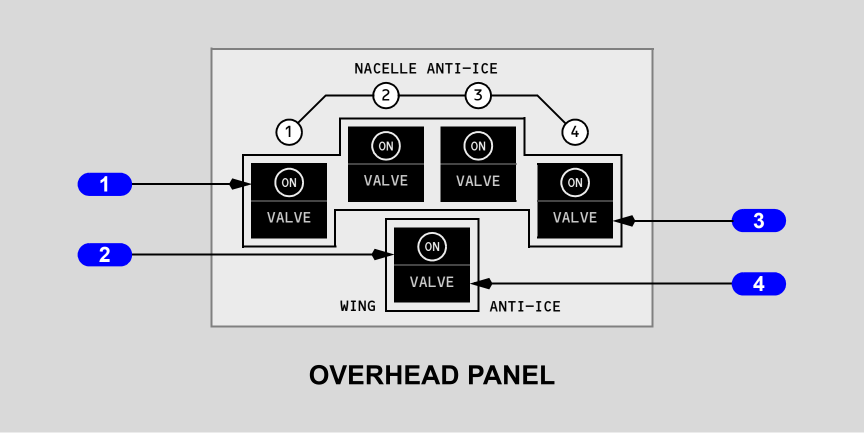
Nacelle and Wing Anti-Ice

Nacelle and Wing Anti-Ice Panel



1 NACELLE ANTI-ICE Switches

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

Off - valve closed

2 WING ANTI-ICE Switch

ON -

- in flight, wing anti-ice valves open to supply bleed air to left and right wing leading edges
- on the ground, wing anti-ice system inhibited

3 NACELLE ANTI-ICE VALVE Lights

Illuminated (amber) - nacelle anti-ice valve position disagrees with switch position

4 **WING ANTI-ICE VALVE Light**

Illuminated (amber) - either wing anti-ice valve position disagrees with switch position

Anti-Ice Indications on EICAS Display

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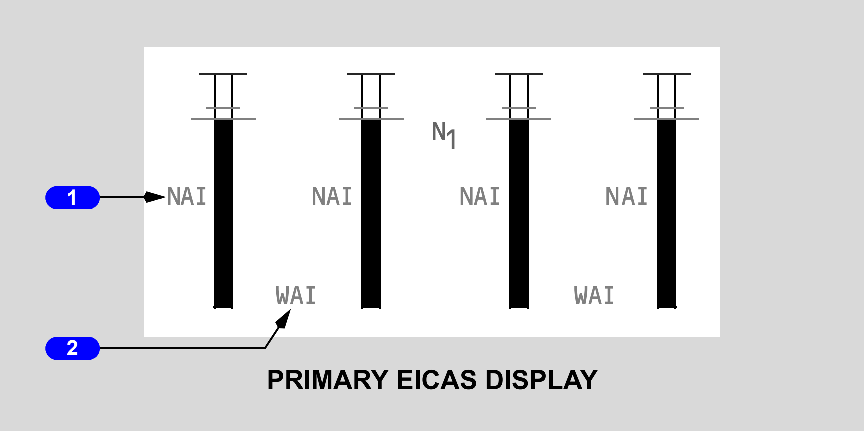

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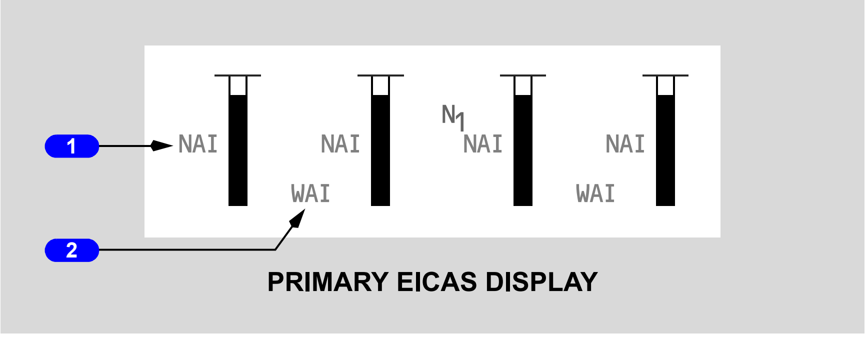

1 **Nacelle Anti-ice Indication**

Displayed (green) - nacelle anti-ice on.

2 **Wing Anti-Ice Indication**

Displayed (green) - wing anti-ice on.

Windshield Heat and Washers

Windshield Heat and Washers Panel

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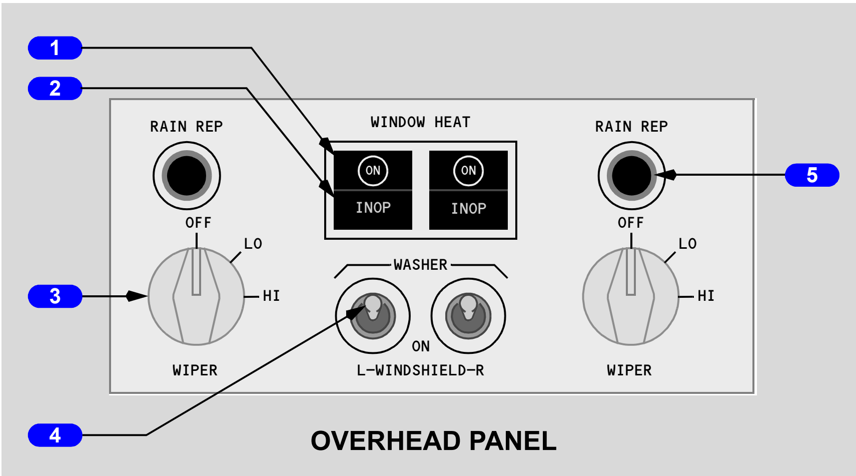

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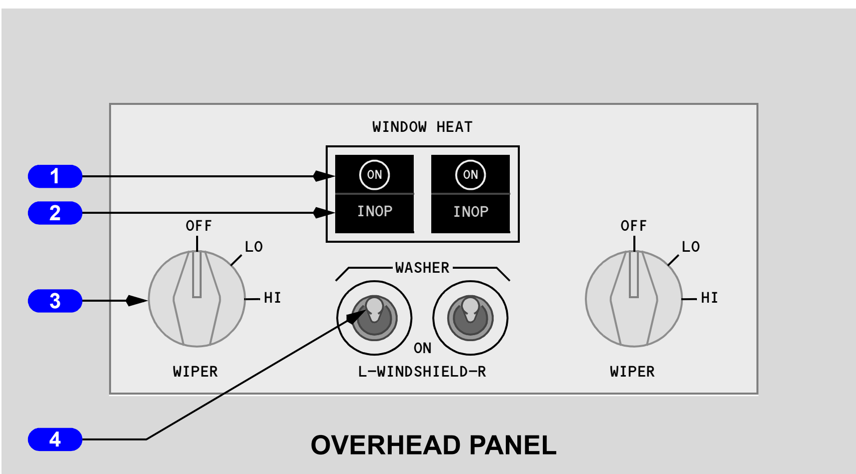


1 WINDOW HEAT Switches

ON - controlled heat applied to the windshield

2 WINDOW HEAT Inoperative (INOP) Lights

Illuminated (amber) -

- windshield overheat or controller fault has been detected
- power removed from windshield

3 Windshield WIPER Selectors

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 Switches

Spring loaded to neutral

ON - applies washer fluid

5 RAIN Repellent (REP) Switches

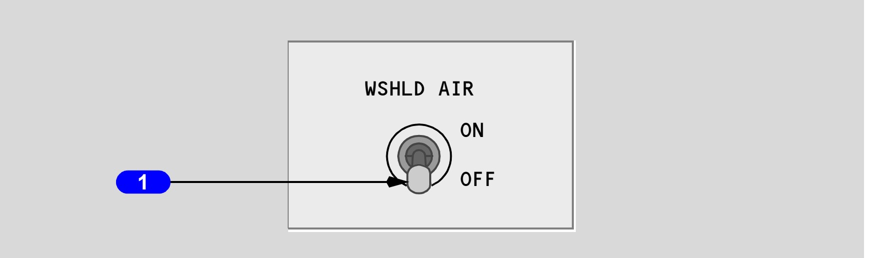
109

Push - measured amount of rain repellent applied to windshield

Note: Do not use on dry windshield.

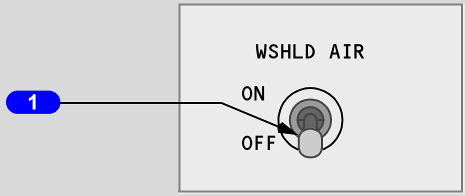
Windshield Air Switch

109, 405



CAPTAIN AUXILIARY PANEL
FIRST OFFICER AUXILIARY PANEL

570



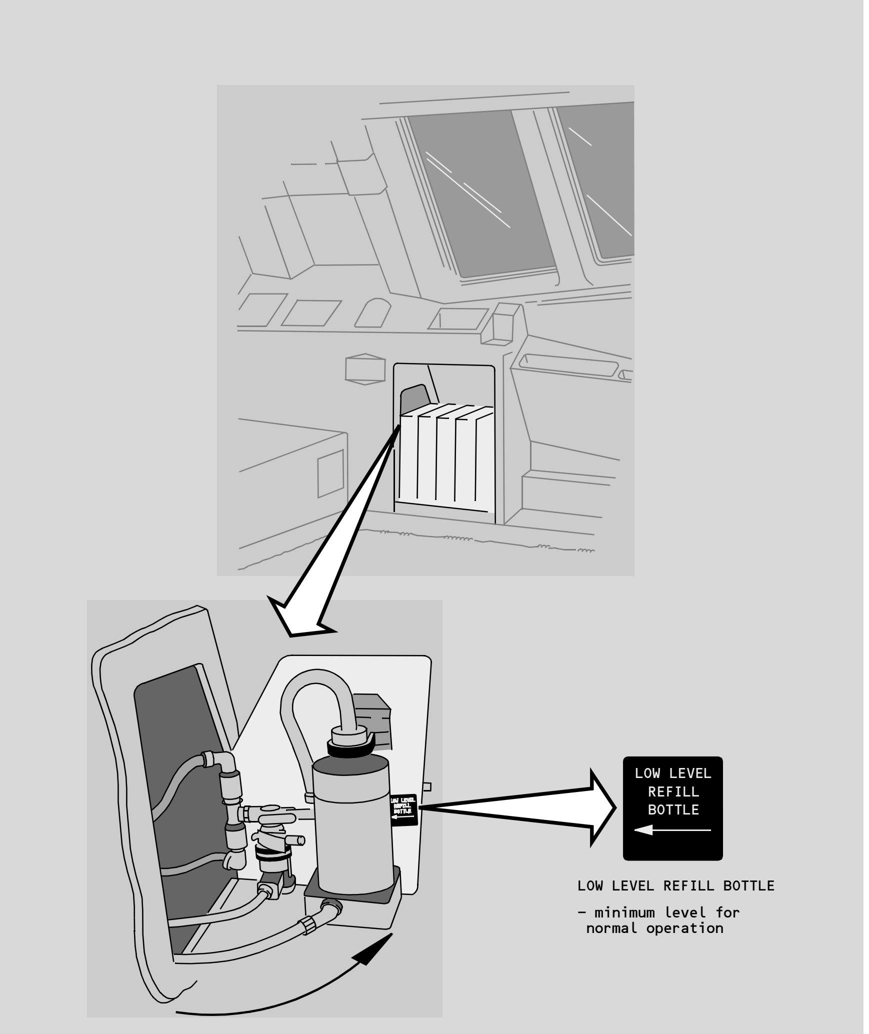
CAPTAIN AUXILIARY PANEL
FIRST OFFICER AUXILIARY PANEL

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:

109, 570

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

405

- engine anti-ice
- wing anti-ice
- flight deck window heat
- windshield wipers
- probe heat

Anti-Ice Systems

Ice Detection System

109, 570

The automatic ice detection system detects airplane icing in flight.

An ice detection system probe on the forward fuselage detects airplane icing in flight. The system provides data for displaying EICAS alert messages.

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 the Nacelle Anti-Ice switch is ON the selected engine igniters operate continuously.

Nacelle Anti-Ice System Operation

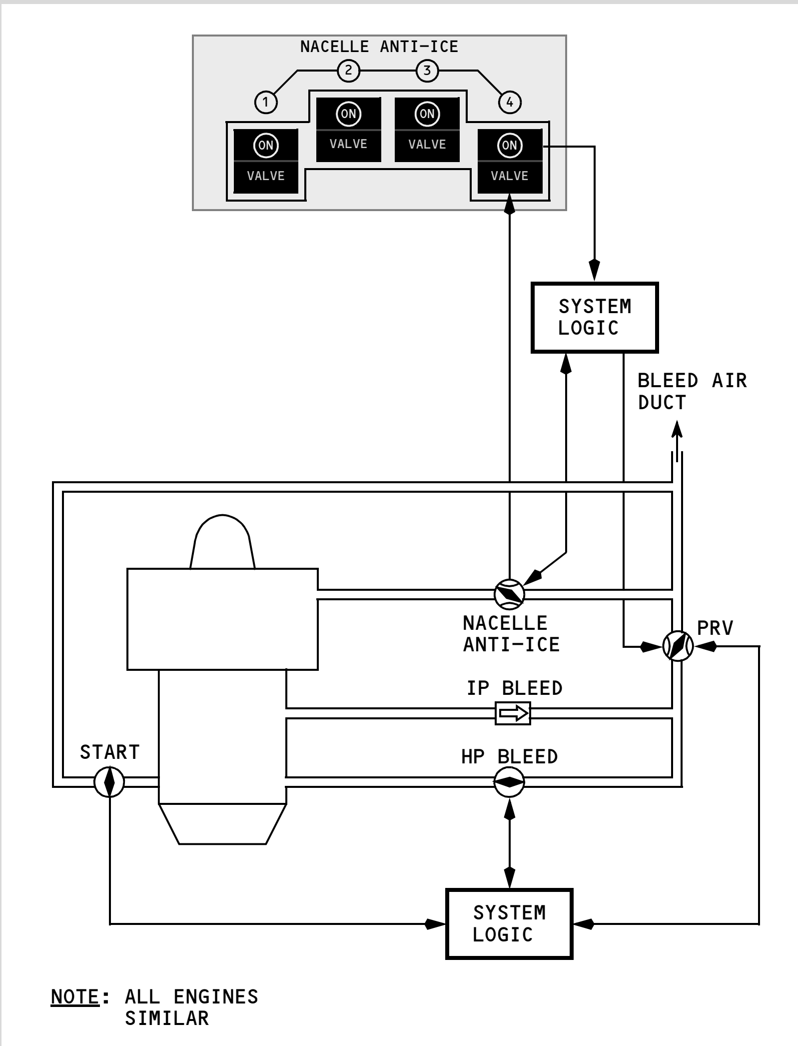
When the Nacelle Anti-Ice switch is ON, bleed air opens the nacelle anti-ice valve and bleed air is supplied to the engine inlet cowl.

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 the Nacelle Anti-Ice switch is 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 can be operated in flight only. It is inhibited 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 Operation

In flight, when the Wing Anti-Ice switch is ON, the wing anti-ice valve in each wing opens. Wing anti-ice is ineffective when leading edge flaps are extended.

Flight Deck Window Heat

All flight deck windows are electrically heated. The forward windows have exterior surface anti-icing, and interior surface anti-fogging protection. The side windows have interior surface anti-fogging 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. Windshield Air switches on the Captain and First Officer auxiliary panels turn on anti-fogging air to the related windshields.

Windshield Wipers and Washers

The Captain and First Officer 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 and First Officer 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 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	Message Logic

405

>ANTI-ICE	Advisory		Any nacelle or wing anti-ice system on and TAT greater than 12°C.

109, 570

>ANTI-ICE	Advisory		Any nacelle or wing anti-ice system on, TAT greater than 12°C, and ice detector does not detect ice.

HEAT L, R TAT	Advisory		Heater failure on TAT probe, or ground/air logic has failed to remove power and TAT probe heated on the ground.
HEAT P/S CAPT, FO, L AUX, R AUX	Advisory		Heater failure on P/S probe.
HEAT WINDOW L, R	Advisory		Window heat of windshield not powered.

109, 570

>ICING	Caution	Beeper	Ice detector detects ice.

NAI VALVE 1, 2, 3, 4	Advisory		Nacelle anti-ice valve not in commanded position.

109, 570

>NO ICING	Advisory		Ice no longer detected.

WAI VALVE LEFT, RIGHT	Advisory		Wing anti-ice valve not in commanded position.

Intentionally
Blank

Automatic Flight — Chapter 4
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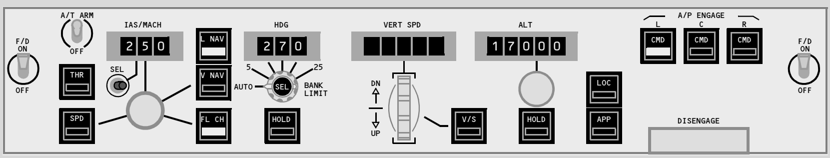
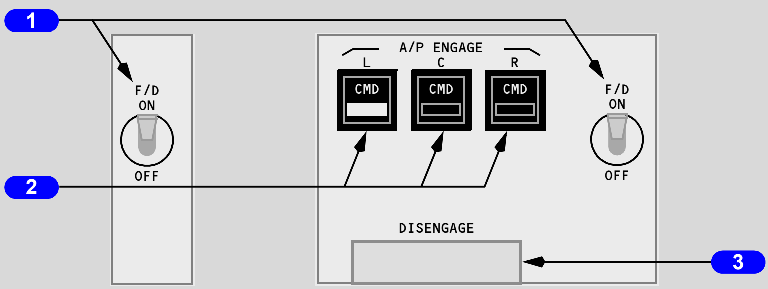
Mode Control Panel (MCP)



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

109, 405
  - heading hold (HDG HOLD) as the roll mode, or if bank angle greater than five degrees, attitude hold (ATT)

570
  - heading hold (HDG HOLD) as the roll mode
- 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

109, 405
  - heading hold (HDG HOLD) or attitude hold (ATT) as the roll mode

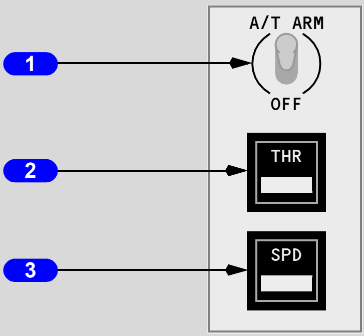
570
  - heading hold (HDG HOLD) as the roll mode

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 activates when VNAV, FLCH, or TO/GA switch pushed
- A/T activates when speed switch pushed and pitch mode is ALT, 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 activates 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; used to select climb thrust after takeoff or go-around.

Push -

Light remains extinguished (thrust limit function) -

- after takeoff with VNAV or FLCH selected, changes reference thrust limit to armed climb thrust limit, or CON if engine inoperative
- after go-around, changes reference thrust limit to CLB, or CON if engine inoperative or CON selected

Note: Reference thrust limit remains GA when flaps in landing position or pitch mode is G/S.

Light illuminates (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

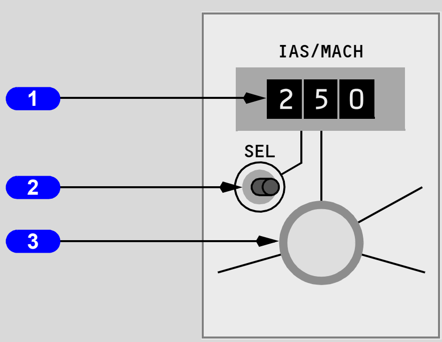
3 Speed (SPD) Switch

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 approximately .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 -

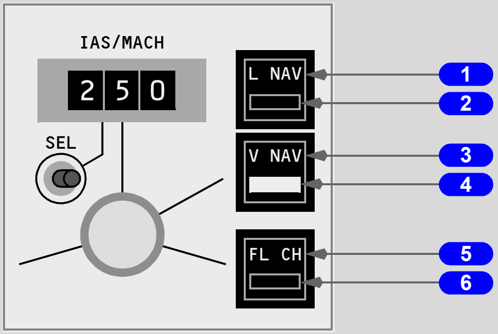
- sets speed in IAS/MACH window and command speed on both PFDs
- inoperative when IAS/MACH window blank

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 in 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. Resetting the MCP altitude window and pushing the altitude selector continues the climb or descent. If below the VNAV path, resetting the MCP altitude window and intercepting the VNAV path will also continue the 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

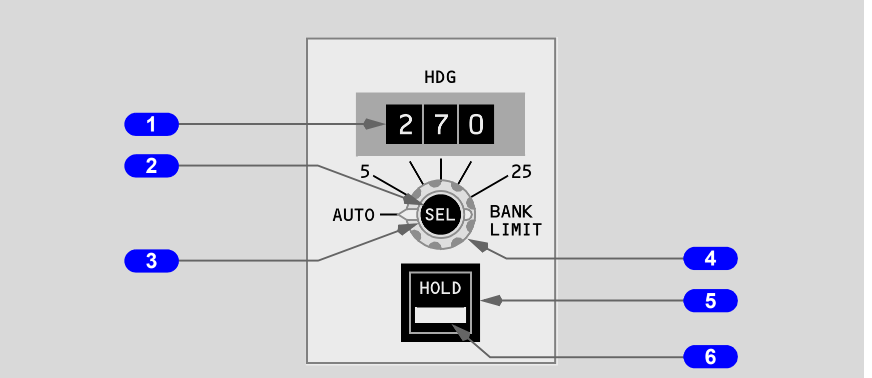
Push -

- 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 operates in 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 (HDG) 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, depending on TAS, flap position, and V2
- 5, 10, 15, 20, or 25 - selected value is maximum, regardless of airspeed

5 Heading (HDG) HOLD Switch

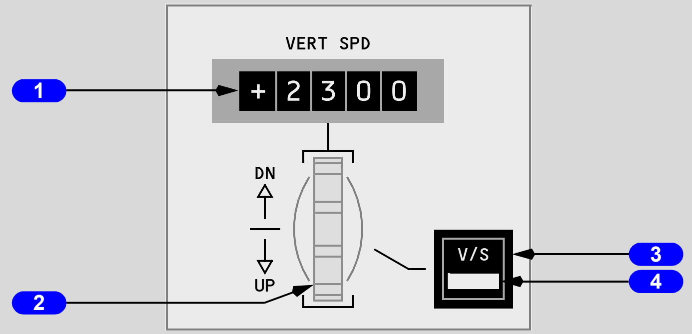
Push -

- 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

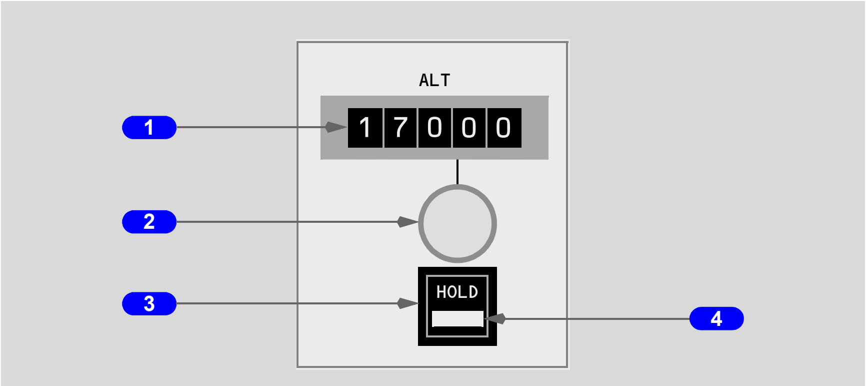
Push -

- 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.

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

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

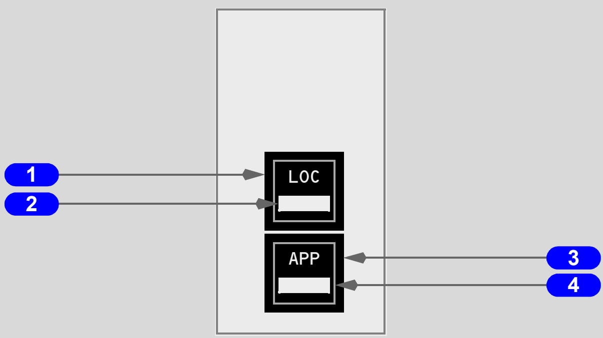
Push -

- 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, or captures localizer (LOC) as roll mode
- displays LOC in white (armed) on 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 -

- 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 before localizer and glideslope capture
- displays LOC and G/S in green (active) on PFD roll and pitch flight mode annunciations after each is captured
- arms other A/P systems (CMD switch lights illuminated) for engagement at localizer and glideslope capture and radio altitude less than 1,500 feet
- A/P systems are powered by separate sources
- AFDS captures and tracks localizer and captures glideslope mode upon interception

  109, 570
- either localizer or glideslope can be captured first
- localizer captures when intercept track angle is within 120 degrees of localizer course

  109, 570
- glideslope captures when intercept track angle is within 80 degrees of localizer course

  405
- glideslope capture is inhibited until localizer capture and intercept track angle is within 80 degrees of localizer course

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

  109, 570
- 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.

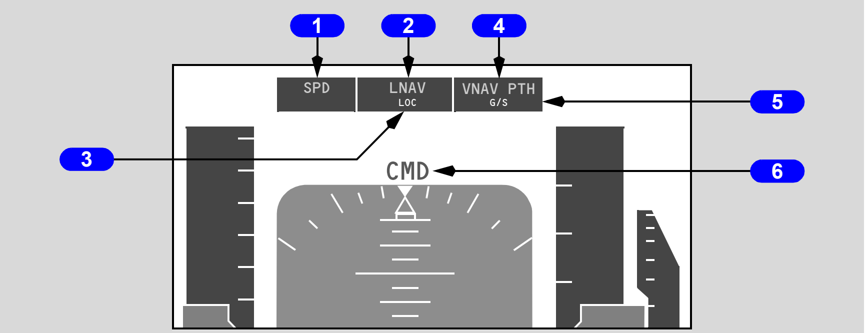
PFD Flight Mode Annunciations (FMAs)

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

109, 405
- 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

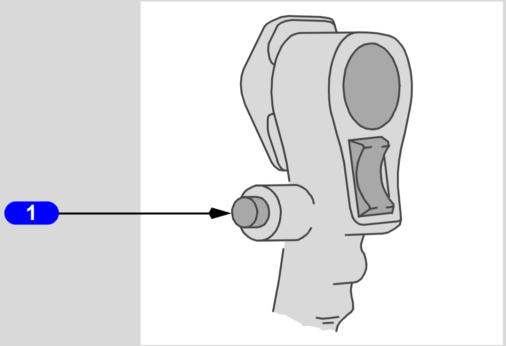
6 AFDS (Active)

Displayed (green) -
- FD
- CMD
- LAND 3
- TEST

Displayed (green with white triangles) - ▷LAND2◁

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

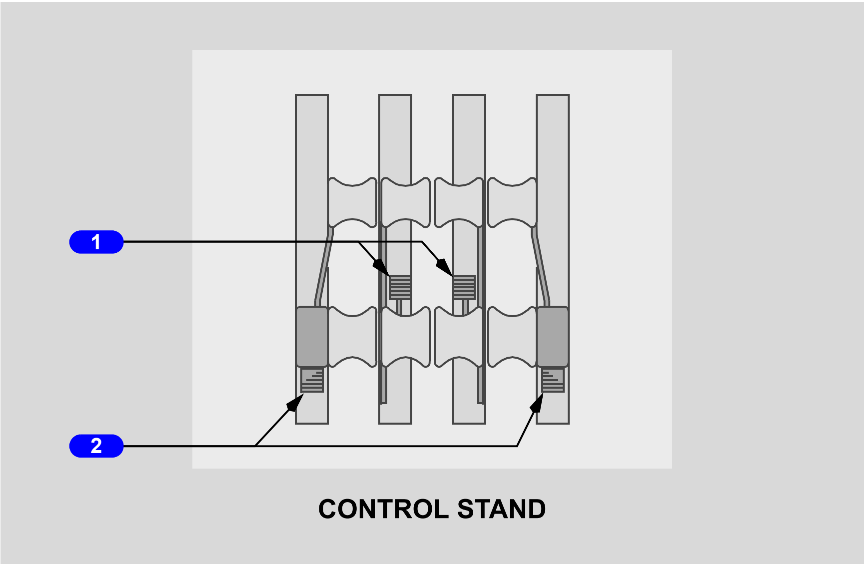
  570
- sounds a siren aural warning

  109, 405
- sounds a wailer aural warning for a minimum of one second

Second push - resets:

- master warning lights
- EICAS warning message
- aural warning

Autothrottle Disconnect and TO/GA Switches



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

On the ground:

Push -

- below 50 knots and flaps out of up, activates A/T in THR REF mode at reference thrust limit selected on THRUST LIMIT page. If not pushed below 50 knots, A/T operation is inhibited until reaching 400 feet altitude
- updates FMC position to runway landing threshold or position shift point if GPS updating not active

In flight:

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

- removes takeoff derates
- A/T in HOLD, activates A/T in THR REF mode
- between 50 feet and 400 feet, selects TO/GA roll mode
- above 400 feet, selects TO/GA roll and pitch modes

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

- activates A/T in THR mode with GA reference thrust limit displayed
- selects TO/GA roll and pitch modes
- second push - activates A/T in THR REF mode

Note: With no A/P or F/D 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 >AUTOTHROT DISC
- if A/T automatically disconnects, resets master caution lights and EICAS message

Second push - resets master caution lights and EICAS message.

Autothrottle remains armed.

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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.

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A flight director mode failure, in either pitch or roll, causes the related command bar to disappear.

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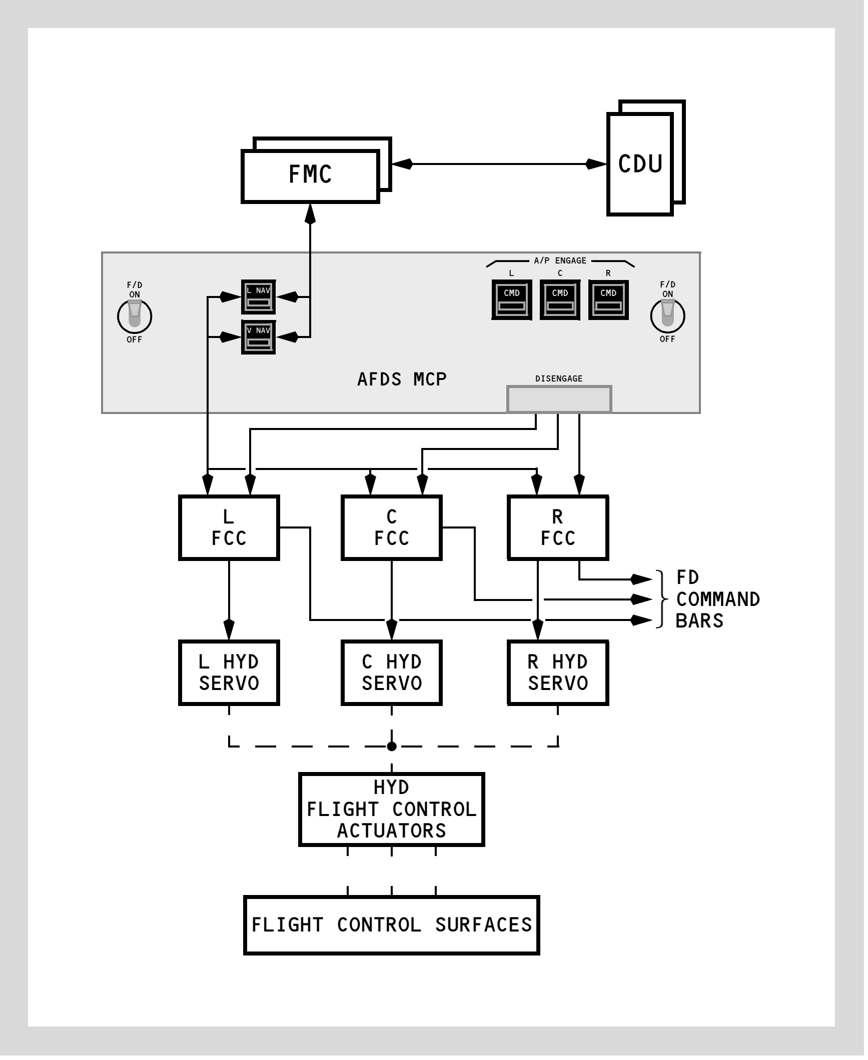
A flight director mode failure, in either pitch or roll, causes the command bars to disappear.

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 flight, 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

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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 guidance becomes active at lift-off
- In flight, TO/GA is armed when flaps are out of up or glideslope is captured. There is no flight mode annunciation for TO/GA armed. TO/GA is activated in flight by pushing a TO/GA switch. The roll steering indication provides guidance to maintain the ground track present at mode engagement

ROLLOUT -

- ROLLOUT (armed) - 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. TO/GA pitch guidance becomes active at lift-off
- 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.

- In flight, TO/GA is armed when flaps are out of up or glideslope is captured
- 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 initiation 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. If below the VNAV path, resetting the MCP altitude window and intercepting the VNAV path will also continue the descent

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.

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 active by 50 knots, it cannot be activated 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:

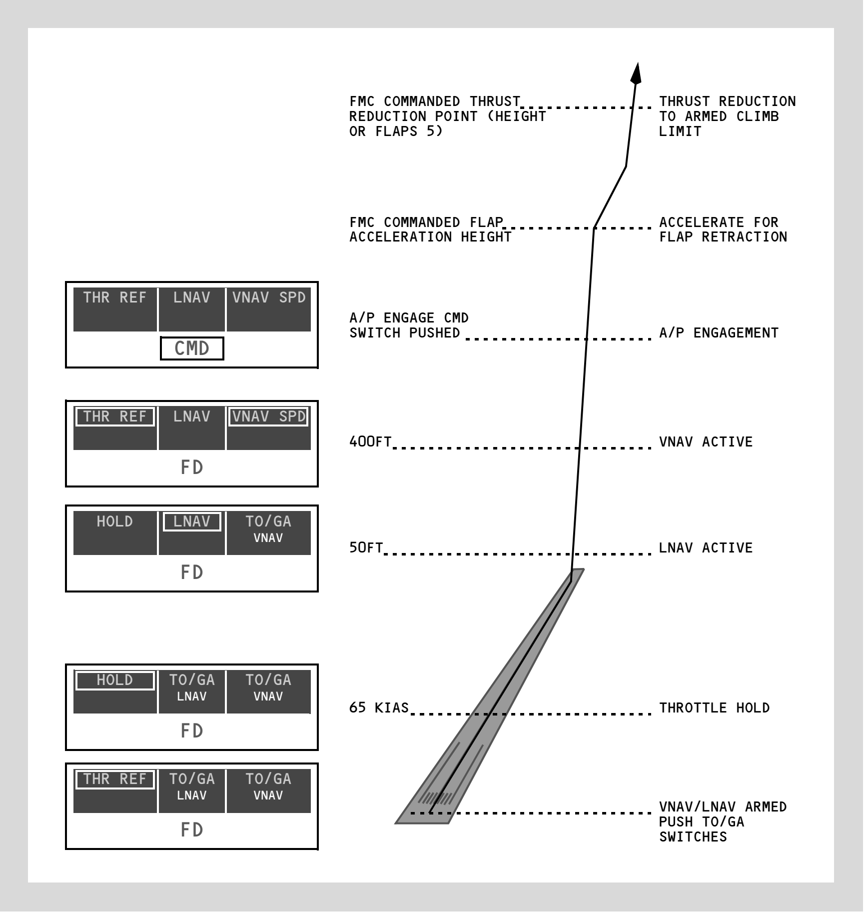
- pitch command target speed is V2 + 10. If current airspeed remains above target speed for 5 seconds, target airspeed is reset to current airspeed (limited to a maximum of V2 + 25)
- if an engine failure occurs on the ground, the pitch command target speed at lift-off is V2 or airspeed at lift-off, whichever is greater
- 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
  - A/T in HOLD, 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:
  - 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 ILS approaches.

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Pushing the APP switch arms localizer in roll mode and glideslope in pitch mode. Either localizer or glideslope can be captured first.

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Pushing the APP switch arms localizer in roll mode and glideslope in pitch mode. Glideslope capture is inhibited until the localizer is captured.

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.

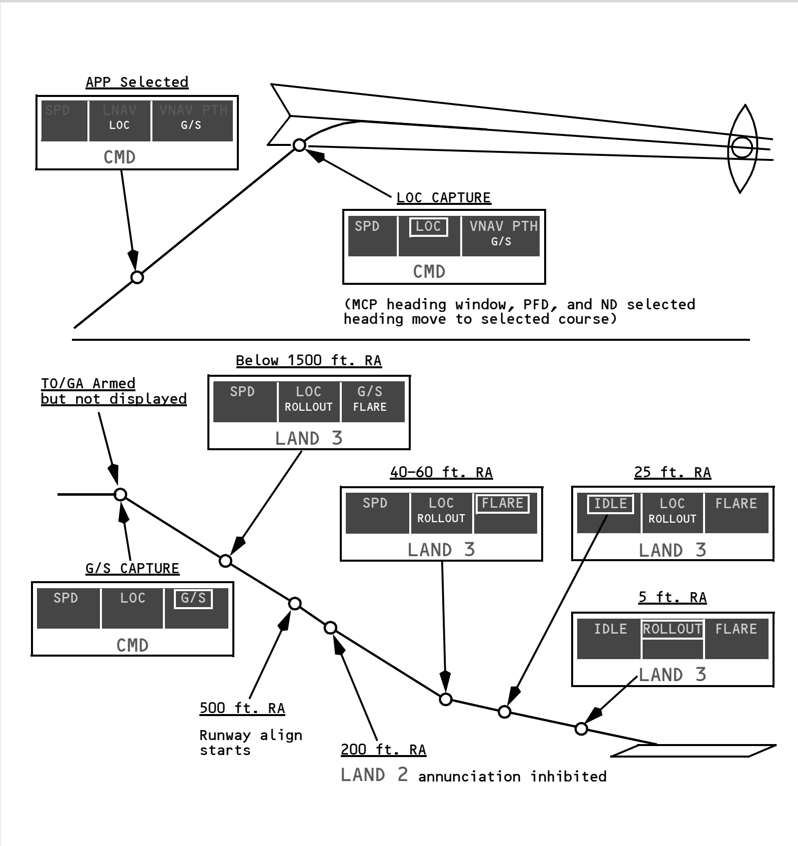
The autopilot controls rudder and nose wheel steering to track the localizer centerline.

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

TO/GA is armed when flaps are out of UP or glideslope is captured. The reference thrust limit changes to GA when flaps are extended out of UP, flaps are extended to landing position, or glideslope is captured. The reference thrust limit is locked in GA when flaps are in landing position or glideslope is captured.

Pushing either TO/GA switch activates a go-around. The mode remains active even if the airplane touches down while executing the go-around.

When the flight director switches are not on, pushing either TO/GA switch displays the flight director bars.

The TO/GA switches are inhibited 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:

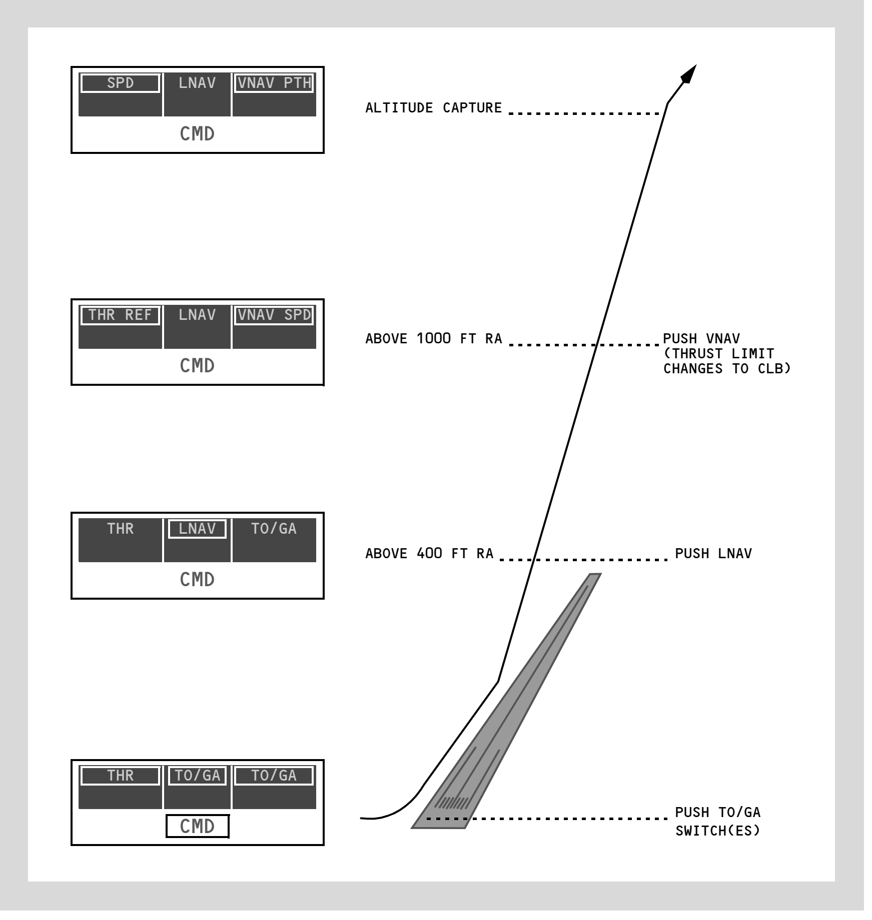
- at the set altitude, the AFDS pitch flight mode annunciation changes to altitude hold (ALT); all autopilots, except first in CMD, disengage
- A/T remains in THR or THR REF until SPD mode is selected. Speed protection prevents exceeding the maximum operating, gear extended, or flap placard speed
- TO/GA 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 asymmetric 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 from 600 to 1200 feet per minute (0 to 600 feet per minute with engine out), AFDS gradually 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

The automatic flight control system provides stall and overspeed protection. Stall protection prevents speed reduction below the minimum maneuvering speed. Overspeed protection prevents exceeding the maximum operating, gear extended, or flap placard speed.

The FMC supplies minimum and maximum speeds to the automatic flight control system. To minimize transient speed overshoots of maximum operating, gear extended, or flap placard speed, and undershoot of flaps extended minimum speed, the FMC uses a five knot margin.

The autothrottle and AFDS independently provide speed protection for all operations except during V/S pitch mode or engine failure above maximum engine-out altitude. Autothrottle speed protection is limited by the reference thrust limit (CLB, CRZ, CON, etc.) and idle. AFDS speed protection is provided through the elevators in the following pitch modes: VNAV SPD, FLCH SPD, or TO/GA.

If FMC data is invalid, VNAV is unavailable and internal FCC speed limits are used for FLCH SPD or TO/GA. 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 speed for flaps down.

During cruise, the AFDS maintains level flight. If an engine fails above maximum engine-out altitude, delaying descent results in a gradual airspeed loss.

Refer to Chapter 15, Warning Systems, for a description of stall and speed related warnings.

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Automatic Flight EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
>AUTOPILOT	Caution	Beeper	Selected autopilot operating in degraded mode. Engaged roll and/or pitch mode may have failed.
>AUTOPILOT DISC	Warning	570 Siren 109, 405 Wailer	All engaged autopilots have disengaged.
>AUTOTHROT DISC	Caution	Beeper	Autothrottle has disconnected. Message and aural inhibited when disconnect occurs due to selection of reverse thrust.
>NO AUTOLAND	Caution Advisory	Beeper	Autoland 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 annunciates. Message is an advisory if fault occurs before LAND 3 annunciates.

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Communications — Chapter 5
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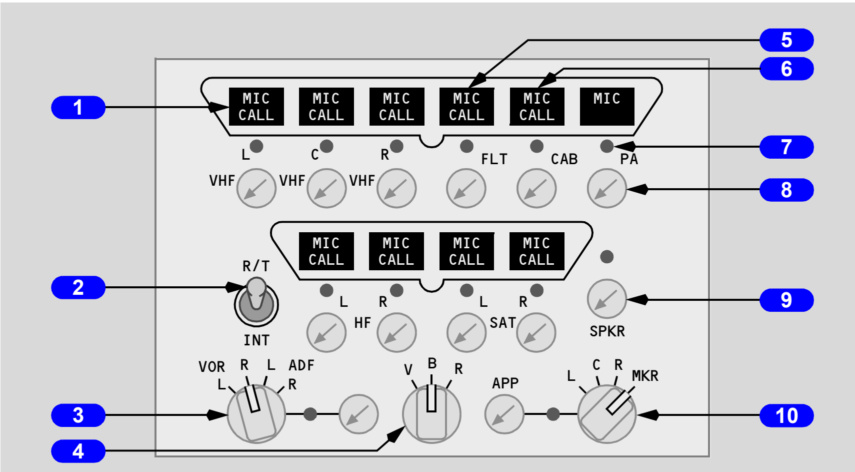
Audio Panel



AFT AISLE STAND AND OBSERVER'S PANEL

1 Transmitter Select Switches

Push –

- MIC light illuminates
- MIC light for any other transmitter extinguishes
- selects respective 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
  109
- pushing CAB transmitter select switch twice within three seconds places a priority call to a selected cabin station

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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 switch 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 respective transmitter is selected.

6 CALL Lights

Illuminated (white) - with aural chime, indicates a call on:

- cabin interphone (CAB) (passenger)
- flight interphone (FLT)
  109, 405
- ACARS (VHF C)
  570
- upper deck crew rest area (FLT)
- main deck cargo area (FLT) (freighter)
- SATCOM (SAT)
- SELCAL (VHF or HF)

Resets when respective 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 respective receiver audio manually selected on.

8 **Receiver Volume Controls**

Push - selects respective receiver audio on.

Rotate - controls receiver volume.

Second push - deselects respective receiver audio.

Note: Will not select off when respective transmitter selected ON, or 121.500 tuned in radio tuning panel Active Frequency indicator.

9 **Captain's and First Officer's Speaker (SPKR) Volume Control**

Push - turns respective flight deck speaker on.

Rotate - controls flight deck speaker volume.

Second push - deselects respective receiver audio.

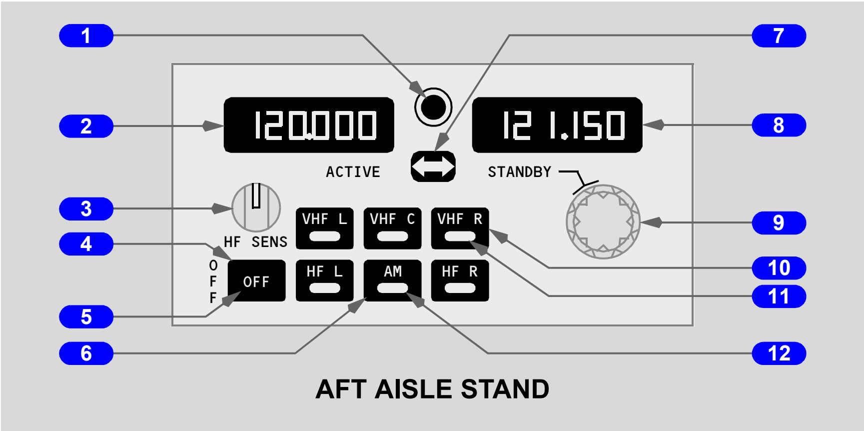
10 **Approach (APP) Receiver Selector**

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



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

  405
- 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.

109, 405

Displays ACARS on VHF C when ACARS selected.

570

Displays DATA on VHF L/C/R or HF L/R when ACARS selected.

3 HF Sensitivity Control

Rotate – adjusts sensitivity of respective 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 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.

109, 405

Displays ACARS on VHF C when selection of the frequency transfer switch would reconfigure VHF C to the data mode.

570

Displays DATA on VHF L/C/R or HF L/R when selection of the frequency transfer switch would reconfigure VHF L/C/R or HF L/R 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

570

Push and hold – removes automatic squelch on selected VHF radio until switch is released.

109

Note: Do not select VHF C for ATC voice communication with ACARS operational.

11 Radio Tuning Lights

Illuminated (white) – indicates selected radio.

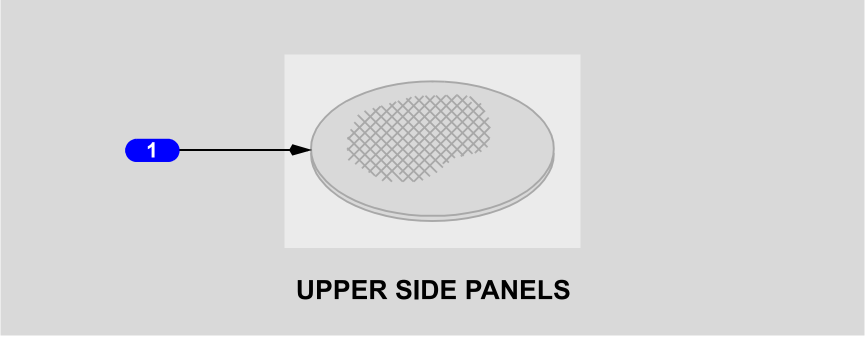
12 **AM Light**

Illuminated (white) – HF AM selected.

Extinguished – HF USB is selected.

Miscellaneous Communication Controls

Flight Deck Speaker

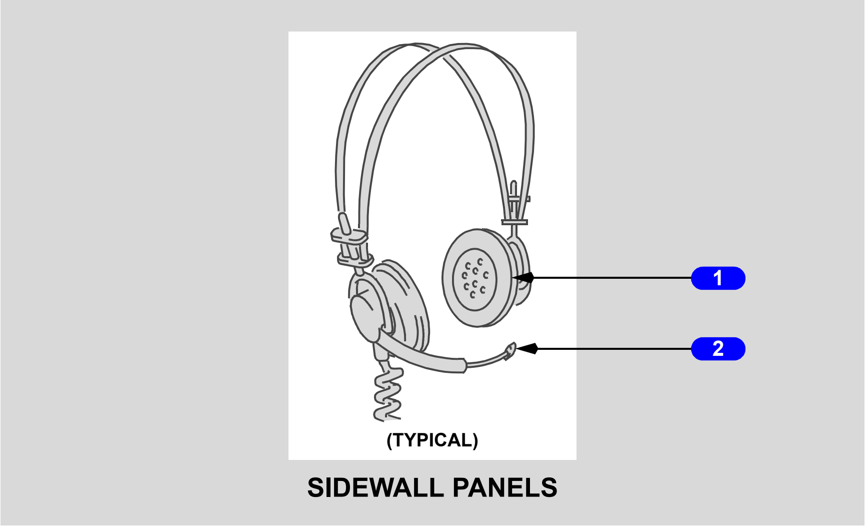


1 **Flight Deck Speaker**

Controlled by speaker volume control on respective audio control panel.

Headphone/Boom Microphone

109, 570



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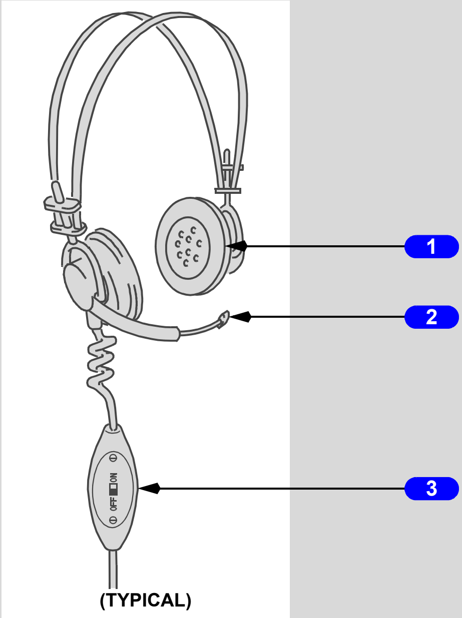


SIDEWALL PANELS

1 Headphone

Used to monitor audio from respective audio control panel.

Audio volume adjusted using audio control panel controls for the respective station.

Available at all four flight deck stations.

2 Boom Mic

Activation of a control wheel or audio control panel mic/interphone switch transmits on the system selected for use at that station.

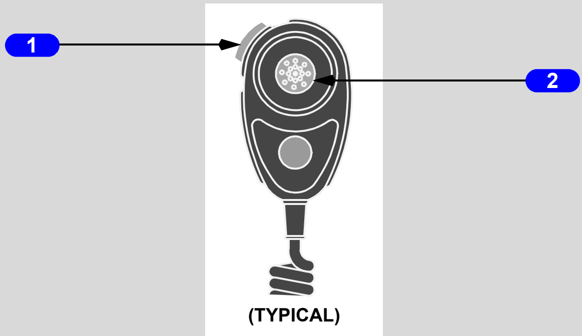
3 Active Noise Reduction Switch

405

OFF – active noise reduction disabled.

ON – active noise reduction enabled.

Hand Microphone



SIDEWALL PANELS

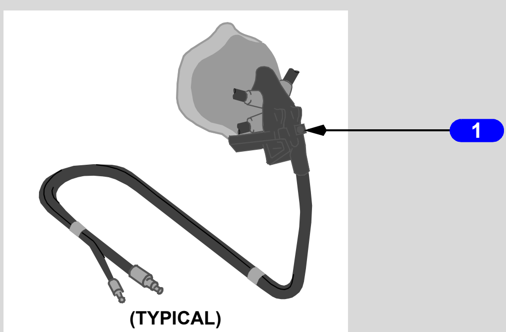
1 Hand Microphone Push–To–Talk Switch

Push – activates hand microphone.

2 Hand Microphone

Transmits on system selected by audio control panel.

Oxygen Mask Microphone



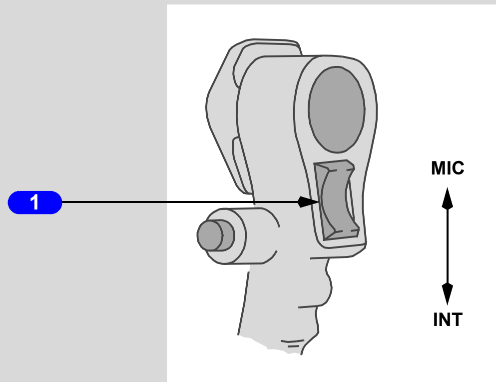
SIDEWALL PANELS

1 Oxygen Mask Microphone

Enabled when oxygen mask doors open. Boom microphone is disabled.

Activation of a control wheel 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.

405

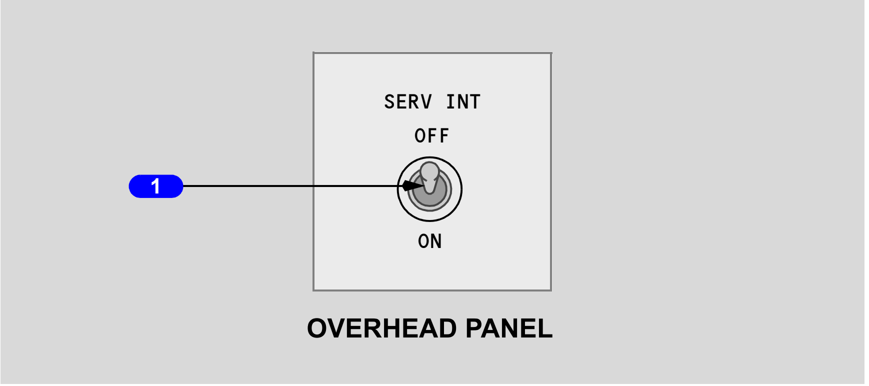
INT – allows oxygen mask or boom microphone transmission on flight interphone system.

109, 570

INT – allows oxygen mask or boom microphone transmission on flight interphone system. Spring–loaded to center.

Service Interphone Switch

109



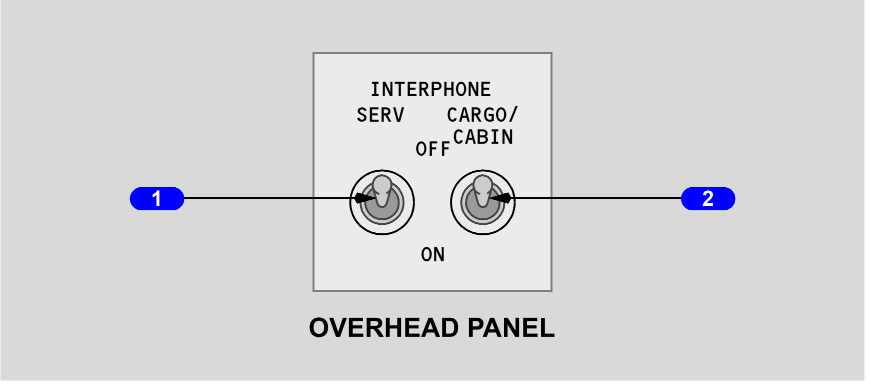
1 Service Interphone (SERV INT) Switch

OFF – allows independent operation of service and flight interphone systems.

ON – connects service and flight interphone systems.

Service and Cargo/Cabin Interphone Switches

405, 570



1 Service (SERV) INTERPHONE Switch

OFF – allows independent operation of service and flight interphone systems.

ON – connects service and flight interphone systems.

2 **CARGO/CABIN INTERPHONE Switch**

570

OFF – allows independent operation of cargo, upper deck, and flight interphone systems.

405

OFF – allows independent operation of cargo and flight interphone systems.

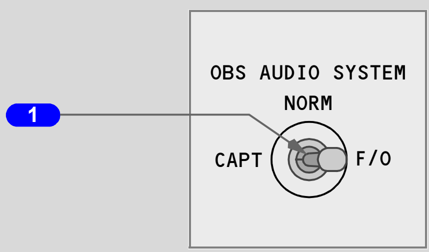
570

ON – connects cargo, upper deck, and flight interphone systems.

405

ON – connects cargo and flight interphone systems.

Observer Audio System Switch



OVERHEAD PANEL

1 **Observer (OBS) AUDIO SYSTEM Switch**

Allows Captain or First Officer to use Observer audio panel.

CAPT - connects Observer audio panel to Captain audio panel:

- hand mic
- boom mic/headset
- headphone
- oxygen mask mic
- speaker
- push-to-talk switches.

NORM - audio panel normal operation

F/O - connects Observer audio panel to First Officer audio panel:

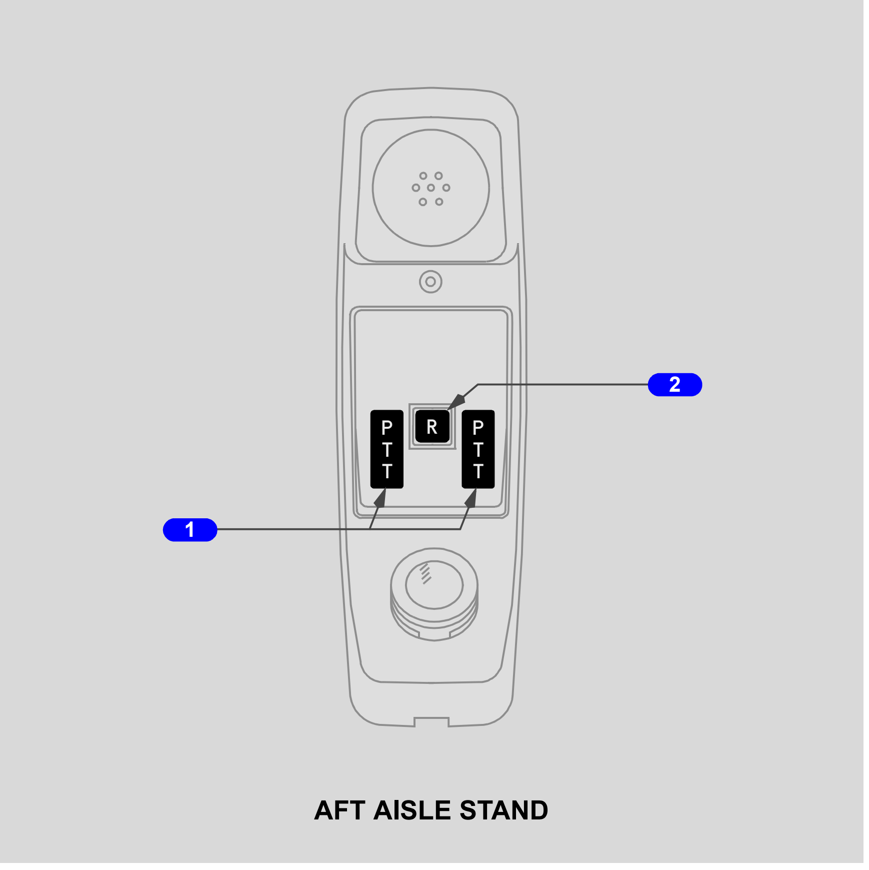
- hand mic
- boom mic/headset

- headphone
- oxygen mask mic
- speaker
- push-to-talk switches

Handset, Passenger

Handset provides communication with other handsets or PA system.

109



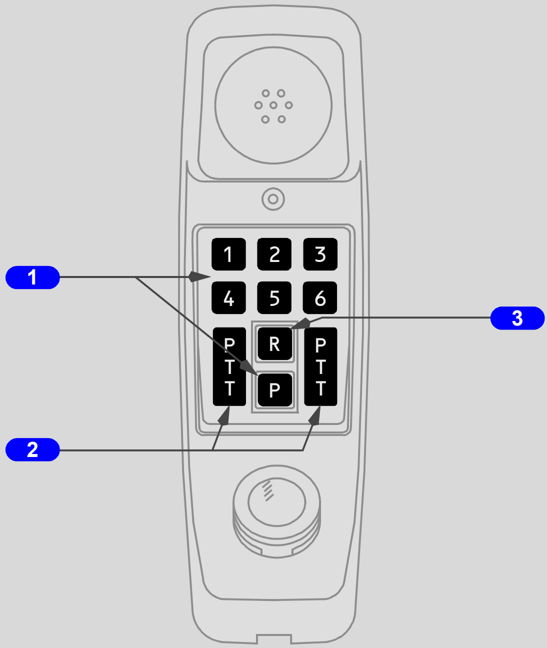
1 PA Push-to-Talk Switches

Push – in PA mode connects handset mic to selected PA area.

2 Reset Switch

Push – cancels call.

109



FLIGHT ATTENDANT PANELS

1 Interphone Keys

Push – selecting two digit code calls respective station or PA area.

2 PA Push-to-Talk Switches

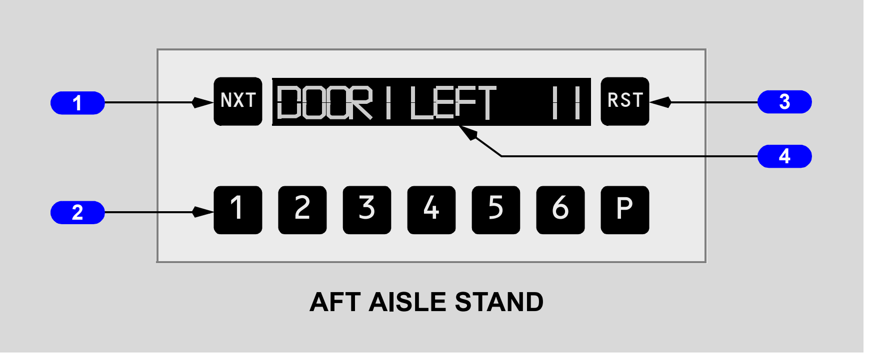
Push – in PA mode connects handset mic to selected PA area.

3 Reset Switch

Push – cancels call or incorrectly selected code.

Call Panel, Passenger

Provides control for either PA (passenger address) or CAB (cabin) interphone communications using either the handset or an audio panel.



1 **Next (NXT) Switch**

Push -

- reviews stored call locations
- when no other calls, scrolls through directory

2 **Call Switches**

Push -

- selecting two digit code calls respective station or PA 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 **Call 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 call panel displays are:

- CABIN READY
- PA IN USE
- PILOT ALERT
- VIDEO IN USE
  109
- PARTY LINE

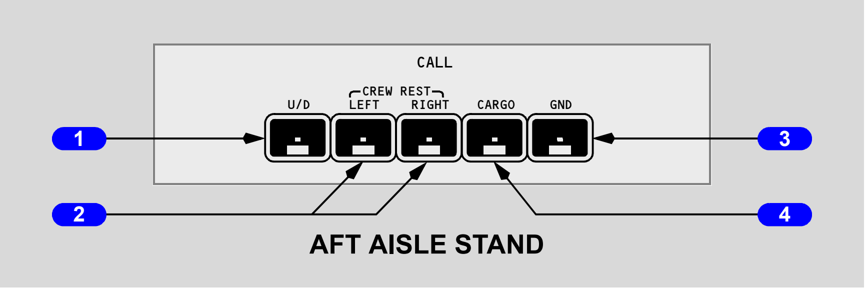
109

Note: Call station directory located on handset. Light sensor adjusts intensity of call station indicator.

Call Panel, Freighter

405, 570

570



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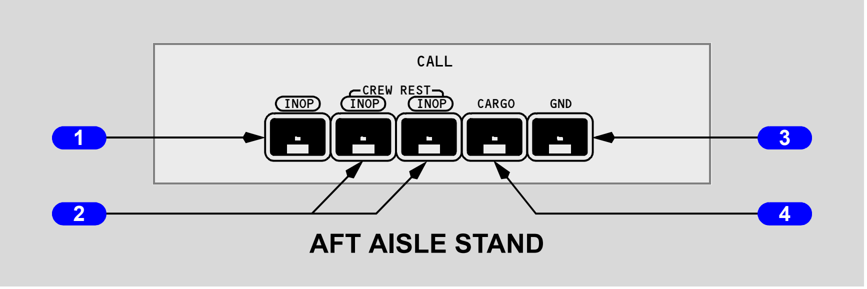


1 Upper Deck (U/D) Call Switch

570

Push – illuminates call light and sounds chime in upper deck seating area.

1 Upper Deck (U/D) Call Switch

405

Inoperative.

2 CREW REST LEFT, RIGHT Call Switches

570

Illuminated (white) - indicates call received from respective upper deck crew rest.

Push - illuminates Flight Deck switch on respective crew rest handset cradle and sounds chime in upper deck crew rest area.

2 CREW REST LEFT, RIGHT Call Switches

405

Inoperative.

3 Ground (GND) Call Switch

Illuminated (white) - indicates call received from nose wheel well.

Push - sounds three second horn in nose wheel well.

4 CARGO Call Switch

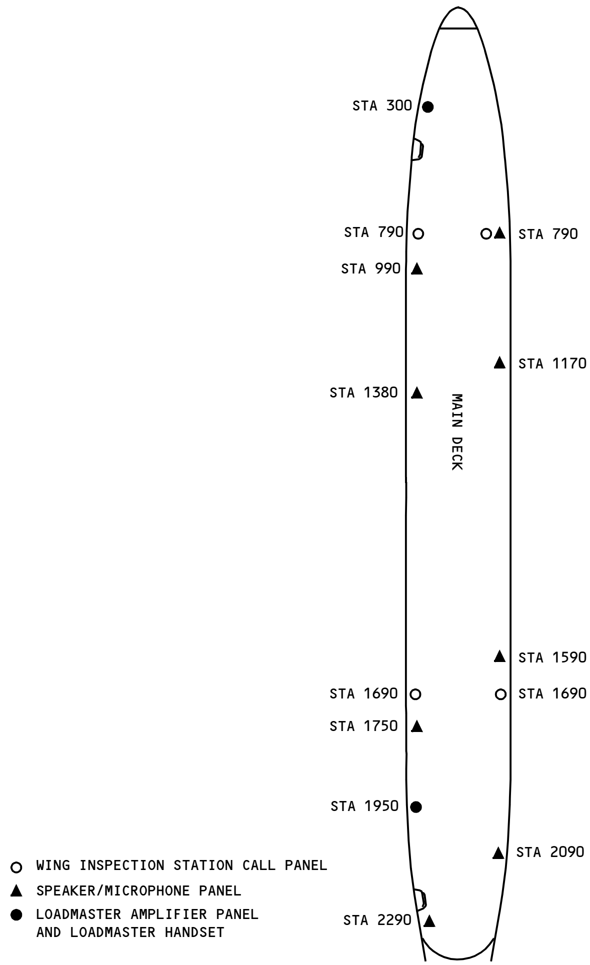
Illuminated (white) - indicates call received from main deck cargo area.

Push - illuminates Flight Deck switch on loadmaster amplifier panels and wing inspection station call panels and sounds a tone in main cargo deck area.

Cargo Interphone Component Locations

405, 570

570



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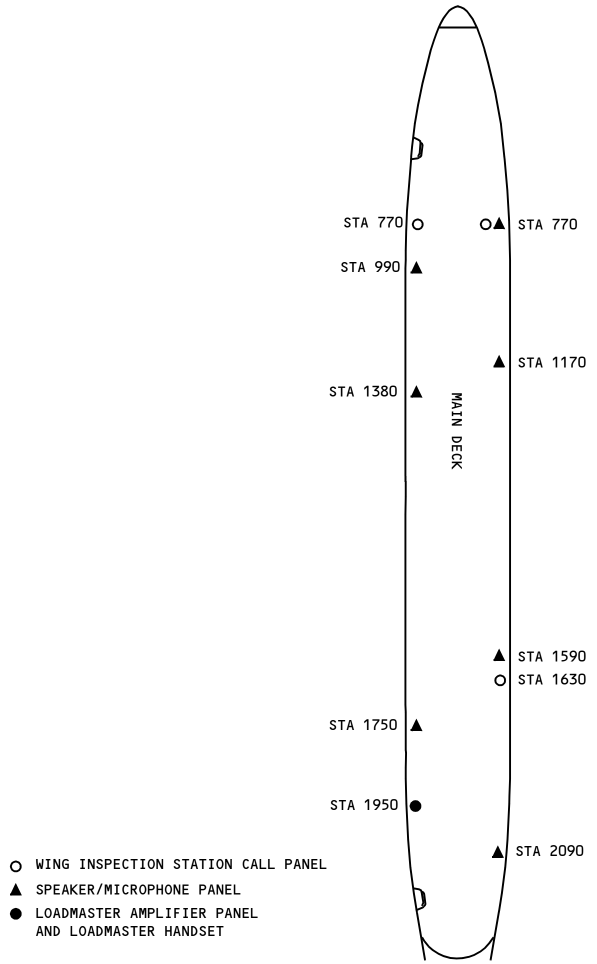
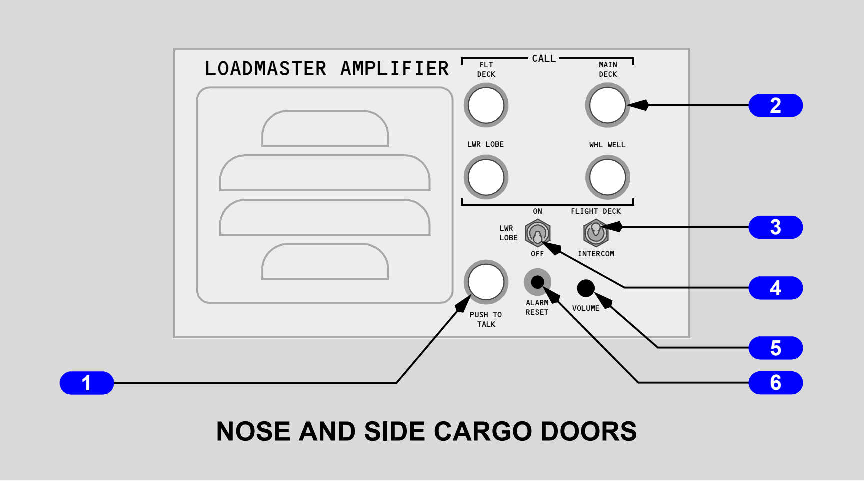

STA 770
STA 770
STA 990
STA 1170
STA 1380
MAIN DECK
STA 1590
STA 1630
STA 1750
STA 1950
STA 2090
WING INSPECTION STATION CALL PANEL
SPEAKER/MICROPHONE PANEL
LOADMASTER AMPLIFIER PANEL
AND LOADMASTER HANDSET

Cargo Interphone Components, Freighter

405, 570

Loadmaster Amplifier Panel

570



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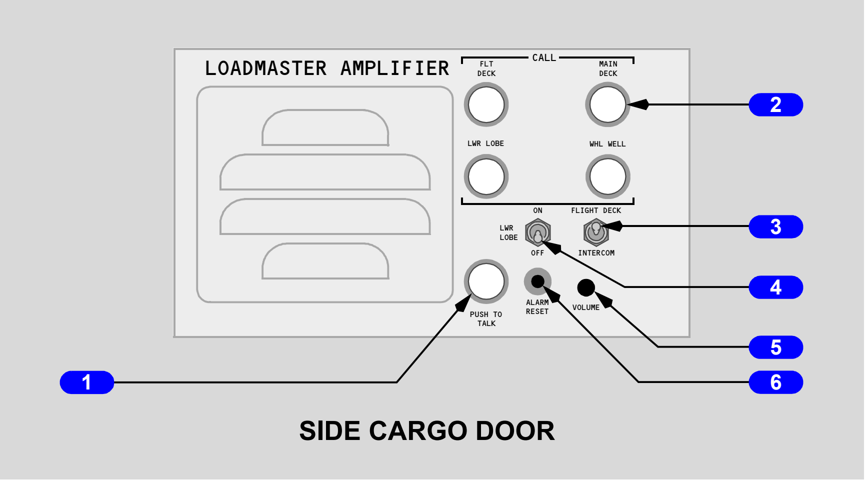


1 PUSH TO TALK Switch

Push - activates loadmaster amplifier panel microphone and connects to any selected area except flight deck.

2 CALL Switches

Illuminated (white) - indicates a call from the respective area. Extinguishes when pushed.

Push - sounds a chime in area being called.

3 FLIGHT DECK/INTERCOM Switch

FLIGHT DECK - connects loadmaster amplifier panel handset to flight deck interphone. Handset must be used for communication with flight deck.

INTERCOM - connects loadmaster panel to main cargo deck speaker/microphone panels.

4 LOWER LOBE Switch

ON - activates lower lobe speaker/microphone panels.

OFF - deactivates lower lobe speaker/microphone panels.

5 VOLUME Selector

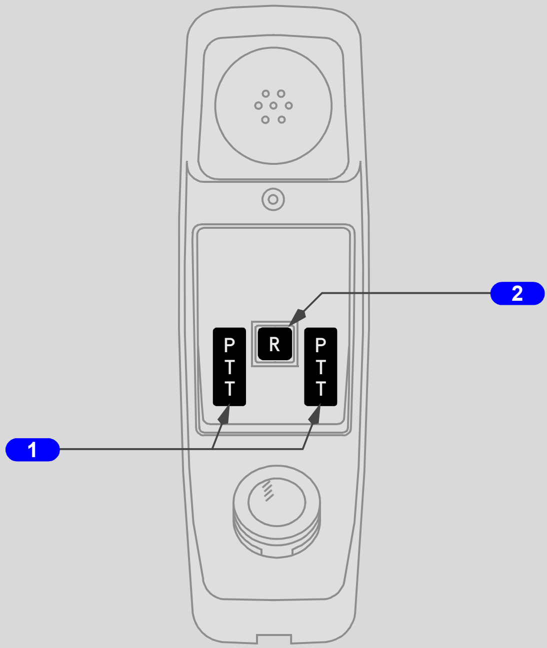
Rotate - adjusts loadmaster amplifier panel speaker volume.

6 ALARM RESET Switch

Push - resets aft c.g. audio alarm.

Loadmaster Handset

The loadmaster handset provides communications on cargo interphone and intercom systems.



MAIN CARGO DECK

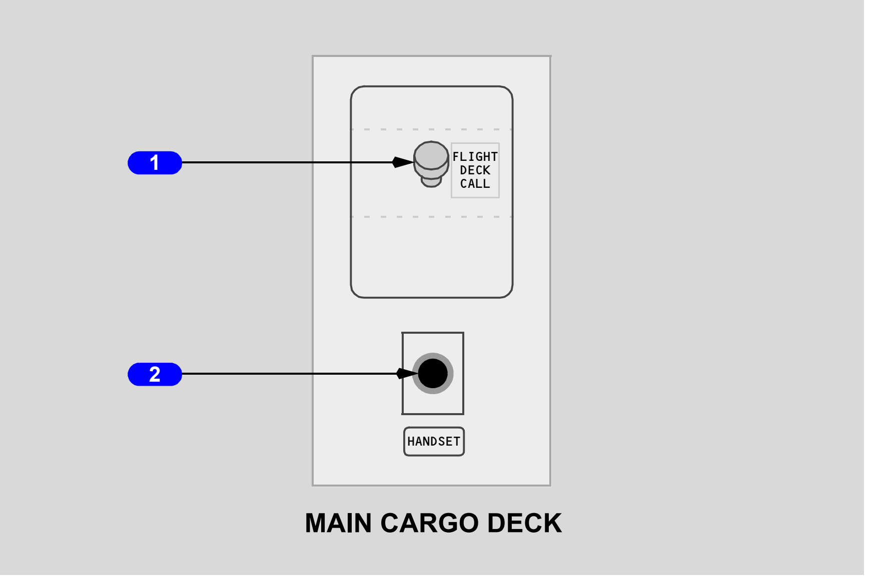
1 PUSH TO TALK Switches

Push - extinguishes Call switch lights.

2 Reset Switch

Push - cancels call.

Wing Inspection Station Call Panel



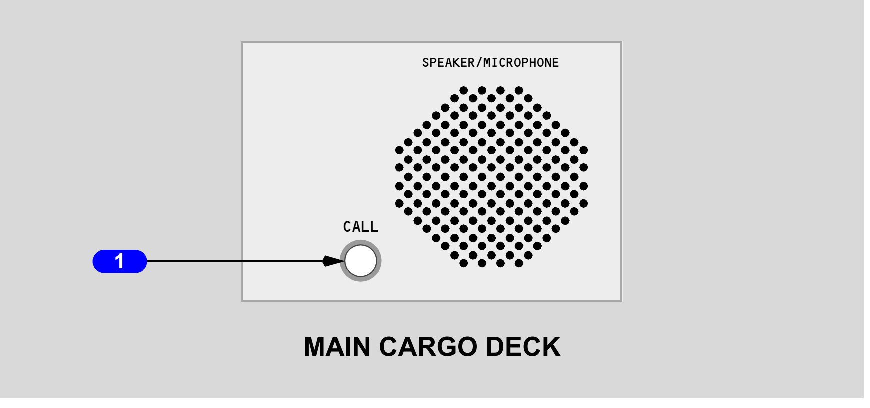
1 FLIGHT DECK CALL Switch

Push - sounds a chime in the flight deck, displays location (CARGO) on flight deck call panel, and illuminates flight (FLT) Call indication on the audio panel.

2 HANDSET Jack

Receptacle for handset connection.

Main Cargo Deck Speaker/Microphone Panel



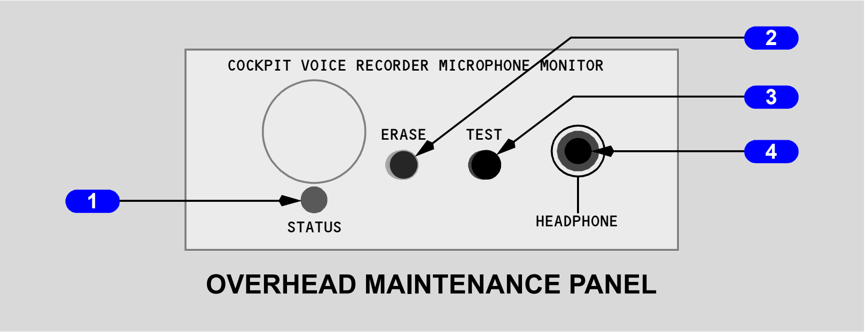
1 **CALL Switch**

Push - sounds a tone and illuminates Main Deck Call switch at each loadmaster amplifier panel.

Cockpit Voice Recorder System

Cockpit Voice Recorder Panel

109



1 **STATUS Light**

Illuminated (green) – test completed successfully. Extinguished after one second.

2 **ERASE Switch**

Push and hold for three seconds - erases voice recorder if on the ground, AC power on, and parking brake set.

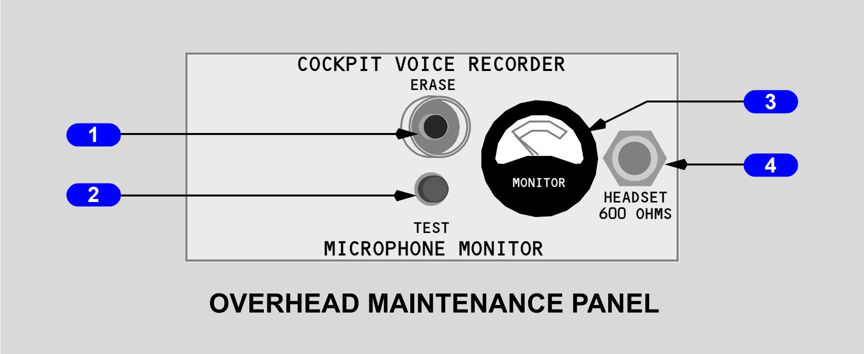
3 **TEST Switch**

Push and hold for five seconds – tests all four cockpit voice recorder channels (1 per second).

4 **Headset Jack**

Headset can be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

Cockpit Voice Recorder Panel
405



1 ERASE Switch

Push and hold for three seconds – erases voice recorder if on the ground, AC power on, and parking brake set.

2 TEST Switch

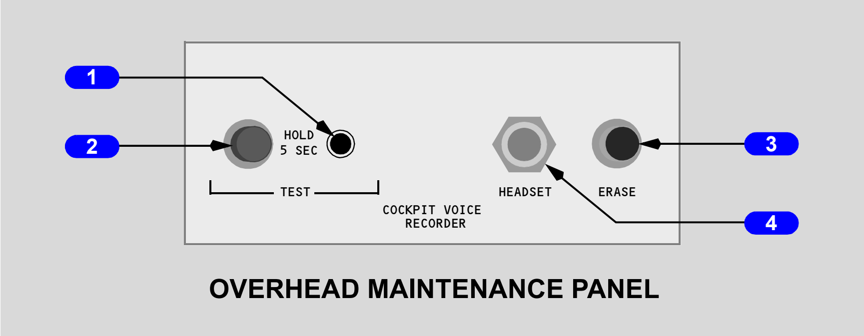
Push - tests all four channels.

3 Monitor Indicator

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 Panel
570



1 **STATUS Light**

Illuminated – test completed successfully. Extinguished after button is released.

2 **TEST Switch**

Push and hold for five seconds – tests all four cockpit voice recorder channels (1 per second).

3 **ERASE Switch**

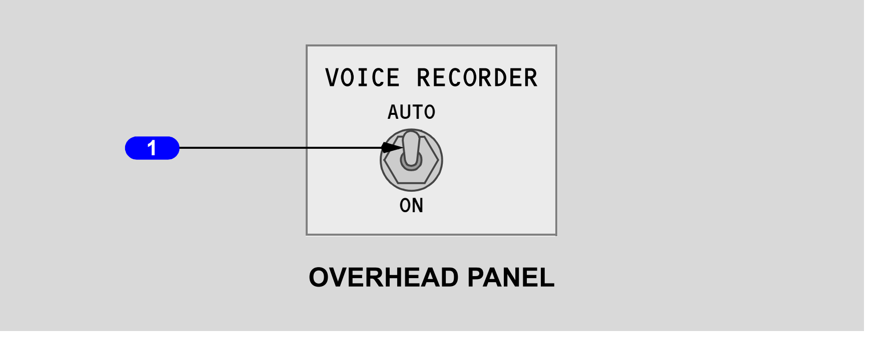
Push and hold for three seconds – erases voice recorder if on the ground, AC power on, and parking brake set.

4 **Headset Jack**

A headset can be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

Cockpit Voice Recorder Switch

405

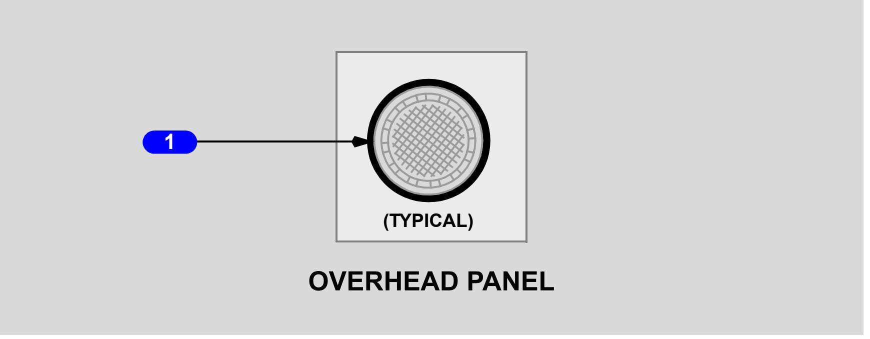


1 **Cockpit VOICE RECORDER Switch**

ON - records before engine start. Spring loaded to AUTO at engine start.

AUTO - records from first engine start until five minutes after last engine shut down. Always records in flight.

Cockpit Voice Recorder Microphone



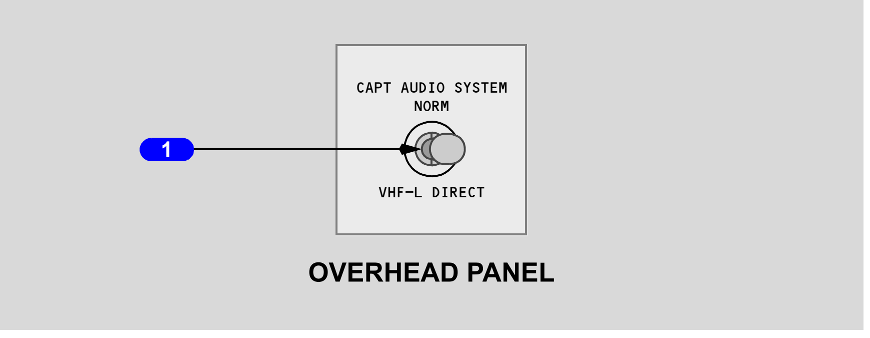
1 Cockpit Voice Recorder Microphone

Area microphone for the voice recorder.

Miscellaneous Communication Switches

570

Captain Audio System Switch

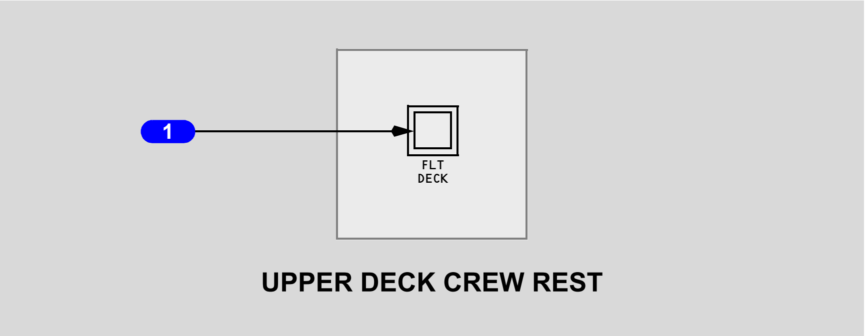


1 CAPT AUDIO SYSTEM Switch

Normal (NORM) - all communication systems operate normally.

VHF-L DIRECT - bypasses audio system by connecting Captain boom/mic headset and control wheel push-to-talk switches directly to VHF-L transceiver. Allows Captain to communicate on VHF-L transceiver if audio system failure causes loss of communication. Volume control is not available.

Upper Deck Crew Rest Call Switch



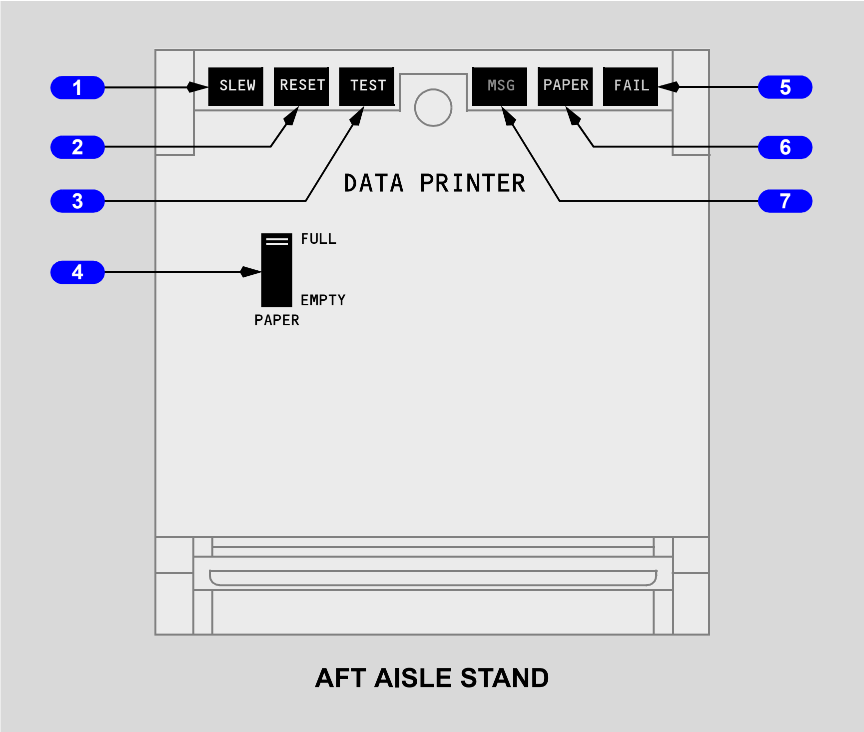
1 Flight (FLT) DECK Call Switch

Illuminated (white) – interphone call from flight deck received, chime also sounds in upper deck crew rest area.

Push – sounds chime in flight deck, displays location (CREW REST LEFT, RIGHT) on flight deck call panel, and illuminates the Flight (FLT) call indication on audio panel.

Printer Controls

109, 570



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.

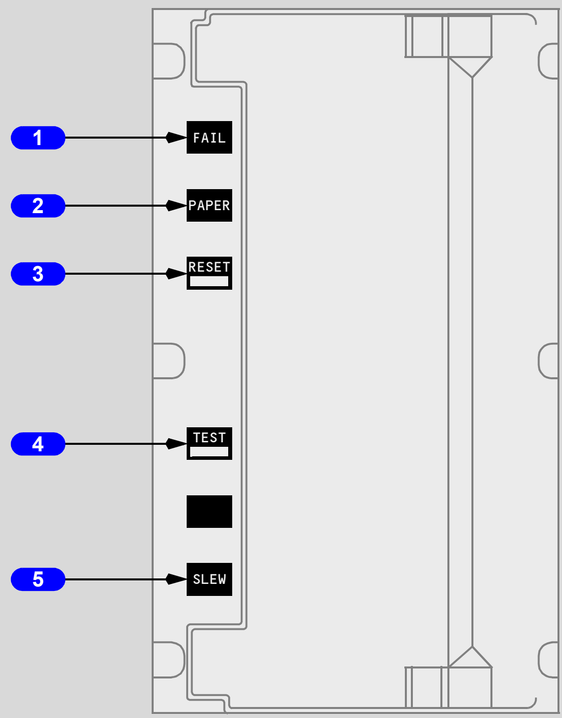
6 PAPER Light

Illuminated (amber) - indicates printer out of paper.

7 Message (MSG) Light

Illuminated (blue) - indicates message sent to printer.

405



AFT AISLE STAND

1 FAIL Light

Illuminated (amber) –

- printer failure, or
- test in progress

2 PAPER Light

Illuminated (amber) -

- test in progress, or
- paper jam

3 RESET Switch

Push –

- aborts current print job
- deletes pending print job(s)
- resets printer

Illuminated (white) -

- reset in progress, or
- test in progress

4 TEST Switch

Push –

- tests printer
- prints test pattern

Illuminated (white) - test in progress.

5 SLEW Switch

Push and hold – advances paper.

Communications Chapter 5
System Description Section 20

Introduction

The communication system includes:

- radio communication system
- cockpit voice recorder system
- interphone communication system
- SATCOM communication system
  405, 570
- ATC data communication system
  405, 570
- 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.

109, 570

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 switch is pushed.

Cockpit Voice Recorder System

The cockpit voice recorder records any transmitted or received flight deck audio as selected on the audio control panels. It also records flight deck area conversations using an area microphone. All inputs are recorded continuously.

Radio Tuning Panels

The radio tuning panels tune the VHF and HF radios. The panels are designated left, center, and right, and are normally associated with the respective VHF and HF radios.

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

  405
- 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 VHF radios (VHF L, C, R) and two 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.

109, 405

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.

570

VHF L, VHF C, or VHF R can be configured for voice or ACARS data communication.

405, 570

VHF radios are equipped with 8.33 kHz channel spacing.

570

HF L or HF R can be configured for voice or ACARS data communication.

The two HF radios share a common antenna. An HF voice transmission disables the opposite side HF radio during transmission. Simultaneous use of both HF radios is limited to receive only.

HF radio sensitivity can only be adjusted using the on-side radio tuning panel. Sensitivity control is not affected by radio tuning panel status.

109, 405

When an HF transmitter is keyed after a frequency change, the antenna tunes while a continuous tone can be heard through the audio system. A tone lasting longer than 7 seconds indicates failure of the system to tune.

570

When an HF transmitter is keyed after a frequency change, the antenna tunes while a continuous or intermittent tone may be heard through the audio system. A tone lasting longer than 7 seconds indicates failure of the system to tune. Data is stored in memory for the last 100 tuned frequencies. Stored frequencies may tune quickly and a tone may not be noticeable.

Stuck Mic Protection

On the ground, any VHF radio transmitting for longer than 35 seconds is disabled following annunciation of a warning beep. 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.

109, 405

ACARS communicates through either VHF C or SATCOM.

570

ACARS communicates through either VHF L/C/R or SATCOM and/or HF L/R.

If ACARS is not available due to lost communication, information to be transmitted is stored and transmitted automatically when communication is regained.

109, 405

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.

570

VHF L/C/R or HF L/R data mode can be selected and deselected by pushing the frequency transfer switch on the radio tuning panel. The VHF or HF radio is in data mode when the word DATA is displayed in the radio tuning panel active frequency window.

109

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.

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When a VHF C standby frequency is transferred to the active window, ACARS is displayed in the standby window. If a new frequency is subsequently selected in the standby window, ACARS is replaced by the new frequency. ACARS can be returned to the standby window by selecting a frequency higher or lower than the allowable VHF frequency range. When in the data mode, VHF C is not available for voice communications. VHF C can be returned to the voice communication mode by transferring a voice frequency into the active frequency window.

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When a VHF L/C/R or HF L/R standby frequency is transferred to the active window, DATA is displayed in the standby window. If a new frequency is subsequently selected in the standby window, DATA is replaced by the new frequency. DATA can be returned to the standby window by selecting a frequency higher or lower than the allowable VHF or HF frequency range. When a VHF radio is in data mode, it is not available for voice communications. HF datalink operation is inhibited on the ground. When an HF radio is in data mode during flight, the opposite side HF is available for voice communications and will preempt any HF datalink operation in progress. HF datalink resumes after a short period following completion of the voice transmission. The VHF or HF radio can be returned to voice communication mode by transferring a voice frequency into the active frequency window.

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 respective radio CALL light illuminates and a chime sounds. The CALL light is reset by selecting the respective 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/Intercom Communication System

The interphone communication system includes the:

- flight interphone system
- cabin interphone system (passenger)
- passenger address (PA) system (passenger)
- personnel address (PA) system (freighter)
- cargo interphone (freighter)
  570
- upper deck interphone system (freighter)
- cargo intercom (freighter main deck)
- 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.

The cargo interphone and upper deck interphone systems can be connected to the flight interphone with the Cargo Interphone switch.

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 of a control wheel switch or 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

On passenger airplanes, 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 flight deck call panel.

On freighter airplanes, crew alerting of a ground crew inititated call is provided by an aural alert chime, illumination of the FLT call indication on the audio panel, and illumination of the Ground Call switch on the call panel. The call indication is reset after a 60 second delay. Pushing the Ground Call switch on the call panel sounds a three second horn in the nose wheel well.

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An incoming call from the left or right upper deck crew rest area illuminates the FLT call indication on the audio panel, sounds a chime, and illuminates the respective Crew Rest switch on the call panel. The call indication is reset after a 60 second time delay. Pushing either Crew Rest Left or Right switch on the call panel sounds a chime and illuminates the Flight Deck switch on the respective crew rest handset cradle.

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/Personnel Address System

Passenger Address System, Passenger

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

Personnel Address System, Freighter

The personnel address (PA) address system is used by the flight crew to make announcements to the upper deck seating area and crew rest areas.

The system is monitored by selecting the PA receiver volume control on an audio panel. The PA system is accessed by selecting the PA Transmitter selector on the audio panel and using the boom microphone, or oxygen mask microphone, or hand microphone. The boom or oxygen mask microphone is used with the R/T position of a Push-to-Talk switch.

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.

Cabin Interphone System

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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 flight deck call panel. The call 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 call panel, and sounds a chime.

The CAB call indication is reset by selecting the respective 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 call 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 call panel displays a "W" followed by the number of stored calls. After completing the call, stored locations can be reviewed with the NXT switch on the call panel.

Upper Deck Interphone System

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The upper deck interphone system permits communication between the flight deck and the upper deck crew rest areas. The upper deck interphone system can be connected to the flight interphone system with the Cargo/Cabin Interphone switch on the flight deck overhead panel.

Cargo Interphone System

405, 570

The cargo interphone system provides communication between load personnel, the flight deck, and ground crew.

The cargo interphone system can be connected to the flight interphone system with the Cargo/Cabin Interphone switch on the flight deck overhead panel.

On the main cargo deck two Loadmaster's Amplifier Panels and four Wing Station Call panels have two-way call capability with the flight deck. In addition, the Loadmaster Amplifier panels have two-way call capability with the nose wheel well and the lower lobe cargo compartments.

Cargo Intercom System

405, 570

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The cargo intercom system has eight speaker/microphone panels located throughout the main cargo deck, which are controlled from either Loadmaster Amplifier panel.

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The cargo intercom system has seven speaker/microphone panels located throughout the main cargo deck, which are controlled from the Loadmaster Amplifier panel.

Intentionally
Blank

Communications — Chapter 5
ATC Datalink — Section 33

This Section Applies to 405, 570

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. Display of the EICAS memo message ATC MESSAGE and a low level aural chime announce uplinked messages to the flight crew.

The ATC REQUEST pages provide capability to create downlink requests for vertical and speed clearances, lateral offsets, and route changes.

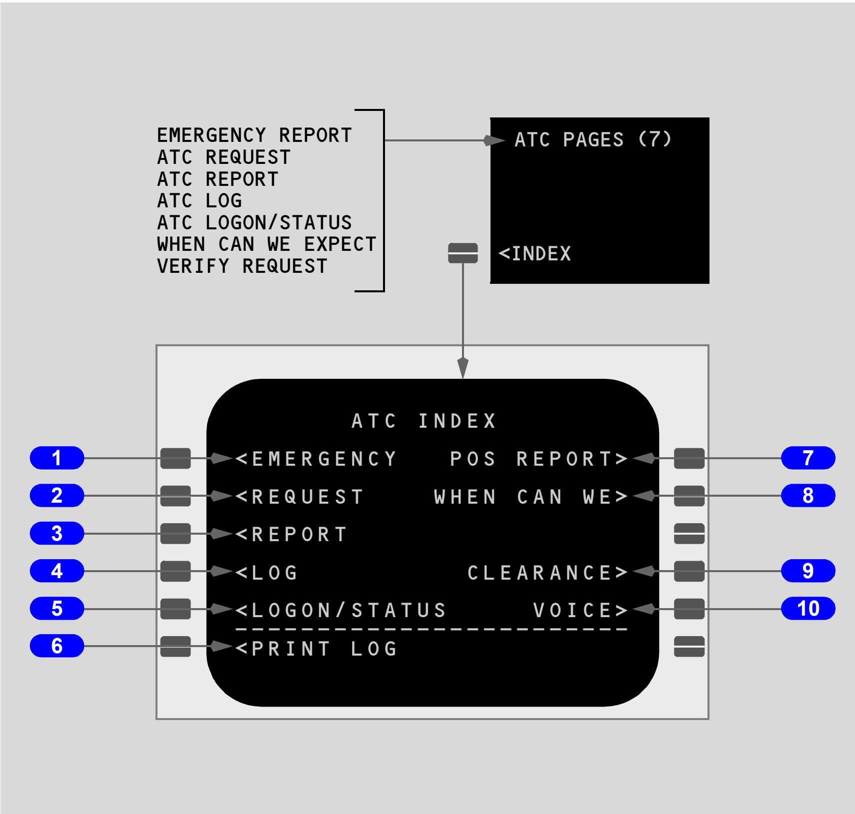
The FMC formats reports in response to requests from an ATS facility for reports and confirmation. These reports are accessible via the ATC REPORT page and display for review or modification on the VERIFY REPORT pages.

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**

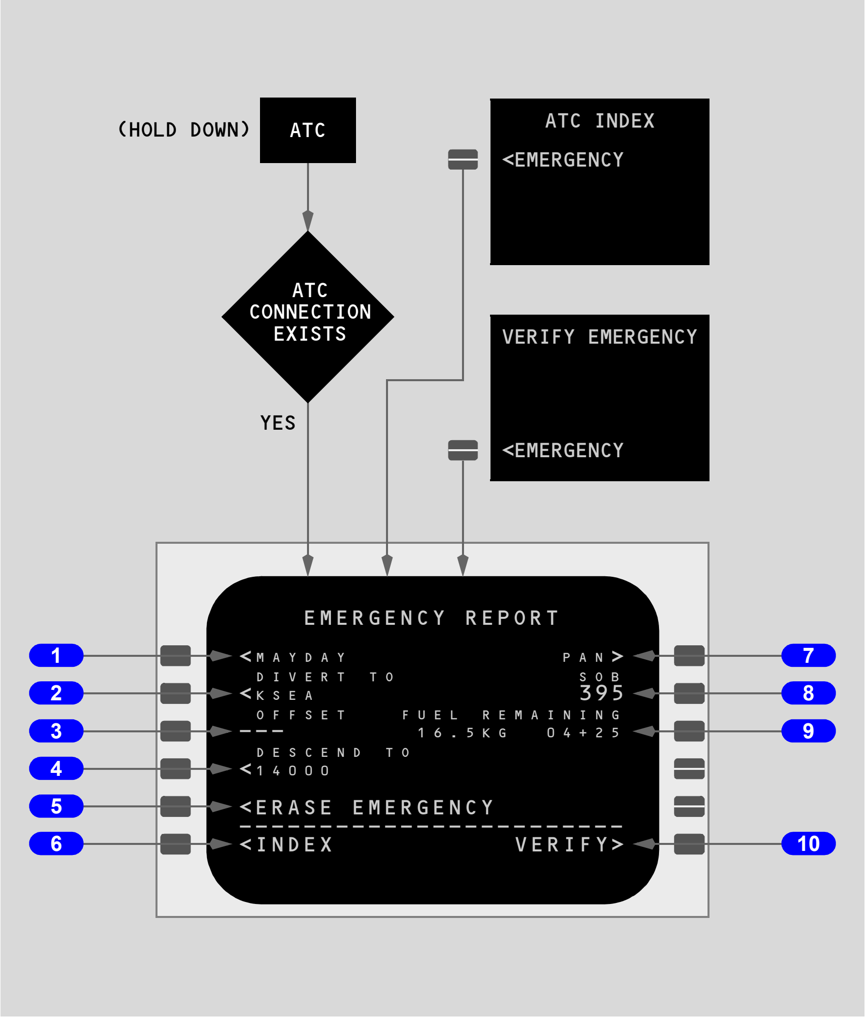
Push - displays VERIFY REQUEST pages for clearance request.

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, or just 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.

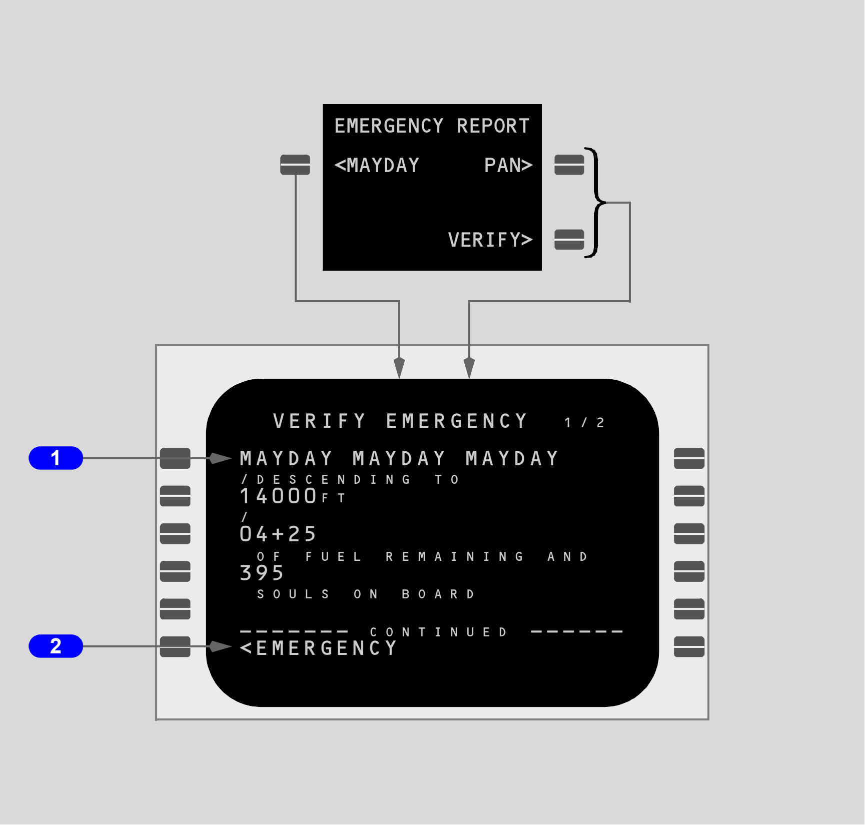
Valid entry is HH+MM (hours and minutes).

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.

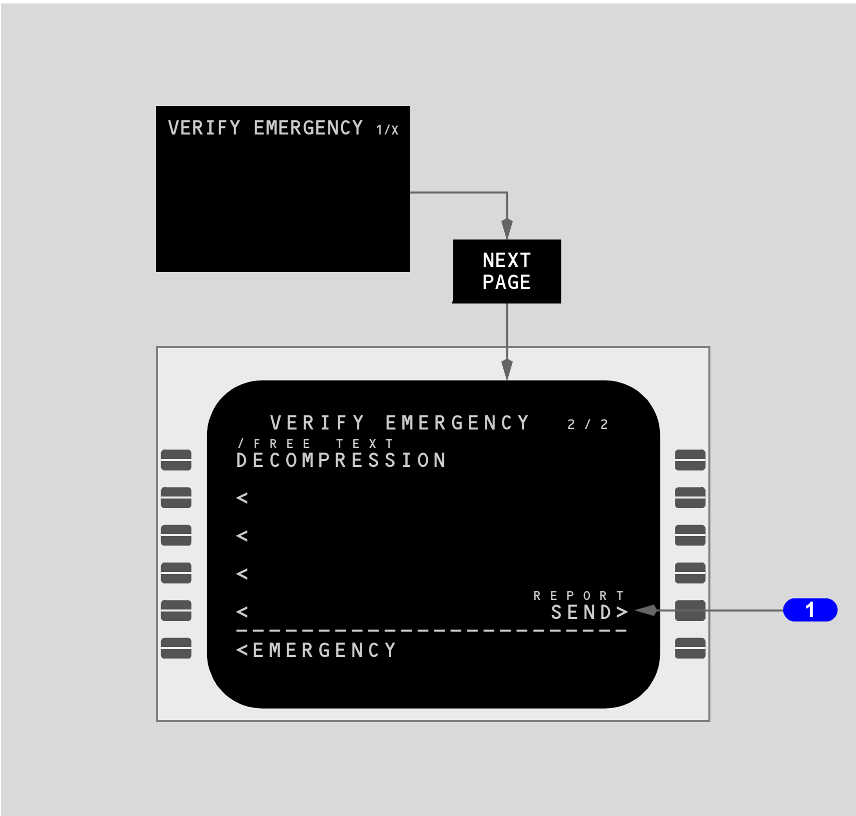
- MAYDAY MAYDAY MAYDAY message and PAN PAN PAN messages may be deleted
- deletion of MAYDAY MAYDAY MAYDAY message deletes DESCENDING TO line

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

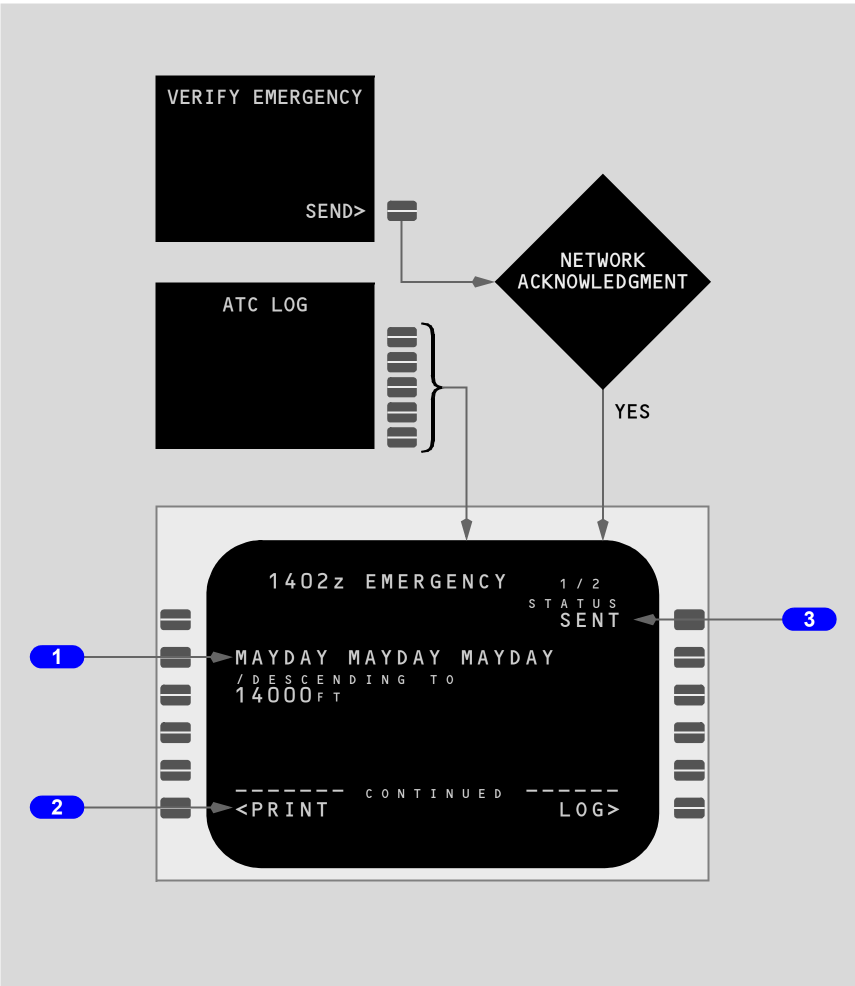
When CANCEL EMERGENCY displayed in 5L:

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 -

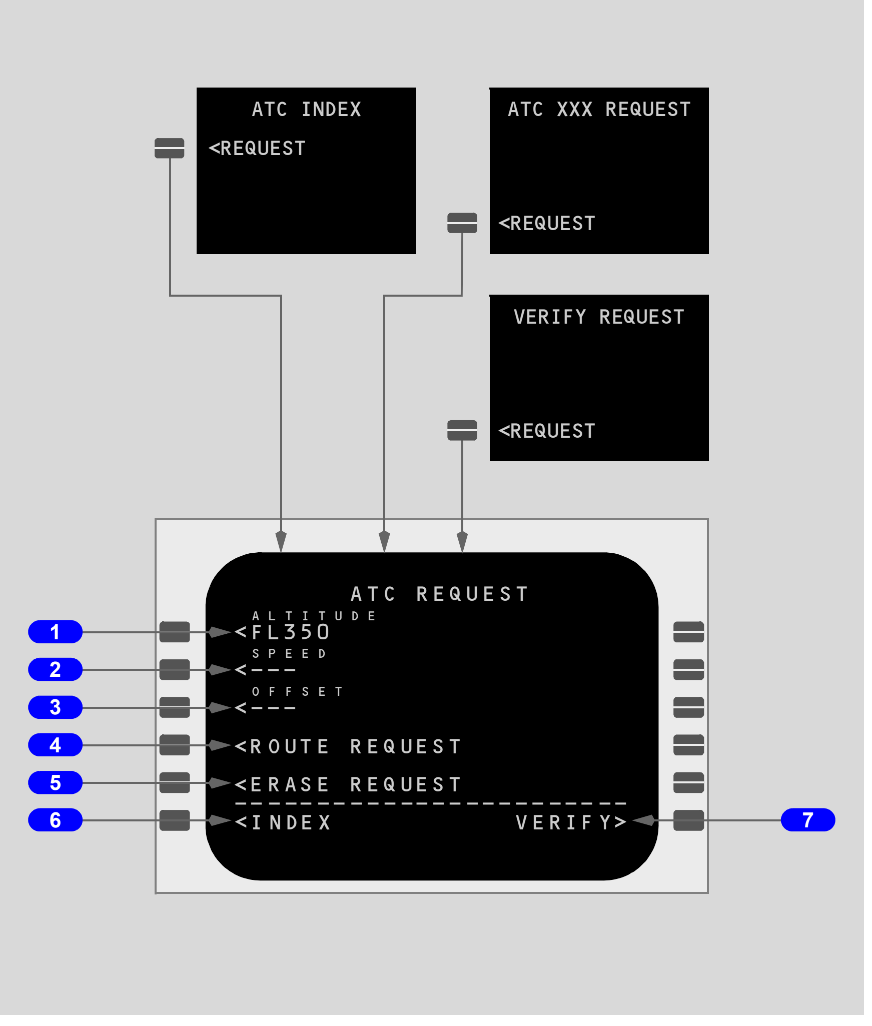
Push - prints XXXXZ EMERGENCY report.

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, or FLXXX/FLXXX.

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, or just 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

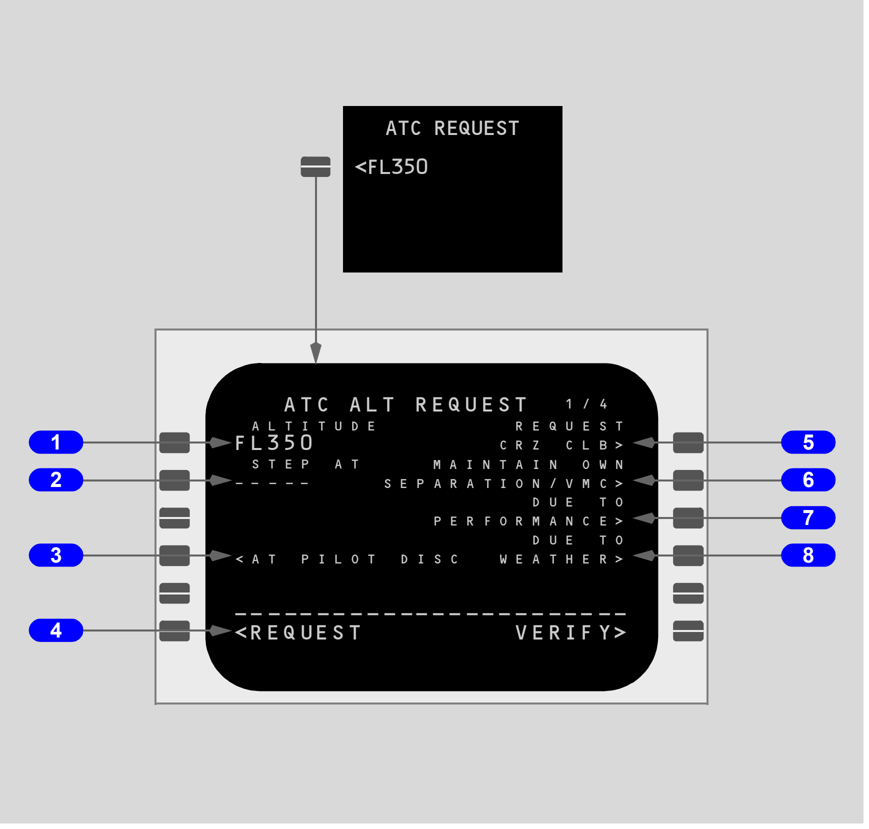
Push - displays ATC INDEX page.

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 requested on ATC REQUEST page.

Valid entries are XXX or FLXXX (flight level), XXXXX (feet), XXXXXM (meters), XXXXX/XXXXX, or FLXXX/FLXXX.

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.

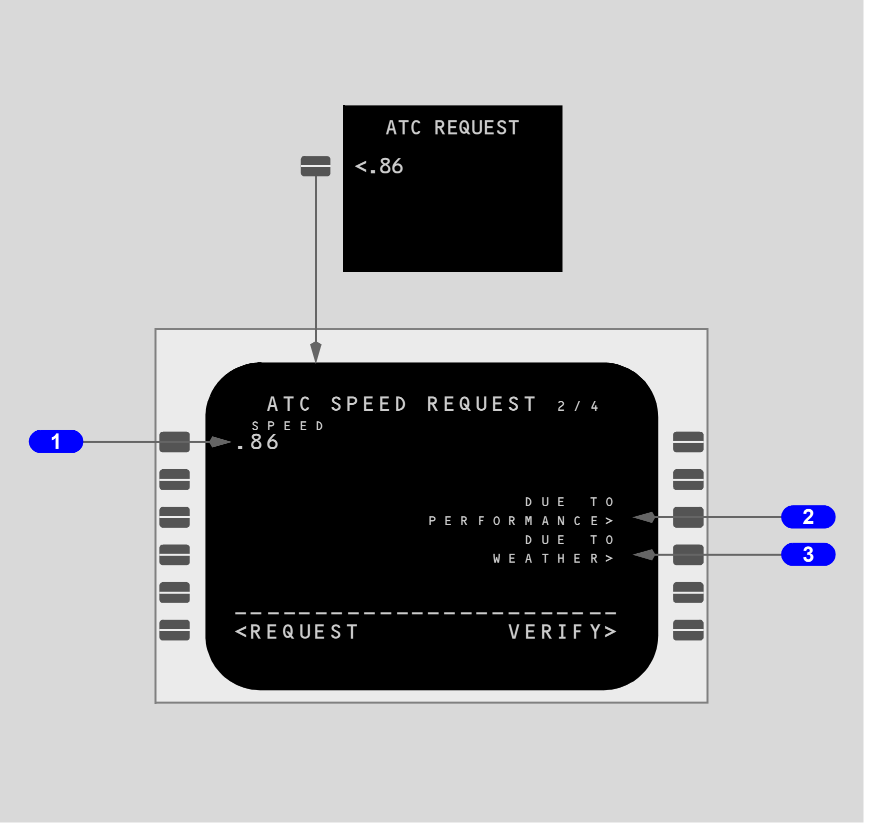
8 DUE TO WEATHER

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.

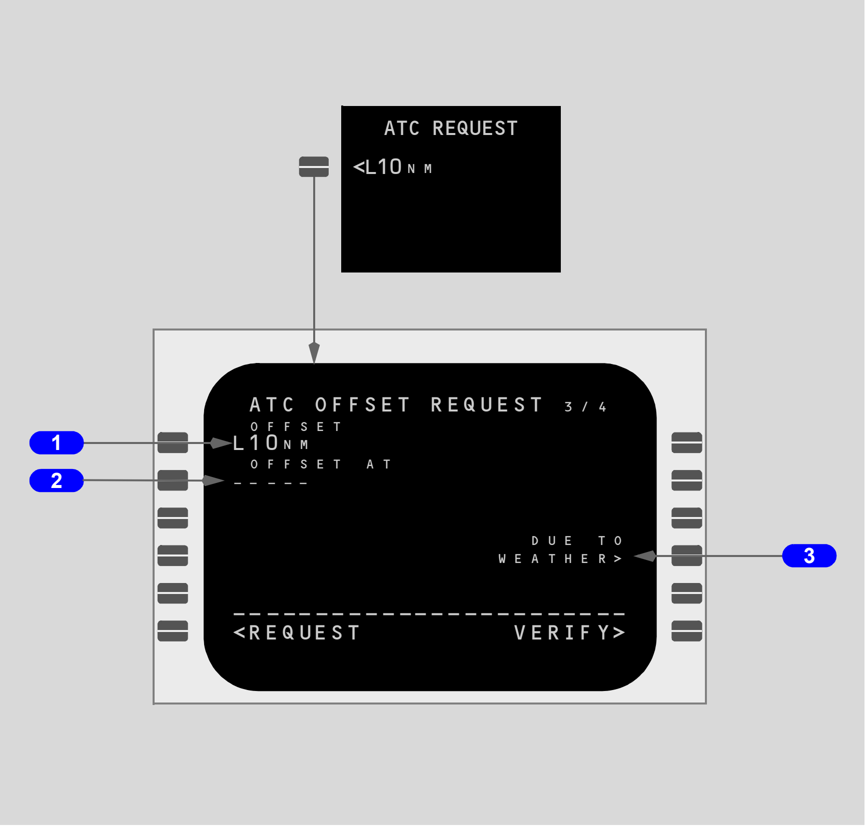
3 DUE TO WEATHER

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 on ATC REQUEST page.

Valid entry is L (or R) XX, or just 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.

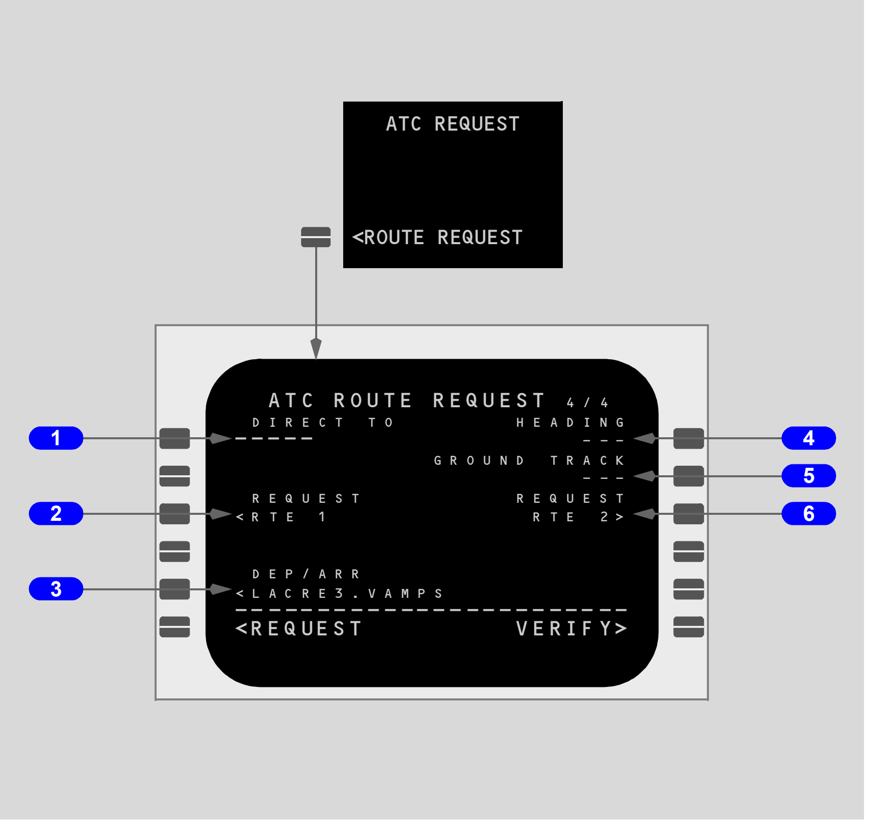
3 **DUE TO WEATHER**

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.

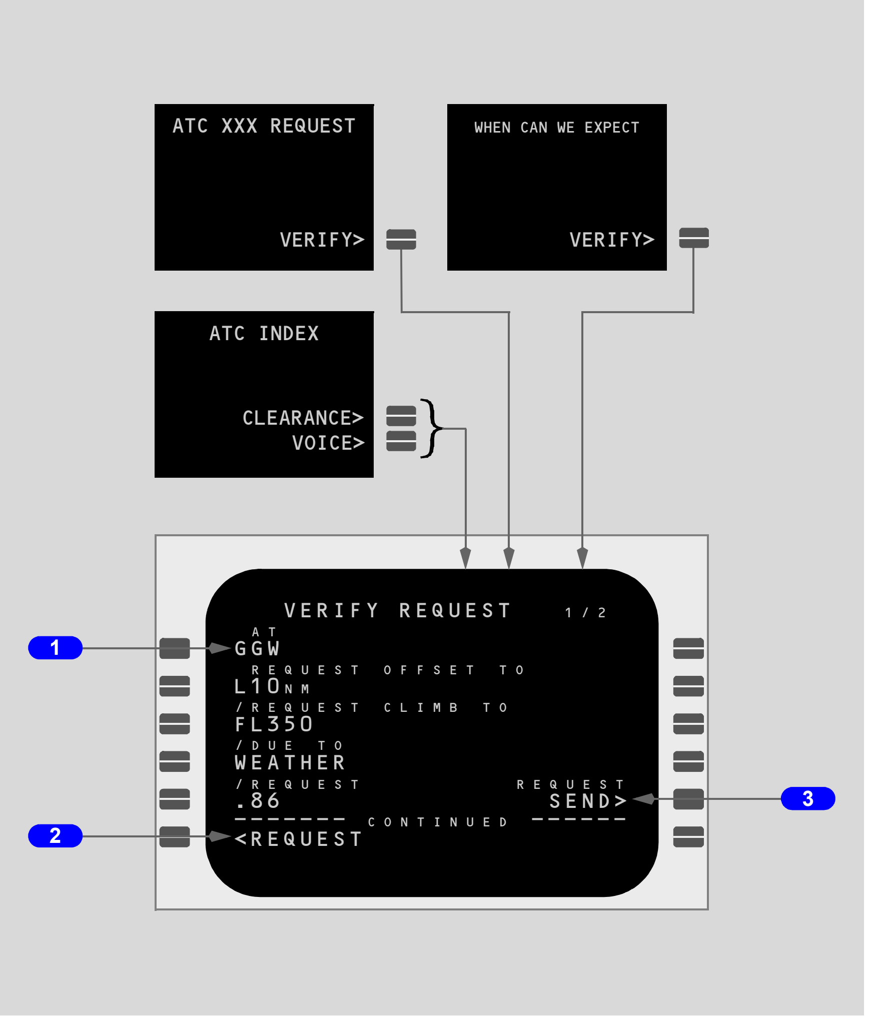
6 REQUEST Route 2 (RTE 2)

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 from ATC REQUEST page.

Displays INDEX when page accessed from ATC 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 EXPECT page.

3 REQUEST SEND

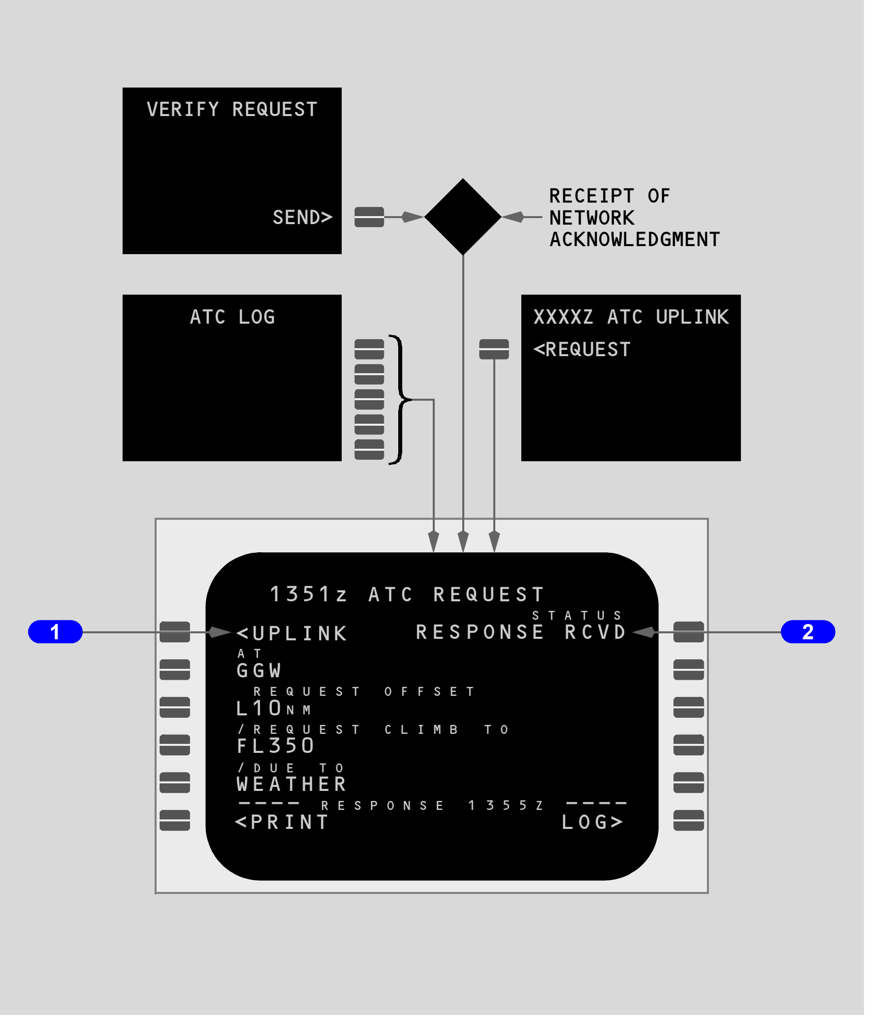
Displays on last VERIFY REQUEST page.

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 to ATC 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 -

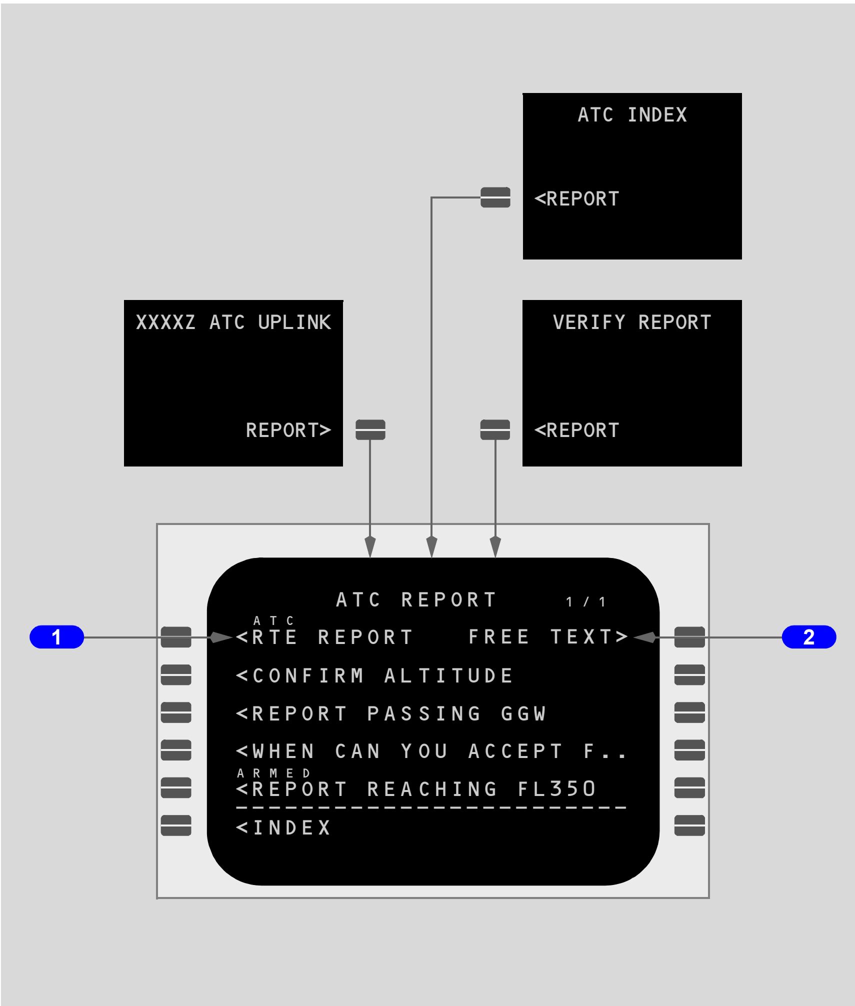
Push - displays the XXXXZ ATC UPLINK 1/X page displaying ATC uplink to displayed request.

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 -

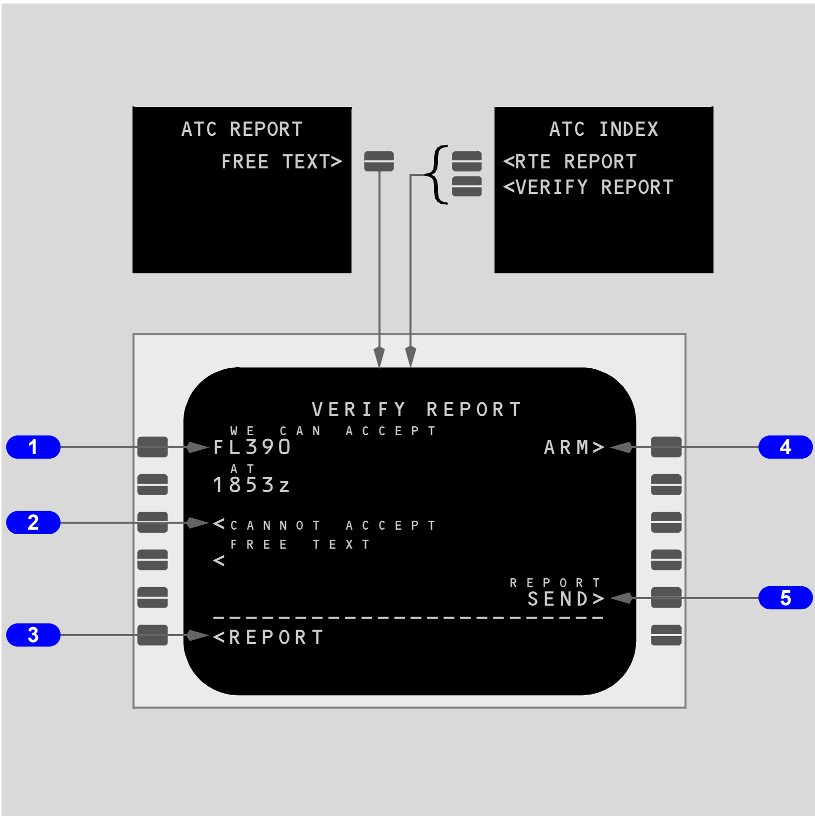
Push - displays ATC requested report or confirmation VERIFY REPORT page.

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

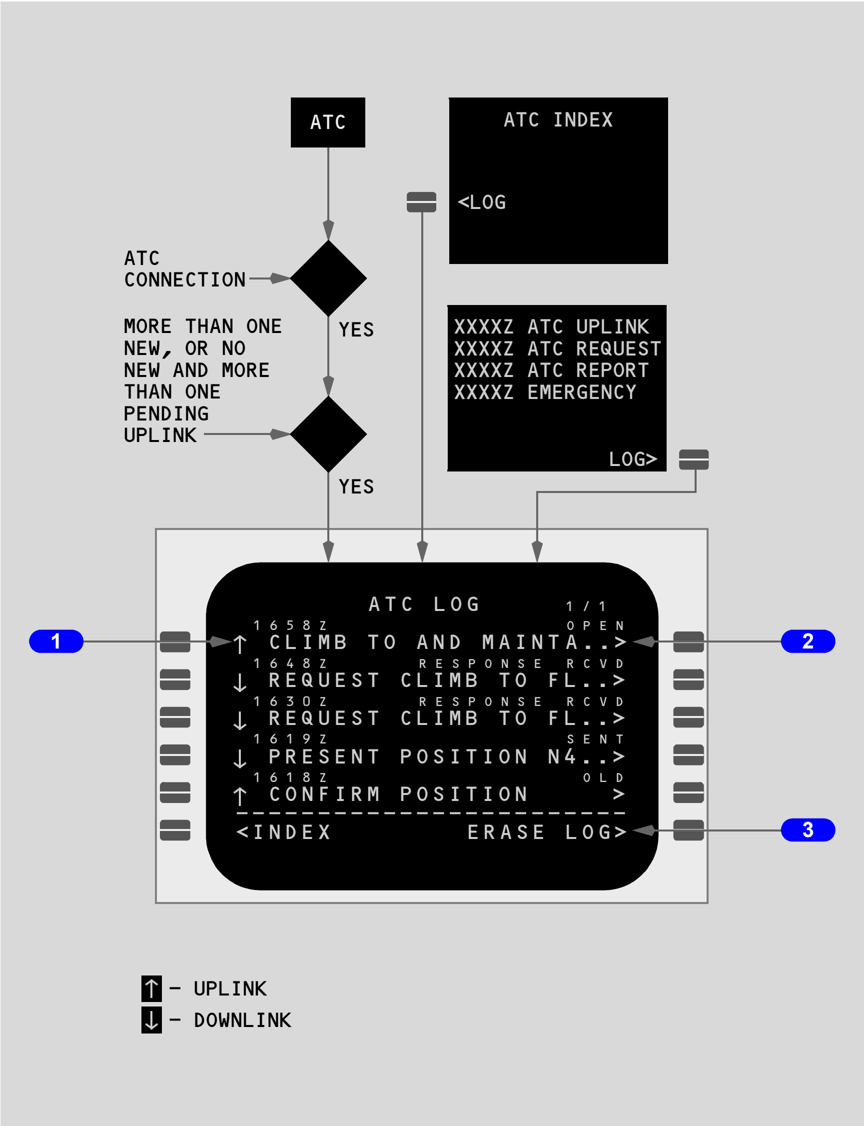
5 SEND

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.

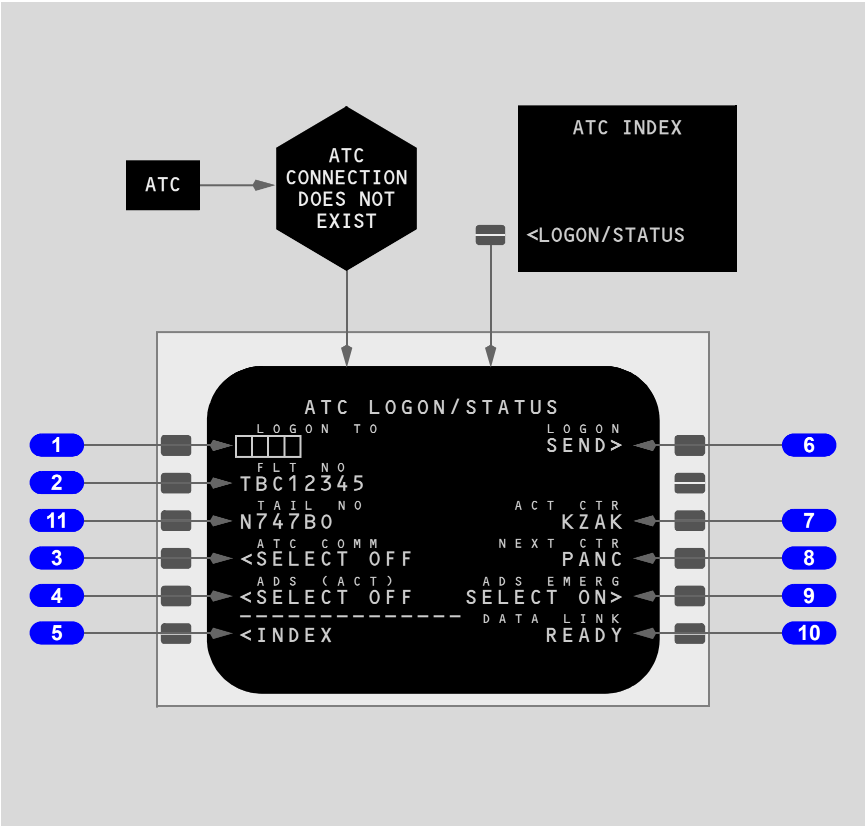
3 **Erase Log**

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 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 SELECT ARM prompt

ADS (OFF)

- ADS selected off
- displays 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.

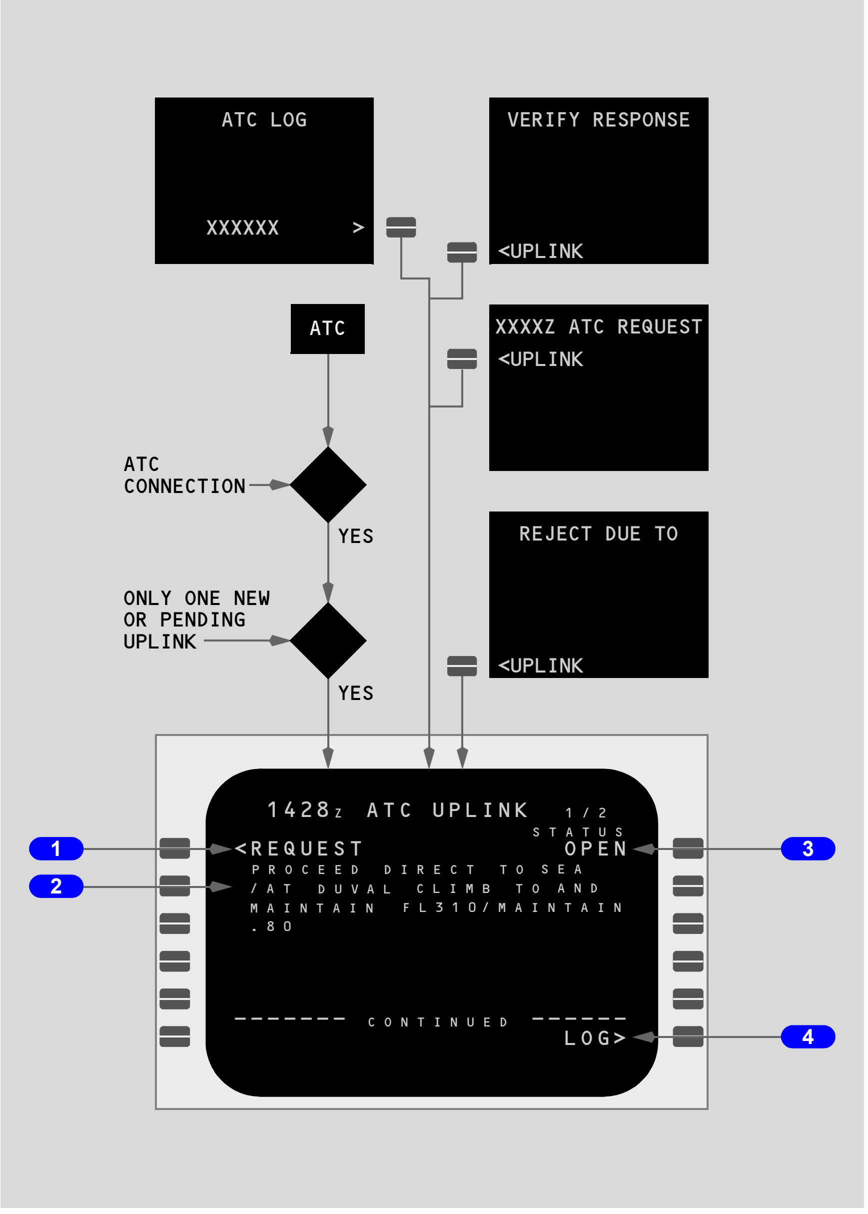
11 Tail Number

Displays tail number stored in FMC.

Valid entry is one to seven alphanumeric tail number characters shown on the flight deck placard.

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. When the uplink message can not be fully displayed on lines 2 to 5, the message can be printed to review the full message.

