BRITISH AIRWAYS

B747
Flight Crew Operating Manual

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Rev. No.	Date Entered	Initials
ALL REVISIONS TO Rev 51 HAVE BEEN INCORPORATED	November 2011	
52	January 2012	
53	February 2013	
54	May 2013	
55	July 2013	
56	November 2013	
57	July 2014	
58	January 2015	
59	June 2015	
60	February 2016	
61	August 2016	
62	January 2017	
63	November 2017	

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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	Serial Number	Tabulation Number
NLK	G-BNLK	24053	RT481
NLN	G-BNLN	24056	RT484
NLO	G-BNLO	24057	RT485
NLP	G-BNLP	24058	RT486
NLY	G-BNLY	27090	RT494
YGA	G-BYGA	28855	RM143
YGB	G-BYGB	28856	RM144
YGC	G-BYGC	25823	RM145
YGD	G-BYGD	28857	RM261
YGE	G-BYGE	28858	RM262
YGF	G-BYGF	25824	RM263
YGG	G-BYGG	28859	RM264
IVA	G-CIVA	27092	RT496
IVB	G-CIVB	25811	RT497
IVC	G-CIVC	25812	RT498
IVD	G-CIVD	27349	RT499

Airplane Number	Registry Number	Serial Number	Tabulation Number
IVE	G-CIVE	27350	RU121
IVF	G-CIVF	25434	RU122
IVG	G-CIVG	25813	RU123
IVH	G-CIVH	25809	RU124
IVI	G-CIVI	25814	RU125
IVJ	G-CIVJ	25817	RU126
IVK	G-CIVK	25818	RU127
IVL	G-CIVL	27478	RU128
IVM	G-CIVM	28700	RU129
IVN	G-CIVN	28848	RU130
IVO	G-CIVO	28849	RU131
IVP	G-CIVP	28850	RU132
IVR	G-CIVR	25820	RM136
IVS	G-CIVS	28851	RM137
IVT	G-CIVT	25821	RM096
IVU	G-CIVU	25810	RM097
IVV	G-CIVV	25819	RM138
IVW	G-CIVW	25822	RM139
IVX	G-CIVX	28852	RM140
IVY	G-CIVY	28853	RM141
IVZ	G-CIVZ	28854	RM142

General

This Flight Crew Operations Manual (FCOM) has been prepared by Boeing Commercial Airplanes, and amended by British Airways Flight Operations Department. 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 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.

Statement of Applicability

The FCOM, QRH and FCTM form part of OM B for the B747. Documents which satisfy the requirements of AMC3.ORO.MLR.100 'Aircraft Operating Matters - Type Related' include:

- OM B GEN Procedures
- FCOM
- QRH
- FCTM
- Performance Manual
- Load and Balance Manual
- FAM
- CDL/MEL

Specific information detailing compliance information and matters pertaining to ORO.GEN.200 are contained in the BA OPM.

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 revision number and page date. The page date is the date of publication of the manual or the most recent revision date.

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):

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

   "N-AA - N-BB ; before SB," 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
(N-AA - N-BB ; SB installs thrust reverser locks)
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.

"N-AA - N-BB ; SB" 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 "installs thrust reverser locks" 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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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
FWSOV	Firewall Shutoff Valve

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
HP	High Pressure
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
IGS	Instrument Guidance System
IN	Inches
IND LTS	Indicator Lights
ILS	Instrument Landing System
IP	Intermediate Pressure
ISFD	Integrated Standby Flight Display

J

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
OM A	Flight Crew Policy Manual
OM B GEN	Crew Procedures Manual
OVHD	Overhead
OVRD	Override

P	
PA	Passenger Address
PASS	Passenger
PBN	Performance Based Navigation
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
PRSOV	Pressure Regulating Shutoff Valve
PRV	Pressure Regulating Valve
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
RNP	Required Navigation Performance
RSV XFER	Reserve Transfer
RTO	Rejected Takeoff
RTP	Radio Tuning Panel
RVSM	Reduced Vertical Separation Minima
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
TAT	Total Air Temperature
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
VPP	VNAV Path Pointer
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

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Revision Transmittal Letter

To: All holders of British Airways Plc 747 Flight Crew Operations Manual, Boeing Document Number D6-30151-406.

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
26	October 1, 1998		27	April 1, 1999	
28	October 1, 1999		29	April 1, 2000	
30	October 1, 2000		31	April 1, 2001	
32	November 1, 2001		33	May 1, 2002	
34	November 1, 2002		35	May 1, 2003	
36	November 1, 2003		37	May 1, 2004	
38	October 1, 2004		39	April 1, 2005	
40	October 1, 2005		41	April 1, 2006	
42	October 1, 2006		43	April 1, 2007	
44	October 1, 2007		45	April 1, 2008	
46	October 1, 2008		47	April 1, 2009	
48	October 1, 2009		49	April 1, 2010	
50	October 1, 2010		51	April 1, 2011	
52	October 1, 2011		53	April 1, 2012	
54	October 1, 2012		55	April 1, 2013	
56	October 1, 2013		57	April 1, 2014	
58	October 1, 2014		59	March 20, 2015	

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
60	October 1, 2015		61	April 1, 2016	
62	October 1, 2016		63	April 1, 2017	

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. This manual is effective upon receipt and supersedes any previous revision of this manual.

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.

Chapter 0 - Preface

Section 6 - Bulletin Record

General

0.6.3 - Revised to reflect current bulletin status.

0.6.3 - Revised to reflect current bulletin status.

Chapter L - Limitations

Section 10 - Operating Limitations

Weight Limitations

L.10.3 - Various effectivity updates to match active fleet

Chapter NP - Normal Procedures

Section 11 - Introduction

Standard Callouts – ILS Approach

NP.11.18 - Continue callout added

Standard Callouts – Non-ILS Approach

NP.11.19 - Continue callout added

Section 21 - Amplified Procedures

Preliminary Preflight Procedure - P2

NP.21.2 - A re-introduction of the CVR test in the preflight procedure. There are two different CVR variants on the fleet and so the steps are slightly different depending on registration.

Preflight Procedure - First Officer

NP.21.16 - Removes Fuel Transfer Main switch without valve light.

Engine Start Procedure

NP.21.34 - Added improved guidance for use of Autostart at high elevation airports.

Flap Retraction Schedule

NP.21.39 - Added procedure step to reflect fleet configuration.

Landing Procedure - Instrument Approach Using VNAV

NP.21.47 - Clarification on the use of VNAV or LNAV minima on RNP APCH procedures and alignment with OM A policy.

Rejected Landing Procedure

NP.21.51 - Rejected landing procedure added.

Chapter SP - Supplementary Procedures

Section 4 - Automatic Flight

AFDS

SP.4.1 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.1 - Paragraph added for 2015 Magvar.

SP.4.1 - Added sentence; Magvar 2015 installed.

SP.4.2 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

Autothrottle Operation

SP.4.3 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.3 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.3 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.3 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.3 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

Instrument Approach Using Vertical Speed (V/S)

SP.4.10 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.10 - Eliminated unnecessary bold font and modified language for consistency with Boeing standards.

SP.4.10 - Revised AUTOTHROTTLE and AUTOPILOT switch nomenclature.

SP.4.10 - Revised AUTOTHROTTLE and AUTOPILOT switch nomenclature.

Section 7 - Engines, APU

Shutdown and Tow In Procedure - APU Unavailable

SP.7.3 - Procedure modified using Boeing standards. Adds robust assurance that hydraulic selections are appropriate.

Shutting Engines Down With APU U/S

SP.7.5 - Deleted as not applicable to this aircraft or engine type.

Section 8 - Fire Protection

SP.8.1 - Deleted info for consistency.

Section 11 - Flight Management, Navigation

SP.11.8 - Deleted Navaid Inhibit Procedure for airplanes with NG FMC installed. Procedure no longer applicable to fleet configuration.

Navaid Inhibit

SP.11.8 - Added Navaid Inhibit Procedure for airplanes with NG FMC installed.

Chapter 2 - Air Systems

Section 20 - Air Conditioning System Description

Lavatory and Galley Ventilation

2.20.6 - Editorial revision. No text change.

Chapter 5 - Communications

Section 36 - Company Datalink (NG FMC)

Company Datalink

5.36.4 - Changed the spelling.

5.36.4 - Changed the spelling.

Chapter 7 - Engines, APU

Section 10 - Primary Engine Indications

Primary Engine Display

7.10.6 - Changed the spelling.

Section 40 - EICAS Messages

EICAS Alert Messages

7.40.1 - Deleted extra space.

Chapter 9 - Flight Controls

Section 20 - System Description

Pitch Control

9.20.4 - Added takeoff thrust derate selection per DLH customer request

Chapter 10 - Flight Instruments, Displays

Section 10 - Controls and Indicators

Heading Reference, Inboard and Lower Displays

10.10.37 - Deleted NORM bullet; no longer applicable to fleet configuration.

10.10.37 - Deleted Note; not applicable to fleet configuration.

Section 20 - System Description

Standby Flight Instruments

10.20.6 - Deleted paragraph that reflected MAGVAR 2015 is not installed.

Chapter 11 - Flight Management, Navigation

Section 20 - Navigation Systems Description

Global Positioning System (GPS)

11.20.2 - DELETED; next generation FMC not installed

Section 31 - Flight Management System Operation

Maintenance Index

11.31.5 - Deleted illustration; next generation FMCs installed.

11.31.5 - Deleted callout; next generation FMCs installed.

FMC Polar Operations

11.31.8 - With FMC extended MAGVAR, information no longer applies.

Navigation Performance

11.31.10 - Deleted illustration; next generation FMCs installed.

Lateral Navigation (LNAV)

11.31.11 - A constant radius-to-fix arc procedure not available.

11.31.16 - Deleted illustration; next generation FMCs installed.

11.31.17 - Deleted paragraph; next generation FMCs installed.

11.31.17 - Deleted paragraph; next generation FMCs installed.

11.31.18 - Deleted bullets; next generation FMCs installed.

Vertical Navigation (VNAV)

11.31.26 - Deleted; next generation FMCS not installed

11.31.26 - Deleted; next generation FMCS not installed

Section 32 - Flight Management Computer

FMC Database

11.32.1 - Deleted bullet list; next generation FMCs installed.

Section 45 - FMC Preflight (NG FMC)

Preflight Pages - Part 2B

11.45.51 - Deleted illustration; next generation FMCs installed.

Section 60 - EICAS Messages

EICAS Alert Messages

11.60.1 - Deleted two level UNABLE RNP message to reflect installation of IDS 508 or later software, or NG FMC.

FMC Messages

11.60.2 - Deleted FMC Alert Message list; next generation FMC installed; new list applies.

11.60.6 - Deleted FMC Advisory Message list; next generation FMC installed; new list applies.

Chapter 12 - Fuel

Section 10 - Controls and Indicators

Miscellaneous Fuel Control

12.10.5 - Revised to reflect airplane configuration.

12.10.5 - Revised to reflect airplane configuration.

Chapter 15 - Warning Systems

Section 20 - System Description

Ground Proximity Warning System (GPWS) and Predictive Windshear (PWS)

15.20.17 - Revised to reflect airplane configuration.

Ground Proximity Warning System (GPWS)

15.20.17 - Revised to reflect airplane configuration.

15.20.17 - Revised to reflect airplane configuration.

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Preface — Chapter 0

List of Effective Pages — Section 5

Page	Rev	Date	Page	Rev	Date
0.0.1	53	Apr 2012	0.5.8	63+	Apr 2017
0.0.2	53	Apr 2012	0.5.9	63+	Apr 2017
0.1.1	63	Apr 2017	0.5.10	63+	Apr 2017
0.1.2	63	Apr 2017	0.5.11	63+	Apr 2017
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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
BAB-7 R6	Anomalous EICAS Messages	October 1, 1998	IE
BAB-88 R1	High Engine Vibration in Icing Conditions	October 1, 1998	IE
BAB-113 R3	Early VNAV Descent and Erroneous FMC Fuel Predictions	June 2, 2003	IE
BAB-135 R1	EICAS Advisory Message NO AUTOLAND	November 11, 2002	IE
BAB-136 R2	FMC Takeoff Speeds Anomaly	June 2, 2003	IE
BAB-146	GPWS Minimums Voice Alert Anomaly	May 8, 2000	IE
BAB-147 R2	Triple Flap Control Unit (FCU) Failure	June 2, 2003	INC
BAB-149 R1	Incorrect Maneuvering Speeds for Flap Retraction	June 2, 2003	IE
BAB-154 R1	FMC Performance Predictions Anomaly	April 1, 2006	IE
BAB-156 R1	Potential Sequential Loss of Multiple Hydraulic Systems	October 2, 2008	IE
BAB-157 R1	Landing Gear Configuration Warning Anomaly	November 21, 2008	IE
BAB-158	Honeywell Flight Management Computer Anomaly	October 15, 2007	IE
BAB-159	Hand microphone use with flight deck PC power outlets	August 20, 2008	IE
BAB-160	FCOM Update - Horizontal Stabilizer Tank (HST) Automatic Fuel Pump Shutoff	October 1, 2010	CANC
BAB-161 R1	Uncommanded Turns When LNAV is in Use	May 7, 2014	IE

Number	Subject	Date	Status
BAB-162 R1	New Core Ice Shedding Procedure When Operating in Freezing Fog	January 7, 2011	IE
BAB-164 R4	FMC Anomalies	December 1, 2014	CANC
BAB-165	Bank Angle Anomaly When LNAV is in Use	April 1, 2014	IE
BAB-166 R2	New and Revised FMC Scratchpad Messages	September 29, 2016	IE
BAB-167 R2	FMC Anomalies	December 22, 2016	IE
BAB-168	New FUEL DISAGREE Non-Normal Checklist and Revised Fuel Leak Engine Non-Normal Checklist	February 1, 2016	INC
BAB-169	Flight crew seat adjustment	December 15, 2017	IE

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-7 R6

IssueDate: October 1, 1998

Airplane Effectivity: G-BNLK - G-BNLP

Subject: Anomalous EICAS Messages

Reason: To inform flight crews that there may be anomalous EICAS messages when there is no problem with the associated system.

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

Anomalous EICAS messages may be displayed as a result of system power-up and shutdown sequencing, system conditional requirements not satisfied prior to system checks, or known deficiencies within EICAS and interfacing systems.

Operating Instructions

The following EICAS messages may be intermittently displayed:

***AUTOBRAKES** - Advisory message may be displayed intermittently with Autobrake Selector in any armed position.

Memo message may blank or change to AUTOBRAKES MAX intermittently for 1-3 seconds then return to the level actually selected.

****TEMP CARGO HEAT** - Advisory message may be displayed after takeoff when ambient temperature is high.

*****BLD DUCT LEAK C** - Caution message will be displayed incorrectly during FIRE/OVERHEAT TEST. Disregard message during test until revised software and the center bleed duct detection system is installed.

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****FUEL STAB XFR - Caution message may be displayed during climb with low fuel in the stabilizer tanks.

*This section does not apply to affected airplanes modified by SB 747-32-2377.

**This section does not apply to affected airplanes modified by SB 747-21-2302.

***This section does not apply to affected airplanes modified by SB 747-26-2157.

****This section does not apply to affected airplanes modified by Service Letter 747-SL-28-63.

Administrative Information

This bulletin replaces bulletin BAB-7 R5 dated February 28, 2007. Discard BAB-7 R5. Revise the Bulletin Record to show BAB-7 R5 “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 BAB-7 R6 as "In Effect" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified all affected airplanes in your fleet have been modified by appropriate Service Bulletins.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

BA NOTE: SB embodiment across the fleet for AUTOBRAKES and FUEL STAB XFR messages. But only partial embodiment for the CARGO TEMP HEAT anomalous EICAS message.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-88 R1

IssueDate: October 1, 1998

Airplane Effectivity: All Airplanes

Subject: High Engine Vibration In Icing Conditions

Reason: To provide a procedure for removing ice from the engine fan blades during operation in icing conditions.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There have been several reported incidents by two 747-400 operators of high engine vibration during cruise in icing conditions. Increase in engine vibration levels were observed with TAT below zero degrees C after extended operation at high altitude in clouds. An AVM “pop-up” at 2.5 units occurred on one or more engines, in some instances, increasing up to full scale (5.0 units). In all of the events, engine vibration returned to normal either prior to or during descent, after temperatures increased to above freezing.

Engine damage should not result from vibration caused by icing, nor is any crew action required for such vibration. Certain crew actions to adjust thrust may, however, reduce or minimize vibration (see operating instructions below).

The reported incidents are under investigation, in the interim the following operating instructions are recommended:

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Operating Instructions

Increase in engine vibration above 2.5 units may occur due to accumulation of ice on the spinner and engine fan blades. After a short period of time, this ice will usually shed and vibration will return to pre-icing encounter levels. If desired, to assist in ice shedding, rapidly retard thrust lever (on one engine at a time) to IDLE. Approximately 5 seconds after the engine reaches idle, advance thrust momentarily to a minimum of 90% N1.

Note: In severe icing conditions, this procedure may not cause complete shedding of ice until descent to an altitude where temperatures have increased to above freezing.

If vibration does not decrease, normal flight operations should be continued. Vibration indications may be reduced by thrust lever adjustment. An engine should not be shutdown unless required by other abnormal engine indications.

Administrative Information

This bulletin replaces bulletin BAB-88 dated February 28, 2007. Discard BAB-88. Revise the Bulletin Record to show BAB-88 “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 BAB-88 R1 as "In Effect" (IE).

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-113 R3

IssueDate: June 2, 2003

Airplane Effectivity: All Airplanes

Subject: Early VNAV Descent And Erroneous FMC Fuel Predictions

Reason: To advise flight crews of erroneous FMC fuel predictions when VNAV descent is initiated using the DES NOW prompt on the CDU.

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 Boeing Service Bulletin 747-34-2785 (FMC software load 16).

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

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

The DES NOW prompt, displayed at 6R on the inactive VNAV Descent page, allows transition to the descent phase early (before T/D). With MCP altitude set for descent, the autothrottle adjusts thrust to descend on a shallow path at approximately 1250 feet per minute. Shallow descent is maintained until the VNAV path is captured and the autothrottle sets idle thrust.

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With the VNAV descent phase active, the FMC computes destination fuel assuming idle thrust on the VNAV path. However, actual fuel flow using DES NOW when not on VNAV path is greater than idle fuel flow used for FMC fuel computations. As a result, early descent using DES NOW introduces a fuel computation error. The error increases with distance from T/D when descent is initiated.

The software coding anomaly causing the FMC to use idle fuel flow data during shallow descents prior to capturing the VNAV path is corrected in FMC software load 16.

Operating Instructions

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

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

Administrative Information

This bulletin replaces bulletin BAB-113 R2 dated December 11, 1998. Discard BAB-113 R2. Revise the Bulletin Record to show BAB-113 R2 “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 BAB-113 R3 as "In Effect" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified all affected airplanes in your fleet have been modified by Service Bulletin 747-34-2785.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

CS3 2556

BA NOTE: This bulletin is not applicable to aircraft with FANS embodiment completed.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-135 R1

IssueDate: November 11, 2002

Airplane Effectivity: G-BNLK - G-BNLY, G-CIVA - G-CIVE

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.

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Administrative Information

This bulletin replaces bulletin BAB-135 dated October 1, 1998. Discard BAB-135. Revise the Bulletin Record to show BAB-135 “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 BAB-135 R1 as "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 Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-136 R2

IssueDate: June 2, 2003

Airplane Effectivity: All Airplanes

Subject: FMC Takeoff Speeds Anomaly

Reason: To inform flight crews of an FMC anomaly affecting takeoff speeds.
Revised to add corrective 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 Boeing Service Bulletin 747-34-2785 (FMC software load 16).

Boeing has received reports of left and right CDUs and/or PFDs displaying different takeoff speeds. This anomaly has been under investigation and, until recently, could not be duplicated under controlled conditions. Engineering investigation of a similar anomaly in the latest version of FMC software (FMC load 15) confirms different takeoff speeds can occasionally display on left and right CDUs. This bulletin revision describes the FMC load 15 anomaly, and adds new information concerning the original anomaly.

In one reported example of the original anomaly, the CDUs displayed the following:

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

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In another instance, the incorrect VR speed on a CDU was the same as the V1 speed on one PFD, while the other PFD displayed all speeds correctly. In other instances, CDUs displayed erroneous speeds, but all speeds displayed correctly on both PFDs.Recent engineering testing demonstrated the anomaly can occur when changes to the following result in recalculation of takeoff speeds:

- performance data on the PERF INIT page
- takeoff thrust limit on the THRUST LIM page.

PERFORMANCE DATA CHANGES -- A change to GR WT, FUEL or ZFW on the PERF INIT page displays recalculated takeoff speeds (small font) on the TAKEOFF REF page. With FMC load 15, previous (invalid) takeoff speeds may display again for up to 20 seconds before the correct speeds display. This occurred intermittently during engineering testing. If previous takeoff speeds are selected, they change to large font and appear on each CDU and each PFD airspeed display. The result is display of invalid takeoff speeds for existing airplane conditions. This occurs only in FMC load 15 and does not appear to be related to the original anomaly.

THRUST LIMIT CHANGES -- Changing the selected takeoff thrust limit on the THRUST LIM page displays recalculated takeoff speeds (small font) on the TAKEOFF REF page. With all versions of FMC software, previous (invalid) takeoff speeds may display briefly. If previous takeoff speeds are selected, invalid large font takeoff speeds display on one CDU, and different, calculated (small font) takeoff speeds display on the other. The invalid large font takeoff speeds display on both PFD airspeed displays.

When these anomalies were observed, invalid takeoff speeds were replaced with valid speeds within 20 seconds provided they were not selected (remained small font). If invalid speeds are selected before engine start, the FMC, after start of the third engine, recalculates takeoff speeds, displays the scratchpad message TAKEOFF SPEEDS DELETED, and displays valid recalculated speeds (small font) on the TAKEOFF REF page. If invalid speeds are selected after engine start, the FMC does not perform a takeoff speed validation and does not provide any flight crew alert.

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

With FMC software load 16, this anomaly is corrected and the requirement for takeoff speed comparison and verification during the BEFORE START PROCEDURE is removed.

Operating Instructions

Before and after selecting takeoff speeds during the BEFORE START PROCEDURE, compare the captain's and first officer's takeoff speeds.

If any speed is incorrect, manually enter the correct speed and compare the displayed speeds.

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If any change is made to performance data on the PERF INIT page or the takeoff thrust limit on the THRUST LIM page after takeoff speeds are displayed on the TAKEOFF REF page, wait a minimum of 20 seconds before selecting the calculated takeoff speeds to large font. Compare the Captain's and First Officer's takeoff speeds. If any speed is incorrect, manually enter the correct speed and compare the displayed speeds.

Administrative Information

This bulletin replaces bulletin BAB-136 R1 dated April 9, 2001. Discard BAB-136 R1. Revise the Bulletin Record to show BAB-136 R1 "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 BAB-136 R2 as "In Effect" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified all affected airplanes in your fleet have been modified by Service Bulletin 747-34-2785.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

CS3 2739

BA NOTE: Current SOPs include mitigation for this anomaly.
This bulletin is not applicable to aircraft with FANS embodiment completed.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-146

IssueDate: May 8, 2000

Airplane Effectivity: G-BYGB - G-BYGG

Subject: GPWS Minimums Voice Alert Anomaly

Reason: To inform flight crews of an anomaly in the Minimums Voice Alert functionality.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The GPWS Minimums Voice Alerts do not always function correctly on airplanes equipped with Look-Ahead Terrain Alerting. If the Minimums Selector (MINS) on the EFIS Control Panel is rotated from BARO to RADIO below 1000 feet AGL, the voice alert may occur immediately and not at the appropriate altitude. This does not occur when the selector is rotated above 1000 feet AGL.

The Landing Altitude/Minimums Indications on the PFD function correctly. These include the BARO Pointer and BARO/RADIO Altitude Reference Display.

Operating Instructions

Do not rotate the Minimums Selector on the EFIS Control Panel from BARO to RADIO once the airplane has descended below 1000 feet AGL.

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 BAB-146 as "In Effect" (IE).

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

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-147 R2

IssueDate: June 2, 2003

Airplane Effectivity: All Airplanes

Subject: Triple Flap Control Unit (FCU) Failure

Reason: To inform flight crews of the effects of failure of all three FCUs.

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 affected 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

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- 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 respective 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 BAB-147 R1 dated March 15, 2001. Discard BAB-147 R1. Revise the Bulletin Record to show BAB-147 R1 “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 BAB-147 R2 as "Incorporated" (INC).

This bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by SB 747-27A2386.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-149 R1

IssueDate: June 2, 2003

Airplane Effectivity: All Airplanes

Subject: Incorrect Maneuvering Speeds For Flap Retraction

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

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

This bulletin does not apply to airplanes modified by Boeing Service Bulletin 747-34-2767 (FMC software load 16).

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

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

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

Operating Instructions

During preflight, verify the FLAP/SPEED line on the CDU APPROACH REF Page is blank. Refer to the revised Preflight Procedures in your Operations Manual.

Operations Manual Information

With FMC load 16, the FLAP/SPEED line verification requirement is removed. Preflight procedures will be restored to original configuration after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-34-2767.

Administrative Information

This bulletin replaces bulletin BAB-149 dated December 19, 2000. Discard BAB-149. Revise the Bulletin Record to show BAB-149 “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 BAB-149 R1 as "In Effect" (IE).

This Operations Manual Bulletin will be cancelled after Boeing has been notified all affected airplanes in your fleet have been modified by Service Bulletin 747-34-2767.

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BA NOTE: Current SOPs include mitigation for this anomaly. This bulletin is not applicable to aircraft with FANS embodiment completed.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-154 R1

IssueDate: April 1, 2006

Airplane Effectivity: All Airplanes

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.

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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 BAB-154 dated January 6, 2006. Discard BAB-154. Revise the Bulletin Record to show BAB-154 “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 BAB-154 R1 as "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.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-156 R1

IssueDate: October 2, 2008

Airplane Effectivity: All Airplanes

Subject: Potential Sequential Loss of Multiple Hydraulic Systems

Reason: This is a reissue of BAB-156, 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.

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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

This bulletin replaces bulletin BAB-156 dated February 28, 2007. Discard BAB-156. Revise the Bulletin Record to show BAB-156 “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 BAB-156 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.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-157 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.

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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 BAB-157 dated October 1, 2007. Discard BAB-157. Revise the Bulletin Record to show BAB-157 “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 BAB-157 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.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-158

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.

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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 BAB-158 as "In Effect" (IE).

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

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-159

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 BAB-159 as "In Effect" (IE).

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

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-161 R1

IssueDate: May 7, 2014

Airplane Effectivity: All Airplanes

Subject: Uncommanded Turns When LNAV is in Use

Reason: To inform flight crews of the possibility of the airplane turning prior to the active waypoint when LNAV is in use.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received several reports of uncommanded turns when LNAV is in use. This condition has been reported on 757, 767, 747-400 and 777 airplanes. When an uncommanded turn occurs, the TO (active) waypoint was observed on the FMC CDU to have prematurely sequenced. In some cases, the ND correctly showed the TO waypoint in front of the airplane, but the waypoint symbol's color was white (indicating inactive) instead of magenta (indicating active). This condition was usually resolved by performing a DIRECT TO to the waypoint that had prematurely sequenced.

Operating Instructions

Incorrect waypoint sequencing can occur when attempting route modifications within approximately 1 NM of the active waypoint for small route modifications, or within approximately 4 NM of the active waypoint for modifications with a large turn.

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When approaching an active waypoint, the following will limit incorrect waypoint sequencing:

- Avoid executing a lateral OFFSET
- Avoid entry of a vertical or lateral flight plan change
- Avoid executing a DIR-TO with ABEAM selected.

If a premature waypoint sequence in the flight plan is observed before executing the flight plan change, the change can be erased. The premature waypoint sequence and the associated uncommanded turn will not occur.

Should an uncommanded turn occur when using LNAV, select HDG SEL to follow the flight plan, then perform a DIRECT TO to the waypoint that prematurely sequenced. Reengage LNAV as desired.

Administrative Information

This bulletin replaces bulletin BAB-161 dated October 21, 2010. Discard BAB-161. Revise the Bulletin Record to show BAB-161 “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 BAB-161 R1 as "In Effect" (IE).

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

This bulletin will be revised to include information about the service bulletin that resolves the condition when that information becomes available.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-162 R1

IssueDate: January 7, 2011

Airplane Effectivity: All Airplanes

Subject: New Core Ice Shedding Procedure When Operating in Freezing Fog

Reason: To inform flight crews of a special ice shedding procedure that can be used in freezing fog conditions.

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

Operators exposed to freezing fog who wish to minimize the risk of unplanned engine removals associated with ice damage to the engine core may use a new, optional core ice shedding procedure. The borescope inspection requirements following exposure to freezing fog in the Aircraft Maintenance Manual (AMM) remain in effect.

Boeing has received reports of internal engine damage on RB211-524 powered 747-400 airplanes. The damage occurred after extended idle thrust operation in freezing fog. In freezing fog, ice can build up in the core of the engine as well as on the fan blades.

Analysis has shown the current RB211-524 ground engine ice shedding procedure, which requires operation at 60% N1 for 10 seconds every 60 minutes, is adequate for shedding fan blade ice accumulations but may not always shed core ice accumulations in freezing fog conditions.

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Analysis has also shown extended exposure to freezing fog conditions below -13°C can create ice accumulations impractical or impossible to shed using ground run-up procedures. The use of engine anti-ice on the ground will not prevent ice accumulations on the fan blades or in the core of the engine. An engine that experiences freezing fog on taxi in to the gate will not shed the ice when the engine is shut down in cold temperatures. For this reason, the total engine running time of taxi in and taxi out, including warm up and cool down times, in freezing fog must be considered.

A new, optional core ice shedding procedure has been developed for operations in freezing fog. This procedure does not apply to operations in snow, hail, sleet, freezing rain, or freezing drizzle. These condition have a larger water particle size that does not cause ice accumulation in the core of the engine.

Boeing and Rolls Royce recommend using the new, optional core ice shedding procedure any time total taxi time in freezing fog (FZFG as reported in the METAR) exceeds 30 or 45 minutes, dependent on ambient air temperature, when visibility is 900 feet (300 meters) RVR or less as reported in the METAR. In freezing fog, inbound flight crews must make a log book entry of the total number of minutes taxiing in when visibility is 300 meters RVR or less so the subsequent outbound flight crew can calculate the total taxi time in these conditions.

The new, optional core ice shedding procedure for operations in freezing fog is summarized in Figure 1.

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Figure 1

Operating Instructions

Flight crews may use the new, optional core ice shedding procedure for RB211-524 engines when freezing fog (FZFG) with visibility of 900 feet (300 meters) RVR or less is reported in the METAR to minimize compressor damage.

Note: If taxi in on the previous flight occurred in freezing fog and the temperature stayed below freezing, the taxi in time from the previous flight must be included in the total time. If the engine is considered free of ice before engine start, only the taxi out time should be included in the total time. The engine is considered free of ice before engine start if:

- the engine has been manually de-iced, or
- the engine has been visually inspected per the AMM, or
- the core ice shedding procedure was conducted within 5 minutes prior to engine shutdown during taxi in.

If the subsequent takeoff cannot be accomplished within 45 minutes total taxi time for a OAT of 0°C to -6°C, or 30 minutes for an OAT of -7°C to -13°C, accomplish the new core ice shedding procedure to clear the ice from the engine core. The core ice shedding procedure should be accomplished at intervals no greater than every 30 or 45 minutes, dependent on OAT, before takeoff.

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For an OAT of -14°C or below, if the subsequent takeoff cannot be accomplished within 30 minutes total taxi time, manual de-icing is needed. To avoid manual de-icing requirements, operators are encouraged to work with airport authorities to limit or eliminate exposure to extended taxi times when freezing fog conditions exist.

If the subsequent takeoff can be accomplished within 45 minutes total taxi time for an OAT of 0°C to -6°C, or 30 minutes total taxi time for an OAT of -7°C or below, the new core ice shedding procedure does not need to be done.

CAUTION: As with all engine run-ups, precautions must be taken for:

- jet blast up to 600 feet (200 meters) behind the aircraft
- snow and ice at the edge of the taxiway that can be ingested by the engines
- slippery taxi surfaces
- airport noise restrictions

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In Figure 1 above, determine the Zone (A, B, or C). For the applicable Zone, accomplish an ice shedding run-up to the % N1 for either of the times shown in Table 1below.

Note: 66% N1 maximum is recommended to prevent engine vibration damage and to respect the takeoff configuration warning that may annunciate at 70% N1.

Run-up Time	30 secs	60 secs
Zone A, 0°C to -6°C See Note 1 (Fuel used, all engine)	60% N1 (170 lbs)	50% N1 (275 lbs)
Zone B, -7°C to -13°C See Note 2 (Fuel used, all engine)	Not Available	66% N1 (425 lbs)
Zone C, -14°C or below	Manually de-ice	

Table 1

- **Note 1:** During taxi, if the temperature falls below -6°C, accomplish an immediate run-up and continue to use the procedure for Zone A. If an immediate run-up cannot be accomplished, use the procedure for Zone B.
- **Note 2:** During taxi, if the temperature falls below -13°C, accomplish an immediate run-up and continue to use the procedure for Zone B. If an immediate run-up cannot be accomplished, use the procedure for Zone C.

In all cases, accomplish the Nacelle Anti-Ice Operation - On the Ground supplementary procedure before brake release for takeoff.

Administrative Information

This bulletin replaces bulletin BAB-162 dated December 20, 2010. Discard BAB-162. Revise the Bulletin Record to show BAB-162 “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 BAB-162 R1 as "In Effect" (IE).

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

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

Number: BAB-165

IssueDate: April 1, 2014

Airplane Effectivity: All 747-400 Airplanes With the Next Generation (NG) FMC

Subject: Bank Angle Anomaly When LNAV is in Use

Reason: To inform flight crews of the possibility of a short duration bank angle overshoot when LNAV is in use and the autopilot is engaged.

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

With LNAV as the active roll mode and the autopilot engaged, a large course change, caused by exiting a hold with a “DIRECT TO” modification of the route, can result in occasional, short duration, bank angle overshoots. The bank angle can momentarily exceed 30 degrees.

Operating Instructions

For a short duration bank angle overshoot, no flight crew action is needed; the autopilot will self-correct. However, if at any time, the automatic systems do not operate as expected, the flight crew should reduce the level of automation, as needed, to achieve proper control and performance.

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 BAB-165 as "In Effect" (IE).

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-166 R2

IssueDate: September 29, 2016

Airplane Effectivity: All 747-400 Airplanes With the Next Generation (NG) FMC

Subject: New and Revised FMC Scratchpad Messages

Reason: To advise flight crews that the non-normal checklist associated with the careted EICAS message >FMC MESSAGE contains procedural steps for the new VNAV STEP CLIMB and the revised INSUFFICIENT FUEL FMC scratchpad messages. This checklist should be done when needed.

Revised to delete references to IDS-508 software, which does not remove the caret from this message for airplanes with the NG FMC installed.

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

When the NG FMC is installed on 747-400 airplanes, two FMC scratchpad message changes are included:

- A new VNAV STEP CLIMB message
- A revised INSUFFICIENT FUEL message

Steps for addressing these scratchpad messages are included in the revised >FMC MESSAGE non-normal checklist.

Operating Instructions

If the >FMC MESSAGE EICAS message shows in flight, do the respective non-normal checklist.

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The current guidance in the Quick Reference Handbook (QRH) for careted messages states “A caret 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 by caret symbols.” However, the revised checklist for >FMC MESSAGE is included in the QRH and flight crews are required to do the appropriate checklist steps when needed.

Administrative Information

This bulletin replaces bulletin BAB-166 R1 dated April 1, 2014. Discard BAB-166 R1. Revise the Bulletin Record to show BAB-166 R1 “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 BAB-166 R2 as "In Effect" (IE).

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-167 R2

IssueDate: December 22, 2016

Airplane Effectivity: All 747-400 Airplanes With the Next Generation (NG) FMC and Block Point (BP) 3.1

Subject: FMC Anomalies

Reason: To inform flight crews of a list of FMC anomalies.

Revised to include two new anomalies and to modify three others.

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 747-400 airplanes when modified by Boeing Service Bulletin (SB) 747-34-3062.

This bulletin details FMC anomalies. These anomalies will be corrected in future FMC software updates.

- **Command Speed Drops to the Top of the Amber Bar After Executing an FMC Air Traffic Service or Company Uplink in Climb**

When an Air Traffic Service (ATS) or company uplink is executed prior to reaching top of climb, VNAV can incorrectly command the minimum maneuvering speed for the current configuration. The command speed at the top of the speed tape on the primary flight display shows this new value, and the command speed bug points to the top of the lower amber bar. The airplane pitches up and the airspeed decreases to the new command speed.

VNAV commands the correct speed upon reaching top of climb. Cruise climbs and step climbs are not affected by an executable uplink.

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Operating Instructions

If an executable ATS uplink is received while in climb, use speed intervention prior to executing the ATS uplink. The IAS/MACH window can be closed once the top of climb is reached.

Do not execute company uplinks between takeoff and top of climb.

- **Erroneous MAP Failed Flags on Both Navigation Displays (ND)**

The FIX INFO pages are used to create reference points and bearing/distance from the reference points on the NDs. Each of the four FIX INFO pages can have one reference point and up to three bearing/distance from the reference point. For the 747-400 with Cathode Ray Tube (CRT) displays, when four or more bearing/distances are entered on the FIX INFO pages, any subsequent flight plan modifications will not show on the NDs. If the modified flight plan is not executed within approximately 35 seconds, all map data are removed and the amber MAP fail flags show on both NDs.

Also, when more than six bearing/distances are entered on the FIX INFO pages, all map data are removed and the amber MAP fail flags show on both NDs.

Operating Instructions

On the FIX INFO pages, limit the total number of bearing/distance entries to three.

- **DIRECT TO Modification When Near the Active Waypoint Can Clear the Active Route**

Executing a DIRECT TO modification when less than 30 seconds from sequencing the active waypoint can cause loss of the active flight plan. This can occur whether the airplane is on or off the active route. When it occurs, all of the active route legs and data are removed from the navigation display (ND) and the ACT RTE X LEGS page. On the RTE page, the ORIGIN is set to the DEST airport. If LNAV and/or VNAV are engaged, these additional flight deck effects occur:

- An amber horizontal line is drawn through the corresponding roll and/or pitch flight mode annunciations (FMAs)
- The EICAS caution message AUTOPILOT displays
- The master CAUTION lights illuminate
- The beeper sounds

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The inactive flight plan is retained.

Note: Sequencing the active waypoint while off the active route occurs when the airplane crosses the angle bisector of the waypoint's inbound and outbound route segments, and is within 21 nm of the waypoint.

Operating Instructions

Do not execute a DIRECT TO modification when less than 30 seconds from sequencing the active waypoint. Use HDG SEL until the waypoint has sequenced.

If the route is removed from the ND and the CDU after a DIRECT TO modification is performed, re-enter the flight plan, including the ORIGIN and DEST.

- **Executing Enroute Winds Before Performance Calculations Are Complete Can Result in a VNAV Mode Failure**

If an enroute wind uplink is loaded and executed before the FMC performance calculations are complete, the VNAV pitch mode can deactivate. These flight deck effects occur:

- The pitch flight mode annunciation (FMA) changes to V/S, with an amber horizontal line drawn through it
- The V/S light on the mode control panel illuminates
- The EICAS caution message AUTOPILOT displays
- The master CAUTION lights illuminate
- The beeper sounds

Operating Instructions

When an enroute wind uplink is received, select the LOAD (LSK 6R) prompt on the ACT RTE X DATA page to load the uplinked data. The predicted ETA and fuel values on the ACT RTE X DATA page blank, indicating that the performance calculations are running. Once the predicted ETA and fuel values are shown again, execute the modification.

If the wind uplink modification was executed before performance calculations were complete and a VNAV mode failure occurs, push the VNAV switch on the mode control panel, after performance predictions are shown, to reselect VNAV mode.

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- **Erroneous ETA and Distance Predictions on the CRZ Page for Routes With More Than One Planned Step**

If there is more than one planned step (CLB or DES) on the RTE LEGS pages, the STEP TO altitude in 1R on the CRZ page and the ETA and distance to go for the next planned step in 2R on the CRZ page can show incorrect values. ETA and DTG on PROGRESS Page 1/4, the Step Climb (S/C) symbol on the ND, and the distance to waypoint on the RTE LEGS page are allcorrect.

Operating Instructions

If there is more than one planned step on the RTE LEGS pages, verify that the STEP TO altitude in 1R and the AT title, ETA and DTG in 2R are correct by comparing them to the waypoint, ETA and DTG on PROGRESS Page 1/4 and to the corresponding altitude on the RTE LEGS page. If any value is erroneous, re-enter the current cruise altitude on the CRZ page (select 1L twice, once to move the current cruise altitude to the scratchpad and a second time to move the current cruise altitude from the scratchpad to 1L). Execute the change.

- **Time and Distance Do Not Show on the VNAV CRZ Page When Above the Engine Out Maximum Altitude**

When the airplane is above the engine out maximum altitude, selection of the ENG OUT> prompt creates a modification and engine out driftdown (D/D) performance data is shown. Due to a software anomaly, the VNAV CRZ page does not show time and distance for the D/D to the E/O MAX altitude shown in [Line 2R].

Operating Instructions

When the airplane is above the engine out maximum altitude and the ENG OUT> prompt is selected, the PROGRESS page shows the time and distance to level off when the driftdown is active, in [Line 4R].

- **Active Cruise Speed Segment Removed After an FMC Executable Air Traffic Service or Company Uplink**

During an active Cruise Speed Segment (CSS), after an Air Traffic Service (ATS) or company uplink is executed, the active CSS speed is removed and the FMC reverts to ECON speed or, if an RTA is present in the flight plan, to RTA speed. The VNAV CRZ page title will change from ACT M.XXX CRZ to ACT ECON CRZ or ACT RTA CRZ.

Operating Instructions

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During an active CSS, after executing an ATS or company uplink, do the following to resume the CSS:

- Select VNAV CRZ page
- Enter the desired speed in [Line 2L]

The FMC will command the entered speed until:

- A waypoint with another CSS entry is sequenced, or
- Top of descent, or
- The speed mode on the VNAV CRZ page is changed.

- **ATC Uplink Containing Multiple ATC Messages Can Print Incorrectly**

When an ATC uplink contains multiple messages and the first message is a route clearance ("CLEARED ROUTE CLEARANCE"), the route clearance message prints correctly; but the subsequent messages in the uplink can be missing from the print. The CDU shows the uplink correctly and the load function, if applicable, also functions correctly.

The CDU display and load functions are the only approved methods of using ATC uplink clearances for navigation. Prints of ATC uplinks may be used only as reference material.

Operating Instructions

Do not use the print of an ATC uplink as a primary means of navigation. When an ATC uplink is received, review the contents of the ATC UPLINK page(s), in sequential order, starting with page 1. When a loadable element is included in the uplink, the <LOAD prompt displays on the last page of the uplink.

- **ATC Uplink Containing Free Text Can Print Incorrectly When Using the Secondary FMC**

When an ATC uplink that contains free text is printed using the secondary FMC (the FMC that is not selected by the FMC selector), some free text can be omitted in the printout, or in a reprint of a previous message.

Operating Instructions

Use the primary FMC to print ATC uplinks.

- **ALTN Airports ETA and Fuel Can Be Incorrect**

Estimated time of arrival and arrival fuel predictions on the ALTN page and the XXXX ALTN page can be incorrect. The magnitude of the error increases with distance to the alternate airport, and is larger for alternate airports that are abeam or behind the airplane. Predictions are accurate once the diversion is made part of the active route.

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Operating Instructions

Do not use the ALTN airports ETA and arrival fuel predictions for any of the alternate airports.

- **Dual FMC Reset Can Occur on Approach if OVERHEAD VIA is the Selected XXXX ALTN Routing**

If the OVERHEAD VIA option (line select key 3L) is currently selected on the XXXX ALTN page and the selected approach in the active flight plan contains a Course Intercept (CI) or Heading Intercept (VI) leg, a dual FMC reset can occur shortly after sequencing the CI or VI leg. The XXXX ALTN page does not have to be displayed for the reset to occur. Following the reset, PERF INIT page data can be missing; and RTE 1 is displayed as the inactive route on the ND, even if RTE 2 was the active route.

Operating Instructions

Select DIRECT TO as the route option when viewing the data for a single airport on the XXXX ALTN page..

- **Single or Dual FMC Reset Can Occur When Sequencing the Holding Fix for Certain Characteristics of the Hold**

A single or dual FMC reset can occur when the holding fix is sequenced if any of the following characteristics of the hold are present:

- An expect further clearance time (EFC TIME - line select key 3R) on the ACT RTE X HOLD page causes the FMC to predict that fuel at destination will be less than the entered reserves
- A predicted ETA entry on the FIX INFO page (line select key 6R) causes placement of the predicted position in the hold
- A predicted altitude entry on the FIX INFO page (line select key 6R) causes placement of the predicted position in the hold

Following the reset, PERF INIT page data can be missing; and RTE 1 can be displayed as the inactive route on the ND, even if RTE 2 was the active route.

Operating Instructions

Do not enter an expect further clearance time that will cause fuel at destination to be less than the entered reserve.

Do not enter a predicted ETA on the FIX INFO page that will causeplacement of the predicted position in the hold.

Do not enter a predicted altitude on the FIX INFO page that will cause placement of the predicted position in the hold.

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- **Descent Speed Target Decreases After Exiting a Hold With DIRECT TO**

In descent, if a hold is exited with DIRECT TO, the SEL SPD on PROGRESS Page 1/4 and the command speed on the PFD will show the current best hold speed. The ECON SPD or SEL SPD title and the expected speed value are shown on the VNAV DES page.

Operating Instructions

To exit a hold, select the EXIT HOLD> prompt.

If a hold is inadvertently exited with DIRECT TO and a different target speed is needed, select ECON, manually enter the speed on the VNAV DES page, or use speed intervention.

- **Autothrottle Enters THR REF Mode When THR Switch is Pushed During Go-Around and Missed Approach Procedure**

When FLCH is selected during a go-around, the autothrottle mode changes to SPD when the airplane acquires the missed approach altitude. If the THR switch is then pushed, the thrust reference correctly changes to CLB, but the autothrottle incorrectly transitions from SPD mode to THR REF mode; the thrust levers advance, and the airplane accelerates.

If during the go-around in FLCH, the THR switch is pushed while the airplane is still climbing in autothrottle mode THR, the thrust reference correctly changes to CLB and the autothrottle correctly stays in THR mode.

Operating Instructions

Select VNAV at acceleration height during go-around.

Administrative Information

This bulletin replaces bulletin TB1-35 R1 dated December 15, 2015. Discard TB1-35 R1. Revise the Bulletin Record to show TB1-35 R1 “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 TB1-35 R2 as "In Effect" (IE).

This bulletin will be updated with Service Bulletin information when revised FMC software is available.

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-168

IssueDate: February 1, 2016

Airplane Effectivity: All 747-400 Airplanes With the Next Generation (NG) FMC and IDS-503 or Later Display System Software

Subject: New FUEL DISAGREE Non-Normal Checklist and Revised Fuel Leak Engine Non-Normal Checklist

Reason: To provide appropriate checklists for airplanes with the Next Generation FMC installed.

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

Model 747-400 airplanes equipped with the Next Generation (NG) FMC and with IDS-503 or later integrated display system software incorporate a new EICAS advisory message FUEL DISAGREE, in place of the FUEL DISAGREE-PROG 2 FMS-CDU scratchpad message that was implemented with the original 747-400 FMC. This requires a new non-normal checklist FUEL DISAGREE. A new CCU scratchpad message FUEL FLOW ENG 1, 2, 3, 4 is also added. These messages require modification of the existing non-normal checklist Fuel Leak Engine. These two checklists are attached to this bulletin.

The table below lists the pages attached to this bulletin. Remove existing pages corresponding to the pages listed below and replace them with the attached pages.

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Page	Date
Alpha.Index.1-8	October 1, 2015
EICAS.Index.1-8	October 1, 2015
Unann.Index.1-2	October 1, 2015
12.TOC.1-2	October 1, 2015
12.1-28	Various

Operating Instructions

If the EICAS advisory message FUEL DISAGREE is shown, do the attached FUEL DISAGREE non-normal checklist. If there is a need to do the Fuel Leak Engine non-normal checklist, do the attached Fuel Leak Engine non-normal checklist.

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 BAB-168 as "Incorporated" (INC).

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

Please send all correspondence regarding Flight Crew Operations Manual Bulletin status to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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Flight Crew Operations Manual Bulletin
for
British Airways

The Boeing Company
Seattle, Washington 98124-2207

747-400

Number: BAB-169

IssueDate: December 15, 2017

Subject: Flight crew seat adjustment

Reason: To inform flight crews of the potential for uncommanded seat movement resulting from damage incurred during manual fore and aft adjustment.

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

Aircraft operators have reported instances of uncommanded seat movement as a result of damage incurred during manual fore and aft adjustments. To mitigate the potential for this to occur, Boeing is including a WARNING in Chapter One of the FCOM which clarifies use of the seat adjustment lever.

Flight Crew Operations Manual Information

The following WARNING will be incorporated into the FCOM at the next scheduled revision. Until then, please reference this OMB for use of the seat adjustment lever.

WARNING: When using the manual release lever to move the seat, ensure the seat motion has stopped before releasing the fore/aft lever. Releasing the fore/aft seat lever while the seat is still moving can damage the seat actuator. Manually moving the seat to the forward or aft stop is permissible as it does not impact the seat actuator.

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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 BAB-169"Incorporated" (INC).

This Flight Crew Operations Manual Bulletin will be cancelled when the WARNING is incorporated in the FCOM Chapter One.

Please send all correspondence regarding this Flight Crew Operations Manual Bulletin to the 747 Manager, Flight Technical Data, through the Service Requests Application (SR App) on the MyBoeingFleet home page.

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General

This chapter contains:

- Airplane Flight Manual (AFM) operational information
- Non-AFM operational information.

Information is included if:

- operationally significant
- required by FAA Airworthiness Directive
- required by another regulatory requirement

Information is not included if it is:

- incorporated into FCOM normal, supplementary, or non-normal procedures, with a few exceptions
- shown on a placard, display, or other marking

Operational information listed in this chapter that must be memorized (memory items) are marked with a (#) symbol. They meet the following criterion - flight crew access by reference can not assure timely compliance, e.g. severe turbulence penetration speeds. They need only be memorized to the extent that compliance is assured. Knowing the exact wording of the limitation is not required.

Assuming that the remaining items are available to the flight crew by reference, they do not need to be memorized.

Airplane General

Operational Limitations

Runway slope	+/- 2%
#Maximum Takeoff and Landing Tailwind Component	15 knots
Maximum Operating Altitude	45,100 feet pressure altitude
#Maximum Takeoff and Landing Altitude	10,000 feet pressure altitude
#Maximum Field Elevation	9,500 feet
#Maximum speed operating in Reduced Vertical Separation Minimum (RVSM) Airspace	0.90 Mach

Note: Maximum takeoff tailwind component 10 knots with takeoff weights greater than 375,574 kgs.

Note: Maximum Landing Tailwind Component for Slippery conditions is 5 knots.

Non–AFM Operational Information

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

Do not operate HF radios during refueling operations.

#Avoid weather radar operation in a hangar or within 50 feet (15.25 meters) of fueling operations or a fuel spill.

Avoid weather radar operation when personnel are within the area normally enclosed by the aircraft radome.

Note: The hangar recommendation does 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
9,500 feet	40 feet	75 feet

Door Mounted Power Assists and Escape Slides

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

Flight Deck Security Door

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

Weight Limitations

Maximum Taxi Weight

G-CIVF – G-CIVI, G-CIVR – G-CIVS, G-CIVV – G-CIVZ, G-BYGA – G-BYGG

366,000 Kilograms

G-BNLK – G-CIVE, G-CIVJ – G-CIVP, G-CIVT – G-CIVU

380,000 Kilograms

Maximum Takeoff Weight

G-CIVF – G-CIVI, G-CIVR – G-CIVS, G-CIVV – G-CIVZ, G-BYGA – G-BYGG

364,000 Kilograms

G-BNLK – G-CIVE, G-CIVJ – G-CIVP, G-CIVT – G-CIVU

378,000 Kilograms

Maximum Landing Weight

G-CIVF – G-CIVI, G-CIVR – G-CIVS, G-CIVV – G-CIVZ, G-BYGA – G-BYGG

285,763 Kilograms

G-BNLA – G-CIVI, G-CIVJ – G-CIVP, G-CIVT – G-CIVU

269,000 Kilograms

Maximum Zero Fuel Weight

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

246,754 Kilograms

G-CIVF - G-CIVI

251,743 Kilograms

Note: For all departures ex-USA, alternative MTOW and maximum taxi weights may apply.

Refer to B747 Load & Balance Manual Section 1.1, Maximum Authorised Weights (kg) for the weight limitations applicable to departures ex-USA.

Airplane General (BA/EU/EASA Limitations)

Crew Complement

Minimum crew, 2 pilots.

Positioning Flights (no passengers)

No additional crew member required.

Passengers

Numbers not to exceed approved seats available. Children under the age of two need not be counted for this purpose.

Minimum Cabin Crew Complement

When passengers are carried, the minimum required Cabin Crew complement is 11. In unforeseen circumstances, the minimum Cabin Crew complement may be reduced in accordance with OM A.

Cabin Crew Rest Seats

The cabin crew rest seats located in Zone ‘F’, the upstairs rest area of modified ‘Heavy’ aircraft, and the Door 5 Crew Rest area of ‘Lite’ aircraft, are not stressed for takeoff or landing and must not be occupied during these phases of flight.

Noise Certification

The 747-400 is certificated in accordance with Chapter 3 of ICAO Annex 16.

Types of Operation

The aeroplane is approved for the following kinds of operation: VFR, IFR, known icing conditions and extended over-water flights.

Window Heat

Must be ON for all flight operations.

Fuel Pump Circuit Breakers

The re-setting of a tripped fuel pump circuit breaker is prohibited.

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 250 feet after takeoff.

#The autopilot must be disengaged below 100 feet in a single channel ILS approach.

#The autopilot must be disengaged below 360 feet in a non-precision approach.

Non-AFM Operational Information

#Do not use FLCH on final approach below 1,000 feet AFE

Automatic Landing

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

#Headwind	25 knots
#Tailwind	15 knots
#Crosswind	25 knots (15 knots in USA Cat II/III Ops)

#The maximum glideslope angle is 3.25 degrees.

#The minimum glideslope angle is 2.5 degrees.

Category II and III operation and automatic landing is approved with flaps 25 or 30 only.

PVD Takeoff

The PVD is only approved for reversionary guidance during takeoff when: PVD minima are quoted for the relevant runway, the rollout element of the localizer is not promulgated as unserviceable and low visibility operations are in force to prevent localizer disruption.

Autoland (BA)

Only permitted with two or more A/P channels engaged, on approved runways.

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.

Engines, APU

Engine Oil System

- #Minimum oil temperature for starting: -30 degrees C
- Minimum oil temperature for advancing thrust levers: -10 degrees C
- Max Oil temperature unrestricted 170 degrees C.

Minimum oil pressure:

- At or below 70% N3 – 25 psi.
- Above 70% N3 – 35 psi.

Engine Fuel System

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

Tank fuel temperature prior to takeoff must not be less than -40°C (-40°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.

Centre Wing Tank and Horizontal Stab Tank

Do not cycle CWT and HST pump switches from ON to OFF to ON with any continuous low pressure indications present.

Reverse Thrust

#Intentional selection of reverse thrust in flight is prohibited.

#Backing the airplane with use of reverse thrust is prohibited.

Auxiliary Power Unit (APU)

Non-AFM Operational Information

APU start duty cycle are:

Between starts	Battery wait:
1 and 2	1 minute
2 and 3	1 minutes
3 and 4	75 minutes

Max EGT

	°C
Takeoff (5 mins – all engines, 10 mins – eng out)	785
Max Continuous	733
Over Temp annunciation	785 – 805 after 20 sec Above 805 instantaneous
Start	Below 50% N3, 600 Above 50% N3 (momentary), 785

Max RPM%

	N1	N2	N3
Takeoff (5 mins – all engines, 10 mins – eng out)	110.5	107.7	99.2
Max Continuous	109.5	105.0	97.1
Overspeed (20 secs)	111.5	109.5	101.5
Reverse (40 secs)	91.0		

Starter Motor (Manual Starts)

Normal Duty Cycle:

- Up to 3 minutes then run down to zero N3, followed by:
- Up to a further 3 minutes then run down to zero N3, followed by:
- Up to a further 1 minute then run down to zero N3 and allow to cool for 30 minutes.

Extended Duty Cycle:

- Up to 5 minutes followed by 30 minute wait.

Flight Management, Navigation

QFE Selection

QFE operations are prohibited. For BA-specific alternative procedures refer to SP.QFE.

FMC Polar Operations - NGFMC embodied aircraft

Polar operations north of 88.5°N latitude or south of 88.5°S latitude are prohibited.

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

The maximum altitude with flaps extended is 20,000 feet.

Flight with flaps extended for prolonged periods, other than holding in the vicinity of an airfield, is prohibited. Flaps 10 or greater should not be used for prolonged holding or other extended periods of flight.

When holding with flap extended, limit speed to 250 K for flaps 1 and 230 K for flaps 5.

Maximum speed for secondary flap extension from 25 to 30 is 160 K.

Non-AFM Operational Information

G-BNLK - G-BNLP

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

G-BNLY - G-CIVZ

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

Warning Systems

GPWS - Look-Ahead Terrain Alerting

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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General

This chapter gives:

- an introduction to the normal procedures philosophy and assumptions
- step by step normal procedures
- general information regarding the execution of British Airways Operational Policy on the B747

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 written for a trained flight crew and assume:

- all systems operate normally
- the full use of all automated features (LNAV, VNAV, autoland, autopilot, and autothrottle). This does not preclude the possibility of manual flight for pilot proficiency where allowed

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. Engineering 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 Minimum Equipment List (MEL) 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 MEL

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

On the ground until the aircraft starts to move, all duties are divided between the P1 and P2. From the start of the taxi phase until the after landing procedure is complete 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 – P1” and “Preflight Procedure – P2”.

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

The general PF (or the P1 on the ground) phase of flight responsibilities are:

- taxiing
- flight path and airspeed control

- airplane configuration
- navigation

The general PM (or the P2 on the ground) 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, P1, P2, 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. PM may make MCP changes to heading and/or altitude without reference to PF in response to instructions given by ATC.

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

In role reversal, at Captain's discretion, P1 and P2 duties may be reversed wholly or in part.

Control Display Unit (CDU) Procedures

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

WARNING: Performance Data entry is a highly critical task. Procedures for data entry contained in this manual are allocated in a way which improves data checking integrity between crew members. Follow these procedures carefully.

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 PF usually makes the CDU entries when the autopilot is engaged. The PM may also make CDU entries as tasked by the PF or in manual flight. 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

It is recommended that appropriate use of the Autoflight system is used throughout flight to:

- achieve maximum efficiency of aircraft operation
- to reduce workload and exposure to errors

Autothrottle and Flight Directors should be engaged for take-off, go-around and at any time the autopilot is engaged.

With the autopilot engaged, the PF will make the required AFDS, thrust mode selections and CDU entries. When the autopilot is not engaged the PM will select the F/D, thrust modes and CDU entries required by the PF.

The crew must always monitor:

- Airplane course
- Vertical path
- Thrust
- 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

Use the PFD to verify mode changes to:

- Selected Altitude
- Selected/Managed Speed

In flight, commencing at or above 400 feet AAL after take-off, and continuing until P1 resumes PF duties on final approach, PM will announce:

- All manually selected, armed and automatic mode changes.
- All altitude selections.
- Changes to A/P and Autothrottle engagement status.

After P1 resumes PF duties, PM will monitor modes but will only announce any unexpected or anomalous changes.

Additionally, PM will announce all FMA modes in the following circumstances:

- During initial climb at or above 400ft AAL, after selection of any required AFDS modes.
- After initiation of a GA or rejected landing.
- After any Time Critical Maneuver.
- After any significant rebuild of the AFDS (e.g. late runway change).

WARNING: FMA indications are used to confirm that the aircraft is following the planned, programmed flight path and are vital for crew situational awareness and aircraft control.

QNH Operations

Changes to altimeter settings must be confirmed and cross checked by all operating crew on all altimeters.

Before Takeoff/Below Transition Altitude:

- set QNH on all altimeters

Above Aa and cleared to climb above Transition Altitude:

- set 1013.2/29.92 on both primary altimeters
- set 1013.2/29.92 on standby altimeter when above MSA/MOA and transition altitude

Before Descent:

- set destination QNH on standby altimeter
- set DH or BARO DA for planned approach procedure

When cleared to descend to an altitude:

- set QNH on both primary altimeters

Preflight and Post Flight Scan Flow

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 - P1, and Preflight Procedure - P2.

Preflight and Postflight Scan Flow – Captain as P1

Note: Overhead panel and pedestal become 'Captain Items' when First Officer is P1. MCP panel becomes a First Officer item when the First Officer is P1.

Areas of Responsibility – Captain as P1

Areas of Responsibility – First Officer as P1

Crew Briefing

P1 is required to conduct a briefing before takeoff, and before approach and landing.

Engine Failure on take-off and the rejected takeoff procedure should always be rehearsed at the start of the duty period. The briefing may also include other emergencies such as engine failure at other stages of flight.

The aim of the briefing is to:

- develop high crew situation awareness;
- identify potential problems, threats;
- develop strategies required to deal with them in both routine and non-normal situations.

This is best achieved through an open and interactive briefing style that allows all crew members to participate and share their experiences.

An effective briefing will:

- Be concise, relevant and conducted at a time of lower workload;
- Include open questions to share experiences and compare mental models;
- Establish gates and bottom lines;
- Review automation handling and use of relevant modes including intervention techniques;
- Anticipate and plan for potential high workload situations.
- Identify potential threats and errors.

The following guide provides a framework to enable crew to construct a relevant and effective brief.

Taxi and Takeoff	Description
Threats	Highlight relevant threats Identify how to avoid associated risk
MEL	Review ADDs
AIS	Review
Weather	Icing selections WX Radar Cabin service Windshear performance, avoidance, maneuver

Taxi and Takeoff	Description
Takeoff Alternate	Requirement Landing weight/Fuel Jettison
Taxi Route	Review likely taxi routing Identify relevant taxi restrictions
Flap	Required flap setting for takeoff Delayed if runway contaminated
Runway	Review planned departure runway Lighting, length, etc.
Performance Considerations Terrain Awareness	Proximate terrain and use of display Emergency turn and AFDS handling Non-standards climb outs, noise considerations Reduced thrust capability
MSA/SSA	Review including relationship to expected SID level-off altitude and associated emergency turn. Include other relevant MSA figures that may be encountered during a re-route or a return to the departure airfield. Identify if SID/ATC cleared altitude is above MSA.
Transition Altitude	Review and check on VNAV CLB page
SID	Confirm SID selection on RTE page 2 Compare with clearance (or DCL) Confirm first cleared altitude Confirm RNP
AFDS	Review set up. Discuss use and selections
Radio Aids	Review
FMC	Route checked/winds Mileage gross error check
Emergencies	Review emergency handling
Review	Review key points in order of significance

Approach	Definition
Threats	Highlight relevant threats Identify how to avoid associated risk
Configuration	Review aircraft status
AIS	Review
Weather	Review Approach type/manual or auto
QNH	Set expected QNH on standby altimeter
Transition level	Review and check DESCENT FORECAST page
MSA/SSA/Elevation	Review including expected point of 'Radio Altimeter' call and likely point(s) on arrival where MSA/SSA will be encountered. Other relevant MSA figures that may be encountered during a re-route should be included.
STAR	Discuss energy and ATC requirements Set approach gates
Approach	Automation Standard profile Appropriate AOM
Go-around	Profile review/automation handling/SOPs Acceleration height
Runway/Flaps/Stopping	Landing Performance (stopping distance and missed approach climb gradient) Flap setting/Autobrake
Radio Aids	Review
Navigation Accuracy	Review serviceability of nav aids RNP/ANP
Airfield Considerations	Engine out taxi Taxi routing and parking position

Approach	Definition
Alternate	Discuss alternate
Fuel Capability	Review fuel endurance against fuel policy Options for holding/diversion
Review	Review key points in order of significance

Note: An additional approach briefing will be required in the event of change from the expected approach procedure, or change in configuration or change of runway in use.

Fuel Efficient (Reduced Noise) Approach

When ATC conditions allow, the following procedure should be adopted:

Select flaps and gear down as necessary, to satisfy required drag and manoeuvre constraints. Gear may be selected down in conjunction with, or subsequent to, flaps 20 selection. However, ensure that the gear is selected down by 1,500 ft AAL and that the aircraft is fully established in the landing configuration by 1,000RA in order to comply with the stabilised approach criteria.

Reduced Flap Landing

Flap 25 or Flap 30 landings are approved for B747 Operations.

Flap 25 is the normal landing flaps setting and provides reduced airport noise and reduced fuel burn.

Before conducting Reduced Flap Landings consider:

- Runway performance
- Planned runway exit
- Landing technique

Reverse Thrust

There are three possible reverse settings that can be selected for landing.

- IDLE REVERSE: This is the normal setting to be used when runway length and/or conditions are not limiting
- PARTIAL REVERSE: For use when it is considered appropriate to reduce energy absorption by the brakes (e.g. hot or high airfields)
- FULL REVERSE: For use when runway length and/or conditions are limiting. Full reverse may be used down to 70 K or until a safe stop is assured

Full Reverse must be used whenever:

- The runway is wet and is annotated ‘Slippery when wet’ in the Brief, it is flooded, or is contaminated by snow, slush, or ice
- The target threshold speed has been increased for a deficiency
- There is any unserviceability of speedbrakes, wheel brakes, or anti-skid.

Autobrake

Autobrake should normally be used to:

- reduce pilot workload
- reduce Brake Wear
- maintain even brake application during crosswind operations

Standard Callouts

Most standard callouts are referred to within a procedure. The following callouts are applicable throughout either more than one procedure or at a point in a procedure which is not easy to define.

- DA/DH referenced callouts only may be omitted after the “VISUAL” call is made.
- Automatic callouts replace a manual callout.

	CONDITION/ LOCATION	CALLOUT	MADE BY
Climb And Descent	When cleared to a Flight Level	"SET STANDARD" "STANDARD SET AND CROSSCHECKED"	PF PM
	When cleared to an Altitude	"SET QNH" QNH ____ SET AND CROSSCHECKED"	PF PM
	1,000 ft. above/below assigned altitude/Flight Level	"1,000 FT TO GO" "CHECKED"	PM PF
	Clearance above/ below MSA.	"CLEARANCE ABOVE /BELOW MSA" "MSA OF ____FT" **Note:** PM must justify decision to continue flight if below MSA.	PF PM
	Passing 10,000ft/ FL100 & FL200	"ALTIMETER CHECK" "PASSING FL___ CLIMBING (DESCENDING) FL(ALTITUDE)___, STANDARD SET AND CROSSCHECKED"	PF PM

	CONDITION/ LOCATION	CALLOUT	MADE BY
All Approaches	First indication of Radio Altitude	"POSITION CHECK"	PF
		• "Runway ___ • Distance from runway___ • Barometric altitude___ • QNH ___ set and crosschecked" **Note:** Both pilots will check aircraft position relative to terrain. PM determines position with a positive statement by comparing barometric altitude, terrain clearance and distance from runway are as briefed for the approach in use.	PM
	1,000R and NOT STABLE	"ONE THOUSAND" "UNSTABLE, GO-AROUND"	Auto or PM PM
	1,000R and STABLE except for SPEED	"ONE THOUSAND" "SPEED"	Auto or PM PM
	When STABLE	"STABLE"	PM

	CONDITION/ LOCATION	CALLOUT	MADE BY
	1,000R and STABLE	"ONE THOUSAND" "STABLE" When Stable call has been made "MAN LAND ___ BARO"	Auto or PM PM PM
	When visual references have been acquired and can be maintained	"VISUAL"	PM
	To assume control, when stable and visual	I HAVE CONTROL	PM
	Rate of descent more than 1,000 fpm below 500R	"SINK RATE"	PM

Standard Callouts – ILS Approach

CONDITION/LOCATION	CALLOUT	MADE BY
First positive inward motion of localizer pointer	"LOCALIZER ALIVE"	PM
First positive motion of Glide Slope pointer	"GLIDE SLOPE ALIVE"	PM
Final approach or equivalent briefed position fix inbound	"OUTER MARKER/FIX, ___FEET GLIDEPATH CHECKED"	PM
1000R (Autoland only)	"AUTOLAND ___ RADIO, I HAVE CONTROL"	P1
50 ft above DA(H)	"FIFTY ABOVE"	AUTO or PF (PM for Autoland)
At DA(H)	"DECIDE"	AUTO or PF (PM for Autoland)
At DA(H) – Suitable visual reference established	"CONTINUE"	PM (PF for Autoland)
At DA(H) – Suitable visual reference not established	"GO AROUND"	PM (PF for Autoland)

Standard Callouts – Non-ILS Approach

CONDITION/LOCATION	CALLOUT	MADE BY
Final approach fix inbound	"VOR/NDB/FIX, PROFILE CHECKED"	PM
At each crossing fix	"___ HIGH/LOW/ON PROFILE, NEXT FIX ___ FEET"	PM
50 ft above DA or MDA	"FIFTY ABOVE"	PF
At DA or MDA	"DECIDE"	PF
At DA or MDA – Suitable visual reference established	"CONTINUE"	PM
At DA or MDA – Suitable visual reference not established	"GO AROUND"	PM

Multi-phase Phraseology

A partial list of standardized words and phrases follows:

Thrust:

- “SET TAKEOFF THRUST”
- “SET GO-AROUND THRUST”
- “SET MAXIMUM CONTINUOUS THRUST”
- “SET CLIMB THRUST”
- “SET CRUISE THRUST”

Flap Settings:

- “FLAPS UP”
- “FLAPS ONE”
- “FLAPS FIVE”
- “FLAPS TEN”
- “FLAPS TWENTY”
- “FLAPS TWENTY-FIVE”
- “FLAPS THIRTY”

Airspeed:

- “80 KNOTS”
- “V1”
- “ROTATE”
- “SET _____ KNOTS”
- “SET VREF PLUS (additive)”
- “SET FLAPS _____ SPEED”

Amplified Procedures

British Airways uses Boeing procedures as a baseline. This section describes detailed procedures and chronology for operating a normal flight.

Crew Briefing

Urgent operational documentation .....Read Both

OMNs on board. Ensure mandatory operational documentation is at the latest revision status.

Aircraft technical status ..... Confirm P1

Use OPDEF if AML is unavailable. When on board aircraft check AML.

Flight documents ..... Collate P2

Obtain and check:

- Brief
- CIRRUS
- Supplementary forms/handouts
- Weather charts
- Track message if required

Supplementary operational information .....Obtain P1

- De-icing status
- RVR

Pre-dispatch brief..... Complete P1

PF briefs PM as required.

Fuel load .....Approve P1

Notify TRM or load-control of required fuel load.

Cabin Crew Preflight Brief..... Complete P1

Share all pertinent flight information with cabin crew.

Preliminary Preflight Procedure - P2

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.

G-BYGA - G-BYGG, G-CIVU - G-CIVZ

VOICE RECORDER switch ..... ON

CVR Test Switch ..... TEST - hold for 5 sec

The voice recorder must be ON before starting the test. The test is successfully completed when the STATUS light illuminates green. After the test the voice recorder switch must be left in the ON position.

G-BNLK to LY and G-CIVA to VT

CVR Test Switch .....TEST - hold as required

The monitor indicator deflects to indicate a successful test. Make sure that the needle on the control panel monitor moves and stays in the green area while the TEST switch is pressed.

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

FLIGHT DECK ACCESS SYSTEM switch ..... Guard closed

Carry out the Flight Deck Door Access System Test once per day.

Circuit breakers ..... Check

Emergency equipment ..... Check

Fire extinguisher - Checked and stowed

Crash axe - Stowed

Emergency escape devices - Stowed

Other needed equipment - Checked and stowed

Aircraft library - Checked and stowed

Hatch ..... Closed and locked

Smoke evacuation handle ..... In

Overhead maintenance panel ..... Guards closed

The split system breaker OPEN light may be illuminated.

Verify that all other lights are extinguished.

FUEL TEMPERATURE SENSOR selector ..... As needed

G-BNLK - G-BNLY, G-CIVA, G-CIVE - G-CIVG
GROUND PROXIMITY WARNING
SYSTEM RADIO ALTITUDE selector ..... As needed

Circuit Breakers ..... Check

Parking brake ..... Set

WARNING: If the parking brake is not set, check with maintenance personnel before setting the brake to avoid injury to crews

CDU Preflight Procedure - P1 and P2

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 Preflight Checklist can be completed.

The P1 or P2 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 Callsign from CIRRUS under FLT NO.

CAUTION: Entering anything other than the CALLSIGN will cause Mode S Transponder problems with ATC and when attempting to log on to CPDLC.

Select Route REQUEST.

When ROUTE UPLINK READY message is displayed select LOAD and check origin, destination and route.

Or:

Manually enter the route.

Use COMPANY RTE, or ATC Flight Plan Route/Airways or FMC/WINDS page from CIRRUS.

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.

POS REF page:

Verify the correct RNP for departure, as needed.

NAV RADIO page:

Tune the navigation radios, as needed.

Initial performance data .....Set

PERF INIT page:

Enter the RESERVES value from CIRRUS.

Enter the desired STEP SIZE.

Enter the COST INDEX from CIRRUS.

Enter the initial CRZ ALT from CIRRUS.

Critical Data Procedure ..... Accomplish

Critical Data Procedure

The following procedure is used to ensure that data critical to the safe conduct of the flight is entered accurately and is cross-checked by the other pilot. This procedure should be conducted once fuelling has been completed and at a time of low workload and minimal distraction. This procedure is also to be used if performance data changes once the aircraft has dispatched.

Note: For changes in Critical Data post-dispatch P1 and P2 procedural steps may be conducted independently. Control must be transferred to facilitate this independent check. The Fleet specific assumptions for a 'Compliance with issue X' message are, aircraft weights are within + 1000 kg to - 5000 kg and the stabiliser setting within +/- 2% MAC TOW(= .5 division) of the provisional figures. There is no requirement to re-request CARD performance data if the 'REVISIONS TO' was solely due to a change in trim.

PERF INIT page ..... Select Both

Loadsheet identification ..... Verify P1

Zero Fuel Weight ..... Read P1

Loadsheet Critical Data ..... Enter P2

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

Enter the ZFW.

Verify GR WT from CDU.

Verify that FUEL value on CDU and Fuel Quantity indicator agree with Loadsheet value.

CIRRUS page 1:

Check for significant ZFW difference.

Calculated CDU GR WT ..... State P2

Taxi weight ..... Confirm P1

Verify that GR WT from CDU is similar to Taxi Weight on Loadsheet.

Takeoff performance calculation ..... Verify P1

Verify performance calculation weight value is appropriate for aircraft type, runway startpoint and environmental conditions.

GR WT – verify that the GW is approximately 1000 kg more than the requested takeoff weight and write in CARD output confirmation box.

THRUST LIM Page ..... Select Both

SEL field ..... Set P2

Select CLB1 or CLB as required.

For full thrust takeoff leave SEL field blank.

Upper EICAS Screen ..... Verify Both

Check TO, TO 1, TO 2 or D-TO and selected/default assumed temperature are displayed.

TAKEOFF REF Page ..... Select Both

Note: On NGFMC embodied aircraft there are 2 TAKEOFF REF pages. Cycle between both pages to enter required information.

Takeoff performance calculation ..... Verify P1

State FLAP/ACCEL HT, EO ACCEL HT and THR REDUCTION.

State V1.

State VR and V2. Both pilots must check these values are within 3 knots of the FMC speeds prior to entering data into CDU (When CARD data not available use FMC VR and V2).

State MACTOW (NGFMC a/c to one decimal place. Other aircraft to nearest integer.)

Takeoff performance data ..... Enter P2

On NGFMC embodied aircraft confirm REF SPDS selected OFF

FLAP/ACCEL HT, EO ACCEL HT and THR REDUCTION.

V1, VR and V2.

MACTOW.

WARNING: If data checking after dispatch ensure that selected flap agrees with calculated value.

WARNING: If VR or V2 differ from the FMC figures by more than 3kt, check that the data entered into the FMC and CARD or manual performance data is correct. If the input data is correct and the difference remains unresolved, use the higher of the FMC or CARD VR and V2.

MCP ..... Set P1

IAS/Mach selector - Set V2
LNAV switch - As required
VNAV switch - Push
Initial Heading - Set
Initial Altitude/FL

Takeoff data ..... Check Both

Takeoff thrust setting (ON EICAS)
Runway (on ND)
Initial altitude (on PFD)
Selected V1 and V2 speeds (on PFD)
VNAV armed (on PFD)
LNAV as required (on PFD)

RTE page 2 .....Verify Both

Verify that SID matches the ATC clearance or Datalink clearance, if available.

ACT RTE DATA page..... Select

- Select Wind REQUEST
- Load and execute en route winds
- Load descent forecast winds

Note: No environmental data will be uplinked to the FMC unless the Critical Data Procedure is completed before making a wind data request.

Exterior Inspection

Before each flight the P1 must verify that the airplane is satisfactory for flight. The exterior inspection may be delegated to the relief pilot if carried.

- check AML Part 1 and Damage Chart

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 reverser ..... Stowed

Popout pin - Check

Exhaust area and tailcone ..... Check

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

Navigation and strobe lights ..... Check

Vertical stabilizer and rudder ..... Check

Static ports ..... Check

Horizontal stabilizer and elevator ..... Check

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
Fuel measuring sticks ..... Flush and secure

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
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 ..... As needed

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

Thrust reverser ..... Stowed

Popout pin ..... Check

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

Access panels ..... Latched

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 - P2

The P2 normally does this procedure. The P1 may do this procedure if needed. Where items are shown in brackets this indicates an alternate selection for use during role reversal.

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 ..... Guard closed

OBSERVER'S AUDIO SYSTEM switch ..... NORM

SERVICE INTERPHONE switch ..... OFF

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

Fire Panel ..... Set

Engine fire switches ..... In

BTL A DISCH and BTL B DISCH lights ..... Extinguished

APU BTL DISCH light ..... Extinguished

APU fire switch ..... In

CARGO FIRE DISCH light ..... Extinguished

CARGO FIRE ARM switches ..... Off

Verify that the 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

AUTO IGNITION selector ..... NORM

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 CROSSFEED valve switches ..... |On

Verify that the VALVE lights are extinguished.

All fuel pump switches ..... Off

Verify that the main pump PRESS lights are illuminated.

G-BNLK - G-BNLY, G-CIVA
Verify that the main 2 aft pump PRESS light is extinguished when APU is running.

G-BYGA - G-BYGG, G-CIVB - G-CIVZ
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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
Verify that the stabilizer pump PRESS lights are extinguished.

Anti-ice panel .....Set

NACELLE ANTI-ICE switches .....AUTO

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

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

PASSENGER OXYGEN switch ..... Guard closed

YAW DAMPER switches ..... ON

INOP lights remain illuminated until first IRU aligns.

G-BNLK - G-BNLY, G-CIVA - G-CIVP

THERAPEUTIC OXYGEN switch ..... Guard closed

CABIN ALTITUDE panel ..... Set

LANDING ALTITUDE switch ..... AUTO

Outflow valve manual switches ..... Off

Cabin Altitude AUTO SELECTOR ..... NORM

ECS panel ..... Set

PASSENGER TEMPERATURE selector ..... AUTO

FLIGHT DECK TEMPERATURE selector ..... AUTO

ZONE SYS FAULT light ..... Extinguished

TRIM AIR switch ..... ON

UPPER and LOWER RECIRCULATION fan switches ..... ON

AFT CARGO HEAT switch ..... Off

EQUIPMENT COOLING selector ..... NORM

HIGH FLOW switch ..... Off

Bleed air panel ..... Set

Pack SYS FAULT light ..... Extinguished

PACK control selectors ..... NORM

LEFT and RIGHT ISOLATION valve switches ..... On

Verify 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

Note: Secondary images might occur on the flight deck windows during night operations.

FLIGHT DIRECTOR switch .....ON

Select the status display.

EFIS control panel .....Set

MINIMUMS reference selector .....RADIO or BARO

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

PVD (if required) ..... ON and check

Oxygen ..... Test and set

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%

Crew and passenger oxygen pressure .....Check EICAS

Verify that the pressure is adequate for dispatch.

SOURCE SELECT panel .....Set

FLIGHT DIRECTOR / PVD source select ..... R (L)

NAVIGATION source selector .....FMC R (L)

EIU source selector .....AUTO

IRS source select .....AUTO

AIR DATA source selector .....AUTO

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 if the ND TFC switch is pushed
- 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

GROUND PROXIMITY
TERRAIN OVERRIDE switch ..... Off

Landing gear panel ..... 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.

G-BYGA - G-BYGG, G-CIVF - G-CIVZ

VHF-L DIRECT COMM switch .....Guard closed

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

NO SMOKING selector ..... ON

SEATBELTS selector .....AUTO or ON when fuelling is complete

AUTOBRAKES selector ..... RTO

Emergency evacuation COMMAND switch .....Guard closed

Right radio tuning panel .....Set

Verify that the OFF light is extinguished.

First Officer's (Captain's) audio control panel .....As desired

Transponder Panel .....Set

FlyPadTray .....Install

CAUTION: Failure to follow mounting instructions may result in damage to the device, reduction in functionality or distraction.

Electronic Charting App .....Set

Select and sequence charting for the planned departure

Select and sequence charting for contingency procedures

CAUTION: Distraction or excessive workload may occur if charting app is not correctly configured before critical flight phases.

CAUTION: Crews should consider the possibility of a non-normal event e.g. airborne return when setting up the chart clip, in order to minimise the potential for distraction during times of high work load.

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.

Whenever the seat is adjusted, verify a positive horizontal (fore and aft) seat lock by pushing against the seat.

Rudder pedals ..... Adjust

Adjust to permit full rudder pedal and brake application.

Do the Critical Data Procedure on the P1's request.

Do the PREFLIGHT checklist on the P1's request.

Preflight Procedure - P1

The P1 normally does this procedure. The P2 may do this procedure if needed. Where items are shown in brackets this indicates an alternate selection for use during role reversal.

Note: Captain Only duties include Check and sign Loadsheet, NOTOC and relevant customs documentation and sign AML. These items cannot be delegated and are not described within this section.

Note: Secondary images might occur on the flight deck windows during night operations.

PVD (if required) ..... ON and check

EFIS control panel ..... Set

MINIMUMS reference selector ..... RADIO or BARO

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

IAS/Mach selector .....set estimated V2

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%

Crew and passenger oxygen pressure .....Check EICAS

Verify that the pressure is adequate for dispatch.

SOURCE SELECT panel .....Set

FLIGHT DIRECTOR / PVD source select ..... L (R)

NAVIGATION source selector .....FMC L (R)

EIU source selector .....AUTO

IRS source selector .....AUTO

AIR DATA source selector .....AUTO

Clock .....Set

RMI ..... Check

VOR/ADF selectors .....As desired

Magnetic Heading .....Correct

CRT select panel .....Set

INBOARD CRT selector .....NORM

LOWER CRT selector .....NORM

STANDBY EFIS selector .....FO

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 if the ND TFC switch is pushed
- 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.

Standby instruments ..... Check

Attitude indicator caging control ..... Pull and release

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

APPROACH selector ..... OFF

Verify that the airspeed indications are correct.

Set the standby altimeter.

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 (First Officer's) Audio Control Panel ..... As needed

FlyPadTray ..... Install

CAUTION: Failure to follow mounting instructions may result in damage to the device, reduction in functionality or distraction.

Electronic Charting App ..... Set

Select and sequence charting for the planned departure

Select and sequence charting for contingency procedures

CAUTION: Distraction or excessive workload may occur if charting app is not correctly configured before critical flight phases.

CAUTION: Crews should consider the possibility of a non-normal event e.g. airborne return when setting up the chart clip, in order to minimise the potential for distraction during times of high work load.

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

Seat ..... Adjust

Position seat for optimum eye reference.

Whenever the seat is adjusted, verify a positive horizontal (fore and aft) seat lock by pushing against the seat.

Rudder pedals ..... Adjust

Adjust to permit full rudder pedal and brake application.

Conduct Taxi and Take-off briefing at a moment of appropriate workload. Briefing must be conduct before the PREFLIGHT checklist is read.

Do the Critical Data procedure when loadsheet and take-off performance data is available.

Call "PREFLIGHT CHECKLIST".

Before Start Procedure

Start the Before Start Procedure after all external doors are closed.

CAUTION: Do not push back without ATC clearance/authorization. Distraction events have resulted in unauthorized pushback events. Both pilots must verify clearances.

Flight deck door ..... Closed and locked P2

Verify that the LOCK FAIL light is extinguished.

CDU display ..... Set Both

Normally the PF selects the TAKEOFF REF page.

Normally the PM selects the LEGS page.

WARNING: Performance data displayed must be considered provisional until FINAL LOADSHEET is received and runway start point is known.

Exterior doors ..... Verify closed P2

If pushback is needed:

Verify that the nose gear steering is locked out.

Ground crew clearance .....Obtain P1

Obtain a clearance to pressurize hydraulic systems.

HYDRAULIC panel ..... Set P2

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 selector .....AUX

Verify that the SYS FAULT light is extinguished.

Verify that the PRESS light stays illuminated.

Hydraulic demand pump 2 and 3 selectors .....AUTO

Verify that the SYS FAULT lights are extinguished.

Verify that the PRESS lights are extinguished.

Fuel panel ..... Set P2

All MAIN tank FUEL PUMP switches ..... ON

Verify that the PRESS lights are extinguished.

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 P2

RECALL switch ..... Push P2

Verify that only the expected alert messages are shown.

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 kgs and that the fuel quantity in tank 3 is less than or equal to tank 4 plus 500 kgs

OVERRIDE pumps 2 (both) switches ..... Off

OVERRIDE pumps 3 (both) switches ..... Off

CROSSFEED valve 1 and 4 switches ..... Off

CANCEL switch ..... Push P2

Verify messages canceled

Trim .....____ Units, zero, zero P2

Stabilizer trim - ___ UNITS

Set the trim for takeoff.

Check that the trim is in the green band.