3 STATUS

Displays status of ATC uplink message from ATC 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 -

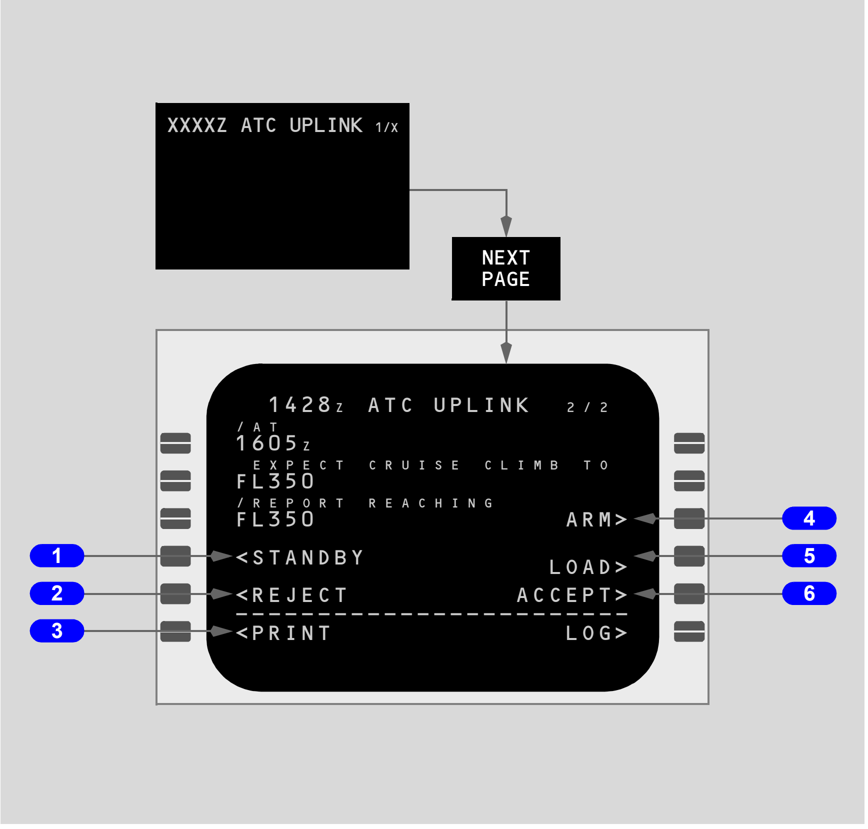
Push - displays ATC LOG page.

REPORT -

Push - displays ATC REPORT page.

XXXXZ ATC Uplink Page X/X

Last XXXXZ ATC UPLINK page continues text of uplinked ATC 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.

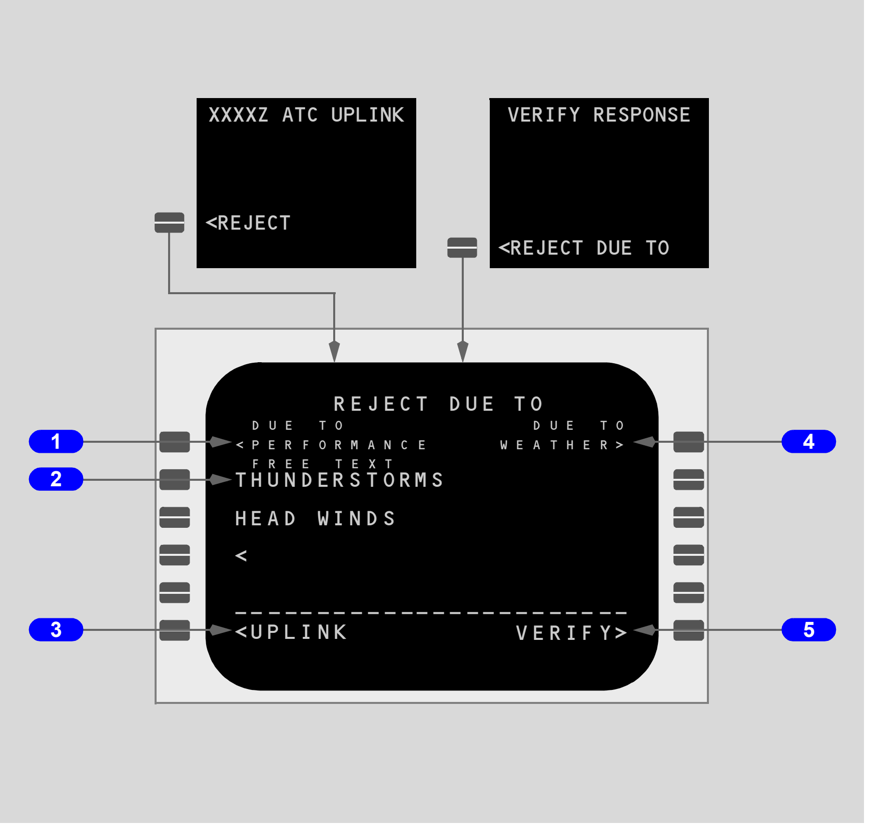
6 ACCEPT

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.

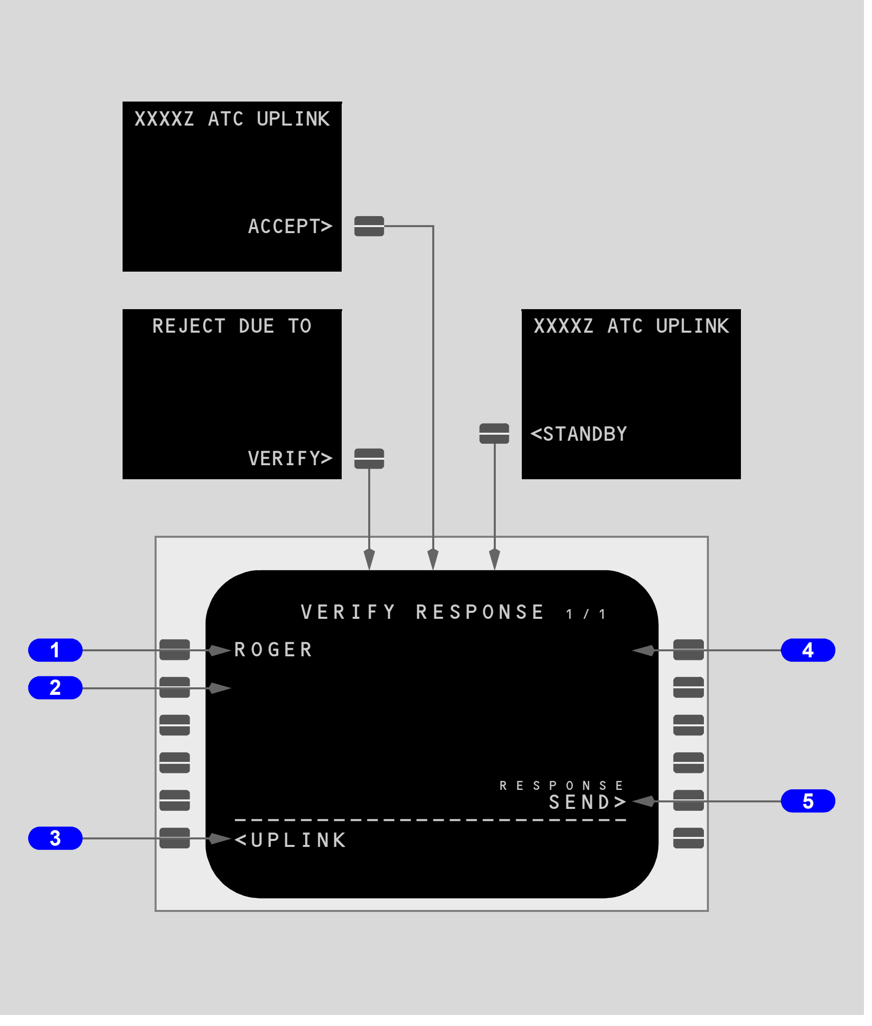
Push - selects DUE TO WEATHER message element in response downlink message.

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.

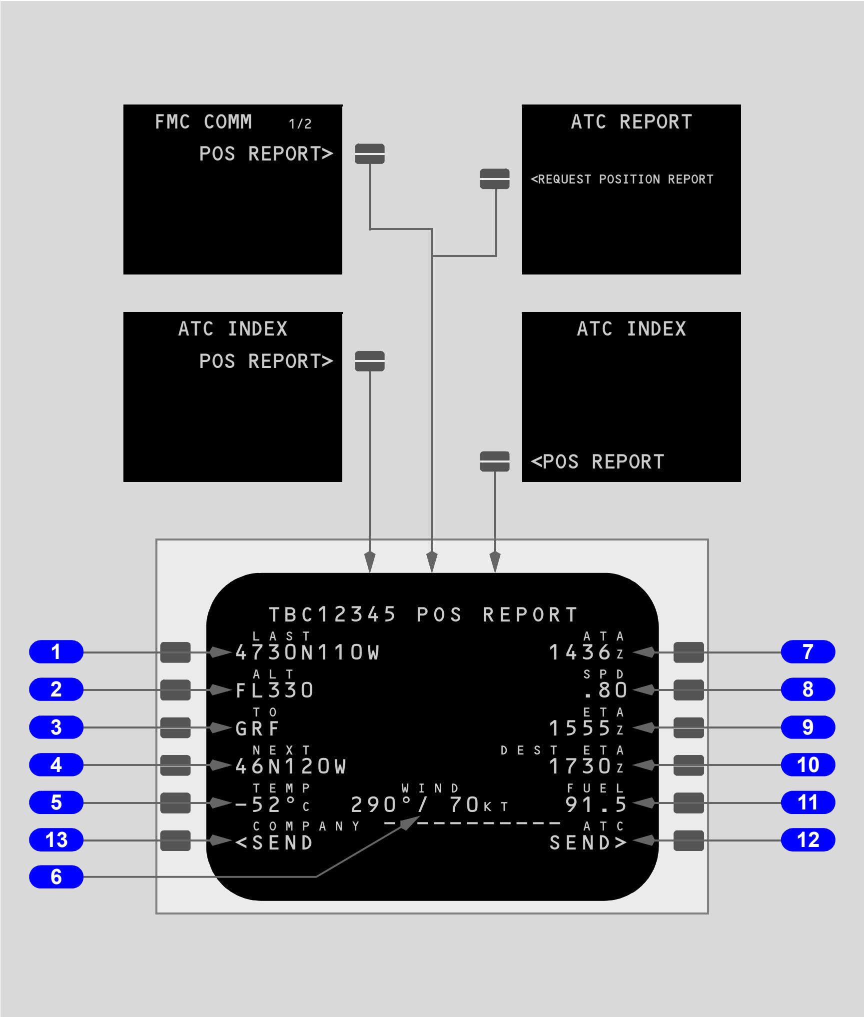
5 RESPONSE SEND

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 and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

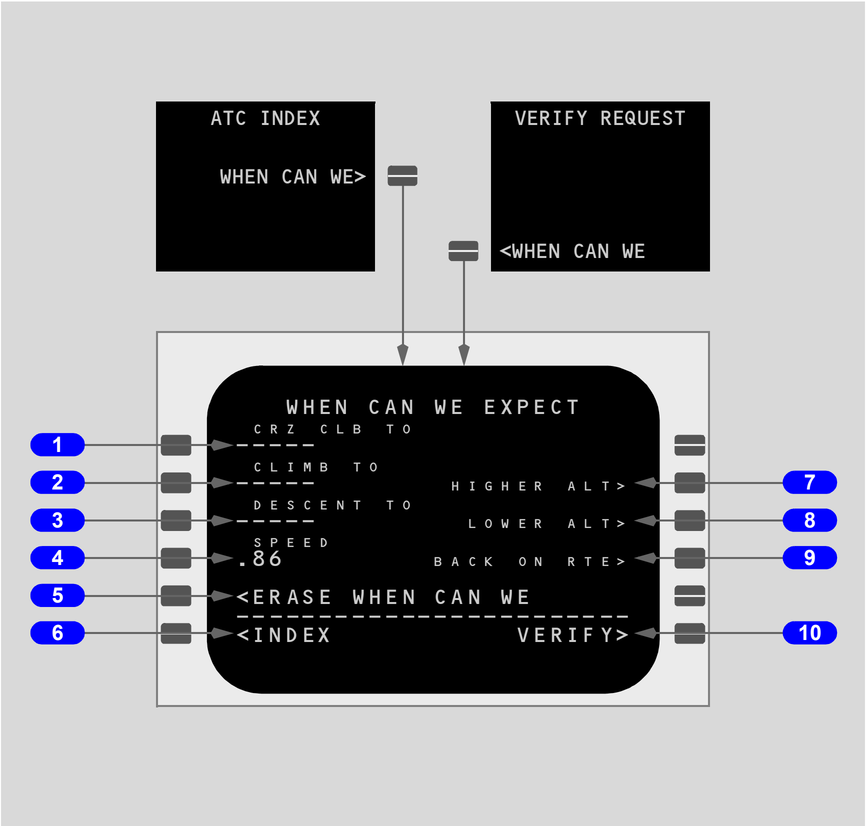
13 COMPANY SEND

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 and no 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.

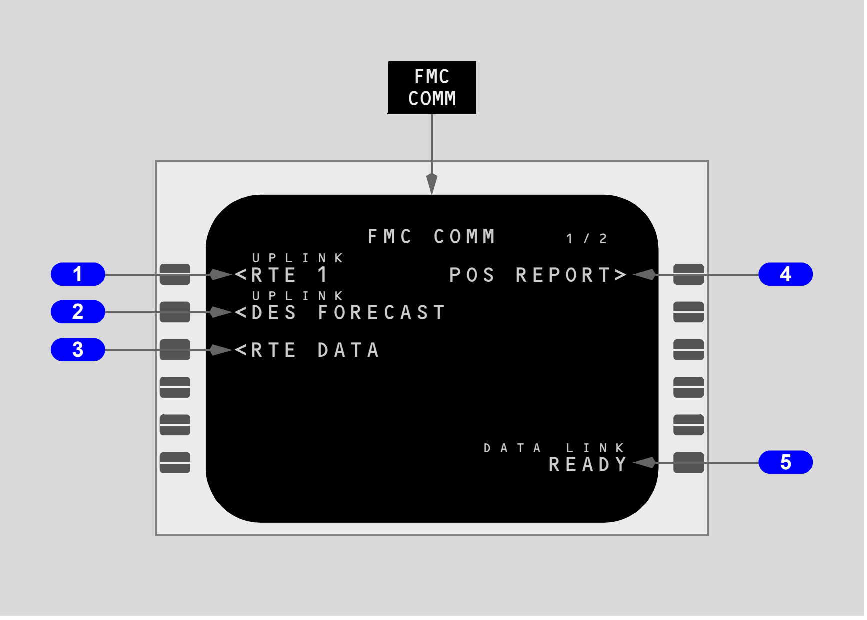
This Section Applies to 405, 570

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

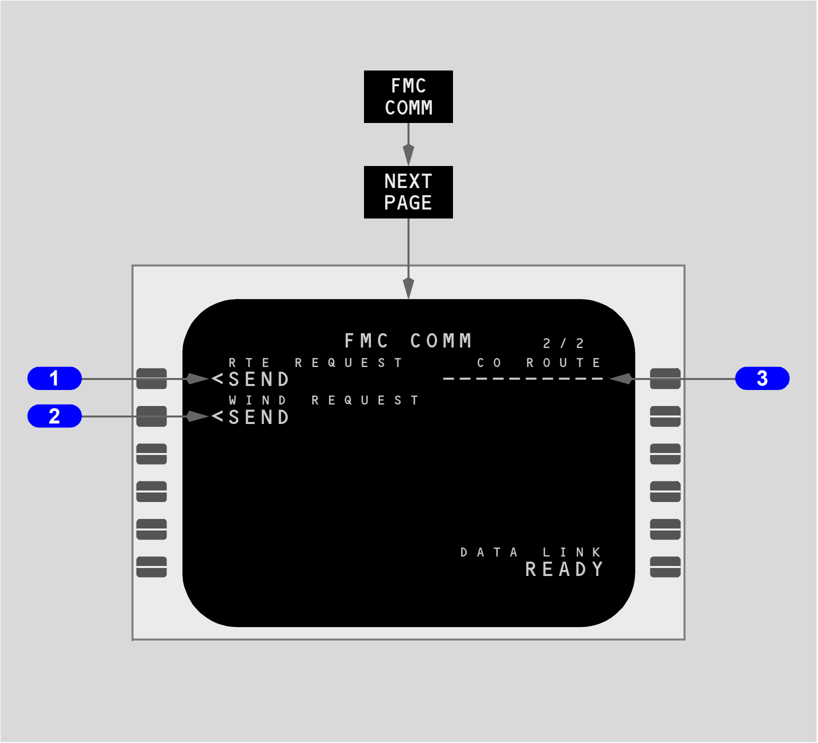
Push - displays POS REPORT page.

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 Messages

The following EICAS messages can be displayed.

EICAS Alert Messages

Message	Level	Aural	Message Logic
>DATALINK AVAIL	Advisory		ACARS capability reestablished after a temporary loss.
>DATALINK LOST	Advisory		ACARS not available due to lost communications.
>DATALINK SYS	Advisory		ACARS system has failed and is not available.

570

Message	Level	Aural	Message Logic
>HF DATA	Advisory		Selected HF radio failed and not available for ACARS data communication.

570

Message	Level	Aural	Message Logic
RADIO TRANSMIT	Advisory		VHF or HF radio keyed for 30 seconds or longer.

Message	Level	Aural	Message Logic
>SATCOM	Advisory		SATCOM system has failed.
>SATCOM DATA	Advisory		ACARS data communication through SATCOM system not available.
>SATCOM VOICE	Advisory		SATCOM voice communication not available. ACARS data communication through SATCOM is available. Loss due to SATCOM voice system failure.
>SATVOICE AVAIL	Advisory		SATCOM voice capability reestablished after a temporary loss.
>SATVOICE LOST	Advisory		SATCOM voice capability temporarily lost. Loss due to a reason other than SATCOM system failure.

EICAS Memo Messages

Message	Message Logic
ACARS MESSAGE	Crew required to access ACARS on CDU or when a message has been received for viewing on the CDU.

405, 570

ATC MESSAGE	ATC uplinked message received.

570

HF DATA OFF	Selected HF radio in voice mode and not available for ACARS data communication.

PRINTER MESSAGE	ACARS message printing.
SATCOM CALL	Ground-to-air voice call received.
SATCOM MESSAGE	Information of voice call status available on CDU SATCOM pages.

109, 405

VHF DATA OFF	VHF C radios in voice mode and not available for ACARS data communication.

570

VHF DATA OFF	All VHF radios in voice mode and not available for ACARS data communication.

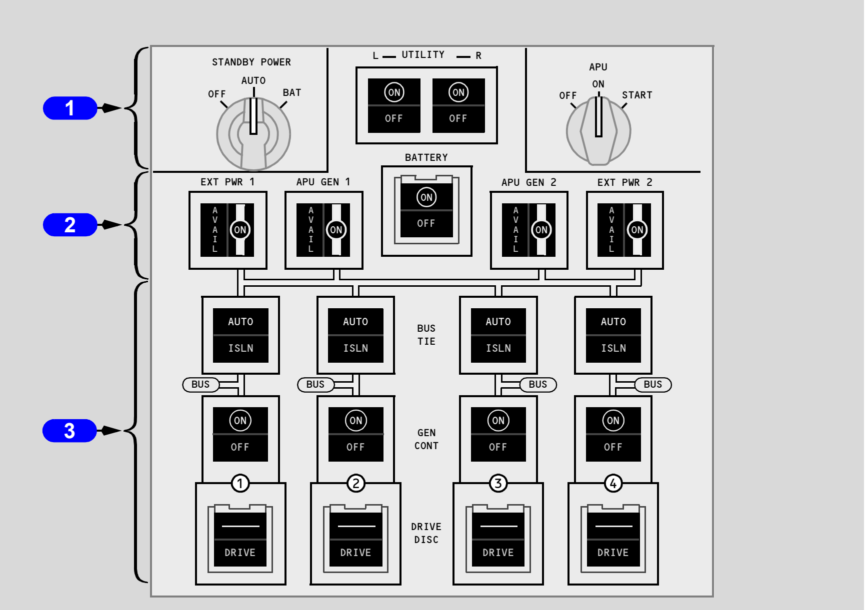
FMC Messages

405, 570

For FMC Message information, refer to Chapter 11.60.

Electrical — Chapter 6
Table of Contents — Section 0

Electrical Panel



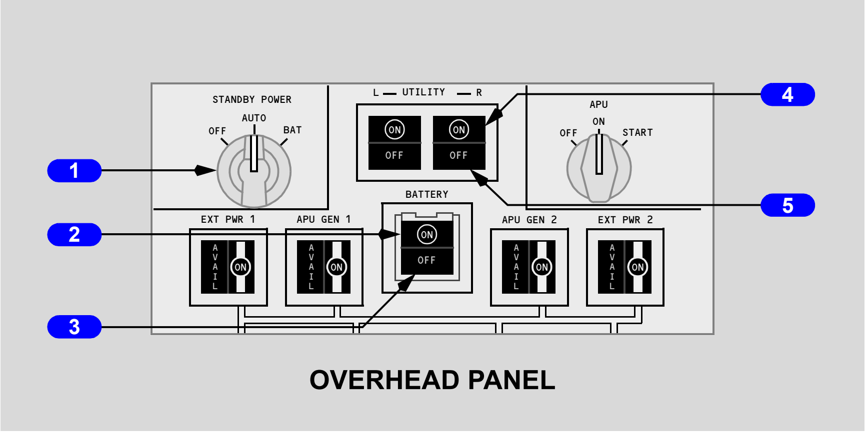
OVERHEAD PANEL

1 Standby Power, Battery, and Utility Bus Controls

2 APU Generators and External Power Controls

3 AC Bus and Generator Controls

Standby Power, Battery, and Utility Bus Controls



1 STANDBY POWER Selector

Push to turn.

OFF -

109, 570
- standby power not available

405
- standby and APU alternate power not available

109, 570
- main and APU standby busses disconnected from all power sources

405
- standby bus and APU alternate power disconnected from all power sources

109, 570

AUTO - allows main and APU standby busses to be powered from available sources.

405

AUTO - allows standby bus and APU alternate power 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

109, 570
- powers main and APU standby busses from their related batteries through their hot battery busses and standby inverters with Battery switch ON

405
- powers standby bus and APU alternate power from their related batteries through their hot battery busses and inverters with Battery switch ON

Note: BAT position for ground maintenance use only.

2 BATTERY Switch

ON -

109, 570
- 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

405
- main battery available as backup power source for main battery bus and standby bus
- APU battery available as backup power source for APU battery bus and APU alternate power

OFF - disconnects main and APU batteries from related battery busses.

3 BATTERY Switch OFF Light

Illuminated (amber) - Battery switch off

4 UTILITY Power Switches

109

ON - each switch powers two utility Electrical Load Control Units (ELCUs) and two galley ELCUs.

405, 570

ON - each switch powers two utility Electrical Load Control Units (ELCUs).

OFF -
- removes power from related ELCUs
- resets fault logic circuitry

5 UTILITY Power OFF Lights
109

Illuminated (amber) -

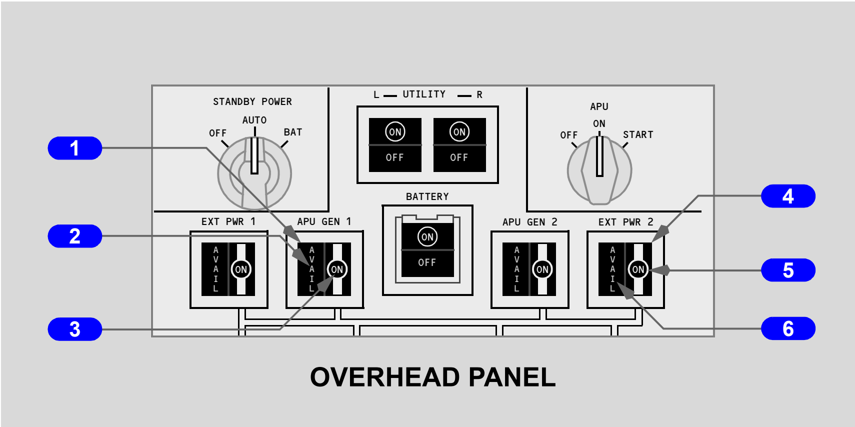
- power removed from related ELCUs by fault protection logic, or
- related Utility Power switch OFF, or
- one or more Galley Emergency Power Off switches OFF
- not illuminated during load shedding

5 UTILITY Power OFF Lights
405, 570

Illuminated (amber) -

- power removed from related ELCUs by fault protection logic, or
- related Utility Power switch OFF
- not illuminated during load shedding

APU Generator and External Power Controls



1 APU Generator (APU GEN) Control Switches

Push -

- AVAIL light illuminated: connects related APU generator to AC electrical system

405, 570

Note: When the main deck cargo handling bus is powered by APU generator 2, pushing APU generator 2 Control switch causes main deck cargo handling bus to lose power.

- 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
  405, 570
- main deck cargo handling bus powered when APU generator 2 AVAIL light illuminated
- 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

405, 570

Note: When the main deck cargo handling bus is powered by external power 2, pushing External Power 2 Control switch causes main deck cargo handling bus to lose power.

- 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) -

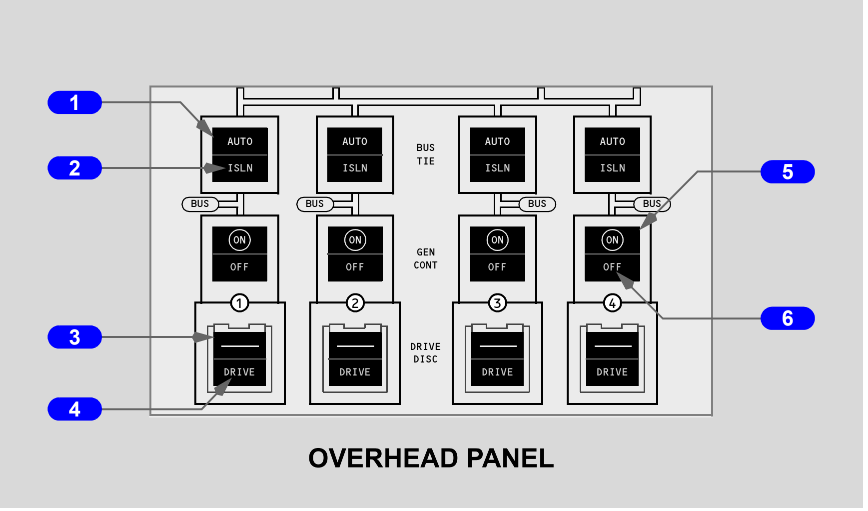
- related external power source plugged in, power quality acceptable
- extinguishes when ON light illuminates

  405, 570
- main deck cargo handling bus powered when external power 2 AVAIL light illuminated

405, 570

Note: When both external power 2 and APU generator 2 AVAIL lights are illuminated, external power 2 powers the main deck cargo handling bus. Pushing the External Power 2 Control switch transfers main deck cargo handling loads to APU generator 2.

AC Bus and Generator Controls



1 BUS TIE Switches

AUTO -

- arms automatic AC bus tie circuitry
- closes related DC isolation relay (DCIR)

OFF -

- opens BTB and related DCIR
- resets fault logic circuitry

2 Bus Isolation (ISLN) Lights

Illuminated (amber) -

- BTB open
- AC bus isolated from synchronous bus

3 Generator Drive Disconnect (DRIVE DISC) Switches

Push -

- disconnects IDG from engine when above idle speed
- opens related Generator Control Breaker (GCB)

Note: Ground maintenance action required to reconnect IDG.

4 Generator DRIVE Lights

570
(SB changes 109 ; improved generator control units for added IDG protection installed)

Illuminated (amber) -

- IDG oil pressure low, or
- IDG oil temperature high, or
- GCB open due to uncorrectable generator frequency fault

405
(SB changes 109 ; before SB, improved generator control units for added IDG protection not installed)

Illuminated (amber) -

- IDG oil pressure low, or
- IDG oil temperature high

5 Generator Control (GEN CONT) Switches

ON - arms GCB to close when generator power quality acceptable

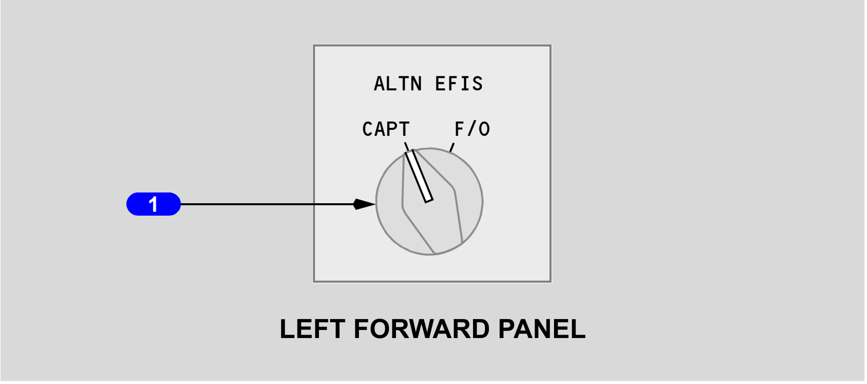
OFF -

- opens generator field and GCB
- resets fault control logic circuitry
- isolates generator from its related AC bus

6 Generator OFF Lights

Illuminated (amber) - GCB open

Alternate EFIS Selector
405



1 ALTERNATE EFIS Selector

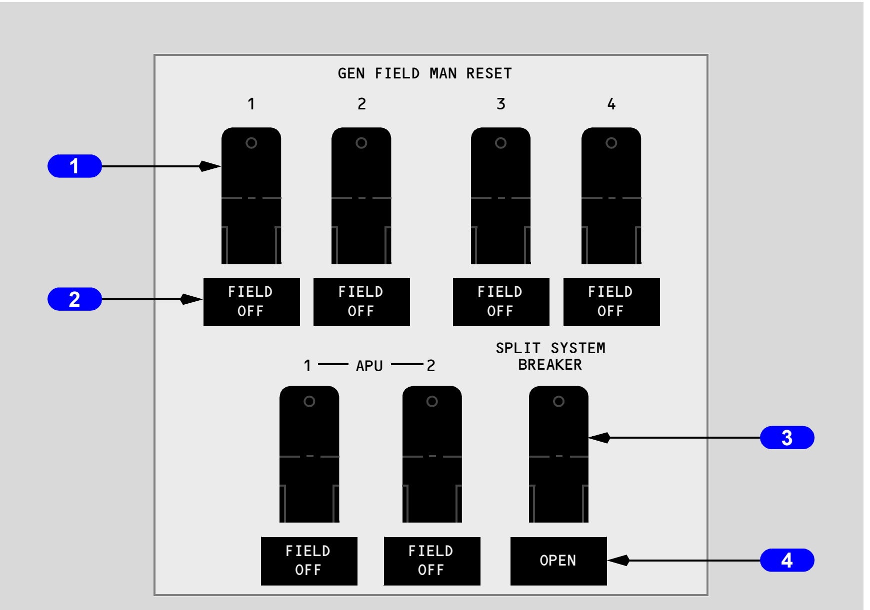
CAPT - left FMC, and left PFD and ND powered by APU alternate power if captain transfer bus unpowered. right PFD and ND unpowered if both transfer busses unpowered.

F/O - left FMC and first officer PFD and ND powered by APU alternate power if first officer transfer bus is unpowered. left PFD and ND unpowered if both transfer busses unpowered.

Note: Selector not functional during normal electrical system operation, or with failure of only captain transfer bus.

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.

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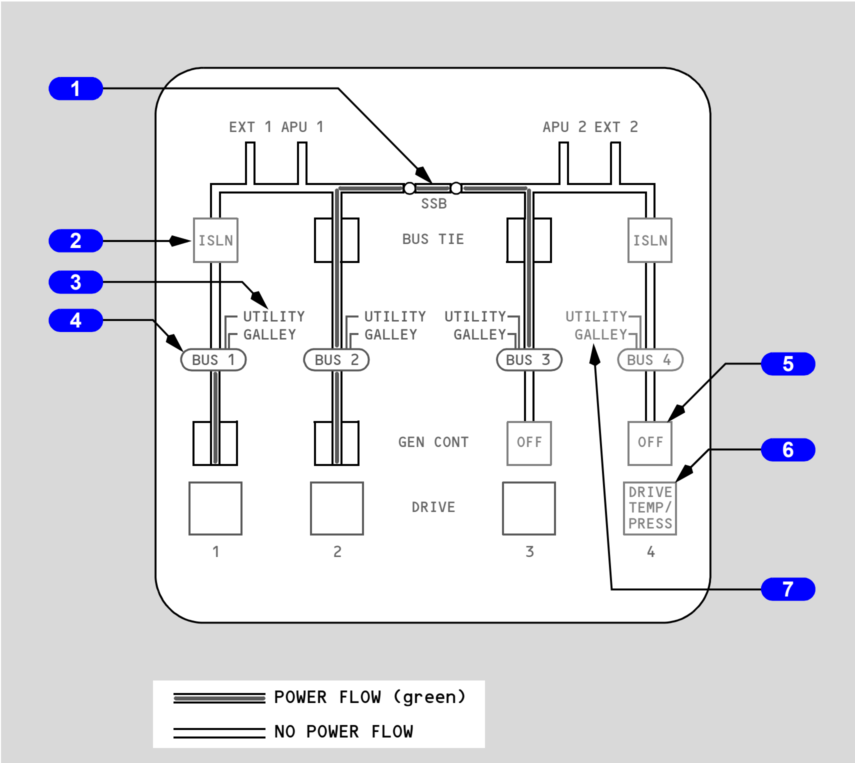
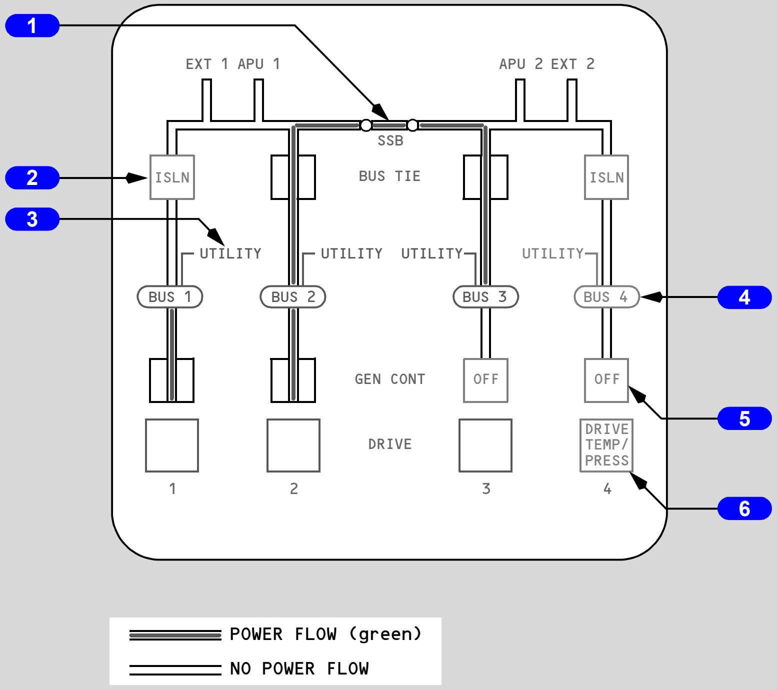


LOWER EICAS DISPLAY

405, 570



LOWER EICAS DISPLAY

1 SSB (Split System Breaker)

Closed - SSB closed, both sides of synchronous bus connected

Open - synchronous bus split.

2 BUS TIE

- power flow bar present - BTB closed
- ISLN (amber) - BTB open

3 UTILITY

- green - utility bus powered
- amber - utility bus not powered

4 **BUS**

- green - AC bus powered
- amber - AC bus not powered

5 **GEN CONT**

- power flow bar present - GCB closed
- OFF (amber) - GCB open

6 **DRIVE**

- blank (green) - normal operation
- DRIVE TEMP/PRESS (amber) - IDG has high oil temperature or low oil pressure

7 **GALLEY**

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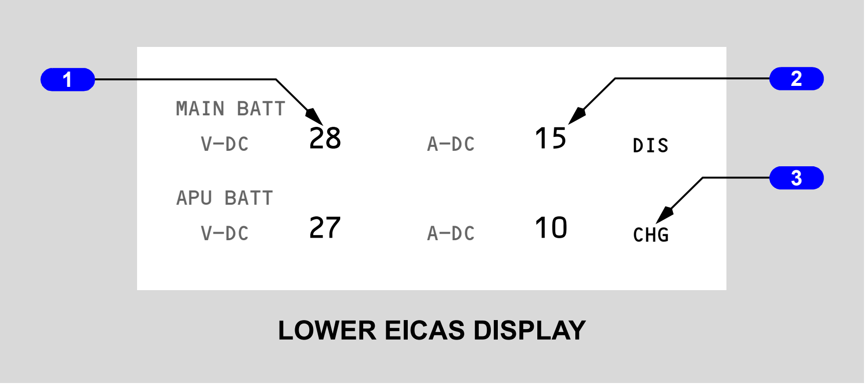
- green - galley bus powered
- amber - galley bus unpowered

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.



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

Intentionally
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.

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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 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.

405, 570

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. Utility bus loads are shed one at a time through ELCUs in a programmed sequence until the overload condition is relieved. 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 OVD CTR L
- FUEL PUMP 2 FWD

AC Electrical System Power Sources

The main AC electrical power sources are:

- four IDGs
- two auxiliary power sources (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. The split system breaker (SSB) divides the synchronous bus allowing each side of the AC electrical system to be powered by separate auxiliary or external power sources.

IDGs

One IDG is mounted on each engine accessory gearbox. 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 auxiliary or external power connected to each side of the electrical system (SSB open), 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 auxiliary or external power source is powering the electrical system and an engine is started, the IDG powers the entire synchronous bus when voltage and frequency are acceptable. The SSB remains closed and the original power source is disconnected.

During power source transfers on the ground, such as switching from IDG to auxiliary or external power, output from IDG and another power source 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 auxiliary or external power source.

IDG Disconnect

Each IDG can be mechanically disconnected from its engine accessory gearbox by pushing the Generator Drive Disconnect switch. When an IDG is disconnected, generator power output is lost and cannot be restored by flight crew action.

The EICAS message ELEC DRIVE displays for low IDG oil pressure or high IDG oil temperature.

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(SB changes 109 ; improved generator control units for added IDG protection installed)

The ELEC DRIVE message also displays if a GCB is open due to an uncorrectable generator frequency fault.

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Excessively high drive oil temperature disconnects the IDG automatically if not manually disconnected by flight crew action. The resulting loss of generator power output opens the GCB and displays the EICAS message ELEC GEN OFF. Pushing the Generator Drive Disconnect switch after automatic disconnect replaces the ELEC DRIVE message with the DRIVE DISC message.

Auxiliary and External Power

Auxiliary power is available only on the ground from generators mounted on the APU. External power is available from ground sources through two power receptacles located on the lower right forward fuselage. Either source can power main AC busses through connection to the synchronous bus. Auxiliary and external power sources cannot be connected to the same side of the synchronous bus simultaneously. The SSB is commanded open or closed to ensure all AC main busses are powered on the ground.

On an unpowered airplane with auxiliary and external power available, when a single power source is selected, the SSB closes and power is provided to the entire synchronous bus by the selected source. When the other same-type power source is selected on the opposite side, the SSB opens and each source powers its side of the synchronous bus. If one power source is disconnected or fails, the SSB closes maintaining power to the entire synchronous bus from the remaining source.

When IDGs are powering the electrical system with auxiliary or external power available, selecting a single power source disconnects IDGs on the same side and opens the SSB. The selected source powers its side of the synchronous bus, while the opposite side remains powered by IDGs. Selecting a second auxiliary or external power source on the opposite side disconnects the remaining IDGs and completes the power transfer from IDG to auxiliary/external power; the SSB remains open.

405, 570

Note: When cargo handling is required, selecting only the number one auxiliary or external power source ON ensures the main deck cargo handling bus remains powered.

AC Electrical Power Distribution

AC power is distributed by the following busses:

- four main busses
- two transfer busses
- ground service and ground handling busses

405
- APU alternate power

109
- four galley busses
- four utility busses

405
- one standby bus

109, 570
- two standby busses

AC Main Busses

Each IDG normally powers its related AC bus through a GCB. Each AC bus is connected to the synchronous bus by a 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:

- 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 transfer bus

405, 570
- each AC bus powers a utility bus

109
- each AC bus powers a utility and galley bus

405
- AC bus 3 powers the captain transfer bus and the standby bus

109, 570
- AC bus 3 powers the captain 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

109, 405
- upper deck emergency doors
- flight deck flood, navigation, and service lights
- miscellaneous service outlets and equipment

109
- horizontal stabilizer fuel pump for defueling

109

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 Transfer Bus

405

The captain transfer bus is normally powered by AC bus 3. If AC bus 3 is unpowered, AC bus 1 powers the captain transfer bus.

109, 570

The captain transfer bus is normally powered by AC bus 3. If AC bus 3 is unpowered, AC bus 1 powers the captain transfer bus. The captain transfer bus powers the APU standby bus.

The captain transfer bus powers individual equipment items such as:

- center EFIS/EICAS Interface Unit (EIU)
- left HF

  109, 405
- center ADC

  405
- left FMC, left ND, left PFD

First Officer Transfer Bus

109, 570

The first officer transfer bus is normally powered by AC bus 2. If AC bus 2 is unpowered, AC bus 1 powers the first officer transfer bus. The first officer transfer bus powers individual equipment items such as:

- autothrottle servo
- lower EICAS display
- right ADC, right EFIS control, right EIU, right FMC
- right CDU, right HF, right ND, right PFD

405

The first officer transfer bus is normally powered by AC bus 2. If AC bus 2 is unpowered, AC bus 1 powers the first officer transfer bus. The first officer transfer bus powers individual equipment items such as:

- right ND and PFD
- autothrottle servo
- lower EICAS display
- right ADC, right EFIS control, right EIU, right FMC
- right CDU, right HF

Utility and Galley Busses
109

Each main AC bus powers one utility bus and one galley bus. Each utility/galley bus is controlled by an 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 EICAS 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.

Utility Busses
405, 570

Each main AC bus powers one utility bus. Each utility bus is controlled by an ELCU that protects the electrical system from utility bus faults and provides load management through automatic load shedding. With the Left Utility Power switch ON, utility busses 1 and 2 are powered according to ELCU logic. With the Right Utility Power switch ON, utility 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
- galley equipment

The EICAS message ELEC UTIL BUS displays and the utility OFF light illuminates if one or both utility busses are unpowered due to a fault, or the related utility power switch is OFF. Cycling the Utility Power switch OFF, then ON restores power to the affected bus if the fault is corrected.

Main Deck Cargo Handling Bus

405, 570

The main deck cargo handling bus is powered on the ground when external power 2 or APU generator 2 is available. An interlock prevents either source from powering main electrical busses and the main deck cargo handling bus simultaneously. Pushing the available power source switch ON deengergizes the main deck cargo handling bus. When both external power 2 and APU generator 2 are available, external power is used. Pushing External Power 2 switch ON transfers main deck cargo handling loads to APU generator 2.

Note: When cargo handling is required, selecting only the number one auxiliary or external power source ON ensures the main deck cargo handling bus remains powered.

The main deck cargo handling bus powers equipment items such as:

- main deck cargo handling equipment and lighting

570

- nose and side cargo doors

405

- side cargo door

Electrical bus Isolation during Autoland

During automatic ILS approach, AC and DC busses 1, 2, and 3 are isolated from the synchronous bus to provide independent power sources for the three autopilots. AC bus 4 continues to power the synchronous bus.

If any AC or DC source fails when busses are isolated for autoland, the system reconfigures automatically to maintain independent power sources for the three autopilots.

During autoland:

- AC bus isolation lights 1, 2, and 3 remain extinguished,
- the EICAS message ELEC BUS ISLN is not displayed,
- the message “ELECTRICAL SYNOPTIC INHIBITED FOR, and AUTOLAND” is displayed on the electrical synoptic.

The electrical system is no longer configured for autoland bus isolation when:

- all autopilots disengage, or
- TO/GA mode is annunciated and the airplane is higher than 100 feet radio altitude, or
- approach mode is disarmed or deselected, or
- the electrical system is unable to maintain a configuration for autoland bus isolation.

AC Standby Power System

The AC standby power system provides electrical power to critical flight deck equipment.

109, 570

Major components of the system include:

- main and APU standby busses
- main and APU batteries
- main and APU standby inverters
- Standby Power selector

405

Major components of the system include:

- standby bus and APU alternate power
- main and APU batteries
- main standby and APU alternate power inverters
- Alternate EFIS and Standby Power selectors

Standby Bus
405

The standby bus is normally powered by AC bus 3. With the Alternate EFIS Selector in either CAPT or F/O and AC bus 3 not powered, the standby bus is powered by the main standby inverter. The main standby inverter, normally unpowered, is activated and receives power from 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 Alternate EFIS Selector in CAPT or F/O and the captain transfer bus not powered, the standby bus is powered by the main standby inverter. The main standby inverter is activated and receives power from the main battery through the main hot battery bus. The main battery can provide power to the standby bus for a minimum of 30 minutes.

Note: The Alternate EFIS Selector has no effect on power to the standby bus.

The standby bus powers individual equipment items such as:

- left EIU, left FMS-CDU, left ILS, left VOR
- left ADC, left EFIS control panel
- various flight control components
- standby ignition for all engines
- primary EICAS display, RMI, standby instrument lights

Main Standby Bus
109, 570

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, normally unpowered, is activated and receives power from 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, normally unpowered, is activated and receives power from 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 CDU, left ILS, left VOR
- various flight control components
- standby ignition for all engines
- primary EICAS display, standby instrument lights
- left ADC, left transponder, left EFIS control panel

APU Standby Bus
109, 570

The APU standby bus is normally powered by the captain transfer bus. With the Battery switch ON, Standby Power selector in AUTO, and the captain 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, normally unpowered, is activated and receives power from 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

APU Alternate power
405

APU alternate power is supplied by the APU alternate power inverter and provides standby power to the following equipment items:

- left FMC
- left PFD and ND, or
- right PFD and ND

The left FMC, and left PFD and ND are normally powered by the captain transfer bus. The right PFD and ND are normally powered by the first officer transfer bus.

With the Alternate EFIS Selector in CAPT or F/O and the captain transfer bus not powered, the left FMC and left PFD and ND are powered by the APU alternate power inverter. The APU alternate power inverter, normally unpowered, is activated and receives power from the APU battery through the APU hot battery bus. The right PFD and ND remain powered by their normal source.

With the Alternate EFIS Selector in CAPT and both captain and first officer transfer busses not powered, the left FMC and left PFD and ND are powered by the APU alternate power inverter. The APU alternate power inverter, normally unpowered, is activated and receives power from the APU battery through the APU hot battery bus. The right PFD and ND are not powered. Moving the Alternate EFIS Selector to F/O provides APU alternate inverter power to the right PFD and ND, and removes power from the left PFD and ND. The left FMC remains powered by the APU alternate power inverter.

Note: The Alternate EFIS Selector has no effect on power to the left FMC.

With the Alternate EFIS Selector in F/O and the first officer transfer bus not powered, the right PFD and ND are powered by the APU alternate power inverter. The APU alternate power inverter, normally unpowered, is activated and receives power from the APU battery through the APU hot battery bus.The left FMC and left PFD and ND are powered by their normal source. Moving the Alternate EFIS Selector to CAPT removes APU alternate inverter power from the right PFD and ND. The left FMC and left PFD and ND remain powered by their normal source.

The APU battery can provide power to the APU alternate power system for a minimum of 30 minutes.

Standby Power Selector - BAT Position

405

With the Standby Power Selector in BAT, both main and APU battery chargers are disabled and the captain and first officer transfer busses isolated from the standby power system. The standby bus is powered by the main standby inverter through the main hot battery bus and main battery. The APU alternate power system is powered by the APU alternate power inverter through the APU hot battery bus and APU battery. The main and APU batteries can provide power to the standby bus and APU alternate power system for at least 30 minutes.

109, 570

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.

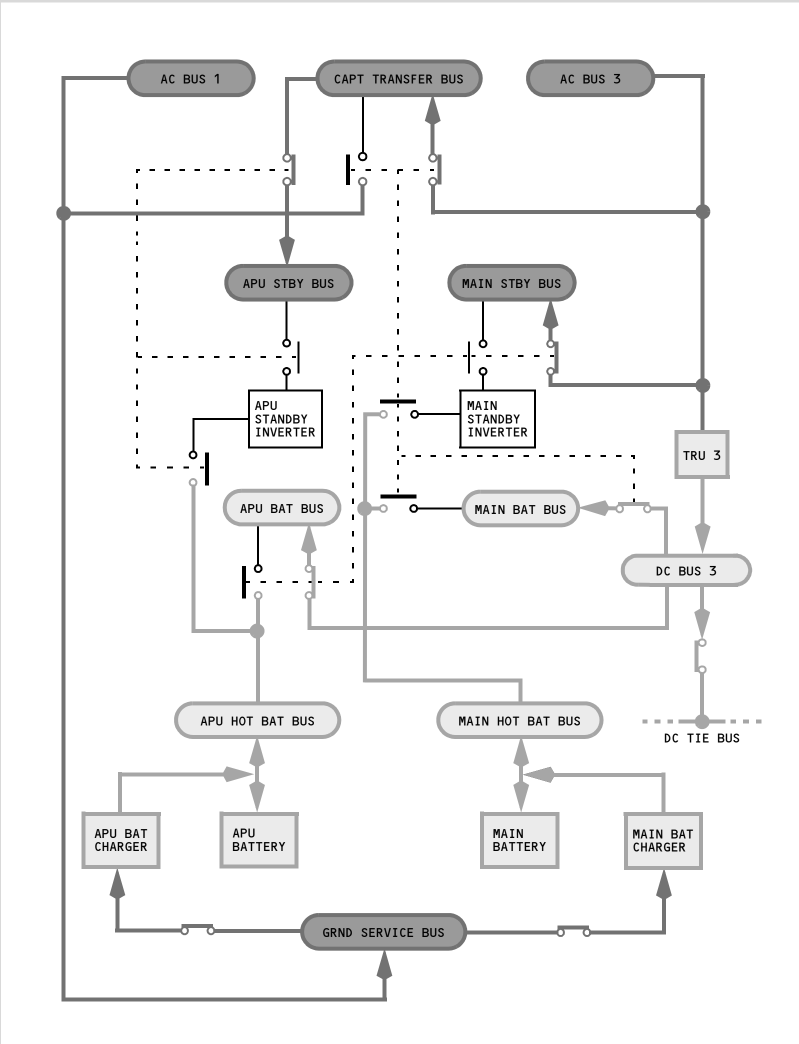
Note: The Standby Power selector must be in AUTO for flight. The BAT position is for ground maintenance use only.

AC Standby Power System Schematics

The schematics on the following pages illustrate the configuration of the AC standby power system and functional relationships of its major components under specific conditions. Sources of electrical power and system components not required for this purpose have been intentionally omitted.

AC Standby Power System Schematic

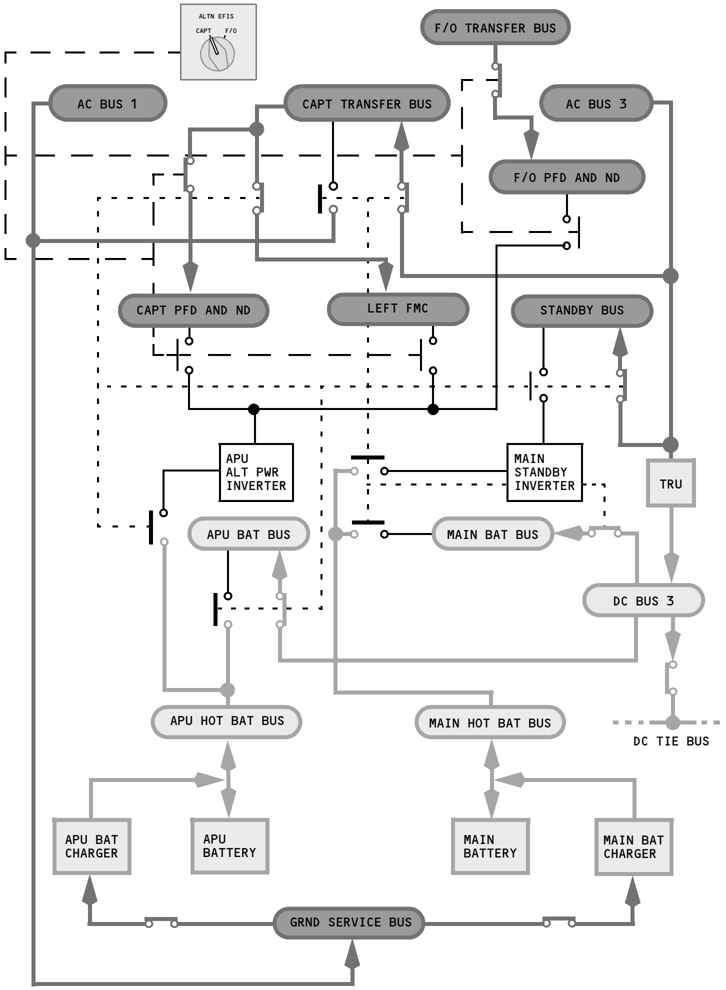
109, 570



<u>CONDITIONS</u>
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALL BUSSES POWERED NORMALLY

POWERED (AC)
POWERED (DC)
UNPOWERED

405

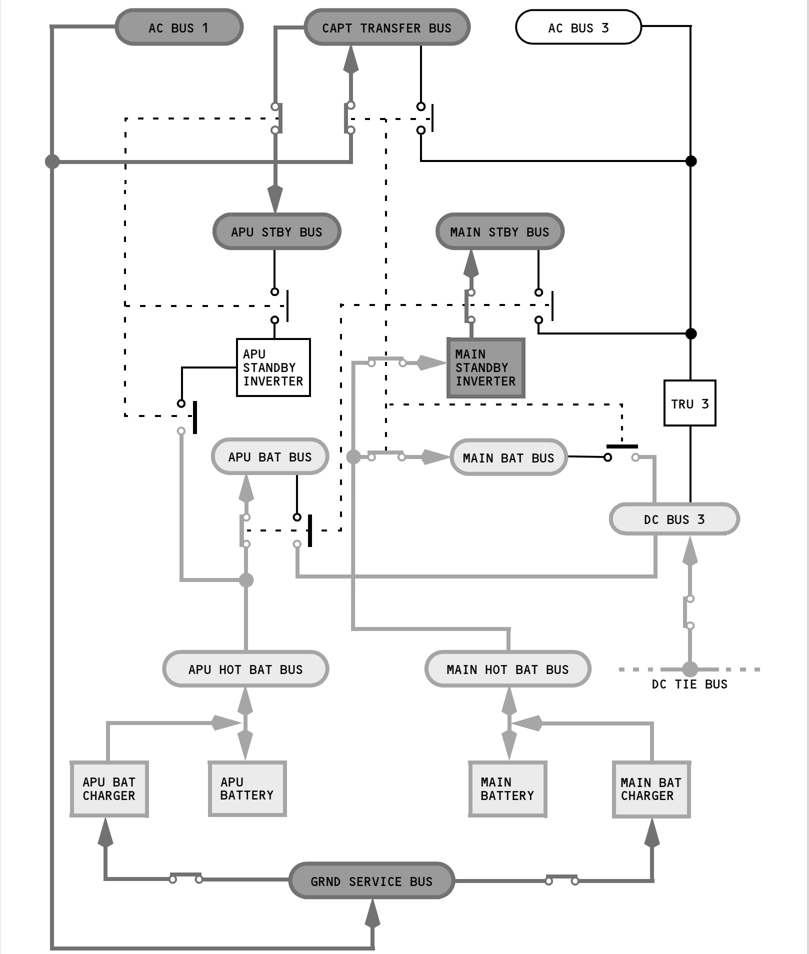


CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALTERNATE EFIS SELECTOR - CAPT
4. ALL BUSSES POWERED NORMALLY

POWERED (AC)
POWERED (DC)
UNPOWERED

AC Standby Power System (AC Bus 3 Unpowered)

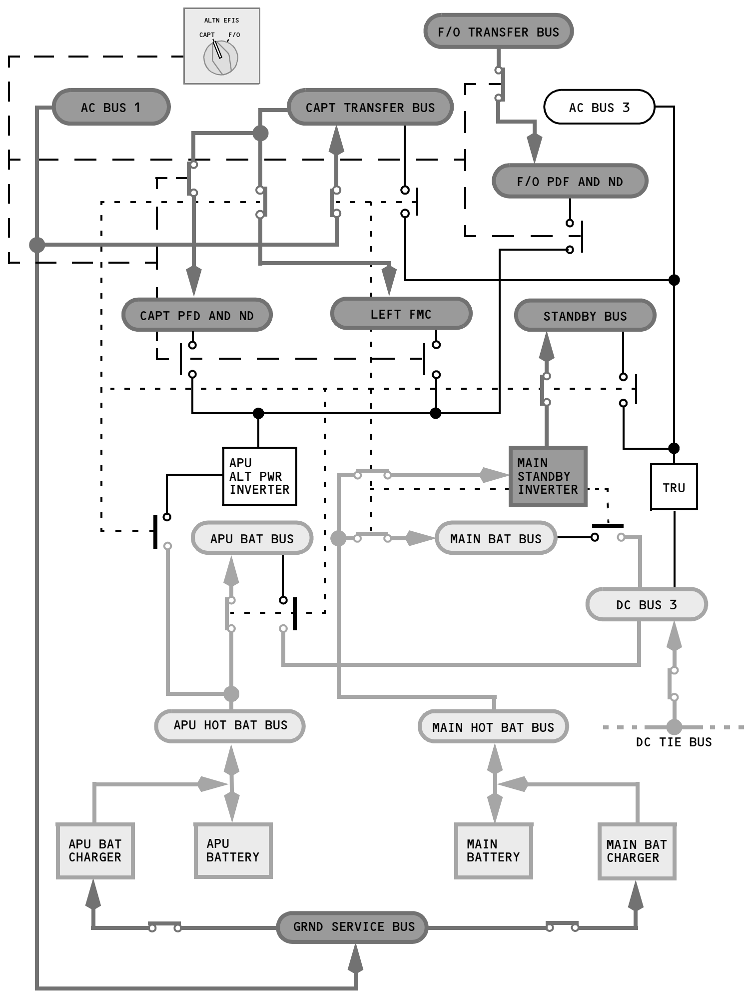
109, 570



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

405

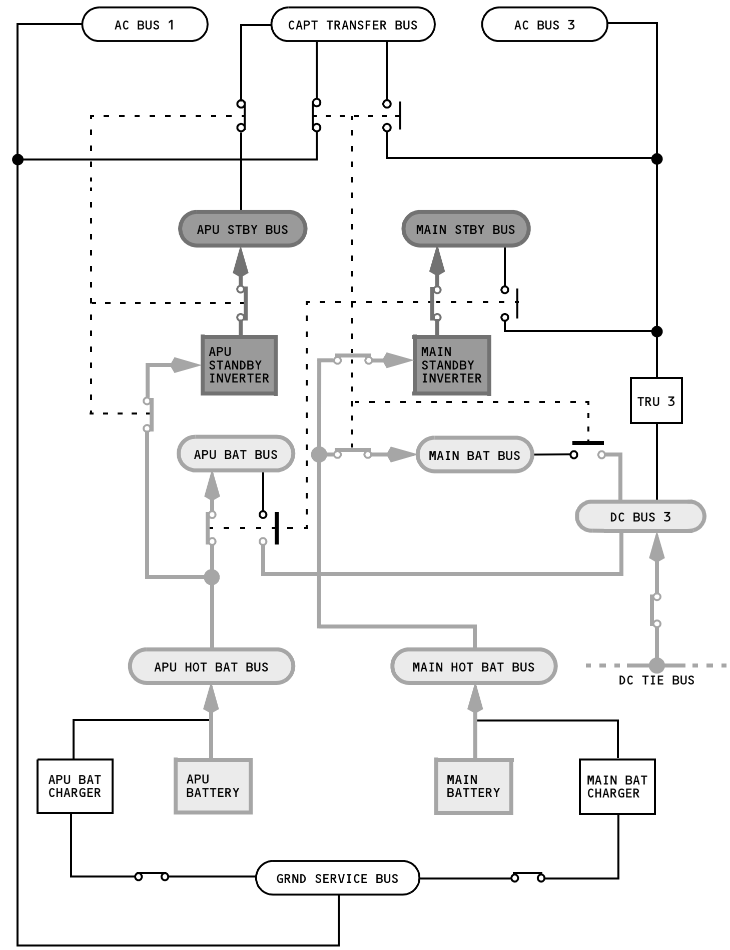


CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALTERNATE EFIS SELECTOR - CAPT
4. AC BUS 3 - UNPOWERED
5. STANDBY POWER AVAILABLE WITHOUT LIMITATION

POWERED (AC)
POWERED (DC)
UNPOWERED

AC Standby Power System (AC Busses 1 and 3 Unpowered)

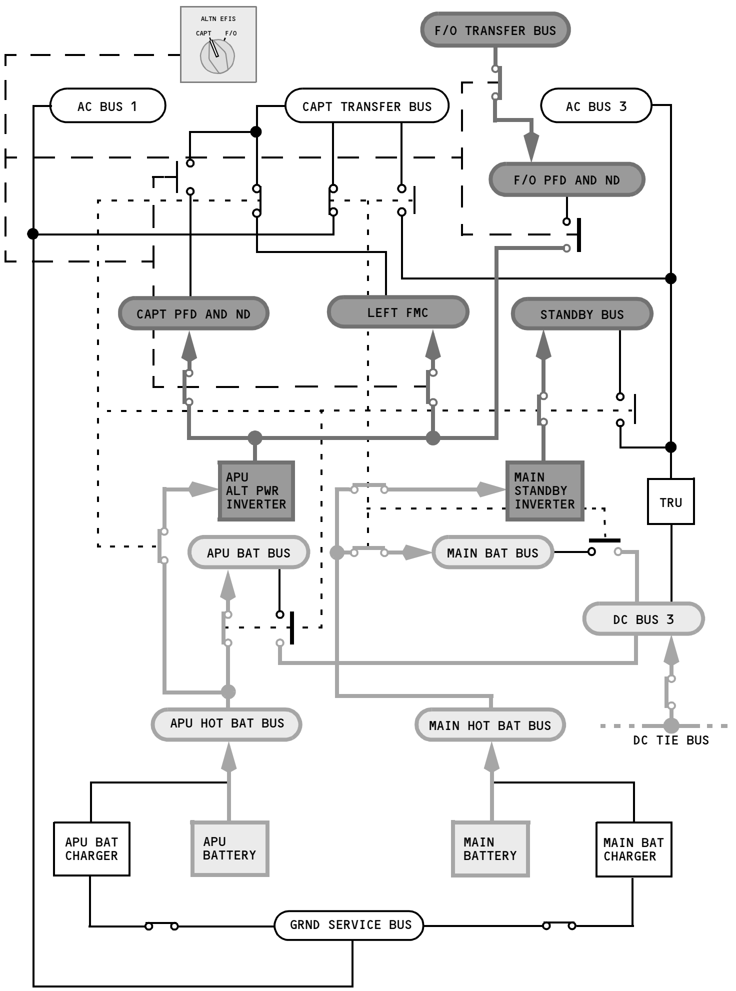
109, 570



<u>CONDITIONS</u>
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

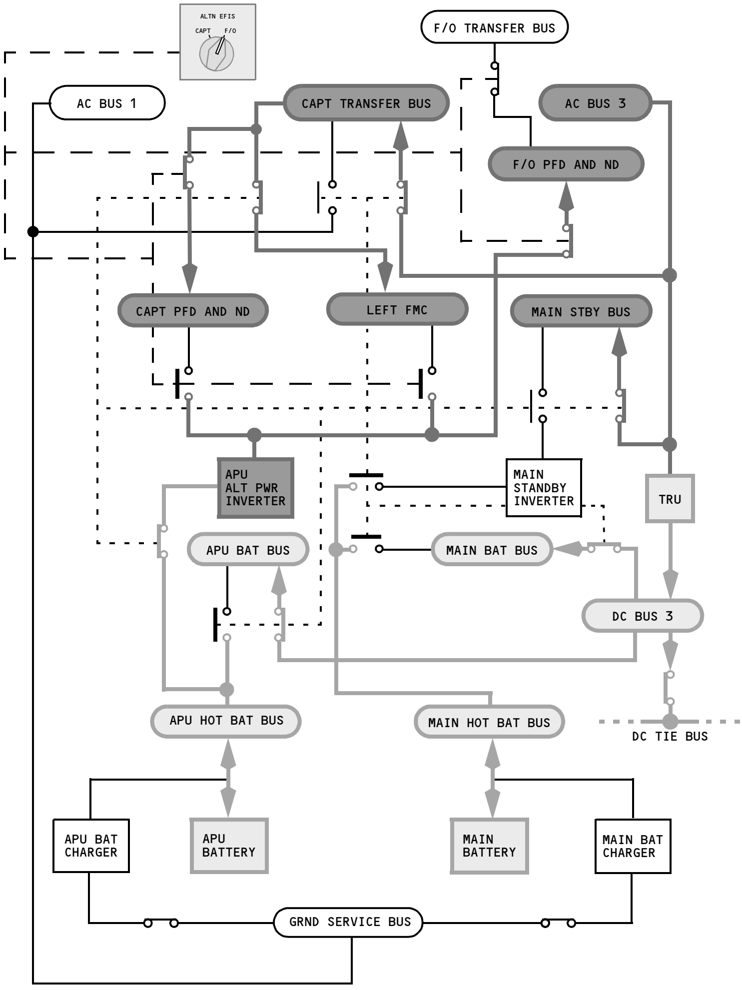
405



<u>CONDITIONS</u>
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALTERNATE EFIS SELECTOR - CAPT
4. AC BUSSES 1 AND 3 - UNPOWERED
5. STANDBY POWER AVAILABLE MINIMUM OF 30 MINUTES

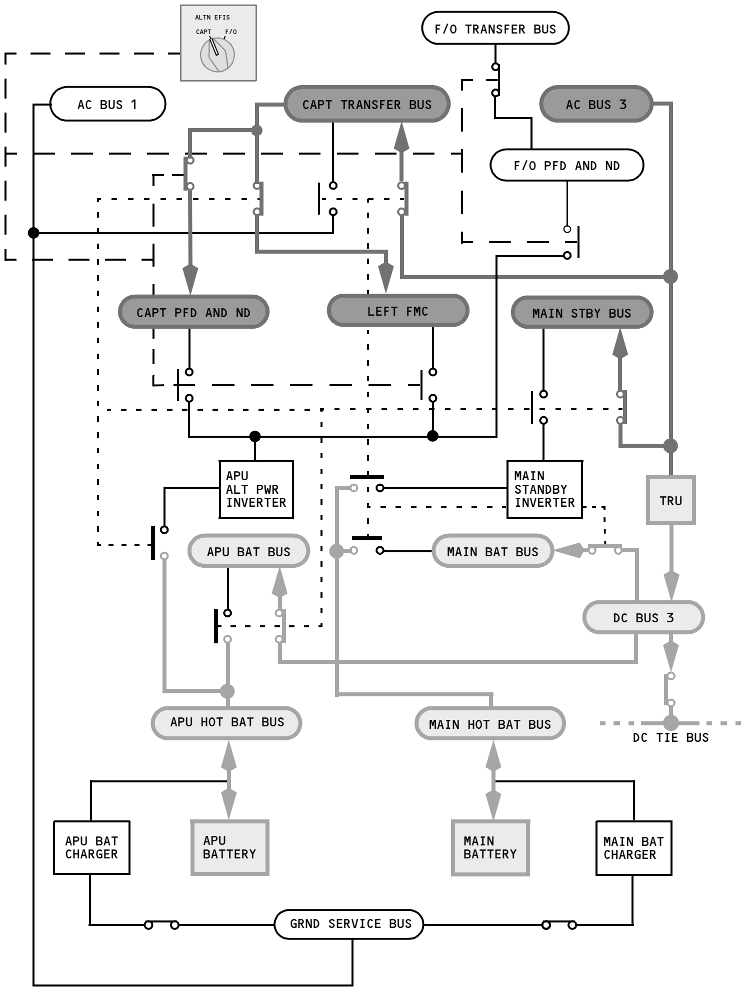
POWERED (AC)
POWERED (DC)
UNPOWERED

AC Stby Pwr Sys (F/O Transfer Bus Unpowered) 405



CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALTERNATE EFIS SELECTOR - F/O
4. F/O TRANSFER BUS UNPOWERED
5. BATTERY POWER AVAILABLE MINIMUM OF 30 MINUTES

POWERED (AC)
POWERED (DC)
UNPOWERED

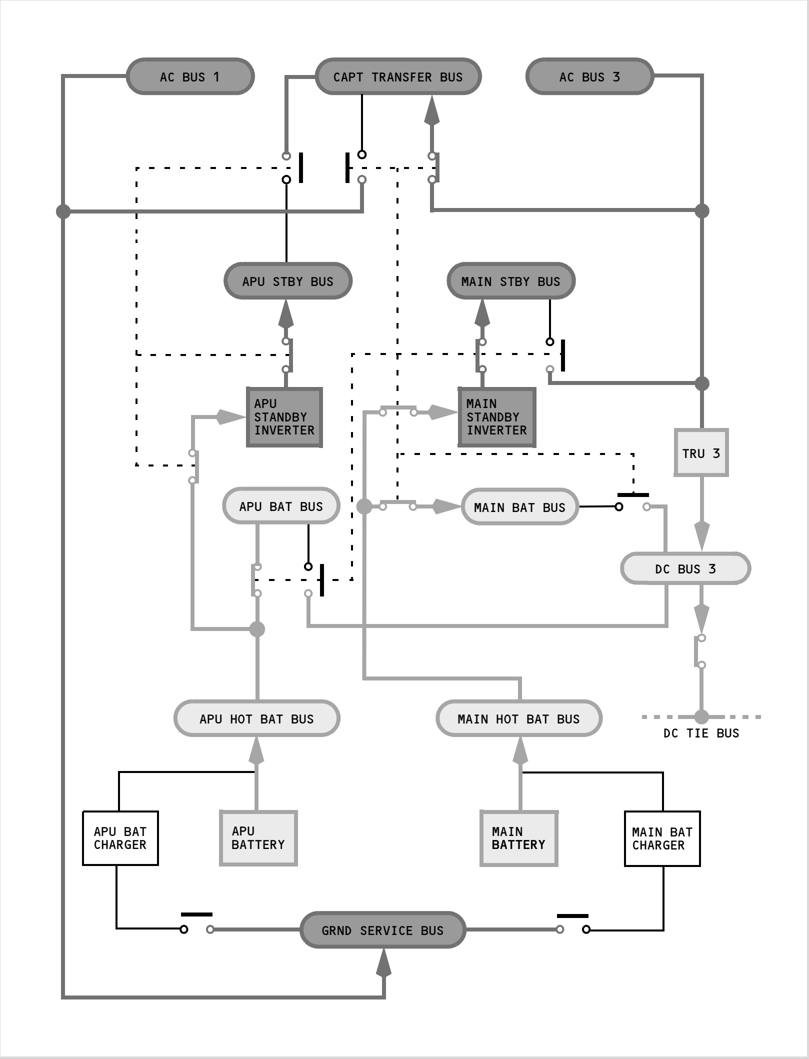


CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - AUTO
3. ALTERNATE EFIS SELECTOR - CAPT
4. F/O TRANSFER BUS UNPOWERED
5. STANDBY POWER AVAILABLE MINIMUM OF 30 MINUTES

POWERED (AC)
POWERED (DC)
UNPOWERED

AC Standby Power System (Standby Power selector - BAT)

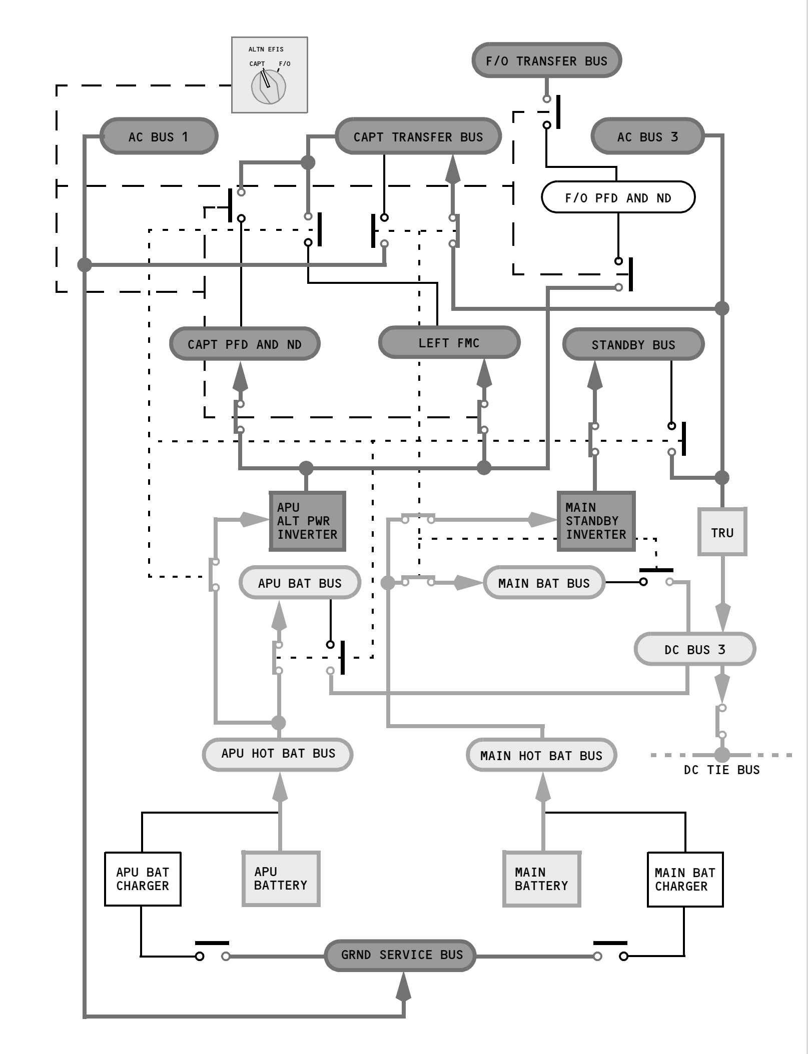
109, 570



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

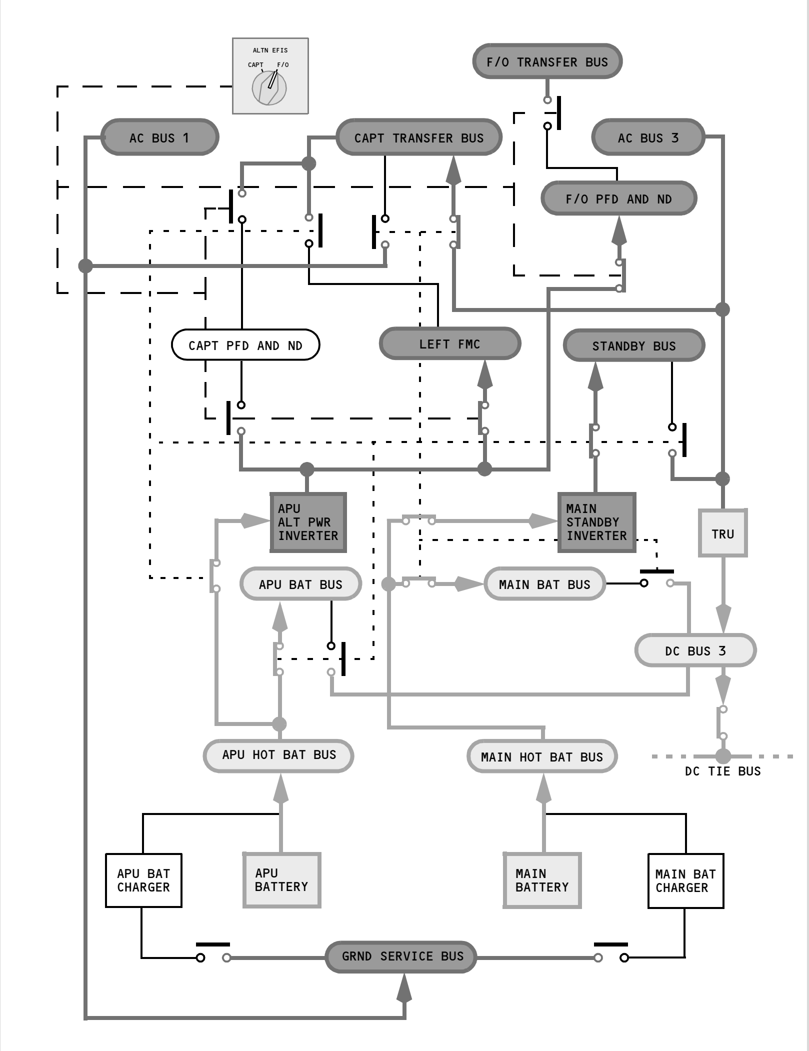
405



CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - BAT
3. ALTERNATE EFIS SELECTOR - CAPT
4. BATTERY CHARGERS DISABLED
5. BATTERY POWER AVAILABLE MINIMUM 30 MINUTES

POWERED (AC)
POWERED (DC)
UNPOWERED

405



CONDITIONS
1. BATTERY SWITCH - ON
2. STANDBY POWER SELECTOR - BAT
3. ALTERNATE EFIS SELECTOR - F/O
4. BATTERY CHARGERS DISABLED
5. 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, which 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
- 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 either AC bus 3 or DC bus 3 is unpowered, each battery bus is powered 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
- captain interphone, left radio tuning panel, left VHF

570
- ISFD

Note: The ISFD is powered by a dedicated battery/charger system capable of providing power for up to 150 minutes after loss of power to the main battery bus.

The APU battery bus powers individual equipment items such as:
- APU DC fuel pump, engine start air control
- cargo, first officer, and service interphones, PA system
- APU and engine fire/overheat detection loops A and B
- APU fire warning horn

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 either AC bus 3 or 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)

Electrical Power System Schematic

The Electrical Power System Schematic illustrates configuration of the electrical power system and functional relationships of its major components. System components not required for this purpose have been intentionally omitted.

Electrical EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
>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 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.

405
(SB changes 109 ; before SB, improved generator control units for added IDG protection not installed)

Message	Level	Aural	Message Logic
ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low or oil temperature high. Inhibited when Generator Drive Disconnect switch pushed.

570
(SB changes 109 ; improved generator control units for added IDG protection installed)

Message	Level	Aural	Message Logic
ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low, oil temperature high, or GCB open due to uncorrectable generator frequency fault. Inhibited when Generator Drive Disconnect switch pushed.

109, 570

Message	Level	Aural	Message Logic
ELEC GEN OFF 1, 2, 3, 4	Advisory		Generator control breaker open. Inhibited when ELEC AC BUS message displayed.

405

Message	Level	Aural	Message Logic
ELEC GEN OFF 1, 2, 3, 4	Caution	Beeper	Generator control breaker open. Inhibited when ELEC AC BUS message displayed.

Message	Level	Aural	Message Logic
>ELEC SSB OPEN	Advisory		Split system breaker (SSB) open when commanded closed.

109

Message	Level	Aural	Message Logic
ELEC UTIL BUS L, R	Advisory		One or more galley or utility busses unpowered, or Galley Emergency Power switch off. Busses may be unpowered due to electrical fault, or related Utility Power switch or Galley Emergency Power switch off. Inhibited during load shedding.

405, 570

Message	Level	Aural	Message Logic
ELEC UTIL BUS L, R	Advisory		One or more utility busses unpowered. Busses may be unpowered due to electrical fault, or related Utility Power switch OFF. Inhibited during load shedding.

109, 570

Message	Level	Aural	Message Logic
>STBY BUS APU	Advisory		APU standby bus not powered.
>STBY BUS MAIN	Advisory		Main standby bus not powered.

405

Message	Level	Aural	Message Logic
>STBY POWER OFF	Advisory		Standby bus not powered.

Intentionally
Blank

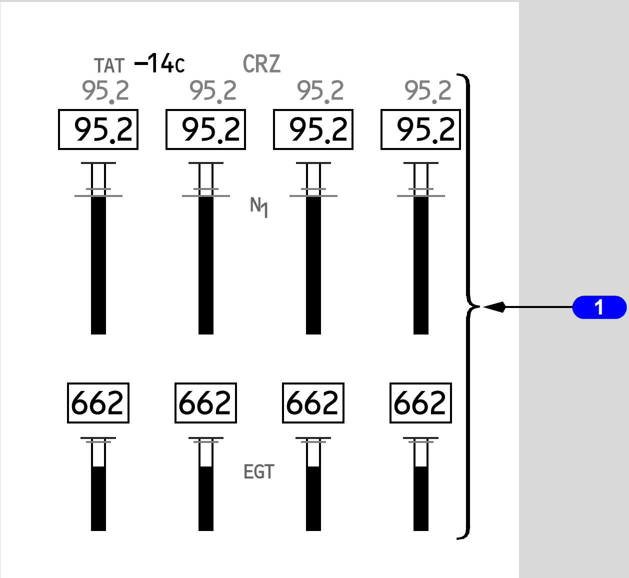
Engines, APU — Chapter 7
Table of Contents — Section 0

Intentionally
Blank

Primary Engine Indications

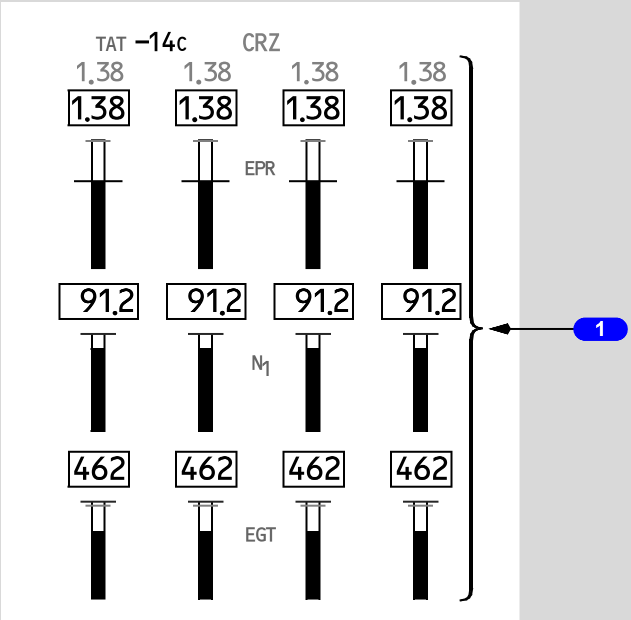
Primary Engine Display

570



PRIMARY EICAS DISPLAY

109, 405



PRIMARY EICAS DISPLAY

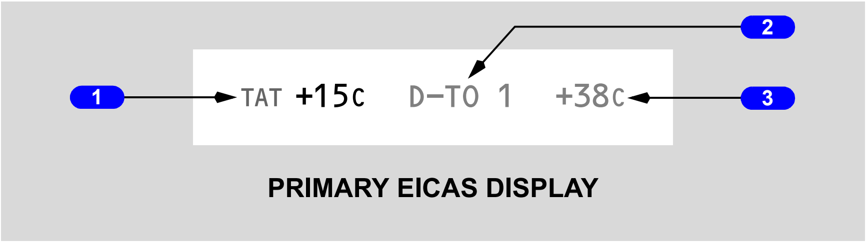
1 Primary Engine Indications

Displayed full time on EICAS display:

109, 405

- EPR
- N1
- EGT

Mode Indications



1 Total Air Temperature (TAT)

Displayed (white) - TAT (degrees C).

2 Thrust Reference Mode

Displayed (green) - selected FMS thrust reference mode:

- TO - maximum rated takeoff thrust
- TO 1 - derate one takeoff thrust
- TO 2 - derate two takeoff thrust
- D-TO - assumed temperature derated takeoff thrust
- D-TO 1 - derate one assumed temperature derated takeoff thrust
- D-TO 2 - derate two assumed temperature derated takeoff thrust
- CLB - maximum rated climb thrust
- CLB 1 - derate one climb thrust
- CLB 2 - derate two climb thrust
- CON - maximum rated continuous thrust
- CRZ - maximum rated cruise thrust
- GA - maximum rated go-around thrust

3 Assumed Temperature

Displayed (green) - selected assumed temperature (degrees C) for reduced thrust takeoff.

570

N1 Indications

109, 405

EPR Indications

570

Note: When reverse thrust activated, the following indications are not displayed:

- command N1
- reference N1

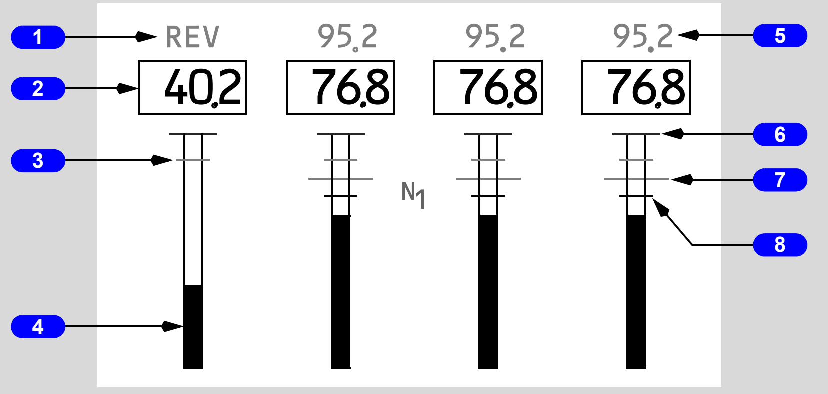
109, 405

Note: During tailwind conditions, slight EPR fluctuations may occur prior to five knots airspeed.

109, 405

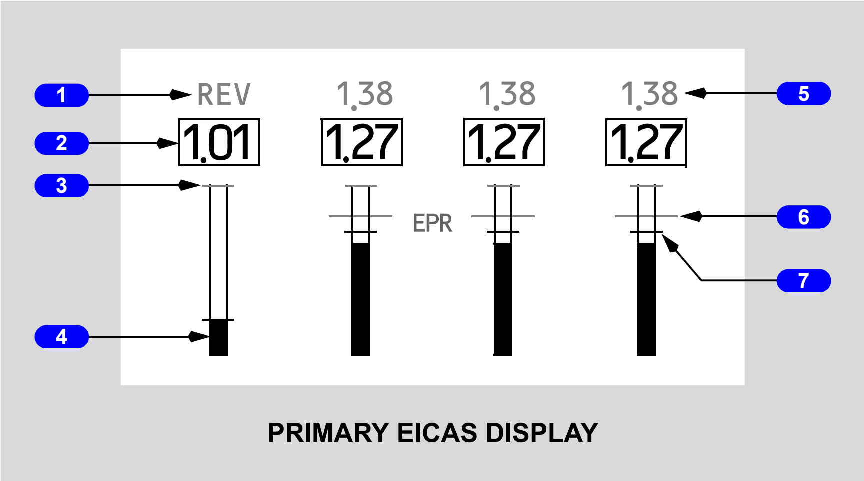
Note: When reverse thrust activated, reference EPR is not displayed.

570



PRIMARY EICAS DISPLAY

109, 405



1 Thrust Reverser Indication

Displayed REV (amber) - reverser in transit.

Displayed REV (green) - reverser fully deployed.

2 N1

570

Digital N1% RPM displayed:

- (white) - normal operating range
- (red) - operating limit reached

2 EPR

109, 405

Digital EPR displayed (white).

3 Maximum N1 Line

570

Displayed (amber).

3 Maximum EPR Line

109, 405

Displayed (amber) - maximum allowable thrust.

Displayed (white) - maximum EPR is invalid.

4 N1 Indication
570

N1 RPM, displayed:

- (white) - normal operating range
- (red) - operating limit reached

4 EPR Indication
109, 405

EPR, displayed:

- (white) - normal operating range
- (red) - operating limit reached

5 Reference N1
570

Displayed (digital, green) - reference thrust selected by FMC.

5 Reference EPR
109, 405

Displayed (digital, green) - reference thrust selected by FMC.

6 N1 Red Line
570

Displayed (red) - N1 RPM operating limit.

6 Reference EPR Indicator
109, 405

Displayed (green) - reference EPR.

Displayed (magenta) - target EPR commanded by FMC.

7 Reference N1 Indicator
570

Displayed (green) - reference N1.

Displayed (magenta) - target N1 commanded by FMC.

7 Command EPR Indicator
109, 405

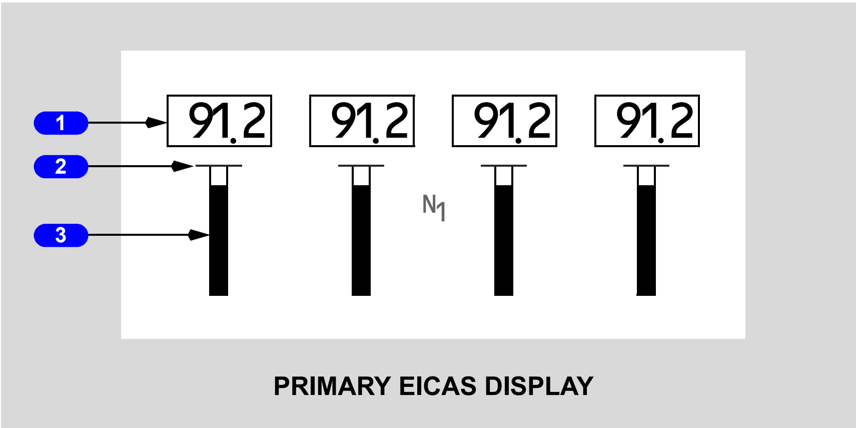
Displayed (white) - EPR commanded by thrust lever position.

8 **Command N1 Indicator**
570

Displayed (white) - N1 RPM commanded by thrust lever position.

N1 Indications

109, 405



1 N1 RPM

Digital N1% RPM displayed:

- (white) - normal operating range
- (red) - operating limit reached

2 N1 Red Line

Displayed (red) _ N1 RPM operating limit.

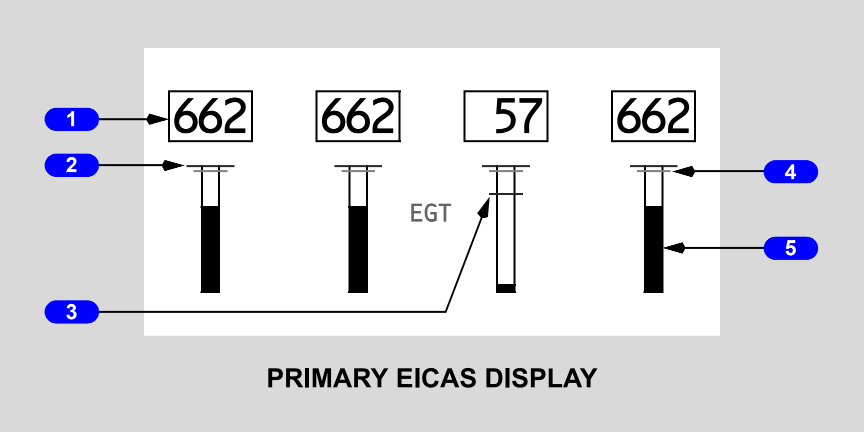
3 N1 RPM Indicator

N1 RPM, displayed:

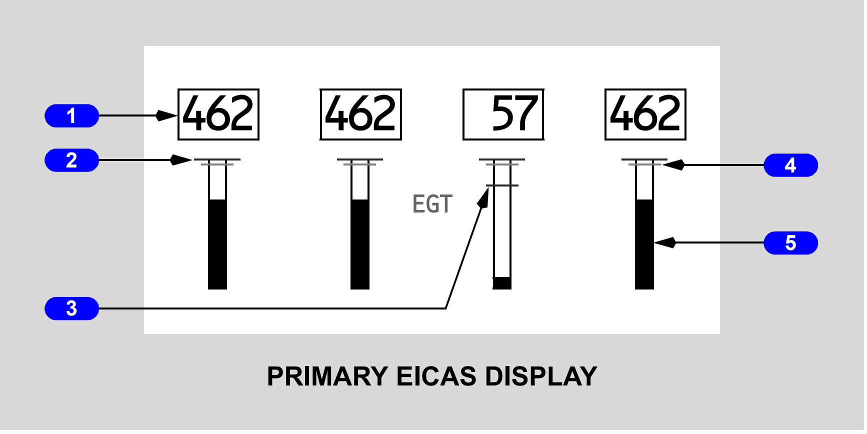
- (white) - normal operating range
- (red) - operating limit reached

EGT Indications

570



109, 405



1 **EGT**

EGT (degrees C), displayed:

- (white) - normal operating range
- (amber) - continuous limit reached
- (red) - start or takeoff limit reached

570

Note: Indication remains white during TO or GA for five minutes even though continuous EGT limit is reached.

109, 405

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 N2 reaches a predetermined RPM

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

570

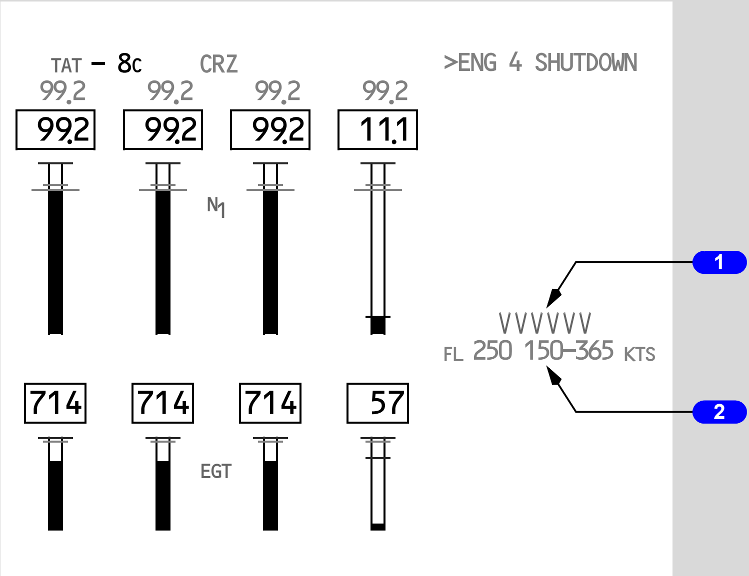
Note: Indication remains white during TO or GA for five minutes even though continuous EGT limit is reached.

109, 405

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.

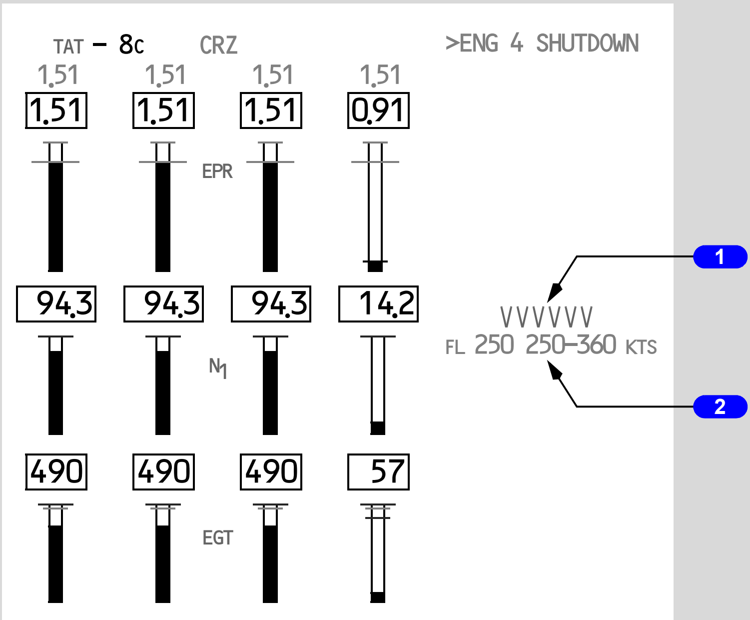
Secondary Exceedance Cue and In-flight Start Envelope

570



PRIMARY EICAS DISPLAY

109, 405



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**

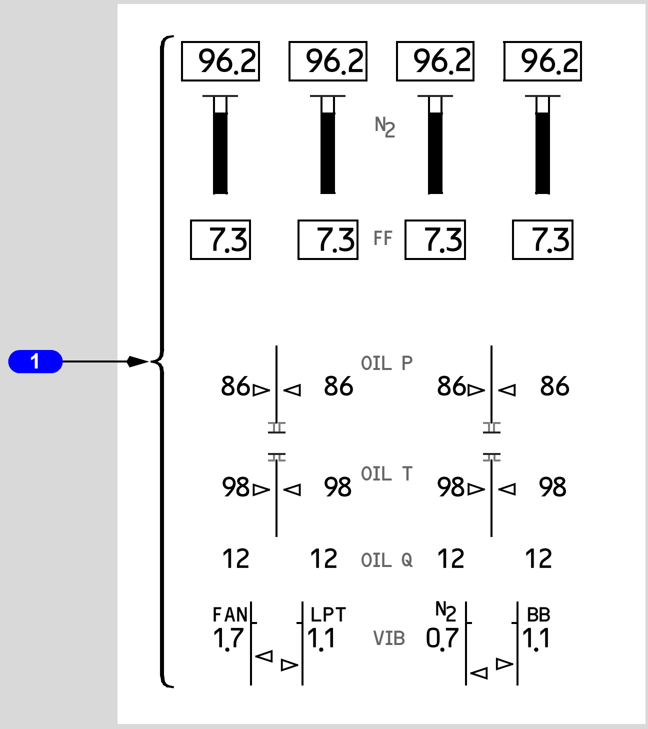
Displayed (magenta) - airspeed range for an in-flight start at the current flight level or maximum flight level (whichever is less) when the related Engine Fire switch is in and a Fuel Control switch is in CUTOFF.

Secondary Engine Indications

See Chapter 10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

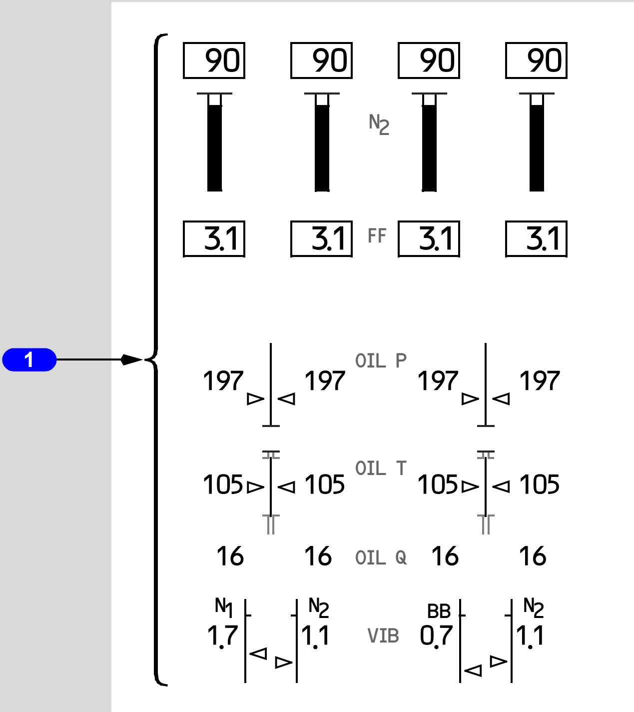
Secondary Engine Display

570



SECONDARY EICAS DISPLAY

109, 405



SECONDARY EICAS DISPLAY

1 Secondary Engine Display

Displays:

570

- N2 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration

109, 405

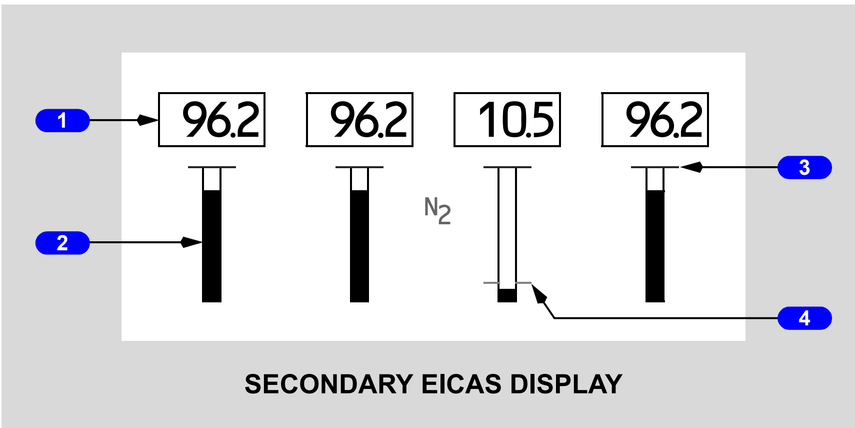
- N2 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration

Displays when:

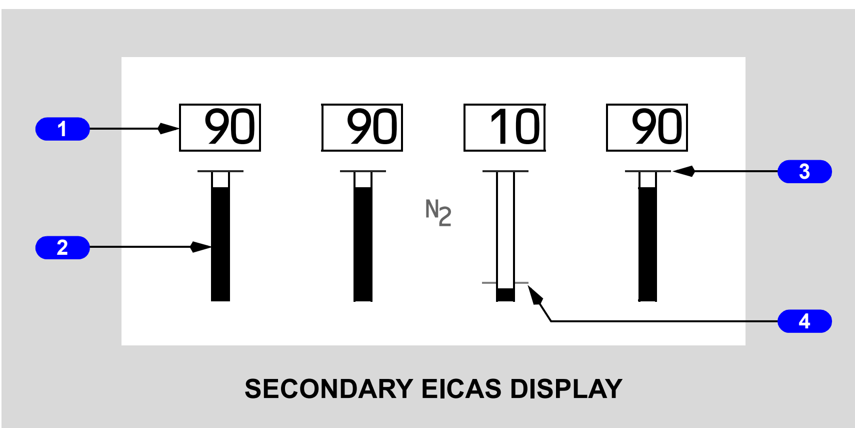
- EICAS initially receives power
- in flight, when a Fuel Control switch is moved to CUTOFF

N2 Indications

570



109, 405



1 **N2**

570

N2 RPM (%), displayed:

- (white) - normal operating range
- (red) - operating limit reached

1 **N2**
109, 405

N2 RPM (%), displayed:
- (white) - normal operating range
- (red) - operating limit reached

2 **N2 Indication**
570

N2 RPM, displayed:
- (white) - normal operating range
- (red) - operating limit reached

2 **N2 Indication**
109, 405

N2 RPM, displayed:
- (white) - normal operating range
- (red) - operating limit reached

3 **N2 Red Line**
570

N2 RPM operating limit, displayed (red).

3 **N2 Red Line**
109, 405

N2 RPM operating limit, displayed (red).

4 **Fuel-On Indicator**
570

Displayed - minimum N2 RPM at which Fuel Control switch should be moved to RUN during a manual start.

Displayed when Fuel Control switch in CUTOFF.

4 **Fuel-On Indicator**
109, 405

405

Displayed - minimum N2 RPM at which Fuel Control switch should be moved to RUN during start.

109

Displayed - minimum N2 RPM at which Fuel Control switch should be moved to RUN during a manual start.

Displayed when Fuel Control switch in CUTOFF.

Fuel Flow Indications

570

109, 405

1 **Fuel Flow**

109, 405

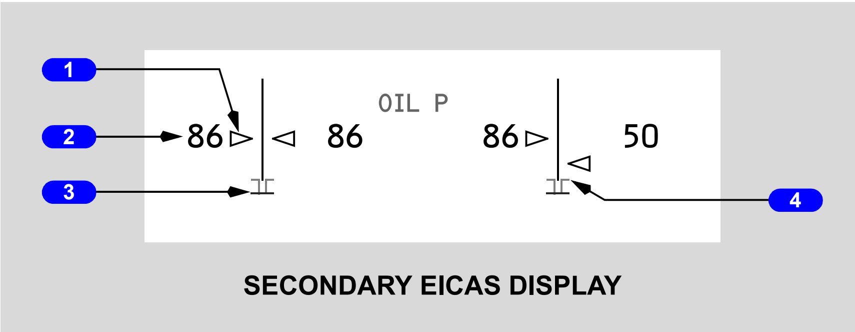
Displayed (white) - fuel flow to the engine (kilograms per hour x 1000).

570

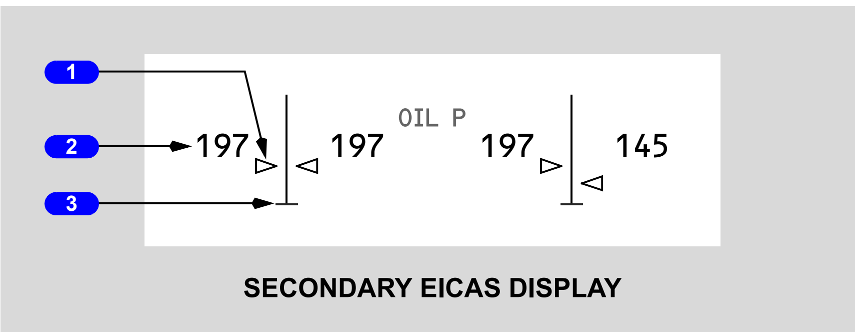
Displayed (white) - fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications

570



109, 405



1 Oil Pressure Indicator

Engine oil pressure, displayed:

- (white) - normal operating range

  570
- (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

  570
- (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.

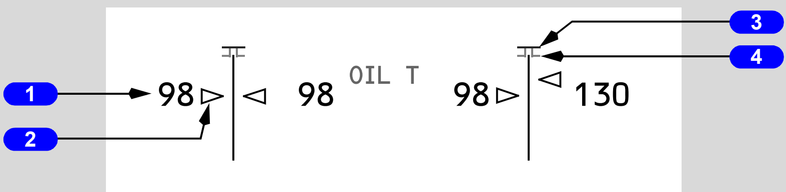
4 **Oil Pressure Amber Band**

570

Displayed (amber) - oil pressure caution range.

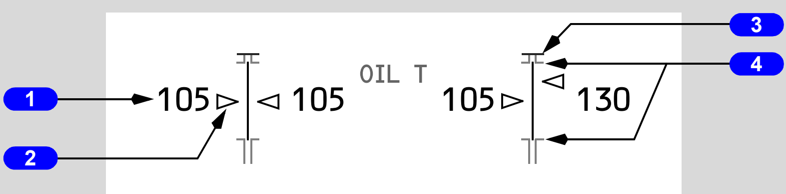
Oil Temperature Indications

570



SECONDARY EICAS DISPLAY

109, 405



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

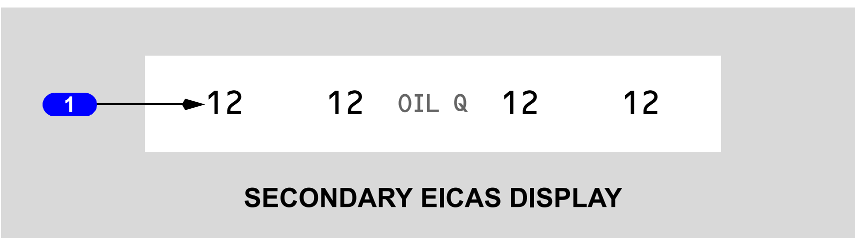
Displayed (red) - oil temperature operating limit.

4 Oil Temperature Amber Band

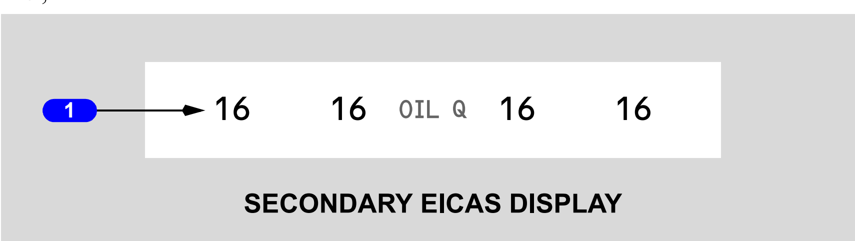
Displayed (amber) - oil temperature caution range.

Oil Quantity Indications

570



109, 405



1 Oil Quantity

109, 405

Usable oil quantity (liters).

570

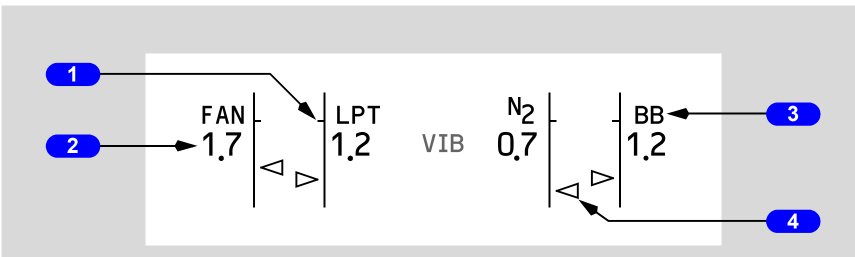
Usable oil quantity (U.S. quarts).

Displayed:

- (white) - normal quantity
  570
- (magenta) - low quantity, or oil differential reached
  109, 405
- (magenta) - low quantity reached

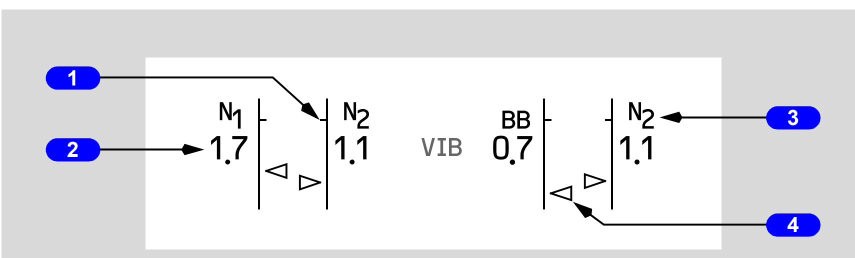
Engine Vibration Indications

570



SECONDARY EICAS DISPLAY

109, 405



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:

570

- FAN - fan vibration
- LPT - Low Pressure Turbine vibration
- N2 - N2 rotor vibration

109, 405

- N1 - N1 rotor vibration
- N2 - N2 rotor vibration

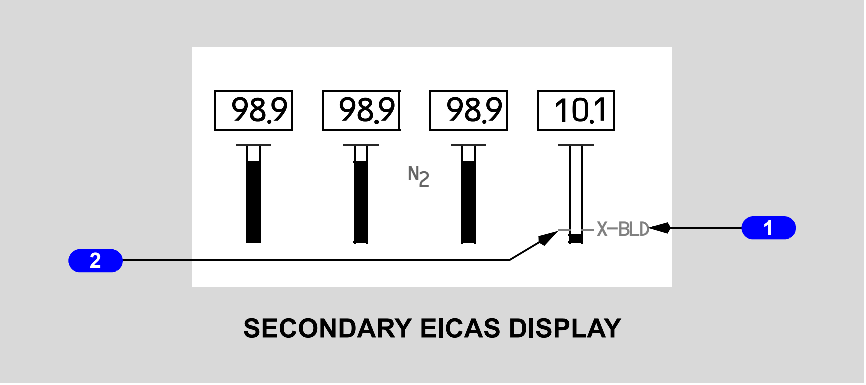
If vibration source BB (broad band vibration) displayed, source is unknown and average vibration displayed.

4 Engine Vibration Indicator

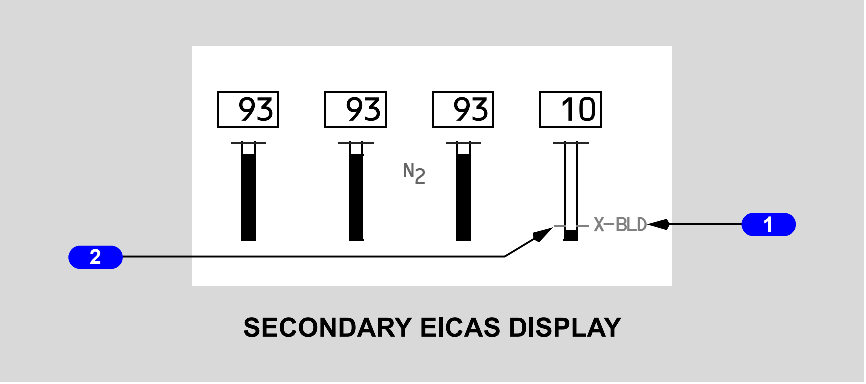
Displayed (white) - engine vibration.

Crossbleed Start Indications

570



109, 405



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

570

Displayed (magenta):

- a Fuel Control switch is in CUTOFF
- minimum N2 RPM at which Fuel Control switch should be moved to RUN during a manual start

2 Fuel-on Indicator

109, 405

Displayed (magenta):

- a Fuel Control switch is in CUTOFF

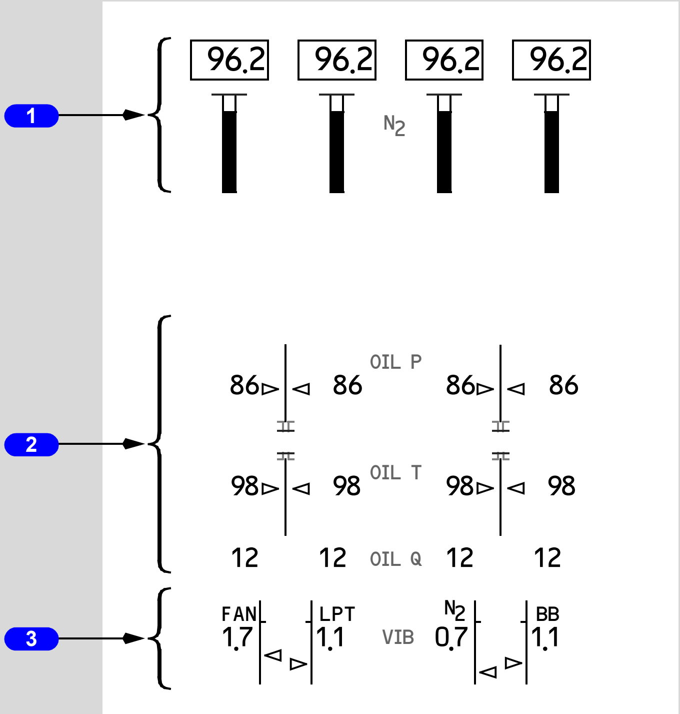
  405
- minimum N2 RPM at which Fuel Control switch should be moved to RUN during start

  109
- minimum N2 RPM at which Fuel Control switch should be moved to RUN during a manual start

Partial Secondary Engine Indications

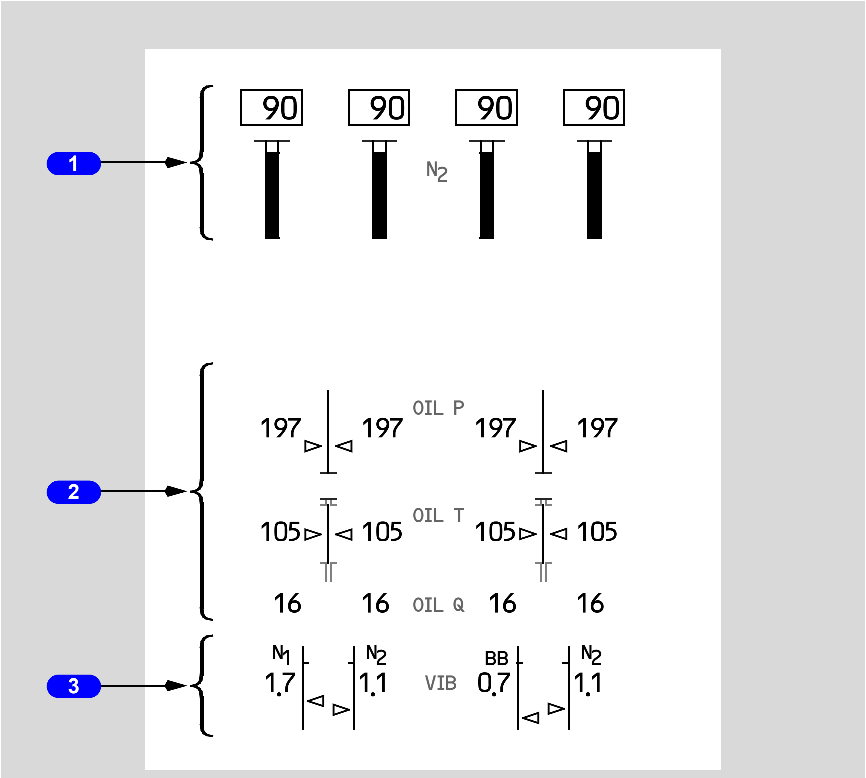
Partial secondary engine indications can display when the secondary engine display is not selected.

570



SECONDARY EICAS DISPLAY

109, 405



SECONDARY EICAS DISPLAY

1 **N2**

570

Displays if an operating limit reached.

1 **N2**

109, 405

Displays if an operating limit reached.

2 OIL P, OIL T, OIL Q

Displays if:

- a caution range or operating limit reached
  570
- oil differential exceeded
- oil quantity low

3 VIB

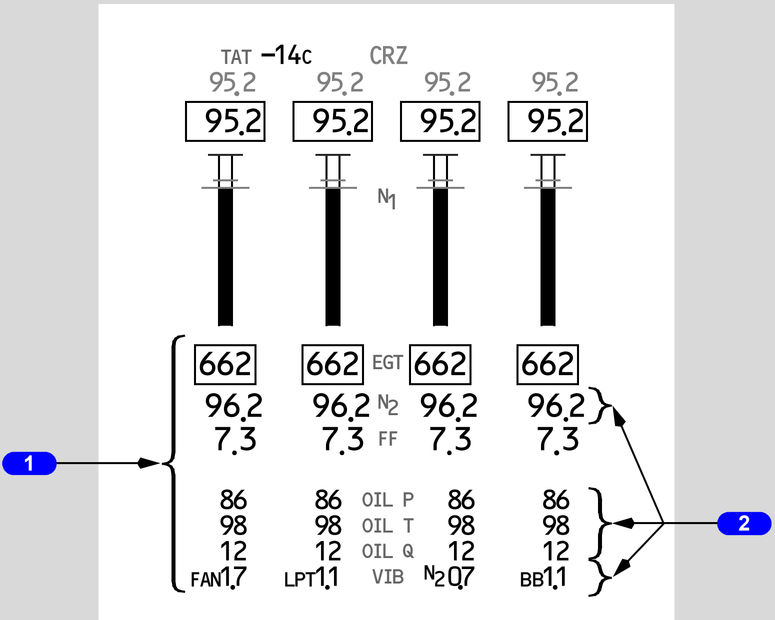
Displays if a display indicator reached.

Compact Engine Indications

Compact engine indications are used when only one display unit is available for EICAS.

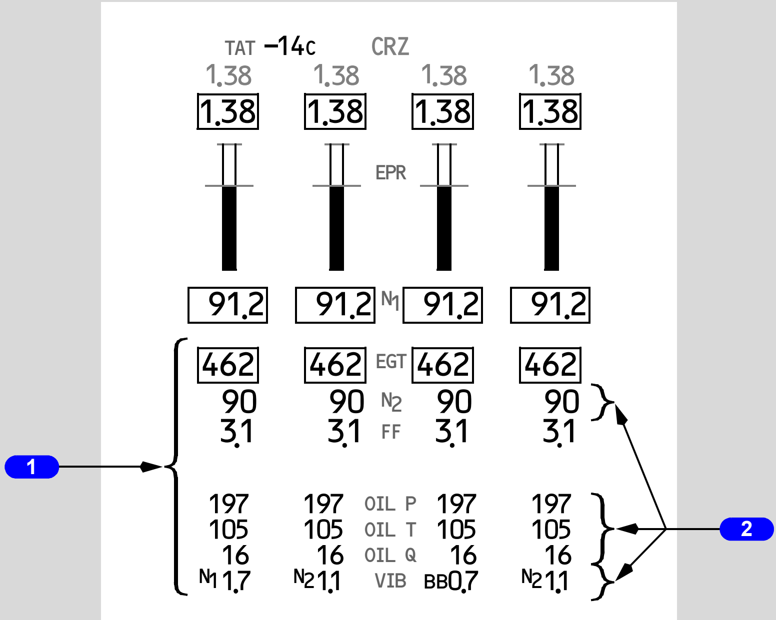
Compact Engine Display

570



PRIMARY EICAS DISPLAY

109, 405



PRIMARY EICAS DISPLAY

1 Compact Engine Indications

Displayed continuously:

109, 405

- EPR
- 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

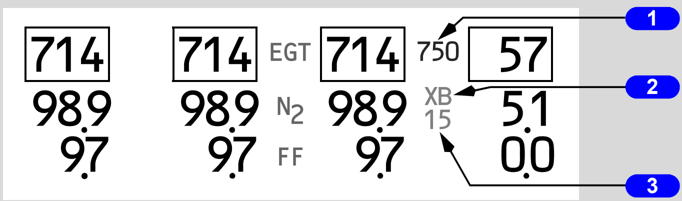
2 Partial Compact Engine Indications

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

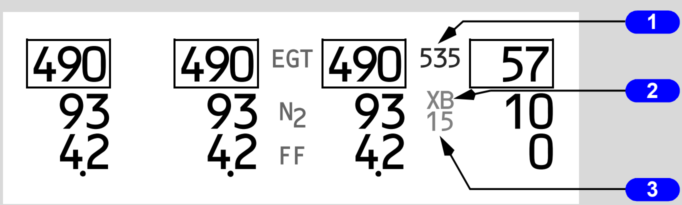
Compact Start Indications

570



PRIMARY EICAS DISPLAY

109, 405



PRIMARY EICAS DISPLAY

1 EGT Start Limit

Displays red.

2 Crossbleed Start

Displays magenta.

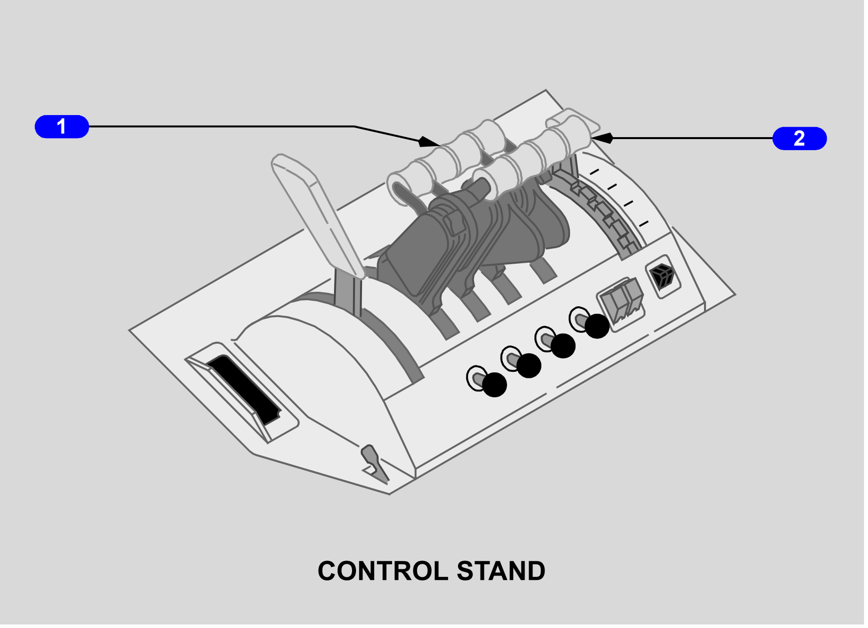
3 Fuel-on Indicator

Displays magenta.

Intentionally
Blank

Engine Controls

Thrust Levers



1 Reverse Thrust Levers

Control engine reverse thrust.

Reverse thrust can only be selected when Forward Thrust levers are closed.

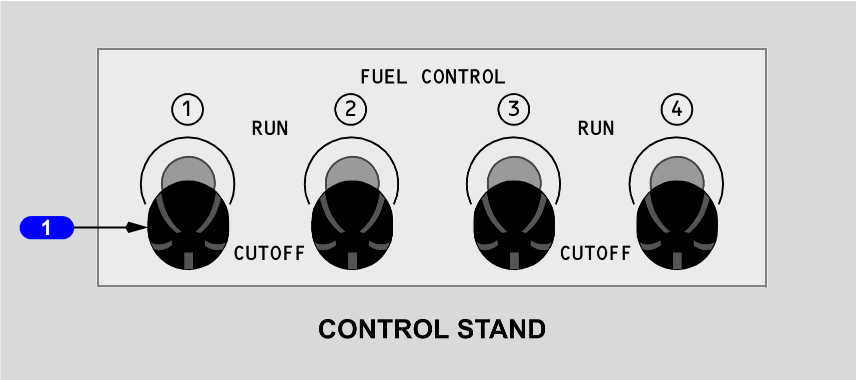
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Controls engine forward thrust.

Thrust levers can only be advanced when Reverse Thrust levers are down.

Fuel Control Switches



1 FUEL CONTROL Switches

109, 570

RUN (Autostart switch ON) -

- opens spar fuel valve
- opens engine fuel valve
- EEC sequences start valve, fuel metering valve, and igniter operation

109, 570

RUN (Autostart switch OFF) -

- opens spar fuel valve
- opens engine fuel valve
- energizes igniter(s)

405

RUN -

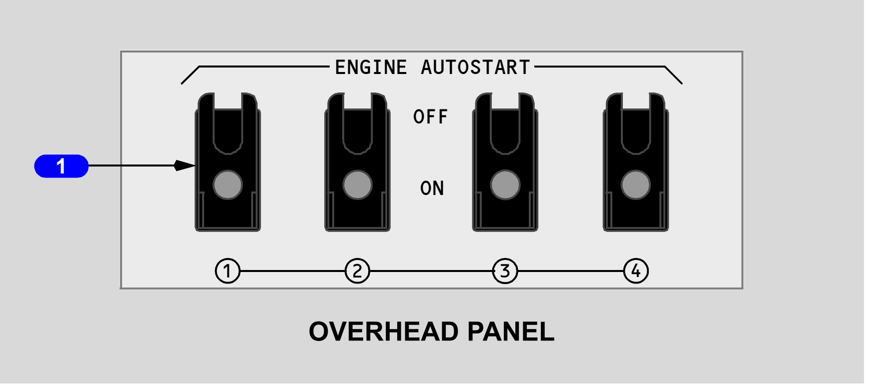
- opens spar fuel valve
- opens engine fuel valve
- energizes igniter(s)

CUTOFF -

- closes fuel valves
- removes igniter power
- commands respective hydraulic demand pump to operate when Demand Pump selector in AUTO
- unlocks Engine Fire switch

Autostart Control Panel

109



1 Engine Autostart Switches

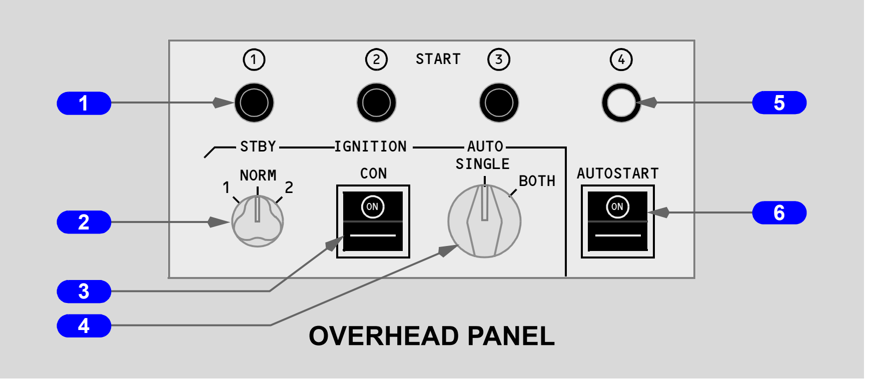
ON - arms the autostart system.

OFF -

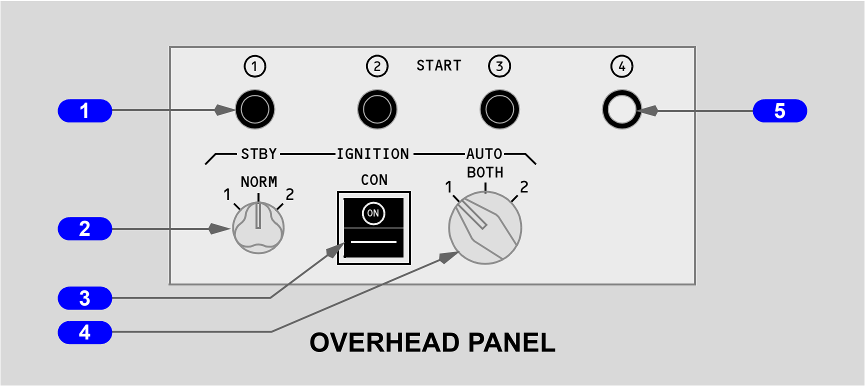
- respective engine autostart system is disabled
- start is manually controlled

Engine Start Panel

570



109, 405



1 Engine START Switches

109, 570

Pull (Autostart switch ON) -

- arms start valve
- opens engine bleed air valve

109, 570

Pull (Autostart switch OFF)-

- opens start valve
- opens engine bleed air valve

405

Pull -

- 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 igniters

  570
- standby power system supplies power continuously to all igniters if AC power system is not powered

  109, 405
- standby power system supplies power continuously to number 1 igniters if AC power system is not powered

1 or 2 - standby power system supplies power continuously to respective igniters.

3 Continuous (CON) IGNITION Switch
109

ON - selected igniters operate continuously.

3 Continuous (CON) IGNITION Switch
405

ON -

- selected igniters operate continuously
- commands approach idle minimum

3 Continuous (CON) IGNITION Switch
570

ON -

- selected igniters operate continuously
- commands approach idle minimum

4 AUTO IGNITION Selector
570

SINGLE -

- EEC alternates igniter 1 and igniter 2 after every second ground start
- EEC selects both igniters for in-flight start or flameout

BOTH - selects all igniters.

Selected igniters operate 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

4 AUTO IGNITION Selector
109

1 or 2 (Autostart switch ON) -

- EEC alternates igniter 1 and igniter 2 for each ground start
- EEC selects both igniters for in-flight start

1 or 2 (Autostart switch OFF) - selects respective igniters.

BOTH - selects all igniters.

Selected igniters operate 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
- autostart ON and engine flameout

4 AUTO IGNITION Selector

405

1, BOTH, or 2 - selects respective igniters.

Selected igniters operate 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

5 Engine Start Lights

Illuminated (white) - start valve is open.

6 AUTOSTART Switch

570

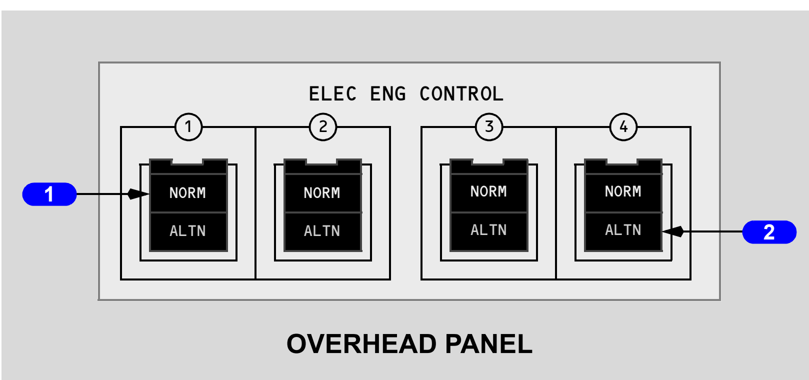
ON - arms the autostart system.

OFF -

- autostart system is disabled
- start is manually controlled

Electronic Engine Control

Electronic Engine Control Panel



1 **Electronic (ELEC) Engine (ENG) CONTROL Switches**

NORM (Normal) -

- selects normal engine control mode
  570
- electronic engine control sets thrust using N1 RPM as the controlling parameter
  109, 405
- electronic engine control sets thrust using EPR as the controlling parameter

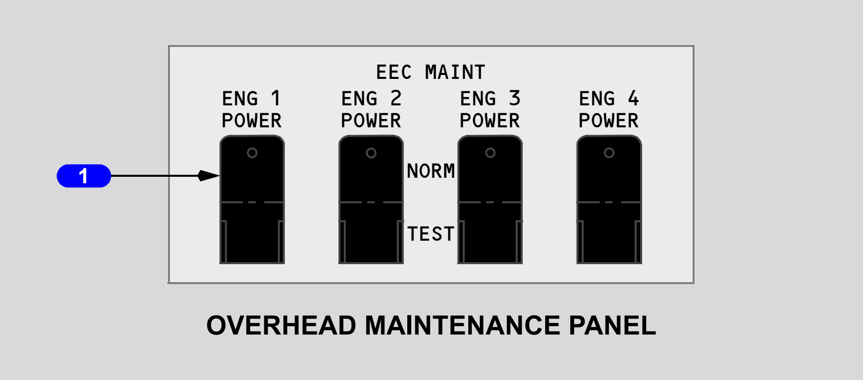
Alternate -

- 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



1 **EEC Maintenance (MAINT) POWER Switches**

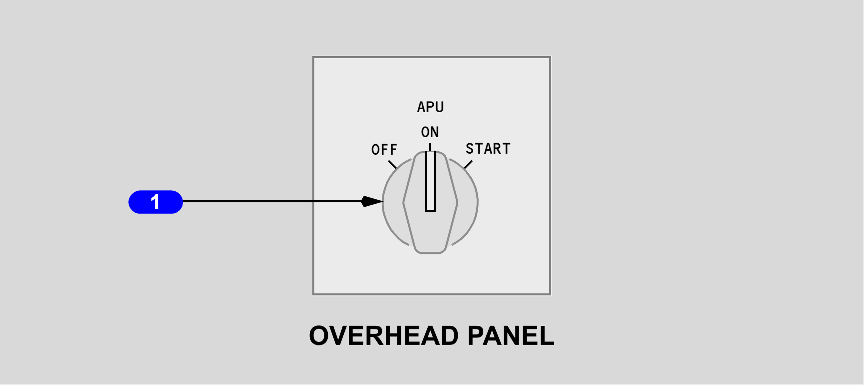
Normal (NORM) - supplies electrical power for normal EEC operation.

TEST - supplies electrical power for EEC maintenance testing when engine not running.

Intentionally
Blank

APU Controls and Indications

APU Selector



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

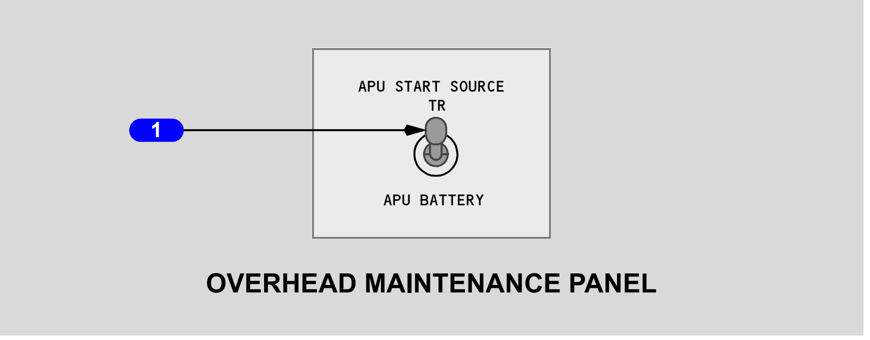
  405
- activates DC or AC fuel pump

  109, 570
- activates DC or two AC fuel pumps

START (momentary position, spring-loaded to ON) - initiates automatic start sequence.

APU Start Source

570



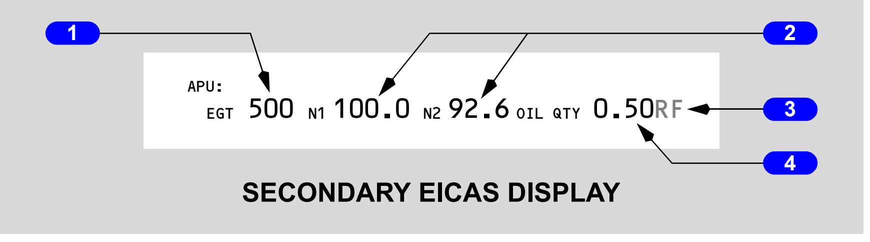
1 APU START SOURCE

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

Located on status (STAT) display.



1 EGT

APU exhaust gas temperature in degrees Celsius.

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).

Intentionally
Blank

Engines, APU — Chapter 7
Engine System Description — Section 20

Introduction

570

The airplane is powered by four General Electric CF6-80C2-B1F engines. The engines are rated at 56,500 pounds takeoff thrust each.

109, 405

The airplane is powered by four Pratt & Whitney PW-4056 engines. The engines are rated at 57,100 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 32, 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

570

N1 and EGT are primary engine indications and always display on primary EICAS.

109, 405

EPR, 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.

570

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.

109, 405

The oil temperature indicator has 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.

570

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.

109, 405

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.

570

The oil quantity indication changes color to magenta if low oil quantity is detected or if the oil quantity differential is exceeded.

109, 405

The oil quantity indication changes color to magenta if low oil quantity is detected.

570

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.

109, 405

Maximum EPR is displayed by an amber line. The EPR indication changes color to red when maximum EPR is reached. The reference EPR indicator displays the reference EPR selected by the FMC. The command EPR indicator displays EPR commanded by Thrust lever position. It equals actual EPR when the engine is stabilized. The command EPR indicator moves when the Thrust lever moves to display the new commanded EPR.

Compact Display Format

570

If only one display unit 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.

109, 405

If only one display unit 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, EPR 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.

570

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.

109, 405

If an N2 RPM increases to the operating limit, the N2 indications display. If an oil pressure decreases to the operating limit, if an oil temperature increases to the caution range or operating limit, or if an oil quantity decreases to the low level, 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 display unit 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)

570

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. Electrical power for each EEC is provided by an alternator mounted on the engine accessory gearbox.

109, 405

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 the normal mode, the EEC uses EPR as the controlling parameter for setting thrust. In the alternate mode the EEC uses N1 as the controlling parameter. Electrical power for each EEC is provided by an alternator mounted on the engine accessory gearbox.

570

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

570

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.

109, 405

In normal mode, EEC sets thrust by controlling EPR based on Thrust lever position. EPR is commanded by positioning the Thrust levers either with the autothrottles, or by the flight crew. The EEC calculates an EPR value between idle and maximum EPR. Maximum EPR is the maximum allowable thrust available from the engine. The calculated EPR is compared to actual EPR. The EEC commands the fuel metering unit to adjust fuel flow until actual EPR equals calculated EPR.

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.

570

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.

109, 405

Maximum EPR represents the maximum rated thrust available from the engine. The EEC continuously computes maximum EPR. Thrust is limited to maximum EPR 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.

570

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.

109, 405

Alternate mode does not provide thrust limiting at maximum EPR. Maximum EPR 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.

570

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.

109, 405

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 EPR.

If the EECs are in the alternate mode, advancing the Thrust levers full forward provides some overboost and should be considered only during emergency situations when all other actions have been taken and terrain contact is imminent.

570

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.

109, 405

If control for any EEC transfers from normal to alternate, the autothrottle disconnects. The autothrottle can be activated after all EECs are again in the normal mode.

109, 405

The EEC selects an unannunciated alternate mode when reverse thrust is used due to EPR sensing inaccuracies during reverser operation.

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

570
- Continuous Ignition switch is ON

405
- Continuous Ignition switch is ON

109, 405

Approach idle decreases acceleration time for go-around. Approach idle is maintained until five seconds after touchdown, when minimum idle is selected.

570

Approach idle decreases acceleration time for go-around. Approach idle is maintained until five seconds after touchdown, when minimum idle is selected. Approach idle is selected during thrust reverser operation.

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

109, 570

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. The start limit remains displayed until N2 reaches a predetermined RPM. 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 during a manual start.

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.

570

During autostart, the EEC monitors EGT and N2 RPM until the engine stabilizes at idle.

109

During autostart, the EEC monitors N1 RPM, 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

570

Note: The autostart system does not monitor oil pressure or N1 rotation.

109

Note: The autostart system does not monitor oil pressure.

570

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.

570

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.

570

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.

109

If the EEC detects no EGT rise, a hot start, or a hung start before starter cutout, it cuts off fuel and ignition. The engine does not motor or attempt a second start for a hung start. For no EGT rise or a hot start, the EEC applies fuel and ignition to both igniters for another start attempt. The EEC makes two start attempts before aborting the autostart sequence. The engine motors for 30 seconds after each failed start attempt. If the autostart sequence is aborted, fuel, ignition, and start air are cut off and the engine does not motor.

109

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

570

During in-flight flameout and/or start, the EEC reacts to a hung start or to EGT reaching the takeoff limit. 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 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.

109

During in-flight start if the EEC detects a hot start, it cuts off and then reapplies 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.

Auto-Relight
570

An auto-relight capability is provided for flameout protection. Whenever the EEC detects an engine flameout, both igniters are activated. A flameout is detected when a rapid decrease in N2 occurs, or N2 is less than idle RPM.

During an in flight start or auto-relight the EEC will first stabilize the engine at idle before advancing the engine to thrust lever postion if forward of idle.

Manual Start

570

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). Pulling the Start switch out (held out by a solenoid) opens the start and engine bleed air valves. The Start light illuminates. When N2 RPM reaches the fuel-on indicator, the Fuel Control switch is moved to RUN. The spar, fuel metering, and engine fuel valves open and the selected igniter energizes. 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 bleed air valves close, the Start light extinguishes, and ignition discontinues. The start must be monitored until the engine stabilizes at idle.

Manual Start

109

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). Pulling the Start switch out opens the start and engine bleed air valves. The Start light illuminates. At maximum motoring, the Fuel Control switch is moved to RUN. The spar and engine fuel valves open and the selected igniter energizes. 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 bleed air valves close, the Start light extinguishes, and ignition discontinues. The start must be monitored until the engine stabilizes at idle.

Engine Ignition

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Each engine has two igniters. The igniters operate separately or together as selected by the Auto Ignition selector and the EEC.

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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.

570

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.

109

Each engine has two igniters. The igniters operate separately or together as selected by the Auto Ignition selector and, when autostart is on, the EEC.

109

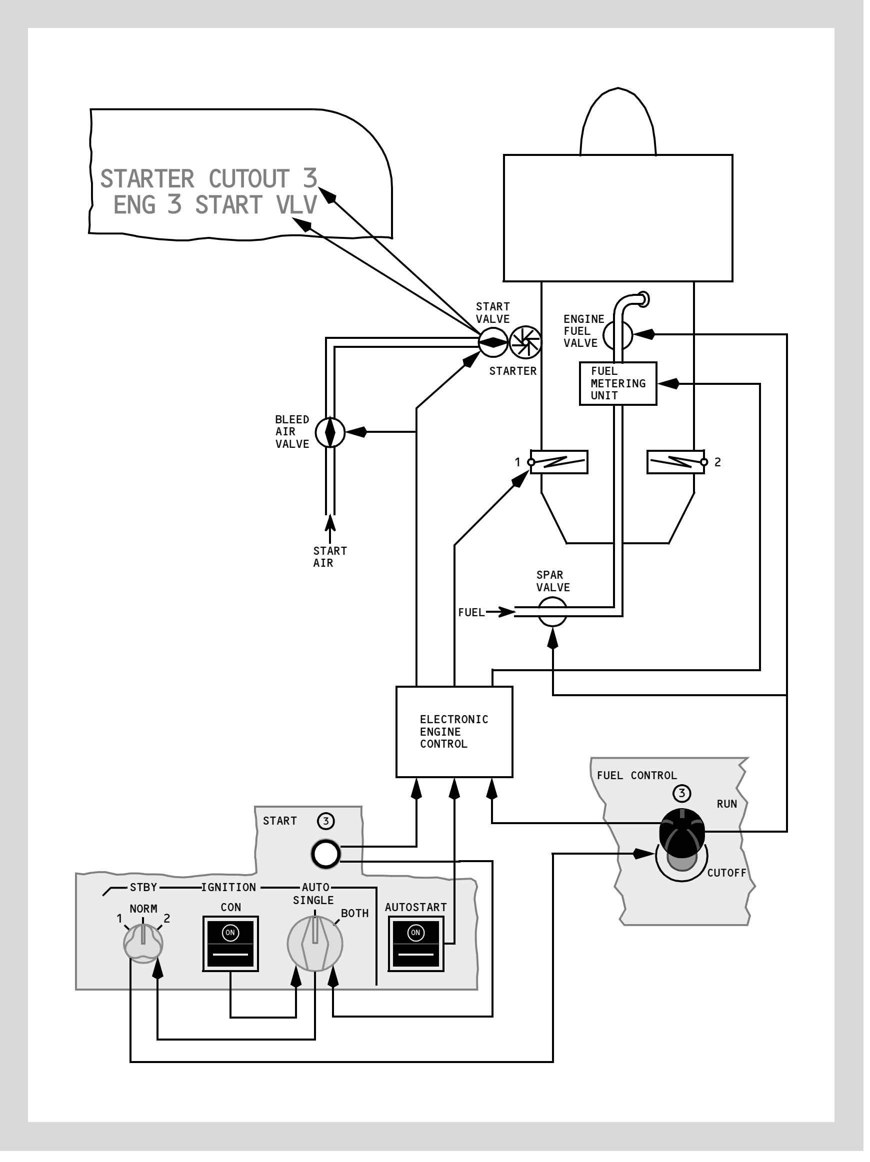
Ignition is selected for each engine when the related Start switch is out, nacelle anti-ice is on, or when autostart is on, a flameout is detected. Ignition is selected for all engines when trailing edge flaps are out of the up position or the Continuous Ignition switch is ON. When ignition is selected, 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.

109

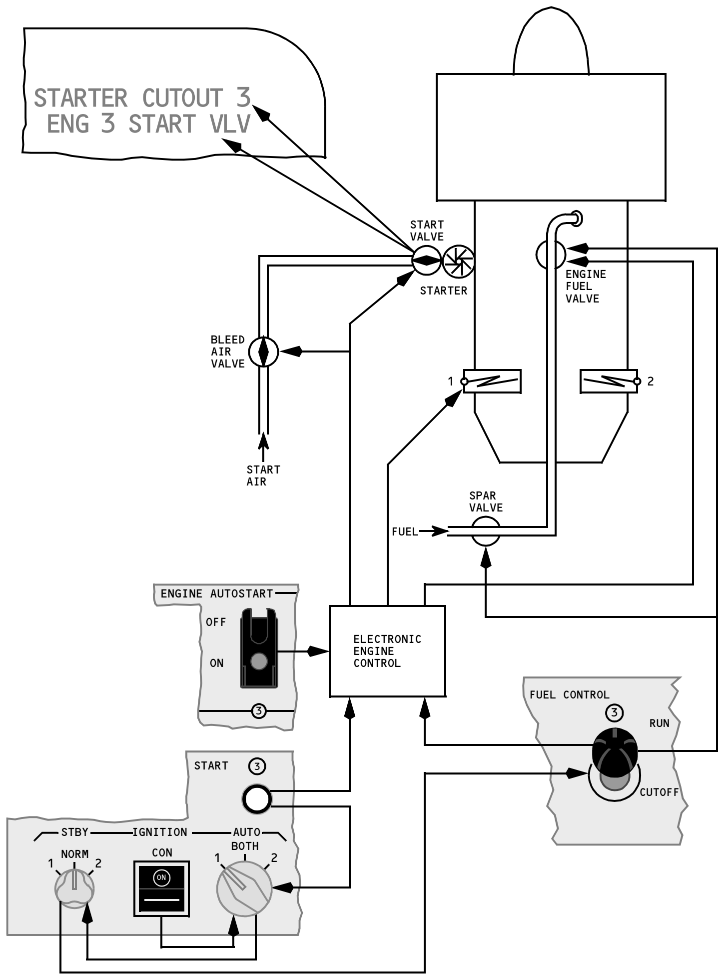
The AC power system is the normal power source for ignition. The standby power system provides a backup source. When the Standby Ignition selector is in NORM, the AC power system supplies power to the selected igniters. If the AC power system is not powered, the standby power system supplies power continuously to igniter 1. 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

570



109


STARTER CUTOUT 3
ENG 3 START VLV
START VALVE
STARTER
ENGINE FUEL VALVE
BLEED AIR VALVE
START AIR
1
2
SPAR VALVE
FUEL
ENGINE AUTOSTART
OFF
ON
3
ELECTRONIC ENGINE CONTROL
FUEL CONTROL
3
RUN
CUTOFF
START
3
STBY
IGNITION
AUTO
NORM
1
2
CON
ON
BOTH
1
2

Engine Fuel System

570

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 respective 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.

109, 405

Fuel is supplied under pressure from fuel pumps located in the fuel tanks. Fuel for each engine flows through a spar valve located in the respective main tank. The first stage engine fuel pump adds 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 second stage engine fuel pump adds final pressure to the fuel. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel flows through the engine fuel valve before distribution to the engine.

109, 570

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.

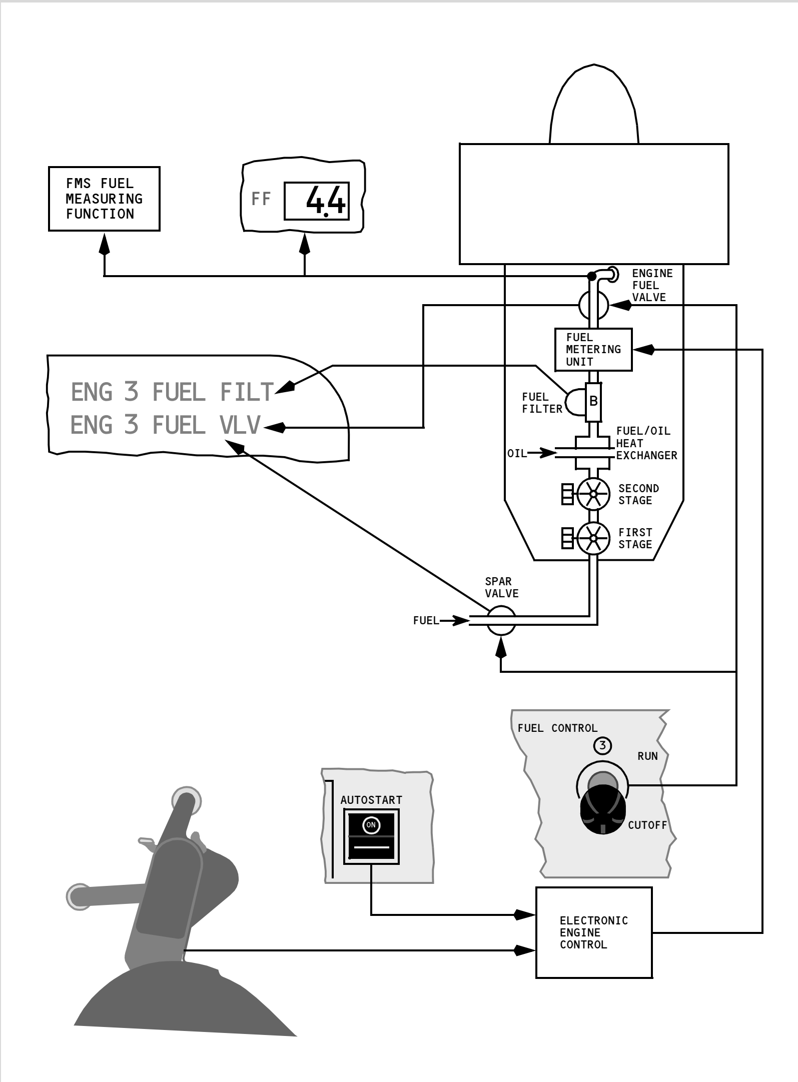
405

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. 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.

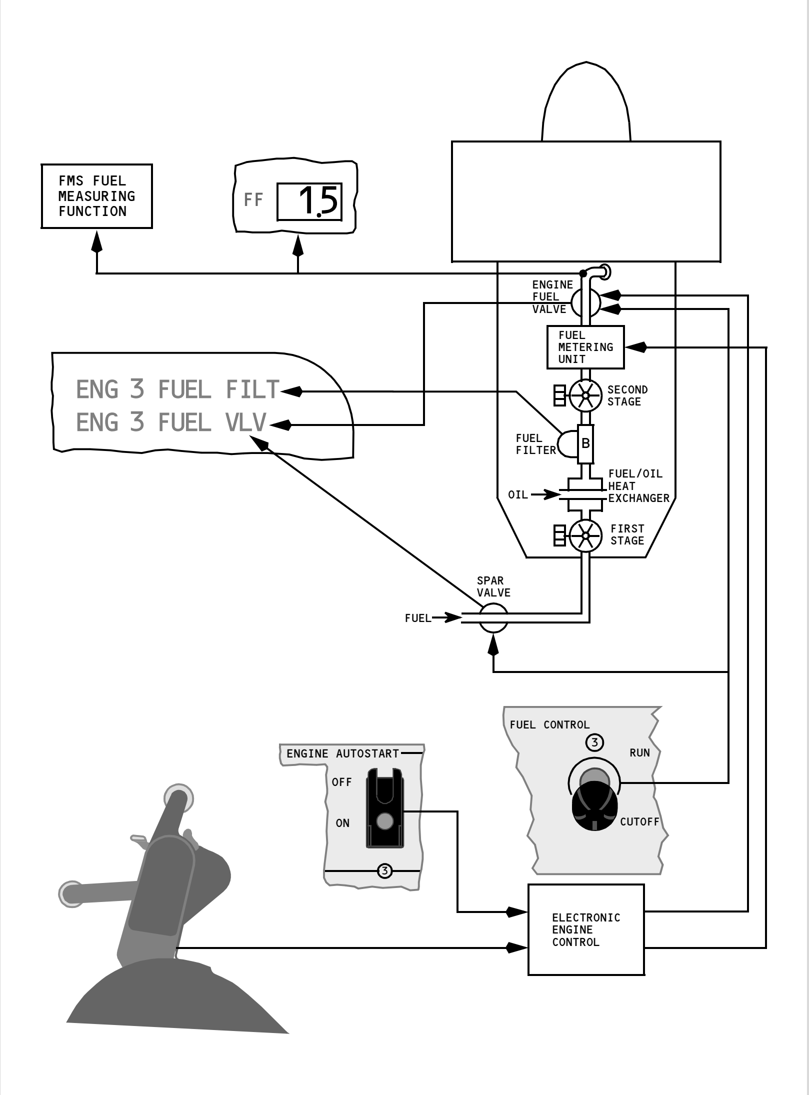
Fuel flow is measured downstream of the engine fuel valve and displays on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic

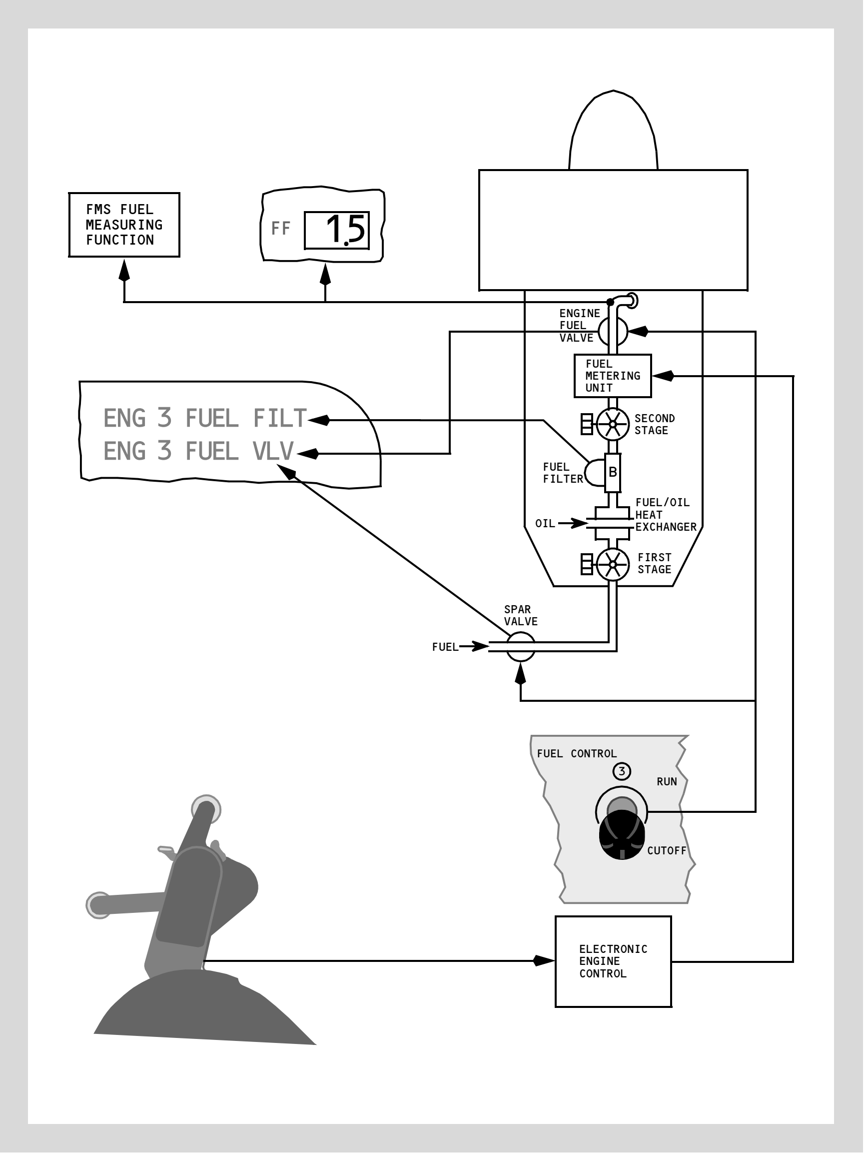
570



109


FMS FUEL
MEASURING
FUNCTION
FF
1.5
ENGINE
FUEL
VALVE
FUEL
METERING
UNIT
ENG 3 FUEL FILT
ENG 3 FUEL VLV
SECOND
STAGE
FUEL
FILTER
B
FUEL/OIL
HEAT
EXCHANGER
OIL
FIRST
STAGE
SPAR
VALVE
FUEL
FUEL CONTROL
3
RUN
CUTOFF
ENGINE AUTOSTART
OFF
ON
3
ELECTRONIC
ENGINE
CONTROL

405


FMS FUEL
MEASURING
FUNCTION
FF
1.5
ENG 3 FUEL FILT
ENG 3 FUEL VLV
ENGINE
FUEL
VALVE
FUEL
METERING
UNIT
SECOND
STAGE
FUEL
FILTER
B
FUEL/OIL
HEAT
EXCHANGER
OIL
FIRST
STAGE
SPAR
VALVE
FUEL
FUEL CONTROL
3
RUN
CUTOFF
ELECTRONIC
ENGINE
CONTROL

Engine Oil System

570

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.

109, 405

The oil system cools and lubricates engine bearings and the accessory gearbox. Oil is pressurized by an oil pump. A dual oil filter removes contaminants. If the primary filter becomes saturated with contaminants, oil bypasses the primary filter. The oil is cooled first by fan air as it flows through the air/oil heat exchanger and then by fuel as it flows through the fuel/oil heat exchanger. The oil cools and lubricates the engine and a scavenge pump returns it to the oil reservoir.

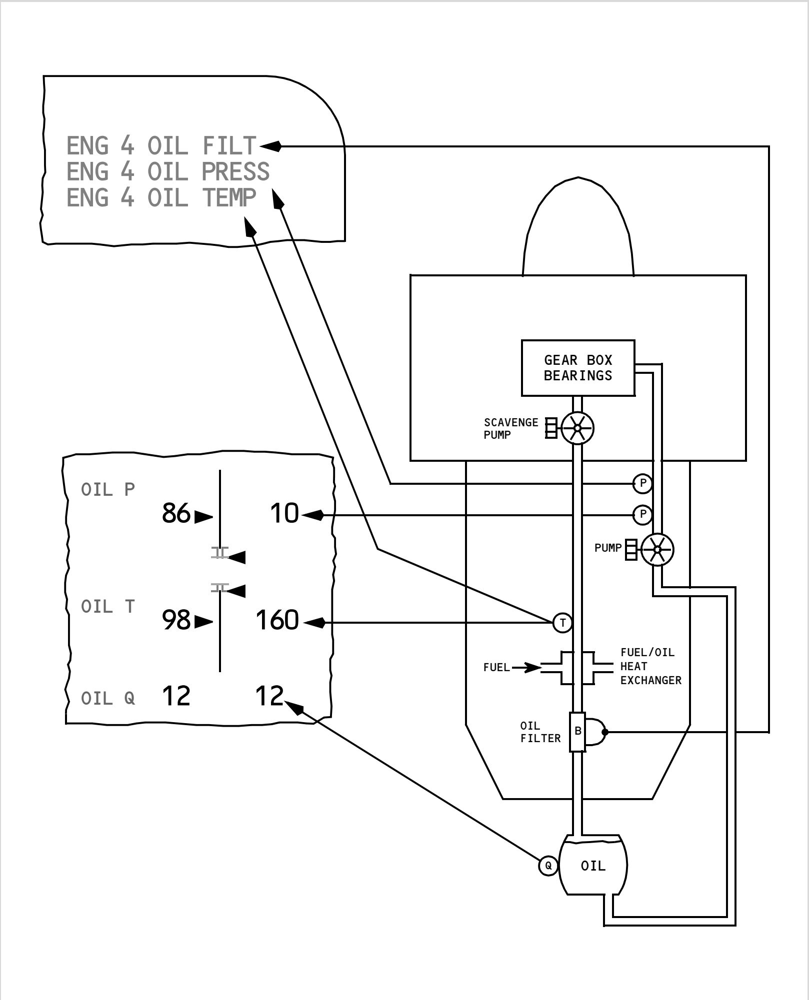
Oil pressure, temperature, and quantity display on the secondary engine display. Oil pressure is measured upstream of the engine. Oil temperature is measured downstream of the engine.

570

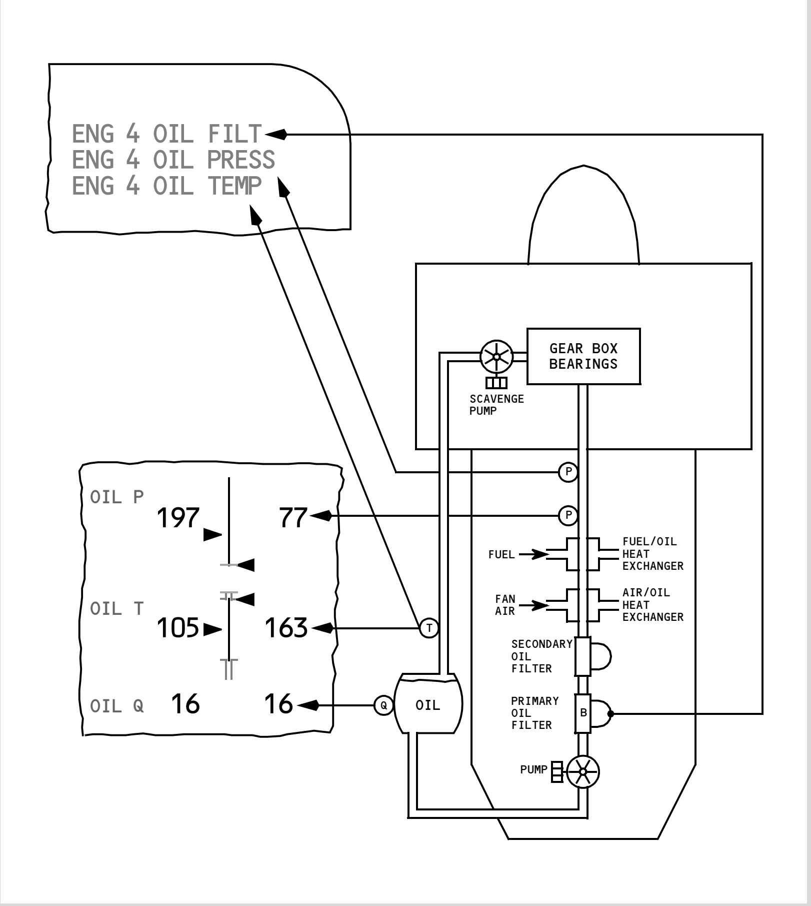
During cruise, oil quantity displays on EICAS whenever oil quantity on one engine differs from any other engine by a predetermined amount. When this occurs, the lowest oil quantity is shown in magenta. If there is an increase in oil quantity during cruise (indicator malfunction or leaking fuel/oil heat 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

570



109, 405


ENG 4 OIL FILT
ENG 4 OIL PRESS
ENG 4 OIL TEMP
GEAR BOX
BEARINGS
SCAVENGE
PUMP
OIL P
197
77
P
P
FUEL
FUEL/OIL
HEAT
EXCHANGER
FAN
AIR
AIR/OIL
HEAT
EXCHANGER
OIL T
105
163
T
SECONDARY
OIL
FILTER
OIL Q
16
16
Q
OIL
PRIMARY
OIL
FILTER
B
PUMP

Thrust Reverser System

570

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.

109, 405

Each engine has a hydraulically actuated fan air thrust reverser. Each thrust reverser is powered by hydraulic pressure from the related hydraulic system. The reverser does not operate if the hydraulic system loses pressure. 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.

570

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,.

109, 405

Raising the Reverse Thrust levers to the idle detent locks the Forward Thrust levers in position. Hydraulic pressure unlocks and extends the reversers aft to the deployed position. A thrust reverser status annunciator displays above the digital indicator of each EPR 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.

570

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.

109, 405

The thrust reversers are protected against deploying inadvertently. If a reverser unlocks and deploys inadvertently, the reverser system applies hydraulic pressure to stow and lock the reverser.

Airborne Vibration Monitoring System

570

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, LPT, or N2), broadband (BB) displays for the affected engine. Broadband vibration is the average vibration detected.

109, 405

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 (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

570

The APU DC electric starter is powered by an APU start transformer rectifier (TR) whenever utility bus 4 is powered. The utility bus may be powered from either an external or internal AC power source through the synchronous bus. If utility bus 4 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.

109, 405

An APU start requires both the main and APU batteries. The APU battery supplies power to the starter, air 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. All APU components except the starter are powered by the main battery while the APU starter is engaged during a start sequence.

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:

570

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 20 minutes then alternate between one and 20 minutes for further starts.		

109, 405

Between starts	Battery wait:
1 and 2	1 minute
2 and 3	5 minutes
3 and 4	1 minute
4 and 5	20 minutes
5 and 6	1 minute
For additional starts, wait 20 minutes then alternate between one and 20 minutes for further starts.	

570

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.

570

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.

Intentionally
Blank

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

Engine Alert Messages

109, 570

Message	Level	Aural	Message Logic
>AUTOSTART OFF	Advisory		Autostart switch OFF.

405

Message	Level	Aural	Message Logic
>EEC 1, 2, 3, 4 TEST PWR	Advisory		EEC maintenance power switch in TEST.

109, 570

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 AUTOSTART	Caution	Beeper	During a ground start, autostart did not start the engine or Fuel Control switch is in RUN at low engine RPM with the Autostart switch off.

Message	Level	Aural	Message Logic
>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		EEC in alternate control mode.
ENG 1, 2, 3, 4 FAIL	Caution	Beeper	Engine failure or flameout. Inhibited on the ground.

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 FUEL FILT	Advisory		Impending fuel filter bypass exists on affected engine.

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 FUEL VLV	Advisory		Engine fuel valve or fuel spar valve position disagrees with commanded position.

570

Message	Level	Aural	Message Logic
ENG IGNITION	Advisory		Ignition system fails to provide ignition when Continuous Ignition switch ON.

109, 405

Message	Level	Aural	Message Logic
ENG IGNITION	Advisory		Ignition system fails to provide ignition when Continuous Ignition switch ON or trailing edge flaps out of up.

570

Message	Level	Aural	Message Logic
>ENG 1, 2, 3, 4 LIM PROT	Caution	Beeper	EEC in alternate control mode and command N1 exceeds maximum rating.

109, 405

Message	Level	Aural	Message Logic
>ENG 1, 2, 3, 4 LIM PROT	Caution	Beeper	EEC in alternate control mode and thrust approaching maximum rating.

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 LOW IDLE	Advisory		Engine idle not in approach setting when commanded.

570

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL FILT	Advisory		Engine oil filter contamination approaching bypass condition.

109, 405

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL FILT	Advisory		Primary engine oil filter contamination approaching bypass condition.

570

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL PRESS	Advisory		Oil pressure reaches red line limit.

109, 405

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL PRESS	Advisory		Oil pressure reaches red line limit.

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL TEMP	Advisory		Oil temperature reaches amber band.

405, 570
(SB changes 109 ; engine thrust reverser locks installed)

Message	Level	Aural	Message Logic
>ENG 1, 2, 3, 4 REVERSER	Advisory		Fault detected in thrust reverser system.

(SB changes 109 ; before SB, engine thrust reverser locks not installed)

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 REVERSER	Advisory		Fault detected in thrust reverser system.

570

Message	Level	Aural	Message Logic
>ENG 1, 2, 3, 4 RPM LIM	Advisory		Engine thrust limited by N2 red line limit.

109, 405

Message	Level	Aural	Message Logic
>ENG 1, 2, 3, 4 RPM LIM	Advisory		Engine thrust limited by N1 or N2 red line limit.

Message	Level	Aural	Message Logic
>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	Message Logic
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		Low pump pressure detected when pump activated, or APU fuel valve not in commanded position.

Engine Memo Messages

Message	Level	Message Logic
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.

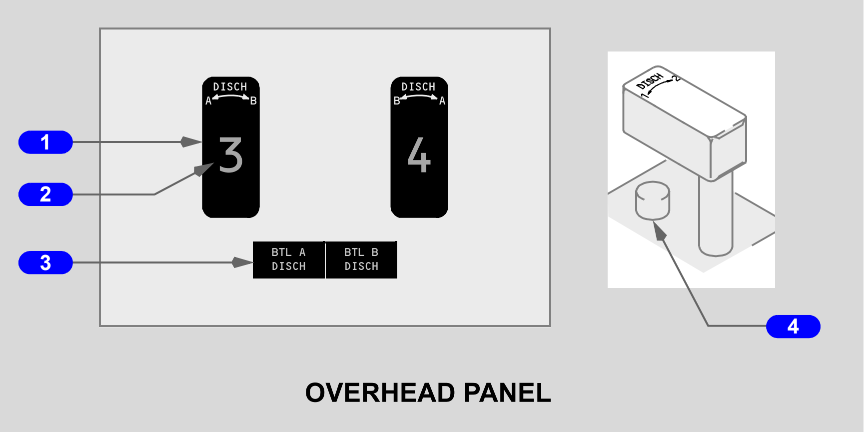
APU Memo Messages

Message	Level	Message Logic
APU RUNNING	Memo	APU selector in ON and APU N1 RPM exceeds 95%.

Fire Protection — Chapter 8
Table of Contents — Section 0

Engine Fire Protection

Engine Fire 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

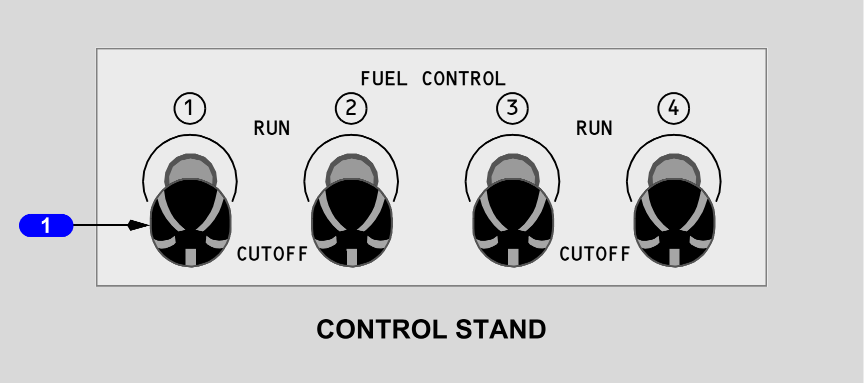
3 Bottle Discharged (BTL DISCH) Lights

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

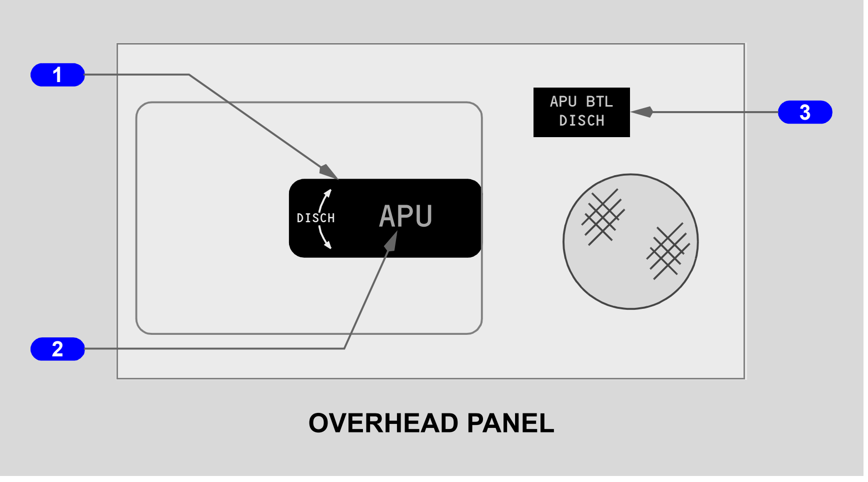


1 FUEL CONTROL Switch Fire Warning Lights

Illuminated (red) -

- a related engine fire is detected, or
- the Fire/Overheat Test switch is pushed

APU Fire Panel



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
- closes APU air inlet door
- 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.

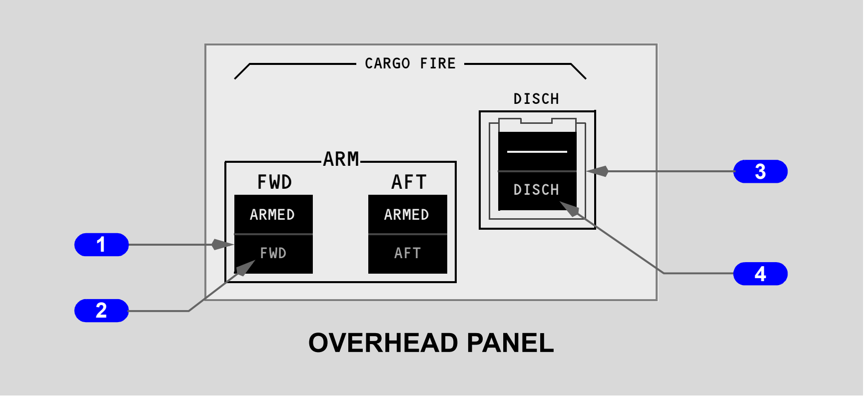
On the ground, the APU extinguisher automatically discharges.

3 APU Bottle Discharged (BTL DISCH) Light

Illuminated (amber) - extinguisher bottle is discharged or has low pressure.

Cargo Fire Panel

109



1 CARGO FIRE ARM Switches

FWD - ARMED -

- arms cargo fire extinguishers
- configures equipment cooling to override mode and turns off airflow and heat into forward compartment
- turns off pack 3 and all fans

AFT - ARMED -

- arms cargo fire extinguishers
- configures equipment cooling to override mode and turns off airflow and heat into forward compartment
- turns off aft cargo heat
- turns off pack 3 and all fans

2 CARGO FIRE Warning Light

Illuminated (red) -

- fire in related cargo compartment, or
- the Fire/Overheat Test switch is pushed

3 CARGO FIRE Discharge (DISCH) Switch

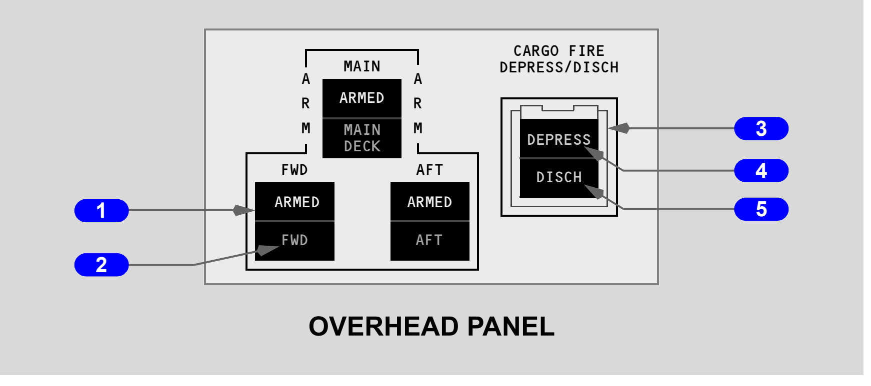
Push - initiates extinguisher discharge sequence to provide effective agent concentration for 195 minutes.

4 CARGO FIRE Discharged (DISCH) Light

Illuminated (amber) - cargo fire extinguishers discharged.

Cargo Fire Panel

405, 570



1 CARGO FIRE ARM Switches

MAIN - ARMED -

- enables main deck fire suppression
- turns off two packs
- configures equipment cooling to closed loop and turns off all airflow to main deck and airflow and heat into lower cargo compartments
- closes master trim air valve

FWD or AFT - ARMED -

- turns off two packs
- arms lower cargo compartment fire extinguishers
- configures equipment cooling to override mode and turns off all airflow and heat into lower cargo compartments
- closes master trim air valve

2 CARGO FIRE Warning Light

Illuminated (red) -

- fire in related cargo compartment, or
- the Fire/Overheat Test switch is pushed

3 CARGO FIRE Depressurization/Discharge (DEPRESS/DISCH) Switch

Push -

MAIN - ARMED - initiates airplane depressurization.

570

FWD or AFT - ARMED - initiates extinguisher discharge sequence to provide effective agent concentration for 210 minutes.

405

FWD or AFT - ARMED - initiates extinguisher discharge sequence to provide effective agent concentration for 334 minutes.

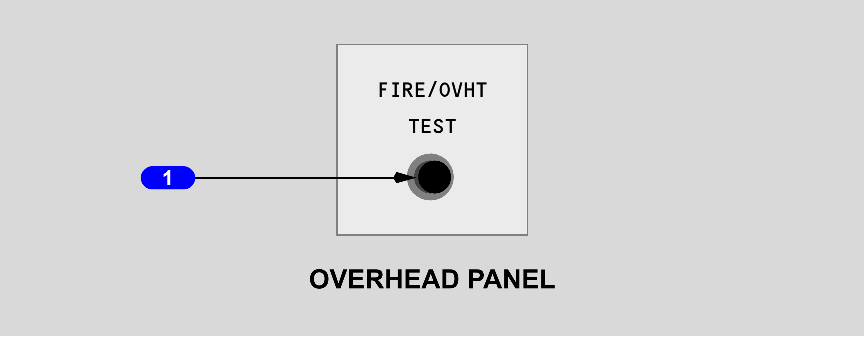
4 CARGO FIRE Depressurization (DEPRESS) Light

Illuminated (amber) - airplane depressurization initiated.

5 CARGO FIRE Discharged (DISCH) Light

Illuminated (amber) - cargo fire extinguishers discharged.

Fire/Overheat Test Switch

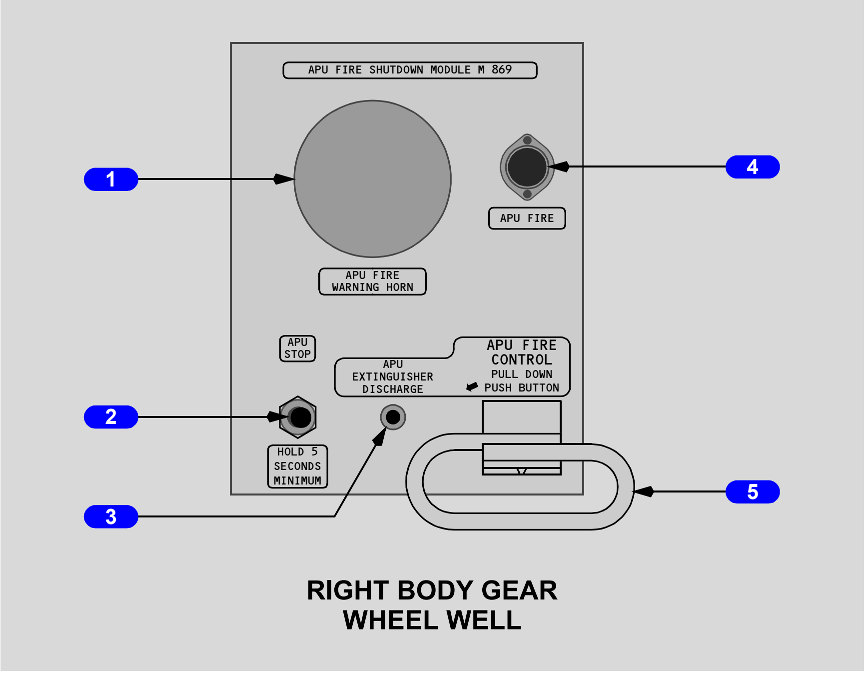


1 FIRE/Overheat (OVHT) TEST Switch

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



1 **APU FIRE WARNING HORN**

Sounds 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

Intentionally
Blank

Fire Protection — Chapter 8
System Description — Section 20

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

570

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.

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If a fire is detected, the flight deck warning bell rings two seconds on, then 3 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 can be silenced by extinguishing the fire or pushing either Master Warning/Caution Reset switch.

The wheel well horn for APU fire can be silenced by extinguishing the fire or 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
109

The forward and aft cargo compartments each have two dual loop smoke detectors. Sample air from throughout each compartment is drawn through the detectors by center bleed duct air. Both loops in a detector must sense smoke to activate the cargo fire warning unless reconfigured for single loop operation.

Cargo Compartment Fire Detection
405

The main deck and forward and aft lower cargo compartments all have dual loop smoke detectors. Both loops in a detector must sense smoke to activate the cargo fire warning unless reconfigured for single loop operation.

Cargo Compartment Fire Detection
570

The forward and aft lower cargo compartments have four dual loop detectors and the main deck has sixteen dual loop detectors.

Sample air from throughout each compartment is drawn through the detectors by center bleed duct air. Both loops in a detector must sense smoke to activate a 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

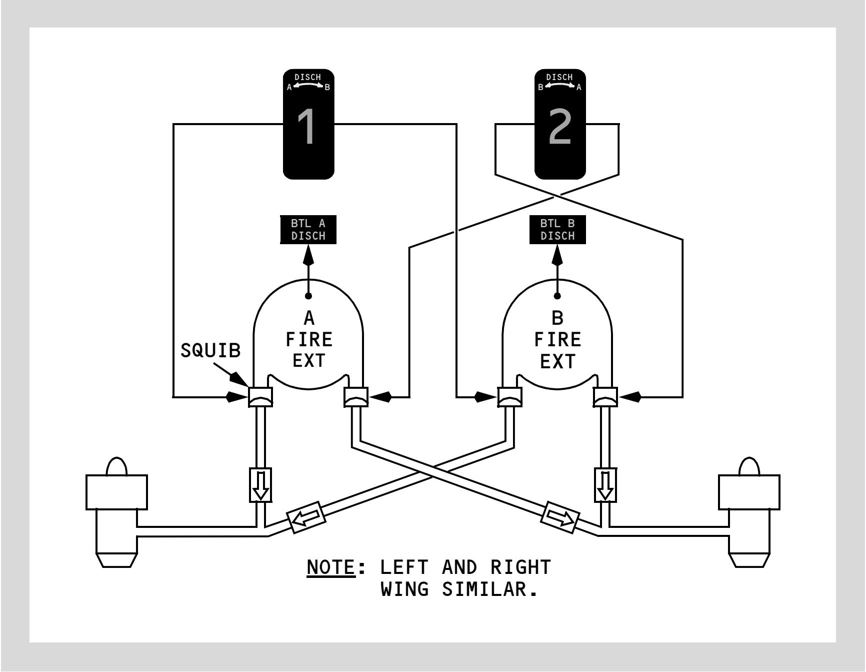
Smoke detectors are installed in crew rest areas. An aural warning sounds in the crew rest compartment when smoke is detected in that compartment.

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



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

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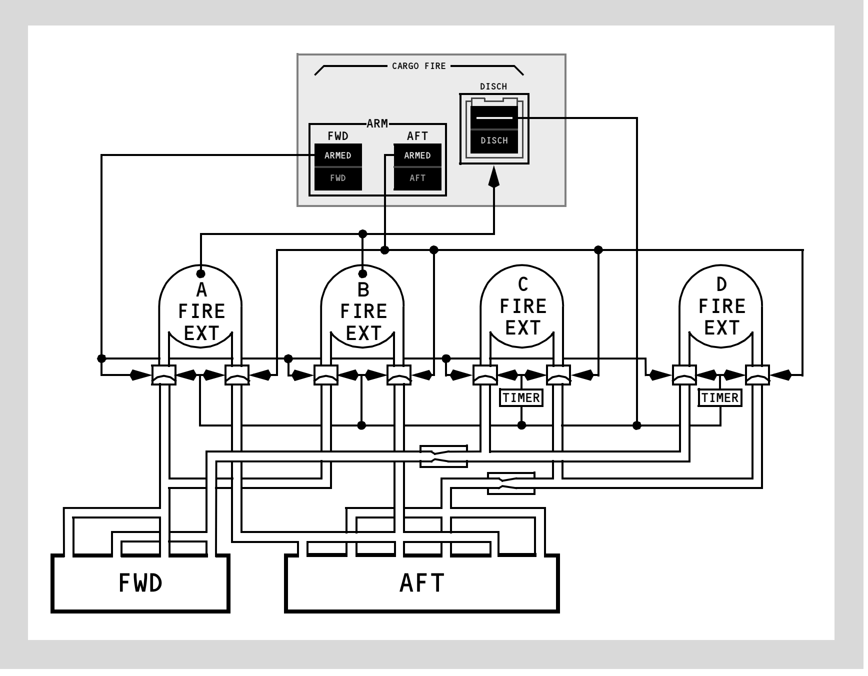
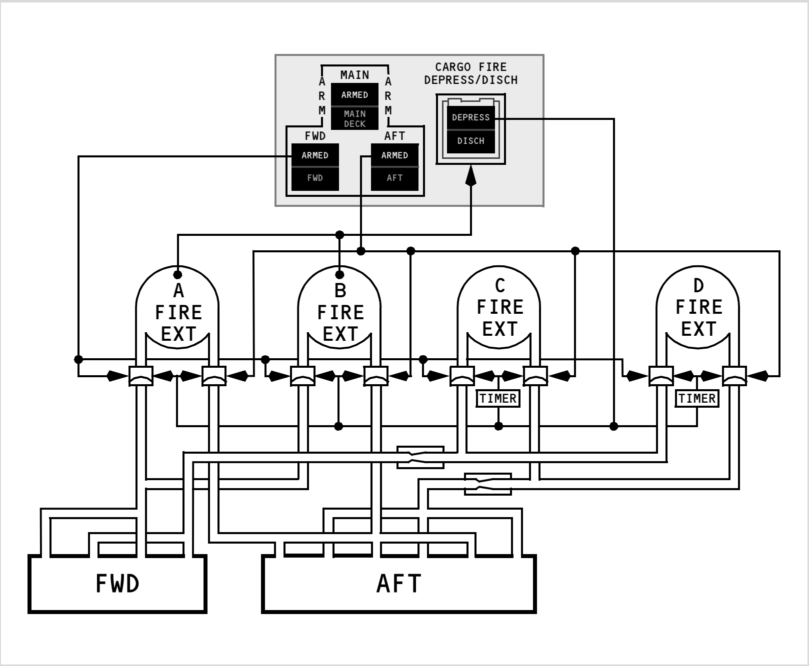


There are four fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other two bottles discharge after a brief delay, or upon touchdown.

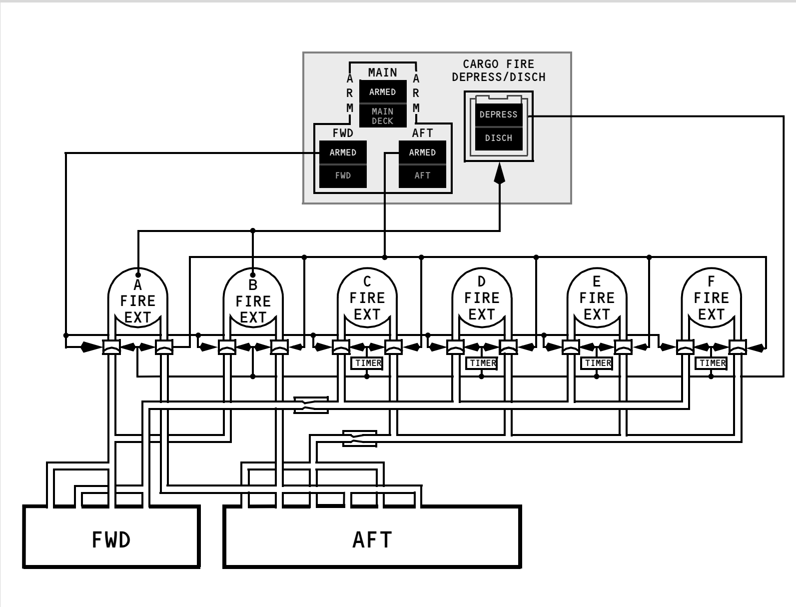
Lower Cargo Compartment Fire Extinguishing
570



There are four fire extinguisher bottles for the forward and aft lower cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other two bottles discharge after a brief delay, or upon touchdown.

Lower Cargo Compartment Fire Extinguishing

405



There are six fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other four bottles discharge after a brief delay, or upon touchdown.

Main Deck Cargo Compartment Suppression

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The main deck cargo compartment is a Class E compartment. Pushing the Main Deck Cargo Fire Arm switch configures equipment cooling to closed loop and turns off two packs and airflow to all cargo compartments. Subsequently pushing the Cargo Depress/Disch switch opens the outflow valves to initiate a controlled cabin depressurization.

Fire and Overheat Detection System Fault Test

The fire overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic Fault Test

The engine detector loops are continuously monitored for faults. In addition to continuous testing of engine detection systems, testing of all dual loop fire/overheat 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.

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Additional testing of cargo smoke or bleed duct leak detectors is initiated when a detection loop senses an overheat condition. If the other loop fails or senses an overheat condition, an overheat signal is activated. If the other loop passes the test and does not sense an overheat condition, a fault code is generated for the failed loop, the zone is configured for single loop operation, and automatic testing is conducted every 60 minutes.

Fire and Overheat Detection System Manual Fault Test

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The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/Overheat (OVHT) 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 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 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 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. The EICAS warning message FIRE WHEEL WELL may momentarily display during the test.

Fire and Overheat Detection System Manual Fault Test

405, 570

The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/Overheat (OVHT) TEST switch.

The indications for a manual fire and overheat detection system test are:

- fire bell rings
- APU fire warning horn sounds (on the ground)
- EICAS message TEST IN PROG is displayed
- these lights illuminate:
  - master WARNING lights
  - engine fire warning lights
  - APU fire warning light
  - FWD and AFT cargo fire warning lights
  - MAIN DECK fire warning light
  - Fuel Control switch fire warning lights

The EICAS warning message FIRE TEST PASS or FIRE TEST FAIL replaces the TEST IN PROG message, failed system EICAS messages display with the FIRE TEST FAIL message.

The EICAS message VLV TST IN PROG is displayed after the FIRE TEST PASS or FIRE TEST FAIL is displayed while holding down the FIRE/Overheat (OVHT) TEST switch. The valve test continues after the FIRE/Overheat (OVHT) TEST switch is released and when the main deck shut off valves and Pack 1 and 3 dump valve test is complete, the EICAS message VALVE TEST PASS or VALVE TEST FAIL replaces the VLV TST IN PROG message.

The wheel well fire detector loop and the bleed duct leak detector loops are tested only during the manually initiated test. The EICAS warning message FIRE WHEEL WELL may momentarily display during the 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.

Fire Protection EICAS Messages

The following EICAS messages can be displayed.

Alert Messages

Message	Level	Aural	Message Logic
>BOTTLE LOW APU	Advisory		APU fire extinguisher bottle pressure low.

Message	Level	Aural	Message Logic
>BTL LO L, R ENG A, B	Advisory		Left or right wing engine fire extinguisher bottle A or bottle B pressure low.

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Message	Level	Aural	Message Logic
>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 lower cargo compartment.
FIRE ENG 1, 2, 3, 4	Warning	Fire Bell	Fire detected in the engine.

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Message	Level	Aural	Message Logic
>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 lower cargo compartment.
FIRE ENG 1, 2, 3, 4	Warning	Fire Bell	Fire detected in the engine.

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Message	Level	Aural	Message Logic
FIRE MAIN DECK	Warning	Fire Bell	Smoke detected in more than one zone of main deck cargo area.

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Message	Level	Aural	Message Logic
FIRE MN DK AFT, FWD, MID	Warning	Fire Bell	Smoke detected in main deck cargo area.

Message	Level	Aural	Message Logic
FIRE WHEEL WELL	Warning	Fire Bell	Fire detected in a main wheel well.

Message	Level	Aural	Message Logic
OVHT ENG 1, 2, 3, 4 NAC	Caution	Beeper	Overheat detected in an engine nacelle.

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Message	Level	Aural	Message Logic
>SMOKE CREW REST	Caution	Beeper	Smoke detected in upper deck crew rest area.

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Message	Level	Aural	Message Logic
SMOKE DR 5 REST	Caution	Beeper	Smoke detected in door 5 crew rest area.

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Message	Level	Aural	Message Logic
>SMOKE LAVATORY	Advisory		Smoke detected in a lavatory.

System Test Messages

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The following messages are associated only with the manually-initiated fire test.

Message	Level	Aural	Message Logic
>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.

System Test Messages

405, 570

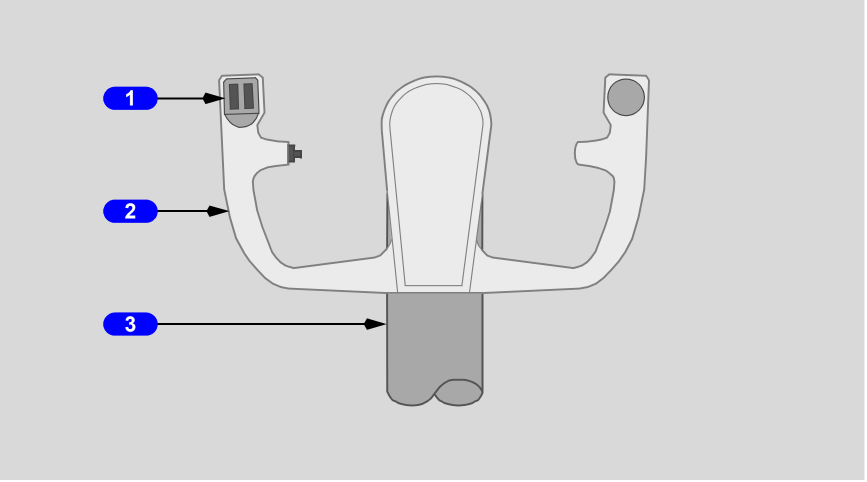
The following messages are associated only with the manually-initiated fire test.

Message	Level	Aural	Message Logic
>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.
>VALVE TEST FAIL	Warning		One or more main deck shut off valve or pack dump failures during valve test.
>VALVE TEST PASS	Warning		No main deck shut off valve or pack dump valve failures during valve test.
>VLV TST IN PROG	Warning		Main deck shut off valves and Pack 1 and Pack 3 dump valve test in progress.

Flight Controls Chapter 9
Table of Contents Section 0

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

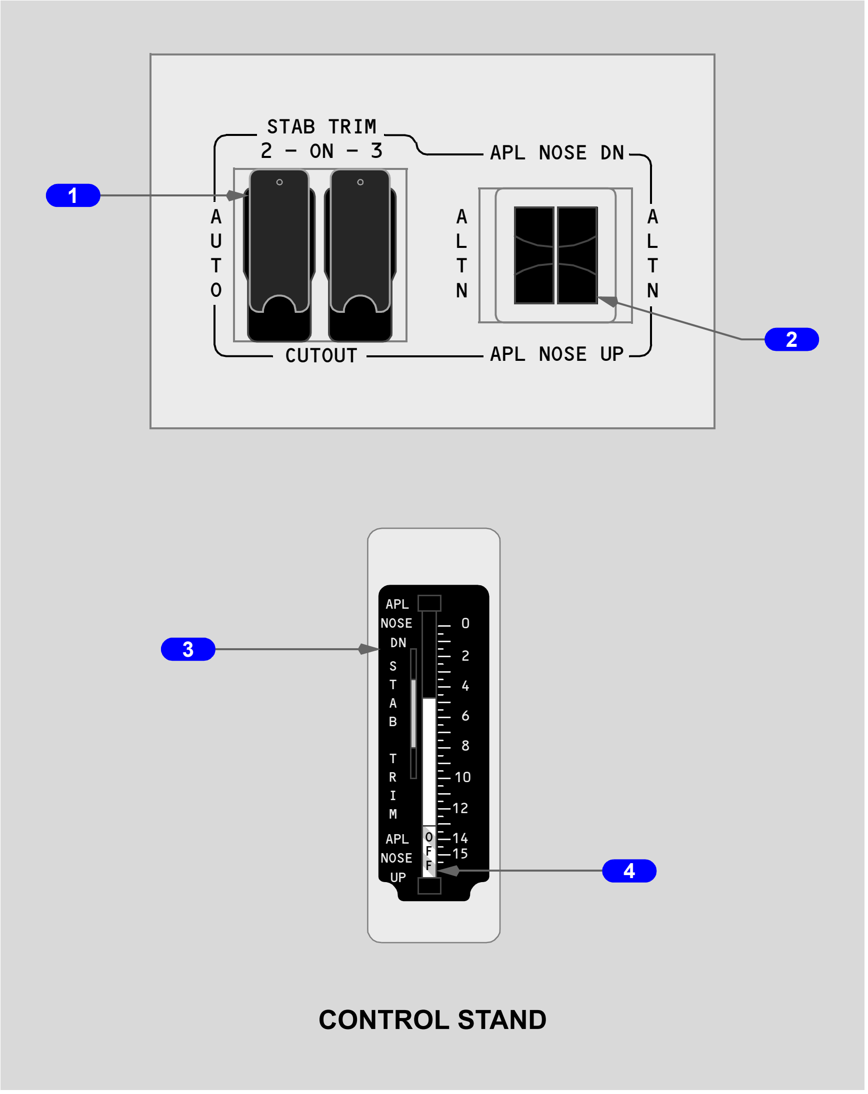
Rotate - deflects ailerons and spoilers in desired direction.

3 Control Column

Push/pull -

- deflects elevators in desired direction
- prevents stabilizer trim in opposite direction

Stabilizer Trim Controls



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

CUTOUT - 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.

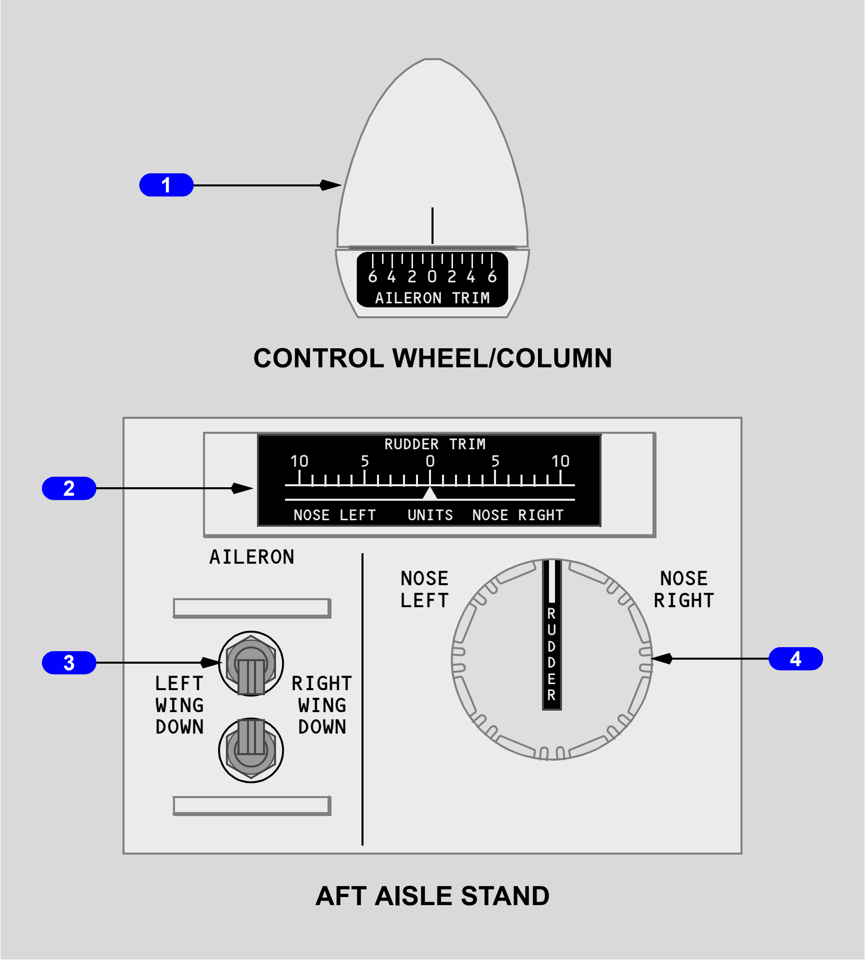
3 Stabilizer Trim Indicator

- 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



1 AILERON TRIM Indicator

Indicates units of aileron trim.

2 RUDDER TRIM Indicator

Indicates units of rudder trim.

3 AILERON Trim Switches

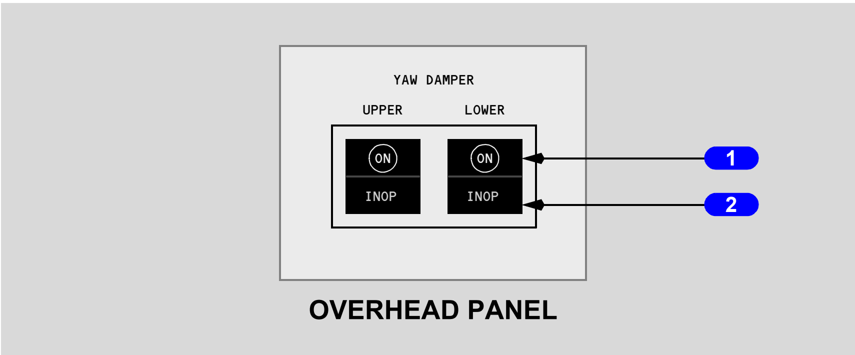
Push (both switches) - trims ailerons in desired direction.

4 **RUDDER Trim Selector**

Spring-loaded to neutral.

Rotate - trims rudder in desired direction.

Yaw Damper Controls



1 **Yaw Damper Switches**

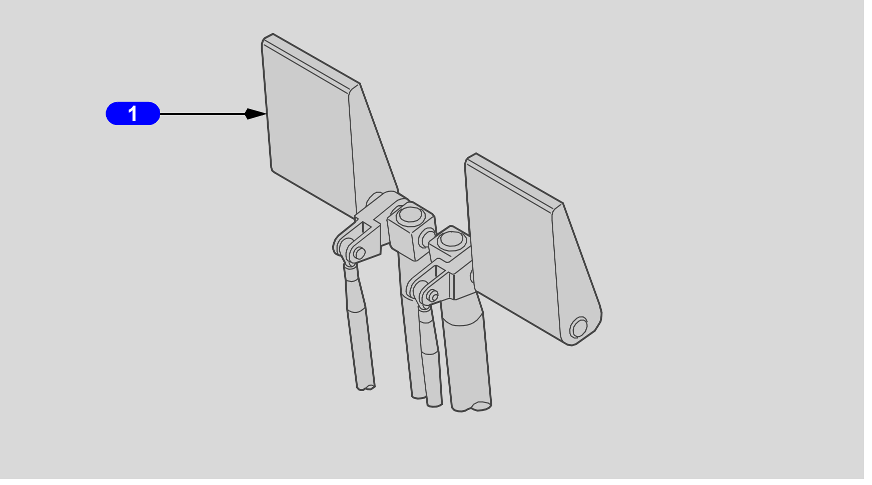
ON - yaw damper powered.

2 **Yaw Damper Inoperative Light**

Illuminated -

- yaw damper switch OFF, or
- yaw damper inoperative

Rudder/Brake Pedals



1 Rudder Pedals

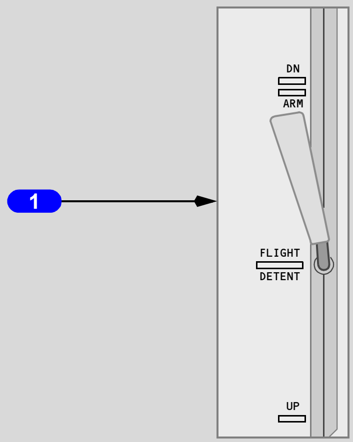
Push - deflects rudders in desired direction.

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

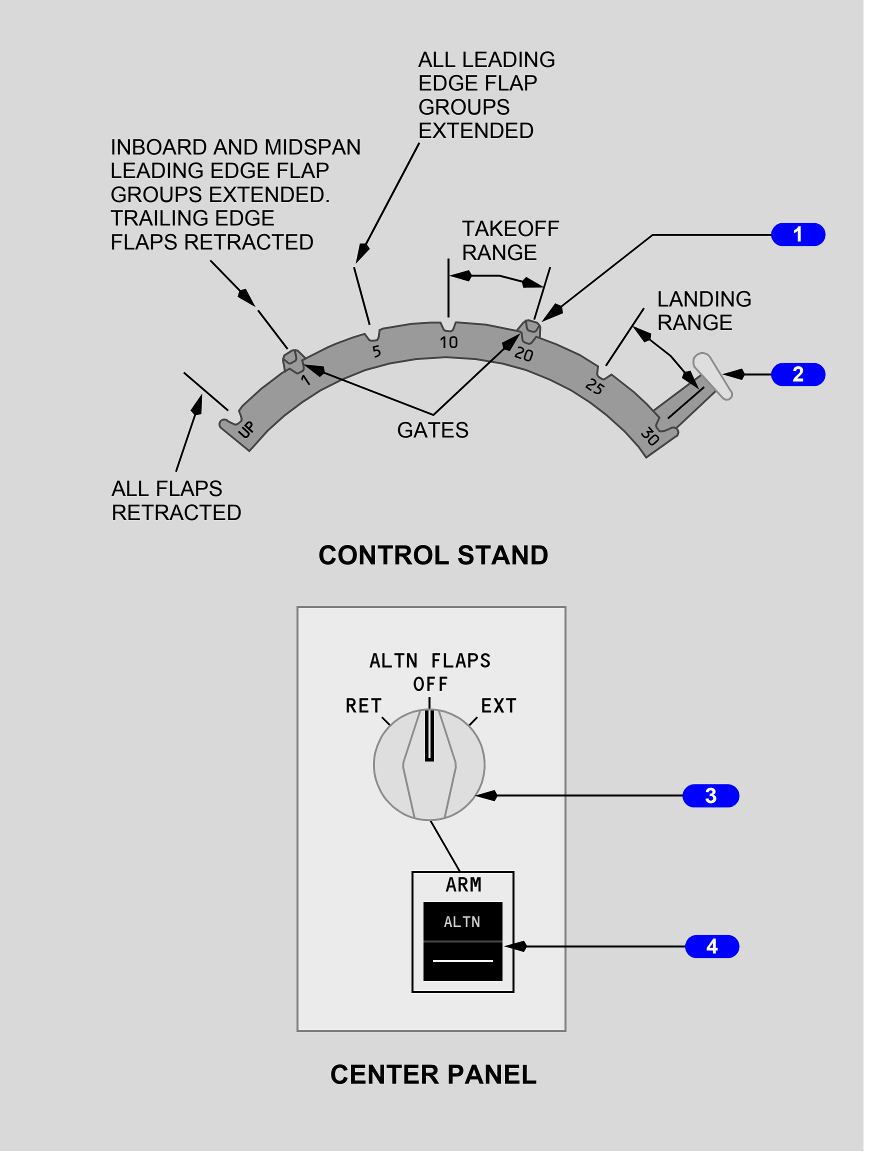
FLIGHT DETENT -

- 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 on-ground position (intermediate positions can be selected).

Flap System

Flap Controls



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 - positions 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) -

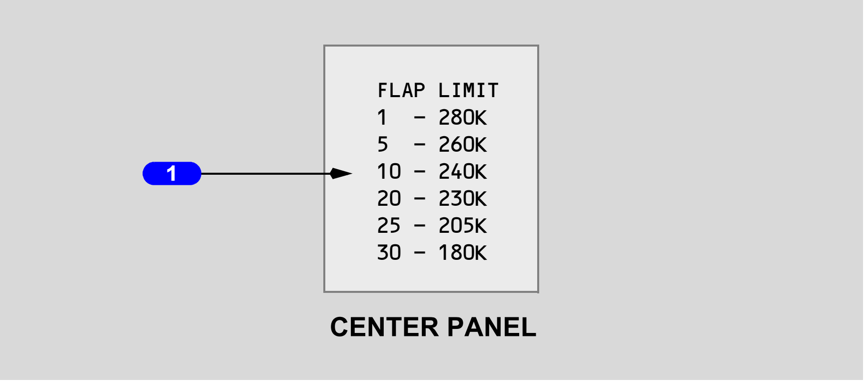
- leading and trailing edge flaps electrically extend
- maximum extension is flaps 25

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



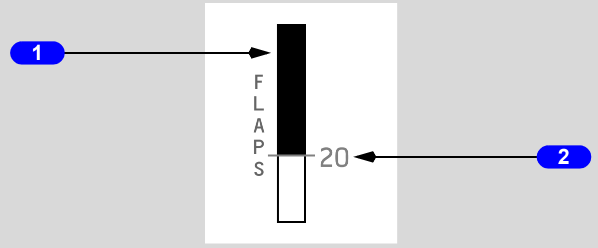
1 **Flap Limit Placard**

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 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 and 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)

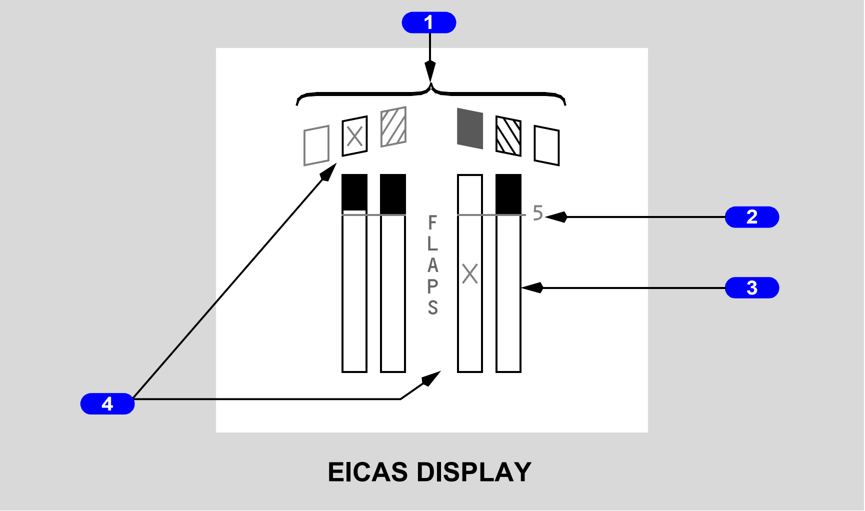
Magenta - flaps in transit to position selected by Flap lever.

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.



1 Leading Edge Flaps Indication

White Box Outline - leading edge flap group retracted.

White Crosshatch - leading edge flap group in transit.

Solid Green Box - leading edge flap group extended.

Amber Box Outline, Crosshatch, or Solid Box - drive unit is inoperative

2 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.

3 Trailing Edge Flaps Indication

White - position of inboard and outboard trailing edge flaps.

Amber - asymmetry or drive failure has occurred in related group.

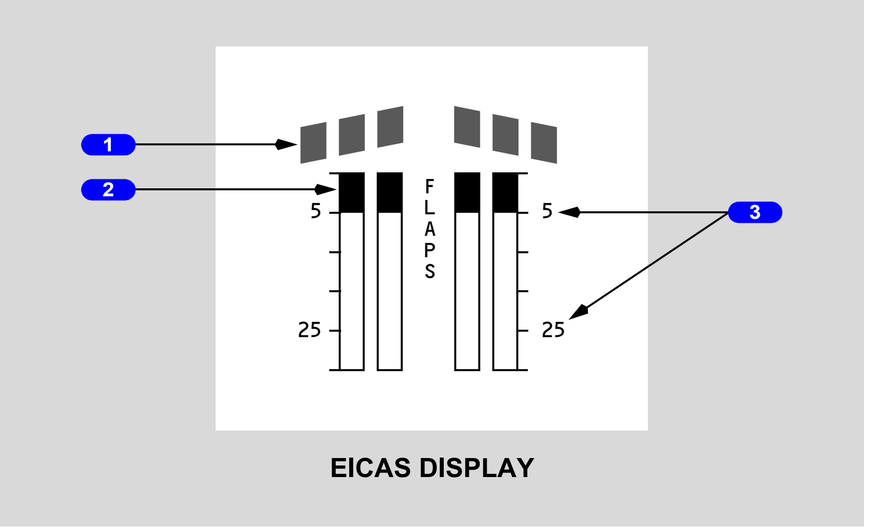
4 Inoperative Sensor (amber)

Position sensor for related 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.



1 Leading Edge Flaps 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

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The surface position indication is displayed by pushing the STAT display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

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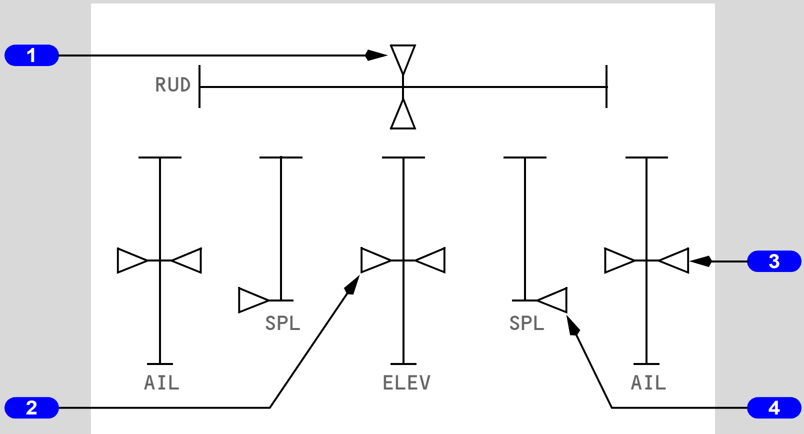
The surface position indication is displayed by pushing the ENG display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

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.

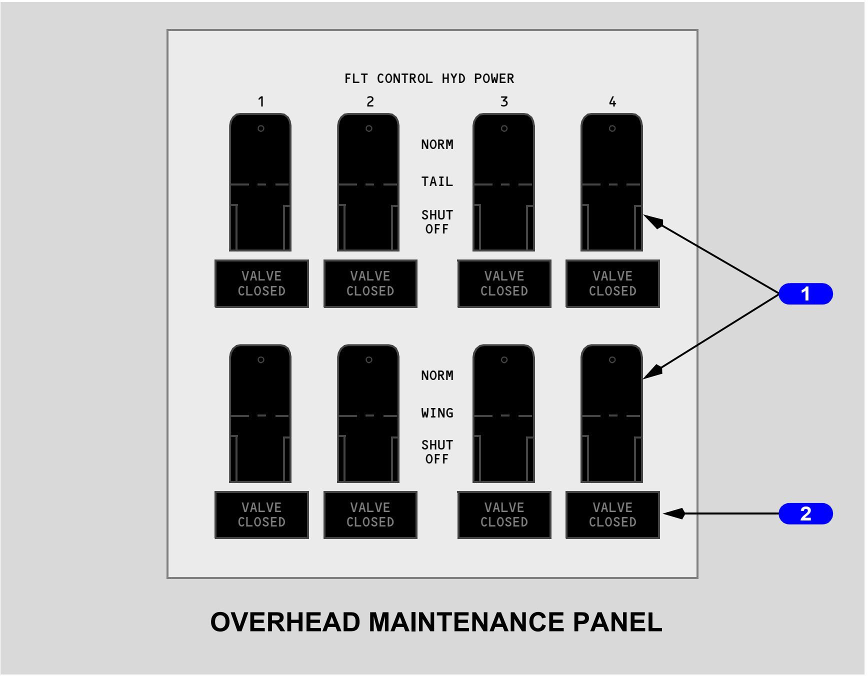
3 Aileron Position

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



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.

Flight Controls — Chapter 9
System Description — Section 20

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

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

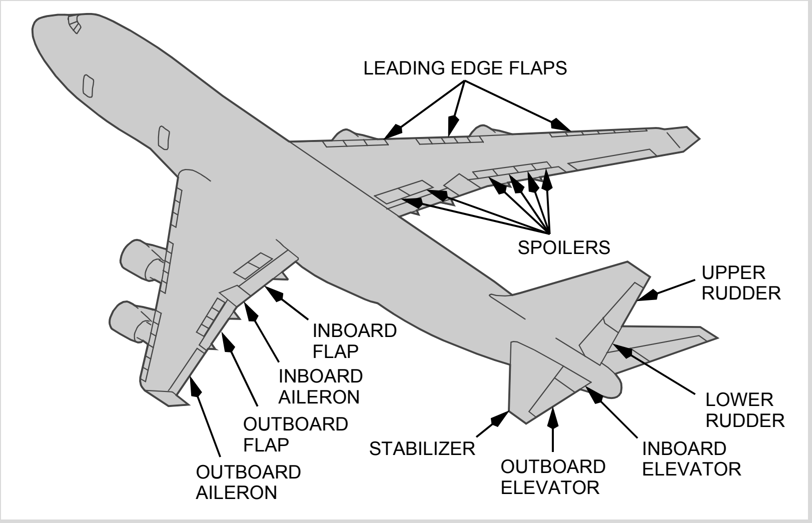
Roll control is provided by:

- 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.

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Left and right outboard elevator positions display on the EICAS status display. A full scale indication corresponds to maximum elevator deflection.

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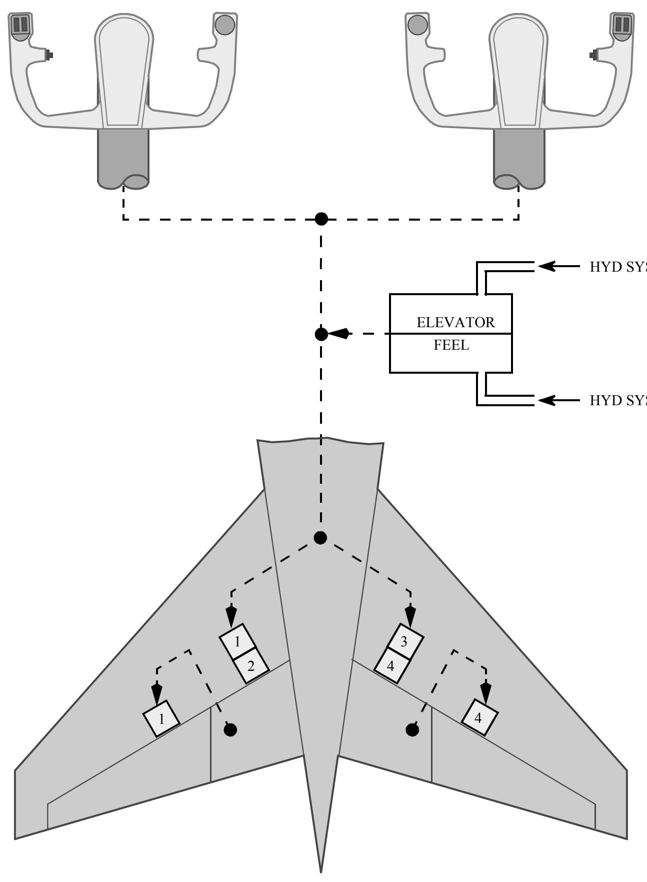
Left and right outboard elevator positions display on the EICAS secondary engine display. A full scale indication corresponds to maximum elevator deflection.

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



NOTE: NUMBERS IN BOXES REFER
TO HYDRAULIC SYTEMS.

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.

405

The mid-band segment may be either backlighted or a highly visible green paint stripe illuminated by ambient light and integral panel lighting.

109, 570

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 Cut out

Hydraulic systems 2 and 3 power stabilizer trim. Two guarded Stabilizer Trim Cut out switches control stabilizer trim. With the guards closed, the switches are held in AUTO position, allowing automatic cut out of the related hydraulic system if unscheduled stabilizer trim is detected. With a Stabilizer Trim Cut out switch in CUTOUT, hydraulic power to the related trim control module is shut off. Positioning a Stabilizer Trim Cut out switch from CUTOUT to AUTO, activates the related actuator after a short time delay. Positioning a switch to ON overrides the automatic cut out function and supplies hydraulic power to the related control module. If automatic cut out has occurred, hydraulic power remains shut off until the related cut out 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 and the stabilizer to move in the desired direction. 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.

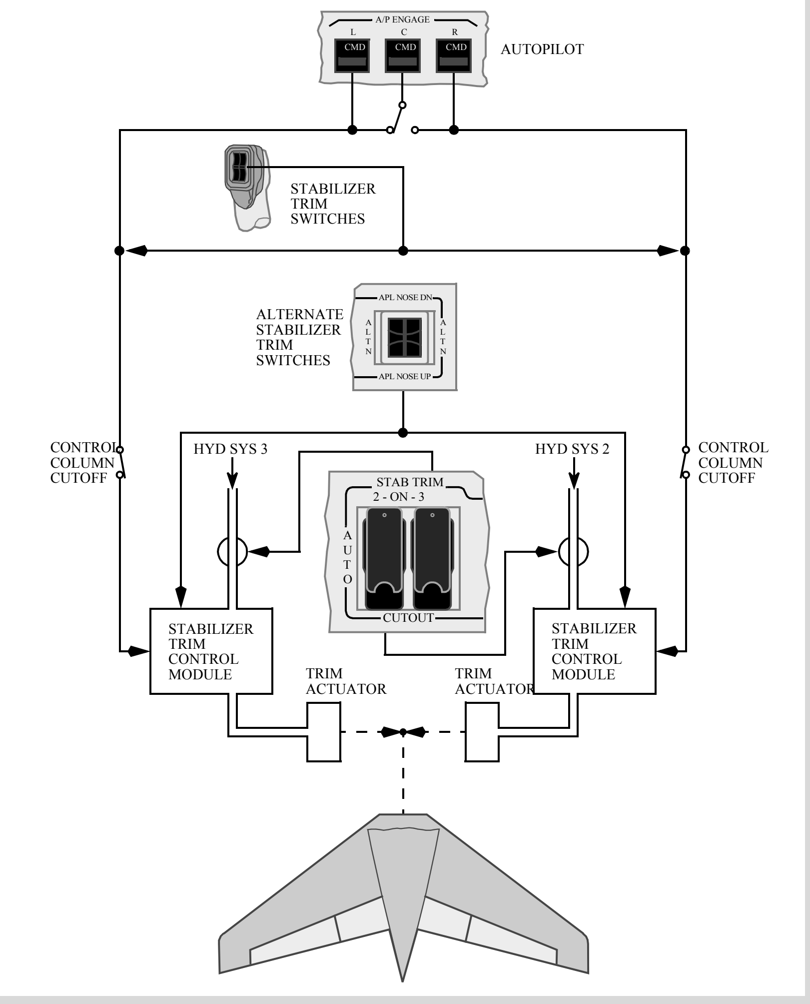
Mach Stability Trim

570

Mach stability trim uses stabilizer trim to improve handling characteristics of the airplane in the higher speed range.

Activating the Stabilizer Trim switches or engaging an autopilot inhibits mach 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 238 knots and permits full travel of the outboard ailerons at lower 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.

109

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.

405, 570

Aileron positions display on the EICAS secondary engine 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.

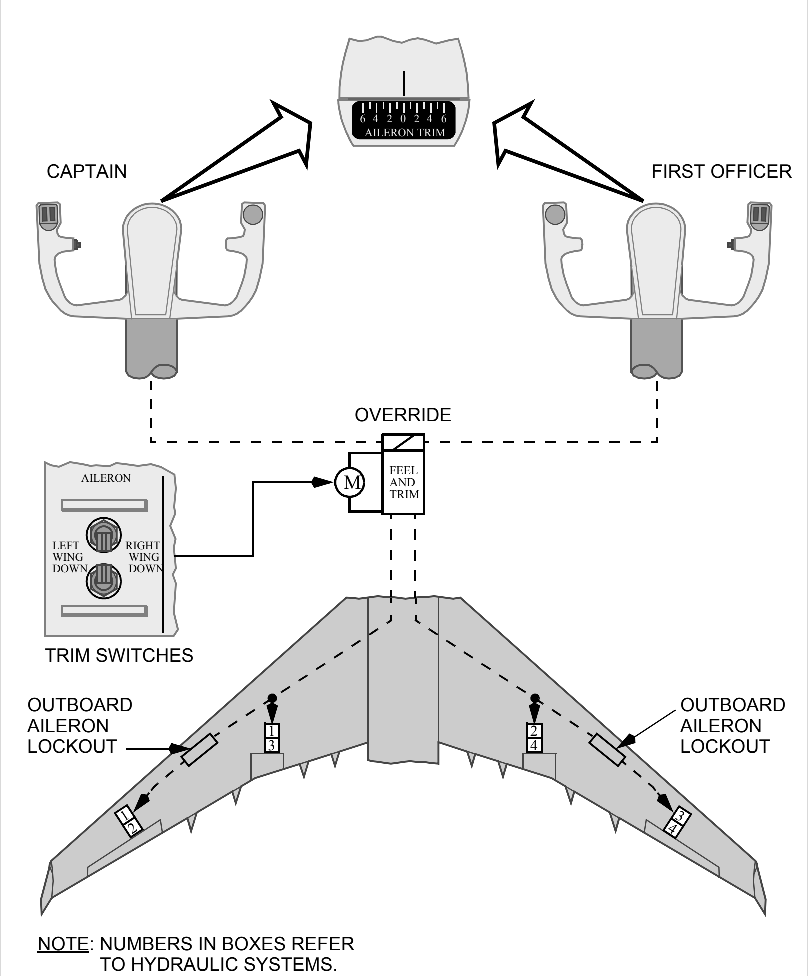
Each side of the mechanical system also incorporates shearouts which may allow the jammed control wheel to be freed when a significant manual force is applied to the jammed wheel.

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.

109

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.

405, 570

Rudder positions display on the EICAS secondary engine 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. A black tape displays with pointer out of view if the trim indicator is inoperative.

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.

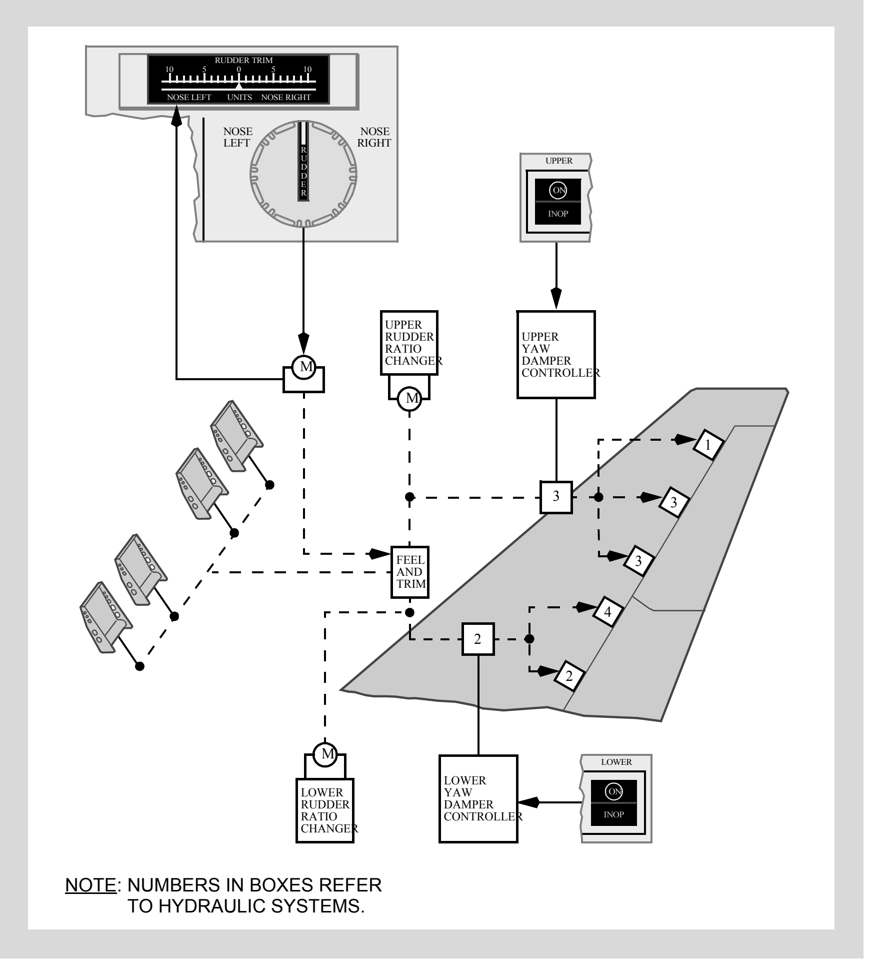
If a ratio changer system fails, the response of the related rudder surface to pedal inputs remains the same as when the failure occurred, regardless of changes in airspeed. Pilot inputs to the rudder may no longer be limited by the ratio changer and abrupt rudder pedal inputs at high airspeeds could 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.

109

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.

405, 570

The position of one spoiler on each wing is displayed on the EICAS secondary engine 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.

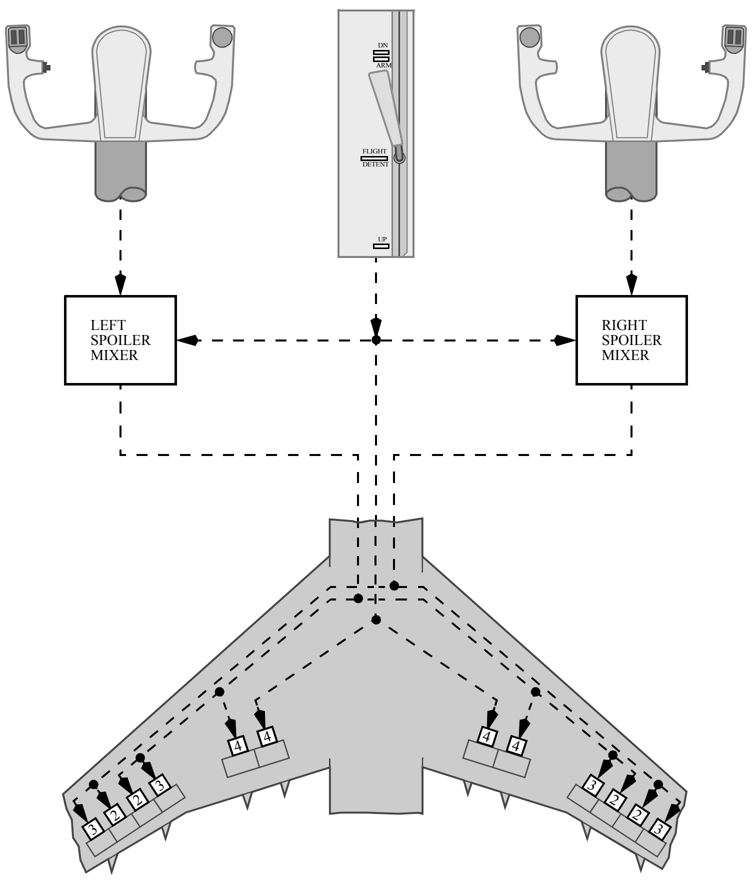
When the Speedbrake lever is in ARMED position, thrust levers 1 and 3 are near the closed position, and the main landing gear touch down, the Speedbrake lever is driven to UP position, extending all spoiler panels.

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



NOTE: NUMBERS IN BOXES REFER TO HYDRAULIC SYSTEMS.

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 after a time delay of between 20 to 45 seconds. 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. Similarly, 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

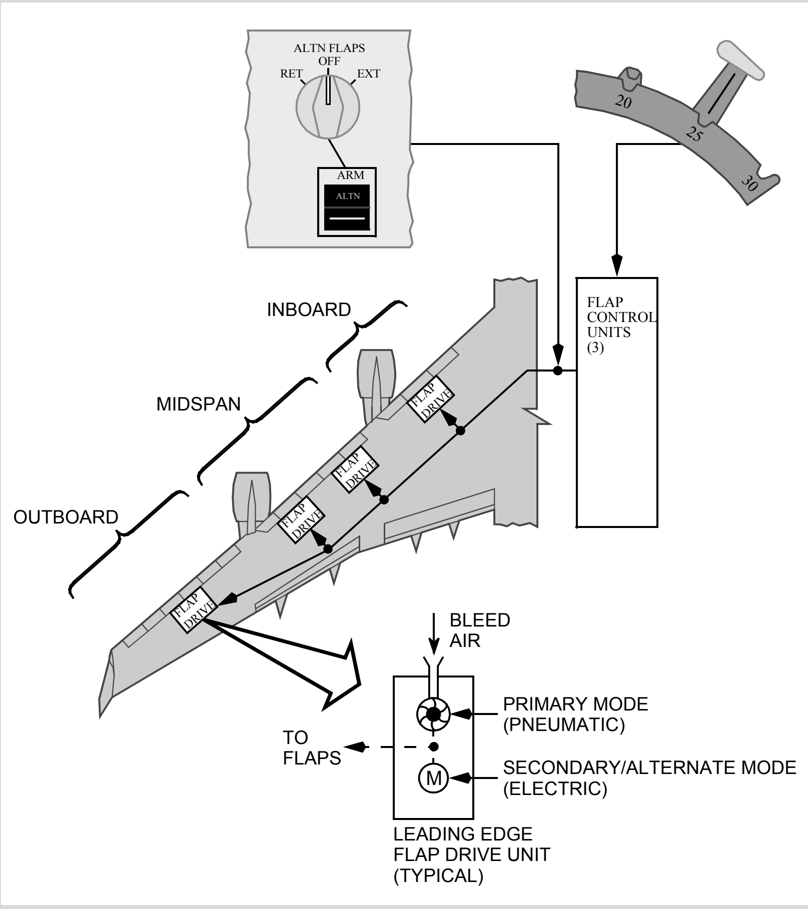
Flap position indications are displayed on the primary EICAS display. A single vertical indicator displays combined leading and trailing edge flap position. The position commanded by the flap lever is also displayed. Ten seconds after all flaps are up, the entire indication is no longer displayed.

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.

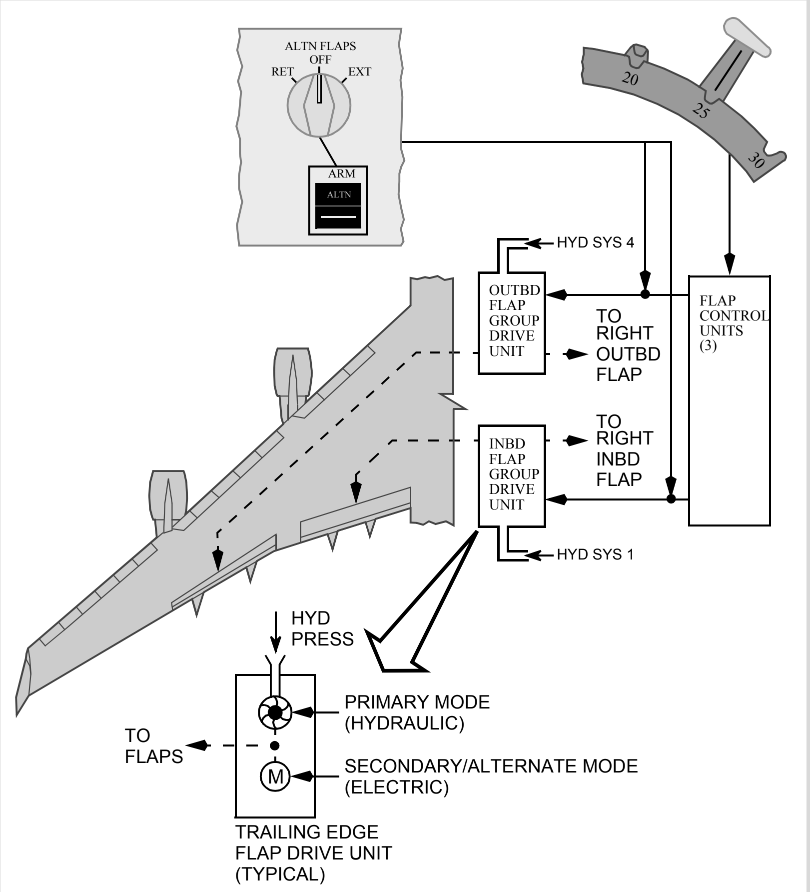
If the standby bus is the only powered AC bus, the left wing trailing edge flap position sensors are not powered. An expanded indication is displayed with an amber X on the left outboard and inboard trailing edge flap indications.

During engine reverse thrust operation, automatic retraction of inboard and midspan leading edge flaps changes the flap position 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.

EICAS Alert Messages

Message	Level	Aural	Message Logic
AILERON LOCKOUT	Advisory		Aileron lockout actuator position disagrees with commanded position. One or both outboard ailerons may be unlocked at high airspeeds or locked out at low airspeeds.
>FLAP RELIEF	Advisory		Flap load relief system operating.
FLAPS CONTROL	Caution	Beeper	Flap control units inoperative, or Alternate Flaps Arm switch in ALTN.
FLAPS DRIVE	Caution	Beeper	One or more flap groups have failed to drive in secondary mode, or an asymmetry condition detected.
FLAPS PRIMARY	Caution	Beeper	One or more flap groups operating in secondary control mode.
>FLT CONT VLVS	Advisory		One or more flight control shutoff valves closed.
RUD RATIO DUAL	Advisory		Rudder ratio changers have failed.
RUD RATIO SNGL	Advisory		Rudder ratio changer has failed.
SPEEDBRAKE AUTO	Advisory		Fault detected in automatic ground spoiler system. Fault could result in loss of automatic ground spoiler function, or in flight with Speedbrake lever in ARM position could result in inadvertent spoiler extension.

Message	Level	Aural	Message Logic
>SPEEDBRAKES EXT	Caution	Beeper	Speedbrakes extended at an inappropriate flight condition. Occurs when Speedbrake lever 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 pressure sensor disagrees with computed stabilizer greenband.
>STAB TRIM 2, 3	Advisory		Stabilizer trim automatic cutout has occurred, or a Stabilizer Trim Cut Out switch in CUTOUT, or trim commanded and respective actuator failed to function.
STAB TRIM UNSCHD	Caution	Beeper	Uncommanded stabilizer motion detected and automatic cutout does not occur, or Alternate Stabilizer Trim switches used with autopilot engaged.
>YAW DAMPER LWR, UPR	Advisory		Yaw damper failure or power failure. May be due to module fault, actuator fault, IRUs off or in align, Yaw Damper switch off, or module power off.

EICAS Memo Messages

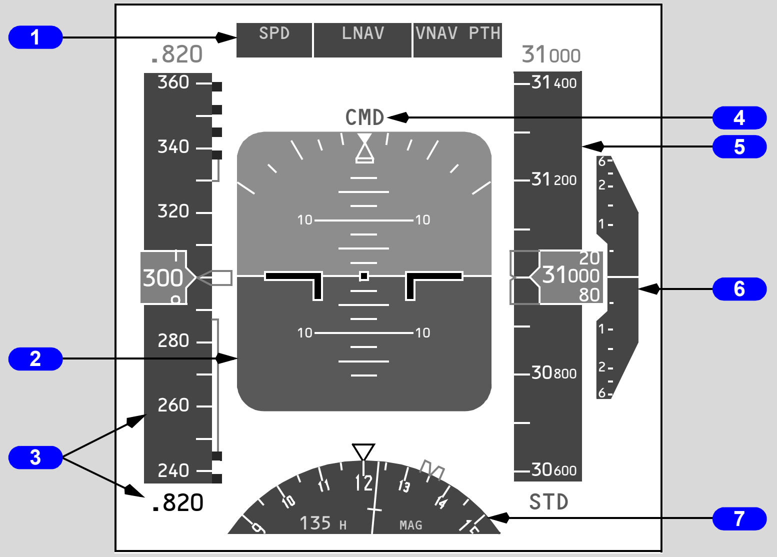
Message	Level	Aural	Message Logic
SPEEDBRAKE ARMED	Memo		Speedbrake lever in Arm position.

Flight Instruments, Displays Chapter 10
Table of Contents Section 0

Primary Flight Display (PFD)

Liquid Crystal Display

109, 405



LEFT AND RIGHT FORWARD PANELS

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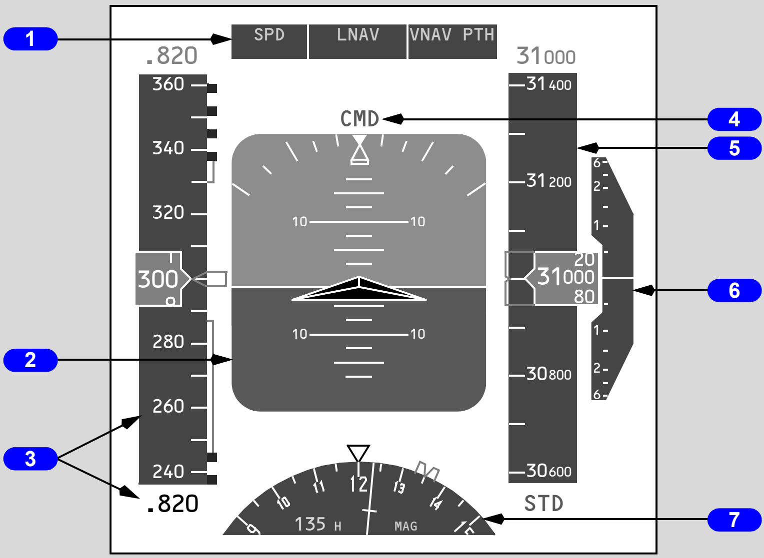
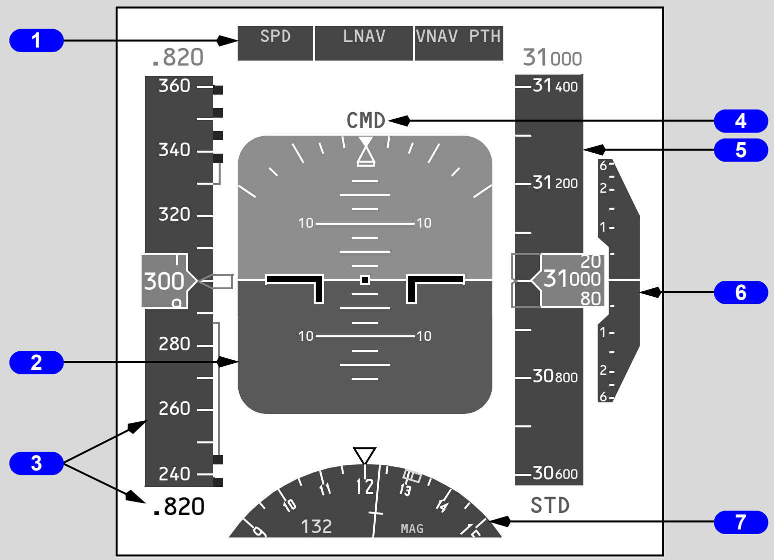


LEFT AND RIGHT FORWARD PANELS

Cathode Ray Tube

109, 405



LEFT AND RIGHT FORWARD PANELS

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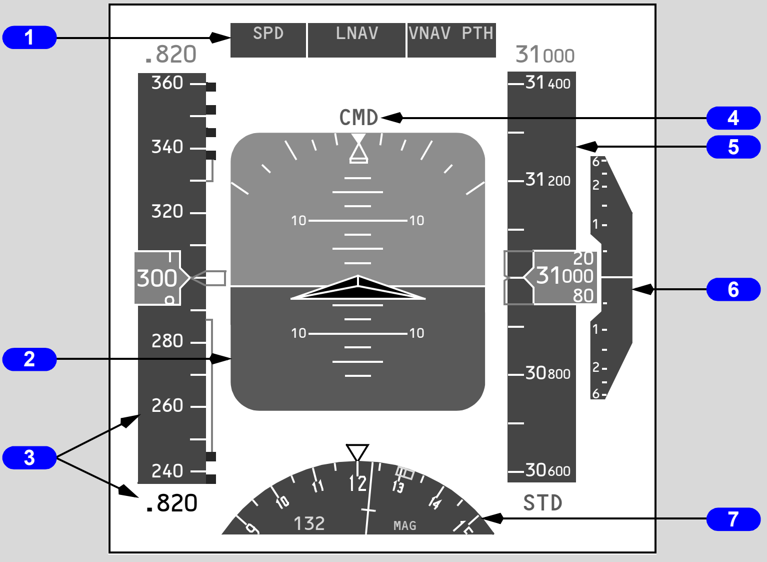


LEFT AND RIGHT FORWARD PANELS

1 **Flight Mode Annunciations**

Refer to Chapter 4, Automatic Flight.

2 **Attitude, Steering, and Miscellaneous Displays**

Displays IRU attitude information.

3 **Airspeed/Mach Displays**

Displays ADC airspeed information and other airspeed related 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**

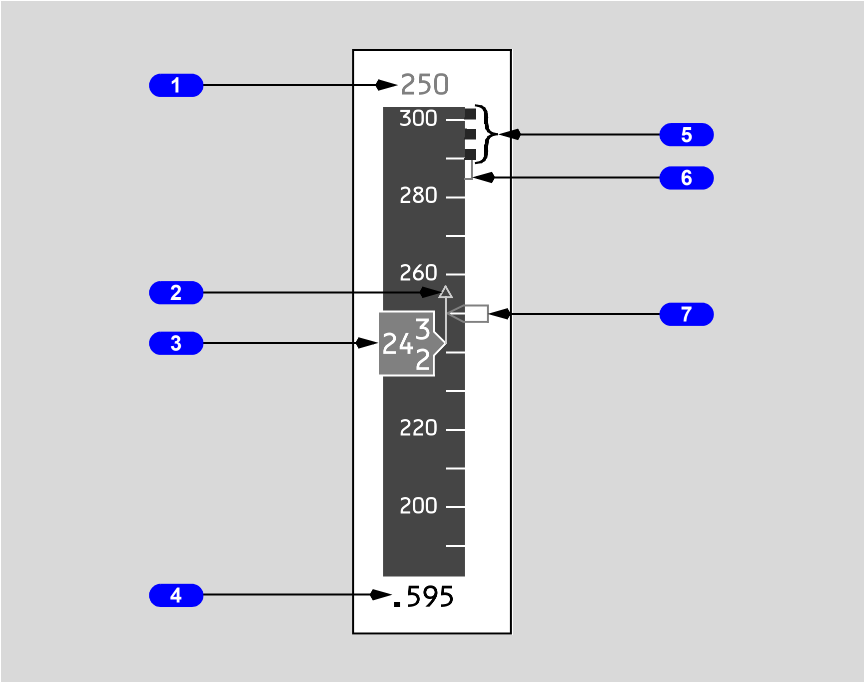
Displays ADC vertical speed as dampened by the IRS.

7 **Heading and Track Displays**

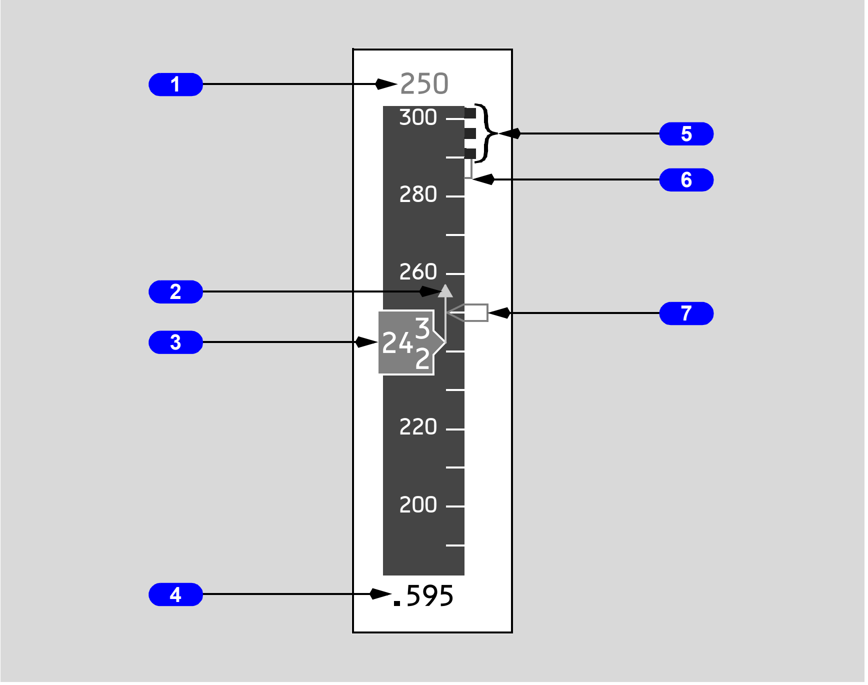
Displays current IRS heading, track, and other heading information.

Airspeed Displays

Liquid Crystal Display



Cathode Ray Tube



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 when Mach .40 or greater.

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

Bottom of amber bar indicates the maximum maneuvering speed. This airspeed provides 1.3g maneuver capability to high speed buffet (or an alternative approved maneuver capability as preset by maintenance). May be displayed when operating at high altitude at relatively high gross weights.

Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

CAUTION: Reduced maneuver capability exists when operating within the amber regions above the maximum maneuvering speed.

7 Command Speed

Points to airspeed/Mach set in MCP IAS/MACH window.

Indicates FMC-computed airspeed when MCP IAS/MACH window blank.

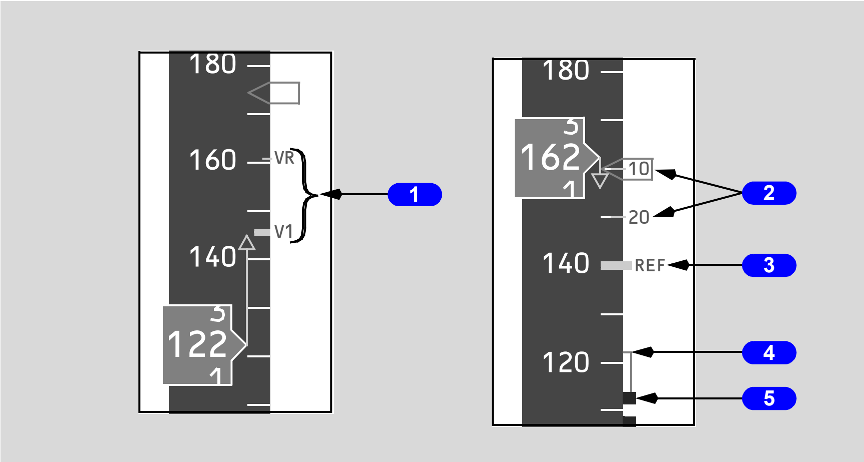
Pointer is five knots in height.

When the selected speed is off scale, the pointer is parked at the top or bottom of the tape, with half the pointer visible.

Reference Speeds

Liquid Crystal Display

109, 405



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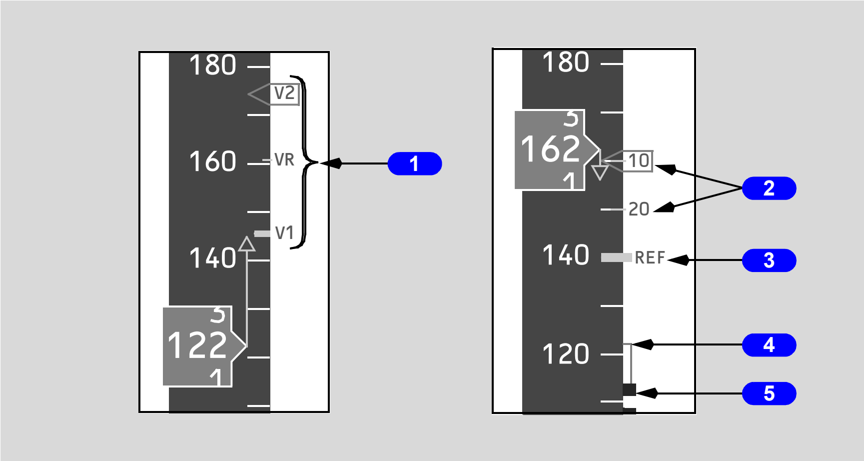

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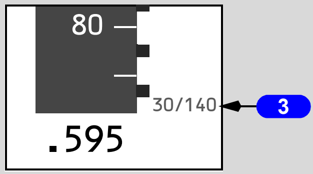
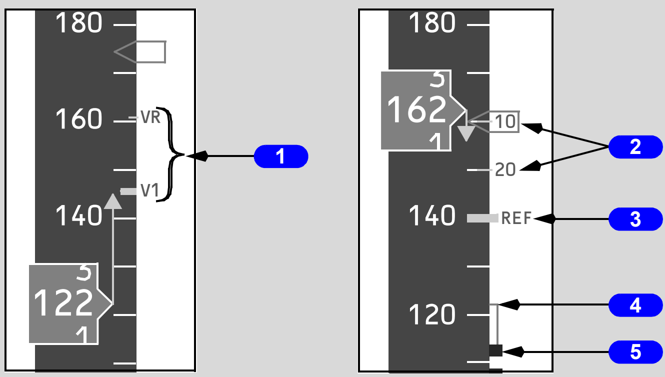


Cathode Ray Tube

109, 405



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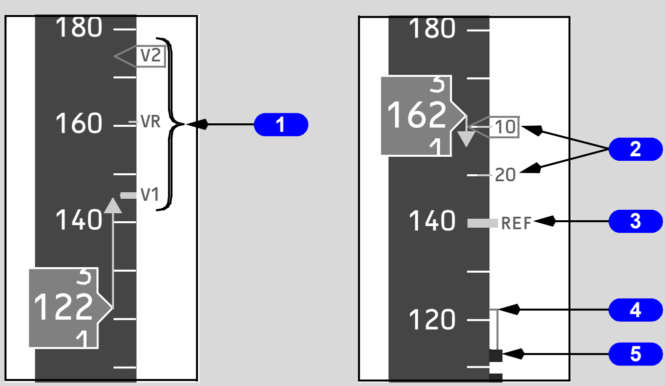

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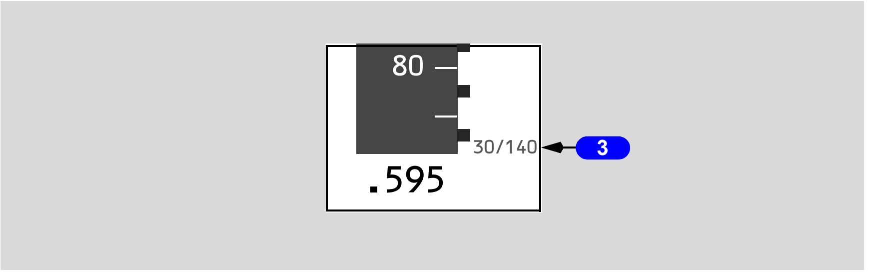


1 Takeoff Reference Speeds
109, 405

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

1 Takeoff Reference Speeds
570

Displays takeoff reference speeds V1, VR (displays R when VR within 4 knots of V1), and V2 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
- V2 is removed on climb-out when flap retraction begins

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

109, 405

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.

3 Selected Landing Flap/Landing Reference Speed

570

Displays landing flaps and 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

Top of amber bar indicates minimum maneuvering speed. This airspeed provides:

- 1.3g maneuver capability to stick shaker with flaps down
- 1.3g maneuver capability to stick shaker or VREF+80, whichever is less, with flaps up below 20,200 FT
- 1.3g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance) above 20,200 FT

Displayed with first flap retraction after takeoff.

Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

CAUTION: Reduced maneuver capability exists when operating within the amber regions below the minimum maneuvering speed. During non-normal conditions the target speed may be below the minimum maneuvering speed.

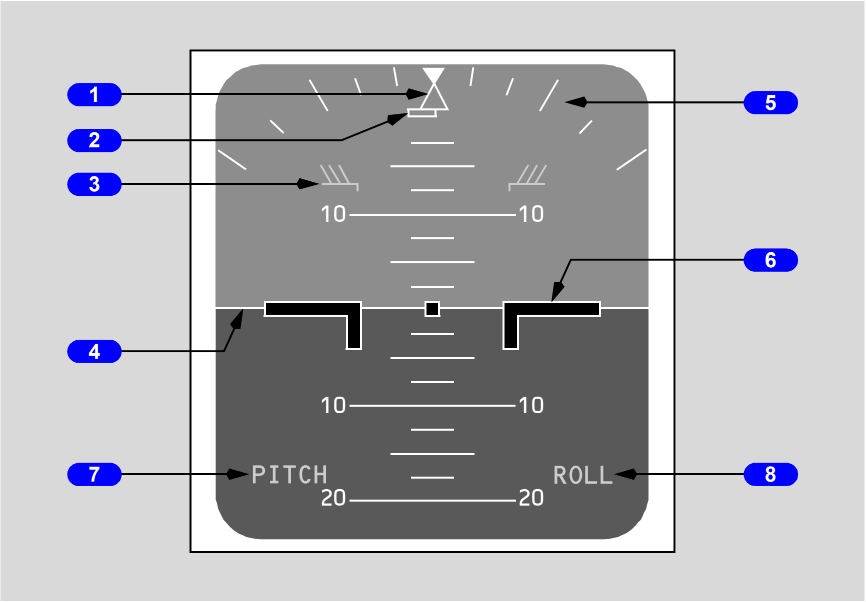
5 Minimum Speed

Indicates airspeed where stick shaker or low speed buffet occurs.

Attitude Indications

Liquid Crystal Display

109, 405



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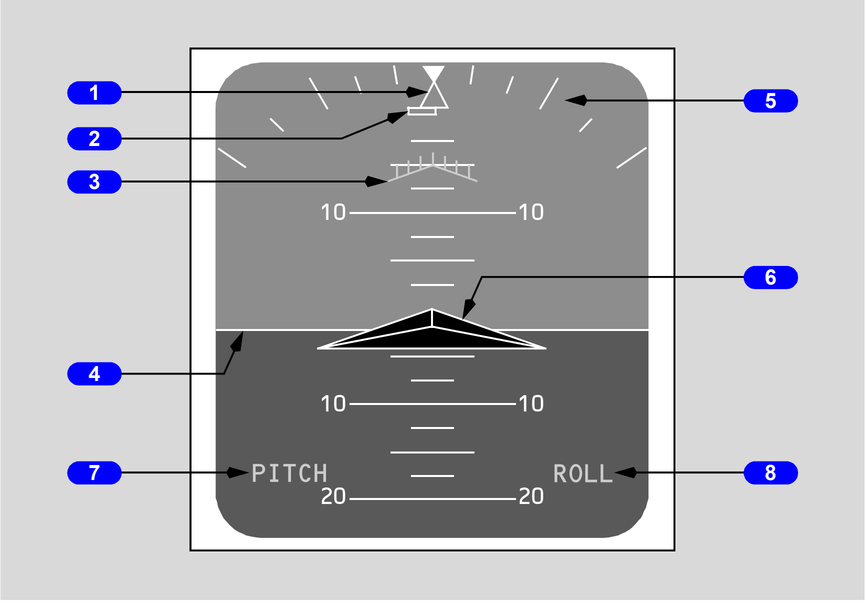


1 Bank Pointer

Indicates IRS bank in reference to bank scale.

Fills solid amber when bank angle is 35 degrees or greater.

2 Slip/Skid Indication

Displaces beneath bank pointer to indicate slip or skid.

When bank angle is less than 35 degrees, indicator fills solid white when fully displaced.

When bank angle is 35 degrees or greater, indicator outline changes to amber.

When bank angle is 35 degrees or greater, indicator fills solid amber when fully displaced.

3 Pitch Limit Indication

Indicates pitch limit (stick shaker activation point for existing flight conditions).

405, 570
Displayed when flaps are not up, or at slow speeds with flaps up.

109
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

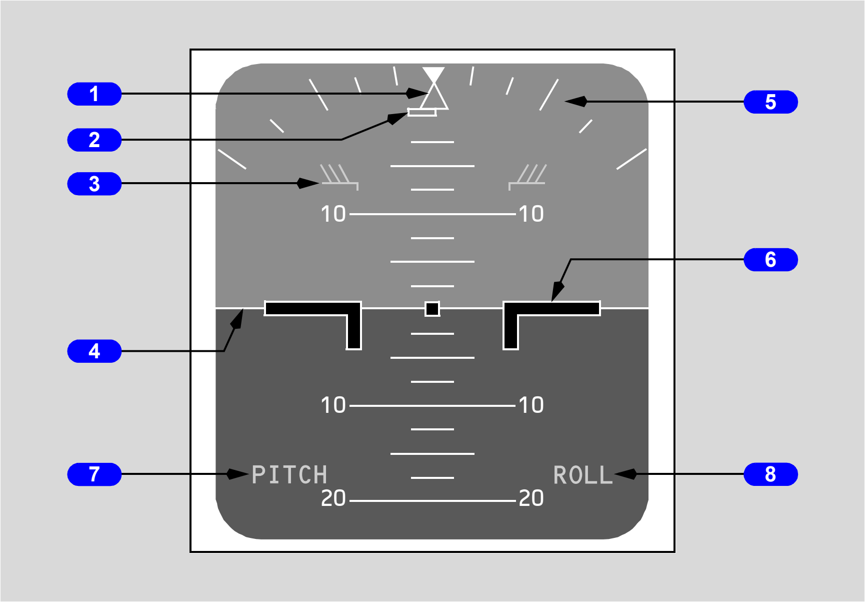
Displays if Captain’s and First Officer’s PFD pitch attitude disagree.

8 ROLL Disagree Flag

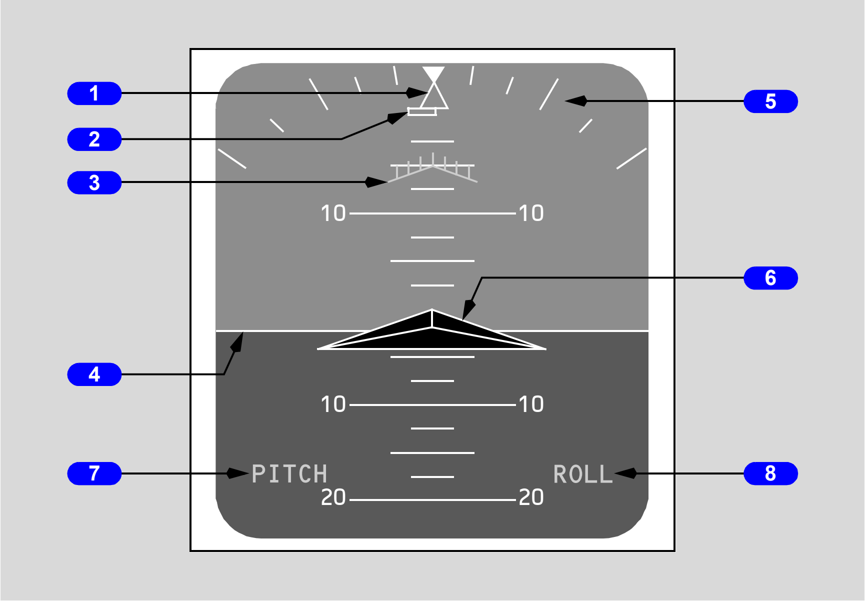
Displays if Captain’s and First Officer’s roll attitude disagree.

Cathode Ray Tube

109, 405



570



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).

405, 570

Displayed when flaps are not up, or at slow speeds with flaps up.

109

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

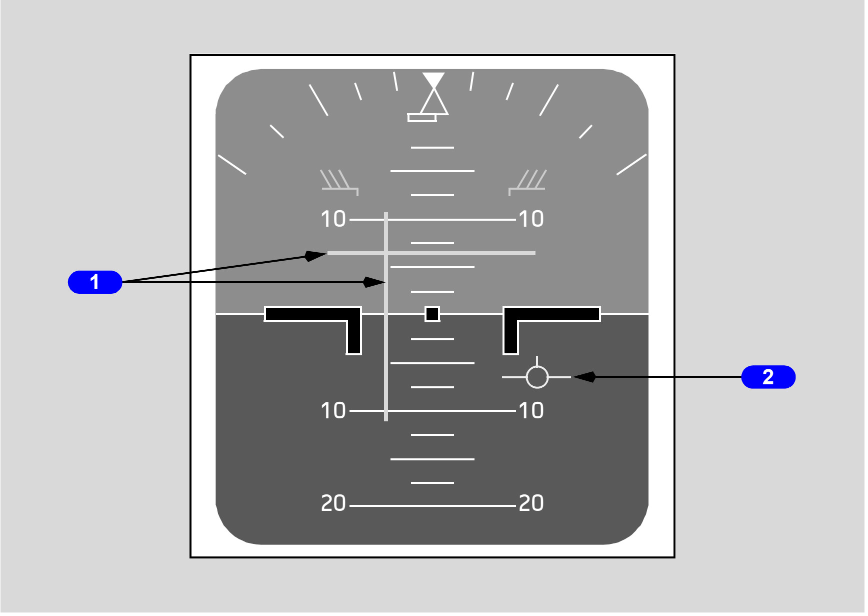
Displays if Captain’s and First Officer’s roll attitude disagree.

Steering Indications

Note: Refer to Chapter 15, Warning Systems, for TCAS Steering Indications and Time Critical Warnings.

Liquid Crystal Display

109, 405



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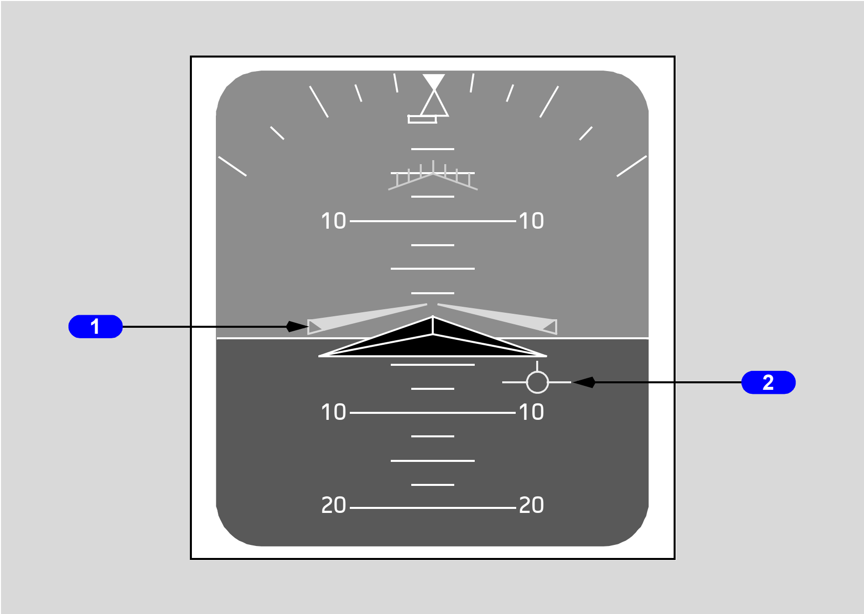
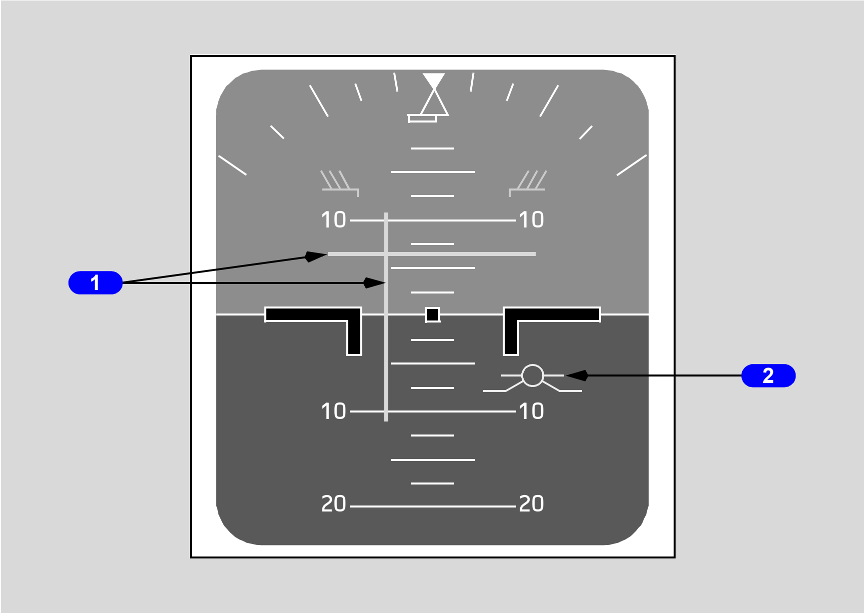
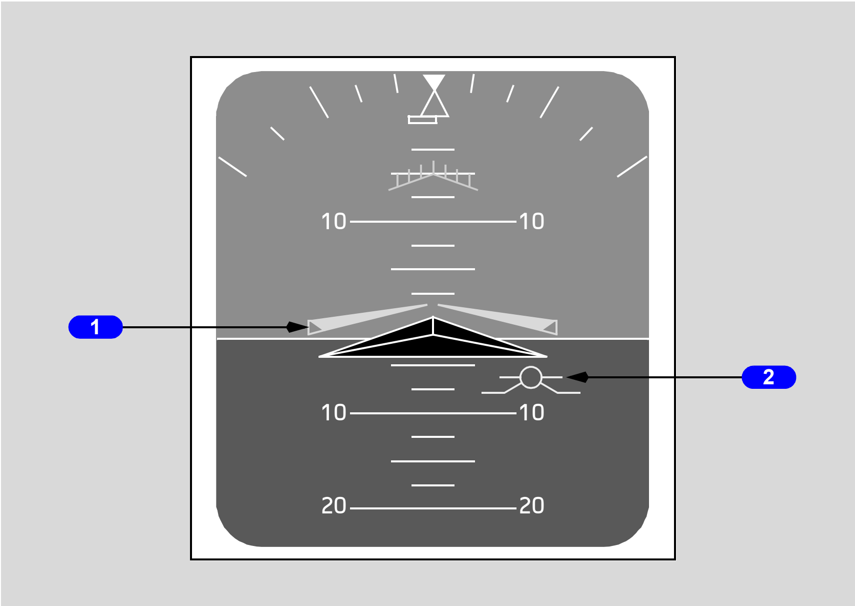


Cathode Ray Tube

109, 405



570



1 Flight Director Command Bars

109, 405

Indicates flight director pitch and roll steering commands.

Refer to Chapter 4, Automatic Flight.

1 Flight Director Command Bars

570

Indicates flight director pitch and roll steering commands.

Refer to Chapter 4, Automatic Flight.

2 Flight Path Vector

Displays flight path angle and drift angle when selected on EFIS control panel.

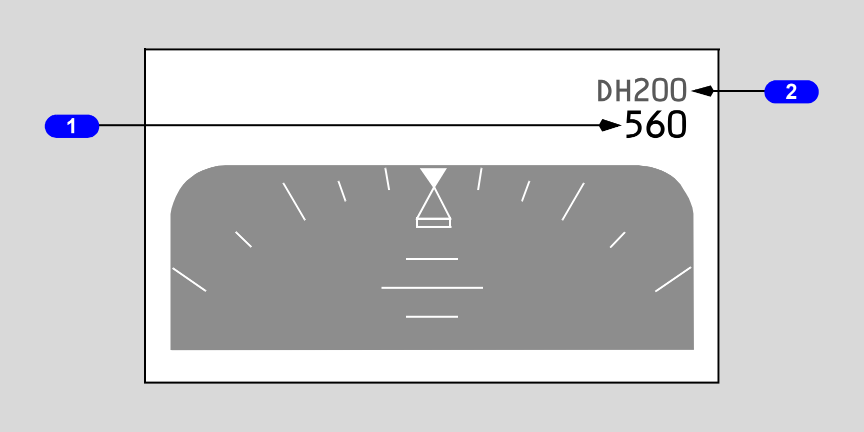
Flight path angle displays relative to the horizon line.

Drift angle is represented by the perpendicular distance from the centerline of the pitch scale to the FPV symbol.

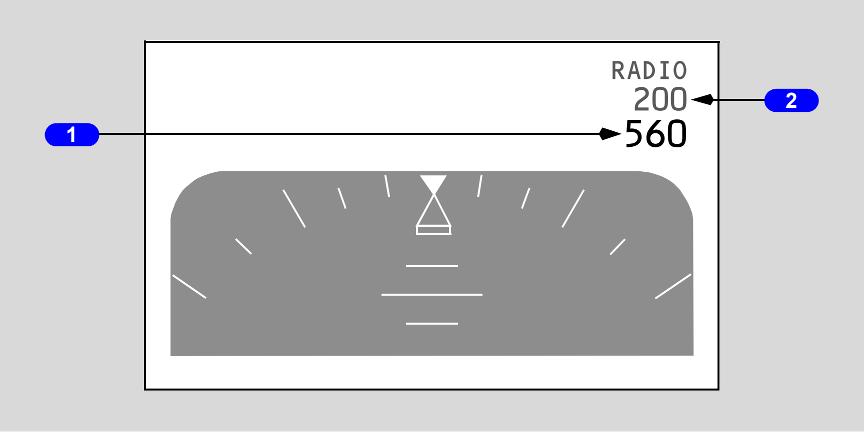
“Arms” are parallel to the horizon line and “feet” are parallel to the airplane symbol (CRT).

Radio Altitude Indications

109



405, 570



1 Radio Altitude

Displays airplane radio altitude below 2,500 feet AGL.

2 Decision Height

109

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

2 RADIO Minimums

405, 570

Displays radio altitude set on EFIS control panel.

RADIO and the altitude setting change color to amber and flash when radio altitude is at or below the setting.

RADIO not displayed when set below 0 feet.

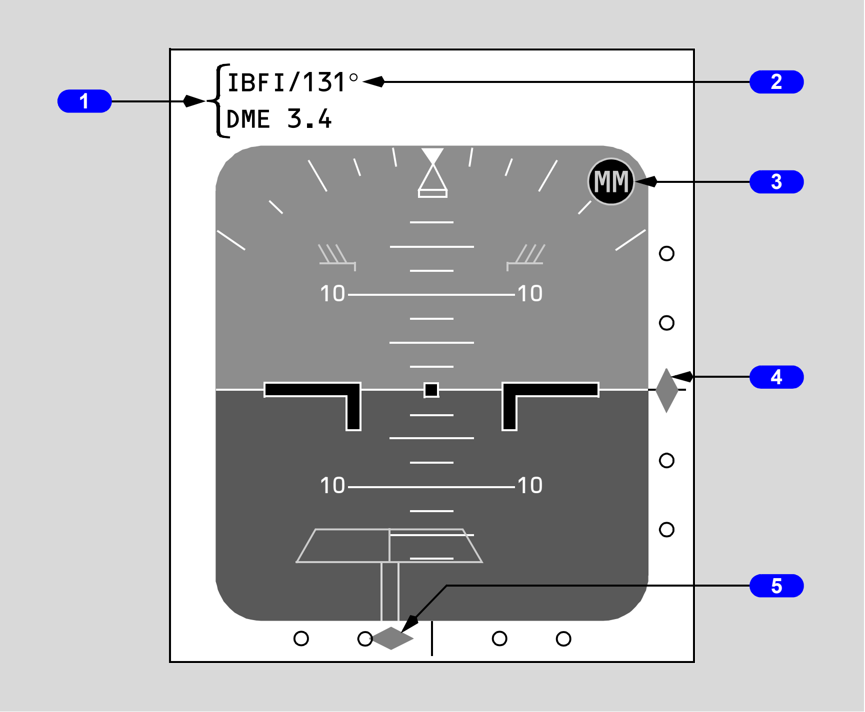
Flashing amber RADIO and the altitude setting reset:

- upon landing
- on go-around at 75 feet above the setting
- when MINS RST switch is pushed

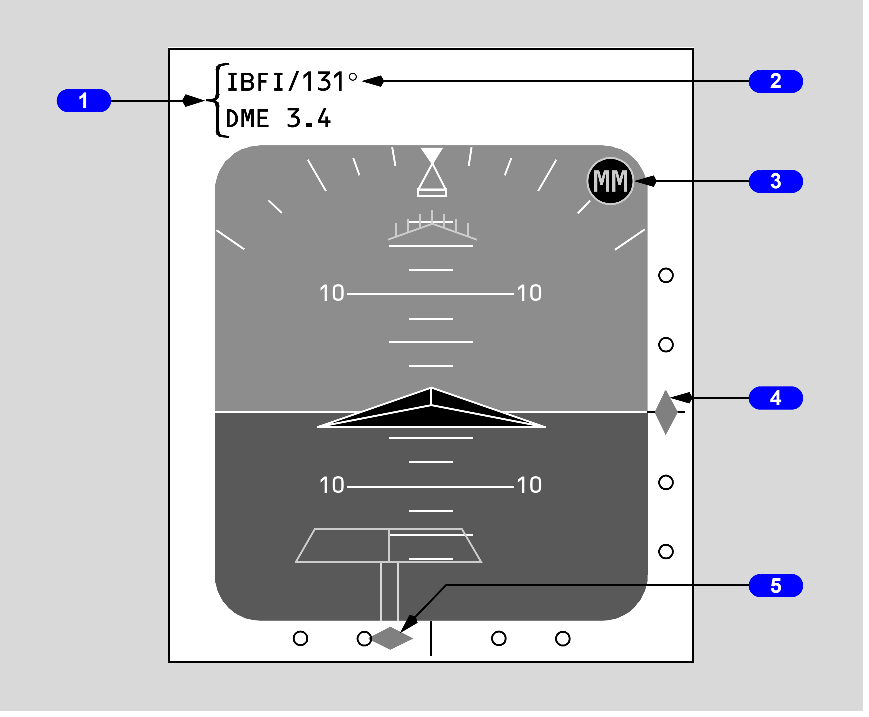
Instrument Landing System Indications

Liquid Crystal Display

109, 405

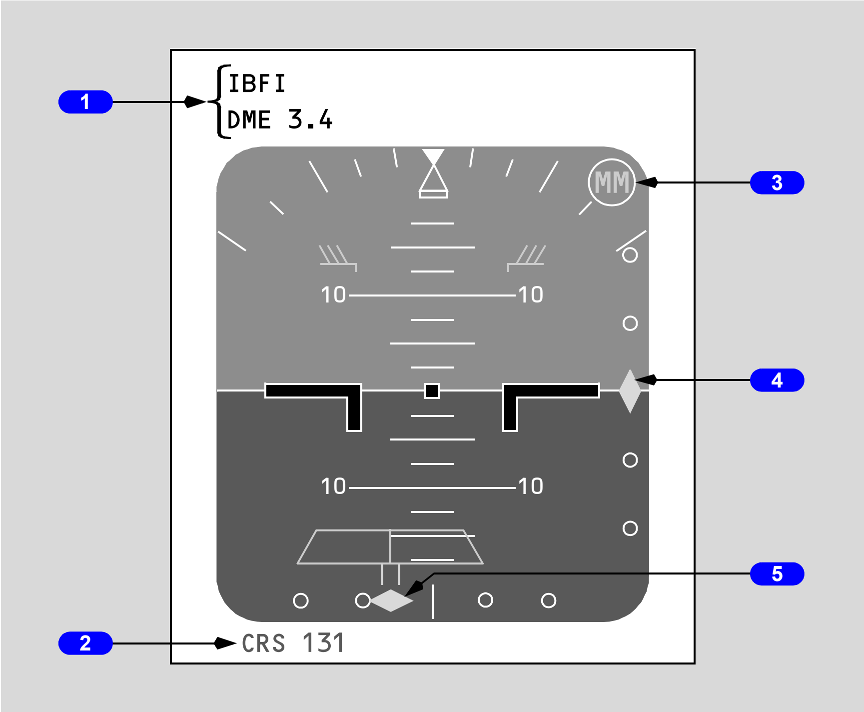


570

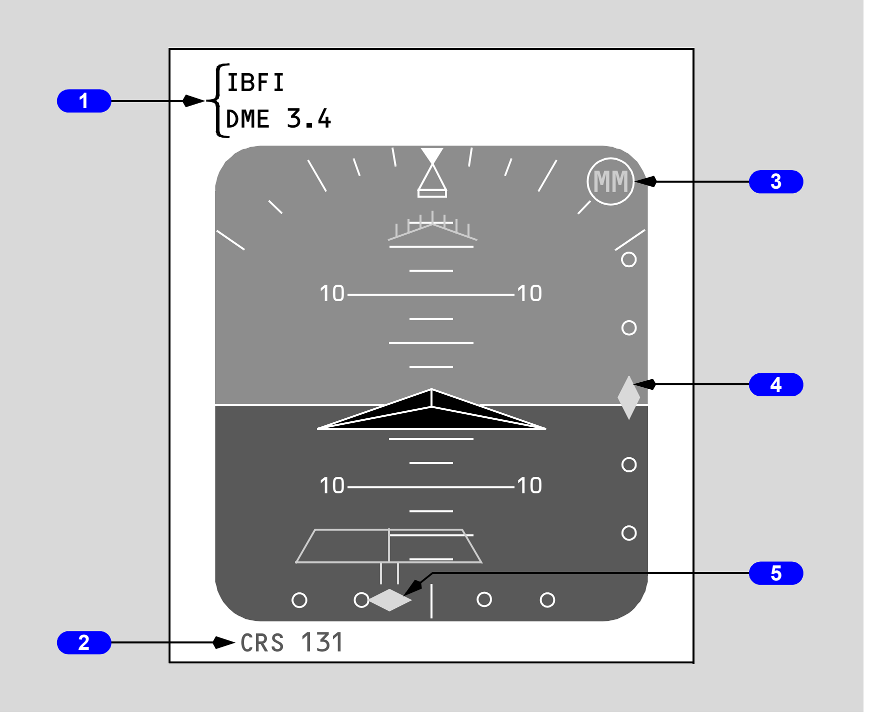


Cathode Ray Tube

109, 405



570



1 Approach Reference

Displays the selected ILS identifier or frequency and ILS DME distance.

If the tuned ILS frequencies disagree, an amber horizontal line is drawn through the frequency.

Refer to Chapter 11, Flight Management, Navigation.

2 Approach Course

Displays the selected ILS approach course.

If the approach courses in the ILS receivers disagree, an amber horizontal line is drawn through the 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 (white)
- MM - a middle marker beacon (amber)
- OM - an outer marker beacon (blue)

Annunciation flashes in cadence with the beacon identifier.

Annunciation not available if left VOR has failed.

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

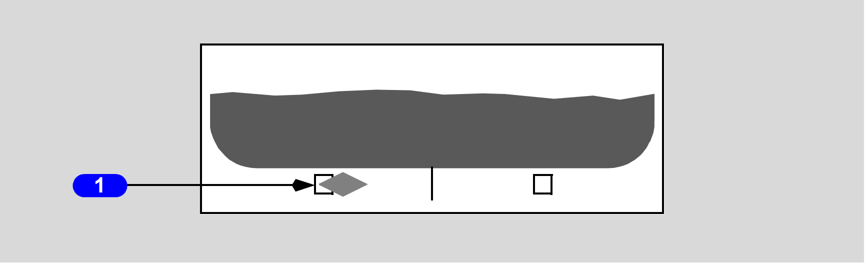
Scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, scale turns amber and the pointer flashes to indicate excessive localizer deviation.

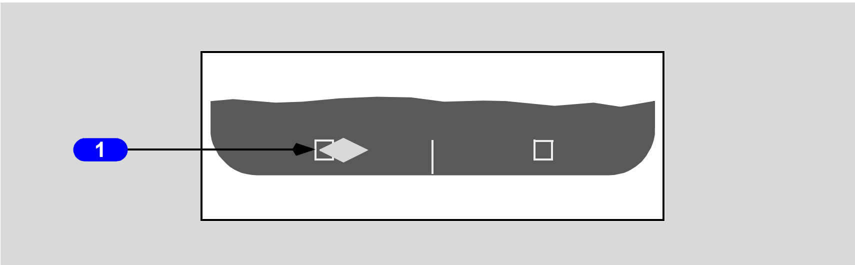
At low altitudes, with LNAV engaged and LOC armed, localizer scale turns amber and the pointer flashes if localizer is not captured.

Expanded Localizer Indications

Liquid Crystal Display



Cathode Ray Tube



1 Expanded Localizer Deviation Scale

Displays when the airplane is close to the localizer centerline. Provides a more sensitive display.

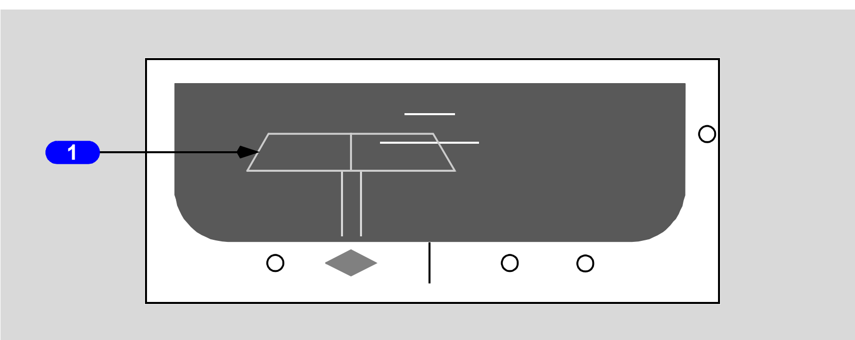
A rectangle equals 1/2 dot deviation.

405

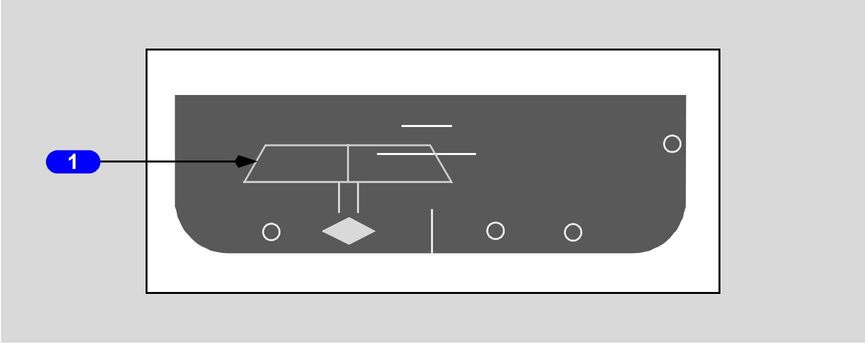
Displays only during autopilot approach.