- Aileron trim - 0 units
- Rudder trim - 0 units

Transponder ..... XPDR P2

Select assigned code if ATC clearance is confirmed.

If ATC code is not assigned select 2000 unless an alternate code is required by local airport regulations.

Call “BEFORE START CHECKLIST.” P1

Do the BEFORE START checklist. P2

Pushback or Towing Procedure

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

CAUTION: Do not push back without ATC clearance/authorization. Distraction events have resulted in unauthorized pushback events. Both pilots must verify clearances.

Pushback communications ..... Establish P1

When ground crew confirm readiness:

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. P1

When pushback or towing is complete:

Verify that the ground crew and all equipment is clear. P1

Verify that the ground crew ‘all clear signal’ includes a visible indication that the steering lockout pin has been removed. When seen give an acknowledgement. P1

Engine Start Procedure

During normal operations autostart two engines simultaneously. Engines must be started individually whenever:

- airport pressure altitude exceeds 6,000 ft amsl; or
- autostart is inoperative; or
- air supply from APU or ground air supply may provide lower than optimum pressure

Note: Engine parameters must be monitored during all starts.

Note: Observe starter duty cycle limitations in the event of ENG 1, 2, 3, 4 AUTOSTART message or Aborted Engine Start.

Autostart does corrective steps for:

- no EGT rise
- a hot start (prior to starter cutout)
- a hung start (prior to starter cutout)
- no N1 rotation

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

- the oil pressure indication is not normal by the time the engine is stabilized at idle
- the fuel control switch is in RUN, the engine RPM is low, and the Autostart switch is off

Ground Crew Start Clearance	Obtain	P1
Select the secondary engine indications.		P2
PACK control selectors	OFF	P2
Start sequence	Announce	P1
Call “START ___ ENGINE”		P1
Engine START switch	Pull	P2
FUEL CONTROL switch	RUN	P2
Verify that the oil pressure increases by idle N3.		P1, P2

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

Before Taxi Procedure

Start the Before Taxi Procedure when all engines are stabilised at idle.

WARNING: Distraction at this phase is a major hazard. Collision risk with ground equipment and injury to ground personnel has resulted from the following procedure being omitted.

APU selector	OFF	P2
Hydraulic demand pump selectors	AUTO	P2
NACELLE ANTI-ICE switches	As needed	P2
AFT CARGO HEAT switch	As needed	P2
PACK control selectors	NORM	P2
Select the status display.		P2
Flap lever	Set takeoff flaps	P2
Recall	Check	Both

Verify that only expected alert messages shown.

Ground Crew clearance	Seen	P1

Verify that Ground Crew and equipment are clear and ‘all clear’ signal has been seen.

Flight controls	Check	P1

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. P2

Do not advance the thrust lever until oil temperature is -10 degrees C or greater.

Call “BEFORE TAXI CHECKLIST.” P1

Do the BEFORE TAXI checklist. P2

Before Takeoff Procedure

Engine warm up requirements:

- when the engines have been shut down more than 1.5 hours:
  - run the engines for at least 5 minutes
- when the engines have been shut down less than 1.5 hours:
  - run the engines for at least 3 minutes
- use a thrust setting normally used for taxi operations
- engine oil temperature must be above the lower amber band before takeoff

WARNING: Taxi is a critical phase of flight and distraction must be kept to a minimum.

WARNING: If new take-off data is required do the Critical Data Procedure. Restart Before Takeoff checklist when new data is entered.

Pilot Flying	Pilot Monitoring
When Final Loadsheet data is acknowledged: • Do the Critical Data Procedure (if required). • Set Trim (if required).	
For all takeoffs, carry out the takeoff Briefing Update by reviewing these items: • TAKEOFF REF pages. • Departure routing. • Supplementary Procedures. • MEL Requirements.	
	Verify that the cabin is secure and advise PF.
Set the weather radar display as needed. Set the terrain display as needed.	
	Set the transponder mode selector to RA/TA.
Call “BEFORE TAKEOFF CHECKLIST.”	Do the BEFORE TAKEOFF checklist.

Takeoff Procedure

Pilot Flying	Pilot Monitoring
Before entering the departure runway, verify that the runway and runway entry point are correct.	
	Signal the cabin crew.
	When entering the departure runway, set the STROBE light switch to ON. Use other lights as needed. Configure Air Conditioning Packs as required.
Verify that the brakes are released. Align the airplane with the runway.	
Verify that the airplane heading agrees with the assigned runway heading.	
Advance the thrust levers to approximately 1.20 EPR. Allow the engines to stabilize.	
Call “SETTING THRUST”. 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 before 80 knots as needed. During strong headwinds, if the thrust levers do not advance to the planned takeoff thrusts, manually advance the thrust levers before 80 knots. Call “THRUST SET”.
After takeoff thrust is set, the PF'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”.

Pilot Flying	Pilot Monitoring
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.	Prior to 3000 ft AAL and when climb thrust is set: • Set one Pack Control Selector to NORM, allow cabin rate to stabilise. • Set the remaining Pack Control Selectors to NORM.
	After flap retraction is complete: • Verify air conditioning packs operating. • Set the Nacelle Anti-Ice switches to AUTO. • Set the Landing Gear lever OFF after landing gear retraction is complete.
Call “AFTER TAKEOFF CHECKLIST”.	
	Do the AFTER TAKEOFF checklist.

Flap Retraction Schedule

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

Pilot Flying	Pilot Monitoring
	During climb and cruise, verify the RNP as needed.
When cleared above transition altitude, set primary altimeters to standard	
When passing 10,000 ft/FL100 verify all altimeters are correctly set	Verify all altimeters are correctly set
	Set the LANDING and LOGO light switches to OFF
	Set the seatbelt signs as needed
When above transition altitude and MSA, set standby altimeter to 1013/29.92.	
Enter the final ZFW into the FMC	Verify entry of final ZFW
Enter the CRZ CG into the FMC	Verify entry of CRZ CG
When passing FL200 verify all altimeters are correctly set	Verify all altimeters are correctly set
	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.

Pilot Flying	Pilot Monitoring
	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.
	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 both Override Pumps 2 switches off, both Override Pumps 3 switches off, and crossfeed valve 1 and 4 switches off.
	Before the top of descent, modify the active route as needed for the arrival and approach.

Descent Procedure

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

Pilot Flying	Pilot Monitoring
	During descent, verify the RNP as needed.
Set Standby Altimeter to arrival airport pressure setting.	Obtain destination weather/ATIS
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.
	Check landing performance.
	Set the AUTOBRAKES selector to the needed brake setting.
Select and sequence charting for planned approach and likely contingencies.	
Do the approach briefing.	
Call “DESCENT CHECKLIST.”	Do the DESCENT checklist.

Approach Procedure

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
	During arrival and approach, verify the RNP as needed.
When passing FL200 verify all altimeters are correctly set.	Verify all altimeters are correctly set.
	Set the passenger signs to ON.
Update the arrival and approach, as needed. Monitor aircraft position and energy against briefed gates.	
Update the approach briefing as needed.	
When passing 10,000 feet MSL/FL100 verify all altimeters are correctly set.	Verify all altimeters are correctly set.
	At or above 10,000 feet MSL/FL100, set the inboard landing lights switches to ON. Set the LOGO lights to ON during hours of darkness.
When cleared below transition level, set and crosscheck the primary altimeters	
Call “APPROACH CHECKLIST”.	Do the APPROACH checklist.

Flap Extension Schedule

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 309,000 kgs, use UP + 20 knots.			
**Flaps 10 and Command Speed "10" are optional.			

Landing Procedure - ILS

Pilot Flying	Pilot Monitoring

Initially
• If on radar vectors
  • HDG SEL
  • Pitch mode (as needed)
• If enroute to a fix
  • LNAV or other roll mode
  • VNAV or other pitch mode	

	Verify that the cabin is secure and advise PF.
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 LOC 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 LNAV, HDG SEL or HDG HOLD to intercept the final approach course, as needed. LNAV may be used to intercept the LOC only if the aircraft has serviceable GPS.	Call “LOCALIZER ALIVE”.
Verify that the localizer is captured.	Verify final approach course heading.
Arm the APP mode.	
	Call “GLIDESLOPE 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.

Pilot Flying	Pilot Monitoring
Set the missed approach altitude on the MCP.	
Call "LANDING CHECKLIST."	Do the LANDING checklist.
At final approach fix (LOM, MKR, DME) verify the crossing altitude.	
Monitor the approach. Verify the autoland status at 500 feet AGL.	

Landing Procedure - Instrument Approach Using VNAV

VNAV should be used only for approaches that have the following feature:

- a published GP angle on the LEGS page for the final approach segment

This procedure is not authorized using QFE.

If both LNAV and VNAV minima are available for an RNP APCH, flight crew should use FCOM procedures and fly to the lower minima.

Note: If flying to VNAV minima, VNAV must be used - it is not permissible to use VNAV minima whilst controlling the vertical path using V/S.

Flight crew should be aware that an approach with VNAV minima is designed as a 3D procedure with a DA; whereas an approach with LNAV minima is designed as a 2D procedure with an MDA. BA's policy is to treat MDA as a DA (Part OM A Section 8.22.7.a); therefore providing normal procedures are used - specifically that a go around is executed promptly at DA so as to minimise height loss during the manoeuvre, there is no degradation of safety.

Pilot Flying	Pilot Monitoring

Initially
• If on radar vectors
  • HDG SEL
  • Pitch mode (as needed)
• If enroute to a fix
  • LNAV or other roll mode
  • VNAV or other pitch mode	

	Verify that the cabin is secure and advise PF.
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	
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: • set DA(H) or MDA(H) on the MCP • select or verify VNAV • select or verify speed intervention	Approximately 2 NM before the final approach fix, call "APPROACHING GLIDE PATH".

Pilot Flying	Pilot Monitoring
Call: “GEAR DOWN” “FLAPS 20”	Set the landing gear lever to DN. Set the flap lever to 20
Set the SPEEDBRAKE lever to ARM.	
Beginning the final approach descent, call “FLAPS __” as needed for landing.	Set the flap lever as directed.
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.	
At the final approach fix: • verify the crossing altitude • crosscheck the altimeters within 100 feet	
Monitor the approach.	
If suitable visual reference is established at MDA(H), DA(H), or the missed approach point, disengage the autopilot in accordance with Limitations – Autopilot/Flight Director System. Maintain the glide path to landing.	

Go-Around and Missed Approach Procedure

Pilot Flying	Pilot Monitoring
At the same time: • push either TOGA switch • Call “GO-AROUND, 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 missed approach altitude, select FLCH or VNAV. If FLCH is selected, press SPD and 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 flaps are set to the planned flap setting and at or above the flap maneuvering speed, if FLCH was selected, push the THRUST switch. **Note:** When NGFMC is fitted, if THRUST switch is selected with autothrottle mode in SPD the autothrottle will transition to THR REF with associated power change.	

Pilot Flying	Pilot Monitoring
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.

Rejected Landing Procedure

Manual Landing : This procedure is to be carried out where the go around is initiated at, or after, the commencement of the flare.

Autoland : During an automatic landing it is desirable to retain the automatic go-around functionality for as long as possible. Crews should ordinarily use the TO/GA function for rejected landings from DH. Where the rejected landing is initiated from below DH or after touchdown, crews should be prepared to use the Rejected Landing Procedure.

Pilot Flying	Pilot Monitoring
WARNING: At low radio altitudes the AFDS TOGA mode is not available. **WARNING: Once reverse thrust is initiated following touchdown, a full stop landing must be made.** **CAUTION: If the aircraft is on the runway when Pilot Flying applies maximum thrust the take-off configuration warning will activate.**	
Call “GO AROUND”	
Disengage autopilot. Disconnect autothrottle(s). Aggressively apply maximum thrust. Verify thrust increases.	Verify that maximum thrust is selected and achieved; adjust if necessary.
Maintain current configuration	
Prevent the attitude from increasing rapidly.	

Pilot Flying	Pilot Monitoring
Maintain directional control and keep wings level.	
At Vref or above, rotate towards the go-around attitude.	Verify the rotation to go–around attitude.
WARNING: Excessive rates of rotation must be avoided in order to prevent a tail strike. **CAUTION: FD pitch guidance may not be valid and should be disregarded at the commencement of this manoeuvre.** **CAUTION: Expect out of trim forces after the engines spool up, leading to the possibility of over-rotation.**	
When safely climbing away, carry out the standard go-around procedure.	

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP.	Verify that the SPEEDBRAKE lever is UP. Call "SPEEDBRAKES UP." If the SPEEDBRAKE lever is not UP and the lever will not move call "SPEEDBRAKES NOT UP."
Monitor the rollout progress.	
Verify correct autobrake 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.	
If reverse thrust greater than idle is required call "FULL/PARTIAL REVERSE" as required.	Apply reverse thrust as needed.
	Verify that the forward thrust levers are closed. Without delay, raise the reverse thrust levers to the interlocks and hold light pressure until the interlocks release. When all REV indications are green, call "REVERSERS NORMAL." If there is no REV indication(s) or the indication(s) stays amber, call "NO REVERSER(S) ENGINE NUMBER ___" or "NO REVERSERS".
If reverse thrust greater than idle has been selected call "REVERSE IDLE" as speed is decreasing below 80 knots.	Call "80 KNOTS." By 80 knots, start movement of the reverse thrust levers to reach the reverse idle detent before taxi speed.
Safe stop assured and taxi speed reached call "FORWARD IDLE".	After the engines are at reverse idle, move the reverse thrust levers full down.

Pilot Flying	Pilot Monitoring
Before taxi speed, disarm the autobrake. Use manual braking as needed. Call “Manual Brakes”.	When autobrake disengages call “AUTOBRAKES”.
Before turning off the runway, disconnect the autopilot.	

After Landing Procedure

Start the After Landing Procedure when clear of the active runway and initial taxi routing is known.

It is Fleet Policy to employ Engine Out Taxi whenever this can be achieved in a manner that ensures safe operation of the aircraft. SP.EOT refers.

Engine cool down recommendations:

- run the engines for at least 1 minute
- use a thrust setting no higher than that normally used for taxi operations

Pilot Flying	Pilot Monitoring
The PF moves or verifies that the SPEEDBRAKE lever is DOWN.	
	Set the NACELLE ANTI-ICE switches ON, if needed.
	Set the exterior lights as needed.
Set the weather radar to off.	
	Set the flap lever to UP.
	Set the transponder mode selector to XPNDR.
	Set the AUTOBRAKE selector to OFF.
	Set the STAB TRIM to 6 UNITS.
	Do the “AFTER LANDING CHECKLIST”.

Shutdown Procedure

Start the Shutdown Procedure when approaching the parking stand.

APU selector .....START, then ON P2

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

Cabin Doors ..... Initiate Disarm P2

PA call: “CABIN CREW DOORS TO MANUAL AND CROSSCHECK”.

Parking brake ..... Set P1

Verify that the PARK BRAKE SET message is shown.

Electrical power ..... Set P2

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.

Hydraulic demand pump 4 selector ..... AUX P2

If pushback or towing is needed:

Hydraulic demand pump 1 selectors ..... AUX P2

Hydraulic demand pump 2, 3 selectors ..... OFF P2

If parked (pushback or towing is not needed):

Hydraulic demand pump 1, 2, 3 selectors ..... OFF P2

Call “SHUTDOWN”. P1

FUEL CONTROL switches ..... CUTOFF P2

If pushback or towing is needed:

Establish communications with ground handling personnel. P1

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. P1

When parked (pushback or towing is complete):

Hydraulic demand pump 1 selector .....OFF P2

SEATBELTS selector .....OFF P2

Fuel pump switches .....OFF P2

NACELLE ANTI-ICE switches ..... AUTO P2

WING ANTI-ICE switch.....OFF P2

BEACON light switch .....OFF P2

FLIGHT DIRECTOR switches .....OFF P2

Status messages .....Check P2

Record shown status messages in maintenance log.

Transponder mode selector STANDBY/2000 P2

Hydraulic demand pump 4 selector .....OFF P2

APU selector ..... As needed P2

Call “SHUTDOWN CHECKLIST.” P1

Do the SHUTDOWN checklist. P2

Secure Procedure

IRS mode selectors ..... OFF

EMERGENCY LIGHTS switch ..... OFF

AFT CARGO HEAT switch ..... OFF

PACK control selectors ..... OFF

EXT PWR switches ..... ON P2

APU selector ..... OFF P2

STANDBY POWER selector ..... OFF P2

When APU has completed shutdown cycle:

BATTERY switch ..... OFF P2

FD ACCESS switch ..... OFF P2

Do the SECURE checklist.

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General

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

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

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

Supplementary procedures are provided by section.

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Flight Deck Door Access System Test

Flight Deck Access System switch ..... 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 ..... Guard closed

Verify LOCK FAIL light extinguishes.

Oxygen Mask Microphone Test

FLIGHT INTERPHONE TRANSMITTER Selector ..... MIC

SPEAKER Selector ..... ON

RESET/TEST Switch ..... Push and hold

EMERGENCY/TEST Selector ..... Push and hold

PUSH-TO-TALK Switch ..... INT

Simultaneously push the Push-to-Talk switch, EMERGENCY/TEST selector, and the RESET/TEST switch.

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

PUSH-TO-TALK Switch ..... Release

EMERGENCY/TEST Selector .....Release

RESET/TEST Switch .....Release

SPEAKER Selector ..... As needed

Therapeutic Oxygen

Use of the therapeutic oxygen ring system may commence after takeoff however, before switching the Therapeutic Oxygen ON, ensure that the cabin crew have plugged a therapeutic mask into the PSU. Before landing, the therapeutic system should be reset and the EICAS Memo message cleared. **This should be done prior to removal of the mask.** These actions, in the correct order, should prevent inadvertent operation of the Automatic Decompression Announcement.

Main Equipment Centre (MEC)

The authority of Maintrol or FMT is required to enter the MEC. Access by one of the crew should be attempted ONLY if an increase in flight safety can be achieved. This is permissible only during smooth flying conditions.

The MEC is not equipped with oxygen or other safety equipment.

Allen security key is located in pouch on rear bulkhead wall of flight deck.

The MEC light switches are unguarded and located:

(1) Upper light switch - on the frame above and to the right of the access ladder.

(2) Lower light switch - on the lower floor beam to the left of the exterior hatch.

Attention is drawn to two guarded switches on the forward bulkhead to the right of the access ladder. The switches are those placarded ‘Gear Down Dispatch’ and ‘Fifth Engine Carriage’. DO NOT OPERATE SWITCHES.

When access is required to the MEC via the floor panel in the First Class Cabin, left hand aisle, the following procedure must be carried out:

(1) Brief a cabin crew member to stand continuous guard of the hatch until the floor panel has been replaced.

(2) Remove the floor panel. Fit the yellow/black safety panel after descending into the equipment bay. (The yellow/black safety panel is stored inside the wardrobe forward of Zone B left hand side.) Refit the floor panel on completion.

ACMS Automatic Printouts

The Aircraft Condition Monitoring System (Flight Recorder) will generate an automatic printout for the following exceedances that require maintenance or operational action. For exceedances requiring an ASR see OM A for applicable criteria.

Appropriate items should be entered into the AML Pt 1 with the printout attached.

- Engine N1, N2, N3, EGT, VIB.
- OIL TEMP, OIL PRESS.
- Flap, Gear and Vmo/Mmo placard.
- Hard Landings.
- Overweight Landings.
- Rejected Takeoff.
- Rotation Rate.
- Tail Proximity, Takeoff and Landing Reports.

  Note: AML entry required when tail clearance < 2.0 ft.

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Air Conditioning Packs

Packs Off Takeoff

It is current BA policy to conduct Packs Off Takeoffs if TOW is greater than 300,000 kg, unless the Captain considers cabin environmental conditions are such that this is not appropriate.

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 when conditioned air is supplied to the airplane. The packs or pack components can be damaged if operated with conditioned air.

RECIRCULATION FANS switches - OFF

Allows conditioned air unit to operate at maximum efficiency.

After disconnecting ground conditioned air:

PACK control selectors - NORM

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

Dual Mode APU/PCA Use

Where necessary for cabin cooling on the ground, the simultaneous use of APU air and ground pre-conditioned air (PCA) is permitted. This is limited to a maximum of 30 minutes with up to three packs selected on.

Flight crew should ensure the Pack High Flow Switch is selected OFF.

The ground crew may ask that the packs are selected off whilst the ground air is disconnected from the aircraft.

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

Before start:

Landing Altitude switch ..... MAN

Verify MAN displayed after landing altitude on Primary EICAS.

Landing Altitude selector ..... 8,000 feet

Before descent:

Landing Altitude switch ..... AUTO

Verify AUTO displayed after landing altitude on Primary EICAS.

AFDS

AFDS Operation

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

If autopilot is needed:

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

Heading Hold

If airplane position north of 82° N latitude (or north of 73° N between 80° W and 170° 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 73° N between 80° W and 170° 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 is needed:

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 is TO/GA:

TO/GA switch .....Push

Verify THR REF displays on flight mode annunciation.

If pitch mode is 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 is needed:

FLCH switch .....Push

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

If VNAV is needed:

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.

Landing Procedure – ILS PRM

These approaches differ from a conventional ILS in the following ways:

- Pilot qualification for generic PRM qualification
- An additional ‘secondary’ VHF ATC frequency which must be monitored by both pilots throughout the approach
- Airport-specific instructions published in the applicable approach charts
- The autopilot is recommended for the ILS portion.

If necessary the ‘Breakout’ instructions will be transmitted on the Secondary frequency. The Breakout Maneuver must be flown in the following way:

- Disengage the autopilot and switch off the Flight Director
- Do not press the TOGA Switches
- Immediate configuration changes are not necessary.

Breakout instructions will include one of the following instructions:

- “turn and climb”
- “turn and maintain altitude”
- “turn and descend”

In the event of a TCAS RA with simultaneous Breakout instructions issued:

- Continue the turn as instructed
- Follow the vertical guidance for the RA.

Additional briefing items are:

- Autopilot breakout manually flown
- Go-around switches
- Workload during reconfiguration
- Autothrottle will provide speed control with Flight Directors off.

Note: A descending breakout will be given when there is no other reasonable option. Descent will not be below the Minimum Vectoring Altitude.

Pilot Flying	Pilot Monitoring
	Verify that the cabin is secure.
Adjust vertical profile to ensure glideslope is joined from below.	
Call “FLAPS___” according to the flap extension schedule.	Set the flap lever as directed.
	Set L VHF to: • Tower frequency • Transmit and receive Set R VHF to: • ‘Approach Monitor’ frequency • Receive only
Monitor R VHF for breakout instructions ensure volume is the same as L VHF.	
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 LOC 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 LNAV, HDG SEL or HDG HOLD to intercept the final approach course, as needed. LNAV may be used to intercept the LOC only if the aircraft has serviceable GPS.	
Verify that the localizer is captured.	Call “LOCALIZER ALIVE”.
Arm the APP mode.	
	Call “GLIDESLOPE ALIVE”.
At glide slope alive, call: • “GEAR DOWN” • “FLAPS 20”	 Set the landing gear lever to DN. Set the flap lever to 20.

Pilot Flying	Pilot Monitoring
Set the SPEEDBRAKE lever to ARMED.	
At glide slope 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 the final approach fix or OM, verify the crossing altitude.	
	Monitor the approach.
	Monitor auto callouts

Go-around and Missed Approach Procedure – PRM Breakout

Pilot Flying	Pilot Monitoring
PRM Breakout is required.	
At the same time: • disconnect the autopilot • maneuver to PRM Breakout heading and vertical profile	Switch off Flight Directors. • make MCP selections to follow PRM maneuver
• For climbing Breakout use a maximum of 10 degrees pitch • For descending breakout, maintain previous descent rate	
	Switch Flight Directors on once Breakout trajectory is established.
Ensure autothrottle is controlling speed appropriately.	
	Select a roll and pitch mode.
Engage autopilot if required.	
Set speed to the maneuver speed for the planned flap setting.	
Call “FLAPS___” according to the flap retraction schedule.	Set the flap lever as directed.
Verify flap setting is 20 or less. Call “GEAR UP”.	Set the landing gear lever to UP.
	Set the landing gear lever to OFF after flap retraction is complete.
Call “AFTER TAKEOFF CHECKLIST”.	Do the AFTER TAKEOFF checklist.

Simultaneous Offset Instrument Approaches (SOIA)

Refer to airport chart for specific approach instructions:

- Use ILS-PRM procedures for the approach where applicable
- Use the autopilot until LDA MAPt
- In order to continue past the LDA MAPt the ILS traffic and the landing runway must be in sight. If either condition is not met, or subsequently lost, a go-around must be flown.
- Disconnect autopilot during visual manoeuvring
- Go-around and missed approach – PRM breakout.

Instrument Approach Using Vertical Speed (V/S)

Pilot Flying	Pilot Monitoring

Initially
• If on radar vectors
  • HDG SEL
  • Pitch mode (as needed)
• If enroute to a fix
  • LNAV or other roll mode
  • VNAV or other pitch mode	

Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.

Recommended roll modes:

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

Note: When using LNAV to intercept a localizer, LNAV might parallel the localizer without capturing it. Use HDG SEL or HDG HOLD to intercept the final approach course, if needed.

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

Pilot Flying	Pilot Monitoring
Use LNAV, or other roll mode to intercept the final approach course, as needed.	

Approximately 2 NM before the final approach fix, set the first intermediate altitude constraint or MDA(H) on the MCP. If the constraint or MDA(H) does not end in zero zero (00) for example, 1820, set the MCP Altitude window to the closest 100 foot increment below the constraint. When the current constraint is assured, set the next constraint before ALT is engaged to achieve a continuous descent path.	Approximately 2 NM before the final approach fix, call "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 ARMED.	

At descent point:

Pilot Flying	Pilot Monitoring
Call "FLAPS __" according to the flap extension schedule.	Set the flap lever as directed.

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).

Pilot Flying	Pilot Monitoring
Call "LANDING CHECKLIST."	Do the LANDING checklist.
At the final approach fix, crosscheck the altimeters within 100 feet.	

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:

AUTOPILOT Disengage switch ..... Push

Disengage autopilot in accordance with regulatory requirements.

AUTOTHROTTLE Disconnect switch ..... Push

Disconnect autothrottle when disengaging the autopilot.

Circling Approach

If using an ILS, do not use APP.

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/HDG HOLD switch ..... Push

Verify HDG SEL or HDG HOLD mode annunciates.

Configuration at MDA(H):

- Gear down
- Flaps 20 (landing flaps optional)
- Speedbrake armed

Before turning base or initiating the turn to base:

- Landing flaps (if not previously selected)
- Do the landing checklist

Intercepting the landing profile:

Autopilot disengage switch ..... Push

Autothrottle disconnect switch ..... Push

Missed approach:

- Make a climbing turn in the shortest direction toward the landing
- runway
- Do the missed approach

Intentionally
Blank

Centre CDU

MENU and ACARS ..... SELECT

Select INIT/PRES FLT, after the FMS route activate prompt has been executed and request flight data via uplink. Enter flight number and send.

CAUTION: Failure to activate the route prior to selecting INIT/PRES FLT and PERF REQ may result in incorrect pre-populated data.

ADS-Contract (ADS-C)

This procedure allows position reporting using the ADS feature of FANS 1 equipped aircraft as an alternative to voice communication position reporting. When initiating the logon to the appropriate OCA/FIR ensure that the CALLSIGN, exactly as stated on the ATC flight plan, is entered into the FLIGHT NUMBER field of the LOGON/STATUS page, e.g. BAW4103 or BAW47V. BAW must be used, not BA, and leading zeros should not be included unless they are included in the ATC flight plan. Ensure that the registration is correctly entered, including the dash, e.g. G-CIVZ.

The default state of ADS is ARMED and is shown on the ATC LOGON/STATUS page. This will change to active (ACT) when a contract has been established with ATC. It can be turned off if required using the ADS SELECT OFF key.

Aircraft Communications Addressing and Reporting System (ACARS)

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.

Note: Ensure any CPDLC departure clearance is printed from the Master FMC as soon as possible. Compare the printed clearance with the CDU display to ensure that the full message is received.

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.

Note: It is BA 747 fleet policy to PRINT then ACCEPT all CPDLC/ACARS clearances (lateral and vertical). If ACCEPT is pressed before the clearance has been printed there is a risk that the complete clearance will not be visible. Compare the printed clearance with the CDU display to ensure that the full message is received.

SATCOM

Access to SATCOM is normally through the MENU page of the centre CDU, though any CDU may be used.

Calls are made and received through headsets using the SATCOM transmit and receive selector buttons on the ASP. The IRSs must be aligned. The MIC and PTT functions for SAT-L or R operate like other radio equipment through the ASP. SAT-L and SAT-R are equivalent to SAT 1 and SAT 2 on the CDU SATCOM pages.

Incoming calls are indicated by the SELCAL chime. Pressing the illuminated SAT CALL button on the ASP allows headset transmission. Whilst the call is in progress, de-selecting the appropriate SAT transmitter selector button on the ASP, e.g. when selecting another transmitter, places the call on hold and allows other communications facilities to be used. Calls are terminated when the illuminated CALL element of the respective SAT transmitter selector button extinguishes (ground party disconnection), or the pilot ends the call by selecting END CALL at 1R on the CDU.

Calls are initiated by selecting the number from the directory on the SATCOM CDU display pages. Manual dialling is not available.

To make a call:

- Select SAT L or R on the ASP.
- Select MENU on the centre CDU.
- <SAT (3L).
- DIRECTORY>(6R).
- Pick the CATEGORY (Subdirectory) of stored numbers (1L, 2L, or 1R, 2R).
- Confirm channel at 1R (if channel is in use, try using the other channel by selecting SAT L or SAT R as appropriate on the ASP).
- Select the number required (2L, 3L, 4L, 5L). The call is then automatically initiated.
- Observe AVAILABLE, DIALLING, CONNECTED on SATCOM MAIN MENU, followed by an audible chime and ASP SAT L or SAT R CALL light illuminated.
- When the call is completed, terminate the call (2R - END CALL)*.

If the system is powered-up, yet appears to be disabled, confirm that the AUTO LOG-ON feature is active by selecting SATCOM SUB-MENU, <:LOG-ON>, and ensure that LOG-ON STATE at 1L is ON. If it is OFF, activate 2L.

If the call does not connect, the number is stored and displayed on the MAIN MENU page on the selected channel with an associated MAKE CALL prompt. Connection can then be remade by pressing 2L or 4L MAKE CALL.

Call Priority

SATCOM provides four priority levels of air-to-ground and ground-to-air communications.

Priority 1/PRI 1* Reserved for Emergency and Distress calls only.

Priority 2/PRI 2* Reserved for regulatory and flight safety calls.

Priority 3/PRI 3* Reserved for non-flight safety calls.

Priority 4/PRI 4* Reserved for passenger correspondence calls.

If all channels are being used by passenger calls, pilot initiated calls will be made in line. However, if a Priority 1/PRI 1* call is made, the passenger hears “Your call has been pre-empted” and the channel is immediately allocated for pilot use. Priority 2, 3 and 4 calls are either connected immediately if a channel is free, or PRE-EMPT and CANCEL CAMP are shown on the SATCOM MAIN MENU page if all channels are in use. The pilot initiated call is then connected in turn unless PRE-EMPT is pressed, upon which the passenger is notified.

WARNING: Do not use Priority 1/PRI 1* for calls except for Emergency aircraft communications.

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

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

Verify ON light(s) illuminated.

EXTERNAL POWER 2 switch ..... As required

Push if main deck cargo handling equipment power not required.

Verify ON light(s) illuminated.

Freighter

Verify ON light(s) illuminated.

If APU power desired:

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.

APU GENERATOR 2 switch ..... Push

Verify ON light illuminated.

Freighter

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.

Engine Crossbleed Start

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

The minimum recommended duct pressure for a crossbleed start is 30 PSI.

Do not advance the thrust lever until oil temperature is -10 degrees C or greater.

Thrust lever (operating engine) ..... Advance

Advance Thrust lever to approximately 70% N3.

Accomplish normal engine start. Autostart should be used. However, if the autostart is not successful, start engines using the MANUAL START PROCEDURE.

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.

If duct pressure is low, close opposite isolation valve during start, to reduce duct leakage. Re-open the isolation valve after the engine is running.

Engine Start Procedure - Manual Start

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

- the EGT does not increase by 30 seconds after the fuel control switch is moved to RUN
- there is no N1 rotation by idle N3
- the EGT quickly nears or exceeds the start limit
- the N3 does not stabilize at idle
- the oil pressure is not normal by the time the engine is stabilized at idle

Select the secondary engine indications. P2

PACK control selectors ..... SET P2

Set two or three packs off.

Start sequence ..... Announce P1

AUTOSTART switch ..... Off P2

Call “START ___ ENGINE” P1

Engine START switch ..... Pull P2

Verify that the N3 RPM increases. P2

When N3 is at 25% or if 25% is not possible, at maximum motoring (N3 acceleration is less than 1% in approximately five seconds):

FUEL CONTROL switch ..... RUN P2

Verify that the EGT increases and stays below EGT limit. BOTH

After the engine is stabilized at idle:

If autostart is operative:

AUTOSTART switch ..... ON P2

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.

Shutdown and Tow In Procedure - APU Unavailable

Do the Shutdown and Tow In Procedure at airports where tow-in parking is required but the APU is unavailable. Start the Shutdown and Tow In Procedure when approaching the shutdown point.

Parking brake ..... Set P1

Verify that the PARK BRAKE SET message is shown.

Towing is needed:

Pushback communications ..... Establish P1

Establish communications with ground handling personnel. Verify that external power is available. P1

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.

If external power is available on the tractor:

Electrical power ..... Set P2

Verify that the external power 1 AVAIL light is illuminated.

EXTERNAL POWER 1 switch - Push

Verify that the respective ON light is illuminated.

Hydraulic demand pump 4 selector ..... AUX P2

Hydraulic demand pump 1 selector ..... AUX P2

Hydraulic demand pump 2, 3 selectors ..... OFF P2

Call “SHUTDOWN”. P1

FUEL CONTROL switches ..... CUTOFF P2

Fuel pump switches ..... OFF P2

If external power is unavailable on the tractor:

Confirm which outer engine is to be left running with ground personnel P1

Hydraulic demand pump selectors (all) ..... AUTO P2

Call "SHUTDOWN ENGINES ____" P1

FUEL CONTROL switches (all required) ..... CUTOFF P2

Fuel pump switches (except running engine)..... OFF P2

Switching off fuel pumps reduces electrical demand

Inform ground handling personnel "READY FOR TOWING" P1

Set or release the parking brake as directed by ground handling personnel. P1

When approaching the stand (pushback or towing is complete):

Cabin Doors ..... Initiate Disarm P2

PA call: "CABIN CREW DOORS TO MANUAL AND CROSSCHECK".

When parked:

Electrical power ..... Set P2

Verify that the external power 2 AVAIL light is illuminated.

EXTERNAL POWER 2 switch - Push

Verify that the respective ON light is illuminated.

EXTERNAL POWER 1 switch (if used) - Push

Verify that the respective AVAIL light is illuminated.

Instruct ground handling personnel to exchange external power from tractor to FEGP.

Verify that the external power 1 AVAIL light is illuminated.

EXTERNAL POWER 1 switch - Push

Verify that the respective ON light is illuminated.

Hydraulic demand pump 1 selector..... OFF P2

If external power from tractor not used

Hydraulic demand pump 1, 2, 3 selectors .....OFF P2

Call "SHUTDOWN ENGINE ____" P1

FUEL CONTROL switches (all required) .....CUTOFF P2

Fuel pump switches (all) .....OFF P2

SEATBELTS selector .....OFF P2

NACELLE ANTI-ICE switches ..... AUTO P2

WING ANTI-ICE switch.....OFF P2

BEACON light switch .....OFF P2

FLIGHT DIRECTOR switches .....OFF P2

Status messages .....Check P2

Record shown status messages in maintenance log.

Transponder mode selector STANDBY/2000 P2

Hydraulic demand pump 4 selector .....OFF P2

Call "SHUTDOWN CHECKLIST". P1

Do the SHUTDOWN checklist. P2

Intentionally
Blank

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.

Intentionally
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Heading Reference Switch Operation

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

HEADING reference switch .....NORM or TRUE

Note: If using HDG SEL and the HDG reference switch position is changed, the AFDS roll mode will change to HDG HOLD. HDG SEL can be reselected.

Note: If the HDG reference switch position must be changed for an approach, it must be changed before the APP mode is armed.

If the HDG reference switch position is changed after the APP mode is armed:

- The AFDS roll mode will not change from HDG SEL to HGD HOLD.
- The AFDS will not follow the MCP-selected heading.
- LOC and FAC capture, and tracking performance may be degraded.
- Exiting the APP mode restores normal operation of the HDG reference switch and the AFDS. APP mode can be reselected.

PVD Check

PVD switch .....Push

Observe PVD display.

PVD display .....RIGHT, LEFT, STOP

Display shutters when not within localizer coverage, or when ILS not tuned.

Intentionally
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MNPS Route Checking and Waypoint Crossing Procedure

The following procedure must be completed in full when a clearance or re-clearance is received for MNPS or Oceanic airspace.

CAUTION: ATC Clearances must be entered into the FMC and checked rigorously, to avoid Gross Navigational Errors:

- **Named alphabetic waypoints that are in the database (eg. NEDUL) may be checked/entered directly in the FMC LEGS page.**
- **Unnamed waypoints (eg. N48W030) must be checked using full lat/long by expanding into the scratchpad where possible.**
- **Unnamed waypoints which cannot be expanded into the scratchpad (eg. 4830N) must be checked using full lat/long with the NAV DATA function.**

CAUTION: Erroneous waypoint entry is a significant cause of GNEs. Use all available resources (CIRRUS, Lido, SFC) to ensure accurate translation of ATC voice or free text (eg ACARS Oceanic Clearance) clearances into FMS waypoints.

CAUTION: The ND truncates waypoint names, so must not be used for checking.

Note: Unnamed MNPS waypoint checking requirements:

- Unnamed waypoints uplinked via CPDLC – Crew do not have to expand and check unnamed waypoints due to downlink and check by the ATC system. See below.
- Unnamed waypoints uplinked via ACARS – PM does not have to expand and check unnamed waypoints; PF must expand and check all unnamed waypoints
- Unnamed waypoints entered manually – Both PF & PM must expand and check all unnamed waypoints

Note: ATC Oceanic Clearances uplinked via CPDLC have greater data integrity than those received using ACARS or voice and therefore should be accepted into the FMC. The subsequent automatic downlink to ATC closes the loop and confirms the clearance; there is therefore no requirement to manually check the lat/long of ATC-uplinked waypoints using CPDLC.

However, CPDLC uplinks do not necessarily contain the domestic flight-planned route beyond the MNPS exit point, which should therefore be confirmed and restored as needed.

Note: Following any reroute, uplink revised wind and temperature data.

Note: All CPDLC clearances must be printed and compared with message shown on CDU to ensure all text is seen in accordance to SP.5 Controller Pilot Datalink Communication (CPDLC) Procedures.

Pilot Flying	Pilot Monitoring
	Read and Acknowledge text ATC clearance. Accept ATC Uplink clearance.
Listen and transcribe voice ATC clearance.	Listen and transcribe voice ATC clearance.
	Validate and Check Clearance against FMC: • Entry Point. • NAT Track, referring to TMI (if applicable). • Exit point. • Flight Level and Mach Number. • Check each waypoint (see CAUTIONS & Notes above).

Pilot Flying	Pilot Monitoring
	If needed, modify FMC, then check each waypoint (see CAUTIONS & Notes above): • LOAD the FMC and EXECUTE for large ATC Uplinks when possible. • Translate ATC-format to FMC lat/long format with care. The hemisphere (eg N or W) is moved from after the degrees to before the degrees (eg. 55N030W is inserted as N55W030). • To enter un-named waypoint format (eg. 5530N), refer to Lido Gen Navigation 8.1.2 for a description of the required format. Exercise extreme caution, entering the letter in the wrong position totally changes the position of the waypoint.
Independently validate and check FMC against clearance: • Entry Point. • NAT Track, referring to TMI (if applicable). • Exit point. • Flight Level and Mach Number. • Check each waypoint (see CAUTIONS & Notes above).	
Starting at first MNPS waypoint, read aloud each MNPS waypoint sequentially from CDU.	Check each waypoint read by PF directly against the clearance.
	Amend Master CIRRUS to reflect cleared route.
Amend Lido Enroute to reflect cleared route.	Amend Lido Enroute/SFC to reflect cleared route.
	Revise ETPs.
Waypoint Crossing Procedure:	

Pilot Flying	Pilot Monitoring
Confirm: • Active waypoint matches clearance. • LNAV FMA. • Aircraft turns towards next waypoint.	
	Check: • Check ANP against RNP. • Active waypoint matches clearance. • LNAV FMA. • Aircraft turns towards next waypoint. • Record ATA & Fuel on CIRRUS. • Revise ETAs and advise ATC if required.

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 ..... Push

If ORIGIN contains an ICAO identifier:

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

INIT REF key ..... Push

<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 the ACTIVE date range is current.

RTE key ..... Push

Leave ORIGIN blank.

DEST ..... Enter

Route ..... Enter

LEGS key ..... Push

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

ACTIVATE and execute the route.

VNAV key ..... Push

Displays the CLB page.

TRANS ALT ..... Enter

NAV RAD key ..... Push

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 ..... Push

NEXT PAGE key ..... Push

FORECAST> ..... Select

Displays 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 ..... Push

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 ..... Push

NEXT PAGE key ..... Push

FORECAST> ..... Select

Displays 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 ..... Push

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

Navaid Inhibit

Note: 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 approach operations not based on WGS-84, unless other appropriate procedures are used. GPS position updates should be used for all other operations, unless a specific state requires the use of other update provisions within their airspace (e.g., to accomodate a non-WGS reference datum).

NAV RAD key ..... Push

Shows the NAV RADIO 1/2 page.

NEXT PAGE key ..... Select

Shows the NAV OPTIONS 2/2 page.

To inhibit GPS updates:

GPS UPDATE> ..... Select

Verify OFF shows in large font.

Note: Airplanes with DME updates defaulted to OFF should select DME UPDATE to ON. Selecting VOR UPDATE to ON, in addition to selecting DME updates to ON, will provide VOR/DME radio updates.

To inhibit DME updates (DME/DME):

Note: VOR/DME updates will also be inhibited.

DME UPDATE> ..... Select

Verify OFF shows in large font.

Verify ALL shows in 1L and 1R.

To inhibit VOR updates (VOR/DME):

VOR UPDATE> ..... Select

Verify OFF shows in large font.

Verify ALL shows in 2L and 2R.

To inhibit LOC updates:

LOC UPDATE> ..... Select

Verify OFF shows in large font.

To inhibit a navaid (for one or two navaids):

Enter the navaid identifier in the scratchpad.

NAVAID INHIBIT (1L or 1R) ..... Enter

To inhibit a VOR (for one or two VORs):

Enter the VOR identifier in the scratchpad.

VOR ONLY INHIBIT (2L or 2R) ..... Enter

Weather Radar Test

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

FMS Drag and Fuel Factor Update

Legacy FMC

If the Drag and Fuel factors on the IDENT page do not agree with CIRRUS, update these values in the PERF FACTORS page.

FMS INDEX page ..... SELECT

MAINT Line Select Key ..... PUSH

MAINT prompt only displayed on the ground.

PERF FACTORS Line Select Key ..... PUSH

Enter ARM in the password field at 6R.

Enter the DRAG/F-F factors as shown on CIRRUS page 1 under Fuel Consumption, using the same numerical signage.

NGFMC

If the Drag and Fuel factors on the IDENT page do not agree with CIRRUS, update these values in the IDENT page.

Type ARM in the scratchpad and press DRAG/FF Line Select Key 5R.

Enter the DRAG/F-F factors as shown on CIRRUS page 1 under Fuel Consumption, using the same numerical signage.

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.

After engine start, any operation of fuel system switches must be monitored by the other pilot.

Fuel Management With One Engine Inoperative

See FCTM Chapter 8 for information on fuel balancing.

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 assumed temperature method only 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.

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.

Generic information is promulgated in OM A.

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, ice 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 allowable; however, all leading edge devices, all control surfaces, and upper wing surfaces must be free of snow, ice and frost.

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.

De-/Anti-icing Treatment and Procedures

De-icing is necessary if frozen deposits are present on the relevant aircraft surfaces.

Anti-icing treatment will be required if frozen or freezing precipitation is falling, or is expected during taxi-out, or when there is freezing fog. A Type II or IV fluid will be required, unless 'remote' de-icing is available, close to the threshold of the active runway.

Confirm the fluid type(s) and treatments available, and consult the appropriate holdover chart to determine the estimated holdover time. The holdover time provided by a 'one step' de-/anti-icing treatment with dilute type II or IV fluid may be sufficient in 'light' conditions, or when taxi times are short. In 'heavier' conditions, or when delays are anticipated, a 'two-step' procedure is advisable, using 100% type II or IV fluid for the second step. If surfaces are 'clean', but precipitation is expected to start before take-off, surfaces may be anti-iced with type II or IV fluid, without the need for de-icing first.

- 'Local Area' De-icing. Where frozen deposits are limited to a small patch of frost on the upper wing surface, de-icing must be carried out and carried out symmetrically even if the frost is only present on one wing. No holdover time will apply as the treatment does not cover the entire wing surface.
- De-icing Crews are required to confirm with the flight crew that the aircraft has been configured for de-/anti-icing before commencing de-icing. This will be done by verbal communication, either by direct conversation, headset, or by designated VHF frequency.
- When all other ramp activities have been completed but the forward passenger door is still open, de-/anti-icing may commence on surfaces that are well away from the open door, provided the operative confirms that passengers and staff will not be subjected to fluid overspray and that the Captain has been informed.
- If surfaces are clean and anti-icing is requested, the fluid will be applied as a 'one step' application onto the required surfaces. If a 'two-step' procedure is required, the anti-icing fluid will be applied to the surfaces as a continuous 'coating' after de-icing.
- Surfaces to be protected are:
  - Wing upper surfaces and leading edges.
  - Horizontal stabiliser upper surfaces and leading edges and elevator upper surfaces.

- Vertical stabiliser and rudder.
- Fuselage upper surfaces (not normally required during light snow/freezing rain as the holdover provided by the first step combined with cabin heat will keep the surfaces clear).

Post De-/Anti-icing Check

A Post De-/Anti-Icing check is required to check that the aircraft is free from frozen/semi-frozen contamination. If clear ice has been removed, this check will include a close inspection of the wing upper surface, using suitable access equipment.

For aircraft de-/anti-iced before the arrival of Flight Crew, the walkround satisfies this check requirement. If de-/anti-icing is carried out with the Flight Crew on board, the check is carried out by the responsible operative releasing the aircraft. They will relay the De-/Anti-icing Code to the Flight Crew.

De-/Anti-icing Prior to Engine Start

Select:

PACK CONTROL SELECTORS ..... OFF

APU BLEED AIR SWITCH ..... OFF

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.

CAUTION: If there is no indication of oil pressure 30 seconds after N3 idle, shut down the engine.

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 P2

When nacelle anti-ice is no longer needed:

Nacelle Anti-ice switches ..... AUTO P2

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

If there is snow or ice accumulation on the wing, consider delaying the flight control check until after de-icing/anti-icing is accomplished.

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 required. P1

Flap lever ..... Set FLAPS___, as required P2

Taxi-Out

When taxiing on contaminated surfaces great care must be taken. Greater distance between the aircraft and other obstacles should be allowed on ice or snow covered areas. Minimum thrust should be used to initiate movement as ice, packed snow or slush can be blown up causing damage to the aircraft, ramp facilities, personnel or other aircraft.

When taxiing on slippery surfaces, particularly in strong crosswinds, keep the ground speed to a minimum and avoid large tiller inputs for sideslip correction. Whenever possible, turns of more than 90° should be avoided.

Nosewheel traction may be lost at speeds as low as 4 K. If it is lost, centralise the nosewheel and reduce ground speed further before attempting to turn again. When the nosewheel is in a skid, the body gear can cause unusual effects and may even aggravate it. However, if the speed is kept to a minimum the combination of nose and body gear steering will give the greatest control. Exceptionally, judicious use of differential braking and/or thrust may be required.

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds can 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:

Check that the area behind the airplane is clear.

Run-up to a minimum of 60% N1 and a maximum of 65% N1 for approximately 10 seconds duration at intervals no greater than 60 minutes.

When line up clearance is anticipated, the flaps must be selected to the takeoff position and the Before Taxi and Before Takeoff checklists completed.

Ground Operations in Freezing Fog

During ground operations in freezing fog as reported by ATIS or METAR in visibility of 300m or less, carry out procedures as detailed in FCOM OMB BAB-162. If operationally possible (see CAUTION on page 4 of OMB) conduct a run up within 5 minutes prior to engine shutdown to allow the engines to be considered free of ice at the start of the next sector.

Following ground operations in freezing fog as reported by ATIS or METAR in visibility of 300m or less, make the following entry in the AML Part 1: “Taxi-in/Taxi-out in conditions of FZFG” and include the following information:

- Duration of operation in minutes.
- Visibility in metres.
- Outside air temperature in degrees Celsius.

- Time of last run up.
- For taxi-in - time of engine shutdown.

Engineering will complete the Action Taken box prior to the next sector.

There is no immediate maintenance action. Engineering will determine a schedule of inspection requirements following exposure to freezing fog

Remote De-icing Engines Running

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 remote de-icing/anti-icing is needed:

APU ..... As needed PM

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

Call “FLAPS UP” if flaps have been selected for taxi-out. PF

Flaps ..... UP PM

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

Thrust levers ..... Idle PF

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

PACK control selectors ..... OFF PM

Reduces the possibility of fumes entering the air conditioning system.

APU bleed air switch (APU running) ..... OFF PM

Reduces the possibility of fumes entering the air conditioning system.

After de-icing / anti-icing is completed:

APU ..... As needed PM

APU bleed air switch (APU running) ..... ON PM

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 PM

Flight controls .....Check, as needed PF

Call for Before Taxi checklist. PF

(This ensures Flaps are re-selected if no taxi-way contamination.)

Remote De-icing with Engines Shut Down

Carry out normal start and pushback procedures.

During the Before Taxi procedure leave the APU running. Select Flaps UP.

Taxi to the remote de-icing area; however, do not action the remainder of the Before Take-off procedure.

Once at the remote de-icing area, re-establish APU electrics and shut down all engines. Switch off the hydraulic demand pumps, monitor brake accumulator pressure and top up if necessary, using the No. 4 Aux pump.

Complete actions as required by De-/Anti-icing Prior to Engine Start procedure.

Prior to re-starting engines, ensure L and R isolation switches are ON and resume standard procedures from the beginning of the Before Start procedure. Aft Cargo Heat may be selected off prior to start. Immediate fire cover and/or ground crew are not required for starting.

Note: Some local procedures require Red Anti-collision light to be OFF before operatives will approach the aircraft. See local de-icing brief for further information.

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 preceded by a static engine run-up. Use the following procedure: PF

Run-up to a minimum of 60% N1 for approximately 10 seconds duration and confirm stable engine operation before the start of the takeoff roll.

Testing of undiluted de-icing/anti-icing fluids has shown that some of the fluid remains on the wing during take-off 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 take-off rotation rate.

Nacelle Anti-ice Operation - In flight

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

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

Manual Use of Nacelle Anti-ice

When using the nacelle anti-ice system manually in areas of possible icing, activate nacelle anti-ice before entering icing conditions.

WARNING: If using the nacelle anti-ice system manually, 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.

When manual use of nacelle anti-ice is needed:

Nacelle anti-ice switches ..... ON PM

When manual use of nacelle anti-ice is no longer needed:

Nacelle anti-ice switches ..... AUTO or OFF PM

Fan Ice Removal

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, if fan icing is suspected due to high engine vibration (exceeding 2.5 units), the fan blades must be cleared of any ice. Do the following procedures on all engines, one engine at a time: quickly reduce thrust to idle for five seconds, then restore the required thrust. If vibration persists, advance thrust lever to 90% N1 momentarily.

Refer to Boeing OMB BAB-88 (R1).

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 extended 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

Landing

Observe performance manual contaminated runway limits for landing.

Braking effectiveness will be significantly reduced on wet, slush or ice covered runways. To reduce the possibility of aquaplaning, make a positive touchdown in the correct place and make full use of autobrakes. On slippery runways, the autobrakes system will not apply the brakes until the wheels spin up and anti-skid locked wheel protection is established.

Apply manual brakes when at a safe taxi speed, maintaining a constant brake pedal force. On initial brake application, the anti-skid system modulates the applied brake pressure up to 3 or 4 times to determine the skid threshold. Braking effectiveness during the readjustment period is reduced.

At slower speeds, especially on slippery surfaces, the effect of the anti-skid system brake releases are even more pronounced. At very low speeds below approximately 8 K the antiskid is inhibited to allow the aircraft to be brought to a halt.

If the full runway width has not been cleared of snow and ice, excessive outboard reverse thrust may throw up loose debris causing flaps and airframe damage. In this event, consideration should be given to the use of reduced reverse thrust on the outboard engines if performance is not limiting.

After Landing Procedure

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. 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 P2

When nacelle anti-ice is no longer needed:

Nacelle anti-ice switches ..... AUTO P2

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: P1

Check that the area behind the airplane is clear.

Run-up to a minimum of 60% N1 and a maximum of 65% N1 for approximately 10 seconds duration at intervals no greater than 60 minutes.

When landing in freezing fog (or fog with OAT at or below 0°C), request the appropriate Engineering or Station Control, where possible via company frequency, to check for (and where present arrange for the removal of) fan blade icing.

At Stations where no Engineer is present to carry out this check, MAINTROL should be contacted to advise how this check will be completed.

Whenever taxi-in is conducted in conditions of Reported FZFG in visibility of 300 m or less, make an appropriate entry in the AML (refer SP.16.6).

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the airplane will be attended:

PACK control selectors .....NORM P2

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

Outflow valve manual control ..... CLOSE

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

Wheel chocks ..... Verify in place

Parking brake ..... Released

Reduces the possibility of frozen brakes.

Protective covers ..... INSTALLED

Protective covers and plugs should be installed to protect the aircraft and engines from snow and ice.

Water storage containers ..... DRAINED

All water tanks, containers and humidifiers should be drained to protect from freezing.

Toilets ..... DRAINED

All toilets should be drained to protect from freezing.

Doors ..... CLOSED

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

Hot Weather Operation

Aircraft operations in extremely high temperatures or at high-density altitude airfields have a significant effect on passenger and crew comfort and generally decrease aircraft performance.

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

- all packs should be used (when possible) for maximum cooling
- recirculation fans should be off because the fans add warm air to the conditioned air

- if cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start
- keep all doors, including cargo doors, closed as much as possible
- electronic components which contribute to a high temperature level in the flight deck should be turned off while not needed
- all air outlets on flight deck should be open
- close all window shades

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

Operation in a Sandy or Dusty Environment

The main hazards of a sandy or dusty environment are erosion (especially of engine fan blades), accumulation of sand or dust on critical surfaces, and blockage. The effects of sand ingestion occur predominantly during takeoff, landing and taxi operations. The adverse effects, however, can occur if the airplane’s flight path was through a cloud of visible sand or dust, or the airplane was parked during a sand or dust storm. Premature engine deterioration can result from sand or dust ingestion, causing increased fuel burn and reduced EGT margins.

CAUTION: After a sandstorm, if all taxiways and runways are not carefully inspected and swept for debris before flight ops are conducted, the risk of engine damage and wear is increased.

Exterior Inspection

Although removal of sand and dust contaminants is primarily a maintenance function, during the exterior inspection, the captain or first officer should carefully inspect areas where accumulation of sand or dust could change or affect normal system operations.

Do the normal Exterior Inspection with the following additional steps:

Windshield ..... Check

Verify that the windshield has been cleaned.

Note: Do not use windshield wipers for sand or dust removal.

Surfaces ..... Check

Verify that the upper surfaces of the wings and other control surfaces are free of sand.

CAUTION: Particular care should be taken to ensure that the fuselage and all surfaces are clean after a sand storm that occurs with a rain storm.

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

Verify that all are free of sand and dust.

Pack inlets ..... Check

Verify that the pack inlets are free of sand and dust.

Outflow valves ..... Check

Verify that the outflow valves are free of sand and dust.

Positive and negative pressure relief doors ..... Check

Verify that all doors are free of sand and dust.

Leading edge flaps ..... Check

Verify that all leading edges are undamaged.

Engine inlets ..... Check

Verify that the inlet cowling is free of sand and dust.

Verify that the fan is free to rotate and fan blades are undamaged.

Fuel tank vents ..... Check

Verify that all vents are free of sand and dust.

Landing gear ..... Check

Verify that gear struts and doors are free of sand and dust build-up.

Vertical and horizontal stabilizers ..... Check

Verify that all leading edges are undamaged.

APU air inlet ..... Check

Ensure that the APU inlet door is free of sand and dust before APU start.

Preflight Procedure - P2

Do the normal Preflight Procedure - P2 with the following modifications:

Note: Minimize the use of air conditioning, other than from a ground air conditioner, as much as possible. If the APU must be used for air conditioning, maintain a temperature as high as possible while still providing a tolerable flight deck and cabin environment.

If APU bleed air will be used and the APU is not operating:

APU bleed air switch ..... Off P2

APU ..... START P2

Note: Run the APU for one full minute before using it as a bleed air source.

APU bleed air switch ..... ON P2

Engine Start Procedure

Do the normal Engine Start Procedure with the following modifications:

Note: Use a filtered ground cart for pneumatic air for engine start, if available.

AUTOSTART switch ..... Off P2

Engine START switch ..... Pull P2

Verify that the N3 RPM increases. P1, P2

Allow maximum motoring for 2 minutes to help remove contaminants.

Note: Maximum motoring occurs when N3 acceleration is less than 1% in approximately five seconds.

FUEL CONTROL switch .....RUN P2

After engine start:

AUTOSTART switch ..... ON P2

Before Taxi Procedure

Do the normal Before Taxi Procedure with special emphasis on the following steps:

If conditions allow, use Packs Off Takeoff procedure.

Flight controls .....Check P1

Verify that there is no increase in control forces due to sand or dust contaminants.

Taxi–Out

Do the following, conditions permitting, to minimize sand and dust ingestion by the engines and to improve visibility during taxi:

- Use all engines during taxi and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible to avoid creating a vortex during ground operations.
- Maintain a greater than normal separation from other aircraft while taxiing and avoid the ingestion of another engine's wake.
- Avoid engine overhang of unprepared surfaces.
- Minimize thrust on the outboard side of the turn during 180° turns.
- In the event of a crosswind during 180° turns, turn away from the wind if possible to minimize sand and dust ingestion.
- Whenever possible, avoid situations that would require the airplane to be brought to a complete stop.
- Avoid excessive braking. The presence of sand or dust will increase brake wear.

Takeoff

Do the following to minimize sand and dust ingestion by the engines during takeoff:

- Use the maximum assumed temperature thrust reduction that meets performance requirements.
- Before takeoff, allow sand and dust to settle if conditions allow.
- Do not take off into a sand or dust cloud.

- Use a rolling takeoff. Whenever possible, avoid setting high thrust at low speed.
- When visible sand and dust exist, consider delaying flap retraction until above the dust cloud, if operations allow.

Landing

Do the following to minimize sand and dust ingestion by the engines during landing:

- Use autobrake on landing to help minimize the need for reverse thrust.
- If performance allows, minimize the use of reverse thrust to prevent ingestion of dust and sand and to prevent reduction of visibility. Reverse thrust is most effective at high speed.

Taxi-In

Do the following, if conditions allow, to minimize sand and dust ingestion by the engines and to improve visibility during the taxi-in:

- Use all engines and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible.
- Maintain a greater than normal separation from other aircraft while taxiing and avoid the ingestion of another engine's wake.
- Avoid engine overhang of unprepared surfaces.
- Minimize engine thrust on the outboard side of the turn during 180° turns.
- In the event of a crosswind during 180° turns, turn away from the wind if possible to minimize sand and dust ingestion.
- Whenever possible, avoid situations that would require the airplane to be brought to a complete stop.
- Avoid excessive braking. The presence of sand or dust will increase brake wear.

Shutdown Procedure

Do the normal Shutdown Procedure with the following modifications:

Note: Use external power and ground air carts as much as possible. Start the APU only if it is needed to provide electrical power or bleed air after engine shutdown.

Note: If the APU must be used for air conditioning, maintain a temperature as high as possible while still providing a tolerable flight deck and cabin environment.

If the APU must be started:

APU bleed air switch ..... Off P2

APU ..... START P2

Note: Run the APU for one full minute before using it as a bleed air source.

APU bleed air switch ..... ON P2

Secure Procedure

Do the normal Secure Procedure with the following modifications:

Outflow valve manual switches ..... ON P2

Outflow valve manual control ..... CLOSE P2

Position the outflow valves fully closed to inhibit the intake of sand and dust.

Additional procedures for securing the airplane during sandy or dusty conditions may be needed. These procedures are normally done by maintenance personnel, and include, but are not limited to:

- Verify that engine covers, if applicable, are in place while the airplane is parked.
- Verify that airplane doors are closed.
- Verify that all openings are plugged or covered while the airplane is parked. Streamers should be used to remind personnel to remove before flight.
- Ensure all compartments are closed.

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

The SCCM will confirm that the passengers are seated with their seat belts fastened using the ‘6P’ CABIN READY signal. The cabin service will continue, excluding hot beverages, unless the cabin crew are told to suspend all service, secure the cabin and fasten their seat belts.

Structural

Flap extension in an area of severe turbulence should be delayed as long as possible as the aircraft can withstand higher gust loads in the clean configuration. Diversion to another airfield may be the best policy.

A rudder input is never the preferred initial response to an extreme condition of undesired roll. If the rudder is used aggressively, large abrupt rudder inputs can generate very large slideslip angles, which result in amplified and abrupt roll rates. If this is followed by sudden commanded full, or nearly full, opposite rudder inputs against a sideslip, this can lead to excessive structural damage.

Maximum Altitude

Do not operate the aircraft above the maximum permitted altitude on the FMS CRZ page. This limit provides a 1.3g margin to buffet onset and will ensure protection against unexpected turbulence. The weight/altitude chart in the QRH also gives maximum permitted altitudes.

Weather Radar

A colour code distinguishes areas by the intensity of the precipitation in them, black for the lowest intensity, green, amber and red for progressively higher intensities and magenta for saturated areas when in the WX+T mode. A ground mapping mode permits the radar to produce more returns from less reflective targets on the ground.

Monitor the weather at both long and short ranges in order to plan efficient course changes. When avoiding storm activity stay upwind of the storm, if possible. If thunderstorms exist over the landing airfield or landing reports indicate severe turbulence, consider delaying landing or diverting.

Plan ahead to avoid large storms:

- Avoid magenta and red radar returns and fringes by at least 20 nm.
- Avoid single magenta areas of turbulence (not associated with heavy precipitation) by at least 5 nm.
- Avoid penetrating a cell or clearing its top by less than 5000 ft, otherwise severe turbulence may be encountered.
- Do not overfly cells if the top of the cell is at or above 25,000 ft to avoid the possibility of encountering turbulence stronger than expected.
- Avoid flying under a thunderstorm due to possible windshear, microbursts, severe turbulence or hail.

If severe turbulence cannot be avoided, an increased buffet margin is recommended. This can be achieved by descending up to 4,000 ft below the FMS optimum altitude.

Adjust the tilt frequently in order to monitor storm development and to get the best cell echo.

Weather radar is not designed to detect volcanic dust.

Turbulence Mode

The turbulence detection mode is only effective up to a range of 40 nm with the antenna tilted to avoid ground return. Closely spaced or thin lines between colour graduations are usually associated with severe turbulence.

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 in clean configuration, the autoflight system is recommended for flight through turbulence. To reduce pitch changes as the AFDS commands speed on 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.

MEL Restrictions

If an MEL item restricts the maximum operating speed, e.g. 280 K, the maximum turbulence penetration speed is reduced to this. Turbulence speeds are recommended speeds whereas an MEL speed restriction becomes a Limitation. In the event that turbulence is encountered, aim to operate at a speed close to the turbulence penetration speed whilst ensuring that the MEL restriction is not exceeded.

Volcanic Dust

Pre-flight

Flight in areas of known volcanic activity must be avoided. This is particularly important during hours of darkness or daytime IMC, when volcanic dust may not be visible.

When a flight is planned into an area with a known potential for volcanic activity, review all NOTAMs and any other information for current status of volcanic activity. If volcanic activity is reported, the flight must be planned to operate well clear of the area and, if possible, upwind of the volcanic dust.

In-Flight

Carry out the Volcanic Ash checklist.

Volcanic dust is very abrasive and can cause serious damage to aircraft engines, wing and tail leading edges, windshields, landing lights, etc. It can cause windshields to become translucent, obstructing vision. If necessary, divert to an airport with autoland capability.

The effectiveness of the landing lights may also be significantly reduced.

For volcanic ash reporting and precautions refer to OM A.

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. Do not penetrate an area of known severe 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

Note: If severe windshear conditions are forecast or reported, DO NOT TAKEOFF or LAND.

- Takeoff with less than full-rated takeoff thrust is not recommended if windshear conditions exist or are suspected, unless the use of a fixed derate is required to meet a dispatch performance requirement (e.g. contaminated runway). When windshear is expected to be encountered and takeoff is into a positive wind gradient (the same direction as landing traffic), where the wind speed can be anticipated to increase with altitude, reduced thrust may be used. If the severity of the windshear cannot be established, use full thrust.
- Use the longest suitable runway provided it is clear of areas of known windshear.
- Use the flight director after takeoff.
- 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. If stick shaker is encountered, reduce pitch attitude. Do not exceed the Pitch Limit Indication.
- Select WXR for display on the ND. This will allow weather radar to start scanning prior to the start of takeoff.

After Lift Off

- Once airborne, if a WINDSHEAR warning is present or occurs, fly a Windshear Escape Maneuver:
- Pitch control forces may be much higher than normal due to the out of trim condition.
- Do not make any stabiliser trim inputs until out of the windshear.
- Be prepared for penetration of additional areas of windshear.
- If obstacle clearance allows, consider using an initial climb speed of V2 + 25 K.
- If an unexpected increase in airspeed is experienced, do not chase airspeed with large pitch increases, even if commanded by the FD, as the airspeed increase may be followed by a sudden decrease.

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 disconnected, or is planned to be disconnected prior to landing, add an appropriate airspeed 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.
- If the stabilised approach criteria cannot be met, go around.
- If a WINDSHEAR warning occurs fly the Windshear Escape Maneuver. A WINDSHEAR warning may only be treated as advisory in the circumstances described in OM A.

Recovery

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

Windshield Washer

Note: Do not use windshield wipers on dry window.

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

Windshield Wiper selector ..... As required

Low Visibility Procedures

Crew Assembly

Weather

For the purpose of determining the takeoff alternate, if required, 120 minutes at the one engine inoperative LRC speed equates to 800 nm.

Briefing

Where it is necessary to use the PVD for takeoff, check that the ILS has not been downgraded from Cat III. In the UK a downgraded ILS may still be available for PVD takeoff if it is promulgated as ‘Suitable for takeoff guidance’.

Check Brief to ensure CAT II or III is available at the destination.

Check the aircraft serviceability in OPDEF.

Crew

Converting Captains and pilots under going command training are qualified to carry out LVPs during their route training. The extent of route training on the 747-400 meets the experience requirements and ensures qualification on completion of a pilot's route training.

Co-pilots are qualified to carry out LVPs on completion of their simulator training.

Fuel

Consideration should be given to loading extra fuel for holding purposes. It should be borne in mind that ATC delays, due to the back log of traffic, may continue for some time after weather improvement, particularly at busy airports.

Pre-Flight

In addition to the normal checks:

Check the autoland status. Ensure that the aircraft has no other defects which will affect approach capability as listed in the Limitations section of FCOM and MEL.

If carrying out a PVD takeoff, enter ILS (Freq/QDM) on the NAV RAD page. Select both PVDs ON to arm the system and set the required display brightness. Identify the ILS and check that the PVD Memo message is displayed.

Check familiarity with the Cat II/III holding points for the takeoff and any special taxiway routeings that should be used.

If flow restrictions are in force in Europe due to destination weather conditions, it is necessary to advise ATC of the aircraft Cat II/III capability on request for start.

Taxi

Taxi slowly.

In poor visibility expect to see bright lights but not unlit or poorly lit objects such as aircraft wingtips or tails. From certain angles aircraft navigation lights do not show up well and the greatest distance from which a white painted aircraft may be visible in 100m RVR may be less than 50m.

Use the Airfield, Taxiway or Low Visibility Routeing Chart to assess the aircraft position and to assist in anticipating taxiway bends. Normal spacing between centreline lights is 30m but is reduced to 15m or 7m on bends, so caution should be exercised when coming out of the bend where lighting spacing reverts to normal. Ensure that the aircraft does not pass the Cat II/III holding point markings. Green taxiway centreline lights may be illuminated beyond the Cat II/III holding point if it does not coincide with a taxiway stopbar or if a preceding aircraft is lining up.

Obtain the minimum RVR for takeoff.

Check the appropriate RVRs are above minima before passing the holding point.

The published runway width must not be reduced by the presence of snowbanks. Snowbanks adjacent to runway edges must not exceed 2.5 ft.

Takeoff

For PVD takeoffs the PVD will unshutter when the aircraft's heading is within 45° of the runway QDM at which point the indications can be checked.

As the aircraft lines up it is essential to confirm that it is lined up on the runway centreline lights of the correct runway and the localiser is centralised.

Check that the minimum number of visible centreline lights is consistent with the reported RVR. The minimum number should be 4 for a spacing of 15 m with an RVR of 75 m.

During the takeoff roll use the centreline lights and/or markings as the prime source of directional guidance. As speed increases, the streaming effect of these improves guidance. As visibility reduces the visible external element moves down the glareshield (towards the PVD) until it is lost. At this point the Captain will be using the PVD as the prime source of directional guidance. If the visibility improves, it does so from just above the PVD. The PVD will shutter when airborne.

Cruise

Monitor the Weather at the Destination and Alternates.

When approaching the destination, advise ATC that a Cat II/III approach will be made. If possible, monitor destination Tower frequency for the latest RVRs as often the Volmet and ATIS RVRs may not have been updated.

Unserviceable Ground Equipment

In the event of any unserviceability of ground equipment or lighting, reference should be made to OM A to assess the impact on operational capability.

Descent

Prior to commencing a Cat II/III approach pilots should check LVPs are in force or specific reference that Cat II or Cat III approaches are in use. If the ATIS and/or ATC do not report otherwise, it can be assumed that all the necessary facilities are serviceable. In which case the appropriate runway and ILS protection procedures are active.

RVR requirements for landing are contained in OM A.

Contaminated Runways

The published runway width must not be reduced by the presence of snowbanks. Snowbanks adjacent to runway edges must not exceed 2.5 ft.

Approach

On first contact with the approach controller advise him of your operational capability.

When making an approach in Cat III, flaps 30 should be used to improve the visual segment.

If a >NO LAND 3 message is displayed the minimum approach category is ILS Cat IIIA.

If a >NO AUTOLAND message is displayed the minimum approach category is ILS Cat I.

With RVRs below 600m, the use of landing lights is not recommended. The visual segment is diminished by the diffusion.

If the RVR falls below minimum after the start of the approach, the Captain may continue the approach to 1,000 ft AAL but must discontinue the approach if the RVR is still below minimum at this height.

RVRs reported below 1,000 ft AAL are for information only. Any RVR deterioration below 1,000 ft AAL may be disregarded and the approach may continue to DA/DH.

On first contact with the Tower, advise the controller that the aircraft is making a Cat II/III approach.

If no landing clearance is given by 200 ft RA, go-around.

1500 ft. Radio

At 1500RA the remaining two A/Ps engage. Check LAND 3, FLARE and ROLLOUT are annunciated on the FMA.

Reversion

In the event of equipment failure, a go-around must be flown unless the RVRs reported by 1,000 ft AAL are at or above the reversion minima for the failure.

1000 ft. Radio

The Captain checks the FMA for LAND 3, LAND 2 or NO AUTOLAND and flight mode annunciations.

The Co-Pilot continues to monitor the flight path by remaining on instruments down to and throughout the flare.

500 ft. Radio

The runway align mode engages, applying slip when the crab angle exceeds 5°. This submode is not annunciated.

200 ft. Radio

Below 200 RA, >NO LAND 3 message and LAND 2 annunciations are inhibited.

100 ft. Radio

If LAND 2 is annunciated, the A/P will apply an increment of nose up trim.

Approaching DH

The Captain seeks visual reference when within 50 ft of decision height, and should respond promptly at DA/DH.

At or below the DA/DH an approach shall be discontinued by an immediate go-around unless the visual reference requirements specified below remain satisfied.

(1) For ILS Cat II, LTS Cat I, OTS Cat II: A segment of at least 3 consecutive lights being the centreline of the approach lights, or touchdown zone lights, or runway centreline lights or runway edge lights, or a combination of these. This visual reference must include a lateral element of the ground pattern, i.e. an approach lighting crossbar or the landing threshold or a barette of the touchdown zone lighting.

(2) For ILS Cat IIIA: A segment of at least 3 consecutive lights being the centreline of the approach lights, or touchdown zone lights, or runway centreline lights or runway edge lights, or a combination of these is attained and can be maintained.

(3) For ILS Cat IIIB: A visual reference containing at least one centreline light

(4) For ILS Cat IIIB No DH: There is no requirement for visual contact with the runway prior to touchdown.

Landing

The aircraft commences the flare at approximately 50RA, dependent on rate of descent. At 25RA the A/T retards the thrust levers to idle. ROLLOUT mode is engaged at 5RA. On touchdown the A/P lowers the nose wheel to the runway.

For a Cat IIIB No DH approach, seek visual reference after nosewheel touchdown.

After touchdown, the A/P can be left engaged until ready to turn off the runway. The A/P maintains the localiser centreline through rudder and nosewheel steering. The rollout control and autobrakes may remain engaged until the aircraft stops, if required.

If low visibility operations procedures are not in force at the airfield be aware that any disturbances to the localiser beam may cause the aircraft to deviate from the centreline. Be prepared to disengage the A/P if required.

Go-Around

The TO/GA mode is available throughout the approach from G/S capture (or flaps selected) until 2 seconds after 5RA. The mode remains engaged even after touchdown during the go-around manoeuvre.

Autoland Reporting

Complete accurately the appropriate boxes in AML Pt 1 in accordance with the requirements of OM A.

Ice Crystal Icing

At temperatures below freezing near convective weather, the airplane can encounter visible moisture made up of high concentrations of small ice crystals. Ice crystals can accumulate aft of the engine fan, in the engine core. Ice shedding can cause engine vibration, engine power loss, and engine damage.

These weather conditions are difficult to detect because ice crystals do not cause significant weather radar returns. They are often found in high concentrations above and near regions of heavy precipitation. Ice crystals do not stick to cold aircraft surfaces.

Flight in clouds containing ice crystals has been associated with engine vibration, engine power loss, engine damage, and airplane Total Air Temperature (TAT) probe icing.

Recognize Ice Crystal Icing Weather

Ice crystals are most frequently found in areas of visible moisture and above altitudes normally associated with icing conditions. Their presence can be indicated by one or more of the following:

- Appearance of rain on the windshield at temperatures too cold for liquid water to exist. This is due to ice crystals melting on the heated windows (sounds different than rain)
- Airplane TAT indication remains near 0 degrees C due to TAT probe icing
- Areas of light to moderate turbulence
- In IMC with:
- No significant radar returns at airplane altitude and
- Heavy precipitation below the airplane, identified by amber and red radar returns on weather radar
- Cloud tops above typical cruise levels (above the tropopause)

Note: There is no significant airframe icing. The icing conditions detections system does not detect ice crystal icing. It is designed to detect supercooled water only.

Avoid Ice Crystal Icing Weather

During flight in IMC, avoid flying directly over significant amber or red radar returns, even if there are no returns at airplane altitude.

Use the weather radar controls to assess weather radar reflectivity below the airplane flight path. Refer to weather radar operating instructions for additional information.

Ice Crystal Icing Suspected

Exit the ice crystal icing conditions. Request a route change to minimize the time above red and amber radar returns.

Do the Ice Crystal Icing non-normal checklist in the Quick Reference Handbook (QRH).

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Engine Out Taxi (EOT)

It is Fleet Policy to employ Engine Out Taxi whenever this can be achieved in a manner that ensures safe operation of the aircraft. Consideration should be given to:

- Systems defects which may not be compatible with Engine Out Taxi (e.g. braking/steering deficiencies)
- Aircraft weight
- Gradient and direction of turns
- Blast hazard to proximate ground handling equipment

Engine Out Taxi Out

EOT may be conducted when predicted taxi time is significant (greater than 30 minutes) and in circumstances where application of the Remote Hold Procedure is impracticable.

Complete the normal Before Start procedure and Before Taxi procedure. All engines should remain running until clear of congested ramp areas and the minimum thermal stabilisation period of 1 minute has elapsed. It is possible to observe the 1.08 EPR taxi limit up to 350 T with engine No. 3 shutdown, and 300 T with engine No. 2 and 3 shutdown.

When engine start required:

Parking brake ..... Set P1

APU selector ..... START, then ON P2

Carry out the normal Engine Start procedure or cross-bleed start as appropriate.

Complete the Before Taxi procedure.

Observe minimum engine warm-up period prior to takeoff.

Note: The Before Take Off procedure must be completed in full after all engines have been started.

Engine Out Taxi In

Note: It is not necessary to start the APU before engine shutdown during taxi-in.

Prior to shutdown the minimum cool down period of 1 minute must be observed. Engine 3 should be shut down for taxi with three engines, and engines 2 & 3 should be shut down for taxi with two engines.

No 2 & 3 Eng Fuel Control Switches .....As required P2

Noise Abatement Procedure

At stations annotated in the Performance Manual or on Brief, the following Noise Abatement procedure will be used.

- Carry out standard takeoff procedure up until 1,000 ft AAL.
- At 1,000 ft AAL reduce power to full CLB power.
- Speed intervene at flaps 10 minimum manoeuvring speed.
- Accelerate to flaps 10 minimum manoeuvring speed, retracting flaps to 10 on schedule.
- Climb at flaps 10 minimum manoeuvring speed to the terminating altitude listed in CARD. If an altitude below this is promulgated or assigned by ATC, continue the acceleration and clean up at this altitude.
- Terminate speed intervention and accelerate on schedule to en-route climb speed.
- Once clean, reduce climb power to CLB 1.

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Positioning Ferry Flights

The minimum operating crew for Positioning Ferry flights is 2 pilots. There is no requirement to carry additional persons in the cabin for any reason.

The following procedures should be completed to prevent damage and minimise the risk of fire/fumes:

- ensure cabin cleaned and all bins and stowages emptied of any combustible material
- ensure cabin is free of unsecured equipment or loose articles
- ensure no freight is carried in the cabin
- ensure all closets are closed and that all overhead lockers are in the UP or CLOSED position
- ensure any catering trolleys or canisters remaining in the galley stowages are fully secured
- ensure all ovens, beverage makers, galley power, chillers and compactors are switched off

CAUTION: If the operating crew use galley equipment, it must be checked at regular intervals during use and switched off when not required.

Galley Emergency power switches ..... On

Flight deck door ..... Open

Latched Toilet doors ..... Open

CAUTION: A toilet smoke warning is likely to be spurious, but should be investigated. Smoke detectors are operational at all times.

At Pursers station or Upper deck Galley control select:

Audio entertainment switch ..... Off

Passenger service system ..... OFF

IFE Master switch ..... OFF

Cabin lights ..... Night

Reading lights ..... Off

All cabin lights, including crew rest areas that generate heat must be switched off.

Before Start Procedure

Do the normal Before Start Procedure with the following modifications:

Ensure flight deck door is unlocked:

FD ACCESS switch .....OFF

Switch seatbelt and no smoking signs off:

Signs .....Off

Doors 2L, 2R and Upper Deck doors .....AUTOMATIC

Shutdown Procedure

Do the normal Shutdown Procedure with the following modifications:

Doors 2L, 2R and Upper Deck doors .....MANUAL

Metric, QFE Operations

At aerodromes where ATC clearances are referenced to meters QFE below Transition Height/Level, the following QNH setting procedures are to be used provided the following criteria are met:

- Approach charting includes “QFE meters to QNH feet” tables.
- QNH is available on the ATIS or derived in accordance this procedure.

The QNH tables allow crews to convert ATC descent/climb clearances from a QFE height in meters directly to a QNH altitude in feet.

- All clearances below Transition Level should be received and read back in meters QFE.
- All inputs on the MCP Altitude Window are in feet QNH.
- All conversions using the tables should be cross-checked by both pilots.

Preflight, Before Start, Before Taxi and Before Takeoff Procedures

Complete all PREFLIGHT, BEFORE START, BEFORE TAXI and BEFORE TAKEOFF procedures normally, and:

- Ensure QNH is set on all altimeters.
- Convert all QFE meters ATC Clearance/SID Heights to QNH feet.
- Check that all altimeters indicate aerodrome elevation.

WARNING: Do not use aircraft metric conversion display when cleared to or operating at or below transition level.

During Climb and Cruise Procedure: When above Aa and cleared to climb above transition height:

- Set both primary altimeters to 1013/29.92.
- Normal altimeter setting procedures apply.
- Use table to convert Metric FL to FL in ft.

Descent Procedure

- QNH (if available) and QFE must be obtained from the ATIS.
- Use the QFE/mb conversion to work out an expected QNH.
- Note the difference against threshold elevation mb equivalent given on the approach chart vertical profile.
- Set QNH on the standby altimeter.

When cleared to descend from a FL to a Height:

- Both pilots set primary altimeters to QNH.
- Convert all QFE meters ATC clearances to QNH feet.

WARNING: Do not use aircraft metric conversion display when cleared to or operating at or below transition level.

Deriving QNH from QFE

If QNH is not available on the ATIS, crews must calculate the QNH by adding the threshold elevation (THR Elev) mb correction on the appropriate approach plate to the ATIS QFE.

CAUTION: Cross-check the calculated QNH against METAR QNH, if available, to avoid gross errors.

Note: The conversion of QFE heights to QNH altitudes is an aircraft only procedure. To avoid the risk of introducing confusion about the clearance or procedure requested from the ATC controller, crews should not request QNH from ATC.

Note: Both pilots are responsible for ensuring that the clearance provided by ATC is referenced to QFE meters. Crews must resolve any altitude discrepancy before accepting an ATC vertical clearance.

Remote Hold

If REMOTE HOLD is required:

Before Taxi Procedure

Complete the Before Taxi Procedure as normal except:

APU selector ..... RUN

If REMOTE HOLD not required:

Any time before FUEL CONTROL switches are set to CUTOFF:

APU selector ..... OFF

When at remote holding point:

Parking brake ..... Set
Verify that the PARK BRAKE EICAS message is annunciated.

Electrical power ..... Set
Verify that the APU RUNNING EICAS message is annunciated.
If APU is unserviceable DO NOT shutdown No. 4 engine.

ENGINE ANTI–ICE switches .....Auto
Complete the appropriate elements of the Shutdown Procedure.

Before Start Procedure

Complete the Before Start Procedure as normal.

CAUTION: Take care with switch selections. Many switch positions will already be in the required position. Do not inadvertently deselect switches.

Complete the Before Taxi Procedure as normal.

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Transit Procedures

The following can be used as an aide memoire of items to be considered during a diversion or unscheduled technical stop with no suitably qualified British Airways staff or handling agents.

Transit Check	Details contained in AML Part 1. An AML entry is required to state that the transit check has been completed.
ATC Flight Plan	Contact Flight Planning (FTD).
CIRRUS fuel plan	Contact Flight Planning (FTD).
Takeoff Performance	CARD or contact Flight Planning (FTD).
Loadsheet/Nil change of load	Forms available in aircraft library.
Refuel	Supplier information is available from Network Operations. Fuelling procedures, if required, are available from Maintrol. Refer to OMB GEN 2.8.5 for generic refuel procedures.

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747-400 RB211-524G C KG FT JAA TO1%10 TO2%20 TALPA

Pkg Model Identification PI.ModID.10.1

General PI.10.1

Assumed Temperature Reduced Thrust PI.10.1
Initial Climb EPR PI.10.1
Max Climb EPR PI.10.2
Go-around EPR PI.10.3
Flight With Unreliable Airspeed / Turbulent Air Penetration PI.10.4

All Engines PI.11.1

Long Range Cruise Maximum Operating Altitude PI.11.1
Long Range Cruise Control PI.11.2
Long Range Cruise Enroute Fuel and Time - Low Altitudes PI.11.3
Long Range Cruise Enroute Fuel and Time - High Altitudes PI.11.4
Long Range Cruise Wind-Altitude Trade PI.11.5
Descent at .84/290/250 . . . . . PI.11.5
Holding PI.11.6

Advisory Information PI.12.1

Runway Surface Condition Correlation PI.12.1
Normal Configuration Landing Distance PI.12.2
Non-Normal Configuration Landing Distance PI.12.6
AIR/GND SYSTEM (Flaps 25) PI.12.6
AIR/GND SYSTEM (Flaps 30) PI.12.7
ANTISKID / ANTISKID OFF (Flaps 25) PI.12.8
ANTISKID / ANTISKID OFF (Flaps 30) PI.12.9

BLD DUCT LEAK L, C, R (Flaps 25) PI.12.10
BLD DUCT LEAK L, C, R (Flaps 30) PI.12.11
ENG 1, 2, 3, 4 SHUTDOWN (Flaps 25) PI.12.12
ENG 1, 2, 3, 4 SHUTDOWN (Flaps 30) PI.12.13
FLAPS CONTROL (Flaps 25) PI.12.14
FLAPS DRIVE (Flaps 25) PI.12.15
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General

The table below shows the airplanes that have been identified with the following performance package. Note, some airplanes may be identified with more than one performance package. This configuration table information reflects the Boeing delivered configuration updated for service bulletin incorporations in conformance with the policy stated in the introduction section of the FCOM. The performance data is prepared for the owner/operator named on the title page. The intent of this information is to assist flight crews and airlines in knowing which performance package is applicable to a given airplane. The performance package model identification information is based on Boeing's knowledge of the airline's fleet at a point in time approximately three months prior to the page date. Notice of Errata (NOE) will not be provided to airlines to identify airplanes that are moved between performance packages within this manual or airplanes added to the airline's fleet whose performance packages are already represented in this manual. These types of changes will be updated in the next block revision. Owners/operators are responsible for ensuring the operational documentation they are using is complete and matches the current configuration of their airplanes, and 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 that any modifications to the listed airplanes are properly reflected in this manual.