Rising Runway Indications

Liquid Crystal Display



Cathode Ray Tube

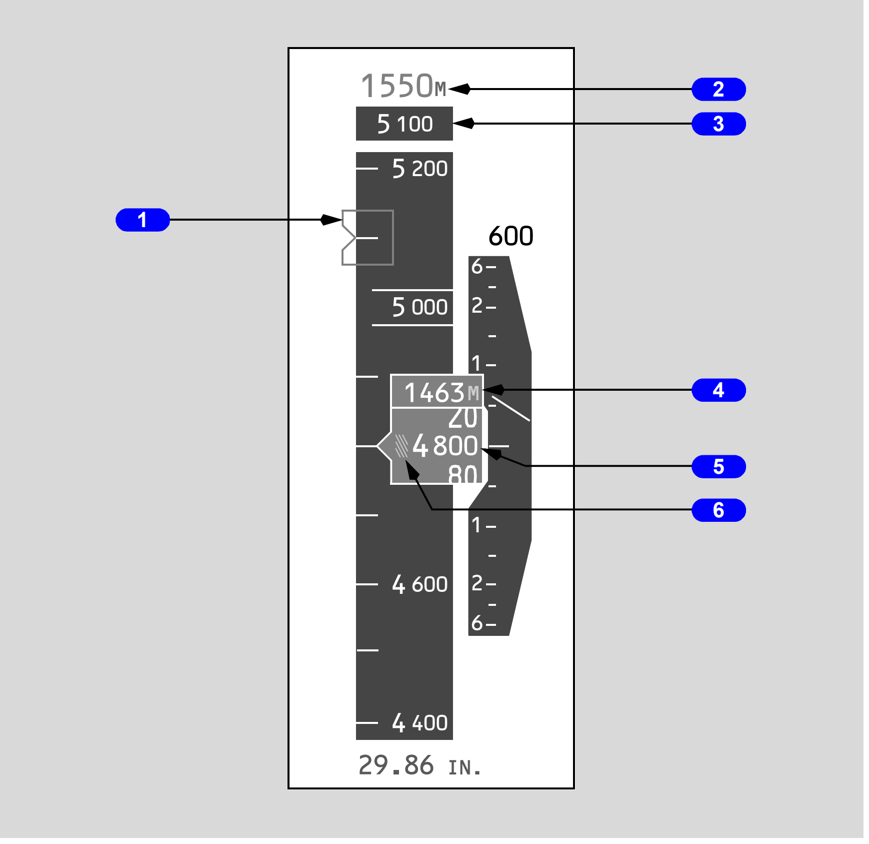


1 Rising Runway

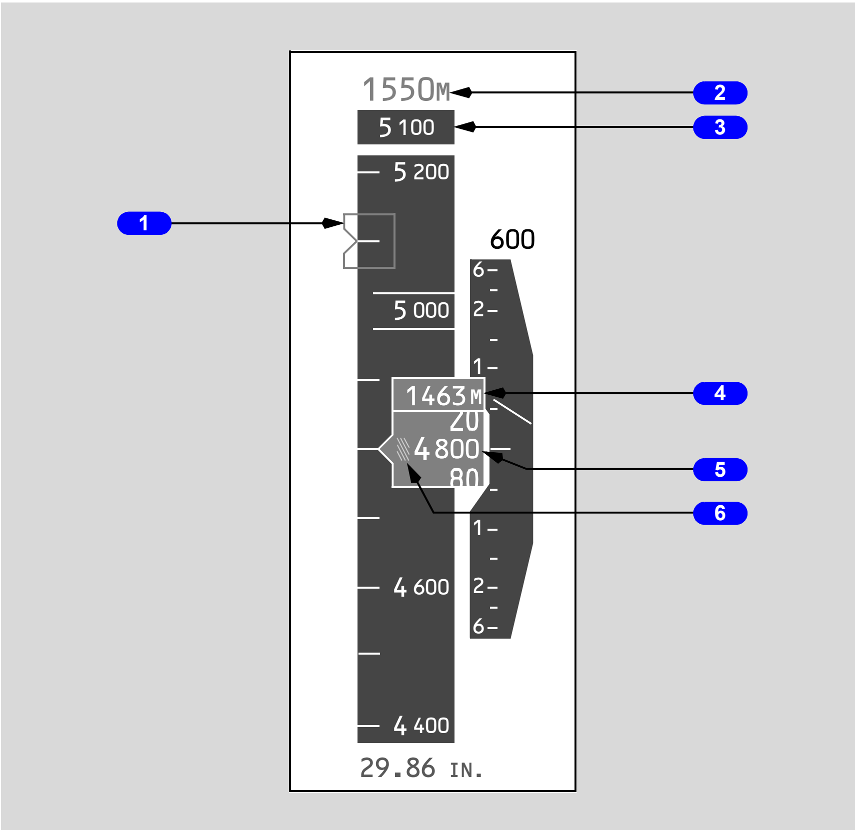
Displays below 2,500 feet radio altitude when the localizer pointer is in view. Moves toward the airplane symbol below 200 feet radio altitude.

Altitude Indications

Liquid Crystal Display



Cathode Ray Tube



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.

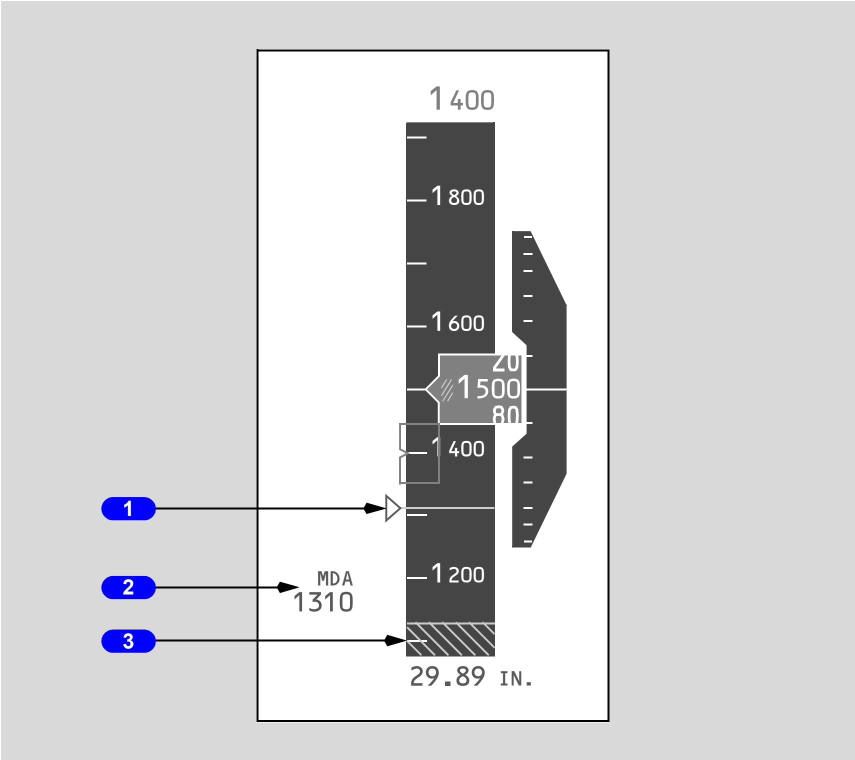
Altitude box changes to amber when deviating from selected altitude between 300 feet and 900 feet.

6 Ten Thousand Digit Display

Cross hatch displays when altitude is below 10,000 feet.

Landing Altitude/Minimums Indications

109



1 MDA Pointer

Indicates barometric altitude set on EFIS control panel.

2 MDA Display

Displays barometric altitude set on EFIS control panel.

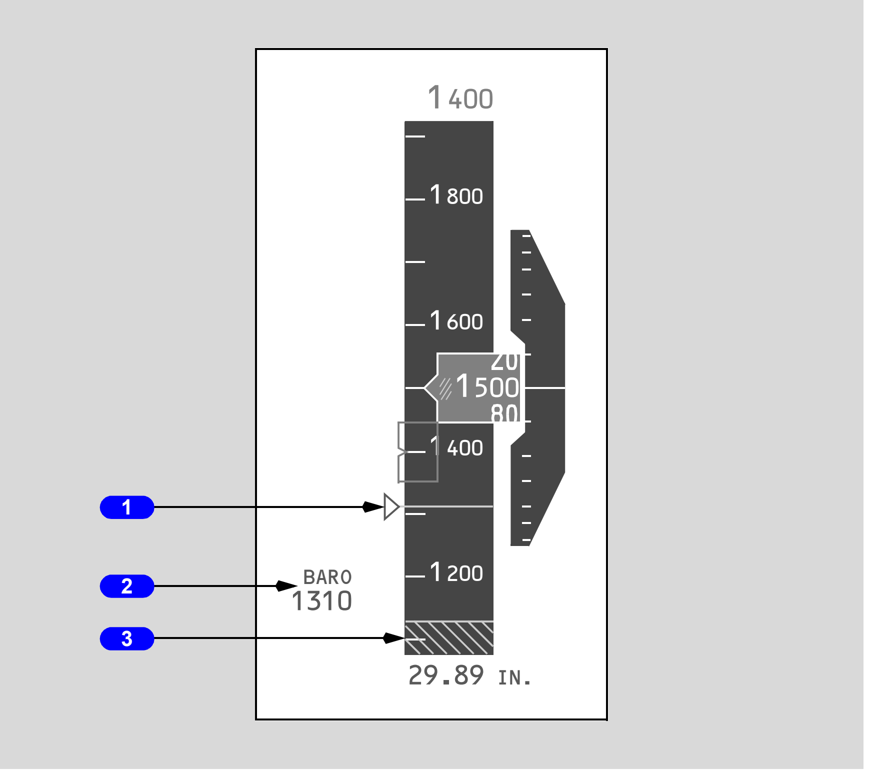
Not displayed when MDA set below -100 feet.

3 Touchdown Zone Indicator

Upper edge of crosshatched area indicates FMC landing altitude for destination runway or airport.

Indicates the landing altitude for the departure runway or airport until 400 NM or one-half the distance to the destination whichever occurs first. See Chapter 11, Flight Management, Navigation, Section 43, arrivals page information.

405, 570



1 BARO Pointer

Indicates barometric altitude set on EFIS control panel.

2 BARO Display

Displays barometric altitude set on EFIS control panel.

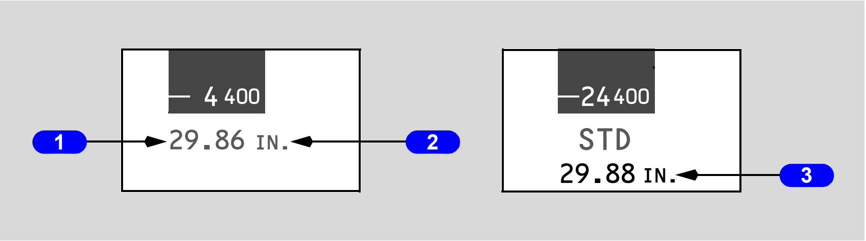
Not displayed when BARO set below -100 feet.

3 Touchdown Zone Indicator

Upper edge of crosshatched area indicates FMC landing altitude for destination runway or airport.

Indicates the landing altitude for the departure runway or airport until 400 NM or one-half the distance to the destination whichever occurs first. See Chapter 11, Flight Management, Navigation, Section 43, arrivals page information.

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, MCP altitude above transition altitude, and airplane climbs 300 feet above transition altitude, or if STD is selected, MCP altitude below transition altitude, and airplane 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

405, 570

QNH/QFE display -

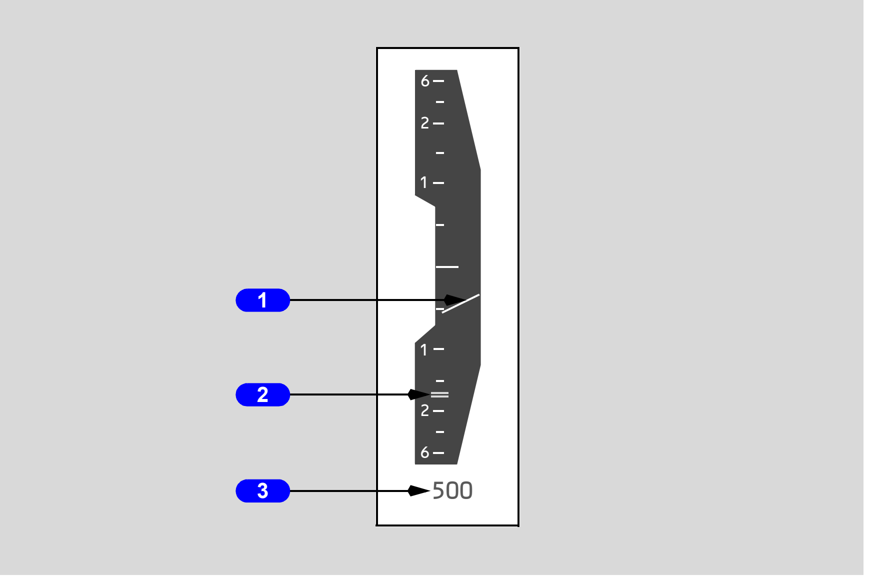
405, 570

- displays QNH or QFE when selected on the APPROACH REF page (refer to Chapter 11, Flight Management, Navigation, Section 43)
- display defaults to QNH after landing or long term power interruption
- QFE and QNH alternately displayed and emphasized for 10 seconds by a highlight box when the QFE/QNH line select key pushed on the APPROACH REF page
- QNH or QFE not displayed when STD is displayed

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 ADC vertical speed as dampened by the IRS.

2 Selected Vertical Speed Pointer

Indicates vertical speed set in MCP vertical speed window with V/S pitch mode active.

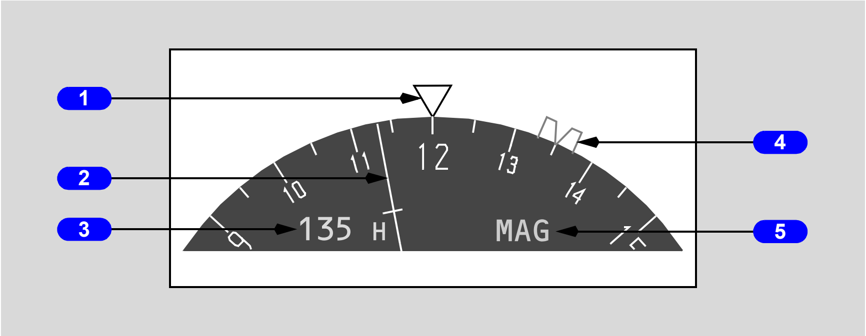
3 Vertical Speed

Displays vertical speed when greater than 400 feet per minute.

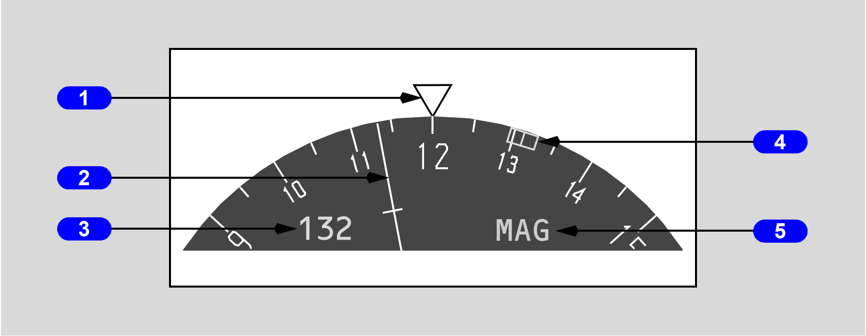
Display is above the vertical speed display when climbing and below when descending.

Heading/Track Displays

Liquid Crystal Display



Cathode Ray Tube



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

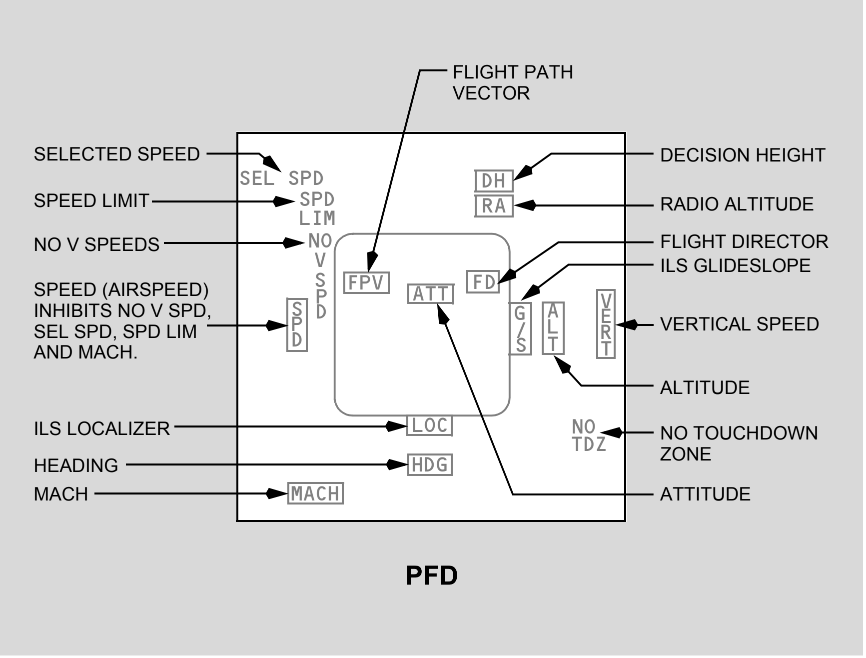
Displays selected heading reference:

- MAG - magnetic north
- TRU - true north, boxed for emphasis

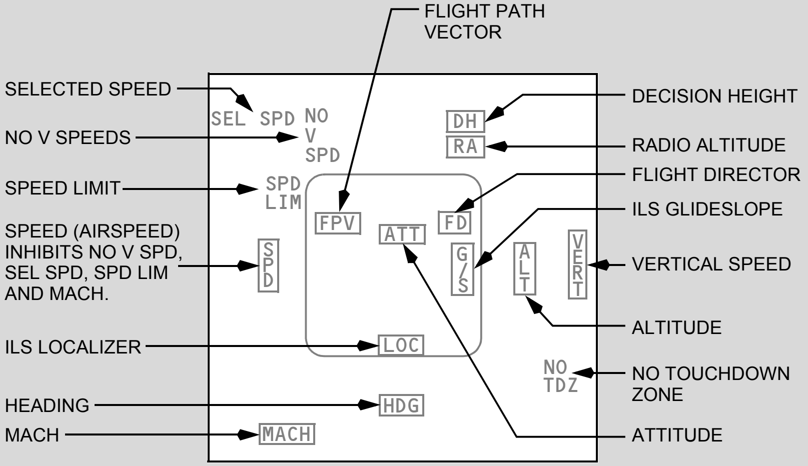
PFD Failure Flags

Note: PFD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.

Liquid Crystal Display



Cathode Ray Tube


FLIGHT PATH VECTOR
SELECTED SPEED
NO V SPEEDS
SPEED LIMIT
SPEED (AIRSPEED) INHIBITS NO V SPD, SEL SPD, SPD LIM AND MACH.
ILS LOCALIZER
HEADING
MACH
SEL SPD
NO V SPD
SPD LIM
SPD
FPV
ATT
FD
G/S
ALT
VERT
DH
RA
LOC
HDG
MACH
NO TDZ
DECISION HEIGHT
RADIO ALTITUDE
FLIGHT DIRECTOR
ILS GLIDESLOPE
VERTICAL SPEED
ALTITUDE
NO TOUCHDOWN ZONE
ATTITUDE

PFD

Navigation Display (ND)

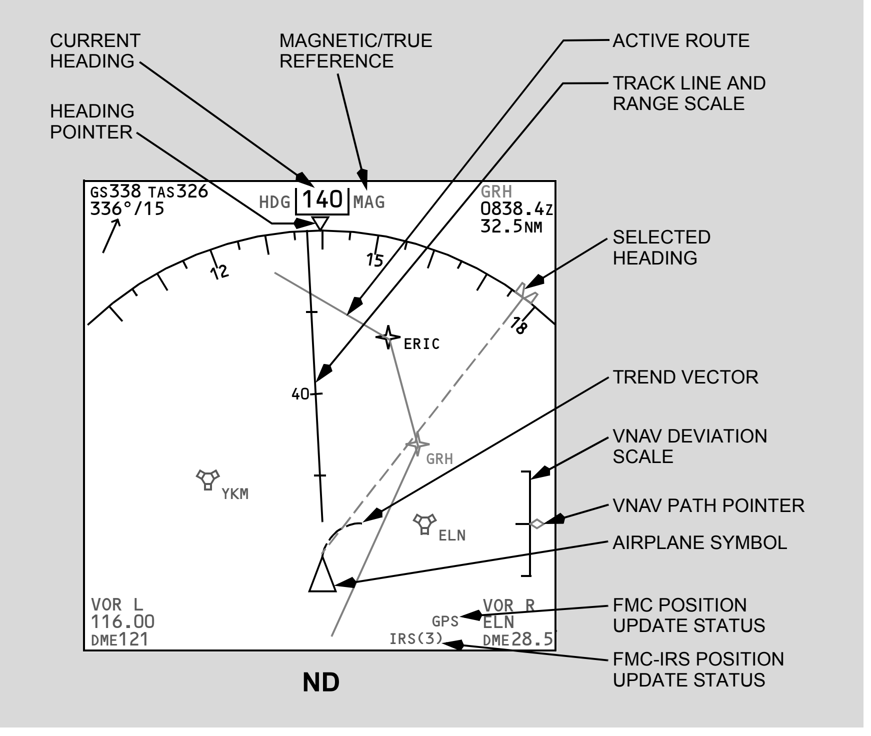
Note: Refer to Navigation Display section of this chapter for a detailed explanation of ND symbology shown on the following pages.

Map Mode

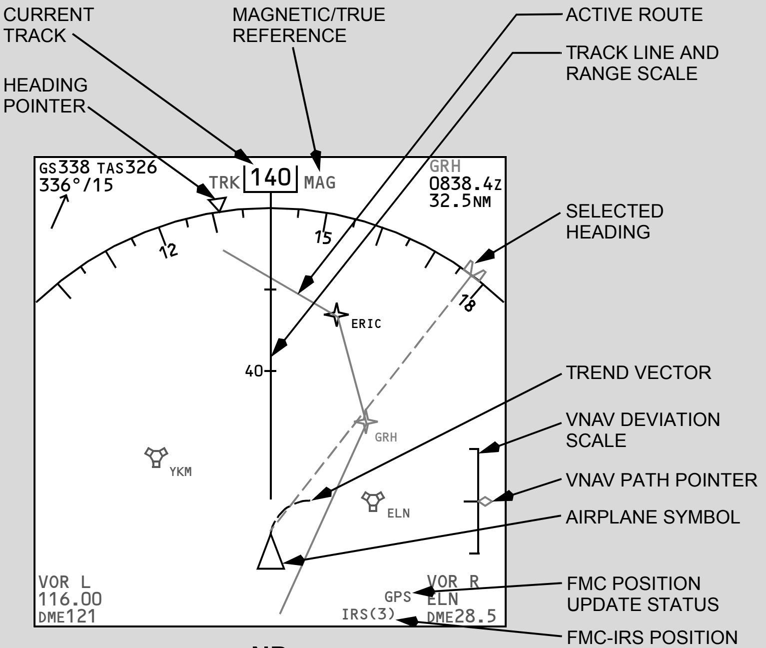
Expanded Map Mode

Liquid Crystal Display

405

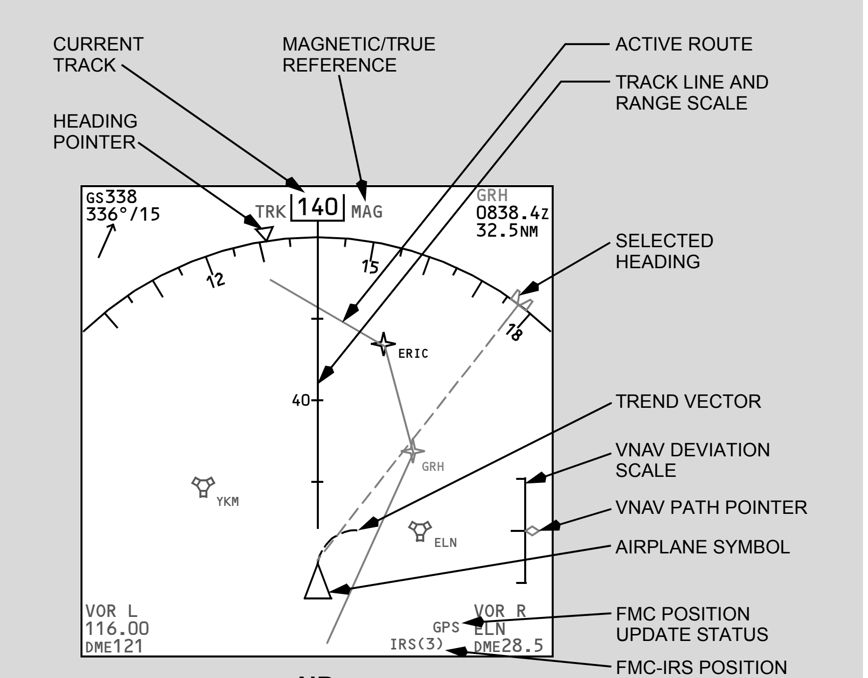


570


CURRENT TRACK
MAGNETIC/TRUE REFERENCE
ACTIVE ROUTE
TRACK LINE AND RANGE SCALE
HEADING POINTER
GS338 TAS326
336°/15
TRK
140
MAG
GRH
0838.4Z
32.5NM
SELECTED HEADING
12
15
18
ERIC
40
TREND VECTOR
GRH
VNAV DEVIATION SCALE
YKM
VNAV PATH POINTER
ELN
AIRPLANE SYMBOL
VOR L
116.00
DME121
GPS
IRS(3)
VOR R
ELN
DME28.5
FMC POSITION UPDATE STATUS
FMC-IRS POSITION UPDATE STATUS

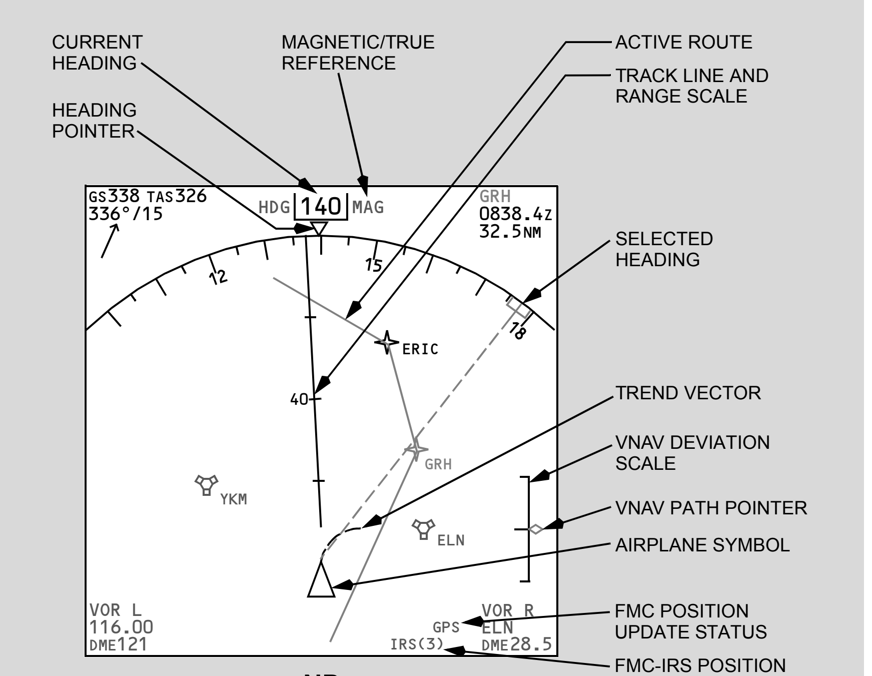
ND

109


CURRENT TRACK
MAGNETIC/TRUE REFERENCE
ACTIVE ROUTE
TRACK LINE AND RANGE SCALE
HEADING POINTER
GS338
336°/15
TRK
140
MAG
GRH
0838.4Z
32.5NM
SELECTED HEADING
12
15
18
ERIC
40
TREND VECTOR
GRH
VNAV DEVIATION SCALE
YKM
VNAV PATH POINTER
ELN
AIRPLANE SYMBOL
VOR L
116.00
DME121
GPS
VOR R
ELN
IRS(3)
DME28.5
FMC POSITION UPDATE STATUS
FMC-IRS POSITION UPDATE STATUS
ND

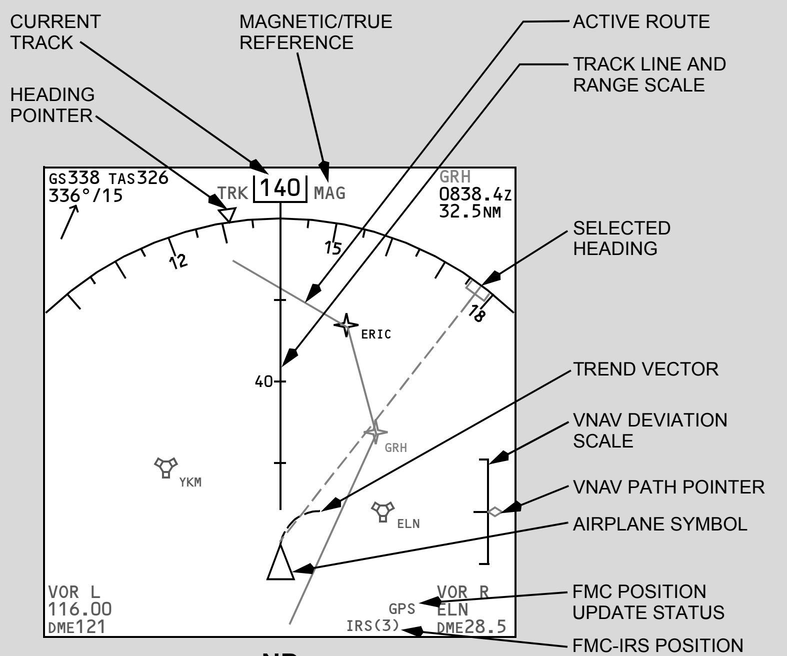
Cathode Ray Tube

405

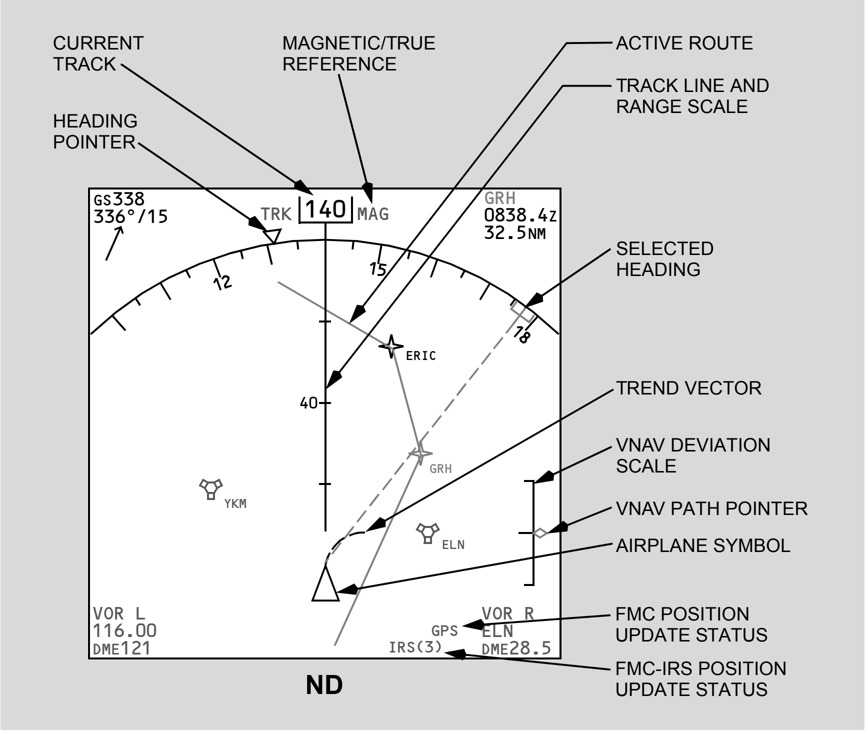


ND

570


CURRENT TRACK
MAGNETIC/TRUE REFERENCE
ACTIVE ROUTE
TRACK LINE AND RANGE SCALE
HEADING POINTER
GS338 TAS326
336°/15
TRK
140
MAG
GRH
0838.4Z
32.5NM
SELECTED HEADING
12
15
18
ERIC
40
TREND VECTOR
GRH
VNAV DEVIATION SCALE
YKM
VNAV PATH POINTER
ELN
AIRPLANE SYMBOL
VOR L
116.00
DME121
VOR R
GPS
ELN
IRS(3)
DME28.5
FMC POSITION UPDATE STATUS
FMC-IRS POSITION UPDATE STATUS
ND

109

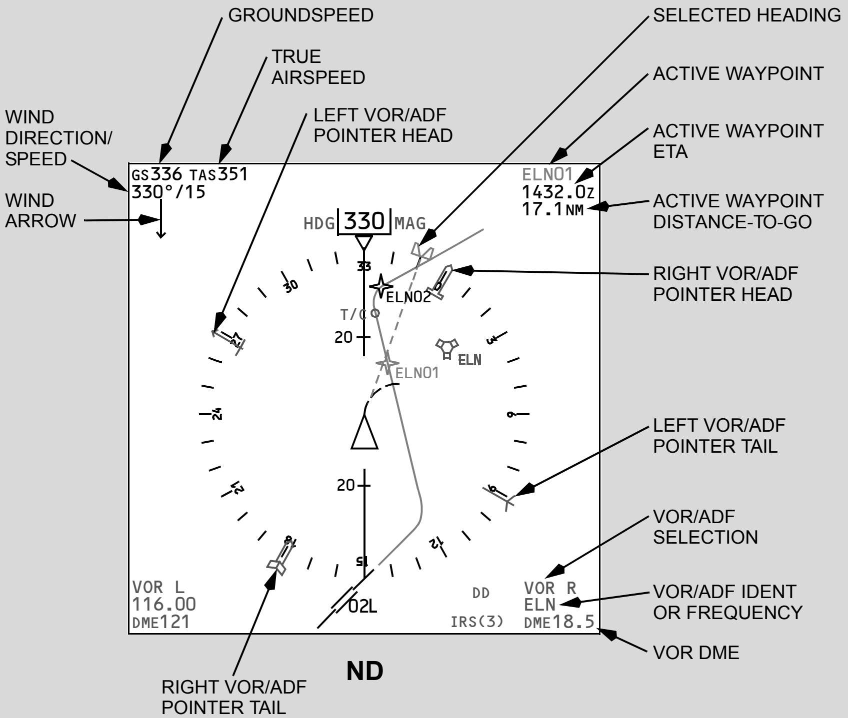

CURRENT TRACK
MAGNETIC/TRUE REFERENCE
ACTIVE ROUTE
TRACK LINE AND RANGE SCALE
HEADING POINTER
GS338
336°/15
TRK
140
MAG
GRH
0838.4Z
32.5NM
SELECTED HEADING
12
15
18
ERIC
40
TREND VECTOR
GRH
VNAV DEVIATION SCALE
YKM
VNAV PATH POINTER
ELN
AIRPLANE SYMBOL
VOR L
116.00
DME121
GPS
VOR R
ELN
FMC POSITION UPDATE STATUS
IRS(3)
DME28.5
FMC-IRS POSITION UPDATE STATUS

ND

Centered Map Mode

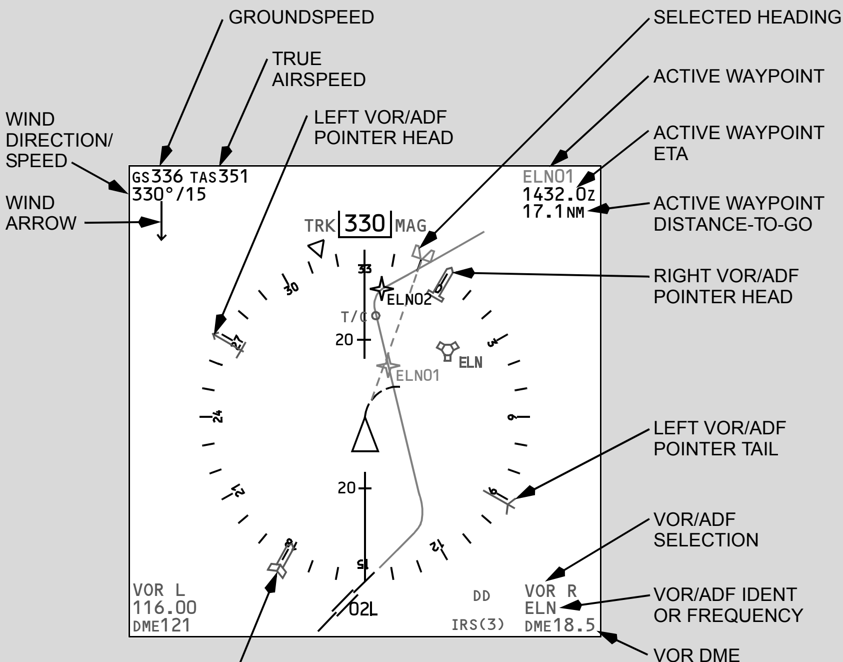
Liquid Crystal Display

405



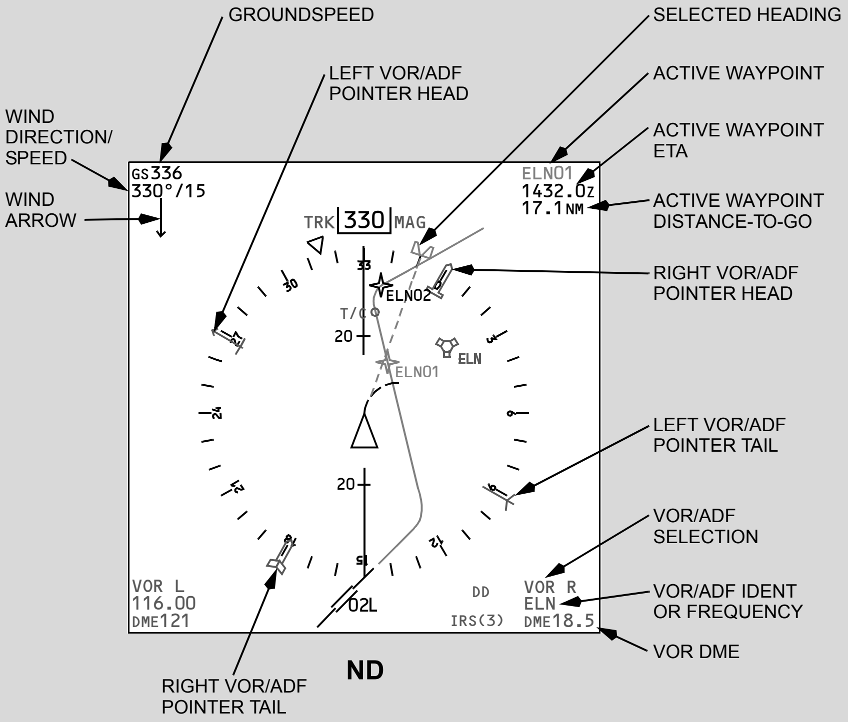
ND

570


GROUNDSPEED
TRUE AIRSPEED
WIND DIRECTION/ SPEED
WIND ARROW
LEFT VOR/ADF POINTER HEAD
SELECTED HEADING
ACTIVE WAYPOINT
ACTIVE WAYPOINT ETA
ACTIVE WAYPOINT DISTANCE-TO-GO
RIGHT VOR/ADF POINTER HEAD
LEFT VOR/ADF POINTER TAIL
VOR/ADF SELECTION
VOR/ADF IDENT OR FREQUENCY
VOR DME
RIGHT VOR/ADF POINTER TAIL
GS336 TAS351
330°/15
TRK 330 MAG
ELN01
1432.0Z
17.1NM
ELN02
T/C
ELN
ELN01
02L
VOR L
116.00
DME121
DD
IRS(3)
VOR R
ELN
DME18.5

ND

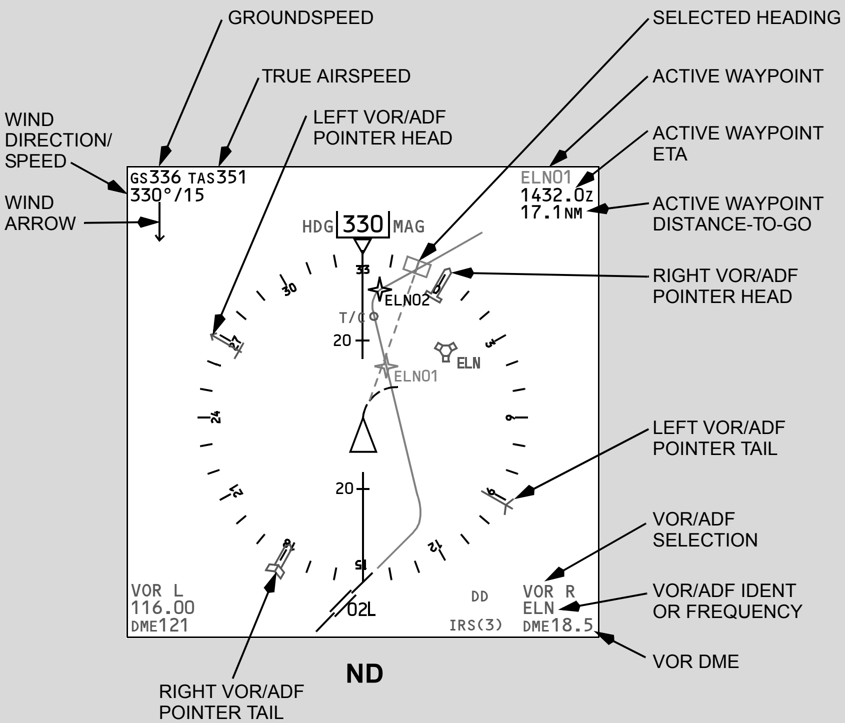
109


GROUNDSPEED
SELECTED HEADING
LEFT VOR/ADF POINTER HEAD
ACTIVE WAYPOINT
WIND DIRECTION/ SPEED
ACTIVE WAYPOINT ETA
WIND ARROW
ACTIVE WAYPOINT DISTANCE-TO-GO
GS336
330°/15
ELN01
1432.0Z
17.1NM
TRK 330 MAG
ELN02
T/C
ELN
ELN01
RIGHT VOR/ADF POINTER HEAD
LEFT VOR/ADF POINTER TAIL
VOR/ADF SELECTION
VOR/ADF IDENT OR FREQUENCY
VOR DME
VOR L
116.00
DME121
02L
DD
IRS(3)
VOR R
ELN
DME18.5
RIGHT VOR/ADF POINTER TAIL

ND

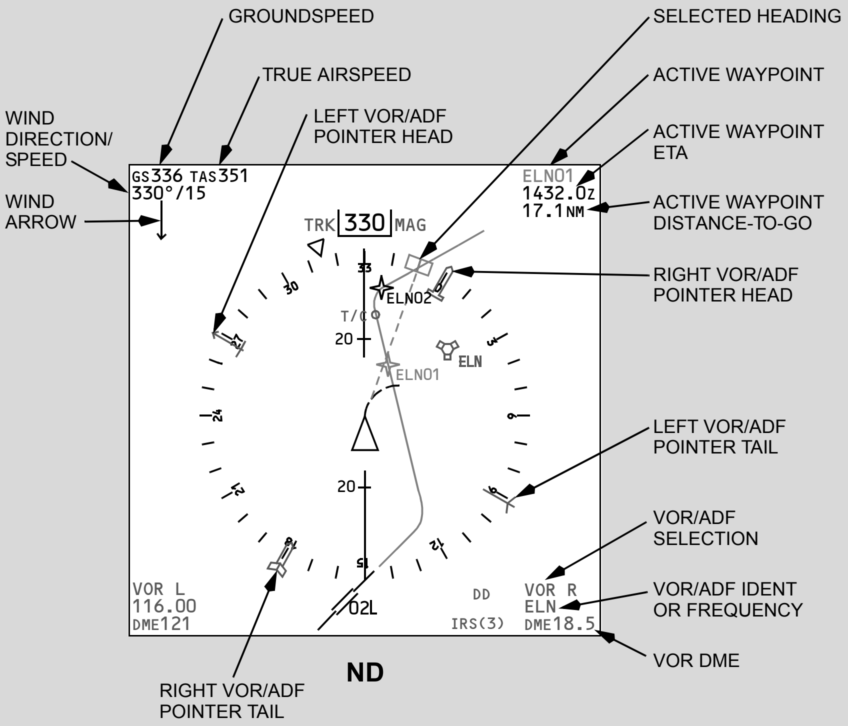
Cathode Ray Tube

405



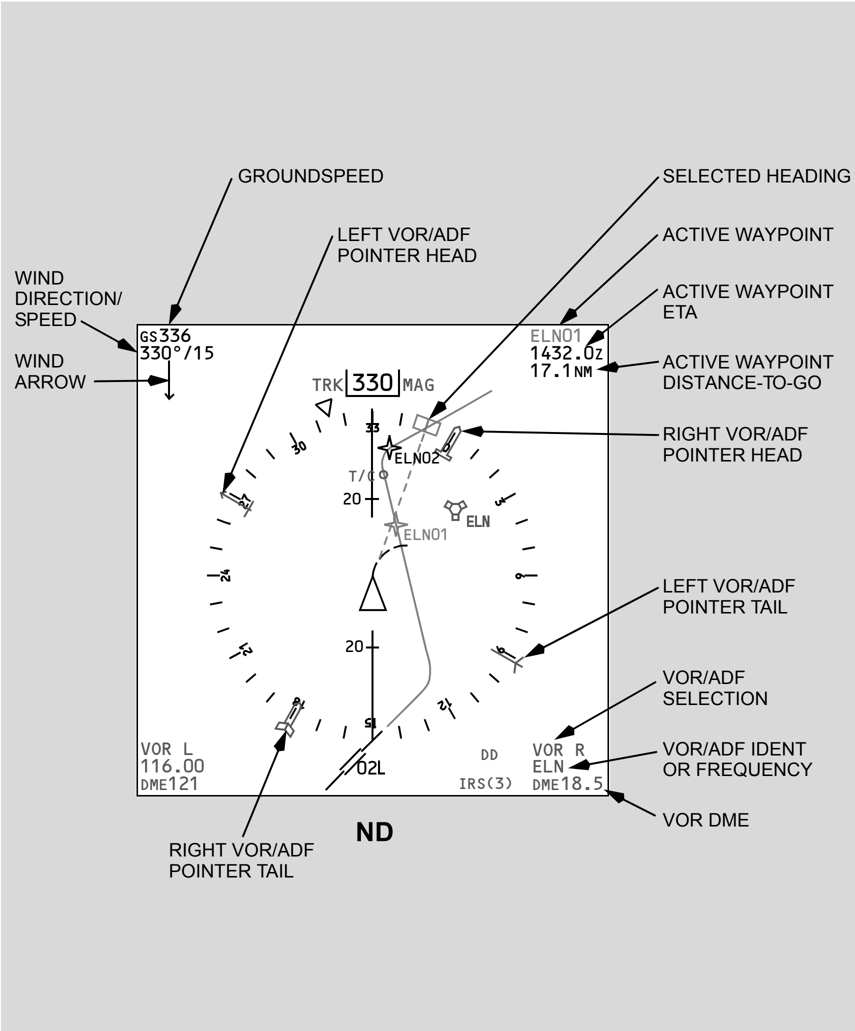
ND

570


GROUNDSPEED
TRUE AIRSPEED
LEFT VOR/ADF POINTER HEAD
WIND DIRECTION/ SPEED
WIND ARROW
SELECTED HEADING
ACTIVE WAYPOINT
ACTIVE WAYPOINT ETA
ACTIVE WAYPOINT DISTANCE-TO-GO
RIGHT VOR/ADF POINTER HEAD
LEFT VOR/ADF POINTER TAIL
VOR/ADF SELECTION
VOR/ADF IDENT OR FREQUENCY
VOR DME
RIGHT VOR/ADF POINTER TAIL
GS336 TAS351
330°/15
TRK 330 MAG
ELN01
1432.0z
17.1NM
ELN02
T/C
ELN
ELN01
02L
VOR L
116.00
DME121
DD
IRS(3)
VOR R
ELN
DME18.5

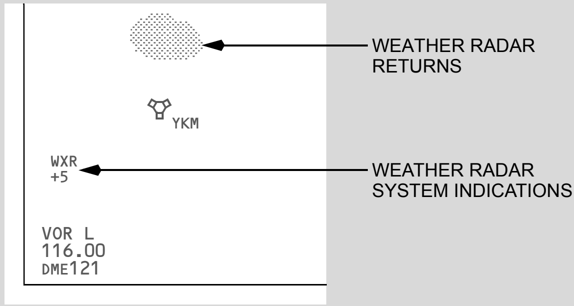
ND

109


GROUNDSPEED
SELECTED HEADING
LEFT VOR/ADF POINTER HEAD
ACTIVE WAYPOINT
WIND DIRECTION/ SPEED
ACTIVE WAYPOINT ETA
WIND ARROW
ACTIVE WAYPOINT DISTANCE-TO-GO
RIGHT VOR/ADF POINTER HEAD
LEFT VOR/ADF POINTER TAIL
VOR/ADF SELECTION
VOR/ADF IDENT OR FREQUENCY
VOR DME
RIGHT VOR/ADF POINTER TAIL
GS336
330°/15
TRK 330 MAG
ELN01
1432.0Z
17.1NM
ELN02
T/C
20
ELN
ELN01
20
02L
VOR L
116.00
DME121
DD
IRS(3)
VOR R
ELN
DME18.5

ND

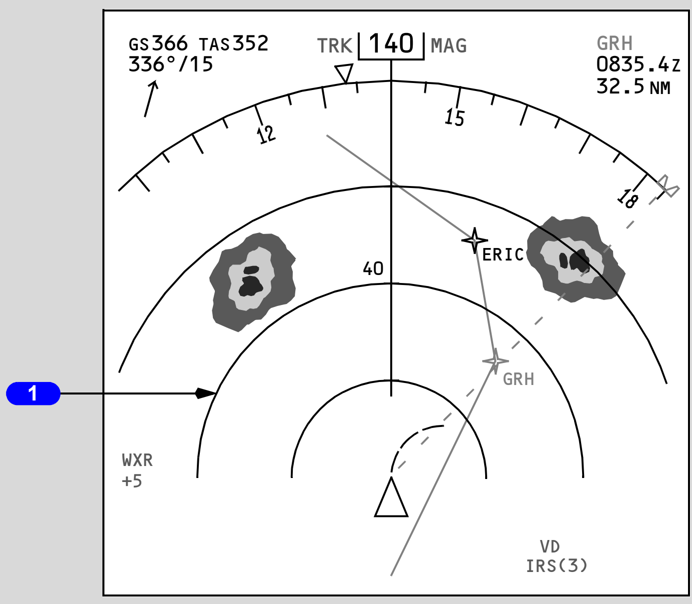
Weather Radar System Display Indications



570

Liquid Crystal Display

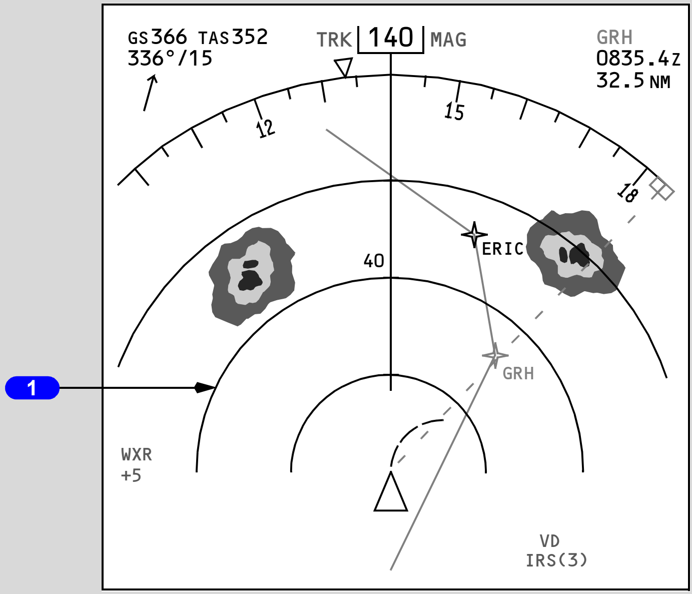
570



570

Cathode Ray Tube

570



ND

570

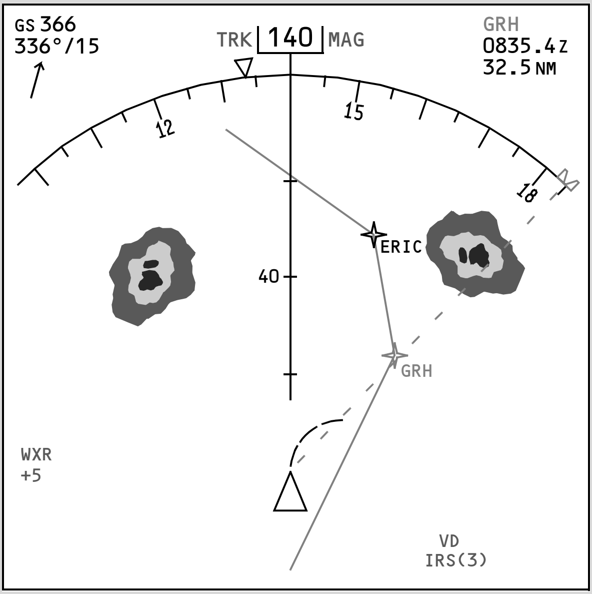
1 Weather Radar Range Arcs

Three range arcs display in place of range scale tics on map when weather radar or terrain selected.

109, 405

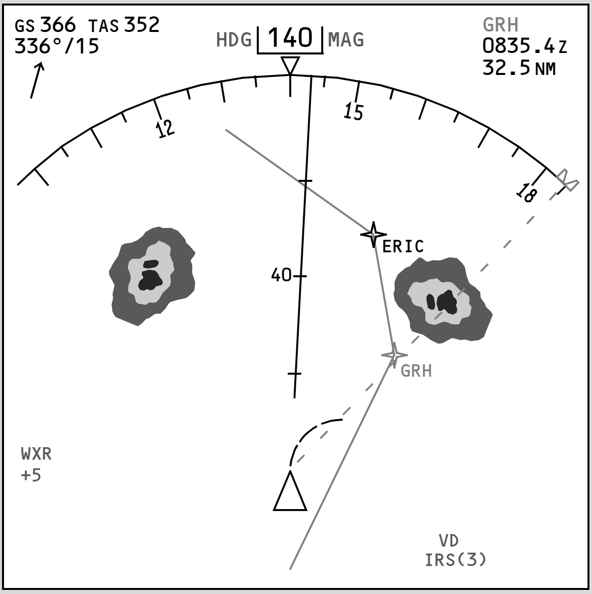
Liquid Crystal Display

109



ND

405

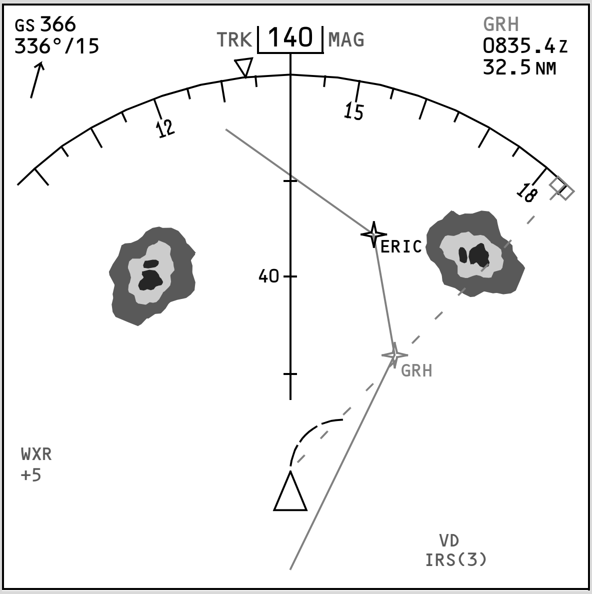

GS 366 TAS 352
336°/15
HDG 140 MAG
GRH
0835.4Z
32.5 NM
12
15
18
ERIC
40
GRH
WXR
+5
VD
IRS(3)

ND

109, 405

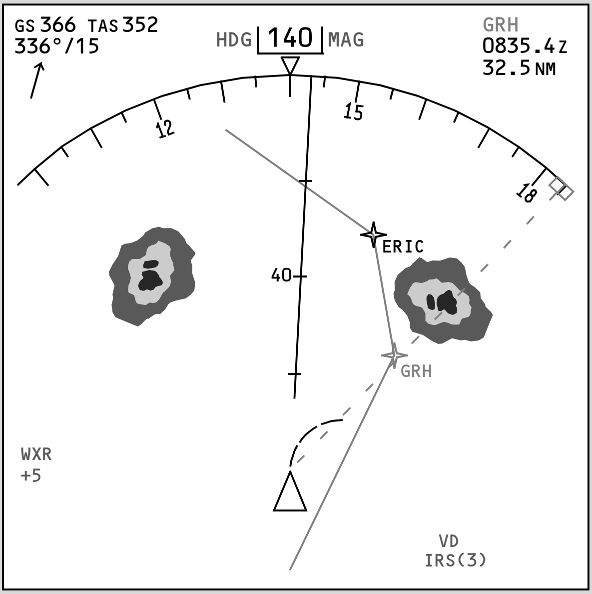
Cathode Ray Tube

109



ND

405

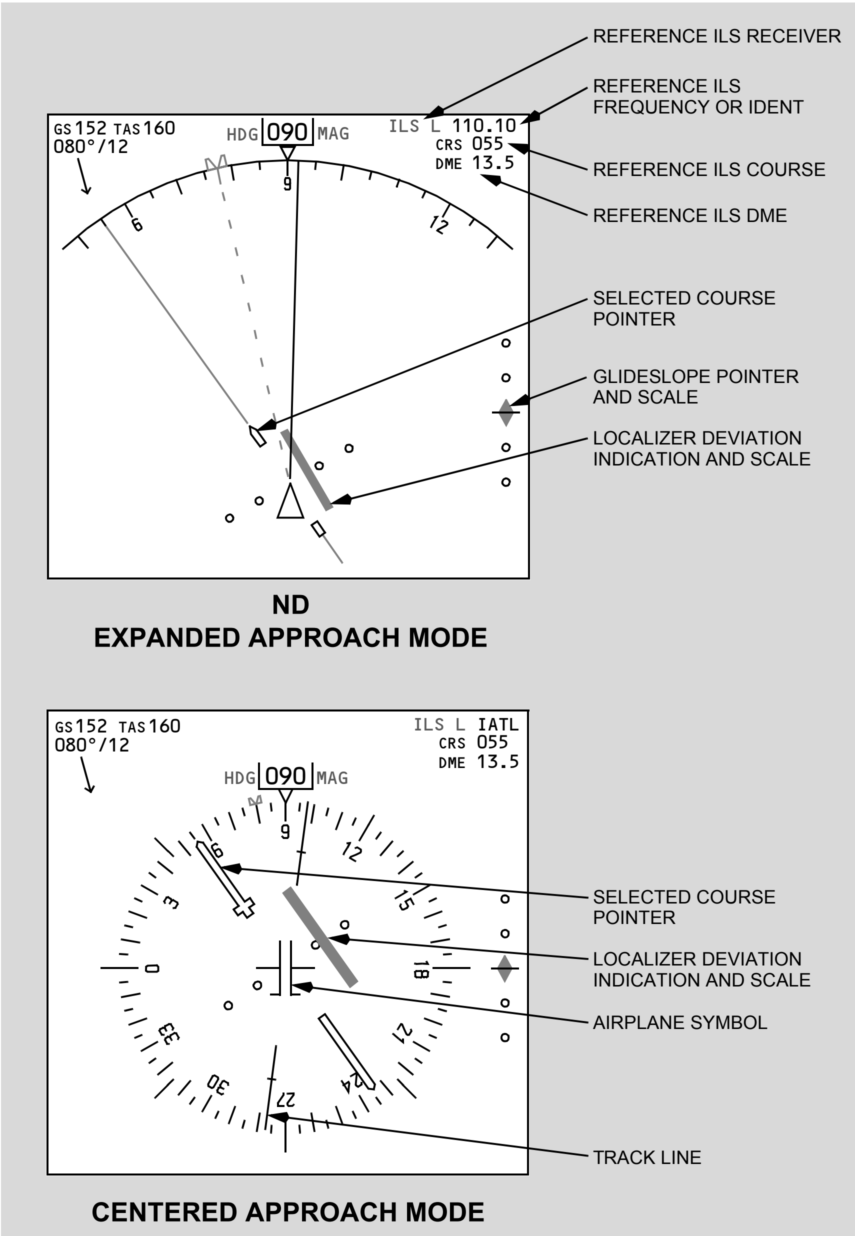

GS 366 TAS 352
336°/15
HDG 140 MAG
GRH
0835.4Z
32.5 NM
12
15
18
ERIC
40
GRH
WXR
+5
VD
IRS(3)

ND

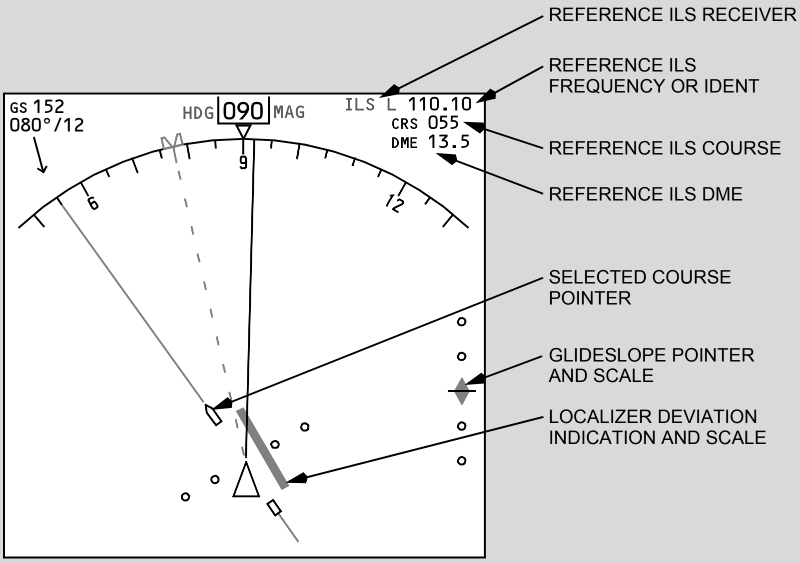
Approach Mode

Liquid Crystal Display

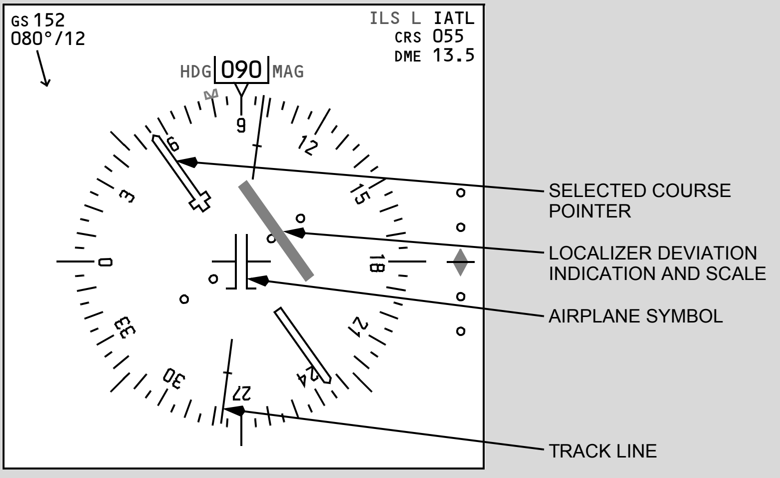
405, 570



109



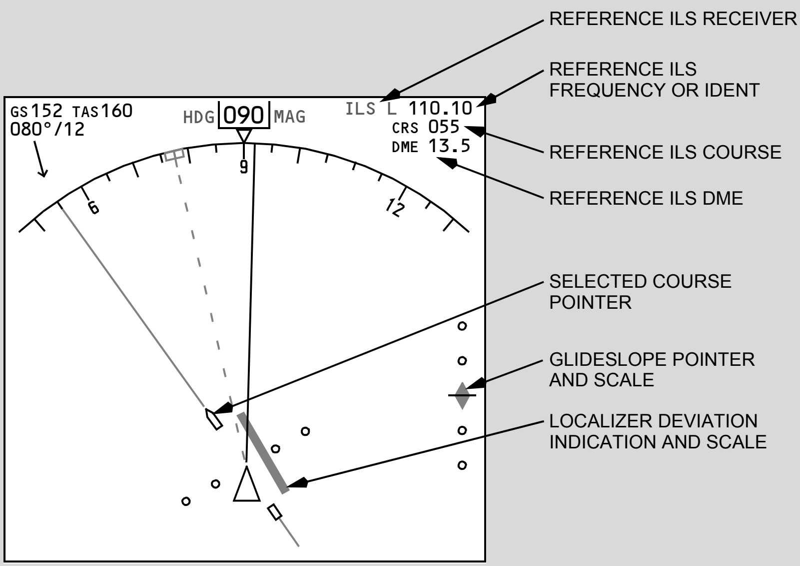
ND
EXPANDED APPROACH MODE



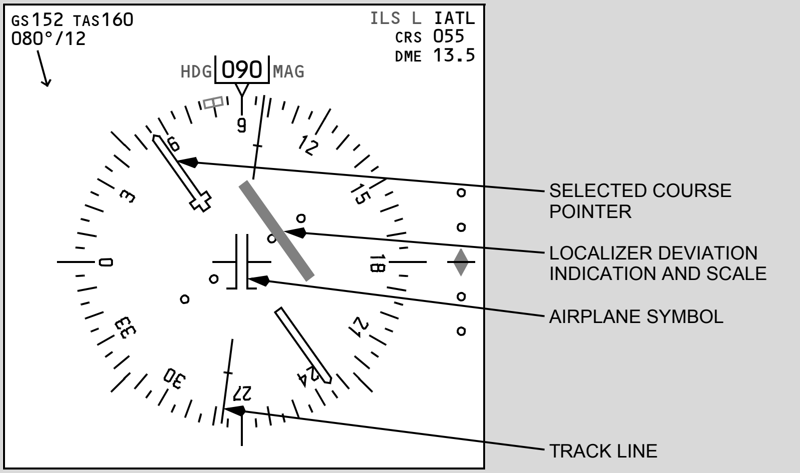
CENTERED APPROACH MODE

Cathode Ray Tube

405, 570

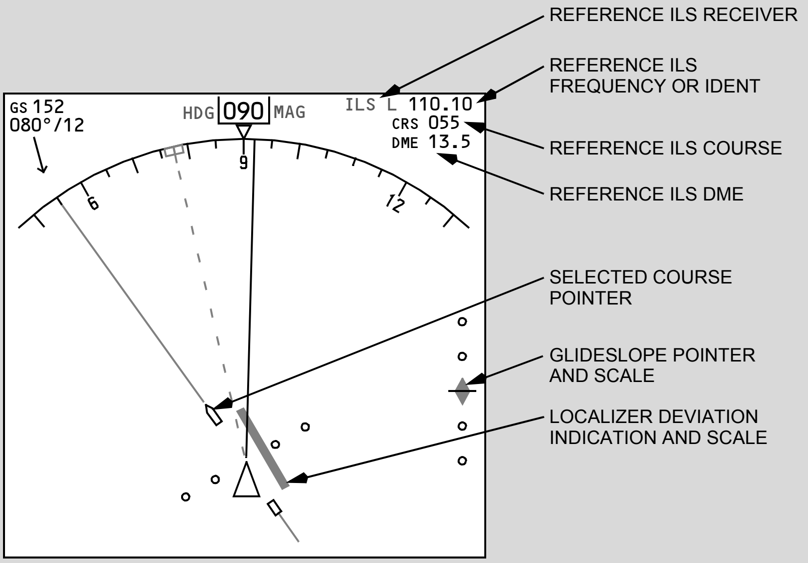


ND
EXPANDED APPROACH MODE

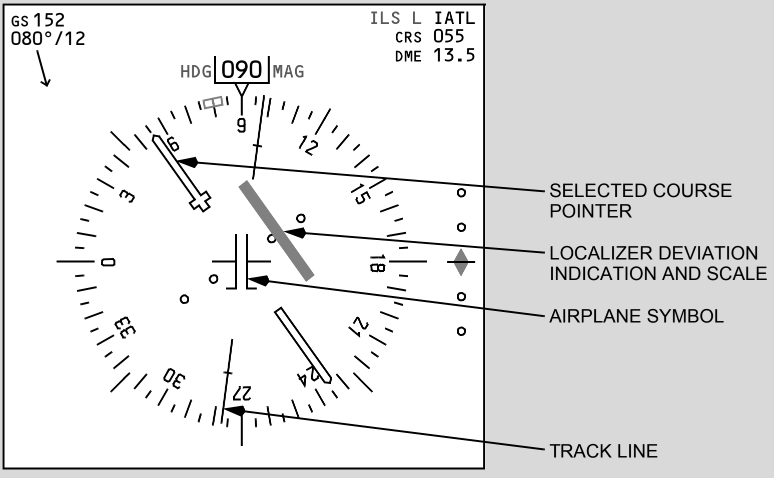


CENTERED APPROACH MODE

109



ND
EXPANDED APPROACH MODE

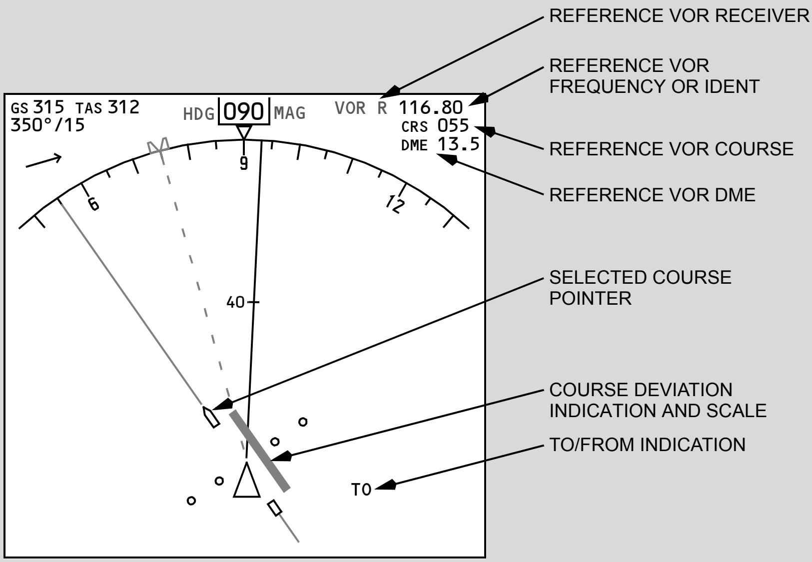


CENTERED APPROACH MODE

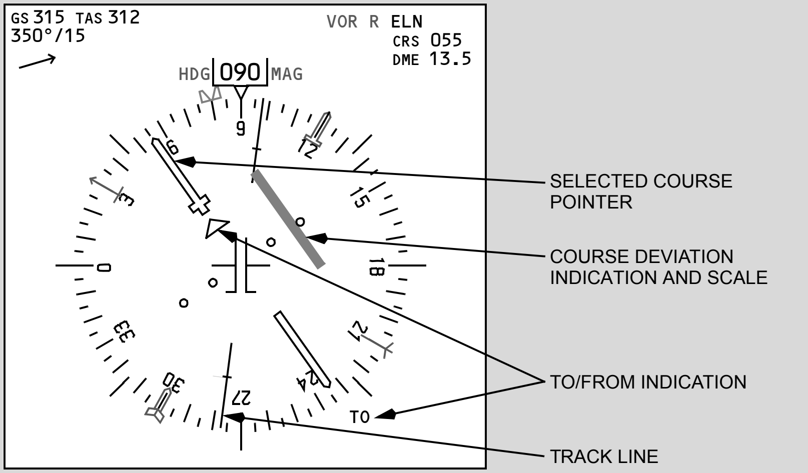
VOR Mode

Liquid Crystal Display

405, 570

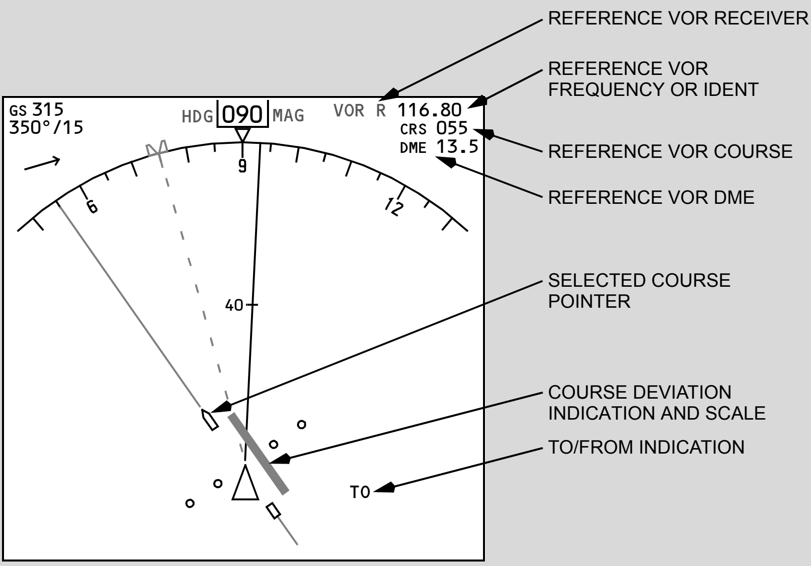


ND
EXPANDED VOR MODE

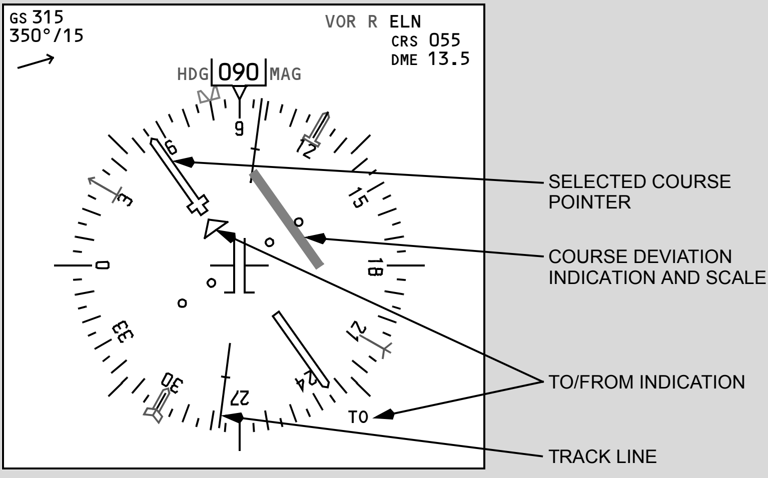


CENTERED VOR MODE

109



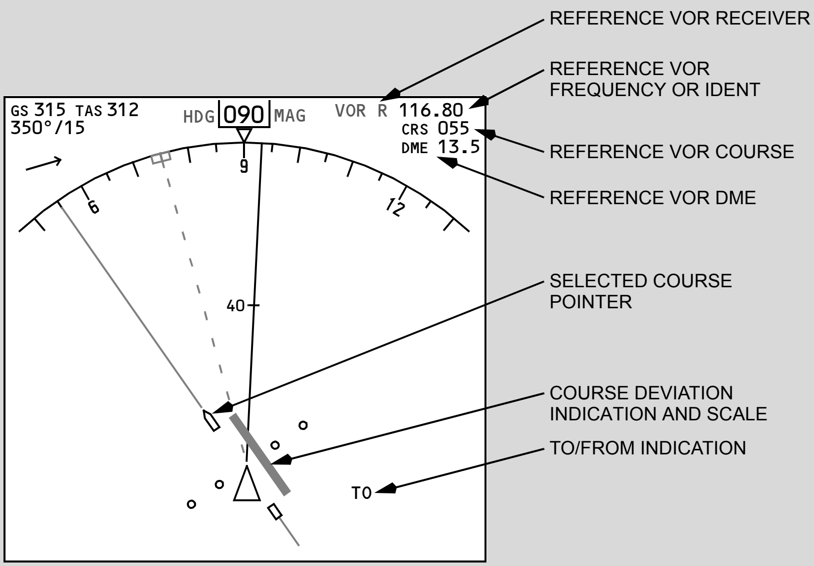
ND
EXPANDED VOR MODE



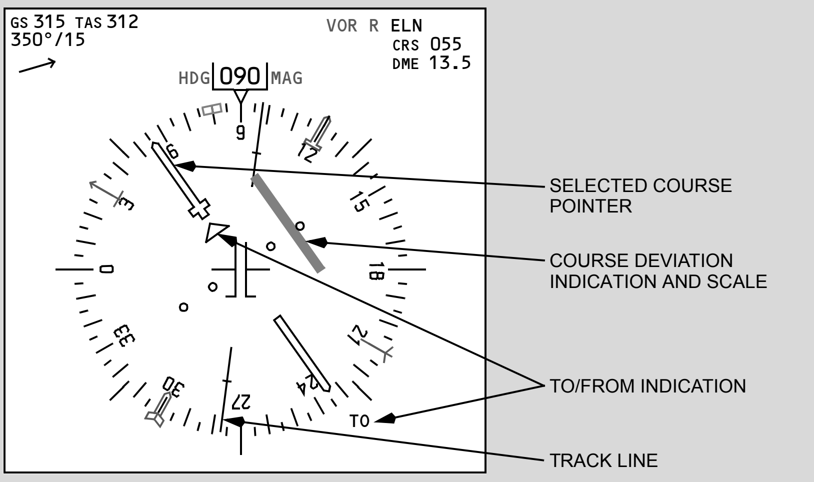
CENTERED VOR MODE

Cathode Ray Tube

405, 570

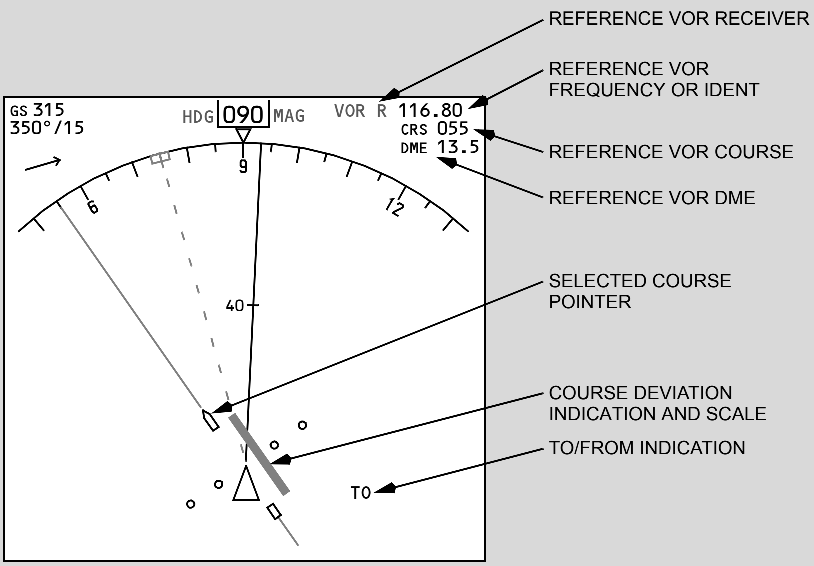


ND
EXPANDED VOR MODE

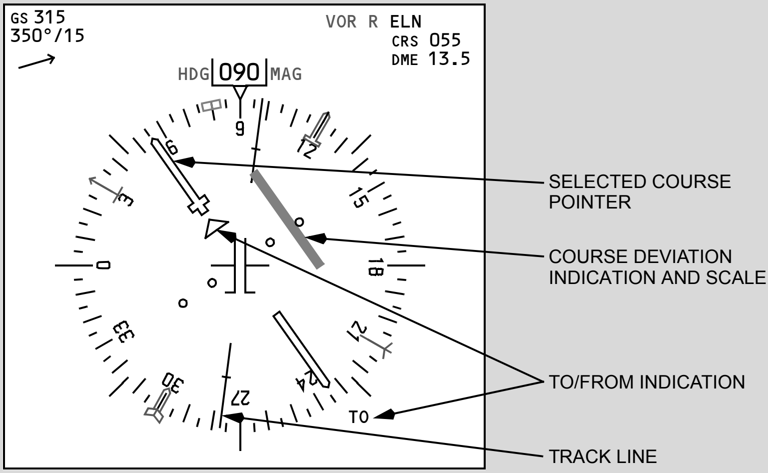


CENTERED VOR MODE

109



ND
EXPANDED VOR MODE

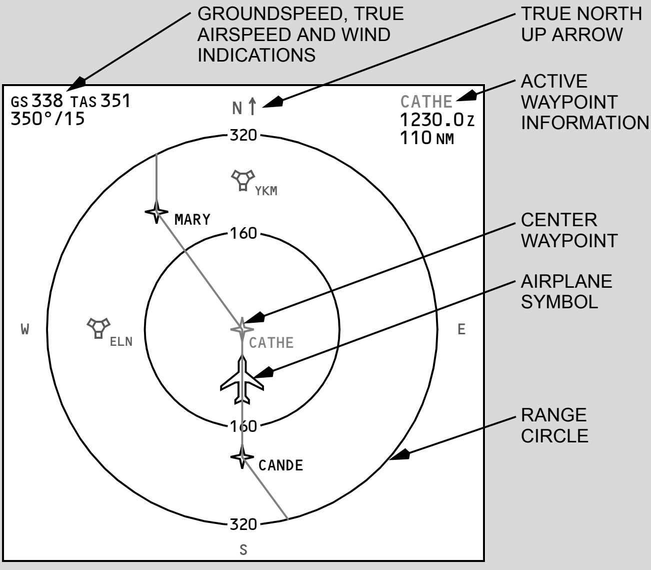


CENTERED VOR MODE

Plan Mode

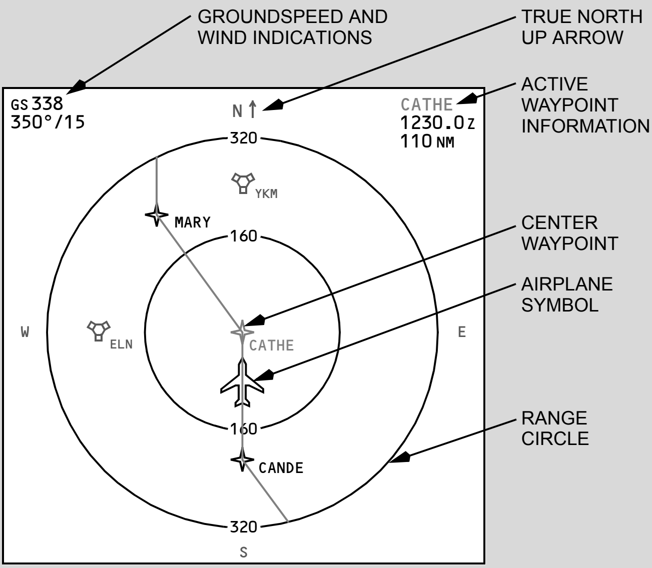
Liquid Crystal Display

405, 570



ND

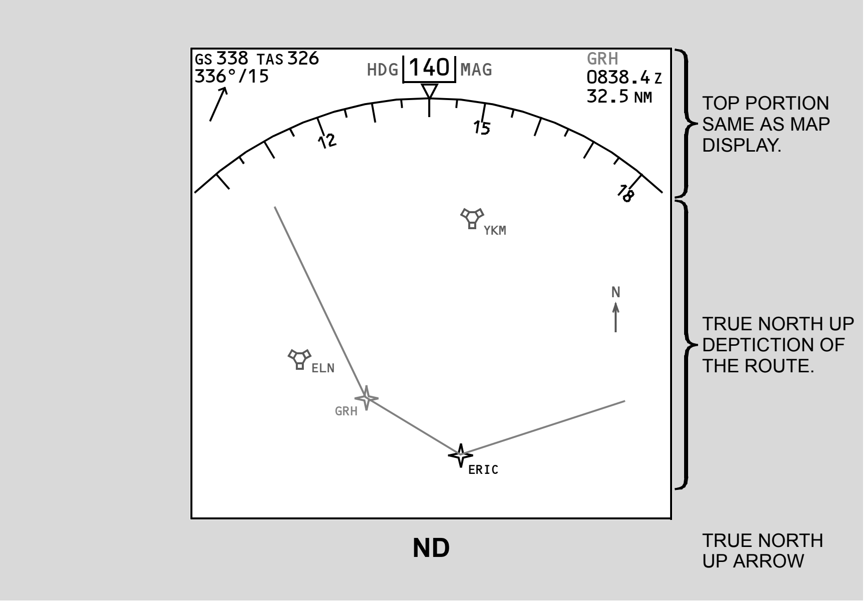
109


GROUNDSPEED AND
WIND INDICATIONS
TRUE NORTH
UP ARROW
ACTIVE
WAYPOINT
INFORMATION
CENTER
WAYPOINT
AIRPLANE
SYMBOL
RANGE
CIRCLE
GS 338
350°/15
N
CATHE
1230.0Z
110 NM
320
YKM
MARY
160
W
ELN
CATHE
E
160
CANDE
320
S

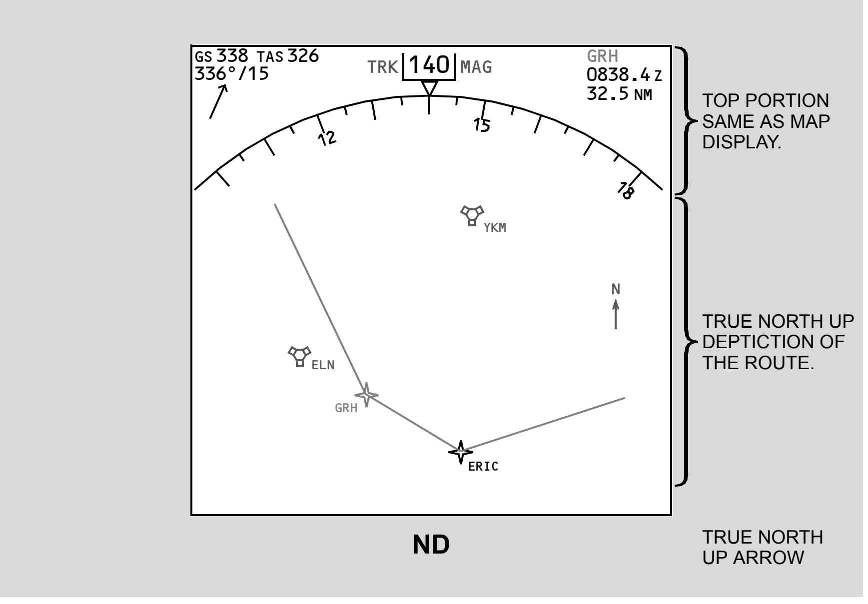
ND

Cathode Ray Tube

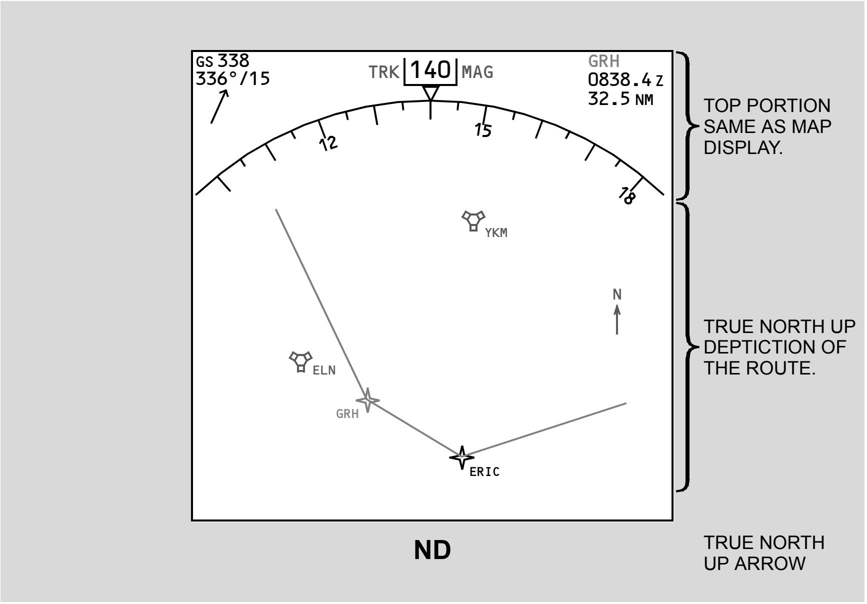
405



570

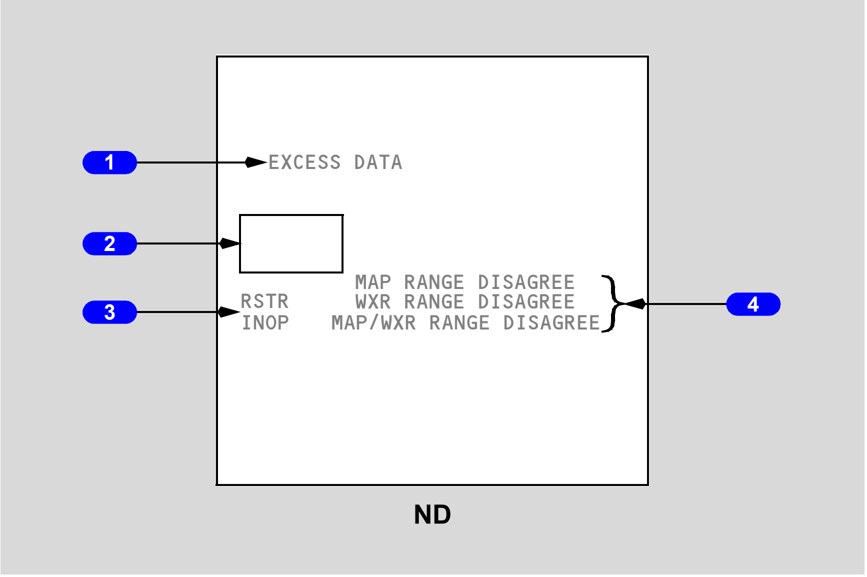


109



ND Failure Indications and Flags

Failure Messages



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)

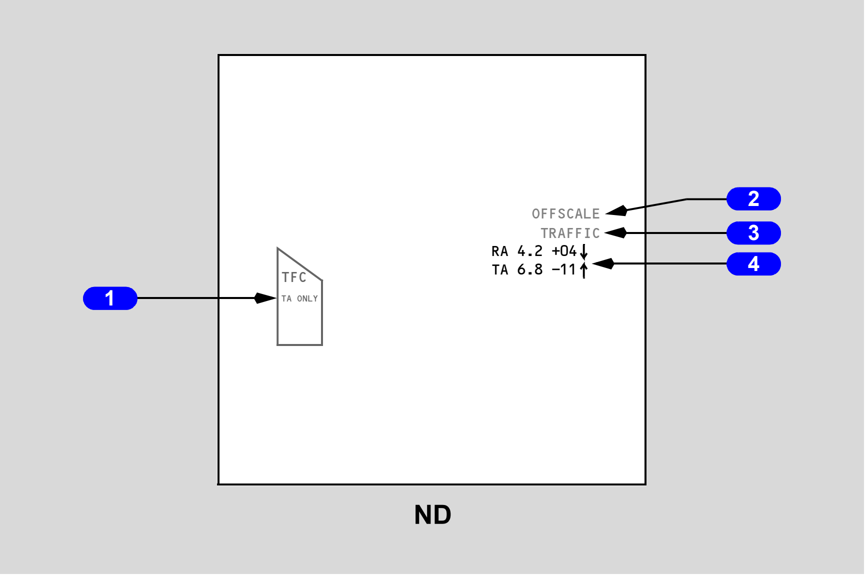
Displays overheat condition.

4 MAP/WXR Range Disagree

Selected range and range of display information disagree.

Map information is removed.

TCAS Messages



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.

570

TA ONLY (blue) - TCAS TA ONLY mode selected; displayed in all ND modes.

109, 405

TA ONLY (blue) - TCAS TA 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 a TA (amber) or RA (red) condition.

Displayed in all ND modes.

4 No Bearing Traffic Messages

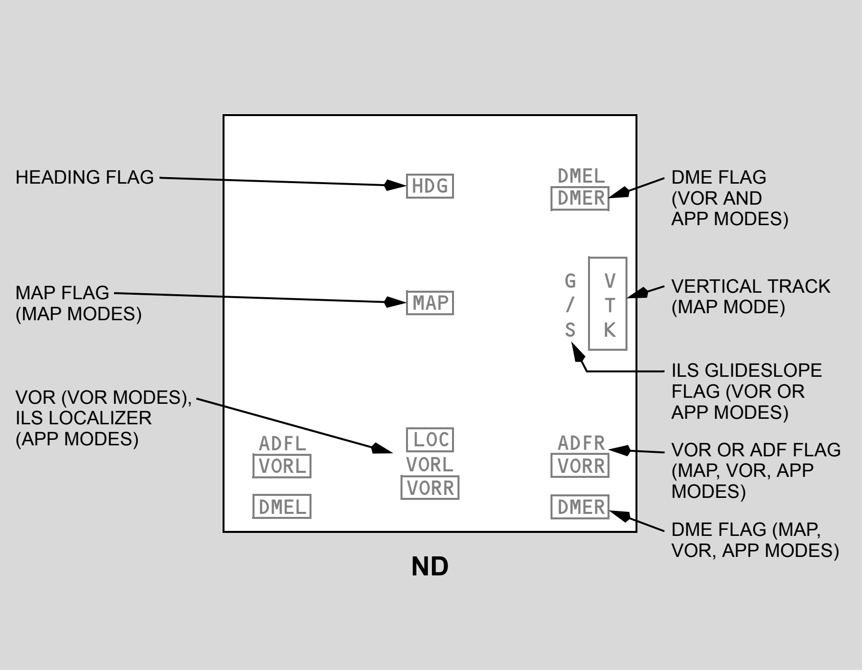
Displayed when no bearing information is available for traffic (see ND symbology chart for display).

Displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

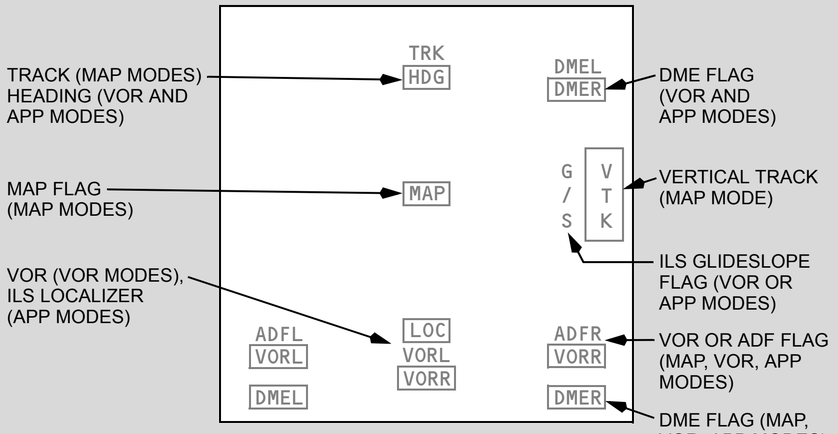
Failure Flags

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.

405



109, 570


TRACK (MAP MODES)
HEADING (VOR AND
APP MODES)
TRK
HDG
DMEL
DMER
DME FLAG
(VOR AND
APP MODES)
MAP FLAG
(MAP MODES)
MAP
G
/
S
V
T
K
VERTICAL TRACK
(MAP MODE)
ILS GLIDESLOPE
FLAG (VOR OR
APP MODES)
VOR (VOR MODES),
ILS LOCALIZER
(APP MODES)
ADFL
VORL
DMEL
LOC
VORL
VORR
ADFR
VORR
DMER
VOR OR ADF FLAG
(MAP, VOR, APP
MODES)
DME FLAG (MAP,
VOR, APP MODES)

ND

EFIS Control Panels

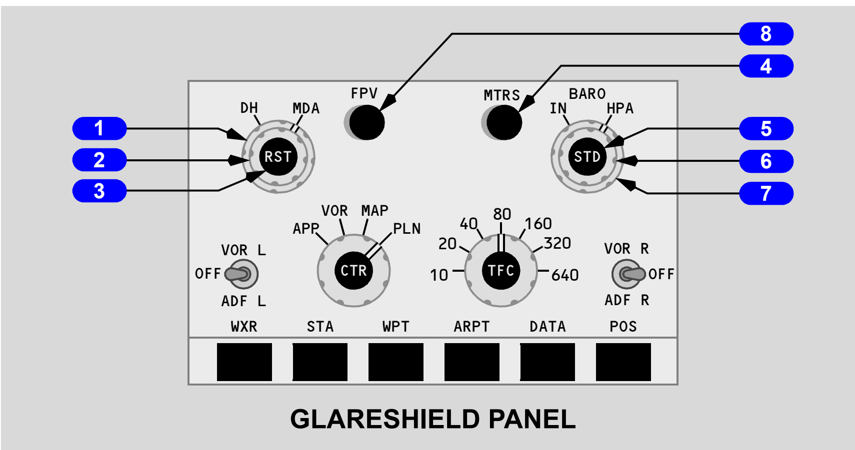
The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

If an EFIS control panel fails, displays are controlled through the related CDU (CDU-152).

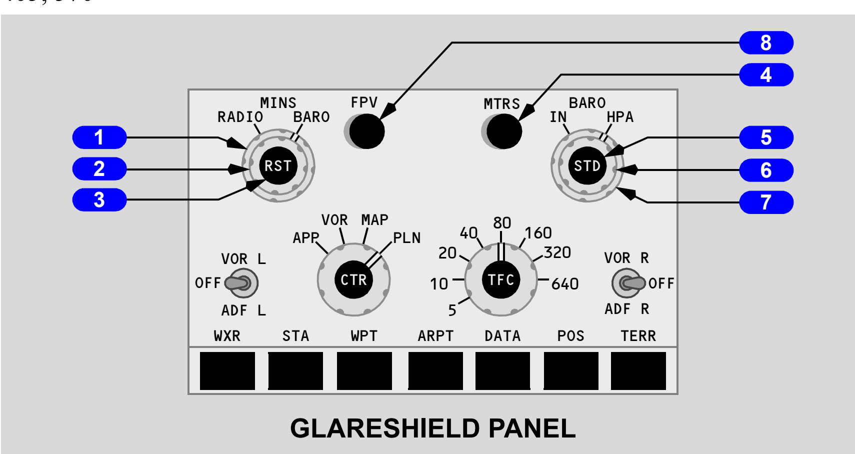
Displays can also be controlled through the related CDU (CDU-161).

Control Panel PFD Controls

109



405, 570



1 **Decision Height/Minimium Descent Altitude Selector (outer)**

109

DH - selects radio altitude as PFD minimums reference.

MDA - selects barometric altitude as PFD minimums reference.

1 **Minimiums (MINS) Selector (outer)**

405, 570

RADIO - selects radio altitude for display on the PFD and as reference for minimums voice alert.

BARO - selects barometric altitude for display on the PFD and as reference for minimums voice alert.

2 **Decision Height (DH)/Minimum Descent Altitude (MDA) Control (middle)**

109

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

2 **RADIO Altitude/Barometric (BARO) Altitude Control (middle)**

405, 570

Rotate -

- when RADIO selected, sets a radio altitude reference in RADIO display in one foot increments
- when BARO selected, sets a barometric altitude reference in BARO display, in increments of ten feet (EFIS CP 112), or one foot increments (EFIS CP 113 or later). BARO pointer indicates the same altitude on the altitude display

3 **Decision Height Reset (RST) Switch (inner)**

109

Push - resets PFD flashing amber DH.

3 **Minimums Reset (MINS RST) Switch (inner)**

405, 570

Push - resets PFD flashing amber RADIO.

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/1013 HPA) 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
  405, 570
- when QFE displayed, selects STD on display and QNH LANDING on the FMC APPROACH REF page (refer to Chapter 11, section 43)

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.

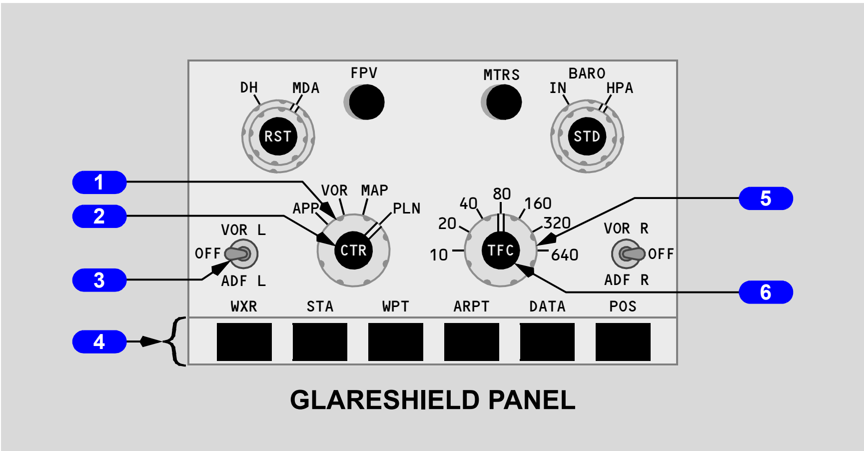
HPA - selects Hectopascals as PFD barometric reference.

8 **Flight Path Vector (FPV) Switch**

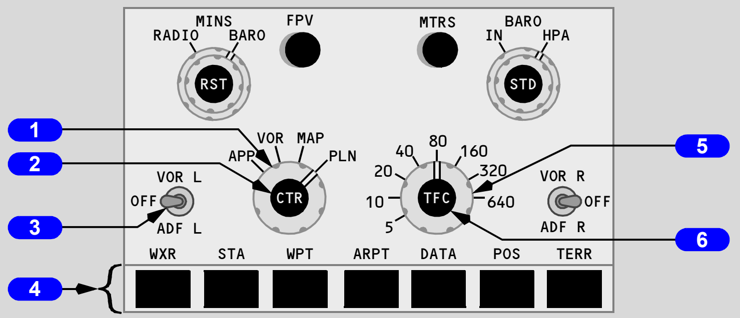
Push - displays PFD flight path vector.

Control Panel ND Controls

109



405, 570



GLARESHIELD PANEL

1 ND Mode Selector (outer)

405, 570

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
- look-ahead terrain, weather radar, PWS, 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
- look-ahead terrain, weather radar, PWS, and TCAS are not displayed in VOR CTR mode

MAP -

405

- displays heading up, full compass rose, FMC-generated route and map information, airplane position, heading, and track

570

- 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
- look-ahead terrain, weather radar, PWS, and TCAS are not displayed in PLN mode

1 ND Mode Selector (outer)

109

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 109

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

4 **WXR, STA, WPT, ARPT, DATA, POS, TERR Switches**
405, 570

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 5, 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 5, 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 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
- displays IRU and GPS positions

TERR (terrain) - GPWS look-ahead terrain mode is described in Chapter 15, Warning Systems.

5 **ND Range Selector (outer)**

Selects desired ND nautical mile range scale.

6 **ND Traffic (TFC) Switch (inner)**

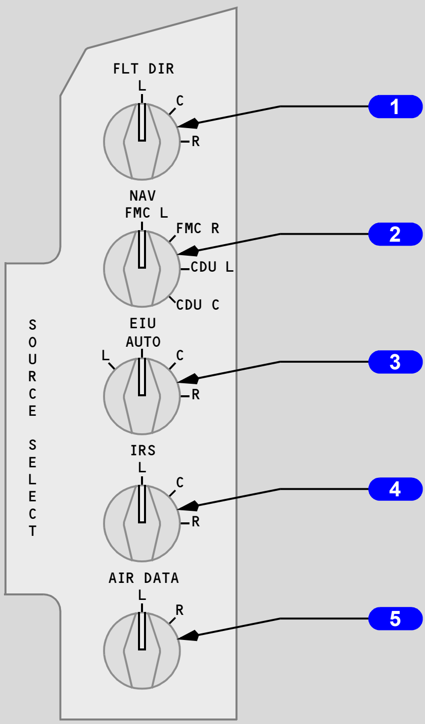
Push - in VOR, APP, MAP, and MAP CTR modes:

- enables TCAS traffic display (Refer to Chapter 15, Warning Systems)
- with TCAS FAIL displayed on ND, cancels TCAS FAIL message.

Instrument Source Select Panels

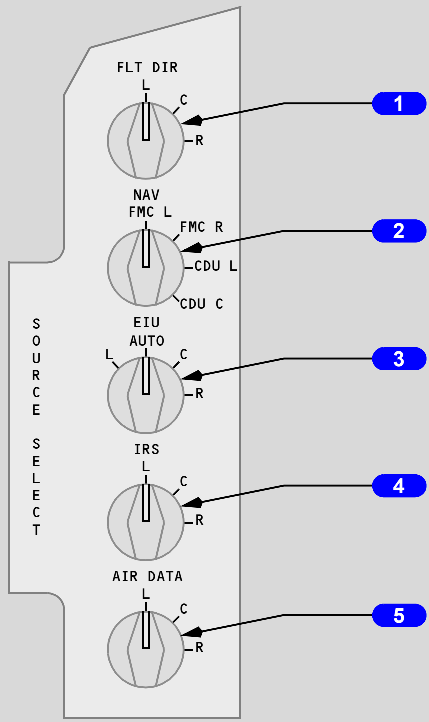
The left panel is shown.

570



PILOT'S PANELS

109, 405



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.

405

IRU selected by Captain provides autobrake reference. IRU selected by F/O provides RMI reference.

109, 570

IRU selected by Captain provides autobrake reference.

5 AIR DATA Source Selector

L - left ADC provides information to the PFD and ND.

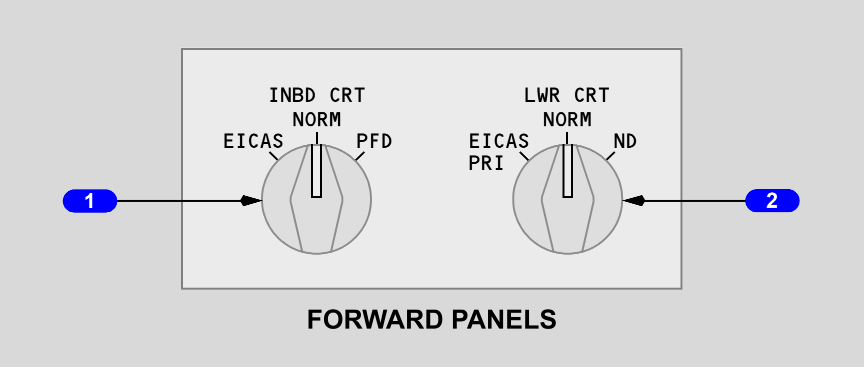
109, 405

C - center ADC provides information to the PFD and ND.

R - right ADC provides information to the PFD and ND.

Heading Reference, Inboard and Lower Displays

Inboard and Lower Display Controls



1 Inboard (INBD) Display Selector

EICAS - displays secondary or primary EICAS display on inboard unit.

NORM - displays ND on inboard display unit. Displays PFD if outboard display unit fails.

PFD - displays PFD on inboard display unit.

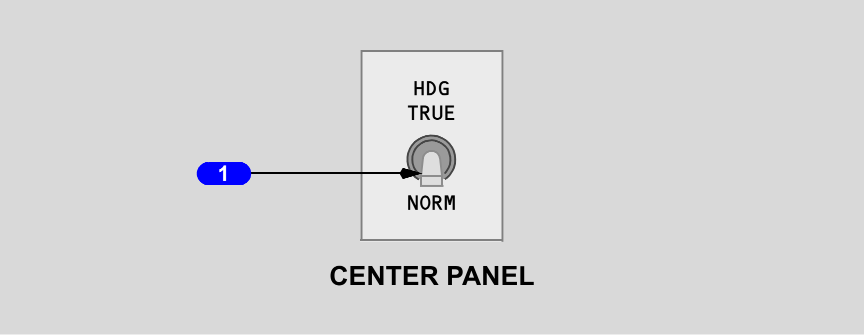
2 Lower (LWR) Display Selector

EICAS PRI - displays primary EICAS on lower display unit.

NORM - displays on lower display unit as selected on EICAS display select panel. Displays primary EICAS if upper display unit fails.

ND - displays ND on lower display unit.

Heading Reference Switch



1 Heading (HDG) Reference Switch

405

Selects heading reference for PFDs, NDs, AFDS, FMCs and RMI.

109, 570

Selects heading reference for PFDs, NDs, AFDS, and FMCs.

TRUE - references true north.

NORM -

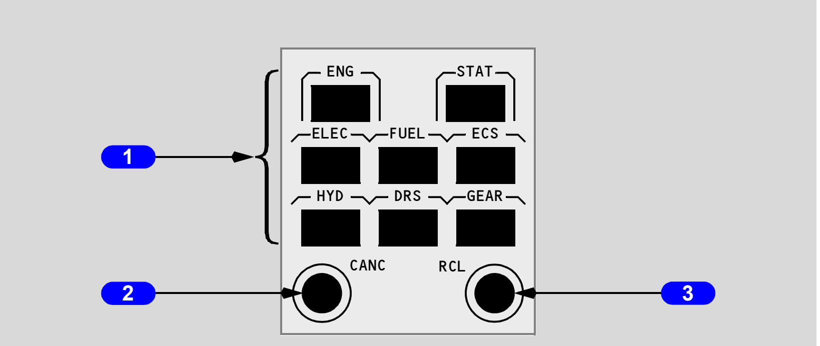
- references magnetic north

  405
- 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.

  109, 570
- 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 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 display unit. 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 synoptic (Ch. 14).

2 Cancel (CANC) Switch

Refer to Warning Systems, Chapter 15.

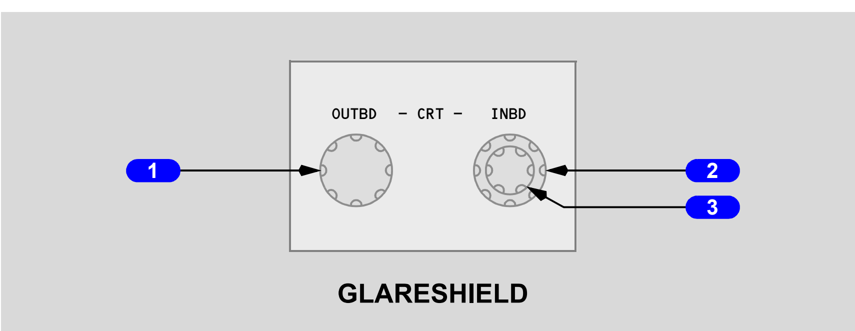
3 Recall (RCL) Switch

Refer to Warning Systems, Chapter 15.

Display Brightness Controls

The left panel is shown.

Outboard/Inboard Display Brightness Controls



1 Outboard (OUTBD) Display Brightness Control

Rotate - adjusts brightness of outboard display.

2 Inboard (INBD) Display Brightness Control (outer)

Rotate - adjusts brightness of inboard display.

3 Inboard (INBD) Display Brightness Control (inner)

109

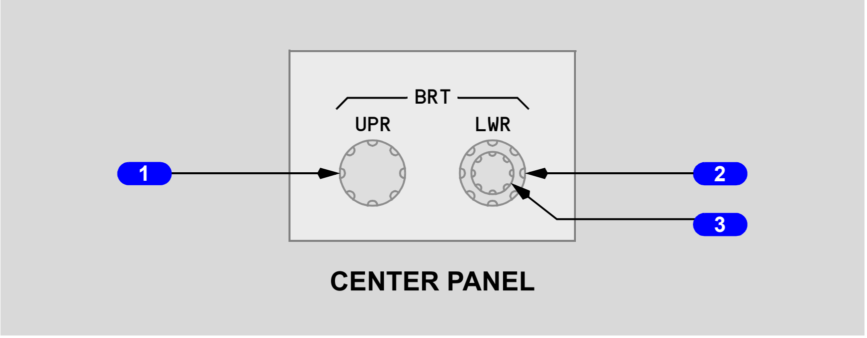
Rotate - adjusts weather radar display brightness on inboard display.

3 Inboard (INBD) Display Brightness Control (inner)

405, 570

Rotate - adjusts weather radar or terrain display brightness on inboard display.

Upper/Lower Display Brightness Controls



1 Upper (UPR) Display Brightness Control

Rotate - adjusts brightness of upper display.

2 Lower (LWR) Display Brightness Control (outer)

Rotate - adjusts brightness of lower display.

3 Lower (LWR) Display Brightness Control (inner)

109

Rotate - adjusts weather radar brightness on lower display.

3 Lower (LWR) Display Brightness Control (inner)

405, 570

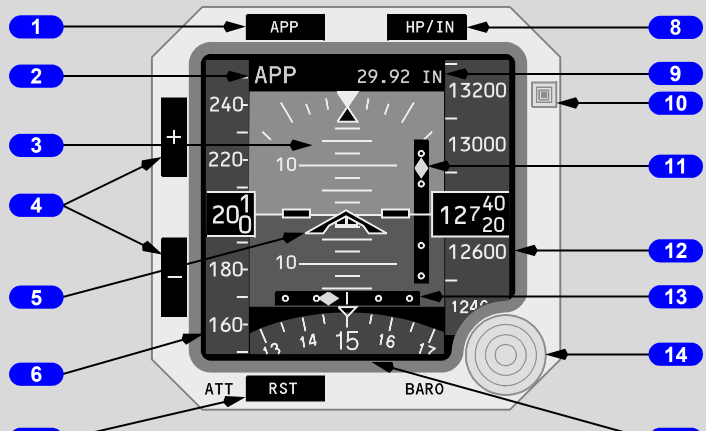
Rotate - adjusts weather radar or terrain display brightness on lower display.

Standby Flight Instruments

Integrated Standby Flight Display (ISFD)

570

Provides an independent source of attitude, airspeed, and altitude information.



CENTER FORWARD PANEL

1 Approach (APP) Switch

Push -

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks

2 Approach Mode Annunciation

Indicates approach mode selected.

Blank - no approach deviation data displayed.

APP - ILS localizer and glideslope deviation data displayed.

BCRS (back course) - reverses sensing for localizer pointer during back course approaches.

3 Attitude Display

Displays airplane attitude.

Indicates bank in reference to the bank scale.

Indicates the horizon relative to the airplane symbol.

Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive and the direction to the horizon line.

4 Display Brightness Switches

Push -

- + increases display brightness
- - decreases display brightness

5 Airplane Symbol

Indicates airplane position with reference to the horizon.

6 Airspeed Indications

Indicates airspeed when above 30 knots.

7 Attitude Reset (RST) Switch

Push and hold at least two seconds -

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds
- starts new initialization sequence if previous attempt failed (ground only).

8 Hectopascal/Inch (HP/IN) Switch

Push - changes units of barometric reference.

9 Barometric Setting

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

10 Ambient Light Sensor

Automatically adjusts display brightness for ambient lighting condition.

11 Glideslope Pointer and Scale

The glideslope pointer indicates glideslope position relative to the airplane -

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the BCRS mode is selected

12 Current Altitude

13 Localizer Pointer and Deviation Scale

The localizer pointer indicates localizer position relative to the airplane -

- the pointer is in view when the localizer signal is received
- the scale is in view when either the APP or BCRS mode is selected

14 Barometric Selector (BARO)

Rotate - changes barometric setting.

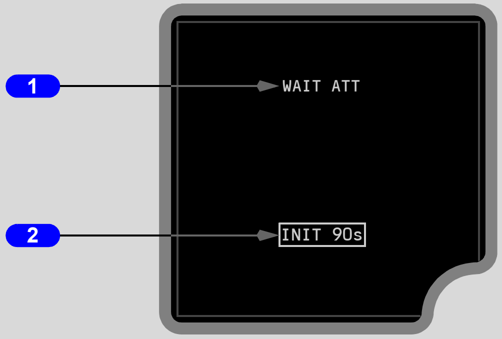
Push -

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD displayed, selects the preselected barometric setting

15 Heading Indication

Displays airplane heading.

ISFD Messages



ISFD

1 Attitude Messages

Indicates attitude display status.

ATT:RST - attitude must be reset using the attitude reset switch.

ATT 10s - 10 second attitude realignment in progress.

WAIT ATT - indicates temporary self correcting loss of attitude.

2 Initialization Message

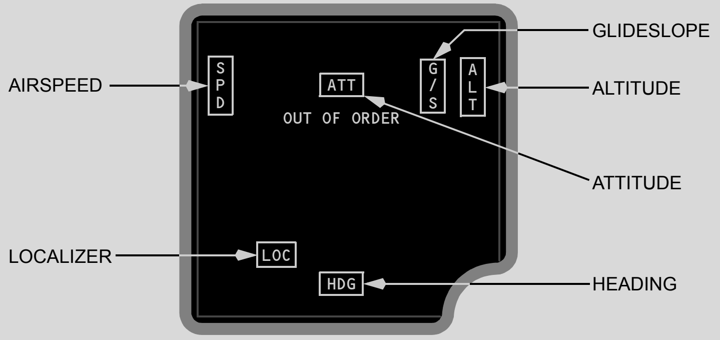
INIT 90s - countdown of 90 second initialization -

- countdown stops if excessive motion is detected
- countdown resumes when motion stops
- ATT:RST displays if initialization is not complete within six minutes.

ISFD Failure Flags

Failure flag replaces appropriate display.

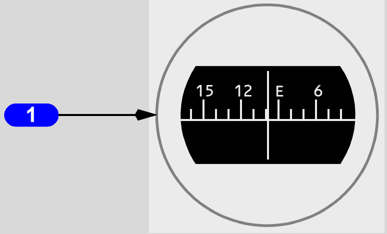
OUT OF ORDER indicates instrument system failure.



ISFD

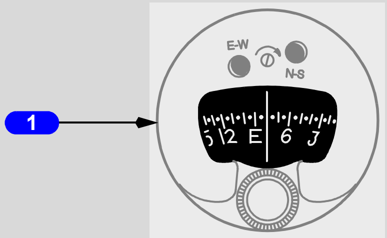
Standby Magnetic Compass

109, 405



CENTER POST
ABOVE GLARESHIELD

570



CENTER POST
ABOVE GLARESHIELD

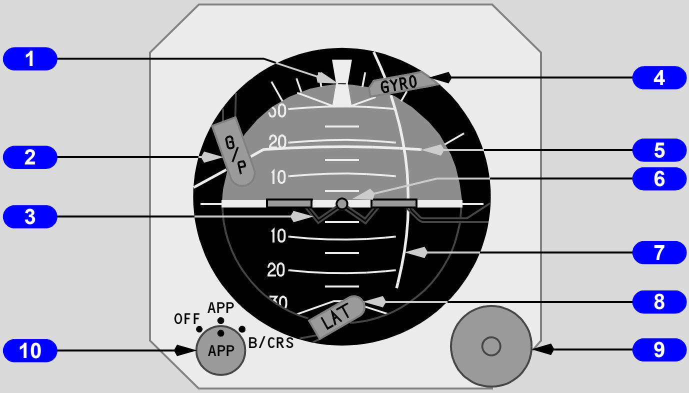
1 **Standby Magnetic Compass**

Displays magnetic heading.

Standby Attitude Indicator

109, 405

Standby attitude indicator provides an independent source of 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.

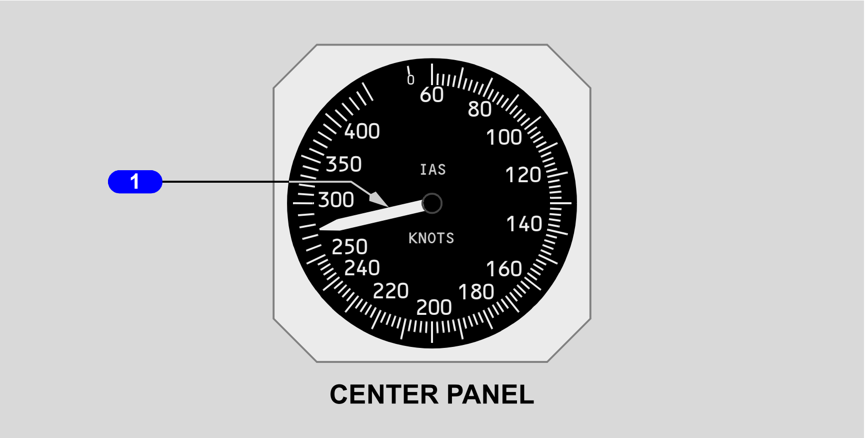
APP (Approach) - glide slope and localizer information displayed. Left ILS receiver used.

B/CRS (Back Course) - reverses sensing for localizer information.

Standby Airspeed Indicator

109, 405

Standby airspeed indicator displays airspeed from auxiliary pitot 1 and alternate static source.



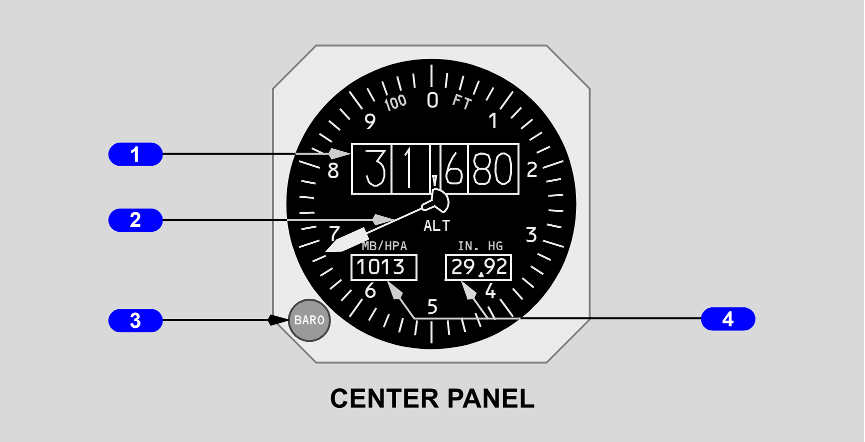
1 **Airspeed Pointer**

Indicates uncorrected airspeed.

Standby Altimeter

109, 405

Standby altimeter displays barometric altitude from alternate static source.



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

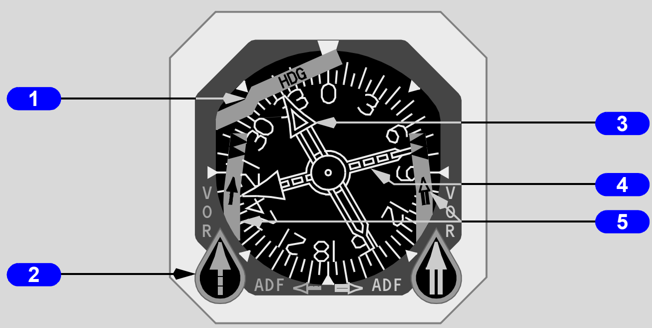
Displays selected barometric reference in Hectopascals (MB/HPA) and inches (IN. HG).

Radio Magnetic Indicator

405

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**

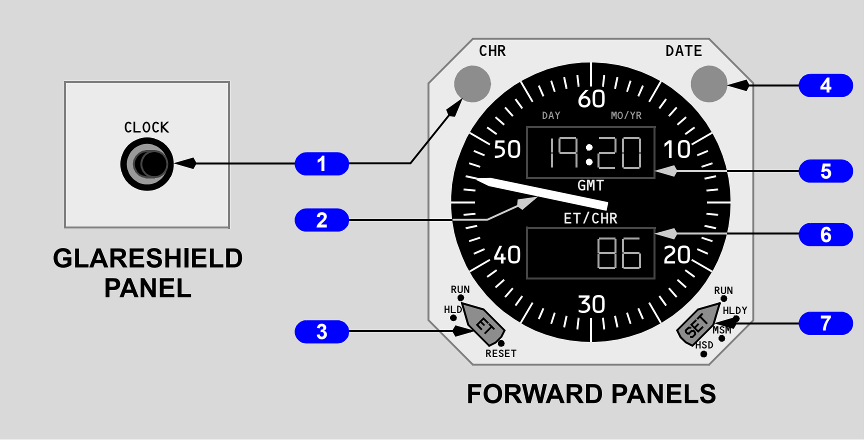
Indicates left VOR or ADF bearing to selected station.

5 **Pointer Flags**

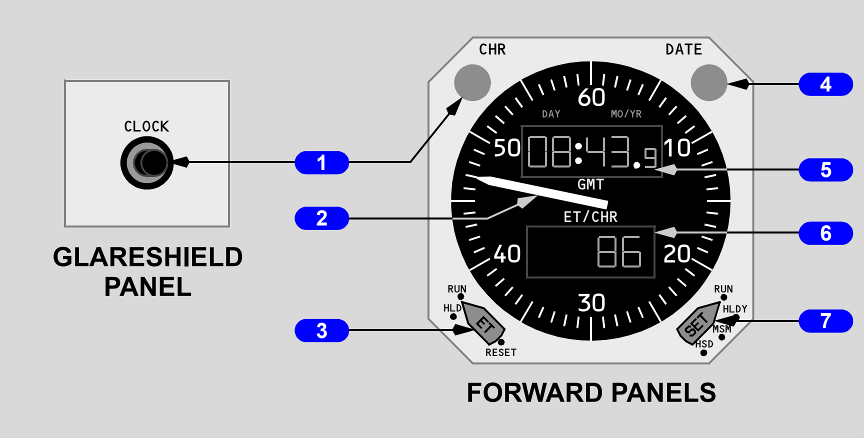
Display when selected information invalid.

Clock

109, 570



405



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
  109, 570
- subsequent push returns display to time (hours, minutes) on GMT display.
  405
- subsequent push returns display to time (hours, minutes, tenths of minutes) on GMT display.

5 **GMT Display**

109, 570

Displays time (hours, minutes).

405

Displays time (hours, minutes, tenths of 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

109

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).

405, 570

The CDU provides an alternate way to control the functions of the EFIS control panel and the display select panel except for TCAS and GPWS 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 -

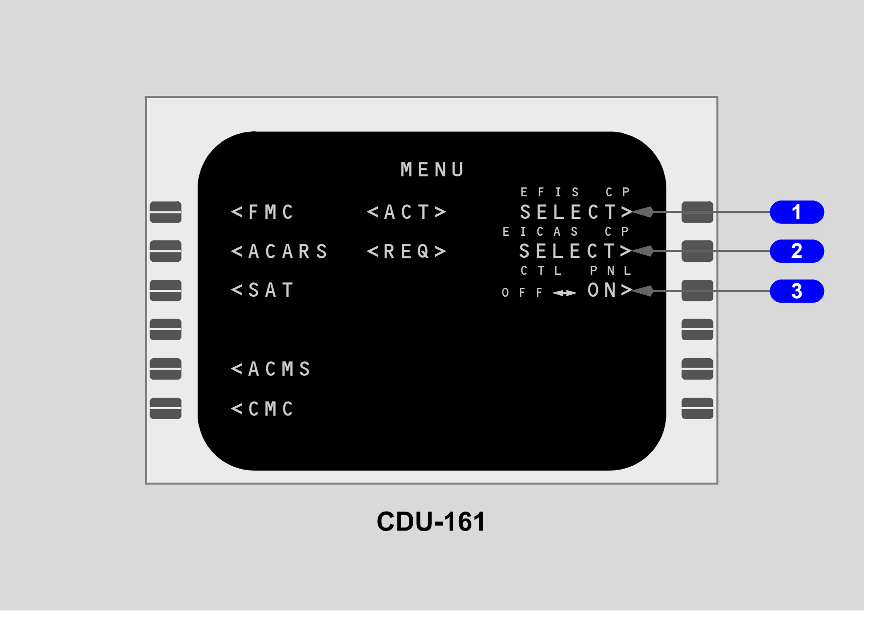
- displays alternate EFIS control page
- available if EFIS control panel fails

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

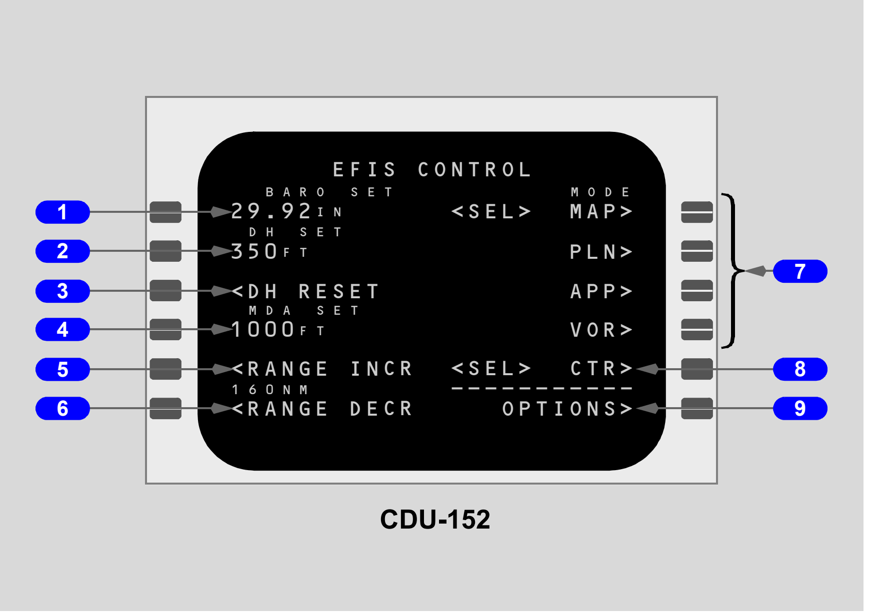
Push - (with SELECT displayed) displays alternate EICAS CONTROL page.

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 and EICAS CP SELECT prompts 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.

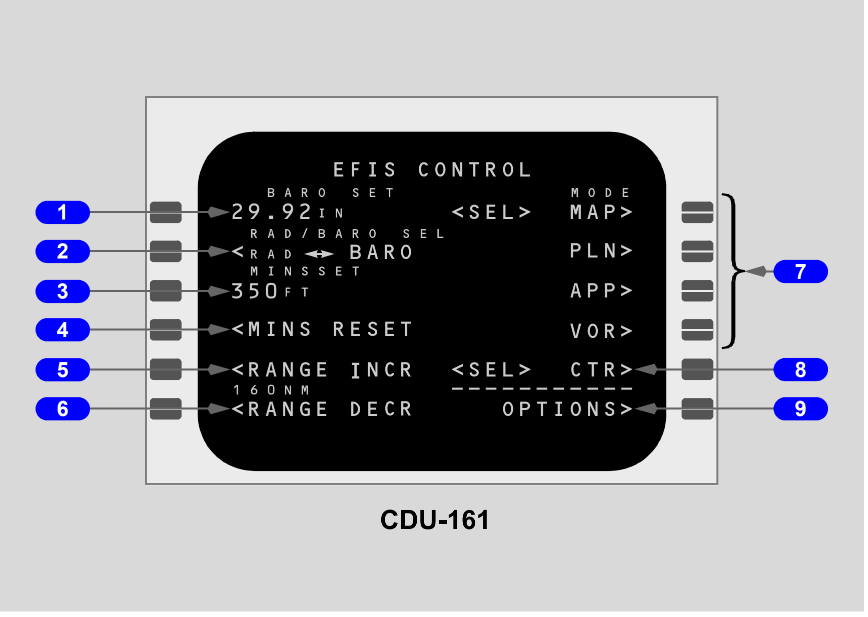
8 **ND Center (CTR)**

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

9 **EFIS OPTIONS**

Push - displays EFIS OPTIONS page.

EFIS Control Page (CDU-161)



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)
405, 570

- Push - alternately selects radio altimeter (RAD) or barometric altimeter (BARO) as the minimums reference on the PFD. Selected mode displays in large font.

2 Radio (RAD) or Barometric (BARO) select (SEL)
109

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.

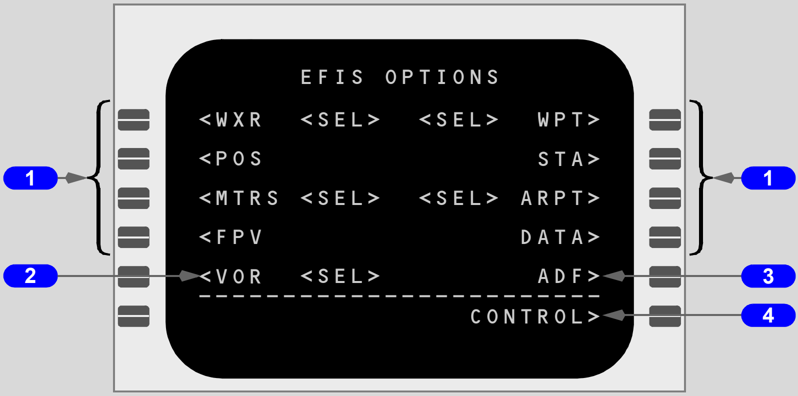
8 Center (CTR)

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, FPV, 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**

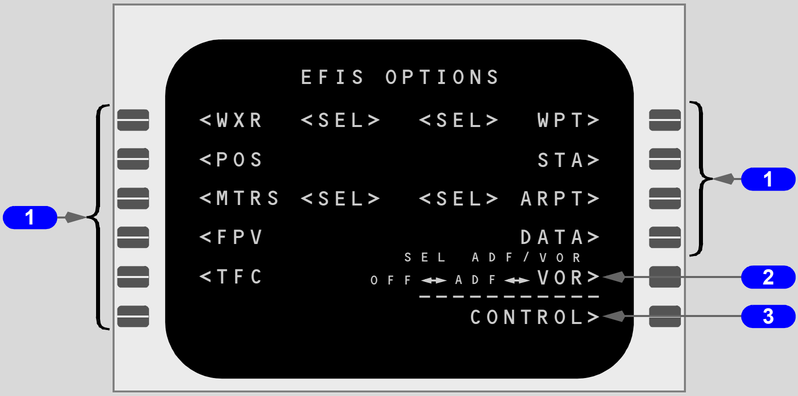
Push - selects left and right ADFs for display on ND and deletes VORs when previously selected.

4 **EFIS CONTROL**

Push - selects EFIS CONTROL CDU page.

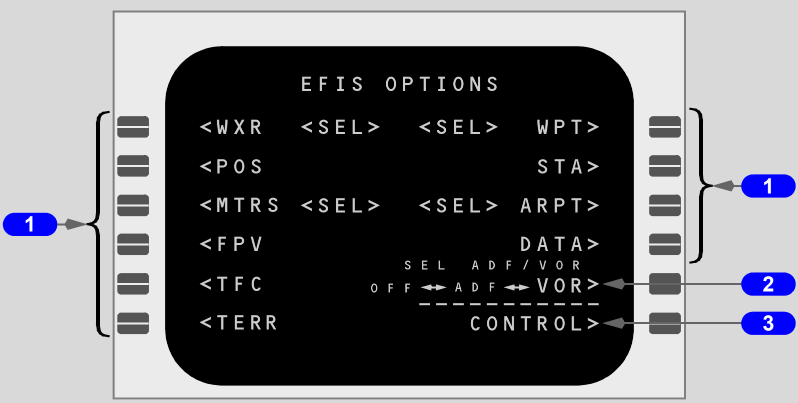
EFIS Options Page (CDU-161)

109



CDU-161

405, 570



CDU-161

1 WXR, POS, MTRS, FPV, TFC, WPT, STA, ARPT, DATA
109

Push - selects related PFD/ND options.

1 WXR, POS, MTRS, FPV, TFC, TERR, WPT, STA, ARPT, DATA
405, 570

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.

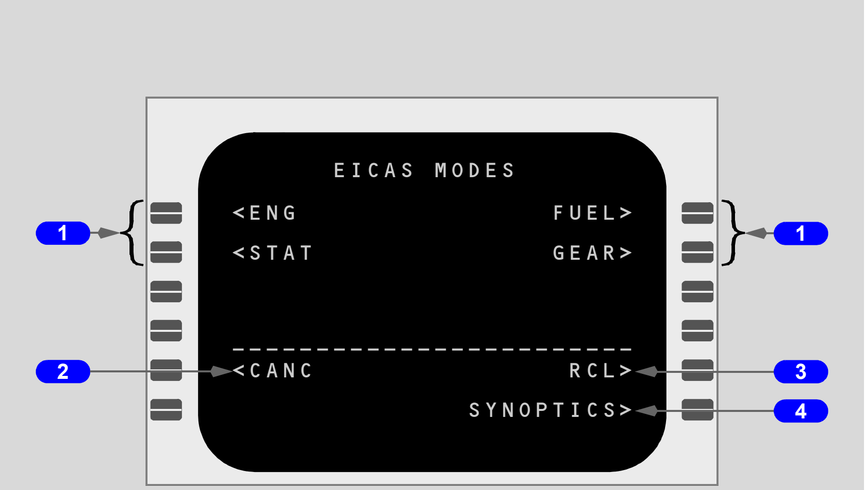
VOR - displays the VOR pointer, frequency, and associated DME on the ND in all modes except PLAN.

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.

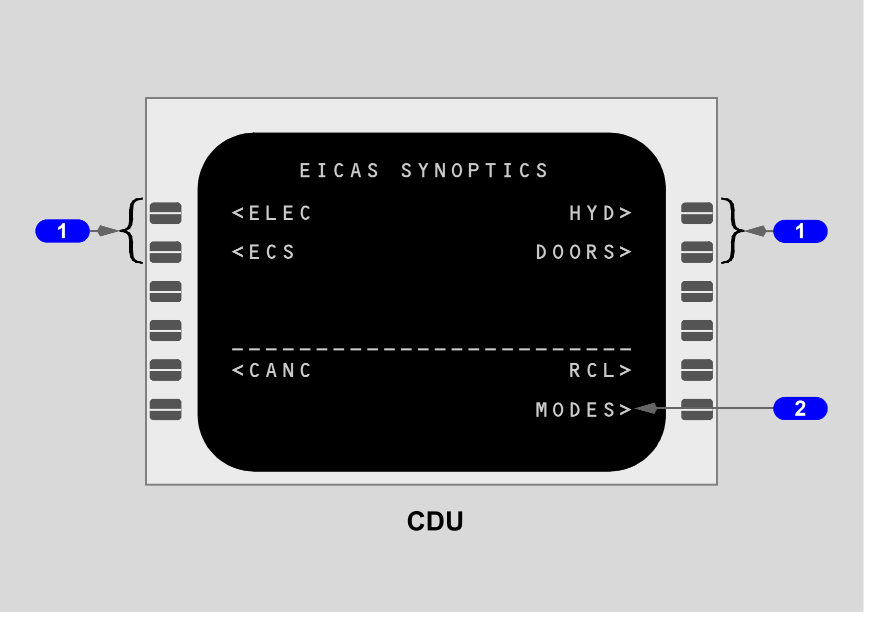
3 Recall (RCL)

Refer to Warning Systems, Chapter 15.

4 EICAS SYNOPTICS

Push - selects EICAS SYNOPTICS page.

EICAS Synoptics Page



1 Synoptic/Display

Push - displays related synoptics/display.

2 EICAS MODES

Push - selects EICAS MODES page.

Flight Instruments, Displays Chapter 10
System Description Section 20

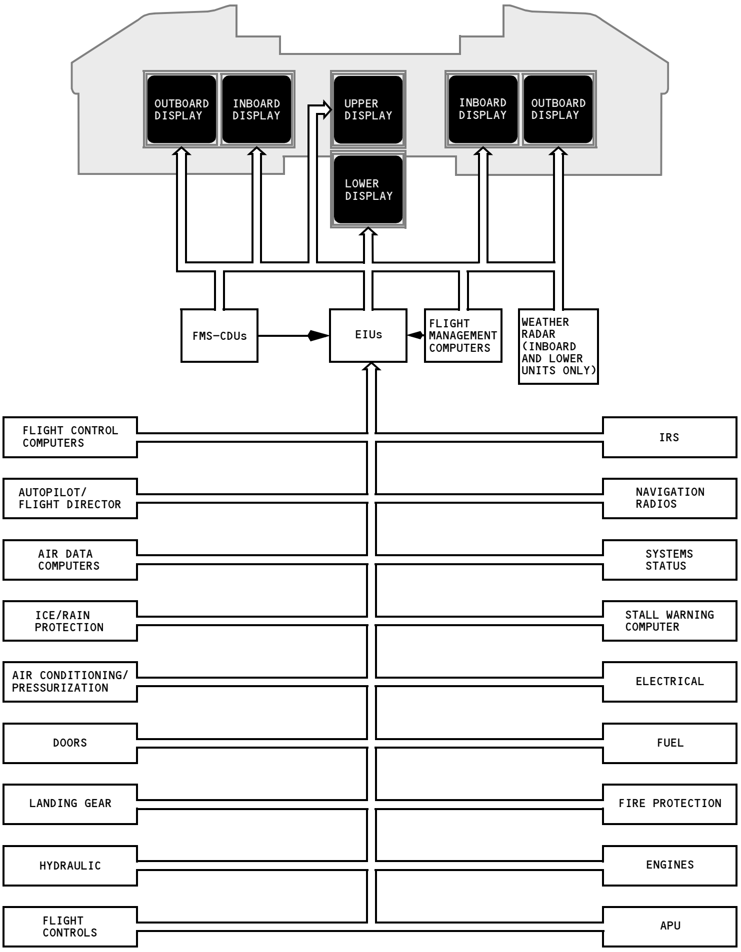
Introduction

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 display units. The units 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 display selectors are set to NORM
- PFDs display on two outboard display units
- NDs display on two inboard display units
- EICAS displays on upper and lower display units

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.

Display Brightness Control

The brightness of each display can be adjusted. The outboard and inboard display brightness controls are on the glareshield. The upper and lower display brightness controls are on the center panel. The inner brightness control for the inboard and lower display units control the weather radar returns.

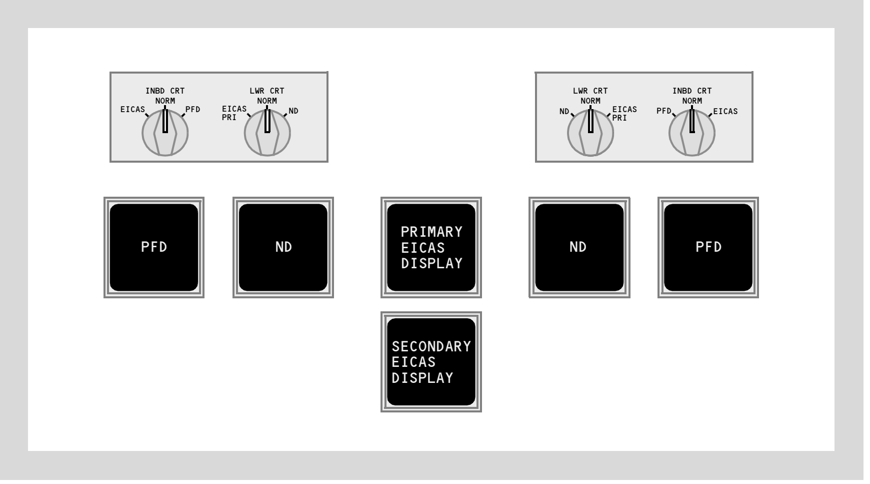
If a display color fails, the display changes color but all indications remain distinguishable and no information is lost.

Light sensors above the glareshield and near each display and CDU measure ambient light level and adjust display brightness to maintain the desired illumination.

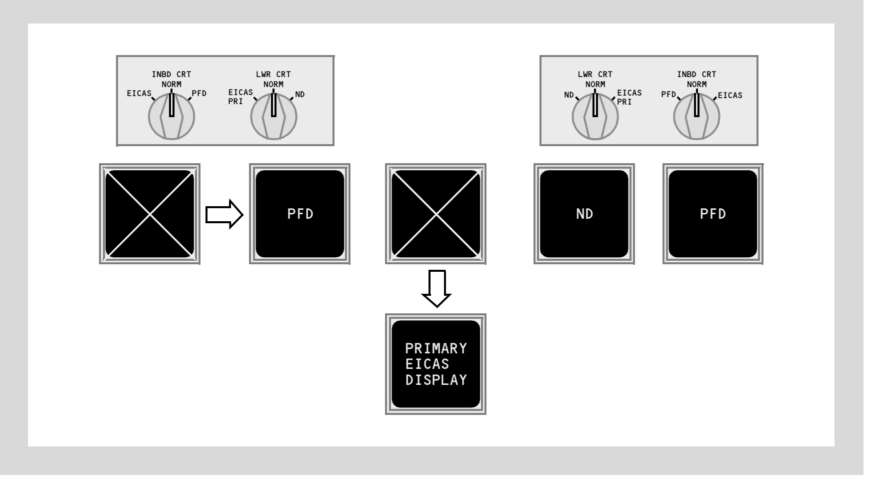
Display Selection and Control Examples

The following examples depict display selections.

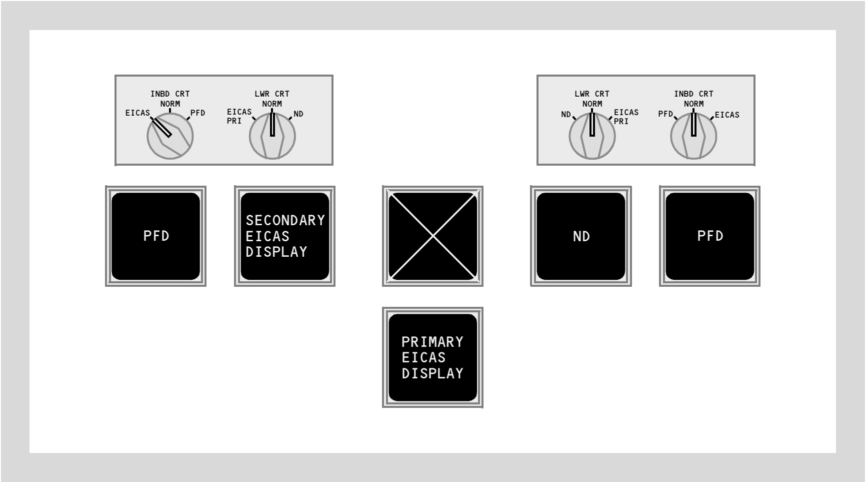
Normal Display Configuration



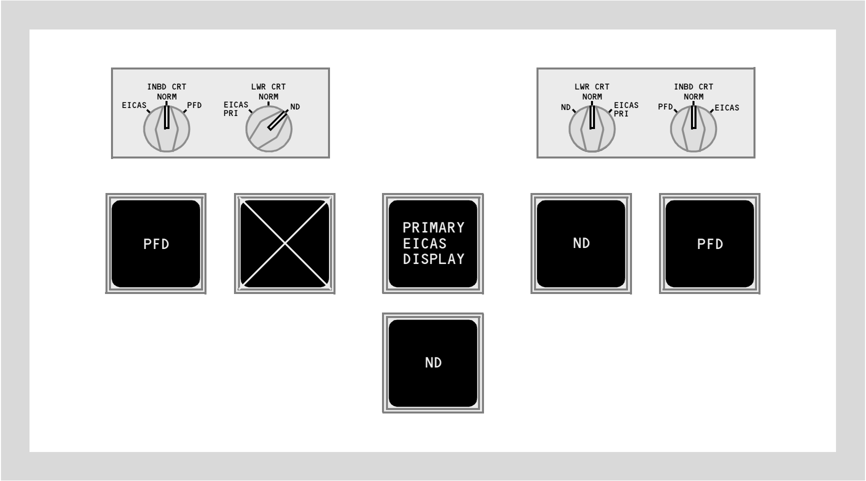
Display Failure Automatic Switching



Inboard Display Switching



Lower Display Switching



Standby Flight Instruments

The standby flight instruments include:

570

- integrated standby flight display
- standby magnetic compass

405

- standby magnetic compass
- standby attitude indicator
- standby airspeed indicator
- standby altimeter
- radio magnetic indicator

109

- standby magnetic compass
- standby attitude indicator
- standby airspeed indicator
- standby altimeter

Integrated Standby Flight Display (ISFD)

570

The ISFD displays attitude, airspeed, altitude, ILS, and magnetic heading information. The ISFD receives pitot and static pressure from auxiliary pitot and alternate static sources. Attitude information is provided by internal inertial sensors. ILS information is provided by the left ILS receiver. The display receives its heading information from the left IRU. Heading information not available in polar regions.

Note: The standby magnetic compass must be used to validate heading information.

The main battery bus powers the ISFD. Selecting the battery switch ON activates the ISFD. After 10 seconds, a 90 second initialization sequence begins. ATT and INIT 90s messages display during initialization. Initialization will stop if airplane movement is excessive and will resume when airplane movement is acceptable for initialization. Upon completion of the initialization sequence, attitude information displays.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. When the ATT:RST message displays, pushing the Attitude Reset switch resets the horizon line with the airplane symbol.

On the ground, pushing the Attitude Reset switch must be accomplished with the airplane stationary. In flight, pushing the Attitude Reset switch must be accomplished with the airplane in wings level, non-accelerated flight. During attitude reset, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If attitude reset is unsuccessful, the ATT:RST message remains displayed and the attitude will not be displayed.

Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is located on the center post above the glareshield. A card located near the compass provides heading correction factors.

Standby Attitude Indicator

109, 405

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

109, 405

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

109, 405

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

405

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 GPS is not available. 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

109, 405

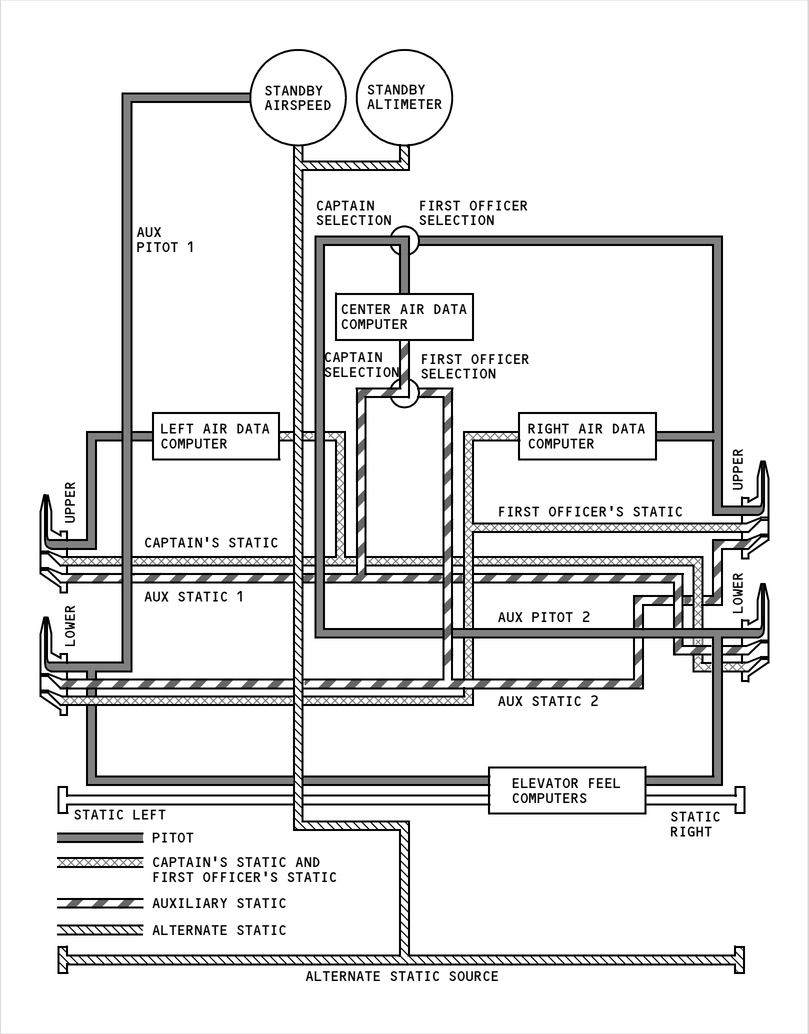
The pitot static system provides pitot pressure and static pressure to the air data computers, standby airspeed indicator, standby altimeter, and elevator feel computer.

570

The pitot static system provides pitot pressure and static pressure to the air data computers, integrated standby flight display, and elevator feel computer.

Pitot Static Diagram

109, 405



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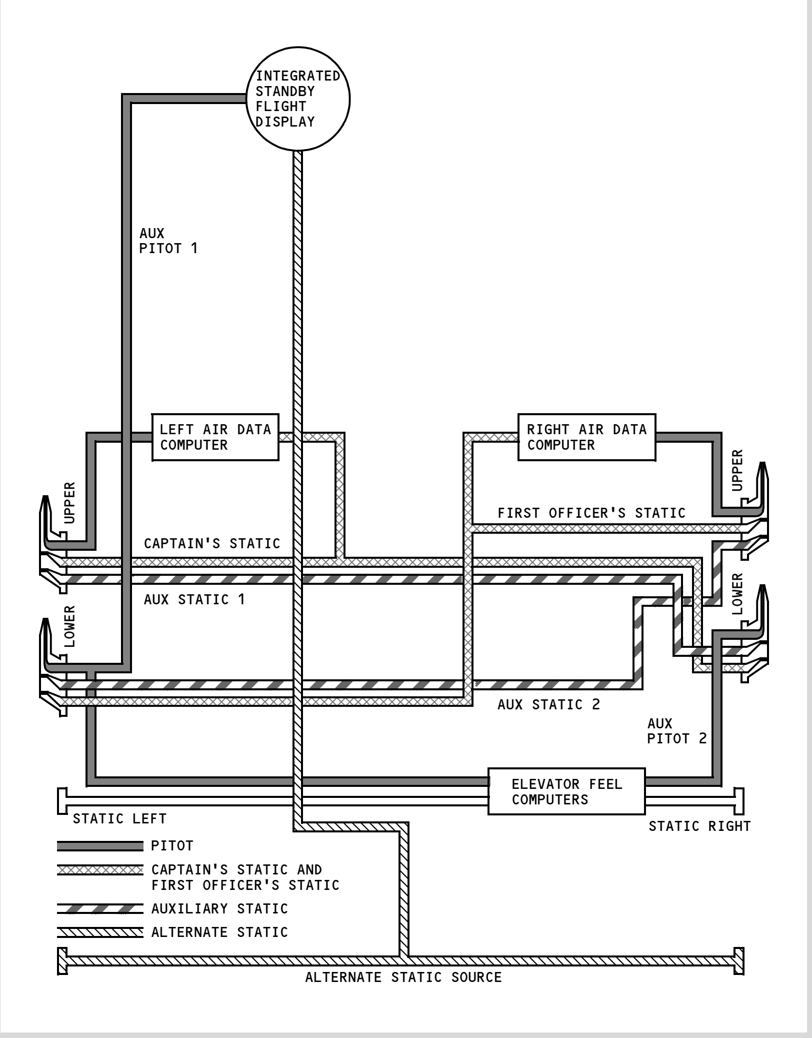

Air Data Computer (ADC) System

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.

570

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.

109, 405

There are two primary ADCs and one standby ADC. 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. The left and right primary ADCs provide flight information to the Captain's and F/O's flight instruments. The center ADC is a backup for the left and right ADCs and is selected with the Air Data Source selectors. AOA sensor inputs to ADCs are required for displaying airspeed, Mach, and altitude information. When selecting the center ADC, vertical speed indications may lag actual conditions.

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. The TAT probe must be aspirated by bleed air to provide accurate information.

Static Air Temperature (SAT)

SAT displays on Progress page 2.

Intentionally
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Flight Instruments, Displays — Chapter 10
Primary Flight Displays (PFDs) — Section 30

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.

Alerts on the PFD display in capital letters between the attitude display and the compass rose. Refer to Chapter 15, Warning Systems.

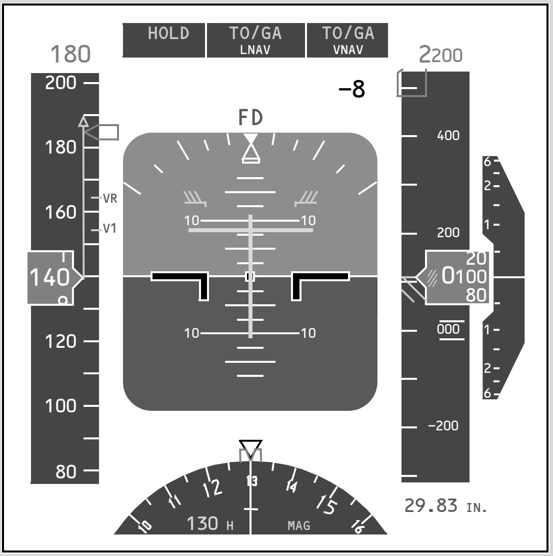
Typical PFD Displays

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

Liquid Crystal Display

109, 405



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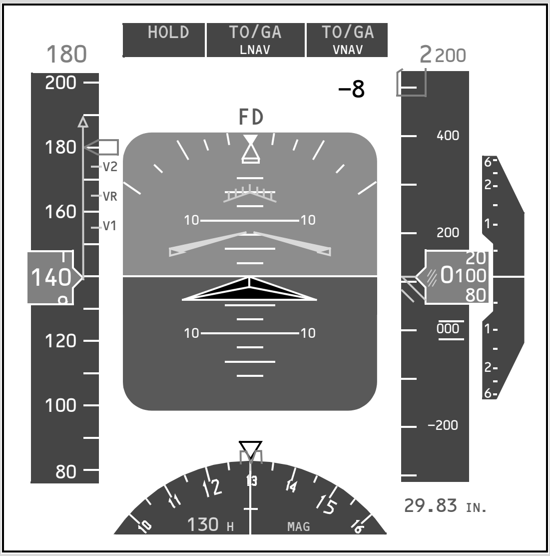
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TO/GA
VNAV
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200
180
160
140
120
100
80
V2
VR
V1
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-8
FD
400
200
-200
20
0100
80
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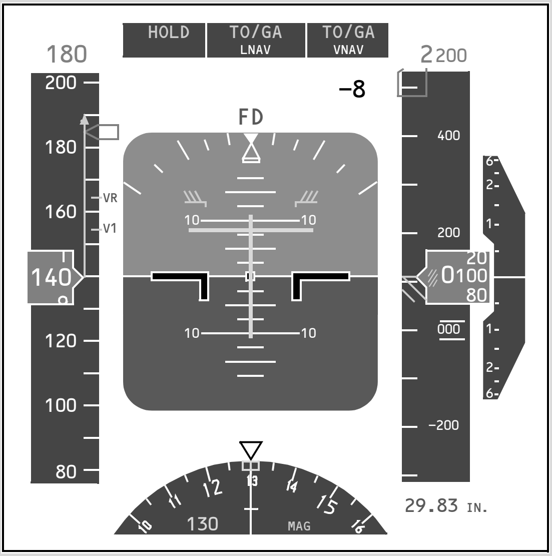
10
10
6
2
1
1
2
6
130 H
MAG
29.83 IN.

Cathode Ray Tube

109, 405



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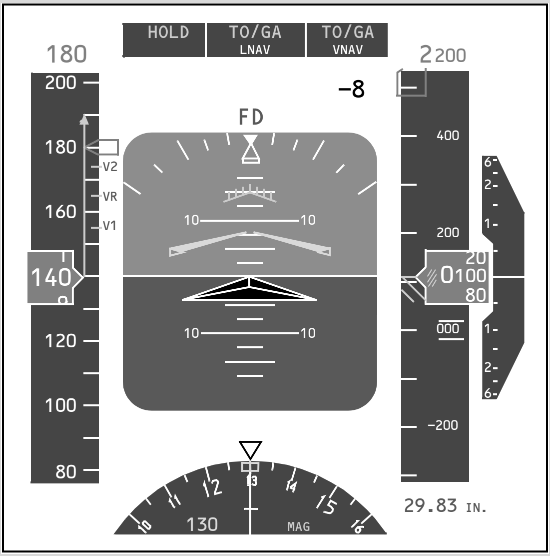
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LNAV
TO/GA
VNAV
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200
180
160
140
120
100
80
V2
VR
V1
FD
-8
10
10
10
10
2200
400
200
0100
20
80
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-200
29.83 IN.
130
MAG
6
2
1
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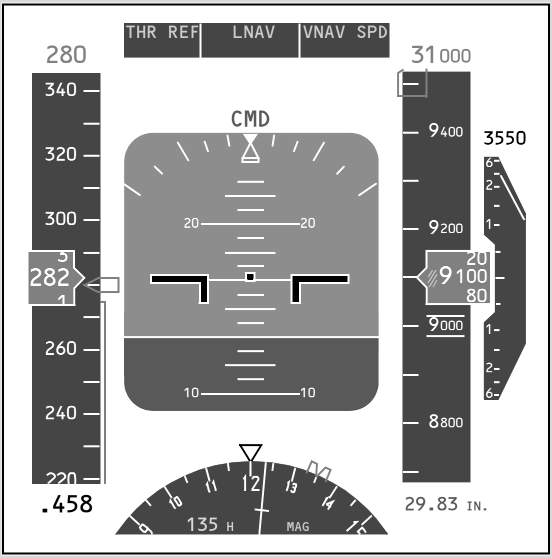
2
6

PFD Climb Display

Liquid Crystal Display

109, 405



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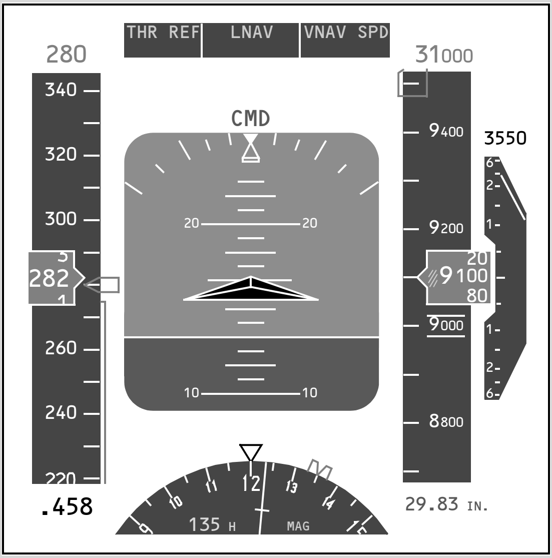
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LNAV
VNAV SPD
280
31000
CMD
340
320
300
282
260
240
220
.458
9400
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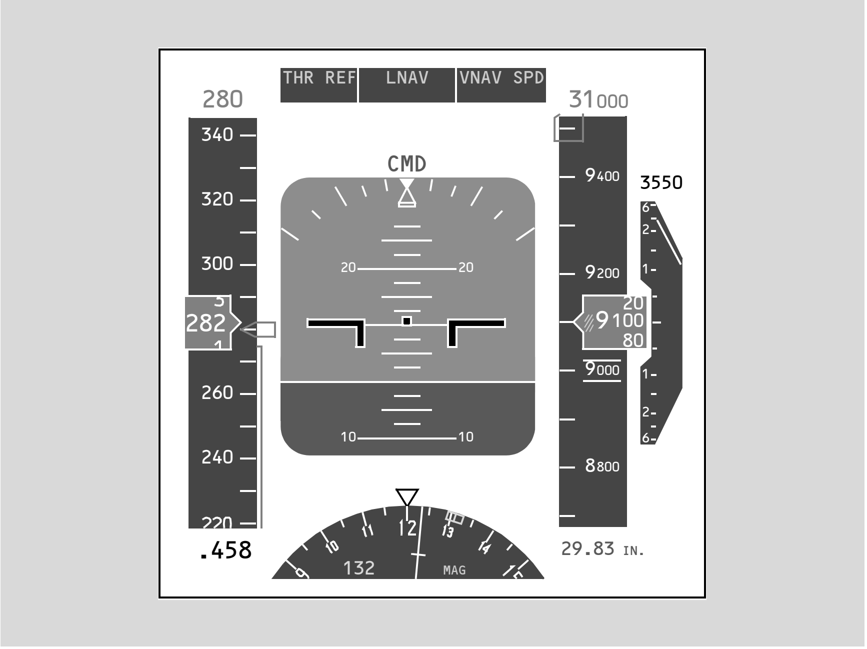
29.83 IN.
135 H
MAG

Cathode Ray Tube

109, 405



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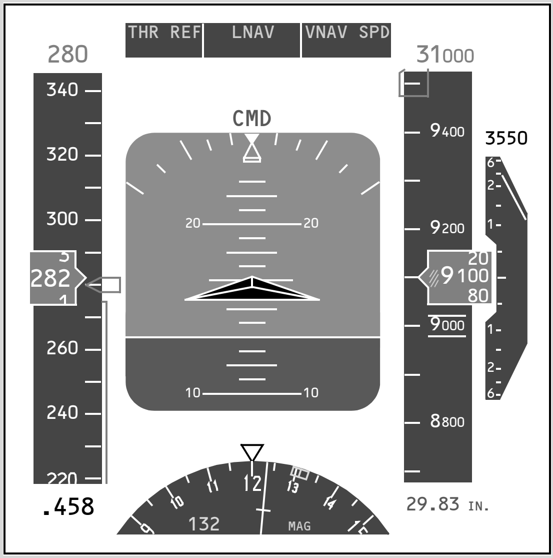
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3550
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20
10
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13
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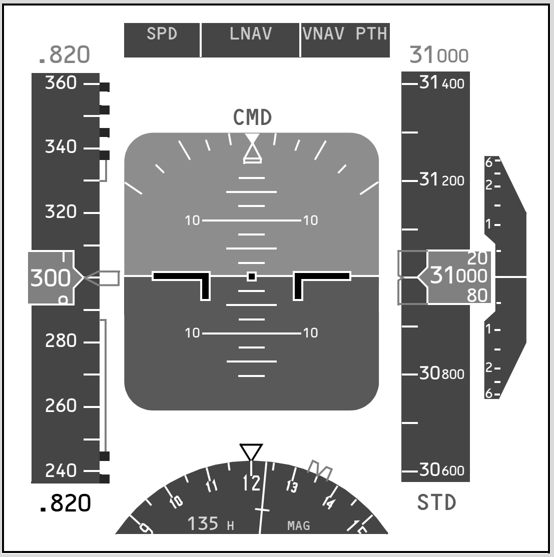
132
MAG

PFD Cruise Display

Liquid Crystal Display

109, 405



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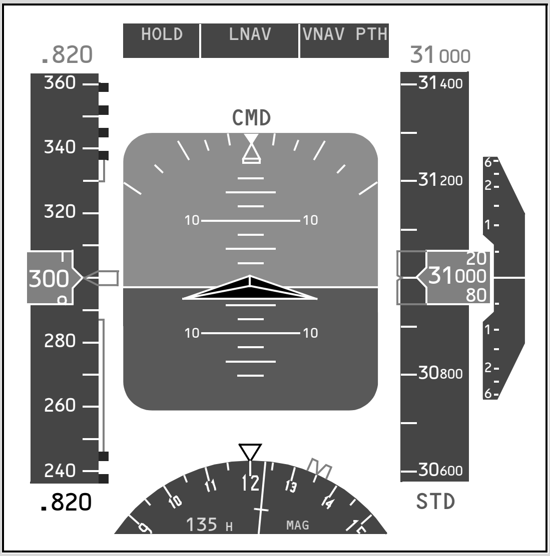
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VNAV PTH
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.820
CMD
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31200
31000
20
80
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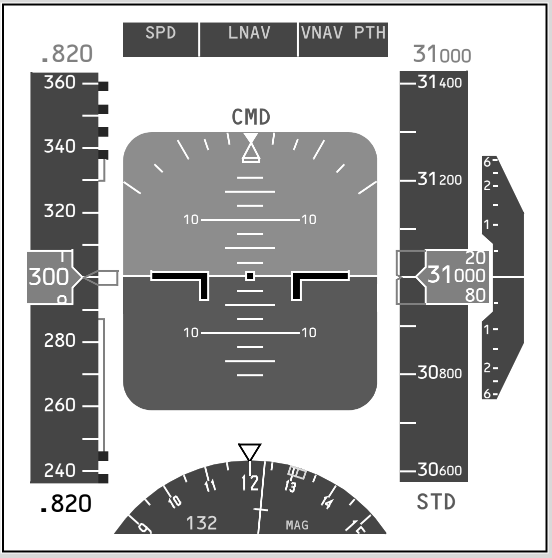
135 H
MAG

Cathode Ray Tube

109, 405



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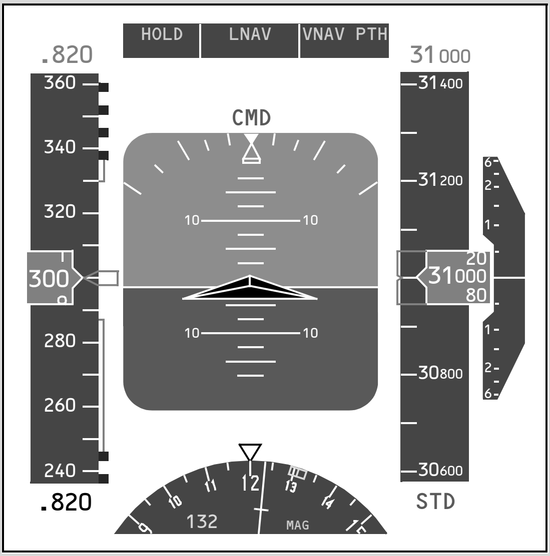
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CMD
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31 400
31 200
20
31 000
80
30 800
30 600
STD
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6
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11
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13
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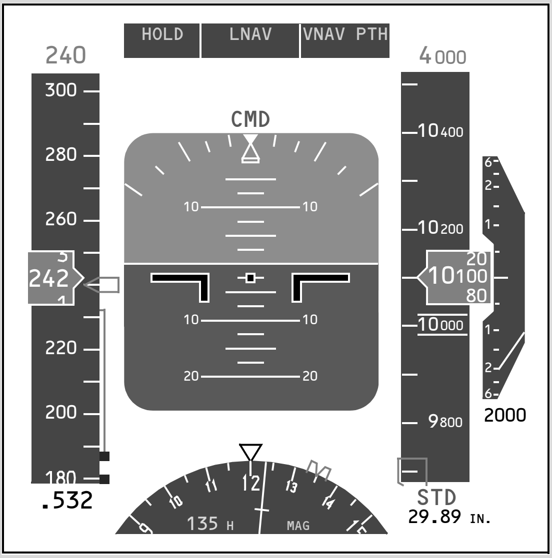
132
MAG

PFD Descent Display

Liquid Crystal Display

109, 405



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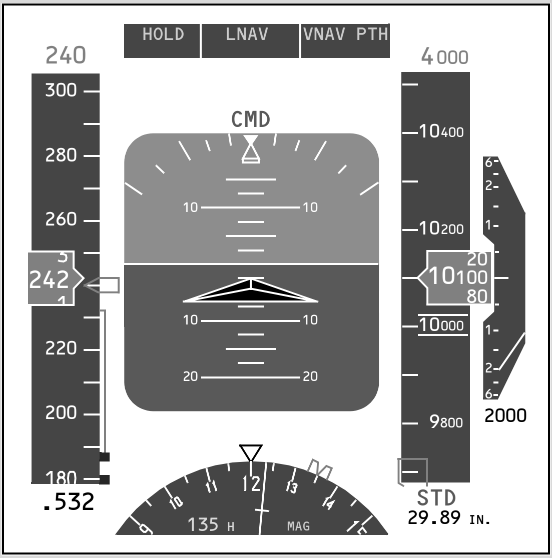
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VNAV PTH
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.532
CMD
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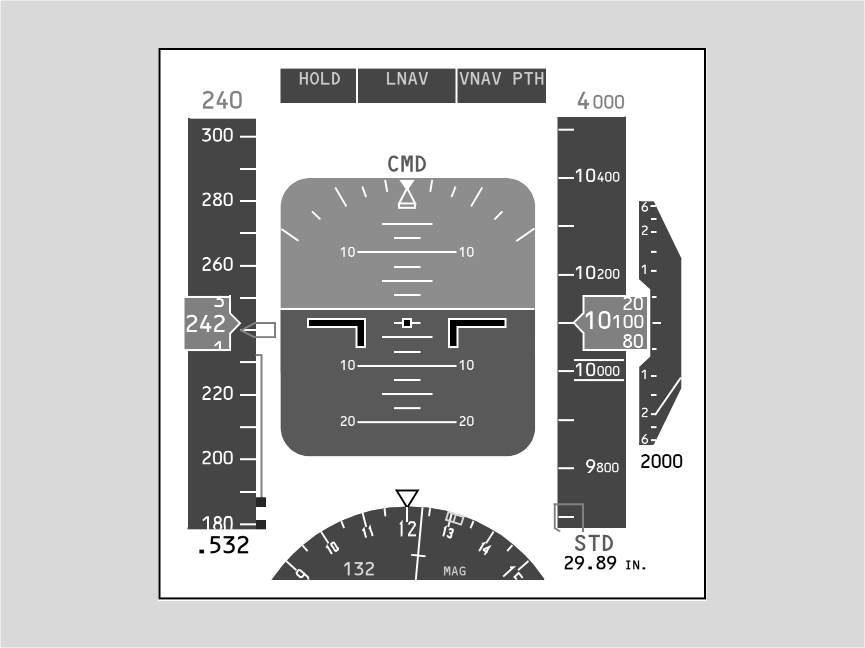
Cathode Ray Tube

109, 405



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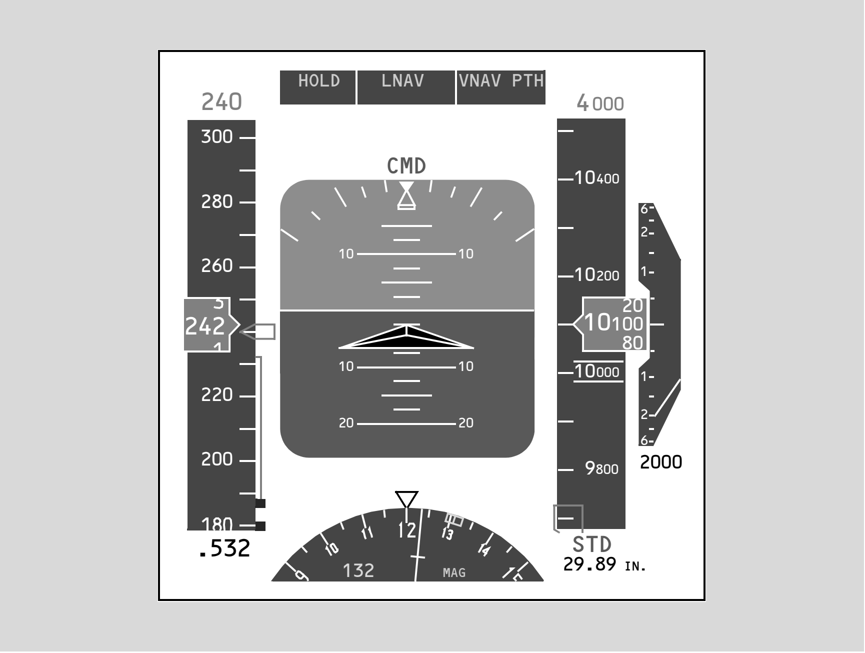
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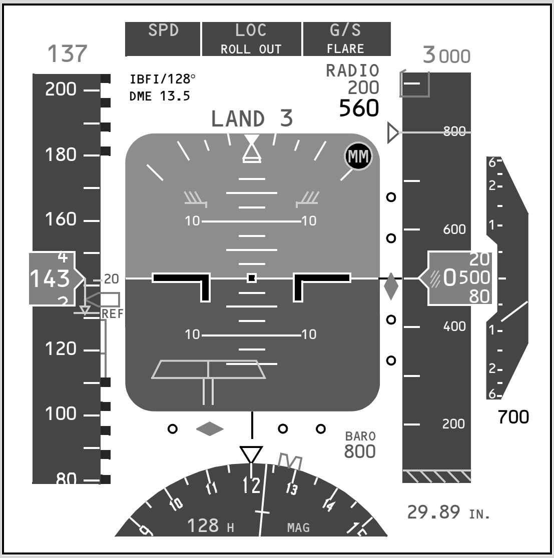
PFD Approach Display

Liquid Crystal Display

405



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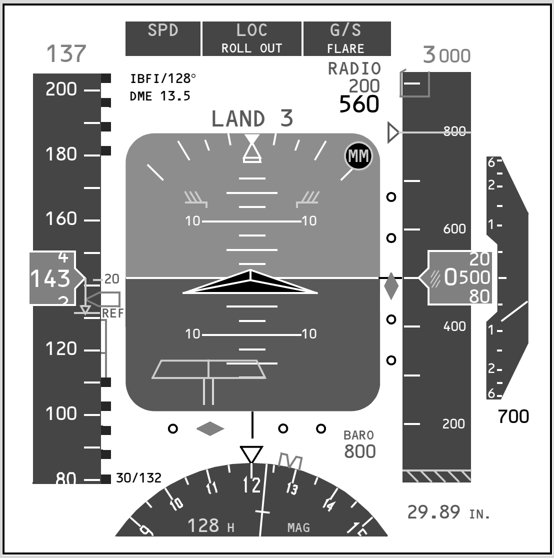
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DME 13.5
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LAND 3
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160
143
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REF
120
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BARO
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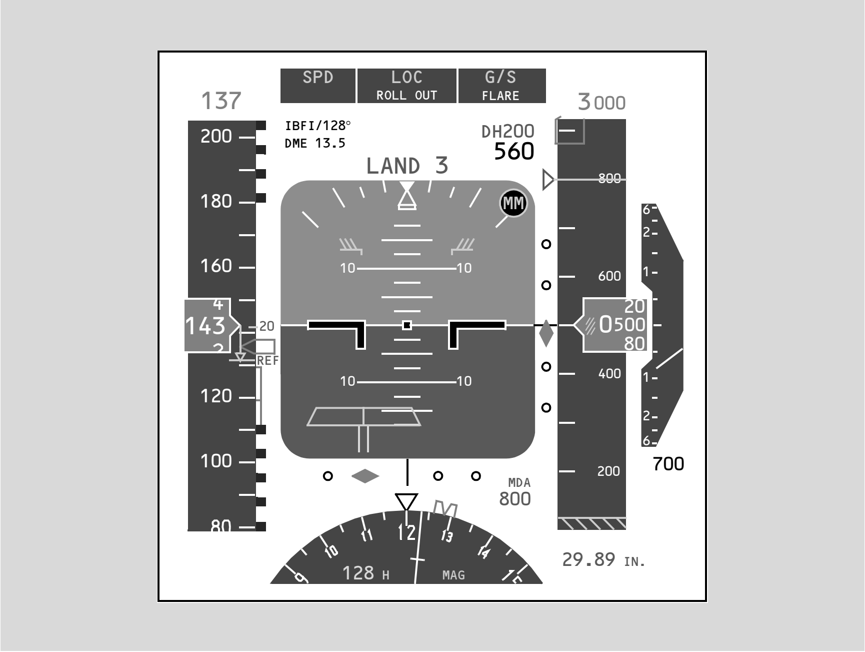
128 H
MAG
29.89 IN.

109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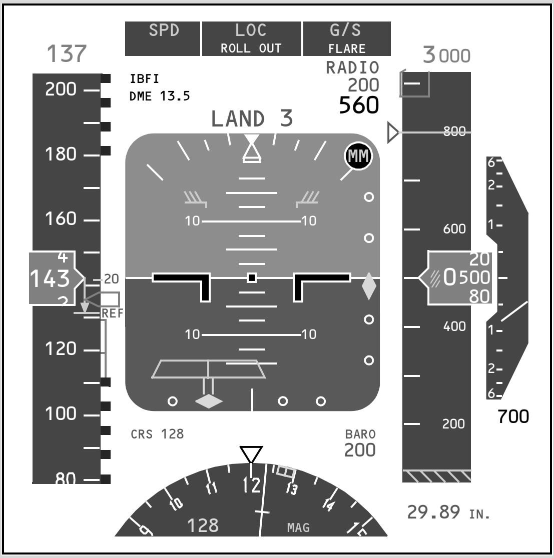
Cathode Ray Tube

405



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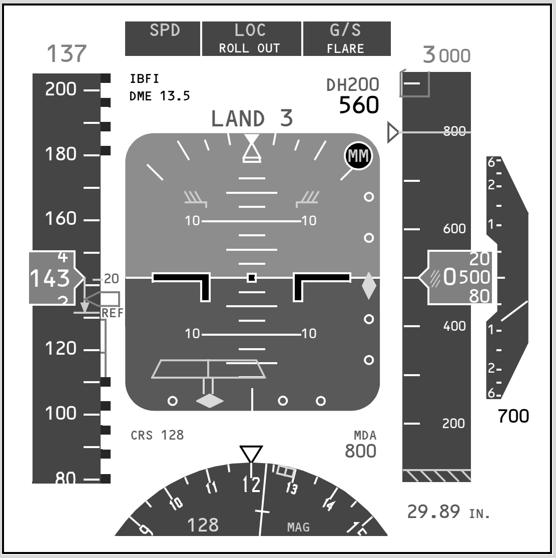
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CRS 128
MDA
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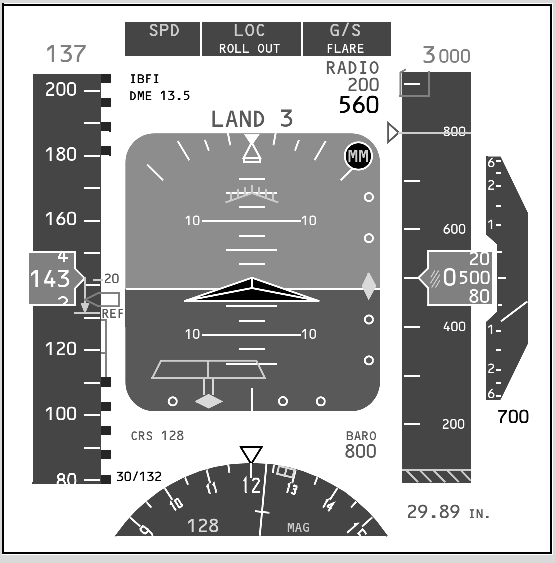
128
MAG
29.89 IN.

570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REF
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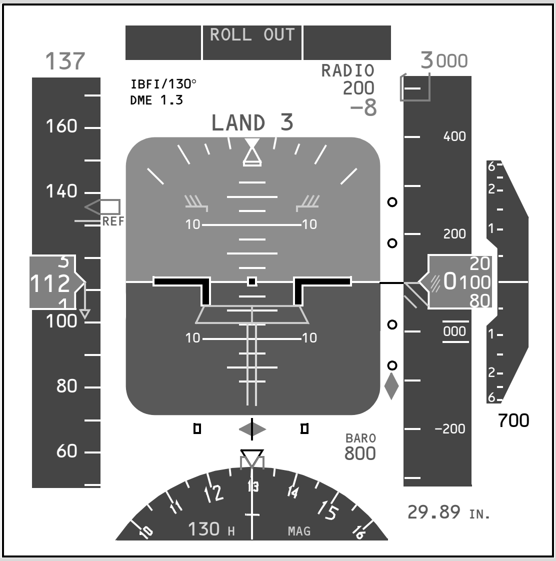
MAG
29.89 IN.

PFD Landing Display

Liquid Crystal Display

405



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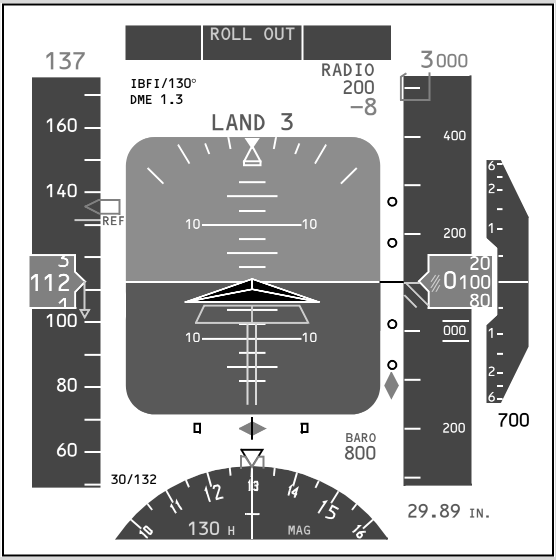
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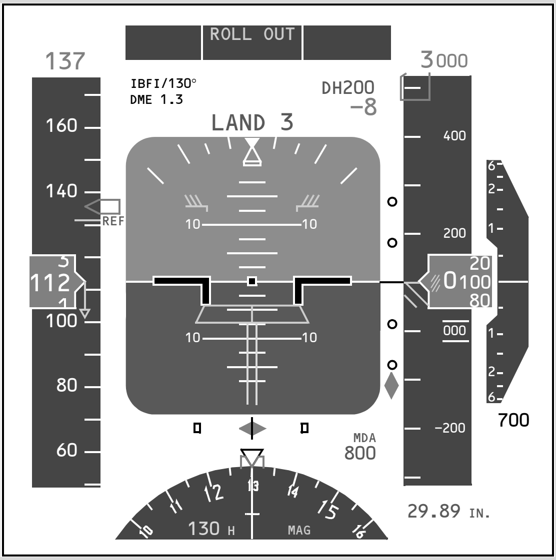
130 H
MAG
29.89 IN.

109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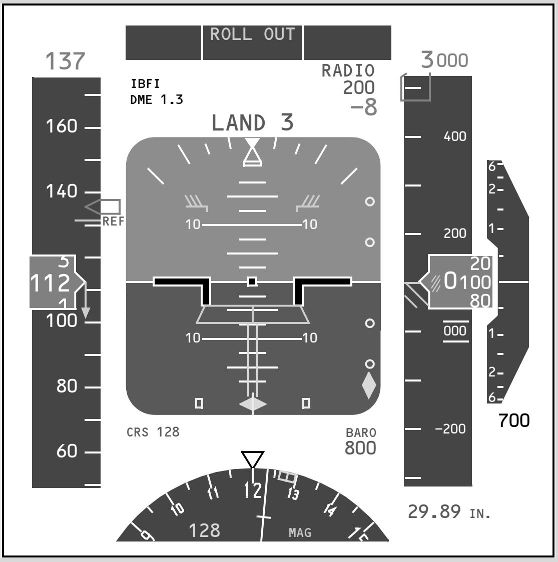
MAG
29.89 IN.

Cathode Ray Tube

405



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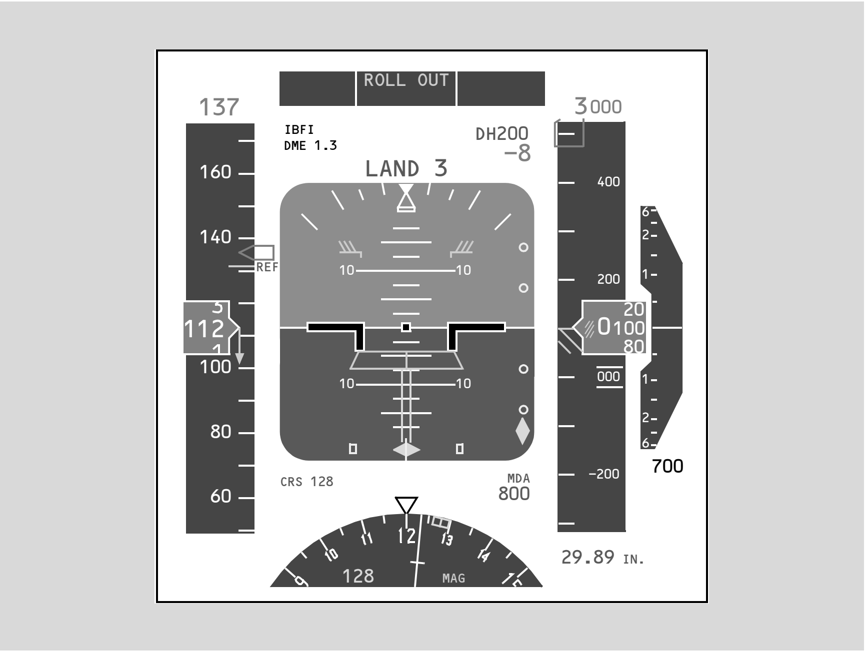
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CRS 128
MDA
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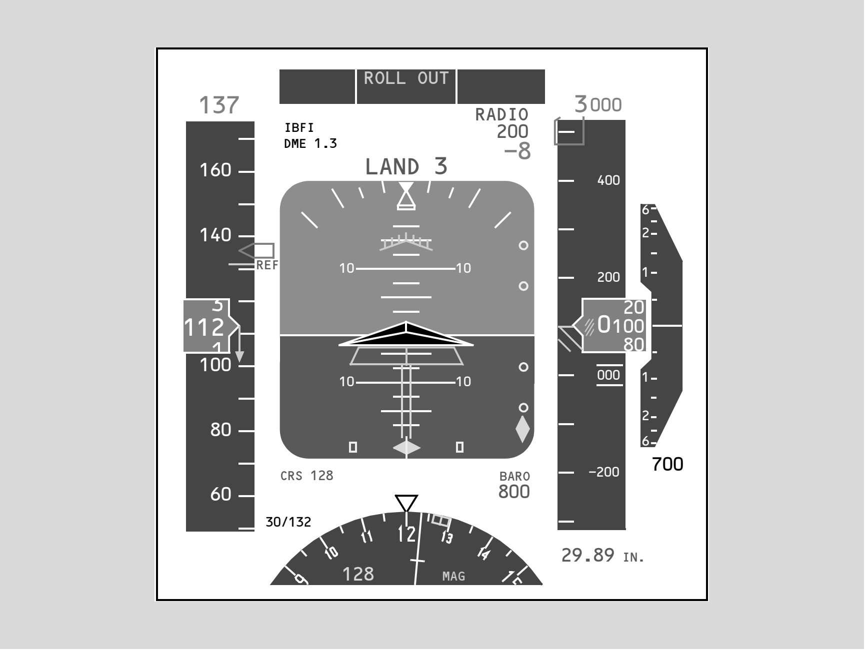
128
MAG
29.89 IN.

570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3000
400
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0100
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80
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-200
700
CRS 128
BARO
800
30/132
12
13
128
MAG
29.89 IN.

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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.

405

Presented heading up, this mode shows airplane position relative to the route of flight against a moving map background.

109, 570

Presented track up, this mode shows airplane position relative to the route of flight against a moving map background.

405, 570

Displayed information can include:

- track
- heading
- route
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points
- TCAS Traffic Display

109

Displayed information can include:

- track
- heading
- route
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data point
- 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 IRU 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.

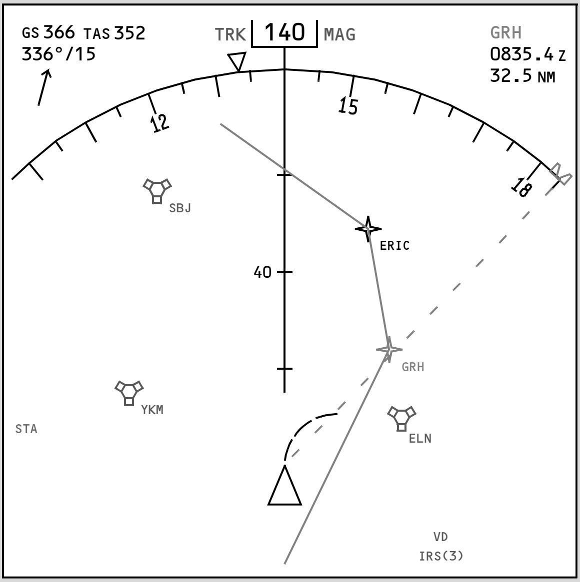
The message EXCESS DATA displays on the ND if the amount of information sent to the ND exceeds the display capability. The message can be removed by deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA).

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.

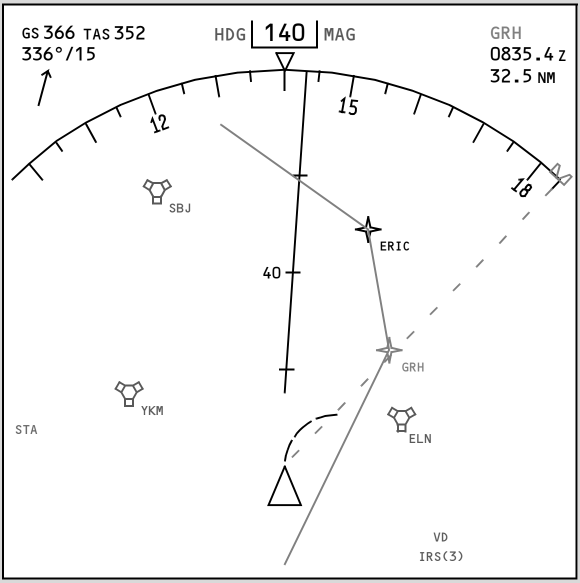
Liquid Crystal Display

570



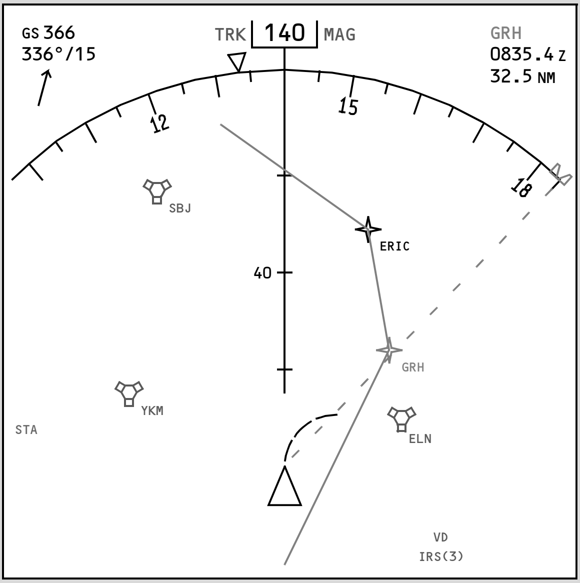
STA (STATION) SELECTED

405



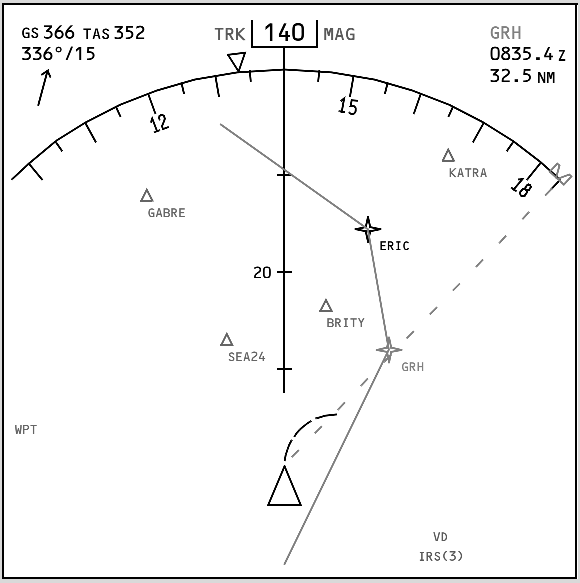
STA (STATION) SELECTED

109



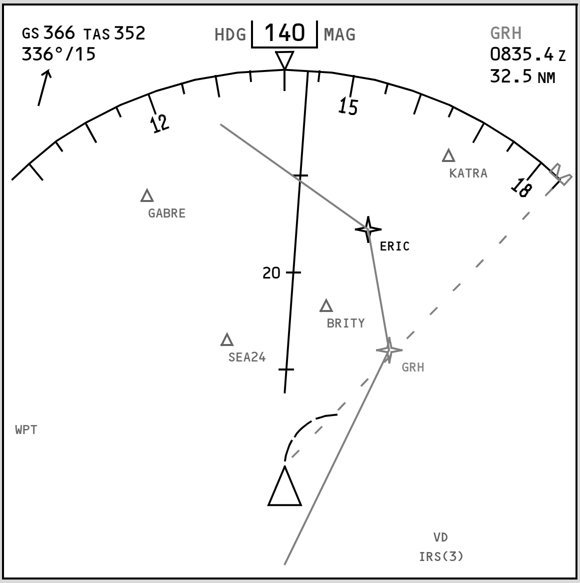
STA (STATION) SELECTED

570



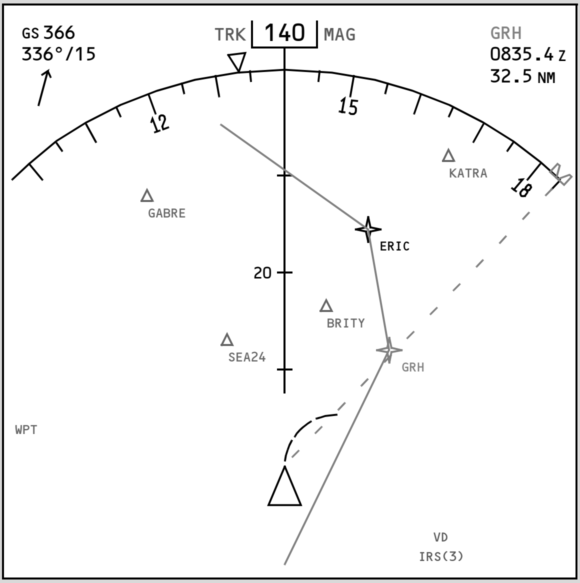
WPT (WAYPOINT) SELECTED

405



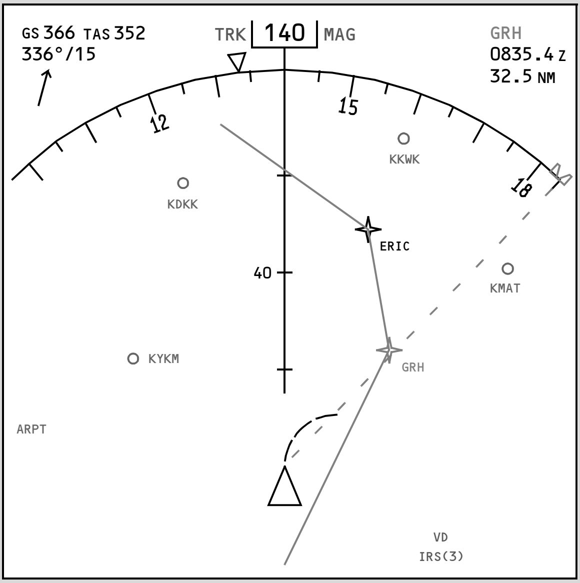
WPT (WAYPOINT) SELECTED

109



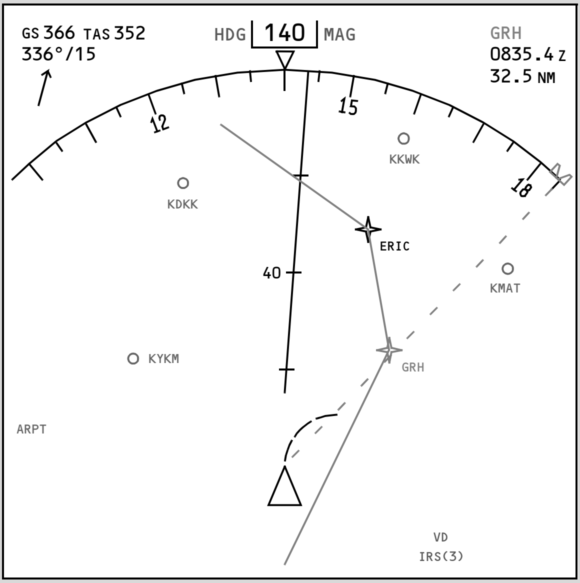
WPT (WAYPOINT) SELECTED

570



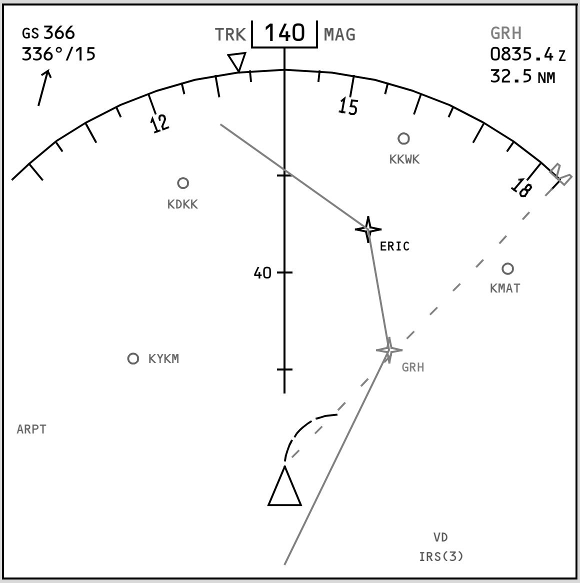
ARPT (AIRPORT) SELECTED

405



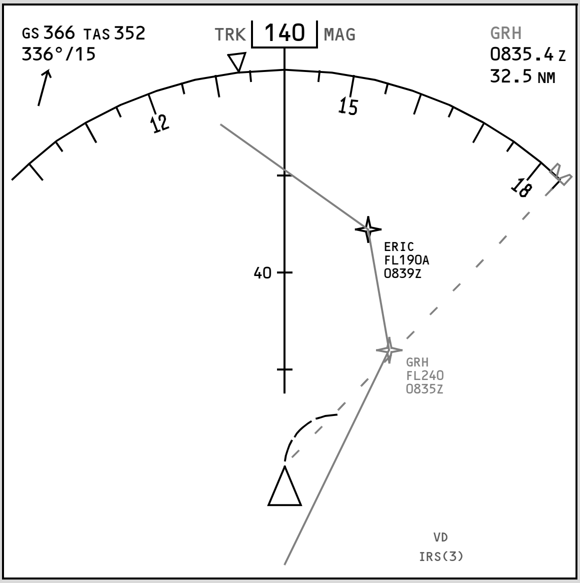
ARPT (AIRPORT) SELECTED

109



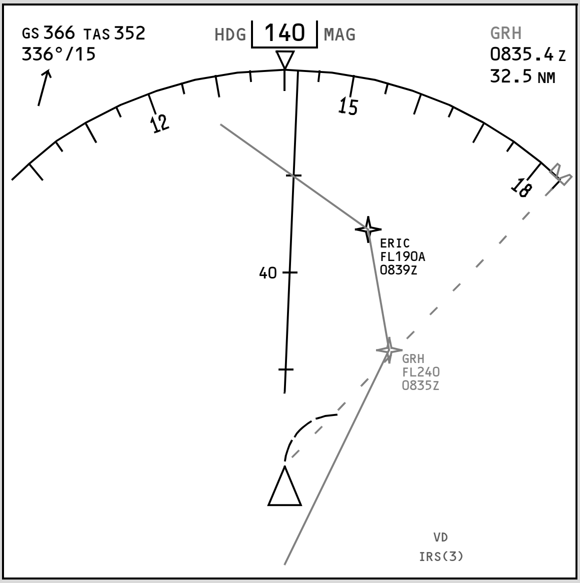
ARPT (AIRPORT) SELECTED

570



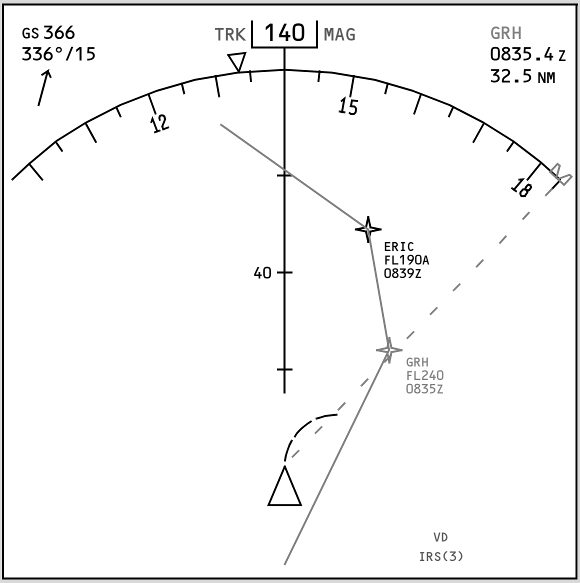
DATA SELECTED

405



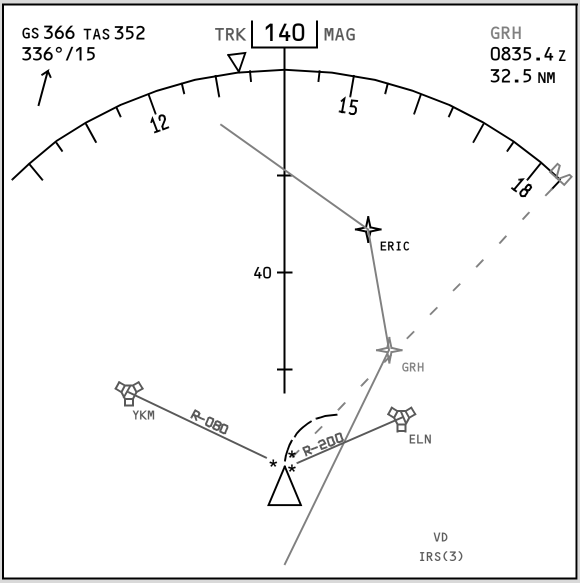
DATA SELECTED

109



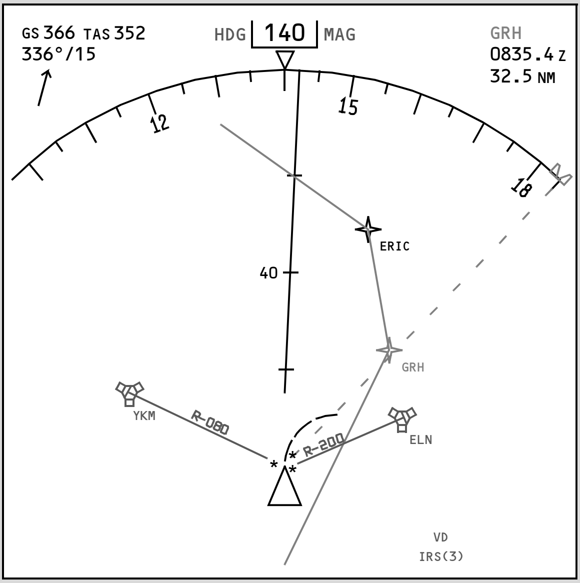
DATA SELECTED

570



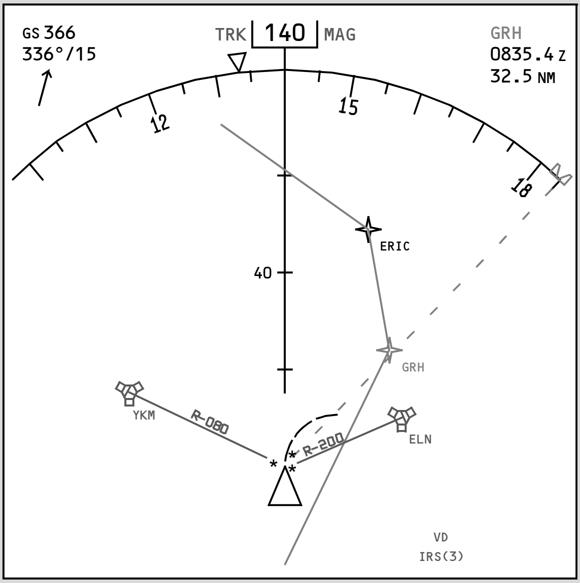
POS (POSITION) SELECTED

405



POS (POSITION) SELECTED

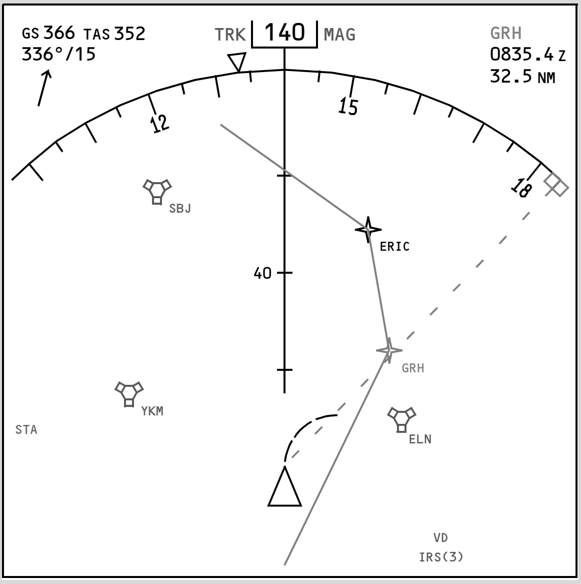
109



POS (POSITION) SELECTED

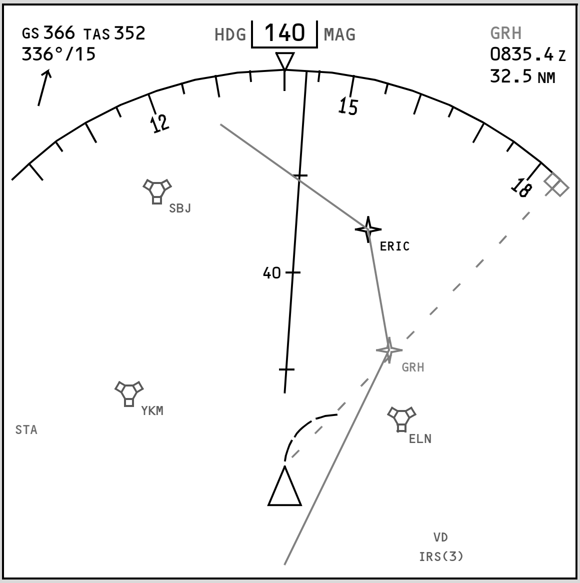
Cathode Ray Tube

570



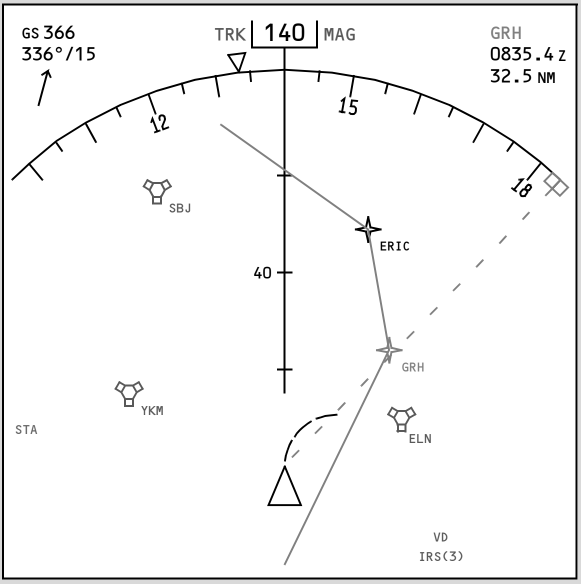
STA (STATION) SELECTED

405



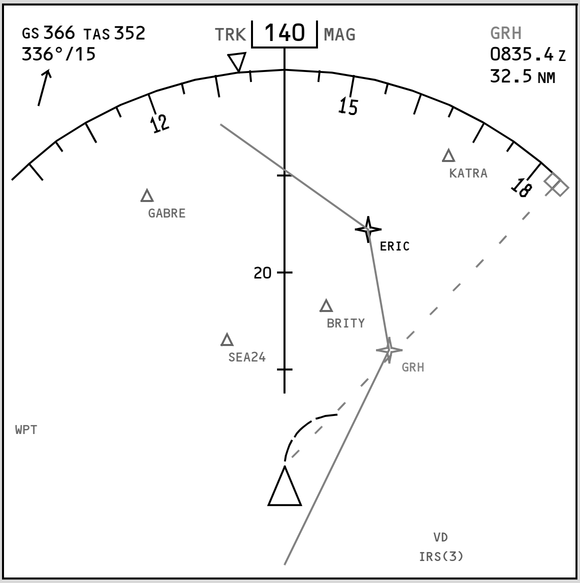
STA (STATION) SELECTED

109



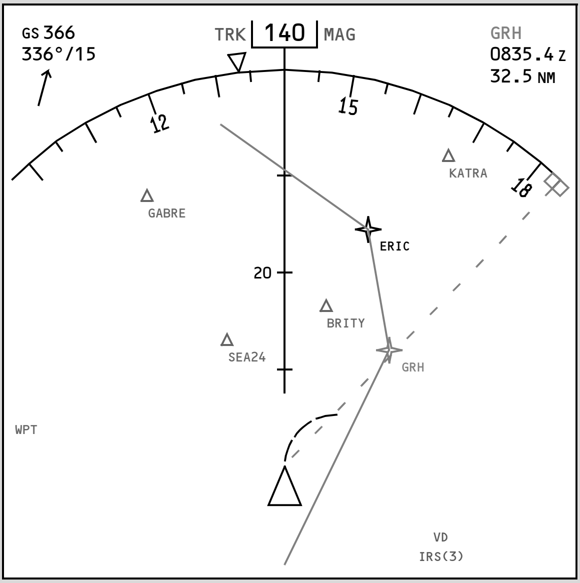
STA (STATION) SELECTED

570



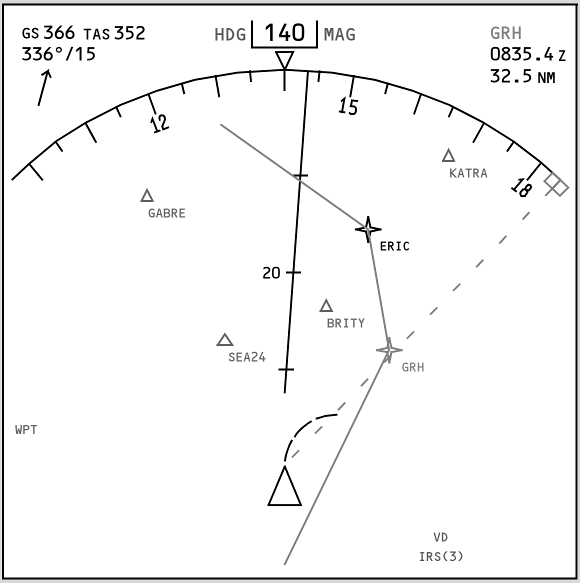
WPT (WAYPOINT) SELECTED

109



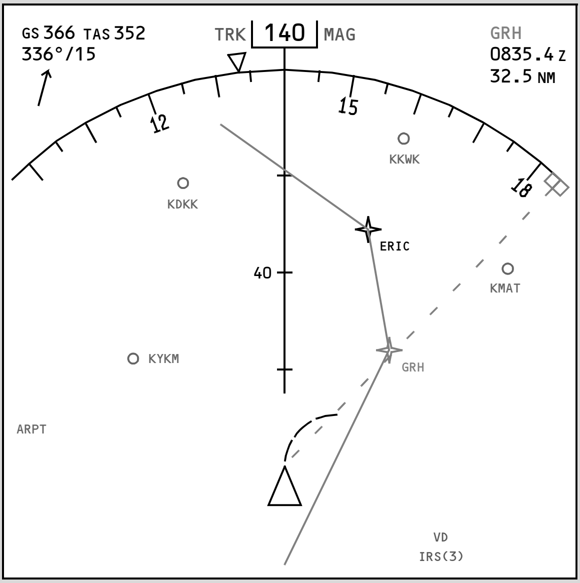
WPT (WAYPOINT) SELECTED

405



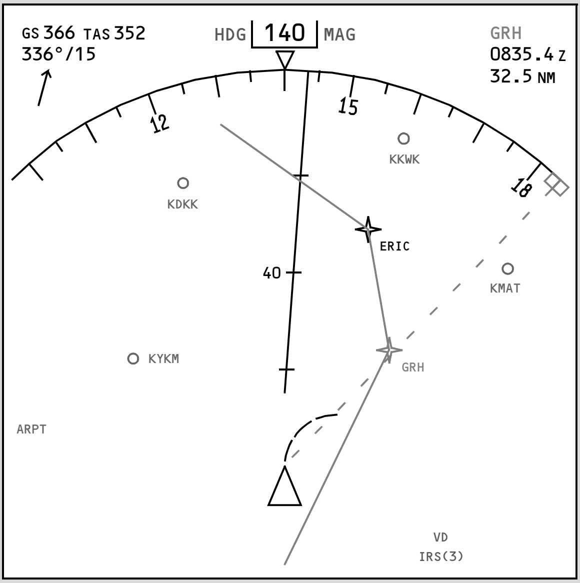
WPT (WAYPOINT) SELECTED

570



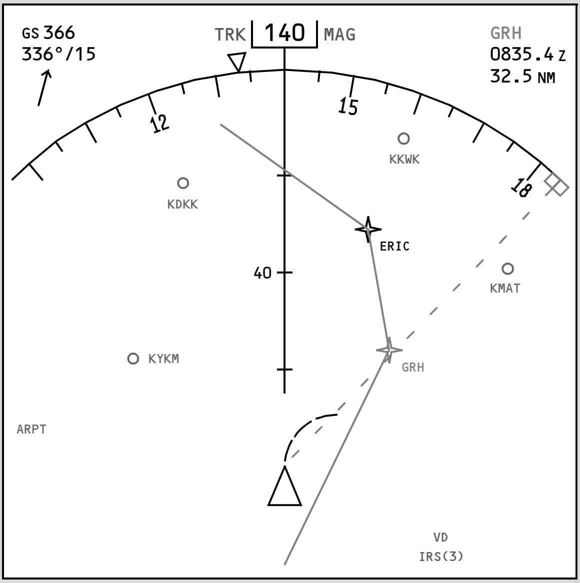
ARPT (AIRPORT) SELECTED

405



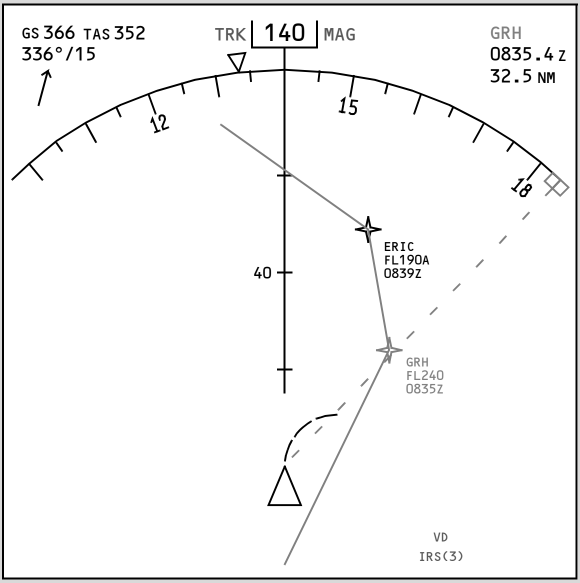
ARPT (AIRPORT) SELECTED

109



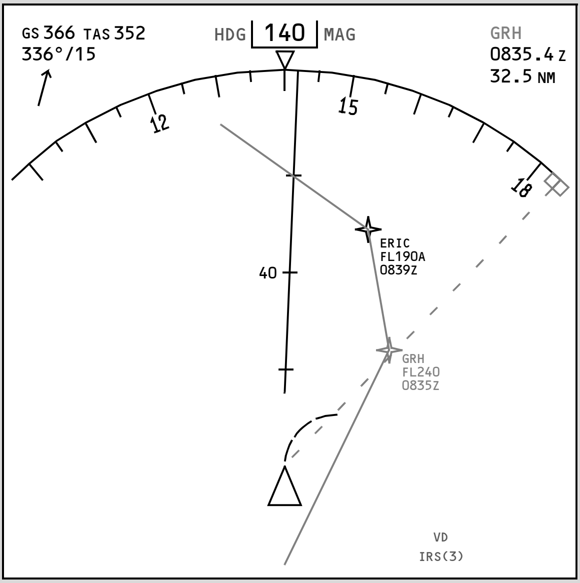
ARPT (AIRPORT) SELECTED

570



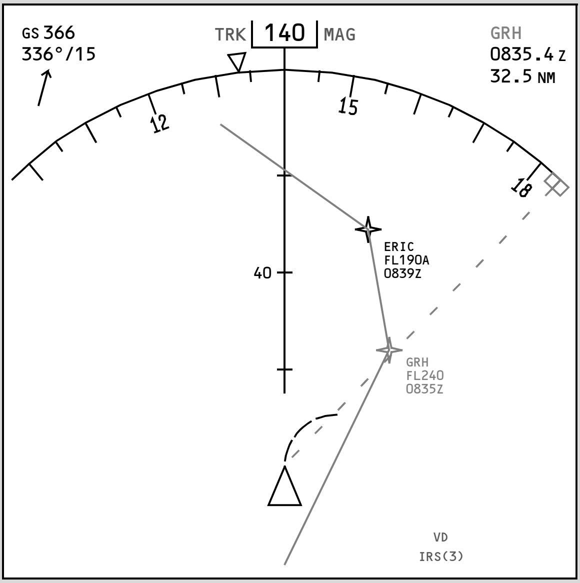
DATA SELECTED

405



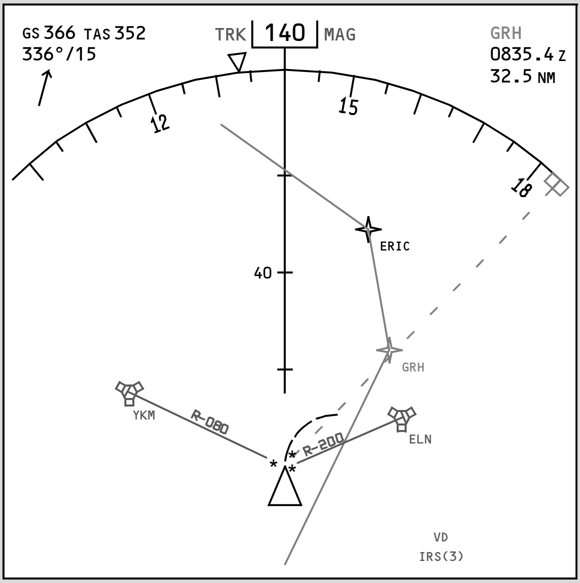
DATA SELECTED

109



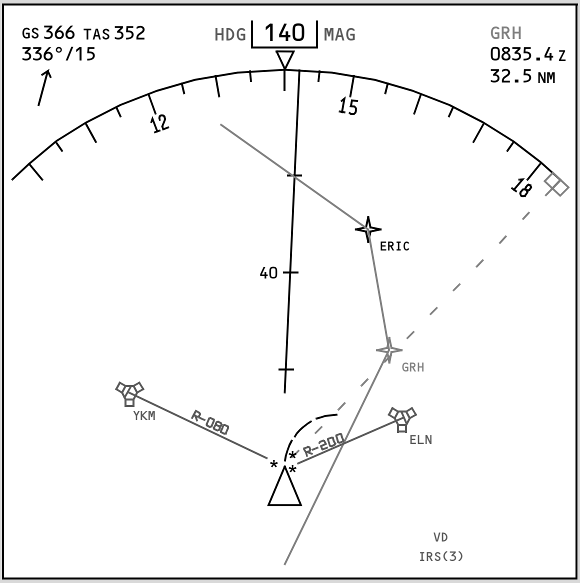
DATA SELECTED

570



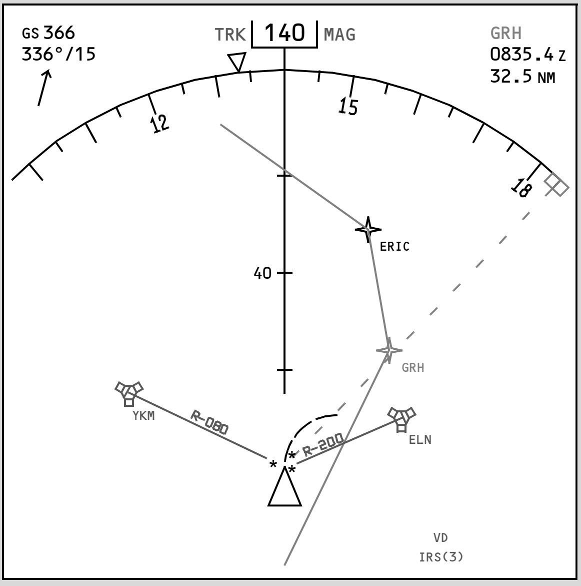
POS (POSITION) SELECTED

405



POS (POSITION) SELECTED

109



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) - 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

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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.

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Symbol	Name	ND Mode	Remarks
HDG 263 MAG ▽	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	Displays heading up for all modes	Displays HDG as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.

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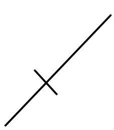
Symbol	Name	ND Mode	Remarks
TAS312	True airspeed (W)	All	Displays true airspeed above 100 knots.

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 (LCD).
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.
 (LCD)  (CRT)	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.

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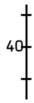
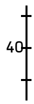
Symbol	Name	ND Mode	Remarks
	Track line and range scale (W)	MAP, MAP CTR, VOR, APP	Line indicates track. Number indicates range. Displays in VOR or APP mode when WXR or TFC on.

405

Symbol	Name	ND Mode	Remarks
	Track line and range scale (W)	MAP, MAP CTR, VOR, APP	Line indicates track. Number indicates range. Displays in VOR or APP mode when WXR, TERR, or TFC on.

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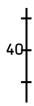
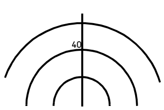
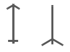
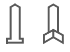
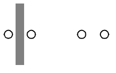
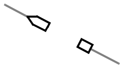
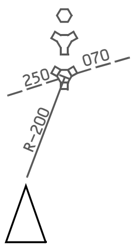
Symbol	Name	ND Mode	Remarks
	Track line and range scale (W)	MAP, MAP CTR, VOR, APP	Line indicates track. Number indicates range. Displays when WXR or TERR not on. Displays in VOR and APP when TFC on.
	Track line and range arcs (W)	MAP, VOR, APP	Line indicates track. Number indicates range. Displays in VOR and APP when WXR or TERR on.

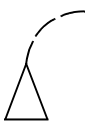
Radio Navigation

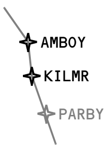
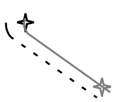
Symbol	Name	ND Mode	Remarks
VOR L, R ILS L, C, R	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Displays selected receiver as display reference.
116.80 OR SEA	ILS/VOR (G) Reference receiver frequency or identifier display	VOR, VOR CTR, APP, APP CTR	Displays frequency before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.
DME 24.6	DME distance (G)	VOR, VOR CTR, APP, APP CTR	Displays DME distance to the reference navaid.
	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.
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.

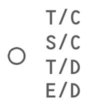
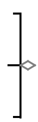
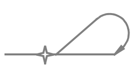
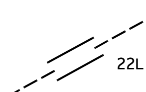
Symbol	Name	ND Mode	Remarks
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (B, G), DME/TACAN (B, G), VORTAC (B, G)	MAP, MAP CTR	Displays appropriate navaids (B) when EFIS control panel STA switch selected on. Tuned VHF navaids display in green, regardless of switch 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.
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.

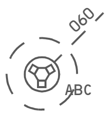
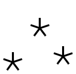
Symbol	Name	ND Mode	Remarks
116.80 OR SEA OR 520 OR BF	VOR frequency or identifier (G), ADF frequency or identifier (B)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays frequency before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME 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.
CRS 135	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Displays VOR course or FMC runway course.

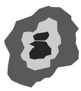
Map

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.
 (LCD)	Airplane symbol (W)	PLAN	Indicates actual position and track along the flight plan route in plan mode only (LCD).
	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.

Symbol	Name	ND Mode	Remarks
	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLAN	Active - represents the waypoint the airplane is currently navigating to. Inactive - represents the waypoints on the active route.
	Off route waypoint (B)	MAP, MAP CTR	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	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 only.
	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	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.

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.
TFC	TCAS mode (B)	MAP, MAP CTR, APP, VOR	Indicates ND TCAS display is active; TFC switch selected on.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in test mode.
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Indicates TCAS failure, when traffic is selected.

570

Symbol	Name	ND Mode	Remarks
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs.
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.

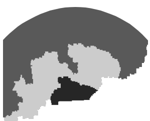
109, 405

Symbol	Name	ND Mode	Remarks
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs.
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Displays when TCAS/ATC mode switch is not in TA or TA/RA, 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)		
WXR FAIL	WXR system failure (A)		
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)		

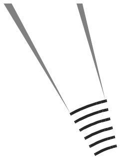
Look-Ahead Terrain
405, 570

Symbol	Name	ND Mode	Remarks
■	Obstacle display (R, A, G)	MAP, MAP CTR, APP, VOR	Displays obstacle data from the GPWS obstacle data base. Color displays using same rules as terrain display.
	Terrain display (R, A, G, M)	MAP, MAP CTR, APP, VOR	Displays terrain data from the GPWS terrain data base. When airplane higher than 2,000 feet above terrain; peaks contours displayed in three densities (G), highest peaks displayed as solid, intermediate height terrain peaks displayed as high density, lowest terrain peaks displayed as low density. When airplane lower than 2,000 feet above terrain; terrain 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude (G), terrain 500 feet (250 feet with gear down) below to 2000 feet above the airplane's current altitude (A), terrain more than 2,000 feet above airplane's current altitude (R), no terrain data available (M).
OBSTACLE	Obstacle annunciation (R, A)	All	Obstacle caution alert (A), obstacle warning alert (R).

Symbol	Name	ND Mode	Remarks
TERR 060 030	Terrain mode annunciation (B) and highest and lowest terrain or obstacle altitudes (R, A, G, M)	MAP, MAP CTR, APP, VOR	Terrain display enabled (manual or automatic display). Numbers displayed below TERR are altitudes, in hundreds of feet, of highest and lowest contours displayed on ND. Color corresponds to colors of highest and lowest terrain or obstacle displayed. Altitudes not displayed when terrain data unavailable.
TERR TEST	Terrain test mode annunciation (B)	All	GPWS operating in self-test mode.
TERRAIN	Terrain annunciation (R, A)	All	Look-ahead terrain caution alert (A), look-ahead terrain warning alert (R).

Symbol	Name	ND Mode	Remarks
TERR FAIL	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display have failed.
TERR POS		MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display unavailable due to GPS position uncertainty.
TERR OVRD		MAP, MAP CTR, APP, VOR	Ground Proximity Terrain Override Switch in OVRD position, GPWS look-ahead terrain alerts and terrain display inhibited.
TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR, APP, VOR	Terrain output range disagrees with range selected by EFIS control.
MAP/TERR RANGE DISAGREE		MAP, MAP CTR	Terrain output range and map display output range disagree with range selected by EFIS control.

Predictive Windshear
405, 570

Symbol	Name	ND Mode	Remarks
	Predictive windshear symbol (R, B, A)	MAP, MAP CTR, APP, VOR	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
WINDSHEAR	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).

Flight Instruments, Displays — Chapter 10
Electronic Flight Bag (EFB) — Section 45

(SB changes 570 ; installs Electronic Flight Bag)

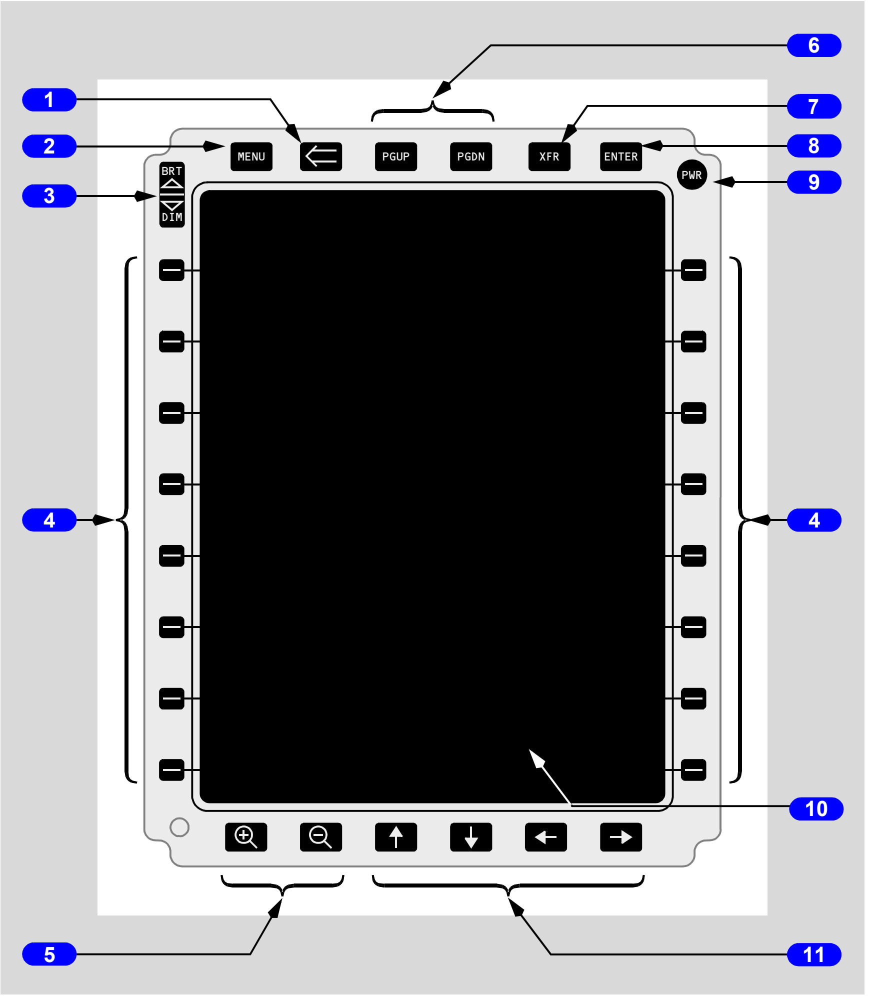
Introduction

The electronic flight bag (EFB) is a suite of applications designed to assist the flight crew with routine tasks and reduce the reliance on paper documents. The flight crew interacts with the EFB through display units located on the side panels. The display units operate independently of each other.

Under typical flight conditions, the majority of pilot interactions consists of manipulating Line Select Keys or the touch screen on a display unit to move back and forth among applications, within applications, and to display data. In addition, the flight crew can use an optional keyboard.

The suite of applications available to the flight crew may be customized by airlines. User modifiable portions of each application may be further customized. These customizing options include assigning applications to keys, revising application names, and defining the order in which applications appear. Descriptions and illustrations provided in this section are examples of a typical installation and may not reflect the exact installed configuration.

Display Unit



1 Back Key

Returns to the previous level within an application.

2 Main Menu (MENU) key

Displays MAIN MENU.

3 Bright (BRT) Dim (DIM) Control

Rocker switch, upper portion brighter, lower portion dimmer.

4 Line Select Keys

Selects item next to key.

5 Zoom Keys

Left key is zoom in, right is zoom out. Repeated selection increases or decreases the zoom level.

6 Page Up (PGUP)/Page Down (PGDN) Keys

Moves up or down within an application where the display exceeds one display screen in length.

7 Transfer (XFR) Key

- View other pilot's EFB display on this display
- XFR displays in green text on upper right
- Selections made off-side are seen on the on-side display in real time
- XFR key (second push) exits transfer and returns display to last view prior to selecting XFR
- MENU key exits transfer and displays the MAIN MENU

8 Enter (ENTER) Key

Activates a high-lighted item when applicable.

9 Power (PWR) Switch

Turns the display backlight on or off.

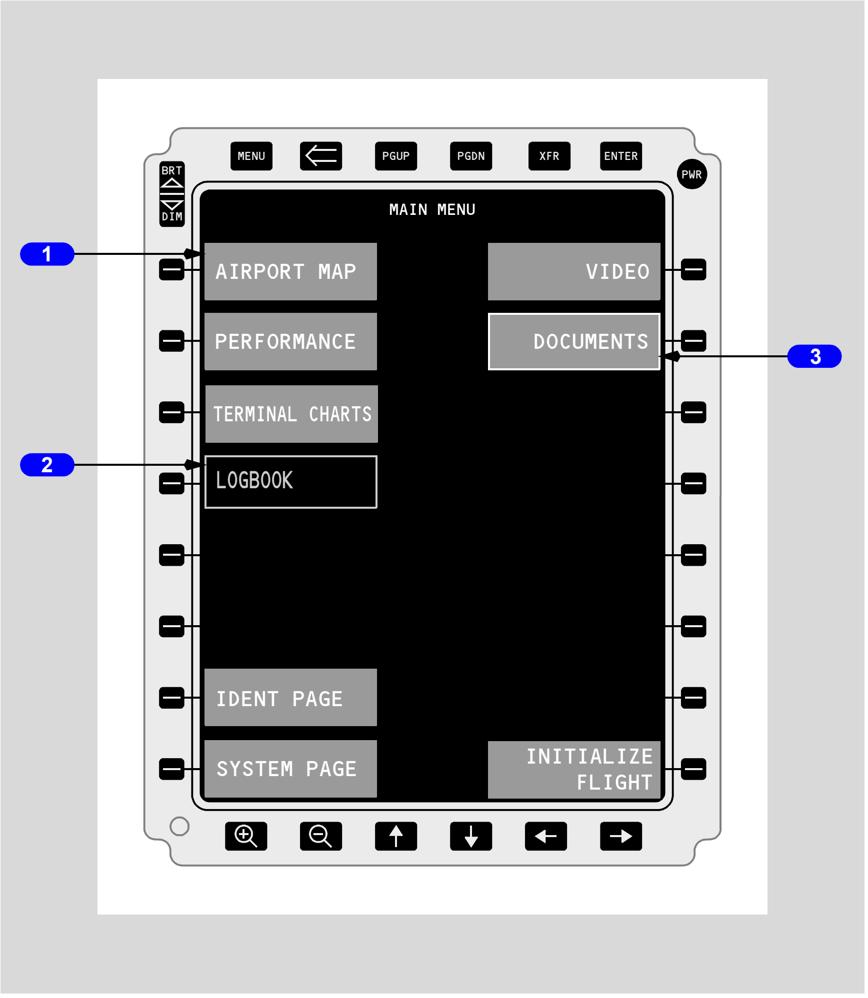
10 Touch sensitive screen

Enables direct selection on the display screen, and in some applications panning and scrolling.

11 Arrow Keys

Moves the viewing window over the display in the direction of the selected arrow.

Display Description



1 Selectable Applications

Menu items for selectable applications display in white text with gray background.

2 Applications not selectable

Menu items for applications that are installed but are not selectable display in cyan text in a cyan box. An application may be initializing and may become selectable later.

3 High-light Box

A white high-light box displays around a selectable application when:

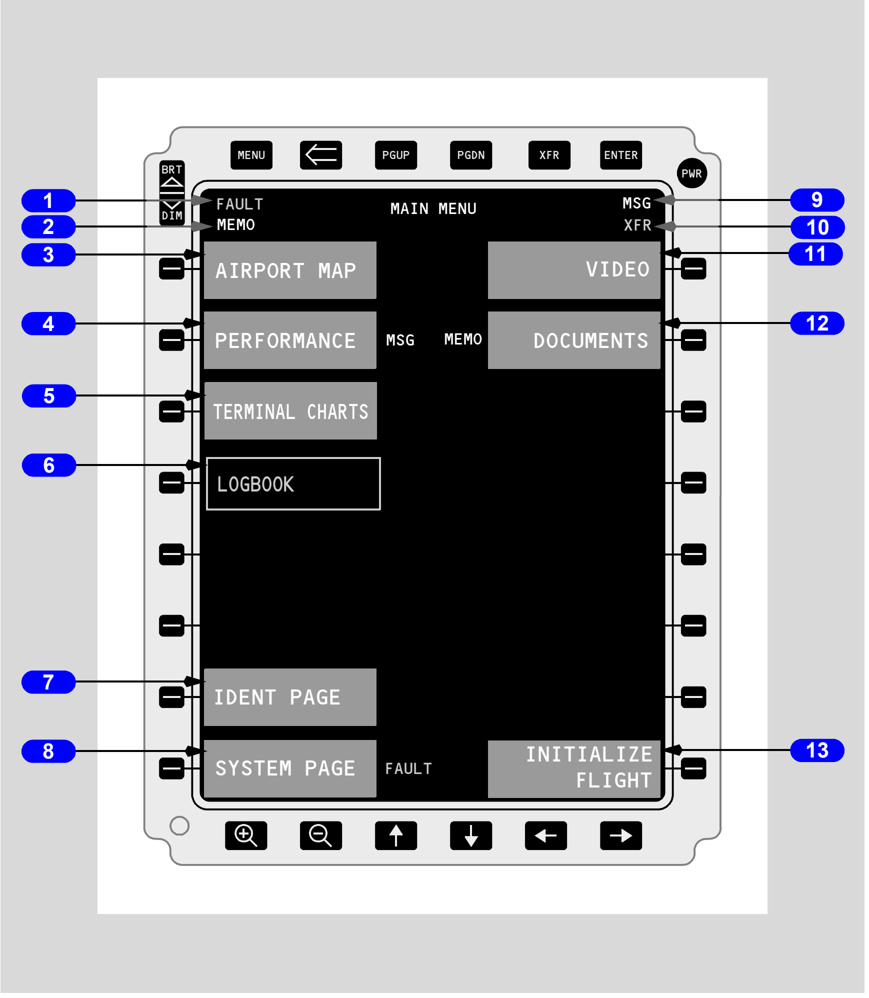
- The selectable menu item is touched
- A line select key is selected

A selectable application is selected when:

- A menu item is touched and released
- A line select key is selected

The menu item for a selected application displays a green background momentarily and then the selection displays.

Main Menu (Typical)



1 FAULT

Displayed (amber) -

- A fault has occurred within an application
- Displays in the header regardless of the application displayed
- Displays next to the SYSTEM PAGE where fault message can be viewed and cleared
- Removed from header upon selection of the SYSTEM page

Only one message at a time may display next to an application. FAULT takes priority over MEMO and MSG. MEMO or MSG display as applicable after the fault is cleared.

2 MEMO

Displayed (white) -

- One or more applications need attention
- Displays in the header regardless of the application displayed
- Displays next to the affected application on the MAIN MENU

3 AIRPORT MAP Application

Selects the AIRPORT MAP application.

- After flight initialization, displays the departure airport in HDG-UP (heading up) mode when on the ground at the departure airport
- Displays the departure airport NORTH UP when in flight
- Displays the destination airport HDG-UP when on the ground at the destination airport

4 PERFORMANCE Application

Selects the PERFORMANCE application.

- After flight initialization, displays the takeoff performance page
- Subsequent selections of the application display the selection that was in view when the application was last exited

5 TERMINAL CHARTS

Selects the TERMINAL CHARTS application.

- After flight initialization, displays the ROUTE SETUP page.
- Origin and destination information downloaded from the FMS.

6 LOGBOOK

Selects the LOGBOOK application.

7 IDENT PAGE

Displays the IDENT page.

8 SYSTEM PAGE

Displays the SYSTEM page.

9 MSG

Displayed (white) -

- One or more applications has an uplink available
- Displays in the header regardless of the application displayed
- Displays next to the affected application on the main menu. Takes priority over MEMO

10 XFR

Displayed (green) -

- The display is in transfer mode
- No selections except MENU and XFR are enabled

11 VIDEO Application

Displays views from surveillance cameras of area outside the flight deck door.

12 DOCUMENTS Application

Selects the DOCUMENTS application

- After flight initialization, displays the documents library
- Subsequent selections of the application display the selection that was in view when the application was last exited

13 INITIALIZE FLIGHT

Initializes all the installed applications for flight

- Clears search results of all previous searches in all applications
- All applications and functions restored to default settings
- Cross loads from FMC applicable data if it has been entered in the FMC
- Menu changes to CLOSE FLIGHT
- CLOSE FLIGHT is not selectable (cyan) during flight

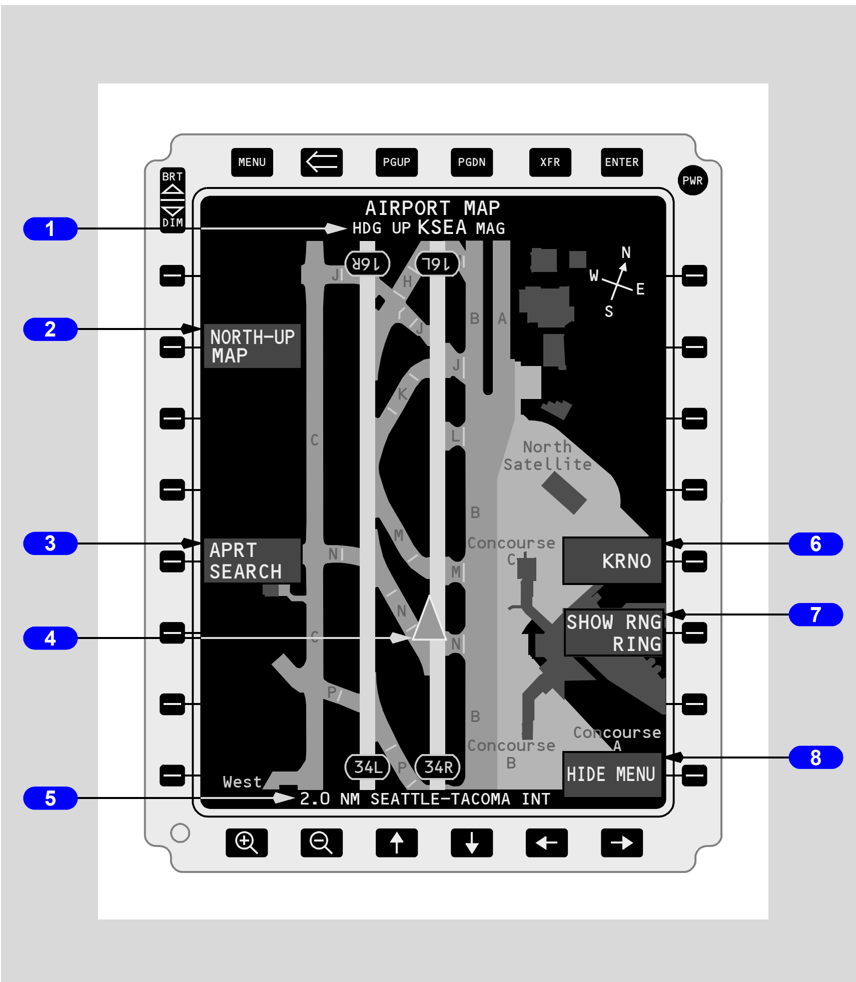
Intentionally
Blank

Airport Maps (Typical)

The maps are based on precise survey of airport geometry by satellite and other means. There may be differences between the electronic airport map and the airport diagrams that are part of the terminal charts, since these charts are derived from different survey methods.

Airport Heading Up (moving) Map

The airplane symbol remains stationary and the map moves to provide the location and orientation of the airplane relative to the map.



1 Map Reference

Displays the map reference.

- HDG-UP (heading up) and MAG (magnetic)

2 NORTH-UP MAP

Selects north up (static) map display.

3 Airport (APRT) SEARCH

Allows searching the database for other airport maps.

4 Airplane symbol

Displays when airplane is on the ground at the displayed airport and groundspeed is less than 40 knots.

5 Display range

Indicates the map range from top to bottom of the display.

6 Airport Identifier

When departure airport is displayed, identifier is destination airport if entered in FMC.

- Selection displays the destination airport in HDG-UP (moving map) mode when on the ground at the destination airport
- Displays the destination airport in NORTH UP (static) mode when in flight

When destination airport is displayed, identifier is departure airport.

7 SHOW/HIDE Range (RNG) RING

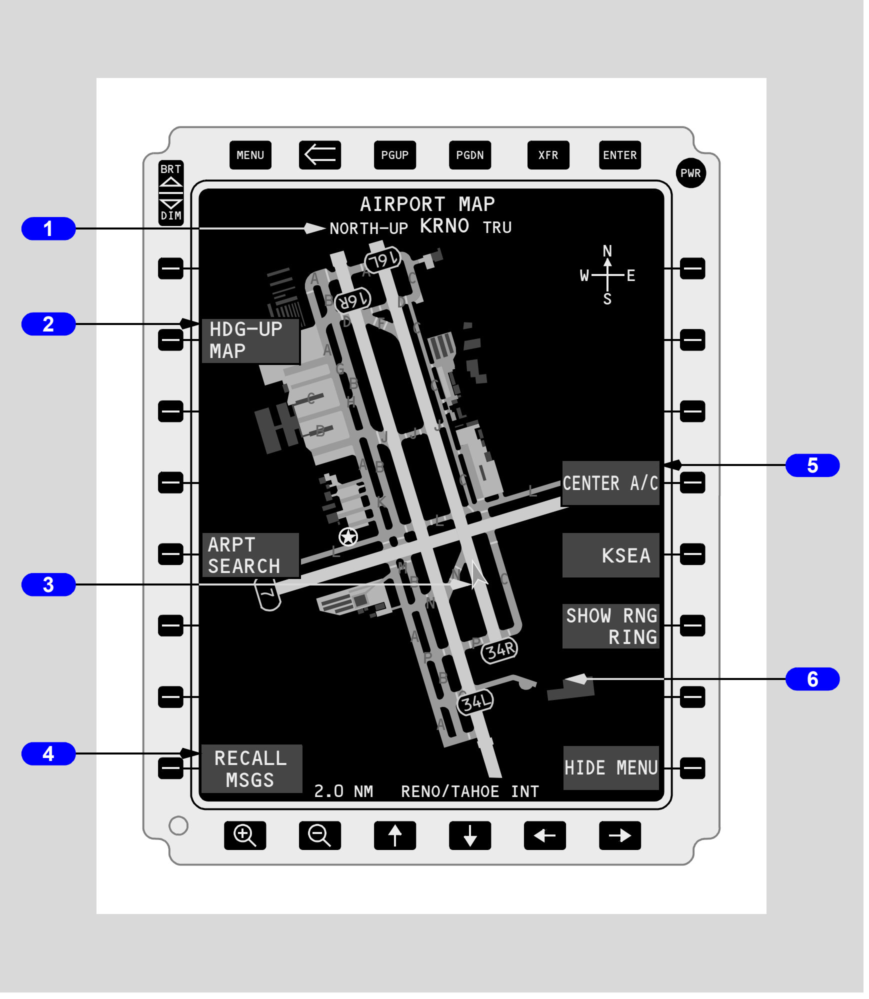
Displays or removes a 1000 foot radius range ring around the airplane symbol.

8 SHOW/HIDE MENU

Displays or hides all other menu selections.

Airport North Up (static) Map

The airplane symbol moves on a stationary map showing the airplanes general location and orientation on the ground at the selected airport. Using the touch screen to "touch and drag", or using the arrow keys, the map may be repositioned on the display.



1 Map reference

Displays the map reference

- NORTH UP
- TRU (true) heading

2 **HDG-UP MAP**

Selects heading up moving map display.

3 **Airplane Symbol**

Displays when airplane is on the ground at the displayed airport and groundspeed is less than 40 knots.

4 **CANCEL/RECALL MSGS (Messages)**

Toggles between Cancel and Recall when map faults exist

- CANCEL removes fault messages from the display
- RECALL displays fault messages

The menu item is inhibited when there are no faults to display.

5 **CENTER A/C**

Centers airplane symbol horizontally and vertically on the display.

6 **Map fault message display area**

Amber fault messages display in this area. More than one message may display at a time.

Airport Map Faults

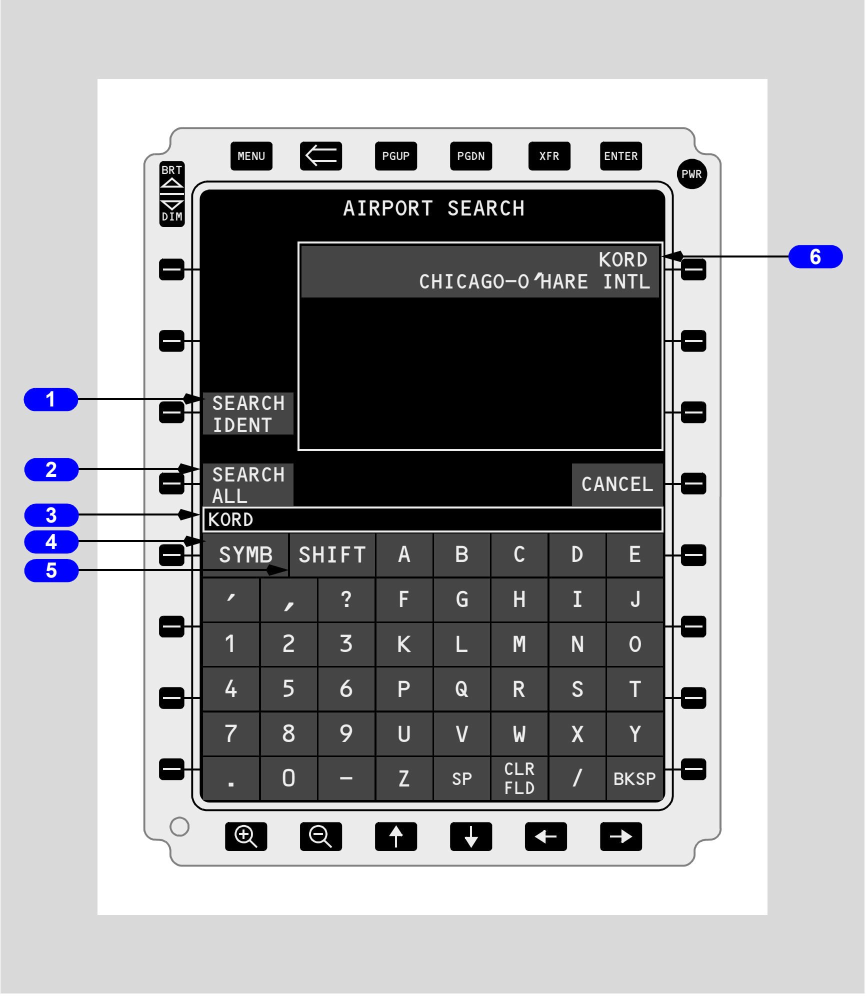
Display (amber) -

Faults may appear on both NORTH-UP and HDG-UP displays.

Fault	NORTH-UP	HDG-UP
IRS DATA (IRS data is lost or invalid.)	Airplane symbol is removed.	Airplane symbol is removed. Map freezes on position and last known heading.
GPS DATA (GPS position data is lost or invalid.)	Airplane symbol is removed.	Airplane symbol is removed. Map freezes on heading and last known position.
UNABLE POS ACCURACY (GPS position accuracy limits are exceeded. Inhibited by GPS DATA and when in flight.)	Airplane symbol is removed.	Airplane symbol is removed. Map freezes on heading and position.

Airport Search

Airport search allows the search and display of other airport maps. Keypad operation for entering, clearing, and deleting characters is the same as with the FMS CDU. All EFB applications that have a search function use an identical keypad and scratchpad in the lower half of the respective search display.



1 **SEARCH IDENT**

Initiates a search of the ident data base using the scratchpad entry.

2 **SEARCH ALL**

Initiates a search of the data base using the scratchpad entry.

3 **Scratchpad**

4 **SYMB/NUM key**

Alternates between SYMB and NUM.

- SYMB displays symbols on the keypad
- NUM displays numbers on the keypad

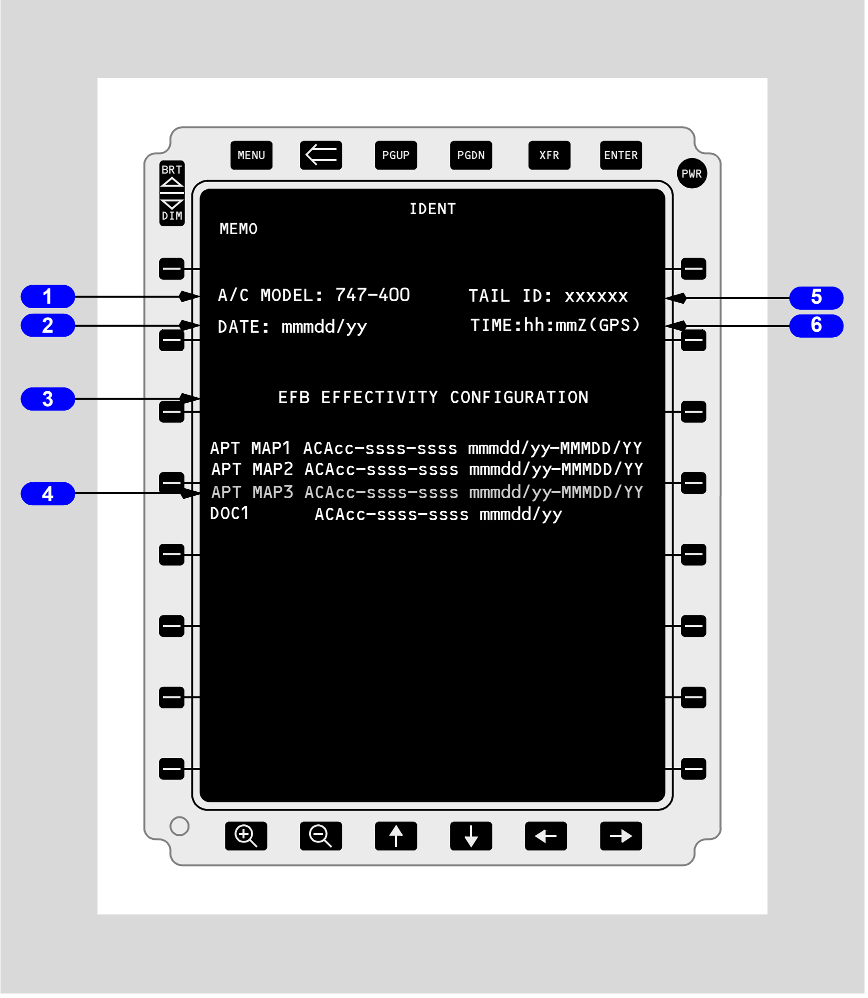
5 **SHIFT key**

Changes letter keys between upper case and lower case.

6 **Airport Identifier**

The results of the airport search are displayed here. Selecting the airport displays the airport map in North Up mode.

IDENT page (Typical)



1 A/C MODEL

Display of aircraft model.

2 DATE

Display of current date.

3 EFB EFFECTIVITY CONFIGURATION

Display of effectivity dates for loaded databases.

4 **Out of date data base (amber)**

An out of date database displays in amber. MEMO displays in the header on all pages and next to affected applications on the Main Menu page.

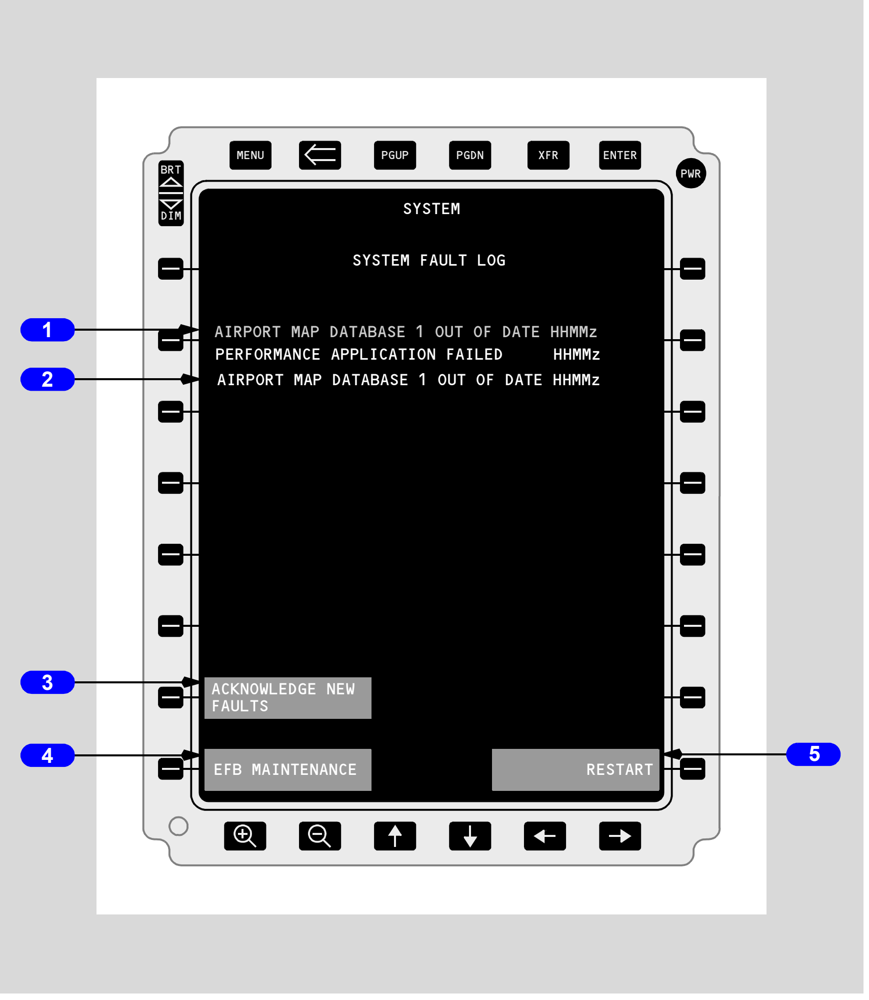
5 **TAIL ID**

Display of tail identification number.

6 **TIME**

Display of time and source of time.

SYSTEM page (Typical)



1 Acknowledged fault

Fault information is displayed in cyan.

2 Un-acknowledged fault

Fault information is displayed in white.

3 ACKNOWLEDGE NEW FAULTS

- Becomes selectable when there are un-acknowledged faults
- Selection acknowledges all new faults
- Selection removes FAULT on MAIN MENU next to SYSTEM

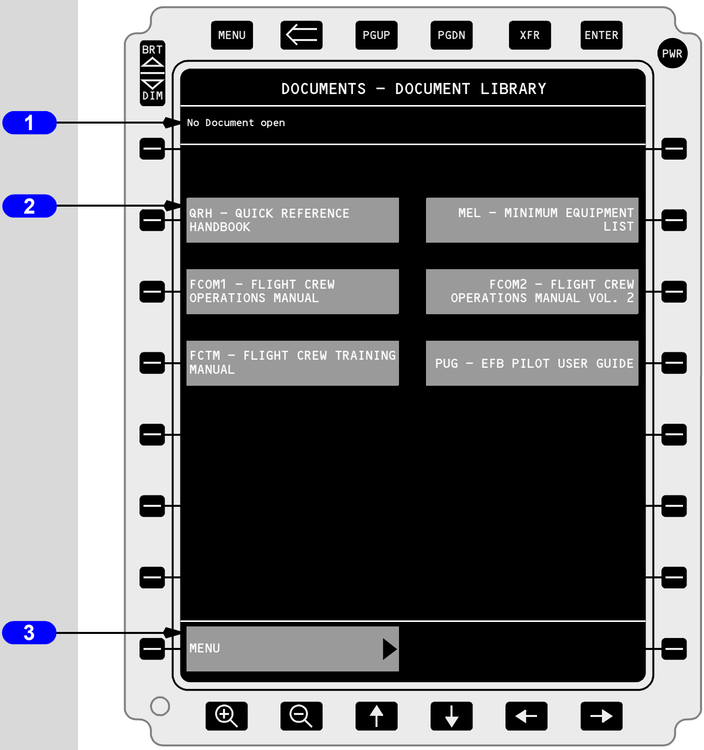
4 EFB MAINTENANCE

Provides access to the maintenance menu page.

5 RESTART

Re-initializes Windows applications.

Documents (Typical)



1 Document hierarchy header

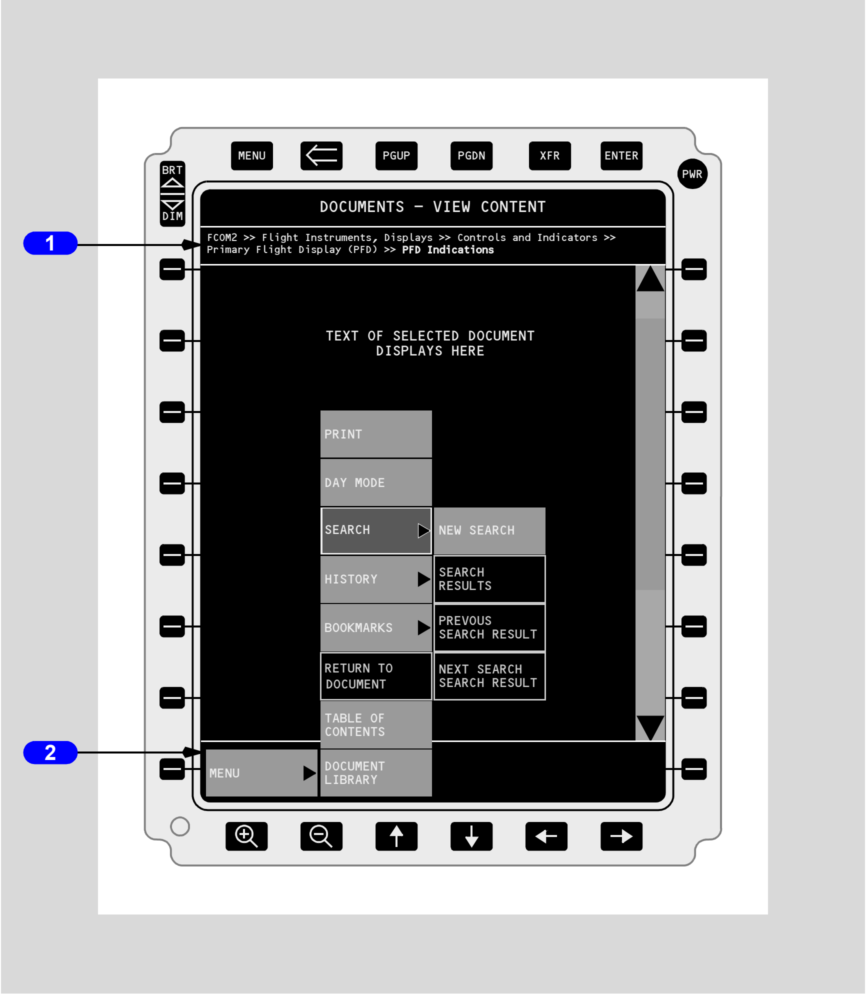
Displays the selected document, section, and sub-section.

2 Selectable documents

Displays the installed and selectable documents.

3 MENU

Initiates cascading menu.



1 Document hierarchy header

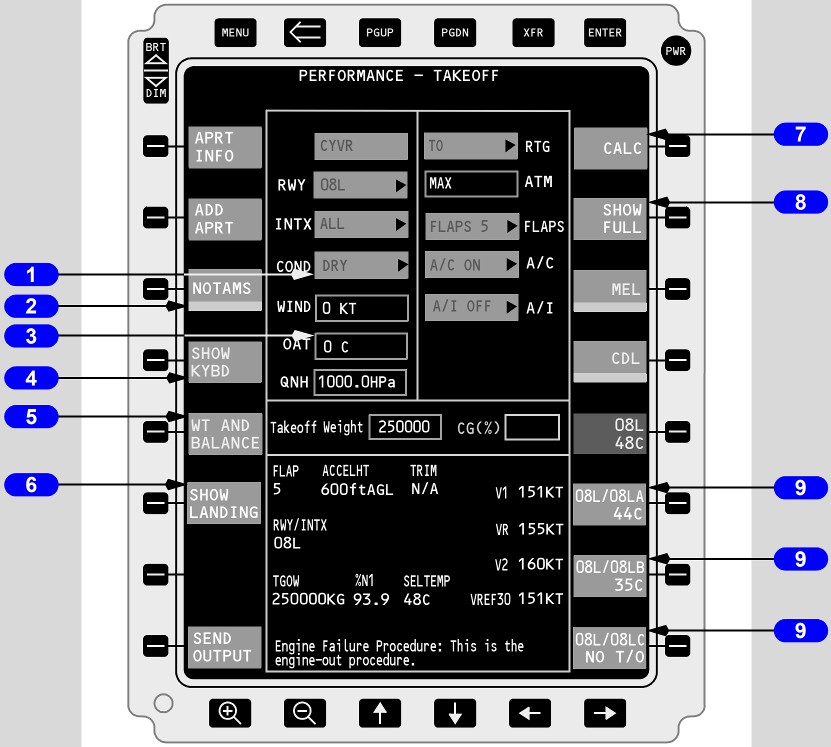
Displays the current document, section, and sub-section.

2 MENU

Initiates cascading menu. Selected item has green background, available item has gray background, and item not selectable is blue. For example, if another function is selected, the RETURN TO DOCUMENT function turns white with a gray background.

- PRINT - Information displayed in the VIEW CONTENTS screen is printed on the flight deck printer (if applicable).
- DAY MODE - Indicates inactive display mode, selection changes mode to mode indicated. Day mode is dark text on a light background, night mode is light text on a dark background.
- SEARCH - Initiates search in multiple documents.
- HISTORY - Displays a list of entries as links for information previously displayed in the VIEW CONTENTS screen.
- BOOKMARKS - Provides link to return to item bookmarked.
- RETURN TO DOCUMENT - Allows return to document from subordinate function.
- TABLE OF CONTENTS - For the document selected.
- DOCUMENT LIBRARY - Provides list of all available documents.

Performance (Typical)



1 DRY (green)

- DRY has been selected for the runway condition
- Triangle in right side of menu indicates a list of options exists
- Selection display the options

2 NOTAMS

- May be used to enter temporary data
- Amber bar displays across menu when data has been entered

3 Data field

Boxes display for fields that require data entry.

4 SHOW KYBD (Keyboard)

Displays a touch sensitive keyboard at the bottom of the page that is used for data entry.

5 WT (Weight) AND BALANCE

Displays the weight and balance page.

6 SHOW LANDING

Displays the landing page.

7 CALC (Calculate)

- Cyan - data has not been entered in all required fields
- White - all required fields have data

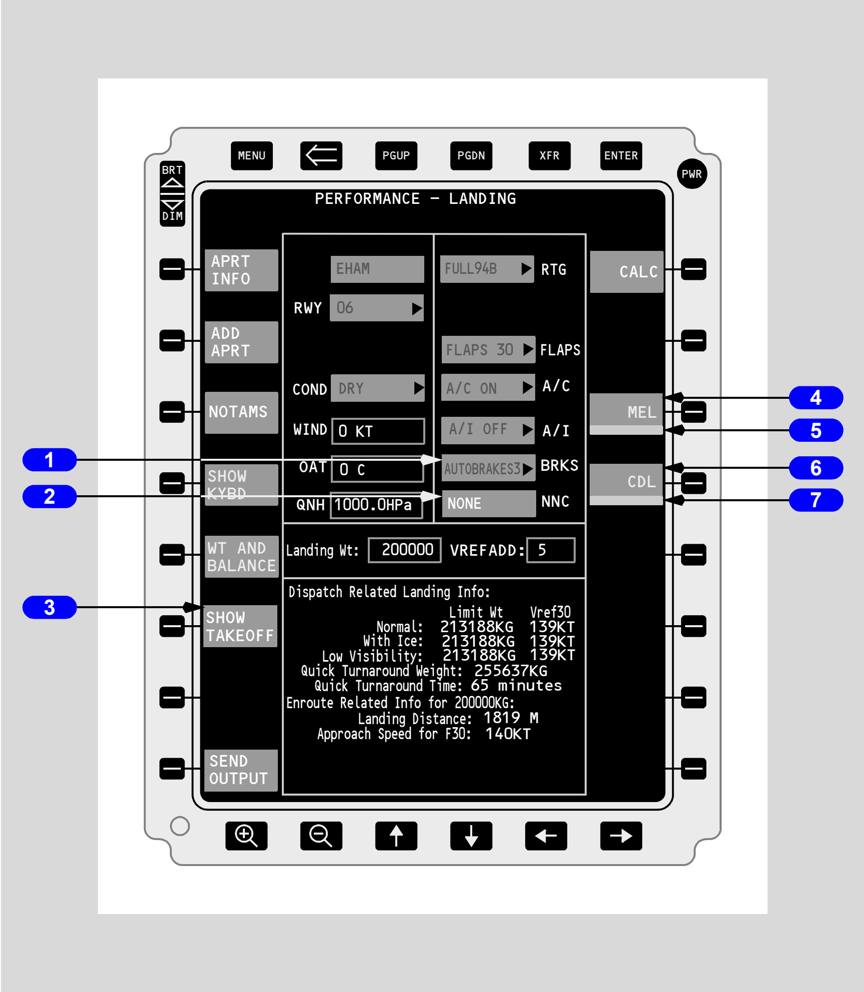
Selection initiates the calculation of takeoff data.

8 SHOW FULL

Selection displays full thrust data for the airport/runway entered.

9 Intersection Takeoff Options

- Intersection takeoff options display on the right side when ALL is selected for INTX (intersection)
- Selection displays takeoff data for the selected intersection



1 **BRKS (Brakes)**

Selection of a brake setting is required for in-flight landing calculations, not dispatch calculations.

2 **NNC**

Selection is required for in-flight calculations, not dispatch calculations.

3 **SHOW TAKEOFF**

Displays the takeoff page.

4 MEL

Displays MEL page.

5 Amber bar

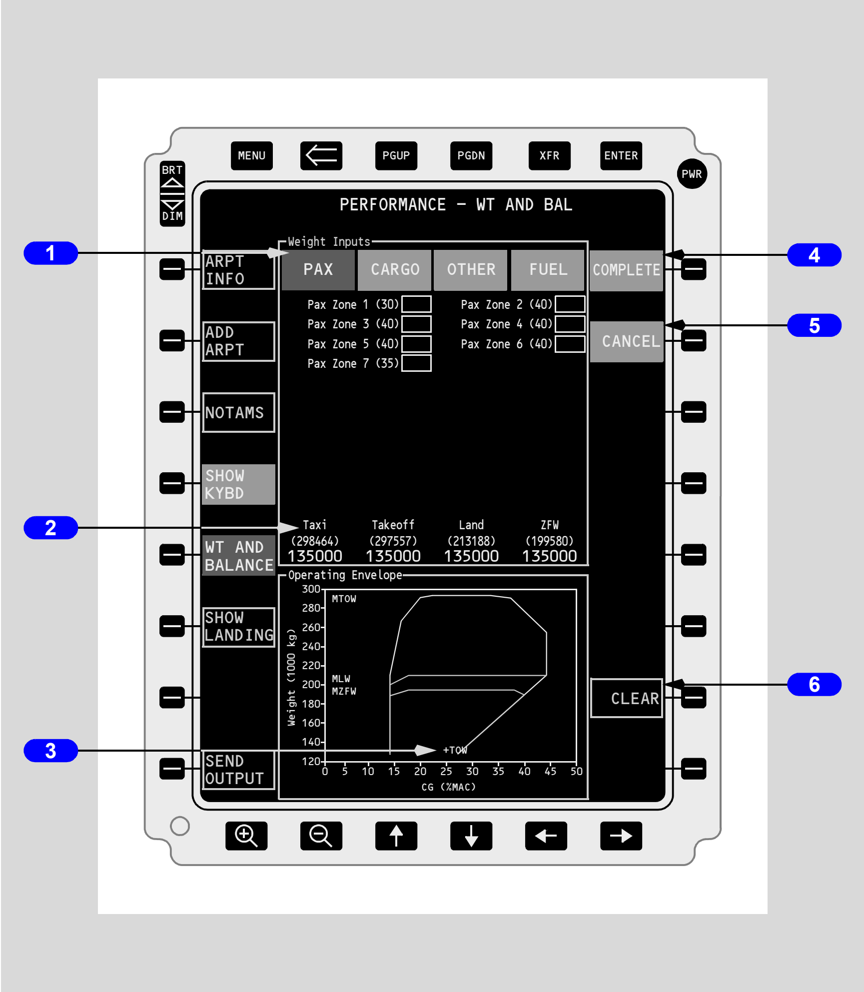
Indicates an active MEL item exists that will be considered in the calculations.

6 CDL

Displays the CDL page.

7 Amber bar

Indicates an active CDL item exists that will be considered in the calculations.



1 PAX/CARGO/OTHER/FUEL

Displays applicable input screen.

2 Aircraft weights

- Initially displays airplane operating empty weight
- Updates as data fields are filled

3 +TOW

Symbol displays airplane CG relative to the CG limits.

4 **COMPLETE**

Selection loads the takeoff page with the calculated takeoff gross weight and CG.

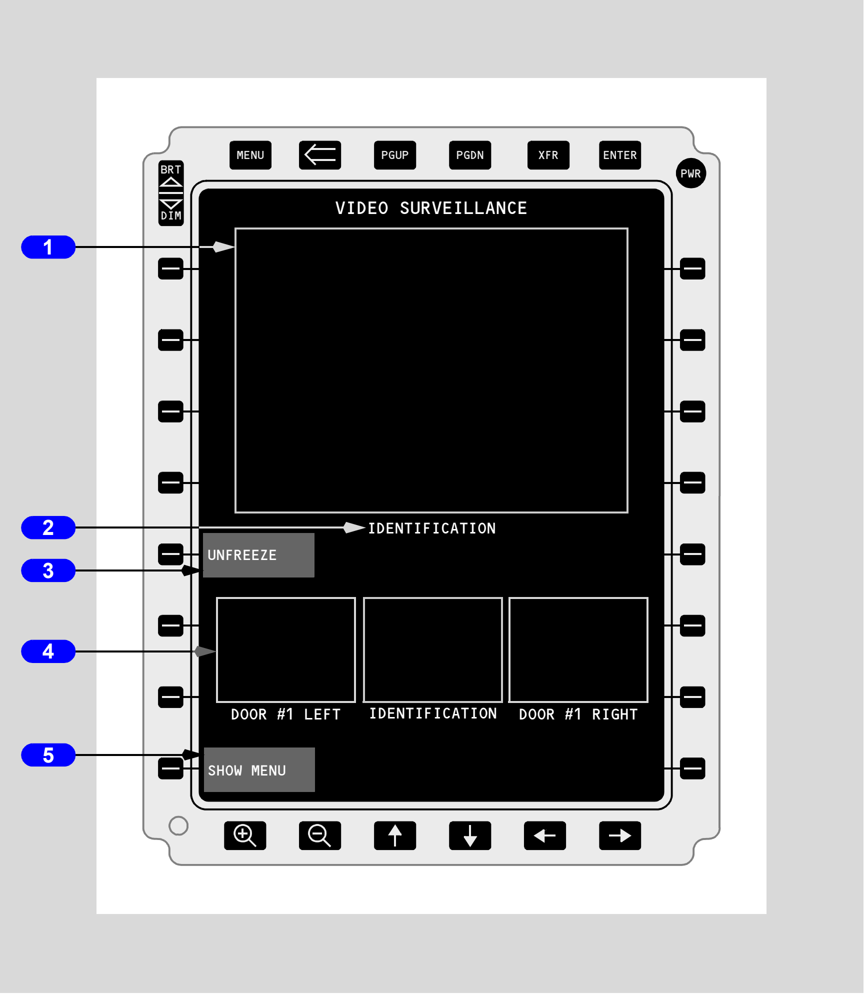
5 **CANCEL**

Clears all entries and returns to the takeoff page.

6 **CLEAR**

Clears all entries.

Video Surveillance (Typical)



1 Primary Display

- Selected thumbnail image displays in this area with green border
- Border changes to cyan when FREEZE is selected
- Border is amber when the selected image is not available and NO VIDEO SIGNAL displays

2 Display selection

Name of the selected thumbnail image displays here.

3 **FREEZE/UNFREEZE**

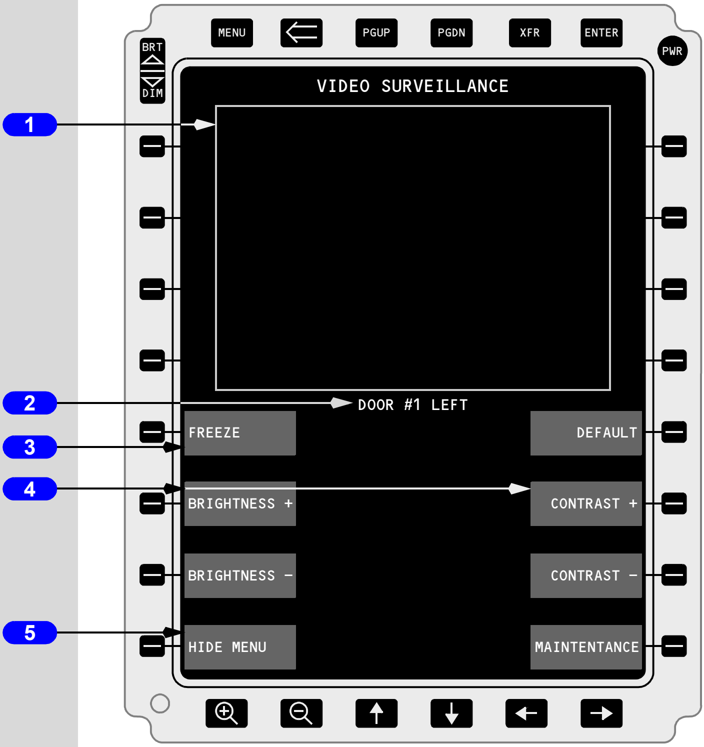
- Selection freezes the image in the primary display
- The display box changes to cyan while the image is frozen
- The menu changes to UNFREEZE

4 **Thumbnails**

- Thumbnail images display here
- Images with a gray border may be selected for display in the primary display
- Selected image has a green border
- Border is amber when the image is not available and NO VIDEO SIGNAL displays

5 **SHOW/HIDE MENU**

- Selecting SHOW MENU adds the BRIGHT, CONTRAST, and MAINTENANCE menus
- After selecting SHOW MENU, the menu changes to HIDE MENU



1 Primary Display

- Selected thumbnail image displays in this area with green border
- Border changes to cyan when FREEZE is selected
- Border is amber when the selected image is not available and NO VIDEO SIGNAL displays

2 Display selection

Name of the selected thumbnail image displays here.

3 **FREEZE/UNFREEZE**

- Selection freezes the image in the primary display
- The display box changes to cyan while the image is frozen
- The menu changes to UNFREEZE

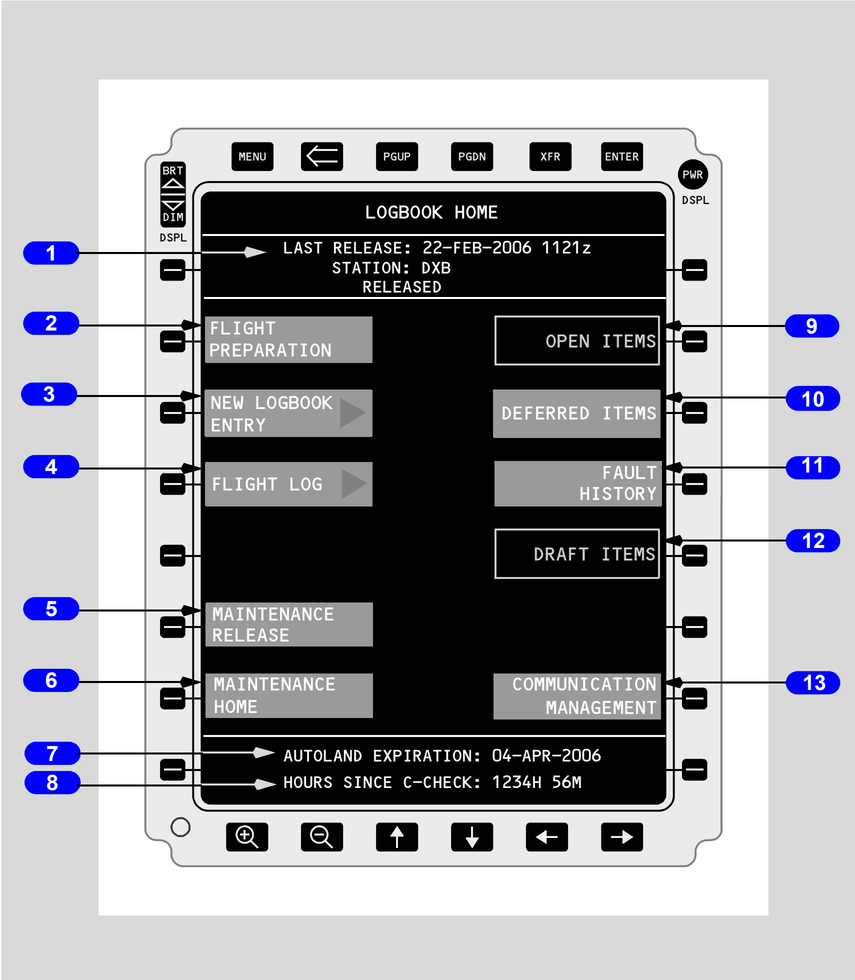
4 **BRIGHT/CONTRAST**

Changes the brightness and contrast of the image in the primary display as indicated by the + and - selections.

5 **SHOW/HIDE MENU**

- Selecting HIDE MENU removes the BRIGHT, CONTRAST, and MAINTENANCE menus
- After selecting HIDE MENU, the menu changes to SHOW MENU

Logbook (Typical)



1 Release Information

- Date and time of last release for flight
- Station where the last release occurred
- Current state of the airplane.

2 FLIGHT PREPARATION

Starts a guided process that prepares a flight log to document the upcoming flight. This function is intended to be used prior to flight.

3 **NEW LOGBOOK ENTRY**

Documents observed faults into the logbook. Uses a graphical fault finder tool that navigates through a series of images to identify selection of a fault. The purpose is to find the appropriate fault description and have it associated with the respective Fault Reporting Manual (FRM) fault code.

4 **FLIGHT LOG**

Displays the flight log for the current flight.

5 **MAINTENANCE RELEASE**

The maintenance release form has 2 pages plus a summary page. The first page includes information such as comments and release date. The second page allows the maintenance crew to document any restrictions associated with this release. Before a release can be signed, the user is required to review the summary page 3 contents of the maintenance release

6 **MAINTENANCE HOME**

The purpose of the maintenance home page is to provide maintenance crews a summary of the maintenance status of the airplane (release status, open & deferred item counts) and quick access to the maintenance functions. This page is accessible only when the airplane is in ground mode

7 **AUTOLAND EXPIRATION**

Displays the date and time the autoland currency expires.

8 **HOURS SINCE C-CHECK**

Displays the hours and minutes since the last C-check was accomplished.

9 **OPEN ITEMS**

Displays all open faults that have been documented for this airplane. It also includes any expired deferrals.

10 **DEFERRED ITEMS**

Displays all deferred faults reported for the airplane. On this page the user can view a brief description, the expiration of the deferral and an indication if any Maintenance (M) or Operational (O) procedures related to this deferral exist.

11 FAULT HISTORY

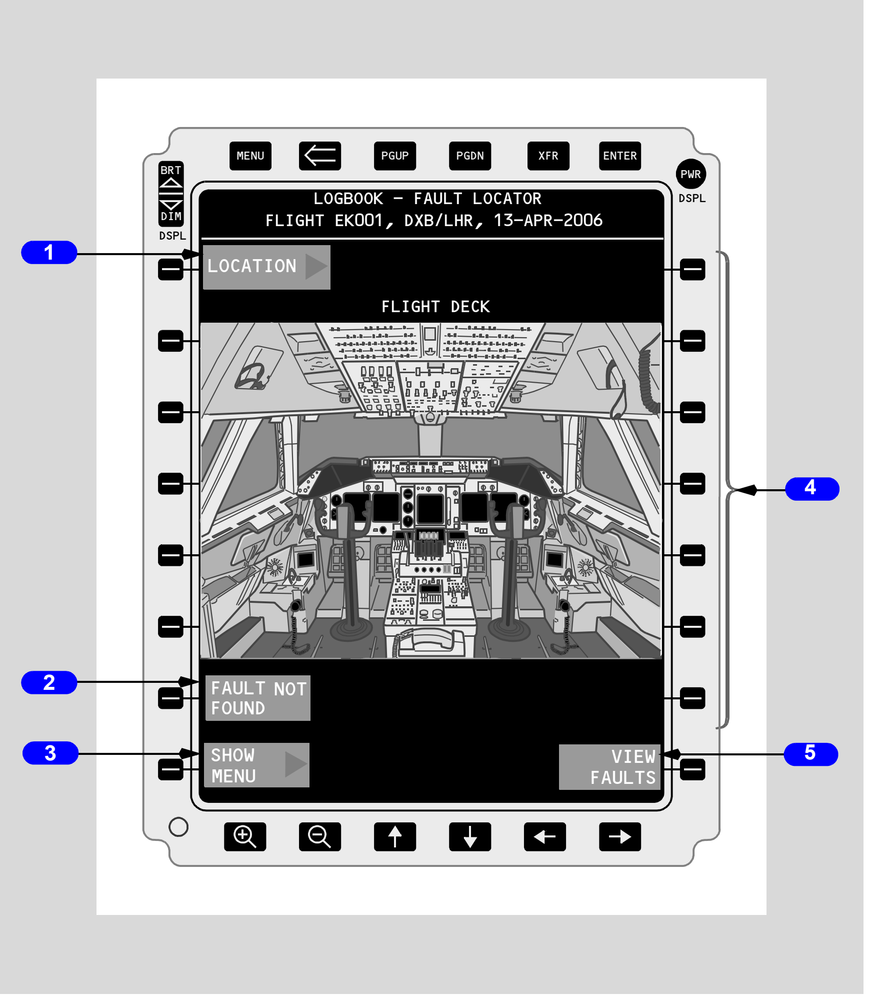
Lists all fault reports for the aircraft. It provides a description of the fault report plus the time it was reported and the current status. This list is organized by the DATE/TIME field.

12 DRAFT ITEMS

Provides the user with a view of all fault reports that have been created but not signed for official entry into the logbook. If a record has not been signed the user will have a choice of either signing the report to make it an official record, modify, or delete.

13 COMMUNICATION MANAGEMENT

Select to receive and send messages to the ground databases. All messages are sent over a secure link to ensure the integrity of the information.