Serial and tabulation number are supplied by Boeing.

Airplane Number	Registry Number	Serial Number	Tabulation Number
NLK	G-BNLK	24053	RT481
NLN	G-BNLN	24056	RT484
NLO	G-BNLO	24057	RT485
NLP	G-BNLP	24058	RT486
NLY	G-BNLY	27090	RT494
YGA	G-BYGA	28855	RM143
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Airplane Number	Registry Number	Serial Number	Tabulation Number
YGC	G-BYGC	25823	RM145
YGD	G-BYGD	28857	RM261
YGE	G-BYGE	28858	RM262
YGF	G-BYGF	25824	RM263
YGG	G-BYGG	28859	RM264
IVA	G-CIVA	27092	RT496
IVB	G-CIVB	25811	RT497
IVC	G-CIVC	25812	RT498
IVD	G-CIVD	27349	RT499
IVE	G-CIVE	27350	RU121
IVF	G-CIVF	25434	RU122
IVG	G-CIVG	25813	RU123
IVH	G-CIVH	25809	RU124
IVI	G-CIVI	25814	RU125
IVJ	G-CIVJ	25817	RU126
IVK	G-CIVK	25818	RU127
IVL	G-CIVL	27478	RU128
IVM	G-CIVM	28700	RU129
IVN	G-CIVN	28848	RU130
IVO	G-CIVO	28849	RU131
IVP	G-CIVP	28850	RU132
IVR	G-CIVR	25820	RM136
IVS	G-CIVS	28851	RM137
IVT	G-CIVT	25821	RM096
IVU	G-CIVU	25810	RM097
IVV	G-CIVV	25819	RM138
IVW	G-CIVW	25822	RM139

Airplane Number	Registry Number	Serial Number	Tabulation Number
IVX	G-CIVX	28852	RM140
IVY	G-CIVY	28853	RM141
IVZ	G-CIVZ	28854	RM142

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Assumed Temperature Reduced Thrust

Based on 25% thrust reduction or minimum allowable EPR

MINIMUM ALLOWABLE EPR FOR REDUCED THRUST	
MAX TAKEOFF EPR FOR ACTUAL OAT	MIN TAKEOFF EPR ALLOWED
1.90	1.67
1.80	1.59
1.70	1.52
1.60	1.45
1.52	1.39
1.50	1.39
1.40	1.39

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	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
50	122	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
45	113	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
40	104	1.49	1.49	1.48	1.48	1.48	1.48	1.48	1.49	1.49	1.49	1.49	1.49	1.48
35	95	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51
30	86	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
25	77	1.54	1.55	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.57	1.57	1.56
20	68	1.54	1.55	1.56	1.57	1.58	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59
15	59	1.54	1.55	1.56	1.57	1.58	1.59	1.61	1.62	1.62	1.62	1.62	1.62	1.62
10	41	1.54	1.55	1.56	1.57	1.58	1.59	1.61	1.62	1.63	1.64	1.65	1.65	1.65
5 & BELOW	41 & BELOW	1.54	1.55	1.56	1.57	1.58	1.59	1.61	1.62	1.63	1.64	1.66	1.67	1.68

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	EPR ADJUSTMENT
NACELLE ANTI-ICE	-0.01
WING ANTI-ICE	-0.01
NACELLE & WING ANTI-ICE	-0.02
EACH 40 KTS ABOVE 200 KIAS	0.01

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	.84	.84	.84	.84
60	1.43	1.43								
50	1.48	1.48	1.47	1.47						
40	1.53	1.53	1.52	1.52	1.51	1.51				
30	1.53	1.57	1.58	1.57	1.57	1.56	1.54			
20	1.53	1.57	1.60	1.63	1.62	1.62	1.60	1.57		
10	1.53	1.57	1.60	1.63	1.66	1.68	1.66	1.63	1.61	1.58
0	1.53	1.57	1.60	1.63	1.66	1.69	1.72	1.69	1.67	1.65
-10	1.53	1.57	1.60	1.63	1.66	1.69	1.73	1.75	1.74	1.71
-20 & BELOW	1.53	1.57	1.60	1.63	1.66	1.69	1.73	1.76	1.76	1.74

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)	
	0	45
ENGINE ANTI-ICE ON	-0.01	-0.01
ENGINE & WING ANTI-ICE ON	-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
51	124	54	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
47	117	50	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59
42	108	45	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
37	99	40	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.64	1.64	1.64
32	90	35	1.66	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.67	1.67	1.66	1.65
27	81	30	1.66	1.68	1.69	1.70	1.70	1.70	1.70	1.70	1.70	1.69	1.68	1.68	1.67
22	72	25	1.66	1.68	1.69	1.70	1.72	1.72	1.72	1.72	1.72	1.71	1.70	1.70	1.69
17	63	20	1.66	1.68	1.69	1.70	1.72	1.73	1.74	1.74	1.74	1.73	1.72	1.72	1.71
12	54	15	1.66	1.68	1.69	1.70	1.72	1.73	1.74	1.74	1.75	1.75	1.74	1.73	1.73
7	45	12	1.66	1.68	1.69	1.70	1.72	1.73	1.74	1.74	1.75	1.75	1.75	1.75	1.74
2 & BELOW	36 & BELOW	5 & BELOW	1.66	1.68	1.69	1.70	1.72	1.73	1.74	1.74	1.75	1.75	1.75	1.75	1.75

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	10000
2 PACKS OFF	0.01	0.01
3 PACKS OFF	0.01	0.01

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)	+1600	+800			
35000	**PITCH ATT**	**4.5**	**4.0**	**4.0**	**3.5**	
	V/S (FT/MIN)	+2800	+1900	+1100	+400	
30000	**PITCH ATT**	**4.5**	**4.5**	**4.5**	**4.5**	**5.0**
	V/S (FT/MIN)	+2700	+2000	+1400	+900	+500
20000	**PITCH ATT**	**7.5**	**7.0**	**6.5**	**6.5**	**7.0**
	V/S (FT/MIN)	+4200	+3100	+2400	+1900	+1500
10000	**PITCH ATT**	**10.5**	**9.5**	**9.0**	**8.5**	**8.5**
	V/S (FT/MIN)	+5400	+4200	+3300	+2600	+2200
SEA LEVEL	**PITCH ATT**	**14.0**	**12.5**	**11.5**	**11.0**	**10.5**
	V/S (FT/MIN)	+6500	+5100	+4100	+3400	+2900

Cruise (.84/290)

Flaps Up, Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		200	250	300	350	390
40000	**PITCH ATT**	**2.0**	**3.0**			
	EPR	1.48	1.59			
	(AltMode%N1)	(85.0)	(90.1)			
35000	**PITCH ATT**	**1.0**	**2.0**	**2.5**	**3.0**	
	EPR	1.42	1.47	1.55	1.67	
	(AltMode%N1)	(82.2)	(84.9)	(88.4)	(94.6)	
30000	**PITCH ATT**	**1.0**	**2.0**	**3.0**	**3.5**	**4.0**
	EPR	1.33	1.38	1.44	1.51	1.60
	(AltMode%N1)	(78.6)	(81.0)	(83.9)	(87.5)	(91.6)
20000	**PITCH ATT**	**1.5**	**2.5**	**3.0**	**4.0**	**4.5**
	EPR	1.23	1.26	1.29	1.34	1.38
	(AltMode%N1)	(71.9)	(74.1)	(76.8)	(79.7)	(82.3)
10000	**PITCH ATT**	**1.5**	**2.5**	**3.5**	**4.5**	**5.0**
	EPR	1.16	1.18	1.20	1.23	1.26
	(AltMode%N1)	(65.6)	(67.3)	(69.6)	(72.2)	(74.7)
SEA LEVEL	**PITCH ATT**	**1.5**	**2.5**	**3.5**	**4.5**	**5.0**
	EPR	1.12	1.13	1.14	1.16	1.18
	(AltMode%N1)	(58.7)	(60.5)	(62.8)	(65.3)	(67.6)

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**	**-1.0**	**0.0**			
	V/S (FT/MIN)	-2600	-2500			
35000	**PITCH ATT**	**-3.0**	**-2.0**	**-1.0**	**-0.5**	
	V/S (FT/MIN)	-3500	-3200	-3100	-3100	
30000	**PITCH ATT**	**-2.0**	**-0.5**	**0.5**	**1.0**	**1.5**
	V/S (FT/MIN)	-2300	-2100	-2000	-2000	-2000
20000	**PITCH ATT**	**-1.5**	**-0.5**	**0.5**	**1.5**	**2.0**
	V/S (FT/MIN)	-2200	-2000	-1800	-1800	-1800
10000	**PITCH ATT**	**-2.0**	**-0.5**	**0.5**	**1.5**	**2.5**
	V/S (FT/MIN)	-2000	-1800	-1600	-1600	-1600
SEA LEVEL	**PITCH ATT**	**-2.0**	**-0.5**	**0.5**	**1.5**	**2.5**
	V/S (FT/MIN)	-1800	-1600	-1500	-1400	-1400

Holding (VREF30+80)

Flaps Up, 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	1.14	1.17	1.20	1.23	1.26
	(Alt Mode %N1)	(58.1)	(63.7)	(68.0)	(71.8)	(74.8)
	KIAS	207	224	242	266	283

Terminal Area (5000 FT)

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	1.12	1.15	1.18	1.21	1.25	1.26
	(Alt Mode %N1)	(54.8)	(61.0)	(65.9)	(70.0)	(73.7)	(74.3)
	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	1.14	1.17	1.21	1.24	1.28	1.29
	(Alt Mode %N1)	(57.3)	(63.3)	(67.9)	(72.0)	(75.9)	(76.5)
	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	1.17	1.21	1.25	1.30	1.34	1.35
	(Alt Mode %N1)	(61.1)	(66.8)	(71.8)	(76.0)	(79.7)	(80.5)
	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	1.17	1.21	1.25	1.29	1.34	1.34
	(Alt Mode %N1)	(60.2)	(66.0)	(71.2)	(75.3)	(78.9)	(79.6)
	KIAS	148	164	179	193	206	209
FLAPS 20 (VREF30+10) (GEAR DOWN)	**PITCH ATT**	**7.5**	**7.5**	**7.5**	**7.5**	**8.5**	**8.5**
	EPR	1.22	1.27	1.33	1.38	1.44	1.45
	(Alt Mode %N1)	(66.4)	(72.5)	(77.5)	(81.8)	(85.6)	(86.5)
	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, Thrust 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	1.12	1.15	1.18	1.21	1.24	1.24
	(Alt Mode %N1)	(52.9)	(58.4)	(63.1)	(67.5)	(71.0)	(71.6)
	KIAS	143	159	175	189	203	205
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**1.0**	**1.0**	*	*	*
	EPR	1.16	1.20	1.24			
	(Alt Mode %N1)	(59.5)	(65.3)	(70.1)			
	KIAS	138	154	168			

***Exceeds flap placard speed**

Go-Around (1500 FT)

Flaps 20, Gear Up, Go-Around Thrust, Maneuver Speed

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		200	250	300	350	400	410
10000	**PITCH ATT**	**17.5**	**14.0**	**11.5**	**10.0**	**9.0**	**9.0**
	VS (FT/MIN)	3500	2700	2100	1600	1200	1100
	KIAS	149	165	181	195	208	211
5000	**PITCH ATT**	**21.0**	**17.0**	**14.0**	**12.5**	**11.0**	**10.5**
	VS (FT/MIN)	4300	3400	2700	2200	1700	1700
	KIAS	148	164	179	193	206	209
SEA LEVEL	**PITCH ATT**	**24.0**	**19.0**	**16.0**	**14.0**	**12.0**	**12.0**
	VS (FT/MIN)	4700	3800	3100	2500	2100	2000
	KIAS	147	163	178	191	204	207

Long Range Cruise Maximum Operating Altitude

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	BUFFET LIMIT PRESSURE ALTITUDE* (FT)	MAXIMUM CLIMB THRUST LIMITED PRESSURE ALTITUDE** (FT)		
			ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	28200	32100	33100	32300	31200
380	29300	33200	34300	33600	32600
360	30500	34300	35700	34900	33900
340	31800	35500	36800	36400	35500
320	33100	36800	38000	37600	36800
300	34500	38100	39300	38800	38000
280	35900	39600	40600	40000	39200
260	37400	41100	42000	41400	40600
240	39100	42800	43600	42800	42000
220	40900	44600	45000	44400	43500
200	42900	45000	45000	45000	45000

***Based on 1.3g/39° bank maneuver capability**
****100 ft/min residual rate of climb**

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)										
		25	27	29	31	33	35	37	39	41	43	45
400	EPR	1.47	1.51	1.56	1.63							
	MACH	.832	.848	.859	.861							
	KIAS	353	345	336	322							
	FF/ENG	3494	3483	3494	3568							
380	EPR	1.45	1.48	1.53	1.59	1.66						
	MACH	.823	.839	.853	.860	.860						
	KIAS	348	341	333	322	308						
	FF/ENG	3312	3291	3292	3319	3434						
360	EPR	1.42	1.46	1.50	1.55	1.62						
	MACH	.814	.829	.845	.858	.861						
	KIAS	344	337	330	321	309						
	FF/ENG	3137	3110	3098	3107	3162						
340	EPR	1.40	1.44	1.48	1.52	1.57	1.65					
	MACH	.803	.819	.835	.851	.860	.860					
	KIAS	339	332	325	318	308	295					
	FF/ENG	2972	2936	2915	2914	2932	3015					
320	EPR	1.38	1.41	1.45	1.49	1.54	1.60	1.68				
	MACH	.791	.808	.824	.840	.855	.860	.860				
	KIAS	334	328	321	314	306	295	282				
	FF/ENG	2811	2770	2742	2730	2735	2766	2898				
300	EPR	1.36	1.39	1.42	1.46	1.50	1.56	1.62				
	MACH	.777	.796	.813	.829	.845	.858	.861				
	KIAS	327	322	316	309	302	294	282				
	FF/ENG	2653	2612	2576	2557	2552	2555	2625				
280	EPR	1.35	1.37	1.40	1.43	1.47	1.52	1.57	1.65			
	MACH	.760	.782	.800	.817	.833	.849	.859	.860			
	KIAS	320	316	311	304	298	291	281	269			
	FF/ENG	2493	2455	2418	2391	2377	2375	2400	2500			
260	EPR	1.33	1.35	1.38	1.41	1.44	1.48	1.53	1.59	1.67		
	MACH	.739	.764	.785	.803	.820	.837	.853	.860	.860		
	KIAS	310	308	304	299	292	286	279	269	257		
	FF/ENG	2325	2298	2262	2233	2211	2200	2214	2263	2368		
240	EPR	1.31	1.33	1.36	1.38	1.41	1.45	1.49	1.54	1.61	1.69	
	MACH	.713	.742	.766	.787	.806	.823	.839	.855	.860	.860	
	KIAS	298	298	296	292	287	280	274	267	257	245	
	FF/ENG	2149	2133	2106	2077	2052	2033	2035	2065	2114	2222	
220	EPR	1.28	1.31	1.33	1.36	1.39	1.42	1.46	1.50	1.55	1.62	
	MACH	.681	.713	.742	.767	.789	.807	.824	.841	.856	.861	
	KIAS	284	286	286	284	280	275	268	262	255	245	
	FF/ENG	1960	1957	1943	1921	1896	1873	1867	1881	1908	1956	
200	EPR	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.46	1.50	1.55	1.62
	MACH	.648	.678	.711	.741	.767	.788	.807	.824	.841	.856	.861
	KIAS	269	271	273	273	271	268	262	256	250	244	234
	FF/ENG	1769	1768	1767	1760	1742	1718	1706	1712	1724	1747	1788

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low 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
683	637	596	560	529	500	479	460	442	426	411
1369	1276	1193	1121	1058	1000	960	923	888	856	827
2059	1919	1793	1683	1587	1500	1441	1385	1334	1286	1243
2754	2565	2395	2247	2118	2000	1921	1848	1779	1716	1658
3454	3214	2998	2812	2648	2500	2402	2310	2225	2146	2073
4161	3868	3606	3379	3180	3000	2882	2772	2670	2575	2488
4876	4528	4217	3949	3713	3500	3362	3234	3114	3004	2902
5599	5194	4831	4519	4246	4000	3843	3696	3559	3432	3316
6333	5867	5451	5093	4781	4500	4322	4157	4002	3860	3729
7077	6547	6075	5670	5317	5000	4802	4617	4446	4287	4142

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	14.2	1:24	12.9	1:21	11.7	1:17	10.7	1:13	10.0	1:12
1000	28.8	2:45	26.4	2:39	24.1	2:30	22.3	2:21	21.0	2:17
1500	43.0	4:08	39.5	3:58	36.3	3:45	33.6	3:30	31.8	3:23
2000	57.0	5:32	52.4	5:18	48.3	5:01	44.7	4:41	42.4	4:30
2500	70.7	6:58	65.0	6:40	60.0	6:19	55.6	5:53	52.7	5:38
3000	84.0	8:26	77.3	8:04	71.4	7:38	66.2	7:07	62.8	6:48
3500	97.1	9:57	89.4	9:29	82.5	8:59	76.5	8:23	72.7	7:59
4000	109.9	11:30	101.2	10:56	93.4	10:21	86.8	9:40	82.3	9:11
4500	122.5	13:05	112.7	12:25	104.1	11:45	96.7	10:59	91.7	10:26
5000	134.7	14:45	124.0	13:56	114.5	13:10	106.5	12:20	100.9	11:42

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-0.8	-0.7	0.0	2.7	7.7
20	-2.5	-1.4	0.0	5.0	13.6
30	-4.2	-2.0	0.0	7.2	18.8
40	-5.8	-2.7	0.0	9.2	23.5
50	-7.4	-3.4	0.0	10.9	27.7
60	-8.9	-4.1	0.0	12.5	31.2
70	-10.3	-4.9	0.0	13.9	34.2
80	-11.6	-5.6	0.0	15.1	36.6
90	-13.0	-6.4	0.0	16.1	38.5
100	-14.2	-7.1	0.0	16.9	39.8
110	-15.4	-7.9	0.0	17.5	40.4
120	-16.5	-8.7	0.0	18.0	40.6
130	-17.6	-9.5	0.0	18.2	40.1
140	-18.6	-10.4	0.0	18.2	39.1

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
3869	3660	3468	3297	3142	3000	2882	2772	2670	2575	2488
4523	4276	4051	3850	3667	3500	3362	3234	3114	3004	2902
5183	4897	4636	4404	4193	4000	3843	3696	3559	3432	3316
5847	5521	5223	4958	4719	4500	4322	4157	4002	3860	3729
6516	6149	5814	5515	5247	5000	4802	4617	4446	4287	4142
7190	6780	6406	6073	5774	5500	5282	5078	4889	4714	4553
7869	7414	7000	6633	6303	6000	5761	5538	5331	5140	4965
8553	8052	7597	7194	6832	6500	6241	5999	5774	5566	5376
9241	8693	8195	7755	7361	7000	6720	6459	6216	5992	5786
9934	9338	8797	8319	7891	7500	7199	6918	6657	6416	6195
10632	9987	9401	8884	8422	8000	7678	7377	7098	6840	6603

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)							
	25		29		33		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	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	-4.6	0.0	11.0	28.0
60	-11.4	-5.7	0.0	12.4	31.0
70	-13.3	-6.7	0.0	13.8	33.8
80	-15.2	-7.7	0.0	15.1	36.5
90	-17.1	-8.6	0.0	16.3	39.0
100	-19.0	-9.6	0.0	17.5	41.3
110	-20.8	-10.6	0.0	18.7	43.5
120	-22.6	-11.5	0.0	19.8	45.6
130	-24.4	-12.5	0.0	20.8	47.4
140	-26.2	-13.4	0.0	21.8	49.1
150	-27.9	-14.4	0.0	22.8	50.7
160	-29.7	-15.3	0.0	23.7	52.1

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										36	10
43									33	10	0
41							59	27	8	0	1
39						45	21	6	0	1	9
37				60	33	14	4	0	2	9	20
35			41	22	8	1	0	3	10	20	34
33	46	27	13	4	0	0	4	11	21	34	48
31	15	6	1	0	1	6	14	23	35	47	61
29	2	0	0	3	9	16	26	36	48	61	74
27	0	2	6	12	20	28	38	49	61	73	85
25	5	9	16	23	32	41	51	62	73	85	96

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)	76	83	90	98	105	112	120	127	134	140	146	152	158	163
TIME (MINUTES)	16	17	18	20	21	22	23	24	25	25	26	27	27	28

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	45000
400	EPR	1.19	1.22	1.27	1.33	1.38	1.47	1.59			
	KIAS	286	286	286	286	307	311	316			
	FF/ENG	3340	3270	3230	3180	3230	3300	3530			
380	EPR	1.18	1.21	1.25	1.31	1.36	1.44	1.56			
	KIAS	280	280	280	280	300	303	307			
	FF/ENG	3180	3100	3050	3000	3050	3090	3250			
360	EPR	1.17	1.20	1.24	1.29	1.35	1.42	1.52			
	KIAS	271	271	271	271	291	294	298			
	FF/ENG	3010	2940	2880	2830	2860	2890	3010			
340	EPR	1.17	1.19	1.23	1.28	1.33	1.40	1.49	1.64		
	KIAS	261	261	261	261	282	285	289	292		
	FF/ENG	2850	2790	2720	2660	2690	2700	2780	3110		
320	EPR	1.16	1.18	1.21	1.26	1.31	1.38	1.47	1.59		
	KIAS	251	251	251	251	273	276	280	284		
	FF/ENG	2700	2640	2570	2520	2520	2520	2570	2780		
300	EPR	1.15	1.17	1.20	1.25	1.29	1.36	1.44	1.55		
	KIAS	242	242	242	242	264	267	270	275		
	FF/ENG	2540	2490	2430	2360	2350	2350	2380	2520		
280	EPR	1.14	1.16	1.19	1.23	1.27	1.34	1.41	1.52		
	KIAS	233	233	233	233	255	257	260	264		
	FF/ENG	2400	2340	2280	2210	2190	2180	2200	2290		
260	EPR	1.13	1.15	1.18	1.21	1.26	1.31	1.39	1.48	1.62	
	KIAS	228	228	228	228	246	248	250	254	259	
	FF/ENG	2250	2190	2140	2060	2050	2010	2020	2080	2370	
240	EPR	1.12	1.13	1.16	1.20	1.24	1.29	1.36	1.45	1.57	
	KIAS	221	221	221	221	236	237	239	243	247	
	FF/ENG	2110	2040	2000	1920	1880	1850	1850	1890	2060	
220	EPR	1.11	1.12	1.15	1.18	1.22	1.27	1.33	1.41	1.52	
	KIAS	215	215	215	215	225	226	229	231	235	
	FF/ENG	1960	1900	1860	1780	1730	1710	1680	1710	1820	
200	EPR	1.10	1.11	1.14	1.16	1.20	1.25	1.31	1.38	1.48	1.61
	KIAS	208	208	208	208	215	216	218	220	223	226
	FF/ENG	2030	1760	1720	1640	1590	1540	1520	1530	1610	1800

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	1.24	1.28	1.34	1.41	1.51
	KIAS	245	246	248	251	251
	FF/ENG	3820	3770	3660	3640	3680
380	EPR	1.23	1.26	1.32	1.39	1.48
	KIAS	240	241	243	245	245
	FF/ENG	3620	3570	3470	3440	3460
360	EPR	1.22	1.25	1.30	1.37	1.45
	KIAS	234	236	238	240	240
	FF/ENG	3430	3380	3280	3240	3250
340	EPR	1.20	1.23	1.28	1.35	1.43
	KIAS	229	230	232	234	234
	FF/ENG	3250	3190	3140	3050	3050
320	EPR	1.19	1.22	1.27	1.33	1.40
	KIAS	223	224	226	228	228
	FF/ENG	3060	3010	2950	2860	2850
300	EPR	1.18	1.20	1.25	1.30	1.38
	KIAS	218	219	220	222	222
	FF/ENG	2880	2830	2760	2680	2660
280	EPR	1.17	1.19	1.23	1.28	1.35
	KIAS	212	213	215	216	216
	FF/ENG	2710	2650	2580	2540	2470
260	EPR	1.16	1.18	1.21	1.26	1.32
	KIAS	207	207	209	210	210
	FF/ENG	2530	2470	2410	2360	2290
240	EPR	1.14	1.16	1.20	1.24	1.30
	KIAS	200	201	202	203	203
	FF/ENG	2360	2300	2240	2180	2110
220	EPR	1.13	1.15	1.18	1.22	1.27
	KIAS	194	194	195	196	196
	FF/ENG	2190	2140	2080	2010	1970
200	EPR	1.12	1.14	1.17	1.20	1.25
	KIAS	187	188	189	190	190
	FF/ENG	2030	1970	1920	1840	1790

This table includes 5% additional fuel for holding in a racetrack pattern.
Holding at Flaps 1 in icing conditions is not recommended.

Intentionally
Blank

ADVISORY INFORMATION

Runway Surface Condition Correlation

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below -15°C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1520	40/-20	40	-65/220	25/-20	40/-35	70	40	90
AUTOBRAKE MAX	1820	35/-20	55	-75/260	0/0	50/-45	95	0	0
AUTOBRAKE 4	2200	40/-30	70	-100/345	0/0	65/-60	120	0	0
AUTOBRAKE 3	2580	45/-35	80	-120/415	10/-15	75/-70	135	5	5
AUTOBRAKE 2	2880	50/-45	95	-140/480	40/-50	90/-85	120	65	65
AUTOBRAKE 1	3160	55/-50	105	-160/560	80/-90	95/-90	120	215	325
Good Reported Braking Action									
MAX MANUAL	1940	35/-25	55	-90/325	55/-45	55/-50	90	110	250
AUTOBRAKE MAX	2040	35/-30	65	-95/330	50/-35	55/-50	95	110	250
AUTOBRAKE 4	2230	40/-35	70	-105/355	20/-5	65/-60	120	20	75
AUTOBRAKE 3	2580	45/-35	80	-120/415	10/-15	75/-70	135	5	5
AUTOBRAKE 2	2880	50/-45	95	-140/480	40/-50	90/-85	120	65	65
AUTOBRAKE 1	3160	55/-50	105	-160/560	80/-90	95/-90	120	215	325
Good To Medium Reported Braking Action									
MAX MANUAL	2250	40/-35	70	-115/415	90/-70	65/-60	95	190	445
AUTOBRAKE MAX	2320	40/-35	75	-115/420	80/-60	70/-60	105	180	435
AUTOBRAKE 4	2420	40/-35	75	-125/435	65/-45	75/-65	120	140	355
AUTOBRAKE 3	2680	45/-35	85	-130/475	55/-35	80/-75	135	80	255
AUTOBRAKE 2	2930	50/-45	95	-145/520	70/-65	90/-85	120	105	215
AUTOBRAKE 1	3180	55/-50	105	-165/580	105/-100	95/-90	120	230	380

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	TWO REV	NO REV
Medium Reported Braking Action									
MAX MANUAL	2560	45/-40	80	-140/510	125/-90	75/-70	105	265	640
AUTOBRAKE MAX	2600	50/-40	80	-140/510	120/-85	80/-70	115	255	625
AUTOBRAKE 4	2610	50/-40	80	-140/515	120/-75	80/-70	115	260	635
AUTOBRAKE 3	2770	50/-40	90	-145/535	95/-60	80/-75	135	160	500
AUTOBRAKE 2	2980	50/-45	95	-155/560	95/-85	90/-85	120	140	360
AUTOBRAKE 1	3190	55/-50	105	-165/595	120/-105	95/-90	120	240	440
Medium To Poor Reported Braking Action									
MAX MANUAL	2910	50/-45	90	-170/655	215/-140	90/-85	110	395	1015
AUTOBRAKE MAX	2930	55/-45	90	-170/660	215/-135	90/-85	115	395	1010
AUTOBRAKE 4	2940	55/-45	90	-175/660	210/-130	90/-85	115	395	1010
AUTOBRAKE 3	3040	55/-45	95	-175/670	200/-115	95/-85	135	340	945
AUTOBRAKE 2	3190	55/-50	100	-185/690	195/-130	100/-90	120	300	825
AUTOBRAKE 1	3350	60/-55	110	-190/715	205/-145	105/-100	120	360	845
Poor Reported Braking Action									
MAX MANUAL	3250	55/-50	100	-205/805	305/-185	100/-90	110	525	1390
AUTOBRAKE MAX	3270	65/-50	100	-205/805	305/-185	100/-95	120	530	1395
AUTOBRAKE 4	3280	65/-50	100	-205/805	305/-185	100/-95	120	520	1385
AUTOBRAKE 3	3310	65/-50	105	-210/810	300/-165	105/-95	135	515	1385
AUTOBRAKE 2	3410	65/-60	110	-215/840	290/-185	110/-105	120	465	1285
AUTOBRAKE 1	3510	65/-60	110	-215/840	290/-185	110/-105	120	480	1260

Reference distance is based on sea level, standard day, no wind or slope, VREF30 approach speed, four-engine maximum reverse thrust, and auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 80 m.
For autobrake and manual speedbrakes, increase reference landing distance by 65 m.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
All reference distances and adjustments shown have been increased by 15%.

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF25	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1610	50/-20	50	-70/230	25/-20	45/-40	65	55	115
AUTOBRAKE MAX	1920	40/-25	55	-75/270	5/0	50/-45	95	0	0
AUTOBRAKE 4	2340	40/-35	75	-105/355	5/0	70/-65	125	0	0
AUTOBRAKE 3	2770	50/-40	90	-130/430	5/-15	80/-75	145	5	10
AUTOBRAKE 2	3110	55/-50	105	-145/500	35/-60	95/-90	135	55	55
AUTOBRAKE 1	3410	65/-60	115	-170/580	90/-100	110/-100	135	275	355
Good Reported Braking Action									
MAX MANUAL	2040	35/-30	65	-90/330	55/-45	55/-50	90	135	300
AUTOBRAKE MAX	2130	40/-30	65	-95/340	50/-35	65/-50	95	135	300
AUTOBRAKE 4	2370	40/-35	75	-105/370	20/-5	70/-65	125	10	80
AUTOBRAKE 3	2770	50/-40	90	-130/430	10/-15	80/-75	145	5	10
AUTOBRAKE 2	3110	55/-50	105	-145/500	35/-60	95/-90	135	55	55
AUTOBRAKE 1	3410	65/-60	115	-170/580	90/-100	110/-100	135	275	355
Good To Medium Reported Braking Action									
MAX MANUAL	2370	40/-35	75	-115/425	95/-70	70/-65	100	230	550
AUTOBRAKE MAX	2430	45/-35	75	-120/430	90/-60	75/-65	110	220	535
AUTOBRAKE 4	2560	45/-35	80	-125/450	70/-45	75/-70	125	165	430
AUTOBRAKE 3	2860	50/-40	90	-140/485	50/-35	90/-85	145	95	320
AUTOBRAKE 2	3160	55/-50	105	-155/540	65/-75	95/-90	135	95	245
AUTOBRAKE 1	3430	65/-60	115	-175/600	110/-105	110/-100	135	285	420

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF25	TWO REV	NO REV
Medium Reported Braking Action									
MAX MANUAL	2710	50/-45	90	-140/520	135/-100	80/-75	110	325	800
AUTOBRAKE MAX	2730	50/-45	90	-140/525	125/-90	80/-75	120	305	775
AUTOBRAKE 4	2740	50/-45	90	-145/525	125/-75	80/-75	120	315	785
AUTOBRAKE 3	2960	50/-45	95	-155/545	90/-60	90/-85	145	180	630
AUTOBRAKE 2	3210	55/-50	105	-160/580	90/-90	95/-90	135	135	425
AUTOBRAKE 1	3450	65/-60	115	-175/620	125/-115	110/-100	135	300	490
Medium To Poor Reported Braking Action									
MAX MANUAL	3090	55/-50	100	-175/675	225/-145	95/-85	110	485	1290
AUTOBRAKE MAX	3100	55/-50	100	-175/675	230/-140	95/-90	120	475	1275
AUTOBRAKE 4	3110	55/-50	100	-175/675	220/-135	95/-90	120	480	1280
AUTOBRAKE 3	3240	55/-50	105	-180/690	200/-115	100/-95	140	405	1200
AUTOBRAKE 2	3430	65/-50	110	-190/715	190/-140	105/-105	130	330	1035
AUTOBRAKE 1	3610	65/-60	120	-200/745	215/-155	110/-105	130	440	1025
Poor Reported Braking Action									
MAX MANUAL	3470	65/-60	110	-210/825	320/-195	110/-100	120	645	1780
AUTOBRAKE MAX	3470	65/-60	110	-210/825	325/-195	110/-105	120	645	1780
AUTOBRAKE 4	3470	65/-60	110	-210/830	325/-195	110/-105	120	640	1775
AUTOBRAKE 3	3520	65/-60	110	-210/835	305/-175	110/-105	140	625	1770
AUTOBRAKE 2	3640	70/-65	115	-225/865	300/-200	120/-110	125	530	1645
AUTOBRAKE 1	3770	70/-65	120	-225/865	300/-200	120/-110	125	580	1565

Reference distance is based on sea level, standard day, no wind or slope, VREF25 approach speed, four-engine maximum reverse thrust, and auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 90 m.
For autobrake and manual speedbrakes, increase reference landing distance by 65 m.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
All reference distances and adjustments shown have been increased by 15%.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AIR/GND SYSTEM (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1660	50/-20	50	-70/230	35/-30	45/-45	95	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2360	40/-30	75	-105/365	105/-75	70/-65	125	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2970	50/-45	95	-145/500	215/-150	90/-85	150	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3580	55/-50	115	-185/640	330/-220	110/-105	170	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	4510	70/-65	145	-255/900	765/-395	145/-140	190	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	5440	80/-75	165	-320/1165	1200/-565	175/-170	205	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AIR/GND SYSTEM (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1570	35/-20	45	-65/225	35/-25	40/-35	90	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2160	35/-30	65	-100/350	90/-70	65/-60	120	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2670	40/-35	85	-135/475	180/-125	80/-75	135	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3170	50/-45	100	-170/595	270/-185	95/-90	150	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3900	60/-50	120	-230/830	605/-315	125/-120	160	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4630	70/-60	140	-290/1065	930/-445	150/-145	170	0	0
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID / ANTISKID OFF (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2580	45/-35	80	-130/470	105/-85	75/-70	100	275	685
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2580	45/-35	80	-130/470	105/-85	75/-70	100	275	685
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2900	55/-45	90	-160/605	170/-125	90/-80	105	415	1110
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3230	60/-50	100	-190/735	235/-170	95/-90	110	555	1530
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3780	70/-60	110	-265/1200	700/-295	120/-110	115	945	3120
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4330	80/-65	125	-335/1665	1160/-420	135/-130	120	1330	4705
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID / ANTISKID OFF (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2430	40/-35	75	-125/460	110/-80	70/-65	95	225	545
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2430	40/-35	75	-125/460	110/-80	70/-65	95	225	545
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2730	50/-40	80	-155/590	190/-120	80/-75	105	340	870
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3030	55/-45	90	-185/720	265/-160	90/-85	105	450	1190
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3540	65/-55	105	-250/1145	820/-280	110/-100	110	785	2430
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4040	75/-60	115	-320/1575	1375/-395	125/-120	110	1110	3675
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BLD DUCT LEAK L, C, R (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1430	40/-20	40	-60/205	25/-20	40/-35	60	35	80
AUTOBRAKE MAX	1670	35/-20	50	-70/235	5/0	45/-40	85	0	0
AUTOBRAKE 2	2730	50/-45	90	-130/440	20/-40	85/-80	125	25	25
Good Reported Braking Action									
MAX MANUAL	1800	30/-25	55	-85/290	50/-35	50/-45	80	100	225
AUTOBRAKE MAX	1870	35/-25	55	-85/300	45/-35	55/-50	85	105	245
AUTOBRAKE 2	2730	50/-45	90	-130/440	20/-40	85/-80	125	25	25
Good To Medium Reported Braking Action									
MAX MANUAL	2110	35/-30	65	-105/375	85/-60	65/-55	90	180	440
AUTOBRAKE MAX	2140	40/-30	65	-105/380	80/-60	65/-60	95	180	445
AUTOBRAKE 2	2780	50/-45	90	-135/470	45/-55	90/-80	125	60	185
Medium Reported Braking Action									
MAX MANUAL	2400	40/-35	75	-125/460	115/-85	75/-85	95	260	650
AUTOBRAKE MAX	2400	45/-35	75	-125/460	120/-80	75/-70	100	260	645
AUTOBRAKE 3	2580	45/-35	80	-130/480	80/-50	80/-75	125	155	535
Medium To Poor Reported Braking Action									
MAX MANUAL	2740	50/-45	90	-155/595	200/-130	85/-75	100	400	1070
AUTOBRAKE MAX	2740	50/-45	90	-155/595	205/-130	85/-80	105	400	1070
AUTOBRAKE 3	2840	50/-45	90	-160/605	175/-105	90/-85	120	345	1015
Poor Reported Braking Action									
MAX MANUAL	3080	55/-50	95	-185/725	280/-170	95/-90	105	540	1490
AUTOBRAKE MAX	3080	55/-50	95	-185/725	285/-175	95/-90	105	540	1490
AUTOBRAKE 3	3110	55/-50	95	-185/730	275/-160	95/-90	115	535	1495

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BLD DUCT LEAK L, C, R (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1340	35/-15	40	-55/195	25/-15	35/-30	65	30	55
AUTOBRAKE MAX	1580	30/-20	50	-65/230	0/0	40/-35	80	0	0
AUTOBRAKE 2	2540	45/-35	80	-125/420	25/-40	75/-70	110	25	25
Good Reported Braking Action									
MAX MANUAL	1720	30/-20	50	-80/285	50/-35	50/-45	80	85	185
AUTOBRAKE MAX	1790	30/-25	55	-85/290	40/-30	50/-45	85	90	200
AUTOBRAKE 2	2540	45/-35	80	-125/420	25/-40	75/-70	110	25	25
Good To Medium Reported Braking Action									
MAX MANUAL	1990	35/-30	60	-100/370	80/-60	55/-50	85	150	355
AUTOBRAKE MAX	2040	35/-30	65	-105/370	80/-50	60/-55	95	155	360
AUTOBRAKE 2	2580	45/-40	85	-130/455	50/-55	80/-75	110	55	155
Medium Reported Braking Action									
MAX MANUAL	2270	40/-35	70	-125/450	110/-85	65/-60	90	215	520
AUTOBRAKE MAX	2280	40/-35	75	-125/450	110/-75	70/-60	100	215	520
AUTOBRAKE 3	2410	40/-35	75	-125/465	90/-50	75/-70	120	135	430
Medium To Poor Reported Braking Action									
MAX MANUAL	2580	45/-40	80	-155/575	190/-125	80/-75	95	330	840
AUTOBRAKE MAX	2580	50/-40	80	-155/580	190/-120	80/-75	100	330	845
AUTOBRAKE 3	2660	50/-40	85	-155/585	180/-100	80/-75	115	290	800
Poor Reported Braking Action									
MAX MANUAL	2880	50/-45	90	-180/705	270/-160	90/-85	100	440	1160
AUTOBRAKE MAX	2890	55/-45	90	-180/705	270/-165	90/-85	100	440	1165
AUTOBRAKE 3	2910	55/-45	90	-180/705	270/-150	90/-85	110	440	1170

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG 1, 2, 3, 4 SHUTDOWN (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1450	45/-20	40	-60/210	25/-20	40/-35	60	0	55
AUTOBRAKE MAX	1670	40/-20	50	-70/235	5/0	45/-40	85	0	0
AUTOBRAKE 2	2750	50/-40	95	-130/440	10/-10	85/-80	150	0	0
Good Reported Braking Action									
MAX MANUAL	1870	35/-25	55	-85/305	55/-45	55/-50	85	0	145
AUTOBRAKE MAX	1960	35/-30	60	-90/310	50/-40	55/-50	95	0	145
AUTOBRAKE 2	2750	50/-40	95	-130/440	10/-10	85/-80	150	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	2250	40/-35	75	-115/400	105/-80	70/-60	95	0	275
AUTOBRAKE MAX	2290	40/-35	75	-115/405	100/-70	70/-65	105	0	270
AUTOBRAKE 2	2820	50/-45	95	-140/485	55/-35	90/-85	150	0	120
Medium Reported Braking Action									
MAX MANUAL	2610	45/-40	85	-140/495	150/-110	80/-75	105	0	410
AUTOBRAKE MAX	2620	50/-40	85	-140/495	150/-100	80/-75	115	0	395
AUTOBRAKE 3	2710	50/-40	90	-140/500	135/-85	85/-75	125	0	375
Medium To Poor Reported Braking Action									
MAX MANUAL	3070	55/-50	100	-175/650	280/-175	95/-90	115	0	675
AUTOBRAKE MAX	3070	55/-50	100	-175/650	280/-170	95/-90	120	0	670
AUTOBRAKE 3	3130	55/-50	105	-175/660	270/-160	100/-90	125	0	665
Poor Reported Braking Action									
MAX MANUAL	3510	65/-55	110	-215/805	405/-240	110/-105	120	0	940
AUTOBRAKE MAX	3520	65/-55	115	-215/805	410/-240	110/-105	120	0	945
AUTOBRAKE 3	3540	65/-55	115	-215/810	405/-240	110/-105	120	0	950

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG 1, 2, 3, 4 SHUTDOWN (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1390	40/-20	40	-60/205	25/-20	40/-35	60	0	45
AUTOBRAKE MAX	1580	35/-20	50	-65/230	5/0	40/-35	80	0	0
AUTOBRAKE 2	2580	45/-35	85	-125/425	5/-5	80/-75	145	0	0
Good Reported Braking Action									
MAX MANUAL	1790	30/-25	55	-85/300	55/-45	50/-45	85	0	120
AUTOBRAKE MAX	1870	30/-25	55	-85/305	50/-35	55/-50	95	0	120
AUTOBRAKE 2	2580	45/-35	85	-125/425	5/-5	80/-75	145	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	2150	40/-30	65	-110/395	105/-75	65/-60	95	0	235
AUTOBRAKE MAX	2190	40/-30	70	-110/400	105/-70	65/-60	105	0	235
AUTOBRAKE 2	2660	50/-40	90	-135/470	55/-30	80/-75	145	0	115
Medium Reported Braking Action									
MAX MANUAL	2510	45/-35	80	-135/485	150/-110	75/-70	105	0	355
AUTOBRAKE MAX	2520	45/-35	80	-135/490	155/-100	80/-70	115	0	350
AUTOBRAKE 3	2580	45/-40	85	-140/495	145/-90	80/-75	125	0	350
Medium To Poor Reported Braking Action									
MAX MANUAL	2970	55/-45	95	-175/645	285/-175	95/-85	115	0	595
AUTOBRAKE MAX	2980	55/-45	95	-175/650	285/-175	95/-85	120	0	600
AUTOBRAKE 3	3020	55/-50	100	-175/650	275/-170	95/-90	125	0	600
Poor Reported Braking Action									
MAX MANUAL	3420	60/-50	110	-210/800	410/-240	110/-100	125	0	840
AUTOBRAKE MAX	3430	65/-55	110	-210/805	415/-245	110/-100	125	0	845
AUTOBRAKE 3	3460	65/-55	110	-215/805	410/-245	110/-105	125	0	850

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS CONTROL (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1400	40/-20	40	-60/200	25/-15	40/-35	55	50	100
AUTOBRAKE MAX	1670	35/-20	50	-70/235	5/0	45/-40	85	0	0
AUTOBRAKE 2	2710	50/-45	90	-125/435	30/-50	80/-75	115	50	50
Good Reported Braking Action									
MAX MANUAL	1770	30/-25	55	-80/290	50/-35	50/-45	80	115	260
AUTOBRAKE MAX	1860	35/-25	55	-85/295	40/-30	55/-45	85	115	260
AUTOBRAKE 2	2710	50/-45	90	-125/435	30/-50	80/-75	115	50	50
Good To Medium Reported Braking Action									
MAX MANUAL	2070	35/-30	65	-100/370	80/-60	65/-55	90	200	480
AUTOBRAKE MAX	2120	40/-30	65	-105/375	80/-55	65/-55	95	190	465
AUTOBRAKE 2	2750	50/-45	90	-135/470	55/-65	85/-80	115	85	215
Medium Reported Braking Action									
MAX MANUAL	2360	40/-35	75	-125/455	115/-85	75/-65	95	280	695
AUTOBRAKE MAX	2380	45/-35	75	-125/455	110/-75	75/-65	105	270	675
AUTOBRAKE 3	2570	45/-35	80	-130/475	75/-50	80/-75	125	160	550
Medium To Poor Reported Braking Action									
MAX MANUAL	2690	50/-45	90	-155/590	200/-130	85/-75	100	420	1120
AUTOBRAKE MAX	2700	50/-45	90	-155/590	200/-125	85/-75	105	415	1110
AUTOBRAKE 3	2820	50/-45	90	-160/600	175/-100	90/-85	125	355	1045
Poor Reported Braking Action									
MAX MANUAL	3020	55/-50	95	-185/720	275/-170	95/-85	105	560	1550
AUTOBRAKE MAX	3020	55/-50	95	-185/720	285/-170	95/-90	105	560	1550
AUTOBRAKE 3	3060	55/-50	95	-185/725	270/-150	95/-90	120	545	1540

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (Flaps 25)
VREF30 + 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1610	45/-20	50	-60/215	25/-20	45/-40	70	65	135
AUTOBRAKE MAX	1980	35/-25	60	-75/255	10/-10	55/-50	85	15	20
AUTOBRAKE 2	3110	50/-45	105	-140/465	60/-65	95/-90	110	160	170
Good Reported Braking Action									
MAX MANUAL	2050	35/-30	65	-90/305	55/-45	60/-55	80	145	330
AUTOBRAKE MAX	2150	35/-30	65	-90/315	55/-45	65/-60	80	160	355
AUTOBRAKE 2	3110	50/-45	105	-140/465	65/-65	95/-90	115	160	170
Good To Medium Reported Braking Action									
MAX MANUAL	2370	40/-35	75	-110/395	90/-70	75/-70	90	245	590
AUTOBRAKE MAX	2440	40/-35	80	-115/400	90/-70	75/-70	95	245	590
AUTOBRAKE 2	3150	50/-50	105	-145/500	90/-80	100/-95	115	200	345
Medium Reported Braking Action									
MAX MANUAL	2690	45/-40	90	-130/480	125/-100	85/-75	95	340	850
AUTOBRAKE MAX	2730	45/-40	90	-135/485	120/-90	85/-80	105	330	830
AUTOBRAKE 3	2990	50/-45	95	-140/510	95/-75	95/-90	115	185	610
Medium To Poor Reported Braking Action									
MAX MANUAL	3040	55/-45	100	-160/620	215/-145	95/-90	105	495	1325
AUTOBRAKE MAX	3070	55/-45	100	-165/620	210/-140	95/-90	105	485	1305
AUTOBRAKE 3	3240	55/-50	105	-170/635	190/-125	105/-100	115	385	1175
Poor Reported Braking Action									
MAX MANUAL	3400	60/-50	110	-195/750	300/-185	110/-100	105	650	1790
AUTOBRAKE MAX	3410	60/-50	110	-195/750	295/-185	110/-100	105	635	1780
AUTOBRAKE 3	3490	60/-50	110	-195/760	280/-175	110/-105	115	580	1730

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Flaps Up Landing (Flaps Up)
VREF30 + 70

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	2340	125/-40	110	-95/400	45/-35	100/-85	110	140	315
AUTOBRAKE MAX	2810	110/-30	100	-95/355	10/-5	90/-85	115	25	110
AUTOBRAKE 2	4610	80/-70	160	-170/570	110/-115	150/-145	135	360	400
Good Reported Braking Action									
MAX MANUAL	2680	110/-35	90	-100/345	70/-55	85/-75	85	225	520
AUTOBRAKE MAX	2930	105/-35	95	-105/365	40/-30	90/-85	110	150	440
AUTOBRAKE 2	4610	80/-70	160	-170/570	110/-115	150/-145	135	360	400
Good To Medium Reported Braking Action									
MAX MANUAL	3180	90/-45	105	-130/450	120/-90	105/-95	95	390	970
AUTOBRAKE MAX	3340	90/-45	110	-130/460	95/-75	105/-100	110	345	915
AUTOBRAKE 2	4650	80/-70	160	-175/605	135/-125	155/-145	135	405	635
Medium Reported Braking Action									
MAX MANUAL	3690	75/-50	120	-155/550	165/-130	120/-110	105	555	1415
AUTOBRAKE MAX	3740	75/-50	125	-155/550	150/-120	120/-115	110	540	1385
AUTOBRAKE 3	4380	70/-60	145	-170/605	125/-105	145/-135	135	300	895
Medium To Poor Reported Braking Action									
MAX MANUAL	4230	80/-65	140	-190/700	275/-190	140/-130	115	825	2305
AUTOBRAKE MAX	4240	80/-65	145	-195/705	265/-180	140/-130	120	805	2260
AUTOBRAKE 3	4680	75/-70	160	-200/735	240/-170	155/-145	135	610	1940
Poor Reported Braking Action									
MAX MANUAL	4760	80/-75	160	-225/855	380/-250	160/-145	120	1095	3190
AUTOBRAKE MAX	4740	80/-75	160	-225/855	375/-240	160/-145	125	1065	3135
AUTOBRAKE 3	4980	80/-75	165	-230/870	355/-235	165/-155	135	925	2985

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE - One Body or One Wing Gear Up (Flaps 25)

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1780	55/-30	50	-75/260	40/-30	50/-45	75	75	160
AUTOBRAKE MAX	1760	65/-25	50	-75/260	40/-20	50/-45	85	65	150
AUTOBRAKE 2	2750	50/-45	95	-130/440	10/-25	85/-80	140	10	10
Good Reported Braking Action									
MAX MANUAL	1940	50/-25	55	-85/305	55/-45	55/-50	85	105	245
AUTOBRAKE MAX	1930	55/-25	55	-85/300	55/-45	55/-50	90	105	235
AUTOBRAKE 2	2760	50/-45	95	-130/440	10/-30	85/-80	140	15	15
Good To Medium Reported Braking Action									
MAX MANUAL	2240	50/-30	70	-105/385	90/-70	65/-60	95	190	465
AUTOBRAKE MAX	2220	50/-30	70	-105/385	90/-70	65/-60	95	190	455
AUTOBRAKE 2	2830	50/-45	95	-140/480	45/-45	90/-85	140	50	180
Medium Reported Braking Action									
MAX MANUAL	2540	45/-35	80	-130/470	125/-90	75/-70	100	275	680
AUTOBRAKE MAX	2520	45/-35	80	-130/470	125/-90	75/-70	105	270	670
AUTOBRAKE 3	2630	45/-35	85	-130/480	95/-55	80/-75	130	160	555
Medium To Poor Reported Braking Action									
MAX MANUAL	2870	55/-45	90	-160/605	205/-140	90/-80	105	415	1115
AUTOBRAKE MAX	2860	55/-45	90	-160/605	215/-140	90/-80	110	410	1110
AUTOBRAKE 3	2920	55/-45	95	-160/610	195/-115	90/-85	125	355	1050
Poor Reported Braking Action									
MAX MANUAL	3210	60/-50	100	-190/735	290/-180	100/-90	110	555	1550
AUTOBRAKE MAX	3200	60/-50	100	-190/735	295/-185	100/-90	110	555	1545
AUTOBRAKE 3	3210	60/-50	100	-190/735	290/-170	100/-90	120	550	1540

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DISAGREE - One Body or One Wing Gear Up (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1670	50/-30	50	-70/250	35/-30	45/-40	70	55	120
AUTOBRAKE MAX	1640	50/-20	50	-70/245	35/-15	45/-40	80	50	110
AUTOBRAKE 2	2580	45/-40	85	-125/425	10/-25	80/-75	125	15	15
Good Reported Braking Action									
MAX MANUAL	1860	40/-25	55	-85/300	55/-40	50/-45	85	90	200
AUTOBRAKE MAX	1840	45/-25	55	-85/295	50/-40	50/-45	90	90	200
AUTOBRAKE 2	2580	45/-40	85	-125/425	10/-30	80/-75	125	15	15
Good To Medium Reported Braking Action									
MAX MANUAL	2130	40/-30	65	-105/380	90/-65	60/-55	90	160	375
AUTOBRAKE MAX	2110	45/-30	65	-105/375	90/-65	60/-55	95	155	370
AUTOBRAKE 2	2640	45/-40	85	-130/465	45/-50	80/-75	125	50	150
Medium Reported Braking Action									
MAX MANUAL	2400	40/-35	75	-125/460	120/-90	70/-65	95	225	545
AUTOBRAKE MAX	2390	40/-35	75	-125/460	120/-85	70/-65	100	220	540
AUTOBRAKE 3	2480	40/-35	80	-130/470	95/-50	75/-70	125	145	450
Medium To Poor Reported Braking Action									
MAX MANUAL	2710	50/-40	80	-155/590	200/-130	80/-75	100	340	875
AUTOBRAKE MAX	2710	50/-40	80	-155/590	200/-130	80/-75	105	340	875
AUTOBRAKE 3	2750	50/-40	90	-155/595	190/-105	85/-80	125	300	830
Poor Reported Braking Action									
MAX MANUAL	3020	55/-45	90	-185/720	275/-170	90/-85	105	455	1210
AUTOBRAKE MAX	3020	55/-45	90	-185/720	280/-175	95/-85	105	455	1210
AUTOBRAKE 3	3020	55/-45	95	-185/720	280/-160	95/-85	120	450	1205

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DISAGREE - Two Body or Two Wing Gear Up (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	2120	110/-40	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-40	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good Reported Braking Action									
MAX MANUAL	2120	110/-35	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-35	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2340	105/-35	85	-115/470	100/-75	75/-60	105	210	510
AUTOBRAKE MAX	2330	120/-35	85	-115/480	100/-75	80/-70	115	210	515
AUTOBRAKE 2	2830	100/-45	95	-140/495	50/-45	90/-85	145	50	185
Medium Reported Braking Action									
MAX MANUAL	2550	95/-35	80	-130/470	125/-95	75/-70	100	275	690
AUTOBRAKE MAX	2530	110/-35	80	-130/470	125/-95	75/-70	105	275	680
AUTOBRAKE 3	2640	105/-35	85	-130/480	95/-60	80/-75	130	170	575
Medium To Poor Reported Braking Action									
MAX MANUAL	2890	80/-45	90	-160/605	210/-140	90/-80	105	425	1145
AUTOBRAKE MAX	2880	95/-45	90	-160/605	215/-140	90/-80	110	425	1135
AUTOBRAKE 3	2930	95/-45	95	-160/610	195/-115	90/-85	125	370	1080
Poor Reported Braking Action									
MAX MANUAL	3230	65/-50	100	-190/740	295/-180	100/-95	110	570	1595
AUTOBRAKE MAX	3220	80/-50	100	-190/740	300/-185	100/-90	110	570	1590
AUTOBRAKE 3	3230	80/-50	100	-190/740	295/-170	100/-90	120	565	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DISAGREE - Two Body or Two Wing Gear Up (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1960	90/-35	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-35	80	-90/430	60/-45	70/-50	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good Reported Braking Action									
MAX MANUAL	1960	90/-30	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-30	80	-90/430	60/-45	70/-50	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2190	80/-30	75	-110/425	90/-70	65/-60	90	170	400
AUTOBRAKE MAX	2170	90/-30	75	-105/445	90/-70	70/-60	105	165	395
AUTOBRAKE 2	2650	75/-40	90	-130/465	45/-45	80/-75	135	50	155
Medium Reported Braking Action									
MAX MANUAL	2410	70/-35	75	-125/460	120/-90	70/-65	95	230	555
AUTOBRAKE MAX	2400	80/-35	75	-125/460	120/-90	70/-65	105	230	550
AUTOBRAKE 3	2480	75/-35	80	-130/470	95/-55	75/-70	125	145	465
Medium To Poor Reported Braking Action									
MAX MANUAL	2730	65/-40	85	-155/590	200/-130	80/-75	105	345	900
AUTOBRAKE MAX	2720	65/-40	85	-155/590	205/-130	80/-75	105	345	895
AUTOBRAKE 3	2760	65/-40	90	-155/595	190/-110	85/-80	120	305	855
Poor Reported Braking Action									
MAX MANUAL	3040	55/-45	95	-185/720	280/-170	95/-85	105	465	1240
AUTOBRAKE MAX	3040	55/-45	95	-185/720	285/-175	95/-85	105	465	1240
AUTOBRAKE 3	3040	55/-45	95	-185/720	285/-160	95/-85	115	465	1235

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DISAGREE - Nose Gear Up (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1400	40/-20	40	-60/200	25/-15	40/-35	55	50	100
AUTOBRAKE MAX	1670	35/-20	50	-70/235	5/0	45/-40	85	0	0
AUTOBRAKE 2	2710	50/-45	90	-125/435	30/-50	80/-75	115	50	50
Good Reported Braking Action									
MAX MANUAL	1770	30/-25	55	-80/290	50/-35	50/-45	80	115	260
AUTOBRAKE MAX	1860	35/-25	55	-85/295	40/-30	55/-45	85	115	260
AUTOBRAKE 2	2710	50/-45	90	-125/435	30/-50	80/-75	115	50	50
Good To Medium Reported Braking Action									
MAX MANUAL	2070	35/-30	65	-100/370	80/-60	65/-55	90	200	480
AUTOBRAKE MAX	2120	40/-30	65	-105/375	80/-55	65/-55	95	190	465
AUTOBRAKE 2	2750	50/-45	90	-135/470	55/-65	85/-80	115	85	215
Medium Reported Braking Action									
MAX MANUAL	2360	40/-35	75	-125/455	115/-85	75/-65	95	280	695
AUTOBRAKE MAX	2380	45/-35	75	-125/455	110/-75	75/-65	105	270	675
AUTOBRAKE 3	2570	45/-35	80	-130/475	75/-50	80/-75	125	160	550
Medium To Poor Reported Braking Action									
MAX MANUAL	2690	50/-45	90	-155/590	200/-130	85/-75	100	420	1120
AUTOBRAKE MAX	2700	50/-45	90	-155/590	200/-125	85/-75	105	415	1110
AUTOBRAKE 3	2820	50/-45	90	-160/600	175/-100	90/-85	125	355	1045
Poor Reported Braking Action									
MAX MANUAL	3020	55/-50	95	-185/720	275/-170	95/-85	105	560	1550
AUTOBRAKE MAX	3020	55/-50	95	-185/720	285/-170	95/-90	105	560	1550
AUTOBRAKE 3	3060	55/-50	95	-185/725	270/-150	95/-90	120	545	1540

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DISAGREE - Nose Gear Up (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1320	35/-15	35	-55/190	20/-15	35/-30	60	35	80
AUTOBRAKE MAX	1580	30/-20	50	-65/230	0/0	40/-35	80	0	0
AUTOBRAKE 2	2500	45/-35	80	-125/415	35/-45	75/-70	105	55	55
Good Reported Braking Action									
MAX MANUAL	1690	30/-20	50	-80/285	50/-35	50/-45	75	95	215
AUTOBRAKE MAX	1770	30/-25	55	-85/290	40/-30	50/-45	85	95	215
AUTOBRAKE 2	2500	45/-35	80	-125/415	35/-45	75/-70	105	55	55
Good To Medium Reported Braking Action									
MAX MANUAL	1960	35/-30	60	-100/360	80/-60	55/-50	85	165	385
AUTOBRAKE MAX	2020	35/-30	65	-100/370	75/-50	60/-55	95	160	380
AUTOBRAKE 2	2550	45/-40	80	-130/455	60/-60	80/-75	105	90	190
Medium Reported Braking Action									
MAX MANUAL	2230	40/-35	70	-120/440	110/-80	65/-60	90	230	555
AUTOBRAKE MAX	2260	40/-35	75	-120/445	105/-75	70/-60	100	220	540
AUTOBRAKE 3	2410	40/-35	75	-125/465	80/-50	75/-70	115	140	440
Medium To Poor Reported Braking Action									
MAX MANUAL	2530	45/-40	80	-150/575	190/-120	80/-70	95	345	885
AUTOBRAKE MAX	2550	50/-40	80	-150/575	185/-115	80/-75	105	340	875
AUTOBRAKE 3	2640	50/-40	85	-155/585	175/-100	80/-75	115	295	825
Poor Reported Braking Action									
MAX MANUAL	2830	50/-45	90	-175/700	265/-160	90/-80	95	455	1210
AUTOBRAKE MAX	2840	55/-45	90	-175/700	270/-160	90/-85	105	460	1215
AUTOBRAKE 3	2880	55/-45	90	-180/705	260/-145	90/-85	115	450	1205

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Gear Lever Jammed In Up Position (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	2120	110/-40	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-40	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good Reported Braking Action									
MAX MANUAL	2120	110/-35	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-35	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2340	105/-35	85	-115/470	100/-75	75/-60	105	210	510
AUTOBRAKE MAX	2330	120/-35	85	-115/480	100/-75	80/-70	115	210	515
AUTOBRAKE 2	2830	100/-45	95	-140/495	50/-45	90/-85	145	50	185
Medium Reported Braking Action									
MAX MANUAL	2550	95/-35	80	-130/470	125/-95	75/-70	100	275	690
AUTOBRAKE MAX	2530	110/-35	80	-130/470	125/-95	75/-70	105	275	680
AUTOBRAKE 3	2640	105/-35	85	-130/480	95/-60	80/-75	130	170	575
Medium To Poor Reported Braking Action									
MAX MANUAL	2890	80/-45	90	-160/605	210/-140	90/-80	105	425	1145
AUTOBRAKE MAX	2880	95/-45	90	-160/605	215/-140	90/-80	110	425	1135
AUTOBRAKE 3	2930	95/-45	95	-160/610	195/-115	90/-85	125	370	1080
Poor Reported Braking Action									
MAX MANUAL	3230	65/-50	100	-190/740	295/-180	100/-90	110	570	1595
AUTOBRAKE MAX	3220	80/-50	100	-190/740	300/-185	100/-90	110	570	1590
AUTOBRAKE 3	3230	80/-50	100	-190/740	295/-170	100/-90	120	565	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Gear Lever Jammed In Up Position (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1960	90/-35	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-35	80	-90/430	60/-45	70/-50	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good Reported Braking Action									
MAX MANUAL	1960	90/-30	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-30	80	-90/430	60/-45	70/-50	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2190	80/-30	75	-110/425	90/-70	65/-5	90	170	400
AUTOBRAKE MAX	2170	90/-30	75	-105/445	90/-70	70/-60	105	165	395
AUTOBRAKE 2	2650	75/-40	90	-130/465	45/-45	80/-75	135	50	155
Medium Reported Braking Action									
MAX MANUAL	2410	70/-35	75	-125/460	120/-90	70/-65	95	230	555
AUTOBRAKE MAX	2400	80/-35	75	-125/460	120/-90	70/-65	105	230	550
AUTOBRAKE 3	2480	75/-35	80	-130/470	95/-55	75/-70	125	145	465
Medium To Poor Reported Braking Action									
MAX MANUAL	2730	65/-40	85	-155/590	200/-130	80/-75	105	345	900
AUTOBRAKE MAX	2720	65/-40	85	-155/590	205/-130	80/-75	105	345	895
AUTOBRAKE 3	2760	65/-40	90	-155/595	190/-110	85/-80	120	305	855
Poor Reported Braking Action									
MAX MANUAL	3040	55/-45	95	-185/720	280/-170	95/-85	105	465	1240
AUTOBRAKE MAX	3040	55/-45	95	-185/720	285/-175	95/-85	105	465	1240
AUTOBRAKE 3	3040	55/-45	95	-185/720	285/-160	95/-85	115	465	1235

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - System 1 or System 2 or System 3 Inoperative (Flaps 25)

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1430	40/-20	40	-60/200	25/-20	40/-35	65	50	110
AUTOBRAKE MAX	1670	35/-20	50	-70/235	5/0	45/-40	85	0	0
AUTOBRAKE 2	2760	50/-45	95	-130/440	5/-25	85/-80	145	10	10
Good Reported Braking Action									
MAX MANUAL	1860	35/-25	55	-85/300	55/-45	55/-50	90	135	310
AUTOBRAKE MAX	1910	35/-30	60	-85/300	50/-35	55/-50	90	130	300
AUTOBRAKE 2	2760	50/-45	95	-130/440	5/-25	85/-80	145	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2180	40/-35	70	-105/385	95/-70	65/-60	95	235	580
AUTOBRAKE MAX	2200	40/-35	75	-105/385	90/-65	65/-60	100	230	565
AUTOBRAKE 2	2810	50/-45	95	-140/480	35/-40	90/-85	145	55	265
Medium Reported Braking Action									
MAX MANUAL	2490	50/-40	80	-130/470	130/-95	75/-70	105	330	845
AUTOBRAKE MAX	2490	50/-40	80	-130/470	130/-90	75/-70	110	325	835
AUTOBRAKE 3	2600	50/-35	85	-130/480	95/-45	80/-75	135	255	775
Medium To Poor Reported Braking Action									
MAX MANUAL	2850	55/-45	95	-160/610	220/-145	90/-85	110	500	1375
AUTOBRAKE MAX	2850	55/-45	95	-160/610	220/-145	90/-85	115	495	1370
AUTOBRAKE 3	2900	55/-45	95	-160/615	205/-110	90/-85	130	460	1340
Poor Reported Braking Action									
MAX MANUAL	3210	65/-50	105	-195/745	305/-190	105/-90	120	665	1910
AUTOBRAKE MAX	3200	65/-50	105	-195/745	315/-195	105/-95	120	665	1905
AUTOBRAKE 3	3210	65/-50	105	-195/745	310/-175	105/-95	125	665	1900

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - System 1 or System 2 or System 3 Inoperative (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1360	35/-15	40	-55/200	25/-15	35/-30	70	40	90
AUTOBRAKE MAX	1580	30/-20	50	-65/225	0/0	40/-35	80	0	5
AUTOBRAKE 2	2580	45/-40	85	-125/425	10/-35	80/-75	125	10	10
Good Reported Braking Action									
MAX MANUAL	1780	30/-25	55	-85/290	55/-40	50/-45	85	115	260
AUTOBRAKE MAX	1830	30/-25	55	-85/300	45/-35	50/-45	90	110	250
AUTOBRAKE 2	2580	45/-40	85	-125/425	10/-35	80/-75	125	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2070	35/-30	65	-105/375	90/-70	65/-55	95	195	465
AUTOBRAKE MAX	2090	35/-30	65	-105/380	85/-60	65/-55	100	190	455
AUTOBRAKE 2	2620	45/-40	85	-130/465	40/-50	80/-75	125	55	210
Medium Reported Braking Action									
MAX MANUAL	2350	40/-35	75	-125/460	125/-90	75/-65	100	275	670
AUTOBRAKE MAX	2360	40/-35	75	-125/460	125/-90	75/-65	105	265	665
AUTOBRAKE 3	2460	40/-35	80	-130/470	95/-55	75/-70	125	215	620
Medium To Poor Reported Braking Action									
MAX MANUAL	2680	50/-45	85	-155/595	210/-135	85/-75	105	410	1065
AUTOBRAKE MAX	2680	50/-45	90	-155/595	215/-135	85/-75	110	400	1065
AUTOBRAKE 3	2740	50/-45	90	-160/595	195/-115	85/-80	120	375	1050
Poor Reported Braking Action									
MAX MANUAL	3000	55/-50	95	-185/725	295/-175	95/-85	110	540	1465
AUTOBRAKE MAX	3010	55/-50	95	-185/725	300/-180	95/-85	110	540	1465
AUTOBRAKE 3	3030	55/-50	95	-185/725	290/-170	95/-90	115	540	1475

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS 1, 2, 3, 4 - System 4 Inoperative (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1710	35/-20	50	-70/250	40/-30	50/-45	85	90	190
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good Reported Braking Action									
MAX MANUAL	2190	40/-30	70	-100/365	80/-60	65/-60	100	205	495
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good To Medium Reported Braking Action									
MAX MANUAL	2500	50/-40	80	-130/465	125/-95	75/-70	105	325	835
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Medium Reported Braking Action									
MAX MANUAL	2820	55/-45	90	-155/565	175/-125	90/-80	110	440	1175
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Medium To Poor Reported Braking Action									
MAX MANUAL	3170	65/-50	100	-190/730	315/-180	100/-90	120	625	1805
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Poor Reported Braking Action									
MAX MANUAL	3520	70/-60	110	-225/895	455/-235	110/-100	120	805	2430
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS 1, 2, 3, 4 - System 4 Inoperative (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1610	25/-20	50	-70/245	35/-30	45/-40	80	70	155
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good Reported Braking Action									
MAX MANUAL	2030	35/-30	65	-100/350	75/-55	55/-50	95	160	370
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good To Medium Reported Braking Action									
MAX MANUAL	2310	40/-35	75	-125/450	120/-85	70/-60	100	245	605
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Medium Reported Braking Action									
MAX MANUAL	2580	50/-40	80	-145/540	160/-115	80/-70	105	330	840
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Medium To Poor Reported Braking Action									
MAX MANUAL	2890	55/-45	90	-175/700	290/-160	90/-85	105	470	1265
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Poor Reported Braking Action									
MAX MANUAL	3190	60/-50	95	-210/855	415/-210	100/-90	105	605	1685
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - Systems 1 and 2 Inoperative or Systems 1 and 3 Inoperative (Flaps 25)

VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1570	50/-20	50	-60/215	30/-20	45/-40	75	65	135
AUTOBRAKE MAX	1870	40/-20	55	-75/250	5/0	55/-50	95	0	0
AUTOBRAKE 2	3110	50/-45	105	-140/470	25/-55	95/-90	130	50	50
Good Reported Braking Action									
MAX MANUAL	2060	35/-30	65	-90/315	60/-50	60/-55	90	160	375
AUTOBRAKE MAX	2120	35/-30	65	-90/320	55/-45	65/-60	95	160	365
AUTOBRAKE 2	3110	50/-45	105	-140/470	30/-55	95/-90	130	50	50
Good To Medium Reported Braking Action									
MAX MANUAL	2400	40/-35	80	-115/400	100/-75	75/-70	100	270	675
AUTOBRAKE MAX	2440	40/-35	80	-115/405	95/-75	75/-70	105	260	660
AUTOBRAKE 2	3160	50/-50	105	-145/505	55/-70	100/-95	130	100	310
Medium Reported Braking Action									
MAX MANUAL	2740	50/-40	90	-135/490	140/-105	85/-80	105	380	970
AUTOBRAKE MAX	2750	50/-40	90	-135/490	135/-100	85/-80	110	365	950
AUTOBRAKE 3	2930	50/-40	95	-140/510	90/-55	90/-85	135	240	830
Medium To Poor Reported Braking Action									
MAX MANUAL	3120	55/-50	100	-170/630	230/-155	100/-90	110	555	1530
AUTOBRAKE MAX	3120	55/-50	105	-170/630	230/-155	100/-90	115	550	1520
AUTOBRAKE 3	3220	55/-50	105	-170/640	205/-120	105/-95	135	480	1455
Poor Reported Braking Action									
MAX MANUAL	3490	65/-55	110	-200/770	325/-200	110/-105	120	730	2090
AUTOBRAKE MAX	3490	65/-55	110	-200/770	325/-200	110/-105	120	730	2090
AUTOBRAKE 3	3520	65/-55	115	-200/770	315/-180	110/-105	130	720	2080

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - Systems 1 and 4 Inoperative (Flaps 25)

VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1930	35/-25	55	-75/265	45/-35	55/-50	90	100	225
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2450	40/-35	75	-110/385	90/-70	75/-70	105	235	565
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2790	50/-40	90	-135/485	145/-105	85/-80	110	360	930
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3130	55/-45	100	-160/590	190/-140	95/-90	115	485	1295
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3490	65/-55	110	-195/755	335/-195	110/-100	120	675	1945
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3840	70/-60	120	-230/920	475/-250	120/-115	120	865	2590
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - Systems 2 and 3 Inoperative (Flaps 25)

VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1660	50/-20	50	-65/220	35/-25	50/-45	85	75	165
AUTOBRAKE MAX	1870	40/-20	55	-75/250	10/0	55/-50	95	10	60
AUTOBRAKE 2	3150	50/-45	105	-140/470	10/-35	100/-95	150	15	15
Good Reported Braking Action									
MAX MANUAL	2180	35/-30	70	-90/325	70/-55	65/-60	105	195	460
AUTOBRAKE MAX	2200	35/-30	70	-95/330	65/-45	65/-60	105	180	430
AUTOBRAKE 2	3150	50/-45	105	-140/470	10/-35	100/-95	150	15	15
Good To Medium Reported Braking Action									
MAX MANUAL	2540	45/-35	80	-115/415	110/-85	80/-70	110	320	810
AUTOBRAKE MAX	2540	45/-35	80	-120/415	115/-85	80/-75	110	315	790
AUTOBRAKE 2	3200	50/-45	105	-145/510	40/-50	105/-100	150	85	415
Medium Reported Braking Action									
MAX MANUAL	2890	50/-45	95	-140/505	155/-115	90/-85	120	445	1160
AUTOBRAKE MAX	2880	50/-45	95	-140/505	160/-115	90/-85	120	440	1155
AUTOBRAKE 3	2970	50/-40	95	-145/515	120/-60	95/-85	140	380	1095
Medium To Poor Reported Braking Action									
MAX MANUAL	3280	60/-50	105	-175/650	250/-170	105/-100	125	645	1820
AUTOBRAKE MAX	3270	60/-50	110	-175/650	260/-170	105/-100	125	640	1815
AUTOBRAKE 3	3320	60/-50	110	-175/650	240/-130	105/-100	135	610	1785
Poor Reported Braking Action									
MAX MANUAL	3670	70/-60	120	-205/790	350/-215	120/-110	125	840	2475
AUTOBRAKE MAX	3660	70/-60	120	-205/870	355/-225	120/-110	125	835	2470
AUTOBRAKE 3	3660	70/-60	120	-205/790	355/-205	120/-110	135	835	2465

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - Systems 2 and 4 Inoperative or Systems 3 and 4 Inoperative (Flaps 25)

VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2030	35/-25	65	-80/275	50/-40	55/-50	105	135	315
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2580	40/-35	80	-115/400	105/-80	80/-70	120	295	735
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2940	50/-45	95	-140/505	160/-115	90/-85	125	450	1195
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3290	60/-50	105	-165/610	215/-155	105/-95	130	595	1650
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3670	70/-60	120	-200/780	370/-215	120/-105	135	820	2450
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4050	75/-65	130	-240/950	520/-270	130/-120	135	1040	3250
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1, 2, 3, 4 - Systems 1 and 2 and 4 Inoperative (Flaps 25)

VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2370	40/-30	75	-100/345	80/-60	70/-65	115	205	500
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2710	45/-40	90	-125/425	115/-90	80/-75	120	320	800
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	3070	55/-45	100	-150/540	180/-130	95/-85	125	480	1290
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3430	60/-50	110	-175/650	240/-170	105/-100	130	635	1785
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3820	70/-60	125	-215/835	430/-230	120/-115	135	870	2650
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4200	80/-70	135	-255/1020	620/-295	135/-125	135	1100	3515
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Jammed Stabilizer Landing (Flaps 25)
VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1530	45/-20	45	-60/210	25/-20	40/-35	60	55	120
AUTOBRAKE MAX	1870	40/-20	55	-75/250	5/0	55/-50	90	0	0
AUTOBRAKE 2	2980	50/-45	100	-135/455	55/-60	95/-85	110	145	150
Good Reported Braking Action									
MAX MANUAL	1950	30/-25	60	-85/300	55/-40	55/-50	80	135	305
AUTOBRAKE MAX	2050	35/-30	65	-90/310	50/-35	60/-55	90	135	310
AUTOBRAKE 2	2980	50/-45	100	-135/455	60/-60	95/-85	110	145	150
Good To Medium Reported Braking Action									
MAX MANUAL	2260	40/-30	75	-105/385	90/-70	70/-65	90	225	545
AUTOBRAKE MAX	2330	40/-35	75	-110/395	80/-60	75/-65	95	220	540
AUTOBRAKE 2	3020	50/-45	100	-140/495	85/-75	95/-90	110	180	310
Medium Reported Braking Action									
MAX MANUAL	2580	45/-35	80	-130/470	120/-90	80/-75	95	315	785
AUTOBRAKE MAX	2620	45/-35	85	-130/475	115/-85	80/-75	105	305	765
AUTOBRAKE 3	2870	45/-40	90	-140/500	90/-70	90/-85	115	165	555
Medium To Poor Reported Braking Action									
MAX MANUAL	2920	50/-45	95	-160/605	205/-135	90/-85	100	465	1230
AUTOBRAKE MAX	2950	55/-45	95	-160/610	200/-130	95/-85	105	455	1215
AUTOBRAKE 3	3110	50/-45	100	-165/625	180/-120	100/-90	115	360	1090
Poor Reported Braking Action									
MAX MANUAL	3260	55/-50	105	-190/740	290/-175	105/-95	105	610	1675
AUTOBRAKE MAX	3280	60/-50	105	-190/740	285/-175	105/-100	105	600	1665
AUTOBRAKE 3	3350	55/-50	105	-195/745	270/-170	105/-100	115	550	1620

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Nose and Body Gear Up (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	2120	110/-40	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-40	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good Reported Braking Action									
MAX MANUAL	2120	110/-35	90	-95/465	75/-50	75/-55	110	145	330
AUTOBRAKE MAX	2140	125/-35	90	-105/485	70/-55	80/-70	125	145	345
AUTOBRAKE 2	2780	100/-45	95	-130/470	25/-25	85/-80	145	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2340	105/-35	85	-115/470	100/-75	75/-60	105	210	510
AUTOBRAKE MAX	2330	120/-35	85	-115/480	100/-75	80/-70	115	210	515
AUTOBRAKE 2	2830	100/-45	95	-140/495	50/-45	90/-85	145	50	185
Medium Reported Braking Action									
MAX MANUAL	2550	95/-35	80	-130/470	125/-95	75/-70	100	275	690
AUTOBRAKE MAX	2530	110/-35	80	-130/470	125/-95	75/-70	105	275	680
AUTOBRAKE 3	2640	105/-35	85	-130/480	95/-60	80/-75	130	170	575
Medium To Poor Reported Braking Action									
MAX MANUAL	2890	80/-45	90	-160/605	210/-140	90/-80	105	425	1145
AUTOBRAKE MAX	2880	95/-45	90	-160/605	215/-140	90/-80	110	425	1135
AUTOBRAKE 3	2930	95/-45	95	-160/610	195/-115	90/-85	125	370	1080
Poor Reported Braking Action									
MAX MANUAL	3230	65/-50	100	-190/740	295/-180	100/-90	110	570	1595
AUTOBRAKE MAX	3220	80/-50	100	-190/740	300/-185	100/-90	110	570	1590
AUTOBRAKE 3	3230	80/-50	100	-190/740	295/-170	100/-90	120	565	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Nose and Body Gear Up (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1960	90/-35	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-35	80	-90/430	60/-45	70/-75	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good Reported Braking Action									
MAX MANUAL	1960	90/-30	75	-90/395	60/-45	55/-50	85	110	245
AUTOBRAKE MAX	1940	95/-30	80	-90/430	60/-45	70/-50	110	105	235
AUTOBRAKE 2	2590	75/-40	90	-125/430	10/-30	80/-75	135	10	10
Good To Medium Reported Braking Action									
MAX MANUAL	2190	80/-30	75	-110/425	90/-70	65/-60	90	170	400
AUTOBRAKE MAX	2170	90/-30	75	-105/445	90/-70	70/-60	105	165	395
AUTOBRAKE 2	2650	75/-40	90	-130/465	45/-45	80/-75	135	50	155
Medium Reported Braking Action									
MAX MANUAL	2410	70/-35	75	-125/460	120/-90	70/-65	95	230	555
AUTOBRAKE MAX	2400	80/-35	75	-125/460	120/-90	70/-65	105	230	550
AUTOBRAKE 3	2480	75/-35	80	-130/470	95/-55	75/-70	125	145	465
Medium To Poor Reported Braking Action									
MAX MANUAL	2730	65/-40	85	-155/590	200/-130	80/-75	105	345	900
AUTOBRAKE MAX	2720	65/-40	85	-155/590	205/-130	80/-75	105	345	895
AUTOBRAKE 3	2760	65/-40	90	-155/595	190/-110	85/-80	120	305	855
Poor Reported Braking Action									
MAX MANUAL	3040	55/-45	95	-185/720	280/-170	95/-85	105	465	1240
AUTOBRAKE MAX	3040	55/-45	95	-185/720	285/-160	95/-85	105	465	1240
AUTOBRAKE 3	3040	55/-45	95	-185/720	285/-160	95/-85	115	465	1235

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Reverser Unlocked (Flaps 25)
VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1580	50/-20	50	-60/215	30/-20	45/-40	65	0	65
AUTOBRAKE MAX	1870	45/-20	55	-75/250	5/0	55/-50	95	0	0
AUTOBRAKE 2	3120	50/-45	105	-140/470	15/-40	95/-90	135	0	10
Good Reported Braking Action									
MAX MANUAL	2080	35/-30	65	-90/325	65/-50	65/-60	90	0	175
AUTOBRAKE MAX	2190	35/-30	65	-95/330	60/-45	65/-60	95	0	175
AUTOBRAKE 2	3120	50/-45	105	-140/470	20/-40	95/-90	135	0	10
Good To Medium Reported Braking Action									
MAX MANUAL	2490	40/-35	80	-120/425	120/-90	80/-75	95	0	325
AUTOBRAKE MAX	2560	40/-35	80	-125/430	110/-80	80/-75	110	0	320
AUTOBRAKE 2	3200	50/-45	105	-150/520	65/-65	100/-95	135	0	135
Medium Reported Braking Action									
MAX MANUAL	2890	50/-45	95	-145/525	165/-125	90/-85	105	0	470
AUTOBRAKE MAX	2930	50/-40	95	-145/525	160/-115	90/-85	120	0	460
AUTOBRAKE 3	3040	50/-45	100	-150/535	145/-90	95/-90	135	0	395
Medium To Poor Reported Braking Action									
MAX MANUAL	3390	55/-50	110	-190/700	315/-195	110/-100	115	0	770
AUTOBRAKE MAX	3400	55/-50	110	-190/700	310/-190	110/-105	120	0	765
AUTOBRAKE 3	3470	55/-50	110	-190/705	305/-175	110/-105	130	0	735
Poor Reported Braking Action									
MAX MANUAL	3880	65/-60	120	-230/870	455/-265	125/-115	120	0	1070
AUTOBRAKE MAX	3880	65/-60	125	-230/870	465/-265	125/-120	120	0	1070
AUTOBRAKE 3	3900	65/-60	125	-230/870	465/-255	125/-120	125	0	1075

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
STAB TRIM UNSCHD (Flaps 25)
VREF30 + 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1530	45/-20	45	-60/210	25/-20	40/-35	60	55	120
AUTOBRAKE MAX	1870	40/-20	55	-75/250	5/0	55/-50	90	0	0
AUTOBRAKE 2	2980	50/-45	100	-135/455	55/-60	95/-85	110	145	150
Good Reported Braking Action									
MAX MANUAL	1950	30/-25	60	-85/300	55/-40	55/-50	80	135	305
AUTOBRAKE MAX	2050	35/-30	65	-90/310	50/-35	60/-55	90	135	310
AUTOBRAKE 2	2980	50/-45	100	-135/455	60/-60	95/-85	110	145	150
Good To Medium Reported Braking Action									
MAX MANUAL	2260	40/-30	75	-105/385	90/-70	70/-65	90	225	545
AUTOBRAKE MAX	2330	40/-35	75	-110/395	80/-60	75/-65	95	220	540
AUTOBRAKE 2	3020	50/-45	100	-140/495	85/-75	95/-90	110	180	310
Medium Reported Braking Action									
MAX MANUAL	2580	45/-35	80	-130/470	120/-90	80/-75	95	315	785
AUTOBRAKE MAX	2620	45/-35	85	-130/475	115/-85	80/-75	105	305	765
AUTOBRAKE 3	2870	45/-40	90	-140/500	90/-70	90/-85	115	165	555
Medium To Poor Reported Braking Action									
MAX MANUAL	2920	50/-45	95	-160/605	205/-135	90/-85	100	465	1230
AUTOBRAKE MAX	2950	55/-45	95	-160/610	200/-130	95/-85	105	455	1215
AUTOBRAKE 3	3110	50/-45	100	-165/625	180/-120	100/-90	115	360	1090
Poor Reported Braking Action									
MAX MANUAL	3260	55/-50	105	-190/740	290/-175	105/-95	105	610	1675
AUTOBRAKE MAX	3280	60/-50	105	-190/740	285/-175	105/-100	105	600	1665
AUTOBRAKE 3	3350	55/-50	105	-195/745	270/-170	105/-100	115	550	1620

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Two Engines Inoperative (Flaps 25)
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	290000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 290000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1500	50/-20	45	-60/215	30/-20	40/-35	65	0	0
AUTOBRAKE MAX	1670	45/-20	50	-130/440	10/0	85/-80	85	0	0
AUTOBRAKE 2	2750	50/-45	95	-130/440	10/-5	85/-80	150	0	0
Good Reported Braking Action									
MAX MANUAL	2010	35/-30	65	-90/325	75/-55	60/-55	95	0	0
AUTOBRAKE MAX	2090	35/-30	65	-95/330	65/-50	60/-60	105	0	0
AUTOBRAKE 2	2750	50/-45	95	-130/440	10/-5	85/-80	150	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	2500	40/-35	80	-125/440	150/-105	80/-75	110	0	0
AUTOBRAKE MAX	2540	40/-35	85	-125/445	145/-100	80/-75	120	0	0
AUTOBRAKE 2	2930	50/-45	100	-145/500	105/-60	90/-85	150	0	0
Medium Reported Braking Action									
MAX MANUAL	2990	50/-45	95	-155/555	220/-155	95/-90	125	0	0
AUTOBRAKE MAX	2980	50/-45	100	-155/555	225/-145	95/-90	135	0	0
AUTOBRAKE 3	3050	50/-45	100	-160/560	220/-155	95/-90	125	0	0
Medium To Poor Reported Braking Action									
MAX MANUAL	3670	60/-55	120	-210/755	465/-265	120/-115	140	0	0
AUTOBRAKE MAX	3670	65/-55	120	-210/755	470/-265	120/-115	145	0	0
AUTOBRAKE 3	3720	65/-55	120	-210/760	465/-270	120/-115	140	0	0
Poor Reported Braking Action									
MAX MANUAL	4360	75/-65	145	-265/955	705/-375	140/-135	150	0	0
AUTOBRAKE MAX	4360	75/-65	145	-265/955	710/-380	140/-135	150	0	0
AUTOBRAKE 3	4400	75/-65	145	-265/955	705/-385	145/-140	150	0	0

Reference distance is based on sea level, standard day, no wind or slope, and maximum available symmetrical reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Reference Distance includes an air distance allowance of 460 m from threshold to touchdown.
Actual (unfactored) distances are shown.

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	2	4	0	2	4	0	2	4	0	2	4	0	2	4	0	2	4
400	0	19.1	20.1	21.1	28.2	29.7	31.3	38.0	40.5	43.1	49.1	52.3	55.3	61.2	65.3	69.3	73.6	78.1	
	15	19.9	20.9	21.9	29.2	30.8	32.5	39.6	42.1	44.8	51.1	54.3	57.5	63.7	67.9	71.9	76.5	81.4	
	20	20.1	21.1	22.1	29.5	31.2	32.9	40.1	42.6	45.3	51.7	55.0	58.4	64.5	68.7	72.8	77.5	82.5	
	40	21.2	22.2	23.2	30.8	32.6	34.5	42.2	44.7	47.4	54.2	57.8	61.4	67.8	72.2	76.5	81.4	87.0	
	60	22.3	23.3	24.2	32.1	33.0	36.1	44.3	46.8	49.6	56.8	60.5	64.4	71.1	75.6	80.1	85.3	91.5	
350	0	17.2	18.0	18.9	25.2	26.7	27.4	33.8	36.0	38.2	43.6	46.4	49.3	54.1	57.6	61.1	65.0	69.4	74.0
	15	17.9	18.8	19.7	26.0	27.6	28.3	35.2	37.4	39.7	45.3	48.2	51.3	56.3	59.9	63.6	68.5	73.1	77.5
	20	18.1	19.1	20.0	26.3	27.9	28.6	35.7	37.9	40.2	45.8	48.8	51.9	57.0	60.6	64.4	69.5	74.2	78.6
	40	19.1	20.2	21.1	27.4	29.1	29.8	37.5	39.9	42.3	47.9	51.2	54.4	59.9	61.8	67.7	73.3	78.1	82.8
	60	20.0	21.3	22.2	28.4	30.3	31.0	39.3	41.8	44.4	50.1	53.6	57.0	62.8	67.1	71.0	75.3	80.6	85.3
300	0	15.4	16.2	16.9	22.0	23.4	24.7	29.7	31.4	33.1	37.8	40.3	42.9	47.1	50.1	53.1	56.3	60.0	63.6
	15	15.9	16.7	17.6	22.8	24.2	25.5	30.8	32.6	34.5	39.4	41.9	44.5	48.9	52.1	55.2	58.6	62.4	66.2
	20	16.1	16.9	17.8	23.1	24.4	25.8	31.2	33.0	34.9	39.9	42.4	45.0	49.5	52.7	55.9	59.4	63.2	67.0
	40	16.7	17.7	18.7	24.1	25.4	26.8	32.6	34.6	36.6	41.9	44.5	47.1	52.0	55.3	58.7	62.5	66.4	70.4
	60	17.4	18.5	19.6	25.1	26.4	27.9	34.0	36.2	38.4	44.0	46.6	49.3	54.4	57.9	61.5	65.6	69.7	73.7
250	0	13.7	14.3	15.0	18.8	19.8	20.8	25.6	27.2	28.7	32.2	34.2	36.2	40.0	42.6	45.3	47.9	50.9	53.9
	15	14.0	14.7	15.4	19.6	20.6	21.6	26.4	28.1	29.7	33.5	35.6	37.7	41.6	44.3	47.0	49.8	52.9	56.1
	20	14.1	14.8	15.5	19.9	20.9	21.8	26.7	28.4	30.0	33.9	36.1	38.2	42.1	44.8	47.6	50.4	53.6	56.8
	40	14.5	15.3	16.1	21.0	21.9	22.9	27.8	29.6	31.3	35.6	37.9	40.2	44.1	46.9	49.9	52.8	56.2	59.7
	60	14.9	15.7	16.7	22.0	23.0	23.9	28.9	30.8	32.7	37.4	39.7	42.1	46.2	49.0	52.2	55.3	58.9	62.6
200	0	11.8	12.3	12.9	15.9	16.6	17.4	21.2	22.5	23.7	26.8	29.3	29.9	32.8	34.9	36.9	39.2	41.9	44.5
	15	12.0	12.5	13.1	16.4	17.3	18.2	22.0	23.3	24.5	27.7	29.5	31.0	34.5	36.3	38.4	40.8	43.6	46.2
	20	12.0	12.6	13.2	16.6	17.5	18.4	22.3	23.5	24.7	28.0	29.6	31.4	34.6	36.7	38.9	41.3	44.0	46.7
	40	12.2	12.9	13.5	17.3	18.3	19.3	23.3	24.5	25.7	29.2	30.9	32.8	36.3	38.7	40.9	43.4	46.1	49.0
	60	12.4	13.1	13.8	18.1	19.1	20.3	24.4	25.6	26.7	30.4	32.1	34.3	38.1	40.5	43.0	45.5	48.2	51.2

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 with SL + 15°.

Adjusted Brake Energy per Brake (Millions of Foot Pounds)

		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	5.0	13.5	22.3	30.6	39.4	48.1	57.2	66.5	75.5
	MAX AUTO	5.0	12.5	20.4	28.5	36.8	45.5	54.1	63.0	72.4
	AUTOBRAKE 4	4.8	12.0	19.3	26.6	34.3	42.3	50.7	60.0	69.3
	AUTOBRAKE 3	4.5	11.0	18.2	25.0	32.1	40.0	47.5	56.2	65.0
	AUTOBRAKE 2	4.4	10.5	17.1	23.4	30.0	36.8	43.7	51.7	60.0
	AUTOBRAKE 1	4.3	10.0	15.4	20.5	26.5	32.5	38.5	45.5	52.0

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

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	1.8	3.0	4.2	5.1	6.0	6.0	CAUTION	FUSE PLUG MELT ZONE
GROUND		10	28	40	55	65	70		
BTMS	UP TO 2	2	2	3	4	4	4	5 TO 6	7 & ABOVE

Observe maximum quick turnaround limit.
Table does not consider the benefit of reverse thrust.
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.

Intentionally
Blank

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		1.76	1.71			1.77	1.76	1.75	1.73	1.71
	MAX TAT		-21	-9			-24	-21	-17	-14	-10
	EPR CORR		0.06	0.07			0.06	0.06	0.06	0.06	0.07
43000	EPR		1.77	1.73	1.67		1.77	1.76	1.75	1.74	1.72
	MAX TAT		-23	-12	1		-24	-21	-17	-14	-10
	EPR CORR		0.06	0.06	0.06		0.06	0.06	0.06	0.06	0.06
41000	EPR		1.78	1.74	1.69		1.78	1.77	1.76	1.74	1.72
	MAX TAT		-25	-15	-3		-24	-21	-17	-14	-10
	EPR CORR		0.06	0.06	0.06		0.06	0.06	0.06	0.06	0.06
39000	EPR		1.79	1.76	1.71		1.79	1.78	1.77	1.75	1.73
	MAX TAT		-27	-17	-6		-24	-21	-17	-14	-10
	EPR CORR		0.05	0.06	0.06		0.05	0.06	0.06	0.06	0.06
37000	EPR		1.79	1.78	1.73		1.79	1.78	1.77	1.75	1.74
	MAX TAT		-29	-19	-9		-24	-21	-17	-14	-10
	EPR CORR		0.05	0.05	0.06		0.05	0.05	0.06	0.06	0.06
35000	EPR		1.80	1.78	1.74		1.79	1.78	1.77	1.75	1.73
	MAX TAT		-28	-19	-9		-22	-19	-15	-11	-7
	EPR CORR		0.06	0.06	0.06		0.06	0.06	0.06	0.06	0.06
33000	EPR		1.79	1.78	1.74		1.78	1.77	1.76	1.74	1.72
	MAX TAT		-25	-17	-8		-18	-14	-11	-7	-3
	EPR CORR		0.06	0.06	0.06		0.06	0.06	0.06	0.06	0.06
31000	EPR		1.79	1.78	1.75	1.70	1.78	1.76	1.75	1.73	1.71
	MAX TAT		-22	-14	-6	4	-13	-10	-6	-2	2
	EPR CORR		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
29000	EPR		1.78	1.76	1.74	1.69	1.76	1.75	1.73	1.71	1.68
	MAX TAT		-19	-12	-4	6	-9	-5	-2	2	7
	EPR CORR		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
27000	EPR	1.79	1.76	1.75	1.73	1.68	1.75	1.73	1.71	1.69	1.66
	MAX TAT	-21	-16	-9	-1	8	-5	-1	3	7	11
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
25000	EPR	1.78	1.75	1.75	1.73	1.68	1.74	1.72	1.69	1.67	
	MAX TAT	-18	-13	-6	1	9	0	3	7	11	
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	

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
2 PACKS OFF	0.01	0.01	0.01	0.01	0.02	0.02
3 PACKS OFF	0.01	0.01	0.01	0.01	0.02	0.02
ENGINE ANTI-ICE ON	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
ENGINE & WING ANTI-ICE ON	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02

1 ENGINE INOP

Max Continuous EPR

24000 FT to S.L. 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	1.77	1.75	1.74	1.73	1.67	1.73	1.70	1.68	1.65	
	MAX TAT	-16	-11	-5	2	10	2	6	10	14	
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
22000	EPR	1.76	1.74	1.74	1.71	1.66	1.70	1.68	1.65		
	MAX TAT	-12	-8	-2	5	13	6	10	14		
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
20000	EPR	1.74	1.73	1.73	1.70	1.65	1.68	1.65			
	MAX TAT	-9	-5	1	7	15	11	14			
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06			
18000	EPR	1.73	1.72	1.71	1.69	1.64	1.65	1.63			
	MAX TAT	-5	-1	4	10	17	15	19			
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06	0.06			
16000	EPR	1.71	1.71	1.71	1.67	1.63	1.63				
	MAX TAT	-2	2	7	13	19	19				
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06				
14000	EPR	1.69	1.70	1.69	1.66	1.62	1.60				
	MAX TAT	2	6	10	16	22	24				
	EPR CORR	0.06	0.06	0.06	0.06	0.06	0.06				
12000	EPR	1.67	1.68	1.67	1.64	1.60					
	MAX TAT	6	9	13	19	25					
	EPR CORR	0.06	0.06	0.06	0.06	0.05					
10000	EPR	1.65	1.67	1.66	1.63	1.59					
	MAX TAT	9	13	17	21	27					
	EPR CORR	0.05	0.06	0.06	0.05	0.05					
5000	EPR	1.61	1.60	1.61	1.59	1.56					
	MAX TAT	19	21	25	29	34					
	EPR CORR	0.05	0.05	0.05	0.05	0.05					
1500	EPR	1.57	1.56	1.58	1.56	1.53					
	MAX TAT	25	28	31	35	39					
	EPR CORR	0.05	0.05	0.05	0.05	0.05					
0	EPR	1.56	1.55	1.56	1.54	1.52					
	MAX TAT	28	30	34	37	42					
	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
2 PACKS OFF	0.01	0.01	0.01	0.01	0.02	0.02
3 PACKS OFF	0.01	0.01	0.01	0.01	0.02	0.02
ENGINE ANTI-ICE ON	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
ENGINE & WING ANTI-ICE ON	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02

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	391	306	26600	25500	24300
390	381	302	27300	26200	25000
380	372	298	28100	26900	25700
370	362	295	28800	27700	26500
360	352	290	29600	28400	27200
350	343	288	30300	29300	28000
340	333	283	31000	30000	28800
330	324	279	31700	30800	29700
320	314	276	32400	31500	30500
310	304	271	33100	32300	31200
300	294	268	33800	33100	32100
290	284	263	34700	33900	32900
280	275	259	35400	34900	33700
270	265	254	36100	35600	34800
260	255	249	36800	36300	35600
250	245	245	37500	37000	36300
240	235	240	38300	37800	37000
230	225	234	39100	38500	37800
220	215	229	39900	39300	38600
210	206	223	40800	40200	39400
200	196	218	41700	41000	40300

Altitude reduced by 1000 ft for additional margin.

1 ENGINE INOP

MAX CONTINUOUS THRUST

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	24700	22500	20100
390	25500	23600	21200
380	26400	24600	22400
370	27200	25600	23500
360	28100	26500	24500
350	28900	27500	25500
340	29800	28400	26500
330	30500	29300	27500
320	31300	30200	28500
310	32000	31000	29600
300	32800	31800	30500
290	33500	32600	31400
280	34400	33500	32300
270	35200	34500	33100
260	35900	35400	34100
250	36700	36100	35300
240	37400	36900	36000
230	38200	37600	36800
220	39000	38400	37500
210	39900	39200	38300
200	40800	40100	39200

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 900 ft.
With engine and wing anti-ice on, decrease altitude capability by 1800 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	1.38	1.44	1.55	1.67						
	MACH	.647	.694	.773	.807						
	KIAS	360	360	360	341						
	FF/ENG	4758	4779	4866	4890						
380	EPR	1.37	1.42	1.53	1.64	1.69					
	MACH	.632	.681	.762	.801	.815					
	KIAS	352	353	354	338	330					
	FF/ENG	4502	4525	4614	4591	4662					
360	EPR	1.35	1.40	1.51	1.61	1.66	1.71				
	MACH	.617	.664	.746	.794	.805	.824				
	KIAS	343	344	346	335	326	321				
	FF/ENG	4246	4252	4338	4323	4336	4454				
340	EPR	1.33	1.38	1.48	1.58	1.63	1.68				
	MACH	.601	.646	.726	.783	.798	.810				
	KIAS	334	334	336	330	323	315				
	FF/ENG	4000	3989	4050	4059	4063	4095				
320	EPR	1.31	1.36	1.46	1.55	1.60	1.64	1.70			
	MACH	.586	.628	.705	.772	.788	.802	.817			
	KIAS	325	325	326	325	319	311	304			
	FF/ENG	3763	3735	3776	3814	3801	3808	3878			
300	EPR	1.30	1.34	1.43	1.52	1.56	1.61	1.66	1.72		
	MACH	.570	.610	.684	.756	.776	.793	.805	.825		
	KIAS	316	315	316	318	313	307	299	294		
	FF/ENG	3533	3492	3507	3571	3552	3549	3563	3670		
280	EPR	1.28	1.32	1.41	1.49	1.54	1.58	1.62	1.67	1.74	
	MACH	.553	.592	.662	.733	.761	.780	.796	.808	.832	
	KIAS	307	305	305	307	307	302	296	288	284	
	FF/ENG	3306	3257	3245	3298	3318	3297	3305	3330	3458	
260	EPR	1.26	1.30	1.38	1.46	1.50	1.54	1.59	1.64	1.69	1.76
	MACH	.535	.573	.639	.707	.738	.765	.783	.799	.812	.839
	KIAS	297	295	294	296	297	296	290	284	276	274
	FF/ENG	3114	3029	2994	3029	3052	3066	3051	3064	3100	3262
240	EPR	1.24	1.28	1.35	1.43	1.47	1.51	1.55	1.60	1.65	1.70
	MACH	.517	.554	.616	.681	.710	.741	.768	.785	.801	.816
	KIAS	287	285	283	284	285	286	284	279	272	265
	FF/ENG	2886	2805	2750	2765	2782	2806	2816	2808	2822	2886
220	EPR	1.23	1.26	1.33	1.40	1.43	1.47	1.51	1.56	1.60	1.65
	MACH	.499	.533	.593	.654	.681	.711	.742	.769	.787	.802
	KIAS	276	274	272	272	272	273	274	272	267	260
	FF/ENG	2673	2610	2517	2508	2519	2535	2562	2570	2565	2594
200	EPR	1.21	1.24	1.30	1.37	1.40	1.43	1.47	1.51	1.56	1.60
	MACH	.480	.512	.569	.625	.651	.679	.709	.741	.769	.787
	KIAS	265	263	260	259	260	260	261	262	260	255
	FF/ENG	2471	2385	2295	2261	2264	2275	2294	2320	2328	2339

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
694	645	601	563	530	500	479	459	441	425	410
1391	1292	1203	1127	1060	1000	959	920	885	852	823
2096	1945	1810	1693	1592	1500	1438	1381	1328	1279	1235
2806	2601	2418	2261	2124	2000	1918	1842	1771	1706	1646
3524	3264	3031	2831	2657	2500	2398	2302	2214	2132	2058
4249	3930	3646	3403	3191	3000	2877	2762	2656	2558	2468
4982	4602	4264	3976	3725	3500	3356	3222	3098	2983	2878
5724	5281	4888	4552	4261	4000	3835	3682	3539	3408	3288
6475	5966	5514	5130	4798	4500	4314	4140	3979	3831	3696
7237	6659	6146	5712	5336	5000	4792	4598	4419	4254	4104

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		22		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)
500	14.0	1:27	12.7	1:23	10.9	1:16	9.6	1:11	9.4	1:10
1000	28.2	2:52	26.0	2:44	22.7	2:27	20.6	2:16	20.3	2:14
1500	42.1	4:19	39.0	4:06	34.2	3:39	31.2	3:21	30.8	3:18
2000	55.7	5:48	51.6	5:30	45.5	4:53	41.5	4:27	40.9	4:22
2500	69.0	7:20	64.0	6:56	56.4	6:09	51.6	5:34	50.7	5:27
3000	82.0	8:53	76.0	8:24	67.0	7:26	61.4	6:42	60.1	6:33
3500	94.6	10:29	87.8	9:53	77.4	8:44	70.9	7:51	69.3	7:39
4000	107.0	12:07	99.4	11:25	87.5	10:05	80.2	9:02	78.1	8:45
4500	119.1	13:48	110.6	12:59	97.4	11:27	89.2	10:14	86.8	9:52
5000	130.9	15:32	121.6	14:36	107.0	12:50	97.9	11:27	95.2	11:01

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	1.9	4.5
20	-3.1	-1.5	0.0	3.9	8.9
30	-4.6	-2.4	0.0	5.7	13.0
40	-6.2	-3.2	0.0	7.5	16.9
50	-7.7	-4.0	0.0	9.1	20.5
60	-9.3	-4.8	0.0	10.7	23.8
70	-10.8	-5.6	0.0	12.1	26.9
80	-12.3	-6.3	0.0	13.4	29.8
90	-13.8	-7.1	0.0	14.7	32.4
100	-15.3	-7.8	0.0	15.8	34.7
110	-16.7	-8.6	0.0	16.9	36.8
120	-18.2	-9.3	0.0	17.8	38.7
130	-19.6	-10.0	0.0	18.6	40.3
140	-21.0	-10.7	0.0	19.4	41.7

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	1.27	1.31	1.37	1.45	1.54	1.66			
	KIAS	286	286	286	286	307	311			
	FF/ENG	4370	4270	4250	4280	4450	4710			
380	EPR	1.25	1.29	1.35	1.43	1.51	1.63			
	KIAS	280	280	280	280	300	303			
	FF/ENG	4150	4050	4010	4020	4170	4360			
360	EPR	1.24	1.27	1.34	1.41	1.49	1.60	1.74		
	KIAS	271	271	271	271	291	294	298		
	FF/ENG	3920	3880	3780	3780	3900	4040	4470		
340	EPR	1.23	1.26	1.32	1.39	1.46	1.57	1.70		
	KIAS	261	261	261	261	282	285	289		
	FF/ENG	3710	3650	3550	3540	3640	3740	4050		
320	EPR	1.21	1.25	1.30	1.37	1.44	1.54	1.66		
	KIAS	251	251	251	251	273	276	280		
	FF/ENG	3490	3440	3340	3310	3390	3470	3680		
300	EPR	1.20	1.23	1.28	1.35	1.41	1.50	1.62		
	KIAS	242	242	242	242	264	267	270		
	FF/ENG	3280	3230	3170	3090	3150	3210	3350		
280	EPR	1.19	1.22	1.26	1.32	1.39	1.47	1.59	1.73	
	KIAS	233	233	233	233	255	257	260	264	
	FF/ENG	3070	3020	2960	2880	2920	2960	3060	3380	
260	EPR	1.18	1.20	1.24	1.30	1.36	1.44	1.55	1.68	
	KIAS	228	228	228	228	246	248	250	254	
	FF/ENG	2870	2810	2750	2670	2690	2710	2780	3000	
240	EPR	1.16	1.18	1.22	1.27	1.33	1.41	1.51	1.63	
	KIAS	221	221	221	221	236	237	239	243	
	FF/ENG	2670	2610	2540	2490	2470	2470	2520	2660	
220	EPR	1.15	1.17	1.20	1.25	1.31	1.38	1.47	1.59	1.74
	KIAS	215	215	215	215	225	226	229	231	235
	FF/ENG	2480	2420	2350	2290	2250	2240	2280	2360	2700
200	EPR	1.14	1.15	1.19	1.23	1.28	1.35	1.43	1.54	1.67
	KIAS	208	208	208	208	215	216	218	220	223
	FF/ENG	2290	2230	2170	2090	2070	2020	2040	2100	2310

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

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	385	296	12600	10900	9100
390	376	293	13600	12000	10200
380	366	289	14600	13000	11300
370	357	286	15700	14000	12400
360	347	282	16700	15000	13400
350	339	279	17700	16000	14400
340	329	275	18600	17100	15400
330	319	271	19400	18100	16500
320	310	267	20200	19000	17500
310	300	263	21100	19900	18500
300	290	259	22000	20700	19400
290	280	255	22900	21700	20300
280	271	251	23800	22600	21200
270	261	246	24700	23500	22200
260	251	242	25700	24500	23200
250	242	237	26600	25500	24200
240	232	233	27700	26500	25300
230	223	228	28900	27500	26400
220	213	223	29900	28800	27500
210	203	219	31100	30100	28900
200	194	213	32200	31300	30200

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
672	628	591	557	527	500	476	454	434	415	398
1334	1251	1177	1111	1053	1000	952	909	869	833	800
1996	1872	1763	1666	1578	1500	1429	1364	1305	1251	1201
2658	2494	2349	2220	2104	2000	1906	1820	1741	1669	1603
3323	3118	2936	2775	2630	2500	2382	2275	2177	2087	2004
3991	3743	3525	3331	3157	3000	2858	2729	2611	2503	2403
4663	4372	4116	3888	3684	3500	3334	3183	3044	2918	2801
5341	5005	4710	4447	4211	4000	3809	3635	3476	3331	3197
6027	5644	5307	5007	4740	4500	4283	4086	3906	3742	3591
6721	6288	5908	5570	5270	5000	4756	4536	4334	4150	3981

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	
500	9.0	9.9	10.5	11.4	12.2	13.0	13.9	14.6	15.4	16.0	16.9	1:17
1000	17.8	19.4	20.9	22.6	24.2	25.8	27.3	28.8	30.4	31.9	33.7	2:30
1500	26.1	28.5	30.8	33.3	35.7	38.0	40.4	42.6	45.0	47.3	50.0	3:44
2000	34.0	37.2	40.3	43.5	46.6	49.8	52.9	55.9	59.1	62.2	65.7	4:57
2500	41.6	45.5	49.3	53.3	57.2	61.0	64.9	68.7	72.6	76.6	80.9	6:11
3000	48.9	53.5	58.0	62.7	67.3	71.9	76.4	81.0	85.7	90.4	95.5	7:27
3500	55.9	61.2	66.4	71.7	77.0	82.3	87.6	92.8	98.3	103.8	109.7	8:44
4000	62.6	68.5	74.4	80.4	86.4	92.4	98.3	104.3	110.5	116.7	123.5	10:03
4500	69.1	75.7	82.2	88.9	95.5	102.1	108.7	115.4	122.4	129.3	136.8	11:24
5000	75.4	82.6	89.7	97.0	104.3	111.5	118.8	126.1	133.8	141.5	149.7	12:48

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	5400	3500	1100
380	7900	5700	3600
360	10300	8200	6100
340	12800	10800	8700
320	15200	13300	11400
300	17700	15900	14100
280	20100	18500	16800
260	22800	21000	19300
240	24900	23600	22000
220	27200	25900	24500
200	29700	28500	27000

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
380	EPR	1.59								
	MACH	.632								
	KIAS	352								
	FF/ENG	6975								
360	EPR	1.56								
	MACH	.617								
	KIAS	343								
	FF/ENG	6519								
340	EPR	1.53	1.62							
	MACH	.601	.646							
	KIAS	334	334							
	FF/ENG	6096	6242							
320	EPR	1.51	1.59	1.66						
	MACH	.586	.628	.665						
	KIAS	325	325	325						
	FF/ENG	5696	5776	5946						
300	EPR	1.48	1.55	1.62						
	MACH	.570	.610	.645						
	KIAS	316	315	315						
	FF/ENG	5310	5343	5457						
280	EPR	1.45	1.52	1.58	1.66					
	MACH	.553	.592	.625	.662					
	KIAS	307	305	305	305					
	FF/ENG	4942	4945	5003	5151					
260	EPR	1.42	1.49	1.55	1.61	1.69				
	MACH	.535	.573	.604	.639	.679				
	KIAS	297	295	294	294	295				
	FF/ENG	4583	4563	4583	4672	4852				
240	EPR	1.39	1.46	1.51	1.57	1.64	1.70	1.76		
	MACH	.517	.554	.583	.616	.654	.681	.710		
	KIAS	287	285	284	283	283	284	285		
	FF/ENG	4229	4194	4193	4230	4343	4469	4644		
220	EPR	1.37	1.42	1.47	1.53	1.60	1.65	1.70	1.76	
	MACH	.499	.533	.562	.593	.628	.654	.681	.711	
	KIAS	276	274	273	272	272	272	272	273	
	FF/ENG	3891	3837	3820	3827	3882	3960	4078	4243	
200	EPR	1.34	1.39	1.43	1.49	1.55	1.59	1.65	1.70	1.76
	MACH	.480	.512	.539	.569	.601	.625	.651	.679	.709
	KIAS	265	263	262	260	260	259	260	260	261
	FF/ENG	3561	3490	3462	3450	3465	3504	3572	3679	3836

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	124	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
50	122	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
45	113	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59
40	104	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.61	1.61
35	95	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.64	1.64	1.64	1.63
30	86	1.65	1.66	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.67	1.66	1.66	1.65
25	77	1.65	1.66	1.68	1.69	1.70	1.70	1.70	1.70	1.70	1.69	1.68	1.67	1.67
20	68	1.65	1.66	1.68	1.69	1.70	1.71	1.72	1.72	1.72	1.71	1.70	1.69	1.69
15	59	1.65	1.66	1.68	1.69	1.70	1.71	1.72	1.73	1.73	1.73	1.72	1.71	1.70
10	50	1.65	1.66	1.68	1.69	1.70	1.71	1.72	1.73	1.74	1.74	1.74	1.73	1.72
5 & BELOW	41 & BELOW	1.65	1.66	1.68	1.69	1.70	1.71	1.72	1.73	1.74	1.74	1.74	1.74	1.74

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	10000
2 PACKS OFF	0.01	0.01
3 PACKS OFF	0.01	0.01

ALTERNATE MODE EEC

Max Continuous %N1

No EPR available

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

45000 FT to 25000 FT Pressure Altitudes

45000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.57	95.0	99.2	96.2	95.2	94.4	93.8	93.1	92.4	91.6	90.8	90.0	88.1
200	.75	95.1	99.2	99.8	98.6	97.5	96.5	95.6	94.9	94.2	93.5	92.9	91.4
250	.91	91.8	95.8	98.7	99.7	98.8	97.4	96.4	95.6	94.9	94.2	93.6	92.2
41000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.53	95.1	99.3	96.2	95.3	94.4	93.8	93.0	92.3	91.5	90.7	89.9	88.0
200	.69	96.5	100.8	100.1	98.9	97.7	96.7	95.8	95.0	94.4	93.7	93.0	91.5
250	.84	94.3	98.5	101.5	100.8	99.5	98.3	97.2	96.4	95.7	95.0	94.3	93.0
270	.90	92.9	97.0	100.0	100.9	100.1	98.7	97.5	96.7	95.9	95.2	94.5	93.2
37000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.48	95.4	99.5	96.3	95.4	94.5	93.7	92.9	92.2	91.5	90.7	89.9	88.0
200	.63	97.3	101.5	99.9	98.7	97.5	96.5	95.6	94.9	94.2	93.5	92.8	91.3
250	.77	96.6	100.8	103.0	101.8	100.5	99.2	98.1	97.2	96.4	95.7	95.0	93.8
300	.91	93.6	97.7	100.7	101.6	101.8	100.3	99.0	97.9	97.1	96.4	95.7	94.4
33000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.44	97.7	102.0	98.4	97.3	96.2	95.3	94.4	93.6	92.9	92.2	91.4	89.7
200	.58	96.9	101.1	100.3	99.1	97.8	96.8	95.9	95.2	94.6	93.8	93.1	91.6
250	71	96.6	100.8	103.4	102.2	100.9	99.6	98.5	97.5	96.7	95.9	95.3	93.9
300	.84	94.2	98.3	101.3	102.3	102.4	101.0	99.8	98.7	97.8	97.0	96.3	95.1
330	.91	92.2	96.3	99.2	100.2	101.1	101.6	100.3	99.1	98.1	97.3	96.6	95.3
29000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.40	98.1	102.4	101.0	99.6	98.3	97.1	96.1	95.3	94.5	93.7	93.0	91.5
200	.53	95.9	100.1	101.4	100.1	98.8	97.7	96.7	95.9	95.2	94.5	93.7	92.2
250	.65	95.2	99.3	102.4	102.6	101.3	100.0	98.8	97.8	96.9	96.2	95.6	94.2
300	.78	93.9	98.1	101.0	102.0	103.0	102.4	101.0	99.9	98.9	98.0	97.3	96.0
350	.89	90.6	94.6	97.5	98.4	99.4	100.3	101.2	100.4	99.2	98.4	97.6	96.2
25000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	35
150	.37	95.0	99.2	100.9	99.5	98.1	97.0	96.0	95.1	94.3	93.6	92.9	91.4
200	.49	93.3	97.4	100.4	100.1	98.7	97.6	96.6	95.7	94.9	94.1	93.4	92.0
250	.60	93.9	98.0	101.0	101.9	102.3	101.0	99.6	98.5	97.6	96.9	96.3	94.9
300	.72	93.4	97.5	100.5	101.4	102.4	103.3	102.5	101.1	100.0	99.0	98.2	96.9
350	.83	89.9	93.9	96.7	97.7	98.6	99.5	100.4	101.1	100.0	99.1	98.3	96.9

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)					
	25	29	33	37	41	45
PACKS OFF	0.6	0.6	0.7	0.9	1	1.1
ENGINE ANTI-ICE ON	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
ENGINE & WING ANTI-ICE ON	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2

ALTERNATE MODE EEC

Max Continuous %N1

No EPR available

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

22000 FT to 12000 FT Pressure Altitudes

22000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.35	93.4	97.5	100.4	100.3	98.8	97.6	96.6	95.7	94.9	94.1	93.4	92.7
200	.46	92.7	96.7	99.7	100.6	100.2	98.9	97.8	96.8	96.0	95.1	94.5	93.7
250	.57	92.9	97.0	99.9	100.9	101.9	101.9	100.5	99.3	98.4	97.6	97.0	96.3
300	.68	91.7	95.7	98.6	99.6	100.5	101.5	102.3	101.0	99.8	98.9	98.1	97.4
350	.78	88.9	92.8	95.7	96.6	97.5	98.4	99.3	100.2	100.1	99.2	98.4	97.7
20000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
200	.44	91.9	95.9	98.8	99.8	100.7	99.6	98.4	97.3	96.4	95.6	94.9	94.2
250	.55	92.3	96.4	99.3	100.3	101.2	102.1	101.2	99.9	98.9	98.1	97.5	96.8
300	.65	90.9	94.9	97.8	98.7	99.6	100.6	101.5	101.3	100.1	99.1	98.3	97.6
350	.75	88.2	92.1	94.9	95.8	96.7	97.6	98.5	99.4	100.2	99.2	98.5	97.7
18000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
200	.44	91.1	95.0	97.9	98.9	99.8	100.2	98.9	97.8	96.9	96.1	95.3	94.6
250	.55	91.2	95.2	98.0	99.0	99.9	100.9	101.3	100.0	98.9	98.1	97.4	96.7
300	.65	89.9	93.9	96.7	97.7	98.6	99.5	100.4	101.3	100.2	99.2	98.4	97.7
350	.75	87.6	91.4	94.2	95.1	96.0	96.9	97.8	98.6	99.5	99.3	98.5	97.8
16000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
200	.42	90.2	94.2	97.0	97.9	98.9	99.8	99.5	98.3	97.3	96.5	95.7	95.0
250	.53	90.4	94.4	97.2	98.2	99.1	100.0	100.9	100.5	99.4	98.4	97.7	96.9
300	.63	89.0	92.9	95.7	96.6	97.5	98.4	99.3	100.2	100.2	99.2	98.4	97.8
350	.73	86.9	90.7	93.4	94.3	95.2	96.1	97.0	97.8	98.7	99.3	98.5	97.8
14000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
200	.39	89.3	93.3	96.1	97.0	97.9	98.8	99.7	98.8	97.8	96.9	96.1	95.4
250	.49	89.4	93.3	96.1	97.0	98.0	98.9	99.8	100.7	99.6	98.6	97.8	97.0
300	.58	88.1	91.9	94.7	95.6	96.5	97.4	98.3	99.2	100.1	99.3	98.6	97.9
350	.68	86.1	89.9	92.6	93.5	94.4	95.3	96.1	97.0	97.9	98.7	98.6	97.9
12000 FT PRESS ALT		TAT (°C)											
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
200	.37	88.4	92.3	95.1	96.0	96.9	97.8	98.7	99.2	98.2	97.3	96.5	95.8
250	.47	88.2	92.0	94.8	95.7	96.6	97.5	98.4	99.3	99.6	98.6	97.8	97.0
300	.56	87.2	91.0	93.7	94.6	95.5	96.4	97.3	98.2	99.0	99.4	98.7	98.0
350	.65	85.4	89.1	91.8	92.7	93.6	94.5	95.3	96.2	97.0	97.9	98.6	97.9

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)					
	12	14	16	18	20	22
PACKS OFF	0.4	0.4	0.4	0.5	0.5	0.5
ENGINE ANTI-ICE ON	-0.5	-0.6	-0.6	-0.6	-0.6	-0.6
ENGINE & WING ANTI-ICE ON	-1	-1.2	-1.2	-1.2	-1.2	-1.2

ALTERNATE MODE EEC

Max Continuous %N1

No EPR available

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

10000 FT to 0 FT Pressure Altitudes

10000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.27	86.2	90.0	92.7	93.6	94.5	95.3	96.2	96.9	96.1	95.3	94.7	94.0
200	.36	87.4	91.2	94.0	94.9	95.8	96.7	97.6	98.4	98.4	97.5	96.7	96.0
250	.45	87.3	91.1	93.9	94.8	95.7	96.6	97.5	98.3	99.2	98.8	98.0	97.2
300	.54	86.2	90.0	92.7	93.6	94.5	95.4	96.2	97.1	97.9	98.8	98.6	97.9
350	.63	84.7	88.4	91.1	91.9	92.8	93.7	94.5	95.4	96.2	97.0	97.9	97.9
8000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.26	85.1	88.9	91.6	92.5	93.3	94.2	95.1	95.9	96.2	95.4	94.8	94.2
200	.35	85.9	89.7	92.4	93.3	94.2	95.0	95.9	96.8	97.6	97.1	96.4	95.7
250	.44	86.3	90.1	92.8	93.7	94.6	95.5	96.3	97.2	98.1	98.9	98.0	97.3
300	.52	85.3	89.0	91.7	92.6	93.5	94.3	95.2	96.0	96.9	97.7	98.4	97.7
6000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.25	84.2	87.9	90.5	91.4	92.3	93.1	94.0	94.8	95.6	95.5	94.9	94.3
200	.34	84.5	88.2	90.9	91.8	92.7	93.5	94.4	95.2	96.1	96.8	96.1	95.4
250	.42	85.3	89.1	91.8	92.6	93.5	94.4	95.3	96.1	96.9	97.8	98.1	97.3
300	.50	84.2	87.9	90.6	91.5	92.3	93.2	94.0	94.9	95.7	96.6	97.4	97.4
4000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.24	83.3	86.9	89.6	90.4	91.3	92.1	93.0	93.8	94.6	95.4	95.0	94.4
200	.33	83.3	87.0	89.6	90.5	91.3	92.2	93.0	93.9	94.7	95.5	95.8	95.1
250	.41	84.4	88.1	90.7	91.6	92.5	93.3	94.2	95.0	95.9	96.7	97.5	97.3
300	.49	83.3	87.0	89.6	90.5	91.3	92.2	93.0	93.9	94.7	95.5	96.3	97.1
2000 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.24	82.4	86.0	88.6	89.5	90.3	91.2	92.0	92.8	93.7	94.5	95.1	94.5
200	.31	82.2	85.9	88.5	89.3	90.2	91.0	91.8	92.6	93.5	94.3	95.1	94.9
250	.39	83.2	86.9	89.5	90.4	91.2	92.1	92.9	93.8	94.6	95.4	96.2	97.0
300	.47	82.5	86.1	88.7	89.6	90.4	91.3	92.1	92.9	93.7	94.5	95.3	96.1
0 FT PRESS ALT								TAT (°C)					
KIAS	M	-50	-30	-15	-10	-5	0	5	10	15	20	25	30
150	.23	81.6	85.1	87.7	88.6	89.4	90.2	91.1	91.9	92.7	93.5	94.3	94.6
200	.30	81.2	84.8	87.4	88.2	89.0	89.9	90.7	91.5	92.3	93.1	93.9	94.7
250	.38	82.0	85.6	88.2	89.1	89.9	90.8	91.6	92.4	93.2	94.0	94.8	95.6
300	.45	81.6	85.2	87.8	88.6	89.5	90.3	91.1	92.0	92.8	93.6	94.4	95.1

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)					
	0	2	4	6	8	10
PACKS OFF	0.3	0.3	0.3	0.3	0.3	0.3
ENGINE ANTI-ICE ON	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
ENGINE & WING ANTI-ICE ON	-1	-1	-1	-1	-1	-1

ALTERNATE MODE EEC

Go-around EPR

Based on engine bleed for 3 packs on

TAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.51
50	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
45	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
40	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.57	1.57	1.57
35	1.59	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.60	1.60	1.59	1.58
30	1.59	1.61	1.62	1.63	1.63	1.63	1.63	1.63	1.63	1.62	1.61	1.61	1.60
25	1.59	1.61	1.62	1.63	1.64	1.64	1.64	1.64	1.64	1.64	1.63	1.63	1.62
20	1.59	1.61	1.62	1.63	1.64	1.65	1.66	1.66	1.66	1.65	1.64	1.64	1.64
15	1.59	1.61	1.62	1.63	1.64	1.65	1.66	1.66	1.64	1.67	1.66	1.65	1.65
12	1.59	1.61	1.62	1.63	1.64	1.65	1.66	1.66	1.64	1.67	1.67	1.67	1.66
5 & BELOW	1.59	1.61	1.62	1.63	1.64	1.65	1.66	1.66	1.64	1.67	1.67	1.67	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	0.01	0.01

ALTERNATE MODE EEC

Go-around %N1

No EPR available

Based on engine bleed for packs on and anti-ice on or off

AIRPORT OAT		TAT	AIRPORT PRESSURE ALTITUDE (FT)								
°C	°F	(°C)	-2000	-1000	0	2000	4000	5700	6000	8000	10000
55	131	58.2	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3
50	122	53.1	100.8	100.8	100.8	100.8	100.8	100.8	100.8	100.8	100.8
45	113	48.1	102.4	102.4	102.4	102.4	102.4	102.4	102.4	102.4	102.4
40	104	43.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0
35	95	38.0	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5
30	86	32.9	105.1	105.9	106.6	106.6	106.6	106.6	106.6	106.6	106.6
25	77	27.9	104.2	104.9	105.7	107.0	107.0	107.0	107.0	107.0	107.0
20	68	22.8	103.2	104.0	104.7	106.2	106.7	106.7	106.7	106.7	106.7
15	59	17.8	102.3	103.0	103.8	105.3	106.5	106.5	106.5	106.5	106.5
10	50	12.7	101.4	102.1	102.8	104.3	105.6	106.2	106.2	106.2	106.2
5	41	7.7	100.5	101.2	101.9	103.3	104.6	105.2	105.2	105.2	105.2
0	32	2.6	99.5	100.2	101.0	102.4	103.6	104.3	104.3	104.3	104.3
-10	14	-7.5	97.6	98.3	99.0	100.3	101.5	102.2	102.2	102.2	102.2
-20	-4	-17.5	95.7	96.4	97.1	98.4	99.5	100.2	100.2	100.2	100.2
-30	-22	-27.6	93.9	94.6	95.2	96.5	97.6	98.3	98.3	98.3	98.3
-40	-40	-37.7	91.9	92.6	93.3	94.5	95.6	96.2	96.2	96.2	96.2
-50 & BELOW	-58 & BELOW	-47.8	90.1	90.7	91.3	92.6	93.6	94.2	94.2	94.2	94.2

%N1 Adjustments for Engine Bleed

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)								
	-2000	-1000	0	2000	4000	5700	6000	8000	10000
PACKS OFF	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

GEAR DOWN

Takeoff Climb Limit

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

Weight (1000 KG)

AIRPORT TEMP (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
	-2000	-1000	SL	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
55	299	283	271	260									
50	318	301	288	275	263	241							
45	336	319	304	291	278	265	253	240	229				
40	354	335	320	307	293	280	267	254	242	229	218		
35	371	353	338	323	309	294	281	268	255	243	230	217	201
30	389	370	354	340	325	310	296	282	269	256	243	230	216
25	393	380	372	357	342	327	312	297	284	270	256	243	229
20	393	380	372	363	355	343	328	313	298	284	270	257	242
15	393	380	372	363	355	346	337	328	314	299	285	270	256
10	393	380	372	363	355	346	337	328	320	301	299	284	270
5 & BELOW	392	380	372	363	354	346	337	328	319	300	301	292	284

Applicable for flaps 10 or 20 takeoff.

Adjustments for Engine Bleed

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (KG)	
	A/C PACKS OFF	A/C PACKS ON
A/I OFF	2250	0
NACELLE A/I ON	-5000	-7550
NACELLE & WING A/I ON	-12450	-14900

Boeing Converted Freighters are not certified for packs-off takeoff.

GEAR DOWN

Landing Climb Limit

Based on engine bleed for 3 packs on

Weight (1000 KG)

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)												
	-2000	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
55	340	328	317										
50	356	343	331	320	308								
45	372	359	346	334	322	310	299	288					
40	388	374	361	348	336	324	312	300	289	278			
35	405	391	377	363	350	337	325	314	302	289	277	265	254
30	406	399	392	378	364	351	338	326	313	299	285	272	259
25	406	399	392	385	374	361	348	335	322	306	292	278	266
20	406	399	392	385	377	367	355	342	329	314	299	285	272
15	406	399	392	385	377	367	358	349	335	321	306	292	278
10	406	399	392	385	377	367	358	349	338	326	314	298	284
5 & BELOW	406	399	392	385	377	367	358	349	338	326	314	302	291

Applicable for flaps 25 or 30 landing.
With engine bleed for 1 pack on, increase weight by 3950 kg.
With engine bleed for packs off, increase weight by 5850 kg.
Reduce landing climb limit weight by 38550 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	31	33	35
	240	240	240	240	240	240	240	240	240	240	240	.60	.60	.60	.60	.60
55	1.45															
50	1.47	1.49														
45	1.49	1.51	1.51													
40	1.52	1.53	1.53	1.52												
35	1.54	1.56	1.56	1.55	1.55	1.54										
30	1.55	1.59	1.59	1.58	1.57	1.57	1.56	1.55								
25	1.55	1.62	1.61	1.61	1.60	1.60	1.59	1.58	1.57	1.56						
20	1.55	1.62	1.64	1.63	1.63	1.63	1.62	1.61	1.60	1.59	1.58					
15	1.55	1.62	1.67	1.67	1.66	1.66	1.65	1.64	1.63	1.62	1.61	1.59				
10	1.55	1.62	1.67	1.68	1.69	1.69	1.68	1.67	1.66	1.65	1.64	1.62	1.61	1.60	1.59	
5	1.55	1.62	1.67	1.68	1.70	1.71	1.71	1.70	1.69	1.68	1.67	1.65	1.64	1.63	1.63	1.62
0	1.55	1.62	1.67	1.68	1.70	1.71	1.72	1.73	1.72	1.71	1.70	1.68	1.67	1.67	1.66	1.65
-5	1.55	1.62	1.67	1.68	1.70	1.71	1.72	1.73	1.74	1.74	1.73	1.72	1.70	1.70	1.69	1.68
-10	1.55	1.62	1.67	1.68	1.70	1.71	1.72	1.73	1.74	1.75	1.76	1.75	1.73	1.73	1.72	1.71
-15	1.55	1.62	1.67	1.68	1.70	1.71	1.72	1.73	1.74	1.75	1.76	1.76	1.76	1.76	1.75	1.74
-20	1.55	1.62	1.67	1.68	1.70	1.71	1.72	1.73	1.74	1.75	1.76	1.76	1.77	1.78	1.78	1.77

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)	
	0	35
ENGINE ANTI-ICE ON	-0.01	-0.01
ENGINE & WING ANTI-ICE ON	-0.02	-0.02

GEAR DOWN

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	19400	17600	15900
390	20200	18300	16600
380	20800	19100	17300
370	21400	20000	18000
360	22000	20600	18700
350	22600	21200	19500
340	23200	21700	20200
330	23900	22400	20900
320	24900	23300	21800
310	25700	24200	22700
300	26600	25200	23600
290	27500	26100	24600
280	28400	27000	25500
270	29300	27900	26500
260	30300	28900	27500
250	31400	29900	28500
240	32400	31200	29500
230	33400	32300	30900
220	34500	33500	32100
210	35500	34700	33400
200	36500	36100	34700

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	1.48	1.56	1.64							
	MACH	.488	.525	.556							
	KIAS	270	270	270							
	FF/ENG	4951	5003	5113							
380	EPR	1.46	1.54	1.61	1.68						
	MACH	.488	.525	.556	.589						
	KIAS	270	270	270	270						
	FF/ENG	4776	4807	4883	5023						
360	EPR	1.45	1.52	1.59	1.66						
	MACH	.488	.525	.556	.589						
	KIAS	270	270	270	270						
	FF/ENG	4621	4635	4682	4786						
340	EPR	1.43	1.50	1.57	1.63						
	MACH	.488	.525	.556	.589						
	KIAS	270	270	270	270						
	FF/ENG	4482	4484	4514	4591						
320	EPR	1.41	1.48	1.54	1.60	1.68					
	MACH	.479	.513	.542	.575	.610					
	KIAS	265	263	263	263	264					
	FF/ENG	4250	4210	4224	4279	4384					
300	EPR	1.39	1.45	1.50	1.57	1.64	1.69				
	MACH	.467	.498	.526	.558	.592	.617				
	KIAS	258	256	255	255	255	256				
	FF/ENG	3995	3929	3925	3953	4029	4111				
280	EPR	1.37	1.42	1.47	1.53	1.60	1.65	1.70			
	MACH	.455	.484	.510	.540	.573	.597	.623			
	KIAS	252	248	247	247	247	247	248			
	FF/ENG	3758	3662	3638	3648	3694	3750	3836			
260	EPR	1.34	1.39	1.44	1.50	1.56	1.61	1.66	1.71		
	MACH	.444	.469	.493	.522	.554	.577	.601	.627		
	KIAS	245	241	239	238	238	238	238	239		
	FF/ENG	3537	3409	3365	3356	3377	3415	3467	3559		
240	EPR	1.32	1.37	1.41	1.46	1.52	1.56	1.61	1.67	1.72	
	MACH	.433	.456	.477	.503	.533	.555	.579	.604	.631	
	KIAS	239	233	231	229	229	229	229	229	230	
	FF/ENG	3329	3172	3105	3076	3078	3096	3132	3184	3278	
220	EPR	1.30	1.34	1.38	1.42	1.48	1.52	1.57	1.62	1.67	1.72
	MACH	.423	.442	.461	.484	.512	.533	.556	.580	.605	.632
	KIAS	234	226	223	221	220	220	220	220	220	220
	FF/ENG	3135	2954	2863	2812	2795	2799	2815	2849	2904	2992
200	EPR	1.29	1.32	1.35	1.39	1.44	1.48	1.52	1.56	1.61	1.67
	MACH	.413	.430	.446	.466	.491	.510	.531	.554	.578	.604
	KIAS	228	220	215	212	210	210	210	210	210	210
	FF/ENG	2956	2752	2641	2567	2527	2518	2520	2536	2569	2623

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
289	266	246	229	213	200	190	182	174	167	161
599	547	500	462	429	400	381	363	347	332	319
907	826	754	695	645	600	571	544	520	497	477
1216	1105	1008	928	860	800	761	725	692	663	636
1526	1386	1263	1161	1076	1000	951	906	865	828	794
1838	1667	1518	1395	1292	1200	1141	1087	1037	992	952
2152	1950	1774	1629	1508	1400	1331	1267	1209	1156	1109
2468	2235	2031	1864	1724	1600	1520	1447	1380	1319	1265
2786	2521	2289	2100	1941	1800	1710	1627	1551	1482	1421
3106	2808	2548	2336	2157	2000	1899	1806	1722	1645	1576
3428	3097	2808	2572	2374	2200	2088	1986	1892	1807	1731
3752	3387	3068	2809	2592	2400	2277	2165	2062	1969	1886
4078	3677	3329	3046	2809	2600	2466	2343	2231	2130	2040
4405	3969	3591	3283	3026	2800	2655	2522	2401	2291	2193
4734	4262	3853	3521	3244	3000	2844	2700	2569	2451	2346
5065	4557	4116	3759	3462	3200	3032	2877	2737	2611	2498
5396	4852	4380	3998	3680	3400	3220	3055	2905	2770	2650
5730	5148	4644	4236	3898	3600	3408	3232	3072	2929	2802
6065	5445	4909	4476	4116	3800	3596	3409	3239	3087	2952
6401	5743	5174	4715	4334	4000	3784	3586	3406	3245	3102

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	0:41	9.3	0:39	8.6	0:38	7.9	0:36	7.6	0:35
400	20.3	1:23	18.7	1:20	17.4	1:16	16.3	1:12	15.7	1:09
600	30.3	2:05	28.1	2:00	26.2	1:54	24.7	1:47	23.9	1:43
800	40.4	2:48	37.4	2:40	35.0	2:32	33.0	2:23	32.0	2:17
1000	50.4	3:30	46.8	3:21	43.8	3:10	41.4	2:59	40.1	2:51
1200	60.0	4:14	55.7	4:03	52.2	3:50	49.3	3:36	47.8	3:26
1400	69.7	4:57	64.6	4:44	60.5	4:29	57.3	4:13	55.5	4:01
1600	79.1	5:41	73.3	5:27	68.7	5:10	65.0	4:51	63.0	4:37
1800	88.3	6:26	81.9	6:10	76.7	5:51	72.5	5:29	70.2	5:14
2000	97.5	7:11	90.4	6:53	84.7	6:32	80.1	6:08	77.5	5:50
2200	106.4	7:57	98.5	7:38	92.2	7:14	87.2	6:48	84.4	6:28
2400	115.3	8:43	106.7	8:22	99.8	7:56	94.4	7:28	91.2	7:06
2600	124.1	9:29	114.7	9:07	107.3	8:39	101.4	8:08	97.9	7:45
2800	132.7	10:16	122.5	9:53	114.5	9:23	108.2	8:50	104.5	8:24
3000	141.3	11:03	130.3	10:39	121.8	10:07	115.0	9:31	111.0	9:03
3200	149.5	11:51	137.9	11:25	128.7	10:52	121.5	10:14	117.2	9:44
3400	157.8	12:39	145.5	12:12	135.7	11:37	127.9	10:57	123.4	10:25
3600	165.9	13:27	153.0	13:00	142.5	12:23	134.3	11:40	129.5	11:06
3800	173.8	14:16	160.3	13:47	149.1	13:10	140.5	12:25	135.4	11:49
4000	181.8	15:04	167.6	14:35	155.8	13:56	146.7	13:09	141.3	12:31

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	-2.8	-1.7	0.0	2.9	6.2
30	-4.4	-2.4	0.0	4.6	9.5
40	-5.9	-3.2	0.0	6.3	12.7
50	-7.4	-3.9	0.0	7.9	15.9
60	-8.9	-4.7	0.0	9.4	19.1
70	-10.3	-5.4	0.0	10.9	22.1
80	-11.7	-6.1	0.0	12.4	25.1
90	-13.1	-6.8	0.0	13.8	28.0
100	-14.5	-7.6	0.0	15.1	30.8
110	-15.9	-8.3	0.0	16.4	33.6
120	-17.2	-8.9	0.0	17.7	36.3
130	-18.5	-9.6	0.0	18.9	38.9
140	-19.8	-10.3	0.0	20.1	41.4
150	-21.1	-11.0	0.0	21.2	43.9
160	-22.3	-11.6	0.0	22.3	46.3

Descent at .66/240

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33	35
DISTANCE (NM)	18	28	37	41	45	49	53	57	61	65	70	73	76
TIME (MINUTES)	5	8	10	10	11	12	13	13	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	1.35	1.40	1.48	1.59			
	KIAS	270	270	270	270			
	FF/ENG	5240	5190	5200	5280			
380	EPR	1.34	1.38	1.46	1.56	1.68		
	KIAS	270	270	270	270	270		
	FF/ENG	5090	5030	5020	5070	5270		
360	EPR	1.33	1.37	1.45	1.54	1.66		
	KIAS	270	270	270	270	270		
	FF/ENG	4950	4880	4850	4880	5030		
340	EPR	1.31	1.35	1.42	1.51	1.63		
	KIAS	261	261	261	261	270		
	FF/ENG	4640	4570	4520	4530	4820		
320	EPR	1.29	1.33	1.39	1.48	1.61		
	KIAS	251	251	251	251	270		
	FF/ENG	4380	4270	4200	4190	4650		
300	EPR	1.27	1.30	1.37	1.45	1.58		
	KIAS	242	242	242	242	264		
	FF/ENG	4090	3980	3910	3880	4360		
280	EPR	1.25	1.28	1.34	1.42	1.55	1.67	
	KIAS	233	233	233	233	255	257	
	FF/ENG	3800	3740	3620	3580	4010	4170	
260	EPR	1.23	1.26	1.32	1.39	1.51	1.63	
	KIAS	228	228	228	228	246	248	
	FF/ENG	3580	3530	3410	3350	3670	3790	
240	EPR	1.22	1.25	1.30	1.36	1.47	1.58	1.71
	KIAS	221	221	221	221	236	237	239
	FF/ENG	3350	3290	3180	3110	3350	3410	3610
220	EPR	1.20	1.23	1.28	1.34	1.43	1.53	1.66
	KIAS	215	215	215	215	225	226	229
	FF/ENG	3130	3070	3000	2900	3040	3060	3200
200	EPR	1.19	1.21	1.26	1.31	1.39	1.49	1.61
	KIAS	208	208	208	208	215	216	218
	FF/ENG	2910	2850	2770	2680	2740	2750	2820

This table includes 5% additional fuel for holding in a racetrack pattern.

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	387	266	9400	7800	6100
390	378	264	10400	8800	7100
380	369	261	11300	9700	8000
370	358	259	12500	10800	9100
360	350	256	13400	11800	10100
350	341	254	14200	12800	11000
340	330	251	15200	13900	12200
330	321	248	15900	14700	13200
320	312	246	16700	15500	14100
310	301	243	17700	16400	15100
300	292	240	18600	17200	15900
290	282	237	19500	18200	16800
280	273	234	20300	19000	17700
270	262	231	21300	20000	18700
260	253	228	22100	20900	19600
250	243	225	23200	21900	20600
240	233	220	24300	23000	21700
230	223	215	25700	24300	22900
220	214	210	27000	25800	24300
210	204	204	28400	27300	26000
200	195	200	29700	28700	27700

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	7900	6000	4000
390	8600	6800	4700
380	9400	7500	5500
370	10100	8200	6200
360	10800	8900	6900
350	11900	10000	8000
340	13100	11300	9300
330	14200	12600	10600
320	15200	13900	11900
310	16200	14800	13200
300	17200	15800	14500
290	18200	16800	15400
280	19300	17800	16500
270	20200	18900	17500
260	21200	19900	18600
250	22300	21000	19700
240	23300	22100	20800
230	24500	23200	21900
220	25800	24400	23100
210	27100	25900	24400
200	28400	27300	26000

Altitude reduced by 1000 ft for additional margin.
With engine bleed for 1 pack on, increase altitude capability by 300 ft.
With engine bleed for 2 packs on, increase altitude capability by 100 ft.
With engine anti-ice on, decrease altitude capability by 900 ft.
With engine and wing anti-ice on, decrease altitude capability by 1700 ft.

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
380	EPR	1.64							
	MACH	.488							
	KIAS	270							
	FF/ENG	6622							
360	EPR	1.61							
	MACH	.488							
	KIAS	270							
	FF/ENG	6356							
340	EPR	1.58	1.68						
	MACH	.476	.514						
	KIAS	264	264						
	FF/ENG	5941	6147						
320	EPR	1.55	1.64						
	MACH	.465	.498						
	KIAS	257	256						
	FF/ENG	5552	5650						
300	EPR	1.52	1.60	1.68					
	MACH	.453	.483	.513					
	KIAS	250	248	248					
	FF/ENG	5194	5194	5358					
280	EPR	1.49	1.56	1.63	1.72				
	MACH	.442	.469	.495	.528				
	KIAS	244	240	240	241				
	FF/ENG	4864	4796	4867	5090				
260	EPR	1.46	1.53	1.59	1.67				
	MACH	.433	.456	.479	.508				
	KIAS	239	233	231	232				
	FF/ENG	4559	4436	4433	4545				
240	EPR	1.43	1.49	1.55	1.62	1.70			
	MACH	.424	.443	.463	.488	.521			
	KIAS	234	227	224	222	223			
	FF/ENG	4280	4107	4054	4086	4235			
220	EPR	1.41	1.46	1.51	1.57	1.64	1.70		
	MACH	.416	.431	.448	.470	.498	.520		
	KIAS	229	221	216	214	213	214		
	FF/ENG	4031	3806	3714	3685	3751	3850		
200	EPR	1.39	1.43	1.47	1.52	1.59	1.64	1.70	1.76
	MACH	.409	.421	.435	.453	.476	.496	.518	.544
	KIAS	226	215	210	206	204	204	204	206
	FF/ENG	3814	3538	3407	3334	3323	3373	3462	3624

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
302	275	251	231	215	200	191	182	174	167	160
610	554	505	464	430	400	381	363	347	333	320
921	835	759	698	646	600	572	545	521	499	479
1233	1117	1015	932	862	800	762	727	694	665	638
1548	1400	1271	1166	1078	1000	952	907	866	829	796
1864	1684	1528	1401	1294	1200	1141	1087	1038	993	953
2182	1971	1787	1637	1511	1400	1331	1268	1210	1157	1110
2502	2258	2045	1872	1728	1600	1520	1447	1380	1320	1266
2823	2546	2305	2109	1944	1800	1710	1627	1551	1482	1421
3146	2835	2565	2345	2161	2000	1899	1806	1722	1645	1576

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		25		29	
	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	9.7	0:43	8.9	0:42	8.4	0:40	8.1	0:38	7.7	0:36
400	20.3	1:26	18.9	1:22	18.1	1:18	17.8	1:13	17.3	1:09
600	30.6	2:09	28.6	2:03	27.5	1:56	27.2	1:49	26.6	1:43
800	40.6	2:52	38.1	2:45	36.6	2:36	36.2	2:25	35.7	2:17
1000	50.5	3:36	47.4	3:27	45.5	3:15	45.0	3:02	44.4	2:52
1200	60.2	4:20	56.5	4:09	54.2	3:56	53.5	3:40	52.9	3:27
1400	69.7	5:05	65.5	4:53	62.6	4:37	61.7	4:18	61.2	4:04
1600	79.1	5:50	74.2	5:36	70.9	5:19	69.6	4:58	69.1	4:41
1800	88.2	6:35	82.7	6:20	78.9	6:01	77.4	5:37	76.8	5:18
2000	97.2	7:21	91.1	7:05	86.8	6:44	84.9	6:18	84.2	5:57

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-1.6	-0.9	0.0	1.1	2.7
20	-3.3	-1.8	0.0	2.6	5.5
30	-5.0	-2.7	0.0	4.1	8.3
40	-6.6	-3.6	0.0	5.6	11.2
50	-8.2	-4.5	0.0	7.2	14.2
60	-9.7	-5.3	0.0	8.8	17.3
70	-11.2	-6.1	0.0	10.5	20.4
80	-12.6	-6.9	0.0	12.1	23.6
90	-13.9	-7.6	0.0	13.8	26.9

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	1.48	1.54				
	KIAS	270	270				
	FF/ENG	6990	7030				
380	EPR	1.46	1.52	1.64			
	KIAS	270	270	270			
	FF/ENG	6760	6790	6950			
360	EPR	1.44	1.51	1.61			
	KIAS	270	270	270			
	FF/ENG	6550	6560	6670			
340	EPR	1.42	1.48	1.58			
	KIAS	261	261	261			
	FF/ENG	6110	6100	6160			
320	EPR	1.39	1.44	1.54	1.66		
	KIAS	251	251	251	251		
	FF/ENG	5680	5660	5680	5860		
300	EPR	1.36	1.42	1.50	1.61		
	KIAS	242	242	242	242		
	FF/ENG	5280	5240	5250	5340		
280	EPR	1.34	1.38	1.47	1.57		
	KIAS	233	233	233	233		
	FF/ENG	4890	4840	4820	4870		
260	EPR	1.32	1.36	1.44	1.54	1.70	
	KIAS	228	228	228	228	246	
	FF/ENG	4610	4560	4520	4530	5220	
240	EPR	1.29	1.34	1.41	1.50	1.65	
	KIAS	221	221	221	221	236	
	FF/ENG	4290	4240	4180	4180	4670	
220	EPR	1.27	1.31	1.38	1.46	1.60	1.73
	KIAS	215	215	215	215	225	226
	FF/ENG	4050	3950	3890	3860	4160	4420
200	EPR	1.25	1.29	1.35	1.43	1.54	1.67
	KIAS	208	208	208	208	215	216
	FF/ENG	3750	3690	3580	3530	3700	3850

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

SPARE ENGINE CARRIAGE

VREF (KIAS)

WEIGHT (1000 KG)	FLAPS	
	30	25
400	188	195
380	182	191
360	177	185
340	172	179
320	166	173
300	161	167
280	155	162
260	149	155
240	143	149
220	136	142
200	130	135

Increase VREF 1 knot for every 2000 ft above sea level.

SPARE ENGINE CARRIAGE

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	31	33	35
	305	305	305	305	305	305	305	305	305	305	305	305	0.78	0.78	0.78	0.78
55	1.46	1.46														
50	1.48	1.48	1.48	1.47												
45	1.51	1.50	1.50	1.50	1.50	1.50										
40	1.53	1.53	1.53	1.52	1.52	1.52	1.52	1.51								
35	1.54	1.56	1.55	1.55	1.55	1.55	1.55	1.54	1.54	1.54						
30	1.54	1.58	1.58	1.58	1.58	1.58	1.57	1.57	1.57	1.57	1.56	1.55				
25	1.54	1.59	1.61	1.61	1.61	1.60	1.60	1.60	1.59	1.59	1.59	1.58	1.57	1.57		
20	1.54	1.59	1.63	1.64	1.64	1.63	1.63	1.63	1.62	1.62	1.62	1.61	1.60	1.60	1.58	
15	1.54	1.59	1.63	1.64	1.66	1.66	1.66	1.66	1.65	1.65	1.65	1.64	1.63	1.63	1.61	1.59
10	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.69	1.68	1.68	1.68	1.67	1.66	1.66	1.64	1.62
5	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.71	1.71	1.70	1.69	1.69	1.67	1.65
0	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.73	1.73	1.72	1.72	1.70	1.68
-5	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.73	1.74	1.75	1.75	1.73	1.71
-10	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.73	1.74	1.75	1.76	1.76	1.74
-15	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.73	1.74	1.75	1.76	1.77	1.77
-20	1.54	1.59	1.63	1.64	1.66	1.67	1.69	1.70	1.71	1.73	1.73	1.74	1.75	1.76	1.77	1.78

EPR Adjustments for Engine Bleed

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	0	10	20	30	40
ENGINE ANTI-ICE ON	-0.01	-0.01	-0.01	-0.01	-0.01
ENGINE & WING ANTI-ICE ON	-0.02	-0.02	-0.02	-0.02	-0.02

Long Range Cruise Maximum Operating Altitude

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	BUFFET LIMIT PRESSURE ALTITUDE* (FT)	MAXIMUM CLIMB THRUST LIMITED PRESSURE ALTITUDE** (FT)		
				ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
400	26800	-9	27000	29800	28400	27000
380	27900	-12	28000	31200	30000	28600
360	29100	-15	29000	32500	31400	30200
340	30400	-17	31000	33900	32900	31700
320	31700	-20	32000	35400	34400	33200
300	33100	-24	33000	36700	36200	34800
280	34600	-27	35000	38000	37400	36600
260	36100	-30	36000	39400	38800	37900
240	37800	-30	38000	40900	40200	39300
220	39600	-30	40000	42600	41800	40900
200	41600	-30	42000	44300	43500	42600

***Based on 1.3g/39° bank maneuver capability**
****100 ft/min residual rate of climb**

SPARE ENGINE CARRIAGE

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)										
		25	27	29	31	33	35	37	39	41	43	45
400	EPR	1.52	1.56	1.62	1.71							
	MACH	.780	.780	.780	.780							
	KIAS	329	315	302	289							
	FF/ENG	3591	3530	3566	3766							
380	EPR	1.49	1.53	1.59	1.66							
	MACH	.777	.780	.780	.780							
	KIAS	327	315	302	289							
	FF/ENG	3428	3357	3332	3422							
360	EPR	1.47	1.51	1.55	1.61	1.69						
	MACH	.768	.780	.780	.780	.780						
	KIAS	323	315	302	289	277						
	FF/ENG	3235	3208	3142	3159	3313						
340	EPR	1.44	1.48	1.52	1.57	1.64						
	MACH	.757	.773	.780	.780	.780						
	KIAS	318	312	302	289	277						
	FF/ENG	3054	3033	2985	2947	3006						
320	EPR	1.42	1.45	1.50	1.54	1.59	1.67					
	MACH	.746	.762	.778	.780	.780	.780					
	KIAS	313	307	301	289	277	264					
	FF/ENG	2878	2850	2837	2777	2769	2866					
300	EPR	1.40	1.43	1.47	1.51	1.55	1.62	1.70				
	MACH	.733	.751	.767	.780	.780	.780	.780				
	KIAS	307	302	296	289	277	264	252				
	FF/ENG	2707	2677	2653	2636	2582	2601	2756				
280	EPR	1.38	1.40	1.44	1.48	1.52	1.57	1.64				
	MACH	.718	.737	.754	.771	.780	.780	.780				
	KIAS	301	296	291	285	277	264	252				
	FF/ENG	2538	2507	2481	2465	2436	2397	2456				
260	EPR	1.35	1.38	1.41	1.45	1.49	1.53	1.59	1.66			
	MACH	.701	.721	.740	.757	.774	.780	.780	.780			
	KIAS	293	290	285	280	274	264	252	241			
	FF/ENG	2368	2339	2311	2291	2281	2241	2234	2324			
240	EPR	1.33	1.36	1.39	1.42	1.45	1.50	1.54	1.60	1.68		
	MACH	.682	.703	.723	.742	.760	.777	.780	.780	.780		
	KIAS	284	282	278	274	269	263	252	241	230		
	FF/ENG	2202	2171	2144	2122	2106	2098	2066	2086	2182		
220	EPR	1.31	1.33	1.36	1.39	1.42	1.46	1.50	1.55	1.61	1.69	
	MACH	.660	.682	.704	.724	.743	.761	.778	.780	.780	.780	
	KIAS	275	273	270	267	262	257	252	241	230	220	
	FF/ENG	2031	2005	1977	1955	1938	1922	1925	1908	1928	2025	
200	EPR	1.28	1.31	1.33	1.36	1.39	1.42	1.46	1.51	1.55	1.61	1.69
	MACH	.635	.658	.681	.703	.724	.743	.761	.778	.780	.780	.780
	KIAS	263	262	261	258	255	251	246	240	230	220	210
	FF/ENG	1854	1835	1812	1789	1771	1755	1750	1765	1748	1764	1851

SPARE ENGINE CARRIAGE

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
690	642	599	562	529	500	479	460	442	426	411
1384	1287	1201	1126	1060	1000	960	922	887	854	824
2086	1938	1806	1691	1591	1500	1439	1383	1330	1282	1237
2794	2593	2413	2258	2122	2000	1919	1844	1774	1709	1649
3509	3252	3023	2827	2655	2500	2399	2304	2216	2135	2060
4232	3918	3638	3398	3189	3000	2878	2764	2658	2560	2471
4963	4589	4256	3972	3723	3500	3357	3223	3099	2985	2881
5703	5267	4878	4547	4259	4000	3836	3682	3540	3409	3289
6453	5951	5504	5125	4795	4500	4314	4141	3980	3833	3698
7217	6645	6137	5706	5334	5000	4793	4600	4421	4256	4105

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	15.2	1:26	13.8	1:22	12.5	1:18	11.5	1:16	10.8	1:14
1000	30.6	2:50	28.2	2:42	25.8	2:34	23.9	2:27	22.7	2:23
1500	45.7	4:16	42.2	4:03	38.8	3:50	36.0	3:40	34.3	3:33
2000	60.4	5:44	55.9	5:26	51.4	5:08	47.9	4:53	45.5	4:44
2500	74.7	7:15	69.2	6:51	63.8	6:28	59.4	6:08	56.5	5:56
3000	88.8	8:48	82.2	8:19	75.9	7:50	70.6	7:25	67.2	7:10
3500	102.5	10:23	94.8	9:48	87.7	9:14	81.6	8:43	77.7	8:24
4000	115.9	12:01	107.2	11:20	99.2	10:39	92.3	10:03	87.9	9:40
4500	129.0	13:41	119.3	12:54	110.4	12:07	102.8	11:24	97.8	10:57
5000	141.8	15:26	131.1	14:31	121.3	13:37	113.1	12:48	107.5	12:16

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-0.9	-0.8	0.0	2.6	7.7
20	-2.6	-1.5	0.0	5.1	13.6
30	-4.3	-2.2	0.0	7.4	19.0
40	-5.9	-2.9	0.0	9.6	23.9
50	-7.5	-3.6	0.0	11.5	28.3
60	-9.0	-4.3	0.0	13.3	32.2
70	-10.5	-5.0	0.0	15.0	35.7
80	-11.9	-5.8	0.0	16.4	38.6
90	-13.2	-6.6	0.0	17.7	41.1
100	-14.5	-7.3	0.0	18.8	43.1
110	-15.7	-8.1	0.0	19.7	44.7
120	-16.8	-8.9	0.0	20.5	45.7
130	-17.9	-9.7	0.0	21.1	46.3
140	-18.9	-10.5	0.0	21.5	46.3

SPARE ENGINE CARRIAGE

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
1310	1231	1160	1101	1049	1000	965	929	891	852	811
1959	1845	1742	1653	1574	1500	1443	1387	1333	1280	1229
2612	2462	2326	2206	2099	2000	1921	1846	1775	1708	1645
3269	3082	2911	2760	2625	2500	2399	2305	2217	2135	2059
3930	3704	3498	3315	3151	3000	2878	2764	2658	2560	2471
4595	4328	4085	3870	3677	3500	3357	3223	3099	2985	2881
5264	4956	4675	4427	4204	4000	3836	3682	3540	3409	3289
5937	5586	5267	4984	4732	4500	4314	4141	3980	3833	3698
6614	6220	5861	5544	5260	5000	4793	4600	4421	4256	4105
7297	6857	6457	6104	5789	5500	5271	5058	4860	4678	4512
7986	7498	7055	6666	6318	6000	5749	5515	5299	5100	4918
8680	8144	7657	7230	6848	6500	6227	5973	5738	5521	5324
9381	8794	8262	7795	7379	7000	6705	6430	6175	5941	5728
10088	9448	8869	8362	7911	7500	7182	6887	6613	6361	6132
10802	10108	9481	8932	8444	8000	7659	7343	7049	6780	6534

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)							
	25		29		33		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
1000	25.4	2:12	24.2	2:11	23.7	2:10	25.1	2:05
1500	35.9	3:26	34.0	3:22	33.1	3:18	34.2	3:12
2000	46.3	4:41	43.8	4:33	42.5	4:27	43.4	4:18
2500	56.8	5:55	53.7	5:44	51.9	5:35	52.5	5:24
3000	67.2	7:10	63.5	6:54	61.3	6:43	61.6	6:30
3500	77.7	8:24	73.3	8:05	70.7	7:51	70.8	7:37
4000	87.9	9:40	82.9	9:17	79.9	9:00	79.6	8:43
4500	97.8	10:57	92.3	10:30	88.8	10:10	88.2	9:51
5000	107.5	12:16	101.4	11:44	97.4	11:21	96.5	10:59
5500	117.0	13:37	110.3	12:59	105.8	12:32	104.5	12:08
6000	126.2	14:59	118.9	14:15	114.0	13:44	112.4	13:17
6500	135.3	16:24	127.4	15:33	122.0	14:58	120.0	14:27
7000	144.1	17:50	135.6	16:53	129.8	16:12	127.4	15:38
7500	152.7	19:19	143.6	18:14	137.4	17:28	134.6	16:50
8000	161.1	20:50	151.5	19:37	144.8	18:45	141.6	18:02

SPARE ENGINE CARRIAGE

Long Range Cruise Enroute Fuel and Time - High Altitudes

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
60	-11.9	-6.0	0.0	13.4	32.2
70	-13.9	-7.0	0.0	14.9	35.4
80	-15.9	-8.0	0.0	16.3	38.3
90	-17.9	-9.0	0.0	17.7	41.1
100	-19.8	-10.0	0.0	18.9	43.6
110	-21.7	-11.0	0.0	20.1	46.0
120	-23.6	-12.0	0.0	21.3	48.2
130	-25.4	-13.0	0.0	22.4	50.2
140	-27.3	-13.9	0.0	23.4	52.1
150	-29.1	-14.9	0.0	24.3	53.7
160	-30.9	-15.8	0.0	25.2	55.1
170	-32.6	-16.8	0.0	26.0	56.4

Descent at .78/305/250

PRESSURE ALT (1000 FT)	15	17	19	21	23	25	27	29	31	33	35	37	39	41
DISTANCE (NM)	57	63	69	75	82	88	94	100	105	110	115	120	126	131
TIME (MINUTES)	13	14	15	16	17	18	19	19	20	21	21	22	23	24

SPARE ENGINE CARRIAGE

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	40000
400	EPR	1.20	1.23	1.28	1.34	1.41	1.51			
	KIAS	290	290	290	290	320	324			
	FF/ENG	3520	3450	3370	3360	3550	3710			
380	EPR	1.19	1.22	1.27	1.33	1.39	1.48	1.63		
	KIAS	284	284	284	284	312	316	322		
	FF/ENG	3350	3280	3230	3170	3330	3450	3900		
360	EPR	1.18	1.21	1.25	1.31	1.37	1.46	1.59		
	KIAS	274	274	274	274	303	307	312		
	FF/ENG	3170	3100	3040	2980	3130	3210	3510		
340	EPR	1.18	1.20	1.24	1.30	1.35	1.43	1.55		
	KIAS	264	264	264	264	294	298	302		
	FF/ENG	3000	2930	2860	2800	2930	2990	3180		
320	EPR	1.17	1.19	1.23	1.28	1.33	1.41	1.51		
	KIAS	254	254	254	254	285	288	292		
	FF/ENG	2830	2770	2700	2630	2750	2770	2900		
300	EPR	1.16	1.18	1.21	1.26	1.32	1.38	1.48	1.63	
	KIAS	245	245	245	245	275	278	282	286	
	FF/ENG	2670	2610	2540	2480	2560	2570	2650	2990	
280	EPR	1.15	1.17	1.20	1.24	1.30	1.36	1.45	1.58	
	KIAS	236	236	236	236	266	268	272	276	
	FF/ENG	2510	2450	2390	2310	2390	2380	2430	2650	
260	EPR	1.14	1.16	1.19	1.23	1.28	1.34	1.42	1.53	1.69
	KIAS	230	230	230	230	256	258	261	265	252
	FF/ENG	2350	2290	2240	2160	2210	2190	2220	2350	2630
240	EPR	1.13	1.14	1.17	1.21	1.26	1.32	1.39	1.49	1.64
	KIAS	224	224	224	224	245	247	250	253	249
	FF/ENG	2210	2140	2090	2010	2050	2010	2020	2110	2340
220	EPR	1.12	1.13	1.16	1.19	1.24	1.29	1.36	1.45	1.58
	KIAS	217	217	217	217	234	236	239	242	245
	FF/ENG	2060	2000	1950	1870	1870	1840	1840	1890	2100
200	EPR	1.11	1.12	1.15	1.18	1.22	1.27	1.33	1.41	1.52
	KIAS	210	210	210	210	224	225	227	229	233
	FF/ENG	2130	1850	1810	1720	1710	1680	1660	1680	1820

This table includes 5% additional fuel for holding in a racetrack pattern.

SPARE ENGINE CARRIAGE

Holding
Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
400	EPR	1.26	1.30	1.36	1.44	1.54
	KIAS	248	250	252	254	254
	FF/ENG	4020	3930	3870	3870	3920
380	EPR	1.24	1.28	1.34	1.41	1.51
	KIAS	243	244	247	249	249
	FF/ENG	3820	3770	3670	3650	3690
360	EPR	1.23	1.26	1.32	1.39	1.48
	KIAS	238	239	241	243	243
	FF/ENG	3620	3580	3480	3440	3460
340	EPR	1.22	1.25	1.30	1.37	1.46
	KIAS	232	233	235	237	237
	FF/ENG	3430	3380	3280	3240	3250
320	EPR	1.20	1.23	1.28	1.35	1.43
	KIAS	226	227	229	231	231
	FF/ENG	3230	3180	3130	3040	3040
300	EPR	1.19	1.22	1.27	1.33	1.40
	KIAS	221	222	223	225	225
	FF/ENG	3040	2990	2940	2850	2830
280	EPR	1.18	1.20	1.25	1.30	1.37
	KIAS	215	216	218	219	219
	FF/ENG	2860	2800	2740	2670	2630
260	EPR	1.17	1.19	1.23	1.28	1.35
	KIAS	209	210	211	213	213
	FF/ENG	2680	2620	2560	2510	2440
240	EPR	1.16	1.18	1.21	1.26	1.32
	KIAS	203	203	205	206	206
	FF/ENG	2500	2440	2380	2330	2250
220	EPR	1.14	1.16	1.19	1.24	1.29
	KIAS	196	197	198	199	199
	FF/ENG	2330	2270	2210	2140	2080
200	EPR	1.13	1.15	1.18	1.22	1.27
	KIAS	189	190	191	192	192
	FF/ENG	2150	2100	2040	1970	1920

This table includes 5% additional fuel for holding in a racetrack pattern.
Do not hold at Flaps 1 in icing conditions.

SPARE ENGINE CARRIAGE

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	392	323	23800	22600	21200
390	383	319	24500	23400	22100
380	372	315	25300	24200	23000
370	363	311	26000	25000	23900
360	354	308	26700	25700	24600
350	345	304	27500	26500	25400
340	334	300	28400	27300	26200
330	325	295	29100	28100	27000
320	316	291	29900	28900	27800
310	305	287	30700	29900	28800
300	296	283	31400	30600	29600
280	276	273	33000	32300	31400
270	267	269	33700	33100	32200
260	256	264	34800	34100	33200
250	247	259	35500	35100	34100
240	236	254	36400	35900	35300
230	226	249	37100	36700	36000
220	218	243	37900	37400	36800
210	206	238	38800	38300	37600
200	197	232	39700	39200	38500

Altitude reduced by 1000 ft for additional margin.

SPARE ENGINE CARRIAGE

1 ENGINE 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
640	606	576	548	523	500	479	460	442	425	410
1283	1214	1152	1097	1046	1000	958	919	883	850	819
1927	1823	1730	1646	1570	1500	1436	1378	1324	1274	1228
2574	2434	2309	2196	2093	2000	1915	1836	1764	1697	1635
3222	3046	2888	2746	2617	2500	2393	2294	2204	2120	2042
3872	3659	3469	3297	3142	3000	2871	2752	2643	2542	2449
4525	4274	4050	3849	3666	3500	3348	3209	3081	2963	2854
5180	4891	4633	4401	4191	4000	3826	3666	3519	3384	3258
5837	5510	5217	4954	4716	4500	4303	4122	3956	3803	3661
6498	6130	5802	5508	5242	5000	4780	4578	4393	4222	4063

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	
500	8.6	9.4	10.2	11.0	11.8	12.6	13.4	14.1	14.9	15.6	16.4	1:06
1000	16.7	18.3	19.8	21.3	22.9	24.4	25.9	27.4	29.0	30.5	32.1	2:12
1500	24.5	26.7	29.0	31.2	33.5	35.8	38.0	40.2	42.5	44.8	47.1	3:20
2000	31.9	34.9	37.8	40.7	43.7	46.6	49.6	52.5	55.5	58.5	61.6	4:27
2500	39.1	42.7	46.2	49.9	53.5	57.1	60.7	64.3	68.1	71.8	75.6	5:36
3000	46.0	50.2	54.4	58.7	63.0	67.2	71.5	75.8	80.2	84.6	89.2	6:45
3500	52.7	57.5	62.3	67.2	72.1	77.0	81.9	86.9	92.0	97.0	102.3	7:56
4000	59.2	64.6	69.9	75.4	80.9	86.5	92.0	97.6	103.3	109.0	115.0	9:07
4500	65.4	71.4	77.3	83.3	89.5	95.6	101.8	108.0	114.4	120.7	127.3	10:19
5000	71.5	78.0	84.4	91.1	97.8	104.5	111.3	118.1	125.1	132.1	139.3	11:31

Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

SPARE ENGINE CARRIAGE

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	23100	21200	19500
390	24100	22200	20100
380	24900	23300	21100
370	25600	24200	22300
360	26500	25100	23400
350	27300	25900	24400
340	28100	26800	25200
330	28900	27700	26100
320	29800	28500	27000
310	30600	29500	28000
300	31300	30400	28900
290	32100	31200	30000
280	32900	32000	30800
270	33700	32900	31700
260	34600	33800	32700
250	35400	35000	33600
240	36200	35800	34900
230	37000	36500	35700
220	37800	37300	36500
210	38700	38200	37300
200	39600	39000	38200

Altitude reduced by 1000 ft for additional margin.