1 LOCATION

Displays a list of airplane areas (Flight Deck, Engine, Exterior, etc.) for use in locating an area where a fault has occurred.

2 FAULT NOT FOUND

Displays a blank fault report form for the user to complete. This is required when a fault can not be found in the selected area.

3 SHOW/HIDE MENU

Toggle button that either shows or hides the extended menu selections.

4 Panel Selection Area

Selection of a boxed area navigates through a series of images to help identify a fault. The purpose is to narrow the search area to find the appropriate fault code.

5 VIEW FAULTS

Displays a list of all faults associated with the region displayed. The more the region is narrowed by selecting specific areas within a graphic, the fewer faults that are returned.

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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 Instruments Source EICAS Alert Messages

Message	Level	Aural	Message Logic
>SNGL SOURCE RA	Advisory		Both pilots' displays referenced to the same radio altimeter receiver.
>SOURCE SEL ADC	Advisory		Both pilots' displays referenced to the same ADC.
>SOURCE SEL EIU	Advisory		Both pilots' displays referenced to the same EIU.
>SOURCE SEL F/D	Advisory		Both pilots' displays referenced to the same FCC.
>SOURCE SEL IRS	Advisory		Both pilots' displays referenced to the same IRU.
>SOURCE SEL NAV	Advisory		Both pilots' displays referenced to the same FMC.

Flight Instruments Disagree EICAS Alert Messages

Message	Level	Aural	Message Logic
ALT DISAGREE	Caution	Beeper	Captain and First Officer uncorrected altitude indications disagree by more than 200 feet. Inhibited until disagreement lasts for more than five seconds.

Message	Level	Aural	Message Logic
>ATTITUDE	Caution	Beeper	Captain and First Officer selected IRS attitude output disagree by 3 degrees or more.

Message	Level	Aural	Message Logic
>BARO DISAGREE	Advisory		Captain and First Officer barometric reference settings disagree for more than one minute.

Message	Level	Aural	Message Logic
>HEADING	Advisory		Captain and First Officer displayed headings disagree by 4 degrees or more.

Message	Level	Aural	Message Logic
IAS DISAGREE	Caution	Beeper	Captain and First Officer airspeed indicators disagree by five knots or more. Inhibited until disagreement lasts for more than five seconds.

Message	Level	Aural	Message Logic
>TRACK	Advisory		Captain and First Officer selected track output disagree by 6 degrees or more.

Flight Instruments Components EICAS Alert Messages

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Message	Level	Aural	Message Logic
>AOA RIGHT	Advisory		Right AOA sensor has failed. AOA system redundancy lost.

Message	Level	Aural	Message Logic
>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 active.

Message	Level	Aural	Message Logic
>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 active.

Message	Level	Aural	Message Logic
>EIU LEFT	Advisory		Left EIU failed. Inhibited in flight.

Intentionally
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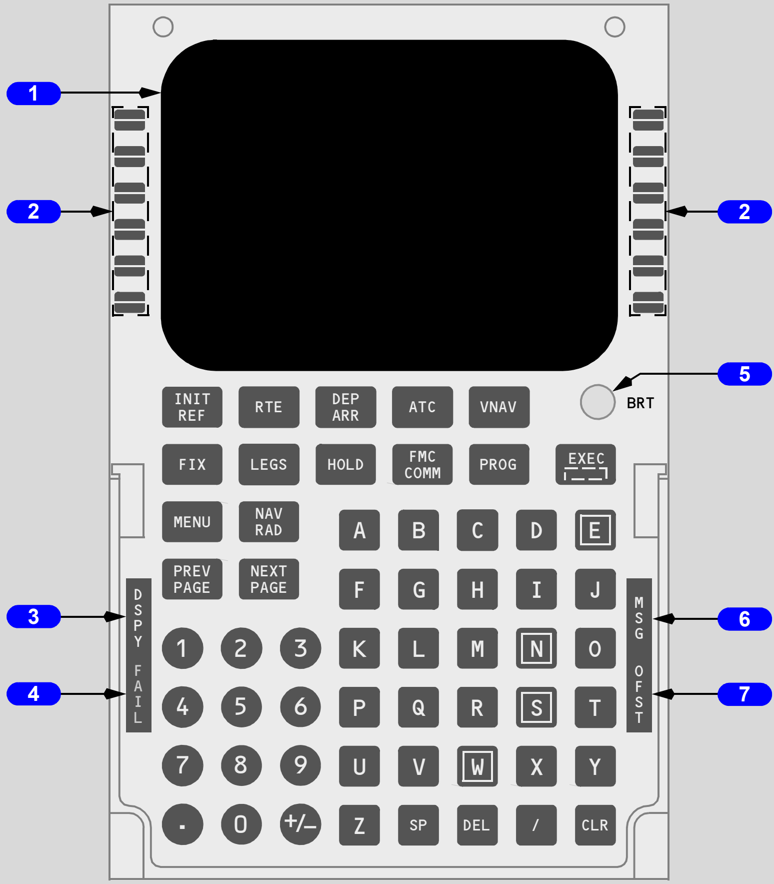
Flight Management, Navigation — Chapter 11
Table of Contents — Section 0

Flight Management, Navigation — Chapter 11
Controls and Indicators — Section 10

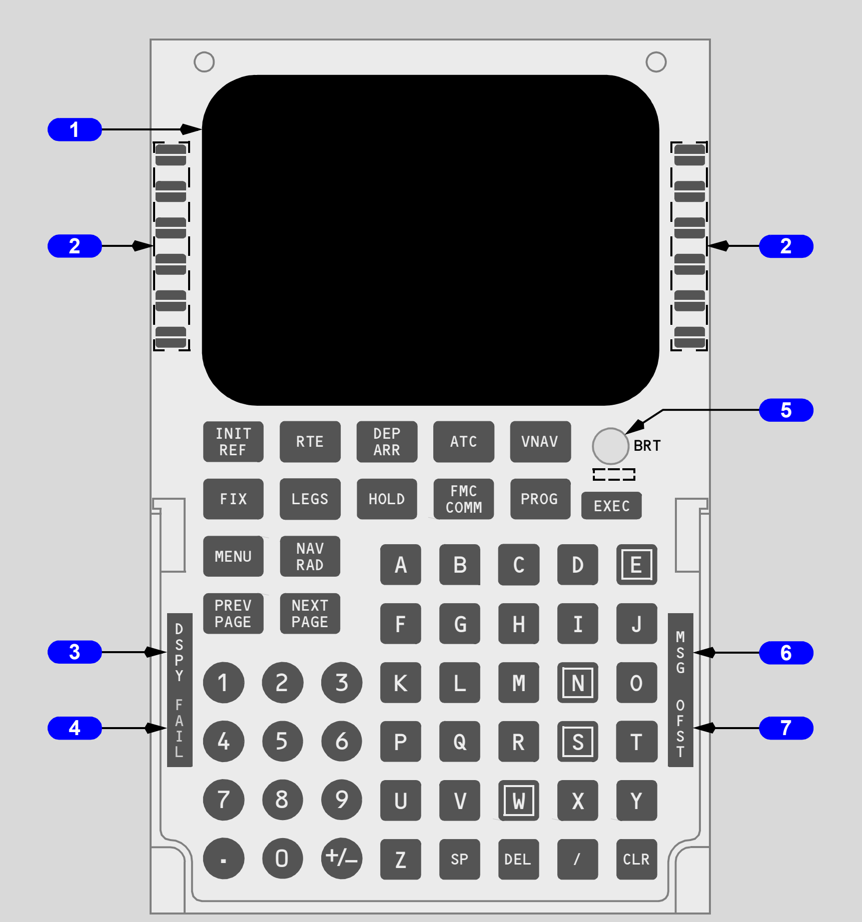
Flight Management System

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**

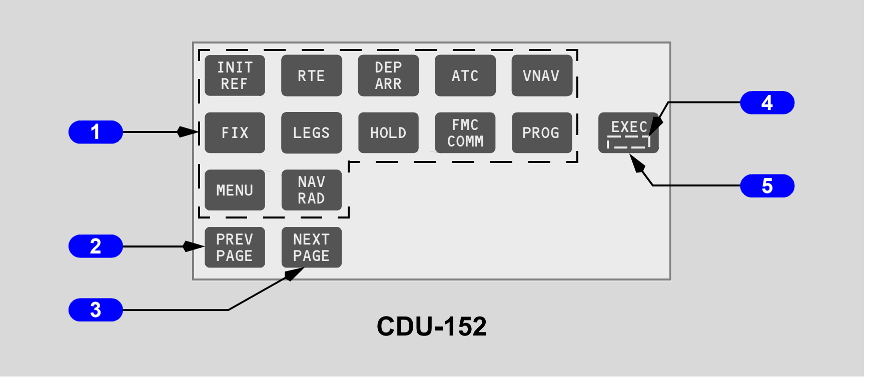
Illuminated (white) -

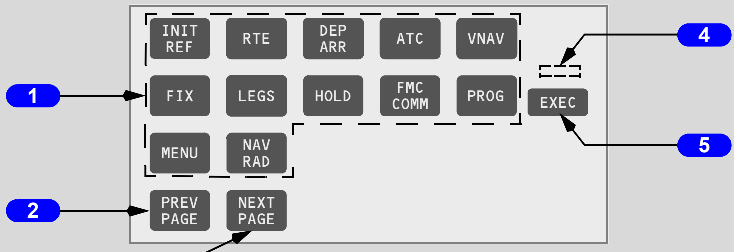
- scratchpad displays message
- pushing clear key extinguishes light and clears message

7 **Offset (OFST) Light**

Illuminated (white) - LNAV gives guidance for lateral route offset.

Function and Execute Keys





CDU-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

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- ATC - displays CDU message KEY/FUNCTION INOP

  405, 570
- 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

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- FMC COMM - displays CDU message KEY/FUNCTION INOP

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- 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 Light**

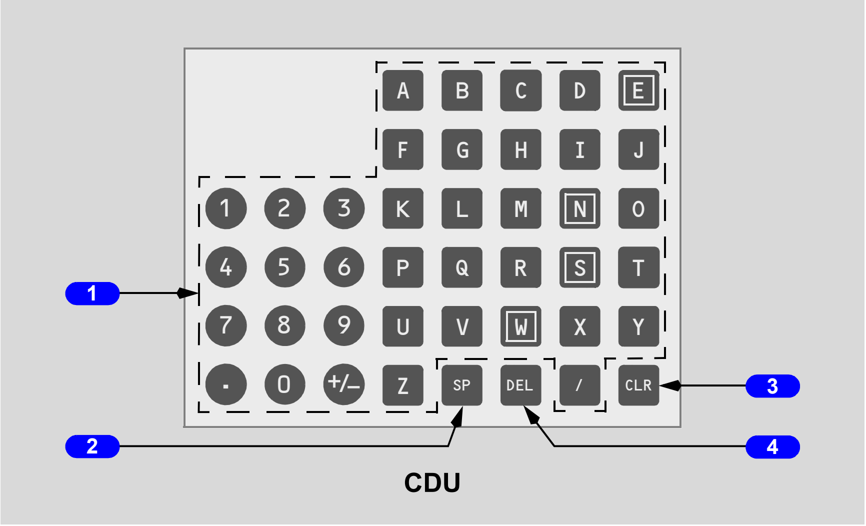
Illuminated (white) - active data modified but not executed.

5 **Execute (EXEC) Key**

Push -

- makes data modification(s) active
- extinguishes execute light

Alpha/Numeric and Miscellaneous Keys



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 -

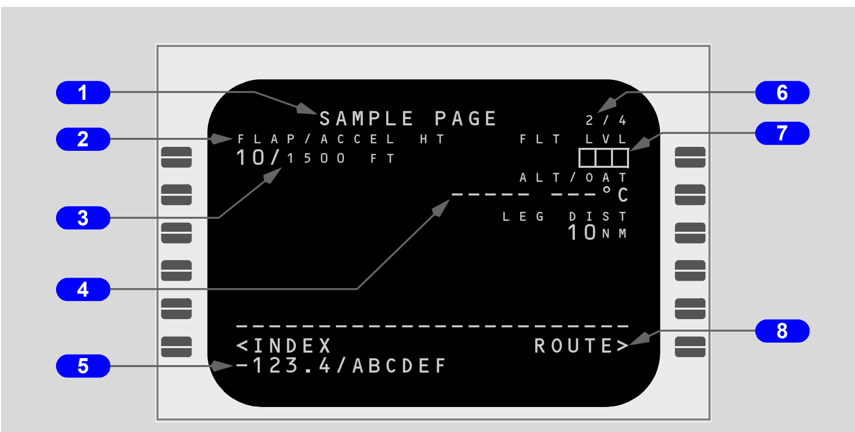
- clears last scratchpad character
- clears scratchpad message

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.

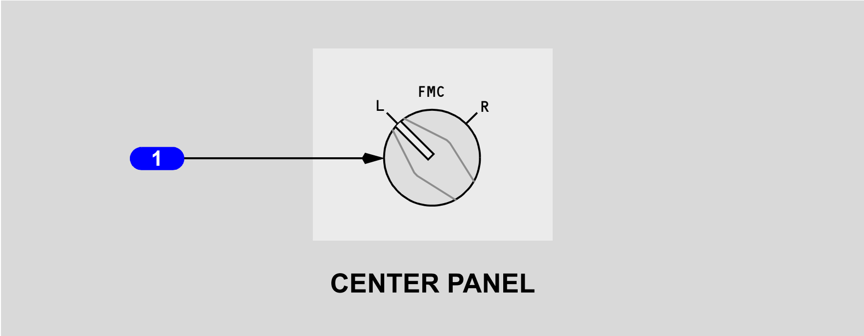
7 Boxes

Data input is mandatory.

8 Prompts

Display pages and control displays. Caret “<” or “>” is before or after prompt.

FMC Selector



1 FMC Master Selector

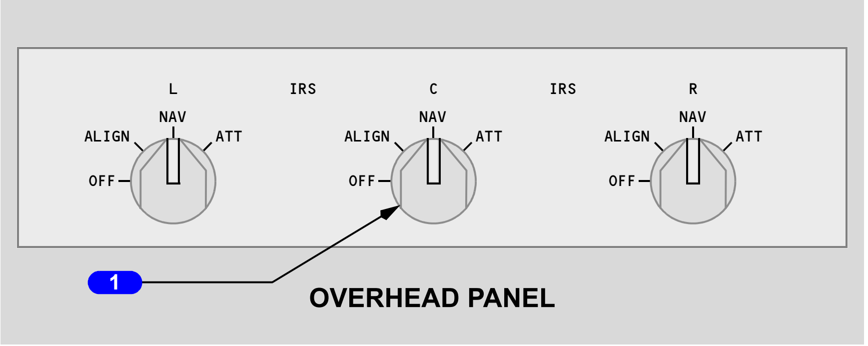
L - selects left FMC to provide guidance commands

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



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

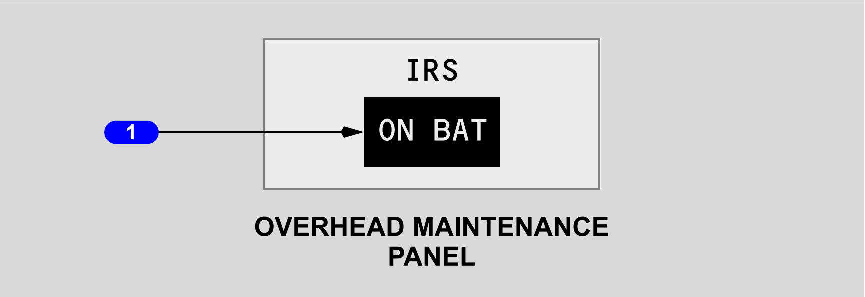
NAV (navigation) -

- system enters navigation mode after completing alignment
- provides IRS information to airplane systems for normal operations

ATT (attitude) -

- system enters attitude mode
- position and velocity information lost until system realigned on ground
- requires magnetic heading input from CDU

IRS On Battery Light



1 IRS ON Battery (BAT) Light

Illuminated (white) - IRS operating on backup electrical power (APU hot battery bus).

Transponder

Transponder Panel

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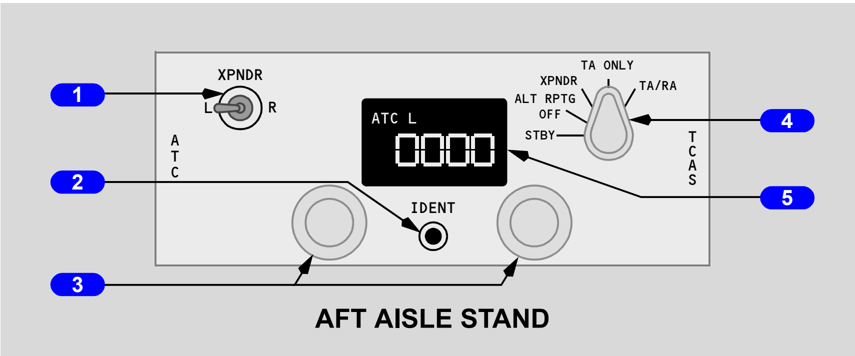

1 Transponder (XPNDR) Switch

L - selects left transponder.

R - selects right transponder.

2 Identification (IDENT) Switch

Push - transmits ident signal.

3 Transponder Code Selectors

Rotate - sets transponder code.

4 Transponder Mode Selector

STBY (standby) - transponder disabled.

ALT RPTG OFF (altitude reporting) -

- transponder enabled
- altitude reporting disabled

XPNDR (transponder) -

- transponder enabled
- in flight, altitude reporting enabled

TA ONLY (traffic advisory) and TA/RA (traffic advisory/resolution advisory) - Refer to Chapter 15, Warning Systems.

5 Transponder Code Display

ATC L, ATC R - transponder selected.

Displays transponder code.

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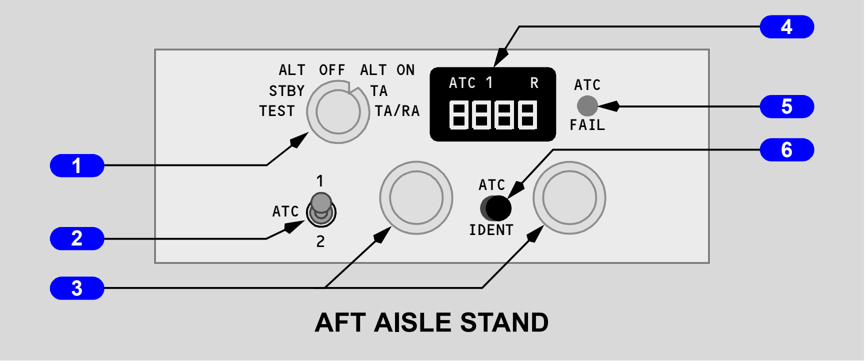

1 **Transponder Mode Selector**

TEST - initiates test.

STBY (standby) - transponder disabled.

ALT OFF (altitude) -

- transponder enabled
- altitude reporting disabled

ALT ON (altitude) -

- transponder enabled
- in flight, altitude reporting enabled

TA (traffic advisory) and TA/RA (traffic advisory/resolution advisory) - Refer to Chapter 15, Warning Systems.

2 **ATC Switch**

1 - selects left transponder.

2 - selects right transponder.

3 **Transponder Code Selectors**

Rotate - sets transponder code.

4 **Transponder Code Display**

ATC 1, ATC 2 - transponder selected.

R - reply indicator.

Displays transponder code.

5 **ATC FAIL Light**

Illuminated (amber) - selected transponder has failed.

6 **Identification (IDENT) Switch**

Push - transmits ident signal.

Weather Radar

Weather Radar Panel

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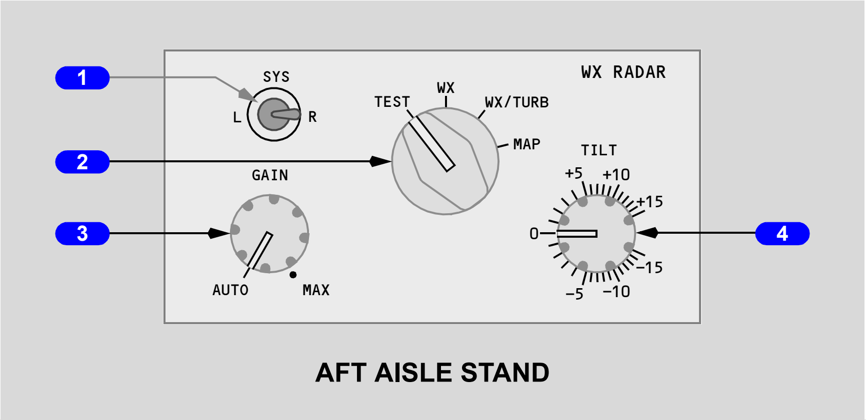

1 **System (SYS) Switch**

Selects receiver/transmitter (R/T) for operation.

L - radar antenna stabilized by left and center IRUs.

R - radar antenna stabilized by right and center IRUs.

2 **Mode Selector**

Controls display on NDs.

TEST -

- tests weather radar system operation without transmitting
- displays test pattern and any fault message on ND with WXR selected (except in PLAN, CTR VOR, and CTR APP modes)

- when on the ground, selecting WXR on the EFIS control panel and TEST on the weather radar control panel activates an 8 second test. Initially, the EICAS alert message WINDSHEAR SYS displays. Next, the amber WINDSHEAR annunciation displays and the aural MONITOR RADAR DISPLAY sounds. Finally, the red WINDSHEAR annunciation displays and the aural GO AROUND WINDSHEAR AHEAD, and then WINDSHEAR AHEAD, WINDSHEAR AHEAD sounds
- the test pattern remains displayed until WXR is selected off on the EFIS control panel, another mode is selected on the Mode Selector, or an actual PWS alert is detected. The source of any faults displays in the weather radar tilt field on the ND

WX (weather) - displays weather radar returns at selected gain level.

WX/TURB (weather/turbulence) - displays weather returns and turbulence. 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.

3 GAIN Control

Rotate - sets receiver sensitivity in WX, WX/TURB, and MAP modes.

AUTO (automatic) - maintains optimum receiver sensitivity.

4 TILT Control

Controls antenna tilt angle with reference to horizon.

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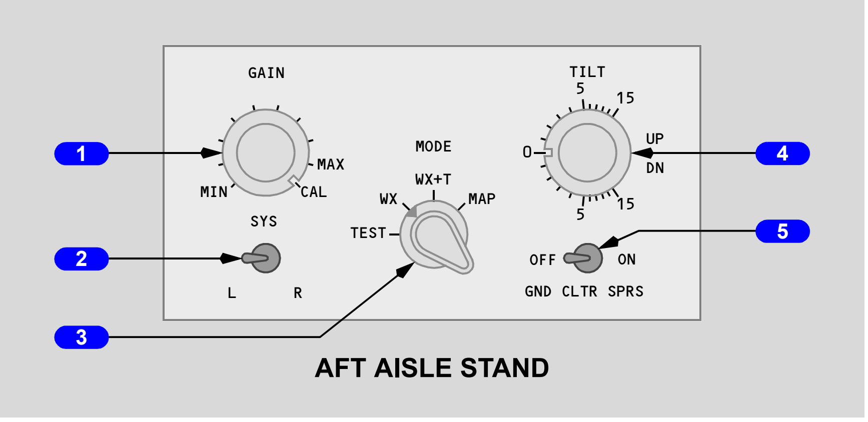

1 GAIN Control

Rotate - sets receiver sensitivity from minimum to maximum.

CAL (calibrated) - maintains receiver sensitivity at a preset level.

2 System (SYS) Switch

Selects receiver/transmitter (R/T) for operation.

L - radar antenna stabilized by left and center IRUs.

R - radar antenna stabilized by right and center IRUs.

3 Mode Selector

Controls display on NDs.

TEST -

- tests weather radar system operation without transmitting
- displays test pattern and any fault message on ND with WXR selected (except in PLAN, CTR VOR, and CTR APP modes)

WX (weather) - displays weather returns at selected gain level.

WX + T (turbulence) - displays weather returns and turbulence within precipitation at selected gain level. 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.

4 TILT Control

Controls antenna tilt angle with reference to horizon.

5 Ground Clutter Suppression (GND CLTR SPRS) Switch

ON - reduces amount of ground returns.

OFF - returns radar to normal operating mode.

Note: Continuous operation is not recommended; weather return intensity may be reduced.

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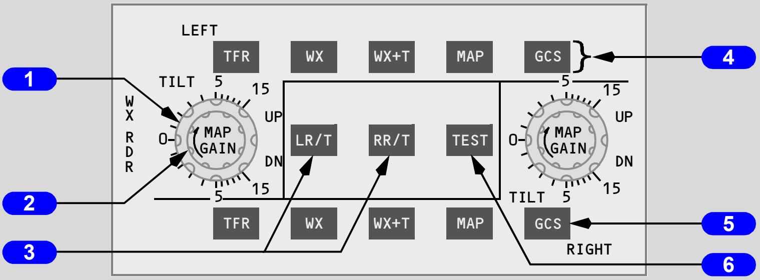

AFT AISLE STAND

1 TILT Control

Rotate outer knob clockwise - tilts radar antenna up.

Rotate outer knob counterclockwise - tilts radar antenna down.

2 MAP GAIN Control

Rotate inner knob - 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 results in the TEST mode; test pattern displays.

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. Selecting a range greater than 40 nm changes mode to WX.

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

Push -

- tests weather radar system operation without transmitting
- displays test pattern and PWS symbol at the end of the test and any fault message on ND with WXR selected (except in PLAN, CTR VOR, and CTR APP modes)
- when on the ground, selecting WXR on the EFIS control panel and TEST on the weather radar control panel activates a 12 second test. To activate the aural messages, TEST must be selected after WXR is selected on the EFIS control panel. Initially, the amber WINDSHEAR annunciation displays and the aural MONITOR RADAR DISPLAY sounds. Next, Master Warning Light illuminates and the EICAS alert message WINDSHEAR SYS displays. Finally, the red WINDSHEAR annunciation displays and the aural GO AROUND WINDSHEAR AHEAD, and then WINDSHEAR AHEAD, WINDSHEAR AHEAD sounds
- the test pattern and PWS symbol remain displayed until WXR is selected off on the EFIS control panel, another mode is selected on the Mode Selector, or an actual PWS alert is detected. The source of any faults displays in the weather radar tilt field on the ND

Flight Management, Navigation — Chapter 11
Navigation Systems Description — Section 20

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 are independent and supply very accurate position data to the FMC. GPS tuning is automatic.

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The GPS also provides data to the GPWS.

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.

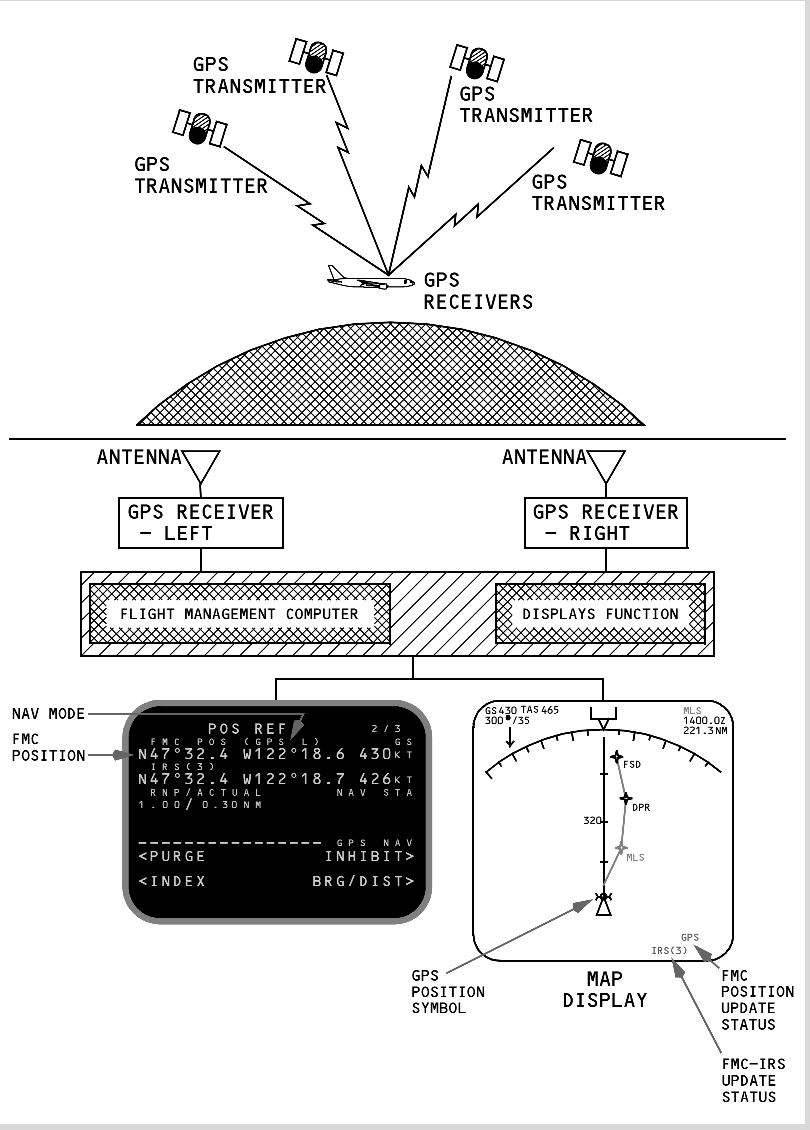
GPS Data

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 should be used during all approaches in which the FMC database and approach procedures are referenced to the WGS-84 reference datum. GPS updates should be inhibited for other approach operations not based on WGS-84 unless other appropriate procedures are used.

GPS position updates should be used for all operations unless a specific state requires the use of other update provisions within their airspace (eg, to accomodate a non-WGS reference datum or other reason).

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 the NAV 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, 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.

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In flight, traffic displays if the transponder mode selector is in TA ONLY or TA/RA.

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In flight, traffic displays if the transponder mode selector is in TA or TA/RA.

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In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPNDR, TA ONLY, or TA/RA.

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In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in ALT ON, TA, or TA/RA.

Refer to Chapter 15, Warning Systems, for a description of TCAS.

Transponders provide selective interrogation and downlink information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Some airports use transponder information to monitor airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). Transponder enhancements also enable air traffic controllers in some areas of the world to use Automatic Dependent Surveillance-Broadcast (ADS-B). TCAS modes should not be used on the ground for ground tracking.

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.

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The weather radar system performs various levels of self test on power up, during each sweep, and when descending through 2,300 feet AGL.

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.

Flight Management, Navigation — Chapter 11
Flight Management System Description — Section 30

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. The FMC also sends landing altitude data to the cabin altitude controller. Map and route data are sent to the NDs. The EFIS control panels select the necessary data for the ND. The mode control panel selects the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays

The FMC is certified for area navigation when used with navigation radio and/or GPS updating. The FMC and CDU are used for enroute and terminal area navigation, RNAV approaches, and to supplement primary navigation during all types of instrument approaches.

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.

Flight Management, Navigation — Chapter 11
Flight Management System Operation — Section 31

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.

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Some ATC information can be entered into the CDU by data link.

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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

The FMC will not sequence the active waypoint when: more than 21 nm off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) use the first waypoint in the route.

Some SIDs or STARS contain a heading vectors leg. VECTORS waypoints display on the ND as a magenta line without an end point leading away from the airplane symbol. If LNAV is active, the DIRECT TO or INTERCEPT COURSE TO 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.

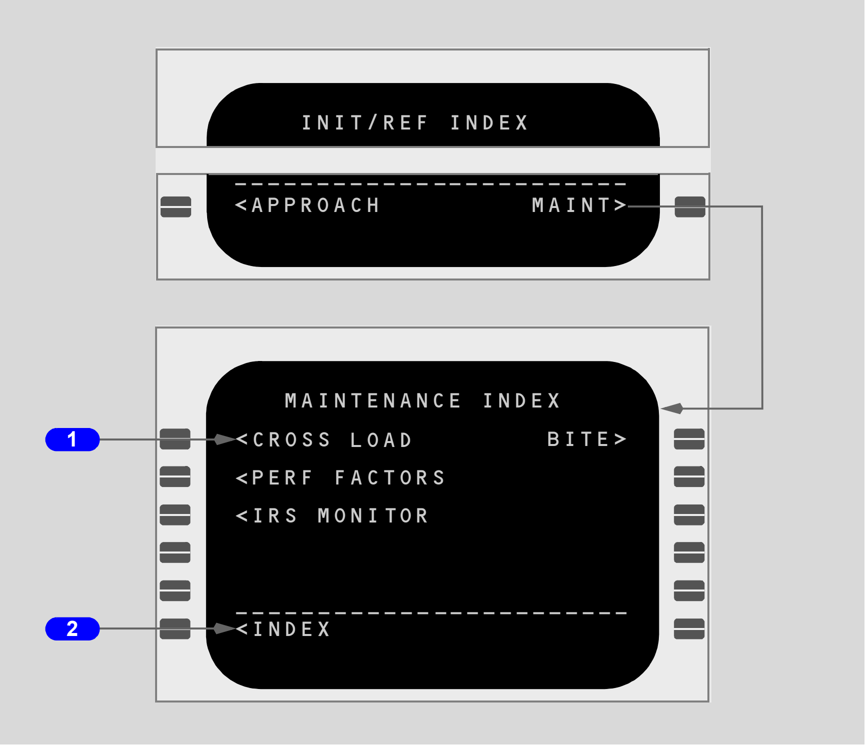
Speed restriction - an airspeed limit.

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 runway threshold or to the position shift position when entered. When making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page.

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 LOC GPS) 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 using IRS and navigation sensor positions occurs in the following priority order:

- LOC and GPS
- LOC and DME-DME
- LOC and collocated VOR/DME
- IRS and LOC
- IRS and GPS
- IRS and DME-DME
- IRS and collocated VOR/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
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
GPS valid, LOC invalid	GPS L, GPS R	GPS
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 localizer navaid elevation
- the airplane is less than 20 nm from the localizer navaid for a front course approach or less than 12 nm for a back course approach
- the airplane is within a 25° sector of the inbound localizer course
- the difference between airplane track and the localizer course is less than a 45° intercept angle

FMC Polar Operations

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 inhibited and the FMC position becomes a single IRU position. The EICAS alert message UNABLE RNP is inhibited. When the FMC position passes south of 88.0°N or north of 88.0°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

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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).

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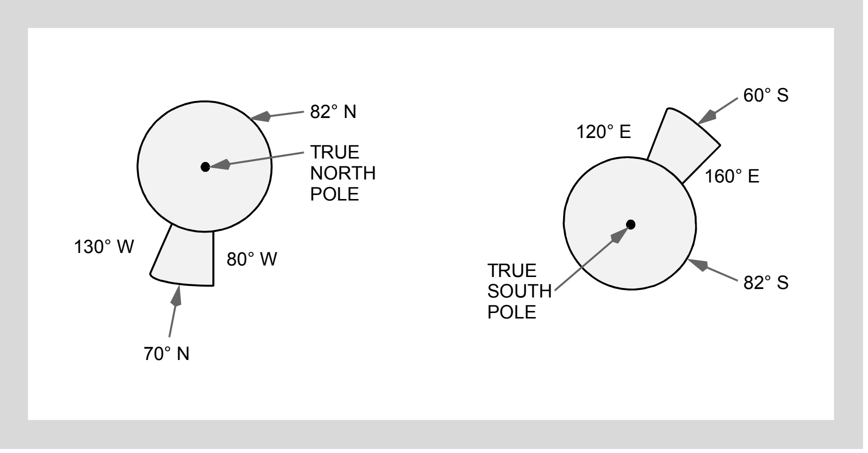
The heading reference for PFDs and NDs changes to true north at 82°N (or north of 70°N between 80°W and 130°W) or at 82°S (or south of 60°S between 120°E and 160°E).

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.

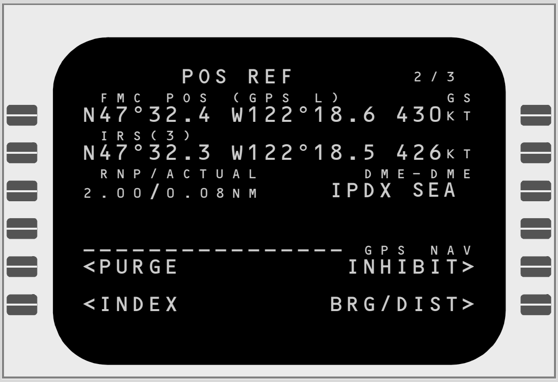
Note: For autopilot operation in high latitudes using a roll mode other than LNAV, the TRUE position on the Heading Reference switch should be selected.

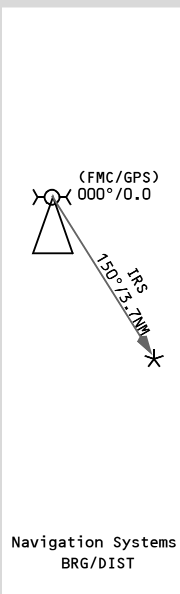
Areas of High Latitude Operations (with expanded MAGVAR)

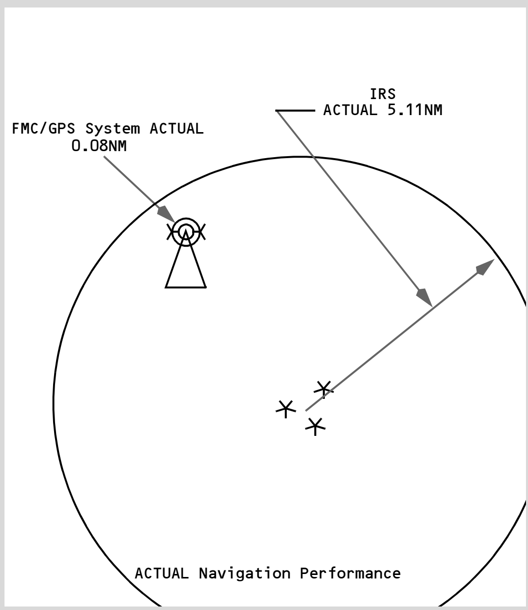


Navigation Performance

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

570

Some approach procedures display a circular arc track, defined in the FMC as a Constant Radius to a Fix, which are centered at an FMC-defined point and terminate at a fix. For example, the Legs page waypoint, ANNE3, followed by "1.9 ARC R". This is an arc to the right with a radius of 1.9 nm.

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.

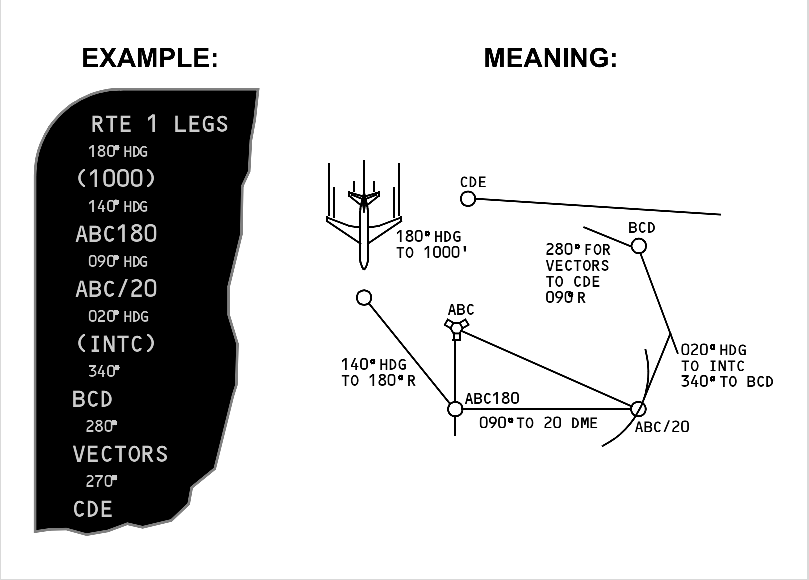
Conditional Waypoints

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°.



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.

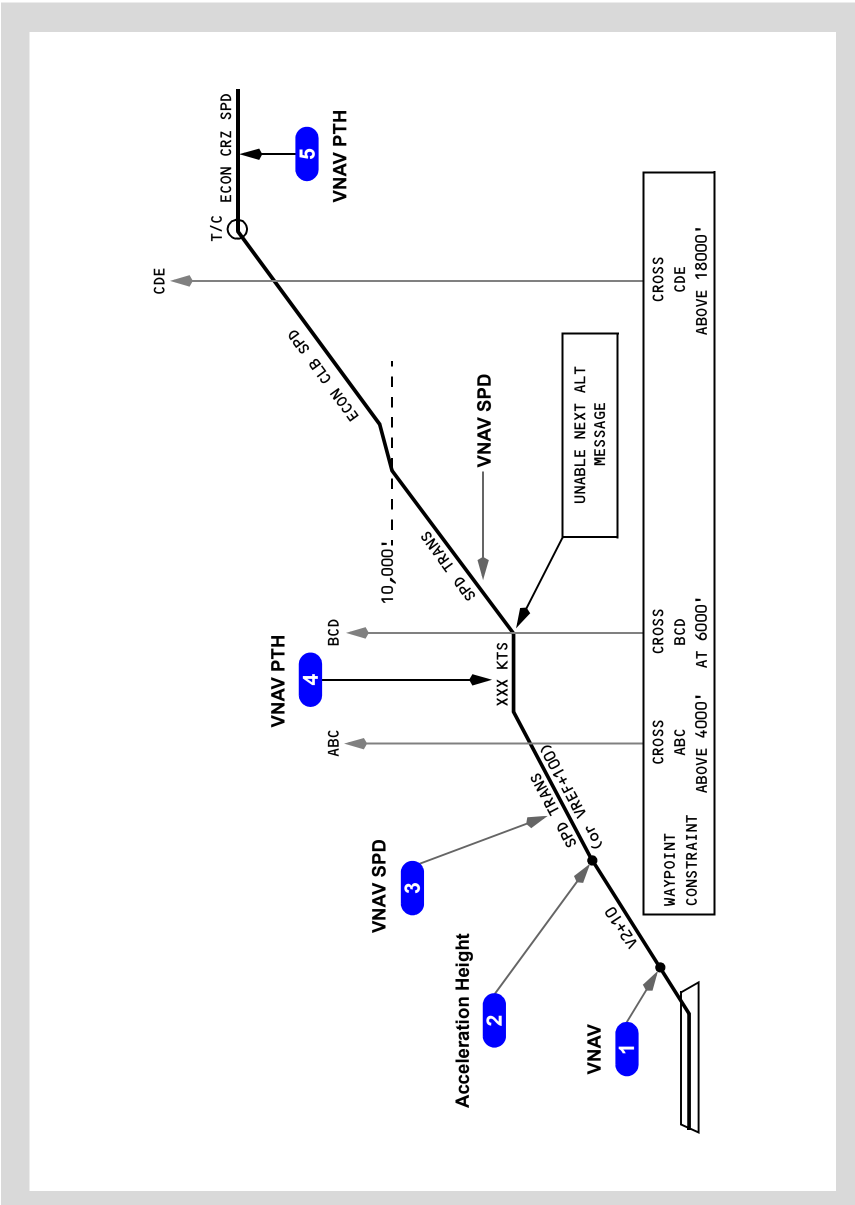
Vertical Navigation (VNAV)

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 or flap retraction, VNAV commands an airspeed increase to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted or at an AFDS capture altitude, VNAV commands the greater of 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 as the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints of an active route Standard Instrument Departure. Autothrottle uses the armed climb thrust limit.

If the climb speed profile cannot achieve an altitude constraint, the UNABLE NEXT ALT scratchpad message displays.

4 Climb Constraints

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed

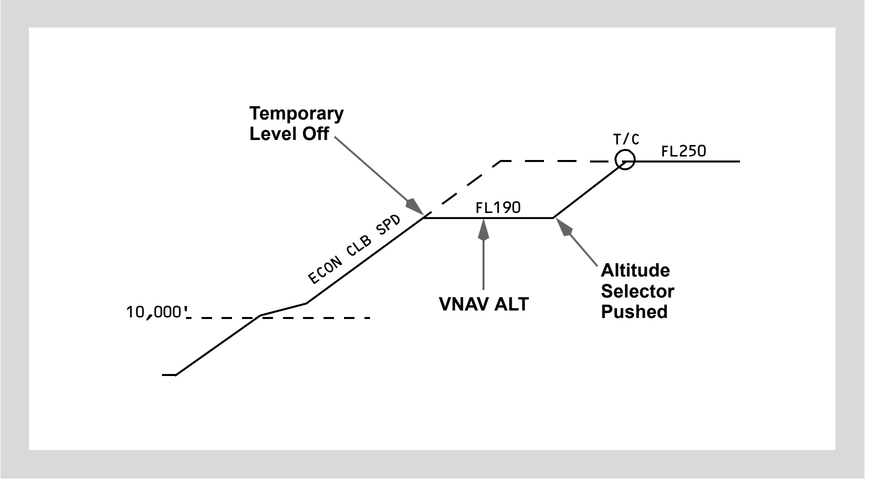
If the FMC predicts the airplane will not reach an altitude constraint, the FMS-CDU message UNABLE NEXT ALTITUDE displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the Thrust Limit page.

5 Top Of Climb (T/C)

The point where 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. Other cruise speed options are:

- long range (LRC)
- engine out (ENG OUT), or
- flight crew entered speed

  109, 405
- required time of arrival (RTA)

The FMC commands maximum range cruise speed with the cost index set to zero. Cost index modifications are allowed until within ten miles of the top of descent.

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.

The FMC calculates step climb points as a function of lateral flight plan, speed mode, present and step to altitude, and gross weight. The gross weight for a step from present CRZ ALT to STEP TO altitude is the gross weight at which the optimum altitude is halfway between the two altitudes.

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. Dashes display on the LEGS page for speed and altitude descent waypoints. When an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan, the FMC creates an E/D. The E/D is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point; which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D is also created when an altitude constraint is entered on the LEGS page on a downstream waypoint.

The top of descent (T/D) is the point where the cruise phase changes to the descent phase. It 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
- FMC cruise wind
- wind entries on the DESCENT FORECAST page
- predicted use of anti-ice
- applicable target speed

The descent may be planned at economy Mach/CAS (based on Cost Index) or a manually entered Mach/CAS. VNAV will not command an economy target speed greater than 349 knots (VMO/MMO minus 16 knots) or a pilot entered speed greater than 354 knots (VMO/MMO minus 11 knots).

The FMC creates the descent path with a deceleration at the speed transition altitude (typically 250 knots below 10,000 feet). VNAV plans a speed target 10 knots below the transition speed to allow for unknown tailwinds.

Descent path segments after the first altitude constraint waypoint are constructed as straight line point-to-point segments. If the VNAV path segment is too shallow to be flown satisfactorily at IDLE thrust, the FMC commands speed on thrust levers (SPD). Elevators control the shallow descent path.

If flight plan modifications or unknown winds occur when above the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

- with greater than 15 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 5 knots above the greater of best holding speed or minimum maneuvering speed, and the scratchpad message THRUST REQUIRED displays again
- with greater than 349 knots (VMO/MMO minus 16 knots), the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 354 knots (VMO/MMO minus 11 knots) to maintain the path. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 349 knots (VMO/MMO minus 16 knots), and the scratchpad message DRAG REQUIRED displays again

If flight plan modifications or unknown winds occur when below the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

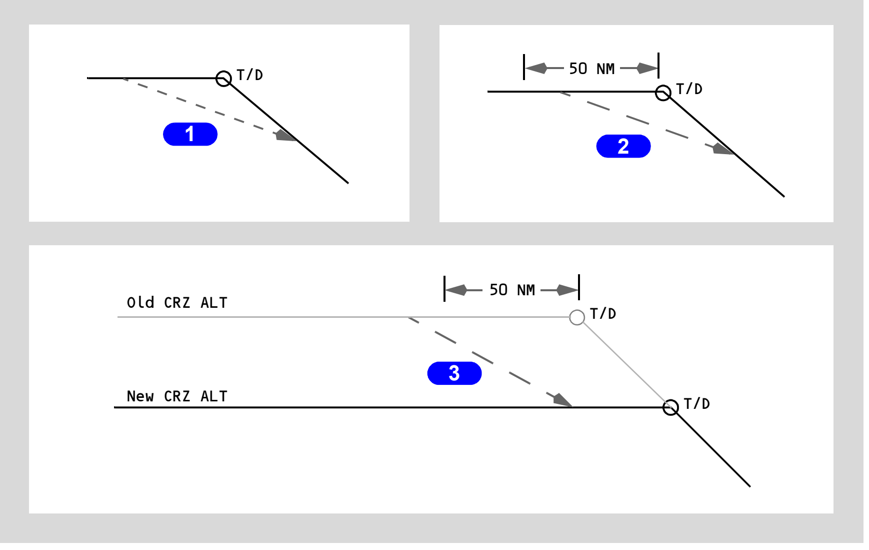
- with greater than 10 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV commands a speed 10 knots less than the transition speed for the destination airport (not less than minimum maneuvering speed), and the scratchpad message THRUST REQUIRED displays again

- with greater than 10 knots above target speed, the scratchpad message DRAG REQUIRED displays. The airplane may accelerate up to 15 knots above target speed to maintain the path. The maximum speed excursion allowed is 5 knots above the transition speed after the airplane is below transition altitude for the destination airport or 5 knots below the flaps placard speed if flaps are extended. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path to stop the acceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV commands a speed 10 knots less than the transition speed for the destination airport, and the scratchpad message DRAG REQUIRED displays again

Early Descent

When a descent is started before the T/D, VNAV commands a descent at a reduced descent rate until the idle descent path is intercepted.

Start an early descent by selecting the DES NOW prompt on the DES page or by pushing the MCP altitude selector. In an early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.



1 DES NOW

Use the DES NOW prompt on the VNAV DES page. VNAV starts an early descent and captures the idle descent path.

2 Within 50 NM of Top of Descent Point

Use the MCP altitude selector to start an early descent. Within 50 NM of the top of descent point, VNAV starts an early descent and captures the idle descent path.

3 More than 50 NM from Top of Descent Point

Use the MCP altitude selector to start a cruise descent. If the distance from the top of descent is more than 50 NM, VNAV begins a cruise descent to the new cruise altitude. VNAV may not capture the idle descent path since the target airspeed is economy cruise and the descent path is based on idle thrust and economy descent airspeed. In the example, VNAV levels at the new cruise altitude.

Approach

The FMC transitions to "on approach" under the following conditions:

- a VFR approach is created and,
  - the airplane has sequenced the FAXXX, or
  - the airplane is enroute to a direct-to or intercept-to the RWYYY waypoint and the airplane is within 25 nm of the runway threshold
- a published instrument approach has been selected and incorporated in the active flight plan and the airplane has sequenced the first waypoint on the published approach

The FMC transitions out of "on approach" under the following conditions:

- selecting TOGA
- the airplane lands
- the airplane flies beyond the last waypoint in the approach (missed approach waypoint or runway) and the VNAV page title changes from "ACT xxxxxx DES" to "ACT END OF DES"

When the FMC is “on approach”, the following features are available:

- the IAS/MACH window can be opened and the command speed can be set while VNAV remains in VNAV PTH descent; VNAV commands the set speed
- the MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current airplane altitude, VNAV continues to command a descent

- VNAV remains in VNAV PTH and follows the descent path unless the airplane accelerates to within 5 knots of the current flap placard and the airplane rises more than 150 feet above the path. In this case, VNAV PTH changes to VNAV SPD
- When a glide path angle is specified for one or more legs on the approach, it displays on the LEGS page and VNAV provides VNAV PTH guidance at the displayed angle. When sequencing a waypoint prior to a descent leg specified by a glide path angle, VNAV commands level flight until the airplane intercepts the descent path

Note: Display of a specified glide path angle is not limited to approaches. A glide path angle may be defined for a leg in a STAR and displays on the LEGS page for the procedure.

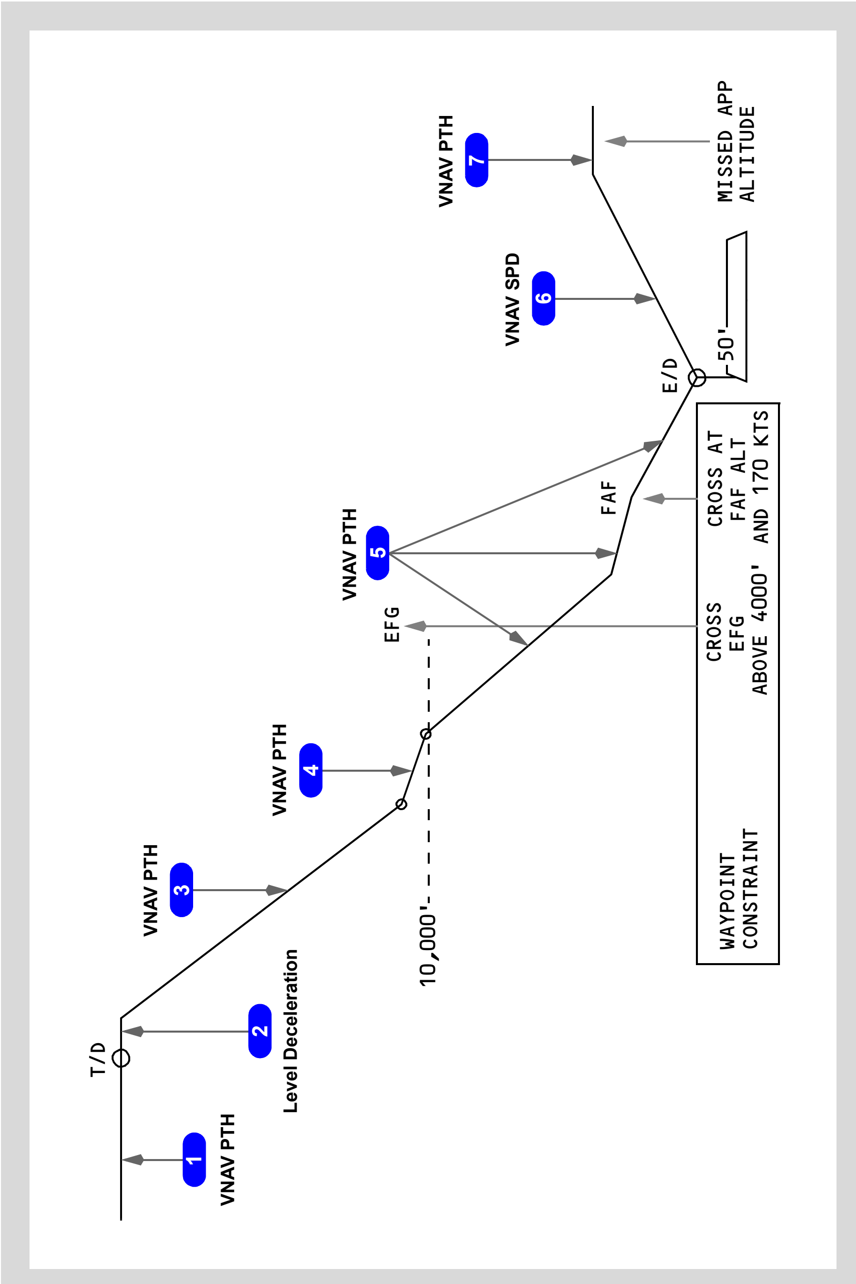
Selection of another approach can be accomplished on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the “INTC CRS TO” line on the LEGS page or by selecting the "XXXXX INTC>" prompt on the ARRIVALS page.

Missed Approach

A missed approach is accomplished by selection of either TOGA switch. The following features are available:

- VNAV (and LNAV) can only be activated when the airplane climbs above 400 feet radio altitude
- all descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan
- the highest altitude in the missed approach procedure becomes the new cruise altitude
- the FMC transitions from active descent to active climb
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected
- when cruise phase is active, the speed target is the most restrictive of speed transition, best hold speed, or ECON cruise (above speed transition altitude)

Cruise and Descent Profile (Instrument Approach using VNAV)



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.

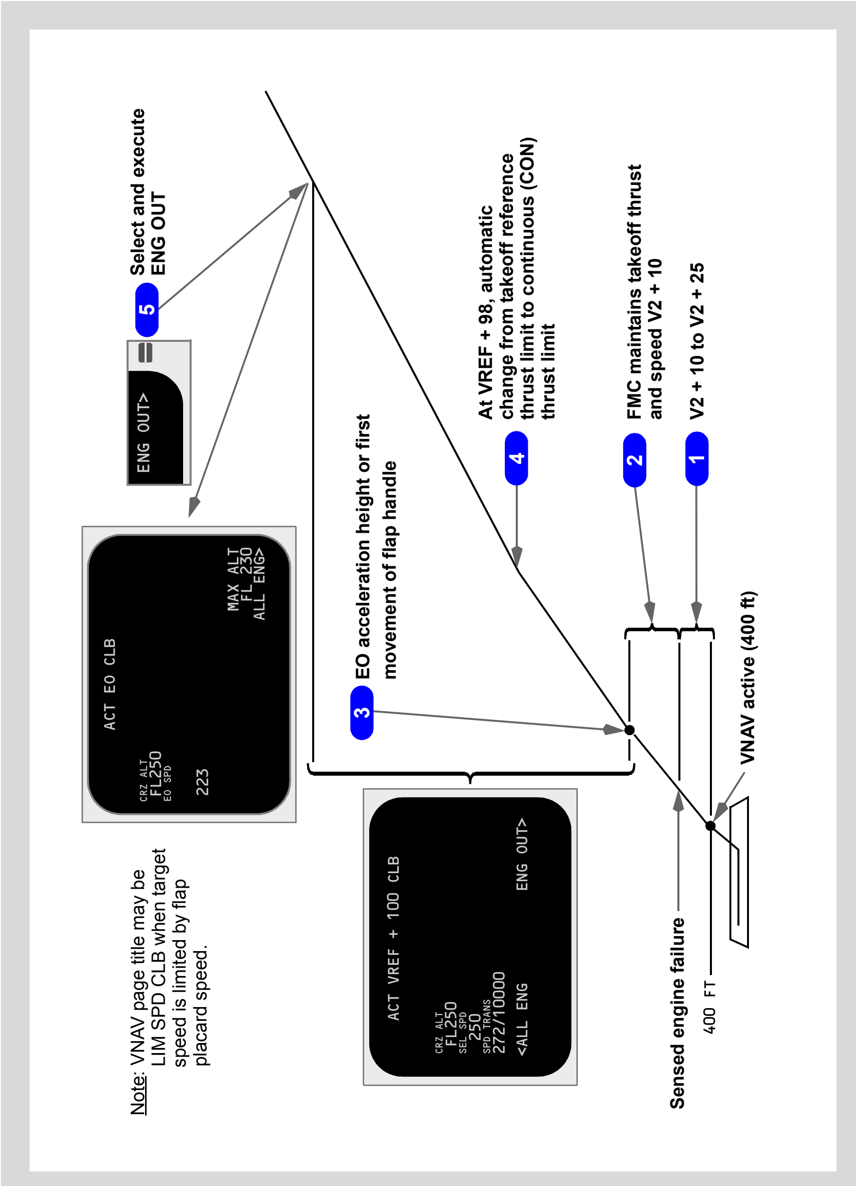
6 **Missed Approach**

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 knots. 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 knots, 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 VREF + 98 knots

Result: thrust is automatically reduced from selected takeoff to continuous (CON) thrust. If the engine failure occurs above the thrust reduction point, the current climb thrust is maintained.

5 VNAV Climb (Engine Out)

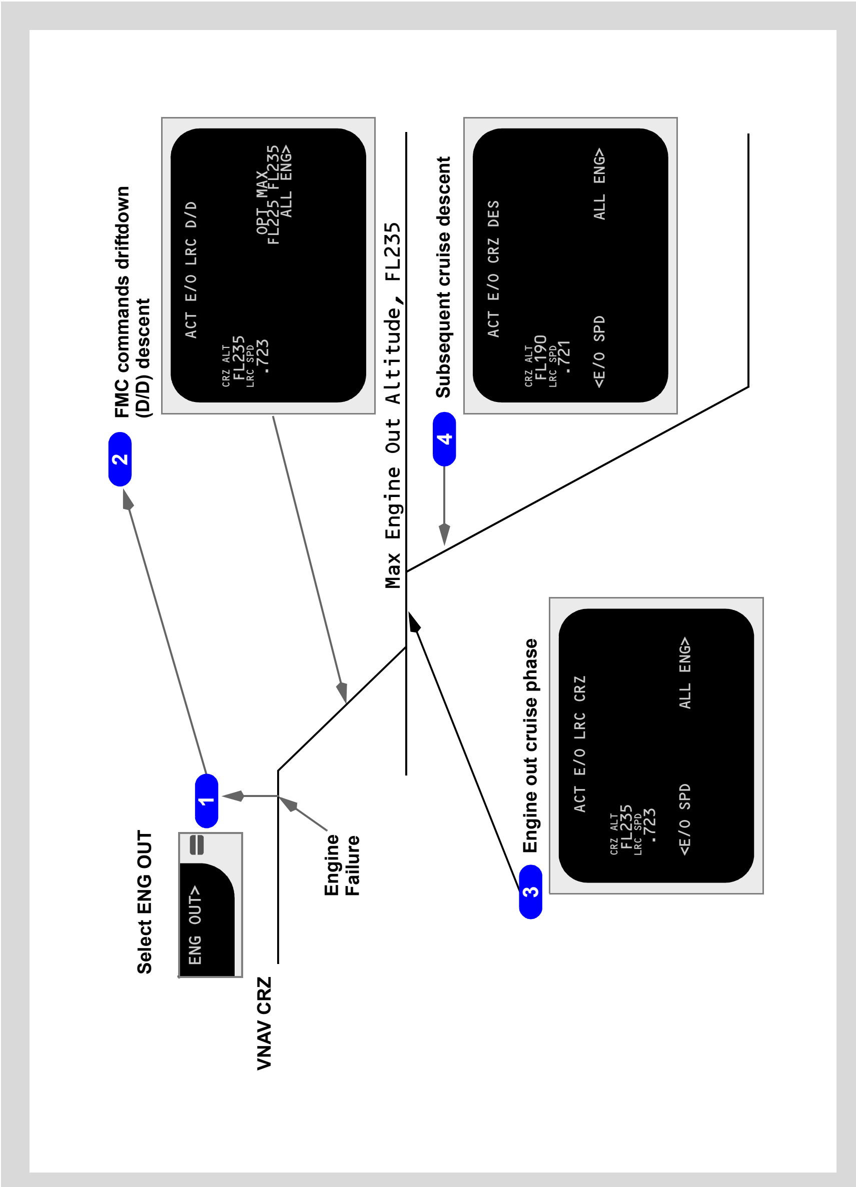
Condition: Selecting the ENG OUT> prompt on the VNAV CLB page displays applicable engine out performance data. The airline engine out speed (E/O SPD) may be selected. Execution activates engine out performance data.

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)

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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 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

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Thrust limits are expressed as N1 limits. Thrust equalization references N1.

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Thrust limits are expressed as EPR limits. Thrust equalization references EPR.

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

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Two fixed derates, TO1 and TO2, can be selected on the THRUST LIM page.

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Two fixed derates, TO1 and TO2, can be selected on the THRUST LIM page. TO1 and TO2 reduce takeoff thrust by percentages specified by the operator [Airline Selectable Option]. The derate percentages can be set between maximum takeoff thrust and the maximum certified derate in one percent increments. The Airplane Flight Manual (AFM) provides performance data for these derates.

With both 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.

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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.

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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 30,000 feet. CLB 2 uses a 20% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 35,000 feet.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of climb derate. For a thrust reduction less than 5 percent, maximum climb thrust is selected by the FMC. For takeoff thrust reductions or derates from 5 percent to less than 15 percent, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions or derates equal to or 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 fuel used by the engines. FUEL USED displays on the PROGRESS page. FUEL USED values are retained through flight completion and are subsequently cleared at engine start or following a long-term power interrupt on the ground. If the fuel flow signal is invalid for greater than two minutes after engine start or is invalid while on the ground, the display blanks.

The 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 inoperative 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.

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Flight Management, Navigation — Chapter 11
FMC Preflight — Section 40

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.

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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.

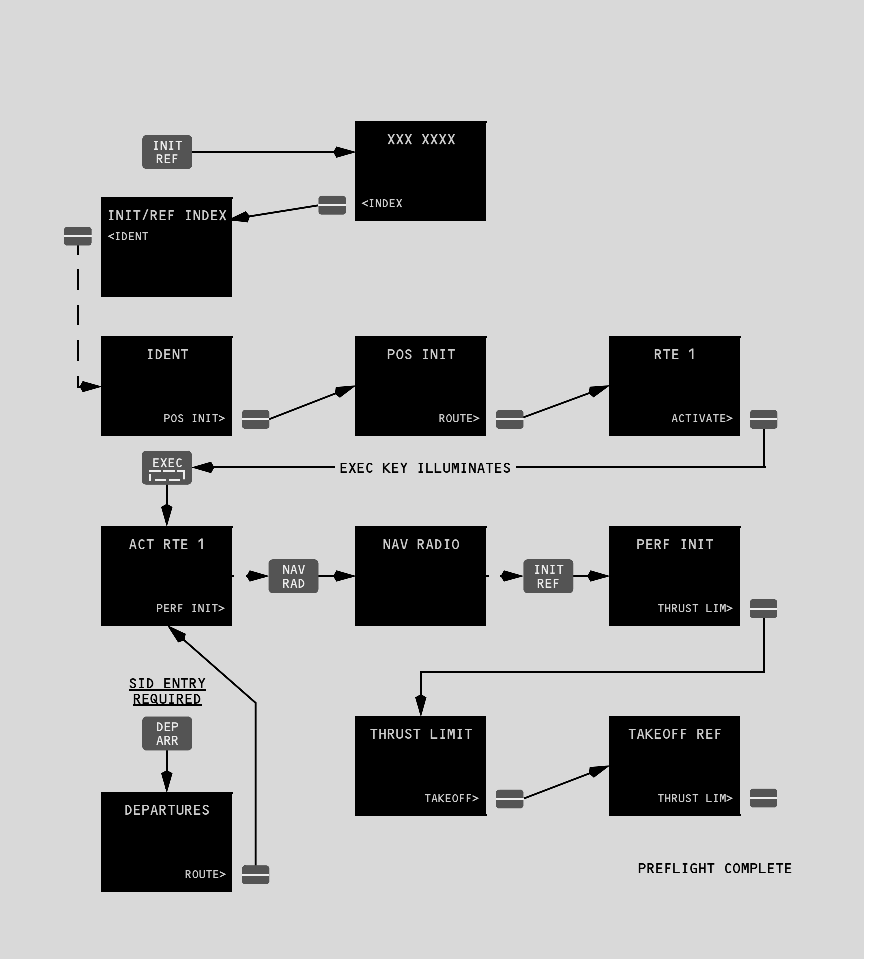
Preflight Page Sequence

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.

FMC 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.

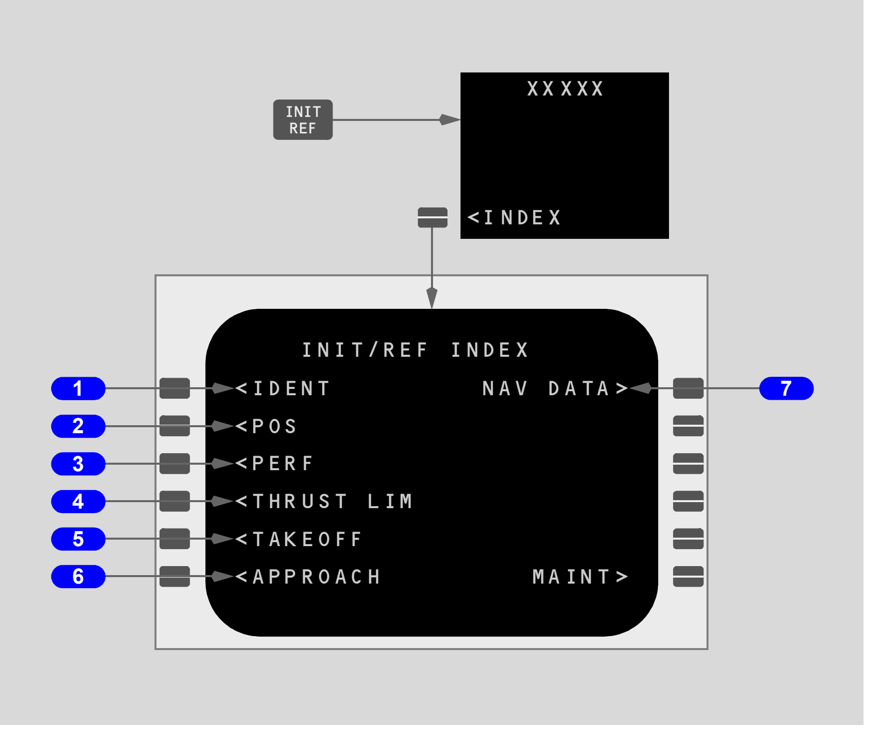
VNAV performance is improved if forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints is entered on the the WIND page. WIND page is described in the FMC Cruise section of this chapter.

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.

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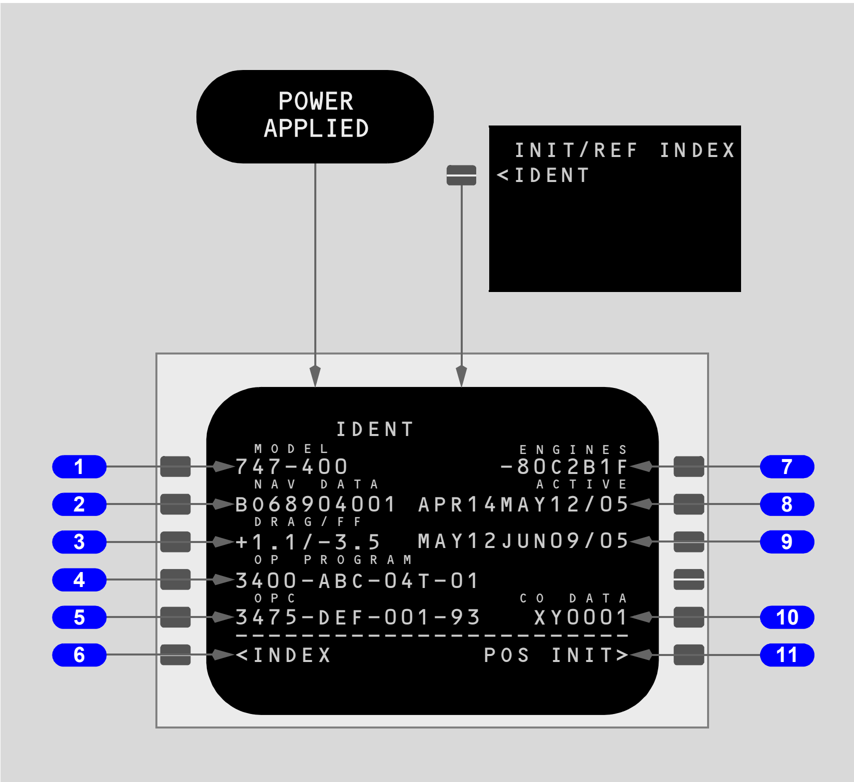

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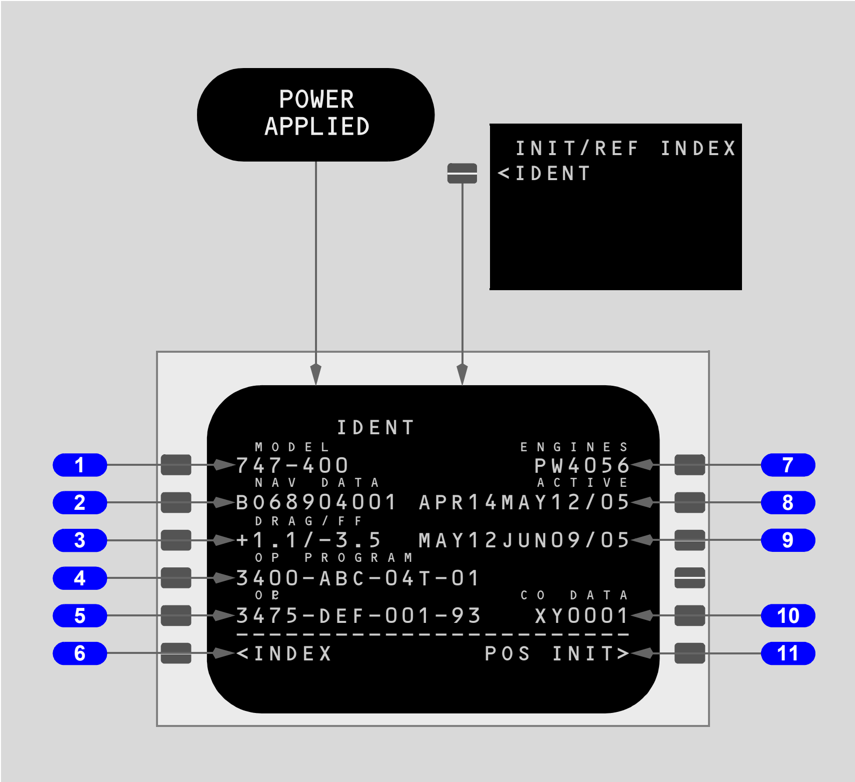


1 **MODEL**

Displays airplane model from FMC performance database.

2 **Navigation Data (NAV DATA)**

Displays navigation database identifier.

3 **DRAG/Fuel Flow (FF)**

Displays airplane drag and fuel flow correction factors.

4 **Operating (OP) PROGRAM**

Displays systems operating program identifier (FMC software load).

5 **Operational Program Configuration (OPC) Number**

Displays the operational program configuration (OPC) part number.

6 INDEX

Push - displays INIT/REF INDEX page.

7 ENGINES

Displays engine model from the FMC performance database.

8 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.

9 Inactive Date Range

Displays the effectivity date range for the inactive navigation database. The inactive database becomes effective at 0901Z on the respective day.

10 Company (CO) DATA

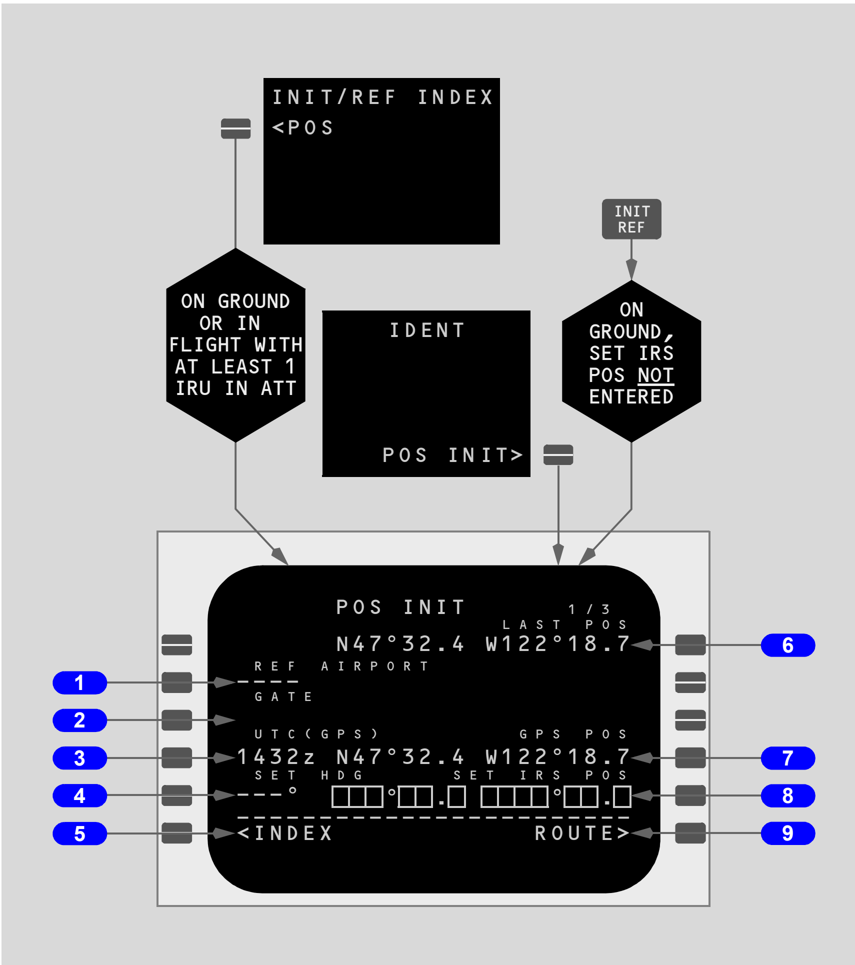
Displays airline policy file identifier.

11 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

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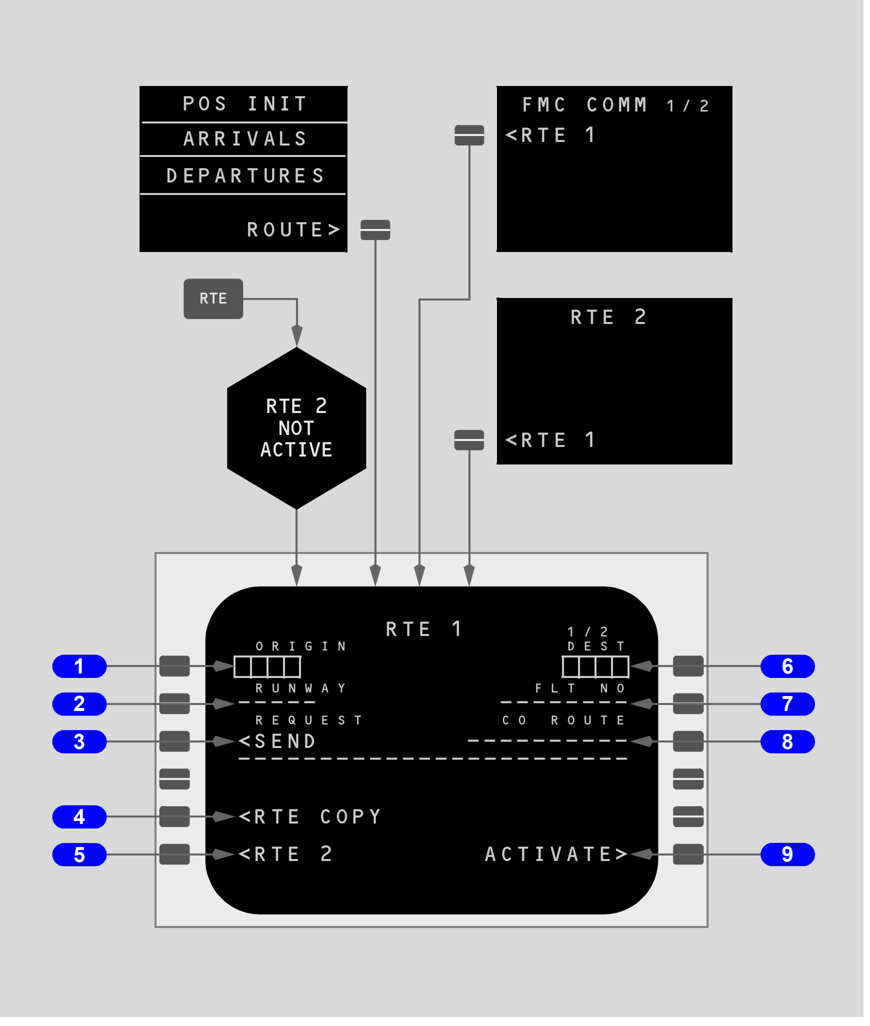
Two routes (RTE 1 and RTE 2) can be displayed in air traffic control format. Routes can be entered by the flight crew or uplinked through data link. All routes have two or more pages. The first route page displays origin and destination data. Subsequent route pages display the route segments between 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 **Route Copy (RTE COPY)**

Push-

- displays when a route is active or is modified
- copies active route into the inactive route
- displays COMPLETE after the route is copied

5 **RTE 2**

Push -

- displays RTE 2 page 1/x
- data line displays RTE 1

6 **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.

7 **Flight Number (FLT NO)**

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Valid entry is any flight crew entered or uplinked company flight number.

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Valid entry is any flight crew entered or uplinked company flight number. FMC sends flight number to each ATC transponder for flight ID function.

Flight crew entered or uplinked.

Flight number displays in PROGRESS page title.

Data line blanks at flight completion.

Transponder transmits flight number to ATC when Eurocontrol-compliant transponder installed.

8 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.

9 ACTIVATE

Displays on inactive route pages.

Activation of a route is required for completion of the preflight.

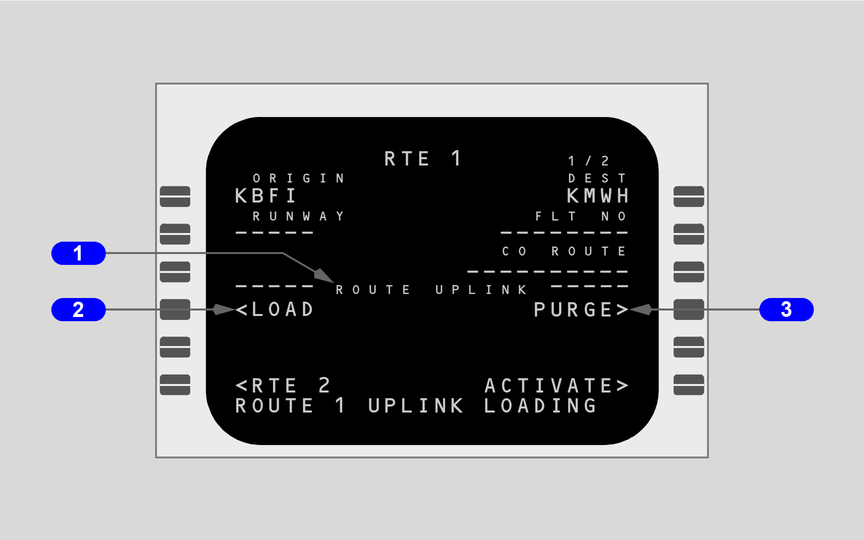
Push - arms the selected route for execution as the active route.

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 1/X
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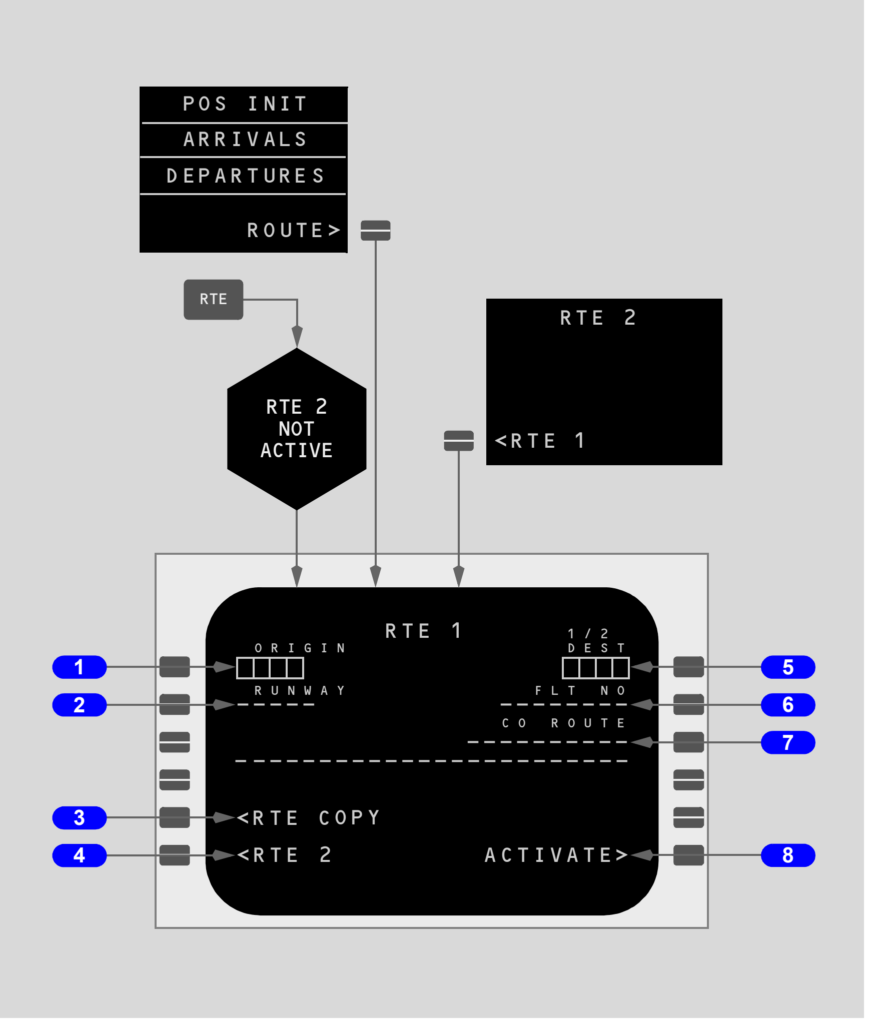
Two routes (RTE 1 and RTE 2) can be displayed in air traffic control format. All routes have two or more pages. The first route page displays origin and destination data. Subsequent route pages display the route segments between waypoints or fixes. ROUTE 1 and ROUTE 2 allow management of alternate or 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 Ready For Entry



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 data base.

Automatically entered when part of a company route.

Can be selected on DEPARTURES page.

FMC deletes runway after sequencing the first waypoint.

3 Route Copy (RTE COPY)

Push-

- displays when a route is active or is modified
- copies active route into the inactive route
- displays COMPLETE after the route is copied

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 flight number.

Flight crew entered or uplinked.

Flight number displays in PROGRESS page title.

Data line blanks at flight completion.

Transponder transmits flight number to ATC when Eurocontrol-compliant transponder installed.

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 company route name. If the name is not contained in the NAV database, the entry is allowed and the scratchpad message NOT IN DATABASE displays.

On the ground, entry of a new company route replaces the previous route.

In flight, entry of a new company route manually 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.

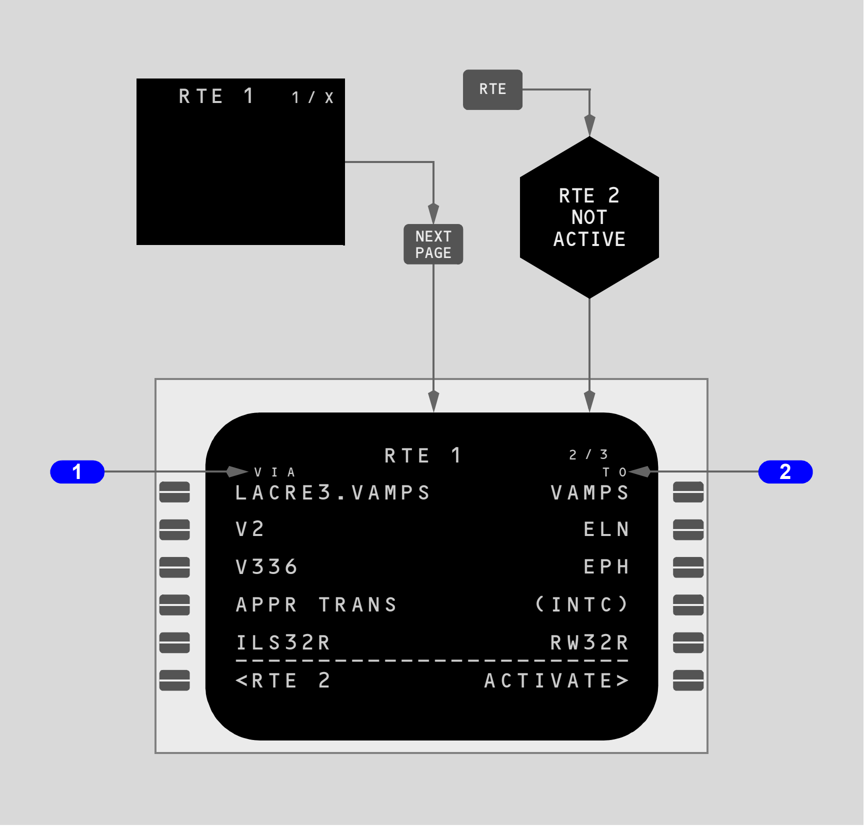
When the EXECUTE key is pushed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

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

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.

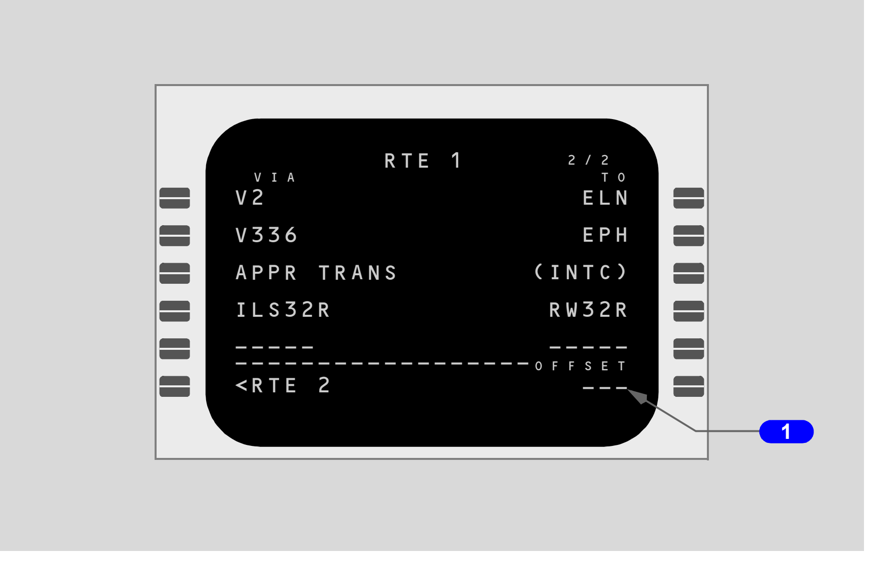
Valid waypoint entries for airways are waypoints or fixes on the airway.

Dashes display on the first TO waypoint after the end of the route.

Route Offset

Select route offsets on RTE page 1. The OFFSET prompt displays when the airplane is in flight and not on a SID, STAR, or transition. The offset route displays as a white dashed line on the ND until 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.

When on the route offset, active route waypoints sequence normally. However, during transition to or from an offset route greater than 21 nm, the crosstrack limit is extended to 200 nm.



1 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.

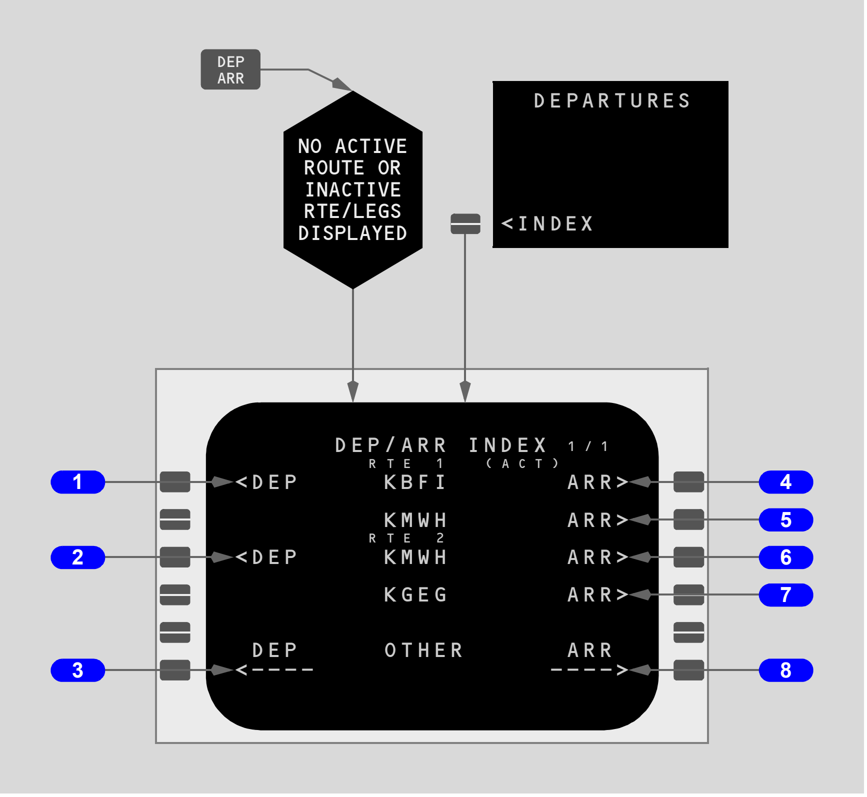
Offset removed by deleting, entering zero, or proceeding direct to a waypoint.

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.

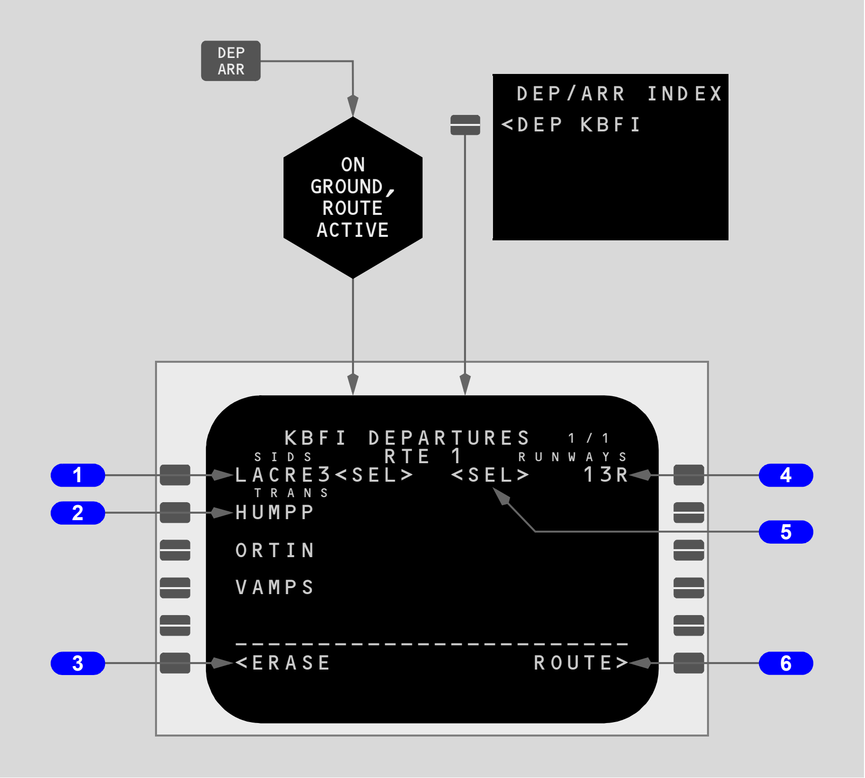
8 Arrival (ARR) - Other

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>**

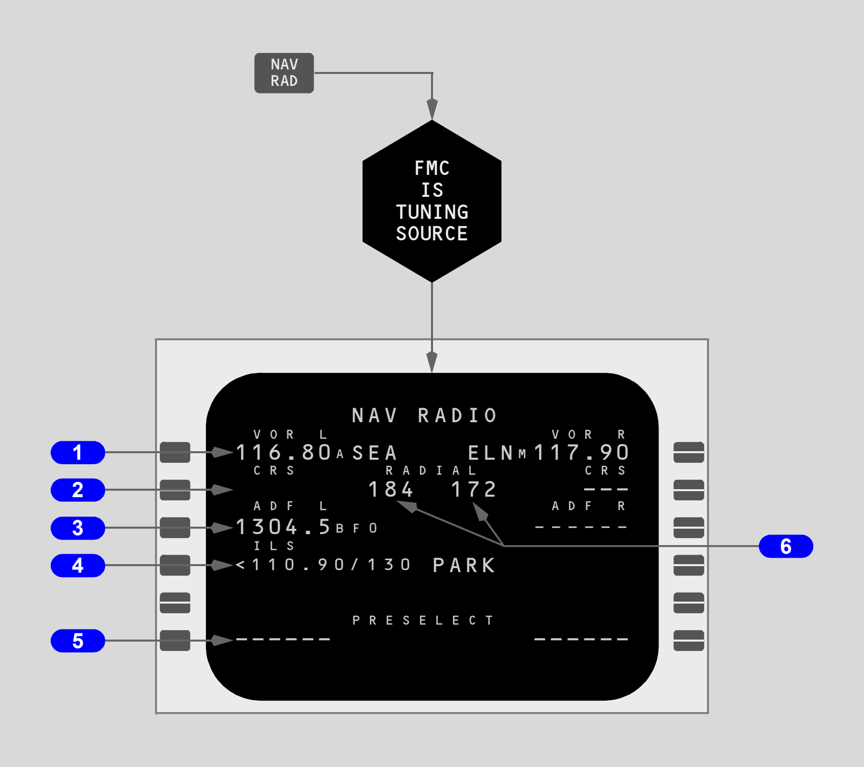
Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>. Executing a modification or leaving the page and returning displays all options and <SEL> or <ACT> prompts.

6 **ROUTE**

Push - displays the respective 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 respective 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 optimizes audio reception and removes ADF bearing data
- BFO (beat frequency oscillator) - mode for audio identification of stations transmitting unmodulated (CW) signals
- 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, whichever represents the lesser distance to destination

Line selection manually tunes ILS.

3 **Tuning Status - Autotune**

ILS frequency, front course, and A display when an ILS, LOC, Back Course; 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.

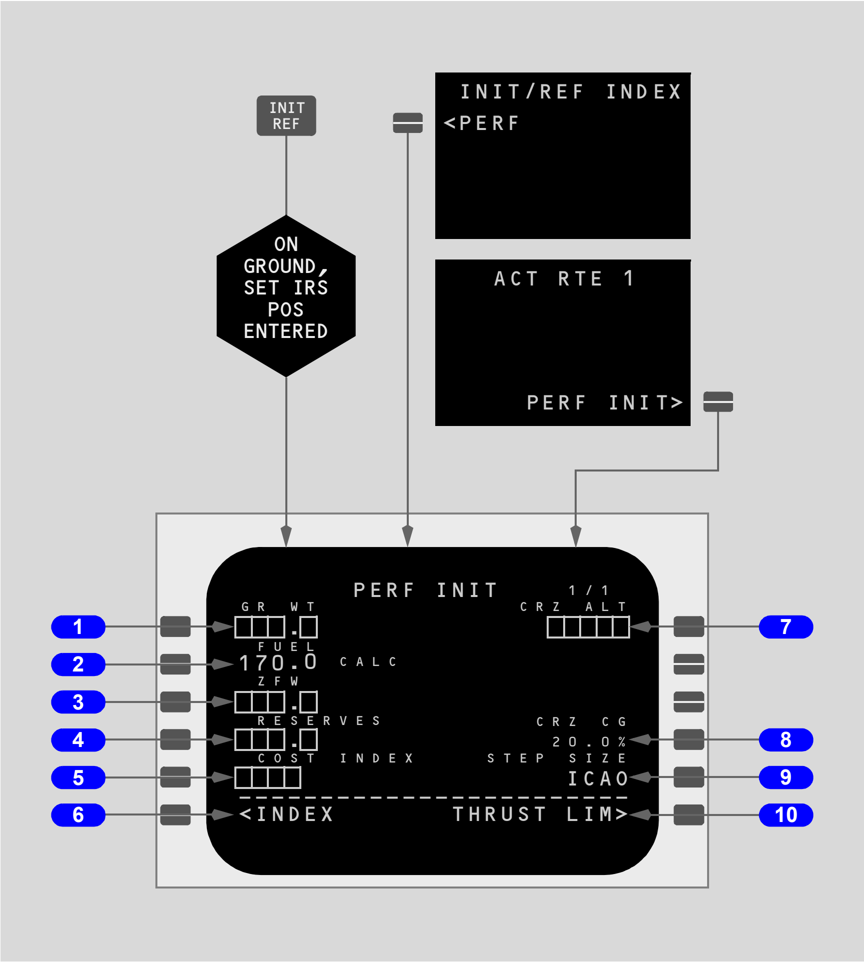
Preflight Pages - Part 2A

Performance Initialization Page

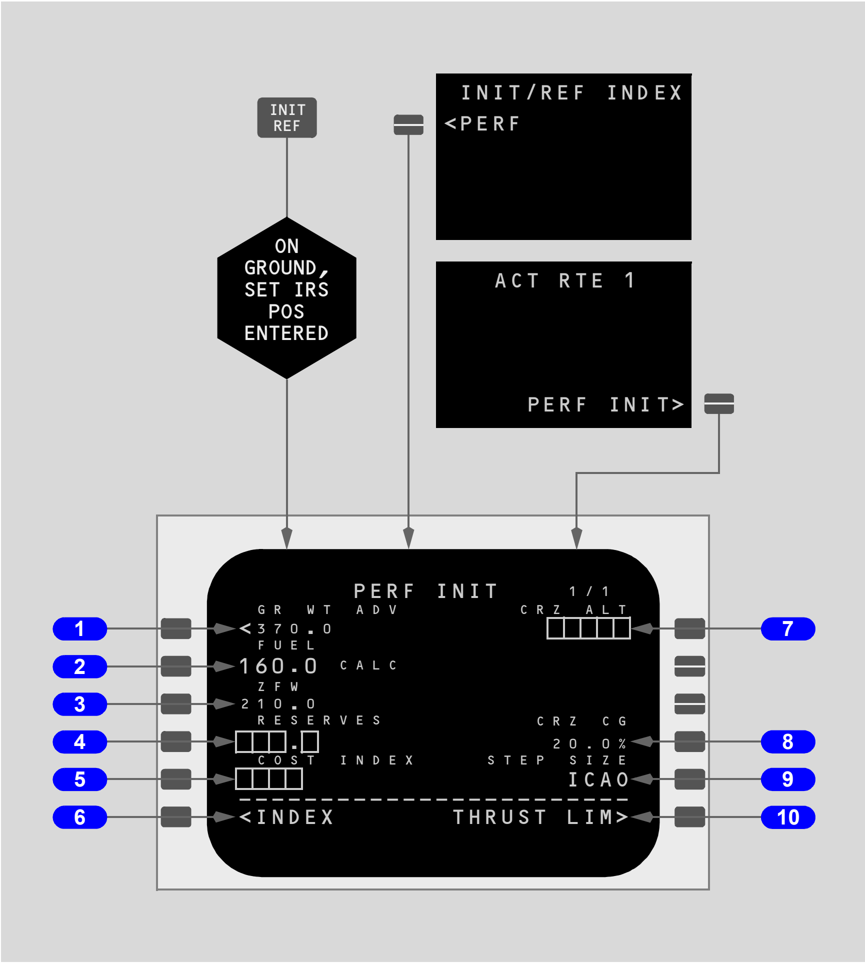
The performance initialization page allows entry of airplane and route data to initialize performance calculations. This data is required for VNAV calculations.

Entered values clear with loss of electrical power or at engine shutdown after flight.

109, 570


INIT
REF
ON
GROUND,
SET IRS
POS
ENTERED
INIT/REF INDEX
<PERF
ACT RTE 1
PERF INIT>
PERF INIT
1/1
GR WT
CRZ ALT
FUEL
170.0
CALC
ZFW
RESERVES
CRZ CG
20.0%
COST INDEX
STEP SIZE
ICAO
<INDEX
THRUST LIM>
1
2
3
4
5
6
7
8
9
10

405



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.

405

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

405

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. A manual entry blanks totalizer and displays under CALCULATED 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.

405, 570

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.

405, 570

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.

405, 570

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.

405, 570

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)

Displays default or pilot entered cruise CG value.

Used by FMC to calculate maximum altitude and maneuver margin to buffet.

Default value, 20.0, displays in small font.

A pilot entered value displays in large font. Deletion of a pilot entered value displays the default cruise CG value.

405, 570

An uplinked value displays in large font.

Valid entry is X.X or XX.X in the range 8.5 to 33.0.

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)

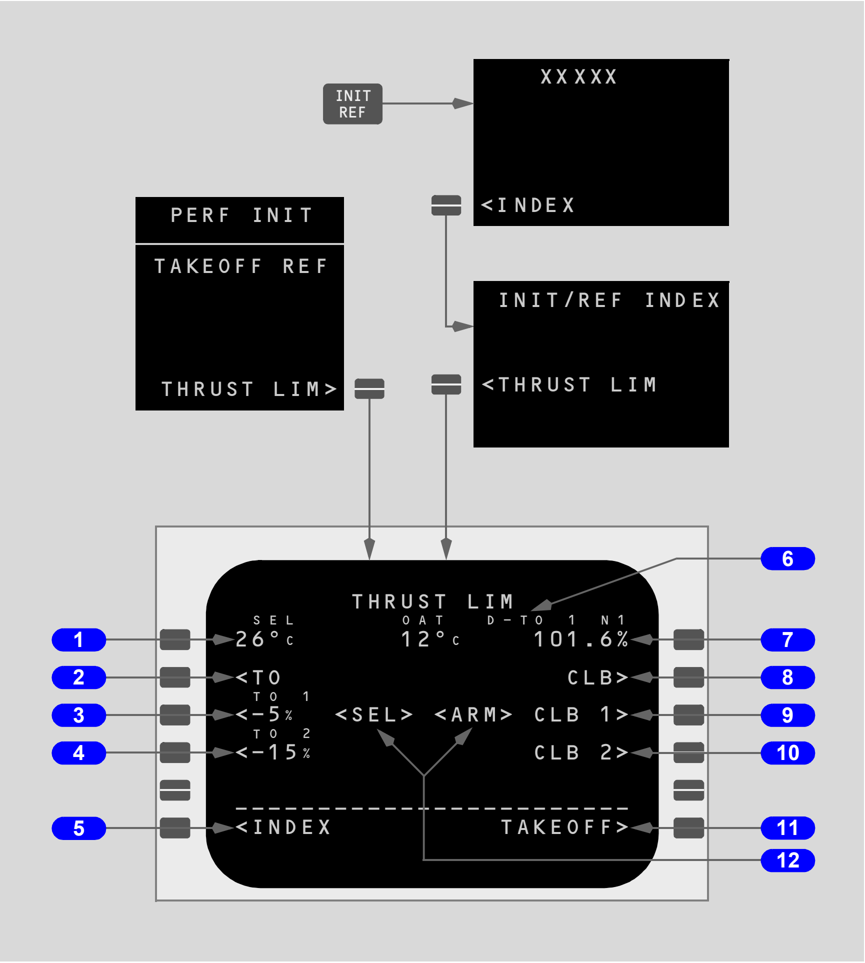
Push - displays THRUST LIM page.

Preflight Pages - Part 2B

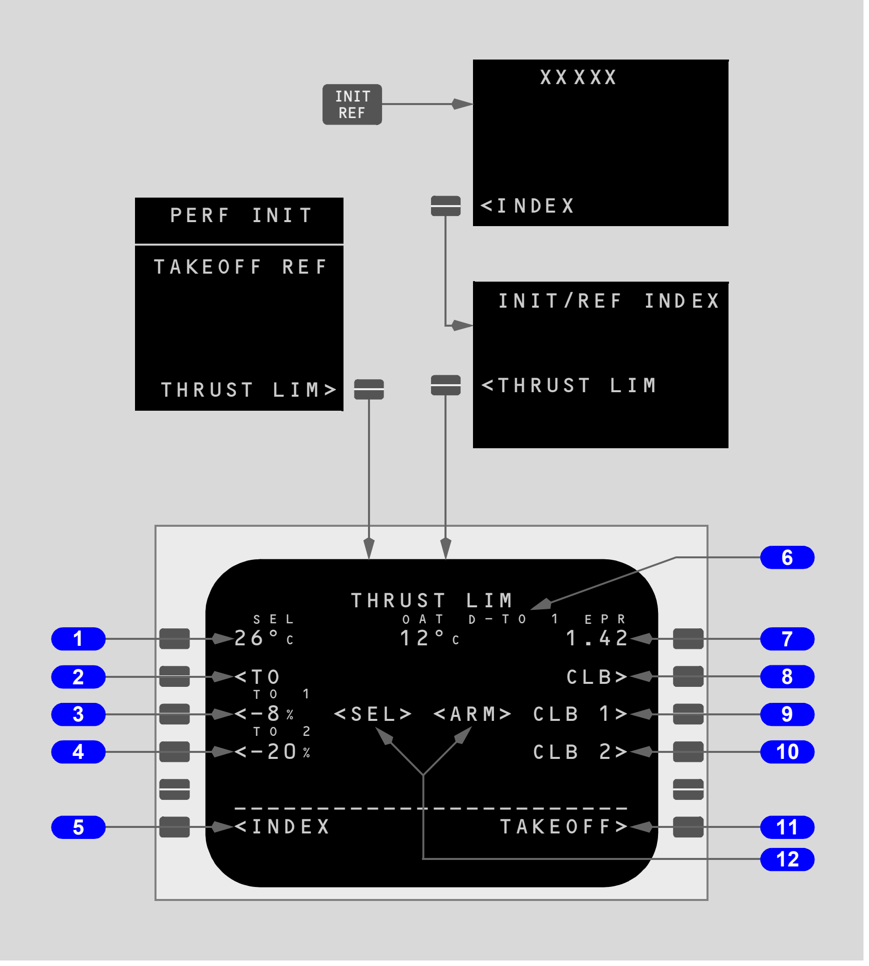
Thrust Limit Page

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.

570


INIT
REF
XXXXX
<INDEX
PERF INIT
TAKEOFF REF
THRUST LIM>
INIT/REF INDEX
<THRUST LIM
THRUST LIM
SEL
26°C
OAT
12°C
D-TO 1 N1
101.6%
<TO
CLB>
TO 1
<-5%
<SEL>
<ARM>
CLB 1>
TO 2
<-15%
CLB 2>
<INDEX
TAKEOFF>
1
2
3
4
5
6
7
8
9
10
11
12

109, 405



1 **Assumed Temperature (SEL), Outside Air Temperature (OAT)**

Initially blank. Entry of an assumed temperature up to the maximum thrust reduction limit of 25% reduces takeoff thrust and displays D in the thrust reference mode line title. When selecting a temperature higher than the maximum assumed temperature limit, the FMC changes the entered temperature to the maximum temperature which gives a 25% thrust derate.

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.

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.

405, 570
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.

405, 570
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
570

Displays takeoff N1 calculated by the thrust management system.

7 Takeoff EPR Limit
109, 405

Displays takeoff EPR calculated by the thrust management system. Displays N1 when engines are operated in the alternate mode.

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.

405, 570
Climb thrust derate can be entered by uplink.

10 Climb 2 (CLB 2)

Push - selects a percentage derate (CLB 2) climb thrust limit.

405, 570
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.

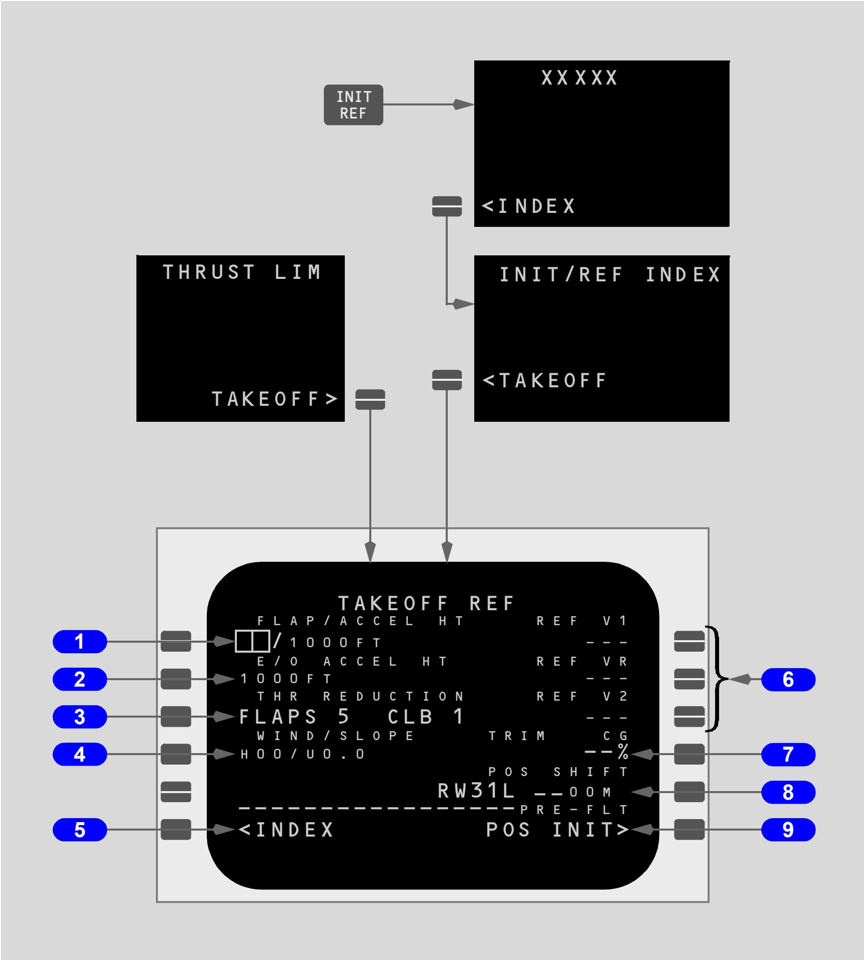
<ARM> - identifies armed climb thrust reference mode. <ARM> changes to <SEL> when armed climb mode becomes active.

Takeoff Reference Page

The takeoff reference page displays takeoff data and preflight status. Takeoff flap setting and V speeds are entered and verified. “PRE-FLT” displays in the header of 6R if other preflight pages are not complete, such as POS INIT, ROUTE, or PERF INIT. When preflight is complete, THRUST LIM> displays allowing selection of other takeoff thrust limits.

Takeoff reference page entries complete the normal preflight.

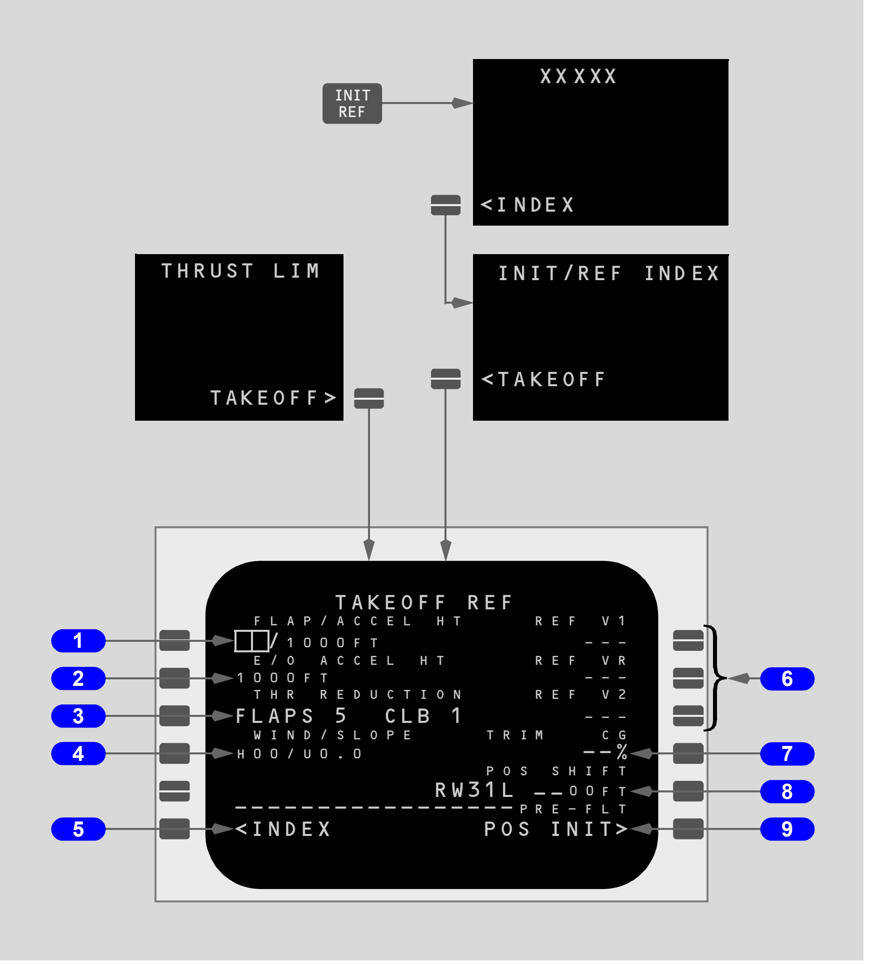
109, 405


INIT REF
XXXXX
<INDEX
INIT/REF INDEX
<TAKEOFF
THRUST LIM
TAKEOFF>
TAKEOFF REF
FLAP/ACCEL HT
REF V1
□□/1000FT

E/O ACCEL HT
REF VR
1000FT

THR REDUCTION
REF V2
FLAPS 5 CLB 1

WIND/SLOPE
TRIM
CG
H00/U0.0
--%
POS SHIFT
RW31L --00M
PRE-FLT
<INDEX
POS INIT>
1
2
3
4
5
6
7
8
9



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 in Height Above Airport (HAA) for flap retraction.

Valid entry is an HAA height from 400 to 9999 feet. The FMC adds runway elevation to entered HAA acceleration height causing acceleration at an MSL altitude. For example, for a runway elevation of 980 feet, an entry of 2020 acceleration height causes acceleration at 3,000 feet MSL.

Entry of a new flap setting 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 in HAA for flap retraction with an engine out.

Valid entry is an HAA height from 400 to 9999 feet.

3 Thrust (THR) REDUCTION

Displays flap setting or height in HAA for reduction from selected takeoff thrust to armed climb thrust.

Displays armed climb thrust rating.

Valid entries are:

- 5 for flaps 5, or
- an HAA height from 400 to 9999 feet. The FMC adds runway elevation to entered HAA thrust reduction height causing thrust reduction at an MSL altitude. For example, for a runway elevation of 980 feet, an entry of 1020 thrust reduction height causes thrust reduction at 2,000 feet MSL.

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. A manually entered V1 speed less than V1MIN is indicated by display of "V1MIN" in the header line and the value of V1MIN in the data line.

Calculated speeds display in small font.

FMC calculated speeds provide VMCA and VMCG protection.

405, 570

Uplinked speeds replace calculated speeds. An accepted uplinked V1 speed less than V1MIN is indicated by display of "V1MIN" in the header line and the value of V1MIN in the data line.

Push -

- selects V1, VR, and V2 to be sent to using systems, or
- crew entered V speeds replace calculated speeds
- display changes to large font; REF and caret no longer display

If performance data changes:

- FMC replaces existing speeds with FMC calculated speeds in small font
- V speeds are deleted from the PFD
- PFD speed tape message NO V SPD displays
- scratchpad message TAKEOFF SPEEDS DELETED displays

Note: After the third engine is started, any combination of gross weight, OAT, or pressure altitude resulting in a change in any computed speed of more than one knot from the previously calculated speed, causes the FMC to calculate and display revised takeoff speeds.

7 TRIM, Center of Gravity (CG)
109, 570

Initially displays dashes.

Valid entries are whole numbers of CG expressed as a percentage of MAC within the range 0 to 40.

After CG entered, the FMC:

- calculates and displays stabilizer takeoff setting to the left of the CG entry (trim display is in 0.1 unit increments)
- updates the takeoff green band displayed on stabilizer position indicators

7 TRIM, Center of Gravity (CG)
405

CG displays in small font with caret. Calculated by FMC using WBS inputs.

Line selection or pilot entry displays CG in large font. Deletion of large font CG returns display of small font WBS CG..

Valid entries are whole numbers of CG expressed as a percentage of MAC within the range 0 to 40.

Dash prompts display if required WBS inputs not available.

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.

109, 405

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).

570

Valid entries are X, XX in + or - hundreds of feet (3 or 03 is 300 feet beyond the runway threshold; -3 or -03 is 300 feet prior to runway threshold)

Entered value updates FMC position to the TO/GA push point when GPS updating not active.

9 PRE-FLIGHT

Displays PRE-FLIGHT in the header and the title (XXXXX) of incomplete page on the data line when preflight is not complete.

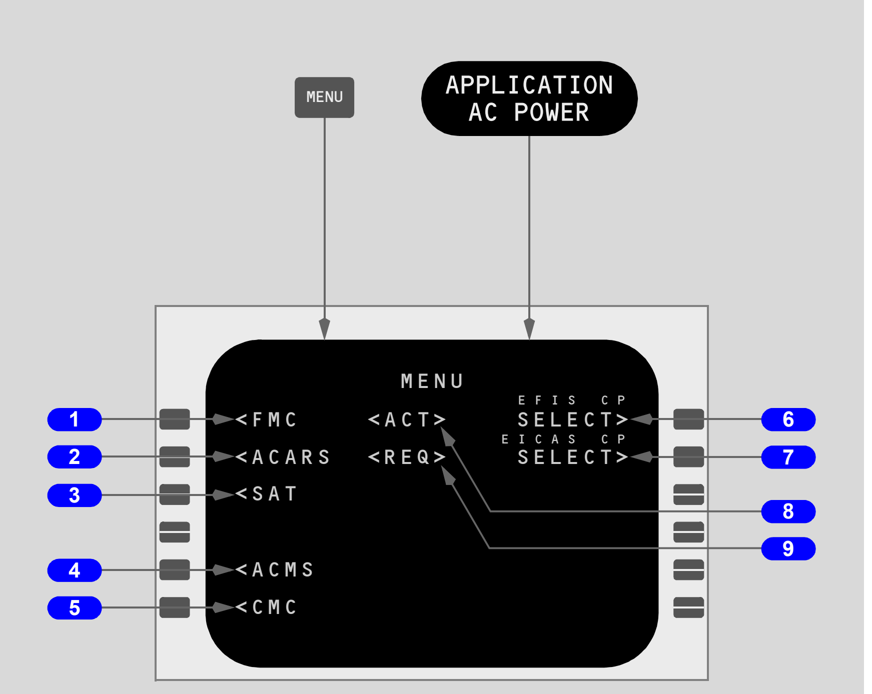
Displays dashes and THRUST LIM when preflight is complete.

Push -

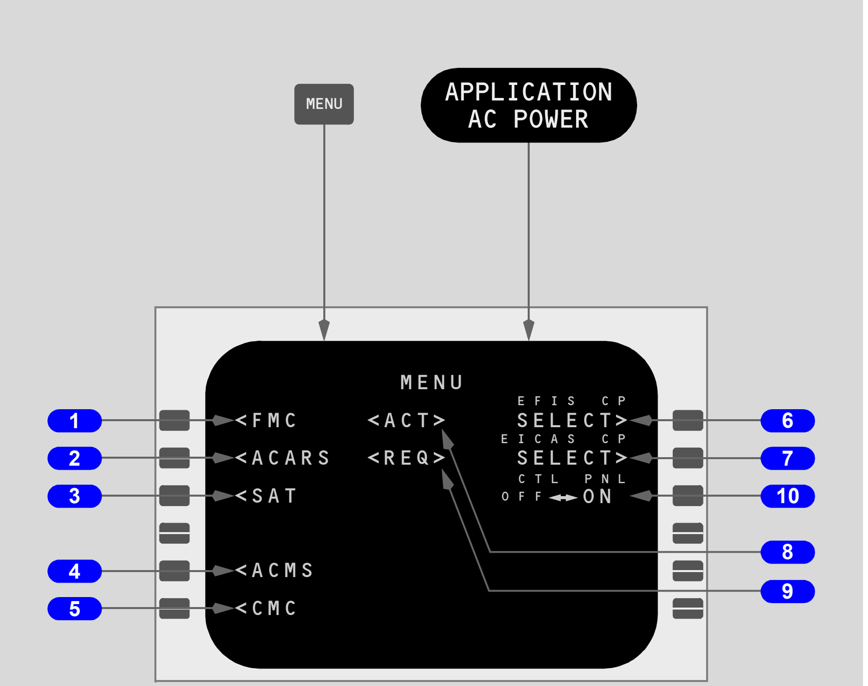
- displays THRUST LIM page when THRUST LIM displayed
- displays incomplete page (XXXXX) when PRE-FLIGHT displayed

Menu Page

Provides access to other systems that use CDU.



CDU-152



CDU-161

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.

10 Control Panel Switch

See Chapter 10, Flight Instruments, Displays.

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, LNAV and VNAV are 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.

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The TAKEOFF REF page changes to the VNAV CLB page during the takeoff phase when the flap lever is moved to initiate flap retraction.

Climb Phase

At acceleration height or the first movement of the flap handle during flap retraction, VNAV commands acceleration to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted, VNAV commands the speed displayed on the SPD TRANS line.

At the climb thrust reduction point, the FMC commands a reduction to the armed climb thrust. Passing the transition altitude displayed on the SPD TRANS line, VNAV commands an acceleration to economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than VREF+100 or the transition speed.

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.

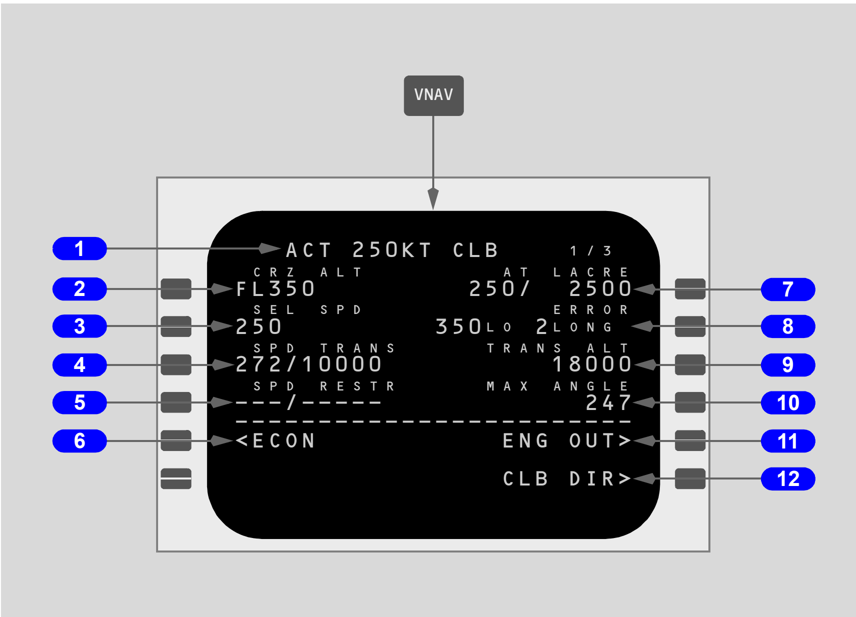
When the climb profile fails to reach a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALTITUDE. Deleting climb derates or selecting a reduced climb speed thus giving a steeper climb angle, may enable the airplane to reach the altitude constraint.

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 the transition speed associated with the origin airport or VREF+100 knots (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 HOLD AT 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; deletes climb speed transition and restriction data.

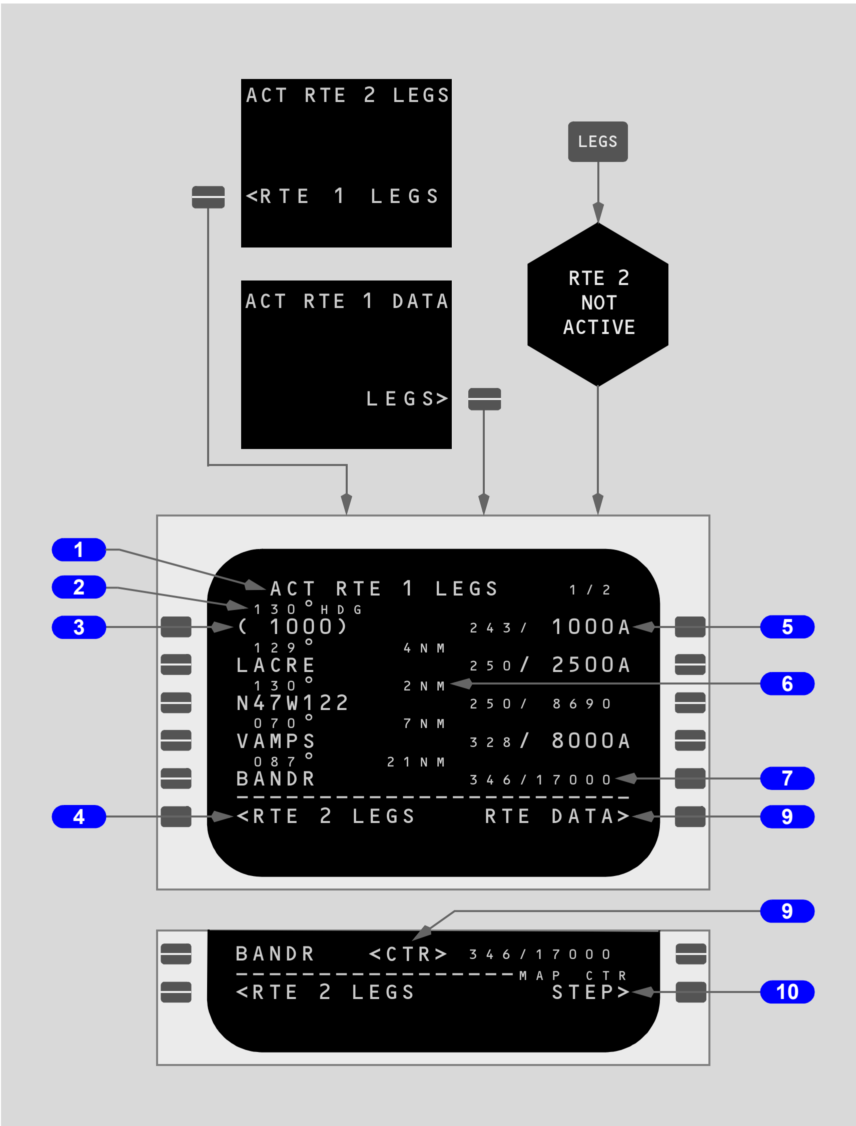
12 **Climb Direct (CLB DIR)**

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 - arc radius in miles, ARC, turn direction (example: 24 ARC L)
- heading leg segments - XXX° HDG
- track leg segments - XXX° TRK
- special procedural instructions from database - HOLD AT, PROC TURN, or PROC HOLD

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.

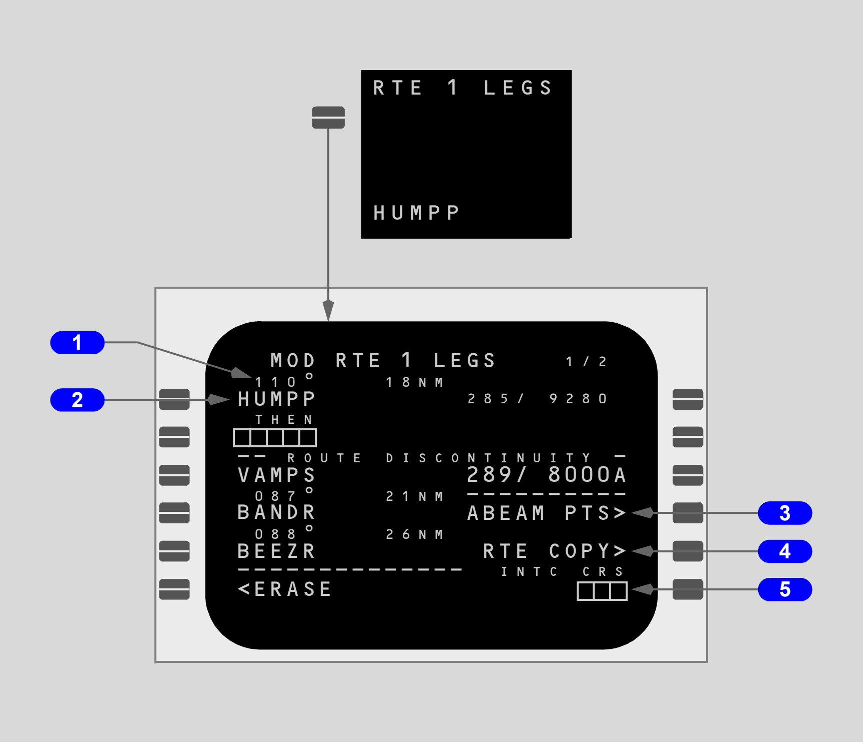
10 **MAP Center (CTR) STEP**

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°.

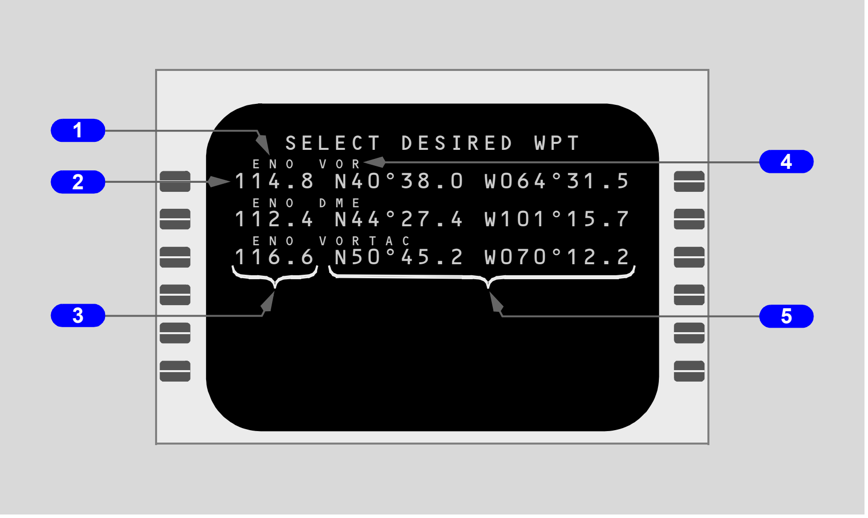
Displays current route course and prompt caret if entered waypoint in the active route.

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.

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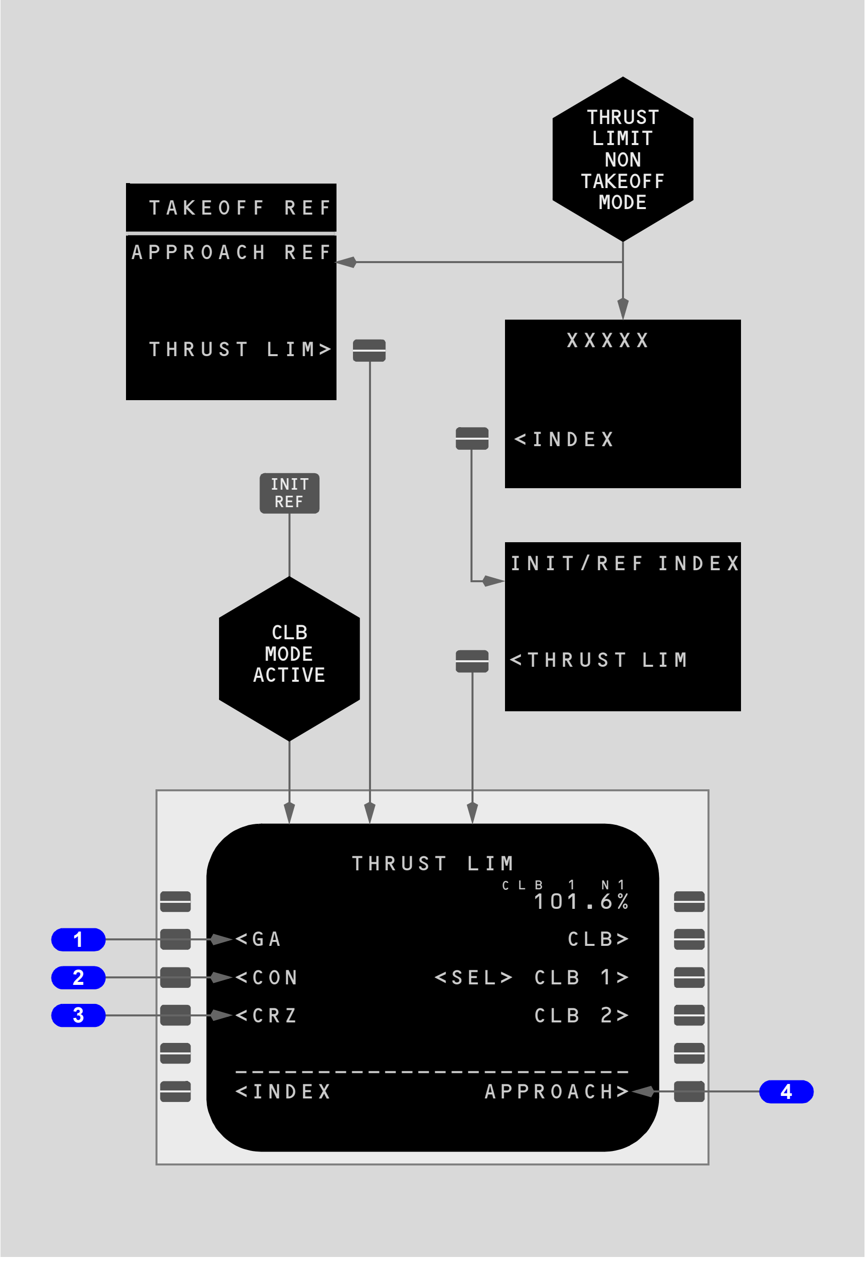
THRUST LIMIT NON TAKEOFF MODE
TAKEOFF REF
APPROACH REF
THRUST LIM>
XXXXX
<INDEX
INIT REF
INIT/REF INDEX
<THRUST LIM
CLB MODE ACTIVE
THRUST LIM
CLB 1 N1
101.6%
<GA
CLB>
<CON
<SEL> CLB 1>
<CRZ
CLB 2>
<INDEX
APPROACH>
1
2
3
4

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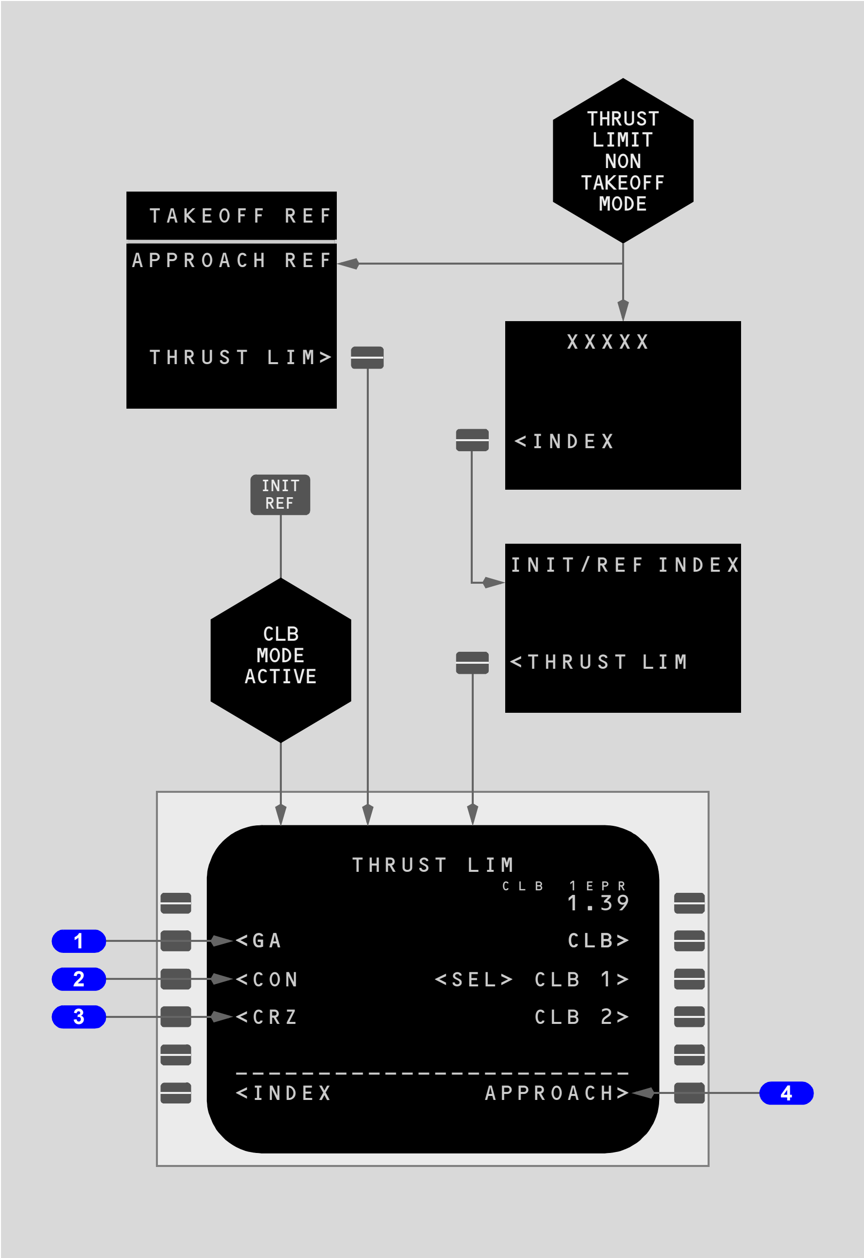


1 Go-Around (GA)

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**

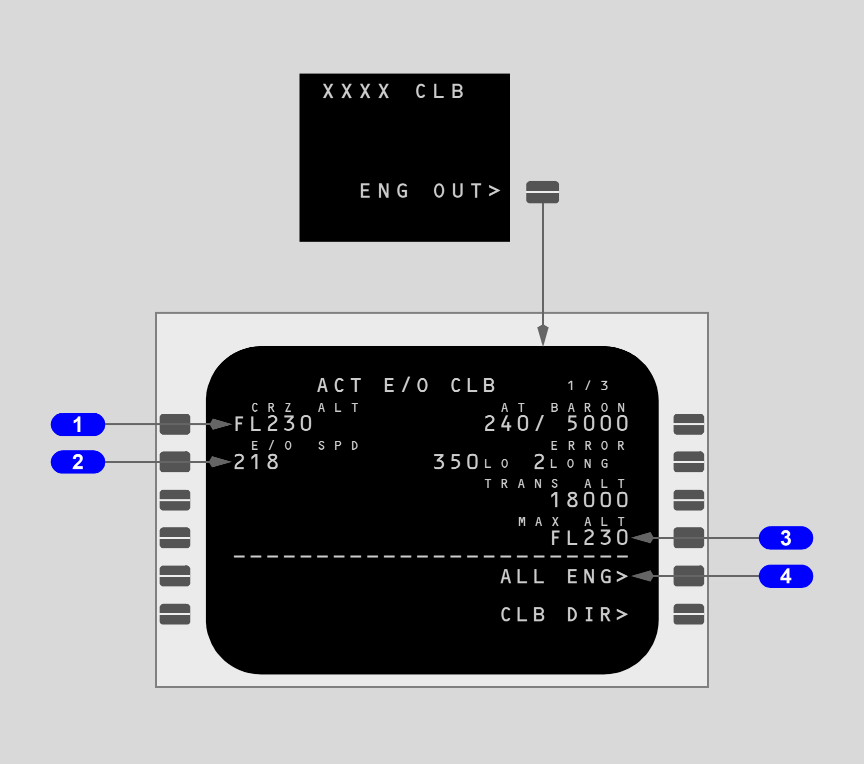
Push - displays APPROACH REF page.

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 MAX ALT.

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

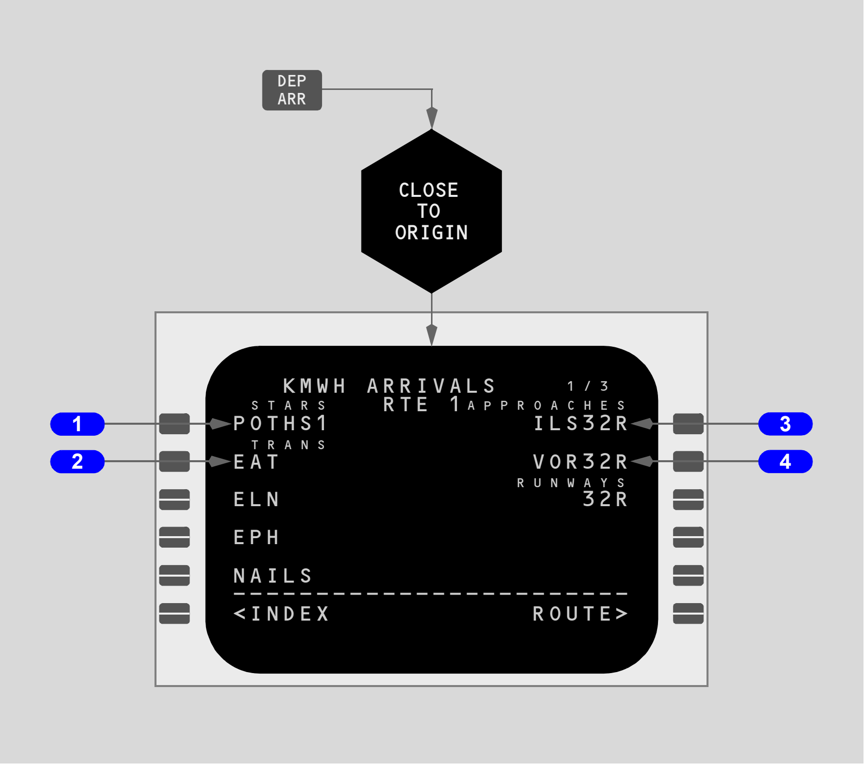
Push - modifies page to display all engine (ALL ENG) performance data.