SPARE ENGINE CARRIAGE

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	1.40	1.47	1.59							
	MACH	.594	.638	.713							
	KIAS	330	330	330							
	FF/ENG	4676	4700	4847							
380	EPR	1.39	1.45	1.57	1.69						
	MACH	.594	.638	.713	.755						
	KIAS	330	330	330	317						
	FF/ENG	4522	4534	4653	4774						
360	EPR	1.37	1.43	1.54	1.65	1.71					
	MACH	.594	.638	.707	.745	.762					
	KIAS	330	330	327	313	307					
	FF/ENG	4383	4384	4433	4443	4551					
340	EPR	1.36	1.42	1.52	1.62	1.67	1.73				
	MACH	.591	.637	.696	.735	.750	.770				
	KIAS	328	329	322	308	302	298				
	FF/ENG	4229	4234	4186	4155	4198	4341				
320	EPR	1.34	1.39	1.49	1.59	1.64	1.69				
	MACH	.571	.621	.683	.725	.740	.756				
	KIAS	317	321	315	304	298	292				
	FF/ENG	3936	3980	3936	3885	3893	3959				
300	EPR	1.32	1.37	1.46	1.56	1.60	1.65	1.71			
	MACH	.551	.601	.667	.713	.729	.744	.761			
	KIAS	306	310	308	298	293	287	282			
	FF/ENG	3665	3704	3680	3630	3625	3641	3732			
280	EPR	1.30	1.35	1.44	1.53	1.57	1.62	1.67	1.73		
	MACH	.534	.579	.650	.700	.717	.733	.748	.767		
	KIAS	296	298	299	292	288	282	276	272		
	FF/ENG	3419	3420	3428	3391	3370	3370	3402	3510		
260	EPR	1.28	1.32	1.41	1.50	1.54	1.58	1.63	1.68	1.75	
	MACH	.517	.555	.631	.684	.702	.720	.736	.751	.773	
	KIAS	287	286	290	285	281	277	271	266	262	
	FF/ENG	3185	3142	3180	3152	3128	3112	3119	3163	3288	
240	EPR	1.26	1.30	1.38	1.46	1.50	1.54	1.59	1.64	1.69	1.76
	MACH	.501	.535	.609	.665	.686	.704	.722	.737	.754	.778
	KIAS	277	275	279	277	274	270	266	260	255	252
	FF/ENG	2991	2898	2921	2901	2891	2869	2860	2872	2919	3076
220	EPR	1.24	1.28	1.35	1.43	1.47	1.51	1.55	1.59	1.64	1.70
	MACH	.483	.515	.580	.643	.665	.686	.705	.723	.739	.756
	KIAS	267	265	266	267	265	263	259	254	249	244
	FF/ENG	2765	2667	2642	2653	2642	2633	2616	2610	2624	2688
200	EPR	1.22	1.26	1.32	1.40	1.43	1.47	1.51	1.55	1.59	1.65
	MACH	.465	.496	.551	.618	.641	.663	.685	.705	.722	.739
	KIAS	257	254	252	256	255	254	251	248	243	238
	FF/ENG	2556	2468	2374	2406	2396	2386	2382	2368	2363	2390

SPARE ENGINE CARRIAGE

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		(NM)	20	40	60	80
702	650	604	565	531	500	478	458	440	423	408
1410	1306	1212	1132	1063	1000	957	918	881	848	817
2126	1966	1823	1701	1595	1500	1436	1376	1321	1271	1225
2848	2630	2437	2272	2129	2000	1914	1835	1761	1693	1632
3579	3301	3055	2845	2663	2500	2392	2292	2200	2115	2038
4318	3978	3677	3421	3199	3000	2870	2750	2639	2537	2444
5066	4661	4301	3998	3735	3500	3348	3208	3077	2957	2848
5824	5350	4931	4578	4273	4000	3825	3663	3514	3377	3252
6592	6047	5565	5160	4811	4500	4303	4120	3951	3796	3655
7375	6754	6206	5746	5352	5000	4780	4576	4388	4215	4058

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		22		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)
500	14.9	1:29	13.6	1:24	11.7	1:17	10.6	1:14	10.7	1:12
1000	30.1	2:58	27.9	2:47	24.4	2:30	22.4	2:23	22.7	2:19
1500	44.8	4:28	41.7	4:12	36.7	3:45	33.9	3:33	34.2	3:27
2000	59.3	6:01	55.1	5:39	48.7	5:01	45.0	4:43	45.1	4:35
2500	73.4	7:36	68.2	7:09	60.4	6:18	55.7	5:54	55.6	5:45
3000	87.1	9:13	80.9	8:40	71.7	7:36	66.1	7:06	65.7	6:55
3500	100.5	10:53	93.4	10:14	82.7	8:57	76.2	8:19	75.5	8:05
4000	113.5	12:36	105.5	11:50	93.4	10:19	86.0	9:33	84.9	9:17
4500	126.2	14:21	117.4	13:29	103.8	11:44	95.5	10:48	94.0	10:29
5000	138.7	16:10	128.9	15:10	113.9	13:12	104.7	12:05	102.8	11:42

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	2.0	4.4
20	-3.1	-1.5	0.0	4.2	9.1
30	-4.7	-2.3	0.0	6.3	13.6
40	-6.3	-3.1	0.0	8.2	17.8
50	-7.9	-3.9	0.0	10.1	21.8
60	-9.4	-4.7	0.0	11.8	25.5
70	-11.0	-5.5	0.0	13.4	28.9
80	-12.5	-6.3	0.0	14.9	32.1
90	-14.1	-7.1	0.0	16.2	35.1
100	-15.6	-7.9	0.0	17.5	37.8
110	-17.1	-8.6	0.0	18.6	40.2
120	-18.6	-9.4	0.0	19.6	42.4
130	-20.1	-10.2	0.0	20.5	44.4
140	-21.6	-10.9	0.0	21.2	46.1
150	-23.1	-11.7	0.0	21.9	47.5

SPARE ENGINE CARRIAGE

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	1.29	1.33	1.39	1.48	1.58				
	KIAS	290	290	290	290	320				
	FF/ENG	4560	4520	4500	4540	4930				
380	EPR	1.27	1.31	1.37	1.46	1.55	1.69			
	KIAS	284	284	284	284	312	316			
	FF/ENG	4380	4280	4250	4270	4600	4980			
360	EPR	1.26	1.29	1.36	1.43	1.53	1.65			
	KIAS	274	274	274	274	303	307			
	FF/ENG	4140	4040	3990	4000	4290	4560			
340	EPR	1.24	1.28	1.34	1.41	1.50	1.61			
	KIAS	264	264	264	264	294	298			
	FF/ENG	3910	3850	3750	3740	4000	4190			
320	EPR	1.23	1.26	1.32	1.39	1.47	1.58	1.73		
	KIAS	254	254	254	254	285	288	292		
	FF/ENG	3670	3620	3510	3490	3730	3850	4280		
300	EPR	1.21	1.24	1.30	1.36	1.44	1.54	1.68		
	KIAS	245	245	245	245	275	278	282		
	FF/ENG	3440	3390	3290	3250	3450	3540	3820		
280	EPR	1.20	1.23	1.28	1.34	1.42	1.51	1.63		
	KIAS	236	236	236	236	266	268	272		
	FF/ENG	3220	3170	3110	3020	3200	3250	3430		
260	EPR	1.19	1.21	1.26	1.31	1.39	1.48	1.59	1.75	
	KIAS	230	230	230	230	256	258	261	265	
	FF/ENG	3010	2950	2890	2810	2940	2980	3090	3500	
240	EPR	1.17	1.19	1.24	1.29	1.36	1.44	1.55	1.69	
	KIAS	224	224	224	224	245	247	250	253	
	FF/ENG	2800	2750	2680	2600	2690	2710	2790	3040	
220	EPR	1.16	1.18	1.22	1.27	1.33	1.41	1.51	1.63	
	KIAS	217	217	217	217	234	236	239	242	
	FF/ENG	2600	2540	2480	2420	2450	2460	2510	2660	
200	EPR	1.14	1.16	1.20	1.24	1.30	1.37	1.46	1.58	1.74
	KIAS	210	210	210	210	224	225	227	229	233
	FF/ENG	2410	2350	2280	2210	2230	2210	2240	2320	2690

This table includes 5% additional fuel for holding in a racetrack pattern.

SPARE ENGINE CARRIAGE

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	385	313	9200	7300	5500
390	376	309	10200	8400	6600
380	366	306	11300	9500	7700
370	357	302	12400	10600	8800
360	347	298	13500	11800	10100
350	338	294	14600	12900	11200
340	329	290	15700	14000	12400
330	319	287	16800	15100	13500
320	310	283	17900	16300	14600
310	300	279	18800	17500	15700
300	290	274	19700	18500	16900
290	281	270	20700	19400	18000
280	271	265	21700	20400	19000
270	261	261	22700	21300	20000
260	252	256	23600	22400	21000
250	242	251	24600	23400	22000
240	233	246	25600	24400	23100
230	223	242	26700	25500	24200
220	213	236	27800	26600	25400
210	203	231	29100	27800	26500
200	194	226	30300	29200	27800

Altitude reduced by 2000 ft for additional margin.

SPARE ENGINE CARRIAGE

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
671	628	590	557	527	500	476	454	434	415	398
1342	1256	1180	1113	1054	1000	952	908	867	831	797
2014	1885	1771	1671	1581	1500	1427	1361	1301	1246	1195
2690	2517	2364	2229	2108	2000	1902	1814	1733	1659	1592
3371	3151	2959	2788	2636	2500	2377	2266	2165	2072	1987
4057	3790	3556	3349	3165	3000	2851	2717	2595	2483	2380
4749	4433	4156	3912	3694	3500	3325	3167	3023	2892	2771
5449	5081	4759	4476	4225	4000	3798	3615	3450	3298	3160
6157	5735	5367	5043	4756	4500	4270	4063	3874	3703	3546
6876	6396	5979	5612	5289	5000	4741	4508	4297	4104	3928

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG) WEIGHT AT START OF DRIFTDOWN (1000 KG)											TIME (HR:MIN)
	200	220	240	260	280	300	320	340	360	380	400	
500	9.7	10.6	11.5	12.4	13.1	13.9	14.9	15.8	16.5	17.5	18.2	1:17
1000	19.1	20.9	22.7	24.5	26.1	27.9	29.7	31.5	33.1	35.1	36.8	2:33
1500	28.1	30.7	33.4	36.1	38.6	41.2	43.9	46.6	49.2	52.1	54.7	3:50
2000	36.7	40.1	43.6	47.1	50.5	53.9	57.5	61.1	64.6	68.5	72.0	5:08
2500	44.9	49.1	53.4	57.7	61.9	66.2	70.6	75.1	79.4	84.2	88.7	6:27
3000	52.7	57.7	62.8	67.9	72.9	77.9	83.2	88.5	93.7	99.4	104.9	7:49
3500	60.2	66.0	71.8	77.7	83.4	89.2	95.2	101.4	107.5	114.1	120.5	9:12
4000	67.4	73.9	80.5	87.0	93.5	100.0	106.9	113.8	120.8	128.2	135.5	10:38
4500	74.3	81.6	88.8	96.1	103.2	110.5	118.1	125.9	133.6	142.0	150.1	12:07
5000	81.0	88.9	96.8	104.8	112.6	120.6	128.9	137.5	146.1	155.2	164.3	13:38

Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

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.

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.

Contaminated Runway Takeoff Performance

Experience has shown that aircraft performance may deteriorate significantly on runways covered with compacted snow, slush, standing water or wet ice. Therefore, a reduction in runway/obstacle limited takeoff weight and revised takeoff speeds are necessary. The following information is intended for guidance in accordance with regulatory advisory material and assumes an engine failure at the critical point during the takeoff.

Contaminated runway takeoff performance data is shown for compacted snow, slush/standing water and wet ice. The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Takeoffs in slush depths greater 13mm (0.50 inches) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature method for reduced thrust is not allowed on contaminated runways. Interpolation for slush depths between the values shown is permitted.

Stopping distances are based on two engine symmetric reverse thrust. Dispatch with an inoperative reverser is not recommend on runways covered by slush, ice or 0.25 inch of standing water due to the possibility of asymmetric reverse thrust application.

Field Limit Weights

Follow the directions provided with the tables.

VMCG Limit Weights

Follow the directions provided with the tables. For flaps 10 takeoff, decrease the flaps 20 contaminated runway VMCG limit weight by 15000 kg.

V1 Speed

Follow the directions provided with the tables. For flaps 10 takeoff, increase V1 by 5 knots unless the takeoff weight is VMCG limited. If the takeoff weight is VMCG limited then set V1 = VMCG.

Anti-skid Inoperative

The anti-skid must be operative when the takeoff is scheduled on a wet runway.

When operating with anti-skid inoperative, the dry 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 adjust the normal runway/obstacle limited weight by the amount shown in the table below. Then, adjust 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 10300 ft.

ANTI-SKID INOPERATIVE ADJUSTMENTS*		
FIELD LENGTH (FT)	WEIGHT (1000 KG)	V1 (KTS)
10000	-24	-35
11000	-24	-34
12000	-24	-32
13000	-24	-31
14000	-23	-30
15000	-23	-29
16000	-22	-28

*Based on two symmetric thrust reversers.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. Use of reduced thrust is not allowed on runways contaminated with water, ice, slush, or snow. Use of assumed temperature reduced thrust is not recommended if potential windshear conditions exist. The minimum allowable EPR for reduced thrust is based on 25% thrust reduction or the minimum allowable EPR. Note that the FMC has not been updated to reflect the absolute minimum EPR setting allowed of 1.39. In the event of disagreement, observe the limit shown in the table rather than that calculated by the FMC. It is not recommended to set takeoff EPR lower than the scheduled Climb EPR.

Field length limited allowable takeoff limit weight must be reduced by 1750 kg for operations at reduced thrust.

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

The Long Range Cruise Maximum Operating Altitude tables provides both optimum altitude and cruise thrust limited pressure altitude for a given weight at Long Range Cruise. Optimum altitudes shown in the Long Range Cruise Maximum Operating Altitude table result in maneuver margins of 1.5g (48° bank) or more. Buffet limits corresponding to a maneuver margin of 1.3g (39° bank) are also shown. 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

Runway Surface Condition Correlation

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. A table is provided that correlates runway condition code to runway surface condition description and reported braking action that can then be used to determine the appropriate Normal Configuration Landing Distance or Non-Normal Configuration Landing Distance.

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distances on dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are 115% of the actual landing distance. The Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance of 1500 ft from threshold to touchdown. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, four-engine maximum reverse thrust, and auto speedbrakes.

To use these tables, determine the reference landing distance for the selected braking configuration and reported braking action. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is applied independently to the reference landing distance. A correction for use of manual speedbrakes is provided in the table notes.

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. Landing distances and adjustments are provided for dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are representative of the actual landing distance, and are not factored. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance of 1500 ft from threshold to touchdown. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, and maximum available symmetrical reverse thrust.

Tables for Non-Normal Configuration Landing Distance in this section are similar in format and used in the same manner as tables for the Normal Configuration Landing Distance previously described.

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 EECs must be in the ALTERNATE mode. The anti-skid system must be operative. Operation on contaminated runways is prohibited. Use of improved climb performance is prohibited. Thrust reductions in addition to those required for ALTERNATE Mode EEC operation are prohibited.

Max Continuous %N1

Max Continuous %N1 which can be set during engine out cruise conditions is presented. Enter the appropriate table with pressure altitude, TAT, and KIAS to obtain Maximum Continuous %N1. Intermediate airspeeds may be interpolated. Appropriate bleed adjustments are shown.

Takeoff EPR/Go-around EPR

Takeoff and Go-around power settings are presented in tabular form for normal air conditioning bleed. Max Takeoff and Go-around EPR may be read directly from the tables for the desired pressure altitude and airport OAT.

Takeoff thrust setting with EECs in ALTERNATE control mode is achieved by advancing or retarding all thrust levers together while setting target EPR using the EPR available engines. Then, adjust the N1 RPM of the engine which does not have EPR available to match that of the other engines. On takeoff, only minor adjustments to N1 RPM may be made. No adjustments to N1 RPM may be safe after a speed of 80 knots is achieved.

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.

Spare Engine Carriage

This section contains performance for airplane operation with spare engine carriage for all phases of flight. The data is based on engine bleeds for normal air conditioning.

The FMC incorporates a spare engine carriage input and accounts for the increased drag associated with spare engine carriage. The FMC also accounts for the reduced VMO of 330 KIAS and increased VREF. Therefore the FMC and the VNAV mode can be used for spare engine carriage operations to generate climb, cruise and descent speed schedules.

Tables for spare engine carriage performance in this section are identical in format and used in the same manner as tables for the basic configuration previously described.

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Principal Dimensions

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.

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.

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

Intentionally
Blank

Overhead Panels

Overhead Panel

Overhead Maintenance Panel

Left Forward Panel

Right Forward Panel

Glareshield Panel

Center Instrument Panel

Forward Aisle Stand

Control Stand

Aft Aisle Stand, Sidewall Panels

Aft Aisle Stand Panels

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

Intentionally
Blank

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. When the switch is on, a mechanical shutter on one half of the switch opens to show an illuminated legend, such as “ON”, “AUTO”, or a flow bar.

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

Additionally, the other half of many switches has a light to indicate system state, such as “PRESS”, “FAIL”, “INOP” or “OFF”.

1 Switch is ON

ON, AUTO, or flow bar visible.

For some switches, system status (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.

Passenger Signs

1 NO SMOKING Selector

OFF – NO SMOKING signs are not illuminated.

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

ON – NO SMOKING signs illuminate.

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

2 SEATBELTS Selector

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

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

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

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

Lighting

Flight Deck Lighting

Storm Lights Switch

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

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 airplane is powered by the ground handling bus, illuminates exit or entry path to or from flight deck; activates the following:

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

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

Exterior Lighting

Landing Light Switches

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

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

1 Navigation (NAV) Lights Switch

ON - illuminates red, green and white 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 (guard closed) – all emergency lights illuminate if airplane electrical power fails or is turned off.

ON – all emergency lights illuminate.

Cabin Emergency Lights Switch

G-BNLK - G-BNLO, G-BYGA - G-BYGG, G-CIVR - G-CIVZ

G-BNLP, G-BNLY, G-CIVA - G-CIVP

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

Oxygen Systems

Oxygen Indications

1 Oxygen Pressure (OXY PR) Display

Displays crew and passenger oxygen cylinder pressure (PSI).

Note: Access is through display select panel STAT switch.

Passenger Oxygen Switch

1 PASSENGER (PASS) OXYGEN Switch

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

NORM (guard closed) – system activates if cabin altitude reaches approximately 14,000 feet.

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

Therapeutic Oxygen Switch

G-BNLK - G-BNLY, G-CIVA - G-CIVP

1 THERAPEUTIC OXYGEN Switch

RESET (spring–loaded) – flow control unit closed electrically if cabin altitude is below 12,000 feet.

NORM (guard closed) – 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. The therapeutic oxygen system must be reset prior to disconnecting all therapeutic oxygen masks.

Oxygen Mask Panel

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

G-BNLK - G-BNLY, G-CIVA - G-CIVP, G-CIVT, G-CIVU

G-BYGA - G-BYGG, G-CIVR, G-CIVS, G-CIVV - G-CIVZ

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

G-BNLK - G-BNLY, G-CIVA - G-CIVP, G-CIVT, G-CIVU

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

G-BYGA - G-BYGG, G-CIVR, G-CIVS, G-CIVV - G-CIVZ

Up – vent valve closed.

Down – vent valve open, allowing oxygen flow to smoke goggles.

4 Protective Strip

G-BYGA - G-BYGG, G-CIVR, G-CIVS, G-CIVV - G-CIVZ

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

1 Evacuation (EVAC) PRESS TO TEST Switch

Push – tests the EVAC light.

2 Evacuation COMMAND Switch

ON –

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

OFF (guard closed) – 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.

Ground Tests Switch

1 Ground (GND) TESTS Switch

ENABLE – allows Central Maintenance Computer to initiate ground tests of airplane systems.

NORM (Normal – guard closed) – systems configured for flight.

Smoke Evacuation Handle

1 Smoke Evacuation Handle

Pull –

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

Doors

Doors Synoptic Display

Flight Deck Door

Deadbolt

1 Deadbolt Levers

2 DEADBOLT POSITION Placard

Flight Deck Emergency Access Panel

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 – guard closed) – 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

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 MANUAL. Lockout pin with warning flag may be installed. Lockout pin prevents handle movement from MANUAL.

1 Door Mode Select Lever

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

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

2 Access Cover

Open – allows access to door mode select lever.

Closed - allows verification of door mode select lever position.

3 Clear Plastic Viewports

AUTOMATIC – knob visible in viewport verifies automatic mode armed.

MANUAL – knob visible in viewport verifies manual mode selected.

Upper Deck Emergency Escape Doors

1 Door Operating Gas Bottle Pressure Gage

If gage needle 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 AUTOMATIC

Down - closes door and engages latches.

3 Door Ground Mode Light/Battery Test Panel

See following graphic.

4 Door Mode Select Lever

See following graphic.

5 Escape Slide Pack

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

Upper Deck Emergency Door Mode Select Panel

1 Door Mode Select Lever

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

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

2 Access Cover

Open – allows access to door mode select lever.

Closed - allows verification of door mode select lever position.

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

3 Clear Plastic Viewports

AUTOMATIC – knob visible in viewport verifies automatic mode armed.

MANUAL – knob visible in viewport verifies manual mode selected.

Door Ground Mode/Battery OK Panel

1 DOOR Ground (GND) MODE Light

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

2 BATTERY OK Test Switch/Light

Push -

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

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

Overhead Escape Hatch Handle

1 Overhead Escape Hatch Handle

Rotate handle to unlock hatch.

Pull hatch inward.

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- emergency equipment
- doors
- flight deck seats

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- passenger signs
- emergency lighting

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- 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.

The landing lights are maximum brightness with the Landing Gear lever DOWN and the Landing Light switches ON. With the Landing Light switches ON and the Landing Gear lever not in the DOWN position, the landing lights are dimmed.

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.

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 and aisle stand flood light 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.

Passenger Signs

The passenger signs are controlled by selectors 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
- passenger oxygen on

NO SMOKING signs (AUTO selected):

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

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

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

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

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

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

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

Emergency Lighting

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

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

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

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

Exterior emergency lighting consists of escape slide and overwing lights.

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

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

Interior Emergency Lighting Locations

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

1 **Emergency Door Light**

2 **EXIT Signs**

3 **Emergency Cross Aisle Light**

4 **Emergency Aisle Lights**

5 **Emergency Escape Path Lighting**

Exterior Emergency Lighting

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

Exterior Emergency Lighting Locations

Oxygen Systems

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

Oxygen pressure displays on the EICAS STATUS page.

Flight Crew Oxygen System

G-BNLK - G-BNLY, G-CIVA - G-CIVP, G-CIVT, G-CIVU
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.

G-BYGA - G-BYGG, G-CIVR, G-CIVS, G-CIVV - G-CIVZ
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 slide lever. This action shuts off oxygen to the mask, stows the flag, deactivates the mask microphone, and activates the boom microphone. The oxygen system can be reactivated by opening the left-hand door of the stowage box.

Passenger Oxygen System

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

Oxygen flow to a mask begins when the mask is pulled down. A flow indicator in the reservoir bag indicates oxygen is flowing to the mask.

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

Passenger oxygen pressure displays on the EICAS STATUS page.

Portable Oxygen Bottles

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

Therapeutic Oxygen System

G-BNLK - G-BNLY, G-CIVA - G-CIVP

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. The therapeutic oxygen system must be reset prior to disconnecting all therapeutic oxygen masks. Oxygen flow can be reset by selecting Therapeutic Oxygen switch to RESET position.

Emergency Equipment Overview

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

- emergency evacuation signal system
- emergency locator transmitters (ELTs)
- fire extinguishers
- emergency equipment locations

Emergency Evacuation Signal System

An Emergency Evacuation Signal switch is located in the flight deck and at all attendant stations. The flight deck Command switch positions are OFF and ON.

In the OFF position, activation of the evacuation signal at an attendant panel illuminates the flashing amber light and sounds the pulsating audio horn on the flight deck and at all flight attendant panels.

In the ON position, a flashing amber light illuminates and a pulsating audio horn sounds at all stations.

Fire Extinguishers

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

Water Fire Extinguishers

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

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

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

On the passenger aircraft, Emergency Locator Transmitters (ELTs) are installed:

- 1 ELT – door 1L
- 1 ELT – door 5L

Note 1: ELTs installed in slide/rafts transmit when the slide/raft is deployed into water.

Note 2: An ELT may be installed at door 4R.

Smoke Barrier

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

Emergency Equipment Location (see BA SEP manual for BA specific current location information)

Flight Deck

Upper Deck/Door 5 Overhead Crew Rest

Note: Door 5 overhead crew rest installed.

Main Deck

(G-BNLB and on)
H2O
HAL
O2
(2) (2)
(2)
C
(3) (8)
(2) (2) (2)
(8)
(G-BNLA through G-BNLD)
(2) (2) (2)
(2)
(6) (8)
G-BNLE and on:
Doors 1L/R, 2L/R, 4L/R and 5L/R:
SP
Each attendant seat stowage:
Under each seat:
As installed

Intentionally
Blank

Doors

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

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 aeroplane.

Door Locations

Flight Deck Door

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

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.

Cockpit Door Surveillance System (CDSS)

General

The Rosemount Aerospace Cockpit Door Surveillance System (CDSS) provides the Flight Crew with live video images of the cockpit door entrance area, thus enabling the pilots to visually identify persons requesting access to the flight deck. Two infrared cameras are mounted in the cabin, one adjacent to the cockpit door and one in a ceiling panel aft of the door. The video image is displayed on a stowable LCD monitor mounted on the rear of the centre cockpit pedestal. The monitor can be rotated and tilted to adjust the viewing perspective.

Release

The RELEASE switch is located on the case of the LCD monitor. When activated, this switch will release the LCD monitor from its stowed position.

Camera System Power

The CAMERA SYSTEM POWER switch is located on the case of the LCD monitor mounted on the rear of the centre cockpit pedestal. Power to the CDSS is controlled with this switch.

Power

The system is powered from the aircraft's 28V DC bus 4. A CB labelled CAMERA SYSTEM (2.5 Amps) is located in the cockpit in the P7 overhead CB panel.

View Select

The VIEW SELECT switch is located on top of the LCD monitor. When activated, this switch will toggle the displayed image between the views captured by camera 1 and camera 2.

Display Brightness/Contract - Screen brightness and contract is automatically controlled for the ambient conditions present in the cockpit. Manual adjustment of screen brightness (upper knob) and contrast (lower knob) is possible using the control knobs provided on the face of the LCD monitor.

Display Sleep Mode - An automatic sleep turns off power to the LCD monitor after 5 minutes of inactivity (no change in camera image is detected). To restore the display image, the VIEW SELECT switch must be pressed (LCD monitor power is restored). The image displayed will be from the last selected camera position if the restore action is taken within the first 120 seconds of sleep mode. If the restore action is taken after 120 seconds of sleep mode, the display will present the Camera 1 image. Power to the cameras and the camera infrared illumination function are not interrupted during sleep mode.

Annunciations

A system status LED (green illumination) is located on the face of the LCD monitor above the manual display control knobs.

- Status LED Illumination
- System Status
- Steady ON
- Power ON and Operational
- Flashing
- System failure detected
- NO illumination
- Power OFF to system

Passenger Entry Doors

The main deck passenger entry doors are used to enter and exit the airplane, and serve as emergency exits. The ten passenger entry doors are paired along the airplane fuselage. The doors are identified 1 through 5 left, and 1 through 5 right. The passenger entry doors can be opened or closed manually from inside or outside of the airplane.

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

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

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

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

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

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

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

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

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

Slide/Raft Deployed

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

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

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

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

DOOR SECURED WITH DITCHING STRAP

Passenger Door 3

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

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

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

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

Door 3 Slide Deployed

Upper Deck Emergency Doors

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

With the door mode select lever in AUTOMATIC position, lifting the door operating handle 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 180 degrees counterclockwise. 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.

CAUTION: The flight deck overhead hatch is hinged to open inward. Care should be taken to avoid personal injury when opening the overhead hatch.

Flight Deck Overhead Hatch Location

Emergency Escape Devices

Four 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.

WARNING: Ensure the descent device is securely fastened to the airplane by pulling sharply on the lanyard prior to exiting the aircraft.

Cargo Doors

The three cargo doors are on the right side of the airplane. The cargo doors all open upward. The forward and aft cargo doors open outward and the bulk cargo door opens inward.

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

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

Flight Deck Seats

The flight deck has three seat types:

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

Pilot Seats

The pilot seats:

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

The seats also have:

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

The seats move outboard during the last four inches of aft travel. Manual controls provide forward and aft adjustment and locking, vertical adjustment, seat bottom tilt, and backrest recline.

Lumbar and thigh pad support can be adjusted using the adjustment hand wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access.

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

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

Pilot Seat Adjustment

Observer Seats

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

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

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

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

Door 5 Overhead Crew Rest

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

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

Evacuation Using Emergency Escape Hatch

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

Door 5 Overhead Crew Rest Emergency Escape Hatch

Intentionally
Blank

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.
DOOR ENTRY L1, L2, L3, L4, L5, R1, R2, R3, R4, R5	Advisory		Main deck entry door not closed and latched condition sensed.
DOOR FWD CARGO	Caution	Beeper	Forward cargo door not closed and latched and locked condition sensed.
DOOR L, R UPPER DK	Advisory		Upper deck door not closed and latched condition sensed.
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.
DOORS ENTRY L, R	Advisory		Two or more entry doors on the same side not closed and latched condition sensed.
DOORS UPR DECK	Advisory		Both upper deck doors not closed and latched condition sensed.

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.

G-BNLK – G-BYGF, G-CIVA – G-CIVZ

>PASS OXY LOW	Advisory		Passenger oxygen pressure low.

PASS OXYGEN ON	Advisory		Passenger oxygen system activated.

EICAS Memo Messages

Message	Level	Aural	Message Logic
DOORS AUTO	Memo		Indicates position of mode select levers for main deck and upper deck doors when on the ground.

G-BYGA – G-BYGG, G-CIVR – G-CIVZ

DOORS AUTO/MAN	Memo		Indicates position of mode select levers for main deck and upper deck doors when on the ground.

DOORS MANUAL	Memo		Indicates position of mode select levers for main deck and upper deck doors when on the ground.
NO SMOKING ON	Memo		NO SMOKING signs manually selected ON.
PASS SIGNS ON	Memo		Passenger signs manually selected ON.
SEATBELTS ON	Memo		FASTEN BELTS signs manually selected ON.

G-BNLK - G-BNLY, G-CIVA - G-CIVP

THERAP OXYGEN ON	Memo		Therapeutic oxygen system activated.

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Air Conditioning System

Air Conditioning

ECS Control

Passenger and Flight Deck Temperature Selectors

1 Passenger (PASS) Temperature (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 temperature 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 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
- master trim air valve reopens if duct overheat no longer exists

2 Zone System (SYS) FAULT Light

Illuminated (amber) -

- temperature zone duct overheat or zone temperature controller fault has occurred, or
- master trim air valve failed closed, or
- Trim Air switch off, or
- 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

G-BNLO, G-BNLP

- inhibited on the ground and during climb

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.

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 occurred

G-BYGA - G-BYGG, G-CIVU - G-CIVZ

- may illuminate briefly when automatically or manually switching from pack temperature controller A to B or B to A

3 PACKS Control Selectors

OFF –

- pack valve closed
- extinguishes Pack System Fault light for pack selected off
- resets pack fault protection system

Normal (NORM) -

- pack controller A or B selected automatically on alternate flights
- selected controller is primary controller; selects secondary controller if primary controller fails

A - selects pack controller A as primary controller; selects B if A fails.

B - selects pack controller B as primary controller; selects A if B fails.

Pilot Auxiliary Heat and Windshield Air

Electric shoulder heater and foot heater operate only in flight.

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.

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 is 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
- strut overheat, or
- FWSOV open when commanded closed

5 ENGINE BLEED Air Switches

ON -

- engine bleed air valve opens for engine start
- engine bleed air valve, FWSOV, and HP bleed valve open by system logic when bleed air pressure available

Off -

- engine bleed air valve, FWSOV, and HP bleed valve closed
- FWSOV opens when nacelle anti-ice on, unless FWSOV closed by:
  - prior or present bleed air overheat, or
  - prior or present strut overheat, or
  - start valve not closed, or
  - HP bleed valve failed open

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

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

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.

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. Actual air flow is not displayed, therefore the display may not represent actual system operation.

G-BNLK - G-BYGA, G-CIVA - G-CIVZ

G-BYGB - G-BYGG

1 Zone Temperature

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 is operating, and
  - Passenger Temperature selector in AUTO, and
  - temperature control is not in backup mode
- (AA) actual temperature on right

MASTER - (MM) temperature setting of Passenger Temperature selector.

G-BYGB - G-BYGG
FWD, AFT, BULK - (AA) actual temperature of cargo compartment.

G-BNLK - G-BYGA, G-CIVA - G-CIVZ
FWD, AFT - (AA) actual temperature of cargo compartment.

2 Pack Control

A - pack controller A is controlling the pack.

B - pack controller B is controlling the pack.

OFF - pack valve is closed.

3 Bleed Air Duct Pressure

White - 12 psi or greater.

Amber - 11 psi or less.

4 Wing Anti-Icing

Wing anti-icing valve is open.

5 Engine Bleed Air Valve

Position of the engine bleed air valve.

6 Nacelle Anti-Icing

Nacelle anti-icing valve is open.

7 APU Bleed Air Isolation Valve

Position of the isolation valve.

8 External Air

- displayed if a pack is operating with APU and engines off, or
- bleed air ducts are pressurized with APU and engines off
- remains displayed momentarily after external air source is removed

9 Outflow Valves Position

OP - open.

CL - closed.

10 Outflow Valve

AUTO - outflow valve is controlled automatically.

MAN - outflow valve is controlled manually.

11 High Flow

HI FLOW - pack is in high flow.

Blank - pack is in normal flow or pack is off.

12 Isolation Valve

Position of isolation valve.

Introduction

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

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

The system supplies ventilation for the passenger cabin:

- lavatories
- galleys
- flight deck crew rest
- door 5 crew rest

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

There are seven temperature zones:

- flight deck
- upper deck
- five main deck cabin zones A through E

Air Conditioning Packs

Three identical air conditioning packs cool bleed air from the engines, APU, or high pressure air from a ground source. Bleed air is precooled before entering the pack. The packs are controlled by two identical pack 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 PACKS 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 rates, 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 Packs 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

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 flight,
- 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

Temperature Control

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 may be 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.

G-BNLK - G-CIVS, G-CIVV - G-CIVZ
The cabin temperature panel accepts temperature modifications after reaching cruise flight until engine shutdown.

Temperature Control With Loss of Trim Air System

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.

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.

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.

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

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

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 ground exhaust valve to manually configure the airplane for flight.

In flight configuration, the inboard exhaust valve is open and the warmed equipment cooling exhaust air discharges into the forward cargo compartment.

With the Equipment Cooling selector in NORM or STBY, the system normally configures to closed loop mode if a single internal fan fails. In closed loop mode, the inboard exhaust valve is closed.

Equipment Cooling Non-Normal Operation

With the Equipment Cooling selector in NORM, the airplane on the ground, and with one or more engines on each wing operating, the EICAS alert message EQUIP COOLING is displayed if the equipment cooling system is not configured for flight. Positioning the selector to STBY configures the system for flight.

An override mode provides equipment cooling in flight if internal fans are inoperative. With the Equipment Cooling selector in OVRD, the internal fans 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 Diagram

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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 controller 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 barometric pressure correction.

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

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

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

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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Introduction

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

Bleed air is used for:

- air conditioning
- pressurization
- wing and engine anti-ice
- engine start
- leading edge flaps
- aft cargo heat
- cargo smoke detection
- hydraulic reservoir pressurization
- potable water tank pressurization
- air driven hydraulic demand pumps
- thrust reversers

Engine Bleed Air Supply

Engine bleed air is supplied from either IP or 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 FWSOV closes if the HP bleed valve fails to close when commanded. 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 FWSOV 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.

If the engine start valve fails to close, bleed air is isolated from the engine starter because both the FWSOV and the engine bleed air valve remain closed. Nacelle anti-ice is not available for the respective engine.

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 FWSOV is positively closed to prevent reverse air flow into the engine compressor sections. Any time the engine start valve is not fully closed, the FWSOV remains positively closed. After N3 increases past 50%, the start valve closes which enables the FWSOV to open and the bleed air valve reverse flow prevention is enabled.

If an Engine Bleed Air switch is off, the respective engine bleed air valve, FWSOV, and HP bleed valve are closed.

If a bleed air overheat is detected, the FWSOV 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 FWSOV is closed by a bleed air overpressure, or
- the FWSOV is closed by a prior or present strut overheat, or
- the start valve is not closed, or
- the HP bleed valve is failed open

Bleed air is available for nacelle anti-ice operation with the Engine Bleed Air switch off except when:

- the FWSOV has failed closed, or
- the FWSOV has been closed due a bleed air overheat, or
- the start valve is not closed, or
- the HP bleed valve is failed open

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 DEM 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 if the FWSOV or HP bleed valve fails to close when commanded. If the respective NAI VALVE message is displayed after pushing the related Nacelle Anti-ice switch ON, the FWSOV is closed because the HP bleed valve failed open and nacelle anti-ice is not available.

Bleed Air System Diagram

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 FWSOV 1, 2, 3, 4 OFF	Advisory		Engine bleed air overheat, engine bleed air overpressure, or FWSOV failed closed.
BLEED 1, 2, 3, 4	Advisory		FWSOV or HP bleed valve 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 APU	Advisory		APU bleed isolation valve position disagrees with commanded position.
BLEED ISLN L, R	Advisory	Beeper	Isolation Valve switch position and valve position disagree.
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

G-BNLK - G-BNLY, G-CIVA - G-CIVP, G-CIVT, G-CIVU

>HUMID DR 5	Advisory		Fault in door five crew rest humidifier.

>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.
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.
>TRIM AIR OFF	Advisory		Master trim air valve closed. Flight deck and passenger cabin temperature controlled in backup mode.

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.

3.10 Controls and Indicators 3.10.1

Nacelle and Wing Anti-Icing 3.10.1
Nacelle and Wing Anti-Ice Panel 3.10.1
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Intentionally
Blank

Nacelle and Wing Anti-Icing

Nacelle and Wing Anti-Ice Panel

1 NACELLE ANTI-ICE Switches

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

AUTO – in flight, nacelle anti-icing operates when nacelle icing conditions exist. The requirements for valve operation are the same as the ON position.

ON –

- the nacelle anti-icing valve opens when engine bleed air pressure is available
- the engine igniters selected by the Auto Ignition selector in 1, 2, or BOTH operate for the first 60 seconds
- the engine bleed FWSOV opens when the nacelle anti-icing valve is open, unless the FWSOV is closed by:
  - an overpressure, or
  - a prior or present strut overheat, or
  - the start valve not closed, or
  - the engine bleed HP valve failed open

2 WING ANTI-ICE Switch

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

ON -

- in flight, the wing anti-icing valves open to supply bleed air to the left and right wing leading edges
- on the ground, the system is off and wing ant-icing valves are closed

3 WING ANTI-ICE VALVE Light

Illuminated (amber) – the position of either wing anti-icing valve disagrees with the switch position.

Anti-Icing Indications on EICAS Display

1 Nacelle Anti-icing Indication

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

2 Wing Anti-icing Indication

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

Windshield Heat and Washers

Windshield Heat and Washers Panel

G-BNLK - G-BNLY, G-CIVA - G-CIVI

G-BYGA - G-BYGG, G-CIVJ - G-CIVZ

1 WINDOW HEAT Switches

ON – controlled heat applied to the windshield

2 WINDOW HEAT Inoperative (INOP) Lights

Illuminated (amber) -

- The switch is off, or
- an overheat has occurred, or
- a system fault has occurred

3 Windshield WIPER Selectors

OFF - the wiper is off and sequenced to stowed position

LO - the wiper operates at low speed

HI - the wiper operates at high speed

4 WINDSHIELD L, R WASHER Switches

Spring loaded to neutral

ON - applies washer fluid

5 RAIN Repellent (REP) Switches
G-BNLK - G-BNLY, G-CIVA - G-CIVI

Push - measured amount of rain repellent applied to windshield

Note: Do not use on dry windshield.

Windshield Air Switch

1 Windshield (WSHLD) AIR Switch

ON – provides air to windshield

OFF – windshield air off

Windshield Washer Fluid

Intentionally
Blank

Introduction

The anti-icing and rain systems include:

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

Anti-icing Systems

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

Icing Detection

The icing detection system detects airplane icing conditions in flight. Two probes on the forward fuselage and system logic:

- Display anti-icing system operating indications on primary EICAS, and
- Display EICAS alert messages.

Nacelle Anti-icing

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

In flight, when a Nacelle Anti-ice switch is in AUTO and nacelle icing conditions are detected, the respective nacelle anti-icing valve is commanded open.

When a Nacelle Anti-ice switch is ON, the respective nacelle anti-icing valve is commanded open.

When nacelle anti-icing is commanded on, the engine igniters selected by the Auto Ignition selector operate for the first 60 seconds.

When nacelle anti-icing is commanded on with the engine bleed valve closed, the HP valve remains closed. Bleed air is supplied by IP bleed only.

Nacelle Anti-Icing System Diagram

Wing Anti-icing

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

In flight, when the Wing Anti-ice switch is ON, the wing anti-icing valves open.

Wing anti-icing is ineffective when the leading edge flaps are not retracted.

Flight Deck Windows

Flight deck windows are electrically heated. The forward windshields have anti-icing protection on the exterior surfaces, and anti-fogging heating on the interior surfaces. The side windows have controlled anti-fogging heating on the interior surfaces.

The window heat switches control heating for the forward windshields only. When the Window Heat switches are ON, electric power is supplied to the forward windshields.

Side window heating is automatic and no flight deck controls are provided. The system is powered whenever the AC electrical system is powered.

If a fault or overheat condition is sensed, power is disconnected from the respective forward windshield or side window system. Pushing a Window Heat switch off for 10 seconds, then ON, resets a forward windshield heat controller fault.

Windshield Wipers and Washers

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

If the wipers are used on a dry windshield, the wipers may scratch the windshield.

The 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. The reservoir has a sight gage and a refill reference mark.

Windshield Air

Windshield air switches on the Captain and First Officer auxiliary panels control anti-fogging air flow from the flight deck conditioned air supply.

Probe Heat

Four pitot-static probes and two angle of attack probes are electrically heated for anti-icing protection when any engine is operating. Two total air temperature probes are electrically heated for anti-icing protection in flight.

Intentionally
Blank

EICAS Alert Messages

Message	Level	Aural	Message Logic
>ANTI-ICE NAC	Advisory		A Nacelle Anti-ice switch is ON, and TAT is more than 12°C, and icing conditions do not exist.
>ANTI-ICE WING	Advisory		Wing Anti-ice switch is ON, and TAT is more than 12°C, and icing conditions do not exist.
HEAT L, R AOA	Advisory		AOA probe heat is failed.
HEAT L, R TAT	Advisory		TAT probe heat is failed, or on the ground, TAT probe is heated.
HEAT P/S CAPT, FO, L AUX, R AUX	Advisory		Pitot static probe heat is failed.
HEAT WINDOW L, R	Advisory		Forward window heat is not operating.
>ICE DETECTORS	Advisory		Icing detection system is failed.

G-BNLK - G-BNLY, G-CIVA - G-CIVP

>ICING	Caution	Beeper	Icing conditions exist, and Wing Anti-Ice switch is OFF or any Nacelle Anti-Ice switch is OFF.

>ICING NAC	Caution	Beeper	Icing conditions exist and any Nacelle Anti-ice switch is OFF.
>ICING WING	Advisory		Icing conditions exist and the Wing Anti-ice switch is OFF.
NAI VALVE 1, 2, 3, 4	Advisory		Nacelle anti-icing valve is not in the commanded position.

G-BNLK - G-BNLY, G-CIVA - G-CIVP

>NO ICING	Advisory		Icing conditions do not exist.

WAI VALVE LEFT, RIGHT	Advisory		Wing anti-icing valve is not in the commanded position.

Intentionally
Blank

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Automatic Flight EICAS Messages 4.30.1

Mode Control Panel (MCP)

Autopilot Flight Director System (AFDS) Controls

1 Flight Director (F/D) Switches

The left F/D switch activates F/D steering indications on the left primary flight display (PFD). The right F/D switch activates F/D steering indications on the right PFD.

ON –

- on the ground with no autopilot (A/P) engaged and both F/D switches OFF, the first F/D switch positioned ON arms the F/D in the takeoff go–around (TO/GA) roll and pitch modes. Positioning the second F/D switch ON displays the flight direction steering indications on the second PFD
- in flight, with the A/P disengaged and both F/D switches OFF, the first F/D switch positioned to ON activates the F/D in:
  - vertical speed (V/S) as the pitch mode, and

  - heading hold (HDG HOLD) as the roll mode, or if bank angle greater than five degrees, attitude hold (ATT)
- in flight, with the A/P engaged and both F/D switches OFF, the first F/D switch positioned to ON activates the F/D in the selected A/P mode(s)

OFF –

- F/D steering indications do not display, unless
- a TO/GA switch is pushed when airspeed is greater than 80 knots and flaps out of up

2 Autopilot (A/P) ENGAGE Switches

Push (any switch engages the autopilot) –

- when either F/D switch is ON, the A/P engages in the selected F/D mode(s)
- when both F/D switches are OFF, the A/P engages in:
  - vertical speed (V/S) as the pitch mode and
  - heading hold (HDG HOLD) or attitude hold (ATT) as the roll mode

3 Autopilot DISENGAGE Bar

Push down –

- disengages all three A/Ps
- prevents A/P engagement
- exposes amber stripe

Lift up -

- enables A/P engagement
- conceals amber stripe

Autothrottle (A/T) System Controls

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

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
- .40 - .95 Mach

Displays selected speed on PFD.

In climb, changes from IAS to Mach at approximately .84 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

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 annunciaton
- 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 select (HDG SEL) or heading hold (HDG HOLD)
- by selecting TO/GA
- by disengaging autopilot and selecting both FDs OFF
- when localizer captures
- with dual FMC failure

LNAV is disarmed by pushing LNAV switch a second time or by selecting LOC or APP.

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. Selecting another pitch mode, 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
- by disengaging autopilot and selecting both FDs OFF
- 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

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

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

1 Altitude Window

Displays selected altitude in 100 feet increments. Display range is 0 to 50000 feet.

Displays selected altitude on PFDs.

Displayed altitude is reference altitude for altitude alerting and level off.

ALT window and PFD altitudes set to 10000 feet when power first applied.

2 Altitude Selector

Rotate – sets altitude in ALT window and selected altitude on both PFDs.

Push –

- during climb or descent with altitude constraints, each push deletes the next waypoint constraint between the airplane altitude and the altitude window setting
- during climb with no altitude constraints, and the altitude window set above the FMC cruise altitude, changes cruise altitude to the altitude window value
- during cruise:
  - with the altitude window set above or below FMC cruise altitude, resets the FMC cruise altitude to the altitude window altitude
  - when in VNAV PTH or VNAV ALT pitch mode, initiates a climb or descent toward the altitude window altitude
  - within 50 NM of the top-of-descent (T/D) point with the altitude window set below cruise altitude, initiates descent now (DES NOW) with a reduced descent rate

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

1 Localizer (LOC) Switch

Push –

- arms, disarms, captures localizer (LOC) as roll mode
- displays LOC in white (armed) on both PFD roll flight mode annunciations before localizer capture; current roll mode remains active until LOC capture
- displays LOC in green (active) on PFD roll flight mode annunciations after localizer capture
- arms AFDS to capture and track inbound on front course
- capture point varies based on range and intercept angle
- localizer capture can occur when intercept track angle is within 120 degrees of the localizer course

Note: After localizer capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

Localizer mode can be disarmed before localizer capture by:

- pushing localizer switch a second time, or
- selecting LNAV

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
- either localizer or glideslope can be captured first

- localizer captures when intercept track angle is within 120 degrees of localizer course
- glideslope captures when 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
- 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.

Note: 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.

1 Autothrottle Modes (Active)

Displayed (green) –

- THR
- THR REF
- HOLD
- IDLE
- SPD

2 AFDS Roll Modes (Active)

Displayed (green) –

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

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

1 Autopilot Disengage Switch

First push (either switch) –

- disengages all autopilots
- master warning lights illuminate
- displays the EICAS warning message >AUTOPILOT DISC
- if A/P automatically disengages, resets master warning lights, EICAS warning message, and aural warning
- sounds 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) Switches

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 and climb derates and assumed temperature thrust reduction.
- 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. Thrust adjusts to provide a minimum 2000 feet per minute climb
- selects TO/GA roll and pitch modes
- activates F/D with no A/P or F/D active

Second push - activates autothrottle in THR REF using GA reference thrust.

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.

Introduction

The automatic flight control system consists of the autopilot flight director system (AFDS) and the autothrottle system (A/T). The mode control panel (MCP) and flight management computer (FMC) control the AFDS and the autothrottle system to perform climb, cruise, descent, and approach.

Autopilot Flight Director System

The AFDS consists of three flight control computers (FCC) and the MCP.

The MCP provides control of the autopilot, flight director, altitude alert, and autothrottle systems. The MCP selects and activates AFDS modes, and establishes altitudes, speeds, and climb/descent profiles.

The three FCCs, left, center, and right, control separate hydraulically powered A/P control servos to operate flight controls. The A/P controls ailerons and elevators. Rudder commands are added only during a multi-A/P approach. Nose wheel steering is also added during rollout from an automatic landing. During an ILS approach with all three A/Ps engaged, separate electrical sources power the three FCCs.

The FCCs also provide inputs for AFDS operating mode displays and FD commands on the PFD.

MCP Switches

MCP switches select automatic flight control and flight director modes. A light in the lower half of the switch illuminates PFD roll and pitch flight mode annunciations to indicate the mode is armed or active. Autothrottle modes are discussed later in this section.

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

- flight level change (FLCH SPD)
- heading hold (HDG HOLD)
- heading select (HDG SEL)
- vertical speed (V/S)
- altitude hold (ALT)

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

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

All modes deactivate by disengaging the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can only be deactivated by disengaging the autopilot and turning both flight directors off or by selecting TO/GA mode. VNAV, LNAV, LOC, and APP modes can be disarmed by pushing the mode switch a second time.

Desired target values can be selected on the MCP for:

- airspeed
- Mach
- heading
- vertical speed
- altitude

All parameters except vertical speed can be preselected before autopilot and/or flight director engagement.

Autopilot Engagement

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

Autopilot Disengagement

Normal autopilot disengagement is through either control wheel autopilot disengage switch. The autopilots can also be disengaged by the MCP autopilot disengage bar. The EICAS warning message AUTOPILOT DISC displays when the autopilot has been manually or automatically disengaged.

AFDS Failures

During autopilot operation, failures affecting the active mode annunciate on the PFD. If the failure affects only the active mode:

- the autopilot remains engaged in an attitude stabilizing mode
- an amber line is drawn through the mode annunciation
- the EICAS caution message AUTOPILOT displays

Failures affecting all autopilot modes result in an autopilot disengagement accompanied by an aural warning. Depending on the system failure, it may be possible to reengage an autopilot by pushing the autopilot engage switch.

A flight director mode failure, in either pitch or roll, causes the related command bar to disappear.

Flight Director Display

The flight director steering indications normally display any time the related Flight Director switch is ON.

Pushing a TO/GA switch when airspeed is greater than 80 knots and the flaps are out of up displays steering indications when the Flight Director switch(es) is OFF. In this case, steering indications can be removed by cycling the flight director switch(es) ON and OFF.

Autopilot Flight Director System Schematic

AFDS Status Annunciation

The following AFDS status annunciations display above the attitude display:

- FD - flight director ON and autopilots not engaged
- CMD - autopilot engaged
- LAND 3 - three autopilots engaged and operating normally for an automatic landing

- LAND 2 - AFDS redundancy reduced; in some cases, only two autopilots available
- NO AUTOLAND - AFDS unable to make an automatic landing

With a LAND 3 indication, the autopilot system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing (fail operational).

With a LAND 2 indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path (fail passive).

An EICAS message displays for any fault limiting the capability of the automatic landing system. Below 200 feet RA, a change from LAND 3 to LAND 2 is not annunciated. Faults not requiring immediate crew action or awareness are annunciated after touchdown.

AFDS Flight Mode Annunciations

Flight mode annunciations display above AFDS status annunciations. Mode annunciations, from left to right, are:

- autothrottle
- roll
- pitch

Active modes display at the top of the flight mode annunciation boxes in large green letters. Armed modes (except for TO/GA in flight) display in smaller white letters at the bottom of the flight mode annunciaton 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 annunciation 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

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 become 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 rotation
- After takeoff, the AFDS commands a pitch attitude less than the pitch limit indicator 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 annunciation 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, the 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 selector 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 (limited to a maximum of V2 + 10)
- 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 with the takeoff reference thrust limit displayed:
  - removes takeoff and climb derates and assumed temperature thrust reduction
  - A/T in HOLD, autothrottle annunciation is THR REF
  - between 50 feet and 400 feet, selects TO/GA roll mode
  - above 400 feet, selects TO/GA roll and pitch modes
- 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 or altitude capture below 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.

Pushing the APP switch arms localizer in roll mode and glideslope in pitch mode. Either localizer or glideslope can be captured first.

Pushing the LOC switch arms only the localizer. Localizer capture can occur when the intercept angle is less than 120 degrees.

Runway Alignment and Asymmetric Thrust Compensation

AFDS controls the rudder during multiple A/P approaches to compensate for crosswind landings and engine-out asymmetric thrust conditions. With LAND 2 or LAND 3 annunciated, A/P control of the rudder is active.

For crosswinds requiring more than 10 degrees of crab angle, runway alignment occurs at 500 feet AGL. A sideslip of 5 degrees is established to reduce the crab angle. This configuration is maintained until touchdown. The airplane lands with the upwind wing low.

For crosswinds requiring a crab angle of between 5 and 10 degrees, an initial alignment occurs at 500 feet AGL, followed by a second alignment at 200 feet AGL. The initial alignment initiates a sideslip to reduce the crab angle to 5 degrees. This configuration is maintained to 200 feet AGL, where a second sideslip alignment increases the sideslip to further reduce the touchdown crab angle.

For crosswinds requiring a crab angle of less than 5 degrees, runway alignment occurs at 200 feet AGL, where a sideslip is introduced to align the airplane with the runway.

If an engine fails prior to the approach, AFDS introduces a sideslip at 1,300 feet AGL. This establishes a wings level configuration. If an engine fails during the approach, the wings level configuration is established when the engine failure is detected.

If moderate or strong crosswinds are from the side opposite the failed engine, no wings level sideslip is commanded, since the airplane is already banked into the wind.

If the A/Ps are disengaged, manually or automatically, in an asymmetric thrust condition with rudder control active, the rudder moves to the trimmed position. The pilot may need to exert rudder pedal force to maintain a smooth transition to manual flying.

Flare

The flare maneuver brings the airplane to a smooth automatic landing touchdown. The flare mode is not intended for single autopilot or flight director only operation.

Flare arms when LAND 3 or LAND 2 annunciates. At approximately 50 feet radio altitude, the autopilots start the flare maneuver. FLARE replaces the G/S pitch flight mode annunciation.

During flare:

- at 25 feet radio altitude, the autothrottle retards thrust levers to idle
- IDLE replaces the SPD autothrottle flight mode annunciation
- at touchdown, the FLARE annunciation no longer displays, and the nose lowers to the runway

Rollout

Rollout provides localizer centerline rollout guidance. Rollout arms when LAND 3 or LAND 2 annunciates.

At approximately five feet radio altitude, rollout activates. ROLLOUT replaces the LOC roll flight mode annunciation.

The autopilot controls rudder and nose wheel steering to track the localizer centerline.

During rollout, autothrottle IDLE mode remains active until the autothrottle disconnects with thrust levers in reverse.

Rollout guidance continues until the autopilots are disengaged.

Note: Ten seconds after reverse thrust levers are down, autothrottle is armed until flaps are UP. Pushing a TO/GA switch while the autothrottle is armed activates the autothrottle in THR REF mode.

Automatic Flight Approach Profile

Automatic Flight - Go–Around

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.

With flaps out of up, but not in landing position, activation of VNAV in VNAV PTH changes the reference thrust limit to CRZ. However, pressing TO/GA changes the reference thrust limit to GA and GA thrust is available.

Pushing either TO/GA switch activates a go–around. The mode remains active even if the airplane touches down while executing the go–around.

When the flight director switches are not on, pushing either TO/GA switch displays the flight director bars.

The TO/GA switches are inhibited when on the ground and enabled again when in the air for a go-around or touch and go.

With the first push of either TO/GA switch:

- 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.

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	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.

Intentionally
Blank

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Audio Control 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
- pushing CAB transmitter select switch twice within three seconds places a priority call to a selected cabin station

G-BNLK - G-BNLY, G-CIVA - G-CIVW

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)
- flight interphone (FLT)
- ACARS (VHF C)
- SELCAL (VHF or HF)

Resets when respective transmitter select switch pushed or; when already pushed, by pressing a MIC/INTERPHONE switch.

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.

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

G-BNLK - G-BNLY, G-CIVA - G-CIVY

G-BYGA - G-BYGG, G-CIVZ

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

G-BNLK - G-BNLY, G-CIVA

- 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.

G-BNLK - G-BNLY, G-CIVA - G-CIVY

Displays ACARS on VHF C when ACARS selected.

G-BYGA - G-BYGG, G-CIVZ

Displays DATA on VHF C when ACARS selected.

3 HF Sensitivity (SENS) Control

G-BNLK - G-BNLY, G-CIVA - G-CIVY

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.

3 HF Sensitivity (SENS) Control

G-BYGA - G-BYGG, G-CIVZ

Rotate – adjusts sensitivity of selected HF receiver.

Control rendered inoperative by radio tuning panel failure or by OFF switch.

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.

G-BNLK - G-BNLY, G-CIVA - G-CIVY

Displays ACARS on VHF C when selection of the frequency transfer switch would reconfigure VHF C to the data mode.

G-BYGA - G-BYGG, G-CIVZ

Displays DATA on VHF C when selection of the frequency transfer switch would reconfigure VHF C to the data mode.

9 Frequency Selector

Rotate – to set frequency in the STANDBY window:

- outer knob – selects the portion of the frequency to the left of the decimal point
- inner knob – selects the portion of the frequency to the right of the decimal point

10 Radio Tuning Switches

Push –

- selects radio to be tuned
- tuned frequency displays in ACTIVE frequency window
- standby frequency displays in STANDBY frequency window

G-CIVX, G-CIVY

Push and hold – removes automatic squelch on selected VHF radio until switch is released.

G-BNLK - G-BNLY, G-CIVA - G-CIVW

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

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, glareshield, or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Hand Microphone

1 Hand Microphone Push To Talk Switch

Push – activates hand microphone.

2 Hand Microphone

Transmits on system selected by audio control panel.

Oxygen Mask Microphone

1 Oxygen Mask Microphone

Enabled when oxygen mask doors open. Boom microphone is disabled.

Activation of a control wheel, glareshield, or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Control Wheel Microphone/Interphone Switch

1 Control Wheel Mic/Interphone Switch

MIC – allows oxygen mask or boom microphone transmission on selected transmitter. Spring-loaded to center.

CENTER – off position.

INT – allows oxygen mask or boom microphone transmission on flight interphone system. Latched in position.

Glareshield Microphone Switch

1 Glareshield Microphone (PTT) Switch

Push – allows oxygen mask or boom microphone transmission on selected transmitter.

Service Interphone Switch

1 Service Interphone (SERV INT) Switch

OFF – allows independent operation of service and flight interphone systems.

ON – connects service and flight interphone systems.

Observer Audio System Switch

1 Observer (OBS) AUDIO SYSTEM Switch

Allows Captain or First Officer to use Observer's audio control panel.

CAPT - connects Observer's audio control panel to Captain's:

- hand mic
- boom mic/headset
- headphone
- oxygen mask mic
- speaker
- push to talk switches

NORM - audio control panel normal operation.

F/O - connects Observer's audio control panel to First Officer's:

- hand mic
- boom mic/headset
- headphone
- oxygen mask mic
- speaker
- push to talk switches

Handset

Handset provides communication with other handsets or PA system.

1 PA Push To Talk (PTT) Switches

Push – in PA mode connects handset mic to selected PA area.

2 Reset Switch

Push – cancels call.

1 Interphone Keys

Push – selecting two digit code calls respective station or PA area.

2 PA Push To Talk (PTT) Switches

Push – in PA mode connects handset mic to selected PA area.

3 Reset Switch

Push – cancels call or incorrectly selected code.

Call Panel

Provides control for either PA (passenger address) or CAB (cabin) interphone communications using either the handset or an audio control 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 control panel or handset

3 Reset (RST) Switch

Push - cancels call or incorrectly selected code, or displays DIRECTORY when scrolling through directory.

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

G-BYGA - G-CIVZ

- PARTY LINE

Note: Call station directory located on handset. Light sensor adjusts intensity of call station indicator.

Cockpit Voice Recorder System

Cockpit Voice Recorder Panel

G-BYGA - G-BYGG, G-CIVU - G-CIVZ

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

G-BNLK - G-BNLY, G-CIVA - G-CIVT

1 Monitor Indicator

2 TEST Switch

Push - tests all four channels.

3 ERASE Switch

Push and hold for three seconds – erases voice recorder if on the ground, AC power on, and parking brake set.

4 Cockpit Voice Recorder Headset Jack

A headset can be plugged in to monitor playback of voice audio, or monitor tone during test.

Cockpit Voice Recorder Switch

G-BYGA - G-BYGG, G-CIVU - G-CIVZ

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.

Flight Recorder Maintenance Power Switch

1 Flight Recorder Maintenance (FLT RCDR MAINT) POWER Switch

OFF – removes power from digital flight data recorder when airplane on the ground and engines not in start or run condition, or air/ground sensors indicate in flight.

ON – allows digital flight data recorder to be powered during maintenance when airplane on the ground.

Miscellaneous Communication Switches

VHF-L Direct Communication Switch

G-BYGA - G-BYGG, G-CIVF - G-CIVZ

1 VHF-L DIRECT Communication (COMM) Switch

NORMAL - all communication systems operate normally.

VHF-L DIRECT - If loss of communication occurs, allows Captain to communicate on VHF-L transceiver if operable. Connects Captain's boom/mic headset and control wheel push to talk switches directly to VHF-L transceiver. No volume control is available.

ACARS Selector

1 ACARS Selector

L - selects left ACARS.

AUTO - selects left ACARS. If left fails, selects right ACARS.

R - selects right ACARS.

Cabin Signal Switch

G-BNLK - G-BNLY, G-CIVA - G-CIVP

1 CABIN SIGNAL Switch

Push - signals ready for takeoff to the cabin.

Lavatory Privacy Switch/Light

G-CIVF - G-CIVO

1 Lavatory Privacy ON Light

Illuminated (white) - forward upper deck lavatory privacy system activated.

2 Lavatory (LAV) Privacy (PRI)

Push -

- illuminates lavatory privacy ON light
- activates forward upper deck lavatory privacy system and reserves upper deck lavatory for flight crew use
- forward upper deck lavatory door locks for 10 minutes when lavatory is vacant
- forward upper deck lavatory door may be opened with flight deck door key

Second push -

- extinguishes lavatory privacy ON light
- cancels lavatory privacy system if it is active and allows passenger use of the forward upper deck lavatory

Printer Controls

1 FAULT Light

Illuminated (amber) - indicates printer failure.

2 Message (MSG) Light

Illuminated (green) - indicates message sent to printer.

3 PAPER Indicator

Indicates amount of paper in printer.

4 TEST Switch

Push –

- tests printer
- prints test pattern

5 Alert Reset (ALRT RST) Switch

Push - resets Message (MSG) light.

6 Repeat (REPT) Switch

Push - reprints last message.

7 SLEW Switch

Push and hold - advances paper.

Cabin Telecommunications Unit (CTU) and SATCOM Control Panel

1 CTU SELECTOR SWITCH

DISABLE

CTU disabled

ENABLE

CTU enabled

Note: The selector switch should normally be left in ENABLE

Flight Crew must exercise judgment when it is appropriate in inhibit telephone communication from the passenger cabin

2 SATCOM SELECTOR SWITCH

STANDBY

Places the SATCOM in Standby mode

#1

SATCOM system #1 selected

AUTO

The system selects the most suitable system when more than one system is installed

#2

SATCOM system #2 selected

Note: The selector switch should normally be left in AUTO

WIFI and SATCOM Control Panel (WIFI enabled a/c only)

1 WIFI SELECTOR SWITCH

DISABLE

WIFI disabled

ENABLE

WIFI enabled

Note: The selector switch should normally be left in ENABLE as the system will automatically be enabled above 10,000 ft and disabled below this height.

Flight Crew must exercise judgment when it is appropriate to inhibit WIFI communication from the passenger cabin.

2 SATCOM SELECTOR SWITCH

STANDBY

Places the SATCOM in Standby mode

#1

SATCOM system #1 selected

AUTO

The system selects the most suitable system when more than one system is installed

#2

SATCOM system #2 selected

Note: The selector switch should normally be left in AUTO

Intentionally
Blank

Introduction

The communication system includes:

- cockpit voice recorder system
- radio communication system
- interphone communication system

(G-BNLK - G-CIVZ ; SB activates ATS datalink)

- air traffic services datalink communications

(G-BNLK - G-CIVZ ; SB activates AOC datalink)

- company datalink communications

The radio tuning and audio control panels control the communications system.

Audio Control Panels

The audio control panels are used to manage radio and interphone communication systems. Navigation receiver audio can also be monitored.

The captain, first officer, and first observer audio control panels are installed on the aft aisle stand.

Microphones are keyed by pushing the desired audio control panel transmitter select switch and then selecting one of the following:

- the MIC position of a control wheel switch
- the R/T position of an audio control panel PTT (Push To Talk) switch
- the PTT position of a glareshield microphone 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 transmitted or received flight deck audio as selected on the audio control panels. It also records flight deck area conversations using an area microphone and crew member boom, oxygen mask, and hand microphones, independent of microphone/interphone switch position. All inputs are recorded continuously.

Radio Tuning Panels

The radio tuning panels tune the VHF and HF radios. The panels, designated left, center, and right, 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

G-BNLK - G-BNLY, G-CIVA

- 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)

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 control panels control voice transmission and receiver monitoring.

VHF L and VHF R are configured for voice communication only. VHF C can be configured for voice or ACARS data communication. Normally, VHF C is configured for ACARS data communication.

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.

G-BNLK - G-BNLY, G-CIVA - G-CIVY

HF radio sensitivity can only be adjusted using the on–side radio tuning panel. Sensitivity control is not affected by radio tuning panel status.

G-BYGA - G-BYGG, G-CIVZ

HF radio sensitivity can be adjusted using any radio tuning panel with the receiver selected. Sensitivity control is rendered inoperative by radio tuning panel failure or by pushing the OFF switch.

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.

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)

(G-BNLK - G-CIVZ ; SB activates ATS datalink)

ACARS datalink provides automatic and manual means to transmit and receive air traffic services, 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.

(G-BNLK - G-CIVZ ; before SB, ATS datalink not activated)

ACARS datalink provides automatic and manual means to transmit and receive operational, maintenance, and administrative information between the airplane and a ground station. ACARS is operational when electrical power is established and is accessed by selecting the ACARS prompt on the CDU main menu.

ACARS communicates through VHF C.

If ACARS is not available due to lost communication, information to be transmitted is stored and transmitted automatically when communication is regained.

G-BNLK - G-BNLY, G-CIVA - G-CIVY

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.

G-BYGA - G-BYGG, G-CIVZ

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 DATA is displayed in the radio tuning panel active frequency window.

G-BNLK - G-BNLY, G-CIVA - G-CIVW
When a VHF C standby frequency is transferred to the active window, voice communication mode is selected and 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.

G-BNLK - G-BNLY, G-CIVA - G-CIVW
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.

G-CIVX, G-CIVY
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.

G-BYGA - G-BYGG, G-CIVZ
When a VHF C 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 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.

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 Access

Normally, ACARS displays are viewed on the center CDU. ACARS prompts are available on the menu page of all CDUs.

1 ACARS

Push –

- displays ACARS page
- activates ACARS control of CDU

ACARS Menu Page

- displayed when ACARS selected on FMS-CDU main Menu page
- provides access to ACARS individual pages or sub menus

1 FLT INIT LINE SELECT KEY

PUSH - displays INITIALISATION page 1/2 prior to OFF event and INITIALISATION page 2/2 page after OFF event

2 WT/BALANCE LINE SELECT KEY

PUSH - displays WT/BALANCE page

3 MESSAGES LINE SELECT KEY

PUSH - isplays MESSAGES MENU page

4 DEFECT REP LINE SELECT KEY

PUSH - displays DEFECT REPORT page

5 ATC REQ LINE SELECT KEY

PUSH - displays ATC REQUEST MENU page

6 PERF REQ LINE SELECT KEY

PUSH - displays PERFORMANCE REQ page

7 WX/AIS LINE SELECT KEY

PUSH - displays WEATHER/AIS page

8 FLT PLAN LINE SELECT KEY

PUSH - displays FLT PLAN page

9 DIVERSION LINE SELECT KEY

PUSH - displays DIVERSION page

10 DEP/ARR LINE SELECT KEY

PUSH - displays DEP/ARR page

11 MISC LINE SELECT KEY

PUSH - displays MISCELLANEOUS sub menu page

12 ADVISORY LINE

- displays ACARS advisory messages

Initialisation Page 1

- page displayed after sending INITIALISATION 2/2 for previous flight and prior to OFF event for forthcoming flight

Use to

- enter data required for basic ACARS operation for forthcoming flight
- enter required data after flight completion prior to flight records being sent
- provides records of flight for crew use
- provides access to ACARS individual pages or sub menus

1 FLT NO LINE

- valid entry is up to four numbers

2 DEP(Departure) LINE

- valid entry is the three letter IATA code or the four letter ICAO code for the departure station

3 DEST(Destination) LINE

- valid entry is the three letter IATA code or the four letter ICAO code for the destination station

4 FOB(Fuel On Board) LINE

- valid input is total fuel load to nearest hundred kgs (automatically supplied from FQIS)

5 ETE(Estimated Time En Route) LINE

- valid entry is XX or XXX or XXXX and is flight time obtained from SWORD plan

- used to generate ETA information

6 PERF REQ LINE SELECT KEY

PUSH - displays PERFORMANCE REQ page

7 GMT LINE

Displays GMT when available from aircraft clocks. Entry permitted when no time available from aircraft clocks and NOCOM before OFF event

8 GND UPDATE LINE SELECT KEY

Only displayed when time not available from aircraft clocks but communication link established

PUSH - sends request for a ground update of the internal ACARS clock

- displays <ACT> when request sent

9 CREW DETAILS LINE SELECT KEY

PUSH - displays CREW DETAILS page

10 PREV FLT REC LINE SELECT KEY

PUSH - displays PREVIOUS FLIGHT page

11 INIT DATA REQ LINE SELECT KEY

PUSH - sends request for uplink of Initailisation Data

Initialisation Page 2

1 OUT LINE

- time park brake released and all doors closed

- cannot be overwritten

2 GMT LINE

- displays current ACARS GMT

3 ON LINE

- time aircraft landed

- cannot be overwritten

4 BLK TIME LINE

- elapsed time between OUT and IN events

5 FUEL REM

- valid entry is fuel remaining to nearest hundred kgs (automatically provided by FQIS)

6 AUTOLAND LINE SELECT KEY

PUSH - adds Autoland status to Flight Records message for Autoland recording and if necessary for FDR inspection for autoland analysis (not currently in use)

- adds <SEL> after AUTOLAND prior to SEND operation

7 OFF LINE

- time aircraft was airborne

- cannot be overwritten

8 IN LINE

- time doors open and park brake set

- if park brake set prior to doors open, time will be when park brake was last set prior to the doors being opened

- if park brake not set, time will be when doors open

- cannot be overwritten

9 FLT TIME LINE

elapsed time between OFF and ON events

10 LDG PILOT LINE

- valid entry is crew members five letter code for landings record

- data may be line selected to scratchpad from appropriate crew member's data field and then line selected to LDG PILOT line

11 SEND LINE SELECT KEY

- displayed only after IN event

PUSH - sends completed data for flight records and returns display to INITIALISATION page for next sector

- available data sent automatically 15 minutes after In event if pages not completed and sent beforehand

- prints data

Crew Details Page

- page displayed when CREW DETAILS Line Select Key pushed on INITIALISATION Page 1/2 provides records of flight for crew use

1 CAPT, CO-PILOT, SUPL AND SCCM LINES

- valid entry is five letter name code for all flight crew and the SCCM

2 FC REPORT LINE

- valid entry is a XXXX GMT entry of the flight crew report time

3 PREV CREW LINE SELECT KEY

PUSH - enters five letter code and report times of crew from previous flight

- entries may be overwritten

4 CC REPORT LINE

- valid entry is a XXXX GMT entry of the cabin crew report time

Wt/Balance Page

- page used to request loadsheet data when appropriate information has not been uplinked automatically

1 WT/BAL REQ LINE SELECT KEY

PUSH - displays <SEL> alongside and stores request for a loadsheet data

2 SEND LINE SELECT KEY

PUSH - sends loadsheet request

- clears <SEL> annotation

Message Menu Page

- displayed when MESSAGES Line Select Key pushed on ACARS MENU PAGE
- provides access to Stored Uplink and Stored Downlink pages
- provides access to FreeText Message pages

1 STORED UPLINKS LINE SELECT KEY

PUSH - displays STORED UPLINKS page

2 STORED DOWNLINKS LINE SELECT KEY

PUSH - displays STORED DOWNLINKS page - clears <SEL> annotation

3 FREE TEXT LINE SELECT KEY

PUSH - displays FREE TEXT page

Stored Uplinks Page

- used for summary display of uplinked messages in order of being received
- used to select full message for display

1 MESSAGE LINE

- displays message number in order of being received

- displays first sixteen characters of message

- displays NEW or OLD for new and previously viewed messages respectively

- message can be deleted by selecting DELETE into scratchpad then line selecting to appropriate line

2 MESSAGE LINE SELECT KEY

PUSH - displays full MESSAGE page and changes NEW to OLD if not previously viewed

Stored Downlinks Page

- used for summary display of pilot selected or generated downlinked messages that are awaiting to be sent when COMM regained
- used to select full message for display and edit if required
- used to delete downlink messages that are no longer valid or required

1 MESSAGE LINE

- displays message number in order of being generated

- displays first sixteen characters of message

- message can be deleted from Downlink queue by selecting associated DEL Line Select Key

2 MESSAGE LINE SELECT KEY

PUSH - if message preceded by a <, displays full MESSAGE page for review and or/edit

Free Text Entry Page

- used to enter a free text downlink message
- use of FMS-CDU NEXT PAGE and PREV PAGE push buttons displays appropriate additional or previous pages for message construction/edit
- used to delete downlink messages that are no longer valid or required

1 TO LINE

- used to enter address for message

- valid address is three to seven letter code. (Company addresses are listed in Route Information Manual). No preceeding full stop required (already prefilled)

2 MESSAGE LINES

- used to enter text of message

3 SUMMARY LINE SELECT KEY

PUSH - displays FREE TEXT SUMMARY page

Free Text Summary Page

- used to review message prior to editing or accepting for transmission

1 EDIT LINE SELECT KEY

PUSH - displays FREE TEXT page 1/n to allow editing of appropriate line

- title changes to <PRINT after message has been accepted

- subsequent PUSH prints message

2 ACCEPT LINE SELECT KEY

PUSH - changes line title to SEND> and <EDIT to <PRINT

- subsequent PUSH sends message

Defect Report Page

- used for entry of FRM codes and/or Free Text for non CMC monitored defects
- page 2 has same format

1 FRM CODE LINES

- valid entry is standard FRM code (four numbers, two letters, two numbers)

2 PRINT LINE SELECT KEY

PUSH - prints all entries

3 TEXT LINE SELECT KEY

PUSH - displays DEFECT TEXT ENTRY Page

4 SEND LINE SELECT KEY

PUSH - send DEP/ARR message with associated entered information and defects

- defect code entries will change from large font to small font

Defect Text Entry Page

- used for entry of Free Text defect information
- can be entered with or without a FRM code

1 FRM CODE LINES

- prefilled with code from DEFECT REPORT PAGE. If no code entered or available left blank

2 ERASE LINE SELECT KEY

PUSH - deletes all entries

3 TEXT LINE

- three lines available for Free Text information related to the defect

4 DEFECT REPORT LINE SELECT KEY

PUSH - displays DEFECT REPORT page

ATC Request Menu Page

- used to select OCEANIC CLEARANCE REQUEST or PRE-DEPARTURE CLEARANCE page

1 OCEANIC CLRNCE LINE SELECT KEY

PUSH - displays OCEANIC CLEARANCE REQUEST page

2 PRE DEP CLRNCE LINE SELECT KEY

PUSH - displays PRE-DEPARTURE CLEARANCE REQUEST page

Oceanic Clearance Request Page

- used to request oceanic clearances

1 ATC ADDRESS LINE SELECT KEY

- select preselected addresses

- selection will cycle field through options as listed:

PIKCLXS	SHANWICK
YQXXRAC	GANDER
REKCLXS	ICELAND
SMACLXS	S.MARIA

manual entry

- valid entry is a seven letter SITA code to define the appropriate ATC centre

2 ENTRY POINT LINE

- valid entry is the alpha/numeric characters of the oceanic entry point.

- displays entry in standard FMS shortened format.

3 ETA LINE

- valid entry is GMT ETA for oceanic entry point.

4 REMARKS LINE

- used to request next best track, flight level or entry point in the event original request is not available.

5 MACH NO LINE

- valid entry is two digit requested mach number

6 FL LINE

- valid entry is three digit requested flight level

7 CALLSIGN LINE

- prefilled with Flt No from INITIALISATION PAGE 1/2
- can be overwritten with callsign where this differs from Flt No.
- valid entry is BAW followed by alpha/numeric callsign

8 SEND LINE SELECT KEY

PUSH - sends request to defined ATC centre

Pre-Departure Clearance Request Page

- used to request Pre-Departure Clearance

1 GATE LINE

- valid entry is the alpha/numeric gate number

2 ATIS LINE

- valid entry is the ATIS code letter

3 DEST LINE

- valid entry is the ICAO code
- prefilled from INITIALISATION PAGE 1/2

4 REMARKS LINE

- used to enter additional information

5 DEP LINE

- valid entry is the ICAO code
- prefilled from INITIALISATION PAGE 1/2

6 ADDRESS LINE

- valid entry is seven character SITA address

7 CALLSIGN LINE

- prefilled with Flt No from INITIALISATION PAGE 1/2
- can be overwritten with callsign where this differs from Flt No.
- valid entry is BAW followed by alpha/numeric callsign

8 SEND LINE SELECT KEY

PUSH - sends request to defined ATC centre

Performance Request Pages

- used to request Takeoff Performance Data

1 DEP LINE

- pre-filled with Departure station from Initiialisation Page

- valid entry is three letter IATA or four letter ICAO code

2 INTS LINE SELECT KEY

PUSH - adds <SEL> alongside header. Indicates an intersection takeoff is being planned and data for all intersection points will be sent back to the aircraft

3 WET LINE SELECT KEY

PUSH - adds <SEL> alongside header. Indicates wet runway conditions

4 WIND LINE

- used to enter surface wind

5 TEMP LINE

- used to enter OAT in °C

6 RUNWAY LINE

- used to enter departure runway

7 ANT-ICE LINE SELECT KEY

PUSH - adds <SEL> alongside header. Indicates engine anti-icing required for takeoff

8 PACKS OFF LINE SELECT KEY

PUSH - adds <SEL> alongside header. Indicates Packs Off data required

9 QNH LINE

- used to enter QNH in Hpa

10 SEND LINE SELECT KEY

PUSH - sends request to BA

- clears all <SEL> prompts

1 EST. TOW LINE

- used to enter estimated TOW

2 EST. MACTOW LINE

- used to enter estimated MACTOW

3 PERFORMANCE CORRECTION LINES

- used to enter two digit code. Code indicates Performance Correction from MEL or non-standard performance requirement

4 SEND LINE SELECT KEY

PUSH - sends request to BA

- clears all <SEL> prompts on PERFORMANCE REQ 1/2 page

Weather/AIS Page

- used to request standard FICO Met, AIS and SIGMET data
- provisions for requesting datalinked ATIS data

1 IDENT LINE

- field is prefilled with Destination station from INITIALISATION page

- may be overwritten, valid entry is 3 letter IATA or 4 letter ICAO identifier for airfield concerned or,

- alternative standard FICO country or area codes or,

- flight number

- display in small letters/numbers indicates request has already been made

2 MET LINE SELECT KEY

PUSH - displays <SEL> and stores request for Met data for airfield, country, area or route as defined by entry in IDENT field

3 ATIS LINE SELECT KEY

PUSH - displays <SEL> and stores request for ATIS for airfield defined in IDENT field

- inactive, provisioned for future use

4 ATIS TYPE LINE SELECT KEY (only displayed when ATIS <SEL> displayed

PUSH - cycles through ARRIVAL, DEPARTURE, UPDATE, UPDATE OFF AND ENROUTE selections

5 ERASE LINE SELECT KEY

PUSH - clears all <SEL> annunciations on page and entry on IDENT field

6 METS LINE SELECT KEY

PUSH - displays <SEL> and stores request for Met data for airfield and its alternates as defined by entry in IDENT field

7 SIGMET LINE SELECT KEY

PUSH - displays <SEL> and stores request for SIGMET data for airfield, country, area or route as defined by entry in IDENT field

8 AIS LINE SELECT KEY

PUSH - displays <SEL> and stores request for AIS data for airfield as defined by entry in IDENT field

9 SEND LINE SELECT KEY.

PUSH - send request for all items with <SEL> annunciations

- clears <SEL> annunciations

Flight Plan Page

- used to request flight plans with or without wind data

1 RTE/WIND LINE SELECT KEY

PUSH - displays <SEL> alongside and stores request for a revised flight plan and its winds

2 RTE LINE SELECT KEY

PUSH - displays <SEL> alongside and stores request for a revised flight plan without winds

3 WINDS LINE SELECT KEY

PUSH - displays <SEL> alongside and stores request for a wind update

4 ERASE LINE SELECT KEY

PUSH - erases selections and entries

5 DEP LINE

- prefilled with departure station entered on INIT page

- can be overwritten with three letter IATA or four letter ICAO code

6 DEST LINE

- prefilled with destination station entered on INIT page
- can be overwritten with three letter IATA or four letter ICAO code

7 CO ROUTE LINE

- optional entry used as means to identify route requested
- valid entry is standard company route identifier

8 LEVEL LINE

- valid entry is three digit number for flight level requested for flight plan

9 SEND LINE SELECT KEY

PUSH - sends request as defined by entries and <SEL> annotations
- clears <SEL> annotations

Diversion Page

- used to advise company of diversion
- used to request data for diversion station

1 DIVERT TO LINE

- valid entry is three letter IATA or four letter ICAO code

2 ETA LINE

- valid entry is GMT ETA at diversion station

3 ERASE LINE SELECT KEY.

PUSH - erases all <SEL> annotations and entries

4 METS LINE SELECT KEY

PUSH - adds <SEL> alongside and stores request for met data for diversion station and its alternates

5 AIS LINE SELECT KEY

PUSH - adds <SEL> alongside and stores request for AIS data for diversion station

6 ATIS LINE SELECT KEY-

PUSH - adds <SEL> alongside and stores request for ATIS data for diversion station

- future provision only

7 SEND LINE SELECT KEY

PUSH - sends message giving diversion station and ETA and request for <SEL> annotated items

Departure/Arrival Page (Prior to out)

- used pre-departure to advise delayed departure time

1 ETD LINE

- ETD header and dashed entry field displayed until OUT message displayed

- valid entry is GMT time

2 DEP DELAY LINE SELECT KEY

PUSH - displays DEParture DELAY page

3 ERASE LINE SELECT KEY

PUSH - erase all entries and <SEL> annotations

4 SEND LINE SELECT KEY

PUSH - sends appropriate message and changes <SEL> annotations to <ACT>

Departure/Arrival Page (between OUT and OFF)

- used pre-takeoff to advise delayed takeoff time

1 ETT LINE

- ETT (Estimated Time of Takeoff) header and dashed entry field displayed if takeoff has not occurred within 20 mins after OUT message

2 RTN-STND LINE SELECT KEY

- displayed between OUT and OFF events

PUSH - adds <SEL> after title and stores Return to Stand message until sent

3 DEP DELAY LINE SELECT KEY

- displayed when ETD entered

PUSH - displays DEParture DELAY page

4 ERASE LINE SELECT KEY

PUSH - erase all entries and <SEL> annotations

5 SEND LINE SELECT KEY

PUSH - sends appropriate message and changes <SEL> annotations to <ACT>

Departure Delay Code Page

- used to select reason for departure delay

1 SLOT LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by ATC slot

2 TECH LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by technical unserviceability

3 CREW LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by crew unavailability

4 RAMP LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by loading or dispatch

5 ARPT LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by Start up, Pushback or Taxy congestion

6 REAC LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by late aircraft arrival

7 PSGR LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by late or missing passengers

8 WX LINE SELECT KEY

PUSH - adds <SEL> alongside title

- when ETD message sent, adds reason for delay as being caused by adverse weather

9 DEP/ARR LINE SELECT KEY

PUSH - displays DEP/ARR page

Departure/Arrival Page (after OFF)

- used in flight to advise ETL
- provides access to ARR MSG page

1 ETL LINE

- ETL header displayed after OFF event

- ETL field prefilled with ETA calculated by adding ETE entry to OFF event

- valid entry is GMT time

2 RWY LINE

- used to define anticipated landing runway for ETL/ETA calculations

3 OVR AV HOLD LINE SELECT KEY

PUSH - adds <SEL> after title and stores Enter Hold message

- used to delete 'Average Hold' addition to ETL time to generate a corrected ETA. Selected when ETL already takes account of known holding delay

4 ERASE LINE SELECT KEY

PUSH - erase all entries and <SEL> annotations

5 ARR MSG LINE SELECT KEY

PUSH - displays ARRIVAL MESSAGE page

6 FLT INFO LINE

- valid entry is BAWxxxx

- requests uplinked information on Captain's next flight that day

7 SEND LINE SELECT KEY

PUSH - sends appropriate message and changes <SEL> annotations to <ACT>

- triggers an ETL uplink message, uplink will not be sent if a previous ETL uplink has been sent and ETL has not changed

- if any data is entered in ARR MSG page, triggers uplinks for Station, Pax Transfer and Stand information. (If uplinks required and no information required to be passed in ARR MSG page, enter a 0 in the MAAS field, then SEND)

Arrival Message Page

- used to select information for ARRIVAL MESSAGE
- page sent from DEP/ARR page
- page only displayed between OFF and ON event

1 MAAS LINE

- Displays the number of passengers requiring meet and assist on arrival

- valid entry is up to 2 numeric characters (leading zeroes not required)

2 YP/UM LINE

- Displays the number of young persons and unaccompanied minors requiring assistance on arrival

- valid entry is up to 2 numeric characters each separated by a slash (leading zeroes not required)

- if UM only are being carried, precede entry by a /

3 WCHR/S/C LINE

- Displays the number of wheelchairs of three different types

- WCHR = Pax can ascend/descend steps and make own way to/from cabin seat but cannot manage long distances

- WCHS = Pax cannot ascend/descend steps but is able to make own way to/from cabin seat

- WCHC = Pax completely immobile - requires wheelchair to/from cabin seat

- valid entry is up to 2 numeric characters (leading zeroes not required) each separated by slashes

e.g. Entry WCHR/S/C

1/1/2	01/01/02
1	01/00/00
/2	00/02/00
//5	00/00/05

4 DIP SELECT KEY

PUSH - adds <SEL> after title and when ARRIVAL MESSAGE sent will indicate diplomatic mail is being carried

Page displayed when ARR MSG selected from DEP/ARR PAGE

5 VAL SELECT KEY

PUSH - adds <SEL> after title and when ARRIVAL MESSAGE sent will indicate valuable cargo is being carried

6 NXT FLT NO LINE

- Valid input is BAWxxxx

- Indicates Flt No applicable to fuel requirements selected below

- Used to order fuel for next sector on multi sector operation

7 FUEL REQD LINE

- Total fuel required for next sector on multi sector operation sector on multi sector operation

8 BURN OFF LINE

- Trip fuel required for next

9 DEP/ARR LINE SELECT KEY

PUSH - displays DEP/ARR page

NOTE: - Any message in scratchpad will be transmitted when ARRIVAL MESSAGE sent. May be used for any additional information

10 SCRATCHPAD

May be used for any additional information

Miscellaneous Menu Page

- used as a sub menu to select listed sections or pages

1 MAINTENANCE LINE SELECT KEY

- inhibited except to maintenance personnel

2 MODE LINE SELECT KEY

PUSH - displays MODE page

Mode Page

- used to select MU for use
- used to select VHF radio to DATA or VOICE

1 ACARS MU LINE SELECT KEY

PUSH - selects MU for use

- displays <SEL> alongside active MU

- defaults to Left MU on power up

2 DATA LINE SELECT KEY

PUSH - selects VHF radio being controlled by ACARS to Data mode

- displays ACARS in active frequency display on Radio Management Panel for ACARS controlled VHF

- defaults Centre VHF to Data mode on power up

3 VOICE LINE SELECT KEY

PUSH - selects ACARS controlled VHF to normal use and control via the Radio Management Panel

Intentionally
Blank

Interphone Communication System

The interphone communication system includes the:

- flight interphone system
- cabin interphone system
- passenger address (PA) system
- service interphone system

The flight interphone, service interphone, and PA systems are normally operated through the audio control panel.