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.

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

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- POS REPORT page -display data for a position report

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- POS REPORT page -display data for a position report; described in Chapter 5.33

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.

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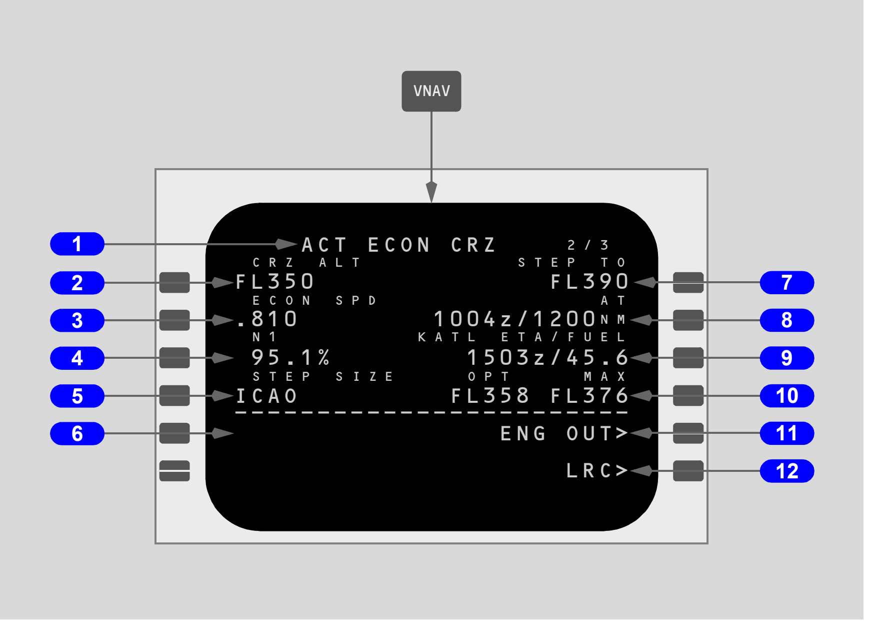

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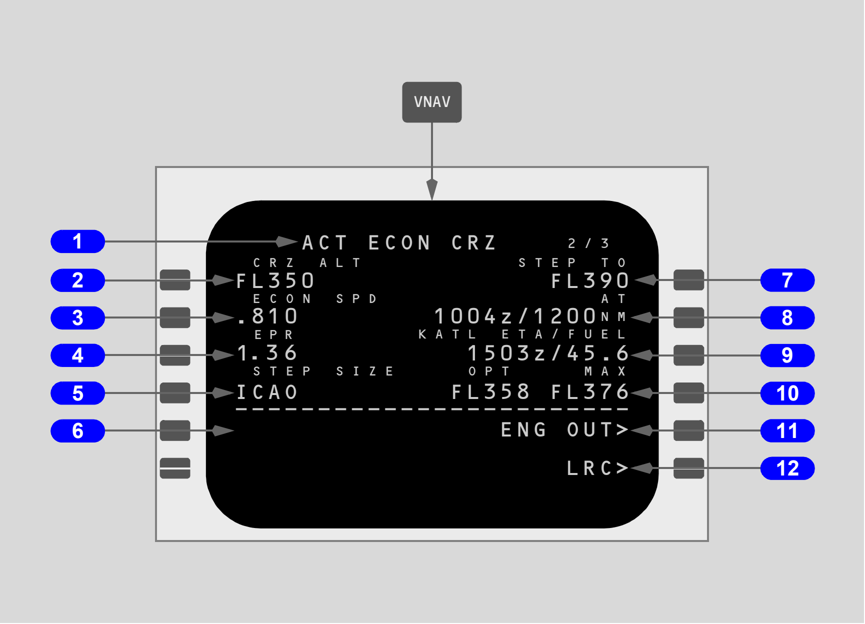

1 Page Title

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

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Displays N1 to maintain level flight at command airspeed.

4 EPR

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Displays EPR 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)

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For RTA CRZ mode active, OPT and MAX altitude are not computed. OPT and MAX headers are blank.

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; also displays LRC CRZ when EO or SEL SPD is the active mode.

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.

If a second engine fails, the page title changes to ACT 2E/O LRC CRZ and the FMC calculates and displays two engine-out maximum/optimum altitudes and performance data.

The following example uses a cruise altitude above the maximum engine out altitude.

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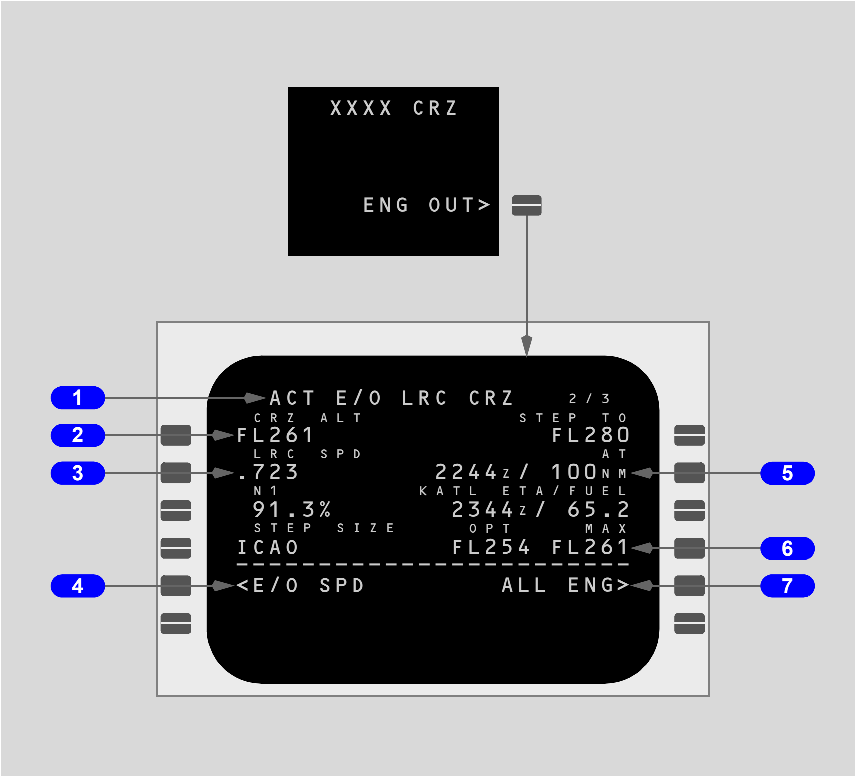

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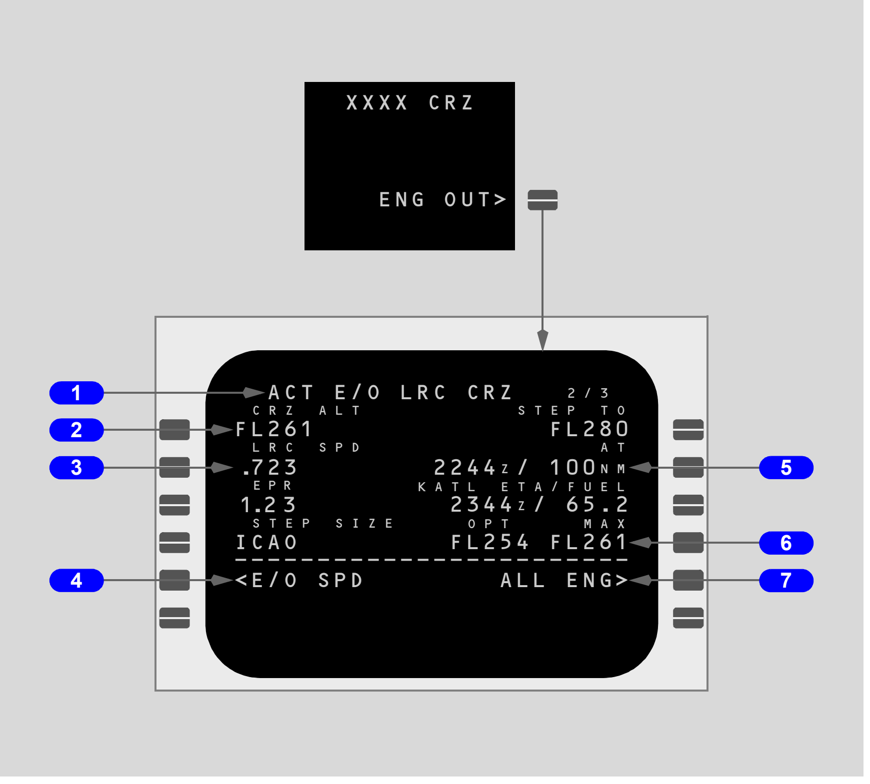

1 Page Title

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.

Required Time of Arrival (RTA) Cruise

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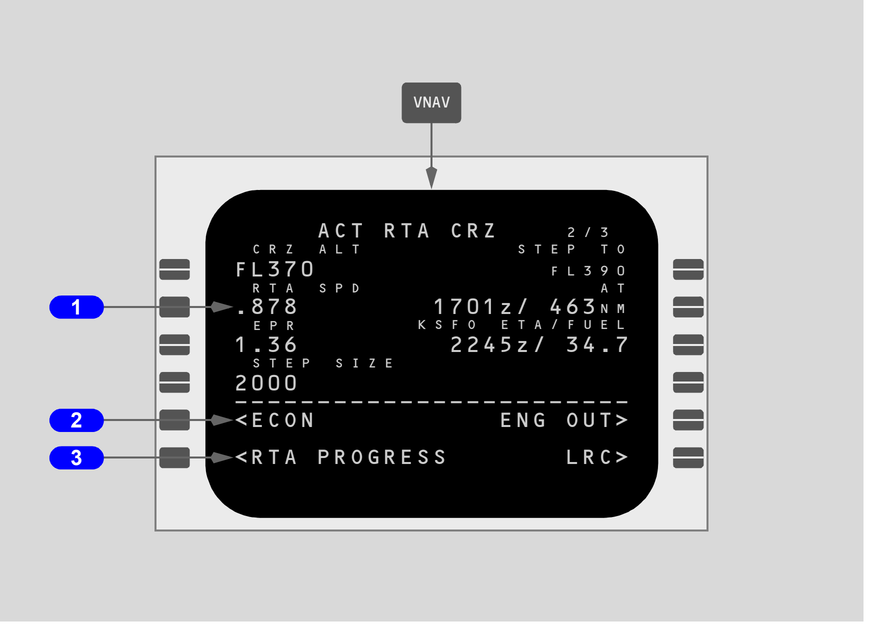
The required time of arrival cruise page is available after entry of Fix and Time on RTA PROG page. This page provides cruise speed required to accomplish RTA.



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).

Push - displays RTA PROGRESS page.

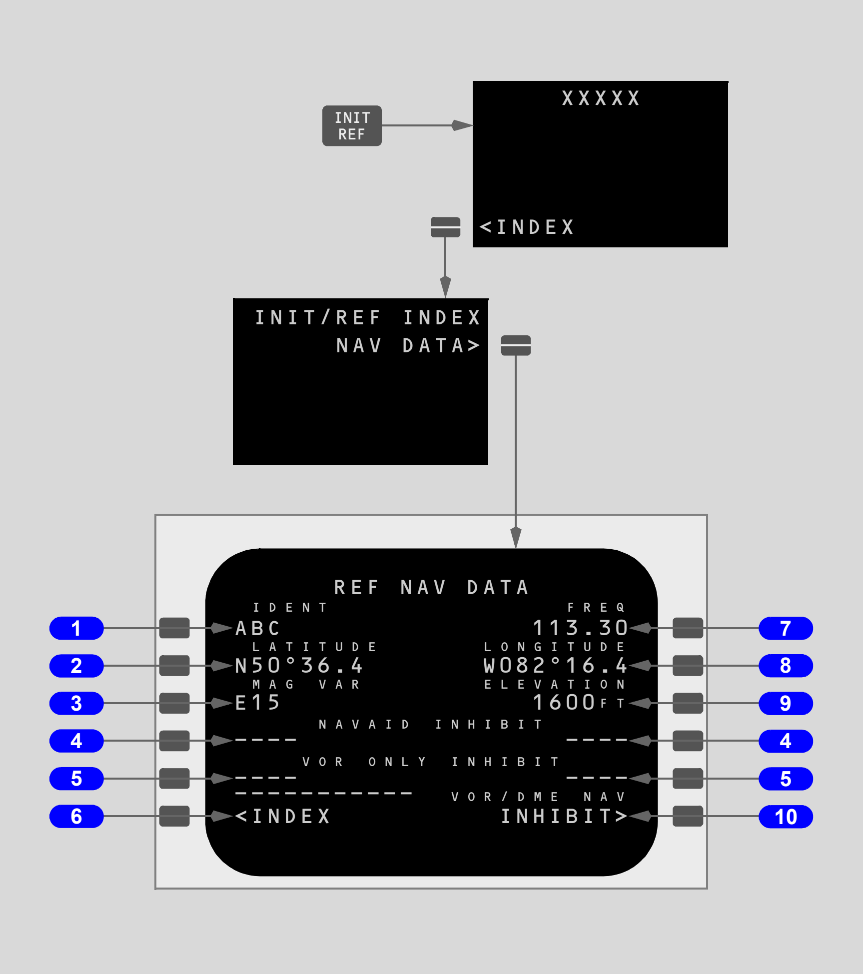
ERASE (displays when modification pending).

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 -

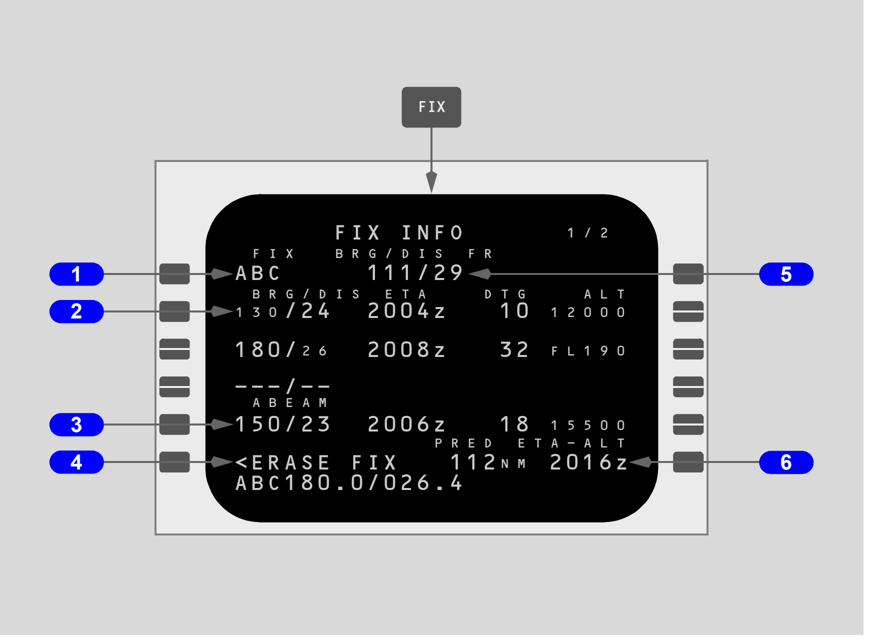
- allows VOR/DME radio position updating
- displays INHIBIT

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

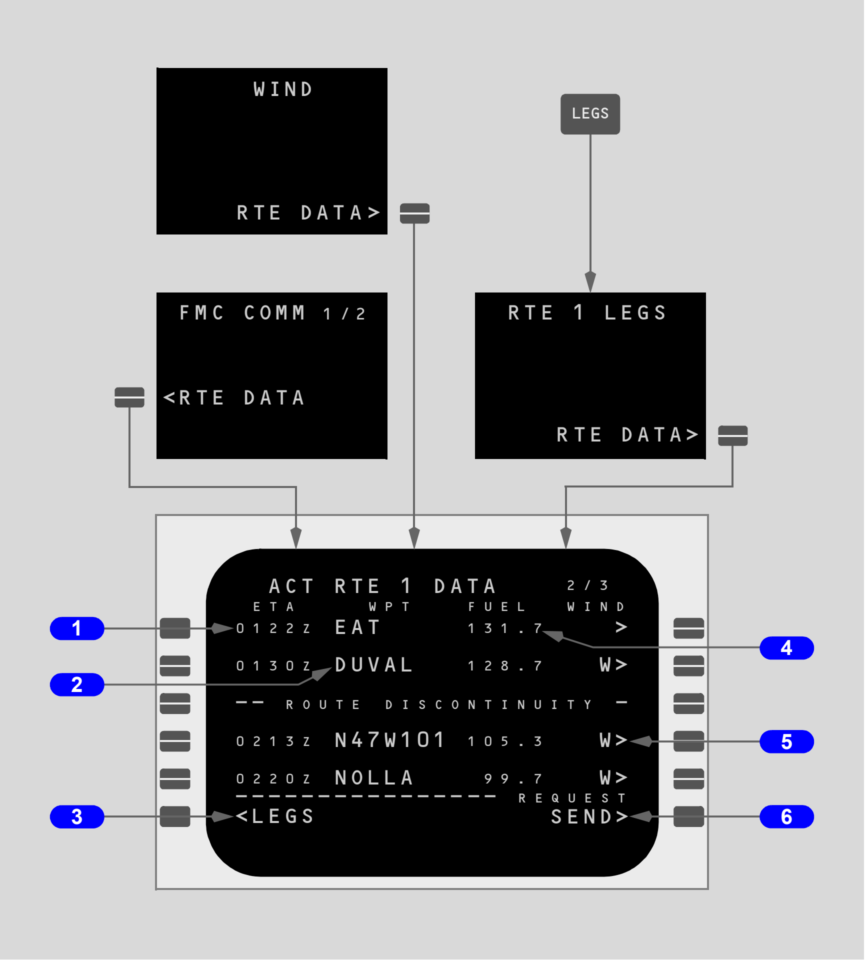
The route data page displays data for each waypoint on ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

405, 570

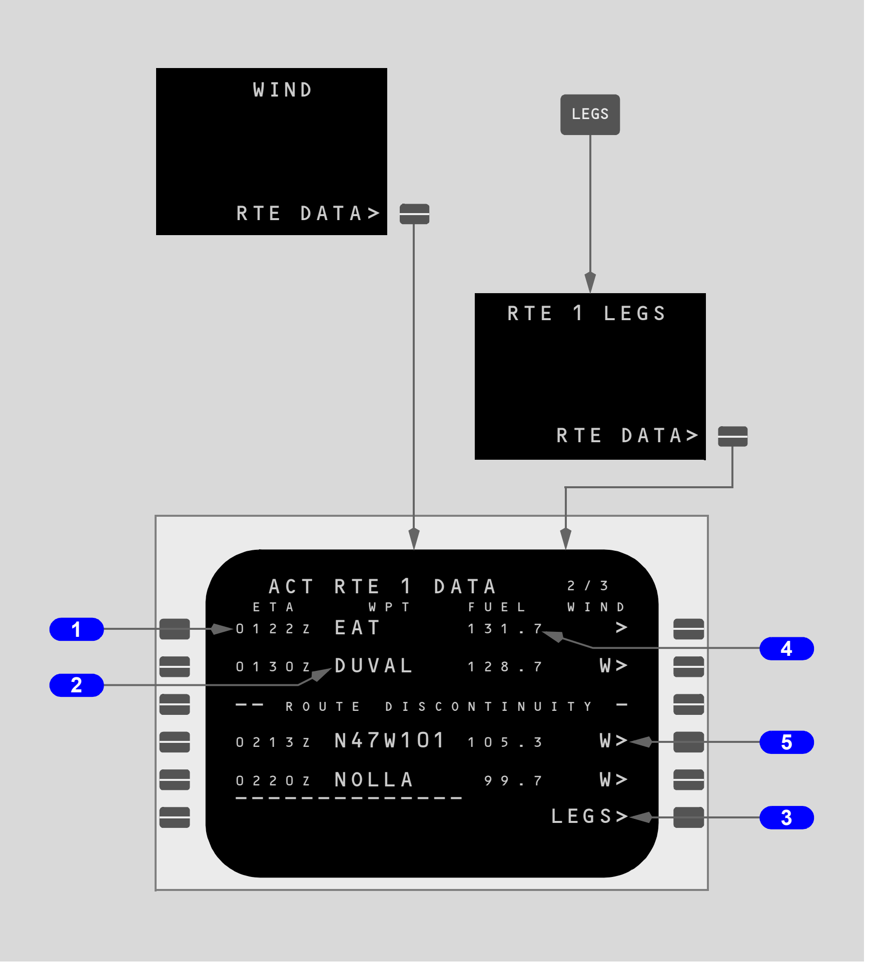
This page allows a downlink request for enroute wind information and allows review of uplinked enroute wind information.

The ETA and calculated fuel remaining display for each waypoint. Manual entry is not possible.

405, 570


WIND
RTE DATA>
LEGS
FMC COMM 1/2
<RTE DATA
RTE 1 LEGS
RTE DATA>
ACT RTE 1 DATA 2/3
ETA WPT FUEL WIND
0122z EAT 131.7 >
0130z DUVAL 128.7 W>
-- ROUTE DISCONTINUITY -
0213z N47W101 105.3 W>
0220z NOLLA 99.7 W>
REQUEST
<LEGS SEND>
1
2
3
4
5
6

109



1 ETA

Displays ETA for waypoint.

2 Waypoint (WPT)

Displays identifier for waypoint.

3 LEGS, ERASE

405, 570

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

3 LEGS
109

LEGS -

Push - displays RTE LEGS page.

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
405, 570

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.

405, 570

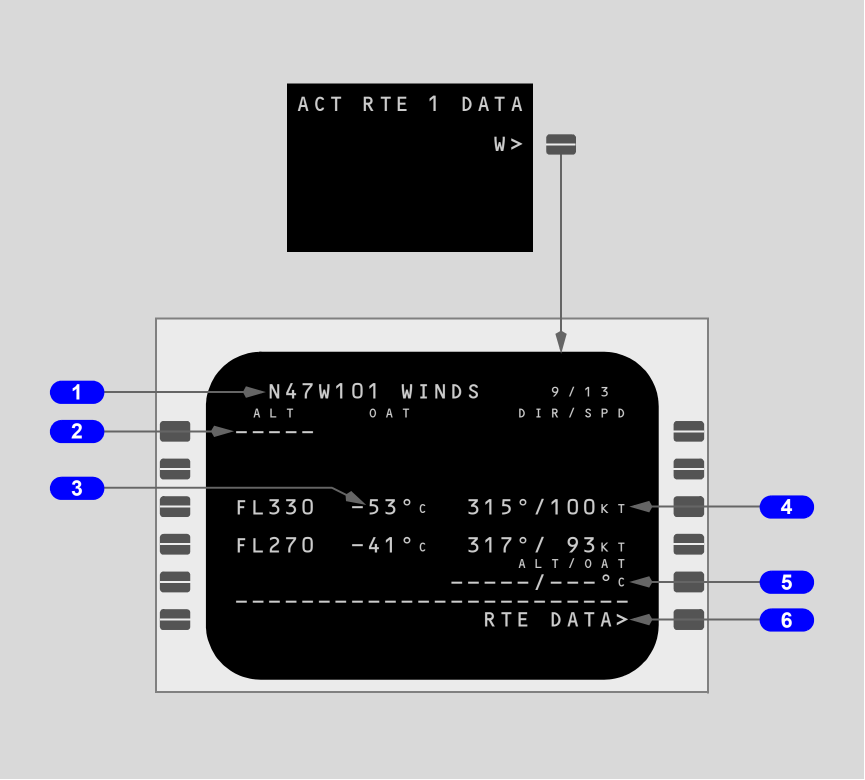
This data can be uplinked or manually entered.

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.



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/and OAT.

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.

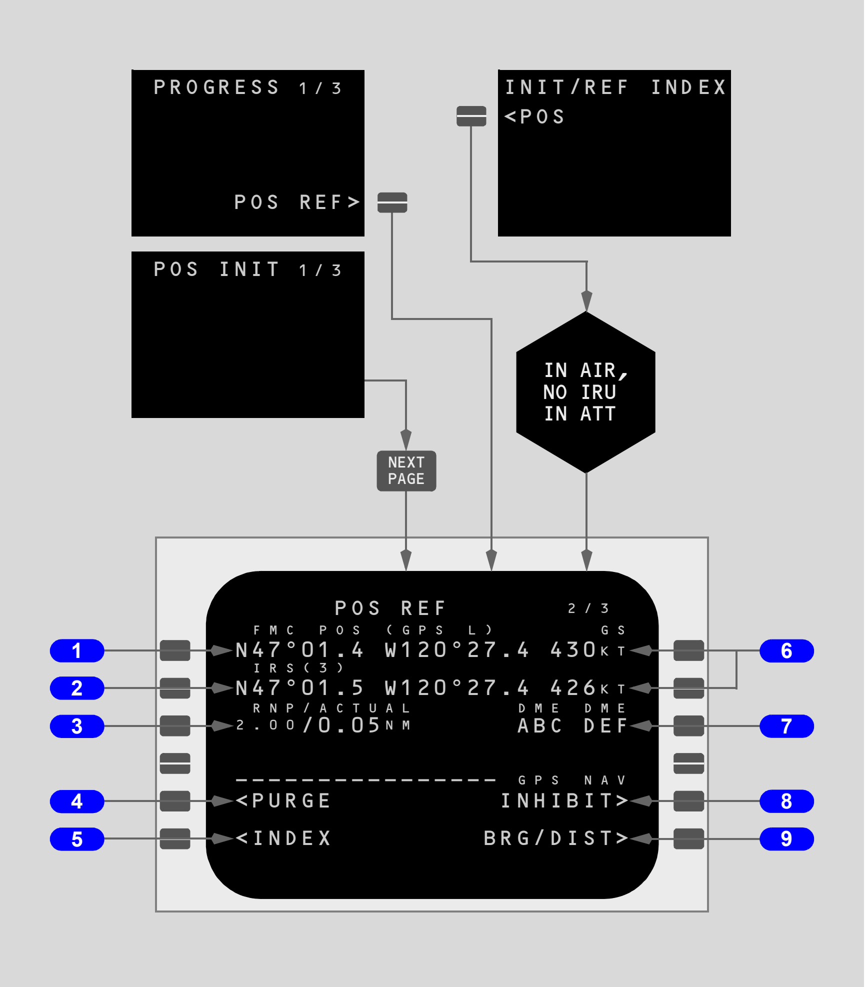
6 Route Data (RTE DATA)

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 -

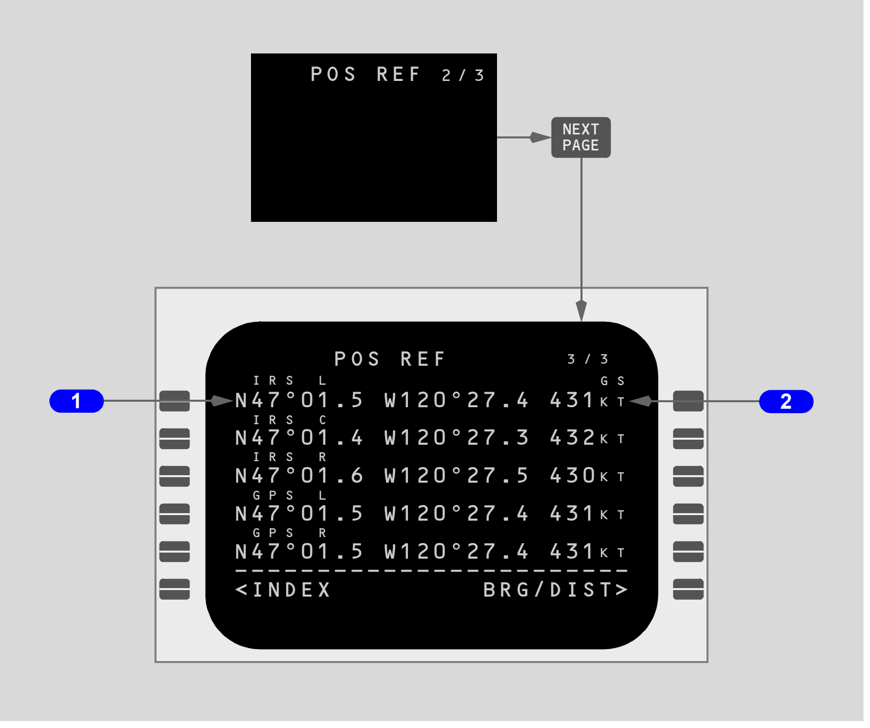
- displays bearing/distance in IRS (X) line relative to FMC position and displays LAT/LON
- if distance is zero, bearing displays 000
- selection when LAT/LON displayed or leaving the POS REF pages on both CDUs returns displays to latitude/longitude and BRG/DIST

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

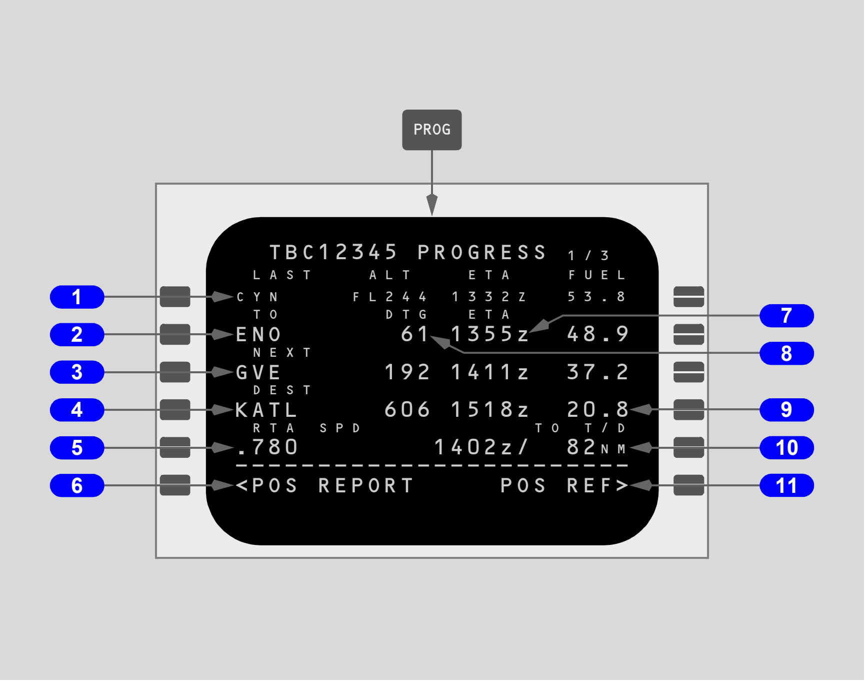
109, 405

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
- T/C, T/D, etc.



1 LAST

Displays last waypoint identifer and altitude (ALT), actual time of arrival (ATA), and lesser of calculated or totalizer fuel remaining at LAST 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:

- ECON SPD - economy speed
- LRC SPD - long range cruise speed
- SEL SPD - selected speed manually entered on the CDU
- EO SPD - engine out speed
- LIM SPD - speed is limited by VMO, MMO, flap limit, or alpha limit
- MCP SPD - MCP speed entered on the MCP IAS/MACH indicator
- 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 T/D**

Data line displays ETA and DTG to line title point.

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 1/2

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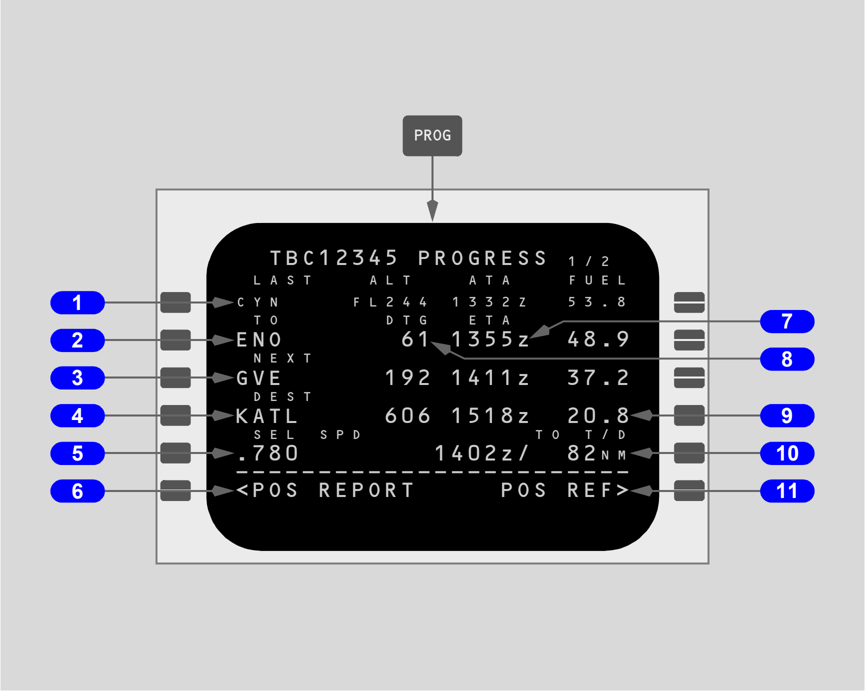
Progress page displays general flight progress data. The FMC Communication section of Chapter 05, Communications describes CDU position reports.

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
- T/C, T/D, etc.



1 LAST

Displays last waypoint identifer and altitude (ALT), actual time of arrival (ATA), and lesser of calculated or totalizer fuel remaining at LAST 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
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Remove entries with DELETE key or change all CDUs to a different page.

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The active speed mode is the same as displayed on the performance page, unless changed by the MCP or a limit. The speed modes are:

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- EO SPD - engine out speed
- LIM SPD - speed is limited by VMO, MMO, flap limit, or alpha limit
- MCP SPD - MCP speed entered on the MCP IAS/MACH indicator
- VREF +100 - engine out during takeoff, engine out not selected, and speed not restricted by limit speed (e.g., flap placard)

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 T/D

Data line displays ETA and DTG to line title point.

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 2/2

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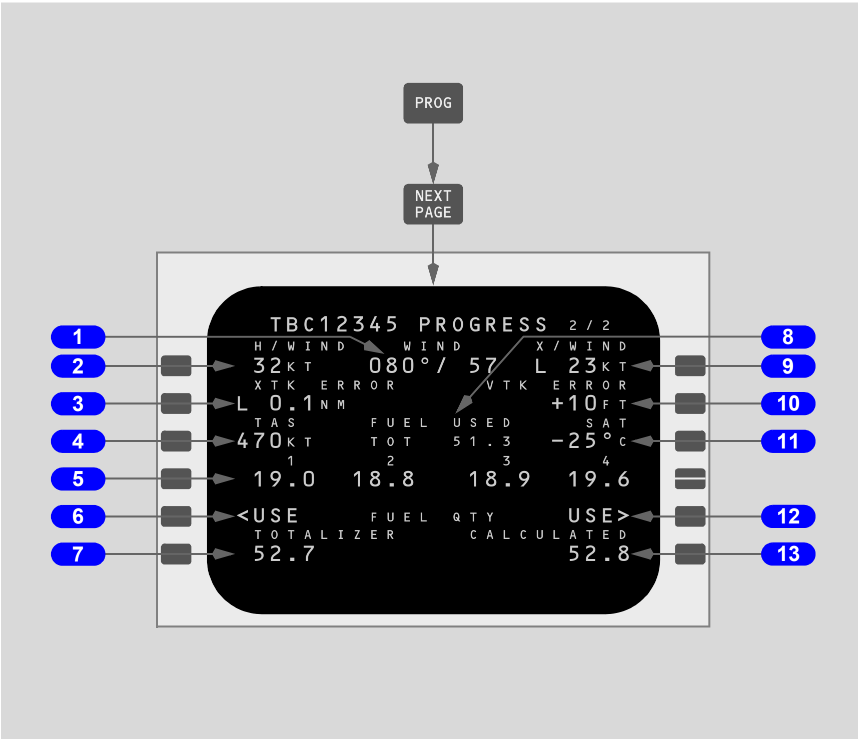
Progress page two contains:

- 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 9,000 lbs 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 9,000 lbs 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 system totalizer
- after engine start, displays fuel quantity at engine start decreased by total fuel flow (FUEL USED)
- after fuel jettison or after all engines are shut down, CALCULATED resets to fuel quantity system totalizer

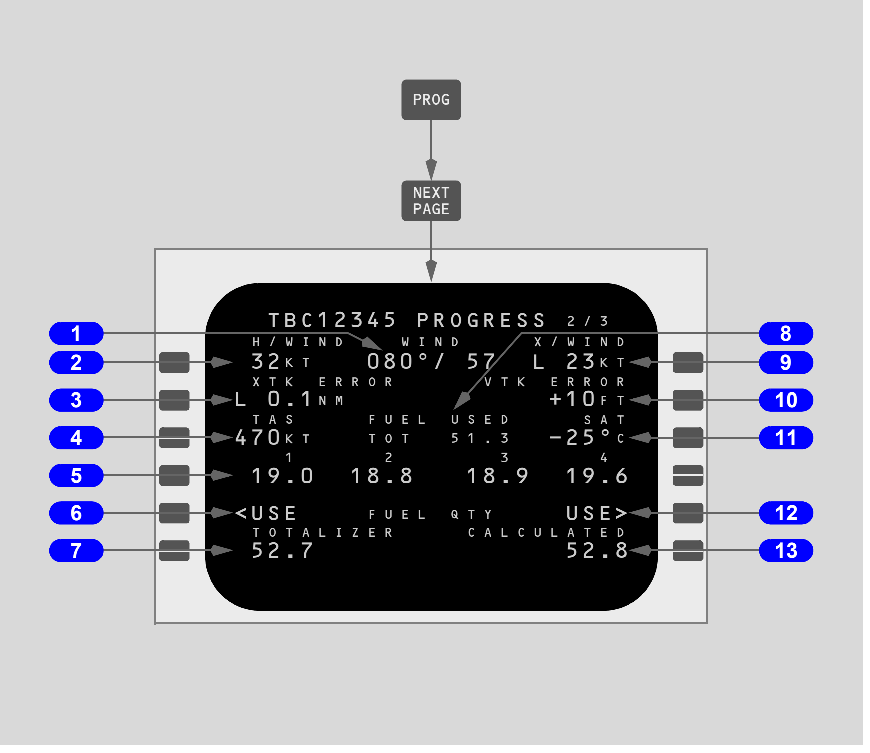
The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations. Fuel flow rate sensing tolerances may allow the CALCULATED and the TOTALIZER fuel quantities to be different by as much as 60 to 85 pounds per hour.

Progress Page 2/3

109, 405

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:

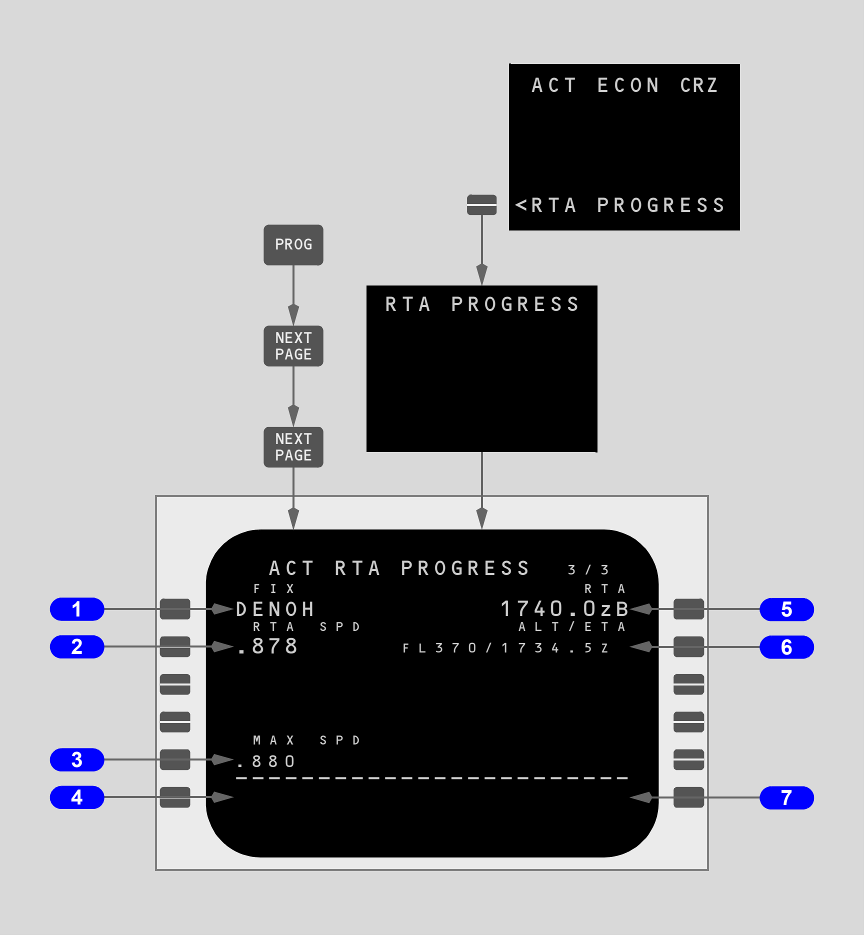
- before engine start, displays fuel quantity calculated by fuel quantity system totalizer
- after engine start, displays fuel quantity at engine start decreased by total fuel flow (FUEL USED)
- after fuel jettison or after all engines are shut down, CALCULATED resets to fuel quantity system totalizer

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations. Fuel flow rate sensing tolerances may allow the CALCULATED and the TOTALIZER fuel quantities to be different by as much as 25 to 40 kilograms per hour.

RTA Progress Page 3/3

109, 405

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 boxes in 1R and RTA in the line title, and ALT/ETA in 2R line title.

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.

Displays boxes when an active or modified route exists.

Displays blank if engine out has been selected.

2 Required Time Of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA.

Blank if no RTA fix or time entered.

3 Maximum Speed (MAX SPD)

Valid entry is Mach .100 to .99; displays in large font.

Deletion of entered value displays default Mach .880 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 of .0 is optional.

Suffix to RTA indicates:

- no suffix - arrive at entered time
- A - arrive at or after entered time
- B - arrive at or before entered time

Deletion terminates RTA and returns ECON as cruise mode.

6 Altitude/ETA (ALT/ETA)

Displays predicted altitude and ETA at RTA fix after entry of FIX in 1L.

Blank until performance data is entered.

7 PRIOR RTA

Displays when prior RTA fix and time exists.

Push -

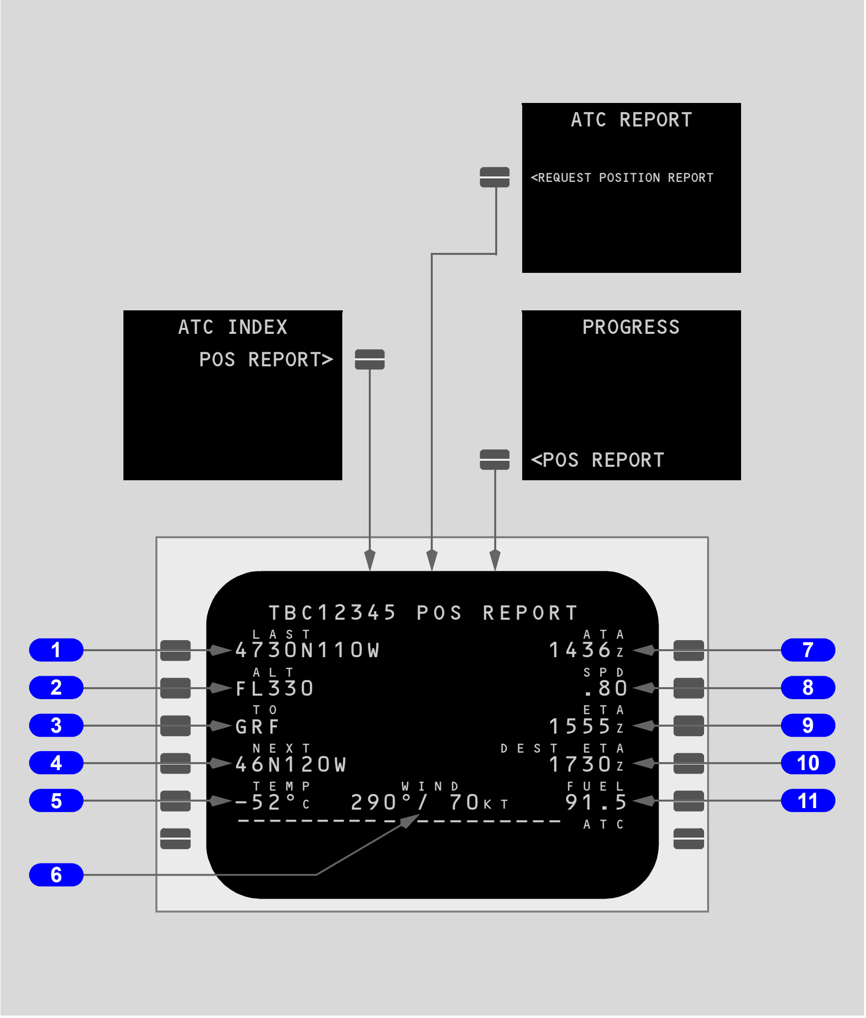
- displays previous RTA fix and time
- initiates RTA flight plan modification

Execution activates RTA function.

Position Report
109

XXXX Position Report Page

The XXXX POS REPORT page allows review of the position report before transmitting to ATC. 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.

4 **NEXT Waypoint**

Displays waypoint identifier of leg following the TO leg.

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.

9 **Estimated Time of Arrival (ETA)**

Displays ETA at TO waypoint.

10 **Destination Estimated Time of Arrival (DEST ETA)**

Displays ETA at destination.

11 **FUEL**

Displays lesser of calculated or totalizer fuel remaining at LAST waypoint.

Intentionally
Blank

Flight Management, Navigation — Chapter 11
FMC Descent and Approach — Section 43

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.

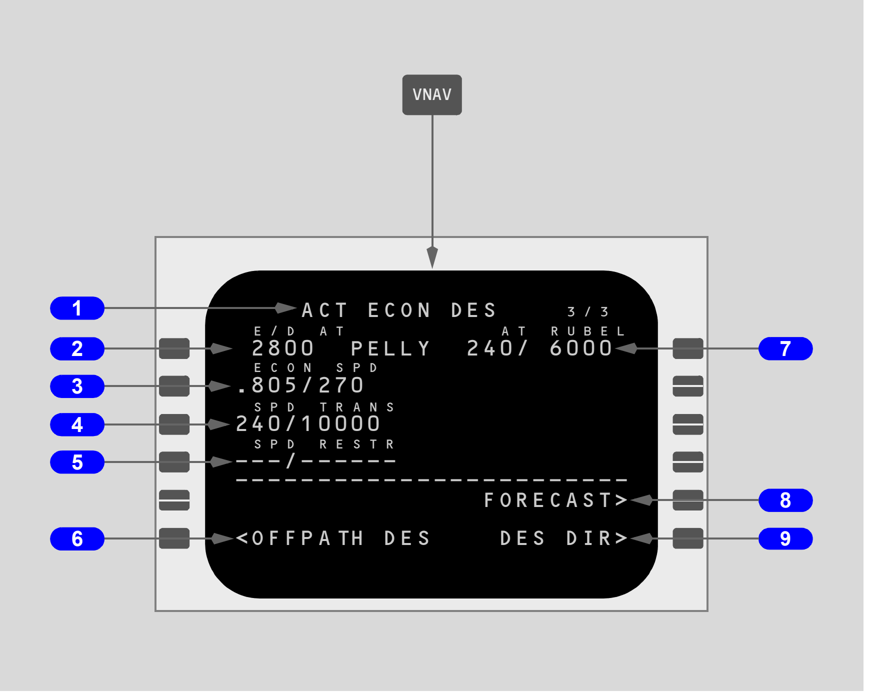
The additional descent pages listed below are used to:

- DESCENT FORECAST page - enter forecast wind data to aid descent planning
- OFFPATH DES page - analyze descent performance with and without the use of speedbrakes

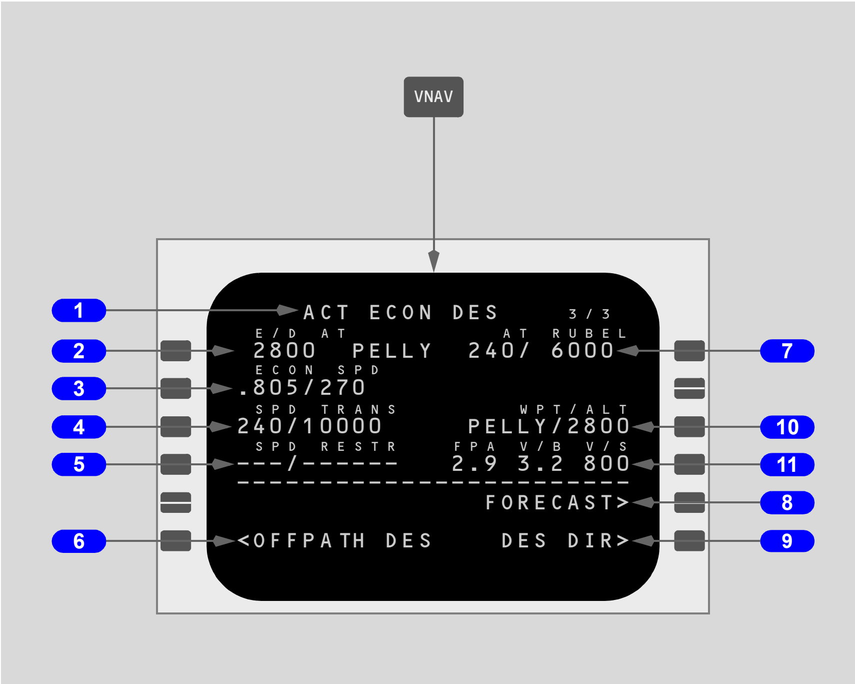
Descent Page

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.

109, 405


VNAV
ACT ECON DES
3/3
E/D AT
2800 PELLY
AT RUBEL
240/ 6000
ECON SPD
.805/270
SPD TRANS
240/10000
SPD RESTR
---/------
FORECAST>
<OFFPATH DES
DES DIR>
1
2
3
4
5
6
7
8
9

570



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/D AT 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/D AT)

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

10 Waypoint/Altitude (WPT/ALT)
570

Line title appears even though the descent page is blank. Displays the same waypoint/altitude restriction displayed on the AT line (1R); may be overwritten by pilot entry. Valid entry is any navigation database waypoint.

11 Flight Path Angle, Vertical Bearing, and Vertical Speed (FPA, V/B, V/S)

570

Initially displays dashes. Following entry of waypoint/altitude:

- FPA - displays the current airplane flight path angle
- V/B - displays vertical bearing from current position to the entered waypoint and altitude
- V/S - displays required vertical speed to maintain the vertical bearing

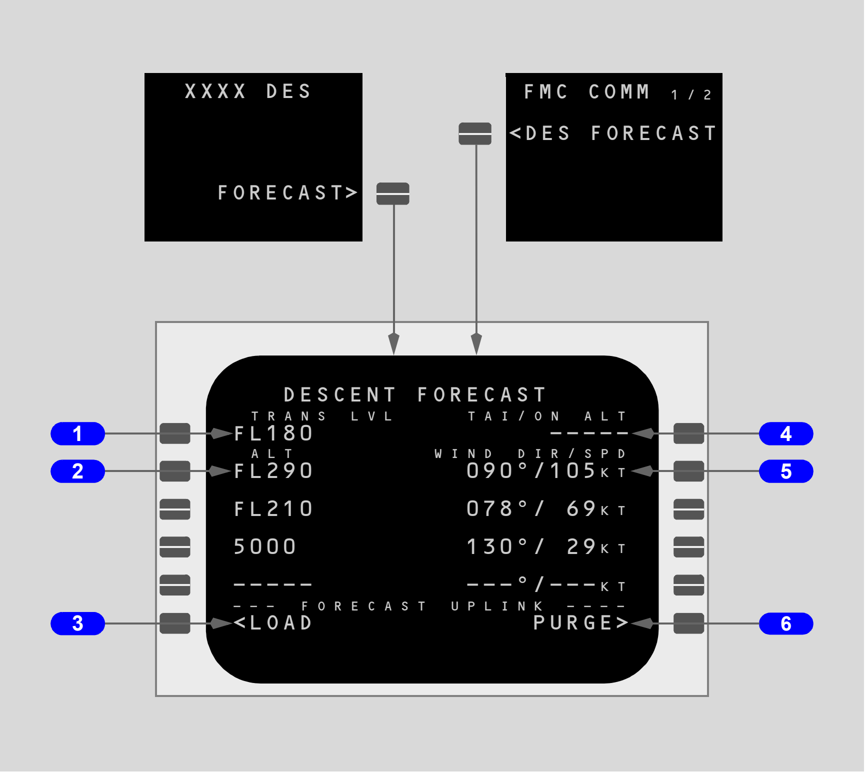
Data blanks if airplane climbs or descends below the entered altitude.

Descent Forecast Page

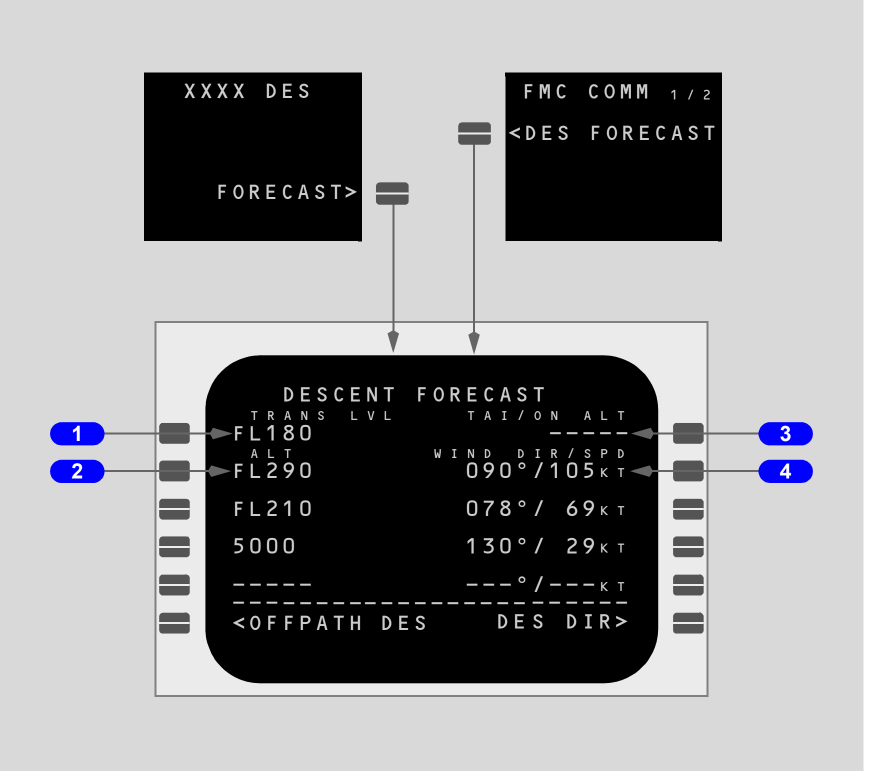
Descent forecast page is used to enter wind data for descent, and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

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.

405, 570



109



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 405, 570

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.

3 Thermal Anti-Ice On Altitude (TAI/ON ALT)
109

Valid entry is altitude or flight level where anti-ice is to be first turned on during the descent.

4 Thermal Anti-Ice On Altitude (TAI/ON ALT)
405, 570

Valid entry is altitude or flight level where anti-ice is to be first turned on during the descent.

4 Wind Direction/Speed (WIND DIR/SPD)
109

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.

5 Wind Direction/Speed (WIND DIR/SPD)
405, 570

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)
405, 570

Displays PURGE prompt when an uplink containing descent forecast uplink data received and error checks passed.

PURGE -

Push - rejects uplinked descent forecast data.

DES -

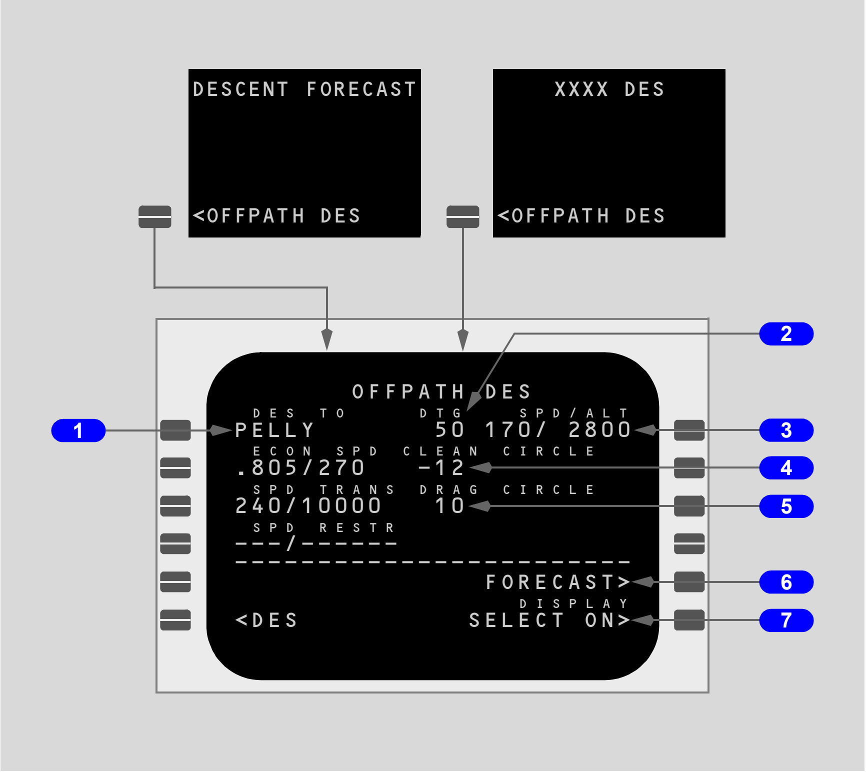
Push - displays the DES page.

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

Accessing the arrivals page more than 400 NM from the departure airport, more than halfway along the active route, beyond the top of climb and within two minutes of top of descent, or beyond the top of descent, displays arrivals for the destination airport. Prior to sequencing any of these points, accessing the arrivals page displays arrivals for the departure airport.

Sequencing any of the above points also causes the FMC to send landing altitude data to the cabin altitude controller. Until an arrival approach has been selected into the active flight plan, the destination airport altitude is used by the cabin altitude controller.

Arrivals Page - IFR Approaches

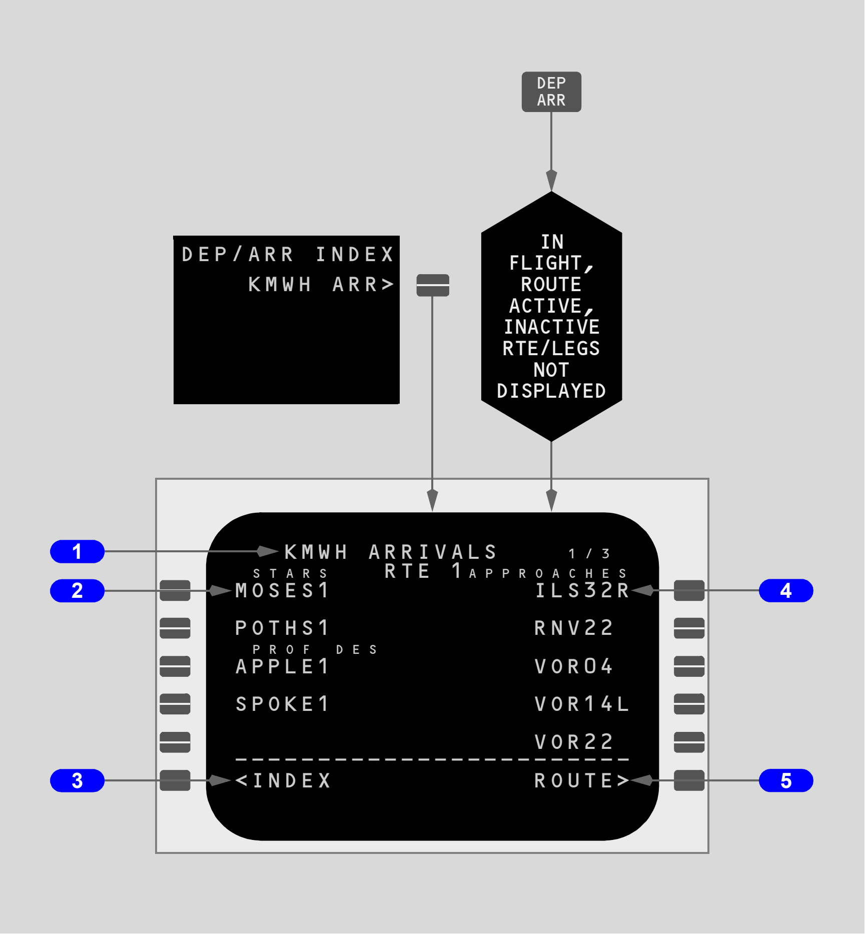
The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

The approaches, STARS/profile descents, and transitions are displayed and selected on this page.

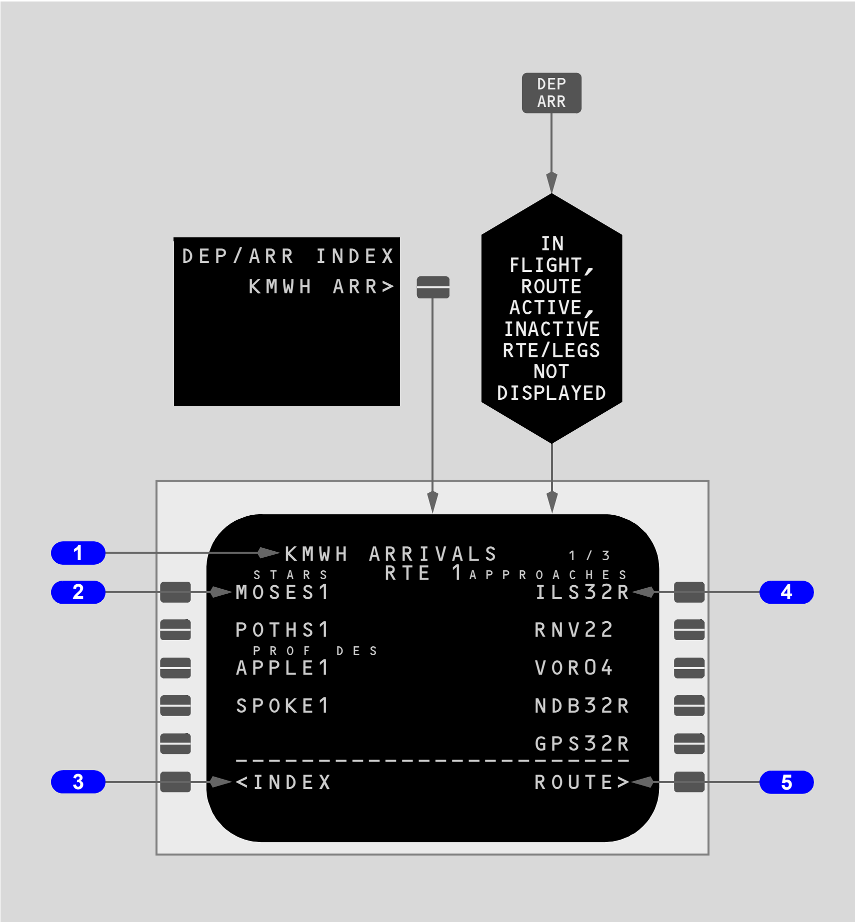
Selecting Options

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.

109



405, 570



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 -

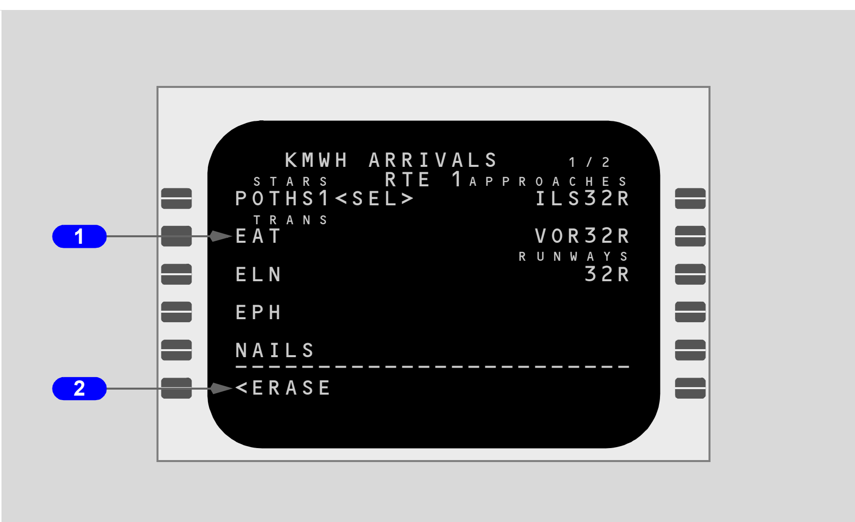
- selects approach for entry into the route, <SEL> displays
- all other approaches and runways no longer display; transitions and profile descents for the selected approach display
- displays INTC prompt for selected approach
- displays ERASE prompt

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

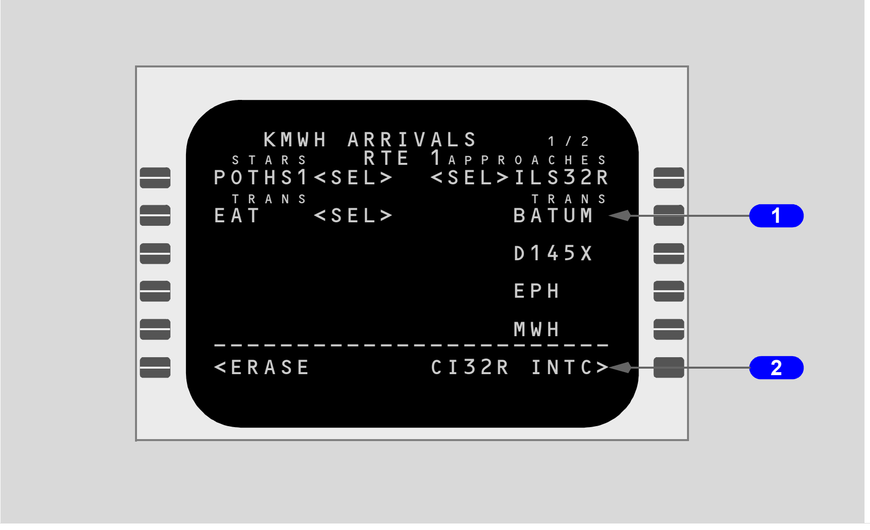
2 **ERASE**

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

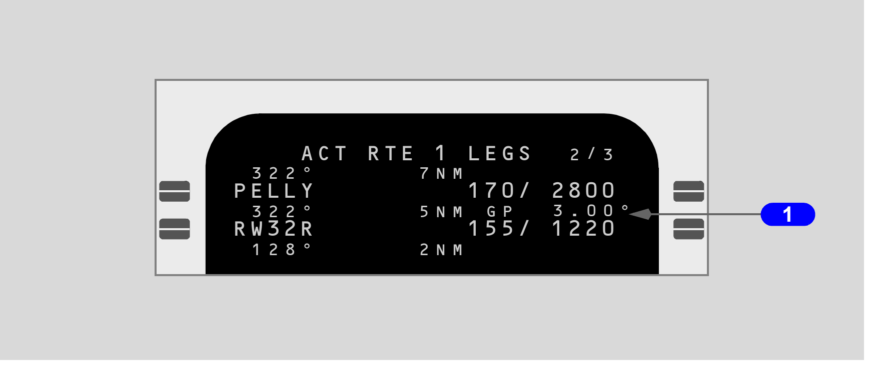
Selecting an arrival runway or approach displays an approach intercept waypoint on the approach course for selected approach or runway.

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

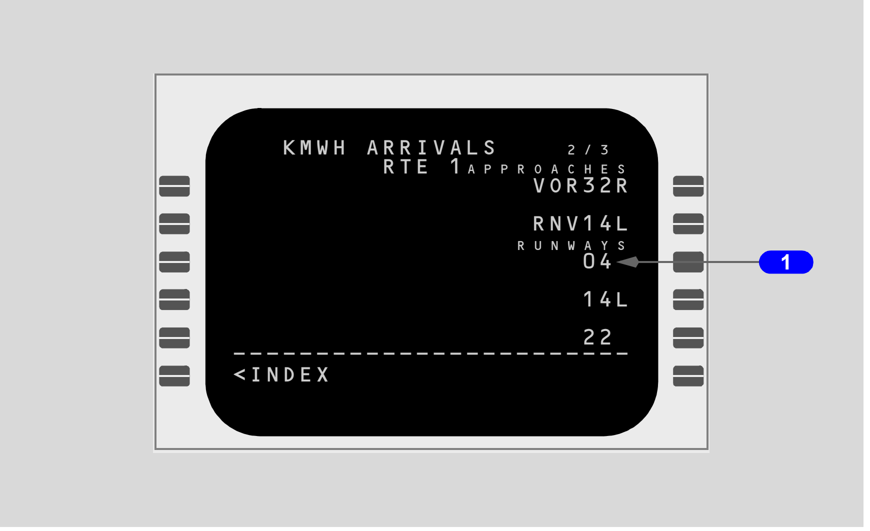
Active Route Legs Page With Glide Path (GP) Angle



1 GP Display

Displays the navigation database GP angle for ILS, B/C, GPS, LOC, RNV, NDB, and VOR approaches. When AFDS pitch mode VNAV PTH is active, vertical path guidance is provided at the displayed GP angle.

Arrivals Page - VFR Approaches



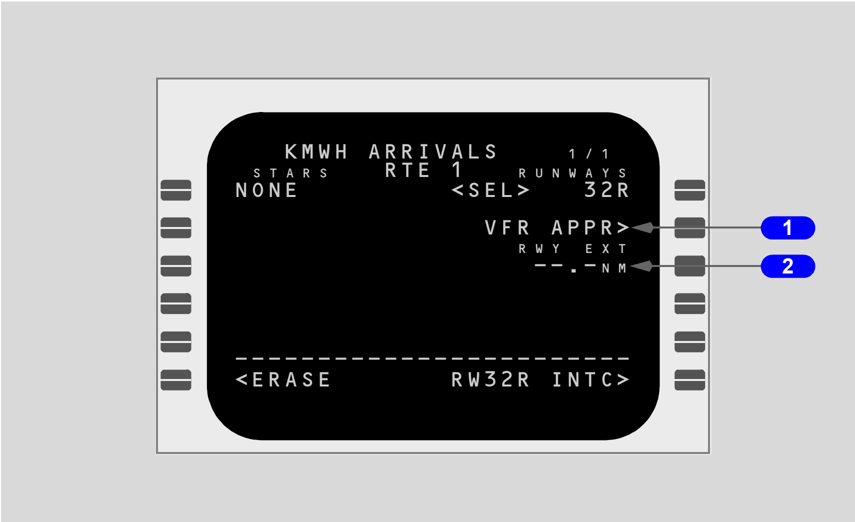
1 RUNWAYS

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)**

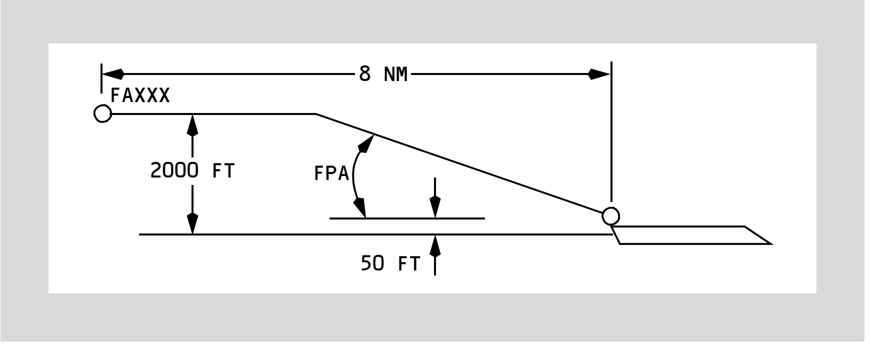
Displays RWY EXT 8.0. FAXXX is part of VFR APPR and distance cannot be changed.

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

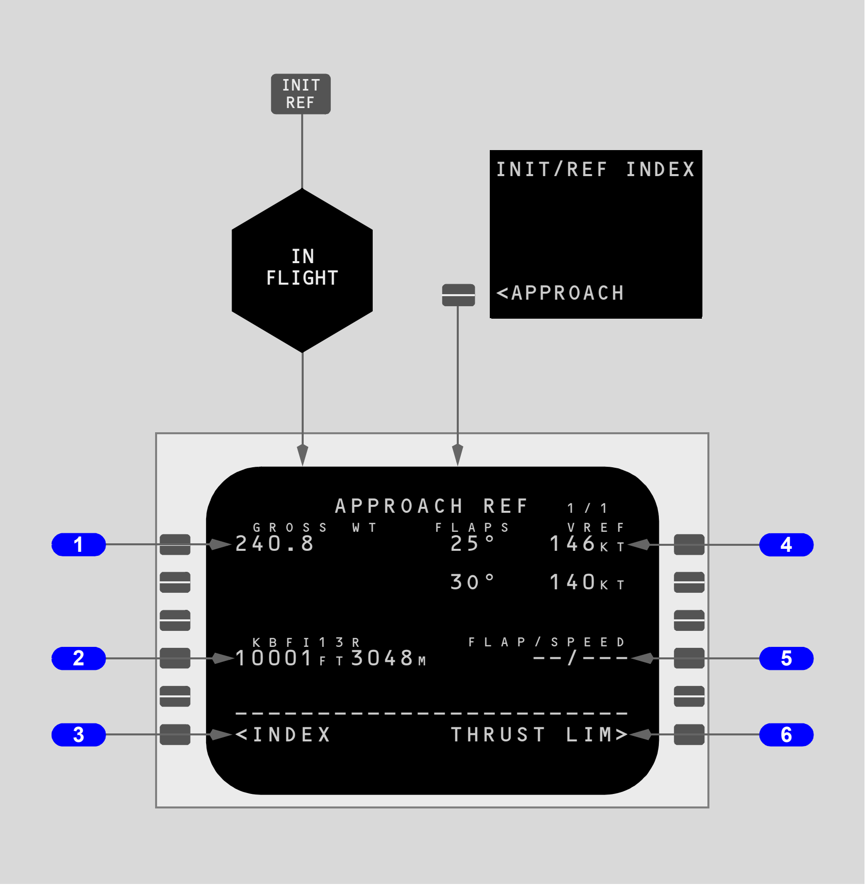


The VFR approach is a level path until the VNAV descent path is intercepted. It terminates at the runway threshold at 50 feet (and 170 knots). Default values display in RWY EXT and FPA.

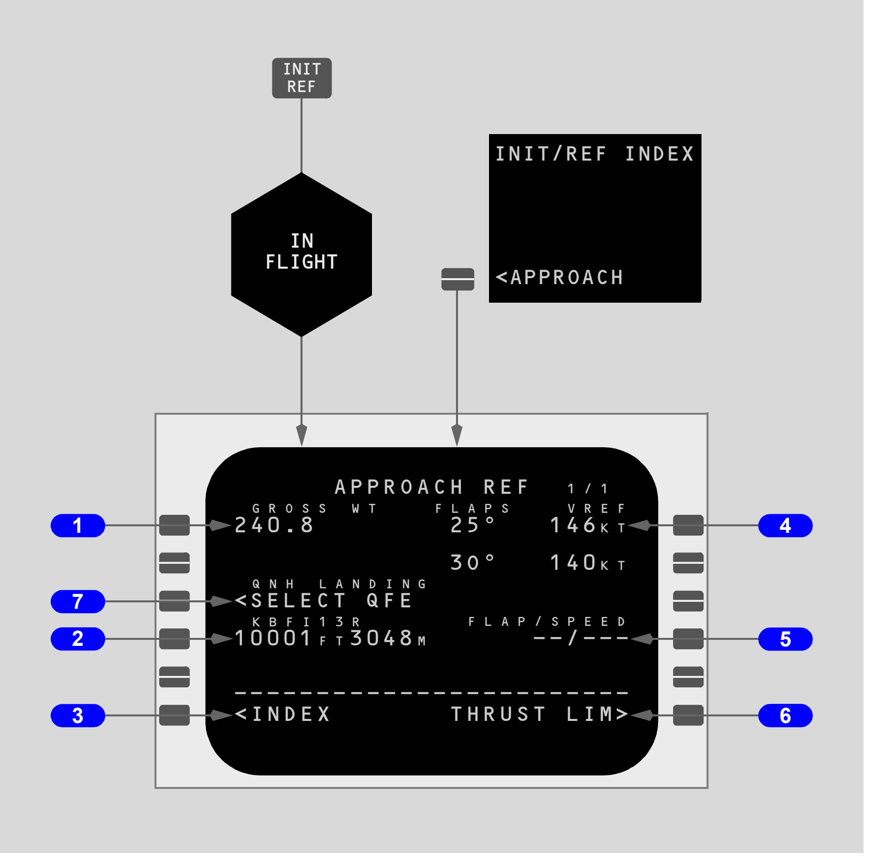
Approach Reference Page

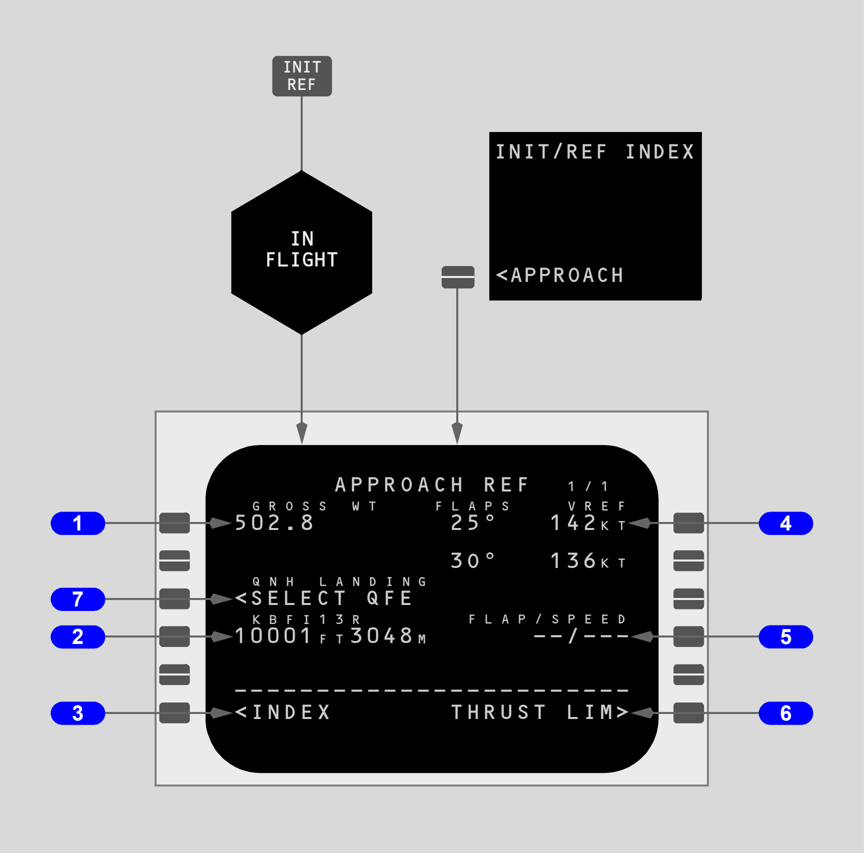
The approach reference page displays approach planning data and the approach reference speed (VREF) selection.

109



405


INIT REF
IN FLIGHT
INIT/REF INDEX
<APPROACH
APPROACH REF 1/1
GROSS WT
240.8
FLAPS
25°
30°
VREF
146KT
140KT
QNH LANDING
<SELECT QFE
KBFI13R
10001FT3048M
FLAP/SPEED
--/---
<INDEX
THRUST LIM>
1
7
2
3
4
5
6



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.

7 **QFE/QNH**

405, 570

Defaults to QNH: after pushing barometric standard switch to STD, after flight completion, or after a long term power interruption.

Line title displays current status as QNH LANDING or QFE LANDING.

Push -

- selects QFE or QNH landing elevation
- when QFE selected, sets Landing Altitude and Touchdown Zone Indicator to zero

Holding

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

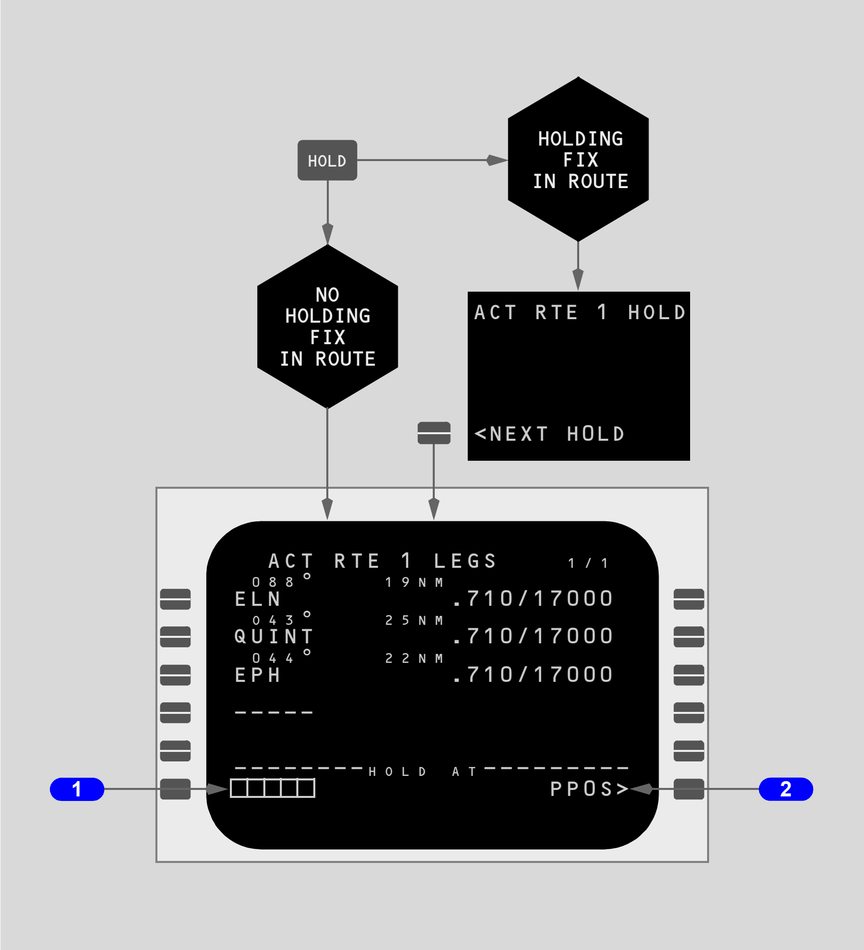
With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- airplane track, not heading or direction from which the active route approaches the holding pattern, determines the entry method used (parallel, teardrop, or direct entry)
- the airplane flies the initial outbound leg a computed distance from the holding fix, rather than a specific time. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active
- teardrop entries use a 40 degree offset angle
- parallel and teardrop entries may cause the airplane to fly beyond the displayed holding pattern; however, the airplane remains in protected FAA or ICAO limits.

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.

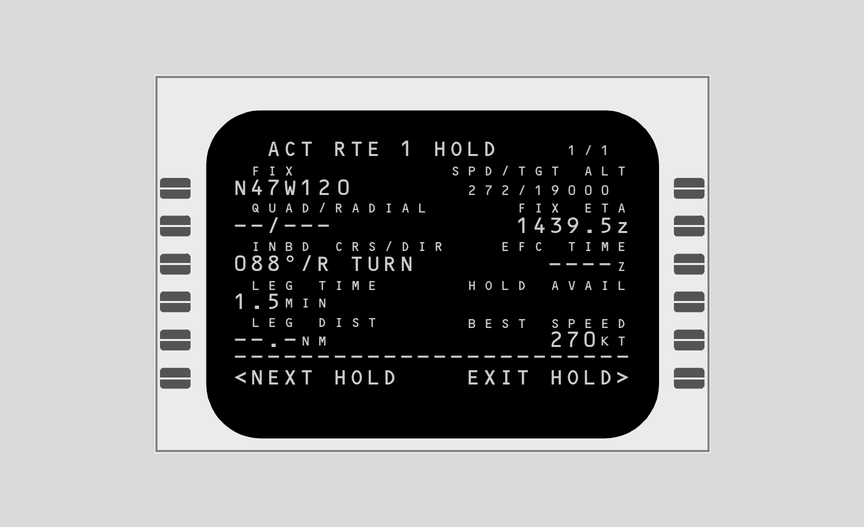
If holding fix not in active route, waypoint is entered in scratch pad, then selected to HOLD AT boxes. HOLD AT XXXXX displays in scratch pad. Selecting HOLD AT XXXX to desired line displays RTE HOLD page; cannot be selected as the active waypoint.

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

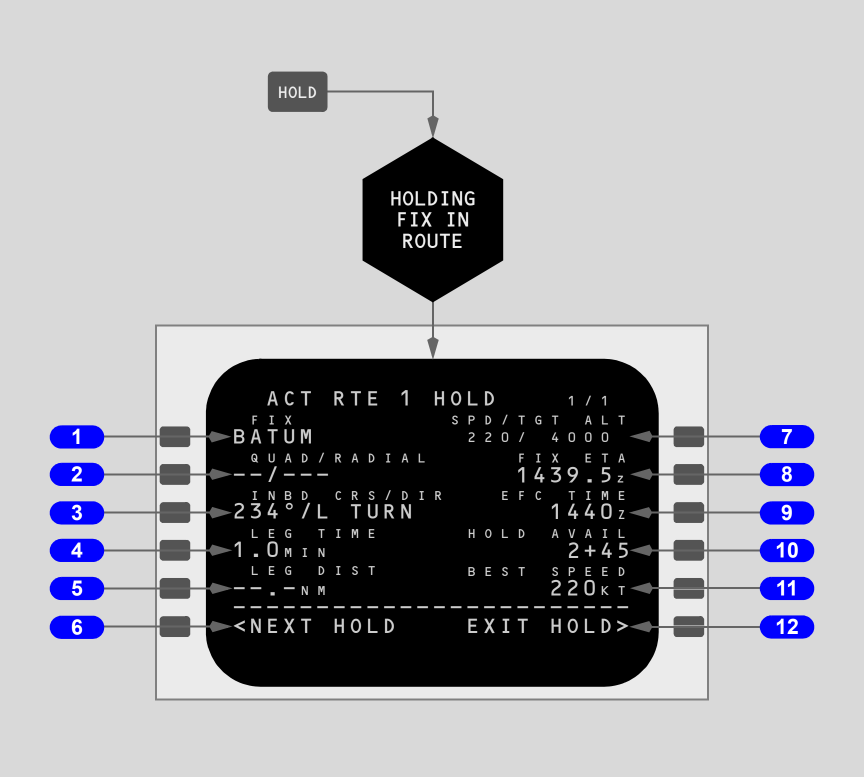
When a hold(s) exists in the route, hold page 1/X displays first existing hold. When more than one hold exists, pushing NEXT PAGE displays succeeding holds.

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. Header at 1L displays PROC HOLD
- for some holding patterns in SIDs, the airplane exits holding when arriving at an altitude. Header at 1L displays HOLD AT



1 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 displays in large font, the FMC adjusts the leg time (1.0 MIN at or below 14,000 feet; 1.5 MIN above 14,000 feet).

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 HOLD AT 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 airplane will next pass the holding fix.

With EFC TIME entry, displays time the airplane will pass the holding fix after the EFC time. The FMC uses this time to calculate downtrack ETAs and fuel values based on departing the holding fix at the new FIX ETA.

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

Flight Management, Navigation — Chapter 11
FMS Alternate Navigation System Description — Section 50

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:

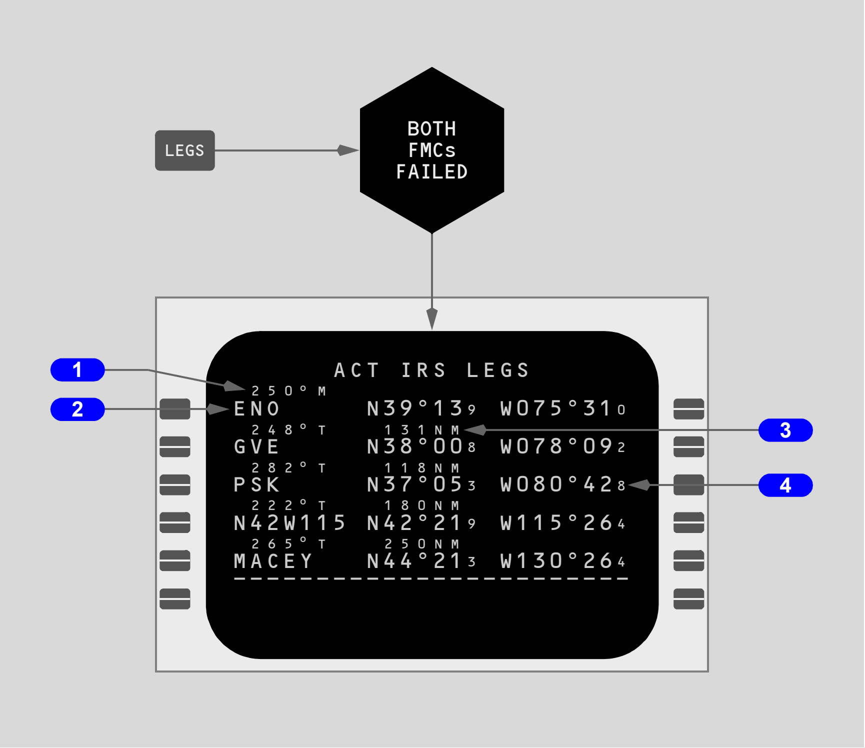
- ALTERNATE NAVIGATION LEGS
- ALTERNATE NAVIGATION PROGRESS
- ALTERNATE NAVIGATION RADIO

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

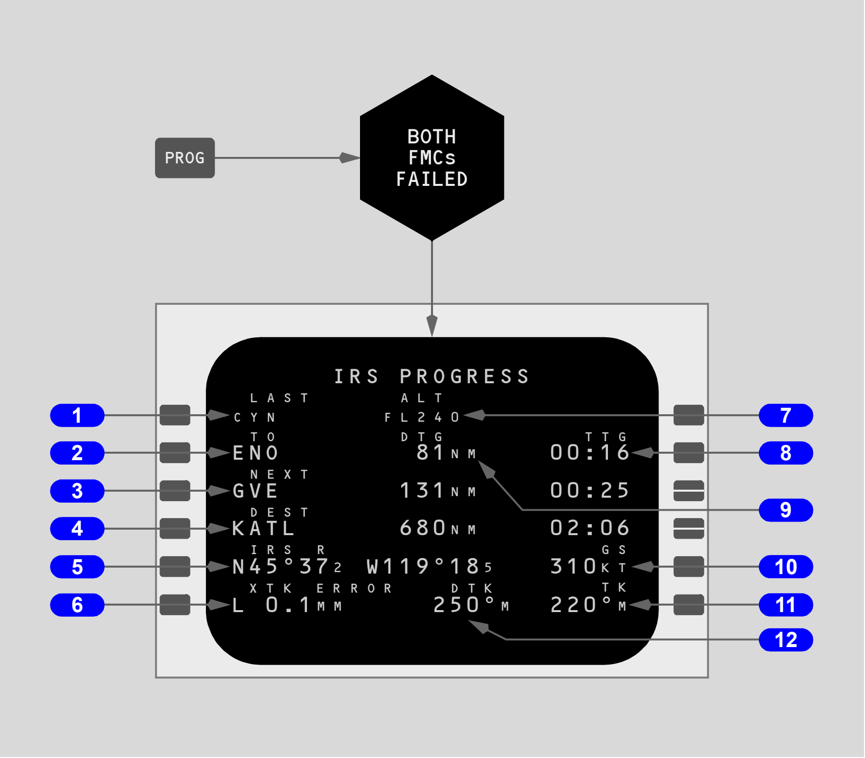
Displays the great circle distance between waypoints.

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.

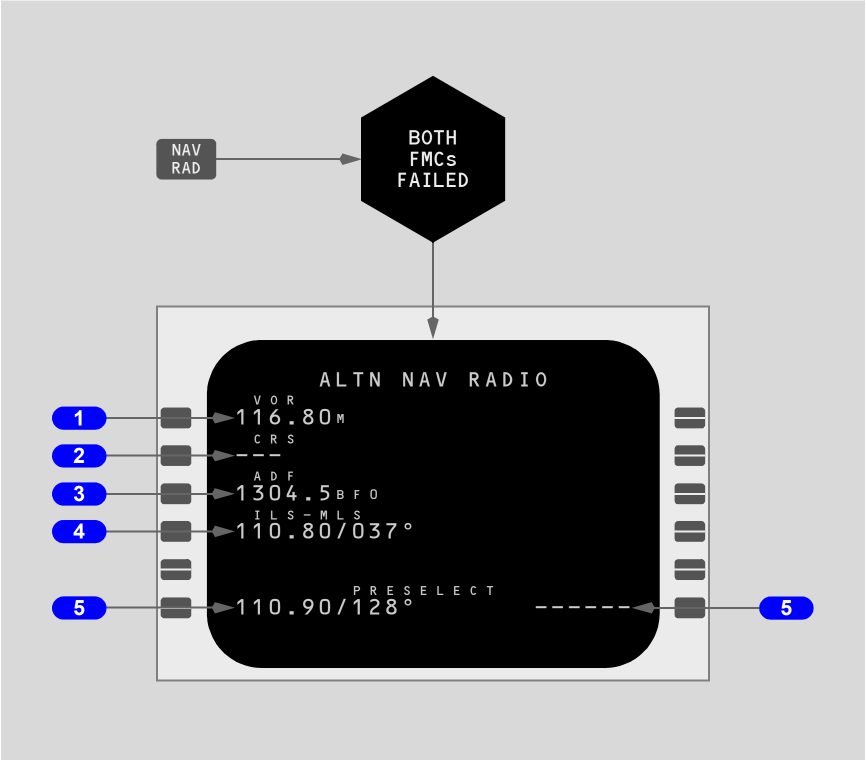
12 Desired Track (DTK)

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 displays PARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note: ILS course and frequency must be entered on the left, center, and right ALTN NAV RADIO page.

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	Message Logic
FMC LEFT, RIGHT	Advisory		Affected FMC has failed.
>FMC MESSAGE	Advisory		High priority FMC message exists.

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Message	Level	Aural	Message Logic
>FMC RUNWAY DIS	Caution	Beeper	Airplane position or heading not within specified limits of active FMC departure runway and takeoff thrust applied.

Message	Level	Aural	Message Logic
>GPS	Advisory		Dual GPS failure.
>GPS LEFT, RIGHT	Advisory		GPS sensor fault.

Message	Level	Aural	Message Logic
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.

Message	Level	Aural	Message Logic
IRS MOTION	Advisory		Excessive airplane motion detected during alignment.
>SNGL SOURCE ILS	Caution	Beeper	Both pilots' displays referenced to the same localizer or glideslope receiver.
>TRANSPONDER L, R	Advisory		Affected ATC transponder has failed.

Message	Level	Aural	Message Logic
UNABLE RNP	Advisory		Navigation performance does not meet required accuracy during navigation phases other than approach. Inhibited in polar region.
UNABLE RNP	Caution	Beeper	Navigation performance does not meet required accuracy during navigation approach phase. Inhibited in polar region.

EICAS Memo Messages

Message	Message Logic
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.

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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

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ATC COMM ESTABLISHED - ATC COMM available or control passed to a new ATC center.

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ATC COMM TERMINATED - ATC datalink is terminated.

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ATC MSG NOT ACKNOWLEDGED - ATC message has been transmitted and no network acknowledgment is received.

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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.

405, 570

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.

405, 570

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.

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FUEL DISAGREE - PROG 2 - fuel totalizer and calculated values disagree by 4,080 Kg or more. This may indicate an engine fuel leak.

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FUEL DISAGREE - PROG 2 - fuel totalizer and calculated values disagree by 9,000 pounds or more. This may indicate an engine fuel leak.

ILS TUNE INHIBITED - MCP - flight control computers inhibiting changes in ILS tuning, and either a manual operation in the ILS tuning field attempted or a new arrival ILS approach activated.

INSUFFICIENT FUEL - estimated fuel at destination less than entered RESERVES value. This may indicate an engine fuel leak.

405, 570

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.

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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.

405, 570

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.

405, 570

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.

405, 570

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.

405, 570

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.

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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.

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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.

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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 another ATC center.

RESET MCP ALT - two minutes prior to T/D point with VNAV active and MCP not set to altitude below cruise altitude.

405, 570

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.

405, 570

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.

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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.

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RTA FIX DELETED - RTA fix has been deleted from the modified flight plan.

RW/ ILS FREQ ERROR - selected ILS frequency does not match the frequency for destination runway in the active route.

RW/ILS CRS ERROR - selected ILS course does not match course for destination runway in the 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.

THRUST REQUIRED - VNAV active, autothrottle disconnected, and additional thrust required to track descent path and maintain speed.

109, 405

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.

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UNABLE RTA - RTA not achievable within applicable arrival time tolerance.

405, 570

UNABLE TO LOAD CLEARANCE - FMC unable to load any of the loadable data in an uplink message.

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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.

405, 570

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 available 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.

TAKEOFF SPEEDS DELETED - selected V speeds are invalid.

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.

VERIFY TAIL NUMBER - the entered tail number disagrees with the tail number contained in the FMC database.

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Fuel System

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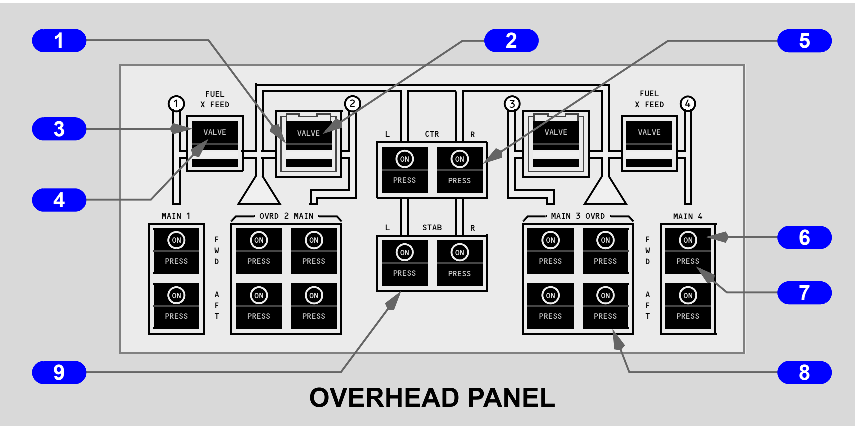

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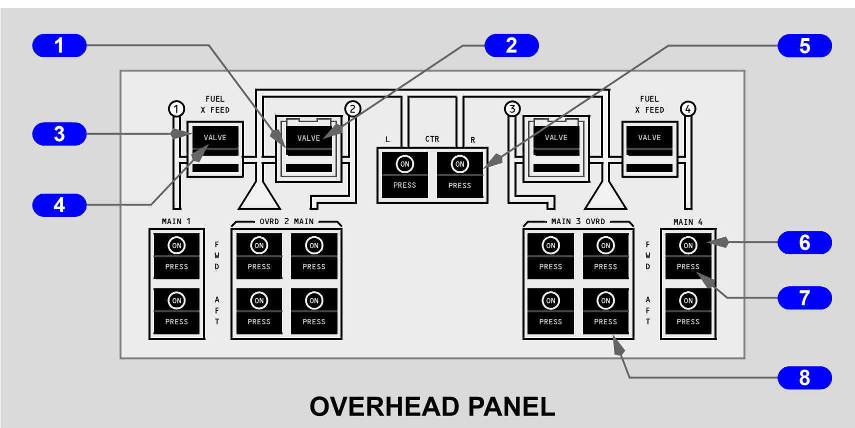

1 Crossfeed (X FEED) Valve Switches 2 and 3

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 **Fuel Pressure (PRESS) Lights**

Illuminated (amber) - fuel 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**

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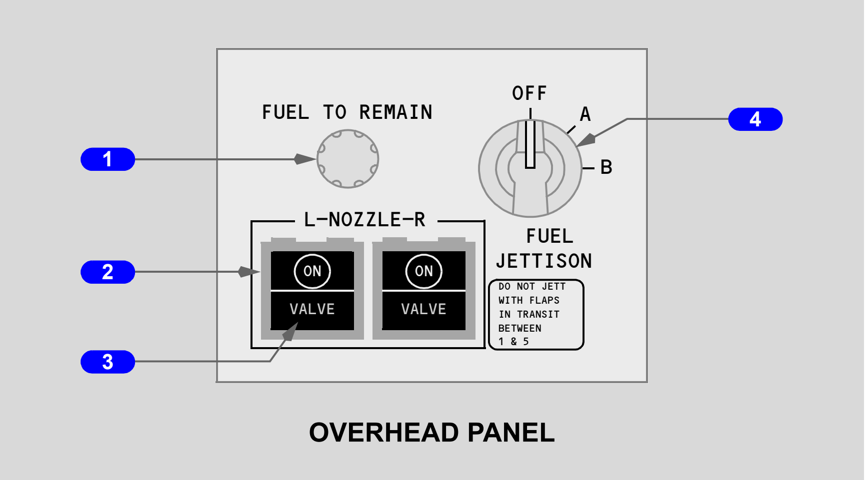
ON - fuel pump operates when commanded by system logic.

Fuel Jettison System



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
  405, 570
- when jettison system armed, activates override/jettison pumps in tanks containing fuel (pump switches must be ON)
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- 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

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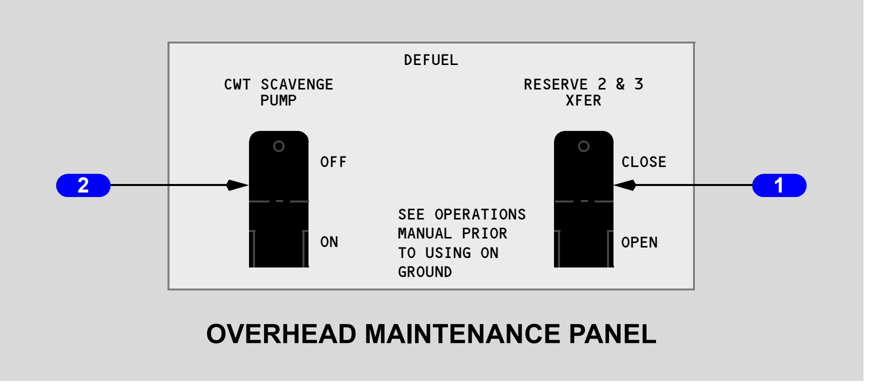

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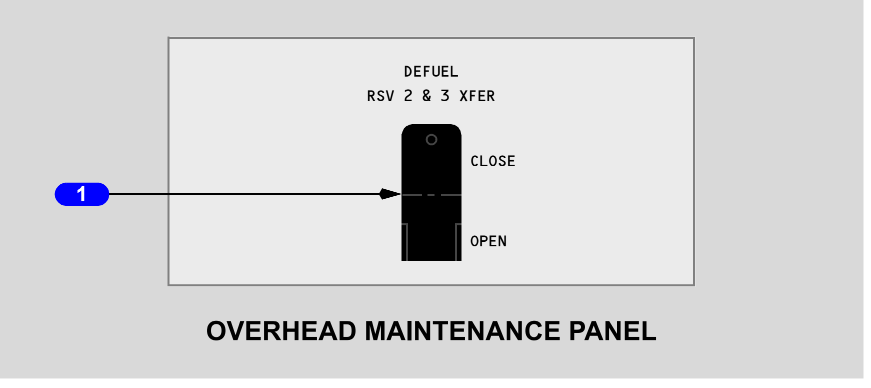

1 Reserve (RSV) 2 & 3 Transfer (XFER) Switch

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**
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ON - pump operates.

OFF - pump operates when commanded by system logic.

Fuel Transfer Main 1 & 4 Switch

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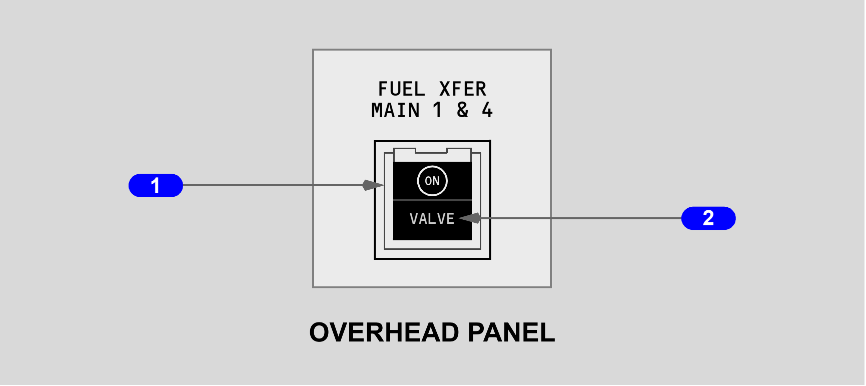

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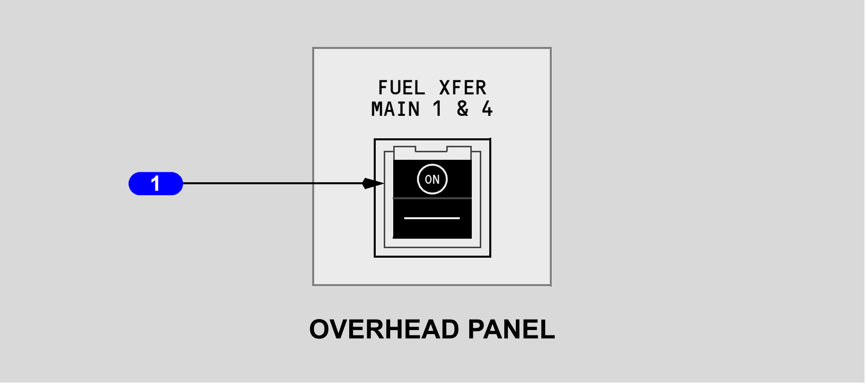

1 **FUEL Transfer (XFER) MAIN 1 & 4 Switch**

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

2 Transfer VALVE Light

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Illuminated (amber) - main 1 and/or 4 transfer valve not in selected position.

Fuel Indications and Displays

Normal Fuel Indications

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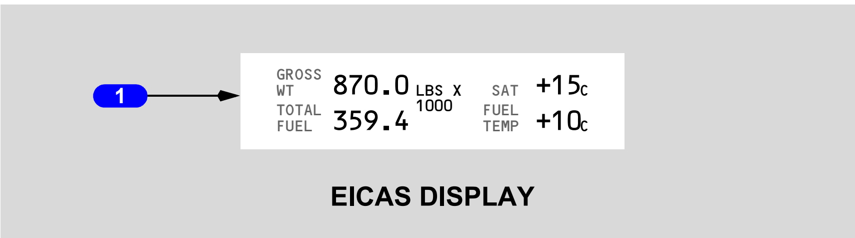

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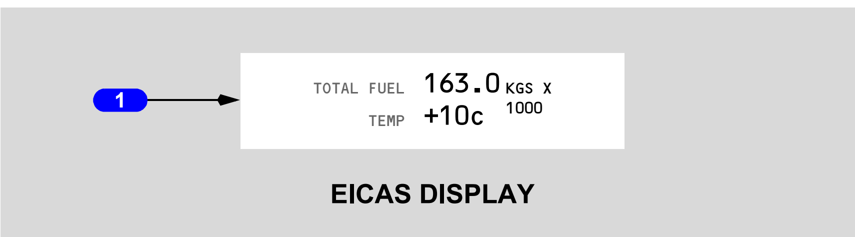

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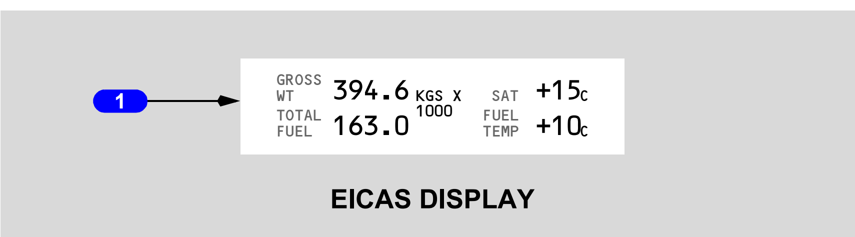


1 Normal Fuel Indications

405

GROSS Weight (WT) (kilograms x 1000).

570

GROSS Weight (WT) (pounds x 1000).

109, 405

Total fuel quantity (kilograms x 1000).

570

Total fuel quantity (pounds x 1000).

405, 570

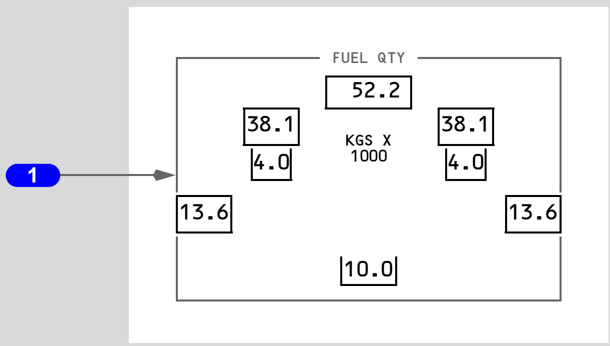
Static Air Temperature (SAT) (degrees Celsius).

Fuel temperature (degrees Celsius).

Amber - fuel temperature is -37°C and below.

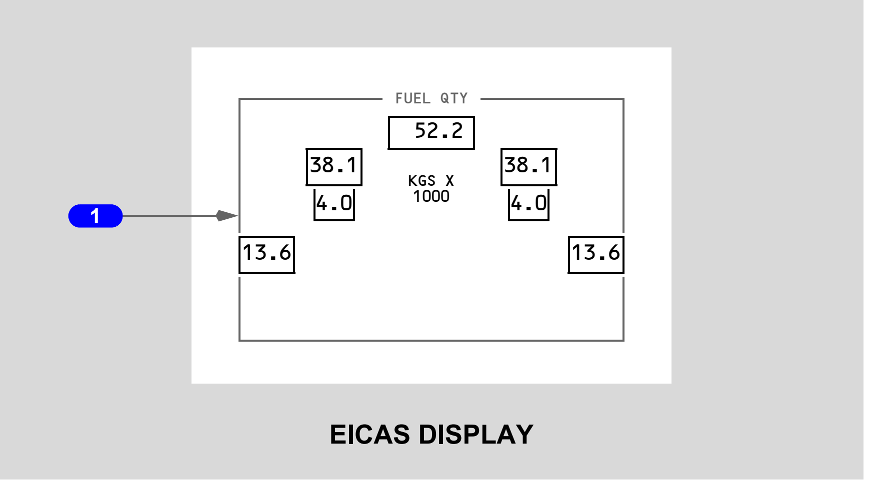
Compacted Fuel Indications

109



EICAS DISPLAY

405



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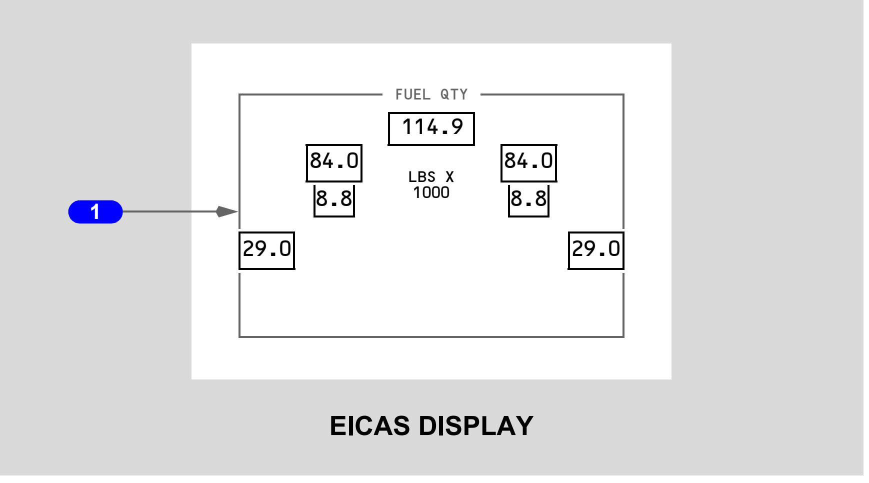


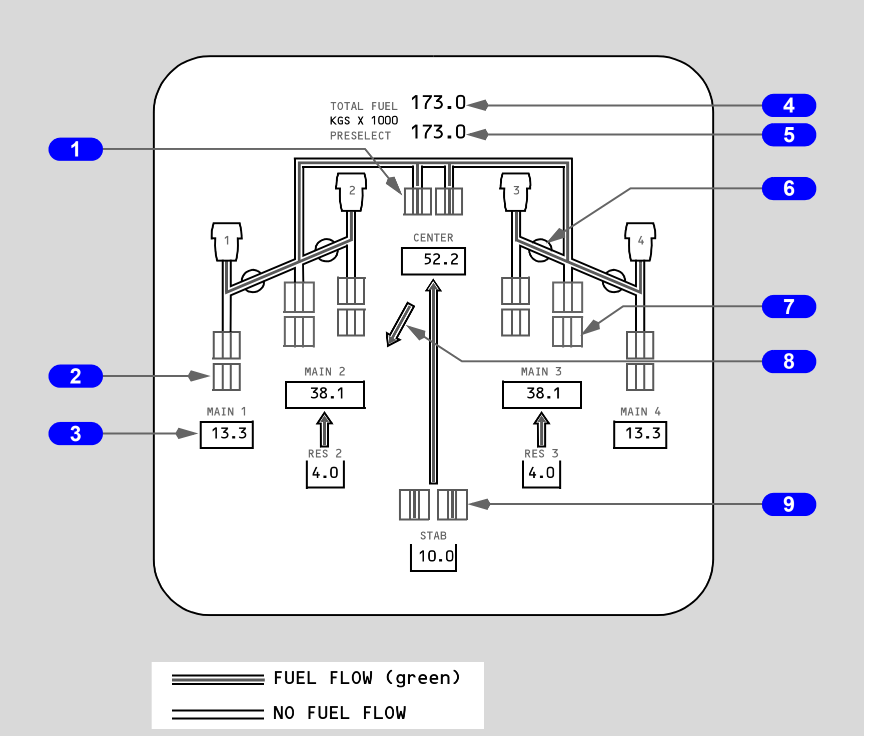
1 Compacted Fuel Indications

Compacted fuel quantity indications display on primary EICAS if only one display 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.

109, 405
Amber (main tank only) - imbalance condition or quantity less than 900 kg.

570
Amber (main tank only) - imbalance condition or quantity less than 2,000 pounds.

4 Total Fuel Quantity

White - indicates total fuel quantity.

5 Preselect Fuel Quantity

White - indicates selected total fuel quantity.

Displayed during fueling. No longer displayed when wing fueling panel door closed.

6 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.

7 Override Pump

White - pump switch off.

Cyan - armed for system logic operation.

Green - pump on.

Amber - pump pressure low.

8 Scavenge Pump Transfer

405

White - pump on

Green - fuel pressure.

9 **Stabilizer Tank Pump**

109

White - pump switch off.

Cyan - armed for system logic operation.

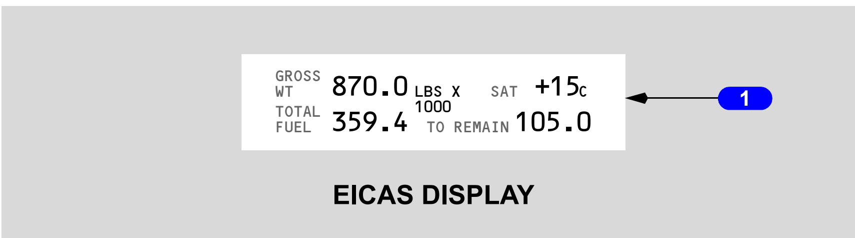
Green - pump on.

Amber - pump pressure low.

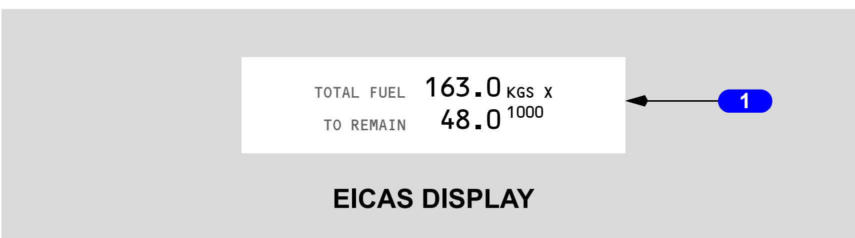
Fuel Jettison Indications

Fuel Jettison Indications, Primary EICAS

570



109



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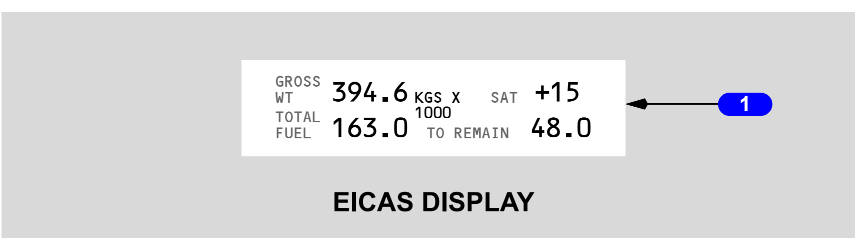


1 **Fuel Jettison Indications**

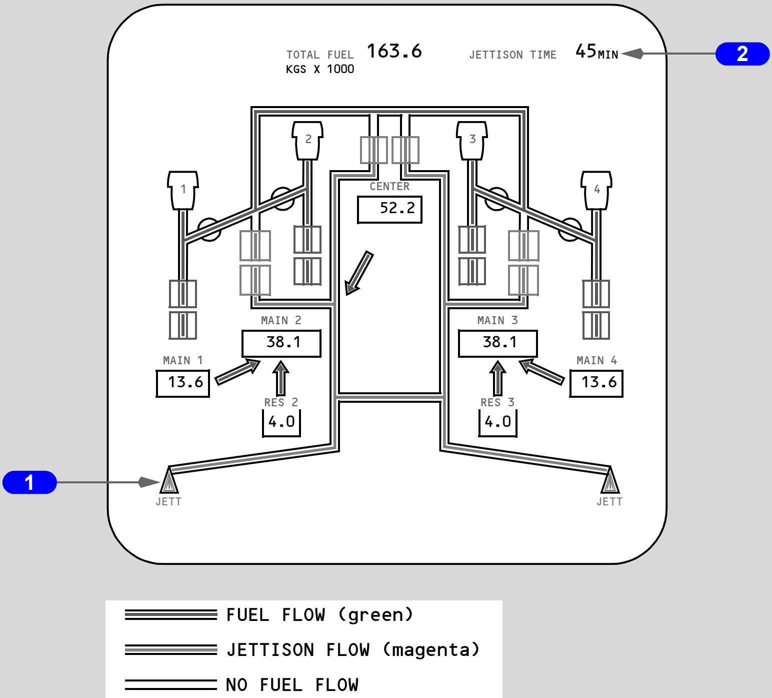
Fuel to remain replaces fuel temperature during jettison operation.

Magenta - indicates fuel to remain at completion of jettison.

White (flashes for five seconds) - indicates jettison has completed.

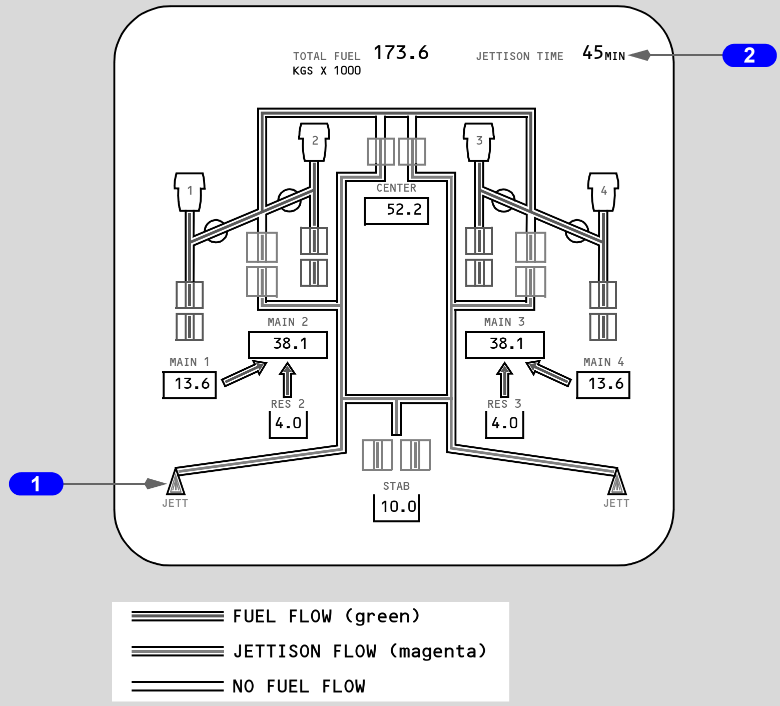
Fuel Jettison Indications, Fuel Synoptic

405



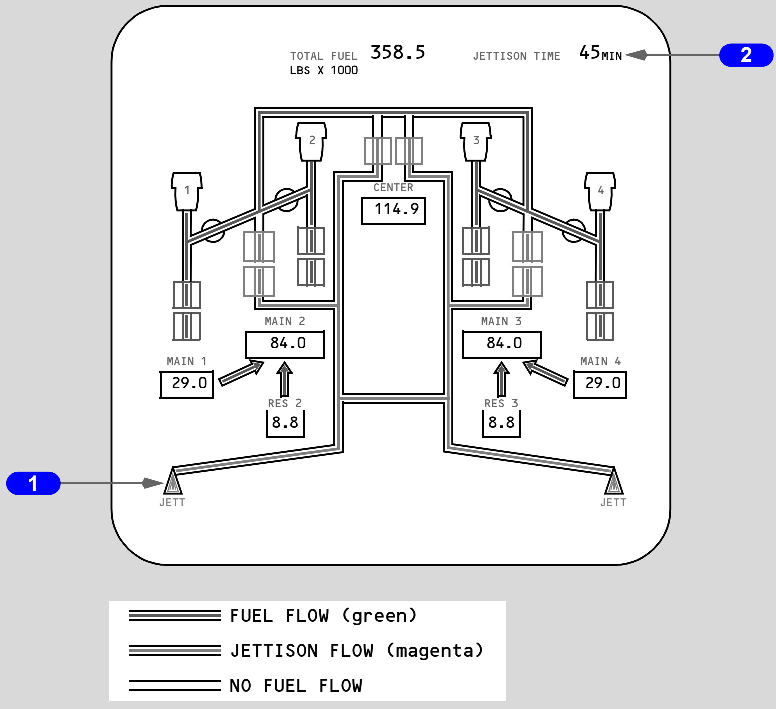
SECONDARY EICAS DISPLAY

109



SECONDARY EICAS DISPLAY

570



SECONDARY EICAS DISPLAY

1 Jettison Nozzle

Magenta - fuel jettison system operating.

2 Time To Complete Jettison

White - time remaining to complete jettison.

Fuel
System Description

Introduction

109

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.

405, 570

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, and reserve tanks 2 and 3. Surge tanks are located in the outer portion of each wing.

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 display 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

109, 405

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 override/jettison pumps have a higher output pressure than the left and right main tank pumps.

570

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 7,000 pounds remaining in the tank. Each override/jettison pump supplies sufficient fuel to operate two engines during takeoff and cruise conditions. The override/jettison pumps have a higher output pressure than the left and right main tank pumps.

The two center wing tank (CWT) fuel pumps are also override/jettison pumps. The CWT pumps override the main tank pumps so CWT fuel is used before wing tank fuel. However, one CWT pump does not override 2 and 3 override/jettison pumps or the outboard main pumps.

405

CWT fuel is scavenged by an electric pump activated by system logic at either or both of two separate instances, one when a CWT override/jettison pump has low output pressure and the other when main tank 2 or 3 fuel quantity decreases to approximately 18,200 kilograms. After each activation, the pump will operate for approximately two hours or until the scavenge pump pressure is low, whichever occurs first. The scavenged fuel is pumped into main tank 2.

109

CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3. Scavenge begins when main tank 2 or 3 fuel quantity decreases to approximately 27,200 kilograms.

570

CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3. Scavenge begins when main tank 2 or 3 fuel quantity decreases to approximately 60,000 pounds.

109
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. If low output pressure is detected, the FUEL PRES STB L or R EICAS message is displayed. If after a brief delay the pump is not selected off, the pump shuts off to protect from overheating.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the airplane climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine may be capable of suction feed operation at cruise power.

Fuel pressure can be provided from a main tank with operating pumps to another engine by opening the appropriate fuel crossfeed valves. Continued crossfeed use will result in a progressive fuel imbalance.

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

109

Tank	Liters	Kilograms*
1 and 4 Main	33,932	27,244
2 and 3 Main	94,984	76,263
Center	64,973	52,167
Reserves	10,009	8,036
Stabilizer	12,492	10,030
Total	216,390	173,740
* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.		

570

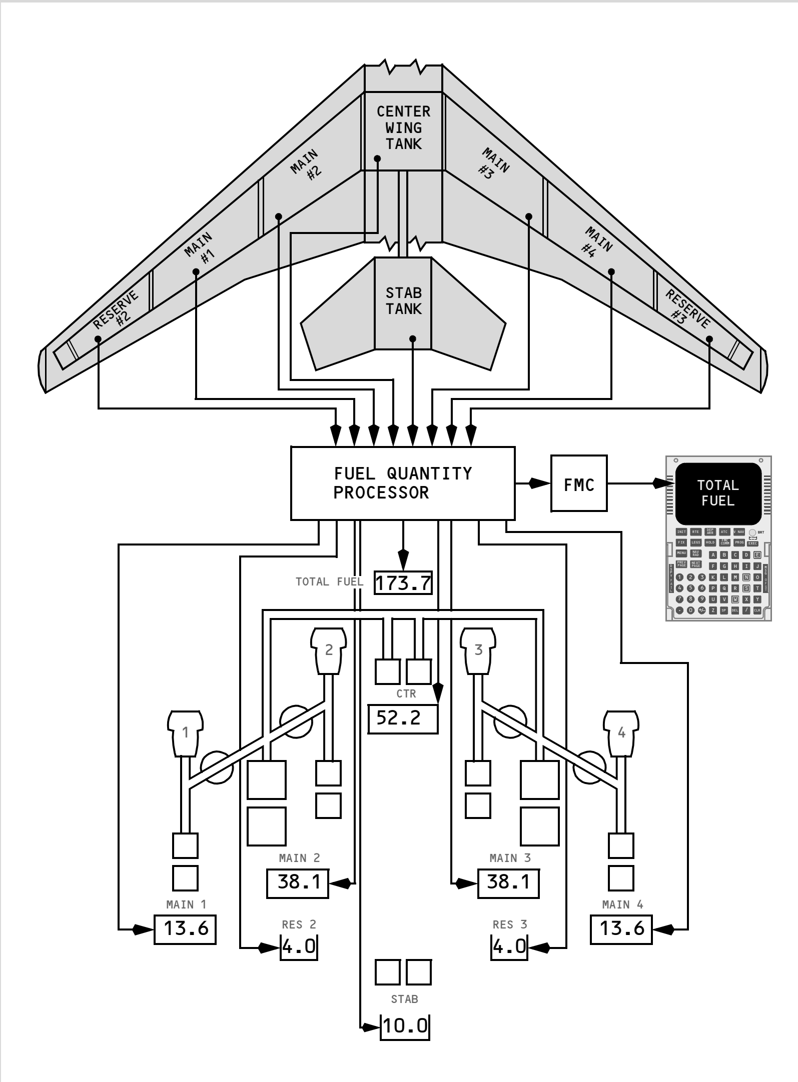
Tank	U.S. Gallons	Pounds*
1 and 4 Main	8,744	58,585
2 and 3 Main	25,092	168,116
Center	17,164	114,999
Reserves	2,644	17,714
Total	53,644	359,414
* Usable fuel at level attitude, fuel density = 6.7 pounds per U.S Gallon.		

405

Tank	Liters	Kilograms *
1 and 4 Main	33,932	27,242
2 and 3 Main	94,983	76,256
Center	64,973	52,162
Reserves	10,009	8,035
Total	203,897	163,695
* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.		

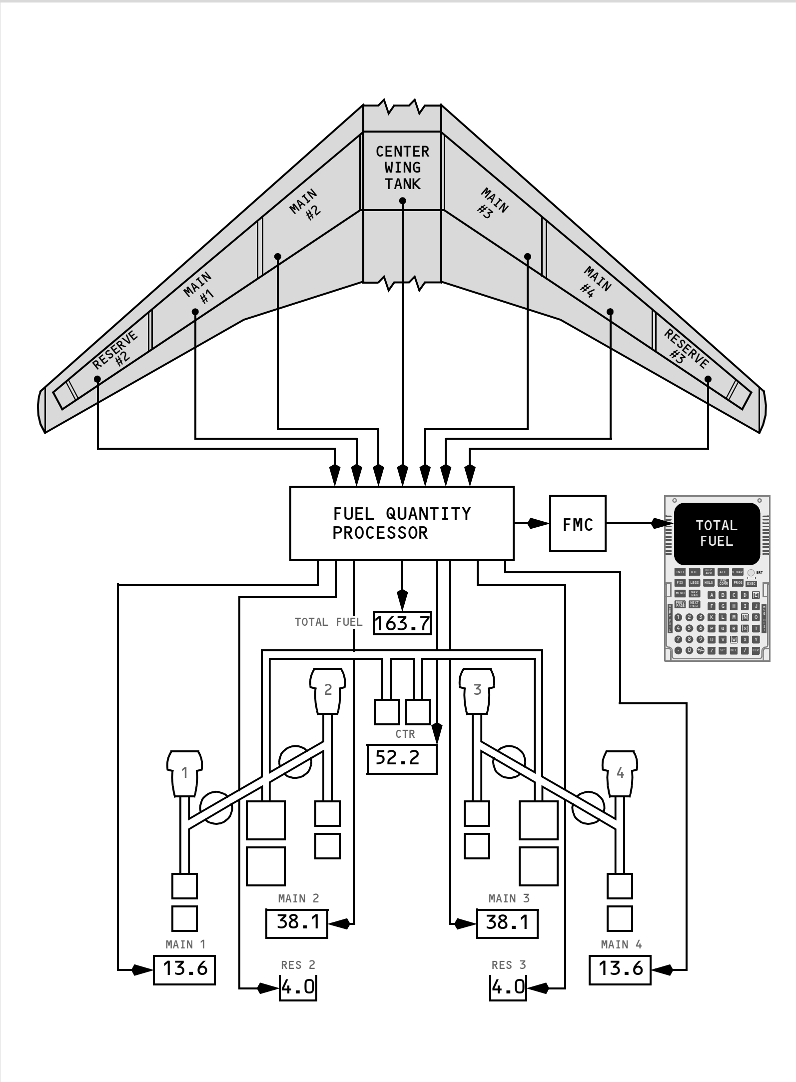
Fuel Quantity Indication

109



DO NOT USE FOR FLIGHT

405



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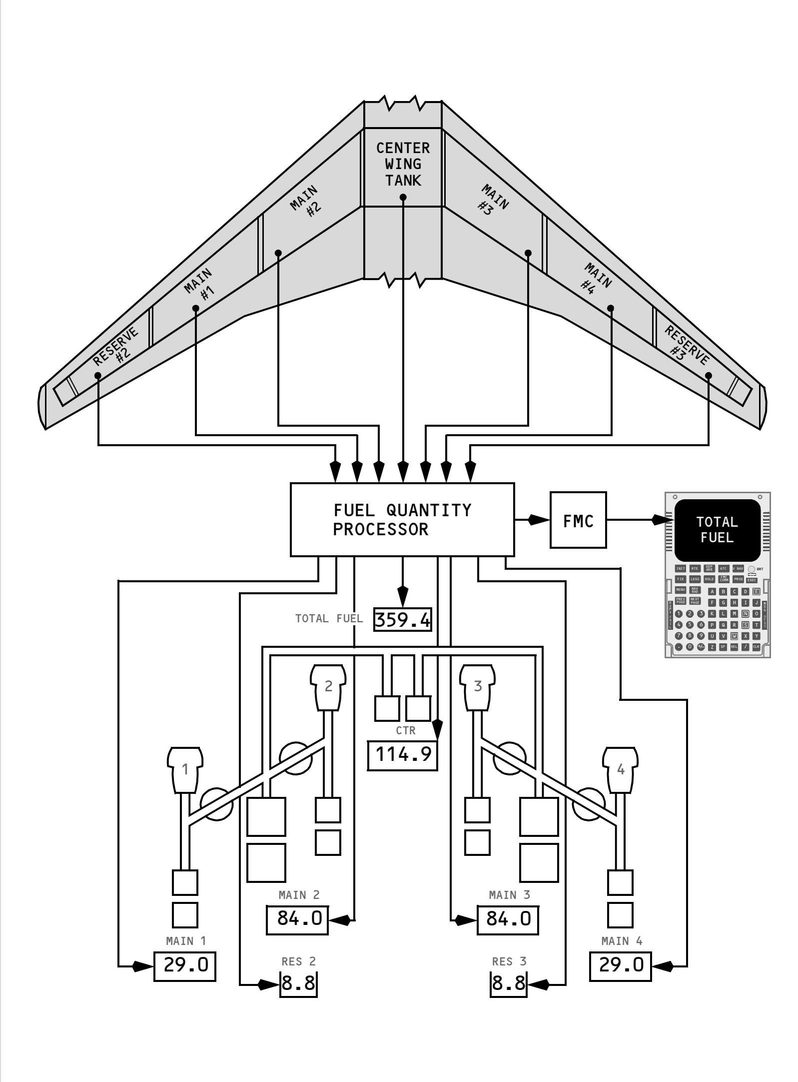
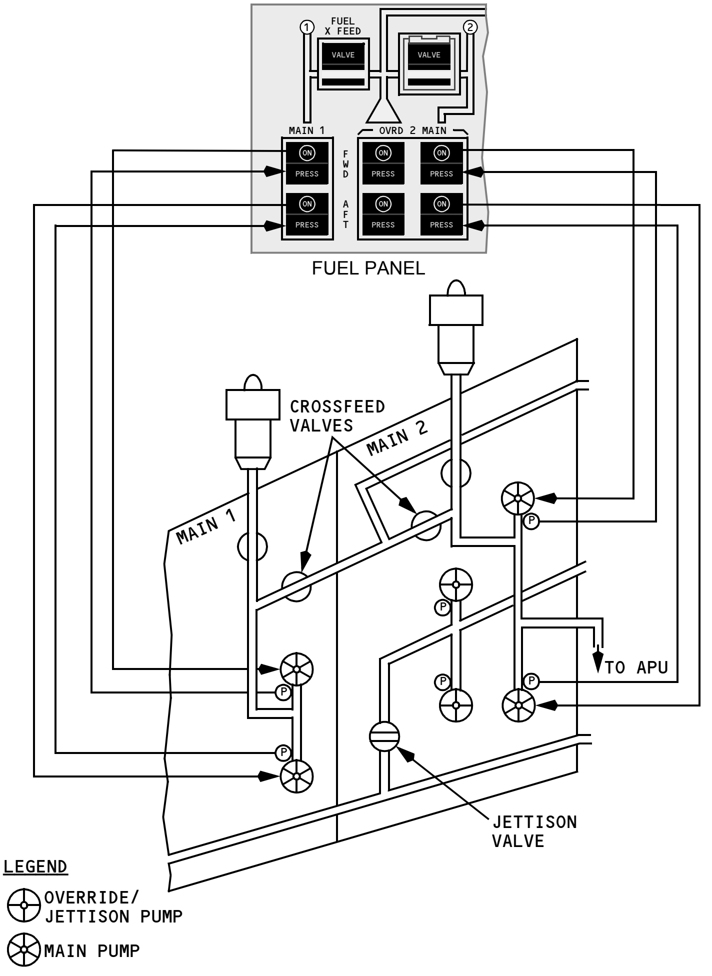
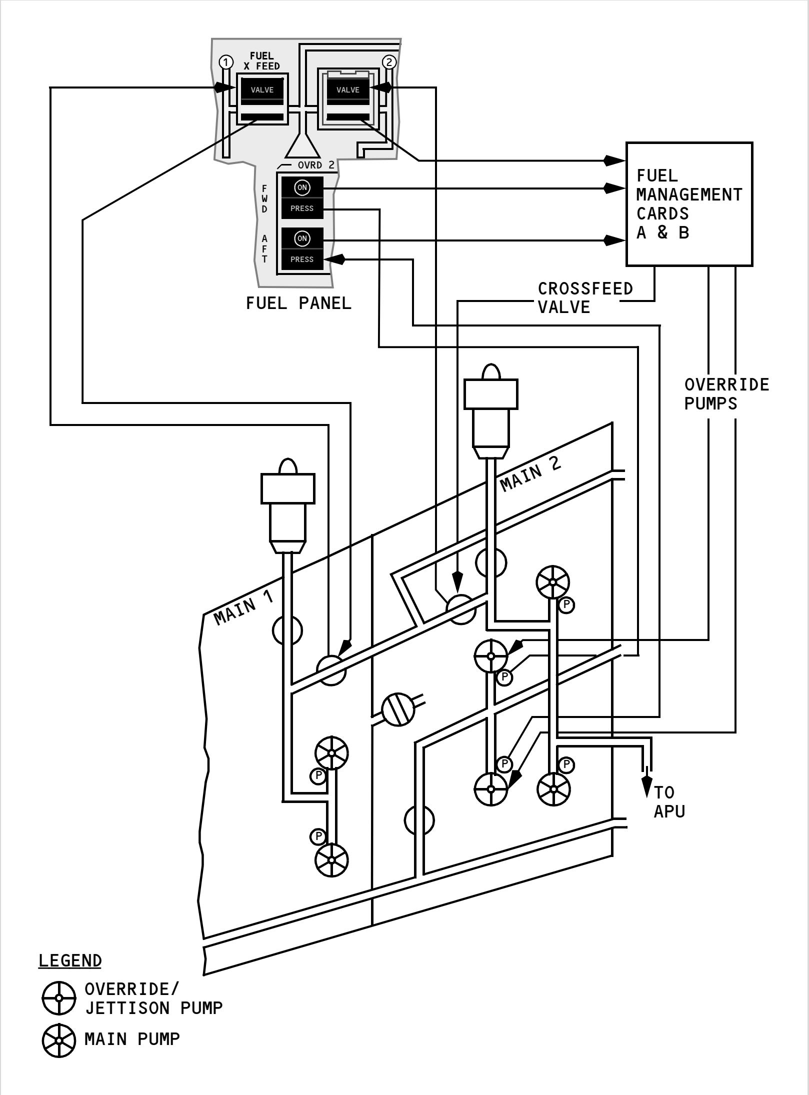

CENTER
WING
TANK
MAIN
#2
MAIN
#3
MAIN
#1
MAIN
#4
RESERVE
#2
RESERVE
#3
FUEL QUANTITY
PROCESSOR
FMC
TOTAL
FUEL
TOTAL FUEL
359.4
CTR
114.9
1
2
3
4
MAIN 2
84.0
MAIN 3
84.0
MAIN 1
29.0
MAIN 4
29.0
RES 2
8.8
RES 3
8.8

Fuel System Schematics

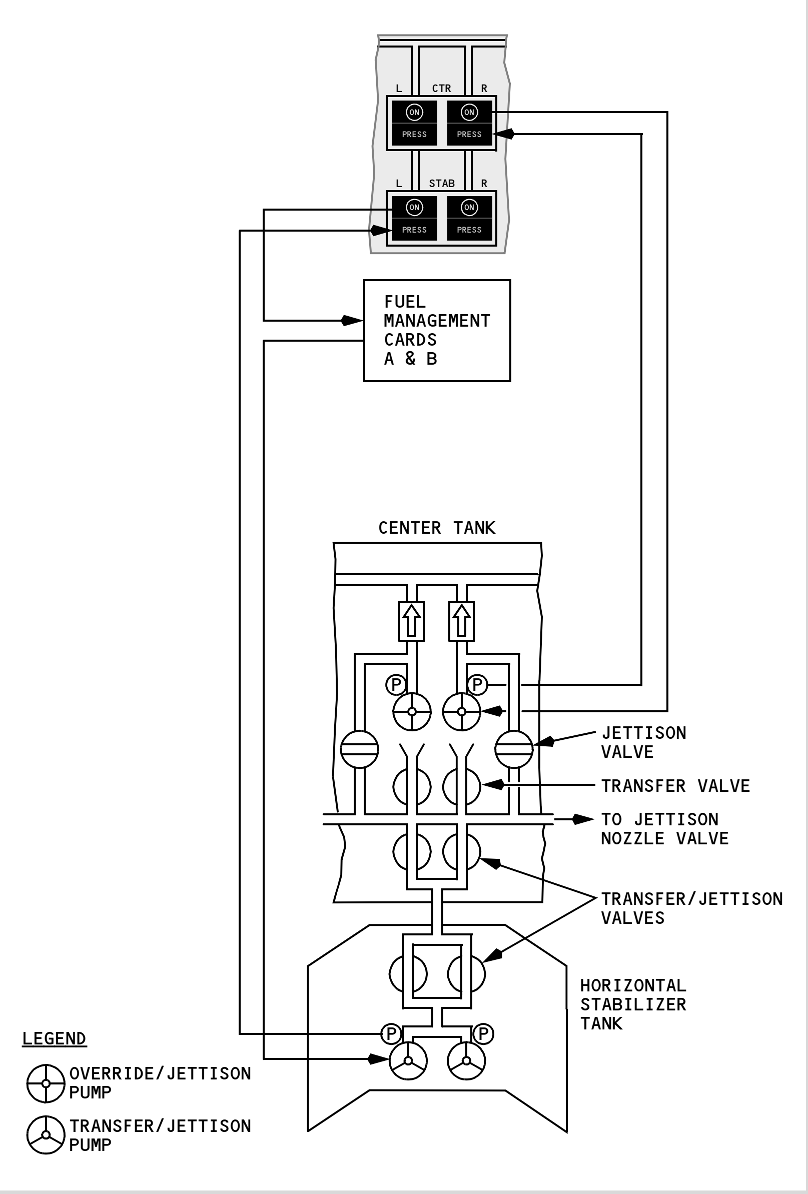
Main Tank Main Pump Schematic



Main Tank Override/Jettison Pump and Fuel Crossfeed Schematic

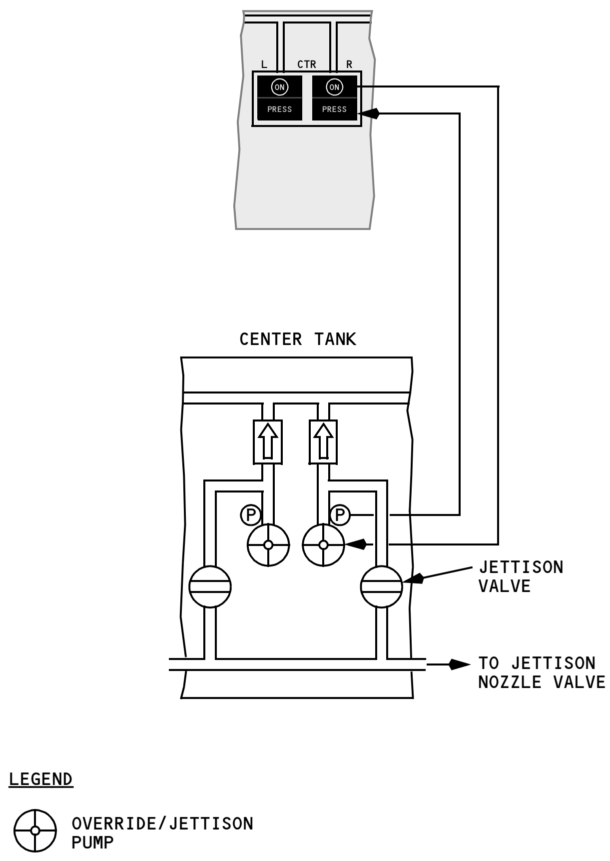


Center Wing and Horizontal Stabilizer Pump Schematic
109



Center Wing Tank Pump Schematic

405, 570



Reserve Tank 2 and 3 Transfer

109, 405

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 approximately 18,200 kilograms.