The cabin interphone is operated through the audio control panel or flight deck handset.

Flight Interphone System

The flight interphone system provides communications between flight deck crew members. The flight interphone system also provides communications between the flight deck and ground crew through the flight interphone jack on the nose landing gear.

The system is used by selecting the INT (interphone) position of a control wheel switch or an audio control panel PTT (Push To Talk) switch. The interphone can also be used by selecting the FLT transmitter select switch on an audio control panel and then selecting one of the following:

- the R/T position of an audio control panel PTT switch
- the MIC position of a control wheel switch
- the PTT position of a hand microphone switch
- the PTT position of a glareshield microphone switch

Crew alerting of a ground crew initiated call is provided by an aural alert chime and illumination of the FLT call indication. The call indication is reset by selecting the FLT transmitter select switch or transmitting on that transmitter. The ground crew is called by selecting P-1 on the flight deck call panel.

Service Interphone System

The service interphone system provides voice communications between ground crew stations at various locations around the airplane. The system can be connected to the flight interphone system through the service interphone switch on the overhead panel.

Passenger Address System

The passenger address (PA) system is used by the flight crew to make cabin announcements. The PA system is accessed using the boom microphone, oxygen mask microphone, hand microphone, or flight deck handset.

The boom, oxygen mask, or hand microphone is used by pushing the PA transmitter select switch and activating a microphone or push to talk switch. The system is monitored by pushing the PA receiver volume control.

The PA system can also be selected through the cabin interphone system, as described in the Cabin Interphone System section.

Cabin PA announcement priorities are:

- flight deck announcements from an audio control panel
- cabin handset direct access announcements
- priority (all area) announcements
- normal announcements from flight attendant or flight deck handsets

Cabin Interphone System

The cabin interphone system provides voice communications between the flight deck and the flight attendant stations.

The cabin interphone system is accessed by using the boom microphone, oxygen mask microphone, hand microphone, or flight deck handset located behind the aisle stand.

The boom or oxygen mask microphone is used by selecting the CAB transmitter select switch 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 volume control.

Selecting the CAB transmitter select switch or removing the flight deck 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 select switch on the audio control 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 control 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 select switch, or transmitting on that transmitter. The call indication is also reset by picking up the flight deck handset.

G-BNLK - G-BNLY
If more than one call is made to the flight deck at a time, the other callers get a busy signal, but the caller location is stored.

G-BYGA - G-CIVZ
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 NEXT switch on the call panel.

Intentionally
Blank

(G-BNLA, G-BNLD - G-CIVZ ; SB installs NG FMC)

Air Traffic Services Datalink

Air Traffic Services Datalink (ATS DL) functions are accomplished on the CDU. These functions include Air Traffic Services Facilities Notification (AFN), 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. Display of the EICAS communications •ATC message and a high 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.

ATC Datalink messages in this section show "N" as the number of pages required to display the complete message.

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.

Uplink Message

ATC Uplinks

An •ATC communications message, an aural chime, and display of the EICAS ATC message block annunciates an arriving ATC message. The message text displays below the normal EICAS engine display. The ATC message LARGE ATC UPLINK displays when the uplink is too large to fit the message area.

Company Uplinks

A •COMM communications message and an aural chime annunciate an arriving company uplink message.

Accept/Reject Uplinks

The XXXXz ATC UPLINK page displays ACCEPT SEND> , STANDBY <SEND, or <REJECT prompt. Select ACCEPT SEND> or <REJECT to respond to the uplink message.

Selecting ACCEPT SEND> displays the VERIFY RESPONSE page with WILCO, ROGER, or AFFIRM in 1L. Selecting <REJECT displays the REJECT DUE TO page when the rejection message is not sending; then, displays the VERIFY RESPONSE page when the rejection message is sending. When the communications network sends a response indicating the message was received, the message status changes to ACCEPTED/REJECTED. Rejected messages are automatically removed five seconds after the message status changes to REJECTED.

The ACCEPT, CANCEL, and REJECT switches on the glareshield perform the same function as the prompts on the CDU.

ATC Index Page

The ATC INDEX page provides access to pages used for clearance requests and to the VERIFY REPORT page for free text downlink. It also provides ATC LOG printing access.

Note: Datalines 1L, 1R - 5R are blank when an Aeronautical Telecommunication Network (ATN) center is active.

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, PRINTERROR

Push - transmits contents of ATC log to printer when <PRINT LOG or <PRINTERROR displayed.

The following display descriptions are the same for all PRINT prompts in Section 5.33.

Displays <PRINTERROR when the printer has an error.

Displays PRINTING when the printer is busy and the print prompt is selected.

Displays BUSY when the printer is busy and the printer prompt has not been selected. The title line displays small font PRINT.

Displays FAIL when the printer has failed. The title line displays PRINT.

7 Position (POS) REPORT

Push - displays POS REPORT page.

8 WHEN CAN WE

Push - displays WHEN CAN WE EXPECT page.

9 FREE TEXT

Push - displays the VERIFY REPORT page with only the free text message element.

10 CLEARANCE

Push - displays VERIFY REQUEST pages for clearance request.

11 VOICE

Push - displays VERIFY REQUEST page for voice contact request.

Emergency Report Page

The EMERGENCY REPORT page provides the capability to create downlink messages to alert ATC to an aircraft emergency and to the lateral and vertical maneuvers the flight crew intend to execute.

1 MAYDAY

Before selecting <MAYDAY or PAN>, entering a number in SOB line displays fuel remaining data for inclusion in the downlink message.

Push -

- displays MAYDAY MAYDAY MAYDAY on the VERIFY EMERGENCY page
- selects, but does not display, additional POSITION REPORT message elements for inclusion in the emergency report downlink
- 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 direct to routing if entered position displayed
- message includes remainder of route if active destination airport 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.

Deletion of a large font altitude displays the default MCP altitude.

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 ATC INDEX

Push - displays ATC INDEX page. This description is the same for all CDU displays in Section 5.33 having the ATC INDEX prompt.

7 PAN

Push -

- displays PAN PAN PAN on the VERIFY EMERGENCY page
- selects, but does not display, additional POSITION REPORT message elements for inclusion in the emergency report downlink

8 Souls On Board (SOB)

Entry of number of persons on airplane displays the lesser of the totalizer or FMC computed fuel remaining and souls on board message elements for inclusion in the emergency report downlink.

Causes remaining fuel quantity to display.

Deletion of SOB deselects the message elements.

9 FUEL REMAINING

Initial display is blank.

Displays lesser of the totalizer fuel or the FMC computed fuel remaining in quantity and time.

Valid entry is HH+MM (hours and minutes).

10 VERIFY

Push - displays VERIFY EMERGENCY page.

Verify Emergency Page 1/N

The VERIFY EMERGENCY page displays the text of the EMERGENCY REPORT which will be downlinked to ATC. The page allows entering free text in the downlink message.

1 Lines 1 - 5

Pages 1/N to N/N display data from the EMERGENCY REPORT page and provide at least one line for free text entry.

Page 1/N 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

When multiple VERIFY EMERGENCY pages exist, the line title shows CONTINUED.

Push - displays EMERGENCY REPORT page.

3 REPORT SEND

Displays on last VERIFY EMERGENCY page.

Push -

- transmits an emergency report message containing the information on the VERIFY EMERGENCY page
- when MAYDAY selected and when enabled in airline policy file: transmits ATC position report, activates ADS in emergency mode, and transmits an AOC emergency report

XXXXz Emergency Page 1/N

The XXXXz EMERGENCY page displays the text of the emergency report message downlinked to ATC. XXXXz is the time the report was transmitted.

1 Lines 1 - 5

Pages 1/N to N/N display message transmitted to ATC at time of page title. Line 1 is blank on page 1/N.

2 Message STATUS

Displays current message status. The status is identical to the status displayed on the ATC LOG page.

3 ATC LOG

Displays on last XXXXz EMERGENCY page.

Push - displays the 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

Initially 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 entered or selected data and any or all of the ATC REQUEST pages.

6 VERIFY

Push - displays VERIFY REQUEST page. This description is the same for all ATC XXX REQUEST pages and for the WHEN CAN WE EXPECT page.

ATC Altitude Request Page 1/4

The ATC ALT REQUEST page 1/4 allows downlink requests for altitude changes.

Note: Datalines 2L, 4L, 1R, and 2R are blank when an ATN center is active.

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 (feet only), 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. This description is the same for all ATC XXX REQUEST pages.

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/Visual Meteorological Conditions (VMC)

Push - displays SEPARATION/VMC in large font and selects MAINTAIN OWN SEPARATION/VMC message 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 lateral offsets.

Note: Dataline 2L is blank when an ATN center is active.

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.

Note: Datalines 3L, 5L, 1R, 2R, and 3R are blank when an ATN center is active.

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 REQUEST 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 1/N

The VERIFY REQUEST pages display the text of the message to be downlinked to ATC for an altitude, speed, offset, or route clearance request.

When an ATN center is active, page access is not available from the ATC INDEX, VOICE selection or from the WHEN CAN WE EXPECT, VERIFY selection.

1 Lines 1 - 5

Pages 1/N to N/N display data which reflect the request and provide at least one line for free text entry.

Entered free text is included in downlink request.

2 ATC INDEX, REQUEST, WHEN CAN WE

Displays <ATC INDEX when page accessed from ATC INDEX page.

Displays <REQUEST when page accessed from ATC REQUEST page or ATC XXX REQUEST pages.

Displays <WHEN CAN WE when page accessed from WHEN CAN WE EXPECT page.

<ATC INDEX -

Push - displays ATC INDEX page.

<REQUEST -

Push - displays ATC REQUEST page.

<WHEN CAN WE -

Push - displays WHEN CAN WE EXPECT page.

3 REQUEST SEND

Displays on last VERIFY REQUEST page.

Push -

- initiates ATC request containing the information displayed on the VERIFY REQUEST page
- displays SENDING before network acknowledgement within time limit
- displays SENT after network acknowledgement within time limit
- displays RESEND when no network acknowledgement within time limit
- 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 1/N

The ATC REQUEST pages display the text of the request message downlinked to ATC. XXXXz is the time request was transmitted.

1 UPLINK

Push - displays the XXXXz ATC UPLINK 1/N page displaying ATC uplink response to displayed request.

Pages 1/N to N/N display data transmitted to ATC at the time in page title.

Page 1/N line 1 displays <UPLINK when ATC response to displayed downlink request exists.

Response time of ATC uplink displays following text.

2 Message STATUS

Displays request downlink message status from ATC LOG page.

ATC Report Page 1/2

The ATC REPORT pages access the VERIFY REPORT pages.

1 Verify Report Line 1 - 5

Push - displays VERIFY REPORT page for the ATC requested reports.

Pages 1/2 and 2/2 lines 1 to 5 display uplinked report or confirmation requests transmitted by ATC. Long messages are abbreviated and followed by two periods.

ATC Report or confirmation request -

Push - displays ATC requested report or confirmation VERIFY REPORT page.

Verify Report Page

The VERIFY REPORT page displays the text of the message to be downlinked in response to an ATC uplink. The page also allows review and modification of the message, entry of free text in the downlink, and sending a free text only downlink message. When the page is accessed from the FREE TEXT on the ATC INDEX page, FREE TEXT displays in the line 1 title.

1 Lines 1 - 4

Display message text and data for each message.

Entry is allowed in any data line displaying boxes.

Entry may be deleted.

At least one line is available for free text entry.

2 CANNOT ACCEPT

Displays in response to WHEN CAN YOU ACCEPT uplinks.

Push - selects a CANNOT ACCEPT message.

Selection may be deleted.

3 REPORT

Push - displays ATC REPORT page.

4 SEND

Push -

- transmits ATC REPORT containing the information displayed on the VERIFY REPORT page
- displays SENDING
- displays SENT upon network acknowledgement within time limit
- displays RESEND when no network acknowledgement within time limit
- displays NO ATC COMM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for datalink fault

XXXXz ATC Report Page

The ATC REPORT page displays the text of the report message downlinked to ATC.

1 Report Text Lines 2 - 5

The text of the transmitted report or confirmation displays in Lines 2 - 5 in the order in which they have been displayed on the VERIFY REPORT page.

ATC Log Page 1/N

The ATC LOG pages display stored uplinks and downlinks. Log automatically erases after flight completion.

Note: When an ATN center is active, page access is not available from the XXXXz EMERGENCY page.

1 Lines 1 - 5

Display text of uplink and downlink messages. Long messages abbreviated and followed by two periods.

Title displays message receipt (uplink) or transmission (downlink) time.

Deleting a line deletes the log entry.

2 Message Status

Title displays one of seven uplink or six 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 occurred

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
- 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, XXXXz ATC REQUEST, or XXXXz ATC REPORT 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 1/2

The ATC LOGON/STATUS page is used to initiate an ATC connection. The page displays ATC COMM and datalink status. ATC COMM can be turned off and a value for maximum uplink delay can be entered.

1 LOGON TO

Displays dashes when no ATC COMM connection exists and no ATC center identifier has been entered.

Valid entry is a four-to-eight 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 when no ATC COMM connection exists; or dashes when an ATC COMM connection exists.

2 Flight Number (FLT NO)

Displays flight number from route page; or when flight number entered, propagates to the ROUTE page 1/N, to the PROGRESS page title, and to the POS REPORT page title.

Valid entry is two to eight alphanumeric characters.

Display clears at flight completion.

3 Tail Number (NO)

Displays tail number (Registry Number) stored in FMC.

Valid entry is one to seven alphanumeric characters.

4 Max Uplink (U/L) Delay

Elapsed time from transmission to receipt of an ATC uplink message causing a late annunciation.

Valid entry is 1 to 999.

5 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; displays boxes in 1L.

6 Origin

Origin is repeated from the Route page. Entry is described in Chapter 11, Route page. Entry will not propagate to the Route page.

7 Destination

Destination is repeated from the Route page. Entry is described in Chapter 11, Route page. Entry will not propagate to the Route page.

8 Active Center (ACT CTR)

Displays four character identifier of active ATC center.

9 Next Center (CTR)

Displays four character identifier of next ATC center when valid uplink message containing the next center exists; otherwise, blank.

10 DATA LINK Status

Displays status: READY, ATN READY, NO COMM, VOICE, or FAIL.

ATC Logon/Status Page 2/2

The ATC LOGON/STATUS page 2 displays ADS and datalink status. ADS can be armed, turned off, or put in emergency mode.

1 ADS OFF/ARM

Line title: ADS

- ADS armed and no ADS connection exists
- displays OFF in small font and ARM in large font

Push -

- no ADS reporting
- displays OFF in large font and ARM in small font

Line title: ADS (ACT)

- ADS on and one or more ADS connections exist
- displays OFF in small font and ARM is large font.

Push -

- terminates all ADS connections and ADS reporting
- displays OFF in large font and ARM in small font

Line title: ADS

- ADS selected off
- displays OFF in large font and ARM in small font

Push -

- arms ADS reporting
- displays ARM in large font and OFF in small font

2 ADS Emergency (EMER) ON/OFF

Line title displays ADS EMERG when ADS is in normal mode, OFF displays in large font and ON displays in small font.

Line title displays ADS EMERG when ADS is in emergency mode. OFF displays in small font and ON displays in large font.

Display is blank when ADS selected off.

OFF in large font -

Push - puts ADS in emergency mode.

ON in large font -

Push - puts ADS in normal mode.

XXXXz ATC Uplink Page 1/N

The ATC UPLINK pages display messages uplinked by ATC. The pages provide the capability to respond to uplinked messages and to load clearances. XXXXz is the message receipt (uplink) time.

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.

2 Message Text

Lines 2 to 5 (first page only), Lines 1 to 5 (all but first and last pages), or Lines 1 to 3 (last page only) display text of uplinked ATC message. If the ATC uplink will be delayed more than the MAX U/L DELAY on the ATC LOGON/STATUS page, "UPLINK DELAY EXCEEDED" displays in the title line. If no delay occurs, the uplink message displays in clear language beginning on the title line. After crew has ACCEPTed or REJECTed an ATC uplink message, RESPONSE XXXXz displays.

If the flight crew response is ACCEPT, then WILCO, ROGER, or AFFIRM displays. If the flight crew response is REJECT, then UNABLE or NEGATIVE displays; and, if a reject reason was selected or entered on the REJECT DUE TO page, the text displays.

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 (on first page only) status of ATC uplink message from ATC log page.

XXXXz ATC Uplink Page N/N

Last XXXXz ATC UPLINK page continues text of uplinked ATC message. Page provides capability to respond to uplinked messages and to load clearances.

1 STANDBY

Displays <SEND on last page until response has been made.

Push - transmits a response message containing the STANDBY response.

2 REJECT

Displays <REJECT on last page when UNABLE or NEGATIVE is a valid response.

Push - displays REJECT DUE TO page when a rejection message is not sending; displays VERIFY RESPONSE page when a rejection message is sending.

3 ARM, ARMED

Displays ARM> when report is armable.

Push -

- arms report for transmission
- displays ARMED
- deleting ARMED displays ARM and disarms report transmission

4 LOAD

Displays LOAD> on last page when uplink message has loadable data.

Push - loads data into route.

5 ACCEPT SEND

Displays SEND> on last page 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.

6 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.

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 XXXXZ ATC UPLINK page.

4 DUE TO WEATHER

Initially, data line displays WEATHER> in small font.

Push - selects DUE TO WEATHER message element in response downlink message.

5 VERIFY

Push - displays VERIFY RESPONSE page.

Verify Response Page

The VERIFY RESPONSE page displays the text of a reject message to be downlinked to ATC in response to an ATC uplink.

1 ROGER, WILCO, AFFIRM, UNABLE, NEGATIVE, STANDBY

Displays UNABLE or NEGATIVE for the associated uplink.

2 Lines 2 - 5

If a reject reason was selected or entered as free text on the REJECT DUE TO page, the text of the reject reason displays in the order selected.

If DUE TO PERFORMANCE was selected on the REJECT DUE TO page, the text displays.

If DUE TO WEATHER was selected on the REJECT DUE TO page, the text displays.

If free text was entered on the REJECT DUE TO page, the text displays.

3 UPLINK, REJECT DUE TO

Displays <UPLINK when the displayed response is SENDING.

Displays <REJECT DUE TO when the displayed response is not SENDING.

UPLINK -

Push - displays XXXXz ATC UPLINK page corresponding to the displayed VERIFY RESPONSE page.

REJECT DUE TO -

Push - displays REJECT DUE TO page corresponding to the displayed VERIFY RESPONSE page.

4 RESPONSE SEND

Push -

- creates a rejection response message containing the information displayed on the VERIFY RESPONSE page and transmits downlink response to the active ATC center
- displays SENDING before network acknowledgement within time limit
- displays SENT after network acknowledgement within time limit
- displays RESEND when no network acknowledgement within time limit
- 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 the flight crew to query ATC about when to expect clearances.

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 HIGHER Altitude (ALT)

Push - selects a message querying ATC when to expect a higher altitude.

Selection may be deleted.

7 LOWER Altitude (ALT)

Push - selects a message querying ATC when to expect a lower altitude.

Selection may be deleted.

8 BACK ON Route (RTE)

Push - selects a message querying ATC when to expect to be cleared back on route.

Selection may be deleted.

Company Datalink

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

The FMC COMM page provides access to CDU pages accessing datalink information. It also indicates pending uplink information and status of the datalink system.

1 Uplink Status

The line title displays UPLINK when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks ensures prerequisite data is available before the uplink message can be selected. All uplink messages should be loaded to allow additional uplink messages to be processed and to avoid nuisance scratchpad messages. The flight crew can then accept or reject the uplinks. Examples of preprocessing include:

- RTE X, ALTN LIST, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete
- Subsequent uplinks of the same type are held until previous uplinks are included or discarded by the flight crew
- TAKEOFF data uplink is held until gross weight is entered, a pending PERF uplink is included or discarded, or a takeoff runway is entered

When both ALTN and ALTN LIST uplinks are pending, "(2)" displays to the right of UPLINK in the line title.

The EICAS message FMC MESSAGE displays whenever any UPLINK message is pending.

Selection of prompt displays the related pages:

- RTE X
- ALTN
- PERF INIT
- TAKEOFF REF
- RTE X DATA
- DESCENT FORECAST
- POS REPORT

2 DATA LINK

Displays the datalink system status. System status can be:

- READY
- NO COMM
- VOICE
- FAIL

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 (up to 10 digits).

1 Position (POS)

Displays waypoint identifier of last sequenced waypoint.

2 Estimate (EST)

Displays the next FMC waypoint; displays in magenta if it is the active waypoint.

Valid entry is any waypoint identifier in the active route; allows compulsory reporting points to be sent to ATC.

Entry overrides displayed waypoint.

Deletion of entry returns default waypoint.

3 NEXT Waypoint

Displays waypoint identifier of leg following the EST waypoint.

Valid entry is any waypoint identifier in the active route; allows compulsory reporting points to be sent to ATC.

Entry overrides displayed waypoint.

Deletion of entry returns default waypoint.

4 Temperature (TEMP)

Displays current static air temperature.

5 WIND

Displays current wind direction and magnitude.

6 COMPANY SEND

Push -

- sends downlink position report to company
- default values are used for EST, NEXT, DEST ETA, and SPD
- displays SENDING
- displays SENT before network acknowledgment within time limit
- displays RESEND when no network acknowledgment within time limit
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK in the line title and NO COMM, VOICE, or FAIL as appropriate for datalink fault

7 Actual Time of Arrival (ATA)

Displays ATA at last sequenced waypoint.

8 Altitude (ALT)

Displays altitude for the last sequenced waypoint.

9 Estimated Time of Arrival (ETA)

Displays ETA at the EST 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 Speed (SPD)

Displays current Mach speed target.

Valid entry is a Mach number in the range .61 to .91.

Entry overrides displayed Mach.

Deletion or page change returns default Mach.

12 Position (POS) FUEL

Displays calculated or totalizer fuel remaining at the POS waypoint as selected on PROGRESS page 2.

13 ATC SEND

Push -

- sends downlink position report to ATC
- default values are used for EST, NEXT, DEST ETA, and SPD
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays SENT before network acknowledgement within time limit
- displays RESEND when no network acknowledgement within time limit
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK in the line title and NO COMM, VOICE, or FAIL as appropriate for datalink fault

Intentionally
Blank

EICAS Alert Messages

Message	Level	Aural	Message Logic
(G-BNLK - G-CIVZ ; SB removes DATALINK AVAIL inhibit option)			
>DATALINK AVAIL	Advisory		ACARS datalink is available after a temporary loss.
(G-BNLK - G-CIVZ ; SB installs careted message)			
>DATALINK LOST	Advisory		ACARS datalink is temporarily lost.
>DATALINK SYS L, R	Advisory		Respective ACARS datalink is failed and not available.
>SATCOM	Advisory		Loss of both satellite voice and data capability due to SATCOM system failure.
>SATCOM DATA	Advisory		Loss of the satellite data communication due to an interface failure.
>SATCOM VOICE	Advisory		Total loss of voice capability due to equipment failure.
>SATVOICE AVAIL	Advisory		Re-establishment of voice capability after temporary loss.
>SATVOICE LOST	Advisory		Temporary loss of voice capability due to log-off, reversion to low gain, etc. Ground to air calls from ATC will not be received.
SATCOM DATA R	Status		Interface problem between SATCOM R and ACARS.
G-BYGA - G-BYGG, G-CIVF - G-CIVZ			
RADIO TRANSMIT	Advisory		VHF or HF radio keyed for 30 seconds or longer.

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.

(G-BNLK - G-CIVZ ; SB activates ATS datalink)

ATC MESSAGE	ATC uplinked message received.

PRINTER MESSAGE	ACARS message printing.
SATCOM CALL	Ground to air call.
SATCOM MESSAGE	SATCOM message received.
VHF DATA OFF	VHF C radio in voice mode and not available for ACARS data communication.

FMC Messages

(G-BNLK - G-CIVZ ; SB activates ATS/AOC datalink)

For FMC Message information, refer to Chapter 11.60.

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Electrical EICAS Messages 6.30.1

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Electrical Panel

1 Standby Power and Utility Bus Controls

2 External Power and APU Generator

3 AC Bus and Generator Controls

Standby Power, Battery, and Utility Bus Controls

1 STANDBY POWER Selector

Push to turn.

OFF –

- standby power not available
- main and APU standby busses disconnected from all power sources

AUTO – allows main and APU standby busses to be powered from available sources.

BAT –

- powers main battery bus from main battery through the main hot battery bus with battery switch ON
- powers APU battery bus from APU battery through the APU hot battery bus with battery switch ON
- disables main and APU battery chargers
- powers main and APU standby busses from their related batteries through their hot battery busses and standby inverters with Battery switch ON

Note: BAT position for ground maintenance use only.

2 BATTERY Switch

ON -

- main battery available as backup power source for main battery bus and main standby bus
- APU battery available as backup power source for APU battery bus and APU standby busses

OFF - disconnects main and APU batteries from related battery busses.

3 BATTERY Switch OFF Light

Illuminated (amber) - Battery switch off

4 UTILITY Power Switches

ON - each switch powers two utility Electrical Load Control Units (ELCUs) and two galley ELCUs.

OFF -

- removes power from related ELCUs
- resets fault logic circuitry
- both OFF, removes all power from IFE including WIFI if installed. Cabin night lighting remains available but must be selected from cabin

5 UTILITY Power OFF Lights

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

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
- ON light illuminated: disconnects related APU generator from AC electrical system

2 APU Generator Power Available (AVAIL) Lights

Illuminated (white) -

- APU generator power quality acceptable
- extinguishes when ON light illuminates

3 APU Generator Power ON Lights

Illuminated (white) -

- related APU generator connected to AC electrical system
- extinguishes when AVAIL light illuminates

4 External Power (EXT PWR) Control Switches

Push -

- AVAIL light illuminated: connects related external power to AC electrical system
- ON light illuminated: disconnects related external power from AC electrical system

5 External Power ON Lights

Illuminated (white) -

- related external power connected to AC electrical system
- extinguishes when AVAIL light illuminates

6 External Power Available (AVAIL) Lights

Illuminated (white) -

- related external power source plugged in, power quality acceptable
- extinguishes when ON light illuminates

AC Bus and Generator Controls

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

G-BYGA - G-BYGG, G-CIVN - G-CIVZ
Illuminated (amber) -

- IDG oil pressure low, or
- IDG oil temperature high, or
- GCB open due to uncorrectable generator frequency fault

G-BNLK - G-BNLY, G-CIVA - G-CIVM
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

Standby EFIS Selector

1 STANDBY EFIS Selector

CAPT - left PFD and ND powered by the Captain APU standby bus if both Captain and First Officer transfer busses unpowered. Right PFD, ND, and EFIS control panel will be unpowered.

F/O - Right PFD, ND, and EFIS control panel powered by First Officer APU standby bus if First Officer transfer bus is unpowered.

Left PFD and ND will be unpowered if both First Officer and Captain transfer busses are 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

1 Generator Field Manual Reset (GEN FIELD MAN RESET) Switches

Push - (spring-loaded toggle, guarded) opens or closes generator field if respective 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.

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

- 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.

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.

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 PRESS 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.

G-BYGA - G-BYGG, G-CIVN - G-CIVZ
The ELEC DRIVE message also displays if a GCB is open due to an uncorrectable generator frequency fault.

G-BYGA - G-BYGG, G-CIVB - G-CIVZ

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.

AC Electrical Power Distribution

AC power is distributed by the following busses:

- four main busses
- two transfer busses
- ground service and ground handling busses
- four galley busses
- four utility busses
- two standby busses

AC Main Busses

Each IDG normally powers its related AC bus through a 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
- Each AC bus powers a utility and galley bus
- 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
- upper deck emergency escape doors
- flight deck flood, navigation, and service lights
- miscellaneous service outlets and equipment

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

- horizontal stabilizer fuel pump for defueling

On the ground when AC bus 1 is not powered, the ground service bus can be connected to the same source powering the ground handling bus by pushing the Ground Service switch on the flight attendant’s panel at door 2L.

Ground Handling Bus

The ground handling bus is powered on the ground when APU generator 1 or external power 1 is available. If both are available, external power is automatically used. The ground handling bus powers individual equipment items such as:

- lower cargo handling equipment and compartment lights
- fueling system
- auxiliary hydraulic pumps 1 and 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

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
- center ADC
- PVD

First Officer Transfer Bus

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 EIU, right FMC
- right CDU, right HF

Utility and Galley Busses

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.

IFE and Cabin Lighting Control

Electrical power to the IFE and some cabin lighting is controlled from the flight deck through the Utility Power switches on the electrical panel. Pushing both Utility Power switches OFF removes all power from the IFE including WIFI if installed.

With the Utility Power switches OFF, the following cabin lights transfer to an alternate source and remain available for illumination:

- passenger reading lights
- crossover and upper deck ceiling lights
- attendant work lights

Note: All utility and galley bus power is lost with both Utility Power switches OFF.

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.

Major components of the system include:

- main and APU standby busses
- captain and first officer APU standby busses
- main and APU batteries
- main and APU standby inverters
- Standby EFIS and Standby Power selectors

Main Standby Bus

The main standby bus is normally powered by AC bus 3. With the Standby EFIS Selector in either CAPT or F/O 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 Standby EFIS Selector in CAPT or F/O and the captain transfer bus not powered (AC busses 1 and 3 unpowered), 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.

Note: The Standby EFIS Selector has no effect on power to the main standby bus.

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
- left ADC, left transponder, left EFIS control panel
- primary EICAS display, RMI, standby instrument lights

APU Standby Busses

The standby power system includes these APU standby busses:

- APU standby bus
- captain APU standby bus
- first officer APU standby bus

The APU standby bus and the captain APU standby bus are normally powered by the captain transfer bus. The first officer APU standby bus is normally powered by the first officer transfer bus.

With the standby EFIS Selector in CAPT or F/O and the captain transfer bus not powered (loss of AC busses 1 and 3), the APU standby bus and captain APU standby bus are 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. The first officer APU bus remains powered by its normal source.

With the Standby EFIS Selector in CAPT and both captain and first officer transfer busses not powered, the APU standby bus and captain APU standby bus are 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. The first officer APU standby bus is not powered. Moving the Standby EFIS Selector to F/O will provide APU inverter power to the first officer APU standby bus and remove power from the captain APU standby bus. The APU standby bus will remain powered by the APU standby inverter.

Note: The Standby EFIS Selector has no effect on power to the APU standby bus.

With the Standby EFIS Selector in F/O and the first officer transfer bus not powered (loss of AC busses 1 and 2), the first officer 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. The APU standby and captain APU standby busses are powered by their normal source. Moving the Standby EFIS Selector to CAPT removes APU inverter power from the first officer APU standby bus. The APU standby and captain APU standby busses remain powered by their normal source.

The APU standby busses provide power as follows:

- APU standby bus powers the left FMC
- captain APU standby bus powers the left PFD and left ND
- first officer APU standby bus powers the right EFIS control panel, right PFD, and right ND.

Standby Power Selector - BAT Position

With the Standby Power Selector in BAT, both main and APU battery chargers are disabled and both the captain and first officer transfer busses isolated from the standby power system. The main standby bus is powered by the main standby inverter through the main hot battery bus and the main battery. With the Standby EFIS Selector in CAPT, the APU standby and captain APU standby busses are powered by the APU standby inverter through the APU hot battery bus and the APU battery. The first officer APU standby bus is not powered.

With the Standby EFIS Selector in F/O, the APU standby and first officer APU standby busses are powered by the APU standby inverter through the APU hot battery bus and the APU battery. The captain APU standby bus is not powered.

Note 1: The Standby Power selector must be in AUTO for flight. The BAT position is for ground maintenance use only.

Note 2: In all cases where main and APU batteries are the power source, standby power from each battery is available for a minimum of 30 minutes.

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

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 System Diagram

Bus Equipment

The following list identifies selected equipment receiving power from the respective busses.

(Information in brackets identifies source of power and alternative source of power for bus)

Main Hot Battery Bus

(Powered by ground service bus/main battery)

ACARS DC
APU fire extinguisher
APU fuel shut-off valve
BCU 2
Emergency evacuation
Eng 1-4 fire extinguishers A and B
Eng 1-4 fuel shut-off valve
Fire switch unlock
Galley/Utility ELCU control
IRS on battery
Lower cargo fire extinguisher
Main battery overheat protection
Main standby inverter

Main Battery Bus

(Powered by DC bus 3/main hot battery bus)

Auxiliary GCU 1
APU alternate control
Autoflight warning
BCU 1
Captain's interphone
E/E cooling smoke override
Eng 1-4 fuel control valves
Eng 1-4 fuel crossfeed valves
Flight control 1L and 2L DC
Flight deck dome lights
Flight deck storm lights
Flight deck Captain's indicator lights
Generator drive (IDG) disconnect 1-4
Hydraulics EDP supply 1-4
Left ILS antenna switch
Left ILS/MLS switch
L and R manual cabin press control/ indication
Left aural warning
Left radio tuning panel
Left stabiliser trim/rudder ratio module DC
Left stick shaker
Left VHF
Oxygen reset
Oxygen valve and indication
Parking brake
Primary trailing edge flap control DC
Stabiliser trim alternate control
Standby altimeter vibrator
Standby attitude indicator
Standby attitude indicator ILS deviation bars
Upper yaw damper

Main Standby Bus

(Powered by AC bus 3/main hot battery bus)

Avionics and warning system status assembly
Flight control 1L and 2L AC
Left ADC
Left ATC transponder
Left EFIS control panel
Left EIU
Left FMS-CDU
Left ILS
Left MLS
Left VOR
Primary trailing edge flap control AC
RMI
Right ADF
Standby ignition 1-4
Standby instrument lights
Upper EICAS display

APU Hot Battery Bus

(Powered by ground service bus/APU battery)

APU duct overheat
APU fire warning horn
APU inlet door
APU primary control
APU standby inverter
BCU 1
IRS left, centre and right DC
Left and right outflow valves

APU Battery Bus

(Powered by DC bus 3/APU hot battery bus)

Auxiliary GCU 2	Eng 1-4 fire/overheat detection loops A and B
APU battery overheat protection	Eng 1-4 speed sensors 1 and 2
APU DC fuel pump	Eng 1-4 start/ignition control
APU fire/bleed duct overheat loops A and B	First Officer's interphone
BCU 2	Passenger address systems 1-4
Cabin interphone	Primary landing gear display and control
EEC 1-4 channel A reset/inhibit	Service interphone

APU Standby Bus

(*Powered by Captain's transfer bus/APU hot battery bus)*

Left FMC

Captain's APU Standby Bus

(Powered by Captain's transfer bus/APU hot battery bus if selected or FO's transfer bus powered)

Left PFD	Left ND

First Officer's APU Standby Bus

(Powered by FO's transfer bus/APU hot battery bus if selected)

Right EFIS Control	Right ND
Right PFD	

Captain's Transfer Bus

(Powered by AC bus 3/AC bus 1)

APU standby bus	Centre EIU
Avionics and warning systems status assembly	Left ATC transponder
Captain's APU standby bus	Left HF
Centre ADC	Paravisual display

First Officer's Transfer Bus

(Powered by AC bus 2/AC bus 1)

Autothrottle servo AC	Right EIU
First Officer's APU standby bus	Right FMC
Lower EICAS display	Right FMC-CDU
Right ADC	Right HF

Ground Handling Bus

(Powered by external power 1/APU generator 1)

Auxiliary hydraulic pumps 1 and 4	Ground service bus (if selected at door 2L)
Fuelling system	Lower cargo handling equipment and lighting

Ground Service Bus

(Powered by AC bus 1/ground handling bus if selected)

Flight deck flood, navigation and service lights	Main and APU battery chargers
Fuel pumps for APU start	Upper deck emergency escape doors

AC Bus 1

Centre FCC
Centre FMS-CDU
Centre ILS
Centre IRU
Centre radio altimeter
Eng 1 probe heat
Eng 1-4 igniter 1
Flight control 1R AC
Ground service bus
L and R wing gear group A control
Left AOA heat
Left aux pitot probe heat
Left pitot probe heat
Left TAT probe heat
TR unit 1
Utility and galley busses 1
Voice recorder

AC Bus 2

ACARS AC
Body gear steering control
First Officer's transfer bus
Flight control 2R AC
L and R wing anti-ice valves
Lower rudder ratio changer
Right ATC transponder
Right DME
Right FCC
Right ILS
Right IRU
Right radio altimeter
Right radio altimeter
Right VOR
Right weather radar R/T
TR unit 2
Utility and galley busses 2
Wheel well fire detection
Window heat 1R, 2L, 3R

AC Bus 3

Captain's transfer bus
Eng 1-4 igniter 2
Eng 2 and 3 probe heat
First Officer's panel lights
Glare shield flood lights
GPWS
LE flap drive group B control
Left ADF
Left DME
Left FCC
Left IRU
Left radio altimeter
Left weather radar R/T
Main standby bus
Observer's panel lights
Overhead panel lights 2
Pilot's main panel flood lights
TCAS
TR unit 3
Upper rudder ratio charger
Utility and galley busses 3
Window heat 2R, 3L

AC Bus 4

Captain's panel lights
Eng 4 probe heat
Eng 1-4 vibrator monitor
Glare shield panel lights
L and R body gear alt extension
Nose gear alt extension
Overhead and P7 panel lights AC
Overhead panel lights 1
Right AOA heat
Right aux pitot probe heat
Right TAT probe heat
TR unit 4
Utility and galley busses 4
Window heat 1L
Windshield washer pump

DC Bus 1

Auto cabin press controller A
First Officer's digital display lights
First Officer's indicator lights
Flight Control 1R DC
Flight deck door release
Fuel system management card A
Fuel transfer valve main 1
Fuel transfer valve reserve 2A and 3A
Ground safety relay
HYDIM system 4
Hydraulic demand pump 1 control
Hydraulic sys 1 EDP depress control
Ignition control
Left centre and main 3 jettison valves
Left autothrottle servo DC
Left manual cabin press control/indication B/U
Nacelle anti-ice eng 1
Observer's interphone

DC Bus 2

Auto cabin press controller B
Flight control 2R DC
Fuel system management card B
Fuel transfer valve reserve 2B and 3B
HYDIM system 3
Hydraulic demand pump 2 control
Hydraulic sys 2 EDP depress control
Landing gear alt display and control
Lower yaw damper
Nacelle anti-ice eng 2
Nose gear steering – primary
Outboard aileron lockout
Right centre and main 2 jettison valves
Right autothrottle servo DC
Right man cabin press control/indication B/U
Right MCP
Right refuel and stab transfer
Right stabiliser trim control
Right stabiliser trim rate
Right stabiliser trim shut-off
Right stick shaker
Wing anti-ice control

DC Bus 3

Aileron trim control
APU battery bus
Centre VHF
Fuel jettison controller A
Fuel quantity 1
HYDIM system 2
Hydraulic demand pump 3 control
Hydraulic quantity indicator
Hydraulic sys 3 EDP depress control
Inboard TE flap control
Left jettison nozzle valve control
Left MCP
Left stabiliser trim control
Left stabiliser trim rate
Left stabiliser trim shut-off
Left windshield wiper
Main battery bus
Master trim air control
Nacelle anti-ice eng 3
Nose gear steering – alternate
Overhead and P7 panel lights DC
Pack temperature controller A
Rudder and stabiliser indicators
Rudder trim control
Speedbrake auto-control
Windshield rain repellent

DC Bus 4

Cockpit door surveillance system
Fuel jettison controller B
Fuel quantity 2
HYDIM System 1
Hydraulic demand pump 4 control
Hydraulic sys 4 EDP depress control
Nacelle anti-ice eng 4
Outboard TE flap electric control
Pack temperature controller B
Right jettison nozzle valve control
Right windshield wiper
Speedbrake flight detent
Spoiler and aileron position indication
Windshield washer

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		IDG disconnected.
ELEC AC BUS 1, 2, 3, 4	Caution	Beeper	AC bus unpowered.
ELEC BUS ISLN 1, 2, 3, 4	Advisory		Bus tie breaker open.

G-BNLK - G-BNLY, G-CIVA - G-CIVM

ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low or oil temperature high.

G-BYGA - G-BYGG, G-CIVN - G-CIVZ

ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low, oil temperature high, or GCB open due to uncorrectable generator frequency fault.

ELEC GEN OFF 1, 2, 3, 4	Caution	Beeper	Generator control breaker open.
>ELEC SSB OPEN	Advisory		Split system breaker (SSB) open when commanded closed.
ELEC UTIL BUS L, R	Advisory		One or more galley or utility busses unpowered, or Galley Emergency Power switch off.
>STBY BUS APU	Advisory		APU standby bus not powered.
>STBY BUS MAIN	Advisory		Main standby bus not powered.

Intentionally
Blank

7.10 Primary Engine Indications 7.10.1

Primary Engine Display 7.10.1
Total Air Temperature (TAT), Thrust Reference, and Assumed Temperature Indications 7.10.2
EPR Indications 7.10.3
N1 Indications 7.10.5
EGT Indications 7.10.6
Secondary Exceedance Cue and In-flight Start Envelope 7.10.7

7.11 Secondary Engine Indications 7.11.1

Secondary Engine Display 7.11.1
N2 Indications 7.11.2
N3 Indications 7.11.2
Fuel Flow Indications 7.11.3
Oil Pressure Indications 7.11.3
Oil Temperature Indications 7.11.4
Oil Quantity Indications 7.11.5
Engine Vibration Indications 7.11.5
Crossbleed Start Indications 7.11.6
Partial Secondary Engine Indications 7.11.7

7.12 Compact Engine Indications 7.12.1

Compact Engine Display 7.12.1
Compact Start Indications 7.12.2

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Intentionally
Blank

Primary Engine Display

PRIMARY EICAS DISPLAY

Total Air Temperature (TAT), Thrust Reference, and Assumed Temperature Indications

1 Total Air Temperature (TAT)

Displayed (white) – TAT (degrees C).

2 Thrust Reference

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
- D-TO 3 - derate three assumed temperature derated takeoff thrust
- CLB - maximum rated climb thrust
- CLB 1 - derate one climb thrust
- CLB 2 - derate two climb thrust
- CLB 3 - derate three 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.

EPR Indications

Note 1: During tailwind conditions, slight EPR fluctuations may occur prior to five knots airspeed.

Note 2: When reverse reverser indication is displayed, reference EPR is not displayed.

1 Thrust Reverser Indication

Displayed REV (amber) – reverser in transit.

Displayed REV (green) – reverser fully deployed.

2 EPR

Digital EPR displayed (white).

3 Maximum EPR Line

Displayed (amber) - maximum allowable thrust.

Displayed (white) - maximum EPR is invalid.

4 EPR Indication

EPR, displayed:

- (white) – normal operating range
- (red) – operating limit reached

5 Reference EPR

Displayed (digital, green) - reference thrust selected by FMC.

6 Reference EPR Indicator

Displayed (green) – reference EPR.

Displayed (magenta) – target EPR commanded by FMC.

7 Command EPR Indicator

Displayed (white) - EPR commanded by thrust lever position.

N1 Indications

1 N1 RPM

Digital N1% RPM displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (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
- (amber) – caution range reached
- (red) – operating limit reached

4 N1 Amber Band

Displayed (amber) – N1 caution range.

EGT Indications

1 EGT

EGT (degrees C), displayed:

- (white) – normal operating range
- (amber) – continuous limit reached
- (red) – start or takeoff limit reached

Note: During TO or GA, indication remains white for five minutes, or for ten minutes if one engine fails or is shut down, when continuous EGT limit is reached or exceeded.

2 EGT Red Line

Displayed (red) - takeoff EGT limit.

3 EGT Start Limit Line

Displayed (red) - with Fuel Control switch in CUTOFF, until N3 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

Note: During TO or GA, iIndication remains white for five minutes, or for ten minutes if one engine fails or is shut down, when continuous EGT limit is reached or exceeded.

Secondary Exceedance Cue and In-flight Start Envelope

1 Secondary Engine Exceedance Cue

Displayed (cyan) -

- secondary engine parameter exceedance is occuring
- no longer displayed when exceeding parameter returns to normal operating range
- 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 lower, when the respective Engine Fire switch is in and a Fuel Control switch is in CUTOFF.

Intentionally
Blank

Secondary Engine Display

See Chapter 10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

SECONDARY EICAS DISPLAY

N2 Indications

1 N2

N2 RPM (%), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached

N3 Indications

1 N3

N3 RPM (%), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached

2 N3 Indication

N3 RPM, displayed:

- (white) – normal operating range

- (amber) – caution range reached
- (red) – operating limit reached

3 N3 Red Line

N3 RPM operating limit, displayed (red).

4 N3 Amber Band

N3 RPM caution range, displayed (amber).

Fuel Flow Indications

1 Fuel Flow

Displayed (white) – fuel flow to the engine (kilograms per hour x 1000).

Oil Pressure Indications

1 Oil Pressure Indicator

Engine oil pressure, displayed:

- (white) – normal operating range
- (red) – operating limit reached
- indication remains white when engine shutdown and during start

2 Oil Pressure

Engine oil pressure (psi), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached
- indication remains white when engine shutdown and during start

3 Oil Pressure Red Line

Displayed (red) – oil pressure operating limit.

4 Oil Pressure Amber Band

Displayed (amber) – oil pressure caution range.

4 Oil Pressure Amber Band

Displayed (amber) – oil pressure caution range.

Oil Temperature Indications

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

1 Oil Quantity

Usable oil quantity (liters).

Displayed:

- (white) – normal quantity
- (magenta) – low quantity, or oil differential reached

Engine Vibration Indications

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:

- N1 - N1 rotor vibration
- N2 - N2 rotor vibration
- N3 - N3 rotor vibration

If vibration source broad band vibration (BB) is displayed, source is unknown and average vibration displayed.

4 Engine Vibration Indicator

Displayed (white) – engine vibration.

Crossbleed Start Indications

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

Partial Secondary Engine Indications

Partial secondary engine indications will be displayed when the secondary engine display is not selected.

N2 and N3 will be displayed if any N2 or N3 operating parameter is reached.

OIL P, OIL T, OIL Q will be displayed if:

- an oil caution range or operating limit reached
- an oil differential is exceeded
- an oil quantity is low

VIB will be displayed if a vibration display indicator is reached.

SECONDARY EICAS DISPLAY

Intentionally
Blank

Compact Engine Display

1 Compact Engine Indications

Displayed continuously:

- EPR
- N1
- EGT

Displayed when selected by secondary engine display switch, or in flight if a Fuel Control switch is moved to CUTOFF:

- N2
- N3
- FF
- OIL P
- OIL T

- OIL Q
- VIB

2 Partial Compact Engine Indications

N2, N3, 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

1 EGT Start Limit

Displays red.

2 Crossbleed Start

Displays magenta.

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

RUN (Autostart switch ON) –

- opens spar fuel valve
- opens engine fuel valve
- EEC sequences start valve, fuel metering valve, and igniter operation

RUN (Autostart switch OFF) –

- opens spar fuel valve
- opens engine fuel valve
- energizes igniter(s)

CUTOFF –

- closes fuel valves
- removes igniter power
- commands respective hydraulic demand pump to operate when Demand Pump selector in AUTO
- unlocks Engine Fire switch

Engine Start Panel

1 Engine START Switches

Pull (Autostart switch ON) -

- arms start valve
- opens engine bleed air valve

Pull (Autostart switch OFF) -

- opens start valve
- opens engine bleed air valve

Releases at 50% N3 RPM -

- start valve closes
- engine bleed air valve closes

2 Standby (STBY) IGNITION Selector

NORM –

- AC power system supplies power to selected igniters
- 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 (CONT) IGNITION Switch

ON – selected igniters operate continuously.

4 AUTO IGNITION Selector

Both igniters energize for in-flight start or when flameout detected.

1, 2, or BOTH - selected igniters operate when any of the following occur:

- during start when N3 RPM less than 50%
- trailing edge flaps out of up position
- first 60 seconds nacelle anti-ice ON

NORM - EEC alternates igniter 1 and igniter 2 for each ground start.

5 Engine Start Lights

Illuminated (white) – start valve is open.

6 AUTOSTART Switch

ON – arms the autostart system.

OFF –

- autostart system is disabled
- start is manually controlled

Electronic Engine Control

Electronic Engine Control Panel

1 Electronic (ELEC) Engine (ENG) CONTROL Switches

NORM (Normal) –

- selects normal engine control mode
- 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.

2 EEC Maintenance Channel (CH) Select (SEL) Switch

Inoperative.

NORM - EEC selects controlling channel

CH B - selects channel B for EEC maintenance testing.

Intentionally
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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

G-BNLK - G-BNLY, G-CIVA

- activates DC or AC fuel pump

G-BYGA - G-BYGG, G-CIVB - G-CIVZ

- activates DC or two AC fuel pumps

START (momentary position, spring–loaded to ON) – initiates automatic start sequence.

APU Indications

Located on status (STAT) display.

1 EGT

APU exhaust gas temperature in degrees Celcius.

2 RPM

APU rotation speeds in percent.

3 Refill (RF)/Low (LO)

Displayed RF or LO (magenta) - oil quantity below prescribed level.

4 APU OIL Quantity

APU oil quantity (1.00 indicates full).

Introduction

The airplane is powered by four Rolls Royce RB211-524G engines. The engines are rated at 59,450 pounds takeoff thrust each.

The engines are three rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of a fan and a low pressure turbine section. The N2 rotor consists of an intermediate pressure compressor section and an intermediate pressure turbine section. The N3 rotor consists of a high pressure compressor and a high pressure turbine section. The N1, N2, and N3 rotors are mechanically independent. The N3 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.

Engine Indications

Engine indications display on the engine indication and crew alerting system (EICAS) display.

Primary Engine Indications

EPR, N1, and EGT are primary engine indications and always display on primary EICAS.

Secondary Engine Indications

N2, N3, 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 N2, 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, N3, 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.

N1, N3, oil pressure, and oil temperature indicators have caution ranges displayed by amber bands. The caution range for N2 is not displayed. The indication changes color to amber if the parameter reaches the caution range.

The EGT indicator has a continuous limit displayed by an amber band. The indication changes color to amber if EGT reaches the continuous limit.

EGT indications are inhibited from changing color to amber during takeoff or go-around for five minutes after the TO/GA switch is pushed, even though EGT reaches the continuous limit. The amber color change is inhibited for ten minutes if one engine fails or is shutdown.

The EGT indicator has a takeoff limit displayed by a red line. The indication changes color to red if EGT reaches the takeoff limit.

N1, N3, oil pressure, and oil temperature indicators have operating limits displayed by red lines. The operating limit for N2 is not displayed. The indication changes color to red if the parameter reaches the operating limits.

An indication changes color back to white when the parameter returns to the normal operating range. The box enclosing the digital indicator remains red as a reminder of the exceedance. The red box color can be selectively canceled to white or recalled to red by pushing the cancel or recall switch on the EICAS Display Select panel.

The oil quantity indication changes color to magenta if low oil quantity is detected or if the oil quantity differential is exceeded.

Maximum 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

If only one CRT is available for use by EICAS, primary EICAS always displays. Primary engine indications display in the normal format. Secondary engine indications are selected by pushing the Secondary Engine Display switch. Pushing the switch displays the primary and secondary engine indications on primary EICAS in compact format. In compact format, 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.

If an N2 or N3 RPM increases to the caution range or operating limit, the related N2 or N3 indications display. If an oil pressure decreases to the caution range or operating limit, if an oil temperature increases to the operating limit, or if an oil quantity decreases to the low level, or the oil quantity differential is exceeded, the oil indications display. If an engine vibration increases to the display indicator, the vibration indications display.

Pushing the Secondary Engine Display switch while the secondary engine display is in the partial format displays the entire secondary engine display. Pushing the switch again returns the secondary engine display to partial format.

Selecting another secondary EICAS display while the secondary engine display is in partial format removes the secondary engine display from secondary EICAS. The partial secondary engine indications display with the primary engine indications on primary EICAS in compact format.

If only one CRT is available for use by EICAS and a secondary engine parameter exceedance occurs, the primary and partial secondary engine indications display on primary EICAS in compact format.

If the secondary engine exceedance cue displays and partial secondary engine indications are not displayed, pushing the Status Display switch displays the primary and partial secondary engine indications on primary EICAS in compact format.

In all cases, the partial secondary engine indications and secondary engine exceedance cue remain displayed until the exceeding engine parameter returns to the normal operating range.

Electronic Engine Control (EEC)

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to control forward and reverse thrust. The EEC has two control modes: normal and alternate. In 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.

EEC Normal Mode

In normal mode, the 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, the EEC keeps thrust constant independent of outside air temperature and pressure. The EEC adjusts thrust for changes in nacelle and wing anti-ice and airplane pressurization bleed requirements. This allows a fixed Thrust lever position throughout a climb.

Maximum 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 the EEC detects a fault and can no longer control the engine using the normal mode, it transfers control to alternate mode. Alternate mode can also be selected manually using the EEC Mode switch.

Alternate mode does not provide thrust limiting at maximum 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.

Alternate mode provides equal or greater thrust than normal mode for the same Thrust lever position. Thrust does not change when the 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.

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.

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

Approach idle decreases acceleration time for go–around. Approach idle is maintained until five seconds after touchdown, when minimum idle is selected.

EEC Overspeed Protection

At thrust settings above idle, the EEC monitors N1, N2, and N3 RPM to prevent rotor overspeed. If a rotor approaches overspeed, the EEC commands the fuel metering unit to reduce fuel flow to keep rotor speed from exceeding the operating limit even though the Thrust lever is commanding more thrust.

Engine Start and Ignition System

The engines can be started using the autostart system or manually. Autostart is the normal starting mode. During autostart, the EEC sequences start valve, engine fuel valve, and igniter operation. Selecting OFF on the Autostart switch disables autostart and allows manual, pilot–monitored, starting. During manual start, the flight crew sequences the operation of the start valve, engine fuel valve, and the selected igniter.

Air from the bleed air duct powers the starter motor, which is connected to the N3 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 N3 reaches a predetermined RPM. The EGT indication changes color to red if EGT start limit is reached.

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 start 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 N3 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. After N3 increases to maximum motoring RPM, 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% N3 RPM. At starter cutout, the Start switch is released to the in position, the start and engine bleed air valves close, the Start light extinguishes, and ignition discontinues.

During autostart, the EEC monitors EGT, N1, N2, and N3 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
- no N1 rotation
- no N2 rotation

Note: The autostart system does not monitor oil pressure.

The EEC makes two start attempts before aborting the autostart sequence.

- If the EEC detects no EGT rise 30 seconds after fuel is applied, it cuts off fuel and ignition and the engine motors for 30 seconds.
- If the EEC detects a hung start or a hot start before starter cutout, it cuts off fuel and ignition. If N3 is above 30%, the starter air is also shut off until N3 is below 30% before the starter is re-engaged. The engine motors until EGT is equal to or less than 100°C.
- The EEC applies fuel and ignition to both igniters for the second start attempt. If the autostart sequence is aborted, fuel and ignition are cut off, and the engine motors for 30 seconds before the start and bleed air valves close.

If the EEC detects an impending hot start after starter cutout, the autostart sequence is aborted immediately. The engine does not motor.

An autostart can be aborted manually by moving the Fuel Control switch to CUTOFF. When the Fuel Control switch is moved to CUTOFF, the start and engine bleed air valves close and the engine does not motor. Pushing the Autostart switch OFF allows crew control of the start valve for manual engine motoring.

In-flight Autostart

During in-flight flameout and/or start, the EEC reacts to no EGT rise or an engine fuel shutoff valve failed closed. If the EEC detects no EGT rise, it cuts off fuel and ignition for 30 seconds and then attempts unlimited restarts. If the EEC detects the EGT reaching the takeoff limit, fuel and ignition are cut off until the EGT reaches 150°C, and the EEC reapplies fuel and ignition for continuous restart attempts. 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 unless the EEC detects an engine fuel shutoff valve failed closed. The EEC continues making start attempts until the engine stabilizes at idle or the Fuel Control switch is moved to CUTOFF.

Manual Start

The Autostart switch must be OFF to accomplish a manual start. The start is accomplished in accordance with the Manual Engine Start procedure (refer to Chapter SP.7). Pulling the Start switch out (held out by a solenoid) opens the start and engine bleed air valves. The Start light illuminates. At 25% N3 or maximum motoring, 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% N3 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.

Starter Operations

Continuous operation of the starter is limited in accordance with the following:

Normal Duty Cycle

- Up to 3 minutes then run down to zero N3, followed by:
- Up to a further 3 minutes then run down to zero N3, followed by:
- Up to a further 1 minute then run down to zero N3 and allow to cool for 30 minutes.

Extended Duty Cycle

- Up to 5 minutes followed by 30 minutes wait.

Engine Ignition

Each engine has two igniters. The igniters operate separately or together as selected by the Auto Ignition selector and the EEC.

Both igniters for each engine are selected during an in-flight start or when a flameout is detected. With the Auto Ignition selector in 1, 2, or BOTH, the selected igniter(s) are energized for each engine when the relative Start switch is out, the first 60 seconds nacelle anti-ice is on, the trailing edge flaps are out of up, or the Continuous Ignition selector is ON. With the Auto Ignition selector in NORM, both igniters on each engine are selected if the Continuous Ignition selector is ON. When ignition is initiated, the selected igniter on each engine energizes when the related Fuel Control switch is in RUN and, during autostart, by EEC command. The selected igniter deenergizes when the Fuel Control switch is placed in CUTOFF.

The AC power system is the normal power source for ignition. The standby power system provides a backup source. When the Standby Ignition selector is in NORM, the AC power system supplies power to the selected igniters. If the AC power system is not powered, the standby power system supplies power continuously to 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

Engine Fuel System

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 then flows through the engine fuel valve. The fuel is additionally heated by the high pressure fuel/oil heat exchanger before distribution to the engine.

The engine fuel valve, fuel metering valve, and spar valve allow fuel flow to the engine when all valves are open. The valves open when the Engine Fire switch is in and the Fuel Control switch is in RUN, and the engine pumps are supplying fuel pressure. The pumps supply pressure when the N3 rotor is turning. During autostart, the fuel metering valve is additionally controlled by the EEC. The engine fuel valve, fuel metering valve, and spar valve close when either the Fuel Control switch is in CUTOFF or the Engine Fire switch is out.

Fuel flow is measured downstream of the engine fuel valve and displays on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic

Engine Oil System

The oil system cools and lubricates engine bearings and the accessory gearbox. Oil is pressurized by the primary oil pump. An oil filter removes contaminants. The oil is cooled by fuel as it flows through the fuel/oil heat exchangers. Depending on low pressure fuel temperature, the control valve directs oil to either the low pressure heat exchanger or the high pressure heat exchanger, or to both. Oil is further pressurized by the secondary oil pump. The oil cools and lubricates the engine and a scavenged 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.

During cruise, oil quantity displays on EICAS whenever oil quantity on one engine differs from any other engine by a predetermined amount. When this occurs, the lowest oil quantity is shown in magenta. If there is an increase in oil quantity during cruise (indicator malfunction or leaking fuel/oil heat exchanger), the EICAS oil partial engine indications display may appear. However, for this condition the low quantity displays in magenta, even though that oil quantity may be normal.

Engine Oil System Schematic

Thrust Reverser System

Each engine has a pneumatically actuated fan air thrust reverser. Each thrust reverser is powered by bleed air from the related engine. Reverse thrust is available only on the ground.

An interlock mechanism in the Thrust lever assembly prevents simultaneous movement of the Forward and Reverse Thrust levers. The Reverse Thrust levers can be raised only when the Forward Thrust levers are in the closed position. When the Reverse levers are down, the reversers are locked in the stowed position.

Raising the Reverse Thrust levers to the idle detent locks the Forward Thrust levers in position. Bleed air unlocks and extends the reversers aft to the deployed position. A thrust reverser status annunciator displays above the digital indicator of each 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.

The thrust reversers are protected against deploying inadvertently.

Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications display on the secondary engine display. The vibration source indication also displays. If the vibration monitoring system cannot determine the source (N1, N2, or N3), 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.

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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

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 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.

EICAS Alert Messages

Message	Level	Aural	Message Logic
APU	Advisory		Automatic shut down of APU with APU selector ON, or APU N1 RPM exceeds 95% with APU selector OFF, or overheat detected in APU bleed air supply line.
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.
>AUTOSTART OFF	Advisory		Autostart switch OFF.
ENG 1, 2, 3, 4 AUTOSTART	Caution	Beeper	EGT start limit has been exceeded or 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.
>ENG 1, 2, 3, 4, CH INHIBIT	Advisory		EEC channel A inhibited.
>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.
ENG 1, 2, 3, 4 FUEL FILT	Advisory		Impending fuel filter bypass exists on affected engine.
ENG 1, 2, 3, 4 FUEL VLV	Advisory		Engine fuel valve or fuel spar valve position disagrees with commanded position.

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.
>ENG 1, 2, 3, 4 LIM PROT	Caution	Beeper	EEC in alternate control mode and thrust approaching maximum rating.
>ENG 1, 2, 3, 4 LOW IDLE	Advisory		Engine idle not in approach setting when commanded.
>ENG 1, 2, 3, 4 OIL FILT	Advisory		Engine oil filter contamination approaching blocking condition.
ENG 1, 2, 3, 4 OIL PRESS	Caution	Beeper	Oil pressure in amber band or reaches red line limit.
ENG 1, 2, 3, 4 OIL TEMP	Advisory		Oil temperature reaches red line limit.
ENG 1, 2, 3, 4 REV LIMTD	Advisory		Fault detected in thrust reverser system.

(G-CIVE - G-CIVG ; before SB, engine thrust reverser locks not installed)

ENG 1, 2, 3, 4 REVERSER	Advisory		Fault detected in thrust reverser system.

G-BNLK - G-CIVD, G-CIVH - G-CIVZ
(G-CIVE - G-CIVG ; SB installs engine thrust reverser locks)

>ENG 1, 2, 3, 4 REVERSER	Advisory		Fault detected in thrust reverser system on the ground.
>ENG 1, 2, 3, 4 RPM LIM	Advisory		Engine thrust limited by N1, N2, or N3 red line limit.
>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.

EICAS Memo Messages

Message	Level	Message Logic
APU RUNNING	Memo	APU selector in ON and APU N1 RPM exceeds 95%.
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.

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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
- either 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
- either 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 Engine/APU Cargo 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

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 Engine/APU Cargo 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.

Fire/Overheat Test Switches

1 FIRE/Overheat (OVHT) TEST Engine (ENG) Switch

Push and hold -

- sends fire/overheat test signals to the engine turbine overheat detectors
- tests flight deck fire and overheat indications (see Fire and Overheat Detection System Manual Fault Test, Section 20)

2 FIRE/Overheat (OVHT) TEST Engine (ENG)/APU CARGO Switch

Push and hold -

- sends fire/overheat test signals to the engine strut and cowl overheat detectors; engine, APU, wheel well and cargo fire detectors; 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 Engine/APU Cargo switch is pushed

5 APU FIRE CONTROL Switch

Pull down -

- shuts down APU
- arms APU fire extinguisher

Introduction

There are fire detection and extinguishing systems for the:

- APU
- cargo compartments
- engines
- lavatories

The crew rest compartments and main gear wheel wells have fire detection systems, but no fire extinguishing systems.

The engines also have overheat detection systems.

Refer to the following chapters for additional information:

- Chapter 2 – Air Systems, for descriptions of equipment smoke evacuation, and bleed duct leak and overheat detection
- Chapter 3 – Anti–Ice, Rain, for a description of engine anti–ice system protection

Fire Warnings

If a fire is detected (or turbine overheat), 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)
- respective Engine, APU, or Cargo Fire Warning lights
- for an engine fire, respective 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 single loop cowl overheat detector, a dual loop strut overheat detector, and a dual loop turbine overheat detector. In normal operation, both loops of a dual loop detector must detect a fire or overheat condition to activate the respective warning or caution.

APU Fire/Overheat Detection

G-BYGA - G-BYGG, G-CIVR - G-CIVZ
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.

G-BNLK - G-BNLY, G-CIVA - G-CIVP
A dual loop fire detector is installed in the APU compartment. There is no overheat detection in the APU compartment. Both fire loops are required for fire detection from first engine start until last engine shutdown. When the engines are shut down, either loop can activate a fire warning. An APU fire warning shuts down the APU and, on the ground, discharges the APU fire extinguisher bottle.

Cargo Compartment Fire Detection

The forward and aft cargo compartments each have two dual loop smoke detectors. Sample air from throughout each compartment is drawn through the detectors 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.

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.

Galley 4 IFE Smoke Detection (Rockwell Collins Equipped Aircraft)

A smoke detector is installed in the Galley 4 IFE equipment cooling exhaust duct.

The EICAS advisory message SMOKE LAVATORY indicates that smoke is detected in a lavatory, or Galley 4 IFE equipment cooling duct. When the smoke detector is clear of smoke, self-testing the smoke detector resets the system and clears the EICAS message.

Fire Extinguishing

Engine Fire Extinguishing

There are two fire extinguisher bottles for each engine. One or both bottles can be discharged in the engine.

The Engine Fire switches are mechanically locked in. If an engine fire occurs, the respective switch is electrically unlocked and can be pulled out.

Pulling an Engine Fire switch arms a squib in each bottle for discharge to the respective engine. Rotating the Fire switch selects a fire extinguishing bottle and discharges it into the respective 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 respective 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 respective switch is electrically unlocked and can be pulled out. Pulling the APU Fire switch arms the fire extinguisher discharge squib. Rotating the APU Fire switch discharges a fire extinguisher into the APU compartment.

The APU Fire switch can be unlocked by pushing the Fire Override switch beneath the Fire switch.

Cargo Compartment Fire Extinguishing

There are four fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other two bottles discharge after a brief delay, or upon touchdown.

Fire and Overheat Detection System 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 respective fire warning or overheat caution activates.

Fire and Overheat Detection System Manual Fault Test

The fire and overheat detection systems can be tested manually by pushing and holding the desired FIRE/Overheat (OVHT) TEST switch.

The indications for a manual Engine (ENG) fire and overheat detection system test are:

- the fire bell rings
- these lights illuminate:
  - the master WARNING lights
  - the engine fire warning lights
  - the Fuel Control switch fire warning lights.
- The EICAS warning message FIRE ENG displays and the EICAS advisory message DET FIRE/OHT is not displayed.

The indications for a manual ENG/APU CARGO 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 Fuel Control switch fire warning lights.
  - the APU fire warning light
  - the FWD and AFT cargo 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 display 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.

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.

EICAS Alert Messages

Message	Level	Aural	Message Logic
>BOTTLE LOW APU	Advisory		APU fire extinguisher bottle pressure is low.
>BTL LOW ENG 1A, 1B, 2A, 2B, 3A, 3B, 4A, 4B	Advisory		Engine fire extinguisher bottle pressure is low.
>CARGO DET AIR	Advisory		Cargo smoke detection airflow is insufficient.
>CGO BTL DISCH	Advisory		On the ground, a cargo fire extinguisher bottle pressure is low. In flight, cargo fire extinguisher bottles A and B are discharged.
>DET FIRE APU	Advisory		APU fire detection loops A and B are failed.
>DET FIRE/OHT 1, 2, 3, 4	Advisory		Engine fire or overheat detection loops A and B are failed.
FIRE APU	Warning	Fire Bell	Fire is detected in the APU.
FIRE CARGO AFT, FWD	Warning	Fire Bell	Smoke is detected in the lower cargo compartment.
FIRE ENG 1, 2, 3, 4	Warning	Fire Bell	Fire is detected in the engine.
FIRE WHEEL WELL	Warning	Fire Bell	Fire is detected in a main wheel well.
OVHT ENG 1, 2, 3, 4 COWL	Caution	Beeper	Overheat is detected in the engine cowl.
OVHT ENG 1, 2, 3, 4 SRUT	Caution	Beeper	Overheat is detected in the engine strut.
SMOKE DR 5 REST	Caution	Beeper	Smoke is detected in the door 5 crew rest area.
>SMOKE LAVATORY	Advisory		Smoke is detected in a lavatory.

System Test Messages

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 is in progress.

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Pitch and Stabilizer Trim Systems

Control Wheel and Column

1 Stabilizer Trim Switches

Spring–loaded to neutral.

Push (both switches) – trims stabilizer in desired direction.

2 Control Wheel

Rotate – deflects ailerons and spoilers in desired direction.

3 Control Column

Push/pull –

- deflects elevators in desired direction
- prevents stabilizer trim in opposite direction

Stabilizer Trim Controls

1 Stabilizer (STAB) Trim Cut Out Switches

ON - supplies hydraulic power for stabilizer trim.

AUTO (guard closed) –

- 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 green band 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.

First spring detent - trims at slow rate.

Second spring detent - trims at fast rate.

Yaw Damper Controls

1 YAW DAMPER Switches

ON – yaw damper powered.

2 Yaw Damper Inoperative (INOP) 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

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 Speedbrake 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.

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 Flap Up 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 Border – drive unit is inoperative with flap group retracted.

Amber Solid Box – drive unit is inoperative with flap group extended.

Amber Crosshatch – drive unit is inoperative with flap group partially extended.

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)

X (amber) – position sensor for respective flap has failed.

Note: The flaps operate normally unless the FLAPS CONTROL, FLAPS DRIVE, or FLAPS PRIMARY EICAS message is displayed.

Alternate Mode Expanded Flap Position Indication

If alternate flaps armed, expands to display all flap positions. May also display without position data if all three FCUs fail.

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

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.

Full pointer deflection indicates full control surface displacement.

Surface Position Indication

1 Rudder (RUD) Position

Indicates upper and lower rudder positions.

2 Elevator (ELEV) Position

Indicates left and right outboard elevator positions.

3 Aileron (AIL) Position

Indicates inboard and outboard aileron positions.

4 Spoiler (SPL) Position

- indicates flight spoiler positions
- indicates in-flight speedbrake position on left wing only

Flight Control Hydraulic Power Controls

1 Flight (FLT) CONTROL Hydraulic (HYD) POWER SHUTOFF Switches

NORM (guard closed) – supplies hydraulic power for flight control surfaces.

SHUT OFF – shuts off hydraulic power to respective flight control surfaces.

2 VALVE CLOSED Light

Illuminated (amber) – hydraulic system flight control valve is closed.

Introduction

The primary flight controls are elevators, ailerons, and rudders. The control column, control wheel, and rudder pedals control these flight control surfaces. The primary flight controls are redundantly powered from the four airplane hydraulic systems; there is no manual reversion.

Secondary flight controls include a moveable horizontal stabilizer, spoilers, and leading and trailing edge flaps. Spoilers operate differentially to assist ailerons for roll control and symmetrically as speedbrakes.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- control wheel Stabilizer Trim switches
- Alternate Stabilizer Trim switches
- Speedbrake lever
- Flap lever
- Aileron Trim switches
- Rudder Trim selector

Control wheels are connected through jam override and shearout mechanisms. If a jam occurs, the pilots can maintain control by applying force to the other control.

The Speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

Trim switches allow the pilots to adjust flight control surfaces to reduce flight control pressures.

Flight Control Surfaces

Pitch control is provided by:

- four elevator surfaces
- a moveable horizontal stabilizer

Roll control is provided by:

- four ailerons
- ten spoilers

Yaw control is provided by an upper and lower rudder.

Increased lift and decreased stall speed for takeoff and landing are provided by leading and trailing edge flaps.

Flight Control Surface Locations

Pitch Control

Four elevator surfaces hinged at the rear of the horizontal stabilizer and a moveable horizontal stabilizer provide pitch control.

Elevator Control

Control column inputs transfer mechanically to hydraulic actuators on the inboard elevator control surfaces. Inboard elevator position controls input for the related adjacent outboard elevator actuator. Shearouts between the inboard and outboard elevators allow elevator control to be regained if a jam occurs and a significant manual force is applied to the control columns.

Left and right outboard elevator positions display on the EICAS status display. A full scale indication corresponds to maximum elevator deflection.

An elevator feel and centering 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 and feel force is no longer a function of airspeed.

Elevator Control Diagram

Stabilizer Trim

The stabilizer trim system provides pitch trim by varying the angle of incidence of the horizontal stabilizer. Normal and alternate electrical channels control two stabilizer trim control modules. Each control module hydraulically powers a trim actuator. Actuator outputs mechanically sum to drive the stabilizer. Trim rate is reduced at high airspeeds.

Trim Control

Stabilizer Trim switches on the pilots' control wheels or Alternate Stabilizer Trim switches on the control stand control stabilizer trim. Pushing both switches in a pair in the same direction power the actuators, which drive the stabilizer in the desired direction. The Alternate Stabilizer Trim switches provide trim commands in the same manner as the Stabilizer Trim switches through a separate control channel. The Alternate Stabilizer Trim switches also provide an increased range of stabilizer travel. If the Alternate Stabilizer Trim switches and control wheel switches are held in opposite directions, no trim is commanded. Holding the captain's and first officer's control wheel switches in opposite directions commands no trim.

Stabilizer Trim Position Indication and Green Band

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 green band which indicates the acceptable range of trim settings for takeoff. There are three possible green bands: a mid-band, a nose down band which includes the mid-band plus additional nose down trim, and a nose up band which includes the mid-band plus additional nose up trim.

The takeoff trim setting is calculated based on the FMC calculated gross weight, center of gravity, takeoff thrust derate selection, and takeoff flap entry. The green band is selected by the Modularized Avionics and Warning Electronics Assembly. The position of the nose gear oleo pressure switch is compared to the calculated green band as a crosscheck to ensure the correct green band is displayed.

G-BNLK - G-BNLP
The mid-band segment may be either backlighted or a highly visible green paint stripe illuminated by ambient light and integral panel lighting.

G-BNLY - G-CIVZ
The mid-band segment is a highly visible green paint stripe illuminated by ambient light and integral panel lighting.

Stabilizer Trim Cutout

Hydraulic systems 2 and 3 power stabilizer trim. Two guarded Stabilizer Trim Cutout switches control stabilizer trim. With the guards closed, the switches are held in AUTO position, allowing automatic cutout of the related hydraulic system if unscheduled stabilizer trim is detected. With a Stabilizer Trim Cutout switch in CUTOUT, hydraulic power to the related trim control module is shut off. Positioning a switch to ON overrides the automatic cutout function and supplies hydraulic power to the related control module. If automatic cutout has occurred, hydraulic power remains shut off until the respective cutout switch is placed ON. If one actuator fails to operate, trim commanded by the flight crew reduces to half the normal scheduled rate.

Trimming with Autopilots Engaged

If a single autopilot is engaged, using the control wheel Stabilizer Trim switches causes the autopilot to disengage 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.

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.

Aileron positions display on the EICAS status display. Separate pointers indicate the inboard and outboard aileron positions on each wing. A full scale deflection of the position indicator corresponds to maximum aileron travel.

The control wheels connect through an override mechanism which allows either wheel to move independently if the other wheel jams and significant manual force is applied to the free wheel. Roll control is then available through the ailerons on the wing corresponding to the free wheel. Approximately half of the flight spoilers are also available for roll control under these conditions.

Each side of the mechanical system also incorporates shearouts which may allow the jammed control wheel to be freed when a significant manual force is applied to the jammed wheel.

Aileron Trim

Pushing both Aileron Trim switches in the desired direction causes the feel and trim mechanism to reposition the aileron neutral point. Both control columns have an aileron trim indicator.

If the Aileron Trim switches are activated with an autopilot engaged, the aileron neutral point is repositioned. When the autopilot is disengaged, the wheel and ailerons move to the repositioned aileron neutral point. The airplane responds with roll proportional to the amount of aileron trim input.

Aileron Control Diagram

Yaw Control

The rudder control system provides yaw control.

Rudder Control and Trim

Either pilot's rudder pedals control the hydraulically powered upper and lower rudders. Rudder pedal inputs mechanically transfer to a single feel and trim mechanism, then transfer through separate ratio changers to the upper and lower rudder hydraulic actuators.

Rudder positions display on the EICAS status display. On the ground, pushing a rudder pedal to the stop causes a full scale deflection of the upper and lower rudder position indicators.

The rudder system shearouts allow upper or lower rudder to be controlled if a jam occurs downstream of the rudder ratio changer and a significant manual force is applied to the rudder pedals.

When the Rudder Trim selector 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 is displayed 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 lateral and directional stability and provide turn coordination. The upper and lower yaw damper actuators are powered by hydraulic systems 3 and 2 respectively. Yaw damper inputs do not result in rudder pedal motion.

With the Yaw Damper switches ON, the systems are powered. If a yaw damper fault exists, hydraulic power is removed from the system and the related yaw damper INOPERATIVE light illuminates.

Rudder Control Diagram

Spoilers

There are six spoiler panels on each upper wing surface just forward of the trailing edge flaps. The four inboard panels on each wing function as speedbrakes in flight. On the ground, all six spoiler panels on each wing function as ground spoilers. The speedbrake and ground spoiler functions are controlled with the Speedbrake lever.

The position of one spoiler on each wing is displayed on the EICAS status display. On the left wing, the position of the fourth spoiler panel in from the wingtip is displayed. This panel functions as a flight spoiler, speedbrake, and ground spoiler. On the right wing, the position of the outboard-most spoiler panel is displayed. This panel functions as a flight spoiler and ground spoiler only. Therefore, speedbrake extension is not indicated on the right wing spoiler position indicator.

Speedbrakes

Speedbrake lever in-flight input is limited to mid-travel position by an automatic stop. With the Speedbrake lever in flight detent position, the two inboard spoiler panels on each wing extend to mid-travel position and the two middle spoiler panels on each wing extend to full travel position.

Ground Spoilers

On the ground, the Speedbrake lever stop retracts allowing the Speedbrake lever to be moved fully aft to UP position. All six spoiler panels on each wing extend to their full travel positions.

When the Speedbrake lever is in the ARM position, Thrust levers 1 and 3 are near the idle position, and the main landing gear touch down, the Speedbrake lever is driven to the UP position, extending all spoiler panels.

The Speedbrake lever is driven to the UP position from the DN position when the main gear are on the ground, Thrust levers 1 and 3 are near the idle position, and reverse Thrust levers 2 or 4 are pulled up to idle detent. This automatic ground spoiler extension is a backup for landing when the Speedbrake lever is not armed during approach.

For go-around protection, if Thrust lever 1 or 3 is advanced from idle position, the Speedbrake lever is driven to the DN position. This occurs whether ground spoilers were automatically or manually extended. The Speedbrake lever can be manually returned to the DN position.

The EICAS advisory message SPEEDBRAKE AUTO indicates a fault that may cause the loss of the automatic ground spoiler function. If the Speedbrake lever is in the 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 the DN position. The spoilers can be operated manually.

Spoiler Control Diagram

Flaps

There are three groups of leading edge flaps on each wing: outboard 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 Units

Flap lever position is transmitted to three identical flap control units (FCUs) which sequence and monitor flap operation. Each FCU performs any or all of the three basic functions:

- primary control
- secondary control
- indication and annunciation

The FCUs also control flap sequencing and trailing edge flap asymmetry, disagree, and uncommanded motion protection in the primary and secondary modes, control the flap load relief function in primary mode only, and send all flap position information to EICAS and other systems.

FCU Primary Mode

In primary mode, the FCUs drive the leading edge flaps pneumatically and drive the trailing edge flaps hydraulically to the selected position.

If a trailing edge asymmetry is detected, primary mode operation is immediately shut down for the failed group and the FCUs do not use secondary mode. The EICAS message FLAPS CONTROL is displayed if all three FCUs fail in their control function. EICAS flap indications from the FCUs may still be valid.

Flap Load Relief in Primary Mode

Flap load relief protects the flaps from excessive air loads if flap airspeed limits are exceeded with flaps 25 or 30 selected. If the airspeed limit is exceeded, the flaps will retract to 25 or 20 as required to reduce/eliminate the exceedance.

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.

FCU Secondary Mode

If any flap group fails to move to the commanded position, the FCUs switch to secondary mode 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 short time delay. 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.

Alternate Mode

An alternate control mode which bypasses the FCUs can be manually selected. In alternate mode, all flaps are extended or retracted by a simplified control system and electric motors. There is no protection provided by the FCUs in alternate mode.

When the Alternate Flaps Arm switch is pushed to ALTN, flaps are extended and retracted using the Alternate Flaps selector. In ALTN, the Flap lever is inoperative.

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 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

EICAS Alert Messages

Note: Configuration (CONFIG) warning messages are described in Chapter 15, Warning Systems.

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		Upper and lower rudder ratio changers have failed.
RUD RATIO SNGL	Advisory		Upper or lower 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 ARM 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 switch disagrees with calculated stabilizer green band.
>STAB TRIM 2, 3	Advisory		Stabilizer trim automatic cutout has occurred, or a stabilizer Trim Cutout switch in CUTOUT, or trim commanded and respective actuator failed to function.
STAB TRIM UNSCHD	Caution	Beeper	Uncommanded stabiliser motion detected and automatic cutout does not occur, or Alternate Stabiliser 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.

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Intentionally
Blank

Primary Flight Display (PFD)

Cathode Ray Tube

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

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/Groundspeed

Displays ADC Mach when Mach .40 or greater. Displays groundspeed when Mach not displayed.

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 manoeuvre capability exists when operating within the amber regions above the maximum manoeuvring speed.

7 Command Speed

Points to airspeed/Mach set in MCP IAS/MACH window.

Points to 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

Cathode Ray Tube

1 Takeoff Reference Speeds

Displays takeoff reference speeds V1 and VR (displays R when VR within 4 knots of V1) selected on the CDU (refer to Chapter 11, Flight Management, Navigation):

- displayed for takeoff
- NO V SPD displays when V speeds are not selected on the CDU
- V1 displays at the top of the airspeed indication when selected and if the value is off the scale
- V1 and VR are removed at lift–off

2 Flap Maneuvering Speeds

Displays flap maneuvering speed for flap retraction or extension for current flap setting and next lesser flap setting.

Not displayed above approximately 20,000 feet altitude.

3 Landing Reference Speed

Displays VREF speed selected on the CDU (refer to Chapter 11, Flight Management, Navigation).

VREF speed displays at the bottom of the airspeed indication when the value is off the scale.

4 Minimum Maneuvering Speed

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 at or below 20,000 FT
- 1.3g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance), with flaps up above 20,000 FT

Displayed with first flap retraction after takeoff.

Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

CAUTION: Reduced manoeuvre capability exists when operating within the amber regions below the minimum manoeuvring speed. During non-normal conditions the target speed may be below the minimum manoeuvring speed.

5 Minimum Speed

Indicates airspeed where stick shaker or low speed buffet occurs.

Attitude Indications

Cathode Ray Tube

1 Bank Pointer

Indicates:

- IRS bank angle in reference to bank angle scale
- direction towards wings level

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). Limited to a maximum of +30 degrees.

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, 45 and 60 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.

Cathode Ray Tube

1 Flight Director Command Bars

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

1 Radio Altitude

Digital - displays radio altitude:

- on the ground, when speed less than 50 knots
- in flight, between 1,000 feet and 2,500 feet AGL

Analog -

- displays radio altitude between 50 knots ground speed and 1,000 feet AGL.
- index marks located at 100 foot intervals
- 0 foot and 1,000 feet index mark at 12 o'clock
- length of arc indicates radio altitude
- digital radio altitude displays in the center

2 RADIO Minimums

Digital - displays selected radio altitude:

- on the ground, when speed less than 50 knots
- in flight, between 1,000 feet and 2,500 feet AGL
- when radio altitude is set to an altitude higher than 1,000 feet AGL, entire RADIO display is replaced by a flashing amber RADIO descending through the set radio altitude

Analog -

- displays radio altitude between 50 knots ground speed and 1,000 feet AGL, pointer indicates RADIO altitude set on the EFIS control panel
- when radio altitude is set to an altitude lower than 1,000 feet AGL, entire analog display changes color to amber and flashes descending through the set radio altitude

RADIO not displayed when set below 0 feet.

Flashing amber RADIO and altitude setting reset to steady green:

- upon landing
- on go-around at 75 feet above the set radio altitude
- when MINS RST switch is pushed

Instrument Landing System Indications

Cathode Ray Tube

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

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.

Rising Runway Indications

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

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

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 flight level, 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

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

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.

Cathode Ray Tube

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

Cathode Ray Tube

Centered Map Mode

Cathode Ray Tube

Approach Mode

Cathode Ray Tube

VOR Mode

Cathode Ray Tube

ND
EXPANDED VOR MODE

CENTERED VOR MODE

Plan Mode

Cathode Ray Tube

Weather Radar System Display Indications

Cathode Ray Tube

ND

ND Failure Indications and Flags

Failure Messages

Cathode Ray Tube

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 System Failures

Displays system failure messages (refer to section 40, this chapter).

3 MAP/WXR Range Disagree

Selected range and range of display information disagree.

Map information is removed.

4 Raster Inoperative (RSTR INOP)

Displays overheat condition.

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.

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.

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 respective CDU (CDU-152).

Displays can also be controlled through the respective CDU (CDU-161).

Control Panel PFD Controls

1 Minimums (MINS) Selector (outer)

RADIO – selects radio altitude for display on the PFD.

BARO – selects barometric altitude for display on the PFD.

2 RADIO Altitude/Barometric (BARO) Altitude Control (middle)

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 Minimums Reset (MINS RST) Switch (inner)

Push - resets PFD flashing amber RADIO and altitude setting to steady green.

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

6 Barometric (BARO) Selector (middle)

Rotate –

- adjusts PFD barometric reference
- preselects 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

G-BYGA - G-BYGG, G-CIVX - G-CIVZ

1 ND Mode Selector (outer)

Selects desired ND display.

APP –

- displays localizer and glideslope information in heading–up format
- displays reference ILS receiver, ILS frequency or identification, course, and DME
- 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 –

- displays heading 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

G-BNLK - G-BNLY, G-CIVA - G-CIVW

1 ND Mode Selector (outer)

Selects desired ND display.

APP –

- displays localizer and glideslope information in heading–up format
- displays reference ILS receiver, ILS frequency or identification, course, and DME
- look-ahead terrain, 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
- look-ahead terrain, weather radar, and TCAS are not displayed in VOR CTR mode

MAP –

- displays heading 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, 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, TERR Switches

The switches:

- select detailed ND information displays
- displays can be selected simultaneously
- EXCESS DATA message displays on ND if amount of data selected is more than can be displayed
- second push removes data

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.

ARPT (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 source select panel controls the left PFD and ND. The right source select panel controls the right PFD and ND.

The left panel is shown.

1 Flight Director/Paravisual Display(FLT DIR/PVD) 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.

AUTO - selects an operable IRU. Captain's selects left, then center, then right; F/O's selects right, then center, then left.

C - center IRU provides attitude and vertical speed information to PFD.

R - right IRU provides attitude and vertical speed information to PFD.

Source for heading, wind direction and speed, slip/skid, track angle, drift angle, and ground speed displayed on PFD and ND depends on the status of the FMCs, IRUs, and position of the Navigation and IRS source selectors.

IRU selected by Captain provides autobrake reference. IRU selected by F/O provides RMI reference.

5 AIR DATA Source Selector

L - left ADC provides information to the PFD and ND.

AUTO - selects an operable ADC. Captain's selects left, then center, then right; F/O's selects right, then center, then left.

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

Selects heading reference for PFDs, NDs, AFDS, FMCs and RMI.

TRUE – references true north.

NORM -

- references magnetic north
- references true north when north of 82°N latitude (or north of 73°N between 80°W and 170°W) or south of 82°S latitude (or south of 60°S between 120°E and 160°E) for PFDs, NDs, and FMCs. Provides no reference for RMI and AFDS roll modes other than LNAV in these areas; HDG SEL, HDG HOLD, and localizer modes are inoperative.

When AFDS roll mode is HDG SEL, switching the Heading Reference switch from NORM to TRUE or TRUE to NORM activates HDG HOLD mode.

Display Select Panel

1 Display Switches

Pushing a switch displays the respective 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)

Rotate – adjusts weather radar 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)

Rotate – adjusts weather radar brightness on lower display.

Standby Flight Instruments

Standby Magnetic Compass

1 Standby Magnetic Compass

Displays magnetic heading.

Standby Attitude Indicator

Standby attitude indicator provides an independent source of airplane attitude.

1 Bank Indicator and Scale

Indicates airplane bank.

Scale marks at 0, 10, 20, 30, 45 and 60 degrees.

2 Glide Path (G/P) Flag

Displays when glide slope information unreliable.

3 Airplane Symbol

Indicates airplane position.

4 Attitude (GYRO) Flag

Displays when attitude information unreliable.

5 Glide Slope Indicator

Indicates glide slope position relative to the airplane.

6 Horizon Line and Pitch Scale

Indicates position of horizon relative to the airplane.

Scale marks in five degree increments.

7 Localizer Indicator

Indicates localizer position relative to the airplane.

8 Localizer (LAT) Flag

Displays when localizer information unreliable.

9 Caging Control

Pull - levels horizon with airplane symbol.

10 Approach Selector

OFF - glide slope and localizer indicators and flags retracted from view.

APP (Approach) - glide slope and localizer information displayed. Left ILS receiver used.

B/CRS (Back Course) - reverses sensing for localizer information.

Standby Airspeed Indicator

Standby airspeed indicator displays airspeed from auxiliary pitot 1 and alternate static source.

1 Airspeed Pointer

Indicates uncorrected airspeed.

2 Airspeed Bugs

Can be set to desired airspeeds.

Standby Altimeter

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

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.

1 Heading (HDG) Flag

Displays when heading invalid.

2 VOR/ADF Selectors

VOR – VOR information provided to respective pointer.

ADF – ADF information provided to respective pointer.

3 Wide Pointer

Indicates right VOR or ADF bearing to selected station.

4 Narrow Pointer

Indicates left VOR or ADF bearing to selected station.

5 Pointer Flags

Display when selected information invalid.

Clock

1 Chronograph (CHR or CLOCK) Switch

Push – subsequent pushing starts, stops, resets the chronograph.

2 Chronograph Pointer

Indicates chronograph seconds.

3 Elapsed Time (ET) Selector

Controls elapsed time function.

RESET – returns elapsed time display to zero (spring loaded to HLD).

HLD (Hold) – stops elapsed time display.

RUN – starts elapsed time display.

4 DATE Switch

Push -

- displays date (alternates day and month, then year) on GMT display
- subsequent push returns display to time (hours, minutes, tenths of minutes) on GMT display.

5 GMT Display

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 with DATE switch
- advances days when date selected with DATE switch

Minutes Slew, Month (MS M) –

- advances minutes when time selected with DATE switch
- advances months when date selected with DATE switch

Hold, Year (HLD Y) –

- stops time indicator and sets seconds to zero when time selected with DATE switch
- advances years when date selected with DATE switch

RUN – starts time indicator.

Para-Visual Display

The PVD system consists of one PVD computer and two PVD indicators. The PVD computer receives guidance commands from the FCCs. The FCC source is selected with the FD/PVD source selector for the respective display.

Using the tuned runway localizer, the PVD provides guidance to runway centerline during ground operations.

1 Para-Visual Display (PVD)

Unshuttered -

- PVD selected on, within valid localizer region, within 45° of runway heading, and on the ground
- “barber pole” rotates in direction of runway centerline

Shuttered - PVD off -

- not within valid localizer region or not within 45° of runway heading
- above 5 feet altitude
- selected PVD source invalid

2 PVD Switch

Push - enables the PVD display unit to unshutter

Second Push - shutters the PVD display unit

Rotate - adjusts brightness.

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

The CDU provides an alternate way to control the functions of the EFIS control panel and the display select panel except for TCAS 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 respective control panels except where described.

CDU EFIS/DSP Control Selection (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)

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)

1 Barometric (BARO) Reference SET

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 (DH) RESET

Push - resets PFD flashing amber DH.

4 Minimum Descent Altitude (MDA SET)

Valid entry is minimum descent altitude.

5 RANGE Increase (INCR)

Push - increases ND nautical mile range scale.

6 RANGE Decrease (DECR)

Push - decreases ND nautical mile range scale.

7 MODE

Push - selects desired ND display.

8 Center (CTR)

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

9 OPTIONS

Push - displays EFIS OPTIONS page.

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)

- Push - alternately selects radio altimeter (RAD) or barometric altimeter (BARO) as the minimums reference on the PFD. Selected mode displays in large font.

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 (INCR)

Push - increases ND nautical mile range scale.

6 Range Decrease (DECR)

Push - decreases ND nautical mile range scale.

7 MODE

Push - selects desired ND display.

8 Center (CTR)

Push - alternately displays centered and expanded APP, VOR, and MAP modes.

9 OPTIONS

Push - displays EFIS OPTIONS page.

EFIS Options Page (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 CONTROL

Push - selects EFIS CONTROL CDU page.

EFIS Options Page (CDU-161)

1 WXR, POS, MTRS, FPV, TFC, TERR, WPT, STA, ARPT, DATA

Push - selects related PFD/ND options.

2 ADF/VOR

Push - sequentially selects ADF, VOR, or OFF for the pointer display on the ND.

ADF - displays the ADF pointers and frequency on the ND in all modes except PLAN.

VOR - displays the VOR pointer, frequency, and associated DME on the ND in all modes except PLAN.

OFF - removes ADF and VOR data from the ND.

3 CONTROL

Push - selects EFIS CONTROL CDU page.

EICAS Modes Page

1 Synoptic/Display

Push - displays respective synoptics/displays.

2 Cancel (CANC)

Refer to Warning Systems, Chapter 15.

3 Recall (RCL)

Refer to Warning Systems, Chapter 15.

4 SYNOPTICS

Push - selects EICAS SYNOPTICS page.

EICAS Synoptics Page

1 Synoptic/Display

Push - displays respective synoptics/display.

2 MODES

Push - selects EICAS MODES page.

Intentionally
Blank

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

Para-Visual Display (PVD) System

The PVD system consists of one PVD computer and two PVD indicators. The PVD computer receives guidance commands from three FCCs. The FCC source is selected with the FD/PVD source selector for the respective display.

Using the runway localizer tuned on the Navigation Radio page, the PVD provides guidance to runway centerline during ground operations.

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:

- standby magnetic compass
- standby attitude indicator
- standby airspeed indicator
- standby altimeter
- radio magnetic indicator

Standby Magnetic Compass

A standard liquid–damped magnetic standby compass is located on the center post above the glareshield. A card located near the compass provides heading correction factors.

Standby Attitude Indicator

The standby attitude indicator on the center instrument panel incorporates an (APP) display, a bank indicator, and a pitch scale display. The main battery powers the standby attitude indicator. The left ILS receiver provides approach information.

Standby Airspeed Indicator

The standby airspeed indicator on the center instrument panel receives pitot pressure from auxiliary pitot source 1 and static pressure from the alternate static source.

Standby Altimeter

The standby altimeter on the center instrument panel receives static pressure from the alternate static source. The pointer completes one revolution every 1,000 feet.

Radio Magnetic Indicator

The radio magnetic indicator displays selected VOR and ADF bearings. The right IRU provides heading information when the F/O's IRS source selector is in RIGHT. The center IRU provides heading information when center or left is selected.

When the Heading Reference switch is in NORM, a heading flag is in view north of 82° latitude (or north of 73°N between 80°W and 170°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

The pitot static system provides pitot pressure and static pressure to the air data computers, standby airspeed indicator, standby altimeter, and elevator feel computer.

Pitot Static Diagram

Air Data Computer (ADC) System

The ADC system supplies air data information to various airplane systems. Air data information enables the EIUs to display altitude, airspeed, Mach, and air temperature.

There are two 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 respective 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.

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

Cathode Ray Tube

PFD Climb Display

Cathode Ray Tube

PFD Cruise Display

Cathode Ray Tube

PFD Descent Display

Cathode Ray Tube

PFD Approach Display

Cathode Ray Tube

PFD Landing Display

Cathode Ray Tube

Intentionally
Blank

Introduction

The NDs provide a mode–selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan)

MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

Map Mode

MAP mode is recommended for most phases of flight.

Presented heading up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- track
- heading
- route
- postion trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points
- TCAS Traffic Display

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA), and position (POS) data may be displayed on the ND in both the expanded and center map modes.

VOR and Approach Modes

VOR and APP modes display heading up. VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or ILS approach information.

Plan Mode

PLN mode displays true north up. The active route may be viewed using the STEP prompt on Legs pages. Position DATA is available for display in plan mode

ND Information

Heading

Heading is supplied by the selected IRU. The ND compass rose can be referenced to magnetic north or true north. The Heading Reference switch is used to manually select magnetic or true reference. The compass display references true north when the airplane is north of 82° N latitude (or north of 73°N between 80° W and 170° 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.

Cathode Ray Tube

STA (STATION) SELECTED

WPT (WAYPOINT) SELECTED

ARPT (AIRPORT) SELECTED

DATA SELECTED

POS (POSITION) SELECTED

ND Symbology

The following symbols display on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

- W (white) – present or modified status, range scales, armed flight mode annunciations
- G (green) – dynamic conditions, active flight mode annunciations
- M (magenta) – active waypoint and route, command information, pointers, symbols, fly–to condition
- B (blue) – inactive or background information, ADF symbols
- A (amber) – cautions, faults, flags
- R (red) – warnings

Heading, Track, and Speed

Symbol	Name	ND Mode	Remarks
	Current heading pointer (W)	MAP, MAP CTR, PLAN	Points to current heading on the compass rose.
	Expanded compass (W)	MAP, APP, VOR, PLAN	Displays 90 degrees of compass rose.
	Groundspeed (W)	All	Displays ground speed in large font below 30 knots; small font at 30 knots and above.
	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.
	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.

Symbol	Name	ND Mode	Remarks
	Track indicator (W)	VOR, VOR CTR, APP, APP CTR	Indicates airplane track when selected mode has heading orientation.
	IRU time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction/speed and wind arrow, on the ground, during alignment.
 	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.
	True airspeed (W)	All	Displays true airspeed above 100 knots.
	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.
	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).

Radio Navigation

Symbol	Name	ND Mode	Remarks
DME 24.6	DME distance (W)	VOR, VOR CTR, APP, APP CTR	Displays DME distance to the reference navaid. Located in the upper right corner.
116.80 OR SEA	ILS/VOR (W) 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. Located in the upper right corner.
VOR L, R ILS L, C, R	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Displays selected receiver as display reference.
	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.
	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.
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.

Symbol	Name	ND Mode	Remarks
	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 POS 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.
	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		
	VOR (G) or ADF (B) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Represents positions of VOR/ADF switches. Located in the lower left or right corner.
	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. Located in the lower left or right corner.

Symbol	Name	ND Mode	Remarks
DME 24.6	DME distance (G)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays DME distance to the referenced navaid. Located in the lower left or right corner.
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	Airplane position is at the apex of the triangle.
	Airplane symbol (W)	VOR CTR, APP CTR	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

Symbol	Name	ND Mode	Remarks
	Active waypoint identifier (M)	MAP, MAP CTR, PLAN	Displays active flight plan waypoint, the next waypoint on the route of flight.
	Active waypoint distance (W)	MAP, MAP CTR, PLAN	Distance to active waypoint.
	Active waypoint ETA (W)	MAP, MAP CTR, PLAN	Displays FMS-calculated ETA at the active waypoint.
	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.

Symbol	Name	ND Mode	Remarks
	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.
	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.

Symbol	Name	ND Mode	Remarks
	Flap speed and descent deceleration profile point and settings (G)	MAP, MAP CTR	Indicates the approximate map position for start of the deceleration to FMC-calculated flap and speed settings. Flap setting is indicated for flaps 1, 5, 10, and 20 only. No more than two flap speed profile points are displayed at the same time. Position and settings are calculated to be on speed, on path and on time at the final approach fix. Descent speed deceleration profile points display as a circle and a speed.
	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.

Symbol	Name	ND Mode	Remarks
	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.
	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).
	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.
	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.

Symbol	Name	ND Mode	Remarks
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.
	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 respective Navigation Source Select switch • both FMCs fail, or • a manually selected FMC fails

Symbol	Name	ND Mode	Remarks
N↑	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.

TCAS

For more information, refer to Chapter 15, Warning Systems.

Symbol	Name	ND Mode
■ ↑ −03	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, APP, VOR
+02 ● ↓	TCAS traffic advisory (TA), relative altitude (A)	MAP, MAP CTR, APP, VOR
◆ ↓ −05	TCAS proximate traffic, relative altitude (W)	MAP, MAP CTR, APP, VOR
+09 ◇ ↑	TCAS other traffic, relative altitude (W)	MAP, MAP CTR, APP, VOR
RA 5.3 +03 ↑ TA 8.9 −12 ↑	TCAS no bearing message (RA-R, TA-A)	MAP, MAP CTR, APP, VOR
TRAFFIC	TCAS traffic alert message (RA-R, TA-A)	All
OFFSCALE	TCAS off scale message (RA-R, TA-A)	MAP, MAP CTR, APP, VOR
TFC	TCAS mode (B)	MAP, MAP CTR, APP, VOR
TCAS TEST	TCAS mode (B)	All

Symbol	Name	ND Mode
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR
TA ONLY	TCAS mode (B)	All
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR

Radar

For more information, refer to Chapter 11, Flight Management, Navigation.

Symbol	Name	ND Mode
STAB LIM	Antenna at pitch or roll stabilization limit	MAP, MAP CTR, APP, VOR
CAL	Automatic gain control failure (A)	MAP, MAP CTR, APP, VOR
STAB	IRS stabilization signal failure (A)	MAP, MAP CTR, APP, VOR
IND	Auxiliary weather display failure (A)	MAP, MAP CTR, APP, VOR

Symbol	Name	ND Mode
MAP	Mode used with down-tilt, when ground mapping (B)	MAP, MAP CTR, APP, VOR
WX+T	WXR and turbulence mode (B)	MAP, MAP CTR, APP, VOR
WXR	WXR precipitation only mode (B)	MAP, MAP CTR, APP, VOR
TEST	Weather radar (WXR) test mode (A) (B)	MAP, MAP CTR, APP, VOR
+15 to −15	WXR antenna tilt (B)	MAP, MAP CTR, APP, VOR
CONT	WXR control panel failure (A)	MAP, MAP CTR, APP, VOR
R/T	WXR receiver transmitter failure (A)	MAP, MAP CTR, APP, VOR
ANT	WXR antenna failure (A)	MAP, MAP CTR, APP, VOR
WXR FAIL	WXR system failure (A)	MAP, MAP CTR, APP, VOR

Look-Ahead Terrain

For more information, refer to Chapter 15, Warning Systems.

Symbol	Name	ND Mode
	Terrain display (R, A, G, M)	MAP, MAP CTR, APP, VOR
TERR	Terrain mode annunciation (B)	MAP, MAP CTR, APP, VOR
TERR TEST	Terrain test mode annunciation (B)	All

Symbol	Name	ND Mode
TERRAIN	Terrain annunciation (R, A)	All
TERR FAIL	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR POS	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR OVRD	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR, APP, VOR
MAP/TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR

Predictive Windshear

For more information, refer to Chapter 15, Warning Systems.

Symbol	Name	ND Mode
	Predictive windshear symbol (R, B, A)	MAP, MAP CTR, APP, VOR
WINDSHEAR	Windshear annunciation (R, A)	All

EICAS Alert Messages

Note: OVERSPEED warning and ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

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.
>ATTITUDE	Caution	Beeper	Captain and First Officer selected IRS attitude output disagree by 3 degrees or more.
>BARO DISAGREE	Advisory		Captain and First Officer barometric reference settings disagree for more than one minute.
>HEADING	Advisory		Captain and First Officer displayed headings disagree by 4 degrees or more.
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.
>ADC LEFT, CENTER, RIGHT	Advisory		Air data computer failure.
>AOA RIGHT	Advisory		Right AOA sensor has failed. AOA system redundancy lost.
>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.
>EIU LEFT	Advisory		Left EIU failed. Inhibited in flight.
>PVD SYS CAPT, F/O	Advisory		PVD system failure.
>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.
>TRACK	Advisory		Captain and First Officer selected track output disagree by 6 degrees or more.
PVD BOTH, CAPT, F/O ON	Memo		PVD selected on.

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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)

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

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
  (G-BNLK - G-CIVZ ; before SB, ATS not active)
- ATC - displays CDU message KEY/FUNCTION INOP
  (G-BNLK - G-CIVZ ; SB activates ATS)
- 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
  (G-BNLK - G-CIVZ ; before SB, AOC not active)
- FMC COMM - displays CDU message KEY/FUNCTION INOP
  (G-BNLK - G-CIVZ ; SB activates AOC)
- 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

For clarity next generation FMC CDUs are depicted below in white on black background to highlight differences where applicable.

Note: All CDUs on BA aircraft display in green on black background.

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 Data 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 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 Panel

1 Altitude (ALT) Reporting (RPTG) Selector

ON – altitude reporting enabled.

OFF – altitude reporting disabled.

2 Identification (IDENT) Switch

Push – transmits ident signal.

3 Transponder (XPNDR) Selector

L – selects left transponder.

R – selects right transponder.

4 Transponder Code Switches

Push – sets transponder code.

CLR (clear) – deletes transponder code.

5 Transponder Code Display

ATC L, ATC R – transponder selected.

Displays transponder code.

6 TCAS Flight Level (F/L) Switch

Refer to Chapter 15, Warning Systems.

7 Transponder (XPDR) FAIL Light

Illuminated (amber) – selected transponder has failed.

8 Transponder Mode Selector

STBY (standby) – transponder disabled.

XPDR (transponder) – transponder enabled.

TA (traffic advisory) and RA/TA (resolution advisory/traffic advisory) – Refer to Chapter 15, Warning Systems.

TEST – initiates test.

9 TCAS Airspace Switch

Refer to Chapter 15, Warning Systems.

Weather Radar Panel

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 Range Selector

Selects desired nautical mile range for auxiliary weather radar display.

3 GAIN Control

Rotate - sets receiver sensitivity.

AUTO - maintains optimum receiver sensitivity.

4 Mode Selector

Controls display on NDs and on auxiliary display.

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)

G-BYGA - G-BYGG, G-CIVX - G-CIVZ

- 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

G-BYGA - G-BYGG, G-CIVX - G-CIVZ

- 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 returns with gain controlled automatically.

WX/TURB (weather/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.

5 TILT Control

Controls antenna tilt angle with reference to horizon.

Auxiliary Weather Radar Display

1 Auxiliary Weather RADAR Display Switch

OFF - removes power from display.

RDR (radar) - activates weather radar and displays radar returns.

AUX (auxiliary) - activates other displays.

2 Brightness Control

Controls brightness of display.

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Introduction

Navigation systems include global positioning system (GPS), inertial reference system (IRS), VOR, DME, ILS, ADF, ATC transponder, weather radar, and the flight management system (FMS). The FMS is described in the Flight Management System Description section of this chapter.

Navigation Systems Flight Instrument Displays

Refer to Chapter 10, Flight Instruments, Displays for flight instrument display system operations and typical instrument displays.

Global Positioning System (GPS)

Left and right GPS receivers are independent and supply very accurate position data to the FMC. GPS tuning is automatic.

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 and velocity data to estimate errors in the inertial reference system (IRS) position and velocity. The IRS position and velocity are corrected to form the FMC 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 (e.g. to accommodate a non-WGS reference datum or other reason).

GPS System Schematic

G-BNLK - G-CIVZ ; SB installs next generation FMC)

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 Realignment

Following operation in the navigation mode and with the airplane parked, performing a realignment 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 realignment completes in approximately 30 seconds.

Fast realignment 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 aligns the system. 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 respective left and right 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 ALTN NAV page. Each DME channel 1 is tuned to the VOR shown on the CDU unless the respective 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.

With a non-ILS approach selected to an ILS/LOC-equipped runway, the ILS autotunes and pointers and deviation scales display for positional awareness.

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 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 respective 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 respective 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; and when interrogated on the ground, it provides airport position.

In flight, traffic displays if the transponder mode selector is in TA or RA/TA.

In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPDR, TA, or RA/TA and the altitude reporting selector is ON.

Refer to Chapter 15, Warning Systems, for a description of TCAS.

Weather Radar

The weather radar system consists of two receiver–transmitter units, an antenna, auxiliary displays, 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.

G-BYGA - G-BYGG, G-CIVX - G-CIVZ

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 cannot be sensed by radar.

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Introduction

The flight management system (FMS) aids the flight crew with navigation, in–flight performance optimization, fuel monitoring, and flight deck displays using Flight Management Computers (FMCs). Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help fly efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting system data to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios and sets courses. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, approaches, 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 primary 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.

Introduction

When first powered, the FMS is in preflight phase. When completing a phase, the FMS changes to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete

Preflight

During preflight, the flight crew enters flight plan and load sheet data into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet data provide performance data to initialize VNAV.

Some ATC information can be entered into the CDU by datalink.

(G-BNLK - G-CIVZ ; SB activates AOC)

Some company information can be entered into the CDU by datalink.

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 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 entry is made on the LEGS page with a duplicate identification, the SELECT DESIRED WPT page displays and the correct navaid can be selected and entered into the active 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 Airline Policy

The airline policy pages display operating parameters in the airline maintained file. The FMC references this file for data before it calculates default values. These pages are not usually used by the flight crew.

3 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. With GPS active, the TO/GA update is inhibited.

In flight, the FMC position is the IRS position updated by GPS or navigation radio source data to compensate for inertial reference errors. Updating priority is based on the availability of valid data from these sources.

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 collocated 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.

IRS position updating occurs in the following priority order:

- LOC and GPS
- LOC and DME-DME
- LOC and collocated VOR/DME
- LOC
- GPS
- DME-DME
- collocated VOR/DME

The station identifiers in use by the FMC for navigation radio updating 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 1.25° of the localizer centerline
- 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

At latitudes between 82°N (or south of 73°N between 80°W and 170°W) and 82°S (or north of 60°S between 120°E and 160°E), IRU heading and track reference is determined by the Heading Reference switch position. North of the 82°N latitudes or south of the 82°S latitudes, IRU heading and track reference true north regardless of Heading Reference switch position.

The active leg course direction displays in true while the PFD and ND directions display in magnetic between 70°N and 73°N between 80°W and 130°W. Intercept course procedures or waypoints entered as place/bearing/distance or place bearing/place bearing may result in incorrectly positioned waypoints in these regions with the Heading Reference switch in NORMAL.

Automatic switching to a true north reference annunciates by a white box around the word TRU on the ND. A TRUE heading reference can be selected with the Heading Reference switch inside or outside 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 a flashing amber box around the word TRU.

Note: The TRUE position on the Heading Reference switch should be selected for autopilot operation in high latitudes when using a roll mode other than LNAV.

Areas of High Latitude Operations (2015 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.

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, a DME arc, or a constant radius-to-fix arc to comply with the procedure.

The FMC creates a path allowing the airplane to turn before reaching a "fly-by" waypoint. When a waypoint is defined as a "fly-over", the FMC directs the airplane to fly directly over the waypoint before turning. The flight path shows on the ND using reduced range.

Waypoints

Waypoint 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

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.

DME step down fixes are identified by the distance and a “D”. Examples: 138D, 106D, 56D, 3D.

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 zeros 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 dash and a single digit corresponding to the FIX INFO page number. When the fix identifier contains three or more characters, the first three are used; when the fix identifier contains less than three characters, the first two are used. Examples:

- SEA330/10 becomes SEA-01
- SEA240/OLM320 becomes SEA-02

The two digit sequence numbers are 01 through 99. Both RTE 1 and RTE 2 use the sequenced numbers; for example, "01", "02", and "04" may be in RTE1 while "03" is in RTE 2.

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 250, 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 250 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
- a pending active route displays as a dashed white 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 calculated 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 altitude capture below acceleration height, 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 UNABLE NEXT ALT scratchpad message 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
- 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 calculations assume the airplane climbs at each calculated step climb point as airplane weight decreases. FMC calculated step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise.

Flight crew entry of a STEP TO altitude on the CRZ page or "S" on a waypoint on the LEGS page overrides FMC step climb calculations. Entry of a step altitude on the LEGS page overrides a STEP TO entry made on the CRZ page.

Calculated step altitudes display on the LEGS page. The distance and ETA to the next step point (calculated or flight crew entered) display on the CRZ and PROGRESS pages. They also display on the ND map display with a green circle and "S/C".

The FMC calculates step climb locations and altitudes as a function of lateral flight plan, current cruise speed mode and altitude, entered forecast winds and temperatures, step size, cruise cg, and gross weight.

The primary factor affecting step climb calculation is the entry of accurate forecast cruise winds and temperatures on the WINDS page. Unless enroute winds are entered, all step climb locations and altitudes are calculated assuming zero wind. IRS winds are not used in the calculation of step climb data.

For ECON cruise, step climbs are optimized to provide minimum trip cost according to the entered Cost Index. For other selected speeds, calculated step climbs minimize trip fuel.

Calculated step locations display on the ND (S/C); the next step displays on the ECON CRZ page. Flight plan calculations of time and fuel at destination are based on executing step climbs as calculated. Legs page waypoint altitudes reflect the optimum step climb profile.

Inflight entry of a STEP TO altitude in 1R causes the FMC to use the entered enroute winds and temperatures to calculate the optimum location for a climb to the step altitude; the ETA and DTG for the step display in 2R. Following entry of an altitude in 1R, the FMC uses only that altitude to calculate data for 2R. When the FMC calculates an immediate step climb to the entered altitude is optimal, 2R displays NOW. If the FMC determines remaining at the current altitude for the duration of the flight is more optimal than flying at the entered altitude, 2R displays NONE.

Planned step climb points (S/C) may be entered on the Legs page at selected waypoints. In this case, both altitude and step location are constrained. With planned step climb points entered, flight plan calculations assume a constant cruise altitude until reaching the planned step waypoint. Optimized step climb calculations resume after passing the last planned step climb waypoint.

When the last planned step is a step descent, step climbs are no longer calculated.

Optimum (OPT) altitude calculation does not use forecast or IRS winds and temperatures. Recommended (RECMD) altitude calculation is based on step size, current CRZ ALT, and entered forecast enroute winds and temperatures.

All altitude calculations are limited by maximum (MAX) altitude.

If a climb is not initiated within 5 minutes after passing a step climb point, the scratchpad message VNAV STEP CLIMB displays.

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.

Required Time of Arrival (RTA)

VNAV controls cruise speed to arrive at a specified waypoint within ± 30 seconds of a specified time. The FMC displays the scratchpad message, UNABLE RTA, if the RTA is not achievable. RTA is not available with engine out.

RTA and Cruise Speed Segments

RTA cruise segments can only be entered following the creation of an RTA Fix and time on the RTA PROGRESS page 3.

Three types of RTA times can be created: AT, AT or AFTER, and AT or BEFORE. AT type RTA entries are entered without a suffix, AT or AFTER type RTAs are entered with an “A” suffix, and AT or BEFORE type RTAs are entered with a “B” suffix. When the RTA type is an AT or AFTER and ECON speed satisfies the RTA, speed is ECON even if the airplane arrives at the RTA waypoint after the RTA time.

When an RTA fix is created before takeoff, the RTA function calculates RTA cruise speed and recommended takeoff time to meet the RTA requirement. Calculation of recommended takeoff time initially uses ECON climb and cruise speeds. If the RTA function calculates takeoff time to be NOW, and takeoff does not occur, calculated cruise speed increases until RTA MAX SPD is reached. When the RTA function calculated MAX SPD is required and takeoff does not occur, the scratchpad message UNABLE RTA displays.

The RTA function can be used with other cruise speed segments. Cruise speed segments can be MACH, LRC, or ECON. They are entered on the LEGS page as MACH (.XXX/), LRC (LRC/ or L/), or ECON (ECON/ or E/) and continue until the start of the next cruise speed segment or until the top of descent. An RTA cruise speed segment can be entered as RTA/ or R/ on a waypoint before the RTA Fix waypoint. When entering an RTA cruise speed segment down path of another cruise speed segment, the commanded cruise speed becomes RTA SPD when reaching the selected RTA cruise speed segment. When an RTA Fix has been entered, an ECON cruise speed segment can only be entered down path of the RTA Fix waypoint.

Entry of accurate winds and temperatures are essential to RTA functionality.

Selection of route offset does not affect RTA functionality.

MCP Speed Intervention

SPEED INTERVENTION PITCH MODES

With VNAV active, pushing the IAS/MACH selector enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

The above illustration shows the VNAV pitch flight mode annunciation for each phase of flight when using speed intervention.

In a VNAV descent after the T/D, the pitch mode does not change with speed intervention and remains VNAV PTH throughout the descent unless VNAV can not maintain the airplane within 150 feet of the path; if this occurs, the pitch mode changes to VNAV SPD. Pitch controls speed in VNAV SPD mode; thrust controls speed in VNAV PTH mode.

During a VNAV or non-ILS approach while using speed intervention, the pitch mode is VNAV PTH. The vertical path is maintained regardless of IAS MACH selector changes.

If a “direct to” is executed to a waypoint in the approach, VNAV transitions to the approach phase when the airplane passes the “direct to” waypoint. If a waypoint located after the first waypoint of an FMC database approach is added and executed, VNAV does not transition to approach phase when passing the first waypoint of the approach.

Descent

The FMC calculates a descent path based on cruise airspeed and altitude and the end of descent (E/D); and, when applicable, waypoint airspeed and altitude constraints. 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:

- off-idle thrust
- speedbrakes retracted
- FMC cruise wind
- wind entries on the DESCENT FORECAST page
- planned use of anti-ice
- applicable target speed

Note: "off-idle" thrust is selectable in the AMI; it allows an off-idle thrust setting to stabilize the descent path and minimize maneuvering at lower altitudes. Changing the AMI value from 1.0 to 1.2 could result in the descent distance increasing.

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

Reversion to VNAV SPD and departure below the path for a condition of speed decrease is inhibited when VNAV is in the “on approach” mode.

The DRAG REQUIRED and THRUST REQUIRED messages are inhibited when VNAV pitch control is speed-on-elevator.

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 dialing the altitude down and 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.

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.

Approach

The FMC transitions to "on approach" mode for any of the following conditions:

- the descent phase is active and flaps are out of up, or
- the airplane has sequenced the first waypoint (or FAXXX) of the active navigation database approach, or
- the airplane is less than 12 NM from the destination airport, on a direct-to or intercept course-to the active waypoint, and a manually entered end of descent altitude constraint is lower than the destination airport plus 500 feet, or
- the runway or missed approach point is the active waypoint and the airplane is within 25 NM of the runway

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 course-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 an 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.

Note: During approach maneuvering with the IAS/MACH window closed, VNAV commands the flap maneuvering speed for the flap position selected. The green flap profile circles shown on the ND indicate where the FMC calculates flap extension should occur.

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)

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 to V2 + 10 knots. Autothrottle remains in THR REF at the selected reference thrust limit for takeoff.

3 Acceleration Height

Condition: at acceleration height or altitude capture below acceleration height.

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. Execution activates engine out performance data and terminates the VNAV engine out takeoff phase.

Result: the FMC engine out climb function is active, the pitch mode is VNAV SPD, the command speed is E/O SPD, and the reference thrust limit is CON. The use of VNAV for descent and approach is enabled.

VNAV Cruise (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. When executing the ENG OUT modification, the reference thrust limit becomes CON, thrust levers advance to CON, the default command speed is EO SPD, and the EO MAX altitude shows as the cruise altitude in 1L. The EO MAX altitude shown in 1L does not change with time or changes in command speed.

1 Engine Out Modification

Selecting ENG OUT> creates a modification and displays applicable engine out driftdown (D/D) performance data.

2 Drift Down Execution

A driftdown descent can be initiated by setting the MCP altitude at or below EO MAX altitude and executing the modification.

Result:

- VNAV commands EO LRC SPD
- when EO LRC SPD is achieved, VNAV controls the driftdown descent rate to a minimum of 300 feet per minute (fpm)
- time and distance for the D/D to EO MAX altitude show at 2R
- VNAV captures the MCP altitude and commands EO LRC CRZ

Executing the ENG OUT modification without descending changed the pitch mode to VNAV ALT. A driftdown descent does not start until setting the altitude at or below EO MAX altitude and pushing the altitude selector. The result above describes the driftdown.

If terrain clearance is a factor, maintaining the highest possible attitude requires a slower command speed. After selection of the ENG OUT prompt, selecting the EO SPD prompt may increase the MAX altitude shown in 4R. If different than 1L, entering the new MAX altitude in 1L results in the shallowest descent profile and level off at the highest engine out altitude. Setting the altitude at or below the new MAX altitude, and executing the modification initiates the driftdown descent as described above, except the command speed is EO SPD.

A normal enroute cruise descent can be initiated by setting the MCP altitude to a lower altitude and pushing the altitude selector.

Result:

- the airplane descends in a normal VNAV cruise descent at four-engine ECON speed
- the reference thrust limit is CLB/CRZ
- the airplane descends at ECON CRZ and approximately 1,250 fpm

During the enroute cruise descent, when the airplane is above EO MAX altitude, executing the ENG OUT modification commands a driftdown descent to the EO MAX altitude. The command airspeed is E/O LRC SPD. The rate of descent decreases to a minimum of 300 fpm.

3 Engine Out Cruise

When VNAV captures the EO MAX altitude, the VNAV cruise page title becomes E/O LRC CRZ and the pitch annunciation is VNAV PTH., regardless of the MCP altitude window setting. Calculations for E/O Step Climb display in 2R. Thrust limit remains in CON.

4 Subsequent Cruise Descent

The FMC is in engine out mode. When the airplane is more than 50 nm from T/D, setting a lower MCP altitude and pushing the altitude selector executes an engine-out cruise descent.

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.

Intentionally
Blank

FMC Databases

The FMC contains five databases:

- navigation
- operational program configuration (OPC)
- aero engine database (AEDB)
- airline modifiable information (AMI)
- MAGVAR tables

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 operational program configuration (OPC) database contains configurable features controlled by the airplane manufacturer.

The aeronautical engine database provides performance data for calculation and optimization of the vertical path, flight plan predictions, and flight optimization. Examples of database parameters are:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds

The flight plan is stored in the FMC and is accessible to other FMC functions requiring information for further flight plan developments.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the navigation chart revision cycle. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and transferred to the FMC before the expiration date of the active data.

Thrust Management

The thrust management function operates the autothrottle in response to flight crew mode control panel inputs or to FMC commands. Reference thrust limits can be selected on the THRUST LIM page. FMC autothrottle commands are made while VNAV is engaged. Thrust management:

- calculates reference thrust limits and thrust settings, or follows FMC thrust settings
- commands thrust levers
- senses and transmits autothrottle failures
- commands thrust equalization through the engine electronic controls

Thrust limits are expressed as 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

Two fixed derates, TO1 and TO2, can be selected on the THRUST LIM page.

With both TO1 and TO2, the thrust setting parameter is considered a limitation for takeoff; therefore, thrust levers should not be advanced further except in an emergency. A further thrust increase following an engine failure could result in a loss of directional control. Use the takeoff speeds calculated by the FMC for the selected derate or variable takeoff rating condition.

Assumed Temperature Thrust Reduction Takeoff

Entering an assumed temperature higher than the actual temperature reduces takeoff thrust.

The maximum thrust reduction authorized is 25 percent below any certified rating.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where more thrust is necessary, the crew can manually apply full thrust.

Note: When the flight crew enters an assumed temperature resulting in thrust reduction; and, manually arms "CLB", a decrease in OAT may cause the FMC to recalculate V-speeds and arm "CLB1" or "CLB2" on the THRUST LIM page. The scratchpad message TAKEOFF SPEEDS DELETED displays.

Derated Thrust Climb

During climb, CLB 1 and CLB 2 derates are gradually removed. In cruise, the thrust reference defaults to CLB or CRZ as set by maintenance.

Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a 10% derate of CLB thrust to 25,000 feet, then increases thrust linearly with altitude to CLB thrust at 35,000 feet. CLB 2 uses a 20% derate of CLB thrust to 25,000 feet, then increases thrust linearly with altitude to 5.5% derate at 35,000 feet.

Note: When VNAV transitions from climb to cruise phase, the derate reference thrust limit CLB-1 or CLB-2 changes to CLB on the EICAS display.

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, VNAV, and autothrottle are not usable. The CDUs supply route data to their respective ND. Alternate navigation using CDUs is discussed in Section 50 of this chapter.

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.

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.

Datalink can load preflight data from airline ground stations. Using datalink reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

Datalink can also load takeoff data onto 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.

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 the TAKEOFF REF page leads the flight crew to the 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 can be removed using the RTE LEGS pages. Similarly, speed/altitude restrictions are entered and removed on RTE LEGS pages described in the FMC Takeoff and Climb section of this chapter.

Waypoint, navigation, airport, and runway data is referenced on the REF NAV DATA page 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 WIND page 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

The INIT/REF page allows manual selection of FMC pages. It gives access to pages used during preflight plus other reference data.

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 displays approach planning data and is used to enter the approach VREF speed.

7 Navigation Data (NAV DATA)

REF NAV DATA page is used for data on waypoints, navaids, airports, and runways. The REF NAV DATA page is accessible only from this page.

8 Alternate (ALTN)

XXXXz ALTN page displays. The page number depends on whether a pending alternate diversion exists.

9 FMC Communications (COMM)

The FMC COMM page provides access to pages used for company datalink functions.

Identification Page

Most data on this page is for flight crew verification. The active navigation database can be selected.

1 MODEL

Displays airplane model from FMC performance database.

2 Navigation Data (NAV DATA)

Displays navigation database identifier.

3 Operating (OP) PROGRAM

Displays systems operating program identifier (FMC software load).

4 Operational Program Configuration (OPC)

Displays the OPC part number containing the database enabling operator requested features. Selection and entry are nonoperational.

5 ENGINES

Displays engine model from the FMC performance database.

6 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.

7 Inactive Date Range

Displays the effectivity date range for the inactive navigation database. The inactive database becomes effective at 0901Z on the respective day.

8 DRAG/Fuel Flow (FF)

Displays airplane drag and fuel flow correction factors.

9 Position Initialization (POS INIT)

Push - displays POS INIT page.

Position Initialization Page 1/4

The POS INIT page allows entry of airplane position for IRU alignment, and displays FMC time and date reference. Heading for IRUs in attitude mode may also be entered.

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 airplane 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 pilot entered time if GPS time is not available or invalid and FMC internal time is invalid

UTC (FMC) - displays if FMC time source is GPS

If sources of time are not available or invalid and the internal FMC time is invalid, boxes display followed by "z" allowing time entry.

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 000°). Dashes display two to four seconds after entry to allow another entry.

5 LAST Position (POS)

Displays the last FMC calculated position. Selection displays the position in the scratchpad.

6 Reference Airport Latitude/Longitude

With an airport displayed in 2L, displays the reference airport position in large font latitude/longitude format. Selection displays the position in the scratchpad.

7 Gate Latitude/Longitude

With a gate displayed in 3L, displays the reference airport gate in large font latitude/longitude format. Selection displays the position in the scratchpad.

8 GPS Position (GPS POS) or MMMDD/YY

GPS Position: displays GPS position when on ground. During preflight, GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

MMMDD/YY - if GPS data not available or invalid, line title displays and dataline displays date, if valid; otherwise boxes.

Valid entry is three letter month, two number day, and two number year. For example: JAN16/08.

Displays blank if GPS data is not available and FMC derived time function is failed.

9 SET IRS Position (SET IRS 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.

10 ROUTE

Push - displays the ROUTE page.

Position Reference Page 2/4

Position reference page 2 displays FMC, IRS, GPS, and radio positions and allows updating of the FMC computed position to match either the IRS, GPS, or radio position.

At power up, the position display format defaults to latitude/longitude. This format can be changed to bearing/distance.

1 FMC Position

Displays FMC calculated latitude/longitude position. Selection (1L through 4L) displays the position in the scratchpad in the latitude/longitude format.

Line title identifies the source for calculating the FMC position:

- (GPS L, GPS R)- FMC calculates position using GPS data
- (IRS) - FMC calculates position using only IRS data
- (RADIO) - FMC calculates position using navigation radio data
- (LOC-RADIO) - FMC calculates position using LOC/VOR/DME/IRS or LOC/DME/DME/IRS data
- (LOC) - FMC calculates position using LOC/IRS data

2 IRS

Displays the IRS latitude/longitude position.

Line title identifies the source for calculating the FMC position:

- (3) - FMC calculates position using triple mix IRS data
- (L) - FMC calculates position using left IRS data
- (C) - FMC calculates position using center IRS data
- (R) - FMC calculates position using right IRS data

Blank when IRU position not computed.

3 GPS

Displays FMC-selected GPS position when GPS position valid; blanks if GPS position data invalid.

4 RADIO

Displays radio position when radio position valid; blanks if radio position data invalid.

5 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Displays RNP and actual navigational performance (ACTUAL) of the FMC. ACTUAL data blanks if FMC position invalid.

Default RNP is in small font. Manual RNP entry displays in large font; entries clear at flight completion. 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.

6 Update Arm

Push -

- arms FMC to update position to IRS, GPS, or radio position by selecting 2R, 3R, or 4R
- displays ARMED
- leaving the POS REF 2/4 page on both CDUs disarms the update function

7 Update To IRS Now

When the IRS position is valid, ACTUAL and the IRS actual navigation performance (ANP) displays in the header. If the IRS position is not valid, ANP is blank.

With an IRS position displayed in 2L and ARMED displayed in 1R, NOW> displays in large font. Selection updates the FMC position to the IRS position.

8 Update To GPS Now

When the GPS position is valid, ACTUAL and the GPS actual navigation performance (ANP) display in the header. If GPS position is invalid, the header is blank.

With a GPS position displayed in 3L and ARMED displayed in 1R, NOW> displays in large font. Selection updates the FMC position to the GPS position.

9 Update To Radio Now

When the radio position is valid, ACTUAL and radio actual navigation performance (ANP) display in the header. If the radio position is invalid, ANP is blank.

With a radio position displayed in 4L and ARMED displayed in 1R, NOW> displays in large font. Selection updates the FMC position to the radio position.

10 Navigation Station

Displays identifiers of navigation stations in use by FMC for radio position computation.

Line title displays type of radio station, DME DME or VOR DME.

Line title is blank if no radio position computed.

11 Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)

Initially displays BRG/DIST.

Push -

- displays bearing/distance in IRS, GPS, and radio positions
- 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 prompt

Position Reference Page 3/4

Position Reference Page 3 displays the current computed GPS and left/right FMC positions.

The page initially displays in the LAT/LON format; the page can also be displayed in the bearing/distance format. The bearing and distance are relative to the FMC position displayed in 1L of the POS REF 2/4 page.

1 GPS Position (GPS L/R)

Displays raw position from the left/right GPS sensor.

Selection displays the GPS L/R position (Lat/Lon) in the scratchpad.

GPS data blanks if GPS position invalid.

2 FMC Position (FMC L/R)

Displays current position from the FMC.

FMC data blanks if FMC position invalid.

Selection displays the FMC L/R position (Lat/Lon) in the scratchpad.

3 Navigation Options (NAV OPTIONS)

Selection displays the NAV OPTIONS page.

4 Latitude/Longitude (LAT/LON)

Selection changes latitude/longitude and bearing/distance formats on Position Reference Pages 2, 3, and 4.

Position Reference Page 4/4

Position Reference Page 4 displays the IRS positions. The page initially displays in the LAT/LON format; the page can also be displayed in the bearing/distance format. The bearing and distance are relative to the FMC position displayed in 1L of the POS REF 2/4 page.

1 IRS Position (IRS L/C/R)

Displays IRS L/C/R position.

Selection displays the IRS L/C/R position (Lat/Lon) in the scratchpad.

IRS data blanks if IRS position invalid.

2 Ground Speed (GS)

Displays ground speed associated with IRS (X). GS data blanks if IRS data invalid.

3 Latitude/Longitude (LAT/LON)

Selection changes latitude/longitude and bearing/distance formats on Position Reference Pages 2, 3, and 4.

Preflight Pages - Part 1B

Route Page 1/N

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 datalink. 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. When a route is inactive or pending activation, the page title displays in cyan.

When Route 2 is active, page display logic is the same as Route 1.

Route Page Before Requesting An Uplink Route

1 ORIGIN

Valid entries are four character alpha-numeric ICAO airport identifiers in the navigation database.

On the ground, entry of a new origin erases the previous route, clears wind levels on the WIND page, and deletes procedure and runway selections on the DEPARTURE page. 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.

Sequencing the destination runway or missed approach point results in the destination airport identifier becoming the origin airport.

2 RUNWAY

Valid entries are origin airport runways in the format: RW, followed by: X or XX, and the optional L, C, or R. For example: RW31L.

Automatically entered when part of a company route.

Can be selected on the DEPARTURES page.

FMC deletes runway after sequencing the first waypoint.

3 Request SEND

Line title 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 datalink request for a flight plan route uplink
- dataline displays SENDING
- upon acknowledgement receipt, dataline displays <SENDsent

If datalink fault occurs, line title displays DATA LINK, dataline displays NO COMM, VOICE, or FAIL.

4 RTE 2, ERASE

Route 2

Push -

- displays RTE 2 page 1/N
- dataline displays RTE 1

ERASE

Push -

- when a modified route displays, deletes the route; displays active route
- when a pending route displays, displays the inactive route

5 Destination (DEST)

Valid entries are four character alpha-numeric ICAO airport identifiers in the navigation database.

Enables selection of arrival procedures for the destination airport.

Automatically entered as part of a company route.

With an active or modified route and a new destination entered either by flight crew entry, uplink, or propagated from the ALTN page, the new destination displays in shaded white text.

6 Flight Number (FLT NO)

Valid entry is any ATC filed and flight crew entered, or uplinked company flight number from two to eight characters. FMC sends flight number to each ATC transponder for flight ID function.

A pilot entry on the ATC LOGON/STATUS page propagates to the ROUTE page.

Flight number displays in PROGRESS page 2 and POSITION REPORT page titles.

Dataline blanks at flight completion.

7 Company (CO) ROUTE

A company route can be called from the navigation database by entering the route identifier. The data supplied with a company route can include origin and destination airports, departure runway, SID and STAR, and route of flight. All company route data is entered when the route identifier is entered.

Valid entry is any flight crew entered or uplinked company route name with a maximum of 10 alphanumeric characters, excluding the slash and period. If the name is not contained in the NAV database, entry is allowed and the scratchpad message NOT IN DATABASE displays.

On the ground, entry of a new company route replaces the previous route.

In flight, entry of a new company route manually, or as a result of a route request downlink, may only be accomplished into the inactive route.

8 Alternate (ALTN)

Push - displays the XXXX ALTN page when a pending alternate diversion exists.

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:

- TAKEOFF>, when the required performance data is complete, or
- PERF INIT>, when the required performance data is incomplete, or
- OFFSET>, when the airplane is in flight and a DIR/INTC modification is not in progress. With an active or modified route and entry of an offset, the offset displays with a shaded background.

Route Page With An Uplink Route Loading

1 Runway

With an active or modified route and a new runway entered, the new runway displays with a shaded background.

2 ROUTE UPLINK

Displays ROUTE UPLINK when flight plan uplink received; otherwise, dashes.

3 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, EXEC light illuminates and <ERASE displays at 6L
- when route inactive, blanks PURGE at 4R
- displays scratchpad message ROUTE 1 UPLINK LOADING

4 PURGE

Displays PURGE> when an uplink has been received, passes an error check, and applies to an inactive route.

Push - clears uplinked route.

More Route Page Prompts for an Active Route

1 Report SEND or LOAD

SEND

Push - transmits a flight plan downlink report

LOAD

Push - if the displayed route is inactive, selection results in the inactive route being replaced or modified by the flight plan uplink. If the displayed route is active, selection results in the active route being replaced or modified by the flight plan uplink.

2 Route PRINT

Push - prints the active or inactive flight plan.

The following display descriptions are the same for all PRINT prompts in Section 11.40.

Displays <PRINTERROR when the printer has an error.

Displays PRINTING when the printer is busy and the print prompt is selected.

Displays BUSY when the printer is busy and the printer prompt has not been selected. The line title displays PRINT.

Displays FAIL when the printer has failed. The title line displays PRINT.

There is PRINT prompt for ATC messages or routes.

3 Route Copy (RTE COPY)

Push-

- displays when a route is active or is modified
- copies active route into the alternate route
- displays COMPLETE after the route is copied

Route Page 2/N

Subsequent route pages 2/N through N/N 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 X LEGS page. When a route is inactive or pending activation, the page title displays in cyan.

1 VIA

VIA 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 either the previous TO waypoint or the airway must 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

Entry of airways or company routes not in the navigation database displays the scratchpad message NOT IN DATA BASE.

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 column.

During preflight when entering a runway on the RTE X 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 the RTE X 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

The OFFSET function is available when the airplane is in flight and not on a SID, STAR, or transition. The offset route displays as a white dashed line on the ND until executed or erased. An executed offset route displays as a dashed magenta line and extends along the route to a Standard Terminal Arrival Route (STAR), approach or approach transition, discontinuity, end of route, track change greater than 135 degrees, or holding pattern. The original route displays as a solid magenta line. When executing the offset modification with LNAV active, the airplane turns to capture the offset course.

When on the route offset, active route waypoints sequence normally. However, during transition to or from an offset route greater than 21 nm, the crosstrack limit is extended to 200 nm.

1 Route Offset

Valid entry is L (left) or R (right) XX (XX is any number between 1 and 99).

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 route or route 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. When changing a departure, select the entire departure; runway, transition, SID, and SID transition

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

Push -

- selects transition for entry into the route
- other transitions no longer display

3 Engine Out (EO) SIDS

Displays airline-defined single engine-out SIDS and all transitions for the selected runway. EO SID can be viewed before takeoff by line selecting and selecting the legs page. EO SID automatically selected during takeoff if an engine-out detected prior to "flaps up". The modification can be either executed or erased. If an EO SID does not exist, NONE displays.

Push - displays EO SID as the selected SID.

4 ERASE, 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.

5 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 and transitions associated with selected runway remain, all others no longer display
- subsequent change of a runway deletes departure procedures previously selected

6 <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.

7 ROUTE

Push - displays the respective route page.

Navigation Radio Page 1/2

VOR and ILS navigation radios are normally autotuned by the FMC. NAV RADIO page displays the VOR, ADF, and ILS 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 frequency (XXX.X or XXX.XX); or, VOR or non-ILS DME identifier
- VOR identifier/course or VOR frequency/course; the course displays on the CRS line

Tunes respective DME. Identifier and frequencies display in green.

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.

2A ADF Frequency and Tune Status

Tuning status displays adjacent to the ADF frequency. 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. Display in cyan.

Entry can be optionally followed by A (ANT) or B (BFO). Deletion while in ANT or BFO mode causes tuning to revert to ADF.

A or B can be entered with a frequency already displayed.

3 ILS Frequency and Course

The ILS receivers operate in FMC autotune or manual-tuning modes. The FMC autotunes ILS frequency and course when a localizer-based approach is selected. When the ILS is not autotuned or manually tuned, the FMC resets 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.X/YYY or XXX.XX/YYY)
- front course, with a frequency and course already entered (/YYY)

ILS displays as: <110.90/130° PARK

4 PRESELECT

Any valid page data may be entered.

5 RADIAL

Displays radial (green) 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, or Back Course 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.

Navigation Options Page 2/2

This page allows inhibiting the use of specific navaids.

1 Navaid Inhibit

Valid entries are: VOR, VOR/DME, VORTAC, or DME identifiers from the navigation database.

Inhibits use of entered navaids for position updating by both FMCs.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

2 VOR Only Inhibit

Valid entries are VOR identifiers from the navigation database.

Inhibits use of VOR only portion of entered navaid for position updating of both FMCs. If the entered VOR is paired with a DME, the DME is not inhibited from position updating.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

3 DME Update ON/OFF

Push - alternately selects DME Update ON or OFF.

ON - DME data is available to the FMC for DME/DME or VOR/DME position updating. ON displays in large font, green letters; OFF displays in small font, white letters.

OFF - DME/DME and VOR/DME position updating are inhibited. OFF displays in large font, green letters; ON displays in small font, white letters. "ALL" displays in 1L and 1R.

4 VOR Update ON/OFF

Push - alternately selects VOR Update ON or OFF.

ON - VOR data is available to the FMC for VOR/DME position updating. ON displays in large font; OFF displays in small font.

Note: For VOR/DME position updating, both DME and VOR Update must be selected ON.

OFF - VOR/DME position updating is inhibited. OFF displays in large font, green letters; ON displays in small font. "ALL" displays in 2L and 2R.

Note: VOR Update selected OFF does not impact DME/DME position updating.

DME/DME position updating is not affected by the VOR Update function.

5 GPS Update ON/OFF

Push - alternately selects GPS Update ON or OFF.

ON - GPS data is available to the FMC for position updating. ON displays in large font, green letters. OFF displays in small font, white letters.

OFF - GPS position updating is inhibited. OFF displays in large font, green letters; ON displays in small font, white letters. Inhibiting GPS updating disables the Airport Moving Map and ECL Before Takeoff Alert function; and, enables TO/GA position updating.

6 LOC Update ON/OFF

Push - alternately selects LOC Update ON or OFF.

ON - LOC data is available to the FMC for position updating when a localizer-based approach is selected. ON displays in large font, green letters. OFF displays in small font, white letters.

OFF - LOC position updating is inhibited. OFF displays in large font, green letters; ON displays in small font, white letters

Note: Automatic LOC position updating is inhibited when GPS updating is active.

7 Position Reference (POS REF)

Selection displays the POS REF 2/4 page.

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.

The page title is PERF INIT UPLINK when a PERF INIT uplink is pending ACCEPT/REJECT.

1 Gross Weight (GR WT)

Entry, selection, or deletion of airplane gross weight is inhibited.

Entry of ZFW results in calculation and display of gross weight in large font.

When a PERF INIT uplink including ZFW is pending ACCEPT/REJECT, the data line displays XXX.X. If a large font ZFW was displayed prior to the uplink, /XXX.X displays in small font beginning at column 6.

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 replaces previous displayed data
- MANUAL - fuel quantity has been manually entered. Manual entries blank totalizer on PROGRESS page 2/4 until flight completion
- boxes display when fuel quantity system not available and fuel jettison not active

Valid entry is XXX or XXX.X. Entries when CALC or MANUAL displayed, replace the previous displayed data.

Only manual entries can be deleted.

3 Zero Fuel Weight (ZFW)

Initially displays boxes.

ZFW can be manually entered or uplinked. Entry of ZFW results in calculation and display of gross weight.

With a PERF INIT uplink that includes ZFW is pending ACCEPT/REJECT, data line displays XXX.X in small font. If a large font ZFW was displayed prior to the uplink, /XXX.X displays in large font beginning at column 6.

Valid entry is XXX or XXX.X.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

4 RESERVES

Valid entry is XXX or XXX.X.

Can be manually entered or uplinked. When a PERF INIT uplink is pending, uplinked values (small font) display.

5 Perf Init REQUEST

With a PERF INIT uplink pending, the header displays:

"----PERF INIT DATA ----", and the dataline displays:

"<REJECT" at 5L and "ACCEPT>" at 5R.

Push -

- transmits datalink request for performance initialization uplink
- dataline displays SENDING
- upon acknowledgement receipt, dataline displays <SENDsent

If datalink fault occurs, line title displays DATA LINK , dataline displays NO COMM, VOICE, or FAIL.

6 Cruise Altitude (CRZ ALT)

Cruise altitude can be entered by the flight crew or from a company route.

Cruise altitude can also be entered by uplink.

Valid entry is XXX, XXXX, XXXXX, or FLXXX.

Altitude displays in feet or flight level depending on transition altitude.

Entry displays this cruise altitude on the CLB and CRZ pages.

7 COST INDEX

Cost index is used to calculate ECON climb, cruise, and descent speeds. Larger values increase ECON speeds. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route.

Cost index can also be entered by uplink.

Valid entries are 0 to 9999.

8 Minimum Fuel Temperature (MIN FUEL TEMP)

Displays minimum fuel operating temperature (3 degrees C warmer than the fuel freeze temperature for a given fuel).

Default value from the AMI displays when no value has been entered and no PERF INIT uplink is pending ACCEPT/REJECT.

When a PERF INIT uplink that includes a minimum fuel temperature value is pending ACCEPT/REJECT, the dataline displays XX degrees C.

Valid entries are -99 to -1 in degrees C. Flight crew entered value displays in large font.

When actual fuel temperature reaches the displayed value, the EICAS advisory message FUEL TEMP LOW displays.

9 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.

An uplinked or pilot entered value displays in large font. Deletion of a pilot entered value displays the default cruise CG value.

Valid entry is XX.X in the range 11.0 to 33.0.

10 STEP SIZE

Displays climb altitude increment used by FMC to calculate optimum step climb.

Defaults to ICAO, RVSM, or fixed step size as defined in the AMI.

Valid entries are:

- "0" to inhibit predicted step climbs
- altitudes from 1000 to 9900 in 100 foot increments, or
- "I" for ICAO, or
- "R" for RVSM

For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

In-flight step size changes are made on the CRZ page.

11 Thrust Limit (THRUST LIM)

Push - displays THRUST LIM page.

Preflight Pages - Part 2B

Thrust Limit Page

The thrust limit page allows selection and display of reference thrust for takeoff. Derating takeoff thrust by use of assumed temperature is also accomplished on this page.

1 Assumed Temperature (SEL), Outside Air Temperature (OAT)

Initially blank. 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.

Selection of a new rating after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

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.

Selection of a new rating after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Takeoff thrust derate can be entered by uplink.

Selecting TO 2 arms CLB 2.

5 Thrust Reference Mode

Displays selected takeoff thrust mode.

6 Takeoff EPR Limit

Displays takeoff EPR calculated by the thrust management system. Displays N1 when engines are operated in the alternate mode.

7 Climb (CLB)

Push - arms the full rated (CLB) climb thrust limit.

Pushing any climb line select key overrides an automatic selection.

8 Climb 1 (CLB 1)

Push - arms a percentage derate (CLB 1) climb thrust limit.

Climb thrust derate can be entered by uplink.

9 Climb 2 (CLB 2)

Push - arms a percentage derate (CLB 2) climb thrust limit.

Climb thrust derate can be entered by uplink.

10 TAKEOFF

Push - displays TAKEOFF REF page.

11 <SEL>, <ACT>

<SEL> - identifies selected takeoff thrust reference mode.

<ARM> - identifies armed climb thrust reference mode. <ARM> changes to <SEL> when armed climb mode becomes active.

Takeoff Reference Page 1/2

The takeoff reference page 1 displays takeoff data and preflight status. Takeoff flap setting and V speeds are entered and verified. “PRE-FLT” displays in the line title at 6R if other preflight pages such as POS INIT, ROUTE, or PERF INIT are not complete. When preflight is complete, THRUST LIM> displays allowing selection of takeoff and climb thrust settings.

1 FLAPS

Initially displays boxes for takeoff flap setting; valid entries are 10 or 20, allowed when no uplink is pending.

Flap position is required for takeoff V speed calculations.

Entry of a new flap setting after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 THRUST

Displays takeoff thrust selected on THRUST LIM page, or flight crew or uplink entered assumed temperature for takeoff thrust derate calculations. Displays dashes if no assumed temperature selected.

Entry is only allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed. A valid entry invalidates large font takeoff speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Valid entries are 0 to 99 degrees C or 32 to 210 degrees F. Entering an assumed temperature displays “D-” to indicate a reduced thrust value.

3 Center of Gravity (CG), TRIM

Initially displays boxes (□□.□). Line title, “TRIM”, displays only after a large font CG value displays.

Valid entries are one or two whole numbers followed by an optional tenths number (XX.X) between the performance database limits.

After CG entered, the FMC:

- calculates and displays stabilizer takeoff setting to the right of the CG entry (trim display is in 0.1 unit increments)
- updates the takeoff green band displayed on stabilizer position indicators

4 Runway/Position (RWY/POS)

Displays the selected takeoff runway and TO/GA “push” distance from the runway threshold or entered intersection.

Displays the takeoff runway from the active RTE page if previously selected. Runway entry does not change runway entered on RTE or DEPARTURES page.

The valid entry for a runway intersection is an alphanumeric up to three characters, preceded by a slash (/).

Valid position entry is a one or two numeric in the range 0-30. It must be followed by two zeros and preceded by a slash (preceding the entry with a "-" means a longer takeoff distance is available; for example, -0300 is 300 meters before the runway threshold).

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Only an entered "push" distance updates FMC position to the TO/GA push point when GPS updating not active.

5 REQUEST SEND

SEND

Push - transmits a datalink request for takeoff data uplink.

Flight crew may enter RWY, intersection or position shift, CG, TOGW or OAT to qualify the request.

REJECT

Push - rejects the takeoff data uplink and returns the SEND prompt.

6 V Speeds (V1, VR, V2)

Displays dashes when:

- required information not entered
- performance calculations inhibited
- IRUs not aligned

G-BYGA - G-BYGG, G-CIVR - G-CIVZ

- spare engine carriage active

Displays FMC calculated speeds when required information entered.

Display of V1 is inhibited.

Flight crew entered or selected, or uplinked speeds display in large font and replace calculated speeds. Manually entered speeds less than V1MIN, VRMIN, or V2MIN are indicated by display of "V1MIN", "VRMIN", or "V2MIN" in small font in the line title and the value of V1MIN, VRMIN, or V2MIN in large font on the data line.

FMC calculated speeds display in small font and provide VMCA and VMCG protection.

Push -

- selects V1, VR, and V2 to be sent to using systems, or
- crew entered V speeds replace calculated speeds
- display changes to large font; REF and caret no longer display

If performance data changes:

- FMC replaces existing speeds with FMC calculated speeds in small font
- V speeds are deleted from the PFD
- PFD speed tape message NO V SPD displays
- scratchpad message TAKEOFF SPEEDS DELETED displays

Note: After third engine started, 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 Gross Weight (GR WT), Takeoff Gross Weight (TOGW)

GR WT displays gross weight from the PERF INIT page.

TOGW - entry of takeoff gross weight different from GR WT sends a downlink request for new takeoff data.

Valid entry is any weight within the allowable takeoff gross weight range. Flight crew entered value is downlinked when the REQUEST prompt is selected.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

Flap position is required for takeoff V speed calculations. Deletion of the TOGW value returns V speeds to small font; displays REF and caret.

8 Reference Speeds (REF SPDS), ACCEPT

REF SPDS:

Displayed when takeoff data uplink is not pending ACCEPT/REJECT.

Enables or disables display of the FMC calculated reference V speeds in the center column of the CDU.

Selection toggles between ON and OFF.

The active state, ON or OFF, displays in green, large font; the inactive state displays in white, small font.

ON - displays FMC calculated takeoff speeds for comparison with the V speeds in the right column.

OFF - deletes speeds from the center column.

ACCEPT:

Displayed when takeoff data uplink is pending ACCEPT/REJECT.

Push - accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

8 ACCEPT

Displayed when takeoff data uplink is pending ACCEPT/REJECT.

Push - accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

9 PRE-FLIGHT

Displays dashes in the line title and THRUST LIM> on the dataline when preflight is complete.

Displays PRE-FLT in the line title and the title (XXXXX) of the incomplete page on the dataline when preflight is not complete.

Push -

- displays THRUST LIM page when THRUST LIM> displayed, or
- displays incomplete page (XXXXX) when PRE-FLT displayed in the line title

Takeoff Reference Page 2/2

The takeoff reference page 2 displays uplinked and/or manually entered takeoff data. The page provides access to standard/alternate uplinked takeoff data. When a takeoff data uplink is pending; selection, entry, or deletion of data is not allowed.

Note: Acceleration/thrust reduction heights are added to airport elevation causing acceleration/thrust reduction at the desired MSL altitude. For example, for a airport elevation of 980 feet, an entry of 2020 acceleration height causes acceleration at 3,000 feet MSL.

Takeoff reference page entries complete the normal preflight.

1 Standard Thrust (STD THRUST), Alternate Thrust/Flaps (ALT THR/FLP), Alternate Thrust (ALTN THRUST), Standard Thrust/Flaps (STD THR/FLP)

Selection provides access to ACCEPT/REJECT options for uplinked takeoff speeds associated with thrust or flap setting and toggles the dataline between standard and alternate thrust (and flaps, if appropriate) settings.

STD THRUST - a standard thrust setting exists for the selected alternate thrust takeoff/runway data. Dataline displays a large font caret followed by the large font standard thrust.

ALTN THRUST - an alternate thrust setting exists for the displayed standard thrust takeoff/runway data. Dataline displays a large font caret followed by the large font alternate thrust.

STD THR/FLP - a standard thrust and flap setting exists for the selected alternate thrust/flap takeoff/runway data. Dataline displays in large font a caret followed by the standard thrust followed by a slash and standard flap setting.

ALT THR/FLP - an alternate thrust and flap setting exists for the displayed standard thrust/flap takeoff/runway data. Dataline displays in large font a caret followed by the alternate thrust followed by a slash and alternate flap setting.

2 Reference Outside Air temperature (REF OAT)

Entries are allowed when large font data or dashes are displayed. Deletion is allowed when large font data is displayed.

Valid entries are -54 to 99 degrees C or -65 to 199 degrees F. All uplink data is in Celsius.

Entered or accepted uplink data displays in large font.

3 WIND

Entry of wind direction and speed is allowed and results in display of runway wind in 4L. Deletion of large font data displays the default data. Entry or deletion invalidates takeoff speeds.

When wind direction and speed are displayed, speed only entries must be prefixed by a slash.

4 Runway (RWY) WIND

Manual entry or deletion of head or tail wind is allowed.

Valid entries are two digit numbers followed by an H (optional) or T, and results in display of dashes in 3L. No crosswind component displays.

When a runway is displayed on TAKEOFF REF 1/2 and there is no data in 3L, "--KT" displays in small font.

When large font data displays in 3L, data line displays large font XX followed by small font "KT" followed by large font H (for headwind) or T (for tailwind) and large font YY followed by small font "KT" followed by large font R (for right crosswind) or L (for left crosswind). Small font data in 3L displays small font data in 4L.

5 SLOPE/COND (Condition)

Displays flight crew entered or uplinked data.

Valid entries are: slope, slope/, slope/cond, or /cond.

- entries for runway slope are 1 or 2 digits, between 0.0 and 2.0
- entries for runway slope direction are U for uphill and D for downhill. No entry assumes an uphill slope
- entry of "D" or "DRY" displays "DRY"
- entry of "W" or "WET" displays "WET" and the FMC uses a different set of V1 data
- entry of "S" or "WET SK-R" displays "WET SK-R" and the FMC computes V1 for a skid resistant runway

Default dataline displays "U0.0/DRY".

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

6 Engine Out Acceleration Height (EO ACCEL HT)

Displays acceleration height in Height Above Airport (HAA) elevation for flap retraction with an engine out.

Default value is from the Airline Modifiable File.

Valid entry is a height from 400 to 9,999 feet.

7 Acceleration Height (ACCEL HT)

Displays acceleration height in 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.

8 Thrust (THR) Reduction

Displays height in HAA for reduction from selected takeoff thrust to armed climb thrust.

Valid entry is an HAA height from 400 to 9,999 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 2020 thrust reduction height causes thrust reduction at 3,000 feet MSL.

Valid entries are "1" for flaps 1 or "5" for flaps 5.

9 Standard Limit Takeoff Gross Weight (STD LIM TOGW), Alternate Limit Takeoff Gross Weight (ALTN LIM TOGW)

Allows selection of an alternate limit takeoff gross weight.

STD or ALTN LIM TOGW header:

- a standard or alternate limit takeoff gross weight displays in small font when a takeoff data uplink is pending
- a standard or alternate limit takeoff gross weight displays in large font when a takeoff data uplink has been accepted

Menu Page

Provides access to other systems that use the CDU.

1 FMC

Push -

- connects FMC to the CDU
- displays last page used
- displays INITIALIZATION page on initial application of AC power

2 Datalink (DLNK)

See Chapter 5.20, Communications.

3 Satellite Communication System (SATCOM)

See Chapter 5.20, Communications.

4 Airplane Condition Monitoring System (ACMS)

Only displays on the center CDU.

Push -

- displays ACMS page
- activates ACMS control of CDU for maintenance use

5 Central Maintenance Computer (CMC)

Operates on the 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 10.10, Flight Instruments, Displays

7 Alternate DSP Control (DSP CTL)

See Chapter 10.10, Flight Instruments, Displays.

8 Control Panel (CTL PNL)

See Chapter 10, Flight Instruments, Displays.

9 Passenger Address (PA)/Cabin Interphone (CI)

Only displays on the center CDU.

See Chapter 5.30, Communications-Interphone Systems.

10 Active (ACT)

Indicates active CDU controller.

Introduction

The 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.

The takeoff phase changes to climb phase when the FMC commands climb thrust. The climb phase ends at the top of climb, where the cruise phase starts.

Prior to takeoff and during climb, the pages listed below are used to:

- TAKEOFF REF page - make changes to the departure runway
- DEPARTURES page - make 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 fixed thrust climb derate 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 comply with the revised clearance. 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 a speed 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 the barometric altitude recorded by the FMC when accelerating through 100 knots and commands roll to fly the active route leg. VNAV activates at 400 feet above the recorded altitude and commands pitch to fly the climb profile.

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 altitude capture below acceleration height, VNAV commands 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 economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than flaps up maneuvering + 20 kts 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 ALT. Deleting climb derates or selecting a reduced climb speed thus giving a steeper climb angle, may enable the airplane to reach the altitude constraint.

Altitude Intervention

If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. VNAV SPD changes to VNAV ALT. The climb can be continued by setting the altitude window to a higher altitude and pushing the altitude selector. If the altitude window is set to an altitude above other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. If cruise altitude is set in the altitude window, all waypoint altitude climb constraints to the T/C can be deleted by selection of the CLB DIR> prompt on the CLB page.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb profile. Data on the climb page comes from preflight entries made on the route and performance pages or from AMI.

1 Page Title

The page title displays active (ACT) or modified (MOD) XXX climb. Usually, the title contains ECON for economy climb. Fixed speed and engine out modify the title.

- ACT ECON CLB - speed based on a cost index
- ACT MCP SPD CLB - MCP speed intervention selected
- ACT XXXKT CLB - fixed CAS climb speed profile
- ACT M.XXX CLB - fixed Mach climb speed selected
- ACT LIM SPD CLB - speed based on an envelope limiting speed

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. Displays in magenta when the altitude is the FMC target altitude.

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), Engine Out Speed (EO SPD)

ECON SPD - displays when the last climb segment speed mode is economy.

- 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. Displays in magenta when the displayed speed is the FMC target speed.

SEL SPD - displays when flight crew enters speed.

EO SPD - displays when ENG OUT has been selected.

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 flaps up maneuver + 20 kts (example 272/10000)

Not displayed above transition.

Displays in magenta when the displayed speed is the FMC target speed.

Can be deleted.

5 Speed Restriction (SPD RESTR)

Speed restrictions at an altitude less than cruise altitude and not associated with a waypoint are entered on this line.

Speed and altitude entries which are not both less than or not both greater than the speed transition speed/altitude, cause line 3L to blank.

Displays dashes before entry by flight crew. Displays in magenta when the displayed speed is the FMC target speed.

Valid entry is a CAS and altitude (example 240/8000).

6 Economy (ECON)

Displays when the climb speed is not ECON.

Push - changes climb speed to ECON.

7 Waypoint Constraint (AT XXXXX)

Displays next airspeed and/or altitude constraint at waypoint XXXXX. Speed/altitude or altitude displays in magenta when the displayed speed/altitude or altitude is the FMC target.

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 default value is 18,000 feet.

Enter transition altitude here or on the 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.

Push - displays the speed in the scratchpad for selection to the speed line.

11 Engine Out (ENG OUT)

Push - displays EO CLB page; deletes climb speed transition and restriction data.

When pushed below EO MAX ALT, changes the cruise altitude to the EO MAX ALT if the current cruise altitude is above the engine out maximum cruise altitude.

When pushed above EO MAX ALT, changes the cruise altitude to the EO LRC maximum altitude and displays the EO LRC D/D page.

12 Climb Direct (CLB DIR)

Displays when climb altitude constraint exists between current altitude and FMC cruise altitude.

Push - deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude or FMC cruise altitude, whichever is lower. FMC cruise altitude is not affected.

RTE X LEGS Page

The 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 - XX.XARCD, XX.X is arc radius in nm and D is arc direction L or R, (example: 24 ARC L)
- heading leg segments - XXX°HDG
- track leg segments - XXX°TRK
- special procedural instructions from database - HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry)

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; displays in magenta.

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. When the speed/altitude is the FMC target speed/altitude, the speed/altitude displays in magenta.

Constraints can be entered manually. Entered by FMC when constraints are part of a procedure.

Valid entries are:

- speed only - XXX/. Enter CAS in the range of 100 to 400
- altitude only, less than cruise altitude - XXX, XXXA, XXXB, XXXAXXXB, XXXBXXXA or may include an optional leading "/". Enter FL190 or 19,000 feet as 190. Enter FL090 or 9,000 feet as 090
- speed/altitude - XXX/XXXX

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, Flight Management System Operation)

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

RTE DATA displays when an active or modified RTE LEGS exists (not in PLAN mode).

ACTIVATE displays on a non-active RTE LEGS page (not in PLAN mode).

Push -

- ACTIVATE - prepares inactive flight plan for activation, illuminates the EXEC key, and displays LEGS page 1/X with first waypoint of the route at the top. Other pages may be accessed and modifications performed before execution.
- RTE DATA - displays route data page

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 To/From

Used to fly direct to or intercept course to/from 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, dataline 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, dataline displays COMPLETE
- subsequent route modifications remove RTE COPY prompt

5 Intercept (INTC) Course (CRS) To/From

Displays current inbound route course and prompt when waypoint entered in the active waypoint line is in the active route.

Displays boxes when waypoint entered in the active waypoint line is not in the active route.

Valid entry is intercept course from 000° to 360°.

Modifying the active waypoint displays the line title INTC CRS TO.

Entering a waypoint and outbound course or the present position in the active waypoint displays the line title INTC CRS FROM.

Push -

- when current route course displayed, selects it as intercept course to active waypoint
- displays entered course or current route course as course to active waypoint
- removes ABEAM PTS and RTE COPY prompts

6 Present Position and Outbound Course

Entering "P/P" and an outbound course in the scratchpad of an active Legs page and line selecting results in a 700 NM course beginning at the current airplane position extending along the entered course.

Airway Intercept

LNAV can be used to intercept an airway. An airway intercept changes the active waypoint on the RTE and LEGS pages.

Example

The active route is direct EPH, then direct MWH. ATC clears the airplane to:

- turn right heading 110°
- intercept V2 to MWH.

1 Active RTE 1 Page

The route page before the ATC clearance.

2 Enter Airway

Enter the airway in the first VIA position on the RTE page. Boxes display in the TO position. A route discontinuity follows on the next line.

3 Airway Exit

Enter desired airway exit point (MWH) in the boxes.

4 Start Airway Waypoint

After entering MWH in the boxes, the FMC selects the waypoint preceding the closest abeam location as the starting waypoint of the new airway. This waypoint displays under TO on line 1R. The entered airway and the selected exit point display on line 2. Executing the modification makes the FMC selected first waypoint the active waypoint; BANDR in this example. If the clearance heading intercepts the new route before the next downtrack waypoint (BEEZR), LNAV can be armed and will capture the new route. The active waypoint will sequence to next downtrack waypoint (BEEZR). Since the clearance heading will not intercept V2 prior to the next downtrack waypoint (BEEZR), use the intercept course procedure to make the inbound course to the next waypoint after the V2 crossing point the active leg segment.

The LEGS page displays this waypoint sequence:

- BANDR - the active waypoint
- BEEZR
- ELN
- PLUSS
- MWH - the V2 exit waypoint

The intercept heading crosses the V2 between ELN and PLUSS. Modify the LEGS page using a course intercept to the waypoint after the airway crossing, PLUSS, making PLUSS the active waypoint on the V2 airway. If the clearance heading does not intercept the new active leg segment, the NOT ON INTERCEPT HEADING scratchpad message displays.

5 Airway Exit

On the LEGS page, move PLUSS to the scratchpad, then to 1L. The INTC CRS TO displays boxes. Enter the V2 inbound course to PLUSS.

Following the course intercept to PLUSS modification and execution, the LEGS page displays PLUSS as the active waypoint. LNAV can be armed and the airway intercept can be completed.

Select Desired Waypoint Page

The SELECT DESIRED WPT page displays after a waypoint entry when the FMC encounters more than one location for the same waypoint name. Selection of a waypoint returns the display to the previous page.

1 Identifier

Displays the identifier for the duplicate named waypoints.

2 Waypoint Lines

Display a sorted list of waypoints with identifier, navaid type, frequency, and coordinates;

- when page is accessed as a result of a flight plan modification, sort is based on proximity to the waypoint preceding the entered waypoint
- when page is accessed as a result of a DIR/INTC or REF NAV DATA entry, sort is based on proximity to current aircraft position

Push - selects waypoint location for use and returns display to page previously in use.

Pushing any CDU function key exits page without selecting a waypoint.

3 Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

4 Type

Displays the type of navaid for each duplicate name.

Blank if the waypoint is not a navaid.

5 Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

Thrust Limit Page

Thrust limits are selected on the thrust limit page. In flight, this display replaces the takeoff thrust limits with applicable thrust limits for climb. The selected limits display here and on the EICAS Display.

Fixed thrust derates can be selected for climb. Go-around, continuous, and cruise thrust limits are available also.

1 Go-Around (GA)

Push - selects go-around thrust limit.

2 Continuous (CON)

Push - selects maximum continuous thrust limit.

3 Cruise (CRZ)

Push - selects cruise thrust limit.

4 APPROACH

Push - displays APPROACH REF page.

Engine Out Climb

Engine out (EO) VNAV climb guidance displays on the EO CLB page. The EO 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.

EO CLB Page

The modified page displays engine out performance data based on one or two engines out. Manual entries are allowed. After execution, VNAV gives EO guidance in the climb; reference thrust limit changes to CON. If a second engine fails, the page title changes to ACT 2E/O CLB.

1 Page Title

Page title displays (ACT) or modified (MOD) climb. Usually, the title contains ECON for economy climb.

Page titles include:

- ACT EO CLB - engine out selected with minimum drag climb speed
- ACT EO MCP SPD CLB - MCP speed intervention selected
- ACT EO XXXKT CLB - fixed CAS climb speed selected
- ACT EO M.XXX CLB - fixed Mach climb speed selected

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude if less than EO MAX ALT. When the altitude is the FMC target altitude, the altitude displays in magenta.

Displays EO MAX ALT if less than cruise altitude.

Manual entry is allowed.

3 Engine Out Speed (EO SPD)

Displays engine out climb speed. When the speed is the FMC target speed, the speed displays in magenta.

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.

4 Engine Out Speed (EO SPD)

Displays <EO SPD when engine out speed is not the FMC target speed.

5 Maximum Altitude (MAX ALT)

Displays lower of maximum altitude at engine out climb speed or cruise speed.

Entry not allowed.

Push - copies altitude to scratchpad.

6 ALL ENG

Push - modifies page to display all engine (ALL ENG) performance data.

Engine Out Departure

1 Engine Out (EO) SIDS

Displays airline-defined single engine-out SIDS and all transitions for the selected runway. EO SID can be viewed before takeoff by line selecting and selecting the legs page. EO SID automatically selected during takeoff if an engine-out detected prior to "flaps up". The modification can be either executed or erased. If an EO SID does not exist, NONE displays.

Push - displays EO SID as the selected SID.

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; or, NONE if no STARs exist at the specified airport.

2 Transitions (TRANS)

Displays transitions for the selected arrival procedure; or, NONE if no transitions exist for the applicable STAR.

3 APPROACHES

Displays approaches for origin airport; or NONE if no approaches exist at the specified airport. When an approach has been selected and approach transitions are available, TRANS displays in the title of line 2 and transitions display on lines 2 through 5.

4 RUNWAYS

Displays runways for origin airport.

Intentionally
Blank

Introduction

Cruise phase starts at top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- CRZ
- PROGRESS

RTE LEGS pages are described in section 11.41. 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
- NAV OPTIONS page - inhibit specific navaids; GPS, DME, VOR, or LOC updating
- FIX INFO page - display data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- POS REPORT page -display data for a position report; described in Chapter 5.34

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 change cruise altitude and speed and to evaluate fuel burn and time to destination. Speed changes can be manually entered or selected using speed intervention. Cruise climbs and descents, and step climbs can be accomplished from the cruise page. Step size can be changed from the default value.

When using VNAV in economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in engine out mode, the data reflects airplane capabilities with one or two engines inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.

1 Page Title

Page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Fixed speed, engine out, and long range cruise modify the title.

Page titles include:

- ACT ECON CRZ - speed based on cost index
- ACT ECON CRZ CLB or CRZ DES - cruise climb or descent with ECON speed

- ACT LRC CRZ - long range cruise speed selected
- ACT LRC CRZ CLB or DES - cruise climb or descent with LRC selected
- ACT MCP SPD CRZ - MCP speed intervention selected
- ACT XXXKT CRZ - fixed CAS cruise speed selected
- ACT M.XXX CRZ - fixed Mach cruise speed selected
- ACT LIM SPD CRZ - speed based on an envelope limiting speed
- RTA CRZ - RTA cruise selected
- RTA CRZ CLB or DES - cruise climb or descent with RTA selected

Fixed cruise speeds are for:

- a flight crew selected speed (SEL SPD)
- a speed constraint associated with an altitude
- waypoint speed constraints
- cruise speed segments

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 when climb or descent initiated.

Changing the MCP altitude and pushing the altitude selector enters the MCP altitude as the active cruise altitude, without creating a modification.

Displays in magenta when the displayed altitude is the FMC target altitude.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD), Long Range Cruise Speed (LRC SPD)

Displays the command speed or Mach.

Valid entries are CAS or Mach.

ECON SPD - displays when ECON selected (or default).

SEL SPD - displays when flight crew enters speed.

LRC - displays when LRC selected.

Displays in magenta when the displayed speed is the FMC target speed.

4 EPR

Displays EPR to maintain level flight at command airspeed.

5 STEP

Displays climb altitude increment used by FMC to calculate optimum step climb.

Defaults to ICAO, RVSM, or fixed step size as defined in the AMI.

Valid entries are:

- "0" to inhibit predicted step climbs
- altitudes from 1000 to 9900 in 100 foot increments, or
- "I" for ICAO, or
- "R" for RVSM

For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

6 Economy (ECON), ECON/RTA, Engine Out (EO SPD)

Push - selects economy cruise speed , ECON/RTA, or EO SPD.

Displays when speed or Mach entered manually, when LRC selected, or when ENG OUT selected.

7 RTA PROGRESS

Push - displays RTA Progress page.

8 STEP TO Altitude

STEP TO displays when all the following are true:

- an active route exists and no pending activation or flight plan modification exists
- the airplane is more than 200 nm from the T/D for calculated or planned steps
- the airplane is more than 500 nm from the destination airport for calculated steps
- an engine out drift down is not active
- step size is not zero or a planned step exists when the step size is zero

The FMC calculates performance based on accomplishing step climbs at calculated step climb points throughout the flight plan.

An altitude can be entered to evaluate a step climb. The FMC calculates the predicted step climb location and displays data on this page and on the PROGRESS page 1, 4R.

Valid entries are FLXXX (or XXX flight level) or XXXXX (feet).

Preflight entry of a non-zero increment, ICAO, or RVSM step size causes the FMC to calculate STEP TO altitudes correct for the direction of flight based on the entered CRZ ALT. Inflight changes to CRZ ALT affect calculation of STEP TO altitudes when using ICAO or RVSM step size.

When entering an altitude in 1R, the FMC calculates the optimum step location based on entered forecast winds and temperature and displays ETA and distance to go on line 2R.

Displays STEP TO altitude based on entering "/S" (following altitude) on a waypoint on the Legs page. The altitude displayed in 1R can be overwritten with a manual entry above or below CRZ ALT.

When using a non-zero step size, the STEP TO altitude is the next higher altitude calculated by adding the step size increment to the current CRZ ALT. If step climbs have not been accomplished as computed, multiple step increments may be used.

Entering an altitude above the maximum altitude predicted at the STEP TO location displays the scratchpad message MAX ALT FLNNN.

Blank when:

- there is no active flight plan, or
- within 200 nm of the T/D, or
- within 500 nm of the destination airport with no planned steps in the flight plan
- engine out drift down is active

9 AT

Displays ETA and distance to go to the optimum manually entered 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 manually entered 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 500 nm of destination. ETA and distance are to T/D.

10 Destination ETA/FUEL

Line title is ETA/FUEL W/MOD when a modified active route is displayed.

Estimated time of arrival and calculated fuel remaining at the destination assuming step climbs are made at planned points to the STEP TO altitude.