570

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 40,200 pounds.

Main Tank 1 and 4 Transfer

109, 405

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.

570

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 7,000 pounds remaining in each outboard main tank.

109, 405

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.

570

During fuel jettison, the valves open when either main tank 2 or 3 fuel quantity decreases to 20,000 pounds. The valves may be opened manually using the Fuel Transfer Main 1 & 4 switch on the overhead panel.

APU Fuel Feed

405

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.

109, 570

APU fuel is normally supplied from main tank 2. When AC power is available, fuel is supplied by main pump 2 aft; main pump 3 aft operates to prevent tank-to-tank transfer and provides fuel if main pump 2 aft fails. 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

109

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.

405, 570

When fuel pump switches are off before engine start, low pressure lights are illuminated on the main pump switches and extinguished on the override, and CWT pump switches.

Operation With Fuel in Center Wing Tank

570

With 17,000 pounds or more fuel in the CWT, both CWT pump switches should be ON. 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.

109, 405

With 7,700 kgs or more fuel in the CWT, both CWT pump switches should be ON. 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.

570

With less than 17,000 pounds of fuel in the CWT, both CWT pump switches should be off. The FSMCs close crossfeed valves 2 and 3 when 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.

109, 405

With less than 7,700 kgs of fuel in the CWT, both CWT pump switches should be off. The FSMCs close crossfeed valves 2 and 3 when 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 out of the range of flaps 10 and flaps 20 settings. With the CWT pump switches ON, the CWT override/jettison pumps provide fuel to all engines. With the CWT pump switches OFF, the override/jettison pumps 2 provide fuel to engines 1 and 2 and override/jettison pumps 3 provide fuel to engines 3 and 4.

109

Stabilizer fuel transfer is enabled in flight when the flaps are retracted out of the range of flaps 10 and flaps 20 settings and the CWT fuel quantity is 36,470 kgs or less.

570

Note: When CWT quantity drops below approximately 5,000 pounds and total fuel consumption is greater than 15,000 pounds 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 2,000 pounds of fuel are consumed from each outboard main tank prior to display of the EICAS message FUEL LOW CTR.

109, 405

Note: When CWT quantity drops below approximately 2,300 kgs and total fuel consumption is greater than 6,800 kgs 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 LOW CTR.

The FSMCs activate override/jettison pumps 2 and 3 when low pressure is detected from either CWT override/jettison pump with the CWT pump switches ON or when both CWT pump switches are pushed off. Override/jettison pumps 2 provide fuel to engines 1 and 2 and override/jettison pumps 3 provide fuel to engines 3 and 4.

109, 570

CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3.

570

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to 40,200 pounds. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

109, 405

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to approximately 18,200 kgs. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

405

The electrical CWT scavenge pump is automatically activated to pump CWT fuel into main tank 2. The pump is deactivated 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. In the tank-to-engine configuration the main pumps provide fuel to their related engine until engine shutdown.

570

Note: On the ground, the FUEL TANK/ENG message can be displayed with as much as 1,000 pounds more fuel in an inboard main tank than the adjacent outboard main tank.

405
(SB changes 109 ; FQIS BLK B installed)

Note: On the ground, the FUEL TANK/ENG message can be displayed with as much as 500 kgs 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 out of the range of flaps 10 and flaps 20 settings. 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.

405
(SB changes 109 ; FQIS BLK B installed)

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.

570

Note: On the ground, the FUEL TANK/ENG message can display with as much as 1,000 pounds 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.

109

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.

405, 570

Pushing either fuel jettison nozzle valve switch ON activates all override/jettison pumps in the tanks containing fuel (pump switches must be ON) and opens the required 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.

109, 405

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.

570

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to 40,000 pounds. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

109, 405

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.

570

When either main tank 2 or 3 fuel quantity decreases to 20,000 pounds during jettison, both main tank 1 and 4 transfer valves open.

109

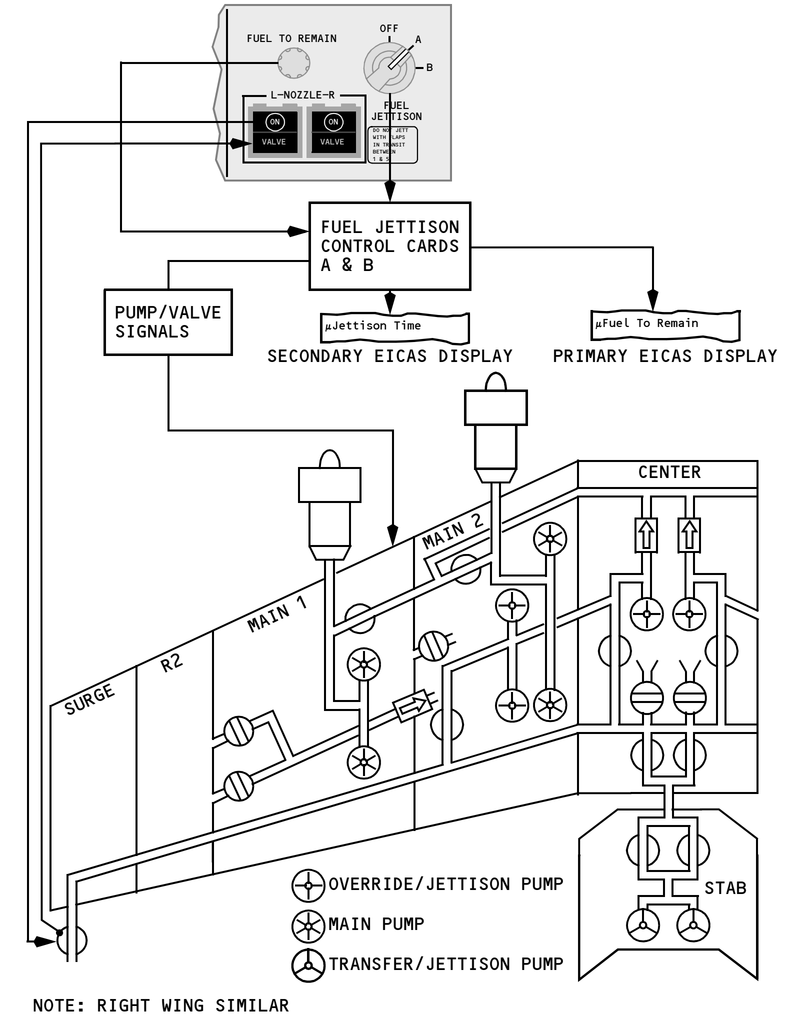
Jettison terminates when total fuel quantity decreases to the fuel to remain quantity. The fuel to remain quantity indication changes color from magenta to white and flashes for five seconds. The jettison control system deactivates all operating override/jettison and transfer/jettison pumps. The related FUEL OVRD pump EICAS messages display until the Fuel Jettison selector is OFF.

405, 570

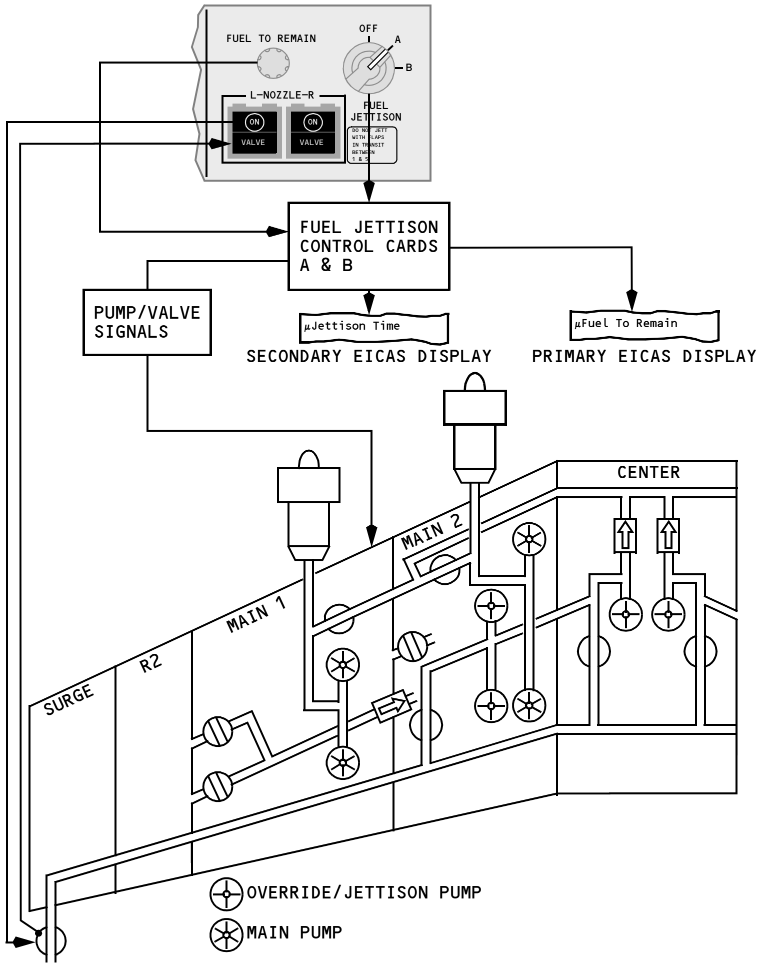
Jettison terminates when total fuel quantity decreases to the fuel to remain quantity. The fuel to remain quantity indication changes color from magenta to white and flashes for five seconds. The jettison control system deactivates all operating override/jettison pumps. The related FUEL OVRD pump EICAS messages display until the Fuel Jettison selector is OFF.

Fuel Jettison Schematic

109



405, 570



NOTE: RIGHT WING SIMILAR

Fuel System EICAS Messages

The following EICAS messages can be displayed.

109, 405

Message	Level	Aural	Message Logic
FUEL IMBAL 1-4	Advisory		Fuel difference of 1,360 kgs between main tanks 1 and 4. Message no longer displayed when difference less than 450 kgs.
FUEL IMBAL 2-3	Advisory		Fuel difference of 2,720 kgs between main tanks 2 and 3. Message no longer displayed when difference less than 450 kgs.
FUEL IMBALANCE	Advisory		Fuel difference of 2,720 kgs 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 kgs.

570

Message	Level	Aural	Message Logic
FUEL IMBAL 1-4	Advisory		Fuel difference of 3,000 pounds between main tanks 1 and 4. Message no longer displayed when difference less than 1,000 pounds.
FUEL IMBAL 2-3	Advisory		Fuel difference of 6,000 pounds between main tanks 2 and 3. Message no longer displayed when difference less than 1,000 pounds.
FUEL IMBALANCE	Advisory		Fuel difference of 6,000 pounds 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 1,000 pounds.

Message	Level	Aural	Message Logic
>FUEL JETT A, B	Advisory		Jettison control system has failed. Message inhibited when FUEL JETT SYS message displayed.
FUEL JETT SYS	Caution	Beeper	Fuel total less than fuel to remain and one fuel nozzle valve open or both jettison cards fail.
FUEL OVRD 2, 3 AFT	Advisory		Low pump pressure detected when pump activated. Pump activates by system logic with Override Pump switch ON. Message displays with Override Pump switch OFF before tank-to-engine configuration.
FUEL OVRD 2, 3 FWD	Advisory		Low pump pressure detected when pump activated. Pump activates by system logic with Override Pump switch ON. Message displays with Override Pump switch OFF before tank-to-engine configuration.

570

Message	Level	Aural	Message Logic
>FUEL LOW CTR L, R	Advisory		Center wing tank quantity less than 17,000 pounds before start with pump switches ON, or center wing tank quantity approximately 7,000 pounds in climb with pump switches ON, or center wing tank quantity approximately 3,000 pounds in cruise with pump switches ON. Message inhibited during jettison.
>FUEL OVD CTR L, R	Advisory		Center wing tank quantity 17,000 pounds or more on the ground with Center Wing Tank Pump switch OFF, or center wing tank quantity 4,000 pounds or more in cruise with Center Wing Tank Pump switch OFF,.

109, 405

Message	Level	Aural	Message Logic
>FUEL LOW CTR L, R	Advisory		Center wing tank quantity less than 7,700 kgs before start with pump switches ON, or center wing tank quantity approximately 3,200 kgs in climb with pump switches ON, or center wing tank quantity approximately 1,300 kgs in cruise with pump switches ON. Message inhibited during jettison.
>FUEL OVD CTR L, R	Advisory		Center wing tank quantity 7,700 kgs or more on the ground with Center Wing Tank Pump switch OFF, or center wing tank quantity 1,800 kgs or more in cruise with Center Wing Tank Pump switch OFF,.

109

Message	Level	Aural	Message Logic
>FUEL PMP STB L	Advisory		Left Stabilizer Tank Pump switch ON on the ground, or stabilizer tank quantity 500 kgs or more in cruise with Left Stabilizer Tank Pump switch OFF. Inhibited when FUEL STAB XFR message displayed.
>FUEL PMP STB R	Advisory		Right Stabilizer Tank Pump switch ON on the ground, or stabilizer tank quantity 500 kgs or more in cruise with Right Stabilizer Tank Pump switch OFF. Inhibited when FUEL STAB XFR message displayed.

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Message	Level	Aural	Message Logic
FUEL PRES STB L, R	Advisory		Low pump pressure detected when pump activated. Pump activates by system logic with Stabilizer Tank Pump switch ON.

405

Message	Level	Aural	Message Logic
FUEL PRESS CTR L, R	Caution	Beeper	FUEL LOW CTR L, R message displayed for 60 seconds, or low pump pressure detected when pump switch ON.

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Message	Level	Aural	Message Logic
FUEL PRESS CTR L, R	Caution	Beeper	FUEL LOW CTR L, R message displayed for 60 seconds, or low pump pressure detected when pump switch ON. Message inhibited during jettison until fuel in Center Wing Tank is less than 2,000 pounds.

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Message	Level	Aural	Message Logic
FUEL PRESS CTR L, R	Caution	Beeper	FUEL LOW CTR L, R message displayed for 60 seconds, or low pump pressure detected when pump switch ON. Message inhibited during jettison until fuel in Center Wing Tank is less than 900 kgs.

Message	Level	Aural	Message Logic
FUEL PRESS ENG 1, 2, 3, 4	Caution	Beeper	Engine on suction feed. Suction feed occurs if both main pumps in a tank fail with the respective crossfeed valve closed.
FUEL PUMP 1, 2, 3, 4 AFT	Advisory		Low pump pressure detected. Message inhibited when FUEL PRESS ENG message displayed.
FUEL PUMP 1, 2, 3, 4 FWD	Advisory		Low pump pressure detected. Message inhibited when FUEL PRESS ENG message displayed.

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Message	Level	Aural	Message Logic
FUEL QTY LOW	Caution	Beeper	Fuel quantity 2,000 pounds or less in one or more main tanks.

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Message	Level	Aural	Message Logic
FUEL QTY LOW	Caution	Beeper	Fuel quantity 900 kgs or less in one or more main tanks.

Message	Level	Aural	Message Logic
FUEL RES XFR 2, 3	Advisory		Reserve transfer valves not in commanded position.

109

Message	Level	Aural	Message Logic
FUEL STAB XFR	Caution	Beeper	Horizontal stabilizer fuel fails to transfer.

(SB changes 109 ; before SB, FQIS BLK B not installed)

Message	Level	Aural	Message Logic
>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. Inhibited during jettison.

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Message	Level	Aural	Message Logic
>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 1,000 pounds and tank 3 less than or equal to tank 4 plus 1,000 pounds and crossfeed valve 1 or 4 open. Inhibited during jettison.

405
(SB changes 109 ; FQIS BLK B installed)

Message	Level	Aural	Message Logic
>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 kgs and tank 3 less than or equal to tank 4 plus 500 kgs and crossfeed valve 1 or 4 open. Inhibited during jettison.

Message	Level	Aural	Message Logic
FUEL TEMP LOW	Advisory		Fuel temperature -37°C or less.
FUEL TEMP SYS	Advisory		Fuel temperature sensing inoperative.

Message	Level	Aural	Message Logic
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. Message inhibited when JETT NOZ ON message displayed.
>JETT NOZZLE L, R	Advisory		Jettison nozzle valve position disagrees with commanded position.

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Message	Level	Aural	Message Logic
>SCAV PUMP ON	Advisory		Center wing tank scavenge pump operating while airplane on the ground.

Message	Level	Aural	Message Logic
>X FEED CONFIG	Advisory		One or more fuel crossfeed valves incorrectly configured. Message displayed when 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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Hydraulics — Chapter 13
Table of Contents — Section 0

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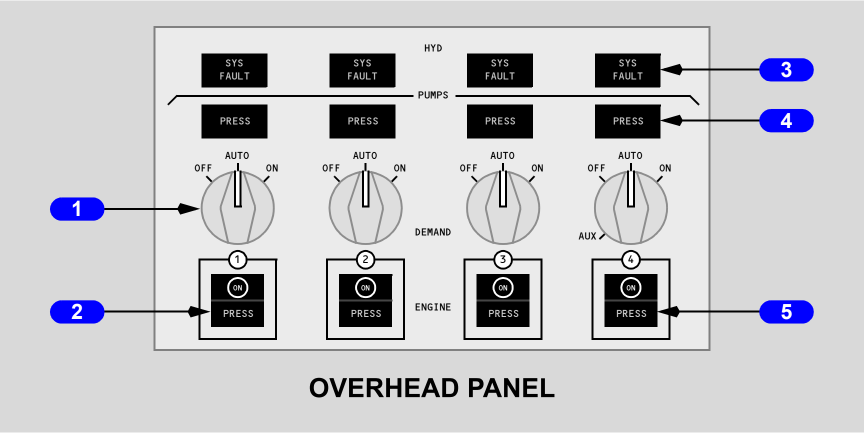
Hydraulics — Chapter 13
Controls and Indicators — Section 10

Hydraulic 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

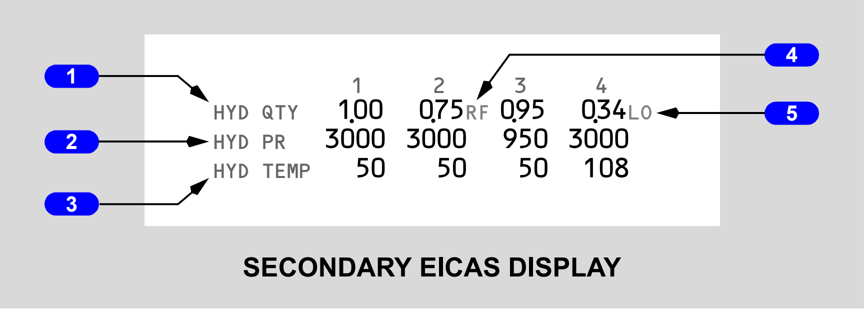
5 ENGINE Hydraulic Pump Low PRESS Light

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



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.

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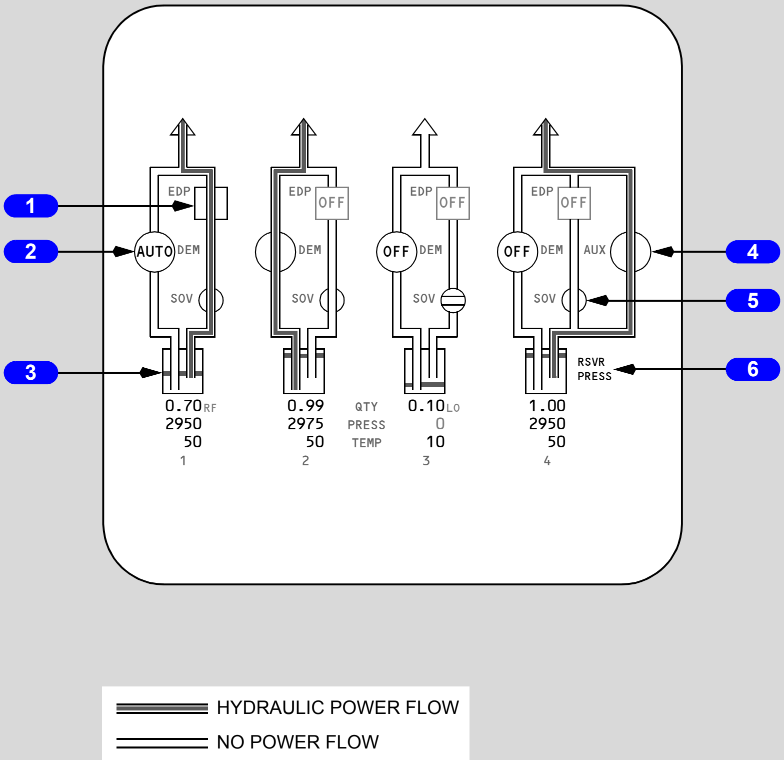
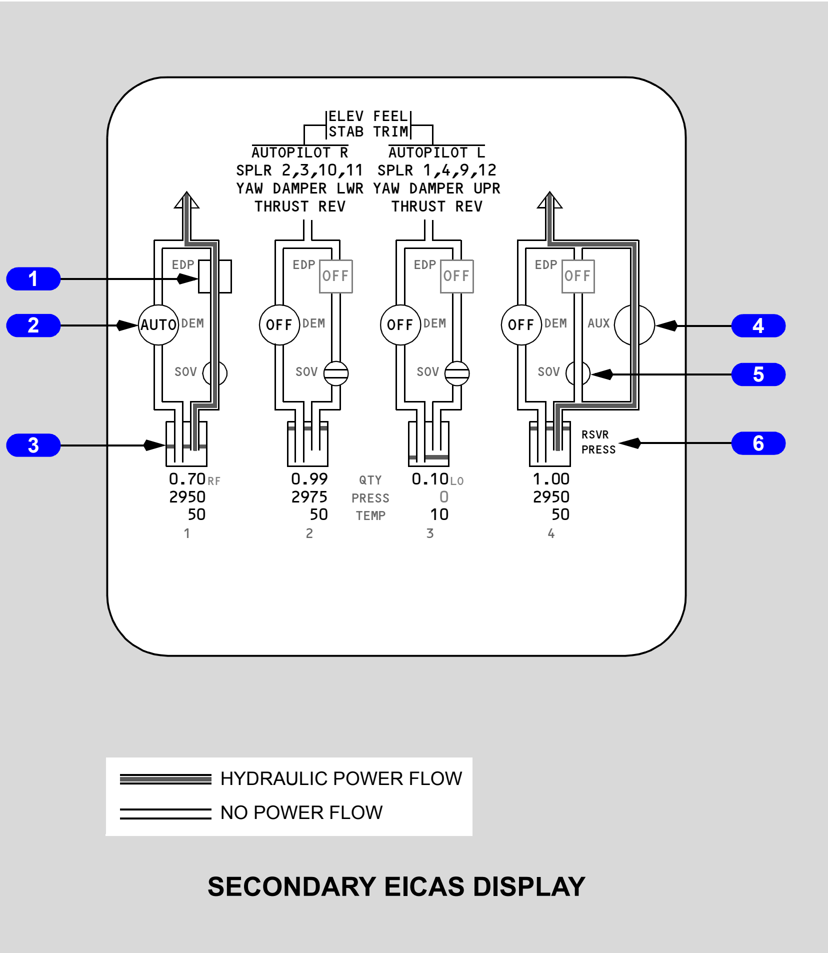


SECONDARY EICAS DISPLAY

405



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.

Hydraulics — Chapter 13
System Description — Section 20

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.

A single Hydraulic Quantity Interface Module (HYQUIM) processes quantity inputs from each reservoir transmitter. Should the HYQUIM fail because of an overvoltage condition, the following false indications may be experienced for all four hydraulic systems:

- hydraulic SYS FAULT lights flashing on and off
- >HYD QTY LOW X advisory messages appearing and disappearing
- EICAS hydraulic quantity indications decreasing and increasing

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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 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

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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.

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Systems 1 and 4 power the trailing edge flaps, landing gear, normal brakes (SYS 4), alternate brakes (SYS 1), steering, and their related thrust reversers. Systems 1 and 4 also provide redundant power to the primary flight controls.

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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.

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Systems 2 and 3 power the primary flight controls, stabilizer trim, elevator feel and their related thrust reversers. 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

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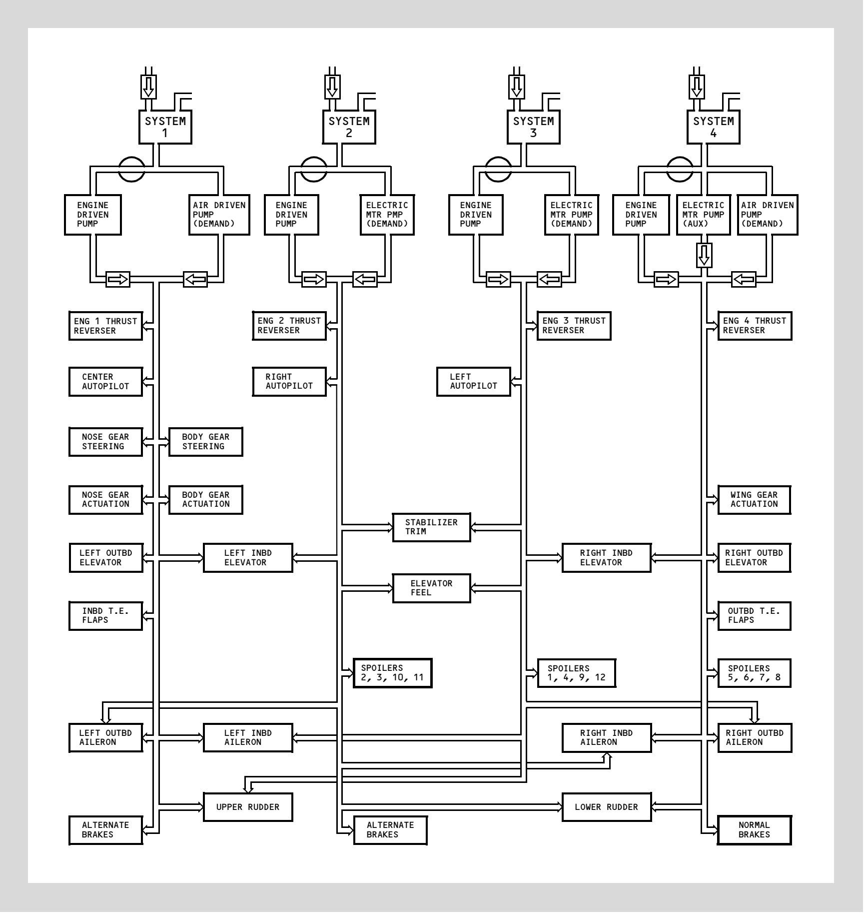

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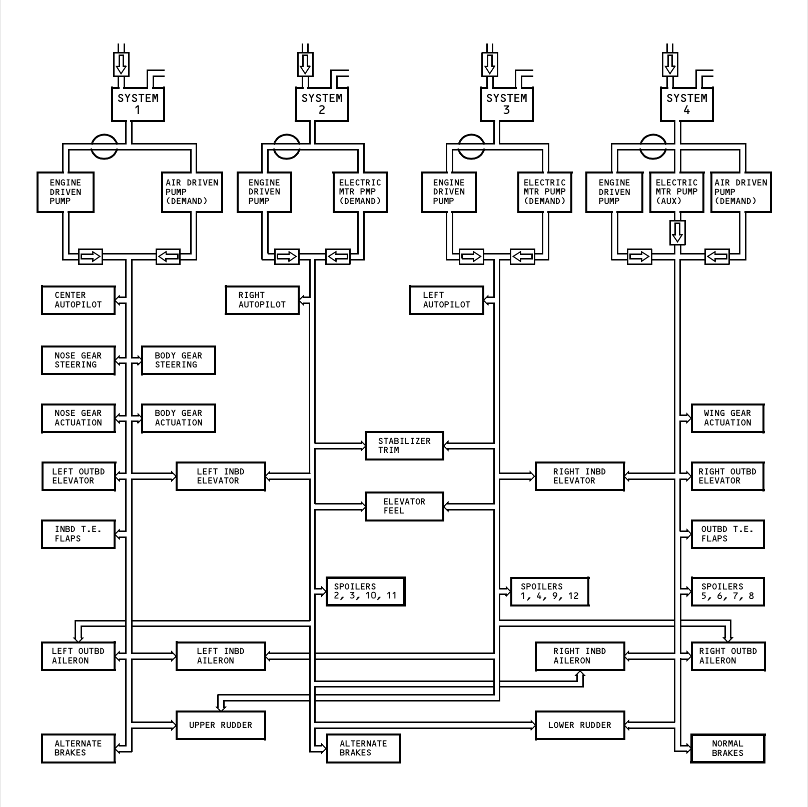
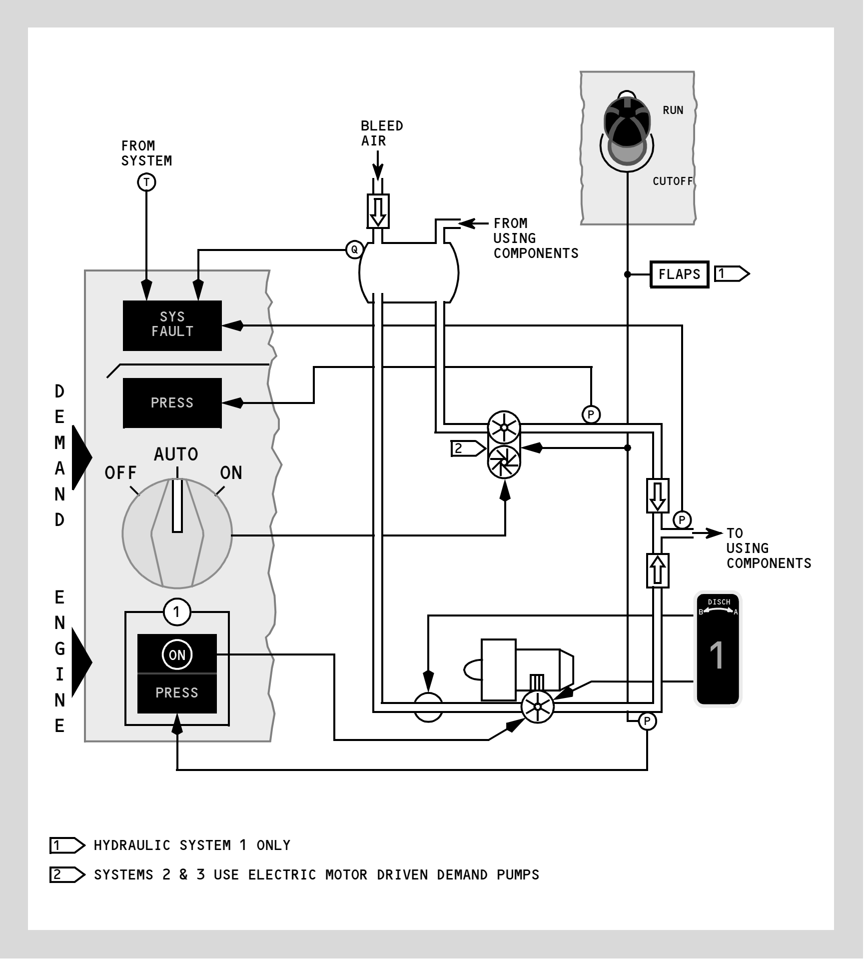
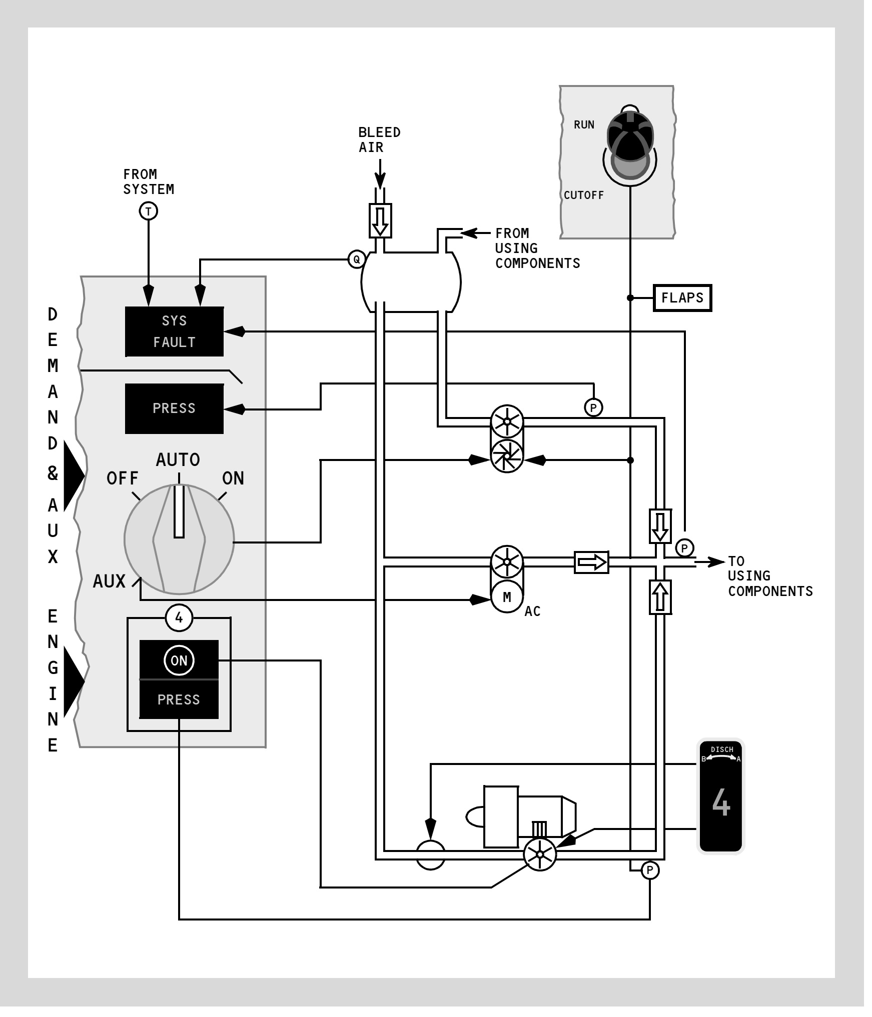

SYSTEM 1
SYSTEM 2
SYSTEM 3
SYSTEM 4
ENGINE DRIVEN PUMP
AIR DRIVEN PUMP (DEMAND)
ENGINE DRIVEN PUMP
ELECTRIC MTR PMP (DEMAND)
ENGINE DRIVEN PUMP
ELECTRIC MTR PUMP (DEMAND)
ENGINE DRIVEN PUMP
ELECTRIC MTR PUMP (AUX)
AIR DRIVEN PUMP (DEMAND)
CENTER AUTOPILOT
RIGHT AUTOPILOT
LEFT AUTOPILOT
NOSE GEAR STEERING
BODY GEAR STEERING
NOSE GEAR ACTUATION
BODY GEAR ACTUATION
WING GEAR ACTUATION
STABILIZER TRIM
LEFT OUTBD ELEVATOR
LEFT INBD ELEVATOR
RIGHT INBD ELEVATOR
RIGHT OUTBD ELEVATOR
ELEVATOR FEEL
INBD T.E. FLAPS
OUTBD T.E. FLAPS
SPOILERS 2, 3, 10, 11
SPOILERS 1, 4, 9, 12
SPOILERS 5, 6, 7, 8
LEFT OUTBD AILERON
LEFT INBD AILERON
RIGHT INBD AILERON
RIGHT OUTBD AILERON
UPPER RUDDER
LOWER RUDDER
ALTERNATE BRAKES
ALTERNATE BRAKES
NORMAL BRAKES

Hydraulic Systems 1, 2, and 3 Diagram



Hydraulic Systems Diagram 4



Hydraulics EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Message Logic
HYD CONTROL 1, 4	Advisory		Hydraulic control system inoperative. Demand pump automatic switching and/or hydraulic systems may not be available.
HYD OVHT SYS 1, 2, 3, 4	Advisory		Excessive hydraulic system temperature.
HYD PRESS DEM 1, 2, 3, 4	Advisory		Demand pump output pressure low. Occurs when 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.
HYD PRESS ENG 1, 2, 3, 4	Advisory		Engine 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	Loss of hydraulic system pressure.
>HYD QTY LOW 1, 2, 3, 4	Advisory		Hydraulic quantity low.

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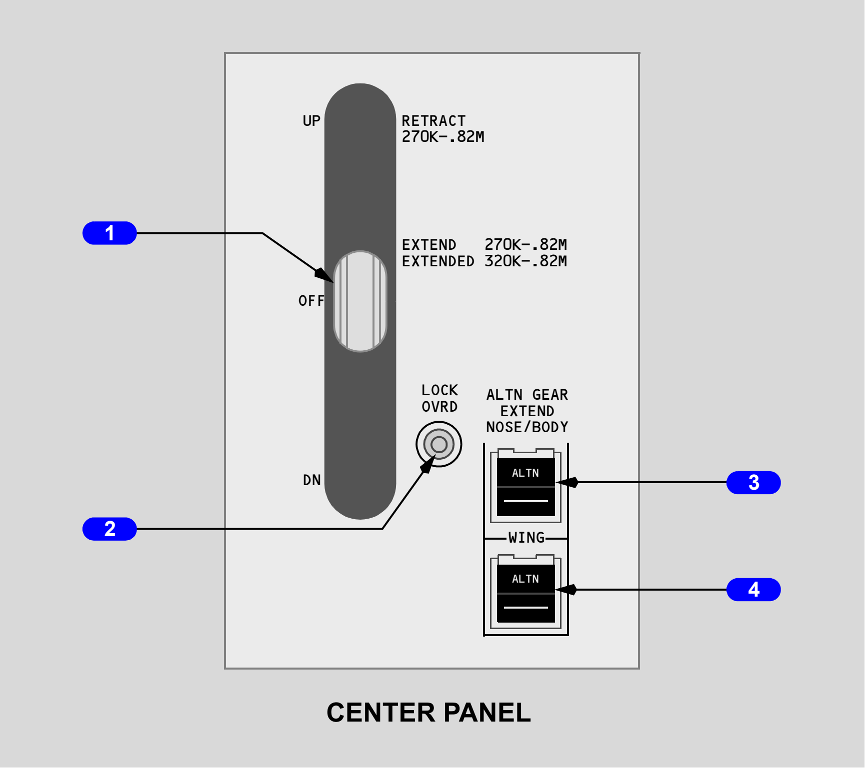
Landing Gear — Chapter 14
Table of Contents — Section 0

Landing Gear 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.

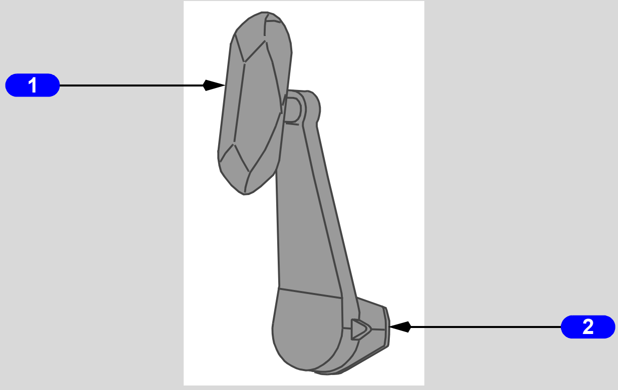
3 NOSE/BODY Alternate (ALTN) GEAR EXTEND switch

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 -

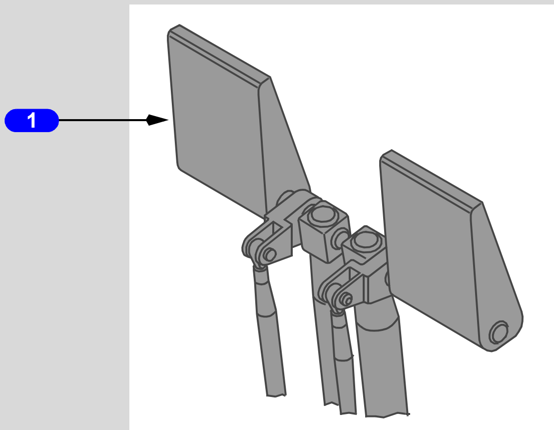
- turns nose wheels up to 70 degrees in either direction
- overrides rudder pedal steering

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

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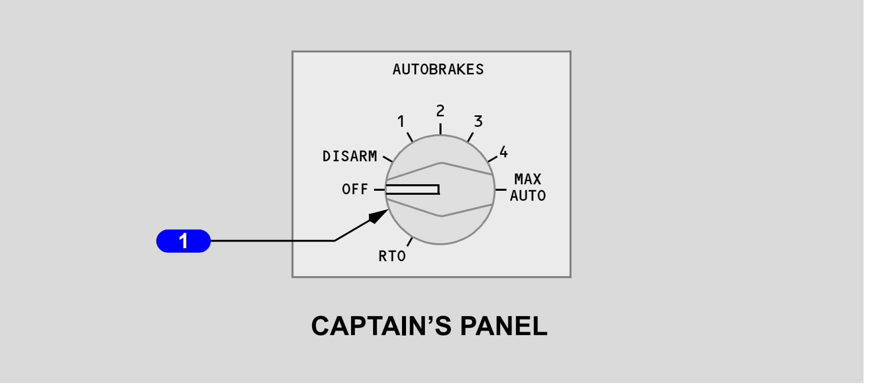
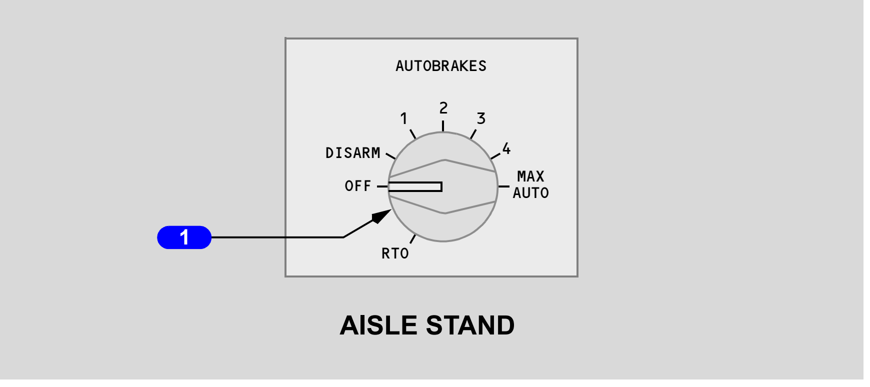


109, 405



1 AUTOBRAKES Selector

OFF - deactivates and resets system.

DISARM -

- disengages autobrake
- releases brake pressure

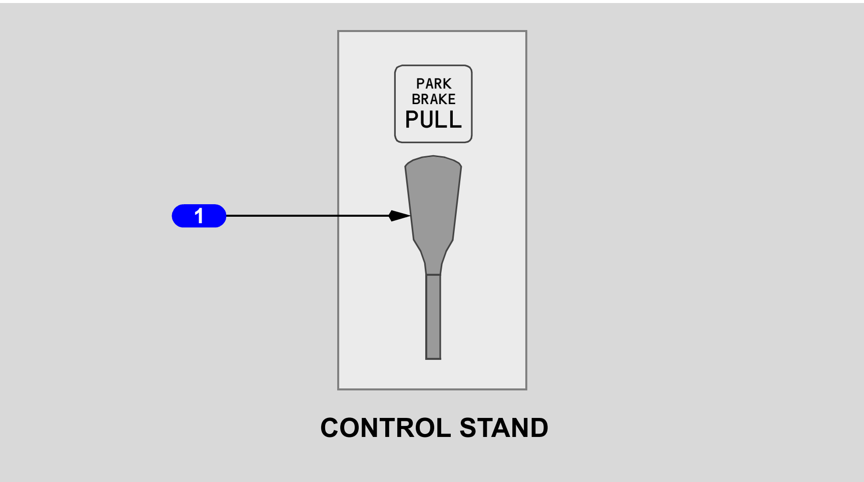
1, 2, 3, 4, MAX AUTO -

- increasing autobrake 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



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

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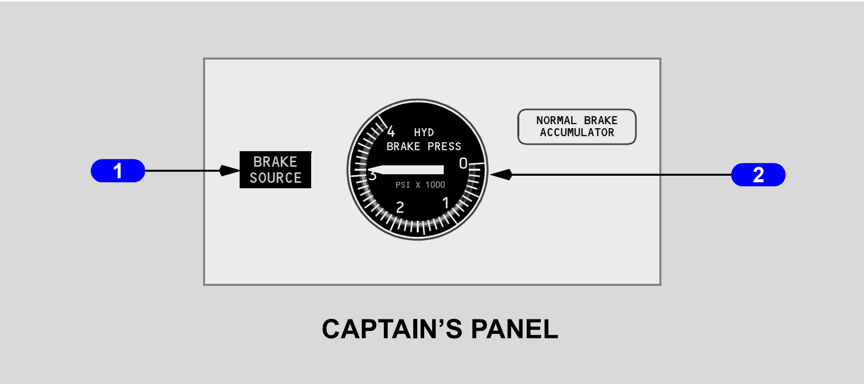

1 **BRAKE SOURCE Light**

Illuminated (amber) - active brake hydraulic sources (hydraulic systems 4, 1, and 2) have low pressure.

2 **BRAKE ACCUMULATOR PRESSURE Indicator**

Indicates brake accumulator pressure.

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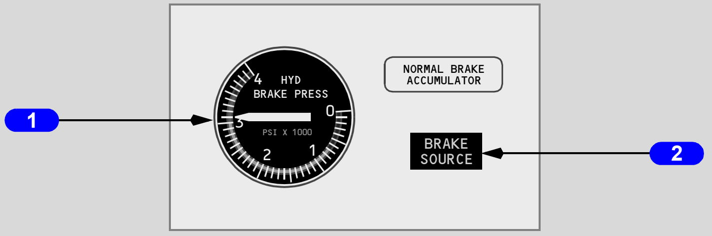


CAPTAIN'S PANEL

1 **BRAKE ACCUMULATOR PRESSURE Indicator**

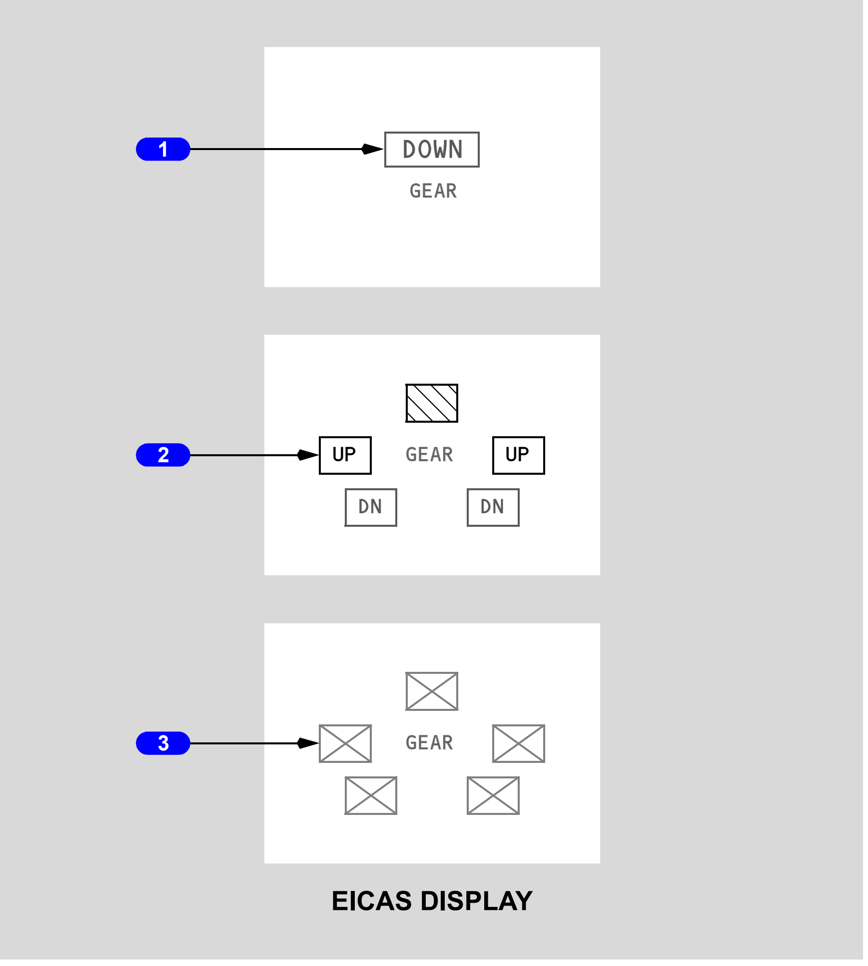
Indicates brake accumulator pressure.

2 **BRAKE SOURCE Light**

Illuminated (amber) - active brake hydraulic sources (hydraulic systems 4, 1, and 2) have low pressure.

Landing Gear System Indications

Landing Gear Position Indications



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.

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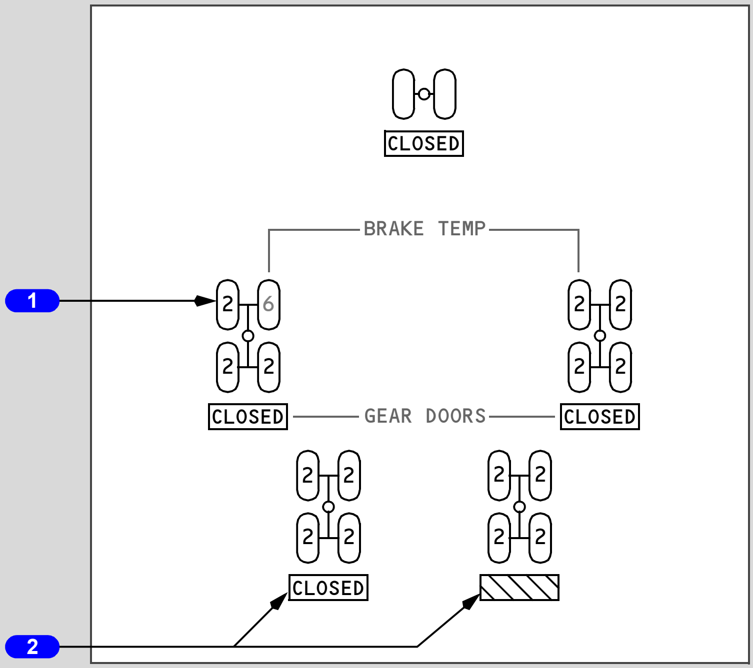


SECONDARY EICAS DISPLAY

1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0 to 9
- white - normal range
- amber - high range

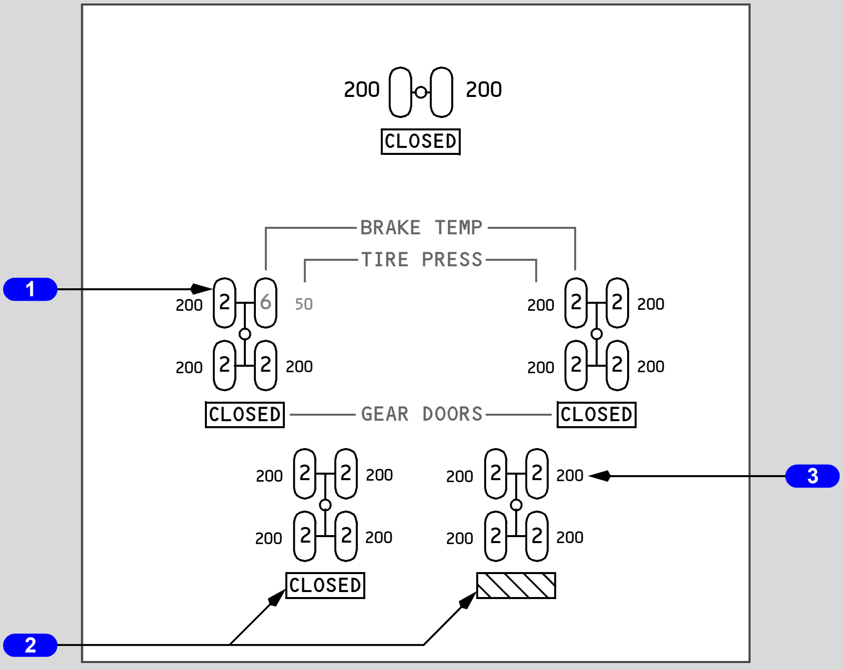
2 Gear Door Status

Crosshatched - door not closed.

CLOSED (white) - door closed.

Empty box(es) (white) - related landing gear door position indicators inoperative.

109



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 Tire Pressure Indication

Displays individual tire pressures:

- white - normal range
- amber - abnormal high or low range

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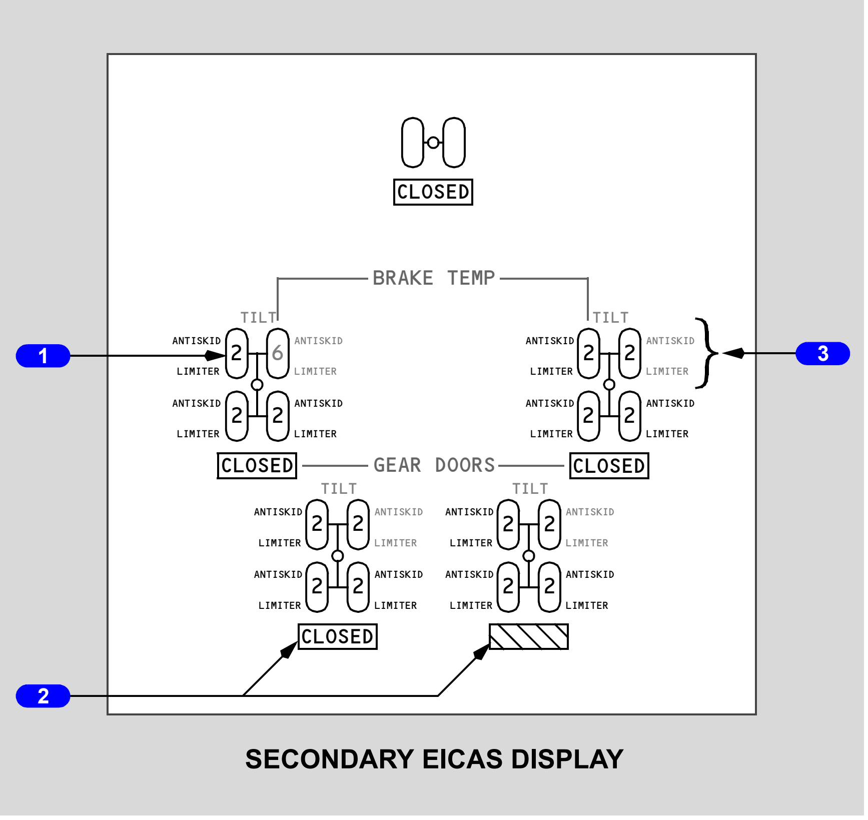


SECONDARY EICAS DISPLAY

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

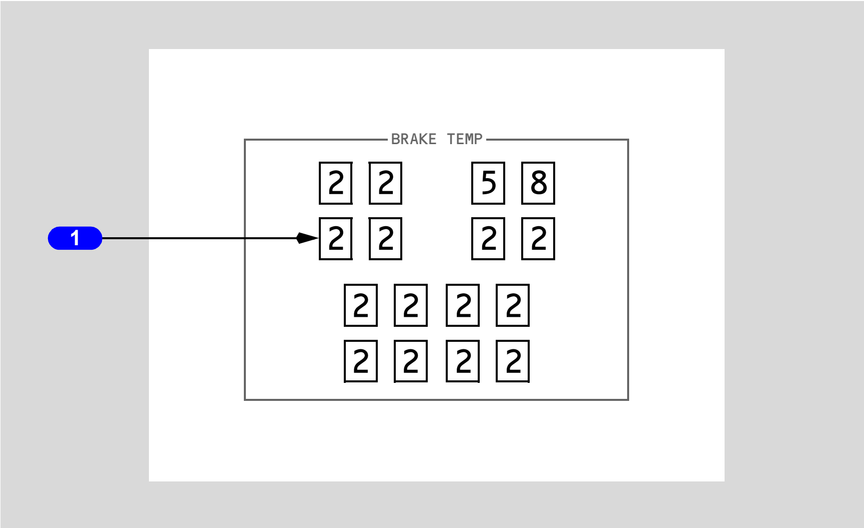
TILT (amber) - main gear truck not in full tilt positions.

ANTISKID (white or amber) - loss of antiskid protection to related wheels.

LIMITER (white or amber) - torque limiting control fault detected.

Compacted Brake Temperature Indications

Compacted brake temperature indications display if only one display is available for EICAS.



1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0 to 9
- white - normal range
- amber - high range

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 hydraulic system 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.

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A brake temperature monitor system and tire pressure indication system displays each brake temperature and tire pressure on the GEAR synoptic display.

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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.

A combination of main gear tilt sensors indicate the gear are tilted (air mode) or not tilted (ground mode) to provide an air/ground signal 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 lever normally controls the landing gear. On the ground, an automatic lever lock prevents movement of the lever from OFF to UP. 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.

All four main gear hydraulically tilt as the airplane lifts off the runway. During landing, ground load brings the gear to a level position.

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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 wing gear has one hydraulically actuated and one mechanically actuated gear door. Each body gear has one hydraulically actuated and two mechanically actuated gear doors. 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 doors open, automatic braking occurs, and the landing gear begin to retract. 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 mechanically 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.

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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 are hydraulically powered 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 electrically 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 hydraulically 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 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 lateral wheel pairs (forward 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.

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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.

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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 Autobrakes selector
- autobrake fault
- normal antiskid system fault
- loss of normal brake hydraulic pressure

When the autobrake system disarms after landing, the Autobrakes 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 Autobrakes 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 accumulator 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 fully depressing both brake pedals, pulling the Parking Brake lever up, then releasing the pedals. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

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.

Tire Pressure Indication

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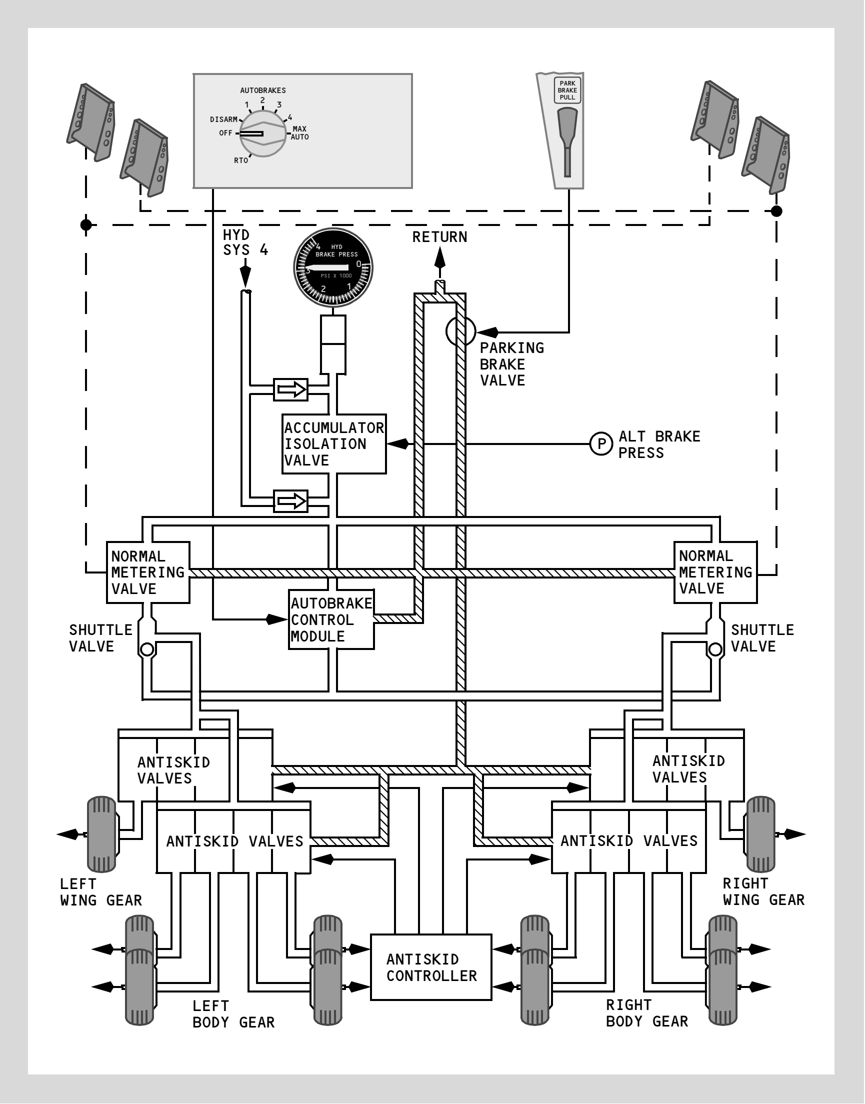
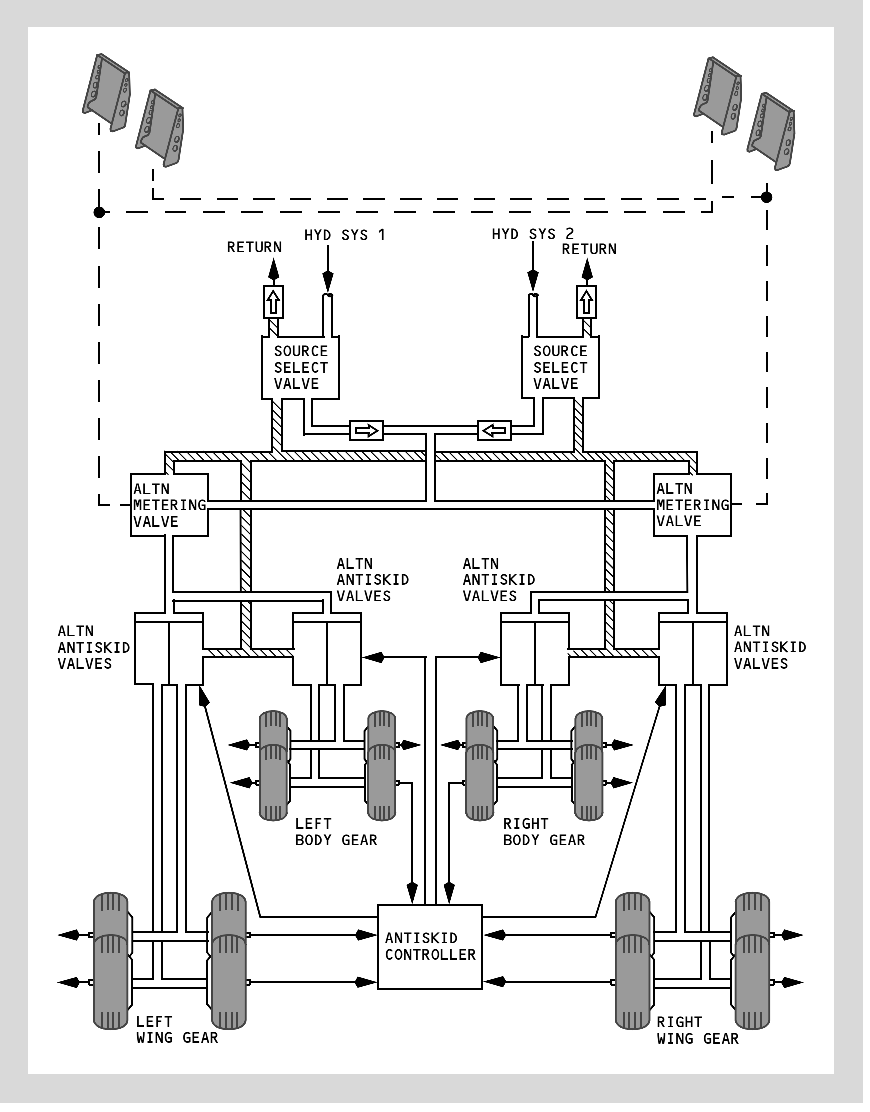
Tire pressures, from 0 to 400 PSI, display beside the individual wheel symbols on the GEAR synoptic display.

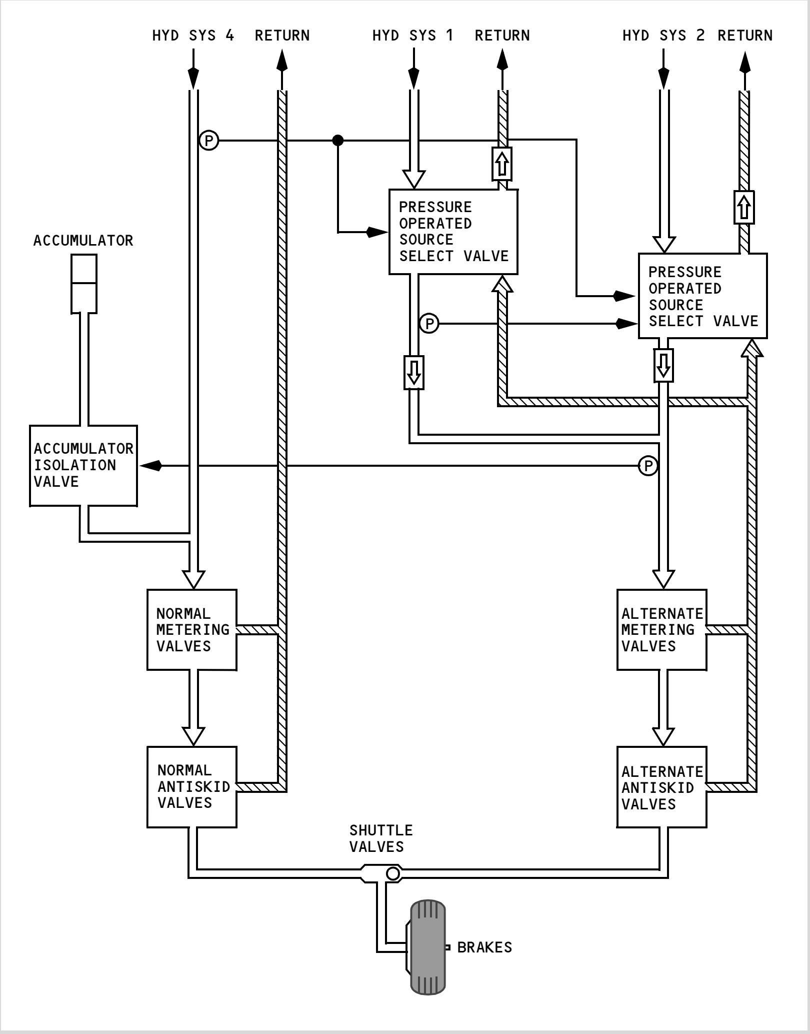
Normal Brake System Diagram



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	Message Logic
AIR/GND SYSTEM	Advisory		Air/ground sensing system failed to air position.
ANTISKID	Advisory		Fault detected in antiskid system. Fault in active antiskid system, either normal or alternate, results in loss of antiskid protection to one or more wheels.
ANTISKID OFF	Advisory		Antiskid power off on all wheels, or parking brake lever released and parking brake valve not fully open, or brake system control unit power loss occurs.
AUTOBRAKES	Advisory		Autobrake disarmed or inoperative, or autobrake armed with Autobrakes selector OFF, or RTO initiated above 85 knots and autobrake has not been applied.
>BODY GEAR STRG	Advisory		Body gear steering unlocked when commanded locked, or pressurized when not commanded.
BRAKE LIMITER	Advisory		Brake torque limiter failure on more than one wheel per truck, or parking brake lever released and parking brake valve not fully open, or brake unit control system power loss.
>BRAKE SOURCE	Caution	Beeper	Brake system pressures from hydraulic systems 1, 2, and 4 are low.
BRAKE TEMP	Advisory		Temperature of one or more brakes excessive. Brake temperature equal to or greater than 5 units.

Message	Level	Aural	Message Logic
GEAR DISAGREE	Caution	Beeper	Gear position disagrees with Landing Gear lever position after normal transit time.
GEAR DOOR	Advisory		One or more gear doors not closed after normal gear transit time. Inhibited if alternate gear extension selected.
GEAR TILT	Caution	Beeper	Main gear trucks not in full tilt position.

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Message	Level	Aural	Message Logic
>TIRE PRESSURE	Advisory		One or more tire pressures out of limits.

EICAS Memo Messages

Message	Level	Aural	Message Logic
AUTOBRAKES 1, 2, 3, 4	Memo		Autobrake level selected.
AUTOBRAKES MAX	Memo		Autobrake MAX selected.
AUTOBRAKES RTO	Memo		Autobrake RTO selected.
PARK BRAKE SET	Memo		Parking brake valve closed.

Warning Systems — Chapter 15
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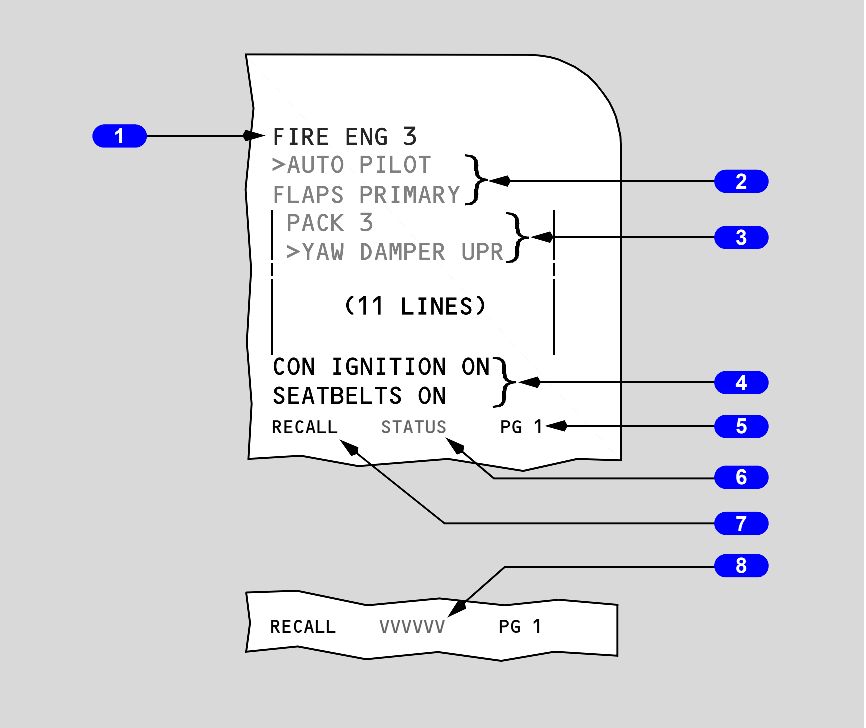
Engine Indication and Crew Alerting System (EICAS)

EICAS Messages



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) -

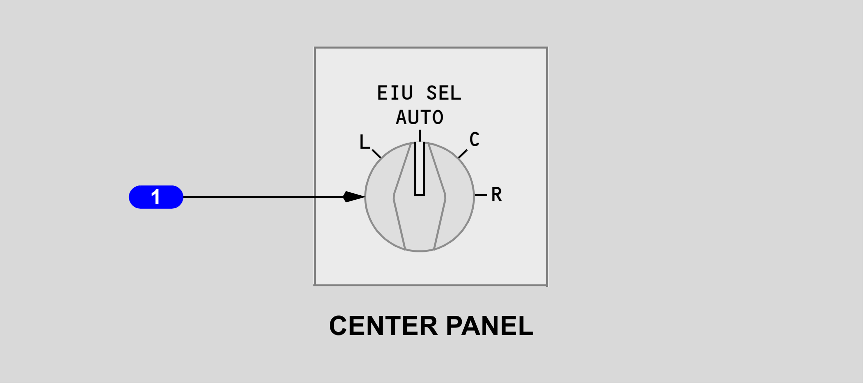
- when RCL switch pushed
- remains displayed for one second after switch released

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



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

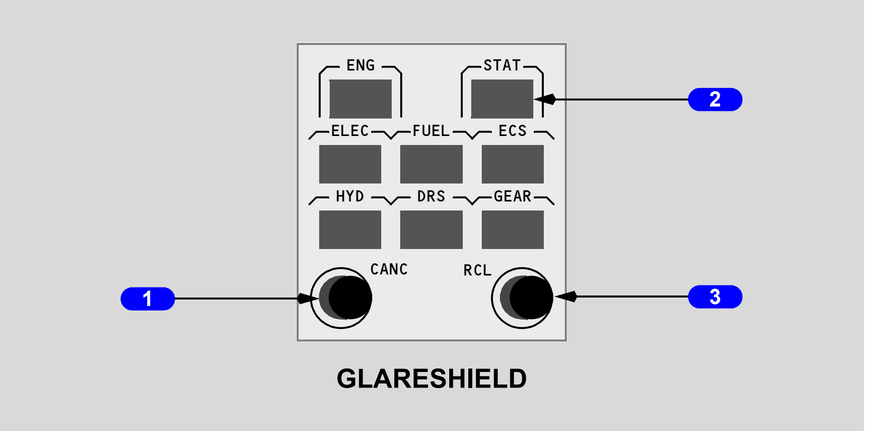
C -

- 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



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 -

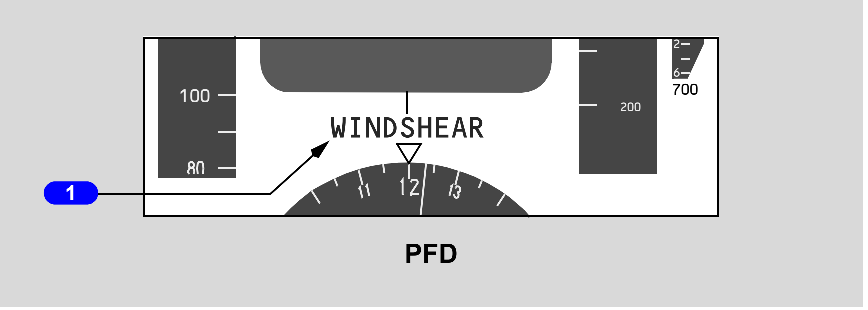
- display next page of status messages when additional pages exist
- secondary EICAS blanks when last status message page displayed

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 and PWS Alerts on PFD
405, 570



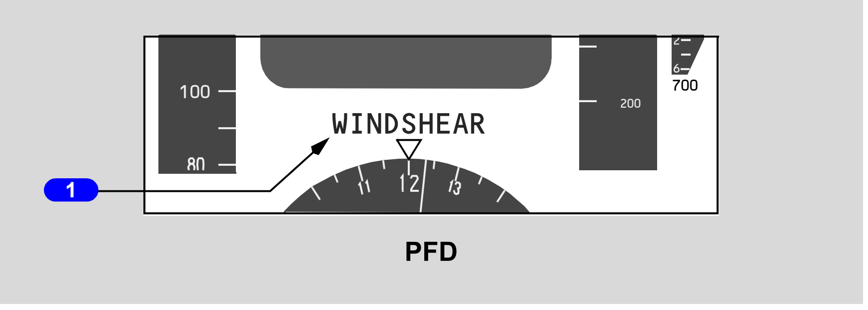
1 Alert on PFD

PULL UP (red) - PULL UP alert is occurring.

WINDSHEAR (red) -

- predictive WINDSHEAR AHEAD alert or immediate WINDSHEAR alert is occurring
- all other GPWS alerts inhibited

GPWS Alerts on PFD
109



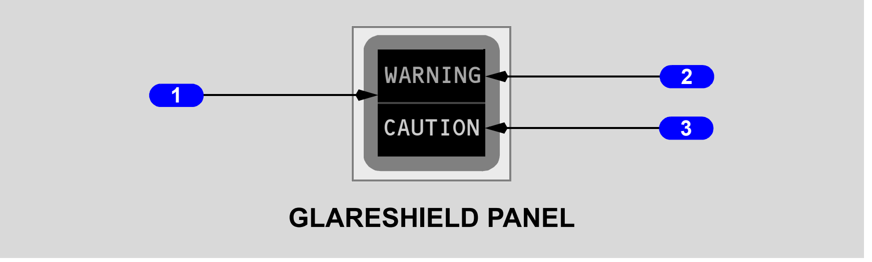
1 Alert on PFD

PULL UP (red) - GPWS PULL UP alert is occurring.

WINDSHEAR (red) -

- WINDSHEAR alert is occurring
- all other GPWS alerts inhibited

Master WARNING/CAUTION Reset Switches and Lights



1 Master WARNING/CAUTION Reset Switch

Push -

- extinguishes master WARNING lights
- extinguishes master CAUTION lights
- silences the aural 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

405, 570

  - OVERSPEED

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(SB changes 109 ; installs PILOT RESPONSE)

  - PILOT RESPONSE

2 Master WARNING Light

Illuminated (red) -

- new EICAS warning message displayed, or
- PULL UP or WINDSHEAR alert displayed on PFD

3 Master CAUTION Light

Illuminated (amber) - new EICAS caution message displayed

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls (Transponder Panel)

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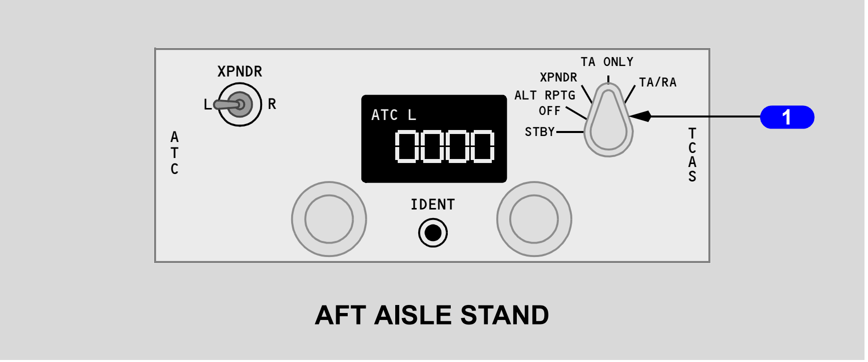


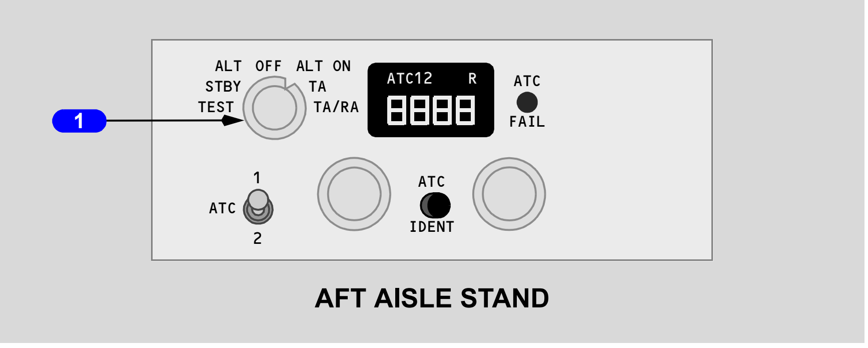
1 Transponder Mode Selector

TA ONLY (traffic advisory) -

- transponder and TCAS TA modes enabled
- all aircraft that would have been predicted as a RA are predicted as a TA

TA/RA (traffic advisory/resolution advisory) - transponder and TCAS TA and RA modes enabled.

109, 405



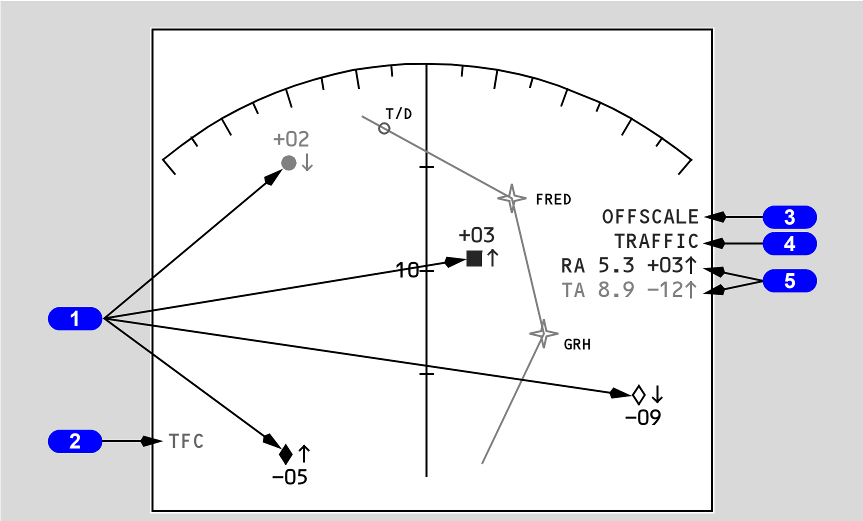
1 Transponder Mode Selector

Traffic Advisory (TA) -

- transponder and TCAS TA modes enabled
- all aircraft that would have been predicted as a RA are predicted as a TA

Traffic Advisory/Resolution Advisory (TA/RA) - transponder and TCAS TA and RA modes enabled.

TCAS Traffic Displays



ND

1 Traffic Display

Indicates relative position of traffic.

- filled red square indicates a resolution advisory (RA)
- filled amber circle indicates a traffic advisory (TA)
- filled white diamond indicates proximate traffic
- unfilled white diamond indicates other traffic
- number is relative 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 displayed on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

Displayed automatically when:

- EFIS control panel fails, 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

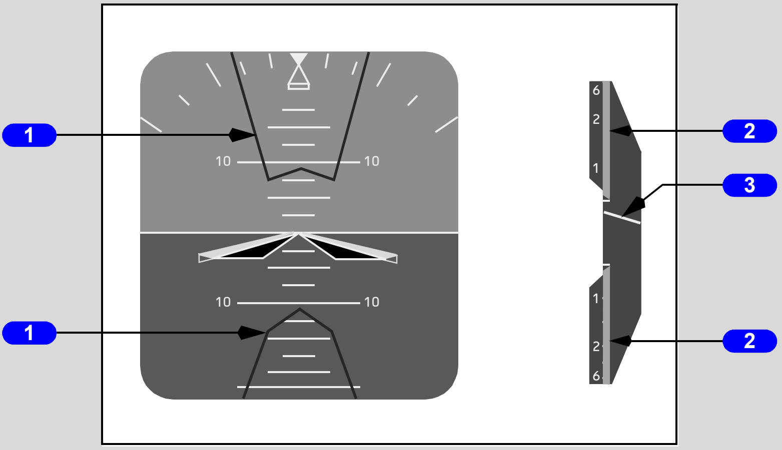
RA (red) - data tag displayed for no-bearing RA.

TA (amber) - data tag displayed for no-bearing TA.

Data tag contains distance, altitude, and vertical motion arrow.

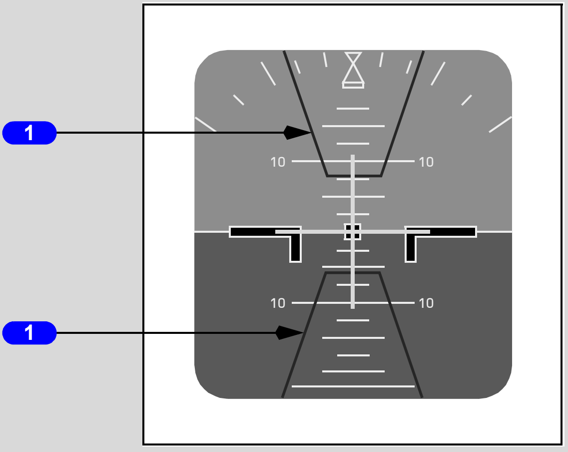
TCAS PFD Vertical Guidance

570



PFD

109, 405



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.

2 **RA Vertical Speed Region to Avoid Traffic (red)**

570

To ensure vertical separation, vertical speed must be outside the red RA vertical speed region to avoid.

3 **Vertical Speed Pointer**

570

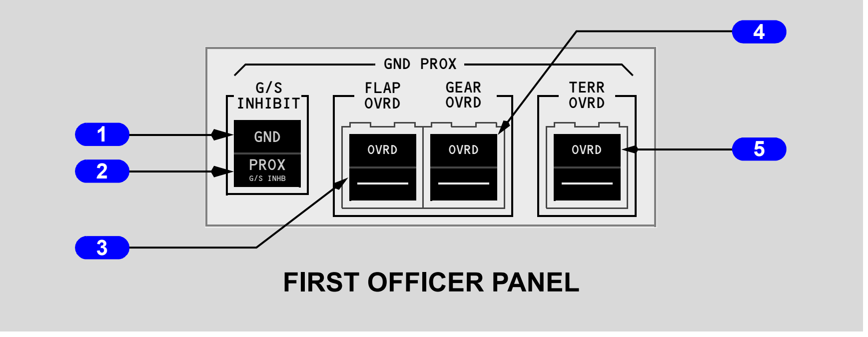
Red - present vertical speed does not ensure traffic is avoided.

White - present vertical speed ensures traffic is avoided.

Ground Proximity Warning System (GPWS) Controls

Ground Proximity Panel

405, 570



1 **Ground Proximity (GND PROX) Glideslope (G/S) Inhibit Switch**

Push - inhibits GLIDESLOPE alert when pushed below 1,000 feet radio altitude.

2 Ground Proximity (GND PROX) Light

Illuminated (amber) -

- GPWS GLIDE SLOPE, SINKRATE, TERRAIN, TOO LOW FLAPS, TOO LOW GEAR, or TOO LOW TERRAIN immediate alert is occurring
- 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
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 250 knots for more than 60 seconds

4 Ground Proximity (GND PROX) Configuration (CONFIG) Gear (GR) Override (OVRD) Switch

Push (OVRD illuminated) -

- inhibits TOO LOW GEAR alert
- inhibits CONFIG GEAR alert
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 290 knots for more than 60 seconds

5 Ground Proximity (GND PROX) Terrain (TERR) Override (OVRD) Switch

Push (OVRD illuminated) - inhibits look-ahead terrain alerts and terrain display.

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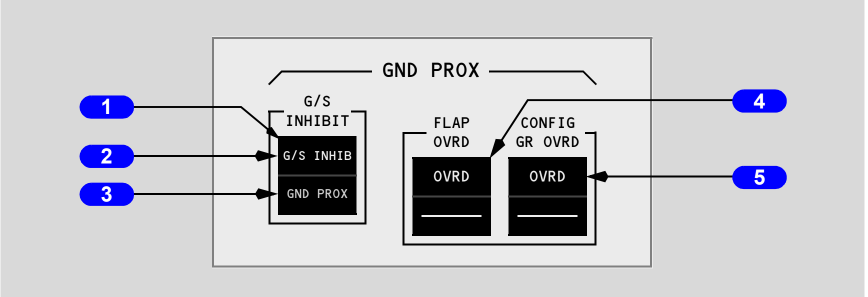


FIRST OFFICER PANEL

1 Ground Proximity (GND PROX) Glideslope (G/S) INHIBIT Switch

Push - inhibits GLIDESLOPE alert.

2 **Glideslope (G/S) INHIBIT Light**

Illuminated (white) - GLIDESLOPE alert inhibited.

3 **Ground Proximity (GND PROX) Light**

Illuminated (amber) -

- GPWS GLIDE SLOPE, SINKRATE, TERRAIN, TOO LOW FLAPS, TOO LOW GEAR, or TOO LOW TERRAIN immediate alert is occurring
- Inhibited for GLIDESLOPE, or TOO LOW FLAPS, or TOO LOW GEAR alerts when respective inhibit or override switch is pushed

4 **Ground Proximity (GND PROX) Flap Override (OVRD) Switch**

Push (OVRD illuminated) -

- inhibits TOO LOW FLAPS alert
- EICAS advisory message GND PROX SYS will be displayed when landing flaps are selected for more than 60 seconds with airspeed greater than 250 knots

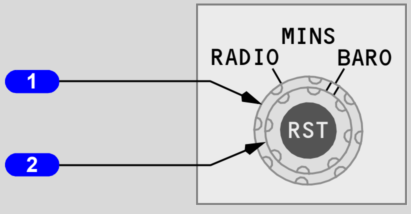
5 **Ground Proximity (GND PROX) Configuration (CONFIG) Gear (GR) Override (OVRD) Switch**

Push (OVRD illuminated) -

- inhibits TOO LOW GEAR alert
- inhibits CONFIG GEAR alert
- EICAS advisory message GND PROX SYS will be displayed when landing flaps are selected for more than 60 seconds with airspeed greater than 290 knots

Radio Altitude/Barometric Altitude Control

405, 570



EFIS CONTROL PANEL

1 Minimums (MINS) Selector (outer)

RADIO - RADIO/BARO control sets RADIO minimums display on PFD and captain control sets RADIO reference for GPWS minimums voice annunciation.

BARO - RADIO/BARO control sets BARO minimums pointer and BARO minimums display on PFD and captain control sets BARO reference for GPWS minimums voice annunciation.

2 RADIO Altitude/Barometric (BARO) Altitude Control (middle)

Rotate -

- when RADIO selected on MINS selector, sets RADIO altitude minimums displayed on PFD
- when BARO selected on MINS selector, sets BARO minimums pointer and BARO minimums display on PFD
- captain control sets RADIO or BARO reference for GPWS minimums voice annunciation

GPWS Look-Ahead Terrain Alerting Display and Annunciations

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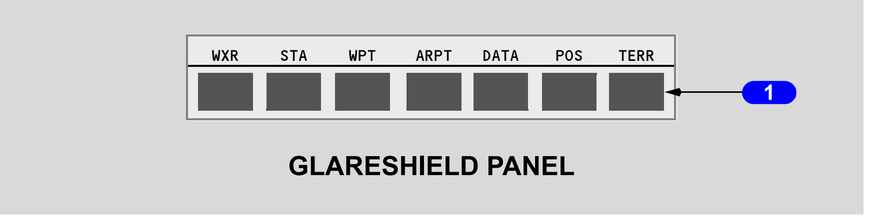
GPWS Terrain Display Select Switch



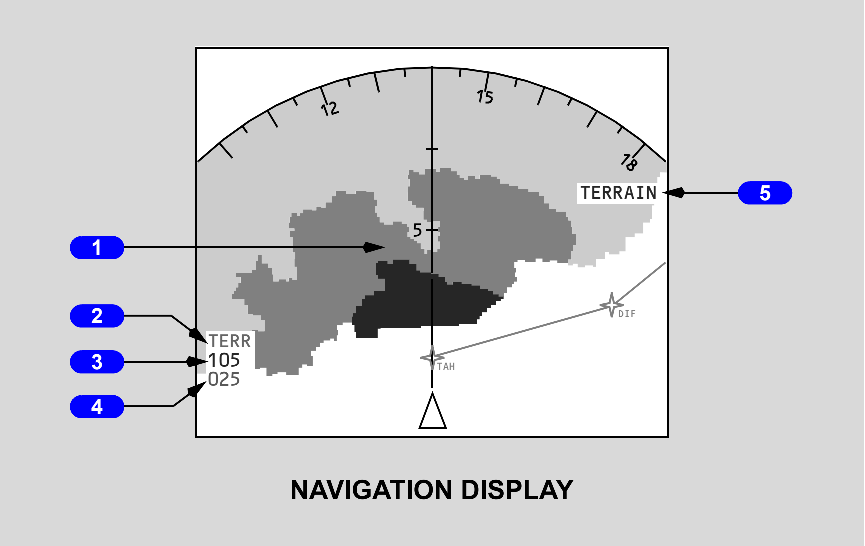
1 GPWS Terrain (TERR) Display Select Switch

Push -

- terrain data displayed in MAP, MAP CTR, VOR, and APP modes
- deselects weather radar display regardless of switch position

Second push - deselects terrain data display.

Terrain Display



1 Terrain Display

When airplane is higher than 2,000 feet above terrain, density based on obstacle height, peaks height, and airplane altitude:

- solid green - highest obstacles or peaks displayed
- high density green - intermediate height obstacles or terrain peaks displayed
- low density green - lowest obstacles or terrain peaks displayed

When airplane is lower than 2,000 feet above terrain, color and density based on obstacle height, terrain height, and airplane altitude:

- dotted green - obstacles or terrain from 2,000 feet below to 500 feet (250 feet with gear down) below airplane altitude
- dotted amber - obstacles or terrain 500 feet (250 feet with gear down) below to 2,000 feet above airplane altitude
- dotted red - obstacles or terrain more than 2,000 feet above airplane altitude
- dotted magenta - no terrain data available
- solid amber - look-ahead terrain caution is occurring
- solid red - look-ahead terrain warning is occurring

Note: In areas without obstacle or terrain data, look-ahead terrain alerting and display functions not available. GPWS immediate alerts function normally.

Displayed automatically when:

- a look-ahead obstacle or terrain alert occurs, and
- TERR not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

Display updates with a display sweep similar to weather radar display.

2 Terrain Mode Annunciation

TERR (cyan) - terrain display enabled.

3 Highest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

4 Lowest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

5 OBSTACLE/TERRAIN Annunciation

OBSTACLE (amber) - obstacle caution is occurring.

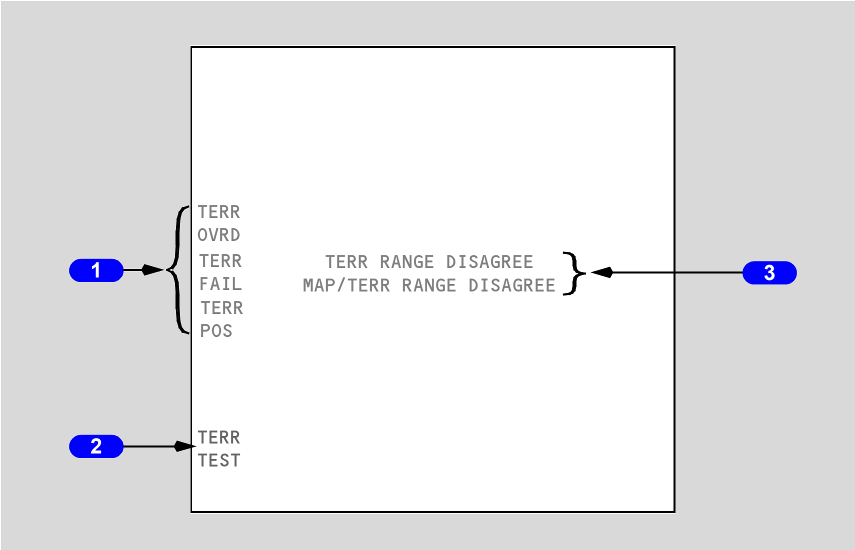
OBSTACLE (red) - obstacle warning is occurring.

TERRAIN (amber) - look-ahead terrain caution is occurring.

TERRAIN (red) - look-ahead terrain warning is occurring.

Displayed in all ND display modes.

Terrain Navigation Display Annunciations



1 Terrain Annunciations

TERR OVRD (amber) - TERR OVRD switch pushed.

TERR FAIL (amber) - look-ahead terrain alerting and display failed.

TERR POS (amber) - look-ahead terrain alerting and display unavailable due to GPS position uncertainty. During time between GPS position failure and display of TERR POS message, IRS provides position for look-ahead alerting and display.

2 Terrain Test Annunciation

TERR TEST (cyan) - GPWS operating in self-test mode.

3 Terrain Range Annunciation

TERR RANGE DISAGREE (amber) -

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel

MAP/TERR RANGE DISAGREE (amber) -

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel, and
- map display output range disagrees with range selected by EFIS control panel

Predictive Windshear (PWS) Display and Annunciations

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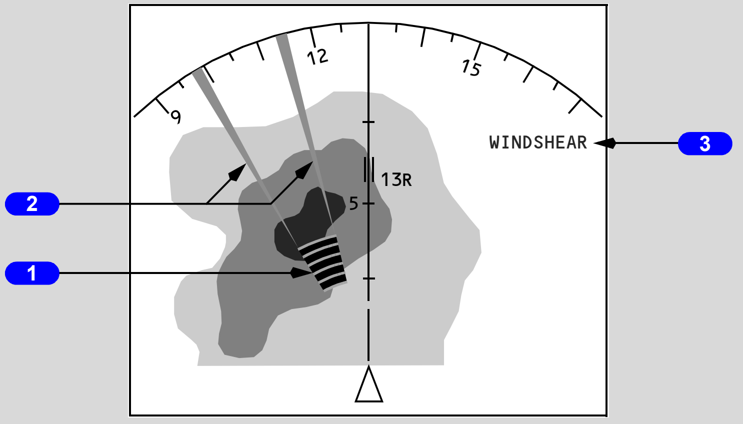


NAVIGATION DISPLAY

1 PWS Symbol

Displayed (red and black) -

- PWS alert is occurring
- displays windshear location and approximate geometric size (width and depth)

Symbol, radials, and weather radar returns displayed automatically when:

- PWS alert occurs, and
- WXR is not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

When terrain display is selected and PWS alert occurs, weather radar display replaces terrain display.

2 PWS Radials

Displayed (amber) -

- PWS alert is occurring
- Extend from PWS symbol to help locate windshear event

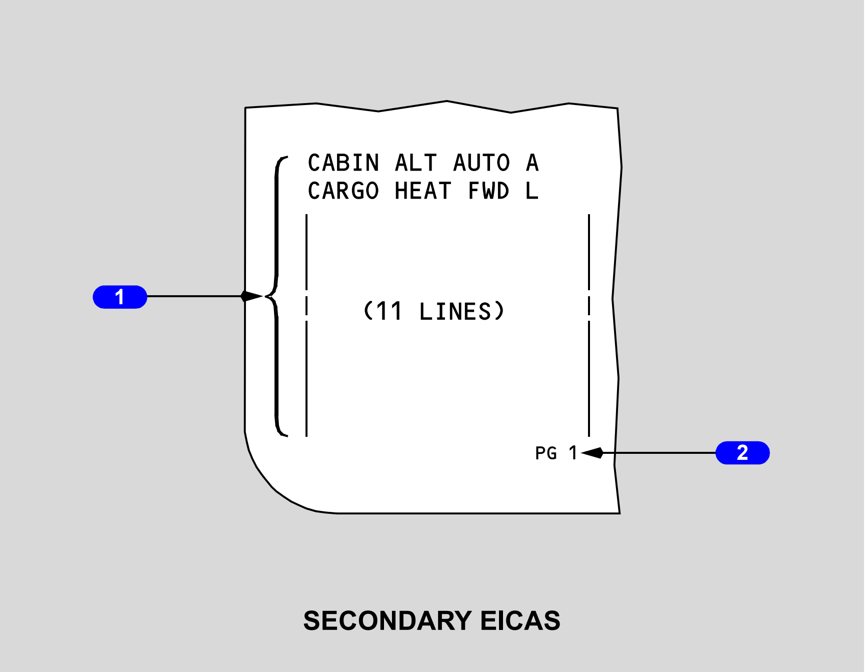
3 WINDSHEAR Annunciation

WINDSHEAR (amber) - PWS caution is occurring.

WINDSHEAR (red) - PWS warning is occurring.

Displayed in all navigation display modes.

Status Display



1 Status Messages

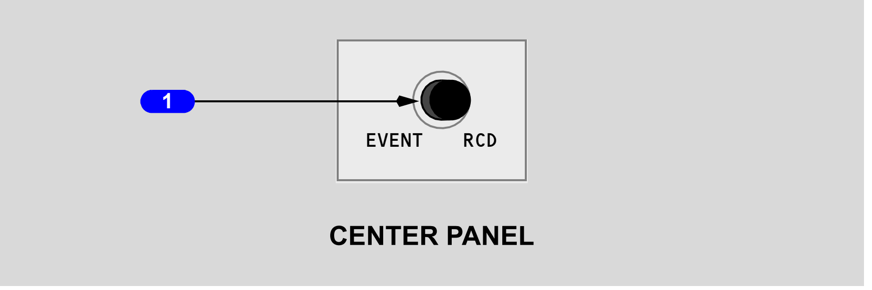
Status messages indicate equipment faults requiring MEL reference for dispatch.

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.

Warning Systems — Chapter 15
System Description — Section 20

Introduction

Warning systems consist of:

- engine indication and crew alerting system (EICAS)
- airspeed alerts
- takeoff and landing configuration warning system
- MCP selected altitude alerts

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  (SB changes 109 ; installs PILOT RESPONSE)
- 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 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.

Aurals, Master WARNING/CAUTION Switches and Lights, and GND PROX Light

Aurals, two master WARNING and CAUTION lights, and the GND PROX light call attention to the following alerts:

- in the following table, parans () describe crew action to silence the aural alert or extinguish the light while the alert is occurring.

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Aural	Light	Calls Attention To:
Bell (Silence by pushing Master WARNING/CAUTION Reset switch.)	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG FIRE WHEEL WELL

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Aural	Light	Calls Attention To:
Bell (Silence by pushing Master WARNING/CAUTION Reset switch.)	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG FIRE MAIN DECK FIRE MN DK AFT, FWD, MID FIRE WHEEL WELL

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Aural	Light	Calls Attention To:
Wailer	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message AUTO PILOT

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Aural	Light	Calls Attention To:
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message: CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG SPOILERS CONFIG STAB

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Aural	Light	Calls Attention To:
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message: CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG SPOILERS CONFIG STAB OVERSPEED

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Aural	Light	Calls Attention To:
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	EICAS warning message: AUTOPILOT CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG SPOILERS CONFIG STAB

(SB changes 109 ; installs PILOT RESPONSE)

Aural	Light	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 PILOT RESPONSE

(SB changes 109 ; before SB, OVERSPEED resetable aural not installed)

Aural	Light	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

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Aural	Light	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 OVERSPEED PILOT RESPONSE

Aural	Light	Calls Attention To:
Beeper	Master CAUTION lights (Extinguish by pushing Master WARNING/CAUTION Reset switch.)	New EICAS caution message, except: ENG SHUTDOWN
Voice annunciation: DON'T SINK, DON'T SINK TOO LOW, TERRAIN	GND PROX light	GPWS immediate alert.

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(SB changes 109 ; installs TCAS Ver. 7.0)

Aural	Light	Calls Attention To:
Voice annunciation: ADJUST VERTICAL SPEED, ADJUST CLIMB, CLIMB CLIMB, CLIMB NOW, CLIMB, CLIMB NOW CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB DESCEND, DESCEND DESCEND, DESCEND NOW, DESCEND, DESCEND NOW DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND INCREASE CLIMB, INCREASE CLIMB INCREASE DESCENT, INCREASE DESCENT MAINTAIN VERTICAL SPEED, MAINTAIN MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN MONITOR VERTICAL SPEED	None	Red regions to avoid on PFD Red TRAFFIC message and TCAS RA traffic display on ND
Voice annunciation CLEAR OF CONFLICT	None	Red regions to avoid on PFD, Red TRAFFIC message, and TCAS RA traffic display on ND are no longer displayed.
Voice annunciation TRAFFIC, TRAFFIC	None	Amber TRAFFIC message and TCAS TA traffic display on ND

(SB changes 109 ; before SB, TCAS Ver. 6.04A installed)

Aural	Light	Calls Attention To:
Voice annunciation: CLIMB, CLIMB, CLIMB CLIMB, CLIMB NOW, CLIMB, CLIMB NOW CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB DESCEND, DESCEND, DESCEND DESCEND, DESCEND NOW, DESCEND, DESCEND NOW DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND INCREASE CLIMB, INCREASE CLIMB INCREASE DESCENT, INCREASE DESCENT MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED REDUCE CLIMB, REDUCE CLIMB REDUCE DESCENT, REDUCE DESCENT	None	Red regions to avoid on PFD Red TRAFFIC message and TCAS RA traffic display on ND
Voice annunciation CLEAR OF CONFLICT	None	Red regions to avoid on PFD, Red TRAFFIC message, and TCAS RA traffic display on ND are no longer displayed.
Voice annunciation TRAFFIC, TRAFFIC	None	Amber TRAFFIC message and TCAS TA traffic display on ND

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Aural	Light	Calls Attention To:
Voice annunciation: OBSTACLE, OBSTACLE, PULL UP TERRAIN, TERRAIN, PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION switch.)	Red PULL UP on both PFDs Red OBSTACLE or TERRAIN message and obstacle or terrain display on ND
Voice annunciation: CAUTION OBSTACLE CAUTION TERRAIN	GND PROX light	Amber OBSTACLE or TERRAIN message and obstacle or terrain display on ND

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Aural	Light	Calls Attention To:
Voice annunciation: WINDSHEAR AHEAD GO AROUND, WINDSHEAR	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION switch)	Red WINDSHEAR on both PFDs Red WINDSHEAR message and PWS display on ND
Voice annunciation MONITOR RADAR DISPLAY	None	Amber WINDSHEAR message and PWS display on ND

Aural	Light	Calls Attention To:
Siren, followed by voice annunciation WINDSHEAR, WINDSHEAR, WINDSHEAR	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION switch)	Red WINDSHEAR on both PFDs

Aural	Light	Calls Attention To:
Voice annunciation PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/CAUTION switch)	Red PULL UP on both PFDs

Aural	Light	Calls Attention To:
Siren (If caused by Thrust lever at idle, silence by pushing Master WARNING/CAUTION switch.)	Master WARNING lights (If caused by Thrust lever at idle, extinguish by pushing Master WARNING/CAUTION switch.)	EICAS warning message CONFIG GEAR for: • Thrust lever at idle, and • radio altitude less than 800 feet, and • gear not down and locked.

Aural	Light	Calls Attention To:
Voice annunciation: GLIDE SLOPE SINK RATE TERRAIN TOO LOW, FLAPS TOO LOW, GEAR TOO LOW, TERRAIN	GND PROX light	GPWS immediate alert
Altitude voice annunciations	None	Altitude voice annunciations during approach

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used with EICAS messages to:

- help locate and identify affected systems and controls
- reduce potential for error

Airspeed Alerts

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns.

Airspeed Low

The EICAS caution message AIRSPEED LOW is displayed and the box around the current airspeed indication on the PFD is highlighted amber when airspeed is below minimum maneuvering speed.

Overspeed Warning

The EICAS 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.

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 set, or
    - Speedbrake lever not in DN detent, or
    - stabilizer trim not in takeoff range

The CONFIG message remains displayed until the airplane is configured for a normal takeoff or umtil engine 2 and 3 thrust is decreased below takeoff range and airspeed is less than V1.

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
- flaps in a landing position (flaps 25 or more)

If the message is displayed because a Thrust lever is closed at low radio altitudes, the message remains displayed until the Thrust levers are advanced or landing gear is down and locked.

If the message is displayed because the flaps are in a landing position, the message remains displayed until the landing gear is down and locked or the Ground Proximity Gear Override switch is pushed..

Speedbrake Lever Extend Beyond ARM During Climb

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In flight, the EICAS warning message CONFIG SPOILERS is displayed if:

- the SPEEDBRAKE lever is extended beyond ARM, and
- climb or higher thrust is set on any two thrust levers

The EICAS message remains displayed until:

- the SPEEDBRAKE lever is DN or at ARM, or
- at least three thrust levers are set below climb thrust

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

Altitude alerting is provided when departing the altitude selected in the MCP altitude window.

Approaching MCP Selected Altitude

At 900 feet prior to reaching the selected altitude a highlighted white box is displayed around the selected altitude and the current altitude on the PFD. The highlights are no longer displayed when within 300 feet of the selected altitude.

Departing 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 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

Alerts when departing MCP selected altitude are inhibited when:

- glideslope captured, or
- landing flaps selected and landing gear down and locked

Crew Alertness Monitor

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(SB changes 109 ; installs PILOT RESPONSE)

The FMC continuously monitors switch action 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 switch action was detected or TOD is passed with no recent switch action , the EICAS advisory message PILOT RESPONSE is displayed.

If there is still no switch action after a brief time, the EICAS caution message PILOT RESPONSE is displayed.

If there is still no switch action, the EICAS warning message PILOT RESPONSE is displayed.

The PILOT RESPONSE message is no longer displayed after pushing any monitored switch.

The PILOT RESPONSE message is inhibited 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 ND messages, voice annunciations, PFD vertical guidance, nor traffic display is provided for other airplanes that do not have operating transponders. TCAS operation is independent of ground-based air traffic control.

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.

TCAS messages TRAFFIC, TA ONLY, and TCAS TEST may be displayed in all ND modes.

TCAS processing priorities may reduce display of certain air traffic on the ND. Reduced display of air traffic does not affect system collision avoidance alerting capablility.

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 aircraft symbol and its accompanying data tag are displayed on the ND.

The TCAS RA Traffic aircraft symbol is a filled red square. The RA data tag contains the altitude and the vertical motion arrow.

For no-bearing RAs, the red RA label is displayed below the red message, TRAFFIC, and the RA data tag information is displayed to the right of the label. The RA 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 aircraft symbol and its accompanying data tag are displayed on the ND.

The TA Traffic aircraft symbol is a filled amber circle. The TA data tag contains the altitude and vertical motion arrow.

For no-bearing TAs, the amber TA label is displayed below the TRAFFIC message, and the TA data tag information is displayed to the right of the label. The TA labels are displayed below the RA labels. The TA data tag contains the distance, altitude, and vertical motion arrow.

When the TA is further from the airplane than the ND range currently displayed, the TCAS amber message OFFSCALE is displayed on the ND.

Proximate Traffic Display

Proximate traffic is another 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 aircraft is within the ND display range, the TCAS Proximate Traffic aircraft symbol is displayed on the ND.

The TCAS Proximate Traffic aircraft symbol is a filled white diamond. When TCAS is receiving and processing altitude data from the Proximate Traffic aircraft, the proximate traffic data tag is displayed on the ND. The proximate traffic data tag contains the altitude and vertical motion arrow.

Other Traffic Display

Other Traffic aircraft is an aircraft that is within the ND display limits but is neither a RA, a TA, or proximate traffic aircraft. When TCAS is not receiving and processing altitude data from the Other Traffic aircraft, the Other Traffic aircraft becomes Proximate Traffic aircraft automatically when within six miles.

When the TCAS cyan message TFC is displayed on the ND and the Other Traffic aircraft is within the ND display range, the TCAS Other Traffic symbol is displayed on the ND.

The TCAS Other Traffic symbol is a hollow white diamond. When TCAS is receiving and processing altitude data from the Other Traffic aircraft, a data tag like that described in Proximate Traffic Display is displayed.

TCAS PFD Vertical Guidance

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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 and vertical speed outside the red RA regions.

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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.

ND Message	Color	Description
OFFSCALE	Red	RA is occurring at range greater than current ND range.
TA ONLY	Cyan	TCAS can not provide RAs. All traffic that would have been RAs are predicted as TAs.
TCAS FAIL	Amber	TCAS failed, or TCAS information cannot be displayed on ND.
TCAS OFF	Amber	TFC switch pushed to display traffic but TCAS not selected on transponder panel.
TCAS TEST	Cyan	TCAS in test mode. Message is displayed on all ND modes and ranges.

TCAS Voice Annunciations

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Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions.	Continue to keep pitch attitude and vertical speed outside the red RA regions.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions.	
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA regions. Airplane will pass through the altitude of the traffic.	

Voice Annunciation	Condition	Response
CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Increase pitch attitude and vertical speed to remain outside the red RA regions.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions. Airplane will climb through the altitude of the traffic.	
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Decrease pitch attitude and vertical speed to remain outside the red RA regions.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions. Airplane will descend through the altitude of the traffic.	
INCREASE CLIMB, INCREASE CLIMB	Existing RA, TCAS requires change in vertical rate. Present pitch attitude and vertical speed are within the red RA regions.	Adjust pitch attitude and vertical speed to remain outside the red RA regions..
INCREASE DESCENT, INCREASE DESCENT		

Voice Annunciation	Condition	Response
ADJUST VERTICAL SPEED, ADJUST	Existing RA, minimum vertical speed required to ensure separation has decreased, present pitch attitude and vertical speed are outside the red RA regions, or, new RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA regions.	Continue to keep pitch attitude and vertical speed outside the red RA regions. Vertical speed may be decreased, or, change pitch attitude and vertical speed to remain outside the red RA regions.
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude and vertical speed are within the red RA regions.	Decrease pitch attitude and vertical speed to remain outside the red RA regions.
CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	Existing RA, previous TCAS vertical guidance was to descend. Present pitch attitude and vertical speed are within the red RA regions.	Increase pitch attitude and vertical speed to remain outside the red RA regions.
CLEAR OF CONFLICT	TCAS PFD vertical guidance is no longer displayed and traffic changes to a TA symbol. Separation is increasing and the RA will not occur. However, the voice annunciation will not sound if TCAS can no longer predict the track of the RA aircraft.	Attempt to visually locate the traffic.

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(SB changes 109 ; installs TCAS Ver. 7.0)

Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude is outside the red RA regions.	Continue to keep pitch attitude outside the red RA regions.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude is outside the red RA regions.	
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude is outside the red RA regions. Airplane will pass through the altitude of the traffic.	
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.	

Voice Annunciation	Condition	Response
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude is within the red R 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.	
INCREASE CLIMB, INCREASE CLIMB	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..
INCREASE DESCENT, INCREASE DESCENT		
ADJUST VERTICAL SPEED, ADJUST	Existing RA, minimum rate required to ensure separation has decreased, present pitch attitude is outside the red RA regions, or, new RA, initial voice annunciation. Present pitch attitude is within the red RA regions.	Continue to keep pitch attitude outside the red RA regions. Vertical speed may be decreased, or, change pitch attitude to remain outside the red RA regions.

Voice Annunciation	Condition	Response
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude 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.

(SB changes 109 ; before SB, TCAS Ver. 6.04a installed)

Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	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.	

Voice Annunciation	Condition	Response
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.	
INCREASE CLIMB, INCREASE CLIMB	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..
REDUCE CLIMB, REDUCE CLIMB		
INCREASE DESCENT, INCREASE DESCENT		
REDUCE DESCENT, REDUCE DESCENT		
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

109, 405

The TCAS operating mode is controlled from the transponder panel. TA/RA is normally selected, however, it is sometimes necessary to select in TA to prevent nuisance RAs.

570

The TCAS operating mode is controlled from the transponder panel. TA/RA is normally selected, however, it is sometimes necessary to select TA ONLY to prevent nuisance RAs.

109, 405

TA is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, TA can be selected when intentionally operating near other traffic that may cause RAs, such as during parallel approaches and VFR operations.

570

TA ONLY is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, TA ONLY can be selected 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 is displayed if TCAS cannot display RA guidance on the respective Captain or First Officer PFD. The ND traffic displays and voice alerts are unaffected.

The EICAS alert message TCAS SYSTEM 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

405, 570

GPWS provides immediate alerts, and look-ahead obstacle and terrain alerts for potentially hazardous flight conditions involving imminent impact with the obstacles and the ground.

GPWS immediate alerts and altitude voice annunciations during approach are based on a combination of 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
- windshear

GPWS provides bank angle voice annunciations and altitude voice annunciations during approach.

GPWS also provides look-ahead terrain mode alerts by monitoring obstacle and terrain proximity using a world-wide terrain data base and an obstacle data base. The obstacle data base is not yet world wide. Proximate obstacle and terrain data may be displayed on the ND. If there is a potential obstacle or terrain hazard, GPWS look-ahead alerts are provided based on estimated time to impact.

Altitude used for look-ahead terrain mode alerts are a weighted combination of radio altitude, barometric altitude, GPS, and previous flight path. Weighting is reduced for an altitude source which becomes less reliable.

Estimated time to impact is based on airplane position, altitude, present track, vertical path, and ground speed. FMC VNAV and LNAV path is not considered in the estimated time to impact.

Note: Obstacle or terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning alert does not guarantee obstacle or terrain clearance.

GPWS Look-Ahead Obstacle and Terrain Mode

405, 570

A GPWS terrain data base in the GPWS computer contains detailed terrain and man made obstacle data. Obstacle and terrain data is not designed to be used as an independent navigation aid.

When the TERR switch is pushed on, the TERR symbol is displayed on the ND and obstacle and terrain contours may be displayed. When obstacle and terrain contours are displayed, the altitudes of the highest and lowest displayed obstacle or terrain are displayed below the TERR symbol. The color of each altitude corresponds to the altitude of the respective contour.

When the airplane is higher than 2,000 feet above the terrain, obstacles and terrain peaks are displayed using solid, high density, and low density contours of green. The highest obstacles or terrain is represented by solid green, and the lowest obstacles or terrain displayed is represented by low density green..

When the airplane is lower than 2,000 feet above the terrain, all obstacles and terrain within 2,000 feet of airplane altitude is displayed on the navigation display.

When a obstacle or terrain alert occurs, the respective message is displayed on the ND. When an OBSTACLE alert occurs while a TERRAIN alert message is displayed, the OBSTACLE alert message replaces the TERRAIN alert message. Both messages will not be displayed at the same time.

The terrain display is correlated to GPS position, or to IRU position if GPS position is intermittently unavailable.

Terrain and weather radar cannot be simultaneously displayed on an ND. When one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps.

GPWS Look-Ahead Obstacle and Terrain Alerts

405, 570

Voice Annunciation	PFD and ND Display and Light	Description
OBSTACLE OBSTACLE PULL UP	Red PULL UP on both PFDs Master WARNING lights Red OBSTACLE message on both NDs Solid red obstacle on ND	20 to 30 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TERRAIN TERRAIN PULL UP	Red PULL UP on both PFDs Master WARNING lights Red TERRAIN message on both NDs Solid red terrain on ND	20 to 30 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
CAUTION OBSTACLE	Amber OBSTACLE message on both NDs Solid amber obstacle on ND GND PROX light	40 to 60 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
CAUTION TERRAIN	Amber TERRAIN message on both NDs Solid amber terrain on ND GND PROX light	40 to 60 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light	Descent below unsafe altitude while too far from any airport in the terrain database. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.

Introduction

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GPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

GPWS immediate alerts and altitude voice annunciations during approach are based on a combination of 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
- windshear

GPWS provides altitude voice annunciations during approach.

Note: GPWS does not provide an alert for flight toward vertically sheer terrain or slow descents into terrain while in landing configuration.

GPWS Immediate Alerts

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Voice Annunciation	PFD and ND Display and Light	Description
DON'T SINK	GND PROX light	Altitude loss with flaps and/or gear up after takeoff or go-around.
GLIDE SLOPE	GND PROX light	Excessive deviation below glide slope. Volume and repetition rate increase as deviation increases. Pushing the GND PROX G/S INHIB switch inhibits the alert.
PULL UP	Red PULL UP on both PFDs Master WARNING lights	Follows SINK RATE alert when descent rate becomes severe, or follows TERRAIN alert with flaps and/or gear not in landing configuration when excessive terrain closing rate continues.
SINK RATE	GND PROX light	Excessive descent rate.
TERRAIN	GND PROX light	Excessive terrain closing rate.

Voice Annunciation	PFD and ND Display and Light	Description
TOO LOW, FLAPS	GND PROX light	Unsafe terrain clearance with flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert.
TOO LOW, GEAR	GND PROX light	Unsafe terrain clearance with gear not in landing configuration at low altitude and airspeed with gear not down. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light	Follows DON'T SINK alert with gear and/or flaps up after takeoff or go-around for altitude loss at low altitude, or unsafe terrain clearance with gear and/or flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert, when the alert is due to flaps not in landing position. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert, when the alert is due to gear not down.

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Voice Annunciation	PFD and ND Display and Light	Description
DON'T SINK	GND PROX light	Altitude loss with flaps and/or gear up after takeoff or go-around.
GLIDE SLOPE	GND PROX light	Excessive deviation below glide slope. Volume and repetition rate increase as deviation increases. Pushing the GND PROX G/S INHIB switch inhibits the alert when pushed below 1,000 feet radio altitude.
PULL UP	Red PULL UP on both PFDs Master WARNING lights	Follows SINK RATE alert when descent rate becomes severe, or follows TERRAIN alert with flaps and/or gear not in landing configuration when excessive terrain closing rate continues.
SINK RATE	GND PROX light	Excessive descent rate.
TERRAIN	GND PROX light	Excessive terrain closing rate.

Voice Annunciation	PFD and ND Display and Light	Description
TOO LOW, FLAPS	GND PROX light	Unsafe terrain clearance with flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert.
TOO LOW, GEAR	GND PROX light	Unsafe terrain clearance with gear not in landing configuration at low altitude and airspeed with gear not down. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light	Follows DON'T SINK alert with gear and/or flaps up after takeoff or go-around for altitude loss at low altitude, or unsafe terrain clearance with gear and/or flaps not in landing configuration at low altitude and airspeed. Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert, when the alert is due to flaps not in landing position. Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert, when the alert is due to gear not down.

Bank Angle Voice Annunciations

405, 570

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The voice alert BANK ANGLE sounds if bank angle exceeds 35°, 40°, and 45°. The voice alert BANK ANGLE also sounds at low altitudes during takeoff and landing for bank angles as small as 10°.

570

The voice alert BANK ANGLE sounds if bank angle exceeds 35°, 40°, and 45°.

Altitude Voice Annunciations During Approach

GPWS provides the following altitude voice annunciations during approach:

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- 500 feet - FIVE HUNDRED, when glideslope or localizer not received, or glideslope or localizer deviation greater than two dots
- 100 feet - ONE HUNDRED

- 50 feet - FIFTY
- 40 feet - FORTY
- 30 feet - THIRTY
- 20 feet - TWENTY
- 10 feet - TEN

109

- 100 feet - ONE HUNDRED
- 50 feet - FIFTY
- 30 feet - THIRTY
- 10 feet - TEN

405

- 2,500 feet - TWENTY-FIVE HUNDRED
- 1,000 feet - ONE THOUSAND
- 500 feet - FIVE HUNDRED
- 100 feet - ONE HUNDRED
- 50 feet - FIFTY
- 40 feet - FORTY
- 30 feet - THIRTY
- 20 feet - TWENTY
- 10 feet - TEN

Minimums Voice Annunciation
405

GPWS provides the voice annunciations APPROACHING MINIMUMS at 80 feet above the altitude set by the captain RADIO/BARO Altitude control on the EFIS control panel, and MINIMUMS at the altitude set.

Minimums Voice Annunciation
570

GPWS provides the voice annunciation MINIMUMS at the altitude set by the captain RADIO/BARO Altitude control on the EFIS control panel.

GPWS Windshear Alert and PWS
405, 570

Windshear alerts are enabled during takeoff, approach, and landing:

- GPWS provides an immediate windshear alert when an excessive downdraft or tailwind is occurring
- PWS provides windshear alerts when an excessive windshear condition is detected ahead of the airplane

PWS Alert System

Weather radar uses radar imaging to detect disturbed air ahead of the airplane.

PWS alerts are enabled approximately 12 seconds after weather radar begins scanning for windshear.

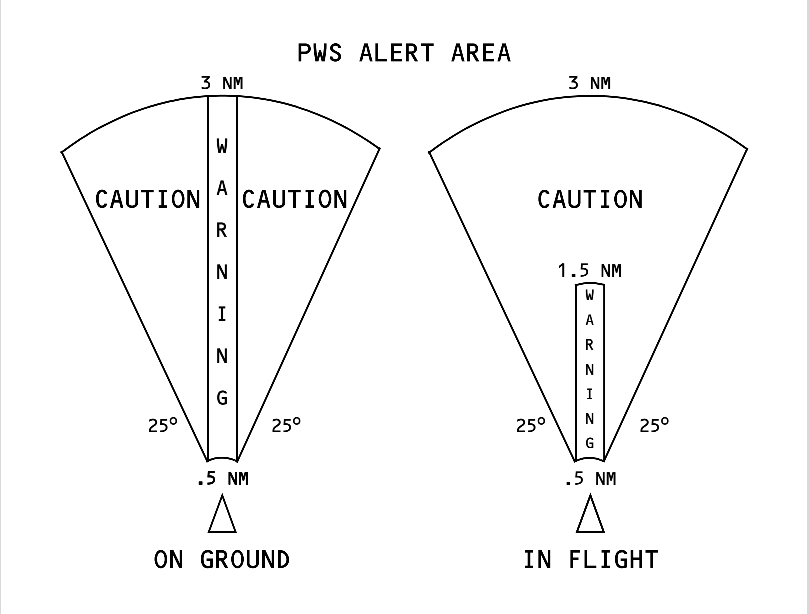
570

When PWS is enabled, radar antenna scan sweep is reduced.

Prior to takeoff, PWS alerts can be enabled by pushing the WXR switch on the EFIS control panel. On the ground with the WXR switch pushed or not pushed, weather radar begins scanning for windshear when engine thrust lever 2 or 3 is in the takeoff range.

In flight with the WXR switch pushed or not pushed, weather radar begins scanning for windshear below 2,300 feet radio altitude. and PWS alerts are enabled below 1,200 feet radio altitude.

When windshear is not predicted by PWS, weather radar returns are displayed only when the Weather Radar switch on the EFIS control panel is pushed.



PWS Alerts

Voice Annunciation	PFD and ND Display and Light	Description
WINDSHEAR AHEAD, WINDSHEAR AHEAD	Red WINDSHEAR on both PFDs Master WARNING lights Red WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted close to and directly ahead of airplane. Enabled during takeoff, below 1,200 feet radio altitude. Windshear position displayed by PWS symbol on the ND in MAP, MAP CTR, VOR, or APP modes only.
GO AROUND, WINDSHEAR AHEAD	Red WINDSHEAR on both PFDs Master WARNING lights Red WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 1.5 miles and directly ahead of the airplane. Enabled during approach, below 1,200 feet radio altitude. WIndshear position displayed by PWS symbol on the ND in MAP, MAP CTR, VOR, or APP modes only.
MONITOR RADAR DISPLAY	Amber WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 3 miles and ahead of the airplane. Enabled during takeoff and approach, below 1,200 feet radio altitude. Windshear position displayed on PWS on ND in MAP, MAP CTR, VOR, or APP modes only.

Note: Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

Note: Weather radar detects microbursts and other windshears with similar characteristics. Weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

Immediate Windshear Alerts

Voice Annunciation	PFD Display and Light	Description
(Siren) WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both PFDs Master WARNING lights	Excessive windshear detected by GPWS. Enabled below 1,500 feet radio altitude. GPWS windshear detection begins at rotation.

GPWS Windshear Alert System

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Windshear alerts are enabled during takeoff, approach, and landing:

- GPWS provides an immediate windshear alert when an excessive downdraft or tailwind is occurring

Windshear Alerts

Voice Annunciation	PFD Display and Light	Description
(Siren) WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both PFDs Master WARNING lights	Excessive windshear detected by GPWS. Enabled below 1,500 feet radio altitude. GPWS windshear detection begins at rotation.

GPWS Non-Normal Operation

405, 570

If there is a fault in any GPWS immediate mode, the alerts are inhibited for the mode in which the fault occurs. For GPWS look-ahead terrain alerting mode, terrain status annunciations indicate display failure. For other GPWS modes, 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.

109

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 inhibited during normal system operation, and during part of the takeoff to prevent distracting the crew.

405, 570

GPWS immediate windshear alert inhibits all PWS, TCAS, and other GPWS alerts.

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GPWS immediate windshear alert inhibits all TCAS and other GPWS alerts.

405, 570

When TA/RA is selected on the transponder panel and a GPWS or PWS warning alert occurs, TCAS automatically inhibits RA mode and operates in TA ONLY mode. All aircraft that would have been predicted as a RA are predicted as a TA. When a subsequent GPWS or PWS warning alert occurs while a RA is occurring, the RA is discontinued and becomes a TA. When GPWS and PWS warning alerts are no longer occurring, TCAS returns to TA/RA mode and provides RAs for all appropriate TAs.

109

When TA/RA is selected on the transponder panel and a GPWS warning alert occurs, TCAS automatically inhibits RA mode and operates in TA ONLY mode. All aircraft that would have been predicted as a RA are predicted as a TA. When a subsequent GPWS warning alert occurs while a RA is occurring, the RA is discontinued and becomes a TA. When GPWS warning alerts are no longer occurring, TCAS returns to TA/RA mode and provides RAs for all appropriate TAs.

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.

Alert Messages Inhibited During Normal System Operation

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.

Voice Annunciation Inhibits

Voice annunciations for warning alerts inhibit new voice annunciations for caution alerts.

All voice annunciations are prioritized to aid flight crew decision making when more than one alert occurs.

ND Display Alert Inhibits and Automatic Display

Alert displays on the NDs are prioritized to aid flight crew decision making when more than one alert occurs. The displays are also prioritized when neither ND is in MAP, MAP CTR, VOR, or APP mode.

405, 570

Immediate windshear alert inhibits the automatic display of new TCAS, look-ahead terrain, or PWS alerts.

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Immediate windshear alert inhibits the automatic display of new TCAS alerts.

405, 570

TCAS traffic can be displayed concurrently with either TERR and WXR display.

109

TCAS traffic can be displayed concurrently with WXR display.

New TCAS alerts:

- When TFC is displayed on the first officer ND and both NDs are in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TCAS traffic continue to be selected on the first officer ND while TCAS traffic display and TFC are inhibited on the captain ND. When the captain TFC switch is subsequently pushed, TCAS traffic and TFC are selected automatically on the captain ND.
- When TFC is displayed on the captain ND and both NDs are in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TCAS traffic continues to be selected on the captain ND while TCAS traffic display and TFC are inhibited on the first officer ND. When the first officer TFC switch is subsequently pushed, TCAS traffic and TFC are selected automatically on the first officer ND.
- When TFC is displayed on neither ND and both NDs are in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TCAS traffic and TFC are selected automatically on both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, TCAS traffic and TFC are selected automatically on that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TCAS display, and TCAS traffic and TFC will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new TCAS TA or RA alert occurs, both NDs are armed for TCAS display. TCAS traffic and TFC will be selected automatically when the respective MAP, MAP CTR, VOR, or APP mode is selected.
- When TCAS traffic and TFC are selected automatically because a TCAS TA or RA had occurred, but TAs and RAs are no longer occurring, TCAS traffic and TFC continue to be selected until the respective TFC switch is pushed; TCAS traffic and TFC are not automatically de-selected.

405, 570

New look-ahead terrain alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, both NDs are armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed for either ND by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode on the respecitve ND.

405, 570

New PWS alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, both NDs are armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.

Alerts Inhibited Before Engine Start and After Shutdown

Alert Inhibited	For Message	Inhibit Occurs
Master CAUTION lights Beeper	For all EICAS caution messages	On the ground, and all FUEL CONTROL switches CUTOFF.
Respective EICAS messages: ELEC GEN OFF ENG CONTROL, ENG EEC MODE ENG FAIL ENG OIL PRESS HYD PRESS ENG 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

405

Alert Inhibited	Inhibit Begins	Inhibit Ends
All new EICAS caution and advisory messages, except: BLEED 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.

109, 570

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

570

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS caution message ENG FAIL	Message is inhibited	On ground	Lift-off
EICAS advisory message TCAS OFF	Message is inhibited		400 feet radio altitude
TCAS TA voice alerts	TCAS TAs		Approximately 500 feet radio altitude
All TCAS RAs	TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND		Approximately 1,000 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude
STATUS cue	All EICAS new status messages	Engine start	30 minutes after lift-off

<table>
<tr><th>Alert Inhibited</th><th>For Message</th><th>Inhibit Begins</th><th>Inhibit Ends</th></tr>
<tr><td>Hi Chime</td><td>Attendant call</td><td>Any engine in takeoff thrust range</td><td>400 feet radio altitude</td></tr>
<tr><td>Master CAUTION lights
Beeper
If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends.
If new EICAS caution messages are displayed during the inhibit, the beeper will sound when the inhibit ends.</td><td>New EICAS caution messages</td><td rowspan="2">80 knots airspeed</td><td>400 feet radio altitude or 20 seconds after rotation, whichever occurs first.
If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.</td></tr>
<tr><td>New PWS caution alerts
EICAS advisory message WINDSHEAR SYS</td><td>Messages are inhibited</td><td>400 feet radio altitude</td></tr>
<tr><td>New PWS warning alerts</td><td>Messages are inhibited</td><td>100 knots airspeed</td><td>50 feet radio altitude</td></tr>
</table>

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master WARNING lights Bell If the Master WARNING lights illuminate and fire bell sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded. If new FIRE messages are displayed during the inhibit, the bell will sound when the inhibit ends.	New EICAS warning messages FIRE	V1	400 feet radio altitude or 25 seconds after V1, whichever occurs first.
Master WARNING lights Siren If the Master WARNING lights illuminate and siren sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded If new EICAS warning messages are displayed during the inhibit, the siren will sound when the inhibit ends.	New EICAS warning messages except: CONFIG GEAR FIRE		
	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 if tank to engine condition occurs after lift-off.	Message is inhibited		Ten minutes after lift-off
All PWS alerts	Messages are inhibited	1,200 feet radio altitude	Approach

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Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS caution message ENG FAIL	Message is inhibited	On ground	Lift-off
EICAS advisory message TCAS OFF	Message is inhibited		400 feet radio altitude
TCAS TA voice alerts	TCAS TAs		Approximately 500 feet radio altitude
All TCAS RAs	TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND		Approximately 1,000 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude
STATUS cue	All EICAS status messages	Engine start	30 minutes after lift-off
Hi Chime	Attendant call	Any engine in takeoff thrust range	400 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master CAUTION lights Beeper If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends. If new EICAS caution messages are displayed during the inhibit, the beeper will sound when the inhibit ends.	New EICAS caution messages	80 knots airspeed	800 feet radio altitude or 30 seconds after rotation, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
New PWS caution alerts EICAS advisory message WINDSHEAR SYS	Messages are inhibited		400 feet radio altitude
New PWS warning alerts	Messages are inhibited	100 knots airspeed	50 feet radio altitude

<table>
<tr><th>Alert Inhibited</th><th>For Message</th><th>Inhibit Begins</th><th>Inhibit Ends</th></tr>
<tr><td>Master WARNING lights
Bell
If the Master WARNING lights illuminate and fire bell sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded.
If new FIRE messages are displayed during the inhibit, the bell will sound when the inhibit ends.</td><td>New EICAS warning messages FIRE</td><td rowspan="2">V1</td><td rowspan="2">400 feet radio altitude or 25 seconds after V1, whichever occurs first.</td></tr>
<tr><td rowspan="2">Master WARNING lights
Siren
If the Master WARNING lights illuminate and siren sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded
If new EICAS warning messages are displayed during the inhibit, the siren will sound when the inhibit ends.</td><td>New EICAS warning messages except:
CONFIG GEAR
FIRE</td></tr>
<tr><td>EICAS warning message CONFIG GEAR</td><td rowspan="2">Lift-off</td><td>800 feet radio altitude or 140 seconds after nose gear strut lift-off, whichever occurs first</td></tr>
<tr><td>EICAS advisory message FUEL TANK/ENG if tank to engine condition occurs after lift-off.</td><td>Message is inhibited</td><td>Ten minutes after lift-off</td></tr>
<tr><td>All PWS alerts</td><td>Messages are inhibited</td><td>1,200 feet radio altitude</td><td>Approach</td></tr>
</table>

(SB changes 109 ; installs TCAS ver. 7.0)

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS caution message ENG FAIL	Message is inhibited	On ground	Lift-off
EICAS advisory message TCAS OFF	Message is inhibited		400 feet radio altitude
TCAS TA voice alerts	TCAS TAs		Approximately 500 feet radio altitude
All TCAS RAs	TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND		Approximately 1,000 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude
STATUS cue	All EICAS new status messages	Engine start	30 minutes after lift-off
Hi Chime	Attendant call	Any engine in takeoff thrust range	400 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master CAUTION lights Beeper If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends. If new EICAS caution messages are displayed during the inhibit, the beeper will sound when the inhibit ends.	New EICAS caution messages	80 knots airspeed	400 feet radio altitude or 20 seconds after rotation, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
EICAS advisory message WINDSHEAR SYS	Message is inhibited		400 feet radio altitude

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(SB changes 109 ; before SB, TCAS ver. 6.04a installed)

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS caution message ENG FAIL	Message is inhibited	On ground	Lift-off
EICAS advisory message TCAS OFF	Message is inhibited		400 feet radio altitude
TCAS TA voice alerts All TCAS RAs	TCAS TAs TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND		Approximately 1,000 feet radio altitude
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude
STATUS cue	All EICAS new status messages	Engine start	30 minutes after lift-off
Hi Chime	Attendant call	Any engine in takeoff thrust range	400 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master CAUTION lights Beeper If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends. If new EICAS caution messages are displayed during the inhibit, the beeper will sound when the inhibit ends.	New EICAS caution messages	80 knots airspeed	400 feet radio altitude or 20 seconds after rotation, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
EICAS advisory message WINDSHEAR SYS	Message is inhibited		400 feet radio altitude

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FIRE</td></tr>
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</table>

Alerts Inhibited During Landing

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Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
All PWS alerts	Alerts are inhibited	2,300 feet radio altitude	1,200 feet radio altitude
TCAS INCREASE DESCENT RAs		Approximately 1,500 feet radio altitude	Go-around at approximately 1,500 feet radio altitude
TCAS DESCEND RAs		Approximately 1,100 feet radio altitude	Go-around at approximately 1,100 feet radio altitude
All TCAS RAs	Alerts are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND	Approximately 1,000 feet radio altitude	Go-around at approximately 1,000 feet radio altitude
STATUS cue Hi chime	All EICAS status messages	800 feet radio altitude	75 knots airspeed
TCAS voice alerts	TCAS TAs	Approximately 500 feet radio altitude	Go-around at approximately 500 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
New PWS caution alerts	Alerts are inhibited	400 feet radio altitude	80 knots airspeed
EICAS alert message WINDSHEAR SYS	Message is inhibited		
EICAS advisory message TCAS OFF			Go-around at 400 feet radio altitude
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 altitude	75 knots airspeed, or 40 seconds elapse, or 800 feet radio altitude
New PWS warning alerts	Alerts are inhibited	50 feet radio altitude	100 knots airspeed

(SB changes 109 ; Installs TCAS Ver.7.0)

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
TCAS INCREASE DESCENT RAs	Alerts are inhibited	Approximately 1,500 feet radio altitude	Go-around at approximately 1,500 feet radio altitude
TCAS DESCEND RAs		Approximately 1,100 feet radio altitude	Go-around at approximately 1,100 feet radio altitude
All TCAS RAs	Alerts are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND	Approximately 1,000 feet radio altitude	Go-around at approximately 1,000 feet radio altitude
STATUS cue Hi chime	All EICAS status messages	800 feet radio altitude	75 knots airspeed

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
TCAS voice alerts	TCAS TAs	Approximately 500 feet radio altitude	Go-around at approximately 500 feet radio altitude
EICAS alert message WINDSHEAR SYS	Message is inhibited	400 feet radio altitude	80 knots airspeed
EICAS advisory message TCAS OFF			Go-around at 400 feet radio altitude
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	75 knots airspeed, or 40 seconds elapse, or 800 feet radio altitude

(SB changes 109 ; before SB, TCAS Ver. 6.04a installed)

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
TCAS INCREASE DESCENT RAs	Alerts are inhibited	Approximately 1,500 feet radio altitude	Go-around at approximately 1,500 feet radio altitude
TCAS DESCEND RAs		Approximately 1,100 feet radio altitude	Go-around at approximately 1,100 feet radio altitude
All TCAS RAs TCAS voice alerts	Alerts are inhibited When RA selected on panel, TCAS switches automatically to TA only mode. and TCAS message TA ONLY is displayed on ND	Approximately 1,000 feet radio altitude	Go-around at approximately 1,000 feet radio altitude
STATUS cue Hi chime	All EICAS status messages	800 feet radio altitude	Airspeed less than 75 knots

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
EICAS alert message WINDSHEAR SYS	Message is inhibited	400 feet radio altitude	Airspeed less than 80 knots
EICAS advisory message TCAS OFF			Go-around at 400 feet radio altitude
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.

Warning Systems EICAS Messages

The following EICAS messages can be displayed.

Configuration EICAS Alert Messages

Message	Level	Aural	Message Logic
>CONFIG FLAPS	Warning	Siren	Flaps not in takeoff position when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range.
>CONFIG GEAR	Warning	Siren	Any landing gear not down and locked when any Thrust lever closed below 800 feet radio altitude or when flaps are in a landing position.
>CONFIG GEAR CTR	Warning	Siren	Body gear not centered when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range.
>CONFIG PARK BRK	Warning	Siren	Parking brake set when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range.

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Message	Level	Aural	Message Logic
>CONFIG SPOILERS	Warning	Siren	Speedbrake lever not DOWN when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range; or, Speedbrake lever extended beyond ARM in flight, and climb thrust or greater set on any two Thrust levers.

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Message	Level	Aural	Message Logic
>CONFIG SPOILERS	Warning	Siren	Speedbrake lever not DOWN when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range.

Message	Level	Aural	Message Logic
>CONFIG STAB	Warning	Siren	Stabilizer not within the greenband when airplane on the ground, airspeed less than V1, three or more Fuel Control switches in RUN, and engine 2 or 3 thrust in takeoff range.
>CONFIG WARN SY	Advisory		Fault detected in configuration warning system.

GPWS EICAS Alert Messages

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Message	Level	Aural	Message Logic
>ALT CALLOUTS	Advisory		Altitude and minimums voice annunciations during approach no longer provided.

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Message	Level	Aural	Message Logic
>ALT CALLOUTS	Advisory		Altitude voice annunciations during approach no longer provided.

Message	Level	Aural	Message Logic
GND PROX SYS	Advisory		GPWS alerts may not be provided.

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Message	Level	Aural	Message Logic
>TERR OVRD	Advisory		Ground Proximity Override switch in OVRD. Look-ahead terrain alerts will not be provided.

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Message	Level	Aural	Message Logic
TERR POS	Advisory		Look-ahead terrain alerting and display unavailable because GPS has failed. During time between GPS failure and display of TERR POS message, IRS provides position for look-ahead alerting and display.

Message	Level	Aural	Message Logic
WINDSHEAR SYS	Advisory		Windshear alerts may not be provided.

TCAS EICAS Alert Messages

Message	Level	Aural	Message Logic
>TCAS OFF	Advisory		TCAS mode TA or TA/RA not selected.

Message	Level	Aural	Message Logic
>TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on respective PFD.
>TCAS SYSTEM	Advisory		TCAS has failed.

Airspeed and Altitude EICAS Alert Messages

Message	Level	Aural	Message Logic
>AIRSPEED LOW	Caution	Beeper	Airspeed less than minimum maneuvering speed.

Message	Level	Aural	Message Logic
>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

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(SB changes 109 ; installs EICAS message >PILOT RESPONSE)

Message	Level	Aural	Message Logic
>PILOT RESPONSE	Warning	Siren	After caution message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specified time.
>PILOT RESPONSE	Caution	Beeper	After advisory message PILOT RESPONSE displayed, FMC does not detect crew activity in monitored area within a specified time.
>PILOT RESPONSE	Advisory		FMC does not detect crew activity in monitored area within a specified time.

Miscellaneous EICAS Memo Messages

Message	Level	Aural	Message Logic
VMO GEAR DOWN	Memo		Gear down dispatch has been selected in the electronics bay.

Message	Level	Aural	Message Logic
VMO SPARE ENGINE	Memo		Spare engine dispatch has been selected in the electronics bay.