Calculations are based on planned step climbs and cruise altitudes.

11 Optimum, Maximum, and Recommended Altitude (OPT, MAX, RECMD)

Blank when RTA is active.

OPT - calculation of OPT altitude is based on gross weight, cost index, selected speed, and pressure altitude. Wind is not used in the calculation.

MAX - displays maximum altitude based on:

- current gross weight
- temperature
- number of engines operating
- cruise reference thrust limit (CRZ or CLB)
- selected speed
- residual rate of climb set by airline (range: 0 to 500 feet per minute; default is 100)
- disregards altitude or speed constraints

RECMD - displays the most economical altitude to fly for the next 500 nm based on gross weight, selected speed, pressure altitude, and entered forecast winds and temperature at cruise altitudes. The FMC evaluates altitudes up to 9,000 feet below the current CRZ ALT and up to less than MAX altitude. Recommended altitudes are consistent with the specified step size and step climb schedule. If the step size is zero, the recommended cruise level is calculated assuming a 2,000 feet step size. The recommended altitude is set to the CRZ ALT when within 500 nm of the T/D.

12 Engine Out (ENG OUT)

Push -

- displays EO LRC 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

13 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 (EO) VNAV cruise guidance displays on EO CRZ page. EO CRZ page must be selected and executed by the flight crew. Engine out data is also available with all engines operating.

EO Cruise Page

Following selection of the ENG OUT prompt on the ECON CRZ page, the modified page displays engine out performance information 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). This graphic is shown under Engine Out Operation, 11.31. The EO LRC (long range cruise) D/D page changes to the EO LRC CRZ page when reaching the engine out cruise altitude (shown below).

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 2EO LRC CRZ and the FMC calculates and displays two engine-out maximum altitude and performance data.

1 Page Title

The page title displays (ACT) or modified (MOD) cruise.

Page titles include:

- ACT EO CRZ - engine out selected with minimum drag cruise speed
- ACT EO MCP SPD - MCP speed intervention selected
- ACT EO XXXKT CRZ - fixed CAS cruise speed selected
- ACT EO M.XXX CRZ - fixed Mach cruise speed selected
- ACT LRC D/D - engine out driftdown with LRC speed
- ACT EO LRC CRZ - engine out cruise with LRC speed
- ACT EO CRZ CLB/DES - cruise climb or descent with EO SPD selected

2 Cruise Altitude (CRZ ALT)

Displays altitude from MAX ALT line when all engine CRZ ALT is above engine out MAX ALT.

Valid entries are the same as all engine cruise page.

Displays in magenta when the altitude is the FMC target altitude.

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 EO SPD prompt selected.

Manual entries may change MAX altitude.

Displays in magenta when the speed is the FMC target speed.

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

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.

Displays in magenta when the speed is the FMC target speed.

2 Economy Speed (ECON)

Displays ECON when RTA in 2L; ECON/RTA when SEL SPD or LRC in 2L.

Push -

- selects ECON CRZ page
- execution activates ECON CRZ and terminates RTA, SEL SPD, or LRC 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

The Reference Navigation Data page displays information about waypoints, navaids, airports, and runways.

1 Identification (IDENT)

Valid entries are any waypoint, navaid, airport, or destination runway from the navigation database. Pilot defined waypoints such as latitude/longitude are also valid entries when in the active route.

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 Frequency (FREQ)/Channel

Displays blanks if a navaid does not exist in 1L.

- with a valid navaid (not GLS) in 1L, displays frequency
- with a valid GLS navaid in 1L, displays a five digit GLS channel

5 LONGITUDE

Displays longitude of entered identifier.

6 ELEVATION

Displays elevation of entered identifier when it is a navaid, airport, or runway.

7 Navigation Options (NAV OPTIONS)

Selection displays the NAV OPTIONS page.

Fix Information Page

Four identical fix information pages are used to create waypoint fixes and waypoints for the ND. Some of the created waypoints can be copied into the route.

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; and, place bearing distance, place bearing/place bearing, along track, and latitude/longitude entries.

Selected fix displays on the ND as a green circle.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT

Valid entries are:

- a bearing followed by an optional slash, XXX/
- a distance preceded by a slash, /YYYY; leading zeros can be omitted
- a bearing/distance, XXX/YYYY

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 closest intersection display.

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 closest intersection display.

ETA - displays the estimated time of arrival to the intersection point.

DTG - displays the distance to go to the intersection point; displays to nearest tenth when the distance is less than 10 nm.

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 in place/bearing/distance format in the scratchpad. Bearing and distance display 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 in place/bearing/distance format in 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 less than the maximum certified altitude, flight level, or time. Time entry must be followed by “Z”.

Entering an altitude or flight level (not above FMC cruise altitude)displays the predicted along track distance and altitude or flight level on this line. The predicted airplane position displays on the ND route line as a green circle with the entered altitude/flight level.

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

Route and Waypoint Data

Route Data Page

The route data page displays data for each waypoint on ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

This page allows a downlink request for enroute wind information and allows review of uplinked enroute wind information.

The ETA and calculated fuel remaining display for each waypoint. Manual entry is not possible.

1 ETA

Displays ETA for active waypoint in magenta.

2 Waypoint (WPT)

Displays identifier for waypoint. The active waypoint displays in magenta.

3 LEGS, ERASE

LEGS -

Push - displays RTE LEGS page.

Displays ERASE prompt when an uplink containing enroute wind data is loaded.

ERASE -

Push -

- rejects uplinked enroute wind data
- displays LEGS prompt

4 FUEL

Displays the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

5 WIND (W>/>)

W> - indicates waypoint winds have been entered.

> - winds not entered.

Push - displays WIND page for the selected waypoint.

6 REQUEST SEND, WIND DATA LOAD

Blank when airplane is active on descent or approach.

Displays SEND prompt when datalink ready and airplane is not active on descent or approach.

Displays LOAD prompt when uplink containing enroute wind data received and error checks passed.

SEND -

Push -

- transmits a datalink request for wind and descent forecast data
- displays LOAD prompt and scratchpad message WIND DATA UPLINK READY when an uplink containing enroute wind data received and error checks passed

- displays scratchpad message DES FORECST UPLINK READY and displays LOAD and PURGE prompts on the DESCENT FORECAST page when an uplink containing descent forecast uplink data received and error checks passed

LOAD -

Push -

- applies enroute wind data to route and results in a modification
- displays ERASE and SEND prompts

Wind Data

The FMC uses temperature, altitude, and wind direction/speed to improve performance prediction accuracy.

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, wind data for waypoints closest to the airplane should be entered first, then wind data for downtrack waypoints can be entered.

For example: at FL 350, 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK through the end of the route.

Entered wind data are mixed with sensed wind data for performance predictions. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. At 200 nm in front of the airplane, the FMC uses 50% predicted winds and 50% sensed winds. Sensed winds display on the PROGRESS page 2/4.

Inaccurate forecast wind and temperature information degrades the accuracy of the recommended altitude displayed on the cruise page.

The FMC adjusts ECON climb speed and top of climb using entered and/or sensed wind data. FMC calculated ECON climb speed may fluctuate if top of climb is near a waypoint with approximately a 45 degree or larger track change and if a significant wind velocity has been entered or is predicted for that waypoint. This fluctuation does not occur when using a manually entered climb speed or speed intervention.

Wind Page

The wind page is used to enter forecast winds and temperatures at up to 250 waypoints for one to four altitudes to enhance VNAV performance.

This data can be uplinked or manually entered.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.

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. OAT is a one-to-three digit entry, including the sign; a plus sign is optional, a minus sign is mandatory. Valid range is -99 to 60.

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.

Progress Pages

Progress Page 1/4

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 (active and next)
- destination data
- FMC speed
- T/C, T/D, etc.

1 TO

Displays active waypoint in magenta.

2 NEXT

Displays identifier of waypoint after the active waypoint.

3 Destination (DEST)

Displays destination identifier.

Valid entry is any airport or waypoint in navigation database or waypoint in the flight plan. The line titles are:

- DEST - performance predictions to destination. Default display

- DIR TO FIX - performance predictions to the entered fix. Line data based on flying direct to the fix
- 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.

4 Selected Speed (SEL SPD)

Displays active command speed and mode.

The active speed mode is the same as displayed on the active VNAV 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 +XYZ - engine out flaps up recommended maneuver speed; XYZ - up to 100 kts
- RTA SPD - RTA SPD when RTA mode active

5 Position Report (POS REPORT)

Push - displays the POS REPORT page.

6 ETA

Displays estimated time of arrival at waypoint or destination.

7 Distance To Go (DTG)

Displays distance to go to waypoint or destination. When the airplane is in the terminal area and not on the FMC lateral path, the NEXT and DEST distance to go values may vary from along track distances on the LEGS page. Distances shown on the LEGS page or ND may be used to determine distance to go. ETA and FUEL values may vary from those shown on the RTE DATA page. Values on the RTE DATA page are correct.

8 FUEL

Displays estimated fuel remaining at waypoint or destination.

9 TO T/D

Data line displays ETA and DTG to line title point.

Line titles are:

- TO T/C - top of climb data
- TO STEP CLB - step climb data
- TO T/D - top of descent data
- TO E/D - end of descent data
- LEVEL AT - time and distance to level off when drift down active

10 Position Reference (POS REF)

Push - displays position reference page 2/4.

Progress Page 2/4

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 error from the active route. L or R indicates left or right of course. "99.99" displays if error is greater than 99.99 NM. Blank if error data is invalid or both routes are inactive.

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 the EICAS message FUEL DISAGREE if a difference of 4,080 kilograms or more exists between TOTALIZER and CALCULATED fuel quantity for 5 minutes.

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 Error (VTK ERROR)

Displays vertical-track error above (+) or below (-) the active VNAV path from 10 to 9,999 feet. Vertical-track errors greater than 9,999 feet display as "9999".

Blank when vertical-track error is invalid or both routes are inactive.

11 Static Air Temperature (SAT)

Displays outside static air temperature.

12 USE CALCULATED

Displays USE prompt and the EICAS message FUEL DISAGREE if a difference of 4,080 kilograms or more exists between TOTALIZER and CALCULATED fuel quantity for 5 minutes.

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 dump, resets to fuel quantity system totalizer
- after landing, resets to fuel quantity system totalizer

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations. Fuel flow rate sensing tolerances may allow the CALCULATED and the TOTALIZER fuel quantities to be different by as much as 25 to 40 kilograms per hour.

RTA Progress Page 3/4

The RTA Progress page allows a time constraint to be specified at an existing flight plan fix. Entry of the fix activates the RTA function and changes the PROGRESS and CRZ page titles to include RTA. RTA operates only in cruise.

1 FIX

Displays boxes when an active or modified route exists.

Entry by flight crew or data link.

Valid entry is any waypoint in the active or pending active route prior to the missed approach. Waypoints defined by coordinates must be down selected to the scratchpad, then selected to the FIX line.

Entry displays boxes at 1R and the ALT/ETA line title at 2R.

When RTA active, deletion of FIX terminates RTA mode and resumes ECON. Display returns to boxes. RTA retained at 6R, PRIOR RTA.

When RTA not active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

Displays blank if engine out has been selected.

2 Required Time Of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA in magenta.

Blank if no RTA fix or time entered.

3 Maximum Speed (MAX SPD)

Valid entry is Mach .100 to .990; displays in large font.

Deletion of entered value displays default Mach .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)

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

Suffix to RTA indicates:

- no suffix - arrive at entered time
- A - arrive at or after entered time
- B - arrive at or before entered time

Entry before takeoff displays RECMD T/O in 3R line title and FMC computed takeoff time. If FMC has not computed a takeoff time, T/O displays in the line title and blanks display for entry.

Deletion terminates RTA and returns ECON as cruise mode.

6 Altitude/ETA (ALT/ETA)

Displays predicted altitude and ETA at RTA fix after entry of FIX in 1L.

Blank until performance data is entered.

7 Recommended Takeoff (RECMD T/O)

Displays T/O in line title and dashes until FIX is entered.

Displays RECMD T/O in line title on the ground when a takeoff time has been entered.

Displays recommended takeoff time to meet RTA at ECON speed.

Displays NOW when no takeoff time has been entered and the current time is later than the computed time to meet an RTA at ECON speed.

Blanks in flight.

Valid entry is time from 0000.0 to 2359.0; decimal entry is optional.

8 PRIOR RTA

Displays when an RTA fix and time exists, and the RTA fix is deleted or another cruise mode is selected prior to sequencing the RTA fix.

Push -

- displays previous RTA fix and time
- initiates RTA flight plan modification

Execution activates RTA function.

9 Cruise Speed Segment

Displays cruise speed segment start and end waypoints when entered on the Legs page. Valid entries are Mach (.XXX/), LRC (LRC/ or L/), RTA (RTA/ or R/), or ECON (ECON/ or E/). The cruise speed segment shown ends at AVE and ECON airspeed is resumed. If an end waypoint has not been entered, the cruise speed segment ends at the T/D.

Entry of RTA or R after an RTA fix or entry of ECON or E before an RTA; or, if entries are made with no RTA fix entered in 1L results in the scratchpad message INVALID ENTRY - RTA ACTIVE.

RNP Progress Page 4/4

Progress page four allows entry of lateral and vertical RNP values and displays status information about RNP operations.

1 Leg Direction

Leg segment data in line title:

- courses - XXX°
- arcs - XX.XARCD, XX.X is arc radius and D is arc direction L or R, (example: 24 ARC L)
- heading leg segments - XXX° HDG
- track leg segments - XXX° TRK
- special procedural instructions from database - HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry)

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

2 Waypoint Identifier

Displays the active waypoint.

3 Required Navigation Performance/Actual Navigation Performance (RNP /ACTUAL)

Display same as 5L POS REF 2/4. Manual entry of RNP displays in large font; propagated to 5L POS REF 2/4 page. Navigation database or OPC values display in small font. Actual (ANP) entry is not allowed. Manual entries are cleared at flight completion.

4 Crosstrack Error (XTK ERROR)

Displays crosstrack error from the active route. L or R indicates left or right of course. "99.99" displays if error is greater than 99.99 NM. Blank if error data is invalid or both routes are inactive.

5 Required Navigation Performance (RNP) Approach

Displays the default approach or airline chosen RNP for the selected approach. Entry not allowed at 6L. Navigation database or OPC values display in small font.

Manual entry at 2L displays in large font.

RNP values from the navigation database display in small font; or, if there are none, displays the default value for the approach navigation flight phase stored in the OPC.

6 Distance To Go

Displays the distance remaining to the next waypoint.

7 Glidepath

Displays the FMC computed glidepath for the approach.

8 Waypoint Speed/Altitude

Displays waypoint speed or altitude constraints in large font. Displays FMC predicted value in small font when no restrictions have been specified.

9 Vertical Navigation Performance

Displays both vertical RNP and ANP for the current leg.

Valid display range for vertical ANP is 1 to 999 feet.

Manual entries are allowed for vertical RNP and display in large font.

Valid entries are 10 to 999 feet and may include an optional trailing "/".

Entries clear at flight completion.

Vertical RNP values from the navigation database or OPC display in small font.

10 Vertical Error (VTK ERROR)

Displays vertical-track error above (+) or below (-) the active VNAV path from 10 to 9,999 feet. Vertical-track errors greater than 9,999 feet display as "9999".

Blank when vertical-track error is invalid or both routes are inactive.

11 Vertical RNP (Approach)

Displays the lowest applicable vertical RNP for the approach.

Manual entries (entered in 2R) display in large font.

Values from the navigation database or OPC display in small font.

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 when the airplane is in descent and flaps are out of up. In general, the approach starts no later than the FAF. 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, the DES NOW function is activated by setting an altitude below the current cruise altitude in the MCP altitude window and pushing the altitude selector 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. Selecting the ECON DES page and selecting DES NOW prompt also activates the DES NOW function.

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

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, a speed is entered on the DES page, or a speed constrained waypoint has been sequenced. The DES page is blank with DES as the title until an altitude constraint below the cruise altitude is entered.

1 Page Title

The page title displays active (ACT) or modified (MOD) descent. Usually, the title contains ECON for economy descent. Other fixed or selected speeds modify the title.

The page title displays the type of descent:

- ACT ECON DES - speed based on a cost index
- ACT MCP SPD DES - MCP speed intervention is selected
- ACT XXXKT DES - fixed CAS descent speed profile
- ACT M.XXX DES - fixed Mach descent speed selected
- ACT LIM SPD DES - speed based on an envelope limiting speed
- ACT END OF DES - airplane has sequenced E/D constraint

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
- flap speed targeting

2 End Of Descent At (E/D AT)

Displays end of descent altitude and waypoint. When altitude and waypoint are the FMC targets, altitude and waypoint display in magenta.

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. When the speed is the FMC target speed, it displays in magenta.

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.

When the speed is the FMC target speed, it displays in magenta.

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). When the speed is the FMC target speed, it displays in magenta.

6 Off Path Descent (OFFPATH DES)

Push - displays OFFPATH DES page.

7 ERROR at Waypoint

Header and data line are blank if any of the following are true:

- performance predictions are not valid
- 1R is blank
- the overshoot error is predicted to be less than 200 feet high
- the distance error is predicted to be less than 1 nm long
- no descent waypoint constraint exists

The vertical error range is from 200 to 9990 feet, rounded to the nearest 10 feet.

The along track error range is from 1 to 99 nm, rounded to the nearest 1 nm.

8 FORECAST

Push - displays DESCENT FORECAST page.

9 Descend Direct (DES DIR), Descend Now (DES NOW)

DES DIR -

Displays in descent phase with altitude constraint between airplane and E/D.

Push - deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

DES NOW -

Displays when T/D created and the descent phase is not active.

Push -

- provides guidance to descend at approximately 1,250 feet per minute using the active descent speed schedule. Thrust levers may be manually repositioned to adjust vertical speed. Upon intercepting the planned descent path, the airplane transitions to the planned descent path
- activates FMC descent phase

Descent Forecast Page

Descent forecast page is used to enter wind data for descent and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

Primary entries are wind direction and speed for up to four descent altitudes, and the altitude anti-ice is to be turned on. Entries can be manual or uplinked.

1 Transition Level (TRANS LVL)

Transition level can be specified by the arrival procedure. FMC default value 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/LOAD

Line title displays FORECAST UPLINK and dashes. Data line displays <REQUEST.

Selecting <REQUEST transmits a data link request; REQUESTING displays until a network acknowledgement has been received. After acknowledgement, <REQUESTsent displays.

When forecast uplink data is pending, <LOAD displays. Selection uploads data and displays PURGE> at 6R.

Displays DATA LINK and data line NO COMM, VOICE, or FAIL if datalink is not READY.

4 Thermal Anti-Ice On/Off Altitude (TAI ON/OFF)

Valid entries are altitude or flight level at which anti-ice is to be turned on and off during the descent.

5 Wind Direction/Speed (WIND DIR/SPD)

Valid entry is wind direction/speed for the specified altitude. Initial entry must have wind direction and speed. Subsequent entries may have direction with a trailing slash or speed with an optional leading slash.

6 FORECAST UPLINK PURGE, Descent (DES)

Displays PURGE prompt when an uplink containing descent forecast uplink data received and error checks passed.

PURGE>

Push - rejects uplinked descent forecast data.

DES>

Push - displays the DES page.

Offpath Descent Page

Offpath descent page allows the analysis of descent performance direct to a selected waypoint. Data entered displays clean and drag descent ranges on the page and on the ND. Ranges are based on an entered waypoint and altitude constraint. Range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC displays the last descent waypoint with an altitude constraint in DES TO.

The ECON SPD, SPD TRANS, SPD RESTR, and DES data are the same as the DES page.

1 Descend To (DES TO)

The waypoint for a direct-to descent. Usually, this is the E/D waypoint from the DES page. DTG calculations are for a descent direct to the DES TO waypoint.

Valid entry is any navigation database 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 TO CLEAN

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 TO DRAG

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 DISPLAY OFF - ON

The active state displays in green.

SELECT when OFF displayed -

- displays ON in large font; displays OFF in small font
- displays CLEAN CIRCLE on ND
- displays DRAG CIRCLE on ND after aircraft inside CLEAN CIRCLE

SELECT when ON displayed -

- displays OFF in large font; displays ON in small font
- removes clean and drag circles from the ND

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 direct and monitor 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, set the approach VREF, and enter the wind correction factor
- ARRIVALS page - select arrival and approach procedures
- HOLD page - create or monitor 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 a runway, approach, approach transition, and Standard Terminal Arrival Route (STAR) at 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.

Selecting Options

Selecting a runway, approach, approach transition, STAR/profile descent, or descent transition option shows <SEL> inboard of the selection, and makes a route modification. The other options within the same category are removed from the list. When executing the modification, <SEL> changes to <ACT>. Selecting another page and returning to ARRIVALS displays all options; the applicable <SEL> or <ACT> prompts are displayed.

1 Page Title

The destination airport identifier displays in the title.

Second line displays route number.

2 Standard Terminal Arrivals (STARS), Profile Descents (PROF DES)

STARs display in a list under the STARs 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 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

4 ROUTE, XXXXX Intercept (INTC)

Push -

ROUTE>

- displays route page for related route
- displayed only on ground or for inactive route

XXXXX INTC>

- results in flight plan MOD and activation of the approach intercept function
- displays the RTE LEGS page with the waypoint XXXXX as the intercept TO waypoint

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, APPROACHES, and RUNWAYS
- displays INDEX prompt

Arrivals Page With STAR, STAR Transition, and Approach Selected

1 Glideslope (G/S)

Displays the active state in large green font when a LOC-based approach is part of the active flight plan.

Provides a means of using IAN glidepath guidance when ILS glideslope guidance is not available.

Defaults:

- ON (large green font) for I/GLS or IGS approaches
- OFF (large green font) for LOC, BAC, LDA, or SDF approaches

Push - toggles glideslope on or off.

2 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

3 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/GLS, B/C, GPS, LOC, RNV, 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 runway extension; and, VFR APP when enabled in the navigation database
- no longer displays other runways and approaches
- displays approach intercept fix for selected runway

Arrivals Page With Runway Selected

1 VFR Approach (VFR APPR)

Displays when a VFR approach is in the navigation database for the selected runway.

Push - following a discontinuity, creates a straight-in VFR approach beginning with a transition waypoint, FAXXX at 8 NM from the runway threshold with an airspeed/altitude constraint of 170 kts/2,000 feet above runway altitude.

The VFR approach ends with a runway altitude constraint of 50 feet.

Displays RWY EXT 8.0 NM and FPA of 3.0 degrees.

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.

Deletes VFR APPR prompt.

3 Approach Intercept

Selecting an arrival runway displays an approach intercept waypoint on the approach course for the selected runway.

Push - modifies the flight plan, displays the RTE LEGS page, and activates the intercept-course-to function.

Arrivals Page With VFR Approach Selected

1 Runway Extension (RWY EXT)

Following selection of a runway, the RWY EXT 8.0 NM waypoint, FAXXX, displays as part of VFR APPR. Distance cannot be changed.

2 Flight Path Angle (FPA)

Displays descent flight 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. The descent path begins at the FAXXX waypoint altitude and terminates at the runway threshold at 50 feet. Default values display in RWY EXT and FPA.

Arrivals Page With Manually Entered Runway Extension

1 Runway Extension (RWY EXT)

Valid entries are from 1.0 to 25.0 nm from the runway threshold.

Entry allowed if VFR APPR is not selected. Entry removes VFR APPR prompt. Example shows 6 nm entered.

Makes waypoint RXYYY, where YYY is the runway; example: RX32R. Makes a route discontinuity before and after waypoint.

Approach Reference Page

The approach reference page displays approach planning data and the approach reference speed (VREF) selection.

1 Gross Weight (GROSS WT)

Displays FMC calculated airplane gross weight.

Displays boxes when gross weight is not available from FMC.

Valid entry is XXX.X. Leaving this page and returning displays the FMC calculated gross weight. Page used for viewing or selecting approach reference speeds for a gross weight other than the current value.

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 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.

4 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.

5 Wind Correction (WIND CORR)

Displays the default wind correction value of 5 kt.

Valid entries are wind correction values from 0 to 20. Manual entry displays in large font. The wind correction is applied to selected reference speed for the final VNAV speed target.

6 Thrust Limit (THRUST LIM)

Push - displays THRUST LIM page.

Alternate Airport Diversions

ALTN page 1/2 lists the nearest, suitable alternate airports, FMC predicted performance data for each alternate, and a method to DIVERT NOW to a selected alternate airport. The page displays four airports in an ETA sequence. Each airport has an XXXX ALTN page with more data. Selecting the caret at 1R to 4R displays the XXXX ALTN page. ALTN LIST page 2/2 shows additional uplinked alternate airports taken from the Company Preferred Alternates list or from the FMC Alternates Candidates list. The two lists are not mutually exclusive.

Alternate Page 1/2

The first alternate page displays alternate airport data. An alternate airport can be selected to change the flight plan destination.

The source of alternate airports can be:

- an uplink directly to the page
- automatic selection from the ALTN LIST page
- automatic selection from the navigation database
- manual entry

Alternate airports automatically selected from the alternate list or from the navigation database display in small font. The alternate airport symbols display on the ND in cyan. All four alternates display when the ND is in the plan mode. The selected alternate airport displays at all times on the ND map. Other alternates display on the ND when the ARPT switch is on.

1 Alternate Airports

Displays the identifier of four alternate airports in ETA order in flight; displays in distance order on the ground.

Valid entry is an airport in the navigation database.

An entry into a field displaying a small font identifier overwrites the airport, but does not delete it from the Alternate Candidates list. After data computation, the overwritten airport is placed on the list according to ETA order. An entry into a field displaying a large font airport overwrites the airport. Manual entries display in large font. The DELETE function key can be used to remove manually entered alternate airports from the ALTN page.

2 Alternate Request (ALTN REQUEST)

Push - transmits a datalink request for a preferred list of alternates (up to four).

Uplinked airports display in ETA order. The scratchpad displays the message ALTN UPLINK when the alternate airport data arrives.

3 Weather Request (WXR REQUEST)

Push - transmits a datalink request for alternate airport weather data.

Uplinked weather is sent to the flight deck printer.

4 ETA

Displays ETA calculated on the routing, altitude, and speed displayed on the XXXX ALTN page. ETA is blank when the airplane is on the ground.

The message UNABLE ALT displays if the altitude specified in the XXXX ALTN page is above the calculated maximum altitude or if the airplane is past the top of descent for the alternate airport.

5 Selected (<SEL>)

The selected alternate is identified by an <A> or <SEL> to the right of the airport identifier. Usually, the closest alternate is selected by the FMC and is identified by <A>. Manually selecting an alternate displays <SEL> to the right of the airport identifier. The selected alternate identifier displays in the line title at 6R.

Entering a new airport into the list of four does not select the new airport.

Deleting a manually selected alternate airport removes <SEL>. The FMC selects a new alternate.

6 FUEL

Displays predicted arrival fuel calculated on the routing, altitude, and speed displayed on the XXXX ALTN page. The message UNABLE FUEL displays in the FUEL column if the predicted arrival fuel is less than zero.

7 Alternate Select

Push - displays the ALTN page for the alternate airport selected.

A manually entered alternate airport displays in large font.

8 Alternate Inhibit (ALTN INHIBIT)

One or two airports can be manually or uplink inhibited. Valid entries are airports in the navigation database in the form: XXXX, XXXX/, /XXXX, or XXXX/XXXX.

Uplinked airports may be contained in the ALTN UPLINK message; or, if uplinked separately, the scratchpad displays the message ALTN INHIBIT UPLINK. Inhibited alternate airports may be manually entered in lines 1L - 4L.

9 DIVERT NOW

Push - creates an LNAV route modification based on the selected VIA (or default DIRECT TO) routing on the XXXX ALTN page with the selected alternate as the destination airport. Details of the route can be confirmed or modified before the diversion is executed. Before execution, displays SELECTED.

Execution of the diversion:

- changes the route destination airport
- includes the route modification into the active flight plan
- deletes all parts of the original route not part of the diversion
- if a descent path exists, deletes all descent constraints (the scratchpad message DESCENT PATH DELETED displays when DIVERT NOW is selected)

After a divert is executed, the XXXX ALTN page is not updated until all CDUs are selected to another page from the XXXX ALTN page.

Alternate List Page 2/2

The ALTN LIST page displays an uplinked list of up to 20 alternate airports. The alternates on the ALTN 1/2 page are selected from this list. The list can be deleted using the PURGE> prompt and a new list can be uplinked.

1 Alternate Airports List

Lines 1 to 4 contain up to 20 airports from which alternates can be selected and displayed on ALTN page 1/2 when preferred uplinked airports do not use all four lines.

The list is uplinked directly to this page. No manual entry is allowed.

2 Request SEND

Push - transmits a request for a new alternate airport list.

3 Alternate List Purge/Confirm (ALTN LIST PURGE/CONFIRM)

When no list exists, alternate airports can be selected from the navigation database.

Selecting the PURGE prompt arms the purge function and displays a CONFIRM prompt before the list is deleted.

Push - deletes all airports from the list.

A new list must be uplinked after a purge.

XXXX Alternate Page

Each of four alternate airports displayed on the ALTN page 1/2 has a related XXXX ALTN page. The XXXX ALTN pages display specific data about alternate airports, the route used for a diversion, and the conditions on which the ETA and fuel calculations are based. All data on the page is related to the alternate airport displayed in the page title. The first page number refers to the line number on the ALTN page; the second page number is the number of alternates on the ALTN page.

Three route options to the airport can be selected:

- DIRECT TO - direct to alternate; default option
- OFFSET - flight plan route with an offset
- OVERHEAD - flight plan route to a waypoint; then, direct to the alternate

The selected route option has an effect on ETA and fuel remaining. It is identified by <SEL>. Selection of a route option for one alternate selects the same route option for the other three alternates.

1 VIA DIRECT TO

Push - FMC creates a direct route from present position to the selected alternate airport. Displays "<SEL>". The FMC also computes direct routing to each of the four alternates listed on the ALTN page with ETA and FUEL to each alternate airport. This FMC function applies to all three "VIA" options.

2 VIA OFFSET

The default data line is "L00 OFFSET". Selection with no content in the scratchpad displays "<SEL>".

Valid scratchpad entry is L (left) or R (right) XX (XX is any number between 1 and 99 nm); value can be manually entered or uplinked.

Selection to 2L propagates the offset to all alternates and displays on all XXXX ALTN pages.

Offset removed by deleting, entering zero, or selection of DIRECT TO.

3 VIA OVERHEAD

Valid entries are the destination airport or any waypoint in the active or modified route; entry can be manually entered or uplinked. Entry can be deleted. Selection with no content in the scratchpad displays "<SEL>".

Data line displays large font when manually entered; displays small font when fix identifier is a pending uplinked identifier.

The waypoints up to the selected or entered overhead waypoint are retained, then routing is direct to the alternate airport. All waypoints after the overhead waypoint are deleted.

4 Engine Out (ENG OUT)

This prompt performs the same function as described on the cruise page. It can be selected before or after the diversion is selected.

Displays the alternate airport ETA; blank when the airplane is on the ground.

5 Alternate (ALTN)

Push - displays the ALTN 1/2 page.

6 Advisory Altitude (ALT)

The FMC computes an advisory altitude for each alternate; or, displays the AMI default altitude in small font.

Valid entries are the standard altitude entry format less than or equal to the maximum altitude; altitude can be manually entered (large font) or uplinked (small font until accepted).

Entry causes a recomputation of ETA and arrival fuel. Altitude entries do not become part of the diversion modification. Altitude entries apply to all four alternates.

7 Advisory Speed (SPD)

The FMC computes an advisory speed for each alternate; or, displays the AMI default speed in small font. AMI speed can be CAS or Mach, or a speed mode.

Valid entries are CAS from 100 to 400 or Mach from .100 to .990, LRC, ECON, EO, EO LRC, or CO.

Entry causes a recomputation of ETA and arrival fuel. Speed entries do not become part of the diversion modification. Speed entries apply to all four alternates.

Speed modes available are:

- ECON (economy)
- LRC (long range cruise)
- EO (engine out)
- EOLRC (engine out long range cruise)
- CO (company speed)
- SPD (with CAS or Mach entry)

8 WIND

Manual entry or uplinked data causes recomputation of ETA and arrival fuel. A wind entry can be made for each of the four alternates. A wind entry applies to only one alternate.

Valid entry is wind direction and speed up to 250.

9 Altitude/Outside Air Temperature (ALT/OAT)

Entry of data causes a recomputation of ETA and arrival fuel. A separate ALT/OAT entry may be made for each of the four alternates.

Valid entry is an altitude/temperature in the range of -99 to 60 degrees C.

10 Alternate Airport ETA/Fuel (XXXX ETA/FUEL)

Displays calculated airport ETA and arrival fuel based on the selected route, altitude, and speed displayed on this page. UNABLE FUEL displays if the fuel prediction is less than zero. UNABLE ALT displays if the entry is above maximum altitude or if the altitude is above the airplane and the airplane would be past the top of descent point for the alternate if it attained the entered altitude.

11 DIVERT NOW

Line title displays XXXX where xxxx is the alternate airport identifier

Push - creates an LNAV route modification based on the selected VIA routing with the selected alternate as the destination airport. If <ENG OUT has been selected, the engine out altitude is loaded into the MOD; and, if the airplane altitude is below engine out maximum, the engine out altitude is also loaded into the MOD. Details of the route can be confirmed or modified before the diversion is executed. Before execution, line title displays DIVERT XXXX and the data line displays SELECTED>.

Execution of the diversion:

- changes the route destination airport
- includes the route modification into the active flight plan
- deletes all parts of the original route not part of the diversion
- if a descent path exists, deletes all descent constraints (the scratchpad message DESCENT PATH DELETED displays when DIVERT NOW is selected)

After a divert is executed, the XXXX ALTN page is not updated until all CDUs are selected to another page from the XXXX ALTN page.

Holding

The route hold page is used to enter holding information in the route or to view or modify an existing holding pattern. Modification and execution of a change to a holding pattern while in the hold display the holding pattern as if an EXIT HOLD has been executed. After the holding fix, the transition to the new holding pattern and the new holding pattern display.

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- airplane track, not heading or direction from which the active route approaches the holding pattern, determines the entry method used (parallel, teardrop, or direct entry)
- the airplane flies the initial outbound leg a computed distance from the holding fix, rather than a specific time. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active
- teardrop entries use a 40 degree offset angle

Holding Entry

Airplane track to the holding fix determines the entry type; direct, teardrop, or parallel. To make efficient use of the holding airspace, lateral guidance may direct the initial turn to the holding pattern prior to crossing the holding fix (fly-by). The holding entry path displays on the ND. For all holding entry types, lateral guidance directs the airplane to fly-by or fly-over the holding fix and to remain on the holding side of the inbound holding course. Depending on the entry track for a direct entry, the flight path may extend beyond the displayed outbound holding turn. For teardrop and parallel entries, the flight path remains within the confines of the depicted holding pattern. Remaining within the prescribed holding airspace requires the airplane to be at holding airspeed at 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 Present Position (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 procedure hold (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 in magenta when the airplane is active in the hold.

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 in magenta when the airplane is active in the hold.

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; or, 1.5 MIN above 14,000 feet

Displays 1.0 or 1.5 in magenta when the airplane is active in the hold.

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

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 respective 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, holding patterns, and missed approach waypoints. Waypoints on the copied route can be referenced by either their identifier, or latitude and longitude.

New waypoints can be entered only 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 similar manner to 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 CDUs initially have the last tuned radio data downloaded from the FMC. For changes to radio data, the radios must be manually tuned on each CDU in alternate navigation. The left CDU tunes the left VOR, DME, and left ILS. The right CDU tunes the right VOR, DME, 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 the primary FMC causes both CDUs to display the MENU page and the scratchpad message TIMEOUT-RESELECT. Failure of the secondary FMC displays the respective CDU MENU page and the scratchpad message TIME-OUT RESELECT. Rotating the respective 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.

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 (IRS X)

Displays IRU present position.

Line title displays IRU source for position.

6 Cross Track (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 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 1: 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 2: The ILS frequency displays PARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note 3: ILS course and frequency must be entered on the left, center, and right ALTN NAV RADIO page.

4 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.

EICAS Alert Messages

Message	Level	Aural	Message Logic
FMC LEFT, RIGHT	Advisory		Affected FMC has failed.
>FMC MESSAGE	Advisory		High priority FMC message exists.
>FMC RUNWAY DIS	Caution	Beeper	Airplane position or heading not within specified limits of active FMC departure runway and takeoff thrust applied.
>GPS	Advisory		Dual GPS failure.
>GPS LEFT, RIGHT	Advisory		Left or Right GPS system failure.
ILS ANTENNA	Caution	Beeper	Glideslope or localizer antenna fails to switch.
>IRS AC CENTER, LEFT, RIGHT	Advisory		Center, Left, or Right IRU AC power failure.
IRS CENTER, LEFT, RIGHT	Advisory		Center, Left, or Right IRU system fault.
>IRS DC CENTER, LEFT, RIGHT	Advisory		Center, Left, or Right IRU backup DC power failure.
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.
UNABLE RNP	Caution	Beeper	Actual navigation performance does not meet required accuracy during navigation phases. Inhibited during polar operation.

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.

(G-BNLK - G-CIVZ ; SB activates ATS or AOC)
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

ARM MCP APP MODE - armed approach mode has been disarmed.

ATC COMM ESTABLISHED - ATC COMM available or control passed to a new ATC center.

ATC COMM TERMINATED - ATC datalink is terminated.

ATC REPORT LIST FULL - nine reports have been generated and are awaiting transmission and a tenth report request has been received.

CHECK AIRLINE POLICY - after loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the loaded value and notifies the flight crew of the difference. This is a maintenance function.

CHECK ALT TARGET - VNAV activates when airplane between MCP and FMC target altitudes. VNAV maintains level flight.

CRZ ALT CHANGED TO XXXXX - an altitude constraint added due to entering a new route, a new destination airport, or selection of a new procedure conflicts with the cruise altitude, resulting in automatically raising the cruise altitude to match the highest waypoint altitude constraint.

CUTBACK DISARMED - the CUTBACK reverts from ON to OFF following a runway change while on the ground.

CUTBACK UNAVAILABLE - the FMC was unable to compute the cutback thrust using the existing conditions.

CYCLE IRS OFF-NAV - IRS align problem requires cycling IRS mode switch OFF, then back to NAV.

CYCLE MCP APP MODE - engaged mode(s) has failed; recovery is possible by pushing the APP switch twice.

DESCENT PATH DELETED - VNAV active and all waypoint altitude constraints defining descent path deleted.

DISCONNECT A/P AND F/D - engaged mode(s) has failed; recovery is possible by turning off both flight directors and disengaging all three autopilots.

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.

FMC APP MODE UNAVAIL-GP - an approach has been activated but the navigation database glidepath is unusable.

FMC APP/TUNE DISAGREE - a non-localizer based approach is active in the active route and an ILS is subsequently tuned.

FMC L/R OUTPUT LOSS - some information used by systems other than the FMS is not available.

INSUFFICIENT FUEL - applies to the inactive route or to the active route in a modified state; estimated fuel at destination less than entered RESERVES value. This may indicate an engine fuel leak.

INVALID ATC UPLINK - ATC uplink message received by FMC contains format or other errors. FMC rejects the uplink and sends a downlink response to ATC center.

INVALID TAKEOFF XXX/YYY - takeoff data for up to six runways or runway intersection pairs has been received but some data for one runway or runway intersection pair (RWXXX/YYY) is invalid.

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.

LNAV BANK ANGLE LIMITED - before entering or while flying a curved path or holding pattern, the FMC predicts the LNAV roll command will be limited by thrust or buffet based roll limits.

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 XXXX (XXXX = required navaid) - signals not received from navaid required for approach procedure.

NO ACTIVE ROUTE - LNAV selected, but no active route activated.

PERF/VNAV UNAVAILABLE - VNAV selected without gross weight, cost index, or cruise altitude entered.

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.

RESPOND TO ATC UPLINKS - ATC uplink received and causes storage to be full or uplink received when storage is full.

RTA FIX DELETED - RTA fix has been deleted from the modified flight plan.

RW/APP TUNE ERROR - during approach, FMC autotuning is incapable of obtaining the correct frequency (ILS) or channel (GLS) - pilot may have a manual entry that does not agree with the selected approach or the multi-mode receiver has malfunctioned.

RW/ILS CRS ERROR - selected ILS course does not match course for destination runway in active route or valid course data not received.

SET TIME/DATE-POS INIT - all clock sources (GPS, FMC) have been unavailable for 10 minutes.

SINGLE FMC L OPERATION - the right FMC is not operational.

SINGLE FMC R OPERATION - the left FMC is not operational.

SPLIT IRS OPERATION - the number of usable IRUs has changed from three to two due to erroneous data from one IRU when compared to the other IRUs data. Possible erroneous data are:

- one IRU having significant position or velocity differences from the triple mix position and/or velocity, or
- data from one IRU compared to the other two IRUs exceeds the comparison threshold

TAKEOFF FLAPS DELETED - selected flap position is invalid.

TAKEOFF SPEEDS DELETED - selected V speeds are invalid.

THRUST REQUIRED - VNAV active, autothrottle disconnected, and additional thrust required to track descent path and maintain speed.

UNABLE FLXXX AT RTA FIX - predicted crossing altitude at RTA fix less than FLXXX, but predicted ETA within tolerance.

UNABLE HOLD AIRSPACE - the radius of the holding pattern calculated by the FMC exceeds the FMC maximum protected airspace limits.

UNABLE NEXT ALT - VNAV active and climb not sufficient to comply with waypoint altitude constraint.

UNABLE RTA - RTA not achievable within applicable arrival time tolerance.

UNABLE TO LOAD CLEARANCE - FMC unable to load any of the loadable data in an uplink message.

UNABLE TO SEND MESSAGE - transmission of a downlink message has been initiated and cannot be delivered to the ACARS MU.

VERIFY POSITION - the FMC calculation of airplane present position is based on conflicting data. The possible conflicts are:

- the active FMC and the inactive FMC positions differ by more than twice the RNP for 5 seconds, or
- the difference between the FMC position and the navigation aid being used (GPS, DME, VOR, or inertial) is greater than 12nm for 5 seconds.

VERIFY RNP - POS REF 2 - the default RNP value has changed for the current phase of flight and the flight crew entered RNP value exceeds the default value.

VERIFY TAIL NUMBER - the entered tail number disagrees with the tail number contained in the FMC database.

VERIFY VERT RNP - PROG 4 -the default vertical RNP has changed for the present phase of flight and the flight crew entered vertical RNP value exceeds the default value.

VIA OFFSET INVALID - flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.

VNAV STEP CLIMB - a climb has not been initiated within 5 minutes after sequencing a step climb point.

FMC Communications Messages

FMC communications messages:

- display in the CDU scratchpad
- illuminate the CDU message (MSG) light

ALTN INHIBIT UPLINK - uplink contains two airports for the ALTN page 1/2 ALTN INHIB line.

ALTN LIST UPLINK - a company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.

ALTN UPLINK - up to four company preferred alternate airports and associated data has been received and is available for preview on the ALTN page.

APP TUNE INHIBITED - MCP - the autopilot inhibits a change to the approach type following a manual entry on the NAV RADIO page. Reselect APP on the MCP.

DES FORECST UPLINK READY - descent forecast data has been received and is available for loading on the DESCENT FORECAST page.

FLT NUMBER UPLINK - a new flight number has been received and is available on the RTE page 1/X.

PARTIAL ROUTE X UPLINK - an uplinked new route to the FMC contains a portion of the route which cannot be loaded.

PERF INIT UPLINK - performance initialization data has been received and is available for preview on the PERF INIT page.

RESET MCP APP MODE - a change is made to the active route while the approach is armed or engaged in either axis. Reset (deselect, reselect) APP on the MCP.

ROUTE X UPLINK READY - a new route or route modification has been received and is available for loading on the RTE X page.

TAKEOFF DATA LOADED - an uplink containing takeoff data matching the runway/position entry on the TAKEOFF page is available for preview (only displays after an initial takeoff uplink has been received) or alternate thrust and/or flaps have been selected.

TAKEOFF DATA UPLINK - an uplink containing takeoff data matching the runway on the TAKEOFF page is available for preview.

WIND DATA UPLINK READY - wind data has been received and is available for loading into the active route.

FMC Advisory Messages

CHECK CONSTRAINT XXXXXXX - an added or changed altitude constraint or cruise altitude conflicts with the constraint altitude at other waypoints in the route.

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.

ENG OUT SID MOD - an engine failure is sensed after takeoff before flaps are fully retracted; the FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.

INVALID ALTN LIST UPLINK - a received company list of up to 20 alternate airports contains invalid data and cannot be displayed.

INVALID ALTN UPLINK - a received company preferred list of alternate airports and associated alternate data contains invalid data and cannot be displayed.

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.

INVALID ENTRY - RTA ACTIVE - entry of an ECON cruise speed segment before an RTA fix while in active RTA mode or between an RTA cruise speed segment and an RTA fix.

INVALID FLT NO UPLINK - a received new flight number contains invalid data and cannot be displayed.

INVALID FORECAST UPLINK - a received descent forecast contains invalid data and cannot be displayed.

INVALID PERF INIT UPLINK - a received performance initialization uplink contains invalid data and cannot be displayed.

INVALID ROUTE UPLINK - a received new flight plan route or modification to the active flight plan route contains invalid data and cannot be displayed.

INVALID TAKEOFF UPLINK - a received takeoff data uplink for up to six runways or runway - intersection pairs contains invalid data and cannot be displayed.

INVALID WIND DATA UPLINK - a received enroute wind data uplink contains invalid data and cannot be displayed.

MAX ALT FLNNN - entered cruise altitude greater than performance maximum altitude.

NOT IN DATA BASE - data not in system.

NOT ON INTERCEPT HEADING - LNAV selected and airplane outside active leg capture criteria and current heading will not intercept active leg.

ROUTE FULL - last route modification fills FMC beyond its capacity of 120 waypoints. Last selection not entered in route.

RUNWAY N/A FOR SID - runway not compatible with SID.

STANDBY ONE - FMC requires more than four seconds to display data.

TIME OUT - RESELECT - communications with selected system have failed. Menu page displayed. Systems with a caret symbol are available for selection. Selecting < FMC displays last page used.

UNABLE CRZ ALT - entered cruise altitude results in climb intersecting the descent path or the time in cruise prior to top of descent less than minimum allowable.

V SPEEDS UNAVAILABLE - the FMC is unable to compute takeoff speeds.

VERIFY RNP ENTRY - manually entered RNP exceeds the default RNP value for the current navigation flight phase or is less than the current ANP.

XXXXXXX - MAX ALT FLXXX - predicted altitude at waypoint XXXXXXX, at which a speed mode transition is specified, exceeds the maximum altitude for the new speed target and predicted conditions at the waypoint.

VERIFY VERT RNP ENTRY - a manual vertical RNP entry exceeds the default value for the present phase of flight.

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Fuel System

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

G-CIVF - G-CIVI

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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

9 Stabilizer (STAB) Tank Pump Switches

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

G-CIVF - G-CIVI

- when jettison system armed, activates override/jettison pumps in tanks containing fuel (pump switches must be ON)

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

- 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

G-BNLK - G-BNLY, G-CIVA

G-BYGA - G-BYGG, G-CIVB - G-CIVZ

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
G-BNLK - G-BNLY, G-CIVA

ON - pump operates.

OFF - pump operates when commanded by system logic.

Fuel Transfer Main 1 & 4 Switch

1 FUEL Transfer (XFER) MAIN 1 & 4 Switch

ON - main 1 and 4 transfer valves open.

Off -

- main 1 and 4 transfer valves closed
- main 1 and 4 transfer valves open when commanded by system logic

Fuel Temperature

1 FUEL Temperature (TEMP) SENSOR Switch

A - selects temperature sensor A as source for fuel temperature displayed on EICAS.

B - selects temperature sensor B as source for fuel temperature displayed on EICAS.

Fuel Indications and Displays

Normal Fuel Indications

1 Normal Fuel Indications

Total fuel quantity (kilograms x 1000).

Fuel temperature (degrees Celsius).

Amber - fuel temperature is -37°C and below.

Compacted Fuel Indications

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

G-CIVF - G-CIVI

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.

1 Center Wing Tank Pump

White - pump switch off.

Green - pump on.

Amber - pump pressure low.

2 Main Pump

White - pump switch off.

Green - pump on.

Amber - pump pressure low.

3 Tank Quantity

White - indicates fuel quantity in tank.

Amber (main tank only) - imbalance condition or quantity less than 900 kg.

4 Total Fuel Quantity

White - indicates total fuel quantity.

5 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

G-BNLK - G-BNLY, G-CIVA

White - pump on

Green - fuel pressure.

9 Stabilizer Tank Pump

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

White - pump switch off.

Cyan - armed for system logic operation.

Green - pump on.

Amber - pump pressure low.

Fuel Jettison Indications

Fuel Jettison Indications, Primary EICAS

1 Fuel Jettison Indications

Fuel to remain replaces fuel temperature during jettison operation.

Magenta - indicates fuel to remain at completion of jettison.

White (flashes for five seconds) - indicates jettison has completed.

Fuel Jettison Indications, Fuel Synoptic

G-BNLK - G-BNLY, G-CIVA

G-BYGA - G-BYGG, G-CIVB - G-CIVE, G-CIVJ - G-CIVZ

G-CIVF - G-CIVI

1 Jettison Nozzle

Magenta - fuel jettison system operating.

2 Time To Complete Jettison

White - time remaining to complete jettison.

Intentionally
Blank

Introduction

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
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.

G-CIVF - G-CIVI
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 fuel temperature is at or below -37°C. During jettison, the TO REMAIN quantity replaces the EICAS display fuel temperature indication.

Fuel Pumps

Each main tank contains two AC-powered fuel pumps which run continuously when selected ON. 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 pump's higher output pressure overrides the main pumps' output.

The two center wing tank (CWT) fuel pumps are also override/jettison pumps. Together, the CWT pumps inhibit 2 and 3 override/jettison pumps and override the main pumps so CWT fuel is used before wing tank fuel. However, one CWT pump alone does not inhibit 2 and 3 override/jettison pumps or override the outboard main pumps.

G-BNLK - G-BNLY, G-CIVA
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.

G-BYGA - G-BYGG, G-CIVB - G-CIVZ
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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
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

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

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.		

G-CIVF - G-CIVI

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
Total	203,898	163,710
* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.		

Fuel Quantity Indication

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

G-CIVF - G-CIVI

CENTER WING TANK
MAIN #1
MAIN #2
MAIN #3
MAIN #4
RESERVE #2
RESERVE #3
FUEL QUANTITY PROCESSOR
FMC
TOTAL FUEL
TOTAL FUEL
163.7
CTR
52.2
1
2
3
4
MAIN 1
13.6
MAIN 2
38.1
RES 2
4.0
MAIN 3
38.1
RES 3
4.0
MAIN 4
13.6

Fuel System Schematics

Main Tank Main Pump Schematic

Main Tank Override/Jettison Pump and Fuel Crossfeed Schematic

Center Wing and Horizontal Stabilizer Pump Schematic

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

Center Wing Tank Pump Schematic

G-CIVF - G-CIVI

Reserve Tank 2 and 3 Transfer

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.

Main Tank 1 and 4 Transfer

Main tank 1 and 4 each contain one transfer valve. When the valves open, fuel gravity transfers from the outboard main tanks to the inboard main tanks. Fuel transfers to approximately 3,200 kilograms remaining in each outboard main tank.

During fuel jettison, the valves open when either main tank 2 or 3 fuel quantity decreases to 9,072 kilograms. The valves may be opened manually using the Fuel Transfer Main 1 & 4 switch on the overhead panel.

APU Fuel Feed

G-BNLK - G-BNLY, G-CIVA
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.

G-BYGA - G-BYGG, G-CIVB - G-CIVZ
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

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
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.

G-CIVF - G-CIVI
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

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.

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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ
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.

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.

G-BYGA - G-BYGG, G-CIVB - G-CIVZ
CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3.

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.

G-BNLK - G-BNLY, G-CIVA

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.

In flight, the EICAS message FUEL TANK/ENG displays when one of the following occurs with the crossfeed valve 1 or 4 open: main tank 2 quantity is equal to or less than main tank 1 quantity or main tank 3 quantity is equal to or less than main tank 4 quantity. In the tank-to-engine configuration the main pumps provide fuel to their respective engine until engine shutdown.

Note: On the ground, the FUEL TANK/ENG message can display when the inboard tank quantity is less than or equal to the sum of the adjacent outboard tank plus 500 kgs in both wings.

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/jettison 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.

Note: On the ground, the FUEL TANK/ENG message can display when the inboard tank quantity is less than or equal to the sum of the adjacent outboard tank plus 500 kgs in both wings.

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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

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.

G-CIVF - G-CIVI

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.

The FSMCs open the reserve transfer valves when main tank 2 or 3 fuel quantity decreases to approximately 18,200 kilograms. Fuel transfers from reserve tanks 2 and 3 to the related main tank.

When either main tank 2 or 3 fuel quantity decreases to 9,072 kilograms during jettison, both main tank 1 and 4 transfer valves open.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

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.

G-CIVF - G-CIVI

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

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

G-CIVF - G-CIVI

FUEL TO REMAIN
OFF
A
B
L-NOZZLE-R
ON
VALVE
ON
VALVE
FUEL JETTISON
FUEL JETTISON CONTROL CARDS A & B
PUMP/VALVE SIGNALS
µJettison Time
µFuel To Remain
SECONDARY EICAS DISPLAY
PRIMARY EICAS DISPLAY
CENTER
MAIN 2
MAIN 1
R2
SURGE
OVERRIDE/JETTISON PUMP
MAIN PUMP
NOTE: RIGHT WING SIMILAR

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EICAS Alert Messages

Message	Level	Aural	Message Logic
FUEL DISAGREE	Advisory		Totalizer fuel quantity and FMC calculated fuel quantity disagree.
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		After reaching FUEL TANK/ENG condition, there is a longitudinal fuel imbalance of 2,720 kgs between inboard main tanks and outboard main plus reserve tanks. Message no longer displayed when difference less than 450 kgs.
>FUEL JETT A, B	Advisory		A fuel jettison system is failed. Message inhibited when FUEL JETT SYS message displayed.
FUEL JETT SYS	Caution	Beeper	Fuel total is less than fuel to remain and one jettison nozzle valve is open, or both fuel jettison systems are failed.

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		On the ground with center wing tank quantity of 7,700 kgs or more with center wing tank pump switch OFF, or in cruise, center wing tank quantity 1,800 kgs or more with center wing tank pump switch OFF.
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.

G-BNLK - G-CIVE, G-CIVJ - G-CIVZ

>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. Message inhibited when FUEL STAB XFR message displayed.

Message	Level	Aural	Message Logic
G-BNLK - G-CIVE, G-CIVJ - G-CIVZ			
>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. Message inhibited when FUEL STAB XFR message displayed.
G-BNLK - G-CIVE, G-CIVJ - G-CIVZ			
FUEL PRES STB L, R	Advisory		Low pump pressure detected when pump activated. Pump activates by system logic with Stabilizer Tank Pump switch ON.
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.
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.
FUEL QTY LOW	Caution	Beeper	Fuel quantity 900 kgs or less in one or more main tanks.
FUEL RES XFR 2, 3	Advisory		Reserve transfer valves not in commanded position.

Message	Level	Aural	Message Logic
G-BNLK - G-CIVE, G-CIVJ - G-CIVZ			
FUEL STAB XFR	Caution	Beeper	Stabilizer tank fuel transfer function is failed.
>FUEL TANK/ENG	Advisory		With crossfeed valve 1 or 4 open: on the ground after fueling, after initial electrical power established, or after CMC ground test; main tank 2 quantity less than or equal to main tank 1 quantity plus 500 kgs and main tank 3 quantity less than or equal to main tank 4 quantity plus 500 kgs, or in flight, 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. Message inhibited during jettison.
FUEL TEMP LOW	Advisory		Fuel temperature -37°C or less.
FUEL TEMP SYS	Advisory		Fuel temperature sensing inoperative.
G-BNLK - G-BNLY, G-CIVA - G-CIVP			
>FUEL WING ISLN	Advisory		Center refueling isolation valve is closed.
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.

Message	Level	Aural	Message Logic
G-BNLK - G-BNLY, G-CIVA			
>SCAV PUMP ON	Advisory		Center wing tank scavenge pump operating while airplane on the ground.
>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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13.30 EICAS Messages 13.30.1

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Hydraulic Panel

1 Hydraulic DEMAND Pump Selector

OFF - demand and auxiliary pumps 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 and 4 also operate when trailing edge flaps are in transit

ON - demand pump operates

Auxiliary (AUX) (System 1 and 4) -

- auxiliary pump operates on ground until respective engine driven pump pressurizes
- respective demand pump off

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 commanded to operate and output pressure is low

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.

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 Shutoff Valve

Indicates open or closed position of shutoff valve.

6 Reservoir Pressure

RSVR PRESS - displays when reservoir bleed air pressure is low.

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Introduction

The airplane has four independent hydraulic systems, numbered by the engine which powers it. The hydraulic systems power the:

- primary flight controls
- autopilot servos
- spoilers
- stabilizer trim
- elevator feel
- landing gear
- flaps
- brakes
- steering

Hydraulic Systems

Each system is powered by an engine driven pump and a demand pump installed in parallel.

Engine Driven Pumps

Each system has an engine driven pump (EDP). The EDP is pressurized when the engine is running and the engine pump switch is ON.

Demand Pumps

The demand pumps supply normal system demands if an engine or EDP fails. Systems 1 and 4 have air driven demand pumps. The bleed air manifold provides pneumatic power for the air driven pumps. Systems 2 and 3 have electric motor driven demand pumps. In the AUTO position, the demand pumps operate during periods of high system demands, such as flaps in transit or gear retraction.

Auxiliary Pumps

Systems 1 and 4 have electric auxiliary pumps 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 pressure, 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 and replaced with the letters LO when a system low quantity exists. Hydraulic quantity levels fluctuate with variations in temperature as well as with the activation of systems using hydraulic power.

Each hydraulic system has a dedicated hydraulic interface module (HYDIM) to process temperature and pressure inputs as well as perform some pump control. Should a HYDIM fail, the following indications may occur on that hydraulic system:

- blank hydraulic pressure and temperature indications on the EICAS status and HYD synoptic pages
- HYD CONTROL X advisory messages

A single hydraulic quantity interface module (HYQUIM) processes quantity inputs from each reservoir transmitter. Should the HYQUIM fail the following false indications may occur 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

A hydraulic fluid shutoff valve is installed in the fluid supply line to each EDP. If an engine fire switch is pulled, the respective hydraulic fluid shutoff valve closes, the EDP depressurizes, and the respective demand pump operates.

Load Assignments

Systems 1, 2, and 3 power the respective center, right, and left autopilot servos.

Systems 2, 3, and 4 power spoilers.

Systems 1 and 4 power trailing edge flaps and landing gear; and provide redundant power to primary flight controls.

Systems 1 and 2 power alternate brakes.

System 1 powers steering.

System 4 powers normal brakes.

SYSTEM 1
SYSTEM 2
SYSTEM 3
SYSTEM 4
EDP
AUX
DEMAND
EDP
DEMAND
EDP
DEMAND
EDP
AUX
DEMAND
CENTER AUTOPILOT
RIGHT AUTOPILOT
LEFT AUTOPILOT
LEFT OUTBOARD AILERON
LEFT INBOARD AILERON
RIGHT INBOARD AILERON
RIGHT OUTBOARD AILERON
SPOILERS 2, 3, 10, 11
SPOILERS 1, 4, 9, 12
SPOILERS 5, 6, 7, 8
LOWER YAW DAMPER
UPPER YAW DAMPER
UPPER RUDDER
LOWER RUDDER
INBOARD TRAILING EDGE FLAP
OUTBOARD TRAILING EDGE FLAP
NOSE STEERING\ ACTUATION
BODY STEERING\ ACTUATION
WING GEAR ACTUATION
ALTERNATE BRAKES
NORMAL BRAKES
ELEVATOR FEEL
STAB TRIM
LEFT OUTBOARD ELEVATOR
LEFT INBOARD ELEVATOR
RIGHT INBOARD ELEVATOR
RIGHT OUTBOARD ELEVATOR

Hydraulic Systems 1 and 4 Diagram

Hydraulic Systems 2 and 3 Diagram

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EICAS Alert Messages

Message	Level	Aural	Message Logic
HYD CONTROL 1, 4	Advisory		Hydraulic control system is inoperative. Hydraulic system indications may be inoperative.
HYD OVHT SYS 1, 2, 3, 4	Advisory		Excessive hydraulic system temperature.
HYD PRESS DEM 1, 2, 3, 4	Advisory		Demand pump pressure low. Occurs when Demand Pump selector OFF, demand pump commanded to run and demand pump output pressure low, or systems 1 or 4 Demand Pump selectors are 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 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

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

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

1 BRAKE SOURCE Light

Illuminated (amber) – active brake hydraulic sources (hydraulic systems 4, 1, and 2) have low pressure.

2 BRAKE ACCUMULATOR PRESSURE Indicator

Indicates brake accumulator pressure.

Landing Gear System Indications

Landing Gear Position Indications

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) – respective landing gear down and locked.

Crosshatched (white) – respective landing gear in transit.

UP (white) – respective 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.

1 Brake Temperature

Indicates a relative value of wheel brake temperature:

- values range from 0 to 9
- white - normal range; 0 to 4
- amber - high range; 5 or higher

2 Gear Door Status

Crosshatched – door not closed.

CLOSED (white) – door closed.

Empty box(es) (white) – respective landing gear door position indicators inoperative.

3 Tire Pressure Indication

Displays individual tire pressures:

- white – normal range
- amber – abnormal high or low range

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; 0 to 4
- amber - high range; 5 or higher

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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, extension, and steering 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.

A brake temperature monitor system and tire pressure indication system displays each brake temperature and tire pressure 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.

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.

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 for the affected gear 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.

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.

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 and antiskid systems are 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 hydraulic system 4. Pressurizing hydraulic system 4 before pressurizing the other hydraulic 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

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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EICAS Alert Messages

Note: Configuration warning messages are covered in Chapter 15, Warning Systems.

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 have 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.
GEAR DISAGREE	Caution	Beeper	Gear position disagrees with Landing Gear lever position after normal transit time.

Message	Level	Aural	Message Logic
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.
>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.

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Intentionally
Blank

Engine Indication and Crew Alerting System (EICAS)

EICAS Messages

1 Warning Messages

Displayed (red) –

- highest priority alert messages
- red alert messages remain displayed and cannot be canceled by pushing the Cancel switch.

2 Caution Messages

Displayed (amber) –

- next highest priority alert messages after warning messages
- amber alert messages can be canceled by pushing the Cancel switch or recalled by pushing the Recall switch

3 Advisory Messages

Displayed (amber) –

- lowest priority alert messages; indented one space
- amber alert messages can be canceled by pushing the Cancel switch or recalled by pushing the Recall switch

4 Memo Messages

Displayed (white) –

- reminder of selected state of controls or systems
- cannot be canceled by pushing the Cancel 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 Recall switch pushed
- remains displayed for one second after switch released

8 Secondary Engine Exceedance Cue

Displayed (cyan) –

- engine parameter on Secondary Engine display is exceeded
- displayed until parameter exceeded 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

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

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

G-BNLK - G-BNLT, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

- 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)

1 TCAS Flight Level (F/L) Switch

Push and hold – absolute altitude displayed in TCAS traffic symbol data tags on both NDs.

2 Transponder Mode Selector

Traffic Advisory (TA) TCAS –

- transponder and TCAS TA modes enabled
- all aircraft that would have been predicted as a RA are predicted as a TA

Resolution Advisory/Traffic Advisory (RA/TA) TCAS – transponder and TCAS RA and TA modes enabled.

3 TCAS Airspace Selector

Above (ABV) – displays altitude reporting traffic from 2,700 feet below to 7,000 feet above current altitude.

Normal (N) – displays altitude reporting traffic from 2,700 feet below to 2,700 feet above current altitude.

Below (BLW) – displays altitude reporting traffic 7,000 feet below to 2,700 feet above current altitude.

TCAS Controls (EFIS Control Panel)

1 ND Traffic (TFC) Switch (inner)

Push – in VOR, APP, MAP, and MAP CTR modes:

- TCAS traffic displayed on ND
- range information displayed when in the expanded APP or VOR modes
- with TCAS FAIL displayed on ND, cancels TCAS FAIL message

TCAS Traffic Displays

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
- number is below the traffic symbol when traffic is below the airplane altitude and above the traffic symbol when traffic is above the airplane altitude
- 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

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)

To ensure vertical separation, vertical speed must be outside the red RA vertical speed region to avoid traffic.

3 Vertical Speed Pointer

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

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 (GEAR) Override (OVRD) Switch

Push (OVRD illuminated) –

- inhibits TOO LOW GEAR alert
- inhibits the aural alert that accompanies the EICAS warning message CONFIG GEAR, if displayed because the landing gear not down and locked, any thrust lever at idle, and radio altitude less than 800 feet
- 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

6 Ground Proximity (GND PROX) Terrain (TERR) Override (OVRD) Switch

Push (OVRD illuminated) – inhibits look-ahead terrain alerts and terrain display.

GPWS Radio Altimeter Selector

G-BNLK - G-BNLY, G-CIVA, G-CIVE - G-CIVG

1 Ground Proximity Warning System Radio Altimeter (GPWS RA) Selector

L – selects left radio altimeter as source for GPWS.

R – selects right radio altimeter as source for GPWS.

GPWS Look-Ahead Terrain Alerting Controls, Display, and Annunciations

See BA Intranet guide for details of EGPWS usage and functionality.

Control Panel ND Controls

1 TERR Switch

Push -

- terrain data is displayed in MAP, MAP CTR, VOR, and APP modes
- weather radar data is not displayed

Terrain Display

1 TERRAIN Annunciation

TERRAIN (amber) – look–ahead terrain caution alert is occurring.

TERRAIN (red) – look–ahead terrain warning alert is occurring.

Displayed in all ND display modes.

2 Terrain Display

Color and density vary based on terrain height and airplane altitude:

- dotted green: terrain from 2,000 feet below to 500 feet (250 feet with gear down) below airplane altitude
- dotted amber: terrain 500 feet (250 feet with gear down) below to 2,000 feet above airplane altitude
- dotted red: terrain more than 2,000 feet above airplane altitude
- dotted magenta: no terrain data available
- solid amber: look–ahead terrain caution alert is occurring
- solid red: look–ahead terrain warning alert is occurring

Note: In areas without terrain data, look–ahead terrain alerting and display functions not available. GPWS immediate alerts function normally.

Note: Terrain more than 2,000 feet below airplane altitude or within 400 feet of the nearest airport runway elevation is not displayed.

Displayed automatically when:

- a look–ahead 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.

3 Terrain Mode Annunciation

TERR (cyan) – terrain display enabled.

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 because GPS has failed. During time between GPS 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

EGPWS (Terrain Peaks)

Normal Operation

When RDR mode is selected, normal weather radar function is available.

When TERR mode is selected, the display will paint relative to the altitude of the aircraft. The range of the terrain display can be selected via the range control on the Weather Radar Control Panel on the Aisle Stand.

Note: If the system detects that there is an area of 'no available terrain data' within the selected range of the display, the 'no data' area will be indicated by a pattern of magenta coloured dots.

Displays

The display is colour and intensity coded (by varying densities of dot patterns) to provide visual indication of the relative vertical distance between the aircraft and the terrain. The colour bands are shown in Figures 1 and 2. The relative elevation of the transition between the yellow bands and the green bands is either -250 or -500 feet below the aircraft (depending on gear status).

When 'Terrain Peaks' is activated the display colour band definitions for the green bands are altered so that terrain is continuously displayed below the aircraft instead of fading to black when more than 2000 feet above any terrain in the display area. This does not affect the altitude definitions of the red and amber bands relative to aircraft altitude. Figures 3 and 4 show the colour band displays at high and low altitudes. The terrain display provides two altitude figures in 100's of feet relative to mean sea level. Figure 3 represents the altitude of the highest peak in the display range. The lower altitude figure represents the lowest altitude of terrain that is still coloured and has not dropped into the black colour band. Water is displayed in cyan.

Relative Altitude (Feet)	Colour	Shading Intensity
+2000 and above	HEAVY RED	50%
+1000 to + 2000	HEAVY YELLOW	50%
-250 or -500 to +1000	MEDIUM YELLOW	25%
-1000 to -250 or -500	MEDIUM GREEN	25%
-2000 to -1000	LIGHT GREEN	12.5%

Figure 1 Terrain Display Colour Bands

EGPWS (TERRAIN PEAKS)

Figure 2 Terrain Display Colour Bands

EGPWS (TERRAIN PEAKS)

Figure 3 Peaks Display Colour Bands at High Altitude

Reference Altitude is projected down from actual aircraft altitude to provide a 30 second advance display of terrain when decending more than 1000 FPM.

Terrain is not shown if it is below the lowest band and/or is within 400 feet of the runway elevation nearest the aircraft. Sea level water is displayed if supported by the display.

EGPWS (TERRAIN PEAKS)

Figure 4 Peaks Display Colour Bands at Low Altitude

Terrain Alerts

If the EGPWS detects a potential conflict between the projected flight path of the aircraft and the terrain, two levels of alerts are provided:

CAUTION: Approximately 40 +/- 20* seconds before predicted impact.

WARNING: Approximately 20 +/- 10* seconds before predicted impact.

* These values are progressively reduced when the aircraft is nearer than 8 miles to a major airport.

With the TERR mode selected, for a ‘Caution’ alert, the threatening terrain is displayed as a solid yellow area (as opposed to the dot matrix display for normal indication). For a ‘warning’ alert, the threatening terrain is displayed as a solid red area.

Predictive Windshear (PWS) Display and Annunciations

1 PWS Symbol

Displayed (red and black) –

- PWS alert is occurring
- displays windshear location and approximate geometric size (width and depth)

Symbol, radials, and weather radar returns displayed automatically when:

- PWS alert occurs, and
- WXR is not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

When terrain display is selected and PWS alert occurs, weather radar display replaces terrain display.

2 PWS Radials

Displayed (amber) –

- PWS alert is occurring
- Extend from PWS symbol to help locate windshear event

3 WINDSHEAR Annunciation

WINDSHEAR (amber) – PWS caution 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.

Intentionally
Blank

Introduction

Warning systems consist of:

- engine indication and crew alerting system (EICAS)
- aurals, Master Warning/Caution lights and switches, and Ground Proximity light
- airspeed alerts
- takeoff and landing configuration warning system
- MCP selected altitude alerts

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

- 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 Cancel switch. Amber EICAS alert messages can be canceled by pushing the Cancel switch and recalled by pushing the Recall 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 Cancel 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 DDG or airline equivalent and provide a cross reference to the 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 Cancel 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 Cancel switch displays the next page of EICAS caution and advisory messages. EICAS warning messages are displayed at the top of each page.

Pushing the Cancel 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 Recall 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 Recall 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 Status Display 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 Status Display switch controls the display of single and multiple pages of status messages in a manner similar to the way the Cancel and Recall switches control the display of EICAS alert messages.

Aurals, Master Warning/Caution Switches and Lights, and Ground Proximity Light

Aurals, two Master Warning/Caution lights, and the Ground Proximity light call attention to the following alerts:

- in the following table, parenthesis () describe crew action to silence the aural alert or extinguish the light while the alert is occurring.

Aural	Light	Calls Attention To:
Bell (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG FIRE WHEEL WELL
Wailer	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message AUTO PILOT
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

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

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

G-BNLY, G-CIVA - G-CIVE

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

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	Ground Proximity (GND PROX) light	GPWS immediate alert.
Voice annunciation TRAFFIC, TRAFFIC	None	Amber TRAFFIC message and TCAS TA traffic display on ND

Aural	Light	Calls Attention To:
Voice annunciation: 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 MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED ADJUST VERTICAL SPEED, ADJUST **or** LEVEL OFF, LEVEL OFF MAINTAIN VERTICAL SPEED, MAINTAIN MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	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.

Aural	Light	Calls Attention To:
Voice annunciation TERRAIN, TERRAIN, PULL UP	Master Warning lights (Extinguish by pushing Master Warning/Caution switch.)	Red PULL UP on both PFDs Red TERRAIN message and terrain display on ND
Voice annunciation CAUTION TERRAIN	Ground Proximity GND PROX) light	Amber TERRAIN message and terrain display on ND
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
Siren, followed by voice annunciation WINDSHEAR, WINDSHEAR, WINDSHEAR	Master Warning lights (Extinguish by pushing Master Warning/Caution switch)	Red WINDSHEAR on both PFDs
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.
Voice annunciation: GLIDE SLOPE SINK RATE TERRAIN TOO LOW, FLAPS TOO LOW, GEAR TOO LOW, TERRAIN	Ground Proximity (GND PROX) light	GPWS immediate alert
Altitude voice annunciations	None	Altitude voice annunciations during approach

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used with EICAS messages to:

- help locate and identify affected systems and controls
- reduce potential for error

Airspeed Alerts

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns.

Airspeed Low

The EICAS caution message AIRSPEED LOW is displayed and the box around the current airspeed indication on the PFD is highlighted amber when airspeed is below minimum maneuvering speed.

Overspeed Warning

The EICAS warning message OVERSPEED is displayed if 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 until 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.

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

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

The FMC continuously monitors switch action on the MCP, EFIS control panel, display select panel, CDUs, and radio transmitter switches. When a predefined time elapses after the last switch action was detected the EICAS alert 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, or
- during climb, or
- when flaps are not up

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other 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 capability.

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

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.

If the traffic aircraft also has TCAS and a mode S transponder, TCAS vertical guidance is coordinated with the traffic aircraft TCAS.

TCAS ND Messages

ND Message	Color	Description
TFC	Cyan	TCAS traffic display enabled. Inhibited if following TCAS messages are displayed: TCAS FAIL, TCAS OFF, TCAS TEST
TRAFFIC	Amber	TA is occurring.
OFFSCALE	Amber	TA is occurring at range greater than current ND range. Replaced by red OFFSCALE when RA is also occurring at range greater than current ND range.
TRAFFIC	Red	RA is occurring.
OFFSCALE	Red	RA is occurring at range greater than current ND range.
TA ONLY	Cyan	TCAS can not provide RAs. All traffic that would have been RAs are predicted as TAs.
TCAS FAIL	Amber	TCAS failed, or TCAS information cannot be displayed on ND.

ND Message	Color	Description
TCAS OFF	Amber	TFC switch pushed to display traffic but TCAS not selected on transponder panel.
TCAS TEST	Cyan	TCAS in test mode. Message is displayed on all ND modes and ranges.

TCAS Voice Annunciations

Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED, 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.
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.	

Voice Annunciation	Condition	Response
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		
LEVEL OFF, LEVEL OFF		
MAINTAIN VERTICAL SPEED, MAINTAIN	Existing RA, TCAS requires continuation of current vertical rate 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, CROSSING MAINTAIN		
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude and vertical speed are within the red RA regions.	Decrease pitch attitude and vertical speed to remain outside the red RA regions.
CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	Existing RA, previous TCAS vertical guidance was to descend. Present pitch attitude and vertical speed are within the red RA regions.	Increase pitch attitude and vertical speed to remain outside the red RA regions.
CLEAR OF CONFLICT	TCAS PFD vertical guidance is no longer displayed and traffic changes to a TA symbol. Separation is increasing and the RA will not occur. However, the voice annunciation will not sound if TCAS can no longer predict the track of the RA aircraft.	Attempt to visually locate the traffic.

TCAS Normal Operation

The TCAS operating mode is controlled from the transponder panel. RA/TA TCAS is normally selected, however, it is sometimes necessary to select TA TCAS to prevent nuisance RAs.

TA TCAS is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, TA TCAS 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 left or right 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) and Predictive Windshear (PWS)

G-BYGA - G-BYGG, G-CIVX - G-CIVZ

Ground Proximity Warning System (GPWS)

G-BNLK - G-BNLY, G-CIVA - G-CIVW

Introduction

G-BYGA - G-BYGG, G-CIVX - G-CIVZ
GPWS and PWS provide:

G-BNLK - G-BNLY, G-CIVA - G-CIVW
GPWS provides:

- look-ahead terrain alerts for potentially hazardous flight conditions involving impact with the ground
- predictive windshear alerts
- immediate windshear alerts

- immediate alerts for potentially hazardous flight conditions involving impact with the obstacles and the ground
- altitude voice annunciations during approach

Look-ahead Terrain Alerting System

Look-ahead terrain alerts are provided by monitoring terrain proximity using a world-wide terrain data base. The data base contains detailed terrain data near major airports, and data in lesser detail for areas between airports. Terrain within 2,000 feet of airplane altitude is displayed on the navigation display. Terrain data is not designed to be an independent navigation aid.

Proximate terrain data may be displayed on the ND. If there is a potential terrain hazard, GPWS look-ahead alerts are provided based on estimated time to impact.

Estimated time to impact is based on airplane position, altitude, present track, vertical path, and ground speed. FMC VNAV and LNAV is not considered in the estimated time to impact.

Altitudes 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.

Note: Terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning alert does not guarantee terrain clearance.

When the GPWS Terrain switch is pushed on, the TERR symbol is displayed on the ND and terrain contours may be displayed.

When the airplane is higher than 2,000 feet above the terrain, terrain more than 2,000 feet below airplane altitude is not displayed.

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.

Note: The GPWS terrain database, GPWS look-ahead terrain alerts, and terrain display do not account for man-made obstructions.

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 Terrain Alerts

Voice Annunciation	PFD and ND Display and Light	Description
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 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.

Predictive Wind Shear Alerting System (PWS)

PWS provides windshear alerts when an excessive windshear condition is detected ahead of the airplane during takeoff, approach, and landing.

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.

Prior to takeoff, PWS alerts can be enabled by pushing the Weather Radar switch on the EFIS control panel. On the ground with the Weather Radar 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 Weather Radar 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 ALERT AREA
3 NM
CAUTION
WARNING
CAUTION
25°
25°
.5 NM
ON GROUND
3 NM
CAUTION
1.5 NM
WARNING
25°
25°
.5 NM
IN FLIGHT

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 1: Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

Note 2: 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 Alerting System

Immediate windshear alerts are provided when an excessive downdraft or tailwind is occurring during takeoff, approach, and landing.

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.

Immediate Alerting System

Voice Annunciation	PFD and ND Display and Light	Description
DON'T SINK	Ground Proximity light	Altitude loss with flaps and/or gear up after takeoff or go-around.
GLIDE SLOPE	Ground Proximity 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 Ground Proximity light	Follows SINK RATE alert when descent rate becomes severe, or follows TERRAIN alert with flaps and/or gear not in landing configuration when excessive terrain closing rate continues.
SINK RATE	Ground Proximity light	Excessive descent rate.
TERRAIN	Ground Proximity light	Excessive terrain closing rate.
TOO LOW, FLAPS	Ground Proximity light	Unsafe terrain clearance with flaps not in landing configuration at low altitude and airspeed. Pushing the Ground Proximity Flap Override switch to OVRD inhibits the alert.
TOO LOW, GEAR	Ground Proximity light	Unsafe terrain clearance with gear not in landing configuration at low altitude and airspeed with gear not down. Pushing the Ground Proximity Flap Override switch to OVRD inhibits the alert.

Voice Annunciation	PFD and ND Display and Light	Description
TOO LOW, TERRAIN	Ground Proximity 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 Ground Proximity Flap Override switch to OVRD inhibits the alert, when the alert is because flaps are not in landing position. Pushing the Ground Proximity Gear Override switch to OVRD inhibits the alert, when the alert is because gear is not down.

Altitude Voice Annunciations During Approach

Altitude voice annunciations during approach are based on a combination of radio altitude, barometric altitude, IRS, airspeed, glide slope deviation, and airplane configuration.

Altitude voice annunciations during approach sound at:

- 100 feet – ONE HUNDRED
- 50 feet – FIFTY
- 30 feet – THIRTY

GPWS Non-Normal Operation

Altitude Voice Annunciations During Approach Non-Normal Operation

If there is a fault in the Altitude Voice Annunciations During Approach system, the EICAS advisory message ALT CALLOUTS is displayed and Altitude Voice Annunciations During Approach are inhibited.

Look-Ahead Alert Non-Normal Operation

If there is a fault in look-ahead terrain alert, the respective terrain status annunciation TERR is displayed.

Windshear Alert Non-Normal Operation

If there is a fault in the immediate windshear system or in the PWS system, the EICAS advisory message WINDSHEAR SYS is displayed and the voice alert WINDSHEAR and the PFD alert WINDSHEAR are inhibited.

Immediate Alert Non-Normal Operation

If there is a fault in any immediate alert, the respective alert is inhibited. If a fault occurs in any immediate alert other than windshear, there is no indication to the flight crew of which alerts are inhibited. GPWS will continue to provide immediate alerts 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.

GPWS immediate windshear alert inhibits all PWS, TCAS, and other GPWS alerts.

When RA/TA TCAS is selected on the transponder panel and a GPWS or PWS warning alert occurs, TCAS 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 RA/TA TCAS 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 are prioritized to aid flight crew decision making when more than one alert could occur:

- Voice annunciations for warning alerts inhibit new voice annunciations for caution alerts.
- Immediate windshear voice annunciations inhibit GPWS and look-ahead terrain voice annunciations, GPWS voice annunciations during approach, and TCAS voice annunciations.
- Voice annunciations for GPWS warning inhibit new look-ahead terrain voice annunciations, and GPWS voice annunciations during approach.
- TCAS voice annunciations and GPWS voice annunciations during approach may sound concurrently.

ND Display Alert Inhibits and Automatic Display

Alert displays on the NDs are prioritized to aid flight crew decision making when more than one alert occurs. The displays are also prioritized when neither ND is in MAP, MAP CTR, VOR, or APP mode.

Immediate windshear alert inhibits the automatic display of new TCAS, look-ahead terrain, or PWS alerts.

TCAS traffic can be displayed concurrently with either TERR and WXR display.

New TCAS alerts:

- When TFC is displayed on the right 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 right ND while TCAS traffic display and TFC are inhibited on the left ND. When the left TFC switch is subsequently pushed, TCAS traffic and TFC are selected automatically on the left ND.
- When TFC is displayed on the left 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 left ND while TCAS traffic display and TFC are inhibited on the rightND. When the right TFC switch is subsequently pushed, TCAS traffic and TFC are selected automatically on the right 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.

New look-ahead terrain alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, TERR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new look-ahead terrain alert occurs, both NDs are armed for TERR display and TERR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. TERR is disarmed for either ND by selecting WXR prior to selecting MAP, MAP CTR, VOR, or APP mode on the respective ND.

New PWS alerts:

- When both NDs are in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for both NDs.
- When only one ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, WXR is selected automatically for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.
- When neither ND is in MAP, MAP CTR, VOR, or APP mode and a new PWS alert occurs, both NDs are armed for WXR display and WXR will be selected automatically when MAP, MAP CTR, VOR, or APP mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP, MAP CTR, VOR, or APP mode.

Alerts Inhibited Before Engine Start and After Shutdown

Alert Inhibited	For Message	Inhibit Occurs
Master CAUTION lights Beeper	For all EICAS caution messages	On the ground, and all Fuel Control switches in 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

Alert Inhibited	Inhibit Begins	Inhibit Ends
All new EICAS caution and advisory messages, except: BLEED ENG AUTOSTART ENG FUEL VALVE ENG SHUTDOWN ENG START VLV STARTER CUTOUT	Engine START switch pulled.	Engine reaches idle RPM, or start is aborted, or five minutes elapse.

Alerts Inhibited During Takeoff

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
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
EICAS advisory message FUEL TANK/ENG	Message is inhibited	Any engine in takeoff thrust range	Lift-off
Hi Chime	Attendant call		400 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
New PWS caution alerts EICAS advisory message WINDSHEAR SYS	Messages are inhibited	80 knots airspeed	400 feet radio altitude
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		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 warning alerts	Messages are inhibited	100 knots airspeed	50 feet radio altitude

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

Alerts Inhibited During Landing

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
All PWS alerts	Alerts are inhibited	2,300 feet radio altitude	1,200 feet radio altitude
TCAS INCREASE DESCENT RAs		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 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
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
New PWS warning alerts	Alerts are inhibited	50 feet radio altitude	100 knots airspeed

EICAS Event Record

Pushing the EICAS EVENT RCD switch records currently displayed engine indications and additional EICAS maintenance information. Up to five events may be recorded by the first five pushes. The system also records out of limit parameters and related conditions when a system parameter is exceeded.

EICAS Alert Messages

Message	Level	Aural	Message Logic
>AIRSPEED LOW	Caution	Beeper	Airspeed less than minimum maneuvering speed.
>ALT CALLOUTS	Advisory		Altitude voice annunciations during approach no longer provided.
>ALTITUDE ALERT	Caution	Beeper	Airplane has deviated more than 300 feet from MCP selected altitude.
>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 steering unlocked 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.
>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.
>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.

Message	Level	Aural	Message Logic
>CONFIG WARN SY	Advisory		Fault detected in configuration warning system.
GND PROX SYS	Advisory		GPWS alerts may not be provided.
>OVERSPEED	Warning	Siren	Airspeed exceeds Vmo/Mmo.

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

>PILOT RESPONSE	Warning	Siren	FMC does not detect crew activity in monitored area within a predefined time.

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

>PILOT RESPONSE	Caution	Beeper	FMC does not detect crew activity in monitored area within a predefined time.

G-BNLK - G-BNLP, G-BYGA - G-BYGG, G-CIVF - G-CIVZ

>PILOT RESPONSE	Advisory		FMC does not detect crew activity in monitored area within a predefined time.

>TCAS OFF	Advisory		TCAS mode TA or RA/TA not selected.
>TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on respective PFD.
>TCAS SYSTEM	Advisory		TCAS has failed.
>TERR OVRD	Advisory		Ground Proximity Override switch in OVRD. Look-ahead terrain alerts will not be provided.
TERR POS	Advisory		Terrain position data has been lost. Look-ahead terrain alerting and display unavailable because GPS has failed. During time between GPS failure and display of TERR POS message, IRS provides position for look-ahead alerting and display.
WINDSHEAR SYS	Advisory		Windshear alerts may not be provided.

EICAS Memo Messages

Message	Level	Aural	Message Logic
VMO GEAR DOWN	Memo		Gear down dispatch has been selected in the electronics bay.
VMO SPARE DOWN	Memo		Spare engine dispatch has been selected in the electronics bay.

Intentionally
Blank